FINAL

LOWER COLUMBIA RIVER CONSERVATION AND RECOVERY PLAN FOR OREGON POPULATIONS OF SALMON AND STEELHEAD

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Acronym and Abbreviation List

α	Alpha parameter
A	Abundance
A/P	Abundance/productivity
ACWA	Oregon Association of Clean Water Agencies
AG	Adult goal
AHSWG	Ad Hoc Supplementation Monitoring and Evaluation Workgroup
AICs	Akaike information criterion
AMS	Average marine survival
AOI	Associated Oregon Industries
B	Beta parameter
BC	Big Creek population
BiOp	Biological opinion
BLM	Bureau of Land Management
BMPs	Best management practices
BOR	Bureau of Reclamation
BPA	Bonneville Power Administration
CAPM	Conservation Assessment and Planning Model
CATAS	Conservation Assessment Tool for Anadromous Salmonids
C&S	Ceremonial and Subsistence
cc	climate change
CCF	Clatsop County Fisheries
CCFB	Columbia County Farm Bureau
CEDC	Clatsop Economic Development Council
cfs	Cubic feet per second
CHART	Critical Habitat Assessment Review Team
ChF	Fall Chinook
ChS	Spring Chinook
CLRSI	Crater Lake/Rainier Snow Index
CM	Clackamas population
COC	Cogan Owens Cogan, LLC
CR	Columbia River
CRE	Columbia River Estuary
CRF	Mean Columbia River Flow
CRFMP	Columbia River Fish Management Plan
CRIC	Columbia River Index for coho
CRITFC	Columbia River Inter-tribal Fish Commission
CRS	Chum Recovery Strategy
CRT	**C**ritical risk threshold
CSMEP	Collaborative Systemwide Monitoring and Evaluation Project
CT	Clatskanie population
CWA	Clean Water Act
CWT	**C**oded-wire tag
D	Diversity
DDT	Dichlorodiphenyltrichloroethane
DIDSON	Dual-Frequency Identification Sonar
DPS	Distinct Population Segment
EDT	Ecosystem Diagnosis and Treatment
EHM	Mortality associated with estuary habitat conditions

EIS	Environmental impact statement
EM	Estuary Module
EMAP	Environmental monitoring and assessment protocol
EPA	Environmental Protection Agency
EPM	Mortality associated with predation in the estuary
ER	Exploitation rate
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
ESUs	All salmon ESUs and the steelhead DPS
FCRPS	Federal Columbia River Power System
FEIS	Final environmental impact statement
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FHM	Mortality associated with fish harvest
FMEP	Fisheries Management and Evaluation Plan
FR	Federal Register
FRAM	Fishery Regulation Assessment Model
γ	Gamma parameter
GRTS	Generalized Randomized-Tessellation Stratified technique
GNRO	Oregon Governor's Natural Resources Office
H	High extinction risk
HCP	Habitat Conservation Plan
HD	Hood River population
HHFM	Mortality associated with the hatchery fish
HGMP	Hatchery Genetic Management Plan
HIP	High Intrinsic Potential
HPM	Mortality associated with hydropower
HRBAHRS	Hood River Basin Aquatic Habitat Restoration Strategy
HRWAP	Hood River Watershed Action Plan
HSRG	Hatchery Scientific Review Group
IC	Implementation Coordinator
ICTRT	Interior Columbia Technical Recovery Team
IEAB	Independent Economic Analysis Board
IMST	Independent Multidisciplinary Science Team
IP	Intrinsic Potential
IPM	Integrated Pest Management
ISAB	Independent Scientific Advisory Board
ISRP	Independent Scientific Review Panel
L	Low extinction risk
LCFRB	Lower Columbia Fish Recovery Board
LCR	Lower Columbia River
LCREP	Lower Columbia River Estuary Partnership
LF/T	Limiting factor/threat
LG	Lower Gorge population
LWD	Large wood debris
MAT	Minimum abundance threshold
Metro	Portland area metropolitan service district
MHQ	Number of miles of high quality habitat to produce a target number of adults
MOP	Minimum operating pool
MPG	Major population group
M	Moderate extinction risk

MSD	mean square deviation
MU	Management Unit
Mxd	Mixed populations
N/A	Not applicable
n/c	Not calculated
NEPA	National Environmental Policy Act
NFH	National Fish Hatchery
NFCP	Native Fish Conservation Policy
NGAA	Northwest Guides and Anglers Association
NGO	Non-government agency
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration-Fisheries
NPCC	Northwest Power and Conservation Council
NRCS	Natural Resources Conservation Service
NSIA	Northwest Sportfishing Industry Association
nSPDO	Negative Spring Pacific Decadal Oscillation index
NWPPA	Northwest Pulp and Paper Association
OAR	Oregon State Administrative Rule
OBA	Oregon Business Association
ODA	Oregon Department of Agriculture
ODEQ	Oregon Department of Environmental Quality
ODF	Oregon Department of Forestry
ODFW	Oregon Department of Fish and Wildlife
ODLCD	Oregon Department of Land Conservation and Development
ODOGAMI	Oregon Department of Geology and Mineral Industries
ODOT	Oregon Department of Transportation
ODSL	Oregon Department of State Lands
OFWC	Oregon Fish and Wildlife Commission
OGNRO	Oregon Governor's Natural Resource Office
OPI	Oregon Production Index
OPRD	Oregon Parks and Recreation Department
OPSW	Oregon Plan for Salmon and Watersheds
OSWA	Oregon Small Woodlands Association
OSU	Oregon State University
OWEB	Oregon Watershed Enhancement Board
OWRD	Oregon Water Resources Department
P	Productivity
PACFISH	Pacific Anadromous Fish Strategy
PAH	Polycyclic aromatic hydrocarbons
PBDE	**P**olybrominated diphenyl ethers
PCB	Polychlorinated biphenyls
PCEs	Primary constituent elements
PCR	Polymerase chain reaction
PCSRF	Pacific Coastal Salmon Recovery Fund
PDO	Pacific Decal Oscillation
PFMC	Pacific Fishery Management Council
pg	population growth
PGE	Portland General Electric
PIT	Passive integrated transponders
PNAMP	Pacific Northwest Aquatic Monitoring Partnership
PNI	Pacific Northwest Index

PST	Pacific Salmon Treaty
PVA	Population Viability Assessment
Rkm	river kilometer
RM	River-mile
RME	Research, Monitoring and Evaluation
RPA	Reasonable and Prudent Alternative
SAB	Select Area Bright fall Chinook
SAFE	Select Area Fisheries Enhancement
SC	Scappoose population
SFA	Salmon For All
SHQ	Number of smolts produced from high quality habitat
SLAM	Species Life-cycle Analysis Modules
SMU	Species Management Units
SNPs	Single nucleotide polymorphisms
SPQ	Number of smolts produced from low quality habitat
SS	Spatial Structure
SS/D	Spatial structure/diversity
SSB	Substitute Senate Bill
SRBAHRS	Sandy River Basin Aquatic Habitat Restoration Strategy
SRBP	Sandy River Basin Partners
STEP	Salmon and Trout Enhancement Programs
StW	Winter Steelhead
StS	Summer Steelhead
SURPH	Survival under proportional hazards
SVB	Sides, vertices, and boundaries
SWCD	Soil and water conservation district
SWW	Selective water withdrawal
SY	Sandy population
TBD	to be determined
TCM	total cumulative mortality
TDG	Total dissolved gas
TEM	Total estuary mortality
THM	Mortality associated with tributary habitat conditions
TMDL	Total maximum daily loads
TRT	Technical Recovery Team
UG	Upper Gorge population
URB	Upriver Bright fall Chinook
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFS	U.S.D.A. Forest Service
USFWS	U.S. Fish and Wildlife Service
UWR	Upper Willamette River
VH	Very high extinction risk
VL	Very low extinction risk
VSP	Viable salmonid population
WC	watershed council
WDFW	Washington Department of Fish and Wildlife
WLC-TRT	Willamette/Lower Columbia Technical Recovery Team
WOE	Weight of Evidence

1: Introduction

1.1 Scope of Recovery Plan

This conservation and recovery plan (Plan) serves as both a recovery plan under the federal Endangered Species Act (ESA) and a State of Oregon conservation plan under Oregon's Native Fish Conservation Policy (NFCP). The Plan provides a framework and roadmap for the conservation and recovery of three lower Columbia River salmon (*Oncorhynchus* species) Evolutionarily Significant Units (ESUs) and one steelhead Distinct Population Segment (DPS; henceforth, the ESUs and DPS will be collectively referred to as ESUs) in Oregon that are listed under the ESA: Lower Columbia River coho (*O. kisutch*), Lower Columbia River Chinook (*O. tshawytscha*), Lower Columbia River steelhead (*O. mykiss*), and Columbia River chum (*O. keta*). These species occupy habitat in Oregon tributaries of the lower Columbia River below, and including, the Hood River at river kilometer (rkm) 270 (Figure 1-1). They are also present in Washington tributaries to the lower Columbia River. The Plan also considers the unlisted steelhead populations in Oregon downstream of the Willamette River and the Clackamas spring Chinook population, which is also ESA-listed as threatened as part of the Upper Willamette River Chinook ESU.

The Plan contains the following major elements:

- A description of the context and process of plan development (Chapter 1).
- Background information on the environmental characteristics and biological structure of the lower Columbia River area (Chapter 2).
- Oregon's recommended criteria to achieve ESA delisting and further "broad sense" recovery, along with a description of the analyses and chapter relations in this Plan (Chapter 3).
- An evaluation of the gaps between current status and different extinction risk levels for individual populations, as determined through a population viability model (Chapter 4).
- A description of the life cycle and location-specific limiting factors and threats currently impacting each population (Chapter 5).
- Details about the desired extinction risk status of strata and populations and their threat scenarios chosen to meet delisting and broad sense recovery criteria (Chapters 6 and 10).
- A list of recovery strategies and management actions necessary to address limiting factors and threats and close gaps between the current and desired status of populations, or maintain current population status into the future (Chapter 7).
- A description of the research, monitoring, and evaluation, and associated measurable criteria, necessary to assess populations, make delisting decisions, understand uncertainties, and allow adaptive management in the future (Chapter 8).
- An adaptive management framework describing requirements for implementation, effectiveness evaluations, strategy and action modification, and reporting (Chapter 9).

Federal listing status, date and documentation for the four species are provided in Table 1-1. The listings reflect concerns regarding low abundance of naturally self-sustaining populations in the ESUs; the widespread presence of hatchery fish in naturally spawning populations; the relatively high harvest rates on the populations; and the degradation and loss of historical spawning and rearing habitats in the area.

Table 1-1. Listing status, dates, and references for ESA-listed salmon and steelhead in the lower Columbia River.

Listed Species (ESU)	Listed Status	Final (Original) Listing	FR Citation
Lower Columbia River Coho	Threatened	6/28/2005	70 FR 37160
Lower Columbia River Chinook (spring, fall, late fall runs)	Threatened	6/28/2005 (3/24/1999)	70 FR 37160
Lower Columbia River Steelhead (winter and summer runs)	Threatened	1/5/2006 (3/19/1998)	71 FR 834
Columbia River Chum (summer and fall runs)	Threatened	6/28/2005 (3/25/1999)	70 FR 37160

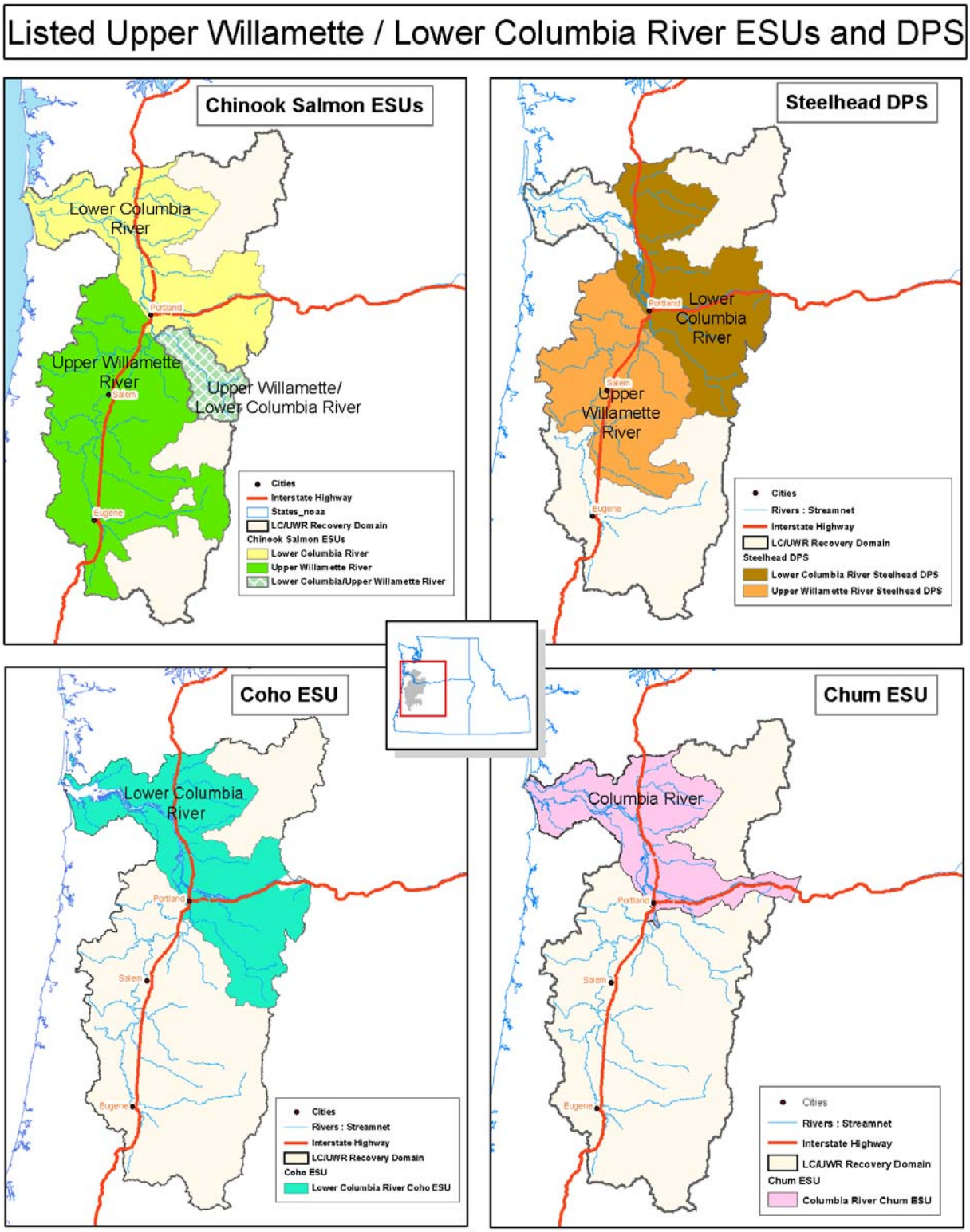


Figure 1-1. The Columbia River salmon ESUs and steelhead DPS addressed in this Plan.

1.2 Species Recovery under ESA

The primary mandate guiding recovery plan development at the federal level is the ESA. Section 4(f) of the ESA requires NMFS to develop and implement recovery plans for species listed as endangered or threatened under the Act. Although the plans are guidance rather than regulatory documents, the authors of the ESA clearly saw recovery plans as a central guiding vehicle for the recovery of listed species.

Recovery plans describe a process to remove the threats to the long-term survival of a species, reverse species decline, and restore the listed species and its ecosystem to a point where the species' future is safeguarded and the protections of the ESA are no longer necessary. These plans must, at a minimum, contain (1) a description of site-specific management actions 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 that the species be removed from the list; and (3) estimates of the time required and cost to carry out the measures needed to achieve the plan's goal and to achieve intermediate steps toward that goal. Delisting, or recovery, criteria must include not only biological criteria but also criteria that address the threats to a species (i.e., the listing factors in ESA section 4[a][1])[1]. ESA section 4(a)(1) lists factors for re-classification or delisting that are to be addressed in recovery plans:

1. The present or threatened destruction, modification, or curtailment of its habitat or range
2. Over-utilization for commercial, recreational, scientific, or educational purposes
3. Disease or predation
4. Inadequacy of existing regulatory mechanisms
5. Other natural or human-made factors affecting its continued existence

NMFS has detailed the impacts of various factors contributing to the decline of Pacific salmon and steelhead in their listing notices (69 FR 33102, 70 FR 37160, 71 FR 834). The Federal Register notices concluded that all of the five factors identified in section 4(a)(1) of the ESA have played a role in the decline of West Coast salmon and steelhead.

NMFS is the agency responsible for recovery planning for salmon and steelhead, and also for decisions to list and delist marine species, including anadromous fish, as endangered or threatened. Nevertheless, NMFS recognizes that local support of recovery plans is essential to their successful implementation. The agency is committed to involving local citizens and groups—those whose activities directly affect the listed species, and whose activities are most affected by recovery requirements—in development of the plans. The State of Oregon has taken the lead, in collaboration with NMFS and many other agencies, in developing the recovery plan for Oregon lower Columbia River species. This plan represents the participation and leadership of local stakeholders. Oregon's intent is for this Plan to fulfill ESA recovery planning requirements for Oregon populations of Lower Columbia River coho, Chinook, and steelhead and Columbia River chum.

A recovery plan serves as a road map for species recovery. It 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 estimated timeframe and costs for the overall effort. The final recovery plan will be considered a "living document." As new information becomes available, revised and additional actions can be added to the plan.

[1] NMFS is the agency responsible for adopting recovery plans for salmon and steelhead and for decisions to list and delist these species under the ESA. Once a species is deemed recovered and therefore removed from a "listed status," section 4(g) of the ESA requires monitoring the species for a period of not less than five years to ensure that it does not decline to a state that requires the need to again list it as either threatened or endangered under the ESA.

Once a species is deemed recovered, and therefore removed from a 'listed status,' section 4(g) of the ESA requires the monitoring of the species for a period of not less than five years to ensure that it retains its recovered status and does not decline to such a state that requires the need to again list it as either a threatened or endangered species under the ESA.

1.3 State of Oregon Recovery Planning

The State of Oregon considers this Plan its conservation plan for the Oregon portions of the Lower Columbia River coho and Chinook ESUs, and steelhead DPS, and Columbia River chum ESU. The Plan supports the State of Oregon's Plan for Salmon and Watersheds (Oregon Plan) and the Oregon Conservation Strategy. The Oregon Plan seeks to restore salmon runs, improve water quality, and achieve healthy watersheds and strong communities throughout the state. It is a comprehensive partnership between government, communities, private landowners, industry and citizens funded by the Oregon Legislature.

The Oregon Plan's mission is:

> *To restore the watersheds of Oregon and to recover the fish and wildlife populations of those watersheds to productive and sustainable levels in a manner that provides substantial environmental, cultural and economic benefits.*

The Plan is designed to meet the requirements of Oregon's Native Fish Conservation Policy (OAR 635-007-0502 to 0509). The NFCP, adopted by the Oregon Fish and Wildlife Commission in November 2002 and revised in September 2003, provides policy guidance to support implementation of the Oregon Plan. The NFCP is Oregon's policy for managing native fish and determining restoration priorities that improve the effectiveness of conservation efforts under the Oregon Plan. The NFCP focuses on the conservation of naturally produced fish because they are the basis for federal ESA listings and are the foundation for productive fisheries programs. As outlined in the NFCP, a recovery plan developed by ODFW should meet the requirements of conservation plans that are specified in the policy, as well as detail how Oregon proposes to recover each listed species covered in the Plan.

The NFCP uses conservation plans as a means to identify and implement strategies and actions to restore and maintain native fish in Oregon. The conservation plans describe State of Oregon goals for conserving the sustainability of species and restoring biological attributes necessary to achieve desired statuses that will provide significant ecological, economic and cultural benefits for all Oregonians. Conservation plans are developed through a sequential process, nearly identical to the one used for this recovery planning effort:

1. Determine the management unit
2. Determine its current status
3. Define a desired status (viability and broad sense goals)
4. Determine any gap between the current status and desired status and the factors causing the gap (limiting factors)
5. Identify strategies and actions that address the limiting factors
6. Monitor and evaluate the status and actions implemented and use adaptive management to make adjustments.

As a conservation plan under the NFCP, the Plan for Oregon lower Columbia River salmon and steelhead populations goes beyond achieving ESA recovery requirements. Its desired status includes achievement of 'broad sense goals', including meeting social and cultural benefits. This approach to species recovery includes development of goals for harvestable population levels viewed essential by all the parties

involved. Although some of the goals may be 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 Oregon and throughout the Pacific Northwest. Consistent with the Oregon Plan and NFCP — as well as the ESA — this Plan provides structure and guidance to efforts to protect and restore Oregon lower Columbia River salmon and steelhead and their habitats, while providing flexibility for actions to be determined by appropriate parties. It is designed to support and build on the existing conservation network across Oregon's portion of the ESUs and DPS. This partnership of regulatory and non-regulatory entities, private landowners, and others represents an effective means for achieving viability targets and broader recovery goals.

1.4 Tribal Treaty/Trust Obligations

In the 19th century, the United States signed approximately 20 treaties with Northwest Indian tribes that had an historical affiliation with the Columbia Basin and its natural resources (Kappler 1904). In 1979 USA courts upheld legally enforceable treaty rights reserving to Northwest tribes a share of the salmon harvest and establishing their position as "co-managers" with state and federal agencies in regulating salmon harvest (Blumm 2002). These rights and expectations may not necessarily be fully met by achieving the basic purposes of the ESA and delisting of the species, although it will lead to major improvements in the current situation.

Current treaty tribal harvests on lower Columbia River salmon and steelhead only capture fish from within the lower Columbia River ESUs that occur above Bonneville Dam, at rkm 234. These fisheries may be implemented in the pool of Bonneville Dam, which is the lower reach of the treaty tribal "Zone 6" fishery that is conducted by tribal fishers from the Yakama, Warm Springs, Umatilla and Nez Perce tribes (WDFW and ODFW 2002). Tribal fisheries also occur in some tributaries of Bonneville Pool. In Oregon, tributary tribal fisheries within the boundaries of these ESUs occur in Hood River and are conducted by members of the Warm Springs tribes.

Native Americans throughout the Pacific Northwest maintain strong spiritual and cultural connections to steelhead and salmon species. These fish have long had important tribal spiritual subsistence, ceremonial and commercial value. 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. Dept 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 ESA recovery and 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 ESUs are no longer likely to require the protection of the Act. Therefore, NMFS will make no delisting decision until it is clear that the threats to the ESUs have been addressed and that the status and trends of both the fish and their habitats will be healthy and sustainable in the long term.

1.5 Plan Development

This recovery plan is one piece of a larger recovery planning effort for listed species across the Pacific Northwest, as well as in other parts of the lower Columbia River. It is also part of a broader planning

effort by the State of Oregon to conserve and rebuild Oregon's native salmon and steelhead runs. These overlapping processes are discussed in this section.

The Plan is the product of a collaborative process led by the Oregon Department of Fish and Wildlife, with extensive participation by the Oregon Governor's Natural Resources Office (GNRO), NMFS, and the Oregon Lower Columbia River Stakeholder Team. In addition to the cooperative efforts of those entities, the Plan has benefited from the involvement of a number of other state, federal, and local agencies.

The Plan was developed under the premise that local support of recovery plans is essential to successful implementation. As a result, consideration was given to Oregon's contemporary political, social, and infrastructure landscape which includes a broad range of federal, state, tribal, and local needs. The Plan was also developed with the understanding that implementation of recovery actions will depend on the statutory and management authorities of a wide range of state and federal agencies, and the willing participation of local governments, community-based conservation organizations, industries, and private landowners that influence salmon and steelhead survival throughout their life cycle.

The Plan provides an informed, strategic approach to recovery that considers the limiting factors and threats to Lower Columbia River coho, Chinook, and steelhead, and Columbia River chum throughout their entire life cycle. It is based on science, supported by stakeholders, and is built on existing efforts supplemented by new recovery actions as needed. It is intended to be a realistic roadmap to recovery that will evolve over time in response to new threats, societal values, and information obtained from research and monitoring.

1.5.1 NMFS's Regional Process

Currently, 17 ESUs and DPSs of Pacific salmon and steelhead in the Pacific Northwest are listed under the ESA. NMFS has designated five geographically based recovery domains for preparing recovery plans for the listed species (Figure 1-2). The four lower Columbia ESUs fall within the Willamette/Lower Columbia Domain, which also includes two listed species in the Willamette River above Willamette Falls (Willamette Spring Chinook ESU and Willamette Winter Steelhead DPS). The other domains are the Interior Columbia River; Puget Sound and Washington Coast; Oregon Coast; and the Southern Oregon/ Northern California Coast domains. Opportunities exist for technical and stakeholder involvement in each domain.

- *Technical Recovery Teams*: For each domain, NMFS appointed an independent Technical Recovery Team (TRT) that has geographic and species expertise for the domain and can provide a solid scientific foundation for recovery plans. The charge of each TRT is to define ESU structures, to develop recommendations on biological viability criteria for ESUs and populations, to provide scientific support to local and regional recovery planning efforts, and to provide scientific evaluations of recovery plans. The TRTs include biologists from NMFS, state, tribal, and local entities, agencies, academic institutions, and private consulting groups. All the TRTs operate from a common scientific foundation. Each TRT has used the same biological principles for developing its recommended ESU and population viability criteria – criteria that will be used, along with threats-based criteria, to determine whether a species has recovered sufficiently to be down-listed to threatened (if endangered) or delisted – although they have developed regionally specific approaches for applying these criteria. Each TRT's recommendations are assessed using the Viable Salmonid Population (VSP) framework, with viability criteria expressed in terms of abundance, productivity (population growth rate), spatial distribution, and diversity (McElhany et al. 2000). The TRT responsible for the domain pertinent to this Plan is the Willamette/Lower Columbia Technical Recovery Team (WLC-TRT).

- *Management Units and Sub-Domains in the Willamette/Lower Columbia Domain:* In each domain, NMFS worked with state, tribal, local and other federal stakeholders to develop local planning forums appropriate to the domain, which builds to the extent possible on ongoing, locally led efforts. The Willamette/Lower Columbia Domain is composed of the Lower Columbia River (LCR) sub-domain and the Upper Willamette River sub-domain. Given that the LCR sub-domain straddles parts of Washington and Oregon, NMFS partitioned this sub-domain into three management units in order to accommodate the different planning efforts, as specified below and in Figure 1-3. These three plans will be synthesized, or "rolled up", by NMFS into one overarching plan that addresses the full lower Columbia River ESUs. The Upper Willamette River sub-domain is not divided into management units and includes the Willamette Basin above Willamette Falls, and spring Chinook in the Clackamas River Basin.

  Washington Lower Columbia management unit: includes the portion of the lower Columbia salmon ESUs and steelhead DPS that occurs within Washington. The Lower Columbia Fish Recovery Board (LCFRB) oversees and coordinates salmon and steelhead recovery efforts in this Washington management unit. The LCFRB developed the Lower Columbia Salmon Recovery and Fish and Wildlife Subbasin Plan in 2004 (LCFRB 2004). NMFS approved the plan as an interim regional recovery plan in February 2006. The LCFRB is currently making major revisions to their plan to finalize it and in preparation for inclusion in NMFS' "roll up" plan.

  White Salmon management unit: includes the White Salmon River basin in Washington. NMFS is developing the recovery plan for this management unit.

  Oregon Lower Columbia management unit: includes the portion of the LCR coho and Chinook ESUs and steelhead DPS and Columbia River (CR) chum ESU that occurs within Oregon, and is addressed by this Plan. The State of Oregon developed this Plan in parallel with recovery planning for the Upper Willamette River sub-domain.

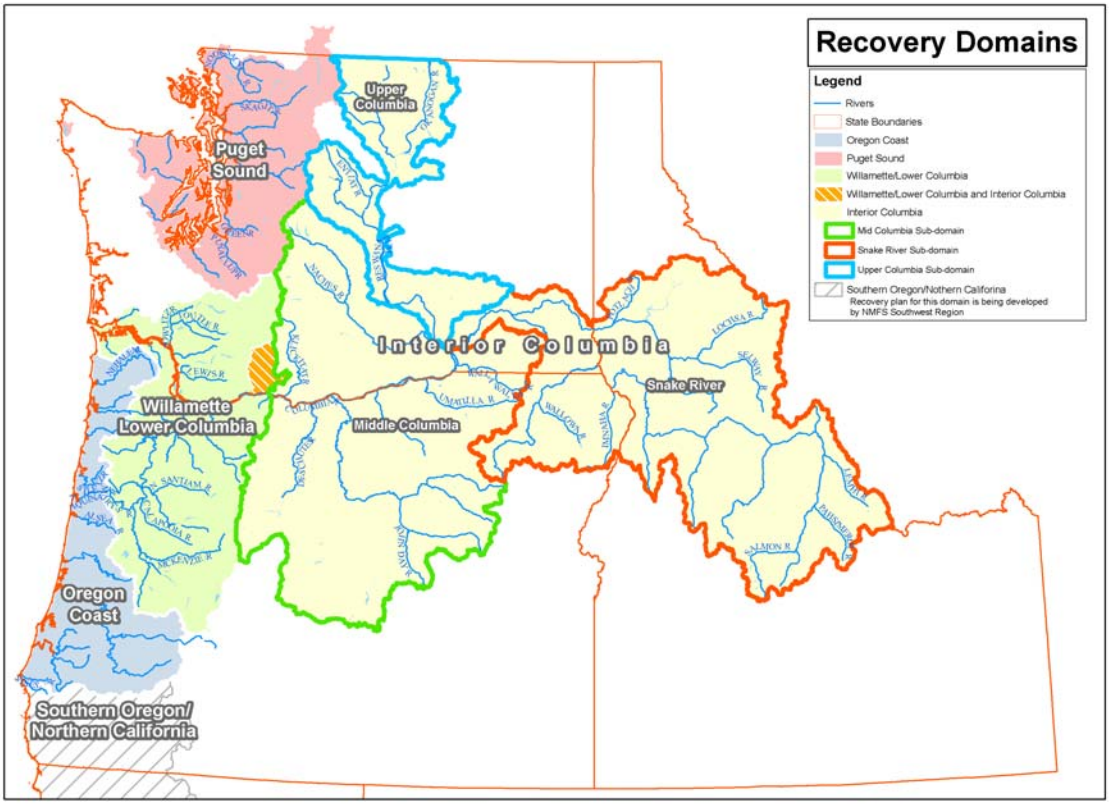


Figure 1-2. NMFS recovery domains for salmon ESUs and steelhead DPSs in Washington, Oregon and Idaho.

Figure 1-3. The three management units in the Lower Columbia River sub-domain, and the Upper Willamette River sub-domain. This Plan addresses the Oregon Lower Columbia Management Unit.

NMFS will work with the states and local entities involved in management unit plan development, and with representatives from other sectors (e.g., ocean harvest, tribal harvest, and Columbia mainstem hydropower) as appropriate to integrate the management unit plans. Synthesis, or "roll-up," of the three Lower Columbia River sub-domain management unit plans will increase the likelihood that the full recovery needs of the listed ESUs are being addressed, including the entire life cycles of salmon and steelhead and all threats to them. For example, there are interdependencies between the states related to some local hatchery and harvest issues, so certain recovery actions have been agreed upon by both states. In addition, some recovery actions related to harvest, hatcheries, the Federal Columbia River Power

System, and the estuary are regional in scope and require a regionally consistent set of assumptions and actions. To provide a basis for regional discussion of these issues, NMFS developed a series of recovery planning modules that are posted on their regional website: http://www.nwr.noaa.gov/Salmon-Recovery-Planning/ESA-Recovery-Plans/Other-Documents.cfm. The roll-up will also address ESU-level recovery criteria and regionally coordinated research, monitoring, evaluation, and adaptive management strategies. As management unit plans are "rolled up" and sub-domain plans are completed, NMFS will ensure that any interdependencies and overlap between the Upper Willamette and Lower Columbia River sub-domains (e.g., both ESUs share the Clackamas Basin and the lower Willamette River mainstem) are adequately addressed and that a recovery strategy for the entire domain is clearly communicated. Final ESA recovery plans will maintain and incorporate the management unit plans, thereby endorsing the recommendations and decisions that are most appropriately left to local recovery planners and implementers. For more information about NMFS, the domains, and the TRTs, see the following website: http://www.nwr.noaa.gov/Salmon-Recovery-Planning/index.cfm.

1.5.2 State of Oregon Recovery Planning Process and Use of the Plan

ODFW took the lead in drafting this Plan with the assistance of a cadre of other entities. Partners included other state and federal natural resources agencies, local communities and interested members of the public. The development process was collaborative with broad technical, stakeholder and public involvement. Critical players in the Plan's development were involved at each stage in the decision-making process. The Plan reflects the substantial review, discussion, critique and recommendations of three planning forums: an "expert panel", a diverse public stakeholders group, and a recovery planning team. Appendix A identifies the members and affiliations of the Planning and Stakeholder Teams. The WLC-TRT was also involved in the process. This involvement has been vital to the Plan's success and will help ensure that it is both scientifically and technically sound and supported by various stakeholders and private landowners.

Briefly, the function and composition of the groups was as follows:

- *Oregon Lower Columbia Expert Panel*. The Oregon Lower Columbia Expert Panel (Expert Panel) was created by ODFW to assist in recovery planning. The panel consisted of biologists with significant knowledge of the limiting factors and threats influencing Oregon's listed salmon and steelhead populations. Panelists identified common key and secondary threat themes and limiting factors for the populations. The findings of the Expert Panel were passed on for review and refinement by the Planning and Stakeholder Teams.

- *Lower Columbia Stakeholder Team*. The Lower Columbia Stakeholder Team (Stakeholder Team) consisted of representatives of local communities; agricultural, business, fishing and timber interests; water and land users and managers; local and state governing bodies; and environmental interests. The Stakeholder Team provided policy guidance in the development of all aspects of the Plan and ensured locally appropriate and locally supported recovery actions that will achieve species recovery goals are included. The Stakeholder Team was particularly instrumental in the development of broad sense recovery goals, recovery scenarios, recovery strategies, and strategic guidance for the development and prioritization of management actions.

- *Lower Columbia Recovery Planning Team*. The Lower Columbia Recovery Planning Team (Planning Team) included members from state, federal, and local governments. The team provided technical guidance and assisted in writing different aspects of the Plan. Team members had technical expertise with salmon and/or their habitats.

The intent of Oregon's recovery planning effort is to develop recovery plans — including this Plan for the Oregon portion of the Lower Columbia River — that meet ESA and greater "broad sense" requirements, are technically sound, and are supported at the community level. The plans are being developed within the context of Oregon's contemporary infrastructures and political and social landscape and will consider a broad range of state, tribal, and local needs. Involvement by these different entities helps ensure that recovery goals and actions are consistent and compatible with the goals and direction adopted in related efforts. This integrated approach establishes partnerships that allow actions to be implemented effectively and efficiently. Ultimately, the successful implementation of recovery actions will depend on the willing participation of all the entities that influence salmon and steelhead survival from the ridge-tops to the ocean feeding pastures that support the life cycle of these species.

As with other Oregon recovery plans, this Plan describes strategies to protect and restore a sufficient level of ecologic function to achieve delisting and broad sense recovery of ESA listed species. The Plan recommends actions that could be carried out under the statutory and management authorities of a wide range of state and federal agencies, industries, local governments, community-based conservation organizations and private landowners. The Plan will evolve as limiting factors and societal values change and as research, monitoring, and evaluation yield new information.

The Oregon Fish and Wildlife Commission must approve this Plan, and adopt associated administrative rules, for it to be adopted as a State of Oregon conservation plan, as required by the Native Fish Conservation Policy. As a conservation plan, the Plan will provide ODFW with conservation and fish management direction, and it will be integrated into other plans and planning processes ODFW undertakes. The Plan will also be used to guide budget priorities through the Governor's Office, as well as funding and program priorities with state agencies, boards, and commissions. In particular, it will be used to help guide the Oregon Watershed Enhancement Board's (OWEB) funding decisions for watershed councils, soil and water conservation districts (SWCDs), and other implementers. The State of Oregon will submit the Plan to NMFS for use as the basis for the ESA recovery plan for the Oregon portion of the LCR coho and Chinook ESUs and steelhead DPS and CR chum ESU. Other state and federal entities and management partners are expected to clarify or formalize their commitment to recommendations in each recovery plan. This and other recovery plans will be used to guide state decisions regarding the allocation of funds to support the implementation of specific actions.

1.5.3 Plan Review, Revision, Adoption and Implementation

The Plan underwent a series of reviews and revisions. Portions of the document were available for review since 2007. An internal review of a complete draft document by NMFS' Northwest Region, NMFS' Northwest Fisheries Science Center, and ODFW staff was initiated in January 2009. After revision, another draft was reviewed by the Stakeholder Team, Planning Team, and Oregon's Independent Multidisciplinary Science Team (IMST). This final version has been revised based on comments received during those review periods, as well as further coordination with other co-managers such as the State of Washington and NMFS. Final approval for the Plan will be sought from the Oregon Fish and Wildlife Commission (OFWC), as a state conservation plan, and within NMFS' "roll up" plan for the Lower Columbia River sub-domain, as a federal recovery plan.

Once this Plan is approved, all federal and nonfederal implementing entities should develop a coordinated and prioritized implementation schedule and funding strategy. To facilitate implementation, NMFS intends to provide streamlined regulatory assurances for actions that are undertaken to implement recovery. Adaptive management including a comprehensive monitoring, evaluation and research component will be a high priority during the recovery effort. On-the-ground actions will be adjusted in response to new information gained from evaluating successes and failures. The challenges of 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 tackle the hard issues to come.

1.5.4 Relationship to Other Efforts

Several other recently completed or ongoing planning efforts have a significant bearing on the design and/or implementation of this Plan. These planning efforts include:

Oregon Plan for Salmon and Watersheds

In 1997 Oregon's Governor and its Legislature adopted the Oregon Plan for Salmon and Watersheds (Oregon Plan; http://www.oregon-plan.org/) to begin state-led recovery efforts. The Plan's mission is:

To restore Oregon's native fish populations and the aquatic systems that support them to productive and sustainable levels that will provide substantial environmental, cultural, and economic benefits. The Plan has a strong focus on salmon because they are important indicators of watershed health and have great cultural, economic and recreational importance to Oregonians.

The Oregon Plan organizes actions around the factors that contribute to the decline in fish populations and watershed health. Most of these focus on actions to improve water quality and quantity and restore habitat. Watershed councils and soil and water conservation districts lead efforts in many basins. Landowners and other private citizens, sport and commercial fishing interests, the timber industry, environmental groups, agriculture, utilities, businesses, tribes, and all levels of government also come together to organize, fund, and implement these measures, which rely on scientific oversight, coordinated tribal and government efforts, and ongoing monitoring and adaptive management to achieve program success.

The Oregon Plan relies on Oregon's spirit of volunteerism and stewardship, along with public education and awareness, strong scientific oversight, coordinated tribal and government efforts, and ongoing monitoring and adaptive management to achieve program success. Oregon will implement the Oregon Plan consistent with ESA recovery planning and with other Oregon related-salmon programs.

Oregon Conservation Strategy

The Oregon Conservation Strategy (Conservation Strategy) was developed by ODFW in response to a national effort guided by Congress and the U.S. Fish and Wildlife Service (USFWS) to encourage states to develop comprehensive wildlife planning. The Conservation Strategy was approved by the Oregon Fish and Wildlife Commission (Commission) in August 2005 and by the USFWS in March 2006. Oregon's approach was to establish a long-term vision and set specific goals not only for conservation actions to be implemented by ODFW, but also as a conservation blueprint for all Oregonians. The overarching goal of the Conservation Strategy is to "maintain healthy fish and wildlife populations by maintaining and restoring functioning habitats, prevent declines of at-risk species, and reverse declines in these resources where possible." The Conservation Strategy emphasizes the proactive conservation and management of 11 strategy habitats across eight state ecoregions. It addresses species conservation through a fine filter approach and identified 286 strategy species based on their population status or that represent the diversity and health of wildlife in Oregon.

The listed and unlisted species addressed in this Plan are listed as strategy species in the Conservation Strategy, and occupy four of the state's ecoregions. This Plan's actions also address the six key issues identified in the Conservation Strategy, in addition to others.

FCRPS Biological Opinion 2008[2]
The Federal Columbia River Power System (FCRPS) is a series of dams, powerhouses, and reservoirs to be managed for multiple purposes—power production, flood control, irrigation, navigation, recreation, and fish, wildlife, and cultural resource protection. NMFS issued the FCRPS 2008 Biological Opinion, also referred to as the Remand of the 2004 Biological Opinion on the FCRPS, on May 5, 2008. The Biological Opinion includes the mainstem Columbia from Bonneville Dam to the river's mouth, which extends through much of the area included in this Plan for the Oregon portion of the lower Columbia. Hydro development from Bonneville Dam upstream has significantly altered the lower river and limited the survival of all Columbia salmon and steelhead that must use it as a migratory corridor. The FCRPS 2008 Biological Opinion's reasonable and prudent alternative (RPA) proposes an expanded program to protect and improve estuary environments based on the biological needs of targeted fish populations with the greatest need. It also provides recommendations to address the long-term effects of climatic variation on salmon and steelhead in the mainstem and estuary.

Northwest Power and Conservation Council Subbasin Plans
Congress created the Northwest Power and Conservation Council (NPCC) in 1980 to give Washington, Oregon, Idaho, and Montana a voice in regional energy planning and in mitigating the effects of the Federal Columbia River Power System on fish and wildlife. The NPCC developed the Columbia Basin Fish and Wildlife Program, which solicits and evaluates proposals for on-the-ground projects and research to meet these responsibilities. The Bonneville Power Administration (BPA) provides funding for NPCC-identified priority projects. In 2005, to update the Columbia Basin Fish and Wildlife Program, the NPCC completed a watershed planning effort that resulted in locally developed plans for 58 of 62 designated subbasins (tributary watersheds or mainstem segments) in the Columbia River basin.

Columbia River Hatchery Scientific Review Group
The Hatchery Scientific Review Group (HSRG) is the independent scientific review panel of the Pacific Northwest Hatchery Reform Project established by Congress in 2000 in recognition that while hatcheries play a legitimate role in meeting harvest and conservation goals for Pacific Northwest salmon and steelhead, the hatchery system was in need of comprehensive reform. The HSRG has reviewed all state, tribal and federal hatchery programs in Puget Sound and Coastal Washington, and released their final report for those in the Columbia River basin in early 2009 (http://www.hatcheryreform.us/hrp/welcome_show.action)[3].

Columbia River Estuary Recovery Plan Module
The Columbia River Estuary Recovery Plan Module (Estuary Module, LCREP 2006; http://www.nwr.noaa.gov/Salmon-Recovery-Planning/ESA-Recovery-Plans/Estuary-Module.cfm) focuses on restoration needs for habitat in tidally-influenced reaches of the lower Columbia River below Bonneville Dam and below Willamette Falls on the Willamette River, as well as the Columbia River estuary and plume. Given that all Columbia River salmon and steelhead will benefit from Estuary

[2] Dissenting View of State of Oregon Regarding Mainstem Operations. At the time this Plan was being finalized, spring 2010, it was the position of the State of Oregon that additional or alternative actions should be taken in mainstem operations of the FCRPS for ESA-listed salmon and steelhead. Some additional or alternative actions recommended by Oregon, while considered, were not included in NMFS's FCRPS Biological Opinion. At this time, Oregon is a plaintiff in litigation against various federal agencies, including NMFS, challenging the adequacy of the measures contained in the current FCRPS Biological Opinion. NMFS is not in agreement with Oregon regarding the need for or efficacy of Oregon's additional or alternative actions.
[3] In most cases, the HSRG does not recommend any changes to lower Columbia River hatchery programs in Oregon. Where changes are suggested, Oregon has considered the recommendations and implemented, or will implement, changes as proposed, or, in a few cases, is taking steps consistent with the desired outcome of the HSRG's recommendations. Also note that the HSRG based their recommendations on what the LCFRB had identified in an earlier draft of their Washington plan for desired statuses of Oregon populations, which are different than final desired statuses agreed upon by the states and NMFS and reflected in this Plan.

Module implementation, it is intended to be incorporated or adopted by reference into all recovery plans for the Columbia River.

The module provides detailed descriptions of limiting factors and proposes recovery actions to improve the survival of ESA-listed salmon and steelhead during their migration and rearing in the estuary and Columbia River plume. The module lists 23 broad actions which, if implemented, would reduce the threats and increase survival of salmon and steelhead during their time in the estuary. These actions include recommendations to address concerns related to the FCRPS. The module also estimates the cost of implementing each action over a 25-year period. Actions and costs from the Estuary Module are included in this Plan. A final version of the module is under development.

Interim Regional Recovery Plan for the Washington Lower Columbia Management Unit

The Lower Columbia Fish Recovery Board (LCFRB) was established by Washington statute in 1998 to oversee and coordinate salmon and steelhead recovery efforts in the lower Columbia region of Washington. The LCFRB comprises representatives from the state legislature, city and county governments, the Cowlitz Tribe, the environmental community, hydroelectric utilities, and concerned citizens. The LCFRB developed a plan for the protection and restoration of native fish, aquatic habitats, and sensitive wildlife species in the Washington portion of the lower Columbia watershed. The plan addressed ESA recovery planning, as well as state recovery and watershed planning and Northwest Power and Conservation Council subbasin planning needs.

The state and LCFRB submitted the plan for the Washington portion of the lower Columbia region to NMFS in December 2004. In April 2005, NMFS solicited public comment on the plan for portions of the Lower Columbia River ESUs. In February 2006, NMFS approved the plan as an interim regional recovery plan. The LCFRB is currently making major revisions to their plan in order to be consistent with this Plan and in preparation for inclusion in NMFS' "roll up" plan. The "roll up" plan for the full Lower Columbia River species will synthesize LCFRB's plan for the Washington Lower Columbia Management Unit, NMFS's plan for the White Salmon Management Unit, and this Plan for the Oregon Lower Columbia Management Unit.

Chapter 2: Environmental and Biological Background

This chapter describes the geographic setting of the Plan, summarizes life history information for the different species, and describes the strata and independent populations that are contained within the lower Columbia River salmon and steelhead ESUs. This background information on the environmental characteristics and biological structure of the lower Columbia River area and the four listed species provides context needed to understand the recovery goals and criteria discussed later in the Plan.

The Plan addresses four Pacific salmon and steelhead species in the State of Oregon that are listed under the ESA: the Lower Columbia River Coho ESU, Lower Columbia River Chinook ESU, Columbia River chum ESU, and Lower Columbia River steelhead DPS. As defined under the ESA, a "species" includes "any subspecies of fish or wildlife or plants and any other group of fish or wildlife of the same species or smaller taxa in common spatial arrangement that interbreed when mature." This definition established that the ESA was intended to preserve the genetic variability within taxonomic species and extended protection to include smaller biological units (i.e., any species, sub-species, or distinct population segment [ESA section (3)(15)]; Waples 1991). NMFS's definitions of smaller biological units, ESUs for salmon[4] and DPSs for steelhead, are consistent with this direction. The ESUs emphasized reproductive isolation and ecological or genetic distinctiveness and subdivided salmon species geographically. The DPSs focused on ecological distinctiveness and divided the *O. mykiss* species into anadromous (steelhead) and resident (trout) life histories[5]. The DPSs also subdivided the steelhead geographically. Steelhead and trout within a common geographic area are not necessarily reproductively isolated or genetically distinct (Kostow 2003). Only steelhead, the anadromous life history of *O. mykiss,* are listed under the ESA.

The four species addressed in this Plan occupy habitat in Oregon tributaries of the lower Columbia River including the Sandy, Clackamas and Hood rivers, tributaries entering Youngs Bay, and other small tributaries that flow directly into the Columbia River between the mouth of the Columbia River and Hood River at river kilometer (rkm) 270. The species are also present in Washington State tributaries of the lower Columbia. For coho, Chinook and chum, the listed ESUs (Waples 1991) extend across the entire area addressed in this Plan. For steelhead, the listed DPS populations are only upstream of the Cowlitz River (Washington at rkm 108) and Willamette River (Oregon at rkm 165) and include only the anadromous life history of the species (71 FR 834).

While recovery focuses on the conservation of self-sustaining naturally produced populations, all four lower Columbia River ESUs include hatchery stocks, which are listed along with naturally produced fish. Inclusion of the hatchery stocks was based on NMFS's determination that any hatchery stocks found to be part of an ESU or DPS would be considered in determining whether the ESU or DPS is threatened or endangered under the ESA, and would be included in any listing of the ESU or DPS (FR 70 37204). According to NMFS's Hatchery Policy: "Hatchery stocks with a level of genetic divergence relative to the local natural population(s) that is no more than what occurs within the ESU: (a) are considered part of the ESU; (b) will be considered in determining whether an ESU should be listed under the ESA; and (c) will be included in any listing of the ESU." The hatchery policy further recognized that the role of hatchery fish in status assessment and recovery would be determined "… in the context of their contributions to conserving natural self-sustaining populations." Hatchery fish were recognized to potentially have either positive or negative effects on the status of natural populations. Nevertheless, the hatchery policy did not give hatchery fish full protection under Section 4(d) of the ESA; instead the policy stated that "for ESUs listed as threatened, NMFS will, where appropriate, exercise its authority

[4] An ESU is a group of Pacific salmon that is (1) substantially reproductively isolated from other groups and (2) represents an important component of the evolutionary legacy of the species.
[5] Rainbow trout, the resident form of *O. mykiss*, are under the jurisdiction of the U.S. Fish and Wildlife Service (USFWS).

under section 4(d) of the ESA to allow the harvest of listed hatchery fish that are surplus to the conservation and recovery needs of the ESU, in accordance with approved harvest plans."

The inclusion of hatchery stocks in ESUs or DPSs was based on a review and analysis of hatchery broodstock origins, broodstock age, management history, and life history and genetic information conducted by Drake et al. (2003). The specific hatchery stocks included in each ESU are provided in the final listing notices (70 FR 37160 and 71 FR 834) and are included in Tables 2-1 through 2-4.

Recovery efforts focus on the long-term conservation of self-sustaining naturally produced populations, however the hatchery stocks could be considered for use in recovery actions for these ESUs. Most hatchery fish released into the lower Columbia are currently marked with an adipose fin clip and are available for use in harvest (70 FR 37204). Thus, while the hatchery fish may be used as a resource in some recovery actions, their status is not the focus of recovery.

2.1 Climate and Geomorphology

Recovery planning efforts for the lower Columbia River ESUs focus on three major geographic zones with distinct ecological characteristics: the Coast Range, Cascade, and Columbia Gorge. These ecological zones are the basis for stratum designations and were adapted in part from the U.S. Environmental Protection Agency's ecoregions, which are based on a simplified summary of environmental characteristics such as elevation, soil type, vegetative land cover, rainfall, and climate (USEPA 2002).

<u>Coast Range Ecological Zone</u>

The Coast Range ecological zone begins at the mouth of the Columbia River (Clatsop Spit and Youngs Bay on the Oregon side) and extends upstream to the Willamette River in Oregon and the Cowlitz River in Washington. The Columbia River estuary consists of the river mouth, nearshore waters, and the mainstem plume. It formed over geologic time through glaciation, volcanism, hydrology, and erosion and accumulation of sediments and nutrients. The current surface area of the estuary (mouth to RM 34) is estimated at 101,750 acres, equivalent to 159 square miles. During low flow periods, tidal impacts on water levels in the Columbia River have been recorded as far upstream as Bonneville Dam (RM 146). Reversal of river flow has been measured as far upstream as Oak Point (RM 53). The discharge at the river mouth ranges from 100,000 to 500,000 cfs (Marriott et al. 2002).

Youngs Bay, Big Creek, Clatskanie, and Scappoose are the major Oregon watersheds in the Coast Range zone. Islands are an important habitat feature of this zone and include, in Oregon waters, Wallace, Crims, Sandy, Deer, Goat, and Sauvie islands, as well as islands in Cathlamet Bay. Cathlamet Bay contains some of the most intact and productive tidal marsh and swamp habitat remaining in the estuary, much of which is protected by the Lewis and Clark National Wildlife Refuge (LCREP 2006). The climate in this zone is dominated by moist Pacific marine air, with wet and mild winters and cool dry summers. Average annual precipitation is 79 to 94 inches, with approximately 80 percent occurring as rain between October and March. Streamflow is dependent on rainfall since drainage elevations generally do not exceed 500 feet in elevation. River flows peak in December and January as a result of winter rainstorms. There is very little precipitation in July or August and corresponding flows are at the lowest with the highest water temperatures occurring in August. These rivers are especially prone to low flow during periods of drought. The estuarine shoreline in Oregon consists primarily of rocky, forested cliffs or, at low elevation, gently sloping floodplains. This region was originally forested with Sitka spruce, western hemlock, Douglas fir, western red cedar, and red alder and in the lowlands, estuarine wetland plants.

The Coast Range zone displays two distinct areas, coastal lowlands and coastal uplands. The coastal lowland region includes the valley bottoms and is characterized by marine estuaries and terraces with

short and low gradient meandering streams. Elevations in this region run from 0 to 300 feet and the watershed receives 60 to 85 inches of annual precipitation, primarily as rainfall (Biscoff et al. 2000a). The coastal upland region extends along Oregon (and Washington) coasts and is typically associated with the upland areas that drain into the coastal lowlands. Coastal upland and headland terraces with medium gradient streams characterize these areas. Elevations run to 500 feet and the watershed receives 70 to 125 inches of precipitation.

Cascade Ecological Zone

The Cascade ecological zone extends east from the Willamette River (and the Cowlitz River in Washington) to the Sandy River (and to the Washougal River in Washington). The volcanic peaks of Mount Hood, Mount Rainer, Mount St. Helens, and Mount Adams, each rising above 10,000 feet in elevation, dominate the topography of this zone. Hayden and Government islands are the main Columbia River islands in this zone. The lower Willamette River below Willamette Falls (RM 26.7) is part of this zone. The Clackamas River, a tributary to the lower Willamette River, is also in this zone but because of shared geography it is included in recovery planning efforts for both the Oregon Lower Columbia sub-domain and the Upper Willamette sub-domain.

The climate at lower elevations in the Cascade zone is similar to that in the Coast Range zone, with wet mild winters and cool dry summers. Precipitation varies from 45 to 150 inches annually, and generally occurs between October and March. Much of the precipitation above 3,000 feet in elevation occurs as snow. In higher elevation basins, snowmelt adds to the surface runoff and provides a secondary peak in flow during the spring. Vegetation is similar to the Coast Range, except at higher elevations, where Pacific silver fir, noble fir, subalpine fir, mountain hemlock, and lodgepole pine occur (McElhany et al. 2003).

Columbia Gorge Ecological Zone

The Columbia Gorge ecological zone encompasses the Columbia River Gorge, which extends from the Sandy River (and the Washougal River in Washington) to the Hood River (and to the White Salmon River in Washington). Ackerman Island is the major island on the Oregon side of the zone. Volcanic lava flows, glaciers, and flooding formed the Columbia Gorge landscape of basalt cliffs, waterfalls, talus slopes, and ridges (Coccoli 2004). Drainages in this region consist of short, steep streams that often limit anadromous passage to less than 1.6 km in smaller creeks. In larger systems, falls in the lower rivers often limit passage of salmon and steelhead. The larger systems are Herman and Eagle creeks and the Hood River. The Hood River basin is the largest system, covering an estimated 217,492 acres or 339 square miles.

The climate and vegetation in this zone, including the Hood River basin, are transitional between the high rain/snowfall area of the Cascades and the drier Columbia Plateau to the east. Stream flow is low in the summer, except in the larger basins where it is influenced by snowmelt. Rivers in the Cascade (and Gorge) zone are subject to catastrophic risks due to volcanic eruptions, such as occurred at Mount St. Helens in 1980 (McElhany et al. 2003).

2.2 General Distributions and Life Histories

This section summarizes the general distributions and life histories of the four salmon and steelhead species addressed in this Plan.

Coho Salmon

Coho salmon are broadly distributed around the Pacific Rim with historic populations ranging from tributaries of the Sea of Japan in Asia to central California in North America (Groot and Margolis 1991).

The NMFS described seven ESUs of coho salmon in the contiguous states of the western United States (Weitkamp et al. 1995), four of which are listed under the ESA. LCR coho are listed as Threatened.

Mature coho salmon typically enter freshwater to spawn from late summer to late autumn. Spawning typically occurs between November and January. Migration and spawning timing of specific local populations may be mediated by factors such as latitude, migration distance, flows, water temperature, maturity, or migration obstacles. Coho salmon generally occupy intermediate positions in tributaries, typically further upstream than chum or fall-run Chinook, but often downstream of steelhead or spring-run Chinook. Duration of egg incubation may range from about 45 to 140 days, depending on water temperature, with longer incubation in colder water. Fry may thus emerge from early spring to early summer. Freshwater rearing occurs until the following spring when the juveniles undergo smoltification and migrate to salt water. In the ocean, coho are distributed in the North Pacific, with stock-specific and seasonal distribution patterns. Coho grow relatively quickly in the ocean, reaching up to six kilograms after about 16 months of ocean rearing. Most coho sexually mature at age three, except for a small percentage of males (called "jacks") who return to natal waters after only a few months of ocean residency. All coho die after spawning. More detailed general life history information, including regional variation across the species range, is available from Groot and Margolis (1991).

Chinook Salmon

Chinook salmon are distributed from northern Japan, into the Bering Sea, east to Alaska, and south along the coast of North America to the California coast (Groot and Margolis 1991). The NMFS described 17 ESUs of Chinook in the contiguous states of the western United States (Myers et al. 1998), and listed nine of them. The Lower Columbia River Chinook ESU includes spring-run, fall-run, and late fall-run populations and is listed as Threatened.

Chinook have varied adult and juvenile life histories. Historically adults probably entered some natal streams nearly every month of the year. However, within specific rivers, there are peaks of adult migration that are identified as "spring-run", "summer-run", "fall-run", "late fall-run" or "winter-run". In the Lower Columbia River, fall Chinook, called "tules," return to the river in mid-August in an advanced state of maturation and spawn within a few weeks. The late fall Chinook are called "brights," because they are less mature at river entry and stay in freshwater longer before spawning. Spring Chinook salmon in the lower Columbia River enter freshwater in March and April and spawn in August and September. Spring Chinook spawn in the higher elevation streams.

Spawning time for Chinook populations can be highly variable, ranging from spring in most northern and winter-run populations, to fall and late winter in other populations. Spring-run populations may enter freshwater as early as March and then hold in freshwater for several months prior to spawning in September. Juvenile life histories are also highly varied. Many fall-run populations spawn in the fall or early winter, their fry emerge in the spring and migrate downstream after as little as a month of freshwater rearing. Winter-run populations spawn in the spring and their fry migrate downstream in the fall. Spring-run populations spawn in the fall; their fry emerge in winter or early spring, then rear for a year until migrating downstream the following spring. Thus spring-run fish may also be called "stream-type" or "stream-rearing" while fall-run fish are "ocean-type". These various life histories may be sympatric within a river basin, and they may be quite reproductively isolated from each other. For example spring-run and fall-run Chinook in the Snake Basin are considered to be distinct ESUs (Myers et al. 1998). However, elsewhere in the species distribution, for example along the Oregon coast, there is apparently some level of interbreeding between the life histories and they are not considered separate ESUs (Myers et al. 1998). This last pattern is the case for the LCR Chinook ESU, where both spring-run and fall-run populations are combined in a single ESU. Some reproductive isolation, even where life histories are combined in ESUs, occurs due to different distributions within shared basins, with spring Chinook penetrating higher into tributaries while fall Chinook use lower mainstem habitats.

Chinook salmon rear in the North Pacific and southern Bering Sea and mature at age two to eight years, depending on life history. Stream-run Chinook mature at a later total age due to their longer freshwater residency. Males in most populations include a younger "jack" life history. Adult Chinook are the largest of the species addressed in this Plan, reaching up to 45 kg. All Chinook die after spawning. More detailed general life history information, including regional variation across the species range, is available from Groot and Margolis 1991.

Steelhead

Steelhead are broadly distributed from the Sea of Okhotsk in Asia, east to Alaska, and down the coast of North America to, historically, the coast of Northern Mexico. The NMFS described 15 DPSs of steelhead in the contiguous states of the western United States (Busby et al. 1996), and listed 11 of them. The LCR steelhead DPS includes both summer-run and winter-run populations, and is listed as Threatened.

Steelhead express two adult life histories based on adult run timing. Winter-run steelhead enter freshwater typically between November and May and spawn in the spring, immediately after arrival. Summer-run steelhead may enter freshwater year-around, but usually have distinctive peaks in the summer and fall. Summer-run steelhead that enter freshwater in the summer and fall have to hold in freshwater until they spawn the following spring. Summer-run steelhead often have longer freshwater migrations, and can pass into tributaries that are inaccessible to winter steelhead due to passage barriers caused by high winter flows.

Steelhead are the most freshwater-oriented of the four lower Columbia listed species. They can be very dispersed within river basins, spawning and rearing in most available small tributaries. Juveniles have a relatively long period of freshwater rearing, remaining in freshwater from one to four years, until finally out-migrating in the spring. Steelhead rear in the North Pacific for one to three years before returning to freshwater to spawn. Some steelhead survive spawning, briefly return to the ocean, and return to freshwater to spawn for a second or third time. As a result of the variable juvenile age at smolting, variable duration of ocean rearing, and repeat spawning, steelhead age structure is highly variable, with total ages ranging from two to eight years. Adult steelhead may reach about 25 kg.

Chum Salmon

Chum salmon are broadly distributed from the Sea of Japan in Asia, north into the Bering Sea and Arctic Ocean, and south along the coast of North America to the northern California coast (Groot and Margolis 1991). The NMFS described four ESUs of Chum in the contiguous states of the western United States (Johnson et al. 1997), and listed two of them. The Columbia River chum ESU is listed as Threatened.

Mature chum salmon may enter their natal tributaries in the summer (summer-run chum) or fall (autumn-run chum), apparently depending on whether their primary migration stimulus to enter freshwater is flow or water temperature. Although chum are strong swimmers, they rarely pass migration barriers that pose no hindrance to other salmon or steelhead. They therefore generally occupy lower reaches of spawning tributaries. Chum salmon are the most marine-oriented of the lower Columbia species. They spawn soon after reaching their spawning grounds. Duration of egg-incubation is influenced by water temperature and may vary annually, but emergence generally occurs in the spring. Chum salmon fry typically emerge at night and promptly migrate downstream into estuaries where they may rear for a period before entering the ocean. Chum rear in the North Pacific and Bering Sea for two to six years, although generally dominated by four-year-olds, before returning to their natal area to spawn. The size of an adult chum ranges from about three to five kilograms. All chum die after spawning. More detailed general life history information, including regional variation across the species range, is available from Groot and Margolis 1991.

2.3 Population and Strata Structure

Recovery planning focuses on a biologically based structure that spans from the species level to a level below the population. This focus reflects the fact that salmonids innate homing instinct—their tendency to return to the locations were their lives began—has created unique populations that share common genetic traits and connectivity reflective of their spawning locations. Over hundreds of years, the populations developed diverse life history, genetic, and morphological characteristics that reflected the geography of the river basins in which they spawned and allowed them to be highly adapted to changes in their environments. It is this variation that gives the species as a whole the resilience to persist over time.

Historically, a salmon ESU or steelhead DPS typically contained multiple populations connected by some small degree of genetic exchange by straying spawners. Thus, the overall biological structure of salmonids is hierarchical; spawners in the same area of the same stream will share more characteristics than those in the next stream over. Fish whose natal streams are separated by hundreds of miles will have less genetic similarity.

The WLC-TRT formally identified two levels in this hierarchy for recovery planning purposes: the ESU for salmon, or DPS for steelhead, and the independent population (McElhany et al. 2000). The WLC-TRT further defined the hierarchy by grouping the independent populations into larger aggregates that share similar genetic, geographic (hydrographic and ecoregion), and/or habitat characteristics. They called these "major groupings" stratum (plural: strata). This Plan focuses actions largely at the scale of local independent populations and strata. The three levels are described below.

1. **Evolutionarily Significant Unit or Distinct Population Segment:** The ESU or DPS is essentially a metapopulation defined by the common characteristics of populations within a geographic range. Two criteria define a salmon ESU or steelhead DPS 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 and DPSs may contain multiple populations that are connected by some degree of migration, and hence may have broad geographic areas, transcending political borders.

- **Strata:** Strata are groups of populations that have been isolated from one another over a longer time scale than the individual populations, but which retain some degree of connectivity greater than that between ESUs or DPSs. They represent groups of populations with similar life history characteristics, mainly run timing, that spawn within an ecological zone (McElhany et al. 2003). Strata are analogous to the “Major Population Groups” (MPGs) that were defined by the Interior Columbia TRT, and to the “geographic regions” that were 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” (Myers et al. 2006, following McElhany et al. 2000).

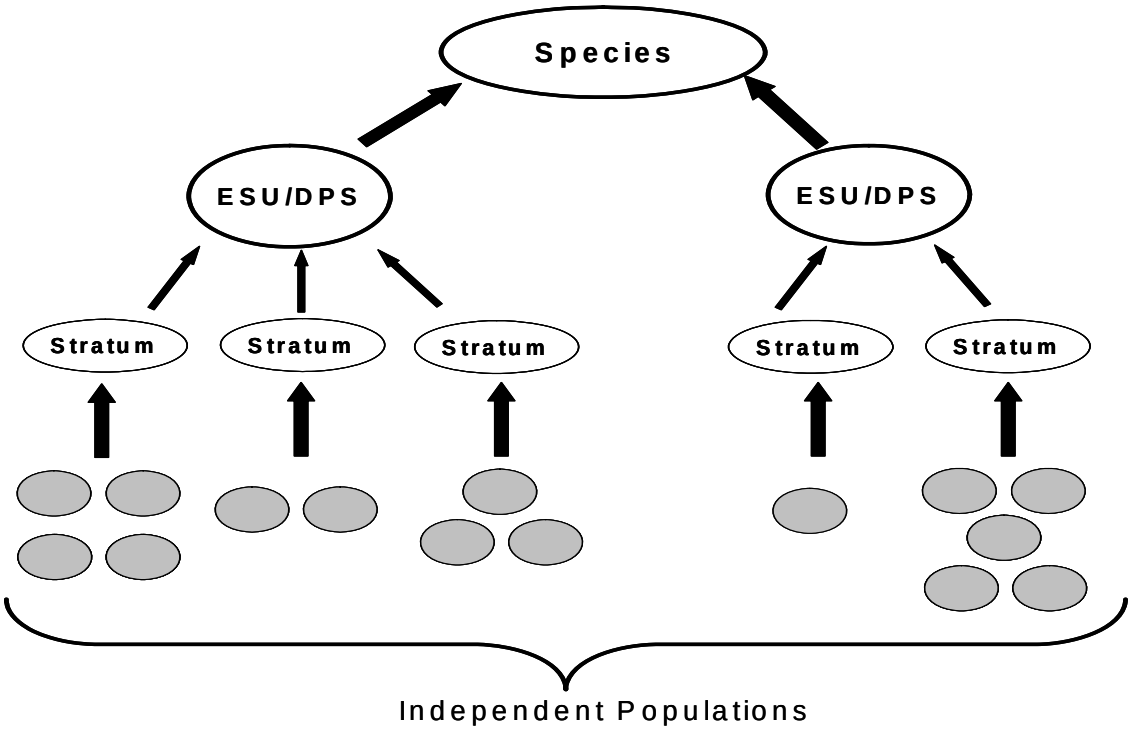


Figure 2-1. Hierarchical population structure within ESA-listed ESUs, as identified by the TRTs.

2.3.1 Coho Salmon

The WLC-TRT identified three strata and 24 historical independent coho populations in the LCR coho ESU (Table 2-1). Figure 2-2 shows the strata and independent populations within the LCR coho ESU.

Table 2-1. Strata, independent populations, and hatchery programs included in the listed Lower Columbia River Coho ESU.

Lower Columbia River Coho ESU	
ESA Listing: Threatened	
3 Strata	24 historical populations
Strata	**Populations**
Coast	Grays, Elochoman, Mill Creek, Youngs Bay, Big Creek, Clatskanie, Scappoose Creek
Cascade	Lower Cowlitz, Coweeman, SF Toutle, NF Toutle, Upper Cowlitz, Cispus, Tilton, Kalama, NF Lewis, EF Lewis, Salmon Creek, Washougal, Clackamas, Sandy
Gorge	Lower Gorge, Washington Upper Gorge and (Big) White Salmon River, Oregon Upper Gorge and Hood River
Hatchery programs included in ESU (25)	Grays River, Sea Resources Hatchery, Peterson Coho Project, Big Creek Hatchery, Astoria High School (STEP) Coho Program, Warrenton High School (STEP) Coho Program, Elochoman Type-S Coho Program, Elochoman Type- N Coho Program, Cathlamet High School FFA Type-N Coho Program, Cowlitz Type-N Coho Program in the Upper and Lower Cowlitz Rivers, Cowlitz Game and Anglers Coho Program, Friends of the Cowlitz Coho Program, North Fork Toutle River Hatchery, Kalama River Type-N Coho Program, Kalama River Type-S Coho Program, Lewis River Type-N Coho Program, Lewis River Type-S Coho Program, Fish First Wild Coho Program, Fish First Type-N Coho Program, Syverson Project Type-N Coho Program, Washougal River Type-N Coho Program, Eagle Creek NFH, Sandy Hatchery, and the Bonneville/ Cascade/Oxbow complex coho hatchery programs.

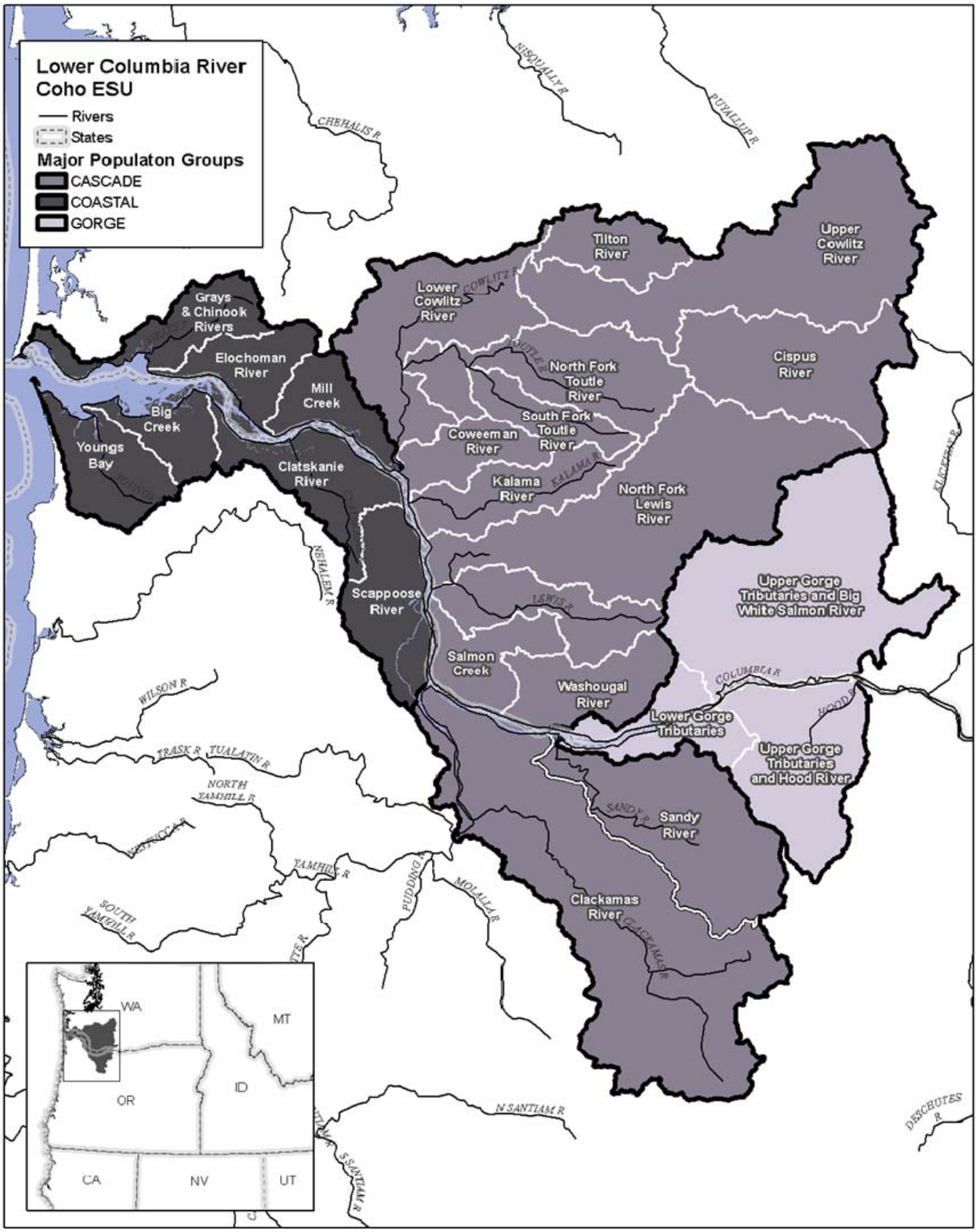


Figure 2-2. Lower Columbia River Coho salmon ESU showing strata and independent populations.

2.3.2 Chinook Salmon

The WLC-TRT identified six strata and 32 historical independent Chinook populations in the LCR Chinook salmon ESU (Table 2-2). Strata and independent populations of LCR fall Chinook, late fall Chinook, and spring Chinook are shown in figures 2-3, 2-4 and 2-5, respectively.

Table 2-2. Strata, independent populations, and hatchery programs included in the listed Lower Columbia River Chinook ESU.

Lower Columbia River Chinook ESU	
ESA Listing: Threatened	
6 strata	32 historical populations (21 fall-run, 2 late fall-run, 9 spring-run)
Strata	**Populations***
Cascade Spring	Upper Cowlitz (C,G), Cispus (C), Tilton, Toutle, Kalama, Lewis (C), Sandy (C,G)
Gorge Spring	White Salmon (C), Hood
Coastal Fall	Grays, Elochoman (C), Mill Creek, Youngs Bay, Big Creek (C), Clatskanie, Scappoose
Cascade Fall	Lower Cowlitz (C), Upper Cowlitz, Toutle (C), Coweeman (G), Kalama, Lewis (G), Salmon Creek, Washougal, Clackamas (C), Sandy
Cascade Late Fall	Lewis (C,G), Sandy (C,G)
Gorge Fall	Lower Gorge, Upper Gorge (C,G), White Salmon (C,G), Hood
Hatchery programs included in ESU (17)	Sea Resources Tule Chinook, Big Creek Tule Chinook, Astoria High School (STEP) Tule Chinook, Warrenton High School (STEP) Tule Chinook, Elochoman River Tule Chinook, Cowlitz Tule Chinook Program, North Fork Toutle Tule Chinook, Kalama Tule Chinook, Washougal River Tule Chinook, Spring Creek NFH Tule Chinook, Cowlitz spring Chinook (2 programs), Friends of Cowlitz spring Chinook, Kalama River spring Chinook, Lewis River spring Chinook, Fish First spring Chinook, Sandy River Hatchery (ODFW stock #11)

* (C) indicates that the population is a core population, (G) that it is a genetic legacy.

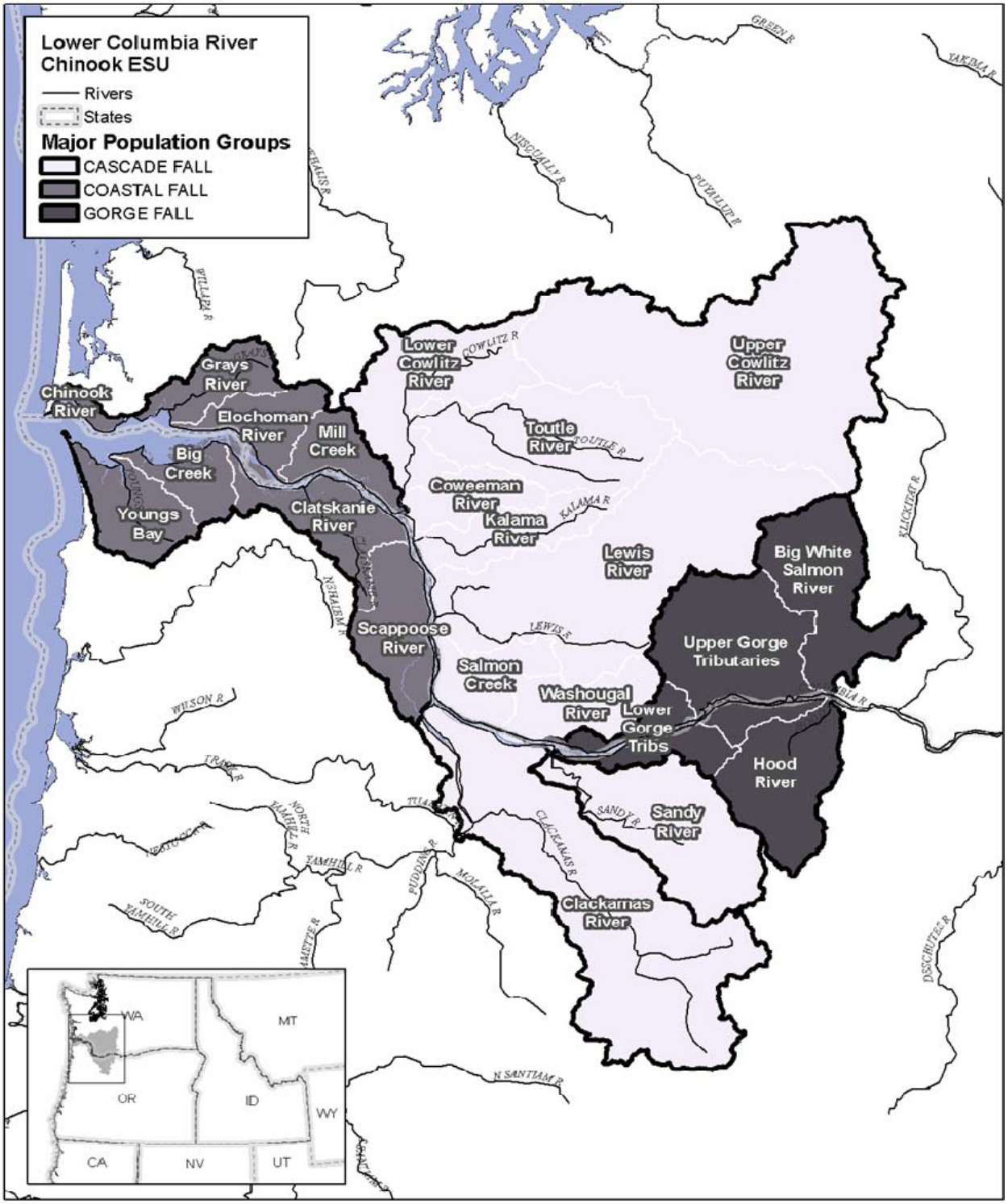


Figure 2-3. Lower Columbia River Chinook salmon ESU showing strata and independent populations of fall Chinook runs.

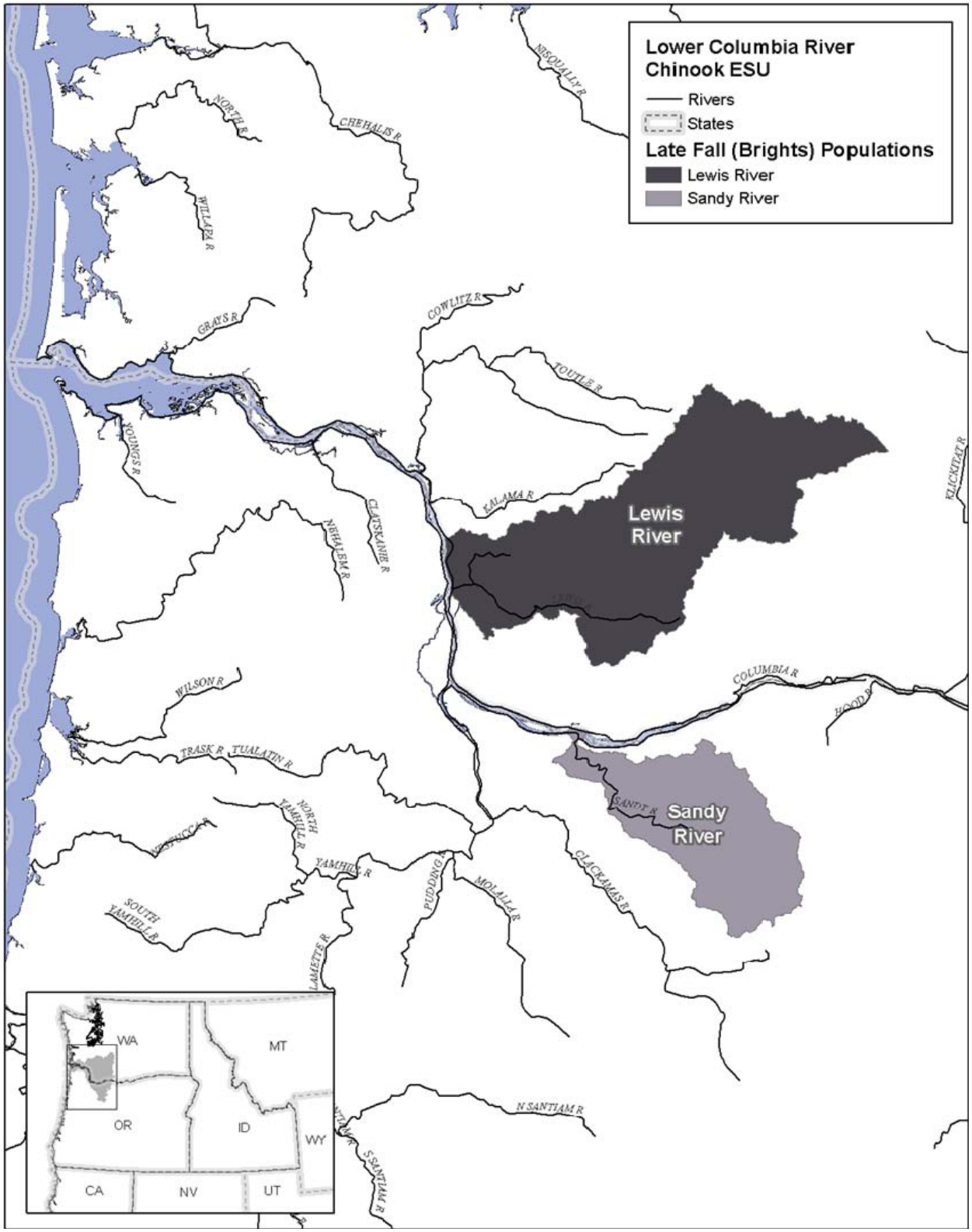


Figure 2-4. Lower Columbia River Chinook salmon ESU showing strata and independent populations of late fall Chinook runs.

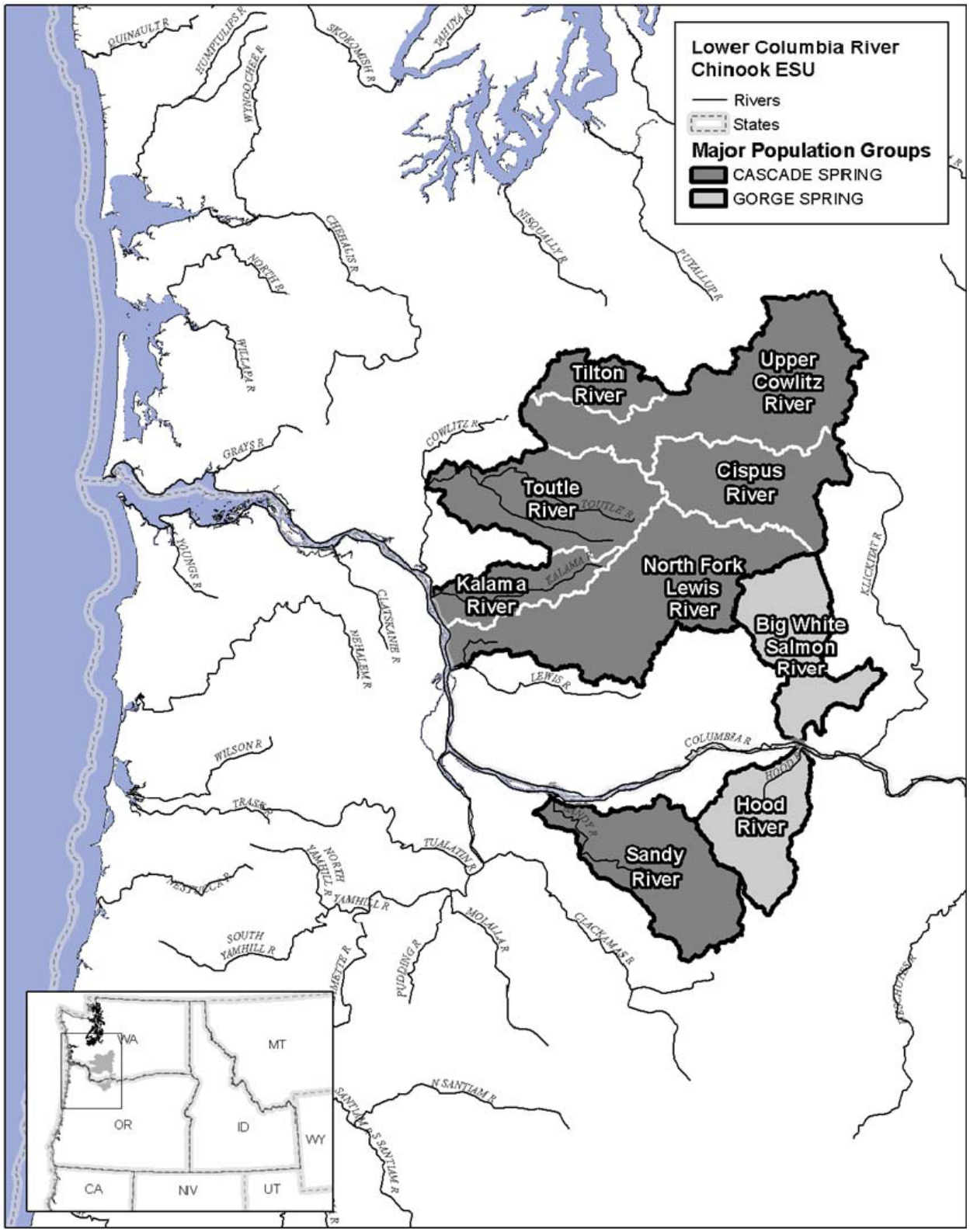


Figure 2-5. Lower Columbia River Chinook salmon ESU showing strata and independent populations of spring Chinook runs.

2.3.3 Steelhead

The WLC-TRT identified four strata and 23 historical independent steelhead populations in the LCR steelhead DPS (Table 2-3). Strata and independent populations of LCR winter steelhead and summer steelhead are shown in figures 2-6 and 2-7, respectively.

Addressing Resident Rainbow Trout

The resident form of the species *Oncorhynchus mykiss* (referred to as rainbow or redband trout, depending on location) is sympatric (occupies the same areas) with anadromous *O. mykiss*, or steelhead, in some areas of the LCR steelhead DPS. Resident *O. mykiss* have not been considered in the viability assessments or recovery strategies for steelhead described in this Plan. The WLC-TRT did not include the resident form in their delineation of populations within the LCR steelhead DPS. Whether these resident fish should be included in the DPS or not is an open debate. Kostow (2003) summarized the information available on the inter-relation or isolation between resident rainbow trout and steelhead throughout the Columbia River basin. Kostow (2003) found several examples of interactions between the two forms, though the levels to which resident and anadromous *O. mykiss* interactions occur in a particular population and how significant those interactions are to the viability of that population have not been quantified. There are several documented examples of each form producing offspring that adopted the other form's adult life-history (Ruzycki et al. 2003, Blouin 2003, Ardren 2003, Berg 2001, Viola and Schuck 1995, McMichael et al. 1999, as cited in Kostow 2003). There are also occurrences of steelhead adults spawning with rainbow trout (Zimmerman and Reeves 1996; B. Knox [ODFW, personal communication], T. Unterwegner [ODFW, retired, personal communication], as cited in Kostow 2003). Based on the information summarized, Kostow (2003) determined that the documented interactions between these two sympatric forms of *O. mykiss* meet the NMFS definition of populations to include in one ESU. NMFS however does not have regulatory authority over resident rainbow trout and chose not to include them in the LCR steelhead DPS. As a result, this Plan does not address resident *O. mykiss*.

It is difficult to differentiate resident trout from steelhead juveniles during routine sampling. As a result, ODFW has used the presence of larger trout (>20 cm) and the professional opinions of local biologists to characterize the occurrence of resident trout in the LCR steelhead DPS. No estimates have been made of the abundance of any resident populations in Oregon's portion of the lower Columbia. Resident rainbow trout are found sympatric with LCR steelhead in the Clackamas, Sandy and Hood populations, where they are thought to be common and in moderate abundances. Resident trout are thought to be rare or absent in the Youngs Bay, Big Creek, Clatskanie, and Scappoose populations.

Although resident *O. mykiss* are not expressly addressed in this plan, the potential importance that these fish may play in the viability of LCR steelhead in some populations is recognized. Kostow (2003) explored the ramifications of including resident rainbow trout in the LCR steelhead DPS and found that including resident trout would increase the abundance, diversity and spatial structure of the DPS. These improvements would likely improve the extinction risk of the DPS to some extent, though there would still be a risk if the DPS lost the anadromous life-history of *O. mykiss* (Kostow 2003).

ODFW will likely undertake the development of a conservation plan for rainbow trout in the Oregon portion of the lower Columbia at some point in the future as staff resources become available. A rainbow trout conservation planning process would build off of the strategies and actions identified in this Plan that address tributary habitat issues for steelhead and coho. Actions that improve the habitat for steelhead and coho will benefit resident rainbow trout and are likely to address some of the key or secondary limiting factors for resident *O. mykiss*. As a result, the exclusion of resident rainbow trout in much of this Plan will not adversely impact either the LCR steelhead populations or the resident populations, and the presence of resident *O. mykiss* should actually provide another conservation buffer for LCR steelhead populations in addition to those factored into this Plan.

Table 2-3. Strata, independent populations, and hatchery programs included in the listed Lower Columbia River Steelhead DPS.

Lower Columbia River Steelhead DPS	
ESA Listing: Threatened	
4 Strata	23 historical populations
Strata	**Population***
Cascade Summer	Kalama (C), NF Lewis, EF Lewis (G), Washougal (C,G)
Gorge Summer	Wind (C), Hood
Cascade Winter	Lower Cowlitz, Coweeman, NF Toutle (C), SF Toutle, Coweeman, Upper Cowlitz (C,G), Lower Cowlitz, Cispus (C), Tilton, Kalama, NF Lewis (C), EF Lewis, Salmon Creek, Washougal, Clackamas (C), Sandy (C)
Gorge Winter	Lower Gorge, Upper Gorge, Hood (C,G)
Hatchery programs included in DPS (10)	Cowlitz Trout Hatchery (in the Cispus, Upper Cowlitz, Lower Cowlitz, and Tilton Rivers), Kalama River Wild (winter- and summer-run), Clackamas Hatchery, Sandy Hatchery, and Hood River (winter- and summer-run) steelhead hatchery programs

* (C) indicates that the population is a core population, (G) that it is a genetic legacy.

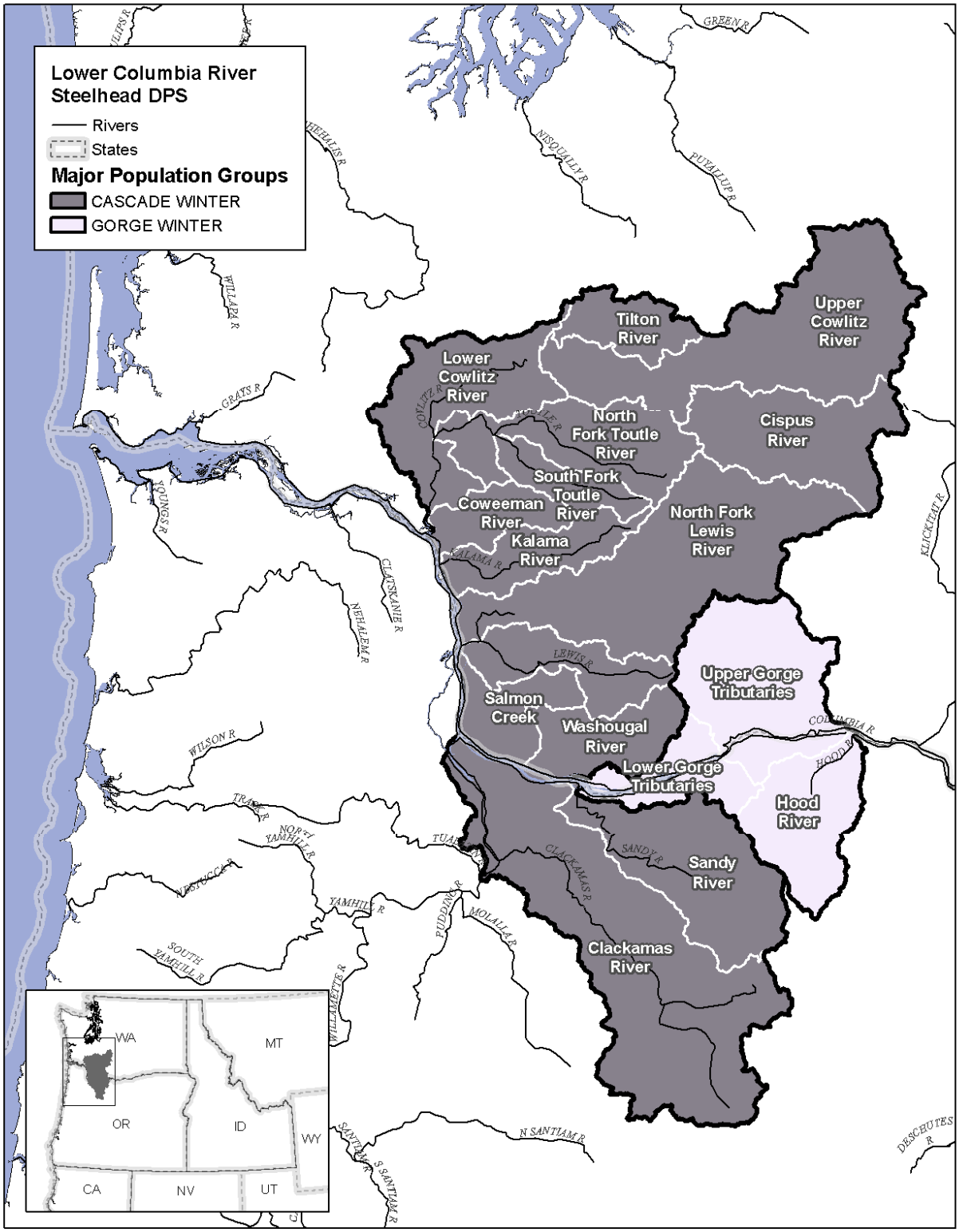


Figure 2-6. Lower Columbia River Steelhead DPS showing strata and independent populations of winter steelhead runs.

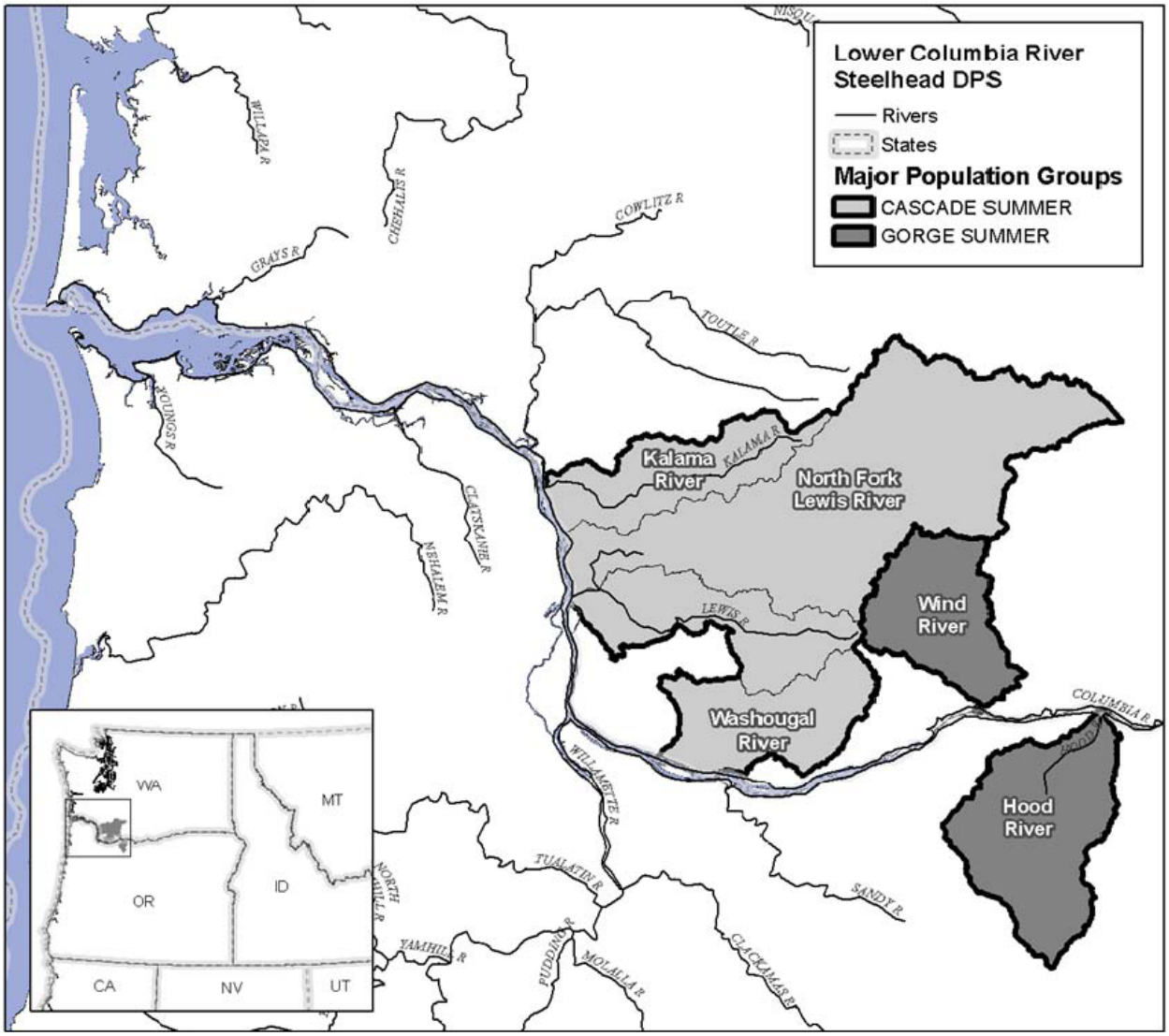


Figure 2-7. Lower Columbia River Steelhead DPS showing strata and independent populations of summer steelhead runs.

2.3.4 Chum Salmon

The WLC-TRT identified three strata and 16 historical independent chum populations in the CR chum salmon ESU (Table 2-4). Figure 2-8 shows strata and independent populations in the Columbia River chum salmon ESU.

Table 2-4. Strata, independent populations, and hatchery programs included in the listed Columbia River Chum ESU.

Columbia River Chum ESU	
ESA Listing: Threatened	
3 Strata	16 historical populations
Strata	**Population***
Coastal	Grays (C,G), Elochoman (C), Mill Creek, Youngs Bay (C), Big Creek (C), Clatskanie, Scappoose
Cascade	Cowlitz (C), Kalama, Lewis (C), Salmon Creek, Washougal, Clackamas (C), Sandy
Gorge	Lower Gorge (C,G), Upper Gorge
Hatchery programs included in ESU (3)	Chinook River (Sea Resources Hatchery), Grays River, and Washougal/Duncan Creek

*(C) indicates that the population is a core population, (G) that it is a genetic legacy.

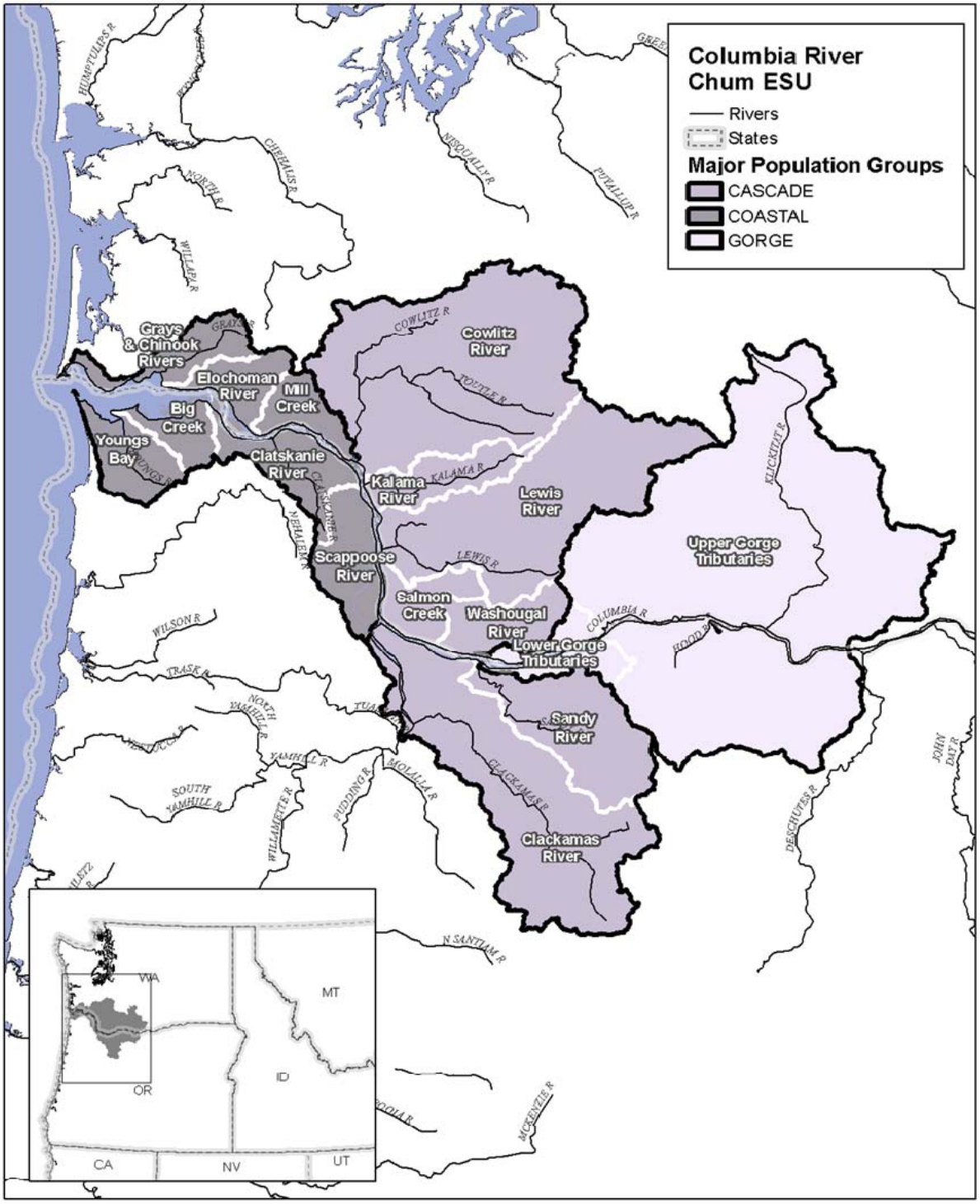


Figure 2-8. Columbia River Chum salmon ESU showing strata and independent populations.

2.4 Differences between NMFS and Oregon Designations

Oregon status assessments conducted under the Native Fish Conservation Policy resemble assessments for ESA recovery. Both assessments focus on groups of populations from a common geographic area with similar genetic and life history traits. In Oregon's status assessments, these areas are called Species Management Units (SMUs). Each SMU is further subdivided into breeding populations, again similar to the federal convention for salmon and steelhead under the ESA.

Oregon's SMUs and designated populations in the lower Columbia area differ somewhat from the ESUs and populations defined under the ESA (compared in Table 2-5). The Oregon approach for describing SMUs, which relied more on life history criteria, designated two SMUs for lower Columbia Chinook and two SMUs for lower Columbia steelhead, with separate spring and fall Chinook SMUs and separate winter and summer steelhead SMUs. The boundaries set by the state and federal governments are also different. For steelhead, the boundary for the Oregon Lower Columbia Winter Steelhead SMU extends from the mouth of the Columbia River up to and including the winter steelhead population in Fifteenmile Creek (rkm 308), while the boundary for the LCR steelhead DPS reaches only from the mouth of the Willamette River (rkm 165) up to and including the winter steelhead population in Hood River (rkm 270). Steelhead populations downstream of the Willamette (not ESA-listed) are assigned to a coastal Washington steelhead DPS and steelhead populations upstream of Hood River are included in the ESA-listed Mid-Columbia steelhead DPS (Busby et al. 1996, 71 FR 834). For Chinook, Oregon's two Chinook SMUs are contained within the boundaries of the LCR Chinook ESU. However, while both Oregon and NMFS placed the historical Clackamas fall Chinook population in the lower Columbia, NMFS placed the Clackamas spring Chinook population with the Upper Willamette River ESU, which is also listed as Threatened (Myers et al. 1998, 70 FR 37160). Designations of individual breeding populations also differ somewhat between the State of Oregon and federal conventions (Table 2-5), reflecting both the differences in ESU verses SMU boundaries and some alternative population divisions within the ESUs and SMUs. The federal convention also takes populations in Washington into consideration and several federal populations cross state boundaries. The sand state conventions similarly include only anadromous *O. mykiss* (steelhead) and exclude resident fish (rainbow trout).

The NFCP (2005) status assessment assigned interim status assessments to Oregon populations in the lower Columbia SMUs (ODFW 2005a). All SMUs were given interim status assignments of "At Risk" except for the Lower Columbia Chum SMU, which was considered to be "Functionally Extirpated". The State of Oregon has also listed some of these SMUs under the Oregon State Endangered Species Act (ORS 496.171-496.192, with implementing rules OAR 635-100- 0080 to 0194) or under Oregon State Sensitive Species Rules (OAR 635-100-0040). Most notable, the Lower Columbia Coho SMU is listed as an Oregon State Endangered Species and is provided with specific management and recovery guidelines by Oregon State Administrative Rule (OAR 635-100-0125, OAR 635-100 -0190 to 0194). Lower Columbia River Fall Chinook, Chum, and Winter and Summer Steelhead SMUs are listed as Oregon State Sensitive Species, designation "Critical" (OAR 635-100-0040) (Table 2-5).

Table 2-5. A comparison of federal and Oregon State conservation management units (ESUs, SMUs, and populations) in the lower Columbia River.

Federally Listed Species (ESU or DPS)	Federally Recognized Populations	Federal Listing Status	Corresponding State Management Unit (SMU)	State Recognized Populations	State Status	Interim Assessment
Lower Columbia River Coho	Youngs Bay Big Creek Clatskanie Scappoose Clackamas Sandy Lower Gorge Upper Gorge/Hood	Threatened	Lower Columbia River Coho	Youngs Bay Big Creek Clatskanie Scappoose Clackamas Sandy Bonneville	Endangered	At Risk
Lower Columbia River Chinook (spring and fall runs)	Youngs Bay *(fall)* Big Creek *(fall)* Clatskanie *(fall)* Scappoose *(fall)* Clackamas *(fall)* Sandy *(fall)* Sandy *(late fall)* Lower Gorge *(fall)* Upper Gorge *(fall)* Hood *(fall)* Sandy *(spring)* Hood *(spring)*	Threatened	Lower Columbia River Fall Chinook	Youngs Bay Big Creek Clatskanie Scappoose Clackamas Sandy *(tule)* Sandy *(late)* Hood	Critical	At Risk
			Lower Columbia River Spring Chinook	Sandy Clackamas Hood	Not Listed	At Risk
Lower Columbia River Steelhead (winter and summer runs)	Clackamas *(winter)* Sandy *(winter)* Lower Gorge *(winter)* Upper Gorge *(winter)* Hood *(winter)* Hood *(summer)*	Threatened	Lower Columbia River Winter Steelhead	Youngs Bay Big Creek Clatskanie Scappoose Clackamas Sandy Gorge Hood Fifteenmile	Critical	At Risk
			Lower Columbia River Summer Steelhead	Hood	Critical	At Risk
Columbia River Chum	Youngs Bay Big Creek Clatskanie Scappoose Clackamas Sandy Lower Gorge Upper Gorge	Threatened	Lower Columbia River Chum	Youngs Bay Big Creek Clatskanie Scappoose Clackamas Sandy Gorge	Critical	Functionally Extirpated

The differences between ODFW's LCR SMU populations and NMFS LCR ESU populations are:

- Clackamas spring Chinook are included by ODFW in the LCR spring Chinook SMU, but are included in the Upper Willamette River (UWR) Chinook ESU by NMFS;

- Coast stratum winter steelhead are included by ODFW in the LCR winter steelhead SMU, but are excluded from the LCR steelhead DPS by NMFS (included in the Southwest Washington DPS);

- Fifteenmile winter steelhead are included by ODFW in the LCR winter steelhead SMU, but included in the Mid-Columbia steelhead DPS by NMFS; and

- Oregon's designates fewer populations in the Gorge stratum, across species, than NMFS.

To account for these differences, this Plan addresses Clackamas spring Chinook (also included in the UWR Plan; ODFW 2010) and Coast stratum steelhead, but excludes Fifteenmile Creek steelhead because they are addressed in the *Conservation and Recovery Plan for Oregon Middle Columbia Steelhead Populations in the Middle Columbia River Steelhead Distinct Population Segment* (ODFW 2010b). These additions and exclusions have no effect on the recovery portion of this Plan. NMFS's finer-scale population designations in the Gorge stratum are used in order to comply with required federal recovery analyses. However, as noted in Appendix B and Chapter 6, Oregon believes the Gorge stratum population designations merit further consideration given that there is some uncertainty with these designations and they may artificially hinder achievement of recovery goals.

It should also be noted that during the development of this Plan, the Planning Team expressed particular concern regarding the designation of Clackamas and Sandy "tule" Chinook as distinct populations. There is belief within the Planning Team, and in particular with on-the-ground biologists, that late fall Chinook are the only true historical native populations in the Clackamas and Sandy, and possibly other Lower Columbia River fall Chinook population areas.

2.5 Critical Habitat

NMFS designated critical habitat for CR chum and LCR Chinook and steelhead on September 2, 2005 (70 FR 52630). Essential features of designated critical habitat include aspects of substrate, water quality, water quantity, water temperature, food, riparian vegetation, access, water velocity, space, and safe passage that are associated with viability for the ESUs. Critical habitat designations for Columbia River chum include 1,139 km of stream habitat; designations for Lower Columbia Chinook include 2,110 km of stream habitat and 85.5 sqkm of lake habitat; and designations for Lower Columbia steelhead include 3,740 km of stream habitat and 70 sqkm of lake habitat, in both Oregon and Washington. Detailed maps of specific critical habitat boundaries for each ESU are provided in the Federal Register notice. Critical habitat maps and information are available at the following website: http://www.nwr.noaa.gov/Salmon-Habitat/Critical-Habitat/Index.cfm. Critical habitat has not yet been designated for Lower Columbia River coho.

Chapter 3: Conservation and Recovery Goals, Criteria, and Analyses

This chapter describes the recovery goals that frame the State of Oregon's path toward recovery of the lower Columbia River salmon and steelhead populations. First, the populations must reach desired levels of biological viability to support removal of the LCR coho and Chinook ESUs and steelhead DPS, and CR chum ESU from the threatened and endangered species list. Second, the State of Oregon seeks to rebuild the populations to provide for sustainable fisheries and other ecological, cultural and social benefits. The chapter identifies potential biological viability criteria that the populations should meet to support delisting of the ESUs. It also describes the timeframe for the Plan, and analyses that were conducted to complete it.

3.1 Recovery Goals

Oregon has adopted two recovery goals for lower Columbia River salmon and steelhead. This Plan discusses the current status, desired status, and strategies and actions needed to achieve these recovery goals. The recovery goals are to:

1) achieve delisting from the federal ESA threatened and endangered species list, and

2) achieve "broad sense recovery", defined as having Oregon populations of naturally produced salmon and steelhead sufficiently abundant, productive, and diverse (in terms of life histories and geographic distribution) that the ESUs as a whole (a) will be self-sustaining, and (b) will provide significant ecological, cultural, and economic benefits.

Broad sense recovery is addressed in Chapter 10. The remainder of this chapter and Chapters 6, 7, and 9 primarily identify and address the goal, criteria (Chapter 3), desired status, threat reduction scenarios (Chapter 6), and actions (Chapters 7 and 9) for recovery aimed at achieving delisting.

3.1.1 ESA Delisting Recovery Goal

The primary goal is to support removal of LCR coho, Chinook and steelhead and CR chum from the threatened and endangered species list. Under the ESA, a species can be delisted when it is no longer in danger of extinction or likely to become endangered within the foreseeable future. NMFS is the agency with ESA jurisdiction for salmon and steelhead, and will evaluate ESU status in order to make delisting decisions.

In accordance with their responsibilities under Section 4(c)(2) of the Act, NMFS will conduct status reviews of the affected ESUs at least once every five years to evaluate the ESUs status and determine whether the ESU should be removed from the list or changed in status. NMFS has noted that such evaluations should consider:

- principles laid out in the NMFS Technical Memorandum *Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units* (McElhany et al. 2000),
- recommendations in the WLC-TRT's Interim Reports on Viability Criteria (McElhany et al. 2003, 2006),
- recommendations in recovery plans,
- best available information on population and ESU status and new advances in risk evaluation methodologies, and
- further technical team recommendations including: the number of viable populations; the number and status of other extant populations; the status of core populations; the distribution of

viable populations relative to the range of historical conditions supporting viable populations; linkages and connectivity among viable populations; the diversity of life history and phenotypes expressed; and considerations regarding catastrophic risk.

3.2 Recovery Criteria

Oregon used two sets of criteria, delisting criteria and broad sense criteria, in the development of this Plan. Achieving the criteria will determine whether the two recovery goals have been met. These criteria shaped the analyses conducted to determine the current and desired recovery status of populations.

> ***Delisting criteria***: Criteria incorporated into ESA recovery plans that define both biological and listing factors (i.e., threats or factors for decline) statuses that, when met, could 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. The biological viability criteria identified by the WLC-TRT are considered the biological delisting criteria. These criteria are based on the population-level parameters of abundance, productivity, spatial structure, and diversity, which describe an independent population, stratum, and ESU with a negligible risk of extinction over a 100-year time frame (i.e., a "viable salmonid population" [VSP]). These criteria are used as technical input into the recovery planning process and provide a technical foundation for development of biological recovery criteria[6]. Listing factors, or threats, criteria are based on the five listing factors in ESA section 4[a][1]. Final delisting criteria and delisting decisions are a NMFS determination and may include both technical and policy considerations.
>
> ***Broad sense recovery criteria***: Criteria that go beyond the requirements for delisting to attain goals defined in the recovery planning process, generally by local stakeholder groups, that, for example, address other legislative mandates or social, economic, and ecological values[7].

3.2.1 Delisting Criteria

Evaluating a species for potential delisting requires an explicit analysis of population or demographic parameters (the biological delisting criteria), and threats under the five ESA listing factors in ESA section 4(a)(1) (threat delisting criteria). Together these make up the "objective, measurable criteria" required under section 4(f)(1)(B). In addition to evaluating threats identified at the time of listing, any new threats identified since listing must also be assessed to ensure that the species no longer requires protection as a threatened species.

NMFS has developed a decision framework for making delisting decisions that consists of a series of question sets that address the status and change in status of a salmonid ESU and the risks posed by threats to the ESU (NMFS 2007a). The relationship between biological criteria, threats criteria, and research, monitoring and evaluation as it pertains to determining an ESU's status is illustrated in Figure 3-1. The framework was developed to inform recovery planners of how NMFS intends to evaluate ESU status along with the questions that research, monitoring and evaluation programs should answer in support of status evaluations.

[6] Viability criteria can become delisting criteria if adopted or recommended in a recovery plan and used by NMFS in delisting decisions.
[7] Broad sense recovery criteria are contained in Chapter 10.

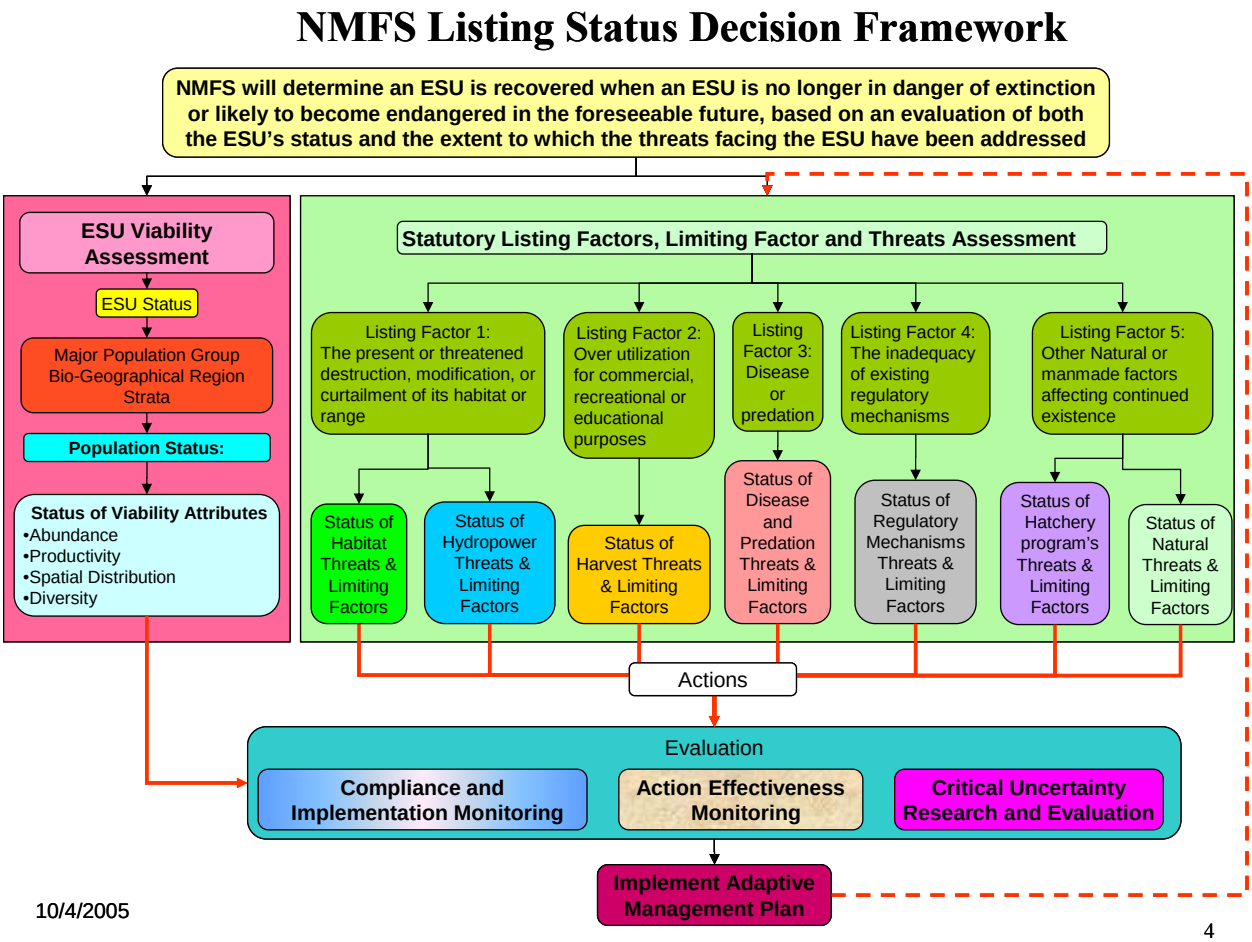


Figure 3-1. NMFS listing status decision framework (from NMFS 2007a).

The delisting criteria comprise the core standards that NMFS believes will lead to conditions upon which the decision to delist a species will be based. The sections below describe biological criteria and threats criteria (listing factors) that Oregon endorses and believes would satisfy the requirements for delisting criteria for lower Columbia River salmon and steelhead populations.

Because all ESA-listed LCR salmon and steelhead ESUs and the CR chum ESU include populations that are produced in Oregon and Washington, performance by some combination of both Oregon and Washington populations will be required to meet delisting criteria.

<u>Biological Delisting Criteria</u>
ESA delisting criteria must include a biological component that incorporates an explicit analysis of population or demographic parameters. To provide a technical foundation for developing biological delisting criteria, NMFS appointed geographically based TRTs, which recommended biologically based viability criteria for application to ESA-listed salmon and steelhead ESUs. The WLC-TRT (McElhany et al. 2003, 2006) defined interim biological viability criteria at the levels of the ESU, strata (spatially related populations), and component populations. The WLC-TRT's approach to viability criteria was guided by a NMFS Technical Memorandum (McElhany et al., 2000) and was based on the same biological principles used by other TRTs, applied in a way specific to information available for the listed lower Columbia River ESUs. The viability criteria identified the biological characteristics and conditions that defined viable populations and strata, and by extension, viable ESUs. At the population level the

criteria are based on the biological parameters of abundance, productivity, spatial structure, and diversity[8]. For ESU level viability criteria, the WLC-TRT considered the geographic distribution and characteristics of component populations to maintain a viable ESU in the context of longer-term ecological and evolutionary processes (see review in Ruckelshaus et al. 2002). Therefore the ESU level viability criteria includes a framework which determines how many and which populations should be at a particular extinction risk level (very low, low, moderate, high, very high; see Chapter 4 for how these risk levels are determined) for the ESU to have an acceptable low risk of extinction. Population boundaries for Pacific salmonids in the Willamette/Lower Columbia domain have been identified (Myers et al. 2006) and the population strata groupings are described in McElhany et al. (2003, 2006).

The ESU-level viability criteria developed by the WLC-TRT incorporated population-level risk assessment attributes, and had five essential elements (McElhany et al. 2003, 2006):

1. *Stratified Approach*: Life history and ecological complexity that historically existed should have a high probability of persistence into the future. The WLC-TRT stratified the Lower Columbia River recovery sub-domain populations into strata based on ecoregion characteristics, life history types and other geographic and genetic considerations.
2. *Viable Populations*: Individual populations within a stratum should have persistence probabilities consistent with a high probability of stratum persistence. The WLC-TRT defined high persistence probability of a stratum as the presence of at least two "viable" historical populations (>95% probability of persistence over 100 years and persistence category score ≥3 on a scale from 0 to 4) and an average of persistence category scores for all historical populations ≥2.25.
3. *Representative Populations*: Representative populations need to achieve viability criteria or be maintained, but not every historical population needs to meet the 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.
4. *Non-deterioration*: No population should be allowed to deteriorate until ESU recovery is assured, and all extant populations must be maintained. Current populations and population segments must be preserved. Recovery measures will be needed in most areas to stop further decline and offset the effects of future impacts.
5. *Safety Factors*: Higher levels of recovery should be attempted in more populations than the minimum needed to achieve ESU viability because not all attempts will be successful. In addition, there needs to be sufficient viable populations to ensure that the stratum is buffered from the risks of catastrophic events, degraded metapopulation processes, and degraded evolutionary processes. 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. Support for these recommendations is provided in the viability reports cited below.

After reviewing the viability criteria recommended by the WLC-TRT (McElhany et al. 2003, 2006), Oregon concluded that the WLC-TRT's recommendations largely describe the characteristics of an ESU that meet or exceed the biological requirements for viability. Oregon, therefore, has based this Plan on these criteria and recommends that NMFS consider delisting the four listed salmonid ESUs addressed by this Plan when the following *biological delisting criteria* are achieved:

[8] The VSP report separates abundance and productivity into two separate attributes for a total of four attributes, but because the effects of abundance and productivity on extinction risk are so interconnected, the WLC-TRT analyzed them together.

1) **ESU/DPS**: all historically existing strata meet **Stratum** delisting criteria[9].
2) **Stratum**: the stratum has a high probability of persistence, where high probability of stratum persistence is defined as:
    a) at least two populations in the stratum meet **Population** viability criteria,
    b) the average of all stratum population extinction risk category scores is 2.25 or greater, and
    c) all populations not meeting **Population** viability criteria do not deteriorate and are maintained.
3) **Population Viability**: a population is "viable" based on an integrated assessment of the population's abundance, productivity, spatial structure, and diversity statuses that produces an extinction risk classification score ranging from 0-4, based on the WLC-TRT's scoring system[10],[11].

NMFS has noted that decisions to delist do not necessarily have to be made based on whether or not an ESU meets delisting criteria proposed or used for purposes other than actually making a delisting decision. Delisting criteria may represent requirements that are greater than what is needed for an ESU to be delisted. Conversely, they may represent requirements that are not enough to achieve delisting. Generally though, the criteria stated above should be considered a baseline at which delisting is very likely, but the criteria are not necessarily the minimum status necessary to qualify for delisting. Nothing in these criteria should be understood as precluding a delisting determination in circumstances where not all the criteria have been satisfied, provided that an ESU is no longer in danger of extinction or likely to become endangered within the foreseeable future. Oregon supports this interpretation and recommends it for this Plan.

Threats Delisting Criteria

Evaluating the potential reclassification or delisting for a species or ESU also requires an explicit analysis of threats under the five ESA listing factors at ESA Section 4(a)(1). Establishing measureable criteria for each of the relevant listing/delisting factors helps to ensure that underlying causes of decline have been addressed and mitigated prior to considering a species for delisting. Legal challenges to recovery plans have affirmed the need to frame recovery criteria in terms of threats as assessed within the five listing factors. Oregon agrees with statements by NMFS in delisting criteria for other plans that these threats may not all be of equal importance in securing the recovery of an ESU, and that therefore every potential threat may not need to be fully addressed before delisting is possible. In fact, Oregon believes that applying equal effort to address every potential limiting factor and threat is counterproductive since it may mean that inadequate resources are directed at the limiting factors and threats that truly play the most significant role in impeding population viability. This is why Oregon has conducted an assessment of limiting factors and threats (Chapter 5). This assessment provides a prioritized listing of the factors responsible for the current status of Oregon LCR coho, Chinook, and steelhead and CR chum populations and is used as the basis for identifying recovery actions (Chapter 7). This is not to say that attention should not be paid to potential limiting factors and threats that do not currently have significant impacts on these salmon and steelhead populations. Rather, the approach should be to ameliorate the impacts of

[9] Given the results of our status and scenario modeling (Chapters 4 and 6), particularly with respect to the Gorge stratum and its populations, ODFW does not feel that this criterion can be feasibly met. For most ESUs, not all strata will meet the Stratum delisting criteria. ODFW feels that the inability to meet this criterion is largely an artifact of the strata and population structure and classification that the WLC-TRT developed. It may be worthwhile to reconsider these for consistency with other plans and ecoregion, genetic, and viability information. See Appendix B and Chapter 6 for a more complete discussion of this issue.
[10] Viable populations have an extinction risk less than 5%, corresponding to at least a 95% persistence probability and a risk classification score of 3 or greater.
[11] Additional measurable criteria related to monitoring a population's progress in these four VSP parameters through time relative to its desired status (Chapter 6) are given in Chapter 8.

current key and secondary limiting factors and threats, while at the same time ensuring that factors not currently posing a significant threat do not do so in the future.

Oregon believes that, in general, threats delisting criteria should demonstrate that there has been measurable progress or improvement made toward resolving threats that contributed to listing decisions and decline, and/or affect the biological status of populations, or demonstrate that threats are being managed at a level consistent with recovery as identified in this Plan. The following are the listing factors for which threat delisting criteria have been developed or may need development:

A) The present or threatened destruction, modification, or curtailment of a species' habitat or range,
B) Overutilization for commercial, recreational, or educational purposes,
C) Disease or predation,
D) The inadequacy of existing regulatory mechanisms, and
E) Other natural or man-made factors affecting continued existence.

Oregon does not believe it is feasible or necessary to set quantitative criteria for all of the potential threats in each listing factor, especially if biological delisting criteria are being met. Chapter 5 of this Plan describes the threats to Oregon populations of LCR salmon and steelhead and CR chum that have resulted from hydropower operation, harvest, current and historical land use, hatchery operations, and changes within marine and freshwater ecosystems. See Chapter 8 for a description of specific measurable criteria for monitoring and evaluating specific threats within these listing factor categories. If further criteria relative to the listing factors need development, Oregon suggests that this occur during the implementation phase of this Plan at the ESU level with NMFS, Washington, and Oregon participation.

3.3 Conservation and Recovery Plan Timeframe

The Plan is a 25-year plan that guides conservation and recovery actions, beginning in the year that the OFWC approves the Plan. The basis for the 25-year timeframe is that actions are scheduled through this time period, as detailed in Chapter 9, though most actions are scheduled to be completed earlier than this. Note that the delisting and broad sense goals of the Plan are not necessarily expected to be achieved within this timeframe, given lag time between action completion and both habitat and population responses.

The 25-year period should not be confused with other timeframes mentioned in the Plan. These include a) the 100-year period used in population viability models to determine extinction risks (Chapter 4 and 6), b) the 60-year period used to model the time necessary for habitat restoration actions to achieve their full benefit (Chapter 6), c) the immediate, 5, 10, 15, or 20-year timeframes scheduled for many actions (Chapter 9), d) the major assessment of the Plan called for after 12 years (Chapter 9), e) the required Implementation Schedules with priorities produced every three years (Chapter 9), or f) the ability to adaptively management specific strategies and actions on an as needed basis (Chapter 9).

Given the adaptive management component and the 12-year assessment timeframe, the Plan should not be considered to be static for the 25-year timeframe. Defining a Plan period was necessary to structure action implementation needs, as well as overall Plan costs (Chapter 9). However, the Plan is designed to be flexible to account for new information, analyses, science, strategies, actions, criteria, population structures, or policy direction that arise within that timeframe.

3.4 Summary of Analyses and Plan Contents

The analyses and approach for developing this Plan were determined by guidance and technical documents produced by NMFS and the TRTs, requirements of the Native Fish Conservation Policy, and

the quality and types of data that exist (or do not exist) for the LCR coho, Chinook and steelhead ESUs and CR chum ESU. NMFS recovery documents and analyses, while sometimes adopted with modifications, determined the population structure which was assessed (Myers et al. 2006); recovery criteria (McElhany et al. 2000, 2003, and 2006); the type of analyses that were conducted to determine the current status of populations with respect to recovery criteria (McElhany et al. 2007); general considerations for determining desired status (NMFS 2007b); and research, monitoring, evaluation, adaptive management, and implementation considerations (NMFS 2007a). This Plan has also adopted many of the scientific recommendations developed in an independent scientific review conducted for other recovery and conservation plans[12]. The major theme in those recommendations has been the presentation of uncertainty. Discussions within the relevant chapters of this Plan document the different types of uncertainty, with the objective of putting uncertainty in context and clarifying how it is addressed. The remainder of this section describes some general strategies that were employed to reduce some of the potential negative effects of uncertainty, relative to improving the chances of meeting recovery plan goals.

With respect to data availability and quality, the analyses of population status required a number of inferences from other data to fill data gaps for certain populations. These are described in their respective chapters. In addition, because data relating specific threats to different life history stages are essentially non-existent, the analysis of limiting factors and threats was based largely on professional judgment. Actual threat rates for broad and general categories that were not life stage-specific were determined subsequently in order to determine scenarios for achieving desired statuses, but these did not provide the specific guidance necessary to determine actions that the initial analysis did. Both analyses were necessary to complete the Plan. Likewise, because of the lack of habitat-based data for most populations, a modeled approach was not used to determine whether specific habitat-based actions would provide the desired improvements in this area. Instead, professional judgment was used in this area to assess whether the proposed type, location, and amount of actions would achieve the desired statuses.

Given data gaps, analyses without direct field data, the potential for imprecise, biased, or inaccurate data, assumptions, and analyses, various methodologies and timeframes to analyze actual data for input, the number of inter-related analyses that could compound errors, and the inability to adequately account for cumulative effects across limiting factors and threats, there is a fair amount of uncertainty in the analyses. Individual instances of uncertainty are noted with the description of each analysis. However, an overall assessment of uncertainty has not been completed (largely because of the complexity of the analyses and uncertainty associated with such an analysis). In order to compensate for uncertainty, a fair number of "analytical conservation buffers" are factored in to the analyses. These buffers are intended to assure that the analyses do not err on the side of determining that recovery goals (i.e., these generally being low extinction risks for many populations and the ESUs as wholes) have been met when in fact they have not, allowing lower Columbia salmon and steelhead to remain at risk without actions being taken to address this uncertainty. These analytical conservation buffers are described within each chapter and are summarized here:

1) Extinction Probability Adjustment. Extinction risk thresholds for different risk classifications were lowered from what was contained in McElhany et al. (2007). This means that a population had to have a lower probability to reach a particular extinction risk classification, which corresponded to a higher probability of persistence and viability. Essentially, this approach "raised the bar" for all risk classes for all populations.

2) Climate Change and Population Growth. The bar was raised further by adding an additional 20 percent abundance increase necessary to reach a certain risk classification (note: this is in

[12] http://www.fsl.orst.edu/imst/reviews.html

addition to the first buffer described). This 20 percent was justified as compensation for unknown and/or unanalyzed future threats due specifically to development from population increase and climate change. It was based on professional judgment of the approximate amount of additional threat that may be realized over the 25 year timeframe of this Plan.

3) "Weight of Evidence" (WOE) Approach. A WOE approach was taken to support the analyses and their results. This means that, where possible, independent analyses were conducted to verify or compare the results of the primary analyses. WOE analyses included comparing a) Species Life-cycle Analysis Modules results to Conservation Assessment Tool for Anadromous Salmonids and Scenario Analysis results, b) Ecosystem Diagnostic and Treatment (EDT) model output to the estimates of mortality associated with tributary habitat degradation, and c) overlaying the results of the limiting factors and threats analysis (based on professional judgment) with the general, data-based estimates of threat category impacts.

4) Research, Monitoring, and Evaluation. RME was made an overarching strategy and requirement for Plan implementation. This will support data gathering to gain information that was not available for analysis in this Plan. The data will be used in future assessments to decrease uncertainty in those analyses, improve precision, bias, and accuracy of data that were used in this Plan, and verify results contained in the Plan and allow for changes if they are needed (i.e., adaptive management).

In addition to the uncertainty with respect to the analyses, there is also uncertainty with respect to whether the proposed actions are enough to get to recovery and whether the proposed actions will actually be completed. There is uncertainty related to whether the actions are sufficient for recovery because specific actions were not analyzed with respect to the desired status for each population. As stated previously, the data do not exist to do this adequately. There is uncertainty with respect to getting actions done because of the voluntary nature of this Plan, costs associated with recovery in times of economic hardship at the local, state, and federal level for both private and public entities, and the feasibility of some required actions due to conflicts with other societal goals, uncooperative or uninterested potential partners, inordinate cost, and/or technological uncertainty of solutions. To address action uncertainty, the Plan takes the following approaches:

1) Analytical Conservation Buffers. The previously-described buffers used for helping to assure that the analyses were conservative (i.e., possibly overestimating the likelihood of extinction for the current statuses and not underestimating the likelihood of recovery for the desired statuses) will have the additional benefit of potentially achieving the desired statuses even if the expected level or amount of actions are not achieved, or prior to their achievement.

2) Adaptive Management. Coupled with the RME necessary to address the analyses' uncertainty in the future, a large emphasis was placed on the need for adaptive management based on the results of the RME. This will help determine if actions are adequate, need to be modified, need to be implemented at a faster rate, or even if they can be stopped for a given population and allow the focus limited resources elsewhere.

3) Comprehensive Threat Reduction Intent. Specific actions are called for to reduce all relevant threats to lower Columbia salmon and steelhead populations. Efforts should be made to implement as many projects as possible for each action in order to make up for actions or projects at other sites that are not implemented. These actions and projects should be consistent with the funding priorities described in Section 9.1 and the *Implementation Schedules* described in Section 9.2. In particular, tributary and estuary habitat improvements

should continue regardless of any specific levels called for in this Plan and the Estuary Module, given uncertainty over future threats and the level of action effectiveness at any site.

4) Implementation Timeline. Although the schedule in Table 9-3 gives a timeframe within which all projects for a specific action should be completed, this Plan calls for action implementation to begin or continue at as high a level as possible *immediately*. This should serve to slow the decline of those populations which are still accumulating impacts in certain threat categories. It should also serve to move populations onto a recovery "trajectory" more quickly so that benefits are compounded into the future and recovery is achieved more quickly. Relative to this strategy, it should be noted that most of the ESUs have been listed for over a decade and the analyses and development for this Plan began over three years ago. Although not noteworthy in terms of plan development, this has two results that aid the recommendation of immediate implementation. First, a large number of actions intended to recover lower Columbia salmon and steelhead have already been implemented or partially implemented. Habitat work has been on-going (although habitat impacts have as well). Fish managers have also implemented and are implementing extensive and beneficial harvest and hatchery reforms (e.g., mark-selective fisheries, hatchery production shifts and reductions). Hydropower and predation actions are also on-going. The second benefit is that the data timeframe for the analyses uses slightly dated threat rates. This actually adds to the analytical conservation buffers mentioned previously, in that an overestimation of threats leads to an overestimation of extinction risk and a resulting overcompensation in proposed actions (although those actions that have already been implemented are noted).

As an additional note relative to uncertainty within the Plan and how acceptance of this uncertainty guided the analyses, the Plan is viewed in some respects as a working hypothesis to be tested. The statuses, gaps, limiting factors and actions to achieve recovery are being proposed and the implementation process, with its dependence on RME and adaptive management, will test to see if the Plan's hypothesis is correct. Unlike a purely scientific process, there is a societal expectation in developing a recovery plan to provide clear guidance in a timely manner on what needs to be done to recover listed ESUs. Attempting to ensure that analyses have factored in all potential sources of uncertainty, and identifying multiple alternative scenarios to cover the range of possible outcomes as a result of the uncertainty would only create confusion on which important actions should be taken. The Plan has attempted to make reasonable adjustments based on uncertainty and provides clear guidance to begin implementing recovery actions along with an adaptive management process that will allow for adjustments to the Plan as information from RME provides more certainty.

Also, it should be re-emphasized that the basic unit for identifying current and desired status was an "extinction risk classification", based on a modeled probability of extinction. Specific numerical abundances and threat rates were calculated and used to model and understand the general level of actions likely needed for threat reductions that would contribute to achieving a specific extinction risk class relative to the current extinction risk class in the long term (i.e., over the time period used for modeling [100 years] or plan implementation [25 years]). However, only if explicitly stated in the actions is it intended that these numbers (i.e., abundances or threat rates) be used to set short-term management objectives, especially since these numbers assume implementation of actions over the long term[13]. Only the actions are intended to dictate short-term management, restoration, and protection direction. Re-assessments of extinction risk in the future may be done with different and better analyses (based upon

[13] Actions specifically require hatchery stray rates to be met, given the importance placed upon them for achieving certain risk classes (i.e., 10% for low or very low extinction risk and 30% for moderate extinction risk). Conversely, specific harvest rates identified in the Plan presume actions have been implemented and are primarily for long term modeling purposes, so should not be used to set short-term harvest limits.

better data, likely resulting from RME called for in this Plan) that do not produce numbers directly comparable to those in this Plan, but which do produce an extinction risk that can be compared to the desired extinction risk classes identified in this Plan. The desired extinction risk classes, the strategies and actions necessary to get there, and the RME required to guide future analyses and adaptive management are the primary products of this Plan; everything else just allowed us to develop these roadmaps for recovery.

Finally, the NFCP guides the development of state conservation plans and requires similar assessments as federal recovery plans. The primary influence of the NFCP on this Plan is the inclusion of a broad sense recovery goal beyond the federal ESA delisting recovery goal, as described previously in this chapter.

3.4.1 Analyses and Chapter Flow

The analyses and chapter contents contained in this Plan are summarized in Figures 3-2 and 3-3. The population structure identified in Myers et al. (2006) and described in Chapter 2 was the basis for identifying populations analyzed for current and desired statuses. In addition, Oregon included several populations (i.e., Coast stratum winter steelhead and Clackamas spring Chinook) in this Plan that are identified in the *Oregon Native Fish Status Report* (ODFW 2005a) as belonging to lower Columbia River management units, but which are not included in Myers et al. (2006) determinations[14].

Two recovery goals were identified by those involved in development of this Plan for Oregon: delisting and broad sense recovery. Delisting recovery criteria were based on McElhany et al. (2006). Delisting recovery goals and criteria (Chapter 3) helped guide the determination of the delisting desired statuses (i.e., delisting extinction risk goals) for each population (Chapter 6). Chapter 10 contains the broad sense recovery goal, criteria, and desired statuses.

Data and data inferences were used to develop recruitment curves for individual populations that were the basis for a population viability assessment (PVA) model, called CATAS (Conservation Assessment Tool for Anadromous Salmonids; Chapter 4). CATAS was used to develop the current status in terms of extinction risk, and abundance and productivity (as a combined VSP parameter for simplicity). Data were used to determine the extinction risk class for the other two VSP parameters (diversity and spatial structure), which were combined with the abundance and productivity extinction risk class to get an overall extinction risk for each population. CATAS was also used to determine the necessary survival increases in terms of abundance and productivity (again, as a combined output for abundance) that were needed to get a population from its current extinction risk class to better extinction risk classes (termed "conservation gaps" for abundance and productivity). Conservation gaps were also developed for the other two VSP parameters.

A “Scenario Analysis” tool was developed to bring together the various pieces needed to identify general threat reductions. The tool used current abundance and VSP extinction risk status (from Chapter 4), historical abundance, and current threat rates for six broad categories for each population to explore different options of threat reductions that would achieve the identified desired statuses (Chapter 6). From this tool, specific scenarios were chosen to accomplish the delisting desired status (and the broad sense desired status in Chapter 10). Professional judgment, legal limitations, and information from other sources (i.e., EDT output) were used to help determine the maximum feasible threat reductions.

For each Scenario option, the threat rate reductions were assumed to be density-independent and multiplicatively combined, and this cumulative mortality was applied to historical abundance estimates to get the resulting threat reduction abundance. This abundance was then "translated" to an abundance and

[14] Also, note that this Plan identifies population designation concerns in the Gorge stratum for all LCR ESUs (see Chapters 2 and 6 and Appendix B).

productivity extinction risk class based on the conservation gaps identified in Chapter 4. Other VSP parameter risk classes were identified based on the revised threat rates for the scenario. The current abundance was subtracted from the specific, chosen, delisting scenario's abundance to get an "abundance and productivity need" which can be used to guide the level of improvement needed for a population to achieve delisting.

Current threat rates for five of the categories used in the Scenario Analysis were based upon data used in the current status assessment and other data (most notably what was contained in the Estuary Module for recovery). The sixth threat category, for tributary habitat impacts relative to "pristine", was calculated from the other threat categories and the historical population abundance based on the same multiplicative threat rate (mortality rate) equation used in the Scenario Analysis to calculate abundances. EDT output for specific populations where it existed was used to compare the results of these calculations as a WOE approach. Historical population abundances were calculated by multiplying the proportion of total "Intrinsic Potential" habitat for a population within an ESU to historical population numbers for the entire ESU.

Another PVA model was used to check the CATAS results and the threat reduction and VSP scenarios that resulted from the Scenario Analysis tool. Although the Scenario Analysis approach can quickly evaluate a suite of possible threat reduction scenarios, there is not a clear methodology to evaluate the sensitivity of the threat reductions to achieve a desired population status. Most notably, CATAS, while used to calculate conservation gaps used in the Scenario Analysis, does not explicitly incorporate life stage, does not incorporate uncertainty that surrounds factors such as environmental variability or variance around point estimates, nor does it consider the impact of the timing of recovery actions on extinction risk. As a result, it has limited ability to predict population response to reductions in threats. The Species Life-cycle Analysis Module (SLAM) was used to address these limitations (see Chapter 6). The SLAM evaluates extinction risk in a different way than CATAS, and was used as an independent comparison. A shortcoming of SLAM is that it is very laborious to construct and parameterize, and therefore it is difficult to analyze a wide array of potential recovery scenarios. Therefore, SLAM was run on a subset of scenarios that are most likely to be realized.

An Expert Panel approach, followed by refinement with the Planning Team and threat-specific managers, was used to determine the limiting factors and threats for each life stage and for different life cycle locations for each population (Chapter 5). This outcome was used as WOE to compare against the more general threat rates used in the Scenario Analysis, as well as to guide and structure specific strategies and actions to address the limiting factors and threats.

Recovery strategies and management actions necessary to address limiting factors and threats and move a population's extinction risk from its current to its desired statuses, or to maintain current population status into the future, were determined based on the results of the limiting factors and threats analysis and the Scenario Analysis (Chapter 7). Again, professional judgment and an RME-based implementation approach were used, rather than models, to determine whether the actions would achieve the desired statuses. In addition to actions developed in this recovery planning process, actions were also brought in from other plans and recovery modules (Estuary and Hydro modules, with addition actions recommended by Oregon). After the strategies and actions were identified, the necessary RME, and associated measurable criteria were defined to resolve uncertainty, fill data gaps, determine progress toward meeting biological delisting criteria (i.e., VSP parameters), quantify threats, and allow adaptive management (Chapter 8). The final step was to describe the implementation efforts necessary to carry out this Plan, including adaptive management approach and challenges.

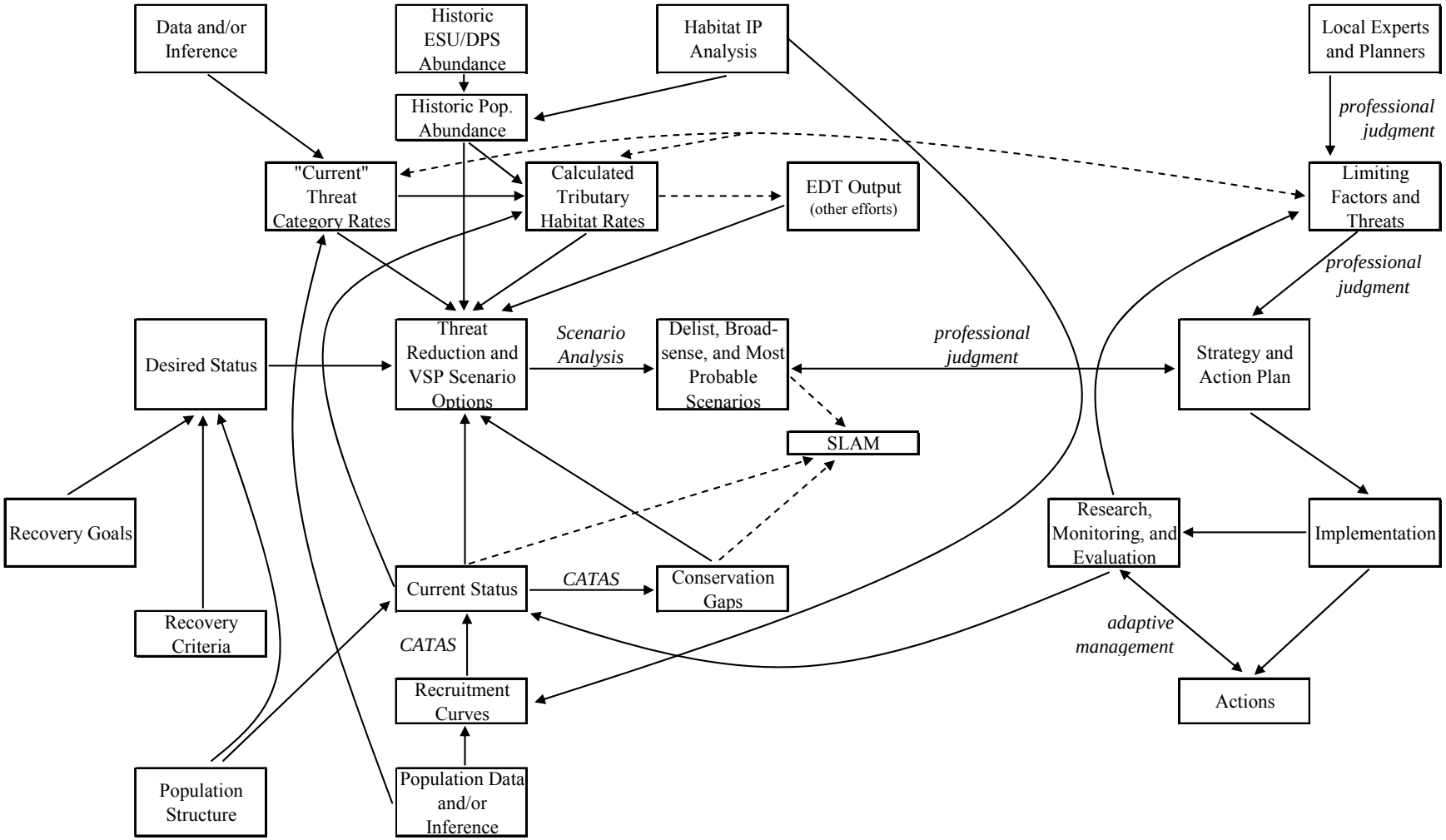


Figure 3-2. The flow of analyses and development in this Plan. Solid arrows indicate contributions to another component of the Plan. Dashed arrows indicate an independent comparison of a component of the Plan.

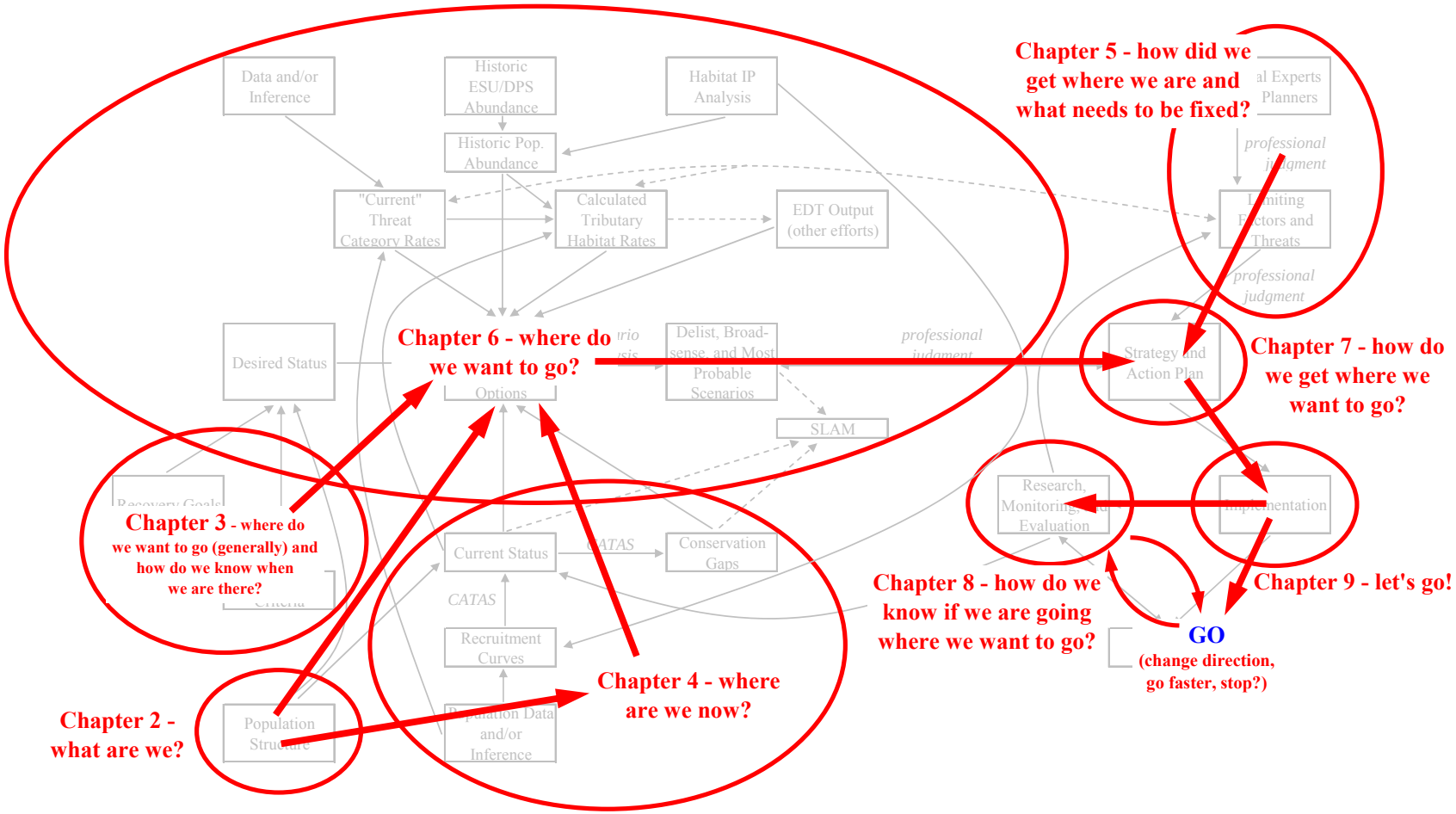


Figure 3-3. The information/analyses contained within, and flow of, chapters in this Plan. This is a simplified summary of Figure 3-2.

Chapter 4: Current Status and Conservation Gaps

The purpose of this chapter is twofold. First, it reviews and updates the 2007 status assessment of the populations covered by the Plan (McElhany et al. 2007). Second, using this status assessment as a baseline, it describes the magnitude of change needed to improve the status of each population and the methodology by which this determination was made. The term 'conservation gaps' is used to describe this magnitude of change. The focus of this chapter is the population level. How the status improvements for individual populations are combined to achieve overall delisting or broad sense recovery objectives are ESU issues and are not covered here. Rather, the chapter describes 1) how the populations are doing now and 2) how much change is needed to make them do better.

4.1 Population Current Status Assessment

Populations of steelhead, coho, Chinook, and chum salmon in Oregon's portion of the lower Columbia River salmon ESUs and steelhead DPS are the biological units of this status evaluation. In addition, because of the shared geography, the assessment also evaluates the status of the steelhead populations downstream from the mouth of the Willamette River that belong to the unlisted Southwest Washington DPS, and the spring Chinook population in the Clackamas basin which is a member of the Willamette ESU.

As described in the 2007 assessment of these populations (McElhany et al. 2007), the focus of the evaluation was to determine which populations were viable and which populations were not based on the definition of a viable salmon population developed by McElhany et al. (2000). One attribute of a viable population is that the risk of extinction is acceptably low. A viable population has less than a 5 percent chance of extinction over a 100-year period (McElhany et al. 2006).

The assessment also examined other benchmarks within the range of possible extinction risk because, in reality, population extinction probabilities can range from zero (no chance of extinction) to one (extinction is certain). Therefore, for the population status summaries and subsequent conservation gap development the range of extinction probabilities was separated into five discrete segments and each segment was designated as a distinct risk category (Table 4-1). These risk category designations (from very low to very high) are referenced through this Plan. The intent was to show either a direct quantitative or indirect qualitative link to the extinction probability assignments shown in Table 4-1 for each of these risk categories.

Table 4-1. Definition of extinction risk categories and associated extinction probabilities (McElhany et al. 2007).

Probability of Extinction	Viability Category	Risk Category	Risk Category Score
0.00 to 0.01	Viable	Very Low (VL)	4.0
0.01 to 0.05	Viable	Low (L)	3.0
0.05 to 0.25	Non-viable	Moderate (M)	2.0
0.25 to 0.60	Non-viable	High (H)	1.0
0.60 to 1.00	Non-viable	Very High (VH)	0.0

The assessment focused on the four biological VSP attributes of viable populations identified by McElhany et al. (2000): abundance, productivity, diversity, and spatial structure. Specific information for each of these VSP attributes was weighed in forecasting extinction risk. Difficulties arose, however, because the four attributes are often interrelated and difficult to separate as independent variables in their effect on extinction risk. This interaction is particularly acute between two VSP attributes, abundance and productivity. Thus, the two attributes were treated as a single entity, abundance/productivity (A/P), during the evaluation. The two attributes were evaluated and ranked as one attribute because abundance

cannot be evaluated without the context of productivity, and productivity cannot be evaluated without the context of abundance. A population with low abundance but high productivity may have exactly the same extinction vulnerability (and therefore risk category) as a population with high abundance and low productivity. Further, there are a very large number of possible combinations of abundance and productivity that may produce the same extinction risk level, a fact that underlies the abundance and productivity viability curves developed for several lower Columbia basin populations by McElhany et al. (2007).

The spatial structure and diversity attributes were treated separately during the assessment. However, because of the difficultly of developing metrics for the two attributes that could be quantitatively linked to extinction risk, a mix of qualitative and quantitative metrics were used for each of the attributes. This approach recognized that the relationship to extinction risk in most cases could not be explicitly modeled, unlike the case for the abundance/productivity attribute. The details of the methodology used to score each of these VSP attributes (spatial structure, diversity, and abundance/productivity) are provided in McElhany et al. (2007).

The approach for evaluating uncertainty was an important feature of the assessment. Due to the uncertainty associated with both the population data and the means of assessment, the results were characterized not as a single extinction risk score, but rather a distribution of possible extinction risk scores for each VSP attribute. Graphically, this is represented as a diamond shaped profile with a shape controlled by the range and frequency of possible extinction risk determinations. For example, Figure 4-1 illustrates the extinction risk profile for three different populations as determined for one of the attributes. For each population the range of possible extinction risk values is bounded by the upper and lower points of the diamonds. The extent of this vertical range reflects a determination of how much uncertainty there is for a particular population's status assessment. The width of the diamond at any point represents the likelihood that a particular level of extinction risk might be correct. Therefore, the 'waist' of the diamond, its widest point, corresponds with what would be considered the most probable risk classification.

Status assessment results were displayed as a graph of extinction risk diamonds for each VSP attribute. The overall risk determination for each population was made by combining the scores and ranges for each of the three population attributes as described in McElhany et al. (2007). This overall population rating was displayed as a fourth graph using the same format (extinction risk diamonds).

The conservation gap estimates developed during the assessment reflect current data. The population data files used for the 2007 assessment were updated with new information. A new procedure was also crafted to evaluate the A/P attribute for populations for which there were little or no data. A precautionary change was also made in interpreting the extinction risk diamonds as an additional step to address uncertainty inherent to extinction risk modeling. These modifications are described later in this chapter. Those relatively uncommon cases where these modifications resulted in a population assessment that was different from the 2007 assessment (McElhany et al. 2007) are flagged and described.

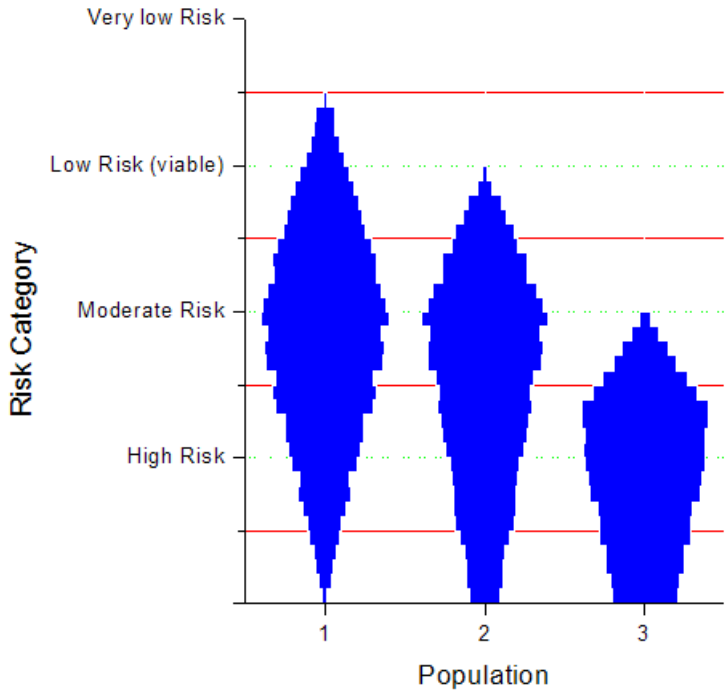


Figure 4-1. Status "diamond graphs" for three hypothetical populations with different risk profiles.

4.1.1 Coho Population Status – High Extinction Risk

The LCR coho ESU is defined as the cluster of 24 populations that historically existed in the Columbia River basin from the Hood River downstream (Figure 2-2). The boundaries for this ESU do not extend into the upper Willamette portion of the lower Columbia River basin, because Willamette Falls (near Portland) was a natural barrier to fall migrating salmonids such as coho.

Wild coho in the Columbia basin have been in decline for the last 50 years. The number of wild coho returning to the Columbia River historically was at least 600,000 fish (Chapman 1986). At a recent low point in 1996, the total return of wild fish may have been as few as 400 fish (Chilcote 1999). Coinciding with this decline in total abundance has been a reduction in the number of self-sustaining wild populations. All Columbia basin coho populations upstream of Hood River have been extirpated. Of the 24 historical populations that comprised the LCR coho ESU, only in the case of the Clackamas and Sandy is there direct evidence of persistence during the adverse environmental conditions of the 1990s. Since 2000, the numbers of wild coho have increased in both the Clackamas and Sandy basins. During this same period, naturally reproducing coho populations have become re-established in the Scappoose and Clatskanie basins.

The most plausible overall conservation status for six of Oregon's eight LCR coho ESU populations was a classification of high or very high extinction risk (Figure 4-2). The most probable status classifications of moderate extinction risk for the Scappoose and Clackamas population were the two exceptions. However, even in the case of these two populations there was considerable uncertainty associated with this conclusion, as illustrated by the vertical extent of the status diamonds for these populations (Figure 4-2). For the Scappoose, Clackamas, and Sandy population, the results of this updated assessment differ somewhat from the results of McElhany et al. (2007). As noted by the open triangles with the dotted outlines in Figure 4-2, the overall status rating changed from high to moderate for the Scappoose population, low to moderate for the Clackamas, and high to very high for the Sandy. The same changes occurred with respect to the A/P attribute for these populations. In the case of the Scappoose this

difference likely reflects the new approach for modeling populations for which there were no data. In the case of the Clackamas and Sandy, this difference was largely a result of additional years of data recently obtained for these populations.

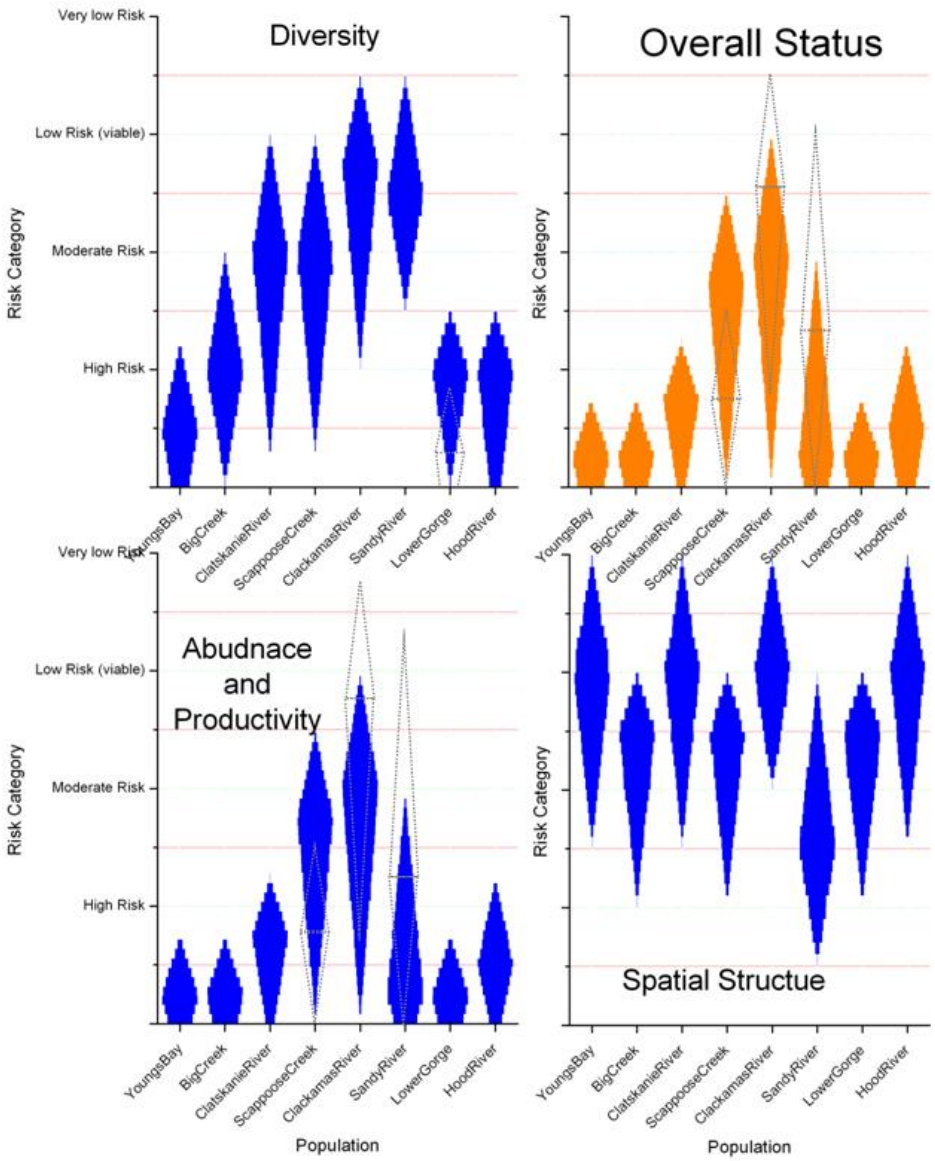


Figure 4-2. Extinction risk ratings for LCR coho populations in Oregon for the assessment attributes abundance/productivity, diversity, and spatial structure as well as an overall rating for populations that combines the three attribute ratings (adapted from McElhany et al. 2007). Where updated ratings differ from those of McElhany et al. (2007) assessment the older rating is shown as an open diamond with a dashed outline.

4.1.2 Chinook Population Status – Very High Extinction Risk

Of the 32 populations that historically comprised the LCR Chinook ESU, 12 of them occurred in Oregon, including nine fall run Chinook; one late fall run Chinook; and two spring run Chinook (Figures 2-3, 2-4 and 2-5). The lower Gorge and upper Gorge populations occurred in both Washington and Oregon, but the focus of the information provided here relates to the status of these shared populations only in the Oregon portion of their range. The status of Clackamas spring Chinook, a member of the upper Willamette ESU, is included because of its shared geography with the LCR Chinook ESU.

In general, wild Chinook in the lower Columbia basin are thought to be substantially reduced compared to historical levels (Myers et al. 1998). Coinciding with this decline in total abundance has been a reduction in the number of functioning wild populations, particularly in the case of fall Chinook in Oregon (spring Chinook populations at an ESU scale have also declined). In addition, the significant presence of stray hatchery fish is thought to be common throughout most of the range. Up to 90 percent of the naturally spawning fall Chinook in Oregon's portion of the LCR Chinook ESU are believed to be stray hatchery fish. Of the 12 historical naturally reproducing Chinook populations in Oregon's portion of the lower Columbia, only four can be confirmed as present: the early fall Chinook population in the Clatskanie, the late fall population in the Sandy, and the spring Chinook populations in the Sandy and Clackamas.

As illustrated in Figure 4-3, only one population, Sandy late fall Chinook, was determined to have a extinction risk rating of low or better (i.e. viable). The remaining 11 populations were all non-viable, with extinction risk classifications mostly in the very high and high categories. Although there was uncertainty in these status determinations, this uncertainty was not so great as to cast doubt on the fact that they were non-viable. As reflected in Figure 4-3, the status diamonds for these populations do not extend into the viable range (exceed the moderate-low risk threshold). The updated assessment of these populations did not differ appreciably from what was reported in 2007 (McElhany et al. 2007). However, in the case of the diversity attribute for both the Clackamas and lower Gorge fall Chinook populations, the risk classification changed from moderate to high (Figure 4-3).

Assessment results showed that the Clackamas spring Chinook population (a member of the upper Willamette ESU) had a most probable extinction risk rating of very low; however there was considerable uncertainty in this classification. If the evaluation results were transferred to a graph similar to Figure 4-3, the lower tail of the status diamond would extend well into the moderate extinction risk zone.

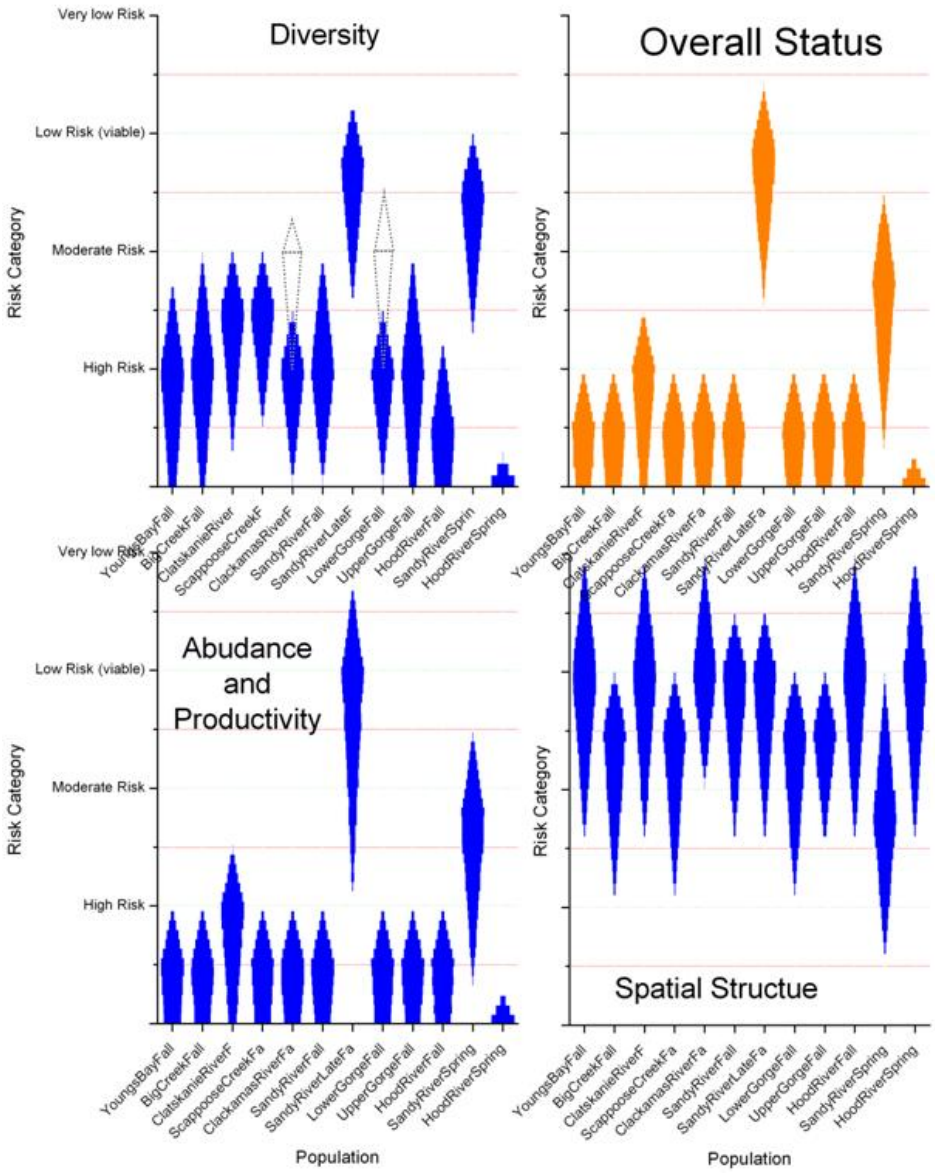


Figure 4-3. Extinction risk ratings for LCR Chinook populations in Oregon for the assessment attributes abundance/productivity, diversity, and spatial structure as well as an overall rating for populations that combines the three attribute ratings. Where updated ratings differ from those presented by McElhany et al. (2007), the older rating is shown as an open diamond with a dashed outline.

4.1.3 Steelhead Status – Moderate Extinction Risk

The LCR steelhead DPS was historically comprised of 17 winter-run and six summer-run populations (Figures 2-6 and 2-7). This section focuses on the status of the six populations that exist within Oregon's portion of this DPS, as well as populations in the Scappoose, Clatskanie, Big, and Youngs basins which are members of the Southwest Washington DPS. The boundaries for these Southwest Washington steelhead DPS populations are the same as for LCR coho ESU populations in this region (Figure 2-2).

Generally, although wild steelhead in Oregon's portion of the LCR steelhead DPS are depressed relative to historical levels, no population extirpations have occurred. However, current extinction risk estimates for these populations are large enough that they all are classified as being at moderate risk or higher, a non-viable status (Figure 4-4). In the updated assessment, the status determination for the lower Gorge population dropped from high to moderate risk and the determination for the upper Gorge population rose from moderate to very high risk. In both cases, this overall result was driven by parallel changes with respect to the A/P attribute. There are very little abundance data available for the group these two populations belong to, and this lack of data is likely the underlying reason why the update assessment results differ from those in the 2007 report. In any case, the uncertainty of these determinations was substantial, particularly for the two Gorge populations and the Hood winter-run population.

Evaluation results for the steelhead populations in Oregon's portion of the Southwest Washington DPS showed that the extinction risks for the Youngs, Clatskanie, and Scappoose populations were most likely in the very low risk category. The extinction risk was slightly higher for the Big Creek population, with a low risk being the most probable category. However, the degree of uncertainty associated with these determinations was substantial. If the results for these populations were transferred to a graph similar to Figure 4-4, the lower tail of the status diamonds for these populations would likely extend well into the moderate and possibly high extinction risk zones.

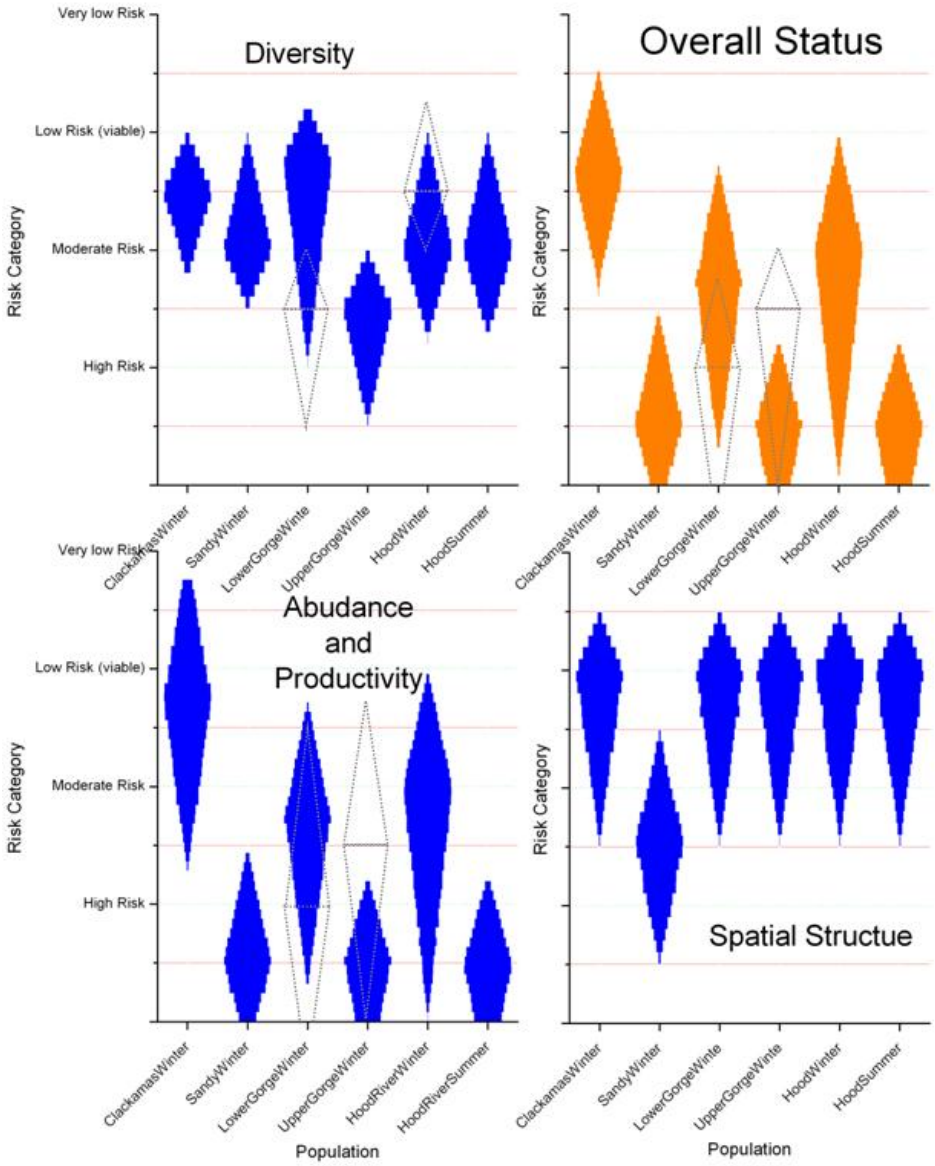


Figure 4-4. Extinction risk ratings for LCR steelhead populations in Oregon for the assessment attributes abundance/productivity, diversity, and spatial structure as well as an overall rating for populations that combines the three attribute ratings. Where updated ratings differ from those presented by McElhany et al. (2007), the older rating is shown as an open diamond with a dashed outline.

4.1.4 Chum Salmon Status – Functionally Extirpated

Chum salmon historically were the most abundant anadromous salmonid in the lower Columbia basin, with returns in some years that exceeded a million fish (McElhany 2005). In recent years the entire Columbia chum salmon return has fluctuated from a few hundred to a few thousand fish. Of the 16 historical populations in the Columbia River chum ESU (Figure 2-8), all of the populations that occurred in Oregon are considered extirpated or nearly so (McElhany et al. 2007).

Chum salmon have been sporadically observed in several Oregon tributaries, most notably Big Creek, however, there are no data that lend themselves to a quantitative status assessment as performed for LCR coho, Chinook and steelhead species. Chum salmon have not been routinely observed in recent years during spawning surveys conducted for coho and Chinook in lower Columbia tributaries. This lack of chum spawners indicates that the fish are no longer present. As a result, Oregon's Columbia River chum salmon populations are considered either extremely depressed or functionally extirpated.

4.2 Population Conservation Gaps

As discussed in the preceding section, most of the salmon and steelhead populations in the Oregon portion of the lower Columbia were determined to have extinction risk levels that are consistent with a classification of "non-viable". The term "conservation gap" is used to describe the magnitude of improvements needed to move the population from its current condition and address the extinction risks of each risk category. For example, if the current extinction risk classification for a population is high risk, then the magnitude of improvements needed to reach moderate, low, and very low risk levels, would each be defined as a conservation gap.

As with the status assessments, conservation gaps were estimated for each of the three VSP attributes: abundance/productivity, diversity, and spatial structure[15]. Although conservation gaps were developed for both the diversity and spatial structure attributes, the focus was on the abundance/productivity conservation gap. There were several good reasons for this focus. First, abundance/productivity is weighed more heavily than spatial structure and diversity in the overall status determinations (McElhany et al. 2007) and, therefore, has a greater influence on a population's overall extinction risk determination. Second, none of the population viability attributes are truly independent. For example, a population that has limited life cycle and genetic diversity will be less likely to have the productivity and resilience to rebound from periods of unfavorable environmental conditions. Likewise, a spatially fragmented population will be more vulnerable to local disturbances and be slow to recover after such events. This condition will effectively depress overall population abundance and as a result make the population more vulnerable to extinction. Third, for salmonid populations the process of extinction is better understood as it relates to abundance and productivity, and is less direct and more difficult to quantify for population diversity and spatial structure.

4.2.1 Methodology – Abundance and Productivity

A multi-step approach was used to calculate conservation gaps for the abundance/productivity attribute. First, a PVA model was used to conduct an iterative search for an increase in total life cycle survival of sufficient magnitude to yield an estimate of extinction risk that matched a particular risk category target (probability of extinction for a 100-year simulation period). The magnitude of this change is expressed as the model-predicted increase in wild spawner abundance that is expected when the survival increase is achieved. Implicit in this approach is that this abundance is the result of both productivity and habitat capacity (abundance potential). Abundance is used as an index of this relationship largely because its measurement is straight forward and easy to understand. However, as used in this case, abundance is merely an indicator of a more complex underlying relationship between abundance, intrinsic productivity, relative survival, and habitat capacity. Further, within this complex relationship the PVA simulations have shown that the strength of a population's intrinsic productivity and relative life cycle survival is a much better predictor of its resistance to extinction than is raw spawner abundance. Regardless, the important point is that although the conservation gaps are expressed in terms of abundance, these units are

[15] See the *Upper Willamette River (UWR) Conservation and Recovery Plan for Chinook Salmon and Steelhead* (ODFW, 2010) for a description of the analyses and calculations used to determine values presented in this Plan for the Clackamas spring Chinook population, which is within the UWR Chinook ESU but is also covered in this Plan due to its inclusion in the LCR SMU (see Section 2.4 for more information on this difference).

a byproduct of a more complex analysis where the population attributes of productivity and abundance are evaluated together in the context of changes in relative life history survival.

While the preceding discussion gives an overview of the approach to estimating A/P conservation gaps, there is substantive methodological detail that merits further description. First, the population data and specifics of the simulation model that were used to estimate extinction probabilities differed somewhat from those reported by McElhany et al. (2007). Spawner abundance data sets for several populations were updated with new information collected from 2006 to 2008. In addition, the estimated proportion of hatchery fish for several populations was changed to reflect new information. The revised data sets from which the A/P conservation gap analyses were based are presented in Appendix C.

While three different PVA models were used by McElhany et al. (2007) to forecast extinction risk, the procedure used here to estimate A/P conservation gaps relied on extinction probabilities calculated from modification of only one of those PVAs. The one model was used to simplify and speed up the A/P conservation gap estimation process. Experience showed that even using just one model it still was very time consuming to find the specific survival improvement value that would produce an extinction probability match with each risk category (i.e., the A/P conservation gap). The decision to use this one PVA also reflected the fact that, among the three PVAs which included the one modified slightly to conduct the conservation gap searches, extinction risk forecasts were usually quite similar (McElhany et al. 2007).

CATAS (Conservation Assessment Tool for Anadromous Salmonids) was the PVA developed to estimate conservation gaps. This PVA was derived from Conservation Assessment and Planning Model (CAPM), one of the PVAs used by McElhany et al. (2007) to evaluate the status of LCR populations. A key element shared by CATAS and CAPM was that the population recruitment model used to power the PVA simulations included an environmental variable intended to track cyclic variations in the marine and freshwater survival. While traditional salmon population recruitment equations attempt to explain variation in offspring produced (recruits) as a function of parental abundance (spawners), the model included this second predictor variable representing an independent environmental variable. Finding show that, via comparison of AICc (corrected Akaike information criterion) scores, recruitment models that include such an environmental variable are almost always superior to those models that rely only on spawner abundance as the predictor variable (i.e., do not include a environmental variable).

In CAPM the environmental variable was assumed to be the same for all populations. A different approach was taken with CATAS in that the environmental variable is selected from a list of four possible indices including: PDO (Pacific Decal Oscillation), PNI (Pacific Northwest Index), CRF (mean Columbia River Flow), and CLRSI (Crater Lake/Rainier Snow Index). All of these indices have been previously described in the literature except CLRSI (see Appendix C for description). This selection process involved the comparison of how well alternative recruitment models fit a population's spawner-recruit data with respect to which environmental variable was included in the model. The alternative model and associated environmental index that was determined to have the lowest AICc score for a particular population was selected for use in subsequent viability model simulations to estimate conservation gaps.

A Beverton-Holt recruitment function was assumed for these data fits, unlike the case for the earlier CAPM model, which assumed a modified Ricker function. This change was made for two reasons. First, as reported by McElhany et al. (2007), the form of the Ricker function used within the CAPM model had to be modified for it to perform realistically when simulating population recruitment at higher spawner abundance levels. However, these modifications were not supported by the underlying data used to fit the model in the first place. This problem was avoided by switching to the Beverton-Holt function. Secondly, use of the Beverton-Holt function had the benefit of making it possible to compare estimates of intrinsic productivity and capacity to those estimated via EDT, a habitat-based model used to aid the

development of habitat recovery actions described later in this Plan, which also assumes the Beverton-Holt function. Additional description about CATAS and the rationale behind its structure is provided in Appendix C.

Another important detail of the methodology was how the problem of populations for which there were little to no abundance data was addressed. This was not an insignificant issue. For a majority of the lower Columbia River populations, annual population census data are unavailable or if available, only for a period of less than five years. In neither case was this sufficient to understand the recruitment characteristics of the population. Without adult abundance data sets, there was no framework available to simulate a population's recruitment behavior over a 100-year PVA test period as the assessment and conservation gap methodology required. The ability to run the CATAS model was needed to estimate extinction risk under any set of conditions and, thereby, to estimate conservation gaps.

To address this problem, approximate recruitment parameter estimates were developed for these 'no data' populations through an inferential process using recruitment information for the population for which there were data, plus ancillary information related to basin size, and expected ratios of hatchery and wild fish on the spawning grounds. The details of this process are described in Appendix C. While there are undoubtedly other solutions to approximate extinction risk and conservation gaps for these 'no-data' populations, this approach was used because once the recruitment curve is approximated the remaining steps in the conservation gap estimation procedure is identical for populations with abundance data sets, and those without. Thereby, the methodological goal to provide a consistent and independently repeatable means to build and weigh the effectiveness recovery strategies for all lower Columbia River populations was achieved. However, in the process of doing so, other, less consistent methods that would have more accurately reflected the status of these 'no-data' populations may have been rejected. Thus, the results from this methodology should not be used as a means to characterize the true conservation status of the 'no-data' populations. A confident assessment of these population will only be possible after an expanded monitored program has been in place long enough to generate at least 15 years of population specific spawner abundance data.

In summary, the methodology described above and in Appendix C was used to determine the best recruitment model for those populations for which data were available and to approximate a recruitment model via inference for those populations for little or no data were available. The parameters associated with these recruitment models and associated information are presented in Table 4-2.

The general form of the Beverton-Holt recruitment equation, to which all of these models conform, is illustrated in Figure 4-5. For each population the value estimated for the alpha (α) parameter describes how rapidly the population can rebound from a low abundance level. The larger the value for alpha, the steeper the initial slope of the recruitment curve and the more resilient the population is to chance events that reduce its abundance to low levels.

The beta (β) parameter represents the asymptotic upper limit for the number of fish that the habitat can produce (theoretical capacity). Large populations have large beta parameter values; small populations have small values for the beta parameter. Finally the gamma (γ) parameter, (not shown in Figure 4-5, see Table 4-2) controls how the recruitment process responds to annual differences in the environmental variable. A large value for the gamma parameter means the population is sensitive to annual fluctuations in the environmental variable; a small value for the gamma parameter means the population's recruitment behavior is less sensitive to fluctuations in the environmental variable.

Evaluations for several populations showed that the recruitment models that included CLRSI as the environmental variable consistently scored the highest among four environmental variables considered. As a result, CLRSI was selected to represent the recruitment behavior of the population (Table 4-2). It

also appeared that time lag for the environmental index was consistently one to three years behind the reference brood year. These results add credence to the prevalent use of the CLRSI variable in the population recruitment models.

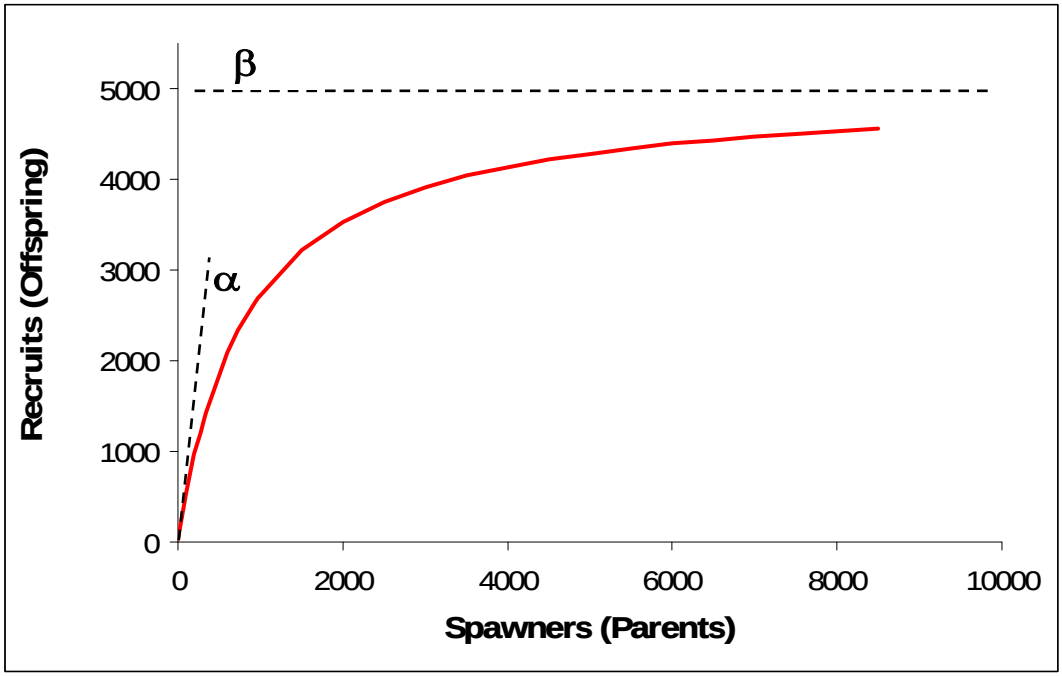


Figure 4-5. An example of the Beverton-Holt recruitment model showing the relationship between spawner and subsequent recruits for population with low abundance productivity (α parameter) equal to 8.0 recruits per spawner and a habitat capacity (β parameter) equal to 5,000 fish.

Further, the conclusion recognizes that one danger of considering a wide range of possible recruitment models (four environmental variables and seven possible time lags in this case) is that what appears to be a best model, may in fact be a random coincidence between a population data set and one of the many possible environmental variable data strings. However, if this was a pervasive issue in the evaluation of these populations, then the environmental indices and time lags selected as the best ones would have likely followed a random pattern with all combinations having equal selection probability. This was not the case. This suggests that there is some underlying association whereby the environmental index selected with a lag period of one to three years provides a meaningful addition to the understanding of the recruitment performance of these populations.

Table 4-2. Recruitment model parameters inferred or estimated from data for lower Columbia River populations of salmon and steelhead with the best matching environmental index and associated time lag relative to parental brood year.

Population	Estimation Method[a]	α Parameter	β Parameter	γ Parameter	Envrmnt Index[b]	Envrmnt Lag[c]
Youngs Coho	Inference	0.68	3717	1.54	CLRSI	-2
Big Coho	Inference	0.68	2166	1.54	CLRSI	-2
Clatskanie Coho	Inference	9.37	3356	1.54	CLRSI	-2
Scappoose Coho	Inference	12.48	4433	1.54	CLRSI	-2
Clackamas Coho	**Data**	6.20	18433	1.62	CLRSI	-2
Sandy Coho	**Data**	7.25	6720	1.47	CLRSI	-1
L Gorge Coho	Inference	0.85	885	1.54	CLRSI	-2
Up Gorge Coho	Inference	0.85	1769	1.54	CLRSI	-2
Youngs FCh	Inference	3.27	3449	0.97	CLRSI	-1
Big FCh	Inference	3.27	2005	0.97	CLRSI	-1
Clatskanie FCh	**Data**	3.58	111	1.00	CLRSI	-1
Scappoose FCh	Inference	3.27	3275	0.97	CLRSI	-1
Clackamas FCh	Inference	3.27	5146	0.97	CLRSI	-1
Sandy FCh	Inference	3.27	1423	0.97	CLRSI	-1
L Gorge FCh	Inference	3.27	680	0.97	CLRSI	-1
Up Gorge FCh	Inference	3.27	188	0.97	CLRSI	-1
Hood FCh	Inference	3.27	317	0.97	CLRSI	-1
Sandy Late FCh	**Data**	9.95	5139	0.92	CLRSI	-2
Clackamas SpCh	**Data**	4.70	1843	1.00	CRF	-3
Sandy SpCh	**Data**	2.58	2820	0.95	CLRSI	-3
Hood SpCh	Inference	3.08	1915	0.97	CLRSI	-3
Youngs StW	Inference	4.03	4116	1.34	CLRSI	-3
Big StW	Inference	2.63	2398	1.34	CLRSI	-3
Clatskanie StW	Inference	5.54	3716	1.34	CLRSI	-3
Scappoose StW	Inference	5.54	4908	1.34	CLRSI	-3
Clackamas StW	**Data**	1.99	9343	2.00	CRF	-2
Sandy StW	**Data**	1.69	2652	0.45	CLRSI	-3
L Gorge StW	Inference	4.98	839	1.34	CLRSI	-3
Up Gorge StW	Inference	4.98	249	1.34	CLRSI	-3
Hood StW	**Data**	9.29	969	1.68	CLRSI	1
Hood StS	**Data**	5.12	543	1.89	nSPDO	3

[a] Populations for which data were used to estimate recruitment model parameters are denoted in this column as "Data" and those for which the parameters were determined indirectly are denoted "Inference"
[b] CLRSI = Crater Lake and Rainier Snow Index, CRF = Columbia River mean Flow index, and nSPDO = negative Spring Pacific Decadal Oscillation index.
[c] Number years the midpoint of the environmental index was lagged relative to the parental brood year that best fit the data or was inferred to provide this fit.

In the case of chum salmon, there were no empirical data for any population that could be used to examine population recruitment. As reflected in the status assessment, it is possible that there are no wild populations of chum salmon in the Oregon's portion of the Columbia basin. Being unable to model viability for any chum salmon population made it impossible to apply the conservation gap and recovery scenario development procedures that were used for the other species.

The 2007 population status report describes a variety of approaches to address recruitment model uncertainty (McElhany et al. 2007). The central problem is that population abundance data often produce a poor fit to a recruitment curve and it is difficult to know if this is due to measurement errors associated with the data, random environmental variability, use of an inappropriate recruitment model, or some combination of all of three. Regardless of the cause, inevitably there will be uncertainty in the true shape of the recruitment curve for a particular population.

CATAS can be run in an expanded mode to examine the effects of recruitment model uncertainty on extinction risk forecasts. In this mode CATAS results are expressed as a distribution of many possible extinction probabilities rather than just a single extinction probability. The details of this procedure are described in Appendix C. CATAS output generated in the expanded mode helps provide insight into how extinction risk forecasts vary due to recruitment parameter uncertainty. Ideally, CATAS would have been run in the expanded mode for all A/P conservation gaps and populations. This would have made it possible to express results as the full distribution of possible extinction risk values that bracket the median extinction risk value. However, in its present form, running CATAS in the expanded mode is up to 1,000 times slower per population, in terms of computer run time, than CATAS used in the standard, median only mode. Given the large number of lower Columbia populations for which A/P conservation gap estimates were needed, it was not practical to use the slower mode of CATAS for all populations.

The expanded version of CATAS was run for several test populations, however, to frame the range of possible extinction probabilities that might be caused by typical recruitment parameter uncertainty. The results of the CATAS runs generated a large range of possible values. For example, running 1,000 bootstrap samples of a population's data set through the expanded version of CATAS would yield 1,000 separate estimates of extinction probability. Further, if the median extinction probability of these 1,000 estimates was 0.05, the range of the individual extinction probabilities typically yielded 200 (out of 1,000) with values greater than 0.10, which is twice that of the median. So, even though the overall (median) probability of extinction was 0.05, there was roughly a 20 percent chance that the probability of extinction was 0.10 or greater. When the results for all of the test populations were compared, there was a stable relation between the median extinction probability values and the threshold for the highest 20 percent of the extinction probability values (80th percentile). This nearly linear relationship between the median probability of extinction and the 80th percentile extinction probability is illustrated in Figure 4-6. In this relationship, when the median extinction probability is 0.10 or less, the value for the 80th percentile extinction probability will be about two times the median. For median extinction probabilities greater than 0.10 the multiplier decreases, such that for a 0.50 median extinction probability the value for the 80th percentile probability is 1.5 times the median or 0.74.

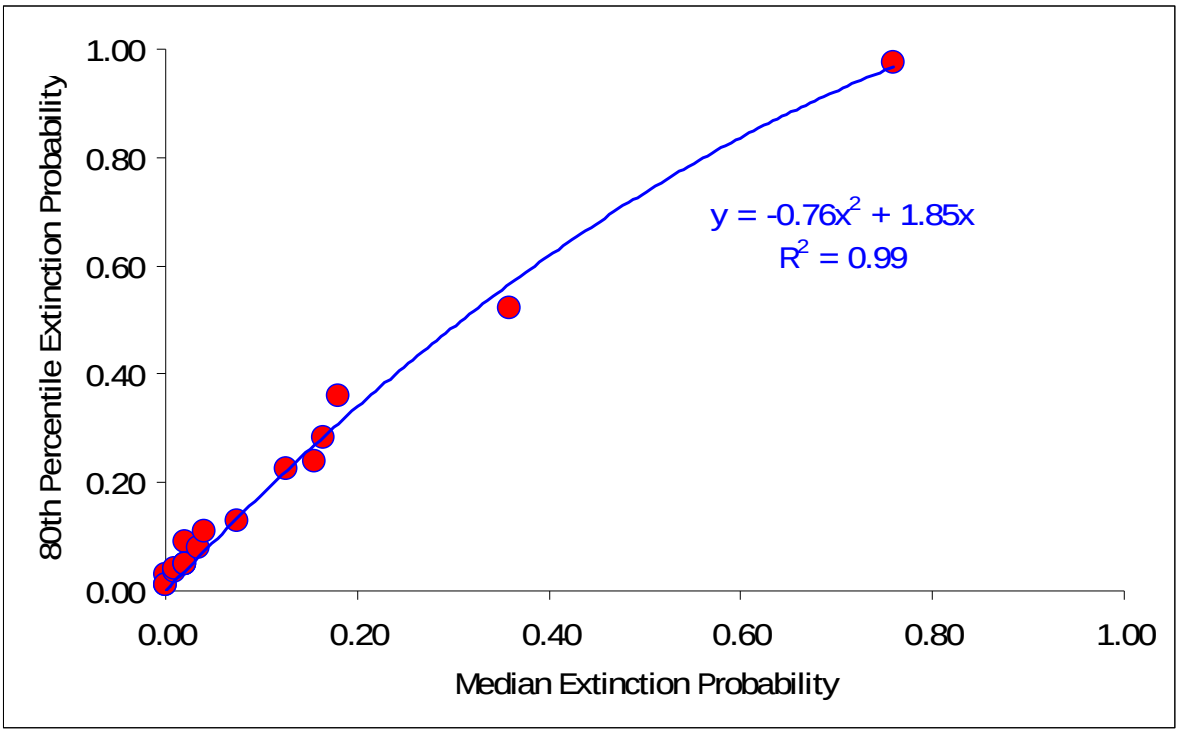


Figure 4-6. Relationship between median extinction probability and 80th percentile extinction probability as estimated by the CATAS model for selected populations of lower Columbia salmon and steelhead.

This apparently stable relation between the median and 80th percentile extinction probabilities was used to craft an approach to incorporate parameter uncertainty into the conservation gap estimates. To understand how this was accomplished, recall that estimating A/P conservation gaps is a modeling exercise of trying different magnitudes of survival improvement until a value is found that results in a probability of extinction matching a particular risk category. For example, if a population was at high risk, the A/P conservation gap to the low risk category would correspond with the amount of survival increase needed to reduce the probability of extinction to 0.05 as determined via CATAS. However, since these extinction probabilities were estimated using CATAS in the basic mode (not expanded), this probability is expressed in terms of a median. By definition, a median is midpoint in a distribution of values such that 50 percent of the points are greater and 50 percent of points are smaller. So for example if the median is 0.05, then 50 percent of the possible outcomes have an extinction probability greater than 0.05. In this example, essentially when parameter uncertainty was factored in, there was only a 50/50 chance that the extinction probability for the population was indeed less than 0.05. These did not seem like acceptable odds as to whether or not the proposed management changes would lift the population from a classification of non-viable to viable. It illustrates why, in light of the potential effects of parameter uncertainty, a more precautionary stance was taken to determined conservation gaps.

To accomplish this, the median probability of extinction target was reduced such that 80 percent of the possible extinction probabilities would fall within the risk category. Essentially, this was an attempt to improve the odds of meeting the risk category threshold from 50/50 to 80/20. The relationship illustrated in Figure 4-6 between median extinction probabilities and the 80th percentile of these probabilities was used to calculate the revised median targets for running CATAS in the non-expanded mode (see Table 4-3).

For example, to move the status of a population into the low risk category, survival rates would be increased until the CATAS simulations yielded a median extinction probability of 0.025. This result

meant that the 80th percentile extinction probability for this same condition, based on the relation illustrated in Figure 4-6, would be 0.05. In other words, by achieving a median probability of 0.025, it would be expected that 80 percent of the possible extinction probability values would be less than 0.05, the threshold for the low risk category.

Table 4-3. The median extinction probability targets for conservation gap CATAS model simulations assumed to ensure that 80th percentile extinction probabilities equal the risk category extinction probability thresholds described by McElhany et al. 2007.

Risk Category	80th Percentile Extinction Probability Threshold	Median Extinction Probability Target
Very Low	0.010	0.005
Low	0.050	0.025
Moderate	0.250	0.180
High	0.600	0.450
Very High	>0.600	> 0.450

This precautionary approach to risk category classification can be illustrated with the extinction risk diamonds used earlier in this chapter to summarize population assessment results. Recall that these extinction risk diamonds visually express the range of possible risk classifications for each population and take the form of an elongated diamond whose widest portion (waist) generally represents the median extinction risk forecast. For example, a population may have extinction probabilities with a median value of 0.048 and with diamond "tails" that range from 0.01 to 0.25 as shown in Figure 4-7 as "Pop 1". Although, the waist of this diamond is within the low risk classification zone, under the precautionary classification approach a moderate risk would be assigned to such a population because more than 20 percent of the diamond is positioned within the moderate risk zone. Alternatively, a population with a median extinction probability of 0.024 and a range of possible extinction values similar to "Pop 2" diamond shown in Figure 4-7 would be assigned a low risk classification. The primary distinction is that in this case (Pop 2) at least 80 percent of the extinction forecasts have values that correspond with either the low or very low risk classification. Only 20 percent of the extinction forecasts are likely to have values that correspond to the moderate risk classification.

Another precautionary element adopted for dealing with the methodological uncertainty associated with the conservation gap estimates was to reject and revise upward any conservation gap estimate that would not also met a population's corresponding MAT (Minimum Abundance Threshold). The MAT values and testing protocol were part of the procedure used to assess population status for the abundance/productivity attribute (McElhany et al. 2007). The concept of MAT was that it served as a secondary test of a population's abundance attribute that was independent of the extinction probability estimates generated by the assessment's PVA models. The abundance levels used as the minimum values for the MAT test metric varied among species and basin size for each risk category.

It should be noted that the MAT evaluation as used in the population assessment (McElhany et al. 2007) was intended as a retrospective assessment of abundance. Specifically, the MAT metric was calculated as the geometric mean of the most recent 12 years of observed wild spawner abundance for each population. Because the conservation gaps are stated in terms of a future (prospective) abundance level, the application of the MAT concept had to be modified. Rather than use a 12-year geometric mean as the test metric, the average abundance from the CATAS simulations was used as the means to determine if the MAT abundance targets were likely to be met. Another difference in the application of MAT was that the critical values for the MAT used in the 2007 assessment were expressed as a range; however for the conservation gaps, each range was condensed to single number. The resulting collection of MAT test thresholds, by population and risk category, used in the development of conservation gaps are presented in Table 4-4.

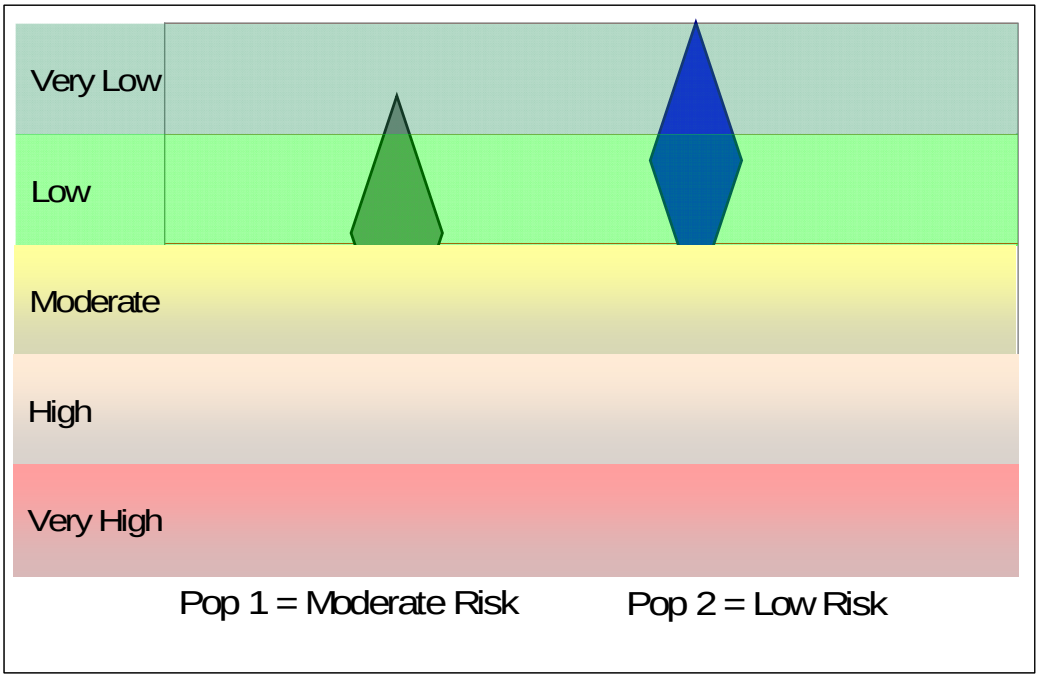


Figure 4-7. Two hypothetical populations with median extinction probabilities in the low risk zone. Populations are classified as either moderate (Pop 1) or low risk (Pop 2) depending on how much of the extinction risk diamond is positioned above the moderate/low risk threshold.

Table 4-4. Wild spawner Minimum Abundance Thresholds (MAT) for very high, high, moderate, low, and very low risk categories by population.

Species	Population	Very High	High	Moderate	Low	Very Low
Coho	Youngs Coho	< 600	600	850	1100	1200
	Big Coho	< 600	600	850	1100	1200
	Clatskanie Coho	< 1200	1200	1700	2200	2400
	Scappoose Coho	< 1200	1200	1700	2200	2400
	Clackamas Coho	< 1800	1800	2500	3300	3600
	Sandy Coho	< 1800	1800	2500	3300	3600
	Lower Gorge Coho	< 600	600	850	1100	1200
	Upr Gorge/Hood Coho	< 1200	1200	1700	2200	2400
Chinook	Youngs FaCh	< 150	150	350	750	1000
	Big FaCh	< 150	150	350	750	1000
	Clatskanie FaCh	< 150	150	350	750	1000
	Scappoose FaCh	< 150	150	350	750	1000
	Clackamas FaCh	<400	400	525	800	1000
	Sandy FaCh	<400	400	525	800	1000
	Lower Gorge FaCh	< 150	150	350	750	1000
	Upper Gorge FaCh	< 150	150	350	750	1000
	Hood FaCh	<400	400	525	800	1000
	Sandy Late FaCh	<400	400	525	800	1000
	Clackamas SpCh	<400	400	525	800	1000
	Sandy SpCh	<400	400	525	800	1000
	Hood SpCh	<400	400	525	800	1000
Steelhead	Youngs StW	< 150	150	350	625	750
	Big StW	< 150	150	350	625	750
	Clatskanie StW	< 225	225	375	750	1000
	Scappoose StW	< 225	225	375	750	1000
	Clackamas StW	< 425	425	475	750	1000
	Sandy StW	< 425	425	475	750	1000
	Lower Gorge StW	< 150	150	350	625	750
	Upper Gorge StW	< 150	150	350	625	750
	Hood StW	< 225	225	375	750	1000
	Hood StS	< 225	225	375	750	1000

In summary, the A/P conservation gap for each population was determined in two steps. First, survival was increased until the probability of extinction matched the adjusted median extinction target values for each risk category as shown in Table 4-3. The difference between the modeled average abundance that corresponded with each of these risk levels and the current conditions modeled abundance estimate was expressed as the A/P conservation gap. Next, the risk category abundance estimates were compared with the MAT value for each risk category. If the risk category abundance level estimate was less than the MAT threshold for the associated risk category as shown in Table 4-4, the CATAS model was used to increased survival rates further until an increase was found that resulted in a forecast average abundance that achieved the MAT threshold. Once this was done, the A/P conservation gap was revised to be the difference between the new abundance level (consistent with MAT) and the modeled abundance under current (no change) conditions.

4.2.2 Methodology – Diversity and Spatial Structure

This section describes the methods used to determine the conservation gaps for diversity and spatial structure.

Diversity

The method for estimating conservation gaps for the diversity attribute was based on metrics described in the WLC-TRT's earlier status assessment of these populations (McElhany et al. 2007). In this assessment, and in the adaptation here to develop conservation gaps, the diversity rating is a synthesis of five components: genetic effective population size, interbreeding with hatchery fish, anthropogenic mortality, life history diversity and habitat diversity. The first three components each have metrics that are quantifiable and have been broken into thresholds for different risk categories. The last two components are difficult to quantify.

The risk category assignment thresholds used in the WLT-TRT status assessments of the lower Columbia River populations (McElhany et al. 2007) were adopted to evaluate the three quantifiable components of the diversity rating. The first of these, genetic effective population size, relates to a minimum population level that must be maintained to minimize the genetic risks associated with small population size such as: inbreeding depression, the loss of diversity through genetic drift, and the accumulation of maladaptive mutations. The second component, interbreeding with hatchery fish, relates to the proportion of hatchery fish in the naturally spawning population. The third component, anthropogenic mortality, reflects the conservation issue that as the human-caused mortality rate on a fish population increases, so does the chance that selective pressures are being exerted that could alter the genetic character of wild populations in ways that are not adaptive and consequently increase extinction risk. Although the status assessment of these populations considered multiple kinds of human-caused fish mortality, the focus here was largely on fishery harvest to estimate conservation gaps. The rationale for this decision was that the adverse selective forces associated with fisheries are widely understood as a potential genetic risk. Secondly, fishery impact rates can be measured and quantified in a direct manner unlike some of the other human related impacts which are more indirect and less tangible. As with the other diversity metrics, the category thresholds used in the status evaluation were adopted with some modification to make the interval between each risk category more uniform (Table 4-5).

Table 4-5. Quantitative metrics for the diversity attribute for different risk levels used to develop conservation gaps. Metrics are shown for effective population size (expressed as mean population census size), hatchery fish proportion (expressed as the mean proportion of hatchery fish on the spawning grounds), and fishery exploitation rates (expressed a proportion of fish directly or indirectly killed as a result of a fishery).

	Very High	High	Moderate	Low	Very Low
Census Population Size	< 25	25 to 50	50 to 250	250 to 1000	> 1000
Hatchery Fish Proportion	> 0.75	0.75 to 0.30	0.30 to 0.10	<0.10	< 0.10
Fishery Exploitation Rates	> 0.85	0.85 to 0.65	0.65 to 0.45	0.45 to 0.25	< 0.25

The last two elements of the diversity attribute, life history diversity and habitat diversity, are difficult to quantify both in terms of a score and, more importantly, what the score means in terms of extinction risk. However, these elements are critical for genetic diversity and the capacity of populations to evolve with changing environments, especially with global warming becoming a reality. This adaptive process may lead to beneficial life history traits and habitat use patterns that will be different from historical benchmarks, either in kind or frequency. Still, while this acknowledgement may be conceptually sound, from a practical standpoint, it makes the rating of these two diversity sub-elements difficult because it is not clear whether the changes that may be observed will be adverse and human caused, or natural and

beneficial to the species survival. As a result, the best professional judgment was used to weigh the importance of this portion of the diversity attribute.

Conservation gaps for the diversity attribute were calculated as the number of risk category steps separating the baseline (current) risk classification from the risk classification of each lower risk category. So for example, if under baseline conditions the diversity risk category is high, then the conservation gap to reach a low risk classification is 2 (i.e., two risk category steps are needed to move from high to low risk).

Spatial Structure

The status assessment metrics described in McElhany et al. (2007) were used to determine conservation gaps for the spatial structure attribute. The spatial structure metric was based on the proportion of stream kilometers accessible to each species relative to the historical kilometers accessible. Evaluation thresholds for each risk category were expressed in terms of the maximum proportion of historically accessible stream (expressed as kilometers of linear distance) lost and varied depending on the basin size occupied by the population. The details of this rating system gaps are shown in Table 4-6. In some cases, this rating scheme was adjusted downward if portions of the currently accessible habitat were qualitatively determined to be seriously degraded. Adjustments were also made if the portion of historical habitat lost was believed to have been a key production area, regardless of the number of stream kilometers involved.

Similar to the diversity gaps, the conservation gaps for structure conservation gaps were calculated as the number of risk category steps separating the baseline risk classification from the lower risk classifications.

Table 4-6. Guideline thresholds for different spatial structure attribute risk categories very high, high, moderate, low and very low; expressed as the proportion of the historically accessible habitat within a basin that has been lost.

Relative Basin Size	Very High Risk	High Risk	Moderate Risk	Low Risk	Very Low Risk
Small	1.00 to 0.50	0.50 to 0.25	0.25 to 0.15	0.15 to 0.05	0.05 to 0.00
Medium	1.00 to 0.60	0.60 to 0.40	0.40 to 0.20	0.20 to 0.10	0.10 to 0.00
Large	1.00 to 0.75	0.75 to 0.50	0.50 to 0.25	0.25 to 0.15	0.15 to 0.00

4.2.3 Methodology – Baseline Condition Specifics

The specifics of the current status evaluations that define the baseline (current) condition of each population and that were used in the calculation of conservation gaps have been described earlier in this chapter and in McElhany et al. (2007). These baseline values, shown as individual scoring for the abundance/productivity, diversity, and spatial structure population attributes, are given in Tables 4-7, 4-8, and 4-9, respectively. Table 4-10 combines the baseline values for each parameter into an overall current status determination calculated as the lesser of ((4/6*A/P score)+(1/6*diversity score)+(1/6*spatial structure score)) or the A/P score.

Because it is potentially a source of confusion, the difference between the two types of abundance data presented in these tables is clarified here. Table 4-7 presents a column of numbers under the heading of "modeled abundance". These numbers do not represent field collected data. They are the theoretical values from the CATAS model simulations. Specifically, they are the average number of wild spawners forecast to return over a 100-year period. These values are used as the baseline for calculating conservation gaps. A critical detail of these abundance forecasts is that they assume the average environmental conditions of the period from 1974 to 2004. The assumption is that the average of the past

is a reasonable predictor of the future[16]. The important point here is that because these estimates are based on the assumption of average conditions they are not comparable with the second type of abundance data which is presented in Table 4-8, "recent wild abundance". The recent abundance values of Table 4-8 are based on an observation period from 1990 to 2004. For each population they represent the average number of fish observed for this period or, in the case of populations with little or no data, they represent professional judgment as to what this average abundance might have been from 1990 to 2004. The environmental conditions that occurred during this period for most populations were poorer than the reference period from 1974 to 2004 used to model these populations. The bottom line is that the modeled abundance numbers of Table 4-7 are not comparable to the recent abundance numbers of Table 4-8 because the environmental conditions, particularly marine survivals, were dissimilar.

Another point of confusion has been the estimates of fishery exploitation rates and the proportion of hatchery fish in natural spawning areas. Values for these two items are presented in Table 4-8 for the purposes of evaluating the diversity attribute. However, these same values also go into the assumed 'current conditions' for CATAS extinction probability forecasts, as well as building recovery strategies in Chapter 6. With respect to fishery exploitation rates, the chosen reference period extends loosely from 1994 to 2004. Due to management changes in recent years, the fishery impact rates for coho and Chinook since the early 2000s are generally lower than those of the reference period. This fact was recognized and, as described later in this Plan, the effect of these lower fishery rates was incorporated in the development of population recovery strategies.

[16] Given potential future threats of climate change, human population growth and development, and ocean shifts, this assumption should be revisited through time. See Section 6.2.1 for further discussion in these areas.

Table 4-7. Summary of abundance and productivity (A & P) components, probability of critical risk threshold (CRT) and modeled abundance, and their respective scores used to determine current status risk classification (VH=very high risk, H=high risk, M=moderate risk, L=low risk, VL=very low risk) for the abundance/productivity attribute for Oregon populations of salmon and steelhead within the lower Columbia basin.

		A & P Components		A&P
Species / Stratum (Run)	Population	Probability of CRT	Modeled Abundance[1]	Risk Classification
COHO				
Coast				
	Youngs Bay	1.000	4	VH
	Big Creek	1.000	8	VH
	Clatskanie	0.134	1,363	H[2]
	Scappoose	0.032	1,942	M
Cascade				
	Clackamas	0.046	6,548	M
	Sandy	0.590	1,622	VH
Gorge				
	Lower Gorge	1.000	22	VH
	Upper Gorge/Hood	1.000	41	VH
CHINOOK				
Coast (Fall)				
	Youngs Bay	0.372	379	H
	Big Creek	0.582	216	VH
	Clatskanie	1.000	6	VH
	Scappoose	0.432	356	H
Cascade (Fall)				
	Clackamas	0.686	558	VH
	Sandy	1.000	144	VH
Gorge (Fall)				
	Lower Gorge	0.976	74	VH
	Upper Gorge	1.000	17	VH
	Hood	1.000	33	VH
Cascade (Late Fall)				
	Sandy	0.000	1,794	VL
Cascade (Spring)				
	Clackamas	0.090	1,371	M
	Sandy	0.026	714	M
Gorge (Spring)				
	Hood	0.542	327	VH
STEELHEAD				
Coast (Winter)				
	Youngs Bay	0.000	2,486	VL
	Big Creek	0.018	1,143	L
	Clatskanie	0.001	2,451	VL
	Scappoose	0.000	3,245	VL
Cascade (Winter)				
	Clackamas	0.178	3,897	M
	Sandy	0.432	674	H
Gorge (Winter)				
	Lower Gorge	0.180	550	M
	Upper Gorge	0.896	151	VH
	Hood	0.066	1,127	M
Gorge (Summer)				
	Hood	1.000	35	VH

[1] This abundance represents the average of 100-year forward projections that assume environmental conditions effecting survival are similar to those from 1974 to 2004; as such is not

comparable to observed wild spawner counts in more recent times when the natural survival rates have been lower and fishery impacts generally less.

[2] This population was rated at high risk because the average abundance was less than the MAT target for this risk category; this result over-rode the fact that probability of CRT (0.134) for this population met the moderate risk category threshold of 0.18.

A similar point exists in the case of estimates for the fraction of the naturally spawning population that are hatchery fish (hatchery proportion). The reference period for the hatchery proportion is 1974 to 2004. Although the hatchery proportion average for this time period may be relatively high, there are many populations that in the last five years, through preemptive management actions, for which this proportion has been reduced dramatically. Again, these changes were acknowledged and incorporated in the package of recovery actions that is proposed for these populations latter in the report. The bottom line is that for most populations, the 2009 fishery exploitation rate and proportion of hatchery fish in the spawning population will be considerably lower than the averages portrayed in Table 4-8.

There are two major exceptions to this statement: the fishery impact rates for steelhead and the proportion of hatchery fish for most fall Chinook populations. In the case of steelhead, regulations that require the release of all wild fish caught in fisheries have been in place for at least 15 years. The fishery mortality rates displayed in Table 4-8 are largely the effect of post-release handling mortality and not directed kill. Therefore, short of completely closing all fishing (which is unlikely to occur) the fishery mortality rate on steelhead will remain unchanged.

In the case of fall Chinook, the true proportion of hatchery fish on the spawning grounds is difficult to determine because less than 5 percent of the fall Chinook released from most hatchery operations have been given identifying fin clip marks. As described in Appendix C under the discussion for Clatskanie fall Chinook, the only means to estimate hatchery proportion in the wild is to compare the mark rate of nearby hatchery programs (typically less than 5%) with the mark rate observed in natural populations during the spawning surveys. While the accuracy of such estimates is undoubtedly low, based on limited available data even the very high hatchery proportion value of 0.90 assigned to most fall Chinook populations may be an underestimate. Therefore, it is likely that the proportion of hatchery fish in natural fall Chinook spawning populations remains in the range of 0.90 and will not change appreciably over the next two to five years.

Table 4-8. Summary of the key elements and their respective scores used to determine current status risk classification for the diversity attribute for Oregon populations of salmon and steelhead within the lower Columbia basin.

		Diversity Components					Diversity
Species / Stratum (Run)	Population	Recent Wild Abundance[1]	Hatchery Proportion[2]	Fishery Exploit. Rate[3]	Life History Diversity Score	Habitat Diversity Score	Risk Classification
COHO							
Coast							
	Youngs Bay	50	0.86	0.90	0	2	VH
	Big Creek	75	0.86	0.70	0	2	H
	Clatskanie	150	0.13	0.35	2	2	M
	Scappoose	150	0.05	0.35	2	2	M
Cascade							
	Clackamas	1,368	0.35	0.35	3	2	L
	Sandy	482	0.09	0.35	3	1	M
Gorge							
	Lower Gorge	20	0.80	0.35	0	1	VH
	Upper Gorge/Hood	30	0.80	0.35	0	1	H
CHINOOK							
Coast (Fall)							
	Youngs Bay	30	0.90	0.75	3	3	H
	Big Creek	35	0.90	0.65	3	2	H
	Clatskanie	41	0.90	0.60	3	4	H
	Scappoose	35	0.90	0.60	3	3	H
Cascade (Fall)							
	Clackamas	60	0.90	0.60	2	4	H
	Sandy	60	0.90	0.60	2	3	H
Gorge (Fall)							
	Lower Gorge	20	0.90	0.60	2	3	H
	Upper Gorge	20	0.90	0.65	2	2	H
	Hood	26	0.90	0.70	3	4	H
Cascade (Late Fall)							
	Sandy	2,771	0.49	0.50	3	3	M
Cascade (Spring)							
	Clackamas	1,100	0.65	0.25	2	3	M
	Sandy	959	0.54	0.25	2	3	M
Gorge (Spring)							
	Hood	30	0.90	0.25	2	3	VH
STEELHEAD							
Coast (Winter)							
	Youngs Bay	900	0.20	0.10	3	2	M
	Big Creek	600	0.40	0.10	3	2	M
	Clatskanie	900	0.05	0.10	4	2	L
	Scappoose	1,200	0.05	0.10	4	2	L
Cascade (Winter)							
	Clackamas	1,168	0.23	0.10	3	3	M
	Sandy	1,040	0.52	0.10	3	3	M
Gorge (Winter)							
	Lower Gorge	120	0.10	0.10	3	3	L
	Upper Gorge	60	0.10	0.15	2	2	M
	Hood	395	0.30	0.15	3	3	M
Gorge (Summer)							
	Hood	195	0.53	0.15	2	3	M

[1] The average number of wild spawners observed in each population from 1990 to 2004 or in the case of populations with little or no data it represents a professional judgment as to what this average abundance might have been from 1990 to 2004.
[2] The 1974 to 2004 average proportion of hatchery fish mixing with the population's wild fish on the spawning grounds.
[3] Estimates of the fishing exploitation rate on the wild fish in each population for the most recent 10-year period. See Appendix D for the allowable harvest limits for 2008 - 2017.

Table 4-9. Summary of the key elements and their respective scores used to determine current status risk classification for the spatial structure attribute for Oregon populations of salmon and steelhead within the lower Columbia basin.

		Spatial Structure Components			Spatial Structure Risk Classification
Species / Stratum (Run)	Population	Basin Stream km	Basin Size Classif.	Prop Stream km Lost[1]	
COHO					
Coast					
	Youngs Bay	94	small	0.12	VL
	Big Creek	78	small	0.23	L
	Clatskanie	105	medium	0.01	VL
	Scappoose	125	medium	0.12	L
Cascade					
	Clackamas	465	large	0.08	VL
	Sandy	247	large	0.32	L
Gorge					
	Lower Gorge	14	small	0.00	VL
	Upper Gorge/Hood	119	medium	0.00	VL
CHINOOK					
Coast (Fall)					
	Youngs Bay	35	small	0.12	VL
	Big Creek	16	small	0.23	L
	Clatskanie	16	small	0.01	VL
	Scappoose	7	small	0.12	L
Cascade (Fall)					
	Clackamas	61	medium	0.08	VL
	Sandy	75	medium	0.32	M
Gorge (Fall)					
	Lower Gorge	10	small	0.05	L
	Upper Gorge	2	small	0.00	VL
	Hood	39	small	0.00	VL
Cascade (Late Fall)					
	Sandy	75	medium	0.32	M
Cascade (Spring)					
	Clackamas	917	medium	0.10	L
	Sandy	125	medium	0.32	M
Gorge (Spring)					
	Hood	75	medium	0.00	VL
STEELHEAD					
Coast (Winter)					
	Youngs Bay	94	small	0.12	VL
	Big Creek	78	small	0.23	L
	Clatskanie	105	medium	0.01	VL
	Scappoose	125	medium	0.12	L
Cascade (Winter)					
	Clackamas	492	large	0.07	VL
	Sandy	348	large	0.32	M
Gorge (Winter)					
	Lower Gorge	14	small	0.09	VL
	Upper Gorge	12	small	0.00	VL
	Hood	154	medium	0.01	VL
Gorge (Summer)					
	Hood	131	medium	0.01	VL

[1] The proportion of total accessible stream kilometers lost as described by McElhany et al. 2007; total basin stream kilometers differ and are generally larger than those reported by McElhany et al. 2006 used to classify the basin size for each population.

Table 4-10. Summary of the key elements and their respective scores used to determine the overall current status risk classification for Oregon populations of salmon and steelhead within the lower Columbia basin.

		Risk Classification Scores for Attributes			Overall	Overall
Species / Stratum (Run)	Population	Abundance and Productivity	Diversity	Spatial Structure	Pop. Risk Class. Score	Pop. Risk Classification
COHO						
Coast						
	Youngs Bay	0	0	4	0	VH
	Big Creek	0	1	3	0	VH
	Clatskanie	1	2	4	1	H
	Scappoose	2	2	3	2	M
Cascade						
	Clackamas	2	3	4	2	M
	Sandy	0	2	3	0	VH
Gorge						
	Lower Gorge	0	0	4	0	VH
	Upper Gorge/Hood	0	1	4	0	VH
CHINOOK						
Coast (Fall)						
	Youngs Bay	1	1	4	1	H
	Big Creek	0	1	3	0	VH
	Clatskanie	0	1	4	0	VH
	Scappoose	1	1	3	1	H
Cascade (Fall)						
	Clackamas	0	1	4	0	VH
	Sandy	0	1	2	0	VH
Gorge (Fall)						
	Lower Gorge	0	1	3	0	VH
	Upper Gorge	0	1	4	0	VH
	Hood	0	1	4	0	VH
Cascade (Late Fall)						
	Sandy	4	2	2	3	L
Cascade (Spring)						
	Clackamas	2	2	3	2	M
	Sandy	2	2	2	2	M
Gorge (Spring)						
	Hood	0	0	4	0	VH
STEELHEAD						
Coast (Winter)						
	Youngs Bay	4	2	4	4	VL
	Big Creek	3	2	3	3	L
	Clatskanie	4	3	4	4	VL
	Scappoose	4	3	3	4	VL
Cascade (Winter)						
	Clackamas	2	2	4	2	M
	Sandy	1	2	2	1	H
Gorge (Winter)						
	Lower Gorge	2	3	4	2	M
	Upper Gorge	0	2	4	0	VH
	Hood	2	2	4	2	M
Gorge (Summer)						
	Hood	0	2	4	0	VH

4.2.4 Conservation Gaps – Results

The conservation gaps presented here are reported as single numbers without a range or uncertainty bars (Table 4-11). However, it is important to stress that for each gap, there is a range of possible results, in terms of population status, that cover more than one extinction risk classification. For example, the risk classifications of high, moderate, low, and very low for Sandy coho correspond with A/P conservation gap values of 416, 1,387, 2,656, and 3,766 adult spawners, respectively (Table 4-11). These values do not represent point estimates, but rather underlying distributions of possible values. Thus, as illustrated in Figure 4-8 a survival increase that results in the population growing by 1,387 wild coho would 'lift' the status diamond for Sandy coho from its current very high risk classification to a moderate risk classification (i.e. close the A/P conservation gap).

Still, there is considerable uncertainty regarding how much the extinction risk will actually decline with a 1,387 increase in population abundance. As the placement of the diamond on this graph reflects, there is a chance that the population would not raise above the zone of high risk. Conversely there is also a chance, somewhat greater, that the population would enter the low risk zone. There is even a small possibility in this example that the extinction risk could fall into the very low risk zone. The important message is that with each of the conservation gap values listed in Table 4-10, there is a diamond-like distribution of extinction probabilities. Thus, as a practical matter, when recovery actions are taken to deliver the survival improvements necessary to close a particular conservation gap, there is a possibility that the future resulting population status could land above or below the intended target.

As one might expect, the calculated A/P conservation gaps varied among species and populations. Steelhead, whose overall status is generally more robust than the other species, tended to have smaller A/P conservation gaps. In contrast, coho tended to have the largest A/P conservation gaps. Within in each species group there was also considerable heterogeneity in the relative magnitude of the estimated A/P conservation gaps. Such variation was not unexpected. For example, in the case of coho populations in Youngs Bay and Big Creek, the assumed future fishery impact rate and frequency of hatchery fish in the spawning population are much higher than for other coho populations. To overcome these high fishery rates and abundance hatchery strays, the number of additional fish needed to reach even a high risk classification is very large, hence the large gap.

It should also be pointed out that the A/P conservation gaps estimated for some populations are very large relative to the current size of the population. Some of these estimates may in fact be too large and may be an artifact of the gap estimation methodology which assumes a linear population response at all population densities and conservation states. For populations that are nearly extinct this linear assumption is probably incorrect and it has likely led to the generation of some exceptionally large A/P conservation gaps.

The estimation procedure could have been modified to reflect a more non-linear behavior at these low abundance levels. However, it was not clear how the nonlinearity should be modeled and there was no assurance a more complicated model would reduce output uncertainty. Therefore, the current approach was applied for all populations. Still, the response for some populations to proposed recovery actions will not be accurately known until the response can actually be observed at some point in the future. Therefore, for these populations an active post-implementing monitoring program will be especially critical.

The spatial structure conservation gaps for most populations were less than for the diversity gaps (Table 4-10). This reflects the situation for most of these populations, that in general much of the historical habitat remains accessible (the exception being the Sandy basin) resulting in most populations being in the viable category with respect to spatial structure. However, with respect to the diversity attribute one of the key elements that affected the results was the high incidence of naturally spawning hatchery fish

believed to occur in many populations. This was particularly evident for fall Chinook, which as a consequence tend to have the largest conservation gaps for the diversity attribute.

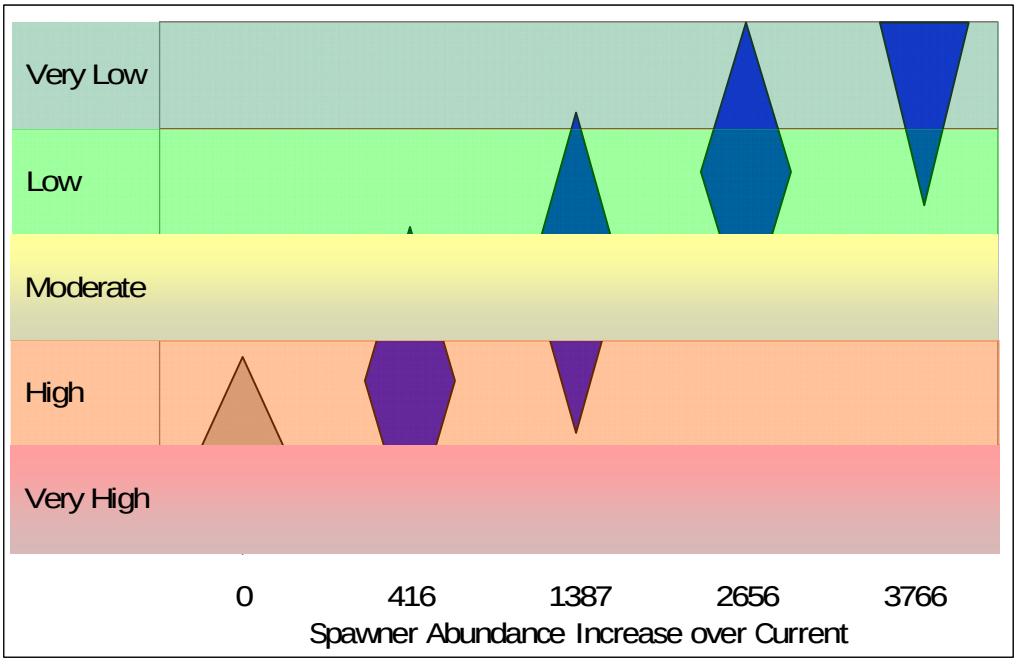


Figure 4-8. Forecast distribution of possible status outcomes (blue diamonds) if the abundance increases necessary to close A/P conservation gaps identified for an example population, Sandy coho. (Current conditions status represented by diamond on far left.)

Table 4-11. Conservation gaps for the population attributes abundance/productivity (A/P), diversity (D), and spatial structure (SS) estimated for Oregon populations of salmon and steelhead from the lower Columbia River basin.

		Conservation Gaps											
		High Risk			Moderate Risk			Low Risk			Very Low Risk		
Species / Stratum (Run)	Population	A&P	D	SS	A&P	D	SS	A&P	D	SS	A&P	D	SS
COHO													
Coast													
	Youngs Bay	3,333	1	0	5,027	2	0	8,283	3	0	9,811	4	0
	Big Creek	1,868	0	0	2,657	1	0	4,343	2	0	5,203	3	1
	Clatskanie	0	0	0	683	0	0	1,080	1	0	1,303	2	0
	Scappoose	0	0	0	0	0	0	462	1	0	686	2	1
Cascade													
	Clackamas	0	0	0	0	0	0	913	0	0	1,900	1	0
	Sandy	416	0	0	1,387	0	0	2,656	1	0	3,766	2	1
Gorge													
	Lower Gorge	780	1	0	1,399	2	0	2,025	3	0	2,549	4	0
	Upper Gorge/Hood	1,606	0	0	2,559	1	0	4,250	2	0	4,530	3	0
CHINOOK													
Coast (Fall)													
	Youngs Bay	0	0	0	135	1	0	657	2	0	873	3	0
	Big Creek	62	0	0	285	1	0	828	2	0	999	3	1
	Clatskanie	216	0	0	522	1	0	1,045	2	0	1,195	3	0
	Scappoose	0	0	0	161	1	0	656	2	0	857	3	1
Cascade (Fall)													
	Clackamas	302	0	0	451	1	0	960	2	0	1,254	3	0
	Sandy	303	0	0	457	1	0	914	2	1	1,089	3	2
Gorge (Fall)													
	Lower Gorge	126	0	0	444	1	0	946	2	0	1,148	3	1
	Upper Gorge	192	0	0	496	1	0	990	2	0	1,187	3	0
	Hood	421	0	0	575	1	0	1,000	2	0	1,223	3	0
Cascade (Late Fall)													
	Sandy	0	0	0	0	0	0	0	1	1	0	2	2
Cascade (Spring)													
	Clackamas	0	0	0	0	0	0	---	1	0	560	2	1
	Sandy	0	0	0	0	0	0	310	1	1	506	2	2
Gorge (Spring)													
	Hood	126	1	0	312	2	0	702	3	0	900	4	0
STEELHEAD													
Coast (Winter)													
	Youngs Bay	0	0	0	0	0	0	0	1	0	0	2	0
	Big Creek	0	0	0	0	0	0	0	1	0	125	2	1
	Clatskanie	0	0	0	0	0	0	0	0	0	0	1	0
	Scappoose	0	0	0	0	0	0	0	0	0	0	1	1
Cascade (Winter)													
	Clackamas	0	0	0	0	0	0	4,982	1	0	7,396	2	0
	Sandy	0	0	0	175	0	0	398	1	1	584	2	2
Gorge (Winter)													
	Lower Gorge	0	0	0	0	0	0	370	0	0	903	1	0
	Upper Gorge	117	0	0	357	0	0	605	1	0	930	2	0
	Hood	0	0	0	0	0	0	234	1	0	723	2	0
Gorge (Summer)													
	Hood	638	0	0	1,008	0	0	1,622	1	0	2,143	2	0

Chapter 5: Limiting Factors and Threats

This chapter describes limiting factors and threats to the recovery of LCR coho, Chinook and steelhead and CR chum populations. These limiting factors and threats were identified through comprehensive review of potential limiting factors and threats across the entire lifecycle, and formed the building blocks for the development of management actions to restore the viability of these listed populations.

This chapter is divided into five sections. The first sections describe the basic components that the Expert Panel and Planning Team used in developing the limiting factors and threats described in this Plan. The following sections provide the results of this process. They identify key and secondary limiting factors specific to LCR coho, Chinook, steelhead, and CR chum in six broad threat categories: tributary habitat, estuary habitat, hydropower/flood control, harvest management, hatchery management, and predation.

Development Process

The development of these limiting factors and threats was an iterative process involving three different groups or teams. The Expert Panel was the first group to consider limiting factors and threats. The Panel convened over a two-day period to provide their professional opinion on the limiting factors and threats that significantly influence the current status Oregon's lower Columbia salmon and steelhead populations. The specific purpose for convening a very brief meeting with the panel of experts was to quickly develop an initial list and ranking of potential limiting factors and threats that would serve as a starting point for more detailed and lengthy deliberations by the Planning Team.

The initial list of limiting factors and threats developed by the Expert Panel was extensively reviewed and modified during a series of meetings by the Planning Team. At these Planning Team meetings, additional information was presented and discussed that either supported or refuted the initial list provided by the Expert Panel. Based on the consensus of the Planning Team, the initial list of limiting factors and threats developed by the Expert Panel was modified to reflect the additional information and more detailed deliberations of the Planning Team.

The updated list of limiting factors and threats was then provided to the Stakeholder Team for their review. Stakeholder comments and input on the updated list of limiting factors and threats were further reviewed by the Planning Team, who again modified the list by consensus. This iterative process involving the Expert Panel, Planning Team and Stakeholder Team resulted in the limiting factors and threats to the recovery of lower Columbia salmon and steelhead populations described in this chapter.

Because of the lack of quantitative data for many of the populations covered by this Plan, the Planning Team did not attempt to conduct a comprehensive, life-stage specific, model-based analysis of limiting factors and threats for all populations across all life stages. However, the results of localized modeling efforts[17] were used to identify limiting factors and threats for some of the populations during team deliberations. Still, because of the widespread lack of reliable, long term, quantitative datasets, the limiting factors and threats outlined in this chapter are essentially working hypotheses that will be tested through research, monitoring, and evaluation as part of the adaptive management of this Plan.

[17] Primarily EDT analyses in the Clackamas, Sandy, and Hood rivers.

5.1 Limiting Factor and Threat Analysis Components

5.1.1 General Limiting Factor Categories

Limiting factors are defined in this Plan as the physical, biological, or chemical conditions and associated ecological processes and interactions (e.g., population size, habitat connectivity, water quality, water quantity, etc.) experienced by the fish that may influence the VSP parameters (i.e. abundance, productivity, spatial structure, and diversity). Table 5-1 describes the categories of limiting factors used in this assessment and their definitions.

Table 5-1. General limiting factor categories, definitions, related limiting factor/threat (LF/T) codes, and VSP parameters affected.

Limiting Factor	Definition	Related LF/T Codes	VSP Parameters Affected
Competition	Interaction between naturally produced fish and other fish or species, both of which need a limited environmental resource (i.e. food or space).	1a (hatchery fish)	abundance, productivity, diversity, spatial structure
Disease	Pathological condition in naturally produced fish resulting from infection.		abundance, productivity, diversity, spatial structure
Food web	Changes in the food web, primarily affecting food sources for naturally-produced fish.	3a (reduced macrodetrital input) 3b (increased microdetrital input)	abundance, productivity, diversity, spatial structure
Habitat access	Impaired access to spawning and/or rearing habitat (e.g., impassable culverts, delayed migration over dams, dewatered stream channels, diked off-channel habitat, etc…).	4a (passage - large dam) 4b (downstream passage - large dam) 4c (upstream passage - hatchery weir) 4d (upstream passage - road crossing) 4e (upstream passage - road crossing, small dam or diversion)	abundance, productivity, spatial structure, and (sometimes) diversity
Hydrograph/water quantity	Altered hydrology (i.e., timing and magnitude of flows).	5a (low-head hydro diversions) 5b (Columbia River hydropower dams) 5c (upslope land uses) 5d (irrigation withdrawals) 5e (municipal withdrawals) 5f (hatchery withdrawals)	abundance, productivity, spatial structure, diversity
Physical habitat quality	Altered quality of physical habitat (e.g., floodplain connectivity and function, channel structure and complexity, channel morphology, riparian condition and large wood recruitment, sediment routing [fine and coarse sediment, sand], and upland processes).	6a (fine sediment - roads) 6b (fine sediment - roads and land use) 6c (sediment/sand - hydro dams) 6d (gravel recruitment - dams) 6e (habitat complexity/diversity, access) 6f (habitat quality and connectivity) 6g (reduced habitat from inundation)	abundance, productivity, spatial structure, diversity
Population traits	Impaired population condition(s) (e.g., genetic, life history, morphological, productivity, fitness, behavioral characteristics, and population size); although population traits are caused by other limiting factors, they may also act independently as a limiting factor.	7a (consumptive, targeted fishery) 7b (fisheries targeted at other stocks or species) 7c (stray hatchery fish interbreeding with wild fish)	Harvest: abundance, diversity Hatcheries: abundance, productivity, diversity
Predation	Consumption of naturally produced fish by another species (does not include fishery mortality).	8a (non-salmonid fish) 8b (birds) 8c (hatchery fish) 8d (marine mammals)	abundance, productivity, diversity

Water quality	Altered physical, chemical, or biological water characteristics (e.g., temperature, dissolved oxygen, suspended sediment, pH, toxins in both water column and sediment, etc…)	9a (elevated temperatures - land use) 9b (elevated temperatures – reservoirs) 9c (toxins – agricultural chemicals) 9d (toxins – urban and industrial)	abundance, productivity, diversity

5.1.2 General Threat Categories

In this Plan, threats are defined as the human actions— habitat alterations, hydro system operations, fishing, hatchery operations, and predation—that *cause or contribute to* limiting factors. A single threat may cause or contribute to one or more limiting factors and may affect one or more life stages. Conversely, a single limiting factor may be caused by one or more threat. In addition, the impact of past threats may continue to contribute to current limiting factors through legacy effects.

Six general threat categories were considered for this limiting factors assessment: tributary habitat management, estuary habitat management, hydropower and flood control management, harvest management, hatchery management, and predation. These threats are summarized in Table 5-2 and discussed below. Threats such as climate change and the impacts of development associated with increases in human population will likely impact lower Columbia salmon and steelhead population viability in the future and are also considered in this Plan. However, because their specific impacts on individual populations and specific life stage are difficult to predict, no attempt was made to provide the level of life stage specific detail of these impacts that was provided under the six aforementioned threat categories. Instead, a more general description of the potential impacts of climate change and human population growth is provided in Section 5.3.

Table 5-2. General threat categories and definitions.

Threat Category	How Threats Cause or Contribute to Limiting Factors
Tributary Habitat Management	Tributary habitat conditions are impacted both by current land use practices causing limiting factors and impairing fish populations, and by current practices not adequate to restore limiting factors caused by past practices. These practices include agricultural, timber harvest, mining and grazing activities, diking, damming, development of transportation corridors, and urbanization.
Estuary Habitat Management	Land and water management activities, combined with the effects of the hydropower/flood control system, have changed estuarine habitat conditions in the Columbia River estuary. Complex habitats have been loss or modified through flow alterations, channelization, diking, development and other practices.
Hydropower and Flood Control Management[18]	Hydropower and flood control management cause a loss or alteration of stream habitat. Management includes dam construction and operations, conversion of riverine habitat to reservoir, and water withdrawals and flow alterations.
Harvest Management	Fisheries cause direct and incidental mortality to naturally produced fish. Direct mortality is associated with fisheries that are managed to specifically harvest target stocks. Incidental mortality includes incidental mortality of fish that are caught and released, encounter fishing gear but are not landed, or are harvested incidentally to the target species or stock. Fisheries can also result in genetic selection (e.g. size or age)
Hatchery Management	Hatchery programs can harm salmonid viability in several ways: hatchery-induced genetic change can reduce fitness of wild fish; hatchery-induced ecological effects—such as increased competition for food and space—can reduce population productivity and abundance; hatchery-imposed environmental changes can reduce a population's spatial structure by limiting access to historical habitat. Hatchery programs can potentially benefit salmonid viability by contributing to increasing natural-origin fish abundance and spatial distribution, by serving as a source population for repopulating unoccupied habitat and by conserving genetic resources. Hatchery practices that affect natural fish production include removal of adults for broodstock, breeding practices, rearing practices, release practices, number of fish released, reduced water quality, and blockage of access to habitat.
Predation	Predation on, and consumption of, lower Columbia salmon and steelhead by birds, non-salmonid fish, marine mammals and other species can affect salmonid viability by reducing abundance, productivity, and/or diversity.

[18] Note that dams that are operated for purposes other than hydropower or flood control (e.g. municipal water sources such as Bull Run in the Sandy Basin, or irrigation diversions dams such as occur in Hood River) are considered under the tributary habitat management threat category.

There are little if any data regarding population impact rates on salmonids due to the effects of hydropower/flood control dams and their operations on geomorphological, hydrologic, thermal, and other natural processes. Given this lack of data, the subsequent analyses of impact rates, and the inability to distinguish impacts on these processes from other anthropogenic sources, these hydropower/flood control impacts were considered part of the tributary habitat or estuary habitat threats. Impacts relating to upstream and downstream passage, blockage of habitat, and inundation of habitat, which are more directly measurable were the impacts directly considered in the hydropower/flood control category. Similarly, the imprecise impacts of hatchery juveniles on wild juveniles in tributaries or the estuary (e.g., competition or predation) were considered as part of the tributary or estuary threats, for which cumulative impact rates were available.

5.1.3 Life Stages and Geographic Areas Considered

Limiting factors and threats to LCR coho, Chinook and steelhead, and CR chum are described for two general life stages and geographic locations. More detailed information for the species and their populations at specific life stages and locations is provided in Appendix E.

Life-Stage Definitions

The Planning Team considered two general life stages, the juvenile life stage and the adult life stage, during its analysis of limiting factors and threats to viability of these salmon and steelhead populations. The team limited its analysis to these two general stages because of the lack of life-stage specific data for many populations. There was also uncertainty regarding the magnitude of impact for many population parameters and threat rates on more specific life stages.

> *Juvenile life stage*: The juvenile life stage extends from the egg through ocean entry. After leaving the egg, juveniles rear in freshwater before undergoing the physiological changes needed to transition to saltwater and migrate to the ocean. More specific stages—egg, alevin, fry, summer parr, winter parr, presmolt and smolt—are included in this category.
>
> *Adult life stage:* The adult life stage occurs during ocean residency and the return to freshwater to spawn. The adult completes its rearing time in the ocean and returns to the estuary, where it again undergoes the physiological changes needed to transition from saltwater to freshwater. It then migrates back to its natal area where it spawns. Salmon die after spawning; steelhead may spawn multiple times, with migration to and from the ocean occurring between spawning events.

Geographic Areas

LCR coho, Chinook and steelhead, and CR chum experience life stage specific limiting factors/threats as they navigate through different geographic areas during their life cycle. The Planning Team examined the wide range of factors impacting the species and populations in the different locations. All of the populations are affected by threats in the tributaries—the non-tidal portions of streams and rivers within specific population areas—as eggs, alevin, fry, summer parr, winter parr, smolts, returning adults and spawners. They are affected by threats in the Columbia River estuary as fry, fingerling/sub-yearlings, yearlings and returning adults. They are affected in the ocean as sub-adults and adults. In addition, salmon and steelhead populations in the Upper Gorge and Hood populations are affected by threats in the mainstem Columbia River above Bonneville Dam as eggs, alevins, fry, fingerling/sub-yearlings, yearlings, returning adults and spawners. Figure 5-1 shows the geographic areas that encompass the lifecycle of LCR coho, Chinook and steelhead, and CR chum populations in Oregon.

Key and secondary threats to lower Columbia salmon and steelhead in these geographic areas are discussed under the various threat categories. Threats identified in the tributary habitat category occur in the tributaries and in the upper mainstem Columbia River above Bonneville Dam. Estuary habitat related threats occur in the Columbia River estuary. Key and secondary threats identified for the species in the

hydropower/flood control, hatchery, and predation categories occur in tributaries, estuary and the mainstem Columbia above Bonneville Dam. Harvest related threats exist in all the geographic areas.

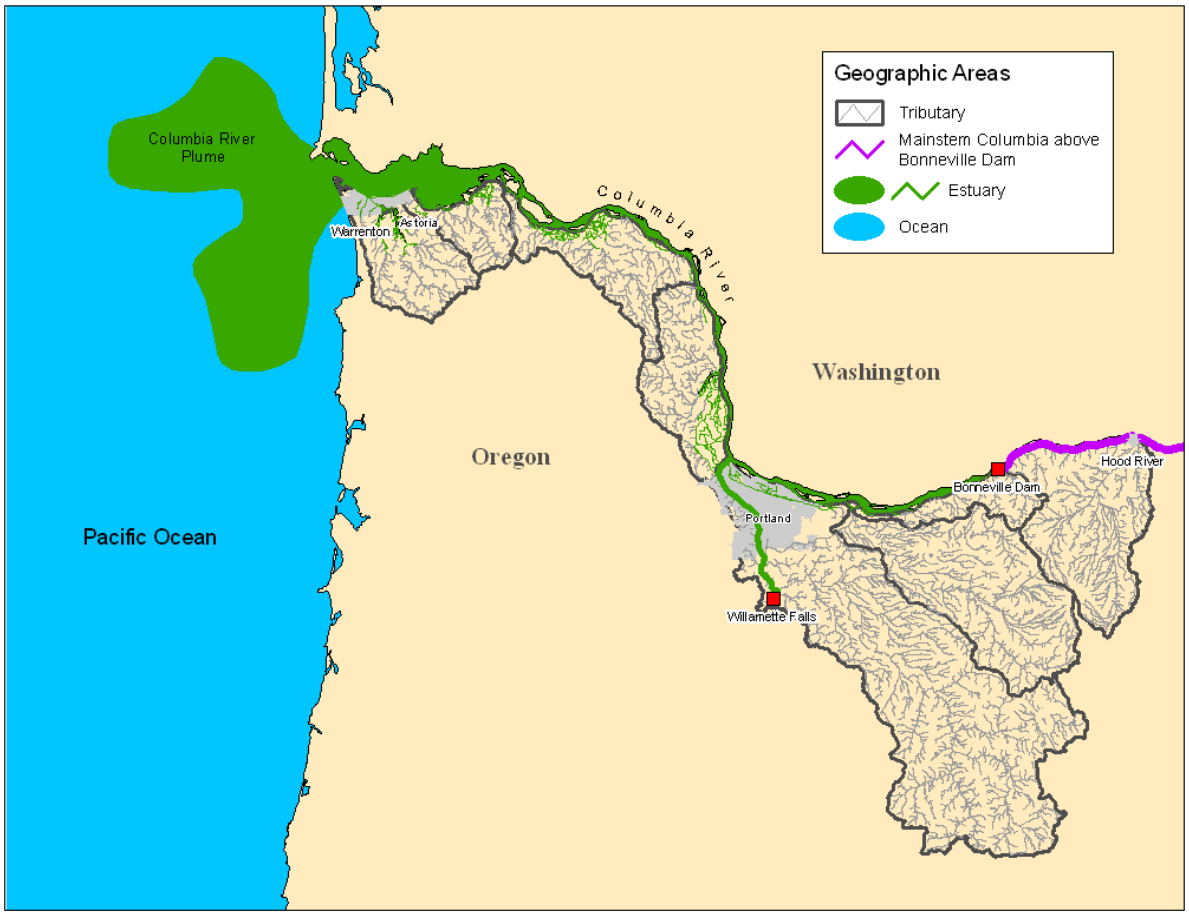


Figure 5-1. Geographic areas for lower Columbia River salmon and steelhead populations in Oregon.

5.1.4 Prioritizing Limiting Factors and Threats

Oregon believes a common pitfall in the design and successful implementation of recovery plans is the failure to provide strategic guidance. Rather than provide a laundry list of all the potential limiting factors and threats, the intent of this Plan is to identify the limiting factors and threats that currently are the most significant impediments to the recovery of Oregon populations of salmon and steelhead in the Lower Columbia River recovery area. Toward this end, this Plan recognizes two categories of limiting factors and threats:

> *Key limiting factors and associated threats are <u>believed</u> to <u>have had</u> the <u>greatest</u> impact on current population viability.*
>
> *Secondary limiting factors and associated threats are also <u>believed</u> to <u>have had</u> <u>significant</u> impacts on population viability, but to a <u>lesser degree</u> than key concerns.*

The words underlined in the previous two sentences underscore a number of important points regarding the process used to identify key and secondary limiting factors and threats. Ideally the process of ranking limiting factors and threats would be based on a strictly quantitative approach wherein precise and

unbiased data on mortality and the causes of mortality would be identified for each species and life history stage. Unfortunately, this ideal situation does not exist. The fact is that for many populations and/or life stages, little if any quantitative data on sources or magnitude of mortality exist. Rather than try to develop an approach to ranking limiting factors and threats that would only give the appearance of a quantitative framework, the final rankings reported later in this chapter represent the consensus opinion of the Planning Team.

Although a formalized quantitative approach was not used to develop the rankings, it does not mean that existing data and analyses were not consulted during the process. As the reader will see in the following sections, considerable review of existing information is provided. The reader should also note that rankings of limiting factors and threats are based not only on what is occurring today, but on the legacy of past impacts as well. For example, in many instances the impact of current fisheries is much less than in the past. However the legacy of past harvest, when combined with the past and/or present impacts of the other threat categories (i.e. tributary habitat, estuary habitat, hatcheries, hydro, and predation) are what led to the current status. Thus, unless otherwise noted, the impacts reported in the following sections represent conditions that led to current status and may not necessarily represent current management approaches.

Ranking harvest-related factors

While no specific harvest rate/ranking benchmarks were used at the time the rankings were established, a retrospective analysis of the rankings based on harvest data available since 1974 showed (with one exception) that harvest was identified as a key concern for a population if the estimated average harvest rate was 35 percent or higher, and as a secondary concern if it was between 10 and 35 percent. The one exception to these benchmarks was in the case of the impact on wild winter steelhead from fisheries targeting other species or hatchery stocks. Incidental mortality of wild winter steelhead in mainstem winter/spring gill and tangle net fisheries is monitored via an onboard observation program. Impacts to wild winter steelhead in this commercial fishery averaged 0.34% during 2005-2009, which is far less than the two percent allowable impact. Incidental winter steelhead mortality in mainstem Columbia River and lower Willamette recreational fisheries is monitored for a majority of the season through a creel program. The estimated impact rate on wild winter steelhead in the mainstem recreational fishery averaged 0.10% during 2005-2009. Wild winter steelhead incidental impact in most tributary recreational fisheries is not directly monitored, but is assumed to average 2-3% (LeFleur and King 2004; NMFS 2005(b); NMFS 2006(b)). These fisheries were listed as a secondary concern for wild winter steelhead because the Planning Team felt there was uncertainty associated with mortality rate estimates[19]. However, the current combined fisheries impact rate is low enough that it does not threaten the recovery of any steelhead population.

These ratings reflect the best information currently available, although data remain limited. Until recently, it was difficult to distinguish wild from hatchery fish since many fish managers only began marking hatchery fish in the late 1990s. Further, limited information exists regarding the differences in migration timing that are known to exist between early and late stocks, between wild and hatchery stocks, and between fish of the same stock from different tributaries. More information is needed regarding these timing differences to better clarify the extent of harvest impacts on the various populations.

Ranking hatchery-related factors

Hatchery strays are identified as a key concern for a population if it is estimated, as described in Chapter 4, that the percentage of hatchery fish on local spawning grounds has likely averaged 30 percent or higher, and as a secondary concern if the proportion averaged between 10 and 30 percent. These

[19] Actions identified in Chapter 7 related to the potential impact of fisheries on winter steelhead passing through the mainstem Columbia focus on gathering information to further assess the impact of both gill/tangle net and recreational fisheries.

designations were arrived at during the process of developing the recovery scenarios described in Chapter 6. There, based on the TRT guidelines for stray hatchery fish presented by McElhany et al. (2007), the following levels were adopted for the percentage of hatchery origin fish spawning in the wild. If the overall desired status goal for a population is low risk or very low risk, then in addition to meeting the abundance and productivity targets for this designation, the average proportion of hatchery fish in the natural spawning population, regardless of their spawn timing, has to be ≤ 10 percent. Likewise, if the recovery goal risk category for a population is 'moderate' then the average proportion of hatchery fish has to be ≤ 30 percent. It is logical that the rankings of the impact of hatchery stray rates should align with future goals for hatchery stray rates that were adopted to address diversity needs.

These rankings represent the best information now available on hatchery stray rates based on coded wire tag (CWT) recoveries, hatchery tagging rates and other data. Overall, however, estimates of hatchery and wild fish on spawning grounds remain highly uncertain. Determining the number of stray hatchery fall Chinook on spawning grounds is particularly challenging because, until recently, only a small fraction of fall Chinook released from hatcheries were fin clipped. In addition, scale pattern differences between hatchery reared and wild reared fish that are readily evident in coho and steelhead are much more difficult to discern in fall Chinook. Thus, the proportion of wild fish, particularly fall Chinook, estimated in natural spawning areas will remain highly uncertain until *all* the hatchery fish reliably marked before their release. Although most hatchery origin fish are mass marked (i.e. fin clip) as of 2009, it will be several years before the benefits from this action will be realized. Information on hatchery stray rates, preferably over three life cycles (9 years), is needed to identify stray rates and the origin of strays with more accuracy. In addition, because mass fin clipping does not result in a 100 percent mark rate, even a 1-2 percent unmarked hatchery fraction could represent a large number of unmarked hatchery strays in some depressed wild populations.

5.2 General Threat Category and Associated Limiting Factor Information

This section describes limiting factors and threats that are common to multiple populations, or strata within the LCR coho, Chinook and steelhead, and CR chum ESUs.

<u>Tributary Habitat Management</u>

Both current and historic management practices pose threats to the recovery of lower Columbia River salmon and steelhead populations. Over the last two hundred years, many once important habitat areas have been degraded through widespread development and land use activities that affected habitat quality and complexity, floodplain connectivity, watershed hydrology, and water quality in many lower Columbia River subbasins. Habitat degradation has affected salmon and steelhead abundance, productivity, spatial structure and/or diversity.

- Timber harvest on unstable slopes and riparian areas has led to the unraveling of watershed processes. Improperly located, constructed, or maintained roads have degraded stream flow and increased movement of fine sediment to stream channels. The historical use of splash dams to transport logs reduced instream structure and available spawning gravel in several stream systems.

- Agricultural development, especially along lowland valley bottoms in the lower Columbia region, has directly impacted riparian areas and floodplains (IMST 2002). Historical floodplain habitats were also lost through the filling of wetlands and levee construction. Runoff from agricultural lands where pesticides, herbicides, and fertilizers are applied has reduced water quality.

- Livestock grazing has directly impacted soil stability (trampling) and streamside vegetation (foraging), and delivered potentially harmful bacteria and nutrients (animal wastes) to streams.

- Construction of dams, culverts and other barriers has limited access to spawning and rearing habitats.

- Urban and rural development has led to the degradation of riparian and floodplain conditions and an increase in the drainage network from roads, ditches and impervious surfaces which alter stream hydrographs and impair water quality due to stormwater runoff, combined sewer overflow events, and toxic contaminants derived from various non-point and wastewater effluent sources.

- Sand and gravel mining along some lower Columbia streams has impacted stream channels by altering instream substrate and sediment volumes.

Together, these factors reduced the amount and quality of spawning and rearing habitats available to lower Columbia salmon and steelhead populations in tributary areas. They severed access to other historically productive habitats and weakened the important watershed processes and functions that once created healthy ecosystems for salmon and steelhead production.

The factors have also reduced water quality in the tributaries. Land use practices, often in conjunction with water withdrawals, have contributed to elevated water temperatures in many population areas. In conjunction with water withdrawals, elevated stream temperatures often exist because of a combination of factors, including water withdrawals and/or altered hydrology and a lack of intact, functional and contiguous riparian management zones and sufficient streamside buffers. In some areas, water quality has also been reduced because of contaminants for agricultural use. This is a concern for salmon and steelhead in the Hood and Clackamas systems, as high levels of a number of pesticides have been reported in streams from these watersheds (Carpenter et al. 2008; Anderson et al. 2006, 2007; Wentz et al. 1998).

Figures 5-2— 5-4 show water quality limited areas in the three population stratums.

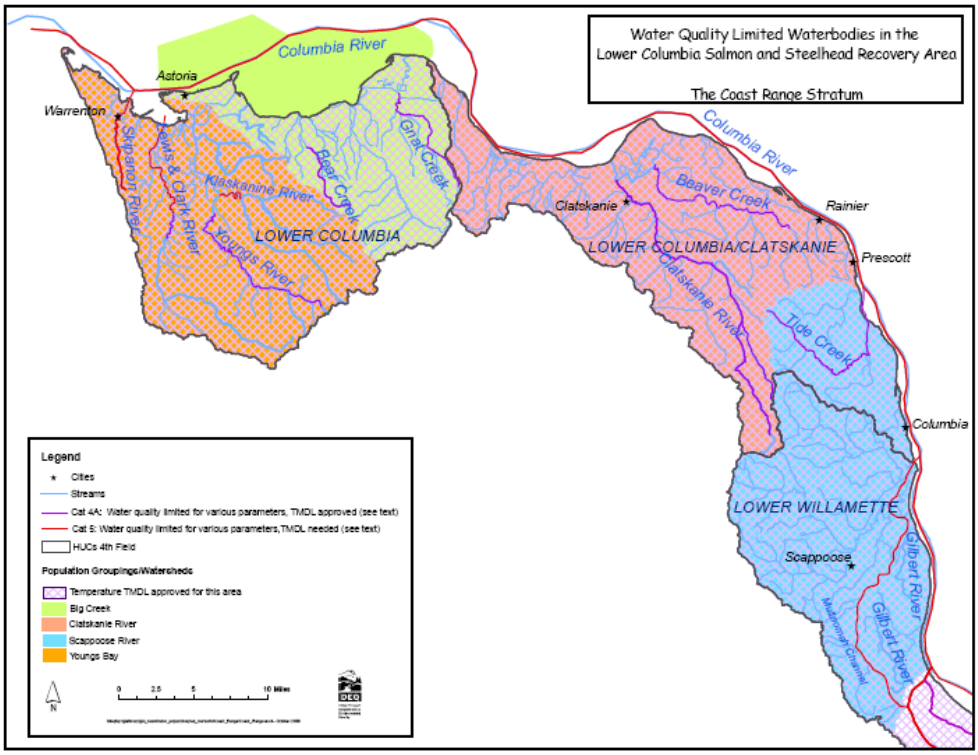


Figure 5-2. Water quality limited areas in the Coast Range Stratum (ODEQ 2008).

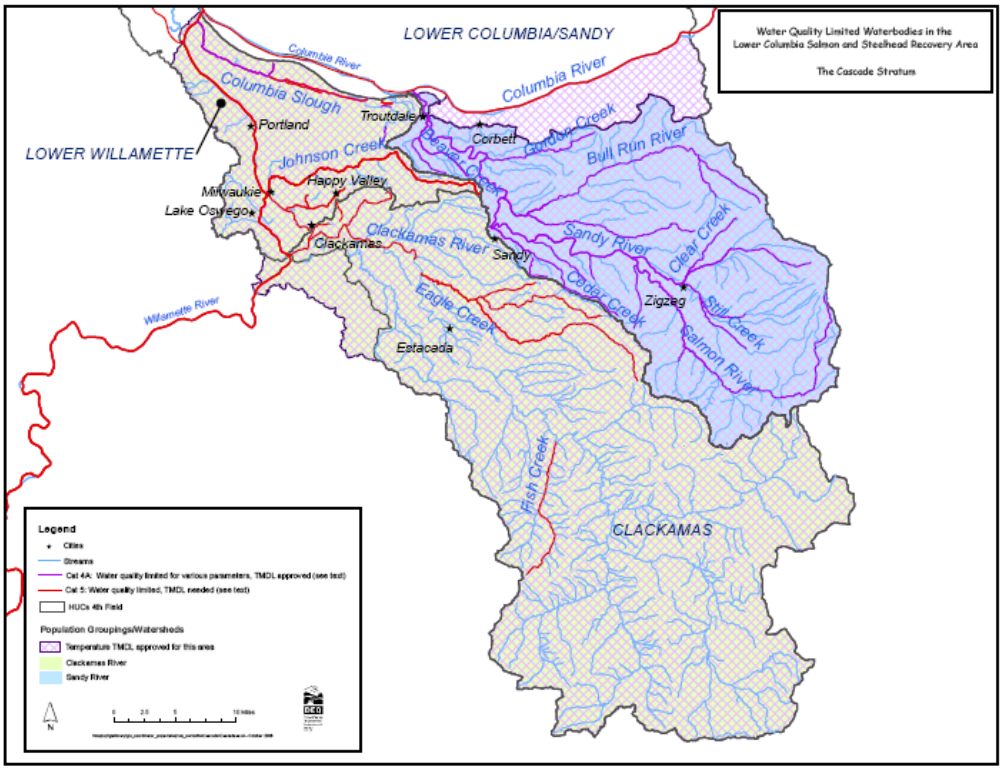


Figure 5-3. Water quality limited areas in the Cascade Stratum (ODEQ 2008).

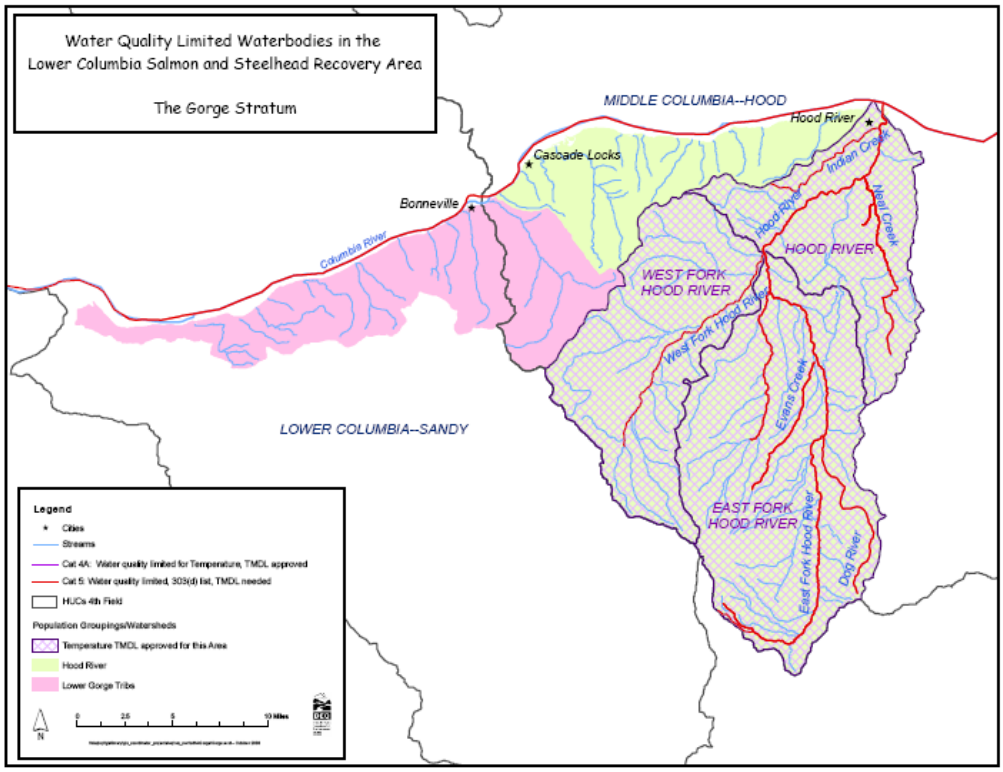


Figure 5-4. Water quality limited areas in the Gorge Stratum (ODEQ 2008).

Today land management practices, including those by forest and agricultural landowners, that led to impaired habitat conditions in the tributaries have improved, but their legacy remains. Many landowners now understand the advantages of good conservation practices and are changing their approaches to help restore healthy watershed processes and functions. However, the combination of historical impacts with increased pressures from human population growth and climate change highlights the need for significantly enhanced efforts to maintain unimpaired habitat and repair degraded habitat to levels that will support viable salmon and steelhead populations.

Estuary Habitat Management

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.

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 once important habitat areas in the estuary have been affected by land and water management activities. Along the lower Columbia, complex habitats have been modified through channelization, diking, development and other practices. 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. As a result 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.

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 lower Columbia River salmon and steelhead populations.

Hydropower and Flood Control Management

Specific threats from hydropower and flood control management have caused the loss or alteration of stream habitat and include dam construction and operations, conversion of riverine habitat to reservoir, and water withdrawals. This management may affect salmonid population viability by influencing abundance, productivity, spatial structure and/or diversity.

The ability of juvenile salmon to access and benefit from habitat depends greatly on instream flow (Fresh et al. 2005). 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 were characterized by 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. 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). Within the United States, 14 multi-purpose

hydropower projects operate as a coordinated system in the Columbia River basin. All LCR coho, Chinook and steelhead, and CR chum populations utilize estuarine habitat below these dams. LCR coho, Chinook and steelhead, and CR chum populations from two areas, the Upper Gorge and Hood River, also use habitat above Bonneville Dam, the lowermost dam on the Columbia River.

Management of the system for hydropower, flood control and other uses has significantly changed the quantity and timing of flows entering the Columbia River estuary and plume from historical conditions (NMFS 2008b; Figure 5-5). Jay and Naik (2002) reported a 16 percent reduction of annual mean flow over the past 100 years and a 44 percent reduction in spring freshet flows. Jay and Naik also reported a shift in the hydrograph to 14 to 30 days earlier in the year, meaning that spring freshets are occurring earlier in the season. In addition, the interception and use of spring freshets (for irrigation, reservoir storage, etc.) have increased flows during other seasons (Fresh et al. 2005).

Changes to the natural flow regime have affected habitat quality, availability and capacity in the estuary. The habitats that salmonids occupy during their residency in the estuary and plume are formed through the interaction of ocean forces, land, and river flow (Fresh et al. 2005; LCREP 2007). 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. Thus, changes in the magnitude, timing, and frequency of flows over the last 200 years have resulted in corresponding changes in formation and availability of salmonid habitats. Some habitat has been removed, reducing the total acreage of the estuary by approximately 20 percent (Fresh et al. 2005). In other cases, particular habitat types have been transformed into different habitat 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 been lost (NPCC 2005), while other shallow-water habitats have increased significantly. The loss of tidal swamps and other forested or vegetated wetlands represents a loss of habitat that ocean-type salmonids use during their estuarine residence. Alterations in flow along with land use impacts have contributed significantly to losses in in-channel, off-channel, and plume habitat. Further, juvenile salmonids have physiological or behavioral traits that set the timing for their transformation to saltwater, and changes in flows may interrupt this timing (LCREP 2006).

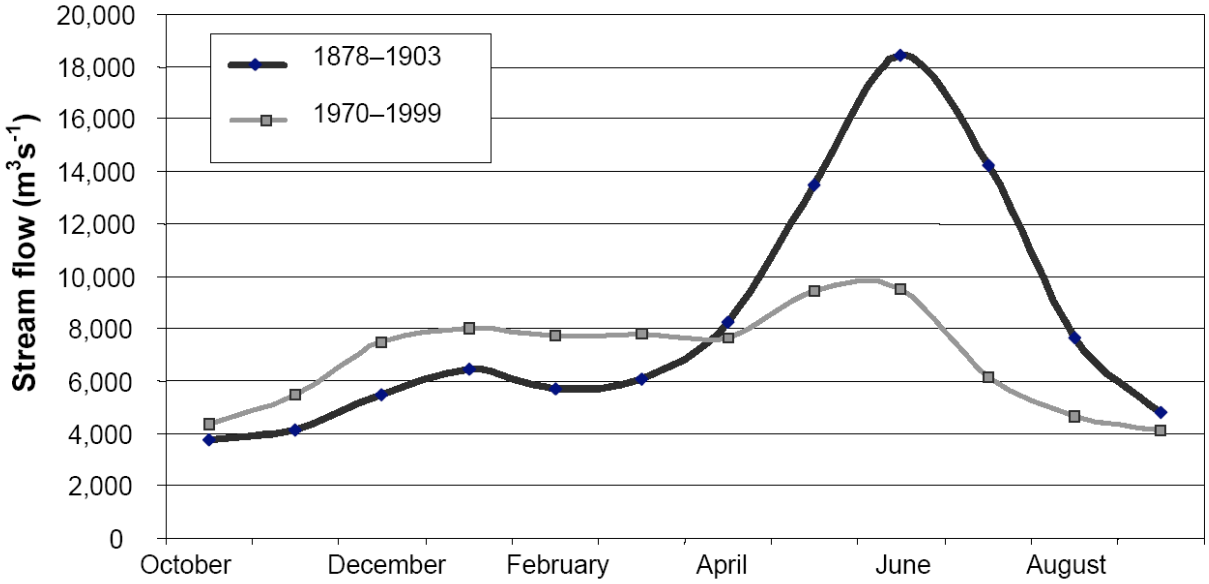


Figure 5-5. Changes in annual Columbia River flow, measured at Beaver Army Terminal, near Quincy, Oregon. Reprinted from Bottom et al. (2005).

Hydropower projects on several lower Columbia River tributaries also reduce salmon and steelhead viability. Dams in the Willamette River system alter the flow regime in the lower Willamette River by controlling downstream flooding in the winter, nearly doubling the flow in the summer, and altering channel dynamics (Primozich and Bastasch 2004). These flow alterations, along with changes in channel structure, are responsible for decreasing habitat complexity in the lower Willamette River. Projects in the Clackamas, Sandy[20] and Hood River[21] systems have also restricted habitat access, influenced population traits and degraded habitat quality.

Several recent adjustments in Columbia River and tributary hydro system operations—including adjusting flows to benefit spring juvenile salmonid migration and setting minimum flow levels to reduce potential dewatering of redds— have reduced some of the impacts from hydro operations. Nevertheless, hydropower and flood control management continues to reduce viability of LCR coho, Chinook and steelhead, and CR chum.

Harvest Management

Lower Columbia River salmon and steelhead may be caught in ocean, estuary, mainstem Columbia River, or tributary fisheries depending on their distribution, run timing relative to fishery openings, and vulnerability to gear. Fishery managers strive to reduce annual catch rates on wild salmon and steelhead while meeting various harvest goals by continuously reviewing changes in population abundance and marine survival conditions, and adjusting harvest rates and timing accordingly. These fisheries influence salmonid population viability by causing direct and incidental mortality to naturally produced fish. Direct mortality is associated with fisheries that are managed to 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. This complex fisheries management system and related harvest impacts on lower Columbia River salmon and steelhead are discussed below.

The fisheries management system that impacts these salmon and steelhead populations has changed significantly over the years. In the late 1800s and early 1900s, nearly all commercial fisheries in the region operated in bays and rivers where they harvested only mature salmon. Commercial fisheries on the lower Columbia River expanded rapidly after 1866 when salmon canning began in the Northwest. Commercial landings were usually canned and estimates of landings are available from cannery records. These records show that landings exceeded 40 million pounds annually in 1883, 1884, 1895, 1911, 1915-1919, and for the last time in 1925. The landings peaked in 1911, with 49.5 million pounds (WDFW and ODFW 2002). Since 1938, landings have ranged from a high of 31.6 million pounds (2,122,500 fish) to a low of 0.9 million pounds in 1995 and 1999 (68,000 fish). Columbia River commercial landings declined steadily after 1940, reflecting changes in fisheries in response to declines in salmonid abundance (Figure 5-6). In the late 1950s, more restrictions were imposed on freshwater and coastal estuary fisheries, and ocean fisheries became more important. Ocean harvest of salmon began around 1912 and peaked in the 1970s and 1980s. More recently, commercial and recreational harvest of salmon and steelhead has been reduced to meet international treaty agreements, fisheries conservation acts, regional conservation goals, the Endangered Species Act, and state and tribal management agreements. During the 1990s, total salmon and steelhead landings averaged 1.9 million pounds (166,300 fish). In 2000, salmon and steelhead landings totaled 2.8 million pounds (246,700 fish) (WDFW and ODFW 2002).

[20] Hydro impacts in the Sandy are the legacy impacts from Marmot Dam (removed in 2007) and Little Sandy Dam (removed in 2008).
[21] Powerdale Dam (Hood River) is scheduled for removal in 2010.

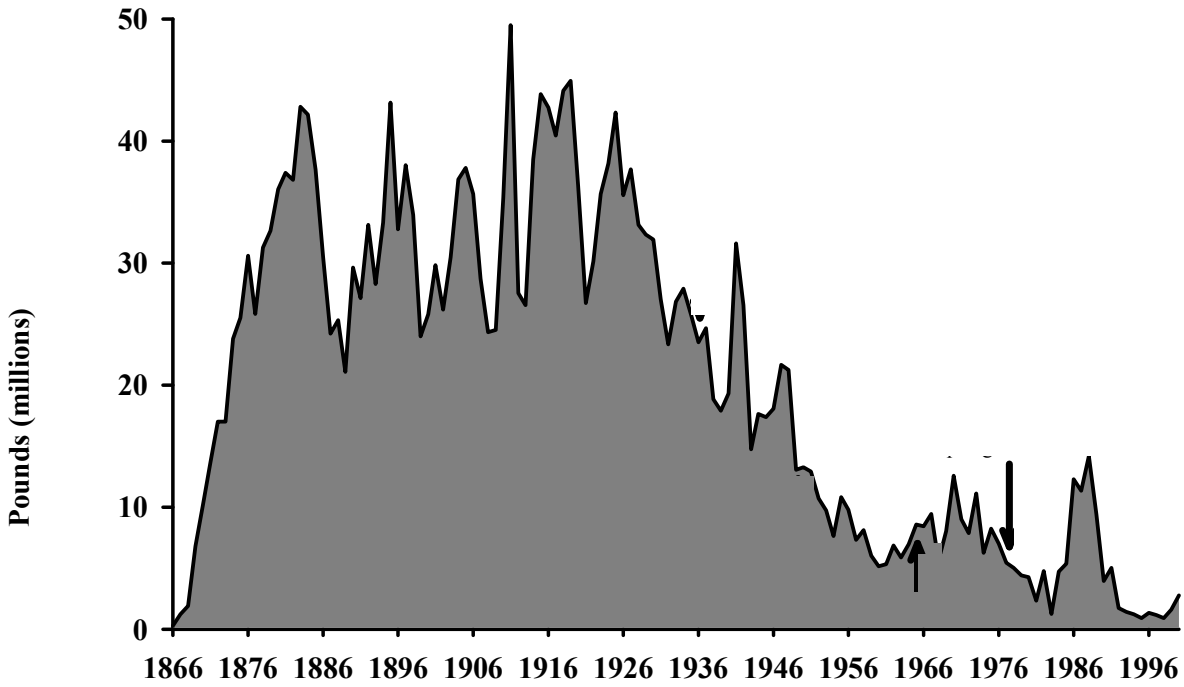


Figure 5-6. Commercial landings of salmon and steelhead from the Columbia River in pounds, 1866–1999 (WDFW and ODFW 2002).

Fishery Types and Areas
Lower Columbia River salmon and steelhead cross numerous fisheries as they make their way from their lower Columbia watershed of origin all the way to Canada and Alaska and then back again. These various fisheries focus on different stocks and populations, and take fish to meet commercial, recreational and tribal needs. The different types of fisheries that may directly or indirectly affect the populations are discussed briefly below.

- *Canada/Alaska ocean fisheries*. Numerous fisheries in Canada and southeast Alaska harvest far-north migrating Chinook stocks from the lower Columbia River basin. A small number of Columbia River coho salmon are also harvested in Canadian fisheries. Canadian marine fisheries include commercial troll and net fisheries, and recreational fisheries in northern British Columbia, central British Columbia, west coast of Vancouver Island, Strait of Georgia, and Strait of Juan de Fuca. In southeast Alaska, marine Chinook fisheries include commercial troll and net fisheries, as well as recreational fisheries.

- *United States West Coast ocean fisheries*. Recreational and commercial ocean fisheries for Chinook and coho also occur along the West Coast. These fisheries are separated into four major management areas: 1) US/Canada border to Cape Falcon, Oregon; 2) Cape Falcon, Oregon to Humbug Mountain, Oregon; 3) Humbug Mountain, Oregon, to Horse Mountain, California; and 4) Horse Mountain, California to the US/Mexico border. These management areas are further divided into subareas depending on the type of fishery. Recreational fisheries are either selective for fin-clipped hatchery fish or non-mark selective depending on the species. Commercial fisheries are either mark selective or non-mark selective troll fisheries. Numerous treaty Indian commercial troll, non-Indian commercial troll, and recreational marine fisheries exist along the West Coast.

LCR fall Chinook (tule) are caught in ocean fisheries off the coasts of Oregon, Washington, and British Columbia. LCR spring Chinook are caught in ocean fisheries off the Washington coast and as far north as Alaska. LCR coho include two distinct runs that are also caught in ocean fisheries: early returning (Type S) coho generally migrate south of the Columbia once they reach the ocean and return to the Columbia River in mid-August, and late returning (Type N) coho have a northern distribution in the ocean and return to the Columbia River from late September through December. Ocean fishing mortality on LCR steelhead and CR chum is assumed to be zero (NMFS 2008).

- *Lower Columbia River commercial fisheries*. Lower Columbia River non-Indian commercial fisheries occur below Bonneville Dam in the mainstem (statistical Zones 1-5) and in Select Areas (off-channel fishing areas; SAFE). Currently, winter and spring fisheries in the mainstem are mark selective but summer and fall fisheries are not. The lower Columbia River commercial fisheries (Figure 5-7) primarily target white sturgeon during the early portion of the winter season (January through mid-April) and 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). A commercial shad season occurs annually in Area 2S (Washougal to Beacon Rock) during May-June. Fisheries targeting summer Chinook, white sturgeon, and occasionally sockeye may occur during the summer (June 16-July 31) season. The fall season (typically August 1-October 31) includes an "early fall" fishery (August to mid-September) targeting Chinook and white sturgeon and a "late fall" fishery (mid-September to late October) targeting coho primarily. Landings of steelhead occurred in commercial fisheries until commercial harvest of steelhead was banned in 1975. The Select Area commercial fisheries target coho and Chinook in off-channel areas (Youngs Bay, Tongue Point/South Channel and Blind Slough/Knappa Slough in Oregon and Deep River in Washington) returning from net pen and hatchery releases in these areas. Commercial fishing seasons in the mainstem Columbia River are established by the Columbia River Compact. Select Area seasons are established by the Columbia River Compact for concurrent waters and by the individual states for state waters. Commercial fishing for chum is not allowed in the lower Columbia.

- *Lower Columbia River recreational fisheries*. The lower Columbia River mainstem below Bonneville Dam is separated into two main areas for recreational harvest; Buoy 10 (ocean/in-river boundary) to the Rocky Point/Tongue Point line, and the Rocky Point/Tongue Point line to Bonneville Dam. These fisheries are mark-selective for spring Chinook, steelhead, and coho. The Buoy 10 sport fishery catches fall Chinook and coho and accounts for the majority of the Columbia River recreational coho harvest. The lower Columbia River sport fishery catches summer and fall Chinook, coho and summer steelhead in the mainstem Columbia River from Rocky Point/Tongue Point to Bonneville Dam. 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. Recreational fishing for chum is not allowed in the lower Columbia.

- *Lower Columbia tributary recreational fisheries*. Salmon and steelhead sport fishing occurs in most lower Columbia River tributaries. These fisheries are mark-selective for spring Chinook, steelhead, and coho. Tributary harvest is managed in Oregon consistent with objectives of the ODFW Native Fish Conservation Policy. Fishing seasons are established based on forecasts of salmon and steelhead returning to the tributaries. In years when returns for some species are forecasted below escapement requirements, fishery impact is reduced or eliminated. Impact reductions are made by time and area closures, gear restrictions, or changes in bag limits.

- *Treaty Indian fisheries*. Treaty Indian harvest includes commercial and ceremonial and subsistence (C&S) fisheries. The treaty Indian 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 tribal C&S fisheries are of highest priority and generally occur before tribal commercial fishing. The Columbia River treaty tribes regulate treaty Indian C&S fisheries in Zone 6.

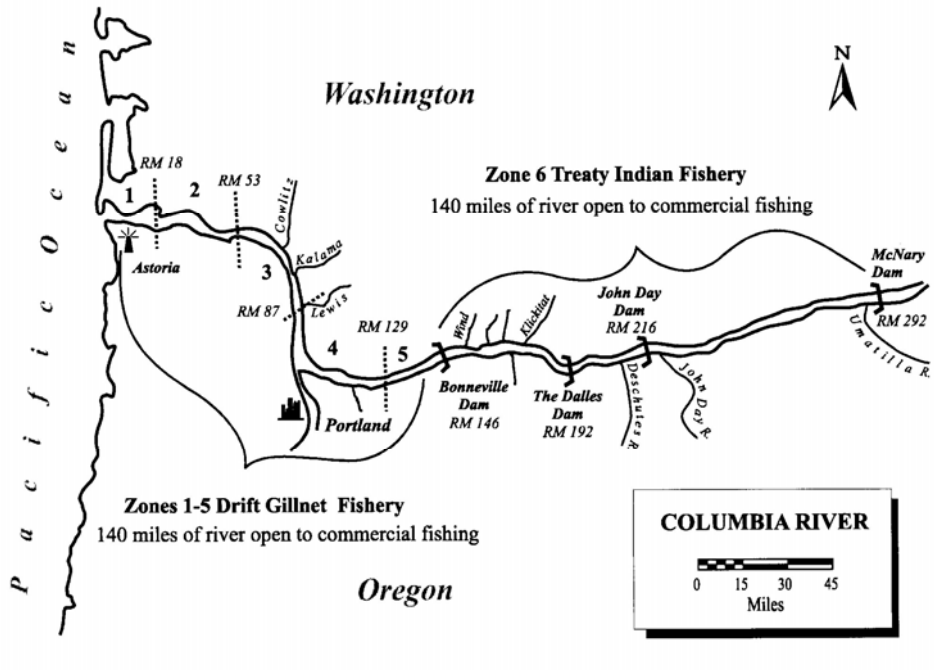


Figure 5-7. Columbia River commercial fishing zones.

Managing the Fisheries

Pacific salmon and steelhead management across this large geographic region is governed by a number of regional agreements and overseen by several organizations (sidebar). The fisheries of the Columbia River are established within the guidelines and constraints of the Pacific Salmon Treaty, the Columbia River Fish Management Plan, the ESA, the Pacific Fishery Management Council, the states of Oregon and Washington, the Columbia River Compact, and management agreements negotiated between the parties to US 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, but that indirectly control impacts on Columbia River fish.

Fishery managers adjust harvest annually in response to changes in abundance to achieve specified escapement levels or harvest rate limits to allow harvest of strong (generally hatchery) stocks while protecting weak (generally wild) stocks. Management is governed by international treaty agreements, fisheries conservation acts, regional conservation goals, the ESA, and state and tribal management agreements. Management through these various organizations has contributed to the decline of harvest rates for Columbia River salmon and steelhead, especially since the 1970s.

Institutions and Processes Affecting Fisheries Management

Pacific Salmon Treaty. Management of Pacific salmon has long been a matter of common concern to the United States and Canada. In 1985, after many years of negotiation, the two countries signed the Pacific Salmon Treaty, setting long-term goals for the benefit of the salmon and the two countries. The principal goals of the treaty are to enable both countries, through better conservation and enhancement, to increase production of salmon and to ensure that the benefits resulting from each country's efforts accrue to that country. The Pacific Salmon Commission oversees implementation of the Treaty and negotiates new fishing agreements from time to time, but the actual regulation of the fisheries is done by domestic management agencies and tribes..

US v. Oregon. In 1968, the US District Court settled a court case known as US v. Oregon and ruled that Columbia River treaty Indians were entitled to an equitable share of the upper Columbia River fish returns. After 20 years of legal tests and negotiations, a long term agreement, known as the Columbia River Fish Management Plan (CRFMP) was adopted by Court order in 1988 and agreed to by the parties: the United States; the states of Oregon, Washington, and Idaho; and the Nez Perce, Umatilla, Warm Springs and Yakama treaty Indian tribes. The agreement expired in 1999 and Columbia River mainstem fisheries have since been managed via short term settlement agreements adopted by the Court until a new Columbia River plan was agreed to in 2008. Artificial propagation programs upstream of Bonneville Dam have been incorporated into these agreements because of their importance to providing fish for harvest. Harvest plans for tributary fisheries are developed cooperatively by the management entities with primary management responsibility in the respective sub-basin.

Endangered Species Act. NMFS administers the Federal Endangered Species Act. Because many Columbia River salmon and steelhead populations are listed under the ESA, harvest managers must consult annually with NMFS to assure that fisheries are regulated to meet no-jeopardy standards established for ESA-listed species. The regulatory agencies and Tribes receive incidental take permits from NMFS for fisheries that have satisfied ESA regulatory requirements.

Magnuson-Stevens Fishery Conservation and Management Act. The Magnuson-Stevens Fishery Conservation and Management Act of 1976 is the principal law governing marine fisheries in the United States. The Pacific Fishery Management Council (PFMC), one of eight regional fishery management councils established by the Magnuson Act, is responsible for all fisheries off the coasts of California, Oregon, and Washington; this includes those for salmon, groundfish and pelagic fish. Chinook and coho salmon are the main salmon species managed by the PFMC in waters extending from the Canadian border to the Mexican border, and 3-200 nautical miles offshore.

North of Falcon. Folded into the PFMC management process is a parallel public process referred to as North of Falcon (NOF). The North of Falcon process integrates management of ocean fisheries between Cape Falcon (on the north Oregon coast) and the Canadian border with inland area fisheries. Columbia River fisheries are a significant part of the NOF process. Coordination and shaping of the ocean and freshwater fisheries occurs to assure that fish conservation objectives are met, and that there is reasonable sharing of the conservation burden between the fisheries and various user groups. In this process there are allocation agreements reached between Oregon and Washington ocean and freshwater commercial and sport fisheries, as well as mandated allocation agreements between the states and treaty Indian tribes. Conditions for incidental take permits concerning ESA-listed Columbia River populations are often developed during the NOF process.

State Fishery Regulations. Regulations for lower Columbia tributary sport fisheries are developed through state public process and adopted into law by the respective fish and wildlife commissions of Washington and Oregon for their jurisdictional waters. ESA authorization for these fisheries are through fisheries management and evaluation plans that, when approved, will exempt these fisheries from take prohibitions under limit 4 of the 4(D) rule. Mainstem Columbia joint waters are coordinated for consistency in the Compact forum (see below) but are adopted into law by the respective states. The state regulatory process includes adoption of permanent rules as well as emergency regulations to enable quicker adjustments of fisheries when needed to meet conservation objectives or provide additional harvest opportunity. The state regulations are made consistent with management strategies reached in the NOF process.

Columbia River Compact. In 1918 the US Congress ratified a compact between Oregon and Washington covering concurrent jurisdiction of Columbia River fisheries. The Compact jurisdiction includes the Columbia River from the mouth to just upstream of McNary Dam. The Compact, which comprises the Washington Fish and Wildlife Commission and the Oregon Fish and Wildlife Commission, sets fishing seasons in the non-Indian commercial Zones 1-5 (Mouth to Bonneville Dam) and in the treaty Indian commercial area Zone 6 (Bonneville Dam to McNary Dam). In recent years, the commissions have delegated decision-making authority to the state fish and wildlife agency's director or designee. Periodic hearings to adopt or review seasonal commercial regulations are held just before major fishing seasons to consider current information and establish season dates and gear restrictions. Additional hearings are held in-season when updated information concerning run size, attainment of escapement goals, or catch guidelines indicates a need to adjust the season.

Fisheries Effects

Harvest decreases adult abundance, and thus the number of spawners. The extent of this decrease in abundance may be measured in terms of numbers of spawners or as an exploitation, rate. Harvest may be selective—either intentionally or unintentionally[22]—and influence diversity and spatial structure of populations, strata, and ESUs.

Fishery managers forecast annual abundance and adjust allowable harvest to achieve established escapement goals or to stay within specified harvest rate limits on wild stocks. They generally try to manage the fisheries using a combination of gear, time, area, and mark-selective regulations to optimize the harvest of strong (generally hatchery) stocks within the series of constraints for weak (generally wild) stock protection. As a result, today's fishery impact rates for most hatchery-produced Chinook, coho, and steelhead are higher than for wild fish of the same species.

- *Directed Harvest Mortality.* Harvest mortality occurs in fisheries directed at a particular species or stock; this harvest can occur in single (terminal) or mixed (intercept) stock fisheries[23]. Single stock fisheries are the most effective method for targeting a specific stock and commonly occur in terminal harvest areas where one stock is known to be present.

  In mixed stock fisheries, the management challenge is to harvest from mixed populations having various available surpluses, sometimes including populations with no surplus, as the populations move through the fishery area at various rates and abundances. Harvest of a specific stock in the mix can be achieved by management decisions (e.g. fishery openings when the targeted stock is abundant relative to other stocks), fishery adaptations (e.g. gear designed to target specific stock/species), or fishery regulations (e.g. prohibitions of retaining certain species). Stock identification techniques are constantly being improved to assist managers in making informed and timely fishery decisions. For example, certain fisheries in the Columbia River focus on harvesting adipose fin-clipped, hatchery-reared fish only by targeting marked hatchery fish while utilizing gear modifications to allow protected stocks to be released. Regulations prohibiting harvest of wild fish (i.e. non-adipose fin-clipped fish) have been relatively successful, especially with regards to the impact of recreational fisheries on wild fish.

- *Incidental Harvest Mortality.* Despite the various methods used to target a specific stock and minimize effects on weak stocks, incidental bycatch, the harvest of non-targeted stocks, still occurs, largely because salmonid migration timing and routes can vary considerably from year to year. Most commercial fisheries have specific reporting requirements and limits for incidental bycatch and drop off mortality[24] that are intended to lessen the harvest impacts to non-targeted stocks. For the Columbia River, specific incidental harvest percentages are set for protected stocks; fisheries are managed so as not to exceed these harvest limits of protected stocks. Access to strong stocks in the Columbia River and ocean fisheries is regulated by impact limits on the weak populations mixed with the strong populations.

- *Catch and Release Mortality.* Catch and release regulations have been used for years to manage sport fisheries. Generally, catch and release restrictions allow resident fish to grow older and larger, thereby creating improved angling opportunities. More recently, catch and release has been employed in

[22] There is "mark-selective" where only hatchery marked fish are supposed to be harvested. There is also "phenotypic selection", "genetic selection" or "evolutionary selection" caused by the fishery preferentially taking certain phenotypes (e.g. size, age, run time).
[23] In reality nearly all salmon fisheries are to some degree "mixed stock" fisheries. Even fisheries that take place close to spawning grounds may encounter strays from other areas. The closer the fishery is to the spawning grounds the less impact there generally is on other stocks.
[24] Drop off mortality can occur when a fish his hooked but not landed.

anadromous fish management practices to enable retention of hatchery salmon and steelhead and release of wild fish in mixed-stock fisheries. Because of the wide range of knowledge among sport anglers regarding proper fish handling techniques and the different degrees of how fish species react to handling stress, mortality occurs as a result of catch and release.

Catch and release has been employed in the Columbia River commercial fisheries since 1950 for non-legal size sturgeon and since 1975 for steelhead. Catch and release is a relatively new concept for commercial salmon fishing, and since 2002 has become a significant part of managing Columbia River spring Chinook stocks. Recent recovery efforts in the Columbia Basin have been focused on maintaining and rebuilding native wild stocks. The hatchery practice of marking released fish with an adipose fin clip has allowed fishery managers to implement fisheries that harvest only hatchery fish while requiring the release of protected wild stocks. Significant gear modifications are continually being evaluated and utilized to reduce any handling mortality that can occur as a result of being caught and released by the commercial fishery.

- *Size, Age, Timing Selection.* Harvest may selectively remove fish based on size, age, distribution or run timing, depending on the gear, timing and location of the fishery. Commercial fishing gear can be size-selective, depending on the type of gear (i.e. gill net vs. troll) or the size of gear (i.e. mesh size). As mentioned in the mixed stock fishery discussion for direct harvest mortality, size selectivity can be a desired result if the gear is designed to harvest a specific size stock or species. However, commercial fishing gear size selectivity can also be undesirable. For example, if a fishery disproportionately harvests the larger individuals in a population, the remaining smaller individuals comprise the effective population (i.e. those individuals that spawn in any given year). If this process is repeated annually, the effect on the adult population is a decreased average size at maturity, which can also modify a stock's age composition. Even when fisheries are not size selective, ocean fisheries harvesting immature fish alter the age structure of the spawning escapement of species with multiple age classes in the spawning population toward younger age classes, and thus exert selective pressure for younger maturation. This happens because fish that would mature at an older age must survive the risk of harvest for more years than fish that mature at younger ages.

  Fisheries may also be selective for a particular timing or segment of the run, depending on management practices. For example, a fishery may disproportionately harvest the early portion of a run because of market- or industry-driven needs, or because of the timing of hatchery fish runs. Because run timing is heritable (Garrison and Rosentreter 1981), fisheries may alter run timing traits due to systematic temporal removals from populations over time. Although there is evidence that run timing alterations have occurred in certain stocks (e.g. LCR coho), it is not a forgone outcome for all stocks exposed to fisheries.

<u>Hatchery Management</u>

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.

Background

Hatcheries have been used to produce fish in the lower Columbia River for more than a century to provide fish for ocean and in-river harvest, often as mitigation to offset the detrimental effects of loss of habitat. At the time many hatchery programs were developed, little was known about the impacts of hatchery fish on the wild populations. Instead, it was 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). As a result, the transfer of hatchery salmon between distant watersheds and facilities became common practice (Matthews and Waples 1991; WDF et al. 1993; Kostow 1995). Consequently, hatchery programs in the lower Columbia basin have included all salmonids native to the region, and some from outside the region. Salmonids often have been transferred among watersheds, regions, states, and countries, either to initiate or maintain hatchery populations or naturally spawning populations (LCFRB 2004).

These past hatchery practices have posed significant threats to natural populations. The transfer of non-native fish into new areas shifted the genetic profiles of some hatchery and natural populations so that the affected population is genetically more similar to distant hatchery populations than to local populations (Howell et al. 1985; Kostow 1995; Marshall et al. 1995). Hatchery fish were often released into areas in large numbers where they overwhelmed the local native population and competed with them for limited habitats. The large hatchery releases also contributed to more intensive mixed stock fisheries, which likely overexploited some wild populations already weakened by habitat degradation.

Today, hatchery fish continue to dominate salmon and steelhead production in the lower Columbia region. The region contains 25 salmon and steelhead production hatcheries, as well as many associated rearing facilities and acclimation sites. In 2004, NMFS determined that these facilities supported 87 artificial production programs in Oregon and Washington, of which 58 produce fish primarily for harvest. Several of these programs produced lower Columbia stocks, including: 21 coho programs, 17 Chinook programs, 3 chum programs, and 10 steelhead programs (NMFS 2004). The actual number of artificial production programs changes yearly based on funding and broodstock availability, and today the number of programs producing lower Columbia River stocks is somewhat lower (Turner 2008).

Together these artificial production programs release millions of fall Chinook, spring Chinook, coho, chum and steelhead into lower Columbia River subbasins each year. In 2008, programs for lower Columbia River stocks released a total of 39,107,500 fall Chinook, 6,054,350 spring Chinook, 12,676,800 coho, 1,416,250 summer steelhead, 2,101,716 winter steelhead and 173,250 chum into lower Columbia River subbasins (Turner 2008). Table 5-3 shows the 2008 hatchery releases of LCR fall Chinook, spring Chinook, coho, summer steelhead and winter steelhead and CR chum by the different fish management entities.

Table 5-3. Hatchery releases of LCR coho, Chinook and steelhead, and CR chum in 2008 (Turner 2008).

Hatchery Releases	ODFW	WDFW	USFWS	Total (# of fish)
Fall Chinook*	9,084,000	13,023,500	17,000,000	**39,107,500**
Spring Chinook	2,150,000	2,734,350	2,170,000	**7,054,350**
Coho	4,143,000	8,033,800	500,000	**12,676,800**
Summer Steelhead	290,000	1,126,250	0	**1,416,250**
Winter Steelhead	495,000	1,456,716	150,000	**2,101,716**
Chum	0	173,250	0	**173,250**
All releases				**61,529,866**

* Fall Chinook includes tules, Upriver Brights, and Select Area Brights.

In addition to the releases of LCR coho, Chinook and steelhead, and CR chum, hatchery releases made in other ESUs/DPSs in the Columbia River basin migrate through the lower Columbia as juveniles and adults and can also impact populations in this region (Figure 5-8).

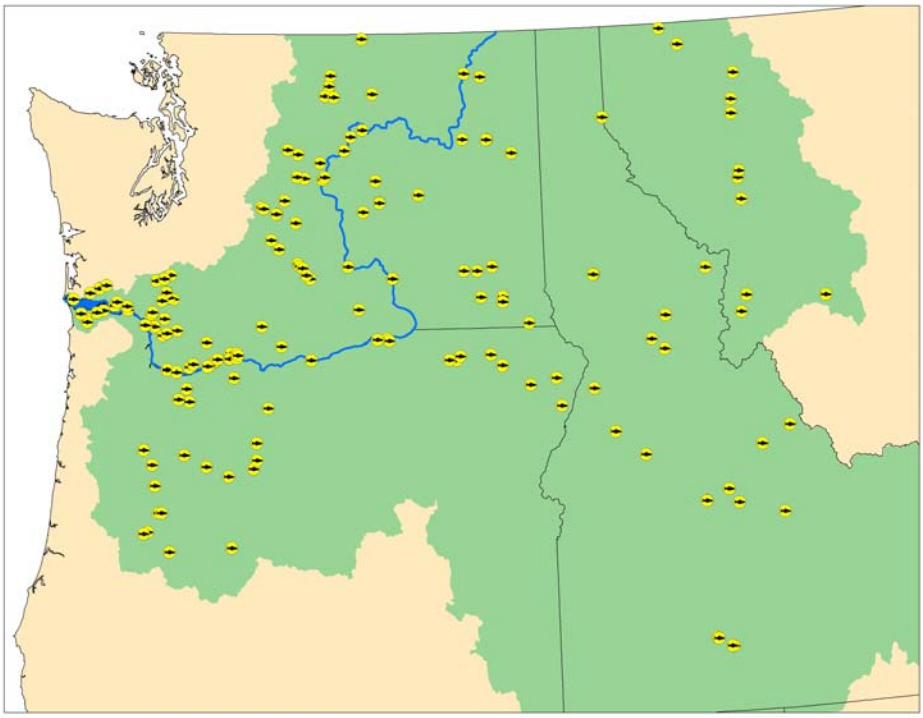


Figure 5-8. Locations of hatchery releases in the Columbia River basin (NMFS 2008).

Recent evaluations show that, while many hatchery programs are being reshaped to provide better protection for wild populations, more improvements are needed (HSRG 2007). Many lower Columbia River salmon populations are characterized by high proportions of hatchery fish on the spawning grounds. The major concern with these hatchery programs is the effect hatchery strays have on productivity and long-term fitness of naturally spawning populations (HSRG 2007).

Predation

Predation, while probably always a significant source of mortality for salmonids, has been exacerbated by changes in the Columbia River ecosystem. Today predation on, and consumption of, lower Columbia River salmon and steelhead by other species may influence salmonid population viability by affecting abundance, productivity, and/or diversity.

Ecosystem alterations attributable to hydropower dams and changes in the hydro system, and to modification of estuarine habitat, have increased predation on lower Columbia River salmon 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 it was estimated that avian predators consumed 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 3.6 million juvenile salmonids were consumed by terns 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. 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).

5.3 Future Threats: Climate Change and Human Population Increases

Climate change and increases in human population will undoubtedly impact LCR coho, Chinook and steelhead, and CR chum populations in the future. Because the specific impacts of these future threats are difficult to predict, the Plan does not prioritize their impacts for each population, geographic area, and salmonid life-stage. The general impacts of these future threats are discussed below.

Climate Change

Climate change will likely have detrimental effects on recovery of ESA-listed salmonids. The Independent Scientific Advisory Board (ISAB) recently completed a review of climate change impacts on Columbia River basin fish and wildlife (ISAB 2007a). While potential ecological and management issues are complex and not precisely predictable, the ISAB found that the forecast of increased winter flooding, decreased summer and fall streamflows, and elevated temperatures in streams, rivers, and the estuary will likely compound already degraded habitat conditions. Table 5-4 summarizes observed and projected impacts of climate change relevant to salmonids in the Pacific Northwest. In addition, while the impacts of global climate change are less clear in the ocean environment, early modeling efforts suggest that warmer temperatures are likely to increase ocean stratification, which in the past has coincided with relatively poor ocean habitat for most Pacific Northwest salmon, herring, anchovies, and smelt populations (Climate Impacts Group 2004).

The effects of lost habitat quality and complexity in the estuary and tributaries—which already limit the viability of all lower Columbia River salmon and steelhead populations—could be amplified through global warming. With expected changes in hydrology and water temperatures, the loss of backwater, sloughs and other off-channel areas that provide cool water refugia and resting habitat important to salmonid survival could pack an even larger punch than it is today. Degraded riparian habitat conditions may intensify the consequences of expected changes to flow and water temperatures by reducing stream shading, bank stabilization, food production, and nutrient and chemical mediation.

Table 5-4. Observed and projected impacts of climate change in major climate/hydrologic indicators. (Sources: Mote et al. 1999; Miles et al. 2000; Mote 2003; Snover et al. 2003; Steward et al. 2004; Wiley 2004 as cited in Climate Impacts Group 2004.)

Indicator	Observed 20th century changes	Projected mid 21st century changes
Temperature	Region-wide warming of about 1.5°F (1920-2000). 1990-2000 was the warmest decade on record, and was warmer than any other decade by 0.9°F.	• 2020s: predicted average increase of 2.7°F. • 2040s: predicted average increase of 4.1°F.
Precipitation	Region-wide increase in precipitation since 1920.	Uncertain, although most models project wetter winters and drier summers.
April 1 snow pack	Substantial declines (>30%) at most monitoring stations below 6,000 feet Data collected during the 20th century revealed widespread increases in average annual temperature and precipitation, and decreases in the April 1 snow water equivalent.	Projected decrease in April 1 snowpack for the Cascades Mountains in Washington and Oregon relative to 20th century climate: • 44% by the decade of the 2020s based on +3°F avg. temp change. • 58% by the decade of the 2040s based on +4.5°F avg. temp change.
Timing of peak spring runoff	Advanced 10-30 days earlier during the last 50 years, with greatest trends in the PNW.	Earlier peak spring runoff expected on the order of 4-6 weeks.
Summer streamflow	Declining in sensitive PNW basins. Example: May-Sept inflows into Chester Morse Lake in the Cedar River watershed (WA) as a fraction of annual flows have decreased 34% since 1946.	Continued and more wide-spread declines. Example: April-Sept natural streamflow in the Cedar River (WA) projected to decrease 35% by the 2040s (based on a 2.5°F increase in average temperature.

Human Population Growth and Development

An estimated five million people live in the Columbia River basin today and the population is expected to increase significantly in coming years. By the end of the twenty-first century, population forecasts predict between 40 million and 100 million people will be living in the region (National Research Council 2004). Fast growth is particularly predicted in areas that support LCR coho, Chinook and steelhead, and CR chum —Clackamas, Clatsop, Columbia, Hood River, and Multnomah counties—where human populations are expected to increase by 41 percent from 2003 to 2040 (State of Oregon Office of Economic Analysis 2004).

The ISAB recently completed a review of the impact of human population growth on Columbia River basin fish and wildlife (ISAB 2007b). In this report they concluded:

- Population growth will increase demand for resources key to fish and wildlife populations: water, land, and forests. This will increase threats and extinction risk for these populations.
- Increased demand for residential land is accelerating the rate of conversion of forest and agricultural lands.
- Changes in land use due primarily to increases in human population size and per capita consumption rates will increase water use, affect land management and, ultimately, affect fish and wildlife habitat.

- The effects of both climate change and population growth may potentially have a combined and/or synergistic impact on fish and wildlife habitats.

- The dominant ongoing pattern of settlement in the Columbia River basin is exurban sprawl— the building of new communities on the fringes of urban growth boundaries—which causes loss, degradation, and fragmentation of habitat. It also increases infrastructure costs, social conflict, and harmful interactions among people and wildlife.

- Demands for freshwater from surface and groundwater will increase. Decreases in the snow pack at higher elevations, resulting from climate change, will exacerbate this situation especially during low-flow summer and fall seasons.

- Urbanization will increase the amount of impervious surfaces in watersheds (pavement, roofs etc.). As a result, precipitation cannot penetrate into the soil, causing an increase in surface runoff during storm events and a reduction base flows due to reduced groundwater recharge.

- Population-related factors external to the Columbia River basin will affect fish and wildlife habitat. These include international trade, shipping, dredging, hazardous material transport, and airborne pollution.

5.4 Limiting Factors and Threats for Lower Columbia River Coho

Key and secondary limiting factors and threats that contribute to the current status of Oregon's LCR coho populations are shown in Table 5-5. A discussion of these threats and factors follows.

Table 5-5. Key and secondary threats and limiting factors to Lower Columbia River coho.

COHO			Threats and Limiting Factors					
Population	Threat Level	Life History Stages	Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation
Youngs Bay	Key	Adult				7a	7c	
		Juvenile	5c, 6e	3a, 3b, 5b, 6c				
	Secondary	Adult	4c					
		Juvenile	5c, 6a, 6e, 9a	1a, 6e, 9a, 9b, 9c				8b
Big Creek	Key	Adult				7a	7c	
		Juvenile	5c, 6e	3a, 3b, 5b, 6c				
	Secondary	Adult	4c					
		Juvenile	5c, 5e, 6a, 6e, 9a	1a, 6e, 9a, 9b, 9c				8b
Clatskanie	Key	Adult				7a		
		Juvenile	6e	3a, 3b, 5b, 6c				
	Secondary	Adult					7c	
		Juvenile	5c, 6b, 6e, 9a	1a, 6e, 9a, 9b, 9c, 9d				8b
Scappoose	Key	Adult				7a		
		Juvenile	6e	3a, 3b, 5b, 6c				
	Secondary	Adult						
		Juvenile	5c, 6b, 6e, 9a	1a, 6e, 9a, 9b, 9c, 9d				8b
Clackamas	Key	Adult				7a	7c	
		Juvenile	6e	3a, 3b, 5b, 6c				
	Secondary	Adult	9b					
		Juvenile	5c, 6a, 6e, 9a, 9b	1a, 6e, 9a, 9b, 9c, 9d	4b			8b
Sandy	Key	Adult				7a		
		Juvenile	6e	3a, 3b, 5b, 6c				
	Secondary	Adult	4c					
		Juvenile	5c, 6a, 6e, 9a	1a, 6e, 9a, 9b, 9c, 9d				8b
Lower Gorge	Key	Adult	6f			7a	7c	
		Juvenile	6f	3a, 3b, 5b, 6c				
	Secondary	Adult	4c					
		Juvenile	5c, 5f	1a, 6e, 9a, 9b, 9c, 9d				8b
Upper Gorge // Hood	Key	Adult				7a	7c	
		Juvenile	5d, 6e	3a, 3b, 5b, 6c				
	Secondary	Adult	4a		4a			
		Juvenile	1a, 5a, 5c, 6a, 6g, 8a, 9a, 9c	1a, 6e, 9a, 9b, 9c, 9d	4a			8b

Code	Limiting Factor	Threat
1a	Competition (hatchery fish)	Smolts from all Columbia Basin hatcheries
3a	Food web (reduced macrodetrital inputs)	Columbia Basin hydropower reservoirs, revetments, and disposal of dredge material
3b	Food web (increased microdetrital inputs)	Columbia Basin hydropower reservoirs
4a	Habitat access (impaired passage)	Large dam(s)
4b	Habitat Access (impaired downstream passage)	Large dam(s)
4c	Habitat access (impaired upstream passage)	Hatchery weir
4d	Habitat access (impaired upstream passage)	Road crossings
4e	Habitat access (impaired upstream passage)	Road crossings, small dams, and diversions
5a	Hydrograph/water quantity (altered hydrology)	Low-head hydro diversions
5b	Hydrograph/water quantity (altered hydrology)	Columbia Basin hydropower dams (impaired access to off-channel habitat, dewatering of redds below, and altered plume dynamics, estuarine habitat, and food web)
5c	Hydrograph/water quantity (altered hydrology)	Upslope land uses
5d	Hydrograph/water quantity (altered hydrology: reduced downstream flows)	Irrigation withdrawals (impaired physical habitat, access to habitat)
5e	Hydrograph/water quantity (altered hydrology: reduced downstream flows)	Municipal withdrawals
5f	Hydrograph/water quantity (altered hydrology: reduced downstream flows)	Hatchery withdrawals (impaired passage and reduced habitat)
6a	Physical habitat quality (excessive fine sediment)	Rural roads
6b	Physical habitat quality (excessive fine sediment)	Rural roads and land use
6c	Physical habitat quality (impaired sediment/sand routing)	Columbia Basin hydropower dams
6d	Physical habitat quality (impaired gravel recruitment)	Large dam(s)
6e	Physical habitat quality (impaired habitat complexity and diversity, including access to off-channel habitats)	Past and/or current land use practices
6f	Physical habitat quality (impaired habitat quality and disconnected habitat)	Transportation corridor development and maintenance
6g	Physical habitat quality (reduced habitat quality/quantity)	Inundation from Bonneville
7a	Population traits (impaired abundance and diversity)	Consumptive, targeted fishery
7b	Population traits (impaired abundance and diversity)	Fisheries targeted at other stocks or species
7c	Population traits (impaired productivity and diversity)	Stray hatchery fish interbreeding with wild fish
8a	Predation (non-salmonid fish)	Bonneville Reservoir and Columbia Basin flow regulations
8b	Predation (birds)	Land use practices that create more favorable conditions for Caspian terns and cormorants to prey on salmonid juveniles in estuary
8c	Predation (hatchery fish)	Smolts from all Columbia Basin hatcheries
8d	Predation (marine mammals)	Bonneville Dam and Columbia Basin flow regulations
9a	Water quality (elevated water temperature)	Land uses that impaired riparian condition or reduced steamflows (e.g. water withdrawals for agricultural, industrial, or municipal uses)
9b	Water quality (elevated water temperature)	Large hydropower reservoirs
9c	Water quality (toxins)	Agricultural chemicals used throughout the Columbia Basin
9d	Water quality (toxins)	Urban and industrial practices

The following threats and factors limit viability of Oregon's LCR coho populations. Appendix E provides more information on the threats and factors limiting the different coho populations during specific life stages.

5.4.1 Tributary Habitat

- *Altered hydrograph/water quantity from upslope land use (5c).*
  Key threat: Youngs Bay and Big Creek coho
  Secondary threat: all other LCR coho populations

  Altered hydrologic processes and/or reduced water quantity due to land use practices on upland slopes is a key threat to Youngs Bay and Big Creek coho during the winter parr life stage and a secondary concern for the populations from the egg through summer parr life stages. The altered flows pose a secondary threat to all other LCR coho populations from the egg through winter parr life stage.

Physical habitat structure in the tributary watersheds is defined largely by physical processes, including the movement of water and sediment within the channel and between uplands, floodplains and the channel. The amount of surface and subsurface flow influences the peaks in a river's hydrograph as a response to storm events. Consequently, they can affect the flow regime, changing the established pattern of natural hydrologic variation and disturbance, thereby altering habitat dynamics (Poff et al. 1997). Altered flow regimes can reduce flows needed for migration, spawning or rearing. Low flows may also decrease salmon and steelhead survival by limiting delivery of nutrients and dissolved oxygen to incubating eggs.

Over the last 200 years, land use practices have altered hydrologic processes on upland slopes in tributary watersheds that support LCR coho. Together, land use on upland slopes—timber harvest activities, agricultural practices, urban or residential development, road development, livestock grazing, and other activities—have reduced soil stability, increased the extent of impermeable surfaces, reduced vegetative cover, and altered drainage systems. As a result, they have reduced the interception and infiltration of precipitation on upland ecosystems and, thus, affected water storage in the soil and delivery to streams. Many stream systems now exhibit higher peak flows and lower base flows than they did historically. Forest practices have particularly impacted habitat for coho winter parr in the Youngs Bay and Big Creek watersheds. The drainages contain a large amount of private timber land that has been extensively harvested.

- *Altered hydrograph/water quantity due to irrigation withdrawals (5d).*
  Key threat: Upper Gorge/Hood coho

  Reduced instream flow due to irrigation withdrawals affects the Upper Gorge/Hood coho population by reducing coho rearing habitat quality and restricting access to historical habitat areas. EDT modeling showed that virtually every stream modeled in the Hood River basin was affected by low flows (Coccoli 2004). Several large water withdrawals for irrigation reduce flows in the Hood River watershed. The reaches of greatest concern are lower East Fork Hood River and the mainstem Hood River, with more than 75 percent of instream flow in lower mainstem Hood River currently diverted. The Odell, Upper Middle Fork, Neal Creek, lower West Fork, upper Middle Fork, Lake Branch, Middle East Fork and upper East Fork watersheds are also affected by water withdrawals (Shively et al. 2006).

- *Reduced physical habitat quality/habitat access due to past and/or current land use practices (6e).*
  Key threat: Youngs Bay, Big, Clatskanie, Scappoose, Clackamas, Sandy, Upper Gorge/Hood coho

  Reduced habitat quality and complexity, and connectivity with off-channel habitats is a key factor limiting juvenile coho viability in all population areas, with the exception of the Lower Gorge population. Land use practices such as channelization, diking, wetland conversion, stream clearing, splash damming and gravel extraction have severed access to historically productive habitats, simplified many remaining tributary habitats, and weakened the important watershed processes and functions that once created healthy ecosystems for salmon and steelhead production.

  In most of the population areas, diking and channelization, especially of lower reaches, have restricted stream channels and reduced connectivity between the river and floodplain. One of the hardest hit areas was the Youngs Bay watershed, where extensive diking, primarily to gain pasture and agricultural land and provide flood control, significantly altered habitat conditions by disconnecting the floodplain from the stream and eliminating access to side channel spawning and rearing habitat. The lower Lewis and Clark and Walluski rivers, mouth of Youngs Bay, and east side of Youngs Bay were particularly affected (Bischoff et al. 2000a). In the lower Big Creek watershed, many historical wetlands have also been drained, diked and/or disconnected from streams, impairing

fish access to side channels and small tributaries. The Blind Slough subwatershed in this drainage has been the most heavily impacted, and now contains predominantly palustrine emergent wetlands that are farmed or used for grazing (Bischoff, et al. 2000c). In the Scappoose population area, channelization and diking for flood control and farming have extensively modified some lowland floodplains, such as near the Multnomah Channel. In the Clackamas River and tributaries, the straightening and restricting of the stream channels has decreased channel complexity and connectivity to side channels and other off-channel areas that historically provided important overwintering habitat for juvenile salmonids.

Coho productivity has further been impacted by such land use practices, and others that disturb ecosystem functions, because they have reduced channel structure and complexity, degraded riparian conditions and large wood recruitment, and increased delivery of fine sediments to downstream areas. In the Clackamas basin, loss of habitat diversity primarily reflects a reduction in large wood in the streams due to degraded riparian condition and large wood recruitment (Primozich and Bastasch 2004). The limited supply of wood in the Clackamas River and tributaries has reduced formation of complex habitats that create deep pools and retain spawning gravels. In the Sandy basin, habitat surveys by Anlauf et al. (2006) show that many surveyed stream reaches in the watershed are considered to be moderate to undesirable for attributes such as large wood density and pool frequency. In the Scappoose watershed, physical habitat surveys conducted by ODFW (1999) found that several reaches of Salmon, Sierkes and Raymond creeks had low levels of wood and few complex pools. ODFW's surveys in the watershed also suggested that riparian zones on a number of stream reaches in the area were not functioning to provide adequate fish habitat (DEA 2000). In the Clatskanie watershed, lack of channel structure and complexity is also a problem. Researchers have ranked most surveyed stream reaches in this watershed as moderate to undesirable for attributes such as large wood density and pool frequency (Bischoff et al. 2000c; Anlauf et al. 2006; Kavanaugh et al. 2006; NPCC 2005).

Road development that restricted stream channels and impinged on channel dynamics has also had a major impact on habitat quality. In the upper Clackamas basin, several roads along streams restrict channel movement and access to off-channel areas that historically provided important overwintering habitat for juvenile salmonids. In the Hood basin, roads and management-related debris flows account for the majority of fine sediment production in the West Fork Hood River watershed (USFS 1996a; Coccoli 2004). Bear, Evans, Tony, and Trout creeks, and the East Fork Hood River also have relatively high road densities that expand the drainage network by intercepting subsurface and overland flow, resulting in increased erosion and delivery of fine sediment to area streams (Coccoli 2004).

Together, these factors reduced the amount and quality of spawning and rearing habitats available to LCR coho populations. The populations have been impacted by changes in riparian condition, loss of large wood in tributary streams, and modified in-channel and side channel habitats. The loss, degradation and impairment of riparian conditions reduced production of food organisms and organic material, shading, nutrient and chemical mediation, control of surface erosion, and production of large-sized woody material. The reduction of large wood supplies in river systems lessened formation of complex habitats that create deep pools and retain spawning gravels. The straightening and restricting of the stream channels decreased channel complexity and connectivity to side channels and other off-channel areas that historically provided important overwintering habitat for juvenile salmonids. Many streams now have lower pool complexity and frequency compared to natural conditions that existed in the past. Channels also lack the complex structure needed to retain gravels for spawning and invertebrate production, and connectivity with shallow, off-channel habitat areas that once provided flood refuge, over wintering and hiding cover, and productive early-rearing habitat.

Appendix E describes conditions in the different population areas that limit physical habitat quality and habitat access for lower Columbia salmon and steelhead, including the coho populations.

- *Degraded physical habitat quality due to transportation corridor development and maintenance (6f).*
  Key threat: Lower Gorge coho

  Activities associated with highway and rail development have degraded habitat quality and connectivity in the Lower Gorge coho population area. Habitat conditions on lower reaches of Lower Gorge streams have particularly been impacted. Interstate Highway 84, the Columbia River Historic Highway 30, and the Union Pacific rail line run parallel to the Columbia River shoreline, traversing all creek drainages and disconnecting uplands from lowlands and the Columbia River. Construction and alignment of the existing interstate and railroad greatly reduced shoreline function, simplified shoreline habitat, and severed shore-bound wetlands from the Columbia River floodplain. Development and maintenance of this transportation corridor has affected channel structure, habitat complexity, gravel aggradation, gravel retention, fish passage, riparian vegetative structure near stream crossings, and stormwater retention. Further, corridors created by roads, trails and power lines provide paths for the spread of noxious weeds, which are disturbing native plant communities (USFS 1998, cited in Coccoli 2004).

- *Impaired habitat access due to dam construction and operations (4a).*
  Secondary threat: Upper Gorge/Hood coho

  Laurance Lake Dam in the Hood River watershed restricts adult coho passage to spawning and rearing habitats above the dam. Coho habitat was documented in Clear Branch before construction of the Laurance Lake Dam, located on Clear Branch approximately 11 miles upstream of the mouth of the Middle Fork Hood River (Oregon State Game Commission 1963). Much of this historical habitat is now inundated by the reservoir or blocked at the dam. The dam blocks all upstream passage and provides only very limited downstream passage. The Middle Fork Irrigation District operates Laurance Lake Dam, as well as diversions on Coe and Elliot Branch creeks for hydroelectric production and irrigation delivery. The diversion on Elliot Branch is screened but upstream and downstream passage is limited at the Coe Branch diversion.

- *Reduced habitat access due to hatchery weirs (4c).*
  Secondary threat: Youngs Bay, Big Creek, Sandy, Lower Gorge coho

  Hatchery weirs in the Youngs Bay, Big Creek, Sandy and Lower Gorge areas impede or prevent adult coho access to spawning and rearing habitat that was historically productive. The weirs exist at Klaskanine Hatchery on the North Fork Klaskanine River in the Youngs Bay population area; at Big Creek Hatchery in the Big Creek area; at Sandy Hatchery on Cedar Creek in the Sandy area; and at Bonneville Hatchery on Tanner Creek in the Lower Gorge area. Coho are now passed over the weirs at Klaskanine and Big Creek hatcheries, but may experience a delay in migration as they wait to be passed. They are not passed above the weirs at Sandy and Bonneville hatcheries.

- *Altered hydrograph/water quantity due to municipal water withdrawals (5e).*
  Secondary threat: Big Creek coho

  Municipal water withdrawals affect juvenile coho in the Big Creek watershed. The largest water withdrawal is for the City of Astoria's municipal use and is drawn from the Bear Creek watershed. Withdrawals from the Bear Creek watershed average 100 percent during the summer low flow

periods of June through October (Bischoff et al. 2000c) and occur high in the drainage, affecting the entire range of summer rearing habitat for coho parr within mainstem Bear Creek.

- *Altered hydrograph/water quantity due to hatchery withdrawals (5f).*
  Secondary threat: Lower Gorge coho

  Water withdrawals for Bonneville Hatchery reduce stream flows in Tanner Creek below the hatchery. The loss of flow concentrates rearing juvenile fish to remaining habitat areas, and can also periodically dewater existing redds.

- *Degraded physical habitat quality, excessive fine sediment, due to roads (6a).*
  Secondary threat: Youngs Bay, Big Creek, Clackamas, Sandy and Upper Gorge/Hood coho

  Impaired physical habitat quality due to fine sediment from forest and rural roads affects coho abundance and productivity in the Youngs Bay, Big Creek, Clackamas, Sandy, and Upper Gorge/Hood coho population areas. The roads have altered sediment routing and led to an overabundance of fine-grained sediments, excess of course-grained sediments, inadequate course-grained sediments, and/or contaminated sediment. Excessive fine sediment reduces egg development and survival during the incubation life stage.

- *Degraded physical habitat quality, inundation from Bonneville Dam (6g).*
  Secondary threat: Upper Gorge/Hood coho

  Inundation from Bonneville Dam reduces habitat quality for juvenile coho in the Upper Gorge/Hood population. Inundation and loss of lowland riparian hardwood communities along the Columbia River has significantly altered habitat conditions. A diversity of stream delta, wetland, and floodplain habitats were permanently flooded in 1938 when Bonneville Dam was constructed. Instream habitat quality and quantity has been lost in the mainstem Hood River downstream of the Interstate Highway 84 Bridge. The loss of the extensive delta area at the Hood River mouth due to inundation from Bonneville reservoir has degraded habitat complexity (Coccoli 2004).

- *Predation from non-salmonid fish in Bonneville Reservoir and Columbia River mainstem (8a).*
  Secondary threat: Upper Gorge/Hood coho

  Predation by non-salmonid fish in Bonneville Reservoir and the mainstem Columbia River impacts juvenile coho from the Upper Gorge/Hood population. This predation, which has likely always been a significant source of mortality for salmonids, has been exacerbated by changes in the Columbia River hydro system. Pikeminnows prey on migrating salmon, often congregating at the dam bypass outfall and hatchery release sites to feed on smolts. Fish managers have reduced the level of this predation through a pikeminnow management program that rewards anglers for harvesting pikeminnows over a certain size, but predation by pikeminnows remains a limiting factor for juvenile salmonids. Walleyes and smallmouth bass also prey on juvenile salmonids.

- *Degraded water quality, elevated water temperatures due to land use practices (9a).*
  Secondary threat: Youngs Bay, Big, Clatskanie, Scappoose, Clackamas, Sandy, Upper Gorge/Hood coho

  High summer water temperatures are a concern for juvenile LCR coho in all population areas, except the Lower Gorge area. Land use practices and water withdrawals contribute to elevated water temperatures. In conjunction with water withdrawals, elevated stream temperatures often exist because of a lack of intact, functional and contiguous riparian management zones and sufficient

streamside buffers. Channel widening may also be a contributing factor. The high water temperatures affect coho population abundance, productivity and spatial structure. They can be lethal, contribute to disease, and/or act as temporary adult migration barriers.

- *Degraded water quality, elevated water temperatures due to large hydropower reservoirs (9b).*
  Secondary threat: Clackamas and Sandy coho

  Hydro projects in the Clackamas and Sandy[25] systems have degraded habitat quality. Water impoundment in reservoirs above Clackamas and Sandy river hydropower dams results in solar heating and contributes to elevated river water temperatures below the hydropower projects. The elevated summer water temperatures limit juvenile coho summer rearing in the Clackamas and Sandy Rivers below the dams, and in the Bull Run River, a Sandy River tributary, from the mouth to Dam #2.

- *Degraded water quality, toxins from agricultural sources (9c).*
  Secondary threat: Upper Gorge/Hood coho

  Agricultural chemicals, including organophosphates and other insecticide levels above state water quality standards impair juvenile coho growth and survival in the Hood River drainage. Water quality is primarily affected by pesticides and bacteria in the lower basin (Baldwin, Indian, Lenz, Odell, and Neal creeks) (Shively et al. 2006). Low flows reduce oxygen and concentrate pollutants and sediments.

  It should be noted that there may be interactions between multiple secondary limiting factors and threats that cumulatively might raise their importance to key status, if these cumulative effects were better understood, quantifiable, or explicitly identified. Given the complexity of this type of relationship, and that actions addressing individual limiting factors and threats also will likely have cumulative benefits, the analysis in this Plan did not address cumulative effects.

5.4.2 Estuary Habitat

- *Altered food web, reduced macrodetrital input due to Columbia Basin hydropower reservoirs, revetments, and disposal of dredge material (3a).*
  Key threat: all LCR coho

  Reduced macrodetrital-based input in the Columbia River estuary affects the viability of all Oregon LCR coho populations. Historically, the estuary food web was macrodetrital-based, made up of plant materials originating from emergent forested and other wetland areas in the estuary. Today, detrital sources from emergent wetlands in the estuary are approximately 84 percent less than they were historically (Bottom et al. 2005). Loss of wetland and side channel habitat has reduced the local macrodetritus inputs from terrestrial and riparian habitats that supported the historical food web. This macrodetritus-based food web was distributed evenly throughout the estuary. 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).

- *Altered food web, increased microdetrital input due to Columbia Basin hydropower reservoirs (3b).*
  Key threat: all LCR coho

[25] Hydro impacts in the Sandy are the legacy impacts from Marmot Dam (removed in 2007) and Little Sandy Dam (removed in 2008).

The estuary's current food web is microdetrital-based, made up of decaying phytoplankton delivered from upstream reservoirs. The substitution of this microdetrital-based food web for the historical macrodetrital-based web reduces coho productivity in the estuary. Unlike the historical macrodetritus-based food web, which was distributed evenly throughout the estuary, the contemporary 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 (Bottom et al. 2005). The estuarine turbidity maximum is thought to contain bacteria that attach to detritus. Together, these represent the primary food source in the estuary today (LCREP 2004).

- *Altered hydrograph/water quantity due to Columbia Basin hydropower dams (5b).*
  Key threat: all LCR coho

  Alteration of the Columbia River hydrograph affects all LCR coho populations. Management of the Columbia River hydro system alters the timing and magnitude of spring freshets, and impairs estuarine habitat quality and access. Reduction of maximum flow levels, along with deposit of dredged material and diking, has all but eliminated overbank flows in the Columbia River (Bottom et al. 2001). The loss of overbank flow restricted access to off-channel habitat areas that at other times were forested swamps or seasonal wetlands, and reduced large woody debris recruitment to the estuary. Artificial regulation of flow, especially rapid diurnal flow fluctuations, has caused unintended and adverse redistribution of mainstem spawners, left redds dewatered, and/or stranded juveniles. Note that efforts have been made to reduce this impact (NMFS 2008b).

- *Impaired physical habitat quality due to Columbia Basin hydropower dams (6c).*
  Key threat: all LCR coho

  Impaired physical habitat quality in the estuary, especially sediment and sand routing, impacts all LCR coho populations. Changes in hydrology impaired sediment routing and gravel recruitment. The force of historical spring freshets in the Columbia River moved sand down the river and into the estuary where it helped form shallow-water habitats vital for juvenile salmonids, particularly ocean types (LCREP 2006). Today, alterations to spring freshet flows due to changes in hydrology and sequestering of sediment behind hydropower dams have reduced sand discharge in the Columbia River estuary to 70 percent of nineteenth-century levels (Jay and Kukulka 2002). The magnitude of change in sand transport contributed to changes in habitat forming processes. It also likely reduced turbidity, leaving juvenile fish more exposed to avian and fish predators.

- *Impaired physical habitat quality due to past and/or current land use practices (6e).*
  Secondary threat: all LCR coho

  Impaired physical habitat quality, including degraded habitat complexity/diversity and loss of access to off-channel habitats, due to land use practices limits the viability of all LCR coho populations. Historically complex habitats in the Columbia River estuary have been modified through channelization, diking, development and other practices. 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). Construction of the North and South jetties altered sediment accretion and erosion processes near the Columbia River mouth. Sediment accretion in the marine littoral areas adjacent to the mouth decreased the inflow of marine sediments into the estuary (LCREP 2004), while the extensive use of dikes and other structures to maintain the shipping channel affected natural flow patterns. Development of the navigation channel reduced flow to side channels and peripheral

bays (LCREP 2004). Docks, piers, and other structures altered habitats and created favorable conditions for predators. Channel alterations changed saltwater intrusion patterns and interrupted nutrient cycles. Dredging and disposal of sand and gravel also caused estuarine habitat loss over the last century; currently, three times more sand is dredged from the estuary than is replenished by upstream sources (LCREP 2004).

As a result of these changes, the surface area of the estuary has decreased by approximately 20 percent over the past 200 years (Fresh et al. 2005). Loss of access to historical spawning and rearing habitats has restricted the populations to sometimes sub-optimal habitat downstream of barriers. Today, access to an estimated 77 percent of historical tidal swamps in the Columbia River estuary has been eliminated (Fresh et al. 2005). Losses of tidal marsh habitat have been most extensive in Youngs Bay, where a loss of over 6,000 acres was documented. Extensive tidal swamp habitat has been lost in all estuary areas where this habitat was historically present. Losses of medium- and deep-water habitat acreage have been less severe (25 percent and 7 percent, respectively) (LCFRB 2004).

Physical habitat quality in the lower Willamette River has also been reduced through land use practices. Loss of habitat diversity and key habitat has resulted from channelization, the loss of wood and other structure, and elimination of much of the shallow water habitat (McConnaha 2002). The loss of this historical habitat diversity and complexity in the lower Willamette River has reduced the amount of juvenile rearing habitat available in the reach for Clackamas coho (Primozich and Bastasch 2004).

- *Competition with hatchery smolts (1a).*
  Secondary threat: all LCR coho

  Competition with hatchery fish from all Columbia River hatcheries for limited habitat and food supplies in the Columbia River estuary affects productivity of all LCR coho populations. In recent years, approximately 1.7 million adult salmon and steelhead have returned annually to the Columbia River. To achieve these returns, an estimated 200 million juveniles are produced each year, 50 to 95 percent of which are of hatchery origin, depending on the species (LCREP 2006; CBFWA 1990; Genovese and Emmett 1997 as cited in Bottom et al. 2005).

  These hatchery fish are often released within a short period of time, causing large pulses of hatchery fish to compete with naturally produced fish for limited habitat and associated resources in the estuary at key times. The hatchery fish are often larger than their naturally produced counterparts, and may have a competitive advantage. This competition may limit the success of juvenile salmonids entering the estuary and plume, and may result in density-dependent mortality. It is possible that too many fish are currently competing for limited habitat and associated resources in the estuary at key times, and the resulting stressors translate into reduced salmonid survival (LCREP 2006). The intensity and magnitude of competition, however, has not been quantitatively documented and depends in part on when hatchery and natural juvenile salmonids enter the estuary and how long they stay. Thus, while it is clear that there is potential for competition with hatchery fish to present a significant impact for coho and other wild salmon and steelhead in the estuary, the Expert Panel and Planning Team concluded that there was insufficient information on the magnitude of this impact to warrant listing competition with hatchery origin fish as a key concern.

- *Degraded water quality, high water temperatures due to land use practices (9a).*
  Secondary threat: all LCR coho

  Land use practices that degraded riparian conditions or reduce streamflows contribute to elevated water temperatures in the estuary. The high water temperatures affect the productivity and survival of

juveniles from all LCR coho populations. In conjunction with water withdrawals, elevated stream temperatures often exist because of a lack of intact, functional and contiguous riparian management zones and sufficient streamside buffers. Channel widening may also be a contributing factor.

- *Degraded water quality, high water temperatures due to large hydropower reservoirs (9b).*
  Secondary threat: all LCR coho

  Elevated water temperatures due to reservoir construction and operations affect juveniles from all LCR coho populations. Flow regulation and reservoir construction in the Columbia Basin have increased average summer water temperatures in the estuary from the historical range. Water temperature measurements downstream of Bonneville Dam indicate that periods of increased temperatures in the estuary are lasting longer than they did historically (National Research Council 2004). Currently, average annual summer water temperatures measured in the estuary downstream of Bonneville Dam are above 20° C, which approaches the upper limits of thermal tolerance for cold-water fishes such as salmon (National Research Council 2004).

- *Degraded water quality, toxins from agricultural sources (9c).*
  Secondary threat: all LCR coho

  Contaminants from agricultural practices found throughout the Columbia River estuary pose a threat to all LCR coho. The U.S. Geological Survey's National Stream Quality Accounting Network program reports that a wide range of commonly used pesticides have been detected at sampling sites near Bonneville Dam and at the confluence of the Willamette and Columbia rivers (LCREP 2007a,b; Fresh et al. 2005). Detected water-soluble pesticides include simazine, atrazine, chlorpyrifos, metolachlor, diazinon, and carbaryl. Short-term exposure to these types of pesticides at environmentally relevant concentrations has been associated with disruption of olfactory function in salmonids; leading to difficulty in homing, predator avoidance, and finding prey (Scholz et al. 2000; Sandahl et al. 2002, 2005; Tierney et al. 2008). Moreover, mixtures of some of these pesticides (e.g., malathion and diazinon or chlorpyriphos) may be acutely lethal to salmonids (Laetz et al. 2009). Certain trace metals, such as lead and arsenic, have also been introduced to the environment through pesticides, such as lead arsenate, which is used as an insecticide for apples (Fresh et al. 2005). Additionally, a number of chlorinated pesticides, including dichlorodiphenyltrichloroethanes (DDTs), chlordanes, and endosulfans, are still present in soils and sediments in the Columbia Basin, even though they were banned in the United States in the 1970s (USEPA 2009).

- *Degraded water quality, toxins from urban and industrial sources (9d).*
  Secondary threat: Clatskanie, Scappoose, Clackamas, Sandy, Lower Gorge and Upper Gorge/Hood coho

  Toxic contaminants from urban and industrial practices reduce habitat quality for juvenile LCR coho from the Clatskanie, Scappoose, Clackamas, Sandy, Lower Gorge and Upper Gorge/Hood areas. The Columbia River downstream of Bonneville Dam is the most urbanized stretch in the entire basin. Trace metals, polychlorinated biphenyls (PCBs), dioxins, polycyclic aromatic hydrocarbon (PAHs), and other compounds have been detected in this reach of the estuary (Fresh et al. 2005). The U.S. Environmental Protection Agency has identified several PCB and DDT hot spots within the estuary, including near Longview, West Sand Island, the Astoria Bridge, and Vancouver (Fresh et al. 2005; Hayslip et al. 2006). Copper, used in brake pads for motor vehicles and often a component of stormwater, has also been measured in the estuary at concentrations shown to interfere with the olfactory function in salmon (Baldwin et al. 2003; Sandahl et al. 2007; LCREP 2007). The Portland and Vancouver sewage treatment plants are large sources of effluent in this area (Fresh et al. 2005). Contaminants from industrial point sources and urban stormwater runoff in the area also affect water

quality (USEPA 2009). Contaminants are also transported downstream to the estuary from areas above Bonneville Dam.

Toxic contaminants are also a problem in the lower Willamette River. An intensive study of sediments in Portland Harbor (the stretch of the Willamette River from Sauvie Island to Swan Island) has uncovered pesticides, PCBs, and other toxic chemicals. Industrial contaminants, such as PAHs, have been detected in sediments from the lower Willamette River in Portland at levels exceeding state or federal sediment quality guidelines (see documentation at: www.portlandharborcag.org/Superfund.html.

5.4.3 Hydropower and Flood Control Management

- *Impaired habitat access due to dam construction and operations (4a).*
  Secondary threat: Upper Gorge/Hood coho

  The Upper Gorge/Hood coho population is affected by impaired adult and juvenile passage in the Hood River[26] system at Powerdale Dam on the mainstem Hood River (RM 4.5), and at Bonneville Dam on the Columbia River. Powerdale Dam hinders access of returning adult coho to historical spawning areas above the dam. The dam began operating in 1923 and the fish ladder, which has undergone extensive modification since originally being built on the left abutment of the dam, is now used to trap fish for sorting and passage of anadromous fish into the upper Hood River Basin. The dam also hinders downstream coho migration. The project flow line suffered extensive damage during a flood event on the Hood River in 2006 and no longer diverts water for hydroelectric generation. It is currently operated only to provide fish passage and will be removed by 2010.

  The Upper Gorge/Hood coho population is affected by impaired passage at Bonneville Dam due to operational practices and/or flows that delay upstream migration. Returning adults can be delayed, injured, or killed while trying to pass upstream at the dam. Concentration of fish at Bonneville Dam also increases risks of predation, pathogen transfer with subsequent possible disease and/or harvest.

- *Impaired habitat access, downstream passage due to dam construction and operations (4b).*
  Secondary threat: Clackamas coho

  Tributary hydropower dams have restricted fish passage in the Clackamas watershed. Impaired downstream passage past the Clackamas hydropower project is a concern for the Clackamas coho population. Mortality of downstream migrating juveniles occurs at North Fork Dam, Faraday Powerhouse and River Mill Dam. Juveniles are affected since they cannot migrate downstream through the hydropower dams or survive downstream passage through or over them. In a DEIS for the Clackamas Hydro Project, FERC (2006) estimated the current average mortality for smolts passing through the hydro complex at 5.0 percent for coho.

5.4.4 Harvest Management

- *Loss of population traits, consumptive, targeted fisheries (7a).*
  Key threat: all LCR coho

  Incidental or direct mortality from targeted fisheries on the same species in the ocean and Columbia estuary reduces abundance and productivity of all Oregon LCR coho populations. LCR coho are caught in ocean fisheries and in non-Treaty fisheries in the mainstem Columbia River below

[26] Powerdale Dam (Hood River) is scheduled for removal in 2010.

Bonneville Dam. In the past 10 years, these fisheries have exerted an overall harvest rate in the range of 35 percent on most LCR coho populations (Chapter 4, Table 4-8).

Additional harvest in Select Area fisheries has resulted in even higher harvest rates for Youngs Bay (90%) and Big Creek (70%) populations. SAFE coho fisheries take place in Youngs Bay and at Tongue Point/South Channel and Blind Slough/Knappa Slough on the lower Columbia River (ISRP & IEAB 2005, ISRP & IEAB 2007, North et al. 2006). These fisheries, which have been implemented since the early 1960s, are separate from the mainstem Columbia River fisheries. The extremely high impact Select Area coho fishery targets a hatchery coho run that returns a few weeks before the historical wild run did, but could exert a strong selection against the early returning portion of the naturally produced run.

Major reductions in ocean and Columbia River fisheries in the mid 1990s substantially reduced the impact rate on the populations. Previously, from the 1950s to the early 1990s, the populations experienced fishery impact rates in the range of 75 to 90 percent McElhany et al. (2007). The legacy of this past heavy harvest on the genetic character of the populations remains unknown. During the last few years, the combined ocean and in-river harvest rates for most of the LCR coho populations has dropped below 20 percent. The harvest rates shown in Figure 5-9 for Clackamas wild coho typify harvest rates on LCR coho populations from ocean and Columbia River fisheries since the mid 1950s.

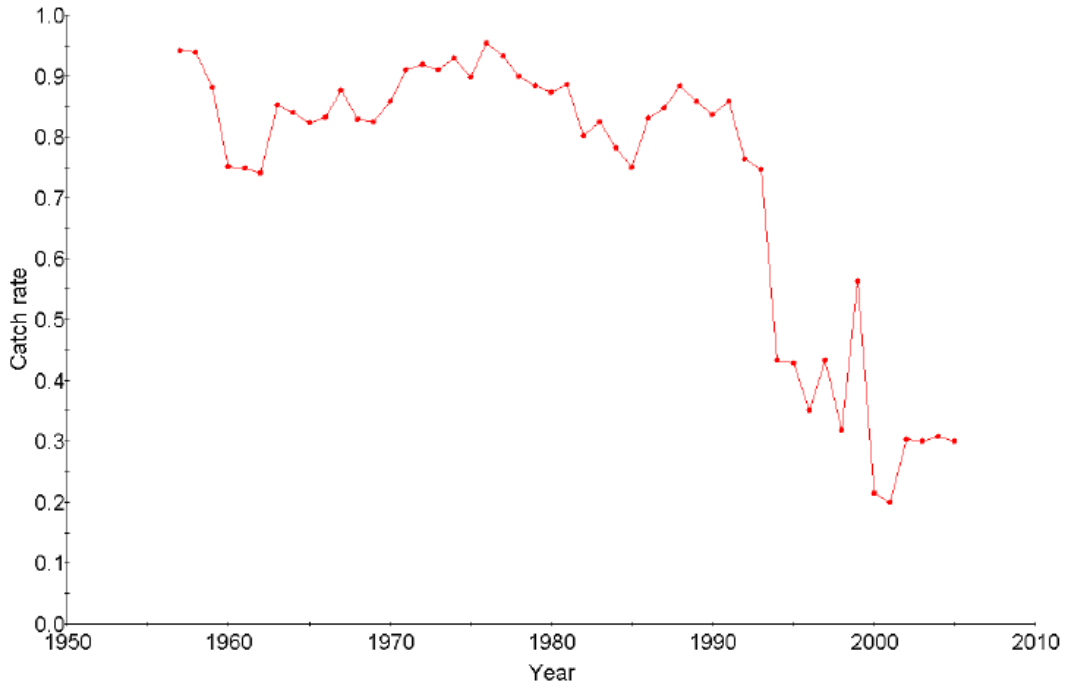


Figure 5-9. Fishery-related morality for Clackamas wild coho salmon population (from McElhany et al. 2007).

5.4.5 Hatchery Management

A number of hatcheries in the lower Columbia River region produce LCR coho stocks. In 2004, NMFS estimated that hatchery facilities in Oregon and Washington supported 21 coho programs (NMFS 2004). The actual number of artificial production programs changes yearly based on funding and broodstock

availability, and today the number of programs producing LCR stocks is somewhat lower (Turner 2008). For example, WDFW closed the Elochoman Hatchery in fall 2008, eliminating two coho programs. Some of the smaller programs identified by NMFS in 2004 have also been terminated (Turner 2008). Table 5-6 shows programs in Oregon that produce coho for release in Lower Columbia River drainages. Figure 5-10 shows coho hatchery production in the larger Columbia River basin from 1990 to 2007.

Table 5-6. Current hatchery programs in Oregon that produce LCR coho.

Species	Stratum	Population	Type	Purpose	Hatchery	Stock	Release #	Release Stage
Coho	Coastal	Youngs Bay	Segregated	Augmentation	Select Area Fisheries Program	Big Crk, Tanner Crk, Sandy, Clackamas	2,490,000	smolt
		Big Creek	Segregated	Augmentation	Big Creek	Big Crk	535,000	smolt
		Clatskanie	none	---	---	---	---	---
		Scappoose	none	---	---	---	---	---
	Cascade	Clackamas	Segregated	Augmentation	Eagle Creek NFH	Clackamas	350,000	smolt
		Sandy	Segregated	Augmentation	Sandy	Sandy	500,000	smolt
	Gorge	Lower Gorge	Segregated	Augmentation	Bonneville, Cascade, Oxbow?	Tanner Crk	725,000	smolt
		Up.Gorge/Hood	none	---	---	---	---	---

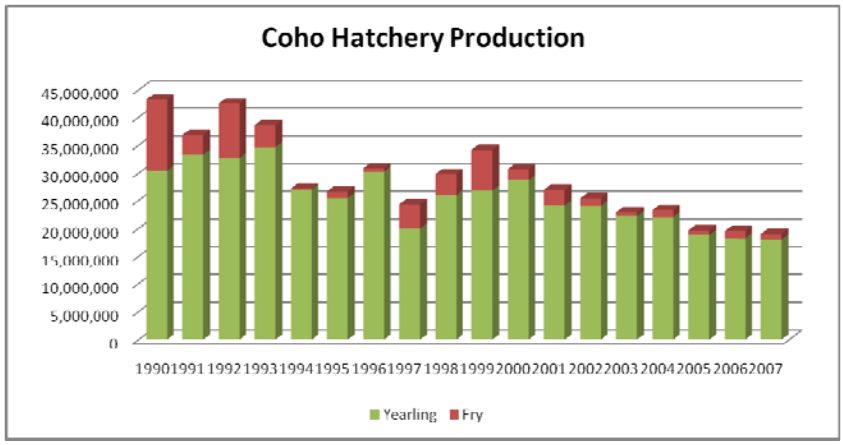


Figure 5-10. Coho hatchery production in the Columbia River basin (Fish Passage Center data).

The artificial production programs release millions of coho into Lower Columbia River subbasins each year. In 2008, programs for LCR coho released an estimated 12,676,800 coho into lower Columbia River subbasins. These coho releases included 4,143,000 from ODFW hatchery programs, 8,033,800 from WDFW programs, and 500,000 from USFWS programs (Turner 2008). A number of other hatchery programs in the Columbia River basin also release coho. Coho returns vary significantly. The abundance of coho returning to the lower Columbia River from 2001 to 2007 ranged from 318,600 to more than 1,108,300 fish, with most of the abundance comprised of hatchery fish (PFMC 2008 in NMFS 2008).

- *Loss of population traits, Stray hatchery fish interbreeding with wild fish (7c).*
  Key threat: Youngs Bay, Big Creek, Clackamas, Lower Gorge and Upper Gorge/Hood coho
  Secondary threat: Clatskanie coho

  The prevalence of hatchery fish spawning in local spawning areas (called straying) where they interbreed with wild fish reduces viability of all LCR coho populations, with the exception of the Scappoose and Sandy populations. The proportion of hatchery strays on spawning grounds in several

LCR coho population areas has been high—in recent years averaging over 80 percent for the Youngs Bay, Big Creek, Lower Gorge, and Upper Gorge/Hood populations; and over 35 percent in the Clackamas population (Chapter 4, Table 4-8). Many of these hatchery fish come from nearby hatcheries.

Interbreeding of these stray hatchery fish with spawners of natural origin can alter the genetic composition and associated traits that affect the long term fitness and survival of the wild populations. For example, the current timing of hatchery and wild coho populations in Youngs Bay and Big Creek shows considerable overlap, whereas historically the native stock was a late-returning stock (Suring et al. 2006). In the Clackamas population, there is some temporal separation between hatchery and wild coho spawners, leading to an unknown level of genetic introgression and resulting hatchery influence (Alsbury 2008). The coho run timing differences warrant further investigation into temporal separation and actual stray rates in the Clackamas.

5.4.6 Predation

- *Increased predation by birds due to land use practices (8b).*
  Secondary threat: all LCR coho populations

  Modification of estuarine habitats has increased the number and/or predation effectiveness of Caspian terns, double-crested cormorants, and a variety of gull species in the Columbia River estuary (LCREP 2006; Fresh et al. 2005). For example, new islands formed through the disposal of dredged materials have attracted terns away from traditional habitats, especially those that are degraded. The new islands are often well-positioned for terns preying on migrating salmonids. Stream-type juvenile salmonids, such as coho, 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. For this reason, the Corps began to reduce the area available for tern nesting in 1999. Under the 2008 FCRPS RPA (action 45), the Corps is further reducing the area available (to 1.5 to 2 acres by 2010). The Corps is also examining the feasibility of reducing the level of predation from double-crested cormorants (RPA action 46). Double-crested cormorants consume a similar number of juvenile salmonids (approximately 3.6 million juveniles) from their East Sand Island nesting grounds (Collis and Roby 2006).

5.5 Limiting Factors and Threats for Lower Columbia River Chinook

Key and secondary limiting factors and threats that contribute to the current status of Oregon's LCR Chinook populations are in Tables 5-7 through 5-9. A discussion of these threats and factors follows.

Table 5-7. Key and secondary threats and limiting factors for Lower Columbia River fall Chinook.

CHINOOK (Fall)			Threats and Limiting Factors					
Population	Threat Level	Life History Stages	Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation
Youngs Bay	Key	Adult				7a	7c	
		Juvenile	5c, 6e	3a, 3b, 5b, 6c				
	Secondary	Adult	4c					
		Juvenile	5c, 6a	1a, 6e, 9a, 9b, 9c				8b
Big Creek	Key	Adult				7a	7c	
		Juvenile	5c, 6e	3a, 3b, 5b, 6c				
	Secondary	Adult	4c					
		Juvenile	5c, 6a	1a, 6e, 9a, 9b, 9c				8b
Clatskanie	Key	Adult				7a	7c	
		Juvenile	6e	3a, 3b, 5b, 6c				
	Secondary	Adult						
		Juvenile	5c, 6b	1a, 6e, 9a, 9b, 9c, 9d				8b
Scappoose	Key	Adult				7a	7c	
		Juvenile	5c, 6e	3a, 3b, 5b, 6c				
	Secondary	Adult						
		Juvenile	5c, 6b	1a, 6e, 9a, 9b, 9c, 9d				8b
Clackamas	Key	Adult				7a	7c	
		Juvenile	6e	3a, 3b, 5b, 6c				
	Secondary	Adult	6d, 9b					
		Juvenile	5c, 6a, 6e, 9a, 9b	1a, 6e, 9a, 9b, 9c, 9d				8b
Sandy	Key	Adult				7a	7c	
		Juvenile	6e	3a, 3b, 5b, 6c				
	Secondary	Adult	6d					
		Juvenile	5c, 6a	1a, 6e, 9a, 9b, 9c, 9d	4b			8b
Lower Gorge	Key	Adult	6f			7a	7c	
		Juvenile	6f	3a, 3b, 5b, 6c				
	Secondary	Adult						
		Juvenile	5c	1a, 6e, 9a, 9b, 9c, 9d				8b
Upper Gorge	Key	Adult	6f, 6g			7a	7c	
		Juvenile	6f, 6g	3a, 3b, 5b, 6c				
	Secondary	Adult			4a			
		Juvenile	1a, 5c, 6g, 8a	1a, 6e, 9a, 9b, 9c, 9d	4a			8b
Hood	Key	Adult				7a	7c	
		Juvenile	5d, 6e	3a, 3b, 5b, 6c				
	Secondary	Adult			4a			
		Juvenile	1a, 5a, 5c, 6a, 6g, 8a, 9c	1a, 6e, 9a, 9b, 9c, 9d	4a			8b

Table 5-8. Key and secondary threats and limiting factors for Lower Columbia River late fall Chinook.

CHINOOK (Late Fall)			Threats and Limiting Factors					
Population	Threat Level	Life History Stages	Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation
Sandy	Key	Adult				7a	7c	
		Juvenile	6e	3a, 3b, 5b, 6c				
	Secondary	Adult	6d					
		Juvenile	5c, 6a	1a, 6e, 9a, 9b, 9c, 9d	4b			8b

Table 5-9. Key and secondary threats and limiting factors for Lower Columbia River spring Chinook.

CHINOOK (Spring)			Threats and Limiting Factors					
Population	Threat Level	Life History Stages	Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation
Clackamas	Key	Adult					7c	
		Juvenile	6e	3a, 3b, 5b, 6c	4b			
	Secondary	Adult	6d, 9b			7a, 7b		
		Juvenile	5c, 6e, 9a, 9b	1a, 6e, 9a, 9b, 9c, 9d				8b
Sandy	Key	Adult					7c	
		Juvenile	6e	3a, 3b, 5b, 6c				
	Secondary	Adult	4a, 6d			7a, 7b		
		Juvenile	5c, 6a	1a, 6e, 9a, 9b, 9c, 9d	4b			8b
Hood	Key	Adult				7a	7c	
		Juvenile		3a, 3b, 5b, 6c				
	Secondary	Adult			4a			8d
		Juvenile	1a, 5a, 5c, 5d, 6a, 6g, 8a, 9c	1a, 6e, 9a, 9b, 9c, 9d	4a			8b

Code	Limiting Factor	Threat
1a	Competition (hatchery fish)	Smolts from all Columbia Basin hatcheries
3a	Food web (reduced macrodetrital inputs)	Columbia Basin hydropower reservoirs, revetments, and disposal of dredge material
3b	Food web (increased microdetrital inputs)	Columbia Basin hydropower reservoirs
4a	Habitat access (impaired passage)	Large dam(s)
4b	Habitat Access (impaired downstream passage)	Large dam(s)
4c	Habitat access (impaired upstream passage)	Hatchery weir
4d	Habitat access (impaired upstream passage)	Road crossings
4e	Habitat access (impaired upstream passage)	Road crossings, small dams, and diversions
5a	Hydrograph/water quantity (altered hydrology)	Low-head hydro diversions
5b	Hydrograph/water quantity (altered hydrology)	Columbia Basin hydropower dams (impaired access to off-channel habitat, dewatering of redds below, and altered plume dynamics, estuarine habitat, and food web)
5c	Hydrograph/water quantity (altered hydrology)	Upslope land uses
5d	Hydrograph/water quantity (altered hydrology: reduced downstream flows)	Irrigation withdrawals (impaired physical habitat, access to habitat)
5e	Hydrograph/water quantity (altered hydrology: reduced downstream flows)	Municipal withdrawals
5f	Hydrograph/water quantity (altered hydrology: reduced downstream flows)	Hatchery withdrawals (impaired passage and reduced habitat)
6a	Physical habitat quality (excessive fine sediment)	Rural roads
6b	Physical habitat quality (excessive fine sediment)	Rural roads and land use
6c	Physical habitat quality (impaired sediment/sand routing)	Columbia Basin hydropower dams
6d	Physical habitat quality (impaired gravel recruitment)	Large dam(s)
6e	Physical habitat quality (impaired habitat complexity and diversity, including access to off-channel habitats)	Past and/or current land use practices
6f	Physical habitat quality (impaired habitat quality and disconnected habitat)	Transportation corridor development and maintenance

6g	Physical habitat quality (reduced habitat quality/quantity)	Inundation from Bonneville
7a	Population traits (impaired abundance and diversity)	Consumptive, targeted fishery
7b	Population traits (impaired abundance and diversity)	Fisheries targeted at other stocks or species
7c	Population traits (impaired productivity and diversity)	Stray hatchery fish interbreeding with wild fish
8a	Predation (non-salmonid fish)	Bonneville Reservoir and Columbia Basin flow regulations
8b	Predation (birds)	Land use practices that create more favorable conditions for Caspian terns and cormorants to prey on salmonid juveniles in estuary
8c	Predation (hatchery fish)	Smolts from all Columbia Basin hatcheries
8d	Predation (marine mammals)	Bonneville Dam and Columbia Basin flow regulations
9a	Water quality (elevated water temperature)	Land uses that impaired riparian condition or reduced steamflows (e.g. water withdrawals for agricultural, industrial, or municipal uses)
9b	Water quality (elevated water temperature)	Large hydropower reservoirs
9c	Water quality (toxins)	Agricultural chemicals used throughout the Columbia Basin
9d	Water quality (toxins)	Urban and industrial practices

The following threats and factors limit viability of Oregon's LCR fall, late fall and spring Chinook populations. Appendix E provides more information on the threats and factors limiting the different Chinook populations during specific life stages.

5.5.1 Tributary Habitat

- *Altered hydrograph/water quantity from upslope land use (5c).*
  Key threat: Youngs Bay, Big Creek, Scappoose fall Chinook
  Secondary threat: all LCR fall, late fall and spring Chinook populations

  Altered hydrologic processes and/or reduced water quantity due to land use practices on upland slopes are a key concern for fall Chinook fry in the Youngs Bay, Big Creek and Scappoose population areas. They pose a secondary concern for winter steelhead eggs, alevins, and summer parr in these population areas. They are a secondary concern for all other LCR fall Chinook populations and Sandy late fall Chinook from the egg through summer parr life stages. They pose a secondary concern for spring Chinook populations from the egg through winter parr life stage.

  As discussed for coho in Section 5.4.1, land use practices on upland slopes have reduced soil stability, increased the extent of impermeable surfaces, reduced vegetative cover, and altered drainage systems. As a result, they have reduced the interception and infiltration of precipitation on upland ecosystems and, thus, affected water storage in the soil and delivery to streams. Many stream systems now exhibit higher peak flows and lower base flows than they did historically.

- *Altered hydrograph/water quantity due to irrigation withdrawals (5d).*
  Key threat: Hood fall Chinook
  Secondary threat: Hood spring Chinook

  Reduced instream flow due to irrigation withdrawals affects the Hood fall and spring Chinook populations by reducing juvenile rearing habitat quality and restricting access to historical habitat areas. The limiting factors are the same as those described for coho in Section 5.4.1.

- *Reduced physical habitat quality/habitat access due to past and/or current land use practices (6e).*
  Key threat: Youngs Bay, Big, Clatskanie, Scappoose, Clackamas, Sandy and Hood fall Chinook; Sandy late fall Chinook; Clackamas and Sandy spring Chinook
  Secondary threat: Clackamas fall Chinook; Clackamas spring Chinook

  Reduced habitat quality and complexity, and connectivity with off-channel habitats limits juvenile fall, late fall and spring Chinook viability in all population areas, with the exception of the Lower

Gorge and Upper Gorge areas. The limiting factors are the same as those described for coho in Section 5.4.1.

- *Degraded physical habitat quality due to transportation corridor development and maintenance (6f).*
  Key threat: Lower Gorge and Upper Gorge fall Chinook

  Activities associated with highway and rail development have degraded habitat quality and connectivity for adult and juvenile fall Chinook in the Lower Gorge and Upper Gorge population areas. The limiting factors are the same as those described for coho in Section 5.4.1.

- *Degraded physical habitat quality, inundation from Bonneville Dam (6g).*
  Key threat: Upper Gorge fall Chinook
  Secondary threat: Upper Gorge and Hood fall Chinook; Hood spring Chinook

  Inundation and loss of lowland riparian hardwood communities along the Columbia River has reduces habitat quality for adult and juvenile fall Chinook in the Upper Gorge area, and for juvenile fall and spring Chinook in the Hood population. The limiting factors are the same as those described for coho in Section 5.4.1.

- *Competition with hatchery fish from Columbia River hatcheries (1a).*
  Secondary threat: Upper Gorge and Hood fall Chinook; Hood spring Chinook

  Competition with hatchery fish for limited habitat and food supplies in the mainstem Columbia River estuary, and in the Columbia above Bonneville Dam has reduced juvenile abundance and productivity for Upper Gorge and Hood fall Chinook and Hood spring Chinook. The limiting factors are generally the same as those described for coho in Section 5.4.1.

- *Impaired habitat access due to dam construction and operations (4a).*
  Secondary threat: Sandy spring Chinook

  The Bull Run water system dams in the Sandy River system hinder upstream passage of spring Chinook to potential spawning and rearing habitat above the dams.

- *Reduced habitat access due to hatchery weirs (4c).*
  Secondary threat: Youngs Bay and Big Creek fall Chinook

  Hatchery weirs in the Youngs Bay and Big Creek population areas impede or prevent adult fall Chinook access to historical spawning and rearing habitat. In the Youngs Bay area, a weir at Klaskanine Hatchery on the North Fork Klaskanine River is believed to hinder fall Chinook access; however, it is unclear how much of the upstream habitat is suitable for fall Chinook. A weir at Big Creek Hatchery blocks fall Chinook access in the Big Creek area. Again, however, the quality of fall Chinook habitat above this hatchery weir is believed to be limited. Fall Chinook are not passed above the weir.

- *Altered hydrograph/water quantity due to low head hydro diversions (5a).*
  Secondary threat: Hood fall Chinook; Hood spring Chinook

  Low-head hydro diversions in the Hood River basin impair habitat access and physical habitat quality for juvenile fall and spring Chinook. Farmers and Middle Fork irrigation districts operate five small hydro plants year-round along their irrigation canals and pipelines. Depending on irrigation demand, some or all of the water is returned to the stream at various points. Their combined generation water

rights total 158 cfs, although actual peak use varies (Coccoli et al. 1999). The maximum winter hydro diversion is 45 cfs from Middle Fork Irrigation District sources (Conners, Middle Fork Irrigation District pers comm., in Coccoli et al. 1999). Farmer's Irrigation District on the mainstem Hood River (RM 11.5) diverts approximately 80 cfs of water from the mainstem Hood River at RM 10, and an additional 30 cfs from other upstream sources for use as both irrigation and hydroelectric production. Depending upon irrigation demand, some or all of the water is returned to the mainstem Hood River at RM 4.5. Screens at the diversions prevent fish entrainment. A small hydro plant is also operated by a private individual on Odell Creek near its mouth.

- *Degraded physical habitat quality, excessive fine sediment, due to roads (6a).*
  Secondary threat: Youngs Bay, Big Creek, Clackamas, Sandy, Hood fall Chinook; Sandy late fall Chinook; Sandy and Hood spring Chinook

  Forest and rural roads have altered sediment routing and led to an overabundance of fine-grained sediments, excess of course-grained sediments, inadequate course-grained sediments, and/or contaminated sediment in stream channels. Excessive fine sediment reduces egg development and survival during the incubation life stage.

- *Degraded physical habitat quality, excessive fine sediment due to roads and land use (6b).*
  Secondary threat: Clatskanie and Scappoose fall Chinook

  Land use practices and road development on unstable slopes have disrupted natural processes that controlled erosion and sediment routing. As a result, excessive amounts of fine sediment have entered the stream system, reducing the quality of spawning gravels and incubation habitat.

- *Degraded physical habitat quality, impaired gravel recruitment due to large dams (6d).*
  Secondary threat: Clackamas and Sandy fall Chinook; Sandy late fall Chinook; Clackamas and Sandy spring Chinook

  Impaired gravel recruitment behind dams affects Chinook spawning habitat quality in the Clackamas and Sandy areas. A geomorphic analysis of the Clackamas River downstream of River Mill Dam shows that gravel recruitment is impaired in the two-mile reach below River Mill Dam (Wampler and Grant 2003). Sediment trapping by the dams has resulted in coarsening of the grain size, channel incision and erosion of margin deposits. Studies also show that high quality spawning gravel is limited in portions of the Sandy River[27] and in the Bull Run River below the dams. Portland General Electric (2002) found that gravels suitable for spawning substrate are limited in some reaches of the middle Sandy River because of high water velocities. Analysis of spawning gravel in the lower Bull Run River by R2 Resource Consultants (1998) and Beak Consultants (2000) indicates that lack of suitable spawning gravel in the reach is limiting Chinook production.

- *Predation from non-salmonid fish in Bonneville Reservoir and Columbia River mainstem (8a).*
  Secondary threat: Upper Gorge and Hood fall Chinook; Hood spring Chinook

- Predation by non-salmonid fish in Bonneville Reservoir and the mainstem Columbia River impacts juvenile Chinook from the Upper Gorge and Hood populations. Pikeminnows congregate at dam bypass outfalls and hatchery release sites to feed on smolts, which dominate their diet at these locations. Impacts from pikeminnow and other non-salmonid fish are generally the same as those described for coho in Section 5.4.1.

[27] This situation may improve with the removal of Marmot Dam in 2007.

- *Degraded water quality, elevated water temperatures due to land use practices (9a).*
  Secondary threat: Clackamas fall Chinook; Clackamas spring Chinook

  High summer water temperatures are a concern for juvenile Chinook in the Clackamas population. EDT results for the watershed identify summer water temperature as limiting juvenile spring Chinook summer rearing (Primozich and Bastasch 2004). Adult fall Chinook are also affected by high summer and fall water temperatures in the lower river, which occur during their spawning period and reduce egg survival. These high water temperatures are primarily the result of decreased riparian forest in the tributaries and mainstem, ponding behind the dams, and other upriver factors, while conditions in the lower Clackamas area have only a minor impact on the conditions (Primozich and Bastasch 2004).

- *Degraded water quality, elevated water temperatures due to large hydropower reservoirs (9b).*
  Secondary threat: Clackamas fall Chinook; Clackamas spring Chinook

  Water impoundment in reservoirs above Clackamas hydropower dams results in solar heating and elevated river water temperatures below the hydropower projects. The elevated water temperatures in the Clackamas River during late summer and early fall limit Chinook spawning success in the lower basin.

- *Degraded water quality, toxins from agricultural sources (9c).*
  Secondary threat: Hood fall Chinook; Hood spring Chinook

  Agricultural chemicals, including organophosphates and other insecticide levels above state water quality standards, impair juvenile Chinook growth and survival in the Hood River drainage. Water quality is primarily affected by pesticides and bacteria in the lower basin (Baldwin, Indian, Lenz, Odell, and Neal creeks) (Shively et al. 2006). Low flows concentrate pollutants.

5.5.2 Estuary Habitat

- *Altered food web, reduced macrodetrital input due to Columbia Basin hydropower reservoirs, revetments, and disposal of dredge material (3a).*
  Key threat: all LCR fall, late fall and spring Chinook populations

  Reduced macrodetrital-based input in the Columbia River estuary significantly affects the viability of all Oregon LCR Chinook populations. The limiting factors are generally the same as those described for coho in Section 5.4.2.

- *Altered food web, increased microdetrital input due to Columbia Basin hydropower reservoirs (3b).*
  Key threat: all LCR fall, late fall and spring Chinook populations

  The substitution of the estuary's current microdetrital-based food web, made up of decaying phytoplankton delivered from upstream reservoirs, for the historical macrodetrital-based web has reduced productivity in the estuary. The limiting factors are generally the same as those described for coho in Section 5.4.2.

- *Altered hydrograph/water quantity due to Columbia Basin hydropower dams (5b).*
  Key threat: all LCR fall, late fall and spring Chinook populations

  Alteration of the Columbia River hydrograph significantly affects all LCR Chinook populations. The limiting factors are generally the same as those described for coho in Section 5.4.2.

- *Impaired physical habitat quality due to Columbia Basin hydropower dams (6c).*
  Key threat: all LCR fall, late fall and spring Chinook populations

  Impaired physical habitat quality in the estuary, especially sediment and sand routing, impacts all LCR Chinook populations. The limiting factors are generally the same as those described for coho in Section 5.4.2.

- *Competition with hatchery smolts (1a).*
  Secondary threat: all LCR fall, late fall and spring Chinook populations

  Competition with hatchery fish from all Columbia River hatcheries for limited habitat and food supplies in the Columbia River estuary affects productivity of all LCR Chinook populations. The limiting factors are generally the same as those described for coho in Section 5.4.2.

- *Impaired physical habitat quality due to past and/or current land use practices (6e).*
  Secondary threat: all LCR fall, late fall and spring Chinook populations

  Physical habitat quality in the Columbia River estuary, including habitat complexity/diversity and loss of access to off-channel habitats, has been degraded through past and current land use practices. The degraded habitat conditions now limit viability of all LCR Chinook populations. The limiting factors are generally the same as those described for coho in Section 5.4.1.

- *Degraded water quality, high water temperatures due to land use practices (9a).*
  Secondary threat: all LCR fall, late fall and spring Chinook populations

  Land use practices that degrade riparian conditions or reduce streamflows have contributed to elevated water temperatures in the estuary. In conjunction with water withdrawals, elevated stream temperatures often exist because of a lack of intact, functional and contiguous riparian management zones and sufficient streamside buffers. Channel widening may also be a contributing factor.

- *Degraded water quality, high water temperatures due to large hydropower reservoirs (9b).*
  Secondary threat: all LCR fall, late fall and spring Chinook populations

  Elevated water temperatures due to reservoir construction and operations affect juveniles from all LCR Chinook populations. The limiting factors are generally the same as those described for coho in Section 5.4.2.

- *Degraded water quality, toxins from agricultural sources (9c).*
  Secondary threat: all LCR fall, late fall and spring Chinook populations

  Contaminants from agricultural practices are found throughout the Columbia River estuary. A wide range of commonly used pesticides have been detected at sampling sites near Bonneville Dam and at the confluence of the Willamette and Columbia rivers (LCREP 2007a,b; Fresh et al. 2005). Detected water-soluble pesticides include simazine, atrazine, chlorpyrifos, metolachlor, diazinon, and carbaryl. Short-term exposure to these types of pesticides at environmentally relevant concentrations has been associated with disruption of olfactory function in salmonids; leading to difficulty in homing, predator avoidance, and finding prey (Scholz et al. 2000; Sandahl et al. 2002, 2005; Tierney et al. 2008). Moreover, mixtures of some of these pesticides (e.g., malathion and diazinon or chlorpyriphos) may be acutely lethal to salmonids (Laetz et al. 2009). Certain trace metals, such as lead and arsenic, have also been introduced to the environment through pesticides, such as lead

arsenate, which is used as an insecticide for apples (Fresh et al. 2005). Additionally, a number of chlorinated pesticides, including DDTs, chlordanes, and endosulfans, are still present in soils and sediments in the Columbia Basin, even though they were banned in the United States in the 1970s (USEPA 2009). These compounds have been observed in tissues and stomach contents of juvenile Chinook salmon from the lower Columbia River and estuary and, in some cases, DDTs have accumulated in salmon tissues to concentrations above estimated toxic effects thresholds (Beckvar et al. 2005; Johnson et al. 2007; LCREP et al 2007b).

- *Degraded water quality, toxins from urban and industrial sources (9d).*
  Secondary threat: Clatskanie, Scappoose, Clackamas, Sandy, Lower Gorge, Upper Gorge, Hood fall Chinook; Sandy late fall Chinook; Clackamas, Sandy and Hood spring Chinook

  Toxic contaminants from urban and industrial practices reduce habitat quality for juvenile LCR Chinook from the Clatskanie, Scappoose, Clackamas, Sandy, Lower Gorge, Upper Gorge and Hood populations. Generally studies have shown that PCB and PAH concentrations in salmon and their prey in the lower Columbia and lower Willamette are comparable to those in organisms in other moderately to highly urbanized areas (Fresh et al. 2005; LCREP 2007; Johnson et al. 2007), and in some cases are above estimated threshold levels for toxic effects (Meador et al. 2002, 2008). In a study by Loge et al. (2005), cumulative delayed disease-induced mortalities were estimated at 3 percent and 18 percent for juvenile Chinook residing in the Columbia River estuary for 30 to 120 days, respectively, with about 50 percent of that mortality estimated to be due to effects of toxic contaminants such as PCBs and PAHs. The limiting factors are generally the same as those described for coho in Section 5.4.2.

5.5.3 Hydropower and Flood Control Management

- *Impaired habitat access due to dam construction and operations (4a).*
  Secondary threat: Upper Gorge and Hood fall Chinook; Hood spring Chinook

- Bonneville Dam impairs adult and juvenile Chinook access to and from habitats in the Upper Gorge and Hood population areas. Operational practices and/or flows can delay passage at the dam. Powerdale Dam on the mainstem Hood River also hinders access of adult Chinook returning to historical spawning areas in the basin above the dam. The dam is scheduled to be removed by 2010. The limiting factors are generally the same as those described for coho in Section 5.4.3.

- *Impaired habitat access, downstream passage due to dam construction and operations (4b).*
  Key threat: Clackamas spring Chinook
  Secondary threat: Sandy fall Chinook; Sandy late fall Chinook; Sandy spring Chinook

  Impaired downstream passage past the Clackamas hydropower project is a concern for the Clackamas spring Chinook population. Mortality of downstream migrating juveniles occurs at North Fork Dam, Faraday Powerhouse and River Mill Dam. In a DEIS for the Clackamas Hydro Project, FERC (2006) estimated the current average mortality for smolts passing through the hydro complex at 24.6 percent for Chinook. The dams may also delay adult salmon and steelhead passage to upriver habitat and reduce spawner success and distribution.

  In the Sandy Basin, mortality of fall, late fall and spring Chinook fry as they migrate downstream past the Little Sandy Dam is a concern for the populations. Lingering impacts on population abundance and productivity due to mortality of fry migrating past Marmot Dam before it was removed in October 2007 are also a concern for the populations.

5.5.4 Harvest Management

- *Loss of population traits due to consumptive, targeted fisheries (7a).*
  Key threat: all LCR fall Chinook populations; Sandy late fall Chinook; Hood spring Chinook
  Secondary threat: Clackamas and Sandy spring Chinook

  Incidental or direct mortality from targeted fisheries on the same species in the ocean and Columbia estuary reduces abundance and productivity of all Oregon LCR fall Chinook populations, Sandy late fall Chinook, and Hood spring Chinook (see Appendix D for most recent harvest limits).

  Fall Chinook: LCR fall Chinook are caught in ocean fisheries and in non-Treaty fisheries in the mainstem Columbia River below Bonneville Dam. The majority of harvest impacts to LCR tule Chinook populations occur in ocean fisheries, which have been responsible for about 70 percent of the harvest impact since 2002 (NMFS 2008). Direct harvest mortality of fall-run Chinook salmon in the Lower Columbia River has also been, and continues to be, relatively high. Over the last 10 years, the total harvest rates on most of the LCR fall Chinook populations below Bonneville Dam are thought to have averaged roughly 60; the rate on the Youngs Bay and Big Creek populations have been higher, averaging an estimated 75 and 65 percent, respectively (Chapter 4, Table 4-8; ISRP & IEAB 2005, ISRP & IEAB 2007, North et al. 2006). The fishery mortality rates shown in Figure 5-11 for Clatskanie tule fall Chinook typify the total harvest rates for LCR fall Chinook populations from ocean and Columbia River fisheries since 1950 (Appendix C). The allowable harvest rate established by NMFS for naturally-spawning tule fall Chinook has decreased from 49 percent in 2006 to 42 percent, 41 percent, and 38 percent for 2007-2009 fisheries.

Figure 5-11. Fishery-related mortality for Clatskanie fall Chinook salmon population (from McElhany et al. 2007).

  Late Fall Chinook: Incidental or direct mortality from targeted fisheries on the same species in the ocean and estuary is a key concern for the Sandy River late fall Chinook population. Late-run fall Chinook salmon are captured in many of the same ocean fisheries as their early fall-run counterparts; although overall, inshore sport and net harvest impacts are somewhat less for late-run fall Chinook.

In recent years the Sandy late fall Chinook population is thought to have experienced a total harvest rate of 50 percent (Chapter 4, Table 4-8). From 1999-2002 the average harvest rate for late-fall run fish was 30.7 percent, using Lewis River fish as a proxy. Since 2002, the annual harvest rate on the run has averaged 19.6 percent. Figure 5-12 shows the pattern of total fishery exploitation rates estimated for Sandy late fall Chinook from all fisheries since 1981, as described in Appendix C.

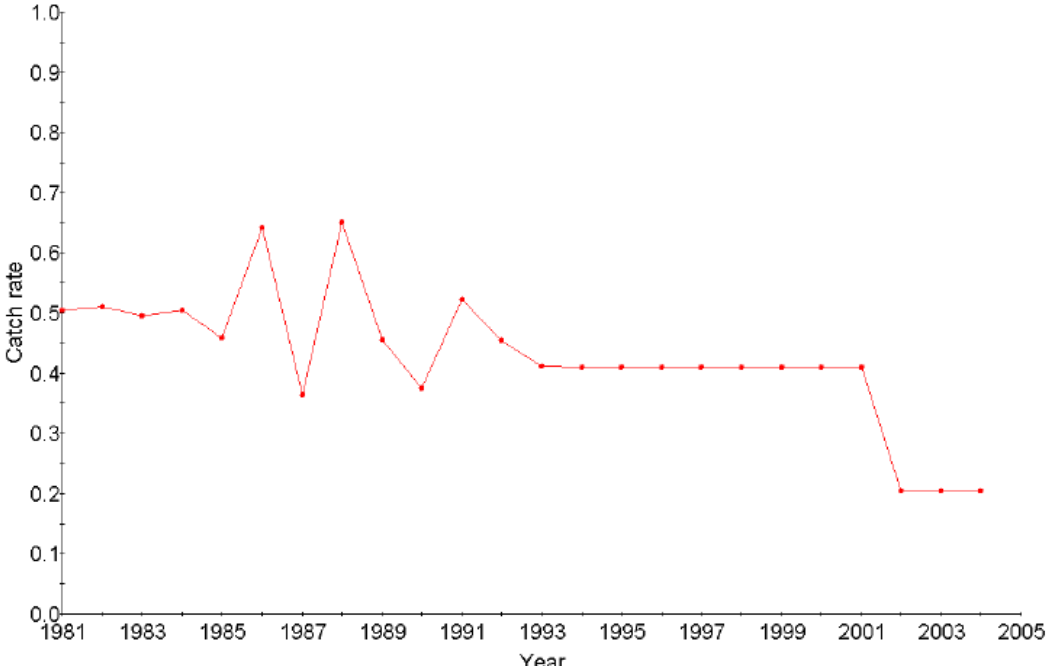


Figure 5-12. Fishery-related mortality for Sandy late fall Chinook salmon population (from McElhany et al. 2007).

Spring Chinook: Incidental or direct mortality from targeted ocean troll and estuary fisheries is a key concern for the Hood River population of LCR spring Chinook. Targeted ocean fisheries pose a secondary concern for the Clackamas and Sandy populations[28]. LCR spring Chinook populations are caught in ocean fisheries, primarily in Alaska and off Vancouver Island, in spring season fisheries in the Columbia River mainstem below Bonneville Dam, and in tributary fisheries targeting hatchery-origin fish. Zone 6 fishery impacts warrant further consideration. In recent years, the fishery exploitation rate on LCR spring Chinook was estimated to have been approximately 25 percent (Chapter 4, Table 4-8). This harvest rate poses a higher risk for the Hood spring Chinook population than for the Clackamas and Sandy populations because the Hood population is already at a high risk of extinction and is less able to absorb a 25 percent harvest rate than the other two, healthier populations. Figure 5-13 illustrates the pattern of total fishery exploitation rates for Sandy spring Chinook other LCR spring Chinook populations since 1950.

[28] The difference in ranking of the impact of ocean and estuary fisheries on Hood River spring Chinook compared to Clackamas and Sandy spring Chinook is because the planning team believes that the low abundance and poor status of Hood River spring Chinook means that they are less resilient to the impact of fisheries than Clackamas or Sandy spring Chinook.

Figure 5-13. Fishery-related morality for Sandy spring Chinook population (from McElhany et al. 2007).

- *Loss of population traits due to fisheries targeted at other stocks or species (7b).*
  Secondary threat: Clackamas and Sandy spring Chinook

  Incidental catch and mortality from recreational and commercial (gill and tangle net) fisheries targeting other stocks in the lower Columbia River also threatens the viability of Clackamas and Sandy spring Chinook. These fisheries target hatchery produced spring Chinook, but incidentally catch wild spring Chinook.

5.5.5 Hatchery Management

A number of hatcheries in the lower Columbia River region produce LCR Chinook. Hatcheries in other ESUs/DPSs in the Columbia Basin also release Chinook, which migrate through the lower Columbia as juveniles and adults and can also impact populations in the region. In 2004, NMFS estimated that hatchery facilities in Oregon and Washington supported 17 Chinook programs (NMFS 2004). The actual number of artificial production programs changes yearly based on funding and broodstock availability, and today the number of programs producing LCR stocks is somewhat lower (Turner 2008). For example, WDFW closed the Elochoman Hatchery in fall 2008, eliminating a fall Chinook program. Some smaller programs identified by NMFS in 2004 have also been terminated (Turner 2008). Table 5-10 shows programs in Oregon that produce Chinook for release in Lower Columbia River drainages. Figure 5-14 shows Chinook hatchery production in the larger Columbia River basin from 1990 to 2007.

Together these artificial production programs release millions of fall Chinook, spring Chinook, coho, chum and steelhead into Lower Columbia River subbasins each year. In 2008, programs for LCR stocks released a total of 39,107,500 fall Chinook and 6,054,350 spring Chinook into lower Columbia River subbasins (Turner 2008).

Table 5-10. Current hatchery programs in Oregon that produce LCR Chinook.

Species	Stratum	Population	Type	Purpose	Hatchery	Stock	Release #	Release Stage
Fall Chinook	Coastal	Youngs Bay	Segregated	Augmentation	CCF	SAB	1,350,000	smolt
					Klaskanine	Big Crk Tule	2,100,000	fingerling
		Big Creek	Segregated	Augmentation	Big Crk	Big Crk Tule	3,700,000	fingerling
		Clatskanie	none	---	---	---	---	---
		Scappoose	none	---	---	---	---	---
	Cascade	Clackamas	none	---	---	---	---	---
		Sandy	none	---	---	---	---	---
	Gorge	Lower Gorge	Segregated	Augmentation	Bonneville	URB and Tule	4,794,000	smolt
		Upper Gorge	none	---	---	---	---	---
		Hood	none	---	---	---	---	---
Spring Chinook	Cascade	Sandy	Integrated	Augmentation	Sandy	Sandy	300,000	smolt
	Gorge	Hood	Integrated / Segregated	"Re-Intro. / Augmentation	Round Butte	Hood (orig. Deschutes)	150,000	smolt
	N/A	Youngs Bay	Segregated	Augmentation	Gnat Crk	MF Willamette	925,000	smolt
		Clackamas	Segregated	Augmentation	Clackamas	Clackamas	1,000,000	smolt
							150,000	pre-smolt
							60,000	unfed fry

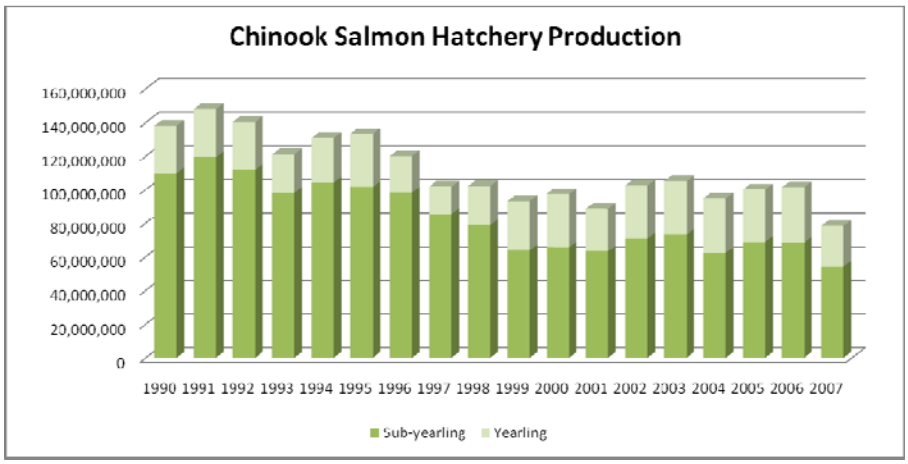


Figure 5-14. Chinook hatchery production in the Columbia River basin (Fish Passage Center data).

Hatchery releases create large returns of adult hatchery origin fish to the Columbia River, many of which are captured in fisheries. The number of adult LCR hatchery fall Chinook returning to the Columbia River from 1980 to 1999 ranged from 40,000 (1999) to 344,100 (1987) and averaged 106,900 adults. From 2000 to 2007, the number of returning LCR hatchery Chinook adults ranged from 27,000 (2000) to 156,400 (2002). The period saw lower returns of LCR wild fall Chinook. From 2000 to 2007, the number of adult LCR wild fall Chinook returning to the mouth of the Columbia River ranged from 4,300 (2007) to 26,000 fish (2003) (Joint Columbia River Management Staff 2008).

- *Loss of population traits, Stray hatchery fish interbreeding with wild fish (7c).*
  Key threat: all LCR fall, late fall and spring Chinook populations

  The prevalence of hatchery fish spawning in local spawning areas (called straying) where they interbreed with wild fish reduces viability of all LCR Chinook populations. As reported in Chapter 4 and described in Appendix C, an analysis of CWT recoveries and hatchery tagging rate information indicates that a substantial proportion of spawners in the population areas are hatchery strays—at

least 90 percent for all LCR fall Chinook populations. Hatchery fish comprise approximately 42 percent of spring Chinook spawners in the Clackamas, 53.6 percent of those in the Sandy, and 90 percent of the spring Chinook on spawning grounds in the Hood River basin (Chapter 4, Table 4-8). Hatchery strays have had a lesser, though still key, effect on the Sandy late-fall Chinook population, with stray rates averaging 24 percent. The limiting factors are generally the same as those described for coho in Section 5.4.5.

5.5.6 Predation

- *Increased predation by birds due to land use practices (8b).*
  Secondary threat: all LCR fall, late fall and spring Chinook populations

  Modification of estuarine habitats has increased the number and/or predation effectiveness of Caspian terns, double-crested cormorants, and a variety of gull species in the Columbia River estuary (LCREP 2006; Fresh et al. 2005). The limiting factors are generally the same as those described for coho in Section 5.4.6.

- *Increased predation by marine mammals due to dam development and flow regulations (8d).*
  Secondary threat: Hood spring Chinook

  Adult spring Chinook destined for the Hood River are affected by predation from marine mammals (sea lions). The sea lions prey on the spring Chinook as they migrate through the lower Columbia River and attempt to pass over Bonneville Dam (USACE 2007). Fall Chinook from Hood River are less impacted by this predation because they usually arrive later when fewer sea lion are present below the dam.

5.6 Limiting Factors and Threats for Lower Columbia River Steelhead

Key and secondary limiting factors and threats that contribute to the current status of Oregon's LCR steelhead populations are in Tables 5-11 and 5-12. A discussion of these threats and factors follows.

Table 5-11. Key and secondary threats and limiting factors to Lower Columbia River winter steelhead.

STEELHEAD (Winter)			Threats and Limiting Factors					
Population	Threat Level	Life History Stages	Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation
Youngs Bay	Key	Adult						
		Juvenile	5c, 6e	3a, 3b, 5b, 6c				
	Secondary	Adult	4c			7b	7c	
		Juvenile	5c, 5e, 6a, 9a	1a, 6e, 9a, 9b, 9c				8b
Big Creek	Key	Adult					7c	
		Juvenile	5c, 6e	3a, 3b, 5b, 6c				
	Secondary	Adult	4c			7b		
		Juvenile	5c, 5e, 6a, 9a	1a, 6e, 9a, 9b, 9c				8b
Clatskanie	Key	Adult						
		Juvenile	6e	3a, 3b, 5b, 6c				
	Secondary	Adult				7b		
		Juvenile	5c, 6b, 9a	1a, 6e, 9a, 9b, 9c, 9d				8b
Scappoose	Key	Adult						
		Juvenile	6e	3a, 3b, 5b, 6c				
	Secondary	Adult				7b		
		Juvenile	5c, 6b, 9a	1a, 6e, 9a, 9b, 9c, 9d				8b
Clackamas	Key	Adult						
		Juvenile	6e	3a, 3b, 5b, 6c				
	Secondary	Adult				7b	7c	
		Juvenile	5c, 6a, 9a, 9b	1a, 6e, 9a, 9b, 9c, 9d	4b			8b
Sandy	Key	Adult					7c	
		Juvenile	6e	3a, 3b, 5b, 6c				
	Secondary	Adult	4a, 4c, 6d			7b		
		Juvenile	5c, 5e, 6a	1a, 6e, 9a, 9b, 9c, 9d				8b
Lower Gorge	Key	Adult	6f					
		Juvenile	6f	3a, 3b, 5b, 6c				
	Secondary	Adult	4c			7b	7c	
		Juvenile	5c, 5f	1a, 6e, 9a, 9b, 9c, 9d				8b
Upper Gorge	Key	Adult	6f, 6g					
		Juvenile	6f, 6g	3a, 3b, 5b, 6c				
	Secondary	Adult	4c		4a	7a, 7b	7c	8d
		Juvenile	1a, 5c, 6g, 8a	1a, 6e, 9a, 9b, 9c, 9d	4a			8b
Hood	Key	Adult						
		Juvenile	5d, 6e	3a, 3b, 5b, 6c				
	Secondary	Adult	4a		4a	7a, 7b	7c	8d
		Juvenile	1a, 5a, 5c, 6a, 6g, 8a, 9a, 9c	1a, 6e, 9a, 9b, 9c, 9d	4a			8b

Table 5-12. Key and secondary threats and limiting factors to Lower Columbia River summer steelhead.

STEELHEAD (Summer)			Threats and Limiting Factors					
Population	Threat Level	Life History Stages	Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation
Hood	Key	Adult					7c	
		Juvenile	5d, 6e	3a, 3b, 5b, 6c				
	Secondary	Adult			4a	7a		8d
		Juvenile	1a, 5a, 5c, 6a, 6g, 8a, 9a, 9c	1a, 6e, 9a, 9b, 9c, 9d	4a			8b

Code	Limiting Factor	Threat
1a	Competition (hatchery fish)	Smolts from all Columbia Basin hatcheries
3a	Food web (reduced macrodetrital inputs)	Columbia Basin hydropower reservoirs, revetments, and disposal of dredge material
3b	Food web (increased microdetrital inputs)	Columbia Basin hydropower reservoirs
4a	Habitat access (impaired passage)	Large dam(s)
4b	Habitat Access (impaired downstream passage)	Large dam(s)
4c	Habitat access (impaired upstream passage)	Hatchery weir
4d	Habitat access (impaired upstream passage)	Road crossings
4e	Habitat access (impaired upstream passage)	Road crossings, small dams, and diversions
5a	Hydrograph/water quantity (altered hydrology)	Low-head hydro diversions
5b	Hydrograph/water quantity (altered hydrology)	Columbia Basin hydropower dams (impaired access to off-channel habitat, dewatering of redds below, and altered plume dynamics, estuarine habitat, and food web)
5c	Hydrograph/water quantity (altered hydrology)	Upslope land uses
5d	Hydrograph/water quantity (altered hydrology: reduced downstream flows)	Irrigation withdrawals (impaired physical habitat, access to habitat)
5e	Hydrograph/water quantity (altered hydrology: reduced downstream flows)	Municipal withdrawals
5f	Hydrograph/water quantity (altered hydrology: reduced downstream flows)	Hatchery withdrawals (impaired passage and reduced habitat)
6a	Physical habitat quality (excessive fine sediment)	Rural roads
6b	Physical habitat quality (excessive fine sediment)	Rural roads and land use
6c	Physical habitat quality (impaired sediment/sand routing)	Columbia Basin hydropower dams
6d	Physical habitat quality (impaired gravel recruitment)	Large dam(s)
6e	Physical habitat quality (impaired habitat complexity and diversity, including access to off-channel habitats)	Past and/or current land use practices
6f	Physical habitat quality (impaired habitat quality and disconnected habitat)	Transportation corridor development and maintenance
6g	Physical habitat quality (reduced habitat quality/quantity)	Inundation from Bonneville
7a	Population traits (impaired abundance and diversity)	Consumptive, targeted fishery
7b	Population traits (impaired abundance and diversity)	Fisheries targeted at other stocks or species
7c	Population traits (impaired productivity and diversity)	Stray hatchery fish interbreeding with wild fish
8a	Predation (non-salmonid fish)	Bonneville Reservoir and Columbia Basin flow regulations
8b	Predation (birds)	Land use practices that create more favorable conditions for Caspian terns and cormorants to prey on salmonid juveniles in estuary
8c	Predation (hatchery fish)	Smolts from all Columbia Basin hatcheries
8d	Predation (marine mammals)	Bonneville Dam and Columbia Basin flow regulations
9a	Water quality (elevated water temperature)	Land uses that impaired riparian condition or reduced steamflows (e.g. water withdrawals for agricultural, industrial, or municipal uses)
9b	Water quality (elevated water temperature)	Large hydropower reservoirs
9c	Water quality (toxins)	Agricultural chemicals used throughout the Columbia Basin
9d	Water quality (toxins)	Urban and industrial practices

The following threats and factors limit viability of Oregon's LCR steelhead populations. Appendix E provides more information on the threats to the different steelhead populations at each life stage.

5.6.1 Tributary Habitat

- *Altered hydrograph/water quantity from upslope land use (5c).*
  Key threat: Youngs Bay and Big Creek winter steelhead
  Secondary threat: all LCR winter and summer steelhead populations

  Altered hydrologic processes and/or reduced water quantity due to land use practices on upland slopes are a key threat to Youngs Bay and Big Creek winter steelhead during the winter parr life stage and a secondary concern for the populations from the egg through summer parr life stages. The altered flows pose a secondary threat to all other LCR winter and summer steelhead populations from the egg through winter parr life stage. The limiting factors are the same as those described for coho in Section 5.4.1. Forest practices have particularly impacted habitat for winter parr in the Youngs Bay and Big Creek watersheds. The drainages contain a large amount of private timber land that has been extensively harvested.

- *Altered hydrograph/water quantity due to irrigation withdrawals (5d).*
  Key threat: Hood winter steelhead; Hood summer steelhead

  Reduced instream flow due to irrigation withdrawals affects juvenile winter and summer steelhead in the Hood River drainage by reducing rearing habitat quality and restricting access to historical habitat areas. The limiting factors are the same as those described for coho in Section 5.4.1.

- *Reduced physical habitat quality/habitat access due to past and/or current land use practices (6e).*
  Key threat: Youngs Bay, Big Creek, Clatskanie, Scappoose, Clackamas, Sandy, and Hood winter steelhead; Hood summer steelhead

  Reduced habitat quality and complexity, and connectivity with off-channel habitats significantly limit juvenile winter and steelhead viability in all population areas, except the Lower Gorge and Upper Gorge population areas. Land use practices such as channelization, diking, wetland conversion, stream clearing, splash damming and gravel extraction have simplified tributary habitat, reducing refugia and resting places. The limiting factors are the same as those described for coho in Section 5.4.1.

- *Degraded physical habitat quality due to transportation corridor development and maintenance (6f).*
  Key threat: Lower Gorge and Upper Gorge winter steelhead

  Activities associated with highway and rail development have degraded habitat quality and connectivity in the Lower Gorge and Upper Gorge winter steelhead population areas. Habitat conditions on lower stream reaches of have particularly been impacted. The limiting factors are the same as those described for coho in Section 5.4.1.

- *Degraded physical habitat quality, inundation from Bonneville Dam (6g).*
  Key threat: Upper Gorge winter steelhead
  Secondary threat: Upper Gorge and Hood winter steelhead; Hood summer steelhead

  Inundation and loss of lowland riparian hardwood communities along the Columbia River has reduces habitat quality for adult and juvenile winter steelhead from the Upper Gorge area. It has also reduced habitat quality for juvenile winter and summer steelhead from Hood River population areas. The limiting factors are the same as those described for coho in Section 5.4.1.

- *Competition with hatchery fish from Columbia River hatcheries (1a).*
  Secondary threat: Upper Gorge and Hood winter steelhead; Hood summer steelhead

  Competition with hatchery fish for limited habitat and food supplies in the mainstem Columbia River estuary, and in the Columbia above Bonneville Dam has reduced juvenile abundance and productivity for Upper Gorge and Hood winter steelhead and Hood summer steelhead. The limiting factors are generally the same as those described for coho in Section 5.4.1.

- *Impaired habitat access due to dam construction and operations (4a).*
  Secondary threat: Sandy and Hood winter steelhead

  The Bull Run water system dams in the Sandy River system and Laurance Lake Dam in the Hood River watershed hinder upstream passage of adult winter steelhead returning to historical spawning areas above the dams in the Sandy and Hood River population areas. The limiting factors for Hood steelhead are generally the same as those described for coho in Section 5.4.1.

- *Reduced habitat access due to hatchery weirs (4c).*
  Secondary threat: Youngs Bay, Big Creek, Sandy, Lower Gorge, and Upper Gorge winter steelhead

  Hatchery weirs in the Youngs Bay, Big Creek, Sandy, Lower Gorge, and Upper Gorge areas impede or prevent winter steelhead access to spawning and rearing habitat that was historically productive. The weirs exist at Klaskanine Hatchery on the North Fork Klaskanine River in the Youngs Bay population area; at Big Creek Hatchery in the Big Creek area; at Sandy Hatchery on Cedar Creek in the Sandy area; at Bonneville Hatchery on Tanner Creek and Cascade Hatchery on Eagle Creek in the Lower Gorge area; and at Oxbow Hatchery on Herman Creek in the Upper Gorge population area. Unmarked steelhead are now passed over the weirs at Klaskanine and Big Creek hatcheries, but may experience a delay in migration as they wait to be passed. Steelhead are not passed above the weirs at Sandy and Bonneville hatcheries. The weir at Cascade Hatchery stops almost all upstream steelhead migration to the area between the dam (RM 0.8) and a natural waterfall at RM 2.0. The fish ladder at the Oxbow Hatchery diversion dam on Herman Creek remains a partial passage barrier, especially at low flows in the fall, and does not meet passage criteria. Approximately two miles of anadromous fish habitat lie upstream of the diversion intake.

- *Altered hydrograph/water quantity due to low head hydro diversions (5a).*
  Secondary threat: Hood winter steelhead; Hood summer steelhead

  Low-head hydro diversions in the Hood River basin impair habitat access and physical habitat quality for juvenile winter and summer steelhead. The limiting factors are generally the same as those described for Chinook in Section 5.3.1.

- *Altered hydrograph/water quantity due to municipal water withdrawals (5e).*
  Secondary threat: Youngs Bay, Big Creek, and Sandy winter steelhead

  Municipal water withdrawals affect juvenile winter steelhead in the Youngs Bay, Big Creek and Sandy watersheds. Youngs Bay winter steelhead are impacted by water withdrawals from the Lewis and Clark River. The river is the primary water source for the City of Warrenton and three of its tributaries (Big South Fork, Little South Fork, and Camp C Creek) serve as secondary sources (Woodward-Clyde 1997). The withdrawals have high potential for dewatering habitat in the Youngs Bay watershed assessment area (Bischoff et al. 2000a).

Big Creek winter steelhead are primarily affected by water withdrawals in the Bear Creek watershed for the City of Astoria's municipal use. Withdrawals from the Bear Creek watershed average 100 percent during the summer low flow periods of June through October (Bischoff et al. 2000c) and occur high in the drainage.

Sandy winter steelhead are impacted by reduced instream flows due to City of Portland water withdrawals. Storage and diversion of water by the Bull Run water supply system alters natural discharge patterns below the dam. The system consists of two storage reservoirs (Dams No. 1 and No. 2) on the Bull Run River, together with an outlet structure on Bull Run Lake, a natural water body near the headwaters. The water supply is an unfiltered water source with the capacity to serve over 800,000 people in the Portland metropolitan area. Municipal uses currently withdraw about 26 percent of the Bull Run River annual flow. Fish may be trapped in isolated mainstem pools below the Headworks Dam when flows decrease as a result of water storage in upstream reservoirs, and may be subject to high mortality due to predation (SRBP 2005).

- *Altered hydrograph/water quantity due to hatchery withdrawals (5f).*
  Secondary threat: Lower Gorge winter steelhead

  Water withdrawals for Bonneville Hatchery reduce stream flows in Tanner Creek below the hatchery. The loss of flow concentrates rearing juvenile fish to remaining habitat areas and can periodically dewater existing redds.

- *Degraded physical habitat quality, excessive fine sediment, due to roads (6a).*
  Secondary threat: Youngs Bay, Big Creek, Clackamas, Sandy and Hood winter steelhead; Hood summer steelhead

  Impaired physical habitat quality due to fine sediment from forest and rural roads affects juvenile winter and summer steelhead abundance and productivity in the Youngs Bay, Big Creek, Clackamas, Sandy, and Hood population areas. The roads have altered sediment routing and led to an overabundance of fine-grained sediments, excess of course-grained sediments, inadequate course-grained sediments, and/or contaminated sediment. Excessive fine sediment reduces egg development and survival during the incubation life stage.

- *Degraded physical habitat quality, excessive fine sediment due to roads and land use (6b).*
  Secondary threat: Clatskanie and Scappoose winter steelhead

  Land use practices and road development on unstable slopes have disrupted natural processes that controlled erosion and sediment routing. As a result, excessive amounts of fine sediment have entered the stream system, reducing the quality of spawning gravels and incubation habitat.

- *Degraded physical habitat quality, impaired gravel recruitment due to large dams (6d).*
  Secondary threat: Sandy winter steelhead

  High quality spawning gravel is limited in portions of the Sandy River and in the Bull Run River below the dams. The limiting factors are the same as those described for Chinook in Section 5.3.1.

- *Predation from non-salmonid fish in Bonneville Reservoir and Columbia River mainstem (8a).*
  Secondary threat: Upper Gorge and Hood winter steelhead; Hood summer steelhead

  Predation by non-salmonid fish in Bonneville Reservoir and the mainstem Columbia River impacts Upper Gorge and Hood winter steelhead, and Hood summer steelhead. Pikeminnows prey on

migrating juvenile steelhead, often congregating at the dam bypass outfall and hatchery release sites to feed on smolts. Walleyes and smallmouth bass also prey on juvenile salmonids.

- *Degraded water quality, elevated water temperatures due to land use practices (9a).*
  Secondary threat: Youngs Bay, Big Creek, Clatskanie, Scappoose, Clackamas, and Hood winter steelhead; Hood summer steelhead

  High summer water temperatures affect juvenile steelhead productivity in the Youngs Bay, Big Creek, Clatskanie, Scappoose, Clackamas and Hood River areas. The temperatures can be lethal, contribute to disease, and/or act as temporary adult migration barriers. The limiting factors are the same as those described for coho in Section 5.4.1.

- *Degraded water quality, elevated water temperatures due to large hydropower reservoirs (9b).*
  Secondary threat: Clackamas winter steelhead

  Water impoundment in reservoirs above Clackamas River hydropower dams results in solar heating and contributes to elevated river water temperatures below the hydropower projects. The elevated summer water temperatures limit juvenile steelhead summer rearing.

- *Degraded water quality, toxins from agricultural sources (9c).*
  Secondary threat: Hood winter steelhead; Hood summer steelhead

  Agricultural chemicals, including organophosphates and other insecticide levels above state water quality standards, impair juvenile steelhead growth and survival in the Hood River drainage. The limiting factors are the same as those described for coho in Section 5.4.1.

5.6.2 Estuary Habitat

- *Altered food web, reduced macrodetrital input due to Columbia Basin hydropower reservoirs, revetments, and disposal of dredge material (3a).*
  Key threat: all LCR winter and summer steelhead populations

  Reduced macrodetrital-based input in the Columbia River estuary significantly affects the viability of all Oregon LCR steelhead populations. The limiting factors are generally the same as those described for coho in Section 5.4.2.

- *Altered food web, increased microdetrital input due to Columbia Basin hydropower reservoirs (3b).*
  Key threat: all LCR winter and summer steelhead populations

  The substitution of the estuary's current microdetrital-based food web, made up of decaying phytoplankton delivered from upstream reservoirs, for the historical macrodetrital-based web has reduced productivity in the estuary. The limiting factors are generally the same as those described for coho in Section 5.4.2.

- *Altered hydrograph/water quantity due to Columbia Basin hydropower dams (5b).*
  Key threat: all LCR winter and summer steelhead populations

  Alteration of the Columbia River hydrograph significantly affects all LCR steelhead populations. The limiting factors are generally the same as those described for coho in Section 5.4.2.

- *Impaired physical habitat quality due to Columbia Basin hydropower dams (6c).*
  Key threat: all LCR winter and summer steelhead populations

  Impaired physical habitat quality in the estuary, especially sediment and sand routing, impacts juveniles in all LCR steelhead populations. The limiting factors are generally the same as those described for coho in Section 5.4.2.

- *Competition with hatchery smolts (1a).*
  Secondary threat: all LCR winter and summer steelhead populations

  Competition with hatchery fish from all Columbia River hatcheries for limited habitat and food supplies in the Columbia River estuary affects productivity of all LCR steelhead populations. The limiting factors are generally the same as those described for coho in Section 5.4.2.

- *Impaired physical habitat quality due to past and/or current land use practices (6e).*
  Secondary threat: all LCR winter and summer steelhead populations

  Physical habitat quality in the Columbia River estuary, including habitat complexity/diversity and loss of access to off-channel habitats, has been degraded through past and current land use practices. The degraded habitat conditions limit viability of all LCR steelhead populations. The limiting factors are generally the same as those described for coho in Section 5.4.2.

- *Degraded water quality, high water temperatures due to land use practices (9a).*
  Secondary threat: all LCR winter and summer steelhead populations

  Land use practices that degrade riparian conditions or reduce streamflows have contributed to elevated water temperatures in the estuary. The limiting factors are generally the same as those described for coho in Section 5.4.2.

- *Degraded water quality, high water temperatures due to large hydropower reservoirs (9b).*
  Secondary threat: all LCR winter and summer steelhead populations

  Elevated water temperatures due to reservoir construction and operations affect juveniles from all LCR steelhead populations. The limiting factors are generally the same as those described for coho in Section 5.4.2.

- *Degraded water quality, toxins from agricultural sources (9c).*
  Secondary threat: all LCR winter and summer steelhead populations

  Contaminants from agricultural practices are found throughout the Columbia River estuary. A wide range of commonly used pesticides have been detected at sampling sites near Bonneville Dam and at the confluence of the Willamette and Columbia rivers (LCREP 2007a,b; Fresh et al. 2005). Short-term exposure to the types of pesticides at environmentally relevant concentrations has been associated with disruption of olfactory function in salmonids; leading to difficulty in homing, predator avoidance, and finding prey (Scholz et al. 2000; Sandahl et al. 2002, 2005; Tierney et al. 2008). Mixtures of some of the pesticides (e.g., malathion and diazinon or chlorpyriphos) may be acutely lethal to salmonids (Laetz et al. 2009). The limiting factors are generally the same as those described for coho in Section 5.4.2.

- *Degraded water quality, toxins from urban and industrial sources (9d).*

Secondary threat: Clatskanie, Scappoose, Clackamas, Sandy, Lower Gorge, Upper Gorge and Hood winter steelhead; Hood summer steelhead

Toxic contaminants in the estuary from urban and industrial practices reduce habitat quality for juvenile steelhead from the Clatskanie, Scappoose, Clackamas, Sandy, Lower Gorge, Upper Gorge and Hood areas. The limiting factors are the same as those described for coho in Section 5.4.2.

5.6.3 Hydropower and Flood Control Management

- *Impaired habitat access due to dam construction and operations (4a).*
  Secondary threat: Upper Gorge and Hood winter steelhead; Hood summer steelhead

  Bonneville Dam impaired adult and juvenile steelhead access to and from habitats in the Upper Gorge and Hood population areas. Operational practices and/or flows can delay upstream passage at the dam. Powerdale Dam on the mainstem Hood River also hinders access of adult steelhead returning to historical spawning areas in the basin above the dam. The limiting factors are generally the same as those described for coho in Section 5.4.3.

- *Impaired habitat access, downstream passage due to dam construction and operations (4b).*
  Secondary threat: Clackamas winter steelhead

  The Clackamas hydropower project on the Clackamas River impairs downstream steelhead passage. Mortality of downstream migrating juveniles occurs at North Fork Dam, Faraday Powerhouse and River Mill Dam. In a DEIS for the Clackamas Hydro Project, FERC (2006) estimated the current average mortality for smolts passing through the hydro complex at 2.7 percent for steelhead. The dams may also delay adult steelhead passage to upriver habitat and reduce spawner success and distribution.

5.6.4 Harvest Management

LCR winter and summer steelhead are not harvested in ocean, but are harvested in the Columbia River (estuary and mainstem above Bonneville) and tributary freshwater fisheries and are affected by direct and incidental fishery mortality. They are also captured incidentally in recreational and gillnet fisheries targeting other stocks in the Columbia River estuary. Impacts on the populations from all freshwater fisheries have averaged roughly 10 percent since the implementation of mark-selective recreational fisheries during the 1990s (NMFS 2008). Most if this is catch and release mortality in tributary fisheries. Mainstem impacts are currently limited to two percent for summer or winter steelhead.

Harvest mortality rates for Clackamas wild steelhead are shown in Figure 5-15. Because of its proximity to a major metropolitan area, the historical harvest rates show for Clackamas steelhead are probably higher than those on steelhead populations in less populated areas. Fishery impact rates on heavily fished steelhead populations in the Portland area were significantly reduced in 1992 with adoption of regulations that prohibit the retention of non-fin clipped fish. As a result, harvest rates on Clackamas wild winter steelhead dropped from a peak of 82 percent in 1968 to the current rate of less than ten percent.

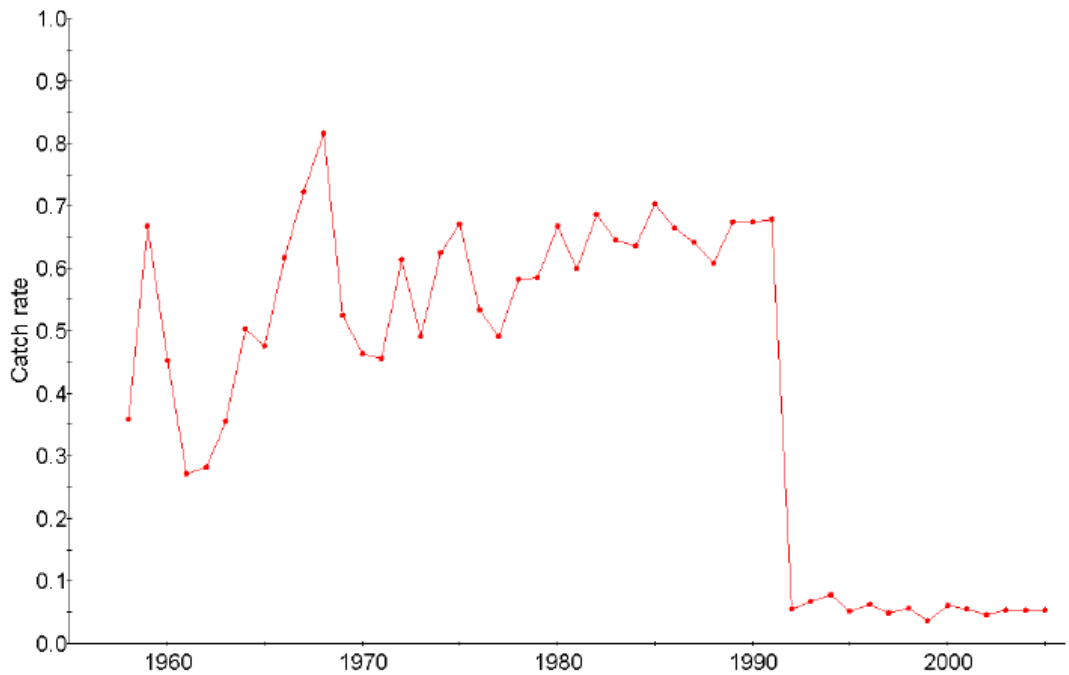


Figure 5-15. Fishery-related morality for Clackamas steelhead population (from McElhany et al. 2007).

- *Loss of population traits due to consumptive, targeted fisheries (7a).*
  Secondary threat: Upper Gorge and Hood winter steelhead; Hood summer steelhead

  Winter and summer steelhead from the Upper Gorge and Hood River areas are affected by fisheries in the Columbia River downstream of Bonneville Dam and in Zone 6 above Bonneville Dam. Direct mortality from the fisheries, which include the Zone 6 gillnet fishery, treaty platform and hook/line fisheries, is considered a secondary concern for the steelhead populations.

  The harvest rate on Upper Gorge and Hood steelhead populations from the treaty Indian fisheries in Zone 6 above Bonneville Dam is approximately five percent. Treaty Indian steelhead harvest is non-mark selective, and takes place in treaty subsistence platform fisheries and in fall gillnet fisheries. Some treaty steelhead harvest also occurs near tributary mouths, including the Hood River. The majority of the fish are caught in the treaty Indian fall season fisheries. Treaty Indian fall fisheries are managed to limit impacts on wild steelhead to no greater than 15 percent based on pre-season run size expectations. Commercial harvest of steelhead by non-Indians has been prohibited since 1975.

- *Loss of population traits due to fisheries targeted at other stocks or species (7b).*
  Secondary threat: all LCR winter steelhead populations

  Incidental mortality of wild winter steelhead in mainstem winter/spring gill and tangle net fisheries is monitored via an onboard observation program. Impacts to wild winter steelhead in this commercial fishery averaged 0.34% during 2005-2009, which is far less than the two percent allowable impact. Incidental winter steelhead mortality in mainstem Columbia River and lower Willamette recreational fisheries is monitored for a majority of the season through a creel program. The estimated impact rate on wild winter steelhead in the mainstem recreational fishery averaged 0.10% during 2005-2009. Wild winter steelhead incidental impact in most tributary recreational fisheries is not directly monitored, but is assumed to average 2-3% (LeFleur and King 2004; NMFS 2005(b); NMFS 2006(b)). These fisheries were listed as a secondary concern for wild winter steelhead because the Planning Team felt there was uncertainty associated with mortality rate estimates. However, the

current combined fisheries impact rate is low enough that it does not threaten the recovery of any steelhead population.

Hood River wild summer steelhead are also subject to incidental harvest in the Columbia and Hood River fisheries. However, harvest is not considered a key or secondary concern for the population. As reported in Chapter 4 (Table 4-8) the total fishery associated mortality rate for wild summer steelhead returning to the Hood River in recent years was 15 percent.

5.6.5 Hatchery Management

Hatcheries in the lower Columbia River region, as well as in other ESUs and DPSs in the Columbia Basin, produce LCR steelhead. In 2004, NMFS estimated that hatchery facilities in Oregon and Washington supported 10 steelhead programs (NMFS 2004). The actual number of artificial production programs changes yearly based on funding and broodstock availability, and today the number of programs producing LCR stocks is somewhat lower (Turner 2008). Table 5-13 shows programs in Oregon that produce steelhead for release in Lower Columbia River drainages. Figure 5-16 shows steelhead hatchery production in the larger Columbia River basin from 1990 to 2007.

Together these artificial production programs release millions of fall Chinook, spring Chinook, coho, chum and steelhead into Lower Columbia River subbasins each year. In 2008, programs for LCR stocks released an estimated 1,416,250 summer steelhead and 2,101,716 winter steelhead into lower Columbia River subbasins (Turner 2008).

Table 5-13. Current hatchery programs in Oregon that produce LCR winter and summer steelhead.

Species	Stratum	Population	Type	Purpose	Hatchery	Stock	Release #	Release Stage
Winter Steelhead	Coastal	Youngs Bay	Segregated	Augmentation	Klaskanine	Big Crk	40,000	smolt
		Big Creek	Segregated	Augmentation	Big Crk, Gnat Crk	Big Crk	100,000	smolt
		Clatskanie	none	---	---	---	---	---
		Scappoose	none	---	---	---	---	---
	Cascade	Clackamas	Integrated	Augmentation	Clackamas, Eagle Crk NFH	Clackamas	165,000	smolt
		Clackamas	Segregated	Augmentation	Eagle Crk NFH	Eagle Crk	100,000	smolt
		Sandy	Integrated	Augmentation	Sandy	Sandy	160,000	smolt
	Gorge	Lower Gorge	none	---	---	---	---	---
		Upper Gorge	none	---	---	---	---	---
		Hood StW	Integrated	Augmentation	Oak Springs	Hood	50,000	smolt
Summer Steelhead	Gorge	Hood StS	none (eliminated)	---	---	---	---	---
	N/A	Clackamas	Segregated	Augmentation	Clackamas	S Santiam	175,000	smolt
		Sandy	Segregated	Augmentation	Sandy	S Santiam	80,000	smolt

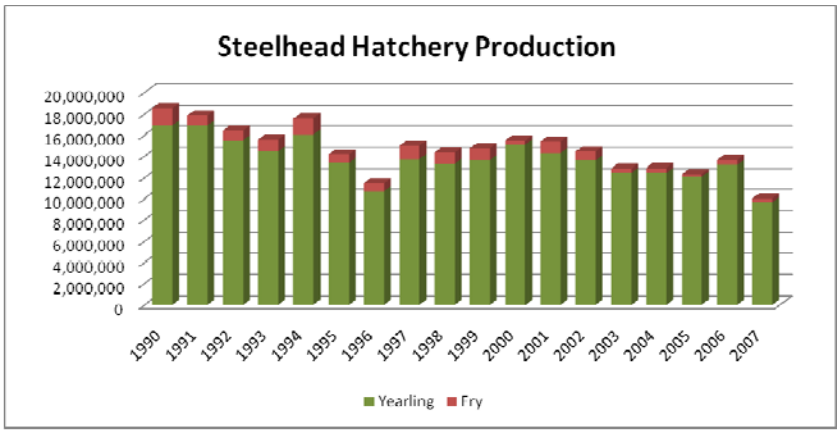


Figure 5-16. Steelhead hatchery production in the Columbia River basin (Fish Passage Center data).

- *Loss of population traits, Stray hatchery fish interbreeding with wild fish (7c).*
  Key threat: Big Creek and Sandy winter steelhead; Hood summer steelhead
  Secondary threat: Youngs Bay, Clackamas, Lower Gorge, Upper Gorge, and Hood winter steelhead

  The prevalence of hatchery fish spawning in local spawning areas (called straying) where they interbreed with wild fish reduces viability of all LCR steelhead populations, with the exception of Clatskanie and Scappoose winter steelhead. The limiting factors related to this threat are generally the same as those described for coho in Section 5.4.5.

  Overall, as reported in Chapter 4 (Table 4-8) the estimated percentage of hatchery strays for the different LCR steelhead populations varies widely, ranging from 53.2 percent for the Hood summer steelhead population to 5 percent for the Clatskanie and Scappoose winter steelhead populations. Hatchery strays are believed to comprise about 40 percent of Big Creek winter steelhead spawners and 52 percent of Sandy winter steelhead spawners. The percentage of hatchery strays in the Youngs Bay, Clackamas, Lower Gorge, Upper Gorge and Hood winter steelhead populations' ranges from 10 percent (Lower and Upper Gorge) to 30 percent (Hood).

  Currently, hatchery steelhead escapement in Hood River is controlled upstream of Powerdale Dam. The ability to remove out-of-basin hatchery-origin fish[29] from the population will be lost at Powerdale Dam after 2010, as the dam will be decommissioned.

5.6.6 Predation

- *Increased predation by birds due to land use practices (8b).*
  Secondary threat: all LCR winter and summer steelhead populations

  Modification of estuarine habitats has increased the number and/or predation effectiveness of Caspian terns, double-crested cormorants, and a variety of gull species in the Columbia River estuary (LCREP 2006; Fresh et al. 2005). For example, new islands formed through the disposal of dredged materials have attracted terns away from their traditional habitats. Reduced sediment in the river has increased terns' efficiency in capturing steelhead juveniles migrating to saltwater at the same time that the birds need additional food for their broods. The limiting factors are generally the same as those described for coho in Section 5.4.6.

[29] Summer steelhead hatchery releases were discontinued in the Hood River 2008.

- *Increased predation by marine mammals due to dam development and flow regulations (8d)*.
  Secondary threat: Upper Gorge, Hood winter steelhead; Hood summer steelhead

  Adult winter steelhead destined for the Upper Gorge and Hood River areas are affected by predation from marine mammals (sea lions) that prey on them as they prepare to pass over Bonneville Dam (USACE 2007). Summer steelhead from Hood River are less impacted by this predation because they usually arrive later when fewer sea lion are present below the dam.

5.7 Limiting Factors and Threats for Columbia River Chum

Key and secondary limiting factors and threats that contribute to the current status of Oregon's CR chum populations are shown in Table 5-14. A discussion of these threats and factors follows.

Table 5-14. Key and secondary threats and limiting factors to Columbia River chum.

CHUM			Threats and Limiting Factors					
Population	Threat Level	Life History Stages	Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation
Youngs Bay	Key	Adult						
		Juvenile		3a, 3b, 5b, 6c				
	Secondary	Adult	4c					
		Juvenile	5c, 6a	6e, 8c, 9a, 9b, 9c				
Big Creek	Key	Adult						
		Juvenile		3a, 3b, 5b, 6c				
	Secondary	Adult	4c					
		Juvenile	5c, 6a	6e, 8c, 9a, 9b, 9c				
Clatskanie	Key	Adult						
		Juvenile		3a, 3b, 5b, 6c				
	Secondary	Adult						
		Juvenile	5c, 6b	6e, 8c, 9a, 9b, 9c, 9d				
Scappoose	Key	Adult						
		Juvenile		3a, 3b, 5b, 6c				
	Secondary	Adult	4e					
		Juvenile	5c, 6b	6e, 8c, 9a, 9b, 9c, 9d				
Clackamas	Key	Adult						
		Juvenile		3a, 3b, 5b, 6c				
	Secondary	Adult	4d					
		Juvenile	5c, 6a	6e, 8c, 9a, 9b, 9c, 9d				
Sandy	Key	Adult						
		Juvenile		3a, 3b, 5b, 6c				
	Secondary	Adult	4d					
		Juvenile	5c, 6a	6e, 8c, 9a, 9b, 9c, 9d				
Lower Gorge	Key	Adult	6f					
		Juvenile	6f	3a, 3b, 5b, 6c				
	Secondary	Adult						
		Juvenile	5c	5b, 6e, 8c, 9a, 9b, 9c, 9d				
Upper Gorge	Key	Adult	6f, 6g		4a			
		Juvenile	6f, 6g	3a, 3b, 5b, 6c	4a			
	Secondary	Adult						
		Juvenile	5c, 8a, 8c	6e, 8c, 9a, 9b, 9c, 9d				

Code	Limiting Factor	Threat
1a	Competition (hatchery fish)	Smolts from all Columbia Basin hatcheries
3a	Food web (reduced macrodetrital inputs)	Columbia Basin hydropower reservoirs, revetments, and disposal of dredge material
3b	Food web (increased microdetrital inputs)	Columbia Basin hydropower reservoirs
4a	Habitat access (impaired passage)	Large dam(s)
4b	Habitat Access (impaired downstream passage)	Large dam(s)
4c	Habitat access (impaired upstream passage)	Hatchery weir
4d	Habitat access (impaired upstream passage)	Road crossings
4e	Habitat access (impaired upstream passage)	Road crossings, small dams, and diversions
5a	Hydrograph/water quantity (altered hydrology)	Low-head hydro diversions
5b	Hydrograph/water quantity (altered hydrology)	Columbia Basin hydropower dams (impaired access to off-channel habitat, dewatering of redds below, and altered plume dynamics, estuarine habitat, and food web)
5c	Hydrograph/water quantity (altered hydrology)	Upslope land uses
5d	Hydrograph/water quantity (altered hydrology: reduced downstream flows)	Irrigation withdrawals (impaired physical habitat, access to habitat)
5e	Hydrograph/water quantity (altered hydrology: reduced downstream flows)	Municipal withdrawals
5f	Hydrograph/water quantity (altered hydrology: reduced downstream flows)	Hatchery withdrawals (impaired passage and reduced habitat)
6a	Physical habitat quality (excessive fine sediment)	Rural roads
6b	Physical habitat quality (excessive fine sediment)	Rural roads and land use
6c	Physical habitat quality (impaired sediment/sand routing)	Columbia Basin hydropower dams
6d	Physical habitat quality (impaired gravel recruitment)	Large dam(s)
6e	Physical habitat quality (impaired habitat complexity and diversity, including access to off-channel habitats)	Past and/or current land use practices
6f	Physical habitat quality (impaired habitat quality and disconnected habitat)	Transportation corridor development and maintenance
6g	Physical habitat quality (reduced habitat quality/quantity)	Inundation from Bonneville
7a	Population traits (impaired abundance and diversity)	Consumptive, targeted fishery
7b	Population traits (impaired abundance and diversity)	Fisheries targeted at other stocks or species
7c	Population traits (impaired productivity and diversity)	Stray hatchery fish interbreeding with wild fish
8a	Predation (non-salmonid fish)	Bonneville Reservoir and Columbia Basin flow regulations
8b	Predation (birds)	Land use practices that create more favorable conditions for Caspian terns and cormorants to prey on salmonid juveniles in estuary
8c	Predation (hatchery fish)	Smolts from all Columbia Basin hatcheries
8d	Predation (marine mammals)	Bonneville Dam and Columbia Basin flow regulations
9a	Water quality (elevated water temperature)	Land uses that impaired riparian condition or reduced steamflows (e.g. water withdrawals for agricultural, industrial, or municipal uses)
9b	Water quality (elevated water temperature)	Large hydropower reservoirs
9c	Water quality (toxins)	Agricultural chemicals used throughout the Columbia Basin
9d	Water quality (toxins)	Urban and industrial practices

The following threats and factors limit viability of Oregon's CR chum populations. Appendix E provides more detail on the threats to the different chum populations at specific life stages.

5.7.1 Tributary Habitat

- *Degraded physical habitat quality due to transportation corridor development and maintenance (6f).*
  Key threat: Lower Gorge and Upper Gorge chum

  Activities associated with highway and rail development have degraded habitat quality and connectivity in the Lower Gorge and Upper Gorge chum population areas. Habitat conditions on lower stream reaches have particularly been impacted. The limiting factors are the same as those described for coho in Section 5.4.1.

- *Degraded physical habitat quality, inundation from Bonneville Dam (6g).*
  Key threat: Upper Gorge chum

Inundation and loss of lowland riparian hardwood communities along the Columbia River has reduces habitat quality for adult and juvenile chum in the Upper Gorge area. The limiting factors are the same as those described for coho in Section 5.4.1.

- *Reduced habitat access due to hatchery weirs (4c).*
  Secondary threat: Youngs Bay and Big Creek chum

  Hatchery weirs in the Youngs Bay and Big Creek population areas impede or prevent chum access to historically productive spawning and rearing habitat. Weirs block chum access at Klaskanine Hatchery on the North Fork Klaskanine River in the Youngs Bay population area; however, it is unclear how much of the upstream habitat is suitable for chum. In the Big Creek area, chum access is blocked by a weir at Big Creek Hatchery. The quantity of chum habitat above this weir is believed to be limited.

- *Reduced habitat access due to road crossings (4d).*
  Secondary threat: Sandy chum

  Barriers at road crossings impede chum passage in several lower Sandy River tributaries. Barriers to chum passage include culverts on Beaver and Buck Creeks in the lower Sandy watershed. The barriers may also restrict winter steelhead and coho access.

- *Altered hydrograph/water quantity from upslope land use (5c).*
  Secondary threat: all CR chum populations

  Altered hydrologic processes and/or reduced water quantity due to land use practices on upland slopes is a concern for all of Oregon's Columbia River chum populations. The limiting factors are the same as those described for coho in Section 5.4.1.

- *Degraded physical habitat quality, excessive fine sediment, due to roads (6a).*
  Secondary threat: Youngs Bay, Big Creek, Clackamas, and Sandy chum

  Impaired physical habitat quality due to fine sediment from forest and rural roads affects chum abundance and productivity in the Youngs Bay, Big Creek, Clackamas and Sandy population areas. The roads have altered sediment routing and led to an overabundance of fine-grained sediments, excess of course-grained sediments, inadequate course-grained sediments, and/or contaminated sediment. Excessive fine sediment reduces egg development and survival during the incubation life stage.

- *Degraded physical habitat quality, excessive fine sediment due to roads and land use (6b).*
  Secondary threat: Clatskanie and Scappoose chum

  Land use practices and road development on unstable slopes have disrupted natural processes that controlled erosion and sediment routing. As a result, excessive amounts of fine sediment have entered the stream system, reducing the quality of spawning gravels and incubation habitat.

- *Predation from non-salmonid fish in Bonneville Reservoir and Columbia River mainstem (8a).*
  Secondary threat: Upper Gorge chum

  Historically, and to the extent that there is any natural production of chum in the Upper Gorge, non-salmonid fish in Bonneville Reservoir and the mainstem Columbia River prey, or have preyed, on

Upper Gorge chum. Pikeminnows prey, or have preyed, on migrating juvenile chum, often congregating at the dam bypass outfall to feed on smolts. Walleyes and smallmouth bass also prey on juvenile salmonids.

- *Predation from hatchery fish (8c).*
  Secondary threat: Upper Gorge chum

  Predation by hatchery smolts in Bonneville Reservoir is a secondary concern for the Upper Gorge chum population. Potential for predation on chum fry by hatchery coho, steelhead, and Chinook can be high when hatchery releases of these species are large.

5.7.2 Estuary Habitat

- *Altered food web, reduced macrodetrital input due to Columbia Basin hydropower reservoirs, revetments, and disposal of dredge material (3a).*
  Key threat: all CR chum populations

  Reduced macrodetrital-based input in the Columbia River estuary has significantly affected the ability of all Oregon CR chum populations to persist or re-establish. The limiting factors are generally the same as those described for coho in Section 5.4.2.

- *Altered food web, increased microdetrital input due to Columbia Basin hydropower reservoirs (3b).*
  Key threat: all CR chum populations

  The substitution of the estuary's current microdetrital-based food web, made up of decaying phytoplankton delivered from upstream reservoirs, for the historical macrodetrital-based web has reduced productivity in the estuary. The limiting factors are generally the same as those described for coho in Section 5.4.2.

- *Altered hydrograph/water quantity due to Columbia Basin hydropower dams (5b).*
  Key threat: all CR chum populations
  Secondary threat: Lower Gorge chum

- Alteration of the Columbia River hydrograph changes the timing and magnitude of spring freshets, and impairs estuarine habitat quality and access. Artificial regulation of flow can stimulate or delay juvenile emigration, thereby affecting the timing of juvenile arrival in the estuary and ocean. Water regulation also affects habitat-forming processes. The limiting factors are generally the same as those described for coho in Section 5.4.2.

  The dewatering of chum redds below Bonneville Dam due to flow fluctuations associated with the hydro system is a secondary concern for Lower Gorge chum, especially in low water years. The fluctuations can dewater chum spawning locations downstream. If redds are dewatered long enough to become desiccated, incubating eggs and/or pre-emergence alevins will die.

- *Impaired physical habitat quality due to Columbia Basin hydropower dams (6c).*
  Key threat: all CR chum populations

  Impaired physical habitat quality in the estuary, especially sediment and sand routing, impacts all CR chum populations. The limiting factors are generally the same as those described for coho in Section 5.4.2.

- *Impaired physical habitat quality due to past and/or current land use practices (6e).*
  Secondary threat: all CR chum populations

  Physical habitat quality in the Columbia River estuary, including habitat complexity/diversity and loss of access to off-channel habitats, has been degraded through past and current land use practices. The degraded habitat conditions limit viability of all CR chum populations. The limiting factors are generally the same as those described for coho in Section 5.4.2.

- *Predation from hatchery fish (8c).*
  Secondary threat: all CR chum populations

  Potential for predation on chum fry by hatchery coho, steelhead, and Chinook can be high when hatchery releases of these species are large (Brewer et al. 2005). This has been well documented for coho smolts in areas outside the lower Columbia River basin (Hunter 1959; Parker 1971; Hargreaves and Lebrasseur 1986). In the case of Columbia River chum, fry likely experience predation from hatchery smolts migrating down the Columbia from the different reaches of the basin. These releases can be large. Releases of coho smolts alone in the Columbia River basin average more than 20 million annually and hatchery releases of Chinook and steelhead throughout the basin also add up to large numbers of fish.

- *Degraded water quality, high water temperatures due to land use practices (9a).*
  Secondary threat: all CR chum populations

  Land use practices that degrade riparian conditions or reduce streamflows have contributed to elevated water temperatures in the estuary. The limiting factors for CR chum are generally the same as those described for coho in Section 5.4.2.

- *Degraded water quality, high water temperatures due to large hydropower reservoirs (9b).*
  Secondary threat: all CR chum populations

  Elevated water temperatures in the lower Columbia River mainstem and estuary due to reservoir construction and operations affect juveniles from all CR chum populations. The limiting factors are generally the same as those described for coho in Section 5.4.2.

- *Degraded water quality, toxins from agricultural sources (9c).*
  Secondary threat: all CR chum populations

  Contaminants from agricultural practices are found throughout the Columbia River estuary. The limiting factors are generally the same as those described for coho in Section 5.4.2.

- *Degraded water quality, toxins from urban and industrial sources (9d).*
  Secondary threat: Clatskanie, Scappoose, Clackamas, Sandy, Lower Gorge and Upper Gorge chum

  Toxic contaminants in the estuary from urban and industrial practices reduce habitat quality for juvenile chum from the Clatskanie, Scappoose, Clackamas, Sandy, Lower Gorge and Upper Gorge areas. The limiting factors are generally the same as those described for coho in Section 5.4.2.

5.7.3 Hydropower and Flood Control Management

- *Impaired habitat access due to dam construction and operations (4a).*
  Key threat: Upper Gorge chum

Bonneville Dam impaired adult and juvenile chum access to and from habitats in the Upper Gorge population area. Operational practices and/or flows can delay upstream passage at the dam. The limiting factors are generally the same as those described for coho in Section 5.4.3.

5.7.4 Harvest Management

Harvest is not considered a limiting factor for CR chum. Harvest on CR chum is limited to incidental fishery mortality. Commercial chum salmon fisheries were closed or drastically minimized in the 1950s due to severe population declines. Currently there are no directed recreational or commercial fisheries in the Columbia River. The number of chum landed as take incidental to the lower river commercial gill net fisheries has been less than 50 fish in each of the last five years. Harvest impacts to chum from Columbia River commercial and recreational fisheries are consistently below 5 percent, and have averaged 1.6 percent since 1998. Ocean fishing mortality on CR chum is assumed to be zero (NMFS 2008). Three factors contribute to the overall low impact of fisheries on CR chum populations: 1) no commercial or recreational fisheries for chum in the estuary or tributaries; 2) fisheries targeting other species most likely only incidentally encounter chum during the early portion of the chum run (in October); and 3) there are very few, if any natural origin chum produced from Oregon streams in the lower Columbia River area.

5.7.5 Hatchery Management

Hatcheries are not considered a key or secondary limiting factor for CR chum. It is unclear if historic hatchery practices influenced chum. Racking the river and removing most chum and taking large percentage for broodstock may have had an effect.

In a 2004 assessment of artificial production programs in Oregon and Washington, NMFS determined that 3 programs produced CR chum (NMFS 2004). None of the programs are in Oregon. Chum hatchery production from 1990 to 2007 is shown in Figure 5-17.

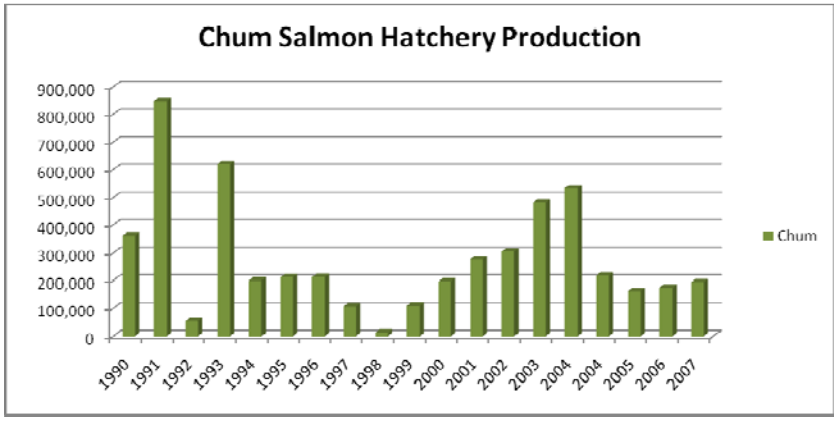


Figure 5-17. Chum hatchery production in the Columbia River basin (Fish Passage Center data).

5.7.6 Predation

As discussed earlier in this section, predation by non-salmonid fish and hatchery salmonids is considered a concern for CR chum.

Chapter 6: Desired Status

Chapter 6 describes the desired status of Oregon's salmon and steelhead populations in the Lower Columbia River Recovery Domain, as well as the approach to achieving the desired status through threat reductions. As noted in Chapter 3, Oregon has two recovery goals, and therefore two levels of desired status: 1) a level that the State of Oregon believes is consistent with ESA delisting and 2) a level consistent with Oregon's vision of broad sense recovery (see Chapter 10).

The first section of this chapter defines a desired status for delisting for each population, which, when looked at in aggregate, constitute a desired status for the ESUs as a whole. The desired statuses are also crafted to meet the delisting recovery criteria. A population's desired status is given as an extinction risk classification, given that the population status analyses in Chapter 4 were conducted in units of extinction risk based on the four VSP parameters.

The second section of this chapter explores threat reduction scenarios for each population. These threat reduction scenarios are used to identify the specific scenario that will be used to achieve the desired status. The scenarios also help elucidate the probability of actually achieving recovery goals for the population, based on an understanding of what it would take to actually address the threats as required by a scenario. Thus, as part of this section, a delisting threat reduction scenario is chosen, and it is assessed as to the confidence of whether it can be achieved.

The last section of this chapter describes a separate population modeling effort conducted to verify that the chosen threat reduction scenarios will achieve the expected extinction risk level and add to the "weight of evidence" that the approach is sound.

6.1 Desired Status to Meet Recovery Goals and Criteria

Desired statuses were chosen to meet the delisting and broad sense recovery criteria outlined in Chapter 3. A population's desired status is given as an extinction risk class, consistent with the analyses for current population status and allowing a comparison between current and desired status. Current and desired statuses were then used in Section 6.2 to identify specific changes in VSP parameters and threat reduction scenarios required for achieving the population's specific desired statuses and detailing the population's status relative to both the biological viability and threat delisting criteria described in Chapter 3.

6.1.1 Desired Status for Delisting

Desired statuses to meet the delisting recovery goal for Oregon salmonid populations also consider populations in Washington because the geographic strata identified by the WLC-TRT (see Chapter 2) include both Oregon and Washington populations and there are strata-level delisting criteria (see Chapter 3). Thus, an iterative process with Washington recovery planners was used to develop desired statuses and extinction risks for each population, based on feasibility of achieving the desired status[30]. For Lower Gorge and Upper Gorge populations, which are shared between Oregon and Washington (i.e., the population boundary crosses the Columbia River), Washington set the delisting recovery desired status given that a greater portion of these populations is in Washington. The sections below outline the manner in which the ESUs achieve delisting criteria by setting extinction risk targets for all populations for coho, Chinook, steelhead, and chum.

[30] Washington uses "population viability" as their unit for defining population status. This is the inverse of extinction risk (i.e., a "very low" viability is the same as a "very high" extinction risk) and uses essentially the same scoring scale (i.e., half numbers from 0.5 to 4.0 for Washington viability scores and whole numbers from 0 to 4 for Oregon extinction risk scores).

Coho

The delisting desired status for LCR coho populations is shown in Figure 6-1 and an analysis of these desired statuses relative to stratum and ESU delisting criteria is shown in Table 6-1. Oregon's general approach to devising the desired status for Oregon coho populations was to achieve a low or very low extinction risk[31] wherever possible based on the current status of the populations and the amount of improvement that the Planning Team deemed as feasible for each population. For the Coast stratum, a within-stratum objective for Oregon populations was to maintain the economic and societal benefits of fisheries targeting hatchery coho from Youngs Bay and Big Creek while minimizing the extinction risk to the Clatskanie and Scappoose populations, where no releases of hatchery coho occur. For the Cascade stratum, the goal for Oregon's two coho populations is to achieve a very low and low extinction risk, respectively. There are only three coho populations within the Gorge stratum. One of these populations is solely in Washington and one is solely in Oregon. The goal for the Oregon population is to achieve a low extinction risk.

Chinook

The delisting desired status for LCR Chinook populations is shown in Figure 6-1 and an analysis of these desired statuses relative to stratum and ESU delisting criteria is shown in Table 6-1. Oregon's general approach to devising the desired status for Oregon fall Chinook populations was to improve populations and reduce extinction risk as much as feasible, while depending on the relatively stronger populations in Washington to attain viability. For the Coast stratum, a within-stratum objective for Oregon fall Chinook populations was to maintain the economic and societal benefits of fisheries targeting hatchery Chinook from Youngs Bay and Big Creek while minimizing the extinction risk to the Clatskanie and Scappoose populations, where no releases of hatchery Chinook occur. For the Cascade stratum, the general approach for late fall Chinook was to improve the already viable population in Oregon (i.e., Sandy late fall Chinook), while the approach for spring Chinook was to achieve a low or very low extinction risk in all populations. Note that Clackamas spring Chinook are included here, although they are not part of the LCR Chinook ESU. For the Gorge spring Chinook stratum, Oregon has targeted a goal of very low extinction risk for the Hood population, but significant challenges remain for the White Salmon population in Washington and unless Washington's desired status for this population is changed, this stratum will not meet delisting criteria[32].

Steelhead

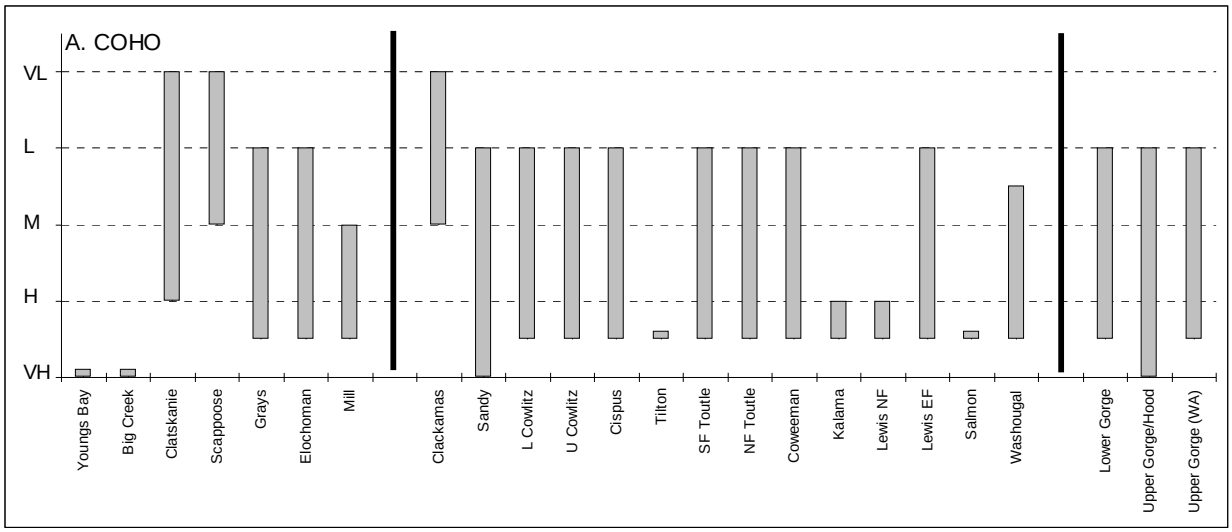
The delisting desired status for LCR steelhead populations is shown in Figure 6-1 and an analysis of these desired statuses relative to stratum and ESU delisting criteria is shown in Table 6-1. Oregon's general approach for steelhead was to achieve a low or very low extinction risk in all but one population. The Coast stratum is not listed under the ESA, but the stratum goals for Oregon broad sense recovery are included here for planning purposes under the State's NFCP. The Upper Gorge winter steelhead population is the only one not targeted for viability, although it is targeted for improvement. This is based on the general difficulty in improving Gorge stratum populations, as discussed later in the chapter.

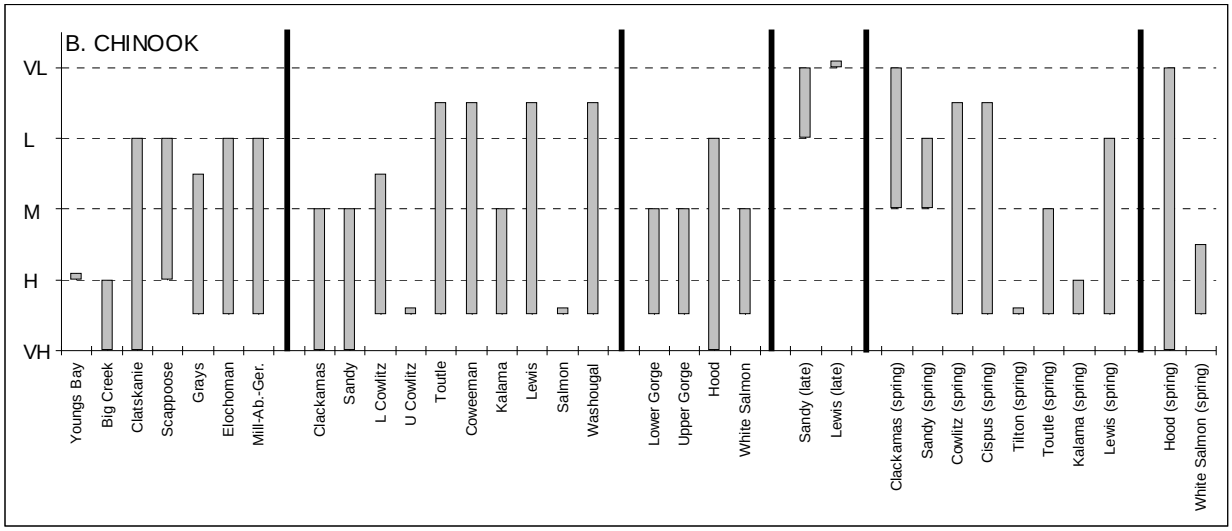
Chum

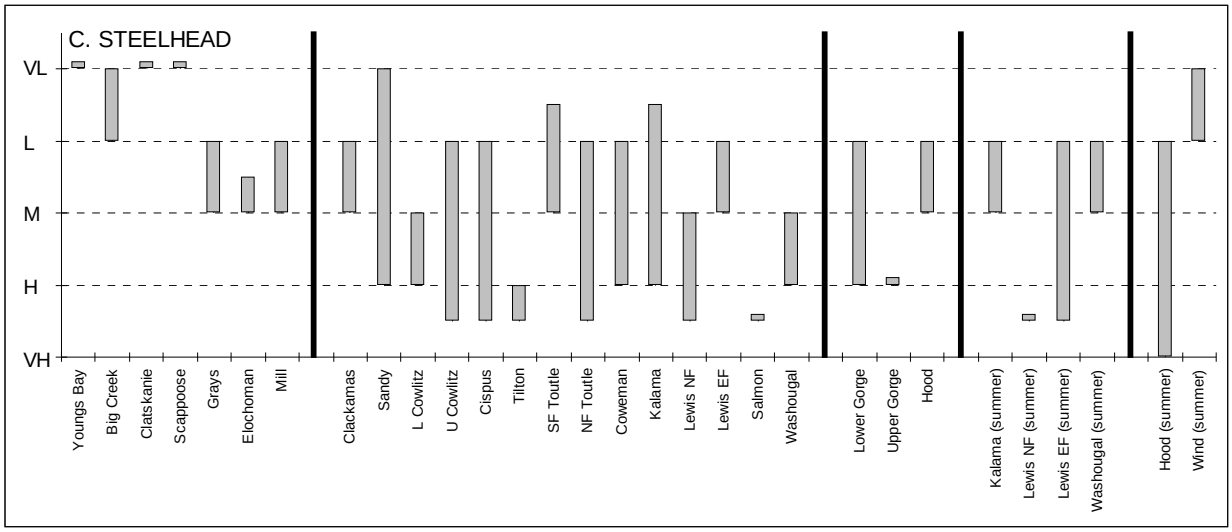
The delisting desired status for CR chum populations is shown in Figure 6-1 and an analysis of these desired statuses relative to stratum and ESU delisting criteria is shown in Table 6-1. Given that chum are considered to be functionally extirpated in Oregon, Oregon set the desired status for populations based on having half of the Oregon populations in a stratum reaching low extinction risk and the others improving significantly. The exceptions to this were Youngs Bay and Big Creek populations, which are likely to

[31] Both the low and very low extinction risk levels are considered "viable" under delisting criteria.
[32] Washington's approach to issues with meeting delisting criteria in the Gorge stratum for all species is to over-compensate within Cascade stratum populations.

stay at a very high extinction risk due to the within-stratum objective to maintain the economic and societal benefits of fisheries on other species that will also likely impact chum.







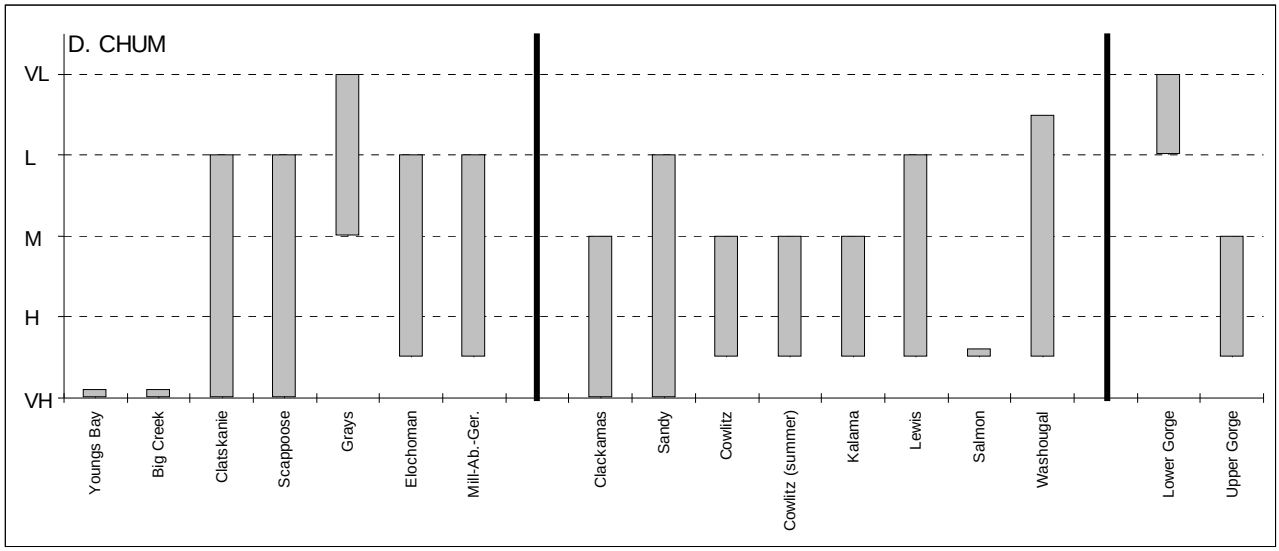


Figure 6-1. Current and desired delisting extinction risk statuses for lower Columbia River populations of A) coho, B) Chinook, C) steelhead, and D) chum. The low end of the bar for each population is in the current extinction risk class and the upper end of the bar is in the desired delisting extinction risk class. Strata are separated by black vertical lines and correspond from left to right to the strata listed in Table 6-1 from top to bottom. "Mill-Ab.-Ger." stands for the Mill-Abernathy-Germany population in Washington. Extinction risk classes on the y-axis are: very low ("VL", score = 4), low ("L", score = 3), moderate ("M", score = 2), high ("H", score = 1), and very high ("VH", score = 0). Oregon and Washington risk classes are based on each state's scoring system, which are described in an earlier footnote.

Table 6-1. Analysis of whether the delisting desired status for populations meets delisting criteria. See Chapter 3 for the strata and ESUs delisting criteria. Red text indicates that a criterion is not being met. Coast winter steelhead are not listed under the ESA and, although included in this table, they are not included in the ESU criteria analysis. Clackamas spring Chinook are not included in this table or analysis. A "?" indicates that a Washington population must either become viable to achieve delisting criteria or their approach of over-compensating for not meeting criteria in one stratum in the next closest stratum must be accepted by NMFS as an alternative criteria. Measures for Oregon populations only are contained in parentheses.

	Populations			Stratum Measures - Desired Status for Delisting						
Species / Stratum (Run)	Oregon	Shared	Total	Viable Populations (Oregon)		Average Score (Oregon)		Non-Viable Pops. Maint.	All Runs Viable	ESU Viability
COHO									NA	Y
Coast	4	0	7	4	(2)	2.29	(2.00)	Y		
Cascade	2	0	14	9	(2)	2.39	(3.50)	Y		
Gorge	1	1	3	3	(1)	3.00	(3.00)	Y		
CHINOOK									Y	?
Coast (Fall)	4	0	7	4	(2)	2.36	(2.00)	Y		
Cascade (Fall)	2	0	10	4	(0)	2.35	(2.00)	Y		
Gorge (Fall)	1	2	4	**1**	**(1)**	2.25	(3.00)	Y		
Cascade (Late Fall)	1	0	2	2	(1)	4.00	(4.00)	Y		
Cascade (Spring)	1	0	7	4	(1)	2.36	(3.00)	Y		
Gorge (Spring)	1	0	2	**1**	**(1)**	2.75	(4.00)	Y		
STEELHEAD									Y	Y
Coast (Winter)	4	0	7	6	(4)	3.50	(4.00)	Y	*(Coast stratum excluded)*	
Cascade (Winter)	2	0	14	9	(2)	2.61	(3.50)	Y		
Gorge (Winter)	1	2	3	2	(1)	2.33	(3.00)	Y		
Cascade (Summer)	0	0	4	3	(N/A)	2.38	(N/A)	Y		
Gorge (Summer)	1	0	2	2	(1)	3.50	(3.00)	Y		
CHUM									N	?
Coast	4	0	7	5	(2)	2.29	(1.50)	Y		
Cascade	2	0	8	3	(1)	2.25	(2.50)	Y		
Gorge	0	2	2	**1**	**(N/A)**	3.00	(N/A)	Y		

With respect to the Gorge stratum, in which, as analyses later in this chapter indicate, it will be difficult to achieve many of the desired statuses to meet delisting criteria, Oregon and Washington took different approaches to setting desired statuses. Oregon set desired statuses for its populations that would meet delisting criteria if achieved, although it will be difficult to do so. Oregon felt it was appropriate to set these high goals because it is required to meet the delisting criteria and because they require improvements that otherwise couldn't be justified (e.g., reduction of hatchery stray rates on spawning grounds). To be conservative, Oregon also set neighboring populations' desired statuses to be viable in order to potentially compensate if goals in the Gorge stratum are not met. Finally, Oregon also believes that the Gorge stratum's population structure should be re-assessed in order to determine whether different criteria should be applied to this area (see Section 2.4, Section 6.2.2's Summary, and Appendix B). Washington took the approach of not setting desired statuses that they did not think were realistic for certain Gorge populations, while focusing on compensation in neighboring populations.

6.2 Population Threat Reduction and VSP Delisting Scenarios

Scenarios are the suite of threat reductions and resulting VSP parameters within a population that are intended to achieve the desired status for that population. In order to do this, mortality rates were assigned to each threat category identified in Chapter 5. This section describes the steps that were taken to develop the threat reduction and VSP scenarios to achieve the desired statuses described in Section 6.1, what the threat reduction options and chosen scenarios were for each population, and how the veracity of scenario results was verified with another population viability model.

6.2.1 Methods

To provide a logical scenario framework for how threat reductions are manifested into different levels of biological viability, the threats identified in Chapter 5 were incorporated into six broad threat categories, and assigned estimates of current mortality rates. The first stage analysis to form projections of how to achieve a future desired state for the populations used scenarios that outlined reductions in mortality across these six broad threat factors, and compared the resulting threat rates and improvement in abundance to the conservation gaps developed from the CATAS model (Chapter 4) to determine the new extinction risk parameters and class to see if the population's desired extinction risk status identified in Section 6.1 was met. Although the CATAS model frames decreases in extinction risk as resulting from increases in survival, closing conservation gaps can conversely be thought of in terms of the mortality reductions needed to achieve desired risk levels for each population. That currency was applied to the scenarios below. Reducing the mortality rates in the threat categories under different combinations made it possible to craft multiple threat reduction and VSP scenarios for a given population that explored specific threat reductions and achieved delisting and broad sense desired statuses. This coupling of the biological and threats criteria discussed in Chapter 3 into a single process is referred to as the "Scenario Analysis".

VSP parameter extinction risk class ratings for different scenarios followed those defined in Chapter 4 for spatial structure and diversity. However, new spatial structure scores were not generally calculated given that large changes in the proportion of lost access to historical habitat were generally not quantified in the Plan. It was also assumed that the productivity criterion was encompassed by the changes required to increase abundance, consistent with reporting them both as one abundance value in Chapter 4. Abundance and productivity extinction risk probabilities were not re-calculated with CATAS for each scenario, but the abundance resulting from the threat reductions was compared to the conservation gaps associated with different extinction risk classes calculated by CATAS in Chapter 4.

An iterative process with Planning Team and resource manager involvement, and based on expert opinion and existing data, was used to outline assumptions regarding the feasibility of reducing mortality rates to prescribed levels for each threat factor. These assumptions were used to formulate sets of threat reduction scenarios that were evaluated by the Planning Team, and a subset of feasible scenarios was presented to the Stakeholder Team to illustrate tradeoffs in threat reductions. The results are the threat reduction scenarios and choices below, which illustrate options for reducing anthropogenic threats to ESA-listed salmonids across several threat categories to achieve a desired risk class for individual populations. A most probable threat reduction and VSP scenario was also developed based on Planning Team input and analyses described below.

Although delisting desired statuses for chum populations in Oregon are described previously, chum were excluded from the Scenario Analysis because they are functionally extirpated in Oregon and it was not possible to calculate conservation gaps or current threat rates for these populations. There is very limited information about the current status of chum salmon in the Oregon populations of the Columbia River ESU. Only a small number of chum are seen spawning regularly in certain locations on the Oregon side of the mainstem Columbia (McElhany et al. 2007). Because of their low numbers, and few studies focused on chum, very little information exists on the quantitative impact of threats to chum salmon in the Lower Columbia. It, therefore, was not possible to determine, through the Scenario Analysis, the likelihood of being able to achieve the delisting goals. Threat reduction scenarios could not be developed. Oregon has identified a strategy to gather more information on chum (see Appendix I) and will utilize this information to refine and further develop recovery actions.

<u>Ocean Impacts</u>

Although there is a large amount of mortality that occurs in the ocean, this was not assessed in our Scenario Analysis, other than as a specific impact in the Harvest threat category. This is because, outside

of the known harvest impacts, ocean mortality was assumed to be part of the natural background mortality, and the Scenario Analysis addressed anthropogenic impacts. Ocean mortality is accounted for in the population viability modeling upon which the Scenario Analysis relied, and it is thus assumed that ocean impacts, along with their short and long term variability, will remain the same into the future. Until recently, this assumption was valid. However, emerging data and new trends (e.g., ocean "dead zones", large scale chemistry shifts, and temperature changes) indicate that ocean impacts in the future may be different than those historically exerted on these species, and they may be due to anthropogenic influences. Given this, ocean impacts are a future critical uncertainty. Despite this, ocean mortality was not directly included as a mortality source in our Scenario Analysis because a) it has not historically been an anthropogenic mortality source, b) the data used by the population viability model (CATAS) to generate our abundance gaps/targets had already accounted for this mortality source, c) the exact future anthropogenic impacts in the ocean are unknown, and d) any regional actions proposed in this plan to reduce the global sources of anthropogenic ocean impacts would likely not be enough to modify the impact rates (i.e., this emerging threat must be addressed at a larger scale).

Addressing Future Threats

A comprehensive evaluation of population status should also include an examination of the threats facing the population with an emphasis on future environmental conditions. Understanding future conditions is necessary to address the stationarity assumption inherent in the biological factor analysis. The stationarity assumption is that the recent past is a reasonable predictor of future fish performance. This assumption would be violated if future environmental conditions are different from the recent past (where "environment" is broadly defined to include anything that affects salmonids). In developing recovery scenarios with the Scenario Analysis, no attempt was made to conduct an assessment of likely future environmental conditions and their predicted impacts on population biological status. Instead, the stationarity assumption was used, but precautionary adjustments were made to the abundance conservation gaps as a way of providing a buffer for these likely future impacts. Although there is uncertainty regarding the magnitude of the future effects of climate change, human population growth[33], and ocean shifts on these salmonid populations, it will likely be negative. Therefore, for each population, a conservation buffer was provisionally embedded in the scenarios by increasing the conservation gap mean abundances by 20 percent (Table 6-3)[34].

[33] Note that localized effects of climate change and human population growth would work through the limiting factors which we have identified in this Plan (e.g., water quality/temperature, hydrograph/water quantity, physical habitat quality).

[34] The 20% increase in the abundance goal for each conservation gap was chosen as a temporary approach to address population growth and climate change. It is currently not possible to accurately estimate the level of productivity loss, if any, that steelhead populations will experience due to these factors. The 20% increase was added to ensure that an increasing trend in population health would occur at the initial implementation of the recovery plan and allow for the science related to identifying the impacts of these factors to evolve. Once a more accurate estimate of the impacts of population growth and climate change can be made, it will be possible to adjust the scenario goals in the recovery plan.

Table 6-2. Revised abundance (with an imbedded productivity) for LCR populations to reach specific extinction risk classes. These abundance levels reflect the current abundance plus a 20% increase (italics) or the current abundance plus the conservation gap identified in Chapter 4 (Table 4-10) plus 20% of the sum of the current abundance plus the conservation gap. If no abundance level is given, then the population's current extinction risk status for abundance and productivity is lower than that risk class. See Chapter 4 for discussion of base values and uncertainties associated with them. Populations shared by Oregon and Washington are indicated by italics and an asterisk; thresholds are for Oregon portion of these populations.

		A&P Conservation Thresholds +20%				
Species / Stratum (Run)	Population	Very High Risk	High Risk	Moderate Risk	Low Risk	Very Low Risk
COHO						
Coast						
	Youngs Bay	*5*	4,004	6,037	9,944	11,778
	Big Creek	*10*	2,251	3,198	5,221	6,253
	Clatskanie	---	*1,636*	2,455	2,932	3,199
	Scappoose	---	---	*2,330*	2,885	3,154
Cascade						
	Clackamas	---	---	*7,858*	8,953	10,138
	Sandy	*1,946*	2,446	3,611	5,134	6,466
Gorge						
	*Lower Gorge**	*26*	962	1,705	2,456	3,085
	Upper Gorge/Hood	*49*	1,976	3,120	5,149	5,485
CHINOOK						
Coast (Fall)						
	Youngs Bay	---	*455*	617	1,243	1,502
	Big Creek	*259*	334	601	1,253	1,458
	Clatskanie	*7*	266	634	1,261	1,441
	Scappoose	---	*427*	620	1,214	1,456
Cascade (Fall)						
	Clackamas	*670*	1,032	1,211	1,822	2,174
	Sandy	*173*	536	721	1,270	1,480
Gorge (Fall)						
	*Lower Gorge**	*89*	240	622	1,224	1,466
	*Upper Gorge**	*20*	251	616	1,208	1,445
	Hood	*40*	545	730	1,240	1,507
Cascade (Late Fall)						
	Sandy	---	---	---	---	*2,153*
Cascade (Spring)						
	Clackamas	---	---	*1,645*	*n / c*	2,317
	Sandy	---	---	*857*	1,229	1,464
Gorge (Spring)						
	Hood	*392*	544	767	1,235	1,472
STEELHEAD						
Coast (Winter)						
	Youngs Bay	---	---	---	---	*2,983*
	Big Creek	---	---	---	*1,372*	1,522
	Clatskanie	---	---	---	---	*2,941*
	Scappoose	---	---	---	---	*3,894*
Cascade (Winter)						
	Clackamas	---	---	*4,676*	10,655	13,552
	Sandy	---	*809*	1,019	1,286	1,510
Gorge (Winter)						
	*Lower Gorge**	---	---	*660*	1,104	1,744
	*Upper Gorge**	*181*	322	610	907	1,297
	Hood	---	---	*1,352*	1,633	2,220
Gorge (Summer)						
	Hood	*42*	808	1,252	1,988	2,614

Current Mortality Estimates

The first step in developing threat reduction scenarios for the Scenario Analysis was to estimate current rates of mortality due to anthropogenic causes associated with the following six major threat categories: tributary habitat, estuary habitat, hydropower, fish harvest, hatchery fish, and estuary predation. The cumulative mortality of these threats represents an anthropogenic mortality rate that is used to calculate the difference between the current and estimated historical abundance of a population. The remaining difference between current and historical abundance is then attributed to anthropogenic alterations to tributary habitat[35]. With mortality rates established for each threat category, rate reductions can be analyzed to achieve the CATAS-derived abundance targets for each risk level. Current threat rates for each threat category and population were developed as described below.

Estuary Habitat and Predation

Based on information presented in the Estuary Module, the mortality rate for coho and steelhead passing through the Columbia River estuary was assumed to be 40 percent for yearly outmigrants, (coho, steelhead, and spring Chinook) and 50 percent for subyearling migrants (fall Chinook and chum salmon). This estimate includes both natural and human related sources of mortality. Since the focus of recovery efforts is on impacts caused by humans, mortality that occurred under pristine conditions was separated from the additional mortality associated with human impacts. To separate natural mortality from human related mortality, the approach of Magnuson and Hilborn (2003) was adapted, wherein the estuarine habitat condition in Oregon and Washington were classified in terms of the percentage of the estuary not impacted by human activity. For fall Chinook (an ocean type or sub-yearling species that spends less than a full year rearing in freshwater), Magnuson and Hilborn (2003) found a relationship between estuary survival rate and proportion of the estuary that was still in a natural state. This relationship predicted that an estuary with no natural habitat left would have a fall Chinook survival rate of only 30 percent relative to fall Chinook migrating through an estuary with no human impacts (this equates to 70 percent of the fall Chinook mortality being due to human impacts in completely degraded estuaries). The same study looked at coho (a stream type or yearling species) and found no relationship between the amount of an estuary in natural condition and survival rate.

In interpreting these results for application to the Columbia estuary it was assumed that: 1) estuary habitat for the Columbia is more degraded than most estuaries examined by Magnuson and Hilborn (2003) and therefore could be viewed as having essentially no remaining natural areas; and 2) the impact of poor estuary habitat on coho probably exists, but perhaps below the level statistically detectable in the Magnuson and Hilborn (2003) study. Based on these assumptions, it was concluded that 70 percent of the mortality estimated for sub-yearling species for the Columbia was likely human related. For coho, steelhead, and yearling Chinook, the difference between the 70 percent impact rate and 0 percent was split to come up with a provisional estimate of 35 percent of the total mortality to be apportioned to human related impacts.

The human related mortality due to estuary habitat was estimated by

$$TEM = M_{total} * F_{human}$$

Where TEM = total estuary mortality due to human related factors, M_{total} = total natural and human mortality rate, by species, (as reported in the Estuary Module), and F_{human} = fraction of total mortality that

[35] The reader should not confuse the difference between current abundance and historical abundance as the conservation gap. Indeed, the conservation gap described above has little relationship to the estimates of historical abundance. The estimates of historical abundance are primarily used as a means to estimate how much a population's tributary habitat has been reduced by human activities. Population viability as estimated via our modeling efforts does not use historical abundance in the viability model's algorithm.

was human related as described above. Solving for this equation results in a human related mortality rate for fall Chinook and chum of 0.70 * 0.50 = 0.35 and for coho, steelhead, and spring Chinook a human related rate of 0.35 * 0.40 = 0.14.

It was necessary to make an additional adjustment to these values because the total estuary mortality impacts reported in the Estuary Module (i.e. 40% for yearlings and 50% for sub-yearlings) included the effects of predation on juveniles. Based on other studies as sources for the total impact of each predator class (Ward et al. 1995; Friesen and Ward 1999; Roby et al. 1998; USFWS 2005; LCREP 2006; Collis et al. 2007; LCFRB 2004; USACE 2005), these rates were adjusted downward to partition out the fraction of the impact that is of human origin. To do this, the same fractions were used as for the habitat calculation (i.e., 0.35 for yearlings and 0.70 for sub-yearlings). Finally, these adjusted predation impacts were removed from the human related estuary habitat impacts using a multiplicative formula rather than a simpler, but incorrect mathematical approach of subtracting the predation impact. The net results of this removal are reflected in the final estimates for human related impacts for estuary habitat (Table 6-4).

The predation impacts were basically a combination of the adjusted predation impacts for terns, cormorants, and pikeminnow and the mortality impacts caused by pinniped predation. For pinnipeds, all of the mortality that occurred at Bonneville Dam was assumed to be human related, whereas for pinniped predation downstream from Bonneville Dam the assumption was that half the estimated impact rate was natural and half was related to changes due to humans. Again, to be mathematically correct it was necessary to combine these various sources of mortality in a multiplicative rather than additive fashion. To accomplish, this mortality rates were converted to survival rates (1 – mortality rate). These survival rates were then all multiplied times each other and the result subtracted from 1 to yield the combined predation impact rate (Table 6-4).

Hydropower
Current hydropower impacts are based on those impacts directly related to the operation of a hydropower facility, and include juvenile mortality due to downstream passage problems and adult mortality due to upstream passage delay or injuries. The impacts of altered streamflows into the Columbia River estuary that are due to the hydropower system are not included in this category, but are instead included in the estimate of estuary habitat impacts. Also, because Bull Run dams are primarily for municipal water withdrawals, their impacts are considered under tributary habitat and not here.

Estimates for juvenile and adult mortality associated with Bonneville Dam were based on values reported in the FCRPS Biological Opinion (NMFS 2008c). Juvenile and adult mortality rates for Marmot Dam on the Sandy River were not available, so professional judgment was used to determine estimates for both. Estimates for juvenile mortality at the Clackamas River Hydropower project were obtained from the Federal Energy Regulatory Commission's Environmental Impact Statement that was developed during the re-licensing process for this facility. Adult mortality estimates due to the Clackamas hydro project were not available, so the adult impacts identified in the Biological Opinion for Bonneville Dam were used as a surrogate. Estimates for juvenile mortality were not available for Powerdale Dam on the Hood River, so the professional judgment of local biologists was used to develop a reasonable estimate. Adult mortality at Powerdale Dam was assumed to be the same as at Bonneville Dam. Table 6-4 shows the estimates of mortality associated with hydropower.

Harvest
Harvest rates are based on those described and used in Chapter 4 for CATAS.

Hatchery
The productivity of naturally reproducing populations, expressed as the number of offspring produced per spawner, has been found to be less in those populations where the long-term average incidence of

hatchery spawners is high. This relationship, initially described by Chilcote (2003) for steelhead and Nickelson (2003) for coho, has recently been confirmed in an unpublished analysis conducted by ODFW for a wider range of populations, including Chinook. The universal feature of this relationship is an inverse relationship between the mean proportion of hatchery fish in natural spawning populations and overall population productivity (Figure 6-2). A more in-depth look at these data suggested that the strength and magnitude of this inverse relationship is less for Chinook than for coho and steelhead, the latter two being quite similar. For example, the reduction in productivity between a population comprised entirely of wild fish and one comprised of equal numbers of hatchery and wild fish is 66 percent for steelhead, 76 percent for coho, and 43 percent for Chinook. Note that the mechanisms behind this relationship merit further investigation, including fitness of various offspring, genotypic and phenotypic responses, hatchery stock origin, hatchery domestication level, amplification of the relationship through time, variance due to spatial or temporal separation of hatchery and wild spawners, and other responses and factors.

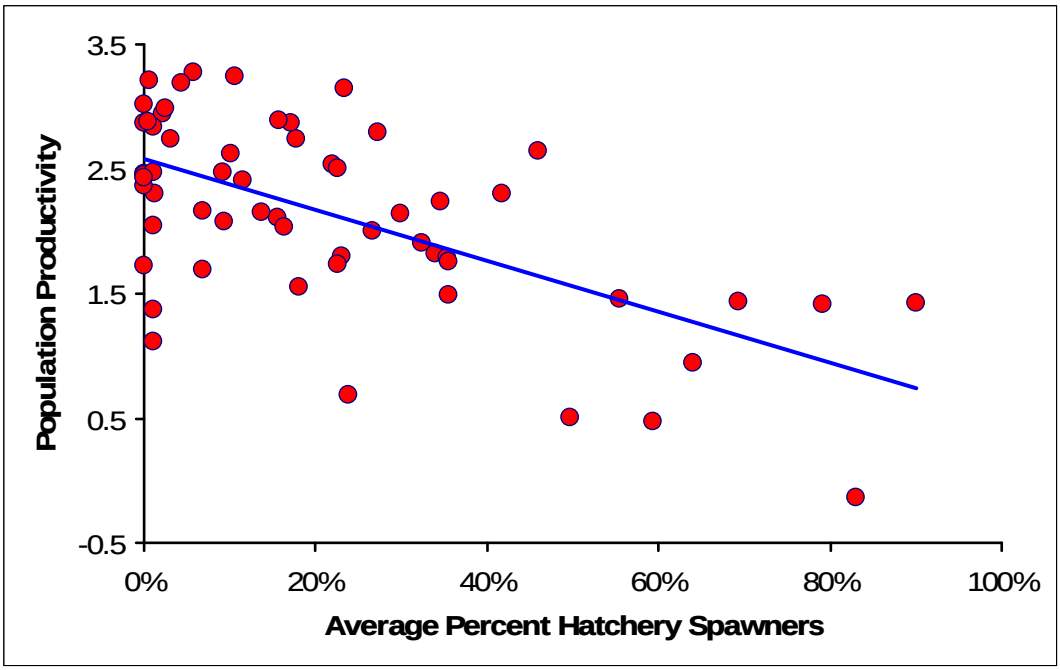


Figure 6-2. Relationship between population productivity, expressed as the natural log of the α parameter in the Beverton-Holt recruitment model, and the mean proportion of the natural spawning population that were hatchery fish for 58 populations of steelhead, coho, and Chinook in Oregon.

Such reductions in productivity can have a substantial impact on a population's ability to survive periods of adverse environmental conditions and to persist over the long-term. Therefore, in those populations with a high proportion of hatchery fish in the natural spawning population the risk of extinction is generally higher. Further, the recovery actions that reduce this proportion of hatchery fish generally will lower the extinction risk. Predicting how much of a reduction would occur with a given reduction in the proportion of hatchery fish is a complicated problem. An evaluation of this question suggests that the relationship is sensitive to both the density of spawners relative to habitat carrying capacity and to base level of hatchery spawners. Essentially the effect on extinction risk is both density (spawners) and frequency (hatchery fish) dependent.

Because of this complexity, several approaches were investigated that would approximate the effect, but be more tractable for the purposes of setting impact rates for scenario modeling. Findings showed that for steelhead and coho, the effects on population extinction risk were similar to assuming the proportion of

hatchery fish in the spawning population was the same as fishery impact rate. In other words, the extinction risk for a population exposed to a 0.50 fishery impact rate was approximately the same as for a population where half of the natural spawners are hatchery fish. Similarly, the benefit of reducing a fishery impact rate from 0.50 to 0.10, in terms of extinction risk, would be the same as reducing the percentage of hatchery spawners from 50 to 10 percent. For Chinook, the hatchery impact rate was assumed to be 50 percent of the 1:1 impact rate assigned to coho and steelhead. For example, if the estimated stray rate was 50 percent, the threat impact was modeled at 25 percent[36]. The estimates of impact rates for each population were based on the stray rates used in Chapter 4, which were based on available data from CWT and spawner surveys (Table 6-4).

Tributary Habitat

Estimates for tributary habitat impacts to salmonids were not available for most populations in the ESUs/DPS. As a result, a provisional method was developed to determine historical tributary impacts for each population by first comparing the populations' estimated current abundance to its estimated historical abundance. The main assumption of this approach is that the difference in abundance from historic to present was equal to the cumulative impact of the six threat categories. For example, a population with a current abundance that is 40 percent of historic has lost 60 percent of its historical abundance. This 60 percent loss represents a cumulative impact to the survival of the population across all six threat categories. Conceptually, this cumulative mortality rate can be represented by the following equation:

$$TCM = 1-((1-EHM)x(1-EPM)x(1-FHM)x(1-HFM)x(1-HPM)x(1-THM))$$

where: TCM = total cumulative mortality = current modeled abundance/historical abundance
EHM = mortality associated with estuary habitat conditions
EPM = mortality associated with predation in the estuary
FHM = mortality associated with fish harvest
HFM = mortality associated with the hatchery fish
HPM = mortality associated with hydropower
THM = mortality associated with tributary habitat conditions

Estimates of historical abundance for the ESU were obtained from NMFS status reviews and the WLC-TRT. To obtain estimates of the historical abundance of individual populations, NMFS estimates of historical kilometers of habitat for each species and population were used to apportion the ESU abundance estimate between all populations. Since, as described previously, estimates of all the variables except THM were available, this equation was used to solve for THM and thereby obtain an estimate of mortality associated with current tributary habitat conditions (Table 6-4)[37].

[36] This excludes Clackamas spring Chinook, which maintained the 1:1 stray to impact rate, as described in the UWR Plan (ODFW, 2010).

[37] Note that ocean mortality is not included in this equation. It is also not rolled into the calculated THM value because it is assumed that ocean conditions cancel out by virtue of being constant over the period since "pristine" conditions formerly existed. See Section 6.2 Ocean Impacts for further discussion.

Table 6-3. Current abundances (from Chapter 4), historical abundances, total cumulative mortality (current abundance / historical abundance), mortality rates for threat categories based on data ("known"), and the calculated threat rate for tributary habitat. Shared populations with Washington are indicated by an asterisk.

					"Known" Threat Rates					Calculated
Species / Stratum (Run)	Population	Current Abundance	Historic Abundance	Cumulative Mortality	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Threat Rate: Tributary Habitat
COHO										
Coast										
	Youngs Bay	4	18,588	0.9998	0.103	0.000	0.900	0.860	0.056	0.9818
	Big Creek	8	10,830	0.9993	0.103	0.000	0.700	0.860	0.056	0.9792
	Clatskanie	1,363	16,781	0.9188	0.103	0.000	0.350	0.130	0.060	0.8297
	Scappoose	1,942	22,164	0.9124	0.103	0.000	0.350	0.050	0.060	0.8317
Cascade										
	Clackamas	6,548	52,565	0.8754	0.103	0.079	0.350	0.350	0.064	0.6187
	Sandy	1,622	19,647	0.9174	0.103	0.040	0.350	0.090	0.064	0.8268
Gorge										
	*Lower Gorge**	22	4,423	0.9950	0.103	0.000	0.350	0.800	0.064	0.9544
	Upper Gorge/Hood	41	8,846	0.9954	0.103	0.269	0.350	0.800	0.073	0.9413
CHINOOK										
Coast (Fall)										
	Youngs Bay	379	15,115	0.9749	0.322	0.000	0.750	0.450	0.056	0.7151
	Big Creek	216	8,785	0.9754	0.322	0.000	0.650	0.450	0.056	0.8004
	Clatskanie	6	14,354	0.9996	0.322	0.000	0.600	0.450	0.065	0.9970
	Scappoose	356	12,515	0.9716	0.322	0.000	0.600	0.450	0.065	0.7960
Cascade (Fall)										
	Clackamas	558	22,554	0.9753	0.322	0.000	0.600	0.450	0.073	0.8211
	Sandy	144	6,237	0.9769	0.322	0.030	0.600	0.450	0.073	0.8279
Gorge (Fall)										
	*Lower Gorge**	74	2,980	0.9752	0.322	0.000	0.600	0.450	0.073	0.8204
	*Upper Gorge**	17	824	0.9794	0.322	0.134	0.650	0.450	0.091	0.7992
	Hood	33	1,391	0.9763	0.322	0.187	0.700	0.450	0.091	0.7130
Cascade (Late Fall)										
	Sandy	1,794	10,000	0.8206	0.309	0.030	0.500	0.250	0.073	0.2301
Cascade (Spring)										
	Clackamas	1,371	27,673	0.9505	0.095	0.272	0.250	0.650	0.121	0.6741
	Sandy	714	26,899	0.9735	0.095	0.080	0.250	0.270	0.121	0.9338
Gorge (Spring)										
	Hood	327	15,041	0.9783	0.095	0.349	0.250	0.450	0.156	0.8940
STEELHEAD										
Coast (Winter)										
	Youngs Bay	2,486	10,396	0.7609	0.095	0.000	0.100	0.200	0.113	0.5863
	Big Creek	1,143	6,057	0.8113	0.095	0.000	0.100	0.400	0.113	0.5647
	Clatskanie	2,451	9,385	0.7388	0.095	0.000	0.100	0.050	0.117	0.6178
	Scappoose	3,245	12,396	0.7382	0.095	0.000	0.100	0.050	0.117	0.6169
Cascade (Winter)										
	Clackamas	3,897	21,186	0.8161	0.095	0.052	0.100	0.230	0.121	0.6480
	Sandy	674	11,687	0.9423	0.095	0.040	0.100	0.520	0.121	0.8252
Gorge (Winter)										
	*Lower Gorge**	550	2,119	0.7404	0.095	0.000	0.100	0.100	0.121	0.5972
	*Upper Gorge**	151	629	0.7599	0.086	0.160	0.150	0.100	0.165	0.5105
	Hood	1,127	3,822	0.7051	0.086	0.358	0.150	0.300	0.165	-0.0115
Gorge (Summer)										
	Hood	35	3,822	0.9908	0.086	0.358	0.150	0.530	0.147	0.9542

As a cross check for this approach to determining the impact of anthropogenic alterations to tributary habitat, the estimates were compared to those estimated by EDT modeling and provided by the City of Portland for Sandy coho, Chinook, and winter steelhead, and reported for Hood Chinook and steelhead in the Hood River Subbasin Plan (Coccoli 2004). The results of these comparisons are shown in Table 6-4. Four out of the nine comparisons showed relatively good agreement between the two modeling approaches (i.e., those above the dashed line). Of these, three showed slightly less impact of tributary habitat conditions under the Scenario Analysis than under the EDT estimates (indicated by a negative difference). In contrast, for four of the comparisons that showed relatively poor agreement between models (i.e., those below the dashed line), the Scenario Analysis approach yielded higher estimates of mortality due to tributary habitat conditions (indicated by a positive difference). This equates to roughly one-half of the time that either the Scenario Analysis overestimates the impact of tributary habitat or EDT underestimates it. Since there is no way of determining which modeling approach is correct, there is some uncertainty surrounding the estimates of mortality associated with tributary habitat conditions.

Table 6-4. Comparison of mortality rates attributable to anthropogenic impacts on tributary habitat as estimated in the Scenario Analysis and by EDT.

Population	Current Threat Estimate	EDT estimate	Difference
Hood CHS	89%	92%	-3%
Sandy Coho	83%	76%	+7%
Sandy late CHF	23%	35%	-12%
Hood CHF	71%	85%	-14%
Sandy STW	83%	54%	+29%
Hood STS	95%	50%	+45%
Sandy CHS	93%	47%	+46%
Sandy CHF	83%	36%	+47%
Hood STW	-1%	74%	-75%

Assumptions and Limitations Applied to Threat Reduction Estimates

Tributary Habitat Threats
Based on the feasible reductions in mortality for the other five threat categories, threat reduction targets for mortality associated with anthropogenic alterations to tributary habitat were based on 1) additional reductions needed to achieve a viability goal for the stratum (population delisting scenarios), or 2) maximum mortality reductions thought to be feasible for broad sense recovery goals for a population. For delisting scenarios, the contribution of mortality reductions in the other threat categories was calculated first, then mortality associated with tributary habitat conditions was decreased to the point where the risk goal was reached.

An underlying uncertainty to using tributary habitat improvements as a restoration tool is whether there is actual potential to improve the habitat to the extent that survival will increase for some specific life stage (see McHugh et al. 2004), and whether this increase represents a large enough proportion in total life cycle survival to produce positive growth rates (Budy and Schaller 2007). Ideally one would first identify a mechanistic link between a specific life stage (example: fry survival) with specific habitat attributes, then attempt to derive a numerical fish response (change in survival rate) to modeled improvements in habitat. At the population level there is an assumption that specific habitat improvements will lead to a cumulative watershed condition where salmonid survival is quantitatively enhanced (Bartz et al. 2005). However, these types of analyses require detailed information on existing habitat conditions for specific populations, and life stage specific survival rates. In the absence of this type of information, the approach was to examine restoration potential using insight from studies in Oregon coastal streams (coho), and use a comparative approach with EDT output for Chinook salmon and steelhead. The main goal with EDT output was to establish upper bounds of the maximum feasible survival improvements.

Context for Tributary Habitat Improvement - Coho
Extensive research on Oregon Coastal Coho populations was used as a way to estimate the number of miles of high quality or moderate quality habitat needed to achieve the desired recovery goals. In those analyses, high quality habitat are capable of producing enough coho smolts to produce an adequate number of adults to fully seed available summer rearing habitat during periods of relatively poor marine survival (i.e. 3 percent). Based on data from coastal Oregon streams, this equates to habitat that can produce ~ 2,800 smolts/mile. Moderate quality

habitat was defined as 2/3 of the productive capacity of high quality habitat (1,866 smolts/mile) and poor quality habitat defined as one-third that of high quality habitat (933 smolts/mile).

Using these smolt production benchmarks, one can estimate the number of miles of low quality habitat that need to be improved to moderate or high quality habitat to produce the number of adult coho needed to achieve recovery goals. To do this, the following formula was used:

$$MHQ = AG/((SHQ - SPQ) * AMS))$$

Where MHQ equals the number of miles of high quality habitat needed to produce a target number of adults; AG = adult goal; SHQ = number of smolts produced from high quality habitat; SPQ = number of smolts produced from low quality habitat; and AMS = average marine survival. For purposes here an average marine survival rate of 5.4 percent was used. Using these values in the equation above results in it taking approximately one mile of high quality habitat (MHQ) to produce 100 more adults from low quality habitat. As an example, if the goal (AG) is to produce an additional 500 adult coho by habitat improvement actions, approximately five miles of low quality habitat would need to be improved to high quality habitat.

A critique of this approach to setting goals for habitat improvement targets for coho recovery is that the smolt production values associated with high, moderate, and low habitat quality are based on data from Oregon coastal streams. While it is probable that the productive capacity of Cascade and Gorge strata streams for coho is different and perhaps lower than coastal streams, the approach is still informative as to the relative amount of habitat improvement needed to achieve recovery goals. If Cascade or Gorge strata streams do not have the productive potential of coastal Oregon streams, than perhaps a restoration goal of creating moderate quality habitat is more appropriate. This will simply result in the need for more miles of habitat improvement in Cascade and Gorge strata streams relative to that required to reach the same adult abundance goals in Coast stratum streams.

Context for Tributary Habitat Improvement - Chinook

It is unknown how well the principles outlined for coho above apply to Chinook salmon. Review of the limiting factors and threats indicates that the major freshwater habitat threats to Chinook salmon are principally poor water quality and substrate conditions in mainstem reaches. This is consistent with the life history characteristic of fall Chinook, which spawn mostly in mainstem reaches and where juveniles migrate as subyearlings. However, predicting the population response (increase in adult spawners) from improvements in mainstem habitat is complex, in part because mainstem habitat conditions are not the result of discrete actions but are influenced by the cumulative effects of conditions upstream. While improvements in upstream areas will presumably have a positive effect on mainstem conditions, their magnitude is unknown. It was assumed that habitat improvements would eventually lead to lower adult pre-spawn mortality and increased early life survival. Where available for specific populations, EDT output was used to estimate improvements in fish survival based on restoration improvements (goals) for which the EDT output were modeled. To apply the EDT output to the Scenario Analysis, it was assumed that increases in the adult and smolt equilibrium abundance from current habitat conditions to projected habitat improvements was the net percent survival improvement. For the Scenario Analysis, the EDT average value of the adult and smolt survival improvements was used to back calculate the mortality reduction these improvements represented. For populations without EDT output, the average juvenile fish survival from those populations where EDT output were available was used.

Context for Tributary Habitat Improvement - Steelhead
The Scenario Analysis approach of determining the tributary habitat impact was compared to the use of EDT analysis to determine loss of tributary habitat survival. Populations in the Hood, Sandy and Clackamas for each ESU have had the EDT analysis performed. The estimates derived from the EDT analysis were comparable in some instances to the estimates generated from the Scenario Analysis approach. In other instances, the EDT estimates are either higher or lower. It is assumed that an approximate 50 percent improvement in survival associated with tributary habitat is the upper limit of what can feasibly be done for steelhead tributary habitat improvement. This assumption is based on what was considered feasible by the Planning Team for coho tributary habitat because of the similar tributary distribution of coho and steelhead. In most cases, the current tributary habitat impact for coho populations was much higher than is seen for most of the steelhead populations. The converse of this is that current survival associated with tributary habitat is much higher for steelhead than coho. As a result, where for coho a doubling of survival was used as the upper limit of feasibility, a doubling for steelhead would result in mortality rates close to pristine. This was not believed to be feasible. The tributary habitat mortality reduction amount associated with a doubling of coho survival appears to be, generally, in the range of 30 to 35 percent. This reduction amount was applied to some of the steelhead populations and generally resulted in a 50 percent increase in survival. This led to the use of 50 percent survival increase as the upper limit for steelhead tributary habitat, which has some uncertainty associated with it given fine scale and/or temporal differences in habitat use between coho and steelhead.

Estuary Habitat Threat
The Estuary Module assumed that feasible estuarine habitat improvements would result in a maximum increase of 20 percent in the number of outmigrants leaving the Columbia River estuary. While the module authors note the difficulty predicting the exact quantitative benefits of estuary actions, for planning purposes, this improvement value was applied for all populations. The current estuary threat estimate is specific for each population, and when the module improvements are applied, the resulting percent survival improvement is slightly different for some populations (see population specific sections below), but for most populations this equates to a reduction of anthropogenic enhanced mortality from 10 percent to 8 percent.

It is the general consensus of the Planning Team that the targeted reduction in mortality related to estuary habitat conditions described for delisting scenarios also represents the maximum feasible improvements for broad sense recovery goals. In addition, the relatively minor impact that estuary habitat conditions represents among all the threats means that further decreasing this threat will have relatively little effect on the status of lower Columbia salmon and steelhead populations.

Hydro Threats
Impacts associated with the Columbia River hydropower system affect all lower Columbia salmon and steelhead populations as they pass through the estuary. As such, reduction in these hydropower impacts are accounted for in the targeted reductions described for estuary habitat conditions (see Estuary Module regarding the threat reductions estimates due to the Columbia River BiOp). Populations above Bonneville Dam are subject to the additional threat that facility represents. Reductions in mortality associated with hydropower projects in tributaries are based on relicensing settlement agreements, or completed or planned removal of projects (i.e. Marmot and Powerdale dams). These mortality reductions associated with hydropower impacts are described under the specific population for which they are targeted.

Harvest Threats
The various ocean, Columbia River and tributary fisheries pose different levels of impact on lower Columbia salmon and steelhead, as well as on the individual populations.

Coho

Current harvest impacts on wild coho occur primarily as incidental mortality related to fin-clip-only fisheries on hatchery coho (selective fisheries) in the ocean and are assumed to affect all populations in the ESU at the same rate. In the Columbia River, sport fisheries operate under fin-clip only regulations, while the commercial gill net fishery does not. However, the gillnet fishery is managed to reduce impacts on wild LCR coho by timing the fishery to target earlier returning hatchery fish and to focus effort on Select Areas such as Youngs Bay and Blind Slough,and Tongue Point, where net pen operations generate large returns of hatchery fish. The impact rate on wild fish passing through these Select Area fisheries (Youngs Bay and Big Creek populations) are subjected to a higher impact rate than other lower Columbia populations. Since most populations are impacted by the same fisheries, it is difficult to manage for different harvest impact goals for different populations. As a result, except for Youngs Bay and Big Creek (populations impacted by terminal coho fisheries), the same impact rate must be used for all coho populations in the LCR coho ESU.

The allowable fisheries impact to wild coho from all fisheries (sport and commercial) may be determined by two harvest matrices, as described in Oregon's 2001 state endangered species management plan for LCR coho (ODFW 2001). The first matrix is for ocean harvest based on PFMC Amendment 13 and the second was developed by Oregon specifically for Columbia River fishery impacts. These harvest matrices utilize a sliding scale that depends on the seeding level of a brood year's parents and the marine survival of that brood year's first summer in the ocean to determine the impact level to wild coho. Higher impacts to wild coho are allowed when parental seeding and marine survival are high, and lower impacts result when seeding and survival are low. In recent years, NMFS has required use of the ocean matrix rather than the combined matrix, which has resulted in even lower annual harvest impacts. See http://www.pcouncil.org/salmon/salfmp/finala13.pdf for a more detailed description of the Amendment 13 harvest matrix.

To assure harvest impacts do not disproportionately impact weaker populations, the matrices could also be based on the concept of "weak stock management", which would entail using a selected weak grouping of populations as the indicator for an abundance-based, sliding scale harvest matrix. With this approach, the allowable impact would be set to protect that weak grouping. Analyses of these harvest matrices have determined that the sliding scale (lower impacts when coho numbers are down and higher levels when numbers are up) combined with a weak stock component would allow for coho populations to rebuild and become abundant.

Approximately 20 million juvenile hatchery coho are currently released each year in the Columbia River. A large proportion of these releases are fin clipped for identification as hatchery fish. These hatchery fish are released to provide harvest opportunities in the ocean and Columbia River. The development of mark-selective fisheries was intended to allow the harvest of these hatchery fish while reducing the impact of these fisheries on wild coho. Because the wild and hatchery coho intermingle in the ocean and upon return to the Columbia River, sport anglers encounter both when trying to catch the hatchery fish. As a result, wild coho are caught and released in the mark-selective fisheries. A percentage of the wild fish caught and released will die from their injuries. This catch and release mortality has been estimated and is used to determine the impact of these mark-selective fisheries on wild coho. To adjust the impact of the fisheries on wild coho, the number of hatchery fish allowed to be caught is adjusted up or down and results in more or less wild coho being caught and released. Generally, as the impact allowed to wild coho goes down, the percentage of hatchery coho in the ocean allowed to be caught also goes down. In addition, the commercial gillnet fishery that takes place in the Columbia is non-

selective in terms of the fish that are caught. Both hatchery and wild fish (clipped and unclipped) are retained. However, as noted earlier, this commercial fishery is shaped in terms of both timing and area to reduce the impact on wild LCR coho.

Since hatchery and wild coho are mixed in the fisheries, no available gear or fishery strategies are currently available to target 100 percent hatchery coho, and thus some wild fish encountered in a fishery, regardless of gear type used, will die. Because of this, it is difficult to completely eliminate incidental mortality of wild coho in fisheries. Not only would all fisheries for hatchery coho need to be terminated, but fisheries on Chinook that also encounter coho would need to be terminated as well. These fisheries occur off the Oregon and Washington coasts, as well as in the Columbia River. Many local economies in these areas would suffer from the loss of sport and commercial fishing opportunities. Because the current harvest management approach using a sliding scale for impacts and weak stock management allows wild coho to rebuild and does not threaten their continued existence, the Plan does not proposed the complete elimination of fishing related mortality to lower Columbia River wild coho.

If the existing single or double fishery matrices are implemented effectively and weak stock management is incorporated into them, a reasonable average impact rate on most LCR wild coho populations over a range of marine survival conditions expected through time would be approximately 25 percent, which was used as the modeled, long-term target value in this chapter for all coho populations except Youngs Bay and Big Creek, where harvest rates of 70 percent and 50 percent, respectively, were used in our analyses (note: in practice, annual harvest levels will still be determined by the abundance-based matrix or matrices and not this long-term rate). When combined with the mortality reductions in the other threat categories, these harvest rates will accomplish the delisting and broad sense recovery goals for LCR coho.

Chinook

As noted above, there are several fisheries that impact fall Chinook, and because they occur in different locations, their cumulative impact on any one population is variable. For example, the Hood and Upper Gorge populations are impacted more by harvest than are other populations due to their longer exposure to fisheries in the mainstem Columbia River. Review with ODFW and NMFS harvest managers suggests that rates on most fall Chinook populations could be reduced from recent historical rates between 60 and 75 percent (as used in Chapter 4) to a 30-45 percent long-term average across populations. This could be accomplished mostly within the Columbia mainstem fisheries through implementing an abundance-based sliding scale harvest matrix based on weak stock management (similar to what is in place and proposed for coho) and, if feasible, a mark-selective fishery in the mainstem Columbia (which would necessitate developing fishing gear and methods that reduce mortality of wild fish). Additional improvements may be realized by reducing incidental mortality from catch and release sport fisheries within the Columbia mainstem and specific basins, by modifying details of the Zone 6 fishery above Bonneville (affecting the Upper Gorge and Hood populations), and by revising hatchery practices to redirect some fisheries to locale-specific terminal fisheries (Youngs Bay and Big Creek). If these actions occur, then the remaining impacts would occur in the non-selective commercial fisheries in the ocean (largely off British Columbia and Alaska). These out-of-jurisdiction impact reductions would require longer-term agreements in a negotiated setting (i.e., PST) with the affected entities, and are currently not being included in this Plan. Selective regulations that target hatchery fall Chinook may eventually be feasible in those areas if marking rates of hatchery fish increase substantially, and it may be possible to further reduce the long-term, average modeled impact on wild fish to < 30-45 percent.

For modeling purposes, an assumption was made that the ocean fishery would continue unaltered, and that, with the changes noted above, harvest impacts from all sources could not be reduced below a 30-45 percent long-term average across populations, which were the rates used as the modeled, long-term target values in this chapter. In order to direct some fisheries away from the upper populations, thereby reducing harvest impacts on those populations, there will be a greater emphasis on terminal fisheries for the Youngs Bay and Big Creek populations. This will constrain the ability to reduce impacts on wild fish returning to these basins. After discussion with fisheries managers, it was thought that a reduction of 5 percent from current rates was feasible for these populations. The current impact from fisheries on wild Spring Chinook is estimated at 25 percent, and retaining these valuable fisheries at this rate was not considered an impediment to their recovery.

Steelhead
Currently, the mortality on wild steelhead from fisheries is associated with some incidental catch during commercial and tribal fisheries and catch-and-release mortality during recreational fisheries on hatchery steelhead. The current mortality impact from fisheries is believed to be low enough that it does not threaten the recovery of any steelhead population. To reduce this impact would require a significant curtailment of the commercial and recreational fisheries mentioned above. These fisheries have considerable social and economic value which would be lost for a relatively small reduction in overall mortality. ODFW has chosen not to identify actions to reduce the impact to wild steelhead from fisheries therefore no impact reduction is identified under the scenarios presented here.

Hatchery Threats
Reducing hatchery stray rates to zero is not feasible for most species and populations without eliminating hatchery production. Given that hatchery fish support almost all fisheries within the lower Columbia River, eliminating hatchery production would also eliminate fisheries which are socially and economically valuable to members of society. For all species, the large number of hatchery fish released within the Columbia basin (~9.7 million coho in 2008) means that eliminating hatchery programs within the lower Columbia ESUs would not completely eliminate hatchery strays, or incidental harvest impacts. Elimination of hatchery programs throughout the Columbia basin would be required to reduce hatchery stray rates to zero.

One possible way to eliminate these out-of-basin hatchery fish would be to operate weirs to remove hatchery fish. One impediment to this in the past has been the lack of 100 percent marking of all hatchery origin fish. Recently agreements have been made to begin marking all hatchery origin coho. While this will theoretically make weirs a possible tool for the removal of hatchery fish from individual population areas, the Planning Team does not believe that it is possible to install weirs that can be operated in all streams under the dynamic streamflow conditions common to lower Columbia rivers. Further, it is likely that some mortality of wild fish will result from them being handled as they are checked for hatchery marks prior to being passed upstream. Handling mortality may present an unacceptable risk in cases where the entire population of wild fish is handled to remove hatchery strays. Weirs also may have localized habitat impacts due to their construction and operation. As a result, some locally released and out-of-basin hatchery fish will most likely continue to spawn at varying levels in lower Columbia populations regardless of actions taken to prevent them short of eliminating all hatchery releases in the Columbia. As discussed in the section on harvest mortality reductions, the complete elimination of hatchery fish in the Columbia basin is not a socially feasible option, and was therefore not modeled to such levels in the scenarios.

This is not to say that the use of weirs or other tools to remove hatchery fish from some areas is not feasible or desirable. Fish removal structures are currently being used to create “wild fish sanctuaries” in

some sub-watersheds and are being proposed as tools to help lower stray rates in other population areas. Challenges remain for reducing stray rates for fall Chinook. Hatchery mark rates are relatively low for these populations, and weirs or other provisions for removing fish would have to be applied within the lower mainstem reaches of basins where these fish spawn. The feasibility of mainstem weirs for fall Chinook is unknown. Ultimately, based on professional judgment, it is believed that the proposed hatchery stray rates at different risk level goals (i.e. 30% for moderate risk, and 10% for low or very low risk) are feasible for most populations, and when combined with other threat reductions outlined in the threat reduction scenarios, will fulfill delisting and broad sense recovery goals.

Predation Threats
The predation reduction goal used in the recovery scenarios is based on the mortality reductions expected from the Caspian Tern Management Plan (USFWS 2005) and the Pikeminnow Reward Program (Beamesderfer et al. 1996. Pinniped control is outlined in NMFS's draft *Environmental Assessment: Reducing the Impact on At-Risk Salmon and Steelhead by California Sea Lions in the Area Downstream of Bonneville Dam on the Columbia River, Oregon and Washington*, with actions primarily directed at reducing the impact of marine mammal predation on spring Chinook and summer steelhead as they pass over Bonneville Dam. The modeled predation reduction rates are slightly different for each population, based on migration timing of yearlings and sub-yearlings, and the relative distance from river of origin. For example, coast stratum populations have a lower mortality rates due to pikeminnow predation than do populations in the Cascade or Gorge strata. For coho and steelhead, the total of the actions identified in the applicable plans equate to an approximate 35 percent and 45 percent reduction (respectively) in the current mortality due to predation that is human influenced. Rates for Chinook represent an approximate 18-55 percent reduction in the current mortality rate due to predation. As with estuary habitat, it is the general consensus of the Planning Team that these reductions in mortality associated with predation is likely the maximum that can be accomplished to alleviate this impact. In addition, the relatively minor impact that predation represents among all the threats means that decreasing predation mortality further will have relatively little effect on the status of lower Columbia River populations.

6.2.2 Population-Specific Scenarios
The following tables show population-specific threat reduction and VSP options and the chosen Delisting Scenario. The key and secondary threats for adults (ocean adults, returning adults, and spawners) and juveniles (all other life stages) identified in Chapter 5 are provided for comparison to current threat rates. Limiting factor codes in the tables can be found in Chapter 5. Note that these two threat identification analyses were conducted independently, based on professional judgment (Chapter 5 information) and data analyses and inference (Chapter 6 rates used in these Scenario Analyses). Historical abundance is indicated in the table, as is the current threat and VSP status. The derivation of current threat statuses was described previously in this chapter. The VSP status was determined in Chapter 4.

The following threat reduction options (i.e., different scenarios from which to choose the Delisting Scenario) were analyzed for each population, unless noted:

a) "20% - All" – a 20 percent reduction in each threat category's current rate,
b) "Max Harvest and Hatchery" – reducing the Harvest and Hatchery threat rates as much as possible (5% for harvest, assuming incidental mortality in some fishery, and 0% for Hatchery, assuming elimination of almost all hatchery programs in the lower Columbia River); the other threat rates were maintained at their current status,
c) "Max Feasible - All" – reducing each threat rate the maximum amount that the Planning Team felt was possible under current biological, social, political, and economic realities,

d) "Min Trib Habitat" – minimizing the amount of tributary habitat reductions, while maximizing the reductions in the other threat categories,

e) "Maintain into Future" – doing the minimum amount necessary to achieve only the 20 percent increase in abundance to meet unknown future threats and maintain the current risk class; threat reductions that will happen outside of a tributary for all populations (e.g., estuary habitat and predation improvements) were applied first,

f) "Low Extinction Risk" – reductions necessary to achieve a low extinction risk class for the population (i.e., viable status), and

g) "Very Low Extinction Risk" – reductions necessary to achieve a very low extinction risk class for the population (i.e., viable status).

Note that threat reduction options a) through d) were based on reducing each threat category a given amount, without respect to the resulting abundance or VSP extinction risk class. Threat reduction options e) through g) were based on threat reductions necessary to achieve a specific abundance or extinction risk class.

As described in the section discussing how tributary threat rates were developed, the threat impacts in the Scenario Analysis are multiplicative (i.e., = 1- ((1-tributary habitat rate) x (1-estuary habitat rate)x(1-hydro rate) x (1-harvest rate) x (1-hatchery rate) x (1-predation rate))[38].

The abundance/productivity VSP parameter for each threat option was determined by comparison to Table 6-3 (derived from the conservation gaps in Chapter 4, plus a 20 percent increase to offset future development and climate change uncertainty). The diversity VSP parameter for each threat option is based on the new threat rates and criteria described in Chapter 4 for this parameter. The spatial structure VSP parameter for each threat rate is almost always the same as the current status risk class for this parameter, because the Scenario Analyses did not quantify large changes in the proportion of lost access to historical habitat for each population, and because the spatial structure parameter is largely addressed by meeting ESU-level criteria of having all strata viable. The derivation of the overall extinction risk class from the component parameters is described in Chapter 4, though it is heavily influenced by the A/P component (which tends to also influence the other components as well).

Finally, the chosen Delisting Scenario for each population is highlighted in light blue and indicated in the "Delisting Scenario" column, with a confidence indicator of whether the desired status can be achieved, and the increase in abundance that is necessary to achieve the Delisting Scenario is also indicated in the A&P Need column (Scenario Abundance minus Current Abundance)[39]. Entries in the "Delisting Scenario" column include "primary" (achieve or maintain a low or very low extinction risk classification), "contributing" (reduce extinction risk one or more classifications, although not to a viable level of low or very low extinction risk), or "stabilizing" (maintain the current non-viable risk class, although with substantive actions and improvements to avoid further degradation and at least cover the 20 percent abundance increase as a buffer for future unknowns). The "Confidence" column contains entries based on Planning Team input of whether the chosen delisting scenario can be achieved with the limitations described previously in this chapter (and indicated in the "Max Feasible – All" scenario option); entries

[38] Note that the simplicity of this analysis and treatment of threats is based on assumptions that all of the threats are density independent and act in some way on separate life stages or sequential groups of fish. In this analysis, we have accepted these simplifying assumptions in order to set imprecise direction for actions necessary to achieve desired statuses. We have tested the validity of this approach by using a more complicated model that allows for density dependence and life stage-specific mortality to verify results of the Scenario Analysis (see Section 6.2.3 for SLAM).

[39] Note that this A&P Need, or gap, is not the same as the conservation gaps identified in Chapter 4, nor the gap between historic and current abundance described previously in this chapter and used to calculate the current cumulative threat mortality and derive the tributary habitat threat rate.

include "achieve" (delisting scenario can be achieved), "exceed" (delist scenario can be exceeded), and "unlikely" (delist scenario is unlikely to be achieved). Note that different threat reduction options may be the same within a population, depending on the specific circumstances of that population.

The tables largely speak for themselves as an exercise in comparing threat reduction options and threat reductions necessary to achieve a given option. Thus, only a minimum of explanatory text, if any, is provided after each table for population-specific nuances. Supporting information for specific table entries can be found in Chapters 4, 5, and this chapter.

Coho

Table 6-5. Threat reduction and VSP scenarios for Youngs Bay coho. The beginning of Section 6.2.2 describes the table contents. Limiting factor codes in the tables can be found in Chapter 5.

Species (Run): **COHO** — Population: **Youngs Bay**

Historic Abundundance: 18,588

Threat Level	Life History Stages	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation
Key	Adult				7a	7c	
	Juvenile	5c, 6e	3a, 3b, 5b, 6c				
Secondary	Adult	4c					
	Juvenile	5c, 6a, 6e, 9a	1a, 6e, 9a, 9b, 9c				8b

		Mortality Rates of Threats: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Cumulative Mortality	% Mortality Improvement	Abundance	VSP Extinction Risk Class: A&P	Diversity	Spatial Structure	Overall	Delisting Scenario	Confidence	A&P Need
Current Status		98.18%	10.30%	0.00%	90.00%	86.00%	5.60%	**99.98%**	---	4	VH	VH	VL	VH	---	---	---
Threat Reduction Options	20% - All	78.54%	8.24%	0.00%	72.00%	68.80%	4.48%	**98.36%**	1.62%	305	VH	VH	VL	VH	---	---	---
	Max Harvest and Hatchery	98.18%	10.30%	0.00%	5.00%	0.00%	5.60%	**98.54%**	1.44%	272	VH	VL	VL	VH	---	---	---
	Max Feasible - All	56.00%	8.00%	0.00%	70.00%	43.00%	3.00%	**93.29%**	6.69%	1,248	VH	VH	VL	VH	---	---	---
	Min Trib Habitat	98.18%	8.00%	0.00%	70.00%	43.00%	3.00%	**99.72%**	0.26%	52	VH	VH	VL	VH	---	---	---
	Maintain into Future	97.00%	8.00%	0.00%	90.00%	86.00%	3.00%	**99.96%**	0.02%	7	VH	VH	VL	VH	Stabilizing	Exceed	3
	Low Extinction Risk	20.00%	8.00%	0.00%	15.00%	10.00%	3.00%	**45.39%**	54.61%	10,152	L	VL	VL	L	---	---	---
	Very Low Extinction Risk	16.00%	8.00%	0.00%	10.00%	5.00%	3.00%	**35.91%**	64.08%	11,913	VL	VL	VL	VL	---	---	---

Due to the very low current abundance of wild coho in Youngs Bay, some actions can and should be implemented to increase their abundance, even though these actions may not technically reduce their risk of extinction. The reduction in mortality associated with tributary habitat under the Max Feasible - All scenario is based upon calculations of the benefit of creating 20 additional miles of high quality habitat[40], or 40 miles of moderate quality habitat[41], for coho (based on the equation MHQ = AG/((SHQ – SPQ) * AMS)) described in Section 6.2.1), which the Planning Team felt was the most that could feasibly be created. A reduction of the impact to wild coho by fisheries targeting hatchery coho is possible through improved management of terminal fisheries. A combination of improved hatchery practices and weirs to remove hatchery strays from selected Youngs Bay streams should reduce the impact of hatchery fish.

[40] Habitat that can produce 2,800 smolts/mile.
[41] Habitat that can produce 1,866 smolts/mile.

Table 6-6. Threat reduction and VSP scenarios for Big Creek coho. The beginning of Section 6.2.2 describes the table contents. Limiting factor codes in the tables can be found in Chapter 5.

Species (Run): **COHO** — Population: **Big Creek**; Historic Abundundance: 10,830

Threat Level	Life History Stages	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation
Key	Adult				7a	7c	
	Juvenile	5c, 6e	3a, 3b, 5b, 6c				
Secondary	Adult	4c					
	Juvenile	5c, 5e, 6a, 6e, 9a	1a, 6e, 9a, 9b, 9c				8b

		Mortality Rates of Threats: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Cumulative Mortality	% Mortality Improvement	Abundance	VSP Extinction Risk Class: A&P	Diversity	Spatial Structure	Overall	Delisting Scenario	Confidence	A&P Need
Current Status		97.92%	10.30%	0.00%	70.00%	86.00%	5.60%	**99.93%**	---	8	VH	H	L	VH	---	---	---
Threat Reduction Options	20% - All	78.34%	8.24%	0.00%	56.00%	68.80%	4.48%	**97.39%**	2.53%	282	VH	H	L	VH	---	---	---
	Max Harvest and Hatchery	97.92%	10.30%	0.00%	5.00%	0.00%	5.60%	**98.33%**	1.60%	181	VH	VL	L	VH	---	---	---
	Max Feasible - All	73.00%	8.00%	0.00%	50.00%	43.00%	3.00%	**93.13%**	6.80%	744	VH	H	L	VH	---	---	---
	Min Trib Habitat	97.92%	8.00%	0.00%	50.00%	43.00%	3.00%	**99.47%**	0.46%	57	VH	H	L	VH	---	---	---
	Maintain into Future	97.00%	8.00%	0.00%	70.00%	86.00%	3.00%	**99.89%**	0.04%	12	VH	H	L	VH	Stabilizing	Exceed	4
	Low Extinction Risk	24.00%	8.00%	0.00%	20.00%	10.00%	3.00%	**51.17%**	48.79%	5,289	L	L	L	L	---	---	---
	Very Low Extinction Risk	19.00%	8.00%	0.00%	15.00%	5.00%	3.00%	**41.63%**	58.34%	6,321	VL	VL	L	VL	---	---	---

Due to the very low current abundance of wild coho in Big Creek, some actions can and should be implemented to increase their abundance, even though these actions may not technically reduce their risk of extinction. The reduction in mortality associated with tributary habitat under the Max Feasible - All scenario is based upon calculations of the benefit of creating 10 additional miles of high quality habitat, or 20 miles of moderate quality habitat, for coho (described in Section 6.2.1), which the Planning Team felt was the most that could feasibly be created. A reduction of the impact to wild coho by fisheries targeting hatchery coho is possible through improved management of terminal fisheries. A combination of improved hatchery practices and weirs to remove hatchery strays from selected Youngs Bay streams should reduce the impact of hatchery fish.

Table 6-7. Threat reduction and VSP scenarios for Clatskanie coho. The beginning of Section 6.2.2 describes the table contents. Limiting factor codes in the tables can be found in Chapter 5.

Species (Run): **COHO** — Population: **Clatskanie**

Historic Abundundance: 16,781

Threat Level	Life History Stages	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation
Key	Adult				7a		
	Juvenile	6e	3a, 3b, 5b, 6c				
Secondary	Adult					7c	
	Juvenile	5c, 6b, 6e, 9a	1a, 6e, 9a, 9b, 9c, 9d				8b

		Mortality Rates of Threats: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Cumulative Mortality	% Mortality Improvement	Abundance	VSP Extinction Risk Class: A&P	Diversity	Spatial Structure	Overall	Delisting Scenario	Confidence	A&P Need
Current Status		82.97%	10.30%	0.00%	35.00%	13.00%	6.00%	**91.88%**	---	1,363	H	M	VL	H	---	---	---
Threat Reduction Options	20% - All	66.38%	8.24%	0.00%	28.00%	10.40%	4.80%	**81.05%**	11.79%	3,180	VL	M	VL	VL	---	---	---
	Max Harvest and Hatchery	82.97%	10.30%	0.00%	5.00%	0.00%	6.00%	**86.36%**	6.01%	2,289	VH	M	VL	VH	---	---	---
	Max Feasible - All	68.00%	8.00%	0.00%	25.00%	10.00%	4.00%	**80.92%**	11.93%	3,201	VL	VL	VL	VL	---	---	---
	Min Trib Habitat	82.97%	8.00%	0.00%	25.00%	10.00%	4.00%	**89.85%**	2.21%	1,704	VH	M	VL	VH	---	---	---
	Maintain into Future	82.97%	8.00%	0.00%	25.00%	13.00%	4.00%	**90.19%**	1.84%	1,647	VH	M	VL	VH	---	---	---
	Low Extinction Risk	70.50%	8.00%	0.00%	25.00%	10.00%	4.00%	**82.41%**	10.30%	2,951	L	VL	VL	L	---	---	---
	Very Low Extinction Risk	68.00%	8.00%	0.00%	25.00%	10.00%	4.00%	**80.92%**	11.93%	3,201	VL	VL	VL	VL	Primary	Achieve	1,838

The reduction in mortality associated with tributary habitat under the Very Low Extinction Risk/Max Feasible - All scenario is based upon calculations of the benefit of creating 19 additional miles of high quality habitat, or 38 miles of moderate quality habitat, for coho (described in Section 6.2.1).

Table 6-8. Threat reduction and VSP scenarios for Scappoose coho. The beginning of Section 6.2.2 describes the table contents. Limiting factor codes in the tables can be found in Chapter 5.

Species (Run): **COHO** — Population: **Scappoose**

Historic Abundundance: 22,164

Threat Level	Life History Stages	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation
Key	Adult				7a		
	Juvenile	6e	3a, 3b, 5b, 6c				
Secondary	Adult						
	Juvenile	5c, 6b, 6e, 9a	1a, 6e, 9a, 9b, 9c, 9d				8b

		Mortality Rates of Threats: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Cumulative Mortality	% Mortality Improvement	Abundance	VSP Extinction Risk Class: A&P	Diversity	Spatial Structure	Overall	Delisting Scenario	Confidence	A&P Need
Current Status		83.17%	10.30%	0.00%	35.00%	5.00%	6.00%	**91.24%**	---	1,942	M	M	L	M	---	---	---
Threat Reduction Options	20% - All	66.54%	8.24%	0.00%	28.00%	4.00%	4.80%	**79.79%**	12.54%	4,478	VL	L	L	VL	---	---	---
	Max Harvest and Hatchery	83.17%	10.30%	0.00%	5.00%	0.00%	6.00%	**86.52%**	5.17%	2,988	L	VL	L	L	---	---	---
	Max Feasible - All	70.00%	8.00%	0.00%	25.00%	5.00%	4.00%	**81.12%**	11.09%	4,184	VL	VL	L	VL	---	---	---
	Min Trib Habitat	83.17%	8.00%	0.00%	25.00%	5.00%	4.00%	**89.41%**	2.00%	2,347	M	M	L	VH	---	---	---
	Maintain into Future	83.17%	8.00%	0.00%	25.00%	5.00%	4.00%	**89.41%**	2.00%	2,347	M	M	L	VH	---	---	---
	Low Extinction Risk	79.25%	8.00%	0.00%	25.00%	5.00%	4.00%	**86.94%**	4.71%	2,894	L	L	L	L	---	---	---
	Very Low Extinction Risk	77.00%	8.00%	0.00%	25.00%	5.00%	4.00%	**85.53%**	6.26%	3,208	VL	VL	L	VL	Primary	Exceed	1,266

To achieve the delist scenario, approximately 10 miles of high quality habitat will need to be created. To achieve the Max Feasible - All scenario, 24 miles of high quality habitat will need to be created (total, not in addition to delist mileage), which is considered the maximum feasible by the Planning Team. If only moderate quality habitat is created, double the number of high quality miles is needed.

Table 6-9. Threat reduction and VSP scenarios for Clackamas coho. The beginning of Section 6.2.2 describes the table contents. Limiting factor codes in the tables can be found in Chapter 5.

Species (Run): **COHO** — Population: **Clackamas**; Historic Abundundance: 52,565

Threat Level	Life History Stages	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation
Key	Adult				7a	7c	
	Juvenile	6e	3a, 3b, 5b, 6c				
Secondary	Adult	9b					
	Juvenile	5c, 6a, 6e, 9a, 9b	1a, 6e, 9a, 9b, 9c, 9d	4b			8b

		Mortality Rates of Threats: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Cumulative Mortality	% Mortality Improvement	Abundance	VSP Extinction Risk Class: A&P	Diversity	Spatial Structure	Overall	Delisting Scenario	Confidence	A&P Need
Current Status		61.87%	10.30%	7.90%	35.00%	35.00%	6.40%	**87.54%**	---	6,548	M	L	VL	M	---	---	---
Threat Reduction Options	20% - All	49.50%	8.24%	6.32%	28.00%	28.00%	5.12%	**78.65%**	10.16%	11,224	VL	L	VL	M	---	---	---
	Max Harvest and Hatchery	61.87%	10.30%	7.90%	5.00%	0.00%	6.40%	**71.99%**	17.77%	14,724	VL	VL	VL	VL	---	---	---
	Max Feasible - All	40.00%	8.00%	6.00%	25.00%	10.00%	4.00%	**66.38%**	24.18%	17,674	VL	VL	VL	VL	---	---	---
	Min Trib Habitat	61.87%	8.00%	6.00%	25.00%	10.00%	4.00%	**78.63%**	10.18%	11,232	VL	VL	VL	VL	---	---	---
	Maintain into Future	61.87%	8.00%	0.00%	25.00%	35.00%	4.00%	**83.58%**	4.52%	8,630	M	L	VL	M	---	---	---
	Low Extinction Risk	61.87%	8.00%	6.00%	35.00%	10.00%	4.00%	**81.48%**	6.92%	9,734	L	VL	VL	L	---	---	---
	Very Low Extinction Risk	61.87%	8.00%	6.00%	25.00%	10.00%	4.00%	**78.63%**	10.18%	11,232	VL	VL	VL	VL	Primary	Exceed	4,684

Taking into account planned reductions in mortality associated with estuary habitat, harvest reductions, and predation (actions implemented at the ESU scale), and reduction of the hatchery stray rate required to meet the desired extinction risk (to below 10 percent), no improvements in tributary habitat conditions are necessary to strictly meet the delisting desired status of very low extinction risk. However, this is based on the modeling approach and it is prudent to both protect and restore habitat to assure healthy, viable populations into the future and account for modeling uncertainty. The Planning Team believes that enough tributary habitat improvements are feasible for coho in the Clackamas to achieve the Max Feasible - All scenario, which requires 61 miles of high quality habitat, or 123 miles of moderate quality habitat, to be created. The number of additional high quality miles needed is approximately one-third of the estimated number of high intrinsic potential stream miles in the Clackamas, and is roughly 11 percent of the total miles historically available to Clackamas coho (see Table 6-39).

Table 6-10. Threat reduction and VSP scenarios for Sandy coho. The beginning of Section 6.2.2 describes the table contents. Limiting factor codes in the tables can be found in Chapter 5.

Species (Run): **COHO** — Population: **Sandy**

Historic Abundundance: 19,647

Threat Level	Life History Stages	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation
Key	Adult				7a		
	Juvenile	6e	3a, 3b, 5b, 6c				
Secondary	Adult	4c					
	Juvenile	5c, 6a, 6e, 9a	1a, 6e, 9a, 9b, 9c, 9d				8b

		Mortality Rates of Threats: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Cumulative Mortality	% Mortality Improvement	Abundance	VSP Extinction Risk Class: A&P	Diversity	Spatial Structure	Overall	Delisting Scenario	Confidence	A&P Need
Current Status		82.68%	10.30%	4.00%	35.00%	9.00%	6.40%	**91.74%**	---	1,622	VH	M	L	VH	---	---	---
Threat Reduction Options	20% - All	66.14%	8.24%	3.20%	28.00%	7.20%	5.12%	**80.94%**	11.78%	3,746	M	L	L	M	---	---	---
	Max Harvest and Hatchery	82.68%	10.30%	4.00%	5.00%	0.00%	6.40%	**86.74%**	5.46%	2,606	H	VL	L	H	---	---	---
	Max Feasible - All	52.00%	8.00%	0.00%	25.00%	9.00%	4.00%	**71.07%**	22.54%	5,685	L	VL	L	L	---	---	---
	Min Trib Habitat	82.68%	8.00%	0.00%	25.00%	9.00%	4.00%	**89.56%**	2.38%	2,051	VH	VL	L	VH	---	---	---
	Maintain into Future	82.68%	8.00%	0.00%	25.00%	9.00%	4.00%	**89.56%**	2.38%	2,051	VH	VL	L	VH	---	---	---
	Low Extinction Risk	52.00%	8.00%	0.00%	25.00%	9.00%	4.00%	**71.07%**	22.54%	5,685	L	VL	L	L	Primary	Achieve	4,063
	Very Low Extinction Risk	45.00%	8.00%	0.00%	25.00%	9.00%	4.00%	**66.85%**	27.14%	6,514	VL	VL	L	VL	---	---	---

EDT modeling for Sandy River coho indicates a current mortality rate of 76 percent due to impaired tributary habitat when compared to pristine conditions. EDT modeling of the actions contained in the City of Portland's Habitat Conservation Plan for the Sandy River indicate that approximately one-third of the tributary habitat mortality reduction necessary to meet the delisting desired status will be achieved through their plan. Contributions by actions in other tributary habitat plans are expected to account for the remaining reductions necessary.

Creating an additional 37 miles of high quality habitat or 74 miles of moderate quality habitat, along with the reductions in mortality targeted for the other threat categories should result in achievement of the delisting goal. The number of additional high quality miles needed is approximately equal to the estimated number of high intrinsic potential stream miles in the Sandy, and is roughly 20 percent of the total miles historically available to Sandy coho (see Table 6-39).

Hydropower impacts have been addressed by the removal of Marmot and Little Sandy Dams.

Table 6-11. Threat reduction and VSP scenarios for Lower Gorge coho. The beginning of Section 6.2.2 describes the table contents. Limiting factor codes in the tables can be found in Chapter 5.

Species (Run): **COHO** — Population: **Lower Gorge**

Historic Abundundance: 4,423

Threat Level	Life History Stages	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation
Key	Adult	6f			7a	7c	
	Juvenile	6f	3a, 3b, 5b, 6c				
Secondary	Adult	4c					
	Juvenile	5c, 5f	1a, 6e, 9a, 9b, 9c, 9d				8b

		Mortality Rates of Threats: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Cumulative Mortality	% Mortality Improvement	Abundance	VSP Extinction Risk Class: A&P	Diversity	Spatial Structure	Overall	Delisting Scenario	Confidence	A&P Need
Current Status		95.44%	10.30%	0.00%	35.00%	80.00%	6.40%	**99.50%**	---	22	VH	VH	VL	VH	---	---	---
Threat Reduction Options	20% - All	76.35%	8.24%	0.00%	28.00%	64.00%	5.12%	**94.66%**	4.86%	236	VH	VH	VL	VH	---	---	---
	Max Harvest and Hatchery	95.44%	10.30%	0.00%	5.00%	0.00%	6.40%	**96.36%**	3.16%	161	VH	L	VL	VH	---	---	---
	Max Feasible - All	63.50%	8.00%	0.00%	25.00%	10.00%	4.00%	**78.24%**	21.37%	962	H	L	VL	H	*Support WA (L)*	Achieve	940
	Min Trib Habitat	95.44%	8.00%	0.00%	25.00%	10.00%	4.00%	**97.28%**	2.23%	120	VH	M	VL	VH	---	---	---
	Maintain into Future	95.44%	8.00%	0.00%	25.00%	80.00%	4.00%	**99.40%**	0.11%	27	VH	VH	VL	VH	---	---	---
	Low Extinction Risk	17.00%	8.00%	0.00%	15.00%	10.00%	4.00%	**43.92%**	55.86%	2,480	L	VL	VL	L	---	---	---
	Very Low Extinction Risk	12.00%	8.00%	0.00%	5.00%	5.00%	4.00%	**29.86%**	69.99%	3,102	VL	VL	VL	VL	---	---	---

Through strategic placement of weirs combined with the future marking of all hatchery coho, the Planning Team believes that the impact of hatchery strays can be reduced from the current 80 percent impact to a 10 percent impact. The Planning Team believes that a target of approximately 10 miles of additional high quality habitat is a reasonable goal for Lower Gorge coho. The number of additional high quality miles needed approximately equals the estimated number of high intrinsic potential stream miles in the Lower Gorge, and is roughly 12 percent of the total miles historically available to Lower Gorge coho (see Table 6-39).

Note that this is a population which lies in both Oregon and Washington. Given that a greater proportion of the area is in Washington, the delisting desired status for this population was set by Washington (indicated in parenthesis in the Delisting Scenario column). VSP risk class information provided in this table is based on the portion of the population in Oregon only. Oregon's goal for this population is to achieve the maximum feasible improvement and support achievement of the delisting goal set by Washington.

Table 6-12. Threat reduction and VSP scenarios for Upper Gorge/Hood coho. The beginning of Section 6.2.2 describes the table contents. Limiting factor codes in the tables can be found in Chapter 5.

Species (Run): **COHO** — Population: **Upper Gorge / Hood**

Historic Abundundance: 8,846

Threat Level	Life History Stages	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation
Key	Adult				7a	7c	
	Juvenile	5d, 6e	3a, 3b, 5b, 6c				
Secondary	Adult	4a		4a			
	Juvenile	1a, 5a, 5c, 6a, 6g, 8a, 9a, 9c	1a, 6e, 9a, 9b, 9c, 9d	4a			8b

		Mortality Rates of Threats: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Cumulative Mortality	% Mortality Improvement	Abundance	VSP Extinction Risk Class: A&P	Diversity	Spatial Structure	Overall	Delisting Scenario	Confidence	A&P Need
Current Status		94.13%	10.30%	26.90%	35.00%	80.00%	7.30%	**99.54%**	---	41	VH	H	VL	VH	---	---	---
Threat Reduction Options	20% - All	75.30%	8.24%	21.52%	28.00%	64.00%	5.84%	**95.66%**	3.89%	384	VH	H	VL	VH	---	---	---
	Max Harvest and Hatchery	94.13%	10.30%	26.90%	5.00%	0.00%	7.30%	**96.61%**	2.94%	300	VH	L	VL	VH	---	---	---
	Max Feasible - All	66.00%	8.00%	23.00%	25.00%	40.00%	5.00%	**89.70%**	9.88%	911	VH	H	VL	VH	---	---	---
	Min Trib Habitat	94.13%	8.00%	23.00%	25.00%	40.00%	5.00%	**98.22%**	1.32%	157	VH	H	VL	VH	---	---	---
	Maintain into Future	94.13%	8.00%	23.00%	25.00%	80.00%	5.00%	**99.41%**	0.13%	52	VH	H	VL	VH	---	---	---
	Low Extinction Risk	8.00%	8.00%	23.00%	5.00%	0.00%	5.00%	**41.18%**	58.63%	5,203	L	VL	VL	L	Primary	Unlikely	5,162
	Very Low Extinction Risk	3.00%	8.00%	23.00%	5.00%	0.00%	5.00%	**37.98%**	61.84%	5,486	VL	VL	VL	VL	---	---	---

The reduction in mortality of Upper Gorge/Hood coho due to hydropower impacts (from 27% to 23%) is based on the removal of Powerdale Dam. Further reduction in hydropower impacts will need to come from reductions of the impact of Bonneville Dam (both passage over the dam and the impacts of inundation of riverine habitat above the dam). So far, no actions have been identified to reduce the impact of Bonneville Dam on Upper Gorge/Hood coho.

Approximately 13 percent of the total stream miles historically available to coho in the Upper Gorge/Hood are High Intrinsic Potential (HIP). This is significantly lower than the percent HIP for Coast stratum populations (41%) or Cascade stratum populations (24%), suggesting that the Upper Gorge/Hood population area was never as productive for coho compared to other areas in the ESU. The Planning Team believes that it may be possible for habitat restoration to create an additional 10 miles of high quality habitat for coho. This is 50 percent of the 20 miles of HIP habitat that occur in the population area (see Table 6-39). To achieve delisting, 53 additional miles of high quality habitat would need to be created.

Also note that the historical abundance may be an overestimate. This was based on IP proportions (described in Section 6.2.1), which need further verification in the Hood. Historically, coho were not likely able to utilize the West Fork due to Punchbowl Falls. The mainstem, East Fork, and Middle Fork has glacial influence which would naturally decrease productivity for fall spawners. Also, most tributary habitat is high gradient and not prime coho habitat.

The Planning Team believes that under the best of circumstances, establishing weirs to prevent hatchery strays from entering selected areas in the Upper Gorge/Hood might result in a reduction of the occurrence of hatchery fish to 40 percent. Reducing the occurrence of hatchery coho into the Upper Gorge/Hood further could theoretically be accomplished by decreasing the number of hatchery fish released from hatcheries outside of the Upper Gorge/Hood area. However, because the number of wild fish currently found in the Upper Gorge/Hood is so low (~40 spawners), it is likely that nearly all out-of-basin hatchery coho releases would have to be eliminated in order to achieve the hatchery stray rates needed to delist this population. In addition, to delist Upper Gorge/Hood coho, this unrealistic reduction in out-of-basin hatchery coho releases would have to be accompanied by an improbable reduction in tributary habitat mortality from 94 to 8 percent. This essentially equates to returning habitat in the Upper Gorge/Hood to pristine conditions.

This is not to say that reductions in out-of-basin hatchery releases would not provide benefits to wild coho in the Upper Gorge/Hood in the future. If actions are implemented to achieve the most probable scenario and wild coho abundance is increased from 40 to 900 adults the relative impact of a fixed number of hatchery strays will diminish, meaning that a reduction in hatchery releases may result in a detectable reduction in the proportion of coho that are of hatchery origin in the Upper Gorge/Hood.

A final note about the apparent inability to reduce mortality to levels needed achieve the extinction risk delisting goal for Upper Gorge/Hood coho is that it is important to remember that the abundance goals established for various extinction risk categories are based to some extent on the gap between current abundance and historical abundance. If the historical abundance of Upper Gorge/Hood coho has been significantly overestimated (which has been suggested by some members of the Planning Team), then the abundance needed to achieve delisting may also be overestimated. The bottom line is that there is no doubt that significant reductions in mortality associated with tributary habitat conditions and hatchery fish impacts will be needed in the Upper Gorge/Hood. The mortality reductions specified for the most probable scenario are significant and, if accomplished, will result in a substantial increase in wild coho in the Upper Gorge/Hood.

The Max Feasible - All scenario option indicates that it is "unlikely" that the chosen Delisting Scenario will be achieved.

Chinook

Table 6-13. Threat reduction and VSP scenarios for Youngs Bay fall Chinook. The beginning of Section 6.2.2 describes the table contents. Limiting factor codes in the tables can be found in Chapter 5.

Species (Run): **CHINOOK (Fall)** — Population: **Youngs Bay**; Historic Abundundance: 15,115

Threat Level	Life History Stages	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation
Key	Adult				7a	7c	
	Juvenile	5c, 6e	3a, 3b, 5b, 6c				
Secondary	Adult	4c					
	Juvenile	5c, 6a	1a, 6e, 9a, 9b, 9c				8b

		Mortality Rates of Threats: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Cumulative Mortality	% Mortality Improvement	Abundance	VSP Extinction Risk Class: A&P	Diversity	Spatial Structure	Overall	Delisting Scenario	Confidence	A&P Need
Current Status		71.51%	32.20%	0.00%	75.00%	45.00%	5.60%	**97.49%**	---	379	H	H	VL	H	---	---	---
Threat Reduction Options	20% - All	57.21%	25.76%	0.00%	60.00%	36.00%	4.48%	**92.23%**	5.40%	1,174	M	H	VL	M	---	---	---
	Max Harvest and Hatchery	71.51%	32.20%	0.00%	5.00%	0.00%	5.60%	**82.68%**	15.20%	2,618	VL	VL	VL	VL	---	---	---
	Max Feasible - All	52.00%	26.00%	0.00%	70.00%	45.00%	4.00%	**94.37%**	3.20%	850	M	H	VL	M	---	---	---
	Min Trib Habitat	71.51%	26.00%	0.00%	70.00%	45.00%	4.00%	**96.66%**	0.85%	505	H	H	VL	H	---	---	---
	Maintain into Future	71.51%	26.00%	0.00%	70.00%	45.00%	4.00%	**96.66%**	0.85%	505	H	H	VL	H	Stabilizing	Exceed	126
	Low Extinction Risk	65.00%	26.00%	0.00%	65.00%	5.00%	4.00%	**91.73%**	5.91%	1,250	L	VL	VL	L	---	---	---
	Very Low Extinction Risk	63.00%	26.00%	0.00%	60.00%	5.00%	4.00%	**90.01%**	7.67%	1,510	VL	VL	VL	VL	---	---	---

Given the proposed emphasis to retain terminal harvest opportunities in Youngs Bay (with the requisite localized hatchery releases), a large proportion of hatchery fish will continue to stray to spawning grounds. Discussions with Planning Team members identified significant challenges to address this issue, including the inability to identify and monitor strays in mainstem spawning areas, and the inability to exclude them from these reaches with weirs or other structures. Given the intense effort directed at hatchery fall Chinook in the Youngs Bay terminal fishery and their entry into the non-selective ocean commercial fishery, there is limited ability to reduce the impact on wild fish in Youngs Bay below 70%.

The reduction of predation to fall Chinook as they migrate through the estuary is based principally on the expected benefits of implementation of the Caspian Tern Management Plan (USFWS 2005).

Under the delisting scenario, when all of the other threat reductions are included in the model, the population remains at high risk without any modeled tributary habitat threat reductions. However, due to uncertainties about the success of those reductions and the magnitude of negative impacts due to climate change and human population growth, it is likely that some tributary habitat improvements will be required to maintain the population at high risk. Using as surrogates the EDT output from the Hood and Sandy populations, where subbasin habitat goals beyond current conditions were identified, it was estimated that a mortality reduction of 28 percent due to tributary habitat improvements was a feasible maximum.

Table 6-14. Threat reduction and VSP scenarios for Big Creek fall Chinook. The beginning of Section 6.2.2 describes the table contents. Limiting factor codes in the tables can be found in Chapter 5.

Species (Run): **CHINOOK (Fall)** — Population: **Big Creek**

Historic Abundundance: 8,785

Threat Level	Life History Stages	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation
Key	Adult				7a	7c	
	Juvenile	5c, 6e	3a, 3b, 5b, 6c				
Secondary	Adult	4c					
	Juvenile	5c, 6a	1a, 6e, 9a, 9b, 9c				8b

		Mortality Rates of Threats: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Cumulative Mortality	% Mortality Improvement	Abundance	VSP Extinction Risk Class: A&P	Diversity	Spatial Structure	Overall	Delisting Scenario	Confidence	A&P Need
Current Status		80.04%	32.20%	0.00%	65.00%	45.00%	5.60%	**97.54%**	---	216	VH	H	L	VH	---	---	---
Threat Reduction Options	20% - All	64.03%	25.76%	0.00%	52.00%	36.00%	4.48%	**92.16%**	5.51%	688	M	H	L	M	---	---	---
	Max Harvest and Hatchery	80.04%	32.20%	0.00%	5.00%	0.00%	5.60%	**87.86%**	9.92%	1,066	M	VL	L	M	---	---	---
	Max Feasible - All	58.00%	26.00%	0.00%	60.00%	45.00%	4.00%	**93.44%**	4.21%	577	H	H	L	H	Contributing	Achieve	361
	Min Trib Habitat	80.04%	26.00%	0.00%	60.00%	45.00%	4.00%	**96.88%**	0.68%	274	VH	H	L	VH	---	---	---
	Maintain into Future	80.04%	26.00%	0.00%	60.00%	45.00%	4.00%	**96.88%**	0.68%	274	VH	H	L	VH	---	---	---
	Low Extinction Risk	57.00%	26.00%	0.00%	50.00%	5.00%	4.00%	**85.49%**	12.35%	1,275	L	M	L	L	---	---	---
	Very Low Extinction Risk	57.00%	26.00%	0.00%	42.00%	5.00%	4.00%	**83.17%**	14.73%	1,479	VL	L	L	VL	---	---	---

Given the proposed emphasis to retain harvest opportunities in the Blind Slough/Knappa Slough Select Area (with the requisite localized hatchery releases), a large proportion of hatchery fish will continue to stray to spawning grounds. Discussions with Planning Team members identified significant challenges to address this issue, including the inability to identify and monitor strays in mainstem spawning areas. Given the intense effort directed at hatchery fall Chinook in this area and their entry into the non-selective ocean commercial fishery, there is limited ability to reduce the impact on wild fish in the Big Creek population below 60 percent.

The reduction of predation to fall Chinook as they migrate through the estuary is based principally on the expected benefits of implementation of the Caspian Tern Management Plan (USFWS 2005).

Using as surrogates the EDT output from the Hood and Sandy populations, where subbasin habitat goals beyond current conditions were identified, it was estimated that a mortality reduction of 28 percent due to tributary habitat improvements was a feasible maximum.

Table 6-15. Threat reduction and VSP scenarios for Clatskanie fall Chinook. The beginning of Section 6.2.2 describes the table contents. Limiting factor codes in the tables can be found in Chapter 5.

Species (Run): **CHINOOK (Fall)** — Population: **Clatskanie**; Historic Abundundance: 14,354

Threat Level	Life History Stages	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation
Key	Adult				7a	7c	
	Juvenile	6e	3a, 3b, 5b, 6c				
Secondary	Adult						
	Juvenile	5c, 6b	1a, 6e, 9a, 9b, 9c, 9d				8b

		Mortality Rates of Threats: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Cumulative Mortality	% Mortality Improvement	Abundance	VSP Extinction Risk Class: A&P	Diversity	Spatial Structure	Overall	Delisting Scenario	Confidence	A&P Need
Current Status		99.70%	32.20%	0.00%	60.00%	45.00%	6.50%	**99.96%**	---	6	VH	H	VL	VH	---	---	---
Threat Reduction Options	20% - All	79.76%	25.76%	0.00%	48.00%	36.00%	5.20%	**95.26%**	4.70%	680	M	H	VL	M	---	---	---
	Max Harvest and Hatchery	99.70%	32.20%	0.00%	5.00%	0.00%	6.50%	**99.82%**	0.14%	26	VH	L	VL	VH	---	---	---
	Max Feasible - All	72.00%	26.00%	0.00%	35.00%	5.00%	5.00%	**87.85%**	12.12%	1,745	VL	VL	VL	VL	---	---	---
	Min Trib Habitat	99.70%	26.00%	0.00%	35.00%	5.00%	5.00%	**99.87%**	0.09%	19	VH	M	VL	VH	---	---	---
	Maintain into Future	99.70%	26.00%	0.00%	45.00%	45.00%	5.00%	**99.94%**	0.02%	9	VH	M	VL	VH	---	---	---
	Low Extinction Risk	79.50%	26.00%	0.00%	35.00%	5.00%	5.00%	**91.10%**	8.86%	1,277	L	L	VL	L	Primary	Exceed	1,271
	Very Low Extinction Risk	76.50%	26.00%	0.00%	35.00%	5.00%	5.00%	**89.80%**	10.16%	1,464	VL	VL	VL	VL	---	---	---

There is no hatchery program in the Clatskanie and strays are from other hatchery programs in the Columbia River basin.

The reduction of predation to fall Chinook as they migrate through the estuary is based principally on the expected benefits of implementation of the Caspian Tern Management Plan (USFWS 2005).

The current tributary habitat mortality rate is likely inflated and is based on the large difference between the historical and current abundances in the analyses. Further investigation of the current habitat conditions is merited. As for the other LCR fall Chinook populations, a 28 percent reduction in tributary habitat mortality was considered the maximum feasible.

Table 6-16. Threat reduction and VSP scenarios for Scappoose fall Chinook. The beginning of Section 6.2.2 describes the table contents. Limiting factor codes in the tables can be found in Chapter 5.

Species (Run): **CHINOOK (Fall)** — Population: **Scappoose**; Historic Abundundance: 12,515

Threat Level	Life History Stages	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation
Key	Adult				7a	7c	
	Juvenile	5c, 6e	3a, 3b, 5b, 6c				
Secondary	Adult						
	Juvenile	5c, 6b	1a, 6e, 9a, 9b, 9c, 9d				8b

		Mortality Rates of Threats: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Cumulative Mortality	% Mortality Improvement	Abundance	VSP Extinction Risk Class: A&P	Diversity	Spatial Structure	Overall	Delisting Scenario	Confidence	A&P Need
Current Status		79.60%	32.20%	0.00%	60.00%	45.00%	6.50%	**97.15%**	---	356	H	H	L	H	---	---	---
Threat Reduction Options	20% - All	63.68%	25.76%	0.00%	48.00%	36.00%	5.20%	**91.49%**	5.83%	1,065	M	H	L	M	---	---	---
	Max Harvest and Hatchery	79.60%	32.20%	0.00%	5.00%	0.00%	6.50%	**87.71%**	9.72%	1,538	VL	VL	L	VL	---	---	---
	Max Feasible - All	57.00%	26.00%	0.00%	35.00%	5.00%	5.00%	**81.33%**	16.28%	2,336	VL	L	L	VL	---	---	---
	Min Trib Habitat	79.60%	26.00%	0.00%	35.00%	5.00%	5.00%	**91.14%**	6.19%	1,108	VH	H	L	VH	---	---	---
	Maintain into Future	79.60%	26.00%	0.00%	45.00%	45.00%	5.00%	**95.66%**	1.54%	543	VH	H	L	VH	---	---	---
	Low Extinction Risk	77.50%	26.00%	0.00%	35.00%	5.00%	5.00%	**90.23%**	7.12%	1,222	L	L	L	L	Primary	Exceed	866
	Very Low Extinction Risk	73.00%	26.00%	0.00%	35.00%	5.00%	5.00%	**88.28%**	9.14%	1,467	VL	L	L	VL	---	---	---

The stray rates in the most recent years are close to the viable and broad sense/most probable scenario rates. There is no hatchery program in the Scappoose and, if there are strays, they are from other hatchery programs in the Columbia River basin.

The reduction of predation to fall Chinook as they migrate through the estuary is based principally on the expected benefits of implementation of the Caspian Tern Management Plan (USFWS 2005).

As for the other LCR fall Chinook populations, a 28 percent reduction in tributary habitat mortality was considered the maximum feasible.

Table 6-17. Threat reduction and VSP scenarios for Clackamas fall Chinook. The beginning of Section 6.2.2 describes the table contents. Limiting factor codes in the tables can be found in Chapter 5.

Species (Run): **CHINOOK (Fall)** — Population: **Clackamas** — Historic Abundundance: 22,554

Threat Level	Life History Stages	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation
Key	Adult				7a	7c	
	Juvenile	6e	3a, 3b, 5b, 6c				
Secondary	Adult	6d, 9b					
	Juvenile	5c, 6a, 6e, 9a, 9b	1a, 6e, 9a, 9b, 9c, 9d				8b

		Mortality Rates of Threats: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Cumulative Mortality	% Mortality Improvement	Abundance	VSP Extinction Risk Class: A&P	Diversity	Spatial Structure	Overall	Delisting Scenario	Confidence	A&P Need
Current Status		82.11%	32.20%	0.00%	60.00%	45.00%	7.30%	**97.53%**	---	558	VH	H	VL	VH	---	---	---
Threat Reduction Options	20% - All	65.69%	25.76%	0.00%	48.00%	36.00%	5.84%	**92.02%**	5.65%	1,800	M	H	VL	M	---	---	---
	Max Harvest and Hatchery	82.11%	32.20%	0.00%	5.00%	0.00%	7.30%	**89.32%**	8.42%	2,409	VL	VL	VL	VL	---	---	---
	Max Feasible - All	55.00%	26.00%	0.00%	35.00%	5.00%	6.00%	**80.67%**	17.28%	4,359	VL	L	VL	VL	---	---	---
	Min Trib Habitat	82.11%	26.00%	0.00%	35.00%	15.00%	6.00%	**93.12%**	4.51%	1,551	M	M	VL	M	Contributing	Exceed	993
	Maintain into Future	82.11%	26.00%	0.00%	35.00%	45.00%	6.00%	**95.55%**	2.03%	1,003	VH	H	VL	VH	---	---	---
	Low Extinction Risk	81.00%	26.00%	0.00%	35.00%	5.00%	6.00%	**91.84%**	5.83%	1,841	L	L	VL	L	---	---	---
	Very Low Extinction Risk	77.00%	26.00%	0.00%	35.00%	5.00%	6.00%	**90.12%**	7.59%	2,228	VL	L	VL	VL	---	---	---

Current hatchery threat rates are based on stray rates derived from general fall Chinook stray rate data and assumptions applied throughout the ESU, although they are likely lower in the Clackamas which is on the Willamette River and has no fall Chinook program. For all scenarios it was assumed that hatchery spring Chinook released in the Clackamas are not affecting fall Chinook there. However there is potential temporal and spatial overlap between the races and future RME should address this assumption. There is some uncertainty whether the hatchery stray rate (equivalent to two times the mortality rate listed here) for the most probable scenario can be achieved if spring Chinook are considered an impact, and this feasibility merits further investigation.

The reduction of predation to fall Chinook as they migrate through the estuary is based principally on the expected benefits of implementation of the Caspian Tern Management Plan (USFWS 2005).

Taking into account planned reductions in mortality associated with estuary habitat, harvest reductions, and predation (actions implemented at the ESU scale), and reduction of the hatchery stray rate required to meet the desired extinction risk (to below 30%), no improvements in tributary habitat conditions are necessary to strictly meet the delisting desired status of moderate extinction risk. However, this is based on the modeling approach and it is prudent to both protect and restore habitat to assure healthy, viable populations into the future and account for modeling uncertainty. Using an EDT assessment for the Clackamas, the conservative maximum feasible reduction of the tributary habitat mortality rate was estimated at 33 percent from its current status.

Table 6-18. Threat reduction and VSP scenarios for Sandy fall Chinook. The beginning of Section 6.2.2 describes the table contents. Limiting factor codes in the tables can be found in Chapter 5.

Species (Run): **CHINOOK (Fall)** — Population: **Sandy**

Historic Abundundance: 6,237

Threat Level	Life History Stages	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation
Key	Adult				7a	7c	
	Juvenile	6e	3a, 3b, 5b, 6c				
Secondary	Adult	6d					
	Juvenile	5c, 6a	1a, 6e, 9a, 9b, 9c, 9d	4b			8b

		Mortality Rates of Threats: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Cumulative Mortality	% Mortality Improvement	Abundance	VSP Extinction Risk Class: A&P	Diversity	Spatial Structure	Overall	Delisting Scenario	Confidence	A&P Need
Current Status		82.79%	32.20%	3.00%	60.00%	45.00%	7.30%	**97.69%**	---	144	VH	H	M	VH	---	---	---
Threat Reduction Options	20% - All	66.23%	25.76%	2.40%	48.00%	36.00%	5.84%	**92.33%**	5.49%	478	VH	H	M	VH	---	---	---
	Max Harvest and Hatchery	82.79%	32.20%	3.00%	5.00%	0.00%	7.30%	**90.03%**	7.84%	622	H	VL	M	H	---	---	---
	Max Feasible - All	57.00%	26.00%	0.00%	35.00%	15.00%	6.00%	**83.47%**	14.55%	1,031	M	M	M	M	Contributing	Achieve	887
	Min Trib Habitat	82.79%	26.00%	0.00%	35.00%	15.00%	6.00%	**93.39%**	4.41%	413	VH	M	M	VH	---	---	---
	Maintain into Future	82.79%	26.00%	0.00%	50.00%	45.00%	6.00%	**96.71%**	1.01%	205	VH	H	M	VH	---	---	---
	Low Extinction Risk	52.00%	26.00%	0.00%	35.00%	5.00%	6.00%	**79.38%**	18.74%	1,286	L	L	M	L	---	---	---
	Very Low Extinction Risk	44.50%	26.00%	0.00%	35.00%	5.00%	6.00%	**76.16%**	22.04%	1,487	VL	L	M	VL	---	---	---

Current stray rates are already lower than the 30 percent called for in the delist and broad sense scenarios. Further reductions may be difficult.

The reduction of predation to fall Chinook as they migrate through the estuary is based principally on the expected benefits of implementation of the Caspian Tern Management Plan (USFWS 2005).

Using an EDT assessment for the Sandy, based on analysis done for the City of Portland's Habitat Conservation Plan, the plan's improvements are assumed to represent approximately one-third of feasible habitat improvements for the affected population. If this assumption is valid, feasible tributary habitat actions would lead to a maximum reduction of the tributary habitat mortality rate of 31 percent from its current status.

Hydropower impacts have been addressed by the removal of Marmot and Little Sandy Dams.

Table 6-19. Threat reduction and VSP scenarios for Lower Gorge fall Chinook. The beginning of Section 6.2.2 describes the table contents. Limiting factor codes in the tables can be found in Chapter 5.

Species (Run): **CHINOOK (Fall)** — Population: **Lower Gorge**; Historic Abundundance: 2,980

Threat Level	Life History Stages	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation
Key	Adult	6f			7a	7c	
	Juvenile	6f	3a, 3b, 5b, 6c				
Secondary	Adult						
	Juvenile	5c	1a, 6e, 9a, 9b, 9c, 9d				8b

		Mortality Rates of Threats: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Cumulative Mortality	% Mortality Improvement	Abundance	VSP Extinction Risk Class: A&P	Diversity	Spatial Structure	Overall	Delisting Scenario	Confidence	A&P Need
Current Status		82.04%	32.20%	0.00%	60.00%	45.00%	7.30%	**97.52%**	---	74	VH	H	L	VH	---	---	---
Threat Reduction Options	20% - All	65.63%	25.76%	0.00%	48.00%	36.00%	5.84%	**92.00%**	5.65%	238	VH	M	L	VH	---	---	---
	Max Harvest and Hatchery	82.04%	32.20%	0.00%	5.00%	0.00%	7.30%	**89.28%**	8.45%	320	H	L	L	H	---	---	---
	Max Feasible - All	59.00%	26.00%	0.00%	35.00%	30.00%	6.00%	**87.02%**	10.76%	387	H	M	L	H	*Support WA (M)*	Achieve	313
	Min Trib Habitat	82.04%	26.00%	0.00%	45.00%	30.00%	6.00%	**95.19%**	2.39%	143	VH	M	L	VH	---	---	---
	Maintain into Future	82.04%	26.00%	0.00%	45.00%	45.00%	6.00%	**96.22%**	1.33%	113	VH	M	L	VH	---	---	---
	Low Extinction Risk	22.00%	26.00%	0.00%	20.00%	5.00%	6.00%	**58.76%**	39.74%	1,229	L	L	L	L	---	---	---
	Very Low Extinction Risk	17.00%	26.00%	0.00%	10.00%	5.00%	6.00%	**50.64%**	48.07%	1,471	VL	VL	L	VL	---	---	---

This population includes significant tributaries in Washington. The proposed threat reductions are consistent with other Oregon populations.

There is a large hatchery program in this population.

The reduction of predation to fall Chinook as they migrate through the estuary is based principally on the expected benefits of implementation of the Caspian Tern Management Plan (USFWS 2005), the pikeminnow reward program (http://www.pikeminnow.org/info.html), and the on-going pinniped management plan at Bonneville Dam.

Based on EDT analysis of other fall Chinook populations, mortality decreases above 28 percent would require significant, and potentially unrealistic, tributary habitat improvements in the Oregon portion of the population. A delisting goal of moderate risk is not feasible for the Lower Gorge without improvements in habitat (and stray rates) for Washington streams as well. There is a limited number of historical stream miles in Oregon that could be improved.

Note that this is a population which lies in both Oregon and Washington. Given that a greater proportion of the area is in Washington, the delisting desired status for this population was set by Washington (indicated in parenthesis in the Delisting Scenario column). VSP risk class information provided in this table is based on the portion of the population in Oregon only. Oregon's goal for this population is to achieve the maximum feasible improvement and support achievement of the delisting goal set by Washington.

Table 6-20. Threat reduction and VSP scenarios for Upper Gorge fall Chinook. The beginning of Section 6.2.2 describes the table contents. Limiting factor codes in the tables can be found in Chapter 5.

Species (Run): **CHINOOK (Fall)** — Population: **Upper Gorge**

Historic Abundundance: 824

Threat Level	Life History Stages	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation
Key	Adult	6f, 6g			7a	7c	
	Juvenile	6f, 6g	3a, 3b, 5b, 6c				
Secondary	Adult			4a			
	Juvenile	1a, 5c, 6g, 8a	1a, 6e, 9a, 9b, 9c, 9d	4a			8b

		Mortality Rates of Threats: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Cumulative Mortality	% Mortality Improvement	Abundance	VSP Extinction Risk Class: A&P	Diversity	Spatial Structure	Overall	Delisting Scenario	Confidence	A&P Need
Current Status		79.92%	32.20%	13.40%	65.00%	45.00%	9.10%	**97.94%**	---	17	VH	H	VL	VH	---	---	---
Threat Reduction Options	20% - All	63.94%	25.76%	10.72%	52.00%	36.00%	7.28%	**93.19%**	4.85%	56	VH	H	VL	VH	---	---	---
	Max Harvest and Hatchery	79.92%	32.20%	13.40%	5.00%	0.00%	9.10%	**89.82%**	8.29%	84	VH	L	VL	VH	---	---	---
	Max Feasible - All	58.00%	26.00%	13.40%	40.00%	30.00%	7.00%	**89.49%**	8.63%	87	VH	H	VL	VH	*Support WA (M)*	Achieve	70
	Min Trib Habitat	79.92%	26.00%	13.40%	40.00%	30.00%	7.00%	**94.97%**	3.03%	41	VH	M	VL	VH	---	---	---
	Maintain into Future	79.92%	26.00%	13.40%	40.00%	45.00%	7.00%	**96.05%**	1.93%	33	VH	H	VL	VH	---	---	---
	Low Extinction Risk	-47.00%	0.00%	0.00%	0.00%	0.00%	0.00%	**-47.00%**	147.99%	1,211	L	VL	VL	L	---	---	---
	Very Low Extinction Risk	-76.00%	0.00%	0.00%	0.00%	0.00%	0.00%	**-76.00%**	177.60%	1,450	VL	VL	VL	VL	---	---	---

Achieving viability in Oregon would require almost a complete elimination of all threats, which is not considered feasible. This includes tributary habitat improvements that would be so great that there would be no anthropogenic source of mortality at all. Also note that the calculated historical abundance is less than some of the conservation thresholds for abundance developed by CATAS (with an added 20% increase for future threats; Table 16-3). This discrepancy is another indicator of recovery issues with this population.

There is no hatchery program in the Upper Gorge, and most strays are assumed to be from the large program at Spring Creek (WA). Operations at Bonneville Dam may decrease mortality more than indicated for the chosen scenarios.

The reduction of predation to fall Chinook as they migrate through the estuary is based principally on the expected benefits of implementing the Caspian Tern Management Plan (USFWS 2005), the pikeminnow reward program, and the pinniped management plan at Bonneville Dam.

Based on EDT analysis of other fall Chinook populations, mortality decreases above 28 percent would require significant, and potentially unrealistic, tributary habitat improvements in the Oregon portion of the population.

Note that this is a population which lies in both Oregon and Washington. Given that a greater proportion of the area is in Washington, the delisting desired status for this population was set by Washington (indicated in parenthesis in the Delisting Scenario column). VSP risk class information provided in this table is based on the portion of the population in Oregon only. Oregon's goal for this population is to achieve the maximum feasible improvement and support achievement of the delisting goal set by Washington.

Table 6-21. Threat reduction and VSP scenarios for Hood fall Chinook. The beginning of Section 6.2.2 describes the table contents. Limiting factor codes in the tables can be found in Chapter 5.

Species (Run): **CHINOOK (Fall)** — Population: **Hood**

Historic Abundundance: 1,391

Threat Level	Life History Stages	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation
Key	Adult				7a	7c	
	Juvenile	5d, 6e	3a, 3b, 5b, 6c				
Secondary	Adult			4a			
	Juvenile	1a, 5a, 5c, 6a, 6g, 8a, 9c	1a, 6e, 9a, 9b, 9c, 9d	4a			8b

		Mortality Rates of Threats: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Cumulative Mortality	% Mortality Improvement	Abundance	VSP Extinction Risk Class: A&P	Diversity	Spatial Structure	Overall	Delisting Scenario	Confidence	A&P Need
Current Status		71.30%	32.20%	18.70%	70.00%	45.00%	9.10%	**97.63%**	---	33	VH	H	VL	VH	---	---	---
Threat Reduction Options	20% - All	57.04%	25.76%	14.96%	56.00%	36.00%	7.28%	**92.92%**	4.82%	99	VH	H	VL	M	---	---	---
	Max Harvest and Hatchery	71.30%	32.20%	18.70%	5.00%	0.00%	9.10%	**86.34%**	11.56%	190	VH	L	VL	VH	---	---	---
	Max Feasible - All	53.00%	26.00%	13.00%	45.00%	45.00%	7.00%	**91.49%**	6.29%	118	VH	M	VL	VH	---	---	---
	Min Trib Habitat	71.30%	26.00%	13.00%	45.00%	45.00%	7.00%	**94.80%**	2.89%	72	VH	M	VL	VH	---	---	---
	Maintain into Future	71.30%	26.00%	13.00%	45.00%	45.00%	7.00%	**94.80%**	2.89%	72	VH	M	VL	VH	---	---	---
	Low Extinction Risk	0.00%	0.00%	10.50%	0.00%	0.00%	0.00%	**10.50%**	89.24%	1,245	L	VL	VL	L	Primary	Unlikely	1,212
	Very Low Extinction Risk	-9.00%	0.00%	0.00%	0.00%	0.00%	0.00%	**-9.00%**	109.22%	1,516	VL	VL	VL	VL	---	---	---

Achieving the delist scenario would require almost a complete elimination of all threats, which is not considered feasible. This includes tributary habitat improvements that would be so great that there would be no anthropogenic source of mortality at all. Also note that the calculated historical abundance is less than some of the conservation thresholds for abundance developed by CATAS (with an added 20% increase for future threats; Table 16-3). This discrepancy is another indicator of recovery issues with this population.

There is no hatchery program in the Hood, and most strays are assumed to be from the large program at Spring Creek (WA).

The reduction in mortality of Hood fall Chinook due to hydropower impacts is based on removal of Powerdale Dam. Note that the current impact rate for Powerdale Dam on Hood fall Chinook needs verification and may be an underestimate (and thus underestimate the survival improvement with its removal). There are no other threat reductions identified, although improved fish passage at Bonneville Dam may provide some benefits.

The reduction of predation to fall Chinook as they migrate through the estuary is based primarily on expected benefits of implementation of the Caspian Tern Management Plan, the pikeminnow reward program, and the on-going pinniped management plan at Bonneville Dam.

Based on an EDT approach used in the Hood River Subbasin Plan for habitat improvements, it is estimated that tributary habitat improvements could lead to a 26 percent reduction in mortality. There is a very limited amount of stream miles for restoration work.

The Max Feasible - All scenario option indicates that it is "unlikely" that the chosen Delisting Scenario will be achieved.

Table 6-22. Threat reduction and VSP scenarios for Sandy late fall Chinook. The beginning of Section 6.2.2 describes the table contents. Limiting factor codes in the tables can be found in Chapter 5.

Species (Run): **CHINOOK (Late Fall)** — Population: **Sandy**

Historic Abundundance: 10,000

Threat Level	Life History Stages	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation
Key	Adult				7a	7c	
	Juvenile	6e	3a, 3b, 5b, 6c				
Secondary	Adult	6d					
	Juvenile	5c, 6a	1a, 6e, 9a, 9b, 9c, 9d	4b			8b

		Mortality Rates of Threats: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Cumulative Mortality	% Mortality Improvement	Abundance	VSP Extinction Risk Class: A&P	Diversity	Spatial Structure	Overall	Delisting Scenario	Confidence	A&P Need
Current Status		23.01%	30.90%	3.00%	50.00%	25.00%	7.30%	**82.06%**	---	1,794	VL	M	M	L	---	---	---
Threat Reduction Options	20% - All	18.41%	24.72%	2.40%	40.00%	20.00%	5.84%	**72.91%**	11.16%	2,709	VL	M	M	L	---	---	---
	Max Harvest and Hatchery	23.01%	30.90%	3.00%	5.00%	0.00%	7.30%	**54.55%**	33.52%	4,545	VL	VL	M	VL	---	---	---
	Max Feasible - All	16.60%	26.00%	0.00%	30.00%	5.00%	6.00%	**61.42%**	25.15%	3,858	VL	VL	M	VL	Primary	Achieve	2,064
	Min Trib Habitat	23.01%	26.00%	0.00%	30.00%	5.00%	6.00%	**64.39%**	21.54%	3,561	VL	VL	M	VL	---	---	---
	Maintain into Future	23.01%	26.00%	0.00%	40.00%	25.00%	6.00%	**75.90%**	7.51%	2,410	VL	M	M	L	---	---	---
	Low Extinction Risk	23.01%	26.00%	0.00%	50.00%	7.50%	6.00%	**75.23%**	8.32%	2,477	VL	M	M	L	---	---	---
	Very Low Extinction Risk	23.01%	26.00%	0.00%	50.00%	5.00%	6.00%	**74.56%**	9.14%	2,544	VL	VL	M	VL	---	---	---

Current stray rates are already likely lower than the 10 percent called for in the delist/broad sense/most probable scenario.

The reduction of predation to late fall Chinook as they migrate through the estuary is based principally on the expected benefits of implementation of the Caspian Tern Management Plan (USFWS 2005) and the pikeminnow reward program.

Using an EDT assessment for the Sandy, based on analysis done for the City of Portland's HCP, it was assumed that HCP improvements represented approximately one-third of feasible habitat improvements for the affected population. If this assumption is valid, feasible tributary habitat actions would lead to a maximum reduction of the tributary habitat mortality rate of 28 percent from its current status.

Hydropower impacts have been addressed by the removal of Marmot and Little Sandy Dams.

Table 6-23. Threat reduction and VSP scenarios for Clackamas spring Chinook. The beginning of Section 6.2.2 describes the table contents. Limiting factor codes in the tables can be found in Chapter 5.

Species (Run): **CHINOOK (Spring)** — Population: **Clackamas**; Historic Abundundance: 27,673

Threat Level	Life History Stages	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation
Key	Adult					7c	
	Juvenile	6e	3a, 3b, 5b, 6c	4b			
Secondary	Adult	6d, 9b			7a, 7b		
	Juvenile	5c, 6e, 9a, 9b	1a, 6e, 9a, 9b, 9c, 9d				8b

		Mortality Rates of Threats: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Cumulative Mortality	% Mortality Improvement	Abundance	VSP Extinction Risk Class: A&P	Diversity	Spatial Structure	Overall	Delisting Scenario	Confidence	A&P Need
Current Status		67.41%	9.50%	27.20%	25.00%	65.00%	12.10%	**95.05%**	---	1,371	M	M	L	M	---	---	---
Threat Reduction Options	20% - All	53.93%	7.60%	21.76%	20.00%	52.00%	9.68%	**88.45%**	6.94%	3,197	VL	L	L	VL	---	---	---
	Max Harvest and Hatchery	67.41%	9.50%	27.20%	5.00%	0.00%	12.10%	**82.07%**	13.65%	4,962	VL	VL	L	VL	---	---	---
	Max Feasible - All	44.00%	8.00%	6.40%	25.00%	10.00%	7.00%	**69.73%**	26.64%	8,377	VL	VL	VL	VL	*N / A*	Achieve	7,006
	Min Trib Habitat	67.41%	8.00%	6.40%	25.00%	10.00%	7.00%	**82.38%**	13.32%	4,875	VL	VL	VL	VL	---	---	---
	Maintain into Future	67.41%	8.00%	6.40%	25.00%	65.00%	7.00%	**93.15%**	2.00%	1,896	M	M	VL	M	---	---	---
	Low Extinction Risk	---	---	---	---	---	---	**---**	---	---	---	---	---	---	---	---	---
	Very Low Extinction Risk	67.41%	8.00%	6.40%	25.00%	10.00%	7.00%	**82.38%**	13.32%	4,875	VL	VL	VL	VL	---	---	---

The reduction of predation to spring Chinook as they migrate through the estuary is based principally on the expected benefits of implementation of the Caspian Tern Management Plan (USFWS 2005) and the pikeminnow reward program.

Using an EDT assessment for the Clackamas, the conservative maximum feasible reduction of the tributary habitat mortality rate was estimated at 35 percent from its current status.

Note that the Clackamas spring Chinook population is not part of the Lower Columbia River Chinook ESU listed under the ESA; it is in the Upper Willamette River Chinook ESU (also listed under ESA). Scenarios for a broad sense desired status, per the recovery goal under the State of Oregon NFCP, are presented for this population.

Table 6-24. Threat reduction and VSP scenarios for Sandy spring Chinook. The beginning of Section 6.2.2 describes the table contents. Limiting factor codes in the tables can be found in Chapter 5.

Species (Run): **CHINOOK (Spring)** — Population: **Sandy**

Historic Abundundance: 26,899

Threat Level	Life History Stages	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation
Key	Adult					7c	
	Juvenile	6e	3a, 3b, 5b, 6c				
Secondary	Adult	4a, 6d			7a, 7b		
	Juvenile	5c, 6a	1a, 6e, 9a, 9b, 9c, 9d	4b			8b

		Mortality Rates of Threats: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Cumulative Mortality	% Mortality Improvement	Abundance	VSP Extinction Risk Class: A&P	Diversity	Spatial Structure	Overall	Delisting Scenario	Confidence	A&P Need
Current Status		93.38%	9.50%	8.00%	25.00%	27.00%	12.10%	**97.35%**	---	714	M	M	M	M	---	---	---
Threat Reduction Options	20% - All	74.70%	7.60%	6.40%	20.00%	21.60%	9.68%	**87.61%**	10.01%	3,334	M	M	M	M	---	---	---
	Max Harvest and Hatchery	93.38%	9.50%	8.00%	5.00%	0.00%	12.10%	**95.40%**	2.00%	1,238	L	VL	M	L	---	---	---
	Max Feasible - All	52.00%	8.00%	0.00%	25.00%	5.00%	7.00%	**70.74%**	27.33%	7,871	VL	VL	M	VL	---	---	---
	Min Trib Habitat	93.38%	8.00%	0.00%	25.00%	5.00%	7.00%	**95.96%**	1.42%	1,086	M	L	M	M	---	---	---
	Maintain into Future	93.38%	8.00%	0.00%	25.00%	20.00%	7.00%	**96.60%**	0.77%	914	M	M	M	M	---	---	---
	Low Extinction Risk	92.50%	8.00%	0.00%	25.00%	5.00%	7.00%	**95.43%**	1.97%	1,230	L	VL	M	L	Primary	Exceed	516
	Very Low Extinction Risk	91.00%	8.00%	0.00%	25.00%	5.00%	7.00%	**94.51%**	2.91%	1,476	VL	VL	M	VL	---	---	---

The reduction of predation to spring Chinook as they migrate through the estuary is based principally on the expected benefits of implementation of the Caspian Tern Management Plan (USFWS 2005) and the pikeminnow reward program.

Using an EDT assessment for the Sandy, based on analysis done for the City of Portland's HCP, it was assumed that HCP improvements represented approximately one-third of feasible habitat improvements for the affected population. If this assumption is valid, feasible tributary habitat actions would lead to a maximum reduction of the tributary habitat mortality rate of 44 percent from its current status. Note that this rate of survival improvement seems very high and the actual numerical response to the projected habitat improvement will need to be examined.

Table 6-25. Threat reduction and VSP scenarios for Hood spring Chinook. The beginning of Section 6.2.2 describes the table contents. Limiting factor codes in the tables can be found in Chapter 5.

Species (Run): **CHINOOK (Spring)** — Population: **Hood**

Historic Abundundance: 15,041

Threat Level	Life History Stages	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation
Key	Adult				7a	7c	
	Juvenile		3a, 3b, 5b, 6c				
Secondary	Adult			4a			8d
	Juvenile	1a, 5a, 5c, 5d, 6a, 6g, 8a, 9c	1a, 6e, 9a, 9b, 9c, 9d	4a			8b

		Mortality Rates of Threats: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Cumulative Mortality	% Mortality Improvement	Abundance	VSP Extinction Risk Class: A&P	Diversity	Spatial Structure	Overall	Delisting Scenario	Confidence	A&P Need
Current Status		89.40%	9.50%	34.90%	25.00%	45.00%	15.60%	**97.83%**	---	327	VH	VH	VL	VH	---	---	---
Threat Reduction Options	20% - All	71.52%	7.60%	27.92%	20.00%	36.00%	12.48%	**91.50%**	6.47%	1,278	L	H	VL	L	---	---	---
	Max Harvest and Hatchery	89.40%	9.50%	34.90%	5.00%	0.00%	15.60%	**94.99%**	2.90%	753	H	L	VL	H	---	---	---
	Max Feasible - All	19.00%	8.00%	12.00%	25.00%	5.00%	7.00%	**56.55%**	42.20%	6,536	VL	VL	VL	VL	---	---	---
	Min Trib Habitat	89.40%	8.00%	12.00%	25.00%	5.00%	7.00%	**94.31%**	3.59%	855	M	L	VL	M	---	---	---
	Maintain into Future	89.40%	8.00%	0.00%	25.00%	45.00%	7.00%	**96.26%**	1.60%	563	VH	VH	VL	VH	---	---	---
	Low Extinction Risk	84.50%	8.00%	12.00%	25.00%	5.00%	7.00%	**91.68%**	6.28%	1,251	L	VL	VL	L	---	---	---
	Very Low Extinction Risk	81.50%	8.00%	12.00%	25.00%	5.00%	7.00%	**90.08%**	7.92%	1,493	VL	VL	VL	VL	Primary	Exceed	1,166

The historical abundance may be an overestimate. This was based on IP proportions (described in Section 6.2.1), which need further verification in the Hood. Historically, spring Chinook may have been limited in distribution to the West Fork.

The reduction in mortality of Hood spring Chinook due to hydropower impacts is based on the removal of Powerdale Dam. There are no other threat reductions identified, although improvements in fish passage at Bonneville Dam may provide some benefits.

The reduction of predation to spring Chinook as they migrate through the estuary is based principally on the expected benefits of implementation of the Caspian Tern Management Plan (USFWS 2005), the pikeminnow reward program, and the on-going pinniped management plan at Bonneville Dam.

Based on an EDT approach used in the Hood River Subbasin Plan for habitat improvements, it is estimated that tributary habitat improvements could lead to a 78 percent reduction in mortality. Note that this rate of survival improvement seems very high and the actual numerical response to the projected habitat improvement will need to be examined.

Steelhead

Table 6-26. Threat reduction and VSP scenarios for Youngs Bay winter steelhead. The beginning of Section 6.2.2 describes the table contents. Limiting factor codes in the tables can be found in Chapter 5.

Species (Run): **STEELHEAD (Winter)** — Population: **Youngs Bay**

Historic Abundundance: 10,396

Threat Level	Life History Stages	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation
Key	Adult						
	Juvenile	5c, 6e	3a, 3b, 5b, 6c				
Secondary	Adult	4c			7b	7c	
	Juvenile	5c, 5e, 6a, 9a	1a, 6e, 9a, 9b, 9c				8b

		Mortality Rates of Threats: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Cumulative Mortality	% Mortality Improvement	Abundance	VSP Extinction Risk Class: A&P	Diversity	Spatial Structure	Overall	Delisting Scenario	Confidence	A&P Need
Current Status		58.63%	9.50%	0.00%	10.00%	20.00%	11.30%	**76.09%**	---	2,486	VL	M	VL	VL	---	---	---
Threat Reduction Options	20% - All	46.90%	7.60%	0.00%	8.00%	16.00%	9.04%	**65.51%**	13.90%	3,585	VL	M	VL	VL	---	---	---
	Max Harvest and Hatchery	58.63%	9.50%	0.00%	5.00%	0.00%	11.30%	**68.45%**	10.04%	3,280	VL	VL	VL	VL	---	---	---
	Max Feasible - All	35.00%	8.00%	0.00%	10.00%	10.00%	6.00%	**54.47%**	28.42%	4,733	VL	VL	VL	VL	*N / A*	Achieve	2,247
	Min Trib Habitat	58.63%	8.00%	0.00%	10.00%	10.00%	6.00%	**71.02%**	6.66%	3,013	VL	VL	VL	VL	---	---	---
	Maintain into Future	53.50%	8.00%	0.00%	10.00%	20.00%	6.00%	**71.05%**	6.63%	3,010	VL	M	VL	VL	---	---	---
	Low Extinction Risk	---	---	---	---	---	---	**---**	---	---	---	---	---	---	---	---	---
	Very Low Extinction Risk	57.00%	8.00%	0.00%	10.00%	10.00%	6.00%	**69.88%**	8.16%	3,131	VL	VL	VL	VL	---	---	---

Note that the Coast stratum for winter steelhead, which includes Youngs Bay winter steelhead, is not part of the Lower Columbia River Steelhead ESU listed under the ESA. Scenarios for a broad sense desired status, per the recovery goal under the State of Oregon NFCP, are presented for this population.

Table 6-27. Threat reduction and VSP scenarios for Big Creek winter steelhead. The beginning of Section 6.2.2 describes the table contents. Limiting factor codes in the tables can be found in Chapter 5.

Species (Run): **STEELHEAD (Winter)** — Population: **Big Creek**; Historic Abundance: 6,057

Threat Level	Life History Stages	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation
Key	Adult					7c	
	Juvenile	5c, 6e	3a, 3b, 5b, 6c				
Secondary	Adult	4c			7b		
	Juvenile	5c, 5e, 6a, 9a	1a, 6e, 9a, 9b, 9c				8b

		Mortality Rates of Threats: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Cumulative Mortality	% Mortality Improvement	Abundance	VSP Extinction Risk Class: A&P	Diversity	Spatial Structure	Overall	Delisting Scenario	Confidence	A&P Need
Current Status		56.47%	9.50%	0.00%	10.00%	40.00%	11.30%	**81.13%**	---	1,143	L	M	L	L	---	---	---
Threat Reduction Options	20% - All	45.18%	7.60%	0.00%	8.00%	32.00%	9.04%	**71.17%**	12.27%	1,746	VL	M	L	VL	---	---	---
	Max Harvest and Hatchery	56.47%	9.50%	0.00%	5.00%	0.00%	11.30%	**66.80%**	17.66%	2,011	VL	VL	L	VL	---	---	---
	Max Feasible - All	25.00%	8.00%	0.00%	10.00%	10.00%	6.00%	**47.46%**	41.50%	3,182	VL	VL	L	VL	*N / A*	Achieve	2,039
	Min Trib Habitat	56.47%	8.00%	0.00%	10.00%	10.00%	6.00%	**69.51%**	14.33%	1,847	VL	VL	L	VL	---	---	---
	Maintain into Future	56.47%	8.00%	0.00%	10.00%	30.00%	6.00%	**76.28%**	5.97%	1,436	L	L	L	L	---	---	---
	Low Extinction Risk	56.47%	8.00%	0.00%	10.00%	30.00%	6.00%	**76.28%**	5.97%	1,436	L	L	L	L	---	---	---
	Very Low Extinction Risk	56.00%	8.00%	0.00%	10.00%	10.00%	6.00%	**69.18%**	14.73%	1,867	VL	VL	L	VL	---	---	---

Note that the Coast stratum for winter steelhead, which includes Big Creek winter steelhead, is not part of the Lower Columbia River Steelhead ESU listed under the ESA. Scenarios for a broad sense desired status, per the recovery goal under the State of Oregon NFCP, are presented for this population.

Table 6-28. Threat reduction and VSP scenarios for Clatskanie winter steelhead. The beginning of Section 6.2.2 describes the table contents. Limiting factor codes in the tables can be found in Chapter 5.

Species (Run): **STEELHEAD (Winter)** — Population: **Clatskanie**; Historic Abundundance: 9,385

Threat Level	Life History Stages	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation
Key	Adult						
	Juvenile	6e	3a, 3b, 5b, 6c				
Secondary	Adult				7b		
	Juvenile	5c, 6b, 9a	1a, 6e, 9a, 9b, 9c, 9d				8b

		Mortality Rates of Threats: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Cumulative Mortality	% Mortality Improvement	Abundance	VSP Extinction Risk Class: A&P	Diversity	Spatial Structure	Overall	Delisting Scenario	Confidence	A&P Need
Current Status		61.78%	9.50%	0.00%	10.00%	5.00%	11.70%	**73.89%**	---	2,451	VL	L	VL	VL	---	---	---
Threat Reduction Options	20% - All	49.42%	7.60%	0.00%	8.00%	4.00%	9.36%	**62.59%**	15.29%	3,511	VL	VL	VL	VL	---	---	---
	Max Harvest and Hatchery	61.78%	9.50%	0.00%	5.00%	0.00%	11.70%	**70.98%**	3.93%	2,723	VL	VL	VL	VL	---	---	---
	Max Feasible - All	42.00%	8.00%	0.00%	10.00%	5.00%	7.00%	**57.57%**	22.08%	3,982	VL	L	VL	VL	*N / A*	Achieve	1,531
	Min Trib Habitat	61.78%	8.00%	0.00%	10.00%	5.00%	7.00%	**72.04%**	2.50%	2,624	VL	L	VL	VL	---	---	---
	Maintain into Future	57.00%	8.00%	0.00%	10.00%	5.00%	7.00%	**68.54%**	7.23%	2,952	VL	L	VL	VL	---	---	---
	Low Extinction Risk	---	---	---	---	---	---	**---**	---	---	---	---	---	---	---	---	---
	Very Low Extinction Risk	57.00%	8.00%	0.00%	10.00%	5.00%	7.00%	**68.54%**	7.23%	2,952	VL	L	VL	VL	---	---	---

Note that the Coast stratum for winter steelhead, which includes Clatskanie winter steelhead, is not part of the Lower Columbia River Steelhead ESU listed under the ESA. Scenarios for a broad sense desired status, per the recovery goal under the State of Oregon NFCP, are presented for this population.

Table 6-29. Threat reduction and VSP scenarios for Scappoose winter steelhead. The beginning of Section 6.2.2 describes the table contents. Limiting factor codes in the tables can be found in Chapter 5.

Species (Run): **STEELHEAD (Winter)** — Population: **Scappoose**; Historic Abundundance: 12,396

Threat Level	Life History Stages	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation
Key	Adult						
	Juvenile	6e	3a, 3b, 5b, 6c				
Secondary	Adult				7b		
	Juvenile	5c, 6b, 9a	1a, 6e, 9a, 9b, 9c, 9d				8b

		Mortality Rates of Threats: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Cumulative Mortality	% Mortality Improvement	Abundance	VSP Extinction Risk Class: A&P	Diversity	Spatial Structure	Overall	Delisting Scenario	Confidence	A&P Need
Current Status		61.69%	9.50%	0.00%	10.00%	5.00%	11.70%	**73.82%**	---	3,245	VL	L	L	VL	---	---	---
Threat Reduction Options	20% - All	49.35%	7.60%	0.00%	8.00%	4.00%	9.36%	**62.54%**	15.29%	4,644	VL	VL	L	VL	---	---	---
	Max Harvest and Hatchery	61.69%	9.50%	0.00%	5.00%	0.00%	11.70%	**70.92%**	3.94%	3,605	L	VL	L	L	---	---	---
	Max Feasible - All	43.00%	8.00%	0.00%	10.00%	5.00%	7.00%	**58.30%**	21.03%	5,169	VL	L	L	VL	*N / A*	Achieve	1,924
	Min Trib Habitat	61.69%	8.00%	0.00%	10.00%	5.00%	7.00%	**71.97%**	2.51%	3,474	L	L	L	L	---	---	---
	Maintain into Future	57.00%	8.00%	0.00%	10.00%	5.00%	7.00%	**68.54%**	7.15%	3,899	VL	L	L	VL	---	---	---
	Low Extinction Risk	---	---	---	---	---	---	**---**	---	---	---	---	---	---	---	---	---
	Very Low Extinction Risk	57.00%	8.00%	0.00%	10.00%	5.00%	7.00%	**68.54%**	7.15%	3,899	VL	L	L	VL	---	---	---

Note that the Coast stratum for winter steelhead, which includes Scappoose winter steelhead, is not part of the Lower Columbia River Steelhead ESU listed under the ESA. Scenarios for a broad sense desired status, per the recovery goal under the State of Oregon NFCP, are presented for this population.

Table 6-30. Threat reduction and VSP scenarios for Clackamas winter steelhead. The beginning of Section 6.2.2 describes the table contents. Limiting factor codes in the tables can be found in Chapter 5.

Species (Run): **STEELHEAD (Winter)** — Population: **Clackamas**; Historic Abundundance: 21,186

Threat Level	Life History Stages	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation
Key	Adult						
	Juvenile	6e	3a, 3b, 5b, 6c				
Secondary	Adult				7b	7c	
	Juvenile	5c, 6a, 9a, 9b	1a, 6e, 9a, 9b, 9c, 9d	4b			8b

		Mortality Rates of Threats: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Cumulative Mortality	% Mortality Improvement	Abundance	VSP Extinction Risk Class: A&P	Diversity	Spatial Structure	Overall	Delisting Scenario	Confidence	A&P Need
Current Status		64.80%	9.50%	5.20%	10.00%	23.00%	12.10%	**81.60%**	---	3,897	M	M	VL	M	---	---	---
Threat Reduction Options	20% - All	51.84%	7.60%	4.16%	8.00%	18.40%	9.68%	**71.08%**	12.89%	6,127	M	L	VL	M	---	---	---
	Max Harvest and Hatchery	64.80%	9.50%	5.20%	5.00%	0.00%	12.10%	**74.78%**	8.36%	5,343	M	VL	VL	M	---	---	---
	Max Feasible - All	47.00%	8.00%	5.00%	10.00%	10.00%	7.00%	**65.11%**	20.22%	7,393	M	VL	VL	M	---	---	---
	Min Trib Habitat	64.80%	8.00%	5.00%	10.00%	10.00%	7.00%	**76.82%**	5.86%	4,910	M	VL	VL	M	---	---	---
	Maintain into Future	64.80%	8.00%	5.00%	10.00%	14.00%	7.00%	**77.85%**	4.59%	4,692	M	M	VL	M	---	---	---
	Low Extinction Risk	23.50%	8.00%	5.00%	10.00%	10.00%	7.00%	**49.63%**	39.18%	10,671	L	VL	VL	L	Primary	Unlikely	6,774
	Very Low Extinction Risk	17.00%	8.00%	5.00%	5.00%	0.00%	7.00%	**35.91%**	56.00%	13,578	VL	VL	VL	VL	---	---	---

Recent counts indicate that the average number of returning adults over the past 5 years is roughly 1,500 fish.

Stray rates in the most recent years likely meet the viable, broad sense, and most probable scenario rates now. Most strays are limited to Eagle Creek, where the Eagle Creek National Fish Hatchery is located.

Achieving the delist scenario would require tributary habitat reductions believed to be more than is feasible.

The Max Feasible - All scenario option indicates that it is "unlikely" that the chosen Delisting Scenario will be achieved.

Table 6-31. Threat reduction and VSP scenarios for Sandy winter steelhead. The beginning of Section 6.2.2 describes the table contents. Limiting factor codes in the tables can be found in Chapter 5.

Species (Run): **STEELHEAD (Winter)** — Population: **Sandy**

Historic Abundundance: 11,687

Threat Level	Life History Stages	Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation
		Threats and Limiting Factors					
Key	Adult					7c	
	Juvenile	6e	3a, 3b, 5b, 6c				
Secondary	Adult	4a, 4c, 6d			7b		
	Juvenile	5c, 5e, 6a	1a, 6e, 9a, 9b, 9c, 9d				8b

		Mortality Rates of Threats									VSP Extinction Risk Class						
		Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Cumulative Mortality	% Mortality Improvement	Abundance	A&P	Diversity	Spatial Structure	Overall	Delisting Scenario	Confidence	A&P Need
Current Status		82.52%	9.50%	4.00%	10.00%	52.00%	12.10%	**94.23%**	---	674	H	M	M	H	---	---	---
Threat Reduction Options	20% - All	66.02%	7.60%	3.20%	8.00%	41.60%	9.68%	**85.25%**	9.53%	1,724	VL	M	M	M	---	---	---
	Max Harvest and Hatchery	82.52%	9.50%	4.00%	5.00%	0.00%	12.10%	**87.32%**	7.34%	1,482	L	VL	M	L	---	---	---
	Max Feasible - All	74.00%	8.00%	0.00%	10.00%	10.00%	7.00%	**81.98%**	13.00%	2,106	VL	VL	M	VL	---	---	---
	Min Trib Habitat	82.52%	8.00%	0.00%	10.00%	10.00%	7.00%	**87.89%**	6.74%	1,416	L	VL	M	L	---	---	---
	Maintain into Future	82.00%	8.00%	0.00%	10.00%	50.00%	7.00%	**93.07%**	1.23%	810	H	M	M	H	---	---	---
	Low Extinction Risk	82.52%	8.00%	0.00%	10.00%	10.00%	7.00%	**87.89%**	6.74%	1,416	L	VL	M	L	---	---	---
	Very Low Extinction Risk	81.25%	8.00%	0.00%	10.00%	10.00%	7.00%	**87.01%**	7.67%	1,519	VL	VL	M	VL	Primary	Exceed	845

Due to fairly recent changes in the management of the hatchery steelhead program, current stray rates are already lower than the 10 percent called for in the chosen Delisting Scenario.

Table 6-32. Threat reduction and VSP scenarios for Lower Gorge winter steelhead. The beginning of Section 6.2.2 describes the table contents. Limiting factor codes in the tables can be found in Chapter 5.

Species (Run): **STEELHEAD (Winter)** — Population: **Lower Gorge**

Historic Abundundance: 2,119

Threat Level	Life History Stages	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation
Key	Adult	6f					
	Juvenile	6f	3a, 3b, 5b, 6c				
Secondary	Adult	4c			7b	7c	
	Juvenile	5c, 5f	1a, 6e, 9a, 9b, 9c, 9d				8b

		Mortality Rates of Threats: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Cumulative Mortality	% Mortality Improvement	Abundance	VSP Extinction Risk Class: A&P	Diversity	Spatial Structure	Overall	Delisting Scenario	Confidence	A&P Need
Current Status		59.72%	9.50%	0.00%	10.00%	10.00%	12.10%	**74.05%**	---	550	M	L	VL	M	---	---	---
Threat Reduction Options	20% - All	47.78%	7.60%	0.00%	8.00%	8.00%	9.68%	**63.11%**	14.77%	782	M	L	VL	M	---	---	---
	Max Harvest and Hatchery	59.72%	9.50%	0.00%	5.00%	0.00%	12.10%	**69.56%**	6.06%	645	H	VL	VL	H	---	---	---
	Max Feasible - All	40.00%	8.00%	0.00%	10.00%	10.00%	7.00%	**58.42%**	21.11%	881	M	L	VL	M	*Support WA (L)*	Achieve	331
	Min Trib Habitat	59.72%	8.00%	0.00%	10.00%	10.00%	7.00%	**72.08%**	2.65%	592	H	VL	VL	H	---	---	---
	Maintain into Future	55.00%	8.00%	0.00%	10.00%	10.00%	7.00%	**68.81%**	7.07%	661	M	L	VL	M	---	---	---
	Low Extinction Risk	24.75%	8.00%	0.00%	10.00%	10.00%	7.00%	**47.85%**	35.38%	1,105	L	VL	VL	L	---	---	---
	Very Low Extinction Risk	0.00%	8.00%	0.00%	3.00%	0.00%	7.00%	**17.01%**	77.03%	1,759	VL	VL	VL	VL	---	---	---

Achieving the Delisting Scenario would require tributary habitat reductions believed to be feasible.

Note that this is a population which lies in both Oregon and Washington. Given that a greater proportion of the area is in Washington, the delisting desired status for this population was set by Washington (indicated in parenthesis in the Delisting Scenario column). VSP risk class information provided in this table is based on the portion of the population in Oregon only. Oregon's goal for this population is to achieve the maximum feasible improvement and support achievement of the delisting goal set by Washington.

Table 6-33. Threat reduction and VSP scenarios for Upper Gorge winter steelhead. The beginning of Section 6.2.2 describes the table contents. Limiting factor codes in the tables can be found in Chapter 5.

Species (Run): **STEELHEAD (Winter)** — Population: **Upper Gorge**

Historic Abundundance: 629

Threat Level	Life History Stages	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation
Key	Adult	6f, 6g					
	Juvenile	6f, 6g	3a, 3b, 5b, 6c				
Secondary	Adult	4c		4a	7a, 7b	7c	8d
	Juvenile	1a, 5c, 6g, 8a	1a, 6e, 9a, 9b, 9c, 9d	4a			8b

		Mortality Rates of Threats: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Cumulative Mortality	% Mortality Improvement	Abundance	VSP Extinction Risk Class: A&P	Diversity	Spatial Structure	Overall	Delisting Scenario	Confidence	A&P Need
Current Status		51.05%	8.60%	16.00%	15.00%	10.00%	16.50%	**75.99%**	---	151	VH	M	VL	VH	---	---	---
Threat Reduction Options	20% - All	40.84%	6.88%	12.80%	12.00%	8.00%	13.20%	**66.24%**	12.83%	212	VH	M	VL	VH	---	---	---
	Max Harvest and Hatchery	51.05%	8.60%	16.00%	5.00%	0.00%	16.50%	**70.19%**	7.64%	188	VH	M	VL	VH	---	---	---
	Max Feasible - All	30.50%	7.00%	16.00%	15.00%	10.00%	10.00%	**62.62%**	17.60%	235	VH	M	VL	VH	*Support WA (H)*	Achieve	84
	Min Trib Habitat	51.05%	7.00%	16.00%	15.00%	10.00%	10.00%	**73.67%**	3.06%	166	VH	M	VL	VH	---	---	---
	Maintain into Future	46.00%	7.00%	16.00%	15.00%	10.00%	10.00%	**70.96%**	6.63%	183	VH	M	VL	VH	---	---	---
	Low Extinction Risk	-45.00%	0.00%	0.00%	0.00%	0.00%	0.00%	**-45.00%**	159.22%	912	L	VL	VL	L	---	---	---
	Very Low Extinction Risk	-107.00%	0.00%	0.00%	0.00%	0.00%	0.00%	**-107.00%**	240.80%	1,302	VL	VL	VL	VL	---	---	---

Achieving viability would require a complete elimination of all threats, which is not considered feasible. This includes tributary habitat improvements that would be so great that they would be beyond was is modeled as "pristine", including the elimination of all anthropogenic sources of mortality. Also note that the calculated historical abundance is less than some of the conservation thresholds for abundance developed by CATAS (with an added 20% increase for future threats; Table 16-3). This discrepancy is another indicator of recovery issues with this population. Issues might include either the assumption that the Upper Gorge was a self-sustaining population or analysis accuracy stemming from uncertainty over this population.

No reduction in hydro impacts from Bonneville Dam has been identified at this time.

Note that this is a population which lies in both Oregon and Washington. Given that a greater proportion of the area is in Washington, the delisting desired status for this population was set by Washington (indicated in parenthesis in the Delisting Scenario column). VSP risk class information provided in this table is based on the portion of the population in Oregon only. Oregon's goal for this population is to achieve the maximum feasible improvement and support achievement of the delisting goal set by Washington.

Table 6-34. Threat reduction and VSP scenarios for Hood winter steelhead. The beginning of Section 6.2.2 describes the table contents. Limiting factor codes in the tables can be found in Chapter 5.

Species (Run): **STEELHEAD (Winter)** — Population: **Hood**

Historic Abundundance: 3,822

Threat Level	Life History Stages	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation
Key	Adult						
	Juvenile	5d, 6e	3a, 3b, 5b, 6c				
Secondary	Adult	4a		4a	7a, 7b	7c	8d
	Juvenile	1a, 5a, 5c, 6a, 6g, 8a, 9a, 9c	1a, 6e, 9a, 9b, 9c, 9d	4a			8b

		Mortality Rates of Threats: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Cumulative Mortality	% Mortality Improvement	Abundance	VSP Extinction Risk Class: A&P	Diversity	Spatial Structure	Overall	Delisting Scenario	Confidence	A&P Need
Current Status		-1.15%	8.60%	35.80%	15.00%	30.00%	16.50%	**70.51%**	---	1,127	M	M	VL	M	---	---	---
Threat Reduction Options	20% - All	-0.92%	6.88%	28.64%	12.00%	24.00%	13.20%	**61.07%**	13.39%	1,488	M	M	VL	M	---	---	---
	Max Harvest and Hatchery	-1.15%	8.60%	35.80%	5.00%	0.00%	16.50%	**52.92%**	24.95%	1,799	L	VL	VL	L	---	---	---
	Max Feasible - All	-43.00%	7.00%	16.00%	15.00%	10.00%	10.00%	**23.09%**	67.26%	2,940	VL	VL	VL	VL	---	---	---
	Min Trib Habitat	-1.15%	7.00%	16.00%	15.00%	10.00%	10.00%	**45.60%**	35.34%	2,079	L	VL	VL	L	---	---	---
	Maintain into Future	-1.15%	7.00%	16.00%	15.00%	30.00%	10.00%	**57.69%**	18.19%	1,617	M	M	VL	M	---	---	---
	Low Extinction Risk	-1.15%	7.00%	16.00%	15.00%	10.00%	10.00%	**45.60%**	35.34%	2,079	L	VL	VL	L	Primary	Exceed	952
	Very Low Extinction Risk	-8.00%	7.00%	16.00%	15.00%	10.00%	10.00%	**41.91%**	40.56%	2,220	VL	VL	VL	VL	---	---	---

Due to the combination of higher mortality rates for hydro and hatchery impacts and the current abundance that is a somewhat higher percentage of historic than in other populations, the current mortality due to tributary habitat impacts is better than pristine conditions, with no source of anthropogenic mortality. Using the modeled level of tributary habitat impact does not allow much room for reduction if it is assumed that it is correct and that the habitat cannot be improved beyond pristine. An assumption about tributary habitat impacts was made that allowed development of a "Max Feasible – All" scenario. This assumption was that, while the estimate for tributary habitat mortality is likely in error, reductions beyond pristine in the model can be made to improve the abundance of Hood winter steelhead. The previous assumption about what amount of survival improvement is feasible (50%) was applied. Although negative mortality rates are not realistic, significant improvements can be made to habitat quality in the Hood.

The reduction in hydro impact is a result of the removal of Powerdale Dam and not diverting water for its operation.

Table 6-35. Threat reduction and VSP scenarios for Hood summer steelhead. The beginning of Section 6.2.2 describes the table contents. Limiting factor codes in the tables can be found in Chapter 5.

Species (Run): **STEELHEAD (Summer)** — Population: **Hood**

Historic Abundundance: 3,822

Threat Level	Life History Stages	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation
Key	Adult					7c	
	Juvenile	5d, 6e	3a, 3b, 5b, 6c				
Secondary	Adult			4a	7a		8d
	Juvenile	1a, 5a, 5c, 6a, 6g, 8a, 9a, 9c	1a, 6e, 9a, 9b, 9c, 9d	4a			8b

		Mortality Rates of Threats: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Cumulative Mortality	% Mortality Improvement	Abundance	VSP Extinction Risk Class: A&P	Diversity	Spatial Structure	Overall	Delisting Scenario	Confidence	A&P Need
Current Status		95.42%	8.60%	35.80%	15.00%	53.00%	14.70%	**99.08%**	---	35	VH	H	VL	VH	---	---	---
Threat Reduction Options	20% - All	76.34%	6.88%	28.64%	12.00%	42.40%	11.76%	**92.97%**	6.17%	269	VH	H	VL	VH	---	---	---
	Max Harvest and Hatchery	95.42%	8.60%	35.80%	5.00%	0.00%	14.70%	**97.82%**	1.27%	83	VH	VL	VL	VH	---	---	---
	Max Feasible - All	65.00%	7.00%	16.00%	15.00%	0.00%	8.00%	**78.62%**	20.65%	817	H	VL	VL	H	---	---	---
	Min Trib Habitat	95.42%	7.00%	16.00%	15.00%	0.00%	8.00%	**97.20%**	1.90%	107	VH	VL	VL	VH	---	---	---
	Maintain into Future	95.42%	7.00%	16.00%	15.00%	53.00%	8.00%	**98.68%**	0.40%	50	VH	H	VL	VH	---	---	---
	Low Extinction Risk	14.00%	7.00%	16.00%	15.00%	0.00%	8.00%	**47.46%**	52.10%	2,008	L	VL	VL	L	Primary	Unlikely	1,973
	Very Low Extinction Risk	-0.25%	7.00%	16.00%	5.00%	0.00%	8.00%	**31.55%**	68.16%	2,616	VL	VL	VL	VL	---	---	---

The elimination of the hatchery impact will occur through the elimination of hatchery releases of summer steelhead in the Hood.

The reduction in hydro impact is a result of the removal of Powerdale Dam and not diverting water for its operation.

Achieving the Delisting Scenario would require tributary habitat reductions believed to be more than is feasible. The Max Feasible - All scenario option indicates that it is "unlikely" that the chosen Delisting Scenario will be achieved.

Summary

Tables 6-36 through 6-39 summarize the results of the Scenario Analysis for each population.

Note that Table 6-36 indicates there are significant challenges for Delisting Scenarios to achieve their desired status in the Gorge stratum, as discussed previously in this chapter. This means that the delisting criteria contained in this plan and established by the WLC-TRT are also unlikely to be met (i.e, the number of viable populations and the average population score within affected strata are likely to be reduced even further than indicated in Table 6-1). The challenges include the small amount of historical or current habitat available within each of these populations compared to other populations within the ESUs (and thus the concomitant limited options for restoration), anthropogenic impacts compounded on smaller populations that are unlikely to change in the near future (e.g., roads, dams, reservoirs, water quality, water quantity), high uncertainty and low precision within the data, models, and analyses relative to the smaller population sizes[42], and potentially inaccurate designation of population structure for this stratum. Most of these issues are related to the last one (population structure designation), and Oregon suggests re-evaluating the Gorge stratum population structure for all species in order to address recovery with this stratum. A more complete discussion of this issue is located in Appendix B (see also Section 2.4). If desired statuses are not achieved and the Gorge population structure is not revised, some form of compensation in the adjacent Cascade stratum should be considered as an alternative delisting criterium, and was factored into Delisting Desired Statuses determinations.

[42] This may be manifest in the fact that a high proportion of the populations for which the CATAS-derived low extinction risk threshold (plus the 20% buffer for future unknowns) is 50% or greater of the independently derived historic population abundance is unlikely to achieve risk status improvements.

Table 6-36. Summary of the current status and Delisting Scenario from the Scenario Analysis. Although chum were not included in the CATAS current status analysis (Chapter 4) or Scenario Analysis, their current and delisting desired status from Section 6.1 are indicated here. Populations that are unlikely to achieve their delisting desired status are indicated with red text ("Unlikely"). The desired status (overall risk class) for populations which are not part of an ESA-listed ESU are indicated in parenthesis. The overall risk class for both the Oregon portion of shared populations (indicated by an asterisk), and the entire population (in parenthesis, determined by Washington), are indicated.

		Current		Delisting Scenario				
Species / Stratum (Run)	Population	Abundance	Overall Risk Class	Contribution to Delisting	Abundance	A&P Gap	Overall Risk Class	Confidence
COHO								
Coast								
	Youngs Bay	4	VH	Stabilizing	7	3	VH	Exceed
	Big Creek	8	VH	Stabilizing	12	4	VH	Exceed
	Clatskanie	1,363	H	Primary	3,201	1,838	VL	Achieve
	Scappoose	1,942	M	Primary	3,208	1,266	VL	Exceed
Cascade								
	Clackamas	6,548	M	Primary	11,232	4,684	VL	Exceed
	Sandy	1,622	VH	Primary	5,685	4,063	L	Achieve
Gorge								
	*Lower Gorge**	22	VH	*Support WA (L)*	962	940	H (L)	Achieve
	Upper Gorge/Hood	41	VH	Primary	5,203	5,162	L	Unlikely
CHINOOK								
Coast (Fall)								
	Youngs Bay	379	H	Stabilizing	505	126	H	Exceed
	Big Creek	216	VH	Contributing	577	361	H	Achieve
	Clatskanie	6	VH	Primary	1,277	1,271	L	Exceed
	Scappoose	356	H	Primary	1,222	866	L	Exceed
Cascade (Fall)								
	Clackamas	558	VH	Contributing	1,551	993	M	Exceed
	Sandy	144	VH	Contributing	1,031	887	M	Achieve
Gorge (Fall)								
	*Lower Gorge**	74	VH	*Support WA (M)*	387	313	H (M)	Achieve
	*Upper Gorge**	17	VH	*Support WA (M)*	87	70	VH (M)	Achieve
	Hood	33	VH	Primary	1,245	1,212	L	Unlikely
Cascade (Late Fall)								
	Sandy	1,794	L	Primary	3,858	2,064	VL	Achieve
Cascade (Spring)								
	Clackamas	1,371	M	*N / A*	8,377	7,006	*(VL)*	Achieve
	Sandy	714	M	Primary	1,230	516	L	Exceed
Gorge (Spring)								
	Hood	327	VH	Primary	1,493	1,166	VL	Exceed
STEELHEAD								
Coast (Winter)								
	Youngs Bay	2,486	VL	*N / A*	4,733	2,247	*(VL)*	Achieve
	Big Creek	1,143	L	*N / A*	3,182	2,039	*(VL)*	Achieve
	Clatskanie	2,451	VL	*N / A*	3,982	1,531	*(VL)*	Achieve
	Scappoose	3,245	VL	*N / A*	5,169	1,924	*(VL)*	Achieve
Cascade (Winter)								
	Clackamas	3,897	M	Primary	10,671	6,774	L	Unlikely
	Sandy	674	H	Primary	1,519	845	VL	Exceed
Gorge (Winter)								
	*Lower Gorge**	550	M (H)	*Support WA (L)*	881	331	M (L)	Achieve
	*Upper Gorge**	151	VH (H)	*Support WA (H)*	235	84	VH (H)	Achieve
	Hood	1,127	M	Primary	2,079	952	L	Exceed
Gorge (Summer)								
	Hood	35	VH	Primary	2,008	1,973	L	Unlikely
CHUM								
Coast								
	Youngs Bay	E	VH	Stabilizing	TBD	---	VH	---
	Big Creek	E	VH	Stabilizing	TBD	---	VH	---
	Clatskanie	E	VH	Primary	TBD	---	L	---
	Scappoose	E	VH	Primary	TBD	---	L	---
Cascade								
	Clackamas	E	VH	Contributing	TBD	---	M	---
	Sandy	E	VH	Primary	TBD	---	L	---
Gorge								
	*Lower Gorge**	E	VH (L)	*Support WA (VL)*	TBD	---	VL	---
	*Upper Gorge**	E	VH	*Support WA (M)*	TBD	---	M	---

Table 6-37. Summary of the percent improvement required for each threat category in order to achieve the delisting desired status. Shared populations with Washington are indicated by an asterisk.

		% Improvement of Threats (Delisting Scenario)						
Species / Stratum (Run)	Population	Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Cumulative
COHO								
Coast								
	Youngs Bay	1.20%	22.33%	---	0.00%	0.00%	46.43%	0.02%
	Big Creek	0.94%	22.33%	---	0.00%	0.00%	46.43%	0.04%
	Clatskanie	18.04%	22.33%	---	28.57%	23.08%	33.33%	11.93%
	Scappoose	7.42%	22.33%	---	28.57%	0.00%	33.33%	6.26%
Cascade								
	Clackamas	0.00%	22.33%	24.05%	28.57%	71.43%	37.50%	10.18%
	Sandy	37.11%	22.33%	100.00%	28.57%	0.00%	37.50%	22.54%
Gorge								
	*Lower Gorge**	33.47%	22.33%	---	28.57%	87.50%	37.50%	21.37%
	Upper Gorge/Hood	91.50%	22.33%	14.50%	85.71%	100.00%	31.51%	58.63%
CHINOOK								
Coast (Fall)								
	Youngs Bay	0.00%	19.25%	---	6.67%	0.00%	28.57%	0.85%
	Big Creek	27.54%	19.25%	---	7.69%	0.00%	28.57%	4.21%
	Clatskanie	20.26%	19.25%	---	41.67%	88.89%	23.08%	8.86%
	Scappoose	2.64%	19.25%	---	41.67%	88.89%	23.08%	7.12%
Cascade (Fall)								
	Clackamas	0.00%	19.25%	---	41.67%	66.67%	17.81%	4.51%
	Sandy	31.15%	19.25%	100.00%	41.67%	66.67%	17.81%	14.55%
Gorge (Fall)								
	*Lower Gorge**	28.08%	19.25%	---	41.67%	33.33%	17.81%	10.76%
	*Upper Gorge**	27.43%	19.25%	0.00%	38.46%	33.33%	23.08%	8.63%
	Hood	100.00%	100.00%	43.85%	100.00%	100.00%	100.00%	89.24%
Cascade (Late Fall)								
	Sandy	27.86%	15.86%	100.00%	40.00%	80.00%	17.81%	25.15%
Cascade (Spring)								
	Clackamas	34.73%	15.79%	76.47%	0.00%	84.62%	42.15%	26.64%
	Sandy	0.94%	15.79%	100.00%	0.00%	81.48%	42.15%	1.97%
Gorge (Spring)								
	Hood	8.84%	15.79%	65.62%	0.00%	88.89%	55.13%	7.92%
STEELHEAD								
Coast (Winter)								
	Youngs Bay	40.30%	15.79%	---	0.00%	50.00%	46.90%	28.42%
	Big Creek	55.73%	15.79%	---	0.00%	75.00%	46.90%	41.50%
	Clatskanie	32.02%	15.79%	---	0.00%	0.00%	40.17%	22.08%
	Scappoose	30.30%	15.79%	---	0.00%	0.00%	40.17%	21.03%
Cascade (Winter)								
	Clackamas	63.73%	15.79%	3.85%	0.00%	56.52%	42.15%	39.18%
	Sandy	1.54%	15.79%	100.00%	0.00%	80.77%	42.15%	7.67%
Gorge (Winter)								
	*Lower Gorge**	33.02%	15.79%	---	0.00%	0.00%	42.15%	21.11%
	*Upper Gorge**	40.25%	18.60%	0.00%	0.00%	0.00%	39.39%	17.60%
	Hood	0.00%	18.60%	55.31%	0.00%	66.67%	39.39%	35.34%
Gorge (Summer)								
	Hood	85.33%	18.60%	55.31%	0.00%	100.00%	45.58%	52.10%
CHUM								
Coast								
	Youngs Bay	---	---	---	---	---	---	---
	Big Creek	---	---	---	---	---	---	---
	Clatskanie	---	---	---	---	---	---	---
	Scappoose	---	---	---	---	---	---	---
Cascade								
	Clackamas	---	---	---	---	---	---	---
	Sandy	---	---	---	---	---	---	---
Gorge								
	*Lower Gorge**	---	---	---	---	---	---	---
	*Upper Gorge**	---	---	---	---	---	---	---

Table 6-38. Summary of harvest and hatchery stray rates used in the Scenario Analysis. The harvest[43] and hatchery stray rates[44] used in the Scenario Analysis[45] for shared populations with Washington are indicated by an asterisk.

		Harvest Mortality Rates		Hatchery Stray Rates	
Species / Stratum (Run)	Population	Current	Delisting Scenario	Current	Delisting Scenario
COHO					
Coast					
	Youngs Bay	90.00%	90.00%	86.00%	86.00%
	Big Creek	70.00%	70.00%	86.00%	86.00%
	Clatskanie	35.00%	25.00%	13.00%	10.00%
	Scappoose	35.00%	25.00%	5.00%	5.00%
Cascade					
	Clackamas	35.00%	25.00%	35.00%	10.00%
	Sandy	35.00%	25.00%	9.00%	9.00%
Gorge					
	*Lower Gorge**	35.00%	25.00%	80.00%	10.00%
	Upper Gorge/Hood	35.00%	5.00%	80.00%	0.00%
CHINOOK					
Coast (Fall)					
	Youngs Bay	75.00%	70.00%	90.00%	90.00%
	Big Creek	65.00%	60.00%	90.00%	90.00%
	Clatskanie	60.00%	35.00%	90.00%	10.00%
	Scappoose	60.00%	35.00%	90.00%	10.00%
Cascade (Fall)					
	Clackamas	60.00%	35.00%	90.00%	30.00%
	Sandy	60.00%	35.00%	90.00%	30.00%
Gorge (Fall)					
	*Lower Gorge**	60.00%	35.00%	90.00%	60.00%
	*Upper Gorge**	65.00%	40.00%	90.00%	60.00%
	Hood	70.00%	0.00%	90.00%	0.00%
Cascade (Late Fall)					
	Sandy	50.00%	30.00%	50.00%	10.00%
Cascade (Spring)					
	Clackamas	25.00%	25.00%	65.00%	10.00%
	Sandy	25.00%	25.00%	54.00%	10.00%
Gorge (Spring)					
	Hood	25.00%	25.00%	90.00%	10.00%
STEELHEAD					
Coast (Winter)					
	Youngs Bay	10.00%	10.00%	20.00%	10.00%
	Big Creek	10.00%	10.00%	40.00%	10.00%
	Clatskanie	10.00%	10.00%	5.00%	5.00%
	Scappoose	10.00%	10.00%	5.00%	5.00%
Cascade (Winter)					
	Clackamas	10.00%	10.00%	23.00%	10.00%
	Sandy	10.00%	10.00%	52.00%	10.00%
Gorge (Winter)					
	*Lower Gorge**	10.00%	10.00%	10.00%	10.00%
	*Upper Gorge**	15.00%	15.00%	10.00%	10.00%
	Hood	15.00%	15.00%	30.00%	10.00%
Gorge (Summer)					
	Hood	15.00%	15.00%	53.00%	0.00%

[43] Note that the harvest rates are those used in our analyses, and are not necessarily those recommended in this Plan as absolute annual targets for harvest management. For coho and fall Chinook these rates represent modeled long term averages of harvest rates, but the actions described in Chapters 7 and 9 should be used to determine the actual annual and long-term harvest rates (e.g., sliding scale harvest matrix based on weak stock management). See Appendix D for the most recent allowable harvest limits.
[44] The hatchery stray rate is the same as the mortality rate used in the analyses for coho, steelhead, and Clackamas spring Chinook. The hatchery stray rate is twice the mortality rate for all other Chinook.
[45] It is unlikely that the rate reductions for Upper Gorge/Hood coho and Hood fall Chinook can be met. The "Max Feasible-All" scenario rates listed in Tables 6-12 and 6-21, respectively, are most likely to be achieved.

Table 6-39. Summary of tributary habitat potential and needs for coho. High intrinsic potential ("HIP") encompasses stream reaches with a combination of gradient, mean annual stream flow, and "valley constraint" that result in conditions that, in the absence of anthropogenic disturbance, are believed to have the highest potential for the creation of high quality habitat for overwintering juvenile coho. HIP does not address the current condition of habitat. "High quality habitat necessary" lists the needs for achieving the Delisting Scenario, as well as the maximum feasible improvements. If only moderate quality habitat is created, double what is listed for high quality would be required to achieve the same adult abundance increases46.

Species / Stratum (Run)	Population	HIP Stream Miles	Historic Total Habitable Stream Miles	High Quality Habitat Necessary	
				Delisting Scenario	Max Feasible Scenario
COHO					
Coast					
	Youngs Bay	115	271	0	20
	Big Creek	49	162	0	10
	Clatskanie	81	188	19	19
	Scappoose	150	299	10	24
Cascade					
	Clackamas	164	544	0	61
	Sandy	41	174	37	37
Gorge					
	*Lower Gorge**	8	84.5	10	10
	Upper Gorge/Hood	20	150	53	10

6.3 Species Life-cycle Analysis Modules (SLAM)

Species Life-cycle Analysis Modules (SLAM) is a tool designed to model life-cycle dynamics and can be used to evaluate the effect of management actions on population abundance and viability. The SLAM tool was used to check results generated using the CATAS model and address its limitations, as well as perform a "risk analysis" of whether the threat reductions identified to achieve the delisting desired status were sufficient (similar in concept to other risk analyses such as Beamesderfer 2007 and 2010). SLAM was used to model life-stage specific stochasticity, density dependence, delays in the effects of management changes, and cyclic patterns like inter-decadal ocean oscillations. However, since building each model (i.e. each scenario) is quite time-consuming, models in SLAM were only created for those scenarios that were most likely to be realized. Generally this was the delisting scenario and a second model for either the broad sense scenario (maximum improvements in excess of the risk level target) or the most probable scenario (maximum possible improvements for those populations where the target could not be attained). The SLAM and time-series generators created by Paul McElhany, Mirek Kos and Anne Mullan are available at http://www.nwfsc.noaa.gov/trt/slam/slam.cfm.

SLAM uses repeated random sampling via a Monte Carlo simulation to generate multiple trajectories for a given scenario. Statistics on the population of trajectories, such as the mean or median trajectory with quantiles, the absolute distribution at a given time point, or the percent of trajectories that fall below a threshold value can then be used to describe the scenario. The number of individuals is tracked through different life stages based on the survival rates from one stage to the next. Further details about development of the life cycle models and parameterization can be found in Appendix F.

[46] Although our modeling approach indicates that no additional miles of high quality habitat are needed for several populations to strictly reach the delisting desired status, we fully support efforts to protect and restore habitat in order to assure healthy populations into the future, meet broad sense and most probable recovery goals, and be precautionary against model and future uncertainty.

Comparison to CATAS

The probability that the population abundance modeled in SLAM, using the threat reductions identified in the Scenario Analysis, would fall below the critical risk threshold (CRT) based on the parameter values for a specific risk scenario was compared to the CATAS model's probability of extinction. See Appendix F for SLAM metadata. In general there was very good concordance between the results of the two models types. In 30 out of 50 cases each model predicted the same risk category (Table 6-40). In 7 of the remaining 20 cases the risk category was one step removed in one model type versus the other. In general, when populations were strong SLAM tended to predict a lower risk than the CATAS-derived results. There were four populations for which SLAM predicted a higher risk of extinction than CATAS, and in three of these cases the current abundance was below or near the CRT.

Delays in Survival Improvement

If the population abundance is already below the CRT, it is easy to see how delays in implementation, or in realizing survival improvements, could have a substantial impact on the proportion of trajectories where the population abundance falls below the CRT.

Table 6-40. Comparison of two PVA Models (CATAS and SLAM). Models were constructed under both CATAS and SLAM that brought the population to the same equilibrium abundance. The probability of extinction was then calculated for each model. This determined the risk category for the population. The Delisting Scenario (CATAS risk classes) for populations which are not part of an ESA-listed ESU are indicated in parenthesis. The Delisting Scenario (CATAS risk classes) for both the Oregon portion of shared populations (indicated by an asterisk), and the entire population (in parenthesis, determined by Washington), are indicated. CRT = critical risk threshold.

		Current Status A&P Extinction Risk Class			Delisting Scenario A&P Extinction Risk Class		
Species / Stratum (Run)	Population	Abundance	CATAS	SLAM	Abundance	CATAS	SLAM
COHO							
Coast							
	Youngs Bay	4	VH	VH	7	VH	---
	Big Creek	8	VH	VH	12	VH	---
	Clatskanie	1,363	H	VL	3,201	VL	VL
	Scappoose	1,942	M	VL	3,208	VL	VL
Cascade							
	Clackamas	6,548	M	VL	11,232	VL	VL
	Sandy	1,622	VH	VH	5,685	L	VL
Gorge							
	*Lower Gorge**	22	VH	VH	962	H (L)	VH
	Upper Gorge/Hood	41	VH	VH	5,203	L	---
CHINOOK							
Coast (Fall)							
	Youngs Bay	379	H	H	505	H	---
	Big Creek	216	VH	H	577	H	H
	Clatskanie	6	VH	VH	1,277	L	H
	Scappoose	356	H	H	1,222	L	H
Cascade (Fall)							
	Clackamas	558	VH	VH	1,551	M	M
	Sandy	144	VH	VH	1,031	M	H
Gorge (Fall)							
	*Lower Gorge**	74	VH	VH	387	H (M)	H
	*Upper Gorge**	17	VH	VH	87	VH (M)	VH
	Hood	33	VH	VH	1,245	L	---
Cascade (Late Fall)							
	Sandy	1,794	L	VL	3,858	VL	VL
Cascade (Spring)							
	Clackamas	1,371	M	---	8,377	*(VL)*	---
	Sandy	714	M	---	1,230	L	---
Gorge (Spring)							
	Hood	327	VH	---	1,493	VL	---
STEELHEAD							
Coast (Winter)							
atus to meet TRT criteria	Youngs Bay	2,486	VL	VL	4,733	*(VL)*	VL
	Big Creek	1,143	L	VL	3,182	*(VL)*	VL
	Clatskanie	2,451	VL	VL	3,982	*(VL)*	VL
	Scappoose	3,245	VL	VL	5,169	*(VL)*	VL
Cascade (Winter)							
	Clackamas	3,897	M	VL	10,671	L	VL
	Sandy	674	H	VL	1,519	VL	VL
Gorge (Winter)							
	*Lower Gorge**	550	M (H)	VL	881	M (L)	VL
	*Upper Gorge**	151	VH (H)	VL	235	VH (H)	VL
	Hood	1,127	M	VL	2,079	L	VL
Gorge (Summer)							
	Hood	35	VH	VH	2,008	L	---

That the two vastly different modeling approaches (CATAS and SLAM) give such similar results provides confidence in the projections. However, it is also clear that when the current population

abundance is low relative to the CRT it is important to use a model that can take delays in recovery implementation into account.

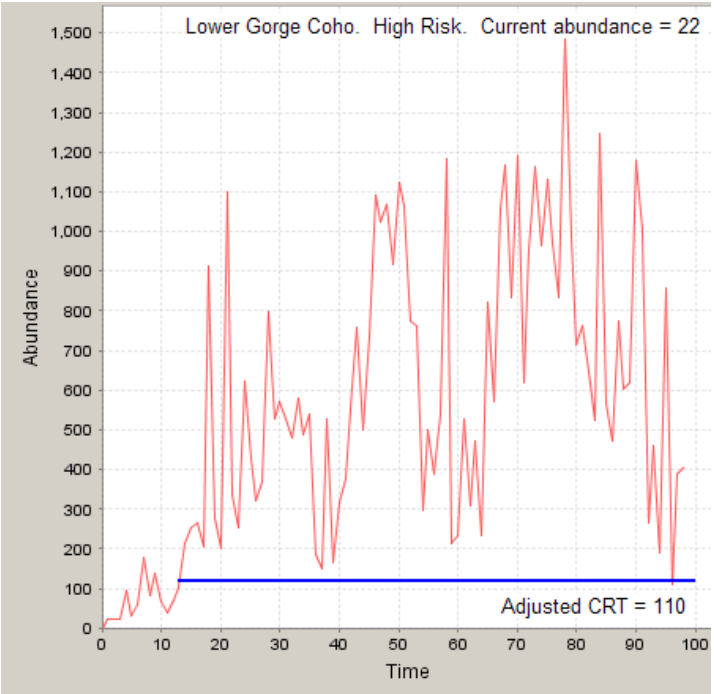
Examination of the individual trajectories for the four populations where risk was higher in SLAM than in CATAS illustrates why delays in implementation of improvements can result in higher estimates of extinction risk. The results for Lower Gorge coho are indicative of the pattern seen for all four of the populations. The model was allowed to equilibrate until it stabilized at the current abundance and then the proportion of trajectories where the number of naturally spawning adults fell below the CRT for 3 consecutive years (coho) or 4 consecutive years (Chinook and steelhead) determined the risk category. In the High Risk Lower Gorge coho model for the Delisting Scenario, no trajectories go extinct after year 22, but several trajectories go extinct between year 11 and year 21 (Figure 6-3), and the risk assessment period was not initiated until year 11 when the model had equilibrated and the mean trajectory reached the current abundance.

Since delays in improvements increased risk estimates for some depressed populations, additional models were constructed without delays to evaluate the importance of delays for different impact categories. For all four populations, immediate imposition of hatchery and harvest improvements resulted in very little change from the original model (Table 6-41 and Figure 6-4). Immediate implementation of habitat improvements, on the other hand, increases the mean abundance by the same magnitude and does so almost immediately. Immediate increases of freshwater capacity and productivity resulted in immediate increases in abundance and a decrease in risk below that predicted by CATAS for two of the populations in question. This makes sense considering how the different impacts work on populations. Removal of harvest or hatchery impacts reduces mortality, but if abundance is already very low you'll have a few more fish, but still very few overall. However, if the reproductive capacity is increased (by improving freshwater habitat), a few fish can create many more fish relatively quickly.

Table 6-41. Extinction probability with and without delays in key impact categories for four populations with low initial abundance. Original risk is the target based on the risk determined by the CATAS model. No hatchery or harvest (HH) delay indicates that there was no delay in the implementation of improvements in hatchery and harvest impacts. Freshwater capacity and productivity values were immediately improved for the models under No freshwater (FW) delay.

Species	Population	Original Risk	Probability <CRT			
			CATAS	SLAM	No HH delay	No FW delay
Coho	Lower Gorge	High	0.452	0.865	No change	0.125
Fall Chinook	Clatskanie	Low	0.000	0.039	No change	0.002
Fall Chinook	Scappoose	Low	0.002	0.032	0.011	0.000
Fall Chinook	Sandy	Moderate	0.004	0.605	No change	0.130

(Figure 6-3A)



(Figure 6-3B)

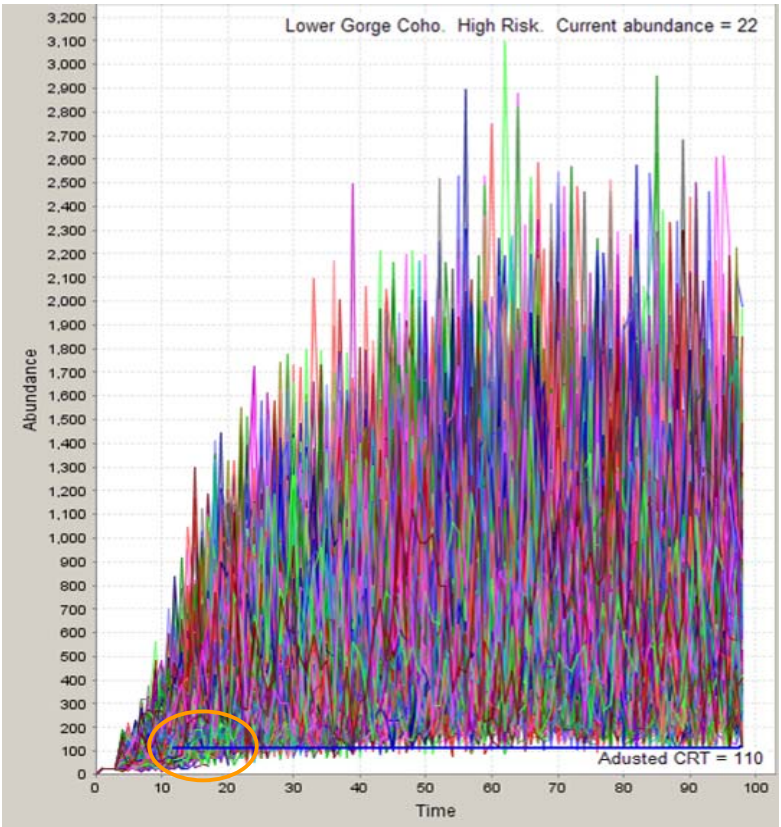


Figure 6-3. A) A single random trajectory for the Lower Gorge coho population and B) all 1,000 trajectories for the Lower Gorge coho population. The line near the bottom of the graph indicates the Critical Risk Threshold (CRT). The threshold has been adjusted to account for unmarked adult spawners that are the offspring of hatchery fish that spawned in the wild. The model was allowed to equilibrate until the mean

trajectory stabilized at the current abundance. The proportion of trajectories where the number of naturally spawning adults fell below the CRT for 3 consecutive years determined the risk of extinction. For this population the period examined for extinctions began in year 11. No trajectories went extinct after year 22, but several trajectories do go extinct during the period from year 11 to year 21 while the mean abundance is increasing from current levels.

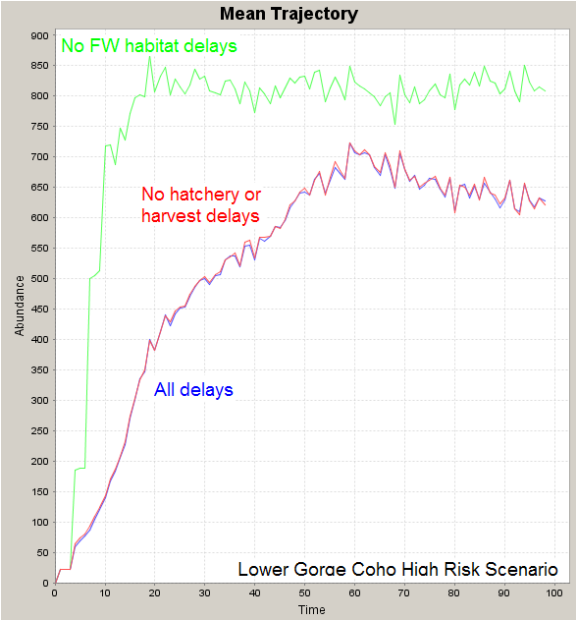


Figure 6-4. Mean trajectories with and without delays in implementation for key impact categories. Lower Gorge coho are shown as an example; trends were similar for all populations for which this analysis was completed.

Given this relationship, it is intuitive to try to improve freshwater habitat conditions immediately. Unfortunately this category is the most intractable of all of the threat categories. One can't make trees grow faster or cause geomorphologic processes to progress faster. However these results do encourage efforts to put habitat improvements in place and to carefully protect habitat in the face of increasing urbanization and climate change.

In conclusion, two different PVA models were used to assess risk to Lower Columbia salmonid populations. Both models gave similar results in almost all cases. In the few cases where the two models differed, the combination of very low current abundance and delays in improvements resulted in higher risk estimates in SLAM. Delays in freshwater habitat improvements had the largest impact on risk. It is advised that multiple PVA models be used when evaluating population extinction risks.

Chapter 7: Strategies and Actions

To successfully recover Oregon lower Columbia populations of salmon and steelhead, strategies must be devised and actions implemented that are effective at both reducing or eliminating the limiting factors and threats that currently impact viability as identified in Chapter 5, and prevent factors that do not currently impact viability from doing so in the future. Because of the diverse life-history of lower Columbia salmon and steelhead populations and the broad array of limiting factors and threats that affect them, strategies and actions are needed that span their entire life-cycle and address all limiting factor and threat categories. The level to which these strategies and actions must be implemented is based on the biological risk and threat reduction scenarios that were described in Chapter 6, the achievement of which will ultimately be determined through RME described in Chapter 8. This chapter describes the strategies and actions needed to address the current impacts as well as those needed to prevent future impacts. An attempt is made at the end of the chapter to estimate the costs of implementing these strategies and actions.

7.1 Conceptual Framework

7.1.1 Key Components

The development of a comprehensive action plan to recover Oregon's lower Columbia salmon and steelhead populations is based on the consideration of the following key components:

- *Threats* – human actions or natural occurrences that cause or contribute to limiting factors.
- *Limiting Factors* – physical, biological, or chemical conditions and associated ecological processes and interactions experienced by the fish that may influence viable salmonid population parameters.
- *Biological Risk Scenarios* – objectives for improvement in each population from the current status to a desired future status.
- *Threat Reduction Scenarios* - objectives for reducing each threat affecting any population to achieve a desired status.
- *Strategies* – general statements about how threat reduction scenarios will be achieved.
- *Actions* – specific activities that are used to accomplish strategic objectives.
- *Priority Areas* – physical locations (e.g. specific stream reaches) where an action will have the greatest beneficial effect *and* where the implementation of that action is most feasible.
- *Programs* – regulatory and non-regulatory mechanisms or projects that govern and/or implement actions.

The relationship between these components is shown in Figure 7-1. The development of the strategies and actions needed to recover Oregon's lower Columbia salmon and steelhead populations began with the assessment of limiting factors and threats described in Chapter 5. Because many of these limiting factors and threats are life-stage and geographically specific, the Planning Team identified priority locations where specific actions are needed to address the limiting factors. A number of overarching strategies, which can be achieved by implementation of specific on-the-ground actions, were then developed to provide an ecological context and foundation for identifying the actions. Once the strategies and actions were identified, the programs and/or entities that could implement them, as well as related costs, were identified.

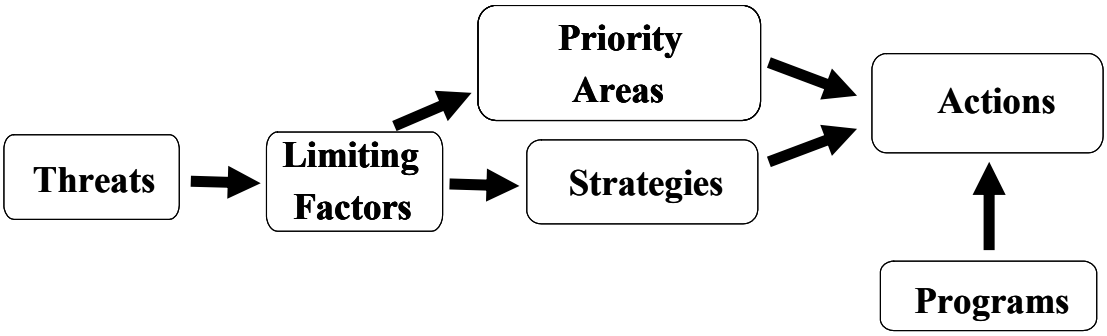


Figure 7-1. Relationship between key components of developing and implementing actions for recovering lower Columbia salmon and steelhead populations.

7.1.2 General Strategies

The strategies developed for this Plan are founded on a firm belief that the following basic goals of conservation biology (Trombulak et al. 2004) are critical to the recovery of lower Columbia salmon and steelhead populations:

- Biological diversity[47]
- Ecological integrity[48]
- Ecological health[49]

Achieving these goals in the context of this Plan requires strategies that incorporate the following principles:

- Act to alleviate the impacts of all threat categories to the viability of lower Columbia salmon and steelhead populations throughout their entire life cycle
- Restore ecosystems that have been degraded
- Protect functional habitat and prevent further degradation
- Ensure that areas with high quality habitat are not adversely impacted by human activities
- Manage fisheries so their impacts on wild salmon and steelhead populations are compatible with recovery goals
- Manage hatchery fish so their impacts on wild salmon and steelhead populations are compatible with recovery goals
- Reduce impacts of predation that are specifically related to anthropogenic alterations to the ecosystem
- Prevent the establishment of non-native species, and where necessary eliminate non-native species that have become established
- Act as quickly as possible to achieve the goals of this Plan

Most of these guiding principles are self explanatory. The last principle (act as quickly as possible to achieve the goals of this Plan) deserves further discussion. This principle is based on the fact that most lower Columbia salmon and steelhead populations are at a moderate, high, or very high risk of extinction.

[47] Biological diversity is a measure of the range of variety and variability within and among living organisms and the ecological complexes in which they occur.
[48] Ecological integrity is a measure of the composition, structure, and function of biological systems.
[49] Ecological health is a measure of a biological system's resiliency and ability to maintain itself over time.

For those populations that are targeted in Chapter 6 (Recovery Scenarios) for lower risk levels, it is critical that actions be implemented as quickly as possible to achieve the risk level goals. This particularly applies to tributary habitat actions, which modeling in Chapter 6 indicated needed more immediate implementation to avoid added extinction risks. The urgency for implementation of tributary habitat actions is especially critical given the time it may take for some of these actions to have their full benefit (e.g., riparian planting) and restore ecological processes.

Based on these principles, 14 recovery strategies were developed to guide the development of actions needed to recover lower Columbia salmon and steelhead populations. These strategies, along with their relation to the general categories of threats that impact the recovery of lower Columbia salmon and steelhead populations are shown in Table 7-1.

The fact that there are many more management strategies listed for habitat related categories than for harvest and hatchery management should not be interpreted as a bias of this Plan toward placing the burden of recovery disproportionately on the backs of those responsible for managing habitat. This is not the case. The larger number of management strategies identified for habitat related categories is simply due to the fact that many more factors can contribute to current habitat conditions compared to the number related to harvest and hatchery impacts. For example, restoring degraded habitat in a watershed may entail strategies to address floodplain connectivity and function, riparian condition, passage impairment, inadequate streamflows, lack of habitat complexity, and degraded water quality. On the other hand, reducing the impact of fish harvest to levels that are needed for recovery simply involves a strategy to reduce fishery harvest rates.

Table 7-1. Strategies to recover lower Columbia River salmon and steelhead populations and their relevance to the general threats impacting those populations.

Strategy		General Threat Category Addressed				
		Fish Harvest	Hatchery Mgmnt.	Hydro/Flood Control	Landuse	Invasive Species
1-	Protect and conserve natural ecological processes that support the viability of wild salmon and steelhead populations and their life history strategies throughout their life cycle.	√	√	√	√	√
2-	Restore floodplain connectivity and function and maintain unimpaired floodplain connectivity and function.			√	√	
3-	Restore riparian condition and LWD recruitment, and maintain unimpaired conditions.			√	√	
4-	Restore passage and connectivity to habitats blocked or impaired by artificial barriers, and maintain unimpaired passage and connectivity.		√	√	√	
5-	Restore and maintain hydrologic regimes that support the ecological needs of wild salmon and steelhead populations.			√	√	
6-	Restore channel structure and complexity, and maintain unimpaired structure and complexity.			√	√	
7-	Restore impaired food web dynamics and function, and maintain unimpaired dynamics and function (both impacts of competition for food resources and altered ecosystem function).		√	√	√	√
8-	Restore degraded water quality and maintain unimpaired water quality.			√	√	
9-	Restore degraded upland processes to minimize unnatural rates of erosion and runoff, and maintain natural upland processes.				√	
10-	Reduce the impact of non-native plants and animals on wild salmon and steelhead populations and prevent the introduction of new non-native plants and animals				√	√
11-	Reduce predation on wild salmon and steelhead that has been exacerbated by anthropogenic changes to the ecosystem.		√	√	√	√
12-	Manage fisheries so that harvest impacts do not compromise the recovery of wild salmon and steelhead populations.	√				
13-	Manage hatchery origin fish in ways that support the recovery of wild salmon and steelhead populations.		√			
14-	Reduce or eliminate other anthropogenic sources of mortality (e.g. beach stranding of juveniles due to ship wakes in the estuary) and prevent them from becoming a problem in areas where they currently do not occur.	√	√	√	√	√

7.1.3 Development of Actions

The actions identified below were developed by the Planning Team with assistance from members of the Stakeholder Team. Only those actions that address a key or secondary limiting factor, as described in Chapter 5, are included in this Plan. For several populations, reach-scale assessments have been

completed that allowed the Planning Team to identify reach- or stream-specific locations for actions to be implemented. For the other populations that did not have watershed assessments, the Planning Team used its professional judgment to identify locations for implementing specific actions. An action has been identified in each population that is lacking a reach-scale assessment to conduct one, and to better define the highest priority areas for recovery actions to be implemented. This Plan has the highest likelihood of being successful in the shortest amount of time if actions that address the key and secondary limiting factors can be implemented in those areas where the greatest benefit will result. This approach will also ensure that the greatest gains in recovery can be made if funds to implement actions are limited.

Building on Past and Current Efforts

Many steps have already been taken or are currently underway that will improve the status of Lower Columbia River salmon and steelhead populations in Oregon. Significant efforts have gone into restoring impaired habitat conditions in both tributary streams and the estuary. In the mainstem Columbia River, hydrosystem and fish resource managers continue to refine hydropower system operations to address the needs for survival and recovery of ESA-listed salmon and steelhead. Hatchery programs have been modified substantially over the past 10 years to reduce threats posed by hatchery fish. Virtually all hatchery salmon and steelhead released from Oregon into the Lower Columbia are now being fin-clipped to allow mark-selective fisheries on hatchery fish and to identify hatchery fish at traps and on the spawning grounds. Releases have shifted to strategies in size and location of release that reduce the level of straying. The use of non-local brood stocks has mostly been discontinued, as has the practice of out-planting surplus hatchery adults. Significant changes in both the mainstem and tributary harvest management have also already been implemented to reduce the impacts of many fisheries[50].

Much of this effort has been based on guidance provided by a number of management plans that have been developed for the region over the last few decades. See Appendix G for a listing of these plans. Many of the actions identified for this recovery plan originate in these earlier plans. Specifically, actions from these plans that address priority (i.e., key or secondary) limiting factors and threats were identified as actions for this Plan.

Successful implementation of this Plan relies on the combined effort of state and federal agencies, local governments, watershed councils, soil and water conservation districts, non-profit organizations, local land owners and others committed to the recovery of lower Columbia salmon and steelhead populations. Most, if not all, of these entities have existing programs that have contributed in the past and in the future will be integral to the implementation of the actions identified in this Plan. Some of these programs are capable of accomplishing their goals with the resources at hand, while others are in need of additional resources in order to fully implement necessary actions. See Appendix H for a listing and description of the key programs that will be involved in implementing many of the actions identified in this Plan.

Enhanced Effort and Innovative Actions

Although past and current efforts undoubtedly play an important role in the recovery of lower Columbia salmon and steelhead populations there is an obvious need for enhanced effort and innovative approaches. The actions identified for this Plan represent a mixture of continuing actions that are currently working, enhancing the effort for actions that should work if more resources are available for their implementation, and new and innovative actions that are not currently being implemented.

Uncertainty - Research, Monitoring, and Evaluation

As with developing the biological and threat reduction scenarios, there is uncertainty associated with the level of improvement the populations will accrue from many of the specific actions identified in this

[50] See Chapter 5 (Limiting Factors and Threats) for a more detailed description of the history of habitat, hydropower, harvest, and hatchery impacts.

chapter. As a result, it is also difficult to determine the level to which these actions must be implemented in order to achieve the level of threat reductions called for in the scenarios outlined in Chapter 6. Research, monitoring and evaluation (RME) will be needed to determine the effectiveness of these actions.

Survival improvements are not uniformly uncertain for all actions. Actions related to harvest reductions have the least uncertainty – a known reduction in harvest will result in a commensurate survival improvement. Actions related to tributary and estuary habitat improvements have possibly the most uncertainty associated with them, although there is less uncertainty related to the survival improvements to be gained from coho salmon tributary habitat actions than for those actions targeted at the other species or in the estuary. This is due to the extensive work that has been done related to coho on the Oregon Coast related to habitat, seeding levels and survival (Nickelson 1998).

In many respects the threats and limiting factors identified and prioritized in Chapter 5, and the actions needed to address them described in this chapter, are hypotheses that need to be tested. To test these "hypotheses" it will be important that enhanced and innovative RME be implemented to support the adaptive management of this Plan. Some monitoring and evaluation needs are identified as actions in this chapter. A detailed description of all RME needs is described in Chapter 8.

Linking Actions to Recovery Goals

The recovery scenarios described in Chapter 6 provide targets for the relative survival improvements that are needed within each major threat category in order to improve the viability of each lower Columbia salmon and steelhead population to the levels needed to recover the ESU. The actions outlined in this chapter were developed through the planning process to address each threat category and, based on professional judgment and our more general modeling efforts, if implemented sufficiently and in total, should provide the necessary survival improvements to achieve the desired status necessary to de-list these ESUs under the ESA. As was noted in Chapter 6, there is uncertainty associated with some of the scenarios to delist some of the ESUs. If recovery is possible in all of the ESUs, the actions identified here should lead to delisting. To achieve the broad sense recovery goal, the same actions as are necessary to achieve delisting are required, only in a greater quantity and/or applied in different populations. A sense of the greater magnitude and additional actions can be gathered by considering the increased survival improvements described in Chapter 6 for the broad sense scenarios.

Ideally, the contribution that each action has toward closing the gap between current status and desired status should be identified so that a quantitative assessment can be made as to whether or not the actions in this Plan will, when considered in total, achieve the goals of this Plan. Unfortunately, the current understanding of the benefits of many of the habitat actions precludes a meaningful assessment. Instead, this Plan will rely heavily on the RME described in Chapter 8 to provide timely information on both the overall progress being made toward achieving recovery goals and the contribution of individual actions. If insufficient progress is being made toward achieving recovery goals, or individual actions are deemed to not be working, the actions implemented for this Plan will be modified as part of the adaptive management process outlined in Chapter 9. Modifications will be based upon the new information gathered by RME.

Immediate Action

A recurring theme that surfaced during discussions with both the Planning and Stakeholder Teams was the need for immediate actions that would "stop the bleeding" and prevent a further decline in the status of salmon and steelhead populations in ESUs that are already at high risk of extinction. The actions identified in this Plan represent a combination of actions that will have a relatively immediate impact on reducing significant threats to lower Columbia salmon and steelhead populations (e.g. harvest and hatchery actions) as well as actions that will take a longer time before benefits are realized (e.g. some

habitat actions). For this Plan to succeed, it is important that short-term and long-term, as well as protective actions, be implemented as soon as possible to stop the decline and begin reducing the risk of extinction on lower Columbia salmon and steelhead populations. Utilizing the priority setting process identified in Chapter 9 will identify the actions that are the most urgent to implement.

Actions to Address Future Threats
In addition to detailed descriptions of current threats and limiting factors, Chapter 5 provides a brief overview of what may be in store for lower Columbia salmon and steelhead populations in view of the predicted impacts of climate change and human population growth. For this Plan to succeed, it is important that actions be implemented now that prevent or mitigate for these future impacts.

7.2 Overarching Strategies and Actions Needed for Recovery

The actions identified in Section 7.3 are intended to address current and future limiting factors and threats to the salmon and steelhead populations in the Oregon portions of the Lower Columbia River ESUs. These actions are intended to reduce the impacts to individual populations to levels called for in the recovery scenarios outlined in Chapter 6. Many of these actions call for the investigation of uncertainties related to developing actions that address a particular threat. Once these uncertainties have been resolved, actions will be defined through the adaptive management process outlined in Chapter 9. The actions listed in Section 7.3 are intended to meet the following overarching objectives for each threat category, which are summarized in Table 7-2.

7.2.1 Land/Water Management - Tributary Habitat

Tributary habitat actions are focused on protecting and restoring stream habitat (adequate pools/glides/riffles, side channels, cover structures, spawning gravels) and water quality/quantity. Providing a diversity of pools, glides and riffles creates a diversity of habitats for fish to utilize for rearing and migration. Side channels and floodplains are important in the winter for small fish to seek refuge in when winter storms cause high flows and velocities that can sweep young fish into less favorable habitats, or even to the ocean, well before their bodies are ready. Cover structures provide hiding places for young fish to avoid predators, or create slow moving water that fish can hold in during high flows. Cover in the form of vegetation can support invertebrates that serve as a food source for fish, or can help cool the water. Providing clean spawning gravels in ample amounts allows adult salmon and steelhead to have plenty of quality areas to spawn and ensures high egg to fry survival, as opposed to gravel that has high levels of silts and sands that cannot be dug up or prevent adequate water flow for incubating eggs. Water quality and quantity must be adequate for fish to live and migrate in. Water quality and quantity improvements come from throughout the drainage and are transferred downstream, so actions in headwater areas that improve water quality will provide benefits for a considerable distance downstream. For mainstem spawners like Chinook and chum, improvements in water quality and quantity will come from actions taken in multiple tributary streams. To create complex stream habitat that interacts with the floodplain, there are short-term and long-term approaches. In the short-term, actions are proposed to help encourage the placement of large wood in streams to create complexity. These actions are intended to bridge the gap until long-term actions begin providing benefits. In the long-term, creating or improving/maintaining riparian areas to provide a continual source of large wood along with benefits to water quality/quantity and complexity are proposed. Actions are proposed to identify sources of sediment entering streams and approaches to reduce or eliminate those sources. Actions are also identified to reduce the impacts of water withdrawals. Tributary habitat actions specific to Chinook and chum salmon are difficult to define because of their use of more mainstem-type of habitat. RME will help identify site-specific actions for Chinook and Chum in the future. Most improvements to their preferred habitats will come from the actions identified above that are implemented in upstream areas for coho and steelhead.

7.2.2 Land/Water Management - Estuary Habitat

Estuary habitat actions seek to protect and restore habitat complexity (shallow waters, side channels, cover vegetation and structures, riparian areas, wetlands), habitat accessibility (tide gates, other structures) and water quality/quantity. Many of these actions came from Estuary Module and apply to the mainstem Columbia from its mouth to Bonneville Dam and the Lower Willamette below Willamette Falls. The actions identified seek to prevent and reduce invasive species; reduce impacts of development activities; reduce pollutants; and restore and protect off channel, side channel, and riparian habitats. In many instances the mechanisms of the impacts or techniques to reduce them are poorly understood and actions are identified for research.

7.2.3 Hydropower/Flood Control Management

Actions to address the impacts of hydropower and flood control dam/reservoir operations are targeted at reducing passage mortality, and restoring more natural flows, temperatures and sediment levels. These actions are intended to increase survival and create better habitat and food sources in the target river and estuary for juvenile salmon and steelhead. Some of the actions identified are based on implementation of operational agreements with federal agencies. In some instances studies and workgroups are proposed to better understand the level of change needed and how to make the desired changes to dam/reservoir operations. The FCRPS BiOp and additional actions proposed by the State of Oregon will play a major role in addressing hydropower/flood control threats in the Columbia mainstem and estuary, and Upper Gorge and Hood populations. FERC agreements and actions will play a role in specific tributaries.

Table 7-2. Summary of overarching threat category strategies and actions for population areas and ESUs.

Population Area	Tributary Habitat	Estuary Habitat	Hydro
All - Within Tributaries	• identify, prioritize, and protect existing high quality/functioning habitat • identify, prioritize, and restore existing degraded habitat • **Chum**: coordinate restoration in conjunction with ChF activities • **ChF, Chum**: realize benefits from CO, St, ChS upper trib restoration work	---	---
All - Mixed Locations	---	• implement Estuary Module actions (with LCR-specific additions; vital component of **ChF, late ChF, and Chum** recovery)	• implement FCRPS BiOp (with State of Oregon additions), including reducing impacts in estuary
Youngs Bay	---	---	---
Big Creek	---	---	---
Clatskanie	---	---	---
Scappoose	---	---	---
Clackamas	• (protection is primary for some species) • implement PGE's FERC Agreement	---	• implement PGE's FERC Agreement
Sandy	• implement City of Portland's HCP	---	• addressed with PGE's removal of Marmot and Little Sandy Dams
Lower Gorge	• (roads/rails make restoration difficult)	---	---
Upper Gorge	• (roads/rails and Bonneville Dam inundation make restoration difficult)	---	• implement FCRPS BiOp (with State of Oregon additions), including reducing impacts in estuary
Hood	---	---	• implement FCRPS BiOp (with State of Oregon additions), including reducing impacts in estuary • proceed with Powerdale Dam removal

Table 7-2 (continued).

Population Area	Harvest	Hatchery
All - Within Tributaries	---	• reduce stray rates to target levels by one or more of the following: - identify source - program changes (reduce, eliminate, shift) - operation changes • mark all hatchery fish released • **ChF**: determine need for reintroduction • **Chum**: use hatchery stock for reintroduction (within Coast stratum initially)
All - Mixed Locations	• **Co, Chf, late ChF**: implement weak stock management • revise (**CO**) and implement (**ChF, late ChF**) sliding scale harvest matrix • **CO:** move toward mark-selective, terminal, commercial fisheries • **ChF, late ChF**: move toward mark-selective fisheries • **late ChF**: protect and assure there is no selection pressure from harvest	• **ChF, late ChF, Chum**: reduce impacts of all hatchery species in estuary (competition)
Youngs Bay	• maintain harvest opportunity in terminal/SAFE areas (**CO, ChF**)	• accept higher hatchery risk to maintain terminal/SAFE fisheries • reduce stray rates to target levels: maintain and/or create "wild fish-only areas"
Big Creek	• maintain harvest opportunity in terminal/SAFE areas (**CO, ChF**)	• accept higher hatchery risk to maintain terminal/SAFE fisheries • reduce stray rates to target levels: maintain and/or "wild fish-only areas"
Clatskanie	---	• reduce stray rates to target levels: maintain existing "wild fish-only area" (no hatchery fish stocked)
Scappoose	---	• reduce stray rates to target levels: maintain existing "wild fish-only area" (no hatchery fish stocked)
Clackamas	---	• reduce stray rates to target levels: maintain existing "wild fish-only area"
Sandy	---	• reduce stray rates to target levels: **ChS**: reduce stray rate due to Marmot Dam removal
Lower Gorge	---	• reduce stray rates to target levels: investigate new "wild fish-only area(s)"
Upper Gorge	---	• reduce stray rates to target levels: investigate new "wild fish-only area(s)"
Hood	---	• reduce stray rates to target levels: establish new "wild fish-only areas" (weirs) after Powerdale Dam is removed • **ChS**: evaluate efficacy of out-of-basin reintroduction stock • **CO**: determine need for reintroduction

Table 7-2 (continued).

Population Area	Predation	RM&E
All - Within Tributaries	---	• understand/monitor harvest, hatchery, habitat impacts • monitor wild populations • address critical uncertainties • adaptively manage based on new information • **ChF**: understand wild populations' status and hatchery influence prior to making the limited hatchery or harvest changes within OR-WA regional control
All - Mixed Locations	• Estuary Module actions (with LCR-specific additions; vital component of **ChF, late ChF, and Chum** recovery)	• understand/monitor harvest, hatchery, habitat impacts • monitor wild populations • address critical uncertainties • adaptively manage based on new information
Youngs Bay	---	---
Big Creek	---	---
Clatskanie	---	• identify level and source of stray hatchery fish • complete reach-scale assessment
Scappoose	---	• identify level and source of stray hatchery fish • complete reach-scale assessment
Clackamas	---	---
Sandy	---	---
Lower Gorge	---	• re-assess stratum and population status and adjust recovery goals accordingly
Upper Gorge	• reduce pinniped predation at Bonneville Dam	• re-assess stratum and population status and adjust recovery goals accordingly
Hood	• reduce pinniped predation at Bonneville Dam	• re-assess stratum and population status and adjust recovery goals accordingly

While actions are included from the Federal Columbia River Power System BiOP (NMFS Fisheries 2008c) in Section 7.3, it is the position of the State of Oregon that additional or alternative actions should be taken in mainstem operations of the FCRPS for ESA listed salmon and steelhead. Some additional or alternative actions recommended by Oregon, while considered, were not included in the FCRPS action agencies' proposed action or NOAA's FCRPS Biological Opinion. At the time this proposed recovery plan was being finalized, Oregon was a plaintiff in litigation against various federal agencies, including NOAA, challenging the adequacy of the measures contained in the current FCRPS Biological Opinion.

7.2.4 Harvest Management

General

Actions related to harvest seek to keep or reduce harvest to levels that do not inhibit recovery[51]. A better understanding of what the actual impacts of harvest are on all species and populations is desired. For coho and Chinook, harvest matrices are proposed that protect a weak grouping of populations, while providing for fisheries when survival and escapements are high. Additional information needs are

[51] See Appendix D for the most recent allowable harvest limits.

defined to shift the existing strong stock-based matrices to weak stock-based matrices (or matrix) for coho and to develop a matrix for fall Chinook. Current terminal and Select Area fisheries will remain, with higher harvest levels, near the Youngs Bay and Big Creek population areas[52]. Mark-selective fisheries for hatchery coho and fall Chinook are proposed for both sport and commercial fisheries where they are not currently in place, if practicable techniques and gear can be developed.

Coho

Significant changes to harvest management in the past 15 years have drastically reduced the impact of harvest on wild LCR coho. Where impacts to wild coho once were 70 to 90 percent, currently they are less than half of that rate. Coho salmon in the lower Columbia are currently managed for incidental impact to wild coho from selective fisheries on hatchery fish. Annual allowable impact rates are set by the PFMC in consultation with NMFS and are based on application of an abundance-based, sliding scale harvest matrix (see Section 6.2.1 for further information). We propose to continue using this management approach into the future with modifications to be made based on a better understanding of the wild LCR coho populations.

The threat scenarios that have been developed for Oregon's LCR coho populations include an average future harvest impact rate of 25 percent for each population. This is the projected average over 100 years and will be controlled by the harvest matrix on an annual basis. The matrix will vary the annual allowable impact based on parental escapements and marine survival. As an example, the allowable impact rates for LCR coho have been 20 percent or less the last five years. These years represented moderate to low marine survival conditions. The 100-year average used in our modeling assumes marine survival will vary, but will average something close to moderate conditions[53].

The harvest matrix has been used to determine harvest impacts on wild LCR coho since 2002. Application of the matrix has been based on determining the status of the Clackamas and Sandy coho populations and scaling the impact on their respective abundances and marine survival conditions. Since these were the only populations in the LCR coho ESU that were monitored, this was the best approach we could develop. Unfortunately, these two populations are believed to be the strongest of the populations in the ESU and this harvest management does not consider how the weaker populations are fairing and whether they could maintain their existence, or rebuild to recovery levels under the impact rates called for in the harvest matrix.

Oregon has implemented monitoring of all of its LCR coho populations the last eight years and has programs in place to continue monitoring into the future. We propose to work with Washington and other harvest managers to review the harvest matrix and revise it based on "weak stock management" – protecting a weak grouping of populations in the ESU (likely within the Coast stratum considering the uncertainty involving the appropriateness of a Gorge stratum with independent populations). This will base future allowable harvest rates on the status of the weak grouping of populations and ensure that those populations can rebuild to levels consistent with recovery and maintain those levels once they are reached. The revised LCR coho harvest matrix will be submitted to NMFS for their approval.

For the Youngs Bay and Big Creek populations of coho, Oregon has decided to allow these populations to remain at high risk of extinction to facilitate the terminal fisheries that currently are implemented in these areas. Commercial terminal fisheries will continue with the objective of harvesting as many hatchery fish as possible. As a result, these fisheries will not be mark-selective and some risk of fishery-related

[52] See ISRP & IEAB (2005), ISRP & IEAB (2007), and North et al. (2006) for summaries and reviews of the SAFE program.
[53] If some projections of the effect of climate change are correct, the marine survival conditions could average something less than moderate. If this occurs, the average impact rate called for by the harvest matrix will be lower than the 25% used in the threat scenarios.

mortality on the wild Youngs Bay and Big Creek populations will remain. However, these fisheries occur primarily on early returning hatchery fish. The intent of this Plan is to recover the late arriving wild coho populations and manage the fisheries in such a way that they will not significantly impact these populations. If this can be accomplished, it may be possible to maintain natural production in these areas and achieve a better delisting risk classification than identified in this Plan.

Harvest impacts to wild fish are primarily based on calculated impacts for hatchery fish from the same area. There is some level of uncertainty that the estimated harvest impact for wild LCR coho is accurate. For this reason, we propose to better understand how the various fisheries impact wild LCR coho populations. To gain this understanding, an action is proposed to tag wild coho smolts from each population to allow identification of the origin and timing of unmarked fish encountered in sport and commercial fisheries. The details of such a study will need to be fleshed out prior to the actual tagging.

Fall Chinook

Fishery-related mortality on LCR fall Chinook has decreased over the past 30 years from a high near 70 percent to a current average near 40 percent (see Appendix D). LCR Chinook salmon are harvested in the ocean primarily off of SE Alaska, British Columbia and the Washington coast. The ocean fishery targets mixed stocks of Chinook from Oregon, Washington, British Columbia and Alaska. At least half of the total harvest impact on LCR Chinook comes from the SE Alaska and British Columbia fisheries. Ocean harvest is managed by the Pacific Salmon Commission as directed by the international Pacific Salmon Treaty (PST) and a bilateral agreement approved by the governments of Canada and the United States of America. The bilateral agreement was recently renegotiated and will expire at the end of 2018. The new agreement reduces the impact of SE Alaska and Canadian fisheries on LCR fall Chinook populations and calls for an evaluation of moving the Canadian fishery to become mark-selective (harvesting only marked hatchery fish) to further protect weak stocks. A timeline for implementing mark-selective fisheries was not specified in the agreement.

Oregon and Washington have outlined a process to evaluate the feasibility of moving all Chinook fisheries (ocean and Columbia River/tributaries, sport and commercial) to become mark-selective. The process to evaluate feasibility includes developing and testing new commercial gear and techniques that allow for the safe handling and release of unmarked wild Chinook. The feasibility of such fisheries is currently being explored and full implementation, if feasible, will occur within 20 years. See Section 7.3.3 for more discussion about these actions.

Oregon is committed to developing a harvest management framework for fall Chinook that considers forecasted abundances, marine survival conditions and weak stocks to ensure adequate escapement for recovery (similar to that discussed for coho). Because there are information gaps that need to be filled before a framework can be developed, actions to fill those gaps are identified as the first steps in this process. Any framework developed will be presented to NMFS for approval.

Based on the conditions of the bilateral agreement under the PST, and the potential for mark-selective fisheries in the Columbia River and tributaries, harvest co-managers determined that a feasible long-term average fishery-related mortality rate, under current international harvest regimes and with action implementation, on LCR fall Chinook will average 35 percent in the future. This assumes that ocean fisheries will not be shifted to mark-selective. If mark-selective fisheries are implemented in ocean fisheries off Alaska and British Columbia, the long-term fishery-related mortality may be projected at a rate lower than 35 percent. Note that, rather than this long-term average, a sliding scale harvest matrix based on weak stock management is intended to set short-term harvest allowances. Prior to development of such a harvest matrix, co-managers are expected to continue determining annual, or other short-term timeframe, harvest rates consistent with recovery objectives, through appropriate scientific analyses, and based upon the best and most recent monitoring information.

For the Youngs Bay and Big Creek populations of fall Chinook, Oregon has decided to allow these populations to remain at high risk of extinction to facilitate the terminal fisheries that currently are implemented in these areas. Commercial terminal fisheries will continue with the objective of harvesting as many hatchery fish as possible. As a result, these fisheries will not be mark-selective and fishery-related mortality on the wild Youngs Bay and Big Creek populations will remain high. It may be possible to manage these fisheries in such a way that late arriving fall Chinook will not be impacted significantly by the terminal fisheries. If this can be accomplished it may be possible to maintain some level of natural production in these areas.

Oregon has one population of late fall Chinook in the Sandy River Basin. This population appears to be relatively healthy and is harvested at a lower rate than LCR fall Chinook. Oregon's harvest strategy for this population is to ensure that it maintains its viability by keeping harvest rates low. This will be done through the evaluation of proposed changes in PST managed fisheries to determine what impact they will have on Sandy late fall Chinook and recommending against those changes that are likely to increase the harvest impact.

Spring Chinook

LCR spring Chinook are affected by fisheries in the ocean (SE Alaska, British Columbia), Columbia River and tributaries. Fishery-related mortality on wild LCR spring Chinook is estimated at 25 percent (McElhany et al. 2007). Fisheries targeted at spring Chinook in the Columbia River and tributaries are mark-selective and impacts are associated with catch and release mortality. Ocean and Columbia River impacts are determined by NMFS and consider impacts to LCR, as well as Upper Willamette and Snake River spring Chinook.

Oregon considers the current fishery-related mortality rate of 25 percent to be consistent with recovery of wild spring Chinook populations. As a result, current fishery management is proposed to continue. Actions being taken to address harvest impacts on other species might be applied to fisheries on spring Chinook through adaptive management, if deemed necessary. At this time, no harvest mortality improvement has been identified in the scenarios shown in Chapter 6.

Steelhead

Wild steelhead are not targeted for commercial harvest. Some incidental mortality occurs on winter steelhead during spring Chinook commercial fisheries, but gear type is required that minimizes the impact. Sport harvest of steelhead, both winter and summer, is restricted to mark-selective fisheries on hatchery fish. Incidental catch and release mortality to wild steelhead is believed to be low. The cumulative impact of commercial and sport harvest on steelhead has been calculated to be less than 10 percent. This level of mortality is believed to be consistent with the recovery of wild populations and as a result, the current steelhead harvest management is proposed to continue. There is directed take of wild steelhead in tribal fisheries above Bonneville Dam, but the level of impact has not been well documented. There is some concern that the cumulative fishery-related mortality for the Upper Gorge and Hood populations of wild steelhead may be 15 percent or more, which may limit the recovery of these wild populations. As a result of this concern, actions are proposed to work with tribal fisheries staff to determine ways to potentially lessen the impact – such as extending closed areas near the mouths of steelhead streams, or modifying season length or timing.

Chum

There are no directed fisheries on Columbia River chum. Chum may be incidentally caught in ocean and Columbia River fisheries, but this is rarely documented. This may be due to the extremely low numbers of chum that enter the Columbia, or they may enter the river at a time when there are few fisheries in

place. More information is needed to determine if fishery-related mortality on chum is limiting their recovery or not. There are no actions proposed that relate to fishery impacts to chum.

7.2.5 Hatchery Management

Interactions between wild and hatchery fish are the focus of actions related to hatcheries. Actions seek to gain a better understanding of what the actual level of naturally spawning hatchery fish is in some areas, and to determine if competition with hatchery fish is having a significant impact on wild populations - the marking of all hatchery fish released is essential to gaining this knowledge. Where interactions are found, actions related to adjusting hatchery releases, modifying hatchery techniques, or removing returning hatchery fish are proposed. Wild fish sanctuaries are proposed to be maintained above barriers with traps and in streams with no hatchery releases.

7.2.6 Predation Management

Increased rates of predation are associated with alterations of stream and estuarine habitats. Actions to address predation focus on reducing the impact of fish, bird, and pinniped predators.

7.2.7 Chum Salmon Recovery

As previously described in Chapter 6, developing realistic recovery scenarios for Oregon's Columbia River chum populations is hampered by a lack of basic information on current mortality rates associated with each of the major threat categories. This, plus the fact that six years of surveys (ODFW, unpublished data) found that few, if any, naturally produced chum currently exist in most of Oregon's lower Columbia streams showed that the recovery strategy for chum should be one of re-establishment. Because very few hatchery or wild chum have been documented in Oregon lower Columbia streams for quite some time, Oregon is taking an aggressive approach to re-establish chum[54]. The intent of the aggressive approach for chum re-establishment is to gather information and develop techniques on re-establishing chum in Oregon. The Chum Recovery Strategy (CRS)[55] starts with research, monitoring and evaluation throughout the Oregon side of the Columbia River chum ESU to determine the availability of adequate habitat for chum. Based on the habitat assessment, the strategy will focus on a) developing and implementing techniques to reintroduce chum, first in the Coastal stratum and in other areas of the ESU using those techniques that are successful, and b) concurrently proceeding with habitat protection and restoration throughout the ESU and likely in conjunction with fall Chinook habitat restoration. The decision whether to reintroduce or to allow natural colonization to re-establish individual populations in the Cascade and Gorge strata will be based on the outcome of specific efforts (both reintroduction in the Coast stratum and habitat assessment and restoration results throughout the ESU). If there seems to be available habitat but too few individuals to colonize it, reintroduction will likely be necessary. Conversely, if habitat is unsuitable and chum re-colonize after restoration efforts, this approach will likely be preferred. Ultimately the determination of how best to recover chum through time will be made based upon cumulative data and experience, and in coordination with co-managers.

Much of the information gathered and habitat restoration undertaken for chum will also be applicable to fall Chinook and improving the status of that ESU. The CRS is based on eight key elements:

1. Identify methods for re-establishing chum populations
2. Identify target populations
3. Identify habitat suitable for chum
4. Identify and obtain brood source for use in reintroduction

[54] This approach is not yet being proposed for fall Chinook, as spawning fall Chinook have been regularly documented in Oregon LCR streams. A similar approach as that identified for chum may be considered for fall Chinook if monitoring shows that little or no natural production of fall Chinook is occurring in Oregon streams.
[55] The Chum Recovery Strategy is contained in Appendix I.

5. Identify facilities for use in conservation hatchery program
6. Identify production goals and program duration
7. Identify artificial production techniques
8. Identify release strategies for reintroduction program

These elements outline the steps to be taken to re-establish chum, but certain specific details have yet to be developed. A Chum Recovery Workgroup will be formed to develop the details to implement the CRS and monitor the success of actions taken. The Workgroup will also help expand chum recovery efforts to the other strata in the Oregon side of the ESU. Implementing the CRS, including implementing the habitat restoration actions described in the following sections of this chapter and the RME described in Chapter 8 and the CRS, should provide a solid foundation to ensure success in recovering Oregon's CR populations of chum salmon.

7.3 Priority Actions

7.3.1 Common Actions

Table 7-3A provides actions common to all Oregon lower Columbia salmon and steelhead populations. Some of these actions represent the continuation of ongoing efforts, while others will require enhancements of existing efforts in order to achieve the recovery goals set out in this Plan. More detailed information on these actions, including priority locations, and estimated costs and implementation timeframes, may be found in Chapter 9.

The actions listed in Table 7-3A address common threats to all lower Columbia salmon and steelhead populations. Site-specific actions are needed in addition to these common actions to improve or maintain the status of each individual ESU to the level required for recovery. Site-specific actions were developed with the help of the Planning and Stakeholder Teams, and utilized any watershed assessments and action plans that have been completed for these population areas. Table 7-3B-D provide the actions that are specifically needed to address the current key and secondary limiting factors and threats to each of the lower Columbia salmon and steelhead ESUs, as outlined in Chapter 5.

As previously mentioned, for steelhead, coho, and Chinook, the gains in survival identified in the recovery scenarios described in Chapter 6 serve as the side boards for determining where efforts and resources can best be allocated to achieve recovery. Actions that address those threat categories that require the most improvement should have a higher priority than actions that address a threat category that is only targeted for a slight improvement. Within a threat category, actions in areas that are believed to result in a significant improvement in survival should be prioritized above those actions in areas that are believed to result in a marginal improvement. To provide this context, preceding a listing of the population specific actions in Section 7.3.3 is the Chapter 6 Scenario Analysis information that show the survival gains needed in each major threat category to achieve delisting. Survival improvement gains are not shown for chum because we currently of the lack of adequate information to conduct scenario modeling on these populations.

7.3.2 Actions to Address Future Threats of Climate Change and Human Population Growth

Although implementation actions to address the key and secondary threats and limiting factors that are currently impairing Oregon's lower Columbia salmon and steelhead populations is crucial to the success of this Plan, actions must also be in place to ensure that conditions that are not currently impaired do not become so in the future. As indicated in Chapter 5, climate change and human population growth are two such future threats that potentially pose disastrous consequences to the long term recovery of lower Columbia salmon and steelhead populations.

One way that this Plan attempts to mitigate for the potential impacts of climate change and population growth is incorporated into the recovery scenarios described in Chapter 6. All of the scenarios described, incorporated an additional 20 percent improvement in survival above that needed to achieve strata delisting goals. While it is difficult, if not impossible to predict the exact impact of future climate change and human population growth, this additional survival improvement goal is intended to set the bar for recovery above that strictly needed to close the current gap. This higher bar will hopefully provide a buffer for managers and scientists to obtain the results from RME projects designed to provide information on the specific impacts of these future threats as well as the effectiveness of mitigation actions. Once better estimates of the impacts of these future threats are known, and the amount of survival improvement gained from implemented actions can be estimated, the adaptive management process used to implement this Plan can make adjustments in the level and types of actions needed to address future threats.

That is not to say that this Plan does not include actions that should provide significant relief to impacts posed by future climate change and human population growth. Many of the actions that have been described previously in this chapter that address both current key and secondary limiting factors and threats will also help to ameliorate the impacts of future climate change and human population development. These actions are identified in Table 7-3.

7.3.3 Action Tables

The following Table (Table 7-3A through 7-3E) contains actions to address the limiting factors and threats identified in Chapter 5 and the Delisting Scenarios and desired statuses chosen in Chapter 6. Note that Section 9.1.3: Action Priorities indicates how to determine which of these actions are implemented relative to a specific population or ESU.

Table 7-3. Actions needed to address the threats and limiting factors for Lower Columbia River ESUs and populations, including actions for A) all ESUs, B) Lower Columbia River coho, C) Lower Columbia River Chinook, D) Lower Columbia River steelhead, and E) Columbia River chum. The threat category and limiting factors which each action addresses are indicated. An "x" means that the action also has connection to the other indicated threat category (e.g., hydropower impacts which were modeled under the estuary threat). Actions which address future threats are also indicated ("cc" = climate change; "pg" = population growth). To distinguish between FCRPS actions and additional actions recommended by the State of Oregon, "RPA" at the beginning of an action indicates the "reasonable and prudent alternatives" (actions) identified in the FCRPS BiOp, and "OR" identifies alternative actions recommended by the State of Oregon. "CRE" ("Columbia River estuary") indicates an action contained in the Estuary Module. Note that actions addressing specific limiting factors and threats for a population may be contained a) within the actions listed specifically for that population, b) within tributary or "mixed location" actions listed for all populations of the specific species, and/or c) within tributary or "mixed location" actions listed for all populations and all species. "Mixed locations" are within the estuary, plume, or ocean. Actions with limiting factor codes that are not applicable to a specific population also apply to other populations within that tributary. Limiting factor codes in the table can be found in Chapter 5. Notes for specific actions appear at the end of the table.

Table 7-3A. Proposed actions to address threats and limiting factors for all ESUs.

Table 7-3A. Actions to Address Threats and Limiting Factors for all ESUs		Threats and Limiting Factors						Future Threats
Action ID	Action	Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	
All Populations - Within Tributaries (All ESUs)								
1 - Trib	Continue the release of hatchery fish as smolts to reduce competition and predation with wild fish in tributaries and estuaries.	1a	1a, 8c			x	x	
2 - Trib	Investigate the feasibility of coordinated release timing among hatcheries, to reduce the numbers of out-migrating hatchery fish in-river at any one time.[56]	1a	1a, 8c			x	x	
3 - Trib	Eliminate/reduce/shift program: To decrease mainstem and estuary competition and predation and reduce straying of hatchery fish onto natural spawning grounds, investigate and/or implement hatchery release reductions or program shifts to lower river terminal areas; include out-of-ESU programs and programs with surplus hatchery fish returns which are not harvested.[57]	1a	1a, 8c			7c	x	
4 - Trib	Require hatchery programs/releases that are new, or increased more than 10% from 2009 levels, to complete or modify an HGMP and receive ODFW Fish Division approval; require reduced or eliminated programs to withdraw or modify their HGMP.	1a	1a, 8c			7c	x	

[56] Many factors affect the specific release timing of hatchery fish, including the fish's stage of development, production and operational needs of the hatchery, and environmental conditions. To coordinate release timing across the entire Columbia River basin would be very complicated and would likely necessitate a large number of compromises between competing needs.
[57] The exact level of competition and predation impact in the estuary is unknown. Hatchery production program reductions and shifts would result in fishery modifications that could cause social and political concerns. Managers may be reluctant to propose or make such changes without adequate conservation justification.

Table 7-3A. Actions to Address Threats and Limiting Factors for all ESUs

Action ID	Action	Threats and Limiting Factors						Future Threats
		Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	
5 - Trib	Maintain screens and fish passage structures.	4a, 4b, 4c, 4d, 4e		x		x		
6 - Trib	Develop recommendations for land management scenarios that address hydrograph changes due to climate change, impervious surfaces, and other factors that result in altered water runoff.	5c						cc
7 - Trib	Limit future in-river and groundwater withdrawals so that they do not impede achievement of recovery goals.	5c						cc
8 - Trib	Develop options for water banking and implement.	5c						cc
9 - Trib	Develop and/or implement stormwater management plans for urban areas and roads.	5c, 6a, 9a, 9d						cc
10 - Trib	Protect and restore riparian areas to improve water quality, provide long-term supply of large wood to streams, and reduce impacts that alter other natural processes.	5c, 6b, 6e, 9a, 9c, 9d						cc
11 - Trib	Assure adequate regulations are in place to protect existing high quality habitat and eliminate, or reduce and fully mitigate, impacts of future development (with cities, counties, ODLCD, ODA, ODEQ, etc…).	5c, 6b, 6e, 9a, 9c, 9d						cc, pg
12 - Trib	Develop methodology to assess and identify, and then protect, stream reaches and population strongholds which will be resilient/resistant to climate change impacts.	5c, 9a						cc
13 - Trib	Protect and restore headwater rivers and streams (salmon and non-salmon bearing) to protect the sources of cool, clean water and normative hydrologic conditions.	5c, 9a, 9c, 9d						cc
14 - Trib	Conduct sediment source analysis and then implement actions to reduce sediment from identified sources.	6a						cc
15 - Trib	Coordinate and streamline efforts to restore impaired instream habitat complexity, access to off-channel habitat, and riparian conditions.	6e, 9a						cc
16 - Trib	Streamline permitting process for large wood placement for streams not covered by Forest Practices Act.	6e, 9a						cc
17 - Trib	Implement credible, science-based programs, policies and rules that contribute collectively to protect fish and water resources.	6e, 9a						cc, pg
18 - Trib	Provide adequate funding and staffing for existing programs to achieve their mandates.	6e, 9a						
19 - Trib	Adequately fund and implement research needed to answer critical uncertainties related to the assumptions under which the recovery plan was developed.	6e, 9a						cc
20 - Trib	Develop joint ODF/ODFW/ODA/ODSL team to more clearly describe the large wood goals and potential ways to achieve these goals.	6e, 9a						cc

Table 7-3A. Actions to Address Threats and Limiting Factors for all ESUs

Action ID	Action	Threats and Limiting Factors						Future Threats
		Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	
21 - Trib	Provide education on the goals of recovery plans, what is needed to achieve these goals, and how citizens can contribute.	6e, 9a						cc
22 - Trib	Support funding for outreach efforts that educate and engage landowners, including Coffee Klatches and Oregon Small Woodland Owner's Howdy Neighbor events.	6e, 9a						cc
23 - Trib	Fund OSU Extension Service to provide Riparian Function Workshops for all Oregon Plan participants to improve success rate of volunteer projects.	6e, 9a						cc
24 - Trib	Provide education and outreach to contractors, developers, and resource owners.	6e, 9a						pg
25 - Trib	Provide enhanced incentives for habitat restoration work, including: a) Rewarding and assisting landowners doing the 'extra' work needed to achieve recovery goals, and b) Developing an equitable system of recognition and rewards for both landowners who are not regulated and landowners who are regulated.	6e, 9a						cc
26 - Trib	Participate in the development of emerging ecosystem markets and ensure they are shaped to be consistent with recovery goals and actions.	6e, 9a						cc
27 - Trib	Provide liability protection for landowners that participate in restoration projects.	6e, 9a						
28 - Trib	Explore land use strategies and regulations to reduce ownership fragmentation, including, but not limited to, acknowledging the importance of family owned forests and supporting actions that help sustain working family owned forests.	6e, 9a						
29 - Trib	Promote and provide technical support for volunteer efforts of private landowners and user groups to increase the amount of large wood in stream channels (e.g. site-specific riparian management plans, placement of large wood, reducing removal).	6e, 9a						cc
30 - Trib	Update floodplain and channel migration maps and incorporate into land use planning; include projected future floodplains resulting from climate change.	6e, 9a						cc, pg
31 - Trib	Develop regulations to ensure that there is no impact from future new development and re-development in the 100-year floodplain (including stormwater, wetlands, vegetation, etc.).	6e, 9a						pg
32 - Trib	Prohibit development of new dikes, levees, and floodwalls in 100-year floodplain unless they will not increase flood volume, size, and/or intensity.	6e, 9a						pg
33 - Trib	Develop regulations to ensure that new or existing levees and floodwalls are vegetated.	6e, 9a						pg
34 - Trib	Revise the National Flood Insurance Program community rating system to be consistent with actions in this Plan.	6e, 9a						pg

Table 7-3A. Actions to Address Threats and Limiting Factors for all ESUs

Action ID	Action	Threats and Limiting Factors						Future Threats
		Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	
35 - Trib	Provide FEMA funding for land acquisition in 100-year floodplain; prioritize acquisitions based on recovery plan priority areas.	6e, 9a						pg
36 - Trib	Regularly update inventories and maps of instream habitat conditions, water quality, wetlands, and riparian conditions (including restoration projects) to more accurately capture current habitat conditions; incorporate information into action plan prioritization process to improve likelihood of achieving desired watershed status goals.	6e, 9a						cc
37 - Trib	Enhance efforts to enforce existing land use regulations, laws, and ordinances.	6e, 9a						pg
38 - Trib	DSL will work within existing mandates to facilitate habitat actions by: 1) Continuing efforts to streamline the permitting process for fish habitat and wetland restoration projects. 2) Strengthening interagency coordination on projects that may impact natural ecological processes. 3) Where restoration projects are identified in this recovery plan, facilitating efforts to implement the action. 4) Requiring avoidance and minimization of impacts to waters of the state in priority areas identified in this recovery plan. 5) Working with landowners to design projects that avoid and minimize impacts to wetlands and other waters of the state. 6) Providing education and technical assistance to those interested in voluntary wetland restoration, creation, or enhancement projects. 7) Exploring opportunities to target compensatory mitigation towards areas with high intrinsic potential for salmon and/or have been identified as priority areas for restoration in watershed assessments and this recovery plan. 8) Exploring conservation easements for state-owned lands with high value for salmon recovery.	6e, 9a						pg
39 - Trib	Where habitat restoration targets exist and progress toward them is tracked, develop population-specific strategies (e.g., funding, incentives, outreach, regulations, etc...) to meet those targets where targets are not being met in the first five years of implementation, with priority given to populations required to become viable.	6e, 9a						cc, pg
40 - Trib	Where population-level habitat monitoring indicates statistically-significant temporal degradation of key habitat features within a population, encourage new or revised regulatory measures for the key habitat feature(s) within the population that eliminate further degradation, protect existing high quality areas, and allow long-term/"passive" restoration in other areas.	6e, 9a						cc, pg

Table 7-3A. Actions to Address Threats and Limiting Factors for all ESUs

Action ID	Action	Threats and Limiting Factors						Future Threats
		Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	
41 - Trib	Streamline the delivery of large wood to restoration sites by: - designating a coordinating entity and creating an online database of large wood that links entities that have large wood to offer with those in need of large wood for restoration projects - developing storage/staging areas to enable storage of wood for future projects - working with federal, state, and private forests and other land managers to identify ways to improve access to available large wood - providing technical advice on what should be done with the large wood that is legally removed (e.g. during dredging operations)	6e, 9a						cc
42 - Trib	Provide more resources and incentives to small (non-metropolitan) communities so they have the infrastructure to better manage runoff from impervious surfaces.	9a, 9c, 9d						cc, pg
43 - Trib	Adequately fund and implement monitoring needed to track progress towards achieving recovery goals.	x	x	x	x	x	x	cc
44 - Trib	Monitor, or continue to monitor, populations to track status and trends and improve understanding of the composition of natural spawners (what type/stray rates? how many? where from? timing?), other life history information, and habitat.	x	x	x	x	x	x	cc
45 - Trib	Fund Implementation Coordinator position.	x	x	x	x	x	x	cc, pg
46 - Trib	Complete annual reporting for this plan and coordinate adaptive management actions as necessary and indicated by monitoring and reporting results.	x	x	x	x	x	x	cc, pg
47 - Trib	Fund development and maintenance of web-based data management and reporting, including tracking needs and accomplishments by entity through a map-based depiction of prioritized actions and locations.	x	x	x	x	x	x	cc, pg
48 - Trib	Assess adequacy of local regulatory programs to address listing threat factors within the federal ESA framework (e.g., 5-year status reviews, delisting decision, other).	x	x	x	x	x	x	pg
49 - Trib	Conduct detailed climate change risk analysis for all populations and use this to help prioritize actions, or develop new ones, that are contained in the Implementation Schedule.	x	x	x	x	x	x	cc
50 - Trib	Develop three-year Implementation Schedules across and within populations for priority actions at a site-specific scale based on existing reach-specific habitat assessments, identified regulatory requirements, other threat reduction needs, research and monitoring needs, and adaptive management; where no reach-specific assessment (i.e., Scappoose, Clatskanie, Big Creek, Youngs Bay), or assessment information at the appropriate scale for specific limiting factors or threats, exist, find funding and conduct assessments in order to develop the Implementation Schedule.	x	x	x	x	x	x	cc, pg

Table 7-3A. Actions to Address Threats and Limiting Factors for all ESUs

Action ID	Action	Threats and Limiting Factors						Future Threats
		Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	
51 - Trib	Recommend to funding entities: - project solicitations and selection should reflect recovery plan priorities, - the majority of funds should be directed to high priority locations and actions, while reserving funding for other appropriate actions to meet goals in all pop areas, and - actions resulting from funding should be reported in metrics that allow tracking of progress toward recovery goals (requires initial work with Implementation Coordinator to develop or identify appropriate metrics).	x	x	x	x	x	x	cc, pg
All Populations - Mixed Locations (All ESUs)								
64 - Mxd	CRE-1: Protect intact riparian areas in the estuary and restore riparian areas that are degraded. 1) Educate landowners about the ecosystem benefits of intact riparian areas and the costs of degraded riparian areas. 2) Encourage and provide incentives for local, state, and federal regulatory entities to maintain, improve (where needed), and enforce consistent riparian area protections throughout the lower Columbia region. 3) Actively purchase riparian areas from willing landowners in urban and rural settings when the riparian areas cannot be effectively protected through regulation or voluntary or incentive programs and (1) are intact, or (2) are degraded but have good restoration potential. 4) Restore and maintain ecological benefits in riparian areas; this includes managing vegetation on dikes and levees to enhance ecological function and adding shoreline/instream complexity for juvenile salmonid refugia. 5) Conduct assessment to update and refine inventory of areas that either currently have high quality riparian conditions or have high riparian restoration potential (by 2010).		3a, 6e	x				cc, pg
65 - Mxd	CRE-2: Operate hydrosystem to reduce the effects of reservoir surface heating, or conduct mitigation measures. 1) Conduct a reservoir heating study to determine the extent of the issue and identify hydrosystem operational changes (including design) that would reduce effects and/or mitigate downstream temperature issues; and 2) Implement hydrosystem operational changes to reduce temperature effects; if no change is possible, mitigate effects by restoring tributary riparian areas.		3a, 3b, 9b	x				cc
66 - Mxd	CRE-3: Establish minimum instream flows for the lower Columbia River mainstem that would help prevent further degradation of the ecosystem. 1) Explore technical options and develop policy recommendations on instream flows. 2) Implement instream flow regulations in accordance with the policy recommendations from the project above.		4a, 5b	x				cc

Table 7-3A. Actions to Address Threats and Limiting Factors for all ESUs

Action ID	Action	Threats and Limiting Factors						Future Threats
		Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	
67 - Mxd	CRE-4: Adjust the timing, magnitude and frequency of flows (especially spring freshets) entering the estuary and plume to better reflect the natural hydrologic cycle, improve access to habitats, and provide better transport of coarse sediments and nutrients in the estuary, plume, and littoral cell. 1) Conduct a flood study to determine the risks and feasibility of returning to more normative flows in the estuary. 2) Conduct a study to determine the habitat effects of increasing the magnitude and frequency of flows (i.e., how much access of river to off-channel habitats would increase). 3) Conduct additional studies to determine the extent of other constraints (international treaties, system-wide fish management objectives, and power management). 4) Make policy recommendations to action agencies on flow (consider beneficial estuary flows, flood management, power generation, irrigation, water supply, fish management, and other interests). 5) Implement modified estuary flow regime (all reaches and plume) annually in concert with other interests (including hydroelectric, flood control, water withdrawals).		4a, 5b	x				cc
68 - Mxd	CRE-5: Study and mitigate the effects of entrapment of fine sediment in reservoirs, to improve nourishment of the littoral cell. 1) Identify the effects of reservoir sediment entrapment on economic and ecological processes; this includes effects on ship channels, turning basins, port access, jetty activities, littoral cell erosion and accretion, and habitat availability. 2) Develop a regionwide sediment plan for the estuary and littoral cell to address salmonid habitat-forming processes. 3) Implement projects recommended in the plan to mitigate the effects of sediment entrapment.		6c	x				
69 - Mxd	CRE-6: Reduce the export of sand and gravels via dredge operations by using dredged materials beneficially. 1) Establish a forum to develop a regionwide sediment plan for the estuary and littoral cell . 2) Identify and implement dredged material beneficial use demonstration projects, including the notching and scrape-down of previously disposed materials and placement of new materials for habitat enhancement and/or creation. 3) Dispose of dredged materials using techniques identified through the demonstration projects and regionwide planning.[58]		3a, 6e	x				
70 - Mxd	CRE-7: Reduce entrainment and habitat effects resulting from main and side-channel dredge activities and ship ballast intake in the estuary. 1) Identify and evaluate dredge operation techniques designed to reduce entrainment and other habitat effects. 2) Initiate demonstration projects designed to test and evaluate dredge operations. 3) Implement best management techniques for dredging. 4) Study the effects of entrainment of juvenile salmonids from ship ballast water intake. 5) Implement a demonstration project to evaluate the feasibility of reducing entrainment of juvenile salmonids from ship ballast intake.		3a, 6e	x				

[58] Dredge disposal techniques and guidelines should include prohibition of disposing contaminated dredge materials in floodplains or floodways.

Table 7-3A. Actions to Address Threats and Limiting Factors for all ESUs

Action ID	Action	Threats and Limiting Factors						Future Threats
		Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	
71 - Mxd	CRE-8: Remove or modify pilings and pile dikes when removal or modification would benefit juvenile salmonids and improve ecosystem health. 1) Inventory, assess, and evaluate in-channel pile dikes for their economic value and their negative and positive impacts on the estuary ecosystem; develop working hypotheses for removal or modification. 2) Implement demonstration projects designed to test working hypotheses and guide future program priorities. 3) Remove or modify priority pilings and pile dikes. 4) Monitor the physical and biological effects of pile dike removal and modification.		3a, 6e	x				
72 - Mxd	CRE-9: Protect remaining high-quality off-channel habitat from degradation and restore degraded areas with high intrinsic potential for high quality habitat. 1) Educate landowners about the ecosystem benefits of protecting and stewarding intact off-channel estuarine areas and the costs of restoring degraded areas. 2) Encourage and provide resources for local, state, and federal regulatory entities to maintain, improve (where needed), and consistently enforce estuarine habitat protections throughout the lower Columbia region. 3) Actively purchase off-channel estuarine habitats in urban and rural settings that (1) cannot be effectively protected through regulation, (2) are degraded but have good restoration potential, or (3) are highly degraded but could benefit from long-term restoration solutions. 4) Restore degraded off-channel habitats with high intrinsic potential for increasing habitat quality.		3a, 6e	x				cc, pg
73 - Mxd	CRE-10: Breach or lower dikes and levees to establish or improve access to off-channel habitats. 1) Breach or lower the elevation of dikes and levees to create and/or restore tidal marshes, shallow-water habitats, and tide channels. 2) Vegetate dikes and levees. 3) Remove tide gates to improve the hydrology between wetlands and the channel and to provide juveniles with physical access to off-channel habitat; use a habitat connectivity index to prioritize projects. 4) Upgrade tide gates or perched culverts where (1) no other options exist, (2) upgraded structures can provide appropriate access for juveniles, and (3) ecosystem function would be improved over current conditions.		3a, 6e	x				cc
74 - Mxd	CRE-11: Reduce the square footage of over-water structures in the estuary. 1) Inventory over-water structures in the estuary and develop a GIS layer with detailed metadata files. 2) Initiate a planning process to evaluate existing and new over-water structures for their economic, ecological, and recreational value. 3) Remove or modify over-water structures to provide beneficial habitats. 4) Establish criteria for new permit applications to consider the cumulative impacts of over-water structures in the estuary. 5) Conduct research, monitoring, and evaluation of modifications that can be made to overwater structures to assess ecological benefits.		6e					pg

Table 7-3A. Actions to Address Threats and Limiting Factors for all ESUs

Action ID	Action	Threats and Limiting Factors						Future Threats
		Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	
75 - Mxd	CRE-12: Reduce the effects of vessel wake stranding in the estuary. 1) Analyze factors contributing to ship wake stranding to determine potential approaches to reducing mortality in locations where juveniles are most vulnerable. Design and implement demonstration projects and monitor their results. 2) Implement projects identified in analysis above that are likely to result in the reduction of ship wake stranding events. 3) Use existing and new research results documenting stranding by ship wakes to estimate juvenile mortality throughout the estuary. Modeling could use newly emerging Light Detection and Ranging (LIDAR) satellite imagery to conduct analyses.		6e					pg
76 - Mxd	(similar to CRE-13): Manage pikeminnow and other piscivorous fish, including introduced species and hatchery fish, to reduce predation on salmonids. 1) Monitor the abundance levels of pikeminnow, smallmouth bass, walleye, and channel catfish. 2) Implement actions as necessary to prevent population growth (i.e., modify habitat); increase the northern pikeminnow bounty program in the estuary. 3) Conduct research to evaluate impact that predation by hatchery origin fish has on wild salmon and steelhead (especially ocean-type salmon juveniles: tules and chum) in the estuary. 4) Develop plan to reduce predation by hatchery origin fish if research above shows significant impact.		8c	x		x	8a, 8b	
77 - Mxd	CRE-15: Implement education and monitoring projects and enforce existing laws to reduce the introduction and spread of invasive plants. 1) Increase public awareness of exotic plant species in the estuary and proper stewardship techniques. 2) Inventory exotic plant species infestations in the estuary and develop a GIS layer with detailed metadata files. 3) Implement projects to address exotic plant infestations on public and private lands. 4) Monitor infestation sites.	x	3a, 6e, 9a	x				
78 - Mxd	CRE-16: Implement projects to redistribute part of the Caspian tern colony currently nesting on East Sand Island. 1) Enhance or create tern nesting habitat at alternative sites in Washington, Oregon, and California. 2) Reduce tern nesting habitat on East Sand Island to 1 to 1.5 acres. 3) Monitor the regional tern population.						8b	
79 - Mxd	CRE-17: Implement projects to reduce double-crested cormorant habitats and encourage dispersal to other locations. 1) Identify, assess, and evaluate methods of reducing double-crested cormorant abundance numbers. 2) Implement demonstration projects resulting from assessment above (i.e., decoys and audio playback methods). 3) Implement projects resulting in reduced predation by cormorants.						8b	

Table 7-3A. Actions to Address Threats and Limiting Factors for all ESUs

Action ID	Action	Threats and Limiting Factors						Future Threats
		Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	
80 - Mxd	(similar to CRE-18) Reduce competition with non-native and hatchery origin fish in the estuary. 1) Organize existing technical information about shad and identify data gaps and potential control methods; 2) Implement demonstration projects to evaluate effective shad management methods; 3) Implement shad population management techniques; 4) Monitor and evaluate shad management techniques; 5) Conduct research to evaluate impact that competition with hatchery origin fish have on wild salmon and steelhead in the estuary; and 6) Develop a plan to reduce competition with hatchery origin fish if research above shows significant impact.		1a			7c		
81 - Mxd	CRE-19: Prevent new introductions of aquatic invertebrates and reduce the effects of existing infestations by: 1) Assemble existing technical information on introduced aquatic invertebrates in the estuary and develop a plan for managing existing infestations and preventing new infestations.[59] 2) Implement recommendations from the plan above for managing existing and preventing new infestations.		3a	x				
82 - Mxd	CRE-20: Implement pesticide and fertilizer best management practices to reduce estuarine and upstream sources of nutrients and toxic contaminants entering the estuary. 1) Implement pesticide, fertilizer, and nutrient best management practices to reduce contaminants entering the estuary.[60] 2) Evaluate adequacy of best management practices and update as needed. 3) Increase funding for education and outreach programs targeted to professional and leisure agricultural activities so as to promote reduced use of toxic materials.		9a, 9c, 9d					pg
83 - Mxd	CRE-21: Identify and reduce terrestrially and marine-based industrial, commercial, and public sources of pollutants. 1) Identify sources, loads, and pathways of point and non-point pollution in the estuary. 2) Provide cost-share incentives for National Pollution Discharge Elimination System (NPDES) permit holders to upgrade effluent above their permit requirements. 3) Study and establish threshold treatment standards for pharmaceuticals and other unregulated substance discharges; update existing NPDES permits to reflect the new standards. 4) Provide grants and low-cost loans to permit holders required to treat effluent to standards established in the study above.		9a, 9c, 9d					pg
84 - Mxd	CRE-22: Restore or mitigate contaminated sites.[61] 1) Develop criteria and a process for evaluating contaminated estuarine sites to establish their restoration potential. 2) Develop an integrated multi-state funding strategy to address contamination cleanup in the estuary from non-identifiable upstream sources. 3) Restore those contaminated estuarine sites that will yield the greatest ecological and economic benefits.		9a, 9c, 9d					pg

[59] Cleaning stations should be made available to the public at boat ramps and other locations throughout the region.
[60] Conventional contaminants such as E. coli are included; this applies to agricultural, urban and rural residential, and commercial landowners.
[61] Maximizing habitat benefits by restoration means improving habitat condition impaired by contaminants rather than just removing pollutants or capping the polluted area. Contaminated site clean-up must be to levels that support survival and recovery in both the short and long term.

Table 7-3A. Actions to Address Threats and Limiting Factors for all ESUs

Action ID	Action	Threats and Limiting Factors						Future Threats
		Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	
85 - Mxd	CRE-23: Implement stormwater best management practices in cities and towns. 1) Monitor stormwater outputs to measure treatment compliance with existing local and state regulations throughout the basin; develop a network of monitoring sites and establish a data repository that includes data collected by permittees. 2) Establish a fund source for regulatory agencies and local governments to use when insufficient resources are available to (1) access best available science, (2) develop standards beyond requirements, or (3) adequately enforce regulations. 3) Evaluate adequacy of best management practices and update as needed. 4) Provide incentives for low impact development practices.[62]		9a, 9c, 9d					cc, pg
86 - Mxd	RPA 4: Operate the FCRPS storage projects for flow management to aid anadromous fish.		4a, 5b	x				cc
87 - Mxd	RPA 5: Operate the FCRPS run-of-river mainstem lower Columbia River and Snake River projects to minimize water travel time through the lower Columbia and Snake rivers to aid in juvenile fish passage.		4a, 5b	x				
88 - Mxd	RPA 6: In-season water management via water management plans and by the Regional Forum.		4a, 5b	x				
89 - Mxd	RPA 7: To address forecasting and climate change/variability, hold annual forecast performance reviews and report on effectiveness of experimental or developing/emerging technologies.		4a, 5b	x				cc
90 - Mxd	RPAs 8-9: Manage the FCRPS for operations and fish emergencies.		4a, 5b	x				cc
91 - Mxd	RPAs 10-13: Columbia River Treaty and non-Treaty storage management, agreements, and coordination.		4a, 5b	x				cc
92 - Mxd	RPA 14: Manage flow during dry years to maintain and improve habitat conditions for ESA-listed species.		4a, 5b	x				cc
93 - Mxd	OR: Draft storage reservoirs to meet lower Columbia summer flow and velocity equivalent objectives on a seasonal and weekly basis.		4a, 5b	x				cc
94 - Mxd	OR: Operate reservoirs at rule curves and seek additional flow augmentation volumes from Snake River and Canadian reservoirs to better meet spring and summer flow and velocity objectives.		4a, 5b	x				cc

[62] An example of a low impact development practice is construction and development techniques that result in permeable surfaces.

Table 7-3B. Proposed actions to address threats and limiting factors for LCR coho populations.

Table 7-3B. Actions to Address Threats and Limiting Factors for LCR Coho Populations								
		Threats and Limiting Factors						Future Threats
Action ID	Action	Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	
All Populations - Within Tributaries (Coho)								
52 - Trib	Develop education and outreach materials on the benefit of beaver dams to ecosystem function in general and specifically to juvenile rearing habitat (especially for coho).	6e, 9a						cc, pg
53 - Trib	Provide technical and financial assistance to landowners with property damage due to beavers, and provide incentives to landowners that want to manage their land to achieve the habitat benefits provided by beaver dams. This includes developing agreements with landowners that would establish benchmarks for the amount of damage done by beavers. Once damage exceeded the agreed upon benchmark, a management entity would remove or reduce the beaver population from the affected property.	6e, 9a						cc, pg
54 - Trib	Tag wild outmigrants from different populations to understand differential harvest/fishery impacts and return timing.				7a			
55 - Trib	Mark all hatchery fish.					7c		
56 - Trib	Evaluate the need for and efficacy of double index tags for all coho hatchery programs.					7c		
57 - Trib	Coded-wire tag enough fish from each hatchery release to allow identification of hatchery origin of strays and evaluate rearing and/or release techniques of problem hatcheries.					7c		
58 - Trib	Monitor stray rates for 9 years and implement adaptive management options if rates called for in recovery scenarios are exceeded.					7c		
59 - Trib	Based on the best available science, evaluate whether integrated or segregated hatchery programs are more compatible with recovery, considering the objective of each hatchery program.[63]				x	7c		
60 - Trib	Re-evaluate current TRT-developed Gorge stratum's historical status and population structure and revise recovery goals if modifications are made.	x	x	x	x	x	x	
All Populations - Mixed Locations (Coho)								
95 - Mxd	Adopt, eliminate, or revise Oregon's in-river coho harvest matrix and modify currently-used PFMC Amendment 13 coho harvest matrix as necessary.				7a			

[63] There is currently no professional consensus on which type of hatchery stock, integrated or segregated, has the least impact on naturally producing fish. This consideration applies primarily to harvest augmentation programs, as opposed to conservation hatchery programs which have the purpose of becoming the wild population (i.e., reintroduction, supplementation, or captive broodstock). Integrated programs are thought to have less genetic impact if hatchery fish stray and spawn with wild fish. However, the need to remove wild fish from the naturally spawning population for broodstock (i.e., direct take) is a significant impact, especially on listed populations, and new information seems to indicate that natural productivity declines with hatchery introgression regardless of brood type. It is recommended that this issue continue to be considered until consensus based upon the best available science is reached on which type of program to apply in specific situations. Until then, decisions should be made on a program-specific basis.

Table 7-3B. Actions to Address Threats and Limiting Factors for LCR Coho Populations

Action ID	Action	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Future Threats
96 - Mxd	Implement "weak stock management" for coho harvest by: a) Identifying appropriate weak grouping of populations based on population recovery goals/probability, run timing relative to harvest, and other factors (not necessarily within the weakest stratum - likely will be within Coast stratum rather than potentially infeasible Gorge stratum), b) Re-calibrating the current coho abundance-based harvest matrices, and c) Conducting weak stock monitoring.				7a			
97 - Mxd	Implement mark-selective, mainstem, commercial coho fisheries by: a) Researching and developing live-capture gear and techniques,[64] and b) Implementing mark-selective, mainstem, commercial fisheries if feasible.				7a	x		
104 - Mxd	Monitor harvest levels in all fishery areas for all species (direct and indirect mortality).				7a, 7b			
Youngs Bay (Coho)								
Limiting Factors and Threats for Different Life History Stages and Threat Levels	Key – Adult				7a	7c		---
	Key – Juvenile	5c, 6e	3a, 3b, 5b, 6c					---
	Secondary – Adult	4c						---
	Secondary – Juvenile	5c, 6a, 6e, 9a	1a, 6e, 9a, 9b, 9c				8b	---
Mortality Rates	Current Status	98.18%	10.30%	0.00%	90.00%	86.00%	5.60%	---
	Delisting Status: *Stabilizing*	97.00%	8.00%	0.00%	90.00%	86.00%	3.00%	---
105 - YB	Provide / improve fish passage and water quality.	4d, 5c, 6e, 9a						
107 - YB	Implement research, monitoring, and evaluation of headwater springs to investigate the concern that they may be drying up due to land management practices.	5c, 5e						cc
108 - YB	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.	5c, 6e, 9a						cc
109 - YB	Preserve recent wood input from 12/7 storm.	5c, 6e, 9a						
110 - YB	Assess need for additional LWD to improve instream habitat complexity.	5c, 6e, 9a						
111 - YB	Restore instream habitat complexity, including large wood placement.	5c, 6e, 9a						cc

[64] Since there are not currently commercial mark-selective fishing gear and techniques (i.e., that provide the ability for live capture, release, and subsequent survival) available that harvest as efficiently as non-selective gear, it is unknown whether these can be developed in manner that is cost effective to commercial fishers. Studies are currently underway to develop and test such gear.

Table 7-3B. Actions to Address Threats and Limiting Factors for LCR Coho Populations

Action ID	Action	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Future Threats
112 - YB	Protect intact and functioning riparian areas through riparian easements and acquisition.	5c, 6e, 9a						cc
113 - YB	Restore (plant and/or fence) and protect (conservation easements, acquisition) riparian areas that are degraded.	5c, 6e, 9a						cc
114 - YB	Conduct sediment source analysis and then implement actions to reduce sediment from identified sources.	6a						
115 - YB	Consider terminal fisheries changes to reduce harvest of late returning wild coho.				7a			
117 - YB	Maintain existing wild fish sanctuary.	4c				7c		
119 - YB	Trap and sort hatchery adults: Investigate placing trap to sort hatchery fish from upstream migrants.[65]					7c		
Big Creek (Coho)								
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Key – Adult					7a	7c		---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Key – Juvenile		5c, 6e	3a, 3b, 5b, 6c					---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Secondary – Adult		4c						---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Secondary – Juvenile		5c, 5e, 6a, 6e, 9a	1a, 6e, 9a, 9b, 9c				8b	---
Mortality Rates	Current Status	97.92%	10.30%	0.00%	70.00%	86.00%	5.60%	---
Mortality Rates	Delisting Status: *Stabilizing*	97.00%	8.00%	0.00%	70.00%	86.00%	3.00%	---
120 - BC	Explore cooperative water conservation measures.	5c, 5e						cc
121 - BC	Implement research, monitoring, and evaluation of headwater springs to investigate the concern that they may be drying up due to land management practices.	5c, 5e						cc
122 - BC	Restore instream habitat complexity, including large wood placement.	5c, 6e, 9a						cc
123 - BC	Possible road re-alignment.	5c, 6e, 9a						
124 - BC	Provide / improve fish passage and water quality.	5c, 6e, 9a						
125 - BC	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.	5c, 6e, 9a						cc
126 - BC	Restore (plant and/or fence) and protect (conservation easements, acquisition) riparian areas that are degraded.	5c, 6e, 9a						cc

[65] Weir feasibility depends on finding a site that accesses enough fish to achieve management objectives (i.e., reduce stray rates to adequate levels), allows safe and reliable installation and operation under the site's hydrogeomorphological conditions at an acceptable cost. Placement of a weir in Youngs Bay will also have to consider policy decisions to maintain this population area at a relatively high extinction risk level, with minimal harvest and hatchery threat reduction levels.

Table 7-3B. Actions to Address Threats and Limiting Factors for LCR Coho Populations

Action ID	Action	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Future Threats
127 - BC	Restore or create off-channel habitat and/or access to off-channel habitat: side channels.	5c, 6e, 9a						cc
128 - BC	Conduct sediment source analysis and then implement actions to reduce sediment from identified sources.	6a						
129 - BC	Consider terminal fisheries changes to reduce harvest of late returning wild coho.				7a			
131 - BC	Trap and sort hatchery adults: Develop trap and haul capability to pass unmarked Coho and STW above hatchery.	4c				7c		
132 - BC	Maintain existing wild fish sanctuary.	4c				7c		
Clatskanie (Coho)								
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Key – Adult					7a			---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Key – Juvenile		6e	3a, 3b, 5b, 6c					---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Secondary – Adult						7c		---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Secondary – Juvenile		5c, 6b, 6e, 9a	1a, 6e, 9a, 9b, 9c, 9d				8b	---
Mortality Rates	Current Status	82.97%	10.30%	0.00%	35.00%	13.00%	6.00%	---
Mortality Rates	Delisting Status: *Primary*	68.00%	8.00%	0.00%	25.00%	10.00%	4.00%	---
135 - CT	Implement research, monitoring, and evaluation of headwater springs to investigate the concern that they may be drying up due to land management practices.	5c						cc
136 - CT	Protect intact and functioning riparian areas through riparian easements and acquisition.	5c, 6b, 6e, 9a						cc
137 - CT	Protect remaining high-quality off-channel habitat from degradation.	5c, 6b, 6e, 9a						cc, pg
138 - CT	Breach, lower, remove, or relocate dikes and levees to establish or improve access to off-channel habitats; vegetate dikes and levees.	5c, 6b, 6e, 9a						cc
139 - CT	Restore instream habitat complexity, including large wood placement.	5c, 6b, 6e, 9a						cc
140 - CT	Establish working group to identify priority areas for riparian and instream habitat enhancement, and work with landowners to implement projects.	5c, 6b, 6e, 9a						cc
141 - CT	Conduct sediment source analysis and then implement actions to reduce sediment from identified sources.	5c, 6b, 6e, 9a						
142 - CT	Conduct full assessment of streams that were heavily damaged during Dec. 2007 storm to determine best approach to restoration.	5c, 6b, 6e, 9a						

Table 7-3B. Actions to Address Threats and Limiting Factors for LCR Coho Populations

Action ID	Action	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Future Threats
143 - CT	Implement Mid-Coast watershed council style limiting factors analysis to improve understanding of reach specific recovery action needs.	5c, 6b, 6e, 9a						
144 - CT	Inventory and assess connectivity and hydrologic function.	5c, 6b, 6e, 9a						
145 - CT	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.	5c, 6b, 6e, 9a						cc
146 - CT	Restore (plant and/or fence) and protect (conservation easements, acquisition) riparian areas that are degraded.	5c, 6b, 6e, 9a						cc
147 - CT	Trap and sort hatchery adults: Investigate placing trap to sort hatchery fish from upstream migrants, if stray rate is greater than 10%. [66]					7c		
148 - CT	Maintain existing wild fish sanctuary (do not stock hatchery fish).					7c		
149 - CT	Explore adding a life-cycle monitoring site in the Clatskanie population.[67]	x	x	x	x	x	x	
Scappoose (Coho)								
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Key – Adult					7a			---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Key – Juvenile		6e	3a, 3b, 5b, 6c					---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Secondary – Adult								---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Secondary – Juvenile		5c, 6b, 6e, 9a	1a, 6e, 9a, 9b, 9c, 9d				8b	---
Mortality Rates – Current Status		83.17%	10.30%	0.00%	35.00%	5.00%	6.00%	---
Mortality Rates – Delisting Status: *Primary*		77.00%	8.00%	0.00%	25.00%	5.00%	4.00%	---
150 - SC	Provide / improve fish passage.	4e, 5c, 6e, 9a						
151 - SC	Implement research, monitoring, and evaluation of headwater springs to investigate the concern that they may be drying up due to land management practices.	5c						cc
152 - SC	Protect intact and functioning riparian areas through riparian easements and acquisition.	5c, 6b, 6e, 9a						cc
153 - SC	Restore (plant and/or fence) and protect (conservation easements, acquisition) riparian areas that are degraded.	5c, 6b, 6e, 9a						cc

[66] The extent of hatchery fish impacts due to stray rates is unknown for this population area. These should be determined prior to the decision to install a weir to reduce this potential impact. In addition to this concern, weir feasibility depends on finding a site that accesses enough fish to achieve management objectives (i.e., reduce stray rates to adequate levels), allows safe and reliable installation and operation under the site's hydrogeomorphological conditions at an acceptable cost.

[67] Feasibility of this action will depend on costs of installation and operation. A life cycle monitoring site is called for in monitoring plans and funding for it is already under consideration.

Table 7-3B. Actions to Address Threats and Limiting Factors for LCR Coho Populations

Action ID	Action	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Future Threats
154 - SC	Protect/manage existing high quality habitat.	5c, 6b, 6e, 9a						pg
155 - SC	Restore instream habitat complexity, including large wood placement.	5c, 6b, 6e, 9a						cc
156 - SC	Restore or create off-channel habitat and/or access to off-channel habitat: side channels.	5c, 6b, 6e, 9a						cc
157 - SC	Restore connectivity to small tributaries.	5c, 6b, 6e, 9a						
158 - SC	Establish working group to identify habitat enhancement projects.	5c, 6b, 6e, 9a						
159 - SC	Work with landowners to implement projects to prevent/reduce impacts from development and land management; provide resources and incentives.	5c, 6b, 6e, 9a						pg
160 - SC	Protect remaining high-quality off-channel habitat from degradation.	5c, 6b, 6e, 9a						cc, pg
161 - SC	Implement Mid-Coast watershed council style limiting factors analysis to improve understanding of reach specific recovery action needs.	5c, 6b, 6e, 9a						
162 - SC	Inventory and assess connectivity and hydrologic function.	5c, 6b, 6e, 9a						
163 - SC	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.	5c, 6b, 6e, 9a						cc
164 - SC	Investigate ways to retain gravel in context of flood impact management considerations.	5c, 6e, 9a						
165 - SC	Improve system for monitoring water quality and quantity and ensure that information is integrated into existing regulatory framework.	5c, 6e, 9a						cc
168 - SC	Maintain existing wild fish sanctuary (do not stock hatchery fish).					7c		
Clackamas (Coho)								
Limiting Factors and Threats for Different Life History Stages and Threat Levels	Key – Adult				7a	7c		---
	Key – Juvenile	6e	3a, 3b, 5b, 6c					---
	Secondary – Adult	9b						---
	Secondary – Juvenile	5c, 6a, 6e, 9a, 9b	1a, 6e, 9a, 9b, 9c, 9d	4b			8b	---
Mortality Rates	Current Status	61.87%	10.30%	7.90%	35.00%	35.00%	6.40%	---
	Delisting Status: *Primary*	61.87%	8.00%	6.00%	25.00%	10.00%	4.00%	---

Table 7-3B. Actions to Address Threats and Limiting Factors for LCR Coho Populations

Action ID	Action	Threats and Limiting Factors						Future Threats
		Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	
170 - CM	Provide / improve fish passage.	4d, 6e						
171 - CM	Implement research, monitoring, and evaluation of headwater springs to investigate the concern that they may be drying up due to land management practices.	5c						cc
172 - CM	Identify and implement flow improvements.	5c						cc
173 - CM	Inventory and protect seeps, springs, and other coldwater sources.	5c						cc
174 - CM	Identify priority areas for increased instream flows.	5c						cc
175 - CM	Establish minimum ecosystem-based instream flows.	5c						cc
176 - CM	Identify and halt illegal water withdrawals.	5c						cc
177 - CM	Enforce existing water rights.	5c						cc
178 - CM	Breach, lower, remove, or relocate dikes and levees to establish or improve access to off-channel habitats; vegetate dikes and levees.	5c, 6a, 6e, 9a						cc
179 - CM	Review land use plans in context of salmon recovery needs (i.e., forest lands of higher value to salmon recovery than urbanized lands).	5c, 6a, 6e, 9a						pg
180 - CM	Provide incentives to promote good landowner stewardship.	5c, 6a, 6e, 9a						
181 - CM	Reduce impact that roads have on impaired hydrograph.	5c, 6a, 6e, 9a						cc
182 - CM	Finish Clackamas Fish Habitat Analysis.	5c, 6a, 6e, 9a						
183 - CM	Develop and/or implement stormwater management plans for urban areas and roads.	5c, 6a, 9a	9d					cc, pg
184 - CM	Protect remaining high-quality off-channel habitat from degradation.	5c, 6e, 9a						cc, pg
185 - CM	Restore or create off-channel habitat and/or access to off-channel habitat: side channels.	5c, 6e, 9a						cc
186 - CM	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.	5c, 6e, 9a, 9b	9c, 9d	x				cc
187 - CM	Improve or regrade/revegetate streambanks.	6a, 6e, 9a						cc
188 - CM	Protect intact and functioning riparian areas through riparian easements and acquisition.	6a, 6e, 9a						cc
189 - CM	Restore (plant and/or fence) and protect (conservation easements, acquisition) riparian areas that are degraded.	6a, 6e, 9a						cc

Table 7-3B. Actions to Address Threats and Limiting Factors for LCR Coho Populations

Action ID	Action	Threats and Limiting Factors						Future Threats
		Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	
191 - CM	Implement all measures in the Clackamas River Hydroelectric Project (FERC Project No. 2195) Fish Passage and Protection Plan, including measures for downstream fish passage (3% or less mortality at River Mill and North Fork dams), Oak Grove Mitigation and improvements to North Fork fish ladder/trap.	6d, 6e, 9b		4b				
192 - CM	Utilize the Clackamas Hydroelectric Project Mitigation and Enhancement Fund to provide for habitat mitigation and enhancements in the Clackamas Basin.	6d, 6e, 9b		x				
194 - CM	Reduce the square footage of over-water structures; where possible, modify remaining overwater structures to provide beneficial habitat.	6e						
195 - CM	Develop and implement Willamette mitigation bank river plan.	6e						
196 - CM	Identify and purchase key salmon habitats.	6e						pg
197 - CM	Remove invasive plants and plant native species.	6e						
198 - CM	Restore instream habitat complexity, including large wood placement.	6e						cc
199 - CM	Daylight stream.	6e, 9a						
200 - CM	Create confluence habitat with cool water, restore channel and reconnect upper creek.	6e, 9a						cc
201 - CM	Reconnect tributary to Willamette River and create high quality habitat at tributary junction.	6e, 9a						
202 - CM	Daylight stream.	6e, 9a						
203 - CM	Revise and update stormwater management manual.	6e, 9a	9c, 9d					cc, pg
204 - CM	Implement Gray2Green program.	6e, 9a	9c, 9d					
205 - CM	Re-establish connection to Columbia River for improved flushing, if feasible.	6e, 9a	9c, 9d					
206 - CM	Implement pesticide and fertilizer best management practices to reduce sources of toxic and conventional contaminants entering the estuary (revise and update integrated pest management (IPM) for Portland-owned property).		9d					
207 - CM	Monitor for contaminants.		9d					pg
208 - CM	Maximize habitat benefits by restoration or mitigation.		9d					
209 - CM	Increase harvest rate of hatchery coho as needed or permanently (3 daily bag) if program is maintained.					7c		
210 - CM	Maintain existing wild fish sanctuary.					7c		
211 - CM	Eliminate/reduce/shift program: Reduce hatchery coho releases (500k to 350k beginning in 2009).					7c		

Table 7-3B. Actions to Address Threats and Limiting Factors for LCR Coho Populations

Action ID	Action	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Future Threats
212 - CM	Eliminate/reduce/shift program: Eliminate in-basin hatchery coho program and releases, if hatchery coho production shifts to out-of-ESU stocks (Yakima and Umatilla).					7c		
213 - CM	Operationally open the hatchery trap for a longer period.					7c		
214 - CM	Purchase a freezer trailer to aid the logistical disposition to carcass placement, tribes, and food banks if program is maintained.					7c		
Sandy (Coho)								
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Key – Adult					7a			---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Key – Juvenile		6e	3a, 3b, 5b, 6c					---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Secondary – Adult		4c						---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Secondary – Juvenile		5c, 6a, 6e, 9a	1a, 6e, 9a, 9b, 9c, 9d				8b	---
Mortality Rates	Current Status	82.68%	10.30%	4.00%	35.00%	9.00%	6.40%	---
Mortality Rates	Delisting Status: *Primary*	52.00%	8.00%	0.00%	25.00%	9.00%	4.00%	---
219 - SY	Provide / improve fish passage.	4c, 4d				7c		
220 - SY	Develop recommendations for land management scenarios that address hydrograph changes that are predicted to occur due to climate change.	5c, 5e						cc
221 - SY	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.	5c, 6e						cc
222 - SY	Protect remaining high-quality off-channel habitat from degradation.	5c, 6e						cc, pg
226 - SY	Conduct sediment source analysis and then implement actions to reduce sediment from identified sources.	6a, 6d						
227 - SY	Develop and/or implement stormwater management plans for urban areas and roads.	6a, 6d						cc, pg
228 - SY	Identify and rectify problem legacy roads.	6a, 6d						
232 - SY	Restore instream habitat complexity, including large wood placement.	6e						cc
233 - SY	Restore or create off-channel habitat and/or access to off-channel habitat: side channels.	6e						cc
235 - SY	Protect intact and functioning riparian areas through riparian easements and acquisition.	6e, 9a						cc
236 - SY	Restore (plant and/or fence) and protect (conservation easements, acquisition) riparian areas that are degraded.	6e, 9a						cc

Table 7-3B. Actions to Address Threats and Limiting Factors for LCR Coho Populations

Action ID	Action			Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Future Threats
237 - SY	Eliminate/reduce/shift program: Reduce hatchery coho releases (700k to 500k in 2010; shifted to Youngs Bay).							7c		
243 - SY	Explore adding a life-cycle monitoring site in the Sandy population.			x	x	x	x	x	x	
Lower Gorge (Coho)										
Limiting Factors and Threats for Different Life History Stages and Threat Levels		Key	Adult	6f			7a	7c		---
			Juvenile	6f	3a, 3b, 5b, 6c					---
		Secondary	Adult	4c						---
			Juvenile	5c, 5f	1a, 6e, 9a, 9b, 9c, 9d				8b	---
	Mortality Rates		Current Status	95.44%	10.30%	0.00%	35.00%	80.00%	6.40%	---
			Delisting Status: *Support WA*	63.50%	8.00%	0.00%	25.00%	10.00%	4.00%	---
244 - LG	Identify and implement flow improvements.			5f				x		cc
245 - LG	Restore (plant and/or fence) and protect (conservation easements, acquisition) riparian areas that are degraded.			6f						cc
246 - LG	Restore instream habitat complexity, including large wood placement.			6f						cc
247 - LG	Provide / improve fish passage.			4c, 6f				x		
248 - LG	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.			6f						cc
249 - LG	Restore or create off-channel habitat and/or access to off-channel habitat: side channels.			6f						cc
250 - LG	Trap and sort hatchery adults: Investigate placing new weir and trap to sort hatchery fish from upstream migrants.[68]			4c				7c		
251 - LG	Eliminate/reduce/shift program: Reduce Bonneville Hatchery coho releases (1.225M to 0.725M in 2010 and shift to lower Columbia River).							7c		
252 - LG	Discuss longer acclimation/rearing at tribal release sites to reduce imprinting at OR and WA hatcheries (rearing sites).							7c		

[68] Weir feasibility depends on finding a site that accesses enough fish to achieve management objectives (i.e., reduce stray rates to adequate levels), allows safe and reliable installation and operation under the site's hydrogeomorphological conditions at an acceptable cost. Placement of weirs here will also have to consider the relatively low desired status for these population areas and the limited amount of habitat available for natural production due to anthropogenic impacts and the naturally small size of this area.

Table 7-3B. Actions to Address Threats and Limiting Factors for LCR Coho Populations

Action ID	Action			Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Future Threats
Upper Gorge / Hood (Coho)										
Limiting Factors and Threats for Different Life History Stages and Threat Levels		Key	Adult				7a	7c		---
			Juvenile	5d, 6e	3a, 3b, 5b, 6c					---
		Secondary	Adult	4a		4a				---
			Juvenile	1a, 5a, 5c, 6a, 6g, 8a, 9a, 9c	1a, 6e, 9a, 9b, 9c, 9d	4a			8b	---
	Mortality Rates		Current Status	94.13%	10.30%	26.90%	35.00%	80.00%	7.30%	---
			Delisting Status: *Primary*	8.00%	8.00%	23.00%	5.00%	0.00%	5.00%	---
270 - HD	Provide / improve fish passage.			4a, 6e						
271 - HD	Ensure that low head hydro projects do not adversely impact winter base streamflows.			5a		x				cc
272 - HD	Implement projects that aid in restoring the natural flow regime (e.g., HRWAP Project FP-3 Central Canal Pipeline/Neal Creek Siphon, future piping projects, Conserved Water Program, landowner technical assistance, etc.).			5c, 5d						cc
273 - HD	Provide education and resources to hobby farms and other rural residents to assist them with water saving measures.			5c, 5d						cc
274 - HD	Work with OWRD and others to keep water saved through publically-funded water conservation efforts instream for fish.			5c, 5d						cc
277 - HD	Identify and implement flow improvements.			5d						cc
279 - HD	Protect intact and functioning riparian areas through riparian easements and acquisition.			6a, 6e, 9a						cc
280 - HD	Restore (plant and/or fence) and protect (conservation easements, acquisition) riparian areas that are degraded.			6a, 6e, 9a						cc
281 - HD	Remove sections of railroad fill.			6e						
282 - HD	Restore or create off-channel habitat and/or access to off-channel habitat: side channels.			6e						cc
283 - HD	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.			6e						cc
284 - HD	Restore instream habitat complexity, including large wood placement.			6e, 6g		x				cc
285 - HD	RPA 15: Continue to update the Water Quality Plan for Total Dissolved Gas and Water Temperature in the mainstem Columbia and Snake rivers, and implement water quality measures to enhance ESA-listed juvenile and adult fish survival and maintain spawning and rearing habitat.			6g		x				

Table 7-3B. Actions to Address Threats and Limiting Factors for LCR Coho Populations

Action ID	Action	Threats and Limiting Factors						Future Threats
		Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	
286 - HD	RPAs 18-21: Prepare, in cooperation with NMFS and comanaging agencies, configuration and operational plans for the Bonneville Project (2008), The Dalles Project, John Day Project (2008) and McNary Project (2009).			4a				
287 - HD	RPA 27: Operate turbine units to achieve best fish passage survival (currently within 1% of best efficiency at mainstem dams on the lower Columbia and lower Snake rivers).			4a				
288 - HD	RPA 28: Implement structural improvements to adult passage at the mainstem Columbia River and Snake River projects.			4a				
289 - HD	RPA 32: Prepare annually a fish passage plan in coordination with NMFS and the Regional Forum. Operate projects year around in accordance with the criteria in the fish passage plan.			4a				
290 - HD	OR - Operate lower Columbia reservoirs at minimum operating pool (MOP) during spring and summer as long as barge transport and irrigation needs are met.	6g		x				
291 - HD	OR - Provide spill to total dissolved gas limits of water quality waivers or biological constraints at all dams, except maximize transportation at Snake River collector projects during lowest (10th percentile) flow years.			4a				
292 - HD	Remove dam.			4a				
293 - HD	Provide cover at mouth of Herman Creek that is inundated by Bonneville pool to reduce predation.	8a		x			x	cc
294 - HD	Implement BMPs for ag chemicals.	9c						
297 - HD	Eliminate/reduce/shift program: Investigate further reducing releases of Klickitat and Umatilla coho (primary strays in Hood R); coho releases in the Umatilla will be reduced from 1.5M to 1.0M in 2010 and all fish will be marked. [69]					7c		
298 - HD	Identify the specified time period, stock, timing, and strategies for reintroduction if fish managers determine that reintroductions are needed to recover the coho population.					7c		
299 - HD	Trap and sort hatchery adults: Investigate placing new weir and trap to sort hatchery fish from upstream migrants.[70]					7c		
300 - HD	Trap and sort hatchery adults: Install a floating weir to remove stray hatchery winter steelhead, spring Chinook and coho.					7c		
308 - HD	Explore adding a life-cycle monitoring site in the Hood population.	x	x	x	x	x	x	

[69] Reduction of these out-of-ESU hatchery programs will have to be weighed against their intended purpose and other alternatives.
[70] Weir feasibility depends on finding a site that accesses enough fish to achieve management objectives (i.e., reduce stray rates to adequate levels), allows safe and reliable installation and operation under the site's hydrogeomorphological conditions at an acceptable cost.

Table 7-3C. Proposed actions to address threats and limiting factors for LCR Chinook populations.

Table 7-3C. Actions to Address Threats and Limiting Factors for LCR Chinook Populations								
		Threats and Limiting Factors						Future Threats
Action ID	Action	Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	
FALL CHINOOK								
All Populations - Within Tributaries (Fall Chinook)								
55 - Trib	Mark all hatchery fish.					7c		
57 - Trib	Coded-wire tag enough fish from each hatchery release to allow identification of hatchery origin of strays and evaluate rearing and/or release techniques of problem hatcheries.					7c		
58 - Trib	Monitor stray rates for 9 years and implement adaptive management options if rates called for in recovery scenarios are exceeded.					7c		
59 - Trib	Based on the best available science, evaluate whether integrated or segregated hatchery programs are more compatible with recovery, considering the objective of each hatchery program.[71]				x	7c		
60 - Trib	Re-evaluate current TRT-developed Gorge stratum's historical status and population structure and revise recovery goals if modifications are made.	x	x	x	x	x	x	
61 - Trib	Trap and sort hatchery adults: Identify a fall Chinook population with high stray rates, no hatchery program, and potential for un-supplemented wild fish recovery and place weir to see if hatchery fish removal causes wild fish increase.					7c		
62 - Trib	Identify the most appropriate stock, timing, and strategies for a reintroduction hatchery program and implement, if fish managers determine that reintroductions are needed to recover any fall Chinook population.	x	x	x	7a	7c	x	
All Populations - Mixed Locations (Fall Chinook)								
98 - Mxd	Implement the new Pacific Salmon Treaty (reduce ocean fisheries on Chinook).				7a			
99 - Mxd	Support mark-selective ocean fisheries when a new PST is negotiated in 10 years.[72]				7a			

[71] See note for this action in Table 7-3B for coho.
[72] Marking fish and switching to appropriate gear and techniques for mark-selective fisheries will require a major investment of time and money by Canada, as well as a shift in their fundamental fisheries policy. Issues with developing gear and techniques for mark-selective capture are discussed in the note for Action 100-Mxd.

Table 7-3C. Actions to Address Threats and Limiting Factors for LCR Chinook Populations

Action ID	Action	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Future Threats
100 - Mxd	Implement mark-selective Columbia fall Chinook fisheries[73] by: a) Developing live-capture commercial gear and techniques, b) Conducting release mortality studies for all fisheries, c) Implementing for Columbia R commercial fisheries in August and September if live-capture is feasible, and d) Implementing for sport fisheries in ocean, Buoy 10, tributaries, and mainstem above Buoy 10 (if upriver/Snake wilds are low).				7a			
101 - Mxd	Develop an abundance-based, sliding scale harvest matrix that incorporates "weak stock management" for fall Chinook by implementing population monitoring and then: a) Identifying appropriate weak grouping of populations based on population recovery goals/probability, run timing relative to harvest, and other factors, b) Developing run forecast model, and c) Developing marine survival indices for returning adults.				7a, 7b			
104 - Mxd	Monitor harvest levels in all fishery areas for all species (direct and indirect mortality).				7a, 7b			
Youngs Bay (Fall Chinook)								
Limiting Factors and Threats for Different Life History Stages and Threat Levels	Key – Adult				7a	7c		---
	Key – Juvenile	5c, 6e	3a, 3b, 5b, 6c					---
	Secondary – Adult	4c						---
	Secondary – Juvenile	5c, 6a	1a, 6e, 9a, 9b, 9c				8b	---
Mortality Rates	Current Status	71.51%	32.20%	0.00%	75.00%	45.00%	5.60%	---
	Delisting Status: *Stabilizing*	71.51%	26.00%	0.00%	70.00%	45.00%	4.00%	---
105 - YB	Provide / improve fish passage and water quality.	4d, 5c, 6e, 9a						
107 - YB	Implement research, monitoring, and evaluation of headwater springs to investigate the concern that they may be drying up due to land management practices.	5c, 5e						cc
108 - YB	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.	5c, 6e, 9a						cc
109 - YB	Preserve recent wood input from 12/7 storm.	5c, 6e, 9a						

[73] There are large uncertainties related to implementing a mark-selective fall Chinook fishery in the Columbia River. These include: a) a low mark rate of URBs (a healthy, un-marked wild population) returning at the same time might cause a mark-selective fishery to have the same mortality on wild fish as a non-selective fishery (i.e., handling rate rises and the incidental mortality numbers increase); b) unlisted URBs are the preferred catch of fall Chinook (as opposed to the listed tules which this action addresses) due to their quality for many fishers; if they are not able to be harvested, the remaining fishery will have less social and economic value and may not be viable; c) successful live capture and release during the harvest period (August and September) will be difficult due to increased mortality of handled fish in this warm period; and d) commercial gear to efficiently access fall Chinook will be more difficult to develop than for other species given their migration location (near the bottom of the main channel) and timing (they migrate and move through the fishery quickly).

Table 7-3C. Actions to Address Threats and Limiting Factors for LCR Chinook Populations

Action ID	Action	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Future Threats
110 - YB	Assess need for additional LWD to improve instream habitat complexity.	5c, 6e, 9a						
111 - YB	Restore instream habitat complexity, including large wood placement.	5c, 6e, 9a						cc
112 - YB	Protect intact and functioning riparian areas through riparian easements and acquisition.	5c, 6e, 9a						cc
113 - YB	Restore (plant and/or fence) and protect (conservation easements, acquisition) riparian areas that are degraded.	5c, 6e, 9a						cc
114 - YB	Conduct sediment source analysis and then implement actions to reduce sediment from identified sources.	6a						
116 - YB	Consider implementing terminal commercial fisheries for fall Chinook to reduce stray rates.				x	7c		
118 - YB	Trap and sort hatchery adults: Begin passing tules and chum if suitable habitat exists.	4c				7c		
Big Creek (Fall Chinook)								
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Key – Adult					7a	7c		---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Key – Juvenile		5c, 6e	3a, 3b, 5b, 6c					---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Secondary – Adult		4c						---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Secondary – Juvenile		5c, 6a	1a, 6e, 9a, 9b, 9c				8b	---
Mortality Rates	Current Status	80.04%	32.20%	0.00%	65.00%	45.00%	5.60%	---
Mortality Rates	Delisting Status: *Contributing*	58.00%	26.00%	0.00%	60.00%	45.00%	4.00%	---
121 - BC	Implement research, monitoring, and evaluation of headwater springs to investigate the concern that they may be drying up due to land management practices.	5c, 5e						cc
122 - BC	Restore instream habitat complexity, including large wood placement.	5c, 6e, 9a						cc
123 - BC	Possible road re-alignment.	5c, 6e, 9a						
125 - BC	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.	5c, 6e, 9a						cc
126 - BC	Restore (plant and/or fence) and protect (conservation easements, acquisition) riparian areas that are degraded.	5c, 6e, 9a						cc
127 - BC	Restore or create off-channel habitat and/or access to off-channel habitat: side channels.	5c, 6e, 9a						cc
128 - BC	Conduct sediment source analysis and then implement actions to reduce sediment from identified sources.	6a						

Table 7-3C. Actions to Address Threats and Limiting Factors for LCR Chinook Populations

Action ID	Action	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Future Threats
130 - BC	Consider implementing terminal commercial fisheries for fall Chinook to reduce stray rates.				x	7c		
133 - BC	Trap and sort hatchery adults: Begin passing tules and chum.	4c				7c		
134 - BC	Eliminate/reduce/shift program: Reduce hatchery tule releases (5.7M to 3.7M in 2009; shifted to Youngs Bay).					7c		
Clatskanie (Fall Chinook)								
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Key – Adult					7a	7c		---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Key – Juvenile		6e	3a, 3b, 5b, 6c					---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Secondary – Adult								---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Secondary – Juvenile		5c, 6b	1a, 6e, 9a, 9b, 9c, 9d				8b	---
Mortality Rates	Current Status	99.70%	32.20%	0.00%	60.00%	45.00%	6.50%	---
Mortality Rates	Delisting Status: *Primary*	79.50%	26.00%	0.00%	35.00%	5.00%	5.00%	---
135 - CT	Implement research, monitoring, and evaluation of headwater springs to investigate the concern that they may be drying up due to land management practices.	5c						cc
136 - CT	Protect intact and functioning riparian areas through riparian easements and acquisition.	5c, 6b, 6e, 9a						cc
137 - CT	Protect remaining high-quality off-channel habitat from degradation.	5c, 6b, 6e, 9a						cc, pg
138 - CT	Breach, lower, remove, or relocate dikes and levees to establish or improve access to off-channel habitats; vegetate dikes and levees.	5c, 6b, 6e, 9a						cc
139 - CT	Restore instream habitat complexity, including large wood placement.	5c, 6b, 6e, 9a						cc
140 - CT	Establish working group to identify priority areas for riparian and instream habitat enhancement, and work with landowners to implement projects.	5c, 6b, 6e, 9a						cc
141 - CT	Conduct sediment source analysis and then implement actions to reduce sediment from identified sources.	5c, 6b, 6e, 9a						
144 - CT	Inventory and assess connectivity and hydrologic function.	5c, 6b, 6e, 9a						
145 - CT	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.	5c, 6b, 6e, 9a						cc
146 - CT	Restore (plant and/or fence) and protect (conservation easements, acquisition) riparian areas that are degraded.	5c, 6b, 6e, 9a						cc

Table 7-3C. Actions to Address Threats and Limiting Factors for LCR Chinook Populations

Action ID	Action	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Future Threats
147 - CT	Trap and sort hatchery adults: Investigate placing trap to sort hatchery fish from upstream migrants, if stray rate is greater than 10%.[74]					7c		
148 - CT	Maintain existing wild fish sanctuary (do not stock hatchery fish).					7c		
Scappoose (Fall Chinook)								
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Key – Adult					7a	7c		---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Key – Juvenile		5c, 6e	3a, 3b, 5b, 6c					---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Secondary – Adult								---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Secondary – Juvenile		5c, 6b	1a, 6e, 9a, 9b, 9c, 9d				8b	---
Mortality Rates	Current Status	79.60%	32.20%	0.00%	60.00%	45.00%	6.50%	---
Mortality Rates	Delisting Status: *Primary*	77.50%	26.00%	0.00%	35.00%	15.00%	5.00%	---
151 - SC	Implement research, monitoring, and evaluation of headwater springs to investigate the concern that they may be drying up due to land management practices.	5c						cc
152 - SC	Protect intact and functioning riparian areas through riparian easements and acquisition.	5c, 6b, 6e, 9a						cc
153 - SC	Restore (plant and/or fence) and protect (conservation easements, acquisition) riparian areas that are degraded.	5c, 6b, 6e, 9a						cc
155 - SC	Restore instream habitat complexity, including large wood placement.	5c, 6b, 6e, 9a						cc
156 - SC	Restore or create off-channel habitat and/or access to off-channel habitat: side channels.	5c, 6b, 6e, 9a						cc
157 - SC	Restore connectivity to small tributaries.	5c, 6b, 6e, 9a						
158 - SC	Establish working group to identify habitat enhancement projects.	5c, 6b, 6e, 9a						
159 - SC	Work with landowners to implement projects to prevent/reduce impacts from development and land management; provide resources and incentives.	5c, 6b, 6e, 9a						pg
160 - SC	Protect remaining high-quality off-channel habitat from degradation.	5c, 6b, 6e, 9a						cc, pg
162 - SC	Inventory and assess connectivity and hydrologic function.	5c, 6b, 6e, 9a						

[74] See note for this action in Table 7-3B for coho.

Table 7-3C. Actions to Address Threats and Limiting Factors for LCR Chinook Populations

Action ID	Action	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Future Threats
163 - SC	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.	5c, 6b, 6e, 9a						cc
165 - SC	Improve system for monitoring water quality and quantity and ensure that information is integrated into existing regulatory framework.	5c, 6e, 9a						cc
166 - SC	Breach, lower, remove, or relocate dikes and levees to establish or improve access to off-channel habitats; vegetate dikes and levees.	5c, 6e, 9a						cc
167 - SC	Identify and implement flow improvements (to provide better migration into and out of Sturgeon Lake).	5c, 6e, 9a						cc
168 - SC	Maintain existing wild fish sanctuary (do not stock hatchery fish).					7c		
Clackamas (Fall Chinook)								
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Key – Adult					7a	7c		---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Key – Juvenile		6e	3a, 3b, 5b, 6c					---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Secondary – Adult		6d, 9b						---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Secondary – Juvenile		5c, 6a, 6e, 9a, 9b	1a, 6e, 9a, 9b, 9c, 9d				8b	---
Mortality Rates	Current Status	82.11%	32.20%	0.00%	60.00%	45.00%	7.30%	---
Mortality Rates	Delisting Status: *Contributing*	82.11%	26.00%	0.00%	35.00%	5.00%	6.00%	---
170 - CM	Provide / improve fish passage.	4d, 6e						
171 - CM	Implement research, monitoring, and evaluation of headwater springs to investigate the concern that they may be drying up due to land management practices.	5c						cc
172 - CM	Identify and implement flow improvements.	5c						cc
173 - CM	Inventory and protect seeps, springs, and other coldwater sources.	5c						cc
174 - CM	Identify priority areas for increased instream flows.	5c						cc
175 - CM	Establish minimum ecosystem-based instream flows.	5c						cc
176 - CM	Identify and halt illegal water withdrawals.	5c						cc
177 - CM	Enforce existing water rights.	5c						cc
178 - CM	Breach, lower, remove, or relocate dikes and levees to establish or improve access to off-channel habitats; vegetate dikes and levees.	5c, 6a, 6e, 9a						cc

Table 7-3C. Actions to Address Threats and Limiting Factors for LCR Chinook Populations

Action ID	Action	Threats and Limiting Factors						Future Threats
		Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	
179 - CM	Review land use plans in context of salmon recovery needs (i.e., forest lands of higher value to salmon recovery than urbanized lands).	5c, 6a, 6e, 9a						pg
180 - CM	Provide incentives to promote good landowner stewardship.	5c, 6a, 6e, 9a						
181 - CM	Reduce impact that roads have on impaired hydrograph.	5c, 6a, 6e, 9a						cc
182 - CM	Finish Clackamas Fish Habitat Analysis.	5c, 6a, 6e, 9a						
183 - CM	Develop and/or implement stormwater management plans for urban areas and roads.	5c, 6a, 9a	9d					cc, pg
184 - CM	Protect remaining high-quality off-channel habitat from degradation.	5c, 6e, 9a						cc, pg
185 - CM	Restore or create off-channel habitat and/or access to off-channel habitat: side channels.	5c, 6e, 9a						cc
186 - CM	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.	5c, 6e, 9a, 9b	9c, 9d	x				cc
187 - CM	Improve or regrade/revegetate streambanks.	6a, 6e, 9a						cc
188 - CM	Protect intact and functioning riparian areas through riparian easements and acquisition.	6a, 6e, 9a						cc
189 - CM	Restore (plant and/or fence) and protect (conservation easements, acquisition) riparian areas that are degraded.	6a, 6e, 9a						cc
190 - CM	Annually place 8,000 yd3 of spawning sized gravel below River Mill Dam as per FERC settlement agreement.	6d, 6e		x				
191 - CM	Implement all measures in the Clackamas River Hydroelectric Project (FERC Project No. 2195) Fish Passage and Protection Plan, including measures for downstream fish passage (3% or less mortality at River Mill and North Fork dams), Oak Grove Mitigation and improvements to North Fork fish ladder/trap.	6d, 6e, 9b		4b				
192 - CM	Utilize the Clackamas Hydroelectric Project Mitigation and Enhancement Fund to provide for habitat mitigation and enhancements in the Clackamas Basin.	6d, 6e, 9b		x				
193 - CM	Restore instream habitat complexity, including large wood placement (mitigate for loss of fall and spring Chinook habitat complexity due to Clackamas hydropower dams).	6e		x				cc
194 - CM	Reduce the square footage of over-water structures; where possible, modify remaining overwater structures to provide beneficial habitat.	6e						
195 - CM	Develop and implement Willamette mitigation bank river plan.	6e						
196 - CM	Identify and purchase key salmon habitats.	6e						pg

Table 7-3C. Actions to Address Threats and Limiting Factors for LCR Chinook Populations

Action ID	Action	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Future Threats
197 - CM	Remove invasive plants and plant native species.	6e						
198 - CM	Restore instream habitat complexity, including large wood placement.	6e						cc
199 - CM	Daylight stream.	6e, 9a						
200 - CM	Create confluence habitat with cool water, restore channel and reconnect upper creek.	6e, 9a						cc
201 - CM	Reconnect tributary to Willamette River and create high quality habitat at tributary junction.	6e, 9a						
202 - CM	Daylight stream.	6e, 9a						
203 - CM	Revise and update stormwater management manual.	6e, 9a	9c, 9d					cc, pg
204 - CM	Implement Gray2Green program.	6e, 9a	9c, 9d					
205 - CM	Re-establish connection to Columbia River for improved flushing, if feasible.	6e, 9a	9c, 9d					
206 - CM	Implement pesticide and fertilizer best management practices to reduce sources of toxic and conventional contaminants entering the estuary (revise and update IPM for PDX owned property).		9d					
207 - CM	Monitor for contaminants.		9d					pg
208 - CM	Maximize habitat benefits by restoration or mitigation.		9d					
210 - CM	Maintain existing wild fish sanctuary.					7c		
213 - CM	Operationally open the hatchery trap for a longer period.					7c		
214 - CM	Purchase a freezer trailer to aid the logistical disposition to carcass placement, tribes, and food banks if program is maintained.					7c		
Sandy (Fall Chinook)								
Limiting Factors and Threats for Different Life History Stages and Threat Levels	Key – Adult				7a	7c		---
	Key – Juvenile	6e	3a, 3b, 5b, 6c					---
	Secondary – Adult	6d						---
	Secondary – Juvenile	5c, 6a	1a, 6e, 9a, 9b, 9c, 9d	4b			8b	---
Mortality Rates	Current Status	82.79%	32.20%	3.00%	60.00%	45.00%	7.30%	---
	Delisting Status: *Contributing*	57.00%	26.00%	0.00%	35.00%	15.00%	6.00%	---
220 - SY	Develop recommendations for land management scenarios that address hydrograph changes that are predicted to occur due to climate change.	5c, 5e						cc

Table 7-3C. Actions to Address Threats and Limiting Factors for LCR Chinook Populations

Action ID	Action	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Future Threats
221 - SY	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.	5c, 6e						cc
222 - SY	Protect remaining high-quality off-channel habitat from degradation.	5c, 6e						cc, pg
223 - SY	Obtain better understanding of fall Chinook and late fall Chinook life history, habitat needs, and response to restoration in tributaries and estuary.	5c, 6e, 9a	x			7c		
226 - SY	Conduct sediment source analysis and then implement actions to reduce sediment from identified sources.	6a, 6d						
227 - SY	Develop and/or implement stormwater management plans for urban areas and roads.	6a, 6d						cc, pg
228 - SY	Identify and rectify problem legacy roads.	6a, 6d						
229 - SY	Gravel placement for spawning.	6a, 6d						
230 - SY	Remove dam.	6d		4b				
231 - SY	Protect instream water right for fish.	6d		4b				cc
232 - SY	Restore instream habitat complexity, including large wood placement.	6e						cc
234 - SY	Breach, lower, remove, or relocate dikes and levees to establish or improve access to off-channel habitats; vegetate dikes and levees.	6e						cc
235 - SY	Protect intact and functioning riparian areas through riparian easements and acquisition.	6e, 9a						cc
236 - SY	Restore (plant and/or fence) and protect (conservation easements, acquisition) riparian areas that are degraded.	6e, 9a						cc
243 - SY	Explore adding a life-cycle monitoring site in the Sandy population.	x	x	x	x	x	x	
Lower Gorge (Fall Chinook)								
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Key – Adult		6f			7a	7c		---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Key – Juvenile		6f	3a, 3b, 5b, 6c					---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Secondary – Adult								---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Secondary – Juvenile		5c	1a, 6e, 9a, 9b, 9c, 9d				8b	---
Mortality Rates – Current Status		82.04%	32.20%	0.00%	60.00%	45.00%	7.30%	---
Mortality Rates – Delisting Status: *Support WA*		59.00%	26.00%	0.00%	35.00%	30.00%	6.00%	---
245 - LG	Restore (plant and/or fence) and protect (conservation easements, acquisition) riparian areas that are degraded.	6f						cc

Table 7-3C. Actions to Address Threats and Limiting Factors for LCR Chinook Populations

Action ID	Action	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Future Threats
246 - LG	Restore instream habitat complexity, including large wood placement.	6f						cc
247 - LG	Provide / improve fish passage.	4c, 6f				x		
248 - LG	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.	6f						cc
249 - LG	Restore or create off-channel habitat and/or access to off-channel habitat: side channels.	6f						cc
250 - LG	Trap and sort hatchery adults: Investigate placing new weir and trap to sort hatchery fish from upstream migrants.[75]	4c				7c		
Upper Gorge (Fall Chinook)								
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Key – Adult		6f, 6g			7a	7c		---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Key – Juvenile		6f, 6g	3a, 3b, 5b, 6c					---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Secondary – Adult				4a				---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Secondary – Juvenile		1a, 5c, 6g, 8a	1a, 6e, 9a, 9b, 9c, 9d	4a			8b	---
Mortality Rates – Current Status		79.92%	32.20%	13.40%	65.00%	45.00%	9.10%	---
Mortality Rates – Delisting Status: *Support WA*		58.00%	26.00%	13.40%	40.00%	30.00%	7.00%	---
253 - UG	Provide / improve fish passage.	4c, 6f				x		
254 - UG	Restore or create off-channel habitat and/or access to off-channel habitat: side channels.	5c, 6e, 9a						cc
255 - UG	Restore (plant and/or fence) and protect (conservation easements, acquisition) riparian areas that are degraded.	6a, 6e, 9a						cc
256 - UG	Restore instream habitat complexity, including large wood placement.	6e						cc
257 - UG	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.	6f						cc
258 - UG	RPA 15: Continue to update the Water Quality Plan for Total Dissolved Gas and Water Temperature in the mainstem Columbia and Snake rivers, and implement water quality measures to enhance ESA-listed juvenile and adult fish survival and maintain spawning and rearing habitat.	6g		x				
259 - UG	RPAs 18-21: Prepare, in cooperation with NMFS and comanaging agencies, configuration and operational plans for the Bonneville Project (2008), The Dalles Project, John Day Project (2008) and McNary Project (2009).	6g		x				

[75] See note for this action in Table 7-3B for coho.

Table 7-3C. Actions to Address Threats and Limiting Factors for LCR Chinook Populations

Action ID	Action	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Future Threats
260 - UG	RPA 27: Operate turbine units to achieve best fish passage survival (currently within 1% of best efficiency at mainstem dams on the lower Columbia and lower Snake rivers.			4a				
261 - UG	RPA 28: Implement structural improvements to adult passage at the mainstem Columbia River and Snake River projects.			4a				
262 - UG	RPA 29: Provide spill to improve juvenile fish passage while avoiding high TDG supersaturation levels or adult fallback problems.			4a				
263 - UG	RPA 32: Prepare annually a fish passage plan in coordination with NMFS and the Regional Forum. Operate projects year around in accordance with the criteria in the fish passage plan.			4a				
264 - UG	OR - Operate lower Columbia reservoirs at minimum operating pool (MOP) during spring and summer as long as barge transport and irrigation needs are met.	6g		x				
265 - UG	OR - Provide spill to total dissolved gas limits of water quality waivers or biological constraints at all dams, except maximize transportation at Snake River collector projects during lowest (10th percentile) flow years.			4a				
266 - UG	Provide cover at mouth of Herman Creek that is inundated by Bonneville pool to reduce predation.	8a, 8d		x			x	cc
268 - UG	Trap and sort hatchery adults: Investigate placing trap to sort hatchery fish from upstream migrants.[76]					7c		
Hood (Fall Chinook)								
Limiting Factors and Threats for Different Life History Stages and Threat Levels	Key – Adult				7a	7c		---
	Key – Juvenile	5d, 6e	3a, 3b, 5b, 6c					---
	Secondary – Adult			4a				---
	Secondary – Juvenile	1a, 5a, 5c, 6a, 6g, 8a, 9c	1a, 6e, 9a, 9b, 9c, 9d	4a			8b	---
Mortality Rates	Current Status	71.30%	32.20%	18.70%	70.00%	45.00%	9.10%	---
	Delisting Status: *Primary*	0.00%	0.00%	10.50%	0.00%	0.00%	0.00%	---
271 - HD	Ensure that low head hydro projects do not adversely impact winter base streamflows.	5a		x				cc
272 - HD	Implement projects that aid in restoring the natural flow regime (e.g., HRWAP Project FP-3 Central Canal Pipeline/Neal Creek Siphon, future piping projects, Conserved Water Program, landowner technical assistance, etc.).	5c, 5d						cc

[76] Weir feasibility depends on finding a site that accesses enough fish to achieve management objectives (i.e., reduce stray rates to adequate levels), allows safe and reliable installation and operation under the site's hydrogeomorphological conditions at an acceptable cost. Placement of weirs here will also have to consider the relatively low desired status for these population areas and the limited amount of habitat available for natural production due to anthropogenic impacts and the naturally small size of this area.

Table 7-3C. Actions to Address Threats and Limiting Factors for LCR Chinook Populations

Action ID	Action	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Future Threats
273 - HD	Provide education and resources to hobby farms and other rural residents to assist them with water saving measures.	5c, 5d						cc
274 - HD	Work with OWRD and others to keep water saved through publically-funded water conservation efforts instream for fish.	5c, 5d						cc
277 - HD	Identify and implement flow improvements.	5d						cc
279 - HD	Protect intact and functioning riparian areas through riparian easements and acquisition.	6a, 6e, 9a						cc
280 - HD	Restore (plant and/or fence) and protect (conservation easements, acquisition) riparian areas that are degraded.	6a, 6e, 9a						cc
285 - HD	RPA 15: Continue to update the Water Quality Plan for Total Dissolved Gas and Water Temperature in the mainstem Columbia and Snake rivers, and implement water quality measures to enhance ESA-listed juvenile and adult fish survival and maintain spawning and rearing habitat.	6g		x				
286 - HD	RPAs 18-21: Prepare, in cooperation with NMFS and comanaging agencies, configuration and operational plans for the Bonneville Project (2008), The Dalles Project, John Day Project (2008) and McNary Project (2009).			4a				
287 - HD	RPA 27: Operate turbine units to achieve best fish passage survival (currently within 1% of best efficiency at mainstem dams on the lower Columbia and lower Snake rivers).			4a				
288 - HD	RPA 28: Implement structural improvements to adult passage at the mainstem Columbia River and Snake River projects.			4a				
289 - HD	RPA 32: Prepare annually a fish passage plan in coordination with NMFS and the Regional Forum. Operate projects year around in accordance with the criteria in the fish passage plan.			4a				
290 - HD	OR - Operate lower Columbia reservoirs at minimum operating pool (MOP) during spring and summer as long as barge transport and irrigation needs are met.	6g		x				
291 - HD	OR - Provide spill to total dissolved gas limits of water quality waivers or biological constraints at all dams, except maximize transportation at Snake River collector projects during lowest (10th percentile) flow years.			4a				
292 - HD	Remove dam.			4a				
308 - HD	Explore adding a life-cycle monitoring site in the Hood population.	x	x	x	x	x	x	
LATE FALL CHINOOK								
All Populations - Within Tributaries (Late Fall Chinook)								
55 - Trib	Mark all hatchery fish.					7c		
57 - Trib	Coded-wire tag enough fish from each hatchery release to allow identification of hatchery origin of strays and evaluate rearing and/or release techniques of problem hatcheries.					7c		

Table 7-3C. Actions to Address Threats and Limiting Factors for LCR Chinook Populations

Action ID	Action	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Future Threats
58 - Trib	Monitor stray rates for 9 years and implement adaptive management options if rates called for in recovery scenarios are exceeded.					7c		
59 - Trib	Based on the best available science, evaluate whether integrated or segregated hatchery programs are more compatible with recovery, considering the objective of each hatchery program.[77]				x	7c		
All Populations - Mixed Locations (Late Fall Chinook)								
98 - Mxd	Implement the new Pacific Salmon Treaty (reduce ocean fisheries on Chinook).				7a			
99 - Mxd	Support mark-selective ocean fisheries when a new PST is negotiated in 10 years.[78]				7a			
100 - Mxd	Implement mark-selective Columbia fall Chinook fisheries by: a) Developing live-capture commercial gear and techniques, b) Conducting release mortality studies for all fisheries, c) Implementing for Columbia R commercial fisheries in August and September if live-capture is feasible, and d) Implementing for sport fisheries in ocean, Buoy 10, tributaries, and mainstem above Buoy 10 (if upriver/Snake wilds are low).[79]				7a			
101 - Mxd	Develop an abundance-based, sliding scale harvest matrix that incorporates "weak stock management" for fall Chinook by implementing population monitoring and then: a) Identifying appropriate weak grouping of populations based on population recovery goals/probability, run timing relative to harvest, and other factors, b) Developing run forecast model, and c) Developing marine survival indices for returning adults.				7a, 7b			
102 - Mxd	Develop harvest management strategies to protect the strongest Chinook population (late Sandy ChF).				7a, 7b			
104 - Mxd	Monitor harvest levels in all fishery areas for all species (direct and indirect mortality).				7a, 7b			
Sandy (Late Fall Chinook)								
Limiting Factors and Threats for Different Life History Stages and Threat Levels — Key — Adult					7a	7c		---
Limiting Factors and Threats for Different Life History Stages and Threat Levels — Key — Juvenile		6e	3a, 3b, 5b, 6c					---
Limiting Factors and Threats for Different Life History Stages and Threat Levels — Secondary — Adult		6d						---
Limiting Factors and Threats for Different Life History Stages and Threat Levels — Secondary — Juvenile		5c, 6a	1a, 6e, 9a, 9b, 9c, 9d	4b			8b	---
Mortality Rates	Current Status	23.01%	30.90%	3.00%	50.00%	25.00%	7.30%	---
Mortality Rates	Delisting Status: *Primary*	16.60%	26.00%	0.00%	30.00%	5.00%	6.00%	---

[77] See note for this action in Table 7-3B for coho.
[78] See note for this action in Table 7-3C for fall Chinook.
[79] See note for this action in Table 7-3C for fall Chinook.

Table 7-3C. Actions to Address Threats and Limiting Factors for LCR Chinook Populations

Action ID	Action	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Future Threats
220 - SY	Develop recommendations for land management scenarios that address hydrograph changes that are predicted to occur due to climate change.	5c, 5e						cc
221 - SY	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.	5c, 6e						cc
222 - SY	Protect remaining high-quality off-channel habitat from degradation.	5c, 6e						cc, pg
223 - SY	Obtain better understanding of fall Chinook and late fall Chinook life history, habitat needs, and response to restoration in tributaries and estuary.	5c, 6e, 9a	x			7c		
226 - SY	Conduct sediment source analysis and then implement actions to reduce sediment from identified sources.	6a, 6d						
227 - SY	Develop and/or implement stormwater management plans for urban areas and roads.	6a, 6d						cc, pg
228 - SY	Identify and rectify problem legacy roads.	6a, 6d						
229 - SY	Gravel placement for spawning.	6a, 6d						
230 - SY	Remove dam.	6d		4b				
231 - SY	Protect instream water right for fish.	6d		4b				cc
234 - SY	Breach, lower, remove, or relocate dikes and levees to establish or improve access to off-channel habitats; vegetate dikes and levees.	6e						cc
243 - SY	Explore adding a life-cycle monitoring site in the Sandy population.	x	x	x	x	x	x	
SPRING CHINOOK								
All Populations - Within Tributaries (Spring Chinook)								
52 - Trib	Develop education and outreach materials on the benefit of beaver dams to ecosystem function in general and specifically to juvenile rearing habitat (especially for coho).	6e, 9a						cc, pg
53 - Trib	Provide technical and financial assistance to landowners with property damage due to beavers, and provide incentives to landowners that want to manage their land to achieve the habitat benefits provided by beaver dams. This includes developing agreements with landowners that would establish benchmarks for the amount of damage done by beavers. Once damage exceeded the agreed upon benchmark, a management entity would remove or reduce the beaver population from the affected property.	6e, 9a						cc, pg
55 - Trib	Mark all hatchery fish.					7c		
57 - Trib	Coded-wire tag enough fish from each hatchery release to allow identification of hatchery origin of strays and evaluate rearing and/or release techniques of problem hatcheries.					7c		

Table 7-3C. Actions to Address Threats and Limiting Factors for LCR Chinook Populations

Action ID	Action	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Future Threats
58 - Trib	Monitor stray rates for 9 years and implement adaptive management options if rates called for in recovery scenarios are exceeded.					7c		
59 - Trib	Based on the best available science, evaluate whether integrated or segregated hatchery programs are more compatible with recovery, considering the objective of each hatchery program.[80]				x	7c		
60 - Trib	Re-evaluate current TRT-developed Gorge stratum's historical status and population structure and revise recovery goals if modifications are made.	x	x	x	x	x	x	
All Populations - Mixed Locations (Spring Chinook)								
98 - Mxd	Implement the new Pacific Salmon Treaty (reduce ocean fisheries on Chinook).				7a			
99 - Mxd	Support mark-selective ocean fisheries when a new PST is negotiated in 10 years.[81]				7a			
103 - Mxd	Shift mainstem commercial spring Chinook harvest to terminal areas during low return years (de facto "sliding scale").				7a, 7b			
104 - Mxd	Monitor harvest levels in all fishery areas for all species (direct and indirect mortality).				7a, 7b			
Clackamas (Spring Chinook)								
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Key – Adult						7c		---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Key – Juvenile		6e	3a, 3b, 5b, 6c	4b				---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Secondary – Adult		6d, 9b			7a, 7b			---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Secondary – Juvenile		5c, 6e, 9a, 9b	1a, 6e, 9a, 9b, 9c, 9d				8b	---
Mortality Rates – Current Status		67.41%	9.50%	27.20%	25.00%	65.00%	12.10%	---
Mortality Rates – Delisting Status: *N / A*		44.00%	8.00%	6.40%	25.00%	10.00%	7.00%	---
170 - CM	Provide / improve fish passage.	4d, 6e						
171 - CM	Implement research, monitoring, and evaluation of headwater springs to investigate the concern that they may be drying up due to land management practices.	5c						cc
172 - CM	Identify and implement flow improvements.	5c						cc
173 - CM	Inventory and protect seeps, springs, and other coldwater sources.	5c						cc
174 - CM	Identify priority areas for increased instream flows.	5c						cc

[80] See note for this action in Table 7-3B for coho.
[81] See note for this action in Table 7-3C for fall Chinook.

Table 7-3C. Actions to Address Threats and Limiting Factors for LCR Chinook Populations

Action ID	Action	Threats and Limiting Factors						Future Threats
		Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	
175 - CM	Establish minimum ecosystem-based instream flows.	5c						cc
176 - CM	Identify and halt illegal water withdrawals.	5c						cc
177 - CM	Enforce existing water rights.	5c						cc
178 - CM	Breach, lower, remove, or relocate dikes and levees to establish or improve access to off-channel habitats; vegetate dikes and levees.	5c, 6a, 6e, 9a						cc
179 - CM	Review land use plans in context of salmon recovery needs (i.e., forest lands of higher value to salmon recovery than urbanized lands).	5c, 6a, 6e, 9a						pg
180 - CM	Provide incentives to promote good landowner stewardship.	5c, 6a, 6e, 9a						
181 - CM	Reduce impact that roads have on impaired hydrograph.	5c, 6a, 6e, 9a						cc
182 - CM	Finish Clackamas Fish Habitat Analysis.	5c, 6a, 6e, 9a						
183 - CM	Develop and/or implement stormwater management plans for urban areas and roads.	5c, 6a, 9a	9d					cc, pg
184 - CM	Protect remaining high-quality off-channel habitat from degradation.	5c, 6e, 9a						cc, pg
185 - CM	Restore or create off-channel habitat and/or access to off-channel habitat: side channels.	5c, 6e, 9a						cc
186 - CM	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.	5c, 6e, 9a, 9b	9c, 9d	x				cc
187 - CM	Improve or regrade/revegetate streambanks.	6a, 6e, 9a						cc
188 - CM	Protect intact and functioning riparian areas through riparian easements and acquisition.	6a, 6e, 9a						cc
189 - CM	Restore (plant and/or fence) and protect (conservation easements, acquisition) riparian areas that are degraded.	6a, 6e, 9a						cc
190 - CM	Annually place 8,000 yd3 of spawning sized gravel below River Mill Dam as per FERC settlement agreement.	6d, 6e		x				
191 - CM	Implement all measures in the Clackamas River Hydroelectric Project (FERC Project No. 2195) Fish Passage and Protection Plan, including measures for downstream fish passage (3% or less mortality at River Mill and North Fork dams), Oak Grove Mitigation and improvements to North Fork fish ladder/trap.	6d, 6e, 9b		4b				
192 - CM	Utilize the Clackamas Hydroelectric Project Mitigation and Enhancement Fund to provide for habitat mitigation and enhancements in the Clackamas Basin.	6d, 6e, 9b		x				

Table 7-3C. Actions to Address Threats and Limiting Factors for LCR Chinook Populations

Action ID	Action	Threats and Limiting Factors						Future Threats
		Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	
193 - CM	Restore instream habitat complexity, including large wood placement (mitigate for loss of fall and spring Chinook habitat complexity due to Clackamas hydropower dams).	6e		x				cc
194 - CM	Reduce the square footage of over-water structures; where possible, modify remaining overwater structures to provide beneficial habitat.	6e						
195 - CM	Develop and implement Willamette mitigation bank river plan.	6e						
196 - CM	Identify and purchase key salmon habitats.	6e						pg
197 - CM	Remove invasive plants and plant native species.	6e						
198 - CM	Restore instream habitat complexity, including large wood placement.	6e						cc
199 - CM	Daylight stream.	6e, 9a						
200 - CM	Create confluence habitat with cool water, restore channel and reconnect upper creek.	6e, 9a						cc
201 - CM	Reconnect tributary to Willamette River and create high quality habitat at tributary junction.	6e, 9a						
202 - CM	Daylight stream.	6e, 9a						
203 - CM	Revise and update stormwater management manual.	6e, 9a	9c, 9d					cc, pg
204 - CM	Implement Gray2Green program.	6e, 9a	9c, 9d					
205 - CM	Re-establish connection to Columbia River for improved flushing, if feasible.	6e, 9a	9c, 9d					
206 - CM	Implement pesticide and fertilizer best management practices to reduce sources of toxic and conventional contaminants entering the estuary (revise and update IPM for PDX owned property).		9d					
207 - CM	Monitor for contaminants.		9d					pg
208 - CM	Maximize habitat benefits by restoration or mitigation.		9d					
210 - CM	Maintain existing wild fish sanctuary.					7c		
213 - CM	Operationally open the hatchery trap for a longer period.					7c		
214 - CM	Purchase a freezer trailer to aid the logistical disposition to carcass placement, tribes, and food banks if program is maintained.					7c		

Table 7-3C. Actions to Address Threats and Limiting Factors for LCR Chinook Populations

Action ID	Action			Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Future Threats
Sandy (Spring Chinook)										
Limiting Factors and Threats for Different Life History Stages and Threat Levels		Key	Adult					7c		---
			Juvenile	6e	3a, 3b, 5b, 6c					---
		Secondary	Adult	4a, 6d			7a, 7b			---
			Juvenile	5c, 6a	1a, 6e, 9a, 9b, 9c, 9d	4b			8b	---
Mortality Rates			Current Status	93.38%	9.50%	8.00%	25.00%	27.00%	12.10%	---
			Delisting Status: *Primary*	92.50%	8.00%	0.00%	25.00%	5.00%	7.00%	---
218 - SY	Implement measures in the Bull Run Water Supply Habitat Conservation Plan (HCP).			4a						
220 - SY	Develop recommendations for land management scenarios that address hydrograph changes that are predicted to occur due to climate change.			5c, 5e						cc
221 - SY	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.			5c, 6e						cc
222 - SY	Protect remaining high-quality off-channel habitat from degradation.			5c, 6e						cc, pg
226 - SY	Conduct sediment source analysis and then implement actions to reduce sediment from identified sources.			6a, 6d						
227 - SY	Develop and/or implement stormwater management plans for urban areas and roads.			6a, 6d						cc, pg
228 - SY	Identify and rectify problem legacy roads.			6a, 6d						
230 - SY	Remove dam.			6d		4b				
231 - SY	Protect instream water right for fish.			6d		4b				cc
232 - SY	Restore instream habitat complexity, including large wood placement.			6e						cc
233 - SY	Restore or create off-channel habitat and/or access to off-channel habitat: side channels.			6e						cc
234 - SY	Breach, lower, remove, or relocate dikes and levees to establish or improve access to off-channel habitats; vegetate dikes and levees.			6e						cc
235 - SY	Protect intact and functioning riparian areas through riparian easements and acquisition.			6e, 9a						cc
236 - SY	Restore (plant and/or fence) and protect (conservation easements, acquisition) riparian areas that are degraded.			6e, 9a						cc

Table 7-3C. Actions to Address Threats and Limiting Factors for LCR Chinook Populations

Action ID	Action	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Future Threats
238 - SY	Acclimate 100% of hatchery spring Chinook releases into the Sandy.					7c		
239 - SY	Trap and sort hatchery adults: Collect (weir and trap at or near acclimation sites) hatchery spring Chinook if stray rate is too high.					7c		
240 - SY	Increase water quantity in Cedar Creek for more attraction (end illegal diversions, increase outreach and coordination with OWRD, potentially purchase water rights).					7c		cc
241 - SY	Implement a sliding scale for take of wild winter steelhead and spring Chinook broodstock for the integrated hatchery programs based on the forecasted total returns of wild fish to the population (<500: no take; 500-1000: reduced take); develop forecast model as necessary.					7c		
243 - SY	Explore adding a life-cycle monitoring site in the Sandy population.	x	x	x	x	x	x	
Hood (Spring Chinook)								
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Key – Adult					7a	7c		---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Key – Juvenile			3a, 3b, 5b, 6c					---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Secondary – Adult				4a			8d	---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Secondary – Juvenile		1a, 5a, 5c, 5d, 6a, 6g, 8a, 9c	1a, 6e, 9a, 9b, 9c, 9d	4a			8b	---
Mortality Rates – Current Status		89.40%	9.50%	34.90%	25.00%	45.00%	15.60%	---
Mortality Rates – Delisting Status: *Primary*		81.50%	8.00%	12.00%	25.00%	5.00%	7.00%	---
271 - HD	Ensure that low head hydro projects do not adversely impact winter base streamflows.	5a		x				cc
273 - HD	Provide education and resources to hobby farms and other rural residents to assist them with water saving measures.	5c, 5d						cc
274 - HD	Work with OWRD and others to keep water saved through publically-funded water conservation efforts instream for fish.	5c, 5d						cc
275 - HD	Develop and implement Best Management Practices and rules from the Hood River Agricultural Water Quality Area Management Plan and Rules.	5c, 6a, 6e						
276 - HD	Continue education and outreach programs identified in the HRWAP.	5c, 6a, 6e						
278 - HD	Work to expand streamside vegetation buffers.	6a, 6e						cc
279 - HD	Protect intact and functioning riparian areas through riparian easements and acquisition.	6a, 6e, 9a						cc
280 - HD	Restore (plant and/or fence) and protect (conservation easements, acquisition) riparian areas that are degraded.	6a, 6e, 9a						cc

Table 7-3C. Actions to Address Threats and Limiting Factors for LCR Chinook Populations

Action ID	Action	Threats and Limiting Factors						Future Threats
		Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	
284 - HD	Restore instream habitat complexity, including large wood placement.	6e, 6g		x				cc
285 - HD	RPA 15: Continue to update the Water Quality Plan for Total Dissolved Gas and Water Temperature in the mainstem Columbia and Snake rivers, and implement water quality measures to enhance ESA-listed juvenile and adult fish survival and maintain spawning and rearing habitat.	6g		x				
286 - HD	RPAs 18-21: Prepare, in cooperation with NMFS and comanaging agencies, configuration and operational plans for the Bonneville Project (2008), The Dalles Project, John Day Project (2008) and McNary Project (2009).			4a				
287 - HD	RPA 27: Operate turbine units to achieve best fish passage survival (currently within 1% of best efficiency at mainstem dams on the lower Columbia and lower Snake rivers).			4a				
288 - HD	RPA 28: Implement structural improvements to adult passage at the mainstem Columbia River and Snake River projects.			4a				
289 - HD	RPA 32: Prepare annually a fish passage plan in coordination with NMFS and the Regional Forum. Operate projects year around in accordance with the criteria in the fish passage plan.			4a				
290 - HD	OR - Operate lower Columbia reservoirs at minimum operating pool (MOP) during spring and summer as long as barge transport and irrigation needs are met.	6g		x				
291 - HD	OR - Provide spill to total dissolved gas limits of water quality waivers or biological constraints at all dams, except maximize transportation at Snake River collector projects during lowest (10th percentile) flow years.			4a				
292 - HD	Remove dam.			4a				
295 - HD	Improve domestic on-site sewage system management and residential chemical use.	9c	9d					
296 - HD	Discuss Zone 6 fishery actions with Tribes to reduce potential additional impacts. Potential actions include extending sanctuaries from mouths, and/or modifying season length or timing.				7a			
300 - HD	Trap and sort hatchery adults: Install a floating weir to remove stray hatchery winter steelhead, spring Chinook and coho.					7c		
301 - HD	Trap and sort hatchery adults: Install and operate a fish trap at Moving Falls to remove stray hatchery spring Chinook.					7c		
302 - HD	Move toward in-basin rearing of hatchery spring Chinook for better local adaptation of the out-of-ESU Deschutes stock used for re-introduction.					7c		
303 - HD	Work with Confederated Tribes of Warm Springs to evaluate re-introduction and explore alternative options if current program not successful.					7c		

Table 7-3C. Actions to Address Threats and Limiting Factors for LCR Chinook Populations

Action ID	Action	Threats and Limiting Factors						Future Threats
		Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	
304 - HD	Work with the Confederated Tribes of Warm Springs to develop a sliding scale for take of wild spring Chinook broodstock for the integrated hatchery program based on the forecasted total return of wild fish to the population; develop forecast model as necessary.					7c		
307 - HD	(similar to CRE-14) Expand federal and state activities at Bonneville Dam to test and implement non-lethal and potentially lethal methods of reducing pinniped populations. This includes efforts to manage pinnipeds through the Marine Mammal Protection Act.			x			8d	
308 - HD	Explore adding a life-cycle monitoring site in the Hood population.	x	x	x	x	x	x	

Table 7-3D. Proposed actions to address threats and limiting factors for LCR steelhead populations.

Table 7-3D. Actions to Address Threats and Limiting Factors for LCR Steelhead Populations									
			Threats and Limiting Factors						Future Threats
Action ID	Action		Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	
WINTER STEELHEAD									
All Populations - Within Tributaries (Winter Steelhead)									
52 - Trib	Develop education and outreach materials on the benefit of beaver dams to ecosystem function in general and specifically to juvenile rearing habitat (especially for coho).		6e, 9a						cc, pg
53 - Trib	Provide technical and financial assistance to landowners with property damage due to beavers, and provide incentives to landowners that want to manage their land to achieve the habitat benefits provided by beaver dams. This includes developing agreements with landowners that would establish benchmarks for the amount of damage done by beavers. Once damage exceeded the agreed upon benchmark, a management entity would remove or reduce the beaver population from the affected property.		6e, 9a						cc, pg
55 - Trib	Mark all hatchery fish.						7c		
57 - Trib	Coded-wire tag enough fish from each hatchery release to allow identification of hatchery origin of strays and evaluate rearing and/or release techniques of problem hatcheries.						7c		
58 - Trib	Monitor stray rates for 9 years and implement adaptive management options if rates called for in recovery scenarios are exceeded.						7c		
59 - Trib	Based on the best available science, evaluate whether integrated or segregated hatchery programs are more compatible with recovery, considering the objective of each hatchery program.[82]					x	7c		
60 - Trib	Re-evaluate current TRT-developed Gorge stratum's historical status and population structure and revise recovery goals if modifications are made.		x	x	x	x	x	x	
All Populations - Mixed Locations (Winter Steelhead)									
104 - Mxd	Monitor harvest levels in all fishery areas for all species (direct and indirect mortality).					7a, 7b			
Youngs Bay (Winter Steelhead)									
Limiting Factors and Threats for Different Life History Stages and Threat Levels	Key	Adult							---
		Juvenile	5c, 6e	3a, 3b, 5b, 6c					---
	Secondary	Adult	4c			7b	7c		---
		Juvenile	5c, 5e, 6a, 9a	1a, 6e, 9a, 9b, 9c				8b	---
Mortality Rates		Current Status	58.63%	9.50%	0.00%	10.00%	20.00%	11.30%	---
		Delisting Status: *N / A*	35.00%	8.00%	0.00%	10.00%	10.00%	6.00%	---

[82] See note for this action in Table 7-3B for coho.

Table 7-3D. Actions to Address Threats and Limiting Factors for LCR Steelhead Populations

Action ID	Action	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Future Threats
106 - YB	Explore cooperative water conservation measures.	5c, 5e						cc
107 - YB	Implement research, monitoring, and evaluation of headwater springs to investigate the concern that they may be drying up due to land management practices.	5c, 5e						cc
108 - YB	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.	5c, 6e, 9a						cc
109 - YB	Preserve recent wood input from 12/7 storm.	5c, 6e, 9a						
110 - YB	Assess need for additional LWD to improve instream habitat complexity.	5c, 6e, 9a						
111 - YB	Restore instream habitat complexity, including large wood placement.	5c, 6e, 9a						cc
112 - YB	Protect intact and functioning riparian areas through riparian easements and acquisition.	5c, 6e, 9a						cc
113 - YB	Restore (plant and/or fence) and protect (conservation easements, acquisition) riparian areas that are degraded.	5c, 6e, 9a						cc
114 - YB	Conduct sediment source analysis and then implement actions to reduce sediment from identified sources.	6a						
117 - YB	Maintain existing wild fish sanctuary.	4c				7c		
119 - YB	Trap and sort hatchery adults: Investigate placing trap to sort hatchery fish from upstream migrants.[83]					7c		
Big Creek (Winter Steelhead)								
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Key – Adult						7c		---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Key – Juvenile		5c, 6e	3a, 3b, 5b, 6c					---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Secondary – Adult		4c			7b			---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Secondary – Juvenile		5c, 5e, 6a, 9a	1a, 6e, 9a, 9b, 9c				8b	---
Mortality Rates – Current Status		56.47%	9.50%	0.00%	10.00%	40.00%	11.30%	---
Mortality Rates – Delisting Status: *N / A*		25.00%	8.00%	0.00%	10.00%	10.00%	6.00%	---
120 - BC	Explore cooperative water conservation measures.	5c, 5e						cc
121 - BC	Implement research, monitoring, and evaluation of headwater springs to investigate the concern that they may be drying up due to land management practices.	5c, 5e						cc
122 - BC	Restore instream habitat complexity, including large wood placement.	5c, 6e, 9a						cc

[83] See note for this action in Table 7-3B for coho.

Table 7-3D. Actions to Address Threats and Limiting Factors for LCR Steelhead Populations

Action ID	Action	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Future Threats
123 - BC	Possible road re-alignment.	5c, 6e, 9a						
125 - BC	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.	5c, 6e, 9a						cc
126 - BC	Restore (plant and/or fence) and protect (conservation easements, acquisition) riparian areas that are degraded.	5c, 6e, 9a						cc
127 - BC	Restore or create off-channel habitat and/or access to off-channel habitat: side channels.	5c, 6e, 9a						cc
128 - BC	Conduct sediment source analysis and then implement actions to reduce sediment from identified sources.	6a						
131 - BC	Trap and sort hatchery adults: Develop trap and haul capability to pass unmarked Coho and STW above hatchery.	4c				7c		
132 - BC	Maintain existing wild fish sanctuary.	4c				7c		
Clatskanie (Winter Steelhead)								
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Key – Adult								---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Key – Juvenile		6e	3a, 3b, 5b, 6c					---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Secondary – Adult					7b			---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Secondary – Juvenile		5c, 6b, 9a	1a, 6e, 9a, 9b, 9c, 9d				8b	---
Mortality Rates – Current Status		61.78%	9.50%	0.00%	10.00%	5.00%	11.70%	---
Mortality Rates – Delisting Status: *N / A*		42.00%	8.00%	0.00%	10.00%	5.00%	7.00%	---
135 - CT	Implement research, monitoring, and evaluation of headwater springs to investigate the concern that they may be drying up due to land management practices.	5c						cc
136 - CT	Protect intact and functioning riparian areas through riparian easements and acquisition.	5c, 6b, 6e, 9a						cc
137 - CT	Protect remaining high-quality off-channel habitat from degradation.	5c, 6b, 6e, 9a						cc, pg
138 - CT	Breach, lower, remove, or relocate dikes and levees to establish or improve access to off-channel habitats; vegetate dikes and levees.	5c, 6b, 6e, 9a						cc
139 - CT	Restore instream habitat complexity, including large wood placement.	5c, 6b, 6e, 9a						cc
140 - CT	Establish working group to identify priority areas for riparian and instream habitat enhancement, and work with landowners to implement projects.	5c, 6b, 6e, 9a						cc

Table 7-3D. Actions to Address Threats and Limiting Factors for LCR Steelhead Populations

Action ID	Action	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Future Threats
141 - CT	Conduct sediment source analysis and then implement actions to reduce sediment from identified sources.	5c, 6b, 6e, 9a						
142 - CT	Conduct full assessment of streams that were heavily damaged during Dec. 2007 storm to determine best approach to restoration.	5c, 6b, 6e, 9a						
144 - CT	Inventory and assess connectivity and hydrologic function.	5c, 6b, 6e, 9a						
145 - CT	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.	5c, 6b, 6e, 9a						cc
146 - CT	Restore (plant and/or fence) and protect (conservation easements, acquisition) riparian areas that are degraded.	5c, 6b, 6e, 9a						cc
147 - CT	Trap and sort hatchery adults: Investigate placing trap to sort hatchery fish from upstream migrants, if stray rate is greater than 10%.[84]					7c		
148 - CT	Maintain existing wild fish sanctuary (do not stock hatchery fish).					7c		
149 - CT	Explore adding a life-cycle monitoring site in the Clatskanie population.[85]	x	x	x	x	x	x	
Scappoose (Winter Steelhead)								
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Key – Adult								---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Key – Juvenile		6e	3a, 3b, 5b, 6c					---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Secondary – Adult					7b			---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Secondary – Juvenile		5c, 6b, 9a	1a, 6e, 9a, 9b, 9c, 9d				8b	---
Mortality Rates – Current Status		61.69%	9.50%	0.00%	10.00%	5.00%	11.70%	---
Mortality Rates – Delisting Status: *N / A*		43.00%	8.00%	0.00%	10.00%	5.00%	7.00%	---
150 - SC	Provide / improve fish passage.	4e, 5c, 6e, 9a						
151 - SC	Implement research, monitoring, and evaluation of headwater springs to investigate the concern that they may be drying up due to land management practices.	5c						cc
152 - SC	Protect intact and functioning riparian areas through riparian easements and acquisition.	5c, 6b, 6e, 9a						cc
153 - SC	Restore (plant and/or fence) and protect (conservation easements, acquisition) riparian areas that are degraded.	5c, 6b, 6e, 9a						cc

[84] See note for this action in Table 7-3B for coho.
[85] See note for this action in Table 7-3B for coho.

Table 7-3D. Actions to Address Threats and Limiting Factors for LCR Steelhead Populations

Action ID	Action	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Future Threats
154 - SC	Protect/manage existing high quality habitat.	5c, 6b, 6e, 9a						pg
155 - SC	Restore instream habitat complexity, including large wood placement.	5c, 6b, 6e, 9a						cc
156 - SC	Restore or create off-channel habitat and/or access to off-channel habitat: side channels.	5c, 6b, 6e, 9a						cc
157 - SC	Restore connectivity to small tributaries.	5c, 6b, 6e, 9a						
158 - SC	Establish working group to identify habitat enhancement projects.	5c, 6b, 6e, 9a						
159 - SC	Work with landowners to implement projects to prevent/reduce impacts from development and land management; provide resources and incentives.	5c, 6b, 6e, 9a						pg
160 - SC	Protect remaining high-quality off-channel habitat from degradation.	5c, 6b, 6e, 9a						cc, pg
162 - SC	Inventory and assess connectivity and hydrologic function.	5c, 6b, 6e, 9a						
163 - SC	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.	5c, 6b, 6e, 9a						cc
164 - SC	Investigate ways to retain gravel in context of flood impact management considerations.	5c, 6e, 9a						
165 - SC	Improve system for monitoring water quality and quantity and ensure that information is integrated into existing regulatory framework.	5c, 6e, 9a						cc
168 - SC	Maintain existing wild fish sanctuary (do not stock hatchery fish).					7c		
Clackamas (Winter Steelhead)								
Limiting Factors and Threats for Different Life History Stages and Threat Levels	Key – Adult							---
	Key – Juvenile	6e	3a, 3b, 5b, 6c					---
	Secondary – Adult				7b	7c		---
	Secondary – Juvenile	5c, 6a, 9a, 9b	1a, 6e, 9a, 9b, 9c, 9d	4b			8b	---
Mortality Rates	Current Status	64.80%	9.50%	5.20%	10.00%	23.00%	12.10%	---
	Delisting Status: *Primary*	23.50%	8.00%	5.00%	10.00%	10.00%	7.00%	---
170 - CM	Provide / improve fish passage.	4d, 6e						

Table 7-3D. Actions to Address Threats and Limiting Factors for LCR Steelhead Populations

Action ID	Action	Threats and Limiting Factors						Future Threats
		Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	
171 - CM	Implement research, monitoring, and evaluation of headwater springs to investigate the concern that they may be drying up due to land management practices.	5c						cc
172 - CM	Identify and implement flow improvements.	5c						cc
173 - CM	Inventory and protect seeps, springs, and other coldwater sources.	5c						cc
174 - CM	Identify priority areas for increased instream flows.	5c						cc
175 - CM	Establish minimum ecosystem-based instream flows.	5c						cc
176 - CM	Identify and halt illegal water withdrawals.	5c						cc
177 - CM	Enforce existing water rights.	5c						cc
178 - CM	Breach, lower, remove, or relocate dikes and levees to establish or improve access to off-channel habitats; vegetate dikes and levees.	5c, 6a, 6e, 9a						cc
179 - CM	Review land use plans in context of salmon recovery needs (i.e., forest lands of higher value to salmon recovery than urbanized lands).	5c, 6a, 6e, 9a						pg
180 - CM	Provide incentives to promote good landowner stewardship.	5c, 6a, 6e, 9a						
181 - CM	Reduce impact that roads have on impaired hydrograph.	5c, 6a, 6e, 9a						cc
182 - CM	Finish Clackamas Fish Habitat Analysis.	5c, 6a, 6e, 9a						
183 - CM	Develop and/or implement stormwater management plans for urban areas and roads.	5c, 6a, 9a	9d					cc, pg
184 - CM	Protect remaining high-quality off-channel habitat from degradation.	5c, 6e, 9a						cc, pg
185 - CM	Restore or create off-channel habitat and/or access to off-channel habitat: side channels.	5c, 6e, 9a						cc
186 - CM	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.	5c, 6e, 9a, 9b	9c, 9d	x				cc
187 - CM	Improve or regrade/revegetate streambanks.	6a, 6e, 9a						cc
188 - CM	Protect intact and functioning riparian areas through riparian easements and acquisition.	6a, 6e, 9a						cc
189 - CM	Restore (plant and/or fence) and protect (conservation easements, acquisition) riparian areas that are degraded.	6a, 6e, 9a						cc

Table 7-3D. Actions to Address Threats and Limiting Factors for LCR Steelhead Populations

Action ID	Action	Threats and Limiting Factors						Future Threats
		Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	
191 - CM	Implement all measures in the Clackamas River Hydroelectric Project (FERC Project No. 2195) Fish Passage and Protection Plan, including measures for downstream fish passage (3% or less mortality at River Mill and North Fork dams), Oak Grove Mitigation and improvements to North Fork fish ladder/trap.	6d, 6e, 9b		4b				
192 - CM	Utilize the Clackamas Hydroelectric Project Mitigation and Enhancement Fund to provide for habitat mitigation and enhancements in the Clackamas Basin.	6d, 6e, 9b		x				
194 - CM	Reduce the square footage of over-water structures; where possible, modify remaining overwater structures to provide beneficial habitat.	6e						
195 - CM	Develop and implement Willamette mitigation bank river plan.	6e						
196 - CM	Identify and purchase key salmon habitats.	6e						pg
197 - CM	Remove invasive plants and plant native species.	6e						
198 - CM	Restore instream habitat complexity, including large wood placement.	6e						cc
199 - CM	Daylight stream.	6e, 9a						
200 - CM	Create confluence habitat with cool water, restore channel and reconnect upper creek.	6e, 9a						cc
201 - CM	Reconnect tributary to Willamette River and create high quality habitat at tributary junction.	6e, 9a						
202 - CM	Daylight stream.	6e, 9a						
203 - CM	Revise and update stormwater management manual.	6e, 9a	9c, 9d					cc, pg
204 - CM	Implement Gray2Green program.	6e, 9a	9c, 9d					
205 - CM	Re-establish connection to Columbia River for improved flushing, if feasible.	6e, 9a	9c, 9d					
206 - CM	Implement pesticide and fertilizer best management practices to reduce sources of toxic and conventional contaminants entering the estuary (revise and update IPM for PDX owned property).		9d					
207 - CM	Monitor for contaminants.		9d					pg
208 - CM	Maximize habitat benefits by restoration or mitigation.		9d					
210 - CM	Maintain existing wild fish sanctuary.					7c		
215 - CM	Eliminate/reduce/shift program: Reduce the Eagle Creek hatchery winter steelhead releases if needed (150k to 100k).					7c		
216 - CM	Implement a sliding scale for take of wild winter steelhead broodstock for the integrated hatchery program based on the forecasted total return of wild fish to the population (<500: no take; 500-1000: reduced take); develop forecast model as necessary.					7c		

Table 7-3D. Actions to Address Threats and Limiting Factors for LCR Steelhead Populations

Action ID	Action	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Future Threats
217 - CM	Explore feasibility of shifting the Clackamas Hatchery winter steelhead program to a 2-year old smolt program. If implemented and they maintain wild run-timing, consider segregated program to reduce wild brood harvest.[86]					7c		
Sandy (Winter Steelhead)								
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Key – Adult						7c		---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Key – Juvenile		6e	3a, 3b, 5b, 6c					---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Secondary – Adult		4a, 4c, 6d			7b			---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Secondary – Juvenile		5c, 5e, 6a	1a, 6e, 9a, 9b, 9c, 9d				8b	---
Mortality Rates	Current Status	82.52%	9.50%	4.00%	10.00%	52.00%	12.10%	---
Mortality Rates	Delisting Status: *Primary*	81.25%	8.00%	0.00%	10.00%	10.00%	7.00%	---
218 - SY	Implement measures in the Bull Run Water Supply Habitat Conservation Plan (HCP).	4a						
219 - SY	Provide / improve fish passage.	4c, 4d				7c		
220 - SY	Develop recommendations for land management scenarios that address hydrograph changes that are predicted to occur due to climate change.	5c, 5e						cc
221 - SY	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.	5c, 6e						cc
222 - SY	Protect remaining high-quality off-channel habitat from degradation.	5c, 6e						cc, pg
224 - SY	Limit future in-river and groundwater withdrawals so that they do not impede achievement of recovery goals.	5e						cc, pg
225 - SY	Meet minimum streamflow requirements for water temperature compliance below Bull Run dams (modified tower intakes and spillway plunge pool).	5e, 9a						cc
226 - SY	Conduct sediment source analysis and then implement actions to reduce sediment from identified sources.	6a, 6d						
227 - SY	Develop and/or implement stormwater management plans for urban areas and roads.	6a, 6d						cc, pg
228 - SY	Identify and rectify problem legacy roads.	6a, 6d						
229 - SY	Gravel placement for spawning.	6a, 6d						
230 - SY	Remove dam.	6d		4b				

[86] This action entails holding and rearing these fish for an extra year to better mimic their natural life cycle. It is unknown whether this will truly result in a hatchery fish that mimics wild fish run timing. It will also require significant amount of hatchery production space and additional costs. This will likely affect other production programs and decisions about priorities and trade-offs may be necessary.

Table 7-3D. Actions to Address Threats and Limiting Factors for LCR Steelhead Populations

Action ID	Action	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Future Threats
231 - SY	Protect instream water right for fish.	6d		4b				cc
232 - SY	Restore instream habitat complexity, including large wood placement.	6e						cc
233 - SY	Restore or create off-channel habitat and/or access to off-channel habitat: side channels.	6e						cc
235 - SY	Protect intact and functioning riparian areas through riparian easements and acquisition.	6e, 9a						cc
236 - SY	Restore (plant and/or fence) and protect (conservation easements, acquisition) riparian areas that are degraded.	6e, 9a						cc
241 - SY	Implement a sliding scale for take of wild winter steelhead and spring Chinook broodstock for the integrated hatchery programs based on the forecasted total returns of wild fish to the population (<500: no take; 500-1000: reduced take); develop forecast model as necessary.					7c		
242 - SY	Eliminate the upper basin and Marmot Dam acclimation pond releases.					7c		
243 - SY	Explore adding a life-cycle monitoring site in the Sandy population.	x	x	x	x	x	x	
Lower Gorge (Winter Steelhead)								
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Key – Adult		6f						---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Key – Juvenile		6f	3a, 3b, 5b, 6c					---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Secondary – Adult		4c			7b	7c		---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Secondary – Juvenile		5c, 5f	1a, 6e, 9a, 9b, 9c, 9d				8b	---
Mortality Rates – Current Status		59.72%	9.50%	0.00%	10.00%	10.00%	12.10%	---
Mortality Rates – Delisting Status: *Support WA*		40.00%	8.00%	0.00%	10.00%	10.00%	7.00%	---
244 - LG	Identify and implement flow improvements.	5f				x		cc
245 - LG	Restore (plant and/or fence) and protect (conservation easements, acquisition) riparian areas that are degraded.	6f						cc
246 - LG	Restore instream habitat complexity, including large wood placement.	6f						cc
247 - LG	Provide / improve fish passage.	4c, 6f				x		
248 - LG	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.	6f						cc
249 - LG	Restore or create off-channel habitat and/or access to off-channel habitat: side channels.	6f						cc

Table 7-3D. Actions to Address Threats and Limiting Factors for LCR Steelhead Populations

Action ID	Action			Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Future Threats
250 - LG	Trap and sort hatchery adults: Investigate placing new weir and trap to sort hatchery fish from upstream migrants.[87]			4c				7c		
Upper Gorge (Winter Steelhead)										
Limiting Factors and Threats for Different Life History Stages and Threat Levels		Key	Adult	6f, 6g						---
			Juvenile	6f, 6g	3a, 3b, 5b, 6c					---
		Secondary	Adult	4c		4a	7a, 7b	7c	8d	---
			Juvenile	1a, 5c, 6g, 8a	1a, 6e, 9a, 9b, 9c, 9d	4a			8b	---
	Mortality Rates		Current Status	51.05%	8.60%	16.00%	15.00%	10.00%	16.50%	---
			Delisting Status: *Support WA*	30.50%	7.00%	16.00%	15.00%	10.00%	10.00%	---
253 - UG	Provide / improve fish passage.			4c, 6f				x		
254 - UG	Restore or create off-channel habitat and/or access to off-channel habitat: side channels.			5c, 6e, 9a						cc
255 - UG	Restore (plant and/or fence) and protect (conservation easements, acquisition) riparian areas that are degraded.			6a, 6e, 9a						cc
256 - UG	Restore instream habitat complexity, including large wood placement.			6e						cc
257 - UG	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.			6f						cc
258 - UG	RPA 15: Continue to update the Water Quality Plan for Total Dissolved Gas and Water Temperature in the mainstem Columbia and Snake rivers, and implement water quality measures to enhance ESA-listed juvenile and adult fish survival and maintain spawning and rearing habitat.			6g		x				
259 - UG	RPAs 18-21: Prepare, in cooperation with NMFS and comanaging agencies, configuration and operational plans for the Bonneville Project (2008), The Dalles Project, John Day Project (2008) and McNary Project (2009).			6g		x				
260 - UG	RPA 27: Operate turbine units to achieve best fish passage survival (currently within 1% of best efficiency at mainstem dams on the lower Columbia and lower Snake rivers.					4a				
261 - UG	RPA 28: Implement structural improvements to adult passage at the mainstem Columbia River and Snake River projects.					4a				
262 - UG	RPA 29: Provide spill to improve juvenile fish passage while avoiding high TDG supersaturation levels or adult fallback problems.					4a				

[87] See note for this action in Table 7-3B for coho.

Table 7-3D. Actions to Address Threats and Limiting Factors for LCR Steelhead Populations

Action ID	Action	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Future Threats
263 - UG	RPA 32: Prepare annually a fish passage plan in coordination with NMFS and the Regional Forum. Operate projects year around in accordance with the criteria in the fish passage plan.			4a				
264 - UG	OR - Operate lower Columbia reservoirs at minimum operating pool (MOP) during spring and summer as long as barge transport and irrigation needs are met.	6g		x				
265 - UG	OR - Provide spill to total dissolved gas limits of water quality waivers or biological constraints at all dams, except maximize transportation at Snake River collector projects during lowest (10th percentile) flow years.			4a				
266 - UG	Provide cover at mouth of Herman Creek that is inundated by Bonneville pool to reduce predation.	8a, 8d		x			x	cc
267 - UG	Discuss Zone 6 fishery actions with Tribes to reduce potential additional impacts. Potential actions include extending sanctuaries from mouths, and/or modifying season length or timing.				7a			
269 - UG	(similar to CRE-14) Expand federal and state activities at Bonneville Dam to test and implement non-lethal and potentially lethal methods of reducing pinniped populations. This includes efforts to manage pinnipeds through the Marine Mammal Protection Act.			x			8d	
Hood (Winter Steelhead)								
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Key – Adult								---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Key – Juvenile		5d, 6e	3a, 3b, 5b, 6c					---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Secondary – Adult		4a		4a	7a, 7b	7c	8d	---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Secondary – Juvenile		1a, 5a, 5c, 6a, 6g, 8a, 9a, 9c	1a, 6e, 9a, 9b, 9c, 9d	4a			8b	---
Mortality Rates – Current Status		-1.15%	8.60%	35.80%	15.00%	30.00%	16.50%	---
Mortality Rates – Delisting Status: *Primary*		-1.15%	7.00%	16.00%	15.00%	10.00%	10.00%	---
270 - HD	Provide / improve fish passage.	4a, 6e						
271 - HD	Ensure that low head hydro projects do not adversely impact winter base streamflows.	5a		x				cc
272 - HD	Implement projects that aid in restoring the natural flow regime (e.g., HRWAP Project FP-3 Central Canal Pipeline/Neal Creek Siphon, future piping projects, Conserved Water Program, landowner technical assistance, etc.).	5c, 5d						cc
273 - HD	Provide education and resources to hobby farms and other rural residents to assist them with water saving measures.	5c, 5d						cc
274 - HD	Work with OWRD and others to keep water saved through publically-funded water conservation efforts instream for fish.	5c, 5d						cc

Table 7-3D. Actions to Address Threats and Limiting Factors for LCR Steelhead Populations

Action ID	Action	Threats and Limiting Factors						Future Threats
		Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	
275 - HD	Develop and implement Best Management Practices and rules from the Hood River Agricultural Water Quality Area Management Plan and Rules.	5c, 6a, 6e						
276 - HD	Continue education and outreach programs identified in the HRWAP.	5c, 6a, 6e						
277 - HD	Identify and implement flow improvements.	5d						cc
278 - HD	Work to expand streamside vegetation buffers.	6a, 6e						cc
279 - HD	Protect intact and functioning riparian areas through riparian easements and acquisition.	6a, 6e, 9a						cc
280 - HD	Restore (plant and/or fence) and protect (conservation easements, acquisition) riparian areas that are degraded.	6a, 6e, 9a						cc
281 - HD	Remove sections of railroad fill.	6e						
282 - HD	Restore or create off-channel habitat and/or access to off-channel habitat: side channels.	6e						cc
283 - HD	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.	6e						cc
284 - HD	Restore instream habitat complexity, including large wood placement.	6e, 6g		x				cc
285 - HD	RPA 15: Continue to update the Water Quality Plan for Total Dissolved Gas and Water Temperature in the mainstem Columbia and Snake rivers, and implement water quality measures to enhance ESA-listed juvenile and adult fish survival and maintain spawning and rearing habitat.	6g		x				
286 - HD	RPAs 18-21: Prepare, in cooperation with NMFS and comanaging agencies, configuration and operational plans for the Bonneville Project (2008), The Dalles Project, John Day Project (2008) and McNary Project (2009).			4a				
287 - HD	RPA 27: Operate turbine units to achieve best fish passage survival (currently within 1% of best efficiency at mainstem dams on the lower Columbia and lower Snake rivers).			4a				
288 - HD	RPA 28: Implement structural improvements to adult passage at the mainstem Columbia River and Snake River projects.			4a				
289 - HD	RPA 32: Prepare annually a fish passage plan in coordination with NMFS and the Regional Forum. Operate projects year around in accordance with the criteria in the fish passage plan.			4a				
290 - HD	OR - Operate lower Columbia reservoirs at minimum operating pool (MOP) during spring and summer as long as barge transport and irrigation needs are met.	6g		x				
291 - HD	OR - Provide spill to total dissolved gas limits of water quality waivers or biological constraints at all dams, except maximize transportation at Snake River collector projects during lowest (10th percentile) flow years.			4a				

Table 7-3D. Actions to Address Threats and Limiting Factors for LCR Steelhead Populations

Action ID	Action	Threats and Limiting Factors						Future Threats
		Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	
292 - HD	Remove dam.			4a				
294 - HD	Implement BMPs for ag chemicals.	9c						
295 - HD	Improve domestic on-site sewage system management and residential chemical use.	9c	9d					
296 - HD	Discuss Zone 6 fishery actions with Tribes to reduce potential additional impacts. Potential actions include extending sanctuaries from mouths, and/or modifying season length or timing.				7a			
300 - HD	Trap and sort hatchery adults: Install a floating weir to remove stray hatchery winter steelhead, spring Chinook and coho.					7c		
305 - HD	Implement a sliding scale for take of wild winter steelhead broodstock for the integrated hatchery program based on the forecasted total return of wild fish to the population (<200: no take); develop forecast model as necessary.					7c		
307 - HD	(similar to CRE-14) Expand federal and state activities at Bonneville Dam to test and implement non-lethal and potentially lethal methods of reducing pinniped populations. This includes efforts to manage pinnipeds through the Marine Mammal Protection Act.			x			8d	
308 - HD	Explore adding a life-cycle monitoring site in the Hood population.	x	x	x	x	x	x	
SUMMER STEELHEAD								
All Populations - Within Tributaries (Summer Steelhead)								
52 - Trib	Develop education and outreach materials on the benefit of beaver dams to ecosystem function in general and specifically to juvenile rearing habitat (especially for coho).	6e, 9a						cc, pg
53 - Trib	Provide technical and financial assistance to landowners with property damage due to beavers, and provide incentives to landowners that want to manage their land to achieve the habitat benefits provided by beaver dams. This includes developing agreements with landowners that would establish benchmarks for the amount of damage done by beavers. Once damage exceeded the agreed upon benchmark, a management entity would remove or reduce the beaver population from the affected property.	6e, 9a						cc, pg
55 - Trib	Mark all hatchery fish.					7c		
57 - Trib	Coded-wire tag enough fish from each hatchery release to allow identification of hatchery origin of strays and evaluate rearing and/or release techniques of problem hatcheries.					7c		
58 - Trib	Monitor stray rates for 9 years and implement adaptive management options if rates called for in recovery scenarios are exceeded.					7c		

Table 7-3D. Actions to Address Threats and Limiting Factors for LCR Steelhead Populations

Action ID	Action	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Future Threats
59 - Trib	Based on the best available science, evaluate whether integrated or segregated hatchery programs are more compatible with recovery, considering the objective of each hatchery program.[88]				x	7c		
60 - Trib	Re-evaluate current TRT-developed Gorge stratum's historical status and population structure and revise recovery goals if modifications are made.	x	x	x	x	x	x	
All Populations - Mixed Locations (Summer Steelhead)								
104 - Mxd	Monitor harvest levels in all fishery areas for all species (direct and indirect mortality).				7a, 7b			
Hood (Summer Steelhead)								
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Key – Adult						7c		---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Key – Juvenile		5d, 6e	3a, 3b, 5b, 6c					---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Secondary – Adult				4a	7a		8d	---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Secondary – Juvenile		1a, 5a, 5c, 6a, 6g, 8a, 9a, 9c	1a, 6e, 9a, 9b, 9c, 9d	4a			8b	---
Mortality Rates	Current Status	95.42%	8.60%	35.80%	15.00%	53.00%	14.70%	---
Mortality Rates	Delisting Status: *Primary*	14.00%	7.00%	16.00%	15.00%	0.00%	8.00%	---
271 - HD	Ensure that low head hydro projects do not adversely impact winter base streamflows.	5a		x				cc
273 - HD	Provide education and resources to hobby farms and other rural residents to assist them with water saving measures.	5c, 5d						cc
274 - HD	Work with OWRD and others to keep water saved through publically-funded water conservation efforts instream for fish.	5c, 5d						cc
275 - HD	Develop and implement Best Management Practices and rules from the Hood River Agricultural Water Quality Area Management Plan and Rules.	5c, 6a, 6e						
276 - HD	Continue education and outreach programs identified in the HRWAP.	5c, 6a, 6e						
278 - HD	Work to expand streamside vegetation buffers.	6a, 6e						cc
279 - HD	Protect intact and functioning riparian areas through riparian easements and acquisition.	6a, 6e, 9a						cc
280 - HD	Restore (plant and/or fence) and protect (conservation easements, acquisition) riparian areas that are degraded.	6a, 6e, 9a						cc

[88] See note for this action in Table 7-3B for coho.

Table 7-3D. Actions to Address Threats and Limiting Factors for LCR Steelhead Populations

Action ID	Action	Threats and Limiting Factors						Future Threats
		Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	
285 - HD	RPA 15: Continue to update the Water Quality Plan for Total Dissolved Gas and Water Temperature in the mainstem Columbia and Snake rivers, and implement water quality measures to enhance ESA-listed juvenile and adult fish survival and maintain spawning and rearing habitat.	6g		x				
286 - HD	RPAs 18-21: Prepare, in cooperation with NMFS and comanaging agencies, configuration and operational plans for the Bonneville Project (2008), The Dalles Project, John Day Project (2008) and McNary Project (2009).			4a				
287 - HD	RPA 27: Operate turbine units to achieve best fish passage survival (currently within 1% of best efficiency at mainstem dams on the lower Columbia and lower Snake rivers).			4a				
288 - HD	RPA 28: Implement structural improvements to adult passage at the mainstem Columbia River and Snake River projects.			4a				
289 - HD	RPA 32: Prepare annually a fish passage plan in coordination with NMFS and the Regional Forum. Operate projects year around in accordance with the criteria in the fish passage plan.			4a				
290 - HD	OR - Operate lower Columbia reservoirs at minimum operating pool (MOP) during spring and summer as long as barge transport and irrigation needs are met.	6g		x				
291 - HD	OR - Provide spill to total dissolved gas limits of water quality waivers or biological constraints at all dams, except maximize transportation at Snake River collector projects during lowest (10th percentile) flow years.			4a				
292 - HD	Remove dam.			4a				
295 - HD	Improve domestic on-site sewage system management and residential chemical use.	9c	9d					
296 - HD	Discuss Zone 6 fishery actions with Tribes to reduce potential additional impacts. Potential actions include extending sanctuaries from mouths, and/or modifying season length or timing.				7a			
306 - HD	Eliminate/reduce/shift program: Discontinue hatchery summer steelhead program (last smolt release in 2009).					7c		
307 - HD	(similar to CRE-14) Expand federal and state activities at Bonneville Dam to test and implement non-lethal and potentially lethal methods of reducing pinniped populations. This includes efforts to manage pinnipeds through the Marine Mammal Protection Act.			x			8d	
308 - HD	Explore adding a life-cycle monitoring site in the Hood population.	x	x	x	x	x	x	

Table 7-3E. Proposed actions to address threats and limiting factors for CR chum populations.

Table 7-3E. Actions to Address Threats and Limiting Factors for CR Chum Populations									
			Threats and Limiting Factors						Future Threats
Action ID	Action		Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	
All Populations - Within Tributaries (Chum)									
60 - Trib	Re-evaluate current TRT-developed Gorge stratum's historical status and population structure and revise recovery goals if modifications are made.		x	x	x	x	x	x	
63 - Trib	Carry out the Columbia River Chum Salmon Recovery Strategy, including: 1) Assess, identify, and protect chum habitat (all strata). 2) Restore chum habitat, looking for efficiencies with fall Chinook restoration efforts (all strata). 3) Reintroduce chum using an appropriate hatchery stock (one Coast stratum population initially, followed by other populations and strata as needed or as reintroduction knowledge grows).		4c, 4d, 4e, 5c, 6a, 6b, 6f, 6g, 8a, 8c	3a, 3b, 5b, 6c, 6e, 8c, 9a, 9b, 9c, 9d	x		x		
Youngs Bay (Chum)									
Limiting Factors and Threats for Different Life History Stages and Threat Levels	Key	Adult							---
		Juvenile		3a, 3b, 5b, 6c					---
	Secondary	Adult	4c						---
		Juvenile	5c, 6a	6e, 8c, 9a, 9b, 9c					---
Mortality Rates		Current Status	---	---	---	---	---	---	---
		Delisting Status: *Stabilizing*	---	---	---	---	---	---	---
105 - YB	Provide / improve fish passage and water quality.		4d, 5c, 6e, 9a						
107 - YB	Implement research, monitoring, and evaluation of headwater springs to investigate the concern that they may be drying up due to land management practices.		5c, 5e						cc
108 - YB	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.		5c, 6e, 9a						cc
114 - YB	Conduct sediment source analysis and then implement actions to reduce sediment from identified sources.		6a						
118 - YB	Trap and sort hatchery adults: Begin passing tules and chum if suitable habitat exists.		4c				7c		

Table 7-3E. Actions to Address Threats and Limiting Factors for CR Chum Populations

Action ID	Action			Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Future Threats
Big Creek (Chum)										
Limiting Factors and Threats for Different Life History Stages and Threat Levels		Key	Adult							---
			Juvenile		3a, 3b, 5b, 6c					---
		Secondary	Adult	4c						---
			Juvenile	5c, 6a	6e, 8c, 9a, 9b, 9c					---
	Mortality Rates		Current Status	---	---	---	---	---	---	---
			Delisting Status: *Stabilizing*	---	---	---	---	---	---	---
121 - BC	Implement research, monitoring, and evaluation of headwater springs to investigate the concern that they may be drying up due to land management practices.			5c, 5e						cc
125 - BC	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.			5c, 6e, 9a						cc
127 - BC	Restore or create off-channel habitat and/or access to off-channel habitat: side channels.			5c, 6e, 9a						cc
128 - BC	Conduct sediment source analysis and then implement actions to reduce sediment from identified sources.			6a						
133 - BC	Trap and sort hatchery adults: Begin passing tules and chum.			4c				7c		
Clatskanie (Chum)										
Limiting Factors and Threats for Different Life History Stages and Threat Levels		Key	Adult							---
			Juvenile		3a, 3b, 5b, 6c					---
		Secondary	Adult							---
			Juvenile	5c, 6b	6e, 8c, 9a, 9b, 9c, 9d					---
	Mortality Rates		Current Status	---	---	---	---	---	---	---
			Delisting Status: *Primary*	---	---	---	---	---	---	---
135 - CT	Implement research, monitoring, and evaluation of headwater springs to investigate the concern that they may be drying up due to land management practices.			5c						cc
136 - CT	Protect intact and functioning riparian areas through riparian easements and acquisition.			5c, 6b, 6e, 9a						cc
137 - CT	Protect remaining high-quality off-channel habitat from degradation.			5c, 6b, 6e, 9a						cc, pg

Table 7-3E. Actions to Address Threats and Limiting Factors for CR Chum Populations

Action ID	Action	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Future Threats
138 - CT	Breach, lower, remove, or relocate dikes and levees to establish or improve access to off-channel habitats; vegetate dikes and levees.	5c, 6b, 6e, 9a						cc
139 - CT	Restore instream habitat complexity, including large wood placement.	5c, 6b, 6e, 9a						cc
140 - CT	Establish working group to identify priority areas for riparian and instream habitat enhancement, and work with landowners to implement projects.	5c, 6b, 6e, 9a						cc
141 - CT	Conduct sediment source analysis and then implement actions to reduce sediment from identified sources.	5c, 6b, 6e, 9a						
145 - CT	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.	5c, 6b, 6e, 9a						cc
146 - CT	Restore (plant and/or fence) and protect (conservation easements, acquisition) riparian areas that are degraded.	5c, 6b, 6e, 9a						cc
Scappoose (Chum)								
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Key – Adult								---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Key – Juvenile			3a, 3b, 5b, 6c					---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Secondary – Adult		4e						---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Secondary – Juvenile		5c, 6b	6e, 8c, 9a, 9b, 9c, 9d					---
Mortality Rates – Current Status		---	---	---	---	---	---	---
Mortality Rates – Delisting Status: *Primary*		---	---	---	---	---	---	---
150 - SC	Provide / improve fish passage.	4e, 5c, 6e, 9a						
151 - SC	Implement research, monitoring, and evaluation of headwater springs to investigate the concern that they may be drying up due to land management practices.	5c						cc
152 - SC	Protect intact and functioning riparian areas through riparian easements and acquisition.	5c, 6b, 6e, 9a						cc
153 - SC	Restore (plant and/or fence) and protect (conservation easements, acquisition) riparian areas that are degraded.	5c, 6b, 6e, 9a						cc
156 - SC	Restore or create off-channel habitat and/or access to off-channel habitat: side channels.	5c, 6b, 6e, 9a						cc
158 - SC	Establish working group to identify habitat enhancement projects.	5c, 6b, 6e, 9a						
163 - SC	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.	5c, 6b, 6e, 9a						cc

Table 7-3E. Actions to Address Threats and Limiting Factors for CR Chum Populations

Action ID	Action	Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Future Threats
Clackamas (Chum)								
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Key – Adult								---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Key – Juvenile			3a, 3b, 5b, 6c					---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Secondary – Adult		4d						---
Limiting Factors and Threats for Different Life History Stages and Threat Levels – Secondary – Juvenile		5c, 6a	6e, 8c, 9a, 9b, 9c, 9d					---
Mortality Rates – Current Status		---	---	---	---	---	---	---
Mortality Rates – Delisting Status: *Contributing*		---	---	---	---	---	---	---
169 - CM	Remove dam.	4d						
170 - CM	Provide / improve fish passage.	4d, 6e						
171 - CM	Implement research, monitoring, and evaluation of headwater springs to investigate the concern that they may be drying up due to land management practices.	5c						cc
172 - CM	Identify and implement flow improvements.	5c						cc
173 - CM	Inventory and protect seeps, springs, and other coldwater sources.	5c						cc
174 - CM	Identify priority areas for increased instream flows.	5c						cc
175 - CM	Establish minimum ecosystem-based instream flows.	5c						cc
176 - CM	Identify and halt illegal water withdrawals.	5c						cc
177 - CM	Enforce existing water rights.	5c						cc
178 - CM	Breach, lower, remove, or relocate dikes and levees to establish or improve access to off-channel habitats; vegetate dikes and levees.	5c, 6a, 6e, 9a						cc
179 - CM	Review land use plans in context of salmon recovery needs (i.e., forest lands of higher value to salmon recovery than urbanized lands).	5c, 6a, 6e, 9a						pg
180 - CM	Provide incentives to promote good landowner stewardship.	5c, 6a, 6e, 9a						
181 - CM	Reduce impact that roads have on impaired hydrograph.	5c, 6a, 6e, 9a						cc
182 - CM	Finish Clackamas Fish Habitat Analysis.	5c, 6a, 6e, 9a						
183 - CM	Develop and/or implement stormwater management plans for urban areas and roads.	5c, 6a, 9a	9d					cc, pg
184 - CM	Protect remaining high-quality off-channel habitat from degradation.	5c, 6e, 9a						cc, pg

Table 7-3E. Actions to Address Threats and Limiting Factors for CR Chum Populations

Action ID	Action	Threats and Limiting Factors						Future Threats
		Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	
185 - CM	Restore or create off-channel habitat and/or access to off-channel habitat: side channels.	5c, 6e, 9a						cc
186 - CM	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.	5c, 6e, 9a, 9b	9c, 9d	x				cc
187 - CM	Improve or regrade/revegetate streambanks.	6a, 6e, 9a						cc
188 - CM	Protect intact and functioning riparian areas through riparian easements and acquisition.	6a, 6e, 9a						cc
189 - CM	Restore (plant and/or fence) and protect (conservation easements, acquisition) riparian areas that are degraded.	6a, 6e, 9a						cc
194 - CM	Reduce the square footage of over-water structures; where possible, modify remaining overwater structures to provide beneficial habitat.	6e						
195 - CM	Develop and implement Willamette mitigation bank river plan.	6e						
196 - CM	Identify and purchase key salmon habitats.	6e						pg
197 - CM	Remove invasive plants and plant native species.	6e						
198 - CM	Restore instream habitat complexity, including large wood placement.	6e						cc
199 - CM	Daylight stream.	6e, 9a						
200 - CM	Create confluence habitat with cool water, restore channel and reconnect upper creek.	6e, 9a						cc
201 - CM	Reconnect tributary to Willamette River and create high quality habitat at tributary junction.	6e, 9a						
202 - CM	Daylight stream.	6e, 9a						
203 - CM	Revise and update stormwater management manual.	6e, 9a	9c, 9d					cc, pg
204 - CM	Implement Gray2Green program.	6e, 9a	9c, 9d					
205 - CM	Re-establish connection to Columbia River for improved flushing, if feasible.	6e, 9a	9c, 9d					
206 - CM	Implement pesticide and fertilizer best management practices to reduce sources of toxic and conventional contaminants entering the estuary (revise and update IPM for PDX owned property).		9d					
207 - CM	Monitor for contaminants.		9d					pg
208 - CM	Maximize habitat benefits by restoration or mitigation.		9d					

Table 7-3E. Actions to Address Threats and Limiting Factors for CR Chum Populations

Action ID	Action			Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Future Threats
Sandy (Chum)										
Limiting Factors and Threats for Different Life History Stages and Threat Levels		Key	Adult							---
			Juvenile		3a, 3b, 5b, 6c					---
		Secondary	Adult	4d						---
			Juvenile	5c, 6a	6e, 8c, 9a, 9b, 9c, 9d					---
	Mortality Rates		Current Status	---	---	---	---	---	---	---
			Delisting Status: *Primary*	---	---	---	---	---	---	---
219 - SY	Provide / improve fish passage.			4c, 4d				7c		
220 - SY	Develop recommendations for land management scenarios that address hydrograph changes that are predicted to occur due to climate change.			5c, 5e						cc
221 - SY	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.			5c, 6e						cc
222 - SY	Protect remaining high-quality off-channel habitat from degradation.			5c, 6e						cc, pg
226 - SY	Conduct sediment source analysis and then implement actions to reduce sediment from identified sources.			6a, 6d						
227 - SY	Develop and/or implement stormwater management plans for urban areas and roads.			6a, 6d						cc, pg
228 - SY	Identify and rectify problem legacy roads.			6a, 6d						
229 - SY	Gravel placement for spawning.			6a, 6d						
232 - SY	Restore instream habitat complexity, including large wood placement.			6e						cc
233 - SY	Restore or create off-channel habitat and/or access to off-channel habitat: side channels.			6e						cc
234 - SY	Breach, lower, remove, or relocate dikes and levees to establish or improve access to off-channel habitats; vegetate dikes and levees.			6e						cc
235 - SY	Protect intact and functioning riparian areas through riparian easements and acquisition.			6e, 9a						cc
236 - SY	Restore (plant and/or fence) and protect (conservation easements, acquisition) riparian areas that are degraded.			6e, 9a						cc
243 - SY	Explore adding a life-cycle monitoring site in the Sandy population.			x	x	x	x	x	x	

Table 7-3E. Actions to Address Threats and Limiting Factors for CR Chum Populations

Action ID	Action			Threats and Limiting Factors: Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Future Threats
Lower Gorge (Chum)										
	Limiting Factors and Threats for Different Life History Stages and Threat Levels	Key	Adult	6f						---
			Juvenile	6f	3a, 3b, 5b, 6c					---
		Secondary	Adult							---
			Juvenile	5c	5b, 6e, 8c, 9a, 9b, 9c, 9d					---
	Mortality Rates		Current Status	---	---	---	---	---	---	---
			Delisting Status: *Support WA*	---	---	---	---	---	---	---
246 - LG	Restore instream habitat complexity, including large wood placement.			6f						cc
247 - LG	Provide / improve fish passage.			4c, 6f				x		
248 - LG	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.			6f						cc
249 - LG	Restore or create off-channel habitat and/or access to off-channel habitat: side channels.			6f						cc
Upper Gorge (Chum)										
	Limiting Factors and Threats for Different Life History Stages and Threat Levels	Key	Adult	6f, 6g		4a				---
			Juvenile	6f, 6g	3a, 3b, 5b, 6c	4a				---
		Secondary	Adult							---
			Juvenile	5c, 8a, 8c	6e, 8c, 9a, 9b, 9c, 9d					---
	Mortality Rates		Current Status	---	---	---	---	---	---	---
			Delisting Status: *Support WA*	---	---	---	---	---	---	---
253 - UG	Provide / improve fish passage.			4c, 6f				x		
254 - UG	Restore or create off-channel habitat and/or access to off-channel habitat: side channels.			5c, 6e, 9a						cc
256 - UG	Restore instream habitat complexity, including large wood placement.			6e						cc
257 - UG	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.			6f						cc

Table 7-3E. Actions to Address Threats and Limiting Factors for CR Chum Populations

Action ID	Action	Threats and Limiting Factors						Future Threats
		Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	
258 - UG	RPA 15: Continue to update the Water Quality Plan for Total Dissolved Gas and Water Temperature in the mainstem Columbia and Snake rivers, and implement water quality measures to enhance ESA-listed juvenile and adult fish survival and maintain spawning and rearing habitat.	6g		x				
259 - UG	RPAs 18-21: Prepare, in cooperation with NMFS and comanaging agencies, configuration and operational plans for the Bonneville Project (2008), The Dalles Project, John Day Project (2008) and McNary Project (2009).	6g		x				
260 - UG	RPA 27: Operate turbine units to achieve best fish passage survival (currently within 1% of best efficiency at mainstem dams on the lower Columbia and lower Snake rivers.			4a				
261 - UG	RPA 28: Implement structural improvements to adult passage at the mainstem Columbia River and Snake River projects.			4a				
262 - UG	RPA 29: Provide spill to improve juvenile fish passage while avoiding high TDG supersaturation levels or adult fallback problems.			4a				
263 - UG	RPA 32: Prepare annually a fish passage plan in coordination with NMFS and the Regional Forum. Operate projects year around in accordance with the criteria in the fish passage plan.			4a				
264 - UG	OR - Operate lower Columbia reservoirs at minimum operating pool (MOP) during spring and summer as long as barge transport and irrigation needs are met.	6g		x				
265 - UG	OR - Provide spill to total dissolved gas limits of water quality waivers or biological constraints at all dams, except maximize transportation at Snake River collector projects during lowest (10th percentile) flow years.			4a				
266 - UG	Provide cover at mouth of Herman Creek that is inundated by Bonneville pool to reduce predation.	8a, 8d		x			x	cc

Chapter 8: Research, Monitoring, and Evaluation

8.1 Introduction

Research, monitoring and evaluation (RME) are needed to assess the status of 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. This chapter outlines the RME needs of this Plan as they pertain to biological criteria (i.e. abundance, productivity, diversity, and spatial structure) and listing criteria (i.e. habitat degradation, fish harvest, hatcheries, disease and predation, inadequate regulatory mechanisms, or other natural or manmade factors) affecting the continued existence of Oregon's salmon and steelhead populations in the lower Columbia River.

Because RME needs related to the estuary and mainstem Columbia hydropower are pertinent to all recovery domains in the Columbia River, RME plans for estuary and mainstem Columbia hydropower are being developed through implementation of the Estuary Module and the FCRPS BiOp. Chapter 9 (Implementation) describes how the proposed RME will be incorporated into an adaptive management plan.

Much of the guidance followed in developing this RME plan for the Oregon portion of the Lower Columbia River coho, Chinook and steelhead ESUs and CR chum ESU comes from a 2007 NMFS document entitled "Adaptive Management for ESA-Listed Salmon and Steelhead Recovery: Decision Framework and Monitoring Guidance[89]". Based on this guidance, this RME plan is specifically designed to:

- Provide information to key questions that need to be addressed in delisting decisions.
- Track progress toward achieving recovery goals.
- Provide managers and others implementing the plan with information needed to adjust management actions (i.e. what does and doesn't work and why).
- Address questions of metrics and indicators, including frequency, distribution, and intensity of monitoring.
- Evaluate the adequacy of existing monitoring programs to meet the needs of this Plan, identify needed adjustments in those programs, and outline additional monitoring not currently provided by existing programs.

8.2 Key Questions, Analytical Guidelines, Measurable Criteria, and Needs

In order to identify the RME needed to support this Plan it is necessary to consider: 1) the key questions that must be answered for delisting decisions; 2) the analytical framework that will be used to answer these questions; and 3) the specific measurable criteria (or benchmarks) against which progress towards achieving recovery goals will be measured.

The NMFS listing status decision framework described in Chapter 3 and shown in Figure 3-1 provides the foundation for the key questions that need to be answered to inform delisting decisions. These key questions can be broken down into those pertaining to ESU viability (i.e. biological criteria) or the status of statutory listing factors (i.e., threats criteria). Questions on ESU viability are based on the four VSP parameters: abundance, productivity, spatial distribution, and diversity. Questions on the status of statutory listing factors are based on information of threats related to habitat condition, hydropower, fish harvest, disease and predation, regulatory programs, hatcheries, and natural events.

[89] http://www.nwr.noaa.gov/Salmon-Recovery-Planning/ESA-Recovery-Plans/upload/Adaptive_Mngmnt.pdf

Guidance on the analytical framework as it applies to the biological recovery criteria are provided by the WLC-TRT (McElhany et al. 2006[90]). No guidance has been developed for the analytical framework for listing criteria. If and when such guidance becomes available, the RME outlined in this Plan related to the threats criteria may need to be updated.

Measurable criteria related to biological recovery are based on the specific goals for each lower Columbia salmon and steelhead population established in Chapter 6 (Recovery Scenarios). Measurable criteria for the listing criteria are primarily based on the goals of specific actions described in Chapter 7 (Management Strategies and Actions) that are designed to address the listing factors. With regards to the assessment of biological criteria (i.e. abundance, productivity, spatial structure, and diversity), the benchmarks outlined in this chapter are intended to serve as interim measures of progress towards achieving recovery goals absent full viability analyses (as conducted for development of this Plan), which require long term data trends to show progress. The suite of RME identified as necessary to evaluate these measurable criteria will also ultimately provide the foundation for more comprehensive viability analyses, such as those described in McElhany et al. (2007[91]) that follow the viability criteria framework established by the WLC-TRT (McElhany et al. 2006[2]).

8.3 Research, Monitoring, and Evaluation Categories

An RME plan needs to provide information to answer three fundamentally different questions:

1. What is the condition or status of X over time?
2. What is the effect of Y on the condition or status of X?
3. What are the uncertain relationships or conditions that are critical to making good decisions?

The programs that generate data to address these three classes of questions are fundamentally different. While they can be related, integrated or interconnected, they cannot be substituted one for the other. As described by NMFS (2007), there are six general types of monitoring that are relevant to recovery plan implementation and assessment.

Status monitoring is used to characterize existing conditions, establish a baseline for future comparisons, and capture temporal and spatial variability in the parameters of interest. *Trend monitoring* involves measurements taken at regular time or space intervals to assess the long-term trend in a particular parameter. Status and trend monitoring is equally pertinent to both the biological and listing factor criteria.

The general approach that will be implemented for this Plan to obtain information on status and trend of fish abundance, distribution, and habitat conditions will be to follow the survey design structure currently implemented for Oregon coastal coho. While the individual components of this approach are outlined in this chapter, the reader is referred to Firman and Jacobs (undated[92]) for an overview of this integrated monitoring approach.

Implementation monitoring determines whether actions were carried out as planned. For example, if a restoration action is initiated to fence 20 miles of stream with the hope of reducing stream temperature and fine sediment input from run-off and bank erosion, the implementation monitoring would consist of confirming the presence of the fence. *Compliance monitoring* determines whether specified criteria are being met as a direct result of an implemented action. With the fencing example, the compliance monitoring indicator would be an assessment of the project's basic intent — preventing livestock from

[90] http://www.nwfsc.noaa.gov/trt/wlc_docs/Revised_WLC_Viability_Criteria_Draft_Apr_2006.pdf
[91] http://www.nwfsc.noaa.gov/trt/trt_documents/part_1_sep07.pdf
[92] http://oregonstate.edu/dept/ODFW/spawn/pdf%20files/reports/emappaper.pdf

entering the riparian corridor — and thus an appropriate metric would be the presence or absence of livestock in the fenced-off area. Because implementation and compliance monitoring deals mainly with evaluating whether or not actions are being implemented, they are generally more applicable to monitoring related to listing factors.

Effectiveness monitoring evaluates whether the management actions achieved their direct effect or goal. Success may be measured against "reference areas," "baseline conditions," or "desired future conditions." In the fencing example, the effectiveness monitoring indicators would be an assessment of the project's effect on the riparian habitat, given that the project was properly implemented and in compliance with expected impact. Because effectiveness monitoring deals mainly with determining the effectiveness of actions designed to ameliorate the impacts of listing factors, it is generally not pertinent to monitoring related to the biological criteria.

Critical Uncertainty Research verifies the basic assumptions behind effectiveness monitoring and models, prioritization of limiting factors and threats, or any other topic for which assumptions have been made, which if untrue, would significantly alter the actions identified for implementation by the Plan. Because critical uncertainties are associated with the biological criteria and the listing factors, critical uncertainty research is needed in both contexts[93].

8.4 Biological Recovery

As described earlier, biological recovery is assessed in terms of four parameters: 1) abundance; 2) productivity; 3) spatial structure; and 4) diversity. The following describes the decisions, key questions, analytical guidelines, measurable criteria, and specific RME needed by this Plan to assess the status of biological recovery of salmon and steelhead populations in the Oregon portion of the Lower Columbia River.

8.4.1 Decisions and Key Questions[94]

<u>Decisions</u>

1. The aggregate status and change in status of the three strata in the ESU demonstrate a level of risk, natural sustainability, or probability of persistence sufficient to warrant a change in ESU listing status.
2. The aggregate status and change in status over time of the populations and habitats within a stratum demonstrates a level of risk, natural sustainability, or probability of persistence sufficient to consider the stratum viable.
3. The status and change in status of the population's viability parameters, in the aggregate, demonstrate a level of risk, or probability of persistence, sufficient to consider that the population has achieved the viability targets established for its classification (i.e., the level of risk considered acceptable for this population).

<u>Key Questions</u>

1. Do all strata that historically existed have a high probability or are clearly trending toward a high probability of persistence?
   Specifically do:

[93] In most cases, the detailed approach and proposals for critical uncertainty research will be prioritized, developed, and implemented as part of implementation, specifically during development of the three-year *Implementation Schedules* (see Chapter 9).
[94] Decisions and key questions come from a 2007 NMFS document entitled "Adaptive Management for ESA-Listed Salmon and Steelhead Recovery: Decision Framework and Monitoring Guidance".

a) At least two populations in the stratum have at least a 95 percent probability or are clearly trending toward a high probability of persistence (i.e. low extinction risk)?
b) Other populations in the stratum have persistence probabilities consistent with or are clearly trending toward a high probability of stratum persistence (i.e., the average of all stratum population scores is 2.25 or higher, based on the TRT's scoring system)?

The population specific extinction risk levels needed to achieve both ESU delisting and broad sense recovery are described fully in Chapter 6 and 10. As outlined in Chapter 4, (Current Status) the ability to answer these questions relies on collecting and analyzing information related to the four VSP parameters (abundance, productivity, spatial structure, and diversity). What follows is an outline of the analytical guidelines for each of these VSP parameters, along with the specific measurable criteria. Measurable criteria are required under the ESA and Oregon's Native Fish Conservation Policy[95] and are critical for *evaluating progress* towards achieving recovery goals.

8.4.2 Analytical Guidelines, Measurable Criteria and RME for Abundance and Productivity[96]

Analytical Guidelines – Abundance and Productivity

1. In general, viable populations should demonstrate a combination of population growth rate, productivity, and abundance that produces an acceptable probability of population persistence. Various approaches for evaluating population productivity and abundance combinations may be acceptable, but must meet reasonable standards of statistical rigor.
2. A population with a non-negative growth rate and an average abundance approximately equivalent to estimated historical average abundance should be considered to be in the highest persistence category. The estimate of historical abundance should be credible, the estimate of current abundance should be averaged over several generations, and the growth rate should be estimated with an adequate level of statistical confidence. This criterion takes precedence over criterion 1.

Measurable Criteria – Abundance and Productivity

Abundance and Productivity Metric
Annual estimates of abundance of naturally-produced spawners in each coho, Chinook, or steelhead population[97].

Abundance and Productivity Evaluation Thresholds (delisting)

Pass – The observed spawner abundance is ≥ the abundance modeled for delisting at least six times in any 12-year[98] period *and* the average observed spawner abundance is ≥ the average modeled abundance for delisting over that same time period.

Fail – The observed spawner abundance is ≥ the abundance modeled for delisting less than six times in any 12-year period *or* the average observed spawner abundance is < the average modeled abundance for delisting over that same time period.

[95] http://www.dfw.state.or.us/fish/nfcp/rogue_river/docs/nfcp.pdf
[96] Analytical guidelines are from Willamette/Lower Columbia Technical Review Team (WLC-TRT 2006).
[97] No measurable criteria have been established for Oregon's CR populations of chum. Instead, a recovery strategy will be initiated to determine the best methods for re-introducing chum to areas where they are extirpated and abundance targets will need to be developed in the future.
[98] 12 years was selected because it represents roughly three to four brood cycles for salmon and steelhead and should thus provide a reasonable snapshot in time of the trend in status of a population.

Abundance and Productivity Evaluation Thresholds (broad sense recovery)

Pass – The observed spawner abundance is ≥ the abundance modeled for broad sense recovery at least six times in any 12-year[99] period *and* the average observed spawner abundance is ≥ the average modeled abundance for broad sense recovery over that same time period.

Fail – The observed spawner abundance is ≥ the abundance modeled for broad sense recovery less than six times in any 12-year period *or* the average observed spawner abundance is < the average modeled abundance for broad sense recovery over that same time period.

Analytical Procedures for Abundance and Productivity

As described in Chapter 4 (Population Conservation Gaps) stock-recruitment curves were developed for each Oregon lower Columbia River population of salmon[100] and steelhead as a way of determining the abundance and productivity needed to achieve delisting and broad sense recovery. Because the abundance and productivity derived from these recruitment curves represent the long term (i.e. 100 year) average, annual benchmarks of abundance and productivity will be developed that will allow managers to provide more timely assessments of the progress being made to achieving recovery goals. To do this, in addition to the stock recruitment curves generated for each population, annual estimates of spawner abundance, harvest of wild fish, age at return, and an index of climate impact are needed. Because natural fluctuations in climate conditions play such a significant role in the annual abundance of salmon and steelhead spawners, it is necessary to scale the average abundance targets to an annual index of climate.

The following illustrates how this information will be used to derive annual benchmarks for abundance and productivity against which progress towards recovery can be assessed. The example in this case is for Clackamas winter steelhead.

Step 1- Obtain recruitment parameters for population[101]

Alpha	Beta	Gamma	Clm Indx	Indx Lag
1.986	9343	1.999	CRF	-2

Step 2 – Determine the age composition of the returning fish

Return Year	Parental Brood Years					
	age 2	age 3	age 4	age 5	age 6	age 7
2002	2000	1999	1998	1997	1996	1995

Step 3 – Obtain total number of spawners (hatchery + wild) for each brood year

Spawner Abundance by Parent Year					
2000	1999	1998	1997	1996	1995
843	363	858	895	361	1876

Step 4- Obtain climatic index for each brood year

1998	1997	1996	1995	1994	1993
0.524	0.587	0.462	0.164	0.200	-0.159

[99] 12 years was selected because it represents roughly three to four brood cycles for salmon and steelhead and should thus provide a reasonable snapshot in time of the trend in status of a population.
[100] No recruitment curves were developed for LCR chum due to lack of data.
[101] CRF stands for Columbia River Flow

Step 5 – Calculate recruits for each brood year using the following equation based on recruitment curve for Clackamas winter steelhead

$$1)\quad \ln(R_t) = \ln(\alpha) + \ln(S_t) - \ln(1 + (\alpha/\beta * S_t)) + (\gamma * C_{t+lag})$$

where S_t is the total number of fish that spawned (including both hatchery and wild fish) in year t, R_t is the number of naturally produced recruits that were produced by the fish that spawned in year t, C is the climatic index with a lag period equal to t+lag, where lag may assume any value in the search range form -3 to +3, and α, β, γ are parameters for the recruitment equation.

Step 6 – Calculate recruits after fishery (i.e. spawners) using the fishery impact rates used to determine the "modeled current" abundance described in chapter 6 (0.10 in this case).

Estimated pre-harvest recruits without recovery actions, pre-harvest (by year)					
2000	**1999**	**1998**	**1997**	**1996**	**1995**
4051	2166	3630	2070	993	1939

Note: Numbers above are calculated as the exp (Ln(Rt)) estimated from Eq. 1)

Step 7 – Multiply each brood year recruits by recovery scalar[102] (described in chapter 4) to obtain the number of spawners needed to meet recovery goals given climate conditions for each brood year.

Estimated pre-harvest recruits with recovery actions (by year)					
2000	**1999**	**1998**	**1997**	**1996**	**1995**
7074	3782	6338	3615	1734	3385

Step 8 – Use the age composition for this population to determine how many of each age fish returned using the brood year recruits estimated in Step 7.

Age at Spawning (Proportion of Total)						
2	3	4	5	6	7	
0.000	0.005	0.510	0.398	0.083	0.004	2002 forecast TOTAL
age 2 (00BY)	age 3 (99BY)	age 4 (98BY)	age 5 (97BY)	age 6 (96BY)	age 7 (95BY	
0	20	3232	1439	143	14	4848

Step 9 – Take the forecast total for 2002 return and expand it by 20 percent as described in Chapter 6 to provide a buffer for the impacts of climate change.

4848 x 1.20 = 5818

Step 10 – The number derived in Step 9 is the forecast return of wild winter steelhead for 2002 if recovery goals have been met. These annual forecasts can be plotted along with the actual number of spawners observed to track progress towards recovery (see Figure 8-1 for a hypothetical example). In this example the population does not pass the abundance and productivity measurable criteria since observed spawner abundance equals or exceeds the forecasted abundance needed to achieve recovery goals only four out of the 12 years.

[102] The recovery scalar is the amount that the current survival rate needs to be improved to get the probability of CRT to the threshold for the risk category targeted for this population – in this instance the recovery scalar for Clackamas winter steelhead to achieve a low risk of extinction = 1.94

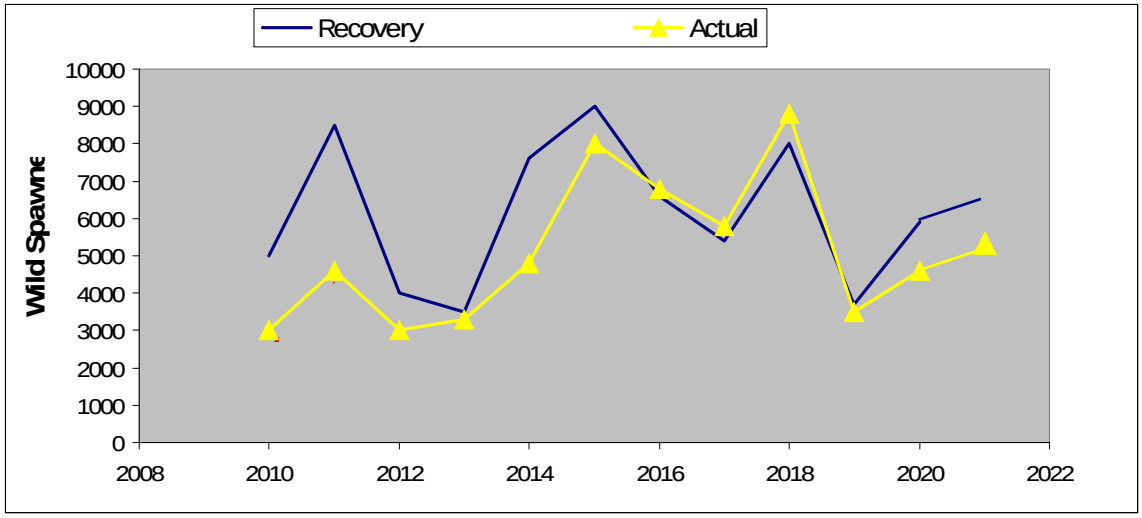


Figure 8-1. Hypothetical example comparing observed spawner abundance with recovery goals scaled to climate conditions.

RME Needed to Assess Abundance and Productivity

Status and Trend Monitoring:

1. Annual estimates of the abundance of natural and hatchery origin fish that spawn in each lower Columbia River salmon and steelhead population.
   Relevance: Needed to calculate annual spawner and recruit estimates.
   Approach: Census surveys for Chinook, and summer steelhead. Spatially balanced, random surveys based on the Generalized Randomized-Tessellation Stratified (GRTS) technique (Stevens and Olsen 2004). Field protocols for coho, and fall Chinook will follow those outlined in ODFW (2007a[103]). Field protocols for summer and winter steelhead will follow those outlined in ODFW (2007b[104]). Field protocols for spring Chinook will follow those outlined in Schroeder et al. (2007[105]). The objective will be to provide annual estimates of abundance with a 95 percent confidence interval of ± 30 percent. Examination for hatchery fin clips of carcasses recovered during spawning surveys. These samples will be supplemented where necessary and feasible with scale and/or otolith analyses, and capture of live fish when carcasses cannot be recovered (e.g. steelhead redd surveys).

2. Annual estimates of mortality due to harvest for each lower Columbia salmon and steelhead population.
   Relevance: A needed component of estimating total recruits for abundance and productivity analyses.
   Approach: TBD[106]

Critical Uncertainty Research:

1. Refinement of knowledge of the extent of potential spawning and rearing distribution of each lower Columbia salmon and steelhead population.

[103] http://oregonstate.edu/dept/ODFW/spawn/pdf%20files/reports/07SSManual.pdf
[104] http://oregonstate.edu/dept/ODFW/spawn/pdf%20files/reports/07StwManual.pdf
[105] https://nrimp.dfw.state.or.us/CRL/Reports/AnnPro/annual%2006-07_final_web%20v3.pdf
[106] Early in the implementation phase of this recovery plan, workgroups will be convened to develop the approach for this and all other TBD RME elements.

Relevance: Accurate expansion of survey data to population estimates requires accurate information on population range.
Approach: TBD

2. Development of efficient survey designs for assessing patchily-distributed populations based on understanding factors that influence annual variation in distribution (e.g. fish abundance and streamflow).
Relevance: Traditional GRTS-based surveys can be misleading or costly to implement when populations exhibit patchy distributions. Understanding of factors that influence distribution will aid the design of more precise and efficient surveys.
Approach: TBD

3. Cost effective survey designs and methods for assessing fish populations in streams where conditions (stream size, turbidity, cover) reduce the efficacy of traditional visual survey methods.
Relevance: Many areas in the lower Columbia River are not amenable to traditional visual spawning survey protocols.
Approach: TBD

4. Annual estimates of the marine and freshwater survival rates of wild salmon and steelhead for selected areas in each lower Columbia River strata.
Relevance: Needed to provide supplemental information on environmental factors influencing observed abundance and productivity.
Approach: At least one intensively monitored watershed (i.e. trapping of adults in and smolts out) in each strata.

8.4.3 Analytical Guidelines, Measurable Criteria and RME for Spatial Structure

Analytical Guidelines

1. The spatial structure of a population must support the population at the desired productivity, abundance, and diversity levels through short-term environmental perturbations, longer-term environmental oscillations, and natural patterns of disturbance regimes. The metrics and measurable criteria for evaluating the adequacy of a population's spatial structure should specifically address:

a. Quantity: Spatial structure should be large enough to support growth and abundance, and diversity criteria.
b. Quality: Habitat underlying spatial structure should be within specified habitat quality limits for life-history activities (spawning, rearing, migration, or a combination) taking place within the patches.
c. Connectivity: Spatial structure should have permanent or appropriate seasonal connectivity to allow adequate migration between spawning, rearing, and migration patches.
d. Dynamics: The spatial structure should not deteriorate in its ability to support the population. The processes creating spatial structure are dynamic, so structure will be created and destroyed, but the rate of loss should not exceed the rate of creation over time.
e. Catastrophic Risk: The spatial structure should be geographically distributed in such a way as to minimize the probability of a significant portion of the structure being lost due to a single catastrophic event, either anthropogenic or natural.

Measurable Criteria – Spatial Structure

Spatial Structure Metric – Percent Occupied Habitat

The occupancy of spawning adults or juveniles at spatially balanced, random survey sites.

Percent Occupied Habitat Evaluation Thresholds

Pass – The percentage of sites not occupied by spawning adults or rearing juvenile salmon or steelhead is ≤ the thresholds shown in Table 8-1 at least six times during a 12-year period *and* the overall average percentage of sites not occupied during that same time period is ≤ than the thresholds shown Table 8-1.

Fail – The percentage of sites not occupied by spawning adults or rearing juveniles is > the thresholds shown Table 8-1 less than six times during a 12-year period *or* the overall average percentage of sites not occupied during that same time period is > the thresholds shown Table 8-1.

Table 8-1. Occupancy thresholds for Oregon Lower Columbia River coho salmon and steelhead populations. Watershed size is from McElhany et al. (2006).

Coho					
				Occupancy Threshold	
Stratum	Population Area	Watershed Size	Delisting Risk Goal	Delisting	Broad Sense (Very Low Risk)
Coast	Youngs Bay	Small	Very High	100%	5%
	Big Creek	Small	Very High	100%	5%
	Clatskanie	Medium	Very Low	10%	10%
	Scappoose	Medium	Very Low	10%	10%
Cascade	Clackamas	Large	Very Low	15%	15%
	Sandy	Large	Low	25%	15%
Gorge	Lower Gorge	Small	High	50%	5%
	Upper Gorge/Hood	Medium	Low	20%	10%

Chinook					
				Occupancy Threshold	
Stratum	Population Area	Watershed Size	Delisting Risk Goal	Delisting	Broad Sense
Coast	Youngs Bay	Small	High	50%	5%
	Big Creek	Small	High	50%	5%
	Clatskanie	Small	Low	15%	5%
	Scappoose	Small	Low	15%	5%
Cascade	Clackamas	Large	Moderate	50%	15%
	Clackamas spring	Medium	Very Low	10%	10%
	Sandy	Medium	Moderate	40%	10%
	Sandy Late	Medium	Very Low	10%	10%
	Sandy Spring	Medium	Low	20%	10%
Gorge	Lower Gorge	Small	High	50%	5%
	Upper Gorge	Small	Very High	100%	5%
	Hood	Small	Low	15%	5%
	Hood Spring	Medium	Very Low	10%	10%

Steelhead					
				Occupancy Threshold	
Stratum	Population Area	Watershed Size	Delisting Risk Goal	Delisting	Broad Sense
Coast[107]	Youngs Bay	Small	NA	NA	5%
	Big Creek	Small	NA	NA	5%
	Clatskanie	Medium	NA	NA	10%
	Scappoose	Medium	NA	NA	10%
Cascade	Clackamas	Large	Low	25%	15%
	Sandy	Large	Very Low	15%	15%
Gorge	Lower Gorge	Small	Moderate	25%	5%
	Upper Gorge	Small	Very High	100%	5%
	Hood	Medium	Low	20%	10%
	Hood Summer	Medium	Low	20%	10%

[107] Coast stratum steelhead are not listed under ESA.

Spatial Structure Metric – Geographic Distribution
Comparison of the spatial pattern of potential spawning distribution to that observed using Sides, Vertices, and Boundaries (SVB[108]) spatial statistics.

Geographic Distribution Evaluation Thresholds (Adults and Juveniles)

Pass – The observed distribution the SVB statistic of sites occupied by four or more adult spawning fish or one juvenile is not significantly different from a random distribution at least six times in any 12-year period.

Fail – The observed distribution the SVB statistic of sites occupied by four or more adult spawning fish or one juvenile is not significantly different from a random distribution less than six times in any 12-year period.

Analytical Procedure for Spatial Structure
The manner in which juveniles and adults (spawners) are distributed within the freshwater portion of a population's home range is an important consideration in assessing the conservation status of a population (McElhany et al. 2000; Bisson et al. 1997). Healthy populations will experience periods when the distribution of spawners becomes spatially compressed (e.g., during poor marine survival periods) and periods when the spatial distribution of spawners expands (e.g., during good marine survival). It is important to keep in mind that distribution is also governed by some factors that are unrelated to population size, like weather patterns. During years with little rain and low stream flows, fish may not be able to access much of the habitat and distribution may be constricted even if the population size is large. The challenge is to select a criterion that will identify when a restriction in spawner distribution is greater than expected for a healthy population under given environmental conditions.

Because adult and juvenile salmon and steelhead often rely on different aspects of habitat during their stay in freshwater, it is important that the distribution of both adult and juveniles are monitored. Two measurable criteria are provided for spatial structure. Both rely on spatially balanced, random surveys of the presence/absence of adult spawners and rearing juveniles that are conducted throughout their historic range. Adult spawner will also provide information needed on abundance and productivity as described earlier. Surveys will not need to be conducted above known barriers; however, the survey design process will include such sites to enable a statistically rigorous analysis of occupancy across a species historic distribution[109].

The first measurable criterion is based on WLC-TRT guidance on the relationship between population persistence and the overall percentage of accessible habitat. Analysis of survey data for this criterion is relatively straight forward and simply involves calculating the percentage of sites that where spawners are absent.

The second criterion is designed to obtain information on the geographic distribution of spawning. For this criterion the SVB statistic (Stevens 2006) will be used to determine if the spatial distribution of occupied sites is comparable to the spatial distribution of sites where spawning may potentially occur. To calculate the SVB statistic, a polygon will be drawn around each point that encompasses the area closer to that point than to any other. If the polygons are similar in size and shape, then the distribution is more regular. If the polygons differ in size and shape then the distribution is more clustered. One criterion that is sensitive to both variation in area and shape is the variation of the distance from a point to the boundary of its polygon. If a Side is defined as a division between two polygons, a Boundary as a segment of the domain boundary, and a Vertex as the intersection between two Sides or a Side and a Boundary, then the SVB can be approximated by the mean square deviation (MSD) of the distance from a sample point to

[108] SVB stand for Sides, Vertices, and Boundaries
[109] Random survey sites above known barriers will be automatically assigned to the "absent" category.

Sides, Vertices, and Boundaries, relative to a nominal value (such as the MSD for a hexagon with area = [domain area / number of samples]).

To test that occupancy occurs at random over the domain, a pattern of random presence/absence can by simulated by assigning each of the survey points either a zero (indicating absence) or one (indicating presence). By repeating the process multiple times, each time calculating the SVB statistic, a distribution of the SVB statistic can be constructed. The distribution will be specific to that particular population, because it will depend on the geometry of the stream network occupied by a population. The distribution will also depend on the occupancy rate.

Various hypotheses can be tested by choosing an occupancy rate, and then assigning absence following some hypothesized relationship. For example, to test the hypothesis of a shrinking domain, higher probability of absence could be assigned to stream sites near the domain boundary, or to stream segments deemed to have less suitable habitat. Standard randomization test procedures can then be used to establish significance level of the test. It is then possible to test various hypotheses about the actual distribution by comparing the observed value to the random distribution. A population would pass this criterion as long as the observed SVB statistic distribution did not significantly differ from the random distribution.

RME Needed to Assess Spatial Structure

Status and Trend Monitoring:

1. Annual estimates of the distribution and density of natural origin spawning adult and rearing juvenile salmon and steelhead for each lower Columbia River population.
   Relevance: Used in combination with habitat information to assess existing spatial structure relative to desired status.
   Approach: Spatially balanced, random surveys based on the GRTS technique. Snorkel and electrofishing surveys for juveniles following protocols describe in Rodgers (2000[110]) and Rodgers (2001[111]). Field protocols for spawning coho, chum, and fall Chinook will follow those outlined in ODFW (2007a[112]). Field protocols for spawning summer and winter steelhead will follow those outlined in ODFW (2007b[113]). Field protocols for spawning spring Chinook will follow those outlined in Schroeder et al. (2007[114]). The objective will be to detect a change in spatial distribution of approximately 15 percent with an 80 percent certainty.

2. Five-year assessment of habitat conditions throughout the accessible distribution of each lower Columbia River salmon and steelhead population.
   Relevance: Used in combination with fish distribution information to assess existing spatial structure relative to desired status. Need to know whether or not changes in observed fish distribution are due to changes in habitat conditions.
   Approach: Spatially balanced, random surveys based on the GRTS technique. Field sampling protocols will be based on ODFW Aquatic Inventory protocols[115].

3. Annual monitoring of streamflow.

[110] http://nrimp.dfw.state.or.us/crl/Reports/WORP/WORPAN99.pdf
[111] https://nrimp.dfw.state.or.us/crl/Reports/WORP/WORPAN00.pdf
[112] http://oregonstate.edu/dept/ODFW/spawn/pdf%20files/reports/07SSManual.pdf
[113] http://oregonstate.edu/dept/ODFW/spawn/pdf%20files/reports/07StwManual.pdf
[114] https://nrimp.dfw.state.or.us/CRL/Reports/AnnPro/annual%2006-07_final_web%20v3.pdf
[115] http://oregonstate.edu/dept/ODFW/freshwater/inventory/pdffiles/hmethd08.pdf

Relevance: Distribution can be significantly influenced by streamflow (e.g. less habitat assessable during drought years).
Approach: TBD

Critical Uncertainty Research:

1. Refinement of knowledge of the extent of historical spawning and rearing distribution of each lower Columbia River salmon and steelhead population.
   Relevance: Needed for comparisons of desired or potential distribution to actual distribution.
   Approach: TBD

2. Refinement of knowledge of the accuracy of field protocols to detect occupancy.
   Relevance: Presence of individuals in samples is proof of occupancy, but absence cannot be proven. The problem is that frequency of "false" absences depends on the abundance and distribution of individuals, the sampling method and intensity, and the grain of sampling. This can be particularly problematic for species that are rare or patchily distributed or as species and populations decline in abundance and distribution leading to errors in estimates that vary with habitat and environmental conditions and species abundance.
   Approach: TBD

3. Refinement of knowledge of relationship factors that influence annual variation in distribution (e.g. fish abundance and streamflow).
   Relevance: Needed to refine spatial distribution measurable criteria.
   Approach: TBD

4. Refinement of knowledge of the relationship between spatial structure and viability.
   Relevance: While it is acknowledged that spatial structure has the potential to play a major role in population viability, there is little quantitative information on how the extent of this relationship.
   Approach: TBD

8.4.4 Analytical Guidelines, Measurable Criteria and RME for Diversity

Analytical Guidelines

1. Sufficient life-history diversity must exist to sustain a population through short-term environmental perturbations and to provide for long-term evolutionary processes. The metrics and measurable criteria for evaluating the diversity of a population should be evaluated over multiple generations and should include:
   a. substantial proportion of the diversity of a life-history trait(s) that existed historically,
   b. gene flow and genetic diversity should be similar to historical (natural) levels and origins,
   c. successful utilization of habitats throughout the range,
   d. resilience and adaptation to environmental fluctuations.

Measurable Criteria – Diversity

Diversity Metric #1: Effective Population Size
Effective population size relates to a minimum population level that must be maintained to minimize the genetic risks associated with small population size, such as: inbreeding depression, the loss of diversity through genetic drift, and the accumulation of maladaptive mutations. Since the population abundance goals described in section 8.4.2 are designed to equal or exceed abundance needed to satisfy effective

population size requirements, passing the abundance and productivity thresholds described in section 8.4.2 will mean that effective population size requirements are met.

Diversity Metric #2: Interbreeding with hatchery fish
See measurable criteria for hatchery related threats in section 8.5.5.

Diversity Metric #3: Anthropogenic mortality
See measurable criteria for fish harvest related threats in section 8.5.2.

Diversity Metric #4: Life-history traits
Approach to be determined – see discussion below on analysis procedures for diversity metrics.

Diversity Metric #5: Habitat diversity
Approach to be determined – see discussion below on analysis procedures for diversity metrics.

Analytical Procedures for Diversity Metrics
Within-population diversity is the result of phenotypic differences among individuals. These differences provide the flexibility of the population as a whole to respond successfully to short-term environmental variations. They also are the basis by which populations are able to adapt and evolve as conditions within their home range go through changes that are more permanent. Therefore, maintaining sufficient within-population diversity is an issue of both short-term and long-term survival.

Within-population diversity is affected by a variety of forces including: evolutionary legacy, immigration from other populations, mutation, selection, and random loss of genetic variation due to small population size. However, population size (abundance) is most commonly recognized as a concern for species that are vulnerable to extinction. The genetic consequences of small population size and numerous approaches to defining minimum population abundance thresholds have been investigated widely (Soulé 1980; Lande 1995; Franklin and Frankham 1998; Rieman and Allendorf 2001). In nearly all cases, this becomes an exercise of identifying a rate at which genetic variation can be lost without causing a risk to a population's short or long-term persistence. The diversity criterion incorporates this concept.

While there is general consensus that life-history diversity is important to the long term resilience of salmon and steelhead populations, there is little consensus or guidance available on specifically how information on life-history diversity should be analyzed in order to assess whether or not salmon and steelhead populations have the range of life-history characteristics necessary for long term resilience in the face of a changing climate. As a result, it is difficult to establish specific pass/fail thresholds for this metric. Despite this, monitoring of key life history traits (see RME needs below) is important to establish a baseline and trend for diversity evaluations. This combined with more research into what key life-history traits should be maintained in the face of future climate change and reconstruction of the historical life-history diversity of lower Columbia River salmon and steelhead populations should help to better define future analytical approaches.

Given that there is considerable uncertainty about how and what to monitor, a monitoring approach involving stratifying the status and trend abundance sampling (described earlier) by distinct environments that are presumably the template for the expression of diversity might provide information on the relationship between diversity metrics and environmental/habitat conditions.

RME Needed to Assess Diversity

Status and Trend Monitoring Needs:

1. Periodic monitoring of key life history characteristics of each lower Columbia River salmon and steelhead population. For example:
   a. Timing of return to fresh water
      - Run time (e.g., fall vs. spring)
      - Variation within a specific run time
   b. Age at maturation
   c. Spawn timing
   d. Outmigration timing
      - Distribution to downstream or upstream rearing habitat
      - Specific nursery habitat utilization
   e. Smoltification timing
      - Entrance to marine environment
      - Duration of residence in intertidal or Columbia River plume areas
   f. Developmental rate
   g. Egg size
   h. Fecundity
   i. Freshwater distribution
   j. Ocean distribution
   k. Size at maturation
   l. Timing of ascension to the natal stream

   Relevance: Information of key life history characteristics is important to understanding the long-term resilience and adaptability of lower Columbia River salmon and steelhead populations.
   Approach: TBD

2. Annual monitoring of the spatial distribution, abundance, and origin of adult salmon and steelhead spawning in the wild in each lower Columbia River population area.
   Relevance: If fish spawn and rear in a variety of freshwater habitats in a basin, the population, as a whole, will be buffered against year-to-year environmental variations. Hatchery strays can impact the diversity of wild populations.
   Approach: See RME needs for abundance and productivity.

3. Regular hatchery monitoring.
   Relevance: Hatcheries affect diversity largely through the process of domestication and the introgression. Additionally, hatchery propagation may produce non-genetic effects on the expression of life history traits via non-natural rearing regimes.
   Approach: TBD

4. Periodic genetic marker monitoring.
   Relevance: Monitoring of genetic changes within and among populations can reveal changes in the genetic characteristics of a population or ESU.
   Approach: TBD

5. Periodic assessment of habitat diversity, occupancy, and anthropogenic changes to habitat and the environment.

Relevance: Assessing the effects of artificial selection must include the degree to which a population's life history diversity has been modified relative to its historical locally-adapted state.
Approach: See RME needs for spatial structure.

Critical Uncertainty Research:

1. Research into which life-history traits or other diversity parameters are the most meaningful measures of diversity, particularly in the context of future climate change impacts.
   Relevance: Development of meaningful measures of diversity is difficult largely because of the lack of understanding of the expression of individual life history traits (the genetic and environmental effects) and the degree of correlation between those traits.
   Approach: TBD
2. Reconstruction of the historical life-history diversity of lower Columbia River salmon and steelhead populations
   Relevance: Needed in order to provide a template for life history diversity benchmarks.
   Approach: TBD

8.4.5 Summary of Strategic Approach to Monitoring VSP Parameters

Oregon's strategy for monitoring the 8 populations of coho and chum salmon, 13 populations of Chinook, and 10 populations of steelhead in the Oregon portion of the lower Columbia, involves following basic components:

A. Conduct research to document the precision and bias associated with various fish monitoring protocols (e.g. spawning surveys, snorkel surveys, smolt trapping) across the range of conditions that exist within Oregon's portion of the ESUs.
B. Where field protocols for spawning surveys are deemed to provide acceptable precision and bias, and access is possible for most of the potential areas in the sample frame, implement either GRTS-based or census-based spawning surveys to provide population level information on abundance (spawners), productivity (recruits/spawner), diversity (occurrence of hatchery strays on spawning grounds, run timing, size, age, genetics), and distribution. Goal is to provide annual spawner abundance estimates at the ESA population scale with a precision of ± 30 percent or better. These surveys are preferable to fixed station counting since they have the potential to provide information on distribution which is not available with fixed station counts. They are, however, only preferable if they can produce estimates with acceptable precision and bias.
C. Where field protocols are not amenable, use information from existing or new adult trapping facilities to provide abundance, productivity, and diversity for sub-watershed areas. (In these instances distribution criteria will not be assessed.) Conduct research to assess the representativeness of these index areas and evaluate magnitude of pre-spawning mortality.
D. Cross check precision and bias of GRTS-based or census-based spawning surveys by comparing the results of survey implemented above adult traps to counts made at the traps. Conduct these evaluations over the range of conditions that exist within Oregon's portion of the ESUs.
E. Evaluate the potential for using sonar (e.g. DIDSON) to monitor abundance. Implement where feasible and cost effective in situations where surveys cannot be conducted or adult trapping facilities do not exist.
F. Develop programs to monitor fishery related mortality[116] that include reliable information on bias and precision.

[116] Needed for productivity estimates.

G. Conduct hatchery monitoring to provide information on number of fish released, marked[117], returned to hatchery, and wild fish collected for brood stock.
H. Where field protocols for juvenile surveys provide acceptable precision and bias, and access is possible for most of the potential areas in the sample frame, implement GRTS-based surveys to provide strata level information on an index of abundance (fish/m^2), productivity (juveniles per mile/spawners per mile), and distribution. Goal is to provide annual estimates of juvenile density at the ESA strata scale with a precision of $\pm$ 30 percent or greater.
I. In at least one sub-watershed per strata, trap adults in and juveniles out to provide estimates of marine and freshwater productivity (i.e. life cycle monitoring sites). Goal is to provide annual estimates of adults in and adults out of selected watersheds with a precision of $\pm$ 30 percent or better.
J. Evaluate how well life cycle monitoring sites represent conditions outside of the index areas and investigate the potential for implementing additional trap sites that could be operated periodically on a rotating basis to "calibrate" index sites to broader areas.

Priorities

Monitoring of harvest or hatcheries basically is considered the cost of doing business. Therefore, decisions to continue existing harvest or hatchery monitoring or to implement new monitoring will be primarily linked to decisions regarding the existence of these harvest or hatchery programs. Assuming harvest and hatchery programs continue, the monitoring described in items F and G (above) must be a high priority. Without this information it will be difficult to assess any of the VSP parameters in any wild populations exposed to fishery or hatchery impacts, and also to meet the management needs of harvest and hatchery programs.

For the other monitoring components (spawners, juveniles, life/cycle), when funds are limited there are three primary ways to reduce monitoring effort (and thus expenditures). In priority order these are:

1. Reduce effort throughout the sample frame[118] (may decrease precision).
2. Reduce effort in parts of the sample frame (may increase bias).
3. Eliminate one or more of the components describe above (may result in inability to provide any information on certain monitoring objectives)

Oregon's strategic approach *to fluctuations in monitoring support* is to design monitoring programs that are scalable and provide information on the variance structure of monitored indicators. This information will enable calibration of information gathered during periods of reduced effort to information gathered during periods of enhanced (or non-reduced) effort. Oregon's first priority is to use this approach to reduce effort throughout the sample frame while still keeping (at least for the short term) acceptable precision.

In instances when either calibration information has not been developed, does not show that acceptable precision and bias goals can be achieved with reduced effort, or where budget shortfalls require deeper reductions, Oregon's next priority is to reduce effort in parts of the sample frame. For lower Columbia River populations of salmon and steelhead, Oregon will follow priorities set for delisting goals in Chapter 6 of this Plan. Under the stratum delisting scenario in the Plan the following populations are currently at high or very high risk of extinction, are not targeted for status improvements, and thus will be the first areas where species specific monitoring of adult escapement or juvenile abundance will be either temporarily suspended or postponed if necessary to respond to budget shortfalls:

[117] Needed to estimate hatchery stray rates.
[118] The sample universe or spatial extent over which the target indicator may be distributed.

- Youngs Bay coho and fall Chinook
- Big Creek coho and fall Chinook
- Upper Gorge fall Chinook and winter steelhead

In addition, because of the essentially extirpated status of Oregon populations of Columbia River chum, no status targets are currently established for them. Instead, Oregon is proposing research to determine the best approach for re-establishing chum populations. Until this research has been completed, monitoring of chum will be restricted to that needed for the research program.

Finally, if the two steps described above still do not yield enough fiscal reductions to meet budget shortfalls, Oregon's final step will be to eliminate entire monitoring components in the following order:

1. GRTS-based juvenile surveys
2. Life cycle monitoring
3. GRTS-based spawner surveys

By following this strategic approach, Oregon believes that with adequate funding it can provide scientifically rigorous information on the four VSP parameters that is crucial for future decisions on the status and trend of salmon and steelhead in the lower Columbia River. This strategic approach also provides a rational way to establish priorities for providing quality information given available monitoring resources, and provides managers and policy makers with a better framework for making decisions regarding the funding of monitoring programs.

8.4.6 Summary of Current Monitoring for VSP Parameters

A variety of monitoring programs are currently in place that can provide some of the information needed to assess VSP parameters for Oregon populations of salmon and steelhead in the lower Columbia River. See Appendix J for a description of existing monitoring programs.

8.5 Listing Factors

In addition to RME needed to address the biological criteria, to be approved by NMFS, a recovery plan must also include RME that addresses the five ESA section 4(a)(1) listing factors:

A. The present or threatened destruction, modification, or curtailment of the species' habitat or range
B. Over-utilization for commercial, recreational, scientific or educational purposes
C. Disease or predation
D. The adequacy of existing regulatory mechanisms
E. Other natural or manmade factors affecting its continued existence

In contrast to the viability assessment for biological recovery, the decision framework for listing factors does not rely on explicit criteria when considering the Stratum (major population group) scale, but steps down directly from the ESU to the individual population, when possible. Also in contrast to the assessment of biological criteria, NMFS offers no explicit analytical guidance for decisions related to the listing factors. In contrast to the measurable criteria developed for biological recovery (which have a direct connection to assessments of population viability), the measurable criteria described below for the listing factors are primarily related to directly tracking the success of actions designed to reduce the impact of current threats or serve as an early warning for emerging threats.

The following describes the decisions, key questions, measurable criteria, and RME needed by this Plan to assess the status of the five listing factors

8.5.1 Decisions, Key Questions, Measurable Criteria and RME for Listing Factor A: The Present or Threatened Destruction, Modification, or Curtailment of a Species' Habitat or Range.

Decisions:

1. Habitat related threats have been ameliorated such that they do not limit attainment of the desired status of the population. The desired status of each population is defined by viability criteria identified in the recovery plan.
2. Hydropower related threats have been ameliorated such that they do not limit attainment of the desired status of the populations relative to population-specific viability criteria identified in the recovery plan.

Key Habitat Related Threat Question:
Are there significant effects of habitat degradation on the observed abundance, productivity, spatial structure, and diversity of the natural-origin fish in this population?

Measurable Criteria – Habitat Related Threats

Habitat Related Metrics
Five-year assessments of:

A. Floodplain Connectivity and Function
B. Channel Structure and Complexity
C. Riparian Condition and LWD Recruitment
D. Stream Substrate
E. Stream Flow
F. Water Quality
G. Fish Passage

Evaluation Thresholds for Habitat Related Metrics – All Species

Pass – Positive trend in the status of the habitat degradation metrics
Fail – Negative trend or no improvement in the status of the habitat degradation metrics

Pass – Restoration action quantities equal or exceed "x"/15 of those shown in Table 8-2, where "x" is the number of years after adoption of this Plan and 15 is the number of years this Plan allows for tributary habitat restoration.
Fail – Restoration action quantities are less than "x"/15 of those shown in Table 8-2.

Evaluation Thresholds for Habitat Related Metrics – Coho

Pass – The number of additional/new miles of high quality miles habitat (as determined by ODFW's Habitat Limiting Factors Model) equals or exceeds that shown in Table 8-2.
Fail – The number of additional/new miles of high quality miles habitat (as determined by ODFW's Habitat Limiting Factors Model) is less than that shown in Table 8-2.

Table 8-2. Additional miles of high quality habitat needed to achieve delisting and broad sense recovery abundance goals for coho[119].

Population	Additional Miles of High Quality Coho Habitat Needed	
	Delisting	Broad Sense
Youngs Bay	0[a]	>135
Big Creek	0[a]	76
Clatskanie	19	19
Scappoose	10	24
Clackamas	0[a]	61
Sandy	37	37
Lower Gorge	10	31
Upper Gorge/Hood	53	>53

[a] Although the modeling approach indicates that no additional miles of high quality habitat are needed for several populations to strictly reach the delisting desired status, Oregon fully supports efforts to protect and restore habitat in order to assure healthy populations into the future, meet broad sense recovery goals, and be precautionary against model and future uncertainty. Chapter 6 also indicates a most probable scenario for Youngs Bay and Big Creek, between delisting and broad sense scenarios, where additional high quality habitat is necessary; the most probable scenario for Clackamas is the same as the broad sense goal presented here.

Analytical Procedures for Habitat Related Metrics

Although it may be possible to achieve passing grades for the fish-based biological criteria, the ESU can still be deemed at risk of extinction if habitat conditions are deteriorating. Even if conditions are not declining but simply remaining the same, significant improvement to habitat condition is still needed to achieve recovery goals, and the status quo in habitat condition should serve as an indication that recovery goals are not being achieved.

Establishing baseline conditions for the habitat metrics listed above, and periodically reassessing these conditions, will make it possible to evaluate whether or not habitat conditions are improving, staying the same, or declining. Efforts are also needed in tributary streams to compare habitat conditions to those at relatively undisturbed "reference" sites to gauge how far current habitat conditions are from "pristine" conditions. Ultimately, goals are needed for each habitat metric that would be used to assign a target number of stream miles in each population area that should have habitat conditions similar to reference conditions. With the possible exception of coho, the current lack of quantitative information that specifically links habitat conditions to the biological criteria (i.e. abundance, productivity, diversity, and spatial structure) makes it difficult to develop quantitative habitat status benchmarks. Instead, until more research is conducted to establish a sound quantitative linkage between habitat conditions and the biological criteria, measurable criteria evaluation thresholds have been established that are based on the trend in habitat conditions.

An example of the types of analyses that will be conducted on the collected instream habitat data may be found in ODFW (2005[120]). Comparison of monitored habitat conditions to undisturbed "reference" sites to gauge departure from pristine conditions has been a common goal in monitoring across the region, but it is often complicated by relatively high variability in individual parameters and limited power to detect meaningful trends. Because of this, it is critical that habitat information be regularly reviewed to assess ability of monitoring program to detect biologically meaningful changes in habitat conditions.

[119] See Anlauf et al. (2006) for an evaluation of the amount of high quality habitat currently available for coho.
[120] http://nrimp.dfw.state.or.us/OregonPlan/default.aspx?p=152&path=ftp/reports/Final%20Reports/Agency%20Reports/ODFW&title=&link= (select ODFWHabitatFinalReport.pdf)

RME Needed to Assess Habitat Related Threats

Status and Trend Monitoring:

1. Five-year estimates of the spatial pattern and status of indicators of floodplain connectivity and function, channel structure and complexity, riparian condition and LWD recruitment, stream substrate, and fish passage for within each lower Columbia River population area
   Relevance: Used to establish baseline habitat conditions and habitat trend in tributary streams
   Approach: Spatially balanced, random surveys based on the GRTS technique. Field sampling protocols will be based on ODFW Aquatic Inventory protocols[121]. Objective will be to characterize habitat conditions within strata at ± 15 percent with 80 percent certainty.

2. Five-year estimates of the spatial pattern and status of indicators of floodplain connectivity and function, channel structure and complexity, riparian condition and LWD recruitment in the estuary
   Relevance: Used to establish baseline habitat conditions and habitat trend in the estuary
   Approach: Spatially balanced, random surveys based on the GRTS technique. Field sampling protocols will be based on ODFW Aquatic Inventory protocols.

3. Annual assessments of status and spatial pattern of water quality for each lower Columbia River population area and in the estuary. This includes monitoring stormwater and cropland runoff for status/trends of concentrations of malathion, diazinon, and chlorpyrifos, and identifying their sources.
   Relevance: Used to establish baseline water quality conditions and water quality trend in tributary streams and the estuary
   Approach: Spatially balanced, random water quality sampling based on the GRTS technique. Survey design will be integrated with habitat and fish monitoring survey design. Field sampling protocols will be based on ODEQ protocols. An example of the types of analyses that will be conducted on the collected water quality data may be found in ODEQ (2005[122]).

4. Annual assessments of status and spatial pattern of streamflow for each lower Columbia River population area and for streamflows entering the estuary
   Relevance: Used to establish baseline streamflow conditions and trend in streamflows in tributary streams and entering the estuary
   Approach: TBD

Implementation and Compliance Monitoring:

1. Annual assessments of compliance with existing habitat protection rules and regulations
   Relevance: Needed to assess compliance with rules and regulations designed to protect habitat conditions
   Approach: Depending on the extent of the regulatory issue, agencies responsible for managing and/or enforcing habitat protection rules and regulations will either conduct annual censuses or statistically rigorous field surveys to assess compliance

2. Annual assessments of the implementation of habitat management best management practices
   Relevance: Application of recognized best management practices is a critical component of volunteer efforts to protect and restore habitat. Regular assessments of the extent to which

[121] http://oregonstate.edu/dept/ODFW/freshwater/inventory/pdffiles/hmethd08.pdf
[122] http://nrimp.dfw.state.or.us/OregonPlan/default.aspx?p=152&path=ftp/reports/Final%20Reports/Agency%20Reports/ODEQ&title=&link=

best management practices is a critical component of adaptively managing volunteer habitat programs (e.g. lack of implementation may mean that more technical assistance or other incentives are needed)
Approach: TBD

3. Annual assessments of implementation of recovery actions designed to protect and restore habitat conditions
Relevance: Needed to assess degree of implementation of recovery plan actions designed to protect and restore habitat conditions
Approach: Depending on the scope of the action implementation, agencies responsible for managing or implementing the actions will either conduct annual censes or statistically rigorous field surveys to assess implementation

Effectiveness Monitoring:

1. In coordination with the Pacific Northwest Monitoring Partnership (PNAMP), establish a series of Intensively Monitored Watersheds which can be used to assess the effect of habitat restoration and protection measures and best management practices. Studies will be designed that have the ability to detect a 30-50 percent change in fish response.
Relevance: Needed to assess the effectiveness of habitat restoration and protection
Approach: TBD

2. Site specific monitoring of the effectiveness of habitat protection and best management practices
Relevance: Needed to assess the effectiveness of habitat protection and best management practices
Approach: TBD

3. Annual before and after habitat evaluations of sites where habitat restoration actions of been implemented
Relevance: Needed to assess the effectiveness of reach specific habitat restoration efforts
Approach: ODFW Aquatic Inventory survey protocols

Critical Uncertainty Research:

1. Improved understanding of impact that habitat related limiting factors and threats have relative to other potential limiting factors and threats over the entire life-cycle of lower Columbia River salmon and steelhead populations
Relevance: Needed to better inform decisions on where to prioritize funds for recovery actions
Approach: TBD

2. Determine whether emerging data and new trends for ocean conditions (e.g., ocean "dead zones", large scale chemistry shifts, temperature changes) indicate that future ocean impacts may be anthropogenically caused and different than natural impacts historically exerted on LCR salmon and steelhead populations
Relevance: Needed to understand the larger context for recovery actions and their benefit
Approach: TBD

Key Hydropower Related Threat Question:
Are there significant effects of the hydropower/flood control system on the observed abundance, productivity, spatial distribution, and diversity of the natural-origin fish in this population?

Specific limiting factors for which this question should be answered are:

Hydropower Related Metrics
Annual assessments of:

a. Fish passage
b. Above and below dam habitat conditions

Evaluation Thresholds for Hydropower Related Metrics – Clackamas Fish Passage

Pass – Achievement of fish passage goals outlined in the Clackamas River Hydroelectric Project (FERC Project No. 2195) Fish Passage and Protection Plan

Fail – Failure to achieve the fish passage goals outlined in the Clackamas River Hydroelectric Project (FERC Project No. 2195) Fish Passage and Protection Plan

Evaluation Thresholds for Hydropower Related Metrics – Habitat Conditions Above and Below Clackamas Hydropower Projects

Pass – Achievement of habitat goals outlined in the Clackamas River Hydroelectric Project (FERC Project No. 2195) Fish Passage and Protection Plan

Fail – Failure to achieve the habitat goals outlined in the Clackamas River Hydroelectric Project (FERC Project No. 2195) Fish Passage and Protection Plan

Evaluation Thresholds for Hydropower Related Metrics – Hood Fish Passage

Pass – Provision of passage for adult and juvenile coho and winter steelhead at Laurance Lake Dam

Fail – Lack of passage for adult and juvenile coho and winter steelhead at Laurance Lake Dam

Analytical Procedures for Hydropower Related Metrics
For Clackamas River hydropower related threats, see the Clackamas River Hydroelectric Project (FERC Project No. 2195) Fish Passage and Protection Plan. Analytical procedures for Laurance Lake Dam Passage are TBD.

RME Needed to Assess Hydropower Related Threats
For Clackamas River hydropower related threats, see the Clackamas River Hydroelectric Project (FERC Project No. 2195) Fish Passage and Protection Plan. Analytical procedures for Laurance Lake Dam Passage are TBD.

8.5.2 Decisions, Key Questions, Measurable Criteria and RME for Listing Factor B: Over-utilization for commercial, recreational, scientific or educational purposes

Decision:
Harvest related threats have been ameliorated such that they do not, and will not, limit attainment of the desired status of populations relative to population-specific viability criteria stated in the recovery plan.

Key Harvest Related Threat Questions:

1. Are there significant effects of fish harvest on the observed abundance, productivity, spatial structure, and diversity of the natural-origin fish in this population?
2. Does the status of the *other* listing factors modify the absolute risk posed by the current and potential future status of *this* listing factor?

Measurable Criteria – Harvest Related Threats

Harvest Related Metrics

Annual estimates of the number of wild salmon and steelhead harvested from each lower Columbia River population[123].

Evaluation Thresholds for Harvest Related Metrics for Clatskanie, Scappoose, Clackamas, Sandy, and Lower Gorge Coho[124]

Pass – Harvest rates of wild coho do not exceed the seeding and ocean condition category specific harvest rates shown in Table 8-3 in any given year more than once in 10 years (≥ 90% compliance)

Fail – Harvest rates of wild coho do exceed the seeding and ocean condition category specific harvest rates shown in Table 8-3 more than once in 10 years (≤ 90% compliance)

Evaluation Thresholds for Harvest Related Metrics for all populations of fall and late fall Chinook[125]

Pass – Harvest rates of wild fall and late fall Chinook do not exceed those contained in a sliding scale harvest matrix (to be developed as part of implementation of this Plan[126]) in any given year more than once in 10 years (≥ 90% compliance)

Fail – Harvest rates of wild fall and late fall Chinook do exceed those contained in a sliding scale harvest matrix in any given year more than once in 10 years (≤ 90% compliance)

Evaluation Thresholds for Harvest Related Metrics for all populations of spring Chinook and Steelhead

Pass – The average harvest rate over a 12-year period does not exceed the impact shown in Table 8-4.

Fail – The average harvest rate over a 12-year period exceeds the impact shown in Table 8-4.

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[123] See Appendix D for the most recent allowable harvest limits.

[124] Terminal fisheries within the Youngs Bay and Big Creek areas will increase impacts on these two coho populations relative to the base rate indicated in Table 8-3. Maximum allowable harvest impacts for these populations should be commensurate with those indicated in Table 8-3 plus the difference in long-term modeled harvest rate between these populations and those to which Table 8-3 applies directly (i.e., annually, the Table 8-3 rate plus 45% [Youngs Bay] and 25% [Big Creek]). The Delisting Scenario for the Upper Gorge/Hood population indicates a long-term modeled harvest rate which is well below the base rate applied to other populations. Efforts should be made to decrease harvest impacts on this population approximately 20% over the long-term relative to other populations to which Table 8-3 applies directly; however, given the mixed stock nature of harvest impacts, it is likely that the annual harvest rate of Upper Gorge/Hood coho will be the base rate indicated in Table 8-3.

[125] Given additional fisheries that affect Youngs Bay, Big Creek, and Upper Gorge (and Hood, though see below) fall Chinook populations, similar considerations as those applied to Youngs Bay and Big Creek coho metrics are needed for these populations. Hood fall Chinook likewise have similar considerations as Upper Gorge/Hood coho (i.e., threat reductions which are well below the baseline for the species and which are unlikely to be met due to mixed stock harvest). The Sandy late fall Chinook population should have harvest impacts at least 5% below the long-term average for other populations to which the base rate applies, based on historical impacts on this population relative to the others and desired threat reductions.

[126] Until the harvest matrix can be developed, harvest co-managers should continue determining annual, or other short-term timeframe, harvest rates consistent with recovery objectives, through appropriate scientific analyses, and based upon the best and most recent monitoring information.

Table 8-3. Allowable harvest impacts as determined from parental status and marine survival index for LCR coho (except Youngs Bay, Big Creek, and Upper Gorge/Hood populations; from ODFW [2001]). This table will be revised as actions are implemented (e.g., incorporation of weak stock management).

Parental Escapement		Marine Survival Index (based on return of jacks per hatchery smolt)			
		Critical (<0.0008)	Low (< 0.0015)	Medium (< 0.0040)	High (> 0.0040)
High	> 0.75 full seeding	**< 11.7%**	**< 21.4%**	**< 40.5 %**	**< 57.4%**
Medium	0.75 to 0.50 full seeding	**< 11.7%**	**< 21.4%**	**< 29.2%**	**< 49.8%**
Low	0.50 to 0.20 full seeding	**< 11.7%**	**< 21.4%**	**< 22.7%**	**< 34.4%**
Very Low	0.20 to 0.10 of full seeding	**< 11.7%**	**< 16.3%**	**< 18.1%**	**< 19.9%**
Critical	< 0.10 of full seeding	**0.0 – 11.7%**	**0.0 – 11.7%**	**0.0 – 11.7%**	**0.0 – 11.7%**

Table 8-4. Maximum allowable average harvest rates for Oregon populations of spring Chinook salmon and steelhead in the LCR.

Species	Population	Harvest Impact
Spring Chinook	Clackamas, Sandy, Hood	25%
Winter Steelhead	Youngs Bay, Big Creek, Clatskanie, Scappoose, Clackamas, Sandy, Lower Gorge	10%
	Upper Gorge, Hood	15%
Summer Steelhead	Hood	15%

Analytical Procedures for Harvest Related Threats

The allowable harvest rate goals specified in Chapter 6 represent long-term modeled average estimates of harvest rates after implementation of actions and that, when combined with survival improvements in other threat categories, are conducive to the long-term viability of the ESU. As such, they represent average harvest rates over a 100-year period. Because assessments of harvest impacts must be available on shorter timeframes, a 12-year (3-4 generation) time frame will be used to conduct this analysis. This does not mean that it will necessarily take a full 12 years to determine if harvest rates are out of line with the measurable criteria. If, for example very high harvest rates occur in the first years of the assessment, an analysis can be conducted that may show that lower harvest rates need to be implemented in the ensuing years in order to meet the measurable criteria.

Over the long term, the advantage for monitoring of using harvest matrices as the measurable criteria for coho and fall and late fall Chinook populations instead of a long-term average (e.g., those contained in Chapter 6 for modeling purposes) is that it is feasible to make annual comparisons of harvest rates to those mandated in the harvest matrix. Because of this, a more rapid assessment of the compliance to the allowable harvest impacts specified in this Plan is possible. Note also that the coho harvest matrix may need to be revised (see Chapter 7) and a shift from basing matrix determinations on "strong stocks" to "weak stocks" is called for in the Plan.

<u>RME Needed to Assess Harvest Related Threats</u>

Status and Trend Monitoring:

1. Annual estimates of mortality due to harvest for each lower Columbia River salmon and steelhead population.
   Relevance: Used to directly assess compliance with harvest measurable criteria.
   Approach: TBD

2. Annual estimates of the marine survival rates of wild coho salmon LCR strata.
   Relevance: Used to assign observed abundance to proper ocean survival category for benchmark comparisons.
   Approach: At least one intensively monitored watershed (i.e. adults in and smolts out) in each strata.

Implementation and Compliance Monitoring:

1. See item #1 under status and trend monitoring

2. Check for implementation of the following mark-selective Chinook fisheries[127]:

a. Mark selective sport: ocean, Buoy 10, tribs (start 2011-2016)
b. Mark selective sport: mainstem above Buoy 10 if upriver/Snake wilds are low (start 2011-2016)
c. Mark selective commercial if live-capture is feasible: August and September (start 2017-2022, possibly earlier)
   Rationale: Components needed to achieve average harvest rate benchmarks.
   Approach: TBD

3. Monitor commercial and tribal spring Chinook harvest for shift to terminal area fisheries during low return years.
   Rationale: Shift to terminal fisheries during low return years is important component needed to achieve long term harvest goals for spring Chinook.
   Approach: TBD

Effectiveness Monitoring:

1. Conduct studies to assess effectiveness of harvest management actions needed to achieve harvest impact goals.
   Rationale: Critical information for the adaptive management process.
   Approach: TBD

Critical Uncertainty of Research:

1. Explore feasibility of mark-selective, terminal, commercial coho and fall Chinook fisheries (develop live-capture techniques and implement if feasible).
   Rationale: Improved harvest techniques will aid fishery managers in achieving harvest goals
   Approach: TBD

2. Review existing information on mortality associated with catch and release and determine if information is adequate to assess mortality impact in potential mark-selective fisheries and if not, implement studies to assess impact that would occur in mark-selective fisheries.
   Rationale: Accurate fishery/gear specific release mortality rates are needed to estimate impacts to released stocks.
   Approach: TBD

[127] Note that mark-selective fisheries will only be widely implemented if they are shown to be feasible.

3. Look into developing a return forecast model and abundance-based, sliding scale harvest matrix and implementation of weak stock management for Chinook, as well as mark-selective fisheries.
   Rationale: A harvest matrix-based approach similar to that used for coho will enable fishery managers to manage Chinook fisheries on a more biologically sound foundation and allow for more time sensitive assessments of compliance with harvest goals

4. Indentify and develop a return forecast model for a weak grouping of coho populations.
   Rationale: Needed to provide basis for applying coho harvest matrix shown in Table 8-3.
   Approach: TBD

5. Develop harvest management strategies to protect the Sandy late-fall Chinook populations
   Rationale: Sandy late-fall Chinook is a unique fall Chinook population for which special attention should be paid to harvest impacts.
   Approach: TBD

6. Improved, population-specific understanding of impact that mortality and phonotypic selection related to fish harvest has relative to other potential limiting factors and threats over the entire life-cycle of lower Columbia River salmon and steelhead populations.
   Relevance: Needed better inform decisions on harvest management and where to prioritize funds for recovery actions. Maintaining existing diversity and improving diversity where impaired is critical for populations to be resilient in the face of climate change.
   Approach: TBD

7. Initiate snapshot sampling programs in the various coastal fisheries designed to capture the genetic structure of the TRT populations within the specific fishery in preparation for a future coast wide annual coordinated genetic stock identification approach and recalibration of the Fishery Regulation Assessment Model (FRAM).
   Relevance: FRAM is currently used by the Pacific Fishery Management Council (PFMC) and the North of Falcon process to annually estimate impacts of proposed ocean and terminal fisheries on Chinook and coho salmon stocks (PFMC 2008). FRAM is a single-season modeling tool with separate processing code for Chinook and coho salmon. The Chinook version models populations from central California north to southern British Columbia, Canada. The coho version models populations from central California to Southeast Alaska. The FRAM has been used in recent years, not only to model harvest fisheries, but to determine compliance with ESA restrictions on allowable take. Currently, 123 stock groups are represented in the Coho FRAM and 3833 stock groups are represented in the Chinook FRAM. Each of these groups have both marked and unmarked components to permit assessment of mark-selective fishery regulations. For most wild stocks and hatchery stocks without marking or tagging programs, the cohort size of the marked component is zero; therefore, the current version of FRAM has a virtual total of 246 stock groups for coho and 76 for Chinook. The model assumes that CWT fish accurately represent the modeled stock. In nearly all cases wild stocks are aggregated with hatchery stock and both are represented by the hatchery stock. As the coast moves toward stock identification that goes beyond CWTs, the FRAM model will continue to need to be modified.
   Approach: TBD

8. Research on migration timing.
   Relevance: One key uncertainty that would aid fisheries planning is a better understanding of how fish from specific stocks migrate through the lower river. With this information, managers could avoid harvest impacts on some stocks entirely. Some information is

available for hatchery stocks based on CWTs, but almost none exists on wild fish. A program of intensive radio tracking that tagged fish in the estuary, then tracked them all the way to their home tributaries would allow managers to set fisheries to avoid or reduce impacts to sensitive stocks. PIT tagging could be used as well, but would not provide as much resolution. These are, and will always be, mixed stock fisheries. Implementation of this kind of research could provide information that would allow for complete avoidance of listed stocks, rather than simply "reduced impacts" from mark-selective fisheries.

Approach: TBD

8.5.3 Decisions, Key Questions, Measurable Criteria and RME for Listing Factor C: Disease and Predation

Decision:
Disease and predation related threats have been ameliorated such that they do not, and will not, limit attainment of the desired status of populations relative to viability criteria stated in the recovery plan.

Key Disease and Predation Related Threat Questions:

1. Are there significant effects of disease on the observed abundance, productivity, spatial structure, and diversity of the natural-origin fish in this population?
2. Are there significant effects of predation by marine mammals, avian predators, or piscine predators on the observed abundance, productivity, spatial structure, and diversity of the natural-origin fish in this population?
3. Does the status of the *other* listing factors modify the absolute risk posed by the current and potential future status of *this* listing factor?

Measurable Criteria – Disease and Predation Related Threats

Disease Related Metrics
None identified[128].

Predation Related Metrics
Annual assessments of the predation impact on Oregon populations of coho, Chinook, and steelhead by Caspian terns, double-crested cormorants, marine mammals, and northern pikeminnow.

Evaluation Thresholds for Caspian Tern and Double-crested Cormorant Predation Metric

Pass – The average cumulative mortality of Oregon populations of coho, Chinook, and steelhead due to predation by Caspian terns, double-crested cormorants, marine mammals, and northern pikeminnow over a 12-year period due to anthropogenic influences is equal to or less than that shown in Table 8-5.

Fail – The average cumulative mortality of Oregon populations of coho, Chinook, and steelhead due to predation by Caspian terns, double-crested cormorants, marine mammals, and northern pikeminnow over a 12-year period due to anthropogenic influences is greater than that shown in Table 8-5.

[128] Although no specific benchmarks have been established for disease, monitoring for status and trend is needed and is described below.

Table 8-5. Cumulative mortality rate targets for Oregon populations of coho, fall Chinook (CHF), spring Chinook (CHS), winter steelhead (STW), and summer steelhead (STS).

Population and Species	**Predation Mortality Rate**				
	CHF	CHS	Coho	STW	STS
Youngs	4%		3%	6%	
Big Creek	4%		3%	6%	
Clatskanie	5%		4%	7%	
Scappoose	5%		4%	7%	
Clackamas	6%	7%	4%	7%	
Sandy	6%	7%	4%	7%	
Gorge L	6%		4%	7%	
Gorge U	7%			10%	
Hood	7%	7%	5%	10%	8%
Sandy late	6%				

Analytical Procedures for Disease and Predation Related Threats
The evaluation thresholds for the predation are based on the reductions in predation related mortality described in Chapter 6 (Recovery Scenarios). These mortality rates represent long term (100-year) average rates that recovery scenario modeling indicates will, when combined with reduction in mortality in other threat categories, will be sufficient to ensure long term viability of the ESU. In order to provide for more timely assessments of progress towards achieving recovery goals for predation, this measurable criterion is linked to a 12-year time frame (i.e. 3-4 salmon or steelhead generations).

<u>RME Needed to Assess Disease and Predation Related Threats</u>

Status and Trend Monitoring:

1. Monitoring of predation associated with anthropogenic alterations in the Columbia River estuary, at Bonneville Dam, and Bonneville Reservoir.
   Relevance: Needed to assess status and trend in predation rates.
   Approach: TBD

2. Sampling of natural populations in and near the hatcheries to determine the occurrence of pathogens that may cause disease in the natural population.
   Relevance: Needed to assess the extent to which pathogens and the diseases they cause exist in wild populations due to hatchery operations
   Approach: TBD

3. Watershed scale sampling for the occurrence of invasive aquatic species known to affect salmon and steelhead
   Relevance: Needed to assess the magnitude of impact of invasive aquatic species such as Chinese mitten crabs, non-native zooplankton (*Pseudodiaptomus inopinus*) on wild salmon and steelhead
   Approach: TBD

Implementation and Compliance Monitoring:
TBD

Effectiveness Monitoring:
TBD

Critical Uncertainty Research

1. Conduct research to determine the impact of predation by hatchery fish on natural origin salmon and steelhead in the estuary.
   Relevance: Predation by hatchery fish on natural origin salmon and steelhead in the estuary is listed as a secondary threat for many lower Columbia River salmon and steelhead populations. No actions are currently recommended to specifically address this issue because there is a lack of information on the magnitude and specific nature of the problem.
   Approach: TBD

2. Compile existing invasive species information to determine which species are of threats to the health of wild salmon and steelhead
   Relevance: Needed to inform status and trend RME need #2.
   Approach: TBD

3. Research into the relationship between land management, parasitism, and the impacts of parasitism on the survival of salmon and steelhead.
   Relevance: New research conducted on Oregon Coast suggests that parasites may have a significant impact on the early ocean survival of coho salmon (Jacobson et al. 2008). Preliminary results of research being conducted by researchers at Oregon State University, Idaho State University, and ODFW suggest that the occurrence and infestation rate of certain salmonid parasites may be influenced by watershed conditions. The results of this research may be important to identifying improved land management practices and critical areas for implementing these land management practices.
   Approach: See Appendix K for a summary.

4. Research into the effects of bull trout reintroduction in the Clackamas River on recovery of lower Columbia River and upper Willamette River salmon and steelhead
   Relevance: Bull trout are also listed under the ESA and are extirpated from the Clackamas River. Efforts are underway to re-introduce this species to the Clackamas and the resulting ecological interactions between these different listed species should be understood.
   Approach: TBD.

8.5.4 Decisions, Key Questions, Measurable Criteria and RME for Listing Factor D: Adequacy of Existing Regulatory Mechanisms

Decision:
Inadequacies of existing regulatory mechanisms have been addressed such that regulatory mechanisms do not, and likely will not, limit attainment of the desired status of populations relative to viability criteria stated in the recovery plan.

Key Questions Related to Adequacy of Existing Regulatory Mechanisms:

1. Are the regulatory mechanisms in place adequate to address the limiting factors such that those limiting factors will not pose a significant threat in the future to the maintenance of the population at viability levels identified in the recovery plan?
2. Are the regulatory mechanisms in place adequate to prevent potential limiting factors that are not currently threats from becoming threats in the future?

Measurable Criteria – Adequacy of Existing Regulatory Mechanisms
No measureable criteria have been established for this listing factor.

Analytical Procedures for Adequacy of Existing Regulatory Mechanisms
TBD

RME Needed to Assess the Adequacy of Existing Regulatory Mechanisms

Status and Trend Monitoring:
None identified

Implementation and Compliance Monitoring:

1. Implement a recovery plan tracking system that will be capable of recording whether local and state agencies are implemented regulatory actions need to achieve the goals of this recovery plan
   Relevance: Needed to provide information on whether or not regulatory actions are adequately implemented
   Approach: TBD

2. Develop a randomized sampling program to test whether permits issued under local and state regulatory actions designed to protect riparian and instream habitat are in compliance and that the provisions have been enforced.
   Relevance: Needed to assess permit compliance with riparian and instream habitat rules and regulations
   Approach: TBD

Effectiveness Monitoring:
None identified.

Critical Uncertainty Research:

1. Additional research is needed to determine the effectiveness of existing BMPs for forest practices, stormwater management, hydraulic permits, shoreline development, and other activities that affect the marine and aquatic areas.
2. *Relevance:* Needed to assess if regulatory mechanisms in place are adequate to address the limiting factors such that those limiting factors will not pose a significant threat in the future to the maintenance of the population at viability levels identified in the recovery plan and whether regulatory mechanisms in place are adequate to prevent potential limiting factors that are not currently threats from becoming threats in the future
   Approach: TBD

8.5.5 Decisions, Key Questions, Measurable Criteria and RME for Listing Factor E: Other Natural or Manmade Factors Affecting the Continued Existence of the ESU

Decisions:

1. Other natural factors have been accounted for such that they do not limit attainment of the desired status of populations relative to viability criteria identified in the recovery plan.
2. Hatchery related threats have been ameliorated such that they do not, and will not, limit attainment of the desired status of populations relative to viability criteria stated in the recovery plan.

Key Listing Factor E Questions:

1. Are there significant effects of natural factors not covered in listing factors A-C on the observed abundance, productivity, spatial structure, and diversity of the natural-origin fish in this population? Examples are:
    a. Ocean conditions
    b. Climate change
    c. Volcanic eruptions or earthquakes
2. Are there significant effects of hatchery operations on the observed abundance, productivity, spatial structure, and diversity of the natural-origin fish in this population? Specific hatchery related threats or limiting factors for which this question should be answered are:
    a. Broodstock collection
    b. Genetic introgression
    c. Domestication
    d. Disease
    e. Competition
    f. Predation
    g. Timing of egg take
    h. Rearing practices
    i. Release practices
3. Are there significant effects of any listing factors on ecosystem nutrient dynamics on the observed abundance, productivity, spatial structure, and diversity of the natural-origin fish in this population?
4. Does the status of the *other* listing factors modify the absolute risk posed by the current and potential future status of *this* listing factor?

Measurable Criteria – Hatchery Related Threats

Hatchery Related Metrics
Annual assessments of the proportion of spawning fish that are of hatchery origin in each lower Columbia River population.

Evaluation Thresholds for Hatchery Related Metrics – Delisting

Pass – Over a nine-year period, the average percentage of the total number of spawners that are of hatchery origin is on average less than or equal to that shown in Table 8-6.

Fail – Over a nine-year period, the average percentage of the total number of spawners that are of hatchery origin is on average than that shown in Table 8-6.

Table 8-6. Hatchery stray rate targets[129] to achieve delisting for Oregon populations of coho, fall Chinook (CHF), spring Chinook (CHS), winter steelhead (STW), and summer steelhead (STS).

Population and Species	Average Allowable Hatchery Stray Rates				
	CHF	CHS	Coho	STW	STS
Youngs	90%		43%	10%	
Big Creek	90%		43%	10%	
Clatskanie	10%		10%	10%	
Scappoose	10%		10%	10%	
Clackamas	30%	10%	10%	10%	
Sandy	30%	10%	10%	10%	
Gorge L	90%		10%	10%	
Gorge U	90%			10%	
Hood	0%	10%	0%	10%	0%
Sandy late	10%				

[129] Upper Gorge/Hood coho and Hood fall Chinook rates are based on the Delisting Scenario, which is unlikely to be achieved. Probable rates are 40% and 90%, respectively.

Evaluation Thresholds for Hatchery Related Metrics – Broad Sense Recovery

Pass – Over a nine-year period, the average percentage of the total number of spawners that are of hatchery origin is on average less than or equal to 10 percent.

Fail – Over a nine-year period, the average percentage of the total number of spawners that are of hatchery origin is on average greater than 10 percent.

Analytical Procedures for Hatchery Stray Rates

As outlined in Chapter 6 (Recovery Scenarios) the hatchery stray rates shown in Table 8-6 represent hatchery stray rates, that when combined with the targeted reductions in other threat categories, should lead to the long term viability of the ESU (i.e. delisting). To achieve broad sense recovery, which is achieved when all populations have a very low risk of extinction, stray rates should not exceed 10 percent in any population. While the target stray rates represent what is needed over the long term (100 years), in order to conduct more timely assessments of the status and trend in hatchery stray rates, a nine-year average was used for the analysis. For all species except coho, this average will be calculated as a whole over nine years. Because coho exhibit very strong three-year cohort fidelity[130], the analysis of coho hatchery stray rates should be conducted by averaging cohorts.

<u>RME Needed to Assess Other Natural or Manmade Factors Affecting the Continued Existence of the ESU</u>

Status and Trend Monitoring:

1. Conduct annual assessments of the abundance, distribution, and origin of hatchery fish spawning in each lower Columbia River population.
   Relevance: Needed to assess compliance with hatchery stray rate goals, and to inform managers on sources of hatchery strays so they can take appropriate actions to limit their occurrence
   Approach: Examination for hatchery fin clips of carcasses recovered during spawning surveys. These samples will be supplemented where necessary and feasible with scale and/or otolith analyses, and capture of life fish when carcasses cannot be recovered (e.g. steelhead redd surveys).

2. Annual monitoring of the spatial and temporal distribution of juvenile fish released by hatchery programs
   Relevance: Needed to evaluate the ecological (e.g. competition, predation, disease) impacts of juvenile hatchery fish on wild populations
   Approach: TBD

3. All status and trend monitoring described for fish abundance, productivity, spatial structure, and diversity, and habitat conditions
   Relevance: Needed to provide foundation for critical uncertainty research related to Key Listing Factor E questions 1 and 4.
   Approach: See previous sections

Implementation and Compliance Monitoring:

1. Provide monitoring and documentation that demonstrates that Hatchery Genetic Management Plans have been implemented. This should include annual monitoring, recording, and

[130] i.e. fish that spawn in year 0 produce progeny that spawn as adults in year 3, fish spawning in 1 produce adult progeny that spawn as adults in year 4, and fish spawning in year 2 produce progeny that spawn as adults in year 5

reporting of the practices and protocols employed by hatcheries during fish culture operations.
Relevance: Needed to assess whether or not required Hatchery Genetic Management Plans have been adequately implemented
Approach: Continue normal hatchery data collection and reporting.

Effectiveness Monitoring:
See item #1 under status and trend monitoring.

Critical Uncertainty of Research:

1. Implement recommendations of the Ad Hoc Supplementation Monitoring and Evaluation Workgroup (AHSWG) and develop a large scale treatment/reference design to evaluate long term trends in the abundance and productivity of supplemented populations.
   Relevance: Needed to provide future guidance on best management practices for hatchery fish
   Approach: See AHSWG (2008[131]) recommendations.

2. Conduct research to determine the effects of the hatchery program on the reproductive fitness of natural origin salmon and steelhead.
   Rationale: Considerable uncertainty exists about the specific quantitative impacts that hatchery programs have on the reproductive fitness of natural origin fish. A more refined understanding is needed so that to insure that actions designed to address key limiting factors and threats to the long term viability of lower Columbia River salmon and steelhead populations are focused properly.
   Approach: TBD

3. Conduct research on the impact of competition with non-native and hatchery origin fish on natural origin salmon and steelhead.
   Rationale: Competition with non-native and hatchery origin fish with natural origin salmon and steelhead was identified as an immerging issue within the Lower Columbia Recovery Planning Team. Better information is needed on the nature and magnitude of the threat in order to craft appropriate management responses.
   Approach: TBD

4. Conduct research that will provide information at the population area scale on:
   a. Potential patterns and impacts of future human population growth and climate change
   b. Identify critical areas and parameters for monitoring
   c. Recommendations for specific actions to address these impacts

   Rationale: While this Plan acknowledges that climate change and human population growth will likely have considerable negative impacts on the viability of lower Columbia River salmon and steelhead populations in the future, it is unable to directly address these future threats because of a lack of population area specific information on the exact nature of these threats. Improved information on these future impacts will allow for enhanced efforts to address them.
   Approach: TBD

[131] http://www.cbfwa.org/csmep/web/documents/general/Documents/FINAL%20REPORT%20AHSWG.pdf

8.6 Additional Research, Monitoring, and Evaluation Needs

8.6.1 Development of Integrated Monitoring Plans

Each year millions of dollars are spent to monitor the status and trend of natural resources and determine the effectiveness of restoration programs in the Pacific Northwest. While there is increasing consensus among regional federal, private, state, and tribal organizations with respect to the need for integrated and standardized monitoring information, funding for these activities is stagnant or declining. As a result, there is an increasing need to improve the efficiency and cost effectiveness of monitoring programs.

Although some monitoring questions are unique to particular agencies and organizations the need for comprehensive and efficient collection of information on metrics and indicators on all or certain aspects of the status and trend of fish, habitat, and watershed health is common to entities involved in monitoring in the Pacific Northwest. By applying well-coordinated monitoring approaches, technical and fiscal resources can be more effectively shared among interested parties, data can be shared, and resulting information can provide increased scientific credibility, cost-effectiveness in use of limited funds, and greater accountability to stakeholders.

Logical steps towards maximizing the cost-effectiveness of monitoring efforts include reducing duplication of effort and implementing programs that will allow data collected by multiple entities and programs to inform a larger regional monitoring framework. To do this, individual agencies and organizations will need to develop a survey design process that promotes data sharing with partner organizations, agree on a core set of monitoring questions with common indicators, coordinate activities, and develop common protocols and methods or ways to "crosswalk" data derived from disparate protocols.

PNAMP[132] currently has a number of workgroups developing resources that will help facilitate more coordinated and efficient monitoring programs in the Lower Columbia ESU. Regional entities responsible for monitoring natural resource in the lower Columbia River should assist these efforts by providing staff and financial resource to PNAMP. In addition, NMFS, ODFW, and Washington will establish a monitoring workgroup that will meet annually to review RME programs and needs.

8.6.2 Data Management and Access

Timely and efficient analysis and reporting on the RME described in this chapter will require improvements in the way that natural resource agencies manage and distribute information. In addition to building larger scale distributed data systems that can communicate between the various agencies involved in natural resources, the natural resource agencies should be given adequate resources to develop automated internal infrastructure to assess and evaluate their data and to report it through the various systems that require the information.

In addition to the need for a physical data management infrastructure that is adequate for managing and sharing information, in order to successfully use information collected by a variety of entities it is important that recovery entities strive to have elements of the PCSRF database dictionary within their databases and or/ adequate data mapping to be able to provide data to the database when NMFS is conducting a status review. All regional and local restoration efforts should be capable of being reported and correlated with listing factors as defined in the PCSRF data dictionary so that the cumulative effects of restoration actions can be tracked and given proper credit by MPG and ESU.

[132] http://www.pnamp.org/web/Content.cfm?SectionID=8

Toward this end, Oregon will work with PNAMP, NMFS, and the State of Washington to develop and implement a regional data management infrastructure. In addition, NMFS, ODFW, and Washington will establish a monitoring workgroup that will meet annually to review data management needs and implementation.

8.6.3 Reassessment of the Delineation of Populations and Strata

The delineation of populations and strata has a significant role in the future of lower Columbia River salmon and steelhead populations. Incorrect population or strata delineations can lead to improper recovery objectives, priorities, and strategies. During the development of this Plan, the Planning Team expressed particular concern regarding the designation of Clackamas and Sandy "tule" Chinook as distinct populations. There is belief within the Planning Team, and in particular with on-the-ground biologists, that late fall Chinook are the only true historical native populations in the Clackamas and Sandy.

As discussed in Chapter 6, scenario modeling indicates that the current population structure in the Gorge stratum may be erroneous. For many of the Gorge populations, and in particular fall Chinook, conditions need to be restored to nearly pristine (i.e. no mortality associated with any human impacts) in order to simply achieve delisting. Figure 8-2 shows habitat availability based on recent analyses by NMFS. These results show that the available habitat is very small for gorge populations even in relatively large watersheds. This suggest that many Gorge populations are not sufficiently-sized to provide reproductive isolation from other populations and exhibit adequate productivity to support sufficient numbers of fish and ensure long term sustainability. That is why recovery gap analyses are having such a hard time identifying scenarios that lead to high viability—there is simply not enough quality habitat available to support enough fish to sustain a high level of population viability. A reassessment is needed to on the delineation of the population and strata, with particular attention paid to whether or not certain populations should more appropriately be classified as dependent rather than independent populations.

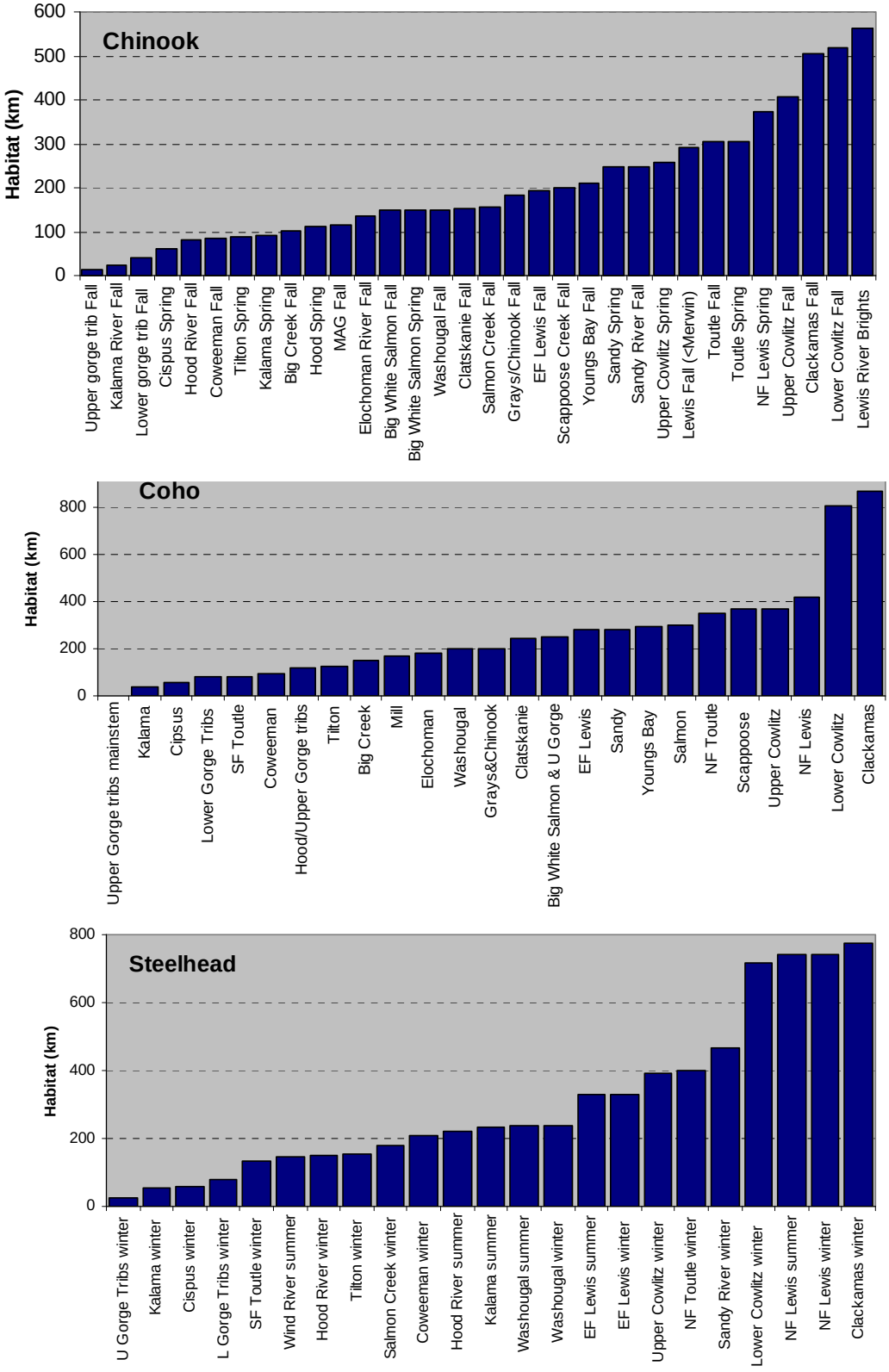

Figure 8-2. Habitat (km) available to Chinook, coho, and steelhead in each LCR population (from NMFS GIS analysis using intrinsic potential model).

8.6.4 RME Needed to Support Chum Reintroduction

As described in Chapter 7, the initial effort to recover Oregon's Columbia River populations of chum revolves around several approaches designed to provide information that will lead to ESU-wide chum recovery throughout their range in Oregon's portion of the Columbia River. The following information is needed to support this effort. See Appendix I for a detailed description of the recovery strategy.

Artificial Propagation (Broodstock Programs)

- Monitor in-hatchery performance and adult returns at Big Creek and Hunt Creek as directed by standards identified in Section 11 of the HGMP's for those facilities.

Reintroduction/Out-planting Program

- Monitor freshwater survival and performance of hatchery fed-fry, direct planted eyed-eggs, and natural production following reintroduction of chum salmon into targeted sub-basins.
- Continue to conduct spawning ground surveys outlined under the habitat and biological data program with additional emphasis of survey effort on sub-basins targeted for reintroduction (i.e. Clatskanie and/or Scappoose).
- In conjunction with existing harvest evaluation programs in the lower Columbia River, monitor fisheries for incidental harvest of chum salmon; identify harvest rates and stock of origin.

Habitat and Biological Data Program[133]

- Conduct systematic spawning surveys of lower Columbia River coast strata tributaries to identify presence of chum salmon and establish a baseline for reintroduction efforts.
- Evaluate ecological interactions, particularly predation impacts, associated with reintroduction of chum salmon into Columbia River coast strata tributaries.
- Evaluate long-term trends in physical habitat and water quality conditions, especially in Clatskanie and Scappoose population areas.

[133] Chum spawning surveys and habitat monitoring will be conducted throughout the ESU, in conjunction with fall Chinook spawning surveys and low system (i.e., non-wadeable) habitat surveys.

Chapter 9: Implementation

The ability of this Plan to improve the status of the salmon and steelhead populations in Oregon's portion of the Lower Columbia ESUs/DPS depends on its successful implementation. There are two distinct processes that must both be initiated to implement this Plan. First, the actions identified in Chapter 7 must be implemented through a coordinated effort with all of the various organizations and land managers/owners with an interest in the resource being involved. Second, an adaptive management framework must be functioning to implement the necessary RME identified in Chapter 8, and to review the outcomes of the RME to evaluate the effectiveness of the actions that have been implemented and to modify those actions if necessary.

The successful implementation of both of these processes will require significant funds and the coordinated work of ODFW, State agencies, tribes, counties, irrigation districts, agriculture and private forest land managers, NMFS, U.S. Forest Service, BLM, other federal agencies, municipalities, local residents, citizen groups, utilities, other agencies, and individuals. The process to implement the actions identified in Chapter 7 has not been fully developed. This section identifies the elements necessary for recovery plan action implementation and the process Oregon will use to adaptively manage the implementation of this Plan.

9.1 Action Details: Locations, Schedule, Costs, and Potential Implementers

An implementation plan within a recovery plan must contain "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" (ESA section 4(f)(1)(A)(iii)). The implementation plan will also serve as the guidance document that describes the time- specific implementation of actions for all programs as well as serve as the benchmark of expected milestones that allows for tracking of progress in the recovery plan action implementation.

An ESA implementation plan identifies the following:

- recovery actions,
- priority for completing the actions,
- timeline and duration for completion of the actions,
- lead agency/entity to implement each action, and
- estimated cost for each action over a specified period of time.

Section 9.1.3 serves as the implementation plan for the Plan. It contains actions, locations, schedule, costs, and potential implementers. In addition, a description of priorities is included. Note that many implementing entities (i.e. watershed councils, tribes, state agencies, federal agencies) have been fully involved in developing the draft Oregon Lower Columbia River Salmon and Steelhead Recovery Plan. "Potential" implementers are identified because entities were in general uncomfortable fully committing to the responsibility of a given action without assured funding, especially given the voluntary nature of this plan.

9.1.1 Timeframe Considered for Schedule and Costs

The Plan is a 25-year plan that guides conservation and recovery actions, beginning in the year that the OFWC approves the Plan. The basis for the 25-year timeframe is that actions are scheduled through this time period, as detailed in Section 9.1.3, though most actions are scheduled to be completed earlier than this. Note that the delisting and broad sense goals of the Plan are not necessarily expected to be achieved

within this timeframe, given lag time between action completion and both habitat and population responses.

The 25-year period should not be confused with other timeframes mentioned in the Plan. These include a) the 100-year period used in population viability models to determine extinction risks (Chapter 4 and 6), b) the 60-year period used to model the time necessary for habitat restoration actions to achieve their full benefit (Chapter 6), c) the immediate, 5, 10, 15, or 20-year timeframes scheduled for many actions (Section 9.1.3), d) the major revision of the Plan called for after 12 years (Section 9.3), e) the required Implementation Schedules and priorities every three years (Section 9.2), or f) the ability to adaptively management specific strategies and actions on an as needed basis (Section 9.3).

In addition to 25 years being the maximum period for which actions were scheduled in Section 9.1.3, this period was also used to calculate costs for which there were recurring costs. These are also summarized in Section 9.1.3.

9.1.2 Methods to Determine Costs

Costs were determined for many of the actions detailed in Chapter 7. Given that many of the actions were repeated across the different ESUs, all actions were compiled across ESUs for the cost estimates. Only costs associated with implementing new actions or increasing programs resulting from this recovery plan were included. Other costs, referred to as "baseline" costs, which are part of an entities base program or mission, or which are required by regulatory processes (e.g., FERC permits, BiOp actions), were not considered part of the recovery costs, even though they are vital to achieving recovery. In addition, although actions resulting from the Plan will potentially have a wide economic impact (e.g., modified land use or harvest opportunities), these "opportunistic" costs were also not considered as recovery costs since they are not direct costs to implement actions and a in-depth economic analysis would be required to assess these costs. For example, the value of sport and commercial fisheries to local communities within the lower Columbia River is generally understood (e.g., Runyan 2009), but exactly how recovery actions might affect these would take an economic analysis. However, it is advisable to more precisely understand or determine these wider economic benefits or detriments when recovery actions are implemented, or when seeking funding or policy changes.

The approach used to estimate costs varied based on the different threat categories, due to the nature of the actions required in these categories and the ability to estimate the amount of actions necessary to achieve desired statuses for populations (Table 9-1). If there was not enough information to determine costs or make assumptions about the exact nature of the action or its quantity, cost estimates were deferred until implementation of that action (noted as "TBD" in Section 9.1.3).

Table 9-1. Summary of the methods used to calculate cost estimates for different threat categories.

Threat	Cost Estimate Basis
Tributary Habitat	• calculation of restoration action quantities coupled with data analysis and expert opinion to assign unit costs (method described below) • estimates from other plans • ODFW professional judgment ("Expert Opinion")
Estuary Habitat	• estimates from the Estuary Module
Hydro	• actions considered part of baseline costs, which are not included in this plan
Harvest	• ODFW professional judgment ("Expert Opinion")
Hatchery	• ODFW professional judgment ("Expert Opinion")
Predation	• estimates from the Estuary Module • ODFW professional judgment ("Expert Opinion")

Calculation of Specific Quantifiable Restoration Actions

The following method was used because the modeling and analyses contained in the Plan did not determine the amount of any one action necessary for achieving a given desired status. Thus, we used this method to determine an approximate population-level estimate for cumulative restoration projects of five different, specific types within a population area (see Table 9-2). Even though only five action-types are calculated in this manner, they cover actions which directly address some of the major limiting habitat factors. The following describes our approach to determining the costs for each of these tributary habitat action quantities and unit costs.

Step 1: Obtain estimate of the number of miles historically available for each population.
Source: NMFS intrinsic potential (IP) analysis of historic mileage.
Comments: IP mileages probably over-estimate the amount of historically available stream miles. It is, however, the only available data that is derived from a documented and consistently applied approach (by species) for each lower Columbia River population. It is also what we used to estimated historical population proportions for population and scenario modeling.

Step 2: Calculate the amount "Currently Properly Functioning Miles".
Source: Based on estimate of current mortality attributed to tributary habitat conditions in the Scenario Analysis.
Comments: This assumes that current production comes from properly functioning habitat. While this is certainly not the case, it is probably safe to assume that the majority of production (especially during periods of poor marine survival) comes primarily from properly functioning habitat.

Step 3: Calculate the additional miles of properly functioning habitat needed to achieve targeted risk reduction for the Delisting Scenario.
Source: Based on estimates of reductions in mortality needed from tributary habitat improvements in the Scenario Analysis.
Comments: Mortality reduction (or survival gain) needed to achieve the various risk reductions are assumed to represent an equivalent proportional increase in needed amount of properly functioning habitat.

Step 4: Calculate the number of miles of instream habitat restoration needed to achieve the additional properly functioning miles target for each of the five habitat actions.

Source: Based on comparison of current instream habitat conditions compared to reference ("pristine") conditions.
Comments: ODFW's Aquatic Inventories Project conducts GRTS-based (i.e. random, spatially balanced) surveys of habitat conditions in the Lower Columbia. They also have a number of reference sites which have been selected to represent (to the extent possible) what habitat conditions should be under pristine conditions[134]. In addition to the assumption that the reference sites are representative of pristine conditions, we also make the assumption that, due to natural disturbance regimes, not all habitat under pristine conditions should be considered high quality. Rather, we make the assumption that quality habitat is normally distributed across the reference sites with 25 percent in "poor", 50 percent in "moderate", and 25 percent in "high" quality condition. This means that properly functioning habitat does not mean that all habitat is of high quality, but rather there is a mixture of habitat quality in roughly the proportions described above. The objective then is to restore the targeted additional properly functioning miles to roughly the same proportion of poor, moderate, and high quality habitat found on average at the reference sites.

Another consideration in this analysis is of the selection of habitat parameters to evaluate for the habitat restoration actions. ODFW's habitat surveys record a wide variety of habitat parameters. Because the objective of this analysis was to ultimately estimate the number of stream miles needing treatment with specific habitat restoration practices, the measured habitat variables had to be linked to restoration actions. For the purposes of this exercise, the measured habitat variables were categorized into one of four action categories: 1) instream structure (large wood placement); 2) side channel; 3) riparian; and 4) off channel wetland complexes. The following shows each of the parameters measured by ODFW habitat surveys and their corresponding action category.

Habitat Parameter	Associated Action Category
# key pieces LWD/100m	Instream Structure
# pieces LWD/100m	Instream Structure
volume LWD/100m	Instream Structure
% bedrock	Instream Structure
% gravel in riffles	Instream Structure
% pools	Instream Structure
>1m deep pools/km	Instream Structure
% secondary channel	Off-channel
# conifers>50cm dbh/1000ft.	Riparian
% fines in riffles	Riparian
% shade	Riparian
% slack water pools	Slack Water

Each of the habitat variables listed above are represented by a different proportion of poor, moderate, and high quality habitat. To determine targets for instream habitat and riparian actions and avoid further complicating the already complicated modeling effort, a single parameter was selected to represent current habitat conditions for each action category. The volume of large wood and number of conifers over 50cm dbh were used respectively for instream structure and riparian action analyses because they consistently deviate the most from reference conditions. Only one habitat parameter (percent secondary channel) represents conditions that are addressed by secondary channel habitat actions and one habitat parameter (percent slackwater pools) represents conditions for slackwater habitat actions.

The fifth habitat action type was based on sub-dividing riparian features into those needing additional fencing and those that did not based on land use patterns. So, another step was to refine actions related to

[134] http://oregonstate.edu/dept/ODFW/freshwater/inventory/pdffiles/OPHabitatCoastalESU2009.pdf

improving riparian conditions with regards to the number of miles of stream that simply need riparian plantings versus the miles needing both planting and fencing actions. To do this, GIS was used to determine the percentage of stream miles that were in agricultural land. This percentage was multiplied by the total number of stream miles needing riparian actions to obtain the number of miles of stream needing both fencing and riparian planting. These mileages were then subtracted from the total miles of riparian restoration needed to obtain the number of miles in need of riparian plantings only. This differentiation, or sub-division, of the riparian actions yielded the five habitat restoration actions we used for cost estimates under this methodology.

Another step was also needed to determine the amount of slackwater habitat that is needed. Because the slackwater habitat parameter includes both habitat found in beaver ponds and off-channel alcoves, we used the proportion of slackwater habitat that is in alcoves at reference sites to determine the proportion of total slackwater habitat needed that should be obtained from the creation of alcoves.

Step 5: For each population area, calculate the total miles of each habitat action type needed to achieve survival improvements targeted for all species that reside in that population area.
Source: Partial summation of data derived in step 4.
Comments: Step 4 provides for estimates for individual species, estimates of the number of miles of moderate and high quality restoration needed by action category. Because the actual quality of habitat resulting from restoration activities is difficult to predict, for the purposes of this exercise the two estimates were combined to provide an estimate of the total restoration miles. The values generated, however, are specific to each species and need to be at least partially summed across species. This is not a completely additive process, however, because there is some overlap in the distribution of the species. To account for overlap in species distribution we used the following rule set to derive an estimate of the total miles of instream structure restoration, off-channel restoration, and riparian restoration needed to achieve survival improvements targeted for all species that reside in that population area. First it was assumed that coho and winter steelhead have roughly similar distributions and use the larger of the two calculated values. Summer steelhead in Hood River were assumed to have significantly different distribution than coho or winter steelhead. Next it was assumed that fall Chinook and spring Chinook have significantly different distributions, neither of which overlap with coho or steelhead, and thus add the values for fall Chinook and spring Chinook (where present) to obtain a single Chinook value. Finally, the coho or winter steelhead value (whichever is larger) was added to the Chinook value (and summer steelhead value in Hood River) to obtain an overall estimate of the number of stream miles needed for the population area.

Step 6: Calculate unit costs for each of the five habitat action types and apply to habitat action quantities to get a total cost.
Source: Data analysis by NMFS economist and ODFW habitat restoration biologist in the Western Oregon Stream Restoration Program.
Comments: NMFS' economist analyzed data from OWEB for three of the habitat restoration types. Data were unavailable for the other two. The results of this analysis were then compared to cost estimates per unit derived by ODFW's habitat restoration expert. In most cases these costs were very close, and where they were not, the cost based on expert opinion was used because the differences were able to be explained by techniques which were not able to be reflected in the historical data.

In some cases measurement unit conversions had to be made in order to get unit costs in the same units as the action quantities calculated in Steps 1-5. For example, cost data for riparian restoration is reported in acres and the action quantity was reported in miles. In order to apply one to the other, the width of restoration actions had to be determined so a unit cost per mile could be determined. Table 9-2 indicates the quantity of habitat actions needed as well as restoration standards applied to them to determine costs (note: other action assumptions to determine costs were made but are not considered restoration action

standards so are not included in Table 9-2). Unit costs are shown in Section 9.1.3 for the respective actions.

Note that if the quantity of restoration action indicated in Table 9-2 is divided by the implementation schedule for that action in Section 9.1.3, an annual rate of restoration can be calculated[135]. This can be compared to reported restoration projects and progress toward these habitat recovery action goals can be tracked. In addition, the restoration action standards indicated in Table 9-2 should be considered when funding entities consider projects and implementers should also consider these when implementing such actions. These standards are based on habitat needs to achieve high quality habitat (large wood placement) and restoration of ecological processes (riparian planting and protection zone).

Table 9-2. Summary of the quantity of specific restoration actions needed for all species within population areas of lower Columbia River ESUs and associated restoration standards.

Population Area	Large Wood Placement (miles)	Side-Channel Increase (miles)	Riparian Planting with Fencing (miles)	Riparian Planting without Fencing (miles)	Off-Channel Wetland Complex Increase (m^2)
Youngs Bay	46	0	4	15	5,186
Big Creek	58	5	2	17	20,486
Clatskanie	76	0	3	17	24,624
Scappoose	61	20	6	16	7,216
Clackamas	192	114	8	54	34,738
Sandy	53	27	1	27	8,140
Lower Gorge	15	9	2	7	6,774
Upper Gorge	4	2	0	2	1,424
Hood	91	55	17	35	41,652
Restoration Standards Applied for Cost:	• 20 m^3 of large wood per 100 m of stream	• none	• 30 m width on each side of stream	• 30 m width on each side of stream	• none

9.1.3 Action Table

Table 9-3 indicates actions identified in Chapter 7, along with the species to which they apply, locations identified in the planning process where they should be implemented[136], time period or schedule within which they should be completed, the basis, unit cost, quantity, and total cost, and potential implementers. A total cost for all recovery actions is provided at the end of the table.

Appendix L has maps for each population area referenced in Table 9-3. These maps can be used as references for the location information contained in Table 9-3.

The schedule timeframe for individual actions was consistent with those timeframes used in SLAM modeling to determine the effect of time lags for recovery actions on achievement of desired statuses. Although this modeling indicated that lags in tributary habitat would have the most significant negative impact on extinction risk, the longer implementation period for tributary habitat actions (15 years) was used as the schedule due to the inability to actually immediately conduct the number of restoration activities needed. Thus, for tributary habitat action schedules, as well as for all other threat categories, the

[135] Also note that the quantities of habitat actions listed in Table 9-2 are not directly comparable to those listed in Table 6-39, although they are similar in many cases. Those in Table 9-2 are for all species rather than just coho, are for specific projects rather than general habitat potential, and were calculated in a very different manner.
[136] Given the lack of spatially-detailed data for some population areas, the location list should not be considered complete or necessarily to consist of the highest priority locations. Specific locations and priorities for actions will be determined for the three-year Implementation Schedules (see Section 9.2).

number of years indicated for the action should not be considered the time when projects get implemented, but the time when all projects are implemented for that category. In most cases, action implementation should occur immediately. The three-year Implementation Schedules discussed in Section 9.2 will determine more specific schedule timeframes, and site and action priorities. Several actions which are required for overarching coordination of Plan implementation are noted as immediate needs.

For costs, significant costs were not calculated (listed as "TBD" under the cost basis column; e.g., water conservation; easements and habitat protection) because not enough information to determine or make assumptions about unit costs, quantities, or action scope was available. A maintenance cost of 2% of the original installation cost of capital projects for 20 years is included in the grand total at the end of Table 9-3, but not in the cost for each specific action. Uncertainty of the survival effect of many of the habitat actions also makes estimation of the full extent of habitat action costs difficult. So, although the total recovery cost is a significant number (~$758M[137]), it represents a minimal cost for recovery given all of the costs which are not included in this Plan and the uncertainty associated with those that are.

[137] Note that costs from Estuary Module actions that will occur in Oregon and inflation are also not included in this cost.

Table 9-3. Summary of actions identified in this Plan, species which benefit, locations, schedule, costs and potential implementers for conservation and recovery of lower Columbia River salmon and steelhead.

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
All Populations - Within Tributaries									
1 - Trib	Continue the release of hatchery fish as smolts to reduce competition and predation with wild fish in tributaries and estuaries.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	on-going	Baseline	---	---	N/A	ODFW, WDFW
2 - Trib	Investigate the feasibility of coordinated release timing among hatcheries, to reduce the numbers of out-migrating hatchery fish in-river at any one time.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	within 15 years	Baseline	---	---	N/A	ODFW, NMFS, WDFW
3 - Trib	Eliminate/reduce/shift program: To decrease mainstem and estuary competition and predation and reduce straying of hatchery fish onto natural spawning grounds, investigate and/or implement hatchery release reductions or program shifts to lower river terminal areas; include out-of-ESU programs and programs with surplus hatchery fish returns which are not harvested.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	on-going	Baseline	---	---	N/A	ODFW, NMFS, WDFW
4 - Trib	Require hatchery programs/releases that are new, or increased more than 10% from 2009 levels, to complete or modify an HGMP and receive ODFW Fish Division approval; require reduced or elimintated programs to withdraw or modify their HGMP.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	on-going	Baseline	---	---	N/A	ODFW, NMFS
5 - Trib	Maintain screens and fish passage structures.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	on-going	Baseline	---	---	N/A	Owners
6 - Trib	Develop recommendations for land management scenarios that address hydrograph changes due to climate change, impervious surfaces, and other factors that result in altered water runoff.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	within 15 years	Baseline	---	---	N/A	ODFW, ODF, OWRD, ODLCD, ODA, Counties, Metro, Municipalities

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
7 - Trib	Limit future in-river and groundwater withdrawals so that they do not impede achievement of recovery goals.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	on-going	Baseline	---	---	N/A	OWRD, Legislature, Metro
8 - Trib	Develop options for water banking and implement.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	within 15 years	TBD	---	---	---	OWRD, Metro
9 - Trib	Develop and/or implement stormwater management plans for urban areas and roads.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	within 15 years	TBD	---	---	---	ODEQ, Counties, Metro, Municipalities
10 - Trib	Protect and restore riparian areas to improve water quality, provide long-term supply of large wood to streams, and reduce impacts that alter other natural processes.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	within 15 years	TBD and in Popltn. actions	---	---	---	WS Councils, ODFW, SWCD, Counties, Municipalities
11 - Trib	Assure adequate regulations are in place to protect existing high quality habitat and eliminate, or reduce and fully mitigate, impacts of future development (with cities, counties, DLCD, ODA, DEQ, etc…).	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	within 15 years	Baseline	---	---	N/A	ODLCD, Counties, Municipalities
12 - Trib	Develop methodology to assess and identify, and then protect, stream reaches and population strongholds which will be resilient/resistant to climate change impacts.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	within 15 years	TBD	---	---	---	WS Councils, ODFW, ODSL, Counties, Municipalities
13 - Trib	Protect and restore headwater rivers and streams (salmon and non-salmon bearing) to protect the sources of cool, clean water and normative hydrologic conditions.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	within 15 years	TBD	---	---	---	WS Councils, ODFW, ODF, ODSL, OWRD, ODA, USFS, Counties, Metro, Municipalities
14 - Trib	Conduct sediment source analysis and then implement actions to reduce sediment from identified sources.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	within 15 years	TBD	---	---	---	ODEQ, ODA

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
15 - Trib	Coordinate and streamline efforts to restore impaired instream habitat complexity, access to off-channel habitat, and riparian conditions.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	within 15 years	see Action 29-Trib and 45-Trib	---	---	---	WS Councils, ODFW, ODF, ODSL, ODA, USFS, NRCS, SWCD, Metro
16 - Trib	Streamline permitting process for large wood placement for streams not covered by Forest Practices Act.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	within 15 years	Baseline	---	---	N/A	ODFW, ODSL, USACOE
17 - Trib	Implement credible, science-based programs, policies and rules that contribute collectively to protect fish and water resources.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	within 15 years	TBD	---	---	---	ODFW, OWEB, ODF, ODSL, ODEQ, OWRD, ODLCD, ODOT, ODOGAMI, ODA, OPRD, USFS, Counties, Metro, Municipalities
18 - Trib	Provide adequate funding and staffing for existing programs to achieve their mandates.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	on-going	Baseline	---	---	N/A	Legislature, USFS, Metro
19 - Trib	Adequately fund and implement research needed to answer critical uncertainties related to the assumptions under which the recovery plan was developed.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	within 15 years	TBD	---	---	---	ODFW, OWEB, Legislature, NMFS, Metro
20 - Trib	Develop joint ODF/ODFW/ODA/DSL team to more clearly describe the large wood goals and potential ways to achieve these goals.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	within 15 years	Baseline	---	---	N/A	ODFW, ODF, ODSL, ODA
21 - Trib	Provide education on the goals of recovery plans, what is needed to achieve these goals, and how citizens can contribute.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	within 15 years	see Action 29-Trib and 45-Trib	---	---	---	WS Councils, ODFW, OWEB, ODF, ODSL, ODEQ, OWRD, ODLCD, ODOT, ODOGAMI, ODA, OPRD
22 - Trib	Support funding for outreach efforts that educate and engage landowners, including Coffee Klatches and Oregon Small Woodland Owner's Howdy Neighbor events.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	on-going	TBD	---	---	---	OWEB, ODF

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
23 - Trib	Fund OSU Extension Service to provide Riparian Function Workshops for all Oregon Plan participants to improve success rate of volunteer projects.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	within 15 years	TBD	---	---	---	OWEB, OSU Extension Service
24 - Trib	Provide education and outreach to contractors, developers, and resource owners.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	on-going	see Action 29-Trib	---	---	---	WS Councils, ODFW, ODF, ODSL, ODEQ, OWRD, SWCD, Metro
25 - Trib	Provide enhanced incentives for habitat restoration work, including: a) Rewarding and assisting landowners doing the 'extra' work needed to achieve recovery goals, and b) Developing an equitable system of recognition and rewards for both landowners who are not regulated and landowners who are regulated.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	within 15 years	TBD	---	---	---	WS Councils, ODFW, OWEB, ODF, ODSL, ODA, OGNRO, Legislature, NMFS, NRCS
26 - Trib	Participate in the development of emerging ecosystem markets and ensure they are shaped to be consistent with recovery goals and actions.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	on-going	Baseline	---	---	N/A	ODFW, OWEB, ODF, ODSL, ODEQ, OWRD, ODLCD, ODOT, ODOGAMI, ODA, OPRD, OGNRO, NRCS, SWCD
27 - Trib	Provide liability protection for landowners that participate in restoration projects.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	within 15 years	TBD	---	---	---	Legislature, OR Attorney General
28 - Trib	Explore land use strategies and regulations to reduce ownership fragmentation, including, but not limited to, acknowledging the importance of family owned forests and supporting actions that help sustain working family owned forests.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	within 15 years	TBD	---	---	---	ODF, ODLCD, Counties, Municipalities
29 - Trib	Promote and provide technical support for volunteer efforts of private landowners and user groups to increase the amount of large wood in stream channels (e.g. site-specific riparian management plans, placement of large wood, reducing removal).	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	within 15 years	Expert Opinion	$90,000 / person / yr	6 staff; 15 yrs	$8,100,000	WS Councils, ODFW, OWEB, ODF, ODSL, ODEQ, NRCS, SWCD

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
30 - Trib	Update floodplain and channel migration maps and incorporate into land use planning; include projected future floodplains resulting from climate change.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	within 15 years	TBD	---	---	---	ODLCD, ODOGAMI, FEMA, Metro
31 - Trib	Develop regulations to ensure that there is no impact from future new development and re-development in the 100-year floodplain (including stormwater, wetlands, vegetation, etc.).	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	within 15 years	Baseline	---	---	N/A	ODSL, ODLCD, Counties, Metro, Municipalities
32 - Trib	Prohibit development of new dikes, levees, and floodwalls in 100-year floodplain unless they will not increase flood volume, size, and/or intensity.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	within 15 years	Baseline	---	---	N/A	ODSL, USACOE, FEMA, Counties, Municipalities
33 - Trib	Develop regulations to ensure that new or existing levees and floodwalls are vegetated.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	within 15 years	Baseline	---	---	N/A	ODSL, USACOE, Counties, Municipalities
34 - Trib	Revise the National Flood Insurance Program community rating system to be consistent with actions in this Plan.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	within 15 years	Baseline	---	---	N/A	FEMA
35 - Trib	Provide FEMA funding for land acquisition in 100-year floodplain; prioritize acquisitions based on recovery plan priority areas.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	within 15 years	TBD	---	---	---	FEMA
36 - Trib	Regularly update inventories and maps of instream habitat conditions, water quality, wetlands, and riparian conditions (including restoration projects) to more accurately capture current habitat conditions; incorporate information into action plan prioritization process to improve likelihood of achieving desired watershed status goals.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	within 15 years	TBD	---	---	---	ODFW, ODF, ODSL, ODEQ, ODA, USFS
37 - Trib	Enhance efforts to enforce existing land use regulations, laws, and ordinances.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	within 15 years	TBD	---	---	---	ODFW, ODF, ODSL, ODEQ, ODLCD, ODOGAMI, ODA, Legislature, Counties, Metro, Municipalities

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
38 - Trib	DSL will work within existing mandates to facilitate habitat actions by: 1) Continuing efforts to streamline the permitting process for fish habitat and wetland restoration projects. 2) Strengthening interagency coordination on projects that may impact natural ecological processes. 3) Where restoration projects are identified in this recovery plan, facilitating efforts to implement the action. 4) Requiring avoidance and minimization of impacts to waters of the state in priority areas identified in this recovery plan. 5) Working with landowners to design projects that avoid and minimize impacts to wetlands and other waters of the state. 6) Providing education and technical assistance to those interested in voluntary wetland restoration, creation, or enhancement projects. 7) Exploring opportunities to target compensatory mitigation towards areas with high intrinsic potential for salmon and/or have been identified as priority areas for restoration in watershed assessments and this recovery plan. 8) Exploring conservation easements for state-owned lands with high value for salmon recovery.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	on-going	Baseline	---	---	N/A	ODSL
39 - Trib	Where habitat restoration targets exist and progress toward them is tracked, develop population-specific strategies (e.g., funding, incentives, outreach, regulations, etc...) to meet those targets where targets are not being met in the first five years of implementation, with priority given to populations required to become viable.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	within 15 years	Baseline	---	---	N/A	ODLCD, Counties, Municipalities
40 - Trib	Where population-level habitat monitoring indicates statistically-significant temporal degradation of key habitat features within a population, encourage new or revised regulatory measures for the key habitat feature(s) within the population that eliminate further degradation, protect existing high quality areas, and allow long-term/"passive" restoration in other areas.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	within 15 years	Baseline	---	---	N/A	ODLCD, Counties, Municipalities

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
41 - Trib	Streamline the delivery of large wood to restoration sites by: - designating a coordinating entity and creating an online database of large wood that links entities that have large wood to offer with those in need of large wood for restoration projects - developing storage/staging areas to enable storage of wood for future projects - working with federal, state, and private forests and other land managers to identify ways to improve access to available large wood - providing technical advice on what should be done with the large wood that is legally removed (e.g. during dredging operations)	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	within 15 years	TBD	---	---	---	WS Councils, ODFW, OWEB, ODF, ODSL, ODOT, OPRD, USFS, City of Portland, Port of Portland
42 - Trib	Provide more resources and incentives to small (non-metropolitan) communities so they have the infrastructure to better manage runoff from impervious surfaces.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	within 15 years	TBD	---	---	---	WS Councils, OWEB, ODEQ, Metro
43 - Trib	Adequately fund and implement monitoring needed to track progress towards achieving recovery goals.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	immediate	Expert Opinion	$2,832,669 / yr	25 yrs	$70,816,725	ODFW, OWEB, Legislature, NMFS, LCREP
44 - Trib	Monitor, or continue to monitor, populations to track status and trends and improve understanding of the composition of natural spawners (what type/stray rates? how many? where from? timing?), other life history information, and habitat.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	immediate	see Action 43-Trib	---	---	---	ODFW
45 - Trib	Fund Implementation Coordinator position.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	on-going	Expert Opinion	$100,000 / person / yr	25 yrs	$2,500,000	ODFW, OWEB, NMFS
46 - Trib	Complete annual reporting for this plan and coordinate adaptive management actions as necessary and indicated by monitoring and reporting results.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	immediate	see Action 45-Trib	---	---	---	ODFW

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
47 - Trib	Fund development and maintenance of web-based data management and reporting, including tracking needs and accomplishments by entity throaugh a map-based depiction of prioritized actions and locations.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	within 5 years	Expert Opinion	$100,000 to develop; $100,000 / yr to maintain	25 yrs	$2,600,000	OWEB, NMFS
48 - Trib	Assess adequacy of local regulatory programs to address listing threat factors within the federal ESA framework (e.g., 5-year status reviews, delisting decision, other).	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	within 5 years	Baseline	---	---	N/A	NMFS
49 - Trib	Conduct detailed climate change risk analysis for all populations and use this to help prioritize actions, or develop new ones, that are contained in the Implementation Schedule.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	immediate	Expert Opinion	$147,000 / yr	2 yrs	$294,000	ODFW
50 - Trib	Develop three-year Implementation Schedules across and within populations for priority actions at a site-specific scale based on existing reach-specific habitat assessments, identified regulatory requirements, other threat reduction needs, research and monitoring needs, and adaptive management; where no reach-specific assessment (i.e., Scappoose, Clatskanie, Big Creek, Youngs Bay), or assessment information at the appropriate scale for specific limiting factors or threats, exist, find funding and conduct assessments in order to develop the Implementation Schedule.	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	immediate	see Action 45-Trib	---	---	---	ODFW
51 - Trib	Recommend to funding entities: - project solicitations and selection should reflect recovery plan priorities, - the majority of funds should be directed to high priority locations and actions, while reserving funding for other appropriate actions to meet goals in all pop areas, and - actions resulting from funding should be reported in metrics that allow tracking of progress toward recovery goals (requires intitial work with Implementation Coordinator to develop or identify appropriate metrics).	Coho, ChF, late ChF, ChS, StW, StS, Chum	---	on-going	Baseline	---	---	N/A	ODFW, NMFS
52 - Trib	Develop education and outreach materials on the benefit of beaver dams to ecosystem function in general and specifically to juvenile rearing habitat (especially for coho).	Coho, ChS, StW, StS	---	within 15 years	TBD	---	---	---	ODFW

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
53 - Trib	Provide technical and financial assistance to landowners with property damage due to beavers, and provide incentives to landowners that want to manage their land to achieve the habitat benefits provided by beaver dams. This includes developing agreements with landowners that would establish benchmarks for the amount of damage done by beavers. Once damage exceeded the agreed upon benchmark, a management entity would remove or reduce the beaver population from the affected property.	Coho, ChS, StW, StS	---	within 15 years	TBD	---	---	---	ODFW, OWEB, ODA, NRCS, SWCD
54 - Trib	Tag wild outmigrants from different populations to understand differential harvest/fishery impacts and return timing.	Coho	---	within 10 years	Expert Opinion	$197,000 / yr	3 yrs	$591,000	ODFW, NMFS
55 - Trib	Mark all hatchery fish.	Coho, ChF, late ChF, ChS, StW, StS	---	completed (with 2009 tribal coho releases)	Baseline	---	---	N/A	ODFW, NMFS, WDFW
56 - Trib	Evaluate the need for and efficacy of double index tags for all coho hatchery programs.	Coho	---	within 15 years	Baseline	---	---	N/A	ODFW
57 - Trib	Coded-wire tag enough fish from each hatchery release to allow identification of hatchery origin of strays and evaluate rearing and/or release techniques of problem hatcheries.	Coho, ChF, late ChF, ChS, StW, StS	---	within 15 years	TBD	---	---	---	ODFW, NMFS, USFWS, WDFW
58 - Trib	Monitor stray rates for 9 years and implement adaptive management options if rates called for in recovery scenarios are exceeded.	Coho, ChF, late ChF, ChS, StW, StS	---	within 15 years	see Action 43-Trib	---	---	---	ODFW
59 - Trib	Based on the best available science, evaluate whether integrated or segregated hatchery programs are more compatible with recovery, considering the objective of each hatchery program.	Coho, ChF, late ChF, ChS, StW, StS	---	within 15 years	TBD	---	---	---	ODFW
60 - Trib	Re-evaluate current TRT-developed Gorge stratum's historical status and population structure and revise recovery goals if modifications are made.	Coho, ChF, ChS, StW, StS, Chum	---	within 5 years	Baseline	---	---	N/A	ODFW, NMFS, WDFW

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
61 - Trib	Trap and sort hatchery adults: Identify a fall Chinook population with high stray rates, no hatchery program, and potential for un-supplemented wild fish recovery and place weir to see if hatchery fish removal causes wild fish increase.	ChF	---	within 15 years	Expert Opinion	$2,000,000 install; $30,000 / yr to operate-maintain	5 yrs develop; 20 yrs implement	$2,600,000	ODFW
62 - Trib	Identify the most appropriate stock, timing, and strategies for a reintroduction hatchery program and implement, if fish managers determine that reintroductions are needed to recover any fall Chinook population.	ChF	---	within 15 years	TBD	---	---	---	ODFW, NMFS
63 - Trib	Carry out the Columbia River Chum Salmon Recovery Strategy, including: 1) Assess, identify, and protect chum habitat (all strata). 2) Restore chum habitat, looking for efficiencies with fall Chinook restoration efforts (all strata). 3) Reintroduce chum using an appropriate hatchery stock (one Coast stratum population initially, followed by other populations and strata as needed or as reintroduction knowledge grows).	Chum	---	within 15 years	TBD	---	---	---	ODFW, ODSL, ODA, Counties, Municipalities
All Populations - Mixed Locations									
64 - Mxd	CRE-1: Protect intact riparian areas in the estuary and restore riparian areas that are degraded. 1) Educate landowners about the ecosystem benefits of intact riparian areas and the costs of degraded riparian areas. 2) Encourage and provide incentives for local, state, and federal regulatory entities to maintain, improve (where needed), and enforce consistent riparian area protections throughout the lower Columbia region. 3) Actively purchase riparian areas from willing landowners in urban and rural settings when the riparian areas cannot be effectively protected through regulation or voluntary or incentive programs and (1) are intact, or (2) are degraded but have good restoration potential. 4) Restore and maintain ecological benefits in riparian areas; this includes managing vegetation on dikes and levees to enhance ecological function and adding shoreline/instream complexity for juvenile salmonid	Coho, ChF, late ChF, ChS, StW, StS, Chum	estuary	within 25 years (see EM)	see Estuary Module	---	---	---	WS Councils, ODFW, OWEB, ODSL, USACOE, SWCD, BPA, LCREP, Counties, Municipalities

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
	refugia. 5) Conduct assessment to update and refine inventory of areas that either currently have high quality riparian conditions or have high riparian restoration potential (by 2010).								
65 - Mxd	CRE-2: Operate hydrosystem to reduce the effects of reservoir surface heating, or conduct mitigation measures. 1) Conduct a reservoir heating study to determine the extent of the issue and identify hydrosystem operational changes (including design) that would reduce effects and/or mitigate downstream temperature issues; and 2) Implement hydrosystem operational changes to reduce temperature effects; if no change is possible, mitigate effects by restoring tributary riparian areas.	Coho, ChF, late ChF, ChS, StW, StS, Chum	FCRPS	within 25 years (see EM)	see Estuary Module	---	---	---	USACOE, LCREP
66 - Mxd	CRE-3: Establish minimum instream flows for the lower Columbia River mainstem that would help prevent further degradation of the ecosystem. 1) Explore technical options and develop policy recommendations on instream flows. 2) Implement instream flow regulations in accordance with the policy recommendations from the project above.	Coho, ChF, late ChF, ChS, StW, StS, Chum	estuary	within 25 years (see EM)	see Estuary Module	---	---	---	USACOE, LCREP

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
67 - Mxd	CRE-4: Adjust the timing, magnitude and frequency of flows (especially spring freshets) entering the estuary and plume to better reflect the natural hydrologic cycle, improve access to habitats, and provide better transport of coarse sediments and nutrients in the estuary, plume, and littoral cell. 1) Conduct a flood study to determine the risks and feasibility of returning to more normative flows in the estuary. 2) Conduct a study to determine the habitat effects of increasing the magnitude and frequency of flows (i.e., how much access of river to off-channel habitats would increase). 3) Conduct additional studies to determine the extent of other constraints (international treaties, system-wide fish management objectives, and power management). 4) Make policy recommendations to action agencies on flow (consider beneficial estuary flows, flood management, power generation, irrigation, water supply, fish management, and other interests). 5) Implement modified estuary flow regime (all reaches and plume) annually in concert with other interests (including hydroelectric, flood control, water withdrawals).	Coho, ChF, late ChF, ChS, StW, StS, Chum	estuary	within 25 years (see EM)	see Estuary Module	---	---	---	USACOE, LCREP
68 - Mxd	CRE-5: Study and mitigate the effects of entrapment of fine sediment in reservoirs, to improve nourishment of the littoral cell. 1) Identify the effects of reservoir sediment entrapment on economic and ecological processes; this includes effects on ship channels, turning basins, port access, jetty activities, littoral cell erosion and accretion, and habitat availability. 2) Develop a regionwide sediment plan for the estuary and littoral cell to address salmonid habitat-forming processes. 3) Implement projects recommended in the plan to mitigate the effects of sediment entrapment.	Coho, ChF, late ChF, ChS, StW, StS, Chum	estuary, FCRPS	within 25 years (see EM)	see Estuary Module	---	---	---	USACOE, LCREP

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
69 - Mxd	CRE-6: Reduce the export of sand and gravels via dredge operations by using dredged materials beneficially. 1) Establish a forum to develop a regionwide sediment plan for the estuary and littoral cell . 2) Identify and implement dredged material beneficial use demonstration projects, including the notching and scrape-down of previously disposed materials and placement of new materials for habitat enhancement and/or creation. 3) Dispose of dredged materials using techniques identified through the demonstration projects and regionwide planning.	Coho, ChF, late ChF, ChS, StW, StS, Chum	estuary	within 25 years (see EM)	see Estuary Module	---	---	---	ODSL, NMFS, USACOE, LCREP, Port of Portland
70 - Mxd	CRE-7: Reduce entrainment and habitat effects resulting from main and side-channel dredge activities and ship ballast intake in the estuary. 1) Identify and evaluate dredge operation techniques designed to reduce entrainment and other habitat effects. 2) Initiate demonstration projects designed to test and evaluate dredge operations. 3) Implement best management techniques for dredging. 4) Study the effects of entrainment of juvenile salmonids from ship ballast water intake. 5) Implement a demonstration project to evaluate the feasibility of reducing entrainment of juvenile salmonids from ship ballast intake.	Coho, ChF, late ChF, ChS, StW, StS, Chum	estuary	within 25 years (see EM)	see Estuary Module	---	---	---	ODFW, ODSL, USACOE, LCREP
71 - Mxd	CRE-8: Remove or modify pilings and pile dikes when removal or modification would benefit juvenile salmonids and improve ecosystem health. 1) Inventory, assess, and evaluate in-channel pile dikes for their economic value and their negative and positive impacts on the estuary ecosystem; develop working hypotheses for removal or modification. 2) Implement demonstration projects designed to test working hypotheses and guide future program priorities. 3) Remove or modify priority pilings and pile dikes. 4) Monitor the physical and biological effects of pile dike removal and modification.	Coho, ChF, late ChF, ChS, StW, StS, Chum	estuary	within 25 years (see EM)	see Estuary Module	---	---	---	ODFW, ODSL, USACOE, BPA, LCREP

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
72 - Mxd	CRE-9: Protect remaining high-quality off-channel habitat from degradation and restore degraded areas with high intrinsic potential for high quality habitat. 1) Educate landowners about the ecosystem benefits of protecting and stewarding intact off-channel estuarine areas and the costs of restoring degraded areas. 2) Encourage and provide resources for local, state, and federal regulatory entities to maintain, improve (where needed), and consistently enforce estuarine habitat protections throughout the lower Columbia region. 3) Actively purchase off-channel estuarine habitats in urban and rural settings that (1) cannot be effectively protected through regulation, (2) are degraded but have good restoration potential, or (3) are highly degraded but could benefit from long-term restoration solutions. 4) Restore degraded off-channel habitats with high intrinsic potential for increasing habitat quality.	Coho, ChF, late ChF, ChS, StW, StS, Chum	estuary	within 25 years (see EM)	see Estuary Module	---	---	---	WS Councils, ODFW, OWEB, ODSL, ODLCD, NMFS, USACOE, SWCD, BPA, LCREP, Counties, Municipalities
73 - Mxd	CRE-10: Breach or lower dikes and levees to establish or improve access to off-channel habitats. 1) Breach or lower the elevation of dikes and levees to create and/or restore tidal marshes, shallow-water habitats, and tide channels. 2) Vegetate dikes and levees. 3) Remove tide gates to improve the hydrology between wetlands and the channel and to provide juveniles with physical access to off-channel habitat; use a habitat connectivity index to prioritize projects. 4) Upgrade tide gates or perched culverts where (1) no other options exist, (2) upgraded structures can provide appropriate access for juveniles, and (3) ecosystem function would be improved over current conditions.	Coho, ChF, late ChF, ChS, StW, StS, Chum	estuary	within 25 years (see EM)	see Estuary Module	---	---	---	ODFW, ODSL, USACOE, BPA, LCREP

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
74 - Mxd	CRE-11: Reduce the square footage of over-water structures in the estuary. 1) Inventory over-water structures in the estuary and develop a GIS layer with detailed metadata files. 2) Initiate a planning process to evaluate existing and new over-water structures for their economic, ecological, and recreational value. 3) Remove or modify over-water structures to provide beneficial habitats. 4) Establish criteria for new permit applications to consider the cumulative impacts of over-water structures in the estuary. 5) Conduct research, monitoring, and evaluation of modifications that can be made to overwater structures to assess ecological benefits.	Coho, ChF, late ChF, ChS, StW, StS, Chum	estuary	within 25 years (see EM)	see Estuary Module	---	---	---	ODSL, ODLCD, USACOE, LCREP
75 - Mxd	CRE-12: Reduce the effects of vessel wake stranding in the estuary. 1) Analyze factors contributing to ship wake stranding to determine potential approaches to reducing mortality in locations where juveniles are most vulnerable. Design and implement demonstration projects and monitor their results. 2) Implement projects identified in analysis above that are likely to result in the reduction of ship wake stranding events. 3) Use existing and new research results documenting stranding by ship wakes to estimate juvenile mortality throughout the estuary. Modeling could use newly emerging Light Detection and Ranging (LIDAR) satellite imagery to conduct analyses.	Coho, ChF, late ChF, ChS, StW, StS, Chum	estuary	within 25 years (see EM)	see Estuary Module	---	---	---	ODFW, USACOE, LCREP, Port of Portland
76 - Mxd	(similar to CRE-13): Manage pikeminnow and other piscivorous fish, including introduced species and hatchery fish, to reduce predation on salmonids. 1) Monitor the abundance levels of pikeminnow, smallmouth bass, walleye, and channel catfish. 2) Implement actions as necessary to prevent population growth (i.e., modify habitat); increase the northern pikeminnow bounty program in the estuary. 3) Conduct research to evaluate impact that predation by hatchery origin fish has on wild salmon and steelhead (especially ocean-type salmon juveniles: tules and chum) in the estuary. 4) Develop plan to reduce predation by hatchery origin fish if research above shows significant impact.	Coho, ChF, late ChF, ChS, StW, StS, Chum	estuary	within 25 years (see EM)	see Estuary Module, TBD	---	---	---	ODFW, USACOE, LCREP, Metro

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
77 - Mxd	CRE-15: Implement education and monitoring projects and enforce existing laws to reduce the introduction and spread of invasive plants. 1) Increase public awareness of exotic plant species in the estuary and proper stewardship techniques. 2) Inventory exotic plant species infestations in the estuary and develop a GIS layer with detailed metadata files. 3) Implement projects to address exotic plant infestations on public and private lands. 4) Monitor infestation sites.	Coho, ChF, late ChF, ChS, StW, StS, Chum	estuary	within 25 years (see EM)	see Estuary Module	---	---	---	ODFW, ODA, USACOE, BPA, LCREP
78 - Mxd	CRE-16: Implement projects to redistribute part of the Caspian tern colony currently nesting on East Sand Island. 1) Enhance or create tern nesting habitat at alternative sites in Washington, Oregon, and California. 2) Reduce tern nesting habitat on East Sand Island to 1 to 1.5 acres. 3) Monitor the regional tern population.	Coho, ChF, late ChF, ChS, StW, StS, Chum	estuary	within 25 years (see EM)	see Estuary Module	---	---	---	ODFW, USACOE, USFWS, LCREP
79 - Mxd	CRE-17: Implement projects to reduce double-crested cormorant habitats and encourage dispersal to other locations. 1) Identify, assess, and evaluate methods of reducing double-crested cormorant abundance numbers. 2) Implement demonstration projects resulting from assessment above (i.e., decoys and audio playback methods). 3) Implement projects resulting in reduced predation by cormorants.	Coho, ChF, late ChF, ChS, StW, StS, Chum	estuary	within 25 years (see EM)	see Estuary Module	---	---	---	ODFW, USACOE, USFWS, LCREP

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
80 - Mxd	(similar to CRE-18) Reduce competition with non-native and hatchery origin fish in the estuary. 1) Organize existing technical information about shad and identify data gaps and potential control methods; 2) Implement demonstration projects to evaluate effective shad management methods; 3) Implement shad population management techniques; 4) Monitor and evaluate shad management techniques; 5) Conduct research to evaluate impact that competition with hatchery origin fish have on wild salmon and steelhead in the estuary; and 6) Develop a plan to reduce competition with hatchery origin fish if research above shows significant impact.	Coho, ChF, late ChF, ChS, StW, StS, Chum	estuary	within 25 years (see EM)	see Estuary Module, TBD	---	---	---	ODFW, NMFS, WDFW, LCREP
81 - Mxd	CRE-19: Prevent new introductions of aquatic invertebrates and reduce the effects of existing infestations by: 1) Assemble existing technical information on introduced aquatic invertebrates in the estuary and develop a plan for managing existing infestations and preventing new infestations. 2) Implement recommendations from the plan above for managing existing and preventing new infestations.	Coho, ChF, late ChF, ChS, StW, StS, Chum	estuary	within 25 years (see EM)	see Estuary Module	---	---	---	ODFW, ODA, LCREP, Port of Portland
82 - Mxd	CRE-20: Implement pesticide and fertilizer best management practices to reduce estuarine and upstream sources of nutrients and toxic contaminants entering the estuary. 1) Implement pesticide, fertilizer, and nutrient best management practices to reduce contaminants entering the estuary. 2) Evaluate adequacy of best management practices and update as needed. 3) Increase funding for education and outreach programs targeted to professional and leisure agricultural activities so as to promote reduced use of toxic materials.	Coho, ChF, late ChF, ChS, StW, StS, Chum	estuary	within 25 years (see EM)	see Estuary Module	---	---	---	ODEQ, ODA, NRCS, LCREP, Counties, Municipalities

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
83 - Mxd	CRE-21: Identify and reduce terrestrially and marine-based industrial, commercial, and public sources of pollutants. 1) Identify sources, loads, and pathways of point and non-point pollution in the estuary. 2) Provide cost-share incentives for National Pollution Discharge Elimination System (NPDES) permit holders to upgrade effluent above their permit requirements. 3) Study and establish threshold treatment standards for pharmaceuticals and other unregulated substance discharges; update existing NPDES permits to reflect the new standards. 4) Provide grants and low-cost loans to permit holders required to treat effluent to standards established in the study above.	Coho, ChF, late ChF, ChS, StW, StS, Chum	estuary	within 25 years (see EM)	see Estuary Module	---	---	---	ODEQ, LCREP, Counties, Municipalities
84 - Mxd	CRE-22: Restore or mitigate contaminated sites. 1) Develop criteria and a process for evaluating contaminated estuarine sites to establish their restoration potential. 2) Develop an integrated multi-state funding strategy to address contamination cleanup in the estuary from non-identifiable upstream sources. 3) Restore those contaminated estuarine sites that will yield the greatest ecological and economic benefits.	Coho, ChF, late ChF, ChS, StW, StS, Chum	estuary	within 25 years (see EM)	see Estuary Module	---	---	---	ODFW, ODEQ, NMFS, LCREP
85 - Mxd	CRE-23: Implement stormwater best management practices in cities and towns. 1) Monitor stormwater outputs to measure treatment compliance with existing local and state regulations throughout the basin; develop a network of monitoring sites and establish a data repository that includes data collected by permittees. 2) Establish a fund source for regulatory agencies and local governments to use when insufficient resources are available to (1) access best available science, (2) develop standards beyond requirements, or (3) adequately enforce regulations. 3) Evaluate adequacy of best management practices and update as needed. 4) Provide incentives for low impact development practices.	Coho, ChF, late ChF, ChS, StW, StS, Chum	estuary	within 25 years (see EM)	see Estuary Module	---	---	---	ODEQ, LCREP, Municipalities

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
86 - Mxd	RPA 4: Operate the FCRPS storage projects for flow management to aid anadromous fish.	Coho, ChF, late ChF, ChS, StW, StS, Chum	FCRPS	within 25 years	Baseline	---	---	N/A	USACOE
87 - Mxd	RPA 5: Operate the FCRPS run-of-river mainstem lower Columbia River and Snake River projects to minimize water travel time through the lower Columbia and Snake rivers to aid in juvenile fish passage.	Coho, ChF, late ChF, ChS, StW, StS, Chum	FCRPS	within 25 years	Baseline	---	---	N/A	USACOE
88 - Mxd	RPA 6: In-season water management via water management plans and by the Regional Forum.	Coho, ChF, late ChF, ChS, StW, StS, Chum	FCRPS	within 25 years	Baseline	---	---	N/A	USACOE
89 - Mxd	RPA 7: To address forecasting and climate change/variability, hold annual forecast performance reviews and report on effectiveness of experimental or developing/emerging technologies.	Coho, ChF, late ChF, ChS, StW, StS, Chum	FCRPS	within 25 years	Baseline	---	---	N/A	USACOE
90 - Mxd	RPAs 8-9: Manage the FCRPS for operations and fish emergencies.	Coho, ChF, late ChF, ChS, StW, StS, Chum	FCRPS	within 25 years	Baseline	---	---	N/A	USACOE
91 - Mxd	RPAs 10-13: Columbia River Treaty and non-Treaty storage management, agreements, and coordination.	Coho, ChF, late ChF, ChS, StW, StS, Chum	FCRPS	within 25 years	Baseline	---	---	N/A	USACOE
92 - Mxd	RPA 14: Manage flow during dry years to maintain and improve habitat conditions for ESA-listed species.	Coho, ChF, late ChF, ChS, StW, StS, Chum	FCRPS	within 25 years	Baseline	---	---	N/A	USACOE
93 - Mxd	OR: Draft storage reservoirs to meet lower Columbia summer flow and velocity equivalent objectives on a seasonal and weekly basis.	Coho, ChF, late ChF, ChS, StW, StS, Chum	FCRPS	within 25 years	Baseline	---	---	N/A	USACOE
94 - Mxd	OR: Operate reservoirs at rule curves and seek additional flow augmentation volumes from Snake River and Canadian reservoirs to better meet spring and summer flow and velocity objectives.	Coho, ChF, late ChF, ChS, StW, StS, Chum	FCRPS	within 25 years	Baseline	---	---	N/A	USACOE

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
95 - Mxd	Adopt, eliminate, or revise Oregon's in-river coho harvest matrix and modify currently-used PFMC Amendment 13 coho harvest matrix as necessary.	Coho	estuary	within 10 years	Baseline	---	---	N/A	ODFW, NMFS, PFMC, WDFW
96 - Mxd	Implement "weak stock management" for coho harvest by: a) Identifying appropriate weak grouping of populations based on population recovery goals/probability, run timing relative to harvest, and other factors (not necessarily within the weakest stratum - likely will be within Coast stratum rather than potentially infeasible Gorge stratum), b) Re-calibrating the current coho abundance-based harvest matrices, and c) Conducting weak stock monitoring.	Coho	estuary	within 10 years	Baseline and see Action 43-Trib	---	---	---	ODFW, NMFS, PFMC, WDFW
97 - Mxd	Implement mark-selective, mainstem, commercial coho fisheries by: a) Researching and developing live-capture gear and techniques, and b) Implementing mark-selective, mainstem, commercial fisheries if feasible.	Coho	estuary	within 10 years	Expert Opinion	$400,000 develop/study; $25,000 / yr to implement	5 yrs develop; 20 yrs implement	$900,000	ODFW, WDFW
98 - Mxd	Implement the new Pacific Salmon Treaty (reduce ocean fisheries on Chinook).	ChF, late ChF, ChS	ocean	on-going	Baseline	---	---	N/A	ODFW, PSC, WDFW
99 - Mxd	Support mark-selective ocean fisheries when a new PST is negotiated in 10 years.	ChF, late ChF, ChS	ocean	~2017	Baseline	---	---	N/A	ODFW, NMFS, WDFW
100 - Mxd	Implement mark-selective Columbia fall Chinook fisheries by: a) Developing live-capture commercial gear and techniques, b) Conducting release mortality studies for all fisheries, c) Implementing for Columbia R commercial fisheries in August and September if live-capture is feasible, and d) Implementing for sport fisheries in ocean, Buoy 10, tributaries, and mainstem above Buoy 10 (if upriver/Snake wilds are low).	ChF, late ChF	ocean, estuary, mainstem, and/or tributaries	within 20 years [a) and b) by 2016; c) start 2017-2022 (sooner if possible); d) start 2011-2016]	Expert Opinion	$2,600,000 develop/study; $25,000 / yr to implement	5 yrs develop; 20 yrs implement	$3,100,000	ODFW, NMFS, WDFW

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
101 - Mxd	Develop an abundance-based, sliding scale harvest matrix that incorporates "weak stock management" for fall Chinook by implementing population monitoring and then: a) Identifying appropriate weak grouping of populations based on population recovery goals/probability, run timing relative to harvest, and other factors, b) Developing run forecast model, and c) Developing marine survival indices for returning adults.	ChF, late ChF	estuary	within 20 years	Baseline and see Action 43-Trib	---	---	---	ODFW, NMFS, PSC, WDFW
102 - Mxd	Develop harvest management strategies to protect the strongest Chinook population (late Sandy ChF).	late ChF	estuary	within 20 years	Baseline	---	---	N/A	ODFW, PSC, WDFW
103 - Mxd	Shift mainstem commercial spring Chinook harvest to terminal areas during low return years (de facto "sliding scale").	ChS	estuary	within 20 years	Baseline	---	---	N/A	ODFW, WDFW
104 - Mxd	Monitor harvest levels in all fishery areas for all species (direct and indirect mortality).	Coho, ChF, late ChF, ChS, StW, StS	estuary	on-going; modify as needed	Baseline and TBD	---	---	---	ODFW, PFMC, WDFW
Youngs Bay									
105 - YB	Provide / improve fish passage and water quality.	Coho, ChF, Chum	Tucker Crk and Crosel Crk tide gates	within 15 years	Expert Opinion	$200,00 / gate	2 gates	$400,000	WS Councils, ODFW, NRCS, SWCD
106 - YB	Explore cooperative water conservation measures.	StW	Lewis and Clark R	within 15 years	TBD	---	---	---	WS Councils, ODFW, OWRD, City of Warrenton
107 - YB	Implement research, monitoring, and evaluation of headwater springs to investigate the concern that they may be drying up due to land management practices.	Coho, ChF, StW, Chum	watershed-wide	within 15 years	TBD	---	---	---	ODFW, OWRD
108 - YB	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.	Coho, ChF, StW, Chum	Lower/mid Lewis and Clark R; Wallooskie Crk; Youngs R; South and North forks Klaskanine R	within 15 years	Calculated	$53 / m2	5,186 m2	$274,858	WS Councils, ODFW, ODF, NRCS, SWCD

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
109 - YB	Preserve recent wood input from 12/7 storm.	Coho, ChF, StW	Upper Lewis and Clark HEA	within 15 years	TBD	---	---	---	WS Councils, ODFW, ODF
110 - YB	Assess need for additional LWD to improve instream habitat complexity.	Coho, ChF, StW	Middle and North Fork Klaskanine	within 15 years	Expert Opinion	$20,000 / study	1 study	$20,000	WS Councils, ODFW
111 - YB	Restore instream habitat complexity, including large wood placement.	Coho, ChF, StW	Cullaby Crk; Upper Wallooskie; Upper Lewis and Clark HEA	within 15 years	Calculated	$80,000 / mi	46 miles	$3,680,000	WS Councils, ODFW, ODF
112 - YB	Protect intact and functioning riparian areas through riparian easements and acquisition.	Coho, ChF, StW	Youngs Bay – mainly Lewis and Clark R	within 15 years	Expert Opinion	---	---	$2,500,000	WS Councils, ODFW, OWEB, ODF, ODSL, ODA, NRCS, SWCD
113 - YB	Restore (plant and/or fence) and protect (conservation easements, acquisition) riparian areas that are degraded.	Coho, ChF, StW	Youngs Bay – mainly Lewis and Clark R	within 15 years	Calculated	$330,000 / mi (with fence); $310,000 / mi (without fence)	4 miles (with fence); 15 miles (without fence)	$5,970,000	WS Councils, ODFW, OWEB, ODF, ODA, NRCS, SWCD
114 - YB	Conduct sediment source analysis and then implement actions to reduce sediment from identified sources.	Coho, ChF, StW, Chum	watershed-wide	within 15 years	TBD	---	---	---	WS Councils, ODEQ
115 - YB	Consider terminal fisheries changes to reduce harvest of late returning wild coho.	Coho	Youngs Bay	within 10 years	Baseline	---	---	N/A	ODFW, WDFW
116 - YB	Consider implementing terminal commercial fisheries for fall Chinook to reduce stray rates.	ChF	Youngs Bay	within 15 years	Expert Opinion	$45,000 / yr	25 yrs	$1,125,000	ODFW
117 - YB	Maintain existing wild fish sanctuary.	Coho, StW	sort at Klaskanine Hatchery	on-going	Baseline	---	---	N/A	ODFW
118 - YB	Trap and sort hatchery adults: Begin passing tules and chum if suitable habitat exists.	ChF, Chum	Klaskanine Hatchery	within 15 years	Expert Opinion	$20,000 / yr	25 yrs	$500,000	ODFW

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
119 - YB	Trap and sort hatchery adults: Investigate placing trap to sort hatchery fish from upstream migrants.	Coho, StW	Lewis and Clark R at the current City of Warrenton diversion's fishway	within 15 years	Expert Opinion	$800,000 install; $30,000 / yr to operate-maintain	5 yrs develop; 20 yrs implement	$1,400,000	ODFW
Big Creek									
120 - BC	Explore cooperative water conservation measures.	Coho, StW	Bear Crk; Water Supply Cr	within 15 years	TBD	---	---	---	WS Councils, ODFW, OWRD, City of Astoria
121 - BC	Implement research, monitoring, and evaluation of headwater springs to investigate the concern that they may be drying up due to land management practices.	Coho, ChF, StW, Chum	Watershed-wide	within 15 years	TBD	---	---	---	ODFW, OWRD
122 - BC	Restore instream habitat complexity, including large wood placement.	Coho, ChF, StW	Coon Crk; Elk Crk; up. Big Crk; Rock Crk; l. Gnat Crk; Bear Crk; Water Supply Cr	within 15 years	Calculated	$80,000 / mi	58 miles	$4,640,000	WS Councils, ODFW, ODF, NRCS, SWCD
123 - BC	Possible road re-alignment.	Coho, ChF, StW	Bear Crk; Water Supply Crk	within 15 years	TBD	---	---	---	ODFW
124 - BC	Provide / improve fish passage and water quality.	Coho	John Day Crk tide gate (Clairmont Rd)	within 15 years	Expert Opinion	$200,00 / gate	1 gate	$200,000	WS Councils, ODFW, SWCD
125 - BC	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.	Coho, ChF, StW, Chum	Upper Big Crk; Coon Crk; Elk Crk; Rock Crk; Lower Big Crk; Little Crk; Bear Crk; Water Supply Cr	within 15 years	Calculated	$53 / m2	20,486 m2	$1,085,758	WS Councils, ODFW, ODSL, SWCD
126 - BC	Restore (plant and/or fence) and protect (conservation easements, acquisition) riparian areas that are degraded.	Coho, ChF, StW	Big Crk Pop-wide	within 15 years	Calculated	$330,000 / mi (with fence); $310,000 / mi (without fence)	2 miles (with fence); 17 miles (without fence)	$5,930,000	WS Councils, ODFW, OWEB, ODF, ODA, SWCD
127 - BC	Restore or create off-channel habitat and/or access to off-channel habitat: side channels.	Coho, ChF, StW, Chum	---	within 15 years	Calculated	$330,000 / mi	5 miles	$1,650,000	WS Councils, ODFW, NRCS, SWCD

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
128 - BC	Conduct sediment source analysis and then implement actions to reduce sediment from identified sources.	Coho, ChF, StW, Chum	watershed-wide	within 15 years	TBD	---	---	---	WS Councils, ODEQ
129 - BC	Consider terminal fisheries changes to reduce harvest of late returning wild coho.	Coho	Knappa/Blind Slough	within 10 years	Baseline	---	---	N/A	ODFW
130 - BC	Consider implementing terminal commercial fisheries for fall Chinook to reduce stray rates.	ChF	Knappa/Blind Slough	within 15 years	Expert Opinion	$45,000 / yr	25 yrs	$1,125,000	ODFW
131 - BC	Trap and sort hatchery adults: Develop trap and haul capability to pass unmarked Coho and STW above hatchery.	Coho, StW	Gnat Crk Hatchery	within 15 years	Expert Opinion	$2,500,000 install; $30,000 / yr to operate-maintain	5 yrs develop; 20 yrs implement	$3,100,000	ODFW
132 - BC	Maintain existing wild fish sanctuary.	Coho, StW	Big Crk Hatchery	on-going	Baseline	---	---	N/A	ODFW
133 - BC	Trap and sort hatchery adults: Begin passing tules and chum.	ChF, Chum	Big Crk Hatchery	completed (2009)	Expert Opinion	$20,000 / yr	25 yrs	$500,000	ODFW
134 - BC	Eliminate/reduce/shift program: Reduce hatchery tule releases (5.7M to 3.7M in 2009; shifted to Youngs Bay).	ChF	---	completed (2009)	Baseline	---	---	N/A	ODFW
Clatskanie									
135 - CT	Implement research, monitoring, and evaluation of headwater springs to investigate the concern that they may be drying up due to land management practices.	Coho, ChF, StW, Chum	watershed-wide	within 15 years	TBD	---	---	---	ODFW, OWRD
136 - CT	Protect intact and functioning riparian areas through riparian easements and acquisition.	Coho, ChF, StW, Chum	Priority tidal areas; lower Clatskanie; Middle Clatskanie; lower Beaver Crk	within 15 years	Expert Opinion	---	---	$2,500,000	WS Councils, ODFW, OWEB, ODSL, ODA, NRCS, SWCD

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
137 - CT	Protect remaining high-quality off-channel habitat from degradation.	Coho, ChF, StW, Chum	Priority tidal areas; lower Clatskanie; Middle Clatskanie; lower Beaver Crk	within 15 years	TBD	---	---	---	WS Councils, ODFW, ODSL, ODA, NRCS, SWCD, Counties, Municipalities
138 - CT	Breach, lower, remove, or relocate dikes and levees to establish or improve access to off-channel habitats; vegetate dikes and levees.	Coho, ChF, StW, Chum	Priority tidal areas	within 15 years	Expert Opinion	---	---	$3,300,000	WS Councils, ODFW, NRCS, SWCD
139 - CT	Restore instream habitat complexity, including large wood placement.	Coho, ChF, StW, Chum	Lower & upper Clatskanie R; Plympton Crk; lower Page Crk; lower NF Clatskanie, lower Carcus Crk, lower Miller Crk, lower Perkins Crk, lower Conyers Crk, lower Keystone Crk; Middle Clatskanie R; lower Beaver Cr	within 15 years	Calculated	$80,000 / mi	76 miles	$6,080,000	WS Councils, ODFW, NRCS, SWCD
140 - CT	Establish working group to identify priority areas for riparian and instream habitat enhancement, and work with landowners to implement projects.	Coho, ChF, StW, Chum	Lower Clatskanie R Middle Clatskanie R; lower Beaver Crk	within 15 years	Baseline	---	---	N/A	WS Councils, ODFW, ODF, ODSL, ODA, NRCS, SWCD
141 - CT	Conduct sediment source analysis and then implement actions to reduce sediment from identified sources.	Coho, ChF, StW, Chum	Up. Middle Clatskanie R; Plympton Crk; Little Clatskanie R; upper Clatskanie R; lower Page Crk; lower NF Clatskanie; lower Carcus Crk; lower Miller Crk; lower Perkins Crk; lower Conyers Crk; lower Keystone Crk; numerous small tributaries and headwaters streams	within 15 years	TBD	---	---	---	WS Councils, ODFW, ODF, ODEQ, NRCS, SWCD
142 - CT	Conduct full assessment of streams that were heavily damaged during Dec. 2007 storm to determine best approach to restoration.	Coho, StW	Numerous small streams in western portion of population area	within 15 years	Expert Opinion	$20,000 / study	1 study	$20,000	WS Councils, ODFW
143 - CT	Implement Mid-Coast watershed council style limiting factors analysis to improve understanding of reach specific recovery action needs.	Coho	watershed-wide	within 15 years	Expert Opinion	$62,500 / study	1 study	$62,500	WS Councils, ODFW

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
144 - CT	Inventory and assess connectivity and hydrologic function.	Coho, ChF, StW	Tidal areas and wetlands	within 15 years	TBD	---	---	---	WS Councils, ODFW, NRCS, SWCD
145 - CT	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.	Coho, ChF, StW, Chum	Priority tidal areas; lower Clatskanie; Middle Clatskanie; lower Beaver Crk	within 15 years	Calculated	$53 / m2	24,624 m2	$1,305,072	WS Councils, ODFW, ODSL, ODA, NRCS, SWCD
146 - CT	Restore (plant and/or fence) and protect (conservation easements, acquisition) riparian areas that are degraded.	Coho, ChF, StW, Chum	Priority tidal areas; lower Clatskanie; Middle Clatskanie; lower Beaver Crk	within 15 years	Calculated	$330,000 / mi (with fence); $310,000 / mi (without fence)	3 miles (with fence); 17 miles (without fence)	$6,260,000	WS Councils, ODFW, OWEB, ODSL, ODA, NRCS, SWCD
147 - CT	Trap and sort hatchery adults: Investigate placing trap to sort hatchery fish from upstream migrants, if stray rate is greater than 10%.	Coho, ChF, StW	current fishway in lower R at RM 10 falls	within 15 years	Expert Opinion	$100,000 install; $40,000 / yr to operate-maintain	5 yrs develop; 20 yrs implement	$900,000	ODFW
148 - CT	Maintain existing wild fish sanctuary (do not stock hatchery fish).	Coho, ChF, StW	watershed-wide	on-going	Baseline	---	---	N/A	ODFW
149 - CT	Explore adding a life-cycle monitoring site in the Clatskanie population.	Coho, StW	current fishway in lower R at RM 10 falls	within 15 years	within Action 43-Trib	---	---	---	ODFW
Scappoose									
150 - SC	Provide / improve fish passage.	Coho, StW, Chum	NF Scappoose (Bonnie Falls ladder); Milton Crk, Salmon Crk, Cox Crk, Siercks Crk, Dart Crk road crossings	within 15 years	Expert Opinion	$350,000 / site	4 sites	$1,400,000	WS Councils, ODFW, ODF, Counties
151 - SC	Implement research, monitoring, and evaluation of headwater springs to investigate the concern that they may be drying up due to land management practices.	Coho, ChF, StW, Chum	watershed-wide	within 15 years	TBD	---	---	---	ODFW, OWRD

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
152 - SC	Protect intact and functioning riparian areas through riparian easements and acquisition.	Coho, ChF, StW, Chum	Lower Merril, Tide & McBride Crks; lower Scappoose; lower SF Scappoose; Mid/upper Merril, Tide & McBride Crks; Goble Crk; Milton Crk; NF Scappoose headwater streams; SF Scappoose headwaters	within 15 years	Expert Opinion	---	---	$2,500,000	WS Councils, ODFW, OWEB, ODF, ODSL, ODA, NRCS, SWCD
153 - SC	Restore (plant and/or fence) and protect (conservation easements, acquisition) riparian areas that are degraded.	Coho, ChF, StW, Chum	Lower Merril, Tide & McBride Crks; lower Scappoose; lower SF Scappoose; Mid/upper Merril, Tide & McBride Crks; Goble Crk; Milton Crk; NF Scappoose headwater streams; SF Scappoose headwaters	within 15 years	Calculated	$330,000 / mi (with fence); $310,000 / mi (without fence)	6 miles (with fence); 16 miles (without fence)	$6,940,000	WS Councils, ODFW, OWEB, ODF, ODSL, ODA, NRCS, SWCD
154 - SC	Protect/manage existing high quality habitat.	Coho, StW	Upper SF Scappoose Crk, Upper Milton Crk, Lower NF Scappoose Crk	within 15 years	TBD	---	---	---	WS Councils, ODFW, ODF, ODSL, ODA, Counties, Municipalities
155 - SC	Restore instream habitat complexity, including large wood placement.	Coho, ChF, StW	Merril Crk, Tide Crk, McBride Crk, NF Scappoose, SF Scappoose, Scappoose Crk, Goble Crk, Milton Crk, Dart Cr	within 15 years	Calculated	$80,000 / mi	61 miles	$4,880,000	WS Councils, ODFW, ODF, NRCS, SWCD
156 - SC	Restore or create off-channel habitat and/or access to off-channel habitat: side channels.	Coho, ChF, StW, Chum	Lower Merril, Tide & McBride Crks; lower NF Scappoose; lower Scappoose; Deer Island; Milton Crk; Mid/upper Merril, Tide & McBride Crks; Goble Cr	within 15 years	Calculated	$330,000 / mi	20 miles	$6,600,000	WS Councils, ODFW, NRCS, SWCD
157 - SC	Restore connectivity to small tributaries.	Coho, ChF, StW	Lower SF and NF Scappoose	within 15 years	TBD	---	---	---	WS Councils, ODFW, NRCS, SWCD

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
158 - SC	Establish working group to identify habitat enhancement projects.	Coho, ChF, StW, Chum	Lower Merril, Tide & McBride Crks; Mid/upper Merril, Tide & McBride Crks; Goble Cr	within 15 years	Baseline	---	---	N/A	WS Councils, ODFW, ODF, ODSL, ODA, NRCS, SWCD
159 - SC	Work with landowners to implement projects to prevent/reduce impacts from development and land management; provide resources and incentives.	Coho, ChF, StW	Lower Merril, Tide & McBride Crks; lower NF Scappoose; lower Scappoose; lower SF Scappoose; Mid/upper Merril, Tide & McBride Crks; Goble Crk; NF Scappoose (upper mid-mainstem and tribs); Dart Cr	within 15 years	TBD	---	---	---	WS Councils, ODFW, ODSL, ODA, NRCS, SWCD, Counties, Municipalities
160 - SC	Protect remaining high-quality off-channel habitat from degradation.	Coho, ChF, StW	Scappoose Bottomlands tidal areas and wetlands	within 15 years	TBD	---	---	---	WS Councils, ODFW, ODSL, NRCS, SWCD, Counties, Municipalities
161 - SC	Implement Mid-Coast watershed council style limiting factors analysis to improve understanding of reach specific recovery action needs.	Coho	watershed-wide	within 15 years	Expert Opinion	$62,500 / study	1 study	$62,500	WS Councils, ODFW
162 - SC	Inventory and assess connectivity and hydrologic function.	Coho, ChF, StW	Tidal areas and wetlands	within 15 years	TBD	---	---	---	WS Councils, ODFW, NRCS, SWCD
163 - SC	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.	Coho, ChF, StW, Chum	lower Scappoose; lower Merril, Tide & McBride Crks; lower NF Scappoose; SF Scappoose; Deer Island; mid/upper Milton Crk; mid/upper Merril Crk; Goble Crk	within 15 years	Calculated	$53 / m2	7,216 m2	$382,448	WS Councils, ODFW, ODSL, NRCS, SWCD
164 - SC	Investigate ways to retain gravel in context of flood impact management considerations.	Coho, StW	Lower Milton Crk	within 15 years	TBD	---	---	---	WS Councils, ODFW, ODSL
165 - SC	Improve system for monitoring water quality and quantity and ensure that information is integrated into existing regulatory framework.	Coho, ChF, StW	watershed-wide	within 15 years	TBD	---	---	---	WS Councils, ODEQ, OWRD

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
166 - SC	Breach, lower, remove, or relocate dikes and levees to establish or improve access to off-channel habitats; vegetate dikes and levees.	ChF	South Sauvie Island, Deer Island	within 15 years	Expert Opinion	---	---	$3,300,000	WS Councils, ODFW, NRCS, SWCD
167 - SC	Identify and implement flow improvements (to provide better migration into and out of Sturgeon Lake).	ChF	Dairy Crk and Gilbert R	within 15 years	TBD	---	---	---	WS Councils, ODFW, OWRD
168 - SC	Maintain existing wild fish sanctuary (do not stock hatchery fish).	Coho, ChF, StW	watershed-wide	on-going	Baseline	---	---	N/A	ODFW
Clackamas									
169 - CM	Remove dam.	Chum	Kellogg Crk Dam	within 15 years	Expert Opinion	$10,000,000 / dam	1 dam	$10,000,000	ODFW
170 - CM	Provide / improve fish passage.	Coho, ChF, ChS, StW, Chum	Miller Crk confluence, Tryon Crk-Highway 43 Culvert, Clear Crk, Deep Crk, Johnson Crk	within 15 years	Expert Opinion	$3,500,000 / site	5 sites	$12,500,000	ODFW, ODOT
171 - CM	Implement research, monitoring, and evaluation of headwater springs to investigate the concern that they may be drying up due to land management practices.	Coho, ChF, ChS, StW, Chum	watershed-wide	within 15 years	TBD	---	---	---	ODFW, OWRD
172 - CM	Identify and implement flow improvements.	Coho, ChF, ChS, StW, Chum	watershed-wide	within 15 years	TBD	---	---	---	WS Councils, ODFW, OWRD, USFS, NRCS, SWCD
173 - CM	Inventory and protect seeps, springs, and other coldwater sources.	Coho, ChF, ChS, StW, Chum	watershed-wide	within 15 years	TBD	---	---	---	WS Councils, ODFW, USFS, BLM
174 - CM	Identify priority areas for increased instream flows.	Coho, ChF, ChS, StW, Chum	watershed-wide	within 15 years	TBD	---	---	---	WS Councils, ODFW, OWRD, USFS
175 - CM	Establish minimum ecosystem-based instream flows.	Coho, ChF, ChS, StW, Chum	Johnson Crk	within 15 years	TBD	---	---	---	ODFW, OWRD

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
176 - CM	Identify and halt illegal water withdrawals.	Coho, ChF, ChS, StW, Chum	watershed-wide	within 15 years	Baseline	---	---	N/A	WS Councils, ODFW, OWRD
177 - CM	Enforce existing water rights.	Coho, ChF, ChS, StW, Chum	watershed-wide	within 15 years	Baseline	---	---	N/A	ODFW, OWRD
178 - CM	Breach, lower, remove, or relocate dikes and levees to establish or improve access to off-channel habitats; vegetate dikes and levees.	Coho, ChF, ChS, StW, Chum	Columbia Slough; Joslin Property	within 15 years	Expert Opinion	---	---	$3,300,000	WS Councils, ODFW, City of Portland, Metro
179 - CM	Review land use plans in context of salmon recovery needs (i.e., forest lands of higher value to salmon recovery than urbanized lands).	Coho, ChF, ChS, StW, Chum	Eagle Crk; Clear Crk; mainstem Clackamas R -- R Mill Dam to Goose Crk; mainstem Clackamas R -- R Mill Dam to Abernathy Crk; Deep Crk; Johnson Cr	within 15 years	Baseline	---	---	N/A	ODFW, ODLCD, USFS, Counties, City of Portland, Metro, Municipalities
180 - CM	Provide incentives to promote good landowner stewardship.	Coho, ChF, ChS, StW, Chum	Eagle Crk; Clear Crk; mainstem Clackamas R -- R Mill Dam to Goose Crk; mainstem Clackamas R -- R Mill Dam to Abernathy Crk; Deep Crk; Johnson Cr	within 15 years	TBD	---	---	---	WS Councils, OWEB, ODSL, NRCS, Counties, City of Portland, Metro
181 - CM	Reduce impact that roads have on impaired hydrograph.	Coho, ChF, ChS, StW, Chum	upper Clackamas and Collawash	within 15 years	TBD	---	---	---	WS Councils, ODFW, USFS, Counties, City of Portland, Municipalities
182 - CM	Finish Clackamas Fish Habitat Analysis.	Coho, ChF, ChS, StW, Chum	watershed-wide	within 15 years	TBD	---	---	---	WS Councils, ODFW, USFS
183 - CM	Develop and/or implement stormwater management plans for urban areas and roads.	Coho, ChF, ChS, StW, Chum	Deep Crk; Johnson Crk; all areas within urban growth boundaries	within 15 years	TBD	---	---	---	WS Councils, ODFW, ODEQ, NRCS, SWCD, Counties, City of Portland, Municipalities

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
184 - CM	Protect remaining high-quality off-channel habitat from degradation.	Coho, ChF, ChS, StW, Chum	Priority urban areas in lower watershed; Cathedral Park; Centennial Mills; Johnson Crk confluence; Columbia Slough; Johnson Crk confluence; Linnton Neighborhood; Saltzman Crk; Willamette Cove; Forest Park area; Stephens Crk confluence	within 15 years	TBD	---	---	---	WS Councils, ODFW, ODSL, Counties, City of Portland, Metro, Municipalities
185 - CM	Restore or create off-channel habitat and/or access to off-channel habitat: side channels.	Coho, ChF, ChS, StW, Chum	---	within 15 years	Calculated	$330,000 / mi	114 miles	$37,620,000	WS Councils, ODFW, NRCS, SWCD, City of Portland, Metro
186 - CM	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.	Coho, ChF, ChS, StW, Chum	Linnton Neighborhood; Owens-Corning Banks and Floodplain; Ross Island; Swan Island lagoon; Columbia Slough confluence; Ramsey lake wetland; Tryon Slough confluence; Powerline Corridor; Forest Park area; Kelley Point Park; Miller Crk confluence; Oaks Bottom Wildlife Refuge; West Hayden Island; Willamette Cove; Willamette Park; Cathedral Park; Centennial Mills; Johnson Crk confluence; Saltzman Crk; watershed-wide	within 15 years	Calculated	$53 / m2	34,738 m2	$1,841,114	WS Councils, ODFW, NRCS, SWCD, PGE, City of Portland, Metro
187 - CM	Improve or regrade/revegetate streambanks.	Coho, ChF, ChS, StW, Chum	Linnton Neighborhood; Oaks Bottom Wildlife Refuge; Owens-Corning Banks and Floodplain; Swan Island lagoon; Tryon Cr confluence; West Hayden Island; Willamette Cove; Willamette Park; Balch Cr confluence; Cathedral Park	within 15 years	TBD	---	---	---	ODFW, Counties, City of Portland, Metro, Municipalities

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
188 - CM	Protect intact and functioning riparian areas through riparian easements and acquisition.	Coho, ChF, ChS, StW, Chum	Eagle Crk; Clear Crk; mainstem Clackamas R (River Mill Dam to Goose Crk, R Mill Dam to Abernathy Cr); tributaries below R Mill Dam; Deep Crk; Johnson Crk; Forest Park area; Willamette R; West Hayden Island	within 15 years	Expert Opinion	---	---	$7,500,000	WS Councils, ODFW, OWEB, ODSL, USFS, NRCS, SWCD, City of Portland, Metro
189 - CM	Restore (plant and/or fence) and protect (conservation easements, acquisition) riparian areas that are degraded.	Coho, ChF, ChS, StW, Chum	Eagle Crk; Clear Crk; mainstem Clackamas R (River Mill Dam to Goose Crk, R Mill Dam to Abernathy Cr); tributaries below R Mill Dam; Deep Crk; Johnson Crk; Forest Park area; Willamette R; West Hayden Island	within 15 years	Calculated	$330,000 / mi (with fence); $310,000 / mi (without fence)	8 miles (with fence); 54 miles (without fence)	$19,380,000	WS Councils, ODFW, OWEB, ODSL, NRCS, SWCD, City of Portland
190 - CM	Annually place 8,000 yd3 of spawning sized gravel below River Mill Dam as per FERC settlement agreement.	ChF, ChS	Mainstem Clackamas R below R Mill Dam	within 15 years	Baseline	---	---	N/A	PGE
191 - CM	Implement all measures in the Clackamas River Hydroelectric Project (FERC Project No. 2195) Fish Passage and Protection Plan, including measures for downstream fish passage (3% or less mortality at River Mill and North Fork dams), Oak Grove Mitigation and improvements to North Fork fish ladder/trap.	Coho, ChF, ChS, StW	PGE's Clackamas R Hydroelectric Project	within 15 years	Baseline	---	---	N/A	ODFW, PGE
192 - CM	Utilize the Clackamas Hydroelectric Project Mitigation and Enhancement Fund to provide for habitat mitigation and enhancements in the Clackamas Basin.	Coho, ChF, ChS, StW	watershed-wide	within 15 years	Baseline	---	---	N/A	ODFW, PGE
193 - CM	Restore instream habitat complexity, including large wood placement (mitigate for loss of fall and spring Chinook habitat complexity due to Clackamas hydropower dams).	ChF, ChS	High intrinsic potential rearing areas for fall and spring Chinook watershed-wide	within 15 years	TBD	---	---	---	ODFW, PGE, City of Portland
194 - CM	Reduce the square footage of over-water structures; where possible, modify remaining overwater structures to provide beneficial habitat.	Coho, ChF, ChS, StW, Chum	Willamette R	within 15 years	TBD	---	---	---	ODSL, ODLCD, City of Portland

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
195 - CM	Develop and implement Willamette mitigation bank river plan.	Coho, ChF, ChS, StW, Chum	Willamette R	within 15 years	Baseline	---	---	N/A	ODFW, NMFS, Counties, City of Portland, Metro, Municipalities
196 - CM	Identify and purchase key salmon habitats.	Coho, ChF, ChS, StW, Chum	Willamette R	within 15 years	TBD	---	---	---	ODFW, OWEB, City of Portland, Metro
197 - CM	Remove invasive plants and plant native species.	Coho, ChF, ChS, StW, Chum	Kelley Point Park; Oaks Bottom Wildlife Refuge; Ross Island; West Hayden Island	within 15 years	TBD	---	---	---	City of Portland, Metro
198 - CM	Restore instream habitat complexity, including large wood placement.	Coho, ChF, ChS, StW, Chum	Johnson Crk confluence; Tryon Crk confluence; Eagle Crk; Clear Crk; mainstem Clackamas R -- R Mill Dam to Goose Crk; mainstem Clackamas R -- R Mill Dam to Abernathy Crk; Johnson Cr)	within 15 years	Calculated	$80,000 / mi	192 miles	$15,360,000	WS Councils, ODFW, USFS, NRCS, SWCD, PGE, Metro
199 - CM	Daylight stream.	Coho, ChF, ChS, StW, Chum	lower Doane Crk/Railroad Corridor; lower Saltzman Crk	within 15 years	TBD	---	---	---	City of Portland
200 - CM	Create confluence habitat with cool water, restore channel and reconnect upper creek.	Coho, ChF, ChS, StW, Chum	Doane Crk/Railroad Corridor; Saltzman Crk	within 15 years	TBD	---	---	---	ODFW
201 - CM	Reconnect tributary to Willamette River and create high quality habitat at tributary junction.	Coho, ChF, ChS, StW, Chum	Historical Swan Island channel; Saltzman Crk; Miller Crk confluence	within 15 years	TBD	---	---	---	ODFW
202 - CM	Daylight stream.	Coho, ChF, ChS, StW, Chum	Centennial Mills	within 15 years	TBD	---	---	---	City of Portland
203 - CM	Revise and update stormwater management manual.	Coho, ChF, ChS, StW, Chum	"Pork Chop" and Portland-wide	within 15 years	Expert Opinion	$90,000 / yr	1 yr	$90,000	ODEQ, City of Portland, Municipalities

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
204 - CM	Implement Gray2Green program.	Coho, ChF, ChS, StW, Chum	"Pork Chop" and Portland-wide	within 15 years	Baseline	---	---	N/A	City of Portland
205 - CM	Re-establish connection to Columbia River for improved flushing, if feasible.	Coho, ChF, ChS, StW, Chum	Columbia Slough	within 15 years	TBD	---	---	---	ODFW
206 - CM	Implement pesticide and fertilizer best management practices to reduce sources of toxic and conventional contaminants entering the estuary (revise and update IPM for PDX owned property).	Coho, ChF, ChS, StW, Chum	Clackamas R; Willamette R	within 15 years	TBD	---	---	---	ODEQ, Counties, Port of Portland, Metro, Municipalities
207 - CM	Monitor for contaminants.	Coho, ChF, ChS, StW, Chum	Willamette R	within 15 years	TBD	---	---	---	ODEQ, City of Portland, Port of Portland
208 - CM	Maximize habitat benefits by restoration or mitigation.	Coho, ChF, ChS, StW, Chum	Willamette R	within 15 years	TBD	---	---	---	ODFW, ODSL, City of Portland, Metro
209 - CM	Increase harvest rate of hatchery coho as needed or permanently (3 daily bag) if program is maintained.	Coho	Below North Fork Dam	within 15 years	Baseline	---	---	N/A	ODFW
210 - CM	Maintain existing wild fish sanctuary.	Coho, ChF, ChS, StW	sort at North Fork Dam	on-going	Baseline	---	---	N/A	ODFW, PGE
211 - CM	Eliminate/reduce/shift program: Reduce hatchery coho releases (500k to 350k beginning in 2009).	Coho	Eagle Crk Nat'l Hatchery	completed (2009)	Baseline	---	---	N/A	ODFW, USFWS
212 - CM	Eliminate/reduce/shift program: Eliminate in-basin hatchery coho program and releases, if hatchery coho production shifts to out-of-ESU stocks (Yakima and Umatilla).	Coho	Eagle Crk Nat'l Hatchery	within 15 years	Baseline	---	---	N/A	USFWS
213 - CM	Operationally open the hatchery trap for a longer period.	Coho, ChF, ChS	Eagle Crk Nat'l Hatchery	within 15 years	Expert Opinion	$20,000 / yr	25 yrs	$500,000	ODFW, USFWS

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
214 - CM	Purchase a freezer trailer to aid the logistical disposition to carcass placement, tribes, and food banks if program is maintained.	Coho, ChF, ChS	Eagle Crk Nat'l Hatchery	within 15 years	Expert Opinion	$5,000 / unit	1 unit	$5,000	ODFW, USFWS
215 - CM	Eliminate/reduce/shift program: Reduce the Eagle Creek hatchery winter steelhead releases if needed (150k to 100k).	StW	Eagle Crk Nat'l Hatchery	2010	Baseline	---	---	N/A	ODFW, USFWS
216 - CM	Implement a sliding scale for take of wild winter steelhead broodstock for the integrated hatchery program based on the forecasted total return of wild fish to the population (<500: no take; 500-1000: reduced take); develop forecast model as necessary.	StW	Below North Fork Dam	within 15 years	Baseline	---	---	N/A	ODFW
217 - CM	Explore feasibility of shifting the Clackamas Hatchery winter steelhead program to a 2-year old smolt program. If implemented and they maintain wild run-timing, consider segregated program to reduce wild brood harvest.	StW	Clackamas Hatchery	within 15 years	Expert Opinion	$50,000 / yr	25 yrs	$1,250,000	ODFW
Sandy									
218 - SY	Implement measures in the Bull Run Water Supply Habitat Conservation Plan (HCP).	ChS, StW	watershed-wide	within 15 years	Baseline	---	---	N/A	City of Portland
219 - SY	Provide / improve fish passage.	Coho, StW, Chum	Sandy Hatchery on Cedar Crk; Beaver Crk and Buck Crk road crossings	on-going	Expert Opinion	$1,500,000 / site	3 sites	$4,500,000	ODFW, City of Portland
220 - SY	Develop recommendations for land management scenarios that address hydrograph changes that are predicted to occur due to climate change.	Coho, ChF, late ChF, ChS, StW, Chum	watershed-wide	within 15 years	Baseline	---	---	N/A	WS Councils, ODFW, USFS, Counties, Municipalities
221 - SY	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.	Coho, ChF, late ChF, ChS, StW, Chum	lower Salmon R; Sandy R above Salmon R confluence; lower Gordon & Trout Crks; Beaver Crk	within 15 years	SRBAHRS	---	(8,140 m2)	$10,500,000	WS Councils, ODFW, City of Portland

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
222 - SY	Protect remaining high-quality off-channel habitat from degradation.	Coho, ChF, late ChF, ChS, StW, Chum	lower Salmon R; Sandy R above Salmon R confluence; lower Gordon & Trout Crks	within 15 years	TBD	---	---	---	WS Councils, ODFW, ODSL, USFS, NRCS, SWCD, Counties, City of Portland, Municipalities
223 - SY	Obtain better understanding of fall Chinook and late fall Chinook life history, habitat needs, and response to restoration in tributaries and estuary.	ChF, late ChF	watershed-wide	within 15 years	within Action 43-Trib	---	---	---	ODFW
224 - SY	Limit future in-river and groundwater withdrawals so that they do not impede achievement of recovery goals.	StW	watershed-wide	within 15 years	Baseline	---	---	N/A	ODFW, OWRD
225 - SY	Meet minimum streamflow requirements for water temperature compliance below Bull Run dams (modified tower intakes and spillway plunge pool).	StW	lower Bull Run R	within 15 years	Portland HCP	---	---	$7,203,000	ODFW, OWRD, City of Portland
226 - SY	Conduct sediment source analysis and then implement actions to reduce sediment from identified sources.	Coho, ChF, late ChF, ChS, StW, Chum	watershed-wide	within 15 years	TBD	---	---	---	WS Councils, ODFW, ODEQ
227 - SY	Develop and/or implement stormwater management plans for urban areas and roads.	Coho, ChF, late ChF, ChS, StW, Chum	watershed-wide	within 15 years	TBD	---	---	---	ODEQ, Counties, Municipalities
228 - SY	Identify and rectify problem legacy roads.	Coho, ChF, late ChF, ChS, StW, Chum	watershed-wide	within 15 years	SRBAHRS	---	---	$362,900	WS Councils, ODFW, USFS, Counties, , Municipalities
229 - SY	Gravel placement for spawning.	ChF, late ChF, StW, Chum	below Bull Run Dams	within 15 years	Portland HCP	$15,000 / placement	50 placements	$750,000	ODFW, PGE, City of Portland
230 - SY	Remove dam.	ChF, late ChF, ChS, StW	Little Sandy R diversion	Completed (2008)	Baseline	---	---	N/A	ODFW, OWRD, PGE

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
231 - SY	Protect instream water right for fish.	ChF, late ChF, ChS, StW	Little Sandy R diversion	on-going	Baseline	---	---	N/A	ODFW, OWRD, PGE
232 - SY	Restore instream habitat complexity, including large wood placement.	Coho, ChF, ChS, StW, Chum	Salmon R; Still Crk; Clear Fork; Zig Zag R; Cedar Crk; Beaver Crk; lower Gordon & Trout Crks	within 15 years	SRBAHRS	---	(53 miles)	$6,037,200	WS Councils, ODFW, USFS, City of Portland
233 - SY	Restore or create off-channel habitat and/or access to off-channel habitat: side channels.	Coho, ChS, StW, Chum	lower Sandy R; Salmon R	within 15 years	Calculated	$330,000 / mi	27 miles	$8,910,000	WS Councils, ODFW, USFS, City of Portland
234 - SY	Breach, lower, remove, or relocate dikes and levees to establish or improve access to off-channel habitats; vegetate dikes and levees.	ChF, late ChF, ChS, Chum	Sandy R Delta	within 15 years	Portland HCP	---	---	$1,100,000	WS Councils, ODFW, USFS, City of Portland
235 - SY	Protect intact and functioning riparian areas through riparian easements and acquisition.	Coho, ChF, ChS, StW, Chum	Salmon R; Zig Zag R; Cedar Crk; lower Gordon & Trout Crks	within 15 years	SRBAHRS	---	---	$2,881,700	WS Councils, ODFW, OWEB, ODSL, NRCS, SWCD, City of Portland
236 - SY	Restore (plant and/or fence) and protect (conservation easements, acquisition) riparian areas that are degraded.	Coho, ChF, ChS, StW, Chum	Salmon R; Zig Zag R; Cedar Crk; lower Gordon & Trout Crks	within 15 years	Calculated	$330,000 / mi (with fence); $310,000 / mi (without fence)	1 miles (with fence); 27 miles (without fence)	$8,700,000	WS Councils, ODFW, OWEB, ODSL, NRCS, SWCD, City of Portland
237 - SY	Eliminate/reduce/shift program: Reduce hatchery coho releases (700k to 500k in 2010; shifted to Youngs Bay).	Coho	Sandy Hatchery	2010	Baseline	---	---	N/A	ODFW
238 - SY	Acclimate 100% of hatchery spring Chinook releases into the Sandy.	ChS	Sandy Hatchery (Cedar Crk) and Bull Run R or Gordon Crk	within 15 years	see Action 239-SY	---	---	---	ODFW, City of Portland
239 - SY	Trap and sort hatchery adults: Collect (weir and trap at or near acclimation sites) hatchery spring Chinook if stray rate is too high.	ChS	Cedar Crk (mouth) and Bull Run R or Gordon Crk	within 15 years	Expert Opinion	$360,000 / site install; $20,000 / yr / site to operate-maintain	2 sites; 5 yrs install; 20 yrs implement	$1,520,000	ODFW, City of Portland

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
240 - SY	Increase water quantity in Cedar Creek for more attraction (end illegal diversions, increase outreach and coordination with OWRD, potentially purchase water rights).	ChS	Cedar Crk	within 15 years	TBD	---	---	---	ODFW
241 - SY	Implement a sliding scale for take of wild winter steelhead and spring Chinook broodstock for the integrated hatchery programs based on the forecasted total returns of wild fish to the population (<500: no take; 500-1000: reduced take); develop forecast model as necessary.	ChS, StW	watershed-wide	within 15 years	Baseline	---	---	N/A	ODFW
242 - SY	Eliminate the upper basin and Marmot Dam acclimation pond releases.	StW	watershed-wide	completed	Baseline	---	---	N/A	ODFW
243 - SY	Explore adding a life-cycle monitoring site in the Sandy population.	Coho, ChF, late ChF, ChS, StW, Chum	Cedar Crk and/or Sandy R	within 15 years	within Action 43-Trib	---	---	---	ODFW
Lower Gorge									
244 - LG	Identify and implement flow improvements.	Coho, StW	Bonneville Hatchery	within 15 years	TBD	---	---	---	ODFW
245 - LG	Restore (plant and/or fence) and protect (conservation easements, acquisition) riparian areas that are degraded.	Coho, ChF, StW	---	within 15 years	Calculated	$330,000 / mi (with fence); $310,000 / mi (without fence)	2 miles (with fence); 7 miles (without fence)	$2,830,000	WS Councils, ODFW, OWEB, ODF, ODSL, ODEQ, ODA, USFS, NRCS, SWCD
246 - LG	Restore instream habitat complexity, including large wood placement.	Coho, ChF, StW, Chum	---	within 15 years	Calculated	$80,000 / mi	15 miles	$1,200,000	WS Councils, ODFW, NRCS, SWCD, PGE
247 - LG	Provide / improve fish passage.	Coho, ChF, StW, Chum	watershed-wide; Cascade Hatchery	within 15 years	Expert Opinion	$3,500,000 / site	≈ 20 sites	$70,000,000	WS Councils, ODFW, ODOT, USFS

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
248 - LG	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.	Coho, ChF, StW, Chum	watershed-wide	within 15 years	Calculated	$53 / m2	6,774 m2	$359,022	WS Councils, ODFW, ODOT, USFS, NRCS, SWCD
249 - LG	Restore or create off-channel habitat and/or access to off-channel habitat: side channels.	Coho, ChF, StW, Chum	watershed-wide	within 15 years	Calculated	$330,000 / mi	9 miles	$2,970,000	WS Councils, ODFW, ODOT, USFS, NRCS, SWCD
250 - LG	Trap and sort hatchery adults: Investigate placing new weir and trap to sort hatchery fish from upstream migrants.	Coho, ChF, StW	Eagle Crk (near mouth); Tanner Crk	within 15 years	Expert Opinion	$2,000,000 install; $20,000 / yr to operate-maintain	5 yrs develop; 20 yrs implement	$2,400,000	ODFW
251 - LG	Eliminate/reduce/shift program: Reduce Bonneville Hatchery coho releases (1.225M to 0.725M in 2010 and shift to lower Columbia River).	Coho	Bonneville Hatchery	2010	Baseline	---	---	N/A	ODFW
252 - LG	Discuss longer acclimation/rearing at tribal release sites to reduce imprinting at OR and WA hatcheries (rearing sites).	Coho	Out-of-ESU	within 15 years	TBD	---	---	---	ODFW, NMFS
			Upper Gorge						
253 - UG	Provide / improve fish passage.	ChF, StW, Chum	all railroad and I-84 crossings; Oxbow Hatchery	within 15 years	Expert Opinion	$3,500,000 / site	≈ 20 sites	$70,000,000	WS Councils, ODFW, ODOT, USFS
254 - UG	Restore or create off-channel habitat and/or access to off-channel habitat: side channels.	ChF, StW, Chum	---	within 15 years	Calculated	$330,000 / mi	2 miles	$660,000	WS Councils, ODFW, NRCS, SWCD
255 - UG	Restore (plant and/or fence) and protect (conservation easements, acquisition) riparian areas that are degraded.	ChF, StW	---	within 15 years	Calculated	$330,000 / mi (with fence); $310,000 / mi (without fence)	0 miles (with fence); 2 miles (without fence)	$620,000	WS Councils, ODFW, OWEB, ODF, ODSL, ODEQ, ODA, USFS, NRCS, SWCD
256 - UG	Restore instream habitat complexity, including large wood placement.	ChF, StW, Chum	---	within 15 years	Calculated	$80,000 / mi	4 miles	$320,000	WS Councils, ODFW, NRCS, SWCD, PGE

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
257 - UG	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.	ChF, StW, Chum	---	within 15 years	Calculated	$53 / m2	1,424 m2	$75,472	WS Councils, ODFW, ODOT, USFS, NRCS, SWCD
258 - UG	RPA 15: Continue to update the Water Quality Plan for Total Dissolved Gas and Water Temperature in the mainstem Columbia and Snake rivers, and implement water quality measures to enhance ESA-listed juvenile and adult fish survival and maintain spawning and rearing habitat.	ChF, StW, Chum	Bonneville Dam	within 15 years	Baseline	---	---	N/A	ODFW, USACOE, BPA
259 - UG	RPAs 18-21: Prepare, in cooperation with NMFS and comanaging agencies, configuration and operational plans for the Bonneville Project (2008), The Dalles Project, John Day Project (2008) and McNary Project (2009).	ChF, StW, Chum	Bonneville Dam	within 15 years	Baseline	---	---	N/A	ODFW, NMFS, USACOE, BPA
260 - UG	RPA 27: Operate turbine units to achieve best fish passage survival (currently within 1% of best efficiency at mainstem dams on the lower Columbia and lower Snake rivers.	ChF, StW, Chum	Bonneville Dam	within 10 years	Baseline	---	---	N/A	ODFW, USACOE, BPA
261 - UG	RPA 28: Implement structural improvements to adult passage at the mainstem Columbia River and Snake River projects.	ChF, StW, Chum	Bonneville Dam	within 10 years	Baseline	---	---	N/A	ODFW, USACOE, BPA
262 - UG	RPA 29: Provide spill to improve juvenile fish passage while avoiding high TDG supersaturation levels or adult fallback problems.	ChF, StW, Chum	Bonneville Dam	within 10 years	Baseline	---	---	N/A	ODFW, USACOE, BPA
263 - UG	RPA 32: Prepare annually a fish passage plan in coordination with NMFS and the Regional Forum. Operate projects year around in accordance with the criteria in the fish passage plan.	ChF, StW, Chum	Bonneville Dam	within 10 years	Baseline	---	---	N/A	ODFW, USACOE, BPA
264 - UG	OR - Operate lower Columbia reservoirs at minimum operating pool (MOP) during spring and summer as long as barge transport and irrigation needs are met.	ChF, StW, Chum	Bonneville Dam	within 15 years	Baseline	---	---	N/A	ODFW, USACOE, BPA

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
265 - UG	OR - Provide spill to total dissolved gas limits of water quality waivers or biological constraints at all dams, except maximize transportation at Snake River collector projects during lowest (10th percentile) flow years.	ChF, StW, Chum	Bonneville Dam	within 10 years	Baseline	---	---	N/A	ODFW, USACOE, BPA
266 - UG	Provide cover at mouth of Herman Creek that is inundated by Bonneville pool to reduce predation.	ChF, StW, Chum	Herman Crk	within 15 years	TBD	---	---	---	WS Councils, ODFW
267 - UG	Discuss Zone 6 fishery actions with Tribes to reduce potential additional impacts. Potential actions include extending sanctuaries from mouths, and/or modifying season length or timing.	StW	Columbia R mainstem	within 10 years	Baseline	---	---	N/A	ODFW
268 - UG	Trap and sort hatchery adults: Investigate placing trap to sort hatchery fish from upstream migrants.	ChF	Herman Crk at Oxbow Hatchery	within 15 years	Expert Opinion	$1,000,000 install; $15,000 / yr to operate-maintain	5 yrs develop; 20 yrs implement	$1,300,000	ODFW
269 - UG	(similar to CRE-14) Expand federal and state activities at Bonneville Dam to test and implement non-lethal and potentially lethal methods of reducing pinniped populations. This includes efforts to manage pinnipeds through the Marine Mammal Protection Act.	StW	Bonneville Dam	on-going	see Estuary Module, TBD	---	---	---	ODFW, NMFS, USACOE, BPA, WDFW, LCREP
			Hood						
270 - HD	Provide / improve fish passage.	Coho, StW	Laurance Lake Dam on Clear Branch; Moving Falls fish ladder on West Fork Hood R; irrigation diversions, road and railroad crossings, barriers formed by 2006 flood, and other barriers on Tony Crk, Upper Gorge tributaries, MF Hood R, and EF Hood R	within 15 years	HRBAHRS	---	---	$25,500,000	WS Councils, ODFW, USFS

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
271 - HD	Ensure that low head hydro projects do not adversely impact winter base streamflows.	Coho, ChF, ChS, StW, StS	Hood R Basin	within 15 years	Baseline	---	---	N/A	ODFW, OWRD
272 - HD	Implement projects that aid in restoring the natural flow regime (e.g., HRWAP Project FP-3 Central Canal Pipeline/Neal Creek Siphon, future piping projects, Conserved Water Program, landowner technical assistance, etc.).	Coho, ChF, StW	Neal Crk Watershed	within 15 years	HRBAHRS	---	---	$5,451,312	WS Councils, ODFW, OWRD, Counties, Municipalities
273 - HD	Provide education and resources to hobby farms and other rural residents to assist them with water saving measures.	Coho, ChF, ChS, StW, StS	Hood R Basin	within 15 years	see Action 272-HD	---	---	---	WS Councils, ODFW, NRCS, SWCD
274 - HD	Work with OWRD and others to keep water saved through publically-funded water conservation efforts instream for fish.	Coho, ChF, ChS, StW, StS	Hood R Basin	within 15 years	see Action 272-HD	---	---	---	WS Councils, ODFW, OWRD
275 - HD	Develop and implement Best Management Practices and rules from the Hood River Agricultural Water Quality Area Management Plan and Rules.	ChS, StW, StS	Hood R	within 15 years	TBD	---	---	---	ODFW, ODA, USFS
276 - HD	Continue education and outreach programs identified in the HRWAP.	ChS, StW, StS	Hood R	on-going	Baseline	---	---	N/A	WS Councils, ODFW, USFS, NRCS, SWCD
277 - HD	Identify and implement flow improvements.	Coho, ChF, StW	East Fork Hood R; Middle Fork Hood R, Hood R	within 15 years	see Action 272-HD	---	---	---	WS Councils, ODFW, OWRD, USFS, East Fork, Middle Fork, Farmers Irrigation Districts
278 - HD	Work to expand streamside vegetation buffers.	ChS, StW, StS	Hood R	within 15 years	TBD	---	---	---	WS Councils, ODFW, ODA, USFS, NRCS, SWCD, Counties, Municipalities
279 - HD	Protect intact and functioning riparian areas through riparian easements and acquisition.	Coho, ChF, ChS, StW, StS	lower Hood R; Neal Crk; Lenz Crk; Hood R Delta; West Fork Hood R; upper West Fork Hood R	within 15 years	HRBAHRS	---	---	$4,248,000	WS Councils, ODFW, OWEB, ODF, ODSL, ODEQ, ODA, USFS, NRCS, SWCD

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
280 - HD	Restore (plant and/or fence) and protect (conservation easements, acquisition) riparian areas that are degraded.	Coho, ChF, ChS, StW, StS	lower Hood R; Neal Crk; Lenz Crk; Hood R Delta; West Fork Hood R; upper West Fork Hood R	within 15 years	Calculated	$330,000 / mi (with fence); $310,000 / mi (without fence)	17 miles (with fence); 35 miles (without fence)	$16,460,000	WS Councils, ODFW, OWEB, ODF, ODSL, ODEQ, ODA, USFS, NRCS, SWCD
281 - HD	Remove sections of railroad fill.	Coho, StW	lower Hood R	within 15 years	TBD	---	---	---	ODFW
282 - HD	Restore or create off-channel habitat and/or access to off-channel habitat: side channels.	Coho, StW	lower Hood R	within 15 years	Calculated	$330,000 / mi	55 miles	$18,150,000	WS Councils, ODFW, USFS, NRCS, SWCD
283 - HD	Restore or create off-channel habitat and/or access to off-channel habitat: alcoves, wetlands, and floodplains. - Restoration includes revegetation.	Coho, StW	East Fork Hood R; Neal Crk; Lenz Cr	within 15 years	Calculated	$53 / m2	41,652 m2	$2,207,556	WS Councils, ODFW, USFS, NRCS, SWCD
284 - HD	Restore instream habitat complexity, including large wood placement.	Coho, ChS, StW	Tony Crk (above diversion); Hood R Delta; East Fork Hood R; upper West Fork Hood R	within 15 years	HRBAHRS	---	(91 miles)	$8,765,000	WS Councils, ODFW, USFS
285 - HD	RPA 15: Continue to update the Water Quality Plan for Total Dissolved Gas and Water Temperature in the mainstem Columbia and Snake rivers, and implement water quality measures to enhance ESA-listed juvenile and adult fish survival and maintain spawning and rearing habitat.	Coho, ChF, ChS, StW, StS	Bonneville Dam	within 15 years	Baseline	---	---	N/A	ODFW, USACOE, BPA
286 - HD	RPAs 18-21: Prepare, in cooperation with NMFS and comanaging agencies, configuration and operational plans for the Bonneville Project (2008), The Dalles Project, John Day Project (2008) and McNary Project (2009).	Coho, ChF, ChS, StW, StS	Bonneville Dam	within 10 years	Baseline	---	---	N/A	ODFW, NMFS, USACOE, BPA
287 - HD	RPA 27: Operate turbine units to achieve best fish passage survival (currently within 1% of best efficiency at mainstem dams on the lower Columbia and lower Snake rivers).	Coho, ChF, ChS, StW, StS	Bonneville Dam	within 10 years	Baseline	---	---	N/A	ODFW, USACOE, BPA

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
288 - HD	RPA 28: Implement structural improvements to adult passage at the mainstem Columbia River and Snake River projects.	Coho, ChF, ChS, StW, StS	Bonneville Dam	within 10 years	Baseline	---	---	N/A	ODFW, USACOE, BPA
289 - HD	RPA 32: Prepare annually a fish passage plan in coordination with NMFS and the Regional Forum. Operate projects year around in accordance with the criteria in the fish passage plan.	Coho, ChF, ChS, StW, StS	Bonneville Dam	within 10 years	Baseline	---	---	N/A	ODFW, USACOE, BPA
290 - HD	OR - Operate lower Columbia reservoirs at minimum operating pool (MOP) during spring and summer as long as barge transport and irrigation needs are met.	Coho, ChF, ChS, StW, StS	Bonneville Dam	within 15 years	Baseline	---	---	N/A	ODFW, USACOE, BPA
291 - HD	OR - Provide spill to total dissolved gas limits of water quality waivers or biological constraints at all dams, except maximize transportation at Snake River collector projects during lowest (10th percentile) flow years.	Coho, ChF, ChS, StW, StS	Bonneville Dam	within 10 years	Baseline	---	---	N/A	ODFW, USACOE, BPA
292 - HD	Remove dam.	Coho, ChF, ChS, StW, StS	Powerdale Dam	2010	Baseline	---	---	N/A	PacifiCorp
293 - HD	Provide cover at mouth of Herman Creek that is inundated by Bonneville pool to reduce predation.	Coho	Herman Crk	within 15 years	TBD	---	---	---	WS Councils, ODFW
294 - HD	Implement BMPs for ag chemicals.	Coho, StW	Neal & Lenz Crk	within 15 years	TBD	---	---	---	ODEQ, ODA
295 - HD	Improve domestic on-site sewage system management and residential chemical use.	ChS, StW, StS	Hood R	within 15 years	TBD	---	---	---	ODEQ, Counties, Municipalities
296 - HD	Discuss Zone 6 fishery actions with Tribes to reduce potential additional impacts. Potential actions include extending sanctuaries from mouths, and/or modifying season length or timing.	ChS, StW, StS	Columbia Mainstem	within 10 years	Baseline	---	---	N/A	ODFW

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
297 - HD	Eliminate/reduce/shift program: Investigate further reducing releases of Klickitat and Umatilla coho (primary strays in Hood R); coho releases in the Umatilla will be reduced from 1.5M to 1.0M in 2010 and all fish will be marked.	Coho	Out-of-ESU	on-going	Baseline	---	---	N/A	ODFW, NMFS, WDFW
298 - HD	Identify the specified time period, stock, timing, and strategies for reintroduction if fish managers determine that reintroductions are needed to recover the coho population.	Coho	watershed-wide	within 15 years	Baseline	---	---	N/A	ODFW, NMFS
299 - HD	Trap and sort hatchery adults: Investigate placing new weir and trap to sort hatchery fish from upstream migrants.	Coho	Neal Crk	within 15 years	Expert Opinion	$2,000,000 install; $15,000 / yr to operate-maintain	5 yrs develop; 20 yrs implement	$2,300,000	ODFW
300 - HD	Trap and sort hatchery adults: Install a floating weir to remove stray hatchery winter steelhead, spring Chinook and coho.	Coho, ChS, StW	East Fork Hood R	within 15 years	Expert Opinion	$3,500,000 install; $40,000 / yr to operate-maintain	5 yrs develop; 20 yrs implement	$4,300,000	ODFW
301 - HD	Trap and sort hatchery adults: Install and operate a fish trap at Moving Falls to remove stray hatchery spring Chinook.	ChS	West Fork Hood R at Moving Falls	within 15 years	Expert Opinion	$2,000,000 install; $15,000 / yr to operate-maintain	5 yrs develop; 20 yrs implement	$2,300,000	ODFW, NMFS
302 - HD	Move toward in-basin rearing of hatchery spring Chinook for better local adaptation of the out-of-ESU Deschutes stock used for re-introduction.	ChS	watershed-wide	within 15 years	TBD	---	---	---	ODFW
303 - HD	Work with Confederated Tribes of Warm Springs to evaluate re-introduction and explore alternative options if current program not successful.	ChS	watershed-wide	within 15 years	Baseline	---	---	N/A	ODFW
304 - HD	Work with the Confederated Tribes of Warm Springs to develop a sliding scale for take of wild spring Chinook broodstock for the integrated hatchery program based on the forecasted total return of wild fish to the population; develop forecast model as necessary.	ChS	West Fork Hood R	within 15 years	Baseline	---	---	N/A	ODFW

Action ID	Action	Species / Run Benefitting	Location	Schedule	Cost Basis	Unit Cost	Quantity	Total Cost	Potential Implementers
305 - HD	Implement a sliding scale for take of wild winter steelhead broodstock for the integrated hatchery program based on the forecasted total return of wild fish to the population (<200: no take); develop forecast model as necessary.	StW	East Fork Hood R	within 15 years	Baseline	---	---	N/A	ODFW
306 - HD	Eliminate/reduce/shift program: Discontinue hatchery summer steelhead program (last smolt release in 2009).	StS	watershed-wide	completed (2009)	Baseline	---	---	N/A	ODFW
307 - HD	(similar to CRE-14) Expand federal and state activities at Bonneville Dam to test and implement non-lethal and potentially lethal methods of reducing pinniped populations. This includes efforts to manage pinnipeds through the Marine Mammal Protection Act.	ChS, StW, StS	Bonneville Dam	on-going	see Estuary Module, TBD	---	---	---	ODFW, NMFS, USACOE, BPA, WDFW, LCREP
308 - HD	Explore adding a life-cycle monitoring site in the Hood population.	Coho, ChF, ChS, StW, StS	Neal Crk	within 15 years	within Action 43-Trib	---	---	---	ODFW

TOTAL COST *(with capital maintenance costs)*: $758,200,000

Action Priorities
A significant step towards prioritizing the actions needed for this Plan was accomplished while identifying and prioritizing the threats and limiting factors described in Chapter 5. Actions contained in Table 9-3 are those identified in the planning process that address key and secondary limiting factors and threats. Thus, these actions represent priorities among the suite of all possible actions which were not included in the Plan. However, the actions in the Plan can also be prioritized further to aid implementation schedules, proposals, and funding decisions. More detailed prioritization between actions and by location within actions will occur during the implementation phase, specifically during development of the three-year Implementation Schedules discussed in Section 9.2. However, the following guiding principles should be applied when making more detailed prioritization decisions:

- actions for populations which must achieve viability status (Low or Very Low extinction risk) are a priority
- actions addressing a threat reduction need (i.e., a decrease in a specific threat category's mortality rate going from the Current Status to the Delisting Scenario in Chapter 6[241]) are a priority
- actions which address a key limiting factor are a priority
- actions which address a greater gap between current and desired status or a greater threat reduction need are a priority
- actions in locations which will result in or protect accessible and connected high quality habitat are a priority
- restoration actions in high intrinsic potential (IP) locations are a priority
- actions intended to protect threatened high quality or highly productive habitat are a priority
- actions which provide resiliency against climate change are a priority

Although the quantity of certain restoration actions was quantified in this section, the quantity of protection actions was not. Quantifying this need is difficult given that the action addresses future unknowns in general. However, habitat protection is a very important need and it will be up to implementation efforts to determine the quantity of protection that is necessary.

It is important to provide prioritized action lists given the finite funding supply and the critical need for certain actions (see Section 9.2: Funding Strategies). This will help implementers and funding entities make more informed decisions.

9.2 Action Implementation

The Plan identifies recovery strategies and actions using the best available science to address limiting factors and threats to recover lower Columbia River salmon and steelhead in Oregon. NMFS

[241] The population scenarios in Chapter 6 describe risk level goals for each LCR salmon and steelhead population. To achieve these risk level goals, threat reduction scenario goals are described that outline the relative survival gains needed in each of the major threat categories to close the gap between current and desired status. These needed survival gains serve as the side boards for determining where efforts and resources can best be allocated to achieve recovery. Actions that address those threat categories that require the most improvement should have a higher priority than actions that address a threat category that is only targeted for a slight improvement. Within a threat category, actions in areas that are believed to result in a significant improvement in survival should be prioritized above those actions in areas that are believed to result in a marginal improvement.

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. Consequently, this recovery plan is based primarily on voluntary implementation of proposed recovery actions, and existing laws, regulations and agreements, although it is acknowledged that regulatory agencies may use this Plan to guide their decisions.

It is important to note that recovery actions are being and have been implemented by many entities based on draft versions of this Plan and the known conservation and recovery need of these ESUs given the numerous years they have been listed under the state and/or federal ESAs (Table 1-1). This Plan will help to better guide and prioritize the actions already being implemented, as well as identify other necessary actions. Many of the organizations which are currently implementing, and will implement, recovery actions in the future are not obligated to participate. It is anticipated that these organizations will choose to participate to advance their missions, as part of funding and contractual agreements, and in response to public education and outreach. In fact, there are many examples of voluntary recovery actions already being taken that support salmon and steelhead recovery.

It is also acknowledged that there may be alternative actions to those proposed in this Plan that may also attain recovery strategies. Actions to achieve a specific recovery strategy may vary due to logistics, funding constraints, or an organization's authorities and administrative processes.

Implementation Challenges

Despite the conclusion and optimism that recovery goals and desired statuses for most, if not all, lower Columbia River salmon and steelhead populations are achievable, there are significant challenges with respect to implementing enough actions to reach recovery goals. Due to the voluntary nature of this Plan, costs associated with recovery in times of economic hardship at the local, state, and federal level for both private and public entities, the timeliness necessary to improve certain populations, and the feasibility of some required actions due to conflicts with other societal goals, uncooperative or uninterested potential partners, inordinate cost, and/or technological uncertainty of solutions, uncertainty remains. In particular, chum and fall Chinook habitat restoration will be difficult given that larger human population centers are typically located within their lower system habitat locations and engineering within these "big" systems is more challenging. Additionally, as highlighted in this Plan, there are significant future threats which will have an unknown impact, but likely will be significant risk factors. If RME indicates that recovery goals are not being met, more restrictive management, and possibly new or enhanced regulatory programs, may be necessary. It will take a concerted effort on the part of all local, state, federal, tribal, private, corporate, non-governmental, and other interested and affected entities within the lower Columbia River and beyond to achieve the goals of this Plan: the conservation and recovery of lower Columbia River salmon and steelhead.

Funding Strategies

Given the challenges of Plan implementation, the large price tag associated with this (Table 9-3) and other recovery plans, and limited funding available to address conservation and recovery actions within and across populations, strata, ESUs, and domains, it is recommended that a strategic approach to funding be taken. Project solicitations and selection for funds from the NPCC Fish and Wildlife Program/BPA, OWEB, NMFS Mitchell Act program, and others should reflect Plan priorities and address limiting factors and threats identified in the Plan. In addition, these funding entities should adopt overarching strategies in line with the following:

- within ESUs, place a majority of funds in high priority actions and locations

- within ESUs, reserve some proportion of funds for lower priority actions and locations to encourage and engage ESU-wide conservation and recovery participation and achieve local Plan goals
- report funding activities in order to measure progress toward Plan objectives
- coordinate reporting metrics to assure they are appropriate for tracking purposes
- encourage innovative funding approaches such as targeted Requests for Proposals (RFPs) and Strategic Investment Partnerships (SIPs)

Oregon's Implementation Structure

Oregon's recovery plan implementation framework is intended to provide a collaborative approach to implementation, science guidance and policy direction, as well as facilitate information exchange and coordination from local-level action entities to upper level decision makers and provide linkage to state, ESU and regional forums. Existing forums, groups, partnerships and involved citizens make this implementation structure possible, but additional resources and funding will be needed to make it work effectively and successfully. The basic components of Oregon's implementation framework include a Recovery Team, an Implementation Coordinator, an Implementation Team, a Technical Team, and Strata Teams (Figure 9-1). These teams will interface with and potentially strengthen the various state agency teams associated with the Oregon Plan for Salmon and Watersheds that provide for policy, management, and monitoring of interagency Oregon Plan programs for the conservation and restoration of habitat, water quality, and salmon (http://www.oregon.gov/OPSW/). In addition, these teams will function to coordinate within the Oregon lower Columbia River implementation and adaptive management framework (Figure 9-2). The implementation framework will adapt and change as necessary to adjust to funding, available resources, and implementation needs. The roles of each of these implementation teams and the coordinator are described below.

Recovery Team: The Recovery Team provides oversight and vision to recovery plan implementation, in a similar role as the LCR Stakeholder Team served in the plan development process. This team is the responsible entity for reporting to NMFS and shares accountability for species recovery in this Management Unit (MU). The Recovery Team coordinates at state, federal and regional levels; makes decisions and acts on policy, funding and legislative needs; provides overall guidance to the recovery plan teams and coordinates with other domain teams and the Oregon Plan Core Team (interagency policy forum); and serves as the state's representative at the bi-state lower Columbia River Forum. Members of this team include representatives from the Oregon Governor's Natural Resources Office, ODFW (including the Implementation Coordinator), and the Oregon Watershed Enhancement Board. Additional membership will include interested parties from counties, tribes, federal agencies and NGOs. While the Recovery Team serves a unique purpose and function, members of this Team will also be members of the Implementation Team.

Implementation Coordinator: An ODFW implementation coordinator will serve as Oregon's "MU lead" for recovery plan implementation, under the advice and guidance of the Recovery Team. The Coordinator will be a key connector to the various teams, groups, subgroups and individual entities. The Implementation Coordinator will work in conjunction with the Implementation Team and Strata Teams to plan, schedule, track and report on action implementation, and in coordination with any Technical Teams to develop, track and report on RME activities. The Implementation Coordinator will also be a member of the Recovery Team. The Implementation Coordinator will lead the Implementation Team in its deliberations and actions, coordinate and lead three-year *Implementation Schedule* development (described later in this section) and adaptive management processes, coordinate and communicate with Watershed Teams (or individual implementation entities) and the Oregon Plan Regional Management

Teams (interagency regional manager forum), and coordinate implementing actions for which ODFW is responsible (including development of Hatchery Program Management Plans pursuant to the Fish Hatchery Management Policy that incorporate actions identified in this Plan for the hatchery programs summarized in Chapter 5 and any new programs that are developed). This MU lead will also integrate with regional forums for hydro, harvest and hatchery issues, including the FCRPS BiOp, US v OR, Northwest Planning and Conservation Council, and Columbia Basin Fish and Wildlife Authority, through linkage with ODFW staff representatives in these forums. Actions and decisions within these forums are important for achieving successful plan implementation and recovery of lower Columbia River salmon and steelhead.

Implementation Team: The Implementation Team provides advice, recommendations and support to the Implementation Coordinator (chair). This Team assists in the communication and coordination with Strata Teams or local implementation groups, development, tracking and reporting of three-year implementation plans, and tracking and reporting of research and monitoring. The Implementation Team also facilitates gathering and exchange of information, identifies and pursues funding sources, and provides for public participation, education and outreach.

Team Members include members of the LCR Stakeholder Team (cities, utilities, private forest and agriculture representatives, conservation groups, federal representatives, watershed councils, SWCDs) and other local stakeholders, interest groups, tribes and governments. This diverse group represents differing perspectives, missions, and geographic areas, with the overall objective of collectively and synergistically working together to achieve and advance recovery plan goals. The Implementation Team will be staffed by a facilitator and a NMFS representative.

Technical Team: The Technical Team provides advice and guidance on technical and science issues related to monitoring, research and evaluation, data analysis, and adaptive management that supports and strengthens effective implementation of recovery plan actions. The Team will be ad hoc and provide advice and guidance as needed and not provided by the Oregon Plan Monitoring Team (interagency monitoring forum). Members of any Technical Team may include members of the recovery plan Planning Team and Expert Panel, as well as other key state, federal, tribal, utility and private scientists and biologists, consultants, and university staff as is appropriate for the particular issue needing their advice and guidance. A voluntary chair will facilitate team operations.

Strata Teams: Strata Teams are comprised of the various local entities implementing local restoration and conservation actions via their respective authorities, mandates, missions, and work plans, and include watershed councils, SWCDs, federal and state agencies, local governments, tribes, conservation groups, and utilities. Strata Teams will be encouraged to form on a voluntary basis for a specific stratum, or will be collaborative partnership forums already in existence. In many cases, watershed councils currently serve this function with representation from a diversity of interest and action groups. Team chairs will be voluntary and teams will be self-directed. Collaborative teams will facilitate coordination and prioritization of actions and exchange of information within the stratum. They will provide project information to the Implementation Coordinator (or members of the Implementation Team) to support development of three-year implementation schedules, plans, and reports. Collectively or individually, Strata Teams will promote public involvement through outreach, education, and volunteer opportunities.

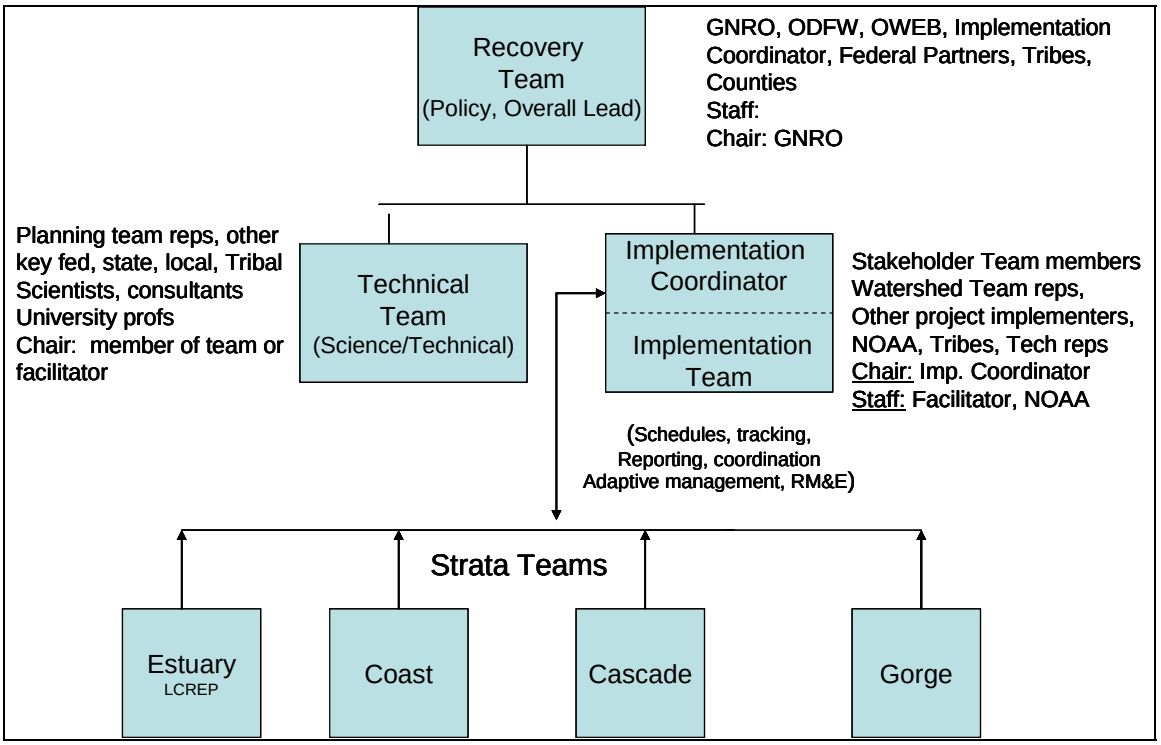

Figure 9-1. Implementation and adaptive management organizational chart for this Plan.

To help understand how the recovery plan will be implemented and how each team defined above will function within the framework described, the following description is provided.

Actions to be implemented in the recovery plan are those priority actions that address a key or secondary limiting factor. The Implementation Team will take these priority actions and develop three-year *Implementation Schedules* every three years to outline priorities for implementing the Plan in the upcoming years. These schedules will be shared with all entities involved in implementation of recovery plan actions. The funding sources identified in the Plan or Schedule will be made aware of the three-year Implementation Schedule priorities and asked to adopt or support those priorities. The recovery plan will be shared with Strata Teams, watershed councils, SWCDs, government agencies, other implementers and the general public by the Implementation Coordinator (IC) to make them aware of the priorities outlined in the plan for their local area and to seek commitment to help implement the recovery plan. The IC or members of the Implementation Team will regularly communicate with implementing organizations to keep them informed on implementation issues and to provide assistance or guidance. Members of the Implementation Team, as well as members of watershed councils and other implementing groups will be asked to encourage their constituents to commit to the implementation of the recovery plan and three-year Implementation Schedules. Watershed councils, SWCDs, cities, counties, land managers and other implementers will use the action priorities outlined in the three-year Implementation Schedules to identify projects to implement and seek funding. First priority may be to complete a reach-scale assessment or a basin-specific action plan to determine specific locations for priority actions (if this has not already been done).

The Implementation Coordinator will develop a reporting process for gathering information from implementers, including government agencies, and funding entities that will allow development of annual reports on plan implementation that will be shared with implementers, funding entities, the Implementation, Recovery and Oregon Plan Teams, and the public. Annual reports will be used to assess the effectiveness of implementation at the population and ESU level. The Implementation Team will

periodically (quarterly or annually) review progress towards implementation of priority actions and address local needs for more effective implementation (garner support from key landowners or entities, resolve uncertainties in determining priorities, support funding initiatives, etc.)

Local implementers will forward issues related to recovery plan implementation to the Implementation Coordinator or Implementation Team members to be brought before the Implementation Team. Oregon Plan Regional Management Teams will meet quarterly, or as needed, and will include an agenda item at each meeting on recovery plan implementation. The Oregon Plan Regional Management and Recovery Teams will address issues brought to the group by the Implementation Team (better agency coordination, specific issue for state agency action/enhancement, need for agency policy modification, etc.). These teams will be the source of information on improvements needed for project implementation (e.g., permitting and project coordination issues). The Oregon Plan Regional Management Team will bring recovery plan implementation issues that require a higher policy level solution to the Oregon Plan Core Team for resolution. Issues may be brought to the Recovery Team and/or LCR Forum that require resolution or cooperation at the Oregon/Washington, sovereign-to-sovereign or federal level.

As situations arise where technical advice is needed for proper recovery plan implementation or RME, an ad hoc Technical Team of technical experts from various agencies and groups can be brought together (e.g., transportation, stormwater, or contaminant focus groups at and across appropriate levels of government). The composition of the team(s) will be tailored to the specific issue to ensure appropriate expertise is involved in reviewing the issue.

Annual reports on RME results will be reported to the Implementation Team and Implementation Coordinator to facilitate adaptive management. These results and any modifications to plan implementation arising from the results will be conveyed to the individual implementing organizations by the Implementation Coordinator. The Implementation Coordinator and Implementation Team members will convey information passed down from the Recovery or Oregon Plan Regional Management Teams to the appropriate implementers or organizations.

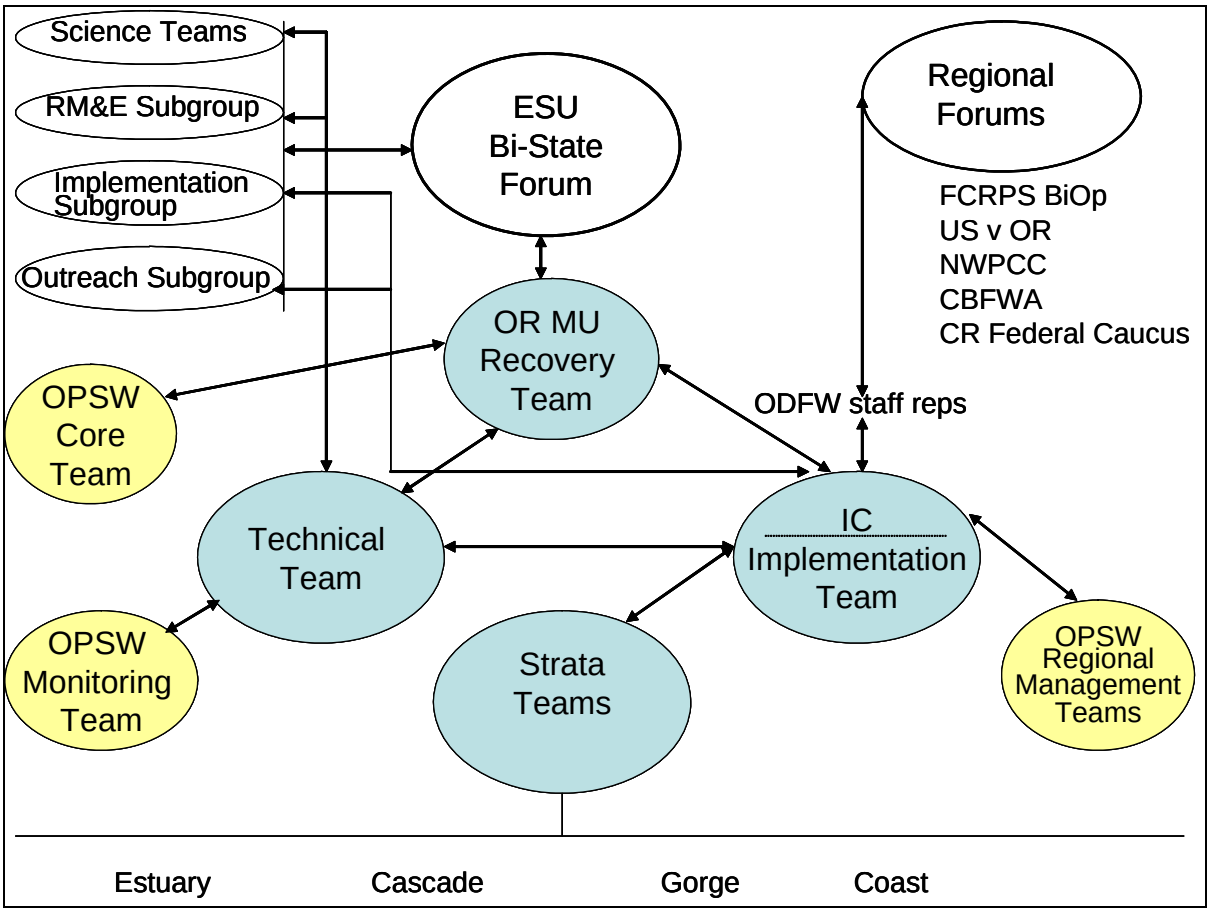

Figure 9-2. Conceptual diagram of Oregon recovery plan implementation and adaptive management approach, vertically integrated into an ESU implementation structure and horizontally integrated into other Oregon fish conservation frameworks.

9.3 Adaptive Management

Implementation of the Plan will be guided with an adaptive management process. Lower Columbia River salmon and steelhead have complex life cycles which traverse habitats from high elevation tributaries to the open ocean. Life history strategies are diverse and life stage specific habitat requirements are complex. As described earlier in this Plan, there are many limiting factors and threats that influence the viability of Oregon's lower Columbia River salmon and steelhead at all life stages. The suite of proposed management actions to address primary limiting factors and threats across the entire life cycle is equally broad and diverse. Although the limiting factors and threats, as well as the management actions, have been developed based on best available science, there remains considerable uncertainty regarding the outcomes and effectiveness of the proposed management actions and the status of populations. It is this uncertainty which generates the essential need for an effective adaptive management process.

A successful adaptive management process requires an understanding of how and why salmon and steelhead and their associated habitats respond to the management actions taken to improve their status. In addition, success requires a decision framework and process which considers new information in the development of future management actions. Also note that this Plan does not preclude the development of future, more detailed comprehensive actions at a later date through regulatory processes (e.g., NEPA and ESA; HGMP development), which will be advised by the overarching strategies identified in this Plan.

A detailed RME plan is presented in Chapter 8 which provides the foundation for gathering and synthesizing the essential information needed for adaptive management of this salmon and steelhead recovery effort. Information needs fall into four categories: 1) status and trends monitoring; 2) implementation and compliance monitoring; 3) action effectiveness monitoring; and 4) critical uncertainty research. The RME plan links the biological and physical responses to the management actions.

Oregon's Adaptive Management Plan

The Plan is intended to describe key elements for immediate implementation and also provide a strategic means of improving management decisions in the future – in essence, to be a living document. This will be done through an adaptive management process that will allow for the continual assessment of the effectiveness of management strategies and actions to improve the status of salmon and steelhead in the lower Columbia River ESUs. Through the analysis of RME data, the Oregon Plan Core Team, Regional Management Team, and LCR Advisory Board will be able to determine if the premise of the plan – that the management strategies will be able to help the ESUs achieve desired status – is accurate. If not, the adaptive management process will allow for the state to consider a different premise.

The adaptive management process for the Plan will utilize the information gathered from the RME plan to evaluate the effectiveness of the Plan in achieving its goals. Oregon will consider this information at regular intervals to assess the progress in population, strata and ESU health, along with the success of implementing actions and the effectiveness of those actions. These regular assessments will occur at three levels and within an implementation governance framework described above[242].

1. Annual status reports. The Implementation Coordinator responsible for implementing this Plan will direct production of a very brief annual report that reviews the most recent data available for the ESUs/DPSs *(see example format in Table 9-4*). This annual report will serve as an *early warning system* (see discussion later in this section) that will alert Oregon to unexpectedly adverse marine conditions; management conditions; biological characteristics of the lower Columbia River fish populations; or the habitat that supports the ESUs. The annual report will also formally document adaptive management decisions and actions, as well as how they relate to actions, desired statuses, and Delisting threat reduction Scenarios in this Plan.

2. Five-year status report. Oregon will provide RME information to NMFS for their five-year status reports, including a succinct status report regarding implementation of commitments by agencies, restoration work accomplished, and summarizing salmon, steelhead and habitat data available by population and strata.

3. Twelve-year ESU assessment. Produce a comprehensive assessment of the status of each ESU, including performance of the fish, trends in habitat, and implementation and effectiveness of restoration and management commitments. This assessment would be similar in scope to the 2005 Oregon Coastal Coho Assessment (ODFW 2005b). Depending on the outcome of this thorough 12-year assessment, the periodicity of future detailed assessments may be adjusted.

[242] The three-year Implementation Schedules described in Section 9.2 will be one vehicle for implementing adaptive management.

Table 9-4. Proposed content of annual status report which will include elements of the early warning system described later in Section 9-3.

Oregon Lower Columbia River Recovery Plan Annual Report Card

Summary Regarding Overall Status of each ESU

Short paragraph regarding the overall status of each ESU – are there any alarming data or observations that would call Oregon's recovery assumptions or programs into question? Are there indications that the ESU is at greater risk than anticipated in the Recovery Plan? Is additional monitoring or scientific evaluation warranted? If so, how and when should the analysis be conducted?

Data Reviewed

- Adult counts – are data regarding adult distribution and abundance available? If so, are the values within previously observed and/or expected values and are they consistent with expectations based on marine survival?
- Juvenile monitoring data – are data regarding juvenile distribution and abundance available? If so, are the values within previously observed and/or expected values?
- Habitat data – is habitat trend data available? If so, what does the trend indicate?
- Harvest impact data – are harvest impacts consistent with conservation, progress towards desired status, and recovery guidelines?
- Hatchery survival data – is survival of hatchery fish within previously observed and/or expected values?
- Natural fish survival rates data – is survival of naturally produced fish within previously observed and/or expected values?
- Information from local entities and landowners – e.g. Rapid BioAssessments; restoration efforts; and results of effectiveness monitoring.
- Conservation project implementation data – are agencies meeting commitments in an effective and timely manner?

Recommendations regarding the ESU

Note key recommendations, if any, regarding new monitoring, implementation emphasis, management action, and or scientific analysis that should receive priority during the next year.

Date Recovery Plan adopted:
Date reviewed:

The adaptive management process will play out on different levels as the Plan is implemented. Annual RME information collected will be reviewed to determine the effectiveness of site-specific actions (e.g., enhancing an area to promote the development of beaver dams). Those actions found to be ineffective will be discouraged. New actions based on the results of research may be proposed to more effectively implement a strategy. The state will make these responsive adjustments as more information is collected. Considering changes to strategies will be a more deliberative process.

Assessing the effectiveness of the Plan, including its strategies, will be conducted in 2022, and periodically thereafter. An assessment will also be considered if information suggests there has been a significant decline in the health of any of the ESUs (i.e., the annual report will serve as an early warning system). Assessments of the Plan will be coordinated by the Implementation Coordinator, with involvement of the Advisory Board, the Governor's Natural Resources Office, and Oregon Plan teams, and will include public participation.

The adaptive management process can lead to changes in all aspects of the Plan. The review of information may suggest revision of one or more of the RME's measurable criteria, their metrics, or thresholds for passing. The population delineations in the Plan could also be revised in the future. Any such revisions would involve NMFS and Oregon's other co-managers.

If the periodic assessment of this Plan's effectiveness shows that progress is not being made toward achieving the desired status of any or all of the ESUs, it may be necessary to consider other approaches to obtain the improvements in survival needed. In this situation Oregon will convene the Planning Team and consider alternate approaches. The first alternative to consider would be whether the timeline identified for delisting is appropriate. If it is determined that the timeline is still appropriate, alternative actions should be considered. It is impossible to outline all of the potential alternatives to consider without knowing what the results of RME that may have been conducted have concluded. Some alternatives that may be considered include: implementing additional actions that have immediate benefits, such as those related to harvest and hatcheries; identifying actions that seek to increase the level of protective and restorative practices for tributary habitat, potentially shifting from mostly voluntary to more regulatory approaches; or developing new actions for threats that were not initially identified as limiting. This list of potential alternatives is not complete and these additional actions are not suggested at this time. They are only being provided as examples of what might be considered in the future.

Population Status Assessments

The effectiveness of Oregon's Lower Columbia River Recovery Plan to recover salmon and steelhead in the Lower Columbia will be determined by regularly assessing the status of each of Oregon's populations over time. To determine the status of each population, an assessment will be made of each population's current status utilizing the interim measurable criteria identified in Chapter 8. A comparison of that current status to the population's status at the time the Plan was implemented, or the population's status at the time of the prior assessment, will be used to determine whether status has improved, remained the same, or declined. Status cannot be evaluated over a short period of time, but may be discernable prior to the full assessment period called for within each interim criterion (e.g., six straight years of lower than expected abundance and productivity would cause the abundance criterion to be considered unmet before the full 12 years had expired).

A decline in the status of any population would require Oregon to evaluate whether the decline is the result of ineffective actions, or unforeseen limiting factors and threats. If a population decline is indicated, the Implementation Coordinator will convene appropriate entities and groups to consider the cause for the decline and the strategies and actions necessary to reverse the decline and set a trend towards recovery. The results of this assessment and proposed strategies and actions will be shared with the public and the legislature.

Assessments showing no change in population status, or improvement, will be utilized to determine if the strategies and actions implemented are as effective as anticipated. Action effectiveness will be considered during the 12-year review process.

Future NMFS Status Reviews and Plan Modifications

The future implementation of this Plan relies heavily on incorporating knowledge gained from research, monitoring, and evaluation of populations, limiting factors and threats, and the actions designed to achieve the desired statuses. As part of this adaptive management process, the ESA requires a review of all listed species at least once every five years. NMFS interim recovery guidance (NMFS 2007b) requires that immediately following this five-year review, approved recovery plans will be reviewed, in conjunction with implementation monitoring, to determine whether or not the Plan needs to be brought up to date.

NMFS's Interim Recovery Guidance describes 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[243].

Updates can be made by NMFS and would be forwarded to stakeholders and cooperators, and posted on the NMFS website. 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. Minor addenda such as information updates to implementation strategies also can be added to a plan after it has been approved. A revision is a substantial rewrite and is required if major changes are needed 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 must include a public review and comment period.

Using Monitoring Information as an Early Warning System for Adaptive Management

In order to provide timely guidance to those responsible for the adaptive management of this recovery plan, it is important to incorporate information gathered by RME into an early warning system that will raise "red flags" regarding the need for potential course corrections to the plan. This system also provides the conservation status required in the NFCP.

The early warning system for the Plan will be based on annual assessments of the likelihood of attaining the measurable criteria goals over the time interval specified by the criteria in Chapter 8, given previously observed results. The following illustrates an example of how the measurable criteria will be used as an early warning system for actions related to this plan.

Example: Evaluation Thresholds for Hatchery Related Metrics (from Chapter 8)

Pass – Over a nine year period, the average percentage of the total number of spawners that are of hatchery origin is on average less than or equal to 10 percent.
Fail – Over a nine year period, the average percentage of the total number of spawners that are of hatchery origin is on average greater than 10 percent.

Early warning analysis

Table 9-5 shows three hypothetical examples of hatchery stray rates. In example one, the annual stray rates over a nine-year period result in an average stray rate of nine percent, which means a pass for the hatchery stray metric used in this example. In example two, the annual stray rates during the first three years are high enough that even if no hatchery fish are found spawning with the natural origin fish for the remaining three years, the population would fail for this criterion. In this case, a red flag would be raised after the third year of monitoring telling those responsible for managing hatchery strays to modify their approach to reducing hatchery stray rates. Example three is similar to example two, except that a red flag would not be raised until after year six.

[243] For example, if LCR fall Chinook are upgraded to "endangered" status, the Plan will need to be revised.

Table 9-5. Hypothetical examples of hatchery stray rate "red flag" scenarios. A red flag is raised after year three in example #2 and after year six in example 3.

	% Hatchery Strays		
Year	**Example 1**	**Example 2**	**Example 3**
1	5%	40%	10%
2	10%	30%	30%
3	20%	40%	10%
4	5%	0%	10%
5	10%	0%	20%
6	10%	0%	30%
7	5%	0%	0%
8	10%	0%	0%
9	5%	0%	0%
Average	9%	12%	12%

Similar analyses for all measurable criteria will be incorporated into the annual report card described in this chapter to get the conservation status levels for lower Columbia River salmon and steelhead populations.

Chapter 10: Broad Sense Recovery

The earlier chapters in this Plan have defined what is believed to be necessary for the lower Columbia River ESUs to be viable and potentially delisted. Along with this definition, the chapters have described what the current status is, the factors limiting the fish and the actions that will be necessary to close the gap between current statuses and the desired statuses for delisting. If Oregon is successful in effectively implementing the actions identified in this plan, we believe the delisting recovery goal will be achieved.

Achieving the level of recovery defined in the delisting scenarios in Chapter 6 will result in a few populations in each stratum being viable and the other populations being at moderate, high, or very high risk of extinction. Under these scenarios, it will be unlikely for the wild salmon and steelhead populations in the Oregon portion of the lower Columbia River ESUs to provide many significant benefits to the citizens of Oregon.

For those populations that achieve viability, they will be able to withstand some level of incidental impact from fisheries targeting hatchery fish, but will have little ability to withstand direct harvest. Returning wild spawners will number in the several thousands, but will not be numerous enough to be seen spawning throughout the population area. Many streams will remain unoccupied by salmon and steelhead and many people will not be aware that they are living with salmon. Cultural and ecological benefits of having numerous salmon and steelhead spawning throughout the ESUs will not be achieved.

For those populations that are not targeted for viability, there will be fewer, if any, of the benefits a viable population can provide. These populations will be maintained at levels that provide little more than insurance against an ESA listing. They will not be much more than remnants of what once were present in these areas.

10.1 Goal and Criteria for Broad Sense Recovery

For many Oregonians, maintaining salmon and steelhead as something close to "museum pieces" is not enough. The public advisory group that helped develop Oregon's Native Fish Conservation Policy recognized this and supported the objective of conserving Oregon's native fish at levels that can "provide recreational, commercial, cultural and aesthetic benefits … to present and future citizens" (ODFW 2002). The NFCP uses this statement as the basis for a desired status within each native fish conservation plan. This objective also fulfills the mission of the *Oregon Plan for Salmon and Watersheds*, which is to restore "Oregon's native fish populations and the aquatic systems that support them to productive and sustainable levels that will provide substantial environmental, cultural, and economic benefits". The OPSW is founded on the principle that citizens throughout the region value and enjoy the substantial ecological, cultural and economic benefits that derive from having healthy, diverse populations of salmon and steelhead. Such a desired status is also considered in ESA recovery plans and has been called "broad sense recovery." Since this Plan, which serves as a federal recovery plan and a State of Oregon conservation plan, has two desired statuses (i.e., delisting and providing greater societal benefits), we will use the term "broad sense recovery" to represent the long-term goal of providing societal benefits beyond delisting. The LCR Stakeholder Team that helped develop this conservation and recovery plan discussed the idea of broad sense recovery early in the planning process. Based on those discussions a general goal for wild populations of salmon and steelhead in the Oregon portion of the lower Columbia River ESUs was developed.

Broad Sense Recovery Goal

Oregon aims to achieve the following broad sense recovery goal for lower Columbia River salmon and steelhead:

> *Oregon populations of naturally produced salmon and steelhead are sufficiently abundant, productive, and diverse (in terms of life histories and geographic distribution) that the ESU as a whole (a) will be self-sustaining, and (b) will provide significant ecological, cultural, and economic benefits.*

Broad Sense Recovery Criteria

Broad sense recovery criteria are not intended to be applied to all lower Columbia River salmon and steelhead ESUs, since these ESUs include some populations in Washington. Thus, meeting the following broad sense recovery criteria is not dependent on performance of populations in Washington. The following criteria have been developed to help measure attainment of the broad sense recovery goal in Oregon.

1) All Oregon lower Columbia River salmon and steelhead populations have a "very low" extinction risk and are "highly viable" over 100 years throughout their historic range[244]; and

2) The majority of lower Columbia River salmon and steelhead populations are capable of contributing social, cultural, economic and aesthetic benefits on a regular and sustainable basis.

The first criterion can be measured based on the risk of extinction over 100 years being less than 1 percent – the same metric for a population at very low risk. It is uncertain whether the achievement of this criterion in itself will lead to the achievement of the broad sense recovery goal, or if greater improvement in status is needed to achieve the second criterion of broad sense recovery. It can also be measured based on the abundance monitoring and targets identified in Chapter 8.

The second criterion is much more subjective and will be based on value judgments made by the Implementation Team during the regular 12-year plan assessments. These judgments will likely include a review of the amount and types of fisheries being supported by each wild population, the public perception of how healthy the populations are, and whether any cultural or aesthetic uses of the populations are being limited.

Broad sense recovery is a long-term goal for the lower Columbia River ESUs. There are no rules or laws that require that it be achieved within a stated period of time; rather it will be a goal to measure progress against. Because the broad sense recovery goal requires all of the populations to be highly viable, the lower Columbia River ESUs will achieve the delisting recovery goal before they achieve broad sense recovery. It is likely that some populations can achieve the first broad sense recovery criterion (very low risk of extinction) well before other populations. For many populations, it appears possible to go beyond very low risk, and for those populations (with a VL+ risk class in Table 10-1) the broad sense scenario is to achieve that higher level of viability (see Chapter 6 for comparison of broad sense and maximum feasible scenarios).

[244] Having a "very low" extinction risk is equivalent to being "highly viable" in the parlance of population status assessment for recovery plans. A "highly viable" naturally-producing salmonid population with a "very low" extinction risk has less than a 1% probability of extinction over a 100-year period, corresponding to at least a 99% persistence probability. Probabilities result from an integrated assessment of the population's abundance, productivity, spatial structure, and diversity statuses (see Chapter 4 for more detail).

10.2 Broad Sense Scenarios

The effort needed to achieve broad sense recovery for all of the ESUs is uncertain, but believed to be substantial and well beyond what is necessary to achieve delisting. Table 10-1 shows the current and broad sense abundances for each population and the gap between the two under their respective broad sense scenarios. This table also shows the level of confidence that the planners expressed in society's ability to achieve the scenario objectives. This confidence was based on professional judgment as to what level of improvements could be made for each threat category and the current constraints (both socially and infrastructure-wise) that might prevent threat reductions from going as low as is called for in Table 10-2.

Tables 10-2 and 10-3 show respectively the threat impact rates needed to achieve the broad sense recovery goal for each population and the resulting percent mortality improvement for each threat category. The current impacts can be found in the scenario tables in Chapter 6.

The professional opinion of the Planning Team is that it will be difficult to achieve broad sense recovery in some populations (Table 10-1). The amount of effort needed to achieve the threat reductions called for in Table 10-2 is difficult to determine. For this reason, the majority of this conservation and recovery plan focuses on defining the delisting scenarios and what must be done to achieve them. Delisting recovery is the first priority for this plan, but broad sense recovery is the long-term goal.

Table 10-1. Broad sense scenario targets (abundance and risk class) for all Oregon lower Columbia River salmon and steelhead populations. Shared populations with Washington are indicated by an asterisk. (Note: Unable to determine for chum populations).

		Current		Broad Sense Scenario			
Species / Stratum (Run)	Population	Abundance	Overall Risk Class	Abundance	A&P Gap	Overall Risk Class	Confidence
COHO							
Coast							
	Youngs Bay	4	VH	11,913	11,909	VL	Unlikely
	Big Creek	8	VH	6,321	6,313	VL	Unlikely
	Clatskanie	1,363	H	3,201	1,838	VL	Achieve
	Scappoose	1,942	M	4,184	2,242	VL +	Achieve
Cascade							
	Clackamas	6,548	M	17,674	11,126	VL +	Achieve
	Sandy	1,622	VH	6,514	4,892	VL	Unlikely
Gorge							
	*Lower Gorge**	22	VH	3,102	3,080	VL	Unlikely
	Upper Gorge/Hood	41	VH	5,486	5,445	VL	Unlikely
CHINOOK							
Coast (Fall)							
	Youngs Bay	379	H	1,510	1,131	VL	Unlikely
	Big Creek	216	VH	1,479	1,263	VL	Unlikely
	Clatskanie	6	VH	1,745	1,739	VL +	Achieve
	Scappoose	356	H	2,336	1,980	VL +	Achieve
Cascade (Fall)							
	Clackamas	558	VH	4,359	3,801	VL +	Achieve
	Sandy	144	VH	1,487	1,343	VL	Unlikely
Gorge (Fall)							
	*Lower Gorge**	74	VH	1,471	1,397	VL	Unlikely
	*Upper Gorge**	17	VH	1,450	1,433	VL	Unlikely
	Hood	33	VH	1,516	1,483	VL	Unlikely
Cascade (Late Fall)							
	Sandy	1,794	L	3,858	2,064	VL +	Achieve
Cascade (Spring)							
	Clackamas	1,371	M	8,377	7,006	VL +	Achieve
	Sandy	714	M	7,871	7,157	VL +	Achieve
Gorge (Spring)							
	Hood	327	VH	6,536	6,209	VL +	Achieve
STEELHEAD							
Coast (Winter)							
	Youngs Bay	2,486	VL	4,733	2,247	VL +	Achieve
	Big Creek	1,143	L	3,182	2,039	VL +	Achieve
	Clatskanie	2,451	VL	3,982	1,531	VL +	Achieve
	Scappoose	3,245	VL	5,169	1,924	VL +	Achieve
Cascade (Winter)							
	Clackamas	3,897	M	13,578	9,681	VL	Unlikely
	Sandy	674	H	2,106	1,432	VL +	Achieve
Gorge (Winter)							
	*Lower Gorge**	550	M	1,759	1,209	VL	Unlikely
	*Upper Gorge**	151	VH	1,302	1,151	VL	Unlikely
	Hood	1,127	M	2,940	1,813	VL +	Achieve
Gorge (Summer)							
	Hood	35	VH	2,616	2,581	VL	Unlikely
CHUM							
Coast							
	Youngs Bay	E	VH	TBD	---	VL	---
	Big Creek	E	VH	TBD	---	VL	---
	Clatskanie	E	VH	TBD	---	VL	---
	Scappoose	E	VH	TBD	---	VL	---
Cascade							
	Clackamas	E	VH	TBD	---	VL	---
	Sandy	E	VH	TBD	---	VL	---
Gorge							
	*Lower Gorge**	E	VH	TBD	---	VL	---
	*Upper Gorge**	E	VH	TBD	---	VL	---

Table 10-2. Threat rates to achieve broad sense recovery scenarios for Oregon lower Columbia River salmon and steelhead populations. Shared populations with Washington are indicated by an asterisk. (Note: Unable to determine for chum populations)

		Broad Sense Scenario Threat Rates						
Species / Stratum (Run)	Population	Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Cumulative
COHO								
Coast								
	Youngs Bay	16.00%	8.00%	0.00%	10.00%	5.00%	3.00%	35.91%
	Big Creek	19.00%	8.00%	0.00%	15.00%	5.00%	3.00%	41.63%
	Clatskanie	68.00%	8.00%	0.00%	25.00%	10.00%	4.00%	80.92%
	Scappoose	70.00%	8.00%	0.00%	25.00%	5.00%	4.00%	81.12%
Cascade								
	Clackamas	40.00%	8.00%	6.00%	25.00%	10.00%	4.00%	66.38%
	Sandy	45.00%	8.00%	0.00%	25.00%	9.00%	4.00%	66.85%
Gorge								
	*Lower Gorge**	12.00%	8.00%	0.00%	5.00%	5.00%	4.00%	29.86%
	Upper Gorge/Hood	3.00%	8.00%	23.00%	5.00%	0.00%	5.00%	37.98%
CHINOOK								
Coast (Fall)								
	Youngs Bay	63.00%	26.00%	0.00%	60.00%	5.00%	4.00%	90.01%
	Big Creek	57.00%	26.00%	0.00%	42.00%	5.00%	4.00%	83.17%
	Clatskanie	72.00%	26.00%	0.00%	35.00%	5.00%	5.00%	87.85%
	Scappoose	57.00%	26.00%	0.00%	35.00%	5.00%	5.00%	81.33%
Cascade (Fall)								
	Clackamas	55.00%	26.00%	0.00%	35.00%	5.00%	6.00%	80.67%
	Sandy	44.50%	26.00%	0.00%	35.00%	5.00%	6.00%	76.16%
Gorge (Fall)								
	*Lower Gorge**	17.00%	26.00%	0.00%	10.00%	5.00%	6.00%	50.64%
	*Upper Gorge**	-76.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-76.00%
	Hood	-9.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-9.00%
Cascade (Late Fall)								
	Sandy	16.60%	26.00%	0.00%	30.00%	5.00%	6.00%	61.42%
Cascade (Spring)								
	Clackamas	44.00%	8.00%	6.40%	25.00%	10.00%	7.00%	69.73%
	Sandy	52.00%	8.00%	0.00%	25.00%	5.00%	7.00%	70.74%
Gorge (Spring)								
	Hood	19.00%	8.00%	12.00%	25.00%	5.00%	7.00%	56.55%
STEELHEAD								
Coast (Winter)								
	Youngs Bay	35.00%	8.00%	0.00%	10.00%	10.00%	6.00%	54.47%
	Big Creek	25.00%	8.00%	0.00%	10.00%	10.00%	6.00%	47.46%
	Clatskanie	42.00%	8.00%	0.00%	10.00%	5.00%	7.00%	57.57%
	Scappoose	43.00%	8.00%	0.00%	10.00%	5.00%	7.00%	58.30%
Cascade (Winter)								
	Clackamas	17.00%	8.00%	5.00%	5.00%	0.00%	7.00%	35.91%
	Sandy	74.00%	8.00%	0.00%	10.00%	10.00%	7.00%	81.98%
Gorge (Winter)								
	*Lower Gorge**	0.00%	8.00%	0.00%	3.00%	0.00%	7.00%	17.01%
	*Upper Gorge**	-107.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-107.00%
	Hood	-43.00%	7.00%	16.00%	15.00%	10.00%	10.00%	23.09%
Gorge (Summer)								
	Hood	-0.25%	7.00%	16.00%	5.00%	0.00%	8.00%	31.55%
CHUM								
Coast								
	Youngs Bay	---	---	---	---	---	---	---
	Big Creek	---	---	---	---	---	---	---
	Clatskanie	---	---	---	---	---	---	---
	Scappoose	---	---	---	---	---	---	---
Cascade								
	Clackamas	---	---	---	---	---	---	---
	Sandy	---	---	---	---	---	---	---
Gorge								
	*Lower Gorge**	---	---	---	---	---	---	---
	*Upper Gorge**	---	---	---	---	---	---	---

Table 10-3. Improvement in threat mortality needed for Oregon lower Columbia River salmon and steelhead populations to achieve broad sense recovery scenarios. Shared populations with Washington are indicated by an asterisk. (Note: Unable to determine for chum populations.)

		% Improvement of Threats (Broad Sense Scenario)						
Species / Stratum (Run)	Population	Tributary Habitat	Estuary Habitat	Hydro	Harvest	Hatchery	Predation	Cumulative
COHO								
Coast								
	Youngs Bay	83.70%	22.33%	---	88.89%	94.19%	46.43%	64.08%
	Big Creek	80.60%	22.33%	---	78.57%	94.19%	46.43%	58.34%
	Clatskanie	18.04%	22.33%	---	28.57%	23.08%	33.33%	11.93%
	Scappoose	15.84%	22.33%	---	28.57%	0.00%	33.33%	11.09%
Cascade								
	Clackamas	35.35%	22.33%	24.05%	28.57%	71.43%	37.50%	24.18%
	Sandy	45.57%	22.33%	100.00%	28.57%	0.00%	37.50%	27.14%
Gorge								
	*Lower Gorge**	87.43%	22.33%	---	85.71%	93.75%	37.50%	69.99%
	Upper Gorge/Hood	96.81%	22.33%	14.50%	85.71%	100.00%	31.51%	61.84%
CHINOOK								
Coast (Fall)								
	Youngs Bay	11.90%	19.25%	---	20.00%	88.89%	28.57%	7.67%
	Big Creek	28.79%	19.25%	---	35.38%	88.89%	28.57%	14.73%
	Clatskanie	27.78%	19.25%	---	41.67%	88.89%	23.08%	12.12%
	Scappoose	28.39%	19.25%	---	41.67%	88.89%	23.08%	16.28%
Cascade (Fall)								
	Clackamas	33.02%	19.25%	---	41.67%	88.89%	17.81%	17.28%
	Sandy	46.25%	19.25%	100.00%	41.67%	88.89%	17.81%	22.04%
Gorge (Fall)								
	*Lower Gorge**	79.28%	19.25%	---	83.33%	88.89%	17.81%	48.07%
	*Upper Gorge**	195.10%	100.00%	100.00%	100.00%	100.00%	100.00%	177.60%
	Hood	112.62%	100.00%	100.00%	100.00%	100.00%	100.00%	109.22%
Cascade (Late Fall)								
	Sandy	27.86%	15.86%	100.00%	40.00%	80.00%	17.81%	25.15%
Cascade (Spring)								
	Clackamas	34.73%	15.79%	76.47%	0.00%	84.62%	42.15%	26.64%
	Sandy	44.31%	15.79%	100.00%	0.00%	81.48%	42.15%	27.33%
Gorge (Spring)								
	Hood	78.75%	15.79%	65.62%	0.00%	88.89%	55.13%	42.20%
STEELHEAD								
Coast (Winter)								
	Youngs Bay	40.30%	15.79%	---	0.00%	50.00%	46.90%	28.42%
	Big Creek	55.73%	15.79%	---	0.00%	75.00%	46.90%	41.50%
	Clatskanie	32.02%	15.79%	---	0.00%	0.00%	40.17%	22.08%
	Scappoose	30.30%	15.79%	---	0.00%	0.00%	40.17%	21.03%
Cascade (Winter)								
	Clackamas	73.77%	15.79%	3.85%	50.00%	100.00%	42.15%	56.00%
	Sandy	10.32%	15.79%	100.00%	0.00%	80.77%	42.15%	13.00%
Gorge (Winter)								
	*Lower Gorge**	100.00%	15.79%	---	70.00%	100.00%	42.15%	77.03%
	*Upper Gorge**	309.60%	100.00%	100.00%	100.00%	100.00%	100.00%	240.80%
	Hood	-3639.13%	18.60%	55.31%	0.00%	66.67%	39.39%	67.26%
Gorge (Summer)								
	Hood	100.26%	18.60%	55.31%	66.67%	100.00%	45.58%	68.16%
CHUM								
Coast								
	Youngs Bay	---	---	---	---	---	---	---
	Big Creek	---	---	---	---	---	---	---
	Clatskanie	---	---	---	---	---	---	---
	Scappoose	---	---	---	---	---	---	---
Cascade								
	Clackamas	---	---	---	---	---	---	---
	Sandy	---	---	---	---	---	---	---
Gorge								
	*Lower Gorge**	---	---	---	---	---	---	---
	*Upper Gorge**	---	---	---	---	---	---	---

10.3 Strategies and Actions to Achieve Broad Sense Recovery

As was mentioned above, populations and ESUs will likely achieve delisting recovery before broad sense recovery. As progress is made in implementing the actions identified in Chapter 7, the effectiveness and status monitoring identified in Chapter 8 will help define how much effort will be needed to achieve not only delisting recovery, but broad sense recovery as well. The factors outlined in Chapter 5 that currently limit Oregon lower Columbia River salmon and steelhead from achieving the delisting scenarios defined in Chapter 6 are also the same factors limiting the achievement of the broad sense scenarios. It will require reducing the impacts of those factors to the levels indicated in Table 10-2, a greater extent than required for the delisting scenarios, to achieve the broad sense scenarios.

Just as the same limiting factors must be addressed for broad sense as for delisting, the same strategies and actions identified to achieve delisting (Chapter 7) will need to be implemented for broad sense – only to a greater level or on a broader scale. As a result, no additional actions are identified in this Plan to achieve broad sense recovery. The quantity of work identified that must get done to achieve the threat reductions outlined in the delisting scenarios can be used to gauge how much additional work will be needed to achieve the threat reductions needed to achieve very low risk throughout the ESUs.

The threat reduction scenarios identified for each population to achieve broad sense recovery (Table 10-2) outline the amount each threat category must be reduced. For those populations that there is confidence that they can achieve the broad sense scenario, the threat impacts for all but the tributary habitat impact show the same threat impact rate as was defined for desired status. This results in the required reduction in threat impact coming only from additional improvements in tributary habitat. As was stated in Chapter 6, the reductions in estuary habitat, hydro, harvest, hatchery and predation called for in the delisting scenarios were the maximum that the Planning Team believed were possible.

The threat rates for most of the populations that are identified in Table 10-1 as being unlikely to achieve the broad sense scenarios were adjusted down in the Scenario Analyses to achieve the modeled abundance necessary to achieve a very low risk of extinction. These scenarios are considered unlikely to be achieved because they call for reductions beyond what the Planning Team believed to be possible. For these populations, it will be necessary to monitor their status improvement as actions are implemented to achieve their delisting scenarios. Because there were anomalies in the data used to develop the conservation gaps and broad sense scenarios for these populations, it may become apparent that it will not take as much threat reduction as called for in the above scenarios. The issues related to the delineation of the Gorge Stratum may have also played a role in the scenarios for Gorge populations being challenging. The scenarios for the Gorge populations will be revisited if it is determined that a different delineation should be made for this portion of the ESUs.

Additional actions may be needed in some population areas to obtain the hatchery threat reductions associated with achieving very low risk (i.e., hatchery spawners comprising 10 percent or less of the natural spawners). Some, or most, of these reductions may be achieved through actions already proposed to address this threat in other populations' delisting scenarios (addressing stray hatchery fish from out-of-ESU areas). The same actions identified to remove hatchery fish in some populations under the desired status scenario would need to be implemented for those populations needing still further reductions in spawning hatchery fish under the broad sense scenario.

For the Youngs Bay and Big Creek populations of coho and fall Chinook, the continued implementation of the large hatchery releases and terminal fisheries in those areas will likely remain a limiting factor to achieving viability, or broad sense recovery. It may be possible to achieve broad sense recovery for these populations after the other populations in the ESUs achieve high viability. If other populations can

support a significant level of harvest in the ocean and Columbia River, that would reduce the need for the hatchery programs and terminal fisheries in Youngs Bay and Big Creek. This would then allow the hatchery and harvest impacts to be reduced to levels identified in Table 10-2 for broad sense recovery.

Additional threat reductions in estuary habitat will need to be reevaluated as the effectiveness of actions taken in the estuary become known. The threat reduction used in all of the population scenarios came from the proposed NMFS Estuary Module and was a hypothetical value the scientists suggested could be achieved if all actions identified in the Module were implemented to their fullest. Effectiveness monitoring may determine that greater benefit is being achieved from implemented actions than NMFS scientists thought. Until such evidence is found, no additional estuary habitat actions are proposed to achieve the broad sense scenarios.

While the same tributary actions identified for achieving delisting scenarios in Chapter 7 will be needed for broad sense recovery, additional site-specific locations beyond those identified and treated for delisting recovery will need to be identified and the actions implemented. The locations for additional actions will come from data gathered from implementing actions in Chapter 7 that call for documenting habitat conditions and prioritizing locations. The level of additional habitat actions needed to achieve the broad sense scenarios will become apparent as results of RME associated with determining which actions should be implemented and the effectiveness of actions become available.

10.4 Implementation and Adaptive Management for Broad Sense Recovery

The RME identified in Chapter 8 and adaptive management process outlined in Chapter 9 will inform the Implementation and Recovery Teams on progress towards achieving the broad sense recovery goal. The benchmarks identified in Chapter 8 to measure progress related to biological recovery and to address the five ESA listing factors can also be used to determine progress towards broad sense recovery. The results of effectiveness monitoring will help determine how long it may take to achieve broad sense recovery, or if it appears to even be possible. The results of RME will inform the quantity, types and locations of actions that need to be implemented to achieve broad sense recovery, or results may identify that additional strategies may be needed to address a newly discovered limiting factor.

The adaptive management process identified in Chapter 9 has already been identified as being a crucial part of this recovery plan being effective and successful at achieving the desired delisting status. It will be even more important to the achievement of broad sense recovery. The uncertainties around what broad sense recovery looks like, what effort it will take to achieve it, and how long it will take to achieve it, are greater than those surrounding desired delisting status. The annual and periodic review of information related to implementation of the actions identified in this plan, the changing status of populations and the resolution of critical uncertainties will be necessary to begin to lessen the uncertainties surrounding broad sense recovery. Through the adaptive management process the Implementation and Recovery Teams will learn not only what is working and what is not, but also how responsive each population is to improvements made and how that influences the need for additional actions and progress towards delisting and broad sense recovery.

10.5 Conclusion

The development of an effective implementation framework coupled with a responsive adaptive management plan provides the best assurance that this *Lower Columbia River Conservation and Recovery Plan for Oregon Populations of Salmon and Steelhead* will be fully implemented and effective. The identification in this Plan of the gaps that must be closed to achieve both delisting and broad sense recovery, along with the highlighting of the key and secondary factors that have caused those gaps and the

actions necessary to address those factors and reverse their impacts, will ensure that the goals for recovery will be achieved if fully implemented. Implementation and the success of this plan, however, relies on more than just what is described and identified in this Plan. This Plan will only be successful if the citizens of Oregon living within the Lower Columbia River sub-domain embrace this Plan and voluntarily take the actions that are described herein. It is only through the involvement of all of those who live and work in this area that recovery will be achieved.

References

Ad Hoc Supplementation Monitoring and Evaluation Workgroup (AHSWG). 2008. Recommendations for broad scale monitoring to evaluate the effects of hatchery supplementation on the fitness of natural salmon and steelhead populations. Final Report of the Ad Hoc Supplementation Monitoring and Evaluation Workgroup.

Alsbury, T. 2008. Personal communications. Oregon Department of Fish and Wildlife.

Anderson et al. 2006 and 2007. Distribution of dissolved pesticides and other water quality constituents in small streams, and their relation to land use, in the Willamette River Basin, Oregon. Water-Resources Investigations Report 97–4268.]

Anlauf, K., K. Jones, C, Stein and P. Kavanagh. 2006. Lower Columbia River Basin coho salmon habitat assessment: status of habitat and production potential and capacity for coho salmon. Oregon Department of Fish and Wildlife, unpublished report.

Ardren, W. 2003. Genetic Analyses of Steelhead in the Hood River, Oregon: Statistical Analyses of Natural Reproductive Success of Hatchery and Natural-Origin Adults Passed Upstream of Powerdale Dam. Report to the Bonneville Power Administration, Portland, OR.

Baldwin, D.H., J.F. Sandahl, J.S. Labenia, and N.L. Scholz. 2003. Sublethal effects of copper on coho salmon: impacts on non-overlapping receptor pathways in the peripheral olfactory nervous system. Environmental Toxicology and Chemistry 22(10):2266-2274.

Bambrick, D., T. Cooney, B. Farman, K. Gullett, L. Hatcher, S. Hoefer, E. Murray, R. Tweten, R. Gritz, P. Howell, K. McDonald, D. Rife, C. Rossel, A. Scott, J. Eisner, J. Morris and D. Hand. 2004. Critical Habitat Analytical Review Team (CHART) Assessment for the Middle Columbia River Steelhead ESU.

Bartz, K., K. Lanueux, M. Scheuerell, T. Beechie, A. Haas, and M. Ruckelshaus. 2005. Translating restoration scenarios into habitat conditions: an initial step in evaluating strategies for Chinook salmon (*Oncorhynchus tshawytsch*). Canadian Journal of Fisheries and Aquatic Sciences 63:1578-1595.

Beak Consultants. 2000. Adult salmonid and spawning surveys for the Lower Bull Run River, 1999. Technical memorandum to Steve Kucas, Portland Bureau of Water Works. February 8, 2000. Portland, Oregon.

Beamesderfer, R.C., D.L. Ward, and A.A. Nigro. 1996. Evaluation of the biological basis for a predator control program on northern squawfish (*Ptychocheilus oregonensis*) in the Columbia and Snake rivers. Canadian Journal of Fisheries and Aquatic Sciences 53:2898-2908.

Beamesderfer, R.C. 2007. Fishery risk assessment for Columbia River coho based on population viability analysis. In *Lower Columbia Salmon Recovery and Fish and Wildlife Subbasin Plan*. Lower Columbia Fish Recovery Board (LCFRB). 2010. Appendix E, Chapter 13.

Beamesderfer, R.C. 2010. Risk analysis of all-H recovery strategies for tule fall Chinook. In *Lower Columbia Salmon Recovery and Fish and Wildlife Subbasin Plan*. Lower Columbia Fish Recovery Board (LCFRB). 2010. Appendix E, Chapter 14.

Beckvar, N., T.M. Dillon, and L.B. Read. 2005. Approaches for linking whole-body fish tissue residues of mercury or DDT to biological effects thresholds. Environmental Toxicology and Chemistry 24:2094-2105.

Berg, L. 2001. Yakima Subbasin Summary. Northwest Power Planning Council, Portland, OR.

Bischoff, J. M., R. B. Raymond, K. U. Snyder, L. Heigh, and S. K. Binder. 2000a. Youngs Bay Watershed Assessment. E and S Environmental Chemistry, Inc. and Youngs Bay Watershed Council, Corvallis, OR.

Bischoff, J.M., R.B. Raymond, K.U. Snyder, L. Heigh, and S.K. Binder. 2000b. Skipanon Watershed Assessment. E and S Environmental Chemistry, Inc. and Skipanon Watershed Council.

Bischoff, J.M., R.B. Raymond, K.U. Snyder, J. Bergeron, and S.K. Binder. 2000c. Nicolai-Wickiup Watershed Assessment. E and S Environmental Chemistry Inc. and Nicolai-Wickiup Watershed Council August 2000.

Bisson. P.A., G.H. Reeves, R.E. Bilby, and R.J. Naiman. 1977. Watershed management and Pacific salmon: Desired future conditions. In: D.J. Stouder, P.A. Bisson, and R.J. Naiman (eds.), Pacific salmon and their ecosystems, p. 447-474. Chapman and Hall, New York.

Blouin, M. 2003. Relative reproductive success of hatchery and wild steelhead in the Hood River. Report to Oregon Department of Fish and Wildlife, Portland, OR.

Blumm, M.C.. 2002. Sacrificing the Salmon: A legal and policy history of the decline of Columbia Basin Salmon. Book World Publications. Portland OR

Bottom, D.L., C.A. Simenstad, J. Burke, A.M Baptista, D.A. Jay, K.K. Jones, E. Casillas, and M.H. Schiewe. 2005. Salmon at river's end: The role of the estuary in decline and recovery of Columbia River Salmon. U.S. Dept. Commerce, NOAA technical memorandum. NMFSNWFSC-68, 246p.

Bottom, D.L., and C.A. Simenstad. 2001. Bottlenecks, barges, and super fish: Rethinking conservation of estuaries and salmon. Oregon salmon: Essays on the state of the fish at the turn of the millennium. Oregon Trout, Portland.

Brook, B.W., J.R. Cannon, R.C. Lacy, C. Mirande and R. Frankham (1999). Comparison of the population viability analysis packages GAPPS, INMAT, RAMAS and VORTEX for the whooping crane (Grus americana). Animal Conservation, 2:23-31. Budy, P. and H. Schaller. 2007. Evaluating tributary restoration potential for pacific salmon recovery. Ecological Applications 17:1068-1086.

Budy, P., H. Schaller. 2007. Evaluating tributary restoration potential for pacific salmon recovery. Ecological Applications: Vol. 17, No. 4, pp. 1068-1086.

Busby, P.J., T.C. Wainwright, G.J. Bryant, L.J. Lierheimer, R.S. Waples, F.W. Waknitz, and I.V. Lagomarsino. 1996. Status review of West Coast steelhead from Washington, Idaho, Oregon, and California. U.S. Dept. of Commer., NOAA Tech. Memo. NMFS-NWFSC-27.

Carpenter, K.D., S. Sobieszczyk, A.J. Arnsberg, and F.A. Rinella. 2008. U.S. Geological Survey. Scientific Investigations Report 2008–5027. Pesticide occurrence and distribution in the lower Clackamas River Basin, Oregon, 2000–2005. Prepared in cooperation with the Clackamas

Watershed Management Group (Clackamas River Water Providers and Clackamas County Water Environment Services) and the National Water-Quality Assessment Program.

Chapman, D.W. 1986. Salmon and steelhead abundance in the Columbia River in the nineteenth century. Trans. Am. Fish. Soc. 115:662-670.

Chilcote, M.W. 1999. Conservation status of lower Columbia River coho salmon. Oregon Department of Fish and Wildlife, Fish Division Information Report 99-3, 41p. Department of Fish and Wildlife, Salem, Oregon.

Chilcote, M.W. 2003. Relationship between natural productivity and the frequency of wild fish in mixed spawning populations of wild and hatchery steelhead (*Oncorhynchus mykiss*). Canadian Journal of Fisheries and Aquatic Sciences 60:1057-1067.

Clatsop County. 2008. Summary of the Clatsop County Fisheries Project. Clatsop County web site.

Climate Impacts Group (CIG). 2004. Overview of climate change impacts in the U.S. Pacific Northwest. University of Washington, Seattle, WA. www.cses.washington/edu/cig

Coccoli, J., B. Lamb, K. Hale, E. Salminen, M. Burke, J. Wells. 1999. Hood River Watershed Assessment. Hood River Watershed Group. December 1999.

Coccoli, H. 2004. Hood River subbasin plan: including lower Oregon Columbia Gorge tributaries. Hood River Soil and Water Conservation District (SWCD). Prepared for the Northwest Power and Conservation Council, Portland, OR. (http://www.nwcouncil.org/fw/subbasinplanning/Hood/plan)

Cole, M.B. and L. Hennings. 2004. Baseline assessment of stream habitat and macroinvertebrate communities in and adjacent to the Damascus area Urban Growth Boundary Expansion, Oregon: Forest Grove, Oregon, ABR, Inc.—Environmental Research and Services, 39 p.

Collis, K., and D.D. Roby. 2006. Research, monitoring, and evaluation of avian predation on salmonid smolts in the Lower and Mid-Columbia River. Bonneville Power Administration and U.S. Army Corps of Engineers. Draft 2005 season summary.

Collis, K. et al. 2007. Research, monitoring, and evaluation of avian predation on salmonid smolts in the lower and mid-Columbia River – 2006 season summary. USGS report to Bonneville Power Administration and the U. S. Army Corps of Engineers.

Columbia Basin Fish and Wildlife Authority (CBFWA). 1990. Review of the history, development, and management of anadromous fish production facilities in the Columbia River Basin. Unpubl. manuscr., 52 p., U.S. Fish & Wildlife Service.

David Evans and Associates, Inc. (DEA). 2000. Scappoose Bay Watershed Assessment. Prepared for the Scappoose Bay Watershed Council.

Dewberry, T.C., J.R. Karr, and J.W. Adams. 1999. Evaluating aquatic resources in the Clackamas River Basin of Oregon: Portland, Oregon, U.S. Environmental Protection Agency Contract # CR825041-01, 57 p.

Drake, J., M. Ford, K. Kostow, J. Myers, B. Waknitz and P. Adams. 2003. Hatchery broodstock summaries and assessments for chum, coho, and Chinook salmon and steelhead stocks within

Evolutionarily Significant Units listed under the Endangered Species Act. National Marine Fisheries Service, Seattle, WA.

Ecotrust. 2000. Rock and Richardson Creek Watershed Assessment. Prepared for Clackamas River Basin Council.

Federal Energy Regulatory Commission (FERC). 2006. Final Environmental Impact Statement (FEIS) for the Clackamas River Hydroelectric Project in Clackamas County, Oregon (P-2195-011). December 2006.

Firman, J. and S.E. Jacobs. Undated. A survey design for integrated monitoring of salmonids. Oregon Department of Fish and Wildlife, Salem.

Franklin, I.R. and R. Frankham. 1998. How large must populations be to retain evolutionary potential? Animal Conservation. 1:69-34.

Fresh, K.L., E. Casillas, L.L. Johnson, and D.L. Bottom. 2005. Role of the estuary in the recovery of Columbia River Basin salmon and steelhead: An evaluation of the effects of selected factors on salmonid population viability. NOAA technical memorandum, Northwest Fisheries Science Center, National Marine Fisheries Service. Seattle, WA. 136 pp.

Friesen, T.A., and D.L. Ward. 1999. Management of northern pikeminnow and implications for juvenile salmonid survival in the lower Columbia and Snake rivers. North American Journal of Fisheries Management 19:406-420.

Fulop, J. 2003. Oregon lower Columbia River fall and winter chinook spawning ground surveys, 1952-2002. Oregon Department of Fish and Wildlife, Clackamas, Oregon.

Garrison, R.C., and M.M. Rosentreter. 1981. Stock assessment and genetic studies of anadromous salmonids. Federal Aid Progress Rpts Fisheries, 1980. Oregon Dept. Fish and Wildlife, Fish Div, Portland, Oregon. Pages 66.

Genovese, P.V., and R.L. Emmett. 1997. Desktop Geographic Information System for salmonid resources in the Columbia River Basin. U.S. Dept. of Commerce, NOAA technical memorandum. NMFS-NWFSC-34.

Goodson, K. 2005. Oregon Native Fish Status Report. Oregon Department of Fish and Wildlife, Salem, Oregon.

Good, T.P., R.S. Waples, and P. Adams (editors). 2005. Updated status of Federally listed ESUs of West Coast salmon and steelhead. U.S. Commerce., NOAA Technical Memo. NMFS-NWFSC-66, 598p. Available at http://www.nwr.noaa.gov/Publications/Biological-Status-Reviews/upload/SR2005-allspecies.pdf.

Groot, C. and L. Margolis. 1991. Pacific salmon life histories. UBC Press, Vancouver, British Columbia.

Hargreaves, N.B. and R.J. LeBrasseur. 1986. Size selectivity of coho (*Oncorhynchus kisutch*) preying on juvenile chum salmon (*O. keta*). Canadian Journal of Fisheries and Aquatic Sciences. Vol. 43, no. 3, pp. 581-586. 1986.

Hatchery Scientific Review Group (HSRG). 2007. Preview of key findings for Lower Columbia River hatchery programs. Memo prepared by the Hatchery Scientific Review Group for the Columbia River Hatchery Reform Steering Committee. July 18, 2007.

Hayes, T.B., C. Paola, S. Chui, D. Chung, C. Haefele, K Haston, M. Lee, V. Pheng, Y. Marjuoa, J. Parker, and M. Tsui. 2006. Pesticide mixtures, endocrine disruption, and amphibian declines—Are we underestimating the impact? Environmental Health Perspectives. 114 (suppl 1):40-50.

Hayslip, G., L. Edmond, V. Partridge, W. Nelson, H. Lee, F. Cole, J. Lamberson , and L. Caton. 2006. Ecological condition of the estuaries of Oregon and Washington. EPA 910-R-06-001. U.S. Environmental Protection Agency, Office of Environmental Assessment, Region 10, Seattle, Washington.

Hood River Watershed Group. 2002. Hood River Watershed Action Plan. http://www.hoodriverswcd.org/ActionPlan.pdf

Howell, P., D. Scarnecchia, et al. 1985. Stock assessment of Columbia River anadromous salmonids. Portland, Oregon, Oregon Department of Fish and Wildlife and Bonneville Power Administration.

Hunter, J.G. 1959. Survival and production of pink and chum salmon in a coastal stream. Journal of the Fisheries Research Board of Canada 16:835-886.

Independent Multidisciplinary Science Team (IMST). 2002. Recovery of wild salmonids in western Oregon lowlands. Technical Report 2002-1 to the Oregon Plan for Salmon and Watersheds, Governor's Natural Resources Office, Salem, Oregon.

Independent Scientific Advisory Board (ISAB). 2007a. Climate change impacts on Columbia River Basin fish and wildlife. ISAB Report 2007-2.

Independent Scientific Advisory Board (ISAB). 2007b. Human population impacts on Columbia Basin fish and wildlife. ISAB Report 2007-3.

Independent Scientific Review Panel (ISRP) and Independent Economic Analysis Board (IEAB). 2005. Review of the Select Area Fishery Evaluation Project: 1993-2003 Final Project Completion Report (J. North et al. June 2004), Project #1990-060-00. ISRP & IEAB Report # 2005-8. March 16, 2005.

Independent Scientific Review Panel (ISRP) and Independent Economic Analysis Board (IEAB). 2007. SAFE Review 2007 – Review of the Select Area Fishery Evaluation Project Reports: Final Completion Report, October 1993 to October 2005 (April 2006) and Economic Analysis Study (November 2006), Project #1993-060-00. ISRP & IEAB Report # 2007-3. April 11, 2007.

Jacobson, K.C., D. Teel, D.M. Van Doornik, and E. Casillas. 2008. Parasite-associated mortality of juvenile Pacific salmon caused by the trematode Nanophyetus salmincola during early marine residence. Marine Ecology Progress Series 354:235-244.

Jay, D.A., and T. Kukulka. 2002. Impacts of Columbia River discharge on salmonid habitat. Manuscript submitted to the Journal of Geophysical Research.

Jenkins, J.L. and W.R. Trevathan. 2004. Pesticides in Oregon surface water 1969-2004. Report prepared by the Department of Environmental and Molecular Toxicology. Oregon State University, Corvallis, Oregon.

Joint Columbia River Management Staff. 2008. 2008 Joint Status Report: Stock status and fisheries for fall Chinook salmon, coho salmon, chum salmon, summer steelhead and white sturgeon. Oregon Department of Fish and Wildlife and Washington Department of Fish and Wildlife. July 14, 2008.

Jones, K.L., C.A. Simenstad, J.L. Burke, T.D. Counihan, I.R Waite, J.L. Morace, A.B. Borde, K.L. Sobocinski, N. Sather. S.A. Zimmerman. L.L. Johnson. P.M. Chittaro. K.H. Macneale. O.P. Olson. S.Y. Sol, D.J. Teel, G.M. Ylitalo, and L. Johnnson. 2008. Lower Columbia River ecosystem monitoring project annual report for year four (September 1, 2007 to August 31, 2008). Prepared by the Lower Columbia River Estuary Partnership with support from the Bonneville Power Administration. October 2008.

Johnson, L.L., G.M. Ylitalo, C.A. Sloan, T. Lundrigan, B.F. Anulacion, A.N. Kagley, M.R. Arkoosh, T.K. Collier, K. Larson, and M. Siipola. 2007. Contaminants in juvenile Chinook salmon (*Oncorhyncus tshawytscha*) from the Lower Columbia Estuary. Sci. Total Environ. 374:342-366.

Johnson, L.L., G.M. Ylitalo. 2009. Northwest Fish Science Center (NWFSC), unpublished data.

Johnson, O.W., W.S. Grant, R.G. Kope, K. Neely, F.W. Waknitz, and R.S. Waples. 1997. Status review of chum salmon from Washington, Oregon, and California. U.S. Dept. of Commer. NOAA Tech Memo NMFS-NWFSC-32.

Kappler, C.J. 1904. Indian Affairs: Laws and Treaties. Vol. II (Treaties). Washington: Government Printing Office. Published on-line at http://digital.library.okstate.edu/kappler/Vol2/Toc.htm accessed on April 8, 2009.

Kasper, B., D. Turner, E. Nigg, and M. Boyd. 2003. North coast subbasins Total Maximum Daily Load (TMDL). Oregon Department of Environmental Quality. Portland, Oregon.

Kavanagh, M., D. Olson, B. Brignon, T. Hoffman, D. Dysart and S. Turner. 2006. Eagle Creek ecological interactions: Distribution and migration of hatchery and wild steelhead and coho Progress Report 2005. Kavanagh, M., D. Olson, B. Brignon, T. Hoffman, D. Dysart and S. Turner, United States Fish and Wildlife Service, Columbia River Fisheries Program Office, Vancouver WA. D. Dysart and S. Turner, Eagle Creek National Fish Hatchery Estacada, Oregon.

Kavanaugh, P., P. Jacobsen, K. Anlauf, and K. Jones. 2006. Fish habitat assessment in the Oregon Department of Forestry Lower Columbia North project area. Oregon Department of Fish and Wildlife, Aquatic Inventories Project, Corvallis, Oregon.

Kostow, K. 1995. Biennial report on the status of wild fish in Oregon. Oregon Dept. Fish and Wildlife, Portland, Oregon.

Kostow, K. 2003. Factors that influence Evolutionarily Significant Unit boundaries and status assessment in a highly polymorphic species, *Oncorhynchus mykiss*, in the Columbia Basin. Oregon Department of Fish and Wildlife Information Report No. 2003-04. Clackamas, Oregon.

Laetz, C.A., D.H. Baldwin, T.K. Collier, V. Hebert, J.D. Stark, and N. L. Scholz. 2009. The synergistic toxicity of pesticide mixtures: Implications for risk assessment and the conservation of endangered Pacific salmon. Environ Health Perspect 117:348–353.

Lande, R. 1995. Mutation and conservation. Conservation Biology 9:782-791.

LeFluer, C. and S. King. 2004. Biological assessment of incidental impacts on winter steelhead listed under the Endangered Species Act in non-Indian mainstem Columbia River fisheries. February 13, 2004. 38 pp.

Lichatowich, J. 1999. Salmon Without Rivers: A History of the Pacific Salmon Crisis. Washington, D.C.: Island Press, 1999.

Loge, F.J., M.R. Arkoosh, T.R. Ginn, L.L. Johnson, and T.K. Collier. 2005. Impact of environmental stressors on the dynamics of disease transmission. Environment, Science and Technology.

Lower Columbia Fish Recovery Board (LCFRB). 2004. Lower Columbia Salmon Recovery and Fish and Wildlife Subbasin Plan, Vol I. Lower Columbia Fish Recovery Board, Longview, Washington.

Lower Columbia River Estuary Partnership (LCREP). 2004. Mainstem Lower Columbia River and Columbia River Estuary Subbasin Plan. Prepared for the Northwest Power and Conservation Council. May 28, 2004.

Lower Columbia River Estuary Partnership (LCREP). 2006. Columbia River Estuary Recovery Planning Module. Prepared for National Oceanic and Atmospheric Administration. Portland, Oregon. September 27, 2006.

Lower Columbia River Estuary Partnership (LCREP). 2007. Lower Columbia River and Estuary Eocosystem Monitoring Water Quality and Salmon Sampling Report. Prepared for Bonneville Power Administration. 70 pp.

Macneale, K. 2008. Modeling potential indirect effects of pesticides on endangered salmon populations. Proceedings of the SETAC North America 29th Annual Meeting, Tampa, FL. November 16-20, 2008.

Magnusson, A. 2002. Survival rates of coho (*Oncorhynchus kisutch*) and chinook salmon (*O. tshawytscha*) released from hatcheries on the U.S. and Canadian Pacific coast 1972–1998, with respect to climate and habitat effects. M.S. Thesis, University of Washington, Seattle, Washington.

Magnusson A., R. Hilborn. 2003. Estuarine survival rates of coho (*Oncorhynchus kisutch*) and chinook salmon (*Oncorhynchus tshawytscha*) released from hatcheries on the U.S. Pacific Coast. Estuaries 26 (4B):1094-1103.

Maher, M., M.B. Sheer, E.A. Steel, and P. McElhany. 2005. Atlas of salmon and steelhead habitat in the Oregon Lower Columbia and Willamette Basins. Report for the Willamette-Lower Columbia Technical Recovery Team. Produced by the NOAA Northwest Fisheries Science Center. 203 pp.

Marriott, D., and 27 contributors. 2002. Lower Columbia River and Columbia River Estuary Subbasin Summary. Report Prepared for the Northwest Power Conservation Council, dated May 17, 2002. (Available at: http://www.cbfwa.org/)

Marshall, A.R., C. Smith, et al. 1995. Genetic diversity units and major ancestral lineages for Chinook salmon in Washington. C. Busack and J.B. Shaklee. Washington Department of Fish and Wildlife, Olympia, WA.

Matthews, G.M. and R.S. Waples. 1991. Status review for Snake River spring and summer chinook salmon. National Marine Fisheries Service, Northwest Fisheries Science Center. Seattle, WA.

McClure, M., T. Cooney and the Interior Columbia Basin Technical Recovery Team. 2003. Independent populations of Chinook, steelhead, and sockeye for listed Evolutionary Significant Units within the Interior Columbia River Domain. Working Draft July, 2003.

McConnaha, W.E. 2002. Assessment of habitat potential in Johnson Creek for coho and Chinook salmon. Prepared for the City of Portland, Oregon.

McElhany, P., M.H. Ruckelshaus, M.J. Ford, T.C. Wainwright, and E.P. Bjorkstedt. 2000. Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units. U.S. Department of Commerce, NOAA Technical Memorandum: NMFS-NWFSC-42. NOAA, Seattle, WA.

McElhany, P., T. Backman, C. Busack, S. Heppel, S. Kolmes, A. Maule, J. Myers, D. Rawding, D. Shively, A. Steel, C. Steward, and T. Whitesel. 2003. Interim Report on Viability Criteria for Willamette and Lower Columbia Basin Pacific Salmonids. Willamette/ Lower Columbia Technical Recovery Team. NMFS Northwest Fisheries Science Center. Seattle, WA. http://www.nwfsc.noaa.gov/trt/wlc_viabrpt/appendix_a.pdf

McElhany, P., T. Backman, C. Busack, S. Kolmes, J. Myers, D. Rawding, A. Steel, C. Steward, T. Whitesel, and C. Willis. 2004. Status Evaluation of Salmon and Steelhead Populations in the Willamette and Lower Columbia River Basins. Willamette/Lower Columbia Technical Recovery Team. NMFS Northwest Fisheries Science Center. Seattle, WA.

McElhany, P. 2005. Columbia River chum salmon ESU. In T.P. Good, R.S.Waples, and P. Adams, editors. Updated status of Federally listed ESUs of west coast salmon and steelhead. NOAA Northwest Fisheries Science Center, Seattle, WA.

McElhany, P., C. Busack, M. Chilcote, S. Kolmes, B. McIntosh, J. M. Myers, D. Rawding, A. Steel, C. Steward, D. Ward, T. Whitesel, and C. Willis. 2006. Revised viability criteria for salmon and steelhead in the Willamette and Lower Columbia Basins. Draft Report, NOAA Northwest Fisheries Science Center, Seattle, WA.

McElhany, P., M. Chilcote, J. Myers, R. Beamesderfer. 2007. Viability status of Oregon salmon and steelhead populations in the Willamette and lower Columbia basins, review draft. National Marine Fisheries Service Northwest Fisheries Science Center, Seattle, WA.

McHugh, P., P. Budy, H. Schaller. 2004. A Model-based assessment of the potential response of Snake River spring–summer Chinook salmon to habitat improvements. Transactions of the American Fisheries Society 2004.

McMichael, G.A., T.N. Pearsons and S.A. Leider. 1999. Behavioral interactions among hatchery-reared steelhead smolts and wild *Oncorhynchus mykiss* in natural streams. North American Journal of Fisheries Management. 19: 948-956.

Meador, J.P., J. Buzitis, C.F. Bravo. 2008. Using fluorescent aromatic compounds (FACs) in bile from juvenile salmonids to predict exposure to polycyclic aromatic hydrocarbons. Environmental Toxicology and Chemistry, 27(4):845-853.

Meador, J.P., F.C. Sommers, G.M. Ylitalo, C.A. Sloan. 2006. Altered growth and related physiological responses in juvenile chinook salmon (*Oncorhynchus tshawytscha*) from dietary exposure to polycyclic aromatic hydrocarbons (PAHs). Canadian Journal of Fisheries and Aquatic Sciences, 63:2364-2376.

Meador, J.P., T.K. Collier, J.E. Stein. 2002. Determination of a tissue and sediment threshold for tributyltin to protect prey species for juvenile salmonids listed by the U. S. Endangered Species Act. Aquatic Conservation: Marine and Freshwater Ecosystems, 12:539-551.

Miles, E.L., A.K. Snover, A.F. Hamlet, B.M. Callahan, and D.L. Fluharty. 2000. Pacific Northwest regional assessment: The impacts of climate variability and climate change on the water resources of the Columbia River Basin. Journal of the American Water Resources Association 36(2):399-420.

Mills, L.S., S.G. Hayes, C. Baldwin, M.J. Wisdom, J. Citta, D.J. Mattson, and K. Murphy. 1996. Factors leading to different viability predictions for a grizzly bear data set. Cons. Biol. 10:863-573.

Mote, P.W., D.J. Canning, D.L. Fluharty, R.C. Francis, J.F. Franklin, A.F. Hamlet, M. Hershman, M. Holmberg, K.N. Ideker, W.S. Keeton, D.P. Lettenmaier, L.R. Leung, N.J. Mantua, E.L. Miles, B. Noble, H. Parandvash, D. W. Peterson, A.K. Snover, and S.R. Willard, 1999. Impacts of climate variability and change, Pacific Northwest. NOAA Office of Global Programs, and JISAO/SMA Climate Impacts Group, Seattle, WA. 110p.

Mote, P.W., E.A. Parson, A.F. Hamlet, K.N. Ideker, W.S. Keeton, D.P. Lettenmaier, N.J. Manua, E.L. Miles, D.W. Peterson, D.L. Peterson, R. Slaughter, and A.K. Snover. 2003. Preparing for climate change: The water, salmon, and forests of the Pacific Northwest. Climatic Change 61:45-88.

Mulvey, M.P. and A.N. Borisenko. 2006. Lower Columbia wadeable stream conditions report. Oregon Department of Environmental Quality, Watershed Assessment Section.

Murtagh, T., R. Rohrer, M. Gray, E. Olsen, T. Rien, and J. Massey. 1992. Clackamas Subbasin fish management plan. Oregon Department of Fish and Wildlife, Portland, Oregon.

Myers, J.M., R.G. Kope, G.J. Bryant, D. Teel, L.J. Lierheimer, T.C. Wainwright, W.S. Grant, F.W. Waknitz, K. Neely, S.T. Lindley and R.S. Waples. 1998. Status review of Chinook salmon from Washington, Idaho, Oregon and California. NOAA Technical Memorandum NMGS-NWFSC-35. Seattle, WA.

Myers, J., C. Busack, D. Rawding, A. Marshall, D. Teel, D.M. Van Doornik, and M.T. Maher. 2006. Historical population structure of pacific salmonids in the Willamette River and Lower Columbia River Basins. NOAA Technical Memorandum NMFS-NWFSC-73, February, 2006. Seattle, WA.

Nickelson, T.E. 1998. A Habitat-Based Assessment of Coho Salmon Production Potential and Spawner Escapement Needs for Oregon Coastal Streams. Information Reports Number 98-4. Oregon Department of Fish and Wildlife, Portland, Oregon.

Nickelson, T.E. 2003. The influence of hatchery coho (Oncorynchus kisutch) on the productivity of wild coho salmon populations in Oregon coastal basins. Can. J. Fish. Aquat. Sci. 60(9): 150-1056.

National Marine Fisheries Service (NMFS). 1998. Conclusions regarding the status of hatchery populations in deferred ESUs of West Coast steelhead. Memo to W. Stelle (Northwest Region, NMFS) and W. Hogarth (Southwest Region, NMFS) from M. Schiewe (Northwest Fisheries Science Center), 13 January 1998. (Available from NMFS, 1201 NE Lloyd Blvd, Suite 1100, Portland, OR 97232.)

National Marine Fisheries Service (NMFS). 2004. Salmonid Hatchery Inventory and Effects Evaluation Report. Technical Memorandum NMFS-NWR/SWR (NMFS 2004b). An Evaluation of the Effects of Artificial Propagation on the Status and Likelihood of Extinction of West Coast Salmon and Steelhead under the Federal Endangered Species Act. May 28, 2004.

National Marine Fisheries Service (NMFS). 2005. 70 FR 37160. June 28, 2005. Endangered and Threatened Species: Final Listing Determinations for 16 ESUs of West Coast Salmon, and Final 4(d) Protective Regulations for Threatened Salmonid ESUs 70 (123): 37160-37204.

National Marine Fisheries Service (NMFS). 2005(b). The proposed increase in allowable incidental take of steelhead Evolutionarily Significant Units (ESUs) affected by the non-Indian commercial spring Chinook fishery in 2005. Supplemental Biological Opinion. January 2005.

National Marine Fisheries Service (NMFS). 2006. 71 FR 834. January 5, 2006. Endangered and Threatened Species: Final listing determinations for 10 Distinct Population Segments of West Coast Steelhead; Final Rule. 71(3): 834-862.

National Marine Fisheries Service (NMFS). 2006(b). Supplemental Biological Opinion on impacts of non-treaty fisheries in the Columbia River basin in years 2006 and 2007, on winter steelhead listed under the Endangered Species Act and Magnusen-Stevens Act essential fish habitat consultation. March 2006.

National Marine Fisheries Service (NMFS). 2007(a). Adaptive management for ESA-listed salmon and steelhead recovery: decision framework and monitoring guidance. NW Region & NMFS Northwest Fisheries Science Center, Seattle, WA.

National Marine Fisheries Service (NMFS). 2007(b). Interim Endangered and Threatened Species Recovery Planning Guidance Version 1.2. NMFS, Silver Spring, Maryland.

National Marine Fisheries Service (NMFS). 2008. NOAA Fisheries 2008-2017 United States v. Oregon Management Agreement. May 5, 2008.

National Marine Fisheries Service (NMFS). 2008(b). Recovery plan module: mainstem Columbia River hydropower projects. September 24, 2008.

National Marine Fisheries Service (NMFS). 2008(c). 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)(I)(A) Permit for Juvenile Fish Transportation Program (Revised and reissued pursuant to court order, NWF v. NMFS, Civ. No. CV 01-640-RE (D. Oregon)). F/NWR/2005/05883. May 5, 2008.

National Research Council. 2004. Managing the Columbia River: Instream flows, water withdrawals, and salmon survival. The National Academies Press. Washington D.C.

Nickelson, T.E. 1998. A habitat-based assessment of coho salmon production potential and spawner escapement needs for Oregon coastal streams. Info. Rep. 98-4. Oregon Department of Fish and Wildlife.

North, J., M. Miller, J. Sewall, T. Jones, A. Dietrichs, and T. Miethe. 2006. Select Area Fishery Evaluation Project: 1993-2005 Final Project Completion Report. Prepared for Bonneville Power Administration. BPA Project #199306000, ODFW Contract #0004121, WDFW Contract #0004131, CEDC Contract #0004129. April 2006.

Northwest Power and Conservation Council (NPCC). 2001. Dams and Hydropower. Personal communication. Portland, OR.

Northwest Power and Conservation Council (NPCC). 2005. Section 2: Assessment. In Mainstem Lower Columbia River and Columbia River Estuary Subbasin Plan. Portland, Oregon, 2005.

O'Neal, K. 2002. Effects of global warming on trout and salmon in U.S. streams. Defenders of Wildlife, Natural Resources Defense Council. 46 pp.

Oregon Department of Environmental Quality (ODEQ). 2005. Sandy River Basin Total Maximum Daily Load (TMDL). March 2005.

Oregon Department of Environmental Quality (ODEQ). 2008. Maps of water quality limited areas in the Coast Range, Cascade and Gorge strata.

Oregon Department of Fish and Wildlife (ODFW). 1999. Habitat survey data for Scappoose Creek.

Oregon Department of Fish and Wildlife (ODFW). 2001. Oregon Department of Fish and Wildlife's Endangered Species Management Plan for Lower Columbia Coho Salmon. Oregon Department of Fish and Wildlife, Salem, Oregon.

Oregon Department of Fish and Wildlife (ODFW). 2002. Lower Columbia River Coho Recovery Plan and Passage Report. July 2002.

Oregon Department of Fish and Wildlife (ODFW). 2003. Native Fish Conservation Policy, 635-007-0502 through 0509. November 8, 2002; revised September 12, 2003.

Oregon Department of Fish and Wildlife (ODFW) 2005a. 2005 Oregon Native Fish Status Report. Oregon Department of Fish and Wildlife, Salem, Oregon.

Oregon Department of Fish and Wildlife (ODFW). 2005b. Oregon Coast Coho Assessment: Habitat. Appendix report to Oregon Plan for Salmon and Watershed Assessment of the Status of Oregon Coastal Coho. Oregon Department of Fish and Wildlife, Salem, Oregon.

Oregon Department of Fish and Wildlife (ODFW). 2007a. Coastal salmon spawning surveys procedures manual. Oregon Department of Fish and Wildlife, Salem, Oregon.

Oregon Department of Fish and Wildlife (ODFW). 2007b. Coastal steelhead spawning surveys procedures manual. Oregon Department of Fish and Wildlife, Salem, Oregon.

Oregon Department of Fish and Wildlife (ODFW). 2010. Draft Upper Willamette River conservation and recovery plan for Chinook salmon and steelhead. February 23, 2010.

Oregon Department of Fish and Wildlife (ODFW). 2010b. Conservation and Recovery Plan for Oregon Middle Columbia Steelhead Populations in the Middle Columbia River Steelhead Distinct Population Segment. February 2010.

Oregon State Game Commission (OSGC). 1963. The fish and wildlife resources of the Hood Basin, Oregon, and their water use requirements. Federal Aid to Fish Restoration Progress Report. Fisheries Stream Flow Requirements Project F-69-R-1, Job Number 1.

Pacific Fishery Management Council (PFMC). 2008. Council Fishery Regulation Assessment Model (FRAM) An Overview for Coho and Chinook v30 [Report] / Model Evaluation Workgroup. - Portland OR : Pacific Fishery Management Council, October 2008. 39p.

Pape-Lindstrom, P.A., and M.J. Lydy. 1997. Synergistic toxicity of atrazine and organophosphate insecticides contravenes the response addition mixture model: Environmental Toxicology and Chemistry 16:2415–2420.

Parker, R.R. 1971. Size selective predation among juvenile salmonid fishes in a British Columbia Inlet. J. Fish Res Board Canada. Vol. 28, No. 10, P. 1503-1510.

Poff, N.L., J.D. Allan, M.B. Bain, J.R. Karr, K.L. Prestegaard, B.D. Richter, R.E. Sparks, J.C. Stromberg. 1997. The natural flow regime; a paradigm for river conservation and restoration. BioScience 47: 769-784.

Portland General Electric (PGE). 2002. Bull Run hydroelectric project draft biological evaluation. Portland, Oregon.

Portland State University (PSU). 2001. Lower Columbia-Clatskanie Watershed Assessment. Prepared for the Lower Columbia River Watershed Council.

Primozich, D.and R. Bastasch. 2004. Draft Willamette Subbasin Plan. Prepared by Willamette Restoration Initiative for the Northwest Power and Conservation Council. May 28, 2004.

R2 Resource Consultants. January 1998. Technical memorandum: Fish resource issues, habitat conditions, and mitigation alternatives of the lower Bull Run and Sandy Rivers. Revised draft Report. Prepared for the City of Portland Bureau of Water Works.

Relyea, R.A. 2009. A cocktail of contaminants: how mixtures of pesticides at low concentrations affect aquatic communities. Oecologia. 159:363-376.

Rieman, B.E. and F.W. Allendorf. 2001. Effective population size and genetic conservation for bull trout. North American Journal of Fisheries Management 21:756-764.

Rinella, F.A., and M.L. Janet. 1998, Seasonal and spatial variability of nutrients and pesticides in streams of the Willamette Basin, Oregon, 1993–95: U.S. Geological Survey Water-Resources Investigations Report 97-4082-C. 59 p.

Roby, D.D., D.P. Craig, K. Collis, and S.L. Adamany. 1998. Avian predation of juvenile salmonids in the lower Columbia River. 1997 annual rep., Columbia River Inter-Tribal Fish Commission, Portland, OR.

Rodgers, J.D. 2000. Abundance of juvenile coho salmon in Oregon coastal streams, 1998 and 1999). Monitoring Program Report Number OPSW-ODFW-2000-1. Oregon Department of Fish and Wildlife, Portland, Oregon.

Rodgers, J.D. 2001. Monitoring of the abundance of juvenile coho salmon in Oregon coastal streams, 2001). Monitoring Program Report Number OPSW-ODFW-2001-1. Oregon Department of Fish and Wildlife, Portland, Oregon.

Ruckelshaus, M.H., P.S. Levin, J.B. Johnson, and P.M. Kareiva. 2002. The Pacific Salmon wars: what science brings to the challenge of recovering species. Annual Review of Ecology and Systematics 33:665-706.

Rule, G. and J. Maser. 2002. Lower Columbia - Clatskanie River Watershed Assessment. Submitted to Oregon Watershed Enhancement Board.

Runyan, D. 2009. Fishing, Hunting, Wildlife-Viewing and Shellfishing in Oregon. Prepared for the Oregon Department of Fish and Wildlife, Salem, Oregon. May 2009. Dean Runyan and Associates.

Runyon, J. and E. Salminen. 2005. Clackamas Basin summary rish populations and aquatic riparian habitat. Prepared for the Clackamas River Basin Council, Clackamas, Oregon. May 2005. Water Professionals Network.

Ruzycki, J.R., M.W. Flesher, R.W. Carmichael, and D.L. Eddy. 2003. Oregon Evaluation Studies, Lower Snake Compensation Plan. Oregon Department of Fish and Wildlife. Portland, OR.

Sandahl, J.F., D.H. Baldwin, J.J. Jenkins, and N.L. Scholz. 2007. A sensory system at the interface between urban stormwater runnoff and salmon survival. Environmental Science & Technology, 41(8):2998-3004.

Sandahl J.F., D.H. Baldwin, J.J. Jenkins, and N.L. Scholz. 2005. Comparative thresholds for acetylcholinesterase inhibition and behavioral impairment in coho salmon exposed to chlorpyrifos. Environ Toxicol Chem 24(1):136–145.

Sandahl J.F. and J.J. Jenkins. 2002. Pacific steelhead (*Oncorhynchus mykiss*) exposed to chlorpyrifos: benchmark concentra¬tion estimates for acetylcholinesterase inhibition. Environ Toxicol Chem 21(11):2452–2458.

Sandy River Basin Partners (SRBP). 2005. Sandy River Basin Characterization Report. Prepared by the Sandy River Basin Partners. July 2005.

Schroeder, R.K., K.R. Kenaston, and L.K. McLaughlin. 2007. Spring Chinook in the Willamette and Sandy Basins. Annual Progress Report, Fish Research Project Number F-163-R-11/12. Oregon Department of Fish and Wildlife, Salem, Oregon.

Scholz, N.L., N.K. Truelove, B.L. French, B.A. Berejikian, T.P. Quinn, E. Casillas, and T.K. Collier. 2000. Diazinon disrupts antipredator and homing behavior in Chinook salmon (*Oncorhynchus tshawytscha*): Canadian Journal of Fisheries and Aquatic Sciences, v. 57, p. 1911–1918.

Sherman, T.J., M.D. Siipola, R.A. Abney, D.B. Ebner, J. Clarke, G. Ray, and J.A. Steevens. 2009. Corbicula fluminea as a Bioaccumulation Indicator Species: A case study at the Columbia and Willamette Rivers. Report Number ERDC/EL TR-09-X. Prepared for the U.S. Army Corps of Engineers by the U.S. Army Engineer District, Portland, OR and the U.S. Army Engineer Research and Development Center, Vicksburg, MS. January 2009.

Shively, D., G. Asbridge, J. Dodd, D. Morgan, S. Stampfli. 2006. Hood River Basin Aquatic Restoration Strategy. Mt. Hood National Forest, Hood River Ranger District, U.S.D.A. Forest Service. November 2006.

Sloan, C.A., B.F. Anulacion, J.L.. Bolton, D. Boyd, O.P. Olson, S.Y. Sol, G.M. Ylitalo, and L.L. Johnson. 2009. Polybrominated diphenyl ethers in outmigrant juvenile Chinook salmon from the Lower Columbia River and Estuary and Puget Sound, WA. Arch. Environ. Contam. Toxicol (submitted).

Snover, A.K., A.F. Hamlet, and D.P. Lettenmaier. 2003. "Climate change scenarios for water planning studies: Pilot applications in the Pacific Northwest." Bulletin of the American Meteorological Society 84(11):1513-1518.

Sol, S.Y., O.P. Olson, K.H. Macneale, P. Chittaro, and L.L. Johnson. 2009. Summary of results of the fish monitoring component of the Lower Columbia River restoration effectiveness monitoring project 2007-2008. Prepared for the Lower Columbia Estuary Partnership by the NOAA Fisheries Northwest Fisheries Science Center. January 2009.

Soulé, M.E. 1980. Thresholds for survival: maintaining fitness and evolutionary potential, in Conservation Biology: An evolutionary-ecological perspective. M.E. Soulé and B.A. Wilcox (eds). Sinauer, Massachusetts.

State of Oregon Office of Economic Analysis. 2004. Forecasts of Oregon's County Populations and Components of Change, 2000—2040.

Stevens, D.L., Jr. 2006. Spatial properties of design-based versus model-based approaches to environmental sampling, pp. 119-125 in Proceedings of Accuracy 2006: The 7th international symposium on spatial accuracy assessment in natural resources and environmental sciences. Instituto Geographica, Portugales, Lisboa, Portugal. 908 pp.

Stevens, D.L., Jr. and Olsen, A.R. 2004. Spatially-balanced sampling of natural resources. Journal of American Statistical Association 99: 262–278.

Steward, I.T., D.R. Cayan, and M.D. Dettinger. 2004. "Changes in snowmelt runoff timing in western North America under a 'Business as Usual' climate change scenario. Climatic Change 62:217-232.

Suring, E.J., E.T. Brown, and K.M. Moore. 2006. Lower Columbia River coho status report 2002-2004: Population abundance, distribution, run timing, and hatchery influence. Report Number OPSW-ODFW-2006-6. ODFW, Salem, Oregon.

Takata, T. 2005. Oregon Lower Columbia River fall and winter Chinook spawning ground surveys, 1952-2004. ODFW. Focus on 2003-2004.

Theis, L. and K. Melcher. 1995. Oregon Lower Columbia River fall and winter Chinook spawning ground surveys, 1948-94. ODFW, Columbia River Management, Clackamas, OR.

Tierney K.B., J.L. Sampson, P.S. Ross, M.A. Sekala, and C.J. Kennedy. 2008. Salmon olfaction is impaired by an environmentally realistic pesticide mixture. Environ Sci Technol. 142:4996-5001.

Trombulak, S.C., K.S. Omland, J.A. Robinson, J.J. Lusk, T.L. Fleischner, G. Brown and M. Domroese. 2004. Principles of Conservation Biology: Recommended guidelines for conservation literacy from the Education Committee of the Society for Conservation Biology. Conserv. Biol. 18:1180-1190.

Turner, R. 2008. Personal conversation with Richard Turner, Fisheries Biologist, Salmon Recovery Division, NMFS. Portland, Oregon.

U.S. Army Corps of Engineers (USACE). 2007. Status report—pinniped predation and hazing at Bonneville Dam in 2007. Fisheries Field Unit CENWPOP-SRF Bonneville Lock and Dam, Cascade Locks, Oregon.

U.S. Army Corps of Engineers (USACE). 2005. Summary of pinniped observations at Bonneville Dam in 2005. Letter report from Robert Stansell to David Clugston. Fisheries Field Unit CENWP-OP-SRF Bonneville Lock and Dam. Cascade Locks, OR.

U.S. Environmental Protection Agency (USEPA). 2002. Primary distinguishing characteristics of Level III Ecoregions of the Continental United States (Draft). Seattle, WA. http://www.epa.gov/wed/pages/ecoregions.htm

U.S. Environmental Protection Agency (USEPA). 2008. First five-year review report for Reynolds Metals superfund site City of Troutdale. Multnomah County, Oregon. United States Environmental Protection Agency Region 10. July 2008.

U.S. Environmental Protection Agency (USEPA). 2009. Columbia River Basin: State of the River Report for Toxics. EPA Report EPA-910-08-004, US EPA Region 10, January 2009.

U.S. Fish and Wildlife Service (USFWS). 2005. Caspian Tern management to reduce predation of juvenile salmonids in the Columbia River estuary. Final Environmental Impact Statement. Portland, Oregon.

U.S. Fish and Wildlife Service (USFWS). 2007. Eagle Creek National Fish Hatchery Assessments and Recommendations Final Report, Summary July 2007. U.S. Fish and Wildlife Service - Pacific Region Columbia River Basin Hatchery Review Team.

U.S. Forest Service (USFS). 1995. Watershed analysis. Upper Clackamas Watershed. U.S. Forest Service, Portland, OR.

U.S Forest Service (USFS). 1996a Mt. Hood National Forest. West Fork of Hood River Watershed Analysis Report. Mt. Hood-Parkdale, Oregon.

U.S. Forest Service (USFS). 1996b. Mt. Hood National Forest. East Fork Hood River and Middle Fork Hood River Watershed Analysis. Mt. Hood-Parkdale, Oregon.

U.S. Forest Service (USFS). 1997. Bull Run watershed analysis – Mt. Hood National Forest.

U.S. Forest Service (USFS). 1998. Columbia Tributaries East Watershed Analysis. Hood River Ranger District and Columbia River Gorge National Scenic Area. Mt. Hood National Forest. Pacific Northwest Region.

Viola, A.E. and M.L. Schuck. 1995. A method to reduce the abundance of residual hatchery steelhead in rivers. North American Journal of Fisheries Management. 15:488-493.

Wampler, P.J., G. Grant. 2003. Final report, geomorphic changes resulting from River Mill Dam operations, Portland General Electric Company, Portland, OR, 43 p.

Waples, R.S. 1991. Definition of "Species" Under the Endangered Species Act: Application to Pacific Salmon. NOAA Technical Memorandum NMFS F/NWC-194, Seattle, WA.

Ward, D.L., J.H. Peterson, and J.J Loch. 1995. Index of predation on juvenile salmonids by northern squawfish in the lower and middle Columbia River and in the lower Snake River. Trans. Am. Fish. Soc. 124:321-334.

Washington Department of Fisheries (WDF), Washington Department of Wildlife (WDW), and Western Washington Treaty Indian Tribes (WWTIT) 1993. 1992 Washington state salmon and steelhead stock inventory (SASSI). Washington Department of Fish and Wildlife, 212 pp. + appendices. Appendix 1: Hood Canal and Strait of Juan de Fuca (December 1994, 424 pp.), North Puget Sound (June 1994, 418 pp.), and South Puget Sound (September 1994, 371 pp.) volumes. Appendix 2: Coastal stocks (August 1994, 587 pp.). Appendix 3: Columbia River stocks (June 1993, 580 pp.). Washington Department of Fish and Wildlife, P.O. Box 43151, Olympia, WA 98504.

Washington Department of Fish and Wildlife (WDFW) and Oregon Department of Fish and Wildlife (ODFW). 2002. Status Report Columbia River Fish Runs and Fisheries, 1938-2000. August 2002.

Watershed Professional Network (WPN), LLC. 2002. Clear and Foster Creek Watershed Assessment. Prepared for Clackamas River Basin Council.

Watershed Professionals Network (WPN), LLC. 2004. Deep and Goose Creek Watershed Assessment. Prepared for Clackamas River Basin Council.

Weitkamp, L.A., T.C. Wainwright, G.J. Bryant, G.B. Milner, D.J. Teel, R.G. Kope and R.S. Waples. 1995. Status Review of Coho Salmon from Washington, Oregon and California. NOAA Technical Memorandum NMFS-NWFSC-24, Seattle, WA.

Wentz D.A, et al. 1998. Environmental setting and hydrologic conditions of the Willamette Basin. Water Quality in the Willamette Basin, Oregon, 1991- 95. U.S. Geological Survey Circular 1161, 1998.

Wiley, M.W. 2004. Analysis techniques to incorporate climate change information into Seattle's long range water supply planning. M.S.C.E. thesis, Department of Civil and Environmental Engineering, University of Washington, Seattle, WA.

Willamette Riverkeepers. 2006. 2006 Willamette Riverkeeper Volunteer Monitoring Assessment. Monica Vogel, Water Quality Coordinator/NWSA Member.

Williams, G.D., and R.M. Thom. 2001. Development of guidelines for aquatic habitat protection and restoration: marine and estuarine shoreline modification issues. PNWD-3087. Prepared for the Washington State Department of Transportation, Washington Department of Fish and Wildlife, and

the Washington Department of Ecology, by Battelle Marine Sciences Laboratory, Sequim, Washington.

Woodward-Clyde International-Americas. 1997. Water management plan for Coastal Clatsop County. Report prepared for Clatsop County Planning Department.

Zabel, R.W., M.D. Scheuerell, M.M. McClure, J.G. Williams. 2006. The Interplay between climate variability and density dependence in the population viability of Chinook salmon. Contributing paper, Conservation Biology. 20(1):190-200, February 2006.

Zimmerman, C.E. and G.H. Reeves. 1996. Steelhead and rainbow trout early life history and habitat use in the Deschutes River, Oregon. 1995 Annual Report. Prepared for Portland General Electric Co. Portland, OR.