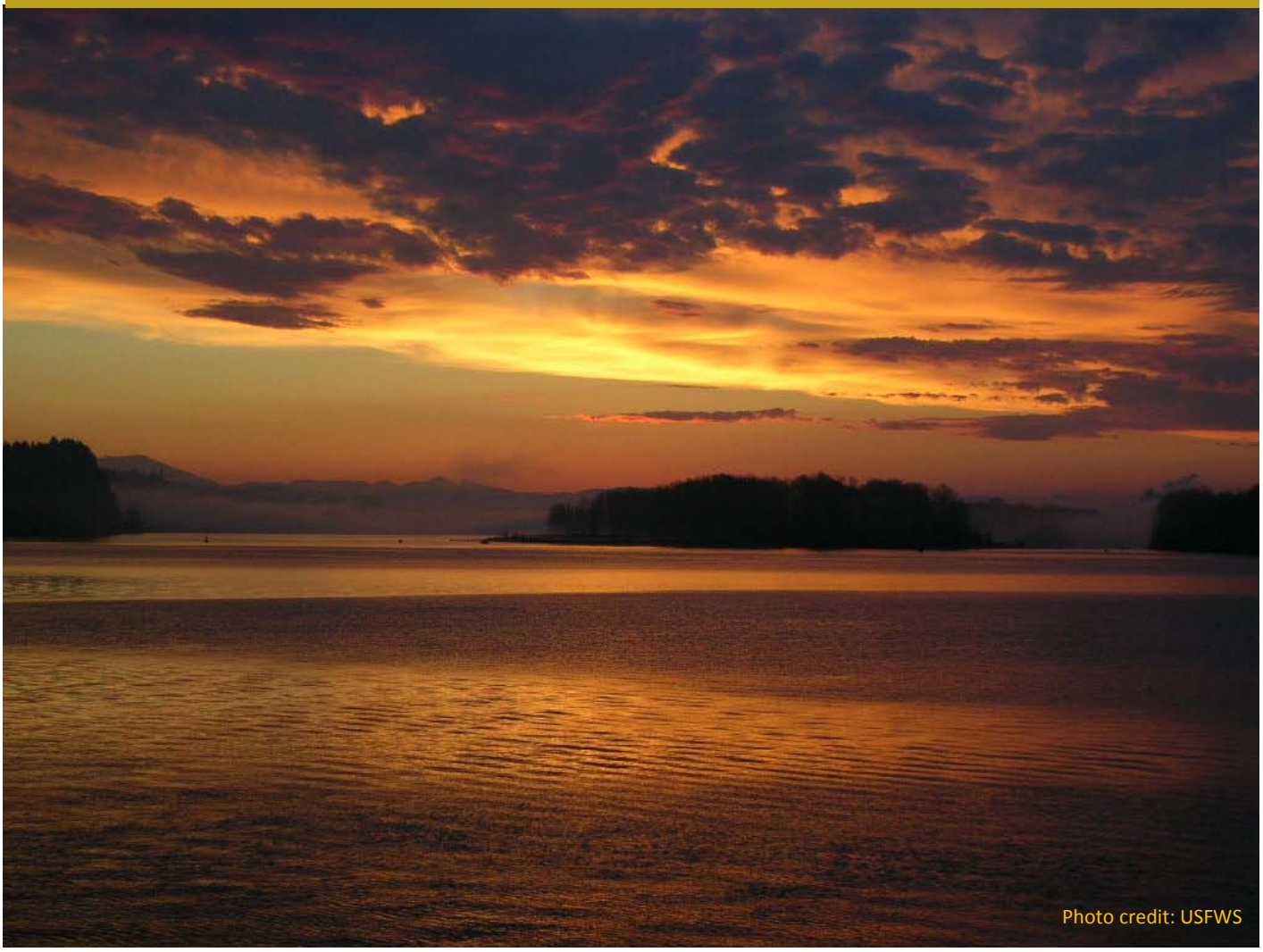
Washington Lower Columbia Salmon Recovery And Fish & Wildlife Subbasin Plan



Lower Columbia Fish Recovery Board
May 28, 2010
Final

Preface

This is one in a series of volumes that together comprise a Recovery and Subbasin Plan for Washington lower Columbia River salmon and steelhead:

--	Plan Overview	*Overview of the planning process and regional and subbasin elements of the Plan.*
Vol. I	Regional Plan	*Regional framework for recovery addressing species, biological objectives, listing factors, strategies, measures, monitoring, and implementation.*
Vol. II	Subbasin Plans	*Subbasin vision, assessments, and management plan for each of Washington lower Columbia River subbasins consistent with the Regional Plan. These volumes describe implementation of the regional plan at the subbasin level.* *II.A. Lower Columbia Mainstem and Estuary* *II.B. Estuary Tributaries: Chinook, Wallacut, Deep* *II.C. Grays Subbasin* *II.D. Elochoman/Skamokawa Subbasin* *II.E. Mill, Abernathy & Germany Subbasin* *II.F. Upper Cowlitz Subbasin* *II.G. Lower Cowlitz Subbasin* *II.H. Coweeman Subbasin* *II.I. Toutle Subbasin* *II.J. Kalama Subbasin* *II.K. North Fork Lewis Subbasin* *II.L. East Fork Lewis Subbasin* *II.M. Salmon Subbasin* *II.N. Washougal Subbasin* *II.O. Lower Columbia Gorge Tributaries* *II.P. Wind Subbasin* *II.Q. Little White Salmon Subbasin* *II.R. Upper Columbia Gorge Tributaries* *White Salmon River (see NMFS)*
Appdx. A	Focal Fish Species	*Species overviews and status assessments for lower Columbia River Chinook salmon, coho salmon, chum salmon, steelhead, and bull trout.*
Appdx. B	Other Species	*Descriptions, status, and limiting factors of other fish and wildlife species of interest to recovery and subbasin planning.*
Appdx. C	Program Directory	*Descriptions of federal, state, local, tribal, and non-governmental programs and projects that affect or are affected by recovery and subbasin planning*
Appdx. D	Economic Framework	*Potential costs and economic considerations for recovery and subbasin planning.*
Appdx. E	Assessment Methods	*Methods and detailed discussions of assessments completed as part of this planning process.*

OVERVIEW

CONTENTS

Tables

Figures

Vision

Washington lower Columbia salmon, steelhead and bull trout are recovered to healthy, harvestable levels that will sustain productive sport, commercial, and tribal fisheries through the restoration and protection of the ecosystems upon which they depend and the implementation of supportive hatchery and fishery practices.

The health of other native fish and wildlife species in the lower Columbia will be enhanced and sustained through the protection of the ecosystems upon which they depend, the control of non-native species, and the restoration of balanced predator/prey relationships.

The lower Columbia River and its tributary rivers and streams were once among the most productive salmon and steelhead systems. These rivers supported tremendous biological diversity, including five salmonid species that filled practically every accessible niche and habitat. Fish runs sustained fisheries that were intricately woven over millennia into the region's economy and fabric of life. Now, pervasive, compounding impacts of a variety of factors have driven these fish to the brink of elimination. Historical wild runs numbering a million or more in Washington lower Columbia streams have been reduced to averages of only about 30,000 per year. Virtually every population of these keystone species is currently estimated to be at high to very high risk of extinction.

Other fish and wildlife species of the lower Columbia basin have been affected by the operation of the Federal Columbia River Power System and ecosystem changes stemming from a wide range of human activities. Some species such as sturgeon, lamprey, eulachon, and Columbian whitetail deer have been adversely affected habitat loss. Other species, including northern pikeminnow, Caspian terns, and pinnepeds (seals and sealions), have thrived in modified habitat conditions, alteringthe balance of predator-prey relationships. Finally, introduced non-native plant and animal species such as Eurasion milfoil, Himalayan blackberry, and smallmouth bass have displaced native species or compete with native species for habitat and nutrients.

This Plan is intended to serve as 1) a recovery plan for Washington lower Columbia salmon and steelhead populations and 2) a Northwest Power and Conservation Council Fish and Wildlife Plan for eleven lower Columbia subbasins. The vision is of a scientifically credible, socially and culturally acceptable, and economically and politically sustainable plan to:

- Restore the region's fish species listed as threatened under the federal Endangered Species Act (ESA) to healthy, harvestable levels, and;
- Protect and enhance other fish and wildlife species that have been adversely affected by human actions, including the development and operation of the Federal Columbia River Power System.

The Plan is the product of a collaborative process facilitated by the Lower Columbia Fish Recovery Board (LCFRB) and involving federal and state agencies, tribes, local governments, and the public. It recognizes that recovery of fish and wildlife is a shared responsibility and can only be achieved through the cooperative and combined efforts of federal, tribal, state, and local interests. To ensure consistency in goals, strategies and actions and eliminate needless duplication of effort, the process integrated planning for ESA recovery, Northwest Power and Conservation Council (NPCC) fish and wildlife program, and Washington State watershed management.

Recovery of fish, enhancement of wildlife, and wise management of water resources cannot be accomplished by addressing a single threat or limiting factor. It requires a comprehensive approach that addresses the needs of each species throughout its life history. It must work for fish and wildlife and the people of the region. The Plan provides a roadmap for recovery. It melds science with cultural, social, and economic considerations. The Plan sets forth a "directional" approach based on objectives, strategies, measures and actions needed to address the full range of threats as they are currently understood. The aim is to reverse long term declining trends and establish a trajectory leading to recovery within 25 years. Since existing information is too uncertain to prescribe the exact course to recovery, progress will be evaluated regularly and, where necessary, the course adjusted.

The Plan will be implemented by a regional partnership of local, state, federal and tribal interests. The Plan is not a regulatory document. It does not obligate any party, but does establish specific responsibilities for actions that have been identified as important to fish recovery. It focuses on achieving outcomes and allows implementing agencies and other entities the flexibility to craft innovative, scientifically sound approaches that best fit local conditions and values. Recovery partners will be asked to commit to implementation through a six-year implementation schedule.

Figure 1. Naturally spawning fall Chinook salmon.

Introduction

The original version of this Plan was completed by the LCFRB in 2004 and accepted in 2006 by the National Marine Fisheries Service (NMFS) as the interim recovery Plan for the Washington portion of the lower Columbia River region. The Plan was also adopted by the NPCC in 2005 as an amendment to their Columbia River Basin Fish and Wildlife Program, which guides Bonneville Power Administration's protection, mitigation and enhancement programs for fish and wildlife affected by hydropower dams.

This 2010 version of the Plan is a revision of the interim Plan undertaken to reconcile Washington planning elements with the recovery planning process for the Oregon components of the listed species and to more fully address the needs for coho salmon, which were formally listed as threatened after completion and adoption of the interim Plan. At the same time, this revision also incorporates significant new information on species status and listing factors that has become available in the intervening period.

The Plan describes:

- A vision for recovery of lower Columbia River salmon, steelhead, and bull trout, and the ecosystems upon which they depend, and for the protection and enhancement of other focal fish and wildlife species.
- An overview of the planning process.
- A description of listed species, status, and life histories.
- A summary of the limiting factors and threats to these species.
- Recovery goals and criteria consistent with the vision.
- Regional strategies and measures to address each category of threat.
- Discussion of limiting factors and threats specific to each species.
- Threat reduction targets and benchmarks.
- A description of monitoring and research plans.
- A framework for Plan implementation including an institutional structure, adaptive management strategy, and list of actions and responsibilities.
- Detailed subbasin plans including assessments of species status, limiting factors and threats, and actions for implementing strategies and measures in each subbasin.
- Descriptions of federal, state, and local programs that play roles in implementation.
- Extensive documentation of species and assessment methods.

Plan Organization

Volume I – The Regional Plan that describes the current status of listed Lower Columbia salmon and steelhead populations, discusses threats and other factors affecting the listed species, establishes recovery goals and objectives, sets forth region-wide recovery strategies and measures, summarizes subbasin or watershed conditions and strategies, describes monitoring and research measures, discusses implementation processes, and provides recovery cost estimates.

Volumes II.A-II.R – A series of subbasin or watershed-level Plans describing local conditions, objectives and targets, and implementation details.

Appendices A-E – Additional details on focal species, other species, related programs, economic considerations, and assessment methods.

An Integrated Plan

The planning process integrated the following four interrelated initiatives to produce a single Recovery/Subbasin Plan for the lower Columbia:

- U.S. ESA recovery planning for listed salmon, steelhead and trout.
- NPCC subbasin planning for eight full and three partial subbasins which guides Bonneville Power Administration's funding of projects to implement the fish and wildlife program.
- Watershed planning pursuant to the Washington Watershed Management Act, RCW 90.82.
- Habitat protection and restoration pursuant to the Washington Salmon Recovery Act, RCW 77.85.

This integrated approach ensures consistency and compatibility of goals, objectives, strategies, priorities and measures; eliminates redundancy in the collection and analysis of data; and establishes a partnership of federal, state, tribal and local governments under which agencies can effectively and efficiently coordinate planning and implement actions.

ESA Recovery Planning

Four salmon and steelhead species in the lower Columbia region, including Chinook, chum, coho, and steelhead have been listed as threatened under the ESA. The ESA requires preparation of a Recovery Plan that includes:

- Site-specific management actions necessary for the conservation and survival of the species;
- Objective, measurable criteria which, when met, result in a determination that the species be removed from the list (i.e., delisting); and
- Estimates of the time required and cost to carry out those measures needed to achieve recovery.

Recovery plans are guidance documents that serve as a central vehicle for the recovery of listed species. As the listing agency for anadromous salmonids, the NMFS will adopt this Plan for the Washington Management Unit along with White Salmon River Plan, Columbia River Estuary Recovery Module, and Oregon's Management Unit Plan to complete a comprehensive Recovery Plan for the Lower Columbia River Recovery Planning subdomain for Chinook, chum, and coho salmon and steelhead. The USFWS is responsible for developing a separate bull trout recovery plan.

NPCC Subbasin Planning

The NPCC was created by Congress in 1980 to give Washington, Oregon, Idaho, and Montana a voice in how the region plans for its energy needs, while at the same time mitigating the effects of the Federal Columbia River Power System on fish and wildlife resources. To this end, the Council has developed the Columbia Basin Fish and Wildlife Program. The program sets forth goals and strategies for the protection and enhancement of fish and wildlife resources and is used by the Council to solicit and evaluate proposals for on-the-ground projects and research. The program includes 62 subbasin plans encompassing the Columbia Basin.

Adopted by the NPCC in 2005, this Plan serves as the subbasin plans for the eight Washington subbasins and portions of three other subbasins shared with Oregon. Subbasin plans:

- Identify the goals for fish, wildlife, and habitat;
- Define objectives that measure progress toward the those goals;
- Establish strategies to achieve the objectives; and
- Incorporate and build upon existing fish and wildlife information and activities.

Washington Watershed Planning

The state Watershed Management Act (RCW 90.82) provides local communities the opportunity to plan for the future use of their water resources in consultation with state agencies. The LCFRB lead efforts to develop watershed management plans for four of five Water Resource Inventory Areas (WRIAs) in the Lower Columbia region. These plans have been approved by county governments and state agencies.

Water quantity and quality data collected by the watershed planning initiatives have been incorporated in this Plan. Habitat data collected by the recovery planning effort have been incorporated in the watershed management plans. Policies, strategies, actions, and priorities of this Plan and the watershed plans have been coordinated to ensure that they are consistent and compatible.

Washington Salmon and Habitat Protection and Restoration

The Washington Salmon Recovery Act (RCW 77.85) establishes a grant funding program for habitat protection and restoration projects. The LCFRB serves as the Lead Entity for this program in the Lower Columbia region. As such, the LCFRB maintains a Habitat Work Schedule that identifies and prioritizes protection and restoration needs. It also solicits, evaluates, and ranks habitat project proposals and submits a recommended list of projects to the statewide Salmon Recovery Funding Board (SRFB) for consideration. The Habitat Work Schedule is based on and is consistent with the strategies, measures, and actions set forth in the Plan.

An Ecosystem Approach

This Plan takes an ecosystem approach to salmon and steelhead recovery that recognizes:

- The hierarchical organization and function of salmon and steelhead from species through population levels;
- Environmental and human factors affecting each species and population throughout it's life cycle at landscape and local scales;
- The combination of overlapping and unique life cycle requirements and limiting factors among salmon and steelhead species; and
- Other significant fish and wildlife species that share habitats and are affected by protection and restoration of salmon and steelhead.

An ecosystem approach is essential to the development of an effective recovery plan for salmon and steelhead in the lower Columbia region because of the large scale of the affected area and the large number of listed species. Where recovery plans for other species and areas more typically focus on a single species or a limited number of populations, the lower Columbia Plan addresses 4 species comprised of over 100 populations originating in two states and migrating between two countries. Any action taken to benefit a specific species or area will inevitably affect associated species and areas. Consideration of overlapping needs and affects will, by design, optimize the balance of effectiveness and efficiency of recovery.

Planning Area

The planning area includes all Washington Columbia River subbasins from the Chinook River near the ocean to and including the Little White Salmon River in the gorge, as well as the Washington portion of the estuary and mainstem up to the Little White Salmon River, as shown in the map below (Figure 2). Recovery planning for the White Salmon River was conducted by NMFS. This area represents the Washington portion of the Lower Columbia salmon ESUs and steelhead DPS.

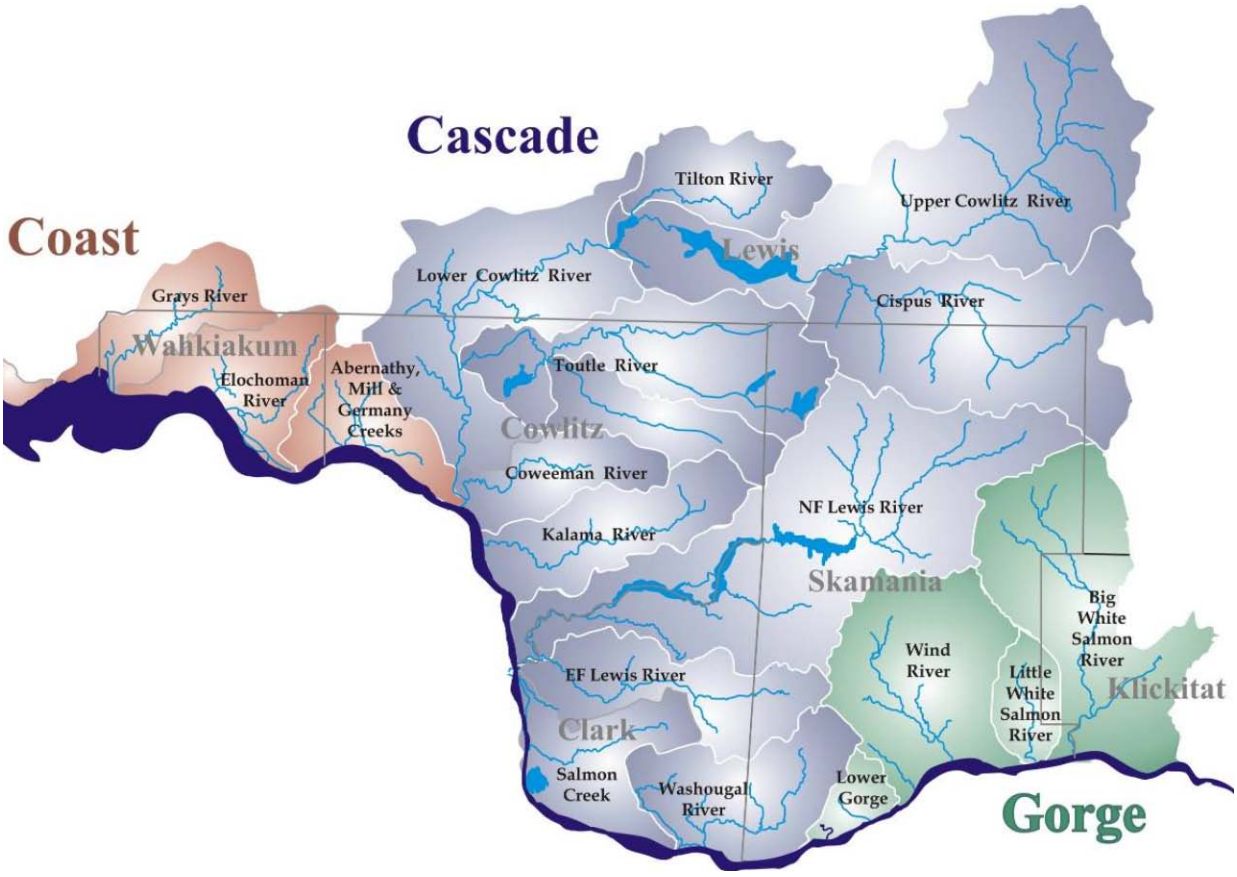


Figure 2. Lower Columbia River – Washington planning area

Planning Area Features

- *5,700 square miles*
- *2,200 river and stream miles*
- *Over half a million people*
- *All of Clark, Cowlitz, Skamania, and Wahkiakum Counties and portions of Lewis and Pacific Counties.*
- *13 cities as well as numerous unincorporated communities.*
- *Lands of interest to the Yakama Indian Nation and the Cowlitz and Chinook tribes where reserved fishing and hunting rights are exercised, natural resources are co-managed, and tribal trust lands are inhabited.*

Planning Horizon

The Plan uses a planning period or horizon of 25 years, dating from a baseline referenced to the initial salmon and steelhead listings in 1998-1999. The goal is to fully implement, within 25 years, all actions needed to achieve recovery of the listed salmon species and the biological objectives for other fish and wildlife species of interest. It is recognized, however, that full realization of habitat conditions and watershed processes needed to reach the healthy and harvestable goals of this Plan will likely take 50 years or more.

Planning Organization & Participants

The LCFRB led and coordinated the development of the interim Plan and this revised edition. The Board was established by state statute (RCW 77.85.200) in 1998 to oversee and coordinate salmon and steelhead recovery efforts in the lower Columbia region of Washington. Representatives from the state legislature, city and county governments, the Cowlitz Tribe, private property owners, hydro project operators, the environmental community, and citizens comprise the LCFRB.

Revisions to the Plan were developed in consultation with the Lower Columbia ESU Recovery Roll-up Steering Committee consisting of representatives from NMFS, the Washington Governor's Salmon Recovery Office (GSRO), the Oregon Governor's Office, LCFRB, WDFW, Oregon Department of Fish and Wildlife, and the Lower Columbia River Estuary Partnership.

A variety of partners representing federal agencies, tribal governments, Washington state agencies, regional organizations, local governments, and members of the public participated in the Plan update process. Participation was achieved through public meetings, workshops, and comment periods.

Domain Coordination

The Washington Recovery Plan, or management unit plan, is an element of the overall Lower Columbia Domain salmon and steelhead Recovery Plan. Other elements include the Oregon recovery or management unit plan, the White Salmon River recovery plan, and Columbia River Estuary Salmon and Steelhead Recovery module.

Completion of this revised Plan for the Washington management unit involved an extensive coordination process with Oregon and NMFS to ensure a comprehensive and complementary approach to salmon recovery across all domain Plan elements. Since completion of the interim Washington Plan in 2004, Oregon has undertaken an extensive recovery planning process for their portion of the domain. Effective recovery strategies require development of coordinated goals, strategies, measures and actions by both states to address common factors. The process of synthesizing or "rolling-up" the various domain plan elements addresses interdependencies and issues of regional scope, and ensures that all threats to the entire salmon life cycle are addressed.

The domain coordination process involved a series of technical and policy level meetings to exchange information and to develop approaches and alternatives for further consideration in the recovery planning processes of each state. This coordination process was facilitated by an ESU Recovery Roll-up Steering Committee consisting of representatives from involved governmental agencies.

Community and Public Participation

Public and community participation in Plan update process was provided by:

- Reviews of Plan revisions at LCFRB meetings;
- A 30-day public comment period; and
- Four public workshop meetings conducted across the region.

The final Plan was revised to address agency and public comments.

Listed Species

The Plan is the primary instrument guiding protection, enhancement, and recovery of listed salmon and steelhead species in the Washington lower Columbia region. Recovery focuses on achieving self-sustaining, naturally-produced populations of salmon and steelhead. Chinook salmon, chum salmon, coho salmon, steelhead, and bull trout of the lower Columbia River region, including parts of Washington and Oregon, were listed as Threatened under the U.S. Endangered Species Act (ESA) between 1998 and 2005. Under the ESA, NMFS has responsibility salmon and steelhead, while the United States Fish and Wildlife Service (USFWS) has responsibility for Bull Trout.

Almost every lower Columbia population of these listed salmonid species is currently estimated to be at high to very high risk of extinction (Figure 3).

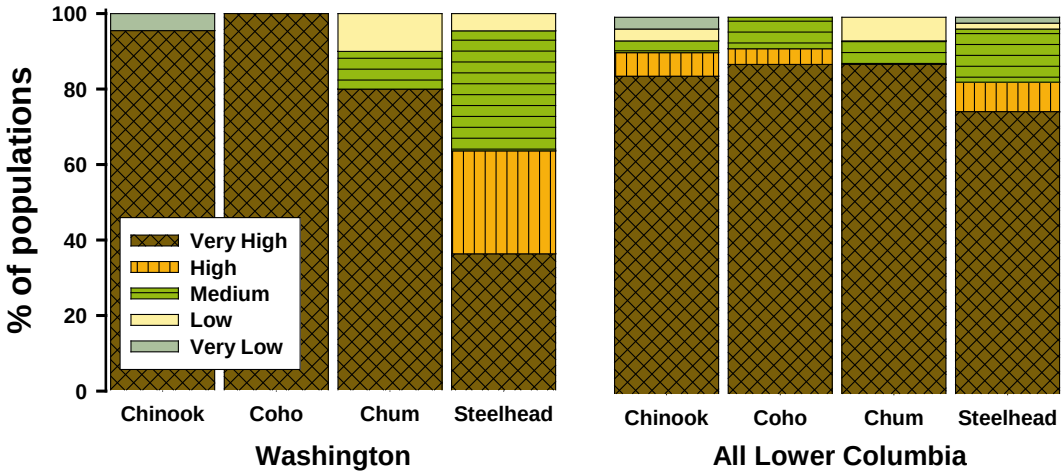


Figure 3. Estimated extinction risks of populations of listed Lower Columbia River salmon and steelhead in Washington and throughout the region (including both Washington and Oregon). Risks are defined based on extinction probability within the next 100 years (Very high: >60%, high: 26-60%, medium: 6-25%, low: 1-5%, and very low: <1%).

NMFS has explicitly identified listing units for each species and defined a hierarchy of units and subunits including evolutionarily significant units (ESUs) for salmon and distinct population segments (DPSs) for steelhead, major population groups or strata, and demographically-independent populations. Geographic boundaries identified for lower Columbia River salmon ESUs and steelhead DPSs generally include the Columbia River and its tributaries, from its mouth at the Pacific Ocean upstream to a transitional point between Washington and Oregon east of the Hood River and the White Salmon River, and upstream in the Willamette River to Willamette Falls, Oregon. Selected hatchery stocks were included in all four Lower Columbia River ESUs/DPS and are listed along with naturally produced fish.

A wide variety of other key fish and wildlife species will also benefit from the Plan's ecosystem approach to salmonid recovery. This Plan focuses on such 27 fish and wildlife species including American shad, eulachon, lamprey, Larch Mountain salamander, western pond turtle, Columbian white-tailed deer, western gray squirrel, Bald Eagle, and Sandhill Crane. The health of these species and their habitats has been impacted by the Federal Columbia River Power System. The restoration and enhancement of species is an element in the NPCC subbasin fish and wildlife planning process. These additional fish and wildlife species are identified and discussed in detail in Appendix B of the Plan and in

the Estuary/Mainstem, Wind River, and Little White Salmon River chapters found in Volume II of the Plan.

Chinook Salmon (*Oncorhynchus tshawytscha*)

Spring, tule fall, and bright fall Chinook runs were included in the lower Columbia River ESU first listed as threatened under the ESA on March 24, 1999. Chinook salmon are the largest and most diverse of the listed lower Columbia salmonid species. Over a quarter million Chinook salmon historically returned annually to lower Columbia systems. Spring, fall, and late fall runs spawn in river mainstems from the Columbia to the headwaters of the larger tributaries and juvenile Chinook rear or migrate through the lower Columbia River in practically every month of the year. Chinook salmon range north to the Gulf of Alaska, typically on a multi-year journey, before returning home again.

Chum Salmon (*Oncorhynchus keta*)

The lower Columbia River chum ESU was first listed as threatened on March 25, 1999. Chum salmon return to spawn in the lower-most reaches of streams and rivers. Almost a million chum historically returned annually to lower Columbia River streams. Young chum spend the briefest time of any of the species in freshwater, migrating seaward soon after emerging from the clean spring-fed gravel upon which they depend. They migrate to the far north Pacific and the Bering Sea before returning to their natal streams.

Coho Salmon (*Oncorhynchus kisutch*)

The lower Columbia coho ESU was first listed as threatened on June 28, 2005. Annual returns of lower Columbia coho salmon historically numbered in the hundreds of thousands. Early and late coho runs spawn in fall and winter in smaller, lower gradient streams throughout the lower Columbia from low elevation valley bottoms to the mountainous headwaters. Coho inhabit the nearshore ocean of the Oregon and Washington coasts where weather-related upwelling patterns and the short 3-year life cycle of this species cause highly variable population cycles.

Steelhead (*Oncorhynchus mykiss*)

The Lower Columbia steelhead DPS was listed as threatened under the ESA on March 19, 1998. The Grays, Elochoman, Skamokawa, Abernathy, Mill, and Germany steelhead populations are in the Southwest Washington ESU and are not listed under the ESA but are affected by measures identified in this Plan.

Steelhead, including summer and winter runs, return to freshwater during every month of the year and typically spawn and rear in the steeper boulder-strewn upper reaches of lower Columbia tributary rivers and streams. Freshwater life history of steelhead is very diverse, with juveniles rearing 1-3 years before emigrating to the ocean. Steelhead range widely in the Pacific Ocean. Unlike salmon, not all steelhead die after spawning and some return to spawn again.

Bull Trout (*Salvelinus confluentus*)

On June 10, 1998, bull trout in the Columbia and Klamath basins were listed by the USFWS as threatened under the ESA, and are the subject of a draft recovery plan. USFWS delayed completion of the recovery plan in lieu of a 5-year review of the bull trout listing. Bull trout rely on cold headwater streams, of which few remain. Current distribution in the lower Columbia is limited to the upper Lewis River, and several Columbia River Gorge streams. Bull trout feed primarily on other fish, and may have historically depended on the large salmon runs for sustenance in this area. Bull trout populations in the lower Columbia rarely leave freshwater but life histories often involve extensive upstream and downstream migration between streams, rivers, and lakes.

Limiting Factors, Threats, & Impacts

The status of lower Columbia River salmon and steelhead results from the combined effects of habitat degradation, dam building and operation, fishing, hatchery operations, ecological changes, and natural environmental fluctuations. Understanding the life cycle of the fish and their biological needs in relation to limiting factors, threats, and their impacts is essential to the development of an effective recovery program (Figure 4). This Plan includes descriptions and estimates of limiting factors, threats, and impacts based on an extensive review and synthesis of the published and unpublished scientific literature of these species in the lower Columbia River region.

Limiting factors are described in relation to the biological needs of the species and include a wide spectrum of conditions that affect salmon throughout their life cycle, such as access to floodplain habitats or changes in timing and magnitude of river and stream flows. Threats describe the human activities or other dynamics that affect the limiting factors. This Plan identifies seven categories of threats for lower Columbia River salmon and steelhead: 1) stream habitat, 2) Columbia River mainstem and estuary habitat, 3) dams, 4) fisheries, 5) hatcheries, 6) ecological interactions, and 7) climate/ocean. They address the statutory listing factors identified by the ESA as potentially threatening the probability of long term persistence of the ESU/DPS. Impacts are the effect of the potentially-manageable threats quantified in this Plan as proportional reductions in abundance and productivity of the species. For

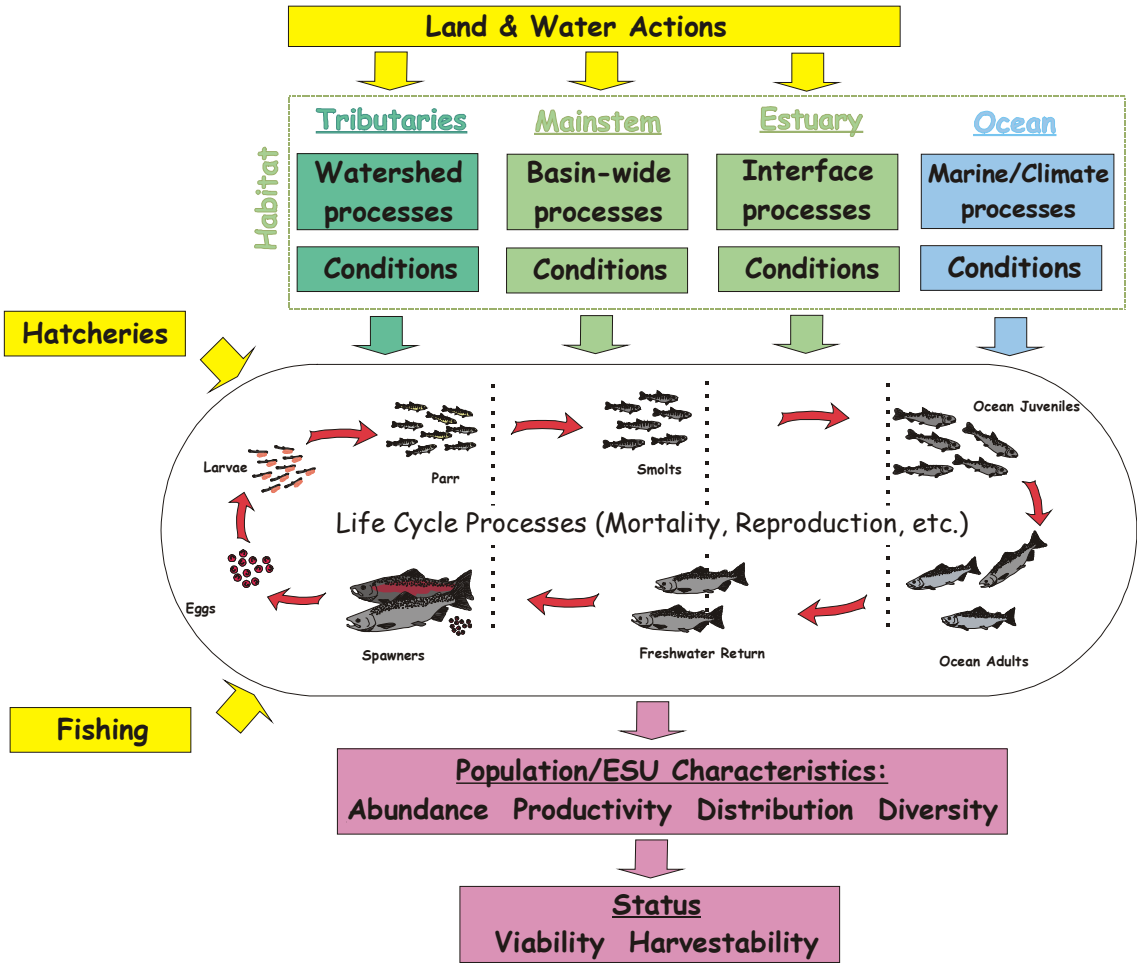


Figure 4. Relationship of listing factors, influences on the salmon life cycle, and species status.

example, mortality associated with harvest for a given population is cited as a percentage of combined mortality across all seven threat categories. Threat impacts for individual populations are presented as pie graphs in the Volume II Subbasin chapters. As an example, the graphs for salmon and steelhead populations in the Grays River Subbasin are provided in Figure 5.

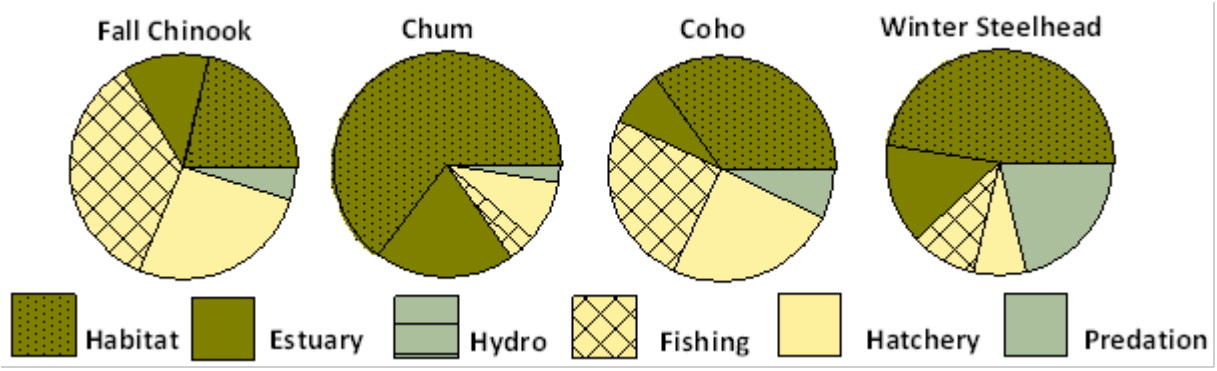


Figure 5. Relative contribution of potentially manageable impacts on Grays River salmonid populations.

The seven categories of threats are further described below:

Stream Habitat

Analysis suggests stream habitat productivity in the region have been degraded by 10-98% relative to historical conditions for salmon, steelhead, and trout. Fish have been adversely affected by changes in access, stream flow, water quality, sedimentation, habitat diversity, channel stability, riparian conditions, and floodplain interactions. Corresponding threats include dams and other barriers, water withdrawals, urban and rural development, forest practices, agriculture practices, mining, channel manipulations, and recreational activities. Detailed assessments of stream habitat conditions, watershed conditions, and habitat forming processes are found in the subbasin chapters of the Plan (Volume II).

Estuary and Mainstem Habitat

Estuary and lower Columbia mainstem habitats play an important but poorly understood role in the anadromous fish life cycle. Large-scale changes in river flow, water circulation, sediment transport, and floodplain and wetland destruction or isolation have altered habitat conditions and processes important to migratory and resident fish and wildlife. Hydro flow regulation, channel alternations, and floodplain development and diking have all contributed to these habitat changes. Estuary conditions and influences are described in detail in the subbasin volume of the Plan (Volume II).

Hydropower

Habitat conditions for fish and in particular, anadromous fish, have been fundamentally altered throughout the Columbia River basin by the construction and operation of a complex of tributary and mainstem dams and reservoirs for power generation, navigation, and flood control. Lower Columbia salmon, steelhead and trout are threatened by hydrosystem-related flow and water quality effects, obstructed and/or delayed passage, and ecological changes in impoundments. Dams in the North Fork Lewis, Cowlitz, Toutle, and White Salmon subbasins have blocked access by anadromous fish to large areas of productive habitat.

Harvest

Harvest of lower Columbia salmon and steelhead includes commercial, recreational, and tribal fisheries in the ocean from Alaska to northern California and in the mainstem Columbia and tributaries. Prior to

listing, fishing impact rates on wild salmon populations ranged from less than 5% for chum salmon to 65% for tule fall Chinook. Fisheries have been progressively reduced in order to protect natural populations. Fisheries generally seek to avoid harvest of weak, listed, wild salmon or steelhead populations but significant numbers of listed fish (of some species) are incidentally caught in fisheries for hatchery and strong wild stocks.

Hatcheries

At the time of listing, hatcheries were releasing over 50 million salmon and steelhead per year in Washington lower Columbia River subbasins. Many of these fish are released to mitigate for loss of habitat resulting from the Columbia River hydrosystem and widespread habitat loss. Hatcheries provide valuable mitigation and conservation benefits but may also cause significant adverse impacts if not prudently and properly operated. Risks to wild fish include genetic deterioration, reduced fitness and survival, ecological effects such as competition or predation, facility effects on passage and water quality, mixed stock fishery effects, and confounding the accuracy of wild population status estimates.

Ecological Interactions

Ecological interactions refer to the relationships of salmon and steelhead with other elements of the ecosystem. Limiting factors include interactions with non-native species, effects of salmon on system productivity (e.g. nutrient cycling), and native predators of salmon. Each of these factors can be exacerbated by human activities either by direct actions or indirect effects of habitat alternation.

Climate & Ocean Effects

Large fluctuations in fish survival over the last three decades have demonstrated that ocean conditions are much more dynamic than previously thought. The ocean is subject to annual and longer-term climate cycles just as the land is subject to periodic droughts and floods. Land and ocean weather patterns are related and their combination drives natural variation in salmon survival and productivity as those seen in recent years.

Goals, Criteria & Objectives

It is the overarching **goal** of this Plan to return all Lower Columbia salmon and steelhead populations to **healthy** and **harvestable** levels within 25 years.

- Salmon and steelhead species are considered **healthy** or **viable** when they are no longer in danger of extinction or likely to become endangered within the foreseeable future and no longer require protection under ESA.
- A species is **harvestable** when it is viable, and when fish numbers are sufficient to allow direct and sustainable sport, commercial, and tribal harvest without jeopardizing the species' viability.

Criteria for species viability are established by NMFS and are based on risk of extinction over time. The Viable Salmonid Population (VSP) criteria include measures of species abundance, productivity, diversity, and spatial structure. The VSP criteria, in combination with modeling and analysis of available population data, were used to assess current status and set recovery **objectives** for the Lower Columbia ESU. These objectives include population-level, strata-level and ESU/DPS-level recovery objectives. The combination of population viability objectives that collectively meet NMFS' criteria are called the recovery scenario (Figure 6).

Population-level **targets** for improvements needed to meet the viability objectives have been established. These targets describe relative improvements in population attributes (including abundance and productivity) needed to close the "gap" between current status and population objectives.

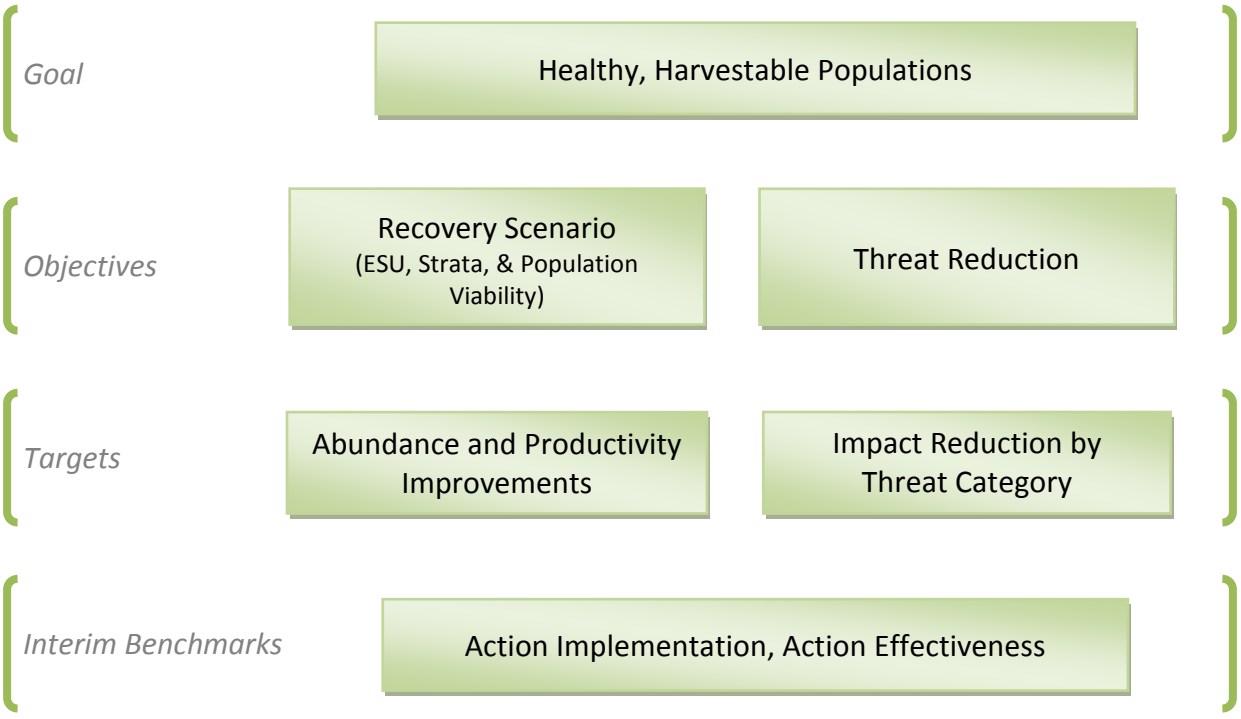


Figure 6. Hierarchy of Recovery Plan goals, objectives, targets, and benchmarks identified for Washington Lower Columbia River salmon and steelhead.

In addition to improvement targets for VSP parameters, **targets** for threat impact reduction are identified. As part of the listing process under the ESA, NMFS identified listing factors for each listed species. Listing factors and threats are categories of conditions that affect or limit fish viability at some point in their life cycle. This Plan defines impact reduction targets for each potentially-manageable threat category (stream habitat, estuary habitat, dams, fisheries, hatcheries, and ecological interactions). Collectively, impact reduction targets for the potentially-manageable threat categories identify the overall threat impact reduction needed to achieve the population viability objective. The "recovery burden" is equitably allocated among threat categories in proportion to the significance of the threat. Targets also reflect long-term harvestability goals of the Plan.

The Plan's objectives and targets define desired conditions at the time of recovery. Since recovery will require several decades or longer, interim **benchmarks** have been established in order to guide implementation over time and assess progress toward recovery.

Recovery Goals

The goal of this Plan is recovery of all Lower Columbia salmon and steelhead species to healthy and harvestable levels.

Healthy goals will be met when a species is recovered to viable levels where it is no longer in danger of extinction or likely to become endangered within the foreseeable future (and can be removed from listing under ESA). The Plan adopts recovery goals for viability based on scientific criteria recommended by the NMFS' Technical Recovery Team.

Viability is simply the ability of a population, or group of populations, to persist over an extended period of time. For ESA purposes, a viable ESU is one that is not endangered or threatened with extinction. Extinction results from the interaction of fish population processes and external factors that reduce population size to critical low levels that are no longer self-sustaining. A viable salmonid species has been defined as having a negligible risk of extinction (<5%) over a 100-year time frame. Figure 7 highlights how a hypothetical population may have high numbers in particular years, but the overall population trend is downward leading to risk of extinction (numbers <5%).

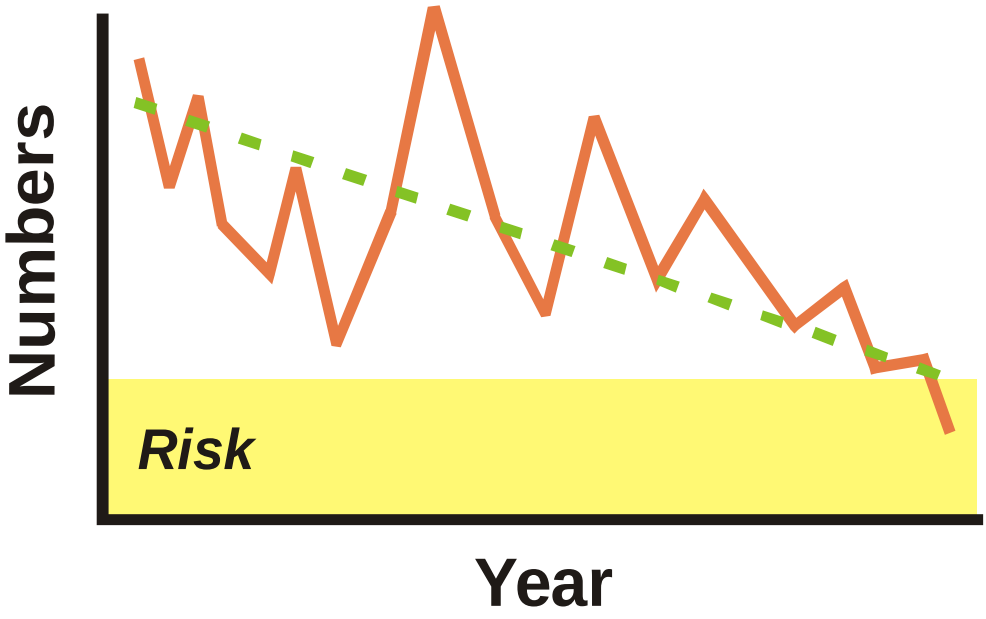


Figure 7. Hypothetical example of a population at high risk of extinction.

Harvestability goals are reached when adult production exceeds viability objectives and fish can be directly harvested at levels that maintain spawning escapement at or above viability objectives (Figure 8). Under the ESA, recovery of an ESU/DPS might be reached when the ESU/DPS viability criteria are achieved. However, the recovery vision in this Plan of healthy, harvestable populations will require improvement to levels greater than the minimum levels required by the ESA.

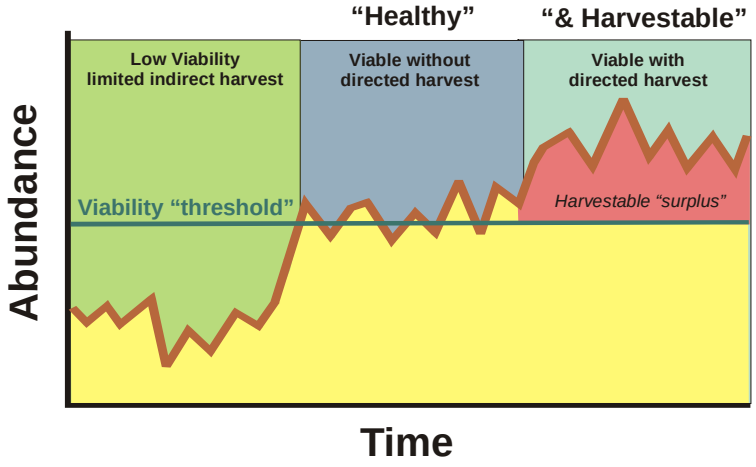


Figure 8. Example recovery trajectory illustrating long term healthy and harvest goals of this Plan.

Currently, the harvest of listed populations that are not considered viable is typically limited to indirect take in mixed stock fisheries of strong wild runs and hatchery stocks. The Plan proposes a significant reduction of harvest impacts on wild populations in the near and intermediate-term. Over the long term, harvest impact rates on these natural populations would be gradually increased as the benefits of other recovery measures are realized. Once recovery is achieved harvest rates would be commensurate with escapement levels needed to ensure that salmon and steelhead populations remain viable. Harvest targets once recovery is achieved are shown in Table 1.

Table 1. Target Harvest Rates once recovery is achieved. Ranges reflect annual or population differences.

Species	Fishing rates at recovery	Fishery Opportunities
Spring Chinook	20-30%	• Directed freshwater sport, commercial & treaty tribal fisheries.
Fall Chinook	40-50%	• Directed U.S. ocean & freshwater sport, commercial & treaty tribal fisheries. • Limited incidental harvest in AK & CAN sport & commercial fisheries.
Chum	3-5%[1]	• Incidental impact of limited late fall fisheries in freshwater.
Coho	10-30%[1]	• Directed U.S. ocean & freshwater sport, commercial. & treaty tribal fisheries.
Steelhead	5-10%	• Directed harvest in treaty tribal fisheries above Bonneville Dam. • Catch and release impacts of freshwater sport fisheries. • Limited incidental impacts of spring mainstem commercial fisheries.

[1] Recovery fishing rates for some species are identified in this Plan based on current rates. Sustainable fishing rates at recovery might be greater but will be ultimately be determined based on wild population parameters

Biological Recovery Criteria

The biological goals for salmon and steelhead in this Plan are based on, and explicitly incorporate, the work of the Willamette/Lower Columbia TRT convened by NMFS.

Each ESU or DPS consists of two or more strata (Figure 9). The TRT defines a stratum as group of populations of an ESU/DPS with similar life history traits within the same ecological zone (Myers et al. 2003). Distinct ecological zones or strata in the Lower Columbia include the Coast, Cascades, and Gorge. Fish life histories are typically described by species and season of return (e.g., fall Chinook).

Figure 9. Ecological zones identified for recovery strata by the Technical Recovery Team for listed lower Columbia River salmon and steelhead.

The TRT's recommendations address a hierarchy of ESU, strata, and population standards. Key standards recommended by TRT include:

- ***Stratified Approach–*** Every life history (spring run, fall run, etc.) and ecological zone (Coast, Cascade, Gorge) stratum that historically existed should have a high probability of persistence.
- ***Viable Populations–*** Individual populations within a stratum should have persistence probabilities consistent with a high probability of strata persistence. The TRT defined high persistence probability based on the presence of at least two populations with a negligible risk of extinction per stratum and other populations in the stratum have persistence probabilities consistent with 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). Population viability depends on naturally-produced fish spawning in the wild.
- ***Representative populations–*** Not every historical population needs to be restored, but selected populations should include "core" populations that are highly productive, "legacy" populations that represent historical genetic diversity, and "dispersed" populations that minimize susceptibility to catastrophic events.
- ***Non-deterioration–*** No population should be allowed to deteriorate until ESU recovery is assured. Currently-productive populations must be preserved. Recovery measures will be needed in most areas to arrest declining status and offset the effects of future impacts.
- ***Safety factors–*** Recovery efforts must target more than the minimum number of populations and more than the minimum population levels to ensure viability because not all attempts will be successful.

According to the TRT criteria, an ESU/DPS is viable when every stratum is viable. A stratum is viable when it contains at least two populations of high or greater viability (extinction risk of 5% or less) and the strata-wide average viability for all populations exceeds medium (extinction risk < 25%). Population viability is determined based on Viable Salmonid Population (VSP) attributes including abundance, productivity, spatial structure and diversity. Abundance is the numerical size of the population (typically based on annual number of spawning adults for salmon and steelhead). Productivity refers to a populations' ability to replace itself and rebound from a low level to the equilibrium population level. Spatial structure refers to the amount of habitat available, the organization and connectivity of habitat patches, and the relatedness and exchange rates of adjacent populations. Diversity refers to individual and population variability in genetic-based life history, behavioral, and physiological traits. Table 2 lists the population viability designations developed by the TRT.

Table 2. Viability and extinction risk categories identified by the Willamette-Lower Columbia Technical Recovery Team.

Score	Viability		Extinction risk	
	Category	Persistance probability[1]	Category	Extinction probability[1]
0	Very low	<40%	Either extinct or very high	>60%
1	Low	40-74%	High	26-60%
2	Medium	75-94%	Moderate	6-25%
3	High[2]	95-99%	Low[2]	1-5%
4	Very High	>99%	Very low	<1%

[1] 100-year probabilities.
[2] Represents a "viable" level.

The Recovery Scenario – Population Viability Objectives

The recovery scenario identifies viability objectives for each population. The combination of populations and population status levels is designed to meet TRT recovery criteria for a viable ESU. Specific population objectives range between very low and very high levels of viability. Both Washington and Oregon populations are considered in the recovery scenario because lower Columbia listing units include populations from both states.

The TRT's recommendations state that not every population needs to be restored to high levels of viability to recover an ESU. The criteria allow efforts to be concentrated in subbasins where multiple species occur and moderate to high quality habitat provides good prospects for cost effective results. Substantial improvements are not required in some severely degraded subbasins, but additional protection and restoration efforts are required to prevent further declines. A collaborative stakeholder process considered scientific, biological, social, cultural, political, and economic factors to develop a recovery scenario consistent with the TRT's recommended criteria.

Populations that are targeted for restoration to high or greater level of viability are designated **Primary populations**. These populations are the foundation of salmon recovery. At least two populations per strata must be at high or better viability to meet recommended TRT criteria. Populations for which some improvement in viability is needed to achieve the TRT recommended strata-wide average of medium viability are designated as **Contributing populations**. Most Contributing populations are targeted for a medium viability level. Populations to be maintained at their current viability level are designated as **Stabilizing populations**. These are typically populations that are currently at very low viability. Stabilizing populations might include those where significance is low, feasibility is low, and uncertainty is high. While stabilizing populations are not targeted for significant improvement, substantive recovery actions will typically be required to avoid further degradation. Figure 10 illustrates the relationship between population status and population improvements identified in the recovery scenario.

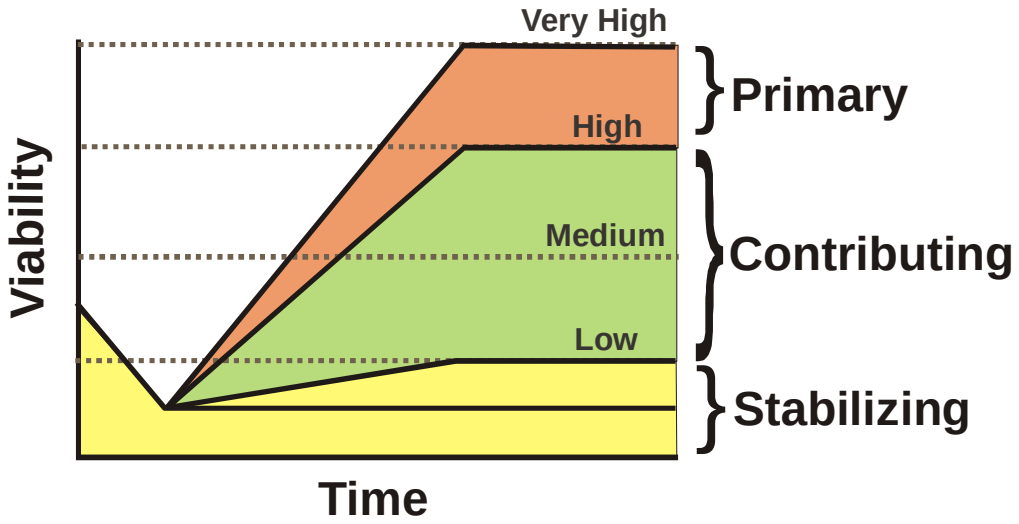


Figure 10. Example population trajectories corresponding to scenario designations.

A total of 103 historical salmon and steelhead populations have been identified within the Lower Columbia River recovery domain which includes areas of both Washington and Oregon. Of these, 72 occur in Washington, including 7 that are shared with Oregon (noted in Table 3). The recovery scenario identifies a total of 63 primary, 27 contributing, and 13 stabilizing populations in Washington and Oregon.

The recovery scenario presented in Table 3 meets or exceeds strata-level recovery criteria, except for Gorge fall Chinook, Gorge spring Chinook, Gorge chum, and Gorge summer steelhead. These strata fall short due to severe habitat limitations in these areas. In several cases, component populations are functionally extinct. Rather than focusing limited restoration resources on populations with low prospects for recovery, the Recovery Plan has targeted other populations in adjacent strata for higher levels of recovery in order to ameliorate ESU-wide risks.

Table 3. Recovery Scenario - Population viability objectives for lower Columbia salmon and steelhead populations in Washington and Oregon (Primary, Contributing, Stabilizing). Changes in the recovery scenario from the scenario identified in the 2004 interim plan are noted in strikeout format.

		Chinook			Chum		Steelhead		Coho
		Fall	Late Fall	Spr.	Fall	Sum.	Win.	Sum.	
COAST	Grays/Chinook	~~P~~ C	--	--	P	--	P[2]	--	P
	Eloch./Skam.	P	--	--	P	--	C[2]	--	P
	Mill/Aber./Ger.	~~C~~ P	--	--	P	--	P[2]	--	C
	Youngs Bay (OR)	S	--	--	~~P~~ S	--	P[2]	--	S
	Big Creek (OR)	~~S~~ C	--	--	~~C~~ S	--	P[2]	--	~~P~~ S
	Clatskanie (OR)	P	--	--	~~C~~ P	--	P[2]	--	~~S~~ P
	Scappoose (OR)	~~S~~ P	--	--	~~C~~ P	--	P[2]	--	P
CASCADE	Lower Cowlitz	C	--	--	C	C	C	--	P
	Coweeman	P	--	--			P	--	P
	SF Toutle	~~S~~ P	--	C			P	--	P
	NF Toutle		--				P	--	P
	Upper Cowlitz	S	--	P			~~C~~ P	--	~~C~~ P
	Cispus		--	P	--	--	~~C~~ P	--	~~C~~ P
	Tilton		--	S	--	--	C	--	~~C~~ S
	Kalama	~~P~~ C	--	~~P~~ C	C	--	P	P	C
	NF Lewis	P	P	P	P	--	C	S	C
	EF Lewis		--	--		--	P	P	P
	Salmon	S	--	--	S	--	S	--	S
	Washougal	P	--	--	P	--	C	P	C
	Sandy (OR)	~~S~~ C	P	P	P	--	P	--	P
	Clackamas (OR)	C	--	P[1]	C	--	P	--	P
GORGE	Lower Gorge	C[3]	--	--	P	--	P	--	P[3]
	Upper Gorge	~~S~~ C	--	--	C	--	S[3]	P	~~C~~ P
	White Salmon	C	--	C		--	--	--	
	Hood (OR)	~~S~~ P	--	P		--	P	P	C

[1] Clackamas spring Chinook are part of the Upper Willamette ESU.
[2] Winter steelhead of the Coast Strata are not listed under the Federal ESA.
[3] Designation for shared population based on WA and OR objectives.

Abundance & Productivity Targets – The Gap Analysis

The Plan describes population abundance and productivity improvement targets that close the "gap" between current and objective viability status for each population. Figures 11 through 16 illustrate the current and objective viability and risk level for each population. Substantial increases in population viability and reductions in extinction risk will require significant improvements in abundance and productivity. Population abundance targets, consistent with the gap analysis, represent average annual spawning escapements of naturally-produced fish that will achieve objective risk levels.

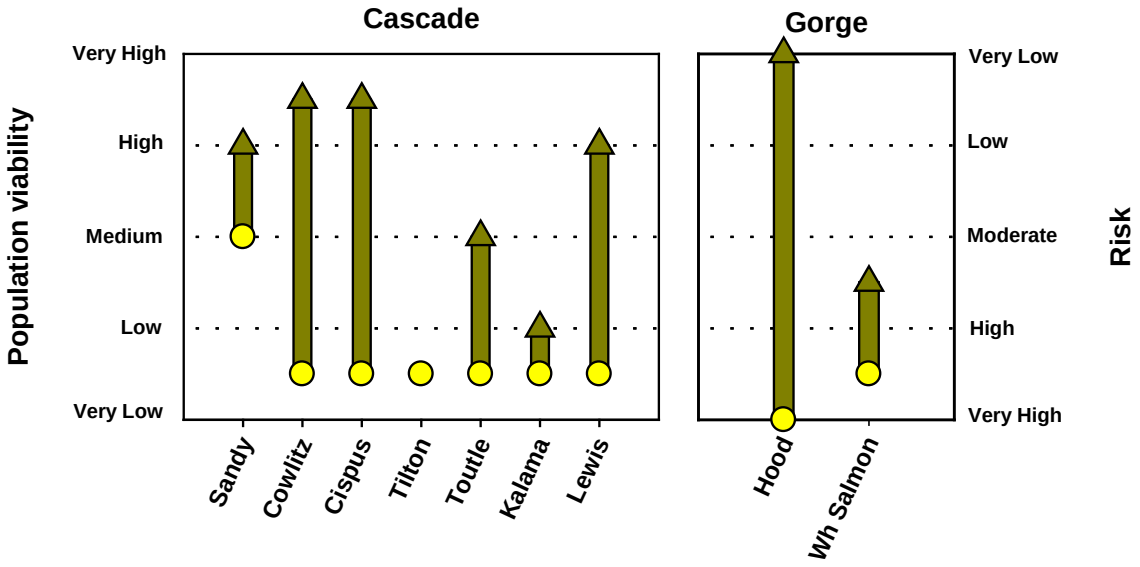


Figure 11. Viaiblity objectives for spring Chinook identified in the recovery scenario.

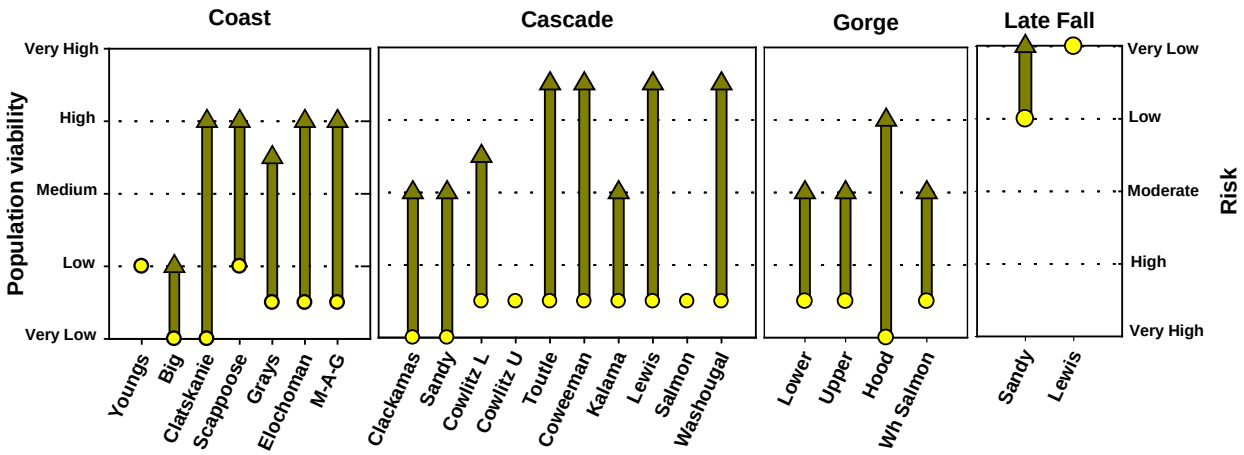


Figure 12. Viability objectives for fall Chinook identified in the recovery scenario.

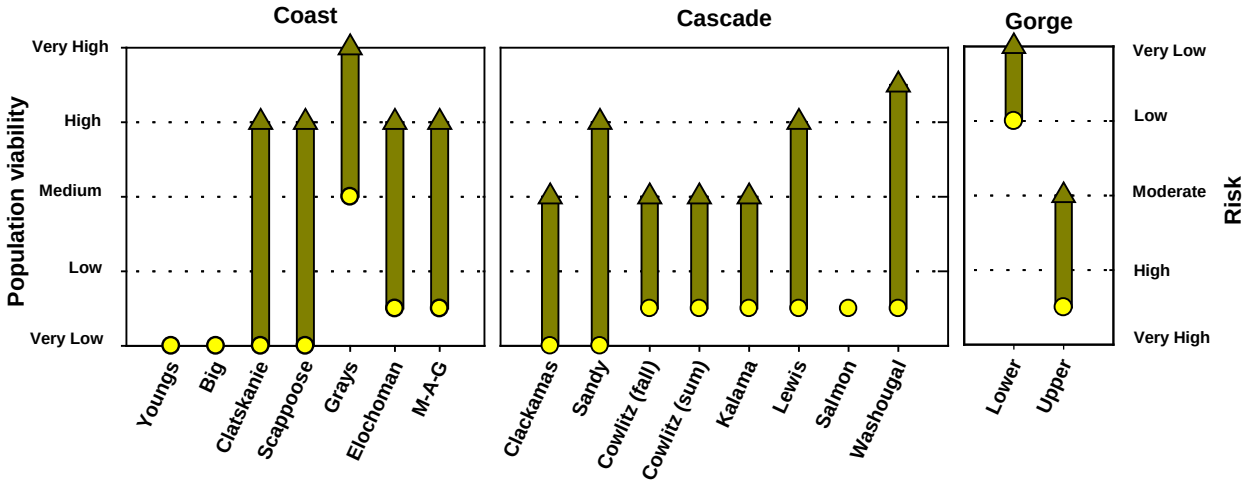


Figure 13. Viability objectives for chum identified in the recovery scenario.

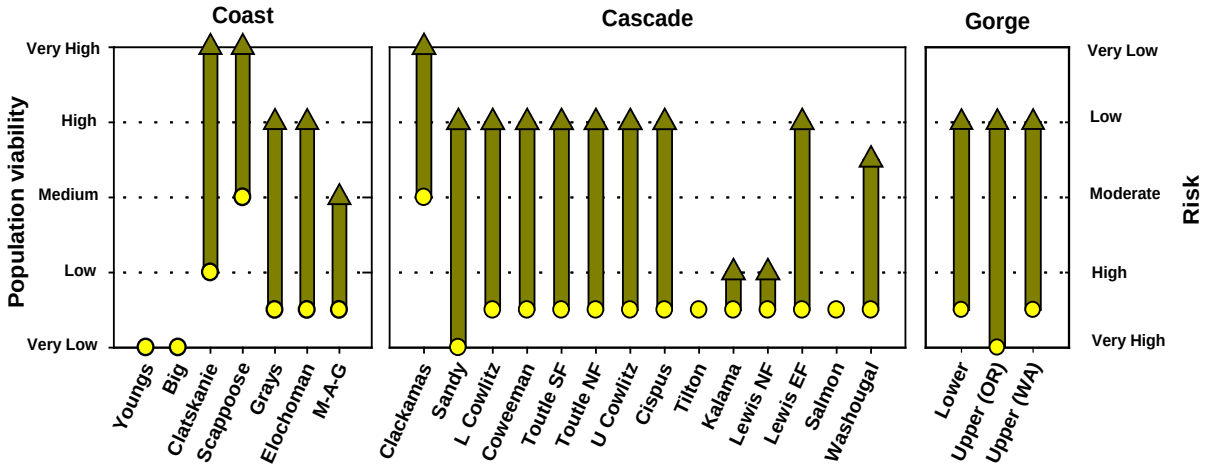


Figure 14. Viability objectives for coho identified in the recovery scenario.

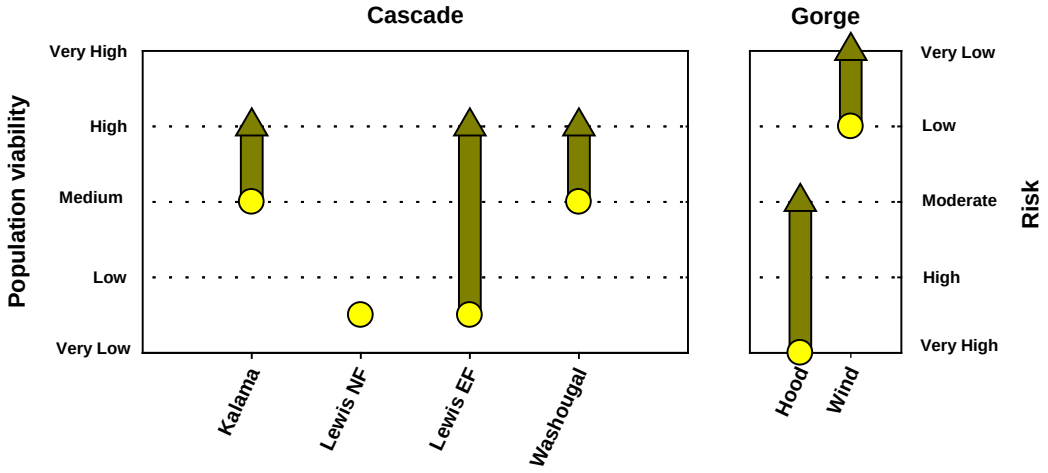


Figure 15. Viability objectives for summer steelhead identified in the recovery scenario.

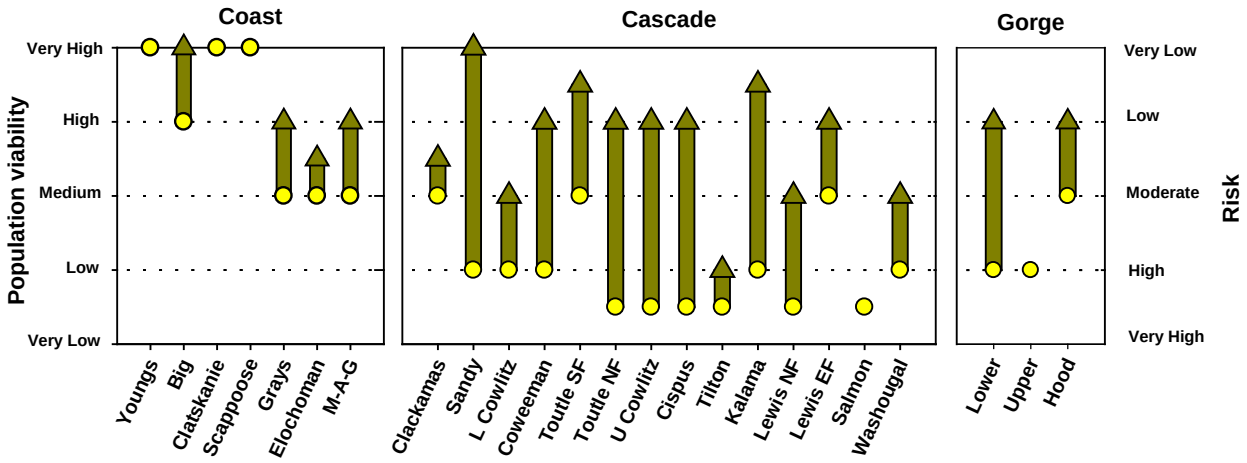


Figure 16. Viability objectives for winter steelhead identified in the recovery scenario.

Abundance targets are reached when populations consistently reach or exceed target numbers in most years. Productivity improvement targets derived from the gap analysis represent incremental improvements in spawner to spawner replacement rates needed to achieve objective risks levels. Abundance targets and productivity improvement targets assume related increases in spatial structure and diversity consistent with desired improvements. Abundance and productivity improvement targets were estimated for each population with a quantitative Population Viability Analysis using a stochastic life cycle model.

Listing Factor & Threat Criteria - Impact Reduction Targets

Listing factors and threats are categories of conditions that affect or limit fish status or viability at some point in their life cycle. Limiting factors may include a broad suite of conditions, but listing factors are conditions that specifically contribute to a species' endangered or threatened status. Section 4(a)(1) of the ESA explicitly identifies five listing factors:

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

Establishing measureable "threats criteria" for each of the relevant listing factors helps to ensure that underlying causes of decline have been addressed and mitigated prior to considering a species for de-listing. Neither NMFS nor the TRT has defined criteria for evaluating listing factors or threats. This Plan addresses the need for threat criteria by defining impact reduction targets for each threat category based on population viability objectives and population improvement targets.

In their supplement to the 2004 Washington lower Columbia River Management Unit Plan, NMFS identified a series of qualitative criteria for evaluating listing factors or threats but did not define measurable standards for determining if criteria are met (NMFS 2005). This Plan addresses the need for measurable threat criteria by defining impact reduction targets for each threat category. Targets are derived from population viability objectives and population improvement targets described in the following sections.

Interim Benchmarks – The Road to Recovery

Interim benchmarks provide near-, intermediate-, and long-term reference points for evaluating progress toward recovery in the implementation of actions addressing each category of threat (i.e. red light/green light signals). Benchmarks are integral to the adaptive implementation approach identified in this Plan involving periodic checkpoints of progress and course corrections toward recovery goals and objectives. This adaptive implementation process is required because of the high degree of uncertainty in scale of recovery action implementation and the benefits of specific actions.

Benchmarks were developed based on impact reduction targets. Benchmarks were established for each threat category. Required impact reductions (e.g. improvements) were apportioned over time. Benchmarks were developed with the following three principles:

- Incorporate threat-specific trajectories that consider the need to substantially reduce near term risks and recognize the lag time in realizing of the biological benefits of many recovery actions.
- Implementation of recovery actions will be completed within 25-years period, but many biological benefits of recovery actions will be recognized incrementally over a 50-year period.
- Benchmarks should be set on 12-year intervals corresponding with the adaptive management process identified in the Plan.

Benchmarks based on impact reduction trajectories provide a quantitative basis for the development of effective strategies and measures. Benchmarks also provide standards for evaluation of threat-specific action effectiveness.

Regional Strategies and Measures

Regional recovery depends on substantive reductions in every threat category (stream habitats, estuary and mainstem habitats, hydropower, harvest, hatcheries, and ecological interactions). The Plan sets forth strategies, measures and actions to achieve these reductions. Strategies, measures, and actions describe increasingly-specific activities for achieving recovery.

Strategies are based on underlying working hypotheses that describe assumptions, conclusions, or testable hypotheses. They describe the over-arching approaches for achieving the biological objectives identified in the Plan. Measures are more specific means by which strategies will be accomplished. Measures define a mechanism or categories of actions that are needed to carry out the strategies. Measures are generally described at the level of the desired physical or biological effects (e.g. protect and restore riparian habitat). The Plan assumes that recovery will require substantive measures to address every significant threat due to the uncertainty in the degree of benefit that will accrue from any given measure. Actions are an even finer definition of recovery requirements. They tend to be more specific than measures and are generally described at the implementing organization and program level. Actions relate back to the desired biological or physical effect (e.g. Washington Department of Natural Resources will implement forest practices rules on private timber lands to protect riparian areas) and are described in the implementation chapter and subbasin volumes of the Plan.

The strategies, measures, and actions were identified based on species and recovery goals and objectives. Additional measures and actions may be needed but until additional information demonstrates otherwise, all measures and actions identified in the Plan are assumed to be those necessary to achieve recovery objectives. Priorities will evolve over time based on new information, progress in implementation, and adaptive management.

Integrated Regional Strategy

Working hypotheses emphasize that:

- It is feasible to recover Washington lower Columbia wild salmon and steelhead to healthy and harvestable levels.
- Substantial improvements in salmon and steelhead numbers, productivity, distribution, and diversity will be required.
- Recovery cannot be achieved based solely on improvements for any one limiting factor or threat.
- Existing programs are insufficient to reach recovery goals.
- Actions needed for salmon recovery will have broader ecosystem benefits for all fish and wildlife species of interest.
- Strategies and measures likely to contribute to recovery can be identified but the incremental improvements resulting from each specific action are uncertain.

Integrated strategies include:

- Recognize the importance of implementing strategies and measures that address each limiting factor and threat category.
- Prescribe improvements in each factor/threat category in proportion to its magnitude of contribution to salmon declines.

- Identify an appropriate balance of strategies and measures that address regional, upstream, and downstream threats.
- Scale a suite of factor-specific recovery strategies and measures to meet biological objectives while also recognizing large uncertainty in the incremental contributions of individual actions.
- Focus near term actions on species at risk of extinction while also ensuring a long term balance with other species and the ecosystem.

Stream Habitats

Habitat strategies, measures, and actions were based on an extensive review of the available habitat information and analyses as well as new analysis of stream conditions, watershed conditions, and habitat forming processes. Modeling tools were applied to identify reach scale issues that need to be addressed and provide a prioritization scheme that is linked to the input data and to expectations of the actions proposed.

Working hypotheses include, but are not limited to:

- Healthy, harvestable salmon populations depend on favorable stream habitats for migration, spawning, and rearing.
- Current stream habitat is much less favorable than necessary to support healthy natural salmon and steelhead populations.
- Substantial changes are needed to support recovery.
- Recovery can be achieved without restoration of pristine conditions and without restoration of optimum habitat in every subbasin.
- Some level of increased habitat protection and restoration will be required in every subbasin to arrest declining trends and restore populations.

Habitat strategies include:

- Restoration of harvestable salmon and steelhead through better habitat access, protection, and restoration.
- Strong protection of habitats that currently support significant fish production for priority fish populations.
- Address both instream habitat conditions that limit fish and watershed stream habitat-forming processes that shape, create, or maintain habitat.

*M**easures*** for protecting and restoring stream habitats address broad topics including:

- Critical preservation areas
- Habitat protection & land-use planning
- Instream flows
- Habitat connectivity
- Forest land management
- Channel restoration
- Riparian and floodplain restoration
- Watershed process restoration
- Wetlands restoration
- Recreation management.

Habitat ***measures*** are relatively specific. For example, recommendations under the topic of land-use planning include:

- Discourage land-use conversion to more detrimental uses (e.g. forestry to crop land, crop land to residential).
- Establish urban growth boundaries based on resource protection criteria.
- Prevent increased watershed imperviousness.

Estuary and Lower River Habitat

The estuary and lower Columbia River play a critical role in the life cycles of all Columbia Basin salmon and steelhead. This Plan addresses both historic and current factors limiting salmon and steelhead. Actions are linked to threats at a general level consistent with our current knowledge and analytical tools. Hypotheses, strategies, and measures are consistent with the Bi-State Estuary/Lower Mainstem Subbasin Plan and with the Lower Columbia River Estuary Partnership Comprehensive Conservation and Management Plan.

Working hypotheses for estuary and lower river habitat include:

- Complex and dynamic interactions between physical river and ocean processes, along with climate and human activities, affect fish and wildlife habitat in the estuary and lower mainstem.
- Human activities have altered how natural processes interact, changing estuary and lower mainstem habitat conditions.
- Current understanding of interrelationships among fish, wildlife, and limiting habitat conditions in the estuary and lower mainstem is not robust and introduces substantial uncertainty in recovery and sustainability of natural resources.

Strategies for the lower river and estuary include:

- Avoid large scale habitat changes where risks to salmon and steelhead are uncertain.
- Protect functioning habitats and restore impaired habitats to properly functioning conditions.
- Understand, protect, and restore habitat-forming processes in the estuary and lower mainstem.

Recommended ***Measures*** include:

- Restore tidal swamp and marsh habitat in the estuary and tidal freshwaters.
- Restore connectedness between river and floodplain.
- Limit the effects of toxic contaminants on salmon and steelhead and wildlife fitness and survival in the estuary, lower mainstem, and nearshore ocean.
- Mitigate channel dredge activities in the estuary and lower mainstem.
- Improve knowledge of the interrelationships among fish, wildlife, and limiting habitat conditions in the estuary and lower mainstem.

Hydropower

Near-term and long-term strategies and measures are identified to ensure that hydroelectric facilities and their operations in subbasins and on the mainstem Columbia River support recovery of naturally-spawning lower Columbia River fish.

Working hypotheses include:

- Tributary hydropower development and operation has blocked access to large areas of historically productive habitat in some subbasins and affected habitat conditions and suitability downstream.

- Bonneville Dam affects migration and passage of juvenile and adult salmon and inhibits recovery.
- Construction and operation of the Columbia River hydropower system has contributed to changes in estuary and lower mainstem habitat and habitat forming processes that inhibits salmon and steelhead population resilience and recovery.

Hydropower ***strategies*** include:

- Restoring access of key populations to blocked habitats in historically accessible portions of subbasins.
- Assuring that the Columbia River hydropower system is managed to contribute to recovery of lower river, as well as upstream, populations.

Specific ***measures*** identified to reduce the effects of hydropower operations on salmon and steelhead recovery include:

- Implement anadromous fish reintroduction upstream of Cowlitz and Lewis hydroelectric projects as part of relicensing processes or requirements. Improve and operate effective juvenile and adult passage facilities at Bonneville Dam.
- Maintain adequate flows in Bonneville Dam tailrace and downstream habitats during salmon incubation and migration periods.
- Establish an annual Columbia River water budget that simulates peak seasonal discharge, increases flow variability during salmonid emigrations, and restores estuarine tidal channel complexity.

Harvest

Strategies, measures, and actions focus on two harvest aspects. The first is to limit harvest impacts on recovery efforts and to ultimately restore naturally-spawning fish populations to harvestable levels. The second is to preserve fishery opportunities focusing on hatchery fish and strong wild stocks in a manner that does not adversely affect recovery efforts. Measures are included to integrate consideration of recovery goals into the Pacific Salmon Treaty, Pacific Fishery Management Council, and U.S. v. Oregon processes and to improve marking programs and monitoring of fishery catch.

Working hypotheses help to set the stage for identifying strategies and measures. Examples include:

- Historic fishing rates, in conjunction with other factors, posed significant risks to the continued existence of many naturally spawning populations and were not sustainable.
- Recent changes in fishery management have substantially reduced harvest risks to naturally spawning populations.
- Additional fishery management opportunities exist for reducing population risks for some species, such as fall Chinook, but are limited for others, such as chum and steelhead.

Harvest ***strategies*** include:

- Assure fishery impacts to lower Columbia naturally spawning populations are managed to contribute to recovery.
- Preserve fishery opportunity focused on hatchery fish and strong naturally spawning stocks in a manner that does not adversely affect recovery.

Harvest ***measures*** include:

- Adhere to Fishery Management and Evaluation Plans for lower Columbia ESUs that will support recovery goals and priorities.
- Research and employ best available technology to reduce incidental mortality of non-target, naturally-spawning fish in selective fisheries.

- Conduct periodic review of harvest and escapement relative to habitat productivity and capacity to assure harvest is properly managed for recovery.
- Improve tools to monitor and evaluate fishery catch to assure impacts to natural populations are maintained within agreed limits.

Hatcheries

The hatchery strategy describes near-term and long-term strategies and measures to ensure that hatcheries support recovery of naturally-spawning fish. Some subbasins will be free of hatchery influence and hatchery programs. In other subbasins, hatchery programs will serve specific conservation and harvest purposes consistent with goals for naturally-spawning populations. This mosaic of programs is designed to ensure that overall, each ESU will be naturally self-sustaining.

Working hypotheses were developed that address the effects of hatcheries on natural salmonid populations. Examples include:

- Additional reductions in hatchery impacts are needed for recovery of natural populations.
- Changes in hatchery operations have and will continue to contribute to reduced risks to naturally spawning populations.
- Conservation hatchery programs can contribute to recovery through the preservation, reintroduction, and supplementation of natural populations.
- Hatcheries can provide harvest opportunities consistent with measures to maintain healthy harvestable naturally spawning populations.

Hatchery ***strategies*** include:

- Expand hatchery reintroduction and supplementation to help recover natural populations when and where appropriate.
- Reconfigure production-based hatchery programs to minimize impacts on natural populations and complement recovery objectives.

Hatchery ***measures*** include:

- Promote region-wide recovery by using hatcheries as tools for supplementation and reintroduction in appropriate watersheds.
- Operate hatcheries with appropriate risk containment measures for: 1) hatchery- origin adults returning to natural spawning areas, 2) release of hatchery juveniles, 3) handling of natural-origin adults at hatchery facilities, 4) water quality and effective disease control, and 5) mixed stock fisheries.
- Mark hatchery-produced fish to assure they are identifiable for harvest management and escapement accounting.
- Adaptively manage hatcheries to respond to future knowledge, enhance natural production, and improve operational efficiencies.
- Use appropriate broodstock in hatchery programs.

Ecological Interactions

Ecological interactions refer to the relationships of salmon and steelhead with other elements of the ecosystem. Strategies and measures are identified to address non-native species, effects of salmon on ecosystem productivity, and native predators of salmon.

Ecological interactions ***working hypotheses*** recognize that:

- Non-native, invasive, and exotic species often reduce or displace native species, particularly in human-altered habitats.
- Salmon are but one element in a complex ecosystem, have been a significant source of nutrients in freshwater systems, and are both predator and prey.
- Human-induced habitat changes have substantially exacerbated predation in the lower Columbia River mainstem and estuary.

Three region-wide ***strategies*** have been identified to address ecological interactions:

- Aggressive measures should be taken to avoid introductions of new species and to reduce the potential adverse effects of existing non-native species.
- The significance of salmon to the productivity of other species and the salmon themselves should be recognized.
- Manage predation by selected species while also maintaining a balance of predator populations.

Ten specific ***measures*** for ecological interactions have been developed. Several of these are:

- Implement regulatory, control, and education measures to prevent additional invasions or spread of non-native species.
- Take proactive steps to control or reduce the impacts of introduced, invasive, or exotic species.
- Manage established populations of introduced gamefish to limit or reduce significant predation or competition risks to salmon, and to optimize fishery benefits within these constraints.
- Consider ecological functions of salmon, including nutrients they deliver to watersheds, in setting escapement goals.

Species: Recovery Strategies & Benchmarks

Since listing determinations and delisting criteria are ultimately based on "evolutionarily significant units" or "distinct population segments" of a species, recovery will depend on strategies and actions that affect specific species and threats at the population level. By evaluating the current status of a population (i.e. extinction risk) and analyzing the threats and their related impacts, recovery objectives and targets can be established that are specific to that population. Along the way, progress can be evaluated against pre-determined benchmarks.

Population viability objectives are classified by the improvements needed to fulfill the recovery scenario. The recovery scenario designates populations as primary, contributing or stabilizing, depending on their objective level of viability. To achieve the viability objectives, target improvements were established. Targets fall into two general categories: reduction in impacts and abundance/productivity improvements. The following principles have also been incorporated:

- Population viability objectives in combination meet ESU/DPS viability goals described in the recovery scenario.
- Abundance and productivity targets describe improvements calculated to achieve viability objectives for each population.
- The recovery strategy involves equitable sharing of the "recovery burden" whereby every constituency is expected to make a substantive contribution by reducing their impact in proportion to the magnitude of their effect.
- Impact reduction targets for each threat guide the development of effective measures.
- Interim benchmarks provide reference points for planning and evaluating recovery progress over the duration of Plan implementation.

Explanation of population status and objective values identified for each species.

1. Primary, contributing, and stabilizing designations reflect the relative contribution of a population to recovery goals and objective levels of viability consistent with recovery criteria.
2. Baseline viability is based on Technical Recovery Team viability rating approach. A&P = abundance and productivity, S = spatial structure, D = diversity. Net viability is the lowest of the individual parameters for the population. OR values are as reported in the Oregon plan. (Note that the Oregon plan uses 2007 conditions as a baseline while WA uses the late 1990s initial listing period as a baseline. Use of different baselines means that viability estimates for WA and OR populations are not directly comparable. Estimated viability of some WA populations would be greater under 2007 baseline conditions because of fishery and hatchery reductions in the interim.)
3. Viability objective is based on the scenario contribution.
4. Productivity improvement target is defined as the relative increase in population production or density-independent recruits per spawner required to reach the population viability objective (e.g. 100% = current x 2). This improvement is the net benefit of actions across all limiting factors (habitat, harvest, hatchery, hydropower, estuary, ecological). Increments are relative to conditions prevalent at time of listing.
5. Baseline abundance is the median number of naturally-produced fish estimated based on conditions prevalent at the time of listing independent of the continuing contribution of hatchery-origin fish.
6. Abundance targets were estimated by population viability simulations based on population viability objectives. This number refers to median abundance over any successive 12-year period which is consistent with species generation times and the moving three-year average basis for assessing risk in the population viability analysis.

Spring Chinook Salmon

Extinction risks were estimated to be very high in all seven Washington populations of Spring Chinook, and eight of nine Washington and Oregon populations that comprise the ESU (Table 4). Very high risks result from a combination of low abundance and productivity, losses of spatial structure particularly due to loss of access to historical production areas above tributary dams, and reduced diversity due to low numbers and pervasive hatchery effects.

Five of the nine Spring Chinook populations in Washington and Oregon are prioritized for improvement to high levels of viability or low extinction risk (Table 4). All populations except the Tilton are identified for some level of improvement. Most historical spring Chinook habitat in the Washington lower Columbia is found in the Upper Cowlitz, Cispus, and NF Lewis Rivers. Recovery criteria cannot be met for spring Chinook without restoration of viable populations in at least two of these three major historical production areas, which are currently blocked by hydroelectric dams.

Declines in status of lower Columbia River spring Chinook salmon result from the combined impacts of human activities involving freshwater habitat, estuary habitat, dam construction and operation, fishing, fish hatcheries, and ecological factors such as predation (Figure 17). No single factor accounts for the majority of the reduction in fish numbers and the significance of specific factors varies from population to population. Impacts compounded across the life cycle drive most populations to current very low levels. Net effects of quantifiable and potentially manageable impacts translate into a greater than 90% reduction in abundance and productivity of populations in Washington.

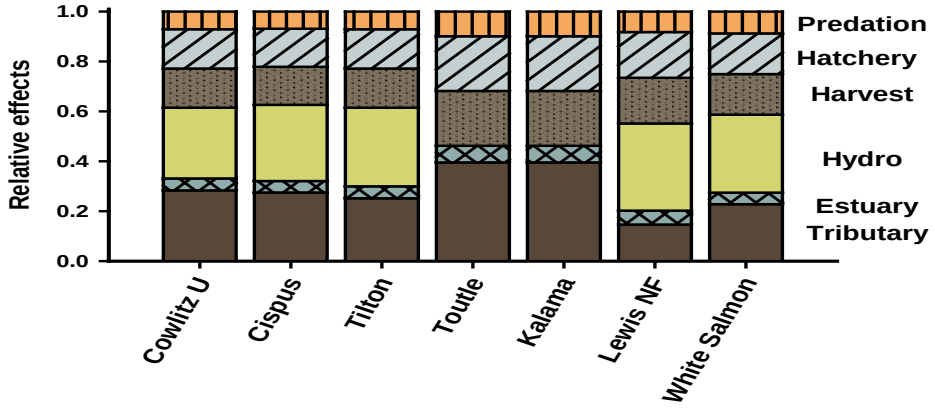


Figure 17. Relative contribution of potentially manageable impact factors on spring Chinook salmon in Washington lower Columbia River subbasins.

An estimated 50% reduction in impacts will be required to meet population improvement targets for spring Chinook. The long term recovery strategy for spring Chinook depends on restoration of access into historical production areas of the upper Cowlitz, Lewis and White Salmon basins. Protection and restoration of habitat conditions in these core historical production areas will also be critical. In the interim, continuing limitations on fishery impacts and reform of hatchery programs are required to protect remnant wild populations and provide fish required by reintroduction efforts. High historical harvest rates and hatchery impacts cannot be sustained by spring Chinook under current habitat conditions. Recovery will also require significant improvements in estuary, hydro, and ecological conditions. Table 5 outlines the interim benchmarks for spring Chinook impact reductions. These benchmarks provide near, intermediate, and long term reference points for evaluating progress of impact reduction efforts for each category of threat. These benchmark values incorporate both the timeframe when actions will be implemented, as well as when the benefit of those actions will be realized.

Table 4. Baseline viability status, viability and abundance objectives, and productivity improvement targets for lower Columbia River Chinook populations.

		Baseline viability					Prod.	Abundance		
Population	**Contribution**	**A&P**	**S**	**D**	**Net**	**Obj.**	**target**	**Historical**	**Baseline**	**Target**
Coast Fall										
Grays/Chinook	Contributing[2]	VL	H	VL	VL[2]	M+	+500%	800	<50	1,000
Eloch/Skam [C]	Primary	VL	H	L	VL[2]	H	+150%	3,000	<50	1,500
Mill/Aber/Germ	Primary[1]	VL	H	L	VL[2]	H	+155%	2,500	50	900
Youngs Bay (OR)	Stabilizing	--[3]	--[3]	--[3]	L	L	--[3]	--[3]	--[3]	--[3]
Big Creek (OR) [C]	Contributing[1]	--[3]	--[3]	--[3]	VL	L	--[3]	--[3]	--[3]	--[3]
Clatskanie (OR)	Primary	--[3]	--[3]	--[3]	VL	H	--[3]	--[3]	--[3]	--[3]
Scappoose (OR)	Primary[1]	--[3]	--[3]	--[3]	L	H	--[3]	--[3]	--[3]	--[3]
Cascade Fall										
Lower Cowlitz [C]	Contributing	VL	H	M	VL[2]	M+	+50%	24,000	500	3,000
Upper Cowlitz	Stabilizing	VL	VL	M	VL	VL	--	28,000	0	--
Toutle[C]	Primary[1]	VL	H	M	VL[2]	H+	+265%	11,000	<50	4,000
Coweeman [G]	Primary	VL	H	H	VL[2]	H+	+80%	3,500	100	900
Kalama	Contributing[2]	VL	H	M	VL[2]	M	+110%	2,700	<50	500
Lewis [G]	Primary	VL	H	H	VL[2]	H+	+280%	2,600	<50	1,500
Salmon	Stabilizing	VL	H	M	VL	VL	--	n/a	<50	--
Washougal	Primary	VL	H	M	VL[2]	H+	+190%	2,600	<50	1,200
Clackamas (OR) [C]	Contributing	--[3]	--[3]	--[3]	VL	M	--[3]	--[3]	--[3]	--[3]
Sandy (OR)	Contributing[1]	--[3]	--[3]	--[3]	VL	M	--[3]	--[3]	--[3]	--[3]
Cascade L Fall										
Lewis NF [C,G]	Primary	VH	H	H	VH[1]	VH	0%	23,000	7,300	7,300
Sandy (OR) [C,G]	Primary	--[3]	--[3]	--[3]	L	VH	--[3]	--[3]	--[3]	--[3]
Cascade Spring										
Upper Cowlitz [C,G]	Primary	VL	L	M	VL[2]	H+	>500%	22,000	300	1,800
Cispus [C,G]	Primary	VL	L	M	VL[2]	H+	>500%	7,800	150	1,800
Tilton	Stabilizing	VL	VL	VL	VL	VL	0%	5,400	100	100
Toutle	Contributing	VL	H	L	VL	M	>500%	3,100	100	1,100
Kalama	Contributing[2]	VL	H	L	VL	L	>500%	4,900	100	300
Lewis NF [C]	Primary	VL	L	M	VL	H	>500%	15,700	300	1,500
Sandy (OR) [C,G]	Primary	--[3]	--[3]	--[3]	M	H	--[3]	--[3]	--[3]	--[3]
Gorge Fall										
L. Gorge (WA/OR)	Contributing	VL	M	L	VL[2]	M	>500%	n/a	<50	1,200
U. Gorge (WA/OR) [C]	Contributing[1]	VL	M	L	VL[2]	M	>500%	n/a	<50	1,200
White Salmon [C]	Contributing	VL	L	L	VL	M	>500%	n/a	<50	500
Hood (OR)	Primary	--[3]	--[3]	--[3]	VL	H	--[3]	--[3]	--[3]	--[3]
Gorge Spring										
White Salmon [C]	Contributing	VL	VL	VL	VL	L+	>500%	n/a	<50	500
Hood (OR)	Primary	--[3]	--[3]	--[3]	VL	VH	--[3]	--[3]	--[3]	--[3]

[1] Increase relative to the interim Plan.
[2] Reduction relative to the interim Plan.
[3] Addressed in the Oregon Management Unit plan.
[4] OR analysis indicates a low probability of meeting their delisting objective of high viability for this population.
[C] Designated as a historical core population by the Technical Recovery Team.
[G] Designated as a historical legacy population by the Technical Recovery Team.

Table 5. Interim benchmarks for action implementation, action effectiveness and related status improvements of spring Chinook.

		Years					
	Benchmark type	**Baseline**	**1-12**	**13-24**	**25-36**	**37-48**	**49+**
Habitat	Actions implemented	0%	50%	100%	100%	100%	100%
	Habitat impact	40-90%	35-80%	30-80%	26-80%	21-80%	20-80%
	% of threat target @ recovery	--	25%	50%	75%	100%	100%
	Status improvement	--	7-51%	15-127%	23-241%	32-414%	33-450%
	Tilton	--	--	--	--	--	--
	Lewis EF	--	7%	15%	23%	32%	33%
	White Salmon	--	20%	45%	74%	110%	117%
	Cowlitz U	--	51%	127%	241%	414%	450%
	Cispus	--	51%	127%	241%	414%	450%
	Toutle	--	51%	127%	241%	414%	450%
	Kalama	--	51%	127%	241%	414%	450%
Dams	Actions implemented	0%	50%	100%	100%	100%	100%
	Dams impact	0-100%	0-100%	0-100%	0-100%	0-100%	0-100%
	% of threat target @ recovery	--	50%	75%	100%	100%	100%
	Status improvement	--	Undefined for reintroduced populations				
Fishery	Actions implemented	0%	100%	100%	100%	100%	100%
	Fishery impact	50%	15-25%	15-25%	15-25%	20-30%	20-30%
	% of threat target @ recovery	--	100%	>100%	>100%	100%	100%
	Status improvement	0%	50-70%	50-70%	50-70%	40-60%	40-60%
Hatch.	Actions implemented	0%	80%	100%	100%	100%	100%
	Hatchery Impact	50%	44-50%	38-50%	32-50%	26-50%	25-50%
	% of threat target @ recovery	--	25%	50%	75%	100%	100%
	Status improvement	--	0-10%	0-21%	0-34%	0-48%	0-50%
Ecol.	Actions implemented	0%	50%%	100%	100%	100%	100%
	Predation impact	22-27%	16-22%	11-22%	11-22%	11-22%	11-22%
	% of threat target @ recovery	--	50%	100%	100%	100%	100%
	Status improvement	--	0-9%	0-18%	0-18%	0-18%	0-18%

Baseline refers to prevalent conditions prior to widespread listings (1998-1999).

Years are counted relative to the listing baseline (1998-1999), thus years 1-12 include 1999-2010, years 13-24 include 2011-2022, etc.Actions implemented between listing and Plan completion are included in year 1-12 benchmarks.

The percentage of actions implemented refers to the actions identified in the Recovery Plan. Actions throughout the 50-year implementation period will be adjusted and revised based on monitoring and evaluation.

The threat reduction target relates impacts to the long term impact reduction targets.

Status improvement is measured in terms of fish benefits relative to the baseline period. These values describe the incremental improvement in fish numbers due to the benefits of actions implemented during each interval.

Fall Chinook Salmon

Extinction risks were estimated to be very high in 14 of 15 Washington populations of fall Chinook (93%), and 19 of 23 Washington and Oregon populations (83%) that comprise the ESU (Table 4). Very high risks primarily result from low abundance and productivity. Fall Chinook remain widely distributed throughout the region as fish continue to have access to most areas of historical spawning habitat (except in upper Cowlitz and White Salmon rivers where dams block access).

Eight of 21 tule fall Chinook populations and two of two bright late fall Chinook populations are prioritized for recovery to high or very high levels of viability. Almost all fall Chinook populations (21 of 23 or 91%) are identified for high levels of viability or significant improvements to meet ESU objectives (Table 4).

Declines in status of lower Columbia River fall Chinook salmon result from the combined impacts of human activities involving freshwater habitat, estuary habitat, dam construction and operation, fishing, fish hatcheries, and ecological factors such as predation (Figure 18). No single factor accounts for the majority of the reduction in fish numbers and the significance of specific factors varies from population to population. Impacts have compounded across the life cycle to drive most populations to their current very low levels. Net effects from quantifiable and potentially manageable impacts translate into a 75-100% reduction in abundance and productivity of populations in Washington.

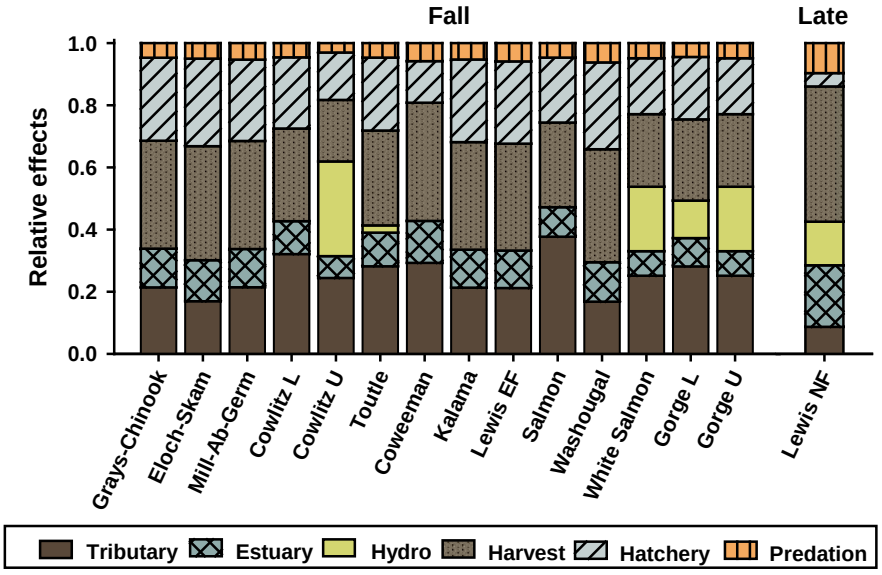


Figure 18. Net effect and relative contribution of potentially manageable impact factors on fall Chinook salmon in Washington lower Columbia River subbasins.

An estimated 8-61% reduction in impacts will be required to meet population improvement targets for Primary and Contributing populations in the Coast and Cascade strata. The long term recovery strategy depends on effective habitat restoration in lower elevation mainstem reaches of large streams and rivers throughout the lower Columbia Region. Significant habitat improvements will be difficult and costly to achieve because of extensive development along many of these streams and the watershed scale of factors that affect these habitats. In the interim, substantial reductions in fishery impacts and reform of hatchery programs will be critical to the preservation of remnant wild populations. Historical high harvest rates and hatchery impacts simply cannot be sustained by fall Chinook under current degraded habitat conditions. Recovery will also require significant improvements in estuary, hydro, and ecological conditions. Table 6 outlines the interim benchmarks for fall Chinook impact reductions. These benchmarks provide near, intermediate, and long term reference points for evaluating progress of impact reduction efforts for each category of threat. These benchmark values incorporate both the timeframe when actions will be implemented, as well as when the benefit of those actions will be realized.

Table 6. Interim benchmarks for action implementation, action effectiveness and related status improvements of tule fall Chinook.

		Years					
	Benchmark type	**Baseline**	**1-12**	**13-24**	**25-36**	**37-48**	**49+**
Habitat	Actions implemented	0%	50%	100%	100%	100%	100%
	Habitat impact	30-90%	28-90%	25-90%	23-90%	17-90%	16-90%
	% of threat target @ recovery	--	25%	50%	75%	100%	100%
	Status improvement	--	3-20%	6-45%	9-74%	12-110%	12-117%
	Salmon	--	--	--	--	--	--
	Eloch-Skam	--	3%	6%	9%	12%	12%
	Kalama	--	3%	7%	10%	14%	14%
	Washougal	--	3%	7%	10%	14%	15%
	Mill-Ab-Germ	--	4%	9%	13%	18%	19%
	Lower Cowlitz	--	4%	8%	13%	18%	18%
	Coweeman	--	4%	8%	13%	17%	18%
	Lewis EF	--	6%	13%	19%	27%	28%
	Grays-Chinook	--	8%	18%	28%	38%	40%
	Toutle	--	10%	21%	33%	46%	49%
	White Salmon	--	20%	45%	74%	110%	117%
	Lower Gorge	--	20%	45%	74%	110%	117%
	Upper Gorge	--	20%	45%	74%	110%	117%
Dams	Actions implemented	0%	50%	100%	100%	100%	100%
	Dams impact	0-100%	0-100%	0-100%	0-100%	0-100%	0-100%
	% of threat target @ recovery	--	50%	75%	100%	100%	100%
	Status improvement	--	0-34%	0-51%	0-68%	0-68%	0-68%
Fishery	Actions implemented	0%	90%	100%	100%	100%	100%
	Fishery impact	65%	38-49%	33-38%	38-45%	40-50%	40-50%
	% of threat target @ recovery	--	100%	>100%	>100%	100%	100%
	Status improvement	0%	50-90%	90-110%	90-110%	60-90%	50-80%
Hatch.	Actions implemented	0%	80%	100%	100%	100%	100%
	Hatchery Impact	23-50%	22-50%	21-50%	20-50%	19-50%	19-50%
	% of threat target @ recovery	--	25%	50%	75%	100%	100%
	Status improvement	--	0-12%	0-25%	0-41%	0-57%	0-61%
Ecol.	Actions implemented	0%	50%%	100%	100%	100%	100%
	Predation impact	9-14%	6-12%	3-11%	3-11%	3-11%	3-11%
	% of threat target @ recovery	--	50%	100%	100%	100%	100%
	Status improvement	--	0-4%	0-8%	0-8%	0-8%	0-8%

Baseline refers to prevalent conditions prior to widespread listings (1998-1999)

Years are counted relative to the listing baseline (1998-1999), thus years 1-12 include 1999-2010, years 13-24 include 2011-2022, etc.Actions implemented between listing and Plan completion are included in year 1-12 benchmarks.

The percentage of actions implemented refers to the actions identified in the Recovery Plan. It should be noted that actions throughout the 50-year implementation period will be adjusted and revised based on monitoring and evaluation.

The threat reduction target relates impacts to the long term impact reduction targets identified in the Recovery Plan.

Status improvement is measured in terms of fish benefits relative to the baseline period. These values describe the incremental improvement in fish numbers due to the benefits of actions implemented during each interval.

Chum Salmon

Extinction risks were estimated to be very high in nine of eleven populations of chum salmon occurring in whole or in part in Washington. All six of the Oregon-only populations are believed to be functionally extirpated (Table 7). Very high risks primarily result from low abundance, productivity and diversity. Chum continue to have access to most areas of historical spawning habitat although the spatial distribution of suitable habitat has been substantially reduced by habitat degradation. Diversity has been greatly reduced by diminished numbers and the loss of many populations.

Almost all chum populations (14 of 17 or 82%) are identified for high levels of viability or significant improvements to meet ESU objectives (Table 7). Five contributing populations in Washington and Oregon are slated for improvement to moderate levels of viability. The scenario meets TRT criteria of at least two populations at high or better viability and strata averages exceeding moderate in Coast and Cascade strata but not in the Gorge where only one Primary population has been identified. Recovery prospects of upper Gorge chum to high levels are constrained by current low numbers, limited habitat availability, and inundation of historically productive habitats by Bonneville Dam.

Declines in status of Columbia River chum salmon result from the combined impacts of human activities involving freshwater habitat, estuary habitat, dam construction and operation and ecological factors such as predation. Fishery and hatchery impacts are currently very low for chum salmon (Figure 19). Impacts of each factor are compounded across the salmon life cycle to drive most populations to current very low levels. Net effects of quantifiable and potentially manageable impacts translate into an estimated 71-99% (average 94%) reduction in abundance and productivity of Columbia River chum populations in Washington.

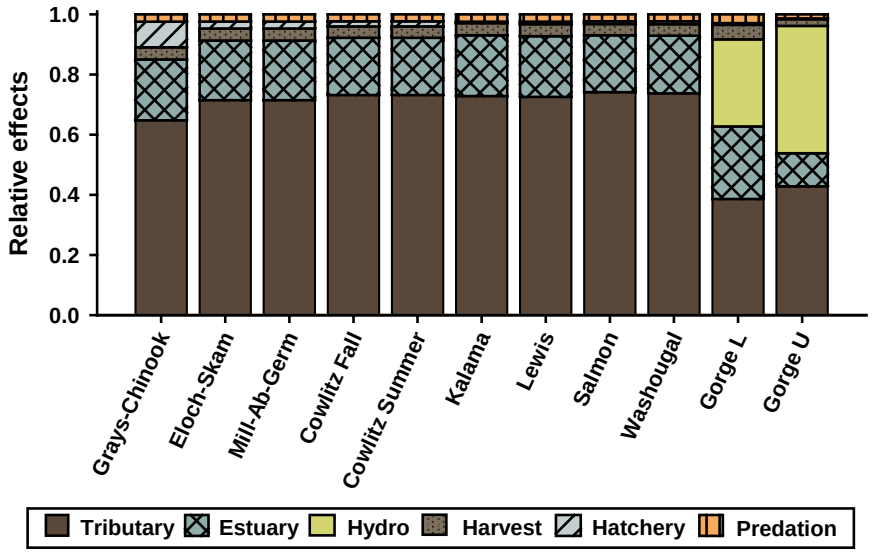


Figure 19. Relative contribution of potentially manageable impact factors on chum salmon in Washington lower Columbia River subbasins.

Impact reduction targets for Washington chum consistent with viability objectives and improvement targets were defined at 50% of current values. Habitat restoration in tributary spawning and estuary rearing habitats is the key to chum salmon recovery. No other factor can effectively address recovery this species. Table 8 outlines the interim benchmarks for chum impact reductions. These benchmarks provide near, intermediate, and long term reference points for evaluating progress of impact reduction efforts for each category of threat. These benchmark values incorporate both the timeframe when actions will be implemented, as well as when the benefit of those actions will be realized.

Table 7. Baseline viability status, viability and abundance objectives, and productivity improvement targets and recovery goals for lower Columbia River chum populations.

		Baseline viability					Prod.	Abundance		
Population	**Contribution**	**A&P**	**S**	**D**	**Net**	**Obj.**	**target**	**Historical**	**Baseline**	**Target**
Coast										
Grays/Chinook [C,G]	Primary	VH	M	H	M[1]	VH	0%[4]	10,000	1,600	1,600
Eloch/Skam [C]	Primary	VL	H	L	VL[2]	H	>500%	16,000	<200	1,300
Mill/Ab/Germ	Primary	VL	H	L	VL	H	>500%	7,000	<100	1,300
Youngs (OR) [C]	Stabilizing[2]	--[3]	--[3]	--[3]	VL	VL	--[3]	--[3]	--[3]	--[3]
Big Creek (OR) [C]	Stabilizing[2]	--[3]	--[3]	--[3]	VL	VL	--[3]	--[3]	--[3]	--[3]
Clatskanie (OR)	Primary[1]	--[3]	--[3]	--[3]	VL	H	--[3]	--[3]	--[3]	--[3]
Scappoose (OR)	Primary[1]	--[3]	--[3]	--[3]	VL	H	--[3]	--[3]	--[3]	--[3]
Cascade										
Cowlitz (Fall) [C]	Contributing	VL	H	L	VL	M	>500%	195,000	<300	900
Cowlitz (Summer) [C]	Contributing	VL	L	L	VL	M	>500%	n/a	n/a	900
Kalama	Contributing	VL	H	L	VL	M	>500%	20,000	<100	900
Lewis [C]	Primary	VL	H	L	VL	H	>500%	125,000	<100	1,300
Salmon	Stabilizing	VL	L	L	VL	VL	0%	n/a	<100	--
Washougal	Primary	VL	H	L	VL[2]	H+	>500%	18,000	<100	1,300
Clackamas (OR) [C]	Contributing	--[3]	--[3]	--[3]	VL	M	--[3]	--[3]	--[3]	--[3]
Sandy (OR)	Primary	--[3]	--[3]	--[3]	VL	H	--[3]	--[3]	--[3]	--[3]
Gorge										
L. Gorge (WA/OR) [C,G]	Primary	VH	H	VH	H[1]	VH	0%[4]	6,000	2,000	2,000
U. Gorge (WA/OR)	Contributing	VL	L	L	VL	M	>500%	11,000	<50	900

[1] Increase relative to the interim Plan.
[2] Reduction relative to the interim Plan.
[3] Addressed in the Oregon Management Unit plan.
[4] Improvement increments are based on abundance and productivity, however, this population will require improvements in spatial structure or diversity to meet recovery objectives.
[C] Designated as a historical core population by the Technical Recovery Team.
[G] Designated as a historical legacy population by the Technical Recovery Team.

Table 8. Interim benchmarks for action implementation, action effectiveness and related status improvements of chum.

		Years					
	Benchmark type	**Baseline**	**1-12**	**13-24**	**25-36**	**37-48**	**49+**
Habitat	Actions implemented	0%	50%	100%	100%	100%	100%
	Habitat impact	40-98%	40-98%	40-98%	40-98%	40-98%	40-98%
	% of threat target @ recovery	--	25%	50%	75%	100%	100%
	Status improvement	--	0-100%	0-300%	0->500%	0->500%	0->500%
	Salmon	--	--	--	--	--	--
	Grays-Chinook	--	0%	0%	0%	0%	0%
	Lower Gorge	--	0%	0%	0%	0%	0%
	Eloch-Skam	--	50%	130%	240%	400%	450%
	Mill-Ab-Germ	--	50%	130%	240%	400%	450%
	Kalama	--	50%	130%	240%	400%	450%
	Lewis	--	50%	130%	240%	400%	450%
	Lower Cowlitz	--	85%	240%	>500%	>500%	>500%
	Washougal	--	85%	240%	>500%	>500%	>500%
	Upper Gorge	--	100%	300%	>500%	>500%	>500%
Dams	Actions implemented	0%	50%	100%	100%	100%	100%
	Dams impact	0-96%	0-72%	0-48%	0-48%	0-48%	0-48%
	% of threat target @ recovery	--	50%	75%	100%	100%	100%
	Status improvement	--	0-600%	0-1200%	0-1200%	0-1200%	0-1200%
Fishery	Actions implemented	0%	100%	100%	100%	100%	100%
	Fishery impact	<5%	<5%	<5%	<5%	<5%	<5%
	% of threat target @ recovery	--	100%	100%	100%	100%	100%
	Status improvement	0%	0-2%	0-2%	0-2%	0-2%	0-2%
Hatch.	Actions implemented	0%	100%	100%	100%	100%	100%
	Hatchery Impact	0-11%	0-11%	0-11%	0-11%	0-11%	0-11%
	% of threat target @ recovery	--	100%	100%	100%	100%	100%
	Status improvement	--	0-2%	0-2%	0-2%	0-2%	0-2%
Ecol.	Actions implemented	0%	50%%	100%	100%	100%	100%
	Predation impact	3%	2%	2%	2%	2%	2%
	% of threat target @ recovery	--	50%	100%	100%	100%	100%
	Status improvement	--	1%	1%	1%	1%	1%

Baseline refers to prevalent conditions prior to widespread listings (1998-1999)

Years are counted relative to the listing baseline (1998-1999), thus years 1-12 include 1999-2010, years 13-24 include 2011-2022, etc.

Actions implemented between listing and Plan completion are included in year 1-12 benchmarks.

The percentage of actions implemented refers to the actions identified in the Recovery Plan. It should be noted that actions throughout the 50-year implementation period will be adjusted and revised based on monitoring and evaluation.

The threat reduction target relates impacts to the long term impact reduction targets.

Status improvement is measured in terms of fish benefits relative to the baseline period. These values describe the incremental improvement in fish numbers due to the benefits of actions implemented during each interval.

Coho Salmon

Every one of the 17 Washington lower Columbia River coho populations is estimated to be at a very high risk of extinction. Twenty-one of the 24 populations in the ESU, including Oregon, are at a very high risk (Table 9). Very high risks result from a combination of low abundance and productivity, loss of spatial structure, and reduced diversity due to low numbers and pervasive hatchery effects.

Fifteen of 24 coho populations are prioritized for recovery to high or very high levels of viability (Table 9). Washington populations prioritized for large improvements include populations with high potential for improvement based on large historical production of the available habitat. Core and legacy populations have not been designated for coho by the TRT. The recovery scenario identifies high levels of recovery in many more populations than the minimums identified in the strata viability criteria. This is because of uncertain prospects for recovery of coho and because not all attempts will be successful. Almost all coho populations (20 of 24 or 83%) are prioritized for high levels of viability or significant improvements to meet ESU goals.

Declines in status of lower Columbia River coho salmon result from the combined impacts of human activities involving freshwater habitat, estuary habitat, dam construction and operation, fishing, fish hatcheries, and ecological factors, such as predation. Impacts of each factor are compounded across the salmon life cycle to drive most populations to current very low levels. Net effects of quantifiable and potentially manageable impacts translate into an estimated 91-100% (average 96%) reduction in abundance and productivity of lower Columbia River coho populations in Washington (Figure 20). Thus, current fish numbers represent only 0-9% of the historical production potential in the absence of potentially manageable impacts and typically 2-10% of population-specific recovery targets. Total reductions would be even greater if all human impacts could be effectively quantified.

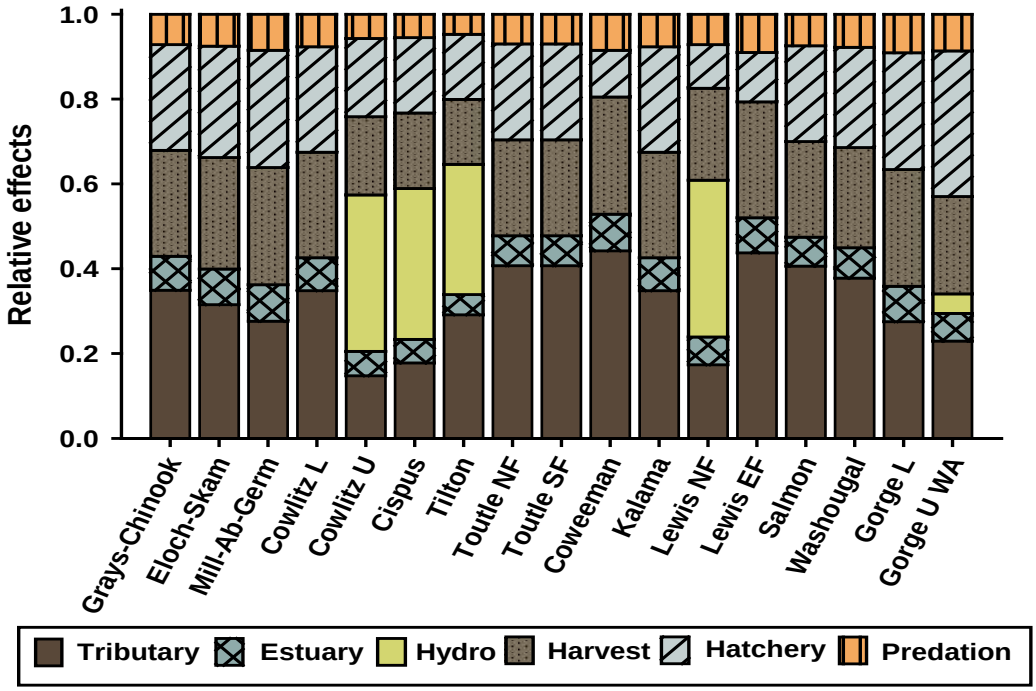


Figure 20. Relative contribution of potentially manageable impact factors on coho salmon in Washington lower Columbia River subbasins.

An estimated 6%-59% reduction in impacts will be required to meet population improvement targets for Primary and Contributing populations. The long term recovery strategy for coho involves significant reductions in the impacts of all threat categories. Table 10 outlines the interim benchmarks for coho impact reductions. These benchmarks provide near, intermediate, and long term reference points for evaluating progress of impact reduction efforts for each category of threat. These benchmark values incorporate both the timeframe when actions will be implemented, as well as when the benefit of those actions will be realized.

Table 9. Baseline viability status, viability and abundance objectives, and productivity improvement targets for lower Columbia River coho populations.

		Baseline viability					Prod.	Abundance		
Population	**Contribution**	**A&P**	**S**	**D**	**Net**	**Obj.**	**target**	**Historical**	**Baseline**	**Target**
Coast										
Grays/Chinook [L]	Primary	VL	H	VL	VL[2]	H	+370%	3,800	<50	2,400
Eloch/Skam [L]	Primary	VL	H	VL	VL[2]	H	+170%	6,500	<50	2,400
Mill/Ab/Germ [L]	Contributing	VL	H	L	VL[2]	M	>500%	2,800	<50	1,800
Youngs (OR) [L]	Stabilizing	--[3]	--[3]	--[3]	VL	VL	--[3]	--[3]	--[3]	--[3]
Big Creek (OR) [L]	Stabilizing[2]	--[3]	--[3]	--[3]	VL	VL	--[3]	--[3]	--[3]	--[3]
Clatskanie (OR) [L]	Primary[1]	--[3]	--[3]	--[3]	L	VH	--[3]	--[3]	--[3]	--[3]
Scappoose (OR) [L]	Primary	--[3]	--[3]	--[3]	M	VH	--[3]	--[3]	--[3]	--[3]
Cascade										
Lower Cowlitz [L]	Primary	VL	M	M	VL[2]	H	+100%	18,000	500	3,700
Upper Cowlitz [E, L]	Primary[1]	VL	M	L	VL	H[1]	>500%	18,000	<50	2,000
Cispus [E, L]	Primary[1]	VL	M	L	VL	H[1]	>500%	8,000	<50	2,000
Tilton [E, L]	Stabilizing	VL	M	L	VL	VL[2]	0%	5,600	<50	--
SF Toutle [E, L]	Primary	VL	H	M	VL[2]	H	+180%	27,000	<50	1,900
NF Toutle [E, L]	Primary	VL	M	L	VL[2]	H	+180%		<50	1,900
Coweeman [L]	Primary	VL	H	M	VL[2]	H	+170%	5,000	<50	1,200
Kalama [L]	Contributing	VL	H	L	VL[2]	L	>500%	800	<50	500
NF Lewis [E, L]	Contributing	VL	L	L	VL[2]	L	+50%	40,000	200	500
EF Lewis [E, L]	Primary	VL	H	M	VL[2]	H	>500%	3,000	<50	2,000
Salmon [L]	Stabilizing	VL	M	VL	VL	VL	0%	n/a	<50	50
Washougal [L]	Contributing	VL	H	L	VL[2]	M+	>500%	3,000	<50	1,500
Clackamas (OR) [E, L]	Primary	--[3]	--[3]	--[3]	M	VH	--[3]	--[3]	--[3]	--[3]
Sandy (OR) [E, L]	Primary	--[3]	--[3]	--[3]	VL	H	--[3]	--[3]	--[3]	--[3]
Gorge										
L Gorge (WA/OR) [L]	Primary	VL	M	VL	VL[2]	H	+400%	n/a	<50	1,900
Upper Gorge (WA) [L]	Primary	VL	M	VL	VL[2]	H	+400%	n/a	<50	1,900
U Gorge/Hood (OR)[E]	Contributing	--[3]	--[3]	--[3]	VL	H	--[3]	--[3]	--[3]	--[3]

[1] Increase relative to the interim Plan.
[2] Reduction relative to the interim Plan.
[3] Addressed in the Oregon Management Unit plan.
[4] Improvement increments are based on abundance and productivity, however, this population will require improvements in spatial structure or diversity to meet recovery objectives.
[4] OR analysis indicates a low probability of meeting their delisting objective of high viability for this population.
[E] Early run (Type S) coho stock.
[L] Late run (Type N) coho stock.
(Core and Legacy populations not designated by the Technical Recovery Team for coho.)

Table 10. Interim benchmarks for action implementation, action effectiveness and related status improvements of coho.

		Years					
	Benchmark type	**Baseline**	**1-12**	**13-24**	**25-36**	**37-48**	**49+**
Habitat	Actions implemented	0%	50%	100%	100%	100%	100%
	Habitat impact	40-95%	35-99%	30-95%	26-95%	21-95%	20-95%
	% of threat target @ recovery	--	25%	50%	75%	100%	100%
	Status improvement	--	1-30%	2-69%	3-120%	4-190%	4-200%
	Tilton	--	--	--	--	--	--
	Salmon	--	--	--	--	--	--
	NF Lewis	--	1%	2%	3%	4%	4%
	Upper Cowlitz	--	7%	15%	23%	32%	33%
	Lower Cowlitz	--	8%	17%	26%	37%	39%
	Gorge U WA	--	8%	17%	27%	37%	39%
	Eloch-Skam	--	9%	19%	30%	42%	45%
	Mill-Ab-Germ	--	10%	21%	34%	48%	50%
	Cispus	--	10%	21%	34%	48%	50%
	Kalama	--	10%	20%	32%	44%	47%
	Lower Gorge	--	12%	25%	40%	56%	59%
	Coweeman	--	17%	36%	59%	86%	91%
	Grays-Chinook	--	18%	39%	64%	94%	100%
	NF Toutle	--	20%	43%	72%	106%	112%
	SF Toutle	--	20%	43%	72%	106%	112%
	EF Lewis	--	30%	69%	121%	187%	200%
	Washougal	--	30%	69%	121%	187%	200%
Dams	Actions implemented	0%	50%	100%	100%	100%	100%
	Dams impact	0-100%	0-100%	0-100%	0-100%	0-100%	0-100%
	% of threat target @ recovery	--	50%	75%	100%	100%	100%
	Status improvement	--	Undefined for reintroduced populations				
Fishery	Actions implemented	0%	90%	100%	100%	100%	100%
	Fishery impact	50%	8-25%	8-25%	8-25%	15-35%	20-50%
	% of threat target @ recovery	--	100%	>100%	>100%	>100%	100%
	Status improvement	0%	50-84%	50-84%	50-84%	30-70%	0-60%
Hatch.	Actions implemented	0%	80%	100%	100%	100%	100%
	Hatchery Impact	21-75%	19-68%	16-61%	14-54%	11-50%	11-50%
	% of threat target @ recovery	--	25%	50%	75%	100%	100%
	Status improvement	--	0-20%	0-44%	0-73%	0-108%	0-115%
Ecol.	Actions implemented	0%	50%%	100%	100%	100%	100%
	Predation impact	14-19%	11-16%	8-12%	8-12%	8-12%	8-12%
	% of threat target @ recovery	--	50%	100%	100%	100%	100%
	Status improvement	--	3-4%	7-9%	7-9%	7-9%	7-9%

Baseline refers to prevalent conditions prior to widespread listings (1998-1999)

Years are counted relative to the listing baseline (1998-1999), thus years 1-12 include 1999-2010, years 13-24 include 2011-2022, etc.

Actions implemented between listing and Plan completion are included in year 1-12 benchmarks.

The percentage of actions implemented refers to the actions identified in the Recovery Plan. It should be noted that actions throughout the 50-year implementation period actions will be adjusted and revised based on monitoring and evaluation.

The threat reduction target relates impacts to the long term impact reduction targets identified in the Recovery Plan.

Status improvement is measured in terms of fish benefits relative to the baseline period. These values describe the incremental improvement in fish numbers due to the benefits of actions implemented during each interval.

Summer Steelhead

Five of six summer steelhead populations in the lower Columbia ESU occur in Washington. Of these, two are at very high risk of extinction, two are at moderate risk, and one is at low risk (Table 11). The sole Oregon summer steelhead population in the ESU also has a very high risk of extinction. Risks result from a combination of low abundance and productivity, loss of spatial structure, and reduced diversity due to low numbers and pervasive hatchery effects.

The recovery scenario prioritizes key populations for high levels of restoration – these selected populations will be the foundation for ESU recovery which includes both Washington and Oregon populations. Five of six (83%) summer steelhead populations are found in Washington streams. Four of six summer steelhead populations are prioritized for recovery to high or very high levels of viability (Table 11).

Declines in status of lower Columbia River summer steelhead result from the combined impacts of human activities involving freshwater habitat, estuary habitat, dam construction and operation, fishing, fish hatcheries, and ecological factors such as predation (Figure 21). Impacts of each factor are compounded across the salmon life cycle to drive most populations to current very low levels. Net effects of quantifiable and potentially manageable impacts translate into an estimated 70-95% reduction in abundance and productivity of lower Columbia River summer steelhead populations in Washington.

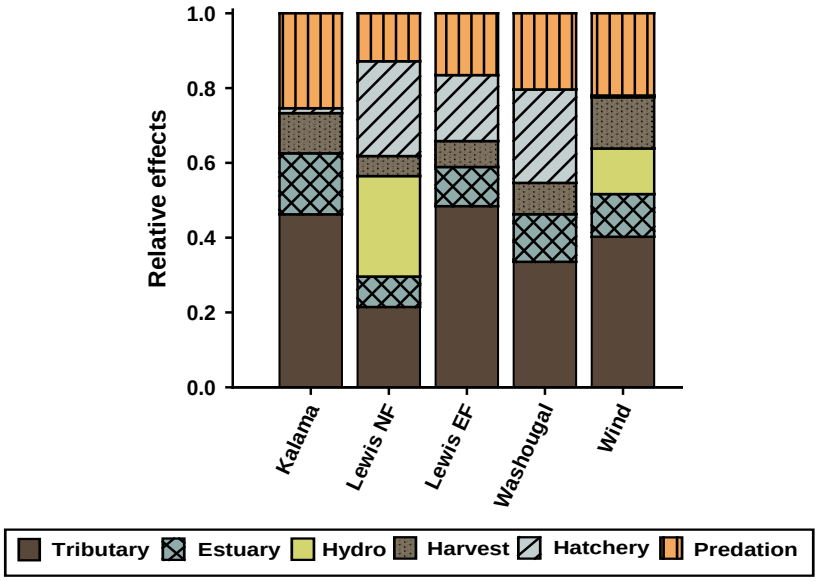


Figure 21. Relative contribution of potentially manageable impact factors on summer steelhead in Washington lower Columbia River subbasins.

An estimated 1%-50% reduction in impacts will be required to meet population improvement targets for Primary and Contributing populations of winter and summer steelhead. The long term recovery strategy for steelhead involves significant reductions in the impacts of all threat categories. Key interim actions will include habitat restoration, reintroduction upstream from tributary dams, and hatchery reform. Fishery impacts have already been substantially reduced by implementation of mark-selective fisheries for hatchery fish and with limits on commercial fishery impacts. Table 12 outlines the interim benchmarks for summer and winter steelhead impact reductions. These benchmarks provide near,

intermediate, and long term reference points for evaluating progress of impact reduction efforts for each category of threat. These benchmark values incorporate both the timeframe when actions will be implemented, as well as when the benefit of those actions will be realized.

Table 11. Baseline viability status, viability and abundance objectives, and productivity improvement targets for lower Columbia River steelhead populations.

		Baseline viability					Prod.	Abundance		
Population	**Contribution**	**A&P**	**S**	**D**	**Net**	**Obj.**	**target**	**Historical**	**Baseline**	**Target**
Coast Winter										
Grays/Chinook	Primary	VH	VH	M	M[1]	H	0%[4]	1,600	800	800
Eloch/Skam	Contributing	VH	VH	M	M[1]	M+	0%[4]	1,100	600	600
Mill/Ab/Germ	Primary	H	VH	M	M[1]	H	0%[4]	900	500	500
Youngs Bay (OR)	Primary	--[3]	--[3]	--[3]	VH	VH	--[3]	--[3]	--[3]	--[3]
Big Creek (OR)	Primary	--[3]	--[3]	--[3]	H	VH	--[3]	--[3]	--[3]	--[3]
Clatskanie (OR)	Primary	--[3]	--[3]	--[3]	VH	VH	--[3]	--[3]	--[3]	--[3]
Scappoose (OR)	Primary	--[3]	--[3]	--[3]	VH	VH	--[3]	--[3]	--[3]	--[3]
Cascade Winter										
Lower Cowlitz	Contributing	L	M	M	L	M	+5%	1,400	350	400
Upper Cowlitz [C,G]	Primary	VL	M	M	VL[2]	H[1]	>500%	1,400	<50	500
Cispus [C,G]	Primary	VL	M	M	VL[2]	H[1]	>500%	1,500	<50	500
Tilton	Contributing	VL	M	M	VL	L	>500%	1,700	<50	200
SF Toutle	Primary	M	VH	H	M	H+	+35%	3,600	350	600
NF Toutle [C]	Primary	VL	H	H	VL[2]	H	+125%		120	600
Coweeman	Primary	L	VH	VH	L[2]	H	+25%	900	350	500
Kalama	Primary	L	VH	H	L[2]	H+	+45%	800	300	600
NF Lewis [C]	Contributing	VL	M	M	VL[2]	M	>500%	8,300	150	400
EF Lewis	Primary	M	VH	M	M[1]	H	+25%	900	350	500
Salmon	Stabilizing	VL	H	M	VL[2]	VL	0%	n/a	<50	50
Washougal	Contributing	L	VH	M	L[2]	M	+15%	800	300	350
Clackamas (OR) [C]	Primary	--[3]	--[3]	--[3]	M	H	--[3]	--[3]	--[3]	--[3]
Sandy (OR) [C]	Primary	--[3]	--[3]	--[3]	L	VH	--[3]	--[3]	--[3]	--[3]
Cascade Summer										
Kalama [C]	Primary	H	VH	M	M[1]	H	0%[4]	1,000	500	500
NF Lewis	Stabilizing	VL	VL	VL	VL	VL	0%	n/a	150	150
EF Lewis [G]	Primary	VL	VH	M	VL[2]	H	>500%	600	<50	500
Washougal [C,G]	Primary	M	VH	M	M[1]	H	+40%	2,200	400	500
Gorge Winter										
L Gorge (WA/OR)	Primary	L	VH	M	L[2]	H	+45%	n/a	200	300
U Gorge (WA/OR)	Stabilizing	L	M	M	L[2]	L	0%	n/a	200	200
Hood (OR) [C,G]	Primary	--[3]	--[3]	--[3]	M	H	--[3]	--[3]	--[3]	--[3]
Gorge Summer										
Wind [C]	Primary	VH	VH	H	H[1]	VH	0%[4]	n/a	1,000	1,000
Hood (OR)	Primary	--[3]	--[3]	--[3]	VL	H	--[3]	--[3]	--[3]	--[3]

[1] Increase relative to the interim Plan.
[2] Reduction relative to the interim Plan.
[3] Addressed in the Oregon Management Unit plan.
[4] Improvement increments are based on abundance and productivity, however, this population will require improvements in spatial structure or diversity to meet recovery objectives.
[5] OR analysis indicates a low probability of meeting their delisting objective of high viability for this population.
[C] Designated as a historical core population by the Technical Recovery Team.
[G] Designated as a historical legacy population by the Technical Recovery Team.

Table 12. Interim benchmarks for action implementation, action effectiveness and related status improvements of steelhead.

		Years					
	Benchmark type	**Baseline**	**1-12**	**13-24**	**25-36**	**37-48**	**49+**
Habitat	Actions implemented	0%	50%	100%	100%	100%	100%
	Habitat impact	10-90%	9-80%	8-80%	6-80%	5-80%	5-80%
	% of threat target @ recovery	--	25%	50%	75%	100%	100%
	Status improvement	--	0-51%	0-130%	0-240%	0-400%	0-450%
	NF Lewis (summer run)	--	--	--	--	--	--
	Salmon (winter run)	--	--	--	--	--	--
	Gorge U (winter run)	--	--	--	--	--	--
	Grays-Chinook (winter run)	--	0%	0%	0%	0%	0%
	Eloch-Skam (winter run)	--	0%	0%	0%	0%	0%
	Mill-Ab-Germ (winter run)	--	0%	0%	0%	0%	0%
	Kalama (summer run)	--	0%	0%	0%	0%	0%
	Wind (summer run)	--	0%	0%	0%	0%	0%
	Lower Cowlitz (winter run)		1%	2%	2%	3%	3%
	NF Lewis (winter run)	--	1%	3%	4%	5%	6%
	EF Lewis (winter run)	--	2%	4%	6%	9%	9%
	Washougal (winter run)	--	2%	4%	6%	8%	8%
	Washougal (summer run)	--	3%	6%	10%	13%	14%
	Coweeman (winter run)	--	3%	6%	10%	13%	13%
	Kalama (winter run)	--	5%	11%	17%	24%	25%
	SF Toutle (winter run)	--	6%	12%	19%	25%	27%
	Lower Gorge (winter run)	--	6%	13%	20%	28%	29%
	Upper Cowlitz (winter run)	--	7%	15%	23%	32%	33%
	Cispus (winter run)	--	14%	31%	50%	71%	75%
	NF Toutle (winter run)	--	15%	33%	54%	78%	82%
	EF Lewis (summer run)	--	20%	45%	74%	110%	117%
	Tilton (winter run)		51%	127%	241%	414%	450%
Dams	Actions implemented	0%	50%	100%	100%	100%	100%
	Dams impact	0-100%	0-75%	0-50%	0-50%	0-50%	0-50%
	% of threat target @ recovery	--	50%	75%	100%	100%	100%
	Status improvement	--	Undefined for reintroduced populations				
Fishery	Actions implemented	0%	100%	100%	100%	100%	100%
	Fishery impact	10%	5-10%	5-10%	5-10%	5-10%	5-10%
	% of threat target @ recovery	--	100%	100%	100%	100%	100%
	Status improvement	0%	0-6%	0-6%	0-6%	0-6%	0-6%
Hatch.	Actions implemented	0%	80%	100%	100%	100%	100%
	Hatchery Impact	1-50%	1-50%	1-50%	1-50%	1-50%	1-50%
	% of threat target @ recovery	--	25%	50%	75%	100%	100%
	Status improvement	--	0-10%	0-21%	0-33%	0-46%	0-49%
Ecol.	Actions implemented	0%	50%%	100%	100%	100%	100%
	Predation impact	20-30%	16-30%	12-30%	12-30%	12-30%	12-30%
	% of threat target @ recovery	--	50%	100%	100%	100%	100%
	Status improvement	--	0-5%	0-10%	0-10%	0-10%	0-10%

Baseline refers to prevalent conditions prior to widespread listings (1998-1999)

Years are counted relative to the listing baseline (1998-1999), thus years 1-12 include 1999-2010, years 13-24 include 2011-2022, etc.

Actions implemented between listing and Plan completion are included in year 1-12 benchmarks.

The percentage of actions implemented refers to the actions identified in the Recovery Plan. Actions throughout the 50-year implementation period will be adjusted and revised based on monitoring and evaluation.

The threat reduction target relates impacts to long term reduction targets.

Status improvement is measured in terms of fish benefits relative to the baseline period. These values describe the incremental improvement in fish numbers due to the benefits of actions implemented during each interval.

Winter Steelhead

Six Washington populations are at very high risk of extinction, six are at high risk, and five are at moderate risk (Table 11). No Washington populations are at low or very low risk of extinction. Of the seven additional populations occurring only in Oregon, six are at moderate, low, or very low risk (Table 11). Risks result from a combination of low abundance and productivity, loss of spatial structure, and reduced diversity due to low numbers and pervasive hatchery effects.

Sixteen of 24 winter steelhead populations are identified for recovery to high or very high levels of viability (Table 11). Washington populations prioritized for large improvements typically include the strongest existing populations, core populations with large historical production and genetic legacy populations. Other Primary populations are included (South Fork Toutle, Coweeman, Kalama, East Fork Lewis) to meet the TRT direction to attempt higher levels of recovery in more populations than identified in the strata viability criteria because not all attempts will be successful.

Declining status results from the combined human impacts in freshwater habitat, estuary habitat, dams, fishing, fish hatcheries, and ecological factors such as predation (Figure 22). Impacts of each factor are compounded across the salmon life cycle to drive most populations to current very low levels. The net effects of quantifiable and potentially manageable impacts translate into an estimated 67-100% reduction in abundance and productivity of lower Columbia River steelhead populations in Washington.

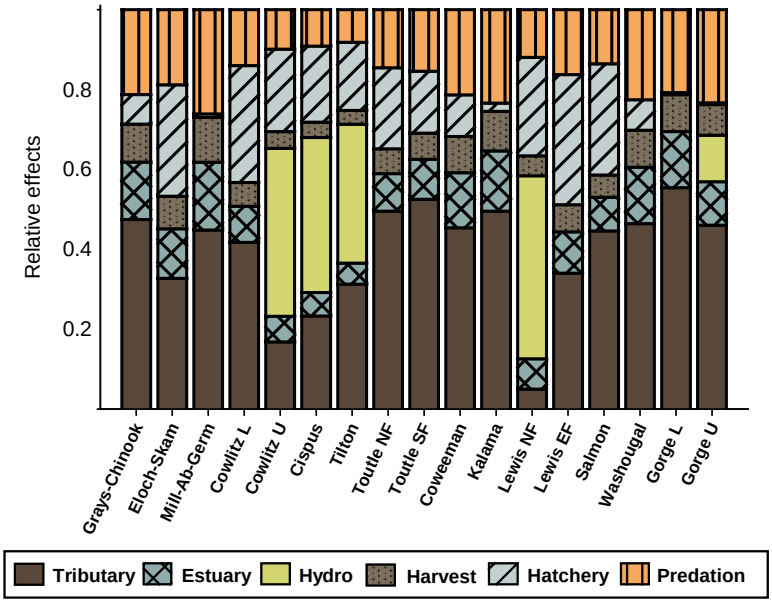


Figure 22. Relative contribution of potentially manageable impact factors on winter steelhead in Washington lower Columbia River subbasins.

An estimated 1%-50% reduction in impacts will be required to meet population improvement targets for Primary and Contributing populations of summer steelhead. The long term recovery strategy for steelhead involves significant reductions in the impacts of all threat categories. Key interim actions will include habitat restoration and hatchery reform. Fishery impacts have already been substantially reduced by implementation of mark-selective fisheries for hatchery fish and with limits on commercial fishery impacts. Table 12 outlines the interim benchmarks for summer and winter steelhead impact reductions. These benchmarks provide near, intermediate, and long term reference points for evaluating progress of impact reduction efforts for each category of threat. These benchmark values incorporate both the timeframe when actions will be implemented, as well as when the benefit of those actions will be realized.

Bull Trout

The USFWS[1] released a Lower Columbia River bull trout draft recovery plan in 2002. Revisions to critical habitat designations were proposed by the USFWS in 2010. The goal of the plan was to ensure the long-term persistence of self-sustaining, complex, interacting groups of bull trout distributed throughout the species' native range, so that the species can be delisted. To achieve this goal the following objectives were identified for bull trout in the Lower Columbia Recovery Unit:

- Maintain current distribution of bull trout and restore distribution in previously occupied areas within the Lower Columbia Recovery Unit.
- Maintain stable or increasing trends in abundance of bull trout.
- Restore and maintain suitable habitat conditions for all bull trout life history stages and strategies.
- Conserve genetic diversity and provide opportunity for genetic exchange.

Historic and current land use activities within the Lower Columbia Recovery Unit have impacted local bull trout populations. Dams have fragmented bull trout habitat, isolated local populations, and prevented access to historical foraging and overwintering habitat. Forest management activities have altered habitat conditions in portions of the recovery unit. Impacts to bull trout result from impassable culverts, excessive erosion and sedimentation, reduced recruitment of large woody debris, channel changes, and altered water temperatures, instream flow, and runoff patterns. Grazing has resulted in eroded stream banks, increased sedimentation, and incised stream channels. Water withdrawals for agriculture have reduced instream flows and resulted in increased water temperatures. Nonnative species pose a threat to bull trout through potential hybridization, competition for resources, and predation. There are currently no directed fisheries for bull trout in the Lower Columbia. However, they are incidentally caught in other fisheries and some illegal harvest likely occurs.

The 2002 Lower Columbia River bull trout draft recovery plan strategy identified seven measures needed to recover bull trout, namely:

1. Protect, restore, and maintain suitable habitat conditions for bull trout.
2. Prevent and reduce negative effects of nonnative fishes and other nonnative taxa on bull trout.
3. Establish fisheries management goals and objectives compatible with bull trout recovery, and implement practices to achieve goals.
4. Characterize, conserve, and monitor genetic diversity and gene flow among local populations of bull trout.
5. Conduct research and monitoring to implement and evaluate bull trout recovery activities, consistent with an adaptive management approach using feedback from implemented, site-specific recovery tasks.
6. Use all available conservation programs and regulations to protect and conserve bull trout and bull trout habitats.
7. Assess the implementation of bull trout recovery by recovery units, and revise recovery unit plans based on evaluations.

[1] *The USFWS has federal jurisdiction over bull trout and has developed a separate Draft Recovery Plan.*

A key strategy is to reconnect access to historical bull trout habitats. The first priority identified was to provide fish passage at Swift and Yale dams to reconnect Cougar, Rush, and Pine creeks local populations in the Lewis River basin. Reconnecting these populations would allow bull trout to move between reservoirs and would strengthen spawning populations in Cougar Creek. Improving bull trout passage at Speelyai hatchery diversion and Merwin Dam would provide access to historical overwintering and feeding habitats in the Lewis Basin and mainstem Columbia River. Providing fish passage at Condit Dam is essential for reestablishing fluvial bull trout in the White Salmon River. In addition, the recovery plan recognized that reestablishment of local populations within the White Salmon and Klickitat Rivers within 25 years may require the use of artificial propagation.

In 2008, the USFWS also initiated a process to develop an action plan for prioritizing recovery actions in the interim until a recovery plan can be formally competed.

Subbasin Summaries

A series of Subbasins Plans (Volumes II.A-II.R) describe local conditions and detail implementation of the regional plan at the subbasin level. Each subbasin plan includes:

- An ***overview summary*** of key priorities, such as managing forest lands to protect and restore watershed processes and/or restore floodplain function, etc.
- An ***assessment*** that describes the subbasin, species of interest, subbasin habitat conditions, stream habitat limitations, watershed process limitations, other factors such as hatcheries, harvest, hydropower, and out-of-subbasin effects. The assessment includes qualitative and quantitative information.
- A ***program and project inventory*** describing significant activities in the subbasin. (More detailed program descriptions may also be found in a regional program directory contained in Technical Appendix C.)
- A ***management plan*** that details a subbasin vision, biological objectives, integrated strategy, and specific measures and actions for each threat category.

Lower Columbia Mainstem and Estuary

The lower Columbia River mainstem is a critical migration corridor and rearing area for every population of salmon and steelhead in the Columbia River basin as well as a variety of other fish and wildlife species. Habitats and habitat shaping processes have been substantially altered by local development and changes in river dynamics that have accompanied extensive hydropower development throughout the system. The estuary subbasin plan is consistent with the joint Oregon and Washington subbasin plan. Priority actions were previously described under regional strategies and measures.

Estuary Tributaries

The Estuary Tributaries subbasin includes a series of small Washington tributaries from the ocean upstream to Deep River. These streams historically supported thousands of fall Chinook, chum, and coho. All populations need to be restored to a high level of viability in these tributaries to meet regional recovery objectives. Priority actions include:

- Restoring passage at tide gates, culverts, and other artificial barriers,
- Restoring estuary, floodplain, and riparian habitats,
- Managing forests pursuant to Forest and Fish Rules to protect and restore watershed processes,
- Addressing immediate risks with short term habitat fixes, and
- Reducing out-of-subbasin impacts.

Grays Subbasin

This subbasin is particularly important to regional recovery because it is one of two major basins in the coastal strata of the ESU. Populations of fall Chinook, winter steelhead, chum and coho need to be restored to medium to high levels of viability in this subbasin to meet regional recovery objectives. Priority actions include:

- Reducing out-of-subbasin impacts,
- Managing forests pursuant to Forest and Fish Rules to restore watershed processes,
- Restoring valley floodplain function and stream habitat diversity, and
- Aligning hatchery priorities with conservation objectives.

Elochoman Subbasin

This subbasin includes the Elochoman, Skamokawa, Mill, Abernathy, and Germany watersheds. Populations of fall Chinook, chum, coho and winter steelhead need to be restored to medium and high levels of viability to meet regional recovery objectives. The Elochoman/Skamokawa populations are particularly important for recovery. Priority actions include:

- Managing forest lands pursuant to Forest and Fish Rules to protect and restore watershed processes,
- Restoring lowland floodplains, riparian conditions, and stream habitat diversity,
- Reducing out-of-subbasin impacts, and
- Aligning hatchery priorities with conservation objectives.

Cowlitz Subbasin

This subbasin is particularly important to regional recovery by virtue of its large size and diverse habitats. It includes lower Cowlitz, upper Cowlitz, Cispus, Tilton, Toutle, and Coweeman watersheds. One or more populations of tule fall Chinook, spring Chinook, chum, winter steelhead, summer steelhead, and coho are present and many need to be restored to high levels of viability to meet regional recovery objectives. Priority actions include:

- Restoring access above dams to the upper portion of the basin,
- Protecting intact forests in headwaters,
- Managing forest land pursuant to Forest and Fish Rules to protect and restore watershed processes,
- Managing growth and development to protect watershed processes and habitat conditions,
- Restoring passage at culverts and other artificial barriers,
- Restoring lowland floodplain function, riparian conditions, and stream habitat diversity,
- Addressing immediate risks with short term habitat fixes,
- Aligning hatchery priorities with conservation objectives, and
- Reducing out-of-subbasin impacts.

Kalama Subbasin

Populations of winter steelhead and summer steelhead need to be restored to a high level of viability to meet regional recovery objectives. Coho, fall Chinook, and spring Chinook will need some level of improvement in viability, and a chum population needs to be established and stabilized. Priority actions include:

- Managing forests pursuant to Forest and Fish Rules to restore watershed processes,
- Managing growth and development to protect watershed processes and habitat conditions,
- Restoring passage at culverts and other artificial barriers,
- Aligning hatchery priorities with conservation objectives, and
- Reducing out-of-subbasin impacts.

Lewis Subbasin

This subbasin is particularly important to regional recovery due to its large size and diverse habitats. It includes the upper North Fork, lower North Fork, and East Fork Lewis watersheds. One or more populations of tule fall Chinook, bright fall Chinook, spring Chinook, chum, winter steelhead, summer steelhead, and coho are present and many need to be restored to high levels of viability to meet regional recovery objectives. Priority actions include:

- Restoring access above dams to the upper portion of the North Fork watershed,
- Protecting intact forests in headwaters,
- Managing forest land pursuant to Forest and Fish Rules to protect and restore watershed processes,
- Managing growth and development to protect watershed processes and habitat conditions,
- Restoring passage at culverts and other artificial barriers,
- Restoring lowland floodplain function, riparian conditions, and stream habitat diversity,
- Addressing immediate risks with short term habitat fixes,
- Aligning hatchery priorities with conservation objectives, and
- Reducing out-of-subbasin impacts.

Washougal Subbasin

The Washougal Subbasin includes both Washougal River populations and Salmon Creek populations. Salmon Creek and Lake River have been heavily urbanized; the urban streams will play a limited role in salmon recovery. Washougal fall Chinook, chum, and summer steelhead need to be restored to a high level of viability, and coho and winter steelhead need to be restored to a medium level of viability. The subbasin is diverse with significant portions in forest, agriculture, rural residential, and urban uses. Priority actions include:

- Protecting intact forests in headwaters,
- Managing forest land pursuant to Forest and Fish Rules to protect and restore watershed processes,
- Managing growth and development to protect watershed processes and habitat conditions,
- Restoring passage at culverts and other artificial barriers,
- Restoring lowland floodplain function, riparian conditions, and stream habitat diversity,
- Addressing immediate risks with short term habitat fixes,
- Aligning hatchery priorities with conservation objectives, and
- Reducing out-of-subbasin impacts.

Lower Columbia Gorge Tributaries

This subbasin includes a series of small tributaries between the City of Vancouver and Bonneville Dam including Duncan, Hardy, and Hamilton Creeks. These tributaries are largely in forest lands. Populations of fall Chinook, winter steelhead, chum and coho in lower gorge tributaries will be important to recovery. Priority actions include:

- Restoring floodplain function, riparian conditions, and stream habitat diversity,
- Managing growth and development to protect watershed processes and habitat conditions,
- Managing forests pursuant to Forest and Fish Rules to restore watershed processes,
- Restoring passage at culverts and other artificial barriers,
- Addressing immediate risks with short term habitat fixes,
- Aligning hatchery priorities with conservation objectives, and
- Reducing out-of-subbasin impacts.

Wind Subbasin

This subbasin historically supported abundant fall Chinook, winter steelhead, summer steelhead, chum, and coho. Coho and summer steelhead need to be restored to a high level of viability to meet regional recovery objectives. Chum and fall Chinook need to be restored to a medium level of viability. Priority actions include:

- Reducing out-of-subbasin impacts,
- Protecting intact forests in headwaters,
- Managing forest lands pursuant to Forest and Fish Rules and federal forest plans to protect watershed processes,
- Managing growth and development to protect watershed processes and habitat conditions,
- Restoring passage, floodplain function, riparian function, and stream habitat diversity in critical areas, and
- Aligning hatchery priorities with conservation objectives.

Little White Salmon Subbasin

This subbasin will play a limited role in salmon recovery but is significant for many resident fish and wildlife species. A limited amount of habitat is available for anadromous fish and much of the historical habitat for fall Chinook and chum salmon was inundated by Bonneville Reservoir. Priority actions include:

- Managing growth and development to protect watershed processes and habitat conditions,
- Restoring passage at culverts and other artificial barriers,
- Addressing immediate risks with short term habitat fixes,
- Aligning hatchery priorities with conservation objectives, and
- Reducing out-of-subbasin impacts.

Upper Columbia Gorge Tributaries

This subbasin includes small tributaries between Bonneville Dam and the White Salmon River, of which Rock Creek is the largest. Gorge populations of coho salmon will need to be restored to a high level of viability, and fall Chinook and chum need to be restored to a medium level of viability to meet regional recovery objectives. Priority actions include:

- Reducing out-of-subbasin impacts,
- Addressing immediate risks with short term habitat fixes,
- Managing forest lands pursuant to Forest and Fish Rules and federal forest plans to protect watershed processes, and
- Managing growth and development to protect watershed processes and habitat conditions.

Other Species

While primarily focused on listed salmon, steelhead, and trout, this Plan also recognizes the benefits of a comprehensive ecosystem-based approach to salmonid recovery on other fish and wildlife species throughout the region. This Plan addresses the needs of the Northwest Power and Conservation Council with respect to other fish and wildlife species affected by construction and operation of the federal Columbia River hydropower system. To recognize the ecosystem scope of these efforts, the Plan also included a representative subset of other significant fish and wildlife species that affect salmon, are affected by salmon recovery, or are useful for characterizing watershed status, functions, or management actions. The *NPCC Technical Guide of Subbasin Planners (NPCC 2001)* identified criteria for species selection based on designation as federal endangered or threatened species; ecological significance; cultural significance; and local significance.

Ten non-focal fish species are considered in this Plan. Two are currently listed as threatened under ESA: green sturgeon and eulachon. In contrast, cutthroat trout, white sturgeon, northern pikeminnow, and American shad are relatively abundant throughout the lower Columbia. Pacific lamprey and eulachon have experienced declining trends or variable abundance in recent years; both are an integral part of the lower Columbia River ecosystem and are considered an important food source for sturgeon and pinnipeds. The remaining fish species (smallmouth bass, walleye, and channel catfish) appear to have stable but low population abundance relative to other areas of the Columbia River basin. Smallmouth bass, walleye, and channel catfish are all introduced species in the Columbia River basin and there is currently no basis for attempting to increase their productivity or abundance in the lower Columbia River ecosystem, particularly because of potential negative consequences on salmonid recovery.

Seventeen wildlife species are also included. Five of these (Larch Mountain Salamander, Columbia Whitetail Deer, Fisher, Stellar Sea Lion, and the Western Gray Squirrel) are listed under ESA. In addition, the Oregon Spotted Frog, Western Pond Turtle, and Sandhill Crane are listed as threatened under Washington State law. Columbia River seal and sea lion populations appear to be stable or increasing. Caspian Terns, native to the region but historically were not present in the lower Columbia River ecosystem, are now consistently found in the area because of human-induced habitat change. The Sandhill Crane and Dusky Canada Goose are other avian species that were not historically present in the lower Columbia River ecosystem. Agricultural lands in the lower Columbia floodplain have attracted cranes and geese to the region. Two avian species (Bald Eagle and Osprey) have relatively stable population trends but appear to be experiencing low reproductive success as a result of contaminant exposure. Two vastly different species (Columbian white-tailed deer and western pond turtle) have extremely low abundance levels in the lower Columbia River ecosystem. Data are sparse for a number of species, specifically Yellow Warbler and Red-eyed Vireo. Evidence suggests that abundance of both of these species is generally low in the lower Columbia River ecosystem; only possible evidence of breeding exists for the area.

The other fish and wildlife species addressed in this Plan are limited by many of the same factors as those identified for salmonids. Thus, it follows that many of the hypotheses, strategies, and measures developed for salmonids also apply to and benefit these other fish and wildlife species. In particular, regional strategies and measures for subbasin habitat, estuary and mainstem habitat, hydropower operation, and ecological interactions are most pertinent to the other fish and wildlife species. In addition, biological objectives and strategies are identified in this Plan for each species. Objectives and strategies take different forms due to inherent differences in species significance, ecological interactions, information available, and management structures in place. With the implementation of an ecosystem-based approach to the recovery of ESA-listed species, the effects of recovery actions on other fish and wildlife species should be considered.

Monitoring & Research

Given the non-prescriptive nature of this Plan, a comprehensive and adaptive monitoring and research effort will be critical for evaluating progress toward recovery and making appropriate course adjustments along the way. Monitoring and evaluation strategies and measures are designed to answer five questions regarding progress in recovery (Figure 23). Corresponding monitoring and research elements include:

1) Biological status and trend monitoring that describes progress toward ESU recovery objectives and establishes a baseline for evaluating causal relationships between limiting factors and a population response.
2) Habitat status monitoring that identifies the cumulative effect of human activity trends and recovery measures on critical limiting factors.
3) Implementation/compliance monitoring that tracks whether actions were implemented as planned and/or meets established laws, rules, or benchmarks.
4) Action effectiveness monitoring that determines if specific habitat, hydropower, hatchery, harvest, and ecological interaction measures produce the specific intended effect.
5) Uncertainty and validation research that targets specific issues that constrain effective Recovery Plan implementation including evaluations of cause and effect relationships between fish, limiting factors, and actions that address specific threats related to limiting factors.

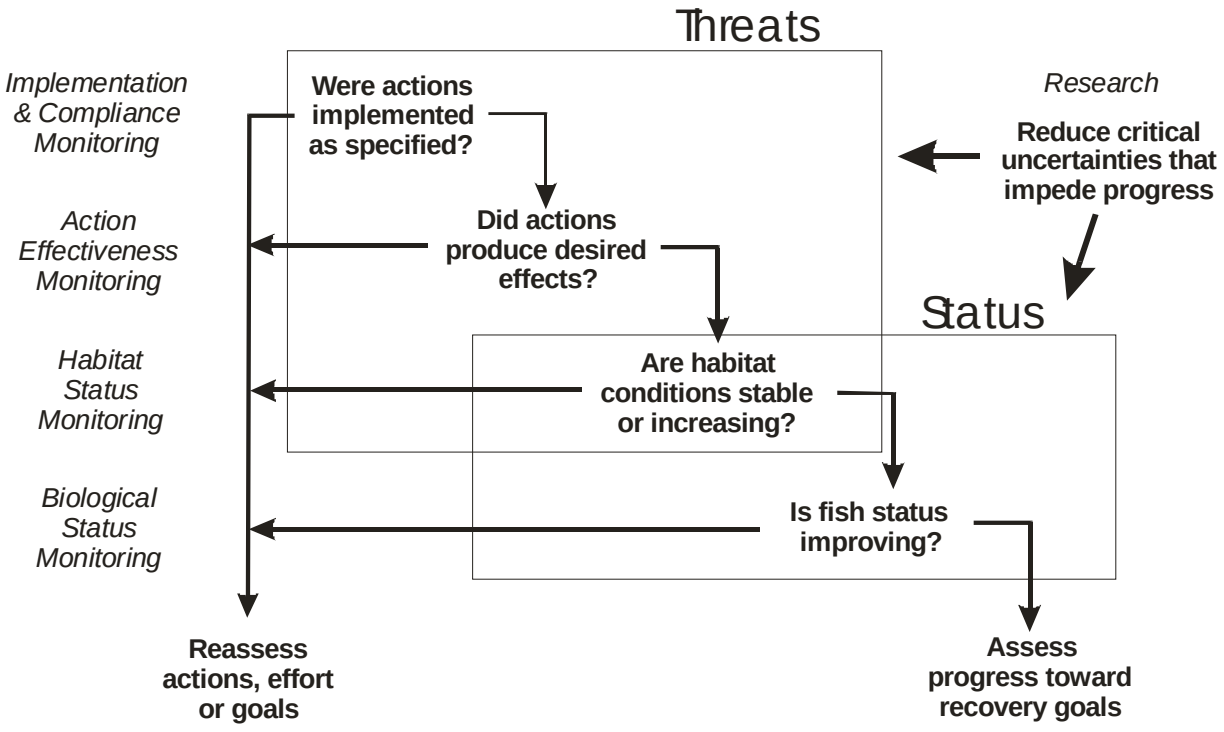


Figure 23. Monitoring, research and evaluation program elements.

Biological Status Monitoring

Biological status monitoring is intended to characterize the likelihood of long term persistence (and conversely the risk of extinction) relative to the baseline condition at listing, periodic checkpoints in Recovery Plan implementation, and recovery goals. In addition to describing progress toward ESU recovery objectives, biological status monitoring also provides data necessary for action effectiveness monitoring and research to resolve critical uncertainties.

Attributes of biological status include viability and Viable Salmonid Population (VSP) characteristics including abundance, productivity, distribution, and diversity (Figure 24).

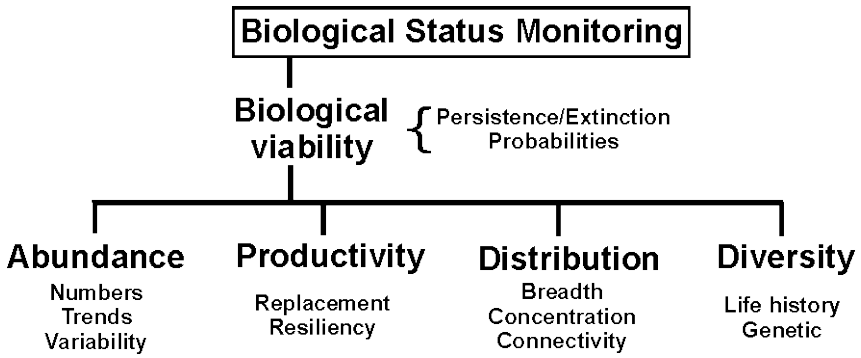


Figure 24. Elements for biological status monitoring for salmon recovery.

This program identifies a stratified, representative, multi-level sampling framework for monitoring the biological status at a population unit scale. It is not realistic to monitor every VSP parameter for every population in every year at a high level of precision due to costs of intensive biological monitoring, other monitoring and research needs, and tradeoffs in funding priorities between monitoring and other recovery actions. The stratified, representative, multi-level sampling design addresses the following four elements:

- Population strata (Species, Life History, and Ecoregion)
- Intensity (Intensive, Inventory, Indicator)
- Life stage (Juveniles, Adults)
- Frequency (Annual, Periodic)

Three levels of sampling intensity, Intensive, Inventory, and Indicator, are distinguished by the depth and breadth of adult and juvenile sampling activities (Table 13).

Table 13. Major Population Group-level sampling guidelines at low, moderate, and high levels of coverage for biological monitoring (number of populations monitored by sampling intensity).

Relative certainty	Sampling depth	Sampling breadth	Sampling coverage
	Intensive	**Inventory or Intensive**	**Indicator or Inventory or Intensive**
Low	<1 per species/life history (juveniles & adults)	<2 per species/life stage & strata (adults or juveniles)	<33% of populations (adults or juveniles)
Moderate	1 per species/life history (juveniles & adults)	2 per species/life stage & strata (adults or juveniles) [1]	≥33% of populations (adults or juveniles)
High	>1 per species/life history & strata (juveniles & adults)	>2 per species/life stage & strata (adults or juveniles)[2]	>50% of populations (adults or juveniles)

[1]Or two populations if only two in the strata.
[2]Or two or three populations in strata with only two or three, respectively.

The monitoring program identifies target sample numbers for strata by sampling intensity level based on the following guidelines:

1. Biological monitoring needs to address both ESU and population level viability recovery criteria and population parameters related to viability (abundance, productivity, spatial structure, and diversity).
2. The status of every population needs to be assessed but all populations do not need to be monitored.
3. The highest priorities for monitoring are assigned to populations targeted in recovery strategies for high viability or large improvements.
4. Representative samples are needed for Primary and Contributing populations for every species/life and strata (major population group) based on intensive or inventory level monitoring.
5. Intensive monitoring of juveniles and adults should occur for at least one population of every species/life history type (major population group).
6. Higher priority is assigned to additional coverage of populations at intensive or inventory sampling intensity than coverage of multiple populations within a species/life history (major population group) at an intensive sampling level.

Habitat Status Monitoring

Habitat information addresses a multitude of critical questions including long-term cumulative effects of recovery measures and other human activities, inferences of fish potential where biological data is incomplete, identification of key limiting factors and functional relationships, and site-specific effects of specific recovery measures. Habitat monitoring, more than any other element of this program, is complicated by issues of multiple and overlapping objectives, scales, information needs, and jurisdictional responsibilities. Each element implies a specific set of information needs and sampling regimens.

The program identifies sampling components at three habitat scales: 1) stream, riparian, and floodplain characteristics which are referred to in this Plan as “stream corridor”, 2) watershed, hillslope/upland, and wetland conditions which are referred to in this Plan as “landscape,” and 3) water quality and quantity (Figure 25).

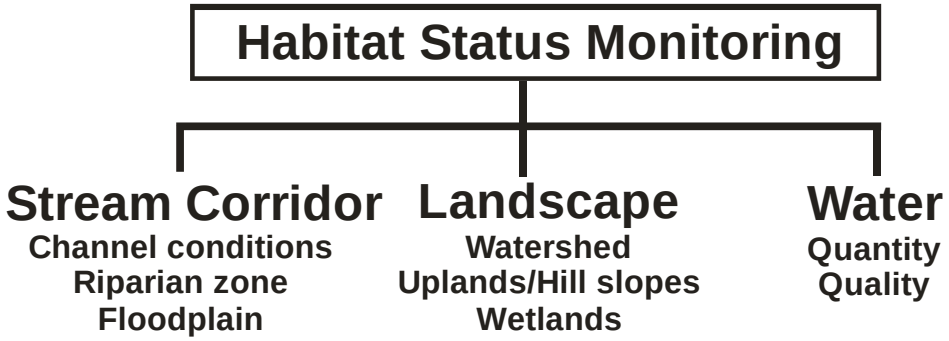


Figure 25. Elements for habitat status monitoring of fish recovery.

Habitat status monitoring at the stream scale is primarily intended to characterize conditions for salmon relative to a baseline at listing and improvements consistent with recovery. Stream corridor monitoring strategies include:

1. Complete comprehensive assessments of stream habitat status and significance to salmon at 12 year intervals as prescribed by the Recovery Plan.
2. Utilize a multi-level stream habitat sampling approach to address the multitude of objectives and applications of this information.
3. Assess stream habitat status of every subbasin in a representative fashion (although every subbasin does not need to be monitored at the same sampling level).
4. Employ a range of sampling intensities consistent with the multiple objectives.
5. Monitor subbasins that are a higher priority for recovery at a greater intensity.
6. Design stream habitat monitoring for salmon recovery evaluations to make maximum use of other regional monitoring where consistent.
7. Adopt habitat monitoring protocols for dedicated salmon recovery habitat monitoring that are compatible with other regional monitoring efforts.

Habitat status monitoring at the landscape scale is primarily intended to characterize watershed upland/hill slope and wetland conditions that affect stream habitat for salmon relative to a baseline at listing and improvements consistent with recovery. The objective at this scale is to detect broad changes in watershed conditions that affect stream habitat forming processes. Landscape monitoring strategies include:

1. Complete comprehensive assessments of landscape condition status and trends at 12 year intervals as prescribed by the Recovery Plan.
2. Derive landscape-scale data for status and trends monitoring primarily from existing datasets or other regional activities.

The habitat monitoring program incorporates elements of Watershed Plan monitoring pertinent to fish. The Watershed Plans are designed to address the salmon-related monitoring needs for water quantity or quality data. Water quality and quantity monitoring strategies include:

1. Complete comprehensive assessments of water quality and quantity status and trends at 12 year intervals as prescribed by the Recovery Plan.
2. Monitor water quality and quantity as prescribed in the WRIA's 25/26 and 27/28 Watershed Management Plans.

Implementation/Compliance Monitoring

Implementation and compliance monitoring will determine whether actions were implemented as planned or meet established laws, rules, and benchmarks. Salmon Recovery and Watershed Plans for the lower Columbia Region identify over 650 specific actions for implementation by over 80 partners. Partners include a broad spectrum of federal, state, and local governmental agencies, as well as a variety of nongovernmental organizations. Neither of these plans has the authority to mandate implementation of these actions. Objective success will thus depend on voluntary implementation of actions. Implementation and compliance monitoring is one of the simplest and most direct measures of whether the Plan is being implemented as designed.

Strategies for implementation and compliance monitoring include:

1. Complete comprehensive assessments of action implementation and compliance at 2-year intervals for the purpose of evaluating Salmon Recovery and Watershed Plan progress.
2. Rely on implementing agencies to identify, evaluate and report on progress in the implementation and compliance of specific actions identified by the Plan.
3. Develop and maintain a centralized clearinghouse and database to track and summarize action implementation.

Action implementation and compliance is evaluated based on identification and completion of activities and tasks specific to each action. Activities and tasks are identified by the implementing agent during development of their 6-Year Implementation Work Schedules (IWS). Evaluations are based on partner and action assessments. Partner assessments describe progress in the implementation of all activities, actions and tasks under the responsibility of each implementing partner. Action assessments describe progress in the implementation of all activities and tasks across partners.

Partners can enter and maintain information on salmon recovery and watershed management actions for their programs using the web-tool Salmon PORT (Salmon Partners Ongoing Recovery Tracking) (Figure 26).

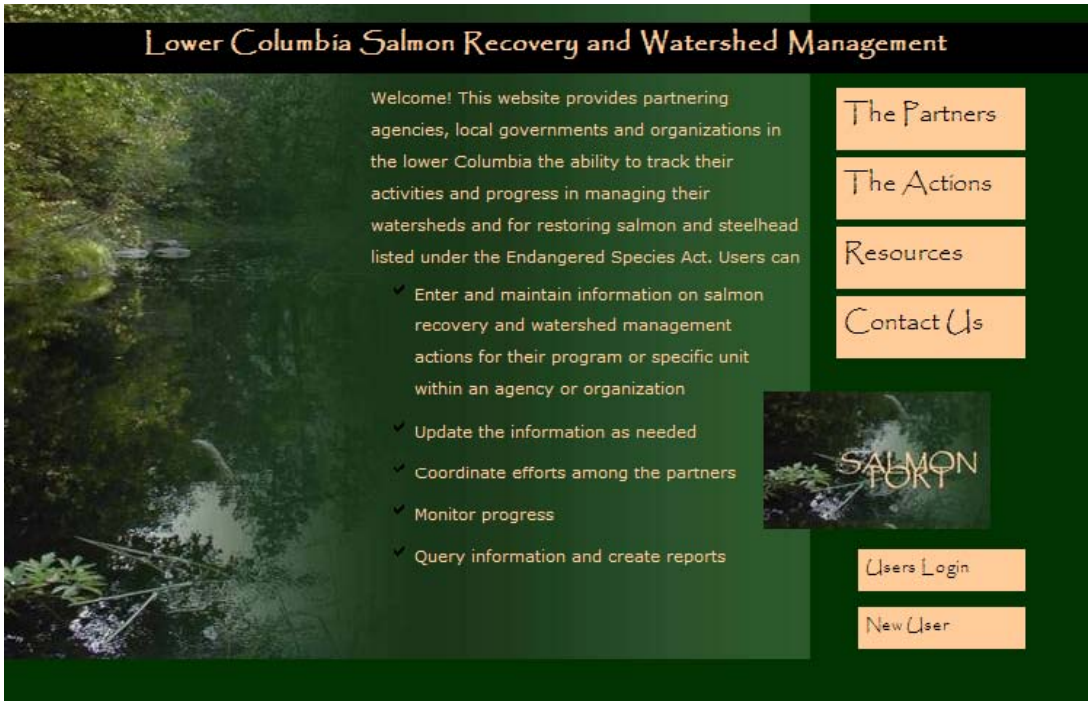


Figure 26. Salmon PORT interface page at http://www.lowercolumbiasalmonrecovery.org/.

Action Effectiveness Monitoring

Action effectiveness monitoring is designed to evaluate the significance and types of threats to listed salmon and steelhead status, and changes in threat levels associated with specific types of recovery actions. This monitoring is specifically intended to evaluate the status and trends in statutory listing factors identified by NMFS. Where species and habitat status and trend monitoring weighs the aggregate effect of a full complement of protection and restoration actions, action effectiveness monitoring considers the incremental effects of specific actions or suites of actions that affect habitat, hydropower, hatchery, fishery, and ecological interaction threats (Figure 27).

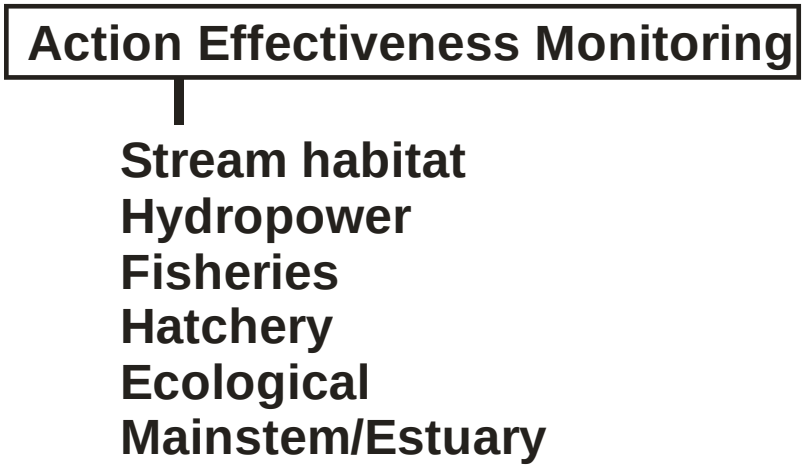


Figure 27. Categories of action effectiveness monitoring addressed by this Plan.

Stream habitat action effectiveness monitoring is intended to determine if specific protection and restoration projects function as planned. Where the baseline habitat status and trend monitoring generally provides a more global picture of the net effects of all activities and programs on conditions for fish, stream habitat action effectiveness monitoring is focused on the specific proximate effect of a particular action and whether actions function as intended. Monitoring strategies include:

1. Complete comprehensive assessments of habitat action effectiveness at 6-year intervals for the purpose of evaluating Recovery Plan progress.
2. Monitor the effectiveness of habitat-related actions affecting the stream, water quantity and quality, and watershed conditions.
3. Develop and maintain a comprehensive up-to-date inventory of habitat-related actions across the region.
4. Intensively monitor the effectiveness of a subset of representative habitat actions using a formal statistical research design.
5. Estimate and report on the physical and biological effects and functional lifespan of every habitat-related project or program implemented in the region based on site-specific evaluations or by inference from similar project types elsewhere.
6. Conduct habitat action effectiveness monitoring in close and complementary association with habitat status and trend monitoring.

Hydropower action effectiveness monitoring is intended to determine if related fish protection, restoration, and mitigation actions reduce or limit effects on wild fish to levels consistent with the conservation and recovery of listed fish species while also achieving desired fish production benefits. Monitoring strategies include:

1. Complete comprehensive assessments of hydropower action effectiveness at 6-year intervals for the purpose of evaluating Recovery Plan progress.
2. Evaluate hydropower action effectiveness for passage, habitat protection and restoration, reintroduction and mitigation-related impacts on salmon and steelhead at all significant mainstem and tributary facilities that currently limit the viability of listed lower Columbia River populations.
3. Monitor facility operations that potentially affect fish or fish habitat.
4. Conduct intensive annual monitoring and evaluation of juvenile and adult passage.
5. Monitor and evaluate effectiveness of hydro-related habitat measures based on downstream effects on stream habitat characteristics, water quantity, and water quality.
6. Monitor effectiveness of adaptively-implemented reintroduction efforts above tributary facilities in the Cowlitz, Lewis, and White Salmon rivers based on net productivity.
7. Monitor effectiveness of additional actions designed to mitigate hydropower impacts, where appropriate.
8. Implement hydropower monitoring programs consistent with requirements of Federal Energy Commission Licenses, Biological Opinions, and other plans and agreements.

Fisheries action effectiveness monitoring is intended to determine if fishery management regulatory processes and actions reduce or limit fishery-related mortality to levels consistent with the conservation and recovery of listed fish species while also providing significant and sustainable fishery opportunity and harvest. Monitoring strategies include:

1. Complete comprehensive assessments of fishery action effectiveness at 6 year intervals as prescribed by the Recovery Plan.
2. Monitor annual impacts relative to prescribed limits for significant ocean and Columbia River sport and commercial fisheries on representative index groups for all species. This should be based on in-season data on fish numbers and fishery mortality collected using systematic statistical surveys of catch, catch composition, and harvest.
3. Periodically re-evaluate effects of prescribed fishery impact levels and strategies on long term viability of listed stocks based on risk assessments that consider recent stock abundance and productivity.
4. Monitor annual fishery opportunity based on effort, harvest, and value in significant ocean, Columbia River, and tributary sport and commercial fisheries for all species.
5. Conduct annual evaluations of fishery assessment and management processes and tools based on post-season run reconstruction and analysis of forecast, in-season and actual information on fishery impacts and opportunities in order to optimize efficacy.
6. Systematically implement improvements in assessment methods, processes, and tools based on annual efficacy evaluations and directed investigations of critical uncertainties in current assessments and systems.

Hatchery action effectiveness monitoring is intended to determine if hatchery management actions reduce or limit effects on wild fish to levels consistent with the conservation and recovery of listed fish species while also achieving desired fish production benefits. Monitoring strategies include:

1. Complete comprehensive assessments of fishery action effectiveness at 6 year intervals as prescribed by the Recovery Plan.
2. Intensively monitor potential hatchery threats to wild population status for every salmon and steelhead hatchery program.
3. Monitor the potential impacts of hatcheries on the status of wild populations based on the annual incidence of natural spawning by hatchery fish and the contribution of natural origin fish to the hatchery brood stock.

4. Monitor hatchery performance and practices in order to evaluate program benefits relative to associated risks and activities related to both risks and benefits.

Ecological interactions refer to the relationships of salmon and steelhead with other elements of the ecosystem including interactions with non-native species, effects of salmon on system productivity (e.g. nutrients), and native predators. Ecological action effectiveness monitoring is intended to determine if current management activities are adequate to address current or developing threats involving new species invasions and potentially manageable predation. Monitoring strategies include:

1. Complete comprehensive assessments of ecological interaction action effectiveness at 6-year intervals for the purpose of evaluating Recovery Plan progress.
2. Evaluate effectiveness of actions to address ecological interactions involving non-native species introductions and predation effects that currently limit or could grow to limit the viability of listed lower Columbia River populations.
3. Implement a periodic systematic monitoring program for aquatic nonindigenous species of plants, invertebrates, and fishes in the Columbia River mainstem and estuary.
4. Monitor the status of existing introduced species (including shad) based on current information and identify appropriate refinements in critical uncertainty research regarding the potential significance of this threat.
5. Conduct intensive annual monitoring and evaluation of the effectiveness of measures to manage predation in the Columbia River mainstem and estuary by northern pikeminnow, marine mammals and piscivorous birds.

Uncertainty & Validation Research

Uncertainty and validation research targets specific issues that constrain effective Recovery and Watershed Plan implementation. Research includes evaluations of cause and effect relationships between fish and limiting factors and actions that address specific threats related to limiting factors. Research also tests assumptions about population trends, land use trends, and flow and water quality conditions. Research needs were identified by a review of the literature and plans related to salmon status and recovery. Research examples include:

1. Validate recovery goals and preliminary estimates of persistence probabilities based on life cycle analyses and long term data sets.
2. Apply monitoring feedback loops to inform EDT analysis and improve estimates of fish productivity and capacity based on habitat and fish productivity data.
3. Determine feasibility of re-establishing self-sustaining anadromous populations upstream of hydropower facilities in the Lewis, Cowlitz and Tilton systems.
4. Evaluate innovative techniques (e.g., terminal fisheries and tangle nets) to improve access to harvestable stocks and reduce undesirable direct and indirect impacts to wild populations.
5. Determine relative performance of hatchery and wild fish in the wild in relation to broodstock divergence and hatchery practices.
6. Experimentally evaluate nutrient enrichment benefits and risks using fish from hatcheries or suitable analogs.
7. Move estuary evaluations from a collection of available conceptual frameworks to an integrative implementation framework. This is where we combine what we have learned in the various conceptual frameworks to identify the most important areas for restoration actions, along with the most likely avenues for success.

Data & Reporting

Data management and reporting are critical elements in the coordination of a regional monitoring program. This program identifies several actions related to data management necessary for successful implementation of a complex, multi-jurisdictional monitoring effort. One goal of these actions is to coordinate among complementary data management activities throughout the region. For example, the Pacific Northwest Aquatic Monitoring Partnership (PNAMP) is developing a forum for coordinating state, federal, and tribal aquatic habitat and salmonid monitoring programs. Other RM&E efforts are underway at local and regional scales across the Pacific Northwest. Coordination of Washington lower Columbia River efforts will provide synergistic benefits. Standardization of data methods will greatly enhance comparative and interpretative power of monitoring and research activities. Data management and reporting actions include:

1. Conduct a data management needs assessment and use it to develop a data management plan.
2. Maintain consistent regionally-standardized datasets and archives in regional data storage and management facilities (e.g., Pacific State Marine Fisheries Commission StreamNet, Washington Department of Fish and Wildlife SSHIAP, NMFS biological datasets).
3. Produce and distribute regular progress and completion reports for monitoring and research activities.
4. Closely coordinate Washington lower Columbia River monitoring, research, and evaluation efforts with similar efforts throughout the basin, including prioritization of activities and standardization of data methods.

Plan Implementation

This Plan provides a blueprint for salmon and steelhead recovery that includes specific strategies, measures, and actions needed to:

- Address all threats.
- Reverse long term declining trends and establish a trajectory toward recovery.
- Obtain sufficient information to measure progress.
- Make course corrections as necessary.

Implementation Mechanism

The pervasive scale of human activities that limit or threaten salmonids means that recovery will require a dedicated long-term collective social commitment to preserve and restore salmon and steelhead. The Plan identifies the partners with the authority, jurisdiction, or resources needed to implement each action.

The Plan does not obligate any party but does establish specific responsibilities for taking actions that have been identified as important to fish recovery. Obligation will come through the commitment of each implementing partner to undertake and complete their actions in a timely, sound, and thorough manner.

Institutional Structure

The institutional structure for Plan implementation involves oversight, implementation, and facilitation/coordination responsibilities.

Key oversight bodies include NMFS, U.S. Fish and Wildlife Service, tribal governments, the Washington Department of Fish and Wildlife, the Washington Governor's Office, and the Northwest Power and Conservation Council.

Implementation responsibilities will involve programs and projects by numerous federal, state, local, and nongovernmental bodies. These entities are referred to as implementation partners.

The Lower Columbia Fish Recovery Board working with a steering committee will facilitate and coordinate efforts among oversight and implementing partners. The steering committee will include representatives of oversight bodies and a cross section of implementing partners. Facilitation and coordination will involve setting priorities, evaluating progress, tracking implementation, inventorying and synthesizing monitoring results, developing implementation partnerships and agreements, and revising the Plan.

Coordination & Administration

The Plan implementation process will involve preparation of a series of 6-year implementation work schedules identifying tasks, schedules, priorities, costs, constraints, and responsibilities associated with partners' actions. Federal, state, tribal, local, and non-governmental partners will be asked to prepare an implementation work schedule for their recovery actions. The individual action schedules will be used to develop a coordinated regional 6-year action schedule.

It is likely during the course of implementing the Recovery Plan that questions will arise that will require interpretation or clarification of the Plan goals, objectives, strategies, measures, and actions. Revisions may also be warranted to address issues or new information that may arise during implementation or to facilitate effective Plan implementation. The Implementation Steering Committee shall be

responsible for such interpretations, clarifications, or revisions and may consult with federal state or local agencies or the NMFS Technical Recovery Team (TRT) as deemed appropriate.

The Recovery Plan will be routinely evaluated and revised as necessary based on the adaptive management process and intervals set forth in this Plan. However, it may be desirable or necessary to revise the Plan between these intervals in order to address issues or new information that may arise during implementation. Such revisions may be needed to clarify provisions of the Plan or to facilitate effective Plan implementation. Interim revisions to address or incorporate new information or data may also be warranted in instances where the benefits to recovery efforts are deemed to be sufficiently significant.

The LCFRB and the Implementation Steering Committee will direct and coordinate the implementation of the monitoring, research and evaluation provisions of this Plan. The program will also define the procedures and benchmarks for implementing the Adaptive Management Process. The LCFRB and Implementation Steering Committee shall convene and work with a Monitoring, Research, and Evaluation Working Group to develop implementation measures and responsibilities.

Adaptive Management

An adaptive management process and schedule is described that includes checkpoints, assessments, benchmarks, and decisions (Figure 28). ***Checkpoints*** are formal decision points where the need for changes in direction will be considered. ***Assessments*** are formal evaluations of progress and results. ***Benchmarks*** are standards or criteria that will drive decisions depending on observed progress in implementation efforts and effectiveness based on the 6-year implementation schedules prepared by the implementing partners. ***Decisions*** identify refinements in efforts or new directions based on progress relative to benchmarks observed at checkpoints. Decisions will be based on:

- Whether recovery strategies and measures have been implemented as planned.
- Whether specific strategies and measures have significantly reduced the corresponding threats.
- Whether fish and habitat conditions improved as a result of recovery actions.

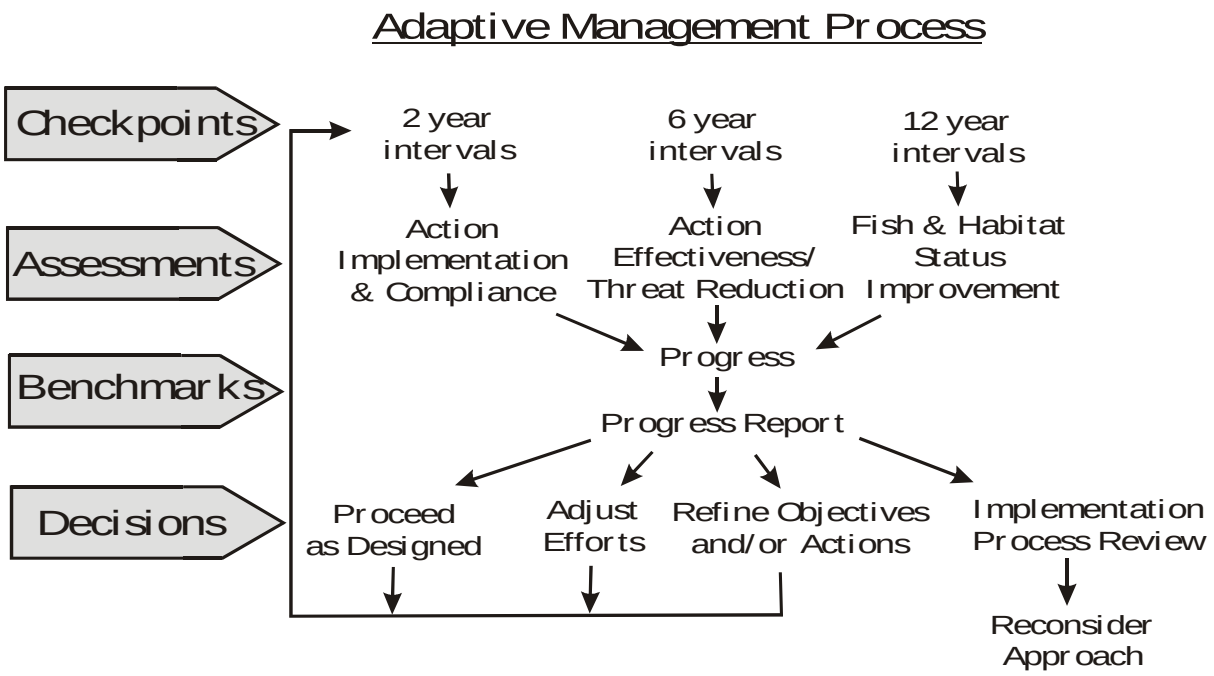


Figure 28. Elements and decision structure for adaptive management process for implementation of the Washington Lower Columbia River Salmon Recovery Plan.

Public Education and Outreach

Education refers to the development or promotion of general knowledge or training. Outreach refers to directed educational and involvement efforts directed toward specific constituencies and intended to focus on specific problems or actions.

It is a goal of public education and outreach to engage the public as an active partner in implementing and sustaining recovery efforts. A regional education and outreach program will be established to support, assist and coordinate with similar education and outreach efforts by individual implementing partners.

Evaluating Plan Sufficiency

Evaluation of the sufficiency of this Plan is based on: 1) substantive strategies, measures, and actions that address all current threats to the viability and harvestability of Washington lower Columbia salmon and steelhead populations, 2) incorporation of effective monitoring, evaluation, and adaptive management measures and actions as well as an institutional framework for Plan implementation, and 3) assessments confirming that reductions in threats are of an order of magnitude consistent with recovery.

Threats to viability and harvestability include all categories of human activities that impact fish numbers, adaptive population characteristics, and habitats. This Plan has cataloged threats at length and related them to fish limiting factors. Impacts of key factors in each threat category were quantified based on the best available information and were related to improvement increments needed to achieve biological objectives.

Monitoring, evaluation, and adaptive management components of the Plan consider whether actions were implemented as designed, whether actions produce the expected effect, and if the net effects of multiple actions produce the desired improvement in fish populations. Quantitative estimates of the impacts of key threat factors and expected responses projected from fish life cycle and habitat models provide testable hypotheses for the monitoring, evaluation, and adaptive management efforts.

The immediate test of Plan sufficiency is whether current working hypotheses, strategies, measures, and actions provide a plausible scientific basis for reversing declining fish trends and provide a significant trajectory toward recovery. Existing information and tools are adequate to evaluate whether proposed actions are of an order of magnitude to significantly reduce threats to the level where a response in fish populations can feasibly be measured and a trajectory for recovery can be detected. These assessments will be completed as part of the Plan development and implementation process.

Responsibilities and Schedule

All actions identified in this Plan were deemed to be significant for recovery, hence can be considered a high priority. Some actions warrant more immediate implementation because of the acute nature of the problem they address and the availability of necessary infrastructure and resources.

Actions are organized by the entity that would be involved in implementation. Because multiple entities are involved in the implementation of certain actions, some actions are listed under more than one entity. In some cases, no single entity has full authority to implement an action, and successful implementation will depend on the coordination and cooperation of a number of agencies. In other cases, while one entity may have lead authority and implementation responsibility, effective implementation will depend on the involvement, support, and agreement of a number of agencies. In the process of developing implementation schedules, lead entities may be identified for an action involving two or more partners.

Costs

Strategies, measures and actions in this Plan have been designed and selected based on their anticipated contribution to recovery goals. They are heavily based on biological and technical factors, although consideration was also given social, cultural, and general economic factors. Additional consideration of cost and economic factors will play an important function in developing specific implementation mechanisms and actions that are both scientifically sound and politically and fiscally feasible.

The ESA directs that recovery plans incorporate to the maximum extent practical "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" [Sec. 4(f)(1)(B)(iii)]. This chapter provides estimates costs of actions undertaken solely to address recovery of listed species. This does not include costs for actions or programs that may be critical to recovery efforts but are mandated or required by statutes, laws, regulations, or policy directives other than the ESA. ESA section 7 consultation costs are not included. Costs of actions that would have been implemented regardless of whether species were listed are considered "baseline" costs. Indirect costs are not included but Appendix D provides a broader discussion of the economic context of fish recovery.

Costs of implementing actions to address each threat category (stream habitat, dams, fisheries, hatcheries, ecological factors) are discussed in this chapter. Costs for recovery implementation coordination and administration and for monitoring, evaluation, and reporting per Recovery Plan Chapter 9 are also discussed.

Stream Habitat. Recovery-driven stream habitat costs include stream habitat protection and restoration projects developed to provide multi-species benefits in high value stream reaches based on fish production potential and fish population priorities for recovery. Stream habitat project costs are based on cost per mile for projects identified in on-the-ground watershed assessments of selected subbasins. The total estimated cost of stream habitat preservation and restoration projects is $548 million, including project implementation and long term costs related to maintenance and replacement.

Dedicated habitat projects have been identified that will be needed to supplement overall habitat restoration efforts. These projects include targeted chum salmon spawning habitat restoration projects needed to augment multi-species habitat project efforts, and off-channel habitat restoration efforts targeting fall Chinook rearing areas in close proximity to the river mouths along the Columbia River. Assuming one project for each of the Primary chum and fall Chinook populations, costs of these projects are estimated to be $60 million.

Recovery of stream habitat also depends on the effective implementation of a suite of land and natural resource management and regulatory measures. Since these measures are mandated under laws, statutes, regulations, or policy directives other than the ESA, their costs are considered baseline costs and are not included in this Plan. In addition, water resource actions affecting stream flow and surface water are considered baseline costs addressed in the WRIA 25/26 and 27/28 Watershed Management Plans . Watershed actions affecting stream habitat forming processes such as the Clean Water Act, DNR or Forest and Fish Habitat Conservations Plans are also considered baseline costs.

Estuary & Columbia Mainstem Habitat. These costs are identified in the Columbia River Estuary Salmon and Steelhead Recovery Module prepared by NMFS.

Hydro. The costs associated with hydropower operations on the Columbia mainstem and tributaries are not identified in this Plan because they are effectively treated elsewhere. For the Columbia River

mainstem, hydropower costs are addressed in the Federal Columbia River Power System Biological Opinion and regional hydro module prepared by NMFS. These would include baseline costs under current operations and additional costs identified in Reasonable and Prudent Alternatives specified by the FCRPS Biological Opinion. Tributary hydropower operation costs supporting recovery are identified through FERC licensing requirements and associated agreements.

Fisheries. Recovery-driven fishery costs are limited to specific actions needed to reduce interim fishery impacts on listed populations to benchmark levels and that are outside of base fishery management programs. These include development of alternative fishing methods for selective harvest of hatchery fish. Costs will be estimated by WDFW. Hatchery fish marking costs to support selective fisheries are baseline costs that are not included. Indirect costs including those of foregone harvest opportunity for the protection of listed fish are not included, although potentially significant.

Hatcheries. Hatchery costs related to recovery include costs associated with reducing hatchery fish on spawning grounds, reducing competition and other adverse interactions among hatchery and natural origin fish, and supporting supplementation and reintroduction efforts consistent with population recovery goals. Routine hatchery operations and maintenance and associated capital improvement costs are not included. These costs estimates will be provided by WDFW based on recent Conservation and Sustainable Fishery Plans.

Monitoring & Research. Monitoring needs identified in this Plan will be met largely through a combination of currently ongoing monitoring efforts by federal and state agencies, local governments and research organizations. The costs associated with these ongoing programs are considered baseline costs. The cost of monitoring efforts to fill gaps in existing programs in order to fully meet the needs identified in this Plan will be recovery costs. Since monitoring programs for recovery are currently in the early stages of development, it is not possible to estimate their cost at this time.

Implementation. These include costs associated with coordination, direction and tracking of implementation efforts, periodic assessments of implementation and recovery progress, adaptive management and maintenance of the Recovery Plan. Over a 25 year period, these costs are estimated to be over $11 million.

Total direct costs of recovery actions identified in this chapter are estimated to be 1.23 billion dollars over the next 25 years. This would be a conservative estimate of direct costs that does not include hydro or monitoring and evaluation costs. Nor does this estimate reflect costs of baseline programs that will also be critical to recovery or indirect costs of recovery-related actions.

Table 14. Summary of estimated recovery costs by category (millions of dollars).

Action category	Estimated cost		
	Years 1-10	Years 11-25	Total
Stream habitat preservation and restoration projects	$421	$126	$548
Dedicated stream habitat projects	--	--	$36
Estuary & Columbia River mainstem habitat	--	--	$528
Dams		Not included	
Fisheries methods & management	$11.25	$15	$26.25
Hatcheries	$50.5	$24	$74.5
Monitoring & research		Not included	
Implementation Coordination & Administration	$7.35	$11.19	$18.64
Total			$1,231.39

Acknowledgments

The 2010 edition was developed by the Lower Columbia Fish Recovery Board and its consultants in consultation with NMFS, and a cooperative partnership between federal, state and local governments, tribes and concerned citizens.

2010 LOWER COLUMBIA FISH RECOVERY BOARD **Charter Members*

Taylor Aalvik	Tribal Representative	Cowlitz Indian Tribe
Blair Brady	Wahkiakum County	Commissioner
F. Lee Grose	Lewis County	Commissioner
Henry Johnson*	Wahkiakum County	Citizen
Kathleen Johnson	Cowlitz County	Commissioner
Tom Linde	Skamania County	Citizen
Irene Martin	Wahkiakum County	Citizen
Tom Martin	Hydro-Electric Representative	Tacoma Power
Jim Richardson	Skamania County	Commissioner
Steve Stuart	Clark County	Commissioner
Don Swanson	SW WA Environmental Representative	Citizen
Randy Sweet*	Cowlitz County & Private Property Interests	Citizen
Dean Takko	Legislative Representative	WA State House of Representatives
Chuck TenPas	Lewis County	Citizen
Jade Unger	Clark County	Citizen
Dennis Weber	SW WA Cities Representative	Longview City Council

2010 LOWER COLUMBIA FISH RECOVERY BOARD TECHNICAL ADVISORY COMMITTEE

Randy Sweet -Chairman	LCFRB Member
Ron Rhew -Vice Chairman	U.S. Fish and Wildlife Service
Stephanie Ehinger	National Marine Fisheries Service
Pat Frazier	WA Department of Fish and Wildlife
Jim Fisher	Citizen
Angela Haffie	WA Department of Transportation
Evan Haas	Lower Columbia River Estuary Partnership
David Hu	U.S. Forest Service-Gifford Pinchot National Forest
Kelley Jorgensen	Citizen
Steve Manlow	U.S. Army Corps of Engineers
Scott McKinney	WA Department of Ecology
Phil Miller	Governor's Salmon Recovery Office (ExOfficio)
Doug Stienbarger	WSU, Clark Extension
Shannon Wills	Cowlitz Tribe

Lower Columbia Fish Recovery Board Staff

Jeff Breckel	Executive Director
Bernadette	Salmon & Watershed
Graham Hudson	Program Manager
Melody Tereski	Program Manager
Eli Asher	Habitat Manager
Lorie Clark	Program Assistant
Marlies Wierenga	Environmental Planner

Consultant Team

Ray Beamesderfer	Cramer Fish Sciences
Gardner Johnston	Interfluve
Kathryn Arndt	Cramer Fish Sciences
Abigail Andrews	Cramer Fish Sciences
Randy Ericksen	Cramer Fish Sciences