6. SPECIES: RECOVERY STRATEGIES & BENCHMARKS

This chapter provides detailed guidance for the recovery of each species based on: 1) population-specific objectives and targets based on analysis of baseline status and potential, 2) an evaluation of the significance of threats and impacts to each species, and 3) impact reduction targets, strategies, and benchmarks for addressing threats. Where previous chapters provided broad guidance and definitions applicable to all species, this chapter details specific application of the regional recovery framework to each species. Species and population targets reflect goals, criteria and objectives described in Chapter 4 including viability objectives described in the Recovery Scenario (Section 4.4). Detailed assessments of species-specific threats and impacts follow definitions and general descriptions outlined in Chapter 3. Impact reduction targets and benchmarks are defined in Chapter 4 to address recovery goals and objectives. Species-specific strategies reflect regional strategies and measures identified in Chapter 5.

6. SPECIES: RECOVERY STRATEGIES & BENCHMARKS

Tables

Figures

6.1 Overview

While 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 species and threats at the population level. This chapter describes populations for each species and details population objectives and targets, impacts of threats, impact reduction targets, strategies, and benchmarks.

Population viability objectives collectively meet ESU/DPS viability goals described in the recovery scenario. The recovery scenario prioritizes Primary populations for restoration to high or very high levels of viability – these selected populations will be the foundation for ESU recovery which includes both Washington and Oregon populations (see section 4.4). The scenario also prioritizes additional populations for more moderate improvements in viability needed to meet ESU/DPS and strata/MPG level recovery criteria. Abundance and productivity targets describe improvements calculated to achieve viability objectives of each population. Appendix E details the derivation of abundance and productivity improvement targets based on the Population Viability Analysis modeling approach.

Threats include human activities and other dynamics that affect limiting factors. Significant categories of threats include stream habitat, estuary/mainstem habitat, dams, fisheries, hatcheries, and ecological effects. "Impacts" are defined in this Plan as proportional reductions in population productivity due to potentially-manageable threats. Impacts are the reduction in the baseline period prior to widespread listings (1998-1999) relative to the pre-development condition.

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 needed to reach biological objectives and targets. Greater net reductions in impacts are identified for factors with greater net impacts. At the same time, life cycle model analysis included in this Plan has clearly demonstrated the need and biological benefits of improvements in all threat categories. Synergistic benefits of actions affecting each stage of the salmon life cycle will produce much more substantial improvements than efforts limited to selected risk factors. Any benefits of limited improvements are eroded by the impacts of other factors.

Interim benchmarks provide reference points for planning and evaluating recovery progress over the duration of Plan implementation. Benchmarks are described for habitat, fishery, hatchery, dams, and ecological threats – direction for estuary habitat progress monitoring is referred to in the estuary module. Benchmarks are established for action implementation, action effectiveness, and related status improvements. Action implementation is based on a percentage of the actions identified in Chapter 5. Action effectiveness is based on incremental achievement of long term impact reduction targets. Status improvement is measured in terms of fish benefits due to action effectiveness. Benchmarks are based on a front-loaded incremental implementation strategy that involves a combination of actions with immediate effects to reduce near-term risk and actions with longer-term process-based effects for which benefits occur more gradually. Benchmarks were established at 12-year intervals consistent with the adaptive management process identified in Chapter 10 of the Recovery Plan.

Figure 6-1 provides an example of the definitions and and linkages of population status, objectives, targets, and benchmarks information presented in this chapter for each species. This example is for Coweeman fall Chinook. Numbers described in this example may be found in Table 6-1(baseline viability, viability objective, productivity and abundance targets), Table 6-2 (impacts by threat, impact reduction targets, impact targets), and Table 6-4 (interim benchmarks). Similar tables may also be found for each species.

This population was estimated to be at very low viability in the baseline period around the time of listing (1998-1999). Abundance and productivity parameters for this population were estimated to be consistent with a “Very Low” viability based on Population Viability Analysis (PVA) using the “PopCycle” model described in Appendix E Chapter 12. The PVA estimated a 73% risk of falling below a critical risk threshold which is greater than the risk 60% threshold for very low viability (criteria as defined in Chapter 4.2.1). Spatial structure and diversity parameters for this population were determined, based on qualitative criteria, to be consistent with “High” viability (Appendix E Chapter 1). However, net viability was categorized as “Very Low” based on the lowest of the individual attribute scores.

Coweeman fall Chinook were targeted for recovery to high to very high levels of viability based on an assessment of the biological significance and feasibility of improvement for this population (Chapter 4.4.1, Appendix E Chapter 12). A productivity improvement of approximately 80% was estimated to be required to reduce risks from the baseline 73% to the 2.5% criteria identified for “High+” viability. That is to say, adult-to-adult production would have to almost double on average to reduce risks to target levels. This productivity improvement was estimated by iteratively solving the PopCycle model for the improvement required to meet the target risk. This improvement in productivity was estimated using the model to increase median abundance of natural spawners from 100 to 900, independent of the effects of hatchery fish spawning in the wild. The 900 spawner number is identified as an abundance target for this population at the target productivity level.

As of the baseline period, Coweeman fall Chinook were subject to impacts of potentially-manageable threats on the order of 65% for fisheries, 23% for estuary habitat, 50% for freshwater habitat, 10% for predators, and 23% for hatcheries (impacts further defined in Chapter 4.5.2 and Appendix E Chapter 10). The compounded effect of all of these impacts translates into over a 90% reduction in net productivity of this population which helps explain the baseline very low viability. When impact reductions were equitably shared among impacts in proportion to their significance, it was estimated that an 18% reduction in each would achieve the 80% productivity improvement target based on a simple population model analysis (using the “AEIOU” model described in Chapter 4.5.2 and Appendix E Chapter 10). For instance, an 18% reduction in habitat impacts of 50% produces a target habitat impact of 41% (which is equivalent to an 18% improvement). Similarly, an 18% reduction in fishery impacts of 65% produces a target of 53%.

Interim benchmarks establish a schedule for achieving factor-specific impact reduction targets (Chapter 4.5.3). Benchmarks ultimately serve as criteria for monitoring and evaluation of progress in addressing each category of threat based on action implementation, action effectiveness, and resulting status improvements. For instance, freshwater habitat action implementation benchmarks identify the need for 50% of habitat measures to be implemented within the first 12-year period following the initial listing. The first 12-year period is completed in 2010. Because there is typically a lag time in realization of the benefits of habitat measures following implementation, 50% implementation of habitat actions in the initial 12-year period is targeted to achieve only a 25% improvement in habitat conditions relative to the impact reduction target for habitat. Under the front-loaded incremental recovery strategy (Chapter 4.5.3), benchmarks vary among factor categories with respect to implementation schedules and effects.

Additional details on freshwater habitat factors limiting each population and targeted for specific actions may be found in Volume II management plans for each subbasin. Subbasin plans also prioritize tributary stream segments across populations at the watershed scale consistent with the ecosystem approach of this plan.

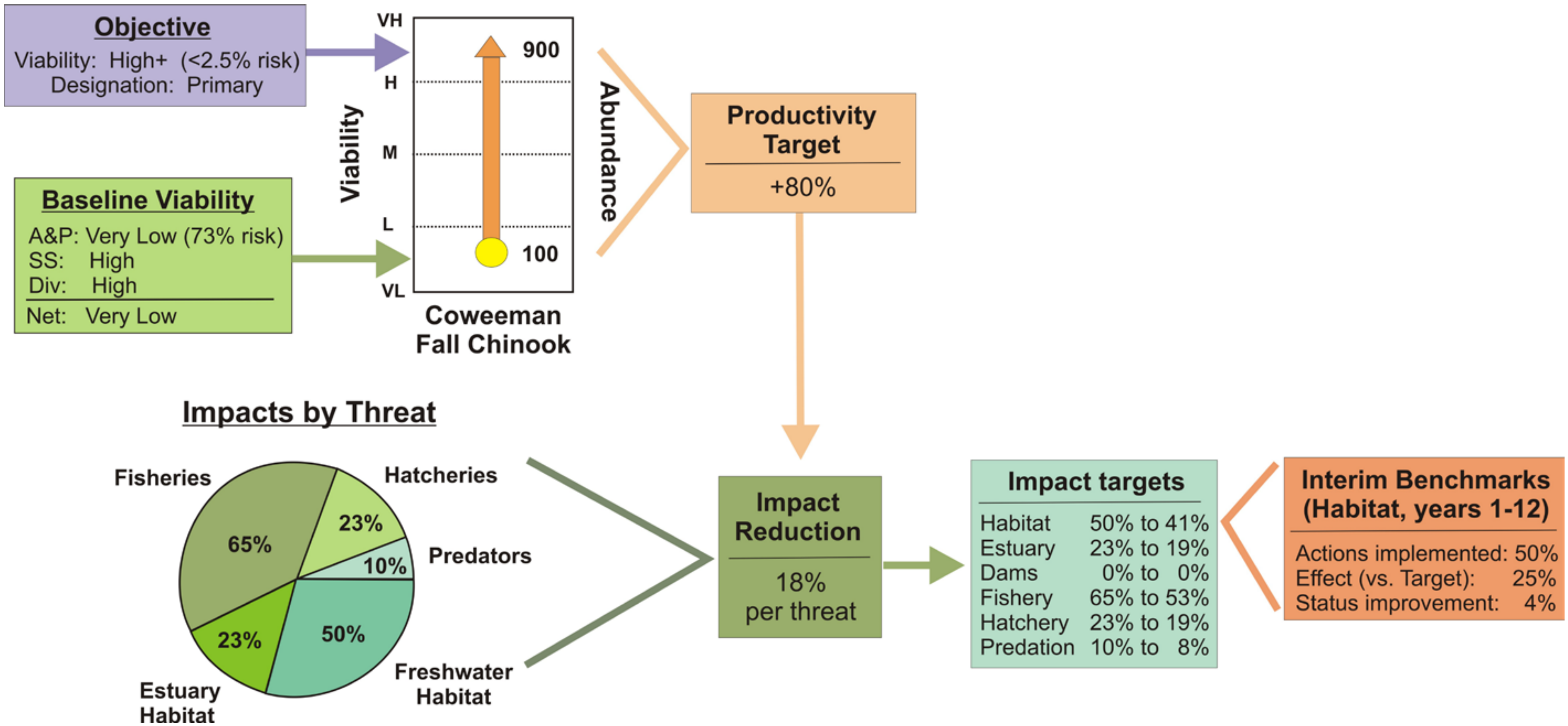


Figure 6-1. Example of population status, objectives, targets, and benchmarks information included for each species in this recovery plan.

6.2 Chinook Salmon

6.2.1 Population Descriptions

Spring Chinook

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 6-1). Very high extinction 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.

Upper Cowlitz Spring Chinook: Historically, all Cowlitz spring Chinook spawned in the upper basin, particularly in the mainstem Cowlitz above Packwood and in the Cispus River. Completion of Mayfield Dam (RM 52) blocked upstream migration in 1962. Spring Chinook adults were passed over the dam from 1962-66 and hauled to the Tilton and upper Cowlitz Rivers from 1974-80. Currently, natural spawning returns are part of an upper Cowlitz and Cispus River reintroduction program. Since 1994, adults have been trapped below Mayfield Dam and hauled above Cowlitz Falls Dam to the upper Cowlitz River. Spawning now primarily occurs in the Cowlitz mainstem above Packwood. Juveniles are captured at the Cowlitz Falls collection facility, acclimated at Cowlitz Salmon Hatchery and released into the lower Cowlitz. Hatchery releases of spring Chinook in the Cowlitz began in the 1940s. The Cowlitz River Hatchery releases Cowlitz origin hatchery produced spring Chinook into the upper and lower Cowlitz each year. Natural spawning in the Cowlitz River below Mayfield Dam is concentrated in the mainstem between the Cowlitz Salmon and Trout Hatcheries (~8 miles). To date, juvenile spring Chinook have been the most difficult of the three species to collect at Cowlitz Falls Dam. Despite these activities, to realize full potential of habitat, adequate passage through the Cowlitz hydro systems must be achieved.

Cispus Spring Chinook: Historically, spring Chinook spawned in the Cispus River between Iron and East Canyon Creeks. Completion of Mayfield Dam (RM 52) in 1962 blocked upstream migration to the upper Cowlitz, including the Cispus River. Currently, natural spawning returns are part of an upper Cowlitz and Cispus River reintroduction program. Since 1994, adults have been trapped below Mayfield Dam and hauled above Cowlitz Falls Dam to the Cispus River. Juveniles are captured at the Cowlitz Falls collection facility, acclimated at Cowlitz Salmon Hatchery and released into the lower Cowlitz. To date, collection of naturally produced spring Chinook juveniles at Cowlitz Falls Dam has been the most difficult of the three species reintroduced into the upper Cowlitz basin. Despite these activities, to realize full potential of habitat, adequate passage through the Cowlitz hydro systems must be achieved.

Tilton Spring Chinook: Historically, spring Chinook were thought to have spawned in the Tilton River but this has not been confirmed and spawning distribution is unknown. Completion of Mayfield Dam (RM 52) blocked upstream migration in 1962. Spring Chinook adults were passed over the dam from 1962-66 and hauled to the Tilton and upper Cowlitz Rivers from 1974-80. Currently, natural spawning returns above Mayfield Dam are part of an upper Cowlitz and Cispus River reintroduction program. Since 1994, adults have been trapped below Mayfield Dam and hauled above Cowlitz Falls Dam to the upper Cowlitz and Cispus Rivers. Spawning in the Tilton River, if it occurs with the reintroduction program, has not been well documented.

Table 6-1. Baseline viability status, viability and abundance objectives, and productivity improvement targets for lower Columbia River Chinook populations. (See Box 6-1 for explanation of values.)

		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]	H	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	--
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[4]	--[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.
[C] Designated as a historical core population by the Technical Recovery Team.
[G] Designated as a historical legacy population by the Technical Recovery Team.

Box 6-1. Explanation of population status and objective values.

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 (TRT) 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% = baseline 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.

Toutle Spring Chinook: It is unclear whether spring Chinook were native to the Toutle River. The basin is large enough geographically to have sustained a spring Chinook run, but it may have lacked the persistent cold-water sources that normally distinguish spring Chinook spawning habitat. Hatchery releases of spring Chinook began in the Cowlitz Basin (which includes the Toutle River) in the 1940s. In 1951 an estimated 400 spring Chinook were spawning in the upper Toutle River. The Cowlitz Salmon and Trout Hatcheries have released spring Chinook smolts into the Toutle River in recent years. The mainstem and NF Toutle are still recovering from the effects of the Mt. St. Helens eruption, but there may be some potential for spring Chinook production in the SF Toutle and NF Toutle tributaries.

Kalama Spring Chinook: Reports of considerable historical numbers of spring Chinook in the Kalama have not been verified. By the 1950s, only remnant (<100) spring Chinook runs existed in the Kalama. Natural spawning is concentrated in the mainstem Kalama between the Kalama Falls (RM 10.5) and Fallert Creek (Lower Kalama) hatcheries (RM 4.8). Excess hatchery spring Chinook are passed above Lower Kalama Falls and spawners have been observed upstream as far as upper Kalama Falls (RM 36.8). Hatchery releases of spring Chinook in the Kalama began in the 1960s. Hatchery brood stock has been mostly native Kalama stocks although some Cowlitz stock transfers have occurred. Currently, spring Chinook are released at Fallert Creek Hatchery and some are also reared at Gobar Pond (~4 miles up Gobar Creek).

North Fork Lewis Spring Chinook: Historical spring Chinook spawning was almost entirely in the upper Lewis Basin which was blocked by Merwin Dam in 1931. Currently, natural spawning occurs in the North Fork mainstem Lewis River between Merwin Dam and the Lewis River Hatchery (~4 miles). However, natural production of spring Chinook in the lower North Fork is not significant and the available habitat cannot support a viable demographically-independent population without the benefit of upper basin production areas. Measures included in the FERC relicensing settlement agreement for Lewis River hydroelectric projects call for the taking of steps to achieve a genetically viable, self-sustaining, naturally reproducing, harvestable spring chinook population above Merwin Dam. However, adequate passage through the Lewis hydro system must be achieved to realize habitat potential. The majority of upper

Lewis spawning habitat is above Swift Reservoir in the mainstem North Fork Lewis, the Muddy River, Clearwater Creek, and Clear Creek. Spring Chinook eggs were collected for hatchery production beginning in 1926 and the Lewis River Salmon Hatchery located about RM 15 was completed in 1930. The hatchery has reared eggs from outside sources, primarily from the Cowlitz, but a few years in the 1970s there were fish transferred from Klickitat and Carson hatcheries.

White Salmon Spring Chinook: The native population of spring Chinook salmon was extirpated when Condit Dam blocked upstream fish migration following construction at RM 3 in 1913. Condit Dam is currently scheduled for removal in 2010 which is expected to restore access to 14 miles of Chinook salmon habitat. Reintroduction would require use of an outside stock. The nearest similar source stock may be from the Klickitat, which is outside the lower Columbia ESU. Several decades would likely be required to restore a locally-adapted natural population from an out-of-basin stock. The majority of lower Columbia River spring Chinook populations occur in whole or in part in Washington streams (7 of 9 or 78%). The recovery scenario identifies significant contributions from both Washington and Oregon populations in order to meet ESU-wide recovery criteria.

Fall Chinook

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 6-1). 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 the upper Cowlitz and White Salmon rivers where dams block access).

Grays/Chinook Fall Chinook: The historical Grays River fall Chinook population was likely average in abundance for coastal tule fall Chinook populations. Fall Chinook spawn in the West Fork below the Grays River Salmon Hatchery (RM 1.4) and in the mainstem Grays River from the area of tidal influence to above the confluence of the West Fork (RM 8-14). A native fall Chinook population existed in the Grays River prior to the construction of the Grays River Hatchery located at about RM 2 on the West Fork that operated from 1961-1997. The hatchery fall Chinook program in the basin has been eliminated but, until recently, significant portions of the spawning population were hatchery strays from outside the Grays subbasin. Recent genetic data indicates that the native wild stock has been largely diluted by stray hatchery-reared Rogue River bright fall Chinook from the lower Columbia River terminal fishery program. Baseline returns of naturally produced fall Chinook are among the lowest in the ESU.

Elochoman/Skamokawa Fall Chinook: The Elochoman River likely contained the most significant historical coastal fall Chinook population and baseline habitat conditions are generally better than many other watersheds. This population was designated as a core population by the TRT. Fall Chinook spawn in the lower Elochoman above tidewater (RM 4 to the Elochoman Hatchery at RM 9). In Skamokawa Creek, spawning occurs from Wilson Creek upstream to Standard and McDonald creeks (4.5 miles). The vast majority of adults return to the Elochoman River and most of the natural spawning consists of hatchery-origin fish. Fall Chinook were native to the Elochoman River while the Skamokawa Chinook population likely originated from naturally spawning hatchery strays. The Elochoman Hatchery released juvenile fall Chinook into the Elochoman River until 2008 when the program was terminated; there are no hatchery fish released into Skamokawa Creek. A weir operation at tidewater in the Elochoman provides the opportunity to distinguish marked hatchery fish and to implement an integrated hatchery and wild program.

Mill/Abernathy/Germany Fall Chinook: Fall Chinook spawn naturally in Mill Creek from the Mill Creek Bridge downstream to the mouth (2 miles); in Abernathy Creek from the Abernathy Fish Technology Center to the mouth (3 miles); and in Germany Creek from the mouth to 3.5 miles upstream. These tributaries are not thought to have supported large historical populations of fall Chinook. Natural spawning returns have been highly influenced by the release of Spring Creek Hatchery stock released at the Abernathy Fish Technology Center which was discontinued in 1995. Life history and run timing currently resemble Spring Creek hatchery stock more than lower Columbia fall Chinook.

Lower Cowlitz Fall Chinook: This was likely the most significant historical fall Chinook population in the lower Columbia and has been designated as a core population by the TRT. Fall Chinook currently spawn in the mainstem Cowlitz River between the Kelso Bridge and the Cowlitz River Salmon Hatchery (~45 miles). Spawning is concentrated in the area between the Cowlitz Trout Hatchery and Cowlitz Salmon Hatchery (RM 41 - 52). There is a large hatchery program but few out of basin hatchery transfers have occurred. Hatchery releases of fall Chinook in the Cowlitz River began in 1952 and the Cowlitz River Salmon Hatchery located about 2 miles below Mayfield Dam currently releases Cowlitz native stock fall Chinook. Hatchery production currently accounts for most of the fall Chinook returning to the river. The hatchery and natural spawners are similar, although the natural population has consistent annual contributions from stray Lewis River wild spawners.

Upper Cowlitz Fall Chinook: Historically, Cowlitz River fall Chinook were distributed from the mouth to upper tributaries such as the Ohanapecosh and Tilton Rivers and throughout the upper basin. Completion of the Mayfield Dam in 1962 blocked access above the dam (RM 52). All fish were passed over the dam from 1962-66 and from 1967-80 small numbers of fall Chinook were hauled to the Tilton and upper Cowlitz. Fall Chinook are not currently being hauled to the upper Cowlitz to avoid conflict with spring Chinook reintroduction efforts.

Toutle Fall Chinook: This was historically a large fall Chinook population and has been designated as a core population by the TRT. Prior to the eruption of Mt. St. Helens in 1980, most fall Chinook spawned in the lower 5 miles of the mainstem Toutle and in the lower NF Toutle, but also spawned as far upstream as Coldwater Creek on the NF Toutle River (46 mi from the river mouth). The eruption devastated much of the spawning area in the mainstem and NF Toutle. Current spawning primarily occurs in the lower Green below the North Toutle Hatchery (~0.6 mi), and in the lower SF Toutle from the 4700 Bridge to the confluence with the mainstem Toutle River (~2.6 mi). Hatchery releases of fall Chinook have occurred in the Toutle River basin since 1951. The North Toutle Hatchery (formerly called the Green River Hatchery) located on the lower Green River near the confluence with the NF Toutle River was destroyed in the 1980 eruption of Mt. St. Helens. Rearing ponds near the original hatchery site were developed after the eruption and began operation in 1985. The North Toutle Hatchery was rebuilt in 1990 and continues to produce fall Chinook salmon.

Coweeman Fall Chinook: This population is one of two tule populations without a history of significant hatchery influence and is considered a genetic legacy population. Fall Chinook spawn in the mainstem Coweeman, primarily from Mulholland Creek to the Jeep Club Bridge (about 6 miles). This population is considered wild production with limited hatchery influence. Hatchery releases of fall Chinook from Spring Creek, Washougal, and Toutle Hatcheries occurred from 1951-1979, but were discontinued in 1980. No hatchery strays have been recovered in Coweeman River natural spawning fall Chinook since 1980, indicating the population is not currently influenced by hatchery fish from outside the system. This population has historically been used as an indicator stock for the calculation of fishery impacts on lower Columbia River fall Chinook. The baseline population is small; at about 300-900 adult spawners per year.

Kalama Fall Chinook: Spawning primarily occurs in the mainstem between Kalama Falls Hatchery and the I-5 Bridge (11 miles). Lower Kalama Falls (RM 10.5) is a natural barrier to upstream migration. Hatchery releases of fall Chinook in the Kalama began in 1895 with the completion of the Lower Kalama (Fallert Creek) Hatchery (RM 4.8) (one of the oldest hatcheries in the Columbia basin). The hatchery program has maintained a local stock with negligible outside basin influence.

North Fork Lewis Late Fall Chinook: This is the healthiest fall Chinook population in the lower Columbia basin and one of only two late fall bright populations. Spawning occurs primarily between Merwin Dam and the Lewis River Salmon Hatchery (~4 miles). Construction of Merwin Dam eliminated approximately half of the fall Chinook spawning habitat in the North Fork, which historically extended up to the Yale Dam site. A fall Chinook hatchery program started in 1932 at the Lewis River Salmon Hatchery with fish trapped at Merwin Dam collection facility (RM 19). In addition, the Speelyai Hatchery (completed in 1958) is located on Speelyai Bay in Lake Merwin and the Merwin Hatchery (completed in 1983) is located about RM 19. Hatchery releases of fall Chinook were discontinued in 1986 to eliminate interactions with the highly viable wild population. There is currently no direct hatchery fall Chinook program influence and the FERC license includes flow enhancement and hatchery safeguards.

Lewis Fall Chinook: Tule fall Chinook occur in both the lower North Fork Lewis and the East Fork Lewis but the east fork supports most of the production. The EF Lewis holds one of only two fall Chinook populations without a history of significant hatchery influence and is considered a genetic legacy population although baseline numbers are relatively small. Spawning occurs primarily in the East Fork Lewis from Lewisville Park downstream to Daybreak Feeders (~6 miles). Hatchery fall Chinook have never been released into the East Fork. Production of tule fall Chinook from the North Fork is limited, in part due to the large late run fall Chinook population in the mainstem. A significant portion of the current tule production potential in the North Fork comes from Cedar Creek. However, the habitat potential is not sufficient to support a viable demographically independent population.

Salmon Creek Fall Chinook: Fall Chinook historically spawned in the lower 5 miles of Salmon Creek and the lowest reach of Burnt Bridge Creek. Numbers were thought to be small, probably 100 – 400 fish. Hatchery produced fall Chinook have not been released into the Salmon Creek drainage. Historical habitats for fall Chinook in the urban lower reaches of this stream are highly degraded.

Washougal Fall Chinook: This was a large tule fall Chinook population historically and current combined hatchery and wild returns are large. Natural spawning occurs in the mainstem Washougal primarily between Salmon Falls Bridge (RM 15) and the fish and wildlife access area (~4 miles). A ladder was constructed at Salmon Falls in the late 1950s, providing fish access up to Dougan Falls (RM 21.6). Spawning upstream of Salmon Falls can be significant in years with early fall rain. Hatchery releases of fall Chinook in the Washougal basin began in the 1950s and numerous lower Columbia broodstock sources were used. The Washougal Hatchery, completed in 1958 at RM 16.0, currently releases significant numbers of fall Chinook. No outside basin stocks have been used in recent years.

Lower Gorge Fall Chinook: The lower Gorge subbasin includes small Oregon and Washington streams between the Washougal River and Bonneville Dam. On the Washington side, these include Hamilton, Hardy, and Duncan Creeks. Fall Chinook historically spawned in the lower reaches of these small streams and in the Columbia River mainstem. Spawning currently occurs in the Columbia River mainstem from the upper end of Pierce Island to the lower end of Ives Island, along the Washington shore in Hamilton Slough between the mouths of Duncan and Hardy Creeks, and in the lower reaches of Hardy and Hamilton Creeks. Available spawning habitat depends on the spill regime at Bonneville Dam, as low flows in the early fall may not provide adequate access for fall Chinook spawning in small tributaries and in the mainstem Columbia. There is some potential for competition in the mainstem Columbia with a colonizing population of later-spawning upriver bright fall Chinook. The Spring Creek National Fish Hatchery near the White Salmon River released fall Chinook into Hamilton Creek in 1977.

Upper Gorge Fall Chinook: This is a shared population with Oregon but most of the habitat exists in Washington. Historically, fall Chinook were limited to the lower reaches of the Wind River, Little Wind River, and Little White Salmon River. Completion of Bonneville Dam (1938) inundated primary fall Chinook spawning areas in these rivers. A ladder was constructed in the Wind River at Shipherd Falls

(RM 2) in 1956, providing fish access to the upper basin. Fall Chinook have been observed up to the Carson NFH (RM 18), but the majority of spawning occurs in the lower two miles of the mainstem. Spawning may also occur in the Little Wind River (RM 1) and in the Little White Salmon River in a ¼ mile stretch of river downstream from the Little White Salmon Hatchery and upstream of Drano Lake. A state operated salmon hatchery near the mouth of the Wind River produced Wind River fall Chinook salmon from 1899 until 1938 when the hatchery was flooded by Bonneville Dam Reservoir. The Carson National Fish Hatchery (NFH), at Tyee Springs (RM 18) released Spring Creek NFH fall Chinook into the Wind River until 1976. The Little White Salmon (RM 1) and the Willard National Fish Hatcheries (RM 5) are located in the Little White Salmon Basin. Spring Creek Hatchery fall Chinook consistently stray into the Wind River. This historical significance upper gorge fall Chinook as a demographically-independent population is uncertain. Tributary spawning habitats for fall Chinook are limited although significant numbers of mainstem spawners may have occurred. Prospect for significant improvements of this population under current conditons are highly uncertain due to inundation of potential mainstem spawning areas by Bonneville Reservoir. This plan recognizes that uncertainty by targeting other ESU populations for compensating higher levels of recovery.

White Salmon Fall Chinook: The historical fall Chinook population in the White Salmon was significant. The construction of Condit Dam (RM 3) in 1913 blocked access to most of the historical spawning habitat. Condit Dam has been decommissioned and is scheduled to be removed in 2010. Removal of the dam is expected to restore access to 14 miles of Chinook salmon habitat. Fall Chinook from the White Salmon River were used as broodstock in 1901 for the Spring Creek NFH located on the Columbia River near the mouth of the White Salmon River. The Spring Creek stock may still retain some of the historical genetic and life history characteristics.

6.2.2 Population Objectives & Targets

Spring Chinook

Five of the nine spring Chinook populations in Washington and Oregon are prioritized for improvement to high levels of viability (Figure 6-2). 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. Viability will depend on the success of reintroduction efforts into these areas. Given the difficulty in achieving effective downstream passage at these dams, there is considerable uncertainty in the prospects for recovery of lower Columbia spring Chinook in Washington. Thus, multiple populations are prioritized in the recovery scenario for aggressive recovery efforts to balance ESU risk. Oregon's Sandy River population, which is currently the strongest population in this ESU, will also be key to restoring ESU viability.

Near-term prospects for spring Chinook recovery in the Columbia River gorge are limited by the presence of only two populations and their baseline very low viability. Both Washington's White Salmon and Oregon's Hood River populations have been functionally extirpated by a combination of factors. Neither of these populations is thought to have been historically very large and productive for spring Chinook due to the low habitat suitability of these steep, cold systems. Both populations are slated for reintroduction but prospects for success are uncertain. Successful reintroduction into the White Salmon will require removal of Condit Dam which is currently in the planning stages. Successful reintroduction into both systems will require identification of a suitable source stock from adjacent subbasins. While long term objectives of this Plan might consider restoration of the White Salmon population to high levels of viability, this Plan also recognizes the inherent limitations of basin habitat and likely low initial productivity from an introduced stock by designating the White Salmon as a contributing population.

This Plan addresses uncertainty in future prospects for Gorge spring Chinook populations by prioritizing the Cascade stratum for higher levels of improvement than would otherwise be needed to meet TRT criteria in the Cascade stratum alone.

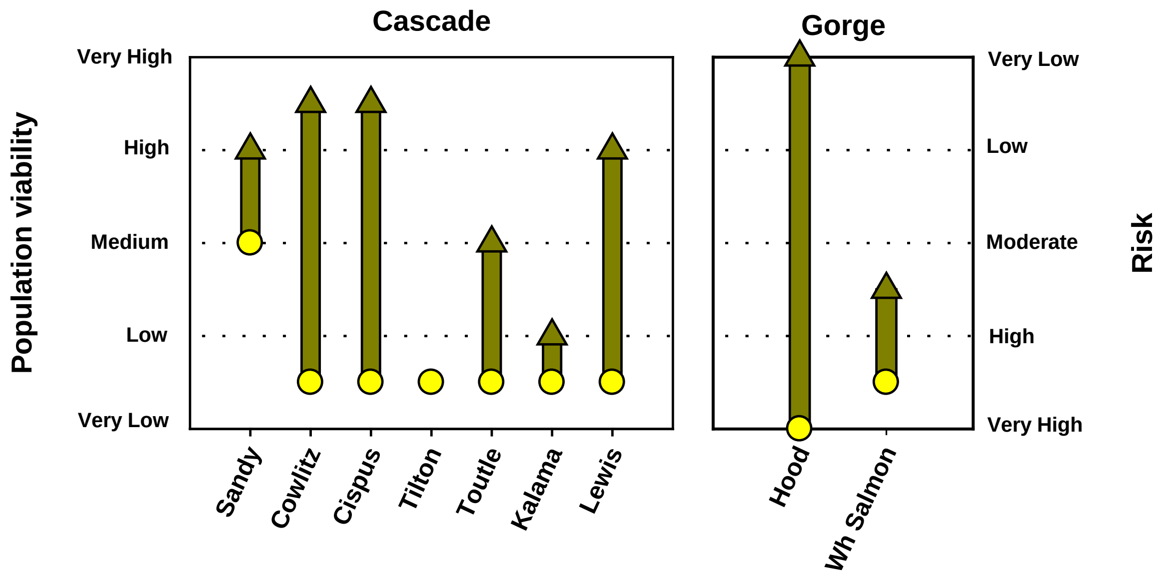


Figure 6-2. Viability objectives for spring Chinook identified in the recovery scenario for Washington and in Oregon's Recovery Plan.

Very large improvements in abundance and productivity will be required to meet viability objectives for Washington spring Chinook populations (Table 6-1). Baseline abundance and productivity of most spring Chinook populations is unknown or so low as to be essentially undefined, either because access has been eliminated to all historical habitat or because data were inadequate to quantify baseline populations' trends. As an initial planning target, population improvement targets of at least 500% were identified for all Washington populations of spring Chinook, with the exception of the Stabilizing Tilton population where no improvement was targeted.

Fall Chinook

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 (Figure 6-3). Washington populations identified for large improvements typically include the strongest existing populations (Lewis River bright), core populations with high potential for improvement based on large historical production of the available habitat (Elochoman, Toutle) and genetic legacy populations representative of critical elements of the native genetic diversity (Coweeman, Lewis). Other primary populations are included (Mill/Abernathy/Germany, Washougal) 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.

Almost all fall Chinook populations (21 of 23 or 91%) are identified for high levels of viability or significant improvements to meet ESU objectives. The scenario includes ten Contributing populations in Washington and Oregon, typically prioritized for improvement to moderate levels of viability (Figure 6-3). These improvements are needed to meet TRT criteria for strata-average viabilities exceeding medium values (2.25 or better). Contributing populations also include several areas (Lower Cowlitz, Kalama, Upper Gorge) designated for significant hatchery production to sustain fishery opportunities in the interim until natural population productivity can be restored by a combination of recovery actions including habitat improvements in the subbasin and the estuary.

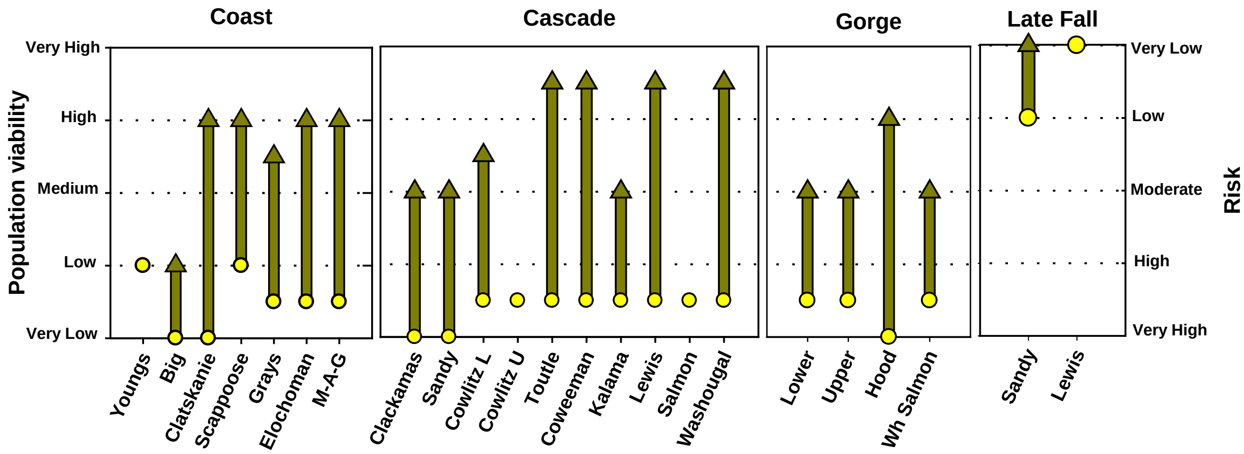


Figure 6-3. Viability objectives for fall Chinook identified in the recovery scenario for Washington and in Oregon's Recovery Plan.

The scenario meets TRT criteria of at least two populations at high or better viability and strata averages exceeding moderate (score ≥ 2.25) in all fall Chinook strata except the Gorge. Recovery prospects of Gorge fall Chinook populations to high levels are constrained by baseline low numbers, limited habitat availability, and inundation of historically productive habitats by Bonneville Dam. This Plan prioritizes additional populations in the Coast and Cascade strata for higher levels of viability in order to compensate for limited recovery prospects in the Gorge.

Some level of recovery effort will still be needed in every population in order to arrest continuing long term declining trends, even among Stabilizing populations targeted for minimal improvement. Only three fall Chinook populations are designated as Stabilizing where significant improvements in viability are not planned. In Washington's Salmon Creek population, habitat has been severely degraded by urban development, historical production was relatively small, and finite recovery resources are better focused in other areas with higher benefit-cost ratios. In Washington's upper Cowlitz River, the recovery effort has prioritized spring Chinook reintroduction upstream from Mayfield Dam based on habitat potential and more limited alternatives. In Oregon's Young's Bay, minimal improvements are identified in the Oregon Plan in order to continue to provide flexibility to implement terminal commercial fisheries designed to reduce harvest on other populations.

The majority of lower Columbia River fall Chinook populations occur in whole or in part in Washington streams (19 of 23 or 83%). The recovery scenario identifies significant contributions from both Washington and Oregon populations in order to meet ESU-wide recovery criteria. Washington is carrying a recovery "burden" for fall Chinook proportionate to the distribution of populations between Washington and Oregon and the greater habitat potential for this species in Washington.

Substantial improvements in abundance and productivity will be required to meet viability objectives for Washington fall Chinook populations (Table 6-1). Populations in the Coast and Cascade strata will require relative improvements of 15-190% to meet Primary or Contributing population objectives. Baseline abundance and productivity of Gorge fall Chinook populations is uncertain – for these populations the Plan identifies population improvement targets of at least 500% as initial planning values.

6.2.3 Threats & Impacts

Declines in status of lower Columbia River 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. Impacts of each factor are compounded across the salmon life cycle to drive most populations to baseline very low levels. Net effects of quantifiable and potentially manageable impacts translate into an estimated 75-100% (average 96%) reduction in abundance and productivity of lower Columbia Chinook populations in Washington (Figure 6-4). Thus, baseline fish numbers represent only 0-25% of the historical production potential in the absence of potentially manageable impacts and typically 2-20% of population-specific recovery objectives. Total reductions would be even greater if all human impacts could be effectively quantified.

No single factor accounts for the majority of the reduction in fish numbers and the significance of specific factors varies from population to population (Figure 6-4, Table 6-2). For example, the Grays-Chinook population of fall Chinook was reduced by an estimated 93% by combined impacts of a 40% reduction in tributary habitat conditions, a 23% reduction in estuary habitat conditions, a 65% fishery impact rate, a 50% hatchery impact rate, and a 9% predation rate. Even spring Chinook populations, severely limited by loss of access to upper Cowlitz and Lewis basin spawning and rearing areas, are significantly impacted by a variety of other factors.

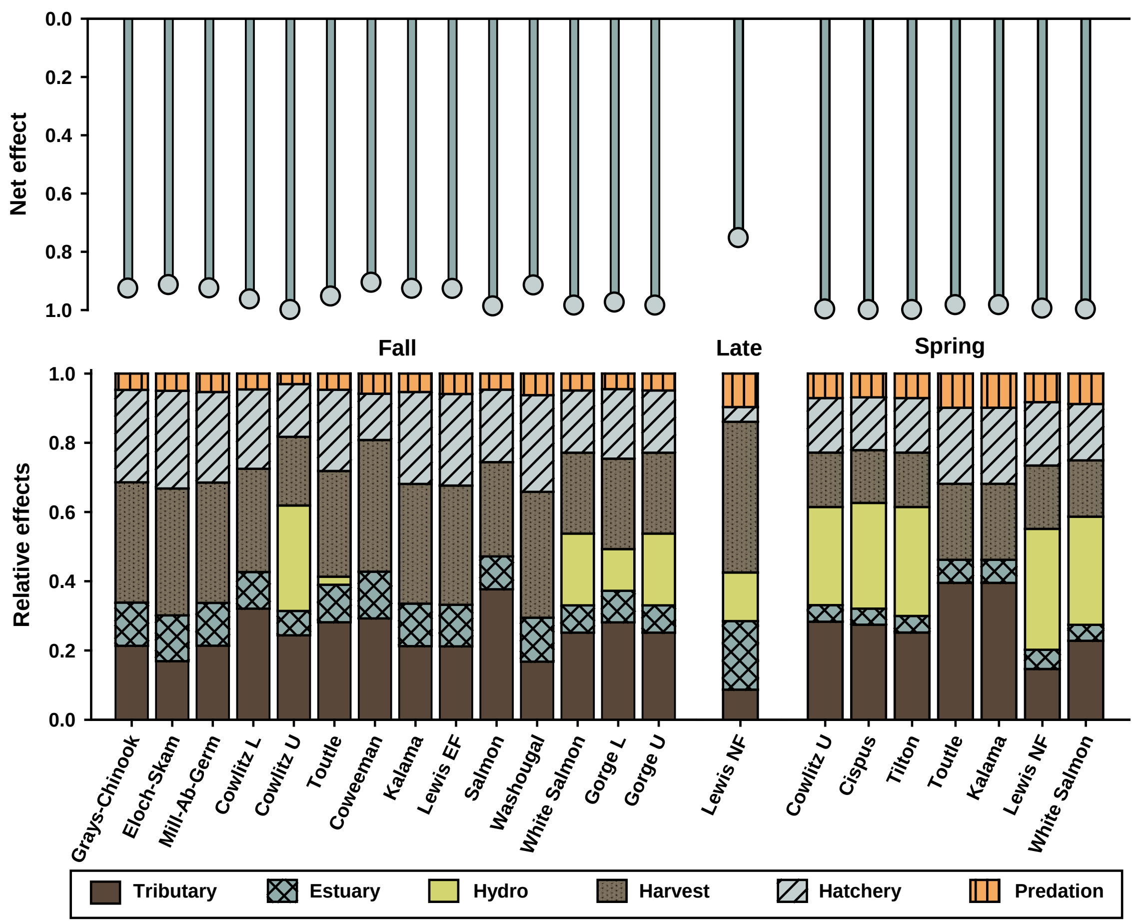


Figure 6-4. Net effect and relative contribution of potentially manageable impact factors on Chinook salmon in Washington lower Columbia River subbasins. Net effect is the approximate reduction from historical fish numbers as a result of manageable factors included in this analysis.

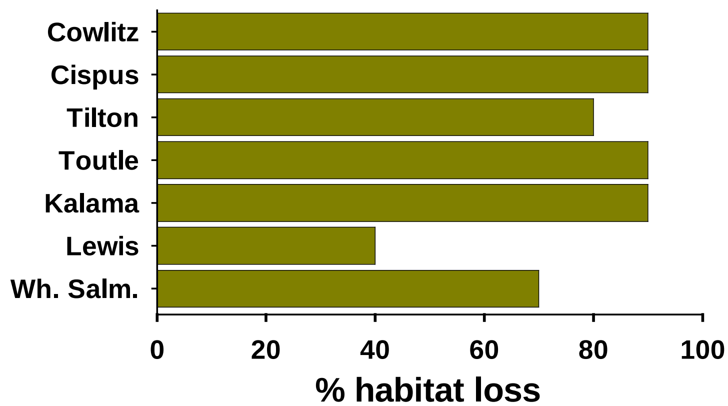
Table 6-2. Potentially manageable impacts of threats, productivity improvement targets, and impact reduction targets consistent with recovery of Washington lower Columbia River Chinook populations if reductions are distributed across factors in proportion to their baseline impact.

	Productivity	Baseline impacts (listing date reference)							Impacts at target					
Population	Target	Hab	Est	Dams	Fishery	Hat	Pred	Δ	Hab	Est	Dams	Fishery	Hat	Pred
Coast Fall														
Grays/Chinook	+500%	0.40	0.23	0.00	0.65	0.50	0.09	61%	0.16	0.09	0.00	0.26	0.20	0.03
Eloch/Skam	+150%	0.30	0.23	0.00	0.65	0.50	0.09	29%	0.21	0.17	0.00	0.46	0.35	0.06
Mill/Aber/Germ	+155%	0.40	0.23	0.00	0.65	0.49	0.10	28%	0.29	0.17	0.00	0.47	0.35	0.07
Cascade Fall														
Lower Cowlitz	+50%	0.70	0.23	0.00	0.65	0.50	0.10	8%	0.64	0.21	0.00	0.60	0.46	0.09
Upper Cowlitz	0%	0.80	0.23	1.00	0.65	0.50	0.10	0%	0.80	0.23	1.00	0.65	0.50	0.10
Toutle	+265%	0.60	0.23	0.05	0.65	0.50	0.10	32%	0.41	0.16	0.03	0.44	0.34	0.07
Coweeman	+80%	0.50	0.23	0.00	0.65	0.23	0.10	18%	0.41	0.19	0.00	0.53	0.19	0.08
Kalama	+110%	0.40	0.23	0.00	0.65	0.50	0.10	21%	0.31	0.18	0.00	0.51	0.39	0.08
Lewis EF	+280%	0.40	0.23	0.00	0.65	0.50	0.11	42%	0.23	0.13	0.00	0.38	0.29	0.06
Salmon	0%	0.90	0.23	0.00	0.65	0.50	0.11	0%	0.90	0.23	0.00	0.65	0.50	0.11
Washougal	+190%	0.30	0.23	0.00	0.65	0.50	0.11	34%	0.20	0.15	0.00	0.43	0.33	0.07
Cascade L Fall														
Lewis NF	0%	0.10	0.23	0.16	0.50	0.05	0.11	0%	0.10	0.23	0.16	0.50	0.05	0.11
Cascade Spring														
Upper Cowlitz	>500%	0.90	0.15	0.90	0.50	0.50	0.22	50%	0.45	0.08	0.45	0.25	0.25	0.11
Cispus	>500%	0.90	0.15	1.00	0.50	0.50	0.22	50%	0.45	0.08	0.50	0.25	0.25	0.11
Tilton	0%	0.80	0.15	1.00	0.50	0.50	0.22	0%	0.80	0.15	1.00	0.50	0.50	0.22
Toutle	>500%	0.90	0.15	0.00	0.50	0.50	0.22	50%	0.45	0.08	0.00	0.25	0.25	0.11
Kalama	>500%	0.90	0.15	0.00	0.50	0.50	0.22	50%	0.45	0.08	0.00	0.25	0.25	0.11
Lewis NF	>500%	0.40	0.15	0.95	0.50	0.50	0.22	50%	0.20	0.08	0.48	0.25	0.25	0.11
Gorge Fall														
L. Gorge (WA/OR)	>500%	0.70	0.23	0.30	0.65	0.50	0.11	50%	0.35	0.11	0.15	0.33	0.25	0.06
U. Gorge (WA/OR)	>500%	0.70	0.22	0.54	0.65	0.50	0.14	50%	0.35	0.11	0.27	0.33	0.25	0.07
White Salmon	>500%	0.70	0.22	0.54	0.65	0.50	0.14	50%	0.35	0.11	0.27	0.33	0.25	0.07
Gorge Spring														
White Salmon	>500%	0.70	0.14	0.96	0.50	0.50	0.27	50%	0.35	0.07	0.48	0.25	0.25	0.13

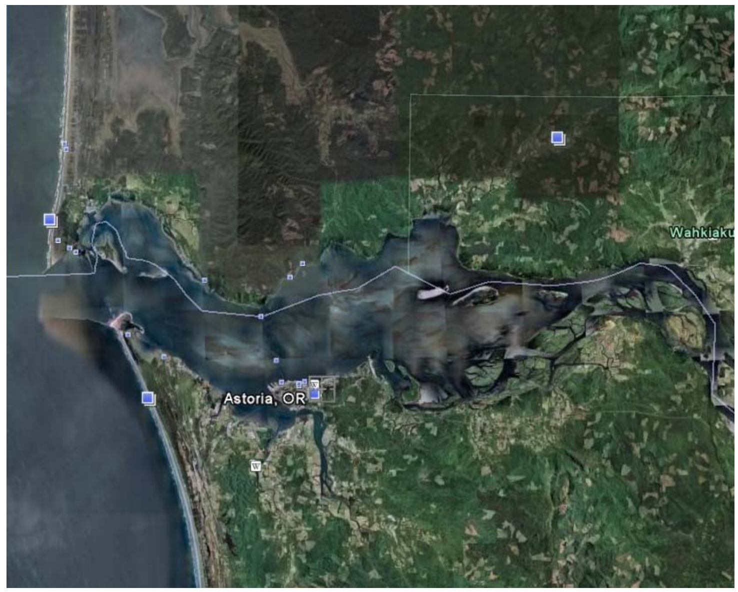
Spring Chinook

The significance of threats affecting spring Chinook salmon is summarized as follows:

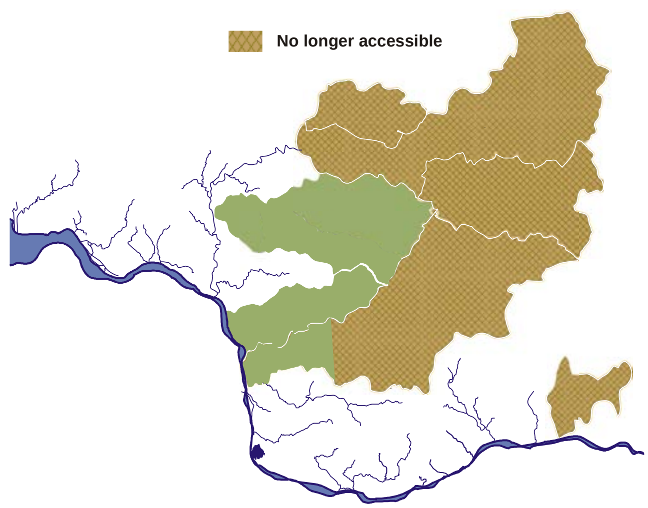
Habitat: Reductions in quantity and quality of freshwater spawning and rearing habitats account for a large share of net impact on spring Chinook. Changes in stream flow, temperature, sedimentation, and channel characteristics related to land use have reduced habitat for this species by 40-90% based on analysis of baseline and historical conditions for fish using the Ecosystem Diagnosis and Treatment model.



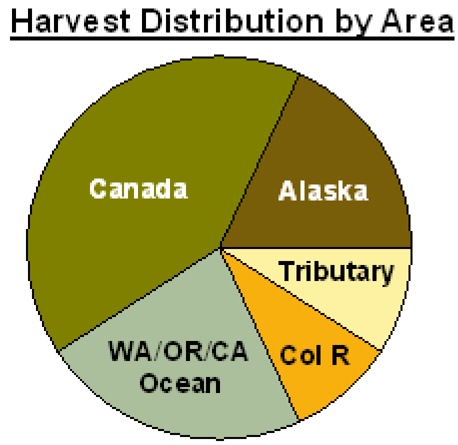
Estuary: An estimated 40% of stream-type salmon such as spring Chinook die during the critical smolt migration and saltwater acclimation periods that occur in the lower Columbia River mainstem, estuary, and plume. The human-caused portion of this total is unknown but likely significant due to large-scale changes in river discharge patterns and estuary habitats related to water use, channel maintenance, and activities. For planning purposes, strategic impact reduction targets were based on half of the non-predation related estuary mortality which is equivalent to 15% impact.



Dams: Dam construction in tributary subbasins is the single greatest impact on WA lower Columbia spring Chinook populations. Hydropower facilities, blocking anadromous fish passage, have virtually eliminated 5 of 7 WA spring Chinook populations including historical stronghold production areas of the upper Cowlitz and Lewis systems. Condit Dam has blocked upstream passage on the White Salmon River in the gorge. Gorge populations are also affected by adult and juvenile passage mortality at Bonneville Dam.



Fisheries: The majority of the current harvest occurs in the ocean with a significant proportion in Canada and Alaska. Impacts on wild fish, including harvest and incidental fishing mortality, averaged about 50% per year around the time of first listing. During the 1970s and 80s, impacts were as high as 70%. Harvest rates have been reduced to around 25% or less since listing by restrictions of ocean fisheries and implementation of mark-selective fisheries for hatchery spring Chinook in freshwater.



Hatcheries: Most spring Chinook currently returning to WA lower Columbia streams are produced in hatcheries operated to mitigate for lack of upstream passage (at tributary hydropower facilities) and habitat degradation. Recent annual hatchery releases of spring Chinook into the lower Columbia populations have averaged about 5.8 million, primarily from State and Federal programs in Washington. Analyses by the regional Hatchery Scientific Review Group estimated a 50% reduction in productivity of wild populations in Washington due to natural spawning of less-fit hatchery origin fish over decades of hatchery operation.

Hatchery Releases (@ listing)

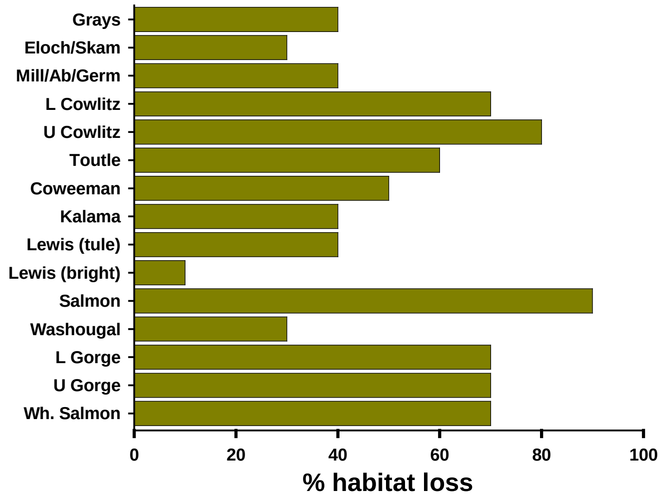
Location	Number
Deep	200,000
L. Cowlitz	1,000,000
U. Cowlitz	300,000
Kalama	500,000
Lewis	1,000,000
Lit. Wh. Salmon	1,000,000
Wind	1,400,000
WA total	**5,400,000**
OR total	**360,000**

Ecological: Impacts of ecological factors including non-native species, food web interactions, and predation are difficult to quantify. Potentially-manageable mortality due to predation by birds, marine mammals, and northern pikeminnow in the lower Columbia River mainstem and estuary has been estimated to be on the order of magnitude of 22-27% for lower Columbia spring Chinook. Sea lion predation has recently been identified as a significant concern for spring Chinook.

Fall Chinook

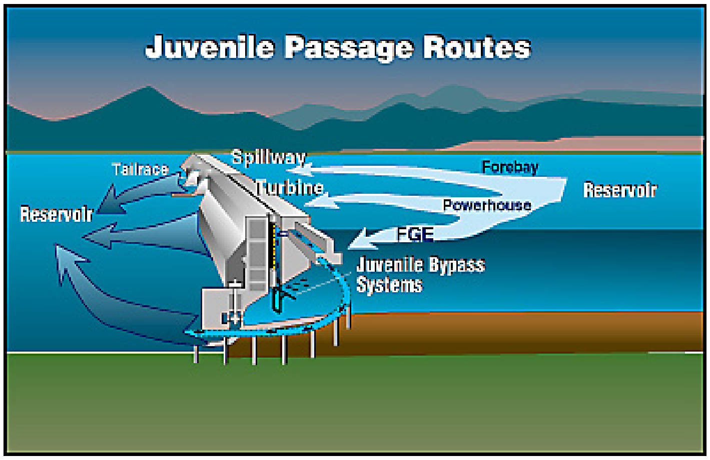
The significance of threats affecting fall Chinook salmon is summarized as follows:

Habitat: Reductions in quantity and quality of freshwater spawning and rearing habitats account for a large share of net impact on fall Chinook. Changes in stream flow, temperature, sedimentation, and channel characteristics related to land use have reduced freshwater productivity for this species by 30-90% for tule fall Chinook and 10% for bright late fall Chinook based on analysis of baseline and historical conditions for fish using the Ecosystem Diagnosis and Treatment model.

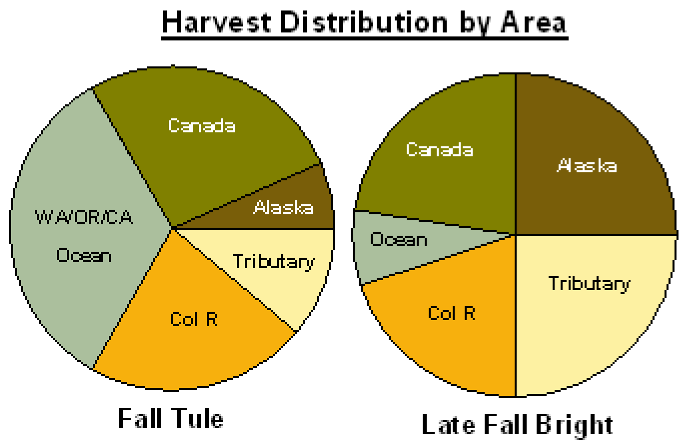


Estuary: An estimated 50% of ocean-type salmon such as fall Chinook die during the critical rearing, migration and saltwater acclimation periods that occur in the lower Columbia River mainstem, estuary, and plume. The human-caused portion of this total is unknown but likely significant due to large-scale changes in river discharge patterns and estuary habitats related to water use, channel maintenance, and activities. For planning purposes, strategic impact reduction targets were based on half of the non-predation related estuary mortality which is equivalent to a 23% impact.

Dams: Direct dam impacts vary among populations ranging from zero to 100%. Most populations spawn in the lower portions of subbasins where dam impacts mostly involve largely unquantifiable habitat process effects. Hydropower facilities have blocked passage of the upper Cowlitz population. Gorge populations have been significantly impacted by inundation of historical spawning areas and passage mortality of juveniles and adults from Bonneville Dam.



Fisheries: The majority of the current harvest occurs in the ocean with a significant proportion in Canada and Alaska (for late fall Bright). Impacts on wild fish, including harvest and incidental fishing mortality, averaged about 65% for tule fall Chinook and 50% for bright fall Chinook prior to the time of first listing. During the 1970s and 80s, impacts were as high as 80%. By 2010, harvest rates had been reduced to 38%.



Hatcheries: Most fall Chinook currently returning to WA lower Columbia streams are produced in hatcheries operated to produce fish for fisheries. Columbia River State and Federal hatcheries have recently been releasing about 46 million fall Chinook per year in the lower Columbia region. Production has been substantially reduced from peak levels during the late 1970s. Analyses by the regional Hatchery Scientific Review Group estimated a 23-50% reduction in productivity of wild tule fall Chinook populations due to natural spawning of less-fit hatchery origin fish over decades of hatchery operation. Hatchery programs for Washington late fall bright Chinook have been eliminated and historical impacts were estimated at just 5%.

Hatchery Releases (@ listing)

Location	LCR tule	UCR bright[a]
Chinook	100,000	0
Elochoman	2,000,000	0
Cowlitz	5,000,000	0
Toutle	2,500,000	0
Kalama	5,000,000	0
Washougal	4,000,000	0
Lit. Wh. Salmon	0	2,000,000
Bonneville pool	15,100,000	0
WA total	**33,700,000**	**2,000,000**
OR total	**8,500,000**	**2,000,000**
Combined	**42,200,000**	**4,000,000**

[a] *Out-of-ESU upper Columbia River stock.*

Ecological: Impacts of ecological factors including non-native species, food web interactions, and predation are difficult to quantify. Potentially-manageable mortality due to predation by birds, marine mammals, and northern pikeminnow in the lower Columbia River mainstem and estuary has been estimated to be on the order of magnitude of 9-14% for lower Columbia fall Chinook. Northern pikeminnow (right) have been found to eat significant numbers of juvenile fall Chinook during their extended mainstem residence period.

6.2.4 Impact Reduction Targets, Strategies, & Benchmarks

Spring Chinook

An estimated 50% reduction in impacts will be required to meet population improvement targets for spring Chinook (Table 6-2). Thus, impact reduction targets are half of the baseline value for each potentially manageable impact category. These impact reduction targets were established as interim planning targets until future monitoring and evaluation efforts can provide empirical estimates of the productivity and capacity of remaining wild spring Chinook habitats.

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 baseline habitat conditions. Recovery will also require significant improvements in estuary, hydro, and ecological conditions.

Habitat. Protection and restoration of significant historical production areas will be critical to the future viability of spring Chinook. While portions of these upper watersheds contain favorable habitats, large valley bottom areas that were historically very productive for spring Chinook have been degraded by development and land use. Substantial improvements are required in marginal areas of potentially-productive habitat. Without significant habitat improvements, benefits of estuary, hydro, harvest, and hatchery actions will not be realized. Effective habitat restoration actions will include a combination of site-specific projects with more immediate benefits and watershed-based actions to repair habitat forming processes that will provide more long term benefits. Effective habitat protection actions will include a combination of site-specific projects in currently-productive and potentially productive habitats identified as high priority in this Plan as well as watershed, local government, or state programmatic actions to manage resources in a manner that protects long term habitat function. While many habitat-related actions have already been undertaken, current activities do not reflect the scale of habitat improvements needed for recovery. Subasin plans included in Volume II of this Recovery Plan identify high priority stream reaches, limiting habitat conditions, and effective habitat actions for this species.

This Plan estimates a 40% to 90% decline in habitat conditions across spring Chinook populations between historical and baseline conditions (depending on the population). Long term impact reduction targets describe habitat improvements relative to the baseline conditions ranging from 0% for stabilizing populations to 450% in several populations that would need to be restored to high levels of viability to meet stratum targets specified by the Technical Recovery Team. Benchmarks target implementation of all substantive habitat actions within the first 24 years (Table 6-3). Benchmarks for habitat improvements (i.e. reduction in threat) are based on gradual incremental improvement in habitat conditions over the next 50 years reflecting the time lag in effect.

Estuary. Estuary recovery strategies have been identified for the benefit of all Columbia basin ESU's including those of the lower Columbia. Current plans in the estuary module have identified the objective of a 20% improvement in juvenile survival. For stream-type life histories such as spring Chinook, this translates into a 12% improvement (e.g. 20% of the 60% survival rate currently estimated by the estuary module). Improvements will depend on a combination of site-specific habitat improvement projects and restoration of functional habitat-forming processes which depend in part on river discharge patterns. Benchmarks are not identified in this Plan for estuary habitat – (refer to the estuary module for further guidance on estuary habitat targets and schedules).

Table 6-3. 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.

Dams. Recovery of spring Chinook will require successful reintroduction into the upper Cowlitz, Cispus, and Lewis systems. These areas are the core historical production areas for this species because habitat and watershed conditions are relatively intact, and the available habitat provides the highest potential for spring Chinook of any of the historical production areas. These upper elevation streams are likely to become even more critical due to impacts of lower elevation habitats from expected future climate trends. Successful reintroduction will depend on collection and passage of both returning adults and outmigrating smolts. High downstream passage efficiencies have historically been difficult to achieve in reservoir systems of this type but have been achieved in other systems. Requirements contained in Federal Energy Regulatory Commission relicensing agreements for the Cowlitz and Lewis subbasins are intended to address the need for successful reintroduction.

Interim benchmarks assume 50% implementation of hydro-related measures during the first 12 year period and 100% implementation by year 24 (Table 6-3). Most passage-related actions will have immediate effects but reintroduction efforts will require a longer period to reach objectives which require rebuilding of productive locally-adapted populations. Status improvements due to reintroduction will be very large but undefined relative to a starting point of zero.

Harvest. Historical high harvest rates at or above 50% are inconsistent with the sustainability of unproductive wild spring Chinook, heavily impacted by lost access to core historical spawning and rearing areas and habitat degradation in areas that remain accessible. Population Viability Analysis results reflected in Table 6-2 identify the need for fishery impact reductions to 25% in order to achieve long-term viability objectives. Interim benchmarks of 15-25% (Table 6-3) were identified to reflect the need for lower rates than 25% in some years to reduce risks of critical low escapements in years of low ocean survival and the effects of fishery restrictions within selected subbasins to protect local populations.

The recovery strategy involves a significant reduction of high historical harvest rates of naturally-produced fish through a combination of fishery impact limits and mark-selective sport and commercial fisheries in the Columbia River and tributaries. All appropriate fishery measures identitifed in the plan for spring Chinook have been implemented during the first 12 years following listing. As of 2010, these measures have effectively reduced the fishery impact rate to 25% which meets both the long term impact reduction target of 25% and the interim benchmark range of 15-25%. The majority of the remaining impact occurs in in ocean fisheries in Washington, Canada, and Alaska. Current impacts of half the historical baseline level, are projected to have effectively increased wild spawner numbers by 50% relative to what would have returned at the higher historical fishing rate.

This plan has not identified futher reductions in spring Chinook fishery impact rates below current (2010) levels of 25% except for: 1) year and area restrictions identified above to address specific annual or population concerns, and 2) any additional restrictions that might be considered at such time when significant natural populations are re-established in Washington subbasins.

Hatchery. The recovery strategy involves significant reductions in hatchery impacts on wild populations by elimination of hatchery releases and exclusion of stray hatchery fish from key natural production areas, and by integrating wild broodstock into hatchery programs in order to improve fitness. These include recommendations of the regional Hatchery Scientific Review Group (HSRG) and review of all state, tribal and federal hatchery programs. Hatchery production will continue to be used for mitigation of lost production and for support of limited fisheries in the interim until natural populations are restored to harvestable levels. Given the widespread habitat losses, most of the remaining historical diversity in Washington currently resides in the hatchery stocks. Conservation hatchery programs will be critical to initial reintroduction efforts above passage barriers.

Interim benchmarks for reductions in hatchery impacts and corresponding fish status benefits are based on gradual incremental improvements over the next 50 years (Table 6-3). Some hatchery actions are expected to produce immediate benefits, but there will be a time lag in realization of many benefits dependent on productivity improvements resulting from restoration of natural population diversity. Many hatchery actions have already been implemented and additional reforms are expected to be implemented within the next few years. Benchmark values for hatchery actions describe minimums needed to meet recovery objectives. It is anticipated that many hatchery actions will result in significantly greater and more rapid improvements in many populations. Additional action effectiveness benchmarks can be established as part of implementation planning based on the percentage of hatchery origin spawners (pHOS) in natural spawning populations and proportionate natural influence (PNI) which reflects both the numbers and quality of hatchery-origin spawners.

Ecological. Effects of ecological factors are complicated and difficult to manage. The recovery strategy involves management of predation by birds, marine mammals, and fish where predation impacts have been exacerbated by human activities. This includes redistributing nesting tern colonies in the estuary, excluding or removing sea lions from the vicinity of dam passage facilities which increase salmon vulnerability, and fisheries regulations or incentives to encourage exploitation of fish predators increased by habitat alterations. The strategy also involves preventative measures to avoid potentially disastrous impacts of exotic species invasions.

Potentially manageable ecological impacts include predation by birds, marine mammals, and pikeminnows. Interim benchmarks for reductions in predation impacts and corresponding fish status benefits are based on gradual incremental improvements over the next 50 years. Many predation-related actions have already been implemented but additional actions are also scheduled to occur. Some actions have immediate benefits (tern nesting colony translocation, marine mammal removal). Benefits of others may be realized in future years (pikeminnow population restructuring). As a result, the greatest impact reductions will be realized within the near and intermediate term. Longer term benefits will involve maintenance of target levels and smaller net impact reductions. Specific action effect monitoring benchmarks can also be established for each ecological factor. For instance, impact reductions assume a two-thirds reduction in tern predation and a 25% reduction in pikeminnow predation. Note that benefits of actions are population-specific depending on the extent of predation exposure which depends on the subbasin of origin for each population.

Fall Chinook

An estimated 8-61% reduction in impacts will be required to meet population improvement targets for Primary and Contributing populations of fall Chinook in the Coast and Cascade strata (Table 6-2). Impact reduction objectives of 50% were established as interim planning targets for Gorge populations.

The long term recovery strategy for fall Chinook 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 fall Chinook 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.

Habitat. Recovery of fall Chinook will require restoration of habitat quality in significant historical production areas throughout the region. These include lower mainstem areas of large streams and rivers favored by fall Chinook. Protection of remaining habitat functions will also be critical to avoid further degradation and provide a foundation for restoration. However with few exceptions, significant fall Chinook production will not be restored by other measures without substantial improvements in habitat conditions which are currently very poor for most fall Chinook populations. Effective habitat restoration will depend on watershed-based actions to repair habitat forming processes that determine mainstem stream habitat conditions. Process-related actions typically demand large scale and long term efforts but provide long term benefits. More limited but immediate benefits can also be provided by site-specific projects. Protection of key production areas downstream from NF Lewis and Cowlitz dams will also be critical. Subasin plans included in Volume II of this Plan identify high priority stream reaches, limiting habitat conditions, and effective habitat actions for this species. While many habitat-related actions have already been undertaken, current activities do not reflect the scale of habitat improvements needed for recovery. Without significant habitat improvements, benefits of estuary, hydro, harvest, and hatchery actions will not be realized.

Table 6-4. 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%
	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.

Benchmarks are not identified for bright fall Chinook because the Washington population is currently at target levels.

This Plan estimates a 30% to 90% decline in habitat conditions across tule fall Chinook populations between historical and baseline conditions (depending on the population). Long term impact reduction targets describe habitat improvements relative to the baseline conditions ranging from 0% for stabilizing populations to 117% in Gorge populations that would need to be restored to high levels of viability to meet stratum targets specified by the Technical Recovery Team. Benchmarks target implementation of all substantive habitat actions within the first 24 years (Table 6-4). Benchmarks for habitat improvements (i.e. reduction in threat) are based on gradual incremental improvement in habitat conditions over the next 50 years reflecting the time lag in effect.

Estuary. Estuary recovery strategies have been identified for the benefit of all Columbia basin ESU's including those of the lower Columbia. Current plans have identified the objective of a 20% improvement in juvenile survival. For ocean-type life histories such as fall Chinook, this translates into a 10% improvement (e.g. 20% of 50%). Improvements will depend on a combination of site-specific habitat improvement projects and restoration of functional habitat-forming processes which depend in part on river discharge patterns. Benchmarks are not identified in this Plan for estuary habitat – (refer to the estuary module for further guidance on estuary habitat targets and schedules).

Dams. Dam impacts due to passage mortality and habitat inundation are significant for gorge populations of lower Columbia River fall Chinook. Significant dam impacts also occur on fall Chinook in the Cowlitz and Lewis where reservoirs have inundated historical habitat and have also resulted in unquantified downstream flow and habitat effects. Because of their lower basin distribution, reintroduction of fall Chinook above subbasin dam complexes is not critical to recovery. However, effects of dam operation on critical downstream habitats are a consideration in the Cowlitz, Lewis, and Columbia mainstems. Gorge populations will also benefit from effective upstream and downstream passage measures at Bonneville Dam - beneficial to all species. Loss of spawning habitat in the upper gorge, due to inundation by Bonneville Dam, will be more effectively addressed by habitat mitigation for other lower basin populations.

Interim benchmarks assume 50% implementation of dams-related-measures during the first 12 year period and 100% implementation by year 24 (Table 6-4). Most passage-related actions will have immediate effects but reintroduction efforts will require a longer period to reach objectives which require the rebuilding of productive, locally-adapted, populations.

Fishery. Prior to listing, the harvest impact rate on fall Chinook was estimated to be 65 percent. This baseline harvest rate represented a significant threat to wild fall Chinook populations. During the first 12 years following listing (1999-2010), many fishery-related recovery actions identified in this Plan for fall Chinook were implemented. These actions have reduced harvest impacts from 65 percent to 49 percent in 2002 and to 38 percent in 2009. These reductions have been achieved through fishery impact limits designed to protect listed wild fish in freshwater and the ocean, extensive fishery reductions, intensive in-season time and area fishery regulations, refocus of commercial fisheries on hatchery fish in terminal fishery areas, Pacific Salmon Treaty revisions to reduce Canadian harvest, mass marking of hatchery fish, and implementation of mark-selective fisheries. Additional actions expected to be implemented in the near future will include mark-selective ocean and freshwater fisheries where appropriate. Increased opportunities for selective fisheries will also be afforded by increasing mark-rates of fall Chinook in returns over the next few years as previously-marked broods return.

Reductions in fishery impacts alone provide immediate improvements in spawning escapement with corresponding reductions in extinction risks. Improvements in viability associated with fishery impact reductions have been projected using the PVA model. The Figure 6-5 displays the effects of fishery impact rates on the long- term (100 year) risk of falling below critical abundance thresholds for key lower Columbia River tule Chinook populations. For instance, under a 65% fishery impact, Coweeman tules are at an estimated 73% risk of extinction which places them in the very high risk category (e.g. >60%). Reducing fishery impacts from 65% to 38% for Coweeman tules results in a significant improvement in status with the risk dropping to just 3% which places them in the low risk category (e.g. 1-5%).

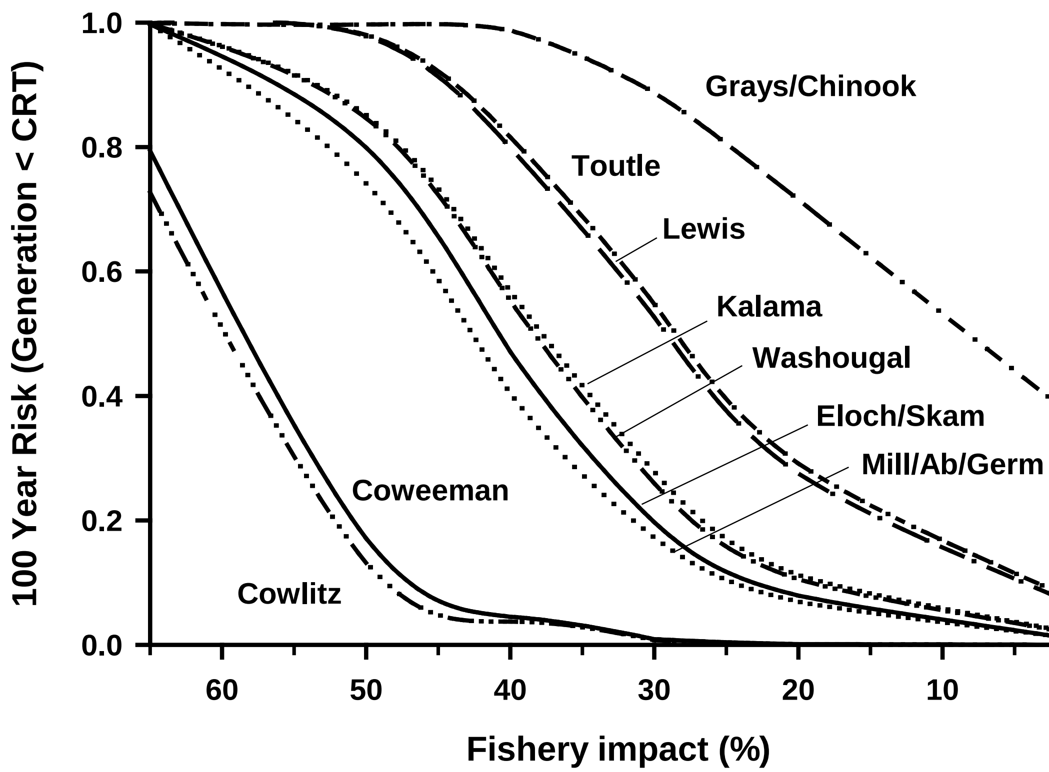


Figure 6-5. Effect of fishing on risk of falling below critical abundance threshold for lower Columbia River populations of tule fall Chinook targeted for recovery to high levels of viability (based on fishery reductions only; from Appendix E, Chapter 14).

Other tule Chinook populations also respond to fishery impact reductions but the degree of response depends on habitat productivity as demonstrated by the PopCycle modeling (Table 6-5). The stronger populations, like the Coweeman, benefit from substantially reduced long-term risk. Very weak populations, like the Grays, benefit, but not enough to substantially reduce their very high long-term risk. Unproductive populations are unable to capitalize on the benefits of increased escapement because of low spawner replacement rates and will require significant habitat improvements to realize significant benefits of fishery reductions. Most populations fall between these extremes.

Table 6-5. Long-term (100-year) population viability of fall Chinook at fishery impact rates of 65% (pre-listing baseline) and 38% (2009-2010 fisheries). Estimates are based on risks of falling below critical population size thresholds calculated by PopCycle model population viability analysis.

Population	@ 65% impact		@ 38% impact	
	Risk	Risk category	Risk	Risk category
Coast Fall				
Grays/Chinook	1.00	VH	0.97	VH
Eloch/Skam	1.00	VH	0.40	H
Mill/Aber/Germ	1.00	VH	0.35	H
Cascade Fall				
Lower Cowlitz	0.79	VH	0.03	L
Toutle	1.00	VH	0.77	VH
Coweeman	0.73	VH	0.03	L
Kalama	1.00	VH	0.50	H
Lewis	1.00	VH	0.74	VH
Salmon	1.00	VH	1.00	VH
Washougal	1.00	VH	0.49	H
Gorge Fall				
L. Gorge (WA/OR)	1.00	VH	1.00	VH
U. Gorge (WA/OR)	1.00	VH	1.00	VH
White Salmon	1.00	VH	1.00	VH

Under the equitable conservation burden sharing strategy of this plan, population-specific fishery impacts would need to be reduced to 33%-53% in order to achieve long-term viability objectives (Table 6-2). The current 38% impact rate is less than the long-term impact targets for most populations (40-50%) set forth in this plan. An exception is the severely depleted Gorge populations where long term target impact rates are 33%.

Although fishery impacts are approaching long-term targets, the Plan's front-loaded recovery strategy calls for additional near-term fishery reductions. These reductions are necessary to reduce near-term extinction risks until risk reductions can be achieved for other threat categories. Recovery will require a concerted effort to reduce all threats to fall Chinook and this Plan is based on the premise that aggressive near-term action will be taken to address these risks on all levels. Even with immediate, aggressive action to address all threats, risk reductions achieved through recovery actions will be realized over differing timeframes. Reductions in fishery impacts result in an immediate reduction in risk. The risk reductions associated with other recovery actions, particularly those related to habitat and hatchery recovery actions are often realized incrementally over years, and, in some instances, decades. While opportunities to reduce near-term extinction risks must be pursued for all threat categories, reductions in fisheries impacts is the most effective means of achieving significant near-term risk reduction.

The Plan's front-loaded recovery strategy is reflected in a series on interim benchmarks for each threat category (Table 6-4). These benchmarks are intended guide recovery efforts and assist in measuring progress toward achieving the Plan's recovery goals and objectives. Interim fishery benchmarks of 38-49% in years 1-12 and 33-38% in years 13-24 reflect the lower rates needed to reduce near-term risks until the benefits of recovery actions addressing other threats are realized. Interim benchmarks of 38-45% for years 25-36 and 40-50% for years 37-48 reflect higher fishery impact rates possible due to risk reductions achieved for other threat categories. It should be noted that substantial impact reductions reflected in the benchmarks for years 1 through 12 (1999-2010) have already been achieved. Benchmarks for years 13-24 (33-38%) are intended to further reduce immediate risks of critical low run sizes for Washington populations targeted for significant improvement. Figure 6-6 displays the effects of fishing on the risk of falling below critical abundance thresholds in the near term (10 years). Population simulations project that fishery impact rates of 33-38% will reduce near-term extinction risks to 5% or less for all populations except the Grays where near-term risks continue to exceed 5% even if fishing is eliminated. This 5% standard is intended to ensure that near-term fishery impacts will not significantly jeopardize the long-term success of recovery efforts.

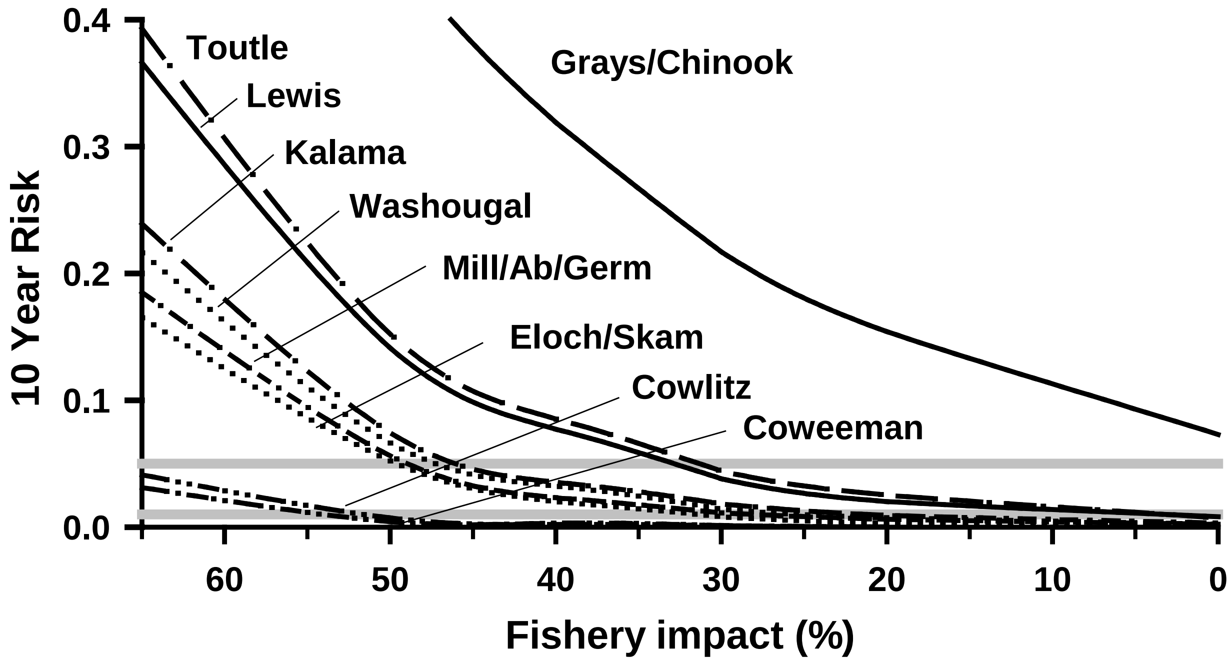


Figure 6-6. Effect of fishing on short term (10-year) risk of falling below critical abundance thresholds for lower Columbia River populations of tule fall Chinook targeted for recovery to high levels of viability (from Appendix E Chapter 14).

It is important to note that benchmark impact rates identified for fall Chinook are defined as multi-year average rates. Benchmarks are not maximum annual rates. Depending on abundance, higher or lower impact rates may be consistent with the 5% risk criteria. Risk analyses demonstrate that a variety of variable annual rate strategies may produce equivalent risks. For instance, risk effects of higher fishing rates in large return years could be offset by reduced fishing rates in low return years. It is typically the poor ocean survival years that pose the greatest risk of critical low escapements. This is the basis for the abundance-based fishery strategy that this Plan proposes for consideration.

While population-specific indicators for fall Chinook are clearly not adequate to implement a population-specific abundance-based strategy, variable fishing rates in years of low aggregate ocean survival will reduce the effective average annual rate with corresponding risk reduction benefits. The greater the reduction in impacts in the low return years, the greater the flexibility to absorb higher impacts in the large return years. The flexibility to implement an abundance-based fishery strategy is intended to assist in maintaining a viable fishery until harvestable wild population recovery can be achieved.

The difficulty in achieving impact reductions beyond those proposed for fall Chinook stems from the broad distribution of fisheries which they encounter. Tule fall Chinook are harvested in Alaska sport and commercial, Canadian sport and commercial, Treaty Indian ocean, Washington ocean sport and commercial, and Columbia River sport, commercial and treaty Indian fisheries. No single fishery accounts for a large impact but the combined effect of all fisheries accounts for the observed impact levels. As of 2010, these fisheries collectively account for a net impact of approximately 38% (3% Southeast Alaska, 12% British Columbia, 15% PFMC ocean, and 8% Columbia River). Further reductions beyond the 35-38% range could only be achieved by closures of non-Indian U.S. Ocean and lower Columbia River sport and commercial fisheries. However, risk analyses show that population risks are relatively insensitive to small changes in fishery impact rates on the order of ± 3 to 5% (Figure 6-6). The adverse effects to fishery interests associated with extended closures would be inconsistent with the long term harvestability goals and equitability strategy of this Recovery Plan.

Hatchery. The recovery strategy involves significant reductions in hatchery impacts on wild populations by elimination of hatchery releases and exclusion of stray hatchery fish from key natural production areas, and by integrating wild broodstock into hatchery programs in order to improve fitness. Hatchery production will continue to be used for mitigation of lost production and support limited fisheries in the interim until natural populations are restored to harvestable levels. Given widespread habitat losses, most of the remaining historical diversity in Washington currently resides in the hatchery stocks. While hatchery fish are typically less productive than naturally-produced fish, many lower Columbia populations are demographically supported with hatchery-produced natural spawners. Reforms of hatchery programs need to be phased over time and effectiveness will depend on concurrent habitat improvements.

Interim benchmarks for reductions in hatchery impacts and corresponding fish status benefits are based on gradual incremental improvements over the next 50 years (Table 6-4). Some hatchery actions are expected to produce immediate benefits but there will be a time lag in realization of many benefits dependent on productivity improvements resulting from restoration of natural population diversity. Many hatchery actions have already been implemented and additional reforms are expected to be implemented within the next few years. Benchmark values for hatchery actions describe minimums needed to meet recovery objectives. It is anticipated that many hatchery actions will result in significantly greater and more rapid improvements in many populations. Additional action effectiveness benchmarks can be established as part of implementation planning based on the percentage of hatchery origin spawners (pHOS) in natural spawning populations and proportionate natural influence (PNI) which reflects both the numbers and quality of hatchery-origin spawners.

Ecological. Effects of ecological factors are complicated and difficult to manage. The recovery strategy involves management of predation by birds, marine mammals, and fish where predation impacts have been exacerbated by human activities. This includes redistributing nesting tern colonies in the estuary, excluding or removing sea lions from the vicinity of dam passage facilities which increase salmon vulnerability, and fisheries regulations or incentives to encourage exploitation of fish predators increased by habitat alterations. The strategy also involves preventative measures to avoid potentially disastrous impacts of exotic species invasions.

Potentially manageable ecological impacts include predation by birds, marine mammals, and pikeminnows. Interim benchmarks for reductions in predation impacts and corresponding fish status benefits are based on gradual incremental improvements over the next 50 years. Many predation-related actions have already been implemented but additional actions are also scheduled to occur. Some actions have immediate benefits (tern nesting colony translocation, marine mammal removal). Benefits of others may be realized in future years (pikeminnow population restructuring). As a result, the greatest impact reductions will be realized within the near and intermediate term. Longer term benefits will involve maintenance of target levels and smaller net impact reductions. Specific action effect monitoring benchmarks can also be established for each ecological factor. For instance, impact reductions assume a two-thirds reduction in tern predation and a 25% reduction in pikeminnow predation. Note that benefits of actions are population-specific depending on the extent of predation exposure which depends on the subbasin of origin for each population.

6.3 Chum Salmon

6.3.1 Population Descriptions

Extinction risks were estimated to be very high in nine of eleven populations of chum salmon occurring in whole or in part of Washington. All six of the Oregon-only populations are believed to be functionally extirpated (Table 6-6). 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 diminished by reduced numbers and the loss of many populations.

Table 6-6. 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.

Grays/Chinook Chum: The Grays River chum population has persisted at low to moderate numbers over the past 50 years although habitat degradation has eliminated significant habitat. Returns averaged 15,000 per year during 2002 through 2004, but fell to 4,900 per year during 2005 through 2007. Chum salmon spawn in the mainstem Grays River from RM 9.5-13.0, the lower 1.4 miles of the West Fork of the Grays River, the lower 0.5 miles of Crazy Johnson Creek, and in Gorley Creek at RM 12 of the Grays River. Natural spawning also occurs in the lower mainstem of the Chinook River. Grays River returns are predominately from natural production except for a minor contribution from a small enhancement hatchery program at Grays River Hatchery. Outside stocks used for hatchery brood in the 1980s from Hood Canal and Japan failed to produce significant adult returns. The use of outside stocks has been discontinued and the hatchery program goal has been to augment and reduce risks to naturally spawning Grays River chum since 1998. In the Chinook River, most fish are produced from Sea Resources Hatchery, which is using Grays River stock chum to supplement natural production. This population currently meets abundance and productivity attribute criteria consistent with very high levels of viability but increases in spawning habitat distribution are needed to meet the spatial structure attribute criteria of 'very high'.

Elochoman/Skamokawa Chum: The historical population was significant. Fair numbers of chum (more than 150 per year) spawned in the Elochoman River and Skamokawa Creek in 2002, 2003, and 2006. Spawning occurs primarily in the lower mainstem Elochoman between tidewater and the Elochoman Hatchery and in Skamokawa Creek between tidewater and Standard and McDonald creeks. Jim Crow Creek, which flows directly into the Columbia downstream of Skamokawa Creek, is also an important chum spawning area. Large numbers of hatchery fry of various chum stocks were released between 1958-1983 in the Elochoman River and 1978-1983 in Skamokawa Creek. After hatchery releases were discontinued, chum returns dropped precipitously. Recent year counts have been higher in Skamokawa Creek than in the Elochoman River.

Mill/Abernathy/Germany Chum: Fair numbers of spawning chum have been counted in Germany and Abernathy Creeks. There is potential for a protected habitat area in lower Germany Creek. Chum salmon spawn in the lower 0.4 miles of Abernathy Creek and in the lower parts (above tidewater) of Mill and Germany Creeks. Hatchery fry releases of various chum stocks occurred from 1958-1991 in Abernathy Creek and 1982-1983 in Germany Creek. After hatchery releases were discontinued, chum returns dropped dramatically.

Cowlitz Chum: The Cowlitz fall chum salmon population was historically the largest in the lower Columbia Basin and included production from the mainstem Cowlitz, Toutle, and Coweeman Rivers. Natural spawning primarily occurs in the lower Cowlitz, lower mainstem Toutle, Ostrander Creek, and the lower Coweeman. Some chum historically migrated into areas upstream from Mayfield Dam. Baseline returns are very low, likely less than 150 fish. Chum salmon habitat in the lower river has been significantly reduced by diking in the Longview/Kelso area. No hatchery releases of chum salmon have occurred in the Cowlitz Basin.

Cowlitz Summer Chum: The Cowlitz historically produced chum salmon that returned in late summer and fall. It is unclear if the summer fish were a demographically independent population or a component of the historically-diverse chum population in this large system. Chum salmon recently captured in the mainstem Cowlitz River and at the Cowlitz Salmon Hatchery have an early "summer" run timing. Genetic analysis indicates that these fish are genetically different from fall chum salmon in the Cowlitz and nearby tributaries.

Kalama Chum: The historical significance of the Kalama chum population is unknown. Chum spawning is limited to the mainstem Kalama River between Modrow Bridge (RM 2.4) and Lower Kalama Falls (RM

10). Baseline returns are very low, likely less than 50 fish. No hatchery releases of chum have occurred in the Kalama basin.

Lewis Chum: Chum salmon spawn in the lower reaches of the mainstem NF and EF Lewis River. Historically, significant numbers of chum salmon spawned in the lower Lewis River and Cedar Creek, and were reported to ascend to the mainstem above the Merwin Dam site and spawn at the site of the reservoir. Currently, less than 100 chum salmon spawn in the Lewis River each year. Some volunteer enhancement efforts are ongoing in the lower East Fork Lewis. Chum in the Lewis Basin are all naturally-produced as no hatchery chum are released in the area.

Salmon Creek Chum: Chum salmon historically were widely distributed in Columbia River tributaries below Celilo Falls including Salmon Creek. There is currently no significant spawning by chum salmon in this basin and prospects for restoration of significant chum habitat are limited in this urbanized subbasin.

Washougal Chum: Chum salmon spawn in several locations in and around the Washougal Basin; including the lower reaches of the mainstem Washougal, Little Washougal, and Lacamas Creek. A potentially-related population spawns in the mainstem Columbia and tributaries near the I-205 Bridge. Natural spawning chum in the Washougal are all naturally produced as no hatchery chum are released in the area.

Lower Gorge Chum: This population is considered the healthiest remaining in the Columbia River Basin. The population is shared with Oregon and includes spawners in several tributaries and the mainstem Columbia upstream from the I-205 Bridge. Chum salmon spawn in the lower mile of Hardy and Hamilton Creeks, Hamilton Slough, Duncan Creek, and in the mainstem Columbia at Ives and Pierce Islands as well as scattered sites on the Oregon side. Multi-agency enhancement efforts are ongoing including use of the Washougal Hatchery for risk reduction and enhancement. An artificial spawning channel exists in Hardy Creek and Hamilton Spring to increase chum spawning habitat. A chum habitat restoration and enhancement program is currently underway in Duncan Creek. Hatchery releases of chum have not occurred on Hardy or Hamilton Creeks. This population currently meets abundance and productivity attribute criteria consistent with very high levels of viability but increases in spawning habitat distribution are needed to meet spatial structure attribute criteria for 'very high'.

Upper Gorge Chum: This is a shared population with Oregon but most of the habitat exists in Washington. The majority of the historical chum spawning habitat was flooded after the construction of Bonneville Dam in 1938. Small numbers of adult chum salmon continue to be counted in fish ladders at Bonneville Dam but spawning distribution upstream has not been determined. Spawning habitat is potentially available in the lower reaches of Rock Creek, Wind River below Shipperd Falls, Little White Salmon River, and lower Big White Salmon River. WDFW biologists have not determined whether chum are currently spawning in these tributaries. No hatchery chum are released in the area.

6.3.2 Population Objectives & Targets

Nine of 17 chum populations in Washington and Oregon are identified for improvement to high or very levels of viability (Figure 6-7). Washington populations prioritized for large improvements include the strongest existing populations (Grays, Lower Gorge) and other core populations with potential for improvement based on large historical production (Elochoman/Skamakowa, Lewis). Other primary populations are included (Mill/Abernathy/Germany, Washougal) 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.

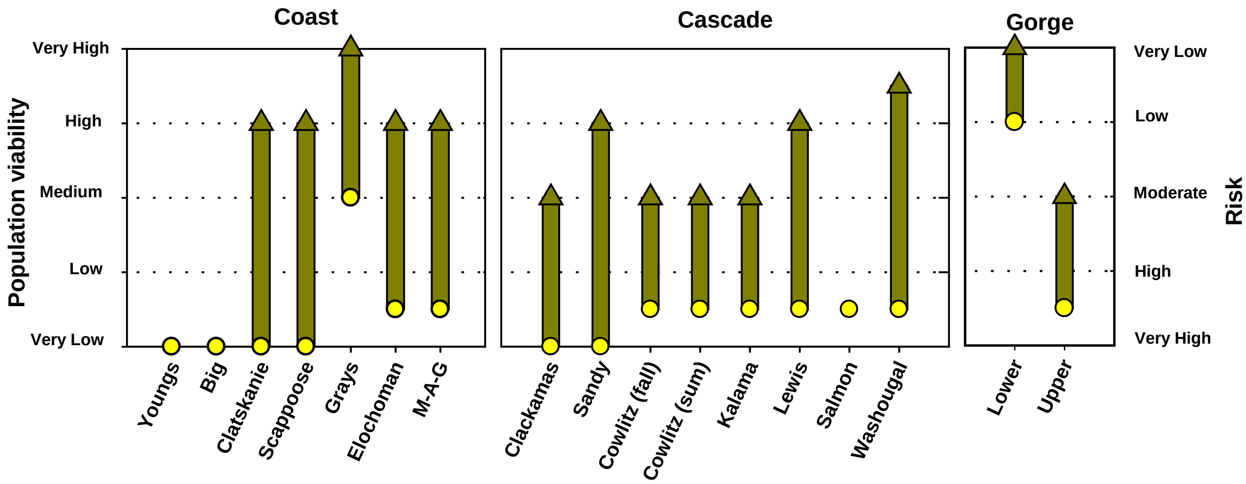


Figure 6-7. Viability objectives for chum salmon identified in the recovery scenario for Washington and in Oregon's Recovery Plan.

Almost all chum populations (14 of 17 or 82%) are identified for high levels of viability or significant improvements to meet ESU objectives. The scenario includes five contributing populations in Washington and Oregon, slated for improvement to moderate levels of viability (Figure 6-7) in order to meet TRT criteria for strata-average viabilities exceeding medium values (2.25 or better). The scenario meets TRT criteria of at least two populations at high or better viability and a strata average exceeding moderate (score ≥ 2.25) 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 baseline low numbers, limited habitat availability, and inundation of historically productive habitats by Bonneville Dam. This Plan prioritizes additional populations in the Coast and Cascade strata for higher levels of viability in order to compensate for limited recovery prospects in the Gorge.

Some level of recovery effort will still be needed in every population in order to arrest long term declining trends, even among stabilizing populations targeted for minimal improvement. Only three chum populations are designated as stabilizing. In Washington's Salmon Creek population, habitat has been severely degraded by urban development and historical production was relatively small, thus finite recovery resources are better focused in other areas with higher benefit-cost ratios. In Oregon's Young's Bay and Big Creek, minimal improvements are identified in the Oregon Plan in order to continue to provide flexibility to implement fall terminal commercial fisheries for Chinook and coho designed to reduce harvest on other populations.

The majority of lower Columbia River chum populations occur in whole or in part in Washington streams (11 of 17 or 65%). The recovery scenario identifies significant contributions from both Washington and Oregon populations in order to meet ESU-wide recovery criteria. However, Washington will carry a proportionately greater share of the recovery "burden" for chum salmon because of its greater number of populations and greater habitat potential for this species.

Very large improvements in abundance and productivity will be required to meet viability objectives for Washington chum populations (Table 6-7). Baseline abundance and productivity of most populations is unknown or so low as to be essentially undefined because data were inadequate to quantify baseline populations' productivity. As an initial planning target, population improvements of at least 500% are identified for most Washington populations of chum. Exceptions were the stabilizing Salmon Creek population where no improvement was targeted, and the primary Grays and Lower Gorge populations where abundance and productivity objectives are currently met but improvements in spatial structure are required to meet population viability objectives.

6.3.3 Threats & Impacts

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, 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 baseline 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 6-8). Thus, baseline fish numbers represent only 1-29% of the historical production potential and typically 6-30% of population-specific recovery targets.

No single factor accounts for the majority of the reduction in fish numbers and the significance of specific factors varies from population to population (Figure 6-8, Table 6-7). For example, the Elcohoman-Skamakowa population of chum was reduced by an estimated 93% by combined impacts of a 90% reduction in tributary habitat conditions, a 25% reduction in estuary habitat conditions, a 5% fishery impact rate, a 3% hatchery impact rate, and a 3% predation rate (Table 6-7). Biological objectives will require a 500% improvement in this population which translates into a 50% reduction in each impact.

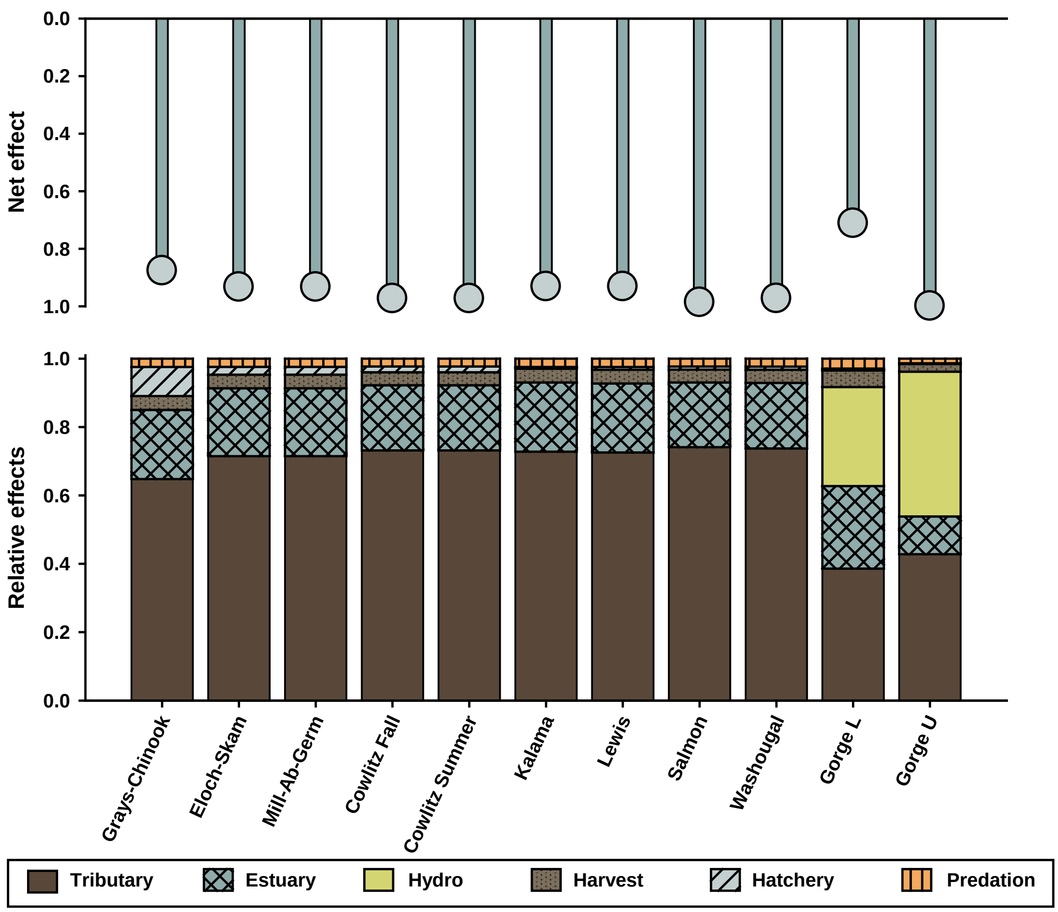


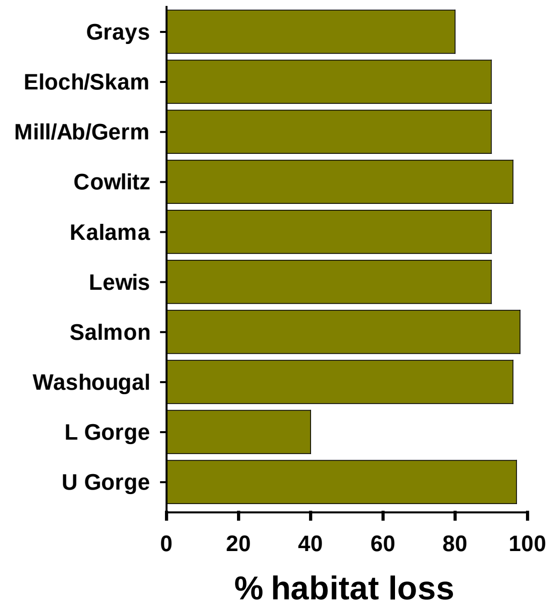
Figure 6-8. Net effect and relative contribution of potentially manageable impact factors on chum salmon in Washington lower Columbia River subbasins. Net effect is the approximate reduction from historical fish numbers as a result of manageable factors included in this analysis.

Table 6-7. Potentially manageable impacts of threats, productivity improvement targets, and impact reduction targets consistent with recovery of Washington lower Columbia River chum populations if reductions are distributed across factors in proportion to their baseline impact.

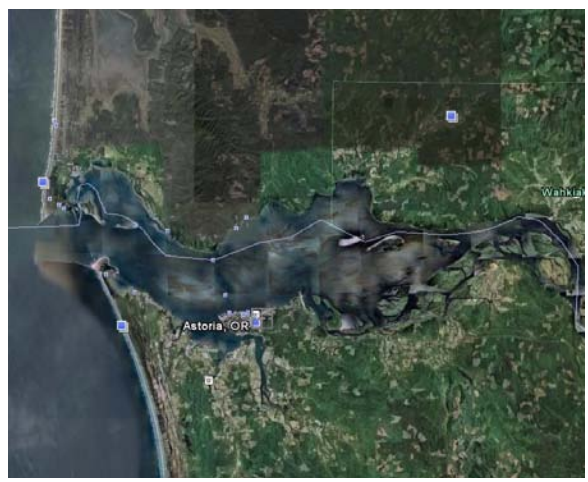
	Productivity	Baseline impacts (listing date reference)							Impacts at target					
Population	**Target**	**Hab**	**Est**	**Dams**	**Fishery**	**Hat**	**Pred**	**Δ**	**Hab**	**Est**	**Dams**	**Fishery**	**Hat**	**Pred**
Coast														
Grays/Chinook	0%	0.80	0.25	0.00	0.05	0.11	0.03	0%	0.80	0.25	0.00	0.05	0.11	0.03
Eloch/Skam	>500%	0.90	0.25	0.00	0.05	0.03	0.03	50%	0.45	0.13	0.00	0.03	0.01	0.02
Mill/Ab/Germ	>500%	0.90	0.25	0.00	0.05	0.03	0.03	50%	0.45	0.13	0.00	0.03	0.01	0.02
Cascade														
Cowlitz (Fall)	>500%	0.96	0.25	0.00	0.05	0.02	0.03	50%	0.48	0.13	0.00	0.03	0.01	0.02
Cowlitz (Summer)	>500%	0.96	0.25	0.00	0.05	0.02	0.03	50%	0.48	0.13	0.00	0.03	0.01	0.02
Kalama	>500%	0.90	0.25	0.00	0.05	0.01	0.03	50%	0.45	0.13	0.00	0.03	0.00	0.02
Lewis	>500%	0.90	0.25	0.00	0.05	0.01	0.03	50%	0.45	0.13	0.00	0.03	0.01	0.02
Salmon	0%	0.98	0.25	0.00	0.05	0.01	0.03	0%	0.98	0.25	0.00	0.05	0.01	0.03
Washougal	>500%	0.96	0.25	0.00	0.05	0.01	0.03	50%	0.48	0.13	0.00	0.03	0.01	0.02
Gorge														
Lower Gorge	0%	0.40	0.25	0.30	0.05	0.01	0.03	0%	0.40	0.25	0.30	0.05	0.01	0.03
Upper Gorge	>500%	0.97	0.25	0.96	0.05	0.01	0.03	50%	0.49	0.13	0.48	0.03	0.00	0.02

The significance of threats affecting chum salmon is summarized as follows:

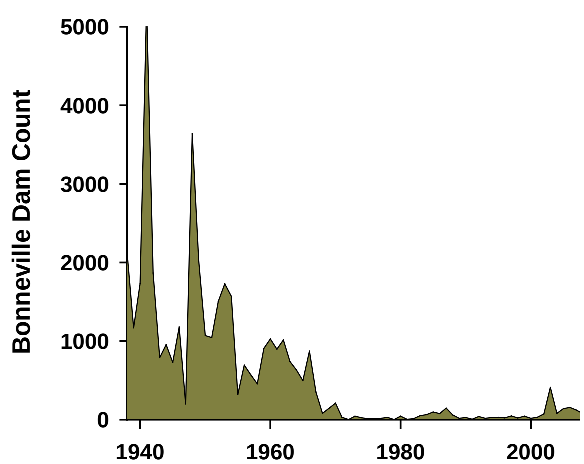
Habitat: Habitat degradation is responsible for the near-absolute collapse of lower Columbia River chum salmon. Chum require clean gravel in low gradient, low elevation reaches of streams and rivers. Spawning typically occurs in mainstem or side channel areas fed by upwelling from intergravel flows or springs. Freshwater productivity of chum populations has been reduced by 80-99%, except in the lower gorge portion of the Columbia River mainstem where a viable but small population remains. Losses result from sedimentation, channel alteration, and loss of floodplain connectivity related to land use throughout the watershed and development throughout historical low elevation valley floor habitats. Estimates of habitat loss are based on analysis of baseline and historical conditions for fish using the Ecosystem Diagnosis and Treatment model.



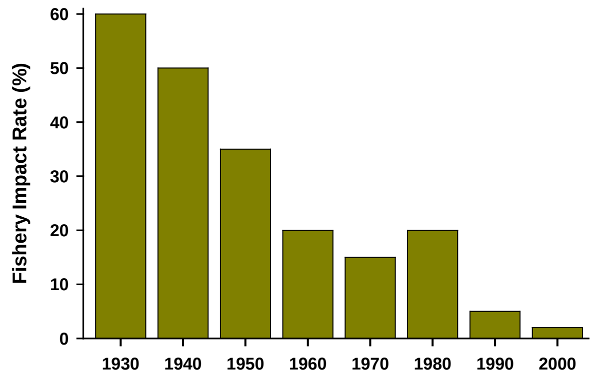
Estuary: Estuary habitats are particularly critical to juvenile chum salmon due to a very early age of entry after emigration as fry from spawning areas soon after emergence from the gravel. Estuary plans have estimated that 50% of ocean-type salmon die during the critical rearing, migration and saltwater acclimation periods that occur in the lower Columbia mainstem, estuary, and plume. The human-caused portion of this total is unknown but likely significant due to large-scale changes in river discharge patterns and estuary habitats related to water use, channel maintenance, and other activities. For planning purposes, strategic impact reduction targets were based on half of the non predation related estuary mortality (a 25% impact).



Dams: Upper gorge and inland populations have been practically eliminated by inundation of historical spawning areas followed by historically high passage mortality of juveniles and adults at Bonneville Dam. Spawning success of the mainstem portion of the lower gorge is affected by water management activities of the hydropower system which can result in dewatering of redds. Most lower Columbia populations spawn in the lower portions of subbasins where impacts of upstream dams in the subbasin largely involve unquantifiable habitat process effects. Some chum were historically produced in now-blocked areas of the upper Cowlitz basin.



Fisheries: No directed harvest of Columbia River chum currently occurs. Nor are significant numbers incidentally taken in current freshwater or ocean fisheries. Abundant historical chum populations were heavily exploited in Columbia River commercial fisheries for canning during the early 1900s. However, increasing restrictions of late fall commercial seasons over time have steadily reduced harvest. Fishery impacts have been less than 5% per year since 1993. In many years, impacts are less than 2%.

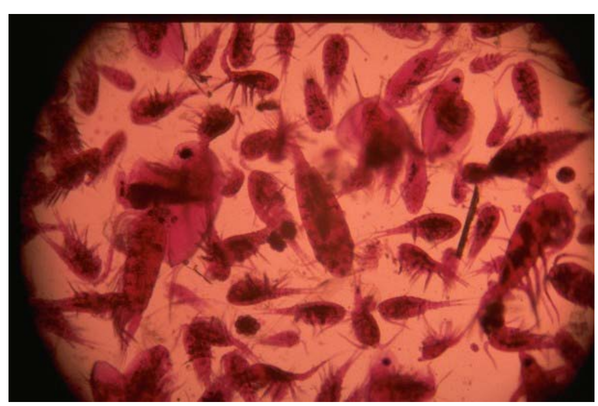


Hatcheries: Chum salmon are not heavily impacted by hatchery production. Large hatchery production programs were not developed as chum declined in the early 1900s because of the low market value compared to other species. Limited hatchery programs in some coast strata streams prior to 1990 failed to produce significant adult returns. More recent programs have targeted production of about 500,000 fry per year for conservation-based efforts to supplement natural populations in the Chinook River, Grays River, and lower gorge tributaries. Analyses by the regional Hatchery Scientific Review Group estimated a 1-11% reduction in productivity of wild chum populations due to hatchery effects. (This does not consider the positive demographic benefits of increasing natural spawning abundance by hatchery supplementation.) Chum salmon might also be subject to predation by the hatchery coho and steelhead which are released at much larger sizes but the significance of this effect has not been determined.

Hatchery Releases (@ listing)

Location	Number
Chinook	150,000
Grays	300,000
Lower Gorge	100,000
WA total	**550,000**
OR total	**0**

Ecological: Chum salmon are subject to naturally-occurring ecological factors including inter-species interactions, food web relationships, and predation. However, effects of human-caused ecological factors are difficult to distinguish and even harder to quantify. Estimates of potentially-manageable mortality due to predation by birds, marine mammals, and northern pikeminnow in the lower Columbia River mainstem and estuary are typically much lower than in other salmon species (on the order of 3%).



6.3.4 Impact Reduction Targets, Strategies & Benchmarks

Impact reduction targets for Washington chum consistent with viability objectives and improvement targets were defined at 50% of baseline values (Table 6-7). Thus, impact reduction targets are half of the baseline value for each potentially manageable impact category. These impact reduction targets were established as interim planning targets until future monitoring and evaluation efforts can provide empirical estimates of the productivity and capacity of remaining wild spring habitats.

Habitat restoration in tributary spawning and estuary rearing habitats is the key to chum salmon recovery. No other factor can effectively address recovery for this species. Fishery and hatchery impacts are very low for chum salmon.

Habitat. Recovery of chum will require restoration of habitat quality in significant historical production areas throughout the region. Key habitats include lower mainstem and off-channel areas of large streams and rivers. Effective long-term habitat restoration will depend on watershed-based actions to repair habitat forming processes that determine mainstem stream habitat conditions, particularly those involving sedimentation and loss of floodplain connectivity. Process-related actions typically demand large scale and long term efforts. More immediate benefits can be obtained by projects to reconnect, restore, or construct spawning channels. Protection of key production areas in the Grays River and Columbia River mainstem will also be critical. Effective habitat protection actions will include a combination of site-specific projects located in currently-productive and potentially productive habitats identified as high priority in this Plan as well as watershed, local government, or state programmatic actions to manage resources in a manner that protects long term habitat function. Subbasin plans, included in Volume II of this Plan, identify high priority stream reaches, limiting habit conditions, and effective habitat actions for this species. While many habitat-related actions have already been undertaken, current activities do not reflect the scale of habitat improvements needed for recovery.

This Plan estimates a 40% to 98% decline in habitat conditions has occurred across chum populations from historical to baseline conditions (depending on the population). Long term impact reduction targets describe habitat improvements relative to the baseline conditions ranging from 0% for stabilizing populations to over 1000% in several populations that would need to be restored to high levels of viability to meet stratum targets specified by the Technical Recovery Team. Benchmarks target implementation of all substantive habitat actions within the first 24 years (Table 6-8). Benchmarks for habitat improvements (i.e. reduction in threat) are based on gradual incremental improvement in habitat conditions over the next 50 years reflecting the time lag in effect.

Estuary. Restoration of estuary habitats critical to early life history of chum salmon will be an essential building block of recovery. Estuary recovery strategies have been identified for the benefit of all Columbia basin ESU's including those of the lower Columbia. Current plans have identified the objective of a 20% improvement in juvenile survival. For ocean-type life histories such as chum, this translates into a 10% improvement (e.g. 20% of 50%). Improvements will depend on a combination of site-specific habitat improvement projects and restoration of functional habitat-forming processes which depend in part on river discharge patterns. Benchmarks are not identified in this Plan for estuary habitat – refer to the estuary module for further guidance on estuary habitat targets and schedules.

Table 6-8. Interim benchmarks for action implementation, action effectiveness and related status improvements of chum.

	Benchmark type	Years					
		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%
	Gorge L	--	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%
	Cowlitz L	--	85%	240%	>500%	>500%	>500%
	Washougal	--	85%	240%	>500%	>500%	>500%
	Gorge U	--	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 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.

Dams. Effects of dam operation on critical downstream habitats are a consideration, particularly for the mainstem spawning population of the Lower Gorge. Production in this population can be affected by redd dewatering which is related to differences in dam discharge during fall spawning and winter incubation periods. Effects on ESU viability due to loss of spawning habitat in the upper gorge (inundation by Bonneville Dam and dam passage impacts) might be more effectively addressed by habitat mitigation for other lower basin populations. This Plan elevates chum recovery efforts in the Cascade and Coastal strata, in lieu of recovery of the upper Gorge, to a high level of viability. Interim benchmarks assume 50% implementation of dam-related measures during the first 12 year period and 100% implementation by year 24 (Table 6-8).

Harvest. Chum salmon are not currently subject to significant harvest in freshwater or the ocean. While high historical harvest rates may have significantly contributed to reductions in abundance, productivity, distribution, and diversity, baseline fisheries are not a significant constraint. The harvest strategy for this species involves continued protection from incidental impacts of fisheries for hatchery fall Chinook and coho during late fall. Harvest benchmarks for chum are based on no significant increases from baseline levels.

Hatchery. Chum salmon are not currently subject to significant negative hatchery impacts. However, conservation hatchery programs will be used to reintroduce and supplement natural populations as an interim recovery strategy concurrent with habitat restoration activities. Reductions in hatchery programs for coho and steelhead are also expected to benefit chum by reducing the potential for predation impacts of other salmonid hatchery smolts on chum fry. Hatchery benchmarks for chum are based on no significant increases from baseline levels.

Ecological. Effects of ecological factors are complicated and difficult to manage. The recovery strategy involves management of predation by birds, marine mammals, and fish where predation impacts have been exacerbated by human activities. This includes redistributing nesting tern colonies in the estuary, excluding or removing sea lions from the vicinity of dam passage facilities which increase salmon vulnerability, and fisheries regulations or incentives to encourage exploitation of fish predators increased by habitat alterations. The strategy also involves preventative measures to avoid potentially disastrous impacts of exotic species invasions. Ecological benchmarks for chum are based on predation reduction identified for the benefit of other more-heavily impacted species.

6.4 Coho Salmon

6.4.1 Population Descriptions

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 6-9). Very high risks result from a combination of low abundance and productivity, losses of spatial structure, and reduced diversity due to low numbers and pervasive hatchery effects.

Table 6-9. 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[2]	VL	M	L	VL	VL[2]	0%	5,600	<50	--
Toutle SF [E, L]	Primary	VL	H	M	VL[2]	H	+180%	27,000	<50	1,900
Toutle NF [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%	na	<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%	na	<50	1,900
U Gorge (WA) [L]	Primary[1]	VL	M	VL	VL[2]	H	+400%	na	<50	1,900
U Gorge/Hood (OR)[E]	Contributing[4]	--[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.
[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.)

Grays/Chinook Coho: Historically Grays River coho salmon were considered late stock with an ocean distribution generally north of the Columbia River. Natural spawning occurs primarily in upper mainstem and large tributaries throughout the basin. Potential natural spawning areas include the upper Grays, South Fork, West Fork, Crazy Johnson Creek, and Hull Creek. Other potential coho spawning streams in the vicinity include Crooked Creek, Hitchcock Creek, and Jim Crow Creek. The Grays River Hatchery located on the West Fork produces early stock fish and currently accounts for most of the coho returning to Grays River.

Elochoman/Skamokawa Coho: Historically Elochoman River coho salmon were considered late stock with an ocean distribution generally north of the Columbia River. Natural spawning is thought to occur in most areas accessible to coho. Duck Creek in the lower watershed is an important coho spawning area, but the majority of the spawning area is in the upper watershed above the hatchery, in particular the West Fork of the Elochoman. In Skamokawa Creek, important spawning areas include the mainstem, and Wilson, Left Fork, Quartz, Standard, and McDonald Creeks. Spawning also occurs in Jim Crow Creek, a tributary of the Columbia River just downstream of Skamokawa Creek. The Elochoman Hatchery was built in 1953 and releases both early and late stock coho into the river.

Mill/Abernathy/Germany Coho: Late stock coho were historically present in the Mill, Abernathy, Germany, and Coal Creeks. Natural spawning is thought to occur in most areas accessible to coho in Mill, Abernathy (including Cameron Creek), Germany, and Coal Creeks. There are no production hatcheries located on these creeks, although out-of-basin early stock coho have been planted in past years.

Lower Cowlitz Coho: This population was likely one of the largest historical populations in the lower Columbia with production occurring in many tributary streams. Late stock fish were widely distributed throughout the basin until upstream migration was blocked by the construction of the Mayfield Dam in 1962. Natural spawning in the lower Cowlitz is thought to occur in most tributaries accessible to coho including Olequa, Lacamas, Brights, Ostrander, Blue, Otter, Mill, Arkansas, Foster, Stillwater, Campbell, and Hill Creeks. Hatchery production now accounts for most coho returning to the Cowlitz River. Several hatcheries released coho into the Cowlitz Basin as early as 1915. The Cowlitz River Hatchery located about 2 miles below Mayfield Dam currently produces late stock coho. Unlike many lower Columbia River hatcheries, this program has not included significant numbers of out-of-basin broodstock. These hatchery fish are being used for reintroduction in the upper Cowlitz and Cispus rivers. Recent surveys have found areas (Olequa Creek) where the natural spawners were primarily unmarked, naturally-produced coho.

Upper Cowlitz Coho: Early and late run coho historically returned to the upper Cowlitz River until upstream migration was blocked by construction of the Mayfield Dam in 1962. Current natural spawning returns are part of an upper Cowlitz and Cispus River reintroduction program. Reintroduction efforts in the upper Cowlitz River basin have demonstrated good production potential in tributaries above the dams, but efforts are challenged in passing juvenile production through the system. Adult coho are released upstream of the dams to spawn naturally in the upper Cowlitz River. Cowlitz origin hatchery coho are also planted in the upper Cowlitz basin. Smolts are captured at the Cowlitz Falls Dam collection facility, acclimated at Cowlitz Salmon Hatchery and released into the lower Cowlitz. Natural spawning occurs in the mainstem and tributaries of the upper Cowlitz River. Successful reintroduction to habitats upstream of the dams in the Cowlitz River will depend on effective passage. Collection of juvenile coho reintroduced upstream of Cowlitz Falls Dam has been difficult, but better than that of spring Chinook.

Cispus Coho: Early and late-run coho historically returned to the Cispus River in the upper Cowlitz until upstream migration was blocked by construction of the Mayfield Dam in 1962. Current natural spawning returns are part of an upper Cowlitz and Cispus River reintroduction program. Adult coho are released upstream of the dams to spawn naturally in the upper Cowlitz Basin. Smolts are captured at the Cowlitz

Falls Dam collection facility, acclimated at Cowlitz Salmon Hatchery, and released into the lower Cowlitz. Success will depend on effective passage. Reintroduction efforts to date have been constrained by low juvenile collection efficiencies.

Tilton Coho: Late run coho historically returned to the Tilton River in the upper Cowlitz until upstream migration was blocked by construction of the Mayfield Dam in 1962. The Tilton River Hatchery released coho in the Cowlitz basin from 1915-1921. Current natural spawning returns are part of an upper Cowlitz and Cispus River reintroduction program. Adult coho are released upstream of the dams to spawn naturally in the upper Cowlitz Basin. Smolts are captured at the Cowlitz Falls Dam collection facility, acclimated at Cowlitz Salmon Hatchery, and released into the lower Cowlitz. Improvements to the Tilton coho population are linked to successful reintroduction and passage upstream of Mayfield Dam.

South Fork Toutle Coho: South Fork Toutle River coho are generally considered an early stock with a typical ocean distribution south of the Columbia River. The 1980 Mt. St. Helens eruption had minor effects on the South Fork Toutle compared to the mainstem and North Fork. Natural spawning is thought to occur in most areas accessible to coho in the SF Toutle including its tributaries. This watershed does not have a coho hatchery program, is not in urban areas, and is expected to benefit from forest management plans and fishery reductions.

North Fork Toutle Coho: North Fork Toutle River coho historically included early and late run fish. Current returns are primarily an early stock with an ocean distribution typically south of the Columbia River. The Toutle River system likely provided the most productive habitat in the basin in the 1960s and 1970s. Natural spawning was thought to occur in most areas accessible to coho, including all accessible tributaries. Productivity in some areas was greatly reduced after the 1980 Mt. St. Helens eruption. Other tributaries (primarily on the Green and South Toutle) had minor effects from the eruption. Bear, Hoffstadt, Johnson, Alder, Devils, and Herrington Creeks are examples of tributaries important to coho. Coho adults are collected and passed to tributaries above the North Toutle Sediment Retention Structure. The North Toutle Hatchery, located on the Green River less than a mile upstream of the confluence with the North Fork Toutle River, releases early coho smolts.

Coweeman Coho: Coweeman River coho are generally considered a late stock with an ocean distribution typically north of the Columbia River. This population was likely modest to average in numbers historically. Coho spawn primarily in tributaries downstream of the confluence of Mulholland Creek. The existing population is considered to be of mixed stock origin due to widespread transfers between basins, although hatchery transfers were eliminated by the early 1990s. This sub-basin does not have a coho hatchery program, is not in urban areas, and is expected to benefit from forest management plans and fishery reductions.

Kalama Coho: Kalama coho historically were likely average or less in population abundance and consisted primarily of late stock fish. Natural spawning was historically limited to accessible tributaries below Kalama Falls (RM 10). A fish ladder was installed at Kalama Falls in 1936 to provide access above the falls. However, most fish are believed to spawn below the falls. Coho have been planted in the Kalama basin since 1942. Currently, early stock coho are produced at Fallert Creek Hatchery and late stock fish at Kalama Falls Hatchery.

North Fork Lewis Coho: Both early and late run coho historically spawned throughout the North Fork Lewis basin until construction of the Merwin Dam in 1932. Adult coho were initially trapped and passed above Merwin Dam until 1957 after the completion of Yale Dam (1953) and just prior to completion of Swift Dam (1959). Coho currently spawn in North Fork Lewis tributaries below Merwin Dam including Ross, Cedar, NF and SF Chelatchie, Johnson, and Colvin Creeks. Key historical production areas in the upper basin, lower basin, and Cedar Creek were not identified as demographically-independent from each other by the TRT. Measures included in the FERC relicensing settlement agreement for Lewis River hydroelectric projects call for the taking of steps to achieve a genetically viable, self-sustaining, naturally reproducing, harvestable coho population above Merwin Dam. Successful reintroduction will require effective juvenile and adult passage measures. Hatchery coho have been planted in the basin since 1930. Early and late coho are currently produced at the Lewis River Hatchery (completed in 1932) located at RM 13 and Speelyai Hatchery (completed in 1958) located at Merwin Reservoir. Significant hatchery production in the lower basin, combined with habitat constraints, will limit prospects for significant improvement of this population if reintroduction is not successful. A naturally spawning population is currently being managed by WDFW in Cedar Creek.

East Fork Lewis Coho: The historical East Fork Lewis coho run was likely about average in numbers and consisted of both late and early stock fish. Natural spawning occurs downstream of Lucia Falls (RM 21), particularly in Lockwood, Mason, and Rock creeks. There are no hatcheries in the East Fork Lewis, although coho fry were periodically released from the Lewis River Hatchery into the East Fork Lewis in past years.

Salmon Creek Coho: Historical returns are believed to be primarily late run fish. Natural spawning can occur throughout the Salmon Creek basin, but principally in the upper mainstem Salmon Creek, and Morgan, Rock, Mill, and Weaver creeks. Potential for coho spawning also exists in nearby streams, including Burnt Bridge and Whipple creeks. Salmon Creek flows through Clark County (downstream of the Washougal River and upstream of the Lewis River) and has been largely impacted by urban development. Habitat enhancement efforts have been conducted on Salmon Creek in recent years. There are no hatcheries on Salmon Creek but coho subyearlings have been released into the Salmon Creek Basin. Prospects for restoration of significant salmon habitat are limited in this urbanized subbasin yet; substantial protection and restoration efforts will be needed to preserve what remains.

Washougal Coho: Historical production is believed to have been primarily late run fish. Natural spawning is thought to occur in most areas accessible to coho, but principally in the Little Washougal River where 7.5 miles of stream area habitat exists. Other potential coho spawning areas include the Washougal mainstem downstream of Salmon Falls, West Fork Washougal River, and Winkler Creek. The Washougal Hatchery (completed in 1958) produced early and late coho in the past but the current program produces only late stock fish. Most of this production is planted in the Klickitat River as part of a federal, state, and tribal production agreement.

Lower Gorge Coho: This is a shared population with Oregon that was historically dominated by late run fish. Most of the available habitat is in Washington streams including Duncan, Hardy and Hamilton creeks. The population in Hardy and Hamilton creeks may be one of the more productive remaining in the Washington lower Columbia region. Other potential coho spawning tributaries include: Gibbons Creek, Lawton Creek, St. Cloud Creek, Woodward Creek, and Greenleaf Creek (a tributary of Hamilton Creek). There are no hatcheries on Duncan, Hardy, or Hamilton Creeks. However, Washougal Hatchery late coho were planted in Duncan and Greenleaf Creeks in 1983. Oregon operates a very large hatchery program in the lower gorge downstream from Bonneville Dam.

Upper Gorge Coho: This is a shared population with Oregon but most of the habitat occurs in Washington. Early run coho salmon spawn in accessible sections of Rock Creek, Spring Creek, Wind River, and Little White Salmon River. The lower reaches of these tributaries were flooded after the construction of Bonneville Dam in 1938. Little is known about historical coho salmon runs in the Big White Salmon although they were believed to migrate up to Trout Lake (RM 28) prior to the construction of Condit Dam (RM 3) in 1913.

6.4.2 Population Objectives & Targets

Fifteen of 24 coho populations are prioritized for recovery to high or very high levels of viability (Figure 6-9). 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 minimums identified in the strata viability criteria 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. The scenario includes five contributing populations in Washington and Oregon. These improvements are needed to meet TRT criteria for strata-average viabilities exceeding medium values (2.25 or better). The scenario meets TRT criteria of at least two populations at high or better viability and strata averages exceeding moderate (score ≥ 2.25) in all coho strata.

Some level of recovery effort will still be needed in every population in order to arrest continuing long term declining trends, even among stabilizing populations identified for minimal improvement. Only four coho populations are designated as stabilizing. In Washington's Salmon Creek population, habitat has been severely degraded by urban development, historical production was relatively small, and finite recovery resources are better focused in other areas with higher benefit-cost ratios. In Washington's Tilton River, the recovery effort has prioritized coho reintroduction efforts in the Upper Cowlitz and Cispus rivers upstream from Mayfield Dam based on habitat potential. In Oregon's Young's Bay and Big Creek, minimal improvements are identified in the Oregon Plan in order to continue to provide flexibility to implement terminal commercial fisheries designed to reduce harvest on other populations.

The majority of lower Columbia River coho populations occur in whole or in part in Washington streams (17 of 24 or 71%). However, Oregon's Clackamas and Sandy river coho populations are two of the most significant remaining natural populations. The recovery scenario identifies significant contributions from both Washington and Oregon populations in order to meet ESU-wide recovery criteria.

Very large improvements in abundance and productivity will be required to meet viability objectives for Washington coho populations (Table 6-9). Populations will require relative productivity improvements of 50->500% to meet primary or contributing population objectives. Values of >500% are identified as initial population improvement targets for populations where baseline natural population abundance and productivity is very low and highly uncertain. These include populations in the Upper Cowlitz and Cispus rivers where access has been eliminated.

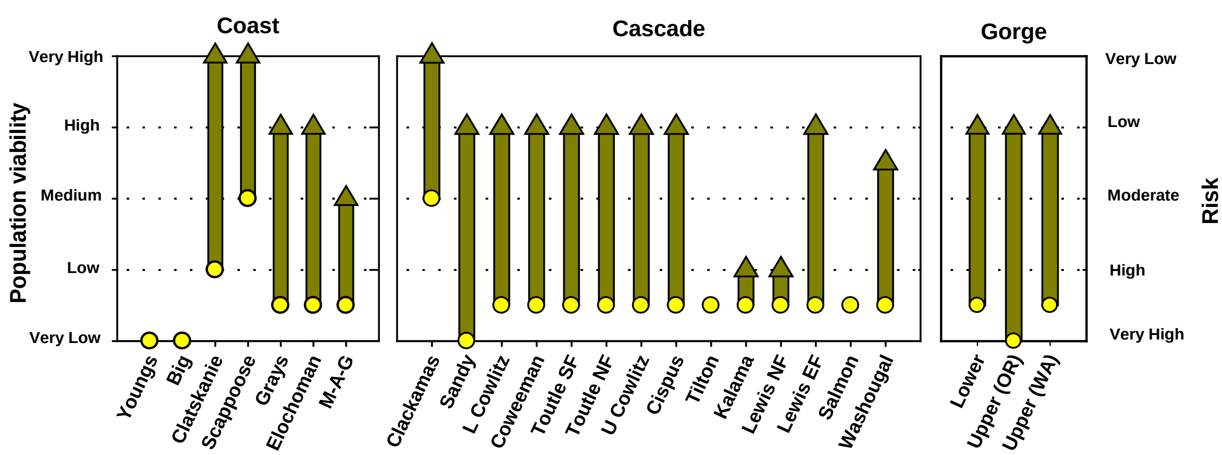


Figure 6-9. Viability objectives for coho identified in the recovery scenario for Washington and in Oregon's Recovery Plan.

6.4.3 Threats & Impacts

Declines in the 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 their baseline 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 6-10). Thus, baseline fish numbers represent only 0-9% of the historical production potential and typically 2-10% of population-specific recovery targets. Total reductions would be even greater if all human impacts could be effectively quantified.

No single factor accounts for the majority of the reduction in fish numbers and the significance of specific factors varies from population to population (Figure 6-10, Table 6-10). For example, the Grays-Chinook population of coho was reduced by an estimated 95% by combined impacts of a 70% reduction in tributary habitat conditions, a 16% reduction in estuary habitat conditions, a 50% fishery impact rate, a 50% hatchery impact rate, and a 14% predation rate. Biological objectives will require a 370% improvement in this population which translates into a 43% reduction in each impact.

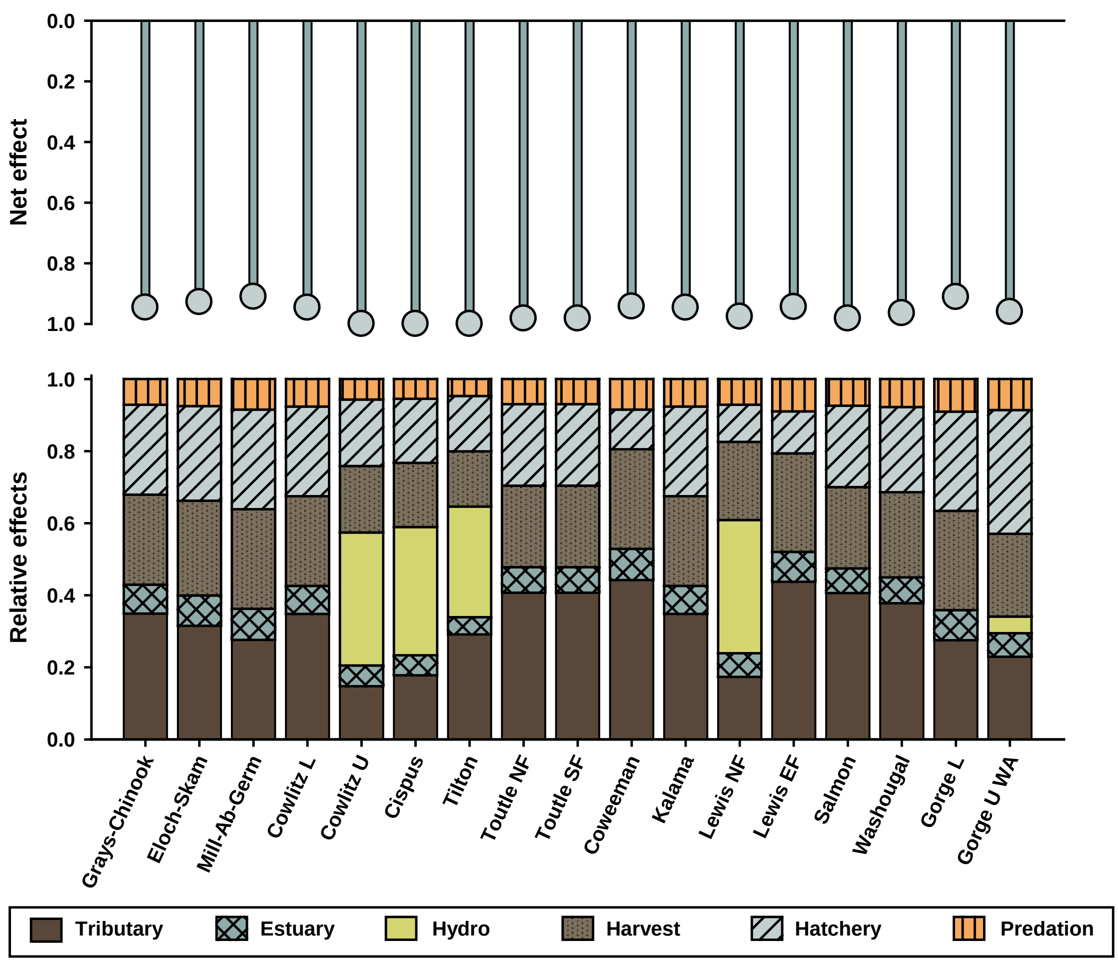


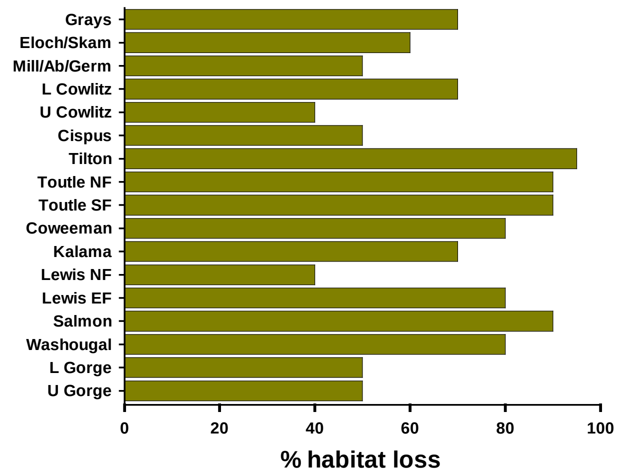
Figure 6-10. Net effect and relative contribution of potentially manageable impact factors on coho salmon in Washington lower Columbia River subbasins. Net effect is the approximate reduction from historical fish numbers as a result of manageable factors included in this analysis.

Table 6-10. Potentially manageable impacts of threats, productivity improvement targets, and impact reduction targets consistent with recovery of Washington lower Columbia River coho populations if reductions are distributed across factors in proportion to their baseline impact.

Population	Productivity Target	Baseline impacts (listing date reference)						Δ	Impacts at target					
		Hab	Est	Dams	Fishery	Hat	Pred		Hab	Est	Dams	Fishery	Hat	Pred
Coast														
Grays/Chinook	+370%	0.70	0.16	0.00	0.50	0.50	0.14	43%	0.40	0.09	0.00	0.29	0.29	0.08
Eloch/Skam	+170%	0.60	0.16	0.00	0.50	0.50	0.14	30%	0.42	0.11	0.00	0.35	0.35	0.10
Mill/Ab/Germ	>500%	0.50	0.16	0.00	0.50	0.50	0.15	50%	0.25	0.08	0.00	0.25	0.25	0.08
Cascade														
Lower Cowlitz	+100%	0.70	0.16	0.00	0.50	0.50	0.15	17%	0.58	0.13	0.00	0.42	0.45	0.13
Upper Cowlitz	>500%	0.40	0.16	1.00	0.50	0.50	0.15	50%	0.20	0.08	0.50	0.25	0.25	0.08
Cispus	>500%	0.50	0.16	1.00	0.50	0.50	0.15	50%	0.25	0.08	0.50	0.25	0.25	0.08
Tilton	0%	0.95	0.16	1.00	0.50	0.50	0.15	0%	0.95	0.16	1.00	0.50	0.50	0.15
Toutle NF	+180%	0.90	0.16	0.00	0.50	0.50	0.15	12%	0.79	0.14	0.00	0.44	0.44	0.13
Toutle SF	+180%	0.90	0.16	0.00	0.50	0.50	0.15	12%	0.79	0.14	0.00	0.44	0.44	0.13
Coweeman	+170%	0.80	0.16	0.00	0.50	0.20	0.15	23%	0.62	0.12	0.00	0.39	0.15	0.12
Kalama	>500%	0.70	0.16	0.00	0.50	0.50	0.15	20%	0.56	0.12	0.00	0.40	0.40	0.12
NF Lewis	+50%	0.40	0.15	0.85	0.50	0.24	0.16	6%	0.38	0.14	0.80	0.47	0.22	0.15
EF Lewis	>500%	0.80	0.15	0.00	0.50	0.21	0.16	50%	0.40	0.08	0.00	0.25	0.11	0.08
Salmon	0%	0.90	0.15	0.00	0.50	0.50	0.16	0%	0.90	0.15	0.00	0.50	0.50	0.16
Washougal	>500%	0.80	0.15	0.00	0.50	0.50	0.16	50%	0.40	0.08	0.00	0.25	0.25	0.08
Gorge														
L Gorge	+400%	0.50	0.15	0.00	0.50	0.50	0.16	59%	0.20	0.06	0.00	0.20	0.20	0.07
U Gorge	+400%	0.50	0.14	0.06	0.50	0.75	0.19	39%	0.31	0.09	0.04	0.31	0.46	0.12

The significance of threats affecting coho salmon is summarized as follows:

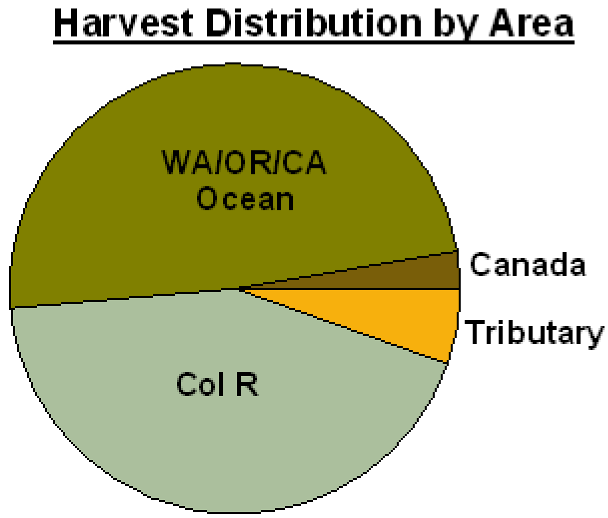
Habitat: Reductions in quantity and quality of freshwater spawning and rearing habitats account for a large share of net impact on coho salmon. Changes in stream flow, temperature, sedimentation, and channel characteristics related to land use have reduced freshwater productivity potential for this species by 40% in some of the healthier forested watersheds such as the upper Cowlitz and Lewis rivers to as much as 90% in many of the developed lower elevation subbasins. Estimates were based on analysis of baseline and historical conditions for fish using the Ecosystem Diagnosis and Treatment model.



Estuary: An estimated 40% of stream-type salmon such as coho die during the critical smolt migration and saltwater acclimation periods that occur in the lower Columbia River mainstem, estuary, and plume. The human-caused portion of this total is unknown but likely significant due to large-scale changes in river discharge patterns and estuary habitats related to water use, channel maintenance, and additional activities. For planning purposes, strategic impact reduction targets were based on half of the non-predation related estuary mortality which is equivalent to a 14%-15% impact.

Dams: Direct dam effects on lower Columbia River coho populations vary from negligible to very high (0 to 100%). Hydropower facilities have eliminated access of upper Cowlitz, Cispus, Tilton, and North Fork Lewis populations to large areas of historically very productive habitat. The upper Gorge population is impacted by passage mortality of juveniles and adults from Bonneville Dam. Populations downstream from Bonneville Dam are affected dam-related habitat effects in the Columbia River mainstem and estuary.

Fisheries: Coho are currently harvested in coastal Washington and Oregon ocean waters and in the mainstem Columbia River. Columbia River coho rarely migrate north of Washington or south of Oregon. Average impacts on wild fish, including harvest and incidental fishing mortality, were about 50% around the time of first listing. During the 1970s, fishery impacts on coho approached or exceeded 80%. Recently, fishery impact rates on wild coho have been reduced by half or more. Coho fisheries are currently managed for variable harvest rates, depending on spawning escapement and marine survival, to protect wild spawning escapement in low return years.



Hatcheries: Most coho currently returning to WA lower Columbia streams are produced in hatcheries operated as fishery mitigation for hydropower or habitat effects. State and Federal lower Columbia River hatcheries have recently been producing about 16 million coho per year including both early and late stock coho. Hatchery production has been substantially reduced from peak release levels of over 30 million coho per year during the late 1980s. Analyses by the regional Hatchery Scientific Review Group estimated a 20-50% reduction in productivity of wild coho populations due to the effects from natural spawning of less-fit hatchery origin fish over decades of hatchery operations.

Hatchery Releases (@ listing)

Location	Early	Late	Total
Estuary	600,000	0	250,000
Chinook	50,000	0	50,000
Grays	150,000	0	150,000
Elochoman	418,000	512,000	930,000
Cowlitz	0	3,200,000	3,200,000
Toutle NF	800,000	0	800,000
Kalama	350,000	350,000	700,000
Lewis NF	880,000	815,000	1,695,000
Washougal	0	500,000	500,000
Lit. Wh. Salmon	1,000,000	0	1,000,000
WA total	**4,248,000**	**5,377,000**	**9,625,000**
OR total	**6,345,000**	**0**	**6,345,000**
Combined	**10,593,000**	**5,377,000**	**15,970,000**

Ecological: Impacts of ecological factors including non-native species, food web interactions, and predation are difficult to quantify. Potentially-manageable mortality due to predation by birds, marine mammals, and northern pikeminnow in the lower Columbia River mainstem and estuary has been estimated to be on the order of magnitude of 14-19% for lower Columbia coho. Stream type migrant life histories have been found to be vulnerable to significant predation in the estuary by birds including large nesting colonies of Caspian Terns and cormorants.

6.4.4 Impact Reduction Targets, Strategies & Benchmarks

An estimated 6%-59% reduction in impacts will be required to meet population improvement targets for primary and contributing populations (Table 6-10). The long term recovery strategy for coho involves significant reductions in the impacts from all threat categories.

Habitat. Recovery will require concerted efforts to protect remaining areas of favorable habitat and to restore habitat quality in significant historical production areas for priority populations. Substantial improvements are required in marginal areas of potentially-productive habitat extending into many small streams and watersheds. A dedicated field sampling program is needed to identify significant remaining production areas for wild coho in Washington streams. Without significant habitat improvements, benefits of estuary, dams, harvest, and hatchery actions will not be realized. Effective habitat restoration actions will include a combination of site-specific projects, with more immediate benefits, and watershed-based actions to repair habitat forming processes that will provide more long term benefits. While many habitat-related actions have already been undertaken, current activities do not reflect the scale of habitat improvements needed for recovery. Effective habitat protection actions will include a combination of site-specific projects (that are currently-productive) and potentially productive habitats (identified as high priority in this Plan) as well as watershed, local government, or state programmatic actions to manage resources in a manner that protects long term habitat function. Subasin plans included in Volume II of this Plan identify high priority stream reaches, limiting habitat conditions, and effective habitat actions for this species.

This Plan estimates a 40% to 95% decline in habitat conditions across coho populations from historical to baseline conditions (depending on the population). Long term impact reduction targets describe habitat improvements relative to the baseline conditions and range from 0% for stabilizing populations to 200% in several populations that would need to be restored to high levels of viability to meet stratum targets specified by the Technical Recovery Team. Benchmarks target implementation of all substantive habitat actions within the first 24 years (Table 6-10). Benchmarks for habitat improvements (i.e. reduction in threat) are based on gradual incremental improvement in habitat conditions over the next 50 years reflecting the time lag in effect.

Estuary. Estuary recovery strategies have been identified for the benefit of all Columbia basin ESU's including those of the lower Columbia. Current plans have identified the objective of a 20% improvement in juvenile survival. For stream-type life histories such as coho, this translates into a 12% improvement (e.g. 20% of the estimated 60% survival through the estuary). Improvements will depend on a combination of site-specific habitat improvement projects and restoration of functional habitat-forming processes which depend in part on river discharge patterns. Benchmarks are not identified in this Plan for estuary habitat – refer to the estuary module for further guidance on estuary habitat targets and schedules.

Dams. Recovery objectives also assign high priority to successful reintroduction into the upper Cowlitz, Cispus, and Lewis systems. These areas were core historical production areas for this species, habitat and watershed conditions are relatively intact, and the available habitat provides the highest production potential of any available area. These upper elevation streams are likely to become even more critical due to impacts of lower elevation habitats from expected future climate trends. Successful reintroduction will depend on collection and passage of both returning adults and outmigrating smolts. High downstream passage efficiencies have historically been difficult to achieve in reservoir systems of this type.

Table 6-11. 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	--	--	--	--	--	--
	Lewis NF	--	1%	2%	3%	4%	4%
	Cowlitz U	--	7%	15%	23%	32%	33%
	Cowlitz L	--	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%
	Gorge L	--	12%	25%	40%	56%	59%
	Coweeman	--	17%	36%	59%	86%	91%
	Grays-Chinook	--	18%	39%	64%	94%	100%
	Toutle NF	--	20%	43%	72%	106%	112%
	Toutle SF	--	20%	43%	72%	106%	112%
	Lewis EF	--	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.

Interim benchmarks assume 50% implementation of dams-related measures during the first 12 year period and 100% implementation by year 24 (Table 6-11). Most passage-related actions will have immediate effects but reintroduction efforts will require a longer period to reach objectives which require the rebuilding of productive locally-adapted populations. Status improvements due to reintroduction will be very large but undefined relative to a starting point of zero.

Harvest. High harvest rates are inconsistent with sustainability of unproductive wild coho, heavily impacted by habitat degradation. The recovery strategy involves a significant reduction of high historical harvest rates of naturally-produced fish through a combination of fishery impact limits, abundance-based annual management, and mark-selective fisheries. Many of these changes have already been implemented with significant and immediate benefits to spawning escapement. Fishery impact targets at recovery were estimated to be 20-50% based on the equitable conservation burden sharing approach adopted by the Washington Plan. However, even greater reductions will be required as part of the front-loaded impact reduction strategy to reduce near-term extinction risk until the benefits of impact reductions from other longer-term recovery actions are realized (particularly including habitat and hatchery actions). Rates of 8-25% are identified as interim benchmarks (Table 6-11). These values are based on projected benefits of harvest actions identified in the Plan including implementation of mark-selective fisheries and abundance-based management. Near-term benchmark rates are approximately less than half of baseline levels, or impact levels, prior to listing; effectively increasing wild spawner numbers by 50-80%. Most fishery-related recovery actions are assumed to be substantially implemented during the first 12 years following listing (1999-2010). Long-term fishery benchmarks are based on equitable impact reduction targets identified in the Plan. Harvestability objectives of the Recovery Plan are met by future increases in fishing rates as the cumulative productivity benefits of all recovery actions are realized.

Hatchery. The recovery strategy involves significant reductions in hatchery impacts on wild populations by the elimination of hatchery releases and exclusion of stray hatchery fish from key natural production areas, and by integrating wild broodstock into hatchery programs in order to improve fitness. Hatchery production will continue to be used for mitigation of lost production and support limited fisheries in the interim until natural populations are restored to harvestable levels. Given widespread habitat losses, most of the remaining historical diversity in Washington currently resides in the hatchery stocks. While hatchery fish are typically less productive than naturally-produced fish, many lower Columbia populations are demographically supported with hatchery-produced natural spawners. Reforms of hatchery programs need to be phased over time and effectiveness will depend on concurrent habitat improvements.

Interim benchmarks for reductions in hatchery impacts and corresponding fish status benefits are based on gradual incremental improvements over the next 50 years (Table 6-11). Some hatchery actions are expected to produce immediate benefits but there will be a time lag in realization of many benefits dependent on productivity improvements resulting from restoration of natural population diversity. Many hatchery actions have already been implemented and additional reforms are expected to be implemented within the next few years. Benchmark values for hatchery actions describe minimums needed to meet recovery objectives. It is anticipated that many hatchery actions will result in significantly greater and more rapid improvements in many populations. Additional action effectiveness benchmarks can be established as part of implementation planning based on the percentage of hatchery origin spawners (pHOS) in natural spawning populations and proportionate natural influence (PNI) which reflects both the numbers and quality of hatchery-origin spawners.

Ecological. Effects of ecological factors are complicated and difficult to manage. The recovery strategy involves management of predation by birds, marine mammals, and fish where predation impacts have been exacerbated by human activities. This includes redistributing nesting tern colonies in the estuary, excluding or removing sea lions from the vicinity of dam passage facilities which increase salmon vulnerability, and fisheries regulations or incentives to encourage exploitation of fish predators increased by habitat alterations. The strategy also involves preventative measures to avoid potentially disastrous impacts of exotic species invasions.

Interim benchmarks for reductions in predation impacts and corresponding fish status benefits are based on gradual incremental improvements over the next 50 years. Many predation-related actions have already been implemented but additional actions are also scheduled to occur. Some actions have immediate benefits (tern nesting colony translocation, marine mammal removal). Benefits of others may be realized in future years (pikeminnow population restructuring). As a result, the greatest impact reductions will be realized within the near and intermediate term. Longer term benefits will involve maintenance of target levels and smaller net impact reductions. Specific action effect monitoring benchmarks can also be established for each ecological factor. For instance, impact reductions assume a two-thirds reduction in tern predation and a 25% reduction in pikeminnow predation. Note that benefits of actions are population-specific depending on extent of predation exposure which depends on the subbasin of origin for each population.

6.5 Steelhead

6.5.1 Population Descriptions

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. 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.

Kalama Summer Steelhead: This was historically one of the larger populations in the region. Summer steelhead spawn above Lower Kalama Falls in the mainstem and NF Kalama River and throughout many tributaries, including Gobar, Elk, Fossil, and Wild Horse Creeks. Kalama summer and winter steelhead have been observed spawning in the same areas, therefore runs are not always reproductively separate. Hatchery produced summer steelhead of Kalama and Skamania stocks are released at Kalama Falls and Fallert Creek Hatcheries. Summer steelhead smolts from Beaver Creek and Skamania Hatcheries have been transferred to Gobar Pond and acclimated for 1-2 months prior to release. Summer steelhead returns can be monitored at the Kalama Falls Trap. While abundance and productivity of this population are high, diversity has been affected by historical hatchery practices and influences. Diversity issues are being addressed with hatchery measures.

North Fork Lewis Summer Steelhead: Most historical spawning occurred in lower Merwin Reservoir tributaries (now blocked) and in Cedar Creek. Spawning currently occurs in the lower North Fork Lewis from approximately RM 7 to RM 20 and in tributaries below Merwin Dam, most notably in Cedar Creek. Skamania stock hatchery summer steelhead are released into the North Fork Lewis basin for harvest opportunity from the Ariel (Merwin) Hatchery located below Merwin Dam.

East Fork Lewis Summer Steelhead: Summer steelhead spawn throughout the basin, extending to the mainstem East Fork Lewis and tributaries upstream of Moulton Falls. Hatchery origin summer steelhead smolts are currently released into the EF Lewis River. Recent snorkel surveys indicate hatchery summer steelhead comprise about 35% of the spawning escapement on the EF Lewis River. The high incidence of hatchery-origin fish will need to be addressed in order to meet objectives for EF Lewis summer steelhead which have been prioritized as a Primary population destined for recovery to high viability.

Washougal Summer Steelhead: This population was likely large historically and is considered a genetic legacy population. Current returns are about average for recent returns to lower Columbia streams. Summer steelhead spawn throughout the Washougal Basin, including the mainstem Washougal and tributaries upstream of Dougan Falls, the Little Washougal, and the North Fork Washougal. The Skamania Hatchery located about 1 mile from the mouth of the West Fork has released winter steelhead in the basin since the 1950s.

Wind Summer Steelhead: This is the highest rated summer steelhead population in the lower Columbia. Current adult returns are high and above average for recent years, and there is reasonable juvenile production in key reaches. Summer steelhead spawn throughout the Wind Basin including the mainstem Wind, the Little Wind, and Panther, Bear, Trout, Trapper, Dry, and Paradise creeks. High gradients and waterfalls exist throughout the basin; some have been modified to promote fish passage while others remain as impediments to upstream steelhead migration. Shipperd Falls (40 ft cascade) was a block to winter steelhead until a fish ladder was constructed in 1956. Construction of Bonneville Dam inundated the lower one mile of river, flooding spawning and rearing habitat. Summer steelhead hatchery releases began in the basin in 1960; releases were suspended in the early 1980s for wild steelhead management then reinstated in the mid 1980s. Skamania and Vancouver Hatchery stock were planted in the Wind River Basin. Hatchery steelhead releases were discontinued in 1997. Trout Creek trap counts conducted in 1992 indicate almost no migration of hatchery steelhead into this drainage; the hatchery fish that are captured are excluded from the drainage to preserve genetic diversity of the wild stock. While abundance and productivity of this population are high, diversity has been affected by historical hatchery practices and influences. Diversity issues are being addressed with hatchery measures.

Table 6-12. 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
S.F. Toutle	Primary	M	VH	H	M	H+	+35%	3,600	350	600
N.F. 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
N.F. Lewis [C]	Contributing	VL	M	M	VL[2]	M	>500%	8,300	150	400
E.F. Lewis	Primary	M	VH	M	M[1]	H	+25%	900	350	500
Salmon	Stabilizing	VL	H	M	VL[2]	VL	0%	na	<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
N.F. Lewis	Stabilizing	VL	VL	VL	VL	VL	0%	na	150	--
E.F. 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%	na	200	300
U. Gorge (WA/OR)	Stabilizing	L	M	M	L[2]	L	0%	na	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]	na	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.*
[C] *Designated as a historical core population by the Technical Recovery Team.*
[G] *Designated as a historical legacy population by the Technical Recovery Team.*

Winter Steelhead

Washington lower Columbia winter steelhead include six populations at very high risk of extinction, six at high risk, and five at moderate risk (Table 6-12). No Washington populations are at low or very low risk of extinction. In contrast, of the seven additional populations occurring only in Oregon, six are at moderate, low, or very low risk. Risks result from a combination of low abundance and productivity, losses of spatial structure, and reduced diversity due to low numbers and pervasive hatchery effects.

Grays/Chinook Winter Steelhead: This population is part of the Southwest Washington steelhead ESU which is not listed under the Federal ESA. Winter steelhead are distributed throughout the mainstem above tidal influence and throughout the East, West, and South Forks. In 1957, Grays River Falls (RM 13) was lowered with explosives, providing easier upstream migration; during the 1950s numerous other natural and man-made barriers above Grays Falls were cleared to improve steelhead access to the upper watershed. Hatchery produced winter steelhead from Elochoman and Cowlitz Rivers and Chambers Creek stocks have been planted in the Grays River basin since 1957. However, interaction with naturally produced fish is likely low due to different spawn timing. Hatchery fish contribute little to natural winter steelhead production in the Grays River basin.

Elochoman/Skamokawa Winter Steelhead: This population is part of the Southwest Washington steelhead ESU which is not listed under the Federal ESA. Winter steelhead are distributed throughout the mainstem Elochoman and in the lower reaches of Beaver, Duck, Clear, Rock, and Otter Creeks and the East, North, and West Fork Elochoman. In the Skamokawa, steelhead are distributed throughout the mainstem Skamokawa, Wilson, Left Fork, Quartz, and McDonald Creeks, and smaller tributaries such as Bell Canyon, Pollard, and Standard Creeks. Hatchery produced winter steelhead from Elochoman and Cowlitz Rivers and Chambers Creek stocks have been planted in the Elochoman River basin since 1955. Currently, the Elochoman Hatchery, located on the mainstem, produces winter steelhead smolts. Although hatchery winter steelhead constitute the majority of the run, hatchery fish contribute little to natural winter steelhead production in the Elochoman and Skamokawa River watersheds. Interactions between hatchery and naturally produced fish are thought to be low due to different spawn timing.

Mill/Abernathy/Germany Winter Steelhead: This population is part of the Southwest Washington steelhead ESU which is not listed under the Federal ESA. Spawning in Mill Creek occurs in the mainstem, North Fork and unnamed tributaries. Spawning in Abernathy Creek occurs in the mainstem, Slide Creek, and Cameron Creek. Spawning in Germany Creek occurs in the mainstem, Loper Creek, and John Creek. There are no steelhead hatcheries located on any of these creeks. However, Elochoman River, Chambers Creek, and the Cowlitz River stocks produced at the Beaver Creek Hatchery were planted annually in Abernathy and Germany Creeks from 1961 to 2000. Hatchery plantings have rarely occurred in Mill Creek. Hatchery fish contribute little to natural winter steelhead production in these creeks because natural fish spawn later than hatchery stocks.

Lower Cowlitz Winter Steelhead: The lower Cowlitz winter steelhead historical population may have been one of the largest in the lower Columbia Basin. Winter steelhead are distributed throughout the mainstem Cowlitz below Mayfield Dam; natural spawning occurs in Olequa, Ostrander, Salmon, Arkansas, Delameter, Stillwater and Whittle Creeks. Hatchery winter steelhead have been planted in the Cowlitz River basin since 1957 using broodstock from Cowlitz River and Chambers Creek. The Cowlitz Trout Hatchery, located on the mainstem Cowlitz at RM 42, currently produces winter steelhead. Both non-local stock (early-timed) and local stock (late-timed) hatchery winter steelhead programs exist in the lower Cowlitz. Hatchery fish account for the majority of the winter steelhead run to the Cowlitz River basin.

Upper Cowlitz Winter Steelhead: Historically, winter steelhead were distributed throughout the upper basin; known spawning areas included the mainstem Cowlitz near Riffle, the reach between the Muddy

Fork and the Clear Fork, and the lower Ohanapecosh River. Construction of Mayfield Dam in 1963 blocked access to the upper watershed. Current natural spawning returns are part of an upper Cowlitz reintroduction program initiated in 1994. Adults are captured at Cowlitz hatcheries and transported to the upper Cowlitz Basin for release. In addition, Cowlitz origin hatchery produced late spawning winter steelhead are planted in the upper basin. Smolts are captured at the Cowlitz Falls Dam collection facility, acclimated at Cowlitz Salmon Hatchery and released into the lower Cowlitz. Successful reintroduction will depend on effective passage. Collection efficiencies of downstream migrant steelhead, that have been reintroduced upstream of Cowlitz Falls Dam, has been difficult but better than that of spring Chinook juveniles.

Cispus Winter Steelhead: Winter steelhead historically returned to the Cispus River before construction of Mayfield Dam in 1963 blocked access to the upper watershed. Current natural spawning returns are part of a steelhead reintroduction program initiated in 1994. Adults are captured at Cowlitz hatcheries and transported to the Cispus River for release. Smolts are captured at the Cowlitz Falls Dam collection facility, acclimated at Cowlitz Salmon Hatchery and released into the lower Cowlitz. Successful reintroduction will depend on effective passage.

Tilton Winter Steelhead: Winter steelhead historically returned to the Tilton River in average numbers before construction of Mayfield Dam in 1963 blocked access to the upper watershed. Current natural spawning returns are part of a steelhead reintroduction program initiated in 1994. Adults are captured at Cowlitz hatcheries and transported to the Tilton River for release. In addition, late stock winter steelhead are planted into the Tilton River. Smolts are captured at the Cowlitz Falls Dam collection facility, acclimated at Cowlitz Salmon Hatchery and released into the lower Cowlitz.

South Fork Toutle Winter Steelhead: This population is currently one of the healthiest in the lower Columbia ESU. Spawning occurs in the mainstem SF Toutle and Studebaker, Johnson, and Bear Creeks. The 1980 eruption of Mt. St. Helens greatly altered the habitat within the Toutle River. Aside from small releases of winter steelhead fry after the 1980 Mt. St. Helens eruption, no hatchery winter steelhead have been released in the SF Toutle River.

North Fork Toutle Winter Steelhead: Winter steelhead spawn primarily in the NF Toutle River mainstem, Alder and Deer Creeks. In the Green River they spawn in the mainstem and Devils, Elk, and Shultz Creeks. The 1980 eruption of Mt. St. Helens greatly altered the habitat within the Toutle River Basin; the NF Toutle sustained the most significant habitat degradation. Wild steelhead are trapped and passed over the NF Toutle sediment retention structure to allow access to tributaries upstream. Hatchery winter steelhead have been planted in the NF Toutle River basin since 1953 using Elochoman and Cowlitz Rivers and Chambers Creek broodstock. The Cowlitz Trout Hatchery, located on the mainstem Cowlitz at RM 42, is the only hatchery in the basin producing winter steelhead. Aside from small releases of winter steelhead fry after the 1980 Mt. St. Helens eruption, no hatchery winter steelhead have been released in the Green River. Hatchery fish contribute little to winter steelhead natural production due to run timing.

Coweeman Winter Steelhead: Winter steelhead are distributed throughout the mainstem Coweeman, Goble Creek, and the lower reaches of Mulholland and Baird Creeks. Hatchery winter steelhead have been planted in the Coweeman River basin since 1957 using broodstock from the Elochoman and Cowlitz Rivers and Chambers Creek. Hatchery fish comprise most of the winter steelhead run in the Coweeman River basin. Inbreeding with hatchery produced steelhead is thought to be low because of differences in spawn timing.

Kalama Winter Steelhead: Winter steelhead spawn in the mainstem Kalama River up to a 35 ft barrier falls (RM 36.8) and in Gobar, Elk, and Fossil Creeks. After the 1980 Mt. St. Helens eruption, straying

Cowlitz River steelhead spawned with native Kalama stocks. Kalama summer and winter steelhead have been observed spawning together, therefore runs are not reproductively separate. There are both local and non-local hatchery stock programs in the basin. Hatchery winter steelhead have been planted in the Kalama basin as early as 1938. Hatchery winter steelhead are currently released at Kalama Falls Hatchery or transferred to Gobar Pond where they are acclimated and either released directly to Gobar Creek or trucked and released directly into the Kalama River. The Cowlitz and Beaver Creek Hatcheries have released steelhead smolts directly to the Kalama without acclimation.

North Fork Lewis Winter Steelhead: The historical population was one of the largest in the lower Columbia basin and was predominately produced in the upper Lewis watershed above Swift Dam. Construction of Merwin Dam in 1932 blocked access to approximately 80% of the spawning and rearing habitat in the NF Lewis. A dam located on Cedar Creek was removed in 1946, restoring access to habitat throughout this tributary. Currently, spawning occurs in the NF Lewis River downstream of Merwin Dam and in Cedar Creek and other accessible tributaries. The Ariel (Merwin) Hatchery, located below Merwin Dam, has been releasing winter steelhead in the Lewis basin since the early 1990s. Habitat for wild winter steelhead in the lower North Fork Lewis is limited. The winter steelhead program at Merwin Hatchery uses non-endemic early winter steelhead to mitigate for lost fishery opportunities due to dam construction. Measures included in the FERC relicensing settlement agreement for Lewis River hydroelectric projects call for the taking of steps to achieve a genetically viable, self-sustaining, naturally reproducing, harvestable winter steelhead population above Merwin Dam.

East Fork Lewis Winter Steelhead: The EF Lewis currently supports one of the stronger populations in the region. Winter steelhead spawn in the EF Lewis River as well as Rock Creek and other tributaries; rearing habitat is available throughout most of the basin. Upstream migration was improved in 1982 by "notching" Sunset Falls which lowered the falls from 13.5 to 8 feet. Approximately 12% of the run now spawns above Sunset Falls. There are no hatcheries on the EF Lewis River. However, Skamania Hatchery winter steelhead smolts are currently released into the lower EF Lewis River for harvest opportunity.

Salmon Creek Winter Steelhead: Winter steelhead historically spawned throughout the Salmon Creek Basin, the lower reaches of Gee Creek, Whipple Creek, Burnt Bridge Creek and portions of the Lake River. There are no hatcheries on Salmon Creek but hatchery winter steelhead have been planted in the basin since 1957. The Skamania Hatchery currently releases winter steelhead into Salmon Creek for harvest opportunity. The current population status is very low with much of the watershed in heavily urbanized areas.

Washougal Winter Steelhead: Winter steelhead spawn primarily in the mainstem Washougal upstream to Dougan Falls, the Little Washougal, North Fork Washougal, and Stebbins and Cougar Creeks. Several small dams that blocked/impeded steelhead migration have been removed or by-passed, providing access to more of the basin. Dougan Falls at RM 21 is considered a low water barrier to steelhead; above Dougan Falls, the stream is characterized by a series of falls and cascades. The Skamania Hatchery located about 1 mile from the mouth of the West Fork has released winter steelhead in the basin since the 1950s.

Lower Gorge Winter Steelhead: This is a shared population with Oregon but most of the habitat exists in Washington. Winter steelhead spawn primarily in the lower two miles of Hamilton Creek. Hatchery winter steelhead from the Skamania (Washougal) and Beaver Creek (Elochoman) Hatcheries have been planted in the basin since 1958. This is one of only three Gorge winter steelhead populations including the Upper Gorge and Hood River.

Upper Gorge Winter Steelhead: This is a shared population with Oregon but most of the habitat exists in Washington. Winter steelhead currently spawn in streams throughout the area including the Wind

River and White Salmon River below Condit Dam (RM 3). Shipperd Falls (40 ft cascade) was a block to Wind River winter steelhead until a fish ladder was constructed in 1956. Winter steelhead are currently distributed throughout the lower mainstem Wind River (~11 mi) and Trout Creek (RM 10.8). High drop-offs and waterfalls exist throughout the basin; some have been modified to promote fish passage while others remain as impediments to upstream steelhead migration. Construction of Bonneville Dam inundated the lower one mile of the Wind River, flooding spawning and rearing habitat. Hatchery releases of Chambers Creek and Skamania winter steelhead stock occurred in the Wind River Basin between 1951 and 1963. Because of concern with wild steelhead interactions, releases of catchable-size rainbow trout were discontinued in 1994 and hatchery steelhead releases were discontinued in 1997. No anadromous fish except unmarked (wild) steelhead were allowed past Hemlock Dam on Trout Creek. Hemlock Dam was removed in 2009.

6.5.2 Population Objectives & Targets

Summer Steelhead

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. Five of six summer steelhead populations are prioritized for recovery to high or very high levels of viability (Figure 6-11). Washington populations prioritized for large improvements typically include the strongest existing populations (Wind), core populations with high potential for improvement based on large historical production of the available habitat (Kalama, Washougal) and genetic legacy populations representative of critical elements of the native genetic diversity (East Fork Lewis).

Almost all summer steelhead populations (5 of 6 or 83%) are prioritized for significant improvements to meet ESU objectives. Only North Fork Lewis summer steelhead were designated as Stabilizing where significant improvements in viability are not planned. The stabilizing designation for North Fork Lewis summer steelhead recognizes habitat limitations, competing objectives for winter steelhead, and flexibility for significant hatchery production to sustain fishery opportunities in the interim until natural population productivity might be restored.

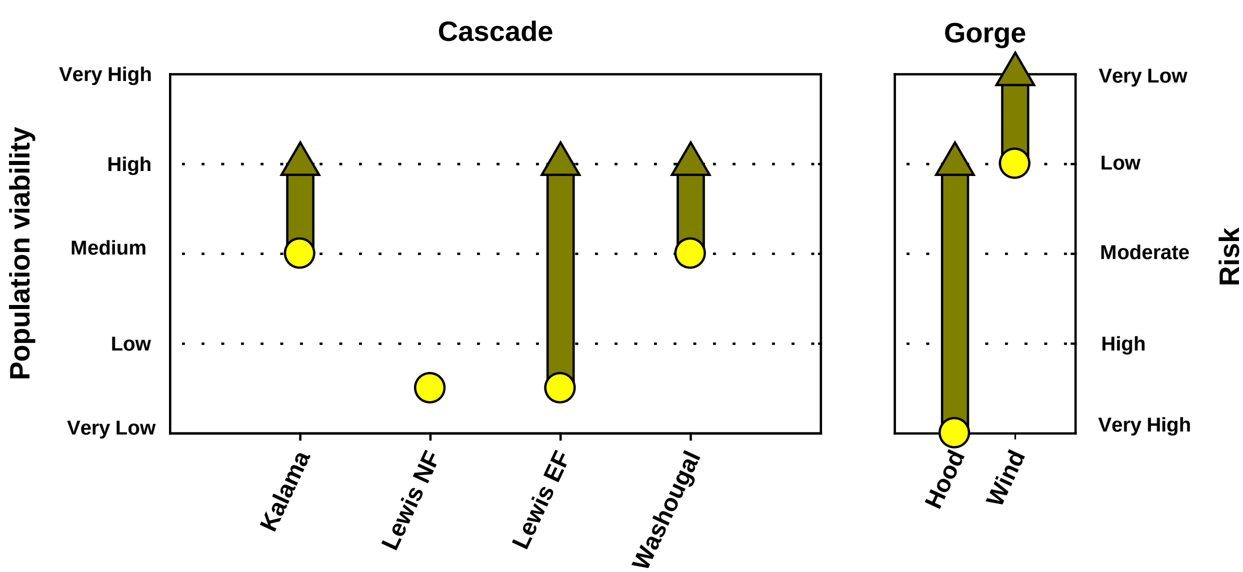


Figure 6-11. Viability objectives for summer steelhead identified in the recovery scenario for Washington and in Oregon's Recovery Plan.

The scenario meets TRT criteria of at least two populations at high or better viability and a strata average exceeding moderate (score ≥ 2.25) in all strata. However, Oregon has determined that inherent habitat limitations make prospects uncertain for recovery of the Hood River population to high levels of viability. This Plan prioritizes additional Washington populations in the Cascade strata for higher levels of viability in order to compensate for limited recovery prospects in the Gorge.

Substantial improvements in population viability attributes will be required to meet viability objectives for summer steelhead populations (Table 6-12). Baseline Kalama and Wind summer steelhead populations meet abundance and productivity objectives but improvements in diversity will be required to meet viability objectives. Baseline abundance and productivity of East Fork Lewis summer steelhead is uncertain – for this population, the Plan identifies a productivity and abundance improvement of at least 500% as initial planning targets. No improvements are identified for the Stabilizing North Fork Lewis population although some level of recovery effort will still be needed to forestall any future declines.

Winter Steelhead

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. Seventeen of 24 winter steelhead populations are identified for recovery to high or very high levels of viability (Figure 6-12). Washington populations prioritized for large improvements typically include the strongest existing populations (Grays, Mill/Abernathy/Germany), core populations with high potential for improvement based on large historical production of the available habitat (North Fork Toutle) and genetic legacy populations representative of critical elements of the native genetic diversity (Upper Cowlitz, Cispus). 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.

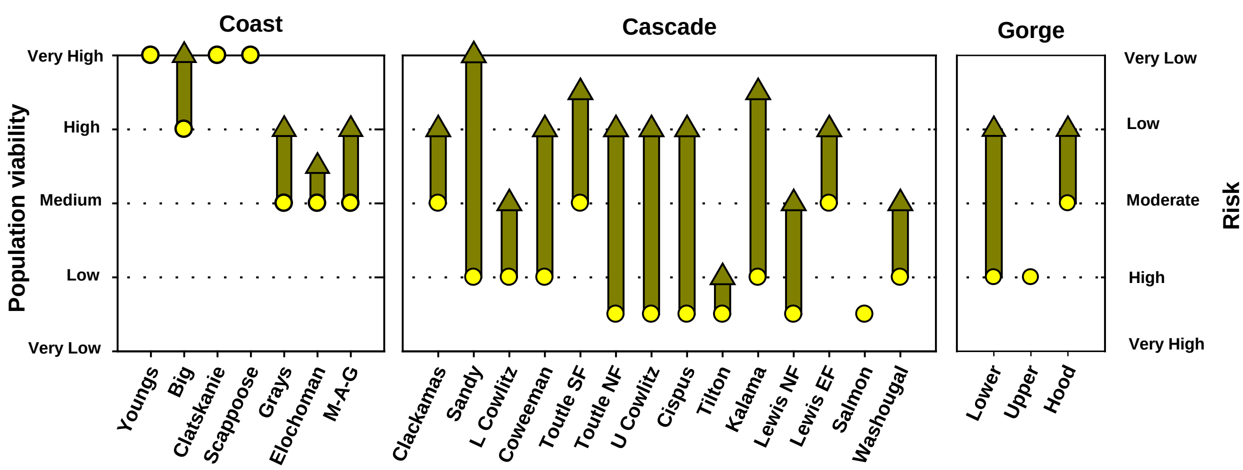


Figure 6-12. Viability objectives for winter steelhead identified in the recovery scenario for Washington and in Oregon's Recovery Plan.

Almost all winter steelhead populations (22 of 24 or 92%) are prioritized for high levels of viability or significant improvements to meet ESU objectives. The scenario includes five contributing populations in Washington and Oregon, typically designated for improvement to moderate levels of viability. These improvements are needed to meet TRT criteria for strata-average viabilities exceeding medium values (2.25 or better). Contributing populations also include several areas (Lower Cowlitz, North Fork Lewis, Washougal) designated for significant hatchery production to sustain fishery opportunities in the interim until natural population productivity can be restored by a combination of recovery actions including habitat improvements in the subbasin and the estuary.

The scenario meets TRT criteria of at least two populations at high or better viability and a strata average exceeding moderate (score ≥ 2.25) in all strata. Only the Cascade and Gorge strata are included in the listed lower Columbia River steelhead ESU. Coast strata populations are part of the unlisted Southwest Washington ESU. These populations are included in this Plan in order to provide guidance to comprehensive Washington planning efforts for land and water use that address fish objectives in addition to recovery of ESA species. The majority of the listed lower Columbia River winter steelhead populations occur in whole or in part in Washington streams (14 of 17 or 82%). The recovery scenario identifies significant contributions from both Washington and Oregon populations in order to meet ESU-wide recovery criteria.

Some level of recovery effort will still be needed in every population in order to arrest continuing long term declining trends, even among Stabilizing populations targeted for minimal improvement. Only two winter steelhead populations are designated as Stabilizing where significant improvements in viability are not planned. In Washington's Salmon Creek population, habitat has been severely degraded by urban development and finite recovery resources are better focused in other areas with higher benefit-cost ratios. In the shared Upper Gorge population, habitat potential for winter steelhead at the upstream limits of their distribution was historically limited.

Substantial improvements will be required to meet viability objectives for Washington winter steelhead populations (Table 6-12). Populations will require relative improvements of 5% to >500% to meet Primary or Contributing population objectives. Corresponding impact reduction targets range from 1% to 50% (Table 6-13).

6.5.3 Threats & Impacts

Declines in status of lower Columbia River 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. Impacts of each factor are compounded across the salmon life cycle to drive most populations to baseline very low levels. Net effects of quantifiable and potentially manageable impacts translate into an estimated 67-100% (average 84%) reduction in abundance and productivity of lower Columbia River steelhead populations in Washington (Figure 6-13). Thus, baseline fish numbers represent only 0-33% of the historical production potential in the absence of potentially manageable impacts and 10-100% of population-specific recovery targets. Total reductions would be even greater if all human impacts could be effectively quantified.

No single factor accounts for the majority of the reduction in fish numbers and the significance of specific factors varies from population to population (Figure 6-13, Table 6-13). For example, the Grays-Chinook population of winter steelhead was reduced by an estimated 73% by combined impacts of a 50% reduction in tributary habitat conditions, a 15% reduction in estuary habitat conditions, a 10% fishery impact rate, an 8% hatchery impact rate, and a 20% predation rate. Biological objectives will require no abundance and productivity improvements in this population because baseline numbers are at objective levels. (Unquantified improvements in diversity are required to meet viability objectives.)

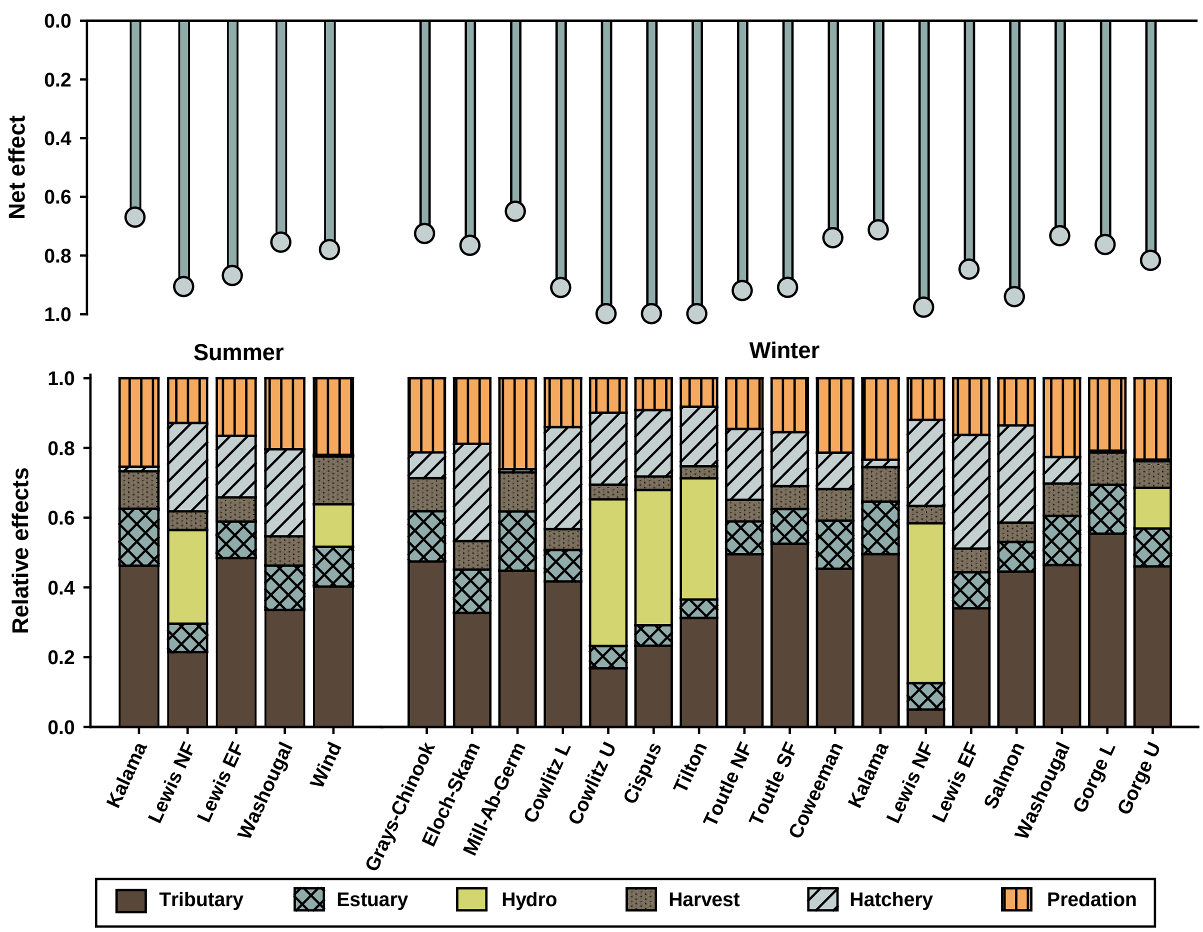


Figure 6-13. Net effect and relative contribution of potentially manageable impact factors on steelhead in Washington lower Columbia River subbasins.

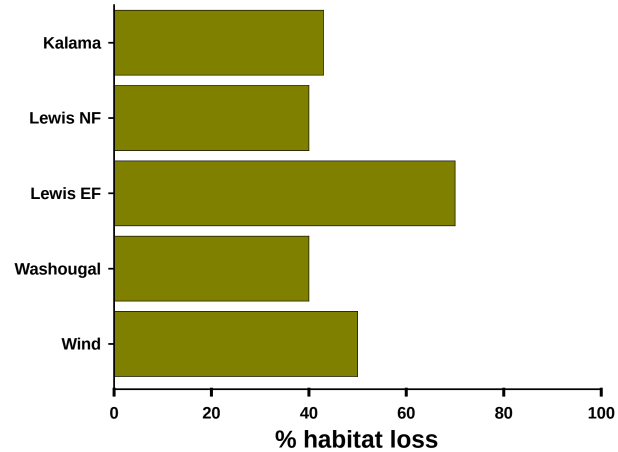
Table 6-13. Potentially manageable impacts of threats, productivity improvement targets, and impact reduction targets consistent with recovery of lower Washington Columbia River steelhead populations if reductions are distributed across factors in proportion to their baseline impact.

	Productivity	Baseline impacts (listing date reference)							Impacts at target					
Population	**Target**	**Hab**	**Est**	**Dams**	**Fishery**	**Hat**	**Pred**	**Δ**	**Hab**	**Est**	**Dams**	**Fishery**	**Hat**	**Pred**
Coast Winter														
Grays/Chinook	0%	0.50	0.15	0.00	0.10	0.08	0.20	0%	0.50	0.15	0.00	0.10	0.08	0.20
Eloch/Skam	0%	0.40	0.15	0.00	0.10	0.34	0.20	0%	0.40	0.15	0.00	0.10	0.34	0.20
Mill/Ab/Germ	0%	0.40	0.15	0.00	0.10	0.01	0.23	0%	0.40	0.15	0.00	0.10	0.01	0.23
Cascade Winter														
Lower Cowlitz	+5%	0.70	0.15	0.00	0.10	0.49	0.24	1%	0.69	0.15	0.00	0.10	0.48	0.23
Upper Cowlitz	>500%	0.40	0.15	1.00	0.10	0.49	0.24	50%	0.20	0.08	0.50	0.05	0.25	0.12
Cispus	>500%	0.60	0.15	1.00	0.10	0.49	0.24	50%	0.30	0.08	0.50	0.05	0.25	0.12
Tilton	>500%	0.90	0.15	1.00	0.10	0.49	0.24	50%	0.45	0.08	0.50	0.05	0.25	0.12
N.F. Toutle	+125%	0.80	0.15	0.00	0.10	0.33	0.24	20%	0.64	0.12	0.00	0.08	0.26	0.19
S.F. Toutle	+35%	0.80	0.15	0.00	0.10	0.24	0.24	7%	0.74	0.14	0.00	0.09	0.22	0.22
Coweeman	+25%	0.50	0.15	0.00	0.10	0.12	0.24	13%	0.43	0.13	0.00	0.09	0.10	0.20
Kalama	+45%	0.50	0.15	0.00	0.10	0.02	0.24	25%	0.37	0.11	0.00	0.07	0.02	0.18
N.F. Lewis	>500%	0.10	0.15	0.92	0.10	0.49	0.24	50%	0.05	0.08	0.46	0.05	0.25	0.12
E.F. Lewis	+25%	0.50	0.15	0.00	0.10	0.48	0.24	9%	0.45	0.14	0.00	0.09	0.44	0.22
Salmon	0%	0.80	0.15	0.00	0.10	0.50	0.24	0%	0.80	0.15	0.00	0.10	0.50	0.24
Washougal	+15%	0.50	0.15	0.00	0.10	0.08	0.24	8%	0.46	0.14	0.00	0.09	0.08	0.22
Cascade Summer														
Kalama	0%	0.43	0.15	0.00	0.10	0.01	0.24	0%	0.43	0.15	0.00	0.10	0.01	0.24
N.F. Lewis	0%	0.40	0.15	0.50	0.10	0.47	0.24	0%	0.40	0.15	0.50	0.10	0.47	0.24
E.F. Lewis	>500%	0.70	0.15	0.00	0.10	0.26	0.24	50%	0.35	0.08	0.00	0.05	0.13	0.12
Washougal	+40%	0.40	0.15	0.00	0.10	0.30	0.24	21%	0.32	0.12	0.00	0.08	0.24	0.19
Gorge Winter														
L. Gorge	+45%	0.60	0.15	0.00	0.10	0.01	0.22	20%	0.48	0.12	0.00	0.08	0.00	0.18
U. Gorge	0%	0.60	0.14	0.11	0.10	0.01	0.30	0%	0.60	0.14	0.11	0.10	0.01	0.30
Gorge Summer														
Wind	0%	0.50	0.14	0.11	0.17	0.01	0.273	0%	0.50	0.14	0.11	0.17	0.01	0.27

Summer Steelhead

The significance of threats affecting summer steelhead is summarized as follows:

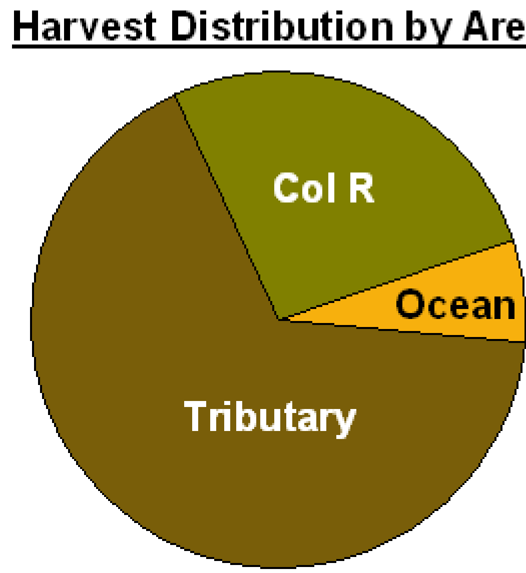
Habitat: Reductions in quantity and quality of freshwater spawning and rearing habitats account for a large share of net impact on summer steelhead. Changes in stream flow, temperature, sedimentation, and channel characteristics related to land use have reduced freshwater productivity potential for this species by 40% in some of the healthier forested watersheds to as much as 70% in more developed subbasins. Estimates were based on analysis of baseline and historical conditions for fish using the Ecosystem Diagnosis and Treatment model.



Estuary: An estimated 40% of stream-type salmon, such as steelhead, die during the critical smolt migration and saltwater acclimation periods that occur in the lower Columbia River mainstem, estuary, and plume. The human-caused portion of this total is unknown but likely significant due to large-scale changes in river discharge patterns and estuary habitats related to water use, channel maintenance, and other activities. For planning purposes, strategic impact reduction targets were based on half of the non-predation related estuary mortality which is equivalent to a 14%-15% impact.

Dams: Direct dam effects on lower Columbia River summer steelhead populations vary from negligible to moderate (0 to 50%). Hydropower facilities have eliminated access of the North Fork Lewis populations to about half of their historical habitat. The Wind River population is impacted by approximately 15% passage mortality of juveniles and adults at Bonneville Dam. For remaining populations, dam effects are largely manifested through Columbia River mainstem and estuary habitat effects.

Fisheries: Fishery impacts on wild summer steelhead are currently limited to incidental mortality in freshwater fisheries. Steelhead are rarely caught in ocean fisheries. Most impacts occur in tributary sport fisheries. Spring and summer commercial fishery impacts below Bonneville are low, on the order of a few percent. Populations above Bonneville are also subject to treaty tribal subsistence and commercial fisheries. Impacts generally averaged about 10% or less around the time of first listing. However, historical fishery impacts regularly exceeded 70%. Non-tribal commercial fisheries for steelhead have been prohibited since 1975. Mark-selective sport fisheries for hatchery steelhead were adopted beginning in the 1980s.



Hatcheries: State and Federal lower Columbia River hatcheries have recently been producing about 1.2 million summer steelhead per year, primarily in Washington. Analyses by the regional Hatchery Scientific Review Group estimated a 1-47% reduction in productivity of wild summer steelhead due to effects of natural spawning of less-fit hatchery origin fish over decades of hatchery operation.

Hatchery Releases (@ listing)

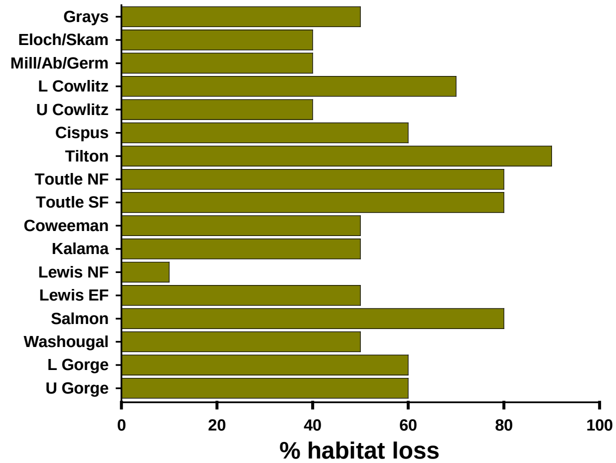
Location	Number
Elochoman	30,000
Cowlitz	500,000
Toutle NF	25,000
Toutle SF	25,000
Kalama	90,000
Lewis NF	225,000
Lewis EF	25,000
Washougal	60,000
WA total	**980,000**
OR total	**215,000**
Combined	**1,198,000**

Ecological: Impacts of ecological factors including non-native species, food web interactions, and predation are difficult to quantify. Potentially-manageable mortality due to predation by birds, marine mammals, and northern pikeminnow in the lower Columbia River mainstem and estuary has been estimated to be on the order of magnitude of 24-30% for lower Columbia steelhead. Stream type migrant life histories have been found to be vulnerable to significant predation in the estuary by birds including large nesting colonies of Caspian Terns and cormorants.

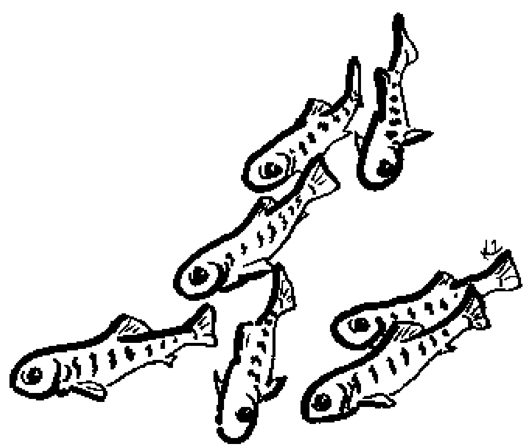
Winter Steelhead

The significance of threats affecting winter steelhead is summarized as follows:

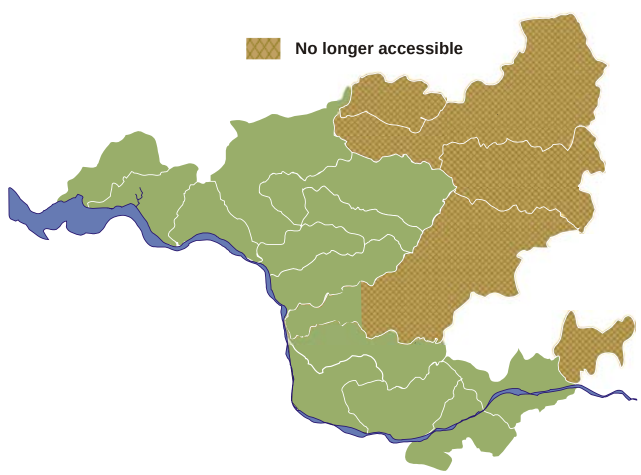
Habitat: Reductions in quantity and quality of freshwater spawning and rearing habitats account for a large share of net impact on winter steelhead. Changes in stream flow, temperature, sedimentation, and channel characteristics related to land use have reduced freshwater productivity potential for this species by 10% in some of the healthier forested watersheds to as much as 80-90% in more developed subbasins. Estimates were based on analysis of baseline and historical conditions for fish using the Ecosystem Diagnosis and Treatment model.



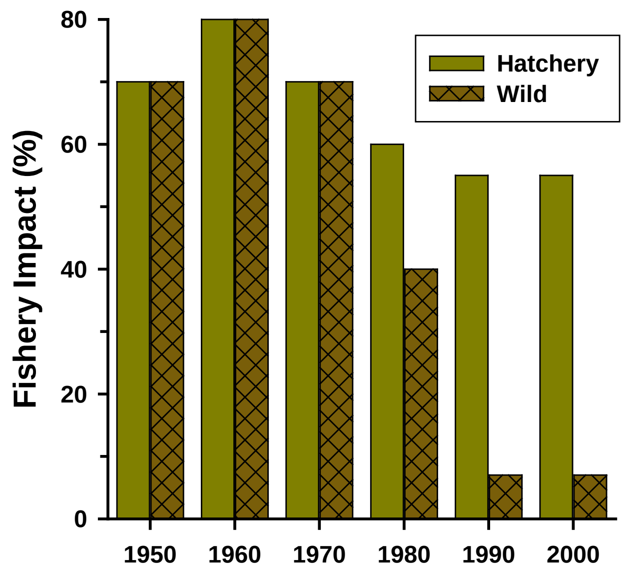
Estuary: An estimated 40% of stream-type salmon such as steelhead die during the critical smolt migration and saltwater acclimation periods that occur in the lower Columbia River mainstem, estuary, and plume. The human-caused portion of this total is unknown but likely significant due to large-scale changes in river discharge patterns and estuary habitats related to water use, channel maintenance, and activities. For planning purposes, strategic impact reduction targets were based on half of the non-predation related estuary mortality which is equivalent to a 14%-15% impact.



Dams: Direct dam effects on lower Columbia River winter steelhead populations vary from negligible to moderate (0 to 100%). Hydropower facilities have eliminated access of upper Cowlitz, Cispus, Tilton, and North Fork Lewis populations to large areas of historically very productive habitat. The upper gorge population is impacted by approximately 15% passage mortality of juveniles and adults at Bonneville Dam. For remaining populations, dam effects are largely manifested through Columbia River mainstem and estuary habitat effects.



Fisheries: Fishery impacts on wild winter steelhead are currently limited to incidental mortality in freshwater fisheries. Steelhead are rarely caught in ocean fisheries. Most impact occurs in tributary sport fisheries. Some winter steelhead are incidentally impacted by early commercial spring Chinook fisheries below Bonneville. Winter steelhead impacts in treaty tribal fisheries above Bonneville are low due to timing differences. Impacts generally averaged about 10% or less around the time of first listing. However, historical fishery impacts exceeded 70%. Non-tribal commercial fisheries for steelhead have been prohibited since 1975. Mark-selective sport fisheries for hatchery steelhead were adopted beginning in the 1980s.



Hatcheries: Columbia River hatcheries have recently been producing about 1.5 million winter steelhead per year in Washington and an additional 400,000 in Oregon. Analyses by the regional Hatchery Scientific Review Group estimated a 1-50% reduction in productivity of wild winter steelhead due to the effects of natural spawning of less-fit hatchery origin fish over decades of hatchery operation.

Hatchery Releases (@ listing)

Location	Yearling	Subyearling
Grays	40,000	
Elochoman	90,000	
Cowlitz	690,000	350,000
Coweeman	20,000	
Kalama	90,000	
Lewis NF	100,000	
Lewis EF	90,000	
Salmon	20,000	
Washougal	60,000	
WA total	**1,200,000**	**350,000**
OR total	**400,000**	**0**
Combined	**1,600,000**	**350,000**

Ecological: Impacts of ecological factors including non-native species, food web interactions, and predation are difficult to quantify. Potentially-manageable mortality due to predation by birds, marine mammals, and northern pikeminnow in the lower Columbia River mainstem and estuary has been estimated to be on the order of magnitude of 22-27% for lower Columbia winter steelhead.

6.5.4 Impact Reduction Targets, Strategies & Benchmarks

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 (Table 6-13). The long term recovery strategy for steelhead involves significant reductions in the impacts of all threat categories.

Habitat. Recovery will require concerted efforts to protect remaining areas of favorable habitat and to restore habitat quality in significant historical production areas for priority populations. Substantial improvements are required in marginal areas of potentially-productive habitat extending into many small streams and watersheds. Without significant habitat improvements, benefits of estuary, dams, harvest, and hatchery actions will not be realized. Effective habitat restoration actions will include a combination of site-specific projects with more immediate benefits and watershed-based actions to repair habitat forming processes that will provide more long term benefits. While many habitat-related actions have already been undertaken, current activities do not reflect the scale of habitat improvements needed for recovery. Effective habitat protection actions will include a combination of site-specific projects, with a focus on currently-productive and potentially productive habitats identified as high priority in this Plan, as well as watershed, local government, or state programmatic actions to manage resources in a manner that protects long term habitat function. Subasin plans, included in Volume II of this Plan, identify high priority stream reaches, limiting habitat conditions, and effective habitat actions for this species.

This Plan estimates a 10% to 90% decline in habitat conditions across steelhead populations between historical and baseline conditions (depending on the population). Long term impact reduction targets describe habitat improvements relative to the baseline conditions ranging from 0% for stabilizing populations to 450% in populations that would need to be restored to high levels of viability to meet stratum targets specified by the Technical Recovery Team. Benchmarks target implementation of all substantive habitat actions within the first 24 years (Table 6-14). Benchmarks for habitat improvements (i.e. reduction in threat) are based on gradual incremental improvement in habitat conditions over the next 50 years reflecting the time lag in effect.

Estuary. Estuary recovery strategies have been identified for the benefit of all Columbia basin ESU's including those of the lower Columbia. Current plans have identified an objective of a 20% improvement in juvenile survival. For stream-type life histories such as steelhead, this translates into a 12% improvement (e.g. 20% of 60%). Improvements will depend on a combination of site-specific habitat improvement projects and restoration of functional habitat-forming processes which depend in part on river discharge patterns. Benchmarks are not identified in this Plan for estuary habitat – refer to the estuary module for further guidance on estuary habitat targets and schedules.

Dams. Recovery objectives also assign high priority to successful reintroduction into the upper Cowlitz, Cispus, and Lewis systems. These areas were core historical production areas for this species, habitat and watershed conditions are relatively intact, and the available habitat provides the highest production potential of any available area. These upper elevation streams are likely to become even more critical due to impacts of lower elevation habitats from expected future climate trends. Successful reintroduction will depend on the collection and passage of both returning adults and outmigrating smolts. High downstream passage efficiencies have historically been difficult to achieve in reservoir systems of this type. Gorge populations will also benefit by effective downstream passage measures at Bonneville Dam.

Table 6-14. 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%
	Lewis NF (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%
	Cowlitz L (winter run)		1%	2%	2%	3%	3%
	Lewis NF (winter run)	--	1%	3%	4%	5%	6%
	Lewis EF (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%
	Toutle SF (winter run)	--	6%	12%	19%	25%	27%
	Gorge L (winter run)	--	6%	13%	20%	28%	29%
	Cowlitz U (winter run)	--	7%	15%	23%	32%	33%
	Cispus (winter run)	--	14%	31%	50%	71%	75%
	Toutle NF (winter run)	--	15%	33%	54%	78%	82%
	Lewis EF (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, 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 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.

Interim benchmarks assume 50% implementation of hydro-related measures during the first 12 year period and 100% implementation by year 24 (Table 6-14). Most passage-related actions will have immediate effects but reintroduction efforts will require a longer period to reach objectives which require rebuilding of a productive, locally-adapted, population. Status improvements due to reintroduction will be very large but undefined relative to a starting point of zero.

Harvest. Harvest rates on naturally-produced steelhead have been reduced to low levels through a combination of fishery impact limits, abundance-based annual management, and mark-selective sport fisheries in the Columbia River, and tributaries. The recovery strategy involves continued regulation of fisheries to limit impacts to baseline levels.

Hatchery. The recovery strategy involves significant reductions in hatchery impacts on wild populations by use of both segregated and integrated hatchery programs. Segregated programs reduce wild impacts by time, area, and productivity differences between hatchery and natural stocks. Integrated programs involve regular incorporation of wild fish into hatchery broodstock in order to improve fitness. Hatchery strategies also involve elimination of hatchery releases and exclusion of stray hatchery fish from key natural production areas. Hatchery production will continue to be used for mitigation of lost production and to support limited fisheries in the interim until natural populations are restored to harvestable levels.

Interim benchmarks for reductions in hatchery impacts and corresponding fish status benefits are based on gradual incremental improvements over the next 50 years (Table 6-14). Some hatchery actions are expected to produce immediate benefits but there will be a time lag in realization of many benefits dependent on productivity improvements resulting from restoration of natural population diversity. Many hatchery actions have already been implemented and additional reforms are expected to be implemented within the next few years. Benchmark values for hatchery actions describe minimums needed to meet recovery objectives. It is anticipated that many hatchery actions will result in significantly greater, and more rapid improvements, in many populations. Additional action effectiveness benchmarks can be established as part of implementation planning based on the percentage of hatchery origin spawners (pHOS) in natural spawning populations and proportionate natural influence (PNI) which reflects both the numbers and quality of hatchery-origin spawners.

Ecological. Effects of ecological factors are complicated and difficult to manage. The recovery strategy involves management of predation by birds, marine mammals, and fish where predation impacts have been exacerbated by human activities. This includes redistributing nesting tern colonies in the estuary, excluding or removing sea lions from the vicinity of dam passage facilities which increase salmon vulnerability, and fisheries regulations or incentives to encourage exploitation of fish predators increased by habitat alterations. The strategy also involves preventative measures to avoid potentially disastrous impacts of exotic species invasions.

Interim benchmarks for reductions in predation impacts and corresponding fish status benefits are based on gradual incremental improvements over the next 50 years. Many predation-related actions have already been implemented but additional actions are also scheduled to occur. Some actions have immediate benefits (tern nesting colony translocation, marine mammal removal). Benefits of others may be realized in future years (pikeminnow population restructuring). As a result, the greatest impact reductions will be realized within the near and intermediate term. Longer term benefits will involve maintenance of target levels and smaller net impact reductions. Specific action effect monitoring benchmarks can also be established for each ecological factor. For instance, impact reductions assume a two-thirds reduction in tern predation and a 25% reduction in pikeminnow predation. Note that benefits of actions are population-specific depending on extent of predation exposure which depends on the subbasin of origin for each population.

6.6 Bull Trout

6.6.1 Objectives

The USFWS released a Lower Columbia River bull trout draft recovery plan in 2002[1]. 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.

6.6.2 Factors and Threats

Historic and current land use activities within the Lower Columbia Recovery Unit have impacted bull trout local 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 reduce instream flows and result in increased water temperatures. Nonnative species pose a threat to bull trout through potential hybridization, competition for resources, and predation. Bull trout do not compete well with introduced salmonids in degraded habitats (McPhail and Baxter 1996). There are currently no directed fisheries for bull trout in the lower Columbia. However, they are incidentally caught in other fisheries and some poaching likely occurs.

6.6.3 Recovery Strategy

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

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.

[1] *This LCFRB recovery plan does not have quite the same relationship to the USFWS Bull Trout Recovery Plan as it has to the NMFS salmon recovery plan. The USFWS has federal jurisdiction over bull trout and has developed a separate Draft Recovery Plan.*

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.

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. Abundances in both the Klickitat and White Salmon rivers are extremely low, and natural recolonization may not occur within recovery time frames. However, the overall recovery strategy for bull trout in the Lower Columbia Recovery Unit will emphasize the removal of threats and habitat restoration. Recovery should emphasize identifying and correcting threats affecting bull trout and bull trout habitats. Artificial propagation programs should not be implemented unless reasons for the decline have been addressed.

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.