# 5 Recovery Goals



This chapter sets forth goals consistent with the healthy and harvestable vision for focal salmonid species addressed by this plan as well as management objectives for other significant fish and wildlife species. The section starts with a summary of draft viability criteria recommended by NOAA's Technical Recovery Team. A recovery scenario then describes target improvements for all populations within the ESU consistent with the viability criteria. These population improvements are described in terms of spawner abundance and productivity improvement increments needed to move from current to desired status. Benchmarks for spatial structure, diversity, juvenile abundance, and habitat are also identified to provide systematic standards for gauging future population status relative to all parameters identified by the WLC-TRT as related to viability. Long term harvestability goals are also discussed.

## 5.1 Overview

The vision of this plan is for all Lower Columbia salmon and steelhead to be recovered to "healthy, harvestable levels that will sustain productive sport, commercial, and tribal fisheries, through the restoration and protection of the ecosystems upon which they depend and the implementation of supportive hatchery and harvest practices." This vision for recovery encompasses ESA de-listing goals in the sense that ESA de-listing could be achieved while working toward this vision.

This recovery plan focuses on Washington subbasins. However, it also presents preliminary assumptions about the recovery of Oregon populations. Lower Columbia River salmon and steelhead ESUs include both Washington and Oregon populations. Assumptions for Oregon populations were used to ensure that Washington goals are consistent with achieving viability of the entire ESU. Assumptions about Oregon populations were developed in consultation with the Oregon Department of Fish and Wildlife, but do not necessarily represent Oregon's view of recovery. Final Oregon population goals will be developed separately and will ultimately be incorporated into a domain wide recovery plan.

Where our data and knowledge of a species permit, recovery goals provide measurable criteria which can be used to monitor progress in protection and recovery. Where our data and understanding are lacking, these goals are more qualitative. In either case, it should be noted that our existing data and knowledge for all species as well as our understanding of the complex ecosystems on which they depend is less than complete. For this reason, it should be expected that recovery criteria and goals may be refined over time as additional scientific analyses are completed and new information becomes available.

This chapter describes the recovery goals for salmon and steelhead as well as objectives for other fish and wildlife species affected by this plan. Salmon and steelhead recovery goals are described using: 1) interim viability criteria identified by the Willamette Lower Columbia Technical Recovery Team (TRT), 2) a recovery scenario that establishes priorities among populations and subbasins, 3) abundance and productivity objectives for each population consistent with the recovery scenario, 4) changes in human impacts and threats consistent with population objectives, 5) benchmarks for other viable salmonid population parameters that provide guidance for recovery strategies and progress evaluations, and 6) long term harvest goals. For other fish and wildlife species, goals are based on the current status of the species, their habitat needs, their role in the ecosystem, and, where applicable, social, cultural, and legal factors.

## 5.2 Salmon and Steelhead Recovery Criteria

The biological goals for salmon and steelhead in this plan are based on and explicitly incorporate the work of the Willamette/Lower Columbia Technical Recovery Team (TRT). The TRT was convened by NOAA Fisheries to provide technical guidance and recommendations relating to the recovery of salmon and steelhead in the Willamette/Lower Columbia Domain. The TRT has developed recommendations for biological criteria for population and ESU-level viability (criteria that would indicate when populations or ESUs had a high probability of persistence into the future). The TRT has submitted a series of recommendations to NOAA Fisheries (McElhany et. al. 2003).

The TRT described viability based on probability of persistence over a 100-year timeframe (Table 1) and developed an approach to recovery that included overall ESU viability criteria, and criteria based on smaller units of strata and populations (Figure 1). The TRT approach has five essential elements:

***Stratified Approach:*** Every life history and ecological zone stratum that historically existed should have a high probability of persistence. Salmon ESUs in the lower Columbia River were stratified by the TRT into ecological zones (coast, cascade, and gorge) and life history types (spring run, fall run, etc.).

***Viable Populations:*** Individual populations within a stratum should have persistence probabilities consistent with a high probability of strata persistence. The TRT defined high persistence probability based on the presence of at least two populations with a negligible risk of extinction and a strata average of a medium-low risk of extinction.

***Representative Populations:*** Representative populations need to be preserved but not every historical population needs to be restored. Selected populations should include "core" populations that are highly productive, "legacy" populations that represent historical genetic diversity, and dispersed populations that minimize susceptibility to catastrophic events.

***Non-deterioration:*** No population should be allowed to deteriorate until ESU recovery is assured. Currently productive populations and population segments must be preserved. Recovery measures will be needed in most areas to arrest declining status and offset the effects of future impacts.

***Safety Factors:*** Higher levels of recovery should be attempted in more populations because not all attempts will be successful. Recovery efforts must target more than the minimum number of populations and more than the minimum population levels thought to ensure viability.

**Table 1. Viability categories identified by the Willamette-Lower Columbia Technical Recovery Team.**

| Scale | Viability | Description | Persistence probability[1] |
|---|---|---|---|
| 0 | Very low (VL) | Either extinct or very high risk of extinction | 0-40% |
| 1 | Low (L) | Relatively high risk of extinction | 40-74% |
| 2 | Medium (M) | Medium risk of extinction | 75-94% |
| 3 | High (H) | Low (negligible) risk of extinction (represents a "viable" level) | 95-99% |
| 4 | Very High (VH) | Very low risk of extinction | >99% |

*[1] 100-year persistence probabilities.*

Populations were delineated by the TRT based on a review of current and historical information (Myers et al. 2003). Strata were defined as groups of populations of an ESU with similar life history traits within the same ecological zone. Each ESU consists of two or more strata containing different life history and ecological zone combinations (Figure 2). Lower Columbia River ESUs generally include Washington and Oregon populations from the Columbia River mouth to the Big White Salmon River in Washington and the Hood River in Oregon. Distinct ecological zones in this range include Coast, Cascades, and Gorge watersheds. Chinook life history types include stream-type spring run, ocean-type fall run (tules), and ocean-type late fall run (brights). Thus, Chinook salmon strata include Coast fall, Cascade fall, Cascade late fall, Gorge spring, etc. Similar distinctions occur for listed steelhead and chum salmon.

The TRT's guidelines for ESU, strata, and population level criteria was drawn from previous work on the VSP concept (McElhany et. al. 2000). Recommendations for ESU and strata criteria address ESU diversity and risks (Box 1). Recommendations for population viability relate population status to adult abundance, adult productivity, juvenile abundance, spatial structure, diversity, and habitat (Box 2). Many of these parameters are interrelated and interactions are complex. Although the TRT pointed to all factors as being important, they developed specific population objectives only for abundance and productivity. For other population parameters, the TRT made general recommendations, which were used by the LCFRB to develop benchmarks that provide guidance for recovery strategies and evaluations of progress. Objectives for abundance and productivity, and benchmarks for spatial structure, diversity, juvenile abundance, and habitat will be refined in the future as outlined in the recovery actions of this plan.

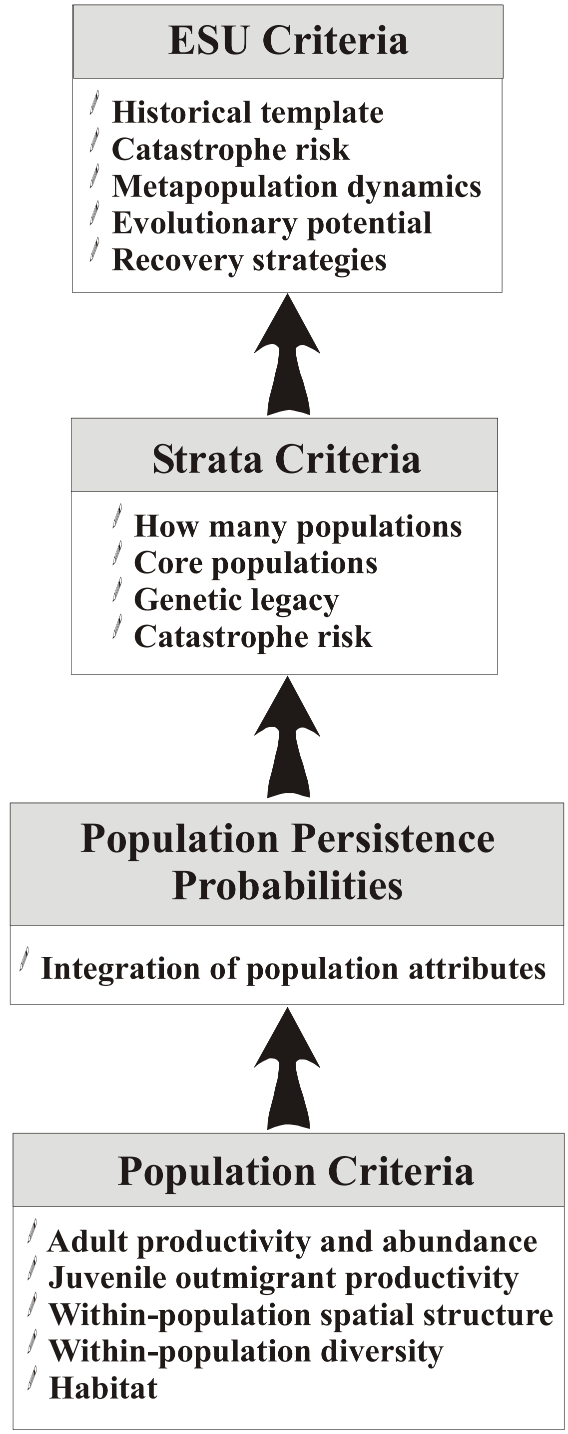


**Figure 1. Willamette/Lower Columbia viability criteria (from McElhany et al. 2003). The bullets list key considerations involved in each criteria.**


**Figure 2. Ecological zones identified for recovery strata by the Willamette/Lower Columbia Technical Recovery Team for listed salmon and steelhead populations in lower Columbia River Evolutionarily Significant Units.**

The TRT also provided a scoring system to evaluate population persistence probabilities (McElhany et al. 2003). Each population criteria is evaluated separately on a 0-4 scale, where 0 is either extinct or a very high risk of extinction, 1 is a relatively high risk, 2 is a medium risk, 3 is a low risk (viable), and 4 is at very low risk of extinction (Table 1). Criteria scores are then averaged to the overall population persistence level (based on all of the population viability criteria). This plan includes assessments of the current status of populations based on an average of scoring done by the TRT and the LCFRB. Since this is a plan for Washington populations, current status is not provided for Oregon populations. Additional details on the application of population scoring in this recovery plan can be found in Appendix E.

**Box 1. ESU and strata viability criteria from the Willamette-Lower Columbia Technical Recovery Team.**

***ESU-Level Viability Criteria***

1. Every stratum (life history and ecological zone combination) that historically existed should have a high probability of persistence.
2. Until all ESU viability criteria have been achieved, no population should be allowed to deteriorate in its probability of persistence.
3. High levels of recovery should be attempted in more populations than identified in the strata viability criteria because not all attempts will be successful.

***Strata-Level Viability Criteria***

1. Individual populations within a stratum should have persistence probabilities consistent with a high probability of strata persistence.
2. Within a stratum, the populations restored/maintained at viable status or above should be selected to:
    a. Allow for normative meta-population processes, including the viability of "core" populations, which are defined as the historically most productive populations.
    b. Allow for normative evolutionary processes, including the retention of the genetic diversity represented in relatively unmodified historic gene pools.
    c. Minimize susceptibility to catastrophic events.

**Box 2. Population viability criteria from the Willamette-Lower Columbia Technical Recovery Team.**

***Adult Population Productivity and Abundance***

1. In general, viable populations should demonstrate a combination of population growth rate, productivity, and abundance that produces an acceptable probability of population persistence. Various approaches for evaluating population productivity and abundance combinations may be acceptable, but must meet reasonable standards of statistical rigor.
2. A population with non-negative growth rate and an average abundance approximately equivalent to estimated historic average abundance should be considered to be in the highest persistence category. The estimate of historic abundance should be credible, the estimate of current abundance should be averaged over several generations, and the growth rate should be estimated with adequate statistical confidence. This criterion takes precedence over criterion 1.

***Juvenile Migrant Production***

1. The abundance of naturally produced juvenile migrants should be stable or increasing as measured by observing a median annual growth rate or trend with an acceptable level of confidence.

***Within-Population Spatial Structure***

1. The spatial structure of a population must support the population at the desired productivity, abundance, and diversity levels through short-term environmental perturbations, longer-term environmental oscillations, and natural patterns of disturbance regimes. The metrics and benchmarks for evaluating the adequacy of a population's spatial structure should specifically address:
   a. Quantity: Spatial structure should be large enough to support growth and abundance, and diversity criteria.
   b. Quality: Underlying habitat spatial structure should be within specified habitat quality limits for life-history activities (spawning, rearing, migration, or a combination) taking place within the patches.
   c. Connectivity: spatial structure should have permanent or appropriate seasonal connectivity to allow adequate migration between spawning, rearing, and migration patches.
   d. Dynamics: The spatial structure should not deteriorate in its ability to support the population. The processes creating spatial structure are dynamic, so structure will be created and destroyed, but the rate of flux should not exceed the rate of creation over time.
   e. Catastrophic Risk: the spatial structure should be geographically distributed in such a way as to minimize the probability of a significant portion of the structure being lost because of a single catastrophic event, either anthropogenic or natural.

***Within-Population Diversity***

1. Sufficient life-history diversity must exist to sustain a population through short-term environmental perturbations and to provide for long-term evolutionary processes. The metrics and benchmarks for evaluating the diversity of a population should be evaluated over multiple generations and should include:
   a. Substantial proportion of the diversity of a life-history trait(s) that existed historically,
   b. Gene flow and genetic diversity should be similar to historic (natural) levels and origins,
   c. Successful utilization of habitats throughout the habitat, and
   d. Resilience and adaptation to environmental fluctuations.

***General Habitat***

1. The spatial distribution and productive capacity of freshwater, estuarine, and marine habitats should be sufficient to maintain viable populations identified for recovery.
2. The diversity of habitats for recovered populations should resemble historic conditions given expected natural disturbance regimes (wildfire, flood, volcanic eruptions, etc.). Historic conditions represent a reasonable template for a viable population; the closer the habitat resembles the historic diversity, the greater the confidence in its ability to support viable populations.
3. At a large scale, habitats should be protected and restored, with a trend toward an appropriate range of attributes for salmonid viability. Freshwater, estuarine, and marine habitat attributes should be maintained in a non-deteriorating state.

## 5.3 Salmon and Steelhead ESU Goals

### 5.3.1 The Recovery Scenario

ESU-level recovery goals are described in this plan by a recovery scenario that identifies a combination of populations and population status levels that meet TRT recovery criteria for a viable ESU. The scenario represents one of many possible combinations of populations and recovery goals that could meet the TRT's ESU- and strata-level viability criteria. Different scenarios may fulfill the biological requirements for recovery but can have unique implications for various stakeholders. Selection of a scenario for incorporation into the recovery plan is in part a policy decision based on scientific, biological, social, cultural, political, and economic considerations. This recovery scenario was developed through a collaborative process with a representative group of stakeholders.

The recovery scenario was developed with specific consideration of the biological significance and recovery feasibility of each population. Biological significance was based on current status, potential for improvement, historical significance, proximity to other selected populations with reference to catastrophic risks, and location relative to strata with reduced expectations. Feasibility of recovery was evaluated based on expected progress as a result of existing programs, absence of apparent impediments toward recovery, and other management considerations (e.g. fish trapping ability).

The recovery scenario designates individual population goals at three levels of contribution:

***Primary populations*** are those that would be restored to high or "high+" viability. At least two populations per strata must be at high or better viability to meet recommended TRT criteria. Primary populations typically, but not always, include those of high significance and medium viability. In several instances, populations with low or very low current viability were designated as primary populations in order to achieve viable strata and ESU conditions. In addition, where factors suggest that a greater than high viability level can be achieved, populations have been designated as High+. High$^+$ indicates that the population is targeted to reach a viability level between High and Very High levels as defined by the TRT.

***Contributing populations*** are those for which some restoration will be needed to achieve a stratum-wide average of medium viability. Contributing populations might include those of low to medium significance and viability where improvements can be expected to contribute to recovery.

***Stabilizing populations*** are those that would be maintained at current levels (likely to be low viability). Stabilizing populations might include those where significance is low, feasibility is low, and uncertainty is high.

The recovery scenario describes the target status (i.e. primary, contributing, or stabilizing) for each population within the lower Columbia ESUs (Table 2). The underlying population-level goals are described in Figure 5 through Figure 10. At least two populations are targeted for improvement to high or high+ levels of viability in every stratum except for strata within the Gorge ecological zone. Overall, the recovery scenario would restore each salmonid stratum to an average viability of medium or higher. Population and strata viability goals were higher than the minimum required to meet TRT criteria to provide a safety factor should goals for some populations not be achieved.

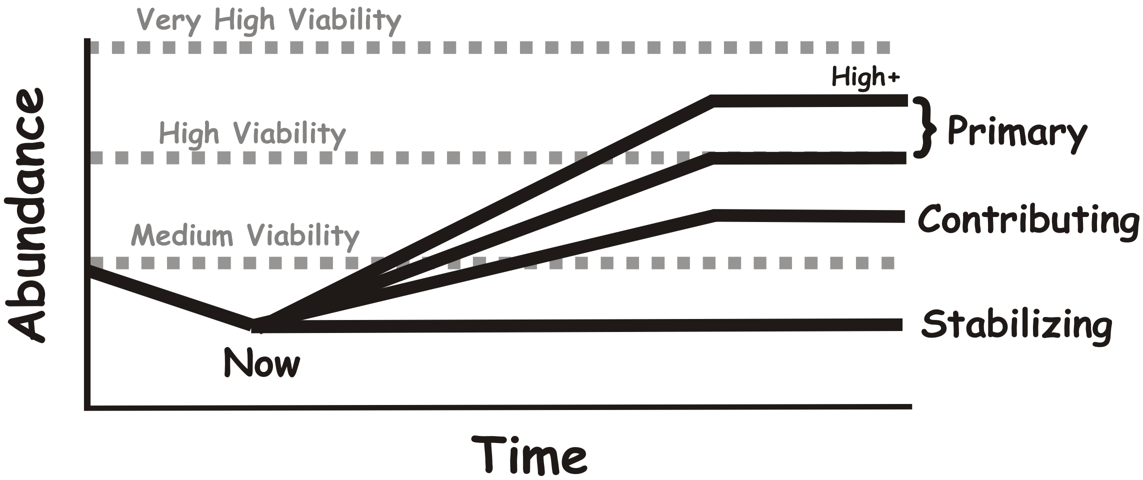


**Figure 3. Example population trajectories corresponding to scenario designations.**

**Table 2. Primary (P), contributing (C), and stabilizing (S) population designations for the recovery scenario. Respective target viabilities are high or better, medium, and no lower than current levels. Primary populations identified for greater than high viability objectives are denoted with an '*'. X refers to subset of larger population. Dashes indicate species is not present.**

| | | Fall Chinook (tule) | Fall Chinook (bright) | Spring Chinook | Chum | Winter steelhead | Summer steelhead | Coho[1] |
|---|---|---|---|---|---|---|---|---|
| COAST | Grays/Chinook | P | -- | -- | P* | P[1] | -- | P |
| | Elochoman/Skamokawa | P | -- | -- | P | C | -- | P |
| | Mill/Abernathy/Germany | C | -- | -- | P | P[1] | -- | C |
| | Youngs Bay (OR) | S | -- | -- | P | na[1] | -- | S |
| | Big Creek (OR) | S | -- | -- | C | na[1] | -- | P |
| | Clatskanie (OR) | P | -- | -- | C | na[1] | -- | S |
| | Scappoose (OR) | S | -- | -- | C | na[1] | -- | P |
| CASCADE | Lower Cowlitz | C | -- | -- | C | C | -- | P |
| | Upper Cowlitz | S | -- | P* | -- | C | -- | C |
| | Cispus | -- | -- | P* | -- | C | -- | C |
| | Tilton | -- | -- | S | -- | C | -- | C |
| | SF Toutle | X | -- | C | X | P* | -- | P |
| | NF Toutle | S | -- | X | X | P | -- | P |
| | Coweeman | P* | -- | -- | X | P | -- | P |
| | Kalama | P | -- | P | C | P* | P | C |
| | Lewis (NF) | X | P* | P | X | C | S | C |
| | EF Lewis | P* | -- | -- | P | P | P | P |
| | Salmon | X | -- | -- | S | S | -- | S |
| | Washougal | P | -- | -- | P* | C | P* | C |
| | Sandy (OR) | S | P | P | P | P | -- | P* |
| | Clackamas (OR) | C | -- | -- | C | P | -- | P* |
| GORGE | Lower Gorge | C | -- | -- | P* | P | -- | P |
| | Upper Gorge | S | -- | -- | C | S | P* | P |
| | White Salmon | C | -- | C | -- | -- | -- | C |
| | Hood (OR) | S | -- | P | -- | P | P | C |

*It is assumed that one tule fall Chinook, one chum, and two coho populations in OR will be "primary" category and three chum populations will be in the "contributing" category. Assignments of specific populations shown are illustrative only. OR will identify specific assignments upon completing its population review.*

Recovery opportunities in the Gorge are limited by the small numbers of populations and the high uncertainty of restoration feasibility because of Bonneville Dam. Recovery of gorge populations will be attempted but success will be highly uncertain given the continued existence of Bonneville Dam. The TRT's strata delineations between the gorge and Cascade strata populations are also uncertain and several chum and chinook populations downstream from Bonneville Dam may be quite similar to those upstream of Bonneville Dam. The recovery scenario identifies improvement in more than the minimum number of populations including several in the adjacent strata in order to provide a safety factor should not all attempts in the gorge prove successful. This approach mitigates some of the increased risk to the ESU that could occur as a result of not achieving the TRT's recommendations for strata within the gorge ecological zone. This is a more precautionary approach to gorge strata recovery uncertainties than merely assuming they can be effective given the fundamental changes to the gorge habitats. Monitoring and adaptive management in the course of plan implementation will provide more information on the feasibility of recovering chinook and chum populations above Bonneville Dam and can lead to adjustments in expectations and actions.

Recovery will require significant actions in most subbasins (Figure 4). Several Washington subbasins have been identified with the potential to provide substantial contributions to the viability of multiple species and populations. These include the Grays and Elochoman in the coast ecological zone; the Cowlitz, Kalama, Lewis, and Washougal in the Cascade ecological zone; and the lower Gorge in the Gorge ecological zone. Substantial improvements are not required in some severely degraded subbasins although recovery goals require additional protection and restoration efforts to prevent further declines until recovery of other populations is achieved. Examples include Salmon Creek.

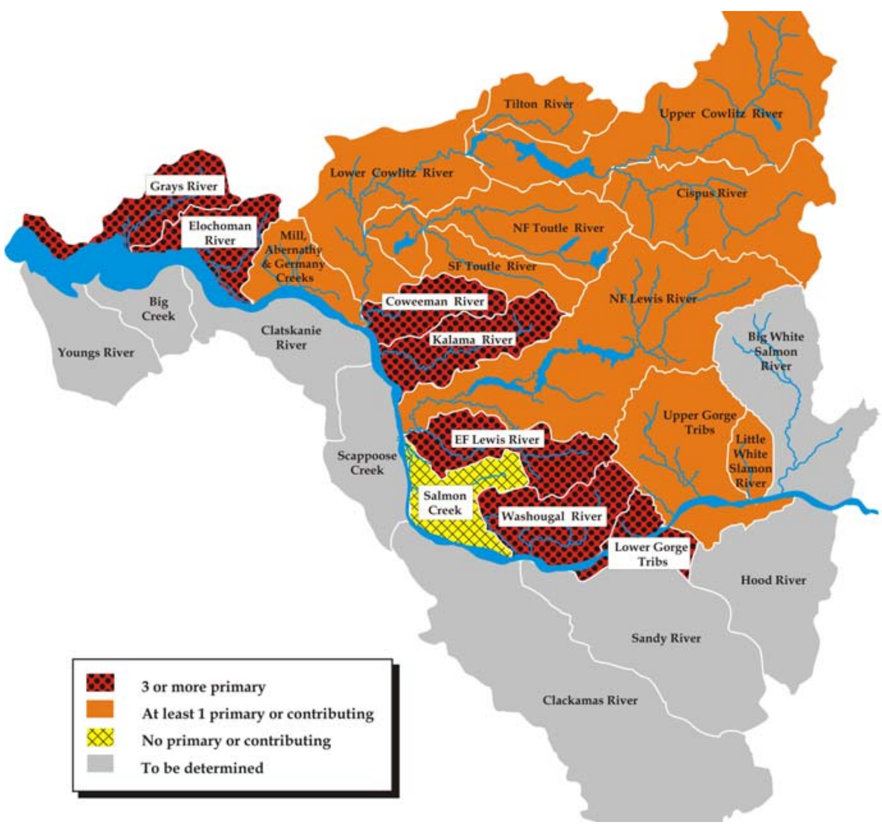


**Figure 4. Numbers of primary, contributing, and stabilizing salmon and steelhead populations in each subbasin.**

### 5.3.2 Population Priorities

Population priority rationales are brief descriptions of the basis for classification and selection for inclusion in recovery scenarios. Rationales summarize the biological significance, risk reduction, feasibility, and social/political considerations upon which designations were based. Rationales are presented for each species.

***Fall Chinook***

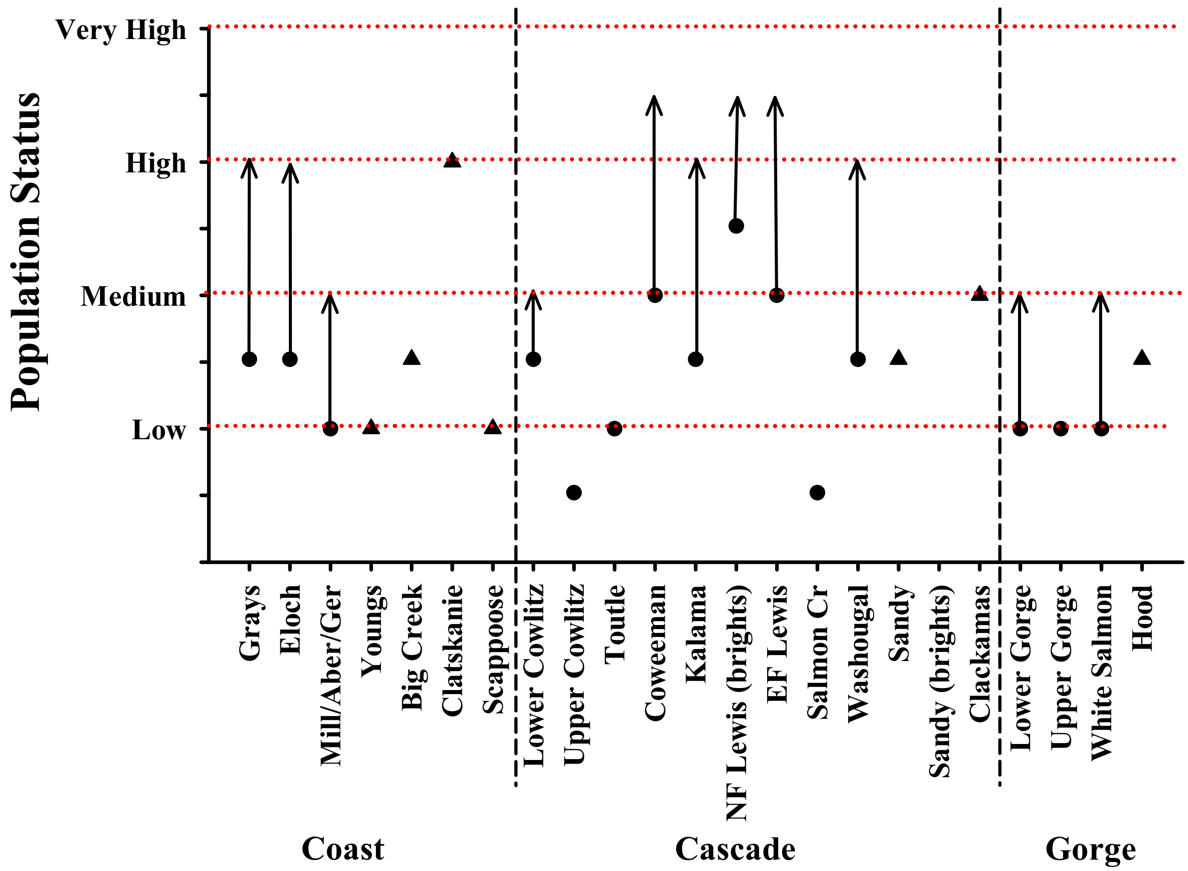


**Figure 5. Improvements in population viability for fall Chinook corresponding to biological objectives identified in recovery scenario for Washington. Oregon populations displayed with (▲) correspond to hypothetical biological objective to achieve ESU recovery across both states.**

The scenario targets recovery of at least two tule fall Chinook populations to high levels of viability in both the Coast and Cascade strata. Recovery of at least two Gorge populations to high levels will be highly uncertain given current low numbers, limited habitat potential for the lower Gorge population, and Bonneville Dam impacts for the upper Gorge population. Medium levels of viability may be realistic for the lower Gorge, upper Gorge, and White Salmon populations. Kalama and Washougal population goals were targeted for high viability because of uncertain prospects of Gorge strata populations. Oregon populations may provide additional risk reduction options although Oregon populations are small and habitat potential is limited.

<u>*Grays (Primary, High)*</u> – The historical Grays River fall Chinook population was likely average in abundance for coastal tule fall Chinook populations. There was a hatchery fall Chinook program in the basin for almost 40 years, but it was recently eliminated. Current returns of natural produced fall Chinook are among the lowest in the ESU.

Elochoman (Primary, High) – Elochoman fall Chinook population were targeted for High status to address ESU and coast strata risks in meeting tule fall Chinook recovery criteria. Historical populations of fall chinook in coastal strata streams may have been small and constrained by low early fall flows but the TRT identified these populations based on a review of the available evidence. The Elochoman River likely contained the most significant historical coastal fall Chinook population, but does have a history of hatchery transfers from other lower Columbia basins. There is a weir operation at tidewater in the Elochoman that could be used to implement an integrated hatchery and wild program, although hatchery fall chinook would need to be marked before separation at he weir could be implemented. Additionally, the current habitat condition is better than many other watersheds for fall Chinook.

Mill/Abernathy/Germany (Contributing, Medium) – Mill/Abernathy/Germany tule fall Chinook population targeted for medium status in response to current adult spawning return information. The TRT identified this populations based on a review of the available evidence. However, the historical significance of the fall Chinook populations in these small tributaries is uncertain. They were largely represented by strays from Abernathy Hatchery until that program was eliminated. They currently support natural spawning populations, with the largest numbers typically in Mill Creek.

Lower Cowlitz-Below Mayfield Dam (Contributing, Medium) – This is likely the most significant historical lower fall Chinook Columbia population. There is a large hatchery program but few out of basin hatchery transfers have occurred. The hatchery and natural spawners are similar, although the natural population has consistent annual contributions from stray Lewis River wild spawners. An integrated hatchery and natural program may be difficult because of the feasibility of sorting fish prior to spawning.

Upper Cowlitz-Above Mayfield Dam (Stabilizing, Very Low) – Upper Cowlitz fall Chinook population is not targeted for improvements. Upper Cowlitz fall Chinook is not currently proposed for reintroduction above the dams on the Cowlitz because of conflicts with spring Chinook reintroduction efforts.

Toutle (Stabilizing, Low) – This was historically a large tule fall Chinook population and the current combined hatchery and wild returns are large. There is a significant history of hatchery transfers from other lower Columbia basins. The primary historical spawning areas of the North Fork and mainstem Toutle remain impacted by the eruption of Mt. St. Helens. There is also spawning that occurs in the lower SF Toutle and Green Rivers.

Coweeman (Primary, High$^{+}$) – Coweeman fall Chinook were targeted for High+ status to address ESU risk in meeting tule fall Chinook recovery criteria. This population is one of two tule populations without a history of significant hatchery influence and is considered a genetic legacy population. The current population is small at about 300-900 adult spawners per year.

Kalama (Primary, High) – The hatchery program has maintained a local stock with negligible outside basin influence. Hatchery and wild fish are likely similar and the combined returns are one of the larger in lower Columbia tule populations. There is an existing weir operation in the lower river that could be used to manage an integrated hatchery and wild program. Kalama fall Chinook were targeted for high viability in part to compensate for lower goals for Gorge populations.

*NF Lewis (Primary, High+)* – North Fork Lewis bright fall Chinook were targeted above high viability to recognize favorable current status, existing program expectations, and risk reduction in meeting recovery criteria for fall Chinook bright populations. This is the healthiest fall Chinook population in the lower Columbia basin and one of only two late fall bright populations. There is no direct hatchery fall Chinook program influence and the FERC license includes flow enhancement and hatchery safeguards. Critical rearing habitat has been protected with the purchase of Eagle Island.

*EF Lewis (Primary, High+)* – The EF Lewis and Coweeman populations are the only tule populations without a history of significant hatchery influence and both are considered a genetic legacy population. The current population is small at about 200-800 adult spawners per year. Salmon Creek fall Chinook are considered part of the East Fork Lewis population although Salmon Creek fall Chinook are not targeted for improvements. EF Lewis and Coweeman fall Chinook populations were targeted for High+ status to address ESU risk in meeting tule fall Chinook recovery criteria.

*Washougal (Primary, High)* – This was a large tule fall Chinook population historically and current combined hatchery and wild returns are large. There is a significant history of hatchery transfers from other lower Columbia basins. This population has the potential to be managed as integrated hatchery and wild programs. There is no current weir operation but it would be feasible in the lower river. Chum enhancement may benefit natural spawning of fall Chinook. Washougal fall Chinook are targeted for high viability to partially compensate for lower goals for Gorge populations.

*Lower Gorge-Below Bonneville Dam (Contributing, Medium)* – The lower Gorge subbasin includes small Oregon and Washington streams between Washougal River and Bonneville Dam. On the Washington side, these include Hamilton, Hardy, and Duncan creeks. There are concerns with low flows in the early fall not providing adequate access for fall Chinook spawning in small tributaries and in the mainstem Columbia. There is competition in the mainstem Columbia with later spawning bright fall Chinook. Recovery to high levels of viability is uncertain because low flows in the late summer and fall restrict access of spawners to these small tributaries.

*Upper Gorge-Above Bonneville Dam (Stabilizing, Low)* – This includes small tule fall Chinook populations in the lower Wind and Hood rivers. There is consistent straying from returning Spring Creek Hatchery tule adults to the Wind River and competition from hatchery and naturally produced upriver bright fall Chinook. The Bonneville Reservoir has inundated significant portions of the historical habitat.

*White Salmon (Contributing, Medium)* – The historical tule fall Chinook population was large in the White Salmon. Currently, the population is impacted by Condit Dam, although fall Chinook habitat is available downstream of the dam, and upstream from Bonneville Reservoir inundation. The spring creek hatchery program, which originated from White Salmon fall Chinook stock, is located immediately downstream of the river mouth and straying of returning hatchery adults to the White Salmon River is consistent. A treaty Indian fishery targets Spring Creek Hatchery fish near the river mouth. The White Salmon population is targeted for medium viability to reflect concerns with hydro impacts (Bonneville and Condit Dam), and higher harvest rates associated with combined Indian and non-Indian fisheries.

***Spring Chinook***

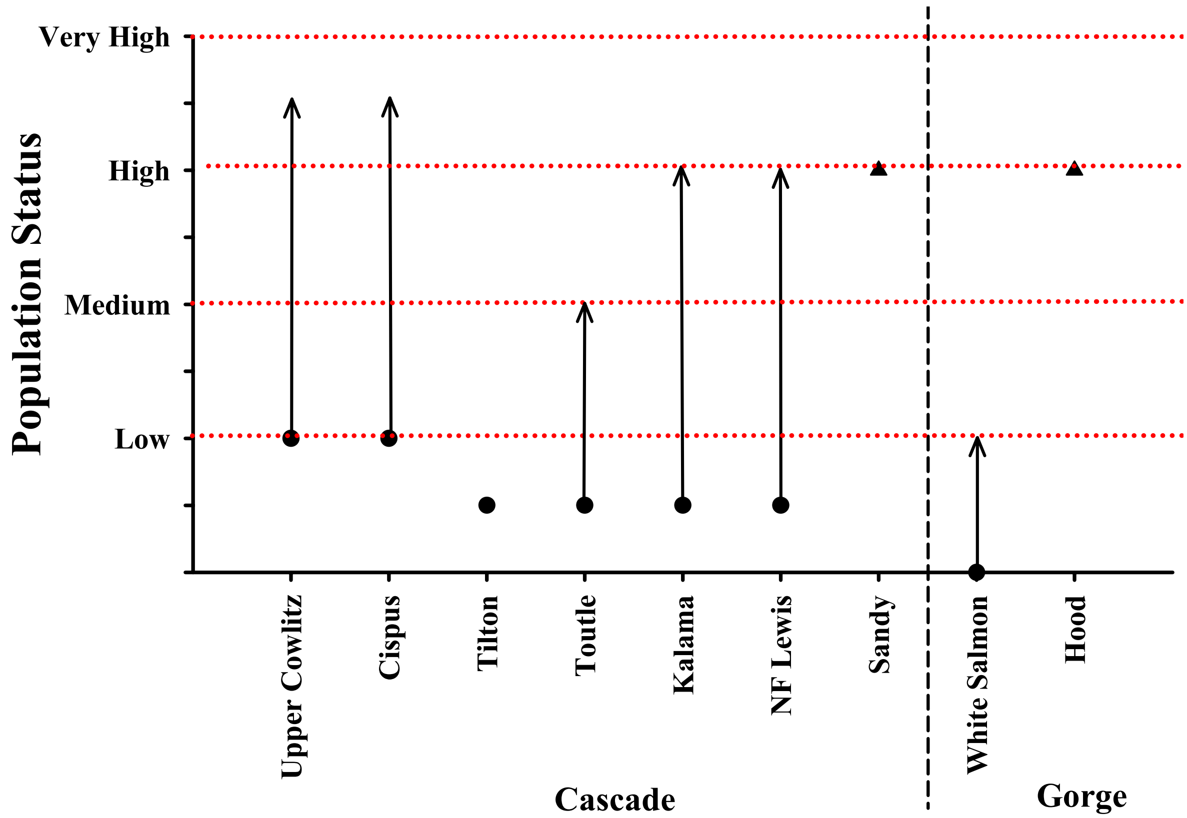


**Figure 6. Improvements in population viability for spring Chinook corresponding to biological objectives identified in recovery scenario for Washington. Oregon populations displayed with (▲) correspond to hypothetical biological objective to achieve ESU recovery across both states.**

Four Cascade populations are targeted for high levels of viability. There is considerable uncertainty in prospects for recovery of the lower Columbia spring Chinook populations. Most Washington populations occurred historically in habitats upstream of current hydrosystems and recovery will rely on reintroduction success. Thus, multiple populations were targeted for aggressive recovery efforts to balance ESU risk. Oregon's Sandy River population will likely make substantial contributions to ESU viability. The historical Hood River population is extinct.

*Upper Cowlitz (Primary) /Cispus (Primary), High+; Upper NF Lewis (Primary, High)* – The vast majority of spring Chinook habitat in the lower Columbia is found in these three areas. Spring Chinook will not likely meet recovery criteria without sustaining viable populations in at least two of these three major historical production areas. Upper Cowlitz and Cispus population targets were targeted for High$^{+}$ status. The upper Cowlitz and Cispus were the most significant production areas in the lower Columbia and current reintroduction efforts have shown the ability for the habitat to produce. There are problems with low collection rates for juvenile passage, but reintroduction efforts have progressed for several years while such efforts in the North Lewis have not yet begun. 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. However, to realize habitat potential, adequate passage through the Cowlitz and Lewis hydro systems must be achieved. Upper Cowlitz and Cispus spring chinook populations will be most effectively managed as a combined unit because of physical difficulties of maintaining separate populations.

*Toutle (Contributing, Medium)* – This population may have been historically small, but it is not affected by a hydrosystem in the watershed. 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. Toutle was targeted for medium viability to compensate for potential uncertainty in other areas. Spring chinook from the Cowlitz hatchery have been released into the NF Toutle in recent years with the last release in 2002.

*Kalama (Primary, High)* – The historical significance of this population is questionable and the best spring Chinook habitat was historically blocked by lower Kalama Falls. However, some natural spawning currently occurs and a hatchery program in the basin provides an opportunity for conservation-based efforts. In addition, Kalama spring Chinook are not limited by difficulties in dam passage that make upper Cowlitz and Lewis reintroduction efforts uncertain. The hatchery program in the Kalama River would need to incorporate naturally-produced spring chinook into the broodstock to meet this goal.

*White Salmon (Contributing, Low)* – This population was historically significant but is currently extinct. Reintroduction would include use of an outside stock and would require passage upstream of Condit Dam. The best source stock may be from the Klickitat, which is outside the lower Columbia ESU. The TRT would need to provide criteria for evaluating appropriate source stocks for reintroduction. The Big White Salmon target of low recognizes the long time frame required to restore a locally-adapted natural population from an out-of-basin stock.

***Chum***

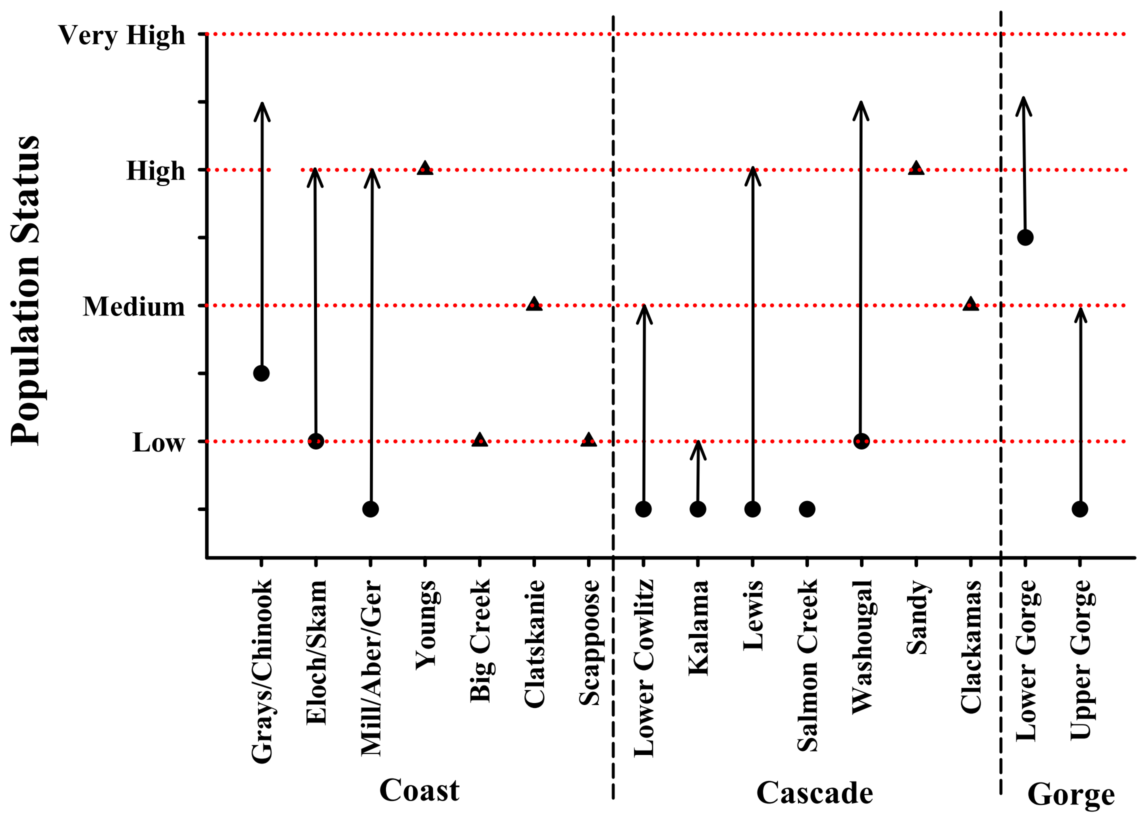


**Figure 7. Improvements in population viability for chum corresponding to biological objectives identified in recovery scenario for Washington. Oregon populations displayed with (▲) correspond to hypothetical biological objective to achieve ESU recovery across both states.**

The TRT criteria specify that each stratum have two populations of each species at a high viability level (95% probability of persistence). The Gorge Stratum currently has one chum population located below Bonneville Dam. To meet the TRT criteria a second population of high viability would have to be re-established above Bonneville Dam. While it may be possible to re-establish a population above the dam, it is unlikely that the population could achieve a high viability level. Upper Gorge chum habitat has been inundated by Bonneville Pool and relative to other salmonid species, chum do not pass barriers effectively (Bonneville Dam passage). Accordingly, the scenario identifies a recovery goal for upper Gorge chum of medium. To compensate for this lower goal, the recovery goal for the lower Gorge population was established at High$^+$. Three coastal and three Cascade strata populations are targeted for High or High$^+$ levels to address ESU-wide uncertainties.

*Grays/Chinook (Primary, High$^+$)* – This population has remained stable at low to moderate levels over the past 50 years. The most recent year returns have been relatively large. Enhancement programs have been on going in the Grays Basin. The population was targeted for High$^+$ viability to address ESU recovery risk and to meet strata recovery criteria.

*Elochoman/Skamokawa (Primary, High)* – There have been fair numbers of spawning chum counted in Skamokawa Creek in the most recent years and the historical population was likely significant. The population was targeted for High$^+$ viability to address ESU recovery risk and to meet strata recovery criteria.

*Mill/Abernathy/Germany (Primary, High)* – Fair numbers of spawning chum have been counted in Germany and Abernathy creeks in the most recent years. There is potential for a protected habitat area in lower Germany Creek.

*Lower Cowlitz-Below Mayfield Dam (Contributing, Medium)* – This was likely the largest historical chum population in the Columbia Basin. However, critical habitat in the lower river has been significantly reduced by diking in the Longview/Kelso area. The lower Cowlitz population is targeted for medium status to reflect improvement difficulty associated with extensive diking in the Longview/Kelso area.

*Kalama (Contributing, Low)* – The historical significance of the Kalama chum population was likely below average for lower Columbia Basin. Few chum are currently found in the Kalama.

*Lewis (Primary, High)* – Significant population occurred historically in the mainstem Lewis and East Fork Lewis. There are currently low levels of production occurring. Some volunteer enhancement efforts are on-going in the lower East Fork Lewis.

*Washougal (Primary, High$^+$)* – Recent years have found chum spawning in several locations in and around the Washougal Basin, including tributaries of the Washougal and the mainstem Columbia near I-205 Bridge. Enhancement and protection efforts are underway for the near I-205 production areas. The population was targeted for High$^+$ viability to address ESU recovery risk and to meet strata recovery criteria.

*Lower Gorge-Below Bonneville Dam (Primary, High$^+$)* – Considered the healthiest Columbia River chum population, it includes several tributaries and the mainstem Columbia for spawning. Multi-agency enhancement efforts are on-going including use of the Washougal Hatchery for risk reduction and enhancement. The population was targeted for High$^+$ viability to address ESU recovery risk and to meet strata recovery criteria.

*Upper Gorge-Above Bonneville Dam (Contributing, Medium)* – The majority of the chum habitat is inundated by the Bonneville Reservoir and passage of adult chum over Bonneville Dam may be problematic. The upper Gorge chum population is targeted for medium viability to reflect uncertainty in resolving Bonneville Dam impacts.

***Coho***

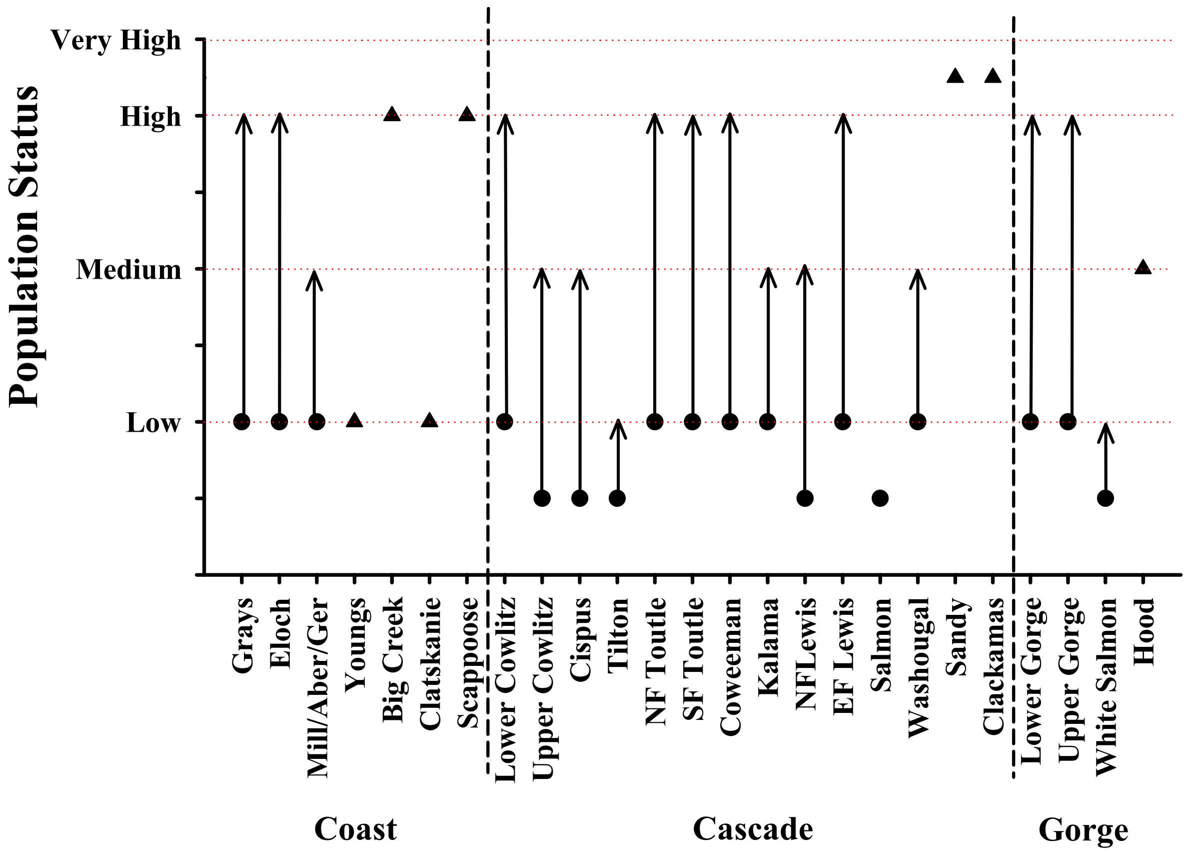


**Figure 8. Improvements in population viability for coho corresponding to biological objectives identified in recovery scenario for Washington. Oregon populations displayed with (▲) correspond to hypothetical biological objective to achieve ESU recovery across both states.**

Meeting lower Columbia coho objectives may be difficult because of the current low status of Washington populations and the need for improvement in a significant number of those populations. Coho ESU viability will rely heavily on Oregon populations (Sandy and Clackamas). These populations are considered to be at medium current status and are listed under Oregon State ESA.

*Grays (Primary, High)* – Natural production occurs throughout the upper watershed and in lower river tributaries. The historical returns were predominately late-timed coho while the current hatchery program produces early-timed coho.

*Elochoman (Primary, High)* – Natural production occurs in the Elochoman River and Skamokawa Creek watersheds, as well as Jim Crow Creek, a direct Columbia River tributary just downstream of Skamokawa Creek. The historical returns to these streams were predominately late-timed coho. Elochoman Hatchery produces both early-timed and late-timed coho.

*Mill/Abernathy/Germany (Contributing, Medium)* – There is coho production in all three streams. There are no hatchery programs in these tributaries. The historical stock was principally late returning coho.

_Lower Cowlitz-Below Mayfield Dam (Primary, High)_ – This population was likely one of the largest historical populations in the lower Columbia with production occurring in many tributary streams. These populations have been mixed with Cowlitz Hatchery production for years, however recent surveys have found areas (Olequa Creek) where the spawners were primarily unmarked naturally produced coho. The type-N coho program in the Cowlitz Salmon Hatchery is the archetype for all type-N coho programs in the lower Columbia River and has been maintained with no outside inputs. These hatchery fish are being used for reintroduction in the upper Cowlitz and Tilton rivers.

_Upper Cowlitz/Cispus (Contributing, Medium)_ – Success is associated with reintroduction to habitats upstream of the dams in the Cowlitz Rivers which will be dependent on passage. Collection of juvenile coho reintroduced upstream of Cowlitz Falls Dam has been difficult, but better than spring Chinook juvenile collection efficiency.

_Tilton (Contributing, Low)_ – Improvements to the Tilton coho population are linked to successful reintroduction and passage upstream of Mayfield Dam.

_SF Toutle (Primary, High)_ – This population occurs in several tributary streams which were not significantly impacted by the Mt. St. Helens eruption. 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. This population was designated for High viability to reduce risk to the ESU.

_NF Toutle (Primary, High)_ – This population was more significant than the SF Toutle population historically, but was seriously effected by the Mt. St. Helens eruption. However, there are several tributary streams in the NF Toutle and in the Green River that still have productive coho habitat. Wild coho are trapped at the USACE Sediment Retention Structure and transported to upper NF Toutle tributaries. There is an early stock coho hatchery program at the Toutle Hatchery on the lower Green River.

_Coweeman (Primary, High)_ – This population was likely modest to average in numbers historically. The current status rating is about average for lower Columbia populations. 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. This population was designated for High viability to reduce risk to the ESU.

_Kalama (Contributing, Medium)_ – This population was likely average or less historically, with production occurring in the lower basin tributaries downstream of Kalama Falls. There are both late and early stock hatchery programs in the Kalama and both types of coho were thought to be present historically.

_NF Lewis (Contributing, Medium)_ – Success is associated with reintroduction to habitats upstream of the dams in the Lewis River, which will be dependent on successful passage measures. A naturally spawning population is being managed by WDFW in Cedar Creek and might be used to supplement other populations in the lower river.

_EF Lewis (Primary, High)_ – This population was likely about average in numbers historically. There has not been a coho hatchery program in the basin for several years. A good portion of the natural production occurs in the lower basin tributaries. There are volunteer habitat enhancement efforts occurring in the lower East Fork.

_Washougal (Contributing, Medium)_ – This population was likely average or less historically, with most production occurring in lower river tributaries. The Little Washougal is likely the most significant production area. There are volunteer habitat enhancement efforts in the Little

Washougal. There is a late stock hatchery program at the Washougal Salmon Hatchery, most of which is planted in the Klickitat River as part of a federal, state, and tribal production agreement.

<u>Lower Gorge-Below Bonneville Dam (Primary, High)</u> – These small tributary coho populations historically returned to Hamilton, Greenleaf, Hardy, Duncan, Gibbons and Lawton creeks. Both early-and late-timed coho were historically present. There are no hatchery programs in these tributaries.

<u>Upper Gorge-Above Bonneville Dam (Primary High)</u> – These populations include the Wind River and several small tributaries between Bonneville Dam and the Little White Salmon River. Most natural production occurs in the lower Wind and in Rock Creek. Historical returns were predominately early-timed coho.

<u>White Salmon (Contributing, Low)</u> – Current potential for coho production is limited by access to habitats upstream of Condit Dam. There may be some coho production occurring in the lower one mile of stream below Condit Dam.

***<u>Winter Steelhead</u>***

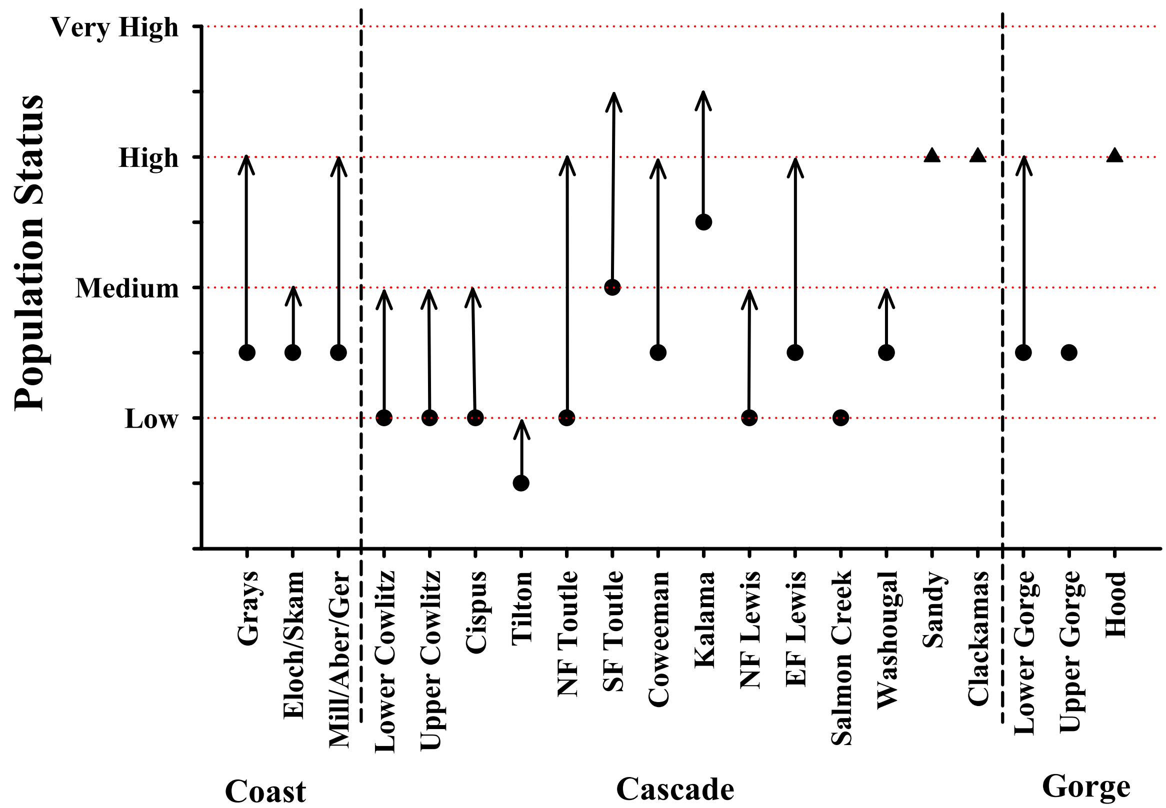


**Figure 9. Improvements in population viability for winter steelhead corresponding to biological objectives identified in recovery scenario for Washington. Oregon populations displayed with (▲) correspond to hypothetical biological objective to achieve ESU recovery across both states.**

The scenario targets recovery of at least two winter steelhead populations for High levels of viability in both the Coast and Cascade strata. Recovery of at least two Gorge populations to High levels will be highly uncertain given current low numbers and limited habitat potential for lower Gorge populations. High levels of viability may be realistic for the lower Gorge but the upper Gorge was targeted for Medium. A total of four Cascade populations are targeted for High or High+ to address ESU-wide uncertainties. An Oregon population in Hood River may provide an additional risk reduction option.

Grays (Primary, High) – Current status may be above average for the lower Columbia. There is a steelhead hatchery program in the watershed.

Elochoman/Skamokawa (Contributing, Medium) – There is winter steelhead production in both Elochoman River and Skamokawa Creek. Non-local stock hatchery programs occur in the Elochoman. A local steelhead broodstock program at Elochoman Hatchery has recently been cut.

Mill/Abernathy/Germany (Primary, High) – There is winter steelhead production in all three streams with fair historical significance. There are no hatchery programs in these tributary streams.

Lower Cowlitz-Below Mayfield Dam (Contributing, Medium) – The lower Cowlitz winter steelhead historical population may have been one of the largest in the lower Columbia Basin. Natural production occurs in several lower Cowlitz tributaries. Both non-local stock (early-timed) and local stock (late-timed) hatchery winter steelhead programs exists in the lower Cowlitz.

Upper Cowlitz/Cispus (Contributing, Medium) – Success is associated with reintroduction to habitats upstream of the dams on the Cowlitz River, which is dependent on passage. Collection of juvenile steelhead reintroduced upstream of Cowlitz Falls Dam has been difficult but better than spring Chinook juvenile collection efficiency. There is uncertainty in even reaching medium status for reintroduced populations in the Upper Cowlitz and Cispus.

Tilton (Contributing, Low) – This population was likely about average historically prior to completion of Mayfield Dam. Contribution from this population would be subject to reintroduction and dam passage success.

SF Toutle (Primary, High$^+$) – Current status is one of the healthiest in the lower Columbia ESU. Impacts associated with the Mt. St. Helens eruption are less than the NF Toutle. There is a small Skamania summer steelhead hatchery program in the watershed. This population is targeted for High$^+$ to address ESU recovery risks.

NF Toutle (Primary, High) – This was a large historical population but near-term potential is limited by the effects of the Mt. St. Helens eruption. However, good habitat remains in many tributary streams and in the Green River watershed. Current returns are about average for lower Columbia streams in recent years. Wild steelhead are trapped and passed over the NF Toutle sediment retention structure to access tributaries in the upper NF Toutle. This population is targeted for High viability to compensate for uncertainty in reintroduction efforts above Lewis and Cowlitz basin dams. The population is not substantially affected by hydro systems and is within the same strata as the upper Cowlitz and upper Lewis populations.

Coweeman (Primary, High) – Current status is average for the lower Columbia. There is a small steelhead hatchery program in the basin.

Kalama (Primary, High$^+$) – This winter steelhead population has the highest current viability in the ESU and the largest current returns. Historical significance was likely about average. There are both local and non-local hatchery stock programs in the basin. This population is targeted for High$^+$ to address ESU recovery risks.

NF Lewis (Contributing, Medium) – The historical population was one of the larger in the lower Columbia basin and was predominately produced in the upper Lewis watershed above Swift Dam. Meeting the biological objective is dependent on successful reintroduction of winter steelhead into the habitats upstream of Swift Dam. The winter steelhead program at Merwin

Hatchery uses non-endemic early winter steelhead and the reintroduction efforts will require using natural origin late winter steelhead.

*EF Lewis (Primary, High)* – The historical population was average or above for the lower Columbia basin. Current status is about average for viability and abundance. There are Skamania stock hatchery steelhead released into the lower East Fork Lewis for harvest opportunity.

*Salmon (Stabilizing, Low)* – The historical Salmon Creek winter steelhead population was significant. Natural spawning occurred throughout the Salmon Creek watershed and in Burnt Bridge, Whipple, and Gee creeks. The current status is low with much of the watershed in heavily urbanized areas. Winter steelhead from Skamania hatchery are released into Klineline ponds.

*Washougal (Contributing, Medium)* – The historical population was likely about average for the lower Columbia. The current returns are about average for the recent years. There are winter and summer hatchery steelhead programs in the basin.

*Lower Gorge-Below Bonneville Dam (Primary, High)* – Includes populations in small tributaries such as Hamilton Creek. This is one of only three Gorge winter steelhead populations including the upper Gorge and Hood River.

*Upper Gorge-Above Bonneville Dam (Stabilizing, Low)* – Habitat potential is limited for very small populations near upstream limits of winter steelhead distribution in the Columbia. A small naturally-produced winter steelhead population occurs in the Wind River. No wild winter steelhead occur in most of these systems and populations are subject to Bonneville Dam passage concerns.

### Summer Steelhead

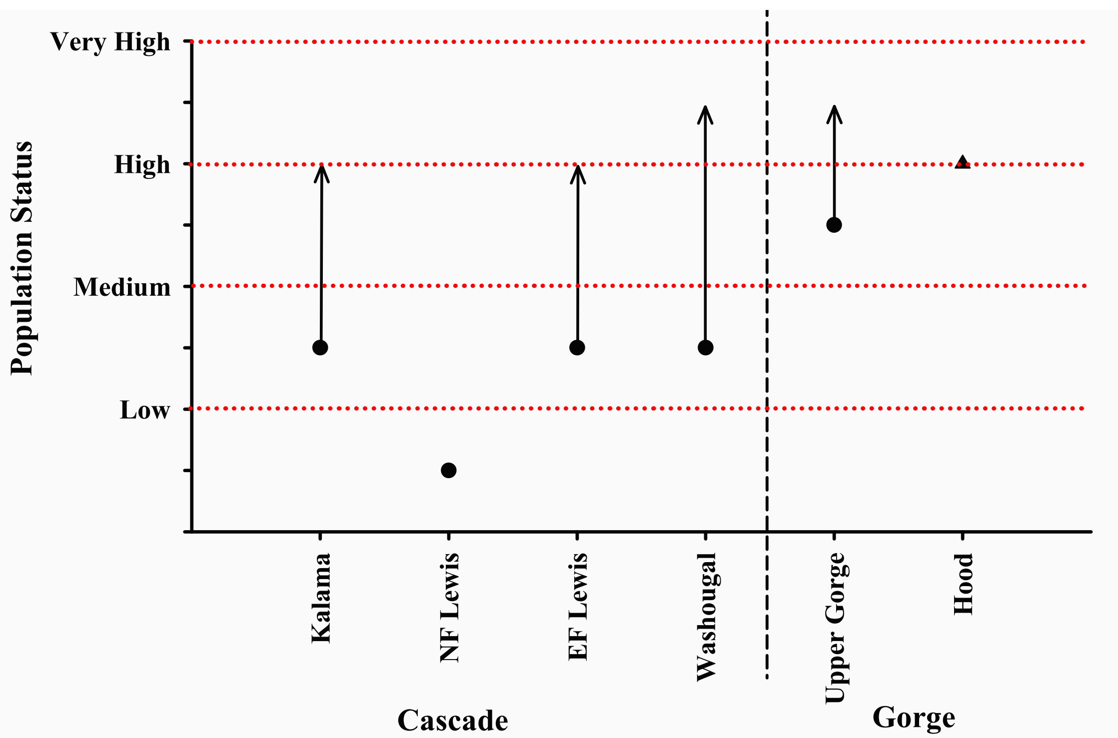


**Figure 10. Improvements in population viability for summer steelhead corresponding to biological objectives identified in recovery scenario for Washington. Oregon populations displayed with (▲) correspond to hypothetical biological objective to achieve ESU recovery across both states.**

Wind River (Upper Gorge) and Washougal summer steelhead populations are targeted for High$^+$ status for risk reduction. The Wind River population current status is near viable levels and has the highest current summer steelhead viability status rating. The Washougal population status is similar to the EF Lewis and Kalama populations, but there is more spatial separation between summer and winter steelhead in the Washougal basin than in the EF Lewis or Kalama basins.

*Kalama (Primary, High)* – This population was likely large historically. Current returns are about average for recent years in the lower Columbia streams. There are both local and non-local hatchery programs in the basin. Returns can be monitored at the Kalama Falls Trap.

*NF Lewis (Stabilizing, Very Low)* –The historical North Lewis summer steelhead population was likely less than average. Most spawning occurred in lower Merwin Reservoir tributaries and in Cedar Creek. Current status is very low with the majority of production occurring in Cedar Creek.

*EF Lewis (Primary, High)* – This population was likely large historically and is also considered a genetic legacy. Current returns are about average for recent years in lower Columbia streams. There is some concern with competition between wild summer and winter steelhead. There are hatchery steelhead programs in the East Fork Lewis.

*Washougal (Primary, High$^+$)* – 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. There is a hatchery program that supplies harvest production to several lower Columbia basins and to the lower Washougal.

*Upper Gorge-Above Bonneville Dam (Wind) (Primary, High$^+$)* – This is the highest rated population in the lower Columbia. Current adult returns are low and about average for recent years, but there is reasonable juvenile production in key reaches. There is no hatchery steelhead program in the basin.

## 5.4 Salmon and Steelhead Population Objectives

Previous sections in this chapter outlined a general approach to salmon and steelhead recovery that utilizes the TRT's interim viability criteria as the foundation. A recovery scenario was then described which integrates the TRT's ESU viability concept with goals for each population and how that effort at the population level will fit into the overall recovery effort for the ESU. Recovery will require improvements for a significant number of historical populations of each species and ESU as prescribed by TRT criteria and reflected in the recovery scenario. In this section, population recovery objectives are described using improvement increments that relate the prescribed changes in viability to specific changes in population parameters, particularly abundance and productivity.

### 5.4.1 Abundance

Population recovery objectives describe the numbers necessary to reach stabilizing, contributing, or primary population levels reflected in the recovery scenario. This plan identifies specific numerical objectives for population abundance and productivity. Abundance objectives are detailed in Table 3 through Table 6. Productivity objectives are described in Section 5.4.2.

Figure 11 is a schematic which describes the relationship between population abundance and productivity, viability levels identified in TRT interim criteria, and population improvements identified in the recovery scenario. In the example, the current population has low viability. As fish numbers or productivity increase, the population will eventually become viable as reflected by a 95% or greater persistence level over 100 years (see Table 1). Threatened or endangered salmon and steelhead typically include some populations where current abundance and productivity fall above the high viability mark, but a majority of populations fall below this level.

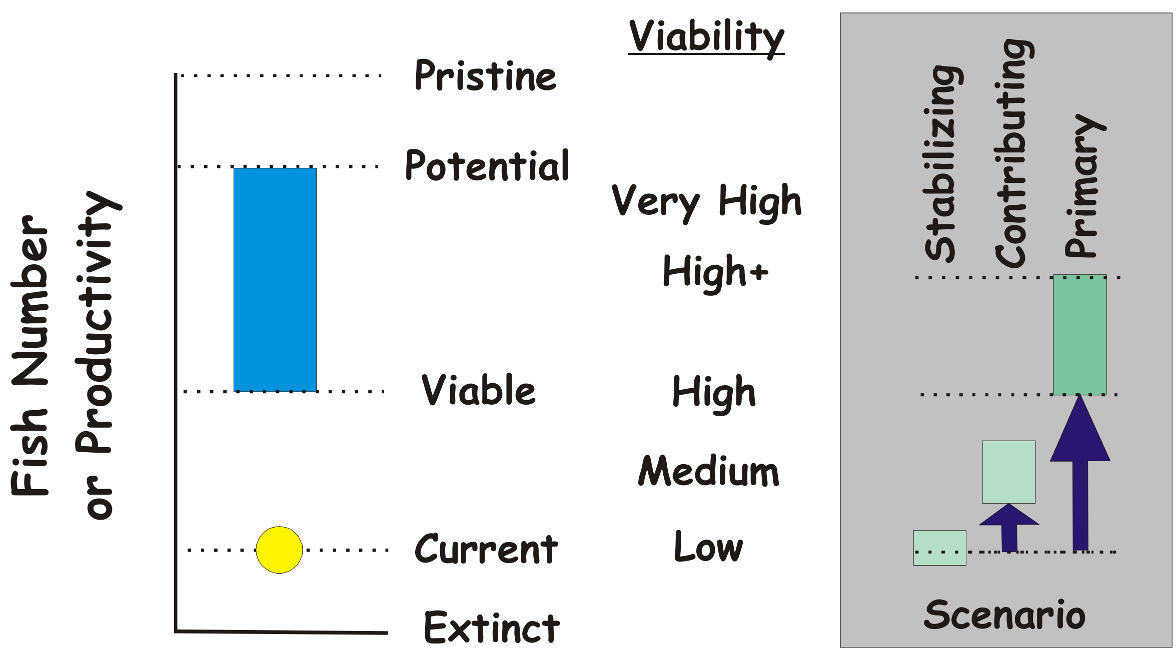


**Figure 11. Schematic relating population abundance and productivity to viability levels identified by the Willamette/Lower Columbia Technical Recovery Team and population goals described by the recovery scenario.**

The upper end of the recovery range is described as "potential" and represents the theoretical capacity if currently-accessible habitat was restored to "properly functioning conditions" (PFC's) identified by NOAA Fisheries. PFC's are benchmarks for habitat protection and restoration efforts that represent generally favorable conditions for salmonids. PFC conditions are assumed to be consistent with very high levels of viability. However, populations can also be assumed to reach high or very high levels of viability at numbers less than the potential represented by PFC.

Abundance and productivity provide simple quantitative metrics for describing population status and objectives. Abundance is the spawning population size averaged over a time period sufficient to account for year-to-year fluctuations due to natural environmental variation. Abundance objectives are reached when populations consistently exceed target numbers in most years. Productivity is the realized spawner to spawner replacement rate which provides a direct description of the dynamics that determine status and viability. Productivity objectives are reached when populations consistently exceed a 1:1 replacement rate by a margin sufficient to rebound quickly from periodic low numbers caused by natural environmental variation in survival conditions. Abundance and productivity objectives vary among individual populations as a result of subbasin differences in habitat quantity, habitat quality, fish distribution, juvenile production, spatial structure, and life history and genetic diversity. Additional work will be required during plan implementation to clarify time frames for measurement of these criteria (e.g. how many years of data are needed, what is an appropriate baseline for reference, and how are the effects of normal environmental variation considered).

Abundance and productivity objectives are intended to be used in close conjunction with these other viable salmonid population attributes (see section 5.4.4) to evaluate population status as recommended by the TRT. All VSP parameters are closely associated such that improvements in one parameter typically cause or are related to improvements in other parameters. For instance, productivity improvements might typically depend on increased diversity or habitat quality and be accompanied by increased abundance and distribution. Substantial improvements in population viability and reductions in extinction risk will require improvements in abundance and productivity. Abundance and productivity objectives assume related increases in other VSP parameters consistent with desired improvements.

**Table 3. Recovery goals for lower Columbia River Chinook populations.**

| Population | Scenario Contrib. | Viability | | Abundance | | | |
|---|---|---|---|---|---|---|---|
| | | Current | Goal | Current | Viable | Potential | Goal |
| **Coast Fall** | | | | | | | |
| Grays/Chinook | Primary | Low+ | High | 73 | 1,400 | 1,400 | 1,400 |
| Eloch/Skam | Primary | Low+ | High | 140 | 1,400 | 4,500 | 1,400 |
| Mill/Aber/Germ | Contributing | Low | Med | 250 | 2,000 | 3,200 | 1,100 |
| Youngs Bay (OR) | Stabilizing | na | Low | na | 1,400 | 2,800 | na |
| Big Creek (OR) | Stabilizing | na | Low+ | na | 1,400 | 2,800 | na |
| Clatskanie (OR) | Primary | na | High | na | 1,400 | 2,800 | na |
| Scappoose (OR) | Stabilizing | na | Low | na | 1,400 | 2,800 | na |
| **Cascade Fall** | | | | | | | |
| Lower Cowlitz | Contributing | Low+ | Med | 602 | 3,900 | 33,200 | 2,300 |
| Upper Cowlitz | Stabilizing | V Low | V Low | 0 | 1,400 | 10,800 | na |
| Toutle | Stabilizing | Low | Low | 1,000 | 1,400 | 14,100 | 1,000 |
| Coweeman | Primary | Med | High+ | 425 | 3,000 | 4,100 | 3,600 |
| Kalama | Primary | Low+ | High | 1,192 | 1,300 | 3,200 | 1,300 |
| Lewis/Salmon | Primary | Med | High+ | 235 | 1,900 | 3,900 | 2,900 |
| Washougal | Primary | Low+ | High | 1,225 | 5,800 | 5,800 | 5,800 |
| Clackamas (OR) | Contributing | na | Med | 56 | 1,400 | 2,800 | na |
| Sandy (OR) | Stabilizing | na | Low+ | 208 | 1,400 | 2,800 | na |
| **Cascade L Fall** | | | | | | | |
| Lewis NF | Primary | Med+ | High+ | 6,493 | 6,500 | 16,600 | 11,600 |
| Sandy (OR) | Primary | na | Low+ | 445 | 5,100 | 10,200 | na |
| **Cascade Spring** | | | | | | | |
| Upper Cowlitz | Primary | Low | High+ | 365 | 2,800 | 8,100 | 5,400 |
| Cispus | Primary | Low | High+ | 150 | 1,400 | 2,300 | 1,800 |
| Tilton | Stabilizing | V Low | V Low | 150 | 1,400 | 2,800 | 150 |
| Toutle | Contributing | V Low | Med | 150 | 1,400 | 3,400 | 800 |
| Kalama | Primary | V Low | High | 105 | 1,400 | 900 | 1,400 |
| Lewis NF | Primary | V Low | High | 300 | 2,200 | 3,900 | 2,200 |
| Sandy (OR) | Primary | na | High | 2,649 | 2,600 | 5,200 | na |
| **Gorge Fall** | | | | | | | |
| L. Gorge (Hamilton) | Contributing | Low | Med | na | 1,400 | 2,800 | 700 |
| U. Gorge (Wind) | Stabilizing | Low | Low | 138 | 1,400 | 2,400 | 100 |
| White Salmon | Contributing | Low | Med | 174 | 1,600 | 3,200 | 900 |
| Hood (OR) | Stabilizing | na | Low+ | na | 1,400 | 2,800 | na |
| **Gorge Spring** | | | | | | | |
| White Salmon | Contributing | V Low | Low | 0 | 1,400 | 2,800 | 400 |
| Hood (OR) | Primary | na | High | 0 | 1,400 | 2,800 | na |

*Notes (for Table 3 through Table 6)*

1. *Primary, contributing, and stabilizing designations are based on priorities identified in the recovery scenario.*
2. *Current viability is based on Technical Recovery Team viability rating approach.*
3. *Viability goal is related to the scenario contribution.*
4. *Recent average numbers are observed 4-year averages or assumed natural spawning escapements. Data typically is through year 2000.*
5. *Viable population size is defined by NOAA's Population Change Criteria. Minimum default values were used where population-specific data were lacking.*
6. *Potential abundance at PFC+ is defined by WDFW's Ecosystem Diagnosis and Treatment (EDT) assessments under properly functioning habitat and historical estuary conditions.*
7. *Abundance goals are interpolated from current, viable, and/or potential numbers based on viability goals.*
8. *These approximations are considered working hypotheses that provide benchmarks for scaling recovery strategies and a reference point for future monitoring, evaluation, and adaptation.*

**Table 4. Recovery goals for lower Columbia River chum populations.**

| Population | Scenario contrib. | Viability | | Abundance | | | |
|---|---|---|---|---|---|---|---|
| | | Current | Goal | Current | Viable | Potential | Goal |
| **Coast** | | | | | | | |
| Grays/Chinook | Primary | Low+ | High+ | 960 | 4,300 | 7,800 | 6,000 |
| Eloch/Skam | Primary | Low | High | <150 | 1,100 | 8,200 | 1,100 |
| Mill/Ab/Germ | Primary | V Low | High | <150 | 1,100 | 3,000 | 1,100 |
| Youngs (OR) | Primary | na | High | na | 1,100 | 2,200 | na |
| Big Creek (OR) | Contributing | na | Low | na | 1,100 | 2,200 | na |
| Clatskanie (OR) | Contributing | na | Med | na | 1,100 | 2,200 | na |
| Scappoose (OR) | Contributing | na | Low | na | 1,100 | 2,200 | na |
| **Cascade** | | | | | | | |
| Cowlitz | Contributing | V Low | Med | <150 | 1,100 | 135,700 | 600 |
| Kalama | Contributing | V Low | Low | <150 | 1,100 | 12,200 | 150 |
| Lewis | Primary | V Low | High | <150 | 1,100 | 71,000 | 1,100 |
| Salmon | Stabilizing | V Low | V Low | <150 | 1,100 | 4,200 | 75 |
| Washougal | Primary | Low | High+ | <150 | 1,100 | 9,400 | 5,200 |
| Clackamas (OR) | Contributing | na | Med | na | 1,100 | 2,200 | na |
| Sandy (OR) | Primary | na | High | na | 1,100 | 2,200 | na |
| **Gorge** | | | | | | | |
| Lower Gorge | Primary | Med+ | High+ | 542 | 2,600 | 3,100 | 2,800 |
| Upper Gorge | Contributing | V Low | Med | <100 | 1,100 | 5,900 | 600 |

**Table 5. Recovery goals for lower Columbia River steelhead populations.**

| | Scenario | Viability | | Abundance | | | |
|---|---|---|---|---|---|---|---|
| **Population** | **contrib.** | **Current** | **Goal** | **Current** | **Viable** | **Potential** | **Goal** |
| **Coast Winter** | | | | | | | |
| Grays/Chinook | Primary[1] | Low+ | High | 150 | 600 | 2,300 | 600 |
| Eloch/Skam | Contributing[1] | Low+ | Med | 150 | 600 | 1,000 | 400 |
| Mill/Ab/Germ | Primary[1] | Low+ | High | 150 | 600 | 1,500 | 600 |
| **Cascade Winter** | | | | | | | |
| Lower Cowlitz | Contributing | Low | Med | na | 600 | 1,500 | 300 |
| Coweeman | Primary | Low+ | High | 228 | 800 | 1,200 | 800 |
| S.F. Toutle | Primary | Med | High+ | 453 | 1,400 | 1,900 | 1,600 |
| N.F. Toutle | Primary | Low | High | 176 | 700 | 3,500 | 700 |
| Upper Cowlitz | Contributing | Low | Med | 0 | 600 | 1,600 | 300 |
| Cispus | Contributing | Low | Med | 0 | 600 | 1,200 | 300 |
| Tilton | Contributing | V Low | Low | 0 | 600 | 1,300 | 150 |
| Kalama | Primary | Med+ | High+ | 541 | 600 | 700 | 650 |
| N.F. Lewis | Contributing | Low | Med | na | 600 | 3,400 | 300 |
| E.F. Lewis | Primary | Low+ | High | 77 | 600 | 1,300 | 600 |
| Salmon | Stabilizing | Low | Low | na | 600 | 1,200 | 300 |
| Washougal | Contributing | Low+ | Med | 421 | 600 | 1,000 | 500 |
| Clackamas (OR) | Primary | na | High | 277 | 1,000 | 2,000 | na |
| Sandy (OR) | Primary | na | High | 589 | 1,800 | 3,600 | na |
| **Cascade Summer** | | | | | | | |
| Kalama | Primary | Low+ | High | 291 | 700 | 1,000 | 700 |
| N.F. Lewis | Stabilizing | V Low | V Low | na | 600 | 1,200 | 75 |
| E.F. Lewis | Primary | Low+ | High | 463 | 200 | 400 | 200 |
| Washougal | Primary | Low+ | High+ | 136 | 500 | 900 | 700 |
| **Gorge Winter** | | | | | | | |
| L. Gorge (HHD) | Primary | Low+ | High | na | 200 | 300 | 200 |
| U. Gorge *(Wind)* | Stabilizing | Low+ | Low+ | na | 100 | 100 | 50 |
| Hood (OR) | Primary | na | High | 436 | 1,400 | 2,800 | na |
| **Gorge Summer** | | | | | | | |
| Wind | Primary | Med+ | High+ | 391 | 1,200 | 1,900 | 1,600 |
| Hood (OR) | Primary | na | High | 154 | 600 | 1,200 | na |

*[1] Not listed under the U.S. Endangered Species Act*

**Table 6. Recovery goals for lower Columbia River coho populations.**

| Population | Scenario contrib. | Viability | | Abundance | | | |
|---|---|---|---|---|---|---|---|
| | | Current | Goal | Current | Viable | Potential | Goal |
| **Coast** | | | | | | | |
| Grays/Chinook | Primary | Low | High | na | 600 | 4,600 | 600 |
| Eloch/Skam | Primary | Low | High | na | 600 | 7,000 | 600 |
| Mill/Ab/Germ | Contributing | Low | Med | na | 600 | 3,700 | 300 |
| Youngs (OR) | Stabilizing | na | Low | na | 600 | 1,200 | na |
| Big Creek (OR) | Primary | na | High | na | 600 | 1,200 | na |
| Clatskanie (OR) | Stabilizing | na | Low | na | 600 | 1,200 | na |
| Scappoose (OR) | Primary | na | High | na | 600 | 1,200 | na |
| **Cascade** | | | | | | | |
| Lower Cowlitz | Primary | Low | High | na | 600 | 19,100 | 600 |
| Coweeman | Primary | Low | High | na | 600 | 7,600 | 600 |
| S.F. Toutle | Primary | Low | High | na | 600 | 32,900 | 600 |
| N.F. Toutle | Primary | Low | High | na | 600 | 1,200 | 600 |
| Upper Cowlitz | Contributing | V Low | Med | na | 600 | 28,800 | 300 |
| Cispus | Contributing | V Low | Med | na | 600 | 6,600 | 300 |
| Tilton | Contributing | V Low | Low | na | 600 | 4,000 | 150 |
| Kalama | Contributing | Low | Med | na | 600 | 1,300 | 300 |
| NF Lewis | Contributing | Low | High | na | 600 | 5,900 | 600 |
| EF Lewis | Primary | Low | High | na | 600 | 4,100 | 600 |
| Salmon | Stabilizing | V Low | V Low | na | 600 | 5,700 | 75 |
| Washougal | Contributing | Low | Med | na | 600 | 4,200 | 300 |
| Clackamas (OR) | Primary | na | High+ | 1,684 | 600 | 1,200 | na |
| Sandy (OR) | Primary | na | High+ | 587 | 600 | 1,200 | na |
| **Gorge** | | | | | | | |
| L Gorge (Hamilton) | Primary | Low | High | na | 600 | 1,200 | 600 |
| U Gorge (Wind) | Primary | Low | High | na | 600 | 1,100 | 600 |
| White Salmon | Contributing | V Low | Low | na | 600 | 1,200 | 150 |
| Hood (OR) | Contributing | na | Med | na | 600 | 1,200 | na |

### 5.4.2 Productivity

Productivity objectives are described in terms of relative improvement increments that identify increases needed to recover populations from current status to medium, high, and high+ levels of population viability consistent with the recovery scenario. Tables 7-10 identify the productivity improvements specified for each population consistent with meeting the overall productivity goal.

Productivity is defined as the inherent population replacement rate and is typically expressed as a median rate of population increase or a spawner recruit per spawner replacement rate. Increments defined in terms of productivity can be directly related to the impacts of specific limiting factors and threats. This provides a basis for systematic quantitative analysis of the effects of factors and threats on population status and viability. It translates the effects of different threats into common units that allow consideration of tradeoffs in strategies and measures among different factor and threat categories. These numbers also provide clear reference points for monitoring population performance as part of plan evaluation and implementation.

Productivity improvements are based on the needed increase relative to the current status. For instance, an improvement of 30% would be necessary to reach a median rate of population increase of 120% corresponding to high viability in a primary population if the current rate was 90% [(120-90)/90]. Equivalent calculations may also be based on Ln(recruits/spawner). Values are based on viable population productivity levels derived by NOAA Fisheries using their Population Change Criteria (PCC) analysis (McElhany et al. 2003) and on estimates of current and potential productivity derived by WDFW using an Ecosystem Diagnosis and Treatment (EDT) analysis (Appendix E of this plan).

Analyses highlight the need for substantial improvements in productivity of almost all populations to reach recovery goals. Net improvement increments for fall Chinook ranged from 0% for stabilizing populations to 200% for at least one population targeted for very high viability. Net productivity improvements for fall Chinook populations targeted for high viability averaged 30%. Improvement increments were undefined for spring Chinook either because access has been eliminated to all historical habitat or because data were inadequate to quantify current populations trends. Net productivity increments to reach high viability were 30-1000% for chum and 10-80% for steelhead. Data were insufficient for comparable estimates for coho but it can be assumed that improvement increments are similar to or greater than those of steelhead. For several populations, productivity improvements were undefined, for instance where dams have completely blocked access to potentially-productive habitats.

Improvement increments highlight order of magnitude improvements needed in each population to reach recovery goals. Population-specific objectives are subject to significant uncertainties in assessments but species averages and ranges provide a general idea of the scale of improvements that need to be addressed by recovery strategies, measures, and actions. This approximation approach is consistent with the scale in other uncertainties associated with all input parameters as well as the effects of specific recovery actions. Given the ultimate uncertainty in the effects of recovery actions and the need to implement an adaptive recovery program, this approximation should be adequate for developing order-of-magnitude estimates to which recovery actions can be scaled consistent with the current best available science and data.

### 5.4.3 Human Impacts and Threats

This plan also identifies objectives for reducing human impacts and threats that constrain population viability. These incremental improvements are identified as starting points to indicate the general level of effort that will be required from each sector to achieve recovery. Impact reduction objectives describe changes in potentially manageable factors consistent with abundance and productivity objectives. Changes are referenced to a baseline period corresponding to species listing dates. Tables 7-10 identify baseline impacts that quantify effects in each area of human impact (habitat, hydropower, harvest, etc.) and reduced impact levels consistent with meeting the overall productivity goal. Impact objectives address the subset of all threats that can be quantified with productivity impacts as reflected in the Appendix E. Recovery strategies, measures, and actions detailed elsewhere in this plan address both quantifiable and unquantifiable threats. Specific threat criteria are not explicitly identified in this plan but the plan does incorporate substantive strategies and measures to reduce threats in every category.

Impacts are estimates of the proportional reduction in population productivity associated with human-caused and other potentially manageable impacts including stream habitats, estuary/mainstem habitats, hydropower, harvest, hatcheries, and selected predators. Quantifiable impacts include:

- reductions in smolts produced per spawner caused by tributary habitat development relative to historical conditions,
- decreases in mainstem and estuary survival of migrants as a result of habitat changes,
- loss of habitat access and passage mortality due to tributary and mainstem dam construction and operation,
- predation rates by northern pikeminnow mortality, marine mammals, and terns,
- direct and indirect harvest rates from fishing, and
- reductions in natural population fitness and interspecific predation due to hatcheries.

Impact estimates are based on a simple salmon life cycle modeling approach (Adult Equivalent Impacts Occurring Unconditionally or 'AEIOU') developed by the LCFRB for this plan (see Appendix E for detailed methods). This approach has also been used in this plan to illustrate the relative significance of each factor with a series of pie diagrams (Figure 12) shown for each subbasin and population in Volume II of this plan.

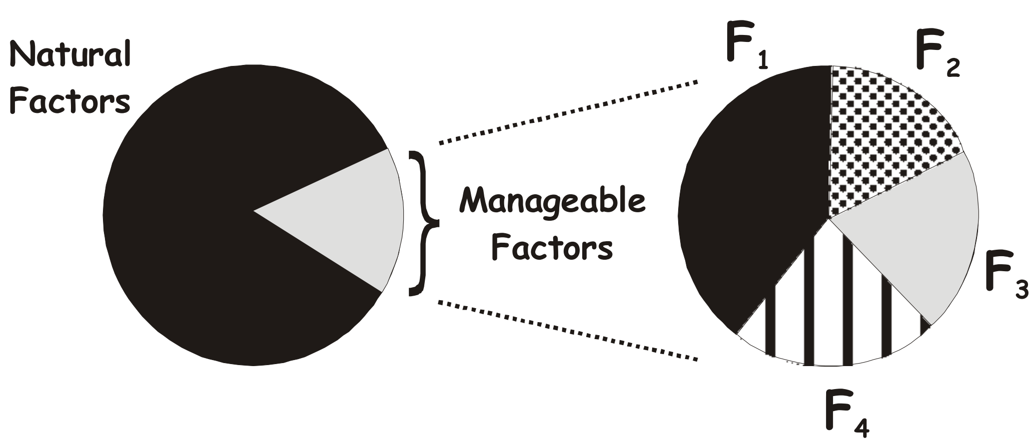


**Figure 12. Manageable human factors affecting salmon mortality, productivity, and numbers represented as a portion of all factors and as their own pie.**

Incremental improvements needed in each impact factor were estimated from the net productivity improvement needed to reach the population goal, the net effect of human and other potentially manageable impacts, and the distribution of impacts among the factors. The model simply assumes density-independent effects of all impacts but calculations are complicated by the need to translate back and forth between survival rates that can be directly related to productivity and mortality rates that can be directly related to human effects. For instance, a 33% increase in productivity needed to move from current to high viability would require a 33% improvement in net survival throughout the life cycle. Where the combined effects of all impacts produce a 90% reduction in survival [$(1\text{-Impact}_1)\ (1\text{-Impact}_2)\ldots(1\text{-Impact}_n)$], the net impact from all factors would need to be reduced to 86.7% to produce an improvement in survival from 10% (100-90) to 13.3% [(10(1 + 0.33)].

Average reductions in each human impact (Δ) are less than the net change in productivity required for the population. Effects of impacts acting at various stages of the salmonid life cycle are multiplicative and compounded. For instance, a 60% habitat quality impact combined with a 60% fishery harvest rate will reduce population productivity by a net 84% {1-[(1-0.6)(1-0.6)}. As a result, improvements in multiple risk factors provide compounding benefits and the benefits of improvement in any given factor are multiplied by benefits in other factors. Incremental improvements in each of multiple impact factors are thus less than the net productivity improvement needed to reach the population objective. For instance, a required 33% improvement increment would require only a 8% improvement per impact where proportional impact reductions were required of six factors. This approach is a simple example of a life cycle analysis and is effective because density-dependent effects for salmon are largely concentrated in freshwater stream habitats and thus do not confound extrapolations of other impacts on net population productivity.

Population productivity improvement increments are ultimately translated into target values for each human impact. Thus to move our example population to high viability as specified by the recovery scenario, the 30% improvement in net productivity would require an 8% improvement for each impact factor. Thus, tributary habitat impacts might need to be reduced from 70% to 64% [(1-0.08)(70)], fishery impacts might need to be reduced from 5% to 4.6% [(1-0.08)(5)], and so on. These estimates assume net improvements for each human factor in proportion to the magnitude of the impact. Larger impacts would need to make larger net contributions than smaller impacts because X% of a large factor is greater than X% of a small factor. For instance, a net 6% reduction in habitat impacts (70%-64%) represents a greater change than a net 0.4% reduction in fishery impacts (5%-4.6%) in the example where habitat impacts represent a much larger share of the problem.

Analyses demonstrate the compounding benefits of improvements in multiple areas. This synergism of benefits means that recovery is imminently realistic if multiple impact factors can be affected. Analyses also confirm that recovery will require significant improvements in multiple risk factors. It is rarely feasible to reach recovery goals based solely on improvements in any single risk factor. Required improvement increments are primarily driven by the largest impacts among the various factors. The smaller impacts (<10%) generally have limited power to affect significant changes. Recovery flexibility is constrained by among-population and among-species requirements. Even where productivity improvements in any given population are modest, requirements in other populations or species typically demand more significant improvements in any given risk factor.

Desired future conditions consistent with these biological objectives are not identified by this plan because the available scientific information and methods is inadequate for making robust estimates of these values and because many different combinations of future conditions can be expected to meet the biological objectives. Definition of any given combination of desired future conditions for habitat for instance might artificially constrain flexibility in implementation and adaptive management efforts. Benchmark conditions such as an historical template or NOAA's properly functioning habitat (PFC) conditions provide useful indicators of the direction recovery strategies and actions should take to produce desired improvements in fish status toward the biological objectives. However, historical template and PFC conditions do not represent conditions that must be achieved to meet viability or use objectives. It is likely that many populations would be healthy and harvestable if historical template or PFC conditions were restored. However, it is also likely that healthy and harvestable objectives can be achieved at levels substantially less than historical template or PFC conditions.

**Table 7. Productivity improvements and impact reduction objectives consistent with recovery of lower Columbia River Chinook populations.**

| | **Prod.** | **Baseline impacts** | | | | | | | **Impacts at goal** | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Population** | **Incr.** | **Trib** | **Est** | **Dams** | **Pred** | **Harv** | **Hat** | **Δ** | **Trib** | **Est** | **Dams** | **Pred** | **Harv** | **Hat** |
| **Coast Fall** | | | | | | | | | | | | | | |
| Grays/Chinook | 30% | 0.37 | 0.35 | 0.00 | 0.22 | 0.65 | 0.19 | 8% | 0.34 | 0.32 | 0.00 | 0.20 | 0.59 | 0.18 |
| Eloch/Skam | 30% | 0.30 | 0.35 | 0.00 | 0.23 | 0.65 | 0.40 | 8% | 0.34 | 0.32 | 0.00 | 0.20 | 0.59 | 0.36 |
| Mill/Aber/Germ | 20% | 0.56 | 0.35 | 0.00 | 0.23 | 0.65 | 0.24 | 4% | 0.54 | 0.34 | 0.00 | 0.22 | 0.62 | 0.23 |
| Youngs Bay (OR) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Big Creek (OR) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Clatskanie (OR) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Scappoose (OR) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Cascade Fall** | | | | | | | | | | | | | | |
| Lower Cowlitz | 20% | 0.64 | 0.37 | 0.00 | 0.23 | 0.65 | 0.47 | 4% | 0.61 | 0.36 | 0.00 | 0.23 | 0.62 | 0.45 |
| Upper Cowlitz | 0% | 0.71 | 0.38 | 1.00 | 0.23 | 0.65 | 0.20 | -- | -- | -- | -- | -- | -- | -- |
| Toutle | 0% | 0.56 | 0.36 | 0.00 | 0.23 | 0.65 | 0.31 | 0% | 0.56 | 0.36 | 0.00 | 0.23 | 0.65 | 0.31 |
| Coweeman | 200% | 0.44 | 0.30 | 0.00 | 0.23 | 0.65 | 0.00 | 40% | 0.26 | 0.18 | 0.00 | 0.14 | 0.39 | 0.00 |
| Kalama | 30% | 0.43 | 0.27 | 0.00 | 0.24 | 0.65 | 0.27 | 7% | 0.40 | 0.25 | 0.00 | 0.22 | 0.61 | 0.25 |
| Lewis/Salmon | 230% | 0.53 | 0.32 | 0.00 | 0.24 | 0.65 | 0.01 | 39% | 0.32 | 0.20 | 0.00 | 0.14 | 0.39 | 0.00 |
| Washougal | 30% | 0.47 | 0.29 | 0.00 | 0.24 | 0.65 | 0.20 | 7% | 0.43 | 0.27 | 0.00 | 0.23 | 0.61 | 0.19 |
| Clackamas (OR) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Sandy (OR) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Cascade L Fall** | | | | | | | | | | | | | | |
| Lewis NF | 110% | 0.16 | 0.39 | 0.07 | 0.24 | 0.50 | 0.17 | 35% | 0.11 | 0.26 | 0.05 | 0.16 | 0.33 | 0.11 |
| Sandy (OR) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Cascade Spring** | | | | | | | | | | | | | | |
| Upper Cowlitz | -- | 0.82 | 0.20 | 0.90 | 0.31 | 0.53 | 0.27 | -- | -- | -- | -- | -- | -- | -- |
| Cispus | -- | 0.88 | 0.20 | 1.00 | 0.31 | 0.53 | 0.27 | -- | -- | -- | -- | -- | -- | -- |
| Tilton | -- | -- | 0.20 | 1.00 | 0.31 | 0.53 | 0.27 | -- | -- | -- | -- | -- | -- | -- |
| Toutle | -- | 1.00 | 0.20 | 0.00 | 0.31 | 0.53 | 0.45 | -- | -- | -- | -- | -- | -- | -- |
| Kalama | -- | 0.92 | 0.20 | 0.00 | 0.31 | 0.53 | 0.45 | -- | -- | -- | -- | -- | -- | -- |
| Lewis NF | -- | 0.81 | 0.20 | 0.90 | 0.31 | 0.53 | 0.45 | -- | -- | -- | -- | -- | -- | -- |
| Sandy (OR) | -- | 0.63 | 0.20 | 0.92 | 0.34 | 0.53 | 0.70 | -- | -- | -- | -- | -- | -- | -- |
| **Gorge Fall** | | | | | | | | | | | | | | |
| L. Gorge (Hamilton) | 10% | 0.45 | 0.29 | 0.20 | 0.25 | 0.65 | 0.29 | 3% | 0.44 | 0.28 | 0.19 | 0.24 | 0.63 | 0.28 |
| U. Gorge (Wind) | 10% | 0.63 | 0.30 | 0.60 | 0.27 | 0.65 | 0.19 | 0% | 0.63 | 0.30 | 0.60 | 0.27 | 0.65 | 0.19 |
| White Salmon | | | 0.30 | 0.60 | 0.27 | 0.65 | 0.11 | -- | -- | -- | -- | -- | -- | -- |
| Hood (OR) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Gorge Spring** | | | | | | | | | | | | | | |
| White Salmon | -- | -- | 0.20 | 0.92 | 0.34 | 0.53 | 0.70 | -- | -- | -- | -- | -- | -- | -- |
| Hood (OR) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |

**Table 8. Productivity improvements and impact reduction objectives consistent with recovery of lower Columbia River chum populations.**

| | Prod. | Baseline impacts | | | | | | | Impacts at goal | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Population** | **Incr.** | **Trib** | **Est** | **Dams** | **Pred** | **Harv** | **Hat** | **Δ** | **Trib** | **Est** | **Dams** | **Pred** | **Harv** | **Hat** |
| **Coast** | | | | | | | | | | | | | | |
| Grays/Chinook | 90% | 0.85 | 0.28 | 0.00 | 0.22 | 0.05 | 0.03 | 14% | 0.73 | 0.24 | 0.00 | 0.19 | 0.04 | 0.02 |
| Eloch/Skam | 50% | 0.86 | 0.28 | 0.00 | 0.23 | 0.05 | 0.03 | 7% | 0.80 | 0.26 | 0.00 | 0.21 | 0.05 | 0.03 |
| Mill/Ab/Germ | 60% | 0.88 | 0.28 | 0.00 | 0.23 | 0.05 | 0.03 | 7% | 0.81 | 0.26 | 0.00 | 0.22 | 0.05 | 0.02 |
| Youngs (OR) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Big Creek (OR) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Clatskanie (OR) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Scappoose (OR) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Cascade** | | | | | | | | | | | | | | |
| Cowlitz | 40% | 0.96 | 0.59 | 0.00 | 0.23 | 0.05 | 0.11 | 2% | 0.95 | 0.58 | 0.00 | 0.23 | 0.05 | 0.11 |
| Kalama | 30% | 0.92 | 0.51 | 0.00 | 0.24 | 0.05 | 0.03 | 2% | 0.90 | 0.50 | 0.00 | 0.23 | 0.05 | 0.03 |
| Lewis | 30% | 0.93 | 0.58 | 0.00 | 0.24 | 0.05 | 0.04 | 2% | 0.91 | 0.57 | 0.00 | 0.23 | 0.05 | 0.04 |
| Salmon | 0% | 1.00 | 0.58 | 0.00 | 0.24 | 0.05 | 0.00 | 0% | 1.00 | 0.58 | 0.00 | 0.24 | 0.05 | 0.00 |
| Washougal | 350% | 0.96 | 0.58 | 0.00 | 0.24 | 0.05 | 0.01 | 11% | 0.86 | 0.51 | 0.00 | 0.22 | 0.04 | 0.01 |
| Clackamas (OR) | -- | -- | -- | -- | -- | -- | -- | | | | | | | |
| Sandy (OR) | -- | -- | -- | -- | -- | -- | -- | | | | | | | |
| **Gorge** | | | | | | | | | | | | | | |
| Lower Gorge | 90% | 0.86 | 0.38 | 0.20 | 0.25 | 0.05 | 0.01 | 11% | 0.77 | 0.33 | 0.18 | 0.22 | 0.04 | 0.00 |
| Upper Gorge | 960% | 0.50 | 0.56 | 0.96 | 0.27 | 0.05 | 0.07 | 22% | 0.39 | 0.44 | 0.75 | 0.21 | 0.04 | 0.06 |

**Table 9. Productivity improvements and impact reduction objectives consistent with recovery of lower Columbia River steelhead populations.**

| | Prod. | Baseline impacts | | | | | | | Impacts at goal | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Population** | **Incr.** | **Trib** | **Est** | **Dams** | **Pred** | **Harv** | **Hat** | **Δ** | **Trib** | **Est** | **Dams** | **Pred** | **Harv** | **Hat** |
| **Coast Winter** | | | | | | | | | | | | | | |
| Grays/Chinook | 20% | 0.677 | 0.183 | 0.000 | 0.224 | 0.100 | 0.038 | 0.059 | 0.64 | 0.17 | 0.00 | 0.21 | 0.09 | 0.04 |
| Eloch/Skam | 10% | 0.515 | 0.183 | 0.000 | 0.230 | 0.100 | 0.065 | 0.040 | 0.49 | 0.18 | 0.00 | 0.22 | 0.10 | 0.06 |
| Mill/Ab/Germ | 20% | 0.441 | 0.183 | 0.000 | 0.233 | 0.100 | 0.040 | 0.108 | 0.39 | 0.16 | 0.00 | 0.21 | 0.09 | 0.04 |
| **Cascade Winter** | | | | | | | | | | | | | | |
| Lower Cowlitz | 10% | 0.885 | 0.109 | 0.000 | 0.235 | 0.100 | 0.276 | 0.010 | 0.88 | 0.11 | 0.00 | 0.23 | 0.10 | 0.27 |
| Coweeman | 30% | 0.730 | 0.150 | 0.000 | 0.235 | 0.100 | 0.161 | 0.088 | 0.67 | 0.14 | 0.00 | 0.21 | 0.09 | 0.15 |
| S.F. Toutle | 80% | 0.820 | 0.112 | 0.000 | 0.235 | 0.100 | 0.006 | 0.142 | 0.70 | 0.10 | 0.00 | 0.20 | 0.09 | 0.01 |
| N.F. Toutle | 10% | 0.900 | 0.112 | 0.000 | 0.235 | 0.100 | 0.000 | 0.010 | 0.89 | 0.11 | 0.00 | 0.23 | 0.10 | 0.00 |
| Upper Cowlitz | -- | 0.498 | 0.137 | 1.000 | 0.235 | 0.100 | 0.300 | -- | -- | -- | -- | -- | -- | -- |
| Cispus | -- | 0.520 | 0.136 | 1.000 | 0.235 | 0.100 | 0.300 | -- | -- | -- | -- | -- | -- | -- |
| Tilton | -- | 0.854 | 0.137 | 1.000 | 0.235 | 0.100 | 0.300 | -- | -- | -- | -- | -- | -- | -- |
| Kalama | 50% | 0.497 | 0.127 | 0.000 | 0.236 | 0.100 | 0.031 | 0.281 | 0.36 | 0.09 | 0.00 | 0.17 | 0.07 | 0.02 |
| N.F. Lewis | 10% | 0.586 | 0.104 | 0.952 | 0.239 | 0.100 | 0.231 | 0.005 | 0.58 | 0.10 | 0.95 | 0.24 | 0.10 | 0.23 |
| E.F. Lewis | 30% | 0.749 | 0.132 | 0.000 | 0.239 | 0.100 | 0.357 | 0.067 | 0.70 | 0.12 | 0.00 | 0.22 | 0.09 | 0.33 |
| Salmon | 10% | 0.869 | 0.132 | 0.000 | 0.243 | 0.100 | 0.357 | 0.010 | 0.86 | 0.13 | 0.00 | 0.24 | 0.10 | 0.35 |
| Washougal | 0% | 0.743 | 0.124 | 0.000 | 0.243 | 0.100 | 0.350 | 0.010 | 0.74 | 0.12 | 0.00 | 0.24 | 0.10 | 0.35 |
| Clackamas (OR) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Sandy (OR) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Cascade Summer** | | | | | | | | | | | | | | |
| Kalama | 10% | 0.348 | 0.043 | 0.000 | 0.236 | 0.100 | 0.035 | 0.075 | 0.32 | 0.04 | 0.00 | 0.22 | 0.09 | 0.03 |
| N.F. Lewis | -- | 0.586 | 0.586 | 0.500 | 0.239 | 0.100 | 0.651 | 0.000 | 0.59 | 0.59 | 0.50 | 0.24 | 0.10 | 0.65 |
| E.F. Lewis | 10% | 0.790 | 0.043 | 0.000 | 0.239 | 0.100 | 0.189 | 0.020 | 0.77 | 0.04 | 0.00 | 0.23 | 0.10 | 0.19 |
| Washougal | 50% | 0.707 | 0.049 | 0.000 | 0.243 | 0.100 | 0.175 | 0.135 | 0.61 | 0.04 | 0.00 | 0.21 | 0.09 | 0.15 |
| **Gorge Winter** | | | | | | | | | | | | | | |
| L. Gorge (HHD) | 20% | 0.561 | 0.134 | 0.000 | 0.246 | 0.100 | 0.007 | 0.085 | 0.51 | 0.12 | 0.00 | 0.23 | 0.09 | 0.01 |
| U. Gorge *(Wind)* | 10% | 0.750 | 0.106 | 0.154 | 0.273 | 0.100 | 0.000 | 0.022 | 0.73 | 0.10 | 0.15 | 0.27 | 0.10 | 0.00 |
| Hood (OR) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Gorge Summer** | | | | | | | | | | | | | | |
| Wind | 50% | 0.673 | 0.090 | 0.154 | 0.273 | 0.100 | 0.147 | 0.146 | 0.58 | 0.08 | 0.13 | 0.23 | 0.09 | 0.13 |
| Hood (OR) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |

**Table 10. Productivity improvements and impact reduction objectives consistent with recovery of lower Columbia River coho populations.**

| | Prod. | Baseline impacts | | | | | | | Impacts at goal | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Population | Incr. | Trib | Est | Dams | Pred | Harv | Hat | Δ | Trib | Est | Dams | Pred | Harv | Hat |
| **Coast** | | | | | | | | | | | | | | |
| Grays/Chinook | na | 0.715 | 0.287 | 0 | 0.224 | 0.510 | 0.477 | na | na | na | na | na | na | na |
| Eloch/Skam | na | 0.790 | 0.179 | 0 | 0.230 | 0.510 | 0.508 | na | na | na | na | na | na | na |
| Mill/Ab/Germ | na | 0.766 | 0.179 | 0 | 0.233 | 0.510 | 0.440 | na | na | na | na | na | na | na |
| Youngs (OR) | na | -- | -- | -- | -- | -- | -- | na | na | na | na | na | na | na |
| Big Creek (OR) | na | -- | -- | -- | -- | -- | -- | na | na | na | na | na | na | na |
| Clatskanie (OR) | na | -- | -- | -- | -- | -- | -- | na | na | na | na | na | na | na |
| Scappoose (OR) | na | -- | -- | -- | -- | -- | -- | na | na | na | na | na | na | na |
| **Cascade** | | | | | | | | | | | | | | |
| Lower Cowlitz | na | 0.765 | 0.179 | 0 | 0.235 | 0.510 | 0.321 | na | na | na | na | na | na | na |
| Coweeman | na | 0.778 | 0.179 | 0 | 0.235 | 0.510 | 0.114 | na | na | na | na | na | na | na |
| S.F. Toutle | na | 0.888 | 0.179 | 0 | 0.235 | 0.510 | 0.258 | na | na | na | na | na | na | na |
| N.F. Toutle | na | 0.888 | 0.179 | 0 | 0.235 | 0.510 | 0.271 | na | na | na | na | na | na | na |
| Upper Cowlitz | na | 0.239 | 0.179 | 1.000 | 0.235 | 0.510 | 0.288 | na | na | na | na | na | na | na |
| Cispus | na | 0.423 | 0.191 | 1.000 | 0.235 | 0.510 | 0.288 | na | na | na | na | na | na | na |
| Tilton | na | 0.942 | 0.194 | 1.000 | 0.235 | 0.510 | 0.288 | na | na | na | na | na | na | na |
| Kalama | na | 0.629 | 0.194 | 0 | 0.236 | 0.510 | 0.311 | na | na | na | na | na | na | na |
| NF Lewis | na | 0.607 | 0.194 | 0.952 | 0.239 | 0.510 | 0.245 | na | na | na | na | na | na | na |
| EF Lewis | na | 0.751 | 0.194 | 0 | 0.239 | 0.510 | 0.235 | na | na | na | na | na | na | na |
| Salmon | na | 0.853 | 0.194 | 0 | 0.243 | 0.510 | 0.201 | na | na | na | na | na | na | na |
| Washougal | na | 0.790 | 0.194 | 0 | 0.243 | 0.510 | 0.463 | na | na | na | na | na | na | na |
| Clackamas (OR) | na | -- | -- | -- | -- | -- | -- | na | na | na | na | na | na | na |
| Sandy (OR) | na | -- | -- | -- | -- | -- | -- | na | na | na | na | na | na | na |
| **Gorge** | | | | | | | | | | | | | | |
| L Gorge (Hamilton) | na | 0.798 | 0.194 | 0 | 0.246 | 0.510 | 0.455 | na | na | na | na | na | na | na |
| U Gorge (Wind) | na | 0.558 | 0.194 | 0.154 | 0.273 | 0.510 | 0.448 | na | na | na | na | na | na | na |
| White Salmon | na | 0.558 | 0.194 | 1.000 | 0.273 | 0.510 | 0.448 | na | na | na | na | na | na | na |
| Hood (OR) | na | -- | -- | -- | -- | -- | -- | na | na | na | na | na | na | na |

*Notes (for* Table 7 *through* Table 10*)*

1. *Productivity increment indicates needed improvements to reach population viability goal.*
2. *Improvement increments were inferred using existing analytical frameworks including PCC assessments conducted by NOAA Fisheries and EDT assessments conducted by WDFW.*
3. *Productivity improvements for contributing populations were based on half the distance between current productivity and productivity at viability.*
4. *Productivity reference points for populations targeted for High$^+$ viability were based on half the distance between viable and potential productivity. Potential productivity (the top end of the planning range) was based on EDT estimates under favorable habitat conditions in the subbasin, mainstem, and estuary (PFC+). This assumes that persistence probability will approach 100% in many populations under conditions well below historical population levels and properly functioning habitat conditions.*
5. *Species average increments were used for populations where component data were lacking.*
6. *Baseline impacts are effects on productivity at the time of ESA listing for tributary habitat conditions, estuary habitat conditions, hydropower dams, mainstem predation, harvest, and hatcheries.*
7. *Δ refers to proportional reduction in each impact needed to reach productivity improvement and viability goals. (Δ is less than the net productivity improvement because of compounding benefits of changes in each impact factor.)*
8. *Impacts at goal are values consistent with productivity and viability goals where reductions in each factor are evenly distributed in proportion to baseline impacts.*
9. *Uncertainties in the various parameters upon which this analysis is based sometimes produce inconsistent results for specific populations.*
10. *Missing values include: i) Oregon populations for which no EDT is available, ii) extirpated populations for which productivity improvements relative to a zero baseline are undefined, and iii) populations for which PCC and trend data are lacking for any representative (spring Chinook).*
11. *Average species and run type values for viability or incremental improvements needed to reach viability were used for populations where PCC and trend data were lacking. This assumes populations where data were present are representative where data are not. This assumption is probably optimistic because data is typically collected on the most significant populations. As a result, needed improvement increments are likely to be underestimates.*
12. *Improvement increments do not consider effects of measures implemented since listing.*
13. *Improvement increments do not explicitly include contingencies for large-scale risks such as regional or local trends in increasing development pressure, climate change, or exotic species invasions. (However, historic trends in abundance used to estimate productivity increments might capture continuing trends.)*
14. *Productivity improvements are approximations based on existing data and assessments. These approximations are considered working hypotheses that provide benchmarks for scaling recovery strategies and a reference point for future monitoring, evaluation, and adaptation.*

### 5.4.4 Other Viable Salmonid Population Parameters

The WLC-TRT developed guidelines based on a series of viable salmonid population (VSP) parameters including abundance, productivity, spatial structure, diversity, juvenile numbers, and habitat. This plan identifies specific quantitative abundance and productivity objectives for each listed population. Benchmarks values are also identified for other VSP parameters to provide a systematic basis for their consideration during plan implementation and evaluation (Table 11). All VSP parameters will be evaluated in future assessments of population status (using the TRT's scoring system).

Specific objectives were not identified for VSP parameters other than abundance and productivity because many different combinations of specific parameters can be expected to achieve the overarching population objectives. This approach allows for flexibility in tailoring recovery strategies to the threats and opportunities in each area without providing artificial constraints related to piecemeal representation of population parameter objectives. Definition of a series of specific subgoals for each other VSP parameter would unnecessarily burden plan implementers and evaluators with constraints that may not ultimately be related to overarching viability goals. Specific values of many VSP parameters associated with a given level of viability are also highly uncertain and it would be entirely possible to meet the overarching goals but fail some of the secondary goals.

Benchmark values for all VSP parameters were developed in this plan based on general guidance from the WLC-TRT and the VSP concept (McElhany et al. 2000). These benchmarks provide systematic standards for gauging future population status relative to all parameters identified by the WLC-TRT as related to viability. It is expected that specific benchmark values for other VSP parameters will be refined during plan implementation based on new information that addresses current uncertainties.

Benchmark values for all VSP parameters also provide a framework for designing strategies, measures, and actions necessary to substantively address limiting factors related to population viability. This plan identifies substantive measures to address all significant categories of threats including stream habitat, estuary/mainstem habitat, hydropower, harvest, hatcheries, and ecological interactions. This comprehensive treatment of threats can be expected to address the full suite of VSP parameters within populations. Improvements in all mortality factors and impacts will increase fish abundance and realized spawner:spawner productivity. Stream habitat improvements will directly address habitat criteria, increase freshwater production of juveniles, expand distribution, and enhance spatial structure. Improvements in abundance, productivity, and spatial structure will help restore normal evolutionary processes which will help preserve and begin rebuilding diversity. Hydropower actions, particularly related to reintroduction and passage will help restore spatial structure and diversity. Hatchery strategies, measures, and actions will also help protect existing diversity.

**Table 11. Benchmarks for evaluating fish status relative to recovery criteria guidelines.**

| Category | Description | Values[1] |
|---|---|---|
| | **Population Persistence** | |
| **0** | Either extinct or very high risk of extinction | Very low (0-40%) probability of persistence for 100 years |
| **1** | Relatively high risk of extinction | Low (40-75%) probability of persistence for 100 years |
| **2** | Moderate risk of extinction | Medium (75-95%) probability of persistence for 100 years |
| **3** | Low (negligible) risk of extinction | High (95-99%) probability of persistence for 100 years |
| **4** | Very low risk of extinction | Very High (>99%) probability of persistence for 100 years |
| | **Adult Abundance and Productivity** | |
| **0** | Numbers and productivity consistent with either functional extinction or very high risk of extinction | Extinction risk analysis estimates 0-40% persistence probability. |
| **1** | Numbers and productivity consistent with relatively high risk of extinction | Extinction risk analysis estimates 40-75% persistence probability. |
| **2** | Numbers and productivity consistent with moderate risk of extinction | Extinction risk analysis estimates 75-95% persistence probability. |
| **3** | Numbers and productivity consistent with low (negligible) risk of extinction | Extinction risk analysis estimates 95-99% persistence probability. |
| **4** | Numbers and productivity consistent with very low risk of extinction | Extinction risk analysis estimates >99% persistence probability. |
| | **Juvenile Out-Emigrants** | Evaluated based on the *occurrence* of natural production, whether natural production was *self sustaining* or supplemented by hatchery fish, *trends* in numbers, and *variability* in numbers. |
| **0** | Consistent with either functional extinction or very high risk of extinction[3] | No significant juvenile production either because no natural spawning occurs or because natural spawning by wild or hatchery fish occurs but is unproductive. |
| **1** | Consistent with relatively high risk of extinction[3] | Long term trend in wild natural production is strongly negative. Also includes the case where significant natural production occurs in many years but originates primarily from hatchery fish. |
| **2** | Consistent with moderate risk of extinction[3] | Sample data indicates that significant natural production occurs in most years and originates primarily from naturally-produced fish. No trend in numbers may be apparent but numbers are highly variable with only a small portion of the variability related to spawning escapement. |
| **3** | Consistent with low risk of extinction[3] | Sample data indicates significant natural production by wild fish occurs in all years. No long term decreasing trend in numbers is apparent. Juvenile numbers may be variable but at least some of this variability is related to fluctuations in spawning escapement. |
| **4** | Consistent with very low risk of extinction[3] | Sample data indicates significant natural production by wild fish occurs in all years. Trend is stable or increasing over extended time period. Variability in juvenile production is low or a large share of the observed variability is correlated with spawning escapement. |

| Category | Description | Values[1] |
|---|---|---|
| | **Within-Population Spatial Structure** | |
| **0** | Spatial structure is inadequate in quantity, quality[2], and connectivity to support a population at all. | *Quantity* was based on whether all areas that were historically used remain accessible. *Connectivity* based on whether all accessible areas of historical use remain in use. *Catastrophic risk* based on whether key use areas are dispersed among multiple reaches or tributaries. Spatial scores of 0 were typically assigned to populations that were functionally extirpated by passage blockages. |
| **1** | Spatial structure is adequate in quantity, quality[2], and connectivity to support a population far below viable size | The majority of the historical range is no longer accessible and fish are currently concentrated in a small portion of the accessible area. |
| **2** | Spatial structure is adequate in quantity, quality[2], and connectivity to support a population of moderate but less than viable size. | The majority of the historical range is accessible but fish are currently concentrated in a small portion of the accessible area. |
| **3** | Spatial structure is adequate in quantity, quality[2], and connectivity to support population of viable size, but subcriteria for dynamics and/or catastrophic risk are not met | Areas may have been blocked or are no long used but fish continue to be broadly distributed among multiple reaches and tributaries. Also includes populations where all historical areas remain accessible and are used but key use areas are not broadly distributed. |
| **4** | Spatial structure is adequate to quantity, quality, connectivity, dynamics, and catastrophic risk to support viable population. | All areas that were historically used remain accessible, all accessible areas remain in use, and key use areas are broadly distributed among multiple reaches or tributaries. |
| | **Within-Population Diversity** | |
| **0** | All four diversity elements (life history diversity, gene flow and genetic diversity, utilization of diverse habitats, and resilience and adaptation to environmental fluctuations) are well below predicted historical levels, extirpated populations, or remnant populations of unknown lineage | *Life history diversity* was based on comparison of adult and juvenile migration timing and age composition. *Genetic diversity* was based on the occurrence of small population bottlenecks in historical spawning escapement and degree of hatchery influence especially by non local stocks. *Resiliency* was based on observed rebounds from periodic small escapement. Diversity scores of 0 were typically assigned to populations that were functionally extirpated or consisted primarily of stray hatchery fish. |
| **1** | At least two diversity elements are well below historical levels. Population may not have adequate diversity to buffer the population against relatively minor environmental changes or utilize diverse habitats. Loss of major presumed life history phenotypes is evident; genetic estimates indicate major loss in genetic variation and/or small effective population size. Factors that severely limit the potential for local adaptation are present. | Natural spawning populations have been affected by large fractions of non-local hatchery stocks, substantial shifts in life history have been documented, and wild populations have experienced very low escapements over multiple years. |
| **2** | At least one diversity element is well below predicted historical levels; population diversity may not be adequate to buffer strong environmental variation and/or utilize available diverse habitats. Loss of life history phenotypes, especially among important life history traits, and/or reduction in genetic variation is evident. Factors that limit the potential for local adaptation are present. | Hatchery influence has been significant and potentially detrimental or populations have experienced periods of critical low escapement. |

| Category | Description | Values[1] |
|---|---|---|
| **3** | Diversity elements are not at predicted historical levels, but are at levels able to maintain a population. Minor shifts in proportions of historical life-history variants, and/or genetic estimates, indicate some loss in variation (e.g. number of alleles and heterozygosity), and conditions for local adaptation processes are present. | Wild stock is subject to limited hatchery influence but life history patterns are stable. Extended intervals of critical low escapements have not occurred and population rapidly rebounded from periodic declines in numbers. |
| **4** | All four diversity elements are similar to predicted historical levels. A suite of life-history variants, appropriate levels of genetic variation, and conditions for local adaptation processes are present. | Stable life history patterns, minimal hatchery influence, no extended interval of critical low escapements, and rapid rebounds from periodic declines in numbers. |
| | **Habitat** | |
| **0** | Habitat is incapable of supporting fish or is likely to be incapable of supporting fish in the foreseeable future | *Unsuitable habitat.* Quality is not suitable for salmon production. Includes only areas that are currently accessible. Inaccessible portions of the historical range are addressed by spatial structure criteria[2]. |
| **1** | Habitat exhibits a combination of impairment and likely future conditions such that population is at high risk of extinction | *Highly impaired habitat.* Quality is substantially less than needed to sustain a viable population size (e.g. low bound in target planning range). Significant natural production may occur in only in favorable years. |
| **2** | Habitat exhibits a combination of current impairment and likely future condition such that the population is at moderate risk of extinction | *Moderately impaired habitat.* Significant degradation in habitat quality associated with reduced population productivity. |
| **3** | Habitat in unimpaired and likely future conditions will support a viable salmon population | *Intact habitat.* Some degradation in habitat quality has occurred but habitat is sufficient to produce significant numbers of fish. (Equivalent to low bound in abundance target planning range.) |
| **4** | Habitat conditions and likely future conditions support a population with an extinction risk lower than that defined by a viable salmon population. Habitat conditions consistent with this category are likely comparable to those that historically existed. | *Favorable habitat.* Quality is near or at optimums for salmon. Includes properly functioning through pristine historical conditions. |

[1] Rules were derived by the LCFRB and WDFW staff for attribute descriptions from McElhany et al. 2003. Application rules do not represent assessment by the Technical Recovery Team.

[2] Because recovery criteria are closely related, draft category descriptions developed by the Technical Recovery Team often incorporate similar metrics among multiple criteria. For instance, habitat-based factors have been defined for diversity, spatial structure, and habitat standards. To avoid double counting the same information, streamline the scoring process, and provide for a systematic and repeatable scoring system this application of the criteria used specific metrics only in the criteria where most applicable. This footnote denotes these items.

[3] This is a modification of the interim JOM criteria identified by the TRT. JOM scores consistent with persistence probabilities for other criteria. Consistent with an attempt to avoid double counting similar information in different criteria, data quality considerations were not included in the revised JOM criteria descriptions because they are scored separately for all criteria. This modification removes confounding effects of cases where no JOM data is available and provides

### 5.4.5 Harvestability Goals

The vision of this plan is for restoration of viable and harvestable naturally-producing salmon populations. This vision will be realized when:

1. The majority of natural populations have recovered to viable levels and are harvestable in the vast majority of years.
2. Natural populations are productive enough to produce fish at levels which will replace hatchery production and provide even more fishery opportunity, in terms of total catch, than currently is available with the hatchery production.

Harvestable species, ESUs and populations occur when adult production exceeds the population goal and viability level and can be directly harvested at levels that maintain spawning escapement at or above the biological objective. When adult production is less than the biological objective and less than viable, it is not considered harvestable and will only be subject to indirect harvest impacts associated with fisheries targeting other species and populations. These indirect rates will be controlled by ESA harvest impact limits. North Lewis and Hanford Reach natural produced fall chinook are good examples of harvestable naturally produced populations which consistently provide significant ocean and freshwater harvest opportunity.

Improvement increments described in the previous section describe reductions in current direct and indirect fishery impacts on wild populations needed to improve biological status to levels identified in the preferred recovery scenario. The long term vision involves increasing allowable fishing rates on natural populations as the benefits of other recovery measures are realized. For instance, fisheries on natural populations can be phased in as habitat restoration improves fish productivity to the point where natural populations again produce a harvestable surplus in addition to escapement needs for sustaining a viable population.

Increasing natural population productivity and numbers expected in response to implementation of this plan, can be expected to increase the numbers of harvestable wild fish over time and to increase the frequency of years where salmon and steelhead populations produce harvestable numbers. Increasing salmonid numbers can also be expected to provide a variety of other fishery benefits including more consistent seasons and fewer restrictions to access of harvestable numbers of fish of other stocks. Sustainable harvest rates will be based on realized improvements in population viability and productivity.

## 5.5 Bull Trout

***Objectives:*** ***1) maintain current distribution within core areas and restore distribution in additional areas, 2) maintain stable or increasing trends in abundance, 3) restore and maintain suitable habitat conditions for all life history stages and strategies, and 4) conserve genetic diversity and provide opportunity for genetic exchange. (as per Draft Bull Trout Recovery Plan, USFWS 2002)***

Bull trout are listed as threatened under the ESA and are under the jurisdiction of the USFWS. Bull trout are subject of a draft recovery plan, although the USFWS recently decided to delay finishing the recovery plan in lieu of a 5-year review of the bull trout listing. The overarching goal of the bull trout recovery plan is to ensure the long-term persistence of self-sustaining, complex interacting groups (or multiple local populations that may have overlapping spawning and rearing areas) of bull trout distributed across the species' native range. In the lower Columbia, bull trout were believed to be historically distributed in the some large subbasins including the Lewis River and Columbia River upper Gorge tributaries. Of the subbasins addressed by this plan, bull trout currently occur only in the upper Lewis River. Bull trout were reported in the White Salmon River as recently as 1989 but have not been observed since despite focused sampling efforts. In the USFWS bull trout recovery plan, the Lewis, White Salmon, and Klickitat rivers have been identified as core bull trout habitats for the Lower Columbia Recovery Unit.

## 5.6 Other Fish and Wildlife Species

### 5.6.1 Other Sensitive Species

#### ***Bald Eagle***

***Objective:*** ***Increase the viability of the bald eagle breeding population in the lower Columbia River, particularly through increased reproductive success.***

Bald eagles are listed as threatened under the federal ESA; they are also culturally important throughout the Pacific Northwest. Bald eagles are an indicator of a large, mature treed, habitat and may be a good species to help monitor environmental contaminants. Reproductive success of the local population is low, presumably as a result of environmental contaminants and their effects on eggshell thinning. Adult abundance in the local population has remained relatively stable in recent years, but appears to be maintained by adult immigration from adjacent populations.

#### ***Sandhill Crane***

***Objective:*** ***Support and maintain the wintering population of sandhill cranes in the lower Columbia River, while limiting crop depredation.***

Sandhill cranes have ecological, recreational (wildlife viewing) and management significance, along with potentially negative economic (crop depredation) impact. They are a Washington state listed species. Because of their migratory life history, sandhill cranes are protected by the Migratory Bird Treaty Act. This objective involves protecting and expanding availability of winter habitat (particularly on public lands).

### ***Dusky Canada Goose***

***Objective: Reverse the declining abundance trend and maintain a wintering population in the lower Columbia River, while limiting crop depredation.***

The dusky Canada goose has ecological, management, and potentially negative economic (crop depredation) significance. The dusky Canada goose is classed as a migratory bird by federal regulation and thus protected by the Migratory Bird Treaty Act. It is considered a game bird by Washington rule. The Pacific Flyway and Washington Fish and Wildlife Commission regulate harvest. This objective involves protecting and expanding availability of winter habitat (particularly on public lands) and managing goose harvest to minimize impacts to duskys.

### ***Columbian White-tailed Deer***

***Objective: Increase productivity and abundance, thereby creating a stable, viable population.***

The Columbian white-tailed deer is listed as endangered under the federal ESA and is classified as endangered by Washington and Oregon. They are present in the upper estuary and along the river corridor; approximately 300-500 deer are present in this area. Habitat conversion to agricultural land, habitat loss, and low population productivity are currently the most important threats to the population. This objective involves protecting and restoring oak/Douglas fir forest within 200m of a stream/river, enforcing poaching regulations, minimizing negative human-interaction (auto collisions, fence entanglement, etc.), and protecting the population from flooding, particularly during times of fawning.

### ***Fisher***

***Objective: Minimize risks to populations in the process of becoming established while increasing quantity and quality of habitat and minimizing incidental mortality.***

The fisher is a Washington state endangered species and a federal species of concern. Scattered Within the Little White Salmon River subbasin, fishers may be found in multiple types of mixed conifer-hardwood forests. Limiting factors include loss of large tracts of low and mid elevation old growth or late seral forest, habitat fragmentation, stand replacement fires, incidental mortality from vehicle collisions or trapping for other species, and small population risks.

### ***Western Gray Squirrel***

***Objective: Increase quantity and quality of habitat and reduce effects of nonnative species.***

The western gray squirrel is a Washington state threatened species and a Federal species of concern. Within the Little White Salmon River subbasin, western gray squirrels may be found in mesic lowland conifer-hardwood forest in close proximity to westside white oak – dry Douglas fir forest. Limiting factors include loss of large tracts of old growth or late seral forest and increased disease or competition with introduced squirrel species.

### ***Seals and Sea Lions***

***Objective: Maintain current seasonal population abundance while limiting predation risks to adult salmonids.***

Harbor seals, California sea lions, and Steller sea lions are seasonal residents of the lower Columbia estuary and mainstem. Steller sea lions are listed as threatened under the federal ESA. All seals and sea lions are also protected by the Marine Mammal Protection Act. Seals and sea lions are ecologically important in the Columbia River estuary and lower mainstem and are a predator of adult salmonids.

### Western Pond Turtle

***Objective: Reverse the declining abundance trend in Washington and re-establish in the Puget Sound and Columbia Gorge regions at least 5 self-sustaining populations of >200 turtles composed of no more than 70% adults.***

The western pond turtle is listed in the state of Washington as endangered; there are an estimated 250-350 western pond turtles in Washington. The only remaining western pond turtles in the state are thought to consist of two small populations in Skamania and Klickitat counties, as well as a small pond complex in Pierce County where they were recently reintroduced from head-started juveniles from wild nests. This objective involves protection of the existing populations and their associated habitat, evaluation of introduced species (bullfrogs, warm-water fish, or opossum) effects on pond turtle population viability, and investigation of captive bred stock for reintroduction to additional wetland/ pond habitats. The core pond turtle sites should be wetland complexes that may be less susceptible to catastrophes than sites of a single water body.

The WDFW wrote a recovery plan for the species in Washington in 1999 (Hays et al. 1999). The recovery plan objectives are to have a total of 7 populations with more than 200 turtles each in two recovery areas – 3 in Puget Sound and 4 in the Columbia River Gorge. Achieving this recovery objective requires an ongoing program of captive breeding, head-starting wild-hatched turtles, and reintroduction until population numbers are increased to ensure the species' survival in the state.

The establishment of additional populations is needed to reduce the risk of potential loss of the species through catastrophic or other unforeseen circumstances. Threats to the pond turtle populations are predation by introduced predators such as bullfrogs, illegal shooting, mortality from vehicle collisions and disease. Increasing both the number of populations and population sizes can mitigate some of these threats.

### Oregon Spotted Frog

***Objective: Increase quantity and quality of habitat and reduce effects of nonnative species.***

The Oregon spotted frog is listed as endangered in the State of Washington and is a federal candidate for protection under the Endangered Species Act. Oregon spotted frogs are closely associated with open water habitat and may be present in any number of forested or wetland habitats that are intertwined with open water. Limiting factors include loss of wetlands, decreae in water quality, displacement of native plant communities by introduced species, and competition and predation by bullfrogs and introduced fish species.

### Larch Mountain Salamander

***Objective: Increase quantity and quality of habitat and minimize use of key habitats.***

Larch Mountain salamander distribution includes west-side habitats of the southern Cascades region in Washington and the Columbia Gorge area of Oregon and Washington. Larch Mountain salamanders depend on cool, moist environments; they require a suitable combination of slope, rock size, shade, and organic debris. Populations of Larch Mountain salamanders are small, isolated, and occur in a limited geographic area. This salamander is sedentary and its very specific habitat requirements may hinder dispersal.

### 5.6.2 Species of Ecological Significance

***Coastal Cutthroat Trout***

***Objective: Reverse declining abundance trends and maintain life history diversity (resident, fluvial, and anadromous forms).***

The coastal cutthroat trout subspecies was a candidate for listing as threatened, but the USFWS determined that an ESA-listing was not warranted. However, in April 1999, NMFS and the USFWS issued a joint proposed rule for the listing of the anadromous form of coastal cutthroat in Southwest Washington and the Columbia River, including cutthroat trout in Columbia River tributaries downstream from the Klickitat River. At present, WDFW describes coastal cutthroat as depressed in many subbasins of the lower Columbia River because of long-term negative trends or short-term severe declines. This objective involves protecting existing functioning habitats, restoring other subbasin habitats toward historic conditions, and increasing research efforts to determine the abundance, distribution, migration patterns, and population viability of the various life forms

***White Sturgeon***

***Objective: Continue management for a viable population that will maintain sufficient abundance to meet the continued cultural, economic, and ecological needs.***

White sturgeon are culturally, economically, and ecologically important in the lower Columbia River ecosystem; the lower Columbia population is among the largest and most productive in the world. Lower Columbia River white sturgeon support tribal and non-Indian commercial and recreational fisheries and serve as a top predator in the aquatic food web. This objective involves protecting large adult spawners; regulating harvest to sustainable levels; maintaining suitable spawning, incubation, and rearing habitats and flow conditions in the Columbia River Gorge and dam tailraces; monitoring ecological effects of non-indigenous species; and conducting future dredging operations in such a way as to minimize direct and indirect mortality of incubating eggs and juvenile sturgeon.

***Green Sturgeon***

***Objective: Continue management for a viable population that will maintain sufficient abundance to meet the continued cultural, economic, and ecological needs.***

Green sturgeon are seasonal residents of the Columbia River estuary and originate from spawning populations in California and southern Oregon rivers. Considerably less is know about green sturgeon than white sturgeon. Lower Columbia River green sturgeon are incidentally harvested in commercial and recreational fisheries. This objective involves identifying the factors related to green sturgeon use of the estuary and lower mainstem (timing, habitat use, diet analysis, etc.); regulating harvest to sustainable levels; and monitoring ecological effects of non-indigenous species.

***Eulachon (Smelt)***

***Objective: Maintain or increase annual population abundance to continue to provide forage value for other species and harvest opportunities for commercial and recreational fisheries.***

Eulachon are an anadromous species that use unique spawning habitat in the estuary, lower mainstem, and some tributaries. This objective involves managing the lower Columbia run as one population; increasing annual abundance to near historic levels, thus supporting an average annual commercial harvest of at least 2 million pounds; conducting research to reduce the uncertainty regarding all aspects of juvenile life history and ocean usage; avoiding disturbance of incubating eggs and juveniles, particularly by ceasing dredging or other activities in spawning areas during the January 1st to May 31st time period.

### Pacific Lamprey

***Objective:*** ***Reverse the decreasing abundance trend and manage for populations that can meet cultural and ecological needs.***

Lamprey are culturally and ecologically important in the lower Columbia River ecosystem; they have served as an important food source for native peoples and for many Columbia River mainstem and estuary inhabitants (sturgeon, pinnipeds). The objective will require substantial increases in our understanding of the species. At present, research needs include: determining adult swimming and migratory capabilities and the degree of spawning site fidelity; quantifying the level of predation on migrating adults; identifying spawning locations, habitat characteristics, and incubation survival; determining habitat requirements and duration of freshwater residency of juvenile lamprey in the subbasins, mainstem, and estuary; and rectifying difficulties in abundance estimates because of repeated up and downstream movement.

### Northern Pikeminnow

***Objective:*** ***Decrease predation on juvenile salmonids by reducing the number of larger, predaceous pikeminnow in the population, while also maintaining pikeminnow population viability.***

Pikeminnow are a native fish that has increased abundance as a result of habitat alteration in the lower mainstem and large tributary reservoirs. In unaltered systems, pikeminnow and salmonid interactions are limited by habitat preferences and behavior patterns. In altered systems including the Columbia River mainstem and large tributary reservoirs, pikeminnow can become significant predators of juvenile salmonids.

### American Shad

***Objective:*** ***Decrease abundance but maintain a viable population (range from 0.7 to 1.0 million, well below the recent record run sizes) while avoiding adverse impacts on other species, particularly the recovery of salmonids.***

American shad are an introduced species with ecological, management, and minor economic importance. Because of their abundance, shad have become an important component of the lower mainstem and estuary ecosystem. For example, they have been identified as an important food source for sturgeon, a source of large quantities of marine-derived nutrients to freshwater, and may be an significant competitor of juvenile salmonids. Shad objectives involve proactive fishery management to reduce the population to the suggested viable level; thus, harvest is encouraged but is also challenged by the incidental catch of salmonids and other species. Additional research is needed to better understand the interrelationships between shad and salmonids.

### Band-tailed Pigeon

***Objective: Increase quantity and quality of habitat.***

The band-tailed pigeon breeds throughout much of Western Washington. The band-tailed pigeon requires mineral springs as a source of calcium for egg-laying and the production of crop-milk for its young. The proximity of these mineral springs to suitable foraging habitats is an important factor for band-tailed pigeons.

### Caspian Tern

***Objective: Maintain population viability region-wide and decrease the population's vulnerability to catastrophic events while also managing predation on salmon.***

Caspian terns are a colonial nesting species protected under the Federal Migratory Bird Treaty. They are perceived to be a significant predator of juvenile salmonids and have become a significant part of the estuarine ecosystem, based on their abundance and consumptive needs during the breeding season. This objective involves maintaining the regional breeding colony abundance near 10,000 pairs while minimizing predation effects on salmonids by encouraging breeding colony distribution among multiple breeding sites, particularly in locations where non-salmonid food sources are plentiful, consistent with direction emerging from the Caspian Tern Working Group and USFWS EIS process.

### Osprey

***Objective: Increase the viability of the osprey breeding population in the lower Columbia River, particularly through increased reproductive success.***

Osprey can help monitor the presence of environmental contaminants, as well as large, mature trees (although less indicative of this habitat type than bald eagle). Reproductive success of the local population has remained relatively high, despite some of the highest observed DDE concentrations measured in North American osprey. Population productivity in 1997-98 was estimated at 1.64 young/active nest, which is higher than the recognized 0.80 young/active nest needed for a stable population.

### Yellow Warbler

***Objective: Protect critical preferred habitat including riparian zones characterized by a dense deciduous shrub layer (1.5-4 m) with edge and small patch size (heterogeneity).***

Yellow warblers in the lower Columbia River mainstem and estuary are ecologically significant; they are considered an indicator of dense riparian shrub habitat. The species is widely distributed and common.

### Red-eyed Vireo

***Objective: Protect critical preferred habitat including riparian gallery forest with tall, closed canopy forests of deciduous trees (cottonwood, maple, or alder and ash), with a deciduous understory, forest stand sizes larger than 50 acres, and riparian corridor widths greater than 50 m.***

Red-eyed vireos in the lower Columbia River mainstem and estuary are ecologically significant; they are considered an indicator of tall, closed canopy riparian habitat. The species is widely distributed and common.

***River Otter***

***Objective: Maintain current population abundance.***

River otters are ecologically important in the Columbia River estuary and lower mainstem and are thought to be an indicator of overall environmental health. Evidence suggests that abundance in the lower Columbia River has always been relatively low. River otter are concentrated in shallow, tidally influenced backwaters, sloughs, and streams throughout the estuary, particularly in the Cathlamet Bay area.

### 5.6.3 Species of Recreational Significance

***Walleye***

***Objective: Adaptively manage the population to maintain or reduce current abundance levels while minimizing adverse impacts on salmonids and other native fishes.***

Walleye are an introduced species that is widely distributed in the lower Columbia mainstem and common in some specific habitats. Walleye provide some recreational fishery benefits but eat primarily fish including significant numbers of juvenile salmonids. This objective involves an improved understanding of walleye habitat use, abundance, and distribution in the lower mainstem and estuary to evaluate and manage negative interactions between walleye and native species.

***Smallmouth Bass***

***Objective: Adaptively manage the population to maintain or reduce current abundance levels while minimizing adverse impacts on salmonids and other native fishes.***

Smallmouth bass are an introduced species that is widely distributed in the lower Columbia mainstem and common in some specific habitats. Smallmouth bass provide some recreational fishery benefits but are can also be significant salmonid predators in certain situations. This objective involves managing the population to limit or decrease the current level of abundance, evaluate and limit interactions between smallmouth bass and native species, and develop an understanding of smallmouth bass habitat use, abundance, and distribution in the lower mainstem and estuary.

***Channel Catfish***

***Objective: Adaptively manage the population to limit adverse impacts on salmonids and other native fishes.***

Channel catfish are an introduced species that provide fishery benefits in some altered lower Columbia habitats. Channel catfish are salmonid predators in certain situations and might also interact with juvenile sturgeon. This objective involves an improved understanding of channel catfish habitat use, abundance, and distribution in the lower mainstem and estuary to evaluate and manage negative interactions between with native species.