Development of Salmonid Recovery Plans for the White, Puyallup, Chambers-Clover, and Hylebos Watersheds

Strategic Priorities for Salmon Conservation and Recovery Actions in WRIAs 10 and 12

DRAFT

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1.0 INTRODUCTION

Pierce County, as a regional agency, seeks to develop a rational basis for guiding and coordinating salmon conservation and recovery actions within the county. In 2000, it initiated a multi-phased project to formulate a set of strategic priorities for conserving and recovering salmon habitat in area streams and their estuaries. Pierce County contracted with Mobrand Biometrics, Inc. (MBI) to perform the necessary analyses using the EDT Method.[1] This document presents findings from Phase Two of the project. It focuses on strategic priorities for the Puyallup, White, Chambers-Clover, and Hylebos watersheds.

The assessment addresses the need for priorities in recovery planning in two ways. It first identifies protection and restoration priorities based on diagnoses of habitat conditions in the watersheds. It then goes on to identify sets of candidate actions for the watersheds, analyzes them for their potential effect on salmon recovery, and prioritizes them based on projected outcomes. The result of applying this approach is a set of comprehensive, analytically derived priorities from which planners with various agencies and entities can build action plans commensurate to available funding and other social constraints.

In Phase One, completed in June 2001, the initial watershed assessments for WRIAs 10, 12, and 15 were completed (see MBI 2001). That phase produced an initial set of strategic priorities for salmon recovery planning and it evaluated a diverse range of potential actions identified by various entities working in the watersheds.

Phase Two, begun in mid 2002, focused on identifying and evaluating a set of actions referred to as diagnostically-driven. Candidate actions were to be identified by a team of technical individuals familiar both with the Phase One diagnoses and with the watersheds. To qualify, actions had to be considered by a team member as possible within today's social and political setting. The actions were to be evaluated by the team for their expected remedial effectiveness, then analyzed using the EDT Method to project how salmon performance would be affected. Actions were then to be ranked and prioritized with regard to their potential benefit to salmon recovery. Other values, such as monetary or social costs, would be purposefully ignored in ranking the actions—ranks were to be based solely on benefits to the salmon populations. In addition, Phase Two also updated the diagnosis for each watershed based on new information obtained since the completion of Phase One.

A third project phase is currently underway that is moving the planning tools and databases used in the analyses to the Internet. The web site will be accessible to agencies, other entities, and the public to aid in recovery

[1] / short note on EDT

planning. The site will enable individuals to access findings and data. It will provide access to analytical tools to perform new analyses for other actions, as well as for other species. It will also be used by Pierce County to update the habitat databases when new information becomes available.

This document is organized into three sections: Introduction, Methods, and Results and Conclusions. Three appendices accompany the report: Appendix A (Candidate Actions for Freshwater Areas in the Puyallup-White, Hylebos, and Chambers-Clover Watersheds), Appendix B (Candidate Actions for Estuarine and Bay Areas for the Puyallup-White, Hylebos, and Chambers-Clover Watersheds), Appendix C (Stream Reach Analysis For Species Performance In WRIAs 10 and 12) and Appendix D (Stream Reaches and Corresponding Geographic Areas for Focus Watersheds). A CD is included with Appendix C that provides a set of Excel files that contain the reach analysis for each watershed and population.

2.0 METHODS

This section provides a brief overview of EDT concepts and terms to aid the reader in reviewing this document. A more complete description was given in MBI (2001). Additional material can be found on the MBI Web site at: http://www.mobrand.com/MBI/library.html. Following this overview, specific steps as applied in Phase Two of the project are given.

2.1 General Approach

The EDT Method, and the model it includes, is designed to assess the role of habitat in determining salmon population performance. It should be thought of as a habitat model and not a fish population model. Its purpose is to help predict how changes in habitat affect salmonid populations. The changes may be due to natural landscape forming events, climate change, or consequences of human activities. The EDT Method is used extensively in the Pacific Northwest to aid in planning salmon conservation and recovery actions (Figure 2.1). It is used to project the outcome of implementing specific protection and restoration actions.

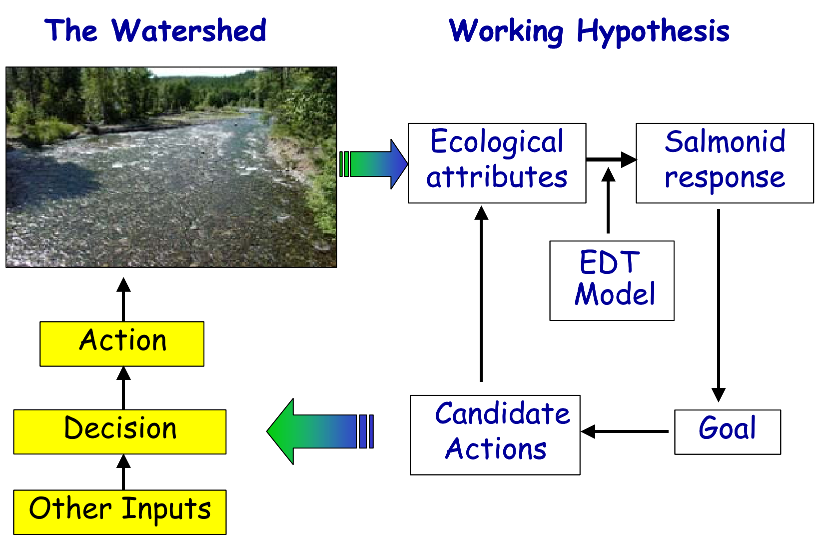

Figure 2.1. Application of the EDT Method in planning salmon conservation and recovery actions.

The EDT Method incorporates many types of information and data to project how habitat affects salmon performance (Figure 2.2). Observed or inferred conditions of the environment are used to characterize salmon habitat using a standard set of attributes (Level Two attributes in Figure 2.2). This characterization is made for all stream reaches relevant to the analysis and

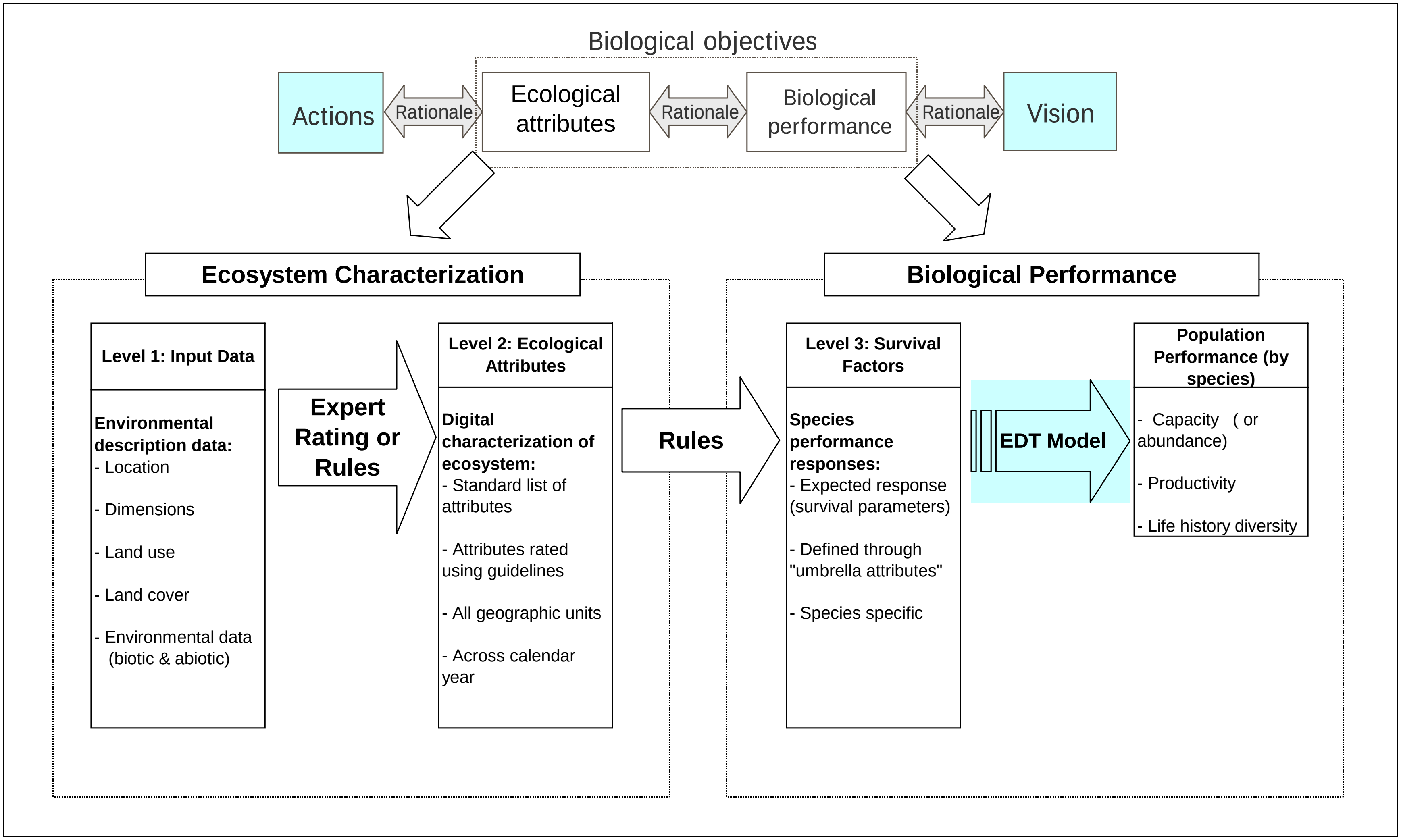

Figure 2.2. Overview of concepts, terminology, and information flow used in the EDT Method.

across a calendar year, both for historic and current conditions. The characterization, which is stored in a database, is then translated through a set of rules into specific-survival responses. This serves as the input to the EDT model. The model is then used to assess population performance under current and historic conditions, which serves as one part of what is called the diagnosis.

In a follow-up step, the model inputs are systematically altered to predict how salmon performance would change under either habitat degradation or restoration. Output from this step is the basis for assessing the relative merits of either protecting from further loss or restoring different areas of the watershed. These results are the second part of the diagnosis. This is the basis for formulating strategic priorities for both protection and restoration actions.

As a third part of the diagnosis, the model is used to compute the contribution of each of the survival factors, such as habitat diversity or sediment (see Figure 2.2), toward salmon performance. These results are displayed in what is called a reach analysis, which serves to diagnose the conditions of each stream reach.

The results from these analytical steps can then be used to identify types of actions and where they might best be implemented. In evaluating potential actions, reasonable assumptions can be made about how effective the actions would be in changing the environment toward historic conditions. The modeling process can then be repeated to project the effect on salmon performance provided the action assumptions are correct. Output from this step is used to rank and prioritize actions based on projected benefits to salmon populations.

Since model output consists of population performance parameters, further definition of these terms is warranted. Population performance is described by three parameters: productivity, capacity[2], and life history diversity. These measures are characteristics of the ecosystem that describe persistence, abundance, and distribution potential of a population. They are the core performance measures used to describe population viability by NOAA Fisheries (see McElhany et al. 2000).

Productivity. This element represents the relative success of the species to complete its life cycle within the environment it experiences.[3] It determines resilience to mortality pressures, such as from fishing, dams, and further habitat degradation. *Habitat quality* (including water quality) is a major determinant of a population's productivity. This performance element is especially important when efforts are being made to reverse long-term

2 / The terms productivity and capacity are used here as defined by Hilborn and Walters (1992). Capacity is the maximum population size for one or more life history segments. Capacity and productivity are not independent.
3 / The productivity rate is the reproductive rate measured over a full generation that would occur at low population density, i.e., when competition for resources among the population is minimal.

downward trends in population abundance. The model estimates productivity for the population of interest under specific management scenarios, expressed as the average number of adult progeny produced per parent spawner (at low population density). A life cycle productivity less than 1 for any part of the population is, by definition, unsustainable. As population productivity approaches 1 (e.g., values less than 2)[4], the population is clearly at risk.

Capacity. This element defines how large a population can grow within the environment it experiences, as a result of finite space and food resources. It determines the effect of this upper limit on abundance to survival and distribution. *Habitat quantity* is a major determinant of the environmental capacity to support population abundance. In the analysis presented here, we frequently refer to "abundance" rather than capacity. Here we are describing the equilibrium run size abundance (or average abundance under steady state conditions), which highly correlates with capacity. The model estimates both capacity and equilibrium abundance for the population of interest corresponding to specific management scenarios.

Life History Diversity. This element represents the multitude of pathways through space and time available to, and used by, a species in completing its life cycle. Populations that can sustain a wide variety of life history patterns are likely to be more resilient to the influences of environmental change. Thus a loss of life history diversity is an indication of declining health of a population (Lichatowich and Mobrand 1995) and perhaps its environment. The model computes an index of life history diversity as the percentage of possible life cycle pathways (i.e., life *trajectories* in space and time that members of a population might follow across the aquatic landscape) having a productivity greater than 1.

The algorithms used to calculate population parameters are based on the Beverton-Holt survival function (after Beverton and Holt 1957). All of the estimates are made for steady state conditions.

4 / The life cycle productivity needed to sustain a population in the face of environmental uncertainty has not been defined.

2.2 Specific Steps As Applied To The Phase Two Analysis

Specific steps and procedures used to perform analyses under Phase Two are summarized below:

1. **<u>Review of Phase One results:</u>** Results from Phase One were reviewed with the technical team, both in subgroups for each watershed and with the team as a whole. The purpose of the review was to identify potential errors in the baseline characterization and to examine the diagnoses of conditions as presented in the Phase One report. The review resulted in a need to update the baseline characterization in some areas of the watersheds, as listed in the next step.

2. **<u>Updating the baseline characterization:</u>** We reviewed the baseline characterizations of habitat conditions for each watershed based on input received from the team. In addition, new information had become available for certain key attributes for some areas of the watersheds, such as the following –

   - water temperature in the White River watershed and the lower Puyallup River (from the upper White River TMDL [Ketcheson et al. 2003] study and other data sets recently collected by WDOE);
   - flow characteristics in the White River watershed (from the TMDL study);
   - fine sediment characteristics in the White River watershed (from the TMDL study);
   - bed scour in White River tributaries (updated material contained in Schuett-Hames and Adams 2003);
   - fish passage barriers in the Puyallup-White and Hylebos systems (over 70 additional potential barriers were added to the databases based on an extensive review by Tom Kantz and other team members of the Pierce County Conservation District's culvert database);
   - habitat characteristics in the Chambers-Clover watershed (based on the recently released basin plan produced by Pierce County [Pierce County 2002]).

   We also visited certain areas of the watersheds where we became aware of a high degree of uncertainty or likelihood for errors in the Phase One characterization. The field visits enabled us to better assess the consistency of how some attributes were characterized during Phase One. One area visited was the upper Puyallup River and tributaries upstream of the Electron Diversion Dam, resulting in an improved characterization of that area.

   Use of some new tools for comparing the large number of habitat characterization ratings in the databases also assisted us in better ensuring that ratings were done consistently between watersheds and areas.

As a result of these measures, we conclude that the Phase Two characterizations are more accurate representations of conditions in the watersheds than those employed in the Phase One analysis.

3. **Identification of candidate actions:** The approach called for team members to formulate candidate actions based on their understanding of the issues affecting salmonid performance, as well as on the diagnostic results of the Phase One analysis. Thirteen members of the team submitted a total of 123 different actions. Each action was described following the format given on the completed forms in Appendix A and B.

4. **Formulation of action effectiveness:** Once all candidate actions were identified and described, the team then evaluated each action for its potential effectiveness in modifying the aquatic environments that affect salmonid performance. Field trips were conducted in September 2002 by the team to visit sites where certain actions would be conducted. The field visits provided on-the-ground inspections of some of the conditions under which the actions would need to be done. The team attempted to visit sites associated with a wide variety of actions. Although these visits could provide only brief snapshots of the conditions present, they afforded opportunity for question and discussion at a variety of the sites involved.

   Following the field trips and a subsequent workshop to further discuss the actions, each team member was given a set of electronic forms for defining expected effectiveness of each action. Each team member, working independently, then completed his/her own evaluation of the actions. This involved assigning effectiveness values for how well an action would move the environment toward the reference condition that existed prior to watershed development. In assigning effectiveness ratings, the team member specified the period of time that would be required to achieve the full effectiveness (e.g., >30 years). Separate effectiveness ratings were assigned for different environmental attributes. Eleven members of the team provided effectiveness ratings in this manner—eight members for actions affecting freshwater stream reaches and three members for the estuary and Commencement Bay.

   We summarized and combined the results obtained from the team. Values were averaged between team members. For actions affecting freshwater reaches, we threw out the high and low values obtained from the team and employed the average of the remaining values. We then scaled the effectiveness values for actions affecting freshwater reaches based on the length of the reaches where the actions would be performed—this ensured that results would not be biased based on the different lengths of stream reaches. We also applied the dispersal ratings obtained from the team to disperse effects of actions on reach conditions downstream of the reaches where actions would be performed. We attempted to standardize all effectiveness ratings to a lag time of 30-100 years, i.e., we wanted to evaluate effects following a passage of at least 30 years (the analysis probably should be considered as having a lag of approximately 50-75 years).

5. **Analysis of baseline conditions and actions:** The EDT model was used to analyze the performance of chinook and coho salmon for the baseline conditions (historic and current equilibrium conditions), under each action, and for groups of actions. Standard EDT procedures for modeling were employed. Fish population performance is expressed through the three parameters previously described: average abundance (number of successful spawners), productivity (number of spawners produced per parent spawner at low population density), and life history diversity (percent of possible life history pathways that would be sustainable).

   Population parameters were summarized for the following watersheds and population components:

Watershed spawning area	Chinook	Coho
Chambers-Clover Creek	✓	✓
Hylebos Creek	✓	✓
Puyallup River	✓	✓
lower White River (below MM Dam)	✓	✓
upper White River (above MM Dam)	✓	✓

Note: MM Dam is Mud Mountain Dam

   We separated the White River watershed into the areas upstream and downstream of Mud Mountain Dam because of how differently each component responded to actions above and below the dam. Also, population components above and below the dam appear to be managed quite differently by management agencies; thus it seems useful to present the results in this fashion to aid decision-making.

   The updated habitat characterizations were also re-analyzed to provide an up-to-date diagnosis of conditions and to assess strategic priorities for protection and restoration. An explanation of the reach analysis, which is a detailed assessment of the condition of survival conditions within each stream reach, is given in Appendix C. Results of the reach analysis for each population are contained in Excel files on a CD that accompanies this report.

6. **Ranking of actions:** We ranked all actions for each watershed spawning area based on the amount of improvement in population performance associated with each action. This produced a set of action rankings for each species and each watershed. We then combined these ranks across species to obtain one set of ranks for a watershed.

   To obtain the action ranks by species, we computed the percent change in each performance measure (average abundance, productivity, and life history diversity) for the population associated with each action (i.e., the percent change from current condition). For example, if the existing average population size is 500 fish and an action would be expected to produce on average 600 fish, then the percent change for that performance measure would be 20% (100 fish increase divided by 500 is a 20% change). We then computed a weighted average percent change across the three performance measures, assigning a weight of 50% to average abundance and 25% each to productivity and life history diversity. This procedure incorporates the three measures but gives a greater weight to the change in abundance, which ultimately is the best measure of success. We then ranked the actions for each species on this combined measure of change in performance. A rank of 1 indicates that the action produced the greatest improvement in species performance compared to all other actions. This procedure allowed for ties in ranks.

   We then obtained a combined rank for each action, combining the ranks across species. The combined rank means that we consider benefits to both species without giving partiality to one species in ranking actions. To do this, we simply averaged the ranks for each species, then ranked these average values. Hence, a combined rank of 1 means that this action produced the greatest average benefit to salmonids across species.

7. **Presentation of results:** We produced three types of displays to present the results for each watershed. These displays address three questions pertinent to identifying priorities of actions:

   1) How do the actions compare to one another in rank?
   2) What is the relative amount of benefit obtained with each action?
   3) What is the relative amount of benefit obtained with groups of actions?

   The first question is addressed through use of a figure that lists the top ranked action (combined across species) at the top of a table, followed by the other actions in descending rank, together with the ranks for each species in the same table. The figure incorporates a pyramid chart to display the results for ease of comparison across species.

The second question is addressed through a series of graphs for each watershed that show the percent change in performance of a species corresponding to the rank (for that species) of each action. Patterns seen in these graphs are useful to compare the relative benefits of actions according to their ranks.

The third question is addressed through a series of bar charts for each watershed that show percent change in performance of a species associated with groups of actions. Actions were grouped by their similarity (e.g., all levee setback actions are grouped together) or by their proximity together in a watershed (e.g., all actions on the West Fork of Hylebos Creek).

3.0 RESULTS AND CONCLUSIONS

3.1 Baseline Salmon Population Performance and Diagnosis of Conditions

Table 1 provides estimates of baseline performance of chinook and coho salmon in the watersheds based on modeling. These results are based on the updated watershed characterizations described earlier. Values shown represent performance of the populations expected to be seen at the end of life (i.e., at spawning) in the absence of fisheries.[5]

We believe the values shown in Table 1 represent reasonable estimates of performance for the watersheds being addressed. We have reviewed the estimates in light of observed numbers of fish at different sites in the drainages and conclude that the modeled estimates are consistent enough with those observations for the purpose of this analysis. In fact, the degree of correspondence appears remarkably good.

Individuals who compare the results in Table 1 to numbers of fish reported by management agencies need to exercise care in making such comparisons. Numbers of fish reported for several sites over the past 5-10 years include returns of hatchery fish (or their progeny), although this fact is usually not evident in the data. Several examples warrant mention here. It has only recently become known that significant numbers of hatchery chinook produced at the Voight Creek Hatchery are straying to various areas of the Puyallup-White system. In 2002, for example, at least 30% of the spawning population in South Prairie Creek (likely in excess of 50%), consisted of stray Voight Creek Hatchery fish.[6] In the same year, approximately 20% of the chinook captured and passed upstream of Mud Mountain Dam appear to have also been stray Voight Creek fish.[7] Moreover, spring chinook captured at the PSE trap on White River have included significant numbers of unmarked hatchery fish returning to acclimation ponds in the Clearwater River, Huckleberry Creek, and West Fork White River over the past eight years.[8] One final example is that large numbers of hatchery coho continued to return to the dam on lower Chambers Creek until approximately 2000 (see MBI 2001).

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[5] / Fisheries are turned off in the analysis so that only the effect of environmental condition is being assessed. This serves to standardize the analysis between watersheds and to focus attention on the effect of changing environmental conditions through the actions being considered.

[6] / We hypothesized in the Phase One report that significant straying of Voight Creek fish might be occurring into South Prairie Creek based on results of EDT modeling (see MBI 2001).

[7] / Estimates of stray hatchery fish are based on personal communications with Chuck Baranski of WDFW.

[8] / Approximately 400,000 chinook fingerlings have been released annually from these ponds since the mid 1990s. If the return rate to the PSE trap is only 0.1% (a low rate), this would result in a return of 400 hatchery adults from this level of release.

Table 1. Baseline performance estimates for chinook and coho salmon in lower White, upper White, Puyallup, Hylebos, and Chambers-Clover basins.

Chinook

Watershed	Average abundance		Productivity		Life history diversity	
	Historic	Current	Historic	Current	Historic	Current
Lower White	15,600	200	7.4	1.3	100%	40%
Upper White	6,700	500	9.7	1.5	100%	40%
Puyallup	42,000	1,300	9.6	1.3	100%	30%
Hylebos	500	40	15.6	2.6	100%	50%
Chambers-Clover	2,100	350	22.0	6.3	100%	61%

Coho

Watershed	Average abundance		Productivity		Life history diversity	
	Historic	Current	Historic	Current	Historic	Current
Lower White	10,500	1,100	18.4	3.6	100%	40%
Upper White	13,500	1,200	17.4	2.0	80%	30%
Puyallup	56,700	5,200	19.6	5.9	90%	30%
Hylebos	1,800	200	25.0	6.5	100%	70%
Chambers-Clover	12,200	700	35.9	7.8	100%	40%

Baseline results for Puyallup and White River chinook indicate exceptionally low productivity (values <2). Such poor productivity is the result of naturally low productivity for these systems compared to non-glacial rivers in the Puget Sound region combined with severely degraded habitat for this species in many areas of the Puyallup-White system (including its estuary and bay). Such poor productivity, here estimated in the absence of fisheries, would indicate, assuming these estimates are reasonable, that these populations are being sustained through on-going supplementation in the basin. The purpose of the recovery efforts in White River using directed supplementation is, of course, to help sustain and rebuild the run. Our modeling results show that such efforts need to continue. In the case of Puyallup chinook, we conclude that the Voight Creek hatchery program is having a similar, though not intentional, effect.

The baseline estimate for average abundance of chinook in Chambers-Creek under current conditions is shown to be approximately 350 in Table 1. In fact, no chinook are allowed to pass upstream of the dam at the head of tidewater by WDFW to spawn naturally. This policy is based on an assumption that this stream did not consistently support chinook historically. Similar questions exist about the use of Hylebos Creek by chinook. Small streams like these that enter directly into the marine environment are normally not used on a consistent basis by chinook. Their small size is believed to be unfavorable for adult chinook entry from the marine environment as well as for other life stages. We discussed this issue in the Phase One final report (see MBI 2001). For purposes of our analysis, we have assumed utilization as shown in Table 1.

Summaries are presented below for each watershed and population analyzed in this report, presenting our conclusions regarding population performance, strategic priorities for protection and restoration, and environmental factors that should be targeted for restoration if possible. Strategic priorities are displayed using two tornado graphs for each population, one based on ranking geographic areas regardless of stream miles within each area and one based on normalizing the analysis for miles of stream within each area. Detailed reach analysis can be obtained through the Excel files contained with Appendix C.

3.1.1 Puyallup River Watershed

3.1.1.1 Puyallup River Fall Chinook

Baseline performance summary:
(in absence of fisheries)

Average abundance		Productivity		Life history diversity	
Historic	Current	Historic	Current	Historic	Current
42,000	1,300	9.6	1.3	100%	30%

Conclusions regarding numeric performance:

- Current average abundance is <5% of historic level; nearly all current production occurs in South Prairie Creek (based on analysis at sub-population level);
- Historic productivity was relatively low, reflecting effects of high sediment load and channel instability associated with strong glacial influence in mainstem rivers;
- Current productivity exceptionally low, indicative of unsustainable population, though parameter value higher for South Prairie sub-population.

Strategic priorities for geographic areas (<u>which</u> <u>areas</u> are most important):
(See Figures 3 A and B)

- Areas of highest priority for restoration are the estuary, the Puyallup mainstem downstream of Orting (to estuary), and the diversion screens associated with the Electron Dam;
- Areas of highest priority for protection are South Prairie Creek mainstem and the estuary;
- The highest priority for actions that consider both protection and restoration is in the estuary (with or without normalizing the results for reach length).

Puyallup Fall Chinook

Relative Importance Of Geographic Areas For Protection and Restoration Measures

Geographic Area	Protection benefit		Restoration benefit	
	Category/rank		Category/rank	
Puyallup estuary	A	1	A	4
Lower Carbon mainstem	B	4	B	6
Puyallup mainstem below Carbon R	B	8	A	2
Lower South Prairie mainstem	A	2	B	9
Clear Creek	B	9	A	3
Mid Puyallup mainstem Orting area	C	12	A	1
Middle South Praire mainstem	A	2	B	11
Puyallup mainstem below White	B	9	A	5
Clarks Creek	B	7	B	8
Wilkeson Creek	B	5	C	16
Lower Kapowsin Creek	B	6	D	22
Lower Voight Cr	C	14	C	14
Electron Dam	E	23	B	7
Upper Carbon mainstem	D	19	B	11
Mid Puyallup mainstem Electron area	C	11	D	20
Mowich River	D	17	D	18
Fennel and Canyon Falls	D	19	D	17
Upper Voight Cr	E	23	C	13
Miscel mid Puyallup tribs below Canyon	D	18	D	19
Upper South Prairie mainstem	C	14	D	23
Commencement Bay	E	23	C	15
Top Upper Puyallup	C	12	E	28
Upper Puyallup mainstem	D	16	E	24
Carbon canyon area	D	21	E	27
Misc Upper Puyallup tribs	D	22	E	26

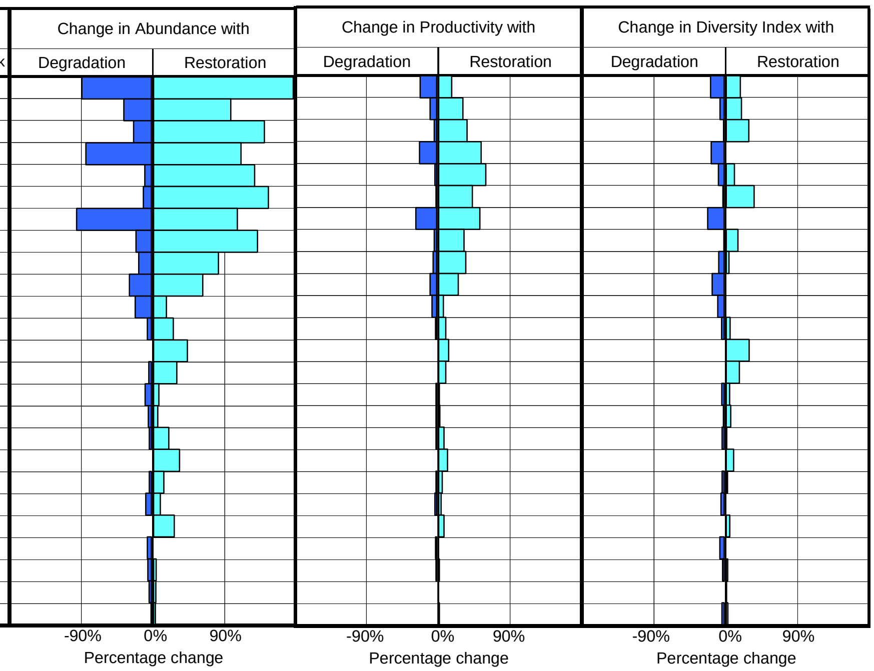


Figure 3A. Priorities for protecting and restoring geographic areas for Puyallup fall chinook. Results NOT normalized for differences in reach lengths.

Puyallup Fall Chinook

Relative Importance Of Geographic Areas For Protection and Restoration Measures (normalized by reach length)

Geographic Area	Protection benefit		Restoration benefit	
	Category/rank		Category/rank	
Puyallup estuary	A	2	A	4
Clarks Creek	B	5	A	4
Middle South Praire mainstem	A	1	B	11
Puyallup mainstem below White	C	10	A	2
Lower South Prairie mainstem	A	3	B	10
Puyallup mainstem below Carbon R	C	13	A	3
Lower Carbon mainstem	C	8	B	9
Clear Creek	C	11	B	8
Wilkeson Creek	B	5	C	15
Lower Voight Cr	C	9	C	13
Upper South Prairie mainstem	B	4	C	18
Electron Dam	E	22	A	1
Mid Puyallup mainstem Orting area	D	17	B	7
Fennel and Canyon Falls	C	12	C	17
Lower Kapowsin Creek	B	7	D	23
Upper Voight Cr	E	25	B	6
Commencement Bay	E	24	B	11
Miscel mid Puyallup tribs below Canyon	D	16	D	19
Mowich River	D	19	D	19
Upper Puyallup mainstem	D	14	E	24
Mid Puyallup mainstem Electron area	D	17	D	22
Misc Upper Puyallup tribs	D	19	D	21
Upper Carbon mainstem	E	25	C	16
Top Upper Puyallup	D	15	E	28
Carbon canyon area	D	21	E	25

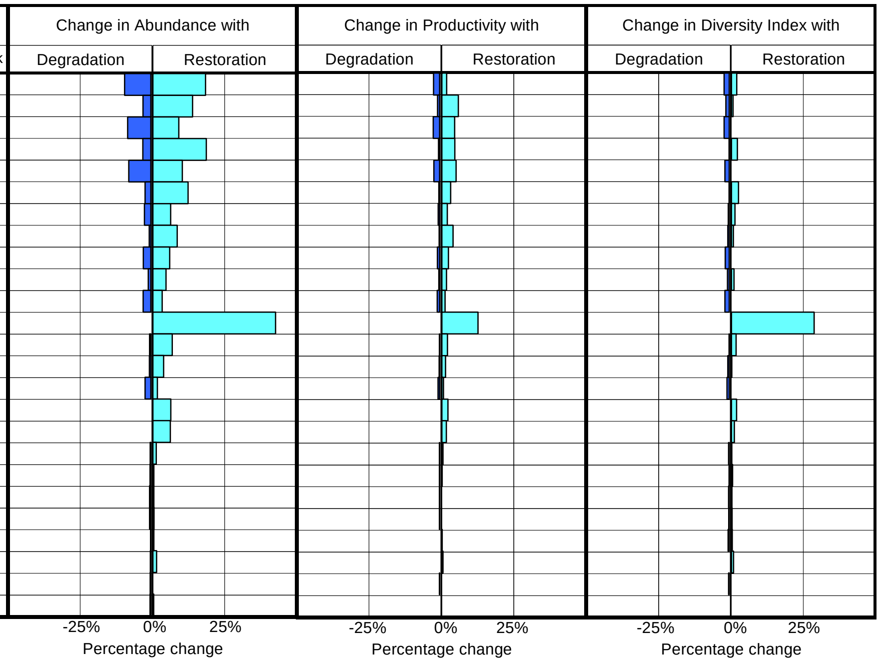


Figure 3B. Results for prioritization based on normalizing for reach length (which areas are most important per mile of stream).

Strategic priorities for environmental factors (what factors are most important): (See Figure 4)

- The most severely impacted factor associated with environmental quality across many geographic areas is habitat diversity, followed by channel stability, and sediment load;
- Loss of habitat quantity has been large in many areas;
- Barriers to fish migration, either for adults or juveniles, exist in several areas.
- See detailed reach analysis results for specifics on each reach (Appendix C).

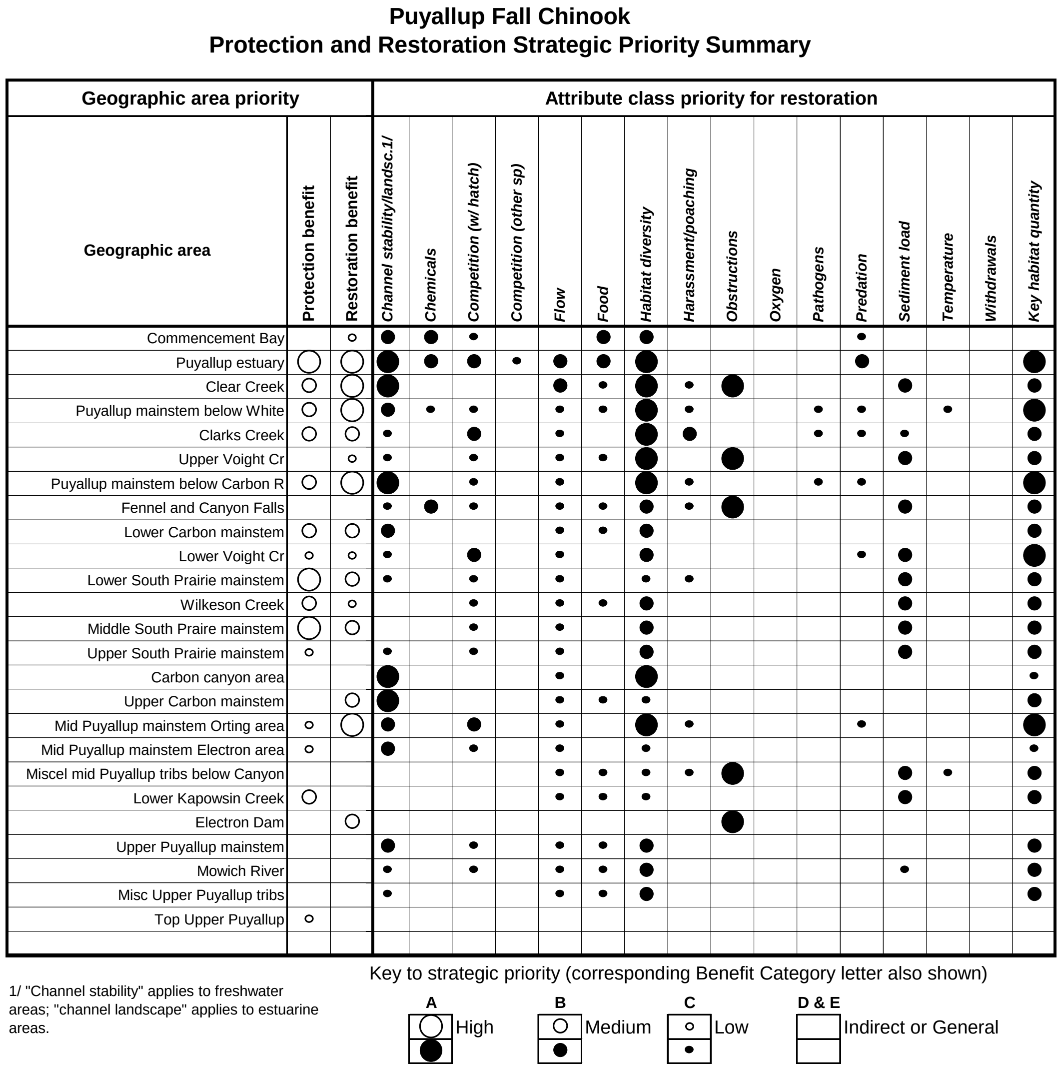


Figure 4. Strategic priorities for restoring environmental factors that affect survival of Puyallup fall chinook. Open circles show the priority of geographic areas (NOT normalized for reach length).

3.1.1.2 Puyallup River Coho

Baseline performance summary:
(in absence of fisheries)

Average abundance		Productivity		Life history diversity	
Historic	Current	Historic	Current	Historic	Current
56,700	5,200	19.6	5.9	90%	30%

Conclusions regarding numeric performance:

- Current average abundance is approximately 10% of historic level;
- Current productivity suggests the population may be self-sustaining; this productivity is strongly supported by conditions within South Prairie Creek, though pockets of good production exist elsewhere, such as in Kapowsin Creek;
- Life history diversity is severely reduced from historic level.

Strategic priorities for geographic areas (which areas are most important):
(See Figures 5A and B)

- Areas of highest priority for restoration are lower and middle South Prairie Creek, Clear Creek, Clarks Creek, and the mid Puyallup mainstem in the vicinity of Orting;
- The most important areas to protect against further degradation are the lower and middle areas of the South Prairie Creek mainstem;
- The highest priority for actions that consider both protection and restoration is in the lower and middle areas of South Prairie Creek (with or without normalizing the results for reach length).

Strategic priorities for environmental factors (what factors are most important):
(See Figure 6)

- The most severely impacted factor associated with environmental quality across many geographic areas is habitat diversity, followed by channel stability and sediment load;
- Loss of habitat quantity has been large in many areas;
- Barriers to fish migration, either for adults or juveniles, exist in many areas.
- See detailed reach analysis results for specifics on each reach (Appendix C).

Puyallup Coho

Relative Importance Of Geographic Areas For Protection and Restoration Measures

Geographic Area	Protection benefit		Restoration benefit	
	Category	rank	Category	rank
Middle South Praire mainstem	A	1	A	4
Lower South Prairie mainstem	A	2	A	6
Misc South Praire tribs	B	5	B	8
Puyallup estuary	B	5	B	8
Upper Kapowsin Creek	B	3	B	10
Clear Creek	C	13	A	2
Wilkeson Creek	B	4	B	16
Lower Carbon mainstem	D	18	A	3
Miscel mid Puyallup tribs below Canyon	B	8	B	13
Mid Puyallup mainstem Orting area	D	21	A	1
Lower Kapowsin Creek	B	5	B	18
Fennel and Canyon Falls	C	10	B	14
Puyallup mainstem below Carbon R	D	18	B	7
Mid Puyallup mainstem Electron area	C	12	B	15
Upper Carbon mainstem	C	17	B	10
Clarks Creek	D	23	A	5
Miscel mid Puyallup tribs below Elect Dam	C	11	C	24
Lower Voight Cr	C	15	C	23
Mowich River	C	16	C	22
Top Upper Puyallup	B	9	D	30
Upper Puyallup mainstem	D	20	C	19
Upper Voight Cr	E	29	B	12
Misc lower Puyallup tribs below Carbon	E	27	C	19
Misc upper Carbon tribs	C	14	D	32
Puyallup mainstem below White	D	22	C	24
Electron Dam	E	30	B	17
Misc Upper Puyallup tribs	D	24	D	27
Upper South Prairie mainstem	D	25	D	26
Misc lower Puyallup tribs below White	E	26	D	28
Carbon canyon area	E	27	D	30
Commencement Bay	E	30	D	28

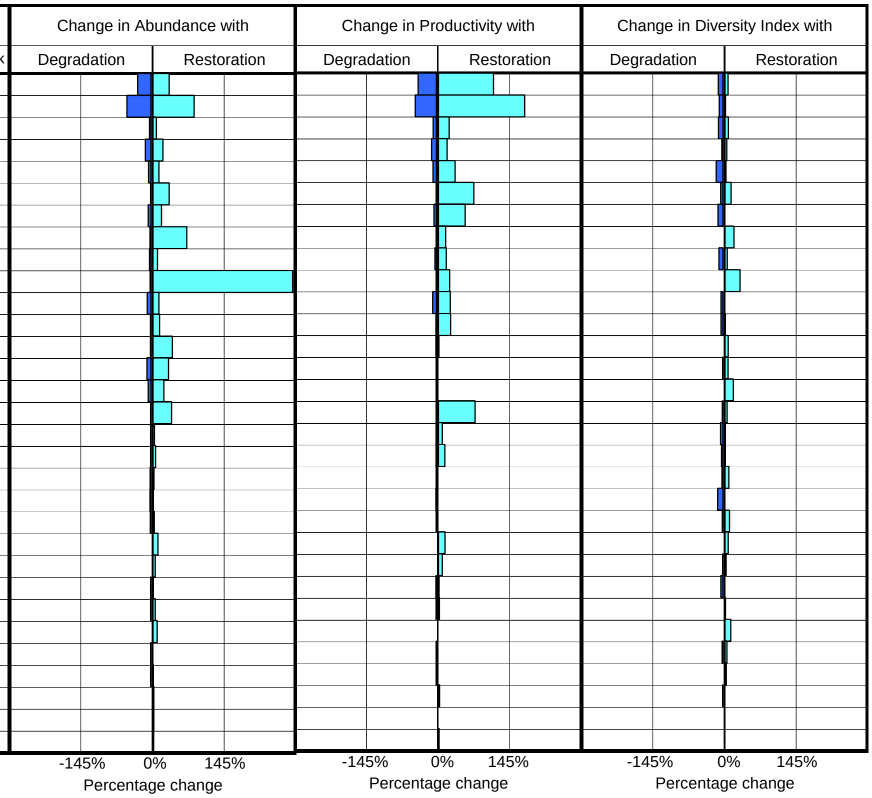


Figure 5A. Priorities for protecting and restoring geographic areas for Puyallup coho. Results NOT normalized for differences in reach lengths.

Puyallup Coho

Relative Importance Of Geographic Areas For Protection and Restoration Measures (normalized by reach length)

Geographic Area	Protection benefit		Restoration benefit	
	Category/rank		Category/rank	
Middle South Praire mainstem	A	1	A	5
Lower South Prairie mainstem	A	2	A	7
Misc South Praire tribs	B	3	B	10
Clarks Creek	D	16	A	1
Upper Kapowsin Creek	B	4	B	14
Puyallup estuary	B	7	B	12
Wilkeson Creek	B	5	B	15
Clear Creek	D	18	A	3
Fennel and Canyon Falls	C	11	B	10
Miscel mid Puyallup tribs below Canyon	C	9	B	16
Lower Kapowsin Creek	B	7	C	20
Lower Carbon mainstem	D	22	A	6
Lower Voight Cr	D	12	B	16
Mid Puyallup mainstem Orting area	E	26	A	2
Upper South Prairie mainstem	D	13	C	19
Upper Voight Cr	E	29	A	3
Miscel mid Puyallup tribs below Elect Dam	C	10	C	23
Puyallup mainstem below Carbon R	D	22	B	12
Mid Puyallup mainstem Electron area	D	15	C	20
Misc upper Carbon tribs	B	6	D	29
Misc lower Puyallup tribs below Carbon	E	27	B	9
Upper Carbon mainstem	D	20	B	16
Upper Puyallup mainstem	D	17	C	20
Electron Dam	E	30	A	8
Puyallup mainstem below White	D	18	D	25
Top Upper Puyallup	D	14	E	31
Misc Upper Puyallup tribs	D	20	D	28
Mowich River	D	22	D	26
Misc lower Puyallup tribs below White	D	25	C	24
Commencement Bay	E	30	D	27
Carbon canyon area	E	28	D	30

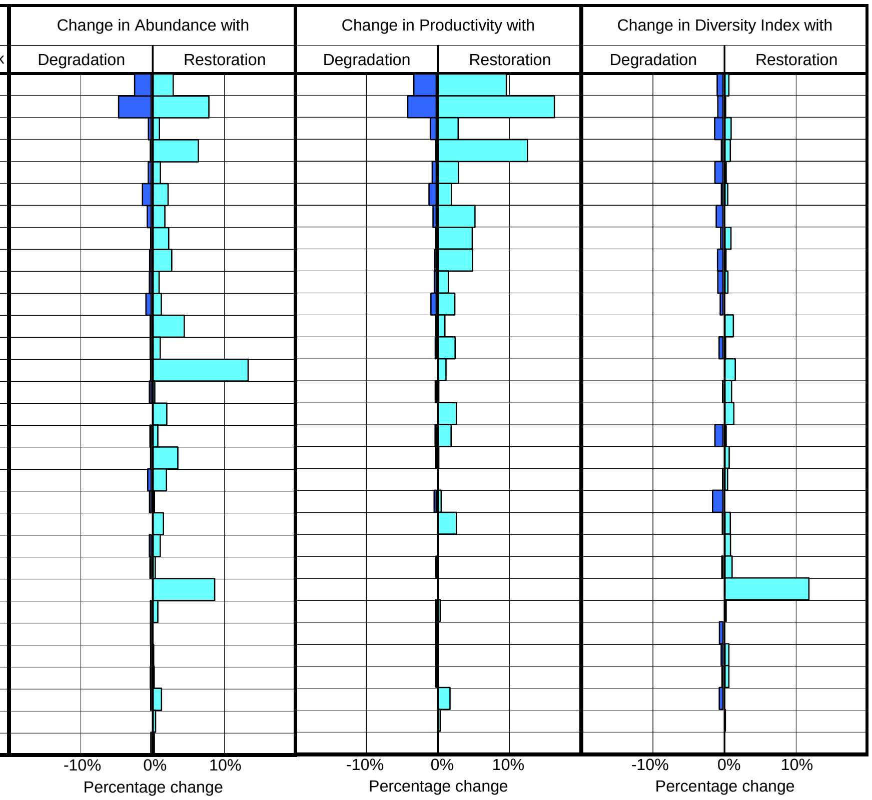


Figure 5B. Results for prioritization based on normalizing for reach length (which areas are most important per mile of stream).

Puyallup Coho
Protection and Restoration Strategic Priority Summary

Geographic area priority			Attribute class priority for restoration															
Geographic area	**Protection benefit**	**Restoration benefit**	***Channel stability/landsc.1/***	***Chemicals***	***Competition (w/ hatch)***	***Competition (other sp)***	***Flow***	***Food***	***Habitat diversity***	***Harassment/poaching***	***Obstructions***	***Oxygen***	***Pathogens***	***Predation***	***Sediment load***	***Temperature***	***Withdrawals***	***Key habitat quantity***
Commencement Bay			•	•	•			•	•									
Puyallup estuary	○	○	⬤	●	●		●	•	⬤					●				
Clear Creek	∘	◯	●				•	•	●		⬤				●			⬤
Puyallup mainstem below White		∘	•	•	•		•	•	⬤				•	•		•		⬤
Clarks Creek		◯	•		•		•		⬤	●			•	•				⬤
Misc lower Puyallup tribs below White							•	•	•	•					●	•		⬤
Upper Voight Cr		○	•				•	•	⬤		⬤				●			●
Puyallup mainstem below Carbon R		○	•		•		●	•	⬤				•	•				⬤
Misc lower Puyallup tribs below Carbon		∘	•				●	•	●	●	⬤				●	•		⬤
Fennel and Canyon Falls	∘	○	•	●			•	•	●		⬤				●			●
Lower Carbon mainstem		◯	⬤				•	•	⬤									⬤
Lower Voight Cr	∘	∘	•		•		•	•	•		●				●			⬤
Lower South Prairie mainstem	◯	◯	•				•		•	•					●	•		●
Wilkeson Creek	○	○	•				•	•	●						●			●
Middle South Praire mainstem	◯	◯	•				•		●						●			●
Misc South Praire tribs	○	○						•	•	•	⬤				•	•		●
Upper South Prairie mainstem			•				•		⬤						●			●
Carbon canyon area			⬤				•		⬤									●
Upper Carbon mainstem	∘	○	⬤					•	●						•			●
Misc upper Carbon tribs	∘		•				•	•	●						●			●
Mid Puyallup mainstem Orting area		◯	⬤		•		●		⬤	•				•				⬤
Mid Puyallup mainstem Electron area	∘	○	●				•		●									•
Miscel mid Puyallup tribs below Canyon	○	○	•				•	•	•	•	⬤				●	•		●
Lower Kapowsin Creek	○	○					•	•	•					•	●			•
Upper Kapowsin Creek	○	○	•				•	•	●						●			●
Miscel mid Puyallup tribs below Elect Dam	∘	∘	•				•	•	●		⬤				●			●
Electron Dam		○									⬤							
Upper Puyallup mainstem		∘	●				•	•	⬤									●
Mowich River	∘	∘	●				•	•	⬤						•			●
Misc Upper Puyallup tribs			•				•	•	⬤									●
Top Upper Puyallup	○																	●

1/ "Channel stability" applies to freshwater areas; "channel landscape" applies to estuarine areas.

Key to strategic priority (corresponding Benefit Category letter also shown)

A	B	C	D & E
◯ / ⬤ High	○ / ● Medium	∘ / • Low	Indirect or General

Figure 6. Strategic priorities for restoring environmental factors that affect survival of Puyallup coho. Open circles show the priority of geographic areas (NOT normalized for reach length).

3.1.2 White River Watershed

3.1.2.1 White River Spring Chinook

Baseline performance summary:
(in absence of fisheries)

Lower White Watershed

Average abundance		Productivity		Life history diversity	
Historic	Current	Historic	Current	Historic	Current
15,600	200	7.4	1.3	100%	40%

Upper White Watershed

Average abundance		Productivity		Life history diversity	
Historic	Current	Historic	Current	Historic	Current
6,700	500	9.7	1.5	100%	40%

Conclusions regarding numeric performance:
(historic production estimates assume that the White River flowed into the Puyallup River)

- Overall historic productivity was relatively low, though it differed between population components depending on extent of exposure to mainstem conditions;
- Low historic productivity due to effects of high sediment load and channel instability associated with strong glacial influence in the mainstem;
- Current abundance for the lower White is approximately 1% of historic level; it is approximately 7% of the level in the upper White;
- Current levels of productivity strongly suggest that the population is currently not sustainable without intervention using hatchery practices.

Strategic priorities for geographic areas (<u>which</u> <u>areas</u> are most important):
(See Figures 7A and B)

- Areas of highest priority for restoration are portions of the lower mainstem river and the estuary—difference exists in some results depending on whether consideration given to normalizing for reach lengths;
- The highest priority for actions that consider both protection and restoration is in the estuary and portions of the mainstem (the Clearwater is given high marks also but results depend on whether reach lengths are normalized in the analysis).

White Spring Chinook

Relative Importance Of Geographic Areas For Protection and Restoration Measures

Geographic Area	Protection benefit Category	Protection benefit rank	Restoration benefit Category	Restoration benefit rank
Clearwater mainstem	A	2	A	3
White mainstem to PSE Dam	A	1	A	5
Puyallup estuary	A	2	A	6
White mainstem reservation	B	5	A	4
Boise Cr	B	6	B	9
White mainstem to Greenwater	B	6	B	10
White mainstem below Powerhouse	D	17	A	2
White mainstem to Bowman Cr	D	19	A	1
White mainstem to Mud Mountain	C	12	B	8
Huckleberry mainstem	B	4	C	18
Lower Greenwater mainstem	C	8	C	14
Mud Mountain and reservoir	D	18	B	7
White mainstem to Huckleberry Cr	C	9	C	16
Middle Greenwater mainstem	C	13	B	13
Upper Greenwater mainstem	C	10	C	20
WF White mainstem	D	20	B	11
Puyallup mainstem below White	D	14	C	19
Upper White mainstem	C	11	E	24
Commencement Bay	E	21	C	15
Reservation tribs	D	15	D	23
TPU XXX and PSE Dam	E	21	C	17
WF White tribs	D	16	E	25

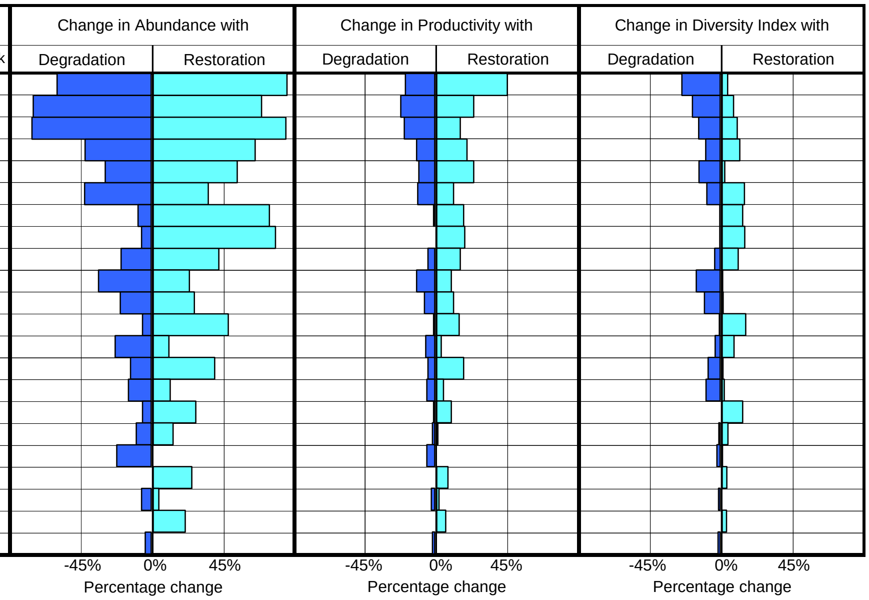


Figure 7A. Priorities for protecting and restoring geographic areas for White spring chinook. Results NOT normalized for differences in reach lengths.

White Spring Chinook

Relative Importance Of Geographic Areas For Protection and Restoration Measures (normalized by reach length)

Geographic Area	Protection benefit Category	Protection benefit rank	Restoration benefit Category	Restoration benefit rank
Boise Cr	A	2	B	5
Puyallup estuary	A	1	B	6
Clearwater mainstem	A	4	B	10
White mainstem reservation	A	6	B	8
White mainstem to PSE Dam	A	3	B	11
White mainstem to Mud Mountain	B	9	B	6
Middle Greenwater mainstem	B	7	B	9
White mainstem below Powerhouse	C	15	A	2
Lower Greenwater mainstem	A	5	C	13
Mud Mountain and reservoir	C	16	B	4
White mainstem to Bowman Cr	C	18	A	3
TPU XXX and PSE Dam	E	21	A	1
White mainstem to Greenwater	B	11	C	12
Upper Greenwater mainstem	B	9	D	17
Huckleberry mainstem	B	8	D	19
White mainstem to Huckleberry Cr	B	12	D	16
Puyallup mainstem below White	C	13	D	17
WF White mainstem	D	20	D	15
Reservation tribs	C	16	E	21
Upper White mainstem	C	14	E	24
Commencement Bay	E	21	E	20
WF White tribs	D	19	E	25

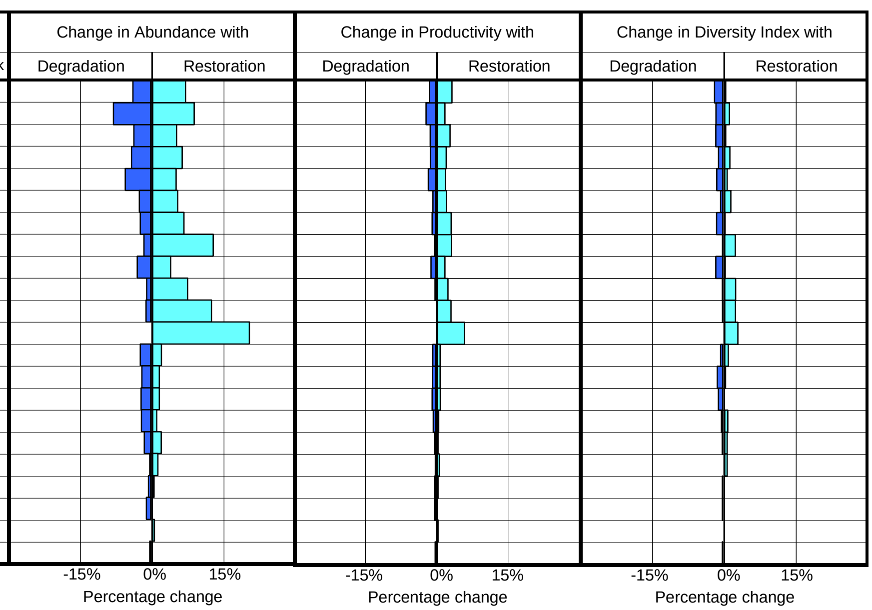


Figure 7B. Results for prioritization based on normalizing for reach length (which areas are most important per mile of stream).

Strategic priorities for environmental factors (<u>what</u> <u>factors</u> are most important): (See Figure 8)

- Top factors for restoration include habitat diversity, channel stability, sediment loading, habitat quantity, and flow conditions (also reflected in habitat quantity);
- See detailed reach analysis results for specifics on each reach (Appendix C).

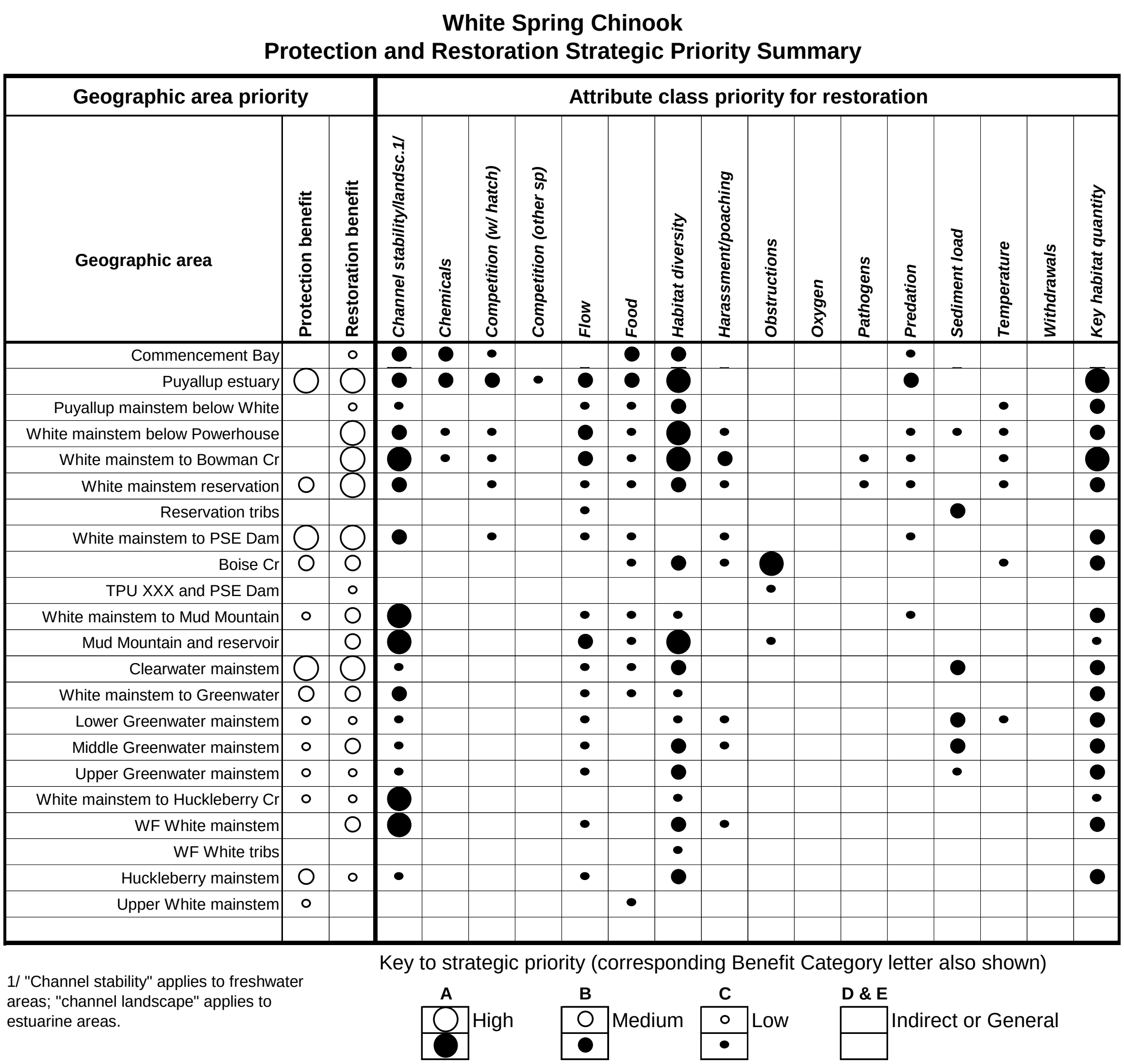


Figure 8. Strategic priorities for restoring environmental factors that affect survival of White spring chinook. Open circles show the priority of geographic areas (NOT normalized for reach length).

3.1.2.2 White River Coho

Baseline performance summary:
(in absence of fisheries)

Lower White Watershed

Average abundance		Productivity		Life history diversity	
Historic	Current	Historic	Current	Historic	Current
10,500	1,100	18.4	3.6	100%	40%

Upper White Watershed

Average abundance		Productivity		Life history diversity	
Historic	Current	Historic	Current	Historic	Current
13,500	1,200	17.4	2.0	80%	30%

Conclusions regarding numeric performance:

- Current average abundances are approximately 10% of historic levels in both the lower and upper watershed;
- Current productivities are quite low, particularly for the sub-population produced in the upper watershed; the analysis presented in the Phase One report (MBI 2001) showed that productivity has likely varied greatly between the three brood lines of coho produced in the upper watershed.

Strategic priorities for geographic areas (<u>which</u> <u>areas</u> are most important):
(See Figures 9A and B)

- Among the top areas for potential restoration benefit are Boise Creek, portions of the Greenwater River, Clearwater River, tributaries flowing through the Muckleshoot Reservation, and portions of the White mainstem;
- Top areas for protection benefit are Boise Creek, portions of Greenwater River, and portions of the White mainstem.

Strategic priorities for environmental factors (<u>what</u> <u>factors</u> are most important):
(See Figure 10)

- The most severely impacted factor associated with environmental quality across many geographic areas is habitat diversity, followed by channel stability, and sediment loading;
- Barriers to fish migration, either for adults or juveniles, exist in several areas.
- Habitat quantity has been severely reduced in some areas;

- See detailed reach analysis results for specifics on each reach (Appendix C).

White Coho

Relative Importance Of Geographic Areas For Protection and Restoration Measures

Geographic Area	Protection benefit		Restoration benefit	
	Category/rank		Category/rank	
Clearwater mainstem	B	6	A	1
White mainstem to PSE Dam	A	1	A	6
Boise Cr	A	2	A	7
White mainstem reservation	A	4	A	5
Reservation tribs	B	7	A	4
Lower Greenwater mainstem	A	3	A	10
Puyallup estuary	B	7	A	11
Huckleberry mainstem	B	7	B	14
White mainstem to Greenwater	C	12	A	9
White mainstem to Mud Mountain	C	14	A	7
Middle Greenwater mainstem	B	10	A	12
Misc Lower White tribs	C	20	A	3
WF White mainstem	C	22	A	2
WF White tribs	A	4	B	21
Greenwater tribs	C	12	B	17
Upper Greenwater mainstem	C	17	B	13
Clearwater tribs	D	23	B	14
Misc Upper White tribs	C	11	D	27
Mud Mountain and reservoir	D	25	B	14
Misc White tribs near Greenwater	C	21	B	19
Puyallup mainstem below White	C	19	B	22
Red and Scatter Crs	C	15	C	26
White mainstem to Huckleberry Cr	C	18	C	24
White mainstem below Powerhouse	D	25	B	18
Upper White mainstem	C	15	D	29
White mainstem to Bowman Cr	E	27	B	20
Huckleberry tribs	D	23	D	28
TPU XXX and PSE Dam	E	29	C	25
Commencement Bay	E	29	D	31
Top Greenwater mainstem	E	28	D	32

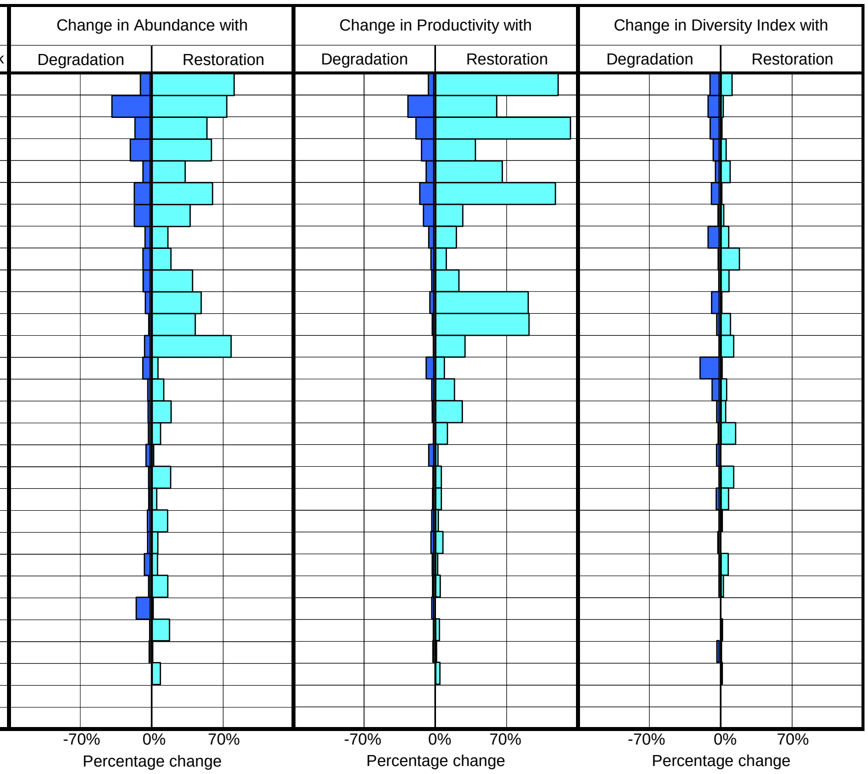


Figure 9A. Priorities for protecting and restoring geographic areas for White coho. Results NOT normalized for differences in reach lengths.

White Coho

Relative Importance Of Geographic Areas For Protection and Restoration Measures (normalized by reach length)

Geographic Area	Protection benefit Category/rank		Restoration benefit Category/rank	
Boise Cr	A	2	A	6
Lower Greenwater mainstem	A	2	A	6
Middle Greenwater mainstem	B	6	A	5
Clearwater mainstem	C	10	A	3
White mainstem reservation	B	7	B	9
White mainstem to Mud Mountain	C	13	A	3
White mainstem to PSE Dam	A	5	B	11
Red and Scatter Crs	A	4	B	15
Reservation tribs	C	11	B	10
Misc Lower White tribs	C	20	A	2
Puyallup estuary	B	9	B	13
Misc Upper White tribs	A	1	C	25
Upper Greenwater mainstem	C	16	B	12
Greenwater tribs	C	14	C	16
TPU XXX and PSE Dam	E	29	A	1
Huckleberry mainstem	C	12	C	20
Mud Mountain and reservoir	D	24	B	8
WF White tribs	B	8	D	26
White mainstem to Greenwater	C	18	C	17
WF White mainstem	D	26	B	13
White mainstem below Powerhouse	C	20	C	19
Puyallup mainstem below White	C	17	C	24
Huckleberry tribs	C	15	D	27
White mainstem to Huckleberry Cr	C	19	C	23
Clearwater tribs	D	25	C	18
Misc White tribs near Greenwater	D	23	C	22
White mainstem to Bowman Cr	E	27	C	21
Upper White mainstem	C	22	D	30
Commencement Bay	E	29	D	28
Top Greenwater mainstem	E	28	D	31

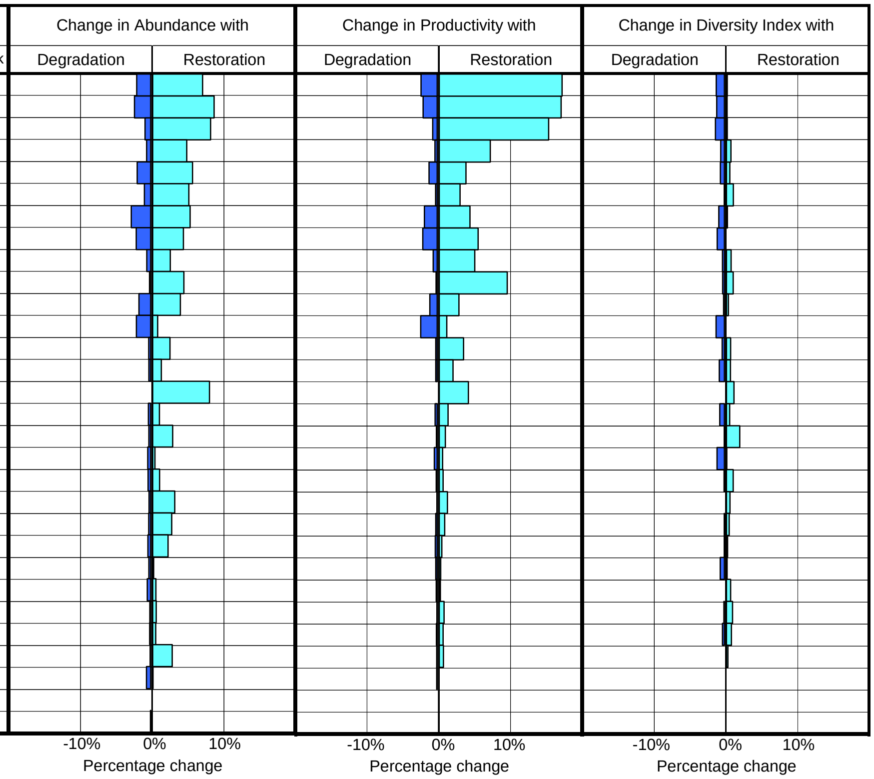


Figure 9B. Results for prioritization based on normalizing for reach length (which areas are most important per mile of stream).

White Coho
Protection and Restoration Strategic Priority Summary

Geographic area priority			Attribute class priority for restoration																
Geographic area	Protection benefit	Restoration benefit	*Channel stability/landsc.1/*	*Chemicals*	*Competition (w/ hatch)*	*Competition (other sp)*	*Flow*	*Food*	*Habitat diversity*	*Harassment/poaching*	*Obstructions*	*Oxygen*	*Pathogens*	*Predation*	*Sediment load*	*Temperature*	*Withdrawals*	*Key habitat quantity*
Commencement Bay			•	•				•	•									
Puyallup estuary	○	◯	⬤	●	●		●	•	⬤					●				
Puyallup mainstem below White	∘	○	•	•	•		•	•	⬤				•	•		•		⬤
White mainstem below Powerhouse		○	•	•	•		•	•	⬤					•	•	•		⬤
Misc Lower White tribs	∘	◯	•				•	•	●	•	⬤				●	•		⬤
White mainstem to Bowman Cr		○	●	•	•		●	●	⬤	•				•		•		⬤
White mainstem reservation	◯	◯	⬤		•		•	•	⬤	•				•		•		●
Reservation tribs	○	◯	•				●	•	●	•	⬤				●	•		●
White mainstem to PSE Dam	◯	◯	●		•			•		•				•				●
Boise Cr	◯	◯	•					•	●		⬤							⬤
TPU XXX and PSE Dam		∘									⬤							
White mainstem to Mud Mountain	∘	◯	⬤				•	•	●									●
Red and Scatter Crs	∘	∘	●				•	•	●									●
Mud Mountain and reservoir		○	⬤				●	•	⬤		•							●
Clearwater mainstem	○	◯	●				•	•	⬤						●			●
Clearwater tribs		○	⬤				●	•	⬤						●			●
White mainstem to Greenwater	∘	◯	⬤				•	•	●									●
Misc White tribs near Greenwater	∘	○	⬤				•	•	⬤		●				●			●
Lower Greenwater mainstem	◯	◯	•				•	•	•	•					●	•		●
Greenwater tribs	∘	○	●				•	•	●		⬤				●			●
Middle Greenwater mainstem	○	◯	●				•	•	●	•					●			●
Upper Greenwater mainstem	∘	○	•				•		●						•			●
Top Greenwater mainstem																		
White mainstem to Huckleberry Cr	∘	∘	⬤					•	•									•
WF White mainstem	∘	◯	⬤				•	•	⬤	•								●
WF White tribs	◯	○	●						•		⬤							•
Huckleberry mainstem	○	○	•				•		●									●
Huckleberry tribs			●				•	•	•									
Upper White mainstem	∘							•										
Misc Upper White tribs	∘									•								

1/ "Channel stability" applies to freshwater areas; "channel landscape" applies to estuarine areas.

Key to strategic priority (corresponding Benefit Category letter also shown)

	Open	Filled	
A	◯	⬤	High
B	○	●	Medium
C	∘	•	Low
D & E			Indirect or General

Figure 10. Strategic priorities for restoring environmental factors that affect survival of White coho. Open circles show the priority of geographic areas (NOT normalized for reach length).

3.1.3 Hylebos Creek Watershed

3.1.3.1 Hylebos Creek Fall Chinook

Baseline performance summary:
(in absence of fisheries)

Average abundance		Productivity		Life history diversity	
Historic	Current	Historic	Current	Historic	Current
500	40	15.6	2.6	100%	50%

Conclusions regarding numeric performance:

- Questions exist about whether this stream historically supported chinook consistently due to its small size and not being directly associated with a large mainstem river;
- Current projected abundance of <50 fish together with low productivity indicates that chinook are not sustainable under existing conditions.

Strategic priorities for geographic areas (which areas are most important):
(See Figures 11A and B)

- The top priority for restoration potential is the lower mainstem below the forks and the lower reaches of the West Fork;
- The most important area to protect is the upper West Fork, followed by the lower West Fork.

Strategic priorities for environmental factors (what factors are most important):
(See Figure 12)

- Top environmental factors to target for restoration are habitat diversity and flow conditions;
- See detailed reach analysis results for specifics on each reach (Appendix C).

Hylebos Fall Chinook

Relative Importance Of Geographic Areas For Protection and Restoration Measures

Geographic Area	Protection benefit Category/rank		Restoration benefit Category/rank	
Lower WF Hylebos	B	2	B	2
Lower mainstem Hylebos	C	4	A	1
Upper WF Hylebos	A	1	C	4
Hylebos estuary	C	3	C	3
Commencement Bay	D	5	D	6

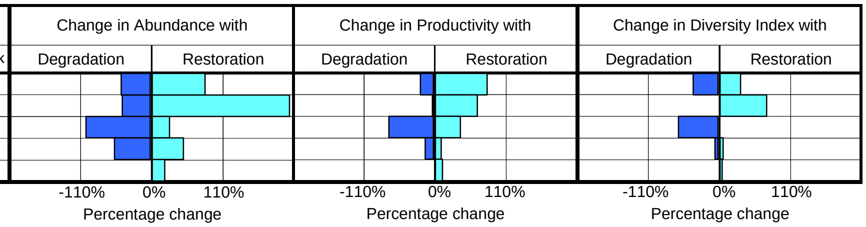


Figure 11A. Priorities for protecting and restoring geographic areas for Hylebos chinook. Results NOT normalized for differences in reach lengths.

Hylebos Fall Chinook

Relative Importance Of Geographic Areas For Protection and Restoration Measures (normalized by reach length)

Geographic Area	Protection benefit Category/rank		Restoration benefit Category/rank	
Lower WF Hylebos	B	2	B	2
Hylebos estuary	B	2	B	3
Lower mainstem Hylebos	C	4	A	1
Upper WF Hylebos	A	1	C	4
Commencement Bay	D	5	D	5

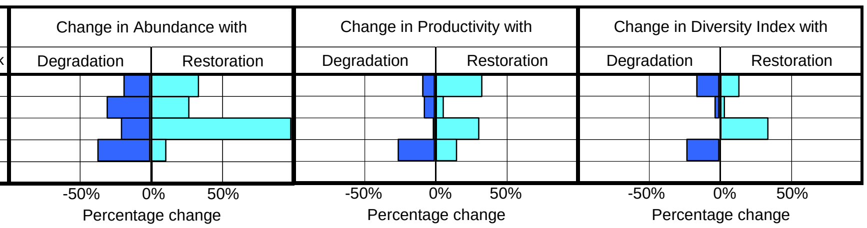


Figure 11B. Results for prioritization based on normalizing for reach length (which areas are most important per mile of stream).

Hylebos Fall Chinook
Protection and Restoration Strategic Priority Summary

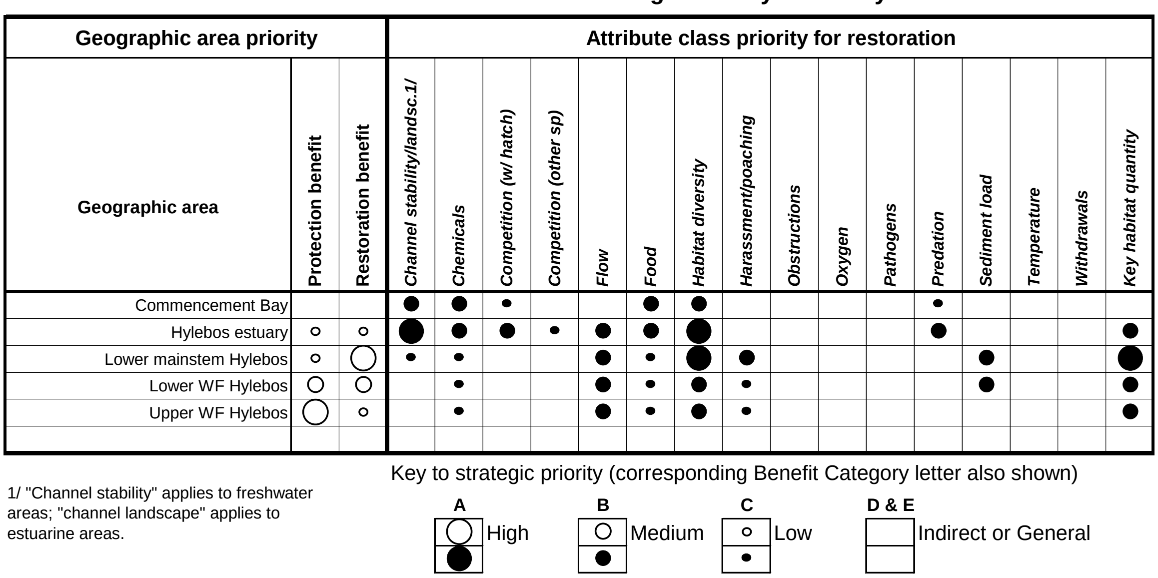


Figure 12. Strategic priorities for restoring environmental factors that affect survival of Hylebos chinook. Open circles show the priority of geographic areas (NOT normalized for reach length).

3.1.3.2 Hylebos Creek Coho

Baseline performance summary:
(in absence of fisheries)

Average abundance		Productivity		Life history diversity	
Historic	Current	Historic	Current	Historic	Current
1,800	200	25.0	6.5	100%	70%

Conclusions regarding numeric performance:

- Current average abundance is approximately 10% of historic level;
- Current productivity suggests the population is self sustaining, though at a very low level;
- Life history diversity appears to be relatively high.

Strategic priorities for geographic areas (which areas are most important):
(See Figures 13A and B)

- Areas of highest priority for restoration are the lower and upper West Fork, Surprise Lake drainage, and lower East Fork;
- Most important areas to protect against further degradation are the lower and upper portions of West Fork (reaches upstream of Highway 99).

Strategic priorities for environmental factors (what factors are most important):
(See Fig. 14)

- Top factors with restoration potential are habitat diversity, flow conditions, sediment loading and habitat quantity;
- See detailed reach analysis results for specifics on each reach (Appendix C).

Hylebos Coho

Relative Importance Of Geographic Areas For Protection and Restoration Measures

Geographic Area	Protection benefit Category	Protection benefit rank	Restoration benefit Category	Restoration benefit rank
Lower WF Hylebos	B	2	A	2
Upper WF Hylebos	A	1	A	5
Lower EF Hylebos	B	4	A	4
Lower NF Hylebos	B	3	B	6
Lower mainstem Hylebos	C	8	A	3
Hylebos estuary	B	6	B	6
Surprise Lake drainage	E	11	A	1
Upper NF Hylebos	B	5	B	9
Trib 0016	C	8	B	8
West Branch NF Hylebos	C	7	C	10
Upper EF Hylebos	D	10	C	10
Commencement Bay	E	12	D	13

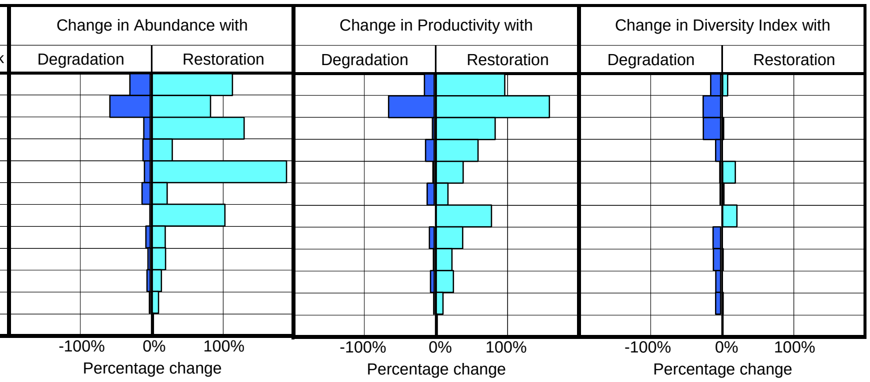


Figure 13A. Priorities for protecting and restoring geographic areas for Hylebos coho. Results NOT normalized for differences in reach lengths.

Hylebos Coho

Relative Importance Of Geographic Areas For Protection and Restoration Measures (normalized by reach length)

Geographic Area	Protection benefit Category	Protection benefit rank	Restoration benefit Category	Restoration benefit rank
Lower NF Hylebos	A	1	A	4
Lower WF Hylebos	B	5	A	1
Upper WF Hylebos	A	1	A	6
Upper NF Hylebos	B	3	B	8
Lower EF Hylebos	C	9	A	4
Lower mainstem Hylebos	C	10	A	3
Surprise Lake drainage	D	11	A	2
Upper EF Hylebos	C	6	B	7
West Branch NF Hylebos	B	4	B	10
Trib 0016	C	7	B	9
Hylebos estuary	C	8	C	11
Commencement Bay	D	12	D	12

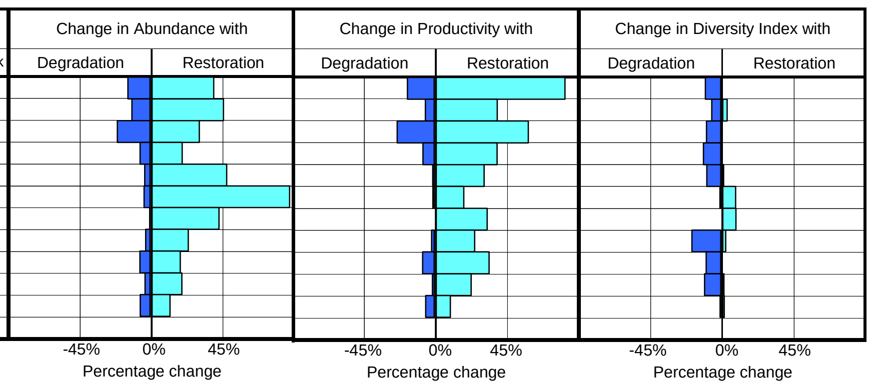


Figure 13B. Results for prioritization based on normalizing for reach length (which areas are most important per mile of stream).

Hylebos Coho
Protection and Restoration Strategic Priority Summary

Geographic area priority			Attribute class priority for restoration															
Geographic area	**Protection benefit**	**Restoration benefit**	***Channel stability/landsc.1/***	***Chemicals***	***Competition (w/ hatch)***	***Competition (other sp)***	***Flow***	***Food***	***Habitat diversity***	***Harassment/poaching***	***Obstructions***	***Oxygen***	***Pathogens***	***Predation***	***Sediment load***	***Temperature***	***Withdrawals***	***Key habitat quantity***
Commencement Bay			•	•	•			•	•									
Hylebos estuary	○	○	⬤	●	●		●	•	⬤					●				
Lower mainstem Hylebos	∘	◯	•	•			●	●	●	●					●	•		⬤
Surprise Lake drainage		◯	•	•			●	•	●	●	⬤				⬤	•		⬤
Lower EF Hylebos	○	◯	●	•			●	•	●		●				●			⬤
Trib 0016	∘	○	●	•			●	•	•						●			●
Upper EF Hylebos		∘	●	•			●	•	•		⬤				●			⬤
Lower WF Hylebos	○	◯		•			•	•	●	•					●			●
Upper WF Hylebos	◯	◯		•			•	•	•						•			●
Lower NF Hylebos	○	○		•			•	•	•	•	●							●
Upper NF Hylebos	○	○		•			•	•	●	•								●
West Branch NF Hylebos	∘	∘		•			•	•	●	•					•			●

1/ "Channel stability" applies to freshwater areas; "channel landscape" applies to estuarine areas.

Key to strategic priority (corresponding Benefit Category letter also shown)

Category	Symbols	Priority
A	◯ / ⬤	High
B	○ / ●	Medium
C	∘ / •	Low
D & E	(blank)	Indirect or General

Figure 14. Strategic priorities for restoring environmental factors that affect survival of Hylebos coho. Open circles show the priority of geographic areas (NOT normalized for reach length).

3.1.4 Chambers/Clover Creek Watershed

3.1.4.1 Chambers/Clover Creek Fall Chinook

Baseline performance summary:
(in absence of fisheries)

Average abundance		Productivity		Life history diversity	
Historic	Current	Historic	Current	Historic	Current
2,100	350	22.0	6.3	100%	61%

Conclusions regarding numeric performance:

- Questions exist about whether this stream historically supported chinook consistently due to its small size and not being directly associated with a large mainstem river;
- Based solely on modeling results, parameter values suggest that chinook might have used the lower portions of the stream historically and that it might be able to support a small population under current conditions

Strategic priorities for geographic areas (which areas are most important):
(See Figures 15A and B)

- The top area with restoration benefit is mainstem Chambers Creek; Chambers Bay is the top ranked area when reach lengths are normalized;
- The highest priority for protecting against further degradation are mainstem Chambers Creek and when normalizing for reach length, Chambers Bay.

Strategic priorities for environmental factors (what factors are most important):
(See Figure 16)

- The top ranked factor for restoration along mainstem Chambers Creek is habitat diversity.
- See detailed reach analysis results for specifics on each reach (Appendix C).

ChambersClover Fall Chinook

Relative Importance Of Geographic Areas For Protection and Restoration Measures

Geographic Area	Protection benefit		Restoration benefit	
	Category/rank		Category/rank	
Chambers mainstem	A	1	A	1
Chambers Bay	B	2	C	4
Flett	B	2	D	6
Lower Clover (to Spanaway)	D	5	B	3
Leach	C	4	C	5
Steilacoom Lake	D	6	D	9

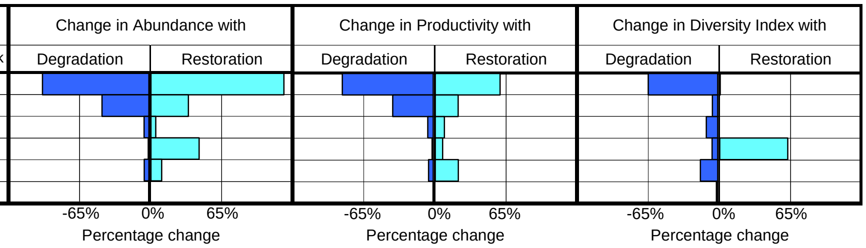


Figure 15A. Priorities for protecting and restoring geographic areas for Chambers/Clover chinook. Results NOT normalized for differences in reach lengths.

ChambersClover Fall Chinook

Relative Importance Of Geographic Areas For Protection and Restoration Measures (normalized by reach length)

Geographic Area	Protection benefit		Restoration benefit	
	Category/rank		Category/rank	
Chambers Bay	A	1	A	1
Chambers mainstem	A	1	A	1
Leach	B	3	C	4
Lower Clover (to Spanaway)	C	5	B	3
Flett	B	4	D	5
Steilacoom Lake	C	6	E	8

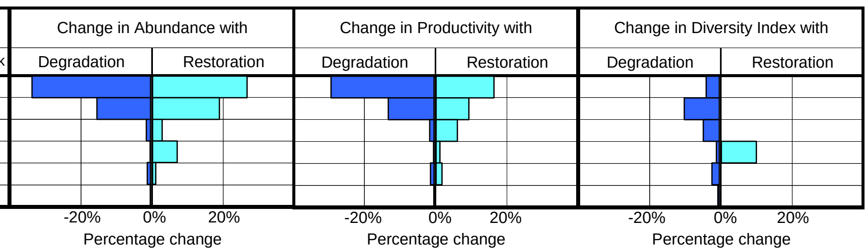


Figure 15B. Results for prioritization based on normalizing for reach length (which areas are most important per mile of stream).

ChambersClover Fall Chinook
Protection and Restoration Strategic Priority Summary

Geographic area priority			Attribute class priority for restoration															
Geographic area	**Protection benefit**	**Restoration benefit**	*Channel stability/landsc.1/*	*Chemicals*	*Competition (w/ hatch)*	*Competition (other sp)*	*Flow*	*Food*	*Habitat diversity*	*Harassment/poaching*	*Obstructions*	*Oxygen*	*Pathogens*	*Predation*	*Sediment load*	*Temperature*	*Withdrawals*	*Key habitat quantity*
Chambers Bay	○ B	∘ C	● B	● B	● B			● A	● A					● B				● B
Chambers mainstem	○ A	○ A		• C				• C	● B	• C				• C	• C			● B
Leach	∘ C	∘ C	● B	• C			● B	• C	● B	● B					● B			● B
Flett	○ B		• C	• C			• C	• C	● B	• C					● B			● B
Steilacoom Lake								• C	• C					• C				
Lower Clover (to Spanaway)		○ B	• C	• C			● B	• C	● A	● B	● A				● B			● B

1/ "Channel stability" applies to freshwater areas; "channel landscape" applies to estuarine areas.

Key to strategic priority (corresponding Benefit Category letter also shown)

Category	Symbols	Priority
A	○ / ● (large)	High
B	○ / ● (medium)	Medium
C	∘ / • (small)	Low
D & E	(blank)	Indirect or General

Figure 16. Strategic priorities for restoring environmental factors that affect survival of Chambers/Clover chinook. Open circles show the priority of geographic areas (NOT normalized for reach length).

3.1.4.2 Chambers/Clover Creek Coho

Baseline performance summary:
(in absence of fisheries)

Average abundance		Productivity		Life history diversity	
Historic	Current	Historic	Current	Historic	Current
12,200	700	35.9	7.8	100%	40%

Conclusions regarding numeric performance:

- For its size, the results suggest that Chambers/Clover was, and still is, the most productive watershed for coho of the four watersheds analyzed;
- Historic production potential exceeded 12,000 with the highest productivity of the four watersheds analyzed;
- High natural productivity of this system is related to the abundance of groundwater and the number of lakes and ponds able to be used by juvenile coho;
- Life history diversity has been reduced substantially from historic level.

Strategic priorities for geographic areas (which areas are most important):
(See Figures 17A and B)

- Top areas with restoration benefit are Steilacoom Lake, lower Clover Creek, and Chambers mainstem—other areas differ depending on whether reach lengths are normalized in the analysis;
- Consider the results of the reach specific analysis (Appendix C) in examining the contribution of Clover Creek upstream of Spanaway Creek because all these reaches were grouped into the Upper Clover area, though conditions differ significantly between these reaches.

Strategic priorities for environmental factors (what factors are most important):
(See Figure 18)

- Top priorities for restoring environmental factors are habitat diversity and flow conditions;
- Loss of habitat quantity has been severe in some areas (this related to flow changes also);
- Barriers to fish migration, either for adults or juveniles, exist in several areas;
- See detailed reach analysis results for specifics on each reach (Appendix C).

ChambersClover Coho

Relative Importance Of Geographic Areas For Protection and Restoration Measures

Geographic Area	Protection benefit Category	Protection benefit rank	Restoration benefit Category	Restoration benefit rank
Upper Clover	A	1	A	3
Lower Clover (to Spanaway)	B	5	A	1
Chambers mainstem	A	3	A	4
Lower Spanaway	A	2	B	5
Steilacoom Lake	B	7	A	1
Chambers Bay	B	4	D	10
Leach	C	9	B	5
Flett	B	6	C	9
NF Clover	D	10	B	5
Morey	E	11	C	8
Ponce de Leon	C	8	D	12
Spanaway Lake	E	11	E	15
Upper Spanaway	E	11	E	15

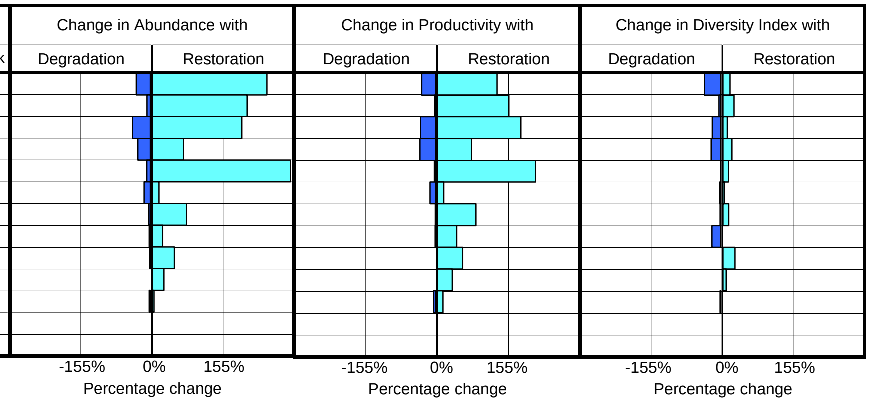


Figure 17A. Priorities for protecting and restoring geographic areas for Chambers/Clover coho. Results NOT normalized for differences in reach lengths.

ChambersClover Coho

Relative Importance Of Geographic Areas For Protection and Restoration Measures (normalized by reach length)

Geographic Area	Protection benefit Category	Protection benefit rank	Restoration benefit Category	Restoration benefit rank
Steilacoom Lake	B	6	A	1
Chambers mainstem	B	4	A	4
Lower Spanaway	A	2	A	6
Ponce de Leon	A	1	A	7
Chambers Bay	A	2	B	9
Lower Clover (to Spanaway)	C	8	A	3
Morey	D	11	A	2
Upper Clover	B	5	B	8
Leach	C	9	A	5
Flett	B	6	B	11
NF Clover	D	10	B	9
Spanaway Lake	D	11	C	15
Upper Spanaway	D	11	C	16

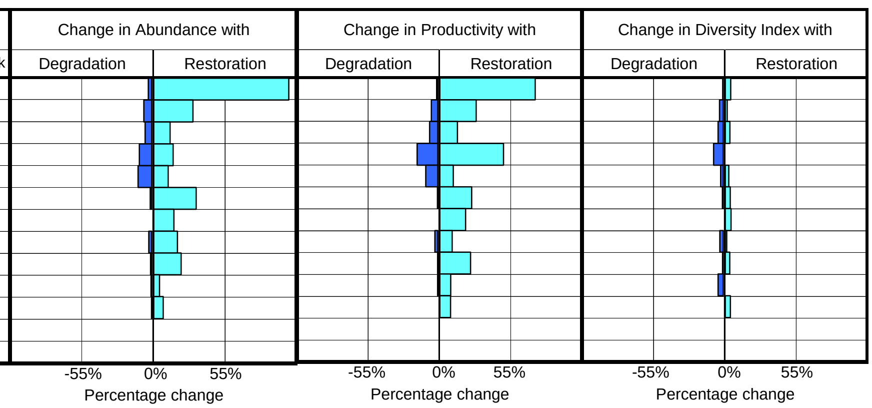


Figure 17B. Results for prioritization based on normalizing for reach length (which areas are most important per mile of stream).

ChambersClover Coho
Protection and Restoration Strategic Priority Summary

Geographic area priority			Attribute class priority for restoration															
Geographic area	**Protection benefit**	**Restoration benefit**	*Channel stability/landsc.1/*	*Chemicals*	*Competition (w/ hatch)*	*Competition (other sp)*	*Flow*	*Food*	*Habitat diversity*	*Harassment/poaching*	*Obstructions*	*Oxygen*	*Pathogens*	*Predation*	*Sediment load*	*Temperature*	*Withdrawals*	*Key habitat quantity*
Chambers Bay	○ B				● B				● A					● B				
Chambers mainstem	○ A	○ A	● C		● C		● C	● C	● A	● C			● C	● C	● C			● B
Leach	○ C	○ B	● B	● C			● B	● C	● A	● B					● B			● A
Flett	○ B	○ C	● C	● C			● B	● C	● B	● B					● B			● B
Steilacoom Lake	○ B	○ A			● C			● C	● B	● C				● C	● C			● A
Ponce de Leon	○ C							● C	● C	● C								● B
Lower Clover (to Spanaway)	○ B	○ A	● C	● C			● B	● C	● B	● B	● A				● B	● C		● A
Morey		○ C						● C	● C	● C	● A				● C	● C		● B
Lower Spanaway	○ A	○ B		● C				● C	● C	● C	● A				● C	● C		● B
Spanaway Lake			● C		● C			● C	● B					● C				
Upper Spanaway								● C	● C	● C	● A				● C	● C		● B
Upper Clover	○ A	○ A	● B				● C	● C	● B	● B					● B	● C		● A
NF Clover		○ B	● C	● B			● B	● C	● B	● B					● A	● C		● A

1/ "Channel stability" applies to freshwater areas; "channel landscape" applies to estuarine areas.

Key to strategic priority (corresponding Benefit Category letter also shown)

A	B	C	D & E
○ / ● High	○ / ● Medium	○ / ● Low	Indirect or General

Figure 18. Strategic priorities for restoring environmental factors that affect survival of Chambers/Clover coho. Open circles show the priority of geographic areas (NOT normalized for reach length).

3.2 Identification of Actions to Be Analyzed

The team submitted a total of 127 actions for consideration. Four of these were largely duplications of one another. Within freshwater areas, another 10 of these actions occurred outside the geographic areas encompassed by our analysis or consisted of actions not pertinent to the analysis (e.g. proposed removal of barriers in a stream where no barriers to fish passage had been identified). Within the bay or estuary, two actions were not defined sufficiently for team members to evaluate with respect to effectiveness. After removing these from consideration, a total of 111 actions remained for analysis.

The actions cover a wide variety of environmental restoration or remediation measures. Examples of the types of measures included are listed below:

Watershed or area	Examples of types of actions
Chambers-Clover Creek	Flow restoration in dewatered reaches
	LWD placement
	Beneficial nutrient resupply (e.g., salmon carcasses)
	Stream corridor acquisition and associated restoration
	Channel reconstruction
	Fish passage barrier removal
	Storm water detention facilities
Hylebos Creek	LWD placement
	Riparian vegetation restoration
	Reconnection of channel to off-channel ponds
	Storm water detention facilities
	Channel reconstruction
	Fish passage barrier removal
Puyallup River	Electron Diversion screen modification
	Levee setbacks
	Oxbow or off-channel habitat reconnection
	Riparian corridor restoration
	LWD placement
	Fish passage barrier removal
White River	Riparian corridor restoration
	Channel reconstruction
	LWD placement
	Restoration of flow to the PSE bypass reach
	Semi-normative flow restoration at Mud Mtn Dam
	Road removal
	Bridge replacement
	Fish passage barrier removal
Estuary/bay	Creation of salt marsh/blind channels
	Creation of distributary channels
	Beach replenishment

It should be noted that some actions were submitted by team members as "what if's", that is, the action may not be seriously proposed for actual implementation. Instead, the team member may have proposed an action to determine how the relative benefits of such an action compare to others that may be given more serious consideration. Such actions help the team to better understand the overall scale of projects that might be necessary to achieve significant recovery to salmonid performance.

For ease of looking up action names, all actions are listed in the Tables 2-5 (by watershed or estuary/bay) by action identification number, corresponding name, and the booklet (appendix) page number where they are described.

Actions conducted in freshwater areas are described in Appendix A (Candidate Actions for Freshwater Areas in the Puyallup-White, Hylebos, and Chambers-Clover Watersheds). Actions conducted in the estuarine and bay areas are described in Appendix B (Candidate Actions for Estuarine and Bay Areas for the Puyallup-White, Hylebos, and Chambers-Clover Watersheds).

Action groups that were analyzed are listed and described for each watershed in Tables 6.

Table 2. List of actions analyzed in the Puyallup-White basin upstream of the estuary. All actions listed here are described in Appendix A (booklet of freshwater actions).

Action no.	Action name	Target area	Booklet page
P-1	White R pH reduction	White R below Mud Mtn	61
P-2	LWD collection-redistribution	White R below Mud Mtn	53
P-3	Setback Levee – Sumner Tractor	lower White R	78
P-4	Pacific Park riparian restoration	lower White R	1
P-5	County-line floodplain acquisition	lower White R	2
P-6	Relocate mobile home park	lower White R	3
P-7	White R estates-riparian buffer	lower White R	4
P-8	Riparian restoration near R-Street	lower White R	5
P-9	Roegner Park riverbank restoration	lower White R	6
P-10	Levee removal-setback at Game Farm	lower White R	7
P-11	Floodplain acquisition on Stuck R Drive	lower White R	8
P-12	Trans Canada levee removal	lower White R	9
P-13	Lower Boise Cr relocation	Boise Cr	15
P-14	Boise Cr LWD enhancement	Boise Cr	16
P-15	Boise Cr revegetation	Boise Cr	20
P-16	Boise Cr restoration at golf course	Boise Cr	92
P-17	Natural river flow in PSE bypass	PSE bypass reach	10
P-18	Mud Mountain Dam flow modifications	below Mud Mtn	11
P-19	Red Cr-White R confluence restore	Red Cr and White R	12
P-20	Greenwater R-White R confluence restore	Greenwater R	13
P-21	Greenwater SR 410 bridge replacement	Greenwater R	14
P-22	28 Mile Cr side channel restoration	Greenwater R	33
P-23	Greenwater R revetment retrofit	Greenwater R	54
P-24	Greenwater R channel restoration	Greenwater R	38
P-25	Greenwater R riparian restoration	Greenwater R	99
P-26	FS Road 7020/7021 decommission	Greenwater R	95
P-27	Greenwater R LWD placement	Greenwater R	97
P-28	Greenwater tribs FS roads decommission	Greenwater R	96
P-29	Greenwater subbasin barrier removal	Greenwater R	41
P-30	FS Road 7320 bridges	WF White R	93

Table 2 continued. List of actions analyzed in the Puyallup-White basin upstream of the estuary. All actions listed here are described in Appendix A (booklet of freshwater actions).

Action no.	Action name	Target area	Booklet page
P-31	Huckleberry Cr LWD placement	Huckleberry Cr	98
P-32	Huckleberry Cr riparian restoration	Huckleberry Cr	100
P-33	WF White subbasin barrier removal	WF White R	49
P-34	White-lower subbasin barrier removal	lower White R watershed	50
P-35	White upper subbasin barrier removal	upper White River watershed	52
P-36	Oxbow reconnections	Puyallup R	88
P-37	Puy R setback levee – Rside Drive	Puyallup R	82
P-38	Puy R setback levee RM 13 – 14.5	Puyallup R	23
P-39	Puy R setback levee – N 128th (RB) A	Puyallup R	79
P-40	Puy R setback levee – N 128th (LB)	Puyallup R	84
P-41	Puy R setback levee – N 128th (RB) B	Puyallup R	85
P-42	S Fork Road setback levee	Puyallup R	89
P-43	Puy R. setback levee – Calistoga N (RB)	Puyallup R	81
P-44	Puy R. setback levee – Calistoga N (LB)	Puyallup R	91
P-45	Old Soldier's Home setback levee	Puyallup R	90
P-46	Puy R setback levee – Ford/Matlock	Puyallup R	83
P-47	Puy R setback levee – Calistoga S	Puyallup R	80
P-48	Lower Carbon R setback levee A	Carbon R	25
P-49	Lower Carbon R setback levee B	Carbon R	87
P-50	Carbon R setback levee – Allward Rd	Carbon R	86
P-51	Lower S Prairie Cr stream corridor aq.	South Prairie Cr	NA
P-52	Foothills trail wetland mitigation site	South Prairie Cr	55
P-53	Electron diversion screen	Puyallup R	60
P-54	S Prairie culvert replace/pond access	South Prairie Cr	63
P-55	Foothills Trail culvert replacement	South Prairie Cr	36
P-56	Carbon R SubBasin barrier removal	Carbon R	39
P-57	Puy-lower SubBasin barrier removal	lower Puyallup watershed	45
P-58	Puy-upper SubBasin barrier removal	upper Puyallup watershed	46
P-59	S Prairie SubBasin barrier removal	South Prairie watershed	47

Table 3. List of actions analyzed in the Puyallup-White and Hylebos estuaries and in Commencement Bay. All actions listed here are described in Appendix B (booklet of estuarine/bay actions).

Action no.	Action name	Target area	Booklet page
Est-1	Clear Creek off-channel habitat	Clear Cr (fw and estuarine)	1
Est-2	Middle Waterway distributary channel	Puyallup estuary	27
Est-3	Puy side channel-estuary	Puyallup estuary	10
Est-4	Gog-Li-Hi-Te wetland expansion	Puyallup estuary	34
Est-5	Puy estuary emergent marsh side channel	Puyallup estuary	26
Est-6	Union Pacific Parcel wetted channel	Puyallup estuary	20
Est-7	Union Pacific transitional marsh/side chan	Puyallup estuary	24
Est-8	Oxbow wetland creation	Puyallup estuary	21
Est-9	Lower Clarks Cr floodplain	Clarks Cr in Puyallup estuary	31
Est-10	Puy estuary riverine-tidal chan relocation	Puyallup estuary	32
Est-11	Hylebos distributary channel	Puyallup estuary	29
Est-12	Puy Estuary riverine-tidal side channels	Puyallup estuary	25
Est-13	Sitcum/Blair Peninsula	Commencement Bay	22
Est-14	Middle/St. Paul Peninsula	Commencement Bay	6
Est-15	Middle Waterway marsh/mudflat/channel	Commencement Bay	8
Est-16	Middle Waterway corridor	Commencement Bay	7
Est-17	Blair/Hylebos Peninsula	Commencement Bay	23
Est-18	Grain Terminal to GSA shoreline rehab	Commencement Bay	13
Est-19	Dickman Mill shoreline rehabilitation	Commencement Bay	14
Est-20	Dock Street to Grain Terminal rehab	Commencement Bay	11
Est-21	Outer Hylebos	Commencement Bay	2
Est-22	Ruston Way beach replenishment	Commencement Bay	3
Est-23	Ruston shoreline enhancement	Commencement Bay	16
Est-24	Asarco shoreline enhancement	Commencement Bay	17
Est-25	Hauff property/ DOT mitigation project	Hylebos estuary	18

Table 4. List of actions analyzed in the Hylebos basin upstream of the estuary. All actions listed here are described in Appendix A (booklet of freshwater actions).

Action no.	Action name	Target area	Booklet page
H-1	Jordan property acquisition	lower Hylebos Cr	65
H-2	Milgard restoration project	lower Hylebos Cr	66
H-3	Invasive weed control/native planting	lower Hylebos Cr	64
H-4	Proposed SR 167 mitigation	lower Hylebos Cr	21
H-5	Hylebos Cr crossing at S 373rd St.	West Fork Hylebos Cr	73
H-6	Reconnect floodplain in Spring Valley	West Fork Hylebos Cr	26
H-7	Justus Pond reconnection	West Fork Hylebos Cr	27
H-8	West Hylebos acquisition project	West Fork Hylebos Cr	67
H-9	S 356th St detention pond expansion	West Fork Hylebos Cr	69
H-10	East Branch conifer planting	East Branch Hylebos Cr	17
H-11	East Branch LWD enhancement	East Branch Hylebos Cr	18
H-12	S. 316th Pl detention facility	West Fork Hylebos Cr	72
H-13	S 360th regional stormwater detention	East Branch Hylebos Cr	70
H-14	Hylebos subbasin barrier removals	extensive	43
Est-25	Hauff property/ DOT mitigation project	Hylebos estuary	18[9]

[9] Action occurs within the Hylebos Estuary, described on page 18 of Appendix B.

Table 5. List of actions analyzed in the Chambers-Clover basin. All actions listed here are described in Appendix A (booklet of freshwater actions).

Action no.	Action name	Target area	Booklet page
C-1	Flett Creek channel restoration	Flett Cr	30
C-2	Shera's Falls barrier correction	Clover Cr	31
C-3	Nutrient enhancement	extensive	59
C-4	Morey Creek barrier correction	Morey Cr	32
C-5	Off-channel habitat creation	extensive	56
C-6	Flow restoration in Clover Creek	Clover Cr	57
C-7	Rechannelization near PLU campus	Clover Cr	22
C-8	LWD enhancement	extensive	58
C-9	Third regional detention pond on NF Clover	NF Clover Cr	77
C-10	Floodplain acquisition	Clover Cr	76
C-11	Spanaway Cr barrier removal	Spanaway Cr	74
C-12	Coffee Cr culvert replacement	Spanaway Cr	75
C-13	Coffee and Spanaway Cr barrier removal	Spanaway Cr	[10]

[10] Action C-13 is a combination of C-11 and C-12.

Table 6. Groups of actions analyzed, listed for the Chambers-Clover, Hylebos, Puyallup, and White basins.

Basin	Group name	Description
Chambers-Clover	Barriers	All physical barriers to fish passage corrected (addresses issues on 4 barriers).
	Mid Clov	Clover Cr channel reconstructed near Pacific Lutheran University and low flow problem remedied.
	Mid Clov & barriers	Clover Cr channel reconstructed near PLU and low flow problem remedied; barriers to fish passage also corrected.
	Others-barriers in	All actions except those that address channel reconstruction near PLU, the low flow issue in the same area, and barriers to fish passage in the drainage.
	Others & barriers	All actions except those that address channel reconstruction near PLU and the low flow issue in the same area.
	All	All actions combined (12 projects).
Hylebos	Storm water	All actions that add or expand storm water detention facilities (3 projects).
	Barriers	All physical barriers to fish passage corrected (addresses issues on 5 barriers).
	E Branch	Actions on East Branch Hylebos Cr except stormwater detention facility additions.
	W Hylebos	Actions on West Fork Hylebos Cr except stormwater detention facility additions.
	Low Hylebos	Actions on lower Hylebos Cr (below forks), including one in the Hylebos estuary.
	All	All actions combined (15 projects).
Puyallup	Bay	All actions in Commencement Bay (12 projects).
	Estuary	All actions in the Puyallup estuary (12 projects).
	Barriers	All physical barriers to fish passage corrected except those associated with Electron Dam (addresses issues on 37 barriers).
	Levees	All setback levee projects (14 projects).
	Off channel	All actions that primarily add off-channel habitat or access to off-channel habitat.
	Electron	Modification to the Electron Diversion screens to remedy mortality issues.
	S Prairie	All actions on South Prairie Creek (including barrier corrections and access to off-channel habitat).
	All FW	All actions affecting freshwater habitat.
	All	All actions combined (49 projects--some consist of multiple measures).

Table 6 continued. Groups of actions analyzed, listed for the Chambers-Clover, Hylebos, Puyallup, and White basins.

Basin	Group name	Description
White	Bay	All actions in Commencement Bay (12 projects).
	Estuary	All actions in the Puyallup estuary (12 projects).
	Barriers	All physical barriers to fish passage corrected except those associated with the PSE Diversion and Mud Mountain Dam (addresses issues on 20 barriers).
	Above MM	All actions upstream of Mud Mountain Dam (16 projects--some consist of multiple measures).
	FW Below MM	All actions downstream of Mud Mountain Dam (excluding those in the estuary/bay and those associated with the PSE Diversion or Mountain Dam (17 projects--some consist of multiple measures).
	PSE	The action that remedies issues associated with the PSE Diversion (excludes any flow modifications at Mud Mountain Dam).
	All-retain PSE	All actions except those associated with the PSE Diversion or Mud Mountain Dam flow modifications (58 projects--some consist of multiple measures).
	All	All actions except those involving flow modifications at Mud Mountain Dam (59 projects -- some consist of multiple measures).

3.3 Analysis of Actions

3.3.1 Puyallup Watershed

The top ranked action for Puyallup River populations is the "Hylebos distributary channel" project. It ranked as number four for coho and number six for chinook (Figure 19). We note however that this action produced much smaller increases in abundance than other highly ranked actions for each species. It ranked number one overall because it produced small or moderate increases across all performance measures.

The top ranked action for Puyallup chinook is the "Electron diversion screen" improvement project. This action was projected to produce the largest increase in abundance (34%), productivity (10%), and life history diversity (27%) (Figure 20). This action was the clear winner for chinook in the watershed. The action was ranked number two overall for the two species combined, while it ranked 10th for coho.

The top ranked action for coho is the "Foothills Trail culvert replacement" project, which would serve to open access to off-channel ponds for rearing and overwintering juveniles in South Prairie Creek. Two other similar actions located in South Prairie Creek (actions P-52 and P-54) ranked high for coho.

Differences in how actions ranked between species, such as the "Foothills Trail culvert replacement" project, reflect differences in life history needs for the two species in some life stages. Levee setback actions, notably those that encompassed long stretches of river, tended to produce high benefits for both species.

The type of actions as a group that produced the greatest increases in abundance for both chinook and coho was levee setbacks (Figure 21). The same group produced the greatest increase in productivity for chinook. In contrast, combined actions in South Prairie Creek, which consisted of several actions aimed at opening access to off-channel ponds, produced the largest increase in productivity for coho. Actions that open access to off-channel ponds tend to increase productivity more than abundance, though both are increased. These findings are consistent with the life history needs of the two species. Estuarine actions grouped together produced the second highest (as a group) increase in abundance for chinook.

All actions combined were projected to increase chinook abundance by nearly 400% over the current production level with an increase in productivity of approximately 55%.

Puyallup River Populations

Combined and species specific action ranks

Action no.	Action name	Rank Cmb	Rank Chin	Rank Coho
Est-11	Hylebos distributary channel	1	6	4
P-53	Electron diversion screen	2	1	10
P-51	Lower S Prairie Cr stream corridor aq.	3	12	2
P-47	Puy R setback levee – Calistoga S	4	4	11
P-38	Puy R setback levee RM 13 – 14.5	5	2	14
Est-7	Union Pacific transitional marsh/side chan	6	10	8
P-39	Puy R setback levee – N 128th (RB) A	7	6	13
P-40	Puy R setback levee – N 128th (LB)	8	8	16
P-36	Oxbow reconnections	9	3	22
Est-10	Puy estuary riverine-tidal chan relocation	9	14	11
P-50	Carbon R setback levee – Allward Rd	11	5	21
P-55	Foothills Trail culvert replacement	12	27	1
P-52	Foothills trail wetland mitigation site	13	26	3
Est-2	Middle Waterway distributary channel	14	15	15
P-41	Puy R setback levee – N 128th (RB) B	15	13	19
P-54	S Prairie culvert replace/pond access	16	28	6
Est-12	Puy Estuary riverine-tidal side channels	16	18	16
Est-1	Clear Creek off-channel habitat	18	9	28
Est-9	Lower Clarks Cr floodplain	19	20	18
P-46	Puy R setback levee – Ford/Matlock	20	30	9
P-44	Puy R. setback levee – Calistoga N (LB)	21	35	5
P-58	Puy-upper SubBasin barrier removal	22	34	7
Est-21	Outer Hylebos	22	10	31
P-48	Lower Carbon R setback levee A	24	16	28
P-57	Puy-lower SubBasin barrier removal	25	25	20
P-49	Lower Carbon R setback levee B	26	17	30
P-56	Carbon R SubBasin barrier removal	27	24	24
Est-5	Puy estuary emergent marsh side channel	28	23	26
Est-8	Oxbow wetland creation	28	22	27
P-37	Puy R setback levee – Rside Drive	30	18	35
Est-15	Middle Waterway marsh/mudflat/channel	31	21	36
Est-4	Gog-Li-Hi-Te wetland expansion	32	31	32
Est-6	Union Pacific Parcel wetted channel	32	29	34
P-43	Puy R. setback levee – Calistoga N (RB)	34	41	24
P-59	S Prairie SubBasin barrier removal	35	47	23
Est-14	Middle/St. Paul Peninsula	35	32	38
Est-22	Ruston Way beach replenishment	37	33	39
Est-17	Blair/Hylebos Peninsula	38	35	40
P-42	S Fork Road setback levee	39	44	33
Est-18	Grain Terminal to GSA shoreline rehab	40	37	41
Est-16	Middle Waterway corridor	41	38	42
Est-13	Sitcum/Blair Peninsula	42	39	42
Est-19	Dickman Mill shoreline rehabilitation	42	39	42
Est-3	Puy side channel-estuary	44	45	37
Est-23	Ruston shoreline enhancement	45	42	45
P-45	Old Soldier's Home setback levee	46	43	48
Est-20	Dock Street to Grain Terminal rehab	46	46	45
Est-24	Asarco shoreline enhancement	48	47	45

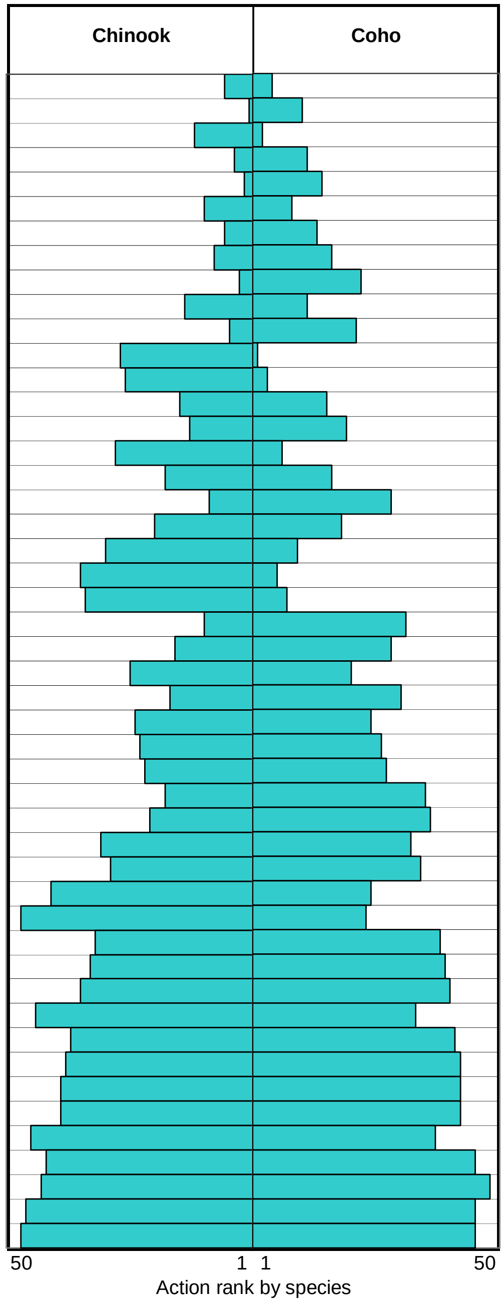


Figure 19. Combined action ranks (across species) and species-specific ranks in the Puyallup basin. Note: Bar size corresponds to rank number. A rank of 1 is the top ranked action.

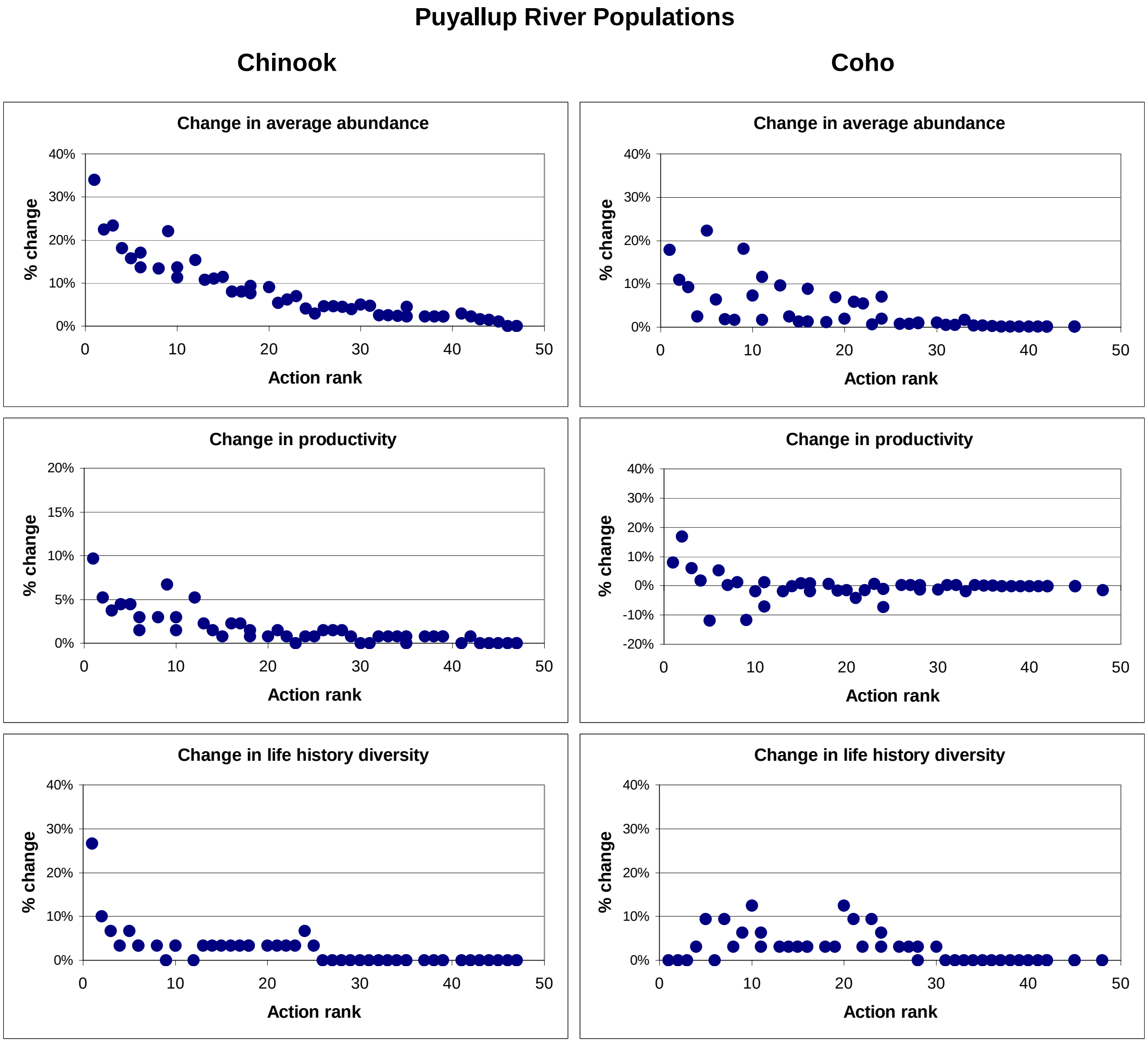


Figure 20. Change in performance of chinook and coho by the rank of each action in Puyallup River. Rank shown is the rank for that species.

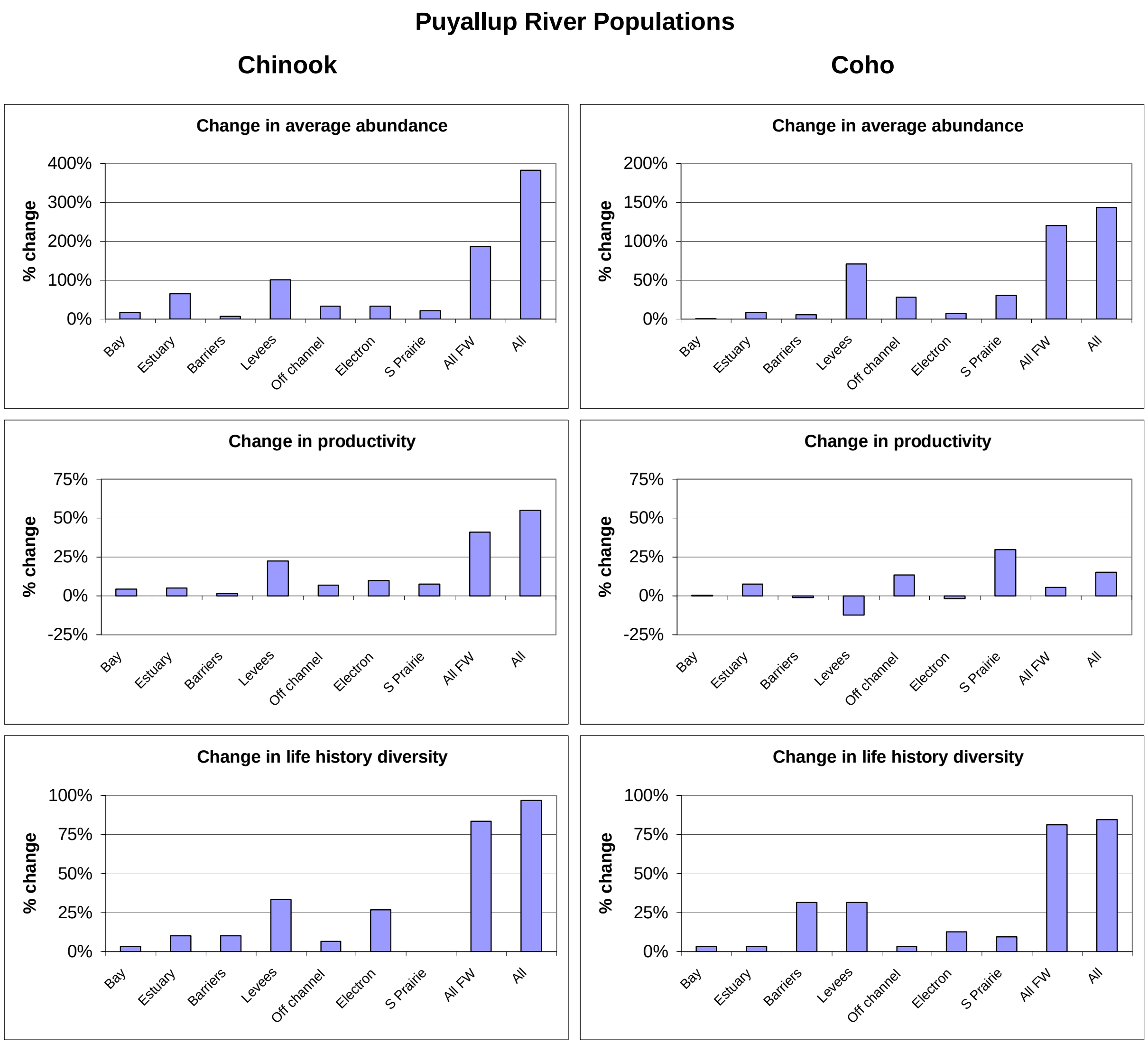


Figure 21. Change in performance of chinook and coho by action groups for populations in the Puyallup River. Groups: <u>Bay</u> - all actions in Commencement Bay; <u>Estuary</u> - all actions in the estuary; <u>Levees</u> - all levee setback actions; <u>Off channel</u> - all actions adding off-channel habitat; <u>Electron</u> - Electron diversion screens; <u>S Prairie</u> - all South Prairie Cr actions; <u>All FW</u> - all freshwater actions; <u>All</u> - all actions.

3.3.2 White River Watershed

3.3.2.1 Lower White River Watershed

The benefits of actions differed significantly for fish produced in the upper and lower drainages. The top three actions in the lower White River watershed (downstream of Mud Mountain Dam) were ranked identically for both chinook and coho (Figure 22). These are, beginning with the top ranked action, Mud Mountain Dam flow modifications, Natural river flow in the PSE bypass, and LWD collection and distribution below Mud Mountain Dam. A brief explanation of the top two actions is warranted.

The action Mud Mountain flow modifications was modeled to include both changes in flow at the PSE bypass as well as a more normalized flow released from Mud Mountain Dam. We assumed that it would make little sense to attempt to model normalized flow realized from the dam while still maintaining the PSE bypass with current operations. For this action, Mud Mountain flows would be modified to achieve a more normative flow pattern with only the most extreme floods reduced by temporary storage. Both this action and the one that eliminates the PSE bypass were regarded as "what if" actions. These actions provide insight into how controlling conditions associated with Mud Mountain Dam and the PSE diversion affect performance of salmonids in the White River. Both actions that address these issues were projected to produce the greatest benefits to salmonids by a substantial margin over other actions (Figure 23).

The third ranked action would provide substantial increases in wood loading to the lower White River from LWD collected behind Mud Mountain Dam. This action also would provide substantial improvements in salmonid performance.

Each of the next three highest ranked actions involved work in Boise Creek.

The groups of actions that produced the greatest benefits to lower White River salmonids targeted freshwater areas. The combined actions in freshwater areas downstream of Mud Mountain Dam produced approximately equivalent benefits to chinook and coho as the action that eliminated the PSE bypass effects (Figure 24). We note that the combination of all actions in this area produced the greatest benefits to chinook compared to the groups that consisted of all actions in the other watersheds analyzed (producing nearly a 900% increase in chinook abundance in the lower White River).

Lower White River Populations

Combined and species specific action ranks

Action no.	Action name	Rank		
		Cmb	Chin	Coho
P-18	Mud Mountain Dam flow modifications	1	1	1
P-17	Natural river flow in PSE bypass	2	2	2
P-2	LWD collection-redistribution	3	3	3
P-13	Lower Boise Cr relocation	4	5	7
P-15	Boise Cr revegetation	4	9	3
P-14	Boise Cr LWD enhancement	6	7	6
Est-11	Hylebos distributary channel	7	11	7
P-1	White R pH reduction	8	14	10
P-5	County-line floodplain acquisition	8	11	13
Est-7	Union Pacific transitional marsh/side chan	10	15	9
P-8	Riparian restoration near R-Street	11	11	16
P-16	Boise Cr restoration at golf course	11	22	5
Est-2	Middle Waterway distributary channel	11	15	12
P-10	Levee removal-setback at Game Farm	14	4	27
Est-12	Puy Estuary riverine-tidal side channels	15	19	14
Est-10	Puy estuary riverine-tidal chan relocation	16	24	11
P-9	Roegner Park riverbank restoration	17	18	18
P-6	Relocate mobile home park	18	20	18
P-11	Floodplain aquisition on Stuck R Drive	18	7	31
Est-21	Outer Hylebos	18	5	33
P-4	Pacific Park riparian restoration	21	20	20
Est-9	Lower Clarks Cr floodplain	21	23	17
P-12	Trans Canada levee removal	23	9	32
P-34	White-lower subbasin barrier removal	24	30	15
Est-5	Puy estuary emergent marsh side channel	25	25	23
Est-8	Oxbow wetland creation	25	27	21
Est-1	Clear Creek off-channel habitat	27	26	24
Est-15	Middle Waterway marsh/mudflat/channel	28	17	34
Est-4	Gog-Li-Hi-Te wetland expansion	29	29	25
P-7	White R estates-riparian buffer	30	28	29
Est-6	Union Pacific Parcel wetted channel	30	31	26
P-3	Setback Levee – Sumner Tractor	32	34	27
P-19	Red Cr-White R confluence restore	33	41	21
Est-3	Puy side channel-estuary	34	34	30
Est-14	Middle/St. Paul Peninsula	35	32	35
Est-22	Ruston Way beach replenishment	36	33	35
Est-17	Blair/Hylebos Peninsula	37	34	35
Est-18	Grain Terminal to GSA shoreline rehab	38	37	35
Est-13	Sitcum/Blair Peninsula	39	38	35
Est-16	Middle Waterway corridor	39	38	35
Est-19	Dickman Mill shoreline rehabilitation	39	38	35
P-20	Greenwater R-White R confluence restore	42	41	35
P-21	Greenwater SR 410 bridge replacement	42	41	35
P-22	28 Mile Cr side channel restoration	42	41	35
P-23	Greenwater R revetment retrofit	42	41	35
P-24	Greenwater R channel restoration	42	41	35
P-25	Greenwater R riparian restoration	42	41	35
P-26	FS Road 7020/7021 decommission	42	41	35
P-27	Greenwater R LWD placement	42	41	35
P-28	Greenwater tribs FS roads decommission	42	41	35
P-29	Greenwater subbasin barrier removal	42	41	35
P-30	FS Road 7320 bridges	42	41	35
P-31	Huckleberry Cr LWD placement	42	41	35
P-32	Huckleberry Cr riparian restoration	42	41	35
P-33	WF White subbasin barrier removal	42	41	35
P-35	White upper subbasin barrier removal	42	41	35
Est-20	Dock Street to Grain Terminal rehab	42	41	35
Est-23	Ruston shoreline enhancement	42	41	35
Est-24	Asarco shoreline enhancement	42	41	35

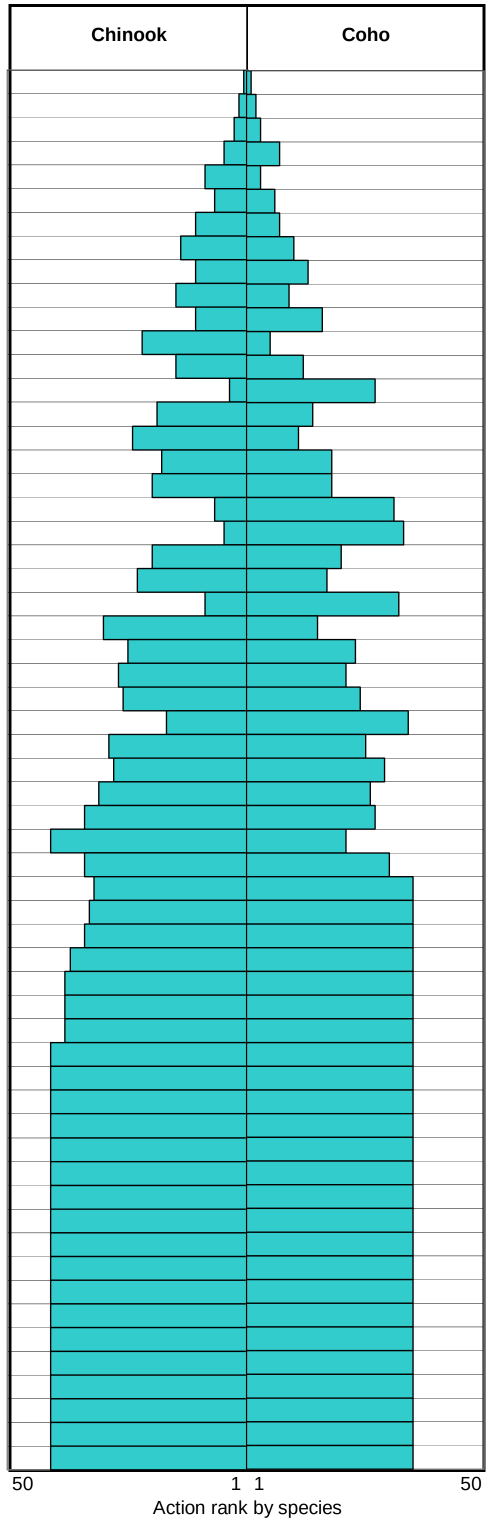


Figure 22. Combined action ranks (across species) and species-specific ranks in the lower White basin. Note: Bar size corresponds to rank number. A rank of 1 is the top ranked action.

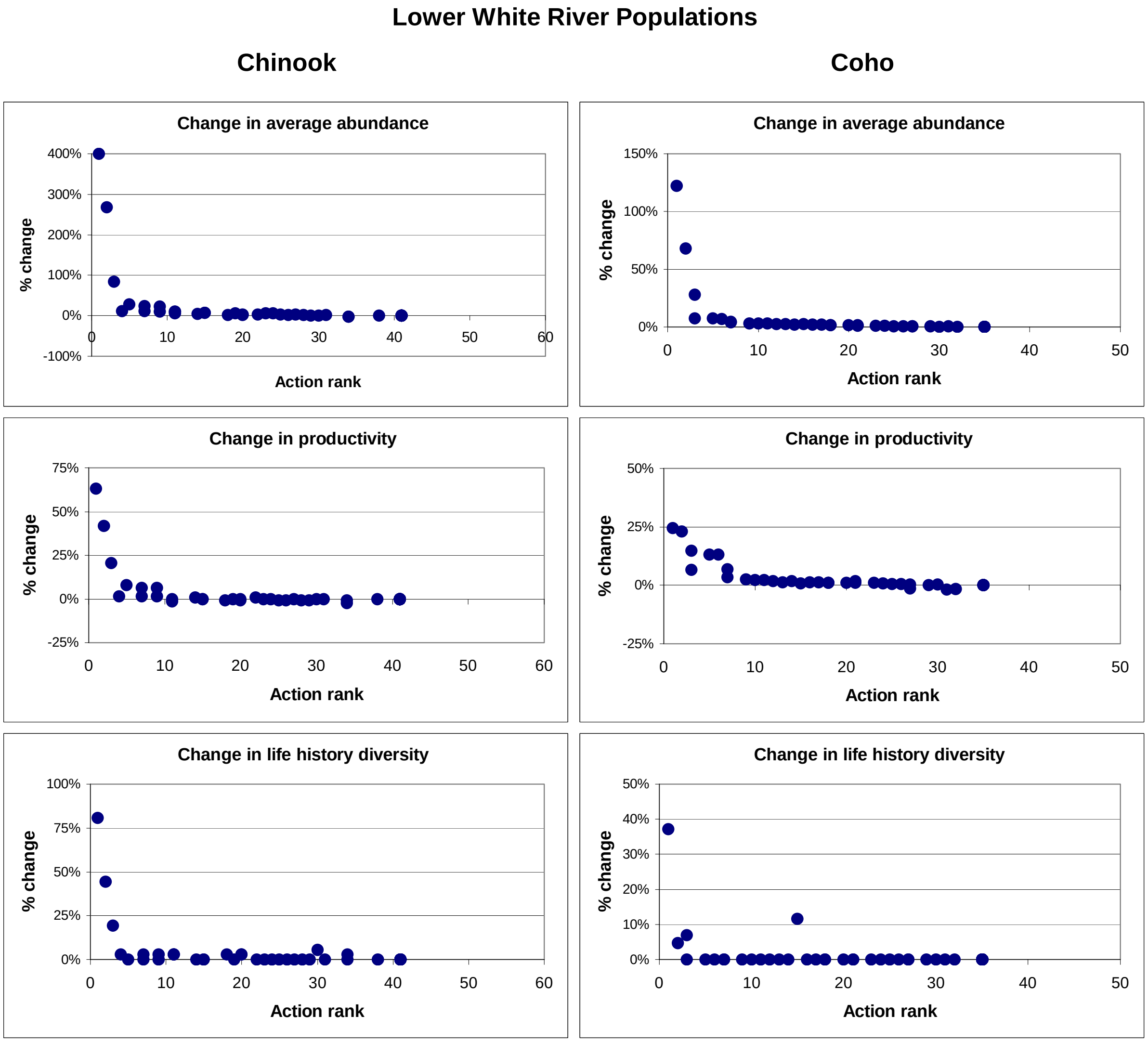


Figure 23. Change in performance of chinook and coho by the rank of each action in the lower White River watershed. Rank shown is the rank for that species.

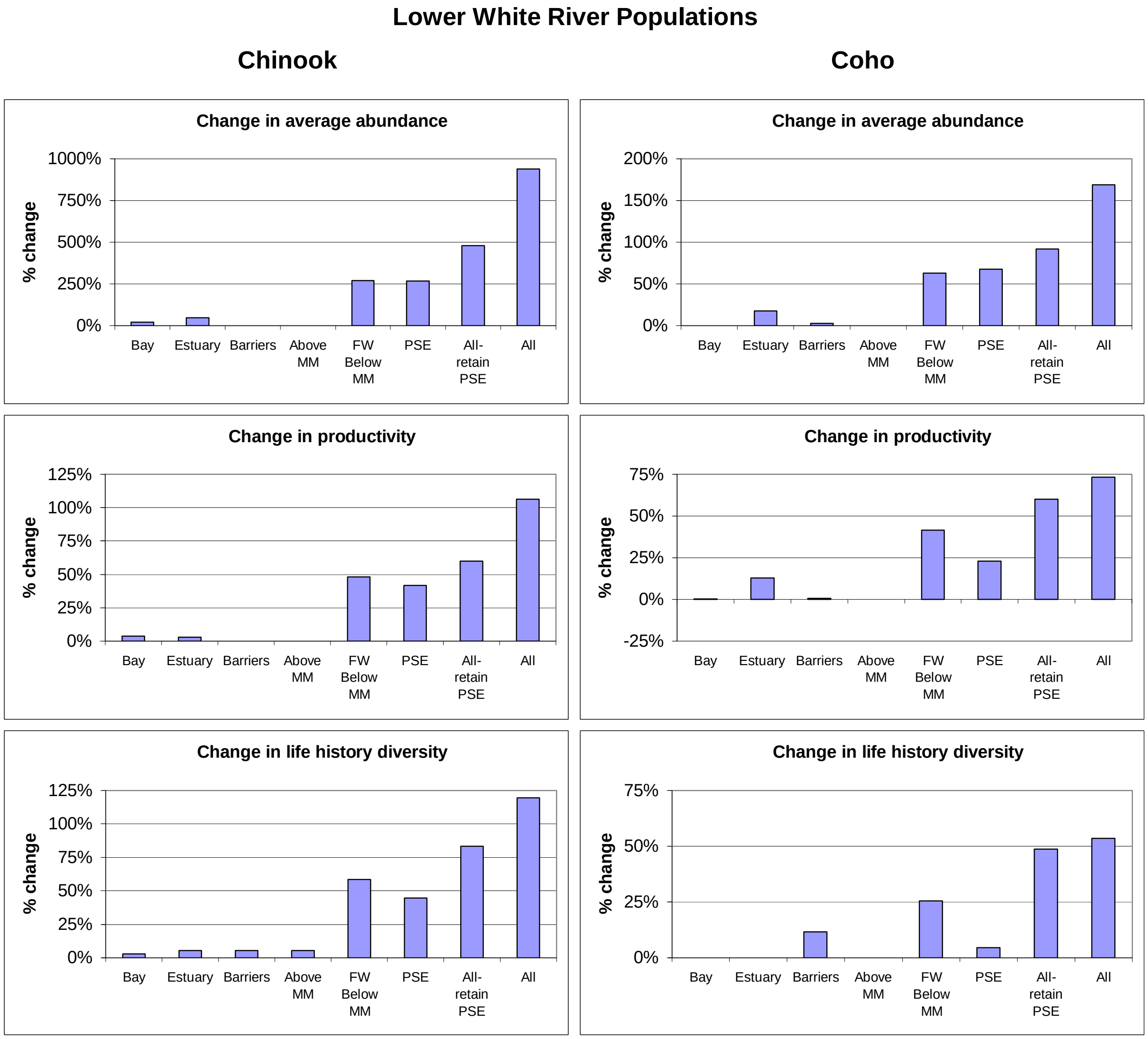


Figure 24. Change in performance of chinook and coho by action groups for the populations produced in the lower White River watershed. Groups: <u>Bay</u> - all actions in Commencement Bay; <u>Estuary</u> - all actions in the estuary; <u>Barriers</u> - all passage barrier actions (except removal of PSE trap, PSE Dam, and Mud Mountain Dam; <u>Above MM</u> - all actions upstream of Mud Mountain Dam; <u>FW Below MM</u> – all actions below Mud Mountain Dam and upstream of the estuary; <u>PSE</u> – elimination of the PSE flow diversion; <u>All-retain PSE</u> - all actions except elimination of PSE diversion and modification of flows released by Mud Mountain Dam ; <u>All</u> - all actions except modification of flows released by Mud Mountain Dam.

3.3.2.2 Upper White River Watershed

Seven of the top ten ranked actions for fish produced in the upper White River (upstream of Mud Mountain Dam) involved actions in the upper drainage (Figure 25). The top ranked action, for example, is "Greenwater River LWD placement." This action alone was projected to produce a nearly 40% increase in abundance for chinook and coho originating in the upper drainage (Figure 26). The two actions "Mud Mountain Dam flow modifications" and "Naturalized flow in the PSE bypass reach" were ranked second and fourth respectively.

These results indicate that the greatest benefits to upper river salmonids will tend to be achieved by actions conducted upstream of Mud Mountain Dam. This is also seen in the effects of groups of actions seen in Figure 27.

In general, there was good correspondence between how actions ranked for chinook and coho in the upper drainage, that is, the combined ranks across species tended to match well how the actions ranked separately for each species.

Upper White River Populations
Combined and species specific action ranks

Action no.	Action name	Rank Cmb	Rank Chin	Rank Coho
P-27	Greenwater R LWD placement	1	3	1
P-18	Mud Mountain Dam flow modifications	2	1	4
P-25	Greenwater R riparian restoration	3	4	2
P-17	Natural river flow in PSE bypass	4	2	6
P-24	Greenwater R channel restoration	5	10	3
P-28	Greenwater tribs FS roads decommission	6	7	7
P-31	Huckleberry Cr LWD placement	6	6	8
Est-11	Hylebos distributary channel	6	5	9
P-32	Huckleberry Cr riparian restoration	9	8	10
Est-7	Union Pacific transitional marsh/side chan	10	11	11
P-2	LWD collection-redistribution	11	13	13
Est-10	Puy estuary riverine-tidal chan relocation	11	14	12
Est-2	Middle Waterway distributary channel	13	12	17
Est-12	Puy Estuary riverine-tidal side channels	14	15	19
Est-9	Lower Clarks Cr floodplain	15	16	20
P-23	Greenwater R revetment retrofit	16	32	5
P-5	County-line floodplain acquisition	17	17	22
P-8	Riparian restoration near R-Street	17	18	21
P-9	Roegner Park riverbank restoration	19	22	24
Est-5	Puy estuary emergent marsh side channel	19	19	27
P-1	White R pH reduction	21	31	16
Est-1	Clear Creek off-channel habitat	22	20	28
Est-8	Oxbow wetland creation	23	25	26
P-6	Relocate mobile home park	24	29	23
Est-21	Outer Hylebos	24	9	43
P-10	Levee removal-setback at Game Farm	26	21	33
P-26	FS Road 7020/7021 decommission	27	33	24
Est-4	Gog-Li-Hi-Te wetland expansion	27	23	34
P-4	Pacific Park riparian restoration	29	30	29
P-12	Trans Canada levee removal	30	24	36
P-29	Greenwater subbasin barrier removal	31	48	13
Est-6	Union Pacific Parcel wetted channel	32	27	35
P-33	WF White subbasin barrier removal	33	48	15
P-11	Floodplain aquisition on Stuck R Drive	34	27	37
P-35	White upper subbasin barrier removal	35	48	18
Est-15	Middle Waterway marsh/mudflat/channel	36	26	44
P-20	Greenwater R-White R confluence restore	37	41	30
P-7	White R estates-riparian buffer	38	34	38
P-21	Greenwater SR 410 bridge replacement	38	41	31
P-3	Setback Levee – Sumner Tractor	40	37	39
Est-3	Puy side channel-estuary	40	35	41
P-22	28 Mile Cr side channel restoration	42	48	32
Est-14	Middle/St. Paul Peninsula	43	36	45
Est-22	Ruston Way beach replenishment	44	38	45
Est-17	Blair/Hylebos Peninsula	45	39	45
Est-18	Grain Terminal to GSA shoreline rehab	45	39	45
Est-16	Middle Waterway corridor	47	41	45
P-30	FS Road 7320 bridges	48	46	41
P-19	Red Cr-White R confluence restore	49	48	40
Est-13	Sitcum/Blair Peninsula	50	44	45
Est-19	Dickman Mill shoreline rehabilitation	51	45	45
Est-23	Ruston shoreline enhancement	52	46	45
P-13	Lower Boise Cr relocation	53	48	45
P-14	Boise Cr LWD enhancement	53	48	45
P-15	Boise Cr revegetation	53	48	45
P-16	Boise Cr restoration at golf course	53	48	45
P-34	White-lower subbasin barrier removal	53	48	45
Est-20	Dock Street to Grain Terminal rehab	53	48	45
Est-24	Asarco shoreline enhancement	53	48	45

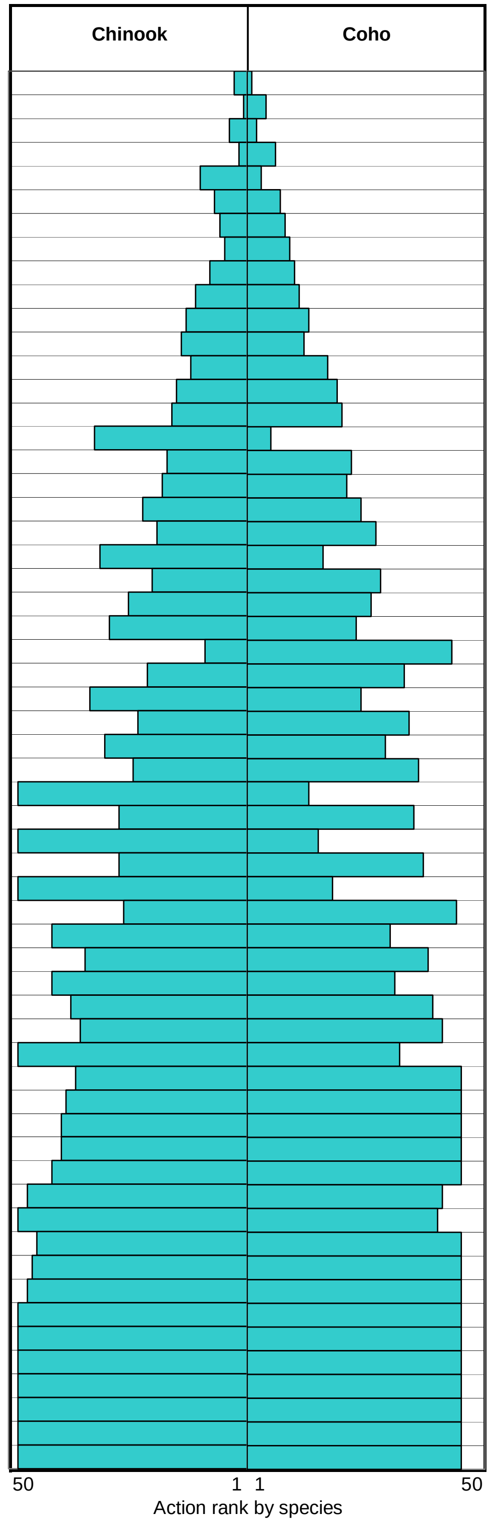


Figure 25. Combined action ranks (across species) and species-specific ranks in the upper White basin.

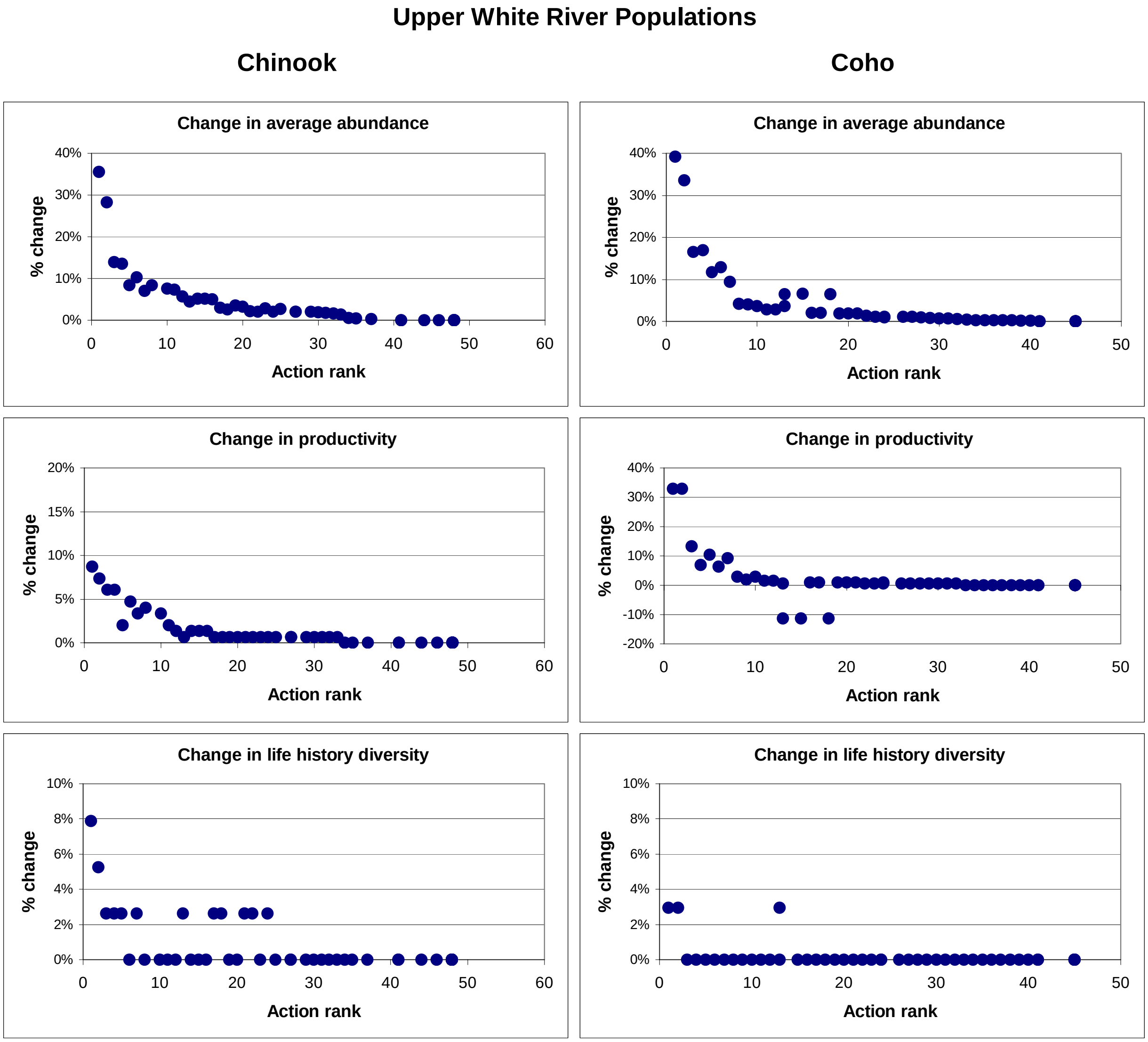


Figure 26. Change in performance of chinook and coho by the rank of each action in the upper White River watershed. Rank shown is the rank for that species.

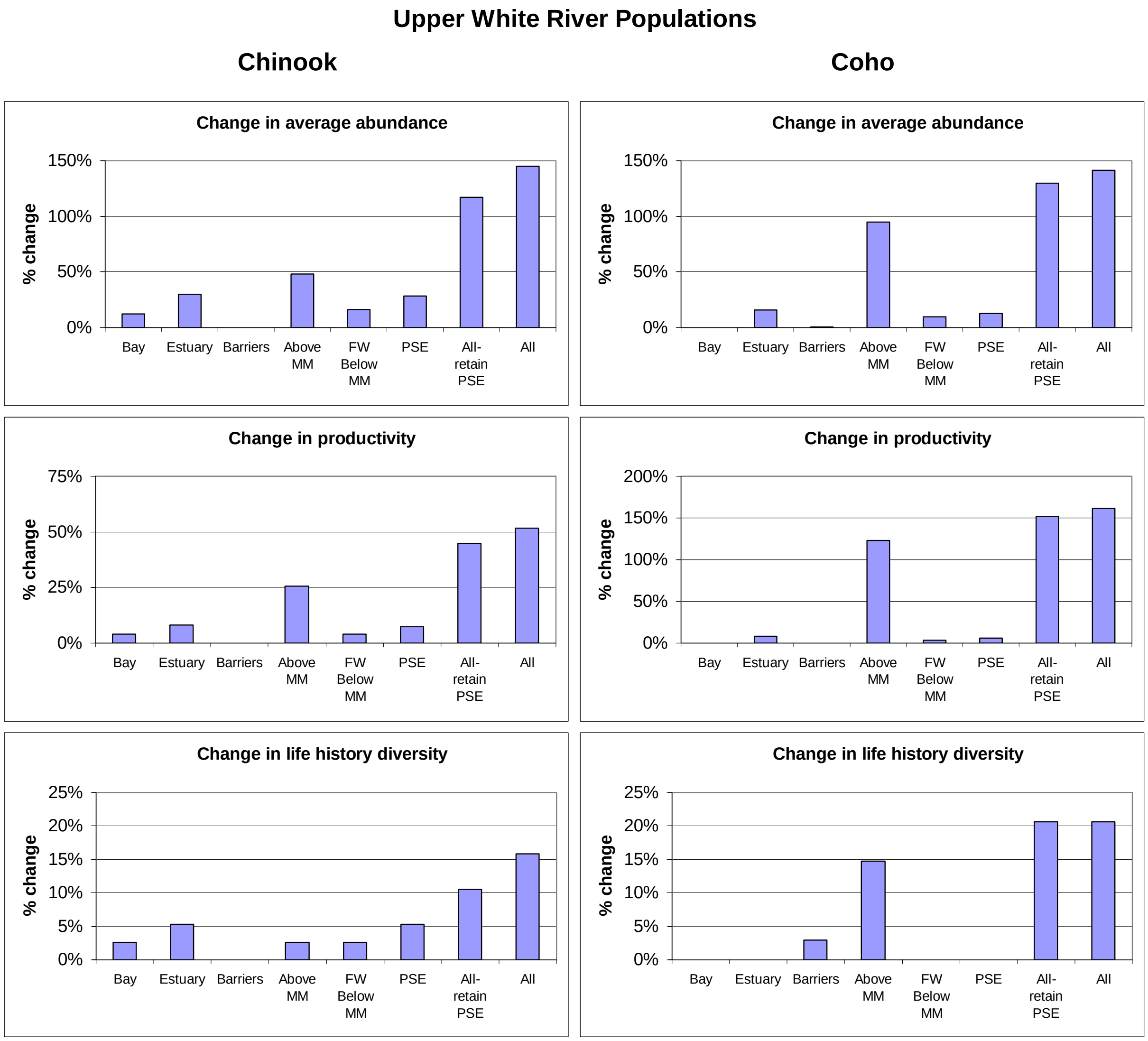


Figure 27. Change in performance of chinook and coho by action groups for the populations produced in the upper White River watershed. Groups: <u>Bay</u> - all actions in Commencement Bay; <u>Estuary</u> - all actions in the estuary; <u>Barriers</u> - all passage barrier actions (except removal of PSE trap, PSE Dam, and Mud Mountain Dam; <u>Above MM</u> - all actions upstream of Mud Mountain Dam; <u>FW Below MM</u> – all actions below Mud Mountain Dam and upstream of the estuary; <u>PSE</u> – elimination of the PSE flow diversion; <u>All-retain PSE</u> - all actions except elimination of PSE diversion and modification of flows released by Mud Mountain Dam ; <u>All</u> - all actions except modification of flows released by Mud Mountain Dam.

3.3.3 Hylebos Creek

The top ranked action in the watershed is the West Hylebos acquisition project. This action ranked number one for coho and number three for chinook (Figure 28). The top four actions combined across species covered the top four actions ranked for chinook and two of the top four ranked for coho. All of these actions focus on the West Fork Hylebos Creek or the lower Hylebos just downstream of the forks.

Hylebos Creek

Combined and species specific action ranks

Action no.	Action name	Rank		
		Cmb	Chin	Coho
H-8	West Hylebos acquisition project	1	3	1
H-5	Hylebos Cr crossing at S 373rd St.	2	1	5
H-4	Proposed SR 167 mitigation	2	2	4
H-6	Reconnect floodplain in Spring Valley	4	3	7
H-14	Hylebos subbasin barrier removals	5	12	1
H-1	Jordan property acquisition	6	6	7
H-3	Invasive weed control/native planting	7	5	9
H-13	S 360th regional stormwater detention	7	8	6
H-7	Justus Pond reconnection	7	11	3
H-2	Milgard restoration project	10	6	9
H-10	East Branch conifer planting	11	8	11
H-11	East Branch LWD enhancement	12	12	11
Est-25	Hauff property/ DOT mitigation project	13	10	15
H-9	S 356th St detention pond expansion	14	12	13
H-12	S. 316th Pl detention facility	15	12	14

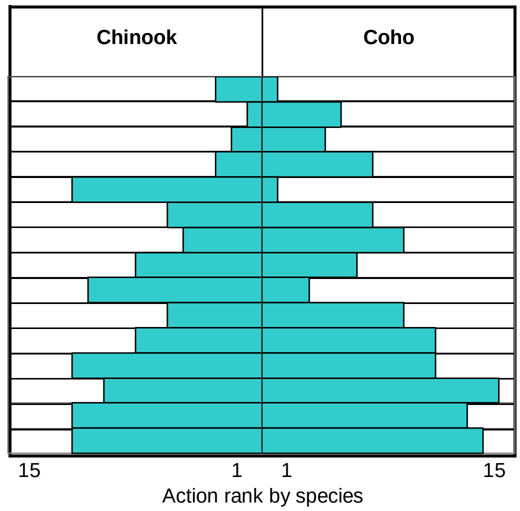


Figure 28. Combined action ranks (across species) and species-specific ranks in the Hylebos basin.

The top ranked action for chinook is the Hylebos Cr crossing project at South 373rd Street. One of the top ranked actions for coho (two actions tied for the top spot) would correct all barriers to fish passage.

The top five actions for chinook were projected to each produce approximately 10% or greater increase in abundance (Figure 29). The action ranked number two (the proposed SR 167 mitigation project) for chinook was projected to produce the largest increase in abundance (approximately 30% increase) for this species.

The top four actions for coho were projected to each produce approximately 10-25% increase in abundance. The largest projected increase in productivity (30% increase) would occur with the West Hylebos acquisition project.

The group of actions projected to produce the largest increase in abundance for chinook addresses issues in the lower Hylebos, whereas the largest increase in productivity would occur with actions in the West Fork Hylebos Creek (Figure

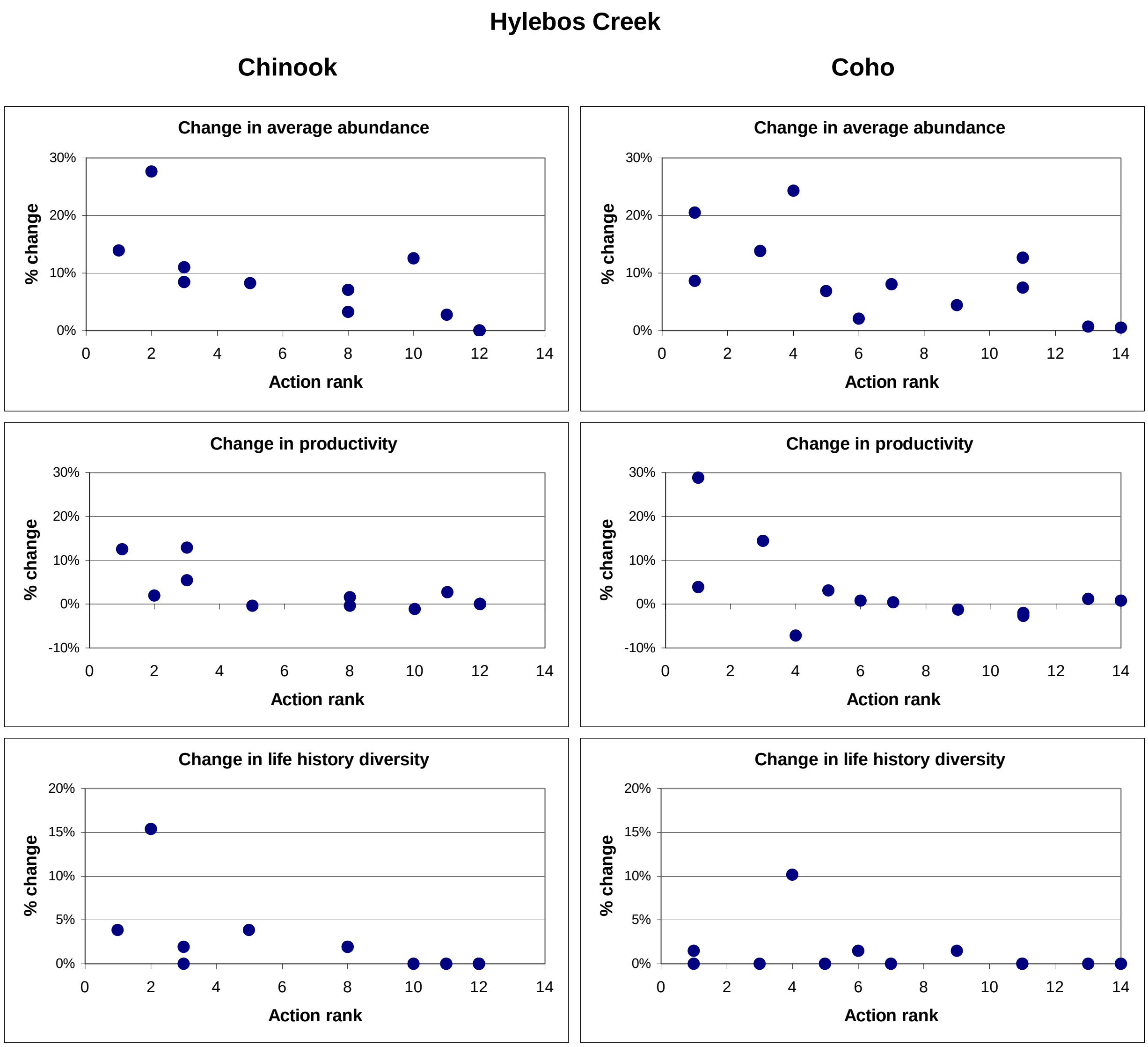


Figure 29. Change in performance of chinook and coho by the rank of each action in Hylebos Creek. Rank shown is the rank for that species.

30). This difference occurs because actions in the lower Hylebos primarily add quantity of habitat, while those in the West Fork improve habitat quality, which affects productivity. We note that it would be more advantageous for this species to improve habitat quality vs. habitat quantity.

The group of actions most beneficial to coho would be implemented in the West Fork Hylebos Creek. The group was projected to improve productivity by approximately 35%. As noted for chinook, improvements in productivity of this magnitude are highly desirable for fish populations that are depressed in performance.

Hylebos Creek

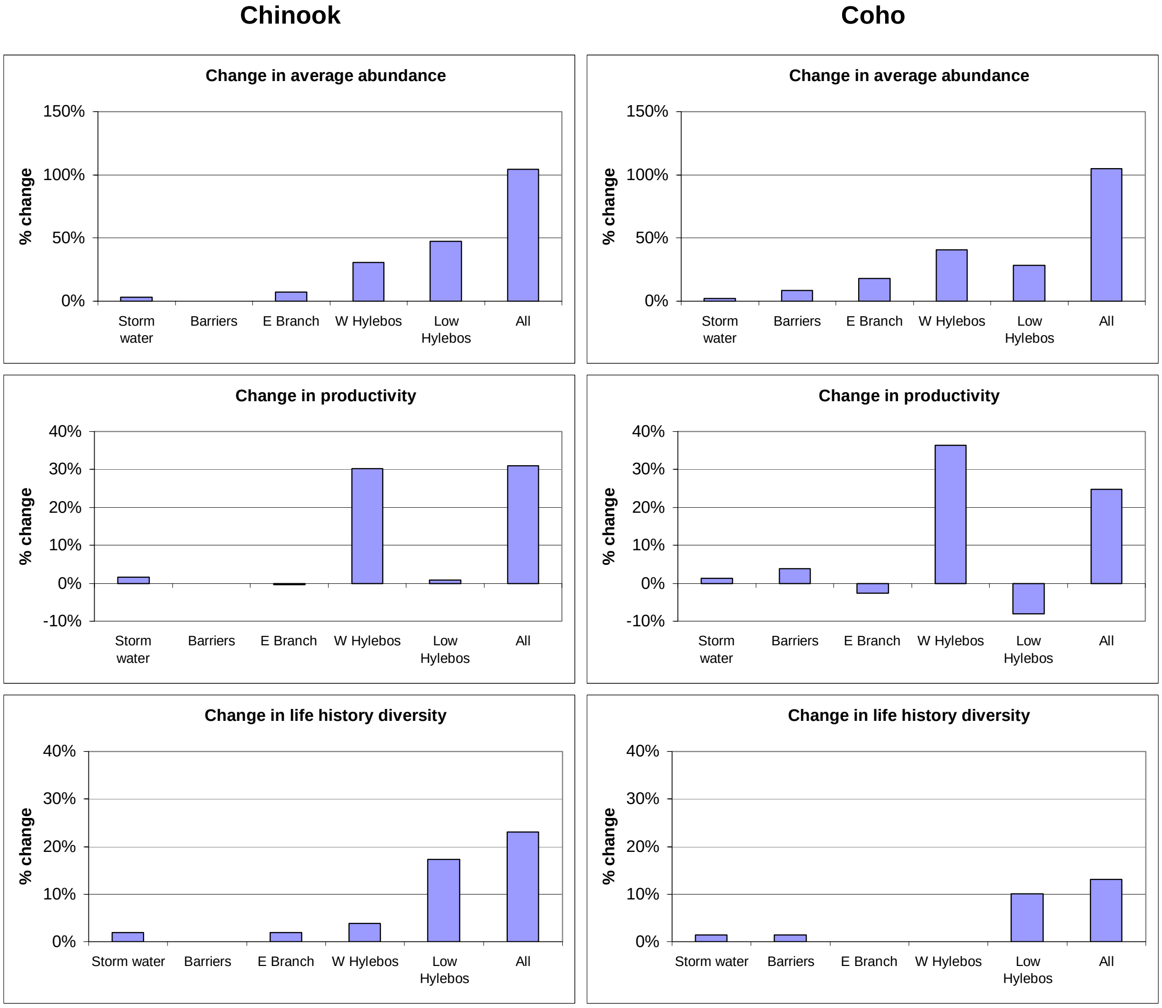


Figure 30. Change in performance of chinook and coho by action groups in Hylebos Creek. Groups: <u>Stormwater</u> - added flow detention ponds; <u>Barriers</u> - barriers to fish passage barriers; <u>E Branch</u> - actions in the East Branch Hylebos; <u>W Hylebos</u> - actions in the West Fork Hylebos; <u>Low Hylebos</u> - actions downstream of Hylebos forks; <u>All</u> - all actions.

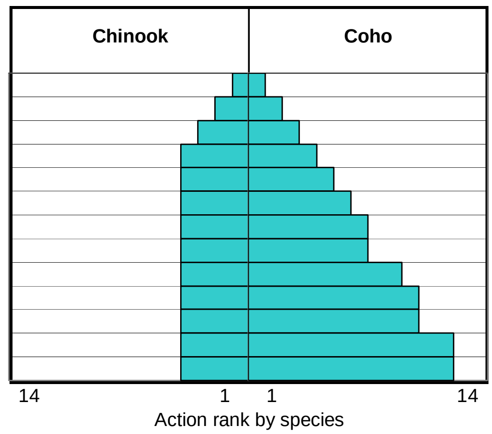
3.3.4 Chambers-Clover Creek

The top three actions in Chambers-Clover Creek were ranked identically for both chinook and coho (Figure 31). Only three actions were applicable to chinook, all others occurring outside the assumed spawning range for the species.

Chambers-Clover Creek

Combined and species specific action ranks

Action no.	Action name	Rank		
		Cmb	Chin	Coho
C-8	LWD enhancement	1	1	1
C-3	Nutrient enhancement	2	2	2
C-2	Shera's Falls barrier correction	3	3	3
C-13	Coffee and Spanaway Cr barrier removal	4	4	4
C-5	Off-channel habitat creation	5	4	5
C-10	Floodplain acquisition	6	4	6
C-7	Rechannelization near PLU campus	7	4	7
C-11	Spanaway Cr barrier removal	7	4	7
C-4	Morey Creek barrier correction	9	4	9
C-1	Flett Creek channel restoration	10	4	10
C-6	Flow restoration in Clover Creek	10	4	10
C-9	Third regional detention pond on NF Clover	12	4	12
C-12	Coffee Cr culvert replacement	12	4	12



Note/ Actions ranked as 4 for chinook have no effect on that species because they are outside the species' range.

Figure 31. Combined action ranks (across species) and species-specific ranks in the Chambers-Clover basin.

The top two actions were ones that would be applied extensively over many reaches in the system. Extensive application of these actions to many reaches is likely the reason the actions ranked over all others, which were more limited in scope.

The results indicate that efforts to increase food organism abundance and quantity of LWD over extensive areas of the watershed would produce highest increases in performance. We point out that we are unaware of any instances where significant attempts have been made to increase beneficial nutrients in urbanized streams such as Chambers-Clover Creek. Research in British Columbia suggests that nutrient enhancement using briquets composed of marine derived nutrients could produce significant increases in fish food organisms.

The top seven actions for coho were projected to each produce between 15-35% increase in average abundance, similar projections were obtained for the top two action for chinook (Figure 32). Three of these actions for coho consist of barrier removals, which could be implemented with relatively little difficulty.

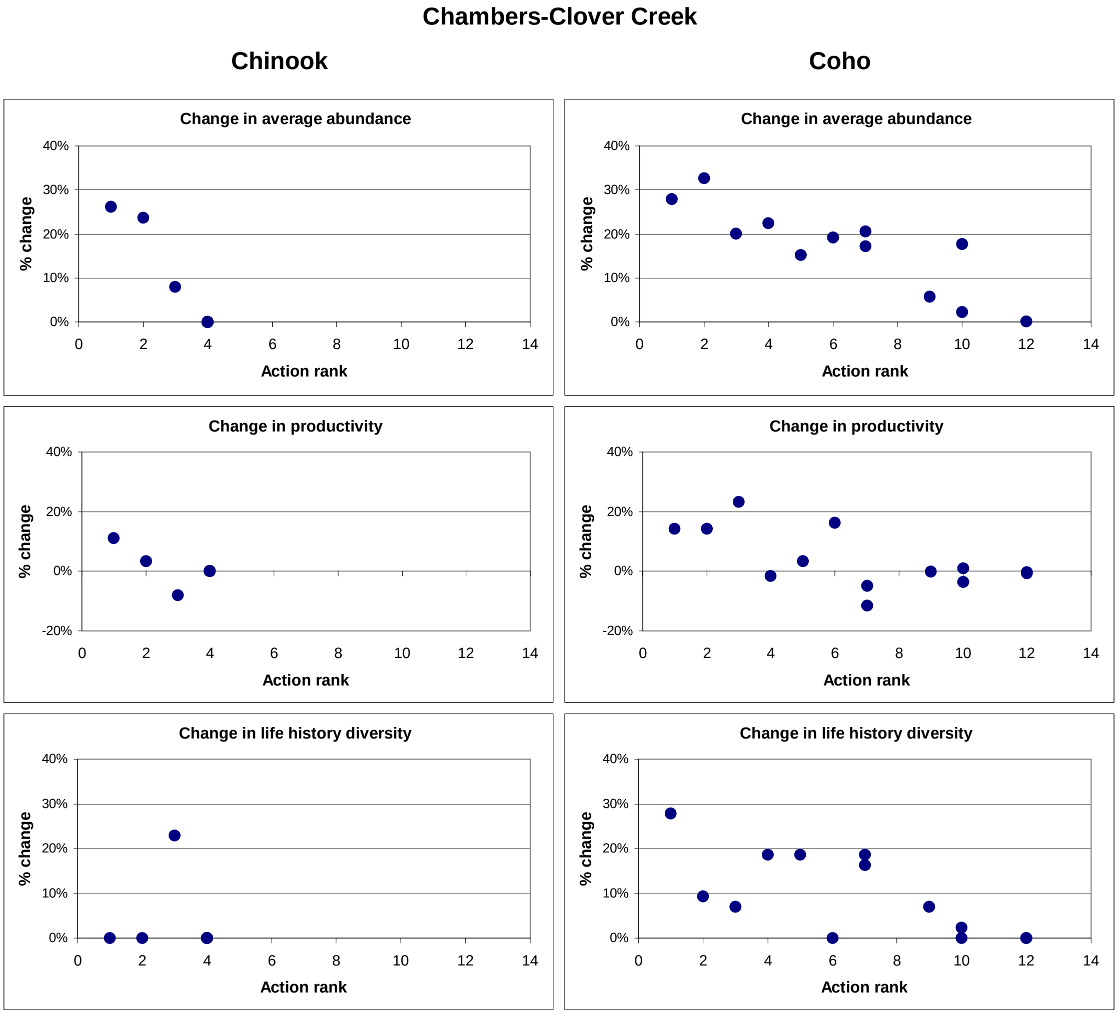


Figure 32. Change in performance of chinook and coho by the rank of each action in Chambers-Clover Creek. Rank shown is the rank for that species.

The results for groups of actions (Figure 33) show very significant increases in coho performance as actions are combined. Much smaller increases are projected for chinook because of the more limited potential range of the species in the drainage. All actions combined except those involving rechanneling and flow restoration in Clover Creek between Spanaway Creek and North Fork Clover Creek, which would be the most difficult to implement, produced more than a 200% increase in coho abundance.

Chambers-Clover Creek

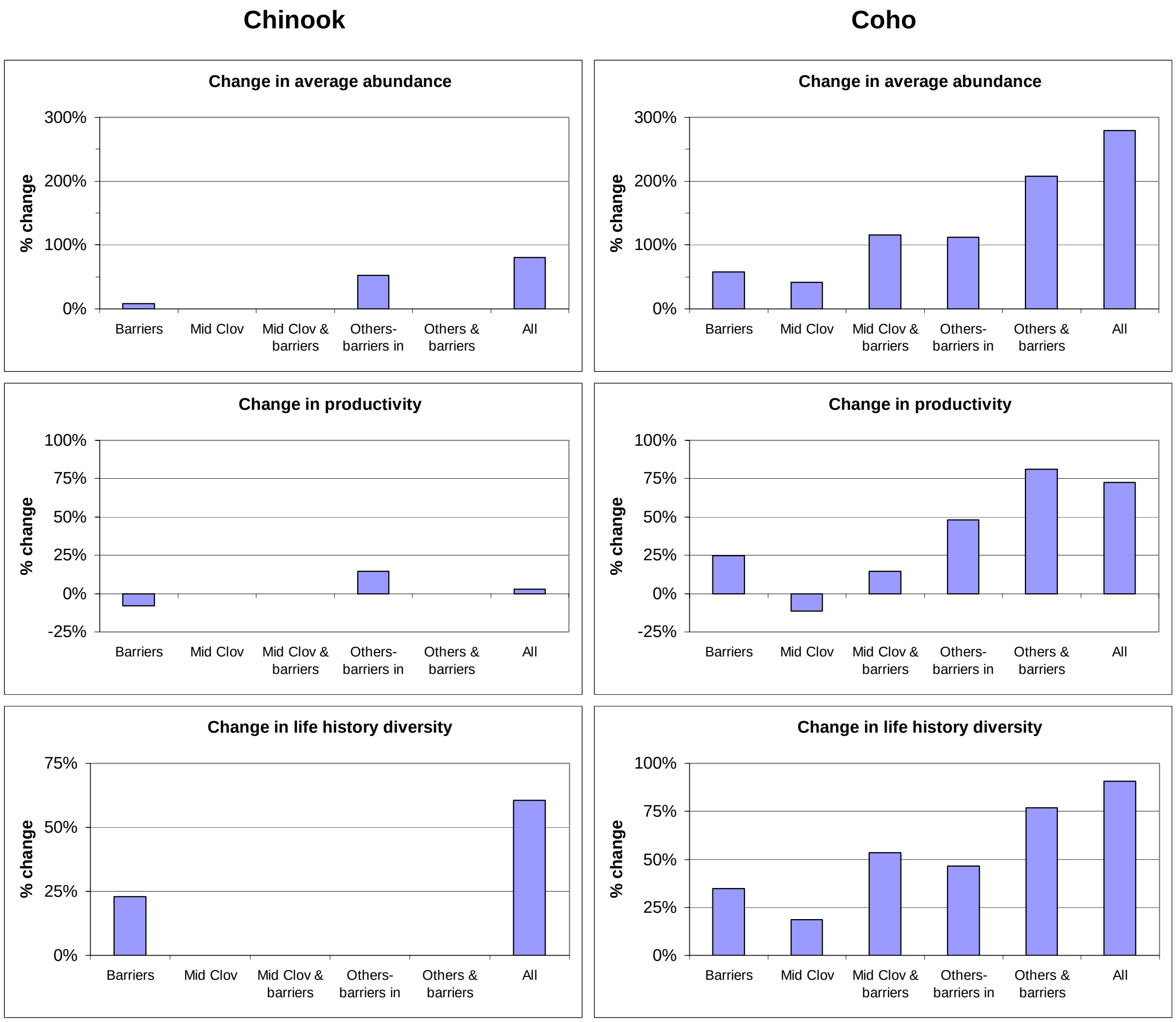


Figure 33. Change in performance of chinook and coho by action groups in Chambers-Clover Creek. Groups: <u>Barriers</u> - all relevant barriers corrected; <u>Mid Clov</u> - channel reconstructed and flow restored in area of PLU (no barriers corrected); <u>Mid Clov & barriers</u> - channel reconstructed and flow restored in area of PLU with barriers corrected; <u>Others-barriers in</u> - all other actions (no barriers corrected); <u>Others & barriers</u> - all other actions with barriers corrected; <u>All</u> - all actions.

3.4 Other Considerations for Recovery Planning

We have two final conclusions regarding the condition and recovery potential for Puyallup-White chinook populations. First, we emphasize that the overall performances of naturally produced chinook in the White-Puyallup system appear to be exceptionally poor. We estimated that the productivities for chinook produced in the Puyallup, upper White, and lower White rivers are 1.5 or less. It should be recognized that these values are aggregate values of population components that have different productivities. For example, South Prairie Creek chinook would have a productivity that exceeds 2.0. Still, the overall performances of chinook in this river system is very low. We believe that it is likely that hatchery production in the system tends to produce an impression that chinook performance is better than it actually is due to straying and the natural production that comes from those strays. It has become increasingly evident in recent years that significant straying is occurring within the system by hatchery fish. In addition, supplementation with hatchery fish in the upper White River also can be interpreted to mean that the runs back to that area are relatively healthy.

Our second conclusion is an extension of the first. We conclude that for the foreseeable future hatchery production needs to continue to be given a role in the Puyallup-White basin. We believe this to be vitally important in the White River system using supplementation fish from the White River hatchery. On the Puyallup River, it appears that hatchery production will also be important to help maintain natural production until more progress is made in habitat restoration. However, hatchery practices will need to be reformed to more directly address how hatchery fish can be used to effectively supplement natural production in this area.

The results presented herein demonstrate that use of habitat measures alone, even conducted on a very extensive scale, is unlikely to achieve desired fish production levels in this basin in the near term.