Appendix C

Stream Reach Analysis For Species Performance
In the Entiat River

February 2003

Stream Reach Analysis for Species Performance

The Stream Reach Analysis is a tool used in diagnosing the relative importance of environmental factors affecting fish population performance. It helps to identify the most important factors contributing to a loss in performance—factors that, if appropriately moderated or corrected, would produce the most significant improvements in overall population performance. It is a comprehensive and analytically derived limiting factors analysis.[1] Reach analyses performed for this project are listed below:

WATERSHED	SPECIES
Entiat River	Spring Chinook
Entiat River	Summer Chinook

The analysis presents results for each stream reach within the Entiat River for spring and summer chinook salmon. Differences between the races are based on differences in life history (geographic areas and temporal patterns). Each reach was analyzed to determine the relative effect of changes in environmental attributes due to watershed development on fish population performance. Results for each reach (by race) are presented on a single chart, depicting in "consumer report" style, the relative importance of environmental attributes by species life stage. The layout of the reach analysis display (Figure 1) was designed to enable the reader to rapidly gain a comprehensive overview of the role of each reach, and the factors operative there, on fish population performance.

The analysis can be a valuable reference tool to watershed planners who need a concise summary of conditions within stream reaches on salmon performance. The analysis identifies strategic priorities for reaches with regard to potential benefits of restoration and protection actions. It identifies the factors that should be considered in planning restoration projects.

Description of Reach Analysis Elements

Species/Component - This line identifies the species to which the reach analysis applies.

Restoration Potential - This line identifies the comparison being used to determine the restoration potential of the reach. The Entiat project compares current habitat conditions versus historic conditions.

Restoration Emphasis - This line identifies whether the results of the analysis depict historic or current fish distribution. The Entiat project presents results for historic distribution.

[1] / The term "limiting factors analysis" is widely used in the Pacific Northwest to refer to various types of analysis, many of which are not analytically derived, on the importance of different environmental factors to salmon performance. The Stream Reach Analysis used in EDT is an analytically derived limiting factors analysis—one that examines the relative contributions of all factors to the loss in salmon performance.

Species/Component:	Spring Chinook
Restoration Potential:	Current Conditions versus Historic Potential
Restoration Emphasis:	Restoration or maintenance/improvement of historic life histories

REACH ANALYSIS SUMMARY FOR ENTIAT RIVER WATERSHED - Spring Chinook

Geographic Area:	Enitat - Potato Moraine to Box Canyon			**Stream:**	Entiat River
Reach:	Entiat-11: From Stormy Creek to Preston Creek; Length (mi): 4.8			**Reach Length (mi):**	4.8
				Reach Code:	Entiat-11
Restoration Benefit Category:1/	B	**Productivity Rank:1/**	4	**Potential % change in productivity:2/**	8.0%
Overall Restoration Potential Rank:1/	5	**Average Abundance (Neq) Rank:1/**	4	**Potential % change in Neq:2/**	24.4%
(lowest rank possible - with ties)1/	10	**Life History Diversity Rank:1/**	7	**Potential % change in diversity:2/**	10.2%
Preservation Benefit Category:1/	A	**Productivity Rank:1/**	1	**% loss in productivity with degradation:2/**	-78.4%
Overall Preservation Rank:1/	1	**Average Abundance (Neq) Rank:1/**	1	**% loss in Neq with degradation:2/**	-181.5%
(lowest rank possible - with ties)1/	8	**Life History Diversity Rank:1/**	2	**% loss in diversity with degradation:2/**	-78.7%

Life stage	**Relevant months**	**% of life history trajectories affected**	**Productivity change (%)**	Life Stage Rank	**Change in attribute impact on survival**															
					Channel stability	Chemicals	Competition (w/ hatch)	Competition (other sp)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Spawning	Sep	18.1%	-1.0%	6							●									○
Egg incubation	Sep-Apr	18.1%	-2.8%	3	●															○
Fry colonization	Mar-May	28.3%	-5.0%	1	●				●	⬤	●									●
0-age active rearing	Mar-Oct	36.1%	-1.2%	4	●		•		•	●	●									●
0-age migrant	Oct-Nov	3.5%	-0.8%	8							•									
0,1-age inactive	Oct-Mar	3.5%	-7.1%	5	•				•	●	●									•
1-age migrant	Mar-Jun	13.1%	-0.1%	9							•									
1-age resident rearing	Mar-May	3.5%	-1.3%	7	•					•	•									•
1-age transient rearing																				
2+-age transient rearing																				
Prespawning migrant	Apr-Aug	57.8%	0.0%	10																○
Prespawning holding	May-Sep	18.0%	-6.5%	2					●		⬤									•
All Stages Combined		58%																		

1/ Ranking based on effect over entire geographic area.

2/ Value shown is for overall population performance.

Notes: Changes in key habitat can be caused by either a change in percent key habitat or in stream width.
Potential % changes in performance measures for reaches upstream of dams were computed with full passage allowed at dams (though reservoir effects still in place).

KEY

NA = Not applicable

	Loss	Gain
None		
Small	•	○
Moderate	●	○
High	⬤	◯
Extreme	⬤	◯

Figure 1. Stream Reach Analysis display.

Geographic Area - This line identifies the geographic area in which the specific focus reach is located. Reaches were aggregated into geographic areas for the sake of analyzing restoration and preservation (protection) benefits. For example, a single major tributary might be identified as a single geographic area, although many stream reaches might be contained within the reach analysis.

Reach - This line provides a brief description of the reach location.

Stream - This line identifies the stream name on which the reach is located.

Reach Length -This line identifies reach length in miles.

Reach Code - This line identifies the reach code used in the database for the focus reach.

Restoration Benefit Category - This item identifies the benefit category in which the geographic area is classified with regard to **potential restoration benefits** to the fish population. Each geographic area is classified into one of four categories based on the potential for affecting overall population performance if all of the reaches within the geographic area were restored to historic conditions. It identifies the strategic importance of restoration in this geographic area relative to the other areas.

The categories are designated A (highest benefits) through D (lowest benefits). No consideration is given to these assignments as to feasibility, cost, or desirability of implementing restoration actions in the reaches—simply, what would be the benefits to the fish population if restoration was carried out.

Classification into the benefit categories was made based on a ranking of the amount of change in one or a combination of the three population performance measures (productivity, abundance, diversity). For example, all of the geographic areas could be assigned a rank based on the resulting change in productivity from restoration to historic conditions. The area having the largest percentage change in overall population productivity would be assigned a 1, all other areas would assigned lower ranks (higher numbers)(ties possible). This procedure is then repeated for the abundance and diversity parameters. The three rankings are then summed and a simple average computed for each with the results reranked to give an overall rank to the geographic area. These results were plotted for each watershed, example shown in Figure 2, to assign benefit categories based on the resultant pattern.

Overall Restoration Potential Rank - This is the overall rank of the geographic area used in plotting (as in Figure 2) to derive the benefit category grade.

Productivity, Average Abundance (NEQ), and Life History Diversity Ranks - These lines identify the rankings of the geographic area relative to other areas for the three performance measures.

Potential % Change in Productivity, Abundance (Neq), and Diversity - These are the basic metrics for comparing the benefit category and ranking of the reaches. They show the potential

for improvement in **overall population performance** if the geographic area was fully restored to historic conditions. The metrics are expressed as the percent change in overall population performance, e.g., the percent increase in average abundance of adults.

Preservation Benefit Category - This item identifies the benefit category in which the geographic area is classified with regard to **potential preservation (or protection) benefits** to the fish population. Potential benefits of protection are assessed by considering the *potential for loss in fish performance* if the geographic area's reaches are altered through extensive development. Each geographic area is classified into one of four categories based on the potential loss to overall population performance if all of the reaches within the geographic area were impacted by environmental development, changing it to a representative fully developed area. The category identifies the strategic importance of preserving the geographic area in its current state relative to the other areas.

The categories are designated A (highest benefits of protection) through D (lowest benefits of protection). No consideration is given to these assignments as to feasibility, cost, or desirability of implementing protection actions in the reaches—simply, what would be the benefits to the fish population if the geographic area was to be preserved in its current state. Areas that designated grade A for protection benefits are those that currently have a major role in supporting existing fish performance. Hence environmental degradation of those areas, i.e., degrading to a state worse than its current condition, would result in the greatest loss in population performance. Areas designated grade D are those that are either already largely developed, i.e., those that already have experienced the most dramatic change from pristine condition and little is left to degrade, or are peripheral areas that contribute little to overall population performance.

Classification into the benefit categories was made using the same procedure described under **Restoration Benefit Category**. See Figure 2 for example of how the area ranks are plotted for assigning grade benefits.

The other items listed with **Preservation Benefit Category** are derived in the same manner as described above for restoration benefits.

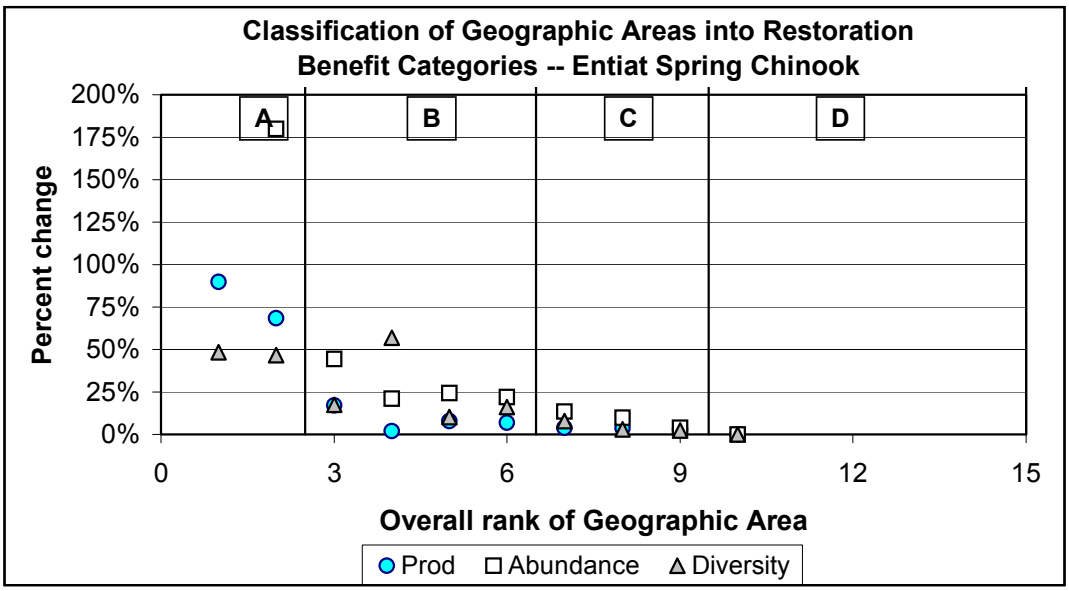
Estuarine reaches were not assigned to a preservation benefit category because no representative developed reach characteristics were formulated. The abbreviation "NA" is indicated for these reaches for this item.

[Information shown below is reach-specific.]

Life Stage - This column indicates the life-stages examined in the analysis.

Relevant Months - The relevant months or target month when the life-stage occurs. Months vary by species.

% of Life History Trajectories Affected By Life Stage - This column shows how the reach is used by the entire fish population. Trajectories are computer-generated pathways that define the



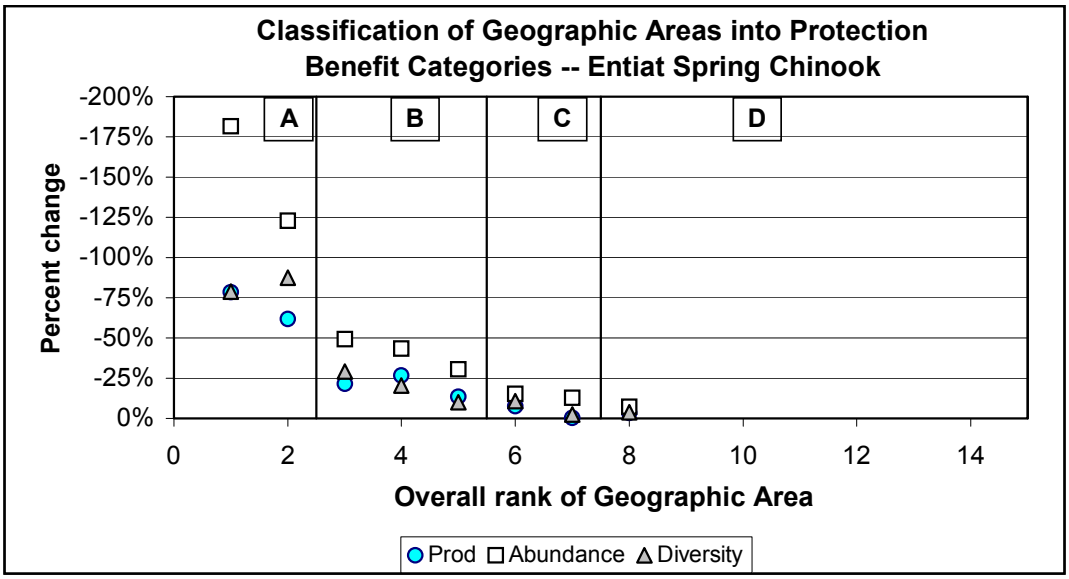


Figure 2. Example plot of the combined rank of geographic areas (combining productivity, abundance, and life history diversity ranks) and corresponding percentage changes in each separate performance measure. Plots for restoration benefits and protection benefits are shown separately.

exact route followed through the aquatic landscape for analytical purposes. Trajectories originate with spawning and end with prespawning holding (i.e., closed life history). The reader should be aware of:

1) The percentage of the total life history trajectories affected are reach specific.
2) The percentage of total life history trajectories affected are life stage specific. So, for example, the percentage of life history trajectories affected during the 0-age active rearing life stage may differ markedly from those during the spawning life stage.

Information on life history trajectories usage in a reach is the means of determining the extent that the population might use a given reach. This measure of usage is analogous to the number of hits that a web site experiences relative to other web sites.

Productivity change (%) - This item indicates the change in life stage specific productivity resulting from the changes in the attributes to the right on the chart (where change in attribute condition is shown by the size of black dots).

Life Stage Rank - This item indicates the extent that distinct environmental attributes have affected species performance by each life stage in the reach. Hence the life stage ranked as "1" has experienced the greatest impact with respect to overall effect on the population performance. The rank is determined through the combination of productivity loss and relative utilization (% life history trajectories affected) of the reach by that life stage. A reach that is heavily used for a particular life stage and that has experienced a large loss will rank high (low ranking numbers). A reach may have experienced a large change in productivity for a life stage but if the reach is not used heavily by that life stage it will rank lower (high ranking numbers).

Change in attribute impact on survival - A Consumer Report style format is used to show the change in each attribute in comparison to the historic condition. Attributes shown here are actually attribute classes (or umbrella attributes) that encompass the full suite of detailed attributes described through the EDT process. Larger black circles indicate greater effect on survival as a result of a decrease in habitat quality (represented by all attributes shown except Key Habitat Quantity. Circles are scaled in comparison to all other circles presented for the reach. The reader should note that a lot of small black circles spread across multiple attributes could equal or exceed the effect of a single large circle. Thus, it is important to look at both the life stage rank and the size of the circles to draw conclusions from the chart. Clear or open circles indicate that attributes conditions have actually improved for life stage survival compared to historic condition. Circle size for Key Habitat indicates the extent that the amount of key habitat (preferred habitat types by life stage) has been altered in the reach compared to historic levels (change could be due to the percentage of key habitat available or the size of the reach or both).

It is important to recognize that the chart only identifies the extent that attribute has been altered compared to historic condition, and further, how this change is perceived by the species with respect to survival. Therefore, if a stream naturally carried a high sediment load (glacial melt) and it still does, then the chart would register no change from the historic condition and no increased impact on species survival. The chart also only identifies where the effect occurs to the

species in the watershed—it does not show the source of the problem. Hence an increased effect of sediment in a reach does not mean that the sediment is actually generated within the reach—it may be produced from a distant subbasin in the watershed. It is therefore essential when applying the results of the analysis to consider the source of the environmental change and what has caused the change. Corrective actions need to be targeted at the source and the cause.