Attachment B

Ecological Integrity of Chinook Salmon Watersheds in the Puget Sound and Population Status

Puget Sound Technical Recovery Team Working Paper

Purpose: The purpose of this analysis is to help prioritization strategies for Puget Sound Chinook salmon. Two key criteria for making choices about salmon recovery in the Puget Sound are to

- Preserve options for the future role of extant, natural populations
- Protect existing salmon habitat and the opportunities for habitat restoration.

This analysis provides information about which populations are most vulnerable to being lost in the near-term and where habitat is important to protect because it has high ecological value (and therefore may not require major restoration) or provides opportunities for restoration.

Results: The two populations most at risk are the SF Nooksack and Cedar River (Figure 1). In both cases the combination low abundances of natural origin recruits and a large proportion of non-local hatchery fish in the watershed are the major demographic threats. Skagit populations, Mid-Hood Canal, and Skykomish watersheds have the highest ecological integrity ratings. All these populations have a significant portion of their watersheds in national forest or parks. The Cascade, Upper Sauk, Suiattle populations also have moderately high risk ratings comparable to the risks for the SF Stillaguamish and White River because of their low abundances. A large group of watersheds, such as the Elwha, SF Stillaguamish, White, and Snoqualmie, have some ecological integrity intact but also have been highly compromised. A smaller group of watersheds, such as the Sammamish, Cedar, and Duwamish-Green rivers, are ecologically highly compromised.

Methods: We compared 22 independent populations of Chinook salmon by the threat of near-term extinction (including the loss of unique, evolutionary identity) and by the ecological integrity of their natal watersheds.

Ecological Integrity—We scored ecological integrity of Puget Sound watersheds containing independent populations of Chinook salmon using data from Frissell et al. (2000). These data were rankings of each GIS-modeled subwatershed (equivalent to US Geological Suvery Hydrologic Code 6) according to four positive indicators (natural wetlands, land cover type, undisturbed habitat, and presence of eagles) and four negative indicators (hydrological modification, road density, slope steepness, and artificial production of fish). Each indicator was ranked on a scale of 0 to 5. The overall score for a watershed was the total of the positive indicators minus the total of the negative indicators. Where more than one independent population occurred in a watershed, overall score was based on the scores of the subwatersheds within the natal spawning area plus the scores of the subwatersheds adjacent to downstream river that outmigrating juveniles or returning adults would transit to and from saltwater. The ecological integrity scores illustrated in Figure 1 are based on areas that were historically accessible to salmon. Including the whole watershed did not qualitatively change the results, except to move Upper Skagit well beyond the Suiattle as the watershed with the highest ecological integrity.

Threat of Extinction

We rated threat of extinction based on four demographic attributes: average cohort abundance of natural origin recruits (2000-2004), average natural origin recruits per natural spawner (1986-2000), proportion of hatchery fish in natural spawners (1999-2004), and whether naturally spawning hatchery fish were of local origin or not. Data were from the TRT Abundance and Productivity database. Criteria for translating data into ratings are in Table 1. Overall score for a population is the sum of scores for all attributes.

Table 1. Criteria used to translate demographic data into risk ratings.

	Ratings					
Data Type	0	1	2	3	4	5
NOR abundance	>1000	801-1000	601-800	401-600	201-400	1-200
Recruits/spawner	>5	4.1-5	3.1-4	2.1-3	1.1-2	0-1
% Non-local hatchery fish	<1	1-5	6-10	11-15	16-20	>20
% Local hatchery fish	0	-1	-2	-3	-4	-5
If NOR < 300	0-10	11-20	21-30	31-40	41-50	>50
If NOR > 300	0	0	0	0	0	0

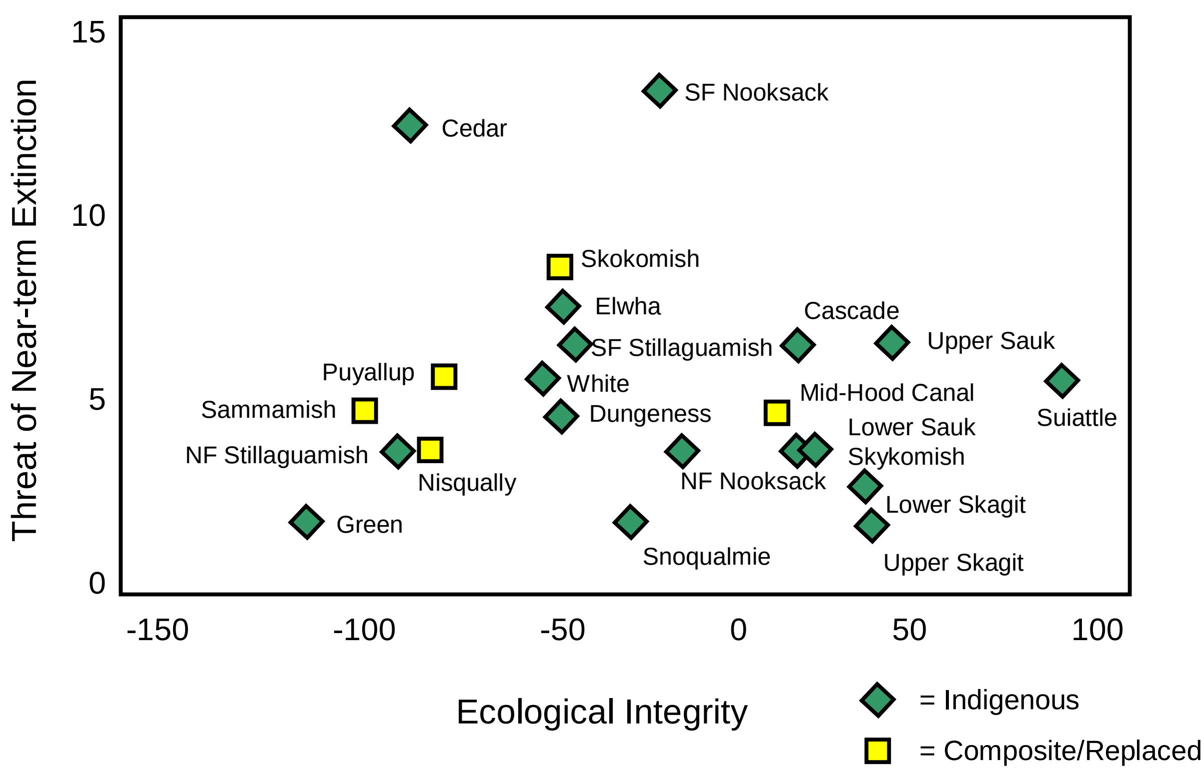

Figure 1. Status of Chinook salmon watersheds and populations. Threat of extinction refers to the near-term (next 3-5 years). Solid diamonds indicate genetically unique, indigenous populations; squares are local populations derived largely from introduced hatchery fish.

It should be recognized that this analysis is preliminary and is considered a working paper by the PSTRT. Other than plotting the populations against their scores for demographic risk and for ecological integrity of their respective watersheds, no further analysis has been done to array or separate populations, or to order them by extinction risk. With that in mind, we urge caution in making definitive conclusions from this chart. We may, however, draw some general conclusions from the relative position of the populations and from the apparent pattern of groups that the chart reveals.

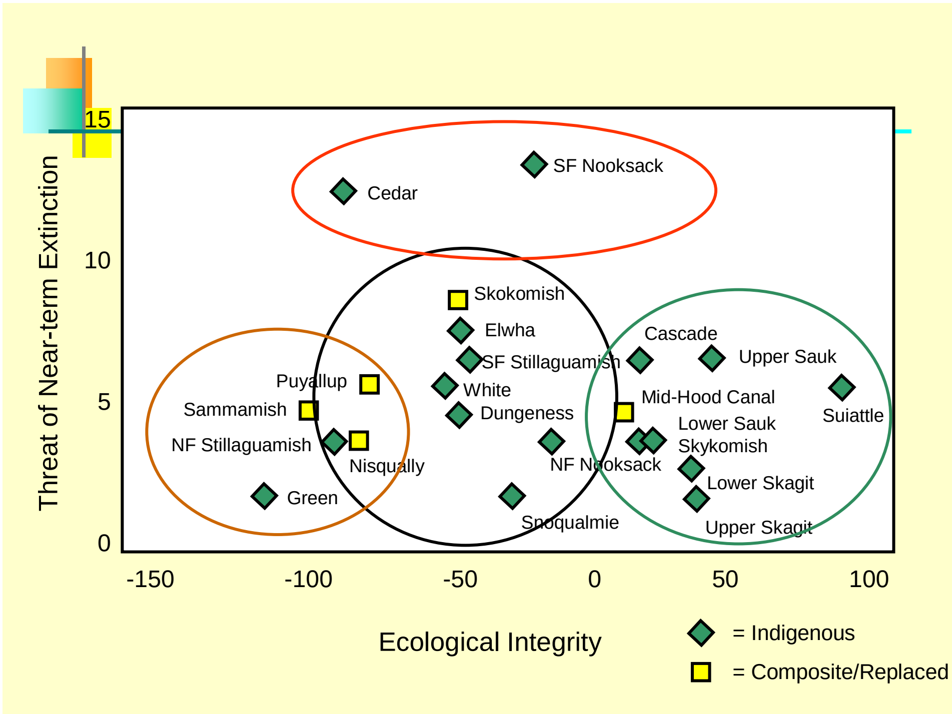

Figure 2

Visual inspection of the Figure 2 reveals four general groups of populations arrayed along the two axes. A first group of 8 populations lies in the lower right quadrant of the chart, in the positive range for ecological integrity and below the midpoint for demographic risk. Included in this group are the Cascade, Upper Sauk, Suiattle, Lower Sauk, Upper and Lower Skagit, the Skykomish, and the Mid-Hood Canal. Six of the populations lie in the Skagit watershed, all 8 have headwaters in wilderness or National Park areas that provide considerable protection for ecological processes that influence habitat quality and distribution. That integrity probably declines with distance from the protected areas and is least in the lower, most populated reaches of the watershed. Nevertheless, the maintenance of this integrity is critical to sustaining these populations and can be abetted by three general types of actions: protection of existing functional landscapes (large-scale actions), protection of specific habitats that can provide connectivity and refuge along the migratory path from ocean to spawning areas, and restoration of habitats where this connectivity has been severed or is at risk. In general, such actions are likely to be most effective in watersheds with high ecological integrity that provide support for basic processes.

A second group of 5 populations lies in the lower left of the chart, in the strongly negative range for ecological integrity but in the lower range for demographic risk. Included in this group are the NF Stillaguamish, Puyallup, Sammamish, Nisqually, and Green River populations. All of these populations are hatchery-supported; the NF Stillaguamish and the Green River populations, however, are derived from indigenous stocks. For these populations, the low demographic risk is the result of the hatchery programs that support them despite the lack of ecological integrity of their watersheds. The likelihood of restoring ecological integrity to their home watersheds is low, certainly in the short to medium term, and the early focus for recovery probably should be on hatchery practices that keep the demographic risk low and on protection of the remaining areas of the watersheds and river systems that do possess high ecological or habitat value. However, populations in this quadrant are likely to require continual intervention—habitat and demographic management—to be sustained.

A third group of 6 populations lies in the center of the range for ecological integrity and in the range from low to moderate for demographic risk. Included in this group are the Snoqualmie (very low demographic risk and moderate ecological integrity), the NF Nooksack, Dungeness, White, Elwha, and the Skokomish (moderate ecological integrity and moderately high demographic risk). These populations are decidedly mixed and only weakly separated from the group to the right and we must further examine the cause for their position in the chart for clues to appropriate management. For most of these populations, a return to higher ecological integrity may be possible through widespread changes in land management and restoration of degraded lands although the effects of these activities will take decades to be manifested. In the short term, habitat-focused actions of protection and restoration may provide a buffer until the effects of a degraded landscape can be ameliorated.

The fourth group of 3 populations is easily seen in the upper third of the chart for demographic risk and in the center-left for ecological integrity. This group includes the SF Stillaguamish, the Cedar, and the SF Nooksack, all populations with extreme risks for extinction in the relatively near term. Given the PSTRT's admonition against the loss of any population, these three high-risk populations must be secured as quickly as possible if their extinction is to be averted. None of the three lies in a watershed with high ecological integrity (although the Nooksack appears to have the best opportunity for ecological recovery) and actions directed at restoration are likely to take longer to be effective than the populations have. In these cases, short-term actions are likely to be directed to averting the demographic risks associated with the population and may include broodstock programs, actions aimed at reducing the cause of the demographic risk. In the case of the Cedar, for example, this may include the restriction of non-Cedar Chinook from the spawning grounds to reduce potential out-breeding depression of any remaining native aggregation.

One serious implication of the array on the chart is this: to be self-sustaining, a population should reside in a watershed with high ecological integrity and not be continuously subject to the kinds of demographic risks described in the demographic criteria. Populations that cannot be "moved" into the lower right quadrant of the chart for both demographic risk (downward) and ecological integrity (rightward) are unlikely to be self-sustaining and will require continual management of the demographic and ecological risks if they are to play a role in ESU viability.

Citations

Frissell, C, P. Morrison, J. Kramer, and M. Mentor. 2000. Conservation priorities: an assessment of freshwater habitat for Puget Sound Salmon. Trust for Public Land, Seattle, Washington. (http://www.tpl.org/).