Summarizing population status: Metrics for diversity

Note: this brief handout is meant to stimulate discussion between technical staff and the TRT liaisons for each watershed. We hope that the ideas presented here are helpful in illustrating possible ways to represent the outcomes of different habitat conditions on diversity in each population. We assume that discussions between watershed technical staff and TRT liaisons can illuminate similar possibilities in each watershed, given locally available information and results. Ultimately, the outcomes of combined habitat, hatchery and harvest conditions on VSP will need to be evaluated for each population—the examples we include here focus on alternative habitat conditions as a starting point.

Background

Salmon exhibit considerable diversity within and among populations in their life history, morphological, physiological and genetic traits. It is one of the 4 key population parameters NOAA Fisheries uses to describe a Viable Salmonid Population (i.e., a VSP). In a spatially and temporally varying environment, there are three main reasons why diversity is important for species persistence: (1) diversity allows a species to use a wider array of environments than they would without it, (2) the more diverse a population is, the more likely it is that some individuals will survive and reproduce in the face of environmental variation, and (3) genetically based diversity provides the raw material for surviving long-term environmental changes. Since salmon regularly face variability in the environments they inhabit, the contributions of diversity to population persistence are critical to consider.

Overview

The examples we present here are aimed at providing simple metrics we can use to summarize diversity for populations of listed salmon in the Puget Sound Chinook and Hood Canal Summer Chum ESUs. Contrasting alternative diversity characteristics under different habitat conditions is a useful way to evaluate the relative value of alternative habitat actions to salmon population status. Thus far, we are aware of 2 diversity metrics that have been summarized in freshwater and some estuarine areas at the population level: (1) the diversity of habitat types occupied by spawners under different habitat conditions, and (2) a diversity index predicted by EDT modeling under different habitat conditions. These metrics can be used to compare alternative land use and habitat condition scenarios in their effects on this key component of VSP.

Additional metrics of diversity, such as those describing genetic diversity of salmon populations (e.g., allelic diversity, frequency of heterozygotes), are available for many populations and are likely to be useful in comparing alternative hatchery practices for recovery planning.

Example products for the Snohomish populations:

- Histogram showing the diversity of habitat types occupied by spawners under current, test case and historical habitat conditions modeled by SHIRAZ in the Basin (Figure 1)
- Diversity index for alternative habitat conditions as predicted by EDT (Figure 2)

Approach and methods for Snohomish populations:

Spatial locations of subwatersheds supporting adult spawning under current, test case and historical habitat conditions were produced as output from the SHIRAZ modeling being conducted in the Snohomish River Basin (Scheuerell et al., unpublished data; see Spatial Structure metrics handout, Fig. 1b). The "current path" alternative describes the changes in land use and habitat conditions expected into the future under current land use, human population and regulatory conditions in the Snohomish Basin. The "test case" alternative represents a set of land use and habitat conditions identified by the Snohomish Technical Committee as those improving recovery prospects for salmon in the Basin.

To generate the histogram depicting the proportion of total occupied subwatersheds occurring in different habitat types, we first assigned each subwatershed to the EPA Level IV Ecoregion in which it occurs. We then tallied the number of occupied subwatersheds in each ecoregion under current path, test case and historical alternative habitat conditions. The resulting histogram shows the proportion of total occupied subwatersheds occurring in each of the habitat (ecoregion) types for the Skykomish and Snoqualmie populations (Figure 1).

The EDT model has been used to estimate the actual number of "sustainable" (here defined to mean cumulative productivity greater than one) Chinook life history trajectories produced under alternative habitat conditions in the model. The EDT index of diversity is the number of sustainable life history trajectories under a given scenario relative to the number under the template (or "historical conditions") scenario. Results from the diagnosis step in EDT for the Snoqualmie population are shown in Figure 2 (K. Rawson, Tulalip Tribes, pers. commun.).

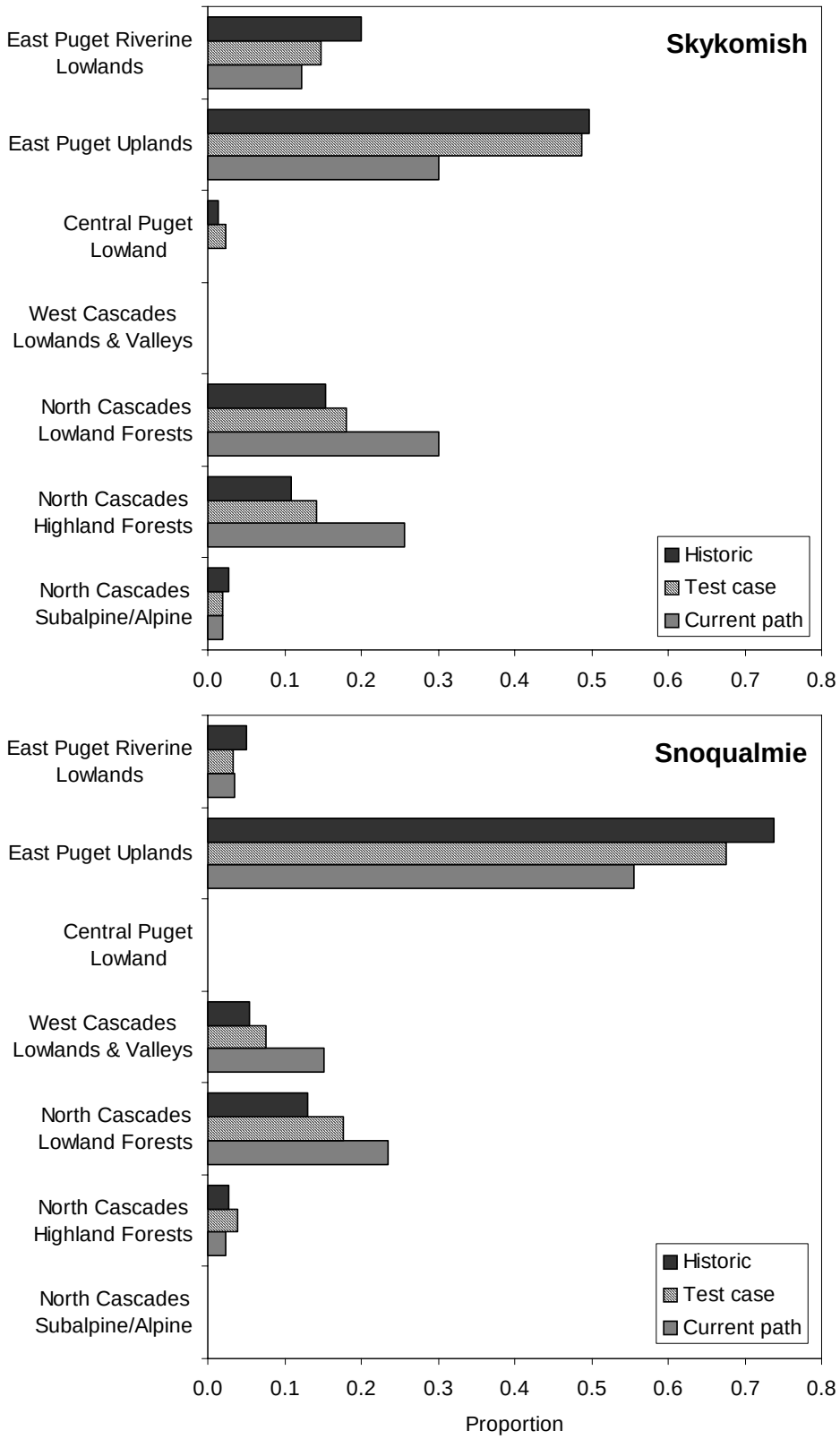

Figure 1. Histogram showing the diversity of habitat types (EPA level IV ecoregions) occupied by spawners under current, test case and historical habitat conditions modeled by SHIRAZ in the Skykomish and Snoqualmie populations in the Snohomish Basin (unpublished results from SHIRAZ modeling for the EASC).

Geographic Area	Preserve Benefit category	Restore Benefit category	Abundance	Productivity	Diversity Index
Marine Areas Outside Puget Sound	NA	D			
Marine Areas Puget Sound	NA	C			
Snohomish Estuary	A	B			
Snohomish mainstem	B	D			
Snoqualmie Mouth	B	B			
Mid-Mainstem Snoqualmie	A	A			
Upper Mainstem Snoqualmie	B	A			
Cherry Creek	C	C			
Lower Tolt River	B	C			
North Fork Tolt River	C	E			
South Fork Tolt River	B	D			
Griffin Creek	C	D			
Patterson Creek	D	D			
Raging River	B	B			
Tokul Creek	E	D			

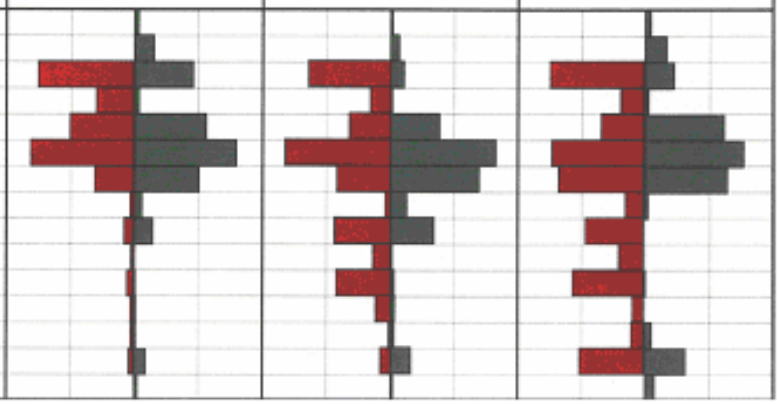

Figure 2. Graphical output from EDT showing relative importance of geographic areas for protection (red) and restoration (green) evaluated for each of the attributes abundance, productivity, and diversity. This example is from the diagnosis for the Snoqualmie Chinook population (source: K. Rawson, Tulalip Tribes.)