APPENDIX C

METHOD FOR INTEGRATING ATTRIBUTES AND ASSESSING POPULATION RISK OF EXTINCTION

Evaluation of Population Attributes

The proposed approach for integrating population attributes involves first evaluating the status of each population attribute separately on a 0–4 scale, then integrating the individual attribute values into an overall assessment of population status. The population attribute scores are based on the persistence category descriptions provided in each attribute section of this document, somewhat similar to those found in Table C.1. For example, the population spatial structure would be evaluated based on whether it is consistent with a persistence probability that is high, low, or somewhere in between and assigned a 0–4 score accordingly. For some criteria (e.g., adult productivity and abundance and juvenile outmigrant [JOM] growth rate), it may be possible to provide more quantitative thresholds associated with each level on the 0–4 scale. For other attributes (e.g., within-population diversity), it may not be possible to identify *a priori* quantitative thresholds, and more reliance on professional judgment will be required to determine the appropriate category. Issues related to the characterization of individual attributes are discussed in the chapter on each attribute; however, the determination of each attribute persistence level will follow a standardized procedure.

The TRT considered a number of possible procedures. Ideally, attribute persistence levels could be determined in a highly quantitative manner; however, in almost all cases the quantity and quality of available information necessary to derive such formulae were lacking (and will continue to be deficient under existing monitoring programs). Furthermore, the biological relationships among population characteristics are poorly understood. Data quality was a major concern for the TRT, and we generally agreed that any population attribute measure needed to include some accounting for uncertainty due to poor data quality, in contrast to uncertainty due to environmental stochasticity. Furthermore, adjustments for poor data quality needed to be precautionary in nature and should be distinct from evaluations of the biological parameters.

Given the current limitations of available information and our present understanding of ecological and population factors and interactions, the TRT agreed that a panel of experts, using

Table C.1 Examples of population attribute level characteristics under different scenarios of information quantity and quality.

Score – Expert A	**0**	**1**	**2**	**3**	**4**
Scenario 1 – Low uncertainty	0	0	10	0	0
Scenario 2 – High Uncertainty	0	2	6	2	0
Scenario 3 – Low Uncertainty	0	0	6	4	0
Scenario 4 – High Uncertainty	0	2	4	2	2

the persistence criteria provided in this document for each attribute, would provide the most efficient method of assessing the status of populations. The panel would be composed of scientists involved in a diverse array of fields related to salmon biology and ecology.[1] It is possible, and desirable, that a more quantitative model be derived as more information is collected (although that is unlikely anytime in the near future).

Panel members would review existing documents and information related to the specific attribute being evaluated. This information could be in written form or as part of a series of presentations by resource co-managers or the TRT. Data interpretation and a review of overall data quality would be discussed by the panel prior to persistence level characterization. The method used to capture the view of each panel member regarding each attribute would be similar to the method used by the NOAA Fisheries Biological Review Team to make initial listing evaluations and based on an approach developed by FEMAT.[2] Each panel member would have ten votes to allocate into the five persistence levels (0–4) for that attribute according to the criteria and evaluation guidelines provided in each attribute section. The distribution of an individual's votes would reflect uncertainty regarding that level determination (e.g., Table C.1). In Table C.1 (scenario 1), the panel member concluded that the information available indicated that for population A the productivity and abundance persistence level should be a 2. By placing all 10 votes in the 2 box, the panel member was indicating a high degree of certainty in the score. In scenario 2 the information was less compelling, and the vote distribution was more broadly set around the mean of 2. Scenario 3 reflects a situation in which the population attribute status is intermediate between 2 and 3; in this case, the mean is 2.4. Panel members will use professional judgment to weight the factors used to arrive at the vote distribution. Finally, scenario 4 illustrates a situation in which the mean vote is still 2.3, but with greater uncertainty in the data.

Persistence levels for the population attribute would be calculated from the combined votes from all panel members (Table C.2). The attribute mean and vote distribution would be presented in describing the population attribute status. When expert panels are employed, voting

Table C.2 Hypothetical scoring of a population attribute and data quality by an expert panel.

Score **Expert**	**0**	**1**	**2**	**3**	**4**	**Data Quality**
A	0	7	3	0	0	1
B	0	4	5	1	0	2
C	0	5	5	0	0	2
D	0	4	5	1	0	3
E	0	6	4	0	0	1
F	0	5	5	0	0	2
G	0	8	2	0	0	1
H	1	7	2	1	0	1
Sums	1	45	31	3	0	1.6
Average	1.46	Poor data	(-0.25)	= 1.21		

[1] A similar body was assembled to evaluate the status of salmon ESUs as part of the listing process.

tables are useful in presenting the uncertainty underlying the evaluations. Additionally, panel members would consider the quality of data utilized to determine the attribute status. Data quality would be scored from 0 to 4, 4 being high-quality data with little measure error. If the panel determined that the data quality was especially poor (0, 1, or 2), they could decide to reduce the population attribute mean as a precautionary measure. The amount of the reduction would be directly related to the data quality score. In the extreme case, where no information exists on a population attribute, the panel may use correlated information to arrive at a score. For example, in a population where the adult productivity and abundance attribute is categorized as 2.8, one might infer that the JOM attribute level would be similar. Where only correlated information is available, the data quality measure would be characterized as being very low. This would lead to a severe reduction in the mean persistence levels for attributes that have not been directly monitored. Further guidelines for calculating persistence levels for attributes with no data are provided in the "Combining Population Attributes" section of this appendix.

Approach to Integrating Population Attributes

Each attribute contributes to a population's viability assessment. Integrating the attributes into a single population persistence level needs to be done in a manner that weighs the relative importance of each attribute. The TRT, in general, concluded that the productivity and abundance metric provided the most direct and objective measure of population viability. The productivity and abundance persistence level was weighted twice as heavily as the other attributes. Additionally, the attributes were grouped into two category types: attributes that describe the population's performance (productivity and abundance and JOM) or the population's potential (population diversity, spatial structure, and habitat). Both performance and potential are essential to a population's viability. Attributes within a category are thought to be highly correlated, and in those cases where no data are available for an attribute, the other attribute(s) in the category provide the most appropriate source of information. Where no attributes exist in a category, neither the category nor the population can be evaluated. Additionally, if any attribute level is categorized as a 0 (in contrast to no data), then the population persistence category must be 0. For example, if there is good habitat, but monitoring indicates that there are no fish present (i.e., in the presence of an impassible barrier), the population has no possibility of persistence. Alternatively, the presence of attributes with means of 0 may indicate problems in data interpretation. If adults are monitored on the spawning grounds, but no juveniles are observed emigrating, the adults may represent strays from other populations or juvenile monitoring is not effectively capturing outmigrants. Under most conditions, however, the population persistence level would be computed according to the formula:

Population = (Performance Attributes) + (Potential (sustainability) Attributes)

as calculated from:

[2] Forest Ecosystem Management Assessment Team (http://www.environment.pdx.edu/fem.htm).

$$Population = \left(\frac{1}{3}(G\ \&\ A) + \frac{1}{6}(JOM)\right) + \left(\frac{1}{6}(Space) + \frac{1}{6}(Diveristy) + \frac{1}{6}(Habitat)\right)$$

In addition to the computation of a single population persistence level, it is more informative to present the persistence levels of the component attributes. This can be done in either graphic form (Figure C.1) or tabular form (Table C.3). For those attribute levels that were derived using poor quality data, the magnitude of any reduction is clearly indicated (as an incentive for improved monitoring). This method confers most of the information used to derive the population persistence levels. It is intended that recovery entities would utilize this information to prioritize actions that would bring the population persistence level to VSP status. Population persistence levels would be used to estimate strata persistence levels and overall ESU viability as described in previous sections.

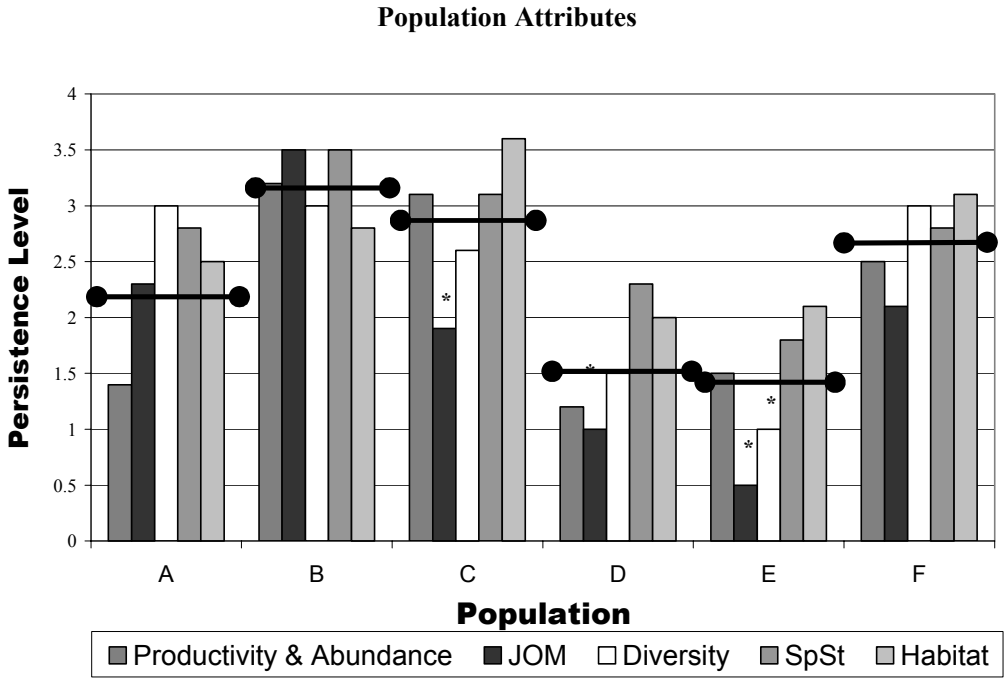

Figure C.1 Example of a graphical display of population attribute persistence levels for populations A–F. The values used are fictional, and not meant to represent any strata or ESU. The dashed lines indicate the overall population persistence levels. Population means were derived using the weighed average algorithm presented above. Asterisks indicate the attribute mean prior to any reduction for poor data quality.

Table C.3 Tabular representation of the information presented in Figure C.1. Population persistence levels are derived from the attribute means using the weighted average algorithm presented earlier in this section. Bracketed numbers following the attribute mean indicates the reduction in attribute mean due to poor data quality.

	Population Attribute Persistence Categories					
Population	**Productivity and Abundance**	**JOM Growth**	**Spatial Structure**	**Diversity**	**Habitat**	**Population Persistence Category**
A	1.4	2.3	3.0	2.8	2.5	2.22
B	3.2	3.5	3.0	3.5	2.8	3.18
C	3.1	1.9 (0.25)	2.6	3.1	3.6	2.88
D	1.2	1.0 (0.50)	1.5	2.3	2.0	1.52
E	1.5	0.5 (0.40)	1.0 (0.30)	1.8	2.1	1.39
F	2.5	2.1	3	2.8	3.1	2.65
Strata						=**1.98**