RECOVERY PLANNING GUIDANCE FOR TECHNICAL RECOVERY TEAMS

National Marine Fisheries Service

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Introduction and Background

As the result of a series of comprehensive status reviews throughout Washington, Oregon, Idaho, and California, the National Marine Fisheries Service (NMFS) has identified over 50 Evolutionarily Significant Units (ESUs) of West Coast salmon and steelhead. Twenty-six of those ESUs have now been listed as endangered or threatened species under the U.S. Endangered Species Act (ESA).

State agencies, local and regional governments and organizations, tribal governments, Federal agencies, and private organizations have responded to this conservation crisis by developing programs to help protect and restore salmon and steelhead and their habitats. These efforts, in conjunction with the regulatory tools provided by the ESA, will play a key role in recovering threatened and endangered salmon. These regulatory tools include prohibitions against Ataking@ listed species and prohibitions against Federal agency actions that reduce the likelihood that the species will survive and recover. Collectively, these programs provide important protections but in many cases will add up only to a piecemeal approach to recovery. Comprehensive recovery plans are needed to provide a framework for addressing problems across entire ESUs and among all of the activities that threaten salmon, and for prioritizing actions necessary for recovery.

Recovery planning efforts for West Coast salmon will be organized into a series of discrete geographic areas, or domains. The intent is to develop area-based recovery plans for all listed anadromous salmonid ESUs within each domain. The ESA stipulates that these plans must contain the following elements:

1) Objective, measurable criteria for determining when delisting is warranted;
2) A comprehensive list of site-specific management actions necessary to achieve the plan's goal for recovery of the species; and
3) An estimate of the cost and time required to carry out those actions.

In addition, NOAA Recovery Planning Guidelines stipulate that recovery plans must include an assessment of the factors that led to population declines and/or which are impeding recovery. Finally, it is important that the plans include a comprehensive monitoring and evaluation program for gauging the effectiveness of recovery measures and overall progress towards recovery.

Element (1) above is largely a technical exercise, with policy input, while elements (2) and (3) are largely a policy exercise, with technical input. NMFS refers to these two sets of tasks as "Phase I" and "Phase II" of recovery planning. In Phase I, biological delisting criteria will be developed by geographically-based Technical Recovery Teams (TRTs). To accomplish the last two tasks, in Phase II NMFS intends to work with state, local, tribal and private entities to craft a recovery planning process that is suited to the area and the situation. As discussed below, it is also expected that TRTs will provide technical support and analysis to these efforts. Ideally, Phase I activities would precede those in Phase II; in practice, the two phases will often overlap because many Phase II activities may be started before Phase I is completed.

Definitions of recovery and recovery goals

It is useful to recognize that there are at least two concepts of salmon recovery: "ESA" recovery, which deals with statutory requirements under the federal ESA, and "broad-sense" recovery, which may be concerned with a wider range of societal interests. As defined by NMFS and the U.S Fish and Wildlife Service (USFWS), "ESA recovery" is "improvement in the status of a listed species to the point at which listing is no longer appropriate." This occurs when the species is no longer threatened or endangered in "all or a significant portion of its range." Accordingly, we can define "ESA delisting criteria" as conditions that must be satisfied before the species can be delisted. These delisting criteria include both "biological delisting criteria" and "administrative delisting criteria."

Biological delisting criteria describe population and ESU characteristics that provide adequate assurance that the species will persist into the future.

Another factor essential to ensuring that the species will persist into the future at viable population levels is assurance that all factors for decline have been addressed. "Administrative delisting criteria" are used to establish this certainty. Although determining what corrective measures to take to reverse factors for decline will be largely a policy task undertaken in Phase II, TRTs can provide valuable technical information about the factors for decline, and about whether proposed corrective measures are likely to be adequate.

In contrast to ESA recovery, "broad-sense" salmon recovery is a more open-ended concept that does not have a single definition; rather, it can mean different things to different people. "Broad-sense recovery goals" thus may reflect societal values in addition to biological ones. For example, different visions of "broad-sense recovery goals" might include a desire to have robust populations that a) can support tribal, commercial, and sport harvest; b) promote fully functioning aquatic and marine ecosystems; or c) provide opportunities for the public to appreciate salmon in the wild. Using the terminology introduced above, Phase I tasks encompass the analyses and planning needed to develop biological delisting criteria, and Phase II tasks include developing and evaluating administrative delisting criteria, as well as considering all of the necessary factors for developing a broad-sense recovery plan.

Neither concept of salmon recovery is intrinsically "better." Furthermore, the two concepts are not inconsistent; in fact, they share a common vision of ensuring that naturally sustainable salmon populations persist into the future. The degree to which the concepts overlap will vary across species and ESUs, depending on the biological attributes of the populations and the societal values encompassed in "broad-sense" salmon recovery. For example, a population whose abundance is just above the viable level may satisfy many of society's "needs" for salmon, and populations at this level may also be productive enough to be able to support some harvest by humans, at least in years of relative abundance. However, in many cases the level of abundance and productivity that would achieve viability criteria would not provide for all the commercial, recreational, and tribal harvest opportunities that might be encompassed by "broad sense" recovery goals.

NMFS is committed to pursuing both types of salmon recovery goals, and one of the guiding principles of NMFS recovery planning for Pacific salmon will be to make the ESA and broad-sense recovery processes as congruent as possible. In some cases, the recovery goals under these two processes may be the same. NMFS has a statutory mandate under the ESA to recover species to the point at which they can be delisted, and NMFS also has a mandate under the Magnuson-Stevens Fishery Conservation and Management Act to restore depleted populations to optimal levels of abundance and productivity. In addition, NMFS has trust responsibility for tribal treaty rights, as articulated in a 21 July 1998 letter from Terry Garcia (NOAA) to Ted Strong (CRITFC):

> It is our policy that the recovery of salmonid populations must achieve two goals: (1) the recovery and delisting of salmonids listed under the provisions of the ESA; (2) the restoration of salmonid populations, over time, to a level to provide a sustainable harvest sufficient to allow for the meaningful exercise of tribal fishing rights. We see no conflict between the statutory goals of the ESA and the federal trust responsibilities to Indian tribes. Rather, the two federal responsibilities complement one another. Unfortunately, in light of the long-term decline of salmonid populations, we cannot achieve either goal within a short time frame. It is important that we achieve a steady upward trend toward ESA delisting in the near term, while making river and land improvements for the long term.

These considerations suggest the following approach for ESA recovery efforts for salmon:

Phase I

1) Technical teams develop biological delisting criteria.

Phase II

2) These biological delisting criteria are passed on to planners and policy makers, who are charged with developing a Recovery Plan that addresses both the biological delisting criteria and the administrative delisting criteria.

3) During Phase II, broad-sense recovery goals may also be considered and the Recovery Plan is crafted to accomplish both the biological delisting criteria and broad-sense recovery goals agreed to by the parties or determined by policy decision. Developing a management framework for tribal treaty harvest will be an integral part of considering broad-sense recovery goals.

4) Delisting can occur when the following conditions are met:

A) There is adequate assurance that the ESU has met the biological delisting criteria (see "Monitoring biological delisting criteria " section for discussion of how these evaluations can be made);

B) Factors that placed the species at risk and/or are limiting recovery have been addressed. Satisfying this administrative delisting criterion is essential to provide assurance that recovery will not be ephemeral; and

[C) A framework is developed to provide for meaningful exercise of tribal treaty rights consistent with the long-term conservation of natural populations.]

[Note: NMFS has not resolved how best to incorporate a tribal fishing framework into ESA delisting criteria. The bracketed language in C suggests one approach, but does not represent official agency policy on this key issue.]

Part One of this document outlines the tasks to be undertaken by the TRTs, with emphasis on tasks that will be undertaken in Phase I. Part Two provides more discussion on some of those tasks as well as guidance on how the TRTs should address a number of related issues.

Part One: Technical Recovery Team Work Program

The primary TRT tasks are to:

* Identify population/ESU delisting criteria
* Characterize habitat/fish productivity relationship
* Identify factors for decline and limiting factors
* Identify early actions for recovery
* Identify research, monitoring, and evaluation needs
* Serve as science advisors to groups charged with developing measures to achieve recovery goals

Because data availability and technical resources will vary across geographic domains and across ESUs within domains, the way these tasks are approached and the time frame for completion will also vary across domains and ESUs. NMFS will work with comanagers, stakeholders, and the TRTs to develop reasonable time frames for completion of these tasks and to determine the appropriate sequence for consideration of multiple listed ESUs within each domain.

TRT tasks are discussed in more detail below.

Identify Population/ESU Delisting Criteria

Recovery Plans must, at a minimum, provide for restoration of listed ESUs to levels at which they are no longer threatened or endangered and therefore can be delisted under the ESA. As noted above, the ESA requires that delisting goals be quantified to the extent possible. Identifying these biological delisting criteria will be a major Phase I task for the TRTs. A number of potential analytical approaches and tools for developing delisting criteria exist, and these approaches can be considered and used by each TRT at its discretion.

One organizing framework for establishing biological delisting criteria the TRTs will use is the concept of Viable Salmonid Populations (VSP) that has been developed by NMFS scientists. The VSP paper (McElhany et al. 2000) is designed to facilitate establishment of ESU-level delisting goals by identifying key parameters related to population viability (abundance, productivity, spatial structure, diversity), providing guidance on how these parameters should be evaluated, and finally relating the viability of individual populations to the viability of the ESU as a whole. The VSP paper has undergone extensive comanager, public, and peer review and comment, but the VSP approaches will continue to be refined and modified as appropriate based on further comments and on experience gained in their application to recovery planning.

Applying VSP concepts to setting biological delisting criteria involves two major steps: identifying VSP characteristics at the population level, and integrating this information up to the ESU level. Below is a brief summary of these key issues; TRT members should consult the VSP paper itself for more details.

I. <u>Identifying VSP characteristics at the population level</u>

Steps in this process include the following:

1) Identify populations .

Before the viability of ESUs and populations can be evaluated, it is necessary to identify demographically independent groups of fish. In the VSP context, an independent population is defined as a group of fish that does not, to a substantial degree, interbreed with fish from another group. The "does not interbreed" criterion is satisfied under VSP if exchanges of individuals among groups do not substantially affect their population dynamics or extinction risk over a 100-year time frame. Making this determination involves using a number of indicators, including genetic distance and gene flow estimates, correlations in abundance, direct estimates of straying, comparisons of life history and other phenotypic traits among groups, geographic relationships among groups, and quantification of similarities in habitat and ecological characteristics. Once independent populations within the ESU have been identified, the extinction risk of each can be estimated, and, ultimately, various combinations of individual populations with various status that would produce a persistent (i.e., recovered) ESU can be determined.

2) Identify abundance and productivity goals for each population.

Specifying the number and productivity of fish necessary for population viability are critical parts of developing delisting goals at the ESU level. The effects of abundance and productivity on population viability are tightly intertwinedCdetermining the number of fish required for a sustainable population depends on the underlying productivity of those fish. Estimating abundance goals will likely involve using a variety of tools, including viability modeling and historical estimates of population size from estimates of habitat capacity, catch data or dam counts. Viability models can incorporate a variety of factors affecting the numbers of fish that are needed for a self-sustaining population, including: deterministic density effects, environmental variation, genetic processes, demographic stochasticity, ecological feedback from intra-and interspecific interactions and habitat/ecosystem characteristics, and catastrophes. Any viability modeling exercise aimed at estimating the abundance necessary for a negligible risk of extinction must make assumptions about the productivity of the population, and these assumptions should be made explicit in TRT analyses and reporting of results.

2A) Abundance goals. Small populations have a greater risk of extinction than large populations for reasons that include environmental variation, demographic stochasticity, genetic processes, and ecological interactions. Identification of the threshold size above which a population is considered safe from extinction due to small population effects is an important task for TRTs. Goals for population size will generally be framed in terms of spawner abundance, though other metrics may be useful in some situations. As with goals for productivity described in Part Two, abundance targets generally will be "mortality source neutral." That is, in Phase I the TRTs will generally not be asked to determine what mortality rates are acceptable from specific sources or at specific life history stages, but rather to stipulate a minimum number of spawners for a recovered population.

2B) Productivity goals. Viable populations must have a trend that is stable or increasing, which implies that the net replacement rate (spawner : spawner ratio) must be at least 1:1. This is true regardless of the mortality factors that affect survival throughout the salmon life cycle. Therefore, in Phase I we can say that, at a minimum, population productivity has to be high enough to allow a net replacement rate of at least 1:1 after accounting for all sources of human and natural mortality and environmental variability throughout the life cycle. As described in more detail in Part Two below (see section on "Productivity"), these mortality factors and their relationship to population productivity will be considered in detail in Phase II. This does not imply that productivity is not an important consideration in Phase I tasks undertaken by the TRTs--as stated above, each TRT should be explicit about what productivity levels they assume in developing abundance goals during Phase I.

3) Describe spatial structure and diversity goals within the population.

Salmonids typically spawn in certain habitat patches within population boundaries. Connectivity among patches (straying) and the dynamics of patch turnover can have important consequences for population persistence that may not be apparent from measures of abundance or productivity. Therefore, TRTs should evaluate the spatial structure of a population and its habitat in developing population viability goals. Goals related to diversity and spatial structure might be expressed as in terms of specific subpopulations, or a percentage of the total number of subpopulations, that need protection; as the maintenance of specific physical process that drive patch dynamics; or some other attribute tailored to the peculiarities of a specific population.

A population may exhibit phenotypic diversity that contributes to population persistence by buffering the population from the effects of environmental variation. Phenotypic diversity can provide this buffering function whether or not the diversity is genetically based, though only genetically based variation will produce an evolutionary change in response to environmental change. Each TRT should document current patterns of variation and establish diversity goals for each population. These goals may include targets for minimum population size to protect genetic diversity, provisions for the protection of specific subpopulations exhibiting unique phenotypes, preservation or restoration of processes affecting straying and patch turnover, or limits on artificial selection (e.g., from harvest, hatcheries, or habitat modification).

II. ESU-wide considerations

Most listed salmon ESUs contain multiple populations or stocks. A major task of the TRTs in Phase I will be to identify different combinations of populations and their status, each of which would provide for recovery of the ESU as a whole. Steps in this process include:

1) Identify components of among-population diversity (ecological, genetic, life history) that are important to viability of the ESU as a whole.
2) Evaluate effects of spatial configuration on vulnerability of the ESU to catastrophic events.
3) Evaluate the number and distribution of VSP populations necessary for ESU-level viability.
4) Evaluate the role populations that are not at VSP can play in promoting ESU viability (e.g., by serving as population "sinks" that, in spite of low per-capita productivity, potentially increase total production, abundance, and diversity of the ESU; by preserving connectivity among more robust populations; by acting as sources for recovery of other populations lost due to catastrophe; by being in a natural recovery trajectory toward viability following a disturbance, etc.).
5) Develop a suite of scenarios that satisfy conditions A-D and lead to ESA recovery of the ESU as a whole. Two possible ways of representing this information for a hypothetical ESU are as follows:

Approach 1: Enumerate, in table form, the degree to which each population is expected to meet VSP criteria under each of several scenarios that lead to overall ESU viability (see Table 1 for a hypothetical example).

Approach 2: Instead of enumerating each possible scenario as in Approach 1, describe the range of permissible outcomes for several criteria. An example of such a result might be something like the following:

ESU X can be delisted if all of the following conditions are met (note that this example is purely hypothetical and does not imply that any of these particular provisions should apply to all ESUs):

1) The three largest populations must meet VSP criteria for viability;
2) At least five other populations must meet VSP criteria for viability;
3) No more than two populations can be below 50% VSP abundance level
4) At least three of the five spring-run populations must meet VSP criteria for viability;
5) Each of the four geographic areas of the ESU must contain at least one population that meets all VSP criteria.

A variety of algorithms are available that can identify populations or combinations of populations that satisfy multiple criteria and therefore should receive high priority in recovery planning.

Characterize Habitat/Fish Productivity Relationship

In addition to establishing viability goals for populations and delisting criteria for ESUs, TRTs will be asked to develop a coarse-scale characterization of the amount, quality, and distribution of freshwater habitat and relate habitat to salmon abundance for each population in the ESU. Specific products of the habitat assessments will include:

1) Spatial distribution of fish abundance for each population in the ESU
2) Association of fish abundance with habitat characteristics
3) Identification of human-factors that have the greatest impact on key freshwater and marine habitat

Restoration of freshwater habitat is expected to be an important factor in the recovery of most ESUs, and understanding important habitat types and their locations is a key aspect of recovery plan development. Habitat information generated by the TRTs will include characterization of the freshwater habitat types and conditions required by the species, locations where these habitat types still occur in relatively intact condition in each watershed, and the primary factors that have impaired habitat. These efforts will be augmented by work being conducted by NWFSC scientists to analyze the relationships between habitat characteristics and relative utilization by chinook salmon (Puget Sound and Willamette River/Lower Columbia River domains and in the Snake River) and steelhead (Willamette River/Lower Columbia River domain) (Bilby et. al. 1999). The TRTs will utilize additional information, related analyses and other relevant data as appropriate to refine the habitat characterization. This information will be used in Phase II to prioritize restoration actions for freshwater habitat and develop performance measures for habitat recovery.

Products of the habitat characterization will include a description of habitat attributes that are associated with areas of high fish production and the locations of these areas. Human actions that have caused detrimental alterations in habitat quality will be identified. Wherever possible, these human alterations should be spatially explicit and a relationship to fish production should be demonstrated. Estuarine and near-shore marine habitats also will be assessed.

A large number of efforts to characterize habitat quality and distribution are underway. In the Puget Sound area, tribal fisheries organizations, state agencies, private landowners and other organizations have all compiled data on habitat characteristics (e.g., the Salmon and Steelhead Habitat Inventory and Assessment Project (SSHIAP), Washington State Watershed Analyses, Department of Ecology River Basin Characterization, etc.). A few of these analyses have included quantitative relationships of salmon utilization (Skagit Watershed Council 1999). Similar efforts are underway in the Willamette River basin. Whenever possible, habitat characterization will include information on historic as well as current habitat conditions. All these sources of information should be used, as appropriate, in habitat analyses for Phase I. .

For watersheds where development of the habitat characterization is limited by poor data availability, information on habitat attributes developed for other watersheds with comparable conditions can be used to provide a preliminary depiction of habitat conditions. These data-poor locations should be identified by each TRT as areas where additional information should be collected.

Factors for Decline and Limiting Factors

Progress towards recovery will be assessed from two major perspectives: 1) How well the populations and ESUs meet the formal viability and delisting criteria, and 2) To what extent the factors that were responsible for the decline and/or were limiting recovery have been satisfactorily addressed. The second step is important to ensure that a temporary rebound in abundance (for example, due to favorable climate conditions) is not mistaken for true recovery.

Two major tasks are involved in this latter process:

1) Identify key life history stages that currently have the greatest effect on population viability.
2) Identify principal factors currently limiting the key life history stages.

NMFS scientists, through the Cumulative Risk Initiative, are currently developing modeling tools to help determine life history stages for which small changes in key parameters such as survival can make a large difference in population viability. These tools will be made available to each TRT for consideration and use as appropriate. Once sensitive stages are identified, the factors limiting these stages can be established based on direct observation (e.g., harvest effects on adult mortality) or experimental results (e.g., experiments on dam passage mortality). Analysis of correlations between various factors and population performance measures (e.g., between a habitat quality indicator and fish productivity) can be a powerful tool for identifying hypotheses about possible causal relationships that can be evaluated with further study. TRT evaluations of factors for decline will begin in Phase I and continue into Phase II. TRT members may want to consult documents NMFS has prepared regarding factors for decline as part of the listing process (e.g., Bryant and Lynch 1996).

Early actions for recovery

Although identifying delisting criteria is necessary before any final decisions can be made about measures to achieve those goals, in many cases the two processes will proceed simultaneously, or at least overlap in time to a significant degree. To facilitate and support those planning processes that are underway in the interim before formal delisting criteria are developed, TRTs may be asked to provide early guidance regarding two questions that are fundamental to recovery planning:

1) What should be done? and
2) Where (geographically) should efforts be focused?

The challenge is to identify actions that can proceed without detailed analysis and planning, can be implemented rapidly, have a high probability of providing a significant benefit to listed species, and will affect populations that are expected to be key components in a recovered ESU. In general, emphasis will be placed on measures that can be implemented in less than 2 years and which should produce significant benefits within about 5 years. Early recovery actions can be considered in a 2 x 2 matrix with the following cells:

Moderate/high impact on recovery -- easy to implement
Low or uncertain impact on recovery -- easy to implement
Moderate/high impact on recovery -- hard to implement
Low or uncertain impact on recovery -- hard to implement

"Early actions" would generally fall in the first cell (moderate/high impact, easy to implement). Although implementation is an issue that will primarily be addressed later in recovery planning, in evaluating "Early Actions" the TRTs may be asked to make a rough assessment of ease of implementation. Information on "Early Actions" provided by the TRTs will be advisory only, to be considered by recovery planners and other interested parties as they deem appropriate in the early stages of recovery planning. In addition, each TRT will need to strike a balance between focusing efforts on identifying early actions and moving forwards with goal-setting so that longer-term recovery actions also can be implemented as soon as possible.

Monitoring and evaluation

A well-designed monitoring and evaluation program is a critical component of any conservation or restoration activity and can play several roles within recovery planning. First, monitoring of specific projects is vital to determine whether those management actions have been effective. Second, large-scale monitoring and evaluation is important to assess the success of integrated actions (or recovery plans) in achieving desired recovery goals. Finally, well-coordinated management actions, when coupled with relevant monitoring and evaluation programs, can reduce uncertainty about the effect of those actions on salmon productivity.

Monitoring and evaluation can be divided into four categories which are applicable to West Coast salmon recovery planning: implementation monitoring, project effectiveness monitoring, recovery program evaluation, and environmental monitoring. TRTs will play an important role in monitoring and evaluation in both Phase I and Phase II. Program evaluation and environmental monitoring should be considered in Phase I and carried out into Phase II. Implementation monitoring and project effectiveness monitoring generally should be incorporated into Phase II. Each of these categories is briefly described below.

I. Types of monitoring

1) Implementation monitoring

This is the most direct aspect of monitoring and evaluation, consisting of the determination that management actions were implemented as requested or required under a Recovery Plan, and that the actions were maintained appropriately. Implementation monitoring should be explicitly supported in each Recovery Plan, including provisions for funding. This type of monitoring would be implemented by regulatory arms (e.g., NMFS regional offices, NMFS Enforcement, states and counties) and by other entities as allowable (e.g., tribal authorities). We do not anticipate that the TRTs will have much direct involvement with implementation monitoring.

2) Project effectiveness monitoring

This crucial yet difficult aspect of monitoring evaluates the linkage between specific management actions and the intended outcomes. To assess efficacy of projects in eliciting biological responses requires an understanding of the mechanisms which link specific conditions (e.g. habitat quality, harvest management, hatchery operations, and hydropower operations) to biological productivity. In the absence of a full understanding of many of these cause-and-effect relationships, we anticipate that many project-effectiveness evaluations will be intertwined with specific research projects. Optimally, evaluation of project effectiveness would then facilitate adaptive management. The evaluation of how multiple projects fit together to contribute to overall Recovery Plan effectiveness will also be a key monitoring issue. As specific elements of recovery plans come into focus in Phase II, TRTs will work with recovery planners to develop effective monitoring and evaluation components for these elements.

3) Recovery program evaluation

As biological delisting criteria are formulated in Phase I, the TRTs will need to consider how progress towards achieving these goals can be measured. Delisting criteria should be quantifiable and measurable, and monitoring and evaluation for overall plan effectiveness should thus be explicitly linked to delisting goals. Because VSP principles will be used to set biological delisting criteria, TRTs will use also VSP principles to determine appropriate monitoring strategies for program evaluation (see "Monitoring biological delisting criteria" below for more detailed discussion).

The broad geographic scope of salmon recovery efforts will generally preclude comprehensive monitoring throughout a geographic region. Therefore, monitoring and evaluation will often need to target specific locales or populations as index sites for evaluating success. Care must be taken in choosing sites or populations to monitor intensively, as well as those to monitor less intensively, such that the overall program success can still be evaluated.

4) Environmental monitoring

Factors outside the control of Recovery Plan actions, such as oceanic and freshwater environmental fluctuations, will affect salmon population parameters and progress towards recovery. Monitoring of natural, or at least non-managed, environmental conditions, and evaluation of their influence on salmon populations, should be included in the planning and implementation of recovery. This type of monitoring has two major benefits for recovery planning. First, understanding the temporal and geographic scale of environmental variation is essential to developing delisting criteria and evaluating short-term population performance (see section in Part Two on "Environmental Variability"). Second, improved assimilation of environmental monitoring data should increase the power of other monitoring and evaluation efforts by allowing researchers to account for and filter out some of the 'noise' in salmon population dynamics resulting from natural variability.

Because much of the necessary environmental monitoring is ongoing and geographically widespread, existing programs should be tied into monitoring and evaluation in specific Recovery Plans. Substantial new monitoring efforts of this type may not be necessary, although individual Recovery Plans may highlight specific environmental data that need to be collected and evaluated.

II. General monitoring and evaluation considerations

1) Statistical power

A common failing of monitoring and evaluation efforts under the ESA is lack of statistical power. This means that the intensity of data collected is too low, given sampling error and environmental variability, to ascertain trends and effects with reasonable statistical confidence within time frames that are useful for feedback into management actions. For example, it is likely that monitoring of population abundance will require at least a decade or more of effort before trends can be reliably ascertained. Each TRT should estimate the statistical power of monitoring and evaluation efforts under their respective Recovery Plans, both for monitoring of progress towards recovery goals (i.e. de-listing), and for monitoring of specific management actions. To estimate power requires an idea of the variability of the measures to be made. Often the magnitude of this variability will be unknown, so power analyses prior to the implementation of the monitoring and evaluation effort may not be highly quantitative. In such cases, *post hoc* power analyses should be incorporated into the monitoring and evaluation plan (see example below under "Monitoring biological delisting criteria").

Many monitoring efforts under ESA recovery planning may include volunteer, or citizen-based, efforts to collect data. Such efforts should not be hindered by an unrealistic expectation of statistical rigor; however, statistical approaches should be supported by implementing agencies to the extent practicable. A major challenge in this area is to find ways (such as meta-analysis) to evaluate the collective power of numerous monitoring and evaluation efforts, even if the individual efforts are of limited power. TRTs can play an important role in helping to develop a monitoring and evaluation framework to accomplish this.

2) Validation of measures

Generally, specific research activities will be necessary for evaluating the appropriateness of assumptions made about the linkages between different life history stages and the environment, and among life history stages. For example, the broad applicability of site-specific relationships between habitat attributes and populations of juvenile salmon can be tested through research efforts. As well, this type of research and monitoring can evaluate assumptions about the implications of altered survival at certain life stages on ultimate reproductive success of a population segment. This validation component is essential to adaptive management strategies, and is increasingly being made explicit in recovery strategies (e.g., this is identified as validation monitoring in the Washington State Salmon Recovery Strategy).

3) Budgetary support and cost efficiencies

Generally, monitoring programs which have sufficient power to feed back to management strategies in reasonable time frames are resource intensive, in terms of time, funds, and people. This cost is a major reason that monitoring and evaluation components are often absent, or weak, in recovery plans. To encourage the inclusion of monitoring and evaluation in salmon recovery efforts, monitoring and evaluation activities should be budgeted for in Recovery Plan implementation. This should foster efforts to increase cost efficiencies of monitoring and evaluation. Cost reductions can be facilitated by open data sharing in which reports generated under monitoring and evaluation efforts are openly accessible to other agencies and the public, presumably via internet access. Coordination among TRTs, facilitated by the Northwest and Southwest Fisheries Science Centers, can promote efficiency and cost effectiveness by helping to avoid unnecessary duplication of effort. Finally, interagency coordination and the appropriate use of volunteer or citizen-based monitoring can assist in reducing costs associated with monitoring and evaluation efforts needed for West Coast salmon recovery.

III. Monitoring biological delisting criteria

Biological delisting criteria can be thought of as population parameters without a specific time horizon. To take an hypothetical example (this example uses population abundance but the same principle applies to other characteristics such as trend), for a particular population the VSP abundance level might be a geometric mean of 5,000 spawners per year. A population at this level could be expected to persist indefinitely into the future because its abundance is high enough to provide resilience, maintain genetic variability, and provide a sufficient buffer against natural fluctuations. The TRT therefore might identify 5,000 spawners per year as that population's expected contribution to the biological delisting criteria for the ESU as a whole.

TRTs will also be asked to identify population characteristics that can be monitored to determine whether the population's viability goal is being met. The only way to do this is to collect data from the population over time to estimate the true value of the parameter. Since abundance varies over time, any particular time series of data may provide an estimate that is higher or lower than the long-term mean. In particular, a population whose true long-term mean abundance is below the viability goal may appear to be more robust based on just a few years of data. A key question then becomes, How can we be confident, based on only an *estimate* of population abundance and trends, that the population's *true* (parametric) abundance and trend meet the viability goal? This question can be answered by a combination of *a priori* and *a posteriori* power analyses, which consider the type of data available (e.g., Are the population counts known without error or only estimates?) and the number of data points available. Certainty will increase with precision of the population estimates and the number of years of data available; certainty will be inversely correlated with the observed (or assumed) variance in abundance over time.

The following formulation provides one way for the TRTs to use *a priori* power analyses:

> In order to have probability X that the long-term geometric mean abundance actually does exceed the viability goal, the estimated geometric mean abundance for a period of T years must be at least Z.

This analysis is called *a priori* because it must make some assumption about what the variability in the data will be. Having made such an assumption, the TRTs can use a variety of statistical and modeling techniques to provide paired values of T and Z that achieve the desired level of confidence. Each pair of T and Z values (e.g., a mean of 8,000 fish measured over 8 years) can be considered a preliminary "performance goal" for the population to be viable. T and Z values will be inversely correlated; the shorter the time series of data, the higher the performance level must be to provide confidence that the true abundance is actually above the viability goal.

Performance goals identified through these *a priori* analyses should be considered preliminary because they depend on assumptions about variability in the time series of data. Once the data are collected, an *a posteriori* power analysis can be performed to adjust the performance goal, as appropriate, based on the observed levels of variability. TRTs may want to identify a minimum time series to be considered for viability, regardless of the actual variance observed in the data. The draft recovery plan for Sacramento River winter run chinook salmon includes power analyses and stipulates a minimum number of years of data required before delisting can be considered.

Choice of an acceptable confidence level (X) that the population actually meets the viability goal is a policy decision that should be informed by technical input. If a value of X is not specified, TRTs might consider a range of values to examine. Monitoring adult abundance will generally be the most reliable way to determine whether VSP and biological delisting criteria have been met. However, it will not always be feasible to collect data on adult spawners, and in such cases monitoring for abundance, trends, and/or productivity may focus on earlier life stages. In addition, the TRTs could include in their monitoring recommendations proxy indicators of fish performance for use in monitoring over short time frames. For example, monitoring habitat characteristics with predictable effects on survival at specific life stages may provide useful information in forecasting likely changes in fish population parameters before they are detectable.

Developing Recovery Plans

Identifying the suite of actions necessary to achieve recovery goals and the means of implementing them--that is, developing a comprehensive recovery plan--is a Phase II activity that will involve choosing among alternative means of achieving recovery, with the options typically differing in feasibility and certainty of meeting the goals. In general, two dimensions of options will be considered during this exercise. First, most ESUs are complexes of many individual populations, and TRTs may identify several different combinations of number and distribution of healthy populations that collectively will add up to recovery of the ESU as a whole. Similarly, the TRTs may identify a variety of combinations of habitat quality and quantity that can be expected to support viable populations within a particular basin. Second, although recovery of some populations or ESUs may clearly depend on correcting one dominant factor for decline, in other cases there may be multiple different combinations of measures that could lead to recovery.

Because evaluating these options requires consideration of economic, social, and policy issues as well as scientific ones, the TRTs will not be responsible for developing recovery measures or recovery plans; that is a Phase II role that may be performed by different state, tribal, local, and private entities in different recovery domains. TRTs will, however, be asked to provide technical evaluation of the effectiveness of the proposed measures for achieving recovery goals. For example, the TRTs may be asked to:

1) Quantitatively evaluate different combinations of actions to ensure that they will lead to recovery;
2) Assess the relative certainty of achieving recovery goals associated with alternative management actions; and
3) Assess how different temporal trajectories for recovery affect the probability of recovery and failing to achieve recovery.

Part Two: Guidelines for Approaching Recovery Planning for Salmon

Although TRTs will focus on technical aspects of recovery planning, they also will face a number of challenging issues that lie at the intersection of science and policy. This section includes more detailed technical discussion of specific issues as well as a summary of legal and policy guidance and constraints under the ESA that are relevant to TRT activities.

Productivity

Productivity of a salmon population is the per capita production by spawning adults, typically expressed in terms of the number of recruits produced per spawner (R/S). Recruits are most frequently measured as spawning adults or preharvest adults, but the term can be more generally used to apply to any life stage. Productivity is the result of interaction between intrinsic characteristics of a population (e.g., individual fecundity, redd-digging ability, size and age at smoltification, etc.) and the entire complement of extrinsic factors (both natural and human-induced) that affect survival throughout the life cycle (e.g., freshwater habitat quality and quantity; estuarine and marine conditions; competition and predation; impediments to migration; and harvest by humans).

These factors affecting productivity may vary considerably over time as a result of natural fluctuations and human influences. Because the nature and magnitude of future human influences on salmon productivity will not be fully considered until Phase II of recovery planning, it is difficult to identify specific values of productivity associated with population viability goals in Phase I. What can be said in Phase I is that, after accounting for all sources of natural and human mortality throughout the life cycle, productivity has to be high enough to provide at least one spawner for each spawner the previous generation. This criterion must be satisfied over a long enough time frame to account for natural fluctuations in environmental conditions. In practice, this means that productivity will generally have to be higher than average during periods of favorable conditions to balance out low productivity during unfavorable periods. Technically, the condition that must be satisfied is that the geometric mean spawner : spawner ratio must be at least 1:1. If this criterion is met the population is stable, and if the population's abundance is also at or above the VSP level, then the population can be considered viable into the future. In most cases there will be a variety of ways to achieve a productivity that will allow a spawner : spawner ratio of at least 1 : 1, and choosing among these alternatives (after they have been technically evaluated by the TRT) will be a major task of Phase II planners.

The fact that the relationship between productivity and viability criteria for salmon populations cannot be fully addressed until Phase II of recovery planning should not be viewed as a constraint on TRT evaluations of productivity and related issues in Phase I; in fact, we expect that technical evaluations of productivity will be important in several components of Phase I. First, one of the critical uncertainties in salmon recovery planning is the relationship between habitat quality and quantity and salmon productivity. Important technical work to advance our understanding of this relationship is expected to occur during Phase I (see TRT Workplan more detail). Second, although identifying population- and ESU-level viability criteria is the primary responsibility for the TRTs in Phase I, they will also be asked to identify early actions for recovery and factors for decline (see TRT workplan for discussion of these items). Evaluations of productivity may play a role in either or both of these elements.

Finally, intrinsic productivity (the expected maximum growth rate when a population is free of density dependence) is important as a measure of a population's resilience. All else being equal, a salmon population with a relatively high intrinsic productivity is expected to be more resilient to perturbations and less prone to extinction than one with low intrinsic productivity. If TRTs can develop sound technical arguments that particular levels of intrinsic productivity are needed to support viable populations, and this relationship holds regardless of the suite of mortality factors that will be fully evaluated only in Phase II, those criteria could be identified in Phase I.

Historical distribution and abundance

As noted above, recovery under the ESA requires that the listed species be restored to the point at which it is no longer threatened or endangered and can therefore be delisted. There is no requirement that the species be restored in all parts of its historic range, nor that it be restored to its historical levels of abundance (recognizing that those levels fluctuated over time; see next section). Nevertheless, the concepts of historic distribution and abundance can be important considerations in developing biological delisting criteria for two reasons.

First, although some ESUs may be sustainable with geographic distribution and/or abundance substantially lower than historic levels, determining how much can be sacrificed while still ensuring viability is a very challenging technical problem. In contrast, because ESUs are thought (by definition) to have persisted as independent units over evolutionary time periods, we can be confident an ESU is sustainable if it approximates its historic patterns of distribution and abundance. Departures from these historic patterns do not mean that an ESU cannot be sustainable; however, all else being equal, the greater the departure from historic conditions the greater the uncertainty regarding viability. Therefore, in considering biological delisting criteria for listed ESUs, scenarios that involve substantial departures from historic patterns of distribution and abundance should be scrutinized carefully to ensure that they do provide adequate assurances of viability.

Second, ESUs are "species" under the ESA, and an ESA species cannot be considered recovered until it is no longer threatened or endangered in "all or a significant portion of its range." Therefore, proposed recovery scenarios involving substantial departures from historic patterns of distribution should be examined carefully to ensure that they will not lead to continuing high risk levels in a "significant portion of the range" of the ESU. The VSP paper (McElhany et al. 2000) contains the following discussion about how to consider this regulatory language in applying VSP guidelines for whole-ESU viability:

> The common scientific usage of "statistical significance" does not appear to be pertinent here; rather, the relevant meaning of "significant" must be more along the lines of "important; of consequence" (Random House Dictionary, 2nd Edition). "Range" has an obvious geographic interpretation, and the sections in this document that discuss number and geographic distribution of populations in a viable ESU are relevant in this context. In addition, we believe it is important to consider other aspects of the "range" concept when evaluating ESU viability; these might include ecological diversity, life history diversity, and genetic diversity. The "Diversity" section [of this VSP paper] (p. 19) discusses long-term ecological and evolutionary processes and thus is directly relevant to this concept of "range."

Environmental variability

To provide adequate assurance that recovery under the ESA is not ephemeral, it is necessary to demonstrate that the factors that have led to the decline and/or are limiting recovery of listed species have been addressed. As articulated in the ESA, in addition to human-mortality factors such as destruction of habitat or overharvest, these factors for decline may include "other natural factors" affecting the continued existence of the species. For Pacific salmon, environmental variability is an "other natural factor" that, in combination with human mortality factors, can substantially affect extinction risk. For example, most salmon spend half or more of their life cycle in the ocean, and there is growing evidence that marine survival rates can profoundly influence the abundance and status of salmon populations. It is also clear that large variations in marine productivity occur on several time scales, including annual, decadal, and longer periods. Substantial environmental fluctuations also occur in freshwater habitats.

These facts lead to two conclusions about the importance of environmental variation in salmon recovery planning. First, environmental fluctuations that affect survival and productivity for salmon have occurred for thousands of years, and salmon have developed behavioral, life history, and genetic adaptations that allow them to respond to these changes and persist through time. If we could duplicate historical conditions in the rest of the salmon life cycle, we could be confident that salmon ESUs would also persist into the future, in spite of continuing environmental fluctuations. However, human influences have changed many factors that affect the life cycles of salmon. So, a key challenge in recovery planning is how to ensure that salmon are sustainable in spite of "typical" levels of environmental fluctuations AND human influences throughout their life cycle.

Second, there is growing evidence that human influences are having such large-scale effects on atmospheric processes (e.g., global warming; ozone depletion) that historic patterns may not be an adequate indication of future conditions. Available data are still open to multiple interpretations, and even if consensus were to emerge on the magnitude of a particular future effect the consequences would vary across species and ESUs. Nevertheless, in developing biological delisting criteria and recovery plans, TRTs should consider the possibility that future environmental conditions will not resemble those in the past.

These conclusions, in turn, lead to two additional conclusions about how to proceed with Phase I of recovery planning. First, biological delisting criteria must take into account natural environmental fluctuations. To be delisted, ESUs should be able to withstand adverse environmental conditions on the same temporal and spatial scales as have occurred in the historic record. Population viability goals should be set to minimize the chances that temporary improvements in population status due to favorable environmental conditions are mistaken for true recovery. TRTs should consider the possibility that human impacts on salmon ecosystems will lead to (or already have led to) a ratchet effect, where populations cannot rebound to historic levels during favorable periods and dip to increasingly lower levels during unfavorable ones.

Second, in spite of intense interest in this topic in recent years, our understanding of long-term environmental fluctuations is still imperfect, and most datasets are too short to provide rigorous evaluation of the temporal scale of fluctuations. Uncertainty associated with predictions about future human effects on the environment is even greater. Therefore, the TRTs should be wary of assuming that future conditions will occur according to any particular scenario. It would be prudent to consider multiple possible scenarios, weighted as appropriate based on available information, and evaluate the sensitivity of recovery trajectories to which assumption is made.

Hatchery fish

Salmon are unique among endangered species in having large scale artificial propagation programs that release individuals into the wild, where they may interact with listed wild populations. This situation presents a number of challenges to those charged with developing a biologically based approach to salmon recovery. This section tries to clarify how the TRTs should consider some of the issues.

One point to note is that artificial propagation of salmon can be consistent with ESA recovery in either of two ways. First, the ESA recognizes that conservation of threatened and endangered species can be facilitated by artificial propagation, and captive breeding programs are part of recovery planning efforts for a number of listed species, including Pacific salmon. Objectives of such programs vary somewhat, but all must, at least in theory, provide a net benefit to the listed species. Potential benefits of artificial propagation for listed species include reducing short-term risk of extinction; supplementing natural populations to speed recovery; and re-establishing natural populations in suitable but currently vacant habitat. Conservation hatcheries for Pacific salmon also create a number of genetic and ecological risks for natural populations, including reduction in population size due to broodstock collection; catastrophic loss of the cultured population; reductions in genetic diversity within and between populations; and domestication selection in a novel environment. Determining the appropriate use of captive propagation in ESA recovery programs for salmon requires a thorough assessment of the risks and potential benefits involved.

A second way in which salmon hatchery programs can be consistent with the ESA is if they do not reduce appreciably the likelihood of survival and recovery of listed species. For example, production hatchery programs designed to produce fish for harvest may be compatible with ESA recovery provided that adverse effects on listed wild populations are kept below some threshold. These effects can be ecological (competition, predation, disease transfer), genetic (outbreeding depression, loss of local adaptations, loss of diversity), or incidental (bycatch of wild fish in fisheries targeting more abundant hatchery populations). In short, hatcheries that are not intended to be part of the solution (i.e., part of formal recovery efforts) can still be consistent with the ESA if they do not become part of the problem.

It is important to recognize that in neither case is artificial propagation considered to be a substitute for resolving the basic problems that brought the species to the point at which it required protection under the Act. ESA policies of both NMFS and USFWS reflect this fact: artificial propagation under the ESA can be a means to achieve an end (ESA recovery of the listed species) but is not an end in itself (Federal Register 58 17573 (April 5, 1993); Hard et al. 1992). This policy guidance follows directly from the stated purpose of the ESA, which is to conserve and promote recovery of threatened and endangered species in their natural ecosystems. In accordance with this precept, the evaluation of a species' status for listing or delisting under the ESA focuses on natural populations, which for Pacific salmon are defined as the progeny of naturally reproducing fish.

It is expected that TRTs will provide valuable technical information about artificial propagation and salmon recovery, but most of this will take place in Phase II. Technical guidance will be particularly useful on how to maximize the benefit/risk ratio of supplementation programs and how to minimize incidental effects of production hatchery programs. Technical expertise of the TRTs can also be used to help integrate supplementation programs into overall recovery plans.

In setting population viability goals in Phase I, the TRTs should focus on the biological requirements for populations to be self-sustaining, independent of any contribution from artificial propagation. Several points follow from this:

* Population viability goals should be described in terms of natural production by naturally produced fish. Production by naturally spawning hatchery fish can be important in helping facilitate recovery, but a population cannot be considered recovered under the ESA if it still relies on hatchery supplementation to maintain its abundance.

* In mixed hatchery-wild systems, meaningful assessments of progress towards population viability goals cannot be made unless the contribution of naturally spawning hatchery fish can be estimated quantitatively. Evaluating this contribution involves two types of information: 1) An estimate of the proportion of naturally spawning fish that were reared in a hatchery, and 2) An estimate of the relative reproductive success of naturally spawning hatchery fish compared to wild

fish. Table 2 illustrates some mixed hatchery-wild scenarios that do and do not provide evidence for viability of the natural component of the population.

* Information regarding #1 is available for at most only a fraction of populations in most listed ESUs; information about #2 is available for only a few populations/species coastwide. This fact suggests two conclusions:

1) Filling this critical information gap should be a high priority for monitoring, evaluation, and research efforts;
2) In the absence of real data, TRTs should consider the following options for dealing with this critical uncertainty:
    A) Extrapolate from data for other species/other areas and assume it applies to the situation in question;
    B) Perform sensitivity analyses of the robustness of results to violation of assumptions such as A above;
    C) Take a risk-averse approach in the face of uncertainty

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Table 1. Hypothetical example showing a series of scenarios leading to recovery of a salmon ESU to the point at which it can be delisted. The scenarios differ in the degree to which individual populations meet VSP criteria for viability. The letters in the body of the table refer to relative health of each population (A = meets all VSP criteria; B = slightly below VSP; C = well below VSP; D = dysfunctional).

Population	**Scenario**				**Range**
	I	II	III	IV	
1	A	A	A	A	A
2	A	B	A	B	A-B
3	C	C	C	C	C
4	A	A	A	A	A
5	B	A	B	A	A-B
6	C	B	B	A	A-C
7	A	B	B	C	A-C
8	B	B	A	A	A-B
9	A	A	A	A	A
10	A	A	B	B	A-B
Probability of achieving recovery	High	High	Low	Medium	

In this hypothetical ESU, populations 1, 4, and 9 are considered anchors and all must be healthy for the ESU as a whole to be delisted, while population 3 is not expected to meet VSP criteria in any realistic scenario (perhaps because of severe habitat degradation that would be difficult to restore). The status of the other populations vary among the scenarios. Note that none of the scenarios include any "dysfunctional" populations (status D). It is difficult to say as a matter of principle that no ESU with any status D populations can be delisted. However, because even minimally functioning populations may contribute to overall ESU viability, the TRTs should be very cautious in identifying populations that can be allowed to become completely dysfunctional.

To the extent that the scenarios differ in the likelihood of achieving recovery or anticipated time needed to achieve recovery, that information would be valuable to Phase II planners in developing a Recovery Plan.

Table 2. Three hypothetical scenarios describing dynamics of a mixed hatchery-wild system. The Adjusted Natural Return Ratio (ANRR) is a measure of whether the natural component of the population is sustaining itself; a value below 1 indicates that the population would decline without constant input from the hatchery. The standard Natural Return Ratio (NRR; Busby et al. 1994) is a simple function of the numbers of hatchery and natural fish spawning naturally [$NRR_t = N_{t+1}/(H_t + N_t)$]. The ANRR also considers the relative reproductive success or effectiveness (E) of naturally spawning hatchery fish compared to wild fish [$ANRR_t = N_{t+1}/(E*H_t + N_t)$]. Since E will often be unknown a range of values should be considered.

Natural spawners				**Adjusted Natural Return Ratio**		
Generation	Hatchery origin (H)	Natural origin (N)	Total	E = 0	E = 0.5	E = 1
Scenario A						
t = 1	2500	2500	5000	1.0	0.67	0.5
t = 2	2500	2500	5000	1.0	0.67	0.5
t = 3	2500	2500	5000			
Scenario B						
t = 1	500	4500	5000	1.0	0.95	0.9
t = 2	500	4500	5000	1.0	0.95	0.9
t = 3	500	4500	5000			
Scenario C						
t = 1	2500	2500	5000	2.0	1.33	1.0
t = 2	2500	5000	7500	1.5	1.2	1.0
t = 3	2500	7500	10000			

In scenario A, the number of natural spawners is constant at 5000 but each generation half of these are produced in a hatchery. The assumption that E = 1 leads to the conclusion that the population would decline at a rate of 50% per generation without support from the hatchery. The natural population is sustaining itself (at a constant level of 2500 natural origin fish) only under the assumption that naturally spawning hatchery fish make no contribution to future generations (E = 0).

Scenario B is similar to A except the hatchery component is smaller.

In Scenario C the population is growing in size, as would be expected for populations on a trajectory towards recovery. The natural component of this population appears to be at least replacing itself regardless what E is. These data might characterize a successful supplementation program--after receiving a temporary boost in abundance, the natural population is able to sustain itself (and perhaps even grow) at the higher abundance level. Some scenarios with ANRR < 1 may still reflect a more limited measure of "success" of a supplementation program (e.g., temporarily avoiding extinction or slowing the rate of decline of the natural population compared to what it would have been without intervention).

These hypothetical scenarios do not attempt to account for any genetic or density dependent interactions that may occur between hatchery and natural fish.

GLOSSARY

Phases of Recovery Planning

Phase I of recovery planning for salmon is primarily concerned with developing *biological delisting criteria*, while *Phase II* is primarily concerned with developing a comprehensive *ESA Recovery Plan* that will achieve the biological and *administrative* delisting criteria and, perhaps, *broad-sense recovery goals* as well. Ideally, Phase I should precede Phase II; in practice, many Phase II activities will already be underway while biological delisting criteria are being developed in Phase I. The TRTs will be involved with both Phase I and Phase II activities. The simplest way to distinguish Phase I and Phase II TRT activities is that Phase I activities are strictly technical and can be carried out without policy involvement (except perhaps for some initial guidance to define parameters), while Phase II activities will generally involve regular interactions between TRT members and policy makers, who will frame questions for the TRTs to evaluate technically.

Evolutionarily Significant Units (ESUs)

The federal Endangered Species Act allows listing of "distinct population segments" of vertebrate species such as salmon. Because the ESA provides no further guidance on how to determine whether a population is "distinct," NMFS developed scientific and policy guidance indicating that salmon populations or groups of populations will be considered "distinct" under the ESA if they are *Evolutionarily Significant Units (ESUs)* of the biological species (Federal Register 56 58612 (November 20, 1991); Waples 1991, 1995). ESUs are considered "species" under the ESA and can be listed if they are threatened or endangered. Since recovery and delisting under the ESA also occurs at the level of ESA "species," ESA recovery planning for salmon will focus on restoring listed ESUs to the point at which they are no longer threatened or endangered.

Biological delisting criteria

Biological delisting criteria are biologically based measures of population viability, integrated across populations to the level of the ESU. An ESU that meets all its biological delisting criteria is no longer considered threatened or endangered and can be delisted, provided that *administrative delisting criteria* (see below) are also met.

ESA delisting criteria

Meeting *biological delisting criteria* is a necessary but not sufficient condition before delisting can occur; two *administrative delisting criteria* must also be met. These criteria are:

1) Assurance that the factors that have led to the decline and/or are limiting recovery of listed species have been addressed. This criterion is important to guard against delisting based on an apparent recovery that is actually due primarily to a period of favorable environmental conditions.

[2) Adequate provision for tribal treaty harvest, consistent with long-term conservation of natural populations at levels above the *biological delisting criteria*. This criterion is important to ensure that federal recovery planning efforts are compatible with the federal trust responsibility to the tribes.] [Note: see statement above in section on "Definitions of recovery and recovery goals" that provision #2 is not official agency policy at this point.]

Broad-sense recovery goals

Broad-sense recovery goals for salmon may reflect a variety of societal values in addition to biological attributes of the species. Broad-sense recovery goals will be considered in *Phase II* of recovery planning for salmon, and provisions to achieve selected broad-sense recovery goals may become part of the formal *ESA Recovery Plan*.

ESA Recovery Plan

An *ESA Recovery Plan* should provide a comprehensive road map that outlines how to achieve *ESA delisting criteria*, and perhaps other *broad-sense recovery goals* identified by recovery planners and policy makers. ESA Recovery Plans will be developed during *Phase II* of recovery planning and will involve both technical and policy considerations. The process for developing ESA Recovery Plans may differ across recovery domains and across ESUs within domains. In any event, Phase II TRT activities are expected to involve technical evaluations of the biological consequences of management actions proposed for inclusion in the Recovery Plan.

Viable Salmonid Populations (VSP)

The *Viable Salmonid Populations* paper describes the biological attributes of healthy salmon populations and more complex conservation units such as *ESUs*. The current VSP paper (McElhany et al. 2000) is revised from an earlier draft known as Properly Functioning Populations (PFP), which was widely circulated for comanager review in early 1999. The PFP/VSP concept originated as an analogue to the NMFS Northwest Region's concept of Properly Functioning Conditions (PFC), which describes attributes of habitat necessary to support salmon populations. The VSP paper provides guidance for setting population viability goals for abundance, trends/productivity, spatial distribution, and diversity; and for combining population evaluations into *biological delisting criteria* at the ESU level.