APPENDIX F

Setting Viable Salmonid Population Goals

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The National Marine Fisheries Service in the National Oceanic and Atmospheric Administration (NOAA Fisheries) has a Technical Recovery Team for the Lower Columbia River evolutionarily significant units (ESUs) of steelhead, Chinook and coho salmon. This team is responsible for setting viable salmonid population goals for the ESU. The City of Portland is working with the Technical Recovery Team to ensure that the City's watershed management efforts are consistent with salmonid recovery planning throughout the region.

Efforts to restore salmon (*Oncorhynchus* Sp.) populations in the Pacific Northwest have traditionally focused on the limiting factors—the bottlenecks—that restrict abundance. The assumption behind this approach was that abundance is the principal determinant of population performance. NOAA Fisheries now believes that recovery of viable salmonid populations must address not only the population parameter of abundance but also other important determinants of population health, such as productivity, diversity and spatial structure (McElhany and others 2000). When making listing decisions regarding Pacific salmonids, NOAA Fisheries' policy is to list ESUs as "distinct population segments" under the Endangered Species Act (McElhany and others 2000). However, there is wide recognition of the need to undertake conservation actions for all population sizes.

Population Performance Measures

NOAA Fisheries defines population performance measures in terms of four key parameters: abundance, productivity, spatial structure and diversity. These parameters are useful population viability guidelines for several reasons: (1) they are reasonable predictors of extinction risk (viability), (2) they reflect general processes (habitat quality, interactions with other species, etc.) that are important to all populations of all species, and (3) they are measurable (McElhany and others 2000). Finally, the parameters can be linked to salmonid life history and habitat relationships. Diversity can be discussed in the context of salmonid life histories, spatial structure can be described as the relationship between life histories and habitat and productivity depends on a network of complex and interconnected habitats that allows adaptations to occur. Together, they determine potential population productivity.

Guidelines for each of the four key parameters—abundance, productivity, spatial structure and diversity—have been defined by NOAA Fisheries (McElhany and others 2000). The parameters and guidelines for their application are described below.

Abundance

All else being equal, small populations are at greater risk than large populations because processes that affect population dynamics operate differently in small populations than they do in large populations. The following guidelines assess population viability based on

[1] This appendix is intended to present an overview of this subject. For more detailed information, readers should consult additional sources.

abundance. Two sets of guidelines are described below: viable size guidelines and critical size guidelines.

With respect to abundance, a population must meet all of the viable population guidelines to be considered viable. If a population meets even one critical guideline, that population is considered to be at a critically low level. NOAA Fisheries also requires that population status evaluations take uncertainty about abundance into account.

Because extinction risk depends largely on specific life-history strategies and the local environment, setting fish abundance levels will require the application of species- or population-specific information. No numerical criteria have been provided by NOAA Fisheries at this time (McElhany and others 2000).

Viable Population Size Guidelines. To be considered viable with respect to abundance, a population should:

- Be large enough to survive environmental variation of magnitudes observed in the past.
- Have sufficient abundance for any compensatory density-dependent processes that affect the population to provide resilience to environmental and anthropogenic perturbation. (An example of a compensatory process is where resources are not sufficient to support a population at a certain level of abundance. As the population decreases in abundance, the remaining members of the population are able to locate the necessary resources to meet critical needs).
- Be sufficiently large to maintain its genetic diversity over the long term.
- Be sufficiently abundant to provide important ecological functions in all the environments it occupies.

Critical Population Size Guidelines. A population would be critically low in abundance if:

- Depensatory processes were likely to reduce it below replacement. (Depensatory processes are processes—such as the ability to find a mate—that would result in decreased productivity with decreasing density. Conversely, compensatory processes are processes—such as competition for food or habitat—that result in an increase in productivity with decreasing density.)
- The population could not avoid the short-term effects of inbreeding depression or loss of rare alleles (genetic material).
- The variation in productivity as a result of demographic stochasticity became a substantial source of risk.

Productivity

Productivity over the entire life cycle is partially accounted for in the process of assessing abundance because abundance integrates productivity over time. The guidelines for productivity are closely linked with those for abundance.

Trends in abundance reflect changes in factors that drive a population’s dynamics and thus determine its abundance. NOAA Fisheries is most concerned with trends in abundance that reflect systematic changes in a population's dynamics. Negative trends in abundance are an indication of extinction risk for populations in decline—no matter what the cause. The guidelines presented below are often conditioned on a population's status in terms of abundance.

Productivity Guidelines. A viable salmonid population should:

- Have a natural productivity that is sufficient to maintain its abundance above the viable level.
- Exhibit sufficient productivity from naturally produced spawners to maintain population abundance at or above viability thresholds in the absence of hatchery subsidy. (This applies to salmonid populations that include naturally spawning hatchery fish.)
- Exhibit sufficient productivity during freshwater life-history stages to maintain its abundance at or above viable thresholds—even during poor ocean conditions.
- Not exhibit sustained declines in abundance that span multiple generations and affect multiple broodyear-cycles.
- Not exhibit trends in traits that portend productivity declines.

Spatial Structure

When evaluating population viability, it is important to take within-population spatial structure needs into account for two main reasons:

- Short-term observations of abundance and productivity may not be sensitive enough to detect the time lag between changes in spatial structure and species-level effects that may have an effect on the overall extinction risk at the 100-year time scale.
- Population spatial structure affects evolutionary processes and may therefore alter a population's ability to respond to environmental change.

A population's spatial structure is made up of both the geographic distribution of individuals within the population and the processes that generate that distribution. A population's spatial structure depends fundamentally on habitat quality, spatial configuration and dynamics, as well as the dispersal characteristics of individuals in the population.

Spatial scales that define habitat patches and subpopulation boundaries are not strictly defined here because such determinations are likely to be species- and population-specific. NOAA Fisheries has emphasized that salmonid spatial structure is not well understood, and there is currently no scientific consensus on what a "typical" spatial structure is (McElhany and others 2000). The guidelines below focus on key processes that are likely to be important in maintaining a viable spatial structure, regardless of population type.

Spatial Structure Guidelines

- Habitat patches should not be destroyed faster than they are created.

- Natural rates of straying among subpopulations should not be substantially increased or decreased by human actions.
- Some habitat patches that appear to be suitable or marginally suitable but currently contain no fish should be maintained.
- Source subpopulations should be maintained.

Diversity

In a spatially and temporally varying environment, diversity is important for species and population viability for three general reasons:

- Diversity allows a species to use a wider array of environments than it could without it.
- Diversity protects a species against short-term spatial and temporal changes in the environment. Fish with different characteristics have different likelihoods of persisting, depending on local environmental conditions. The more diverse a population is, the more likely it is that some individuals will survive and reproduce in the face of environmental variation (Primary Ecological Principle 7).
- Genetic diversity provides the raw material for surviving long-term environmental changes. Salmonids regularly face cyclic or directional changes in their freshwater, estuarine and ocean environments as a result of natural and human changes. Genetic diversity allows the species to adapt to these changes.

Diversity Guidelines

- Human-caused factors such as habitat changes, harvest pressures, artificial propagation and the introduction of exotic species should not substantially alter traits such as run timing, age structure, size, fecundity, morphology, behavior and molecular genetic characteristics.
- Natural processes of dispersal should be maintained. Human-caused factors should not substantially alter the rate of gene flow among populations.
- Natural processes that cause ecological variation should be maintained.
- Population status evaluations should take into account uncertainty about requisite levels of diversity.

As a result of these considerations, the City of Portland has established general fish and habitat goals for the Johnson and Tryon Creek watersheds that include the following population performance measures:

1. Habitat conditions in the Johnson Creek watershed allow fish populations to achieve the necessary abundance, productivity, spatial structure and diversity to promote the survival and recovery of listed species.
2. Habitat conditions in the Tryon Creek watershed allow fish populations to achieve the necessary abundance, productivity, spatial structure and diversity to promote the survival and recovery of listed species.

The City of Portland's Role

While the City of Portland does not have management authority over salmonid populations, it does maintain authority over infrastructure and land use decisions that affect habitat and ecological processes through planning, permitting and enforcement. NOAA Fisheries has indicated that while habitat characteristics are not part of the viability criteria, their effects are ultimately reflected in the four population parameters (McElhany and others 2000). For example, a population's spatial structure is to a large degree dictated by habitat structure. The spatial structure guidelines reflect this. As a result, the City of Portland believes that the viable salmonid population (VSP) population criteria can be met largely through the restoration of habitat functions.

NOAA Fisheries has indicated that an approach that delineates habitat standards that are related to the health of an entire salmon population must occur at a watershed or subwatershed scale—a larger spatial scale than is usually examined in habitat analyses (McElhany and others 2000). Most current habitat standards establish criteria at fine spatial scales—at the reach level or smaller. (An example is the Matrix of Pathways and Indicators in NOAA Fisheries' Properly Functioning Conditions [PFC] document [National Marine Fisheries Service 1996]).

If habitat standards can be developed at larger spatial scales, a better relationship between habitat and population levels can be established. Identification of the characteristics common to those subwatersheds that support high productivity, diversity, abundance and spatial structure will enable a set of watershed-level habitat goals to be developed.

The City of Portland recognizes that NOAA Fisheries and the Willamette Technical Recovery Team (TRT) must play a role in the development of these goals. The City has embarked on an ambitious schedule of data collection, planning and analysis that could inform these discussions. A combination of fish and habitat inventories are either under way or proposed; they include (1) a four-year Willamette River fish use study to determine how juvenile salmonids are using the variety of habitat types that exist in the lower river, (2) aquatic habitat inventories in all of Portland's watersheds, and (3) studies of salmonid presence and seasonal habitat use in all of Portland's tributary streams.

In addition, the City of Portland developed an analytical tool for use in the watershed management process presented in the *Framework for Integrated Management of Watershed Health*. The City of Portland adapted an Ecosystem Diagnosis and Treatment (EDT) model (Lichatowich and others 1995) to assist in the analysis of alternative recovery options. The City will work closely with NOAA Fisheries, the TRT and other interested parties to ensure that this approach is consistent with salmonid recovery planning goals throughout the region.