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NATIONAL MARINE FISHERIES SERVICE
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MEMORANDUM FOR: F/NW - William Stelle
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THRU: F/NWC - Usha Varanasi

FROM: F/NWC1 - Michael H. Schiewe

SUBJECT: Scientific Disagreements Regarding Steelhead Status Under the ESA

The following is a summary of issues related to five evolutionarily significant units (ESUs) of steelhead that have been proposed for listing under the Endangered Species Act (ESA) and for which there remain substantial scientific disagreements about biological data and its interpretation. These ESUs are: Lower Columbia River, Oregon Coast, Klamath Mountains Province, Northern California and Central Valley.

Sources for the information discussed below include public and peer-review comments received on the listing proposal.

I. Issues Relating to ESU definitions

I.1. Inclusion of summer and winter steelhead in the same ESU

I.1.A. The Oregon Department of Fish and Wildlife (ODFW), the California Department of Fish and Game (CDFG), public, and peer reviewers commenting on the Klamath Mountains Province (KMP) and West Coast Steelhead (WCS) proposed rules (16 March 1995 and 9 August 1996, respectively) objected to inclusion of summer and winter steelhead within the same ESU. The objections were based on several points. First, several of the commenters stated that NMFS was overly-reliant on genetic data, especially allozyme data, in determining which fish should be included in an ESU. They argued that diversity in life history traits such as run-timing may not be represented adequately by discrete genetic markers such as allozymes or mitochondrial-DNA (mtDNA). Some reviewers argued that the heritability of the summer and winter steelhead life histories indicate that there are probably genetic differences between the two forms that are not apparent from the electrophoretic data. In addition, many reviewers presumed that summer and winter steelhead are reproductively isolated from one another, and therefore they should not be included in the same ESU.

ESUs affected: Lower Columbia River, Oregon Coast, Klamath Mountains Province, and Northern California.

Comments: The Biological Review Team (BRT) has given considerable attention to the issue of life history variation in their evaluations of steelhead and other salmonid species. With respect to summer and winter steelhead, one of the key issues is the degree of reproductive isolation between the two forms where they co-occur. As this is difficult to evaluate directly in the field, genetic data can be (and have been) very useful in providing insight into population structure and isolation. To date, genetic data on summer and winter steelhead from the same area have been very limited. The Washington Department of Fish and Wildlife has provided new data on the genetic similarity between winter- and summer-run steelhead in the Lower Columbia River ESU. In addition, we have recently obtained samples of both summer and winter steelhead from the Alsea and Umpqua River drainages in the Oregon Coast ESU. Over the next several months we will complete genetic analysis of these and other new steelhead samples, and the results should provide a more comprehensive picture of the relationships between summer and winter steelhead in coastal ESUs.

I.2. Central Valley ESU configuration

I.2.A. There remains considerable scientific disagreement about the geographic boundaries of the Central Valley ESU(s). Some reviewers noted that there are extensive ecological differences (and likely genetic differences) among river basins within the Central Valley. These differences could reflect multiple ESUs with the region. Support for the argument for multiple ESUs includes 1) geological differences between the upper Sacramento River Basin (which drains the southern Cascade Mountain Range) and the lower Sacramento and San Joaquin River Basins (which drain the Sierra Nevada Mountain Range); and 2) the complex ecology of the region as indicated by the taxonomy of *O. mykiss*, which is represented by three subspecies of the resident form in the Sacramento-San Joaquin River Basin: Sacramento redband, coastal rainbow, and California golden trout.

Disagreements and uncertainty are greatest for the San Joaquin River basin. CDFG stated that steelhead were historically present in the basin; in contrast, several other reviewers stated that the San Joaquin River has never supported an anadromous population of steelhead. Even in areas that currently support steelhead, it is not clear whether the extant steelhead represent native populations

because of extensive hatchery fish plantings and widespread habitat destruction in the Central Valley rivers.

Comments: The BRT concluded that it is important to reconsider ESU configurations within the Central Valley, but that it was not possible to resolve this complex issue without pursuing some new sources of information. Over the next several months, we expect to complete genetic analyses of new steelhead samples from the Central Valley ESU, including both natural and hatchery populations. With this new information, we can better address questions regarding the genetic relatedness of wild and hatchery fish, the genetic similarity among naturally-spawning steelhead from different river basins within the Central Valley, and the origin (native or introduced) of steelhead populations. In addition, we can do a more rigorous evaluation of habitat and ecological characteristics throughout the region. In combination with the genetic data, this additional information will allow us to determine whether a finer-scale subdivision of the Central Valley ESU is warranted.

II. Issues Related to Risk Analysis

II.1. Disagreements about threatened/endangered status

II.1.A. ODFW reviewed the status of Oregon steelhead under its state ESA and concluded that a listing is not warranted for the Klamath Mountains Province ESU. ODFW also concluded that the Oregon Coast and Lower Columbia River ESUs are "sensitive" (indicating that the ESUs are more at risk than "not warranted" but less at risk than "threatened"). These conclusions disagree with the conclusions NMFS reached in its listing proposal for WCS.

ESUs affected: Klamath Mountains Province, Oregon Coast and Lower Columbia River

Comments: The ODFW conclusions are based on their recent, comprehensive status review for Oregon steelhead. This review included data for more recent years than were available to us in the 1995 status review, and it also made use of models recently developed by ODFW biologists to estimate abundance and extinction probability for each steelhead ESU. As we only received the model description and the status assessments in June 1997, we have not yet had an opportunity to adequately review them. Some of the key areas of scientific disagreement about risk analysis are discussed in more detail below.

II.2. Hatchery and Wild Steelhead Production

II.2.A. ODFW has revised estimates of the proportion of hatchery fish in steelhead runs in the Klamath Mountains Province, Oregon Coast and Lower Columbia River ESUs based on 1) new field data (creel surveys, scale analysis (1980-92), and dam counts based on hatchery return times), 2) expected responses to changes in hatchery programs implemented in 1994-96, and 3) assumptions about hatchery strays. These methods result in estimates of percent hatchery fish that are lower than those reported by NMFS in the Status Reviews (Busby et al. 1994, Busby et al. 1996).

ODFW did not agree with NMFS' use of estimates of the percentage of hatchery steelhead in a run based on "downstream fisheries," where hatchery steelhead tend to linger longer than do wild steelhead. Furthermore, ODFW believes that in some river basins, the proportion of hatchery steelhead was overestimated because the sampling period missed the peak wild steelhead runs.

The CDFG and several reviewers did not agree with NMFS' conclusions regarding the amount of hatchery infusion into natural steelhead populations throughout KMP and Northern California steelhead ESUs. The reviewers argued that there have not been extensive, recent steelhead hatchery plantings in most of California's smaller coastal rivers. They believe that available information does not support the Status Review's statement that there has been a substantial replacement of natural fish with hatchery fish throughout the ESUs.

ESUs affected: Northern California, Klamath Mountains Province, Oregon Coast and Lower Columbia River

Comments: The data ODFW used to generate the estimates of the proportion of hatchery steelhead in ESUs are new. ODFW assumed that estimates of strays from a few basins are representative of straying rates throughout the ESU. The straying estimates used in the status review (based on older ODFW data) were higher. We need more time to evaluate the relative merits of the different approaches to evaluating hatchery straying.

II.2.B. ODFW argued that NMFS' use of natural return ratios (NRRs) in the absence of information about habitat carrying capacity makes the interpretation of NRRs difficult. For example, one could conclude that an NRR that is less than one indicates that a population is not replacing itself and therefore is not self-sustaining. On the other hand, an NRR less than one also could indicate that the population is fluctuating around the equilibrium population abundance and

that production is temporarily decreasing, following a period of high production that the habitat capacity could not support (i.e., the NRR is dropping in response to a recent overshoot of the equilibrium abundance).

ODFW also argued that the assumptions needed to estimate NRR are not biologically realistic (i.e., populations are closed to immigrants and emigrants, per capita production of wild and hatchery spawners is the same, artificially-produced fish have no effect on wild fish production, and density-dependence is not important in determining overall production).

As an alternative to the NRR approach, ODFW used the models described above to predict spawner-recruit relationships and the equilibrium abundance (N*). ODFW found that in many river basins, their model of spawner-recruit relationships suggests that naturally-spawning hatchery steelhead augment wild steelhead runs above N*. From this result they concluded that in most cases, steelhead production is not dependent on hatchery fish for sustainability. Furthermore, ODFW argued that because there are healthy populations within some ESUs that do not contain hatchery fish, there is little evidence to support NMFS' statement that hatchery steelhead pose a risk to wild run productivity.

A peer reviewer reanalyzed trends in steelhead abundance and NRR in the KMP ESU, separating the years for analyses into pre- and post-hatchery influence. The peer reviewer concluded that there has been little or no detectable effect of the presence of hatchery fish on the sustainability of wild steelhead runs in this ESU. The reviewer also reanalyzed NRRs based on low vs. high assumed straying rates for hatchery fish and found that the NRRs were not significantly different from 1, no matter what the assumed straying rate was.

ESUs affected: Northern California Coast, Klamath Mountains Province, Oregon Coast and Lower Columbia River

Comments: Two factors--the dearth of reliable information on abundance of natural populations and a relatively high fraction of naturally spawning hatchery fish in many basins--greatly complicate extinction risk analyses for WCS. Because of these factors, the concept of the natural return ratio has played an important role in NMFS' steelhead status reviews, and it is a key issue for each of the ESUs under consideration here. In theory, the NRR is a key indicator of the sustainability of natural populations, which in turn is a key indicator of extinction risk for ESUs. However, calculating the NRR depends heavily on reliable estimates of the proportion of natural spawners that are of hatchery

origin, and there is considerable disagreement about how best to use available information to develop estimates of naturally spawning hatchery fish. Furthermore, interpreting NRRs in terms of sustainability requires additional information (or assumptions) about the reproductive success of naturally spawning hatchery fish--information that is almost never available.

The dramatic effect different assumptions can have on interpretations of the NRR is illustrated by an example from the KMP status review. NMFS computed an NRR of 0.47 for the Chetco River, based on an estimated 49% contribution of hatchery fish to the natural spawning population each year. At one extreme, under the assumption that hatchery fish have equal reproductive success to natural fish, an NRR of 0.47 indicates that the naturally-spawning fish are producing less than half an adult for every adult that spawned in the previous generation. Such a population would be in severe decline and at considerable risk. There are indications, however, that hatchery fish typically have reduced reproductive success when they spawn in the wild. Under the other extreme, assuming hatchery fish have no reproductive success when they spawn in the wild, then the spawner-recruit ratio for the natural component of the Chetco population would be nearly 1:1. Such a population would be relatively stable and not necessarily at any significant risk of extinction.

Given the extreme sensitivity of the NRR to various assumptions, it is of critical importance to determine which of the available methods for accounting for naturally spawning hatchery fish is the most reasonable to use at the present time. We have only recently received the ODFW report documenting their models and their suggested approach to this issue, and there has not been sufficient time for us to evaluate their models or to validate their results. For example, the data used to parameterize the models for the Oregon Coast ESU are from only a few rivers within the ESU, and they are considered by ODFW to represent the "highest quality" habitat available for steelhead. As ODFW acknowledges, whether this subset of populations within the Oregon Coast ESU are representative of the status of the ESU as a whole needs to be carefully evaluated.

ODFW's assertion that NRRs < 1 do not provide an unambiguous indicator of the sustainability of a population is only true if the NRRs fluctuate above and below 1 over time. We need to explore the pattern of NRRs over time in these ESUs in order to address this possibility. In addition, ODFW's use of N* as the target steelhead abundance assumes that present conditions allow an "acceptable" habitat capacity. In order to consider NRRs in the context of the overall population

equilibrium abundance, we need time to evaluate whether present habitat capacity (or some historical estimate of capacity) is an adequate benchmark for evaluating the status of steelhead in these ESUs.

II.3. Use of Angler Catch Data to Estimate Abundance

II.3.A. ODFW feels that angler catch data are not adequate for estimating steelhead population abundance. They argued that punch card data reflect primarily the abundance of hatchery fish because of the greater numbers of hatchery fish and because anglers focus on the hatchery portions of a run. Since wild steelhead can enter freshwater after the fishery closes, ODFW argued that the abundance estimates of wild fish (and resulting estimates of the NRR) will be underestimated. Furthermore, ODFW feels that there are inherent errors in punch card records, such as poor recording of the source streams for steelhead caught. Finally, there is uncertainty in abundance estimates due to variation in harvest rates, such as typically lower catch rates in periods of very high or very low river flows.

In lieu of using angler catch data, ODFW used a combination of dam counts, new smolt abundance data, and estimates of spawner densities to parameterize models that were used to predict steelhead abundance in each ESU. Assuming a 10% harvest mortality rate, ODFW estimated wild steelhead escapement and then used a Ricker-recruitment model to estimate the threshold carrying capacity (the number of spawners above which recruitment/spawners is < 1). They then estimated the spawner abundance at which maximum recruitment occurs (Rmax) and used the difference between the observed abundance data and the predicted Rmax to evaluate the extinction risk for each ESU.

ESUs affected: Klamath Mountains Province, Oregon Coast and Lower Columbia River

Comments: The scientific disagreement is over which method--angler catch data (with all of its limitations) or ODFW's modeling approach (an as-yet unvalidated model parameterized with data from a subset of streams within each ESU)--provides a better estimate of population trends for steelhead. This issue is critical to resolve to ensure the most reliable evaluation of extinction risk. The new ODFW data (smolt abundance from 3 rivers in the KMP ESU and more recent estimates of adult abundance from a subset of river basins in all 3 ESUs) need to be reviewed in conjunction with a detailed evaluation of their modeling approach.

III. Summary

The ESUs considered here were all proposed for listing by NMFS in the August 1996 listing proposal for WCS, which was based primarily on BRT conclusions reached in April 1995. Declining abundance and pervasive opportunities for deleterious effects of hatchery fish were important factors in the risk analyses for each of these ESUs. NMFS now has access to three additional years of abundance data which have been submitted by various parties, as well as data now available on the Streamnet database. These extensive new data mandate a thorough reevaluation of the status of each of these ESUs. In addition, serious scientific disagreements have been raised about the methods NMFS used to estimate abundance and trends and to evaluate the effects of hatchery fish in the risk analyses. These critical issues require careful consideration to identify the most reasonable approach.

The BRT has reached conclusions about the status of five ESUs of steelhead that were proposed for listing in 1996: Upper Columbia River, Snake River Basin, Central California Coast, South-Central California Coast, and Southern California (BRT Report memo from M. Schiewe to W. Stelle and W. Hogarth, 7 July 1997). Although there are also some scientific disagreements and uncertainties associated with these ESUs, the BRT concluded that the risks were clear and substantial enough that any additional information that might be developed over the next several months would not be likely to change the BRT conclusions. The ESUs considered here differ from this former group in two important ways: 1) overall abundance of steelhead is generally much higher (and therefore risks are not always so obvious), and 2) hatchery production plays a much bigger role. [The exception to the above is the Central Valley ESU, for which scientific disagreements focus on the ESU determination rather than risk analysis.] Together, these factors make it very difficult to conduct extinction risk analysis for these latter ESUs. Given the volume of new information to consider, and the importance of critically evaluating the new (June 1997) ODFW models of extinction risk for steelhead, we will require an additional several months to complete our evaluations.

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