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THRU: F/NWC – Usha Varanasi

FROM: F/NWC1 – Michael H. Schiewe

SUBJECT: Status of Deferred and Candidate ESUs of West Coast Steelhead

The Biological Review Team (BRT) for the west coast steelhead status review met in Seattle 20-21 November 1997 to discuss comments and new information received by NMFS since the status review was completed in 1995 and the listing proposal was announced in 1996. The BRT discussions focussed on five evolutionary significant units (ESUs) whose final listing determinations were deferred for 6 months because of substantial scientific disagreements. These deferred ESUs are Lower Columbia River, Oregon Coast, Klamath Mountains Province, Northern California, and Central Valley. In addition, the BRT also considered the status of the Middle Columbia River ESU, which was identified as a candidate species by NMFS in 1996, and the Upper Willamette River, which has been identified as a sensitive species by the Oregon Department of Fish and Wildlife.

Attached is the BRT report, "Status Review Update for Deferred and Candidate ESUs of West Coast Steelhead." The report contains a summary of new information received, peer review and public comments, and the conclusions of the BRT. The BRT is presently considering the ESU status of hatchery populations associated with ESUs that were proposed for listing in 1996; BRT conclusions will be summarized in a subsequent report.

Please contact either Dr. Robin Waples or myself if you have any questions about this report.

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Status Review Update for Deferred and Candidate ESUs of West Coast Steelhead

(Lower Columbia River, Upper Willamette River, Oregon Coast, Klamath Mountains Province, Northern California, Central Valley, and Middle Columbia River ESUs)

Prepared by the
West Coast Steelhead Biological Review Team*

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SUMMARY

The Biological Review Team (BRT) for the west coast steelhead status review met in Seattle, 20-21 November 1997, to discuss new information received regarding the status of seven evolutionarily significant units (ESUs) under the Endangered Species Act (ESA).

Five of the ESUs considered were deferred from listing in August, due to substantial scientific disagreement (Lower Columbia River, Oregon Coast, Klamath Mountains Province, Northern California, and Central Valley). The Middle Columbia River ESU, which was designated a candidate species in August 1996, was also considered by the BRT. Additionally, the BRT revisited the Upper Willamette River ESU due to new abundance information and concern expressed by ODFW regarding the viability of this ESU. The conclusions of the BRT are summarized below.

Species Issues Considered

Summer and Winter Steelhead

The BRT considered new genetic information on co-occurring summer and winter steelhead populations within the Siletz and Umpqua River Basins in Oregon, as well as previous information from the Rogue River. The BRT concluded that summer and winter steelhead should be considered part of the same ESU in geographic areas where they co-occur and did not make any changes in ESU definitions for the ESUs containing both summer and winter steelhead.

Central Valley ESU

The BRT concluded that it was likely that, historically, more than one ESU of steelhead occurred in the Central Valley. Several different two- or three-ESU scenarios were proposed and discussed, but given the existing information the BRT could not reach agreement on the number of historic ESUs or their boundaries. The BRT concluded that, at least until better information is developed, steelhead in the Central Valley should be considered part of a single ESU.

Risk Assessment Issues

Deferred ESUs

Lower Columbia River--This ESU was proposed threatened in August 1996. The BRT concluded that this ESU remains at risk of endangerment.

Oregon Coast--This ESU was proposed threatened in August 1996. The BRT concluded that this ESU is not at risk of endangerment at this time. This conclusion was based on updated

abundance data for a few streams in the ESU, all of which showed moderately increasing or stable trends in abundance. In addition, the estimated proportion of hatchery fish in natural escapements has declined since the initial status review, due in part to recently implemented changes in hatchery release practices in some Oregon coastal streams.

Klamath Mountains Province--This ESU was proposed threatened in March 1995. The BRT concluded that this ESU remains at risk of endangerment.

Northern California--This ESU was proposed threatened in August 1996. The BRT concluded that this ESU remains at risk of endangerment.

Central Valley--This ESU was proposed endangered in August 1996. The BRT concluded that this ESU remains at risk of extinction.

Risk Assessment for Other ESUs

Upper Willamette River ESU--This ESU was determined to be not warranted for listing in August 1996. Based on updated information regarding abundance and trends for the natural, late-running winter steelhead that comprise this ESU and concerns over potential genetic interactions among the native steelhead and introduced hatchery stocks of early-run winter steelhead and summer steelhead, the BRT unanimously determined that this ESU is at risk of endangerment.

Middle Columbia River ESU--This ESU was designated a candidate species in August 1996. Based on updated information on abundance and declining trends of wild steelhead and increased straying of non-native steelhead into the Deschutes River, the BRT unanimously determined that this ESU is at risk of endangerment.

INTRODUCTION

In February 1994, the National Marine Fisheries Service (NMFS) received a petition seeking protection under the U.S. Endangered Species Act (ESA) for 178 populations of steelhead (anadromous *Oncorhynchus mykiss*) in Washington, Idaho, Oregon, and California. At the time, NMFS was conducting a status review of coastal steelhead populations (*O. m. irideus*[1]) in Washington, Oregon, and California. In response to the broader petition, NMFS expanded the ongoing status review to include inland steelhead (*O. m. gairdneri*) occurring east of the Cascade Mountains in Washington, Idaho, and Oregon. The results of the status review were published in Busby et al. (1996).

The ESA allows listing of "distinct population segments" of vertebrates as well as named species and subspecies. The policy of NMFS on this issue for anadromous Pacific salmonids is that a population will be considered "distinct" for purposes of the ESA if it represents an evolutionarily significant unit (ESU) of the species as a whole. To be considered an ESU, a population or group of populations must 1) be substantially reproductively isolated from other populations, and 2) contribute substantially to the ecological or genetic diversity of the biological species. Once an ESU is identified, a variety of factors related to population abundance are considered in determining whether a listing is warranted.

On 9 August 1996, NMFS published a federal register notice describing 15 evolutionarily significant units (ESUs) for west coast steelhead from the states of Washington, Idaho, Oregon, and California (NMFS 1996). The notice included a *proposed rule* to list 10 steelhead ESUs as threatened or endangered under the ESA and designated one ESU as a candidate for listing (Table 1). This proposal was largely based upon the status review conducted by the west coast steelhead biological review team (BRT) convened by NMFS (Busby et al. 1996). The BRT met in June 1997 to discuss comments and new data received in response to the proposed rule to determine if new information warranted any modification of the conclusions of the original BRT. The BRT reached final conclusions on the following ESUs: Central California Coast, South-Central California Coast, Southern California, Upper Columbia River, and Snake River Basin. For the five remaining ESUs proposed for listing, substantial scientific issues and disagreement existed which the BRT hoped to resolve with new information being developed. On 18 August 1997, NMFS published a *final rule* (NMFS 1997a) to list two steelhead ESUs as endangered and three ESUs as threatened. At that time, NMFS also announced a six-month extension of the

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[1]West coast steelhead include two major genetic groups: the *inland* and *coastal* groups, generally separated in the Fraser and Columbia River Basins in the vicinity of the Cascade crest (see Busby et al. 1996). Behnke (1992) has proposed that the two groups, including anadromous and nonanadromous forms, should be considered subspecies and suggested the names *O. mykiss irideus* and *O. m. gairdneri* for the coastal and inland forms, respectively.

listing determinations for five additional ESUs, based on substantial scientific disagreements over available data (NMFS 1997b, see also Schiewe 1997b).

The Biological Review Team (BRT) for west coast steelhead met in November 1997 to discuss new information on steelhead received since June 1997. This document summarizes the issues of scientific disagreement, new data and information received, and BRT conclusions on (1) the ESUs for which listing was deferred (Lower Columbia River, Oregon Coast, Klamath Mountains Province, Northern California, and Central Valley), (2) the ESU that was designated a candidate species (Middle Columbia River), and (3) the Upper Willamette River ESU, which was revisited by the BRT based on new abundance information and concern expressed by ODFW regarding the viability of this ESU (ODFW 1997, see also Chilcote 1997).

Summary of Previous Conclusions

The conclusions from the 1996 status review (Busby et al. 1996) for the seven ESUs being considered in this document are briefly presented below.

Resident Fish

The BRT concluded that, in general, the ESUs described below include resident *O. mykiss* in cases where they have the opportunity to interbreed with anadromous fish. Resident populations above long-standing natural barriers, and those that have resulted from the introduction of non-native rainbow trout, would not be considered part of the ESUs. Resident populations that inhabit areas upstream from human-caused migration barriers (e.g., Chief Joseph Dam, Columbia River; the Hells Canyon Dam complex, Snake River; Shasta Dam, Sacramento River; Friant Dam, San Joaquin River; and numerous smaller barriers) may contain genetic resources similar to those of anadromous fish in the ESU, but little information was available on these fish or the role they might play in conserving natural populations of steelhead. The BRT concluded that the status, with respect to steelhead ESUs, of resident fish upstream from human-caused migration barriers must be evaluated on a case-by-case basis as more information becomes available.

Coastal Steelhead ESUs Under Consideration

Lower Columbia River--This ESU occupies tributaries to the Columbia River between the Cowlitz and Wind Rivers in Washington and the Willamette and Hood Rivers in Oregon, inclusive. Excluded are steelhead in the upper Willamette River Basin above Willamette Falls (Upper Willamette River ESU), and steelhead from the Little and Big White Salmon Rivers, Washington (Middle Columbia River ESU). This ESU is composed of both winter and summer steelhead. Genetic data show distinction between steelhead of this ESU and adjacent regions, with a particularly strong difference between coastal and inland steelhead in the vicinity of the Cascade Crest. The majority of stocks for which we had data within this ESU had been declining in the recent past, but some had been increasing strongly. However, the strongest upward trends were either non-native stocks (Lower Willamette River and Clackamas River summer steelhead) or stocks that were recovering from major habitat disruption and were still at low abundance (mainstem and North Fork Toutle River). The data series for most stocks was quite short, so the preponderance of downward trends may have reflected the general coastwide decline in steelhead in recent years. The BRT concluded that the Lower Columbia River steelhead ESU was not in danger of extinction, but it was likely to become endangered in the foreseeable future. The latter conclusion was not unanimous, and there were two distinct minority opinions: one minority of the BRT concluded that there was little likelihood that this ESU will become endangered, while another minority was uncertain whether native steelhead still exist in this region.

Upper Willamette River--This ESU occupies the Willamette River, and its tributaries, upstream from Willamette Falls. The native steelhead of this basin are late-migrating winter steelhead, entering fresh water primarily in March and April. This unusual run timing appears to be an adaptation for ascending Willamette Falls, which function as an isolating mechanism for upper Willamette River steelhead. Early migrating winter steelhead and summer steelhead have been introduced to the upper Willamette River Basin; however, these non-native populations are not components of this ESU. Native winter steelhead within this ESU have been declining on average since 1971 and have exhibited large fluctuations in abundance. The main production of native (late-run) winter steelhead is in the North Fork Santiam River, where estimates of hatchery proportion in natural spawning range from 14% to 54%. The BRT concluded that the Upper Willamette steelhead ESU was neither in danger of extinction, nor likely to become endangered in the foreseeable future. The latter conclusion was not unanimous, and a minority of the BRT concluded that the small numbers and declining trend in the native stock, coupled with other risk factors, indicated a likelihood of becoming endangered.

Oregon Coast--This ESU occupies river basins on the Oregon coast north of Cape Blanco; excluded are rivers and streams that are tributaries of the Columbia River (ESU 3-Southwest Washington). Native Oregon Coast steelhead are primarily winter steelhead; native summer steelhead occur only in the Siletz and Umpqua River Basins. Recent genetic data for steelhead in this ESU show a level of differentiation from populations from Washington, the Columbia River Basin, and coastal areas south of Cape Blanco. Ocean migration patterns also suggest a distinction between steelhead populations north and south of Cape Blanco. Steelhead, as well as chinook (*O. tshawytscha*) and coho (*O. kisutch*) salmon, from streams south of Cape Blanco tend to be south-migrating rather than north-migrating. Most steelhead populations within this ESU had been declining in the recent past, with increasing trends restricted to the southernmost portion (south of Siuslaw Bay). There is widespread production of hatchery steelhead within this ESU, largely based on out-of-basin stocks, and approximately one-half of the streams (including the majority of those with upward trends) were estimated to have more than 50% hatchery fish in natural spawning escapements. Given the substantial contribution of hatchery fish to natural spawning throughout the ESU and the generally declining or slightly increasing trends, it was likely that natural stocks were not replacing themselves throughout the ESU. The BRT concluded that the Oregon Coast steelhead ESU was not in danger of extinction, but that it is likely to become endangered in the foreseeable future. The latter conclusion was not unanimous, with a minority of the BRT concluding that there is little likelihood that this ESU will become endangered.

Klamath Mountains Province--This ESU occupies river basins from the Elk River in Oregon to the Klamath and Trinity Rivers in California, inclusive. This ESU includes both winter and summer steelhead. Steelhead from this region are genetically distinct from populations to the north and south. The "half-pounder" life history is reported only from this region. The Klamath Mountains Province is a unique geographical area with unusual geology and plant communities. While absolute abundance of steelhead within the ESU remained fairly high, since about 1970 trends in abundance had been downward in most steelhead populations for which we had data, and a number of populations were considered by various agencies and groups to be at some risk of extinction. Declines in summer steelhead populations were of particular concern. This ESU was previously studied under a separate status review that was completed in December 1994 (Busby et al. 1994). The BRT previously concluded that this ESU was not in danger of extinction, but that it was likely to become endangered in the foreseeable future (Busby et al. 1994).

Northern California--This ESU occupies river basins from Redwood Creek in Humboldt County, California south to the Gualala River, inclusive, and includes winter and summer steelhead. Allozyme and mitochondrial DNA data indicate genetic discontinuities between steelhead of this region and those to the north and south. Freshwater fish species assemblages in this region are derived from the Sacramento River Basin, whereas streams to the north include fishes representative of the Klamath-Rogue ichthyofaunal province. Population abundances were very low relative to historical estimates, and recent trends were downward in stocks for which we had data, except for two small summer steelhead stocks. Summer steelhead abundance was very low. Risk factors identified for this ESU include freshwater habitat deterioration due to sedimentation and flooding related to land management practices and introduced Sacramento squawfish as a predator in the Eel River. For certain rivers (particularly the Mad River), the BRT was concerned about the influence of hatchery stocks, both in terms of genetic introgression and potential ecological interactions between introduced stocks and native stocks. The BRT concluded that the Northern California steelhead ESU was not presently in danger of extinction, but that it was likely to become endangered in the foreseeable future.

Central Valley--This ESU occupies the Sacramento and San Joaquin Rivers and their tributaries. Recent allozyme data show that samples of steelhead from Deer and Mill Creeks and Coleman National Fish Hatchery on the Sacramento River are well differentiated from all other samples of steelhead from California. The Sacramento and San Joaquin Rivers offer the only migration route to the drainages of the Sierra Nevada and southern Cascade mountain ranges for anadromous fish. The distance from the ocean to spawning streams can exceed 300 km, providing unique potential for reproductive isolation among steelhead in California. Steelhead have already been extirpated from most of their historical range in this region. Habitat concerns in this ESU focussed on the widespread degradation, destruction, and blockage of freshwater habitats within the region, and the potential results of continuing habitat destruction and water allocation problems. The BRT also had a strong concern about the pervasive opportunity for genetic introgression from hatchery stocks within the ESU, and a strong concern for potential ecological interactions between introduced stocks and native stocks. The BRT concluded that the Central Valley steelhead ESU was in danger of extinction.

Inland Steelhead ESU Under Consideration

Middle Columbia River--This ESU occupies the Columbia River Basin from above the Wind River in Washington and the Hood River in Oregon upstream to include the Yakima River, Washington. Steelhead of the Snake River Basin are not included. This ESU includes the only populations of winter inland steelhead in the United States, in the Klickitat River and Fifteenmile Creek. Some uncertainty exists about the exact boundary between coastal and inland steelhead, and the western margin of this ESU reflects currently available genetic data. There is good genetic and meristic evidence to separate this ESU from steelhead of the Snake River Basin. The boundary upstream of the Yakima River is based on limited genetic information and environmental differences including physiographic regions, climate, topography, and vegetation. All BRT members felt special concern for the status of this ESU, particularly Yakima River and winter steelhead stocks. Total steelhead abundance in the ESU appeared to have been increasing recently, but the majority of natural stocks for which we had data within this ESU had been declining, including those in the John Day River, which was the largest producer of wild, natural steelhead. There was widespread production of hatchery steelhead within this ESU, but it was largely based on within-basin stocks. Habitat degradation due to grazing and water diversions had been documented throughout the range of the ESU. The BRT concluded that the Middle Columbia steelhead ESU was not presently in danger of extinction, but reached no conclusion regarding its likelihood of becoming endangered in the foreseeable future. All BRT members felt special concern for the status of this ESU and concluded that NMFS should carefully evaluate conservation measures affecting this ESU and continue monitoring its status.

ESU DEFINITIONS

As a result of comments from peer reviewers, comanagers, and the public following the proposed rule in August 1996 (NMFS 1996), the BRT determined that there were two major issues of scientific disagreement regarding the structure of the steelhead ESUs: the inclusion of summer and winter steelhead within the same ESUs and the configuration of the Central Valley ESU. In addition to the comments received, additional genetic data had become available since the original status review. The comments and new information considered, as well as the conclusions of the BRT on these issues are described below.

New Genetic Information

Since the 1996 status review, NMFS has continued to collect genetic data to obtain a more complete understanding of population structure of west coast steelhead. New allozyme data was collected from 19 *O. mykiss* populations originating from coastal Oregon and California (Table 2). These data were analyzed together with data from 36 samples from south of the Columbia River that were used in the 1996 status review (Busby et al. 1996). Nei's (1978) unbiased genetic distance values, computed from 51 polymorphic gene loci, were used to examine genetic relationships among populations. Patterns of genetic relationships among populations were evaluated using several methods, including dendrograms and multidimensional scaling plots.

The BRT reviewed the new genetic information to address two ESU related issues. The first issue was to reconsider ESU configurations within the Central Valley. Busby et al. (1996), using genetic data from two natural populations (Deer and Mill Creeks) and from the Coleman Hatchery population, found that the Sacramento River Basin samples form a coherent genetic group, distinct from other California steelhead. Following the status review, NMFS obtained new genetic samples to examine additional population structuring within the Central Valley. Of particular interest is the historical relationship of Sacramento River and San Joaquin River populations. NMFS collected genetic data from one new sample from a natural population in the San Joaquin River basin (Stanislaus River) and from three Sacramento River samples, including both natural and hatchery populations from the American River and from the Feather River Hatchery.

In our new analysis of steelhead population structure, all of the Central Valley samples, except for those from the American River, cluster closely together and form a genetic group distinct from all coastal samples. In contrast, the American River samples (Nimbus Hatchery and a sample of naturally spawned juveniles from the American River) cluster with samples from northern California populations and are genetically most similar to a sample from the Eel River. It is likely that the transfer of Eel River stock to the Nimbus Hatchery, and subsequent outplanting of Nimbus Hatchery fish into the American River, are responsible for the genetic associations of the American River populations.

In summary, genetic information does not provide evidence that steelhead from the Central Valley were historically derived from more than a single major genetic lineage. However, it would be premature to conclude from these data that significant differentiation did not occur historically within the Central Valley. Only a single sample of natural fish has been examined from the San Joaquin River basin, and the relationship of the current population in the Stanislaus River to historic populations has not been clearly established.

The BRT reviewed a new report (Nielsen 1997) on genetic variation in *O. mykiss* from a total of 29 hatchery and natural fish sampled from the Mokelumne River of the San Joaquin River basin. Nielsen examined variation in the 5' D-loop region of mitochondrial DNA (mtDNA) and 10 nuclear microsatellite loci. The Mokelumne River samples were compared to samples of steelhead from coastal California and to rainbow trout hatchery strains commonly used for stocking in Central Valley rivers. The Mokelumne River samples were genetically closest to Mount Shasta Hatchery trout, which Nielsen noted may reflect recent hatchery stocking or a shared lineage between the two populations. However, Nielsen also found a genetic association between the Mokelumne River samples and northern California steelhead and suggested that Mokelumne River trout may have been derived from a mixture of anadromous and/or freshwater source populations. Nielsen concluded that genetic analysis of additional samples are needed to help resolve the evolutionary status of Central Valley steelhead.

The BRT also used new genetic information to review a second ESU issue: the inclusion of both summer and winter steelhead in some ESUs. New genetic data were collected from samples of both summer and winter steelhead hatchery populations from the Siletz and Umpqua Rivers of the Oregon Coast ESU. Two of these samples, Siletz summer steelhead and North Umpqua winter steelhead, are from hatchery populations which have been propagated for several decades. The other two samples, Siletz winter steelhead and Umpqua summer steelhead, are from new hatchery programs derived from wild broodstock. In our new analysis, all four of the samples from the Siletz and Umpqua Rivers cluster with a large genetic group of samples from Oregon coastal rivers. This genetic group contains all of the samples from populations in the Oregon Coast ESU. The two Umpqua River samples are genetically most similar to each other, while the two Siletz River samples do not cluster closely to any other samples.

In summary, the new genetic data support a definition of the Oregon Coastal ESU based on a geographic distribution of genetic variation. Genetic differentiation between summer and winter steelhead occurs at a smaller scale than differentiation between ESUs. In particular, the BRT found no evidence for a close genetic relationship among summer-run populations in the Siletz and Umpqua Rivers. Significant allele frequency differences were found between summer- and winter-run hatchery populations in the Siletz River. This may reflect some degree of historic isolation between the two life history forms within the basin, or it may reflect more recent divergence of the hatchery summer run population, which has been cultured for two decades.

The BRT also reviewed a recent report (Phelps et al. 1997) which addressed the genetic relationships between summer and winter steelhead in Puget Sound and the lower Columbia River. This report updates earlier studies by WDFW which described steelhead Genetic Diversity Units (GDUs) within Washington State (Phelps et al. 1994 and Leider et al. 1995). Phelps et al. (1997) concluded that summer and winter run steelhead which occur within a geographic area are part of the same GDU.

Summer and Winter Steelhead

Eight of the fifteen west coast steelhead ESUs contain both summer and winter steelhead ecotypes (Table 3). The Oregon Department of Fish and Wildlife (ODFW), California Department of Fish and Game (CDFG), and some public and peer reviewers commenting on the Klamath Mountains Province ESU and West Coast Steelhead proposed rules (NMFS 1995, 1996) objected to the inclusion of both summer and winter steelhead within the same ESUs. 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 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.

Of the eight ESUs having both summer and winter steelhead, five were either proposed for listing or designated candidate species (Lower Columbia River, Oregon Coast, Klamath Mountains Province, and Northern California, Middle Columbia River). The scientific disagreement summarized above was an issue in extending the final listing decision for these ESUs.

The issue of reproductive isolation under NMFS' species policy has always been one of degrees. Isolation does not have to be absolute, but it must be strong enough to permit evolutionarily important differences to accrue in different population units.

Steelhead enter fresh water throughout the year and while summer steelhead migrate earlier than winter steelhead, there is no absolute point of separation between the two. Generally, summer steelhead are defined as entering fresh water between May and October; winter steelhead are defined as entering fresh water between November and April. More important to the issue of reproductive isolation is the spawn timing of steelhead populations. Despite the difference in migration timing, there is generally a substantial overlap in spawn timing between summer and winter steelhead within a geographic region (see Busby et al. 1996, table 3).

The greatest potential for reproductive isolation between summer and winter steelhead lies in spatial isolation. It appears that the summer steelhead occur where habitat is not fully utilized by winter steelhead; summer steelhead usually spawn farther upstream than winter steelhead (Withler 1966, Roelofs 1983, Behnke 1992). In rivers where the two types co-occur, they are often separated by a seasonal hydrologic barrier, such as a waterfall.

Discussion and BRT Conclusions on Summer and Winter Steelhead

The BRT recognizes that, despite opportunities for interbreeding, some degree of reproductive isolation can and probably does occur between summer and winter steelhead in the same geographic area. Studies have shown that run-time differences can have a heritable as well as environmental component, and the BRT considers both life history forms (summer and winter steelhead) to be important components of diversity within the species. However, the new genetic data reinforce the point, demonstrated in previous analyses, that within a geographic area, summer and winter steelhead typically are more genetically similar to one another than either is to populations with similar run timing in different geographic areas. This indicates that a conservation unit that included summer-run populations from different geographic areas but excluded winter-run populations (or vice-versa) would be an inappropriate unit. The only biologically meaningful way to have summer and winter steelhead populations in separate ESUs would be to have a very large number of ESUs, most consisting of just one or a very few populations. This would be inconsistent with the approach NMFS has taken to defining ESUs in other anadromous Pacific salmonids and, we believe, inconsistent with the intent of the ESA as well.

Taking these factors into consideration, the BRT concluded that summer and winter steelhead should be considered part of the same ESU in geographic areas where they co-occur and did not make any changes in ESU definitions for the eight ESUs containing both summer and winter steelhead.

Central Valley ESU

After the BRT met in June 1997, there remained 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 Range) and the lower Sacramento and San Joaquin River Basins (which drain the Sierra Nevada); 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 were 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 was not clear whether the extant populations represent native populations because of extensive hatchery fish plantings and widespread habitat destruction in the Central Valley rivers.

Ecological Information

Geology--California's Central Valley is known to geologists as the "Great Valley." The valley is bounded on the east by the volcanic Cascade Range (including Mt. Shasta and Lassen Peak) and the uplifted Sierra Nevada. The western boundary is formed by the Klamath Mountains (possibly displaced from the Sierra Nevada by the formation of the Cascade Range, Kreissman 1991) and the Franciscan Coast Ranges

Hydrology--The U.S. Geological Survey (USGS) has delineated three hydrologic subregions within the Central Valley. These are comprised of the Sacramento River Basin, the San Joaquin River Basin and the Kings and Kern River Basins. The Sacramento River Basin subregion is further divided into two smaller units, above and below Shasta Dam. The upper Sacramento River unit includes the McCloud and Pit Rivers. The lower Sacramento River unit includes the Feather, Yuba, and American Rivers. The boundary between the upper and lower

Sacramento River hydrologic subregions is consistent with the location of Lassen Peak, the southernmost of the Cascade Range volcanoes[2]. The San Joaquin River Basin includes the Mokelumne, Tuolumne, Stanislaus, and Merced Rivers.

Ecoregions--Omernik (1987) delineated 3 ecoregions within the freshwater distribution of Central Valley steelhead based on soils, land use, land surface form, and potential natural vegetation. These are described below.

Sierra Nevada (#5)--This ecoregion is comprised of portions of the Klamath, Sierra, Trinity, and Siskiyou Mountains. Annual rainfall varies considerably, from 40 to over 150 cm, depending on elevation and the degree of rainshadowing. Most of the rain comes in the winter months, with summers being hot and dry. Topographically, the region rises to over 2,000 m with an average elevation of 1,000 m. This region contains the headwaters for the Rogue, Klamath, and Sacramento Rivers. Peak flows occur in February, with low flows in August, September, or October. As a result of water diversion and impoundment activities, flows are now more evenly apportioned throughout the year. This has occurred primarily through irrigation/flood mitigation-related reductions in peak flows and less so through increased spillage during the historical time of minimum flows.

Douglas fir is the predominant tree species, but mixed coniferous-oak stands are common. Soils tend to be unstable, and timber harvest or livestock grazing can result in severe erosion. Hydraulic placer mining has had a considerable impact on stream quality and hillslope stability.

Southern and Central California Plains and Hills (#6)--To the east and in the rainshadow of the Coastal Mountain range, the tablelands and hills of this region have generally low levels of annual rainfall (40-100 cm). Tributary rivers to the Sacramento and San Joaquin Rivers flow through this region. Vegetation is composed of California oaks and manzanita chaparral with extensive needlegrass steppe. Livestock grazing in the open woodlands is the predominant land use.

Central California Valley (#7)--The Sacramento and San Joaquin Rivers are the key features of the Central California Valley Ecoregion. The broad flat lands that border the river naturally support needlegrass and marshgrasses, although much of the region has been extensively converted to agricultural use. The annual rainfall for the region is 40-80 cm. The Sacramento and San Joaquin Rivers peak in February with a 6-month period of high flows (>50% of peak flow). Low flows occur in September and October. Changes in the hydrology of tributaries and irrigation withdrawals from the mainstem rivers have drastically altered the flow characteristics of these rivers over the course of the last 100 years. An estimated 90% of the surface water withdrawals were used for irrigation in 1987 (USGS 1990). The maintenance of

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[2]See the USGS Cascades Volcano Observatory internet site: http://vulcan.wr.usgs.gov/home.html. USGS/ David A. Johnston Cascades Volcano Observatory, 5400 MacArthur Blvd., Vancouver, Washington 98661. November 1997.

livestock and cultivation, irrigation, and chemical treatment of crop land has resulted in increases in fecal coliform, dissolved nitrate, nitrite, phosphorus, and sulfate concentration levels (USGS 1993). Industrial and mining runoff from sites, such as the copper mines near Spring Creek in the Sacramento River Basin, also impact water quality in the immediate area.

Diversity of Central Valley *O. mykiss*

The Central Valley supports a variety of forms of the species *Oncorhynchus mykiss*. Coastal rainbow trout and steelhead (*O. m. irideus*), the same subspecies found in Washington and Oregon, occur throughout most of the Sacramento River Basin and into the San Joaquin River Basin.

Sacramento redband trout, are native to the McCloud and Pit Rivers of the upper Sacramento River. Behnke (1992) states that the fish collectively called Sacramento redband trout represent a "mosaic of diversity" and applies the name *O. m. stonei* as a matter of practicality, distinguishing these fish from the neighboring, possibly sympatric, coastal rainbow trout. Behnke (1992, 191) goes on to state that the "redband trout native to Sheepheaven Creek [McCloud River Basin] is sufficiently differentiated to justify recognition as a new subspecies, but the name would be applicable only to the Sheepheaven population." The U.S. Fish and Wildlife Service (USFWS) currently includes "McCloud Redband trout" *(O. mykiss ssp.)* as a candidate for listing under the ESA (USFWS 1997a); it is not clear if this is Behnke's *O. m. stonei* complex or just the Sheepheaven Creek subspecies (Sheepheaven Creek is a tributary of the McCloud River).

California golden trout (*O. m. aguabonita*) and Kern and Little Kern golden trout (*O. m. gilberti*, Behnke 1992) occur in the Kern River Basin at the southern end of the Central Valley. The Little Kern form may be a separate subspecies, *O. m. whitei*, this subspecies is listed under the ESA as threatened[3] (Behnke 1992).

Discussion and BRT Conclusions on the Central Valley ESU

The BRT had two questions to consider regarding the ESU issue for the Central Valley of California. The first was whether steelhead were native to the San Joaquin River Basin. The second question was whether steelhead in the Central Valley comprised a single ESU or multiple ESUs.

Recent observations resulting from monitoring efforts for chinook salmon document steelhead juveniles and/or adults in the lower San Joaquin River, the Stanislaus River, and the Merced River. These steelhead appear to represent natural production since hatchery releases in recent years have been made only into the Mokelumne River. CDFG has presented evidence that steelhead historically occurred in the San Joaquin River Basin, and historically there do not

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[3] The U.S. Fish and Wildlife Service lists the Little Kern golden trout subspecies as *O. aguabonita whitei* (see the USFWS internet site http://www.fws.gov/index.html).

appear to have been any obvious barriers to colonization of the basin by steelhead. The BRT noted that spring chinook salmon and steelhead have somewhat similar ecological requirements, and the San Joaquin River Basin historically supported large runs of spring chinook salmon. The BRT concluded that steelhead probably occurred historically in the San Joaquin River Basin.

The BRT also discussed the diversity of ecological characteristics in the Central Valley of California. These characteristics can be evaluated on several levels. First, the Central Valley as a whole can be divided into three ecoregions based largely on elevation and associated changes in climate and rainfall: 1) a mountainous region, averaging about 1000 m elevation, that includes the headwaters of the Sacramento and tributaries to the San Joaquin Rivers; 2) a region of tablelands and hills at intermediate elevation, through which the tributary rivers flow; and 3) the valley itself, which includes broad, flat lands that border the Sacramento and San Joaquin Rivers. Geologically, the upper Sacramento River Basin, which arises from the volcanic Cascade Range, differs from the lower Sacramento and San Joaquin River Basins, which flow out of the northern and southern Sierra Nevada. The upper Sacramento River Basin is also hydrologically distinctive, and it supports native subspecies of resident *O. mykiss*. The southern part of the San Joaquin River Basin is also very distinct ecologically, although it is not clear that this area has ever supported steelhead populations.

Limited run-timing information suggests there may have been historic differences between populations in the Sacramento River Basin, three distinct runs may have occurred there as recently as 1947 (McEwan and Jackson 1996), including a summer run in the American River (Cramer et al. 1995, McEwan and Jackson 1996) but the data are far from conclusive. Currently, CDFG considers all Central Valley steelhead to be winter steelhead (McEwan and Jackson 1996), others call them fall-run steelhead (Cramer et al. 1995).

Genetic data indicate that, as a group, Central Valley steelhead are quite distinct from all coastal populations. However, existing data are not very informative regarding historic relationships among populations within the Central Valley. The single sample we have from the San Joaquin River basin is genetically similar to samples from Coleman Hatchery, Feather River Hatchery and Deer and Mill Creeks in the Sacramento River. It is not clear whether this reflects historic relationships or more recent effects of stock transfers and/or straying by hatchery fish.

After considering this information in the aggregate, the BRT concluded that it was likely that, historically, more than one ESU of steelhead occurred in the Central Valley. Several different two- or three-ESU scenarios were proposed and discussed, but given the existing information the BRT could not reach agreement on the number of historic ESUs or their boundaries. The BRT concluded that, at least until better information is developed, existing steelhead in the Central Valley should be considered a single ESU.

Oregon Coast--New resting hole counts of winter steelhead in the Wilson, Trask, and Nestucca Rivers (Streamnet 1997) indicate slight to moderate decreases in abundance for the fish in the Wilson (-1.8%) and Nestucca (-4.3%) Rivers, and a slight increase in the Trask (2.1% increase). Newly reported spawner surveys of winter steelhead in the Siletz (-4.2 %) and Salmonberry (-3.2%) Rivers indicate a moderate decline in abundance since the 1960s (Streamnet 1997). Juvenile abundance and smolt production for two small coastal tributaries (Cummins and Tenmile Creeks) from 1991 to the present also was provided to the BRT. These juvenile data suggest a relatively stable trend in abundance over the time period reported.

ODFW (Chilcote 1997) has provided the BRT with new estimates of the percentage of hatchery fish in natural spawning escapements in the ESU, and argues that the overall average is 23% of naturally spawning steelhead in the Oregon Coast ESU are of hatchery origin. This compares with a previous estimate of 52% in the original west coast steelhead status review (Busby et al. 1996). A number of ODFW's estimates are not well justified, or are based on projected changes in hatchery fish escapement due to recent or upcoming shifts in hatchery release practices. For these reasons, the updated estimates were viewed with caution.

Klamath Mountains Province--Counts for the natural portion of the winter-run steelhead on the upper Rogue River have declined by less than 1% per year, and counts for the total run have remained essentially unchanged over the past 11 years (1987-1997). Counts for the natural portion of the summer steelhead run on the upper Rogue River have increased by less than 1% per year (although this increase is not significantly different from zero) while counts for the total run have increased at a rate of slightly less than 3% per year over the past 11 years (1987-1997). Estimates of percent hatchery fish in the upper Rogue River spawning in the wild average 6% for winter steelhead and 27% for summer steelhead over the period 1983-1997 (Chilcote 1997).

The recent trends of estimates for natural and total run-size and escapement of winter steelhead on the Applegate River are not significantly different from zero. ODFW estimates of percent hatchery fish spawning in the wild average 34% over years 1983-1997 (Chilcote 1997).

Smolt trapping results in the Elk River between 1985 and the present suggest relatively stable trends in abundance (Chilcote 1997).

Within the Klamath River basin, returns to Iron Gate Hatchery have declined by about 5% per year, while returns to the Trinity River Hatchery show no significant short or long term trends.

The recent trend for natural winter steelhead run-size estimates above Willow Creek weir on the Trinity River has declined by about 12% per year, while the total run-size has declined by greater than 7% per year. The five-year geometric mean of percent hatchery steelhead spawning in the wild above Willow Creek weir on the Trinity River is 36%. In 1997, over 70% of wild spawning steelhead above Willow Creek weir were hatchery fish (CDFG 1997).

ODFW also argued that the assumptions needed to estimate NRR were 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 suggested 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 Klamath Mountains Province 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, irrespective of the assumed straying rate.

<u>Comments</u>--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 west coast steelhead. 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 River 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. NMFS did not receive the ODFW report (Chilcote 1997) documenting their models and their suggested approach to this issue with sufficient time to evaluate their models or to validate their results prior to the June 1997 BRT meeting. 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. NMFS needed 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, the BRT needed 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.

Use of Angler Catch Data to Estimate Abundance

ODFW stated 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 fresh water after the fishery closes, ODFW argued that the abundance estimates of wild fish (and resulting estimates of the NRR) will be underestimated. Further, ODFW argued 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.

Comments--The question of 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, needed to be carefully considered. This issue is critical to ensuring the most reliable evaluation of extinction risk. The new ODFW data (smolt abundance from 3 rivers in the Klamath Mountains Province ESU and more recent estimates of adult abundance from a subset of river basins in all 3 affected ESUs) needed to be reviewed in conjunction with an detailed evaluation of their modeling approach.

Approach to Risk Assessment

Two major types of information were considered in risk evaluations for steelhead: previous assessments that provided integrated reviews of the status of steelhead populations in our region, and data regarding individual elements of population status, such as abundance, trend, hatchery influence, and habitat conditions. See Busby et al. (1996) for a detailed discussion of the approach to risk analysis. Risk assessments for the west coast steelhead ESUs considered in this document were based on information developed during the status review, supplemented by comments from peer reviewers and the public and updated and new information provided by a number of sources (see details below).

A major problem in evaluations of risk for steelhead is combining information on a variety of risk factors into a single overall assessment of risk facing a population. Formal model-based population viability analysis (PVA) attempts to do this integration in a quantitative manner, resulting in a single estimate of extinction risk. Current models of salmonid populations are inadequate for this type of analysis. In the absence of integrative models, it is still possible to define criteria for some individual risk categories, and use these criteria to devise simple rules for categorizing risk levels; Allendorf et al. (1997) advocated such an approach. However, this limits assessment to those considerations for which adequate measurements are available for all population units under consideration. As our ability to measure some of the important risk factors is quite limited, and for other factors data are often lacking for the populations most at risk, methods are needed that allow inclusion of both quantitative and qualitative information. In this review, we have used a risk-matrix approach through which the BRT applied best scientific judgement to combine qualitative and quantitative evidence regarding multiple risks into an overall assessment. The matrix is more fully described in Appendix B.

It is also possible to construct simple demographic models to evaluate risks associated with population abundance, trend, and variability (e.g. Goodman in press). Such models can provide a partial quantification of risks if adequate data are available. We have not attempted to construct such models for this review but have considered results from such efforts where available (e.g. Emlen 1995; Ratner et al. 1997).

ODFW Data and Conservation Assessment

NMFS received a conservation status assessment of steelhead in Oregon from ODFW which contained new and updated data on abundance, estimates of the percentage of hatchery fish in natural escapements, and description of and results from a spawner-recruit model and an extinction risk model designed to predict the population trajectories of steelhead in a number of Oregon streams. ODFW's report concluded with an overall conservation status designation for each of the steelhead ESUs occurring in Oregon. A brief overview and evaluation of the ODFW report, based on comments from NMFS and a number of peer reviewers, are provided in Appendix A of this document.

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" and less at risk than "threatened"). These conclusions are not consistent with the conclusions NMFS reached in its listing proposal for west coast steelhead.

In summary, the BRT did not place much emphasis on the overall risk conclusions of the ODFW report, for three primary reasons. First, the extinction model is not validated and uncertainty associated with parameter estimation is not adequately addressed. The BRT felt that this uncertainty was especially important because models used for each ESU were based on empirical data from a very small subset of populations. These shortcomings make the results of the modeling exercise difficult to evaluate. Second, peer reviewers were critical of the approach ODFW used to combine scores from their five risk indicator categories. The five risk indicators (probability of extinction, shrinking distribution of populations, declines in abundance, minimum population abundance, and interbreeding with hatchery fish) were each given a score, and these individual scores were then averaged to produce an overall conservation risk score for each ESU. Averaging risk scores in this way can result in a substantial underestimate of overall risk to an ESU. Third, it is not clear how the risk categories used in the ODFW report relate to the definitions of endangered and threatened species in the Federal Endangered Species Act. The ODFW report states (Chilcote 1997; p. iii)

Oregon also has legal provisions enabling listing at risk species as endangered or threatened, as well as the less formal sensitive species designation. While the potential impact on human activities of state listings are less than at the federal level, there is still considerable interest in the criteria by which state listing decisions are made. A set of listing criteria for endangered, threatened, and sensitive species has been developed to clarify this decision process as it relates to steelhead, and to facilitate a consistent, quantitative approach to reviewing the status of steelhead in Oregon.

Since Oregon's endangered species legislation articulates different definitions of endangered and threatened than does the federal ESA, the BRT found it difficult to compare the conservation status assessments provided in the ODFW document with those previously made by NMFS (Busby et al. 1996).

In spite of these limitations of the ODFW report, the updated and new data sets and analyses it provided were very useful to the BRT in several instances. Specific examples of cases where ODFW's report proved to be influential in BRT conclusions are discussed in the ESU-specific sections below.

Population Abundance

Lower Columbia River--For the Lower Columbia River ESU, the BRT received either new or revised estimates for counts of winter and summer steelhead passing Powerdale Dam on the Hood River, and winter steelhead passing North Fork Dam on the Clackamas River and Marmot Dam on the Sandy River (Chilcote 1997). Counts of winter steelhead at Powerdale Dam are available for 1992-1997. The adult trapping facility is located on the Hood River at the dam-site, three miles upstream from the Columbia River. The 5-year geometric mean of these counts for "wild" fish is 309. The 5-year geometric mean for "total fish" is 574. The 5-year geometric mean for counts of "wild" summer steelhead in the Hood River is 229. The 5-year geometric mean for "total fish" is 1428.

Winter steelhead passing North Fork Dam on the Clackamas River prior to 31 March are presumed to be hatchery fish and those passing the dam after 31 March are presumed to be wild fish. This is based on the spawn timing of Big Creek Hatchery fish, which are the main winter steelhead hatchery stock released in the Clackamas River Basin. Some spawning may also occur below the dam. The 5-year geometric mean of winter steelhead at North Fork Dam is 900. For that portion of the run that migrates past North Fork Dam after 31 March the 5-year geometric mean is 590.

Prior to 1997, all winter steelhead passing Marmot Dam on the Sandy River before 1 March were assumed to be hatchery fish and those passing after 1 March were assumed to be wild fish. However, based on observation of fin-clips, analysis of fish passing Marmot Dam in 1997 indicated that 53% of fish counted prior to 1 March were hatchery fish and 32% counted at the dam after 1 March were hatchery fish. The difference between the total count and the hatchery estimate was taken to be the wild fish estimate. Chilcote (1997) then apparently used these 1997 observations to revise the wild and hatchery estimates for all years back to 1978 at Marmot Dam. Using these data, 5-year geometric mean of "wild" winter steelhead at Marmot Dam is 700 and the 5-year geometric mean of the total is 1,300.

The BRT also received updated abundance data for some streams in the Washington portion of the ESU region. Updated data (through 1996-97) for summer steelhead include smolt and adult abundance estimates from counts at Prosser Dam for the Yakima River (total escapement in 1995 was estimated at 451 steelhead), trap counts of adults for Kalama River (1991-96 average natural escapement = 1,100), and snorkel surveys of adults for the East Fork Lewis, Washougal and Wind Rivers (1991-96 average natural escapement = 85, 57 and 222, respectively; WDFW 1997). Snorkel surveys provide index counts for the rivers sampled, and are estimated to represent 25-70% of the natural escapement in each stream. All summer steelhead populations monitored in the Washington portion of the Lower Columbia River are below WDFW's natural escapement goals except the Kalama River run.

Winter steelhead abundance estimates were updated for the following Washington populations in the Lower Columbia River: Cowlitz, Coweeman, Toutle/North Fork Toutle, Green, South Fork Toutle, Kalama, North Fork Lewis, East Fork Lewis, Salmon Creek, Washougal, Hamilton and Wind Rivers. Abundance estimates for the Coweeman, North and South Fork Toutle, and Kalama Rivers are from trap and redd counts that represent the total natural escapement (1991-96 average ranged from 183 to 1,059). Abundance in the remaining rivers is estimated as indices only. Total escapements of naturally-spawning steelhead in the Washington rivers are below WDFW's escapement goals except in the Kalama River (WDFW 1997).

Upper Willamette River--The BRT received revised and some new estimates of winter steelhead abundance in the Upper Willamette ESU. Counts of adult winter steelhead above Foster Dam through 1997 in the upper South Santiam River show very low numbers in the past few years (131-311 wild fish in the last 5 years) (Chilcote 1997). Newly provided run reconstructions for winter steelhead in the Molalla, North Santiam, and South Santiam Rivers suggest moderate-sized runs in these streams (850-1,200 fish estimated in recent natural escapements) (Streamnet 1997). In addition, estimated indices of spawner abundance for the Calapooia River were provided by ODFW, and they indicate that the density of spawners has reached record low levels in the last 5 years (Chilcote 1997).

Oregon Coast--For the Oregon coast ESU, the BRT received revised estimates of spawner escapement of summer steelhead in the North Umpqua River based on counts of adults at Winchester Dam (Chilcote 1997). Data through 1997 indicated that natural escapement of summer steelhead has declined since the mid-1980s (from a high of over 5,000 fish), but has shown slight increases since 1994 (an average of 2700 summer steelhead have escaped to spawn during the period 1992-1997, 25% of which are of hatchery origin). Run reconstructions of "wild" winter steelhead in the North Umpqua indicate declines in abundance since the late 1980s (from a high of 9,600 fish), but they have increased slightly in abundance in recent years (a mean of 4,600 fish escaped to spawn during the period 1991-1997). ODFW provided the BRT with abundance indices from spawner surveys of the Salmonberry River from 1973 to the present; the average return index over this period has been approximately 40 winter steelhead per mile. No additional abundance data were provided for any of the other streams in the Oregon Coast ESU region.

Klamath Mountains Province--Within the Oregon section of the Klamath Mountains Province, the BRT received revised counts of winter and summer steelhead at Gold Ray Dam on the upper Rogue River through 1997, and run reconstruction data for winter steelhead for the years 1983-1997 on the Applegate River (a tributary of the Rogue River) (Chilcote 1997). From 1993 to 1997, counts of winter-run steelhead at Gold Ray Dam on the upper Rogue River ranged from 3,000-11,000 natural steelhead and 3,900-13,600 fish in the total run. Counts of summer steelhead between 1993 and 1997 at Gold Ray Dam on the upper Rogue River ranged from

2,300-5,500 for natural steelhead and 4,400-14,300 for the total run. The 5-year geometric mean of these counts for "wild" winter steelhead is 6,838. The 5-year geometric mean of these counts for "wild" summer steelhead is 3,885.

Although Applegate River winter steelhead are not counted directly, Chilcote (1997) provided estimates of wild and hatchery returns from 1983 to 1997 based on the following information. Chilcote (1997) stated that

> *Estimates for each year's return of wild fish to the Applegate River were made from the percentage of hatchery fish observed in fisheries near it's mouth, (an average of 63%) and the estimated return of hatchery fish to the basin in the same year.*

Based on this method of estimation, the 5-year geometric mean of these counts for "wild" winter steelhead escapement in the Applegate River is 906. Recent 5-year geometric mean of these counts for the total run-size estimate and total escapement are 2,500 and 1,200, respectively.

In addition, juvenile migrant traps have been operated in Hunter Creek and the Winchuck River in 1996-97. ODFW estimates that these traps sample approximately 50 and 61% of the production areas of Hunter Creek and Winchuck River, respectively. Expanded for the entire basins, the 2-year average smolt production for Winchuck River is 7,800 and for Hunter Creek, it is 6,600. ODFW (Chilcote 1997) estimates that these smolt abundances would translate to 650-700 adult steelhead returning to these basins, assuming a 10% ocean survival.

Within the California section of this ESU, the BRT received updated hatchery return data for Iron Gate and Trinity River Hatcheries (CDFG 1997, Rushton 1997); updated spawner surveys for 2 tributary reaches of the Smith River, 11 tributary reaches of the Klamath River, and 6 tributary reaches of the Trinity River (USFWS 1997b); and run reconstruction data for the Trinity River above the weir at Willow Creek (CDFG 1997). The 5-year geometric mean for returns of adult steelhead to Iron Gate (1993-1997) and Trinity River (1992-1996) Hatcheries in the Klamath River Basin are 90 and 750, respectively. The 5-year geometric mean (1992-1996) for fall steelhead above Willow Creek on the Trinity River is 4,500 (CDFG 1997). Five-year geometric means (1992-1996) of the estimated run size and escapement of natural fish above the Willow Creek weir are 2,000 and 1,800, respectively.

Spawner survey data of the Smith, Klamath, and Trinity Rivers consists of peak live fish counts conducted by snorkel from 1980 to 1996, and 1997 in some cases. These survey data have not been expanded to entire basins and therefore do not provide population abundance information, but it was possible to analyze trends in the data and these trends will be discussed in the next section.

Northern California--Few revised or new data were received by the BRT for the Northern California ESU. Abundance of winter and summer steelhead in the upper Eel River (based on dam counts) show a recent total (combined) run of 400 fish (Jones 1997, Streamnet 1997).

Central Valley--No new or updated data on steelhead abundance for the Central Valley ESU were received by the BRT.

Middle Columbia River--The BRT received new and updated data on summer steelhead abundance in the Middle Columbia River ESU. Updated dam counts from the Deschutes River show a 5-year geometric mean of approximately 9,700 summer steelhead in recent runs, corresponding to a natural escapement estimate of 1,400 fish (Streamnet 1997). For 1997, ODFW estimated that steelhead escapement above Sherars Falls included 17,566 stray hatchery steelhead and 1,729 wild Deschutes River steelhead (Chilcote 1997). Run reconstructions for the Yakima, John Day and Touchet Rivers estimate that recent natural escapements are 1,000, 10,000, and 300 steelhead, respectively.

Population Trends and Production

Lower Columbia River--From 1992 to 1997, winter and summer steelhead have been counted at Powerdale Dam on the Hood River, and they have experienced severe declines in abundance (-22 and -33% declines, respectively). Because of the short time period over which these counts have been made, the absolute magnitude of the declines was not weighed heavily. From 1993-1997, an estimated average of 83% of the summer steelhead returning to the Hood River were hatchery fish (Chilcote 1997). Estimates of the percent hatchery fish of total spawners have ranged from 30 to 68% for winter steelhead and 79 to 88% for summer steelhead in Hood River over this period.

The recent trend for naturally-spawning winter steelhead passing North Fork Dam on the Clackamas River indicates a 3% annual decline that is significantly different from zero. ODFW's estimates of percent hatchery fish spawning naturally in the Clackamas River average 30% over the past ten years. Big Creek Hatchery stock has been planted in this basin since the 1960s (Chilcote 1997). Summer steelhead are not native to the Clackamas River but a substantial number of the introduced Skamania summer steelhead stock spawns in the wild; summer steelhead were estimated to comprise 71% of the steelhead spawning in the Clackamas River in 1993 (Chilcote 1997). Because summer hatchery and wild winter steelhead overlap in spawning area and time in the Clackamas Basin and genetic data suggest that introgression between the two forms has occurred, ODFW (Chilcote 1997) analyzed the potential effects of hatchery summer steelhead on the productivity of winter steelhead in the Clackamas River. Their analysis suggests that non-indigenous hatchery steelhead reduce the potential productivity of winter steelhead by 27%.

The recent trend for "wild" winter steelhead passing Marmot Dam on the Sandy River indicates a 5% annual decline that is significantly different from zero. ODFW estimates of percent hatchery fish spawning in the wild average 43% over the past twenty years. Big Creek

Hatchery stock has been the primary source for winter steelhead plants in this basin (Chilcote 1997).

Summer steelhead populations in the East Fork Lewis, Washougal and Wind Rivers all have experienced declines in the last 5 years (WDFW 1997). Because of the pronounced decline in summer steelhead in the Wind River (-22.7% decline in abundance from mid 1980s to the present), WDFW downgraded the population status from "depressed" to "critical" in 1997. Winter steelhead escapements in the Kalama and North Fork Toutle Rivers appear to be increasing or stable; however, escapements in the other 5 winter steelhead stocks monitored in the Washington portion of the ESU have been declining since the late 1980s (range from -5 to -14% declines in abundance).

Numbers of hatchery smolts released into streams in the Washington portion of the Lower Columbia ESU were provided by WDFW (1997). The data indicate that widespread releases of winter and summer steelhead smolts still are occurring in the Coweeman, Cowlitz, Hamilton, Kalama, Lewis, Salmon, Washougal and Wind Rivers. From 1995-97, released hatchery fish range from 4,000 to 700,000 smolts released/river/year. The stock origins of released smolts are primarily from within the ESU. Estimates of the percent hatchery fish in natural escapements of summer steelhead runs in the last 5 years are: Kalama (22%), East Fork Lewis (27%), Washougal (0%), North Fork Washougal (50%), and Wind River (13%). The proportion of hatchery fish in natural escapements of winter steelhead in Washington streams also is high, with most recent 5-year average estimates ranging from 92% in the Cowlitz River, 77% in the Kalama, and 17% in the Green and South Fork Toutle Rivers. The exceptions are low percent hatchery estimates in the North Fork Toutle, Hamilton and Wind Rivers (0-1%) (WDFW 1997).

Upper Willamette River--Based on updated dam counts, the trends in abundance of winter steelhead in the upper South Santiam River are moderately downward over the long term (-6.3% 1960s-present), and there have been more severe declines in the last few years (-8.6%). Spawner surveys of winter steelhead in index areas in the lower South Santiam, Molalla, North Santiam and Calapooia Rivers also have shown consistent declines in abundance through 1997 (-3.1 to -6.4% declines). Updated run reconstructions for the Molalla, North Santiam, South Santiam and Calapooia Rivers suggest even more severe declines between 1980-94 (-7.1 to -12.6% drops in abundance).

New estimates of naturally-spawning hatchery fish in the Upper Willamette ESU have been provided by ODFW (Chilcote 1997). Based on adult trapping and recent/projected changes in hatchery practices in the Molalla and North Santiam Rivers, ODFW estimates that 24 and 17% of naturally spawning steelhead in these rivers are hatchery fish, respectively. Dam counts of hatchery fish on the South Santiam River suggest that the percentage of hatchery winter steelhead in natural spawning escapements is less than 5%. Finally, ODFW estimates that less than 5% of naturally-spawning winter steelhead in the Calapooia River are of hatchery origin, based on predictions about the incidence of strays.

Oregon Coast--New resting hole counts of winter steelhead in the Wilson, Trask, and Nestucca Rivers (Streamnet 1997) indicate slight to moderate decreases in abundance for the fish in the Wilson (-1.8%) and Nestucca (-4.3%) Rivers, and a slight increase in the Trask (2.1% increase). Newly reported spawner surveys of winter steelhead in the Siletz (-4.2 %) and Salmonberry (-3.2%) Rivers indicate a moderate decline in abundance since the 1960s (Streamnet 1997). Juvenile abundance and smolt production for two small coastal tributaries (Cummins and Tenmile Creeks) from 1991 to the present also was provided to the BRT. These juvenile data suggest a relatively stable trend in abundance over the time period reported.

ODFW (Chilcote 1997) has provided the BRT with new estimates of the percentage of hatchery fish in natural spawning escapements in the ESU, and argues that the overall average is 23% of naturally spawning steelhead in the Oregon Coast ESU are of hatchery origin. This compares with a previous estimate of 52% in the original west coast steelhead status review (Busby et al. 1996). A number of ODFW's estimates are not well justified, or are based on projected changes in hatchery fish escapement due to recent or upcoming shifts in hatchery release practices. For these reasons, the updated estimates were viewed with caution.

Klamath Mountains Province--Counts for the natural portion of the winter-run steelhead on the upper Rogue River have declined by less than 1% per year, and counts for the total run have remained essentially unchanged over the past 11 years (1987-1997). Counts for the natural portion of the summer steelhead run on the upper Rogue River have increased by less than 1% per year (although this increase is not significantly different from zero) while counts for the total run have increased at a rate of slightly less than 3% per year over the past 11 years (1987-1997). Estimates of percent hatchery fish in the upper Rogue River spawning in the wild average 6% for winter steelhead and 27% for summer steelhead over the period 1983-1997 (Chilcote 1997).

The recent trends of estimates for natural and total run-size and escapement of winter steelhead on the Applegate River are not significantly different from zero. ODFW estimates of percent hatchery fish spawning in the wild average 34% over years 1983-1997 (Chilcote 1997).

Smolt trapping results in the Elk River between 1985 and the present suggest relatively stable trends in abundance (Chilcote 1997).

Within the Klamath River basin, returns to Iron Gate Hatchery have declined by about 5% per year, while returns to the Trinity River Hatchery show no significant short or long term trends.

The recent trend for natural winter steelhead run-size estimates above Willow Creek weir on the Trinity River has declined by about 12% per year, while the total run-size has declined by greater than 7% per year. The five-year geometric mean of percent hatchery steelhead spawning in the wild above Willow Creek weir on the Trinity River is 36%. In 1997, over 70% of wild spawning steelhead above Willow Creek weir were hatchery fish (CDFG 1997).

New spawner survey data in the Middle and South Fork Smith River exhibited increasing trends between 1983 and 1996; however, these trends were not significantly different from zero. Eight of the ten spawner surveys conducted between 1980 and 1997 in tributaries of the Klamath River showed significant negative trends ranging from a 13% to a 9% annual decline. Of the two remaining spawner surveys on the Klamath River, one showed an increasing trend and one showed a decreasing trend, although these were not significantly different from zero. When combined, these spawner surveys data showed an annual decline of about 10% for the Klamath River Basin. Only 2 of the 5 data sets of spawner surveys conducted between 1980 and 1996 in the Trinity River Basin showed significant trends and these indicated a 21% and an 8% annual rate of increase. Of the three other trends, two were positive and one negative, although these were not significantly different from zero. When combined, these spawner surveys data showed an annual rate of increase of 9% for the Klamath River Basin.

Northern California--The BRT received updated and new data on trends in abundance for summer and winter steelhead in the Northern California ESU. Updated spawner surveys of summer steelhead in Redwood Creek, the south fork of the Van Duzen River (Eel River Basin), and the Mad River suggest mixed trends in abundance: the Van Duzen River fish decreased by -7.1% from 1980-96 and the Mad River summer steelhead have increased by 10.3% over the same time period (Streamnet 1997). The contribution of hatchery fish to these trends in abundance is not known.

New weir counts of winter steelhead in Prairie Creek (Redwood Creek Basin, Humboldt County) show a dramatic increase (over 36%) in abundance during the period 1985-1992 (Streamnet 1997). This increase is difficult to interpret because a major highway construction project during this time period resulted in intensive monitoring of salmonids in this basin and Prairie Creek Hatchery was funded to mitigate lost salmonid production. Therefore, it is unclear whether the increase in steelhead reflects increased monitoring effort and mitigation efforts or an actual recovery of Prairie Creek steelhead.

Central Valley--No new or updated data on steelhead trends or productivity for the Central Valley ESU were received by the BRT since the June 1997 meeting.

Middle Columbia River--Updated data on steelhead trends in abundance in the Middle Columbia River ESU were received by the BRT. Spawner surveys of winter steelhead in Fifteenmile Creek show a severe decline in abundance for the period 1985-1994 (-28.4%) (Streamnet 1997). Spawner surveys of summer steelhead in the Warm Springs and Umatilla Rivers suggest relatively little change in abundance (1.1 and -0.7% changes, respectively) (Streamnet 1997). Stream surveys of summer steelhead in select index areas from regions in the John Day River Basin suggest universal declines in abundance, ranging from -0.9 to -5.6% (Chilcote 1997).

ODFW provided the BRT with new estimates of the percentage of hatchery fish in natural spawning escapements for some Oregon streams in the Middle Columbia River ESU (Chilcote 1997). Mark-recapture and spawning survey data suggest that the percent hatchery fish in the

Deschutes has increased dramatically in recent years; the estimate for 1996-97 was that 71% of naturally-spawning fish are of hatchery origin. ODFW believes that most of these fish are strays from outside the river basin (Chilcote 1997). Estimates of percent hatchery fish in spawning escapements for the John Day and Walla Walla Rivers are 2-5% (based on stray estimates and trapping; Chilcote 1997). Summer steelhead counts past Threemile Dam on the Umatilla River suggest that an average of 36% of naturally-spawning steelhead in the river over the most recent 6 year period are from hatcheries.

Summary and Conclusions of Risk Assessments

Recent Events Considered

Recent events considered in the risk evaluation made by the BRT include Oregon's change in angling regulations in 1992, which required release of all wild steelhead caught by anglers. In addition, the states of Oregon and Washington recently (1995-present) have implemented changes in hatchery release practices (i.e., the number of smolts released and the locations of releases) in many steelhead streams. The BRT considered potential effects of changes in hatchery management policies that already have been implemented in its risk assessments. The effects of recent (1995-97) flooding that has occurred in the geographic regions included in the Klamath Mountains Province, Northern California, and Central Valley ESUs also were considered by the BRT (see Schiewe 1997a for more discussion).

Conservation Measures Considered

In its evaluations, the BRT was prepared to consider specific conservation measures (e.g., habitat or harvest reforms) with quantifiable and predictable biological consequences for natural populations. However, no conservation measures meeting this definition were identified for the ESUs under consideration. Therefore, potential effects of conservation measures did not play a significant role in the BRT conclusions.

ESU-Specific Conclusions

Lower Columbia River--The Lower Columbia River ESU is comprised of numerous, relatively small populations distributed throughout its geographic range. The BRT had several major concerns regarding the health of this ESU. First, populations are at low abundance relative to historical levels, placing this ESU at risk due to random fluctuations in genetic and demographic parameters are characteristic of small populations. Second, there have been almost universal, and in many cases dramatic, declines in steelhead abundance since the mid-1980s in both winter and summer steelhead runs. For example, on the basis of recent severe declines, WDFW has identified a change in the status designation for Wind River summer steelhead from depressed in 1992 to critical in 1997. In addition, the recent Washington state co-managers review determined that, of 21 wild winter and summer steelhead stocks on the northern side of the Lower Columbia River ESU, only 2 are healthy and the remaining 19 are depressed or believed to be depressed (WDF et al. 1993). The BRT also noted with concern the results from ODFW's extinction risk modeling, which predicted that the Kalama River summer run steelhead had a greater than 5% probability of extinction within 100 years. The primary exception to the declines within this ESU is the Toutle River winter steelhead stock, which has increased following decimation by the eruption of Mount St. Helens in 1980, but which remains at very low abundance. In some cases, chinook salmon populations in the same streams have not shown such dramatic declines. There is presently no clear explanation for these declines in steelhead but not chinook salmon.

In addition, there is a widespread occurrence of hatchery fish in naturally spawning steelhead populations throughout the ESU. Recent estimates of the proportion of hatchery fish on the winter steelhead spawning grounds are over 80% in the Hood and Cowlitz Rivers, 45% in the Sandy, Clackamas and Kalama Rivers, and approximately 75% for summer steelhead in the Kalama River. Only 3 out of 14 populations for which there are data had low estimates of percent hatchery fish in natural escapements (i.e., 0% in the Washougal River summer steelhead run and Panther and Trout Creeks of the Wind River Basin). The BRT was unable to identify any natural populations of steelhead in this ESU that could be considered to be at low risk. Contributing to the BRT's concern were new genetic data from WDFW indicating that some introgression has occurred between Puget Sound Chambers Creek Hatchery stock and wild steelhead in the Lower Columbia River ESU.

Summer steelhead are native to the Hood, Lewis, Washougal and Kalama Rivers in this ESU. However, summer-run fish have also been introduced into the Sandy and Clackamas Rivers, and the BRT expressed concern about ODFW's analysis estimating that naturally-spawning winter steelhead populations have been negatively impacted by introductions of non-native summer steelhead due to interbreeding and/or competition (Chilcote 1997). Recently implemented changes in hatchery release practices by WDFW and ODFW were viewed by the BRT as generally positive but having relatively minor mitigating effects on overall risks due to widespread artificial propagation and history of stock transfers in this ESU.

A majority of the BRT concluded that steelhead in the Lower Columbia ESU are at risk of becoming endangered in the foreseeable future. A single member felt that this ESU is presently at risk of extinction. Loss of spawning habitat due to stream blockages and reduction in water quality are considered to be important past and continuing risk factors for populations in this ESU. The widespread release of non-native hatchery fish into streams in the Lower Columbia River and throughout the Columbia River Basin contributed to the BRT's concern about threats to remaining wild steelhead runs in this ESU.

Upper Willamette River--Steelhead in the Upper Willamette River ESU are distributed in a few, relatively small, natural populations. Over the past several decades, total abundance of natural late-migrating winter steelhead ascending the Willamette Falls fish ladder has fluctuated several times over a range of approximately 5,000 - 20,000 spawners. However, the last peak occurred in 1988, and this peak has been followed by a steep and continuing decline. Abundance in each of the last 5 years has been below 4,300 fish, and the run in 1995 was the lowest in 30 years. Declines also have been observed in almost all natural populations, including those with and without a substantial component of naturally spawning hatchery fish. The BRT noted with concern the results from ODFW's extinction assessment, which estimated that the Molalla River population had a greater than 20% extinction probability in the next 60 years, and that the upper South Santiam River population had a greater than 5% extinction risk within the next 100 years (Chilcote 1997).

Steelhead native to the Upper Willamette ESU are late-run winter steelhead, but introduced hatchery stocks of summer and early-run winter steelhead also occur in the upper Willamette River. Estimates of the proportion of hatchery fish in natural spawning escapements range from 5-25%. The BRT was concerned about the potential risks associated with interactions between non-native summer and wild winter steelhead, whose spawning areas are sympatric in some rivers (especially in the Molalla and North and South Santiam Rivers).

The BRT was unanimous in its conclusion that the Upper Willamette ESU is at risk of becoming endangered in the foreseeable future. Curtailed or restricted access to historical spawning grounds caused by dam construction on many of the major streams in the Willamette River Basin is a major continuing risk factor for this ESU. The dams have blocked access to much of the most productive habitat for steelhead, putting increasing pressure on the remaining natural populations.

Although not proposed for listing by NMFS as a result of the initial status review, this ESU was reviewed because of very poor returns in recent years and substantial concern for its status expressed by ODFW. At the time of the initial status review, abundance was at a low point in a series of cyclical fluctuations. As reported by Busby et al. (1996), some BRT members felt that the ESU was at risk of becoming endangered, but the initial conclusion of the majority was that there was no immediate risk of becoming endangered. New data for the past 2 years indicate that the recent declines have continued and even steepened, and it was the consensus of the BRT that risk has increased for this ESU.

Oregon Coast--There are many, relatively small populations of steelhead distributed throughout the range of the Oregon Coast ESU, and indicators of stock health are mixed. For example, the North Umpqua River supports a relatively large (recent 5-year geometric mean escapement estimate = 3,400 per year) and apparently stable natural population of winter steelhead with little hatchery influence. In contrast, only two streams in this ESU support native runs of summer steelhead, and one of these (Siletz River) is in such precarious condition that ODFW recently initiated an emergency supplementation program.

Risk assessment for this ESU proved to be particularly difficult. In the initial status review, the BRT's conclusion that the Oregon Coast ESU was at risk of becoming endangered in the foreseeable future was based primarily on two factors: 1) pronounced and nearly universal short- and long-term declines in abundance for populations throughout the ESU; and 2) substantial contribution of non-native hatchery fish to natural escapements in most basins. Abundance and trend estimates available at the time of the status review were based on angler catch through 1992. Subsequently, catch-and-release regulations for wild steelhead were implemented for most coastal streams, so angler catch no longer provides any information about wild steelhead abundance or trends. Unfortunately, ODFW has not initiated any comprehensive monitoring program to replace the angler catch data. As a result, the BRT was able to review recent (post-1992) abundance data for only 3 of the 40+ populations in this ESU. The abundance of steelhead in the populations for which there are updated data (North Umpqua River summer and winter runs and Salmonberry River in the Nehalem River Basin) is moderate, and the trends are stable or increasing. However, these populations were among the few that showed relatively stable trends in the previous status review, so there is reason to believe that they may not be representative of trends in the ESU as a whole (Chilcote 1997). Spawner surveys from three coastal rivers (Trask, Wilson and Nestucca Rivers) suggest mixed trends in abundance, but no expansions to total abundance estimates for these streams were provided. A major concern to the BRT was the absence of any recent information for a large number of streams that showed sharp declines in the initial status review.

Updated information considered by the BRT provides some indication that the proportion of hatchery fish in natural escapements has declined in some of these coastal steelhead populations in recent years. A review of recent hatchery release information indicates that, compared to previous years, smolt releases have increased in four streams, decreased in four streams, and remained essentially unchanged in four streams. However, release programs have also been terminated in four streams, so the net effect has been some reduction in the number of smolts released. In addition, ODFW has reported that the locations of hatchery releases have been and will be modified in an effort to reduce the incidence of strays. The BRT felt that these recent changes in hatchery practices will somewhat reduce risks to wild steelhead. However, significant opportunities for deleterious effects remain, as many programs continue to release non-native fish, and ODFW data show that hatchery fish stray into and spawn in streams with no hatchery releases.

After considering this information, a majority of the BRT concluded that steelhead in the Oregon Coast ESU are not presently at risk of extinction. Separate minority opinions were 1) that the ESU was likely to become endangered in the future and 2) that there was insufficient information to determine the conservation status of this ESU. The majority view should not be interpreted as a conclusion that this ESU is healthy; rather, it reflects relatively positive recent data for a small fraction of the populations and an absence of any recent data (positive or negative) for most of the populations in the ESU. That most of the populations for which recent data are unavailable were in decline as recently as 5-6 years ago was a source of considerable concern and frustration to the BRT. The BRT felt strongly that the conservation status of steelhead in this ESU should be revisited in the near future, hopefully with the advantage of updated data in a greater proportion of streams.

Klamath Mountains Province--The Klamath Mountains Province ESU includes a number of populations with different life history attributes and very different indicators of stock health. The Rogue River winter steelhead run appears to be the most robust stock in the ESU, with relatively high abundance (5-year geometric mean = 6,800/year), stable (long-term) trends, and a relatively low hatchery contribution to overall abundance. The opposite pattern occurs in the Klamath River, where returns of winter steelhead to Iron Gate Hatchery have declined precipitously since 1990. In the Trinity River, returns of naturally-produced fish have remained relatively stable since 1992 (n = 1300-2800), but in recent years there also have been a very high percentage (50-90%; CDFG 1994-1997) of naturally spawning hatchery fish, so there is concern that the natural population is not replacing itself. Outside the Rogue and Klamath River Basins recent data on winter steelhead are very sparse. Based on angler catch data through 1992, most of the non-Rogue River populations in Oregon were declining, but more recent data are not available. Smolt monitoring in the Elk River indicated a relatively stable trend in smolt production over the period 1985-1996. The usefulness of this information is limited by a lack of data on smolt-adult survival for this population.

This ESU also contains a larger number and better distribution of native summer steelhead populations than occurs in other coastal ESUs. Available data indicate that these summer steelhead populations are relatively small and show almost universal declines. Extinction analyses by ODFW (Chilcote 1997) identified the Middle Rogue River summer steelhead run as having a sensitive status (i.e., it had a greater than 5% probability of extinction in 100 years if survival rates are lower in the future than they have been over the last 30 years). Summer snorkel surveys in the Klamath River show consistent declines, but counts in the Trinity River are up in recent years relative to lows in the mid-1980s. This latter pattern is directly opposite to that found for most other steelhead populations coastwide, which generally showed peaks of abundance in the mid-1980s.

A majority of the BRT concluded that steelhead in the Klamath Mountains Province ESU are likely to become endangered in the foreseeable future, while a minority felt that this ESU was not presently at significant risk. The BRT expressed concern about the many populations in the Klamath Mountains Province ESU for which there are no recent abundance data. The BRT felt that conserving the diversity of both summer and winter life history forms was especially important in this ESU because of the broad distribution of summer steelhead populations throughout the KMP region, resulting in an unusual richness of the summer steelhead ecotype in this, compared to other, coastal steelhead ESUs. Although the percentage of naturally spawning hatchery fish is relatively low to moderate (5-29%) in Oregon streams in this ESU, and the number of hatchery fish planted is being reduced, the BRT expressed concern with the percentage of hatchery strays (average 11%) of unknown origin spawning naturally in unplanted Oregon streams. In California, the risk associated with hatchery operations in the Klamath and Trinity Rivers was a major concern to the BRT, due to the long-term high abundance of naturally spawning hatchery fish in the Trinity River and the apparent inability of the Iron Gate Hatchery stock, derived from native fish, to maintain itself. Although the Iron Gate Hatchery stock was not by itself evaluated as an ESU consideration, its dramatic decline is thought to result from current mainstem habitat conditions, and therefore its downward trend may be representative of risks associated with the native population. Widespread loss of historic spawning habitat due to blockages by dams and reduction in instream habitat quality caused by logging, water withdrawals, sedimentation, and mining are continuing risk factors for steelhead in this ESU.

Northern California--There is no estimate of total abundance for this ESU, and the BRT noted that although steelhead are considered to be widely distributed throughout the region, there is very little abundance information for most populations, particularly the winter runs.

New information that has become available since the status review shows mixed trends. The most complete data set is a time series of dam counts of winter steelhead on the Eel River at Cape Horn Dam. Updated abundances (through 1997) show moderately declining long- and short-term trends, and the vast majority (90%) of these fish are believed to be of hatchery origin. The only runs showing recent increases in abundance in the ESU are relatively small populations of summer steelhead in the Mad River (which has high hatchery production) and winter steelhead in Prairie Creek. For these reasons, the BRT felt that much of the historically important native steelhead production in the Northern California region has declined to levels that place the ESU at significant risk.

Risks associated with interactions between wild and hatchery steelhead in the Northern California ESU also were of concern to the BRT members. The BRT considered it unlikely that potentially deleterious effects of hatchery fish will decline in the foreseeable future because releases of non-indigenous hatchery steelhead in this ESU continue, primarily transfers of Mad River stock to various Northern California streams.

A majority of the BRT concluded that steelhead in the Northern California ESU are likely to become endangered in the foreseeable future. A minority felt that the ESU was not presently at risk, and a separate minority was unable to decide whether the ESU was likely to become endangered or was not presently at risk. Some uncertainty remains about the underlying causes of declines to steelhead in this ESU. Although fish in some streams are not able to access historic spawning habitat due to blockages, there are numerous tributaries with apparently accessible habitat that currently is underutilized. The BRT expressed concern about continued poaching of summer steelhead in the ESU, and noted that reduction in riparian and instream habitat quality due to logging and increased sedimentation are continuing risk factors. Finally, the BRT felt that the lack of reliable abundance or trend data for most steelhead populations in this ESU is also a risk factor.

Central Valley--No new abundance data for the Central Valley have been received since the ESU was proposed for listing as an endangered species in 1996. Therefore, the risk assessment was based on the data available at the time of the status review, supplemented by new qualitative information about the presence of steelhead in the San Joaquin River Basin. Various reports indicated that naturally-spawning steelhead are distributed throughout a number of streams in the Central Valley region, but that they occur in small numbers. Furthermore, many populations are of non-native, mixed, or uncertain origin. The recent total run size to the Sacramento River Basin is probably less than 10,000 steelhead per year, and it is believed that in 1994 in the upper Sacramento River, fewer than 2,000 of those fish were the result of natural production from native populations (based on counts at Red Bluff Diversion Dam). In particular, the status of native steelhead in the American River is in considerable doubt; new genetic data indicate that a sample of natural fish from the river and a sample of fish from the nearby Nimbus Hatchery are genetically similar to samples from the Eel River on the coast of Northern California. Presumably this reflects a lasting influence from transfers of Eel River stock steelhead into the Nimbus Hatchery in a number of previous years.

The BRT considered newly compiled information on the presence of steelhead in streams in the San Joaquin River Basin (see discussion in section on ESU definitions). In summary, steelhead smolts have been found in the lower San Joaquin and Stanislaus Rivers, and adult steelhead have been found in the Stanislaus and Merced Rivers. The only steelhead hatchery program operating in the San Joaquin River Basin is on the Mokelumne River, and no recent releases of juvenile steelhead have been made in other rivers in the basin; therefore, these results were viewed by the BRT as an indication that at least some natural production of steelhead occurs in several streams in the San Joaquin River Basin.

Declining long term (1967-1993) trends in abundance in the Sacramento River and the high risk of interbreeding between wild steelhead and those of hatchery origin are major concerns for the conservation status of this ESU. The high incidence of hatchery steelhead in natural spawning escapements and declining trends in abundance suggest that the native fish in this ESU are not self-sustaining. Steelhead in this ESU have been extirpated from most of their historic range (estimated 80-90%; Yoshiyama et al. 1996, Bryant and Olson in prep.) because of habitat blockages by dams, extensive water diversions, and reduction in instream water quality due to development, logging, and mining in upland habitats.

A majority of the BRT concluded that this ESU is presently in danger of extinction; a minority felt that the risk of extinction was not as great, but that the ESU was likely to become endangered in the foreseeable future. The BRT was especially concerned with the lack of monitoring of steelhead in this ESU since the proposed rule (August 1996). The inadequacy of current abundance data throughout the ESU contributes to the uncertainty in defining ESU boundaries and in assessing risk to the steelhead in the Central Valley. Information that is available indicates that the remaining native steelhead in this ESU are at considerable risk due to small population sizes, the negative effects of interactions with hatchery fish, and continued threats to habitat quality.

Middle Columbia--In the initial status review, the BRT was unable to reach a conclusion about the risk to this ESU, and it was identified by NMFS as a candidate species under the ESA.

Current population sizes are substantially lower than historic levels, especially in the rivers with the largest steelhead runs in the ESU: the John Day, Deschutes, and Yakima Rivers. At least two extinctions of native steelhead runs in the ESU have occurred (the Crooked and Metolius Rivers, both in the Deschutes River Basin). In addition, the BRT expressed concern about the widespread long- and short-term downward trends in population abundance throughout the ESU. Trends in natural escapement in the Yakima and Umatilla Rivers have been highly variable since the mid-late 1970s, ranging from abundances that indicate relatively healthy runs to those that are cause for concern (i.e., from 2,000-3,000 steelhead during peaks to approximately 500 fish during the low points.).

One of the most significant sources of risk to steelhead in the Middle Columbia ESU is the recent and dramatic increase in the percentage of hatchery fish in natural escapement in the Deschutes River Basin. ODFW estimates that in recent years, the percentage of hatchery strays in the Deschutes River has exceeded 70%, and most of these are believed to be long-distance strays from outside the ESU. Coincident with this increase in the percentage of strays has been a decline in the abundance of native steelhead in the Deschutes River. In combination with the trends in hatchery fish in the Deschutes River, estimates of increased proportions of hatchery fish in the John Day and Umatilla River Basins pose a risk to wild steelhead due to negative effects of genetic and ecological interactions with hatchery fish. For example, in recent years, most of the fish planted in the Touchet River are from out of ESU stocks. As a result, a recent analysis of this stock by WDFW found that it was most similar genetically to Wells Hatchery steelhead from the Upper Columbia River ESU.

The new and updated information considered by this BRT suggest that over the past 3-4 years, continued declines in steelhead abundance and increases in the percentage of hatchery fish in natural escapements indicate significantly higher risk than was apparent during the initial status review. Taking this new information into consideration, the BRT unanimously concluded that the Middle Columbia ESU is likely to become endangered in the foreseeable future. Continuing human-induced risk factors for steelhead in this ESU include habitat blockages by dams, reductions in streamflow and water quality and quantity (including thermal blocks that restrict access of steelhead to many areas in the mid-Columbia River Basin), juvenile and adult passage mortality at hydropower facilities on the Columbia River and tributaries, and in-river harvest.

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TABLES

Table 1. Steelhead evolutionarily significant units (ESUs) and their status as determined by the National Marine Fisheries Service.

Current status of steelhead ESUs	Original status proposal
Endangered, listed[1]	
Southern California	Proposed Endangered[2]
Upper Columbia River	Proposed Endangered[2]
Threatened, listed[1]	
Central California Coast	Proposed Endangered[2]
South-Central California Coast	Proposed Endangered[2]
Snake River Basin	Proposed Threatened[2]
Final determination extended[3]	
Lower Columbia River	Proposed Threatened[2]
Oregon Coast	Proposed Threatened[2]
Klamath Mountains Province	Proposed Threatened[2, 4]
Northern California	Proposed Threatened[2]
Central Valley	Proposed Endangered[2]
Candidate species[2]	
Middle Columbia River	Proposed Candidate[2]
No listing warranted[2]	
Puget Sound	No listing warranted[2]
Olympic Peninsula	No listing warranted[2]
Southwest Washington	No listing warranted[2]
Upper Willamette River	No listing warranted[2]

[1] Final rule (NMFS 1997a).
[2] Proposed rule (NMFS 1996).
[3] Proposed rule (NMFS 1997b).
[4] Proposed rule (NMFS 1995).

Table 2. New samples of *Oncorhynchus mykisss* used in genetic analysis for this report.

Source	Sample size	Year collected
Oregon Coast Region		
Siletz Hatchery summer-run	40	1996
Siletz Hatchery winter-run*	40	1996
Alsea Hatchery	87	1995
Alsea Hatchery	60	1996
North Umpqua River summer-run*	30	1994
Umpqua Hatchery winter-run	30	1994
South Fork Coquille River	19	1997
Coquille River, Steel Creek	35	1997
Coquille River, China Creek	33	1997
Central Valley of California		
American River	62	1997
Stanislaus River	46	1997
Nimbus Hatchery	40	1997
Feather River Hatchery	60	1997
California Coastal Region		
Big Sur River	28	1995
Willow Creek, Monterey County	40	1995
San Simeon	35	1995
Sweetwater River, San Diego County	48	1997
Pauma Creek, San Diego County	47	1997
Sespe Creek, Ventura County	40	1997

*Samples collected from new hatchery programs derived from wild broodstock.

Table 3. Steelhead ecotypes occurring in identified evolutionarily significant units (ESUs).

Phylogenetic group / ESU	**Ecotype(s)* present** summer steelhead	winter steelhead
Coastal steelhead		
Puget Sound	x	x
Olympic Peninsula	x	x
Southwest Washington	x	x
Lower Columbia River	x	x
Upper Willamette River		x
Oregon Coast	x	x
Klamath Mtns Province	x	x
Northern California	x	x
Central California Coast		x
S-Central California Coast		x
Southern California		x
Central Valley		x
Inland steelhead		
Middle Columbia River	x	x
Upper Columbia River	x	
Snake River Basin	x	

* Summer steelhead (stream-maturing) enter fresh water between May and October, in a sexually immature condition and require several months to mature and spawn; winter steelhead (ocean-maturing) return to fresh water between November and April, with well-developed gonads and spawn shortly thereafter (see Busby et al. 1996 for a more detailed discussion).

Appendix A: Conservation Status of Steelhead in Oregon (Chilcote 1997)

ODFW REPORT: CONSERVATION STATUS OF STEELHEAD IN OREGON

Chilcote (1997) presents a separate assessment of the status of steelhead populations in Oregon streams by Oregon Department of Fish and Wildlife (ODFW). The report consists of two main quantitative approaches to risk assessment of Oregon's steelhead, a spawner-recruit model and an extinction assessment model. Relative to the information available to the BRT for the West Coast Steelhead and Klamath Mountains Province Status Reviews, these modeling exercises are based on updated data on steelhead abundance and new estimates of harvest rates and the proportion of hatchery fish in natural spawning escapements for some Oregon streams. The summary below provides a brief overview of the modeling approaches used as part of Oregon's risk evaluation of steelhead. In addition, we summarize our overall evaluation of ODFW's approach, incorporating comments from NMFS biologists. Finally, we provide a summary outline of comments and concerns raised by independent peer-reviewers asked by ODFW to evaluate the document.

Overview of Quantitative Approaches

The first step in ODFW's risk evaluation is development of a spawner-recruit model that is used to relate estimates of population abundance to predicted habitat capacity for 26 populations of steelhead. The number of recruits (i.e., offspring returning as adults to freshwater) produced by each year of spawning adults is estimated using abundance data of all naturally-spawning steelhead (including hatchery and wild fish) whose returning recruits were divided into year classes based on an average age distribution for each population. The resulting relationship between spawner abundance and subsequent production of recruits is estimated using a Ricker recruitment function. A linear regression analysis of the log-transformed Ricker equation provides estimates of two parameters (a and B), from which a population equilibrium abundance ($N^* = a/B$) is estimated. The population equilibrium abundance level is defined as "the maximum number of spawners a population can sustain, on the average, given the available habitat capacity and natural mortality factors" (Chilcote 1997, p. 7). Estimates of N* are used as a criterion for assigning risk due to small population sizes for each ESU (see below).

The second part of the quantitative risk evaluation is an extinction assessment model that is used to estimate the probability of extinction of populations. Extinction probabilities are estimated based on predicted recruitment parameters from the spawner-recruit modeling, estimates of harvest rates, and different assumed survival rates throughout the time course of the model. The model is a stochastic simulation of change in abundance over time, based on a Ricker equation that is modified to include a harvest impact term. The number of spawners for each year is predicted from the Ricker recruitment function, the starting population size, and an assumed population age structure. Stochastic variation in recruitment is incorporated as a function of the observed variance in recruitment across all populations. The extinction model predicts the probability of extinction (i.e., the occurrence of 0 spawners for 6 or more consecutive years) for a given set of parameter values (each run = 500 trials).

Steelhead Risk Evaluation

The final evaluation of steelhead conservation status in Oregon is based on an evaluation of 5 risk indicators for each ESU. For each of the indicators, an ESU is assigned a risk assessment category (i.e., endangered, threatened, sensitive, or secure) based on criteria summarized below. A score was assigned for each population and each risk indicator, using the following scale: endangered = "3", threatened = "2", sensitive = "1", and secure = "0".

1. Probability of extinction assessment model indicator
   - Endangered: >20% probability of extinction within 60 years
   - Threatened: >5% probability of extinction within 100 years
   - Sensitive: >5% probability of extinction within 100 years, under a scenario with declining relative survival in the future.

2. Shrinking distribution of populations indicator
   - Endangered: >20% of populations in an ESU have gone extinct in last 100 years
   - Threatened: 15-20% populations have gone extinct in last 100 years
   - Sensitive: 10-15% populations have gone extinct in last 100 years.

3. Declines in abundance indicator
   - Endangered: 50-80% reduction in pre-harvest abundance of wild fish over last 18 years (based on 6-year moving averages)
   - Threatened: 20-50% reduction over last 18 years
   - Sensitive: 10-20% reduction over last 18 years.

4. Minimum population abundance indicator
   - Endangered: pre-harvest abundance of wild fish is < 5% of natural equilibrium level (N*) éstimated from spawner-recruit modeling
   - Threatened: abundance of wild fish is 5-10% of N*
   - Sensitive: abundance of wild fish is 10-25% of N*.

5. Interbreeding with hatchery fish indicator
   - Endangered: hatchery fish comprise > 60% of natural spawners, measured as a 6-year moving average
   - Threatened: hatchery fish are 45-60% natural spawners
   - Sensitive: hatchery fish are 30-45% natural spawners.

Each of these 5 population risk indicators are averaged across populations within an ESU (except for the "distribution of populations" indicator, which is an ESU-wide metric), and then the mean for each indicator is averaged , providing an overall risk assessment score for each ESU (see Table A.1). ODFW modified final ESU scores as they considered appropriate, incorporating information regarding the following:

> *assumed pattern of future ocean survivals, recent management changes that reduce risk to wild populations (e.g., reducing interbreeding between hatchery and wild fish), and expected benefits from improved habitat conditions due to recent and planned restoration and protection efforts* (Chilcote 1997, pp. 18-19).

That is, their determinations take into account projected effects of at least some conservation measures.

In conclusion, ODFW makes the following status evaluations for Oregon steelhead ESUs. Their evaluations apply to the ESUs as a whole, yet they are based on data only from Oregon streams (with the exception of some WDFW data in the Lower Columbia River ESU).

Lower Columbia River (ESU 4): Sensitive
Upper Willamette (ESU 5): Sensitive
Oregon Coast (ESU 6) : Sensitive
Klamath Mountains Province (ESU 7): Secure (indicates no significant risk)
Middle Columbia River (ESU 13): Sensitive

The above evaluations were based upon the following information for each ESU:

A. Lower Columbia River.

1. <u>New data</u>

a. Percent hatchery fish in natural escapements. Winter steelhead in the Clackamas (dam counts), summer Clackamas (genetic analysis of smolts), winter Sandy River steelhead (dam counts based on return timing and proposed management changes), summer Sandy (spawner surveys), and winter and summer steelhead in the Kalama River (data from WDFW, no details provided).

b. Population abundance. Winter steelhead in Clackamas (wild and hatchery fish--dam counts), winters in Sandy (wild and hatchery fish--dam counts), winters and summers in Kalama (wild and hatchery fish, WDFW).

2. <u>Extinction assessments</u>. Stochastic simulation model results for winter steelhead in the Clackamas and Sandy Rivers, and winter and summer steelhead in the Kalama River.

B. Upper Willamette.

1. <u>New data</u>

a. Percent hatchery fish in natural escapements. Molalla, N. and S. Santiam Rivers (wild and hatchery winter steelhead spawner abundance indices, trap counts of adults, changes in smolt release practices) and winter steelhead in the Calapooia River (estimates of strays).

b. Population abundance. Winter steelhead in the S. Santiam (dam counts and redds/mile surveys), Molalla, N. Santiam, and Calapooia Rivers (indices of spawner abundance from redd counts).

2. <u>Extinction assessments</u>. Stochastic simulation model results for winter steelhead in the Molalla, North and South Santiam, and Calapooia Rivers.

C. Oregon Coast.

1. New data

a. Percent hatchery fish in natural escapements. Estimates were provided for winter steelhead runs in the North Nehalem (1995-present trap counts, recent changes in smolt release practices), Nehalem, Miami, Wilson, Tillamook, Little Nestucca, Salmon, Siletz, Drift Creek, Yachats, Tenmile Creek, Big Creek, North Siuslaw, and Smith Rivers (recent changes in release practices), Trask and Siuslaw Rivers (analyses of strays, recent changes in release practices), Nestucca River (recent changes in release practices and angling restrictions), and the Alsea River (adult trapping, recent changes in release practices). Summer steelhead estimates were provided for the Siletz (recent changes in release practices) and N. Umpqua Rivers (dam counts of wild and hatchery fish).

b. Population abundance. Abundance estimates for summer and winter steelhead in the N. Umpqua River (dam counts) and for winter steelhead in the Salmonberry River (spawner surveys). Trends in smolt numbers were provided for Cummins and Tenmile Creeks.

2. Extinction assessments. Stochastic simulation model results for winter steelhead in the N. Umpqua and Salmonberry Rivers and for summer steelhead in the N. Umpqua River are provided.

D. Klamath Mountains Province

1. New data

a. Percent hatchery fish in natural escapements. Estimates for winter steelhead in the Elk, Chetco and Winchuck Rivers (creel surveys), Rogue and Applegate Rivers (dam counts and hatchery returns), Euchre, Hunter and Pistol Creeks and the Illinois River (predictions from other streams) are provided. Estimates for summer steelhead were provided for the Rogue River (dam counts and hatchery returns), and the Applegate River (no details given).

b. Population abundance. Abundance estimates for the Elk River, Hunter Creek and Winchuck River (smolt trapping), winter steelhead abundance estimates for the Rogue (dam counts) and Applegate Rivers (traps, harvest estimates), and summer steelhead estimates for the Rogue River (spawner surveys, dam counts) were provided.

2. Extinction assessments. Stochastic simulation model results are provided for winter steelhead in the Rogue and Applegate Rivers, and for summer steelhead in the Rogue River.

E. Middle Columbia River

1. New data

a. Percent hatchery fish in natural escapements. Summer steelhead estimates were provided for the Deschutes (mark-recapture, spawning surveys), John Day River (stray estimates), Umatilla River (dam counts), and Walla Walla River (trap in upper River).

b. Population abundance. Abundance estimates for summer steelhead in the Deschutes (harvest estimates), John Day (spawner surveys), Umatilla (dam counts) and Walla Walla (dam counts since 1993) Rivers were provided.

2. Extinction assessments. Stochastic simulation model results were provided for the Deschutes, John Day and Umatilla Rivers.

General Evaluation by NMFS

The risk evaluation provided by ODFW represents a significant effort that incorporates a number of potentially important risks to steelhead populations in Oregon, including possible deleterious impacts from harvest, hatchery fish, declines in the size and distribution of populations within an ESU, and variability in stock-recruitment dynamics. For those populations included in this evaluation, the data upon which the risk assessment is built span long time periods, allowing good estimates of recruitment variability to be incorporated into spawner-recruitment models. The report also highlights important gaps in basic abundance information and estimates of the percentage of hatchery fish in natural escapements, thereby identifying critical data needs for the complete evaluation of the conservation status of steelhead.

The risk assessment provided by ODFW differs in important respects from those made by NMFS, published in the West Coast Steelhead and Klamath Mountains Province Status Reviews. In those listing proposals, NMFS concluded that the Lower Columbia River, Oregon Coast and Klamath Mountains Province ESUs should be listed as threatened, the Upper Willamette ESU was not warranted for listing, and the Middle Columbia River ESU was classified as a candidate for listing. The discrepancies between ODFW and NMFS's evaluations are likely due to a number of factors which are outlined briefly below. These factors represent our primary concerns with the risk assessment approach in the Chilcote document, and are the focal points for our review of the steelhead conservation status evaluation performed by ODFW.

1. Data quality and quantity issues

a. Oregon strongly objected to using angler catch data for steelhead abundance and trend estimates, due to biases in angler reporting and from fisheries targeted on hatchery fish. Instead, ODFW opted to use the spawner-recruit model to predict abundance and equilibrium population sizes for those populations with adequate abundance data. NMFS has concerns with this approach because of the few streams for which there are empirical data and restrictive, unvalidated assumptions underlying the spawner-recruit analyses.

b. Oregon argued that its estimation of equilibrium population abundance (N*) is the best way to evaluate trends in abundance in the context of changes in habitat capacity. NMFS is leery of the possible circularity in ODFW's approach and the difficulties in evaluating the adequacy of habitat capacity estimated from time series representing recent and sometimes severe declines in abundance.

c. New and updated abundance data not available to NMFS at the time of the steelhead Status Reviews were provided by Oregon and considered.

d. Oregon presented new estimates of the percentage of hatchery fish in spawning escapements that were not available to NMFS at the time of the steelhead Status Reviews. NMFS is concerned with the usefulness of many of these estimates because of the lack of justification provided for the new numbers and the assumptions ODFW made about the effects of recent or future changes in hatchery release management practices.

2. Risk evaluation

NMFS has concerns about the extinction model used by ODFW, primarily because it is unvalidated, it does not fully account for uncertainty in parameter estimates, and it does not consider the consequences of errors made in model predictions. Model validation is especially important because the extinction probabilities estimated for each ESU are based on empirical data from a very small subset of populations within the ESU.

In addition to using an unvalidated model to predict extinction probabilities for each ESU, ODFW then **averaged** the 5 risk indicators to produce a composite risk score for each ESU. NMFS (and many peer reviewers, see below) is concerned that a simple arithmetic mean of the 5 individual risk scores may severely underestimate the overall risk estimate for an ESU. For example, a population at critically low abundance would be at high extinction risk even if recent trends were stable and there were no hatchery fish in the system.

Comments from Peer Reviewers

Oregon solicited comments on their steelhead risk evaluation from a number of peer reviewers; the respondents are listed below:

Dr. Bill Bakke, Director, Native Fish Society
Dr. Thomas Backman, Past President, Oregon Chapter American Fisheries Society
Dr. Jim Berkson, CRITFC
Dr. Peter Kareiva, Professor, UW, Department of Zoology
Dr. Skip McKinnell, Research Biologist, Department of Fisheries and Oceans, Canada
Dr. John Palmisano, Biological consultant
Dr. Barry Smith, Research Scientist, Environment Canada
Dr. Rick Williams, Chairman, ISAB

Comments from peer reviewers are summarized briefly below. Unless otherwise noted, comments came from a single reviewer.

1. Detailed information on steelhead stocks in Oregon is invaluable, including new and updated data on abundance, and description of changes in hatchery release policies designed to mitigate the effects of hatchery fish on wild steelhead.

2. The document highlights areas where there is insufficient information on steelhead abundance, helping to identify critical data that are needed for adequate conservation assessments of steelhead.
3. Document properly documents the rationale, methodology and reasoning underlying the judgements made about steelhead stock status.
4. Analysis of steelhead stock status is rigorous and scientifically-based, and therefore represents a good assessment of the conservation status of steelhead in Oregon.

5. Extinction model is based on a poor data base (relatively little information re: abundance, variation in age structure and % hatchery estimates), therefore it must be validated. (Comment made by 5 reviewers).
6. Averaging of risk indicator scores contributes to an underestimate of overall risk assessment. (Comment made by 4 reviewers).
7. Uncertainty in parameter estimation for extinction model is not adequately considered. (Comment made by 4 reviewers).
8. Criteria for thresholds used to assign risk categories for sensitive, threatened and endangered status are not well justified. (Comment made by 3 reviewers).
9. The manner in which stochastic (environmental) variation is entered into the extinction model is not appropriate. (Comment from 2 reviewers).
10. The document should address how representative the small subset of populations are in abundance and trends for use in an ESU-wide risk evaluation. (Comment made by 2 reviewers).
11. Conclusions of risk evaluations are at odds with data and observations presented in the report. (Comment made by 2 reviewers).
12. Model results based on a few populations from within an ESU do not allow for consideration of metapopulation-level risks to an ESU (e.g., loss of small, isolated populations vs. large, central ones; reduced extinction risks of some populations by recolonization from nearby stocks–populations in nature are not independent). (Comment made by 2 reviewers).
13. Overall trends in abundance and population equilibrium values should be explored (e.g., are parameters estimated from spawner-recruit modeling declining?) (Comment from 2 reviewers).
14. Use of average abundance values (instead of using abundance indicators from more vulnerable populations) for assessing risk to an entire ESU leads to ineffective management recommendations.
15. New and future management actions are given more weight in risk evaluation than are past practices.
16. Trends in habitat quality of freshwater spawning and rearing habitat should be discussed and considered in the risk evaluation.
17. Better advantage can be taken from the long time series of abundance data available. In particular, a maximum-likelihood approach could more directly estimate parameters describing population change, trends in those parameters, and incorporate environmental variability into the model in a more biologically realistic way.

18. The presence of hatchery fish in natural escapements is considered to be a risk, yet there are times when hatchery fish can be/are used successfully in supplementation programs.
19. The effects of recent drought conditions on trends in abundance in the Middle Columbia River ESU (especially effects on small tributary populations of steelhead in rivers such as the Deschutes) should be considered.
20. The depensation threshold chosen is arbitrary.
21. Potential effects of domestication selection on hatchery steelhead should not be ignored in evaluating risk to wild fish.

Table A.1. Summary of risk indicator scores from ODFW's steelhead conservation assessment document (Chilcote 1997). For explanation of scores, see text in Appendix A of this document. The Snake River ESU is not considered in this document, but it was reviewed by ODFW and it is included here for comparative purposes.

ESU	**EAM**	**DIST**	**Trend**	**Min-Pop**	**% Hatchery**	**Average Score**	**Status**
Lower Columbia	1.25	0	2.75	0	1.7	1.14	Sensitive
Upper Willamette	2.0	0	2.0	0	0.40	0.88	Sensitive
Or. Coast	0.33	0	2.3	0	0.48	0.62	Sensitive
KMP	0.5	0	1.5	0.25	0.09	0.47	Secure
Middle Columbia	0.57	1.0	2.71	0	0.57	0.97	Sensitive
Snake R.	0.67	~0	~1	~0	1	~0.88	Sensitive

<u>Risk Indicator abbreviations</u>:

EAM:	probability of extinction model assessment
DIST:	shrinking distribution of populations
Trend:	declines in abundance
Min-Pop:	minimum population abundance
% Hatchery:	interbreeding with hatchery fish

Appendix B: Biological Review Team Risk Matrix

Appendix B: The Risk Matrix Method

To tie the various risk considerations into an overall assessment of extinction risk for each ESU, Biological Review Team (BRT) members scored risks in a number of categories using a matrix form (Table B.1). For scoring and reaching an overall conclusion regarding extinction risk for an ESU, the following method was used: 1) After reviewing previous documents and hearing presentations and discussions during the meeting, each BRT member filled in as much of the matrix as possible, scoring the various factors according to the relative degree of risk based on available information. 2) Scores from individual members were tallied on a single sheet, and summarized. 3) The BRT reached an overall conclusion regarding the degree of extinction risk facing each ESU after steps 1 and 2 were completed for all ESUs.

The following is a list of factors considered, along with sub-categories and important questions for each. This is not a complete list, but covers the considerations that have been important in past status reviews. Specific considerations within each of these areas are discussed more fully in the main report.

Abundance

Questions regarding abundance can be put into three sub-categories:

Small population risks: Is the overall ESU (or discrete populations within the ESU) at such low abundance that small-population risks (random genetic effects, Allee effects, random demographic or environmental effects) are likely to be significant?

Distribution: Do present populations adequately represent historical patterns of geographic distributi6n and ecological/genetic/life-history diversity? Does fragmentation of previously connected populations pose a risk? Is the ESU at risk in a significant portion of its range?

Habitat capacity: Is abundance limited by current habitat capacity? If so, is current habitat capacity adequate to ensure continued population viability? (Here, only habitat capacity is considered. Habitat quality as it affects trends or productivity is considered in the next section.)

Trends, Productivity, and Variability

Again, considerations may be divided into three sub-categories:

Population trends: Is the overall ESU (or populations within it) declining in abundance at a rate that risks extinction in the near future? Is variation in population abundance, in combination with average abundance and trends, sufficiently high to cause risk of extinction?

Productivity: Has population productivity declined or is it declining toward the point where populations may not be sustainable? Is there evidence that natural populations are/can be self sustaining without the infusion of hatchery-reared fish?

Limiting factors: Are there factors (such as poor freshwater or ocean habitat quality, harvest or other human-induced mortality, interactions with other species) that currently limit productivity to the point where populations may not be sustainable? Are such factors expected to continue into the future? Are there natural or anthropogenic factors that have increased variability in reproduction or survival for populations beyond the historic range of environmental variability? Are there factors that have increased the vulnerability of populations to natural levels of environmental variability?

Genetic integrity

Genetic integrity can be affected through either random effects (included under "Small population risks above) or directional effects. The major sources of directional effects that are of concern here are introduced genotypes, interactions with local or non-native hatchery fish, or artificial selection (e.g. through selective harvest or habitat modification). These directional effects pose two major types of risk for natural populations:

Loss of fitness: Has interbreeding or artificial selection reduced fitness of natural populations to the point that this is a significant extinction risk factor?

Loss of diversity: Has there been a substantial loss of diversity within or between populations?

For both types of risk, it may also be important to ask the following question: Even if such interactions are not occurring at present, have past events substantially affected fitness and/or diversity of natural populations within the ESU to the extent that long-term population sustainability is compromised?

Other risks

Are there other factors that indicate risks to the sustainability of the ESU or component populations? such factors may include disease prevalence, predation, and changes in life history characteristics such as spawning age or size.

Recent events

This category was included to recognize events (natural or human-induced) that have predictable effects on risk for the ESU, but which have occurred too recently to be reflected in abundance, trend, genetic, or other data considered by the BRT. Examples might include recent changes in management (such as harvest rates or hatchery practices), human-induced changes in the environment (habitat degradation or enhancement), or natural events (such as floods or volcanic eruptions). Recent changes in management were only considered where they were already fully implemented and had reasonably predictable consequences.

SCORING CATEGORIES

Levels of Risk--Individual Factors

Risk from individual factors were ranked on a scale of 1 (very low risk) to 5 (high risk):

1) Very Low Risk. Unlikely that this factor contributes significantly to risk of extinction, either by itself or in combination with other factors.

2) Low Risk. Unlikely that this factor contributes significantly to risk of extinction by itself, but some concern that it may in combination with other factors.

3) Moderate Risk. This factor contributes significantly to long-term risk of extinction, but does not in itself constitute a danger of extinction in the near future.

4) Increasing Risk. Present risk is Low or Moderate, but is likely to increase to high risk in the foreseeable future if present conditions continue.

5) High Risk. This factor by itself indicates danger of extinction in the near future.

Levels of Risk--Recent Events

The "Recent Events" category does not represent specific risk factors, but rather factors that may alter the overall risk score for an ESU from the conclusion based on data available to date. This category was scored as follows: "++" - expect a strong improvement in status of the ESU, "+" expect some improvement in status, "0" - neutral effect on status, '-' - expect some decline in status, "--" - expect strong decline in status.

Levels of Risk--Overall Summary

The summary score of overall risk uses categories that correspond to definitions in the ESA: in danger of extinction, likely to become endangered in the foreseeable future, or neither. (Note, however, that these scores do not correspond to recommendations for a particular listing action because they are based only on past and present biological condition of the populations and do not contain a complete evaluation of conservation measures as required under the ESA.)

This summary score is not a simple average of the risk factors for individual categories, but rather a judgement of overall risk based on likely interactions among factors. A single factor with a "High Risk" score may be sufficient to result in an overall score of "in danger of extinction," but such an overall score could also result from a combination of several factors with low or moderate risk scores.

LEVELS OF CONFIDENCE

While the table has no specific box for scoring level of confidence in risk scores, this can be an important consideration in reaching listing decisions. Concerns about confidence were noted in the "Comments" section.

RESULTS FOR THE STEELHEAD REVIEW

BRT scores for the three major categories of risk for each steelhead salmon ESU are summarized in Table B.2. We do not summarize the "Other Risks" and "Recent Events" categories here, as factors included in these categories varied among ESUs; these factors are discussed in the main report. ESUs for which reviews had previously been completed were not scored.

Table B.1. Example of a blank risk matrix for a single ESU. Each Biological Review Team member filled out scores on one form for each ESU.

Risk Factor	Comments	Risk
Abundance Small Population Risks Distribution Habitat Capacity		
Trends/Productivity/Variability Population Trends Productivity Risk Agents		
Genetic Integrity Loss of Fitness Loss of Diversity		
Other Risks		
Recent Events		
Summary: Overall Risk level		
Concerns:		

Table B.2. Summary of main risk categories for the steelhead ESUs. Numbers in each cell are the mean score, with range of scores in parentheses. "NS" means "not scored" and applies to ESUs that had been previously evaluated and had no boundary changes.

ESU	Abundance	Trend-Productivity-Variability	Genetic Integrity
4) Lower Columbia River	3.4 (3-4)	4.1 (3-5)	3.7 (3-5)
5) Upper Willamette River	3.5 (3-4)	3.9 (3-5)	3.4 (2-4)
6) Oregon Coast	2.9 (2-5)	2.9 (2-4)	3.1 (2-4)
7) Klamath Mountains Province	3.4 (2-5)	3.4 (3-4)	3.0 (2-4)
8) Northern California	3.4 (2-4)	3.4 (2-5)	3.0 (2-4)
9) Central California Coast	3.4 (2-4)	3.6 (3-4)	3.4 (3-4)
10) South-Central California Coast	4.2 (3-5)	3.6 (3-4)	2.5 (2-3)
11) Southern California	5 (5)	4.4 (3-5)	2.8 (2-4)
12) Central Valley	4.4 (3-5)	4.4 (4-5)	4.3 (3-5)
13) Middle Columbia River	3.4 (2-4)	3.6 (3-4)	3.8 (3-5)
14) Upper Columbia River	3.9 (2-5)	3.9 (3-4)	3.9 (3-5)
15) Snake River Basin	3.6 (2-4)	3.7 (3-4)	2.8 (2-4)