Status Review Update for West Coast Steelhead from Washington, Idaho, Oregon, and California

Prepared by the
West Coast Steelhead Biological Review Team*

7 July 1997

* The biological review team (BRT) for the updated status review for West Coast Steelhead included Peggy Busby, Dr. Richard Gustafson, Dr. Robert Iwamoto, Dr. Conrad Mahnken, Gene Matthews, Dr. James Myers, Dr. Michael Schiewe, Dr. Thomas Wainwright, Dr. Robin Waples, and Dr. John Williams, from NMFS Northwest Fisheries Science Center (NWFSC); Dr. Peter Adams from NMFS Southwest Fisheries Science Center (SWFSC); Greg Bryant and Craig Wingert from NMFS Southwest Region (SWR); and Dr. Reg Reisenbichler from the National Biological Service (NBS), Seattle.

TABLE OF CONTENTS

INTRODUCTION

On 9 August 1996, the National Marine Fisheries Service (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 U.S. Endangered Species Act (ESA) and to propose 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 the new information warranted any modification of the conclusions of the original BRT. This report summarizes the final BRT conclusions on the following ESUs: Central California Coast, South-Central California Coast, Southern California, Central Valley, Upper Columbia River, and Snake River Basin. For the remaining ESUs, substantial scientific issues and disagreement exist that may be resolved with new information being developed in the next few months.

BACKGROUND INFORMATION

In February 1994, NMFS received a petition seeking protection under the 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 are 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.

---

[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 forms should be considered subspecies and suggested the names *O. mykiss irideus* and *O. m. gairdneri* for the coastal and inland forms, respectively.

The conclusions from the status review for the six ESUs being considered in this document are briefly presented below.

Summary of Previous Conclusions

After considering available information on steelhead genetics, phylogeny and life history, freshwater ichthyogeography, and environmental features that may affect steelhead, the BRT identified 15 ESUs--12 for coastal steelhead and 3 for the inland form. The BRT reviewed population abundance data and other risk factors for these steelhead ESUs and concluded that five (Central California Coast, South-Central California Coast, Southern California, Central Valley, and Upper Columbia River) were presently in danger of extinction, five (Lower Columbia River, Oregon Coast, Klamath Mountains Province, Northern California, and Snake River Basin) were likely to become endangered in the foreseeable future, and four steelhead ESUs (Puget Sound, Olympic Peninsula, Southwest Washington, and Upper Willamette River) were not presently in significant danger of becoming extinct or endangered, although some individual stocks within these ESUs may have been at risk. The BRT concluded that the remaining steelhead ESU (Middle Columbia River) was not presently in danger of extinction but was unable to reach a conclusion as to its risk of becoming endangered in the foreseeable future.

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

9) **Central California Coast**--This ESU occupies river basins from the Russian River south to include Aptos Creek and the drainages of San Francisco and San Pablo Bays; excluded is the Sacramento-San Joaquin River Basin of the Central Valley of California. Mitochondrial DNA and allozyme data indicate genetic differences between the steelhead from this region and those from adjacent areas. Environmental features (e.g., precipitation patterns, vegetation, and soils) show a transition in this region from the northern redwood forest ecosystem to the more xeric southern chaparral and coastal scrub ecosystems. Steelhead populations within the major streams occupied by this ESU appear to be greatly reduced from historical levels; for example, steelhead abundance in the Russian River has been reduced roughly sevenfold since the mid-1960s, but abundance in smaller streams

appears to be stable at low levels. The primary risk factor for this ESU is deteriorated habitat due to sedimentation and flooding related to land management practices. Uncertainty regarding the genetic heritage of the natural populations in tributaries to San Francisco and San Pablo Bays makes it difficult to determine which of these populations should be considered part of the ESU.

10) **South-Central California Coast**--This ESU occupies rivers from the Pajaro River to (but not including) the Santa Maria River. Mitochondrial DNA data provide evidence for a genetic transition among steelhead populations in the vicinity of Monterey Bay. Both mtDNA and allozyme data show large genetic differences between populations in this area, but do not provide a clear picture of population structure. The climate in this region is drier and warmer than it is to the north, resulting in chaparral and coastal scrub vegetation and stream mouths that are closed seasonally by sand berms. In addition to vegetation transitions, the northern end of this region is the southern limit of the distribution of coho salmon. The southern boundary of this ESU is near Point Conception, a well-recognized transition area for the distribution and abundance of marine flora and fauna. Total abundance of steelhead in this ESU is extremely low and declining. Risk factors for this ESU are habitat deterioration due to sedimentation and flooding related to land management practices, blockage of freshwater habitat, and potential genetic interactions with hatchery rainbow trout.

11) **Southern California**--This ESU occupies rivers from the Santa Maria River to the southern extent of the species range. Steelhead occur at least as far south as Malibu Creek, Los Angeles County, and historically may have occurred as far south as the U.S.-Mexico border. Genetic data show large differences among steelhead populations within this ESU as well as between these and populations to the north. Average rainfall is substantially lower and more variable in southern California than in regions to the north, resulting in increased duration of sand berms across the mouths of streams and rivers and, in some cases, complete dewatering of the lower reaches of these streams from late spring through fall. This affects steelhead migration patterns, as well as the ability to residualize and survive elevated water temperatures. Steelhead already have been extirpated from much of their historical range in this region. The BRT had a strong concern about the widespread degradation, destruction, and blockage of freshwater habitats within the region, and the potential results of continuing habitat destruction and water allocation problems. There also was concern about the genetic effects of widespread stocking of rainbow trout.

12) **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 genetically from all other samples of steelhead from California. The Sacramento and San Joaquin Rivers offer the only migration routes 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 already have been extirpated from most of their historical range in this region. Habitat concerns in this ESU focus 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.

Inland Steelhead ESUs Under Consideration

14) Upper Columbia River--This ESU occupies the Columbia River Basin upstream from the Yakima River. All upper Columbia River steelhead are summer steelhead. The streams of this region that are utilized by steelhead primarily drain the northern Cascade Mountains of Washington State. Streamflow is supplied by snowmelt, groundwater, and glacial runoff, often resulting in extremely cold water temperatures that retard the growth and maturation of steelhead juveniles, causing some of the oldest smolt ages reported for steelhead and residualization of juvenile steelhead that fail to smolt. All anadromous fish in this region were affected by the Grand Coulee Fish Maintenance Project (1939 through 1943), wherein anadromous fish returning to spawn in the upper Columbia River were trapped at Rock Island Dam, downstream of the Wenatchee River. Some of these fish were then released to spawn in river basins above Rock Island Dam, while others were spawned in hatcheries and the offspring were released into various upper Columbia River tributaries; in both cases, no attempt was made to return these fish to their natal streams, resulting in an undetermined level of stock mixing within the upper Columbia River fish. While total abundance of populations within this ESU has been relatively stable or increasing, this appears to be true only because of major hatchery supplementation programs. Estimates of the proportion of hatchery fish in spawning escapement are 65% (Wenatchee River) and 81% (Methow and Okanogan Rivers). The major concern for this ESU is the clear failure of natural stocks to replace themselves. The BRT also had a strong concern about problems of genetic homogenization due to hatchery supplementation within the ESU. There also was concern about the apparent high harvest rates on steelhead smolts in rainbow trout fisheries and the degradation of freshwater habitats within the region, especially the effects of grazing, irrigation diversions, and hydroelectric dams.

15) Snake River Basin--This ESU occupies the Snake River Basin of southeast Washington, northeast Oregon, and Idaho. This region is ecologically complex and supports a diversity of steelhead populations; however, genetic and meristic data suggest that these populations are more similar to each other than they are to steelhead populations occurring outside of the Snake River Basin. Snake River Basin steelhead spawning areas are well isolated from other populations and include the highest elevations for spawning (up to 2,000 m) as well as the longest migration distance from the ocean (up to 1,500 km). Snake River steelhead are often classified into two groups, A- and B-run, based on migration timing, ocean age, and adult size. While total (hatchery + natural) run size for Snake River steelhead has increased since the mid-1970s, the increase has resulted from increased production of hatchery fish, and there has been a severe recent decline in natural run size. The majority of natural stocks for which we have data within this ESU have been declining. Parr densities in natural production areas have been substantially below estimated capacity in recent years. Downward trends and low parr densities indicate a particularly severe problem for B-run steelhead, the loss of which would substantially reduce life history diversity within this ESU. The BRT had a strong concern about the pervasive opportunity for genetic introgression from hatchery stocks within the ESU. There was also concern about the degradation of freshwater habitats within the region, especially due to the effects of grazing, irrigation diversions, and hydroelectric dams.

West Coast Steelhead Proposed Rule

On 9 August 1996, NMFS published a proposed rule to list 10 steelhead ESUs as threatened or endangered under the ESA (Table 1) (NMFS 1996). The proposed rule largely followed the findings of the BRT with regard to ESU boundaries and risk assessment.

Species Range

The Federal Register Notice (NMFS 1996) described the present southern extent of the species range as Malibu Creek, California. Busby et al. (1996) cited published accounts that place the historic southern distribution of steelhead at least as far south as the U.S.-Mexico border (Barnhart 1986, Behnke 1992, Burgner et al. 1992), and spawning steelhead have been found as far south as the Santa Margarita River, San Diego County in recent years of substantial rainfall (Barnhart 1986, Higgins 1991).

Resident Fish

NMFS (1996) proposed to list only anadromous forms of *O. mykiss* until the relationship between the two forms could be better defined in individual ESUs.

TECHNICAL COMMENTS

Comments on the status review (Busby et al. 1996) and proposed rule (NMFS 1996) were received from a variety of federal, state, and tribal agencies (Table 2) as well as peer review comments solicited and received from nine west coast fisheries scientists. In addition, individuals knowledgeable about the subject of west coast steelhead also submitted comments and data at a series of public hearings and directly to NMFS.

General Comments

ESU Delineation

The steelhead ESU boundaries determined by NMFS were largely accepted by comanagers and peer reviewers. There was some concern expressed, however, that criteria for designating ESUs were not applied evenly and that insufficient emphasis was given to environmental and life history variables. Several comments were critical of the apparent reliance on genetic data to form ESU boundaries. Some stated that insufficient consideration was given to habitat and life history differences between steelhead populations (CDFG 1997, Pollard 1997, USDI 1997). Others criticized the reliance on data from protein electrophoresis rather than mtDNA (Pollard 1997, USDI 1997).

Resident fish--Those commenting on resident trout agreed that the nonanadromous form should be included in the steelhead ESUs either as a genetic reservoir (CDFG 1997, USDI 1997, USFS 1997) or due to reproductive interaction between the resident and anadromous forms (USDI 1997, USFS 1997).

J. Nielsen provided a manuscript (Nielsen et al. in press) that considered genetic relationships among wild and hatchery steelhead and rainbow trout populations. Nielsen et al. sampled fish from the south-central California coast and southern California regions, and their findings are summarized in the "Discussion and Conclusion of ESU Determinations" section of this document.

ESU-Specific Comments

Coastal Steelhead ESUs

9) Central California Coast--The original description of the geographic area containing this ESU inadvertently left a gap between Soquel Creek and the Pajaro River. The southern boundary of this ESU is more correctly stated to extend to, but not include, the Pajaro River Basin which is in ESU 10.

The California Department of Fish and Game stated that the tributaries of San Pablo Bay (Sonoma Creek and Napa River) are more similar to the streams in the central valley than to those in the central coast and steelhead from these streams may be more like steelhead in the Central Valley steelhead ESU (CDFG 1997). Smith (1997) [San Jose State University] and Alley and Associates (1997) stated that steelhead occupying tributaries to San Francisco and San Pablo Bays should be in their own ESU, and that ESU should be listed as endangered (Alley and Associates 1997) or threatened (Smith 1997). Vasquez (1997) [Santa Cruz County Farm Bureau] and McClary (1996) [Big Creek Lumber Co.] agreed that steelhead in San Francisco and San Pablo Bays were reduced in numbers but didn't believe this should sway the status of the entire ESU.

Nielsen (1997) stated that the boundary between ESU 9 and 10 should not divide north and south populations from the same near-shore ocean environment in Monterey Bay, whereas Smith (1997) stated that an ecological break occurs between ESU 9 and 10 in Monterey Bay, with streams in the southern end of ESU 9 having small coastal plains and easy upstream access while the next three watersheds in ESU 10 have broad coastal valleys with spawning and rearing habitat for steelhead occurring in distant upstream reaches. However, Smith (1997) also stated that coastal streams south of the Carmel River (in ESU 10) are ecologically like those in ESU 9.

Harrell (1996) and Colwell et al. (1996) [Fishermen's Alliance of Monterey Bay], and Vasquez (1997) [Santa Cruz County Farm Bureau] stated that pinniped predation is likely a major factor in steelhead declines along the central and northern California coast, with adult steelhead showing signs of tooth and claw scarring from pinniped encounters at rates of, for example, 15%-50% in the San Lorenzo River and about 50% in Scott Creek.

Ritchie and Beard (1997) [San Francisco Public Utilities Commission and Alameda County Water District] stated that over 100 years of fish planting in Alameda Creek has compromised the genetic integrity of resident fish populations.

Weseloh (1997) [California Trout, McKinleyville] stated that although absolute numbers of steelhead in this ESU are at roughly 10% of historical abundance, steelhead have higher abundance, greater spatial and temporal distribution, fewer extirpations, fewer declining trends, and greater life history diversity than coho salmon in this region and should, therefore, be listed as threatened, not endangered.

10) South-Central California Coast--Alley & Associates (1997) stated that there are significant ecological differences between interior and coastal streams in ESU 10, that steelhead in the Salinas River are virtually extirpated, that some other drainages in this ESU deserve to be classified as threatened (Pajaro River, etc.), that steelhead in Santa Rosa Creek are neither threatened nor endangered, and that overall steelhead in this ESU are not endangered, although steelhead in some individual drainages are threatened. Fuerst and Dettman (1997) [Monterey Peninsula Water Management District] stated that steelhead in ESUs 9 and 10 are threatened, not endangered.

Weseloh (1997) [California Trout, McKinleyville] stated that steelhead are endangered in this ESU and that absolute numbers of steelhead in this ESU are less than 2% of historical, many extirpations have occurred, and few viable populations still exist. Evans (1996) [Evans Environmental Consultants] stated that South-Central and Southern California steelhead are endangered and that rainbow trout planting during the 1950s and 1960s did not have much effect on local steelhead stocks, since anglers took most of the rainbow trout soon after release.

11) Southern California--Numerous comments stated that the southern geographic limit of this ESU should be extended to include all southern coastal steelhead south of Malibu Creek (Capelli 1997 [California Coastal Commission], Hunter 1997 [Trout Unlimited of California], USDI 1997), to the U.S.-Mexico border (Campbell 1996 [San Diego Fly Fishers], CDFG 1997), or to El Rosario, Baja California Norte, Mexico (Hunt 1997 [Consulting Biologist], Greenwood 1997 [San Diego Trout]).

Greenwood (1997) stated that steelhead occur in the Tijuana River, Rio Santo Tomas, Rio Guadalupe, Rio San Rafael, and the Rio Santo Domingo in Baja California Norte, Mexico and that there are wild rainbow trout in 23 San Diego County streams. Greenwood (1997) stated that rainbow trout in Pauma Creek, tributary to the San Luis Rey River, attempt to migrate downstream each spring but are denied access to the ocean due to "instream degradation" and that these Pauma Creek rainbow trout have the mtDNA haplotype ST5, that J. Nielsen has shown are unique to southern wild steelhead. For these reasons Greenwood (1997) stated that the boundary of ESU 11 should encompass all 23 trout-bearing streams in

San Diego County. Campbell (1996) [San Diego Fly Fishers] stated that wild landlocked rainbow trout in Pauma Creek and the West Fork of the San Luis Rey River were observed attempting downstream migration in Pauma Creek in April and May of 1994 and 1995, but that these fish were prevented from reaching the San Luis Rey River by dewatering of lower Pauma Creek. Campbell (1996) also stated that these Pauma Creek and West Fork San Luis Rey River fish carry the southern steelhead mtDNA haplotype.

Trautwein (1996) [Santa Barbara Urban Creeks Council] stated that steelhead still exist in the Santa Ynez River, Arroyo Hondo, Dos Pueblos Creek, San Pedro Creek, Carpinteria Creek, Steer Creek and Gobernador Creek); and that some others have rainbow trout, but anadromous passage is restricted. Hunter (1996) [Trout Unlimited of California] stated that remnant steelhead occur in Santa Clara, Ventura and San Luis Rey Rivers and in Malibu and San Mateo Creeks and that steelhead once existed in the Los Angeles, San Gabriel, Santa Ana, Santa Margarita, San Diego, Sweetwater, and Tijuana Rivers.

Carpanzano (1996) showed that densities of rainbow trout with southern steelhead/rainbow trout mtDNA haplotypes were positively correlated to canopy cover, whereas densities of rainbow trout with widespread steelhead/rainbow trout mtDNA haplotypes were related to maximum depth (at the reach scale) in sections of the Santa Ynez, Ventura, and Santa Clara Rivers and in Gaviota and Rincon Creeks. Hunter (1996) [Trout Unlimited of California] stated that based on Nielsen's mtDNA study and distribution of the genetic marker (haplotype ST5), the northern boundary of ESU 11 should be moved south to Point Conception and steelhead north of this point should be placed in ESU 10.

Farley (1997) [CDFG] stated that there is no evidence to support the assertion in Titus et al. (in press) that steelhead in the Santa Maria River are extinct, and that a healthy rainbow trout population was documented by CDFG in 1995-6 in the Sisquoc River (tributary of Santa Maria River). USDI (1997) documented the occurrence of small numbers of juvenile and spawning adult rainbow trout/steelhead in Santa Ynez River and its tributaries in 1993-1996. Fusaro (1997) [California Trout, Santa Barbara] stated that 64 individual spawners (size not mentioned) were identified on the Santa Ynez River in winter/spring 1995 in upstream and downstream traps and that these fish may represent the bulk of the remaining ESU in the Santa Ynez River. Fusaro (1997) also stated that a component of the ESU still resides in the upper Sisquoc River of the Santa Maria River Basin.

Orton (1996) [Las Virgenes Municipal Water District] stated that in the last 3 years no trout (steelhead or otherwise) have been observed in snorkeling surveys of Malibu Creek below Rindge Dam. In 1989, 1,435 juveniles were counted in Malibu Creek below Rindge Dam. Orton (1996) also stated that due to water imports and urbanization many naturally ephemeral streams have gradually become perennial in character and that, in the case of Malibu Creek, data dating back to 1932 indicate that this creek had zero to near-zero flow prior to importation of water in the 1960s; discharges are now mandated to prevent summertime drying of the creek.

Price et al (1997) [Cachuma Member Units water districts] stated that steelhead runs were lost in the Santa Ynez River in the late 1940s, when drought conditions prevented breaching of the river mouth for 7 years and that since genetic data indicate a gradient of genetic types and not distinct boundaries only one steelhead ESU should be created for steelhead south of San Francisco Bay.

Gientke (1997) [United Water Conservation District] stated that steelhead in the Southern California ESU largely represent non-native hatchery trout or mixtures of hatchery and native strains and do not meet the definition of a distinct vertebrate population under the ESA. Gientke (1997) reported that only 19.5% of the Santa Clara River wild steelhead/rainbow trout and 43% of downstream migrating smolts at Vern Freeman Diversion fish ladder on Santa Clara River have the native southern mtDNA haplotype.

Henke (1996) [Historical Research] stated that historical distribution and abundance of steelhead in the Southern California ESU was about 250,000 adults prior to arrival of Europeans. Weseloh (1997) [California Trout, McKinleyville] stated that current absolute numbers of steelhead in this ESU are less than 1% of historical and that the remaining steelhead are endangered.

12) Central Valley--Comments on the definition and status of the Central Valley ESU varied widely.

Weseloh (1997) [California Trout, McKinleyville]) agreed with the BRT's conclusions about the ESU boundary. However, several water management agencies stated that the ESU, or large parts of it (e.g., steelhead in the American, Mokelumne, and San Joaquin Rivers), may be extinct, largely based on the assumption of introgression from hatchery fish (e.g., Brown 1997, Macaulay 1997, Martin 1997, Nuzum 1997, Sequeira 1997). The U.S. Department of the Interior (USDI 1997) also expressed concern regarding whether the remnant populations of naturally spawning steelhead in the central valley represented an ESU. However, no substantive new information was submitted to support the concept that the ESU, in whole or part, has been either extirpated or thoroughly introgressed by hatchery stocks.

The California Department of Fish and Game (CDFG 1997) specifically commented on extant runs of naturally spawning steelhead in the American, Feather, and Yuba Rivers (Sacramento River Basin) and the Stanislaus, Tuolumne, and Merced Rivers (San Joaquin River Basin). Additionally, CDFG discussed the ecological difference between the Sacramento and San Joaquin River Basins and the potential for genetic differences between the steelhead populations of these large river basins.

Inland Steelhead ESUs

14) Upper Columbia River--There are two main issues in the comments for the Upper Columbia River ESU: the role of resident and residual *O. mykiss* in the ESU and the ramifications of the Grand Coulee Fish Maintenance Project (GCFMP) and subsequent artificial propagation activities for ESU status.

The consensus of the technical comments is that resident/residual *O. mykiss* should be included in the UCR steelhead ESU. Chapman (1996) argued that these fish provide a genetic reservoir for the ESU as it existed prior to the construction of Grand Coulee Dam in 1939. Peven (1996) stated that the resident and anadromous forms of *O. mykiss* in this region are capable of producing offspring of the opposite form; therefore, resident *O. mykiss* must be considered when assessing the status of this ESU.

Both Chapman (1996) and Peven (1996) commented that naturally spawning and hatchery steelhead are indistinguishable in this ESU, due to the GCFMP and subsequent artificial propagation. Based on this, Peven (1996) argued for including hatchery fish in this ESU.

Crawford (1997) [WDFW] and Peven (1996) both acknowledged that wild steelhead in this ESU are not self-sustaining. Chapman (1996), however, stated that the long-term abundance trend for this ESU is upward.

15) Snake River Basin--The State of Idaho (Idaho 1997) acknowledged that "Snake River wild steelhead are imperiled" (p. 3) but opposed listing them under the ESA, due to potential constraints on State management activities, erosion of local support for species protection, and lack of additional benefit to steelhead over and above efforts to recover salmon species already listed.

According to the State of Idaho (1997), "native, naturally reproducing steelhead" (p. iii) are currently limited to the following areas of the Snake River Basin: Lochsa and Selway Rivers, Lower Clearwater River tributaries, Snake River tributaries between Lower Granite Pool and Hells Canyon Dam, Rapid River, Salmon River Canyon tributaries, and the South and Middle Forks of the Salmon River.

The State of Idaho (1997) believes that "non-anadromous rainbow trout populations" (p. 4) should not be listed.

The State of Idaho (1997) identified steelhead from the following areas as having a substantial degree of hatchery influence, and argued that these should be excluded from the Snake River Basin ESU: Upper Salmon River (above Middle Fork), South Fork Clearwater River, and the Little Salmon River. The State of Idaho (1997) believes that no Snake River Basin hatchery stock should be included within the ESU due to the assumption that the "genetic lineage of hatchery broodstocks is different than existing native steelhead populations in the Snake River" (page 8). Idaho uses two primary broodstocks: Dworshak National Fish Hatchery (NFH) B-run, and Pahsimeroi Fish Hatchery A-run. For both of these hatchery stocks, spawn-timing has been advanced from that of wild fish.

Some comments received focussed on the stock structure of Snake River steelhead. Chapman (1996) cited Thurow (1985) and Schreck et al. (1985) as showing that the wild B-run steelhead of the Middle and South Forks of the Salmon River are genetically distinct from the North Fork Clearwater River B-run steelhead reared at Dworshak National Fish Hatchery. Chapman (1996) stated that wild Snake River B-run steelhead qualify for listing as endangered, presumably as a separate ESU from Dworshak B-run and Snake River A-run steelhead. The U.S. Department of the Interior (USDI 1997) stated that the A- and B-runs might qualify as separate ESUs, or treated as separate stocks within one ESU and listed differently, e.g., one endangered and the other threatened. Although he did not describe how to resolve this under current NMFS policy that identifies the ESU as the distinct population segment or "species" for listing Pacific salmonids under the ESA.

DISCUSSION AND CONCLUSION OF ESU DETERMINATIONS

The Biological Review Team discussed the comments and new information received since the proposed rule and re-evaluated the decisions of the original BRT regarding the west coast steelhead ESU determinations. Key elements of the BRTs discussion are summarized below.

Resident Fish

Steelhead is the name applied to the anadromous form of the biological species *Oncorhynchus mykiss*; the taxonomy of this species is complicated and includes anadromous and nonanadromous forms. The nonanadromous form of this species is most commonly referred to as rainbow trout, but actually may be comprised of several subspecies including coastal rainbow trout (nonanadromous *O. m. irideus*), Columbia River redband trout (nonanadromous *O. m. gairdneri*), Sacramento redband trout (*O. m. stonei*), and California golden trout (*O. m. aguabonita*), as well as other forms (see Behnke 1992 for a complete discussion).

Under certain conditions, anadromous and nonanadromous *O. mykiss* apparently are capable not only of interbreeding, but also of having offspring which express the alternate life history form; e.g. anadromous fish can produce nonanadromous offspring, and vice versa (Shapovalov and Taft 1954, Burgner et al. 1992). Mullan et al. (1992, p. K-427) found evidence that in very cold streams, juvenile steelhead had difficulty attaining "mean threshold size for smoltification" and concluded that "Most fish here [Methow River, Washington] that do not emigrate downstream early in life are thermally-fated to a resident life history regardless of whether they were the progeny of anadromous or resident parents." Additionally, Shapovalov and Taft (1954) reported evidence of *O. mykiss* maturing in fresh water and spawning prior to their first ocean migration; this life history variation has also been found in cutthroat trout (*O. clarki*) and Atlantic salmon (*Salmo salar*).

Nielsen et al. (in press) studied mitochondrial DNA (mtDNA) haplotype diversity and allelic frequency distributions for three polymorphic microsatellite nuclear loci in steelhead and rainbow trout from streams in the regions, including the South-Central California Coast and Southern California ESUs. Samples from 29 populations were combined into 6 types based on the ocean access and wild vs. hatchery status for each of the source populations. The six types included landlocked rainbows, resident rainbows that have ocean access, anadromous steelhead, rainbow trout hatchery stocks, and the steelhead population from the Whale Rock hatchery (in the south-central California coast region). The authors found that both local anadromous and resident forms of *O. mykiss* possess genetic markers that are characteristic of the southern California region. A dendrogram based on the microsatellite loci indicated a split between the steelhead (wild and Whale Rock hatchery) and all of the resident trout types. Microsatellite allelic diversity was highest in trout from habitats without access to the ocean. The mtDNA data provided quite different results. In a dendrogram derived from haplotype distributions, ocean-access rainbow trout clustered with steelhead, and these types were separated from the landlocked and hatchery rainbow trout. Haplotype diversity was highest in anadromous fish. Nielsen et al. (in press) concluded that

> Trout from habitats with varying levels of anthropomorphic activity and ocean access proved to have significantly different measures of genetic biodiversity for mtDNA and microsatellites, with the greatest array of rare genotypes found in declining runs of southern steelhead. Analysis of genetic distance measures for both molecular markers, however, showed that consideration of life history patterns and freshwater habitats that retain ocean access remain important factors in the preservation of components of the unique genetic diversity found in *O. mykiss* at the southern extent of their range.

The results of the Nielsen et al. study are difficult to interpret for the purposes of this document because samples from genetically-differentiated populations were combined to form composite samples for each type. The amount of genetic variation among types was not compared to the amount of variation among rivers or among larger geographic scales (such as among areas). Furthermore, the study did not explore the genetic relationships of steelhead populations with rainbow trout populations from the same stream. This type of analysis would help the BRT in deciding whether resident fish should be part of an ESU, and if so, these data would facilitate determining the most appropriate way to include resident fish in risk analyses.

The original BRT concluded that, in general, west coast steelhead ESUs 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. The BRT reaffirmed these conclusions in the June meeting, and further discussed how to address resident populations that inhabit areas upstream from *human-caused migration barriers*. The BRT concluded that, in general, resident fish which are above man-made barriers, but are of native lineage, with ancestral linkage to anadromous *O. mykiss*, should be included in steelhead ESUs. Whether resident fish that exist above any particular man-made barrier meet this definition must still be evaluated on a case-by-case basis. The BRT acknowledged that there may be hundreds of such cases in California alone.

Discussion and Conclusions for Specific ESUs

Coastal Steelhead ESUs

9) Central California Coast--The BRT determined that no changes in the boundaries of the Central California Coast ESU were warranted; however, the original written description of this ESU inadvertently left a gap between Soquel Creek and the Pajaro River. This ESU includes steelhead occupying the Russian River and all basins south to, but not including the Pajaro River Basin, which is in ESU 10.

One peer reviewer questioned the basis for the location of the boundary between this ESU and the South-Central California Coast ESU, which effectively splits the basins that flow into Monterey Bay. The ESU break between Aptos Creek and the Pajaro River largely is based on ecological differences between the river basins. The Pajaro River and river basins south of there drain an arid interior and end in broad coastal plains, whereas north of the Pajaro River, the river basins largely drain coastal mountains at the southern end of the natural range of the redwood forest. This boundary also is consistent with the southern limit of coho salmon, further suggesting a natural ecological break.

The BRT found no biological basis to exclude steelhead from the basins of either San Francisco or San Pablo Bays from this ESU, as had been suggested in some comments received. The characteristics of hydrology, geology, and spawning habitat are consistent with the rest of this region, although resource management activities and urbanization have altered much of the habitat.

10) South-Central California Coast--The BRT determined that no changes in the boundaries of the South-Central California Coast ESU were warranted. See discussion of ESU 9, above, regarding the break between Aptos Creek and the Pajaro River.

Most comments received on this ESU focussed on extinction risk, which will be discussed later in this document, and the genetic legacy of *O. mykiss* above man-made barriers. The BRT recognized that resident trout upstream of man-made migration barriers may be of native lineage, with ancestral linkage to anadromous *O. mykiss* of this ESU. As stated above, whether resident fish that exist above any particular man-made barrier meet this definition must still be evaluated on a case-by-case basis.

11) Southern California--In the original status review, the BRT determined that the Southern California ESU extended to the southern extent of the species range. The Proposed Rule (NMFS 1996) stated that the species range presently extends to Malibu Creek, Los Angeles County. Many comments were received regarding this issue; most (including CDFG 1997 and USDI 1997) supported placing the species/ESU range further south. The reconvened BRT reviewed the many scientific references to steelhead occurring historically and recently in streams as far south as the U.S.-Mexico border, a boundary currently supported by CDFG (1997). The BRT concluded that the Southern California ESU includes native *O. mykiss* with recent links to anadromy to the southern extent of the species range. Malibu Creek is the southernmost stream generally recognized as supporting a persistent, naturally-spawning population of anadromous *O. mykiss*. However, this may reflect sampling effort rather than the natural distribution of the steelhead.

It was acknowledged by the BRT that potentially there are many populations of resident trout upstream of man-made migration barriers in southern California, and that these fish may be of native lineage, with ancestral linkage to anadromous *O. mykiss* of this ESU.

As stated above, whether resident fish that exist above any particular man-made barrier meet this definition still must be evaluated on a case-by-case basis.

12) Central Valley--The BRT considered arguments that the Central Valley ESU should be broken into two or more ESUs, based largely on substantial ecological differences among major geographic areas of the Central Valley. The lines of evidence considered by the BRT included the geological differences between the upper Sacramento River Basin, which drains the southern Cascade Mountain Range, and the lower Sacramento and San Joaquin River Basins, which drain the Sierra Nevada Mountain Range. An indication of the complexity of the ecology of the region is 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.

A majority of the BRT members felt that it is important to reconsider ESU configurations within the Central Valley, but that it is not possible to resolve this complex issue without pursuing some new sources of information (e.g., genetic samples and a more comprehensive analysis of ecological information). The status review team will work to develop some information that will bear on this issue within the next several months.

Inland Steelhead ESUs

14) Upper Columbia River--The BRT determined that no changes in the boundaries of the Upper Columbia River ESU were warranted.

According to Fulton (1970), steelhead historically spawned as far upriver as the lower Pend Oreille River in British Columbia. The BRT acknowledged the importance of resident trout of ancestral linkage to the anadromous *O. mykiss* of this ESU, and determined that any trout above Chief Joseph Dam that meet the criteria above (being of native lineage, with ancestral linkage to anadromous *O. mykiss* of this ESU) should be included in the Upper Columbia River ESU.

15) Snake River Basin--The BRT determined that no changes in the boundaries of the Snake River Basin ESU were warranted. The BRT revisited the issue of dividing this ESU into A- and B-run ESUs, but found no scientific evidence to support this.

Fulton (1970) indicated that steelhead historically utilized spawning habitat as far up the Snake River Basin as Shoshone Falls, and it is possible that these steelhead may have been part of this ESU. The construction of the Hells Canyon Complex dams in the early 1960s blocked anadromous fish passage; however, steelhead may have residualized above this barrier. Any resident trout above the Hells Canyon Dam complex that meet the criteria above (being of native lineage, with ancestral linkage to anadromous *O. mykiss* of this ESU) should be considered part of the Snake River Basin ESU.

DISCUSSION OF EXTINCTION RISK FACTORS

In this section, we discuss important new information and analyses for several risk factors (hatchery production and genetic risks, habitat conditions, population abundance, and population trends and production) for the ESUs under consideration. The following sections summarize these factors, and draw conclusions regarding the degree of extinction risk facing each ESU based on this new information as well as that in Busby et al. (1996).

General Information

Population Data Updates

The original steelhead status review (Busby et al. 1996) largely was based on data through 1994. Now, 2-3 more years of data are available for most ESUs. We have received updates in steelhead escapement estimates and new information regarding juvenile steelhead abundance and abundance of rainbow trout in some ESUs. This information is summarized in Table 3.

1995-1997 Floods

Between November 1995 and April 1996, the Pacific Northwest and California experienced a series of storm and flood events. Another series of strong storms arrived in January 1997. High winds, heavy rainfall, rapid snowmelt, numerous landslides and debris torrents, mobilization of large woody debris and high runoff occurred over portions of California, Oregon, Washington, Idaho, and Montana (USFS and USBLM 1996). These storms also had a potentially large effect on northern California, central valley, and Oregon coast steelhead and their freshwater habitats. However, we found no analyses of the effects on steelhead specifically.

Population Models

ODFW (Chilcote 1997) has applied an extinction risk model to steelhead populations in Oregon. Of the ESUs considered here, this is only relevant to the Oregon portion of the Snake River ESU. We have done a preliminary review of the model, and find the results difficult to evaluate for several reasons, including 1) no results are presented that allow validation of the model output, and 2) the model does not include important sources of biological variability, such as variation in age structure and straying rates among the river basins modeled (the model assumes very low/negligible straying among streams within the river basins.) Chilcote (1997) applied the model to three populations in the Snake River Basin (Joseph Creek, Upper Grande Ronde, and Imnaha), with an estimated probability of extinction of zero over the next 100 years for all 3. Population models have not been used in assessing risk to populations in any other ESUs considered here.

Risk Workshop Recommendations

In November 1996, NMFS Northwest and Southwest Fisheries Science Centers sponsored a symposium/workshop on "Assessing Extinction Risk for West Coast Salmon" (Seattle, 13-15 November 1996). The objective of the workshop was to evaluate methods for assessing various factors contributing to extinction risk of Pacific salmon populations. The final report on panel recommendations is not yet available. Most of these recommendations require long-term development of improved methods, and thus could not be applied in this review.

Population Abundance

Coastal Steelhead ESUs

9) Central California Coast--For the Central California Coast ESU, the BRT has received revised estimates through 1996 of escapement in the San Lorenzo and Russian Rivers and Waddell Creek, with additional information on juvenile abundance in several smaller streams (Table 3).

For the San Lorenzo River population, adult escapement data consist of somewhat irregular counts at Felton Diversion Dam (Jordan 1996, Alley 1997a), along with some earlier (1930s and 1940s) estimates from other locations (Alley 1997a). The Felton Dam trap counts are not good estimates of run size, as the trap is only operated part time, and fish can go over it during high flows. The most recent 5-year geometric mean of these counts is 305 fish. Two recent attempts have been made to estimate total escapement for the San Lorenzo River. Jordan (1996) suggested an average 20% sampling rate for expanding these estimates to total escapement, resulting in a total run size estimate ranging from 605 to 2,335 fish, but there appears to be no clear basis for this expansion factor. Alley (1997a) projected adult returns for 1995-96 through 1997-98 from juvenile abundance estimates using an assumed mortality rate; this resulted in run size estimates between 1,000 and 1,800. Murphy and Sidhom (1995) presented sport catch estimates for juvenile and adult steelhead based on creel survey data for the 1994-95 season; they reported 1,635 steelhead caught, with more than half of the catch under 10" length. They compared this catch with earlier estimates and conclude that the fishery resource has declined significantly over the past 20 years. Alley (1997a) also presented juvenile steelhead density estimates from sampling in 1994-1996, and compared results to similar data from 1981. Compared to 1981, juvenile steelhead abundance was lower in 1994 but higher in both 1995 and 1996. Estimated total number of juveniles was approximately 69,000 in 1981, and 45,000, 75,000, and 83,000 in 1994, 1995, and 1996, respectively.

In the Russian River, we have recent data on adult returns to Warm Springs Hatchery and Coyote Valley Fish Facility (Steiner Environmental 1996). These are predominantly hatchery fish, and have not been analyzed as natural populations. The total return to these facilities has averaged about 4,000 fish per year over the last 5 years.

There is scattered information on abundance of steelhead in other streams within the central California coast region. Smith (1997) estimated adult abundance in Waddell Creek of 260 wild and 27 hatchery fish from a mark-recapture study in 1991-92. Smith (1997) also reported recent juvenile steelhead abundance in Gazos, Scott, Waddell, and Redwood Creeks, but juvenile density estimates generally cannot reliably be expanded to a total adult population estimate. Marin Municipal Water District (MMWD 1997) provided total juvenile population estimates for three streams (Lagunitas Creek, Devils Gulch, and San Geronimo Creek) for 1970-1996, with a recent 5-year geometric mean abundance of about 40,000 juveniles; the survey methods and expansion methods are not documented.

The BRT has also received general comments on the distribution (presence/absence) of steelhead in Marin and Sonoma County streams from CDFG (1997), indicating that steelhead are present in almost all streams in that region. Peter Adams[2] has summarized presence/absence data for a total of 723 streams within the region, and recent data were available for 264 streams. For streams with recent data, 82% had steelhead present (Table 4).

10) South-Central California Coast ESU--For the South-Central California Coast ESU, the BRT has received revised estimates through 1996 of escapement in the Carmel River (CDFG 1997, Dettman 1997), and juvenile abundance in the Carmel River (MPWMD 1996), Santa Rosa and San Simeon Creeks (Alley 1997b), and several other locations (USFS 1997).

In the Carmel River, the recent 5-year geometric mean count at San Clemente Dam was 243 adult steelhead; at Los Padres Dam trap, the average was 23 steelhead. This is substantially above the averages at the time of the original status review. Juvenile abundance has ranged from 22 fish per mile (1989) to 9,300 fish per mile (1986), with a recent 5-year geometric mean of 3,900.

There are juvenile survey data available for some other streams in the south-central California coast region. Alley (1997b) presented 3 years of survey data (1994-1996) for Santa Rosa and San Simeon Creeks. Estimated total abundance was estimated by expanding juvenile densities (fish per 100 feet) by reach lengths. Three-year geometric mean estimates were 7,700 young-of-year and 5,600 older juvenile steelhead in Santa Rosa Creek, and 4,100 young-of-year and 1,500 older juveniles in San Simeon Creek. Using juvenile to adult survivals estimated from earlier studies on Waddell Creek, Alley (1997b) estimated that adult returns from these juveniles would range from 223 to 402 in Santa Rosa Creek, and from 35 to 140 in San Simeon Creek. Given the potential errors in expanding juvenile densities to total abundance and in applying survival estimates from another basin and time, these estimates need to be viewed with caution. The U.S. Forest Service (USFS 1997) presented habitat quality and juvenile density information for a variety of streams in Los Padres National Forest, with density estimates ranging from 0 to 100 fish per 100 feet in various tributaries. Methods are not documented, and no attempt at estimating total abundance was

---

[2]P. Adams, Southwest Fisheries Science Center, National Marine Fisheries Service, 3150 Paradise Drive, Tiburon, CA 94920-1211. Pers. commun., June 1997.

made, so it is difficult to compare this information with other basins. The USFS summary identifies a number of "landlocked remnant native steelhead populations" throughout the region.

Peter Adams (see footnote 2) has summarized presence/absence data for a total of 89 streams in this region, and recent data were available for 33. For streams with recent data, 79% had steelhead present (Table 5).

Nelson (1994a, 1994b and 1995) summarized habitat characteristics and steelhead and rainbow trout censuses for Arroyo de la Cruz and its tributaries (Burnett and Marmolejo Creeks), Santa Rosa Creek and San Simeon Creek in 1993. She provided abundance estimates based on expanded counts from electrofishing for juvenile fish and outmigrant traps for smolts and parr. Nelson reported 154 steelhead smolts and 11 rainbow trout in the outmigrant trap in the Arroyo de la Cruz. Estimated abundance of steelhead from electrofishing in Arroyo de la Cruz and in Burnett and Marmolejo Creeks ranged from 1,082 to 1,373 steelhead per mile. The proportion of young-of-the-year steelhead sampled via electrofishing in the Arroyo de la Cruz system varied from 49-54%. In addition, Nelson reported that her steelhead density estimates were 3 times lower than those estimated in 1981 and 1985 in the same river system (Nelson 1994a).

Nelson (1994b) found 1 steelhead parr, 5 steelhead smolts, and 13 juvenile rainbow trout in the outmigrant trap in Santa Rosa Creek in 1993. Electrofishing in 14 reaches of the creek resulted in an expanded estimate of 12,595 total steelhead throughout Santa Rosa Creek. No estimate of steelhead per mile was provided. These numbers represent a decline relative to previous estimates in the same creek; the estimated steelhead abundance in 1972 was 63,378 fish (Nelson 1994b).

Nelson (1995) trapped 10 steelhead smolts in the downstream migrant trap on San Simeon Creek in 1993, and electrofishing-based estimates of abundance were 1,157 steelhead per mile. Thirty-five percent of the steelhead censused by electrofishing were young-of-the-year.

11) Southern California ESU--For the Southern California ESU, the BRT has received new information on rainbow trout abundance in the Sisquoc River (Cardenas 1996), juvenile and adult steelhead and rainbow trout abundance information for the Santa Ynez River (Entrix 1995, Hanson et al. 1996), and juvenile abundance estimates for several other locations (USFS 1997).

For the Santa Ynez River, Entrix (1995) disputed the historical abundance estimates of 20,000 or more adult steelhead reported in the original status review (attributed to Shapovalov and Taft 1954) as a misinterpretation of visual observations. Entrix suggested that this estimate should be between about 13,000 and 14,500, and represents only the year 1944, which may have been an unusually high year. Entrix provided no more recent estimates. Hanson et al. (1996) reported results of some surveys for steelhead/rainbow trout adults and juveniles in 1993-1996. They reported abundant rainbow trout/steelhead in some mainstem reaches, and multi-aged populations in some tributaries, but noted that most tributaries have not been surveyed. In 1993-94 surveys, a total of about 27 adult *O. mykiss* were observed in mainstem surveys. Adult *O. mykiss* were also observed along with juveniles in 1994-95 snorkel surveys, but adult numbers are not included in the report.

Cardenas (1996) reported results of a 1995 snorkel survey of the upper Sisquoc River, finding a total of 232 rainbow trout in 11 pools surveyed. The U.S. Forest Service (USFS 1997) presented habitat quality and juvenile density information for a variety of streams in Los Padres National Forest, with density estimates ranging from 0 to 100 fish per 100 feet in various tributaries. Methods are not documented, and no attempt at estimating total abundance was made, so it is difficult to compare this information with other basins. The USFS summary identifies a number of "landlocked remnant native steelhead populations" throughout the region.

Entrix (1996) reported results of steelhead and rainbow trout abundance surveys in the Santa Clara River from 1994-96. Steelhead smolt counts in a downstream migrant trap were 81, 111, and 82 smolts in 1994-96, respectively. Over that same time period, 1 adult steelhead was captured each year in 1994-95, and 2 adults were captured in 1996 in an upstream migrant trap. Nine wild and 27 hatchery rainbow trout adults were trapped in 1996 in the river. No attempt was made to convert the trap counts to estimates of river-wide abundance. Entrix (1996) also reported mtDNA analyses of wild steelhead smolts and adults and hatchery rainbow trout sampled from the Santa Clara River. The mtDNA haplotypes identified suggest that some interactions between hatchery rainbow trout and steelhead may have occurred in this area, but because of small sample sizes, these conclusions should be treated as preliminary.

Sibbald et al. (1994) described habitat characteristics and provided survey data for steelhead and rainbow trout in six southern California coastal streams. The sampling methods used were snorkel surveys and electrofishing. The Ventura River and two of its tributary creeks contained rainbow trout, but no steelhead. El Jaro Creek (part of the Santa Ynez drainage) and Malibu Creek had 2 and 13 rainbow trout, respectively, and no steelhead. Twelve of the 13 rainbow trout sampled in Malibu Creek were found below the Rindge Dam. The only creek found to contain steelhead was Gaviota Creek, in which 11 smolts were found, along with "numerous" young of the year rainbow trout. No attempt was made to estimate stream-wide abundances from these data.

Henke (1996) provided estimates of historical abundance and presence/absence of steelhead in southern California coastal streams. Based on oral histories, questionnaires and library research, Henke estimated that prior to the arrival of Europeans in southern California, 250,000 adult steelhead were produced annually in coastal streams in the Santa Ynez, Santa Clara and Ventura River Basins.

12) Central Valley ESU--For the Central Valley ESU, the only new information is from CDFG (1997). They provided some counts of juvenile steelhead in the mainstem San Joaquin River and the Stanislaus River, and noted additional information on distribution of steelhead in the San Joaquin River system (Yoshiyama et al. 1996).

Inland Steelhead ESUs

14) Upper Columbia ESU--For the Upper Columbia ESU, the BRT has received updated information on adult escapement and harvest rates (CRFMP TAC 1996) and new information on juvenile steelhead and rainbow trout abundance in several streams (Peven 1996).

In the original status review, we relied on estimates of hatchery and natural escapement for the Wenatchee and Methow/Okanogan River Basins, as well as adult passage counts at mainstem Columbia River dams. We do not have more recent figures for the Wenatchee and Methow/Okanogan, but have received updated counts for Priest Rapids Dam (CRFMP TAC 1996). Recent average (5-year geometric mean, 1991-1995) adult steelhead abundance at Priest Rapids Dam was 7,900 total and 1,300 natural fish.

Peven (1996) summarized information on juvenile steelhead and rainbow trout abundance for several streams in this region, based on information in Mullan et al. (1992) and other studies. While these data are not adequate to estimate the total resident *O. mykiss* (redband trout) population, they do provide evidence of widespread abundance of redband trout within the region. Peven also provides "fairly strong circumstantial evidence" that resident fish do contribute to anadromous steelhead returns.

15) Snake River Basin ESU--For the Snake River Basin ESU, the BRT has received updated information on adult escapement (CRFMP TAC 1996, Chilcote 1997, Idaho 1997) and juvenile steelhead abundance in several streams (Idaho 1997).

The overall abundance (run size) of steelhead in the ESU is best indexed by adult passage counts at Lower Granite Dam (CRFMP TAC 1996, Chapman 1996). Recent average (5-year geometric mean 1992-1996) abundance was about 75,000 total and 8,900 naturally-produced steelhead. The geometric mean abundance of naturally-produced A-run steelhead was about 7,000, and for B-run abundance was about 1,400. Since 1990, IDFG has conducted widespread aerial redd count surveys to index steelhead spawning (Idaho 1997). This sampling is not sufficient to estimate total adult abundance, but does illustrate the distribution of spawning among sub-basins. These data suggest that spawning steelhead have been most abundant in the South and Middle forks and portions of the main Salmon River, and less abundant in the South Fork Clearwater, Lochsa, and Selway rivers. Parr density estimates (Idaho 1997) suggest that over the past 5 years "wild" A-run steelhead have averaged about 40% of carrying capacity, while "wild" B-run steelhead have averaged only about 10% of carrying capacity; "natural" A-run and B-run steelhead have had intermediate levels of habitat occupancy. ("Wild" steelhead represent natural production in areas with little or no hatchery influence, "natural" steelhead represent natural production in areas with an extensive history of hatchery influence.) IDFG (Idaho 1997) suggested that this low parr habitat occupancy results largely from lack of spawning adults.

Population Trends and Production

Coastal Steelhead ESUs

9) Central California Coast--For most of the new information received since the status review, there is not sufficient information to estimate a recent trend reliably (i.e., we need data for at least 7 of the last 10 years), but some general observations about trends can be made. For the San Lorenzo River, adult counts at Felton Dam trap (Alley 1997a, Jordan 1996) were relatively stable, varying between 121 (1990-91) and 467 fish (1991-92). Jordan (1996) reported that between 44% and 63% of these fish are of hatchery origin, so the counts provide little information regarding sustainability of the natural population. For smaller streams, Smith (1997) concluded that numbers were stable over the last 5 years in Waddell Creek, but fluctuated dramatically in Scott and Gazos Creeks. In Redwood Creek, recent dry years (1992, 1994, and 1996) had fewer juvenile steelhead than wet years (1993, 1995). None of these studies provide sufficient information to estimate population trends reliably. Marin Municipal Water District (MMWD 1997) provided graphs of estimated juvenile steelhead densities for Lagunitas Creek, Devils Gulch, and San Geronimo Creek covering the period from 1970 to 1996, showing generally higher densities in the past 4 years compared with earlier years. They also provided total (for all three streams) juvenile population estimates for the same period, which increased by 5% per year from 1970 through 1996; the survey methods and expansion methods are not documented.

10) South-Central California Coast--For the South-Central California Coast ESU, there are limited data from which to estimate trends in population abundance. Updated information for Carmel River adult populations (CDFG 1997, Dettman 1997) suggests a strong increase in abundance in the past 5 years, but the many years of missing data and numerous zero counts make estimating an exponential trend problematic. When compared with earlier counts, recent counts at San Clemente Dam (geometric mean of 243 for the last 5 years) are considerably lower than those in the late 1960s and 1970s (648 for 1964-1975), but considerably higher than the counts of zero for 1989-1991. Juvenile abundance estimates for 1970-1995 (MPWMD 1996) were relatively stable except for the extremely low estimate (22 fish per mile) in 1989.

11) Southern California--For the Southern California ESU, there is no new information sufficient to estimate population trends.

12) Central Valley--For the Central Valley ESU, there is no new information sufficient to estimate population trends.

Inland Steelhead ESUs

14) Upper Columbia River--Updated adult passage counts at Priest Rapids Dam (CRFMP TAC 1996) indicate continued low abundance of adult steelhead in the Upper Columbia ESU. For the 10-year period 1986-1995, naturally-produced returns to the dam declined at a rate of about 14% per year. This trend may be biased by unusually high abundance in the mid-1980s, but present naturally-produced abundance is substantially below historical levels.

15) Snake River Basin--Updated adult passage counts at Lower Granite Dam (Chapman 1996, CRFMP TAC 1996) indicate continued declines in abundance of adult steelhead in the Snake River Basin ESU. While total abundance at this location has declined at a rate of only about 2% per year for the 10-year period 1987-1996, naturally-produced adults declined at a rate of about 14% per year. If A- and B-run fish are treated separately, the annual rate of decline is about 13% for A-run and 20% for B-run. While redd count data (Idaho 1997) are not yet sufficient for estimating trends, it is clear that spawning abundance has declined substantially since 1990 in some basins; for example, the Middle Fork Salmon River total count declined steadily from 260 in 1990 to 30 in 1996. Over the same period, parr densities have shown less dramatic declines (Idaho 1997). The State of Idaho (1997, p. iii) stated that "wild Snake River steelhead are imperiled."

ODFW has conducted steelhead spawner surveys in three Snake River drainages (Joseph Creek in the lower Grande Ronde River Basin, upper Grande Ronde River Basin, and Camp Creek in the Imnaha River Basin) since 1974 (Chilcote 1997). Results are only reported as fish per mile, and do not provide an overall abundance estimate. They can, however, be used to estimate trends. Over the past 10 years (1987-1996) wild escapement for all 3 populations has been declining at rates ranging from 16% per year (Joseph Creek) to 19% per year (upper Grande Ronde River). These estimates are influenced by unusually high abundances in the late 1980s, and longer term trends are relatively flat, with recent abundances above historical lows that occurred in the 1970s. The upper Grande Ronde River population is largely hatchery-driven; in the past 5 years, hatchery fish of mixed Snake River Basin origin are estimated to comprise 60-90% of naturally spawning steelhead in the upper Grande Ronde River Basin. Joseph Creek has little or no hatchery influence, and ODFW estimates that hatchery influence in the Imnaha River Basin is less than 20%. Chilcote (1997) also applied an extinction risk assessment model, based on a stochastic Ricker stock-recruit function, to these populations, and estimated that all three had a zero probability of extinction over the next 100 years. As discussed earlier, the results of this model have not been validated, so these conclusions should be considered preliminary.

SUMMARY AND CONCLUSIONS OF RISK ASSESSMENTS

General Discussion

Resident Fish

As noted in the previous section, the BRT reaffirmed its previous conclusion that the steelhead ESUs should include native populations of resident fish that historically had opportunities to interbreed with steelhead. Whether any particular population of resident fish meets these criteria must be evaluated on a case-by-case basis. If it is determined that resident *O. mykiss* are included in a steelhead ESU, the question remains how best to incorporate information on resident fish into the overall risk analysis. This is not a simple matter for several reasons. First, in most cases (and this was true for every ESU considered in this report), very little information about resident fish is available. Second, the role of resident fish in the population dynamics and population genetics of steelhead is poorly understood. The few data that are available indicate that the extent of introgression between rainbow trout and steelhead varies among river basins (see discussion in Busby et al. 1996). This means that even if abundance data were available for resident fish, in most cases it would not be clear how to use this information in assessing extinction risk.

Because of these limitations, the presence of resident fish within the ESUs evaluated here was not a major factor in assessing extinction risk to steelhead. Nevertheless, the BRT did reach a consensus on two general issues regarding resident *O. mykiss*.

1) Resident fish can help to buffer extinction risks to an anadromous population by mitigating depensatory effects in spawning populations, by providing offspring that migrate to the ocean and enter the breeding population of steelhead, and by providing a "reserve" gene pool in freshwater that may persist through times of unfavorable conditions for anadromous fish.

2) In spite of these potential benefits, persistence of resident populations is not a substitute for conservation of anadromous populations. A particular concern is isolation of resident populations by human-caused barriers to migration. This interrupts normal population dynamic and population genetic processes and can lead to loss of a genetically based trait (anadromy). As discussed in the NMFS "species identification" paper (Waples 1991), the potential loss of anadromy in distinct population segments should be a legitimate ESA concern.

Environmental Variability

As discussed in the steelhead status review (Busby et al. 1996), environmental changes in both marine and freshwater habitats can have important impacts on steelhead abundance. For example, a pattern of relatively high abundance in the mid-1980s followed by (often sharp) declines over the next decade can be found in steelhead populations from most geographic regions of the Pacific Northwest. This result is most plausibly explained by broad-scale changes in ocean productivity. Similarly, 6-8 years of drought in the late 1980s and early 1990s adversely affected many freshwater habitats for steelhead throughout the region. These natural phenomena put increasing pressure on natural populations already stressed by anthropogenic factors such as habitat degradation, blockage of migratory routes, and harvest. Relaxation of cyclic or episodic environmental stresses (for example, through increases in ocean productivity or shifts from drought to wetter conditions) can help alleviate extinction risk to steelhead populations. However, because our ability to predict climate or environmental conditions in the future is extremely limited, the BRT did not make any particular assumptions about future conditions. Instead, the risk assessments were conducted under the assumption that present conditions would continue into the future (recognizing, of course, that "present conditions" includes natural variability and a range of possible environmental states).

There is one circumstance under which recent environmental events should be considered in evaluating risks to steelhead--cases in which the change in environmental conditions is so recent that their effects have not yet been observed in available abundance data. For example, if there were data indicating that following a return to wet conditions, outmigrating juvenile steelhead abundance had increased dramatically in the last 2 years, the BRT could consider in its risk evaluation the possibility that adult abundance would increase in the future as juveniles mature and enter the adult population. Although wetter conditions in the last 2 years have eased somewhat the drought in freshwater habitats for steelhead throughout much of the region, for the most part we lack information on the effects of this on juvenile abundance. Therefore, while the BRT felt that the at least temporary relief from drought conditions was a generally positive sign, it did not weigh heavily in risk evaluations.

Conservation Measures

In its risk evaluations, the BRT was prepared to consider specific conservation measures (e.g., hatchery 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, possible effects of conservation measures did not play a significant role in the BRT conclusions.

ESU-Specific Conclusions

Coastal Steelhead ESUs

9) Central California Coast--Additional information received since the status review suggests that steelhead in this ESU may be exhibiting slight increases in abundance in recent years. Updated abundance data for the Russian and San Lorenzo Rivers indicate increasing run sizes over the past 2-3 years, but it is not possible to distinguish the relative proportions of hatchery and wild steelhead in those estimates. Additional data from a few smaller streams in the region also show general increases in juvenile abundance in recent years. The BRT discussed sources of uncertainty in the abundance data, including difficulties in comparing different census and expansion methods, variance in sampling efficiency of the trap on the San Lorenzo River, and most importantly, the lack of information concerning the relative contributions of hatchery fish to total abundance estimates in the two major river basins.

Presence/absence data that have become available since the status review show that in a subset of streams sampled in the central California coast region, most contain steelhead. This is in contrast to the pattern exhibited by coho, which are absent from many of those same streams. Those streams in which steelhead were not present are concentrated in the highly urbanized San Francisco Bay region. The BRT raised several concerns about the usefulness of the presence-absence data. First, there was no way to determine whether the steelhead observed were hatchery or wild fish. Second, the methods used do not provide quantitative information about the abundance of steelhead in the streams, so it is difficult to tell whether the fish observed are indicative of viable populations. Finally, there was a possible bias towards sampling higher quality streams in the area. These censuses were designed in part to determine the spatial distribution of coho in streams throughout the region, and the streams chosen for sampling were those predicted to have suitable habitat for coho. The BRT concluded that despite these concerns, it is generally a positive sign that there is a relatively broad distribution of steelhead in smaller streams throughout the region.

In evaluating trends in productivity throughout the ESU, the BRT discussed difficulties arising from the inability to separate out the effects of hatchery productivity from overall run size increases in recent years. The Russian and San Lorenzo Rivers have the highest steelhead productivity in the ESU, but it is likely that many of the fish are of hatchery origin (estimates in both streams range from 40-60% over the last 5 years). If there were data indicating that the recent increases in abundance of steelhead on these larger rivers were not simply reflecting increases in hatchery fish, the BRT's confidence in increasing trends likely would be greater.

After considering available information, a majority of BRT members concluded that steelhead in the Central California Coast ESU are not presently in danger of extinction, but that they are likely to become so in the foreseeable future. Minority views were that the ESU is 1) presently in danger of extinction, and 2) not at significant risk. In contrast, at the time of the status review, the BRT concluded that steelhead in this ESU are in danger of extinction. Factors contributing to the present conclusion included new evidence for greater absolute numbers of steelhead in the larger rivers of the central California coast region and the possible increases in juvenile abundance over the last few years. In addition, the broad geographic distribution of steelhead throughout the region, as indicated by the presence/absence data, also convinced some BRT members that the ESU is not in immediate danger of extinction.

Although overall concerns for this ESU have eased somewhat, the BRT identified some serious, ongoing risk factors for natural steelhead populations in the central California coast region. The most important concern is habitat destruction and degradation and blockage of migratory routes. Spawning and rearing habitat in the two basins with the largest historic steelhead runs (the Russian River and San Lorenzo River) has been profoundly affected by water diversions, conversion of land to agriculture, impassable dams, point- and non-point source pollution, mining and logging; habitat loss through urbanization also has been severe in most tributaries to San Francisco and San Pablo Bays. Although the juvenile surveys indicated steelhead still are present in most coastal streams surveyed, this was not true for coho salmon, which are generally thought to be the first salmonid species to suffer from habitat degradation (due to their narrow habitat requirements). The results for coho salmon suggest that there may be an increased risk for steelhead from habitat degradation in the future within this region. Second, all populations except those in the two major basins appear to be small and therefore vulnerable to natural environmental and demographic fluctuations. Finally, it is difficult to assess the sustainability of natural populations in the two major river drainages because of substantial hatchery programs and a general lack of information about naturally spawning hatchery fish.

10) South-Central California Coast--Updated data on abundance and trends for steelhead in this ESU indicate slight increases in recent years. New data from the Carmel River show increases in adult and juvenile steelhead abundance over the past 2-5 years, but the overall numbers are still well below estimates of historical run sizes. The BRT was concerned about the inability to distinguish resident rainbow trout from steelhead in the juvenile abundance data. Support for this concern comes from the observation that in spite of several years of very low (to zero) abundance of Carmel River adults in the late 1980s-early 1990s, juvenile counts in the years following do not reflect the low adult numbers. The BRT also discussed the lack of good historical data on steelhead abundance for the three large rivers in the region, the Salinas, Pajaro and Carmel Rivers.

The BRT discussed the extensive urbanization and agricultural impacts on habitat in the three main river basins in the south-central California coast region. The BRT concluded that the Salinas, Pajaro and Çarmel Rivers have not been able to maintain historically high steelhead productivity, due in large part to habitat destruction and fragmentation, leading to restricted access of steelhead to remaining suitable habitat.

After weighing this information, the BRT was divided in its evaluation of the overall risk to steelhead in the South-Central California Coast ESU. About half of the BRT members concluded that this ESU is presently in danger of extinction, and the remainder felt that it was not currently endangered, but it was likely to become so in the future. In the previous risk evaluation made at the time of the status review, a majority of the BRT members concluded that the steelhead in this ESU were presently endangered. Reasons for the slightly more optimistic assessment in the current evaluations include new abundance data indicating recent increases in adult and juvenile abundance in the Carmel River and many small coastal tributaries in the southern part of the region.

The status of steelhead in this ESU is uncertain because of the scarcity of abundance data through time. Nevertheless, the extreme decreases in abundance relative to estimated historical levels and the extensive loss of habitat in the most productive river basins for both resident and anadromous *O. mykiss* were cause for continued concerns about the future sustainability of steelhead in this ESU. In addition, the BRT concluded that risks to genetic integrity to steelhead in this ESU are relatively low because of low levels of hatchery stocking (there are a few scattered reports of rainbow trout introductions from rivers outside the central California coast region). Genetic data (allozyme and DNA) indicate relatively high levels of genetic differentiation among steelhead from different streams within this region as compared to variation among populations in more northern steelhead ESUs, increasing the potential magnitude of genetic consequences of local population extinctions within this ESU.

11) Southern California--The sustainability of steelhead populations in the Southern California ESU continues to be a major concern, evidenced by consistently low abundance estimates in all river basins. There are fairly good qualitative accounts of historical abundances of steelhead in this ESU, and recent adult counts are severely depressed relative to the past. The few new data that have become available since the status review do not suggest any consistent pattern of change in steelhead abundance in this region.

The potential contribution of resident rainbow trout to the status of this ESU was discussed at length by the BRT (see previous section on resident fish). The resident trout in many of the rivers and streams in this region are considered to be primarily native, although there is uncertainty about the extent of rainbow trout stocking in this ESU. It is likely that during heavy rain years, juvenile resident trout behind local barriers to migration have access to the sea. The BRT considered the possibility that resident fish have served (or could serve) as a buffer to population declines suffered by the steelhead. Under this scenario, the potential periodic outmigrations of resident fish during wet years could provide a source of anadromous fish to replenish depressed steelhead populations in the river basins below upstream blockages. Unfortunately, there are no genetic data that can be called upon to examine this issue specifically, and the persistently low adult steelhead numbers in spite of the presence of rainbow trout suggest that the effect of the resident fish on steelhead abundance has been small. In addition, the BRT discussed the likelihood that even if resident fish have been contributing to the maintenance of steelhead population sizes, the inability of the anadromous fish to interbreed with resident fish upstream from blockages would ultimately result in a loss of genetic variation for anadromy in resident fish populations. In other words, unidirectional (downstream) migration of rainbow trout having a genetic predisposition for anadromy could eventually result in loss of that trait in upstream populations. The BRT was concerned about the possible loss of such an important life history trait from the resident fish in this ESU, especially considering the possibility that recovery of the ESU may be partly dependent on genetic variation in remaining resident rainbow trout.

A majority of BRT members concluded that the Southern California ESU presently is in danger of extinction, and a minority felt that it is not presently in danger of extinction, but it is likely to become so in the future. The primary reasons for concern about steelhead in this ESU are the widespread, dramatic declines in abundance relative to historical levels. Low abundance leads to increased risks due to demographic and genetic stochasticity in small populations. In addition, the BRT felt that the restricted spatial distribution of remaining populations places the ESU as a whole at risk because of reduced opportunities for recolonization of streams suffering local population extinctions. The main sources of the extensive population declines in steelhead in this ESU are similar to those described in the South-Central California Coast ESU: widespread habitat blockage, water diversions and extensive urbanization and agricultural development in the lower river basins. In addition, because of fire suppression practiced throughout the area, the BRT concluded that the effects of increased fire intensity and duration is likely to be a significant risk to the steelhead in this ESU.

12) Central Valley--Although the ESU configuration of steelhead in California's central valley region remains uncertain, the BRT concluded that any ESUs identified in this geographic area would almost certainly be considered at risk of extinction. The BRT also recognized that native steelhead may no longer exist in many streams in the Central Valley (e.g., in the upper San Joaquin River), and that under some ESU configurations the BRT may not be able to identify any native, naturally-spawning fish of ESA concern in one or more ESUs.

Inland Steelhead ESUs

14) Upper Columbia River--The steelhead in the Upper Columbia River ESU continue to exhibit low abundances, both in absolute numbers and in relation to numbers of hatchery fish throughout the region. Data from this ESU include separate total and natural run sizes, allowing the separation of hatchery and wild fish abundance estimates for at least some areas in some years. Review of the most recent data indicates that natural steelhead abundance has declined or remained low and relatively constant in the major river basins in this ESU (Wenatchee, Methow, Okanogan) since the early 1990s. Estimates of natural production of steelhead in the ESU are well below replacement (approximately 0.3:1 adult replacement ratios estimated in the Wenatchee and Entiat Rivers). The BRT also discussed anecdotal evidence that resident rainbow trout, which are in numerous streams throughout the region, contribute to anadromous run abundance (see previous section on resident fish).

The proportion of hatchery fish is high in these rivers (65-80%). In addition, substantial genetic mixing of populations within this ESU has occurred, both historically (as a result of the GCFMP) and more recently as a result of the Wells Hatchery program. The presence of hatchery fish can mask the true status of natural steelhead runs, making evaluations of risk very difficult. In addition, the BRT discussed problems associated with the extensive mixing of hatchery stocks throughout the Upper Columbia River Basin, and how that mixing may have reduced the opportunity for maintenance of locally adapted genetic lineages among different drainages.

The data on adult replacement ratios merit some discussion because they are essential to understanding the degree of risk faced by natural populations and to developing effective recovery strategies. The low values reported by WDF et al. (1993) for the Entiat (0.25:1) and Wenatchee (0.3:1) Rivers were obtained by comparing the number of naturally produced natural spawners in one generation to the total (natural + hatchery origin) natural spawners in the previous generation (e.g., see Brown 1995). This is equivalent to the "natural return ratio" first used by Busby et al. (1994) in the status review for Klamath Mountains Province steelhead. This ratio provides a useful index of productivity in natural habitat, but it requires some assumptions about the relative reproductive success of natural and hatchery fish before it can be used to assess productivity of naturally produced fish. For example, under the assumption that naturally spawning hatchery fish have reproductive success equal to that of natural fish, natural return ratios of 0.25-0.3 indicate that the naturally-produced natural spawners are far below replacement rate. If this is true, the declines in the natural populations would have been much steeper without the presence of naturally spawning hatchery fish each generation. Under this scenario, it is even possible that the naturally spawning hatchery fish have prevented local subpopulations from going extinct.

At the other extreme, under the assumption that naturally spawning hatchery fish have zero reproductive success, the conclusions are much different. For example, it is estimated that 65% of the natural spawners in the Wenatchee River are of hatchery origin, and the natural return ratio is estimated to be 0.3:1. This ratio would be almost 1:1 after removing naturally spawning hatchery fish from consideration, assuming that all natural production comes from naturally produced fish. Under this scenario, the natural component might be at or near replacement rate, and its productivity might be even higher without the presence of large numbers of naturally spawning hatchery fish.

Almost certainly the reproductive success of naturally spawning hatchery fish lies somewhere between these two extremes. Obtaining estimates of this key parameter is critical to understanding population dynamics of natural populations in the ESU and to determining the appropriate role for hatchery supplementation in recovery planning.

Based on the information above, a majority of the BRT members concluded that the Upper Columbia ESU is presently at risk of extinction, while a minority felt that the ESU is not at immediate risk of extinction but is likely to become so in the foreseeable future. The BRT felt that the primary cause for concern for steelhead in this ESU are the extremely low estimates of adult replacement ratios. The dramatic declines in natural run sizes and the inability of naturally spawning steelhead adults to replace themselves suggest that if present trends continue, this ESU will not be viable. Habitat degradation, juvenile and adult mortality in the hydrosystem, and unfavorable environmental conditions in both marine and freshwater habitats have contributed to the declines and represent risk factors for the future. Harvest in lower river fisheries and genetic homogenization from composite broodstock collections are other factors that may contribute significantly to risk to the Upper Columbia ESU.

15) Snake River Basin--Snake River Basin steelhead recently have been suffering severe declines in abundance relative to historical levels. Low run sizes over the last 10 years are most pronounced for naturally produced steelhead. In addition, average parr densities recently have dropped for both A- and B-run steelhead, resulting in many river basins in this region being characterized as critically underseeded relative to the carrying capacity of streams. Declines in abundance have been particularly serious for B-run steelhead, increasing the risk that some of the life history diversity may be lost from steelhead in this ESU. The BRT also discussed information indicating record low smolt survival and ocean production for Snake River steelhead in 1992-94.

The proportion of hatchery steelhead in the Snake River Basin is very high for the ESU as a whole (over 80% hatchery fish passing Lower Granite Dam), yet hatchery fish are rare to nonexistent in several drainages in the region. In places where hatchery release sites are interspersed with wild reaches, the potential for straying and introgression is high, resulting in a risk to the genetic integrity of some steelhead populations in this ESU. Hatchery/wild interactions that do occur for Snake River steelhead are of particular concern because many of the hatcheries use composite stocks that have been domesticated over a long period of time.

The BRT concluded that steelhead in the Snake River Basin ESU are not presently at risk of extinction but are likely to become so in the future. The primary indicator of risk to the ESU is declining abundance throughout the region, and demographic and genetic risks from small population sizes are likely to be important because few natural steelhead are spread over a wide geographic area. Steelhead in this ESU face risks similar to those in the Upper Columbia River ESU: widespread habitat blockage from hydrosystem management and potentially deleterious genetic effects from straying and introgression from hatchery fish.

In terms of overall risk to the ESU, the BRT concluded that the reduction in habitat capacity resulting from large dams such as the Hells Canyon dam complex and Dworshak Dam is somewhat mitigated by several river basins with fairly good production of natural steelhead runs. The BRT was concerned about several sources of uncertainty in their risk evaluation, stemming from poor abundance data for natural runs in many river basins and inadequate information concerning the extent of interactions between wild and hatchery fish.

HATCHERY POPULATIONS

If any of the ESUs under consideration (Southern California, South-Central California Coast, Central California Coast, Upper Columbia River, or Snake River Basin) are identified as threatened or endangered in the final listing determination, it will be necessary for NMFS to determine the ESA status of hatchery populations that are associated with the listed ESU(s). According to NMFS policy (NMFS 1993, see also Hard et al. 1992), two key questions must be addressed for each hatchery stock associated with a listed species: 1) Is it part of the ESU? And, if so, 2) Should the hatchery population be listed? The focus of these evaluations should be on "existing hatchery fish," which are defined in the policy to include prespawning adults, eggs, or juveniles held in a facility, as well as fish that were released prior to the listing but have not completed their life cycle.

The first question--the ESU status of existing hatchery populations--is a biological one, and the guiding principle should be whether the hatchery population contains genetic resources similar to those of natural populations in the ESU. The second question is an administrative one. According to NMFS policy, existing fish would generally not be listed even if they are part of the ESU unless they are considered "essential" for recovery (see discussion below).

To address the ESU question, the BRT considered information on stock histories and broodstock collection methods for existing hatchery populations associated with the five ESUs. Additionally, where available, the BRT considered genetic information on hatchery populations and their relationship with naturally spawning populations within and outside of the ESU. In evaluating the importance of hatchery stocks for recovery, the BRT considered the relationship between the natural and hatchery populations and the degree of risk faced by the natural population(s). Hatchery programs that have not recently produced steelhead were not considered.

It is important to note two considerations with respect to the evaluations of hatchery populations. First, the BRT conclusions apply to individual hatchery stocks and not to facilities. Stock numbers for Oregon hatchery stocks are included in parentheses to allow identification of the stocks in question in this document. Second, a determination that a stock is not "essential" for recovery does not preclude it from playing a role in recovery. Any hatchery population that is part of the ESU is available for use in recovery if conditions warrant. In this context, an "essential" hatchery population is one that is vital to the success of recovery efforts at the outset (for example, if the associated natural population(s) were already extinct or at high risk of extinction). Under these circumstances, NMFS would consider taking the administrative action of listing the existing hatchery population at the time of the final listing determination. Fish that are progeny of listed fish taken into a hatchery for broodstock automatically will be listed, so any hatchery population involved in formal recovery under the ESA eventually will be comprised of listed fish. (See Appendix for stock histories.)

Hatchery Stock Determinations

Coastal Steelhead ESUs

All coastal steelhead hatchery stocks considered in this document are winter-run steelhead.

9) Central California Coast ESU--Hatchery populations that should be considered part of the ESU:

Scott Creek stock
San Lorenzo River stock

Hatchery populations of uncertain ESU status:

Dry Creek stock

The BRT agreed that both the Big Creek and San Lorenzo River stocks should be part of the ESU. The basis for this conclusion was the minimal influence of releases of fish from outside of the ESU and the genetic similarity between these and other regional stocks. Furthermore, adult collection and spawning procedures practiced by the hatcheries (which included using naturally produced fish) would have helped to reduce selection for domestication and small population effects during the course of hatchery operations.

A slight majority of the BRT was uncertain of the status of the Dry Creek stock used at the Warm Springs Hatchery; however the remainder of the BRT felt that this stock should be included in the ESU. The primary concern was that releases of fish from outside of the ESU (derived from the Northern California ESU) into the Russian River prior to the establishment of the Warm Springs Hatchery may have altered significantly the genetic composition of fish in the river. In the absence of genetic information for the Dry Creek stock (Warm Springs Hatchery) or Russian River populations, and without an opinion from California Department of Fish and Game, the BRT felt that it had insufficient information to make a decision. It is possible that this information may become available prior to the final listing.

Importance for recovery

The BRT decided that the Scott Creek stock probably was not essential for recovery, given current information. It was felt that sufficient naturally spawning populations exist for recovery efforts. Furthermore, the BRT was evenly divided on whether the San Lorenzo River stock should be considered as "possibly essential" or "probably not essential" for recovery efforts. The significant degree of hatchery contribution to steelhead runs in the San Lorenzo River may necessitate the use of this stock in recovery efforts.

10) South-Central California Coast ESU--Hatchery populations that should be considered part of the ESU:

Whale Rock Reservoir steelhead stock

A majority of the BRT concluded that this stock should be considered as part of the ESU, and a minority were uncertain of the ESU status. Although this stock was established from a steelhead population that was trapped behind the Whale Rock Dam in the 1950s, it apparently retains an anadromous component. Juvenile steelhead are able to emigrate from Whale Rock Reservoir during high spill years, and anecdotal information indicates that some of these juveniles return as adults to the base of the dam 2 years later. Genetically, the hatchery population is more closely related to California steelhead than to resident rainbow trout. Allozyme data indicate a closer relationship of the Whale Rock stock to central and northern California steelhead stocks (Busby et al. 1996), yet mtDNA and microsatellite nuclear DNA data suggest that the Whale Rock population is more closely related to south-central and southern California steelhead populations (Nielsen et al. in press). Nielsen et al. (in press) speculated that the allozyme and DNA data may differ because of sampling error (few parental lineages may have been represented in the allozyme samples), or due to year-to-year variation in the genetic composition of broodstocks sampled in 1992 (for DNA samples) and 1995 (for allozyme samples). The BRT was unable to verify these possibilities.

Importance for recovery

A slight majority of the BRT believed that this stock is "possibly essential" for recovery efforts, with the remaining members concluding that the stock probably would not be essential.

11) Southern California ESU--No existing hatchery populations.

Inland Steelhead ESUs

All inland steelhead hatchery stocks considered in this document are summer-run steelhead.

14) Upper Columbia River--Hatchery populations that should be considered part of the ESU:

Wells Hatchery stock

Hatchery populations that should not be considered part of the ESU:

Skamania Hatchery stock

The BRT agreed that the Wells Hatchery stock was in the Upper Columbia River ESU. Although the stock represents a mixture of native populations, it probably retains the genetic resources of steelhead populations above Grand Coulee Dam that are now extinct from those native habitats. Operations at the Wells Hatchery have utilized large numbers of spawning adults (>500) and have incorporated some naturally-spawning adults (10% of the total) into the broodstock each year, procedures which should help minimize divergence from the natural population. .

The BRT agreed that the Skamania Hatchery stock should not included in the ESU, based on the non-native heritage of this stock.

Importance for recovery

The majority opinion of the BRT was that the Wells Hatchery stock was essential for recovery efforts in this ESU, while a minority felt that it may be essential for recovery efforts. This conclusion primarily was based on the low recruits per spawner ratios for naturally-spawning steelhead in this ESU. Given the current conditions, it is unlikely that the naturally spawning component would persist without the use of the Wells Hatchery stock.

15) Snake River Basin ESU--Hatchery populations that should be considered part of the ESU:

Dworshak NFH stock
Imnaha River stock (ODFW stock number 29)
Oxbow Hatchery stock

Hatchery populations that should not be considered part of the ESU:

East Fork trap
Lyons Ferry stock
Pahsimeroi Hatchery stock

Hatchery populations of uncertain ESU status:

Wallowa Hatchery stock (ODFW stock number 56)

The BRT unanimously concluded that the Imnaha River stock should be in the ESU. The Imnaha River Hatchery stock was founded recently from an undiluted stock (with no previous history of non-native hatchery releases) for the purpose of preserving the native genetic resource. The majority of the BRT concluded that the Dworshak NFH stock should also be included in the ESU. A minority of the BRT members felt either that the stock should not be part of the ESU, or they were uncertain as to the status of the stock. Although the historical spawning and rearing habitat for this stock is not available to anadromous migrants (due to the construction of Dworshak Dam), this stock represents the only source of a genetically distinct component of the ESU. Furthermore, due to the absence of any introgression from other populations, the purity of this stock likely has been maintained. The BRT discussed concerns that inadvertent selection for domestication or genetic founder effects may have compromised the integrity of this stock. Hatchery records indicate that a minimum of a thousand adults have been used annually to perpetuate the stock, which would reduce the effects of genetic drift.

A majority of the BRT felt that the Oxbow Hatchery stock should also be included in the ESU. This stock represents a mixture of the now-extinct steelhead populations which spawned upriver of the Hells Canyon Complex in the Malheur, Powder, Weiser, and Bruneau Rivers. Although this stock has been under artificial propagation for several generations and has been propagated almost entirely from hatchery-derived adults, the BRT felt that this stock represented the only pure source of a unique genetic resource and as such was important to preserve as part of the ESU. A minority concluded that the stock not be included in the ESU because of the composite nature of the stock, the long duration of artificial propagation utilizing only hatchery-derived fish as broodstock, and the elimination of access to historical spawning and rearing habitat. A few members of the BRT were undecided on the status of the Oxbow Hatchery stock.

A majority of the BRT felt that the Pahsimeroi Hatchery and Lyons Ferry Hatchery stocks should not be included in the ESU. Additionally, the BRT concluded that the stock used at the East Fork trap (a mixture of Pahsimeroi and Dworshak Hatchery stocks) should not be included in the ESU. The Lyons Ferry Hatchery stock was primarily excluded based on the use of steelhead from stocks which originated outside of this ESU. The Pahsimeroi Hatchery stock consists of a mixture of populations, all of which originate within the ESU; however, the BRT felt that because these populations came from ecologically-distinct regions throughout the Snake River Basin, the assemblage of these populations into one stock did not closely resemble any naturally spawning counterpart. Hatchery practices have focused on propagating this stock solely from hatchery derived adults. A minority of the BRT members were unsure of the ESU status of this stock. None of the BRT members felt that the Pahsimeroi Hatchery, Lyons Ferry Hatchery, or East Fork trap stocks should be included in the ESU.

A majority of the BRT members were undecided on the status of the Wallowa Hatchery stock. The stock was founded by collections of adults from lower Snake River mainstem dams, and there was no clear consensus on which populations within the Snake River Basin were represented in the mixture. A concluded that the stock should not be included in the ESU. Arguments for not including this stock are similar to those for the Pahsimeroi Hatchery stock.

Importance for recovery

For those stocks (Imnaha Hatchery stock, Dworshak NFH stock, and Oxbow Hatchery stock) which the BRT considered to be part of the ESU, the majority concluded that these stocks might be essential for recovery efforts under certain circumstances. The Dworshak NFH stock and Oxbow Hatchery stock both represent the remnants of population(s) of steelhead that have been excluded from their historical spawning and rearing habitat by impassable dams. In fact, these stocks represent the only legacy for the reintroduction of native populations into these areas. If such reintroduction programs are undertaken, it will be important to have maintained these stocks. The BRT concluded that the current health of the naturally-spawning steelhead population(s) in the Imnaha River indicates that the Imnaha River Hatchery stock is not essential for recovery, but it might become essential if naturally spawning population(s) decline considerably in the future. A minority of the BRT expressed a similar opinion for all three stocks: that they probably would not be necessary for recovery. This was based, in part, on the belief that sufficient numbers of naturally spawning fish were available for recovery efforts.

REFERENCES

Alley, D. W. and Associates. 1997. Letter to G. Griffin, NMFS, dated 6 January, 6 p. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

Alley, D. W. and Associates. 1997a. Comparison of juvenile steelhead densities in 1981 and 1994-96 in the San Lorenzo River and tributaries, with an estimate of juvenile population size in the mainstem river and expected adult returns from that production, Santa Cruz County, California. Project Report 143-01, 144-01, prepared for City of Santa Cruz Water Department and San Lorenzo Valley Water District, 79 p. (Available from D.W. Alley & Associates, 330 Old River Lane, P.O. Box 200, Brookdale, CA 95007.)

Alley, D. W. and Associates. 1997b. Comparison of juvenile steelhead densities in 1994-96 in Santa Rosa and San Simeon Creeks, with estimates of juvenile population sizes and expected adult returns from that production, San Luis Obispo County, California. Project Report 100-06, prepared for Cambria Community Services District, 44 p. (Available from D.W. Alley & Associates, 330 Old River Lane, P.O. Box 200, Brookdale, CA 95007.)

Barnhart, R. A. 1986. Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest)--steelhead. U.S. Fish Wildl. Serv. Biol. Rep. 82(11.60), 21 p.

Behnke, R. J. 1992. Native trout of western North America. Am. Fish. Soc. Monog. 6, 275 p. American Fisheries Society, Bethesda, MD.

Brown, L. G. 1995. Mid-Columbia River summer steelhead stock assessment. A summary of the Priest Rapids steelhead sampling project. 1986-1994 Cycles. Progress Report No. AF95-02, 87 p.

Brown, R. L. 1997. Letter from California Department of Water Resources, dated 6 January 1997, 4 p. plus attachments. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

Burgner, R. L., J. T. Light, L. Margolis, T. Okazaki, A. Tautz, and S. Ito. 1992. Distribution and origins of steelhead trout (*Oncorhynchus mykiss*) in offshore waters of the North Pacific Ocean. Int. North Pac. Fish. Comm. Bull. 51, 92 p.

Busby, P. J., T. C. Wainwright, G. J. Bryant, L. J. Lierheimer, R. S. Waples, F. W. Waknitz, and I. V. Lagomarsino. 1996. Status review of west coast steelhead from Washington, Idaho, Oregon, and California. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-NWFSC-27, 261 p.

Busby, P. J., T. C. Wainwright and R. S. Waples. 1994. Status review for Klamath Mountains Province steelhead. U. S. Dep. Commer., NOAA Tech. Memo. NMFS-NWFSC-19, 130 p.

California Department of Fish and Game (CDFG). 1997. Letter from J. E. Shafer, Director, Sacramento, CA, dated 6 January 1997, 2 p. plus attachments. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

Campbell, B. H. 1996. Letter from Conservation Director, San Diego Fly Fishers, San Diego, CA, dated 6 October 1996, 3 p. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

Capelli, M. 1997. Letter from the California Coastal Commission, dated 3 January 1997, 8 p. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

Cardenas, M. 1996. 1995 upper Sisquoc River survey. Study report, California Department of Fish and Game, 10 p. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

Carpanzano, C. M. 1996. Distributions and habitat associations of different age classes and mitochondrial genotypes of *Oncorhynchus mykiss* in streams in southern California. Masters Thesis, Univ. of California-Santa Barbara, 87 p.

Chapman, D. W. 1996. Letter from BioAnalysts, Inc., Boise, ID, dated 22 November 1996, 18 p. plus attachments. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

Chilcote, M. W. 1997. Conservation status of steelhead in Oregon. Draft report dated June 1997 (cover letter dated 3 June 1997), 122 p. (Available from Oregon Department of Fish and Wildlife, 2501 S.W. First Avenue, P.O. Box 59, Portland, OR 97207.)

Columbia River Fisheries Management Plan Technical Advisory Committee (CRFMP TAC). 1996. Summer steelhead. *In* Columbia River fish management plan: 1996 All species review (draft dated 31 December 1996). Technical Advisory Committee, *U.S. v. Oregon*. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

Colwell, R., P. Monroe, and J. Harrell. 1996. Letter from Fishermen's Alliance of Monterey Bay, dated 17 December 1996. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

Crawford, B. 1997. Letter from Fish Management Program, Washington Department of Fish and Wildlife, dated 18 February 1997, 7 p. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

Dettman, D. H. 1997. Letter from Monterey Peninsula Water Management District (MPWMD), dated 24 January 1997, 2 p. plus enclosures. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

Entrix. 1995. Historical steelhead run in the Santa Ynez River. Prepared for Price, Postel and Parma, Santa Barbara, CA. Project No. 374100, 59 p. (Available from Entrix, Inc. 590 Ygnacio Valley Rd., Suite 200. Walnut Creek, CA 94596.)

Entrix. 1996. Results of fish passage monitoring at the Vern Freeman Diversion Facility, Santa Clara River, 1996. Prepared for United Water Conservation District. Santa Paula, CA. Project No. 324402. (Available from Entrix, Inc. 590 Ygnacio Valley Rd., Suite 200. Walnut Creek, CA 94596.)

Evans, W. A. 1996. Letter from Evans Environmental Consultants, San Geronimo, CA, dated 13 September 1996, 4 p. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

Farley, T. C. 1997. Letter from California Department of Fish and Game, dated 27 March 1997, 2 p. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

Fuerst, D. W., and D. H. Dettman. 1997. Letter from Monterey Peninsula Water Management District, Monterey, CA, dated 6 January 1997, __ p. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

Fulton, L. A. 1970. Spawning areas and abundance of steelhead trout and coho, sockeye, and chum salmon in the Columbia River Basin--past and present. U.S. Dep. Commer., Natl. Mar. Fish Serv., Spec. Sci. Rep. Fish. 618, 37 p.

Fusaro, C. 1997. Letter from California Trout, Santa Barbara, CA, dated 3 January 1997, 4 p. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

Gientke, F. J. 1997. Letter from United Water Conservation District, Santa Paula, CA, dated 6 January 1997, 6 p. plus attachment. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

Greenwood, A. 1996. Letter from San Diego Trout, San Diego, CA, dated 4 October 1996, 2 p. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

Hanson, C. H., J. Hagar, S. Engblom, and B. Bemis. 1996. Synthesis and analysis of information collected on the fishery resources and habitat conditions of the lower Santa Ynez River: 1993-1996. Draft Report for the Santa Ynez River Technical Advisory Committee, 504 p. (Available from Hanson Environmental, Inc., 132 Cottage Lane, Walnut Creek, CA 94595.)

Harrell, J. W. 1996. Letter from Co-Director of Research, Fisherman's Alliance of Monterey Bay, dated 11 November 1996, __ p. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

Henke, E. 1996. Letter from E. Henke, Historical Research, Ashland, OR, dated 21 October 1996, 12 p. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

Higgins, P. 1991. Southern California steelhead recovery assessment. Report to the South Coast Chapter, Trout Unlimited, 26 p. (Available from Trout Unlimited of California, 2530 San Pablo Ave., Suite D, Berkeley, CA 94702.)

Hunt, L. E. 1997. Letter from L. E. Hunt, Consulting Biologist, Goleta, CA, dated 5 January 1997, 4 p. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

Hunter, J. 1997. Letter from Trout Unlimited of California, dated 8 October 1996, 3 p. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

Idaho, State of (Idaho). 1997. Proposed Listing of Snake River Steelhead for Protection under the Federal Endangered Species Act: State of Idaho Comments to the National Marine Fisheries Service, dated 3 January 1997, 91 p. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

Jordan, R. 1996. Letter from R. Jordan, Scotts Valley, CA, dated 30 December 1996, 2 p. plus enclosures. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

Macaulay, S. 1997. Letter from General Manager, State Water Contractors, dated 3 January 1997, 15 p. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

Marin Municipal Water District (MMWD). 1997. Letter from S. R. Phelps, Environmental Resources Division Manager, Corte Madera, CA, dated 16 January 1997 letter, 4 p. plus attachments. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

Martin, G. R. 1997. Letter from Western Urban Water Coalition, dated 6 January 1997, 10 p. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

McClary, H. T. 1996. Letter from Big Creek Lumber Co., Davenport, CA, dated 23 December 1996, 2 p. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

Monterey Peninsula Water Management District (MPWMD). 1996. Evaluation of MPWMD five-year mitigation program 1991-1996. 235 p. (Available from Monterey Peninsula Water Management District, 187 Eldorado, Monterey, CA 93940.)

Mullan, J. W., K. R. Williams, G. Rhodus, T. W. Hillman, and J. D. McIntyre. 1992. Production and habitat of salmonids in mid-Columbia River tributary streams. Monograph I, U.S. Fish and Wildlife Service, Box 549, Leavenworth, WA 98826, 489 p.

Murphy, K. and N. Sidhom. 1995. Survey of the 1994-95 San Lorenzo River (Santa Cruz County) winter sport fishery. California Department of Fish and Game, Region 3, Inland Fisheries. Draft report.

National Marine Fisheries Service (NMFS). 1993. Interim policy on artificial propagation of Pacific salmon under the Endangered Species Act. Federal Register [Docket 921186-2286, 5 April 1993] 58(63): 17573-17576.

National Marine Fisheries Service (NMFS). 1996. Endangered and threatened species: Proposed endangered status for five ESUs of steelhead and proposed threatened status for five ESUs of steelhead in Washington, Oregon, Idaho, and California. Federal Register [Docket 960730210-6210-01, 9 August 1996] 61(155):41541-41561.

Nelson, J. 1994a. Steelhead population and habitat assessment on Arroyo de la Cruz, San Luis Obispo County, 1993. California Department of Fish and Game, Region 3, Inland Fisheries.

Nelson, J. 1994b. Summary of steelhead population and habitat sampling. Santa Rosa Creek, San Luis Obispo County, 1993. California Department of Fish and Game, Region 3, Inland Fisheries.

Nelson, J. 1995. Summary of steelhead population and habitat sampling. San Simeon Creek, San Luis Obispo County, 1993. California Department of Fish and Game, Region 3, Inland Fisheries.

Nielsen, J. L. 1997. Letter from J. Nielsen, Hopkins Marine Station, Stanford University, 2 p. plus enclosed manuscripts. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

Nielson, J. L., C. Carpanzano, M. C. Fountain and C. A. Gan. In press. Mitochondrial DNA and nuclear microsatellite diversity in hatchery and wild Oncorhynchus mykiss from freshwater habitats in southern California. Trans. Am. Fish. Soc.

Nuzum, R. C. 1997. Letter from the Manager of Natural Resources, East Bay Municipal Utility District, Oakland, CA, dated 23 December 1996, 22 p. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

Orton, R. D. 1996. Letter from Department of Resource Conservation, Las Virgenes Municipal Water District, Calabasas, CA, dated 23 October 1996, 10 p. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

Peven, C. 1996. Letter from Chelan County PUD, Wenatchee, WA, dated 30 October 1996, 19 p. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

Price, Postel, and Parma. 1997. Letter from Cachuma Member Units (Carpinteria Valley Water District, Goleta Water District, Montecito Water District, City of Santa Barbara, and Santa Ynez River Water Conservation District), dated 6 January 1997, 6 p. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

Pollard, S. 1977. Memo dated 7 January 1997. Fisheries Branch, British Columbia Ministry of Environment, Lands and Parks, Victoria, 4 p. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

Reeves, G. H. 1997. Memo dated 7 January 1997. USDA Forest Service, Pacific Northwest Research Station, Corvallis, Oregon, 1 p. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

Ritchie, S. and J. Beard. 1997. Letter from San Francisco Public Utilities Commission and Alameda County Water District, dated 3 January 1997, 7 p. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

Schreck, C. B., H. W. Li, R. C. Hjort, and C. S. Sharpe. 1986. Stock identification of Columbia River chinook salmon and steelhead trout. Final Report to Bonneville Power Administration, Contract DE-A179-83BP13499, Project 83-451, 184 p. (Available from Bonneville Power Administration, P.O. Box 351, Portland, OR 97208.)

Sequeira, J. 1997. Letter from the Director, Department of Utilities, City of Sacramento, CA, dated 6 January 1997, 2 p. plus enclosures. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

Shapovalov, L., and A. C. Taft. 1954. The life histories of the steelhead rainbow trout (*Salmo gairdneri gairdneri*) and silver salmon (*Oncorhynchus kisutch*) with special reference to Waddell Creek, California, and recommendations regarding their management. Calif. Dep. Fish Game Fish Bull. 98, 375 p.

Sibbald, G. F., S. Engblom and V. Whitman. 1994. Steelhead surveys in six southern California coastal streams: El Jaro Creek, Gaviota Creek, North Fork Matilija Creek, Ventura River, San Antonio Creek and Malibu Creek, 1993. California Department of Fish and Game Region 2, Inland Fisheries. Draft Administrative Report.

Smith, J. J. 1997. Letter to G. Griffin, dated 3 January 1997, 8 p. plus enclosures. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

Steiner Environmental Consulting. 1996. A history of the salmonid decline in the Russian River. Project Report for Sonoma County Water Agency, California State Coastal Conservancy, and Steiner Environmental Consulting, 84 p. (Available from Steiner Environmental Consulting, P.O. Box 250, Potter Valley, CA 95469.)

Thurow, R. 1985. Middle Fork Salmon River fisheries investigations. Job Completion Report, Project F-73-R-6, Study VI, Subproject II, River and Stream Investigations, Idaho Department of Fish and Game, Boise.

Titus, R. G., D. C. Erman, and W. N. Snider. In press. History and status of steelhead in California coastal drainages south of San Francisco Bay. Hilgardia.

Trautwein, B. G. 1996. Letter from Executive Director, Santa Barbara Urban Creeks Council, Goleta, CA, dated 24 October 1996, 6 p. plus attachments. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

United States Department of the Interior (USDI). 1997. Letter from the Director, Office of Environmental Policy and Compliance, United States Department of the Interior (USDI), dated 27 January 1997, 1 p. plus enclosures. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.).

United States Forest Service (USFS). 1997. Letter from A. Olson, Regional Anadromous Fish Program Coordinator, dated 7 January 1996[7], 1 page plus enclosures. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.).

United States Forest Service and United States Bureau of Land Management (USFS and USBLM). 1996. Storms and floods of the winter of 1995-96. USDA Forest Service Pacific Northwest Region and Pacific Northwest Forest and Range Experiment Station and USDI BLM Oregon State Office.)

Vasquez, E. 1997. Letter from E. Vasquez, President, Santa Cruz County Farm Bureau, Watsonville, CA, 6 p. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

Waples, R. S. 1991. Pacific salmon, *Oncorhynchus* spp., and the definition of "species" under the Endangered Species Act. U.S. Natl. Mar. Fish. Serv., Mar. Fish. Rev. 53(3):11-22.

Washington Department of Fisheries (WDF), Washington Department of Wildlife (WDW), and Western Washington Treaty Indian Tribes (WWTIT). 1993. 1992 Washington State salmon and steelhead stock inventory (SASSI). Wash. Dep. Fish Wildlife, Olympia, 212 p. and 5 regional volumes. (Available from Washington Department of Fish and Wildlife, 600 Capitol Way N, Olympia, WA 98501-1091.)

Weseloh, T. J. 1997. Letter from T. Weseloh, California Trout to G. Griffin, NMFS, dated 3 January 1997, McKinleyville, CA, 12 p. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

Yoshiyama, R. M., E R. Gerstung, F. W. Fisher, and P. B. Moyle. 1996. Historical and present distribution of chinook salmon in the Central Valley drainage of California. Dep. Wildl., Fish, and Conservation Biology, 54 p. (Available from Department of Wildlife, Fish, and Conservation Biology, University of California, Davis, CA 95616.)

TABLES

Table 1. Steelhead evolutionarily significant units (ESUs) and their status as proposed by the National Marine Fisheries Service (NMFS 1996).

Status	ESUs
Proposed Endangered	
	Central California Coast
	South-Central California Coast
	Southern California
	Central Valley
	Upper Columbia River
Proposed Threatened	
	Lower Columbia River
	Oregon Coast
	Klamath Mountains Province
	Northern California
	Snake River Basin
Candidate	
	Middle Columbia River
Not proposed for listing	
	Puget Sound
	Olympic Peninsula
	Southwest Washington
	Upper Willamette River

Table 2. Comanaging agencies providing comments on the west coast steelhead status review (Busby et al. 1996) and proposed rule (NMFS 1996).

Category	Agency
Federal Agencies	
	USDA Forest Service
	USDI Fish and Wildlife Service
	USDI Office of the Secretary
State Agencies	
	Oregon Department of Fish and Wildlife
	The Resources Agency of California
	Department of Fish and Game
	Department of Water Resources
	Department of Forestry and Fire Protection
	California Coastal Commission
	The State of Idaho
	Washington Department of Fish and Wildlife
Tribal Agencies	
	Columbia River Inter-Tribal Fish Commission
	The Shoshone-Bannock Tribes
	Confederated Tribes and Bands of the Yakama Indian Nation
	Yurok Tribe
	Round Valley Indian Tribes

Table 3. Summary of new population abundance and distribution information received.

ESU	Type of Information	Source
9-Central California Coast		
	Presence/absence data for Marin and Sonoma County Streams	CDFG 1997
	San Lorenzo River creel survey catch estimates	Murphy and Sidhom 1995
	Marine mammal injury estimates	Murphy and Sidhom 1995
	San Lorenzo River adult counts at Felton Dam trap	Jordan 1996
	Waddell Creek adult counts	Smith 1997
	Gazos, Scott, Waddell, and Redwood Creeks juvenile counts	Smith 1997
	San Lorenzo River adult and juvenile abundance	Alley 1997a
	Marin County juvenile abundance	MMWD 1997
	Russian River adult abundance	Steiner Environmental Consulting 1996
10-South-Central California Coast		
	Carmel River adult abundance	CDFG 1997, Dettman 1997
	Santa Rosa and San Simeon Creeks juvenile abundance	Alley 1997b
	Carmel River juvenile abundance	MPWMD 1996
	Habitat quality and juvenile density for several streams in Los Padres NF	USFS 1997
	Arroyo de la Cruz (and tributaries), Santa Rosa Creek, and San Simeon Creek parr, smolt and adult rainbow trout and steelhead density; habitat characteristics	Nelson 1994a, 1994b, 1995
11-Southern California		
	Sisquoc River rainbow trout abundance and stocking records	Cardenas 1996
	Santa Ynez River stocking records, historical abundance estimates	Entrix 1995
	Santa Ynez River juvenile and adult rainbow trout and steelhead abundance	Hanson et al. 1996
	Habitat quality and juvenile density for several streams in Los Padres NF	USFS 1997

Table 3. Summary of new population abundance and distribution information received. Continued.

ESU	Type of Information	Source
	Santa Clara River smolt and adult steelhead counts	Entrix 1996
	Ventura River (and tributaries), El Jaro and Malibu Creeks steelhead and rainbow trout counts	Sibbald et al. 1994
	ESU-wide historical distribution and abundance of steelhead	Henke 1996
12-Central Valley		
	San Joaquin and Stanislaus Rivers juvenile abundance	CDFG 1997
	Tuolumne River historical adult abundance	CDFG 1997
14-Upper Columbia		
	Juvenile steelhead and rainbow trout abundance, several streams	Peven 1996
	Adult steelhead counts at dams	CRFMP TAC 1996
	Hatchery releases through 1996	CRFMP TAC 1996
15-Snake River Basin		
	Adult steelhead counts at dams	CRFMP TAC 1996
	Grande Ronde and Imnaha Rivers hatchery releases, spawner survey data, and extinction assessments	Chilcote 1997
	Redd counts and counts at weirs, several sub-basins, 1987-1996	Idaho 1997
	Hatchery releases through 1996	CRFMP TAC 1996, Idaho 1997
	Updated parr density data, wild and natural A- and B-runs (graph only)	Idaho 1997

Table 4. Summary of presence/absence data for Central California coast ESU. Data from P. Adams, NMFS Southwest Fisheries Science Center, Tiburon, CA (pers. comm., June 1997).

Area	Total number of streams	Streams with data	Streams with steelhead	Percent of streams with steelhead
Overall	723	264	218	82
Russian River	225	53	52	98
Coastal	280	89	88	99
San Francisco Bay	218	122	78	64

Table 5. Summary of presence/absence data for South-Central California coast ESU. Data from P. Adams, NMFS Southwest Fisheries Science Center, Tiburon, CA (pers. comm., June 1997).

Area	Total number of streams	Streams with data	Streams with Steelhead	Percent of streams with steelhead
Overall	89	33	26	79

Appendix A: Artificial Propagation of Steelhead

Appendix A

ARTIFICIAL PROPAGATION OF STEELHEAD

Key information NMFS considers in evaluating the ESU status of hatchery populations includes stock histories and broodstock collection methods, both at present and in the past. Impacts of artificial propagation to specific river basins prior to and during the operation of the facilities are also considered. In some cases, although hatcheries obtained broodstock from local sources, the local population already may have been substantially changed due to previous introductions of non-native fish.

Under NMFS policy, existing hatchery fish generally would not be listed even if they are part of the ESU unless they are considered *essential* for recovery. However, a determination that a stock is not essential for recovery does not preclude it from playing a role in recovery. Any hatchery population that is part of the ESU is available for use in recovery if conditions warrant. In this context, an essential hatchery population is one that is vital to fully incorporate into recovery efforts at the outset (for example, if the associated natural population(s) were already extinct or at high risk of extinction). Under these circumstances, NMFS would consider taking the administrative action of listing the existing hatchery fish. Fish that are progeny of listed fish taken into a hatchery for broodstock will be listed automatically, so any hatchery population involved in formal recovery under the ESA eventually will be comprised of listed fish.

Steelhead Stocks Used in California Artificial Propagation Facilities

The first hatchery-reared steelhead in California were released into Price Creek in 1902. Egg-taking stations and distribution hatcheries were constructed shortly thereafter. Early hatchery operations obtained the majority of their eggs from either the Eel River (Snow Mountain Station[1], est. 1907) and Price Creek Hatchery (est. 1897)--later Fort Steward (est. 1916)--or Scott Creek (est. 1904). Eggs from these stations were then distributed to hatcheries for incubation and rearing. Overall, there was a general movement of eggs from Scott Creek to the Brookdale Hatchery (1904-1953) (San Lorenzo River), and from Snow Mountain Station to the Ukiah Hatchery (est. 1897) and Talmage Ponds (Russian River). Additionally, eggs from all stations were shipped to the Mt. Shasta (est. 1888) and Mt. Whitney (est. 1917) Hatcheries for distribution throughout the state. Records from the biennial California Department of Fish and Game (CDFG) reports list egg distributions by hatchery (without listing the egg source) and only indicate to which county the fish went. By 1928, nearly 81 million steelhead fry/fingerlings had been released in California from state

---

[1]Snow Mountain Station was renamed Van Arsdale Fisheries Station when the California Department of Fish and Game took over its operation in the 1960s.

hatcheries, in addition to 2.5 million steelhead released from U.S. Bureau of Fisheries hatcheries (Cobb 1930). Egg collections from the Eel and Scott Rivers, and later the San Lorenzo, Russian, and Mad Rivers, have been the primary sources of steelhead eggs for distribution throughout the state.

Current California hatchery steelhead stocks being considered in this document include: Scott Creek, San Lorenzo River, Dry Creek, and Whale Rock Reservoir stocks. All of these are winter-run steelhead.

9) Central California Coast

Kingfisher Flat Anadromous Fish Hatchery (MBSTP/CDFG), ***Scott Creek and San Lorenzo River stocks***--The Kingfisher Flat Anadromous Fish Hatchery is located on Big Creek, a tributary to Scott Creek, in Santa Cruz County, California. The original egg collecting station on Scott Creek was established in 1905. The Big Creek Hatchery on Big Creek began operations in 1926. The Big Creek facilities, in addition to several egg collecting stations on Scott Creek, have provided several million eggs annually. Fish produced were distributed to San Mateo, Santa Cruz, Santa Clara, and Monterey Counties (Bryant 1994), although surplus eggs were distributed throughout the state. The Big Creek Hatchery was destroyed by a flood in 1940. The Big Creek Hatchery site was transferred in 1982 to the Monterey Bay Salmon and Trout Project (a non-profit organization), and given its present name. CDFG still cooperates in overseeing operations at the hatchery (Streig 1993). In 1984, a number of Russian River (Dry Creek stock) steelhead were reared at the Kingfisher Flat Hatchery and released into Big Creek and the San Lorenzo River. Beginning in 1984, the hatchery began collecting naturally-returning adults from Big Creek and acquiring eggs from winter-run steelhead adults returning to the Felton Dam trap on the San Lorenzo River (Streig 1993, Bryant 1994, Cramer et al. 1995). Scott Creek and San Lorenzo River stocks are maintained separately on site. In general, the San Lorenzo River has received considerable releases of Scott Creek stock since the initiation of artificial propagation programs early in the century. Fish from the Carmel River also have been reared intermittently as part of a captive brood/fish rescue program, whereby those fish are rereleased into the Carmel River (Streig 1993, Radford 1996).

Warm Springs Hatchery (CDFG), ***Dry Creek stock***--Warm Springs Hatchery is located on Dry Creek in the Russian River Basin. Hatchery operations began in 1980. Broodstock predominately has consisted of returning adults that were intercepted in the Russian River at the base of the Warm Springs Dam. Although there are numerous records of eggs being shipped from the hatchery, there are no records of eggs from outside the basin being incorporated into the hatchery broodstock (CDFG 1994, Cramer et al. 1995). Before the construction of the hatchery, introductions of non-native stocks into the Russian River Basin may have affected the pedigree of the founding broodstock used by Warm Springs Fish Hatchery. Fish from the Snow Mountain Station (Eel River) historically were transported to the Ukiah (1897-1927) and Cold Creek (1928-1937) Hatcheries in the Russian River Basin for rearing and release. Additionally, some releases of steelhead from the San Lorenzo River may have been made into the Russian River in the 1920s (Bryant 1994). Subsequent to the opening of the Warm Springs Hatchery, releases of fish from the Eel, Mad, and Washougal (Skamania stock, Washington State) Rivers, totalling over half a million fish, have been made into the Russian River. Since 1992, steelhead trapped at Coyote Dam on the Russian River also have been propagated at Warm Springs Hatchery (Cramer et al. 1995).

Comments Received

As of the date of completion of this document, no comments have been received concerning artificial propagation of steelhead in this ESU.

10) South-Central California Coast

Introductions of steelhead stocks from northerly ESUs into the south-central California coast region have been made during the last two decades (Busby et al. 1996). During the early part of this century, there were introductions of winter-run steelhead from the Scott Creek-San Lorenzo River hatchery group (Brookdale and Big Creek hatcheries) and from stocks of unknown origin distributed through the Mt. Shasta (a.k.a. Sisson) and Mt. Whitney Hatcheries.

Whale Rock Hatchery (COOP), ***Whale Rock Reservoir stock***--The construction of Whale Rock Dam in the 1950s resulted in apparent residualization of steelhead in Whale Rock Reservoir. Broodstock were captured from the reservoir in an effort to preserve the genetic legacy of the original steelhead run and mitigate the construction of Whale Rock Dam. The hatchery released 15,000 fish annually back into the reservoir. Water problems resulted in the termination of the hatchery rearing program in 1994. Attempts to collect broodstock in 1997 were unsuccessful due to high water conditions. It is possible that individuals from the 1994 release (11,763 adipose-clipped steelhead (Radford 1996)) are still alive and may be collected in future broodstock operations.

Comments Received

As of the date of completion of this document, no comments have been received concerning artificial propagation of steelhead in this ESU.

11) Southern California

No steelhead hatcheries currently are operating in this ESU, although small-scale introductions of steelhead stocks from northerly ESUs occasionally were made (Busby et al. 1996). California Department of Fish and Game records indicate that steelhead from the Mt. Whitney, Mt. Shasta, Kaweah, and Fillmore Hatcheries were released throughout this ESU (from Santa Barbara to San Diego County on the U.S.-Mexico border) during the early part of this century. From the documents currently available to NMFS, we are unable to identify which egg collection stations provided the eggs for these distribution hatcheries. Additionally, the records do not discriminate between introductions into waters which have migratory access to the ocean and those that do not.

Comments Received

As of the date of completion of this document, no comments have been received concerning artificial propagation of steelhead in this ESU.

Steelhead Stocks Used in Inland Artificial Propagation Facilities

14) Upper Columbia River

Current Upper Columbia River summer-run steelhead stocks to be considered in this document: Wells Hatchery stock (Wells, Eastbank, and Chelan Hatcheries, and Leavenworth NFH), and Skamania stock (Ringold Springs Pond).

Grand Coulee Fish Maintenance Project (GCFMP)--Under the GCFMP, all steelhead bound for the upper Columbia River Basin from 1939 to 1943 were trapped at Rock Island Dam and either trucked to hatchery holding ponds (primarily Leavenworth NFH), or released in racked areas of Nason Creek (Wenatchee River) and the Entiat River. As a result, few if any adult steelhead reached their native spawning areas in the Wenatchee, Entiat, Methow, or Okanogan Rivers during this time (Chapman et al. 1994). However, residualized steelhead or 6+ year-old fish would have been able to spawn in their natal streams. The GCFMP extensively mixed and redistributed steelhead stocks above Rock Island Dam. Some non-native stocks were introduced about this time, but because of low adult returns, these stocks were not thought to have had much of an impact on steelhead in this ESU (Chapman et al. 1994).

Between 1960 and 1981, returning adults were collected at Priest Rapids Dam (except 1974-1976, 1979-81 when they were collected at Wells Dam), and their progeny were distributed to hatcheries throughout the upper Columbia River Basin. Since 1982, most upper Columbia River steelhead used in artificial propagation programs were derived from broodstock collected at Wells Dam. Therefore, there has been an almost continuous homogenization of stocks in the Upper Columbia River ESU since the inception of the GCFMP (Chapman et al 1994). Since 1986, all hatchery-reared steelhead have had their adipose fins clipped. Recently, a proposal has been made to collect the majority of steelhead broodstock for upper Columbia River hatchery operations at Priest Rapids Dam, instead of Wells Dam, due to the greater availability of fish at Priest Rapids Dam. In addition, an attempt to halt the progression toward early-spawning in the hatchery stock was proposed (WDFW 1996). Future plans for the artificial propagation of steelhead in this ESU are being discussed as part of an effort to develop a Habitat Conservation Plan for upper Columbia River salmon and steelhead.

Wells Hatchery (WDFW), ***Wells Hatchery stock***--This hatchery was constructed in 1967 by Douglas County PUD and is currently operated by WDFW. The Wells Hatchery stock originally was developed from steelhead crossing Priest Rapids Dam (Howell et al. 1985), but currently, several hundred adult steelhead are captured at the Wells Dam fish ladder. During the years when broodstock were intercepted at Priest Rapids Dam (1961-

1980) and during the early collections at Wells Dam (beginning in 1974), no attempt was made to discriminate between hatchery- and naturally-produced adults during spawning. Recently, approximately 10% of the adults taken annually for broodstock at Wells Dam were the progeny of naturally-spawning fish (Chapman et al. 1994). From 1981-1993, approximately 670 adults were taken annually for broodstock (Chapman et al. 1994). Broodstock collections have been made throughout the run (in proportion to the size of the run passing the dam) to prevent inadvertent selection of fish with particular life history traits (Chapman et al. 1994). It is not known to what degree previous releases of non-native stocks (e.g. Skamania) into the upper Columbia River have influenced the genetic make-up of the Wells Dam stock, although genetic analysis of recent collections does not indicate any genetic contribution from Skamania stock in the Wells Hatchery stock (Crawford 1997).

Some eggs from the Wells Hatchery stock are shipped to other facilities (Chelan, Leavenworth, Naches and Lyons Ferry) or are reared on site for release into the Wenatchee, Methow or Okanogan River Basins, and some juveniles are released directly from the hatchery (Wold 1993).

Comments Received

WDFW feels that the Wells Hatchery stock should be included in the ESU (Crawford 1997). Although the history of the Wells Dam stock is complex, the underlying goal for this stock has been to preserve its natural characteristics. WDFW believes that without the continuation of the Wells Dam stock program it is likely that the naturally-spawning component of the Upper Columbia River ESU will become extinct. Present and future programs undertaken by WDFW to develop local stocks in the Methow, Entiat and Okanogan River Basins probably will require the use of Wells Dam stock. The use of this stock may be essential to steelhead recovery activities.

USFWS also believes that the Wells Hatchery stock should be included in the ESU (Diggs 1997). Although the USFWS does not consider the population essential for recovery, it acknowledges that without the continuous addition of hatchery fish, it may not be possible to sustain naturally spawning steelhead populations above Wells Dam.

Chelan Hatchery (WDFW), ***Wells Hatchery stock***-- Located on the Chelan River near Chelan Falls, this hatchery spawns adults collected from other stations (primarily Priest Rapids and Wells Dam) or incubates and rears eggs from outside sources (Wold 1993). Fish subsequently are released in the Wenatchee and Entiat Rivers (Delarm and Smith 1990b). Egg sources often originated from dam collections: these include Columbia River (upper), Columbia River (Priest Rapids), and Wells Dam. Prior to 1997, this hatchery used fish from the Wells Hatchery stock. In 1997, the hatchery used fish taken at Priest Rapids, and in the future, WDFW intends to use only fish collected in the Wenatchee River as broodstock (Crawford 1997). (For comments see Wells Hatchery.)

Eastbank Hatchery (WDFW), ***Wells Hatchery stock***--Adults do not return to the Eastbank Hatchery facilities. This facility is located on the Columbia River (RKm 766) and has been operated to mitigate the effects of the Rock Island Dam. Operations began in 1989.

Wells Hatchery has provided broodstock for this hatchery through 1996. In 1997, adults for broodstock were collected at Priest Rapids Dam. However, future broodstock will be limited to collections in the Wenatchee River to develop a local broodstock (Crawford 1997). Fish reared at this facility are released in the Wenatchee River Basin, although some releases also have been made into the Entiat River (Wold 1993). (For comments see Wells Hatchery.)

Ringold Springs Pond (WDFW), ***Skamania Hatchery stock***--This facility was constructed in 1962 and is located on the Columbia River near Richland, Washington. Presently, fish are collected at the Ringold Hatchery complex (on the Columbia River). Adults or eggs are transferred to the Chelan Hatchery and juveniles are temporarily transferred to the Wells Hatchery, and then back to Ringold Springs for final rearing (September to April). The stock was founded by summer steelhead from the Skamania Hatchery (Delarm and Smith 1990b, Wold 1993). From 1980-1996, returns to the hatchery were the primary source of broodstock (Howell et al 1985, Crawford 1997). In 1997, broodstock was collected at Wells Dam to minimize the presence of Skamania stock above McNary Dam (Crawford 1997).

Comments Received

WDFW feels that the Skamania Hatchery stock should not be considered part of the ESU (Crawford 1997). Adults used to establish this stock originated from rivers outside of the upper Columbia River area. This stock is not representative of mid- or upper-Columbia River natural stocks and would not be appropriate for use in recovery programs.

Leavenworth NFH (USFWS), ***Wells Hatchery stock***--Leavenworth NFH was constructed as part of the GCFMP to mitigate the effects of the Grand Coulee Dam. The majority of the fish released from Leavenworth NFH or into Icicle Creek (the adjacent waterway) have come from stocks indigenous to the Upper Columbia ESU (mainstem dam collections and fish returning to the hatchery). A limited number of Chambers Creek (Puget Sound ESU) fish were released from Leavenworth in 1942 and 1943 (Chapman et al. 1994). Additionally, Skamania Hatchery steelhead were released from the Leavenworth Hatchery in 1982. The current steelhead broodstock was developed from Wells Dam stock in 1978. Currently, the hatchery goal is to release 100,000 steelhead smolts each year. Returning adult summer steelhead are collected on site for broodstock throughout the duration of the run and their progeny subsequently are released as yearling smolts (Delarm and Smith 1990a, Shelldrake 1993). The hatchery receives eggs from Wells Hatchery in addition to eggs collected from adults returning to Leavenworth NFH to meet its release goal. Although this program was transferred to the Winthrop NFH in 1996, adults will continue to return to this facility in 1997 and possibly 1998. (For comments see Wells Hatchery.)

Winthrop NFH (USFWS), ***Wells Hatchery stock***--Winthrop NFH was constructed as part of the GCFMP to mitigate the losses of anadromous fish populations above Grand Coulee Dam. The majority of the fish released from Winthrop NFH have come from stocks indigenous to the Upper Columbia ESU (mainstem dam collections and fish returning to the hatchery). The first steelhead program at Winthrop NFH ran from 1942-1951. The initial egg source was from fish trapped at Rock Island Dam (1942-1944). Fish released in 1946 were imported from Carson NFH (lower Columbia River stock) and from 1947-51, eggs were collected from fish returning to the facility. A limited number of Asotin Creek steelhead were released in 1960. No releases occurred from 1966 to 1995. In 1995, the steelhead program at Leavenworth NFH was moved to Winthrop NFH and the first release was in 1996. The steelhead program at Winthrop NFH now relies on brood fish taken at the Wells Dam for its production needs. The yearly release goal is 100,000 smolts (Diggs 1997). (For comments see Wells Hatchery.)

15) Snake River Basin

Current Snake River Basin summer-run steelhead stocks to be considered in this document are: Wallowa Hatchery stock-ODFW stock number 56 (Wallowa Hatchery and Cottonwood Acclimation Ponds), Imnaha River stock-ODFW stock number 29 (Little Sheep Creek), Oxbow Hatchery stock (Oxbow and Niagara Springs Hatcheries), Pahsimeroi Hatchery stock (Pahsimeroi, Sawtooth, Magic Valley, and Niagara Springs Hatcheries, Hagerman NFH, and East Fork Salmon River Trap), Dworshak NFH stock (Dworshak, Hagerman, and Kooskia NFHs, and East Fork Salmon River Trap), and Lyons Ferry Hatchery stock (Lyons Ferry and Tucannon Hatcheries, and Curl Lake Acclimation Ponds).

Wallowa Hatchery and acclimation ponds (ODFW), ***Wallowa Hatchery stock, ODFW Stock Number 56***--The Wallowa Hatchery is located on the Wallowa River in the Grande Ronde River Basin and was constructed in 1920 as a resident trout rearing facility. In 1985, under the auspices of the Lower Snake River Compensation Program (LSRCP), a summer steelhead rearing program was added. Broodstock are captured and spawned on site, although incubation and early rearing of fish takes place at the Irrigon Hatchery (on the mainstem Columbia River) before they are returned to Wallowa, Big Canyon, or Little Sheep Creek stations (Delarm and Smith 1990c, Christianson 1993). The Wallowa Hatchery broodstock was founded using adults collected at Ice Harbor Dam in 1976 and at Little Goose Dam from 1977-78. Collections at the dams were from the "spring run" and no 2-ocean fish were collected in order to minimize the number of B-run fish incorporated into the broodstock (Olsen et al. 1994). After 1980, there were occasional releases of Snake River, Oxbow, Pahsimeroi, and Skamania River hatchery fish (Howell et al. 1985). Broodstocks for Grand Ronde River Basin steelhead programs, collected at Snake River dams, probably included fish from throughout the Snake River Basin (Kostow 1995). Smolts from the Wallowa Hatchery are released in various Grand Ronde River tributaries (Delarm and Smith 1990a).

Comments Received

ODFW feels that the Wallowa Hatchery stock retains enough genetic similarity with wild populations to qualify as a member of the Snake River Basin ESU (Berry 1997). ODFW expressed some concern that the non-random manner in which the original broodstock was obtained and subsequent domestication processes have caused the Wallowa stock to genetically diverge from Snake River Basin ESU "wild" steelhead. Furthermore, since the Wallowa stock was not established using native fish from the Grande Ronde Basin, it would be inappropriate for use in recovering naturally-spawning steelhead in the Grande Ronde Basin.

Little Sheep Creek Pond (ODFW), ***Imnaha River stock, ODFW Stock Number 29--*** Little Sheep Creek is operated as a satellite of the Wallowa Hatchery and is located in the Imnaha River Basin. Collection facilities have existed since 1982, although the permanent facilities were constructed in 1988. The stock was developed from unmarked fish returning to the Little Sheep Creek (RKm 8) in the Imnaha River subbasin. Unmarked summer steelhead from the Imnaha River have been incorporated into the program to reduce the genetic risks to the naturally-spawning fish in the Imnaha River Basin (Delarm and Smith 1990c, Olsen et al. 1994). Current estimates suggest that hatchery fish comprise 20% of the escapement to the Imnaha River subbasin.

Comments Received

ODFW feels that the Imnaha River Hatchery stock retains enough genetic similarity with wild populations to qualify as a member of the Snake River Basin ESU (Berry 1997). The hatchery program is designed to maintain genetic similarity between the hatchery and naturally-spawning steelhead in the Imnaha River Basin. Because of the relatively good health and resiliency of the naturally-spawning steelhead component in the basin, it was not felt that this stock is essential for recovery.

Lyons Ferry Hatchery (WDFW), ***Lyons Ferry stock***--The Lyons Ferry Hatchery is located on the mainstem Snake River near the confluence of the Palouse and Snake Rivers, and was constructed in 1982 as part of the Lower Snake River Compensation Program (LSRCP). Summer steelhead from the Wells Hatchery stock and Wallowa Hatchery stock (ODFW) were used to found the hatchery stock. Returning adults currently are used to provided gametes. Steelhead smolts are released into various southeast Washington streams or released from two satellite facilities, Curl Lake and Dayton Pond (on the Touchet River, not in this ESU) (Delarm and Smith 1990d, Crawford 1997). Considerable releases of fish from Skamania, Wells, and Pahsimeroi hatchery stocks have been released from Lyons Ferry Hatchery.

Comments Received

WDFW argues that the Lyons Ferry Hatchery stock has received a general infusion of fish from a number of sources within and outside the ESU (Crawford 1997). For this reason, WDFW does not feel that the stock should be included in the ESU.

Tucannon Hatchery (WDFW), ***Lyons Ferry stock***--The Tucannon Hatchery is located on the Tucannon River. It was constructed in 1949 and later renovated in the 1980s for use in the LSRCP. It is now operated as a satellite facility to the Lyons Ferry Hatchery (Delarm and Smith 1990d). In the past, the Tucannon Hatchery used stocks from Wells Hatchery, Wallowa Hatchery, Dworshak NFH, the mainstem Snake River (Lower Monumental Dam collections), and Pahsimeroi Hatchery stocks. No steelhead were trapped for broodstock between 1982 and 1991. Recently some unmarked fish also have been used as broodstock. Returning adult steelhead are trapped in a weir at the hatchery and passed upstream (WDFW et al. 1993, Crawford 1997). Although steelhead from the Lyons Ferry Hatchery are transported to the Tucannon River for release, the Tucannon Hatchery primarily is used to rear rainbow trout (Wold 1993). The Tucannon River naturally-spawning steelhead stock recently was categorized as "mixed' (having a non-native component) due to likely hybridization from Lyons Ferry and other stocks of steelhead released in the past (WDFW et al. 1993). (For comments see Lyons Ferry Hatchery.)

Cottonwood acclimation pond (WDFW), ***Wallowa Hatchery stock***--Adult fish are trapped at this facility for use as broodstock for the Cottonwood facility (WDFW) and ODFW lower Grande Ronde program, with no unmarked (natural) fish incorporated into the broodstock (WDFW et al. 1993, Crawford 1997). Located on the Grande Ronde River (near Asotin), this facility was constructed in 1984 to acclimate Wallowa stock summer steelhead in the Washington portion of the Grande Ronde River. This facility receives Wallowa Hatchery stock from the Lyons Ferry Hatchery for a 2-3 month acclimation period (Delarm and Smith 1990d). Because hybridization with Wallowa stock hatchery fish is likely (since 1983), the Grand Ronde River naturally-spawning stock has been categorized as being of "mixed" heritage (having a non-native component) (WDFW et al. 1993). (For comments see Wallowa Hatchery.)

Curl Lake Acclimation Pond (WDFW), ***Lyons Ferry stock***--No adults are collected or spawned here. The facility is located on the Tucannon River. In 1984, this facility was developed to acclimate steelhead from the Lyons Ferry Hatchery for release into the Tucannon River. Fish are received from Lyons Ferry in February or March and reared until April or May. Curl Lake also is used to rear trout for recreational purposes during the remainder of the year (Delarm and Smith 1990d). (For comments see Lyons Ferry Hatchery.)

Oxbow Hatchery (IDFG), ***Oxbow Hatchery stock (A-run from above Hells Canyon)***--The Oxbow Hatchery began operating in 1962 to mitigate fishery losses caused by Idaho Power Company's (IPC) dams on the Snake River, and is used mainly for trapping sufficient numbers of returning adult steelhead and spring chinook salmon to fulfill IPC's anadromous fish mitigation requirements (Delarm and Smith 1990b, Hutchison 1993). The hatchery is located on the mainstem Snake River, near Oxbow Dam. Adult fish are trapped at the Hells Canyon Dam trap, held over winter until mature, and then spawned in the spring. Initially, the Hells Canyon trap collected fish bound for the Burnt, Powder, Payette, Weiser, and Boise Rivers, but because the Hells Canyon Dam complex blocks all upriver access, the majority of fish collected now are of hatchery origin. From 1987 through 1997, there were 22,270 steelhead trapped at the Oxbow trap, of which 289 were unmarked and assumed to be naturally produced. After eyeing, eggs are transported to the Niagara Springs Hatchery for rearing. Prior to 1989, fry were released from the hatchery if excess eggs were available; however, since that time "there have been no non-smolt releases from this facility into anadromous water" (Bowles 1997, page 2; see also Delarm and Smith 1990b).

Comments Received

Comments from the Shoshone-Bannock Tribes of Fort Hall focus on the extension of the present ESU boundaries to Shoshone Falls, well above the current boundary at the Hells Canyon Dam (Boyer and Arthaud 1997). "All hatchery populations that include Hells Canyon stocks should be considered essential and part of the ESU since all stocks originated within the Snake River Basin and may be used in future recovery efforts to indigenous ranges." [This would include the Oxbow and Pahsimeroi Hatchery stocks.]

Magic Valley Hatchery (IDFG), ***Numerous stocks***--The Magic Valley Hatchery was constructed in 1987 by the USACE as part of the LSRCP. The hatchery is located in the Snake River Canyon, near Buhl, Idaho. Because the hatchery is located above the Hells Canyon Dam complex, it neither collects adults nor releases fish on station. Eggs are provided by other hatcheries and collection stations for incubation and rearing to smolt stage (yearling). A-run (from Pahsimeroi and Sawtooth Hatcheries) and B-run (from Dworshak NFH or East Fork Salmon River trap) steelhead smolts are released at various sites in the Salmon River (Delarm and Smith 1990b, Hutchison 1993).

Niagara Spring Hatchery (IDFG), ***Numerous stocks***--This hatchery was constructed by the Idaho Power Company to mitigate the effects of the Hells Canyon Dam. The hatchery is located in the Snake River Canyon near Wendell, Idaho. The stock originally was developed from A-run fish collected at Hells Canyon Dam. Presently, eggs are collected at other hatcheries and adult collection stations, primarily the Pahsimeroi and Oxbow Hatcheries (Howell et al. 1985). Eggs are incubated on site, and juveniles are reared for release at various facilities in the Salmon River Basin and below Hells Canyon Dam (Delarm and Smith 1990b).

Pahsimeroi Hatchery (IDFG), ***Pahsimeroi Hatchery stock (A-run)***--The Pahsimeroi Hatchery began operation in 1969 to mitigate Snake River dams. The hatchery is located on the Pahsimeroi River, near its confluence with the Salmon River. One goal of the mitigation was to relocate mainstem Snake River steelhead to the Salmon River Basin (Hutchison 1993). To accomplish this, the Pahsimeroi Hatchery broodstock originally was developed from fish collected at Hells Canyon Dam and released in the Salmon River Basin. Additionally, an unknown number of indigenous Salmon River steelhead were incorporated into the broodstock (Busby et al. 1996); however, as early as 1969, only 6% of the steelhead trapped at the Pahsimeroi Hatchery were believed to be of natural origin (Bowles 1997). In recent years, steelhead eggs from mainstem Snake River collections have not been transferred to the hatchery. From 1974 to 1983, Dworshak NFH summer steelhead were released from the hatchery. It is possible that there was some mixing of the Pahsimeroi and Dworshak Hatchery stocks. Currently, the facility traps adult steelhead from February to late April, incubates the eggs to the eyed stage and then transfers them to Niagara Springs for hatching, rearing and subsequent release from the Pahsimeroi Hatchery (Delarm and Smith 1990b). Excess eggs are supplied to other basin hatcheries, including Niagara Springs, Magic Valley and Hagerman NFH. In recent years, unmarked fish are passed upstream of the hatchery weir for natural spawning, and only fish of hatchery origin are used for broodstock (Hutchison 1993). In contrast, prior to 1989 the number of hatchery-derived adults that passed above the weir frequently outnumbered the number of naturally-spawning adults (Bowles 1997). From 1985-1997, there were 30,409 steelhead trapped at this facility, of which 1,233 (4%) were naturally produced (Bowles 1997).

<u>Comments Received</u>

IDFG feels that the Pahsimeroi Hatchery stock should not be part of the ESU (Bowles 1997). This conclusion was based on a number of factors: 1) The native production areas of these stocks are no longer accessible to anadromous migration, 2) the stocks represent an admixture of stocks (albeit all from within the ESU), and 3) the hatchery programs have had little recent contribution from wild fish, and rely almost wholly on hatchery returnees for broodstock.

The Shoshone-Bannock Tribes of Fort Hall feel that the present ESU boundary should be extended to Shoshone Falls, well above the current boundary at the Hells Canyon Dam (Boyer and Arthaud 1997). The tribes concluded that "All hatchery populations that include Hells Canyon stocks should be considered essential and part of the ESU since all stocks originated within the Snake River Basin and may be used in future recovery efforts to indigenous ranges." [This would include the Oxbow and Pahsimeroi Hatchery stocks.]

Sawtooth Hatchery (IDFG), ***Pahsimeroi Hatchery stock (A-run)***--The Sawtooth Hatchery is located on the upper Salmon River. It was constructed in 1985 as part of the LSRCP. It was designed to incubate 4.5 million steelhead eggs for hatcheries in the Hagerman Valley. Adult steelhead are trapped at the Sawtooth Hatchery site and at a collection station on the East Fork Salmon River. The broodstock mainly was derived from Pahsimeroi stock (A-run) that were released into the river during the 1970s and 1980s (Idaho 1997). During the first year of adult trapping operations, only 8% of the adults were naturally spawning (Bowles 1997). Currently, unmarked fish are released upstream to spawn (Hutchison 1993); however, in the past large numbers of hatchery adults (Pahsimeroi stock) also were released above the weir. From 1985 through 1997, there were 14,196 steelhead trapped, of which only 4% were naturally produced (Bowles 1997). Adults typically are trapped in March and April. Eggs are incubated, shipped to rearing facilities, and then returned (as smolts) to the Sawtooth and East Fork Salmon River sites for release. In the past, excess fry were released directly into Salmon River tributaries, although this practice was halted in 1989 (Delarm and Smith 1990b). (For comments see Pahsimeroi Hatchery.)

East Fork Trap (IDFG), ***Mixed Dworshak NFH (B-run) and Pahsimeroi Hatchery (A-run) stocks***--The East Fork trap is located on the East Fork of the Salmon River. It was completed in 1985 and was constructed as part of the LSRCP. Broodstock collected at this site originally consisted of adults from Pahsimeroi Hatchery releases (or their descendants), and an unknown proportion of adults native to the East Fork of the Salmon River. From 1985-1997, 2,553 returning adult steelhead were trapped, of which only 8% were believed to have been naturally produced (Bowles 1997). Releases of Dworshak Hatchery summer-run stock juveniles from the Pahsimeroi Hatchery were made in the mid 1980s. Returning adults have been selected according to size in order to obtain Dworshak-derived broodstock in preference to Pahsimeroi-derived broodstock. Subsequently, there have been further releases of Dworshak NFH stock directly from the Dworshak NFH (Keifer et al. 1992, Idaho 1997). (For comments see Pahsimeroi Hatchery and Dworshak NFH.)

Clearwater Hatchery (IDFG), ***Dworshak NFH stock (B-run)*** --The Clearwater Hatchery is located on the North Fork of the Clearwater River. Its satellite stations, the Red River (South Fork Clearwater River), Crooked River (South Fork Clearwater River), and Powell (Lochsa River) hatcheries, were constructed in 1992, the last facilities to be built under the LSRCP. None of these facilities spawns adults, although returning adults are counted at the Clearwater Hatchery. Broodstock collected at the Dworshak NFH provide fish for their operations. The hatchery currently maintains Dworshak NFH stock (B-run). Smolts are released into various Clearwater River tributaries (Hutchison 1993). (For comments see Dworshak NFH.)

Hagerman NFH (USFWS), ***Numerous stocks***--The Hagerman NFH was constructed in 1932 in the Snake River Canyon, near Hagerman, Idaho. Although originally designed as a trout hatchery, it began rearing summer steelhead in the 1970s. The steelhead program was further expanded in 1982 as part of the LSRCP. Because of its location above Hells Canyon Dam, no adults are trapped on site; rather, eggs are received from IDFG hatcheries for incubation (Delarm and Smith 1990a, Shelldrake 1993). The Hagerman Hatchery A-run strain was developed from Niagara Springs Hatchery fish, and the B-run strain was developed from Dworshak and Pahsimeroi hatchery fish (Howell et al 1985).

Kooskia NFH (USFWS), ***Dworshak NFH stock (B-run)*** --Adults are not collected or spawned here. Operations at this hatchery began in 1969 as part of the LSRCP. The Kooskia NFH rears B-run steelhead collected at the Dworshak NFH (Delarm and Smith 1990a). (For comments see Dworshak NFH.)

Dworshak NFH (USFWS), ***Dworshak NFH stock (B-run)*** --The Dworshak NFH began operation in 1969 to mitigate the loss of spawning habitat caused by dams on the Clearwater River Basin and to provide eggs for other LSRCP hatcheries in Idaho (Shelldrake 1993). The broodstock was developed from native North Fork Clearwater River B-run steelhead stock. Adults are captured throughout the run from February to May. Currently, the majority of the fish recovered at the hatchery trap are of hatchery origin. In addition to rearing on-site, some eggs are shipped for incubation and rearing to the Hagerman NFH and Kooskia NFH before being returned for release by the Dworshak NFH (Delarm and Smith 1990a).

Comments Received

IDFG believes that the Dworshak NFH stock should not be considered part of the ESU (Bowles 1997). This conclusion was based on a number of factors: 1) The native production areas of these stocks are no longer accessible to anadromous steelhead (historical spawning and rearing habitat became inaccessible to migrating adults with the construction of the Dworshak Dam), and 2) the hatchery programs have had little recent contribution from wild fish, and rely almost wholly on hatchery returnees for broodstock. Furthermore, although this stock was founded by adults returning to the North Fork Clearwater River, the Dworshak NFH stock (for several generations) has been propagated solely from hatchery returnees.

HATCHERY STOCKS REFERENCES

Berry, R. L. 1997. Letter from Oregon Department of Fish and Wildlife, dated 12 June 1997. Comments on NMFS' draft "Review of Steelhead Stock Used in Snake River Basin Artificial Propagation Facilities." 3 p. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Ser., 525 N. E. Oregon St., Suite 500, Portland, OR 97232.)

Bowles, E. 1997. Letter from Idaho Department of Fish and Game, dated 13 June 1997. Comments on NMFS' draft "Review of Steelhead Stock Used in Snake River Basin Artificial Propagation Facilities." 6 p. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Ser., 525 N. E. Oregon St., Suite 500, Portland, OR 97232.)

Boyer, L. Q. and D. L. Arthaud. 1997. Letter from the Shoshone-Bannock tribes, dated 16 June 1997. 2 p. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Ser., 525 N. E. Oregon St., Suite 500, Portland, OR 97232.)

Bryant, G. 1994. Status review of coho salmon populations in Scott Creek and Waddell Creeks, Santa Cruz County, California. Natl. Mar. Fish. Serv., unpublished report, dated April 1994, 102 p.

Busby, P. J., T. C. Wainwright, G. J. Bryant, L. J. Lierheimer, R. S. Waples, F. W. Waknitz, and I. V. Lagomarsino. 1996. Status review of west coast steelhead from Washington, Idaho, Oregon, and California. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-NWFSC-27, 261 p.

California Department of Fish and Game (CDFG). 1994. Documents submitted to the ESA Administrative Record for coastal steelhead: Annual reports for salmon and steelhead hatcheries. Feather River Salmon and Steelhead Hatchery, 1963-64 through 1991-92, 29 volumes; Iron Gate Salmon and Steelhead Hatchery, 1965-66 through 1991-92, 27 volumes; Lewiston Fish Trapping Facility and Trinity River Salmon and Steelhead Hatchery, 1958-59 through 1991-92, 33 volumes; Mad River Salmon and Steelhead Hatchery, 1970-71 through 1990-91, 21 volumes; Nimbus Salmon and Steelhead Hatchery, 1955-56 through 1991-92, 37 volumes; Van Arsdale Fisheries Station, Mendocino County, 1966-67 through 1991-92, 15 volumes; Warm Springs Salmon and Steelhead Hatchery, 1980-81 through 1990-91, 11 volumes. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

Chapman, D., C. Peven, T. Hillman, A. Giorgi, and F. Utter. 1994. Status of summer steelhead in the mid-Columbia River. Don Chapman Consultants, Inc, 318 p. (Available from Don Chapman Consultants, Inc., 3553 Rickenbacker, Suite 200, Boise, ID 83705.)

Christianson, C. 1993. Operations plan for anadromous fish production facilities in the Columbia River Basin. Volume III, Oregon Department of Fish and Wildlife Hatcheries. 1992 Annual Report to the Bonneville Power Administration, Portland, Oregon, Project 92-043, 324 p. (Available from Bonneville Power Administration, P. O. Box 351, Portland, OR 97208.)

Cobb, J.N. 1930. Pacific salmon fisheries. Report of the U.S. Commissioner of Fisheries for 1930. p 409-709.

Cramer, S. P., and 12 co-authors. 1995. The status of steelhead populations in California in regards to the Endangered Species Act. Document prepared for Association of California Water Agencies, 167 p. (Available from Environmental and Technical Services Division, NMFS, 525 N.E. Oregon St., Portland, OR 97232).

Crawford, B. 1997. Letter from Washington Department of Fish and Wildlife, dated 13 June 1997. Response to NMFS' draft "Review of Steelhead Stock Used in Snake River Basin Artificial Propagation Facilities." 4 p. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Ser., 525 N. E. Oregon St., Suite 500, Portland, OR 97232.)

Delarm, M. R., and R. Z. Smith. 1990a. Assessment of present anadromous fish production facilities in the Columbia River Basin Volume 1: U.S. Fish and Wildlife Hatcheries. Bonneville Power Administration. 89-045, 106 p. (Available from Bonneville Power Administration, Division of Fish and Wildlife-PJ, P.O. Box 3621, Portland, OR 97208.)

Delarm, M. R., and R. Z. Smith. 1990b. Assessment of present anadromous fish production facilities in the Columbia River Basin Volume 2: Idaho Department of Fish and Game Hatcheries. Bonneville Power Administration. 89-045, 77 p. (Available from Bonneville Power Administration, Division of Fish and Wildlife-PJ, P.O. Box 3621, Portland, OR 97208.)

Delarm, M. R., and R. Z. Smith. 1990c. Assessment of present anadromous fish production facilities in the Columbia River Basin Volume 3: Oregon Department of Fish and Wildlife Hatcheries. Bonneville Power Administration. 89-045, 177 p. (Available from Bonneville Power Administration, Division of Fish and Wildlife-PJ, P.O. Box 3621, Portland, OR 97208.)

Delarm, M. R., and R. Z. Smith. 1990d. Assessment of present anadromous fish production facilities in the Columbia River Basin Volume 5: Washington Department of Wildlife Hatcheries. Bonneville Power Administration. 89-045, 122 p. (Available from Bonneville Power Administration, Division of Fish and Wildlife-PJ, P.O. Box 3621, Portland, OR 97208.)

Diggs, D. 1997. Memo from U. S. Fish and Wildlife Service, dated 18 June 1997. 4 p. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Ser., 525 N. E. Oregon St., Suite 500, Portland, OR 97232.)

Howell, P., K. Jones, D. Scarnecchia, L. LaVoy, W. Kendra, and D. Orrmann. 1985. Stock assessment of Columbia River anadromous salmonids. Vol: II. U.S. Dep. Energy, Bonneville Power Administration. Project No. 83-335, 1032 p.

Hutchison, B. 1993. Operations plan for anadromous fish production facilities in the Columbia River Basin. Volume II, Idaho Department of Fish and Game Hatcheries. 1992 Annual Report to the Bonneville Power Administration, Portland, Oregon, Project 92-043, 91 p. (Available from Bonneville Power Administration, P. O. Box 351, Portland, OR 97208.)

Idaho, State of (Idaho). 1997. Proposed Listing of Snake River Steelhead for Protection under the Federal Endangered Species Act: State of Idaho Comments to the National Marine Fisheries Service, dated 3 January 1997, 91 p. Appendix A: Broodstock history of Idaho hatchery facilities. Appendix B: Supplementation Programs. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

Keifer, S., M. Rowe, and K. Hatch. 1992. Stock summary reports for Columbia River anadromous salmonids Volume V: Idaho. Project report. U.S. Dep. Energy, Bonneville Power Administration, Div. Fish Wildl. Project No. 88-108. (Available from Bonneville Power Administration, Division of Fish and Wildlife, P.O. Box 3621, Portland, Oregon 97208.)

Kostow, K. 1995. Biennial Report on the Status of Wild Fish In Oregon. Oreg. Dep. Fish Wildl. Rep., 217 p. + appendix. (Available from Oregon Department of Fish and Wildlife, P.O. Box 59, Portland, OR, 97207.)

Olsen, E. A., P. M. P. Beamesderfer, M. L. McLean, and E. S. Tinus. 1994. Salmon and steelhead stock summaries for the Grande Ronde Basin: an interim report. Oreg. Dep. Fish Wildl. Proj. Rep. 88-108, 132 p. (Available from Environmental and Technical Services Division, National Marine Fisheries Service, 525 N.E. Oregon St., Suite 500, Portland, OR 97232)

Radford, L. 1996. Cooperative artificial propagation programs for salmon and steelhead, 1994-1995. Inland Fisheries Administrative Report No. 96-2. 18 p.

Shelldrake, T. 1993. Operations plan for anadromous fish production facilities in the Columbia River Basin. Volume I, United States Fish and Wildlife Service Hatcheries. 1992 Annual Report to the Bonneville Power Administration, Portland, Oregon, Project 92-043, 158 p.

Streig D. 1993. Monterey Bay salmon and trout project: Project background and description. Monterey Bay Salmon and Trout Project, Davenport, California (unpubl. Rep.) 24 p. (Available from Environmental and Technical Services Division, National Marine Fisheries Service, 525 N.E. Oregon St., Suite 500, Portland, OR 97232)

Washington Department of Fish and Wildlife. 1996. 1996 Broodstock Collection. WDFW Hatcheries Program, Assessment and Development Division/Mid-Columbia River Projects, 113 Second St., Suite 7, Wenatchee, WA 98801.

Washington Department of Fisheries (WDF), Washington Department of Wildlife (WDW), and Western Washington Treaty Indian Tribes (WWTIT). 1993. 1992 Washington State salmon and steelhead stock inventory (SASSI). Wash. Dep. Fish Wildl. Olympia 212 p. and 5 regional volumes. (Available from Washington Department of Fish and Wildlife, 600 Capitol Way N., Olympia, WA 98501-1091.)

Wold, E. 1993. Operations plan for anadromous fish production facilities in the Columbia River Basin. Volume V, Washington Department of Wildlife Hatcheries. 1992 Annual Report to the Bonneville Power Administration, Portland, Oregon, Project 92-043, 131 p. (Available from Bonneville Power Administration, P. O. Box 351, Portland, OR.)