Preliminary conclusions regarding the updated status of listed ESUs of West Coast salmon and steelhead

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B. Steelhead trout

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This section deals specifically with steelhead trout. It is part of a larger report, the remaining sections of which can be accessed from the same website used to access this section (http://www.nwfsc.noaa.gov/). The main body of the report (Background and Introduction) contains background information and a description of the methods used in the risk analyses.

B. STEELHEAD

B.1. BACKGROUND AND HISTORY OF LISTINGS

Background

Steelhead is the name commonly applied to the anadromous form of the biological species *Oncorhynchus mykiss*. The present distribution of steelhead extends from Kamchatka in Asia, east to Alaska, and down to southern California (NMFS 1999), although the historic range of *O. mykiss* extended at least to the Mexico border (Busby et al. 1996). *O. mykiss* exhibit perhaps the most complex suite of life history traits of any species of Pacific salmonid. They can be anadromous or freshwater resident (and under some circumstances, apparently yield offspring of the opposite form). Those that are anadromous can spend up to 7 years in fresh water prior to smoltification, and then spend up to 3 years in salt water prior to first spawning. The half-pounder life-history type in Southern Oregon and Northern California spends only 2 to 4 months in salt water after smoltification, then returns to fresh water and outmigrates to sea again the following spring without spawning. This species can also spawn more than once (iteroparous), whereas all other species of *Oncorhynchus* except *O. clarki* spawn once and then die (semelparous). The anadromous form is under the jurisdiction of the National Marine Fisheries Service (NMFS), while the resident freshwater forms, usually called “rainbow” or “redband” trout, are under the jurisdiction of U. S. Fish and Wildlife Service (FWS).

Within the range of West Coast steelhead, spawning migrations occur throughout the year, with seasonal peaks of activity. In a given river basin there may be one or more peaks in migration activity; since these *runs* are usually named for the season in which the peak occurs, some rivers may have runs known as winter, spring, summer, or fall steelhead. For example, large rivers, such as the Columbia, Rogue, and Klamath rivers, have migrating adult steelhead at all times of the year. There are local variations in the names used to identify the seasonal runs of steelhead; in Northern California, some biologists have retained the use of the terms spring and fall steelhead to describe what others would call summer steelhead.

Steelhead can be divided into two basic reproductive ecotypes, based on the state of sexual maturity at the time of river entry, and duration of spawning migration (Burgner et al. 1992). The *stream-maturing* type (summer steelhead in the Pacific Northwest and Northern California) enters fresh water in a sexually immature condition between May and October and requires several months to mature and spawn. The *ocean-maturing* type (winter steelhead in the Pacific Northwest and Northern California) enters fresh water between November and April with well-developed gonads and spawns shortly thereafter. In basins with both summer and winter steelhead runs, it appears that the summer run occurs where habitat is not fully utilized by the winter run or a seasonal hydrologic barrier, such as a waterfall, separates them. Summer steelhead usually spawn farther upstream than winter steelhead (Withler 1966, Roelofs 1983, Behnke 1992). Coastal streams are dominated by winter steelhead, whereas inland steelhead of the Columbia River Basin are almost exclusively summer steelhead. Winter steelhead may have been excluded from inland areas of the Columbia River Basin by Celilo Falls or by the considerable migration distance from the ocean. The Sacramento-San Joaquin River Basin may have historically had multiple runs of steelhead that probably included both ocean-maturing and stream-maturing stocks (CDFG 1995, McEwan and Jackson 1996). These steelhead are referred to as winter steelhead by the California Department of Fish and Game (CDFG); however, some biologists call them fall steelhead (Cramer et. al 1995). It is thought that hatchery practices and modifications in the hydrology of the basin caused by large-scale water diversions may have altered the migration timing of steelhead in this basin (D. McEwan, pers. commun.).

Inland steelhead of the Columbia River Basin, especially the Snake River Subbasin, are commonly referred to as either *A-run* or *B-run*. These designations are based on a bimodal migration of adult steelhead at Bonneville Dam (235 km from the mouth of the Columbia River) and differences in age (1- versus 2-ocean) and adult size observed among Snake River steelhead. It is unclear, however, if the life history and body size differences observed upstream are correlated back to the groups forming the bimodal migration observed at Bonneville Dam. Furthermore, the relationship between patterns observed at the dams and the distribution of adults in spawning areas throughout the Snake River Basin is not well understood. A-run steelhead are believed to occur throughout the steelhead-bearing streams of the Snake River Basin and the inland Columbia River; B-run steelhead are thought to be produced only in the Clearwater, Middle Fork Salmon, and South Fork Salmon Rivers (IDFG 1994).

The *half-pounder* is an immature steelhead that returns to fresh water after only 2 to 4 months in the ocean, generally overwinters in fresh water, and then outmigrates again the following spring. Half-pounders are generally less than 400 mm and are reported only from the Rogue, Klamath, Mad, and Eel Rivers of Southern Oregon and Northern California (Snyder 1925, Kesner and Barnhart 1972, Everest 1973, Barnhart 1986); however, it has been suggested that as mature steelhead, these fish may only spawn in the Rogue and Klamath River Basins (Cramer et al. 1995). Various explanations for this unusual life history have been proposed, but there is still no consensus as to what, if any, advantage it affords to the steelhead of these rivers.

As mentioned earlier, *O. mykiss* exhibits varying degrees of anadromy. Non-anadromous forms are usually called rainbow trout; however, nonanadromous *O. mykiss* of the inland type are often called Columbia River redband trout. Another form occurs in the upper Sacramento River and is called Sacramento redband trout. Although the anadromous and nonanadromous forms have long been taxonomically classified within the same species, the exact relationship between the forms in any given area is not well understood. In coastal populations, it is unusual for the two forms to co-occur; they are usually separated by a migration barrier, be it natural or manmade. In inland populations, co-occurrence of the two forms appears to be more frequent. Where the two forms co-occur, "it is possible that offspring of resident fish may migrate to the sea, and offspring of steelhead may remain in streams as resident fish" (Burgner et al. 1992, p. 6; see also Shapovalov and Taft 1954, p. 18). Mullan et al. (1992) found evidence that in very cold streams, juvenile steelhead had difficulty attaining mean threshold size for smoltification and concluded that most fish in the Methow River in Washington that did not emigrate downstream early in life were 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 some male chinook salmon (*O. tshawytscha*).

In May 1992, NMFS was petitioned by the Oregon Natural Resources Council (ONRC) and 10 co-petitioners to list Oregon's Illinois River winter steelhead (ONRC et al. 1992). NMFS concluded that Illinois River winter steelhead by themselves did not constitute an ESA "species" (Busby et al. 1993, NMFS 1993a). In February 1994, NMFS received a petition seeking protection under the Endangered Species Act (ESA) for 178 populations of steelhead (anadromous *O. mykiss*) in Washington, Idaho, Oregon, and California. At the time, NMFS was conducting a status review of coastal steelhead populations (*O. m. irideus*) 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.

In 1995, the steelhead Biological Review Team (BRT) met to review the biology and ecology of West Coast steelhead. 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 coastal forms and three inland forms. After considering available information on population abundance and other risk factors, the BRT concluded that five steelhead ESUs (Central California Coast, South-Central California Coast, Southern California, Central Valley, and Upper Columbia River) were presently in danger of extinction, five steelhead ESUs (Lower Columbia River, Oregon Coast, Klamath Mountains Province, Northern California, and Snake River Basin) were likely to become endangered in the foreseeable future, 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 individual stocks within these ESUs may be at risk, and one steelhead ESU (Middle Columbia River) was not presently in danger of extinction but the BRT was unable to reach a conclusion as to its risk of becoming endangered in the foreseeable future.

Of the 15 steelhead ESUs identified by NMFS, five are not listed under the ESA: Southwest Washington, Olympic Peninsula, and Puget Sound (Federal Register, Vol. 61, No. 155, August 9, 1996, p. 41558), Oregon Coast (Federal Register, Vol. 63, No. 53, March 19, 1998, p. 13347), and Klamath Mountain Province (Federal Register, Vol. 66, No. 65, April 4, 2001, p. 17845); eight are listed as threatened: Snake River Basin, Central California Coast and South-Central California Coast (Federal Register, Vol. 62, No. 159, August 18, 1997, p. 43937), Lower Columbia River, California Central Valley (Federal Register, Vol. 63, No. 53, March 19, 1998, p. 13347), Upper Willamette River, Middle Columbia River (Federal Register, Vol. 64, No. 57, March 25, 1999, p. 14517), and Northern California (Federal Register, Vol. 65, No. 110, June 7, 2000, p.36074), and two are listed as endangered: Upper Columbia River and Southern California (Federal Register, Vol. 62, No. 159, August 18, 1997, p. 43937).

The West Coast steelhead BRT[1] met in January 2003 to discuss new data received and to determine if the new information warranted any modification of the conclusions of the original

[1] The biological review team (BRT) for the updated status review for West Coast steelhead included, from the NMFS Northwest Fisheries Science Center: Thomas Cooney, Dr. Robert Iwamoto, Gene Matthews, Dr. Paul McElhany, Dr. James Myers, Dr. Mary Ruckelshaus, Dr. Thomas Wainwright, Dr. Robin Waples, and Dr. John Williams; from NMFS Southwest Fisheries Science Center: Dr. Peter Adams, Dr. Eric Bjorkstedt, Dr. David Boughton, Dr. John Carlos Garza, Dr. Steve Lindley, and Dr. Brian Spence; from the U.S. Fish and Wildlife Service, Abernathy, WA: Dr. Donald Campton; and from the USGS Biological Resources Division, Seattle: Dr. Reginald Reisenbichler.

BRTs. This report summarizes new information and the preliminary BRT conclusions on the following ESUs: Snake River Basin, Upper Columbia River, Middle Columbia River, Lower Columbia River, Upper Willamette River, Northern California, Central California Coast, South-Central California Coast, Southern California, and California Central Valley.

Resident fish

As part of this status review update process, a concerted effort was made to collect biological information for resident populations of *O. mykiss*. Information from listed ESUs in Washington, Oregon, and Idaho is contained in a draft report by Kostow (2003), and the sections below summarize relevant information from that report for specific ESUs. A table (Appendix B.5.1) summarizes information about resident *O. mykiss* populations in California.

The BRT had to consider in more general terms how to conduct an overall risk assessment for an ESU that includes both resident and anadromous populations, particularly when the resident individuals may outnumber the anadromous ones but their biological relationship was unclear or unknown. Some guidance is found in Waples (1991), which outlines the scientific basis for the NMFS ESU policy. That paper suggested that an ESU that contains both forms could be listed based on a threat to only one of the life history traits "if the trait were genetically based and loss of the trait would compromise the 'distinctiveness' of the population" (p. 16). That is, if anadromy were considered important in defining the distinctiveness of the ESU, loss of that trait would be a serious ESA concern. In discussing this issue, the NMFS ESU policy (FR notice citation) affirmed the importance of considering the genetic basis of life history traits such as anadromy, and recognized the relevance of a question posed by one commenter: "What is the likelihood of the nonanadromous form giving rise to the anadromous form after the latter has gone locally extinct?"

The BRT also discussed another important consideration, which is the role anadromous populations play in providing connectivity and linkages among different spawning populations within an ESU. An ESU in which all anadromous populations had been lost and the remaining resident populations were fragmented and isolated would have a very different future evolutionary trajectory than one in which all populations remained linked genetically and ecologically by anadromous forms.

In spite of concerted efforts to collect and synthesize available information on resident forms of *O. mykiss*, existing data are very sparse, particularly regarding interactions between resident and anadromous forms (Kostow 2003). The BRT was frustrated by the difficulties of considering complex questions involving the relationship between resident and anadromous forms, given this paucity of key information. To help focus this issue, the BRT considered a hypothetical scenario that has varying degrees of relevance to individual steelhead ESUs. In this scenario, the once-abundant and widespread anadromous life history is extinct or nearly so, but relatively healthy native populations of resident fish remain in many geographic areas. The question considered by the BRT was the following: Under what circumstances would you conclude that such an ESU was not in danger of extinction or likely to become endangered? The BRT identified the required conditions as:

1) The resident forms are capable of maintaining connectivity among populations to the extent that historic evolutionary processes of the ESU are not seriously disrupted;
2) The anadromous life history is not permanently lost from the ESU but can be regenerated from the resident forms.

Regarding the first criterion, although some resident forms of salmonids are known to migrate considerable distances in freshwater, extensive river migrations have not been demonstrated to be an important behavior for resident *O. mykiss*, except in rather specialized circumstances (e.g., forms that migrate from a stream to a large lake or reservoir as a surrogate for the ocean). Therefore, the BRT felt that loss of the anadromous form would, in most cases, substantially change the character and future evolutionary potential of steelhead ESUs. Regarding the second criterion, it is well established that resident forms of *O. mykiss* can occasionally produce anadromous migrants, and vice versa (Mullan et al. 1992, Zimmerman and Reeves 2000, Kostow 2003), just as has been shown for other salmonid species (e. g., *O. nerka,* Foerster 1947, Fulton and Pearson 1981, Kaeriyama et al. 1992; coastal cutthroat trout *O. clarki clarki,* Griswold 1996, Johnson et al. 1999; brown trout *Salmo trutta,* Jonsson 1985; and Arctic char *Salvelinus alpinus*, Nordeng 1983). However, available information indicates that the incidence of these occurrences is relatively rare, and there is even less empirical evidence that, once lost, a self-sustaining anadromous run can be regenerated from a resident salmonid population. Although this must have occurred during the evolutionary history of *O. mykiss,* the BRT found no reason to believe that such an event would occur with any frequency or within a specified time period. This would be particularly true if the conditions that promote and support the anadromous life history continue to deteriorate. In this case, the expectation would be that natural selection would gradually eliminate the migratory or anadromous trait from the population, as individuals inheriting a tendency for anadromy migrate out of the population but do not survive to return as adults and pass on their genes to subsequent generations.

Given the above considerations, the BRT focused primarily on information for anadromous populations in the risk assessments for steelhead ESUs. However, as discussed below in the "BRT Conclusions" section, the presence of relatively numerous, native resident fish was considered to be a mitigating risk factor for some ESUs.

B.2.10 CALIFORNIA CENTRAL VALLEY STEELHEAD

B.2.10.1 Previous BRT Conclusions

Summary of major risk factors and status indicators

Steelhead were once abundant and widespread throughout the Central Valley (CV), from tributaries to the upper Sacramento in the north to perhaps the Kern River in the southern San Joaquin Valley. Steelhead require cool water in which to oversummer, and much of this habitat is now above impassable dams. Where steelhead are still extant, natural populations are apparently small and subject to habitat degradation, including various effects of water development and land use practices. Concerns included extirpation from most of historic range, a monotonic decline in the single available time series of abundance (Table B.2.10.1; Figure B.2.10.1), declining proportion of wild fish in spawning runs, substantial opportunity for deleterious interactions with hatchery fish (including out-of-basin origin stocks), various habitat problems, and no ongoing population assessments. Compared to most chinook salmon populations in the Central Valley, steelhead spawning above Red Bluff Diversion Dam (RBDD) have a fairly strong negative population growth rate and small population size (Figure B.2.10.2).

Table B.2.10.1. Summary statistics for Central Valley steelhead trend analyses. Numbers in parentheses are 0.90 confidence intervals. Threatened and endangered chinook salmon populations are shown for comparison.

Population	5-yr mean	5-yr min	5-yr max	λ	μ	LT trend	ST trend
Sac. R. steelhead	1,952	1,425	12,320	0.95 (0.90, 1.02)	-0.07 (-0.13, 0.00)	-0.09 (-0.13, -0.06)	-0.06 (-0.26, 0.15)
Sac. R. winter chinook	2,191	364	65,683	0.97 (0.87, 1.09)	-0.10 (-0.21, 0.01)	-0.14 (-0.19, -0.09)	0.26 (0.04, 0.48)
Butte Cr. spring chinook	4,513	67	4,513	1.30 (1.09, 1.60)	0.11 (-0.05, 0.28)	0.11 (0.03, 0.19)	0.36 (0.03, 0.70)
Deer Cr. spring chinook	1,076	243	1,076	1.17 (1.04, 1.35)	0.12 (-0.02, 0.25)	0.11 (0.02, 0.21)	0.16 (-0.01, 0.33)
Mill Cr. spring chinook	491	203	491	1.19 (1.00, 1.47)	0.09 (-0.07, 0.26)	0.06 (-0.04, 0.16)	0.13 (-0.07, 0.34)

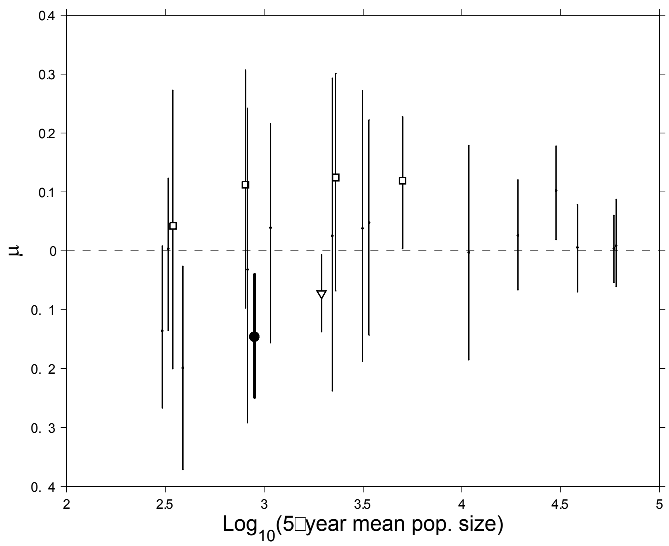

Figure B.2.10.1. Abundance and growth rate of Central Valley salmonid populations. Large filled circle- steelhead; open squares- spring chinook; open triangle- winter chinook; small black dots- other chinook stocks (mostly fall runs). Error bars represent central 0.90 probability intervals for μ estimates. (Note: as defined in other sections of the status reviews, μ ≈log [λ].)

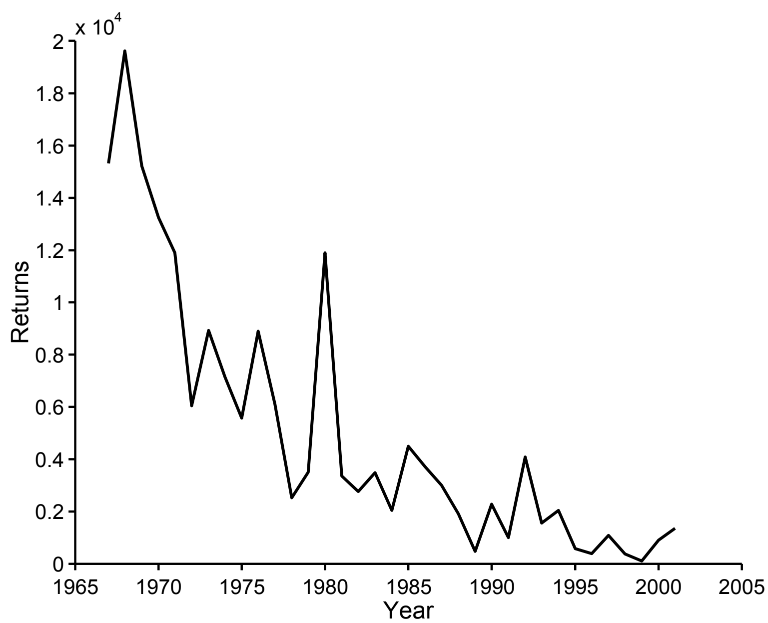

Figure B.2.10.2. Counts of steelhead passing the Red Bluff Diversion Dam fish ladders. These fish include hatchery fish from Coleman NFH.

BRT Conclusions

The BRT previously concluded that the Central Valley ESU was in danger of extinction (Busby et al. 1996), and this opinion did not change in two status review updates (NMFS 1997; NMFS 1998a). The Nimbus Hatchery and Mokelumne River Hatchery steelhead stocks were excluded from the Central Valley ESU (NMFS 1998b).

Listing status

The Central Valley steelhead ESU was listed as Threatened on March 19, 1998.

B.2.10.2 New Data

Historic distribution and abundance

McEwan (2001) reviewed the status of Central Valley steelhead. Steelhead probably occurred from the McCloud River and other northern tributaries to Tulare Lake and the Kings River in the southern San Joaquin Valley. McEwan also guessed that more than 95% of historic spawning habitat is now inaccessible. He did not hazard a guess about current abundance. He guessed, on the basis of the fairly uncertain historical abundance estimates of Central Valley chinook reported by Yoshiyama et al. (1998), that between 1 million and 2 million steelhead may have once spawned in the Central Valley. McEwan's estimate is based on the observation that presently, steelhead are found in almost all systems where spring-run chinook salmon occur and can utilize elevations and gradients even more extreme than those used by spring chinook. Steelhead should therefore have had more freshwater habitat than spring chinook, and the sizes of steelhead populations should therefore have been roughly as big as those of spring chinook.

Current abundance

The only significant new abundance information since the last status review comes from midwater trawling below the confluence of the Sacramento and San Joaquin Rivers at Chipps Island. This trawling targets juvenile chinook; catches of steelhead are incidental. In a trawling season, over 2,000 20-minute tows are made. Trawling occurred from the beginning of August through the end of June in 1997/98 and 1998/99, after which trawling has occurred year-round. Usually, 10 tows are made per day, and trawling occurs several days per week.

Since the 1998 broodyear, all hatchery steelhead have been ad-clipped. Trawl catches of steelhead provide an estimate of the proportion of wild to hatchery fish, which, combined with estimates of basin-wide hatchery releases, provide an estimator for wild steelhead production:

$$N_w = \frac{C_w}{C_h} N_h \qquad (1)$$

where N_w is the number of wild steelhead, C_w and C_h are the total catches of wild and hatchery steelhead, and N_h is the number of hatchery fish released.

Catches of steelhead are sporadic—most sets catch no steelhead, but a few sets catch up to four steelhead. To estimate the mean and variance of C_w / C_h, I resampled (with replacement) the trawl data sets 1,000 times. The mean C_w / C_h ranged from 0.06 to 0.30, and coefficients of variation ranged from 16% to 37% of the means.

From such calculations, it appears that about 100,000-300,000 steelhead juveniles (roughly, smolts) are produced naturally each year in the Central Valley (Table B.2.10.2). If we make the fairly generous assumptions (in the sense of generating large estimates of spawners) that average fecundity is 5,000 eggs per female, 1% of eggs survive to reach Chipps Island, and 181,000 smolts are produced (the 1998-2000 average), about 3,628 female steelhead spawn naturally in the entire Central Valley. This can be compared with McEwan's (2001) estimate of 1million-2 million spawners before 1850, and 40,000 spawners in the 1960s. Table B.2.10.2 shows the effects of different assumptions about survival on estimates of female spawner abundance.

Current distribution

Recent surveys of small Sacramento River tributaries (Mill, Deer, Antelope, Clear, and Beegum creeks) and incidental captures of steelhead during chinook monitoring (Cosumnes, Stanislaus, Tuolumne, and Merced rivers) have confirmed that steelhead are widespread, if not abundant, throughout accessible streams and rivers. Figure B.2.10.3 summarizes the distribution of steelhead in Central Valley streams.

Harvest impacts

Steelhead are caught in freshwater recreational fisheries, and CDFG estimates the number of fish caught. Because the sizes of Central Valley steelhead populations are unknown, however, harvest *rates* are unknown. According to CDFG creel census, the great majority (93%) of steelhead catches occur on the American and Feather rivers, sites of the two largest steelhead hatcheries. In 2000, 1,800 steelhead were retained and 14,300 were caught and released. The total number of steelhead contacted is on the order of basin-wide escapement, so even low catch-and-release mortality may pose a problem for wild populations. Additionally, steelhead juveniles are presumably affected by trout fisheries on tributaries and the mainstem Sacramento.

Table B.2.10..2. Estimated natural production of steelhead juveniles from the Central Valley. C_w/C_h = ratio of unclipped to clipped steelhead; N_r = total hatchery releases; N_w = estimated natural production; ESS = egg-to-smolt survival.

				wild female spawners		
Year	C_w/C_h	N_r (millions)	N_w (thousands)	ESS=1%	ESS=5%	ESS=10%
1998	0.300	1.12	336	6,720	1,344	672
1999	0.062	1.51	93.6	1,872	374	187
2000	0.083	1.38	115	2,291	458	229
average	0.148	1.34	181	3,628	726	363

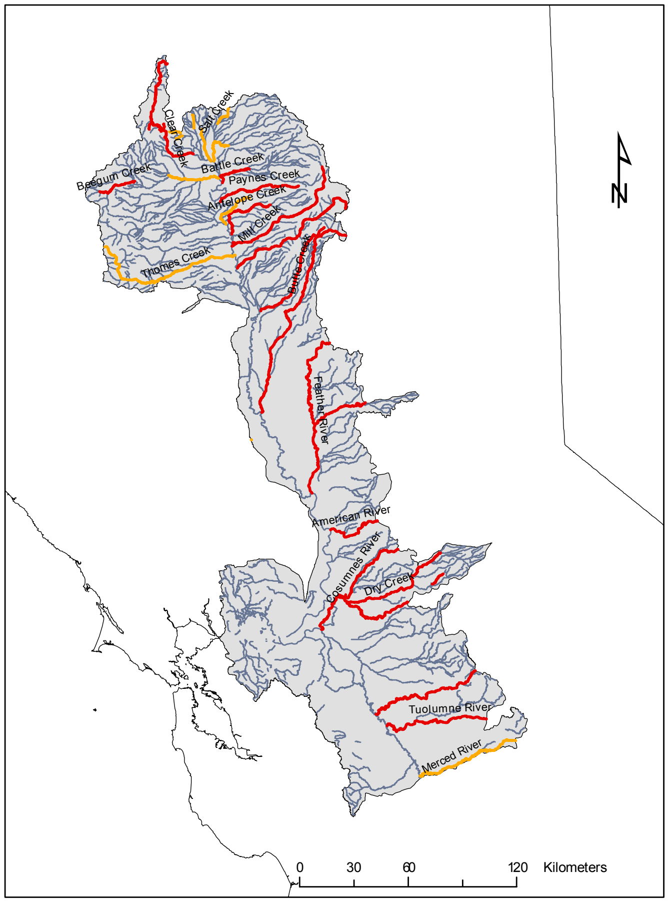

Figure B.2.10.3. Central Valley tributaries known (red lines; bold font) or suspected (orange lines; normal font) to be used by steelhead adults. Kerrie Pipal (NMFS Santa Cruz Lab) assembled this information from agency and consultant reports and discussions with CDFG field biologists.

The State of California's proposed Fishery Management and Evaluation Plan (part of the requirements to obtain ESA coverage for in-river sport fisheries) was recently rejected by NMFS mostly because of the inadequacy of existing and proposed monitoring of fisheries impacts.

B.2.10.3 New Comments

The San Joaquin Tributaries Association proposes that the California Central Valley ESU be delisted. They argue that the basis of the listing was that there are no self-sustaining populations of steelhead in the San Joaquin Valley, and that this argument is flawed because there never have been steelhead in the San Joaquin Valley. Any steelhead observed in San Joaquin tributaries are strays from the Mokelumne River Hatchery. They further argue that exclusion of resident trout populations from the ESU is arbitrary and capricious.

B.2.10.4 New Updated Analyses

Based on the provisional framework discussed in Previous BRT Conclusions, the BRT assumed as a working hypothesis that resident fish below historic barriers are part of the California Central Valley Steelhead ESU, while those above long-standing natural barriers are not. Historically, resident fish are believed to have occurred in all areas in the ESU used by steelhead, although current distribution is more restricted. According to this framework, native resident fish above recent (usually man-made) barriers including Shasta Dam on the Upper Sacramento River; Whiskeytown Dam on Clear Creek; Black Butte Dam on Stony Creek; Oroville Dam on the Feather River; Englebright Dam on the Yuba River; Camp Far West Dam on the Bear River; Nimbus Dam on the American River; Commanche Dam on the Mokelumne River; New Hogan Dam on the Calaveras River; Goodwin Dam on the Stanislaus River; La Grange Dam on the Tuolumne River; and Crocker Diversion Dam on the Merced River; but below natural barriers, provisionally would be part of the ESU.

Coastal *O. mykiss* is widely distributed in the Central Valley basin (Figure B.2.10.6). Roughly half of the trout habitat (by area) in the Central Valley is above dams that are impassable to fish. Higher elevation habitats appear to support quite high densities of trout, ranging from a few hundred to a few thousand 4"-6" fish per km (Table B.2.10.3).

There are several areas of substantial uncertainty that make interpreting this information difficult. First, it is not clear how anadromous and non-anadromous coastal *O. mykiss* interacted in the Central Valley before the era of dam building. In other systems, anadromous and non-anadromous *O. mykiss* forms can exist within populations, while in other systems, these groups can be reproductively isolated despite nearly sympatric distributions within rivers. Second, hatchery produced *O. mykiss* have been widely stocked throughout the Central Valley, Sierra Nevada and southern Cascades. It is possible that this stocking has had deleterious effects on native wild trout populations.

Table B.2.10..3. Estimates of *O. mykiss* density above impassable dams in Central Valley rivers and streams.

Basin	River/stream	Density (fish(km)	Size class	Reference
Upper Sacramento	Sacramento R	420-1670	>4"	CDFG 2000
	McCloud R	2361	>5"	pers. comm.[1]
	Fall R	2541	>6"	Rode and Weidlein 1986
	Hat Cr	159-2539	>8"	Deinstadt and Berry 1999
		32-1335	>12"	Deinstadt and Berry 1999
Lower Sacramento	Nelson Cr	155-621	>6"	CDFG 1979
San Joaquin	Clavey R	1317		Robertson 1985
	San Joaquin R (Upper Main Fk)	119-695	>6"	Deinstadt et al. 1995
	Kern R	43-620		Stephens et al. 1995

[1]CDFG Region 1 biologists: Mike Dean , Mike Berry, Randy Benthin, Bob McAllister, Bill, Jong, Phil Bairrington

In the absence of information on these issues, we presume that coastal *O. mykiss* that are above man-made barriers are part of the Central Valley ESU, because these populations were probably exhibiting some degree of anadromy and interacting with each other on evolutionary time scales prior to barrier construction. Clearly, the Central Valley ESU is severely fragmented by the abundant man-made barriers throughout the basin, and population processes (exchange of migrants, recolonization) that were likely once important have been greatly altered as a result.

B.2.10.5 New Hatchery Information

There is little new information pertaining to hatchery stocks of steelhead in the Central Valley. Figures B.2.10.4 and B.2.10.5 show the releases and returns of steelhead to and from Central Valley hatcheries. As discussed above in the section on new abundance information, hatchery steelhead juveniles dominate catches in the Chipps Island trawl, suggesting that hatchery production is large relative to natural production. Note that Mokelumne River Hatchery and Nimbus Hatchery stocks are not part of the CV ESU due to broodstock source and genetic, behavioral, and morphological similarity to Eel River stocks. Categorization of Central Valley steelhead hatchery stocks (SSHAG 2003) can be found in Appendix B.5.2.

B.2.10.6 Comparison with Previous Data

The few new pieces of information do not indicate a dramatic change in the status of the Central Valley ESU. The Chipps Island trawl data suggest that the population decline evident in the RBDD counts and the previously-noted decline in the proportion of wild fish is continuing. The fundamental habitat problems are little changed, with the exception of some significant restoration actions on Butte Creek. There is still a nearly complete lack of steelhead monitoring in the Central Valley.

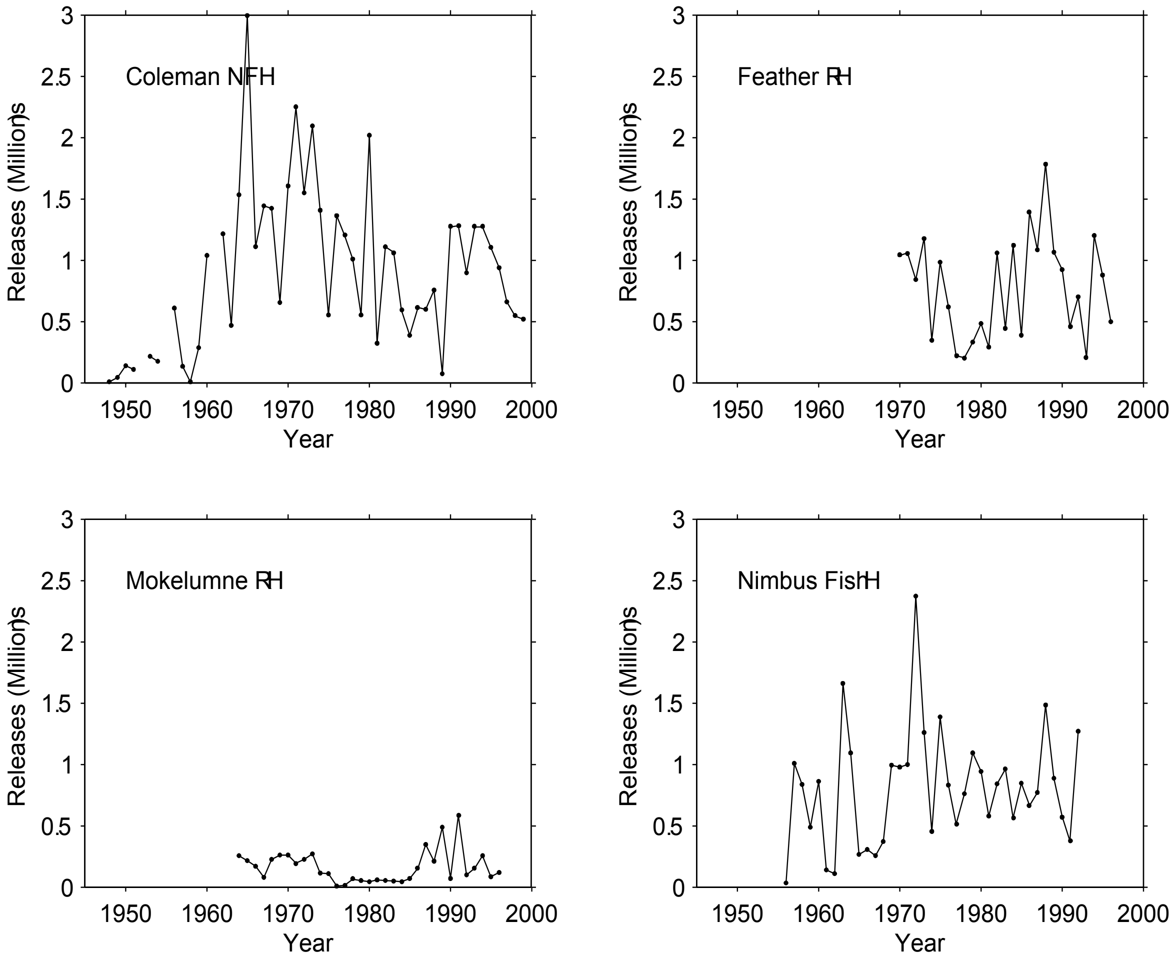

Figure B.2.10.4. Releases of steelhead from Central Valley hatcheries.

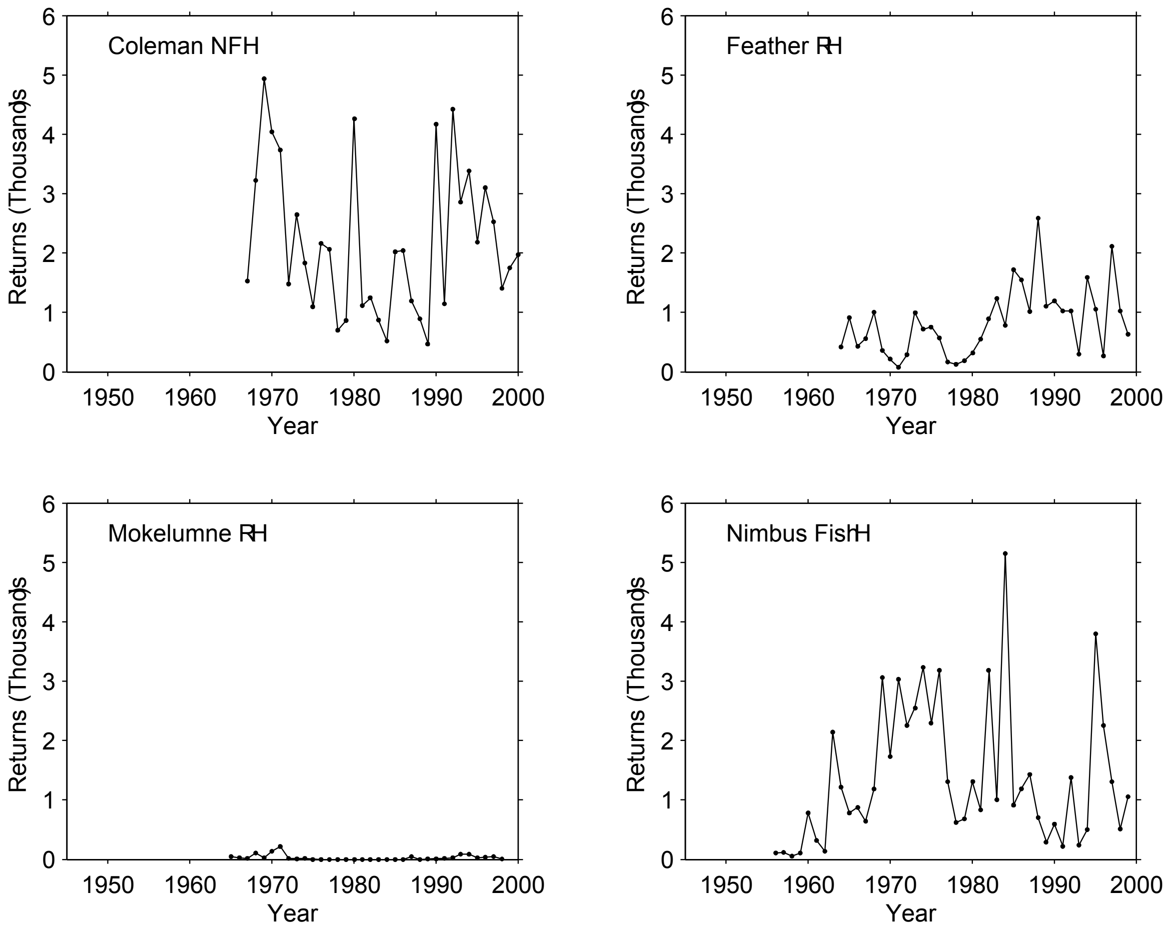

Figure B.2.10.5. Returns of steelhead to Central Valley hatcheries.

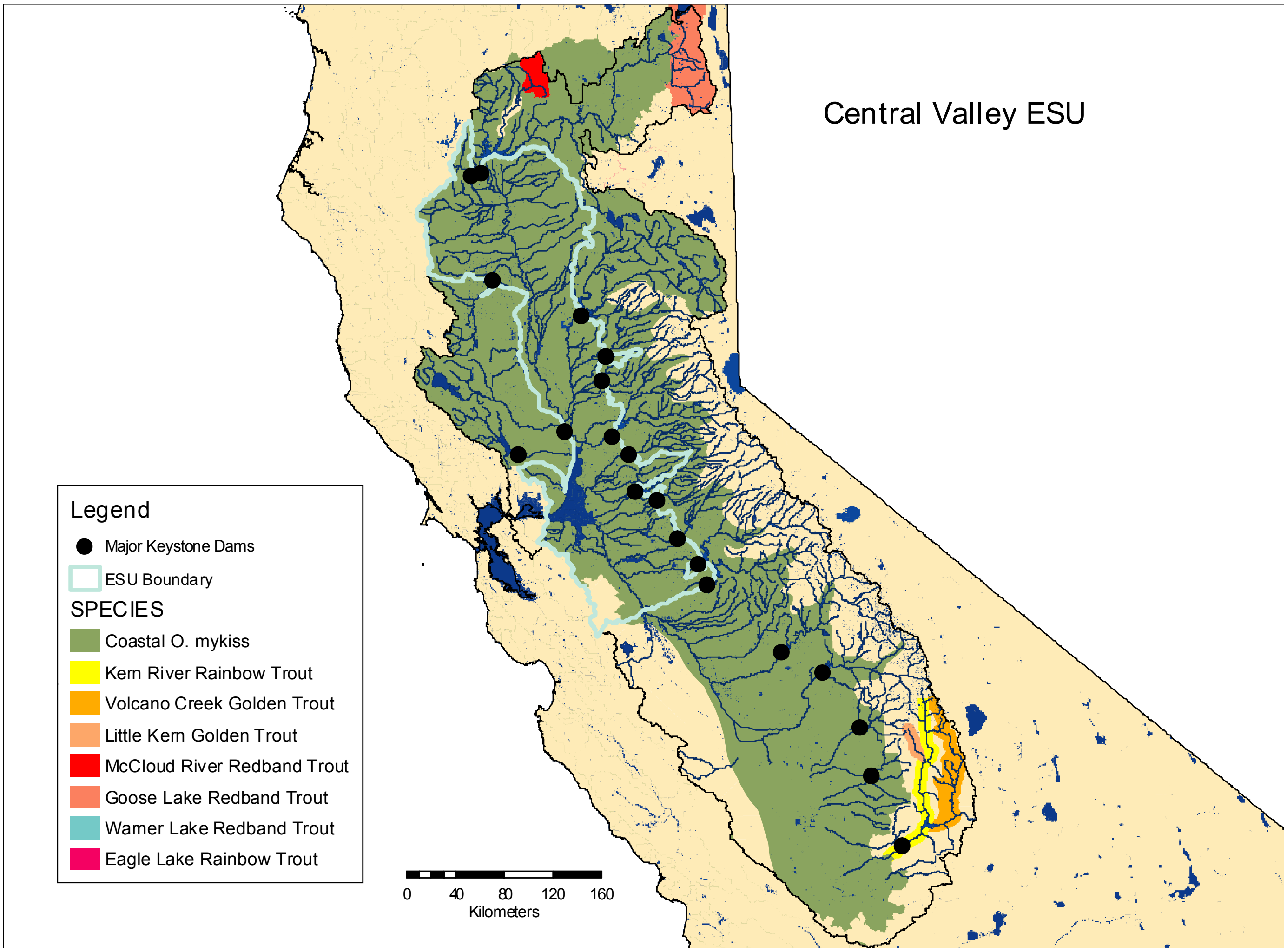

Figure B.2.10.6. Distribution of coastal *O. mykiss* and various *O. mykiss* subspecies in the Central Valley.