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

B. Steelhead trout

February 2003

Co-manager review draft

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.2.1. SNAKE RIVER STEELHEAD ESU

The Snake River steelhead ESU is distributed throughout the Snake River drainage system, including tributaries in southwest Washington, eastern Oregon and north/central Idaho (NMFS, 1996). Snake River steelhead migrate a substantial distance from the ocean (up to 1,500 km) and use high elevation tributaries (typically 1,000-2,000 m above sea level) for spawning and juvenile rearing. Snake River steelhead occupy habitat that is considerably warmer and drier (on an annual basis) than other steelhead ESUs. Snake River basin steelhead are generally classified as summer run, based on their adult run timing patterns. Summer steelhead enter the Columbia River from late June to October. After holding over the winter, summer steelhead spawn during the following spring (March to May). Managers classify up-river summer steelhead runs into to groups based primarily on ocean age and adult size upon return to the Columbia River. A-run steelhead are predominately age-1 ocean fish while B-run steelhead are larger, predominated by age-2 ocean fish.

With one exception (the Tucannon River production area), the tributary habitat used by Snake River steelhead ESU is above Lower Granite Dam. Major groupings of populations and/or subpopulations can be found in 1) the Grande Ronde River system; 2) the Imnaha River drainage; 3) the Clearwater River drainages; 4) the South Fork Salmon River; 5) the smaller mainstem tributaries before the confluence of the mainstem; 6) the Middle Fork salmon production areas, 7) the Lemhi and Pahsimeroi valley production areas and 8) upper Salmon River tributaries.

Resident *O. mykiss* are believed to be present in many of the drainages utilized by Snake River steelhead. Very little is known about interactions between co-occurring resident and anadromous forms within this ESU. The following review of abundance and trend information focuses on information directly related to the anadromous form.

Historical Returns

Although direct historical estimates of production from the Snake basin are not available, the basin is believed to have supported more than half of the total steelhead production from the Columbia basin (Mallet 1974). There are some historical estimates of returns to portions of the drainage. Lewiston Dam, constructed on the lower Clearwater, began operation in 1927. Counts of steelhead passing through the adult fish ladder at the dam reached 40-60,000 in the early 1960s (Cichosz et al. 2001). Based on relative drainage areas, the Salmon River basin likely supported substantial production as well. In the early 1960s, returns to the Grande Ronde River and the Imnaha River may have exceeded 15,000 and 4,000 steelhead per year, respectively (ODFW 1991). Extrapolations from tag/recapture data indicate that the natural steelhead return to the Tucannon River may have exceeded 3,000 adults in the mid-1950s (WDF 1991).

B.2.1.1. Previous BRT Conclusions

The primary concern regarding Snake River steelhead identified in the 1998 status review was a sharp decline in natural stock returns beginning in the mid-1980s. Of 13 trend indicators at that time, nine were in decline and four were increasing. In addition, Idaho Department of

Fish and Game parr survey data indicated declines for both A and B run steelhead in wild and natural stock areas. The high proportion of hatchery fish in the run was also identified as a concern, particularly because of the lack of information on the actual contribution of hatchery fish to natural spawning. The review recognized that some wild spawning areas have relatively little hatchery spawning influence (Selway River, lower Clearwater River, the Middle and South forks of the Salmon River and the lower Salmon River). In other areas, such as the upper Salmon River, there is likely little or no natural production of locally native steelhead. The review identified threats to genetic integrity from past and present hatchery practices as a concern. Concern for the North Fork Clearwater stock were also identified. That stock is currently maintained through the Dworshak Hatchery program but cut off from access to its native tributary by Dworshak Dam. The 1998 review also highlighted concerns for widespread habitat degradation and flow impairment throughout the Snake basin as well as for the substantial modification of the seaward migration corridor by hydroelectric power development on the Snake and Columbia mainstem.

Abundance

The previous status review noted that the aggregate trend in abundance as measured by ladder counts at the upper most Snake River dam (Lower Granite Dam since 1972) has been upward since the mid-1970s while the aggregate return of naturally produced steelhead was downward for the same period. The decline in natural production was especially pronounced in the later years in the series.

Table B.2.1.1. Summary of abundance and trend estimates for Snake River Steelhead ESU.

Population(s)	Percent Natural Origin	1997-2001 Geometric Mean Previous Status Review estimate in ()				
		Total	Natural	Trend (%/yr)	Interim Target	Current vs. Target
Tucannon R.	26% (44)		95 140	-9.2 -18.3	1,300	.07
LGR Run	14%		14,768	+5.3	52,100	.28
Snake A	15%		12,666	+8.6		
Snake B	11%		1,890	-5.9		
Asotin Cr			200	-19.7	500	
Grande Ronde				-3.5 to +3.9	10,000	
Upper Middle Fork	77%		.83 rpm	-2.8		
Joseph Cr	100%		1,542	+5.0	1,400	1.10
Imnaha (Mainstem)	80%			-8.3		
Camp Creek	100% ()		154	+2.0		

B.2.1.2. New Data and Analyses

With a few exceptions, annual estimates of steelhead returns to specific production areas within the Snake River are not available. Annual return estimates are limited to counts of the aggregate return over Lower Granite Dam. Returns to Lower Granite remained at relatively low levels through the 1990s. The 2001 run size at Lower Granite Dam was substantially higher relative to the 1990s. Annual estimates of returns are available for the Tucannon River, sections of the Grande Ronde River system and the Imnaha River. The recent geometric mean abundance was down for the Tucannon relative to the last BRT status review. Returns to the other areas were generally higher relative to the early 1990s.

Overall, long-term trends remained negative for four of the nine available series (including both aggregate measures and specific production area estimates; Figure B.2.1.7). Short-term trends improved relative to the period analyzed for the previous status review. The median

short-term trend was +2.0% for the 1990-2001 period. Five out of the nine data sets showed a positive trend (Figure B.2.1.8).

IDFG has provided updated analyses of parr density survey results through 1999. IDFG concluded that "generational parr density trends, which are analogous to spawner to spawner survivorship, indicate that Idaho spring-summer chinook and steelhead with and without hatchery influence failed to meet replacement for most generations competed since 1985 (IDFG 2002). These data do not reflect the influence of increased returns in 2001 and 2002.

Population growth rate (λ) estimates showed a corresponding pattern. The median long-term λ estimate across the nine series was .998 assuming that natural returns are produced only from natural origin spawners and .733 if both hatchery and wild potential spawners are assumed to have contributed to production. Short-term λ estimates are higher, 1.013, assuming a hatchery effectiveness of 0, and .753, assuming hatchery and wild fish contribute to natural production in proportion to their numbers.

Resident fish

The Snake River Steelhead ESU includes large areas in Idaho, eastern Oregon, and southwest Washington. Additional upstream drainages currently blocked off to anadromous fish by the Hells Canyon Dam complex may have supported populations within this ESU. Resident trout are distributed throughout the ESU. Kostow (2003) has reviewed information on the abundance and distribution of resident trout for this ESU. The following summary excerpts are from Kostow (2003).

O. mykiss trout are the only native Oncorhynchus trout species in the Snake ESU, with the exception of two major basins. Native westslope cutthroat are the dominant trout species throughout most of the Clearwater Basin, and in much of the Salmon Basin.

O. mykiss trout abundance may also be low in the Tucannon, based on incidental observations. Occasional mature trout are seen that are about 30 cm. Some trout redds are seen during steelhead spawning ground surveys, but they are only about 1-2% of the redds observed (M. Schuck, WDFW). However, smaller mature trout and very small redds may be present that would be difficult to detect by incidental observation.

Trout densities or abundances have not been measured in the Imnaha, but the results of a genetics pedigree study in upper Little Sheep Creek suggests that trout may be abundant in this basin.

Joseph Creek is a large tributary of the lower Grande Ronde Basin. It is dominated by O. mykiss, including a relatively large (for a single, relatively small Snake subbasin), all-wild steelhead population...results suggest that most of the parr observed were juvenile steelhead rather than trout....However, it is likely that some of the fish observed during the density sampling were trout.

The US Fish and Wildlife Service is currently mapping the distribution of native westslope cutthroat and their co-occurrence with native and introduced O. mykiss as part of an ESA review of the cutthroat trout (L. Kaeding, USFWS). The issue of co-occurrence has become an important one for the cutthroat listing consideration because the two species form hybrid zones in most areas where they overlap. The USFWS has been legally challenged about not properly evaluating the implication of the hybrid zones during an earlier listing review (Civil Action No. 00-2521, March 2002). Westslope cutthroat are naturally allopatric to O. mykiss through most of their native range. The hybrids in most areas are caused by introduced hatchery rainbow trout and are artificial and invasive. There are also several basins in eastern Washington and western Idaho where cutthroat have been introduced on top of native O. mykiss. However, the two species are naturally sympatric in three basins that have native ESA-listed steelhead: the Clearwater, Salmon and John Day basins, and hybrids between native species occur in all three basins.

Westslope cutthroat are prevalent in many parts of the Salmon Basin, particularly in upper headwater areas. However, several subbasins, such as the Lemhi, Pahsimeroi, and parts of the Middle Fork Salmon, also have O. mykiss trout populations. A recent presence/absence survey by IDFG of native trouts in 84 streams in the Salmon Basin found O. mykiss trout in 48% of the streams surveyed and westslope cutthroat in 43% of the streams surveyed. Hybrids between the two species were found in 13% of the streams (Brimmer et al. 2002, T. Curet, IDFG). When cutthroat and resident and anadromous O. mykiss are all present together in a basin, they seem to sort themselves into different areas. Steelhead are in mainstems and the lower parts of larger tributaries, resident O. mykiss are in the larger and lower tributaries, and the cutthroat are in the smaller headwater tributaries (S. Yundt, IDFG). There are also fluvial O. mykiss and O. clarki in the Middle Fork Salmon and mid-mainstem Salmon. In these cases, the two species mingle in the rearing areas, but separate when they enter the tributaries to spawn, with the O. mykiss trout spawning lower in the tributaries and the O. clarki migrating into upper reaches (T. Curet, IDFG).

IDFG suspects that some of the resident O. mykiss in the Salmon and Clearwater are introduced hatchery rainbow, although they have not done the genetic surveys necessary to explore this question (S. Keifer, IDFG). The hatchery rainbow would be different subspecies than native Snake River O. mykiss because the hatchery stocks used by IDFG are McCloud or Kamloops stocks. None of the O. mykiss genetics survey data collected in the Clearwater or Salmon by NMFS indicate a dominance of hatchery rainbow (Busby et al. 1996, NMFS, unpublished data).

Outside of the Salmon and Clearwater, resident O. mykiss trout are present in all of the current and historic steelhead basins in the Snake ESU. Leary (2001) found evidence of hatchery rainbow trout in several locations above Hells Canyon Dam, but in all cases native trout were also present. The trout populations in many of the desert basins the upper Snake are severely depressed and fragmented due to local habitat impacts, especially hydrological changes caused by irrigation. They are absent from many areas that were historically used in basins like the Owhyee and Burneau. However, they remain well distributed in most of the other basins, in both current and historic steelhead range. Similar to the pattern in the Mid-Columbia ESU, where they are currently sympatric with steelhead, their distribution extends beyond steelhead distribution into smaller headwater tributaries.

B.2.1.3. New Hatchery/ESU Information

Artificial production history

Almost all artificial production of steelhead within the Snake River ESU has been associated with two major mitigation initiatives—the Lower Snake River Compensation Program (LSRCP) and the mitigation program for Dworshak Dam on the North Fork of the Clearwater River. The LSRCP is administered by the USFWS and was established as compensation for losses incurred as a result of the construction and operation of the four lower Snake River hydroelectric dams. Production under this initiative generally began in the mid 1980s. The Dworshak mitigation program provides for artificial production as compensation for the loss of access to the North Fork Clearwater, a major historical production area. Dworshak Hatchery, completed in 1969, is the focus for that production.

The following section provides a summary by major geographic area within the ESU of historical and current artificial production programs for steelhead.

Tucannon River—Artificial production of steelhead in the Tucannon River has been carried out since the early 1980s in response to the LSRCP objective of 878 steelhead to the project area. Until 1998, releases of hatchery steelhead into the Tucannon River occurred via the up river Curl Lake acclimation site. Release numbers ranged from 120,000 to 160,000 between 1985 and 1997. The broodstock for Tucannon releases was primarily the Lyons Ferry stock, which was derived from capturing adults from the mainstem Snake River. Return rates to the Tucannon River from the hatchery program have been relatively low. Beginning in 1998, the release location for hatchery steelhead was moved down river to minimize the opportunity for interbreeding between hatchery and natural returns to the basin. Beginning with the 1999/2000 cycle year, the Tucannon River hatchery steelhead program was switched over to a local broodstock.

Grande Ronde/Imnaha Rivers—There are LSRCP steelhead hatchery mitigation releases in the Grande Ronde and Imnaha River systems. The LSRCP compensation objective for Grande Ronde steelhead returns is 9,200. Trapping facilities for adult broodstock are located at Big Canyon Creek acclimation site. The original program used outside broodstock (including Skamania Hatchery stock) from 1979-1982 before switching to the Wallowa broodstock. Smolts are acclimated and released at two sites—one within the Wallowa drainage, the other at Big Canyon Creek. Oregon manages the Minam River, Joseph Creek and the Wenaha River drainages for natural production. Other sections of the Grande Ronde have been outplanted to supplement natural production.

LSCRP program releases into the Imnaha River are released from a satellite facility on Little Sheep Creek after primary rearing at Wallowa Hatchery. Additional releases are targeted in Horse Creek and the Upper Imnaha basin.

Clearwater Basin—Steelhead hatchery releases into the Clearwater basin are managed under two programs—LRSCMP and Dworshak Dam mitigation. The Lower Snake Compensation Plan program in the Clearwater River drainage utilizes the Clearwater hatchery as

a central rearing facility and has an overall production objective of 14,000 adult steelhead returns to the Snake River. Program release sites include acclimation ponds on the Powell River (Lochsa River drainage), the Red River, and Crooked River sites in the South Fork of the Clearwater River. The Dworshak mitigation program has an adult return objective of 20,000 adult steelhead as compensation for losses due to Dworshak Dam, an anadromous block that cuts off the North Fork of the Clearwater River. Genetics studies have indicated that the hatchery stock used in the Dworshak program may be representative of the original North Fork run.

Salmon River Basin—Steelhead hatchery releases into the Salmon River drainage are under the auspices of two major steelhead hatchery programs—LSRCP and Idaho Fish and Game Department programs funded by Idaho Power Company. In addition, there are state and tribal experimental supplementation programs in the drainage. The LSRCP program goal for the Salmon basin is to produce an annual return of 25,000 adult steelhead above Lower Granite Dam. Juvenile steelhead produced at Magic Valley Hatchery and Hagerman National Fish Hatchery are released into the Salmon drainage. The Idaho Power Company-funded program for steelhead has an objective of releasing 400,000 pounds of steelhead smolts.

The Middle Fork Salmon drainages have had minimal or no hatchery releases. The Upper Salmon drainages, the Pahsimeroi, Lemhi, Little Salmon River and Lower Salmon River areas have received releases in recent years.

Categorizations of hatchery Snake River Basin hatchery stocks (SSHAG 2003) are summarized in Appendix B.5.2.

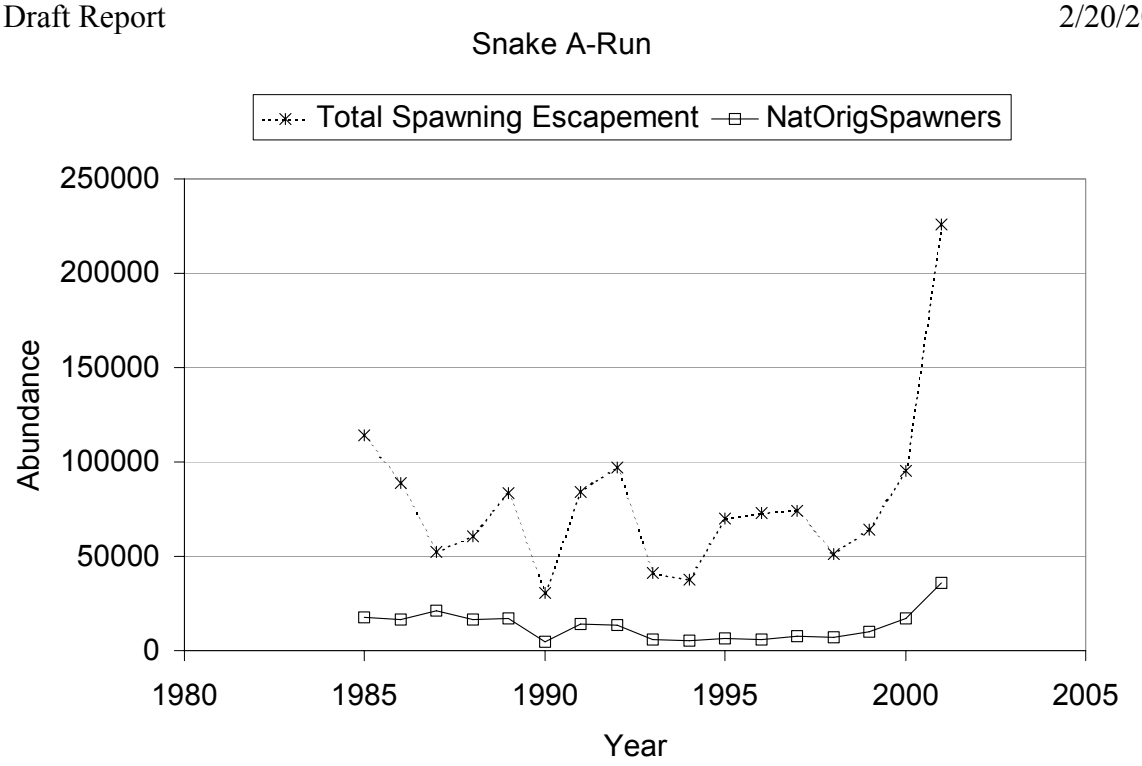

Figure B.2.1.1. Spawning escapement of Snake River A-run steelhead.

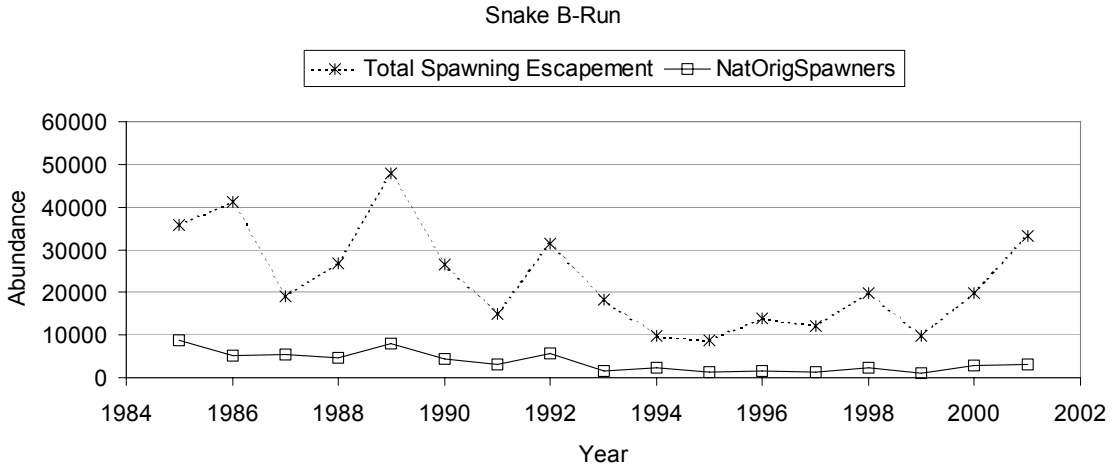

Figure B.2.1.2. Spawning escapement of Snake River B-run steelhead.

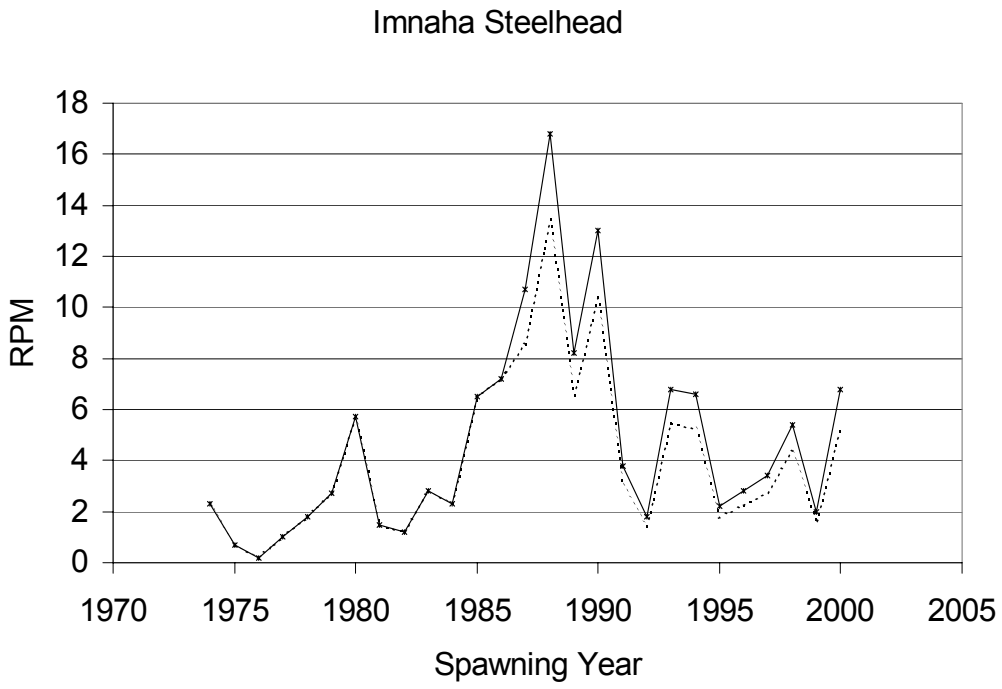

Figure B.2.1.3. Redds/mile for Imnaha steelhead.

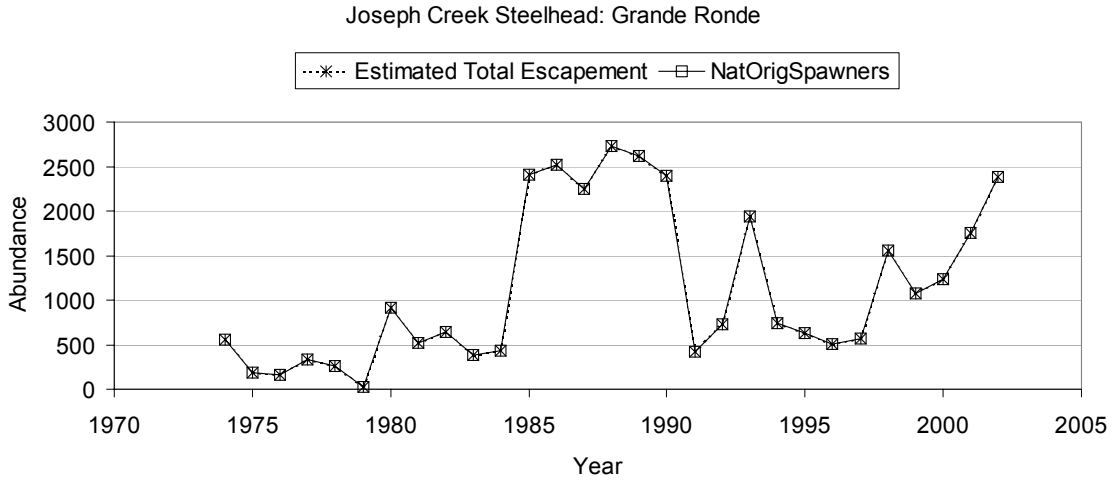

Figure B.2.1.4. Spawning escapement for Joseph Creek steelhead: Grande Ronde.

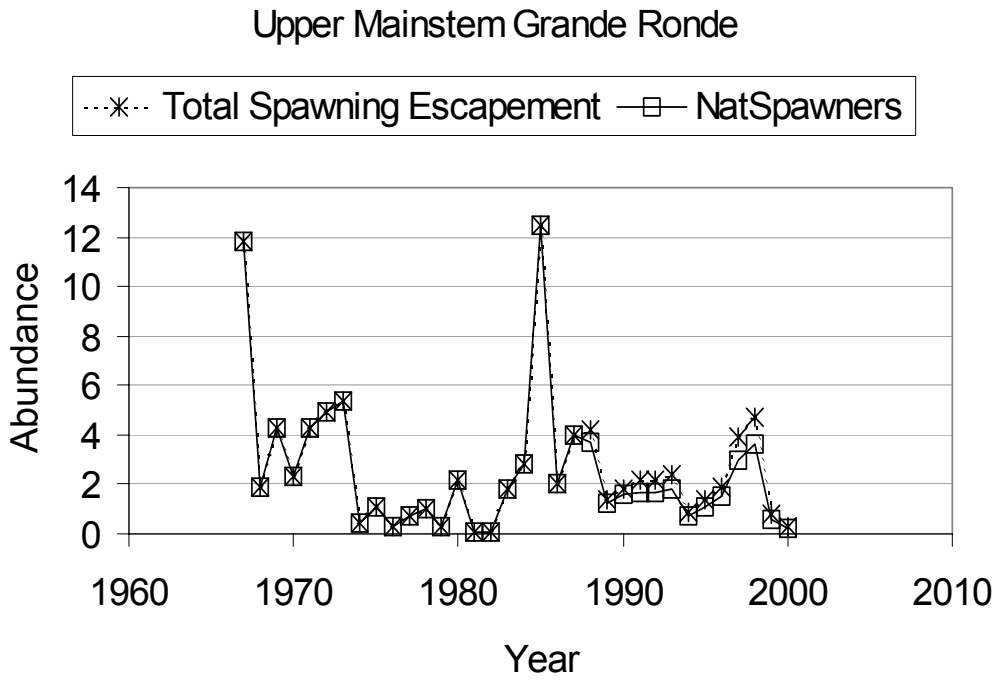

Figure B.2.1.5. Spawning escapement for Upper Mainstem Grande Ronde.

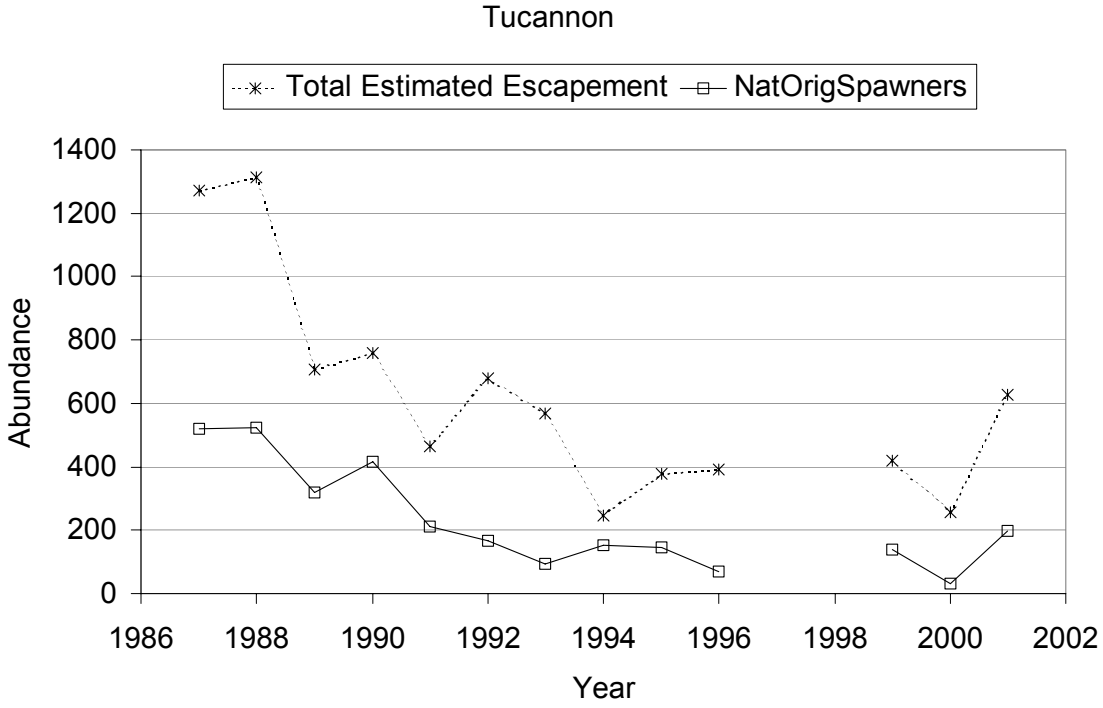

Figure B.2.1.6. Spawning escapement for Tucannon steelhead.

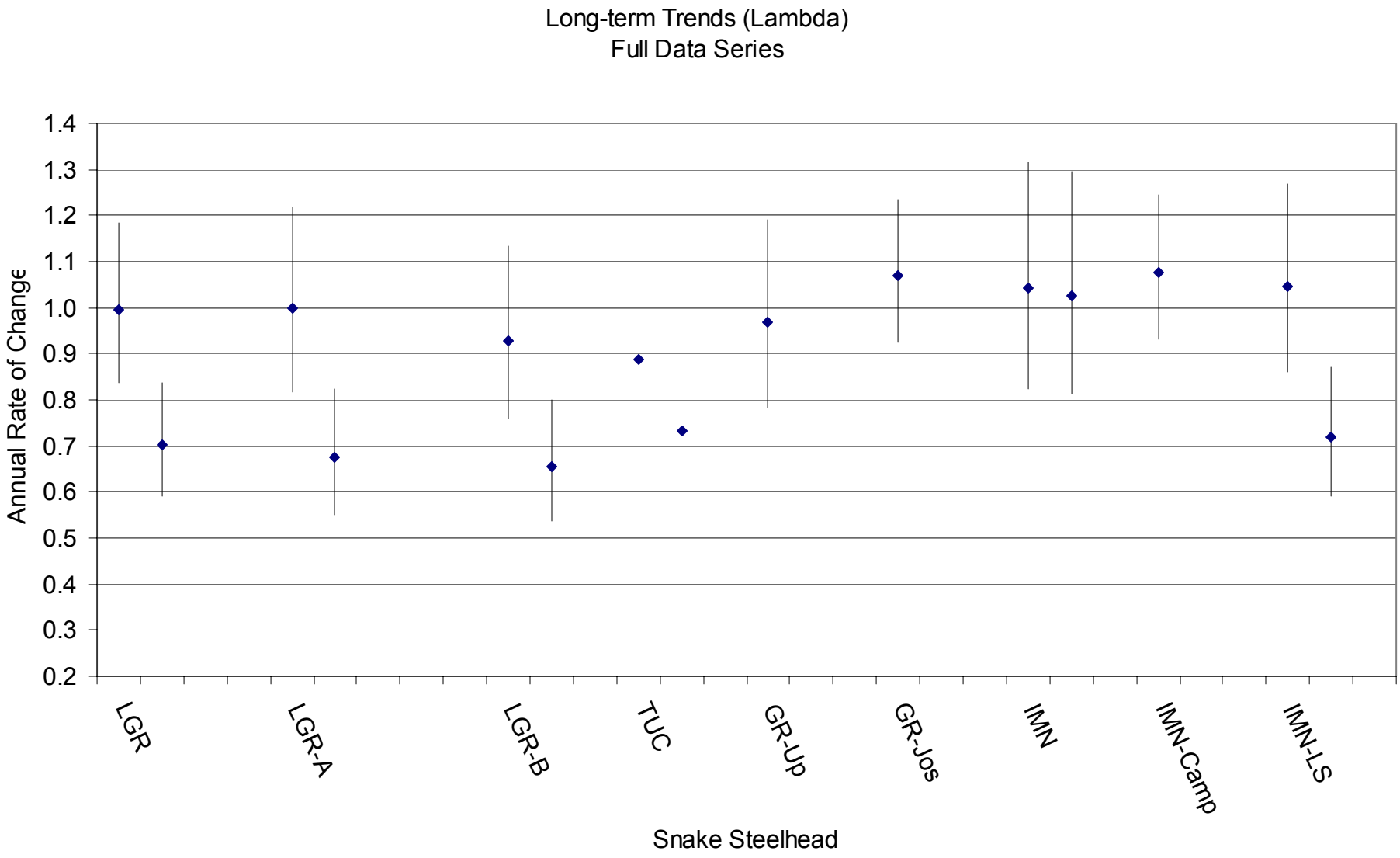

Figure B.2.1.7. Long term population growth rate point estimates and 95% confidence limits for Snake River steelhead data series. Paired estimates for areas with possible hatchery contribution to natural spawning. (note some hatchery cf limits were estimated by extrapolation).

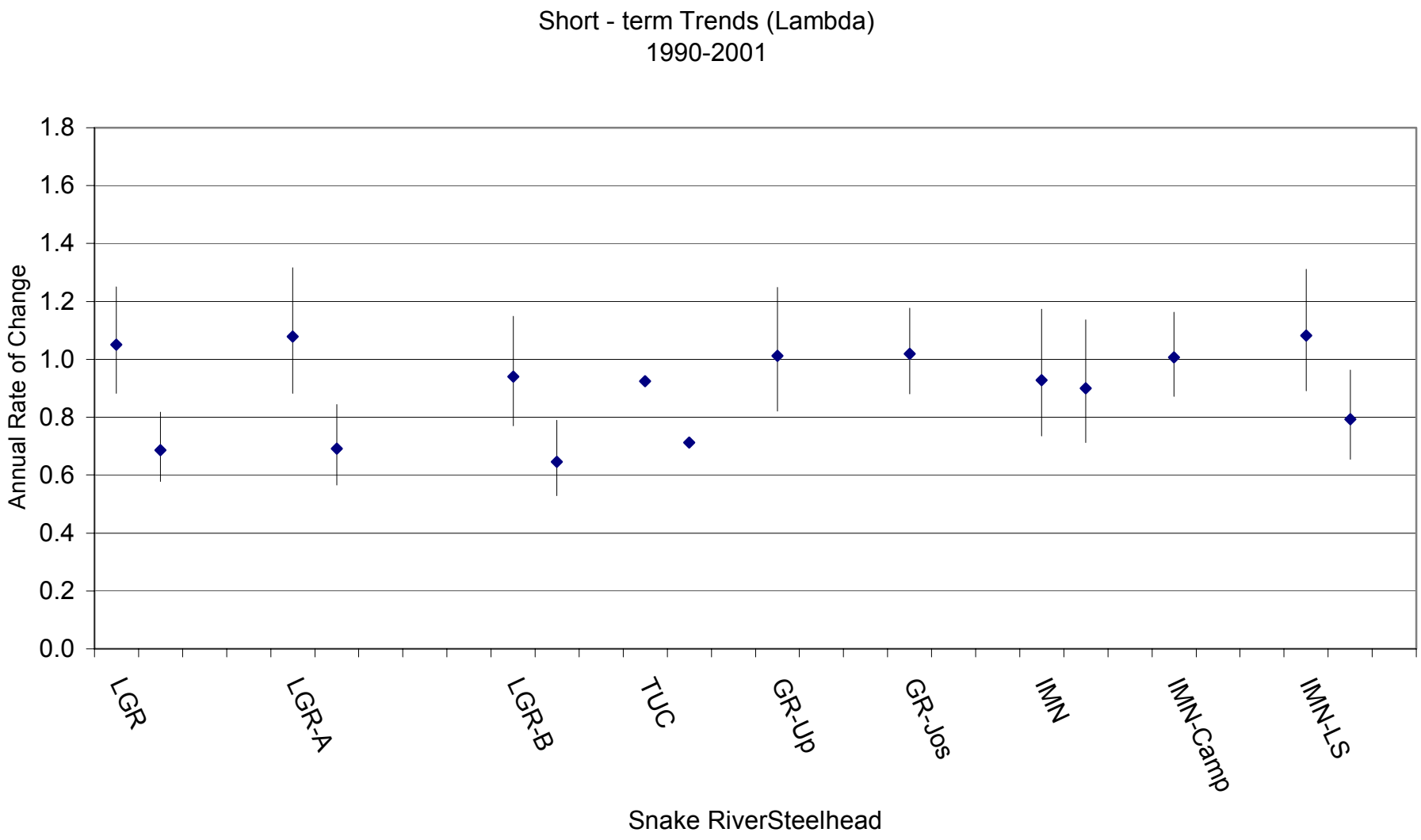

Figure B.2.1.8. Short term population growth rate point estimates and 95% confidence limits for Snake River steelhead data series. Paired estimates for areas with possible hatchery contribution to natural spawning.

B.2.2. UPPER COLUMBIA STEELHEAD

The life-history patterns of upper Columbia steelhead are complex. Adults return to the Columbia River in the late summer and early fall; most migrate relatively quickly up the mainstem to their natal tributaries. A portion of the returning run overwinters in the mainstem reservoirs, passing over the upper mid-Columbia dams in April and May of the following year. Spawning occurs in the late spring of the calendar year following entry into the river. Juvenile steelhead spend 1 to 7 years rearing in freshwater before migrating to the ocean. Smolt outmigrations are predominately age 2 and age 3 juveniles. Most adult steelhead return after 1 or 2 years at sea, starting the cycle again.

Estimates of the annual returns of upper Columbia steelhead populations are based on dam counts. Cycle counts are used to accommodate the prevalent return pattern in up-river summer steelhead (runs enter the Columbia in late summer and fall, some fish overwinter in mainstem reservoirs—migrating past the upper dams prior to spawning the following spring). Counts over Wells Dam are assumed to be returns originating from natural production and hatchery outplants into the Methow and Okanogan systems. The total returns to Wells Dam are calculated by adding annual brood stock removals at Wells to the dam counts. The annual estimated return levels above Wells Dam are broken down into hatchery and wild components by applying the ratios observed in the Wells sampling program for run years since 1982.

Harvest rates on upper river steelhead have been cut back substantially from historical levels. Direct commercial harvest of steelhead in non-Indian fisheries was eliminated by legislation in the early 1970s. Incidental impacts in fisheries directed at other species continued in the lower river, but at substantially reduced levels. In the 1970s and early 1980s, recreational fishery impacts in the upper Columbia escalated to very high levels in response to increasing returns augmented by substantial increases in hatchery production. In 1985, steelhead recreational fisheries in this region (and in other Washington tributaries) were changed to mandate release of wild fish. Treaty harvest of summer run steelhead (including returns to the upper Columbia) occurs mainly in mainstem fisheries directed at up-river bright fall chinook..

Hatchery returns predominate the estimated escapement in the Wenatchee, Methow and Okanogan River drainages. The effectiveness of hatchery spawners relative to their natural counterparts is a major uncertainty for both populations. Hatchery effectiveness can be influenced by at least three sets of factors: relative distribution of spawning adults, relative timing of spawning adults, and relative effectiveness of progeny. No direct information is available for the upper Columbia stocks. Outplanting strategies have varied over the time period the return/spawner data were collected (1976-1994 brood years). While the return timing into the Columbia River is similar for both wild and hatchery steelhead returning to the upper Columbia, the spawning timing in the hatchery is accelerated. The long-term effects of such acceleration on the spawning timing of returning hatchery produced adults in nature is not known. We have no direct information on relative fitness of upper Columbia progeny with at least one parent of hatchery origin.

B.2.2.1. Previous BRT Conclusions

The 1998 steelhead status review identified a number of concerns for the Upper Columbia Steelhead ESU: "While the total abundance of populations within this ESU has been relatively stable or increasing, it appears to be occurring 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 members are also strongly concerned about the problems of genetic homogenization due to hatchery supplementation...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." The BRT also identified two major areas of uncertainty; relationship between anadromous and resident forms, and the genetic heritage of naturally spawning fish within this ESU.

B.2.2.2. New Data and Analyses

Population Definitions and Criteria

An initial set of population definitions for Upper Columbia steelhead ESU along with basic criteria for evaluating the status of each population were developed using the Viable Salmonid Population (VSP) guidelines described in McElhany (2000). The definitions and criteria are described in Ford et al. (2000) and have been used in the development and review of Mid-Columbia PUD plans and the FCRPS Biological Opinion. The interim definitions and criteria are being reviewed as recommendations by the Interior Columbia Technical Recovery Team. Briefly, the joint technical team recommended that the Wenatchee River, the Entiat River and the Methow River be considered as separate populations within the Upper Columbia Steelhead ESU. The Okanogan River may have supported a fourth population, the committee deferred a decision on the Okanogan to the Technical Recovery Team. Abundance, productivity and spatial structure criteria for each of the populations in the ESU were developed and are described in Ford et al. (2001).

Current Abundance

Returns of both hatchery and naturally produced steelhead to the upper Columbia have increased in recent years. Priest Rapids Dam is below upper Columbia steelhead production areas. The average 1997-2001 return counted through the Priest Rapids fish ladder was approximately 12,900 steelhead. The average for the previous 5 years (1992-1996) was 7,800 fish.

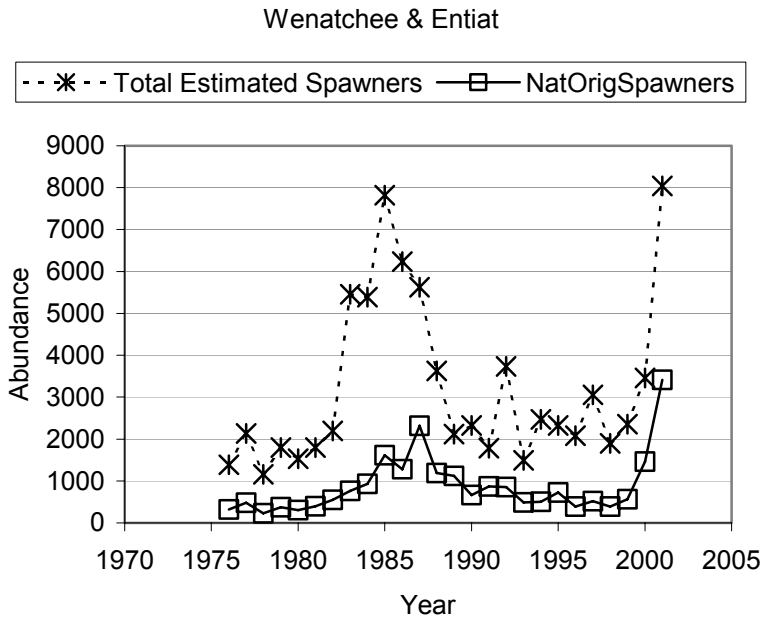

Figure B.2.2.1. Wenatchee/Entiat Steelhead—estimated annual spawning escapements. Cooney, 2001. 1999-2001 data from WDFW.

Total returns to the upper Columbia continue to be predominately hatchery-origin fish. The percentage of the run over Priest Rapids of natural origin increased to over 25% in the 1980s, then dropped to less than 10% by the mid-1990s. The median percent wild for 1997-2001 was 17%.

Abundance estimates of returning naturally produced upper Columbia steelhead have been based on extrapolations from mainstem dam counts and associated sampling information (e.g. hatchery/wild fraction, age composition). The natural component of the annual steelhead run over Priest Rapids increased from an average of 1,040 (1992-1996) to 2,200 (1997-2001).

The estimate of the combined natural steelhead return to the Wenatchee and Entiat Rivers increased to a geometric mean of approximately 900 for the 1996-2001 period. The average percentage natural dropped from 35% to 29% for the recent 5-year period. In terms of natural production, recent production levels remain well below the interim recovery levels developed for these populations (Table B.2.2.1, Figure B.2.2.1).

The Methow steelhead population is the primary natural production area above Wells Dam. The 1997-2001 geometric mean of natural returns over Wells Dam was 358, lower than the geometric mean return prior to the 1998 status review (Table B.2.2.1, Figure B.2.2.2). The most recent return reported in the data series, 1,380 naturally produced steelhead in 2001, was the highest single annual return in the 25-year data series. Hatchery returns continue to dominate the run over Wells Dam. The average percent of wild origin dropped to 9% for 1996-2001 compared to 19% for the period prior to the previous status review.

Table B.2.2.1. Upper Columbia Steelhead. Summary of current abundance and trend information relative to previous BRT status review. Interim targets from Ford et al. (2001).

Population(s)	Pct Natural Origin	1997-2001 Geometric Mean Previous Status Review estimate in ()				
		Total	Natural	Trend (%/yr)	Interim Target	Curren t vs. Target
Wenatchee/Entiat	29% (35%)	3,279	894 (800)	+3.4 (+2.6)	3,000	30%
Methow/Okanogan	9% (19%)	4,815	358 (450)	+5.9 (-12.0)	2,500	14%

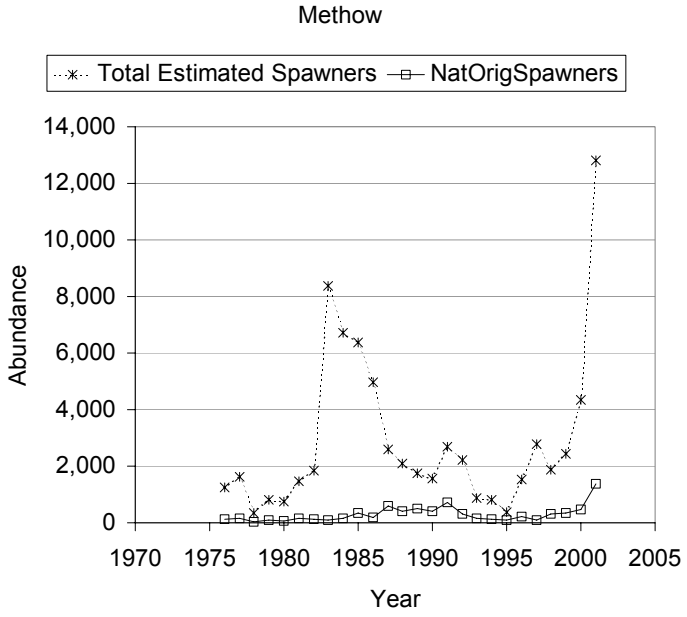

Figure B.2.2.2. Methow Steelhead—estimated annual spawning escapements. Cooney 2001. 1999-2001 data from WDFW.

The analyses described above relied on the 1976-2001 abundance data set. The starting date for that series is set by the advent of counting at Wells Dam (allowed for separate estimates of run strength to the Methow/Okanogan and the Wenatchee/Entiat). The median run (almost all natural origin) from 1933-1954 was approximately 2,300.

Current Productivity

Natural returns have increased in recent years for both stock groupings (Table B.2.2.1). Population growth rates, expressed as λ calculated using the running sum method, are

substantially influenced by assumptions regarding the relative effectiveness of hatchery spawners. The same key factor must be considered in analyzing return per spawner data sets. The relative contribution of returning steelhead of hatchery origin to natural spawning is not clearly understood. There may be timing and spatial differences in the distribution of hatchery and wild origin spawners that affect production of juveniles. Eggs and subsequent juveniles, from natural spawning, involving hatchery-origin fish may survival at a differential rate relative to spawning of natural origin adults.

Two sets of assumptions were used in estimating λ and generating return-per-spawner series for upper Columbia steelhead data sets. These assumptions represented the extremes in the range of possible relative hatchery effectiveness values, relative hatchery effectiveness equal to 1 or 0 with respect to fish of natural origin. Under the assumption that hatchery effectiveness is 0, naturally produced fish returning in a year are the progeny of the natural returns one brood cycle earlier. Under the assumption that hatchery effectiveness is 1.0, natural steelhead returning in any given year are assumed to be the product of total (hatchery plus natural) spawners.

Both short-term and long-term estimates of λ are positive under the assumption that hatchery fish have not contributed to natural production in recent years. λ estimates under the assumption that hatchery fish contributed at the same level as wild fish to natural production are substantially lower—under this scenario natural production is consistently and substantially below the total number (hatchery plus natural origin) of spawners in any given year.

Return-per-spawner patterns for the two steelhead production areas are also substantially influenced by assumptions regarding the relative effectiveness of hatchery origin spawners (Figures B.2.2.3 and B.2.2.4). Under the assumption that hatchery and wild spawners are both contributing to the subsequent generation of natural returns, return-per-spawner levels have been

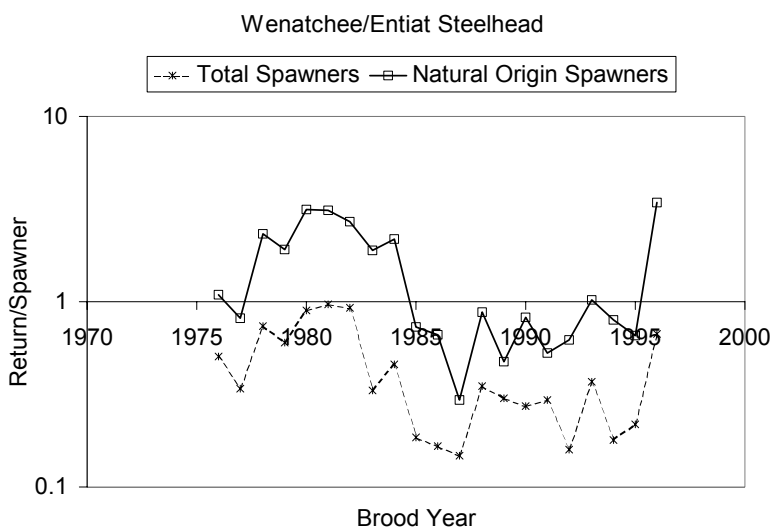

Figure B.2.2.3. Wenatchee/Entiat Steelhead—Return per spawner vs Brood year spawning escapement.

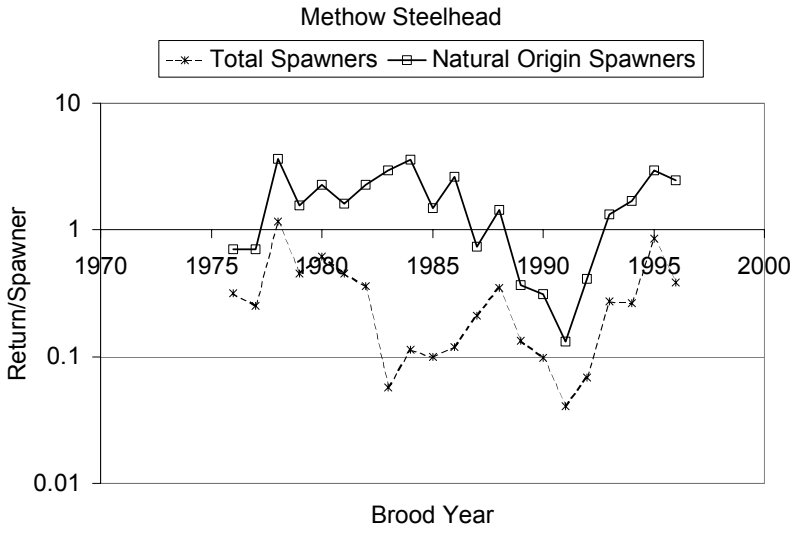

Figure B.2.2.4. Methow Steelhead—Return per spawner vs Brood year spawning escapement.

consistently below 1.0 since 1976. Under this scenario natural production would be expected to decline rapidly in the absence of hatchery spawners. Under the assumption that hatchery fish returning to the upper Columbia do not contribute to natural production, return-per-spawner levels were above one until the late 1980s. Return-per-spawner estimates subsequently dropped below replacement (1.0) and remained low until the most recent brood year with measured returns—1996.

The actual contribution of hatchery returns to natural spawning remains a key uncertainty for upper Columbia steelhead. This information need is in addition to any considerations for long-term genetic impacts of high hatchery contributions to natural spawning.

B.2.2.3. New Hatchery/ESU Information

Hatchery considerations

Hatchery smolt production averaged approximately 300,000 smolts per year in the 1960s, 425,000 in the 1970s, 790,000 in the 1980s, and more than 800,000 in the 1990s (including releases exceeding 1.0 million). Current mitigation/supplementation targets are to use locally obtained returning adults for programs. The objective for the Wenatchee is to release 400,000 smolts per year using broodstock collected from run-of-the-river fish in the Wenatchee (main collection point is Dryden Dam). Broodstock collected at Wells Dam are used for outplanting in the Methow (380,000 target release), and the Okanogan (100,000 target release). The Entiat basin has been designated as a natural production 'reference' drainage—no hatchery outplanting. As of the present, there are no monitoring programs in place to directly estimate natural production of steelhead in the Entiat. Categorizations of Upper Columbia River steelhead hatchery stocks (SSHAG 2003) can be found in Appendix B.5.2.

Resident fish considerations

Resident *O. mykiss* are relatively abundant in upper Columbia tributaries currently accessible to steelhead as well as in upriver tributaries blocked off to anadromous access by Chief Joseph and Grand Coulee dams (Kostow 2003 draft). USFWS biologists surveyed the abundance of trout and steelhead juveniles in the Wenatchee, Entiat, and Methow River drainages in the mid 1980s. (Mullan 1992). Adult trout (defined as trout > 20 cm) were found in surveys in all basins. Juvenile *O. mykiss* were reported from 94% of the surveys conducted in areas believed to be used by steelhead and resident trout (Kostow 2003 draft). The results also supported the hypothesis that resident *O. mykiss* are more abundant in tributary/mainstem areas above the general areas used by steelhead for rearing.

Kostow (2003 draft) reports that biologists who are familiar with the areas above Chief Joseph Dam believe that *O. mykiss* are present in significant numbers. Several of the tributaries above Chief Joseph Dam have been blocked off by dams and introductions of exotic gamefish and trout species have been widespread. *O. mykiss,* believed to be native populations, are present in a number of tributaries draining into Lake Roosevelt (Kostow 2003 draft). Mullan (1992) hypothesized that the native trout populations above Chief Joseph Dam effectively preserved native steelhead lineages present before the construction of the mainstem impassable dams.

B.2.3 MIDDLE COLUMBIA STEELHEAD

The Middle Columbia River Steelhead ESU includes steelhead populations in Oregon and Washington drainages upstream of the Hood and Wind river systems to and including the Yakima River. The Snake River is not included in this ESU. Major drainages in this ESU are the Deschutes, John Day, Umatilla, Walla-Walla, Yakima, and Klickitat river systems. Almost all steelhead populations within this ESU are summer-run fish, the exceptions being winter-run components returning to the Klickitat, and Fifteen Mile Creek watersheds. Most of the populations within this ESU are characterized by a balance between 1- and 2-year-old smolt outmigrants. Adults return after 1 or 2 years at sea.

Hatchery facilities are located in a number of drainages within the geographic area of this ESU, although there are also subbasins with little or no direct hatchery influence. The John Day River system is a large river basin supporting an estimated five steelhead populations. The basin has not been outplanted with hatchery steelhead and out-of-basin straying is believed to be low. The Yakima River system includes four to five populations. Hatchery production in the basin was relatively limited historically and has been phased out since the early 1990s. The Umatilla, the Walla-Walla, and the Deschutes river systems each have ongoing hatchery production programs based on locally derived broodstocks. Straying from out-of-basin production programs into the Deschutes River has been identified as a chronic occurrence.

Blockages have prevented access to sizable steelhead production areas in the Deschutes River and the White Salmon River. In the Deschutes River, Pelton Dam blocks access to upstream habitat historically used by steelhead. Conduit Dam, constructed in 1913, blocked access to all but 2-3 miles of habitat suitable for steelhead production in the Big White Salmon River (Rawding 2001). Substantial populations of resident trout exist in both areas.

B.2.3.1 Previous BRT Conclusions

The 1998 and 1999 BRT reviews (BRT 1998; BRT 1999) identified several concerns including relatively low spawning levels in those streams for which information was available, a preponderance of negative trends (10 out of 14), and the widespread presence of hatchery fish throughout the ESU.

The 1999 BRT review specifically identified "...the serious declines in abundance in the John Day River Basin…" as a point of concern given that the John Day system had supported large populations of naturally spawning steelhead in the recent past. Concerns were also expressed about the low abundance of returns to the Yakima River system relative to historical levels "...with the majority of production coming from a single stream (Satus Creek)." The sharp decline in the returns to the Deschutes River system was also identified as a concern.

The 1999 BRT review also identified increases of stray steelhead into the Deschutes River as a "major source of concern." The review acknowledged that initial results from

radio tagging studies indicated that a substantial proportion of steelhead entering the Deschutes migrated out of the system prior to spawning.

The previous BRT review identified a set of habitat problems affecting basins within this ESU. High summer and low winter temperatures are characteristic of production or migration reaches associated with populations within this ESU. Water withdrawals have seriously reduced flow levels in several Mid-Columbia drainages, including sections of the Yakima, Walla-Walla, Umatilla, and Deschutes rivers. Riparian vegetation and instream structure has been degraded in many areas—the previous BRT report states that "(O)f the stream segments inventoried within this ESU, riparian restoration is needed for between 37% and 84% of the river bank in various basins."

B.2.3.2 New Data and Analyses

Abundance

With some exceptions, the recent 5-year average (geometric mean) abundance for natural steelhead within this ESU was higher than levels reported in the last status review (BRT 1999). Information on recent returns in comparison to return levels reported in previous status reviews is summarized in Table B.2.3.1 and depicted in Figures B.2.3.1-B.2.3.10. Returns to the Yakima River, the Deschutes River, and to sections of the John Day River system were up substantially in comparison to 1992-1997. Yakima River returns are still substantially below interim target levels and estimated historical return levels, with the majority of spawning occurring in one tributary, Satus Creek (Berg 2001). The recent 5-year geometric mean return of the natural-origin component of the Deschutes River run has exceeded interim target levels. Recent 5-year geometric mean annual returns to the John Day basin are generally below the corresponding mean returns reported in the previous status reviews. However, each of the major production areas in the John Day system has shown upward trends since the 1999 return year.

Recent year (1999-2001) redds-per-mile estimates of winter steelhead escapement in Fifteen Mile Creek were also up substantially relative to the annual levels in the early 1990s.

Returns to the Touchet River are lower that the previous 5-year average. Trend or count information for the Klickitat River winter steelhead run are not available but current return levels are believed to be below interim target level.

Productivity

Short-term trends in major production areas were positive for seven of the 12 areas (Table B.2.3.1). The median annual rate of change in abundance since 1990 was +2.5%, individual trend estimates ranged from -7.9% to +11%. The same basic pattern was reflected in λ estimates for the production areas. The median short-term (1990-2001) annual population growth rate estimate was 1.045, assuming that hatchery fish on the

Table B.2.3.1. Summary of recent 5-year average (geometric mean) population abundance and trend estimates in comparison to estimates included in previous BRT review (BRT 1999).

Population(s)	Pct Natural Origin	1997-2001 Geometric Mean Previous Status Review estimate in ()				
		Total	Natural	Trend (%/yr)	Interim Target	Current vs. Target
Klickitat R.	**(?)**	**250+**		(-9.2)	**3,600 sum+win**	**below target**
Yakima R.	**94** (95)		**901** (800)	**+2.9** (+14.0)	**8,900**	**10%**
Fifteen Mile Cr.	**100?** (100?)			**+7.8** (-5.4)	**900**	
Deschutes R.	**38** (50)		**5,566** (3,000)	**+8.9** (+2.6)	**5,400**	**103%**
John Day Upper Mainstem	**99** (100)		**2,256**	**-2.0** (-15.2)	**2,000**	**113%**
John Day Lower Mainstem	No releases			**+1.5** (-15.9)	**3,200**	
John Day Upper North Fork	No releases			**+9.6** (-11.8)	**2,700**	
John Day Lower North Fork	No releases			**+11.0** (-1.2)		
John Day Middle Fork	No releases			**-6.7** (-13.7)	**2,700**	
John Day South Fork	No releases			**-0.8** (-7.4)	**600**	
Umatilla R.	**67** (76)	**2,485** (1,700)	**1,658** (1,096)	**+7.6** (+0.7)	**2,300**	**72%**
Touchet R.	**91** (93)		**290** (300)	**-1.7** (-2.7)	**900** (entire Walla-Walla)	**32%**

spawning grounds did not contribute to natural production, with eight of the 12 indicator trends having a positive growth rate. Assuming that potential hatchery spawners contributed at the same rate as natural-origin spawners resulted in lower estimates of population growth rates. The median short-term $\lambda\epsilon$ under the assumption of equal hatchery/natural origin spawner effectiveness was .967, with six of the 12 indicators exhibiting positive growth rates.

Long-term trend estimates were also calculated using the entire length of the data series available for each production area (Table B.2.3.1). The median estimate of long-term trend over the 12 indicator data sets was -2.1% per year (-6.9 to +2.9), with 11 of the 12 being negative. Long-term annual population growth rates (λ) were also negative (Table B.2.3.1). The median long-term λ was .98 under the assumption that hatchery spawners do not contribute to production, and .97 under the assumption that both hatchery and natural origin spawners contribute equally.

All of the production area trends available for this ESU indicate relatively low escapement levels in the 1990s. For some of the data sets, earlier annual escapements were relatively high compared to the stream miles available for spawning and rearing. In those cases, it is reasonable to assume that subsequent production may have been influenced by density-dependent effects. In addition, there is evidence of large fluctuations in marine survival for Columbia River and Oregon coastal steelhead stocks (Cooney 2000, Chilcote 2001). Spawner return data sets for Mid-Columbia production areas are of relatively short duration. As a result of these considerations, projections based on simple population growth rate trends or on stock recruit relationships derived by fitting recent year spawner return data should be interpreted with caution.

B.2.3.5. New Hatchery/ESU Information

Relatively high numbers of hatchery-origin steelhead returning from releases outside of the Deschutes River system continue to enter the Deschutes system. The actual number of out-of-basin-origin hatchery fish that spawn naturally in the Deschutes is not known. Preliminary results from recent radio tracking studies cited in Cramer et al. (2002) backs up the hypothesis that a significant proportion of hatchery strays entering the Deschutes River are ‘dip-ins,’ fish that migrate out of the system prior to spawning. The estimated escapements to the spawning grounds used in the status review updates already include an adjustment to reflect out-migrating stray hatchery fish. The estimates of spawning escapement into the Deschutes River system depicted in Figure B.2.3.2 assumed that 50% of the estimated number of outside hatchery fish passing over Sherars Falls dropped back down and did not contribute to spawning in the Deschutes River system (Chilcote 2002 spreadsheet analysis). Cramer et al. (2002) identified two other sets of information regarding the potential contribution of hatchery stocks to natural spawning in the Deschutes River. ODFW spawner surveys in Buckhollow, Bakeoven, and Trout creeks indicate a relatively high proportion of wild fish in those major spawning tributaries in recent years, in comparison to the estimated fraction of wild over Sherars Falls (below major mainstem spawning areas). In addition, estimated natural-origin returns to the mainstem/lower tributary roughly track the returns to the Warm Springs River in time, in spite of large differences in estimated hatchery contributions in

some years. Additional information is needed to clarify the potential impact of outside hatchery origin fish to natural production in the system.

Resident *O. Mykiss* Considerations

The following description of the distribution of resident *O. mykiss* associated with the Mid-Columbia ESU is quoted directly from Kostow (2003).

"Coastal cutthroat trout are present in the Little White and White Salmon rivers, in Fifteenmile Creek, and in some smaller tributaries in this area. A unique pocket of native westslope cutthroat trout (O.C. lewisi) is present in the upper John Day basin... O. mykiss trout are present throughout the rest of the ESU. They are sympatric with current steelhead distributions, they occupy all areas of historic steelhead range above dams and other artificial barriers, and they are present above all natural barriers in basins from the Deschutes and Klickitat upstream. Their distribution typically extends beyond the steelhead distribution into small headwater tributaries even when physical barriers other than stream size are absent.

"Natural barriers are less common in this ESU...The most important ones occur in the Deschutes Basin. White River Falls blocks the entire White River, one of the major tributaries of the lower Deschutes. The O. mykiss trout above this falls are highly distinctive (Currens et al. 1990). A second important falls, Big Falls, occurs on the mainstem Deschutes not far upstream from the reservoir behind Round Butte Dam. This falls blocked all anadromous fish access to the upper Deschutes Basin. A third falls blocked most of the North Fork Crooked River basin. Natural falls also block the upper South Fork of the John Day River, and some areas in Fifteenmile Creek and in the two White Salmon basins. Several low waterfalls on the mainstem Deschutes, Klickitat and Umatilla (the latter is now under Threemile Dam) were passable by steelhead. Otherwise, there are no other major physical blockages to steelhead in this ESU, although they probably did not penetrate upper most headwater areas.

"The major artificial barrier in this ESU is the Pelton/Round Butte dam complex on the Deschutes. These dams blocked access to major steelhead production areas in the upper basin, including the Crooked River, Metolius River and Squaw Creek. Conduit Dam, just a few miles above the mouth of the White Salmon River, blocked access to that basin. Irrigation dams in the Umatilla block access to several tributaries. Otherwise, the numerous water diversion structures in this ESU are currently passable to steelhead, although some of them may cause passage problems.

"The Deschutes River is unique among large, inland Columbia Basin tributaries in that its lower mainstem is relatively in tact, with year-round strong flows and cold temperatures. Its natural water storage system is underground aquifers that feed the mainstem through numerous springs. In comparison, the John Day River historically relied on extensive beaver meadows for water storage, and these were largely lost in the late 1800s extensively changing the hydrology of the lower mainstem. The Umatilla, Walla Walla and Yakima mainstems are severely modified by irrigation diversions. The

Deschutes is therefore also unique in that it still has a hugely productive resident, or perhaps combined resident and fluvial, O. mykiss trout population in its lower mainstem. These trout are among the largest, the oldest and the most fecund O. mykiss trout in the Columbia Basin. Possibly the other major rivers in the Mid-Columbia ESU had similar mainstem trout populations historically, but they are gone now because summer and fall water quality is inhospitable.

"The trout in the Deschutes are also well distributed in other areas in the basin, in addition to the mainstem. Below Pelton/Round Butte dams, they also occur throughout Warm Springs River, Shitike Creek and Trout Creek, and in several smaller tributaries. Trout also remain well distributed in the historic steelhead area above Pelton/Round Butte dams. The largest tributary of the Deschutes, the Crooked River, is above the dams and was probably the major steelhead production area historically.... many of the headwater areas still have good desert trout habitats, although the best remaining habitats are above the historic range of steelhead, above the falls on the North Fork."

Resident *O. mykiss* production varies widely among the tributaries of the relatively large Yakima River system. Access by returning anadromous migrants to Upper Yakima River drainage was effectively cut off for 18 years by Roza Dam. That area is believed to have been the most productive historical habitat for steelhead. Resident *O. mykiss* currently dominate production above Rosa Dam. Two lower Yakima tributaries, Satus Creek and Toppenish Creek, support most of the current steelhead production from the basin. The absence of 2+ smolts in these tributaries indicates little or no resident production. Steelhead and resident trout are present in the Naches subbasin.

The John Day system may have historically supported large populations of resident trout; resident trout redds have been observed during steelhead redd surveys in this system (Kostow 2003). Some proportion of the age 0/age 1 fish counted during juvenile transects may be resident trout, although these redds are not systematically counted.

The mainstem Umatilla River has been heavily impacted by water withdrawals and other agricultural activities. However headwater reaches are generally intact and have the capacity to support fairly large anadromous and resident *O. mykiss* juvenile production. Abundance estimates of juvenile *O. mykiss* from the upper Umatilla mainstem and tributaries show a high percentage of age 0 and 1 juveniles, while those 2+ and older make up a relatively small proportion of the juvenile sampled. Kostow (2003) concludes that resident adults may still outnumber returning steelhead in the basin.

"Trout are reported to be present throughout the Klickitat including in the mainstem (Sharp 2001). However, the mainstem Walla Walla is heavily impacted by irrigation development and is only used as a migration corridor by O. mykiss. Trout and steelhead production occurs in the upper Touchet and in the upper North and South forks of the Walla Walla (James 2001). The upper forks drain from Blue Mountain wilderness areas where habitat is in good condition (from Kostow, 2003 draft)."

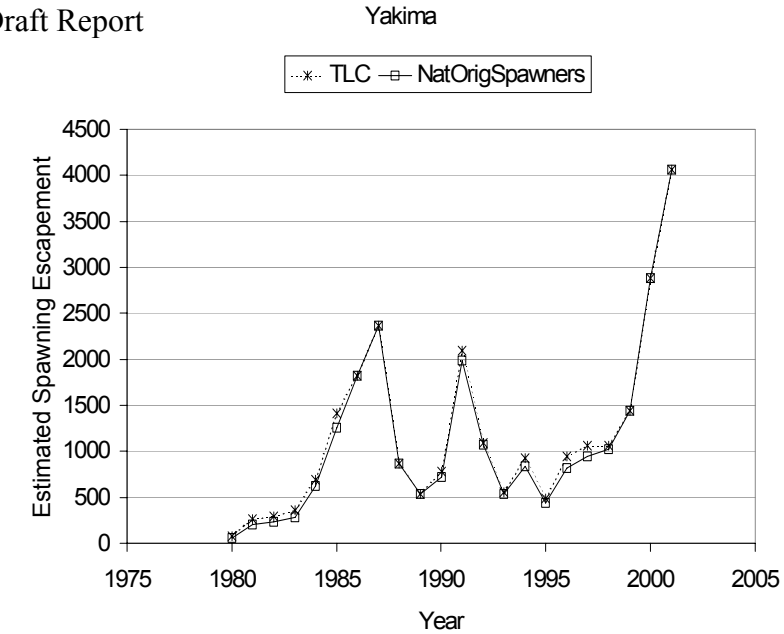

Figure B.2.3.1. Yakima steelhead spawning escapment estimates. From WDFW database. Based on Prosser Dam count.

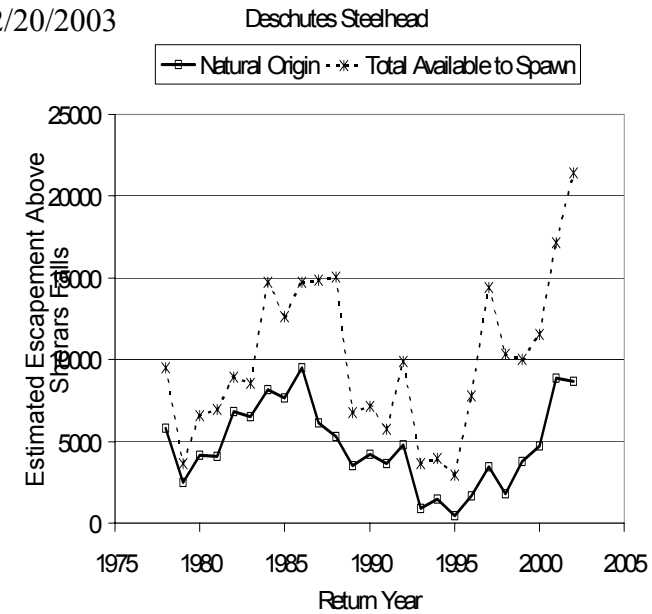

Figure B.2.3.2. Deschutes River Steelhead: Escapement over Sherars Falls. Run size estimates based on ODFW mark/recapture analysis. Hatchery/Wild ratios based on returns to Pelton Ladder and Warm Springs NFH (see Chilcote 2001,2002).

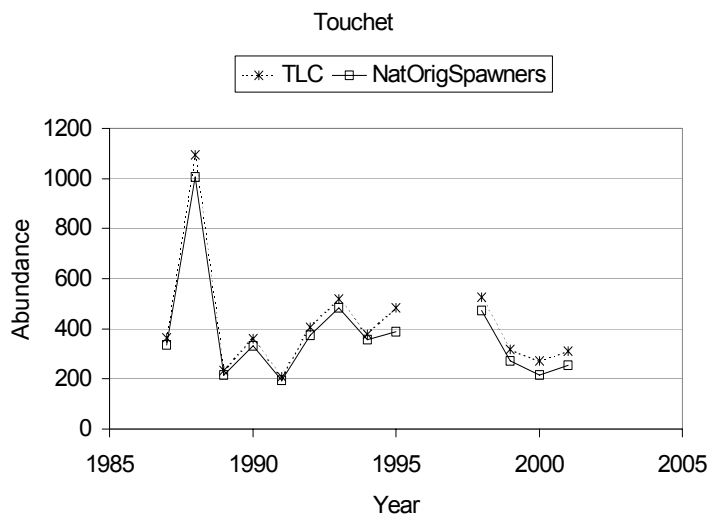

Figure B.2.3.3. Touchet River Steelhead escapement estimates. Counts at Dayton Acclimation dam trap (James & Scheeler 2001).

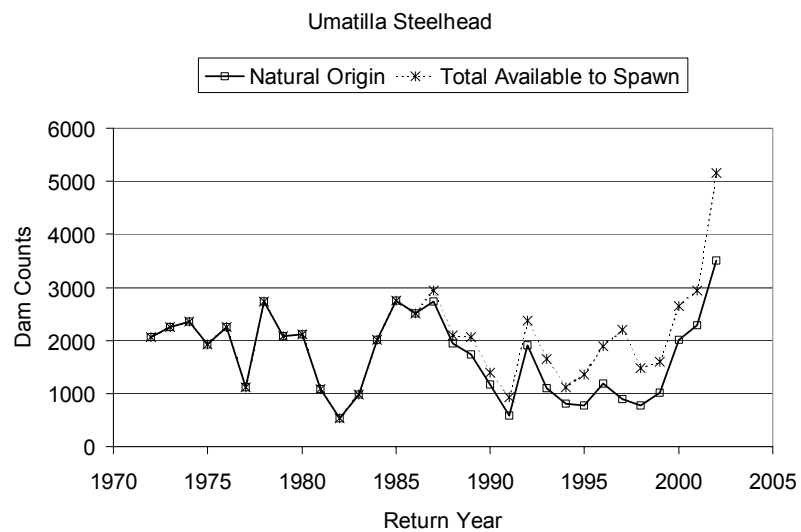

Figure B.2.3.4. Umatilla River Steelhead. Three Mile Dam counts (Chilcote 2001).

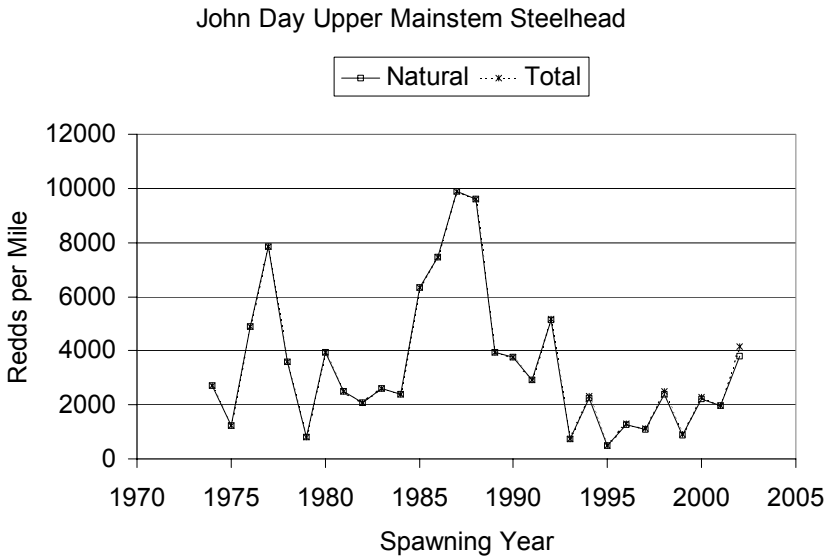

Figure B.2.3.5. Upper John Day Steelhead. Expanded from annual redd counts (Chilcote 2002).

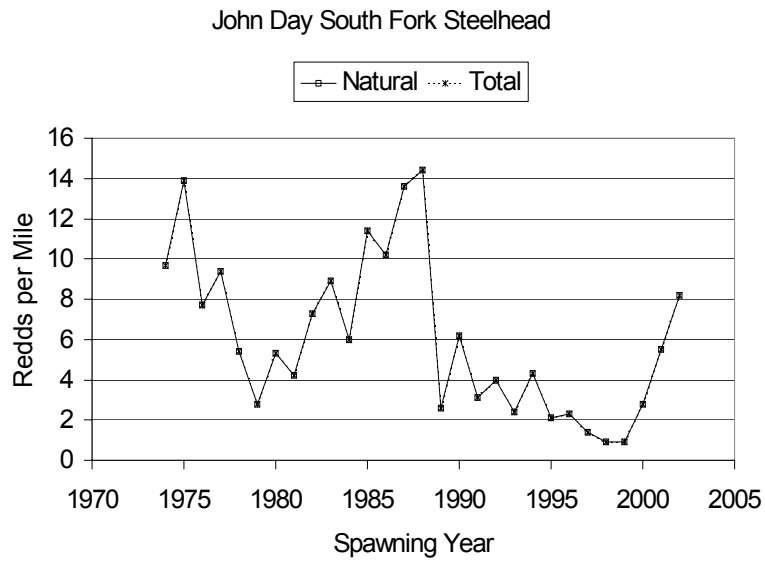

Figure B.2.3.6. South Fork John Day Steelhead. Redds per mile from index areas (Chilcote 2001).

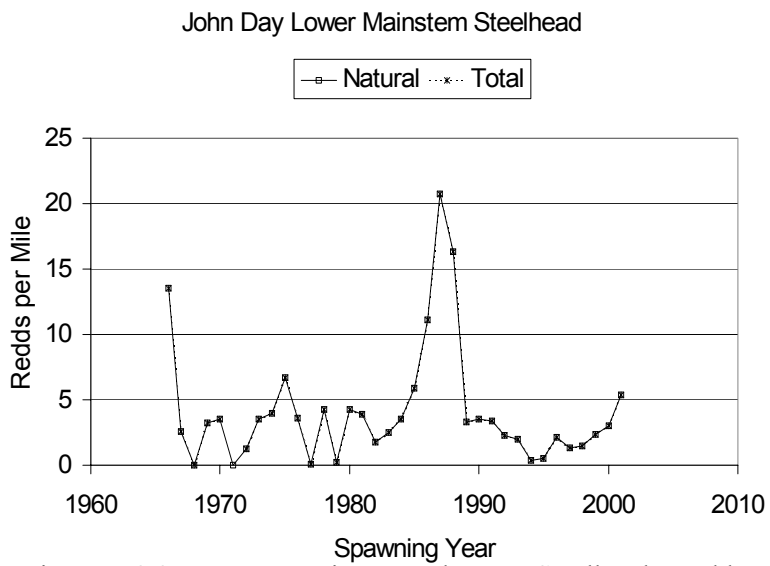

Figure B.2.3.7. Lower Mainstem John Day Steelhead. Redds per mile from index areas (Chilcote 2001).

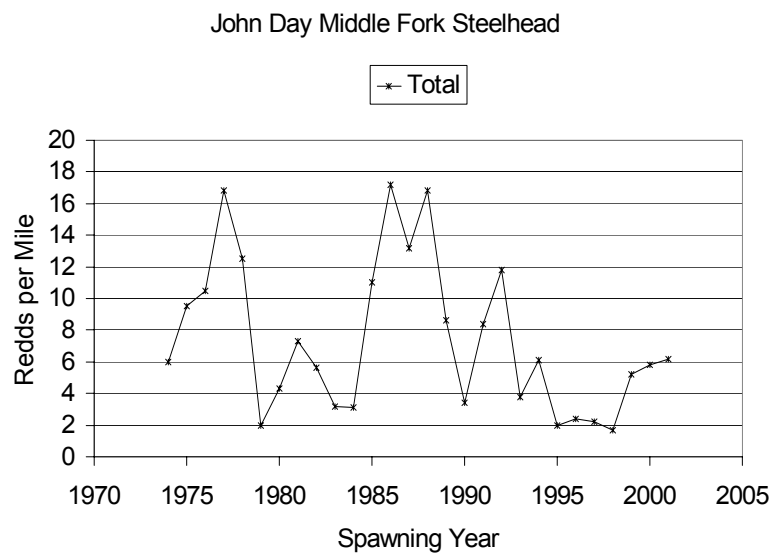

Figure B.2.3.8. Middle Fork John Day Steelhead. Redds per mile from index areas (Chilcote 2001).

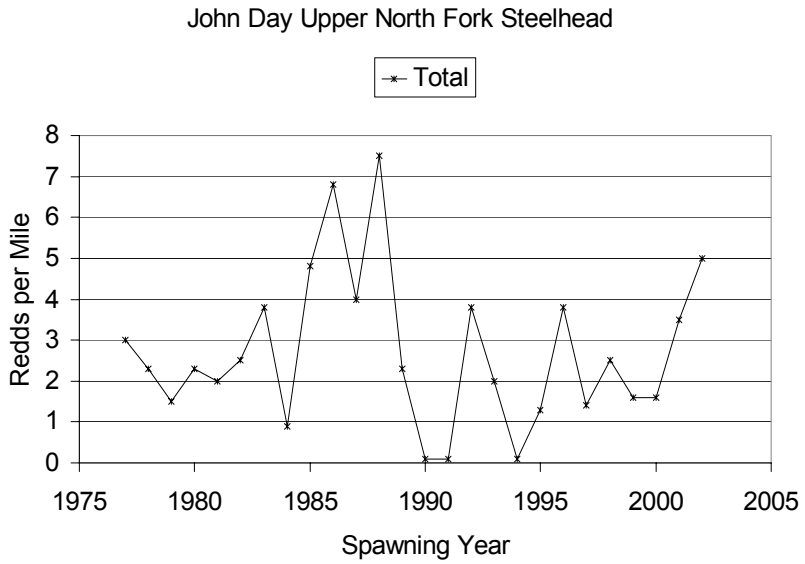

Figure B.2.3.9. Upper North Fork John Day Steelhead. Redds per mile from index areas (Chilcote 2001).

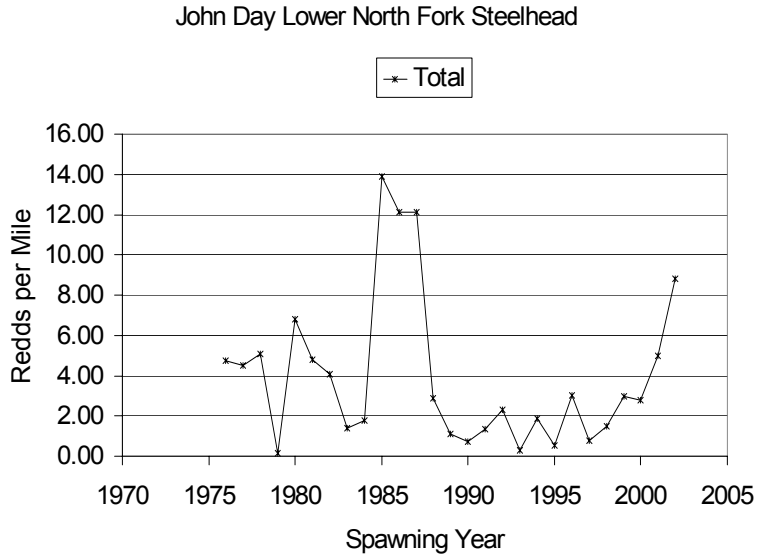

Figure B.2.3.10. Lower North Fork John Day Steelhead. Redds per mile from index areas (Chilcote 2001).

B.2.4. LOWER COLUMBIA STEELHEAD

B.2.4.1. Previous BRT Conclusions

Steelhead status review update 1998

- Populations at low abundance relative to historical levels.
- Near universal, and often drastic, declines had been observed since mid-1980s.
- Widespread occurrence of hatchery fish in naturally spawning steelhead populations.
- Previous BRT was unable to identify any natural populations of steelhead in this ESU that would be considered at low risk.
- Analyses suggest that introduced summer steelhead may negatively affect winter native winter steelhead in some populations.
- Majority of previous BRT concluded that steelhead in the lower Columbia ESU were at risk of becoming endangered in the foreseeable future.

Current Listing Status: threatened

B.2.4.2. New Data

New Data include:

- Spawner abundance through 2001 or 2002.
- New estimates of the fraction of hatchery spawners and harvest estimates.
- EDT based estimates of historical abundance.
- Information on recent hatchery releases.
- Newly compiled information on resident *O. mykiss.*

B.2.4.3. New Updated Analyses

New analyses include:

- Designation of relatively demographically independent populations.
- Recalculation of previous BRT metrics with additional years' data.
- Estimates of median annual growth rate (λ) under different assumptions about the reproductive success of hatchery fish.
- Estimates of current and historically available kilometers of stream.

Results of new analyses

Historical population structure—As part of its effort to develop viability criteria for LCR steelhead, The Willamette/Lower Columbia Technical Recovery Team (WLC-TRT) has identified historically demographically independent populations (Myers et al. 2002). Population boundaries are based on an application of Viable Salmonid Populations definition (McElhany et al. 2000). Myers et al. hypothesized that the ESU historically consisted of 17 winter-run populations and six summer-run populations for a total of 23 populations (Figures B.2.4.1 and

B.2.4.2). The populations identified in Myers et al. are used as the units for the new analyses in this report.

The WLC-TRT partitioned LCR steelhead populations into a number of "strata" based on major life-history characteristics and ecological zones (McElhany et al. 2002). Analysis suggests that a viable ESU would need a number of viable populations in each of these strata. The strata and associated populations are identified in Table B.2.4.1.

Abundance and trends

References for abundance time series and related data are in the Appendix _. Recent abundance of natural origin spawners, recent fraction of hatchery-origin spawners, and recent harvest rates for LCR steelhead populations are summarized in Table B.2.4.1. Natural-origin fish had parents that spawned in the wild as opposed to hatchery-origin fish whose parents were spawned in a hatchery. The abundances of natural-origin spawners range from completely extirpated for some populations above impassable barriers to over 700 for the Kalama and Sandy winter-run populations. A number of the populations have a substantial fraction of hatchery-origin spawners in the spawning areas and are hypothesized to be sustained largely by hatchery production. Exceptions are the Kalama, the Toutle, and East Fork Lewis winter-run populations, which have few hatchery fish spawning on the natural spawning areas. These populations have relatively low recent mean abundance estimates, with the largest being the Kalama (geometric mean of 728 spawners).

Where data are available, the abundance time series information for each of the populations is presented in Figures B.2.4.3.-B.2.4.20. Two types of time series figures are presented. The first type of figure plots abundance against time (Figures B.2.4.3, B.2.4.5, B.2.4.7, B.2.4.9, B.2.4.11, B.2.4.13, B.2.4.14, B.2.4.15, B.2.4.16, B.2.4.17, B.2.4.19). Where possible, two lines are presented on the abundance figure, where one line is the total number of spawners (or total count at a dam) and the other line is the number of fish of natural origin. In some cases, data were not available to distinguish between natural and hatchery origin spawners, so only total spawner (or dam count) information is presented. This type of figure can give a sense of the levels of abundance, overall trend, patterns of variability, and the fraction of hatchery origin spawners.

The second type of time-series figure presents the total number of spawners (natural and hatchery origin) and the number of preharvest recruits produced by those spawners against time (Figures B.2.4.4, B.2.4. 6, B.2.4.8, B.2.4.10, B.2.4.12, B.2.4.18, B.2.4.20). Dividing the number of preharvest recruits by the number of spawners for the same time period would yield an estimate of the preharvest recruits per spawner. This type of figure requires harvest and age structure information, and therefore, could be produced for only a limited number of populations. This type of figure can indicate if there have been changes in preharvest recruitment and the degree to which harvest management has the potential to recover populations. If the preharvest recruitment line is consistently below the spawner line, it indicates that the population would not be replacing itself, even in the absence of all harvest.

Table B.2.4.1. The life history divisions are based on run timing and other correlated characters. The ecological zone is based on ecological community and hydro dynamic patterns. The recent abundance is the geometric mean of natural origin spawners of the last 5 years of available data and the min-max are the lowest and highest 5-year geometric means in the time series. The data years are the data years used for the abundance min-max estimates, the extinction risk estimate and the trends (Figure B.2.4.3). Longer time series may be available for spawners only (see figures), but hatchery fraction information was required to estimate means, extinction risk and trends. The fraction hatchery is the average percent of spawners of hatchery origin over the last 4 years. The harvest rate is the percent of adults harvested. The EDT estimate of historical abundance is based on analysis by WDFW of equilibrium abundance under historical habitat conditions. The quasi-extinction metric is the probability of declining from the current abundance to a 4-year average of 50 spawners/year within 100 years based on stochastic projection.

Life History	Ecological Zone	Population	Recent Abundance	Data Years	Hatchery Fraction (%)	Harvest Rate (%)	EDT Estimate of Historical Abundance	Extinction Risk (%)
Winter Run	Cascade	Cispus River Winter Run	Extirpated					
		Coweeman River Winter Run	233 (215-667)	1987-2002	50	2	2,243	
		Lower Cowlitz River Winter Run					1,672	
		Upper Cowlitz River Winter Run	Extirpated					
		Tilton River Winter Run	Extirpated					
		South Fork Toutle River Winter	498 (424-1707)	1984-2002	2	2	2,627	82
		North Fork Toutle River Winter	196 (82-196)	1989-2002	0	1	3,770	31
		Kalama River Winter Run	726 (556-1036)	1977-2002	0	7	554	95
		North Fork Lewis Winter Run					713	
		East Fork Lewis Winter Run	75 (75-182)	1985-1994	0		3,131	100
		Salmon Creek Winter Run						
		Washougal River Winter Run	144	1991-1995	0		2,497	
		Clackamas River Winter Run	410 (227-1291)	1958-2002	9	54		83

		Sandy River Winter Run	735 (299-1826)	1978-2001	40			99
	Gorge	Lower Gorge Tributaries Winter					793	
		Upper Gorge Tributaties Winter					243	
		Hood River Winter Run	349 (258-368)	1992-2000	52			84
Summer Run	Cascade	Kalama River Summer Run	286 (286-1188)	1977-2001	35	5	3,165	99
		North Fork Lewis Summer Run						
		East Fork Lewis Summer Run					422	
		Washougal River Summer Run	<50	1986-1997			1,419	
	Gorge	Wind River Summer Run	246 (246-602)	1989-2001	21	12	2,288	97
		Hood River Summer Run	152 (138-230)	1992-2000	82			99
		Total	4,050				25,537	
		Average			24	12		87

Summary statistics on population trends and growth rate are presented in Tables B.2.4.2-B.2.4.3 and in Figures B.2.4.21- B.2.4.23. The methods for estimating trends and growth rate (λ) are described in the general methods section. The majority of populations have a long-term trend less than one, indicating the population is in decline. In addition, there is a high probability for most populations that the true trend/growth rate is less than one (Table B.2.4.3). When growth rate is estimated, assuming that hatchery origin spawners have a reproductive success equal to that of natural origin spawners, all of the populations have a negative growth rate except the North Fork Toutle winter run, which had very few hatchery origin spawners (Figure B.2.4.23). The North Fork Toutle population is recovering from the eruption of Mt. St. Helens in 1980 and is still at low abundance (recent mean of 196 spawners). The potential reasons for these declines have been cataloged in previous status reviews and include habitat degradation, deleterious hatchery practices, and climate-driven changes in marine survival.

EDT-based estimates of historical abundance—The Washington Department of Fish and Wildlife (WDFW) has conducted analyses of the LCR chinook populations using the Ecosystem Diagnosis and Treatment (EDT) model (results in McElhany et al. 2002). The EDT model attempts to predict fish population performance based on input information about reach-specific habitat attributes (http://www.olympus.net/community/dungenesswc/EDT-primer.pdf). WDFW populated this model with estimates of historical habitat condition, which produced the estimates of average historical abundance shown in Table B.2.4.1. There is a great deal of unquantified uncertainty in the EDT historical abundance estimates, which should be taken into consideration when interpreting these data. In addition, the habitat scenarios evaluated as "historical" may not reflect historical distributions, since some areas that were historically accessible but currently blocked by large dams are omitted from the analyses and some areas that were historically inaccessible but recently passable because of human intervention are included. The EDT outputs are provided here to give a sense of the historical abundance of populations relative to each other and an estimate of the historical abundance relative to the current abundance.

Loss of habitat from barriers—An analysis was conducted by Steel and Sheer (2002) to assess the number of stream km historically and currently available to salmon populations in the LCR (Table B.2.4.4). Stream km usable by salmon are determined based on simple gradient cut offs and on the presence of impassable barriers. This approach will over estimate the number of usable stream km as it does not take into consideration habitat quality (other than gradient). However, the analysis does indicate that for some populations, the number of stream habitat km currently accessible is greatly reduced from the historical condition.

Table B.2.4.2. Trend and growth rate for subset of Lower Columbia steelhead populations. 95% confidence intervals are in parentheses. The long-term analysis used the entire data set (see table 2 for years). The criteria for the short-term data set is defined in the methods section. In the "Hatchery = 0" columns, the hatchery fish are assumed to have zero reproductive success. In the "Hatchery = Wild" columns, hatchery fish are assumed to have the same relative reproductive success as natural origin fish.

Population	Long-Term Analysis			Short-Term Analysis		
	Trend (C.I.)	Lamda (C.I.)		Trend (C.I.)	Lambda (C.I.)	
		Hatchery = 0	Hatchery = Wild		Hatchery = 0	Hatchery = Wild
Coweeman River Winter Run	**0.913** (0.873-0.954)	**0.908** (0.826-0.999)		**0.932** (0.873-0.995)		
South Fork Toutle River Winter Run	**0.925** (0.892-0.96)	**0.938** (0.862-1.021)	**0.933** (0.832-1.044)	**0.94** (0.879-1.006)	**0.934** (0.858-1.016)	**0.929** (0.829-1.041)
North Fork Toutle River Winter Run	**1.135** (1.038-1.242)	**1.062** (0.957-1.178)	**1.062** (0.914-1.208)	**1.086** (0.999-1.18)	**1.038** (0.936-1.152)	**1.038** (0.903-1.193)
Kalama River Winter Run	**0.998** (0.973-1.023)	**1.01** (0.942-1.083)	**0.916** (0.835-1.008)	**1.004** (0.923-1.091)	**0.984** (0.917-1.055)	**0.922** (0.839-1.013)
East Fork Lewis Winter Run	**0.843** (0.795-0.894)	**0.841** (0.736-0.962)	**0.841** (0.714-1.023)			
Clackamas River Winter Run	**1.005** (0.989-1.021)	**1.012** (0.961-1.065)	**0.883** (0.827-0.949)	**0.944** (0.826-1.079)	**0.965** (0.917-1.016)	**0.897** (0.837-0.96)
Sandy River Winter Run	**0.951** (0.923-0.979)	**0.945** (0.878-1.017)	**0.834** (0.733-0.914)			
Kalama River Summer Run	**0.971** (0.934-1.009)	**0.954** (0.81-1.122)	**0.679** (0.556-0.792)	**0.853** (0.77-0.944)	**0.817** (0.694-0.962)	**0.626** (0.524-0.747)
Wind River Summer Run	**0.898** (0.85-0.95)	**0.892** (0.695-1.144)	**0.82** (0.629-1.079)	**0.913** (0.859-0.972)	**0.901** (0.702-1.156)	**0.828** (0.632-1.085)

Table B.2.4.3. Probability the trend or growth rate is less than one. In the "Hatchery = 0" columns, the hatchery fish are assumed to have zero reproductive success. In the "Hatchery = Wild" columns, hatchery fish are assumed to have the same relative reproductive success as natural origin fish.

Population	Long-Term Analysis			Short-Term Analysis		
	Trend	Lambda		Trend	Lambda	
		Hatchery = O	Hatchery = WIld		Hatchery = 0	Hatchery = Wild
Coweeman River Winter Run	0.999	0.999		0.981		
South Fork Toutle River Winter	1.000	0.917	0.936	0.966	0.843	0.859
North Fork Toutle River Winter	0.005	0.063	0.102	0.026	0.135	0.135
Kalama River Winter Run	0.574	0.405	0.969	0.463	0.593	0.846
East Fork Lewis Winter Run	1.000	0.998	0.996			
Clackamas River Winter Run	0.282	0.376	0.999	0.819	0.601	0.784
Sandy River Winter Run	0.999	0.983	1.000			
Kalama River Summer Run	0.937	0.760	1.000	0.997	0.989	1.000
Wind River Summer Run	0.999	1.000	1.000	0.996	1.000	1.000

Resident *O. mykiss* summary

As discussed elsewhere in this report, our risk evaluation focused on the sustainability of anadromous *O. mykiss*. However, an effort was made to compile existing information on *O. mykiss* so it could considered in the risk evaluation. A distillation of the information in Kostow (2003), as related to the LCR, follows:

- Resident cutthroat trout: Cutthroat trout appear to have historically been the predominant resident trout species in all but a few tributary systems. In the presence of cutthroat trout, the abundance of resident rainbow trout is relatively low.
- Resident rainbow trout: Resident *O. mykiss* are rarely found in the short tributaries near the mouth of the Columbia River. In general, they are found in the headwater regions of major tributaries, especially above impassable barriers. Most notably, resident rainbow trout are found sympatrically with summer steelhead in the Wind River Basin (Shipherd Falls near the mouth of the Wind River historically limited anadromous passage to only summer steelhead).
- Artificial barriers: Resident or residualized rainbow trout are found above dams in the Cowlitz, Lewis, and Sandy River basins. In the Cowlitz River, upper basin rainbow trout are genetically similar to winter-run steelhead below the dam.
- Natural barriers: Resident or residualized rainbow trout are found in the upper watersheds of rivers that support summer-run steelhead (Kalama, Lewis, Washougal, Wind, and Hood rivers).

Table B.2.4.4. Loss of habitat from barriers. The potential current habitat is the kilometers of stream below all currently impassible barriers between a gradient of 0.5% and 4%. The potential historical habitat is the kilometers of stream below historically impassible barriers between a gradient of 0.5% and 4% (summer) and 0.5% and 6% (winter). The current to historical habitat ratio is the percent of the historical habitat that is currently available.

Population	**Potential Current Habitat (%)**	**Potential Historical Habitat (km)**	**Current to Historical Habitat Ratio**
Cispus River Winter Run	0	87	0
Coweeman River Winter Run	85	102	84
Lower Cowlitz River Winter Run	542	674	80
Upper Cowlitz River Winter Run	6	358	2
Tilton River Winter Run	0	120	0
South Fork Toutle River Winter	82	92	89
North Fork Toutle River Winter	209	330	63
Kalama River Winter Run	112	122	92
North Fork Lewis Winter Run	115	525	22
East Fork Lewis Winter Run	239	315	76
Salmon Creek Winter Run	222	252	88
Washougal River Winter Run	122	232	53
Clackamas River Winter Run	919	1,127	82
Sandy River Winter Run	295	386	76
Lower Gorge Tributaries Winter	46	46	99
Upper Gorge Tributaties Winter	31	31	100
Hood River Winter Run	138	138	99
Kalama River Summer Run	49	54	90
North Fork Lewis Summer Run	78	83	94
East Fork Lewis Summer Run	87	364	24
Washougal River Summer Run	181	236	77
Wind River Summer Run	84	164	51
Hood River Summer Run	36	41	90
Total	3,678	5,879	63

B.2.4.3. New ESU Information

Based on the updated information provided in this report, the information contained in previous LCR status reviews, and preliminary analyses by the WLC-TRT, we have tentatively identified the number of historical and currently viable populations (Table B.2.4.5). This summary indicates some of the uncertainty about this ESU. Like the previous BRT, we could not conclusively identify a single population that is naturally self-sustaining. Over the period of the available time series, most of the populations are in decline and are at relatively low abundance (no population has recent mean greater than 750 spawners). In addition, many of the populations continue to have a substantial fraction of hatchery origin spawners and may not be naturally self sustaining.

Table B.2.4.5. Number of populations in the ESU of each life history type. Populations with "some current natural production" have some natural origin recruits present but are not necessarily considered self-sustaining ("viable").

	Life-History Type		
	Winter	**Summer**	**Total**
Historical	17	6	23
Some current natural production	9-14	3-6	12-20
Currently "viable" populations	0-?	0-?	0-?

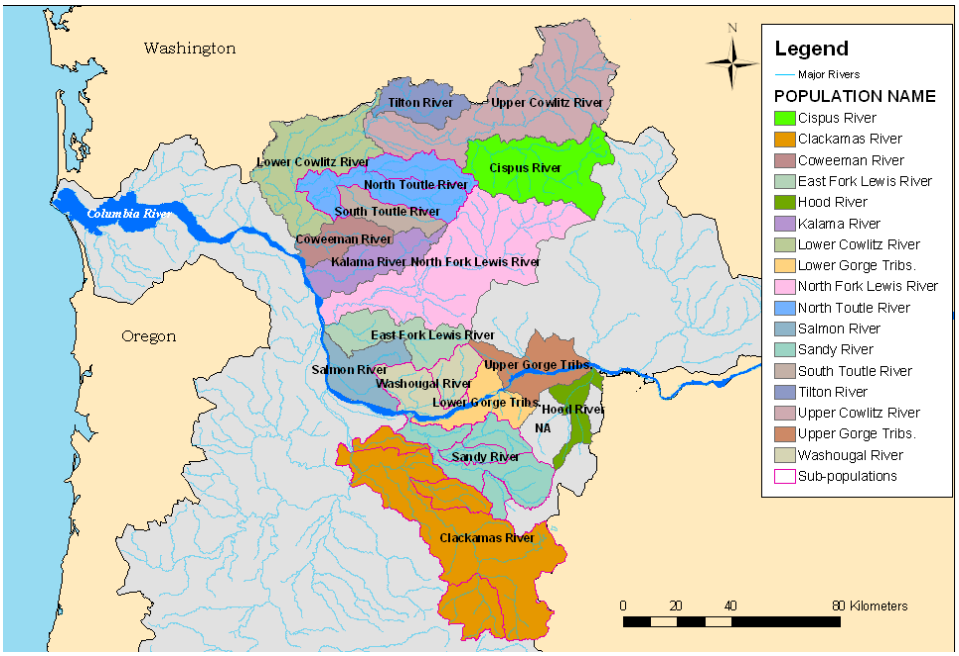

Figure B.2.4.1. Historical population of winter steelhead in the Lower Columbia ESU (Myers et al. 2002)

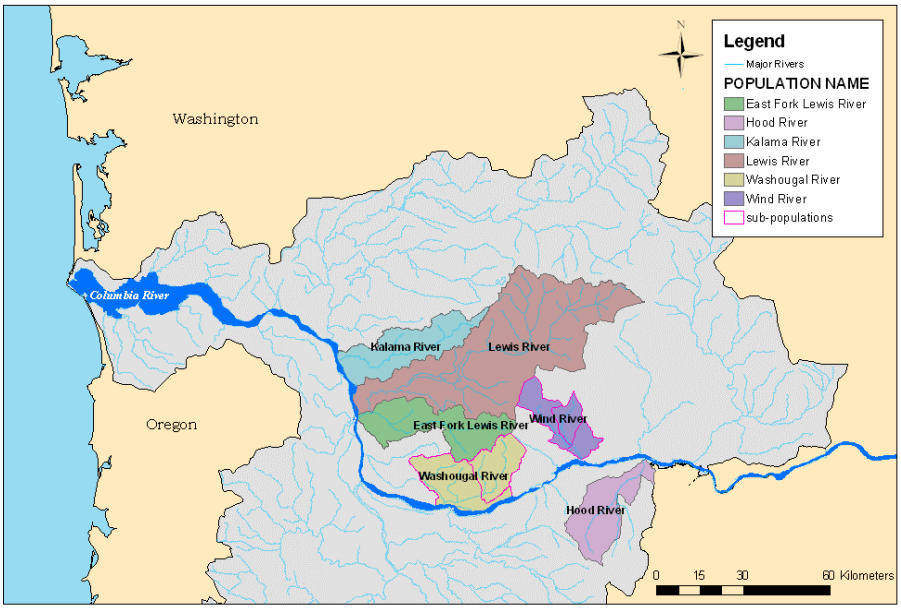

Figure B.2.4.2. Historical population of summer steelhead in the Lower Columbia ESU (Myers et al. 2002)

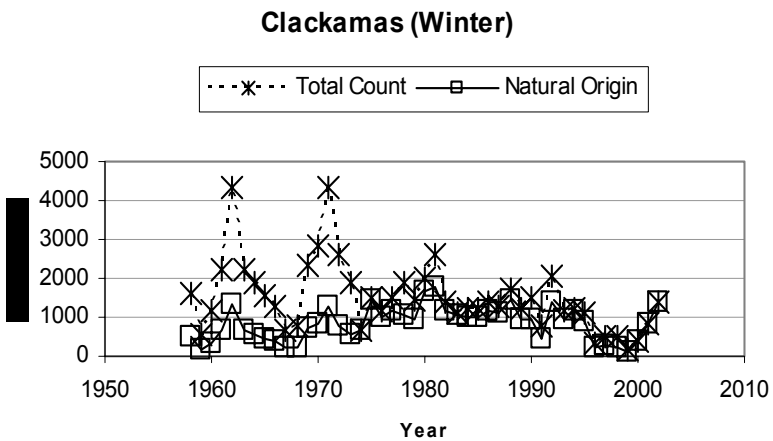

Figure B.2.4.3. Winter steelhead abundance at North Fork dam on Clackamas River (data from Cramer 2002).

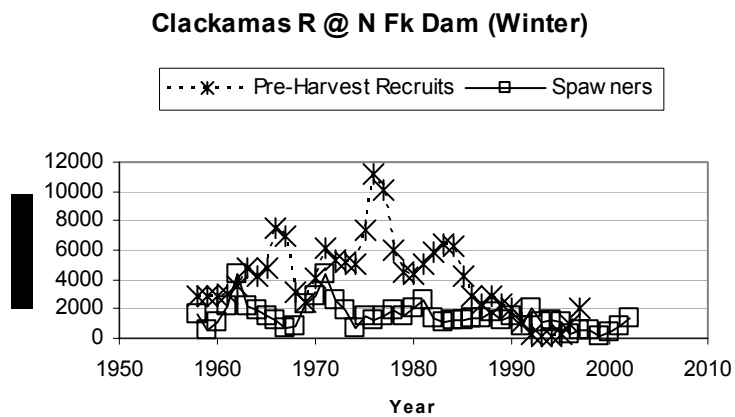

Figure B.2.4.4. Preharvest recruits per spawner for winter steelhead estimated from counts at North Fork Dam on the Clackamas River.

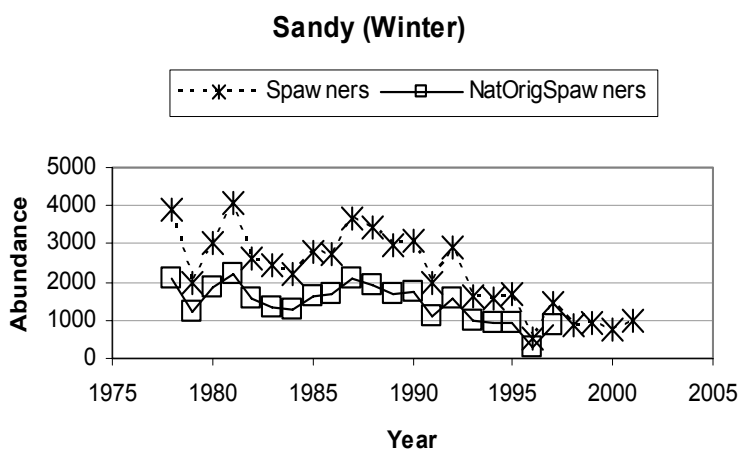

Figure B.2.4.5. Winter steelhead abundance at Marmot dam on the Sandy River (data from Cramer 2002).

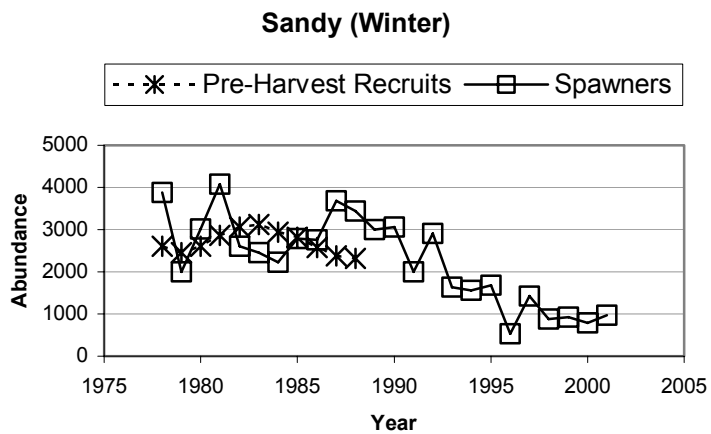

Figure B.2.4.6. Preharvest recruits per spawner for winter steelhead estimated from counts at Marmot Dam on the Sandy River.

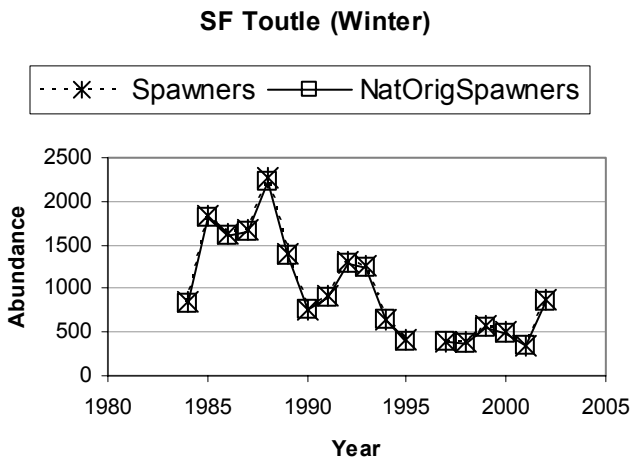

Figure B.2.4.7. Estimate of winter steelhead spawner abundance in the South Fork Toutle River.

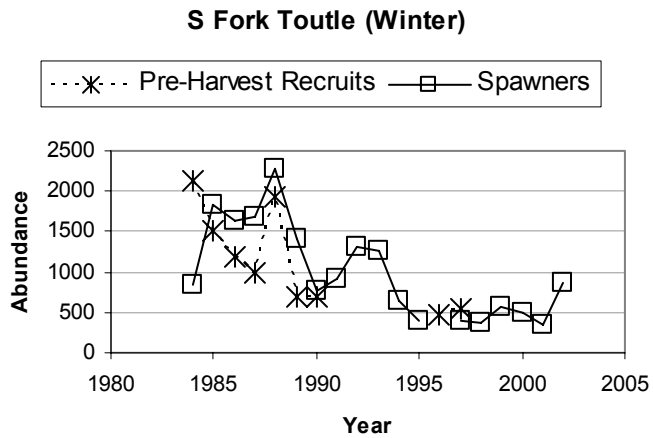

Figure B.2.4.8. Estimate of winter steelhead recruits per spawner in the South Fork Toutle River.

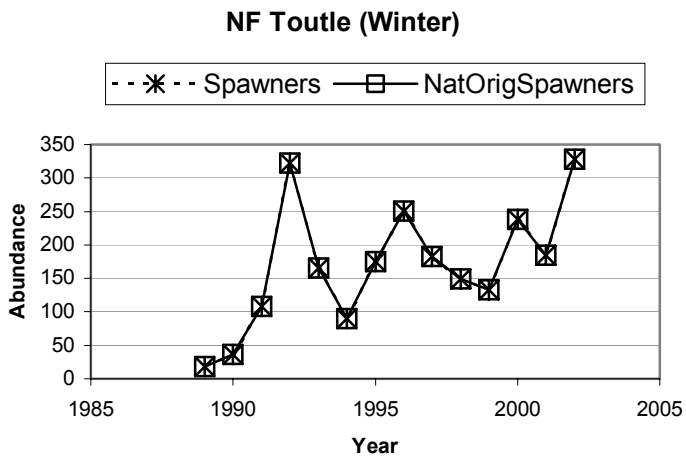

Figure B.2.4.9. Estimate of winter steelhead abundance in the North Fork Toutle.

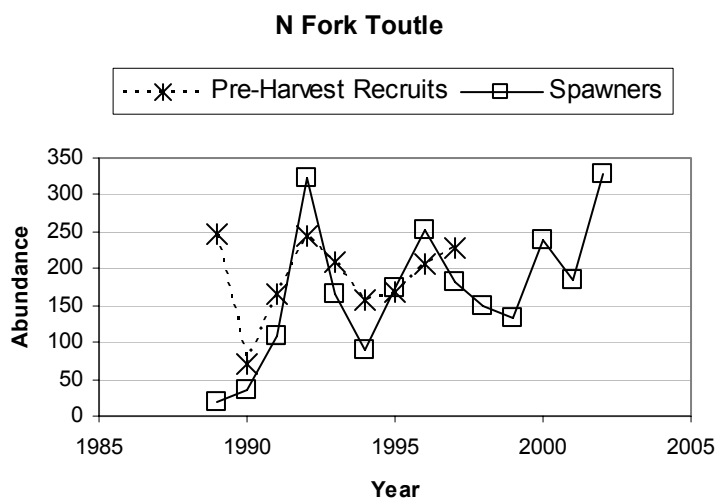

Figure B.2.4.10. Estimate of winter steelhead recruits per spawner in the North Fork Toutle River.

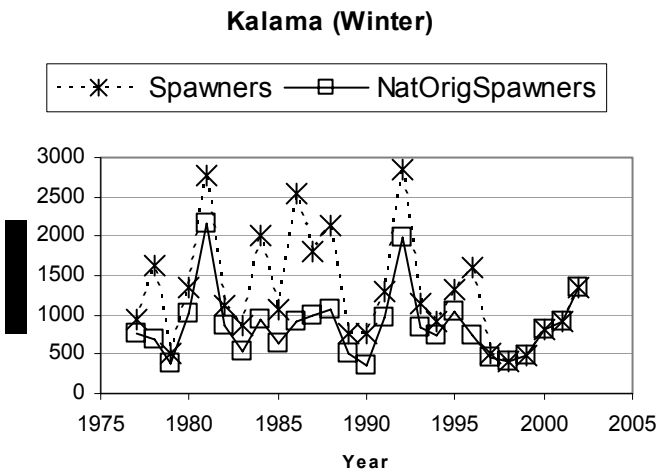

Figure B.2.4.11. Estimate of winter steelhead abundance in the Kalama River.

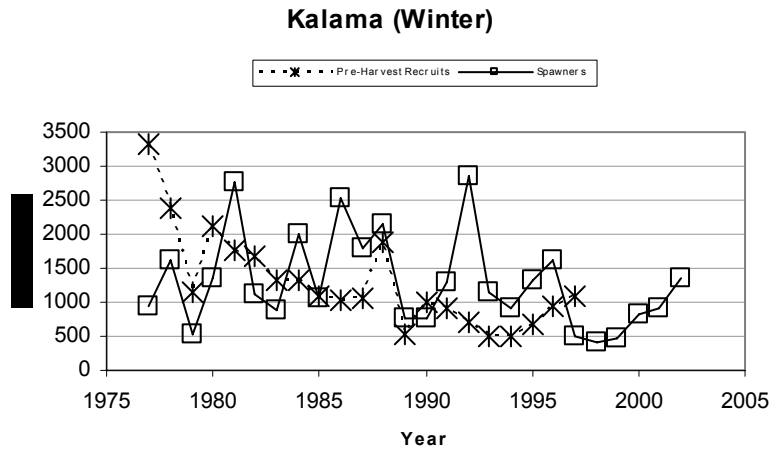

Figure B.2.4.12. Estimate of winter steelhead recruits per spawner in the Kalama River.

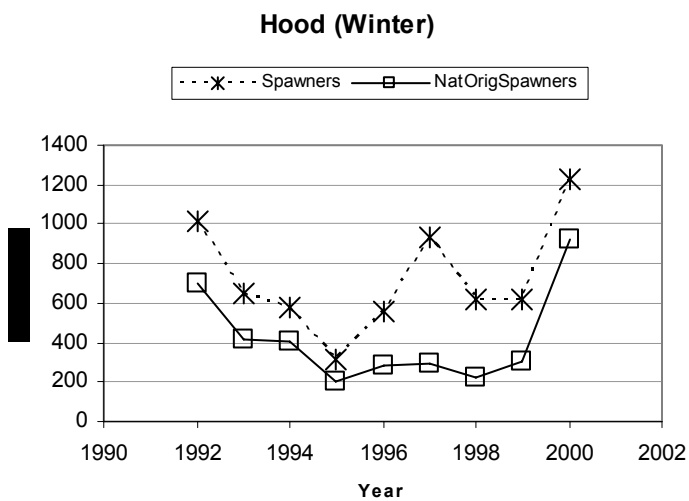

Figure B.2.4.13. Estimate of winter steelhead abundance in the Hood River.

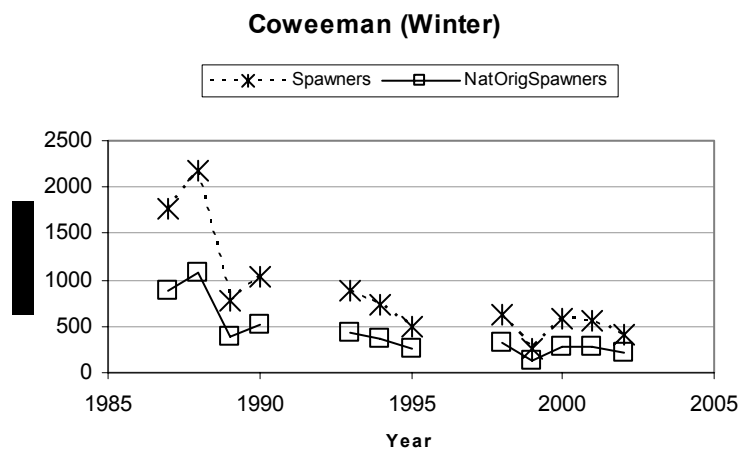

Figure B.2.4.14. Estimate of winter steelhead abundance in the Coweeman River.

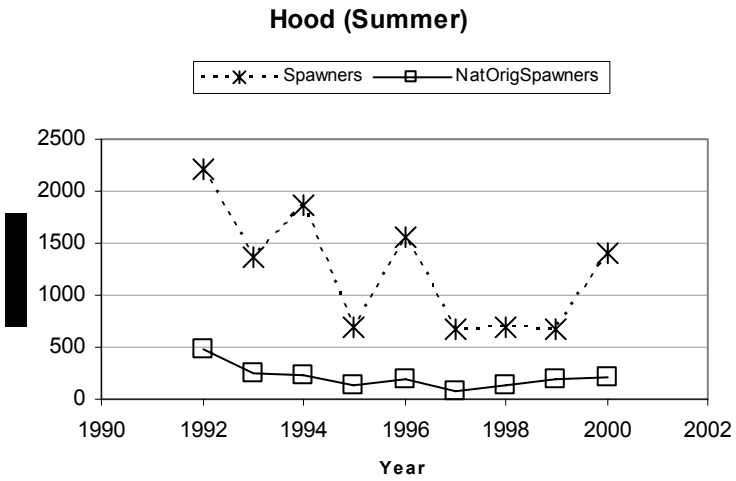

Figure B.2.4.15. Estimate of summer steelhead abundance in the Hood River.

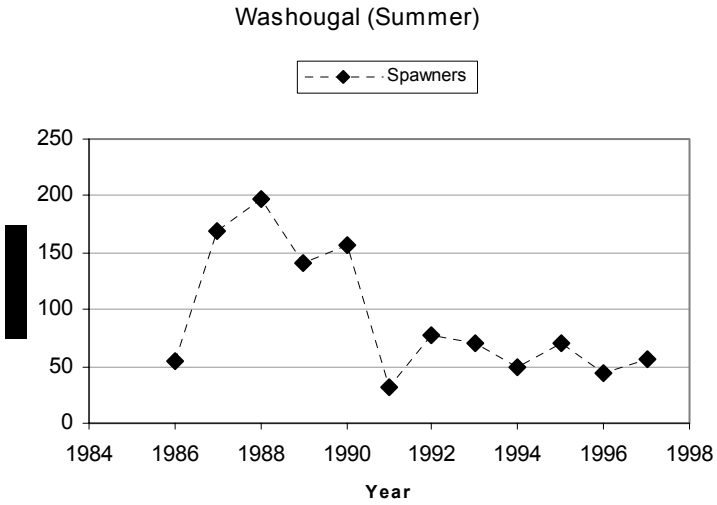

Figure B.2.4.16. Estimate of summer steelhead abundance in the Washougal River.

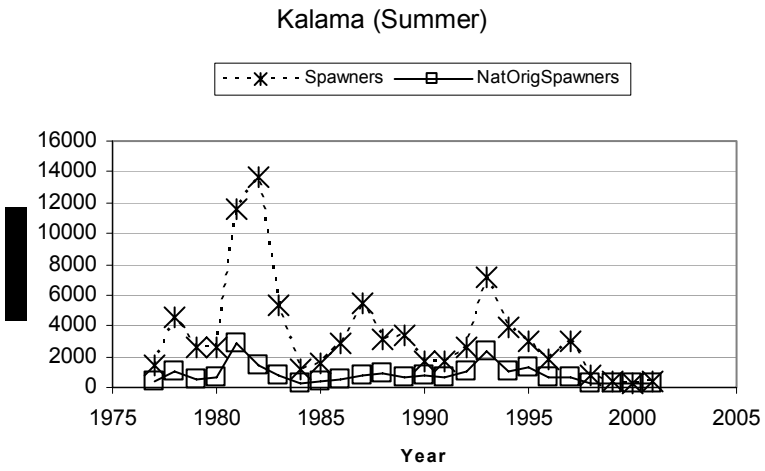

Figure B.2.4.17. Estimate of summer steelhead abundance in the Kalama River.

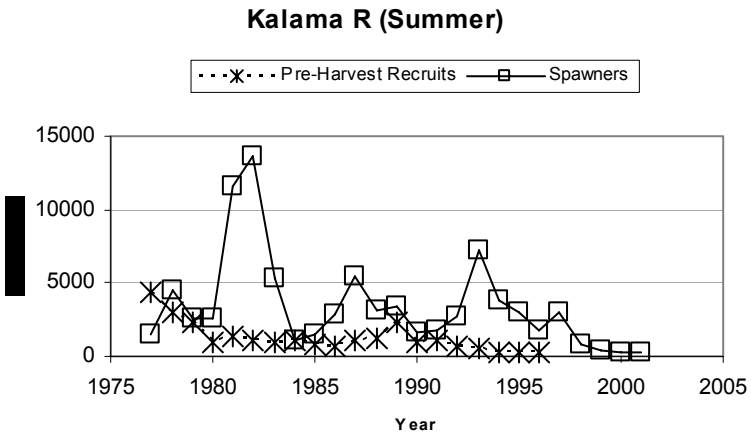

Figure B.2.4.18. Estimate of summer steelhead preharvest recruits in the Kalama River.

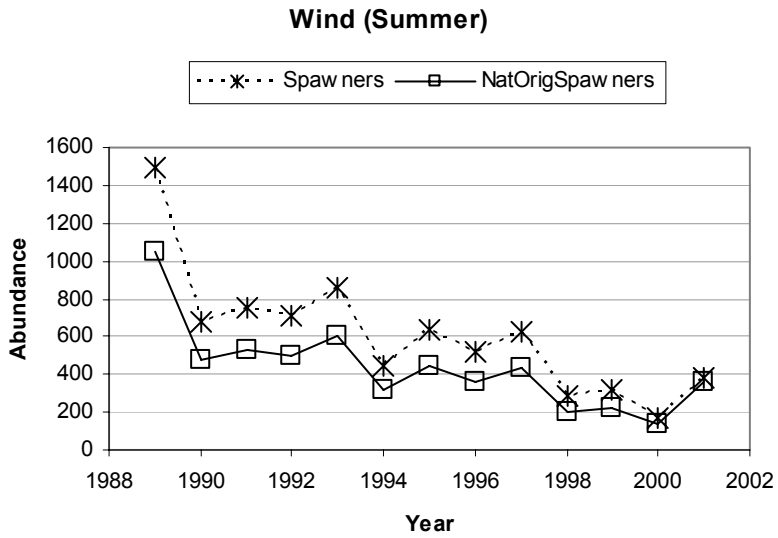

Figure B.2.4.19. Estimate of summer steelhead abundance in the Wind River.

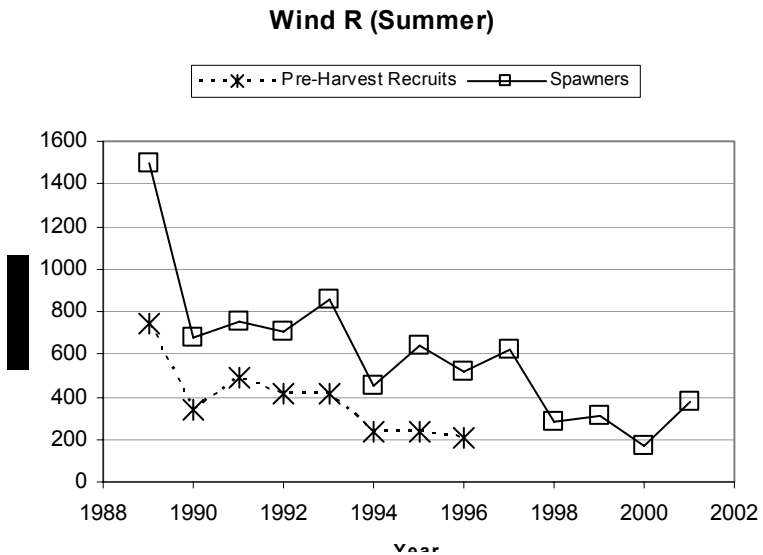

Figure B.2.4.20. Estimate of summer steelhead preharvest recruits in the Wind River.

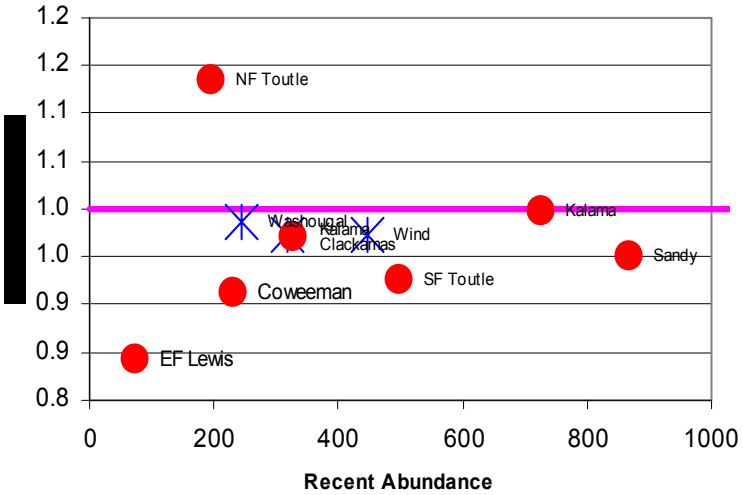

Figure B.2.4.21. Long-term trend vs. recent abundance. The "*" symbol indicates summer run populations.

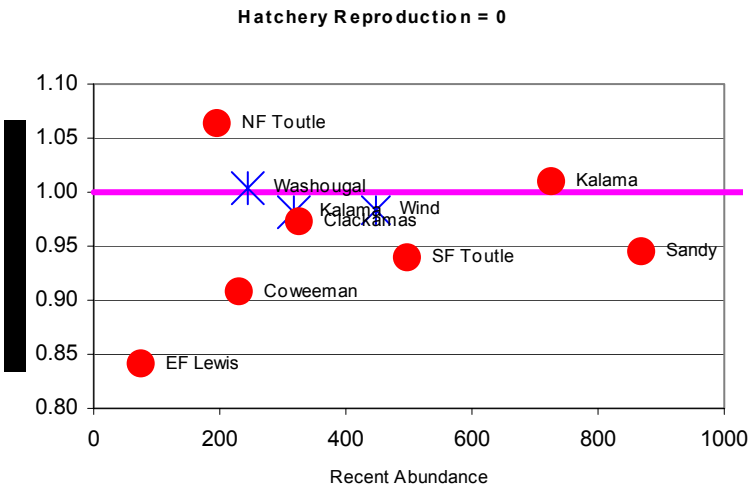

Figure B.2.4.22. Long-term lambda vs. recent abundance. Lambda calculated assuming hatchery fish have a reproductive success of zero. The "*" symbol indicates summer run populations.

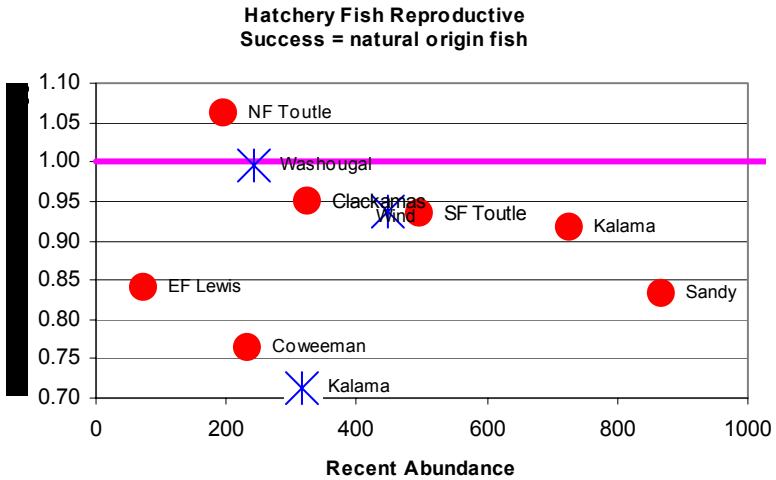

Figure B.2.4.23. Long-term lambda vs. recent abundance. Lambda calculated assuming hatchery fish have a reproductive success equivalent to that of natural origin fish. The "*" symbol indicates summer run populations.

B.2.5. UPPER WILLAMETTE RIVER STEELHEAD

B.2.5.1. Previous BRT Conclusions

- Populations at relatively low abundance.
- Abundance had been steeply declining since 1988.
- The previous BRT was concerned about the potential negative interaction between non-native summer steelhead and wild winter steelhead.
- Unanimous decision of previous BRT that the Upper Willamette steelhead ESU was at risk is of becoming endangered in the foreseeable future.
- Loss of access to historical spawning grounds because of dams was considered a major risk factor.
- Currently listed as threatened.

B.2.5.2 New Data and Analyses

New data include:

- Redd counts and dam/weir counts through 2000, 2001, or 2002.
- New estimated of hatchery fraction and harvest rate through 2000.

New analyses include:

- Designation of relatively demographically independent populations.
- Estimates of current and historically available kilometers of stream.

Results of new analyses

Historical population structure—As part of its effort to develop viability criteria for UW steelhead, the Willamette/Lower Columbia Technical Recovery Team (WLC-TRT) has identified historically demographically independent populations (Myers et al. 2002). Population boundaries are based on an application of Viable Salmonid Populations definition (McElhany et al. 2000). Myers et al. hypothesized that the ESU historically consisted of at least four populations and possibly a fifth (Figure B.2.5.1). There is some uncertainty about the historical existence of a historical population in the west side tributaries. The populations identified in Myers et al. are used as the units for the new analyses in this report.

Abundance and trends

References for abundance time series and related data are in Appendix B.2.5.3. Information on recent abundance of natural origin spawners, recent fraction of hatchery origin spawners, and recent harvest rates for UW Chinook populations is summarized in Table B.2.5.1. The number of winter steelhead passing over Willamette Falls from 1971 to 2002 is shown in Figure B.2.5.2. All steelhead in the ESU must pass Willamette Falls. Two groups of winter steelhead currently exist in the upper Willamette. The “late-run” winter steel exhibit the historical phenotype adapted to passing the seasonal barrier at Willamette Falls. The falls were laddered and hatchery “early-run” winter steelhead fish were released above the falls. The early-

Table B.2.5.1.. The recent abundance is the geometric mean of a dam or trap count over the last 5 years of available data and the min-max are the lowest and highest 5-year geometric means in the time series. These counts are not the total abundance of any single population. The data years show the range of the available time series. The Willamette Falls abundance data are for only "late run" (natural origin native returns). The Willamette Falls hatchery fraction is the 4-year average percentage of the return that was "early run" (non-native). Foster Dam counts are based only on natural origin returns.

Population	**Recent Abundance**	**Data Years**	**Hatchery Fraction (%)**	**Harvest Rate (%)**
Willamette Falls (Composite of all populations)	5819 (2735-12208)	1971-2002	24 (zero in 2002)	2
Molalla		1980-2000 (redd survey)		
Foster Dam (South Santiam)	496 (239-496)	1967-2002	0	
Minto Trap (North Santiam)	129 (79-895)	1960-2000		
Calapooia		1980-2001 (redd survey)		

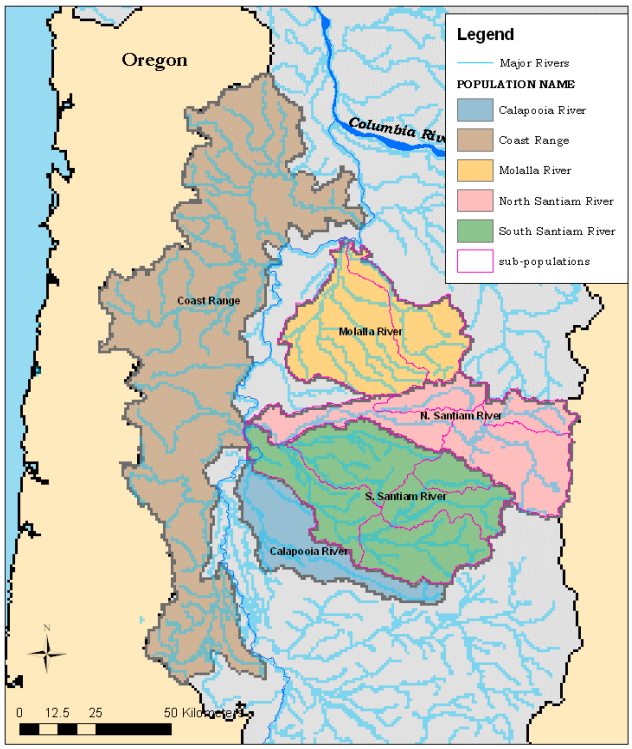

Figure B.2.5.1. Map if populations in the UW steelhead ESU.

Table B.2.5.2. The stocking of winter-run steelhead in the Willamette has been discontinued. However, winter-run hatchery fish are still returning and summer run continue to be stocked in the Willamette. This table shows the last year of winter run releases in each of the basins.

Population	Last Year Winter Run Steelhead Released
Mollala River	1999 (or 1997?)
North Santiam River	1998
South Santiam River	1989
Calapooia River	No hatchery
West side Tributaries	?

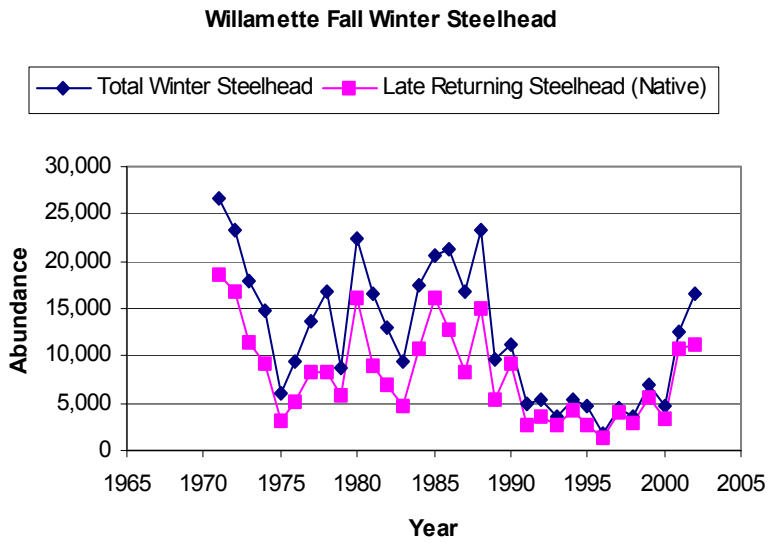

Figure B.2.5.2. Counts of winter steelhead at Willamette Falls.

run fish were derived from Columbia Basin steelhead outside the Willamette and are considered non-native. The release of winter-run hatchery steelhead has recently been discontinued in the Willamette (Table B.2.5.2), but some early-run winter steelhead are still returning from the earlier hatchery releases and from whatever natural production of the early-run fish that has been established. One line on the graph of winter steelhead at Willamette Falls shows the combined early and late returns and the other line shows only the native late run. Non-native summer run hatchery steelhead are also released into the upper Willamette.

At one time, ODFW applied an algorithm involving redd survey and the length of available stream miles to apportion the fish passing Willamette Falls into individual populations. This approach appears to have been dropped in 1997 and there are currently no estimates of the absolute total numbers of spawners in the individual populations. The status of individual populations is discussed below.

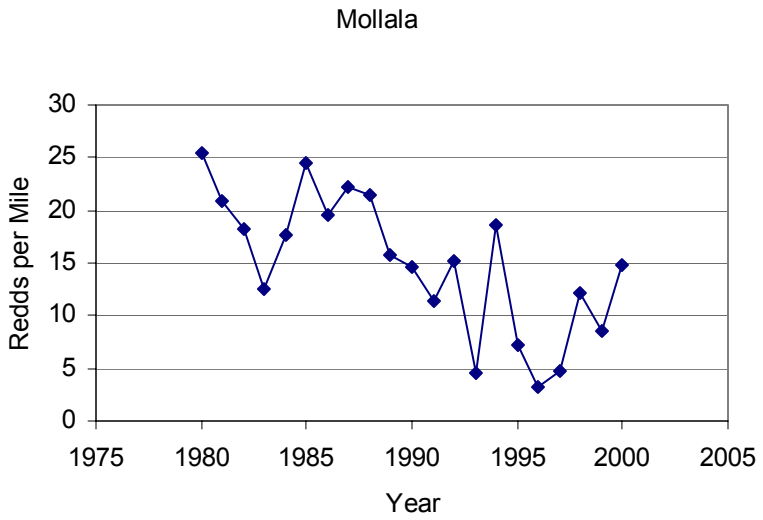

Figure B.2.5.3. Redd surveys of winter steelhead in the Molalla.

Molalla—A time series of redd-per-mile data from the Molalla shows a declining trend from 1980-2000 (Figure B.2.5.3). Estimates of the fraction of hatchery-origin spawners for this population are shown in Figure B.2.5.9, and the estimated harvest rate in Figure B.2.5.10.

North Santiam—A time series of redd-per-mile data from the North Santiam show a declining trend from 1980-2001 (Figure B.2.5.4). A time series also exists the Minto trap on the North Santiam (Figure B.2.5.5). Minto is a hatchery acclimation-and-release site, so it is assumed that the majority of fish trapped at this site over the time series are of hatchery origin. Estimates of the fraction of hatchery-origin spawners for this population are shown in Figure B.2.5.9 and the estimated harvest rate in Figure B.2.5.10.

South Santiam—Counts of winter steelhead at Foster Dam (RKm 77) from 1967 to 2002 are shown in Figure B.2.5.6. A hatchery program was initiated in the 1980s and hatchery-origin fish were identified at the dam facility. Redd surveys are also conducted below Foster Dam (Figure B.2.5.7). Estimates of the fraction of hatchery-origin spawners for this population below Foster Dam are shown in Figure B.2.5.9, and the estimated harvest rate in Figure B.2.5.10.

Calapooia—A time series of redd-per-mile data from the Calapooia shows a declining trend from 1980-2001 (Figure B.2.5.8). Estimates of the fraction of hatchery-origin spawners for this population are shown in Figure B.2.5.9 and the estimated harvest rate in Figure B.2.5.10.

West Side Tributaries—No time series or current counts of spawner abundance for the west side tributaries population are available. It is questionable if there was ever a self-sustaining steelhead population in the west side. There is assumed to be little, if any, natural production of steelhead in these tributaries.

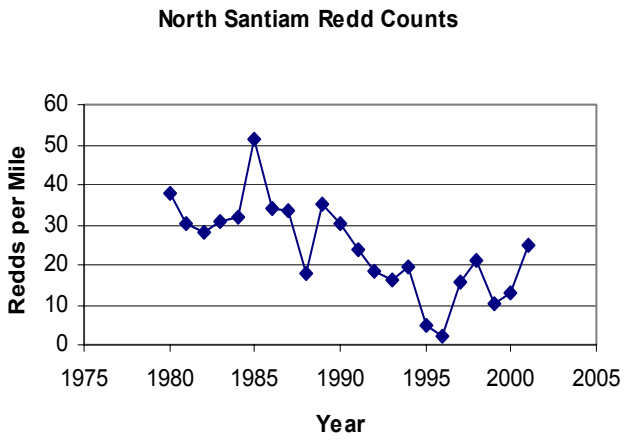

Figure B.2.5.4. Redd surveys of winter steelhead in the North Santiam.

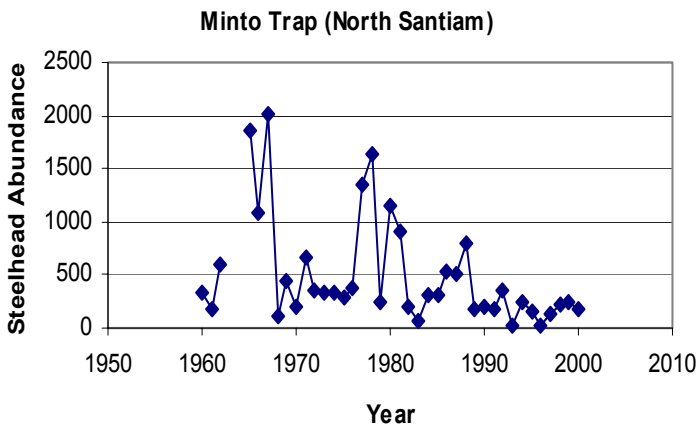

Figure B.2.5.5. Counts of winter steelhead at the Minto trap on the North Santiam. Minto is a hatchery-acclimation pond and release site.

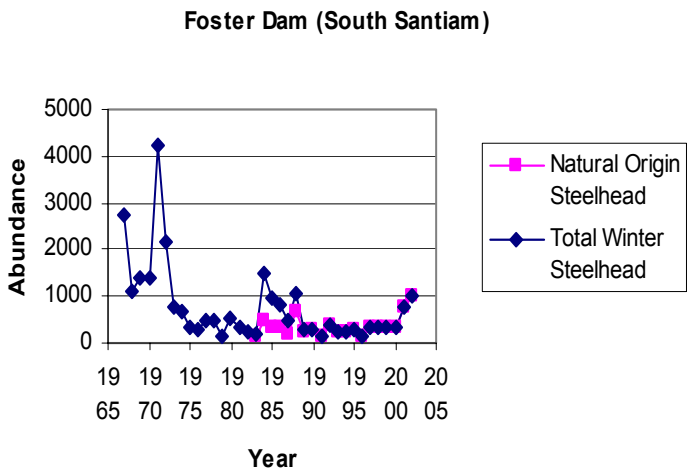

Figure B.2.5.6. Counts of winter steelhead at Foster Dam on the South Santiam (RKm 77)

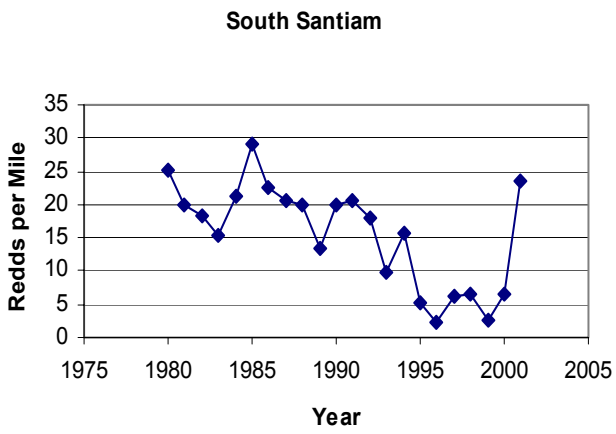

Figure B.2.5.7. Redd surveys of winter steelhead in the South Santiam below Foster Dam.

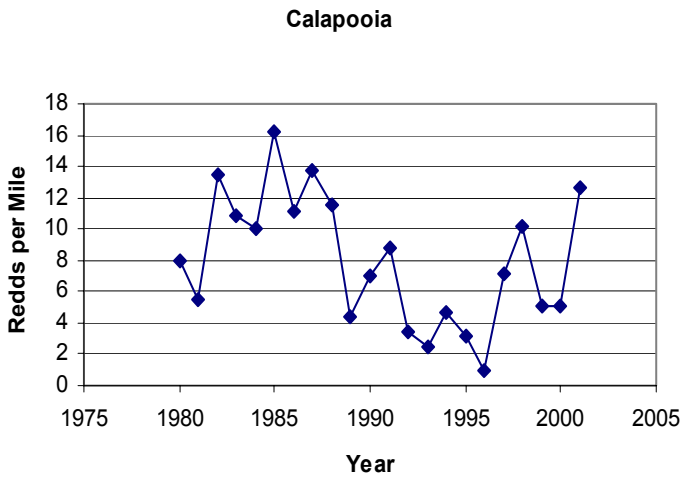

Figure B.2.5.8. Redd surveys of winter steelhead in the Calapooia River.

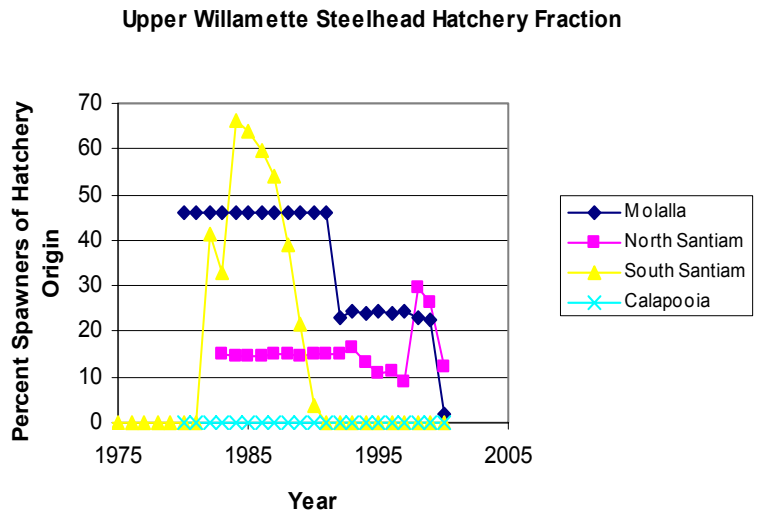

Figure B.2.5.9. Estimates of the fraction of hatchery-origin spawners in populations of UW winter steelhead (Chilcote 2001).

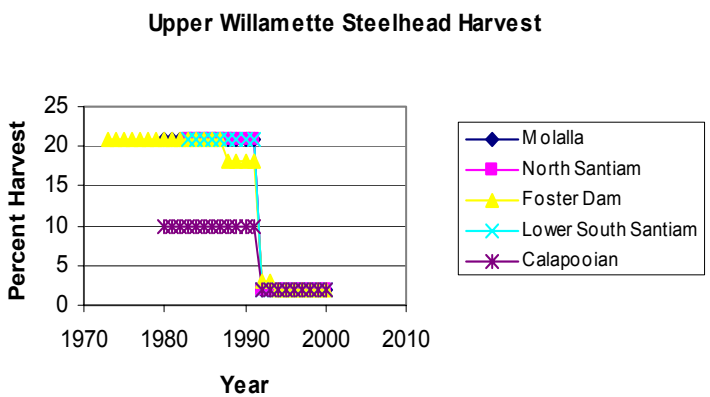

Figure B.2.10. Estimates of the harvest rate on populations of UW winter steelhead (Chilcote 2001).

Table B.2.5.3. Historical populations of upper Willamette spring chinook and loss of habitat from barriers. The potential current habitat is the kilometers of stream below all currently impassible barriers between a gradient of 0.5% and 4%. The potential historical habitat is the kilometers of stream below historically impassible barriers between a gradient and 0.5% and 6%. The current-to-historical habitat ratio is the percent of the historical habitat that is currently available.

Population	**Potential Current Habitat (%)**	**Potential Historical Habitat (km)**	**Current to Historical Habitat Ratio**
Mollala River	524	827	63
North Santiam River	210	347	61
South Santiam River	581	856	68
Calapooia River	203	318	64
West side Tributaries	1,376	2,053	67

Loss of habitat from barriers

An analysis was conducted by Steel and Sheer (2002) to assess the number of stream km historically and currently available to salmon populations in the UW (Table B.2.5.3). Stream km usable by salmon are determined based on simple gradient cut offs, and on the presence of impassable barriers. This approach will over estimate the number of usable stream km as it does not take into consideration habitat quality (other than gradient). However, the analysis does indicate that for some populations the number of stream habitat km currently accessible is greatly reduced from the historical condition.

Resident *O. mykiss* summary

As discussed elsewhere in this report, our risk evaluation focused on the sustainability of anadromous *O. mykiss*. However, an effort was made to compile existing information on *O. mykiss* so it could be considered in the risk evaluation. A distillation of the information in Kostow (2003) as related to the LCR follows:

- Resident cutthroat trout: Cutthroat trout are the found through much of the Willamette River Basin.
- Resident rainbow trout: A genetically distinct rainbow trout (McKenzie redsides) is found in the McKenzie and Middle Fork river basins. Historically, steelhead did not inhabit these basins, although some non-native summer steelhead have been introduced.
- Artificial barriers: Resident or residualized rainbow trout are found above the dams on the North and South Santiam rivers. Historically, the areas above the dams were the primary production areas for steelhead in this ESU.
- Natural barriers: Numerous small waterfalls exist in the headwater regions of this ESU. Resident rainbow trout are found in these areas.

Table B.2.5.4. Number of populations in the ESU. Populations with "some current natural production" have some natural-origin recruits present but are not necessarily considered self-sustaining ("viable").

	Total
Historical	4-5
Some current natural production	4
Currently "viable" populations	0-?

B.2.5.3. ESU Summary

Based on the updated information provided in this report, the information contained in previous LCR status reviews, and preliminary analyses by the WLC-TRT, we have tentatively identified the number of historical and currently viable populations (Table B.2.5.4). This summary indicates some of the uncertainty about this ESU. As in the LCR steelhead ESU, we could not conclusively identify a single population that is naturally self-sustaining. All populations are relatively small, with the recent mean abundance of the entire ESU at less than 6,000. Over the period of the available time series, most of the populations are in decline. The recent elimination of the winter-run hatchery production will allow estimation of the naturally productivity of the populations in the future, but the available time series are confounded by the presence of hatchery-origin spawners. On a positive note, the counts all indicate an increase in abundance in 2001, likely at least partly as a result of improved marine condtions.

B.2.6 NORTHERN CALIFORNIA STEELHEAD ESU

B.2.6.1 Previous BRT Conclusions

The Northern California ESU includes coastal basins from Redwood Creek (Humboldt County) southward to the Gualala River (Mendocino County), inclusive (Busby et al. 1996). Within this ESU, both summer run[2], winter run, and half-pounders[3] are found. Summer steelhead are found in the Mad, Eel, and Redwood rivers; the Middle Fork Eel River population is their southern-most occurrence. Half-pounders are found in the Mad and Eel rivers. Busby et al. (1996) argued that when summer and winter steelhead co-occur within a basin, they were more similar to each other than either is to the corresponding run-type in other basins. Thus Busby et al. (1996) considered summer and winter steelhead to jointly comprise a single ESU.

Summary of major risks and status indicators

Risks and limiting factors—The previous status review (Busby et al. 1996) identified two major barriers to fish passage: Mathews Dam on the Mad River and Scott Dam on the Eel River. Numerous other blockages on tributaries were also thought to occur. Poor forest practices and poor land use practices, combined with catastrophic flooding in 1964, were thought to have caused significant declines in habitat quality that then persisted up to the date of the status review. These effects include sedimentation and loss of spawning gravels. Non-native Sacramento pikeminnow (*Ptychocheilus grandis*) had been observed in the Eel River Basin and could potentially be acting as predators on juvenile steelhead.

Status indicators—Historical estimates (pre-1960s) of steelhead in this ESU are few (Table B.2.6.1). The only time-series data are dam counts of winter steelhead in the upper Eel River (Cape Horn Dam, 1933-present), winter steelhead in the Mad River (Sweasey Dam, 1938-1963), and combined counts of summer and winter steelhead in the South Fork Eel River (Benbow Dam, 1938-75; see Figure B.2.6.1A). More recent data are snorkel counts of summer steelhead that were made in the middle fork of the Eel since 1966 (with some gaps in the time-series) (Scott Harris and Wendy Jones, CDFG, personal communication). Some "point" estimates of mean abundance exist—in 1963, the California Department of Fish and Game made estimates of steelhead abundance for many rivers in the ESU (Table B.2.6.2). An attempt was made to estimate a mean count over the interval 1959 to 1963, but in most cases 5 years of data were not available and estimates were based on fewer years (CDFG 1965); the authors state that "estimates given here which are based on little or no data should be used only in outlining the major and critical factors of the resource" (CDFG 1965).

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[2] Some consider summer-run steelhead and fall-run steelhead to be separate runs within a river while others do not consider these groups to be different. For purposes of this review, summer run and fall run are considered stream-maturing steelhead and will be referred to as summer steelhead (see McEwan 2001 for additional details).

[3] A half pounder is a sexually immature steelhead, usually small, that returns to freshwater after spending less than a year in the ocean (Kesner and Barnhart 1972, Everest 1973).

Table B.2.6.1. Summary of historical abundance (average counts) for steelhead in the Northern California evolutionarily significant unit (see also Figure 1).

		Average count						
Basin	Site	1930s	1940s	1950s	1960s	1970s	1980s	Reference
Eel River	Cape Horn Dam	4,390	4,320	3,597	917	721	1,287	Grass 1995
Eel River	Benbow Dam	13,736	18,285	12,802	6,676	3,355	-	
Mad River	Sweasey Dam	3,167	4,720	2,894	1,985	-	-	

Although the data were relatively few, the data that did exist suggested the following to the BRT: 1) Population abundances were low relative to historical estimates (1930s dam counts; see Table B.2.6.1 and Figure B.2.6.1). 2) Recent trends were downward (except for a few small summer stocks; see Figures B.2.6.1 and B.2.6.2). 3) Summer steelhead abundance was "very low." The BRT was also concerned about negative influences of hatchery stocks, especially in the Mad River (Busby et al. 1996). Finally, the BRT noted that the status review included two major sources of uncertainty: lack of data on run sizes throughout the ESU, and uncertainty about the genetic heritage of winter steelhead in Mad River.

Listing status

Status was formally assessed in 1996 (Busby et al. 1996), updated in 1997 (Schiewe 1997) and updated again in 2000 (Adams 2000). Although other steelhead ESUs were listed as threatened or endangered in August 1997, the National Marine Fisheries Service (NMFS) allowed steelhead in the Northern California ESU to remain a candidate species pending an evaluation of state and federal conservation measures. There is a "North Coast Steelhead Memorandum of Agreement" (MOA) with the State of California, which lists a number of proposed actions, including a change in harvest regulations, a review of California hatchery practices, implementation of habitat restoration activities, implementation of a comprehensive monitoring program, and numerous revisions to rules on forest-practices. These revisions would be expected to improve forest condition on non-federal lands. In March 1998 the NMFS announced its intention to reconsider the previous no-listing decision. On 6 October 1999 the California Board of Forestry failed to take action on the forest practice rules, and the NMFS Southwest Region (SWR) regarded this failure as a breach of the MOA. The Northern California ESU was listed as threatened in June 2000.

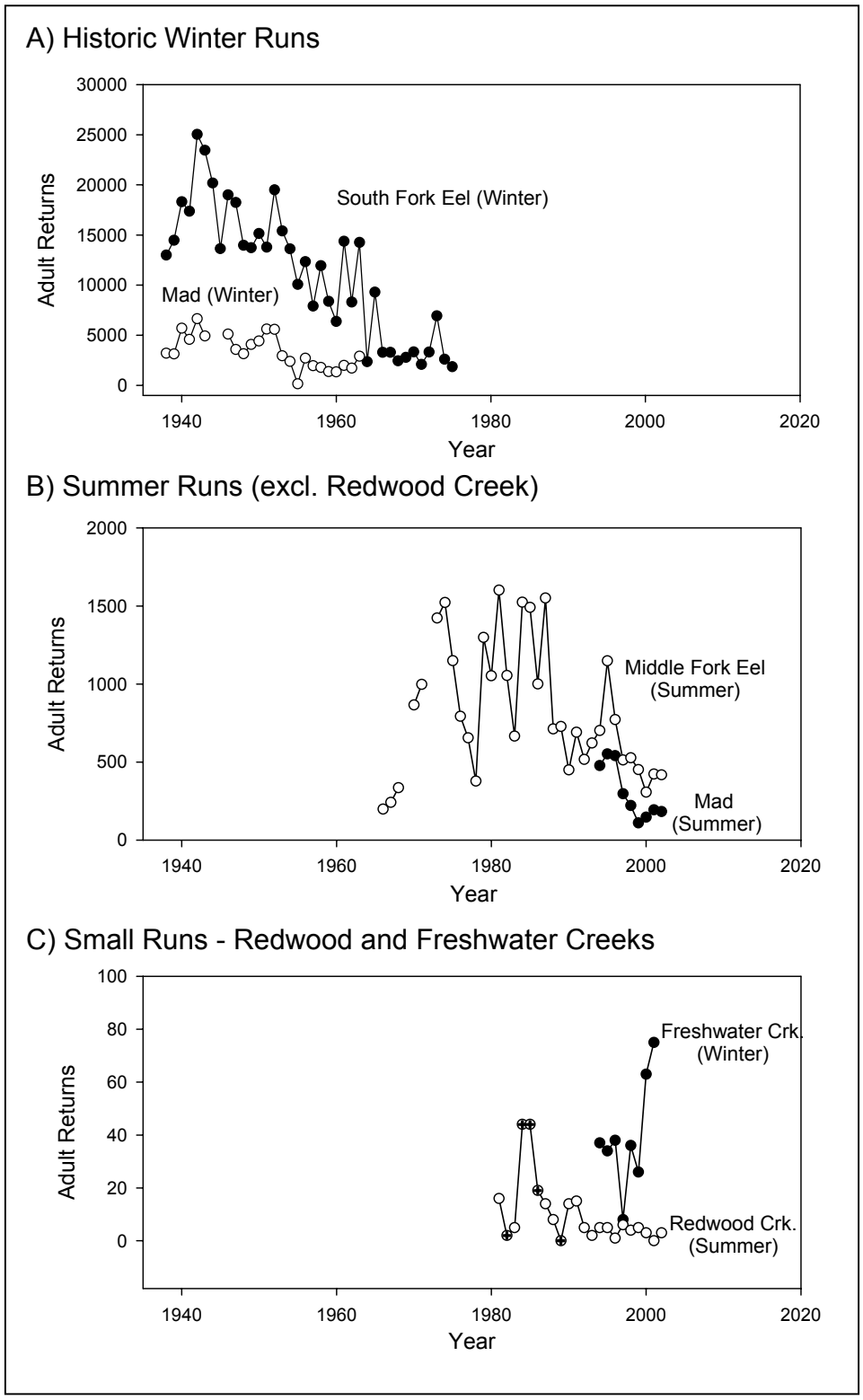

Figure B.2.6.1. Time-series data for the North-Central California Steelhead ESU. A) Historic data from winter runs on the Mad River and South Fork Eel. B) Summer runs on the Middle Fork Eel and Mad River. C) Summer steelhead in Redwood Creek, and winter steelhead in Freshwater Creek, Humboldt County. Symbols with crosses represent minimum estimates. Note the three different scales of the *y*-axis.

Table B.2.6.2. Historical estimates of number of spawning steelhead for California rivers in the Northern California ESU and Central California Coast ESU (data from CDFG 1965). Estimates are considered by CDFG (1965) to be notably uncertain.

ESU	Stream	1963
Northern California		
	Redwood Creek	10,000
	Mad River	6,000
	Eel River (total)	82,000
	Eel River	(10,000)
	Van Duzen River (Eel)	(10,000)
	South Fork Eel River	(34,000)
	North Fork Eel River	(5,000)
	Middle Fork Eel River	(23,000)
	Mattole River	12,000
	Ten Mile River	9,000
	Novo River	8,000
	Big River	12,000
	Navarro River	16,000
	Garcia River	4,000
	Gualala River	16,000
	other Humboldt County stream	3,000
	other Mendocino County streams	20,000
	Total	198,000
Central California Coast		
	Russian River	50,000
	San Lorenzo River	19,000
	other Sonoma County streams	4,000
	other Marin County steams	8,000
	other San Mateo County streams	8,000
	other Santa Cruz County streams	5,000
	Total	94,000

B.2.6.2 New Data

There are three significant sets of new information: (1) updated time-series data exist for the middle fork of the Eel River (summer steelhead; snorkel counts. See Figure B.2.6.1B). (2) There are new data-collection efforts initiated in 1994 in the Mad River (summer steelhead; snorkel counts. Figure B.2.6.1B) and in Freshwater Creek (winter steelhead; weir counts; Freshwater Creek is a small stream emptying into Humboldt Bay. See Figure B.2.6.1C). (3) Numerous reach-scale estimates of juvenile abundance have been made extensively throughout the ESU. Analyses of these data are described below.

B.2.6.3 New and Updated Analyses

Updated Eel River data

The time-series data for the Middle Fork of the Eel River are snorkel counts of summer steelhead, made for fish in the holding pools of the entire mainstem of the middle fork (Scott Harris and Wendy Jones, CDFG, pers. commun.). Most adults in the system are thought to oversummer in these holding pools. An estimate of λ over the interval 1966 to 2002 was made using the method of Lindley (in press; random-walk-with-drift model fitted using Bayesian assumptions). The estimate of λ is 0.98, with a 95% confidence interval of [0.93, 1.04] (see Table B.2.6.3)[4]. The overall trend in the data is downward in both the long- and the short-term (Figure B.2.6.1B).

New time-series

The Mad River time-series consists of snorkel counts for much of the mainstem below Ruth Dam. Some counts include the entire mainstem; other years include only data from land owned by Simpson Timber Company. In the years with data from the entire mainstem, fish from Simpson Timber land make up at least 90% of the total count. The time-series from Freshwater Creek is composed of weir counts. Estimates of λ were not made for either time-series because there were too few years of data.

Vital statistics for these and other existing time-series are given in Table B.2.6.3; trend versus abundance is plotted in Figure B.2.6.2.

[4] Note that Lindley (in press) defines $\lambda \approx \exp(\mu + \sigma^2/2)$, whereas Holmes (2001) defines $\lambda \approx \exp(\mu)$; see the Lindley (in press) for meaning of the symbols.

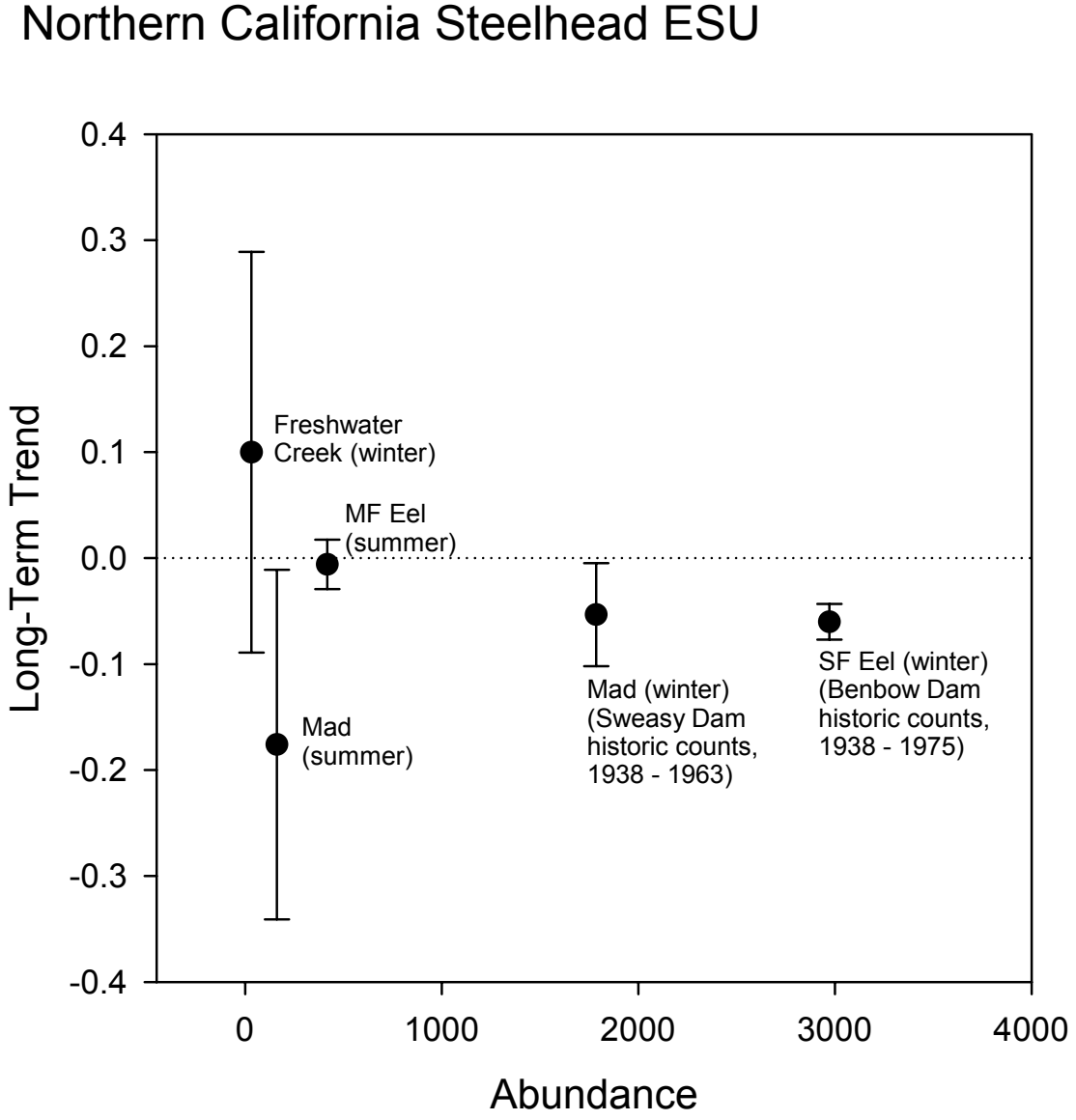

Figure B.2.6.2. Trends versus abundance for the time-series data from Figure 1. Note that neither set of dam counts (Sweasy Dam, Benbow Dam) has any recent data. Vertical bars are 95% confidence intervals.

Table B.2.6.3. Summary of time-series data for listed steelhead ESUs on the California Coast.

Population	Span of time series	5-Year Means[5]			Lambda[6]	Long-term trend (95% conf. int.)	Short-term trend (95% conf. int.)
		Rec.	Min.	Max.			
Northern California ESU (threatened)							
M.Fk. Eel Riv. (summer)	’66-’02	418	384	1,246	0.98 (0.93, 1.04)	-0.00599 (-0.0293, 0.0173)	-0.0668 (-0.158, 0.0243)
Mad River (summer)	’94-’02	162	162	384	Insufficient data	-0.176 (-0.341, -0.0121)	-0.176 (-0.341, -0.121)
Freshwater Crk. (winter)	’94-’01	32	25	32	Insufficient data	0.0999 (-0.289, 0.489)	0.0999 (-0.289, 0.489)
Redwood Crk. (summer)	’81-’02	3	See Fig. 1C[7]		Insufficient data	See Fig. 1C	-0.775 (-1.276, -0.273)
S.Fk. Eel Riv. (winter)[8]	’38-’75	2,971	2,743	20,657	0.98 (0.92, 1.02)	-0.0601 (-0.077, -0.0432)	No recent data
Mad Riv. (winter)[9]	’38-’63	1,786	1,140	5,438	1.00 (0.93, 1.05)	-0.0534 (-0.102, -0.00504)	No recent data
Central California ESU (threatened)							
No data							
South-Central California ESU (threatened)							
Carmel River (winter)[10]	’62-’02	611	1.13	881	Inappropriate data[11]	See Fig. B.2.6.5	See Fig. 5
Southern California ESU (endangered)							
Santa Clara R. (winter)[12]	’94-’97	1.0			Insufficient data		

[5] Geometric means. The value 0.5 was used for years in which the count was zero.
[6] Lambda calculated using the method of Lindley (In press). Note that a population with lambda greater than 1.0 can nevertheless be declining, due to environmental stochasticity.
[7] Certain years have minimum run sizes, rather than unbiased estimates of run size, rendering the time series unsuitable for some of the estimators.
[8] Historic counts made at Benbow Dam.
[9] Historic counts made at Sweasy Dam.
[10] There is a gap in the time series for 1978 – 87.
[11] Recent restoration work in the Carmel River involves substantial transplanting of juveniles from below to above the dam at which counts were made.
[12] Recent abundance is a 4-year mean.

Juvenile data

The juvenile data were collected at numerous sites using a variety of methods. Many of the methods involve the selection of reaches thought to be "typical" or "representative" steelhead habitat; other reaches were selected because they were thought to be typical coho habitat, and steelhead counts were made incidentally to coho counts. In general, the field crew made electro-fishing counts (usually multiple-pass, depletion estimates) of the young-of-the-year and 1+ age classes. Most of the target reaches got sampled several years in a row; thus there are a large number of short time-series. Although methods were always consistent within a time-series, they were not necessarily consistent across time-series.

We analyze these juvenile data below. However, we note that they have limited usefulness for understanding the status of the adult population, due to non-random sampling of reaches within stream systems; non-random sampling of populations within the ESU; and a general lack of estimators shown to be robust for estimating fish density within a reach. In addition, even if more rigorous methods had been used, there is no simple relationship between juvenile numbers and adult numbers (Shea and Mangel 2001), the latter being the usual currency for status reviews. Table B.2.6.4 describes the various possible ways that one might translate juvenile trends into inferences about adult trends.

We calculated trends from the juvenile data. To estimate a trend, the data within each time-series were log-transformed and then normalized, so that each datum represented a deviation from the mean of that specific time-series. The normalization is intended to prevent spurious trends that could arise from the diverse set of methods used to collect the data. Then, the time-series were grouped into units thought to plausibly represent independent populations; the grouping was based on watershed structure. Finally, within each population a linear regression was done for the mean deviation versus year. The estimator for time-trend within each grouping is the slope of the regression line. The minimum length of the time-series is 6 years (Other assessments in this status review place the cut-off at 10 years.). The recent origin of some relevant time-series and the fact that some of the shorter time-series include information for different age-classes prompted us to consider these slightly smaller datasets.

This procedure resulted in 10 independent populations for which a trend was estimated. Both upward and downward trends were observed (Figure B.2.6.3). We tested the null hypothesis that abundances were stable or increasing. It was not rejected (H_o: slope ≥ 0; $p < 0.32$ via one-tailed t-test against expected value). However, it is important to note that a significance level of 0.32 implies a probability of 0.32 that the ESU is stable or increasing, and a probability of $1 - 0.32 = 0.68$ that the ESU is declining; thus the odds are more than 2:1 that the ESU has been declining during the past 6 years. This conclusion requires the assumption that the assessed populations 1) are indeed independent populations rather than plausibly independent populations, and 2) were randomly sampled from all populations in the ESU.

Table B.2.6.4. Interpretation of data on juvenile trends.

		Inference made about adult trends		
		Increasing	Level	Decreasing
Observed juvenile trends	Increasing	Possible, if no density-dependence in the smolt/oceanic phase. The most parsimonious inference.	Possible, if density-dependence occurs in the juvenile over-wintering phase, or in the smolt/oceanic phase.	Possible, if oceanic conditions are deteriorating markedly at the same time that reproductive success per female is improving.
	Level	Possible, if oceanic conditions are improving for adults, but juveniles undergo density-dependence.	Possible. The most parsimonious inference.	Possible, if oceanic conditions are deteriorating.
	Decreasing	Unlikely, but could happen over the short term due to scramble competition at the spawning/redd phases.	Possible, if river habitat is deteriorating, and there was strong, pre-existing density dependence in the oceanic phase.	Likely. The most parsimonious inference.

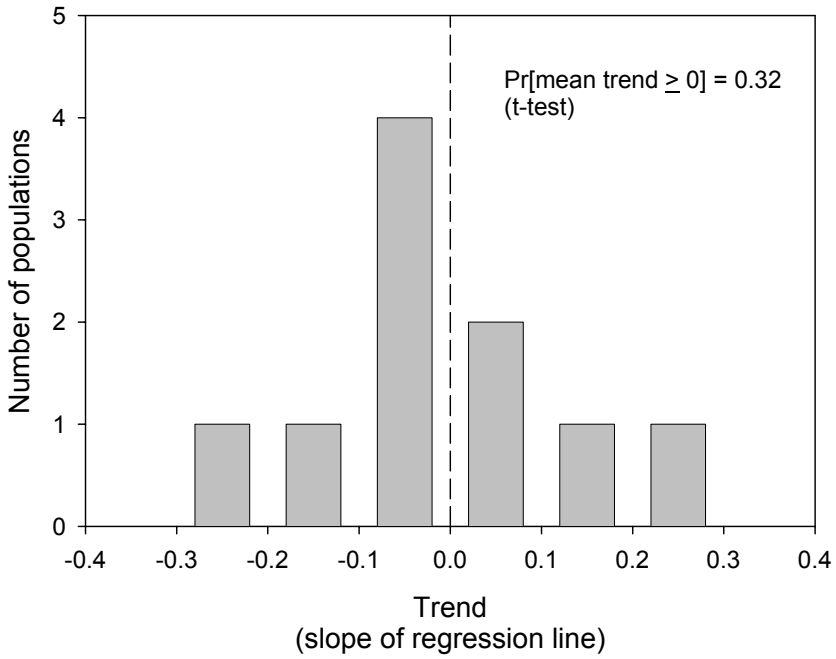

Figure B.2.6.3. Distribution of trends in juvenile density, for 10 "independent" populations within the North Coast steelhead ESU (see text for description of methods). Trend is measured as the slope of a regression line through a time-series; values less than zero indicate decline; values greater than zero indicate increase. Assuming that the populations were randomly drawn from the ESU as a whole, the hypothesis that the ESU is stable or increasing cannot be statistically rejected (p = 0.32), but is only half as likely as the hypothesis that the ESU is declining (p = 1 – 0.32 = 0.68).

Harvest impacts

Sport harvest of steelhead in the ocean is prohibited by the California Department of Fish and Game (CDFG 2002a), and ocean harvest is a rare event (M. Mohr, NMFS, pers. commun.). Freshwater sport fishing probably constitutes a larger impact.

CDFG (2002b) describes the current freshwater sport fishing regulations for steelhead of the northern ESU. All streams are closed to fishing year round except for special listed streams as follows: Catch-and-release angling is allowed year round excluding April and May in the lower mainstem of many coastal streams. Most of these have a bag limit of one hatchery trout or steelhead during the winter months (Albion River, Alder Creek, Big River, Cottoneva Creek, Elk Creek, Elk River, Freshwater Creek, Garcia River, Greenwood Creek, Little River in Humboldt Co., Gualala River, Navarro River, Noyo River, Ten Mile River, and Usal Creek); in a few the ome-fish bag extends to the entire season (Bear River and Redwood Creek, both in Humboldt Co.). The Mattole River has a slightly more restricted catch-and-release season with zero bag limit year round.

The two largest systems are the Mad River and Eel River. The mainstem Mad River is open except for April and May over a very long stretch; bag limit is two hatchery

trout or steelhead; other stretches have zero bag limit or are closed to fishing. Above Ruth Dam, an impassable barrier, the bag limit is five trout per day. The Eel River's mainstem and south fork are open to catch-and-release over large stretches, year round in some areas and closed April and May in others. The middle fork is open for catch and release except mid summer and late fall/winter. It is noteworthy that in the upper middle fork and many of its tributaries, there are summer fisheries with bag limits of two or five fish with no stipulated restriction on hatchery or wild. In the Van Duzen, a major tributary of the mainstem Eel, there is a summer fishery with bag limit five above Eaton Falls (CDFG 2002c).

At catch-and-release streams, all wild steelhead must be released unharmed. There are significant restrictions on gear used for angling. The CDFG (2000) states that "The only mortality expected from a no-harvest fishery is from hooking and handling injury or stress" (p. 16), and estimates this mortality rate to be about 0.25%-1.4%. This estimate is based on angler capture rates measured in other river systems throughout California (range: 5% - 28%) , multiplied by an estimated mortality rate of 5% once a fish is hooked. This estimate may be biased downward because it doesn't account for multiple catch/release events.

Some summer trout fishing is allowed, generally with a two- or five- bag limit. Cutthroat trout have a bag limit of two from a few coastal lagoons or esturaries.

B.2.6.4 New Hatchery/ESU Information

Current California hatchery steelhead stocks being considered in this ESU include the Mad River Hatchery, Yager Creek Hatchery, and the North Fork Gualala River Steelhead Project.

Mad River Hatchery (Mad River Steelhead [CDFG])

The Mad River Hatchery is located 20 km upriver near the town of Blue Lake (CDFG/NMFS 2001). The trap is located at the hatchery.

Broodstock Origin and History—The hatchery was opened in 1970 and steelhead were first released in 1971. The original steelhead releases were from adults taken at Benbow Dam on the South Fork Eel River. Between 1972 and 1974, broodstock at Mad River Hatchery were composed almost exclusively of South Fork Eel River steelhead. After 1974, returns to the hatchery supplied about 90% of the egg take; other eggs originated from Eel River steelhead. In addition, over 500 adult San Lorenzo River steelhead were spawned at Mad River Hatchery in 1972 and progeny of these fish may have been planted in the basin. All subsequent broodyears have come from trapping at the hatchery.

Broodstock size/natural population size—An average of 5,536 adults were trapped from 1991 to 2002 and an average of 178 females were spawned during the broodyears 1991-2002. There are no abundance estimates for the Mad River, but steelhead are widespread and abundance throughout the Basin.

Management—Starting in 1998, steelhead are 100% marked and fish are included in the broodstock in proportion to the numbers returned. The current production goals are 250,000 yearlings raised to 4-8/lb for release in March to May.

Population genetics—Alloyzme data group Mad River samples in with the Mad River Hatchery and then with the Eel River (Busby et al.1996).

Category—Category 3 hatchery. There have been no introductions since 1974, and naturally spawned fish are included in the broodstock. However, there is still an out-of-basin nature to the stock (SSHAG 2003; see Appendix B.5.2).

Yager Creek Hatchery (Yager Creek Steelhead [PalCo])

The Yager Creek trapping and rearing facility is located at the confluence of Yager and Cooper Mill creeks (tributaries of the Van Duzen River, which is a tributary of the Eel River).

Broodstock Origin and History—The project was initiated in 1976. Adult broodstock are taken from Yeager Creek and juveniles are released in the Van Duzen River Basin. As with all Co-operative hatcheries, the fish are all marked and hatchery fish are usually excluded from broodstock (unless wild fish are rare). There are no records of introductions to the broodstock.

Management—About 4,600 Freshwater Creek (a tributary of Humboldt Bay) juvenile steelhead were released in the Yager Creek Basin in 1993 (Busby et al. 1996). The current program goal is the restoration of Van Duzen River Steelhead.

Population genetics—There are no genetic data for this hatchery.

Category—Category 1 hatchery. The broodstock has had no out-of-basin introductions and hatchery fish are excluded from the broodstock (SSHAG 2003; see Appendix B.5.2).

North Fork Gualala River Hatchery (Gualala River Steelhead Project [CDFG/Gualala River Steelhead Project])

This project rears juvenile steelhead rescued from tributaries of the North Fork Gualala River. Rearing facilities are located on Doty Creek, a tributary of the Gualala River 12 miles from the mouth. Steelhead smolts resulting from this program are released in Doty Creek.

Broodstock Origin and History—The project was started in 1981 and has operated sporadically since then. Juvenile steelhead are rescued from the North Fork of the Gualala River and reared at Doty Creek.

Management—The current program goal is restoration of Gualala River steelhead.

Population genetics—There are no genetic data for this hatchery.
Category—Category 1 hatchery. Usually only naturally spawned juveniles are reared at this facility (SSHAG 2003; see Appendix B.5.2).

B.2.7 CENTRAL CALIFORNIA COAST STEELHEAD

B.2.7.1 Previous BRT Conclusions

The Central California Coast ESU inhabits coastal basins from the Russian River (Sonoma County), to Soquel Creek (Santa Cruz County) inclusive (Busby et al. 1996). Also included in this ESU are populations inhabiting tributaries of San Francisco and San Pablo bays. The ESU is composed only of winter-run fish.

Summary of major risks and status indicators

Risks and limiting factors—Two significant habitat blockages are the Coyote and Warm Springs Dams in the Russian River watershed; data indicated that other smaller fish passage problems were widespread in the geographic range of the ESU. Other impacts noted in the status report were: urbanization and poor land-use practices; catastrophic flooding in 1964 causing habitat degradation; and dewatering due to irrigation and diversion. Principal hatchery production in the region comes from the Warm Springs Hatchery on the Russian River, and the Monterey Bay Salmon and Trout Project on a tributary of Scott Creek. At the time of the status review there were other small private programs producing steelhead in the range of the ESU, reported by Bryant (1994) to be using stocks indigeneous to the ESU, but not necessarily to the particular basin in which the program was located. There was no information on the actual contribution of hatchery fish to naturally spawning populations.

Status indicators—One estimate of historical (pre-1960s) abundance was reported by Busby et al. (1996): Shapovalov and Taft (1954) described an average of about 500 adults in Waddell Creek (Santa Cruz County) for the 1930s and early 1940s. A bit more recently, Johnson (1964) estimated a run size of 20,000 steelhead in the San Lorenzo River before 1965, and CDFG (1965) estimated an average run size of 94,000 steelhead for the entire ESU, for the period 1959-1963 (see Table B.2.7.5 for a breakdown of numbers by basin). The analysis by CDFG (1965) was compromised by the fact that for many basins, the data did not exist for the full 5-year period. The authors of CDFG (1965) state that "estimates given here which are based on little or no data should be used only in outlining the major and critical factors of the resource."

Recent data for the Russian and San Lorenzo Rivers (CDFG 1994, Reavis 1991, Shuman 1994[13]; see Table B.2.7.5) suggested that these basins had populations smaller than 15% of the size that they had had 30 years previously. These two basins were thought to have originally contained the two largest steelhead populations in the ESU.

A status review update conducted in 1997 (Schiewe 1997) concluded that slight increases in abundance occurred in the 3 years following the status review, but the analyses on which these conclusions were based had various problems, including inability to distinguish hatchery and wild fish, unjustified expansion factors, variance in sampling efficiency on the San Lorenzo River. Presence/absence data compiled by P. Adams (SWFSC, personal communication)

[13] The basis for the estimates provided by Shuman (1994) appears to be questionable.

Table B.2.7.5. Summary of estimated runs sizes for the Central Coast steelhead ESU, reproduced from Busby et al. (1996), Tables 19 & 20.

River basin	Estimate of Run Size	Year	Reference
Russian River	65,000	1970	CACSS (1988)
	1750 – 7000	1994	McEwan and Jackson (1996), CDFG (1994)
Lagunitas Creek	500		CDFG (1994)
	400 – 500	1990s	McEwan and Jackson (1996)
San Gregorio	1,000	1973	Coots (1973)
Waddell Creek	481	1933–1942	Shapovolov and Taft (1954)
	250	1982	Shuman (1994)[14]
	150	1994	Shuman (1994)[14]
Scott Creek	400	1991	Nelson (1994)
	<100	1991	Reavis (1991)
	300	1994	Titus et al. (MS)
San Vicente Creek	150	1982	Shuman (1994)[14]
	50	1994	Shuman (1994)[14]
San Lorenzo River	20,000	Pre-1965	Johnson (1964), SWRCB (1982)
	1,614	1977	CDFG (1982)
	>3,000	1978	Ricker and Butler (1979)
	600	1979	CDFG (1982)
	3,000	1982	Shuman (1994)[14]
	"few"	1991	Reavis (1991)
	<150	1994	Shuman (1994)[14]
Soquel Creek	500 – 800	1982	Shuman (1994)[14]
	<100	1991	Reavis (1991)
	50 – 100	1994	Shuman (1994)[14]
Aptos Creek	200	1982	Shuman (1994)[14]
	<100	1991	Reavis (1991)
	50 – 75	1994	Shuman (1994)[14]

[14] The basis for the estimates provided by Shuman (1994) appears to be questionable.

indicated that most (82%) of sampled streams (a subset of all historical steelhead streams) had extant populations of juvenile *O. mykiss*.

Previous BRT conclusions

The original BRT concluded that the ESU was in danger of extinction (Busby et al. 1996). Extirpation was considered especially likely in Santa Cruz County and in the tributaries of San Pablo and San Francisco Bays. The BRT suggested that abundance in the Russian River (the largest system inhabited by the ESU) has declined seven-fold since the mid-1960s, but abundance appeared to be stable in smaller systems. Two major sources of uncertainty were: 1) few data on run sizes, which necessitated that the listing be based on indirect evidence, such as

habitat degradation; and 2) genetic heritage of populations in tributaries to San Francisco and San Pablo Bays was uncertain, causing the delineaton of the geographic boundaries of the ESU to be uncertain. A status review update (Schiewe 1997) concluded that conditions had improved slightly, and that the ESU was not presently in danger of extinction, but was likely to become so in the foreseeable future (Minorities supported both more and less extreme views on extinction risk.). Uncertainties in the update mainly revolved around inadequate sampling methods for estimating adult and juvenile numbers in various basins.

Listing status

The status of steelhead was formally assessed in 1996 (Busby et al. 1996). The original status review was updated in 1997 (Schiewe 1997), and the Central California Coast ESU was listed as threatened in August 1997.

B.2.7.2 New Updated Analyses

Juvenile data—The juvenile data were collected at numerous sites using a variety of methods. Many of the methods involved the selection of reaches thought to be "typical" or "representative" steelhead habitat; other reaches were selected because they were thought to be typical coho habitat, and steelhead counts were made incidentally to coho counts. In general, the field crew made electro-fishing counts (usually single-pass) of the young-of-the-year and 1+ age classes. Most of the target reaches got sampled several years in a row; thus there are a large number of short time-series. Although methods were always consistent within a time-series, they were not necessarily consistent across time-series.

We analyze these data below. However, we note that these data have limited usefulness for understanding the status of the adult population, due to non-random sampling of reaches within stream systems, non-random sampling of populations within the ESU, and a general lack of estimators shown to be robust for estimating fish density within a reach. In addition, even if more rigorous methods had been used, there is no simple relationship between juvenile numbers and adult numbers (Shea and Mangel 2001), the latter being the usual currency for status reviews. Table B.2.7.4 describes the various possible ways that one might translate juvenile trends into inferences about adult trends.

We calculated trends from the juvenile data. To estimate a trend, the data within each time-series were log-transformed and then normalized, so that each datum represented a deviation from the mean of that specific time-series. The normalization is intended to prevent spurious trends that could arise from the diverse set of methods used to collect the data. Then, the time-series were grouped into units thought to plausibly represent independent populations; the grouping was based on watershed structure. Finally, within each population a linear regression was done for the mean deviation versus year. The estimator for time-trend within each grouping is the slope of the regression line. The minimum length of the time series is 6 years (Other assessments in this status review place the cut-off at 10 yrs.). The recent origin of some relevant time-series and the fact that some of the shorter time-series include information for different age-classes prompted us to consider these slightly smaller datasets.

This procedure resulted in five independent populations for which a trend was estimated. Only downward trends were observed in the five populations (Figure B.2.7.4). The mean trend across all populations was significantly less than zero (H_o: slope ≥ 0; $p < 0.022$ via one-tailed *t*-test against expected value). This suggests an overall decline in juvenile abundance, but it is important to note that such a conclusion requires the assumptions that the assessed populations 1) are indeed independent populations rather than plausibly independent populations, and 2) were randomly sampled from all populations in the ESU.

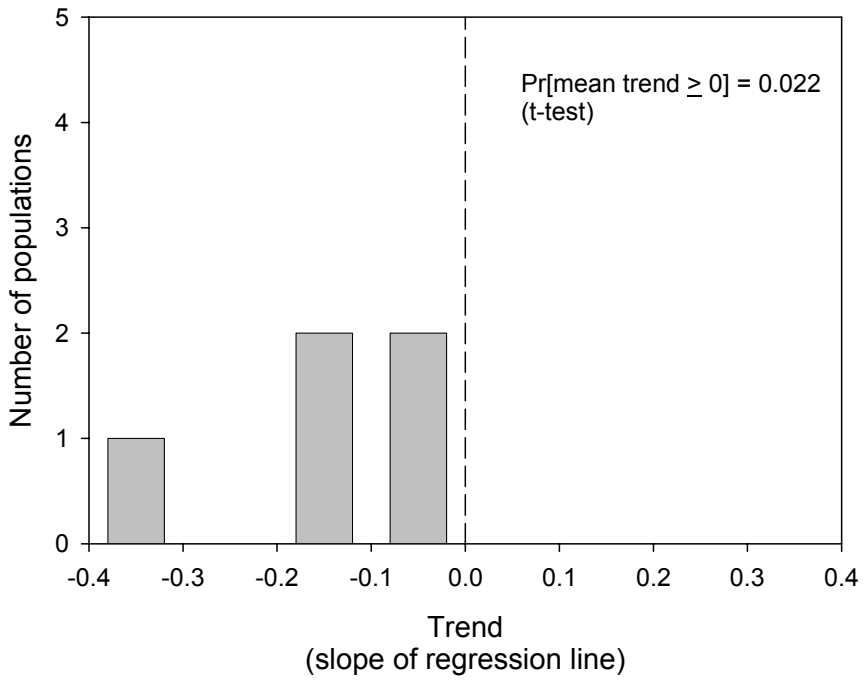

Figure B.2.7.4. Distribution of trends in juvenile densities, for five "independent" populations within the Central Coast steelhead ESU (see text for description of methods). Trend is measured as the slope of a regression line through a time-series; values less than zero indicate decline; values greater than zero indicate increase. Assuming that the populations were randomly drawn from the ESU as a whole, the hypothesis that the ESU is stable or increasing can be statistically rejected ($p = 0.022$); implying an overall decline.

Harvest impacts

Sport harvest of steelhead in the ocean is prohibited by the California Department of Fish and Game (CDFG 2002a), and ocean harvest is a rare event (M. Mohr, NMFS, pers. comm.). Freshwater sport fishing probably constitutes a larger impact.

CDFG (2002b) describes the current freshwater sport fishing regulations for steelhead of the central California ESU. All coastal streams are closed to fishing year round except for special listed streams which allow catch-and-release angling or summer trout fishing. Catch-and-release angling with restricted timing (generally, winter season Sundays, Saturdays, Wednesdays, and holidays) is allowed in the lower mainstems of many coastal streams south of San Francisco (Aptos Creek, Butano Creek, Pescadero Creek, San Gregorio Creek, San Lorenzo River, Scott Creek, Soquel Creek). Notably, Waddell Creek in Santa Cruz Co. had a 5-per day bag limit during the winter, for the short reach between Highway 1 and the ocean; this may have been a mistake as the bag limit was reduced to zero in the supplementary regulations issued in a separate document (CDFG 2002c). Catch and release is allowed year round except April and May in the lower parts of Salmon Creek in Sonoma County and Walker Creek in Marin County. Russian Gulch in Sonoma County has similar regulations except that 1 hatchery fish may be taken in the winter.

The Russian River is the largest system and probably originally supported the largest steelhead population in the ESU. The mainstem is currently open all year and has a bag limit of 2 hatchery steelhead or trout. Above the confluence with the East Branch it is closed year round. Santa Rosa Creek and Laguna Santa Rosa, Sonoma County tributaries to the Russian River, has a summer catch-and-release fishery.

Tributaries to the San Francisco Bay system have less restricted fisheries. All streams in Alameda, Contra Costa, and Santa Clara Counties (east and south Bay) have summer fisheries with bag limit five, except for special cases that are closed all year (Mitchell Creek, Redwood Creek in Alameda Co., San Francisquto Creek and tributaries, and Wildcat Creek). In the north Bay, the lower mainstem of the Napa River has catch-and-release year round except April and May; there is a bag limit of 1 hatchery steelhead or trout. Upper Sonoma Creek and tributaries have a summer fishery with bag limit 5.

For catch-and-release streams, all wild steelhead must be released unharmed. There are significant restrictions on gear used for angling. The CDFG (2000) states that “The only mortality expected from a no-harvest fishery is from hooking and handling injury or stress” (p. 16), and estimates this mortality rate to be about 0.25% - 1.4%. This estimate is based on angler capture rates measured in other river systems throughout California (range: 5% - 28%) , multiplied by an estimated mortality rate of 5% once a fish is hooked. This estimate may be biased downward because it doesn’t account for multiple catch/release events.

Summer trout fishing is allowed in some lakes and reservoirs or in tributaries to lakes, generally with 2 or 5 bag limit.

B.2.7.3 New Hatchery/ESU Information

Current California hatchery steelhead stocks being considered in this ESU include:

Don Clausen Fish Hatchery.
Monterey Bay Salmon & Trout Project.

Don Clausen Fish Hatchery (Warm Springs steelhead [CDFG])

The hatchery and collection site is located on Dry Creek, 14 miles from the confluence of Dry Creek and the Russian River that is 33 miles from the mouth. In 1992, the Coyote Valley Fish Facility was opened at the base of Coyote Valley Dam on the East Fork of the Russian River, 98 miles from the mouth. Both facilities trap fish on site. Coyote Valley fish are trapped and spawned there, but raised at Don Clausen Hatchery. The Coyote Valley steelhead are imprinted for 30 days at the facility before release.

Broodstock origin and history—The hatchery was founded in 1981 and the first steelhead releases were in 1982. The Coyote Valley Fish Facility was opened in 1992. Don Clausen Hatchery has had few out-of-basin transfers into its broodstock. However, significant numbers of Mad River Hatchery steelhead have been released into the basin. In the earlier part of the century, steelhead from Scott Creek were released throughout the basin. Since the Coyote Valley Fish Facility has been constructed, broodstock has been taken from trapping at the facility.

Broodstock size/natural population size—An average of 3,301 fish were trapped from 1992-2002 and 244 females spawned during the broodyears 1992-2002 at Don Clausen Hatchery. At the Coyote Valley Fish Facility, there have been an average of 1,947 steelhead trapped from 1993-2002 and an average of 124 females spawned. There are no steelhead abundance estimates for the Russian River, but fish are widely distributed and plentiful (NMFS, draft HGMP).

Management—Steelhead are 100% ad-clipped, starting in 1998. Both hatchery and naturally spawned fish are included in the broodstock in the proportion that they return to the hatchery until broodyear 2000. Since then, only adipose-marked fish are spawned and all unmarked steelhead are relocated into tributaries of Dry Creek. The production goal for Don Clausen Hatchery is 300,000 yearlings released beginning at December by size and all fish by April. The Coyote Valley Facility's goal is 200,000 yearlings that volitionally release between January and March.

Category—The hatchery is a Category 2 hatchery (SSHAG 2003; Appendix B.5.2). Although some out-of-ESU stocks were present in the basin, there have been no significant introductions since the hatchery began operations. The stock itself has only been cultivated for 20 years. The run is abundant and naturally spawned fish are included in the broodstock until 2000, since that time only adipose-marked steelhead are spawned.

Monterey Bay Salmon & Trout Project (Kingfisher Flat [Big Creek] Hatchery; Scott Creek steelhead)

The Kingfisher Flat Hatchery is located on Big Creek, a tributary of Scott Creek, 6 km miles from the mouth of Scott Creek. Broodstock are taken by divers netting adults usually in Big Creek below the hatchery, but can occur throughout the Scott Creek system (NMFS, draft BO). Steelhead are also taken at a trap on the San Lorenzo River in Felton. San Lorenzo River steelhead are kept separate and released back into the San Lorenzo Basin.

Broodstock Origin and History—The Kingfisher Flat Hatchery began in 1975. However, California state hatchery activity near this site has a long history back to 1904 (Strieg 1991). The state hatchery program ended in 1942 due to flood damage. Under the California state hatchery program, Scott Creek steelhead were widely planted throughout coastal California as they were thought to be an exceptionally healthy stock. The hatchery was damaged by floods in 1941-42 and closed. There are limited records of introductions from Mt. Shasta and Prairie Creek hatcheries into this broodstock. In 1976, the Monterey Bay Salmon & Trout Project began operations at the Big Creek location. Since then, broodstock are taken either in Scott Creek by divers or at a trap in the San Lorenzo River near Felton. Since that time, there have been no introductions into the broodstock. As with all Co-operative hatcheries, the fish are all marked and hatchery fish are usually excluded from broodstock. Fish are released in either Scott Creek or the San Lorenzo River depending on the source of the broodstock.

Broodstock size/natural population size—An average of 98 fish are trapped and 25 females spawned during the 1990-96 broodyears. There are no abundance estimates for Scott Creek and the San Lorenzo River, but juveniles are widespread and abundant (NMFS, draft BO).

Management—Starting in 2000, the practice of planting San Lorenzo fish into the North Fork of the Pajaro River Basin was discontinued. Although the distance is only a matter of miles, it is across ESU boundaries. The current program goal is the restoration of local steelhead stocks.

Population genetics—Alloyzme data groups the Scott Creek, San Lorenzo and Carmel River stocks together (Busby et al. 1996). These three streams falls into the south of the Russian River grouping.

Category—Category 1 hatchery (SSHAG 2003; Appendix B.5.2). The stock has not had out-of-basin introductions in recent years, and hatchery fish are excluded from the broodstock.

B.2.8 SOUTH-CENTRAL CALIFORNIA STEELHEAD

B.2.8.1 Previous BRT Conclusions

The geographic range of the ESU extends from the Pajaro River basin in Monterey Bay south to, but not including, the Santa Maria River Basin near the town of Santa Maria. The ESU was separated from steelhead populations to the north on the basis of genetic data (mitochondrial DNA and allozymes), and from steelhead populations to the south on the basis of a general faunal transition in the vicinity of Point Concepcion. The genetic differentiation of steelhead populations within the same ESU, and the genetic differentiation between ESUs, appears to be much greater in the south than in Northern California or the Pacific Northwest; however the conclusion is based on genetic data from a small number of populations.

Summary of major risks and status indicators

Risks and limiting factors—Numerous minor habitat blockages were considered likely throughout the region; other typical problems were thought to be habitat degradation; and dewatering from irrigation and urban water diversions.

Status indicators—Historical data on this ESU are sparse. In the mid 1960s, the CDFG (1965) estimated that the ESU-wide run size was about 17,750 adults. No comparable recent estimate exists; however, recent estimates exist for five river systems (Pajaro, Salinas, Carmel, Little Sur, and Big Sur), indicating runs of fewer than 500 adults where previously runs had been on the order of 4,750 adults (CDFG 1965). Time-series data only existed for one basin (the Carmel River), and indicated a decline of 22% per year over the interval 1963 to 1993 (Figure B.2.8.1).

Many of the streams have somewhat to highly impassable barriers, both natural and anthropogenic, and in their upper reaches, harbor populations of resident trout. The relationship between anadromous and resident *O. mykiss* is poorly understood in this ESU, but likely plays an important role in its population dynamics and evolutionary potential. A status review update conducted in 1997 (Schiewe 1997) listed numerous reports of juvenile *O. mykiss* in many coastal basins; but noted that the implications for adult numbers were unclear. They also discussed the fact that certain inland basins (the Salinas and Pajaro systems) are rather different ecologically from coastal basins.

BRT Conclusions

The original BRT concluded that the ESU was in danger of extinction, due to 1) low total abundance; and 2) downward trends in abundance in those stocks for which data existed. The negative effects of poor land-use practices and trout stocking were also noted. The major area of uncertainty was the lack of data on steelhead run sizes, past and present. The status review update (Schiewe 1997) concluded that abundance had slightly increased in the years immediately preceding, but that overall abundance was still low relative to historical numbers. They also expressed a concern that high juvenile abundance and low adult abundance observed in some datasets implied that many or most juveniles are resident fish (i.e. rainbow trout). The

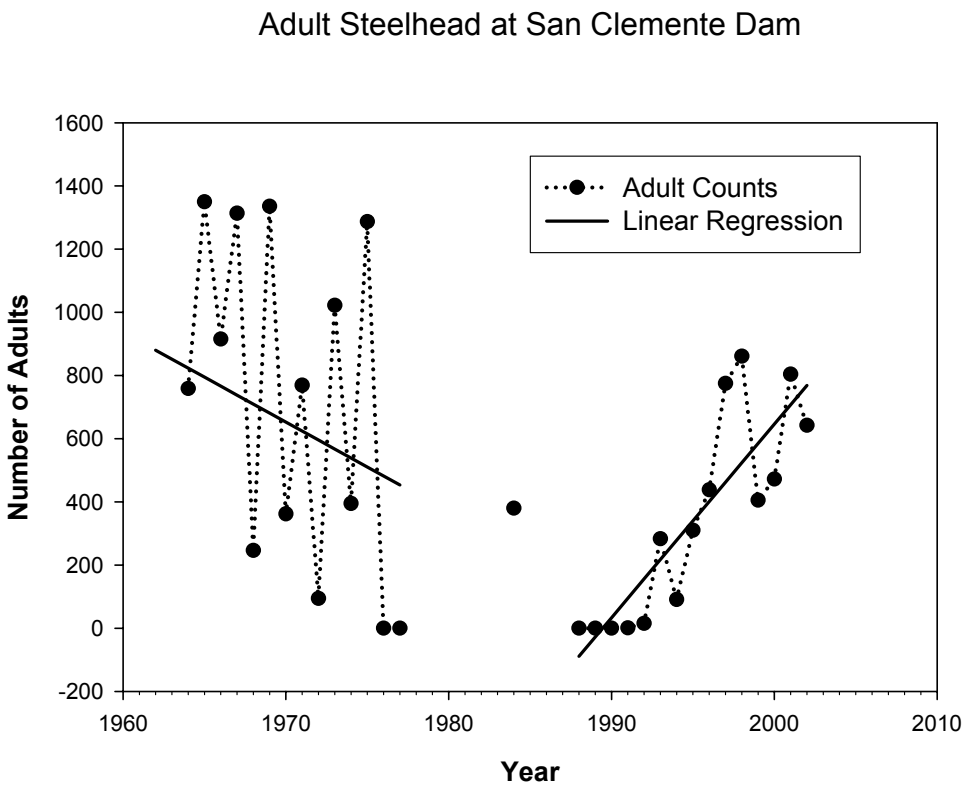

Figure B.2.8.1. Adult counts at San Clemente Dam, Carmel River. Data from the Monterey Peninsula Water Management District. See Snider (1983) for methods of counting fish before 1980. The increase from 1990 onwards is probably due in part to ongoing transplantation of juveniles from below to above the counting station at San Clemente Dam.

BRT convened for the update was nearly split on whether the fish were in danger of extinction, or currently not endangered but likely to become so in the foreseeable future, with the latter view holding a slight majority.

Listing Status

The ESU was listed as threatened in 1997.

B.2.8.2 New Data

There are two new significant pieces of information: 1) updated time-series data concerning dam counts made on the Carmel River (MPWMD 2002) (See analyses section below for further discussion), and 2) a comprehensive assessment of the current geographic distribution of *O. mykiss* within the ESU's historic range (Boughton & Fish MS; see next paragraph).

Table B.2.8.1. Estimates of historic run sizes from the previous status review (Busby 1996).

River basin	Run size estimate	Year	Reference
Pajaro R.	1,500	1964	McEwan and Jackson 1996
	1,000	1965	McEwan and Jackson 1996
	2,000	1966	McEwan and Jackson 1996
Carmel R.	20,000	1928	CACSS (1988)
	3,177	1964 – 1975	Snider (1983)
	2,000	1988	CACSS (1988)
	<4,000	1988	Meyer Resources (1988)

Current distribution vs. historical distribution—In 2002, an extensive study was made of steelhead occurrence in most of the coastal drainages between the northern and southern geographic boundaries of the ESU (Boughton and Fish MS). Steelhead were considered to be present in a basin if adult or juvenile *O. mykiss* were observed in stream reaches that had access to the ocean (i.e. no impassable barriers between the ocean and the survey site), in any of the years 2000-2002 (i.e. within one steelhead generation). Of 37 drainages in which steelhead were known to have occurred historically, between 86% and 95% were currently occupied by *O. mykiss*. The range in the estimate of occupancy occurs because three basins could not be assessed due to restricted access. Of the vacant basins, two were considered to be vacant because they were dry in 2002, and one was found to be watered but a snorkel survey revealed no *O. mykiss*. One of the "dry" basins—Old Creek—is dry because no releases were made from Whale Rock Reservoir; however, a land-locked population of steelhead is known to occur in the reservoir above the dam.

Occupancy was also determined for 18 basins with no historical record of steelhead occurrence. Three of these basins—Los Osos, Vicente, and Villa Creeks—were found to be occupied by *O. mykiss*. It is somewhat surprising that no previous record of steelhead seems to exist for Los Osos Creek, near Morro Bay and San Luis Obispo.

The current distribution of steelhead among the basins of the region is not much less than what occurred historically. This conclusion rests on the assumption that juveniles inhabiting stream reaches with access to the ocean will undergo smoltification and thus are truly steelhead.

B.2.8.3 New Updated Analyses

Two significant analyses exist: 1) A critical review of the historical run sizes cited in the previous status review, and 2) an assessment of recent trends observed in the adult counts being made on the Carmel River.

Review of historic run sizes—Estimates of historic sizes for a few runs were described in the previous status review (Busby et al. 1996), and are here reproduced in Table B.2.8.1.

The recent estimates for the Pajaro River (1,500, 1,000, 2,000) were reported in McEwan and Jackson (1996), but the methodology and dataset used to produce the estimates were not described.

CACCS (1988) suggested an annual run size of 20,000 adults in the Carmel River of the 1920s, but gave no supporting evidence for the estimate. Their 1988 estimate of 2,000 adults also lacked supporting evidence. Meyer Resources (1988) provides an estimate of run size, but was not available for review at the time of this writing. Snider (1983) examined the Carmel River, and in the abstract of his report gave an estimate of 3,177 fish as the mean annual smolt production for 1964 through 1975; Busby et al. (1996) mistakenly cited this estimate as an estimate of run size. Moreover, Snider's "3,177" figure may itself be a mistake, as it disagrees with the information in the body of Snider's (1983) report, which estimates annual smolt production in the year 1973 as 2,708 smolts, and in the year 1974 as 2,043 smolts. Snider (1983) also gives adult counts for fish migrating upstream through the fish ladder at San Clemente Dam, for the years 1964 through 1975 (data not reported in Busby et al. 1996. See Figure B.2.8.1 for counts.). The mean run size from these data is 821 adults. To make these estimates, visual counts were made twice a day by reducing the flow through the ladder and counting the fish in each step; thus they may underestimate the run size by some unknown amount if fish moved completely through the ladder between counts (an electronic counter was used in 1974 and 1975 and presumably is more accurate). In addition, San Clemente Dam occurs 19.2 miles from the mouth of the river and a small fraction of the run probably spawns below the dam.

Thus, much of the historical data used in the previous status review are highly uncertain or mistaken. The most reliable data are the Carmel River dam counts, which were not reported in the previous status review. Further analysis of these data are described below.

Abundance in the Carmel River—The Carmel River data are the only time-series for this ESU. These data suggest that the abundance of adult spawners in the Carmel River has increased since the last status review (Figure B.2.8.1). A continuous series of data exists for 1964 through 1977. A regression line drawn through these data indicates a downward trend, but the trend is not statistically significant (slope = -28.45; $R^2 = 0.075$; $F = 1.137$; $p = 0.304$;). Continuous data have also been collected for the period 1988 through 2002. The beginning of this time series has counts of zero adults for three consecutive years, then shows a rapid increase in abundance. The regression line has a positive slope that is statistically significant (slope = 61.30; $R^2 = 0.735$; $F = 36.00$; $p < 0.0001$). However, due to the initial zeros the data do not meet an assumption of the significance test (constant variance). A regression that omits the zeros also gives a positive slope that is statistically significant (slope = 66.56; $R^2 = 0.634$; $F = 17.33$; $p = 0.0019$) and that appears to meet the assumption of constant variance (see also Table B.2.8.3).

The time series is too short to infer anything about the underlying dynamical cause of the positive trend. In particular, a positive trend in a short time series may be due either to improved conditions (i.e. mean lambda greater than one), or to transient effects of age structure. It is also possible that the trend arises from immigration of adults (or the planting of juveniles) from other areas; in particular, from the lower reaches of the Carmel River below San Clemente dam. The rapid increase in adult abundance from 1991 (one adult) to 1997 (775 adults) seems great enough to require substantial immigration or transplantation as an explanation.

According to the Monterey Peninsula Water Management District, the entity responsible for managing the basin and the fishery, the likely reasons for the positive trend are:

> "Improvements in streamflow patterns, due to favorable natural fluctuations…since 1995; …actively manag[ing] the rate and distribution of groundwater extractions and direct surface diversions within the basin; changes to Cal-Am's [dam] operations … providing increased streamflow below San Clemente Dam; improved conditions for fish passage at Los Padres and San Clemente Dams …; recovery of riparian habitats, tree cover along the stream, and increases in woody debris…; extensive rescues … of juvenile steelhead over the last ten years … ; transplantation of the younger juveniles to viable habitat upstream and of older smolts to the lagoon or ocean; and implementation of a captive broodstock program by Carmel River Steelhead Association and California Department of Fish & Game (CDFG), [including] planting … from 1991 to1994." (MPWMD 2001)

Harvest impacts

Harvest of steelhead in West Coast ocean fisheries is a rare event (M. Mohr, NMFS, personal communication). Freshwater sport fishing probably constitutes a larger impact.

CDFG (2002) describes the current freshwater sport fishing regulations for steelhead of the south-central ESU. CDFG (2000) describes the basis for these regulations in terms of management objectives. The regulations allow catch-and-release winter steelhead angling in many of the river basins occupied by the ESU, specifiying that all wild steelhead must be released unharmed. There are significant restrictions on timing, location, and gear used for angling. The CDFG (2000) states that, "The only mortality expected from a no-harvest fishery is from hooking and handling injury or stress" (p. 16), and estimates this mortality rate to be about 0.25% - 1.4%. This estimate is based on angler capture rates measured in other river systems throughout California (range: 5% - 28%), multiplied by an estimated mortality rate of 5% once a fish is hooked. This estimate may be biased downward because it doesn't account for multiple catch/release events.

Summer trout fishing is allowed in some systems, often with a two- or five-bag limit. These include significant parts of the Salinas system (upper Arroyo Seco and Nacimiento above barriers; the upper Salinas; Salmon Creek; and the San Benito River in the Pajaro system (All: bag limit five trout). Also included in the summer fisheries is the Carmel River above Los Padres Dam (bag limit two trout, between 10" and 16"). A few other creeks have summer catch-and-release regulations. It is worth noting that the draft of the Fishery Management and Evaluation Plan (CDFG 2000) recommended complete closure of the Salinas system to protect the steelhead there, but the final regulations did not implement this recommendation, allowing both summer trout angling and winter catch-and-release steelhead angling in selected parts of the system (CDFG 2002).

B.2.8.4. New Hatchery/ESU Information

Current California hatchery steelhead stocks being considered in this ESU include:

Whale Rock Hatchery (Whale Rock Steelhead [CDFG])

Whale Rock Reservoir was created in 1961 by placing a dam on Old Creek (and Cottontail Creek), 2 km northwest of Cayucos. Old Creek had supported a large steelhead run previous to construction of the dam and these fish were presumably trapped behind the dam. Whale Rock Hatchery was established in 1992 as an effort to improve the sport fishery in the reservoir after anglers reported a decline in fishing success. The original Whale Rock broodstock (40 fish) were collected at a temporary weir placed in the reservoir at the mouth of Old Creek Cove (Nielsen et al. 1997). Adult fish are trapped in the shallows of the reservoir using nets that are set during late winter and spring as the fish begin their migration upstream from the reservoir into Old Creek. The fish are held in an enclosure while they are monitored for ripeness. Eggs and sperm are collected from fish using non-lethal techniques, and then the adult fish are returned to the reservoir. Fish were originally hatched and raised at the Whale Rock Hatchery located below the dam at the maintenance facility, but are now raised at the Fillmore Hatchery in Ventura County. The fry are cared for until September or November at which time they are released back into the reservoir as 3-5" fingerling trout.

Broodstock Origin and History—Hatchery operations began in 1992 and have been sporadic since. The project began as a cooperative venture, but has been taken over by CDFG. Fish were raised in 1992, 1994, 2000, and 2002 (John Bell, personal communication). All broodstock are taken from the reservoir.

Broodstock size/natural population size—An average of 121 fish were spawned. Spawning success was poor. There are no population estimates for the reservoir and the hatchery fish are not marked.

Management—The current program goal is to increase angling success in Whale Rock Reservoir.

Population genetics—Neilsen et al. (1997) found significant genetic identity remains between the Whale Rock Hatchery stock and wild steelhead in the Santa Ynez River and Malibu creeks, despite a loss of an overall genetic diversity within the hatchery stock.

Category—Category 2 hatchery (SSHAG 2003; Appendix B.5.2). Broodstock are taken from the source population, but the small, restricted population could easily lead to significant genetic bottlenecks.

B.2.9 SOUTHERN CALIFORNIA STEELHEAD

B.2.9.1 Previous BRT Conclusions

The geographic range of the ESU extends from the the Santa Maria River Basin near the town of Santa Maria, south to the United States border with Mexico. There is a report of *O. mykiss* populations in Baja California del Norte (Ruiz-Campos and Pister 1995); these populations are thought to be resident trout, but may be part of the ESU if found to be anadromous (note that they do not lie within the jurisdiction of the Endangered Species Act). Schiewe (1997) cites reports of several other steelhead populations south of the border. The southern California ESU is the extreme southern limit of the anadromous form of *O. mykiss*. It was separated from steelhead populations to the north on the basis of a general faunal transition (in the fauna of both freshwater and marine systems) in the vicinity of Point Concepcion. The genetic differentiation of steelhead populations within the ESU, and from other ESUs in northern California or the Pacific Northwest appears to be great; however the conclusion is based on genetic data from a small number of populations.

Summary of major risks and status indicators

Risks and limiting factors—There has been extensive loss of populations, especially south of Malibu Creek, due to urbanization, dewatering, channelization of creeks, human-made barriers to migration, and the introduction of exotic fish and riparian plants. Many of these southern-most populations may have originally been marginal or intermittent (i.e. exhibiting repeated local extinctions and recolonizations in bad and good years respectively). No hatchery production exists for the ESU. The relationship between anadromous and resident *O. mykiss* is poorly understood in this region, but likely plays an important role in population dynamics and evolutionary potential of the fish.

Status indicators—Historical data on the ESU are sparse. The historic run size for the ESU was estimated to be at least 32,000-46,000 (estimates for the four systems comprising the Santa Ynez, Ventura, Santa Clara Rivers, and Malibu Creek; this omits the Santa Maria system and points south of Malibu Creek). Recent run sizes for the same four systems were estimated to be less than 500 adults total. No time series data were found for any populations.

BRT conclusions

The original BRT concluded that that ESU was in danger of extinction, noting that populations were extirpated from much of their historical range (Busby et al. 1996). There was strong concern about widespread degradation, destruction, and blockage of freshwater habitats, and concern about stocking of rainbow trout. The two major areas of uncertainty were 1) lack of data on run sizes, past and present; and 2) the relationship between resident and anadromous forms of the species in this region. A second BRT convened for an update (Schiewe 1997) found that the small amount of new data did not suggest that the situation had improved, and the majority view was that the ESU was still in danger of extinction.

Listing status

The ESU was listed as endangered in 1997.

B.2.9.2 New Data

There are three new significant pieces of information: 1) Four years of adult counts in the Santa Clara River; 2) observed recolonizations of vacant watersheds, notably Topanga Creek in Los Angeles county, and San Mateo Creek in Orange county; and 3) a comprehensive assessment of the current distribution of *O. mykiss* within the historic range of the ESU (Boughton and Fish MS). Items (1) and (2) are described further in the analyses section below; item (3) is described here:

Current distribution vs. historical distribution

In 2002, an extensive study was made of steelhead occurrence in most of the coastal drainages within the geographic boundaries of the ESU (Boughton and Fish MS). Steelhead were considered to be present in a basin if adult or juvenile *O. mykiss* were observed in stream reaches that had access to the ocean (i.e. no impassable barriers between the ocean and the survey site), in any of the years 2000-2002 (i.e. within one steelhead generation). Of 65 drainages in which steelhead were known to have occurred historically, between 26% and 52% were still occupied by *O. mykiss*. The range in the estimate of occupancy occurs because 17 basins could not be surveyed, due to logistical problems, pollution, or lack of permission to survey on private land (most are probably vacant, based on a subjective assessment of habitat degradation). Four basins were considered vacant because they were dry, 18 were considered vacant due to impassable barriers below all spawning habitat; and eight were considered vacant because a snorkel survey found no evidence of *O. mykiss*. One of the "dry" basins—San Diego River—may have water in some tributaries—it was difficult to establish that the entire basin below the dam was completely dry. Numerous anecdotal accounts suggest that several of the basins that had complete barriers to anadromy may have landlocked populations of native steelhead/rainbow trout in the upper tributaries. These basins include the San Diego, Otay, San Gabriel, Santa Ana, and San Luis Rey Rivers. Occupancy was also determined for 17 basins with no historical record of steelhead occurrence; none were found to be currently occupied.

Nehlsen et al. (1991) listed the following Southern California stocks as extinct: Gaviota Creek, Rincon Creek, Los Angeles River, San Gabriel River, Santa Ana River, San Diego River, San Luis Rey River, San Mateo Creek, Santa Margarita River, Sweetwater River, and Maria Ygnacio River. The distributional study of 2002 determined that steelhead were present in two of these systems, namely Gaviota Creek (Stoecker and CCP 2002) and San Mateo Creek (a recent colonization; see below). Nevertheless, the current distribution of steelhead among the basins of the region appears to be substantially less than what occurred historically. Except for the small population in San Mateo Creek in northern San Diego County, the anadromous form of the species appears to be completely extirpated from all systems between the Santa Monica Mountains and the Mexican border.

Table B.2.9.1. Estimates from Busby et al. (1996), for run sizes in the major river systems of the southern steelhead ESU.

River basin	Run size estimate	Year	Reference
Santa Ynez	20,000 – 30,000	Historic	Reavis (1991)
	12,995 – 25,032	1940s	Shapovalov & Taft (1954)
	20,000	Historic	Titus et al (MS)
	20,000	1952	CDFG (1982)
Ventura	4,000-6,000	Historic	AFS (1991)
	4,000-6,000	Historic	Hunt et al. (1992)
	4,000-6,000	Historic	Henke (1994)
	4,000-6,000	Historic	Titus et al. (MS)
Matilija Cr.	2,000 – 2,500	Historic	Clanton & Jarvis (1946)
Santa Clara	7,000 – 9,000	Historic	Moore (1980)
	9,000	Historic	Comstock (1992)
	9,000	Historic	Henke (1994)

Recent colonization events

Several colonization events were reported during the interval 1996-2002. Steelhead colonized Topanga Creek in 1998 and San Mateo Creek in 1997 (R. Dagit, T. Hovey, pers. commun.). As of this writing (October 2002) both colonizations persist although the San Mateo Creek colonization appears to be declining. T. Hovey (CDFG, pers. commun.) used genetic analyses to establish that the colonization in San Mateo Creek was made by two spawning pairs in 1997. In the summer of 2002 a dead mature female was found in the channelized portion of the San Gabriel River in the Los Angeles area (M. Larsen, CDFG, pers. commun.). A single live adult was found trapped and over-summering in a small watered stretch of Arroyo Sequit in the Santa Monica Mountains (K. Pipal and D. Boughton, UCSC and NMFS, pers. commun.). The "run sizes" of these colonization attempts are of the same order as recent "run sizes" in the Santa Clara system—namely, less than five adults per year.

B.2.9.3 New and Updated Analyses

Two significant analyses exist: 1) A critical review of the historical run sizes cited in the previous status review, and 2) A few new data on run size and population distribution in three of the larger basins.

Review of historic run sizes

Few data exist on historic run sizes of southern steelhead. Based on the few data available, the previous status review made rough estimates for three of the large river systems (Table B.2.9.1), and a few of the smaller ones (Busby et al. 1996). The run size in the Santa Ynez system—probably the largest run historically—was estimated to originally lie between 20,000 and 30,000 spawners (Busby et al. 1996). This estimate was based primarily on four references cited in the status review: Reavis (1991) (20,000-30,000 spawners), Titus et al. (MS) (20,000

spawners), Shapovalov and Taft (1954) (12,995-25,032 spawners), and CDFG (1982) (20,000 spawners). Examination of these references revealed the following: Reavis (1991) asserted a run size of 20,000-30,000, but provided no supporting evidence. Titus et al. (MS) reviewed evidence described by Shapovalov (1944), to be described below. Shapovalov and Taft (1954) did not address run sizes in this geographic region; the citation is probably a mis-citation for Shapovalov (1944). CDFG (1982) was not obtained in time to review it for this writing.

Entrix (1995) argued that the above estimates are too large. They argue that the only original data on run sizes are from Shapovalov (1944), and are based on a CDFG employee's visual estimate that the 1944 run was "at least as large" as runs in the Eel River (northern California), which the employee had observed in previous years. Estimated run sizes for the Eel River ranged between 12,995 and 25,032 during the years 1939 to 1944 (Shapovalov 1944), and this has been reported as the estimated run size of the Santa Ynez. Entrix (1995) observed, however, that the employee who made the comparison was only present at the Eel River during two seasons, 1938-39 and 1939-40. The estimates for run sizes in those years were 12,995 and 14,476 respectively, which implies that a more realistic estimate for the Santa Ynez run size is 13,000-14,500.

This revised range of estimates may itself be a maximum, because the year 1944 occurred toward the end of a wet period that may have provided especially favorable spawning and rearing conditions for steelhead (Entrix 1995). In additon, the year 1944 seems to have occurred toward the end of a period in which extensive rescues of juvenile steelhead had been made during low-flow years (Shapovalov 1944, Titus et al. MS). During the interval 1939-1946, a total of 4.3 million juveniles were rescued from drying portions of the mainstem, and usually replanted elsewhere in the system (no rescues were made in 1941, due to sufficient flow). This averages to about 61,400 juveniles rescued per year. Assuming that rescue operations lowered the mean mortality rate as intended, during the 1939-1946 interval, the Santa Ynez population may have increased somewhat (or failed to undergo a decline) due to the rescue operations. These data also suggest that even in wet years, high mortality of juveniles during the summer months was a common occurrence.

On the other hand, the revised range of estimates (13,000-14,500) may be somewhat low, because it was not made until well after a significant proportion of spawning habitat had been lost. The Santa Ynez system currently has two major dams on the mainstem that block portions of spawning and rearing habitat. The upper dam (Gibralter) was built in 1920. At that time, no estimates of run size had been made for the Santa Ynez, but it was widely known that important spawning areas had become landlocked above Gilbralter dam (Titus et al. MS). The lower dam (Cachuma or Bradbury) was completed in 1953. It is also worth noting that due to the flashy nature of the Santa Ynez mainstem, and the propensity of the region for drought, the annual run sizes may have been zero in some years.

According to Titus et al. (MS), the Ventura River was estimated to have a run size of 4,000-5,000 adults during a normal water year. This estimate was made in 1946, after several years of planting juveniles from the Santa Ynez (27,200 in 1943, 20,800 in 1944, and 45,440 in 1945, as well as 40,000 in 1930, 34,000 in 1931, and 15,000 in 1938). Like the estimates for the Santa Clara, this estimate was made toward the end of a wet period, in a system that had received numerous plantings of juveniles. As in the Santa Ynez, anecdotal accounts suggest that run sizes

declined precipitously during the late 1940s and 1950s, due possibly to both drought and to anthropogenic changes to the river system. Similar considerations apply to the estimate made by Clanton and Jarvis (1946), of 2,000-2,500 adults in the Matilija basin, a major tributary of the Ventura River.

Moore's (1980) estimate of 9,000 spawners for the Santa Clara basin is based on the estimate of Clanton and Jarvis (1946) for Matilija Creek. Moore (1980) assumed similar levels of production per stream mile in the two systems, and noted that at least five-times more spawning and rearing habitat exists in the Santa Clara. Moore (1980) regarded his estimate as conservative, because although it included the major spawning areas (Santa Paula, Sespe, and Piru creeks), it omitted numerous small side-tributaries. On the other hand, his estimates also may be biased upwards for the same reasons as the estimates for the Ventura and Santa Ynez basins.

Ed Henke (cited in Schiewe 1997) stated that abundance of steelhead in the Southern California ESU was probably about 250,000 adults prior to European settlement of the region. His argument is based on historical methods of research involving interviews of older residents of the area as well as written records. The original analysis of data producing the estimate was not obtained in time for the current update.

In summary, the estimates of historic run sizes for this steelhead ESU are based on very sparse data and long chains of assumptions that are plausible but not exactly supportable. The existing estimates may be biased upwards, due to the fact that they were all made in the mid-1940s; or they may be biased downwards due to the omission of portions of spawning habitat. The authors of these estimates widely acknowledge both the uncertainty of the estimates, and the fact that average run sizes may not be terribly meaningful for this ESU, due to high year-to-year variability in the amount of water running through the systems.

Recent run sizes of large river systems

It seems likely that the larger river systems were originally the mainstay of the ESU. Large river systems, which probably harbored steelhead populations in the past are (from north to south) the Santa Maria, the Santa Ynez, the Santa Clara, the Los Angeles, the San Gabriel, the Santa Ana, and possibly the San Diego. Of these seven systems, the data suggest that steelhead currently occur in only three—the Santa Maria, Santa Ynez, and Santa Clara.

The Santa Maria—There do not appear to be any estimates for recent run sizes in the Santa Maria system. Twitchell Dam blocks access to a significant proportion of historical spawning habitat, the Cuyama River, one of the two major branches of the Santa Maria. The other major branch, the Sisquoc River, appears to still have substantial spawning and rearing habitat that is accessible from the ocean; juvenile steelhead have recently been observed in these areas (Cardenas 1996, Kevin Cooper, Los Padres NF, pers. commun.).

The Santa Ynez—Most historic spawning habitat is blocked by Cachuma and Gibralter Dams. However, extensive documentation exists for steelhead/rainbow trout populations in a number of ocean-accessible sites below Cachuma dam (Table B.2.9.2). These are Salsipuedes/El

Jaro Creeks, Hilton Creek, Alisal Creek, Quiota Creek, San Miguelito Creek, and three reaches in the mainstem (Hanson 1996, Engblom 1997, 1999, 2001). Various life stages of steelhead, including upstream migrants and smolts, have been consistently observed at some of these sites (see Table B.2.9.2). Run sizes are unknown, but likely small (<100 adults total).

The Santa Clara—A few estimates of recent run sizes exist for the Santa Clara system, due to the presence of a fish ladder and counting trap at the Vern Freeman Diversion Dam on the mainstem. This diversion dam lies between the ocean and what is widely believed to be one of the largest extant populations of steelhead in the ESU (the Sespe Canyon population). The run size of upstream migrants was one adult in each of 1994 and 1995, two adults in 1996, and no adults in 1997. The operation of the counting trap (but not the fish ladder) was discontinued in 1998 at the request of NMFS (the fish ladder itself is currently dysfunctional due to changes in flow patterns of the river).

Harvest impacts

Harvest of steelhead in West Coast ocean fisheries is a rare event (M. Mohr, NMFS, pers. commun.). Freshwater sport fishing probably constitutes a larger impact.

CDFG (2002) describes the current freshwater sport fishing regulations for steelhead of the southern ESU. The regulations specify that all wild steelhead must be released unharmed. Summer-fall catch-and-release angling is allowed in Piru Creek below the dam; San Juan Creek (Orange County); San Mateo Creek (one section); Santa Margarita River and tributaries; and Topanga Creek. Year-round catch and release is allowed in the San Gabriel River (below Cogswell Dam); and Sespe Creek and tributaries (all of the above are historical steelhead streams). Year-round trout fisheries are allowed in Calleguas Creek and tributaries (limit 5); Piru Creek above the dam (limit 2); San Luis Rey River (limit 5); Santa Paula Creek above the falls (limit 5); the Santa Ynez River above Gibralter Dam (limit 2); Sisquoc River (limit 5); and Sweetwater River (limit 5). With the possible exception of the Sisquoc River, these take-fisheries appear to be isolated from the ocean by natural or human-made barriers. Except for Calleguas Creek and possibly the Sweetwater, the above drainages are listed as historic steelhead streams by Titus et al. (MS). It is certainly possible that some currently harbor native trout with the potential to exhibit anadromy.

Table B.2.9.2. Presence of steelhead in the lower Santa Ynez River system (*caught in upstream migrant trap).

Tributary	Redds	<6"	>6"	Smolts	Adults	Unspec	Year (spr.)	Source
Salsipuedes/El Jaro		Y	Y	Y	Y*		1994	Hanson 1996
				Y	Y*		1995	Hanson 1996
	Y	Y	Y	Y	Y*		1996	Hanson 1996, Engblom 1997
	Y	Y	Y	Y	Y*		1997	Engblom 1997
	Y	Y	Y		Y*		1998	Engblom 1999
	Y	Y	Y		Y*		1999	Engblom 1999
					Y*		2000	Engblom 2001
		Y	Y	Y	Y*		2001	Engblom 2001
Hilton Creek		N	N		Y*		1994	Hanson 1996
		Y	Y†	Y	Y*		1995	Hanson 1996
				N	Y*		1996	Hanson 1996, Engblom 1997
	N	Y	Y	N	Y*		1997	Engblom 1997
	Y	Y			Y*		1998	Engblom 1999
					N*		1999	Engblom 1999
		Y	Y		Y*		2001	Engblom 2001
Alisal Creek		Y	Y		Y*		1995	Hanson 1996
Nojoqui Creek		N	N		N*		1994	Hanson 1996
				N	N*		1995	Hanson 1996
				N			1997	Engblom 1997
		N	Y		Y*		1998	Engblom 1999
					N*		1999	Engblom 1999
Quiota Creek (& trib)	Y		Y		N*		1995	Hanson 1996
		Y	Y				1994	Hanson 1996
		Y					1998	Engblom 1999
		Y	Y				2001	Engblom 2001
San Miguelito Creek		Y	Y				1996	Hanson 1996
	Y			Y			1997	Engblom 1997
		Y		N	N*		1998	Engblom 1999
	Y			N	N*		1999	Engblom 1999
Mainstem/Hwy 154		Y	Y				1995	Hanson 1996
		Y	Y				1996	Hanson 1996
					Y		1994	Hanson 1996
		Y	Y				1998	Engblom 1999
	Y						1999	Engblom 1999
		Y	Y				2001	Engblom 2001
Mainstem/Refugio		Y	Y				1995	Hanson 1996
		N	Y				1996	Hanson 1996
		Y	Y				1998	Engblom 1999
	Y	N	Y				1999	Engblom 1999
		Y	Y				2001	Engblom 2001
Mainstem/Alisal reach		Y	Y				1995	Hanson 1996
		N	Y				1996	Hanson 1996
		Y	Y				1998	Engblom 1999
		Y	Y				1999	Engblom 1999
		Y	Y				2001	Engblom 2001
Mainstem/Cargasachi		N	N				1995	Hanson 1996
		N	N				1996	Hanson 1996

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)

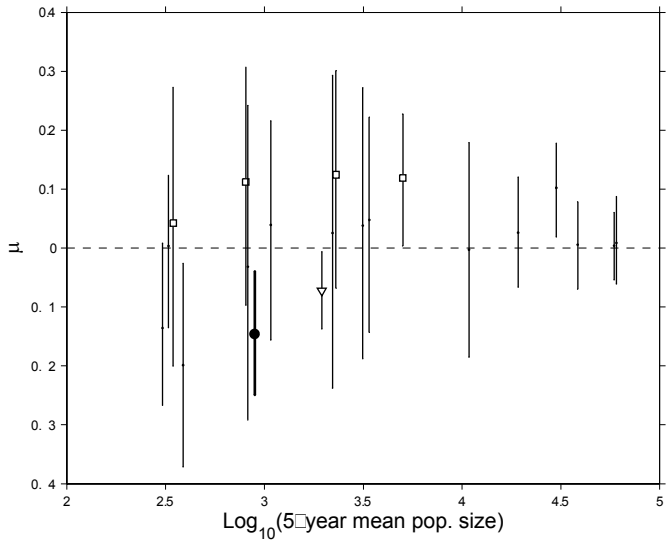

Figure B.2.10.1. Abundance and growth rate of Central Valley salmonid populations. Large filled circle- steelhead; open squares- spring chinook; open triangle- winter chinook; small black dots- other chinook stocks (mostly fall runs). Error bars represent central 0.90 probability intervals for μ estimates.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

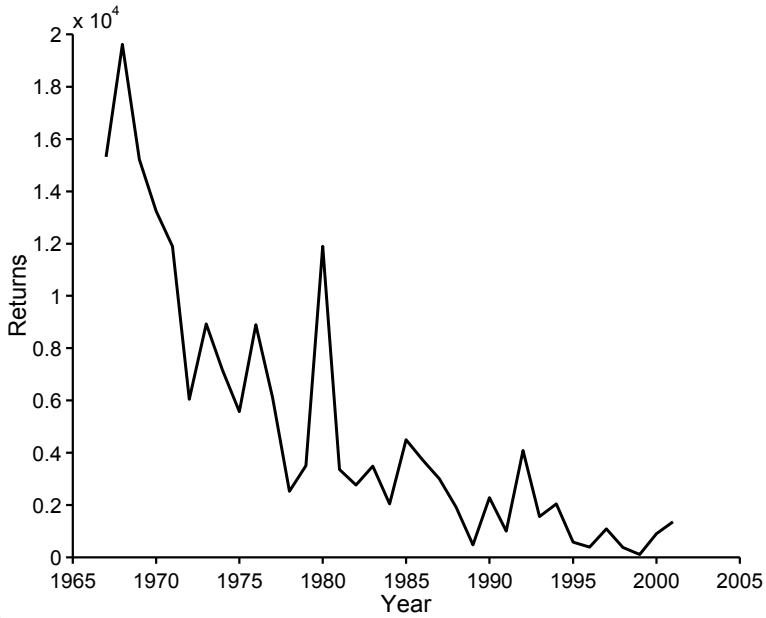

Figure B.2.10.2. Counts of steelhead passing the Red Bluff Diversion Dam fish ladders. These fish include hatchery fish from Coleman NFH.

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

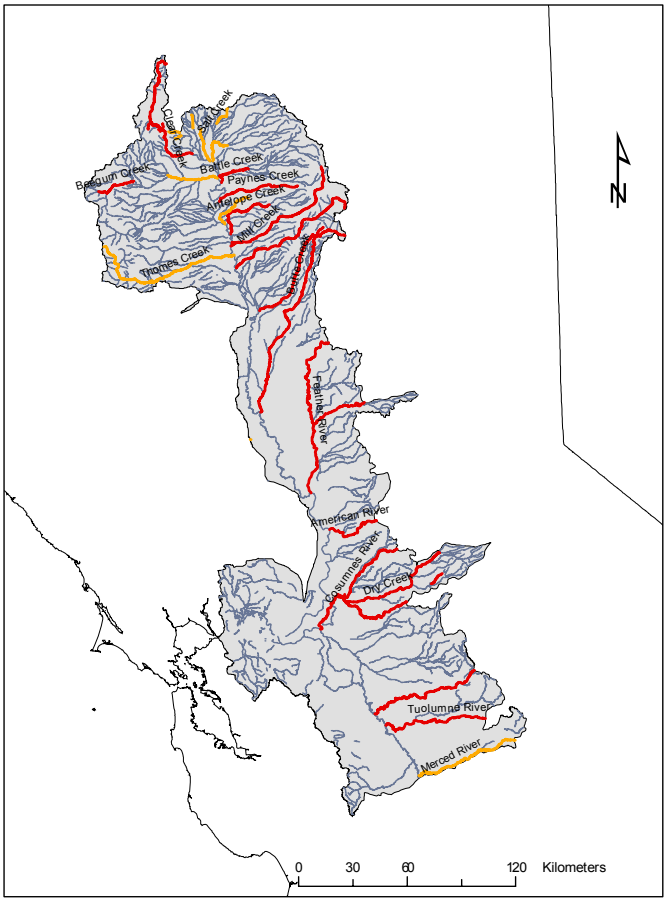

Figure B.2.10.3. Central Valley tributaries known (red lines; bold font) or suspected (orange lines; normal font) to be used by steelhead adults. Kerrie Pipal (NMFS Santa Cruz Lab) assembled this information from agency and consultant reports and discussions with CDFG field biologists.

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.

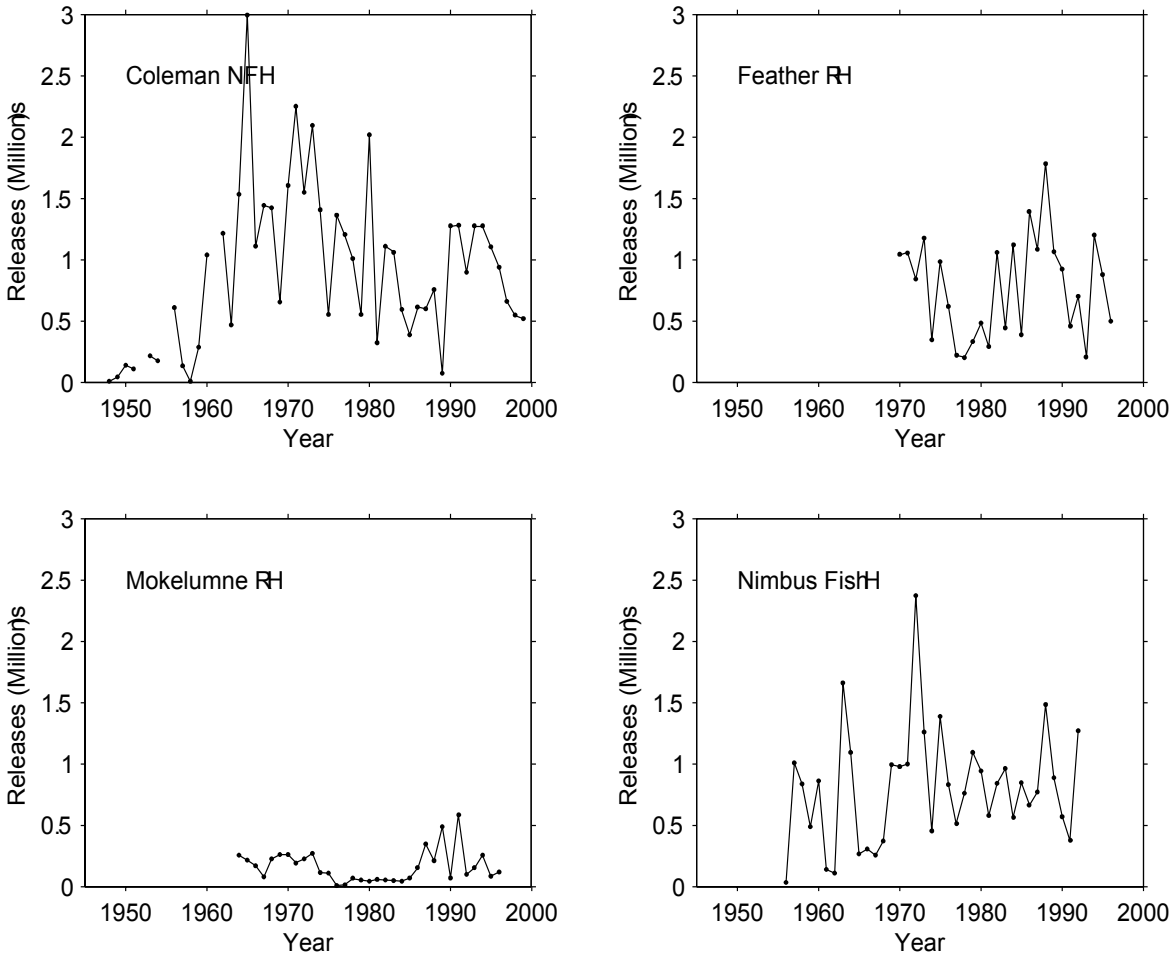

Figure B.2.10.4. Releases of steelhead from Central Valley hatcheries.

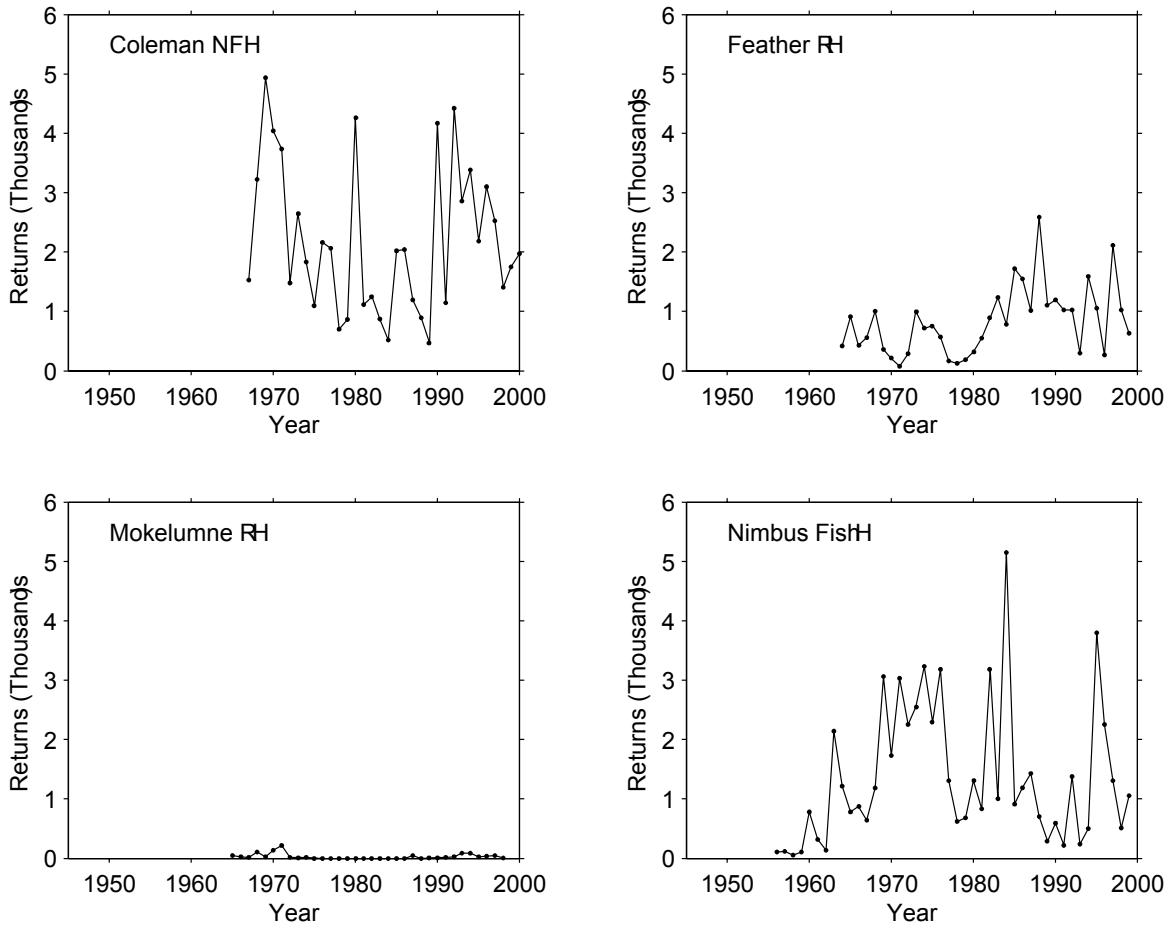

Figure B.2.10.5. Returns of steelhead to Central Valley hatcheries.

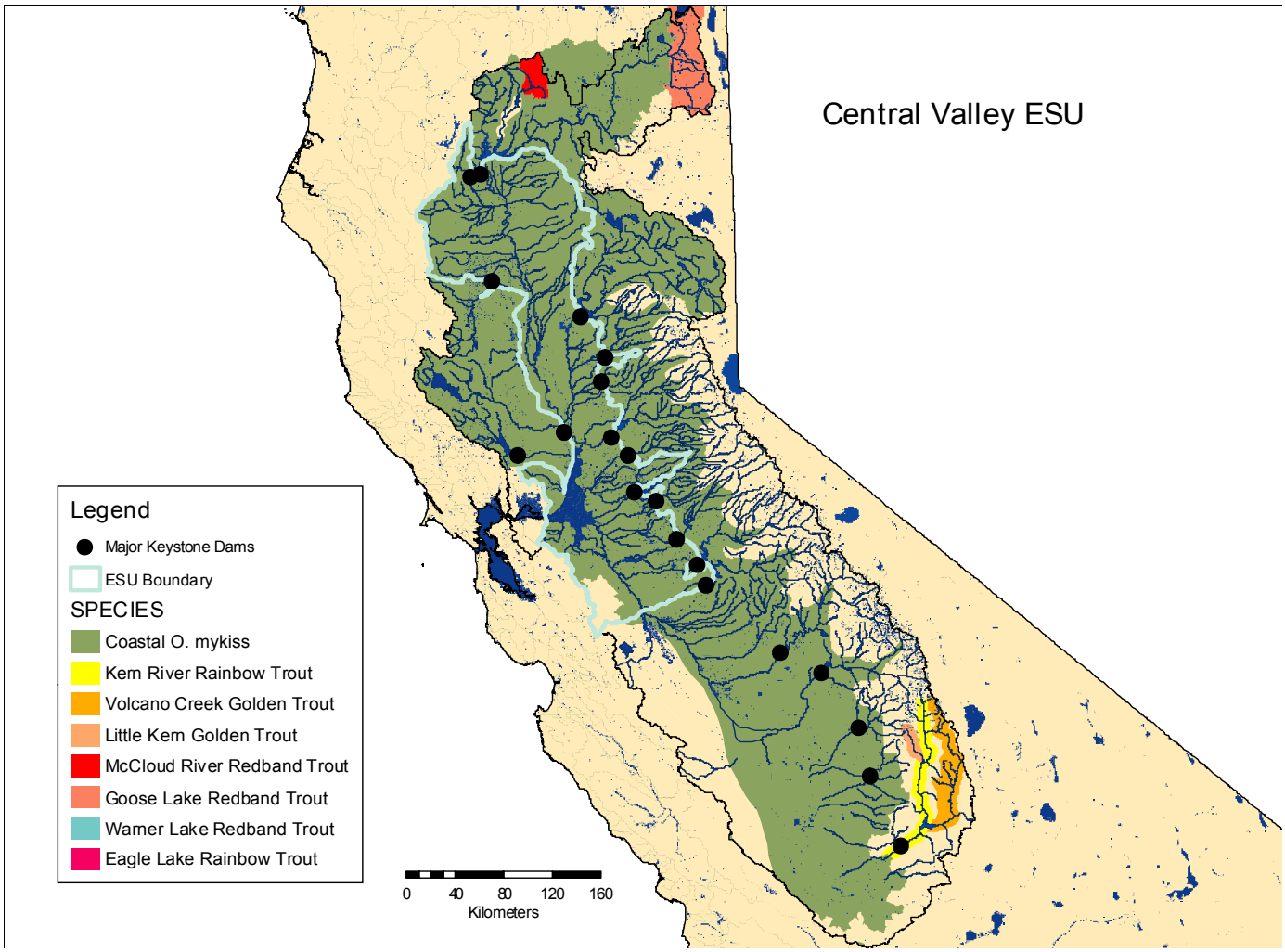

Figure B.2.10.6. Distribution of coastal *O. mykiss* and various *O. mykiss* subspecies in the Central Valley.

B.3 PRELIMINARY STEELHEAD BRT CONCLUSIONS

Snake River steelhead

A majority of the BRT votes for this ESU fell in the "likely to become endangered" category, with small minorities falling in the "danger of extinction," and "not likely to become endangered" categories. The BRT did not identify any extreme risks for this ESU but found moderate risks in all the VSP categories (mean risk matrix scores ranged from 2.5 for spatial structure to 3.2 for growth rate/productivity) (Table B.3.1). The continuing depressed status of B-run populations was a particular concern. Paucity of information on adult spawning escapements makes a quantitative assessment of viability for this ESU difficult. As indicated in previous status reviews, the BRT remained concerned about the replacement of naturally produced fish by hatchery fish in this ESU; naturally produced fish now make up only a small fraction of the total adult run. Again, lack of key information considerably complicates the risk analysis. Although several large production hatcheries for steelhead occur throughout this ESU, relatively few data exist regarding the number of hatchery fish that spawn naturally, or the consequences of such spawnings when they do occur.

On a more positive note, sharp upturns in 2000 and 2001 in adult returns in some populations and evidence for high smolt-adult survival indicate that populations in this ESU are still capable of responding to favorable environmental conditions. In spite of the recent increases, however, abundance in most populations for which there are adequate data are well below interim recovery targets (NMFS 2002).

The BRT did not attempt to resolve the ESU status of resident fish residing above the Hell's Canyon Dam complex, as little new information is available relevant to this issue. However, Kostow (2003) suggested that, based on substantial ecological differences in habitat, the anadromous *O. mykiss* that historically occupied basins upstream of Hell's Canyon (e.g., Powder, Burnt, Malheur, Owhyee rivers) may have been in a separate ESU.

Based on the provisional framework discussed in the introduction, the BRT assumed as a working hypothesis that resident fish below historic barriers are part of this ESU, while those above long-standing natural barriers (e.g., in the Palouse and Malad rivers) are not. Recent genetic data suggest that native resident *O. mykiss* above Dworshak Dam on the North Fork Clearwater River should be considered part of this ESU, but hatchery rainbow trout that have been introduced to that and other areas would not.

Upper Columbia River steelhead

A slight majority of the BRT votes for this ESU fell in the "danger of extinction" category, with most of the rest falling in the "likely to become endangered" category. The most serious risk identified for this ESU was growth rate/productivity (mean score 4.3); scores for the other VSP factors were also relatively high, ranging from 3.1 (spatial structure) to 3.6 (diversity) (Table B.3.1). The last 2-3 years have seen an encouraging increase in the number of naturally produced fish in this ESU. However, the recent mean abundance in the major basins is still only a fraction of interim recovery targets (NMFS 2002). Furthermore, overall adult returns are still

dominated by hatchery fish, and detailed information is lacking regarding productivity of natural populations. The BRT did not find data to suggest that the extremely low replacement rate of naturally spawning fish (estimated adult:adult ratio was only 0.25-0.3 at the time of the last status review update) has improved substantially.

The BRT did not attempt to resolve the ESU status of resident fish residing above Grand Coulee Dam as little new information is available relevant to this issue. Based on the provisional framework discussed in the introduction, the BRT assumed as a working hypothesis that resident fish below historic barriers are part of this ESU, while those above long-standing natural barriers (e.g., in the Entiat, Methow, and perhaps, Okanogan basins) are not. Resident fish potentially occur in all areas in the ESU used by steelhead. According to this framework, native resident fish above Conconully Dam would provisionally be part of the ESU.

Middle Columbia River steelhead

A majority of the BRT votes for this ESU fell in the "likely to become endangered" category, with a minority falling in the "not likely to become endangered" category. The BRT did not identify any extreme risks for this ESU but found moderate risks in all the VSP categories (mean risk matrix scores ranged from 2.5 for spatial structure to 2.8 for abundance) (Table B.3.1).

This ESU proved difficult to evaluate for two reasons. First, the status of different populations within the ESU varies greatly. On the one hand, the abundance in two major basins, the Deschutes and John Day, is relatively high, and over the last 5 years, is close to or slightly over the interim recovery targets (NMFS 2002). On the other hand, steelhead in the Yakima basin, once a large producer of steelhead, remain severely depressed (10% of the interim recovery target), in spite of increases in the last 2 years. Furthermore, in recent years, escapement to spawning grounds in the Deschutes River has been dominated by stray, out-of-basin (and largely out-of-ESU) fish—which raises substantial questions about genetic integrity and productivity of the Deschutes population. The John Day is the only basin of substantial size in which production is clearly driven by natural spawners. The other difficult issue centered on how to evaluate the contribution of resident fish, which according to Kostow (2003) and other sources, are very common in this ESU and may greatly outnumber anadromous fish. The BRT concluded that the relatively abundant and widely distributed resident fish mitigated extinction risk in this ESU somewhat. However, due to significant threats to the anadromous component the majority of BRT members concluded the ESU was likely to become endangered.

Based on the provisional framework discussed in the introduction, the BRT assumed as a working hypothesis that resident fish below historic barriers are part of this ESU, while those above long-standing natural barriers (e.g., in Deschutes and John Day basins) 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 Condit Dam in the Little White Salmon; above Pelton and Round Butte dams (but below natural barriers) in the Deschutes; and above irrigation dams in the Umatilla rivers provisionally would be part of the ESU.

Lower Columbia River steelhead

A majority of the BRT votes for this ESU fell in the "likely to become endangered" category, with small minorities falling in the "danger of extinction," and "not likely to become endangered" categories. The BRT found moderate risks in all the VSP categories, with mean risk matrix scores ranging from 2.7 for spatial structure to 3.3 for both abundance and growth rate/productivity (Table B.3.1). All of the major risk factors identified by previous BRTs still remain. Most populations are at relatively low abundance, although many have shown higher returns in the last 2-3 years, and those with adequate data for modeling are estimated to have a relatively high extinction probability. The Willamette-Lower Columbia River TRT (Myers et al. 2002) has estimated that at least four historic populations are now extinct. The hatchery contribution to natural spawning remains high in many populations.

Based on the provisional framework discussed in the introduction, the BRT assumed as a hypothesis that resident fish below historic barriers are part of this ESU, while those above long-standing natural barriers (e.g., in upper Clackamas, Sandy, and some of the small tributaries of the Columbia River Gorge) are not. According to this framework, native resident fish above dams on the Cowlitz, Lewis, and Sandy rivers provisionally would be part of the ESU.

Upper Willamette River steelhead

A majority of the BRT votes for this ESU fell in the "likely to become endangered" category, with small minorities falling in the "danger of extinction," and "not likely to become endangered" categories. The BRT did not identify any extreme risks for this ESU but found moderate risks in all the VSP categories (mean risk matrix scores ranged from 2.6 for diversity to 2.9 for both spatial structure and growth rate/productivity) (Table B.3.1). On a positive note, after a decade in which overall abundance (Willamette Falls count) hovered around the lowest levels on record, adult returns for 2001 and 2002 were up significantly, on par with levels seen in the 1980s. Still, the total abundance is small for an entire ESU, resulting in a number of populations that are each at relatively low abundance. The recent increases are encouraging but it is uncertain whether they can be sustained. The BRT considered it a positive sign that releases of the "early" winter-run hatchery population have been discontinued, but remained concerned that releases of non-native summer steelhead continue.

Because coastal cutthroat trout is a dominant species in the basin, resident *O. mykiss* are not as widespread here as in areas east of the Cascades. Resident fish below barriers are found in the Pudding/Molalla, Lower Santiam, Calapooia, and Tualatin drainages, and these would be considered part of the steelhead ESU based on the provisional framework. According to this framework, native resident fish above Big Cliff and Detroit dams on the North Fork Santiam and above Green Peter Dam on the South Fork Santiam also would be part of the ESU. Although there are no obvious physical barriers separating populations upstream of the Calapooia from those lower in the basin, resident *O. mykiss* in these upper basins are quite distinctive both phenotypically and genetically and are not considered part of the steelhead ESU.

Northern California steelhead

The majority of BRT votes were for "likely to become endangered," with the remaining votes split about equally between "in danger of extinction," and "not warranted." Abundance and productivity were of some concern (scores of 3.7; 3.3 in the risk matrix); spatial structure and diversity were of lower concern (scores of 2.2; 2.5); although at least one BRT member gave scores as high as 4 for each of these risk metrics (Table B.3.1).

The BRT considered the lack of data for this ESU to be a source of risk due to uncertainty. The lack of recent data is particularly acute for winter runs. While there are older data for several of the larger river systems that imply run sizes became much reduced since the early 20th century, there are no recent data suggesting much of an improvement.

Based on the provisional framework discussed in the introduction, the BRT assumed as a working hypothesis that resident fish below historic barriers are part of the Northern California Coast 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 Robert W. Matthews Dam on the Mad River, and Scott Dam on the Eel River, but below natural barriers, provisionally would be part of the ESU. In this ESU, the inclusion of resident fish does not greatly increase the total numbers of fish nor have the resident fish been exposed to large amounts of hatchery stocking.

Central California Coast steelhead

The majority of BRT votes were for "likely to become endangered," and a minority were for "in danger of extinction." Abundance and productivity were of relatively high concern (mean score of 3.9 for each, with a range of 3-5 for each), and spatial structure was also of concern (score 3.6) (Table B.3.1). Predation by pinnipeds at river mouths and during the ocean phase was noted as a recent development posing significant risk.

There were no time-series data for this ESU. A variety of evidence suggested the largest run in the ESU (the Russian River winter steelhead run) has been reduced in size and continues to be reduced in size. Concern was also expressed about the populations in the southern part of the range of the ESU—notably populations in Santa Cruz County and the South Bay area.

Based on the provisional framework discussed in the introduction, the BRT assumed as a working hypothesis that resident fish below historic barriers are part of the Central California Coast 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 Warm Springs Dam on Dry Creek, Russian River; Coyote Dam on the East Fork Russian River; Seeger Dam on Lagunitas Creek; Peters Dam on Nicasio Creek, Lagunitas Creek; Standish Dam on Coyote Creek; and Dam 1 on Alameda Creek; but below natural barriers, provisionally would be part of the ESU. In this ESU, 22% of habitat is behind recent barriers, but there is no density information.

South-Central California Coast steelhead

The majority of BRT votes were for "likely to become endangered," and the minority were for "in danger of extinction." The strongest concern was for spatial structure (score 3.9; range 3-5), but abundance and productivity were also a concern (Table B.3.1). The cessation of plants to the ESU from the Big Creek Hatchery (Central Coast ESU) was noted as a positive development; whereas continued predation from sport fishers was considered a negative development.

New data exists suggesting that populations of steelhead exist in most of the streams within the geographic boundaries of the ESU; however, the BRT was concerned that the two largest river systems—the Pajaro and Salinas basins—are much degraded and have steelhead runs much reduced in size. Concern was also expressed about the fact that these two large systems are ecologically distinct from the populations in the Big Sur area and San Luis Obispo County, and thus, their degradation affects spatial structure and diversity of the ESU. Much discussion centered on the dataset from the Carmel River, including the effects of the drought in the 1980s, the current dependence of the population on intensive management of the river system, and the vulnerability of the population to future droughts.

Based on the provisional framework discussed in the introduction, the BRT assumed as a working hypothesis that resident fish below historic barriers are part of the South-Central California Coast 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 San Antonia, Nacimiento, and Salinas dams on the Salinas River; Los Padres Dam on the Carmel River; Whale Rock Dam on Old Creek; and Lopez Dam on Arroyo Grande Creek; but below natural barriers, provisionally would be part of the ESU. In this ESU, little of the ESU is behind recent barriers and most of that is on the Salinas River.

Southern California steelhead

The majority of BRT votes were for "in danger of extinction," with the remaining votes being for "likely to become endangered." Extremely strong concern was expressed for abundance, productivity, and spatial structure (mean scores of 4.8, 4.3, and 4.8, respectively), and diversity was also of concern (mean score of 3.6) (Table B.3.1).

The BRT expressed concern about the lack of data on this ESU, about uncertainty as to the metapopulation dynamics in the southern part of the range of the ESU, and about the fish's nearly complete extirpation from the southern part of the range. Several members were concerned and uncertain about the relationship between the population in Sespe Canyon, which is supposedly a sizeable population, and the small run size passing through the Santa Clara River, which connects the Sespe to the ocean. There was some skepticism that flows in the Santa Maria River were sufficient to allow fish passage from the ocean to the Sisquoc River, another "stronghold" of *O. mykiss* in the ESU.

Based on the provisional framework discussed in the introduction, the BRT assumed as a working hypothesis that resident fish below historic barriers are part of the Southern California 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 Twitchell Dam on the Cuyama River; Bradbury Dam on the Santa Ynez River; Casitas Dam on Coyote Creek, Ventura River; Matilija Dam on Matilija Creek, Ventura River; Santa Felicia Dam on Piru Creek, Santa Clara River; and Casitac Dam on Casitac Creek, Santa Clara River; but below natural barriers, provisionally would be part of the ESU. In this ESU, a large portion of the original area is behind barriers and the few densities estimates from this ESU indicate that the inclusion of area above recent barriers substantially increases the number of fish in the ESU. Due to the extremely low numbers of anadromous fish in this ESU, it is possible that above-barrier populations contribute a significant number of fish to the below-barrier population by spill over.

California Central Valley steelhead

The majority of BRT votes were for "in danger of extinction," and the remainder was for "likely to become endangered." Abundance, productivity, and spatial structure were of highest concern (4.2-4.4), although diversity considerations were of significant concern (3.6) (Table B.3.1). All categories received a 5 from at least one BRT member.

The BRT was highly concerned by the fact that what little new information was available indicated that the monotonic decline in total abundance and in the proportion of wild fish in the ESU was continuing. Other major concerns included the loss of the vast majority of historic spawning areas above impassable dams, the lack of any steelhead-specific status monitoring, and the significant production of out-of-ESU steelhead by the Nimbus and Mokelumne River fish hatcheries. The BRT was unmoved by the sparse information suggesting widespread and abundant *O. mykiss* populations in areas above impassable dams, viewing the anadromous life-history form as a critical component of diversity within the ESU. Dams both reduce the scope for and expression of the anadromous life-history form, thereby greatly reducing the abundance of anadromous *O. mykiss*, and preventing exchange of migrants among resident populations, a process presumably mediated by anadromous fish.

Based on the provisional framework discussed in the introduction, 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.

Table B.3.1. Summary of risk scores (1 = low to 5 = high) for four VSP categories (see section "Factors Considered in Status Assessments" for a description of the risk categories) for the 10 steelhead ESUs reviewed. Data presented are means (range).

ESU	Abundance	Growth Rate/Productivity	Spatial Structure and Connectivity	Diversity
Snake River	3.1 (2-4)	3.2 (2-4)	2.5 (1-4)	3.1 (2-4)
Upper Columbia	3.5 (2-4)	4.3 (3-5)	3.1 (2-4)	3.6 (2-5)
Middle Columbia	2.8 (2-4)	2.6 (2-3)	2.5 (1-4)	2.6 (2-4)
Lower Columbia	3.3 (2-5)	3.3 (3-4)	2.7 (2-4)	3.0 (2-4)
Upper Willamette	2.8 (2-4)	2.9 (2-4)	2.9 (2-4)	2.6 (2-3)
Northern California	3.7 (3-5)	3.3 (2-4)	2.2 (1-4)	2.5 (1-4)
Central California Coast	3.9 (3-5)	3.9 (3-5)	3.6 (2-5)	2.8 (2-4)
South Central California	3.7 (2-5)	3.3 (2-4)	3.9 (3-5)	2.9 (2-4)
Southern California	4.8 (4-5)	4.3 (3-5)	4.8 (4-5)	3.6 (2-5)
Central Valley	4.4 (4-5)	4.3 (4-3)	4.2 (2-5)	3.6 (2-5)

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B.5 APPENDICES

Appendix B.5.1. Distribution of *O. mykiss* trout by category in the Columbia Basin steelhead ESUs. Only major barriers are noted; numerous small barriers, both natural and artificial, also exist. *O. mykiss* trout distribution in areas of sympatry with steelhead may be restricted in some areas if native *O. clarki* trout are also in the basin. The generalized listing of basins and subbasins does not imply that these constitute single trout populations or that trout distribution is continuous throughout the areas listed (from Kostow 2003).

ESU	**Category 1** **Trout Populations** **(Sympatric)**	**Category 2** **Trout Populations** **(Major Natural Barriers)**	**Category 3** **Trout Populations** **(Major Artificial Barriers)**
Willamette	Pudding/Molalla Lower Santiam Calapooia Tualatin (Gales Cr.)	All populations upstream of Calapooia McKenzie M. Fork Willamette	NFk. Santiam (Big Cliff/Detroit dams) S. Fork Santiam (Green Peter Dam)
Lower Columbia	Historic use of lower basins by trout may have been greater Wind Clackamas: Callowash Other areas (?) Hood: West Fork Middle Fork Sandy (?) Upper Cowlitz Upper Kalama Upper Lewis Upper Washougal	Clackamas: Roaring R. North Fork South Fork Memaloose (?) Sandy: Little Sandy Salmon (?) Some of the Columbia Gorge small tributaries	Cowlitz (Mayfield Dam) Lewis (Merwin Dam) Sandy (Bull Run dams)

Appendix B.5.1 (continued)

ESU	Category 1 (Sympatric)	Category 2 (Major Natural Barriers)	Category 3 (Major Artificial Barriers)
Mid-Columbia	Historically all areas where steelhead are/were present. Trout distributions currently more restricted. Fifteenmile Eightmile Deschutes Klickitat Umatilla: Upper Umatilla John Day: Upper tributaries Walla Walla Upper tributaries Yakima: Upper Yakima Naches Some other small tributaries	All natural barriers upstream of Klickitat and Deschutes Basins: Deschutes: White River Upper Deschutes (Big Falls) Upper NFk Crooked R. John Day: Upper SFk. John Day	Trout distributions currently more restricted than historically Little White Salmon (Conduit Dam) Deschutes (Pelton/Round Butte dams) Metolius Squaw Cr. Crooked River Umatilla (Irrigation dams) Willow Cr. Butter Cr. McKay Cr.

Appendix B.5.1 (continued)

ESU	Category 1 (Sympatric)	Category 2 (Major Natural Barriers)	Category 3 (Major Artificial Barriers)
Snake	Potentially all areas that are/were used by steelhead. Tucannon Asotin Grande Ronde Imnaha Salmon found in about 43% of streams Clearwater Selway Other areas?	Palouse River Malad River Several Hells Canyon tributaries Upper Malheur Basin "recent" disconnect from lower Malheur Lakes Basin	Trout distributions currently more restricted than historically North Fork Clearwater (Dworshak Dam) Mainstem Snake (Hells Canyon Dam) Powder Burnt Malheur Owhyee Weiser Payette Boise Burneau Salmon Falls Cr. Several small tributaries
Upper Columbia	Potentially all areas that are/were used by steelhead Wenatchee Lower Entiat Methow Okanogan	Upper Entiat Upper Kootenay Methow: Chewuch? Lost Okanogan: Enlow Falls?	Trout distributions currently more restricted than historically Okanogan Basin: Conconully Dam/Enlow Dam? Chief Joseph Dam Lower Spokane to Post Falls Sanpoil Several small tributaries Lower Pend Oreille to Z-Canyon Columbia headwaters in Canada

Table 1. Major manmade barriers on California rivers and associated above barrier populations of *Oncorhynchus mykiss* by ESU and watershed. A major barrier blocks or restricts access to ~ 100 square miles of a watershed. A few minor barriers are included. Names of keystone (lowermost) barriers are shown in bold, partial or seasonal barriers shown in italics. Fish densities were converted from number per mile, but were not rounded to reflect true precision of estimate. SH=steelhead, RT=rainbow trout, BT=brown trout. Dam data and area above dam were derived from California Department of Water Resources dam database, while total watershed areas were derived from the California Watersheds (CALWATER 2.0) database, produced by the California Department of Forestry and Fire Protection. Lower boundaries of some watersheds in the Central Valley are defined differently in the two databases, and thus areas may not be directly comparable. Obvious discrepancies shown in red.

			-------- Watershed --------			Rainbow Trout Above Barrier								
ESU / Basin / Sub Basin	Dam Name	Year Built	Total Area (sq mi)	Above Barrier (sq mi)	Above Barrier (%)	present	distribution	abundance	Density (no./km)	stocked	most recent	source hatchery	stocking notes	source
7 Klamath Mountain Province														
Winchuck River			18.2											
Smith River			704											
Lower Smith River														
South Fork Smith River														
Middle Fork Smith River														
North Fork Smith River														
Klamath River			7,043											
Lower Klamath River														
Klamath River	**Iron Gate**	1962		4,573	65%	yes	unknown			yes	> 25 yrs ago (pre 1977)	Iron Gate		3, 4
	Copco No 1	1922		4,300	61%	yes	unknown		2613 (incl few BT) lower Shovel Cr, 11,549 in upper Shovel Cr	yes	15-30 yrs ago (1972-87)			
	Copco No 2	1925		4,300	61%	yes								
Butte Valley														
Sfk Willow Creek	A And C	1923		120	2%									
Boles Creek	Boles Meadow	?		267	4%									
Lost River	Clear Lake	1910		670	10%									
Salmon River														
Scott River														
Shasta River	**Shasta River**	1928		120	2%	yes	unknown	unknown		yes	ongoing		10,000 / year	4
Trinity River			2,968											
Lower Trinity River														
South Fork Trinity River														
Middle Trinity River														
Upper Trinity River	**Trinity**	1962		688	23%	yes	likely in all tribs	millions in Trinity L.		yes	5-6 yrs ago (1996-97)	Shasta hatchery; Eagle Lake form planted into backcountry lakes?	discontinued stocking of ~ 1/2 of backcountry lakes ~ 3 yrs ago	4
	ESU Total		10,733	5,381	50%									

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ESU / Basin / Sub Basin	Dam Name	Year Built	-------- Watershed -------- Total Area (sq mi)	Above Barrier (sq mi)	Above Barrier (%)	Rainbow Trout Above Barrier present	distribution	abundance	Density (no./km)	stocked	most recent	source hatchery	stocking notes	source
8 Northern California														
Redwood Creek			294											
Maple Creek														
Little River			47											
Mad River			505											
Blue Lake														
North Fork Mad River														
Butler Valley														
Mad River	**Robert W Matthews**	1962		120	24%	yes	unknown	low; gets warm in summer		yes	ongoing	various	18,000 / year	4
Elk River														
Eel River			3,682											
Lower Eel River														
Eel River	*Van Arsdale*	1907		345	9%	SH, RT								
	Scott	1921		288	8%	yes	unknown							17, 5
Van Duzen River														
North Fork Eel River														
Middle Fork Eel River														
Sfk Eel River	*Benbow*	1932		437	12%	SH								
Middle Main Eel River														
Bear River														
Mattole River			373											
Usal Creek			42											
Wages Creek			59											
Ten Mile River			129											
Noyo River			166											
Big River			201											
Albion River			68											
Navarro River			316											
Garcia River			147											
Gualala River			332											
other			350											
	ESU Total		6,710	408	6%									

			------- Watershed -------			Rainbow Trout Above Barrier								
ESU / Basin / Sub Basin	Dam Name	Year Built	Total Area (sq mi)	Above Barrier (sq mi)	Above Barrier (%)	present	distribution	abundance	Density (no./km)	stocked	most recent	source hatchery	stocking notes	source
9 Central California Coast														
Russian River			1,485											
Russian River	*Russian Rv No 1*	1963		1,350	91%									
	Healdsburg Rec	1953		803	54%									
Dry Creek	**Warm Springs**	1982		130	9%	yes	all tribs			yes	unknown	private, Warm Springs	~1984-87, Russian River steelhead from Warm Springs Hatchery released above WS Dam	6
E Fk Russian River	**Coyote Valley**	1959		105	7%	yes	unknown			yes				
Salmon Creek			44											
Estero Americano			39											
Estero San Antonio			54											
Stemple Creek														
Tomales Bay			11											
Walker Creek														
Lagunitas Creek			109											
	Seeger	1961		35.9	33%	yes	hdwtrs of Halleck Cr, prob. in western portion of Nicasio Cr			unknown				6
	Peters	1954		22.1	20%	yes	unknown			yes	ongoing	Silverado Fisheries Base		6
Corte Madera Cr														
Fairfax Cr														
Novato Cr														
Petaluma River														
Petaluma R														
San Antonio Cr														
Adobe Cr														
Sonoma Creek														
Napa River														
Napa R														
San Pablo Cr														
San Leandro Cr														
San Lorenzo Cr														
Alameda Creek			632											
Alameda Creek	Rubber Dam 1	?		633	100%									
	Rubber Dam 3	1990		633	100%									

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			-------- Watershed --------			Rainbow Trout Above Barrier								
ESU / Basin / Sub Basin	Dam Name	Year Built	Total Area (sq mi)	Above Barrier (sq mi)	Above Barrier (%)	present	distribution	abundance	Density (no./km)	stocked	most recent	source hatchery	stocking notes	source
Calaveras Creek	Calaveras	1925		98	16%									
Arroyo Valle	Del Valle	1968		149	24%									
Coyote Creek			369											
Coyote	**Standish**	1994		392	106%									
Coyote Creek	Coyote Percol	1934		227	62%									
Coyote River	Leroy Anderson	1950		194	53%									
Coyote Creek	Coyote	1936		120	32%									
Guadalupe River														
Stevens Cr														
San Pedro Creek														
Denniston Creek	dam, 18'					yes								1
Frenchmans Creek	culvert					unknown								1
Pilarcitos Creek	dam, 40'													1
Purisima Cr														
Lobitos Cr														
Tunitas Creek														
San Gregorio Creek														
Pescadero Creek														
Pescadero Creek														
Butano Cr														
Gazos Creek														
Waddell Creek														
Scott Creek														
San Lorenzo River			146											
Soquel Creek														
Aptos Creek														
Valencia Creek														
	ESU Total													

			-------- Watershed --------			Rainbow Trout Above Barrier								
ESU / Basin / Sub Basin	Dam Name	Year Built	Total Area (sq mi)	Above Barrier (sq mi)	Above Barrier (%)	present	distribution	abundance	Density (no./km)	stocked	most recent	source hatchery	stocking notes	source
10 South Central California Coast														
Pajaro River			1,309											
Salinas River			4,481											
Arroyo Seco River														
San Antonio Rv	**San Antonio**	1965		353	8%	yes	in reservoir, unknown if in stream			yes	ongoing	Silverado Fisheries Base		1, 7
Nacimiento Rv	**Nacimiento**	1957		324	7%	yes	unknown		330-390	yes	ongoing	Silverado Fisheries Base		7, 8
Salinas River	**Salinas**	1942		111	2%	yes	unknown			yes	ongoing	Silverado Fisheries Base	released at Lake Margarita marina	1, 7
Carmel River			256											
	San Clemente	1921		125	49%	SH	unknown							1, 7
	Los Padres	1949		44.9	18%	SH, RT	unknown			no		trap and truck of steelhead around Los Padres Dam for 20 yrs		1, 7
Big Sur Coastal			1,050											
San Jose Creek														
Gibson Creek														
Malpaso Creek														
Sobranes Creek														
Granite Creek														
Doud Creek														
Garrapata Creek														
Rocky Creek														
Bixby Creek														
Little Sur River														
Big Sur River														
Mule Canyon Creek														
Castro Canyon Creek														
Torre Canyon Creek														
Partington Creek														
Mcway Canyon Creek														
Anderson Canyon Creek														
Burns Creek														
Buck Creek														
Hot Springs Creek														
Lime Creek														
Dolan Canyon Creek														
Rat Creek														
Big Creek														

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			------- Watershed -------			Rainbow Trout Above Barrier								
ESU / Basin / Sub Basin	Dam Name	Year Built	Total Area (sq mi)	Above Barrier (sq mi)	Above Barrier (%)	present	distribution	abundance	Density (no./km)	stocked	most recent	source hatchery	stocking notes	source
Vicente Creek														
Limekiln Creek														
Kirk Creek														
Mill Creek														
Wild Cattle Creek														
Prewitt Creek														
Plaskett Creek														
Willow Creek														
Spruce Creek														
Alder Creek														
Villa Creek														
Spring Creek														
Salmon Creek														
San Carpoforo Cr														
Arroyo De La Cruz			43											
Pico Creek														
San Simeon Creek			81											
Santa Rosa Cr			52											
Perry Creek														
Villa Cr			22											
Cayucos Creek			18											
Old Creek	**Whale Rock**	1960	24	20.8	87%	yes	unknown			no				
Toro Cr			16											
Morro Cr			28											
Chorro Cr			47											
Los Osos Creek			28											
Islay Cr														
Coon Creek														
Diablo Canyon Creek														
San Luis Obispo Cr			87											
Pismo Cr			40											
Arroyo Grande Cr	**Lopez**	1969	174	70.0	40%	yes	unknown			yes	ongoing	Silverado Fisheries Base		1
	ESU Total		7,152	923.7	13%									

ESU / Basin / Sub Basin	Dam Name	Year Built	------- Watershed ------- Total Area (sq mi)	Above Barrier (sq mi)	Above Barrier (%)	Rainbow Trout Above Barrier present	distribution	abundance	Density (no./km)	stocked	most recent	source hatchery	stocking notes	source
11 Southern California														
Santa Maria River			1,857											
Santa Maria River														
Sisquoc River														
Cuyama River	**Twitchell**	1958		1,135	61%	yes	all tribs	unknown		yes	10-15 yrs ago (~1987-1992)			2
San Antonio River			212											
Santa Ynez River			900											
Santa Ynez River	**Bradbury**	1953		417	46%	yes	all tribs	unknown		yes	ongoing	Fillmore	into Lake Cachuma	2, 9, 10
Santa Ynez Rv	Gibraltar	1920		214	24%	yes	all tribs	unknown		yes	ongoing	Fillmore	not open to fishing?	2, 10
	Juncal	1930		13.9	2%	yes	all tribs	lots of RT, up to 26"		yes	unknown	Fillmore		2, 10
Canada Honda Cr														
Jalama Cr														
Ventura River			226											
Coyote Creek	**Casitas**	1959		41	18%	yes	where water present, note seasonal streams	unknown		yes	ongoing	Fillmore	32,000 pounds in 2002	2
Matilija Creek	**Matilija**	1949		55.0	24%	yes	unknown			yes	5-6 yrs ago (~1996-97)	Fillmore		2, 11
Santa Clara River			1,621											
Santa Clara River	*Vern Freeman Diversion*	1991				yes								2, 18
Santa Paula Creek														
Sespe Creek						yes		1.08-2.57 RT/ min of electroshocking		yes	unknown			15
Piru Creek	**Santa Felicia**	1955		421	26%	yes	all tribs	unknown	2371-2940; 107-143 (>8"); 0 (>12")	yes	ongoing	Fillmore	Hot Creek strain, into Lake Piru and Frenchman's Flat	2
	Pyramid	1973		293	18%	yes	all tribs			yes	ongoing	Fillmore		2

			------- Watershed -------			Rainbow Trout Above Barrier								
ESU / Basin / Sub Basin	Dam Name	Year Built	Total Area (sq mi)	Above Barrier (sq mi)	Above Barrier (%)	present	distribution	abundance	Density (no./km)	stocked	most recent	source hatchery	stocking notes	source
Castaic Creek	**Castaic**	1973		154	9%	yes	reservoir and where water present, note seasonal streams	unknown		yes	ongoing		into Castaic Lake and Castaic Lagoon (below dam)	2
Malibu Creek			110											
Topanga Creek			31											
Los Angeles River			834											
Los Angeles River	**Sepulveda**	1941		152	18%	no								2
Tujunga Wash	**Hansen**	1940		780	94%	yes	~5 miles or where water present	few fish		yes	ongoing	Fillmore		2
San Gabriel River			714											
San Gabriel River	**Whittier Narrows**	1957		554	78%	yes	reservoir, but probably not far upstream			yes	ongoing	Fillmore		2
	Santa Fe	1949		236	33%	yes	reservoir, but probably not far upstream			yes	ongoing	Fillmore		2
	Morris	1935		210	29%	yes	reservoir		no, washdown from above					2
	San Gabriel No 1	1938		205	29%	yes	all tribs where there is water, EF usu perennial		1550-2706; 129-198 (>8"); 0 (>12")	yes	ongoing	Fillmore	in WF below Cogswell, NF, and EF of San Gabriel R	2, 21
	Cogswell	1935		38.4	5%	yes	unknown			unknown				2
Santa Ana River			1,972											
Santa Ana River	**Prado**	1941		2,230	113%	yes								
Bear Creek						yes			96-732; 14-15 (>8"); 0 (>12")					20, 21
Upper Santa Ana River						yes			29-43; 0-14 (>8"); 0 (>12")					21
San Antonio Creek	San Antonio	1956		111	6%									
Santa Ana River	Seven Oaks	indrcnst		176	9%									
Tr Cajalco Cr	Mathews	1938		40	2%									

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ESU / Basin / Sub Basin	Dam Name	Year Built	Watershed: Total Area (sq mi)	Watershed: Above Barrier (sq mi)	Watershed: Above Barrier (%)	Rainbow Trout Above Barrier: present	distribution	abundance	Density (no./km)	stocked	most recent	source hatchery	stocking notes	source
San Juan Creek			177											
San Mateo Creek			134											
Santa Margarita River			743											
De Luz Creek														
Temecula Creek	Vail	1949		306	41%	unknown				yes	unknown		private stocking	2
San Luis Rey River	Henshaw	1923	560	207	37%	unknown				yes	ongoing	Mojave	into WF of San Luis Rey	2
Escondido Creek			86											
San Dieguito River	Lake Hodges	1918	346	303	88%	no				no			bass and catfish in Hodges	2
San Diego River	El Capitan	1934	436	190	44%	yes	in reservoir	few fish		no				2
Sweetwater River	Sweetwater Main	1888	229	182	79%	unknown				yes	ongoing			2
Otay River	Savage	1919	154	101	66%									
Tijuana River			467											
Cottonwood Cr	Barrett	1922		252										
	Morena	1912		114										
other			2,546											
	ESU Total		14,354											
12 Central Valley														
Upper Sacramento														
	Keswick	1950		-										
	Shasta	1945		6,665		yes			4163-5468 (fish kill); 420 1670 (>4")	yes		Mt. Shasta ; Sacramento and McCloud River stocks	avg. 15,000 from 1994-1998; stocked at least since 1930, average of ~80,000 / yr; max. of 4M RT planted in 1936	16
	Box Canyon	1969	418	126	30%	yes								
Mc Cloud River														
	Keswick	1950		-										
	Shasta	1945		6,665		yes			2361 (>5")					4
	McCloud	1965	682	380	56%	yes	all tribs		1864 (Squaw Valley Cr)	yes	ongoing below McCloud falls, ~7 yrs ago (~1994) above falls		15,000/yr into McCloud reservoir	4
Pit River			5,133											
	Keswick	1950		-		yes								
	Shasta	1945		6,665		yes								
	Pit No 7	1965		5,170	101%	yes								

			------- Watershed -------			Rainbow Trout Above Barrier								
ESU / Basin / Sub Basin	Dam Name	Year Built	Total Area (sq mi)	Above Barrier (sq mi)	Above Barrier (%)	present	distribution	abundance	Density (no./km)	stocked	most recent	source hatchery	stocking notes	source
Lower Pit River	Pit No 6	1965		5,020	98%	yes								
	Pit No 5 Div	1943		4,885	95%	yes								
Burney	Pit No 4	1927		4,740	92%	yes								
	Pit No 3	1925		4,700	92%	yes								
Big Valley	Lookout	1930		2,427	47%									
	Gerig	1939		1,893	37%									
Upper Pit River	Lindauer Concrete	1920		1,087	21%									
	McBrien	1880		1,087	21%									
	West Valley	1936		135	3%									
	Big Sage	1921		107	2%									
Fall River	Pit No 1 Diversn	1922		676	13%	yes			1021-2541 (>6")					22
	Pit No 1 Forebay	1947		260	5%	yes								
Hat Creek						yes			159-2539 (>8"); 32-1335 (>12")					19
Burney	Hat Cr No 2 Div	1942		627	12%									
Sacramento River														
	Red Bluff Diversion	1964		-		SH								
	Anderson Cottonwood	1917		6,860		SH								
	Keswick	1950		-										
	Shasta	1945		6,665										
Clear Creek	**Whiskeytown**	1963		201		yes	Whiskey Cr and Clear Cr		1553-3107	yes	ongoing	private hatchery		
Stony Creek			701											
Stony Creek	Stony Cr Gravel	1906		766										
	Black Butte	1963		741		yes	Stony and Grindstone Crs migrate through,too warm in summer			unknown				13
	Stony Gorge	1928		735		yes	all tribs			yes	ongoing			13
Little Stony Creek	East Park	1910		102		yes	Trout Cr and Stony Cr seasonally			yes	unknown			13

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			------- Watershed -------			Rainbow Trout Above Barrier								
ESU / Basin / Sub Basin	Dam Name	Year Built	Total Area (sq mi)	Above Barrier (sq mi)	Above Barrier (%)	present	distribution	abundance	Density (no./km)	stocked	most recent	source hatchery	stocking notes	source
Cache Creek			953											
Cache Creek	Cache Cr Settling Bn	?		1,114										
	Clear Lake Imp	1914		514										
No Fork Cache Creek	Indian Valley	1976		122										
Putah Creek			567											
Putah Creek	**Putah Div**	1957		644										
	Monticello	1957		576										
Battle Creek														
Antelope Creek														
Deer Creek														
Butte Creek														
Feather River			3,625											
Feather River	Thermalito Div	1967		3,640	100%									
	Feather R Hatchery	1964		3,640	100%									
	Oroville	1968		3,607	100%									
Nfk Feather Rv	Poe	1959		1,950	54%	yes							NF below L Almanor rotenoned at least 3x	12
	Cresta	1949		1,872	52%									
	Rock Creek	1950		1,700	47%									
	Caribou Afterbay	1959		616	17%									
	Lake Almanor	1927		503	14%	yes				yes	ongoing	Eagle Lake strain	80,000/yr during last 15 yr	12
	Chester Diversn	1975		113	3%									
Hamilton Creek	Indian Ole	1924		158	4%									
Bucks Creek	Bucks Storage	1928		30	1%	yes				yes	ongoing		15-30,000/yr	12
Mfk Feather R						yes				yes	unknown		above wild trout section of MF	12
Nelson Creek						yes			155-621 (>6")					14
Sfk Feather Rv	Ponderosa Div	1962		108	3%									
Yuba River			1,495											
Yuba River	**Englebright**	1941		1,100	74%									
No Yuba Rv	New Bullards Bar	197O		481	32%									
Mfk Yuba Rv	Hour House	1968		145	10%									

			------- Watershed -------			Rainbow Trout Above Barrier								
ESU / Basin / Sub Basin	Dam Name	Year Built	Total Area (sq mi)	Above Barrier (sq mi)	Above Barrier (%)	present	distribution	abundance	Density (no./km)	stocked	most recent	source hatchery	stocking notes	source
Sfk Yuba River	Lake Spaulding	1913		118	8%									
Bear River			402											
	Camp Far West	1963		286	71%									
	Camp Far West Dv	1977		281	70%									
	Combie	1928		136	34%									
	Rollins	1965		104	26%									
American River			2,070											
American River	**Nimbus**	1955		1,888	91%									
	Folsom	1956		1,885	91%									
Nfk American River	North Fork	1939		343	17%									
Mfk American Rv	Ralston Afterbay	1966		429	21%									
	L L Anderson	1965		47	2%									
Rubicon River						yes								
Rubicon River	Lower Hell Hole	1966		114	6%									
Sfk American Rv	Chili Bar	1964		590	29%									
	Slab Creek	1967		497	24%									
Silver Creek	Camino	1961		165	8%									
	Junction	1962		142	7%									
	Union Valley	1963		84	4%									
Cosumnes River	**Granlees**	1921	649	535	82%									
Mokelumne River														
Mokelumne River	Woodbridge Div	1910		667										
	Camanche	1963		619										
	Pardee	1929		575										
Nfk Mokelumne Rv	Electra Diversn	1947		365										
	Salt Springs	1931		169										
	Tiger Cr Afterbay	1931		360										
Calaveras River	**New Hogan**	1963	383	363	95%									
Stanislaus River			997											
Stanislaus River	**Goodwin**	1912		997	100%									
	Tulloch	1958		971	97%									
	New Melones	1979		900	90%									
N Fk Stanislaus R	Mckays Pt Diversn	1989		166	17%									
Highland Creek	New Spicer Meadow	1989		47	5%									
Mfk Stanislaus R	Beardsley	1957		309	31%									

			------- Watershed -------			Rainbow Trout Above Barrier								
ESU / Basin / Sub Basin	Dam Name	Year Built	Total Area (sq mi)	Above Barrier (sq mi)	Above Barrier (%)	present	distribution	abundance	Density (no./km)	stocked	most recent	source hatchery	stocking notes	source
	Beardsley Ab	1958		314	31%									
	Donnells	1958		229	23%									
Tuolumne River			1,616											
Tuolumne River	**La Grange**	1894		1,548	96%									
	Don Pedro	1971		1,542	95%									
Clavey River									1,317					23
Tuolumne River	Early Intake	1925		488	30%									
	O Shaughnessy	1923		459	28%									
Cherry Creek	Cherry Valley	1956		114	7%									
Merced River														
Merced River	**Crocker Diversn**	1910		1,045										
	New Exchequer	1967		1,040										
	Mcswain	1966		1,037										
	Merced Falls	1901		1,040										
Tr Burns Creek	Smith's Reservoir	1941		1,963										
Mariposa Creek	Mariposa	1948		107										
Los Banos Creek	Los Banos Detn	1965		160										
Chowchilla River														
	Sierra Vista	1872		275										
	Buchanan	1975		235										
Berenda Slough	Berenda Slough	1962		269										
Fresno River	Hidden	1975		234										
San Joaquin River														
San Joaquin River	Mendota Diversn	1917		1,640										
	Friant	1942		1,675										
	Kerckhoff Div	1920		1,460										
	Big Creek No 7	1951		1,292										
	Big Creek No 6	1923		1,195										
Big Creek	Big Creek No 5	1921		125										
	Big Creek No 4	1913		107										
Upper MF San Joaquin						yes			273-2985; 119-695 (>6")	yes			RT prob not native	26
Kaweah River	Terminus	1962		561										
Kings River			1,849											

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			------- Watershed -------			Rainbow Trout Above Barrier								
ESU / Basin / Sub Basin	Dam Name	Year Built	Total Area (sq mi)	Above Barrier (sq mi)	Above Barrier (%)	present	distribution	abundance	Density (no./km)	stocked	most recent	source hatchery	stocking notes	source
Kings River	**Pine Flat**	1954		1,545	84%									
Nfk Kings Rv	Balch Afterbay	1928		251	14%									
	Balch Diversion	1927		237	13%									
Nfk Kings River	Wishon	1958		177	10%									
Helms Creek	Courtright	1958		39	2%									
Kern River			2,371											
Kern River	Diversion No 1	1906		2,260	95%									
	Isabella	1953		2,074	87%	yes			43-620	yes		Kern River Planting Base	50,500 lbs. / yr above Isabella	27
(all CV watersheds)	**ESU Total**		59,713											

1 pers. comm., Jennifer Nelson, CDFG
2 pers. comm., Dwayne Maxwell, CDFG
3 pers. comm., Dennis Maria, CDFG
4 pers. comm., CDFG Region 1 biologists; Mike Dean, Mike Berry, Randy Benthin, Bob McAllister, Bill Jong, Phil Bairrington
5 pers. comm., Scott Downie, CDFG
6 pers. comm., Bill Cox, CDFG
7 pers. comm., Mike Hill, CDFG
8 pers. comm., Joel Casagrande, Watershed Institute, CSUMB
9 pers. comm., Mauricio Cardenas, CDFG
10 pers. comm., Scott Engblom, Cachuma Operation and Maintenance Board
11 pers. comm., Rick Rogers, NMFS
12 pers. comm., Ken Kundargi, CDFG
13 pers. comm., Emil Ekman, USFS
14 CDFG 1979. Nelson Creek Wild Trout Management Plan
15 CDFG 1986. Sespe Creek Wild Trout Management Plan, Sespe Creek, Ventura County
16 CDFG 2000. Fishery Management Plan for the Upper Sacramento River
17 Jones 2001
18 McEwan and Jackson 1996
19 Deinstadt and Berry 1999
20 Deinstadt et al. 1993
21 Deinstadt et al. 1988
22 Rode and Weidlein 1986
23 Robertson 1985
24 Yoshiyama et al. 2001
25 Titus et al. 2001
26 Deinstadt et al. 1995
27 Stephens et al. 1995

Appendix B.5.2. Preliminary SSHAG (2003) categorizations of hatchery populations of the 10 steelhead ESUs reviewed. See "Artificial Propagation" in General Introduction for explanation of the categories.

ESU	Stock	Run	Basin	SSHAG Category
Snake River	Wallowa	summer	Wallowa	3
	Cottonwood	summer	Grande Ronde	3
	Little Sheep Creek	summer	Imnaha	1
	Oxbow	summer	Snake River	3
	Sawtooth	summer	Salmon	3
	Pahsimeroi	summer	Salmon	3
	Dworshak	summer	Clearwater	3
	Lyons Ferry	summer	Snake River	3 or 4
	Tucannon (Lyons Ferry)	summer	Tucannon	3 or 4
	Tucannon (new)	summer	Tucannon	1
	Curl Lake	summer	Snake River	3 or 4
Upper Columbia River	Wells	summer	U. Columbia River	1 or 2
	Eastbank	summer	Entiat	3
	Eastbank	summer	Wenatchee	1
	Winthrop	summer	Methow	3
	Ringold	summer	U. Columbia River	3
Middle Columbia River	Deschutes (# 66)	summer	Deschutes	3
	Umatilla (# 91)	summer	Umatilla	1 or 2
	Dayton Pond	summer	Touchet	4
	Dayton Pond (new)	summer	Touchet	1
Lower Columbia River	Skamania	summer	Washougal	4
	Sandy (ODFW 11)	winter	Sandy	1
	Clackamas (#122)	winter	Clackamas	1
	Hood (ODFW #50)	winter	Hood	1
	Hood (ODFW #50)	summer	Hood	1
	Big Creek/Eagle Creek	winter	Clackamas	4
	Chambers Creek	winter	various	4
	Cowlitz	late-winter	Cowlitz	2
	Kalama	winter	Kalama	1

	Kalama	summer	Kalama	1
Upper Willamette River	Skamania (# 24)	summer	Santiam	4
Northern California	Mad River	winter	Mad	3
	Yager Creek	winter	Yager	2
	N. Fork Gualala	winter	Gualala	1
Central California Coast	Don Clausen	winter	Russian	2
	Monterey Bay	winter	Scott Cr.	1
South-Central California Coast	Whale Rock	winter	Old Creek	2
California Central Valley	Coleman NFH	winter	Sacramento River	2
	Feather River	winter	Feather River	2
	Nimbus Hatchery	winter	American River	4
	Mokelumne Hatchery	winter	Mokelumne River	4

Appendix B.5.3. Lower Columbia River Steelhead Time Series References

Population	Hood River Summer Steelhead
Years of Data, Length of Series	1992 - 2000, 9 years
Abundance Type	Dam/weir count
Abundance References	Gorman, Leah. 2001.
Abundance Notes	Dam counts at Powerdale dam
Hatchery Reference	Gorman, Leah. 2001.
Harvest Reference	No Harvest Data Available.
Age Reference	Gorman, Leah.2001.
Age Notes	Repeat % total ranged from 2% to 10%.
Population	Kalama River Summer Steelhead
Years of Data, Length of Series	1977 - 2003, 27 years
Abundance Type	Trap Count
Abundance References	Rawding, Dan (WDFW). 2002a.
Abundance Notes	Trap count plus correction estimate for jumpers
Hatchery Reference	Rawding, Dan (WDFW). 2002a.
Hatchery Notes	Work done at RM 10 above the two hatcheries to minimize handle of hatchery fish. Substantial rearing may occur below; trapping takes place during spring
Harvest Reference	Rawding, Dan (WDFW). 2002a.
Age Reference	Rawding, Dan (WDFW).2002a.
Age Notes	From 1998 forward no scales have been aged and mean ages are used for these years
Population	Washougal River Summer Steelhead
Years of Data, Length of Series	1986 - 2003, 18 years
Abundance Type	Index
Abundance References	WDFW. 1997. Rawding 2002a
Hatchery Reference	No Hatchery Data.
Harvest Reference	No Harvest Data Available.
Age Reference	Busby, et al.1996; Chilcote, M.W. 2001; Hulett et al. 1995.
Age Notes	Generic sum age structure

Population	Wind River Summer Steelhead
Years of Data, Length of Series	1989 - 2003, 15 years
Abundance Type	Mark recapture
Abundance References	Rawding, Dan (WDFW). 2001b; Rawding 2002a.
Abundance Notes	Estimates made from mark-recapture from trap efficiency method. Adult trap at Shiperd Falls but adult population is estimate by M-R, since fish jump the falls. Not able to differentiate winter and summer steelhead smolts
Hatchery Reference	Rawding, Dan (WDFW). 2001b.
Harvest Reference	Rawding, Dan (WDFW). 2001b.
Age Reference	Rawding, Dan (WDFW).2001b.
Population	Clackamas River Winter Steelhead
Years of Data, Length of Series	1958 - 2001, 44 years
Abundance Type	Dam/weir count
Abundance References	Cramer, Doug. 2002a.
Abundance Notes	Abundance data delivered via Kathryn Kostow, Or Dept of Fish and Wildlife
Hatchery Reference	Cramer, Doug. 2002a.
Hatchery Notes	Pre-1997 WildFrac determined by run timing; all fish counted on or after March 1 assumed to be Wild. Additional reference for 1997-2001 from Doug Cramer, PG; have #s for wild and hatchery fish as of 1996-1997 run; all winter steelhead trapped and identified as wild or hatchery
Harvest Reference	Oregon Department of Fish and Wildlife. 9999. Personal Communication. Personal communications for reconstructed run year estimates from punch cards for steelhead, 1956-1970
Age Reference	Busby, et al.1996; Chilcote, M.W. 2001; Hulett et al. 1995.
Age Notes	Generic sum age structure
Population	East Fork Lewis River Winter Steelhead
Years of Data, Length of Series	1985 - 1994, 10 years
Abundance Type	Peak Count
Abundance References	Johnson, T.H. and R. Cooper. 1995.
Abundance Notes	Natural population only; East fork Lewis River, trib to Lewis River from mile 0.0 to mile 41.8
Hatchery Reference	Busby, et al. 1996. Status review of west coast steelhead from WA, ID, OR and California
Harvest Reference	No Harvest Data Available.

Age Reference	Busby, et al.1996; Chilcote, M.W. 2001; Hulett et al. 1995.
Population	Hood River Summer Steelhead
Years of Data, Length of Series	1992 - 2000, 9 years
Abundance Type	Dam/weir count
Abundance References	Gorman, Leah. 2001.
Abundance Notes	Dam counts at Powerdale dam
Hatchery Reference	Gorman, Leah. 2001.
Harvest Reference	No Harvest Data Available.
Age Reference	Gorman, Leah.2001.
Population	Kalama River Winter Steelhead
Years of Data, Length of Series	1977 - 2002, 26 years
Abundance Type	Trap Count
Abundance References	Rawding, Dan (WDFW). 2001b. Rawding 2002a.
Abundance Notes	Trap count plus correction estimate for jumpers
Hatchery Reference	Rawding, Dan (WDFW). 2001b.
Hatchery Notes	Work done at RM 10 above the two hatcheries to minimize handle of hatchery fish. Substantial rearing may occur below; trapping takes place during spring
Harvest Reference	Rawding, Dan (WDFW). 2001b.
Age Reference	Rawding, Dan (WDFW).2001b.
Age Notes	From 1998 forward no scales have been aged and mean ages are used for these years
Population	North Fork Toutle River Winter Steelhead
Years of Data, Length of Series	1989 - 2002, 14 years
Abundance Type	Total from redd count
Abundance References	Rawding, Dan (WDFW). 2001b. Rawding 2002a.
Abundance Notes	100% trap count
Hatchery Reference	Rawding, Dan (WDFW). 2001b.
Harvest Reference	Rawding, Dan (WDFW).
Age Reference	Rawding, Dan (WDFW).2001b.
Population	Sandy River Winter Steelhead
Years of Data, Length of Series	1978 - 2001, 24 years

Abundance Type	Dam/weir count
Abundance References	Cramer, Doug. 2002.
Abundance Notes	Dam counts made at Marmot Dam
Hatchery Reference	Chilcote, Mark. 1998.
Harvest Reference	Berry, R.L. 1978.
Harvest Notes	Natural population catch determined by multiplying harvest by wild fraction
Age Reference	Busby, et al.1996; Chilcote, Mark. 1998; Hulett et al. 1995.
Age Notes	Generic winter age structure
Population	South Fork Toutle River Winter Steelhead
Years of Data, Length of Series	1984 - 2002, 19 years
Abundance Type	Redd Surveys
Abundance References	Rawding, Dan (WDFW). 2001b. Rawding 2002a.
Abundance Notes	Winter steelhead in SF Toutle are by redd surveys from March 15 to May 31. Redd surveys assume that you see 100% of the redds, only wild steelhead spawn after March 15, sex ratio is 1:1, and each redd represents 0.8 females. Assumed 2% stray rate
Hatchery Reference	Rawding, Dan (WDFW). 2001b.
Harvest Reference	Rawding, Dan (WDFW). 2001b.
Age Reference	Rawding, Dan (WDFW).2001b.
Age Notes	Applied Kalama estimates to SF Toutle
Population	Washougal River Winter Steelhead
Years of Data, Length of Series	1991 - 1995, 5 years
Abundance Type	Redd index
Abundance References	Washington Dept. of Fish and Wildlife. 1993.
Hatchery Reference	Washington Dept. of Fish and Wildlife. 1993.
Hatchery Notes	Reports little hatchery impact
Harvest Reference	No Harvest Data Available. . .
Age Reference	Busby, et al.1996; Chilcote, M.W. 2001; Hulett et al. 1995.
Age Notes	Generic winter age structure
Population	Coweeman River Winter Steelhead
Years of Data, Length of Series	1987 - 2002, 16 years

Abundance Type	Redd Surveys
Abundance References	Rawding, Dan (WDFW). 2001b. Rawding 2002a.
Abundance Notes	Winter steelhead estimate in the Coweeman are by redd surveys from Mar 15 to May 31. Redd surveys assume that you see 100% of the redds, only wild steelhead spawn after March 15, sex ratio is 1:1, and each redd represents 0.8 females.
Hatchery Reference	Rawding, Dan (WDFW). 2001b.
Hatchery Notes	The estimates for the Kalama are good but the Coweeman and Wind are rough. I am working on a methodology to better estimate these. The winter hatchery steelhead have a reproductive success of ~11% and the summer hatchery steelhead have a reproductive success of ~18% relative to wild fish.
Harvest Reference	Rawding, Dan (WDFW). 2001b.
Age Reference	Rawding, Dan (WDFW).2001b.
Age Notes	Only age structure data is for winters in NF Toutle and Kalama, and summers in the Kalama. Age structure is very similar in Toutle and Kalama winters. Toutle has less repeats 5.3% to 8.9% possibly because kelts must pass through PVC tubes on the Sediment Dam which negatively impacts their survival. I chose to apply the Kalama winter to the Coweeman and SF Toutle.
Population	East Fork Lewis River Summer Steelhead
Years of Data, Length of Series	1996 - 2003, 8 years
Abundance Type	
Abundance References	Rawding, Dan. 2002a.
Hatchery Reference	Rawding, Dan. 2002a.
Harvest Reference	Rawding, Dan. 2002a.
Age Reference	Rawding, Dan. 2002a.

Appendix B.5.4. Upper Willamette River Steelhead Time Series References

Population	Calapooia River Winter Steelhead
Years of Data, Length of Series	1980 - 2000, 21 years
Abundance Type	Redd Count
Abundance References	Anonymous. 1995; Anonymous. 1997; Hunt, Wayne. 1999.
Abundance Notes	data from Streamnet
Harvest Reference	Chilcote, Mark. 2001
Hatchery Reference	Chilcote, Mark. 2001
Population	South Santiam River Winter Steelhead
Years of Data, Length of Series	1983 - 2000, 18 years
Abundance Type	Redd Count
Abundance References	Anonymous. 1995; Anonymous. 1997
Abundance Notes	data from Streamnet
Harvest Reference	Chilcote, Mark. 2001.
Hatchery Reference	Chilcote, Mark. 2001
Population	North Santiam River Winter Steelhead
Years of Data, Length of Series	1983 - 2000, 18 years
Abundance Type	Redd Count
Abundance References	Anonymous. 1998; Anonymous. 1998.
Abundance Notes	data from Streamnet
Harvest Reference	Chilcote, Mark. 2001.
Hatchery Reference	Chilcote, Mark. 2001
Population	Molalla River Winter Steelhead
Years of Data, Length of Series	1980 - 2000, 21 years
Abundance Type	Redd Count
Abundance References	Anonymous. 1997; Hunt, Wayne. 1999.
Harvest Reference	Chilcote, Mark. 2001.
Hatchery Reference	Chilcote, Mark. 2001

Population	South Santiam (Foster Dam)
Years of Data, Length of Series	1973 - 2000, 28 years
Abundance Type	Total Live Fish
Abundance References	ODFW. 1990; Anonymous. 1997; Anonymous. 1994; Hunt, Wayne. 1999.
Harvest Reference	Chilcote, Mark. 2001.
Population	Willamette Falls Dam Winter Steelhead
Years of Data, Length of Series	1971 - 2002, 32 years
Abundance Type	Dam/weir count
Abundance References	Kostow, Kathryn. 2002.