CENTER for BIOLOGICAL DIVERSITY
Because life is good.

Patrick Higgins
Consulting Fisheries Biologist
791 Eighth Street, Suite N
Arcata, CA 95521
(707) 822-9428

June 19, 2009

Board of Forestry and Fire Protection
Attn: Christopher Zimny
Regulations Coordinator
Sacramento, CA

Re: Comments on Proposed Threatened and Impaired Watershed Rules

Dear Mr. Zimny,

I am providing comments below on the proposed Threatened and Impaired (TI) Watershed Rules for the Center for Biological Diversity (the "Center"). The Center is a member based non-profit organization dedicated to the protection of native species and their habitats through applying sound science, policy and environmental law. Although there are a number of at-risk Pacific salmon species in the universe of TI watersheds, I focus on coho salmon (*Oncorhynchus kisutch*) here because they are the least tolerant of water pollution, their stock condition is relatively well known, and timber harvest is the most serious stressor to the species in northwestern California (QVIR 2006, 2008; NMFS 2008a, Higgins 2009). There is a clear and pervasive pattern of extirpation of population units throughout northwestern California by timber harvest and related land use and the TI rule amendments here will not stop their decline.

My Qualifications

I have been a consulting fisheries biologist with an office in Arcata, California since 1989 and my specialty is salmon and steelhead restoration. I authored fisheries elements for several large northern California fisheries and watershed restoration plans (Kier Associates, 1991; Pacific Watershed Associates, 1994; Mendocino Resource Conservation District, 1992) and co-authored the northwestern California status review of Pacific salmon species on behalf of the American Fisheries Society (AFS)(Higgins et al., 1992).

Over the past 20 years I have reviewed over 50 timber harvest plans and written comments on several Total Maximum Daily Load reports (NCRWQCB 2005, 2006, 2007, U.S. EPA 2007), that examine timber harvest as a pollution source. These comments cover the geographic area from Santa Cruz to Oregon. Recent relevant comments I have made include those on the Napa River TMDL (Higgins 2006b) and several proposed timber harvests for vineyard conversion there (Higgins 2006c, 2007a), the Bohemian Club Non-Industrial Timber Management Plan (Higgins 2007) and on a timber harvest plan (THP) in the Noyo River basin (Higgins 2009).

Other relevant publications related to timber harvest and impacts on salmon and steelhead populations include my review of the Simpson Timber Habitat Conservation Plan (Higgins, 2002), a dissenting report on the Pacific Lumber Company Freshwater Creek Watershed Analysis (Higgins, 2001), and my comments on the Jackson Demonstration State Forest Management Plan (Higgins, 2006a). All my THP related documents since 2000 are being provided for the record in addition to these comments.

Since 1994 I have also been working on a regional fisheries, water quality and watershed information database system, known as the Klamath Resource Information System or KRIS (www.krisweb.com). This custom program was originally devised to track restoration success in the Klamath and Trinity River basins, but has been applied to another dozen watersheds in northwestern California. The California Department of Forestry (CDF) funded KRIS projects in six northern California watersheds as part of the North Coast Watershed Assessment Planning effort. The Sonoma County Water Agency (SCWA) also funded regional KRIS projects (IFR, 2003) for several watersheds not covered by CDF projects in order to provide a seamless regional coverage for coho salmon recovery planning. I draw heavily on data from KRIS that overlaps with TI watersheds in these comments (see www.krisweb.com).

Since 2004 I have assisted the Klamath Basin Water Quality Work Group, which is comprised of the environmental departments of five federally recognized Indian tribes, in reviewing Clean Water Act (CWA) related documents. The Scott River and Klamath River TMDL comments I assisted with are most relevant to your TI rules because they are both waterbodies recognized as impaired under the CWA and harbor endangered salmonids, including coho salmon (QVIR 2006, 2007). I am currently assisting the National Marine Fisheries Service (NMFS) as a sub-contractor with preparation of coho salmon recovery profiles for the Oregon watersheds within the southern Oregon/Northern California Coast (SONCC) planning area.

Overview

The Initial Statement of Reasons (CDF 2009) defines TI and the purpose of the proposed revised rules:

> "The 'Threatened or Impaired Watershed' (T/I) rules is the common name used to describe the subset of California Forest Practice Rules (FPRs) intended to protect listed anadromous salmonid (salmon) species and their habitat in forest settings. The T/I rules regulate commercial timber harvesting on private land in watersheds where salmon species are designated as threatened or endangered species under the State or Federal Endangered Species Acts (TES). The rules also address timber harvesting and operational requirements for waterbodies listed under the federal Clean Water Act, section 303(d) as 'impaired.' The T/I rules were originally adopted in July 2000 and have been in place on an interim basis since that time."

As noted above in my statement of qualifications, I have reviewed a number of timber harvests and vineyard conversions since the TI rules were first passed in 2000. I find essentially no change in practices; instead plans continue to go forward as if everything can be mitigated on site, when in fact all watersheds covered by TI rules are over prudent risk limits for disturbance from

logging (Reeves et al. 1993) and the extent of road networks (USFS 1996). Problems with CFPRs noted by Ligon et al. (1999) and Dunne et al. (2001) regarding piecemeal analysis and lack of effective means to prevent cumulative watershed effects still persist under TI rules. Cumulative effects are flattening stream channels and expanding their width to depth ratio and this in turn raises water temperatures above suitable for coho salmon (Welsh et al. 2001). I will demonstrate this pattern with case studies below that extend from the Sonoma to Del Norte and Siskiyou counties.

When I first went before the Board of Forestry (BOF) in 1992 to present the Humboldt AFS paper on salmon and steelhead stocks at risk in northern California (Higgins et al. 1992), I expected that CDF and the timber industry would react appropriately. Instead I saw a pattern of elevated cut levels in coho watersheds spurred in part by potential restraints protection might impose. Those protections that would have caused such deprivation never arrived, including the TI rules of 2000. The amended TI rules proposed here represent an erosion of protections even though protections to date have largely failed.

Pacific salmon thrived in the northwestern California for millions of years despite constantly changing freshwater ecosystems due to patterns of landscape disturbance due to fire, floods, droughts, volcanic eruptions, glacial activity and other natural events. Historic disturbance tended to occur in patches at a sub-basin scale, while the rest of a watershed remained relatively intact and only a portion of any river system was impacted at any given time (Reeves et al. 1995). Salmon would have strayed from temporarily impaired sub-basins for decades or centuries into adjacent intact watersheds that retained healthy aquatic habitats (Williams et al. 2008). Once the impacted sub-basin recovered, fish from the intact basins would provide a source of colonists to rebuild that functional unit of the metapopulation. Under CFPR even with TI restrictions, it is not uncommon for sub-basins to be 50% altered due to logging in the course of a few decades and road networks are far over levels known to increase sediment yield and alter hydrology. Intact functional patches of salmonid habitat are extremely limited or have been completely eliminated in many watersheds, such as the Russian and Gualala Rivers. This landscape pattern does not mimic the natural "patch" disturbance regime and scientists have coined the term "press disturbance" to draw a distinction.

Current Coho Salmon Habitat Conditions and Population Trends in Northwestern California TI Watersheds

There are two coho salmon Evolutionarily Significant Units (ESU) recognized by the National Marine Fisheries Service (Good et al. 2005) in California and they are discussed separately below. The Central California Coast (CCC) covers from the southern extent of the range near Santa Cruz to below the Mattole River, while the SONCC ESU extends from there north to the Elk River in southern Oregon. Coho in the SONCC are listed as Threatened by both state and federal governments and the federal status was reaffirmed in 2005 (Good et al. 2005); CCC coho are listed as endangered.

Factors Threatening Stocks with Extinction in Northwestern California (Higgins et al. 1992) categorized extinction risk for Pacific salmon species from the Russian River north to Oregon and found eight populations of coho salmon to be at risk. Brown et al. (1994) in the paper

Historical Decline and Current Status of Coho Salmon in California noted that populations of coho salmon in California were at less than 5% of historic levels and that there were only seven streams with adult returns numbering in the hundreds (Figure 1). Even as of 1994, the population centers of coho were several hundred miles apart, making natural recovery through metapopulation function unlikely (Williams et al. 2008). Instead of protecting these watersheds to conserve gene resources and to maintain recovery options (Bradbury et al. 1995), all basins except Lagunitas Creek in Marin County and Prairie Creek in Redwood National and State Park have experienced continued high levels of logging.

Currently both ESUs are showing indications of range fragmentation, weak year classes, and extremely low abundance. The most impacted watersheds now have populations that may have entered an "extinction vortex" (NMFS 2008a), where individuals are so rare that they may have trouble finding mates and stochastic events could easily cause complete extirpation (Rieman et al. 1993). The BOF and the timber industry often deflect blame for the loss of coho to other factors, such as ocean conditions. In fact ocean conditions since 1998 have been largely favorable for coho salmon production (Collison et al. 2003) and yet no population increases are apparent. This is a clear indication that freshwater habitat is constraining coho salmon recovery.

Central Coast ESU

Of 133 historical coho salmon streams in the CCC coho ESU for which recent data were available, 43-53% apparently no longer support coho salmon (Moyle et al. (2008)). Moyle et al. (2008) rated CCC coho salmon as category 1, very rare and highly vulnerable to extinction within the next 50 years. In fact there is a wave of extinction sweeping north from the southern extent of the coho range in Santa Cruz that has now progressed through Sonoma County. Late rainfall in Santa Cruz and San Mateo County has prevented entry of coho salmon in several recent years and Dr. Jerry Smith (personal communication) has found coho to be nearly absent in Scott, Waddell and Pescadero Creeks over a complete three year life cycle. CDFG (2002) acknowledges the need to list Central Coast ESU coho under the California ESA and surveys conducted annually from 2000-2002 indicated widespread absence (Figure 2). Streams with coho

Figure 1. The map above shows the coho salmon populations in the hundreds in all of northwestern California as of 1994, according to Brown et al. (1994).

in only one or two years indicate weak or missing coho "year classes" that are interpreted by the California Department of Fish and Game (CDFG) as jeopardy under CESA (ESA Consulting 2008). Of the CCC coho population CDFG (2002) stated: "Extant populations in this region appear to be small. Small population size along with large-scale fragmentation and collapse of range observed in data for this area indicate that metapopulation structure may be severely compromised and remaining populations may face greatly increased threats of extinction because of it."

CDFG (2002) concluded that "coho salmon in the Central Coast Coho ESU are in serious danger of extinction throughout all or a significant portion of their range" and characterized the Russian Gualala River populations as "extirpated or nearly so." Figure 3 is a summary chart of CDFG presence/absence coho salmon survey data from 2000-2002 showing the highest rate of coho extirpation in Sonoma County Coastal watersheds and the Russian River, but still substantial fragmentation in distribution in Mendocino County as well.

Napa River: Coho salmon have been extirpated from the Napa River and conversion of timberlands to vineyards has contributed to such extensive habitat decline that steelhead are on the verge of extirpation (Higgins 2006b, 2006c, 2007a).

Russian River: The recent NMFS (2008a) Biological Opinion (BO) for large scale water users in the Russian River includes information on the viability of Russian River coho, including loss of genetic diversity that threatens their future existence:

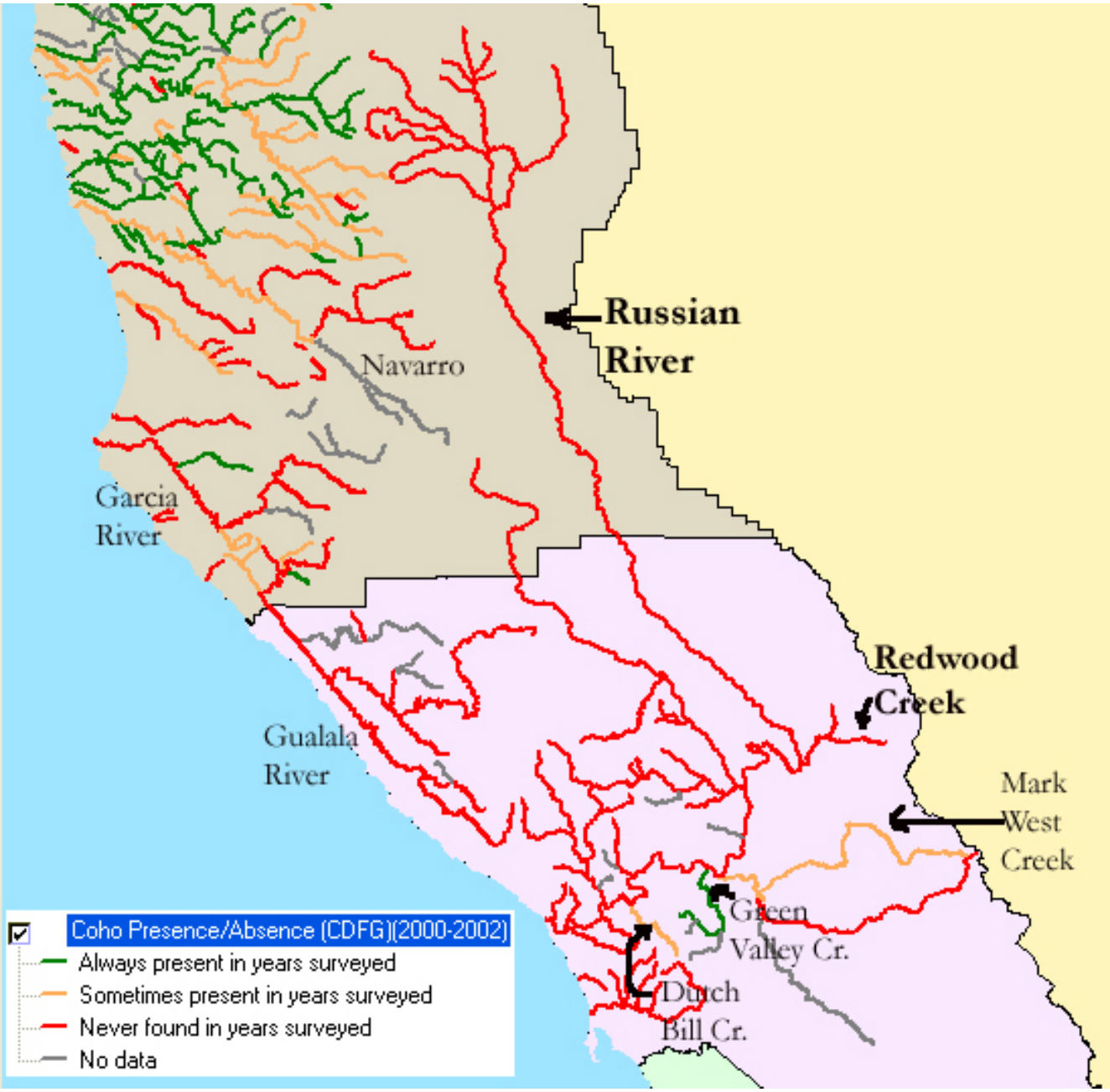

Figure 2. This map shows the CDFG coho salmon presence/absence survey results for the years 2000-2002. Red = no coho found in all three years, orange = absent in at least one year and green = present all years. Only Green Valley Creek had coho all three years in the entire Russian River basin.

> Genetic analyses of coho salmon sampled from Russian River tributaries are consistent with what would be expected for a population with such extremely reduced abundance……This evidence suggests an acute loss of genetic diversity for the Russian River coho salmon population.

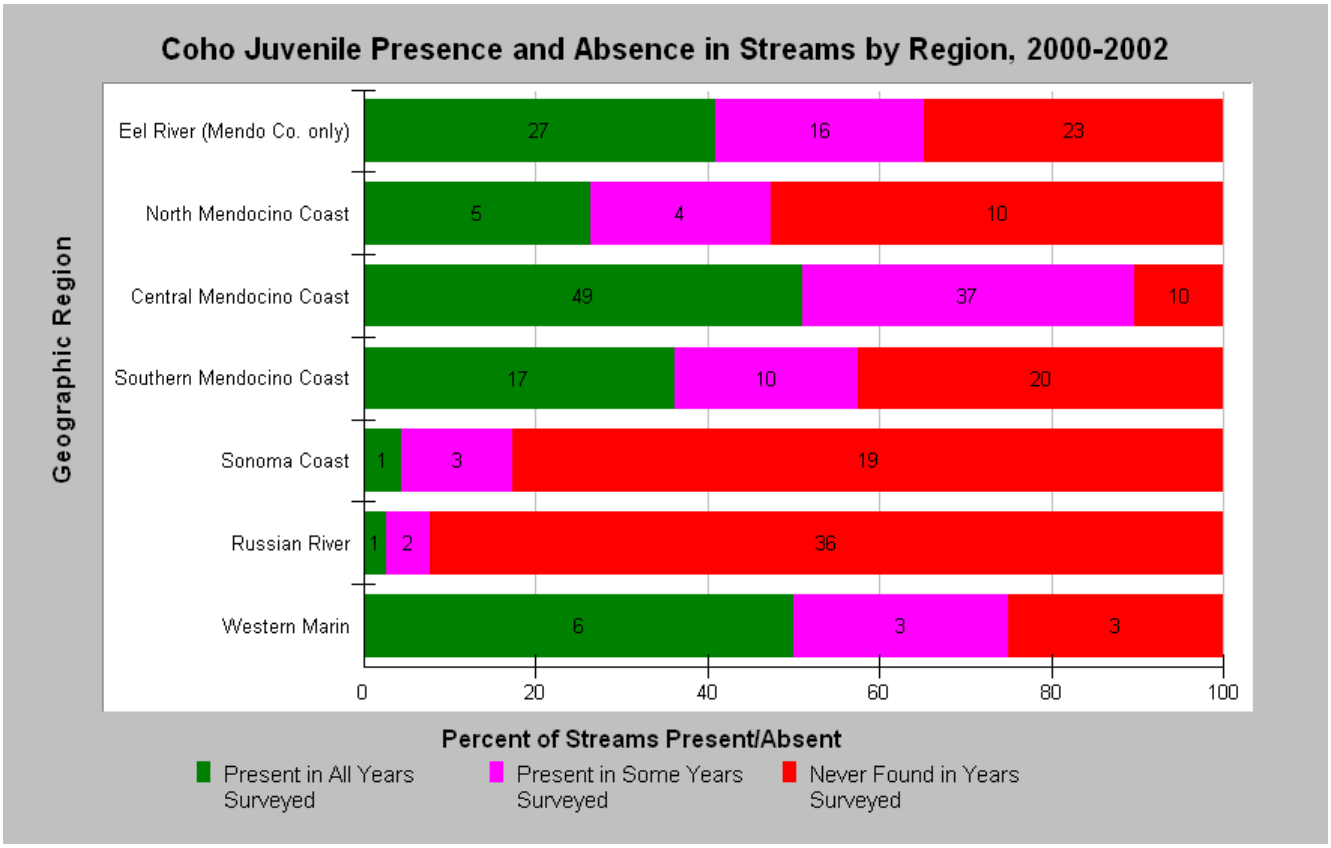

Figure 3. This chart shows a summary of the presence/absence of coho salmon juveniles in streams examined by CDFG in the years 2000-2002. The numbers shown on the chart bars indicate the number of streams in each region in which surveys always, never, or sometimes found coho. Chart from KRIS Garcia (IFR 2003).

> Based on its decline in abundance, restricted and fragmented distribution, and lack of genetic diversity, the Russian River population of coho salmon is likely in an *extinction vortex*, where the population has been reduced to a point where demographic instability and inbreeding lead to further declines in numbers, which in turn, feedback into further declines towards extinction.

The only way that coho salmon can be restored in the Russian River is if lower river tributaries such as Austin, Freezeout, Sheephouse, Dutch Bill and Green Valley Creeks are recovered to functional coho salmon conditions (Reeves et al. 1995). Current aquatic conditions in lower Russian River tributaries are clearly impaired with regard to coho salmon as indicated by low pool frequency, shallow pool depth and water temperatures too warm to support them (Higgins 2007b). Timber harvest is contributing to cumulative watershed effects in these basins and there needs to be a cessation of harvest in at least some of these basins to allow some patches of functional habitat or refugia to be established (Reeves et al. 1995). Instead timber harvests are still routinely conducted (Higgins 2007b).

Gualala River: The Gualala River watershed lies within both Mendocino and Sonoma counties and CDFG (2001) characterized its coho population as extirpated or nearly so. Clear-cut logging

in 80% of the Little North Fork Gualala and harvest rates over 50% in surrounding sub-basins (Figure 4) and subsequent erosion has lead to highly aggraded channel conditions in all Gualala River tributaries (Figure 5) (Higgins 2004a, 2004b, 2007d). The sediment evulsions in the Little North Fork (Figure 5) have caused significant increase in width to depth ratio that increases water temperatures. High bedload movement due to sediment over-supply is also likely causing mortality of eggs (Nawa et al. 1990). Despite planting of coho salmon in the North Fork from 1995-1998, no continuing coho salmon productivity has been established. Channel response to logging in the Little North Fork was a substantial loss of pools and loss of coho was the biological response (Figure 6). Cumulative effects related to logging are the primary stressor on the Gualala River ecosystem and CFPR and TI rules are failing (Higgins 2004a, 2004b, 2007d). For a complete description of cumulative watershed mechanisms derived from data collected in the Gualala River watershed, see Higgins (2007d). For more confirming information see www.krisweb.com/krisgualala/krisdb/html/krisweb/analysis/hypothesis.htm.

Figure 4. Lower Gualala River tributary Rockpile Creek with clear cuts in the riparian zone and in the unstable inner gorge. The riparian buffer appears to provide partial shade, but is not sufficiently wide to restrict warm airflow that further heats a stream that already far exceeds suitable conditions for coho salmon. Photo from KRIS Gualala.

Garcia River: The exception to coho decline in the CCC may be in the Garcia River, where the TMDL (U.S. EPA 1998a) is being implemented, timber harvest levels have been reduced and extensive decommissioning of roads and landings has taken place to lessen erosion and flood damage risk. Habitat trends are positive with pool depths increasing and water temperature decreasing (www.krisweb.com/krisgarcia/krisdb/html/krisweb/analysis/hypothesis.htm). Although coho salmon resurgence to viability is not yet apparent, chum salmon have been seen

spawning in the lower Garcia River and Chinook salmon spawning is occurring for the first time since the 1950's (Craig Bell Personal Comunication).

Figure 5. Highly aggraded stream channel of the Little NF Gualala River just upstream of the North Fork. Pools are filled and small gravels are too unstable for coho spawning. KRIS Gualala.

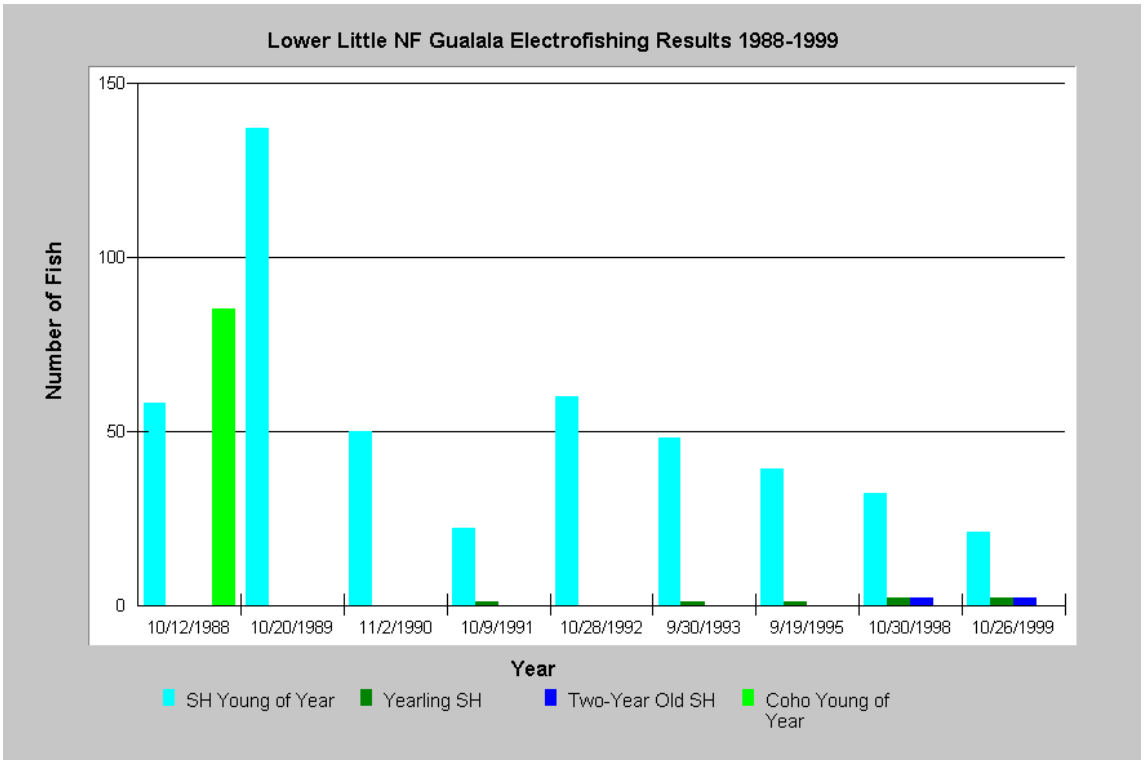

Figure 6. CDFG electrofishing surveys in the Little NF Gualala from 1988 to 1999 show that coho salmon were absent in all years except 1988 indicating that conditions became unsuitable as a result of excess sediment contributions to the stream channel.

Noyo River: The only cluster of basins with consistent presence on the Mendocino Coast is in the vicinity of Jackson Demonstration State forest, where forest age is older and land use management less intense than on private land watersheds that surround it (Higgins 2006). Although Brown et al. (1994) recognized the Noyo River as an important population and one that was still viable, the return to the Noyo River at the CDFG trap was only 13 coho salmon, with three males, three females and seven one year old males known as jacks (Alan Grass personal communication). This indicates a weak year class of coho in the Noyo River, which is equivalent to jeopardy under CESA (ESA Consulting 2008, Higgins 2009). This indicates that the Mendocino coastal population is now at very high risk and may be approaching the status of the Russian and Gualala populations and falling into an extinction vortex. The Willits Redwood THP (THP 1-08-116 MEN) in the upper Noyo River shows the pattern and practice of CDF ignoring CESA requirements for mitigation to protect coho and the ineffectiveness of the TI rules.

Ten Mile River: The Ten Mile River basin to the north of the Noyo River is another classic case-study of cumulative effects eliminating coho salmon. The Ten Mile River was a strong hold for the species and had never had extensive stock transfer or hatchery operation for culturing coho salmon. The South Fork was particularly prime coho habitat after substantial watershed rest from prior logging, but 80% clear cut logging (Figure 7) between 1993-1999 and high road densities caused increased erosion, loss of pools, increased water temperature and loss of coho salmon (see www.krisweb.com/kristenmile/krisdb/html/krisweb/analysis/hypothesis.htm).

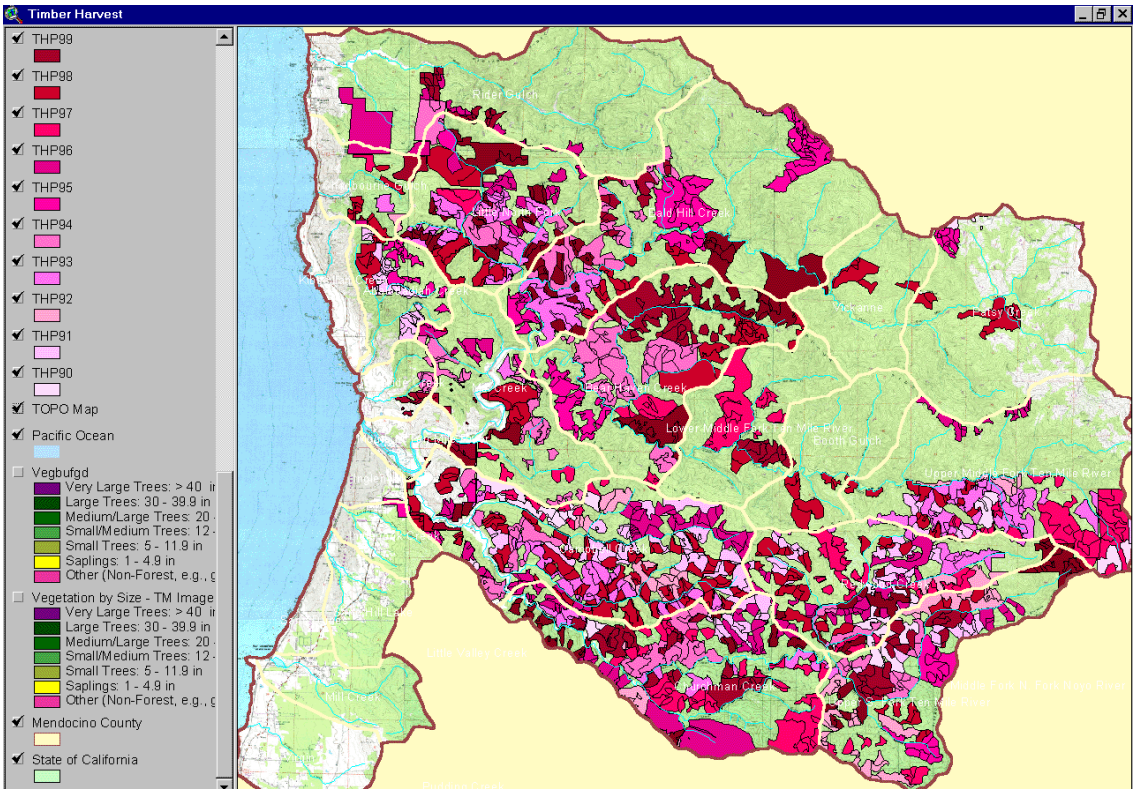

Figure 7. Timber harvest under CFPR from 1993-1999 allowed 80% of the SF Ten Mile watershed to be logged and road densities were 7-10 mi./sq. mi. Map based on data from CDF from KRIS Ten Mile.

Matthews and Associates (2000) found that logging from 1993-1999 under CFPR had caused far fewer landslides than prior logging waves, but that surface erosion and fill failures on road systems still lead to substantial excess sediment contributions.

Southern Oregon Northern California Coastal (SONCC) Coho Salmon ESU

Moyle et al. (2008) rated SONCC coho salmon as category 2, in danger of extinction within the next 50-100 years and as indicated below there are no healthy populations or refugia.

Mattole River: Coho salmon are at very low levels in the Mattole River and the adult population has fallen below 500 fish for nearly 20 years (Figure 8), which is a critically low level (Gilpin and Soule (1986)). Logging in the North Fork on steep unstable terrain has unleashed sediment into the estuary that further degrades coho salmon habitat and threatens Chinook salmon as well (Higgins 1998). BLM (2004) has stopped all logging in their holdings and created the King Range National Recreation Area, and streams on the west side of the Mattole River drainage, such as Bear Creek, are improving with regard to suitability for coho salmon.

Lower Eel River/Van Duzen River: Clear cut logging by Pacific Lumber Company (PL) caused loss of coho salmon in the lower Eel River and Van Duzen River tributaries (Higgins 1998, Higgins 2008b). Pacific Watershed Associates (1998) found that 80% of sediment in Bear Creek, a lower Eel River tributary, came off clear cuts form the previous 15 years. Torrent runout distances from lands slides were much greater because there was little large wood in landslide material and the depth of sediment was 8-15 feet all the way to the mouth of the creek (Figure 9)(PWA 1998). Stream temperatures rose in response to the change in width to depth ratio caused by the aggradation to levels that no longer support coho salmon (Higgins 1998).

Humboldt Bay Tributaries: PL logging since 1988 in the Elk River has created a press disturbance and greatly diminished coho salmon production in what was formerly one of the north coast's population centers (Brown et al. 1994). Freshwater Creek is the most well studied of northern California coho salmon watersheds and their decline in response to PL logging is well documented (Higgins 2001). Logging levels between 1988 and 2000 were as high as 50-80% in Freshwater Creek sub-basins which have road densities ranging from 6-8 miles of road per square mile of watershed (mi./mi.^{2}) when 2.5 mi./mi.^{2} is the prudent risk limit that would meet functional criteria for coho and other Pacific salmon species (NMFS 1995, 1996). This widespread disturbance on weak sandstone bedrock geology in combination with timber harvest resulted in major erosion that filled pools, increased fines sediment in spawning gravels, decreased aquatic insect diversity and caused coho salmon to be lost from some tributaries like Graham Gulch (Figures 10 & 11)(Higgins 2001).

Graham Gulch shows signs of both major sediment evulsions but likely also changes in hydrology. Decreased base flows in response to hydrologic changes like high road density may be playing a role in loss of summer surface flows (Jones and Grant 1996, Montgomery and Dietrich 1993), but it may be more owing to the amount of over burden that has resulted from recent land use. When a stream is buried many feet deep in sediment, its flows are mostly underground during summer and fall months prior to the onset of winter rains. Winter flows are flashy with rapid peaks and mainstem Freshwater Creek remains highly turbid for months on

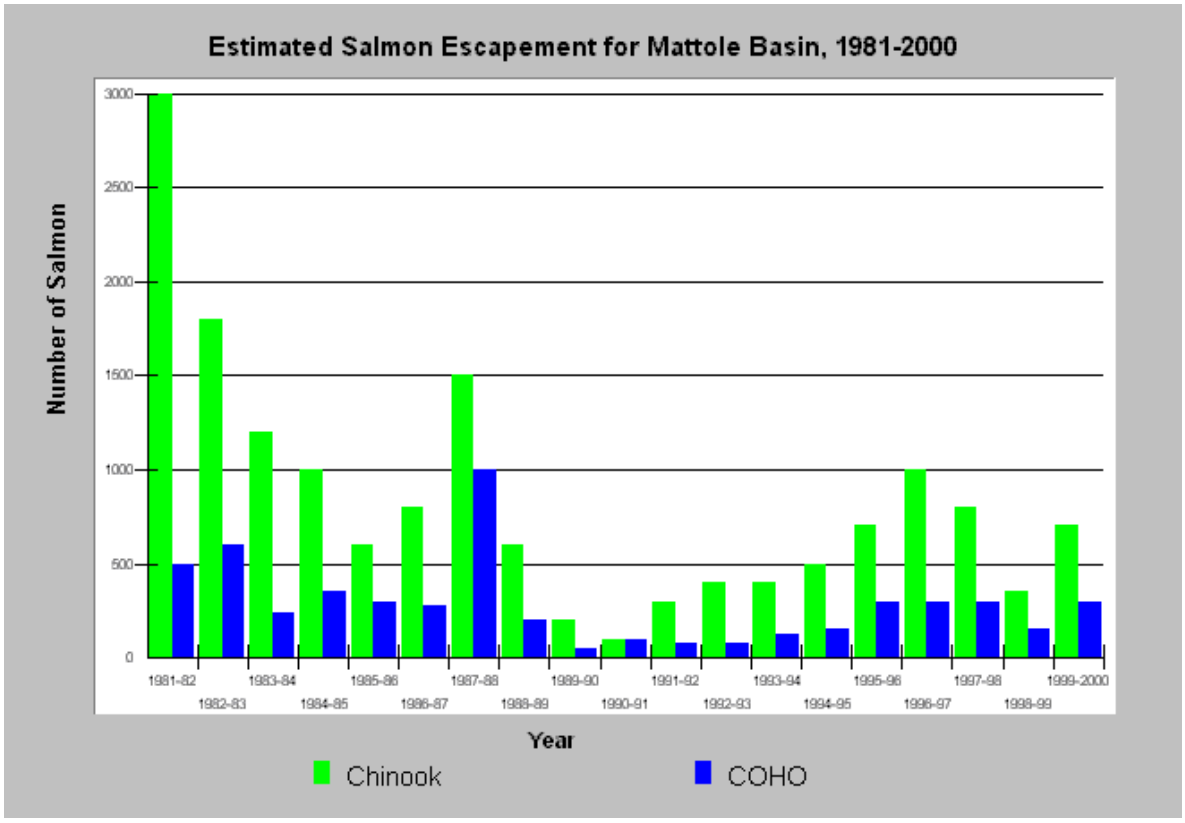

Figure 8. Adult escapement of Chinook and coho salmon in the Mattole River drainage indicate that coho populations are at critically low levels and have been for 20 years. Data from Mattole Salmon Group.

Figure 9. Bear Creek after debris torrents off PL clear cuts on steep slopes triggered by January 1997 storm. Photo by Pat Higgins from KRIS Coho.

Figure 10. Graham Gulch, tributary of Freshwater Creek, shown in February 2002 during high flows with extremely high turbidity apparent. Photo by Pat Higgins. KRIS Humboldt Bay.

Figure 11. Graham Gulch at the same location as the photo above with loss of surface flow due to several feet of aggradation and possibly decreased base flows due to widespread logging disturbance. Photo from KRIS Coho.

end (Higgins 2001)(Figure 10), which restricts coho salmon and steelhead juvenile feeding and growth (Sigler et al. 1984).

Mad River: Simpson Timber Company (now Green Diamond) has been equally injurious to coho salmon through its logging practices and road building that have elevated cumulative effects risk and caused loss of coho salmon in some sub-basins they manage (Higgins 2002, 2008). Coho salmon have been lost from Canon Creek on the Mad River as a result of sediment evulsions, which was formerly an index stream for the species for the Pacific Fisheries Management Council. The last stronghold of coho in the Mad River is in Lindsay Creek where active logging is still occurring and threatening this last vital population unit with extirpation (Higgins 2008).

Redwood Creek: The mainstem of Redwood Creek is severely aggraded and coho and summer steelhead are at very low levels in the watershed above Prairie Creek (Higgins 2002). The mainstem of lower Redwood Creek is so aggraded that it loses surface flow in summer (Figure 12). Landowners in Redwood Creek, including Green Diamond, have operated a downstream migrant trap that shows Chinook salmon and steelhead production is recovering in the upper Redwood Creek watershed but the lack of coho salmon in these traps shows that habitat is not fully recovered. Also, it is likely that the continued high rate of harvest on unstable terrain poses significant continuing high risk of future waves of sediment and recurrence of aggradation. Filling of the estuary is a major constraint on Chinook salmon recovery (U.S. EPA 1998b).

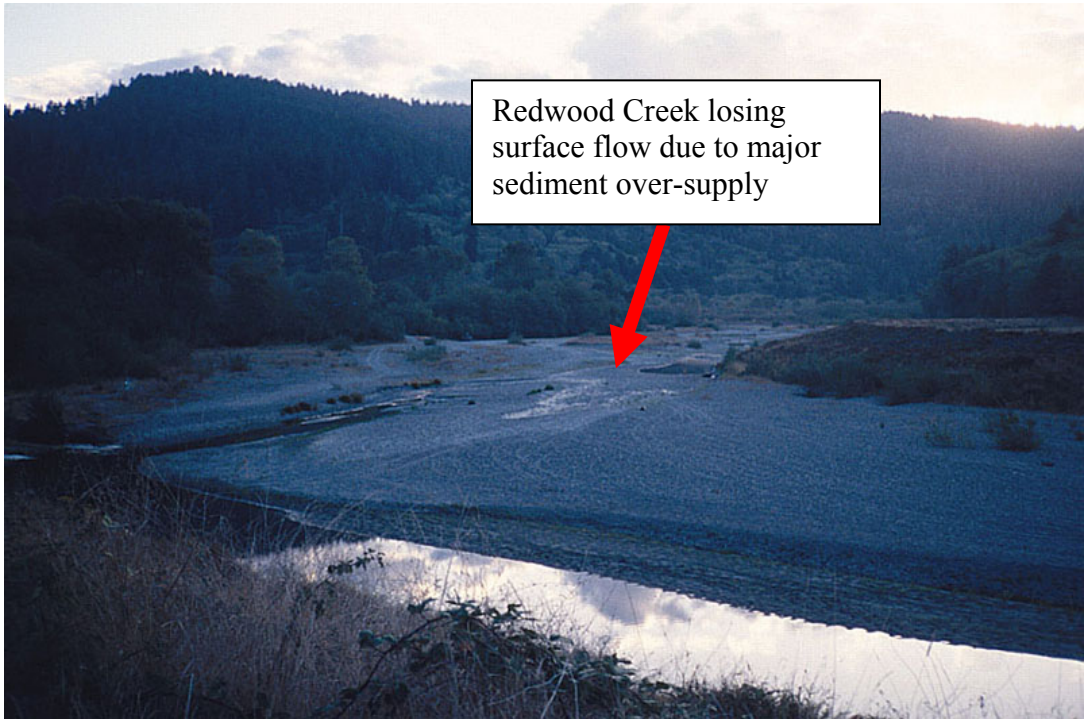

Figure 12. Redwood Creek at its junction with Prairie Creek, with which it converges at the far left of photo. Aggradation from logging and road failures causes the creek to lose surface flows and yet logging continues in this TI watershed. Photo by Pat Higgins in October 2003.

Lower Klamath Tributaries: Rankel (1978) found that Terwer Creek and Blue Creek were the last major producers of Chinook salmon in the Lower Klamath Basin and recommended they be protected. Instead the Terwer Creek watershed was 80% clear cut (Figure 13) and erosion from disturbed slopes buried lower stream reaches making them not only unsuitable for salmon but so aggraded that it loses surface flow (Figure 14). Voight and Gale (1998) note that 14 of 17 Lower

Figure 13. Terwer Creek watershed from the air in 1990, including areas that had burned and been salvage logged. Photo by Pat Higgins from KRIS V 3.0.

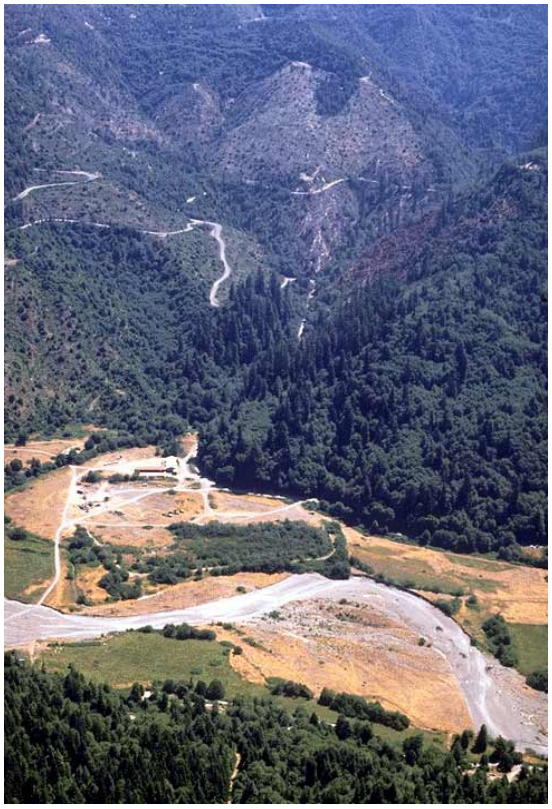

Figure 14. Lower Terwer Creek running underground in 1992 after 80% logging on private industrial timberland. The stream bed is likely buried by 10-15 feet of over-burden due to accumulated debris torrents. Photo by Pat Higgins, KRIS Klamath-Trinity V 3.0.

Klamath Basin tributaries lack surface flow at their point of convergence with the mainstem because the over-burden of bedload buries the original stream bed so deeply (Kier Associates 1991, 1999).

Coats and Miller (1981) pointed out the regulatory dilemma in Terwer Creek, where either logging would have to be curtailed or cumulative effects damage endured, long before coho salmon were listed under ESA. Watersheds and stream conditions similar to Terwer Creek prevail in Hunter Creek and Wilson Creek, which is a Pacific Ocean tributary to north of the Klamath, that are similarly managed by Green Diamond Resources (Higgins 2002). U.S. Fish and Wildlife Service (1990) operated downstream migrant traps in Lower Klamath basin tributaries and found fish communities dominated by warmwater species (Figure 15) as opposed to salmonids, which were the main species prior to disturbance from logging. Kier Associates (1999) found that Yurok Tribe efforts to re-establish Chinook salmon in Hunter Creek were being confounded by poor habitat conditions resulting from sediment over-supply related to logging. Moyle et al (2008) consider Blue Creek refugia because its headwaters are on federal land and forest lands are intact. However, logging on private industrial timberlands in lower Blue Creek are extensive, including in riparian zones and on unstable inner gorge areas (Figure 16).

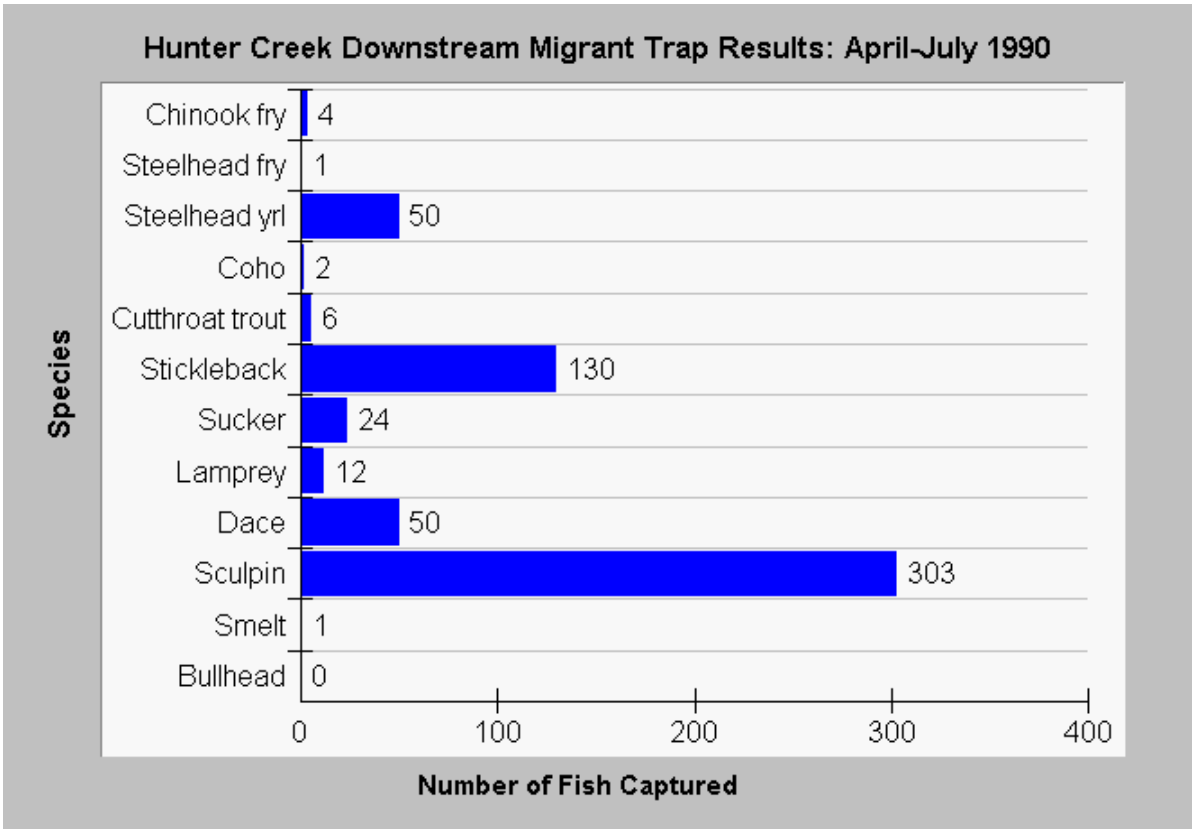

Figure 15. The downstream migrant trap results from Hunter Creek show extremely low numbers of salmonids and a shift in fish community structure to non-salmonids as a result of habitat loss. Data from USFWS (1990).

Figure 16. Lower Blue Creek on Simpson Timber land with logging taking place immediately up to the stream channel (see discussion in riparian section) and the inner gorge. Photo by Pat Higgins from KRIS V 3.0.

Interior Klamath Basin Tributaries (Scott/Middle Klamath): Logging on private land in the interior Klamath River Basin is also causing loss of coho salmon (Kier Associates 1991, 1999). Specifically there are acute problems related to logging on private land in the Scott River watershed (QVIR 2006) and Middle Klamath Basin tributaries with private land holdings like Beaver and Horse Creeks (Kier Associates 1991, 1999, QVIR 2007). Although Six Rivers National Forest has decreased logging rates and decommissioned roads, Klamath National Forest has been actively logging and contributes to cumulative effects risk substantially (Kier Associates 1999). The January 1997 storm caused the scour of 435 miles of stream channels on KNF (de la Fuente and Elder 1998) and many landslides were initiated by timber harvest, landings or road segments that crossed unstable slopes (Figure 17) (Kier Associates 2005). Creeks in the lower Scott River like Kelsey and Middle Creeks and Thomkins Gulch lost riparian cover and became too warm to support coho salmon, although their mouths had formerly served as refugia.

Additional problems in interior basins are unstable soils, like decomposed granite, and potential for rain on snow events (Harr et al. 1975, Jones and Grant 1996). Decomposed granite soils ravel and gully once disturbed resulting in sand levels in the mainstem Scott River stream substrate of over 80% (QVIR 2005) and very high levels in Beaver and Horse Creeks as well (Kier Associates 1991, 1999).

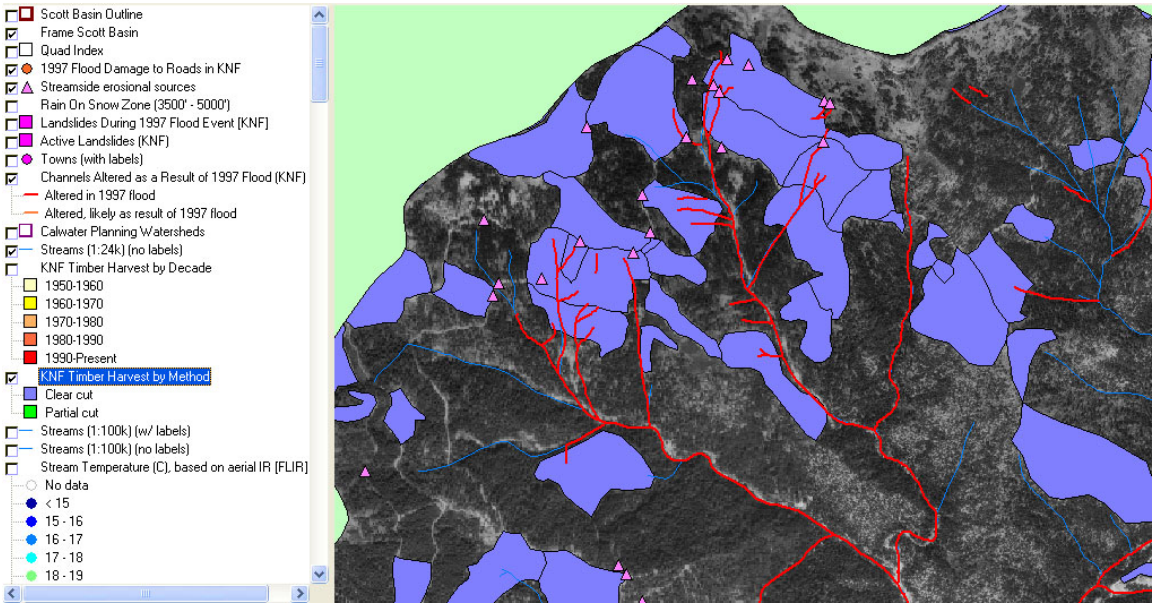

Figure 17. This map shows the overlap of Klamath National Forest clear cut timber harvests in the 1980's and 1990's (blue) and the occurrence of blown culverts or road failures on unstable slopes (pink triangles). The red lines indicate channels scoured by debris torrents.

Coho salmon in the Scott River have only one strong year class and two weak ones, which means that the species meets the definition of jeopardy under CESA (QVIR 2008), yet logging continues. Use of Landsat imagery from different periods allows comparison between years of vegetation (Fischer 2003) and 1994 to 1998 "change scene detection" data show major loss of canopy in French Creek and other Westside Scott River tributaries on private land (Figure 18)(QVIR 2005). This not only contributes to temperature problems, but also depletes the large wood supply so necessary for pool formation and coho salmon habitat.

Continued timber harvest in the Middle Klamath Basin on private land threatens coho salmon refugia at the mouths of streams (Belchik 2003, Watercourse Engineering 2004, QVIR 2006). These cold water islands at tributary junctures are vital to survival of juvenile salmonids (QVIR 2007), particularly since summer mainstem Klamath Water temperature and water quality conditions are sometimes highly stressful or lethal. The U.S. EPA (2003) states that such refugia are of critical import when large rivers are out of compliance with water quality standards and resolution of pollution problems is likely to take along time.

Specific Comments on Proposed Threatened and Impaired Watershed Rules

The proposed Threatened and Impaired Watershed Rules (TIWR) do not conform to recognized best science on land management and preservation and restoration of Pacific salmon species (FEMAT 1993, Spence et al. 1996). Most actions appear geared toward allowing more harvest and would thus include an increased level of take. The largest problem, however, is not the sufficiency of each proposed rule revision, but rather the lack of ability to deal with cumulative

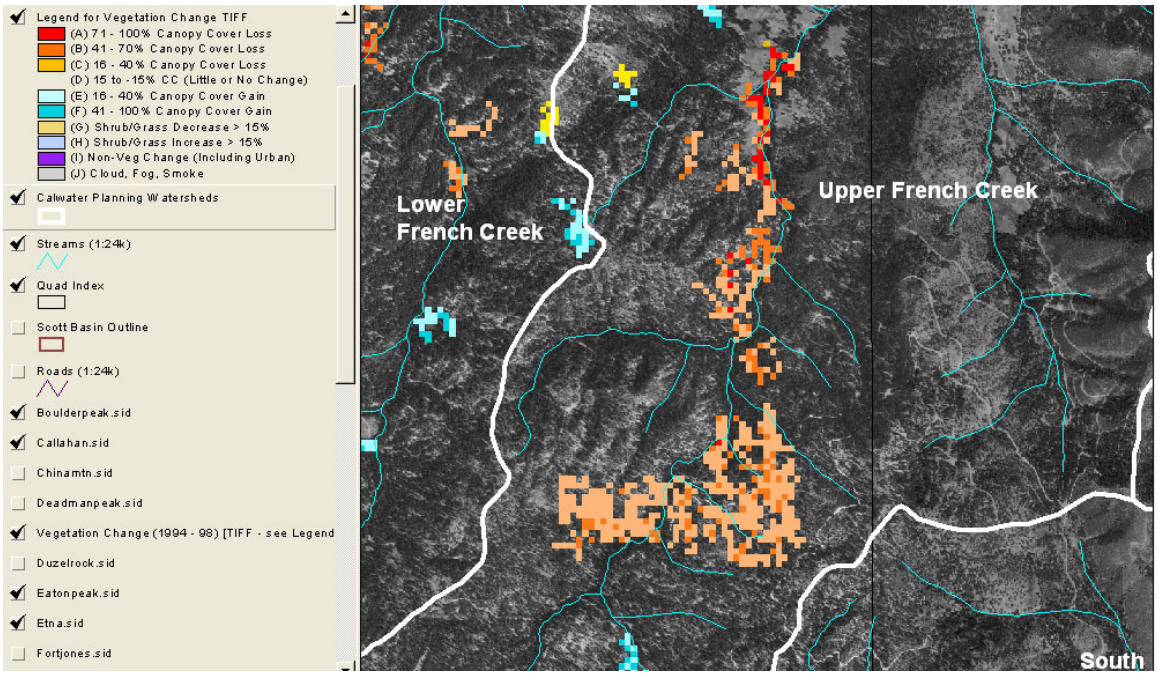

Figure 18. Vegetation change derived by comparing 1994 and 1998 Landsat images shows substantial decrease in trees in the riparian zone and canopy of reaches of lower French Creek. Data are from CDF and USFS Spatial Analysis Lab (Fischer 2003).

watershed effects (Ligon et al. 1999, Dunne et al. 2001, Collison et al. 2003). It doesn't matter what specific restrictions are or what mitigations are applied because interaction between different disturbed landscape patches creates peak flows and sediment yield far above what would be expected from site impacts alone (Frissell 1992, Reeves et al. 1993, 1995). Options for amending TWIR are grouped below for efficiency since many pertain to the same subjects and only vary slightly.

Options 1-19 Proposed Riparian Harvest Changes – All Reduce Protection: The CFPR continue to use shade maintenance as a way to control water temperature, but ambient air temperature over the stream drives maximum water temperature and shade is third in influence following relative humidity (Bartholow et al 1989, Essig 1999). FEMAT (1993) called for protection of the riparian zone (no cut) out to two site potential tree heights or to the edge of the inner gorge. Spence et al. (1996) note that the absolute minimum buffer width for maintaining cool air flow over the stream is one site potential tree height, which would be 180-240 feet in Douglas fir or redwood forest streams. CDF staff and NOAA show that overstory canopy under Options 1 and 2 could be lower by 15-30%, if the 80% Angular Canopy Density (ACD) is used for the inner zone requirement for Class I WLPZ's. Therefore, these rules would cause further degradation, including further depletion of large woody debris, which is a major on-going problem with CFPR (Ligon et al. 1999).

Option 3 deals with Stable Operating Surfaces: "In both the proposed definition and the Optional Amendment 3, the Board's intent is that hauling on a Stable Operating Surface would typically be permitted with minor puddles (such as those created by road watering for dust

abatement during the dry season). However, when the road system has significant ponding that does not drain or evaporate in a reasonable time period, this would not be a characteristic of a stable operating surface." This option is meant to deal with roads that cross wetlands or springs, but the amendment does not state that such locations must be avoided during road layout and construction. This amendment deals with one symptom of major hydrologic perturbation related to roads while TI rules dodge the major questions of limits to road density, roads crossing unstable slopes, or limiting the number and type of stream crossings.

Options 4, 5, 6, 7, 9, 11, 12 and 13 all decrease riparian stocking, canopy closure and the potential to recruit large wood to streams and have the same deficiencies as Options 1 & 2 above and should therefore also be rejected. Stream side timber harvests have already depleted riparian zones (Figures 4, 5, 14, 16) (Ligon et al. 1999) and their ability to recruit large wood may be hampered for more than a century in the future (Spence et al. 1996). Option 5 appears driven by the desire to get more harvest of riparian trees in interior basins where problems with high ambient air temperatures should actually require greater riparian protection. CDFG found that Option 6 is likely to further decrease large wood recruitment to streams and, therefore, counter productive to protection and restoration of Pacific salmon species.

Although Option 8 increases the amount of basal area to be retained in the 100 foot inner band of Class I riparian zones, in addition to the 80% overstory requirement, any further logging within these zones should be disallowed. This retention standard is still well under what is needed to restore fully functional riparian conditions (FEMAT 1993). Option 11 proposes to lessen riparian protection outside the range of the coho salmon, but the same buffering should be maintained to protect other native fishes and amphibians (Spence et al. 1996).

Options 15-19 deal with Class III streams or those that are intermittent. CFPRs and the TWIR continue to afford these sensitive headwater streams insufficient protection when in fact there should be no timber harvest within one site potential tree height (FEMAT 1993) or at least 100 feet. May and Greswell (2003) described how major amounts of large wood found in streams in the Coast Range of southern Oregon came from landslides originating in headwater areas (Class III streams), which is similar to the findings of Reeves et al (2003). The Bear Creek case study (PWA 1998) shows clearly that, when trees are harvested off steep unstable headwalls or in inner gorges, landslides are triggered. Because trees have been removed due to logging, there is not matrix of large wood entrained to meter sediment and provide large wood around which new pools can be scoured. PWA (1998) found that instead of hanging up in log jams, the debris torrent 8-15 feet deep extended all the way to the Eel River.

While logging in Class IIIs has been thought not to increase water temperatures because of lack of flow in summer, Brosofske et al. (1997) found that clear cutting in headwater areas may cause an elevation in ground water temperatures that then contribute to downstream warming.

Options 21-25 are concerned with erosion control, but once again the meaningful questions are not posed and the real problems of cumulative effects avoided.

What Reform of CFPR and TI Rules is Needed to Restore Coho Salmon

The CFPR and TI rules fail because they do not acknowledge watershed processes and how salmon watersheds work. The BOF failure to limit rates of watershed disturbance has precipitated a major change in the timing and amount of sediment, large wood and water contributed to stream systems (Reeves et al. 1995). Streams now bear little resemblance to the streams with which Pacific salmon species co-evolved and this habitat modification is recognized as causing diminished species diversity in coastal Oregon (Reeves et al. 1993) and fragmentation of the distribution of coho salmon in California as demonstrated above. All TI watersheds are over cumulative effects thresholds and have lost or are on the verge of losing the ability to maintain coho salmon and it is clear that there has been a pervasive and unsustainable level of "take" under the Endangered Species Act (ESA) and the California Endangered Species Act (CESA) (Higgins 2008). The proposed TI rules, while better in certain respects than anything the Board has previously offered (e.g., these rules at least finally acknowledge the need for Class 2 and Class 3 restrictions), still fail to address the watershed level problems and fail to account for cumulative impacts; consequently, "take" of listed salmonids, especially coho, will continue. This does not meet the intent of CESA nor does it comply with what NMFS (In Review) recommends pursuant to the ESA.

<u>Road Densities, Near-Stream Roads and Road Stream Crossings</u>: Jones and Grant (1996) point out that watershed hydrology can recovery rather quickly from timber effects, but that hydrologic perturbations from road networks can persist for decades. Hagans et al. (1986) estimated that 50 to 80% of the sediment that enters northwestern California streams stems from road-related erosion. Klein (2003) found a strong correlation of road density with turbidity levels that would limit juvenile salmonid growth (Figure 19).

U.S. Forest Service (1996) studies in the interior Columbia River basin found that bull trout were not found in basins with road densities greater than 1.7 mi/mi^2. They ranked risk road density of greater than 4.7 mi/mi^2 as extremely high (Figure 20). National Marine Fisheries Service (1996) guidelines for salmon habitat characterize watersheds with road densities greater than 3 mi/mi^2 as "not properly functioning" while "properly functioning condition" was defined as less than or equal to 2 mi/mi^2 with no or few stream aide roads. NMFS (1995) set the target for road density in the Columbia River Basin as 2.5 mi./mi.^{2} to attain properly functioning watershed condition for sensitive fish species and CFPR and TI rules would need to achieve this standard to re-establish more normal sediment and hydrologic regimes compatible with coho recovery.

Road densities in TI watersheds typically range from 4-10 mi./mi.^{2} and estimates are conservative because maps on which they are based do not include temporary roads, abandoned roads, skid roads or landings. There should be no new road construction for timber harvest in TI watersheds and an aggressive road decommissioning program should be initiated with any rule package, with a priority given to streamside roads or those that cross unstable slopes. Harr and Nichols (1993) found that road decommissioning prevented stream channel damage by comparing response to a large storm event in basins with and without such treatments. To avoid damaging multiple crossing failures that yield catastrophic amounts of sediment (Figure 17)(de la Fuente and elder 1998), TI rules should mandate that road-stream crossings be reduced to a

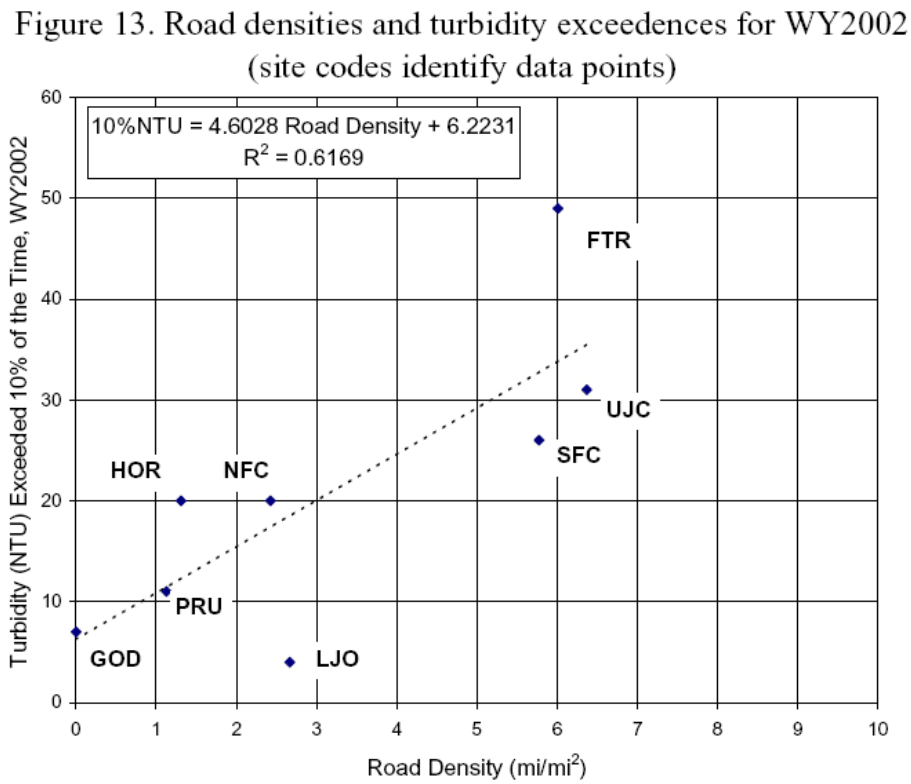

Figure 19. Regression showing string correlation of turbidity and road densities in NW CA. Taken form Klein (2003).

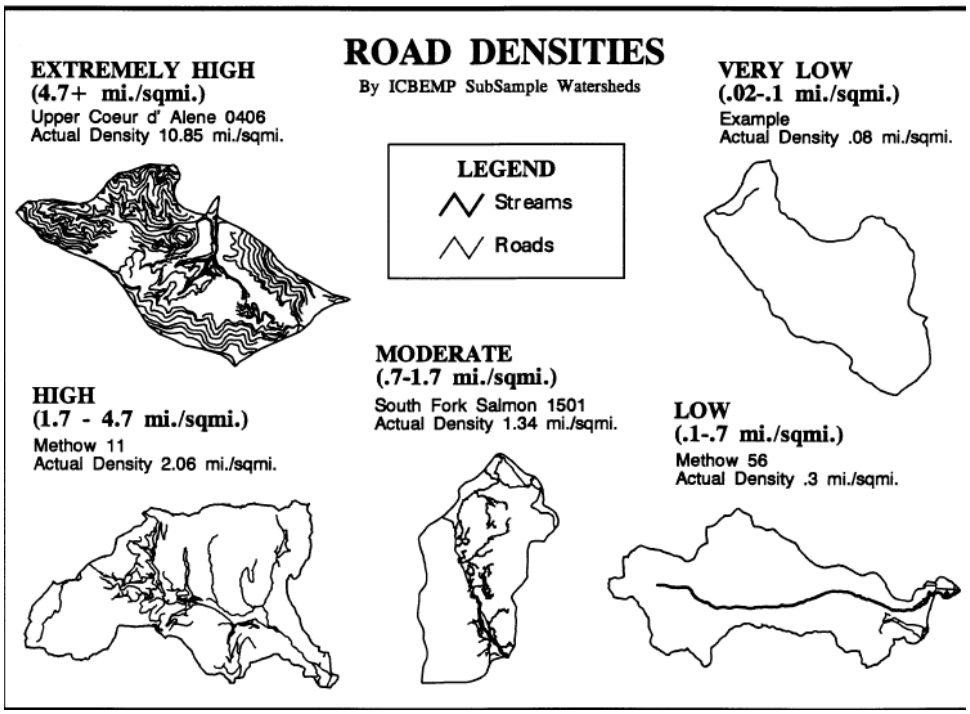

Figure 20. Road density categories from the USFS (1996) rating cumulative effects risk.

target of no more than 2 per mile of stream (Armentrout et al. 1999). Crossings with high risk of failure and stream capture should be the priority for removal.

Prudent Risk Limits to Timber Harvest: Ligon et al. (1999) and Dunne et al. (2001) both concluded that failure to set prudent risk limits for timber harvest was one of the most serious shortcomings of CFPR with regard to protecting salmon and steelhead. This could be done by the BOF requiring watershed rest or limiting timber harvest to less than a prudent risk threshold of 25% of a sub-basin's area logged in 30 years (Reeves et al. (1993). Reeves et al. (1993) found that watersheds on the Oregon coast harvested more than that amount had substantial negative cumulative effects that were manifest in 10-47% loss of pools and substantial reduction of large wood as well as diminished Pacific salmon diversity. This is similar to the findings of Klein (2003) relative to logging and turbidity in northwestern California. He found that there was a logarithmic increase in turbidity with each increase of percent of inventory harvested (POI). Turbidity levels meet beneficial use levels when harvest rates are 1% POI or less, but over 2% POI (50% harvested in 25 years) levels would limit juvenile salmonid growth, which is equivalent to 10% of a watershed per decade or 25-30% over a 25-30 year period.

Riparian Protections: Ample scientific evidence exists on salmonids and riparian zones (FEMAT 1993, Spence et al. 1996, Dong et al. 1998) (Figure 21) . There should be no entry into riparian zones on Class I streams for at least two site potential tree heights and Class II streams for at least one site potential tree height. Lack of protection for intermittent headwater streams (Class III) is perhaps the biggest problem with CFPRs and TI rules and there should be an at least 100 foot no cut buffer in these areas.

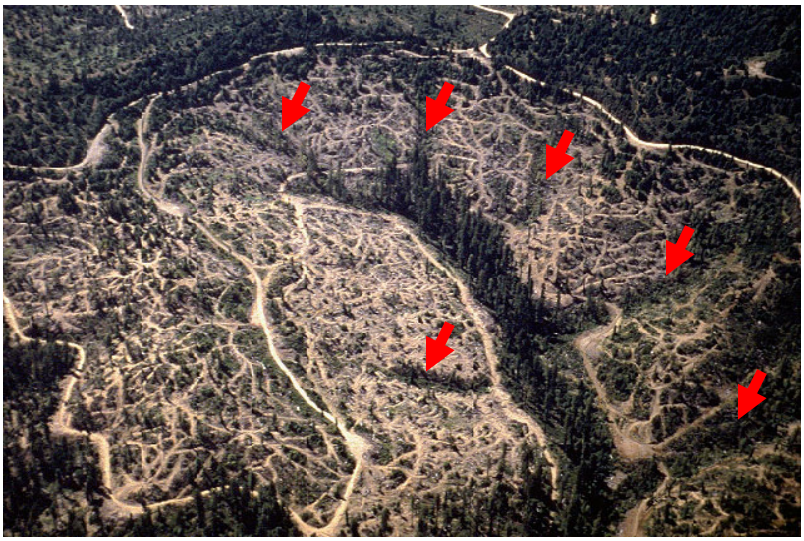

Figure 21. Riparian protection of a Class II stream in the Yager Creek watershed with lack of protection afforded Class III streams (red arrows). KRIS Coho.

Prevention of Logging or Road Building on Unstable Slopes: The Shallow Landslide Stability Model (Dietrich et al. 1998) can act as a screen in THP planning so that steep unstable slopes subject to debris torrents can be avoided. Kier Associates (2005) found that 80% of debris torrents triggered in the lower Westside Scott River basin came from portions of the landscape that fell into high risk and extreme risk SHALSTAB categories. Logging on these areas with

high potential for failure accelerates landsliding due to loss of root strength (Ziemer 1981) and depletion of large wood in these areas deprives downstream reaches of wood supply needed for supporting coho salmon. In worst case scenarios, logging in inner gorges causes failures where all the material is contributed to the stream (Figure 22), which results in streambed damage well downstream (Figure 23). New CFPR and TI rules need to restrict logging and road building on steep unstable slopes indicated as high or extreme risk by the SHALSTAB model.

Figure 22. Inner gorge failure in Jordan Creek, Lower Eel River basin, where PL had logged an inner gorge area. The resulting failure caused massive aggradation in downstream reaches. Photo by Doug Thron from KRIS Coho.

Unstable Soils: Highly active tectonic processes shear coastal soils creating impervious layers that can act as failure plains. Once disturbed and compacted, these clay soils tend to provide a source of chronic fine sediment that causes elevated turbidity noted by Klein (2003). TI watershed protections should include identification and avoidance of such areas.

In interior basins, decomposed granite (DG) is the most erosive of soil type and once disturbed it tends to gully (Figure 24) and cause major sediment over-supply to stream channels (Figure 25). DG soils have low nutrients and moisture holding capacity after clear cuts that can prevent regeneration. This soil type is pervasive in the linear formation from Shasta Bolly Mt. east of Redding that trends north across the Upper Trinity, Scott River and then through Middle Klamath tributaries like Horse and Beaver Creeks near Mt. Ashland. No widespread disturbance or road building should be allowed on DG soils within TI watersheds.

Figure 23. Jordan Creek in Humboldt Redwoods State Park cannot support coho salmon due to sedimentation from logging activity and slope failures upstream. Note boy on bar (red arrow) for scale indicating excess bed load more than 10 feet deep.

Figure 24. Crossing at Phillips Gulch has washed away a substantial amount of fill material. The culvert appears undersized to handle flood flows which has triggered this problem. Just east of Trinity Dam Blvd. 4/99. Photo courtesy of the Trinity County Resource Conservation District. KRIS V 3.0.

Figure 25. This is a large deposits of decomposed granitic sands which have formed a delta below a road gully in the Grass Valley Creek watershed. 5/83. Photo courtesy of the Trinity County Resource Conservation District. KRIS V 3.0.

Lack of Refugia a Major Problem: There are almost no intact coho salmon watersheds in northwestern California with suitable conditions and healthy populations that could serve as a source of colonists in rebuilding regional populations. Watersheds like the Noyo River, Humboldt Bay tributaries and lower Blue Creek that were formerly recognized as major coho salmon producers (Brown et al. 1994) were not protected but have rather been extensively logged. Protected federal lands are often too steep to have streams of optimal gradient; therefore, refugia must be established in coastal basins or coho salmon will not recover (Reeves et al . 1995). Good candidates are the Lower Russian River, Big Salmon Creek, Albion River, Noyo River, JDSF coastal tributaries, SF Eel River, selected Humboldt Bay tributaries, Little River (Humboldt Co.), Redwood Creek, lower Blue Creek, Horse and Beaver Creeks and selected Scott River tributaries.

CDF's Failure to Protect Blocks Restoration Opportunity: Bradbury et al. (1995) point out that preservation can take place without restoration but that restoration of Pacific salmon species cannot take place without habitat protection. Coho salmon can only survive and be recovered if freshwater habitat conditions are suitable and trends are improving. CDF has data at its disposal

that could be used for such habitat trend monitoring, including data they paid to assimilate in KRIS systems, but it chooses not to. When conditions are found to be non-supportive of coho salmon, cessation of anthropogenic stress is needed (Kauffman et al. 1999).

Timber Harvest Practices Compatible with Recovery Are Possible: The Parker Ranch within the North Fork Ten Mile River basin shows the direction California logging should take to avoid cumulative effects: use of high lead, full suspension cable logging, reducing road networks and road bed size, and selectively harvesting to maintain optimal microclimate and forest growth (www.krisweb.com/kristenmile/krisdb/webbuilder/nf_p130.htm).

Timing of Restoration Habitat Recovery and Potential for Coho Salmon Extinction

If prompt action is not taken to reverse the decline in freshwater habitat quality for coho salmon before ocean productivity cycles become less favorable (Hare et al. 1999) and on-land climatic cycles become drier sometime between 2015-2025, then it is highly likely that coho salmon will be extirpated even in the northern part of their range within the State (Collison et al. 2003).

Sincerely,

Patrick Higgins

References

Armentrout, S., H. Brown, S. Chappell, M. Everett-Brown, J. Fites, J. Forbes, M. McFarland, J. Riley, K. Roby, A. Villalovos, R. Walden, D. Watts, and M.R. Williams. 1998. Watershed Analysis for Mill, Deer, and Antelope Creeks. U.S. Department of Agriculture. Lassen National Forest. Almanor Ranger District. Chester, CA. 299 pp.

Bartholow, J.M. 1989. Stream temperature investigations: field and analytic methods. Instream flow information paper no. 13. Biological Report 89(17). U.S. Fish and Wildlife Service, Fort Collins, Co.

Bell, Craig. Personal Communication. Garcia River Watershed Coordinator, Gualala, CA.

Bradbury, W., W. Nehlsen, T.E. Nickelson, K. Moore, R.M. Hughes, D. Heller, J. Nicholas, D. L. Bottom, W.E. Weaver and R. L. Beschta. 1995 Handbook for Prioritizing Watershed Protection and Restoration to Aid Recovery of Pacific Salmon. Published by Pacific Rivers Council, Eugene, OR. 56 p. Available online at:
www.krisweb.com/biblio/gen_xxxx_bradburyetal_1995.pdf

Brown, L.R. and P.B. Moyle. 1990. Eel River Survey: Final Report. Department of Fish and Wildlife, University of California, Davis. Contract F-46-R-2 for the California Department of Fish and Game. U.C. Davis Dept. of Fisheries and Wildlife, Davis, CA.

Brown, L.R., P.B. Moyle, and R.M. Yoshiyama. 1994. Historical Decline and Current Status of Coho Salmon in California. North American Journal of Fisheries Management. 14(2):237-261.
California Department of Fish and Game (CDFG). 2002. Status Review of California Coho Salmon North of San Francisco . Report to the California Fish and Game Commission. California Department of Fish and Game, Sacramento , CA. 336pp.

Cedarholm, C.J., R.E. Bilby, P.A. Bisson, T.W. Bumstead, B.R. Fransen, W.J. Scarlett and J.W. Ward. 1997. Response of Juvenile Coho Salmon and Steelhead to Placement of Large Woody Debris in a Coastal Washington Stream. North American Journal of Fisheries Management. 17:947-963.

Coats, RN. and T.O. Miller. 1981. Cumulative silvicultural impacts on watersheds: a hydrologic and regulatory dilemma. Environmental Management. 5(2): 147- 160.

Collison, A., W. Emmingham, F. Everest, W. Hanneberg, R. Martston, D. Tarboton, R. Twiss. 2003. Phase II Report: Independent Scientific Review Panel on Sediment Impairment and Effects on Beneficial Uses of the Elk River and Stitz, Bear, Jordan and Freshwater Creeks. Independent Science Review Panel performed analysis on retainer to the North Coast Regional water Quality Control Board, Santa Rosa, CA.

Dietrich, W.E., R.R de Asua, J. Coyle, B. Orr, and M. Trso. 1998. A validation study of the shallow slope stability model, SHALSTAB, in forested lands of Northern California. Stillwater Ecosystem, Watershed & Riverine Sciences. Berkeley, CA. 59 pp.

Dong, J., Chen J.J., Brosofske, K.D., and Naiman, R.J. 1998. Modelling air temperature gradients across managed small streams in western Washington. Journal of Environmental Management 53: 309-322.

Dunne, T., J. Agee, S. Beissinger, W. Dietrich, D. Gray, M. Power, V. Resh, and K. Rodrigues. 2001. A scientific basis for the prediction of cumulative watershed effects. The University of California Committee on Cumulative Watershed Effects. University of California Wildland Resource Center Report No. 46. June 2001. 107 pp.

ESA Consulting. 2008. Scott River Watershed-Wide Coho Salmon Incidental Take Permitting Program Draft Environmental Impact Report. Performed under contract to Region 1 CDFG. ESA Consulting, San Francisco, CA. 714 p.

Essig, D. 1998. The Dilemma of Applying Uniform Temperature Criteria in a Diverse Environment: An Issue Analysis. Idaho Division of Environmental Quality Water Quality Assessment and Standards Bureau, Boise, ID. 34p.

Ewing, R.D. 1999. Diminishing Returns: Salmon Decline and Pesticides. Funded by the Oregon Pesticide Education Network, Biotech Research and Consulting, Inc., Corvallis, OR. 55 p.

FEMAT [Forest Ecosystem Management Assessment Team]. 1993. Forest Ecosystem Management: an ecological, economic and social assessment. Report of the Forest Ecosystem Management Assessment Team. 1993-793-071. U.S. Govt. Printing Office.

Fischer, C. 2003. Monitoring Land Cover Changes in California, North Coast Project Area (1994-1998). California Department of Forestry FRAP and USFS Spatial Analysis Lab, Sacramento, CA.

Frissell, C.A. 1992. Cumulative effects of land use on salmon habitat in southwest Oregon coastal streams. Ph.D. thesis, Oregon State University, Corvallis, Oregon.

Gallagher, S.P. 2001. Results of the winter steelhead (Oncorhynchus mykiss) spawning survey on the Noyo River, California with comparison to some historic habitat information. California Department of Fish and Game. Steelhead Research and Monitoring Program. Fort Bragg, CA. 29 pp.

Gilpin, M. E., and M. E. Soule 1986. Minimum viable populations: processes of species extinction. Pages 19-34 in M. Soule, ed. Conservation biology: the science of scarcity and diversity. Sinauer Associates, Inc., Sunderland, MA.

Good, T. P., R. S. Waples and P. B. Adams. 2005. Updated status of federally listed ESUs of West Coast salmon and steelhead. U.S. Department of Commerce, NOAA Technical Memorandum, NMFS-NWFSC-66. 598 pp.

Grass, Alan. Personal Communication. California Department of Fish and Game. 707-743-1535.

Hare, S. R.; Mantua, N. J.; Francis, R. C. 1999. Inverse production regimes: Alaska and the west coast Pacific salmon. Fisheries, Vol. 24 (1): 6-14.

Harr, R.D. and R.A. Nichols. 1993. Stabilizing Forest Roads to Help Restore Fish Habitats: A Northwest Washington Example. Fisheries 18(4): 18-22.

Harr, D.R., W.C. Harper, J.T. Krygier, and F.S. Hsieh 1975. Changes in Storm Hydrographs After Road Building and Clear-Cutting in the Oregon Coast Range. Water Resources Research 11(3).

Higgins, P.T., S. Dobush, and D. Fuller. 1992. Factors in Northern California Threatening Stocks with Extinction. Humboldt Chapter of American Fisheries Society. Arcata, CA. 25 p.

Higgins, P.T. 1998. Comments on the Pacific Lumber Company Habitat Conservation Plan and Draft EIS. Prepared for Sierra Club of California. Submitted to Bruce Halstead, USFWS, Arcata, CA. Patrick Higgins, Consulting Fisheries Biologist, Arcata, CA.

Higgins, P. T. 2001. Freshwater Creek Watershed Analysis dissenting report: Fisheries module. Arcata, CA. 95 pp. Prepared for Freshwater residents by Patrick Higgins, Consulting Fisheries Biologist, Arcata, CA. www.krisweb.com/biblio/hum_xxxx_higgins_2001_freshwater.pdf

Higgins, P.T. 2002. Comments on Simpson Timber Aquatic HCP and Draft EIS. Letter to James Bond and Amedee Brickey, USFWS, Arcata, CA. Patrick Higgins, Consulting Fisheries Biologist, Arcata, CA. 31 p.
http://www.krisweb.com/biblio/ncc_xxxx_higgins_2002_simpsonhcpcomments.pdf

Higgins, P.T. 2004a. Comments on Negative Declaration for THP 1-04-030SON, Hanson/Whistler Timberland Conversion Permit (TCP) #530. Patrick Higgins, Consulting Fisheries Biologist, Arcata, CA. 13 p. 4/14/04

Higgins, P.T. 2004b. Comments on Negative Declaration for Timber Harvest Plan (THP 1-04-055 SON) / Zapar-Roessler Timberland Conversion Permit (TCP 04-533). Patrick Higgins, Consulting Fisheries Biologist, Arcata, CA. 4 p. 8/16/04.

Higgins, P.T. 2006a. Comments on Jackson Demonstration State Forest Management Plan and the Associated Environmental Impact Statement. Letter to Chris Rowney, CDF, Sacramento. Patrick Higgins, Fisheries Consultant, Arcata, CA. 10 p.
http://www.jacksonforest.com/EIR/Comments/higgins_final.pdf

Higgins, P.T. 2006b. Napa River Sediment TMDL and San Francisco Bay Regional Water Quality Control Board Basin Plan Amendment. Memo of August 12, 2006 to Thomas Lippe, Attorney at Law, San Francisco, CA by Patrick Higgins, Fisheries Consultant, Arcata, CA. 21 p.

Higgins, P.T. 2006c. Comments on the proposed Mitigated Negative Declaration for Napa Canyon LLC Vineyard Project in American Canyon Creek Watershed. Memo of October 7, 2006

to Thomas Lippe, Attorney at Law, San Francisco, CA. by Patrick Higgins, Fisheries Consultant, Arcata, CA. 13 p.

Higgins, P.T. 2007a. Timber Harvest Plan and Timber Conversion Plan 1-06-134 NAPA or Abbott Wall Road Vineyard Project. Comments provided for Thomas Lippe, attorney at Law by Patrick Higgins, Fisheries Consultant, Arcata, CA. 16 p.

Higgins, P.T. 2007b. Comments on Cumulative Watershed effects from the Bohemian Grove NTMP (1-06 NTMP11 SON) with and Emphasis on the Aquatic environment a d ESA-Listed Pacific Salmon Species. Prepared for the Bohemian Rescue Club by Patrick Higgins, Consulting Fisheries Biologist, Arcata, CA. 49 p.

Higgins, P.T. 2007c. Comments on Van Duzen River and Yager Creek Sediment TMDL with Recommendations for Implementation Action and Monitoring. Performed for Van Duzen Watershed Project & Friends of Eel River with funding from California State Water Resources Control Board. By Patrick Higgins, Consulting Fisheries Biologist, Arcata, CA. 55p.

Higgins, P.T. 2007d. Comments on THP 1-04-260 MEN - Robinson Creek Calwater Planning Watershed, Dry Creek, North Fork Gualala River. Performed under contract to the Friends of the Gualala River by Patrick Higgins, Consulting Fisheries Biologist, Arcata, CA. 32 p.

Higgins, P.T. 2008. Comments on DRAFT Mad River Total Maximum Daily Load (TMDL) for Sediment and Turbidity. Prepared for the Environmental Protection Information Center (EPIC) by Patrick Higgins, Consulting Fisheries Biologist, Arcata, CA. 21 p.

Higgins, P.T. 2009. Comments on the Willits Redwood Timber Harvest (THP 1-08-116 MEN). Prepared for the Mendocino Group of the Redwood Chapter Sierra Club by Patrick Higgins, Consulting Fisheries Biologist, Arcata, CA. 25 p.

Institute for Fisheries Resources. 1999. KRIS Noyo River Database. Funded by California Department of Forestry, Fire and Resource Assessment Program (FRAP) Sacramento, CA. (www.krisweb.com).

Institute for Fisheries Resources. 2003. KRIS Gualala River Database. Funded by California Department of Forestry, Fire and Resource Assessment Program (FRAP) Sacramento, CA. (www.krisweb.com).

Jones, J.A. And G.E. Grant. 1996. Peak flow response to clear-cutting and roads in small and large basins, Western Cascades, Oregon. Water Resources Research, April 1996. Vol. 32, No. 4, Pages 959-974.

Kauffman, J.B., R.L. Beschta, N. Otting, and D. Lytjen. 1997. An Ecological Perspective of Riparian and Stream Restoration in the Western United States. Fisheries 22(5):12-24.

Kier Associates. 1991. Long Range Plan for the Klamath River Basin Conservation Area Fishery Restoration Program. U.S. Fish and Wildlife Service, Klamath River Fishery Resource Office.

Yreka, CA. 403 pp.

Kier Associates. 1999. Mid-term evaluation of the Klamath River Basin Fisheries Restoration Program. Sausalito, CA . Prepared for the Klamath River Basin Fisheries Task Force. 303 pp.

Kier Associates. 2005. Lower West Side Scott Shallow Landslide Hazard Maps. Performed under contract to the Quartz Valley Indian Reservation by Dr. Jan Derksen of Kier Associates on behalf of the Klamath Basin Water Quality Work Group. September 18, 2005. Kier Assoc., Sausalito, CA. 11 p.

Kier Associates and National Marine Fisheries Service (NMFS). 2008. Updated Guide to Reference Values used in the Southern Oregon / Northern California Coho Salmon Recovery Conservation Action Planning (CAP) Workbook. Kier Associates, Blue Lake, CA and National Marine Fisheries Service, Arcata, CA. 31 pp.

Ligon, F., A. Rich, G. Rynearson, D. Thornburgh, and W. Trush. 1999. Report of the Scientific Review Panel on California Forest Practice Rules and salmonid habitat. Prepared for the Resources Agency of California and the National Marine Fisheries Service. Sacramento, CA. 181 pp.
http://www.krisweb.com/biblio/cal_nmfs_ligonetal_1999_srprept.pdf

Matthews, G. a. A. 2000a. Sediment source analysis and preliminary sediment budget for the Ten Mile River, Mendocino County, CA. Prepared for Tetra Tech, Inc. Fairfax, VA. 143 pp

May, C.L. and R.E. Greswell. 2003. Large wood recruitment and redistribution in headwater streams of the southern Oregon Coast Range. Canadian Journal of Forest Research. 33: 1352-1362.

Montgomery, D. R. and J.M. Buffington, 1993. Channel classification, prediction of channel response, and assessment of channel condition. TFW-SH10-93-002. Prepared for the SHAMW committee of the Washington State Timber/Fish/Wildlife Agreement. Seattle, WA. 110 pp.

Montgomery, D.R. and W.E. Dietrich. 1994. A physically based model for the topographic control on shallow landsliding. Water Resources Research, Vol.30, No.4. April 1994. Pages 1153-1171.

National Marine Fisheries Service. 1995. Endangered Species Act Section 7 Biological Opinion on the Land and Resource Management Plans for the Boise, Challis, Nez Perce, Payette, Salmon, Sawtooth, Umatilla, and Wallowa-Whitman National Forests. NMFS Northwest Region, Seattle, WA. 138 p.

National Marine Fisheries Service (NMFS) 1996. Coastal Salmon Conservation: Working Guidance for Comprehensive Salmon Restoration Initiatives on the Pacific Coast. September 1996. 5pp.

National Marine Fisheries Service. 2001. Status Review Update for Coho Salmon (Oncorhynchus kisutch) from the Central California Coast and the California portion of the Southern Oregon/Northern California Coasts Evolutionarily Significant Units. Southwest Fisheries Science Center, Santa Cruz, CA. 43 p.

National Marine Fisheries Service. 2008a. Biological Opinion for ESA Section 7 Consultation on Water Supply, Flood Control Operations, and Channel Maintenance conducted by the U.S. Army Corps of Engineers, the Sonoma County Water Agency, and the Mendocino County Russian River Flood Control and Water Conservation Improvement District in the Russian River watershed. NMFS, Santa Rosa, CA. 386 p.

National Marine Fisheries Service (NMFS). 2008b. Environmental Protection Agency Registration of Pesticides Containing Chlorpyrifos, Diazinon, and Malathion. National Marine Fisheries Service Endangered Species Act Section 7 Consultation Biological Opinion. NMFS, Silver Springs Md. 478 p.

Nawa, RK, C.A. Frissell, and W.J. Liss. 1990. Life history and persistence of anadromous salmonid stocks in relation to stream habitats and watershed classification. Oak Creek Labs, Oregon State University. Corvalis, OR Performed under contract for Oregon Department of Fish and Wildlife.

Nawa, R. K. and C. A. Frissell. 1993. Measuring scour and fill of gravel streambeds with scour chains and sliding-bead monitors. North American Journal of Fisheries Management 13(3):634-639.

Nehlsen, W., J.E. Williams, J.A.Lichatowich. 1991. Pacific Salmon at the Crossroads: Stocks at Risk from California, Oregon, Idaho, and Washington. Fisheries 16(2):4-21.

North Coast Regional Water Quality Control Board. 2006. Scott River Watershed Sediment and Temperature TMDL. North Coast Regional Water Quality Control Board. Santa Rosa, CA.

Oregon Department of Environmental Quality (ODEQ). 2008. Rogue River Total Maximum Daily Load (TMDL). Accepted by U.S. EPA on 12/28/08. ODEQ, Medford, OR. www.deq.state.or.us/WQ/TMDLs/rogue.htm

Pacific Watershed Associates. 1994. Action plan for the restoration of the South Fork Trinity River watershed and its fisheries. Prepared for U.S. Bureau of Reclamation and the Trinity River Task Force, Contract No. 2-CS-20-01100. Arcata, CA.

Pacific Watershed Associates (PWA). 1998. Sediment Source Investigation and Sediment Reduction Plan for the Bear Creek Watershed, Humboldt County, California. Prepared for The Pacific Lumber Company Scotia, California. Arcata, California. 57 pp.

Poole, G.C., and C.H. Berman. 2000. Pathways of Human Influence on Water Temperature Dynamics in Stream Channels. U.S. Environmental Protection Agency, Region 10. Seattle, WA. 20 p.

Quartz Valley Indian Community. 2006. Comments on the Final Draft Scott River Total Maximum Daily Load (TMDL) Work Plan. Letter to the North Coast Regional Water Quality Control Board. Quartz Valley Indian Reservation, Ft. Jones, CA. 35 p.

Quartz Valley Indian Community. 2007. Comments on Klamath River Nutrient, Dissolved Oxygen, and Temperature TMDL Implementation Plan Workplan Outline for CA (NCRWQCB, 2007). Quartz Valley Indian Community, Fort Jones, CA. 30 p.

Rankel, G. 1978. Anadromous fishery resources and resource problems of the Klamath River basin and Hoopa Valley Indian Reservation with a recommended remedial action program. Preliminary Draft. U.S. Fish and Wildlife Service, Fisheries Assistance Office, Arcata, CA. 99 pp.

Reeves, G. H., F. H. Everest, and J. R. Sedell. 1993. Diversity of juvenile anadromous salmonid assemblages in coastal Oregon basins with different levels of timber harvest. Transactions of the American Fisheries Society. 122(3): 309-317.

Reeves, G.H., L.E.Benda, K.M.Burnett, P.A.Bisson, and J.R. Sedell. 1995. A Disturbance-Based Ecosystem Approach to Maintaining and Restoring Freshwater Habitats of Evolutionarily Significant Units of Anadromous Salmonids in the Pacific Northwest. American Fisheries Society Symposium 17:334-349, 1995.

Reeves, G.H., K.M. Burnett, and E.V. McGarry. 2003. Sources of large wood in the main stem of a fourth-order watershed in coastal Oregon. Can. J. For. Res. 33: 1363–1370.

Rieman, B., D. Lee, J. McIntyre, K. Ovetton, and R. Thurow 1993. Consideration of Extinction Risks for Salmonids. As FHR Currents # 14. US Forest Service, Region 5. Eureka, CA. 12 pp.

Sigler, J.W., T.C. Bjornn, and F.H. Everest. 1984. Effects of Chronic Turbidity on Density and Growth of Steelheads and Coho Salmon. Transactions of the American Fisheries Society. 113:142-150.

Smith, Jerry, Phd. Personal Communication. Professor of Biology at San Jose State University.

Spence, B.C., G.A. Lomnicky, R.M. Hughes and R. P. Novitzki. 1996. An Ecosystem Approach to Salmonid Conservation. Funded jointly by the U.S. EPA, U.S. Fish and Wildlife Service and National Marine Fisheries Service. TR-4501-96-6057. Man Tech Environmental Research Services Corp., Corvallis, OR.
http://www.nwr.noaa.gov/Publications/Reference-Documents/ManTech-Report.cfm

Sullivan, K., D. J. Martin, R. D. Cardwell, J. E. Toll, and S. Duke. 2000. An analysis of the effects of temperature on salmonids of the Pacific Northwest with implications for selecting temperature criteria. Sustainable Ecosystems Institute. Portland, OR. 192 pp.

U.S. Bureau of Land Management (BLM). 2004. King Range NCA Proposed Resource Management Plan and Final Environmental Impact Statement, November 2004. U.S. BLM Arcata Field Office. 357 p. (www.blm.gov/ca/st/en/fo/arcata/kingrange/planning/king_range_plan.html)

US Environmental Protection Agency (USEPA). 1998. (Final) Garcia River Sediment Total Maximum Daily Load. Dated 16 March 1998. USEPA, Region IX. San Francisco, CA. 51 pp.

U.S. Environmental Protection Agency (EPA). 1998. Total maximum daily load for sediment - Redwood Creek, California. Region 9. San Francisco, CA. 72 pp.

U.S. Environmental Protection Agency. 2003. EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards. EPA Project # 910-B-03-002. Region 10 U.S. EPA, Seattle WA. 57 p.

U.S. Fish and Wildlife Service. 1990. Klamath Fisheries Assessment Program: Investigations on lower tributaries Klamath River. Fish. Assistance Office, Arcata, Calif.

U.S. Forest Service and U.S. Bureau of Land Management. 1995. Final Supplemental Environmental Impact Statement on Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl. Interagency SEIS Team, Portland, OR. 557 p. http://www.fs.fed.us/r6/nwfp.htm

Voight, H.N. and D.B. Gale. 1998. Distribution of fish species in tributaries of the lower Klamath River: an interim report for FY 1996. Yurok Tribal Fisheries Program, Klamath, CA. 71 pages plus appendices.

Warbington, R., B. Schwind, C. Curlis and S. Daniel. 1998. Creating a Consistent and Standardized Vegetation Database for Northwest Forest Plan Monitoring in California. USDA Forest Service. Pacific Southwest Region Remote Sensing Lab. Sacramento, CA.

Welsh, H.H., G.R. Hodgson, M.F. Roche, B.C. Harvey. 2001. Distribution of Juvenile Coho Salmon (Oncorhynchus kisutch) in Relation to Water temperature in Tributaries of a Northern California Watershed: Determining Management Thresholds for an Impaired Cold-water Adapted Fauna. August 2000 North American Journal of Fisheries Management. U.S.D.A. Forest Service, Redwood Sciences.

Williams, T.H., B. C. Spence1, W. Duffy, D. Hillemeier, G. Kautsky, T. Lisle, M. McCain, T. Nickelson, G. Garman, E. Mora, and T. Pearson. 2008. Framework for assessing viability of threatened coho salmon in the Southern Oregon /Northern California Coast Evolutionarily Significant Unit. NMFS SW Science Center, Santa Cruz, CA. 97 p.

Ziemer, R. R.. 1981. Storm flow response to road building and partial cutting in small streams of northern California, Water Resources Research, 17(4), 907-917.