41. South Fork Eel River Population

Interior Eel River Diversity Stratum

Core, Functionally Independent Population

Moderate Extinction Risk

Population likely above depensation threshold

9,300 Spawners Required for ESU Viability

689 mi^2 watershed (8% Federal ownership)

464 IP-km (288 IP-mi) (29% High)

Dominant Land Uses are Timber Production and Agriculture

Key Limiting Stresses are 'Lack of Floodplain and Channel Structure' and 'Altered Hydrologic Function'

Key Limiting Threats are 'Roads' and 'Dams/Diversions'

Highest Priority Recovery Actions

• Increase instream flows by reducing diversions • Determine effects of marijuana cultivation and minimize if necessary • Increase large woody debris (LWD), boulders, or other instream structure	• Restore natural channel form and function by addressing confinement and channelization • Reduce abundance of Sacramento pikeminnow • Reduce sediment barriers formed by alluvial deposits at the confluence of tributaries

41.1 History of Habitat and Land Use

Starting in the late 1850s, the South Fork Eel River became populated by homesteaders and ranchers. Because of the remoteness of the area, the South Fork Eel River watershed did not experience rapid growth until the 1900s. The tanbark industry between 1900 and 1920 provided an economic stimulus to the region. However, harvesting tanbark killed many tanoak trees, and resulted in significant environmental impacts in the harvested areas. When synthetic tannin was developed, the industry collapsed around 1920.

After World War II, timber harvesting significantly increased in the watershed. Timber harvest has had a large impact on the physical nature of the South Fork Eel River, as has development and clearing of land for ranches and urbanization. Many riparian areas have been cleared for roads or timber production. Erosion from poorly constructed roads in the highly erosive Franciscan geology has contributed to increased sediment loads in the region's rivers, leaving streams shallower, warmer, and more prone to flooding (Bodin et al. 1982). Sediment mobilized from the 1955 and 1964 floods choked the channels with sediment. As a result, many streams have become wider and shallower (U.S. Environmental Protection Agency (EPA) 1999).

With the establishment of rural residences and smaller ranches, the need for water supplies has increased. Currently most of this demand is accommodated through in-stream diversions or shallow wells which have influenced stream flows during summer low-flow periods.

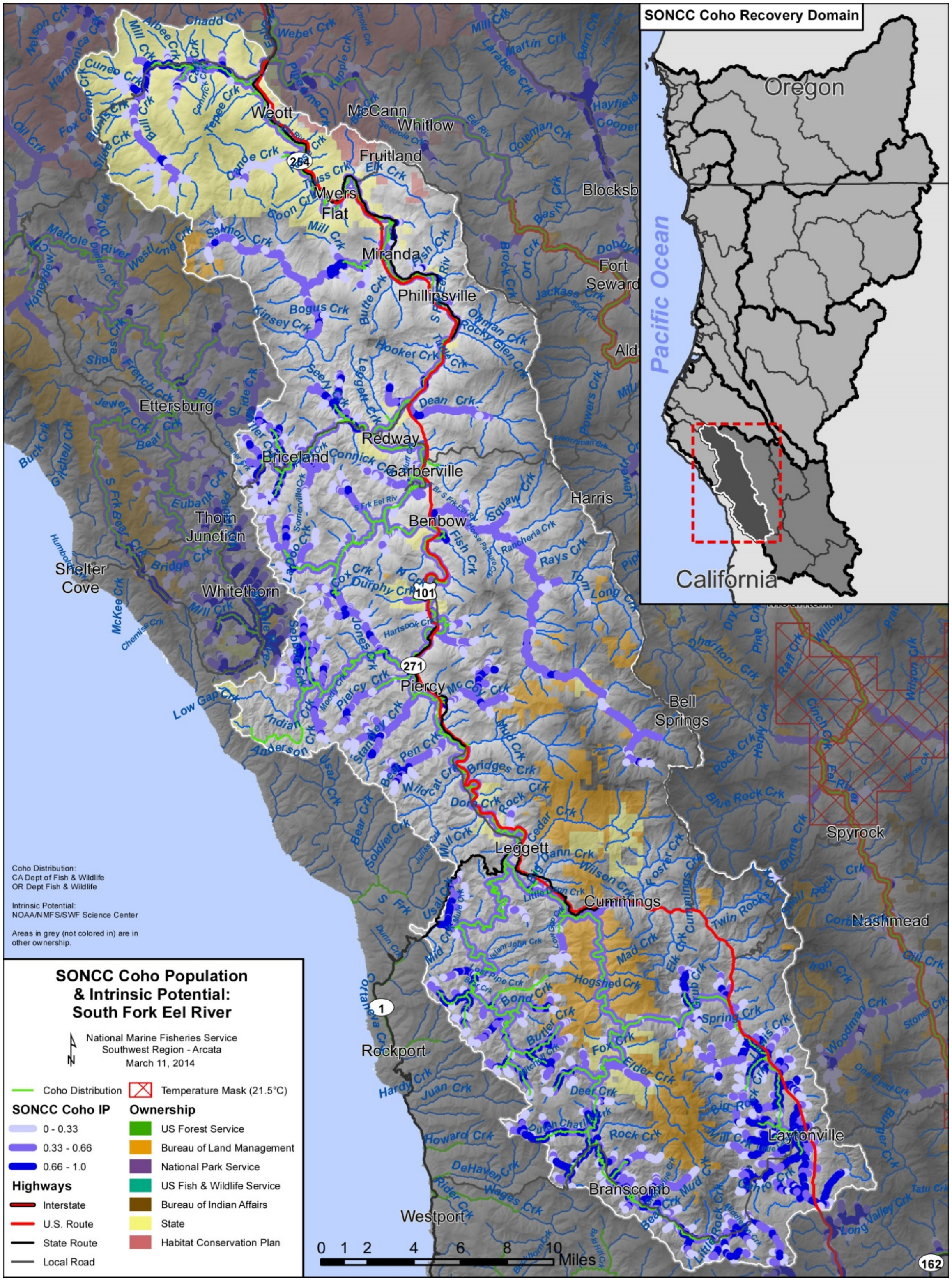

Figure 41-1. The geographic boundaries of the South Fork Eel River coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), land ownership, coho salmon distribution (CDFG 2012a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Interior Eel River diversity stratum (Williams et al. 2006). Grey areas indicate private ownership.

41.2 Historic Fish Distribution and Abundance

The South Fork Eel River watershed has been the largest producer of coho salmon in the Eel River basin, and perhaps one of the largest producers in all of California. An estimated 15,000 to 17,000 coho salmon spawners annually passed Benbow Dam in the 1930s (U.S. Bureau of Land Management [BLM] et al. 1996). In 1975, the last year fish were counted at the Benbow fish station only 509 adult coho salmon were counted (Figure 41-2). Since then, coho salmon abundance has remained low, with an estimate of 1,320 spawners in 1991 for the entire South Fork Eel River (Brown and Moyle 1991). Since 1975, coho salmon abundance has only been surveyed sparingly in the South Fork Eel River watershed. Presence-absence surveys have been conducted more frequently, and show that coho salmon are fairly well distributed in the western tributaries of the watershed. A majority of the eastern tributaries are not found to be used by coho salmon.

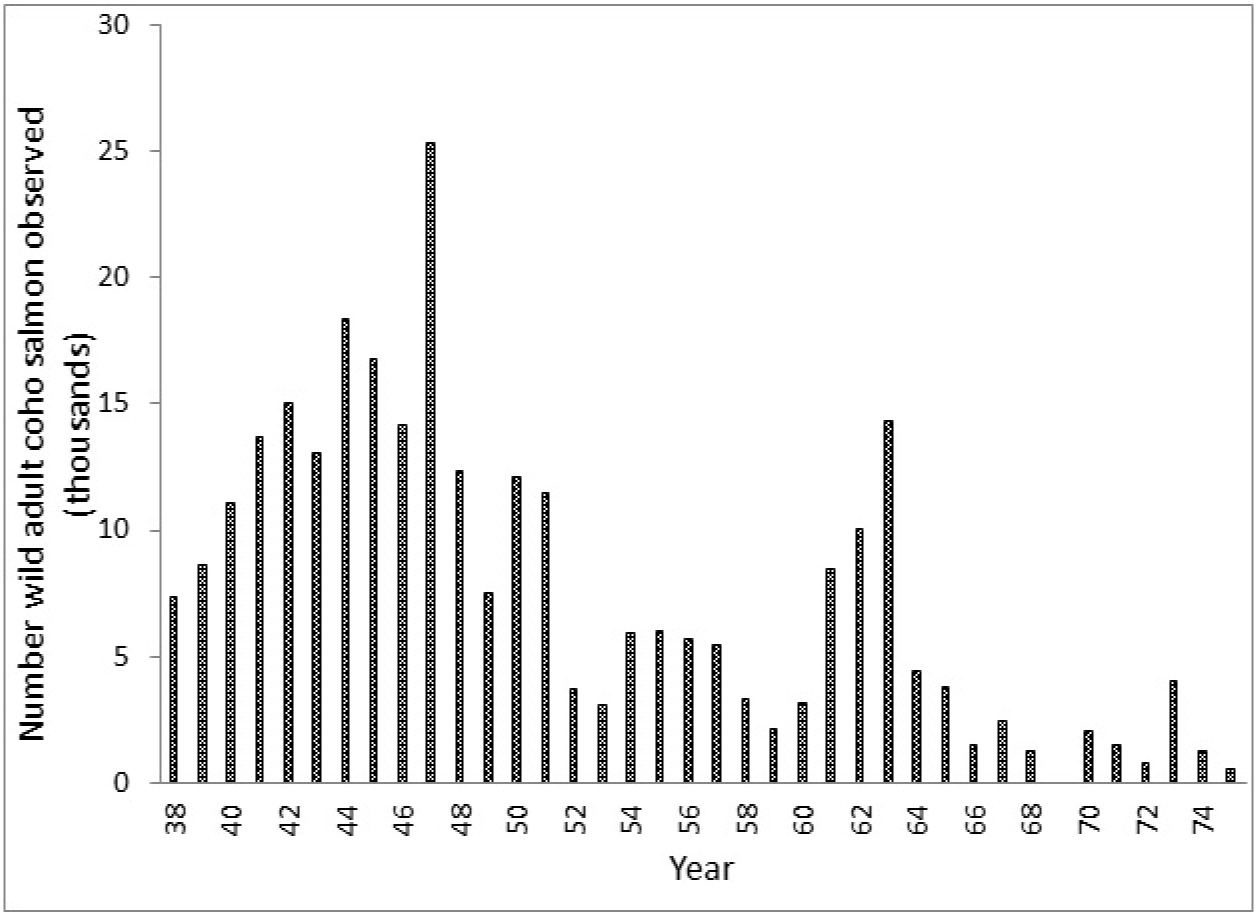

Figure 41-2. Fish counts at Benbow Fish Station, in the South Fork Eel River. Data are from 1938 to 1975 (excluding 1969). Data source: Taylor 1978.

Table 41-1. Tributaries with high IP reaches (IP >0.66) (Williams et al. 2006).

Area	Tributary
Lower	Bull Creek, Canoe Creek, Salmon Creek
Middle	Anderson Creek, Bear Creek, Bear Pen Creek, China Creek, Hollow Tree Creek (Bond Creek, Butler Creek, Huckleberry Creek, Low Gap Creek, Michaels Creek, Redwood Creek, Waldron Creek), Indian Creek, McCoy Creek, Miller Creek, Moody Creek, Piercy Creek, Sebbas Creek, Seely Creek, Sproul Creek, Standley Creek
Upper	Dutch Charley Creek, Grub Creek, Kenny Creek, Redwood Creek, Rock Creek, Tenmile Creek

41.3 Status of South Fork Eel River Coho Salmon

Spatial Structure and Diversity

Williams et al. (2008) determined that at least 20 coho salmon per IP-km of habitat are needed (9,300 spawners total) to approximate the historical distribution of South Fork Eel River coho salmon and habitat. The current distribution of spawners is mostly in western tributaries of the South Fork Eel River. The South Fork Eel population utilizes a 'long run' strategy in which adults and smolts must migrate great distances between the ocean to their natal spawning grounds, or vice versa.

Population Size and Productivity

Williams et al. (2008) determined at least 464 coho salmon must spawn in the South Fork Eel River each year to avoid depensatory effects.

The South Fork Eel River coho salmon population size is unknown, but is likely extremely reduced compared to historic levels. Surveys in the South Fork Eel River are limited, but indicate that coho salmon spawner abundance may be able to reach at least the 464 depensation threshold. In 2009, 357 adult coho salmon were counted at Hollow Tree Creek (Downie 2010). Because numerous other tributaries in the South Fork Eel River provide additional suitable spawning and rearing habitat for coho salmon, the potential is high for the entire South Fork Eel River population to produce at least 464 spawners. Spawning ground surveys conducted in 2011 and 2012 confirm that the number of spawners exceeds the depensation threshold of 464 spawners (Renger, A., pers. comm. 2013). Some cohorts have been lost or severely depressed in some South Fork Eel River streams and the population growth rate is unknown, but expected to be negative in most years for the majority of the tributaries in the population area. Therefore, the South Fork Eel River coho salmon population is at moderate risk of extinction given the moderate population size and probable negative population growth rate.

Nine years (1999 to 2007) of juvenile capture data from the west and south forks of Sproul Creek indicate that both forks have the potential to produce thousands of juvenile coho salmon. The highest combined population estimate of 5,218 smolts occurred in the last year of the study. In addition, a three-year (2000 to 2002) out-migrant population monitoring study in Hollow Tree Creek (Mendocino Redwood Company 2002) reported an estimated smolt population size of 35,178, 35,976, and 9,785, respectively.

Extinction Risk

The South Fork Eel River population is at moderate risk of extinction because NMFS estimates the ratio of the three consecutive years of lowest abundance within the last twelve years to the amount of IP-km in a watershed is greater than one, but the ratio is less than the minimum required spawner density (both criteria described in Williams et al. 2008). NMFS' determination of population extinction risk is based on the viability criteria provided by Williams et al. 2008 (Table 3, p. 17). These viability criteria reflect population size and rate of decline. As Williams et al. (2008) provided no viability criteria for assessing moderate and high risk based on spatial structure and diversity, spatial structure and diversity were not considered in NMFS' determination of population extinction risk.

Role in SONCC Coho Salmon ESU Viability

The South Fork Eel River population is a core, Functionally Independent population within the Interior Eel River diversity stratum; historically having had a high likelihood of persisting in isolation over 100-year time scales, and with population dynamics or extinction risk over a 100-year time period that are not substantially altered by exchanges of individuals with other populations (Williams et al. 2006). To contribute to stratum and ESU viability, the South Fork Eel River core population should have at least 9,300 spawners. Sufficient spawner densities are needed to maintain connectivity and diversity within the stratum and continue to represent critical components of the evolutionary legacy of the ESU. The South Fork Eel population is the largest and most stable in the Interior Eel River diversity stratum. Besides its role in achieving demographic goals and objectives for recovery, it is expected to play a major role in the re-colonization of other populations in the stratum by providing strays.

41.4 Plans and Assessments

State of California

Total Maximum Daily Loads
http://www.swrcb.ca.gov/northcoast/

In December 1999, the USEPA published the final Total Maximum Daily Loads (TMDLs) for temperature and sediment for the South Fork Eel River. The North Coast Regional Water Quality Control Board (NCRWQCB) is required to develop measures that will result in the implementation of the TMDLs in accordance with the requirements of 40CFR 130.6.Amendments of the Water Quality Control Plan for the North Coast Region (the Basin Plan), in the form of an Action Plan, describe the steps that are necessary to meet the TMDLs.

Recovery Strategy for California Coho Salmon
http://www.dfg.ca.gov/fish/Resources/Coho/SAL_CohoRecoveryRpt.asp

The Recovery Strategy for California Coho Salmon was adopted by the California Fish & Game Commission in February 2004. The Recovery Strategy includes analyses and recommendations regarding coho salmon recovery in the South Fork Eel River.

Eel River Salmon and Steelhead Restoration Action Plan

In 1997, the California Department of Fish and Game assessed the Eel River watershed and provided recommendations for restoration of salmonid stocks. Primary recommendations include removing barriers, reducing sediment inputs, improving riparian forest conditions, reducing water withdrawals, enhancing habitat, and suppressing Sacramento pikeminnow.

Mendocino Redwood Company

Habitat Conservation Plan/Natural Communities Conservation Plan

http://www.mrc.com/key-policies/habitat-conservation-planning/The Mendocino Redwood Company Habitat Conservation Plan (HCP) and Natural Communities Conservation Plan (NCCP) have been in the developmental stages since 1999 and are approaching completion. The goals of the HCP/NCCP are to maintain viable populations of covered salmonids and improve and enhance aquatic habitat conditions throughout MRC's forestlands. More information about HCPs in the South Fork Eel watershed can be found in Section 3.2.5.

Watershed Analysis for Hollow Tree Creek

MRC completed a Watershed Analysis in 2004 for their ownership in the South Fork Eel River which occurs primarily in Hollow Tree Creek, a tributary to the South Fork Eel River. It presents results of fish habitat assessments, fish distribution surveys, out-migrant population estimates, stream channel conditions, road inventory, and mass wasting inventories.

Watershed Analysis for the South Fork Eel River

In 1996, the Bureau of Land Management, Six Rivers National Forest, and the U.S. Fish and Wildlife Service finalized a watershed analysis for the South Fork Eel River. This watershed analysis focused on areas where information was available, such as lands managed by BLM and State Parks, and actions that federal agencies could implement to improve habitat.

41.5 Stresses

Table 41-2. Severity of stresses affecting each life stage of coho salmon in the South Fork Eel River. Stress rank categories, assessment methods, and data used to assess stresses are described in Appendix B.

	Stresses	Egg	Fry	Juvenile[1]	Smolt	Adult	Overall Stress Rank
1	Lack of Floodplain and Channel Structure[1]	High	Very High	Very High[1]	Very High	Very High	Very High
2	Altered Sediment Supply	Very High	Very High	Very High	High	Very High	Very High
3	Altered Hydrologic Function[1]	Medium	High	Very High[1]	High	Medium	High
4	Degraded Riparian Forest Conditions	-	High	High	High	Medium	High
5	Impaired Water Quality	Medium	High	High	High	Medium	High
6	Barriers	-	High	High	Medium	High	High
7	Increased Disease/Predation/Competition	Low	High	High	High	Low	High
8	Impaired Estuary/Mainstem Function	-	Low	High	High	Medium	High
9	Adverse Fishery- and Collection-Related Effects	-	-	Low	Low	Medium	Low
10	Adverse Hatchery-Related Effects	Low	Low	Low	Low	Low	Low

[1] Key limiting stresses and limited life stage

Key Limiting Stresses, Limited Life Stage, and Habitat

The key limiting stresses for the population include a 'Lack of Channel and Floodplain Structure' and 'Altered Hydrologic Function'. Water quantity where agricultural (marijuana growing) and domestic use coincides has become a significant stress to summer rearing life stages. This is especially the case in more urbanized areas, such as in the Salmon Creek watershed. The South Fork Eel River is a diverse watershed, where limiting stresses cannot be broadly applied to the entire watershed. Although the South Fork Eel River has been listed as water quality impaired because of elevated water temperature, the upper part of the watershed generally has water temperatures suitable for coho salmon. Elevated water temperature is a concern in the lower half of the South Fork Eel River, from approximately Benbow to the mouth (Downie 2010). Altered hydrologic function due to the dams and diversions for marijuana growing as well as for domestic use has become the key limiting stress in the population. Predation by Sacramento pikeminnow is a significant concern in the South Fork Eel River population area, as well as throughout the Eel River watershed. All of these stresses affect fry, juveniles, and smolts the most, so reducing these stresses would support successful emigration of juveniles and smolts to the ocean.

Because the juvenile life stages are the most limited in this watershed, protecting quality rearing habitat is essential for the viability of this population. Tributaries that have cold water, instream cover, and deep pools are vital for juvenile survival. Tributaries such as Indian, Hollow Tree, Jack of Hearts, Redwood, and Sproul Creeks still provide excellent rearing habitat for coho salmon.

Lack of Floodplain and Channel Structure

This stress was rated as very high for nearly all life stages. Lack of floodplain and channel structure in the South Fork Eel River is primarily due to excessive sediment loads occurring in the watershed, coupled with paucity of large woody and riparian vegetation. Pool depths have been reduced and habitat shelter ratings have diminished over time as sediment loads and a lack of woody debris result in simplified channel structure. Juveniles are stressed by a lack of channel complexity and adults are stressed by a lack of staging pools. These habitat features are important considering the long run distances required to migrate from the ocean to the natal streams, or vice versa. Roads constrict the channel where they occur parallel to the stream.

Altered Sediment Supply

Sediment was rated as a high to very high stress to coho salmon in this population. The USEPA recognized this by listing the South Fork Eel River as sediment impaired. The Eel River has the highest natural sediment load in the United States due to the highly erodible soils in the area, and anthropogenic impacts in the South Fork Eel River have exacerbated these high loads such that pools have filled and substrate quality is poor (Brown and Ritter 1971). High sediment loads result in shallower and less diverse habitat, reduce growth, and reduce reproductive success.

Altered Hydrologic Function

This stress was rated as a high threat overall. Marijuana is the primary agricultural crop grown in the population area and water diversions to support marijuana growing operations have significantly reduced summer base flows leading to dry and disconnected stream channels. Efforts by the CDFW have documented extensive marijuana growing operations in both Redwood Creek and Salmon Creek. In these areas, the CDFW estimates almost 19,000,000 gallons of water are used each growing season to irrigate marijuana crops in these two sub-basins alone. Summer base flows in tributaries to the South Fork Eel River are also affected by rural and urban water withdrawals. Low summer flows reduce habitat and contribute to higher water temperatures.

Degraded Riparian Forest Conditions

Degraded riparian forest conditions are a high stress to the juvenile life stages. Riparian stands are currently dominated by willow, alder, and hardwood. Riparian habitat has somewhat rebounded from past large flood events. Riparian forests shade streams, provide terrestrial subsidies, increase habitat complexity, and influence sediment storage and transport. The interruption in riparian function has led to warming of water temperatures, a reduction in wood recruitment, and ultimately a simplification of habitat and loss of channel complexity.

Sudden oak death (SOD) is an exotic pathogen affecting almost all native species of plants, shrubs, and trees. SOD is in epidemic stages in the population area and in adjacent population areas. Because the SOD pathogen is water borne and can travel downstream in watercourses, the likelihood of SOD outbreaks in the population area and those mainstems in which coho salmon must migrate through are high. One of the largest areas infected by SOD occurs near Redway and is growing at a very fast rate.

Impaired Water Quality

The primary issue with water quality in the South Fork Eel River is water temperatures and excessive nutrient inputs from marijuana growing operations. Water quality is a high stress to the population, the extent of the temperature problem warranted that the South Fork Eel River is listed as impaired for temperature under Clean Water Act Section 303(d). Water temperature in the South Fork Eel River approaches lethal levels in a number of stream reaches, is stressful in most others, and severely limits the amount of habitat available to coho salmon. High temperatures also favor Sacramento pikeminnow productivity. High temperatures are caused by reduced stream flow, lack of riparian canopy, and broader, shallower streams.

Barriers

Barriers to fish passage pose a high stress to coho salmon in the South Fork Eel River and present a significant impediment to restoration and recovery of the South Fork Eel River coho salmon population, resulting in a high stress ranking. Numerous stream-road crossings exist throughout the population area, and at least 58 crossings partially impede fish migration. The Benbow Dam is a seasonal barrier to both adults and juveniles, and has been funded to be removed in the near future. A remnant dam from the former Hollow Tree Creek Fish Hatchery remains partially in place on Hollow Tree Creek. There are currently no other dams in the South Fork Eel River watershed other than unpermitted temporary summer dams on tributaries (Downie 2010).

Increased Disease, Competition and Predation

The non-native Sacramento pikeminnow poses a high threat to coho salmon fry, juveniles, and smolts. Pikeminnow prey on all coho salmon life stages except adults, and also compete with juveniles for limited food and habitat. The pikeminnow is successful in the South Fork Eel River because it thrives in severely impacted habitat that is less favorable for salmonids.

Impaired Estuary/Mainstem Function

All salmon and steelhead that originate from the South Fork Eel River migrate to and from the ocean through the mainstem Eel River and the Eel River estuary. The Eel River estuary was once a highly complex and extensive habitat area that played a vital role in the health and productivity of all Eel River coho salmon. The degraded function of the Eel River estuary and mainstem migratory corridor is a high stress for this population. The Eel River estuary is severely impaired because of diking and filling of wetlands for agriculture and flood protection. Approximately 60 percent of the estuary has been lost through the construction of levees and dikes (CDFG 2010b). There is evidence that the estuary once supported a high degree of estuarine habitat and rearing potential, but very little of that function still exists due to the loss of tidal wetlands and simplification of habitats. Mainstem conditions contribute to this stress because of the issues with reduced flow from diversions, water quality, predation, and degraded habitat in mainstem reaches. Juveniles, smolts, and adults transitioning through estuarine and mainstem habitat are stressed by the degraded conditions in these migratory habitats and suffer from lost opportunity for increased growth and survival.

Adverse Fishery- and Collection-Related Effects

Based on estimates of the fishing exploitation rate, as well as the status of the population relative to depensation and the status of NMFS approval for any scientific collection (Appendix B), these activities pose a medium stress to adults and a low stress to juveniles and smolts.

Adverse Hatchery-Related Effects

Hatchery-origin coho salmon may stray into the South Fork Eel River; however, the proportion of adults that are of hatchery origin is likely less than five percent and there are no hatcheries in the basin. Therefore, adverse hatchery-related effects pose a low risk to all life stages (Appendix B).

41.6 Threats

Table 41-3. Severity of threats affecting each life stage of coho salmon in the South Fork Eel River. Threat rank categories, assessment methods, and data used to assess threats are described in Appendix B.

	Threats	Egg	Fry	Juvenile[1]	Smolt	Adult	Overall Threat Rank
1	Roads[1]	Very High	Very High	Very High[1]	Very High	Medium	Very High
2	Dams/Diversions [1]	Low	High	Very High[1]	Medium	High	High
3	Timber Harvest	High	High	High	High	Medium	High
4	High Severity Fire	High	High	High	Medium	High	High
5	Road-Stream Crossing Barriers	-	High	High	High	High	High
6	Urban/Residential/Industrial Dev.	Medium	High	High	High	Medium	High
7	Invasive Non-Native/Alien Species	Low	Medium	High	High	Low	High
8	Agricultural Practices	Medium	Medium	Medium	Medium	Medium	Medium
9	Channelization/Diking	Medium	Medium	Medium	Medium	Medium	Medium
10	Climate Change	Medium	Medium	Medium	Medium	Medium	Medium
11	Mining/Gravel Extraction	Medium	Medium	Medium	Medium	Medium	Medium
12	Fishing and Collecting	-	-	Low	Low	Medium	Low
13	Hatcheries	Low	Low	Low	Low	Low	Low

[1] Key limiting threats and limited life stage

Key Limiting Threats

The two key limiting threats, those which most affect recovery of the population by influencing stresses, are roads and dams/diversions.

Roads

Dirt and gravel roads are a threat to coho salmon and habitat restoration. Roads constitute a very high threat for most life stages. Road density is very high in most of the population area. Given the sedimentation problems throughout the watershed, roads should be considered for removal or upgrade treatments to reduce sediment delivery. Road building for access to marijuana cultivation sites is common and likely to be unpermitted and contribute sediment to coho salmon streams.

Dams/Diversions

Benbow Dam is a seasonal barrier to both adults and juveniles, and is currently being studied for removal. Localized water diversion for rural residential and agricultural use reduces stream flow during critical juvenile rearing periods and in the early periods of adult migration. Marijuana cultivation has become abundant in many areas of the population. Although the number of plants grown each year is unknown, the water diversion required to support these plants is placing a high demand on a limited supply of water (Bauer 2013a). Most diversion for marijuana cultivation occur at headwater springs and streams, thereby removing the coldest, cleanest water at the most stressful time of the year for coho salmon (Bauer 2013b). Based on an estimate from the medical marijuana industry, each marijuana plant may consume 900 gallons of water per growing season (HGA 2010).

The CDFW mapped the locations of marijuana plants and greenhouses in two tributaries of the South Fork Eel (Redwood Creek and Salmon Creek). CDFW estimates that marijuana grown outdoors or in greenhouses in Redwood Creek and Salmon Creek uses a combined total of 18.6 million gallons of water per season, or approximately 235,381 gallons of water per day (CDFW 2013b), based on industry-provided estimates of water needs. These figures were generated from only Salmon Creek and Redwood Creek, and do not include marijuana cultivation sites from other sub-basins. The high intensity growing in select tributaries is contributing to dry stream channels and warmer water temperatures. As stream channels dry, pools become disconnected and juveniles are subject to predation, competition, and poor water quality.

Timber Harvest

Timber harvest was ranked as a high threat because, given the percentage of the watershed that is privately owned, future timber harvest activities will continue to exacerbate the stresses caused by legacy timber harvest activities. Only a fraction of the land base which is zoned as Timber Production Zones in this watershed is covered by a draft HCP. HCPs have conservation measures and objectives to ensure that both populations of fish and their habitats are maintained or improved over time. Forest lands are being cleared and graded to create new marijuana cultivation sites. In many cases the land disturbance is not regulated, and likely contributes sediment to coho salmon streams. Land clearing and grading for marijuana growing operations has become common in both upslope and riparian areas in the population, as evidenced by Google Earth and reports issued by the CDFW (HGA 2010).

High Severity Fire

Fire constitutes a high threat to most life stages of coho salmon. The altered vegetation characteristics throughout the watershed increase the risk of high severity fires which alter sedimentation processes, as well as riparian vegetation characteristics. Historically, Native American vegetation management and natural fire cycles created a mosaic of fire resistant vegetation that lessened catastrophic fires.

Road-stream Crossing Barriers

Numerous road-stream crossings continue to block fish passage within the South Fork Eel River watershed, and contribute to a high threat to almost all life stages of coho salmon. The

California Fish Passage Assessment Database (CalFish 2009) shows that there are 76 total road crossings that may block fish passage, of which 29 are total barriers, 29 are partial or temporal, and 18 are unknown.

Urban/Residential/Industrial Development

Although Urban/Residential/Industrial Development poses a moderate threat, much of the watershed with high IP value is located in and around the city of Laytonville. Future growth of this area is likely as transportation infrastructure improves and there is further northerly migration from southern metropolitan areas due to declining water supplies and other mandatory amenities in more southerly locations. In addition, further rural residential development is likely as large agricultural holdings are subdivided into smaller ranches. Higher population densities will likely increase road building, land clearing, well drilling, septic system construction, and other development with the consequent increase in stresses.

Invasive Non-Native/Alien Species

The non-native Sacramento pikeminnow is a high threat to fry, juveniles, and smolts because they compete with and prey on the young coho salmon. Sacramento pikeminnow was introduced in Lake Pillsbury in 1979 (Brown and Moyle 1997), and has spread throughout the entire Eel River watershed. The warm water temperatures in the Eel River and Lake Pillsbury allow this voracious predator to thrive in this system. The presence of the Sacramento pikeminnow in Lake Pillsbury makes eradication of this species from the Eel River basin extremely difficult. Any effort to remove this species in the Eel River without treating the lake will only be temporary because the lake will continue to be the source population for the rest of the Eel River watershed.

Agricultural Practices

Grazing occurs throughout the watershed and may contribute to increased sediment generation and delivery. However, specific information on the magnitude of the threat is limited. In addition, remote outdoor agricultural cultivation (marijuana growing) likely results in riparian vegetation impacts, water withdrawals, diesel spills, and pesticide leaching into streams and groundwater. Marijuana cultivation has become abundant in most of the population area and is the primary crop grown. Although the number of plants grown each year is unknown, the herbicides, pesticides, and fertilizers used to support these plants are likely impairing water quality in coho salmon streams. Water withdrawals for agricultural uses were considered in the “Dams/Diversions” threat.

Channelization/Diking

Channelization and diking poses a moderate threat to coho salmon in the population area, and is primarily associated with road building. As populations grow and expand, the need to contain flood waters in the vicinity of towns and cities will become increasingly common. Flood control in rural areas is also a threat as marijuana growing and greenhouses become more common along the floodplains of tributaries and mainstem reaches.

Climate Change

Climate change poses a high threat to this population. The impacts of climate change in this region will have the greatest impact on juveniles, smolts, and adults. The current climate is generally warm and modeled regional average temperature shows a large increase over the next 50 years (see Appendix B for modeling methods). Average temperature could increase by up to 2 °C in the summer and by up to 1 °C the winter. Annual precipitation is predicted to trend downward over the next century (Feely et al. 2008). The vulnerability of the Eel River estuary to sea level rise is very high. Juvenile and smolt rearing and migratory habitat in the South Fork Eel River and mainstem Eel River is most at risk to climate change. Increasing temperatures and changes in the amount and timing of precipitation and snowmelt will impact water quality and hydrologic function in the summer and winter. Rising sea level may also impact the quality and extent of wetland rearing habitat. Overall, the range and degree of variability in temperature and precipitation is likely to increase in all populations. Adults will be negatively impacted by ocean acidification and changes in ocean conditions and prey availability (Independent Science Advisory Board 2007, Portner and Knust 2007, Feely et al. 2008).

Mining/Gravel Extraction

Gravel extraction occurs in the South Fork Eel River, but is relatively isolated and conducted with state and federal oversight. The medium ranking for this threat reflects the sensitivity of the channel to additional disturbances (i.e., lack of floodplain and channel structure).

Fishing and Collecting

Based on estimates of the fishing exploitation rate, as well as the status of the population relative to depensation and the status of NMFS approval for any scientific collection (Appendix B), these activities pose a medium threat to adults and a low stress to juveniles and smolts.

Hatcheries

Hatcheries pose a low threat to all life stages of coho salmon in the South Fork Eel River population area. The rationale for these ratings is described under the "Adverse Hatchery-Related Effects" stress.

41.7 Recovery Strategy

The degraded condition of the South Fork Eel River habitat, combined with the depressed coho salmon population size and distribution, increases the risk of extinction of this important, inland coho salmon population. These factors, combined with the facts that most of the watershed is in private ownership, much of the high IP areas are in developed areas, and predation and competition from non-native Sacramento pikeminnow severely limit juvenile survival, indicates that immediate measures may be necessary to sustain the South Fork Eel River population.

By addressing the major stresses to the population – by restoring summer base flows, reducing sediment from roads, increasing the complexity of stream channels, and reducing the effects of timber harvest – recovery of the South Fork Eel River population will be promoted. Restoration activities that increase summer flows, enhance the complexity of stream habitats, reduce sediment inputs, increase connectivity to floodplains, enhance estuarine habitats, increase riparian vegetation, and reduce the abundance of Sacramento pikeminnow should be immediately implemented.

Coho salmon are found in relatively high numbers in several tributaries in the western region of the population area. Areas with extant sub-populations of coho salmon such as Hollow Tree Creek should receive priority for recovery actions over those areas with little or no coho salmon. Focusing on areas where coho salmon are currently present ensures that recovery actions implemented will have maximum benefit over shorter periods of time. However, the most limited life stages are juveniles and smolts predominantly because of poor migratory habitats in the mainstem and estuary of the Eel River. Addressing Sacramento pikeminnow and the quality of the Eel River estuary as well as other actions to improve the migratory corridors for the South Fork Eel population are top priority. The effects of fishing on this population's ability to meet its viability criteria should be evaluated.

Table 41-4 on the following page lists the recovery actions for the South Fork Eel River population.

Table 41-4. Recovery action implementation schedule for the South Fork Eel River population. Recovery actions for monitoring and research are listed in tables at the end of Chapter 5.

Action ID	Target	KLS/T	Strategy	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-SFER.3.1.6	Hydrology	Yes	Improve flow timing or volume	Increase instream flows	All streams where coho salmon would benefit immediately, especially Redwood, Sproul, Indian, Salmon, and Cedar creeks	1
SONCC-SFER.3.1.6.3	*Identify diversions in tributaries that have subsurface or low flow barrier conditions during the summer*					
SONCC-SFER.3.1.6.4	*Provide incentives and education to landowners to reduce water consumption and reduce groundwater pumping and surface water diversion by utilizing conservation and storage*					
SONCC-SFER.3.1.5	Hydrology	Yes	Improve flow timing or volume	Provide adequate instream flow for coho salmon	Population wide	1
SONCC-SFER.3.1.5.1	*Conduct study to determine instream flow needs of coho salmon at all life stages.*					
SONCC-SFER.3.1.5.2	*If coho salmon instream flow needs are not being met, develop plan to provide adequate flows. Plan may include water conservation incentives for landowners and re-assessment of water allocation.*					
SONCC-SFER.3.1.5.3	*Implement coho salmon instream flow needs plan.*					
SONCC-SFER.3.1.51	Hydrology	Yes	Improve flow timing or volume	Determine effects of marijuana cultivation	Population wide	2c
SONCC-SFER.3.1.51.1	*Assess cumulative effects (e.g., flow, water quality) of marijuana cultivation*					
SONCC-SFER.3.1.51.2	*If needed, develop plan to reduce effects of marijuana cultivation*					
SONCC-SFER.3.1.51.3	*Implement plan*					
SONCC-SFER.3.1.10	Hydrology	Yes	Improve flow timing or volume	Educate stakeholders	Population wide, especially Redwood, Sproul, Indian, Salmon, and Cedar creeks	2c
SONCC-SFER.3.1.10.1	*Develop an educational program about water conservation programs and instream leasing programs*					
SONCC-SFER.3.1.70	Hydrology	Yes	Improve flow timing or volume	Educate stakeholders	Population wide	2d
SONCC-SFER.3.1.70.1	*Develop an educational program about water conservation programs and instream leasing programs*					
SONCC-SFER.3.1.11	Hydrology	Yes	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	2c
SONCC-SFER.3.1.11.1	*Work with partners to streamline the process needed for the dedication of water to fish and wildlife resources under CA Water Code section 1707*					
SONCC-SFER.3.1.11.2	*Implement water dedications to increase instream flows using the streamlined process*					

Action ID	Target	KLS/T	Strategy	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-SFER.3.1.7	Hydrology	Yes	Improve flow timing or volume	Increase instream flows	All streams where coho salmon would benefit immediately, especially Redwood, Sproul, Salmon, Indian, and Cedar creeks	2c
SONCC-SFER.3.1.7.1	*Establish a forbearance program modeled after the Mattole watershed*					
SONCC-SFER.3.1.7.2	*Monitor forbearance compliance and flow*					
SONCC-SFER.3.1.49	Hydrology	Yes	Improve flow timing or volume	Increase instream flows	All streams where coho salmon would benefit immediately	2c
SONCC-SFER.3.1.49.1	*Identify and cease unauthorized water diversions*					
SONCC-SFER.3.1.71	Hydrology	Yes	Improve flow timing or volume	Increase instream flows	Population wide	2d
SONCC-SFER.3.1.71.1	*Identify and cease unauthorized water diversions*					
SONCC-SFER.3.1.72	Hydrology	Yes	Improve flow timing or volume	Increase instream flows	Population wide	2d
SONCC-SFER.3.1.72.1	*Establish a forbearance program modeled after the Mattole watershed*					
SONCC-SFER.3.1.72.2	*Monitor forbearance compliance and flow*					
SONCC-SFER.2.1.1	Floodplain and Channel Structure	Yes	Increase channel complexity	Increase LWD, boulders, or other instream structure	All streams where coho salmon would benefit immediately, prioritize Redwood, Sproul, Cedar, Indian, and Hollow Tree creeks	2c
SONCC-SFER.2.1.1.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-SFER.2.1.1.2	*Place instream structures, guided by assessment results*					
SONCC-SFER.2.1.67	Floodplain and Channel Structure	Yes	Increase channel complexity	Increase LWD, boulders, or other instream structure	Population wide	2d
SONCC-SFER.2.1.67.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-SFER.2.1.67.2	*Place instream structures, guided by assessment results*					

Action ID	Target	KLS/T	Strategy	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-SFER.2.2.3	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Construct off channel habitats, alcoves, backwater habitat, and old stream oxbows	All streams where coho salmon would benefit immediately, prioritize key tributaries such as Redwood, Sproul, Cedar, Indian, and Hollow Tree creeks	2c
SONCC-SFER.2.2.3.1	*Identify potential sites to create refugia habitats. Prioritize sites and determine best means to create rearing habitat*					
SONCC-SFER.2.2.3.2	*Implement restoration projects that improve off channel habitats to create refugia habitat, as guided by assessment results*					
SONCC-SFER.2.2.69	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Construct off channel habitats, alcoves, backwater habitat, and old stream oxbows	Population wide	2d
SONCC-SFER.2.2.69.1	*Identify potential sites to create refugia habitats. Prioritize sites and determine best means to create rearing habitat*					
SONCC-SFER.2.2.69.2	*Implement restoration projects that improve off channel habitats to create refugia habitat, as guided by assessment results*					
SONCC-SFER.2.2.2	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Restore natural channel form and function	All streams where coho salmon would benefit immediately	2c
SONCC-SFER.2.2.2.1	*Conduct assessment to identify and prioritize reaches which are confined and/or channelized by man-made structures such as roads, dikes, and levees*					
SONCC-SFER.2.2.2.2	*Implement priority actions to address confinement and channelization, guided by the assessment*					
SONCC-SFER.2.2.68	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Restore natural channel form and function	Population wide	2d
SONCC-SFER.2.2.68.1	*Conduct assessment to identify and prioritize reaches which are confined and/or channelized by man-made structures such as roads, dikes, and levees*					
SONCC-SFER.2.2.68.2	*Implement priority actions to address confinement and channelization, guided by the assessment*					
SONCC-SFER.5.1.46	Passage	No	Improve access	Reduce sediment barriers	Hartsook Creek confluence with South Fork Eel and Pipeline and Poison Oak Creek, and all streams where coho salmon would benefit immediately	2c
SONCC-SFER.5.1.46.1	*Inventory and prioritize barriers formed by alluvial deposits*					
SONCC-SFER.5.1.46.2	*Construct low flow channels, and reduce stream gradient to provide fish passage over alluvial deposits for all life stages*					
SONCC-SFER.5.1.75	Passage	No	Improve access	Reduce sediment barriers	Population wide	2d
SONCC-SFER.5.1.75.1	*Inventory and prioritize barriers formed by alluvial deposits*					
SONCC-SFER.5.1.75.2	*Construct low flow channels, and reduce stream gradient to provide fish passage over alluvial deposits for all life stages*					

Action ID	Target	KLS/T	Strategy	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-SFER.5.1.25	Passage	No	Improve access	Remove barriers	All streams where coho salmon would benefit immediately	2c
SONCC-SFER.5.1.25.1	*Evaluate and prioritize barriers for removal*					
SONCC-SFER.5.1.25.2	*Remove barriers, based on evaluation*					
SONCC-SFER.5.1.74	Passage	No	Improve access	Remove barriers	Population wide	2d
SONCC-SFER.5.1.74.1	*Evaluate and prioritize barriers for removal*					
SONCC-SFER.5.1.74.2	*Remove barriers, based on evaluation*					
SONCC-SFER.1.2.43	Estuary	No	Improve estuarine habitat	Improve estuary condition	Eel River Estuary	2c
SONCC-SFER.1.2.43.1	*Implement recovery actions for Lower Eel/Van Duzen River population that address the target "Estuary"*					
SONCC-SFER.26.1.63	Low Population Dynamics	No	Increase population abundance	Rescue and relocate stranded juveniles	Population wide	2c
SONCC-SFER.26.1.63.1	*Survey coho-bearing tributaries and relocate juveniles stranded in drying pools*					
SONCC-SFER.14.2.14	Invasive, Non-native Species	No	Reduce predation and competition	Reduce abundance of Sacramento pikeminnow	Population wide	2c
SONCC-SFER.14.2.14.1	*Determine the effectiveness of various pikeminnow suppression techniques and develop experimental control methods. Develop a plan that identifies watersheds suitable for experimental pikeminnow suppression*					
SONCC-SFER.14.2.14.2	*Suppress Sacramento pikeminnow, guided by the suppression plan*					
SONCC-SFER.10.1.48	Water Quality	No	Reduce water temperature, increase dissolved oxygen	Increase cool water and thermal refugia	All streams where coho salmon would benefit immediately	2c
SONCC-SFER.10.1.48.1	*Assess sources of cool water and develop techniques to protect and/or improve cool water habitat*					
SONCC-SFER.10.1.48.2	*Add LWD, boulders, or sources of structure as guided by assessment to augment habitat at cool water sources*					
SONCC-SFER.10.1.48.3	*Increase riparian vegetation and shading at sources of cool water*					
SONCC-SFER.10.1.64	Water Quality	No	Reduce water temperature, increase dissolved oxygen	Increase cool water and thermal refugia	Population wide	2d
SONCC-SFER.10.1.64.1	*Assess sources of cool water and develop techniques to protect and/or improve cool water habitat*					
SONCC-SFER.10.1.64.2	*Add LWD, boulders, or sources of structure as guided by assessment to augment habitat at cool water sources*					
SONCC-SFER.10.1.64.3	*Increase riparian vegetation and shading at sources of cool water*					

Action ID	Target	KLS/T	Strategy	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-SFER.7.1.45	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Increase regulatory oversight	Population wide	2d
SONCC-SFER.7.1.45.1	*Identify and cease all unauthorized land clearing and grading associated with marijuana cultivation*					
SONCC-SFER.3.1.12	Hydrology	Yes	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3c
SONCC-SFER.3.1.12.1	*Establish a categorical exemption under CEQA for water leasing to increase instream flows*					
SONCC-SFER.3.1.13	Hydrology	Yes	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3c
SONCC-SFER.3.1.13.1	*Establish a comprehensive groundwater permit process*					
SONCC-SFER.5.1.9	Passage	No	Improve access	Remove dam	South Fork Eel River at Benbow	3c
SONCC-SFER.5.1.9.1	*Develop a plan to remove Benbow Dam*					
SONCC-SFER.5.1.9.2	*Remove Benbow Dam*					
SONCC-SFER.8.1.18	Sediment	No	Reduce delivery of sediment to streams	Minimize mass wasting	All streams where coho salmon would benefit immediately	3c
SONCC-SFER.8.1.18.1	*Assess and map mass wasting hazard, prioritize treatment of sites most susceptible to mass wasting, and determine appropriate actions to deter mass wasting*					
SONCC-SFER.8.1.18.2	*Implement plan to stabilize slopes and revegetate areas*					
SONCC-SFER.8.1.77	Sediment	No	Reduce delivery of sediment to streams	Minimize mass wasting	Population wide	3d
SONCC-SFER.8.1.77.1	*Assess and map mass wasting hazard, prioritize treatment of sites most susceptible to mass wasting, and determine appropriate actions to deter mass wasting*					
SONCC-SFER.8.1.77.2	*Implement plan to stabilize slopes and revegetate areas*					
SONCC-SFER.8.1.50	Sediment	No	Reduce delivery of sediment to streams	Reduce erosion	All streams where coho salmon would benefit immediately	3c
SONCC-SFER.8.1.50.1	*Identify and cease unauthorized road building or grading*					
SONCC-SFER.8.1.78	Sediment	No	Reduce delivery of sediment to streams	Reduce erosion	Population wide	3d
SONCC-SFER.8.1.78.1	*Identify and cease unauthorized road building or grading*					

Action ID	Target	KLS/T	Strategy	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-SFER.8.1.15	Sediment	No	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	All streams where coho salmon would benefit immediately, prioritize Red Mountain Management Area, Redwood, Sproul, Salmon, Indian, and Cedar Creeks	3c
SONCC-SFER.8.1.15.1	*Assess and prioritize road-stream connection, and identify appropriate treatments*					
SONCC-SFER.8.1.15.2	*Decommission roads, guided by assessment*					
SONCC-SFER.8.1.15.3	*Upgrade roads, guided by assessment*					
SONCC-SFER.8.1.15.4	*Maintain roads, guided by assessment*					
SONCC-SFER.8.1.76	Sediment	No	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	Population wide	3d
SONCC-SFER.8.1.76.1	*Assess and prioritize road-stream connection, and identify appropriate treatments*					
SONCC-SFER.8.1.76.2	*Decommission roads, guided by assessment*					
SONCC-SFER.8.1.76.3	*Upgrade roads, guided by assessment*					
SONCC-SFER.8.1.76.4	*Maintain roads, guided by assessment*					
SONCC-SFER.10.2.19	Water Quality	No	Reduce pollutants	Remove pollutants	All streams where coho salmon would benefit immediately	3c
SONCC-SFER.10.2.19.1	*Remove hazardous materials from streams*					
SONCC-SFER.10.2.65	Water Quality	No	Reduce pollutants	Remove pollutants	Population wide	3d
SONCC-SFER.10.2.65.1	*Remove hazardous materials from streams*					
SONCC-SFER.10.7.62	Water Quality	No	Restore nutrients	Add marine-derived nutrients to streams	All streams where coho salmon would benefit immediately	3c
SONCC-SFER.10.7.62.1	*Develop a plan to supply appropriate amounts of marine-derived nutrients to streams (e.g. carcass placement, pellet dispersal)*					
SONCC-SFER.10.7.62.2	*Supply marine-derived nutrients to streams guided by the plan*					
SONCC-SFER.10.7.66	Water Quality	No	Restore nutrients	Add marine-derived nutrients to streams	Population wide	3d
SONCC-SFER.10.7.66.1	*Develop a plan to supply appropriate amounts of marine-derived nutrients to streams (e.g. carcass placement, pellet dispersal)*					
SONCC-SFER.10.7.66.2	*Supply marine-derived nutrients to streams guided by the plan*					
SONCC-SFER.3.1.4	Hydrology	Yes	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3d
SONCC-SFER.3.1.4.1	*Review General Plan or City Ordinances to ensure coho salmon habitat needs are accounted for. Revise if necessary*					

Action ID	Target	KLS/T	Strategy	Action Description	Area	Priority
Step ID		*Step Description*				
SONCC-SFER.7.1.23	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve regulatory mechanisms	Population wide	3d
SONCC-SFER.7.1.23.1		*Develop planning guidelines or ordinances that protect riparian stands*				
SONCC-SFER.7.1.24	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve timber harvest practices	Population wide	3d
SONCC-SFER.7.1.24.1		*Amend California Forest Practice Rules to include regulations which describe the specific analysis, protective measures, and procedure required by timber owners and CalFire to demonstrate timber operations described in timber harvest plans meet the requirements specified in 14 CCR 898.2(d) prior to approval by the Director (similar to a Spotted Owl Resource Plan).*				
SONCC-SFER.7.1.21	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Increase conifer riparian vegetation	Population wide	3d
SONCC-SFER.7.1.21.1		*Develop an appropriate timber harvest management plan for benefits to coho salmon habitat*				
SONCC-SFER.7.1.21.2		*Thin, or release conifers, guided by the plan*				
SONCC-SFER.7.1.21.3		*Plant conifers, guided by the plan*				
SONCC-SFER.7.1.22	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Reduce fire hazard	Population wide	3d
SONCC-SFER.7.1.22.1		*Identify forested stands for fire hazard reduction*				
SONCC-SFER.7.1.22.2		*Apply appropriate management techniques (e.g. thinning, burning) to reduce risks of high severity fire*				
SONCC-SFER.16.1.28	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating salmonid fishery management plans affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3d
SONCC-SFER.16.1.28.1		*Determine impacts of fisheries management on SONCC coho salmon in terms of VSP parameters*				
SONCC-SFER.16.1.28.2		*Identify level of fishing impacts that does not limit attainment of population-specific viability criteria*				

Action ID	Target	KLS/T	Strategy	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-SFER.16.1.29	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Reduce fishing impacts to levels that do not limit recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3d
SONCC-SFER.16.1.29.1	*Determine actual fishing impacts*					
SONCC-SFER.16.1.29.2	*If actual fishing impacts limit attainment of population-specific viability criteria, modify management so that fishing does not limit attainment of population-specific viability criteria*					
SONCC-SFER.16.2.30	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating scientific collection authorizations affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3d
SONCC-SFER.16.2.30.1	*Determine impacts of scientific collection on SONCC coho salmon in terms of VSP parameters*					
SONCC-SFER.16.2.30.2	*Identify level of scientific collection impact that does not limit attainment of population-specific viability criteria*					
SONCC-SFER.16.2.31	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Reduce impacts of scientific collection to levels that do not limit recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3d
SONCC-SFER.16.2.31.1	*Determine actual impacts of scientific collection*					
SONCC-SFER.16.2.31.2	*If actual scientific collection impacts limit attainment of population-specific viability criteria, modify collection so that impacts do not limit attainment of population-specific viability criteria*					
SONCC-SFER.8.1.17	Sediment	No	Reduce delivery of sediment to streams	Improve regulatory mechanisms	Population wide	3d
SONCC-SFER.8.1.17.1	*Develop grading ordinance for maintenance and building of private roads that minimizes the effects to coho*					
SONCC-SFER.8.1.16	Sediment	No	Reduce delivery of sediment to streams	Reduce erosion	Hermitage Road	3d
SONCC-SFER.8.1.16.1	*Install gates to control vehicle access*					

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