26. Lower Eel and Van Duzen River Population

- Southern Coastal Stratum
- Core, Functionally Independent Population
- High Extinction Risk
- 7,900 Spawners Required for ESU Viability
- 726 mi²
- 394 IP km (244 mi) (50% High)
- Dominant Land Uses are Timber Harvest and Agriculture
- Principal Stresses are 'Altered Sediment Supply' and 'Impaired Estuary/Mainstem Function' and Impaired Water Quality
- Principal Threats are 'Roads', 'Timber Harvest', and Diversions

26.1 History of Habitat and Land Use

Historically, the Lower Eel/Van Duzen River subbasin consisted primarily of late-seral redwood/Douglas-fir (coniferous) forests with limited open oak woodland/prairies farther inland at higher elevations. Beginning near the turn-of-the twentieth century, logging along stream corridors and easily accessible areas led to development of hardwood-dominated forests and reduced large wood recruitment potential to streams. In addition, floodplain and estuarine wetland areas were cleared, diked, and drained to provide land for agriculture and urban development. Technological developments after World War II enabled logging and road building in steeper, more landslide prone areas. This caused excessive sediment delivery to streams, especially following large floods in 1955 and 1964, resulted in shallow pools and wide streams. Levees were constructed along portions of the lower Van Duzen and Eel rivers to protect agricultural land and urban areas from flooding.

Since 1922, Eel River flows have been regulated and water has been diverted to the Russian River for hydroelectric power and agriculture via the Potter Valley Project. There are two major dams on the Upper Eel River associated with the Potter Valley Project: the Cape Horn Dam which impounds the 700 acre-foot Van Arsdale Reservoir and the Scott Dam which impounds the 94,000 acre-foot storage reservoir, Lake Pillsbury. Sacramento pikeminnow were introduced to Lake Pillsbury in 1980 (California Department of Fish and Game (CDFG) 1997b), and have since colonized the entire Eel River watershed. This predator thrives in the warmer waters created by the reservoir, the lower instream flows in the Eel River, a wide and shallow channel caused by high sediment load, and degraded riparian forests.

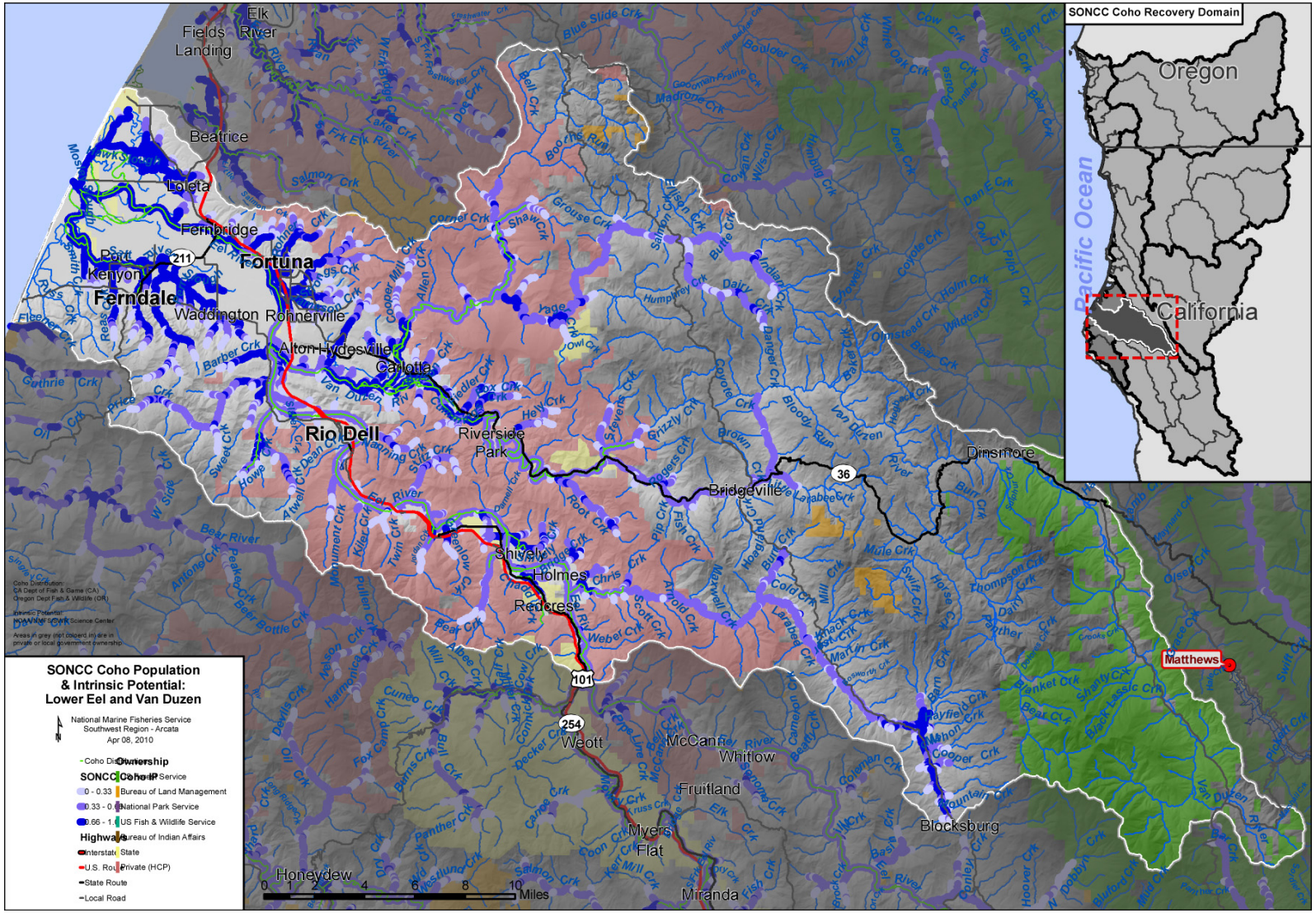

Figure 26-1. The geographic boundaries of the Lower Eel and Van Duzen rivers coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), land ownership, coho salmon distribution (CDFG 2009a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Northern Coastal diversity stratum (Williams et al. 2006. Grey areas indicate private ownership.

Pools that were refuges and reaches that had large wood are lacking because of sedimentation, dams, historic wood removal from stream channels, and degraded riparian forests. These pools and large woody debris would have provided juvenile coho salmon some protection from native predators and the pikeminnow.

Establishment of rural residences, smaller ranches, and agriculture increased the need for water. Currently, much of this demand is accommodated through in-stream diversions or shallow wells, which have lowered stream flows during summer low-flow periods. The Potter Valley Project also diverted 160,000 acre feet of water from the Eel River to the Russian River prior to 2002 (FERC 2000).

In the estuary, salt marsh was drained and riparian vegetation cleared to convert tidelands to pasture (Figure 26-2). The estuary appears to be mixing during the dry months and is stratified, or creates a "salt wedge" during wetter months (Gossard 1986). Tideland reclamation and the construction of dikes and levees have changed the function of the estuary considerably. Slough and creek channels that once meandered throughout the delta are now confined by levees, sufficiently slowing flow to a point that many have become filled with sediment. Remnant slough channels are visible throughout the delta. The estuary and tidal prism have been reduced by over half of their original size (CDFG 2010b).

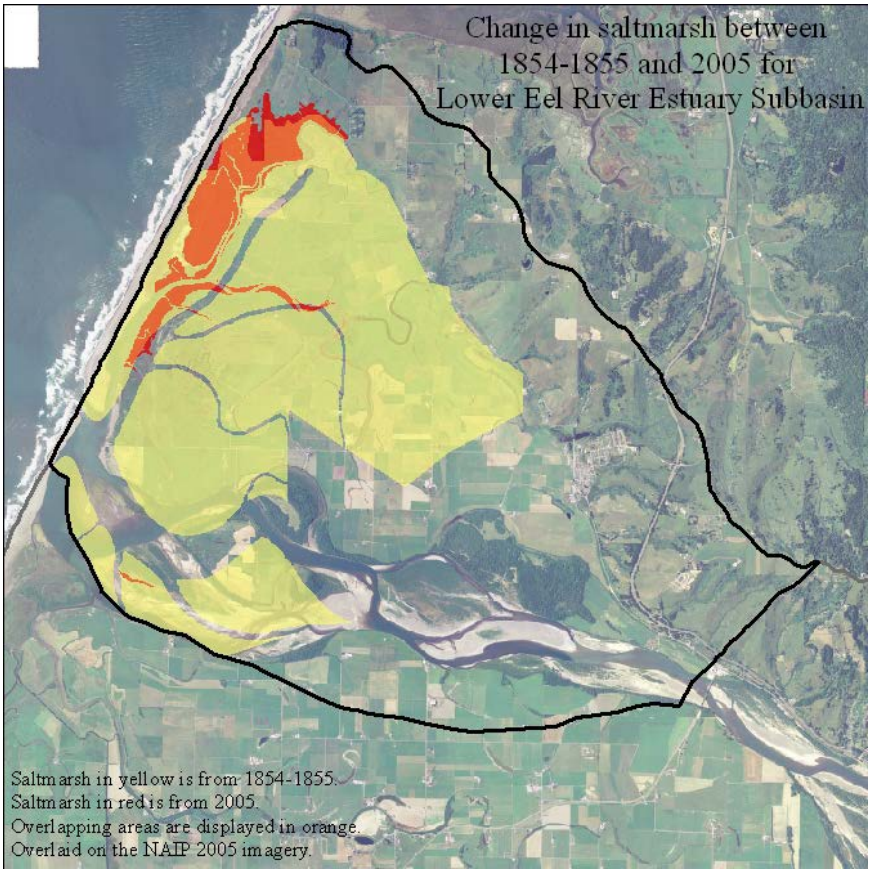

Figure 26-2. Change in salt marsh in the Eel River estuary between 1854 and 2005.

26.2 Historic Fish Distribution and Abundance

Historically, coho salmon occupied much of the Lower Eel and Van Duzen River subbasin. However, information on historic coho salmon use is limited. Coho salmon have been observed intermittently over the past few decades, but absent in many tributaries historically occupied by coho salmon. In 1965, CDFG estimated the escapement to be 500 each for the mainstem Eel River and the Van Duzen River (CDFG 1965). Two decades later, the escapement estimate for 1984 to 1985 declined to 200 for each (Wahle and Pearson 1987).

Survey records show that coho salmon spawned in Carson, Bear, Chadd, and Shaw creeks (CDFG 1994, Brown et al, 2007). In a recent 2011 spawning survey conducted by the CDFG in Fish Creek, a tributary to Lawrence Creek (and Van Duzen River), a total of eight adult coho salmon were observed spawning in a 1-km reach of IP habitat. If multiple surveys had been conducted in a more systematic fashion, it is likely that several more adult coho salmon spawners may have been detected in Fish Creek. This recent observation provides some optimism that the status of coho salmon in the population may be more stable than previously believed. The poor status of this population may be more indicative of a lack of survey effort rather than a lack of fish.

In addition, juveniles were observed in the Van Duzen River, Grizzly, Cummings, Cuddeback, Fiedler, Howe, Wolverine Gulch, Oil, Atwell, Newman, Poison Oak, Strongs, Reas, Francis, Palmer, Rohner, and Jordan creeks (CDFG 1972, Brown and Moyle 1991, PALCO 2006a, Crowser 2005, Downie and Gleason 2007) as well as the Eel River estuary (Puckett 1977), the slough portion of Salt River (CDFG 1977), Centerville Slough (CDFG 1984) and North Slough channels (Puckett 1977). Estuary use by juveniles has been observed in multiple seasons from winter to summer (Puckett 1977, CDFG 2010b).

High IP reaches are found in the Salt River watershed, the lower Van Duzen River, lower Eel River and estuary sloughs, and upper Larabee Creek (see Table 26-1 for all tributaries with instances of high IP habitat).

Table 26-1. Tributaries with instances of high IP reaches (IP > 0.66). (Williams et al. 2006).

Stream Name	Stream Name	Stream Name
Reas Creek	Rohner Creek	Burr Creek
Francis Creek	Strongs Creek	Boulder Flat Creek
Williams Creek	North Fork Strongs Creek	Cooper Creek
Salt River	Jameson Creek	Van Duzen River
Sweet Creek	Rogers Creek	Yager Creek
Howe Creek	Stevens Creek	Cummings Creek
Atwell Creek	Root Creek	Hely Creek
Manning Creek	N. Fk. Yager Creek	Fox Creek
Price Creek	Dairy Creek	Wilson Creek
Nanning Creek	Lawrence Creek	Cuddeback Creek

Hawks Slough	Blanton Creek	Fiedler Creek
Van Duzen River	Yager Creek	Chadd Creek
Penny Slough	Cooper Mill Creek	Bridge Creek
Coffee Creek	Larabee Creek	Greenlow Creek
Oil Creek	Carson Creek	Jordan Creek
Barber Creek	Thurman Creek	Stitz Creek
Eel River	Chris Creek	Burr Creek

26.3 Status of Lower Eel and Van Duzen River Coho Salmon

Spatial Structure and Diversity

The more restricted and fragmented the distribution of individuals within a population, and the more spatial distribution and habitat access diverge from historical conditions, the greater the extinction risk. Williams et al. (2008) determined that at least 20 coho salmon per-IP km of habitat are needed (7,900 spawners total) to approximate the historical distribution of Lower Eel/Van Duzen River coho salmon. The current distribution of spawners is unknown, but expected to be extremely limited because the habitat has been severely degraded in most of the high to moderate IP reaches. The Lower Eel/Van Duzen River coho salmon population is at a high risk of extinction because its spatial structure and diversity are very limited compared to historical conditions.

Population Size and Productivity

The Lower Eel/Van Duzen River coho salmon population size is unknown, but extremely reduced compared to historic levels. Breeding groups have been lost or severely depressed in some Lower Eel/Van Duzen River streams (CDFG 2002b). Population growth rate is unknown, but expected to be negative in most years. Therefore, the Lower Eel/Van Duzen River coho salmon population is at an elevated risk of extinction given the extremely low population size and negative population growth rate.

If a spawning population is too small, the survival and production of eggs or offspring may suffer because it may be difficult for spawners to find mates, or predation pressure may be too great. This situation accelerates a decline toward extinction. Williams et al. (2008) determined at least 394 coho salmon must spawn in the Lower Eel/Van Duzen River each year to avoid such effects of extremely low population sizes.

Extinction Risk

The Lower Eel/Van Duzen River coho salmon population is not viable and at high risk of extinction because the estimated average spawner abundance over the past three years has been less than the depensation threshold (Table ES-1 in Williams et al. 2008).

Role in SONCC Coho Salmon ESU Viability

The Lower Eel/Van Duzen coho salmon population is a non-core "Functionally Independent" population within the Southern Coastal diversity stratum, meaning that it has a high likelihood of persisting in isolation over a 100-year time scale with minimal demographic influence from adjacent populations. The recovery target for the Lower Eel/Van Duzen population is to recover the population to at least a moderate risk of extinction (see chapter 4). 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.

Adjacent Mainstem Eel, Middle Fork Eel, South Fork Eel, Middle Mainstem Eel, and Upper Mainstem Eel populations benefit the Lower Eel/Van Duzen population as a source for genetic diversity, repopulation, and provide refugia during schooling in pools and the ocean. The tributaries and estuary located within this population may serve as essential non-natal rearing habitats for all populations in the Eel River watershed. Large-scale movements into non-natal streams have been documented in the Klamath River, tributaries to Humboldt Bay, and a variety of other locations where the 'nomad' life history pattern has been documented (Koski 2009). It is likely that Lower Eel and Van Duzen tributaries and estuarine habitats are key non-natal habitat for the entire Eel River watershed.

26.4 Plans and Assessments

State of California

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.

California Department of Fish and Game Eel River Salmon and Steelhead Restoration Action Plan

In 1997, the California Department of Fish and Game completed their assessment of the Eel River watershed and provided recommendations for restoration of salmonid stocks. The issues and recommended action plans for the Eel River watershed are incorporated into this plan. Primary recommendations include removing barriers, reducing sediment inputs, improving riparian forest conditions, reducing water withdrawals, habitat enhancement, and controlling Sacramento pikeminnow.

The North Coast Watershed Assessment Program (NCWAP)
http://www.coastalwatersheds.ca.gov

Lower Eel River Basin Assessment Report

The NCWAP Lower Eel River Basin Assessment identifies limiting factors for anadromous salmonids including, estuarine conditions, lack of habitat complexity, increased sediment levels, and high water temperatures.

Environmental Protection Agency (EPA)

In 1999 and 2007, the EPA published the final Total Maximum Daily Loads (TMDL) for the Van Duzen and the Lower Eel River watersheds, respectively. The North Coast Regional Water Quality Control Board is required to develop measures which will result in implementation of these TMDLs in accordance with the requirements of 40 CFR 130.6 EPA's final TMDL identifies their water quality objectives for these watersheds.

Humboldt Redwood Company (HRC)

Habitat Conservation Plan

Pacific Lumber Company (PALCO) finalized a Habitat Conservation Plan (HCP) covering SONCC coho salmon and their habitats in 1999. Since then, in 2008 the Humboldt Redwood Company (HRC) acquired the bankrupt PALCO and formally adopted the PALCO HCP. The HCP requires that forest roads are treated to minimize erosion at the rate of 75 miles of road treatments per year, resulting in 1,500 miles of road treatments in the first two decades of the HCP permit term. The HCP also identifies measures which will help trend aquatic habitat conditions towards 'properly functioning conditions'.

26.5 Stresses

Table 26-2. Severity of stresses affecting each life stage of coho salmon in the Lower Eel and Van Duzen River. Stress rank categories and assessment methods are described in Appendix B, and the data used to assess stresses for the initial threats assessment (described in Appendix B) is presented in Appendix H.

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

[1] Key limiting factor(s) and limited life stage(s).

Limiting Stresses, Life Stages, and Habitat

Based on the type and extent of stresses and threats affecting the population as well as the limiting factors influencing productivity, it is likely that the juvenile life stage is the most limited. Juvenile coho salmon summer and winter rearing success is most limited by elevated water temperatures, decreased flows resulting from the Potter Valley Project and other diversions, and an increased sediment supply that deteriorates the habitat quality in the tributaries. All of these factors contribute to preferable conditions for pikeminnow and a reduction in the size and quality of the estuary. Complexity of freshwater channels and a diverse estuary with suitable cover and deep channels and sloughs is important to juvenile coho salmon, increasing their size and fitness prior to ocean entry, and overall marine survival.

Complex stream channels with deep pools and woody structure as well as tidally influenced wetlands with off channel ponds are important refuge areas for juvenile coho salmon. Properly functional rearing habitat buffer other stresses affecting the population. Juvenile coho salmon would be more protected against predation, competition, and warm mainstem water temperatures if there were additional refugia areas.

Currently, refugia areas for coho salmon are limited in the Lower Eel/Van Duzen River population area. CDFG noted that Oil Creek has a high potential for providing refugia (Downie and Gleason 2007). To some extent, the estuary could serve as a refuge from the poor conditions in the mainstem if tidegates and levees did not prevent juvenile salmon from reaching that habitat.

Altered Sediment Supply

Excessive sediment poses a medium stress to smolts and a very high stress to all other life stages of coho salmon in this population. Except for two sampling sites with moderate percentages of fines (<1mm), all sampling sites throughout the lower Eel and Van Duzen rivers have excessive levels of fines and sand (>6.4 mm). High sediment loads result in excessive embeddedness and reduces pool depths. High sediment levels impair feeding, simplify habitat, reduce reproductive success, and result in adverse physiological stress responses. The EPA listed the Lower Eel and the Van Duzen rivers as impaired by sediment. The Eel River is one of the most erodible watersheds in the United States (Brown and Ritter 1971) because of the highly active tectonic setting, highly erodible soils in the area, and high precipitation. The Eel River carries fifteen times as much sediment as the Mississippi River and more than four times as the Colorado River (Brown and Ritter 1971). Anthropogenic activities in the Lower Eel/Van Duzen River population have exacerbated these naturally high sediment loads. A study of the continental shelf deposits offshore from the mouth of the Eel River indicates that there has been a sudden, three-fold increase in the rate of sedimentation since 1954 (EPA 2007b). Most of the deep pools that existed in the estuary were filled by sediment brought by the flood waters of 1964. Excessive amounts of sediments generated by land use are still delivered to the estuary from upstream sources (EPA 2007b).

Aggradation has interrupted the connectivity of surface flow in several areas. The Van Duzen River is often isolated from the Eel River by subsurface flows in late summer and early fall. An over abundance of gravels and sediment are deposited at the confluence of the Van Duzen and Eel River which results in sub-surface flows and dry channels (Downie and Gleason 2007). Sedimentation has also restricted access to the Salt River downstream of Williams Creek and has severely restricted fish access to Salt River tributaries. Salmon Forever has been monitoring Francis Creek since January 2007, and preliminary results show maximum turbidity levels have reached 2200 ntu during a single storm. Combined with flow data, 2200 ntu is equivalent to 8.5 tons of sediment moving downstream every 10 minutes (Downie and Gleason 2007).

Impaired Estuary/Mainstem Function

This stress refers to the estuary and mainstem conditions in the Eel River, since this population is a part of a larger basin containing multiple populations (see chapter 3 for further description of this stressor). Conditions in the Eel River mainstem and estuary are important to this population since all salmon and steelhead that originate from the Eel River migrate to and from the ocean through the mainstem Eel River and 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 populations. The degraded function of the Eel River estuary and mainstem migratory corridor today constitutes a very high

stress for juveniles, a high stress for smolts, medium stress for adults, and a medium stress for fry. The Eel River estuary is severely impaired because of past diking, and filling of tidal wetlands for agriculture and flood protection. Approximately 60 percent of the estuary has been lost through the construction of levees and dikes and CDFG (2010) estimates that only 10% of salt marsh habitats remain today. The estuary once supported a high degree of estuarine habitat and rearing potential, but very little of that historic function still exists. The function of the estuary (e.g., rearing, refugia, ocean transition) for coho salmon that originate in the Lower Eel/Van Duzen River is very important given the degraded habitat conditions and predation and competition from non-native Sacramento pikeminnow occurring upstream of the estuary in the mainstem river. Juveniles, smolts, and adults transitioning through mainstem and estuarine habitat are stressed by the degraded conditions in these migratory habitats. Juveniles and smolts suffer from the lost opportunity for increased growth, which would improve their survival at ocean entry. The loss and degradation of the formally-extensive and complex estuarine and mainstem habitat is a high stress for the population, with the most affected life stages being juveniles, smolts, and adults due to the degradation of rearing and migratory habitat.

Degraded Riparian Forest Conditions

Degraded riparian forest conditions exist across the subbasin, and present a high stress to fry, juvenile, smolt, and adult coho salmon. Where data exist, streamside canopy cover shows a range of conditions, with some good cover in the headwater areas of some tributaries, primarily in the Lawrence Creek watershed, and poor cover and shade conditions in the mainstem channel of all of the major tributaries in the Lower Eel/Van Duzen River watershed, and in the mainstem of the Lower Eel downstream of about Alton, California. Riparian habitat has somewhat rebounded from past large flood events (e.g., 1964). However, even where streamside canopy cover is good, it consists of open and hardwood dominated riparian forest conditions. Mature coniferous riparian forests provide the size and amount of large wood necessary for coho salmon rearing habitat, shade streams, reduce sediment delivery, and provide terrestrial subsidies. Hardwood and small conifer-dominated riparian forests provide limited large wood recruitment into the Lower Eel/Van Duzen River.

Riparian corridors in the Salt River watershed are, in places, lacking riparian vegetation; particularly the tributaries in the wildcat geological formation. The trans-delta reaches of the Salt River tributaries, such as in Reas Creek, tend to have little to no riparian vegetation.

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 upstream of the population area. Because the SOD pathogen is water borne and can travel downstream in watercourses, the likelihood of SOD outbreaks in the population area are high. One of the largest areas infected by SOD occurs near Redway and is growing at a very fast rate. SOD was recently detected in 2011 in tributaries to the Van Duzen River.

Impaired Water Quality

Impaired water quality, specifically high water temperature, poses a high stress to all rearing life stages and a medium stress to eggs. The Lower Eel River and the Larabee Creek watershed are listed as impaired for elevated temperature under section 303(d) of the Clean Water Act. Water

temperature in the Lower Eel/Van Duzen River and its tributaries approach lethal levels in a number of stream reaches and is stressful in most others, and severely limits the amount of habitat available to rearing coho salmon. An airborne thermal infrared remote sensing study of the main channel, as well as in-water monitoring, indicate water temperature is near lethal levels for rearing coho salmon in most of the mainstem of the Lower Eel River (EPA 2007b). However, modeling efforts show these water temperatures are only marginally higher than they would be with full riparian cover; because the mainstem of the Lower Eel is naturally very wide, much of it was likely not shaded even before the 1800s (EPA 2007b). Tributaries in the coastal zone such as Salt River are important because of their cold water contribution to the mainstem. Temperature problems in the tributaries were attributed to inadequate shading due to removal of riparian vegetation, and to excess sediment which widens streams, fills pools, and makes the river shallower. The loss of deep pools removes cooler-water refugia, which coho salmon could use to persist in areas with otherwise uninhabitable water temperatures.

Additionally, water quality problems from agricultural runoff have been identified in the Salt River watershed and conductivity, turbidity, and dissolved oxygen may be limiting factors in the middle subbasin. Therefore, water quality is likely a limiting factor, specifically nutrient enrichment, excess sediment, elevated water temperatures, and low dissolved oxygen.

Increased Disease/Competition/Predation

Competition and predation from non-native California roach and Sacramento pikeminnow poses a high stress to fry and juveniles and a very high stress to smolts. These invasive species have the greatest impact in watersheds such as the Lower Eel/Van Duzen, with the most impaired habitat conditions, because the altered conditions favor production of these non-native species over indigenous salmonids.

Lack of Floodplain and Channel Structure

The lack of floodplain and channel structure is a high stress for juveniles, smolts, adults, and fry; and a medium stress for eggs. The floodplains and channels have been degraded due to excessive sediment loads, coupled with the paucity of large wood and riparian vegetation. Except for one reach with fair levels of embeddedness, all surveyed reaches of Yager Creek and smaller tributaries to the Eel River have excessive embeddedness. These same surveyed reaches have mostly fair (2.01 to 3 ft) or poor (<2 ft) pool depths and mostly poor pool frequencies (<35 percent by length). Roads constrict the channel where they occur parallel to the stream. In addition, levees in the Lower Eel River from Fortuna to the Pacific Ocean significantly alter floodplain and channel structure (through altered connectivity) and significantly reduce the size of the estuary. Habitat complexity, via pools, large wood cover, and floodplains, is essential for juvenile rearing to optimize forage, avoid predation, and access thermal and velocity refuges.

Adverse Fishery-Related Effects

NMFS has determined that federally-managed fisheries are not likely to jeopardize the continued existence of the SONCC coho salmon ESU (Appendix B). The effect of fisheries managed by the state of California on the continued existence of the SONCC coho salmon ESU has not been formally evaluated by NMFS (Appendix B).

Barriers

Barriers to fish passage do not present a major impediment to restoration and recovery of the Lower Eel/Van Duzen River coho salmon population, as reflected by their low stress ranking. Tidegates that separate the estuary from the river can be problematic, however, because they can block juvenile access to the estuary and therefore make it more difficult for them to utilize the estuary as a refuge from poor habitat conditions in the river. In addition, tide gates reduce the tidal prism of the estuary which is important for maintaining water quality, channel maintenance, and overall estuarine function.

Adverse Hatchery-Related Effects

The effects of hatchery fish on all life stages of coho salmon are described in Chapter 3. There are no operating hatcheries in the Lower Eel/Van Duzen River population area. Hatchery-origin coho salmon may stray into the population area, but the proportion of spawning adults that are of hatchery origin is unknown. Adverse hatchery-related effects pose a low risk to all life stages, because less than five percent of adults are presumed to be of hatchery origin (Appendix B) and there are no hatcheries in the basin

Altered Hydrologic Function

Altered hydrologic function (the timing and availability of water) poses a low stress to coho salmon. Base flows in tributaries to the Lower Eel/Van Duzen River are affected by rural and urban water withdrawals, but it is unknown whether these withdrawals alter water availability to the extent that it harms coho salmon or their habitat. Due to all the land changes that have occurred since the 1800s, the way that water runs off the land is altered compared to historic conditions; overall, peak flows are higher and base flows are lower.

Diversion records for the Eel River have been published for the 91 years from 1910 to 2000. During the high flow months of January, February, and March only 6 percent, 20 percent, and 15 percent of unimpaired flows have been diverted, respectively. During the lower flow months of June, July, August, and September, 81 percent, 88 percent, 69 percent, and 64 percent of the unimpaired flows are diverted, respectively (Center for Environmental Economic Development 2002). The Potter Valley Project diverted as much as 160,000 acre feet of water from the Eel River and into the Russian River prior to 2002 (FERC 2000).

26.6 Threats

Table 26-3. Severity of threats affecting each life stage of coho salmon in the Lower Eel and Van Duzen River. Threat rank categories and assessment methods are described in Appendix B, and the data used to assess threats for the initial threats assessment (described in Appendix B) is presented in Appendix H.

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

Roads

Roads constitute a very high threat across all life stages. Road density is very high (>3 miles per square mile) in the Lower Eel/Van Duzen River subbasin. Unpaved roads deliver large volumes of sediment to stream channels. Roads also alter the hydrology of stream systems resulting in higher peak flows and lower summer base flows.

Timber Harvest

Timber harvest is a very high threat to all life stages. Many of the changes that have occurred to instream and riparian conditions in the Lower Eel/Van Duzen River reflect legacy effects of more intensive harvest from previous decades. However, given the percentage of the watershed that is privately owned by timber companies and actively managed as such, future timber harvest activities will continue to exacerbate the stresses caused by legacy logging activities. Nearly half

of the subbasin has been logged on over 35 percent of its area, and continuing harvest on these areas has the potential to affect high IP-areas downstream by contributing to sediment deposition and reducing sources of large wood.

Dams/Diversions

Dams and diversions pose a medium threat to smolts and a high threat to all other life stages of coho salmon. Scott Dam and the Potter Valley Project altered the historic hydrologic regime under which the Lower Eel/Van Duzen River coho salmon evolved. In addition, localized water diversions for rural residential and agricultural use reduce streamflow during juvenile rearing periods. Tide gates restrict juvenile coho salmon use of the estuary and levees reduce the tidal prism necessary for flushing the high sediment load to the ocean (Figure 26-3 and Figure 26-4).

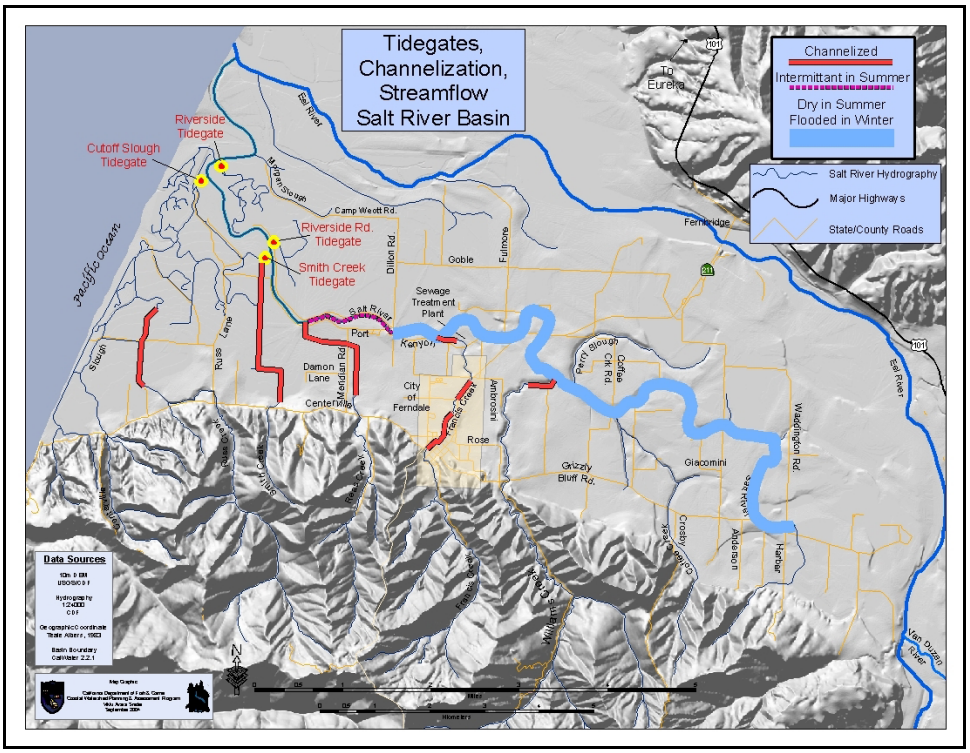

Figure 26-3. A map of tide gates and channelization in the Salt River watershed.

Figure 26-4. Photo of a tidegate on Cutoff Slough in the Lower Eel River estuary.

High Intensity Fire

Fires pose a medium threat to smolts and a high threat to all other life stages. The dense understory vegetation throughout the population area increases the probability for high intensity fires to alter sedimentation processes as well as riparian vegetation characteristics.

Invasive/Non-native Species

Sacramento pikeminnow thrive in the degraded habitat conditions in the Lower Eel/Van Duzen River which favor production of the non-native Sacramento pikeminnow, resulting in significant levels of competition and predation on coho salmon. The non-native Sacramento pikeminnow is a threat to fry, juveniles, and smolts because they compete with and prey on the young coho salmon. Sacramento pikeminnow were introduced to 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 make this voracious predator thrive in this system. The presence of the Sacramento pikeminnow in Lake Pillsbury makes eradication of this species extremely difficult.

Cordgrass (*Spartina densiflora*) is an introduced and invasive salt marsh plant that has spread across the estuarine wetlands. *S. densiflora* tends to displace native marsh species, can exacerbate sediment accumulations in wetlands, and may cause other undesirable changes to the estuarine ecosystem. Eradication projects have cleared areas of invasive cordgrass around Humboldt Bay. No efforts have been planned to control *S. densiflora* in the Eel River estuary. There are also a number of other invasives including non-native eel grass and reed-canary grass that may affect the success of restoration actions.

Agricultural Practices

Grazing occurs throughout the population area and increases sediment generation and delivery. In addition, much of the estuary is directly influenced by agriculture in historical tidelands. Agricultural land makes up 28 percent of the Lower Eel River subbasin, and increases in area closer to the mouth (Downie and Gleason 2007). Livestock have unrestricted access to many of the Lower Eel River tributaries and estuary sloughs, resulting in stream bank erosion. Much of

the Lower Eel River subbasin has been cleared of riparian vegetation to create pastureland for cattle, and waste from the dairy industry has affected water quality. In the past, waste from dairies would flow into low lying areas, which are often former slough channels. During times of heavy precipitation, these often became active sloughs that would transport waste into the estuary.

An excess of nutrients can degrade water quality by fueling toxic algal blooms that increase biological demand either through respiration or decomposition. Algae blooms are naturally occurring, however, excess nitrogen can increase the extent and severity of effects (i.e., decreased dissolved oxygen). The Van Duzen River has chronic issues with toxic blooms of blue-green algae which have led to the deaths of several dogs. Blue green algal blooms are related to excess nitrogen and poor water quality conditions.

Grazing cattle is common in many of the tributaries and grassy openings throughout the population area, including the valley bottoms and ridges of the mainstem Eel and Van Duzen rivers. Grazing beef or dairy cattle is the most common land use in the lower sub-basin and estuary (CDFG 2010b), where rich grasslands thrive in the delta of the Eel and Van Duzen rivers. Although this area has rich grasslands which can support a significant cattle industry, the effects of cattle grazing are very apparent. There are only a few areas with riparian exclusion fencing and livestock are commonly allowed unrestricted access to the creek. .

Channelization/Diking

Channelization and diking is identified as high threat in the population area. The existence of extensive channelization and diking in the Lower Eel River, tributaries to the Eel River, especially in the Salt River watershed, and the estuary severely limits the function of the floodplain and estuary for production of coho salmon. For example, Reas Creek is contained in levees the entire length across the delta, and realigned with two 90 degree turns. The channelization and lengthening of the trans-delta reach of Reas Creek is suspected of causing problems related to sediment deposition and discharge within Reas Creek as well as in the Salt River. Williams Creek was levied in 1999 from the mouth to 2500 feet upstream. In addition, Williams Creek was diverted from the Salt River and now drains to the Eel River through the Old River, resulting in altered hydrology and sediment transport in the Salt River. Rohner Creek has been realigned and channelized through the City of Fortuna.

In 2006, the CDFG received permits to expand, raise, and widen the levee network in the vicinity of the Eel River Wildlife Area to address breaches of the levees which occurred in 1994 and 1998. The levees were enhanced to ensure that tidal action would not compromise the integrity of the levees and also to assist in keeping freshwater impoundments from being exposed to saltwater. Levees in the Eel River estuary are known to reduce the extent and intensity of tidal flushing which causes sedimentation and the resulting widening and reductions in depth. The Eel River estuary appears to be shrinking due to continued sedimentation and the number of species it harbors has apparently diminished from historic numbers (Puckett 1977). The exchange of tide water scours sediment and transports it to the ocean which helps maintain the depths of estuarine channels. In the late 1890's a court agreed that the construction of levees and the ensuing reduction of the tidal prism were responsible for the filling of the channels near the Salt River area (CDFG 2010b).

The Humboldt County Resource Conservation District is the lead agency on the Salt River Ecosystem Restoration Project. In the late 1800's the Salt River was a functioning river and large enough to accommodate small ocean vessels and steamers. At Port Kenyon, the Salt River was approximately 200 feet wide and 15 feet deep. Now the Salt River is so small that a person could jump over it. Over time fine sediments have eroded from the surrounding Wildcat Hills into the tributaries and deposited in the Salt River channel. Vegetation has sprouted up in the channel which traps more sediment, impedes fish passage and increases flooding on the surrounding agricultural lands, roads, and residences.

Reducing the amount of sediment that reaches the tributaries and the Salt River is one step in creating an open and functioning channel. This ecosystem-scale project includes a large tidal wetland restoration component that will create a succession of biologically rich and diverse tidal wetland habitats, including transitional wetlands and adjacent uplands as part of a sustainable estuary system. To offer some insight on the level of sedimentation involved, consider the following: in hydrologic year 2010 the annual suspended sediment yield from the Francis Creek watershed was 38 million pounds. This equates to an annual suspended sediment yield of 6091 tons/sq. mile. By comparison, the sediment impaired Freshwater Creek and Elk River watersheds in Humboldt County have yields of 300-600 tons/sq. mile/year, and the Eel River carries 4,330 tons of sediment/sq. mile/year (Buffleben 2009).

Urban/Residential/Industrial Development

Urban/residential/industrial development is a high threat because much of the watershed with high IP value is located in and around the cities of Ferndale and Fortuna. Future growth of this area is likely, with northerly migration from southern metropolitan areas due to declining water supplies. In addition, further rural residential development is likely as large agricultural holdings are subdivided into smaller ranches. All of this will combine to further increase road building, land clearing, and other development.

When flows are sufficiently high, the Eel River floods the treatment ponds of the Fortuna Wastewater Treatment Plant (Downie and Gleason 2007). In the winter months, the effluent from the Ferndale wastewater treatment plant is directed into Francis Creek, which historically had sufficient flow to meet dilution requirements year round. Sediment deposition has reduced the cross sectional area of the creek and now the wastewater treatment plant effluent exceeds one percent of receiving flows during winter months, which is a violation of Waste Discharge Requirements. The wastewater treatment facility has accumulated 241 water quality violations since 1996 (Spencer Engineering 2004). Improvements to the existing facility have been made in recent years and the number of water quality violations has declined. In addition, the City of Ferndale and the RWQCB have agreed on a design for tertiary treatment of effluent which will result in an improvement to water quality conditions in Francis Creek and the Salt River.

Treatment and percolation ponds are also constructed at the Town of Scotia to ensure that effluents from the mill and town site are allowed to settle and percolate into the sub-surface zones of the gravel bar to comport with NCRWQCB requirements, which does not allow treated or untreated effluents to be discharged into the Eel River. As high winter flow regimes approach in the fall, the percolation ponds are dismantled and allowed to be discharged into the Eel River when flows become high enough to capture the ponds.

Mining/Gravel Extraction

Past gravel mining in the Lower Eel subbasin likely contributed to braiding and flattening of the Eel River between the confluence with the Van Duzen River to one mile downstream of Fernbridge (Humboldt County 1992). A shallow, wide channel provides less cover from predation, less food, and higher water temperatures for juvenile fish as the channel is often decoupled from riparian vegetation. Braiding reduces water depth and can become a migration barrier for adult fish, sometimes leading to stranding on shallows and mortality. A significant level of gravel extraction still occurs in the Lower Eel/Van Duzen River, but is conducted with State and Federal oversight. The medium threat ranking reflects sensitivity of the channel to additional disturbances (i.e., lack of floodplain and channel structure). However, gravel extraction has been used successfully to address some of the problems associated with the high sediment load in the Lower Eel/Van Duzen River including an adult migration barrier that occasionally develops at the Van Duzen/Eel River confluence. Gravel mining methodologies have evolved over time to accommodate the narrowing and deepening of channels by using wet trenching techniques.

Climate Change

Climate change poses a medium threat to this population. The impacts of climate change in this region will have the greatest impact on juveniles, smolts, and adults. Although the current climate is generally cool, modeled regional average temperature shows a moderate increase over the next 50 years (see Appendix B for modeling methods). Average temperature could increase by up to 1.6 ^{o}C in the summer and by 1 ^{o}C in the winter. Annual precipitation in this area is predicted to trend downward over the next century. Snowpack in upper elevations of the Eel River basin, upstream of the Lower Eel and Van Duzen river subbasin, will decrease with changes in temperature and precipitation (California Natural Resources Agency 2009). 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 in the estuary. Wetlands could migrate inland with rising sea level but there are few places that are not armored and would allow for this migration and sea level may rise too quickly for adaptation of wetlands. Overall, the range and degree of variability in temperature and precipitation is likely to increase in all populations. Also, with all populations in the ESU adults will be negatively impacted by ocean acidification and changes in ocean conditions and prey availability (Independent Science Advisory Board 2007, Feely et al. 2008, Portner and Knust 2007).

Fishing and Collecting

California-managed fisheries for species other than coho salmon occur in estuaries, freshwater, and nearshore marine areas. The effects of these fisheries on the continued existence of the SONCC coho salmon ESU have not been formally evaluated by NMFS. NMFS has authorized future collection of coho salmon for research purposes in the Lower Eel and Van Duzen Rivers. NMFS has determined these collections are not likely to jeopardize the continued existence of the SONCC coho salmon ESU.

Hatcheries

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

Road-stream Crossing Barriers

Barriers pose a low threat. However, there are five known barriers to fish habitat, including one on Francis Creek at Port Kenyon road, two on Barber Creek, and two more on an unnamed tributary extending north from the mainstem west of Carlotta, CA.

A culvert on Mill Creek does not meet CDFG and NMFS fish passage guidelines. Other creeks with possible fish passage restrictions include Palmer, Dean, Price, and Adams.

26.7 Recovery Strategy

The degraded condition of the Lower Eel/Van Duzen River population area, combined with the depressed coho salmon population size and restricted distribution significantly increases the risk of extinction of this important, coastal coho salmon population. Most of the population area is in private ownership, much of the high IP areas are in developed areas, and predation and competition from non-native Sacramento pikeminnow severely limits juvenile survival. Restoration activities that improve estuarine habitat, increase floodplain connectivity, reduce sediment inputs, increase riparian vegetation, increase summer instream flows, and reduce the influence of Sacramento pikeminnow should be immediately implemented.

Table 26-4 on the following page lists the recovery actions for the Lower Eel/Van Duzen River population.

Table 26-4. Recovery action implementation schedule for the Lower Eel/Van Duzen River population.

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID		***Step Description***				
SONCC-LEVR.1.1.12	Estuary	Yes	Improve connectivity of tidally-influenced habitat	Set back or remove dikes or levees	Mid-channel islands such as Cock Robin Island, Salt River Slough, Mosley Slough, and McNulty Slough	2
SONCC-LEVR.1.1.12.1		*Assess and prioritize levees for setback or removal.*				
SONCC-LEVR.1.1.12.2		*Remove or setback levees, guided by assessment results*				
SONCC-LEVR.1.1.13	Estuary	Yes	Improve connectivity of tidally-influenced habitat	Remove or replace tidegates	Estuary	2
SONCC-LEVR.1.1.13.1		*Inventory tidegates and develop a plan that prioritizes removal or replacement. Research possible incentive opportunities and work with landowners to replace tidegates with fish friendly versions*				
SONCC-LEVR.1.1.13.2		*Remove or replace tidegates as described in the plan*				
SONCC-LEVR.1.2.14	Estuary	Yes	Improve estuarine habitat	Restore salt marsh and tidal sloughs	State lands including, Hawk Slough, Hogpen Slough, Smith Creek Cuttoff Slough, and Sevenmile Slough	2
SONCC-LEVR.1.2.14.1		*Develop a management plan in the Eel River estuary to restore salt marsh and tidal slough habitat*				
SONCC-LEVR.1.2.14.2		*Restore salt marsh and tidal slough habitat*				
SONCC-LEVR.1.2.15	Estuary	Yes	Improve estuarine habitat	Re-connect tidal channels and wetlands	State lands including, Morgan Slough, Smith Creek, and Sevenmile Slough	2
SONCC-LEVR.1.2.15.1		*Develop a plan to re-connect historic tidal channels and tidal wetlands as well as restore channelized tidal channels to a more natural channel form*				
SONCC-LEVR.1.2.15.2		*Re-connect tidal channels and wetlands, guided by the plan*				
SONCC-LEVR.1.2.15.3		*Restore channelized tidal channels to a more natural channel form*				
SONCC-LEVR.1.2.16	Estuary	Yes	Improve estuarine habitat	Restore brackish wetlands	McNulty Slough and Salt River	2
SONCC-LEVR.1.2.16.1		*Develop a plan for the conversion of freshwater wetlands to functioning tidal habitat*				
SONCC-LEVR.1.2.16.2		*Convert formally brackish wetlands from freshwater wetlands back to functioning tidal habitat*				

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-LEVR.1.2.38	Estuary	Yes	Improve estuarine habitat	Assess estuary and tidal wetland habitat	Estuary	3
SONCC-LEVR.1.2.38.1	*Identify parameters to assess condition of estuary and tidal wetland habitat*					
SONCC-LEVR.1.2.38.2	*Determine amount of estuary and tidal wetland habitat needed for population recovery*					
SONCC-LEVR.8.1.5	Sediment	Yes	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	Population wide	3
SONCC-LEVR.8.1.5.1	*Assess and prioritize road-stream connection, and identify appropriate treatment to meet objective*					
SONCC-LEVR.8.1.5.2	*Decommission roads, guided by assessment*					
SONCC-LEVR.8.1.5.3	*Upgrade roads, guided by assessment*					
SONCC-LEVR.8.1.5.4	*Maintain roads, guided by assessment*					
SONCC-LEVR.8.1.6	Sediment	Yes	Reduce delivery of sediment to streams	Improve regulatory mechanisms	Population wide	3
SONCC-LEVR.8.1.6.1	*Develop grading ordinance for maintenance and building of private roads that minimizes the effects to coho*					
SONCC-LEVR.8.1.7	Sediment	Yes	Reduce delivery of sediment to streams	Improve regulatory mechanisms	Population wide	3
SONCC-LEVR.8.1.7.1	*Limit off-road use of the floodplain*					
SONCC-LEVR.8.1.9	Sediment	Yes	Reduce delivery of sediment to streams	Improve grazing practices	Ferndale and Bridgeville HSAs	BR
SONCC-LEVR.8.1.9.1	*Develop educational materials for landowners that encourage retention of riparian vegetation*					
SONCC-LEVR.8.1.9.2	*Develop riparian buffer ordinance for grazing and agriculture*					
SONCC-LEVR.8.1.11	Sediment	Yes	Reduce delivery of sediment to streams	Reduce risk of catastrophic fire	Population wide	BR
SONCC-LEVR.8.1.11.1	*Assess fire hazard and risk*					
SONCC-LEVR.8.1.11.2	*Promote appropriate treatment to reduce high intensity fire hazard*					
SONCC-LEVR.14.2.4	Disease/Predation/ Competition	No	Reduce predation and competition	Reduce abundance of Sacramento pikeminnow	Population wide	2

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	***Step Description***					
SONCC-LEVR.14.2.4.1	*Determine the effectiveness of various pikeminnow suppression techniques and develop experimental control methods. Develop a plan that identifies watersheds suitable for experimental pikeminnow control*					
SONCC-LEVR.14.2.4.2	*Control Sacramento pikeminnow, guided by the control plan*					
SONCC-LEVR.16.1.22	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	3
SONCC-LEVR.16.1.22.1	*Determine impacts of fisheries management on SONCC coho salmon in terms of VSP parameters*					
SONCC-LEVR.16.1.22.2	*Identify fishing impacts expected to be consistent with recovery*					
SONCC-LEVR.16.1.23	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Limit fishing impacts to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	2
SONCC-LEVR.16.1.23.1	*Determine actual fishing impacts*					
SONCC-LEVR.16.1.23.2	*If actual fishing impacts exceed levels consistent with recovery, modify management so that levels are consistent with recovery*					
SONCC-LEVR.16.2.24	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	3
SONCC-LEVR.16.2.24.1	*Determine impacts of scientific collection on SONCC coho salmon in terms of VSP parameters*					
SONCC-LEVR.16.2.24.2	*Identify scientific collection impacts expected to be consistent with recovery*					
SONCC-LEVR.16.2.25	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Limit impacts of scientific collection to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-LEVR.16.2.25.1	*Determine actual impacts of scientific collection*					
SONCC-LEVR.16.2.25.2	*If actual scientific collection impacts exceed levels consistent with recovery, modify collection so that impacts are consistent with recovery*					
SONCC-LEVR.2.1.17	Floodplain and Channel Structure	No	Increase channel complexity	Increase LWD, boulders, or other instream structure	Population wide	3
SONCC-LEVR.2.1.17.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-LEVR.2.1.17.2	*Place instream structures, guided by assessment results*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	***Step Description***					
SONCC-LEVR.2.1.36	Floodplain and Channel Structure	No	Increase channel complexity	Construct off channel ponds, alcoves, backwater habitat, and old stream oxbows	Population wide, particularly Yager and Lawrence creeks	2
SONCC-LEVR.2.1.36.1	*Identify potential sites to create refugia habitats. Prioritize sites and determine best means to create rearing habitat*					
SONCC-LEVR.2.1.36.2	*Implement restoration projects that improve off channel habitats as guided by assessment results*					
SONCC-LEVR.3.1.19	Hydrology	No	Improve flow timing or volume	Increase instream flows	Population wide	BR
SONCC-LEVR.3.1.19.1	*Reduce diversions*					
SONCC-LEVR.3.1.20	Hydrology	No	Improve flow timing or volume	Educate stakeholders	Population wide	BR
SONCC-LEVR.3.1.20.1	*Provide education and training on conserving water while diverting*					
SONCC-LEVR.3.1.20.2	*Provide incentives to landowners to reduce water consumption*					
SONCC-LEVR.27.1.26	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate abundance	Population wide	3
SONCC-LEVR.27.1.26.1	*Perform annual spawning surveys*					
SONCC-LEVR.27.1.27	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate juvenile spatial distribution	Population wide	3
SONCC-LEVR.27.1.27.1	*Conduct presence/absence surveys for juveniles (3 years on; 3 years off)*					
SONCC-LEVR.27.1.28	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the stress 'Fishing and Collecting'	Population wide	2
SONCC-LEVR.27.1.28.1	*Annually estimate the commercial and recreational fisheries bycatch and mortality rate for wild SONCC coho salmon.*					
SONCC-LEVR.27.1.29	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the threat 'Invasive Species'	Population wide	3
SONCC-LEVR.27.1.29.1	*Annually estimate the density of non-native predators, such as the Sacramento pikeminnow in the Eel River basin*					
SONCC-LEVR.27.1.29.2	*Identify the status and trend of invasive species*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID		***Step Description***				
SONCC-LEVR.27.2.30	Monitor	No	Track habitat condition	Track habitat indicators related to spawning, rearing, and migration	Population wide	3
SONCC-LEVR.27.2.30.1		*Measure indicators for spawning and rearing habitat. Conduct a comprehensive survey*				
SONCC-LEVR.27.2.30.2		*Measure indicators for spawning and rearing habitat once every 10 years, sub-sampling 10% of the original habitat surveyed*				
SONCC-LEVR.27.2.31	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Lack of Floodplain and Channel Structure'	All IP habitat	3
SONCC-LEVR.27.2.31.1		*Measure the indicators, pool depth, pool frequency, D50, and LWD*				
SONCC-LEVR.27.2.32	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Degraded Riparian Forest Condition'	All IP habitat	3
SONCC-LEVR.27.2.32.1		*Measure the indicators, canopy cover, canopy type, and riparian condition*				
SONCC-LEVR.27.2.33	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Altered Sediment Supply'	All IP habitat	3
SONCC-LEVR.27.2.33.1		*Measure the indicators, % sand, % fines, V Star, silt/sand surface, turbidity, embeddedness*				
SONCC-LEVR.27.2.34	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Water Quality'	All IP habitat	3
SONCC-LEVR.27.2.34.1		*Measure the indicators, pH, D.O., temperature, and aquatic insects*				
SONCC-LEVR.27.2.35	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Estuarine Function'	All IP habitat	3
SONCC-LEVR.27.2.35.1		*Identify habitat condition of the estuary*				
SONCC-LEVR.27.1.39	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track life history diversity	Population wide	3
SONCC-LEVR.27.1.39.1		*Describe annual variation in migration timing, age structure, habitat occupied, and behavior*				
SONCC-LEVR.27.1.40	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Refine methods for setting population types and targets	Population wide	3

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID		***Step Description***				
SONCC-LEVR.27.1.40.1		*Develop supplemental or alternate means to set population types and targets*				
SONCC-LEVR.27.1.40.2		*If appropriate, modify population types and targets using revised methodology*				
SONCC-LEVR.27.2.41	Monitor	No	Track habitat condition	Determine best indicators of estuarine condition	Estuary	3
SONCC-LEVR.27.2.41.1		*Determine best indicators of estuarine condition*				
SONCC-LEVR.5.1.37	Passage	No	Improve access	Reduce sediment barriers	Tributary confluences with mainstem Eel and Van Duzen rivers	3
SONCC-LEVR.5.1.37.1		*Inventory and prioritize barriers formed by alluvial deposits*				
SONCC-LEVR.5.1.37.2		*Remove alluvial deposits, construct low flow channels, or reduce stream gradient to provide fish passage at all life stages*				
SONCC-LEVR.7.1.1	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve long-range planning	Population wide	3
SONCC-LEVR.7.1.1.1		*Review General Plan or City Ordinances to ensure coho salmon habitat needs are accounted for. Revise if necessary*				
SONCC-LEVR.7.1.1.2		*Develop watershed-specific guidance for managing riparian vegetation*				
SONCC-LEVR.7.1.2	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Increase conifer riparian vegetation	High IP sub watersheds	3
SONCC-LEVR.7.1.2.1		*Determine appropriate silvicultural prescription for benefits to coho salmon habitat*				
SONCC-LEVR.7.1.2.2		*Thin, or release conifers, guided by prescription*				
SONCC-LEVR.7.1.2.3		*Plant conifers, guided by prescription*				
SONCC-LEVR.7.1.3	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve timber harvest practices	Population wide	2
SONCC-LEVR.7.1.3.1		*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).*				