19. Redwood Creek Population

- Central Coastal Stratum
- Core, Functionally Independent Population
- High Extinction Risk
- 4,900 Spawners Required for ESU Viability
- 293 mi^2
- 151 IP km (94 mi) (38 % High)
- Dominant Land Uses are Timber Harvest and Agriculture
- Principal Stresses are 'Lack of Floodplain and Channel Structure', 'Degraded Estuarine Conditions', and 'Impaired Water Quality'
- Principal Threats are 'Roads' 'Channelization/Diking' and 'Timber Harvest'

19.1 Habitat and Land Use Changes in Redwood Creek

Logging, road building, and the construction of flood control levees are the land uses that have had the most pronounced effect on coho salmon habitat in the Redwood Creek basin. Much of the upper and middle portions of the basin are owned by private timber companies and are used for timber production. In addition, livestock grazing occurs on some private lands, both in the middle and upper portions of the basin and in the valley bottom near Orick, where flood control levees protect the grazing lands. Much of the lower basin is public parkland, managed for protection and restoration of the old-growth redwood forest ecosystem. However, much of the parkland was heavily logged and roaded prior to National Park Service ownership. The largest community in the basin, Orick, is located near the mouth of Redwood Creek. In this valley bottom, 3.4 miles of flood control levees were constructed in 1968 to protect the Orick community and surrounding farm/ranch lands from a 200-year flood event. While providing flood protection for the community, the levees reduced coho salmon habitat by confining Redwood Creek to a 250-foot wide channel and bisecting the estuary.

These past land uses have resulted in impacts that have interacted to reduce available habitat throughout the basin. Increased sediment production from logged hillslopes and roads, especially during the 1955 and 1964 flood events, have choked Redwood Creek with sediment. The loss of riparian vegetation has reduced shading and created a lack of instream large wood.

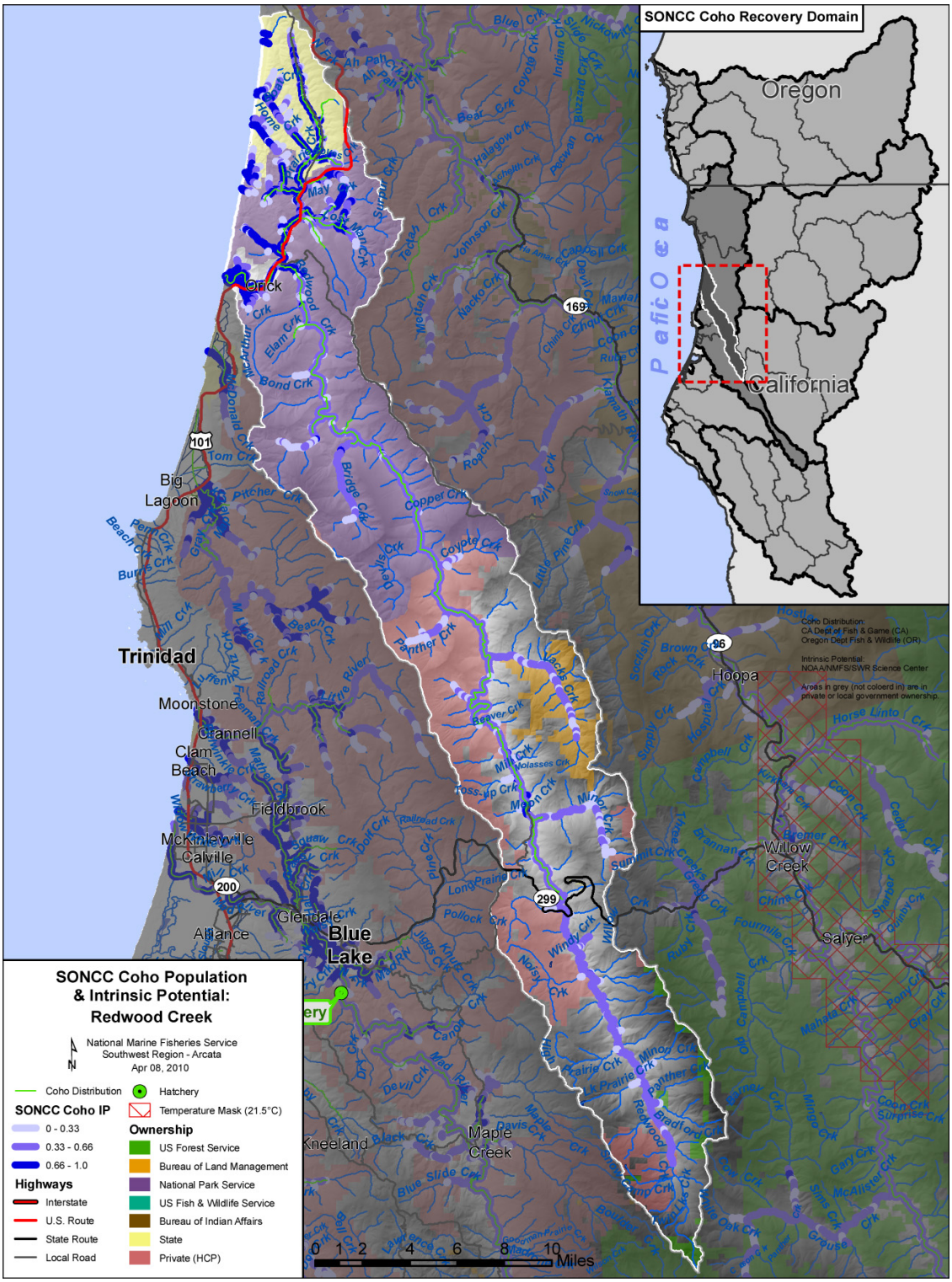

Figure 19-1. The geographic boundaries of the Redwood Creek coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 1006), land ownership, coho salmon distribution (CDFG 1009a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Northern Coastal diversity stratum (Williams et al. 1006). Grey areas indicate private ownership.

These land uses have resulted in warm, shallow and wide instream habitat conditions that have severely impacted coho salmon and their habitat (Cannata et al. 2006). Most of the basin is now comprised of forest stands of smaller diameter trees, with a greater percentage of hardwoods that provide different ecological functions than those found historically. Fortunately, some remaining late seral conifer stands are found within RNSP, particularly within the lower mainstem corridor of Redwood Creek and the Prairie Creek watershed.

The construction of flood control levees along the most downstream 3.4 miles of Redwood Creek has resulted in loss of estuarine area and habitat value (Cannata et al. 2006). In addition, gravel and riparian vegetation continue to be removed to maintain flood conveyance capacity.

Figure 19-2. Aerial photograph of the Redwood Creek estuary, before levees. This photo, taken in September 1948, prior to the construction of the levees, shows the size of the estuary and amount of riparian vegetation. Note that this photo is not prior to other land use impacts, such as logging. Photo from Klamath River Information System (KRIS).

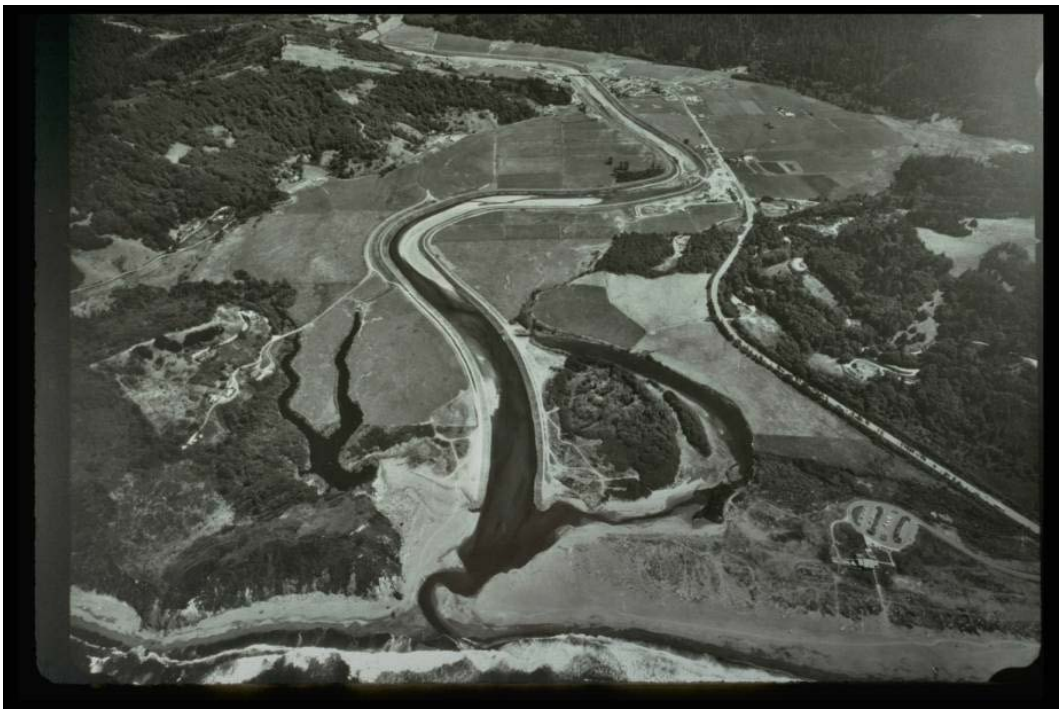

Figure 19-3. Aerial photograph of the Redwood Creek estuary, with levees. Photo shows the levees and continued gravel and vegetation removal for channel maintenance; note the much-reduced estuary size and reduction in habitat complexity. Redwood Creek estuary in 1988 from KRIS.

19.2 Historic Fish Distribution and Abundance

Aside from the data described in the assessment of population viaility detailed further in this section and the IP data shown in Table 19-1, there is limited data that describe the historical coho salmon population in Redwood Creek. Potential coho salmon habitat is distributed throughout the basin. The IP data show the highest values (IP > 0.66) in Prairie Creek and its tributaries, including Lost Man Creek, and in the most downstream 4 miles of mainstem Redwood Creek, including Strawberry Creek and Sand Cache Creek. The Prairie Creek watershed is almost all park lands managed by RNSP. The downstream 4 miles of Redwood Creek is mostly private land. Table 19-1 shows the areas with high IP. In addition, it is notable that almost the entire length of mainstem Redwood Creek is modeled as having moderate IP (IP between 0.33 and 0.66).

Table 19-1. Tributaries with instances of high IP reaches (IP > 0.66) (Williams et al. 2006).

Stream Name	Stream Name	Stream Name
Prairie Creek	Lower Mainstem Redwood Creek.	Strawberry Creek
Lost Man Creek	Skunk Cabbage Creek	Sand Cache Creek
Little Lost Man Creek	Tom McDonald Creek	May Creek
Streelow Creek	Bridge Creek	All of the unnamed tributaries to Prairie Creek
Middle Mainstem Redwood Creek, near Toss-up Creek	McArthur Creek	

Coho salmon have been detected in lower mainstem Redwood Creek, as well as Prairie, Lost Man, Little Lost Man, Streelow, Strawberry, Lacks, Elam, Tom McDonald, Emerald (a.k.a. Harry Weir), McArthur, and Bridge creeks. The historic range includes Coyote, Panther, Minor, Karen and Pilchuck creeks in the Beaver Creek HSA, as well as Sand Cache Creek, tributary to the estuary. Various investigators have found that coho salmon may also use some of the tributaries in the Lake Prairie HSA [Anderson 1988, Brown 1988, Neillands 1990; Pacific Coast Fish, Wildlife and Wetlands Restoration Association (PCFWWRA) 1995, California Department of Fish and Game (CDFG) 2001 surveys, and RNSP unpublished data]. RNSP (2001) described historic presence of coho salmon juveniles and spawning adults in middle and upper mainstem Redwood Creek, including upstream of Highway 299.

Historic estimates of coho salmon abundance in Redwood Creek are scarce. In 1965, CDFG estimated an average run size of 5,000 Chinook salmon, 2,000 coho salmon and 10,000 winter steelhead (CDFG 1965 *in* Good et al. 2005) for the entire Redwood Creek basin. The CDFG report (1965) did not include a time period for the estimates of run size. Hallock et al. (1952) seined 9,610 juvenile coho salmon from Prairie Creek and its tributaries in 1951; however, this information does not include seining information from mainstem Redwood Creek and its other tributaries.

19.3 Status of Redwood Creek Coho Salmon

Spatial Structure and Diversity

Currently, except for Prairie Creek, coho salmon have limited distribution in the Redwood Creek basin, most likely due to habitat degradation and high water temperatures in mainstem Redwood Creek (Madej et al. 2006). Although much of the basin is accessible to adult and juvenile coho salmon, high summer water temperatures in the middle portion of mainstem Redwood Creek are believed to limit most of the current juvenile distribution to lower Redwood Creek and its tributaries, and to the Prairie Creek sub-watershed, where summer water temperatures are cooler than in the middle and upper portions of mainstem Redwood Creek (Madej et al. 2006). High summer water temperatures are likely to continue until streamside conifers mature and provide shade that help to regulate summer water temperatures, and until the mainstem channel condition improves and channel complexity increases so that deep pools could be used as thermal refugia for coho salmon.

During the summer of 2003, RNSP conducted a juvenile coho salmon presence-absence snorkel survey of the lower half of mainstem Redwood Creek. During this survey, no coho salmon were observed in the main channel above river mile 13. A small number of juvenile coho salmon were observed in 9 locations in the section of Redwood Creek between river mile 4.8 and river mile 13 (Ozaki and Anderson 2005).

Additional distribution information is available from Sparkman (2008a, 2008b) who trapped 6 age 0+ coho salmon in mainstem Redwood Creek at river mile 33 in 2007. In addition, Sparkman (2010) trapped 32 age 0+ coho salmon and 7 age 1+ coho salmon at river mile 33 in 2008; the first year in 9 consecutive years of outmigrant trapping in which age 1+ coho salmon were caught in the middle portion of mainstem Redwood Creek. Research is currently ongoing in the Redwood Creek basin to investigate adult abundance and distribution of salmonids, using redds as the population metric. Based on preliminary investigations and professional judgment, coho salmon juveniles and adults are currently present in McArthur, Elam and Bridge creeks, all tributaries to lower to middle mainstem Redwood Creek (Ricker 2011). Bridge Creek in particular likely contains high quality coho salmon spawning habitat, although the quantity and quality of winter rearing habitat appears limited. Available information suggests limited distribution, particularly in the middle to upper portions of mainstem Redwood, indicating that that the current spatial structure is impaired compared to historic conditions.

Williams et al. (2008) determined that at least 32 coho salmon per-IP km of habitat are needed (4,900 spawners total) to approximate the historical distribution of Redwood Creek coho salmon and habitat. Although the estimate of historical adult abundance from Williams et al. (2008) includes Redwood Creek and Prairie Creek, the current distribution of spawning adults appears mostly limited to the Prairie Creek sub-watershed. In addition, recent juvenile outmigrant data from Sparkman (2008a, 2008b) suggests that few adult coho salmon are returning to mainstem Redwood Creek each year to spawn.

Regarding life history diversity traits, Redwood Creek is one of the few places in California with documented variation in the period of freshwater juvenile coho salmon rearing. Coho salmon have been generally thought to rear for one year in northern California streams; a two-year rearing period had only been observed farther north (Bell and Duffy 2007). However, Bell and Duffy (2007) observed that 28 percent of outmigrants from Prairie Creek reared in freshwater for two years. This variation in the length of the freshwater rearing period could be critical to coho salmon persistence in Redwood Creek, because it bolsters the population's resilience to environmental disturbance. The more diverse life history traits are expressed (or the more these traits are not restricted), the more diverse a population is, and the more likely that individuals, and therefore the species, would survive and reproduce in the face of environmental variation (McElhany et al. 2000). Bell and Duffy (2007) also found that the size of age 2 smolts from Prairie Creek was not as large as age 1 smolts from other healthy systems (Shapovalov and Taft 1954 *in* Bell and Duffy 2007), indicating that age 2 smolts from Prairie Creek would not mature precociously and return as jacks at any higher rate than age 1 smolts from Prairie Creek.

Population Size and Productivity

Williams et al. (2008) determined at least 151 coho salmon must spawn in the Redwood Creek basin each year to avoid effects of extremely low population size.

The CDFG has trapped outmigrants in mainstem Redwood Creek to provide information on the current viability of salmonid populations in the basin. Sparkman (2011a) has conducted outmigrant trapping in middle Redwood Creek since 2000, with the trap located at river mile 33 (known as the "upper trap"). Since 2004, Sparkman (2011b) has also conducted outmigrant trapping at river mile 4 (known as the "lower trap"), just upstream of where Prairie Creek enters mainstem Redwood Creek. From 2000 to 2006, Sparkman (2007) did not capture any out-migrating coho salmon at the upper trap, suggesting that coho salmon spawning in mainstem Redwood Creek and tributaries upstream of Prairie Creek may have had limited success for about 7 years. However, 6 age 0+ juveniles were captured at the upper trap in 2007 (Sparkman 2008a, 2008b), and 32 age 0+ and 7 age 1+ juveniles were caught at the upper trap in 2008 (Sparkman 2011b).

Low numbers of juvenile coho salmon have been captured at the lower trap during all of the study years. For example, in 2003, 110 age 0+ and 12 age-1+ were captured at the lower trap, in 2004, 202 age 0+ and 69 age-1+ juvenile coho salmon were captured at the lower trap (Sparkman 2004), and in 2010, 6 age 0+ coho salmon and 13 age 1+ coho salmon were captured at the lower trap (Sparkman 2011b). During 2011, Sparkman captured 226 age 0+ coho salmon and 24 age 1+ coho salmon at the lower trap and no coho salmon at the upper trap. Sparkman estimated juvenile population abundances for mainstem Redwood Creek (not including Prairie Creek) of 884 age 0+ coho salmon and 113 age 1+ coho salmon (Sparkman 2011c).

Sparkman (2011c) also began trapping out-migrants from Prairie Creek during 2011 and captured 198 age 0+ coho salmon and 2,449 age 1+ coho salmon at the Prairie Creek trap located at the mouth of Prairie Creek, just upstream from its confluence with Redwood Creek. For 2011, Sparkman estimated juvenile population abundances for Prairie Creek of 726 age 0+ coho salmon and 8,446 age 1+ coho salmon.

Additionally, Duffy (2011) has monitored juvenile and adult coho salmon populations and estimated juvenile and adult abundance in the Prairie Creek sub-watershed since 1998. Duffy (2011) estimated juvenile abundance using a modified Hankin and Reeves (1988) approach as summarized in Table 19-2.

Using walking surveys to enumerate live fish, redd surveys and carcass mark-recapture studies, Duffy (2011) has also estimated escapement of adult coho salmon to Prairie Creek from 1999 to 2010. These estimates indicate mostly low to occasionally moderate numbers of returning adult coho salmon (Duffy 2011). Numbers of live fish ranged from 680 in 2001-2002 to 28 in 2009-2010 (Table 19-3; Duffy 2011) for the Prairie Creek sub-watershed. Other tributaries to mainstem Redwood Creek contain adult coho salmon (Ricker 2011) but at unknown abundance levels. Williams et al. (2008) estimated that the historic annual spawner abundance for the entire Redwood Creek population unit was about 4,900. All of the available information suggests that the overall number of coho salmon in the Redwood Creek basin is low compared to modeled historic abundance.

Table 19-2. Estimated abundance of juvenile coho salmon in the Prairie Creek sub-watershed of Redwood Creek during 1998-2010 (Duffy 2011).

	Pools	Runs	Riffles	Total

Year	Month	Avg	95% CI	Avg	95% CI	Avg	95% CI	Avg	95% CI
1998	Oct	5080	75	1047	11	0	0	6127	67
1999	Aug	4256	63	1645	23	1229	240	7130	303
1999	Oct	5123	949	1703	27	537	95	7363	850
2000	Aug	2741	138	1733	17	20	0	4494	109
2000	Oct	2622	432	1443	21	22	0	4086	324
2001	Aug	1875	56	728	4	14	0	2617	40
2001	Oct	1588	83	805	8	0	0	2393	62
2002	Aug	4243	886	2919	17	1025	50	8187	657
2002	Oct	4500	2519	2764	32	465	63	7729	1826
2003	Aug	4481	435	2484	24	1699	801	8664	1126
2003	Oct	3709	81	2722	24	686	70	7117	144
2004	Aug	3134	260	1972	24	261	12	5367	231
2005	Aug	1460	93	1391	39	303	30	3154	122
2006	Aug	3870	84	2176	675	701	27	6747	578
2007	Aug	2950	77	1627	72	64	2	4641	107
2008	Aug	3276	217	1698	117	61	1	5035	242
2009	Aug	2465	80	1011	15	565	79	4041	148
2010	Aug	3102	112	1466	17	549	60	5117	153

Table 19-3. Escapement of adult coho salmon to the Prairie Creek sub-watershed during 1999-2011. Estimates are derived from AUC analysis of live fish observations. Year listed is the latter portion of the spawning season (e.g. 1999 = 1998/1999) (Duffy 2011).

	Coho Salmon Estimated Adult Abundance	
Year	n	95% CI
1999	56	3.4
2000	84	6.7
2001	212	6.0
2002	680	19.4
2003	542	46.1
2004	268	12.4
2005	643	40.6
2006	349	27.6
2007	165	8.5
2008	466	44.5
2009	127	25.8
2010	28	4.1
2011	218	22.0

Monitoring data and population estimates from Sparkman (2008a, 2008b, 2011a, 2011b, 2011c) and Duffy (2010, 2011) show a negative population trend, as do the apparent long-term declines of coho salmon observed in Redwood Creek. Therefore, the Redwood Creek coho salmon

population is at high risk of extinction given its small population size and likely negative trends in numbers of juveniles and adults.

Extinction Risk

The Redwood Creek coho salmon population is not viable and at high risk of extinction because the estimated average number of spawners has been below the depensation threshold (151 spawners) for the past three years (Table ES-1 in Williams et al. 2008).

3.4 Role in SONCC Coho Salmon ESU Viability

The Redwood Creek population is considered a functionally independent population within the Central Coastal diversity stratum, meaning that it was sufficiently large to be historically viable-in-isolation and has demographics and extinction risk that were minimally influenced by immigrants from adjacent populations (Bjorkstedt et al. 2005, Williams et al. 2006). In addition, the Redwood Creek coho salmon population is considered a core population. As a core population, the recovery target is for this population to be viable and to have a low risk of extinction according to population viability criteria (Chapter 4).

19.4 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.

Redwood Creek Total Maximum Daily Load (TMDL)
http://www.swrcb.ca.gov/northcoast/

NCRWQCB identified Redwood Creek as water quality limited due to its high sediment loads, and designated the basin as a high priority for Total Maximum Daily Load (TMDL) development in accordance with Section 303(d) of the Clean Water Act. The Environmental Protection Agency and the NCRWQCB worked together to complete the sediment TMDL in 1998.

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

The NCWAPs Redwood Creek Basin Assessment (Cannata et al. 2006) identified limiting factors for anadromous salmonids including:

- Large reduction in area and habitat quality of the estuary/lagoon;
- Excessive sediment in stream channels, and excessive sediment delivery;
- Lack of large conifer contributions and lack of LWD in stream channels;
- High summer water temperatures
- General lack of structural components to create habitat diversity

Redwood Creek Watershed Group

The Redwood Creek Integrated Watershed Strategy
http://co.humboldt.ca.us/planning/Prop 50/01_RWC_IWS%20Final.pdf

The watershed strategy integrates natural resource considerations with infrastructure needs at the basin scale. The strategy identified restoration of Strawberry Creek, wastewater treatment planning for the community of Orick and sediment source reductions as priority projects.

Redwood National and State Parks

Watershed Rehabilitation Plan (1981)

Management Alternatives of the Redwood Creek Estuary (1983)

Redwood National and State Parks, Humboldt and Del Norte Counties: Final General Management Plan/General Plan, environmental impact statement/environmental impact report - USDI National Park Service and California Department of Parks and Recreation (1999)

Road Strategy: Access and Treatment Priorities for Parkland in the Redwood Creek Watershed (2005)

Planning and strategy documents from RNSP focus on ecosystem restoration, especially road removal and forest restoration efforts. Between 1978 and 2010 RNSP removed 266 miles of roads from Park lands, with 114 miles of road remaining to be treated.

Bureau of Land Management, Arcata Field Office

Lacks Creek Management Area Management Plan

The plan identifies road upgrading and decommissioning opportunities within the Lacks Creek sub-watershed.

Green Diamond Resource Company (GDRC)

Green Diamond Habitat Conservation Plan

Approximately 25 percent of private land in the middle to upper portions of Redwood Creek basin is owned by the Green Diamond Resource Company, and managed according to the provisions of their HCP. The plan contains a number of provisions, such as upgrading roads with a high to moderate risk of sediment delivery to stream channels, to reduce impacts on coho salmon and salmon habitat in the Redwood Creek basin.

19.5 Stresses

Table 19-4. Severity of stresses affecting each life stage of coho salmon in Redwood Creek. 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)[2]		Egg	Fry	Juvenile[1]	Smolt	Adult	Overall Stress Rank
1	Lack of Floodplain and Channel Structure[1]	Very High	Very High	Very High[1]	Very High[1]	Very High	Very High
2	Impaired Water Quality[1]	High	Very High	Very High[1]	Very High[1]	High	Very High
3	Impaired Estuary/Mainstem Function[1]	-	Medium	Very High[1]	Very High[1]	High	Very High
4	Degraded Riparian Forest Conditions	-	High	High	High	Medium	High
5	Altered Sediment Supply	Very High	High	Medium	Medium	Medium	High
6	Altered Hydrologic Function	Medium	Medium	Medium	Low	-	Medium
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

[1] Key limiting factor(s) and limited life stage(s).
[2] Increased Disease/Predation/Competition is not considered a stress for this population.

Limiting Stresses, Life Stages, and Habitat

Lack of floodplain and channel structure, impaired estuarine function and impaired water quality are all stressors that limit juvenile rearing success of the Redwood Creek coho salmon population. Except for the valuable habitat that the relatively undisturbed Prairie Creek sub-watershed provides, the majority of summer and winter rearing habitat within the basin is in a currently degraded state. Many of the important, high IP tributaries have legacy logging effects, such as large quantities of sediment deposited within stream channels, lack of channel structure and lack of well-distributed large wood, which adversely affect both summer and winter rearing conditions. In mainstem Redwood Creek, high summer water temperatures, increased sediment supply, lack of channel structure, and a lower river and estuary that is disconnected from off-channel floodplain habitat also combine to adversely affect summer and winter rearing habitat. Based on the type and extent of stressors and threats affecting the population as well as the limiting factors influencing productivity, the juvenile and smolt life stages are likely most limited and quality summer and winter rearing habitat is likely lacking for the population. Cannata et al. (2006) identified Prairie Creek and its tributaries as refugia based on current habitat conditions.

Lack of Floodplain and Channel Structure

Lack of floodplain and channel structure is a very high stress across all life stages. In general, the Prairie Creek sub-watershed contains the best habitat conditions, while the mainstem Redwood Creek and its other tributaries contain the poorest habitat conditions. The mainstem channel is aggraded, and pool frequency and depth are ranked as poor throughout the mainstem (Cannata et al. 2006). Data on instream wood is limited; however given the poor riparian canopy conditions that exist throughout the mainstem, and based on discussions with RNSP, a lack of instream wood structure is limiting the development of complex habitat throughout much of the basin. The most downstream 3.4 miles of Redwood Creek is disconnected from its floodplain and confined to a channel width of 250 feet by flood control levees, resulting in a lower river channel and estuary that is disconnected from sloughs, wetlands and other low gradient tributaries that once provided important over-wintering rearing habitat. In addition, the lower river channel contains few pools and riffles and generally lacks complexity and structure that is important for rearing juvenile coho salmon.

Impaired Water Quality

Impaired water quality is a very high stress for the fry, juvenile and smolt life stages and a high stress for adults. High water temperature in the summer and early fall months stress rearing coho salmon. Redwood Creek is listed as temperature impaired under section 303d of the Clean Water Act. High water temperature in mainstem Redwood Creek, including the estuary, is one of the factors limiting coho salmon production in the basin (Sparkman 2006; Cannata et al. 2006). Madej et al. (2006) demonstrated that high summer water temperatures in mainstem Redwood Creek currently limits juvenile coho salmon distribution in the basin and hypothesized that this restriction did not exist historically. Sparkman (2006) has shown that in some years summer water temperatures are in the lethal range for juvenile coho salmon in the middle section of mainstem Redwood Creek.

Madej et al. (2006) reports that the greatest thermal complexity occurs in lower Redwood Creek upstream of the leveed reach. In this reach, Madej et al. (2006) measured with thermal infrared imaging many cool springs, seeps, side channels and tributaries, and where the water temperatures are influenced by the cooler coastal climate. During the 2003 presence-absence juvenile coho salmon survey (Ozaki and Anderson 2005), 7 of the 9 locations where coho salmon were observed were side pool locations (no coho salmon juveniles were observed upstream of river mile 13). Side pools were separated from the main channel by a gravel bar, but open to Redwood Creek on the downstream end. Many of the pools were influenced by cool seeps and springs, intragravel water flow, groundwater or small tributaries. These pool features were generally cooler than the mainstem of Redwood Creek (Madej et al. 2006).

Impaired Estuarine Functions

Prior to the construction of 3.4 miles of flood control levees in 1968, the Redwood Creek estuary was characterized by its size, depth, and complexity, with a connected north slough channel and estuarine tributaries. The flood control levees cut-off the last meander of Redwood Creek, now known as the south slough, and its tributary, Strawberry Creek. Currently, the estuary covers approximately half of its historic area (Janda et al. 1975). The levees bisect and terminate in the

estuary and the estuary is disconnected from much of its historic off-channel rearing habitat. Water quality, water circulation, riparian vegetation, and pool and riffle habitat have all been greatly reduced (Anderson 1995; Cannata et al. 2006). Since the levees created a smaller estuary than what was historically present with less area for coastal processes such as waves and tides to sustain an open estuary the timing of the closing of the mouth has also changed resulting in a closed lagoon for a longer period of time, which aggravates poor water quality conditions, and can affect juvenile fish passage in the summer and adult fish passage in the fall. The reduction in function of the estuarine system and lower river habitat, which once provided connected sloughs and tributaries for off-channel non-natal rearing, is a limiting factor to salmonid production in the basin. Reconfiguration of the levees (i.e., combination of levee setback and/or removal) to restore estuarine and lower river function is critical to recovery of the Redwood Creek coho salmon population (CDFG 2004b).

Degraded Riparian Forest Conditions

Degraded riparian forest conditions exist across the basin, and present a high stress to the fry, juvenile, and smolt life stages. Data from RNSP (2006) and the Green Diamond Aquatic Habitat Conservation Plan (GDRC 2006) show that streamside canopy cover conditions vary, with some good to very good conditions (70 percent to 100 percent shade) in tributaries, and poor cover and shade conditions in the mainstem channel of Redwood Creek. However, even where streamside canopy cover is in good condition, many of the riparian areas currently consist of open hardwood, and second-growth dominated forests. Hardwood and small conifer dominated riparian forests provide smaller or short-term large wood recruitment into Redwood Creek compared to historic conditions of large wood supply to the channel from once prevalent old-growth redwood forests. However, while hardwood dominated riparian forests may not contribute as valuable large wood recruitment to stream channels, hardwood riparian forests provide allochthonous contributions, a valuable source of food for salmonids. Hardwood and second growth conifers also provide shade to the stream channel.

Altered Sediment Supply

Altered sediment supply constitutes a medium to very high stress across all life stages. Increased sediment delivery has aggraded and widened channels, filled pools and has simplified stream habitat throughout the basin, particularly within mainstem Redwood Creek and its low gradient tributaries. Many tributary mouths have accumulations of sediment that limit access for juveniles and adults (Anderson and Brown 1982). Data from the Prairie Creek watershed suggests that sediment supply may be less of an issue there; for example, measurements suggest that some pools have less fine sediment accumulation than pools in other parts of the basin. However, most data collected on the sediment regime (e.g., high embeddedness) indicate that both stored sediment within the channels, and continued sediment delivery, are critical stresses affecting the population.

High turbidity levels in Redwood Creek are believed to occur more frequently and persist longer than historically (Cannata et al. 2006). RNSP has been measuring turbidity levels in Lost Man Creek at numerous locations since 2002, and has found elevated turbidity from legacy road and stream crossing sediment sources and from first and second year adjustments of recently implemented road removal projects (Klein et al. 2006). Effects to coho salmon from elevated

turbidity include an impaired ability to find food, gill abrasion, food assemblage changes, smothering of eggs and filling of pools with fine sediment.

Altered Hydrologic Function

Altered hydrologic function is a low stress for smolts, and a medium stress for egg, fry and juvenile life stages. Low summer stream flows are problematic where increased stored sediment has aggraded the channel, contributed to subsurface flows, and reduced the amount of available rearing habitat. Reduced hydrologic function (i.e., poor water circulation, changes in the timing of the mouth closing off, low dissolved oxygen) due to the flood control levees also contributes to a significant reduction in available rearing habitat in the lower most 3.4 miles of Redwood Creek. Low fall stream flows can impede adult migrations and low summer stream flows may be aggravated by unauthorized water diversions, affecting the availability of summer rearing habitat. Another factor in hydrologic function may be the conversion of extensive areas from conifer-dominated to dense hardwood forests (e.g., tan oak). This vegetation change may have influences on summer low flows; however, we are unaware of any studies examining this in Redwood Creek.

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

Physical road and stream crossing barriers are a low stressor for all life stages except eggs, which do not require access to other portions of the stream network. Barriers created by excess sediment accumulations at tributary mouths are discussed under the sediment stress above. RNSP has documented road-related barriers or partial barriers within the park, and is in the process of upgrading or removing these culverts and replacing them with bridges, such as the recently completed opening of access in Streelow Creek and the North Fork of Lost Man Creek. The levees also act as barriers, the south levee allows only partial access to Strawberry Creek and the north levee aggravates sand accumulation at the mouth of the north slough, impeding passage into the slough and Sand Cache Creek (Anderson 1995). Invasive reed canary grass also hampers access in Strawberry and Sand Cache Creeks by choking the stream channel with non-native vegetation. Reed canary grass is currently being removed from Strawberry Creek and native riparian vegetation is being planted that will eventually provide shaded conditions that hamper reed canary grass re-growth. In addition, unnaturally large log jams caused by historic logging practices in tributaries such as Bridge and Little Lost Man creeks impede coho salmon passage (RNSP 2006; Ricker 2011).

Adverse Hatchery Related Effects

The effects of hatchery fish on all life stages of coho salmon are described in Chapter 3. The Prairie Creek Fish Hatchery produced coho salmon that were stocked into Redwood Creek until 1992. The genetic effect of this hatchery on coho salmon produced in Redwood Creek is

unknown. No hatchery fish are currently stocked into Redwood Creek. 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 and there are no hatcheries in the basin (Appendix B).

19.6 Threats

Table 19-5. Severity of threats affecting each life stage of coho salmon in the Redwood Creek. 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	Channelization/Diking	High	Very High	Very High	Very High	High	Very High
3	Timber Harvest	High	High	High	High	High	High
4	Mining/Gravel Extraction	-	High	High	High	Medium	High
5	Agricultural Practices	Medium	Medium	Medium	Medium	Medium	Medium
6	Dams/Diversion	Medium	Medium	Medium	Medium	Medium	Medium
7	High Intensity Fire	Medium	Medium	Medium	Medium	Medium	Medium
8	Invasive Non-Native/Alien species	Medium	Medium	Medium	Medium	-	Medium
9	Urban/Residential/Industrial	Medium	Medium	Medium	Medium	Medium	Medium
10	Climate Change	Low	Low	Medium	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 are a very high threat across all life stages. Information found in Cederholm et al. (1981) suggests that fine sediment availability increases in basins with more than three miles of road per square mile of area. As of 2006, Cannata et al. found that the Redwood Creek basin has an average of approximately 4.8 miles of road per square mile of area. Cannata et al. (2006) also found that the road density drops to 2.15 miles of road per square mile of area within the Prairie Creek and lower river sub-basins, and that private lands in the middle and upper portions of the Redwood Creek basin average over 8 miles of road per square mile of area. Although many of the roads in the middle and upper portion of the basin were built prior to current road

construction standards, there is an active road improvement program in this area with the goal of reducing fine sediment delivery to stream channels. Even with active road removal and upgrade efforts, roads are a significant source of both chronic and catastrophic fine sediment input to streams, affecting the quality and quantity of available coho salmon habitat in Redwood Creek and its tributaries. The high road density in Redwood Creek has likely also resulted in an increase in the frequency of road-related landslides in the basin. Roads can also affect fish passage where road-stream intersections have not been adequately designed to allow fish passage.

Channelization/Diking

Channelization and diking is a very high threat overall and a very high threat to fry, juvenile and smolt life stages. As previously discussed, the flood control levees and associated channel maintenance activities significantly reduce available habitat in the estuary and lower portion of Redwood Creek. Ecosystem function within the flood control reach will continue to be impaired by the levees and channel maintenance activities until the levees are reconfigured.

Timber Harvest

Timber harvest is a high threat to the coho salmon population in Redwood Creek. Many of the changes in instream and riparian conditions in Redwood Creek are a result of intensive timber harvest in previous decades. Although current timber harvest practices are more protective of coho salmon habitat than previous practices, timber harvest continues to threaten coho salmon in Redwood Creek by increasing sediment yield and by reducing streamside shading and potential large wood recruitment. Approximately half of the basin is in private ownership as industrial timber land, and timber harvest continues in the middle and upper portions of Redwood Creek.

Mining/Gravel Extraction

Instream gravel extraction is a high threat to fry, juvenile and smolt life stages, and a medium threat to adult coho salmon. Gravel extraction is not a threat to eggs because gravel extraction does not occur in coho salmon spawning habitat in Redwood Creek. Gravel extraction occurred sporadically between 1968 and 2000, and annually between 2004 and 2010 within the flood control reach of the most downstream 3.4 miles of Redwood Creek. Most gravel extraction occurred as part of Humboldt County's channel conveyance maintenance program required by the Army Corps of Engineers' (Corps) Operations and Maintenance Manual for the flood control levees. Some commercial gravel extraction also occurred prior to 2000 within this reach.

The gravel extraction that occurs as channel maintenance is permitted by the Corps and the permit contains numerous measures to reduce the effects on fish habitat, such as a head-of-bar buffer to provide for channel steering around skimmed gravel bars, and a 2-foot vertical offset from summer low flow water surface elevations to provide low to moderate channel confinement. However, even with minimization measures, gravel extraction reduces overall habitat complexity and reduces the quality and quantity of available pool and velocity refuge habitat. Given the sensitivity of the channel to disturbance (i.e., current lack of floodplain and channel structure), and the potential use of the gravel extraction reach by coho salmon juveniles for summer rearing (e.g., if habitat is restored in this reach) due to relatively cooler summer

water temperatures than upstream, gravel extraction is a significant threat to rearing juveniles and a moderate threat to adults who require resting habitat in pools during upstream migration.

Agricultural Practices

Grazing occurs in the lowest reaches of Redwood Creek as well as in the middle and upper portions of the basin and may contribute to increased sediment generation and delivery and decreased riparian vegetation. However, specific information on the magnitude of the threat is limited. Water withdrawals for agricultural uses are discussed in the "Dam/Diversions" section, and the effects of the channelization and dikes, which were installed in the lower reaches of Redwood Creek partly to control flooding on agricultural land, are considered in the "Channelization/diking" section of this profile.

Dams/Diversions

Dams and diversions are of medium threat to the Redwood Creek coho salmon population. Water withdrawals (authorized and unauthorized) for domestic and agriculture use occur in the Orick area, in Redwood Valley and in the upper basin. The water withdrawals affect stream flow quantity in the summer, affecting the availability of summer rearing habitat. From the 1950s through 2002 summer dams were constructed in the Redwood Valley area, but these dams have been denied permits by CDFG since 2003 and summer dams are not a current threat to passage. However, there may be legacy effects from summer dam construction in the form of fine sediment deposition in stream gravels and reduced invertebrate production at the previous dam sites.

High Intensity Fire

The vegetation characteristics throughout the basin present a moderate threat for high intensity fires that could alter the sediment delivery regime as well as riparian vegetation characteristics. Most of the basin contains forests of small diameter trees that are close together. These types of previously logged forests burn with greater intensity than late seral forest stands, and high intensity forest fires create an erosion hazard. The increased sediment yield from high intensity fires would likely deliver sediment to coho salmon habitat in the basin, filling pools and reducing habitat complexity. Conversion of extensive conifer-dominated forests to dense hardwood stands has also likely increased fire risk. However, the Prairie Creek sub-watershed that offers the best habitat available for coho salmon within the basin contains predominately old growth redwood trees that burn with a lower intensity than the second growth found throughout much of the rest of the basin.

Invasive Non-Native/Alien Species

New Zealand mud snails (NZMS) were discovered within lower Redwood Creek in late 2009. This invasive non-native species has very high secondary production (Hall et al. 2006) may out-compete native invertebrates, and provides little food value for juvenile salmonids (Vinson et al. 2007). In addition, Strawberry and Sand Cache creeks, low gradient tributaries to the estuary, contain reed canary grass that is choking the channel, outcompeting native riparian vegetation and adversely affecting water quality, passage and access for coho salmon (Love 2008).

Urban/Residential/Industrial Development

Rural population growth will continue to present a medium threat to coho salmon in Redwood Creek. Such growth can result in removal of vegetation, increased sediment generation and delivery, introduction of exotic species, water withdrawals from stream channels and inadequate septic facilities and pesticide use that affect water quality. Some of the rural growth is in the middle to upper basin, and much of the rural growth is in the Orick area, with some of the growth planned for the floodplain in the flood control levee reach of lower Redwood Creek.

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 and adults. The current climate is generally cool near the coast and moderately hot inland. 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 up to 1°C in the winter. Annual precipitation in this area is predicted to change little over the next century. The vulnerability of the estuary and coast to sea level rise is moderate in this population. Juvenile and smolt rearing and migratory habitat is most at risk to climate change. Increasing temperatures and changes in the amount and timing of precipitation will affect water quality and hydrologic function in the summer and winter. Rising sea level will affect the quality and extent of estuarine rearing habitat for juveniles and smolts. Overall, the range and degree of variability in temperature and precipitation is likely to increase in all populations. Also, as 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, Portner and Knust 2007, Feely et al. 2008).

Fishing and Collecting

California-managed fisheries for species other than coho salmon occur in estuaries, freshwater, and near shore marine areas. The effects of these fisheries on the continued existence of the SONCC coho salmon ESU have not been formally evaluated by NMFS.

Hatcheries

Hatcheries pose a low threat to all life stages of coho salmon in the Redwood Creek population area. The rationale for these ratings is described under the “Adverse Hatchery-Related Effects” stress

Road-Stream Crossing Barriers

Road-stream crossing barriers are a low threat to the population. Most of the existing road-stream crossing barriers occur in high gradient tributaries upstream of coho salmon habitat.

19.7 Recovery Strategy

Coho salmon in the Redwood Creek basin are severely depressed in abundance, and restricted in spatial distribution. Recovery activities in the basin should promote increased spatial

distribution, particularly in the mainstem of Redwood Creek and tributaries such as Bridge Creek, as well as increased productivity and abundance. Efforts to increase distribution will also likely yield increases in diversity, abundance and productivity. Secondly, preservation of observed life history diversity (i.e., two years of freshwater rearing) should be encouraged.

Activities should occur basin-wide, with a focus on Prairie Creek and its tributaries, and lower mainstem Redwood Creek and its tributaries. Top priorities in the basin include restoring estuarine function and lower river connectivity to sloughs, wetlands, tributaries and floodplain habitat through levee reconfiguration, reducing summer stream temperatures in mainstem Redwood Creek by the addition of channel complexity features that will promote pool development and thermal refuge (such as large wood), and reducing sediment sources that have a high risk of delivering sediment to stream channels.

Other important actions include restoring wetlands, low gradient channels, off-channel habitat, sloughs and tributaries in lower Redwood Creek, including Strawberry Creek, and the north slough channel (Sand Cache Creek), reducing gravel and vegetation removal associated with levee maintenance and minimizing timber harvest impacts on riparian corridors to promote large wood delivery to stream channels.

Table 19-6 on the following page lists the recovery actions for the Redwood Creek population.

Table 19-6. Recovery action implementation schedule for the Redwood Creek population.

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	***Step Description***					
SONCC-RedC.1.2.5	Estuary	Yes	Improve estuarine habitat	Remove, set back, or reconfigure levees or dikes	2.8 miles total levee length (1.4 mile each side of Redwood Creek from mouth upstream)	2
SONCC-RedC.1.2.5.1	*Purchase land or conservation easements to facilitate levee reconfiguration.*					
SONCC-RedC.1.2.5.2	*Develop a plan to reconfigure the levees and restore the natural stream channel.*					
SONCC-RedC.1.2.5.3	*Reconfigure the downstream most section of the levees to restore the historic form and function of the estuary*					
SONCC-RedC.1.2.32	Estuary	Yes	Improve estuarine habitat	Assess estuary and tidal wetland habitat	Estuary	3
SONCC-RedC.1.2.32.1	*Identify parameters to assess condition of estuary and tidal wetland habitat*					
SONCC-RedC.1.2.32.2	*Determine amount of estuary and tidal wetland habitat needed for population recovery*					
SONCC-RedC.2.2.1	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Remove, set back, or reconfigure levees or dikes	4 miles total levee length (2 mile each side Redwood Creek from Hwy 101 Bridge upstream)	2
SONCC-RedC.2.2.1.1	*Develop a plan to reconfigure the levees and restore the natural stream channel. Assess habitat and develop a plan to increase complexity with LWD and enhance riparian vegetation in conjunction with levee reconfiguration*					
SONCC-RedC.2.2.1.2	*Reconfigure the upstream portions of the levees.*					
SONCC-RedC.2.2.2	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Enhance non natal rearing sites	3.6 miles of lower Redwood Creek	3
SONCC-RedC.2.2.2.1	*After or during levee reconfiguration, add LWD, boulders, or other instream structure to increase habitat complexity and improve pool frequency and depth*					
SONCC-RedC.2.2.2.2	*Plant native riparian vegetation*					
SONCC-RedC.2.1.3	Floodplain and Channel Structure	Yes	Increase channel complexity	Improve regulatory mechanisms	3.6 miles of lower Redwood Creek	3
SONCC-RedC.2.1.3.1	*Modify Army Corps of Engineers' Operations and Maintenance Manual to reduce the frequency and magnitude of gravel and vegetation removal, while still providing flood protection for the town of Orick*					
SONCC-RedC.2.1.4	Floodplain and Channel Structure	Yes	Increase channel complexity	Increase LWD, boulders, or other instream structure	Population wide	3

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	***Step Description***					
SONCC-RedC.2.1.4.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-RedC.2.1.4.2	*Place instream structures, guided by assessment results*					
SONCC-RedC.16.1.19	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-RedC.16.1.19.1	*Determine impacts of fisheries management on SONCC coho salmon in terms of VSP parameters*					
SONCC-RedC.16.1.19.2	*Identify fishing impacts expected to be consistent with recovery*					
SONCC-RedC.16.1.20	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-RedC.16.1.20.1	*Determine actual fishing impacts*					
SONCC-RedC.16.1.20.2	*If actual fishing impacts exceed levels consistent with recovery, modify management so that levels are consistent with recovery*					
SONCC-RedC.16.2.21	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-RedC.16.2.21.1	*Determine impacts of scientific collection on SONCC coho salmon in terms of VSP parameters*					
SONCC-RedC.16.2.21.2	*Identify scientific collection impacts expected to be consistent with recovery*					
SONCC-RedC.16.2.22	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-RedC.16.2.22.1	*Determine actual impacts of scientific collection*					
SONCC-RedC.16.2.22.2	*If actual scientific collection impacts exceed levels consistent with recovery, modify collection so that impacts are consistent with recovery*					
SONCC-RedC.27.1.23	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate abundance	Population wide	3
SONCC-RedC.27.1.23.1	*Perform annual spawning surveys*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID		***Step Description***				
SONCC-RedC.27.1.24	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track life history diversity	Population wide	3
SONCC-RedC.27.1.24.1		*Describe annual variation in migration timing, age structure, habitat occupied, and behavior*				
SONCC-RedC.27.1.25	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the stress 'Fishing and Collecting'	Population wide	2
SONCC-RedC.27.1.25.1		*Annually estimate the commercial and recreational fisheries bycatch and mortality rate for wild SONCC coho salmon.*				
SONCC-RedC.27.2.26	Monitor	No	Track habitat condition	Track habitat indicators related to spawning, rearing, and migration	Population wide	3
SONCC-RedC.27.2.26.1		*Measure indicators for spawning and rearing habitat. Conduct a comprehensive survey*				
SONCC-RedC.27.2.26.2		*Measure indicators for spawning and rearing habitat once every 10 years, sub-sampling 10% of the original habitat surveyed*				
SONCC-RedC.27.2.27	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Lack of Floodplain and Channel Structure'	All IP habitat	3
SONCC-RedC.27.2.27.1		*Measure the indicators, pool depth, pool frequency, D50, and LWD*				
SONCC-RedC.27.2.28	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Degraded Riparian Forest Condition'	All IP habitat	3
SONCC-RedC.27.2.28.1		*Measure the indicators, canopy cover, canopy type, and riparian condition*				
SONCC-RedC.27.2.29	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Altered Sediment Supply'	All IP habitat	3
SONCC-RedC.27.2.29.1		*Measure the indicators, % sand, % fines, V Star, silt/sand surface, turbidity, embeddedness*				
SONCC-RedC.27.2.30	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Water Quality'	All IP habitat	3
SONCC-RedC.27.2.30.1		*Measure the indicators, pH, D.O., temperature, and aquatic insects*				
SONCC-RedC.27.2.31	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Estuarine Function'	All IP habitat	3

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID		***Step Description***				
SONCC-RedC.27.2.31.1		*Identify habitat condition of the estuary*				
SONCC-RedC.27.1.33	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate juvenile spatial distribution	Population wide	3
SONCC-RedC.27.1.33.1		*Conduct presence/absence surveys for juveniles (3 years on; 3 years off)*				
SONCC-RedC.27.1.34	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Refine methods for setting population types and targets	Population wide	3
SONCC-RedC.27.1.34.1		*Develop supplemental or alternate means to set population types and targets*				
SONCC-RedC.27.1.34.2		*If appropriate, modify population types and targets using revised methodology*				
SONCC-RedC.27.2.35	Monitor	No	Track habitat condition	Determine best indicators of estuarine condition	Estuary	3
SONCC-RedC.27.2.35.1		*Determine best indicators of estuarine condition*				
SONCC-RedC.5.1.10	Passage	No	Improve access	Remove structural barrier	Strawberry Creek. 2 sites on RNSP land and 3 sites on private land	3
SONCC-RedC.5.1.10.1		*Assess culverts and develop a plan to provide passage at all life stages through the upgrade of the culverts.*				
SONCC-RedC.5.1.10.2		*Upgrade culverts, guided by the plan*				
SONCC-RedC.5.1.11	Passage	No	Improve access	Reduce invasive species	3 miles of the tributaries and sloughs Strawberry, Dorance and Sand Cache Creeks.	2
SONCC-RedC.5.1.11.1		*Eradicate Reed Canary Grass*				
SONCC-RedC.7.1.6	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Increase conifer riparian vegetation	Population wide	3
SONCC-RedC.7.1.6.1		*Determine appropriate silvicultural prescription for benefits to coho salmon habitat*				
SONCC-RedC.7.1.6.2		*Thin, or release conifers, guided by prescription*				
SONCC-RedC.7.1.6.3		*Plant conifers, guided by prescription*				

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID		***Step Description***				
SONCC-RedC.7.1.7	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve long-range planning	Population wide	3
SONCC-RedC.7.1.7.1		*Review General Plan or City Ordinances to ensure coho salmon habitat needs are accounted for. Revise if necessary*				
SONCC-RedC.7.1.7.2		*Develop watershed-specific guidance for managing riparian vegetation*				
SONCC-RedC.7.1.8	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve grazing practices	Population wide	3
SONCC-RedC.7.1.8.1		*Assess grazing impact on sediment delivery and riparian condition, identifying opportunities for improvement*				
SONCC-RedC.7.1.8.2		*Develop grazing management plan to meet objective*				
SONCC-RedC.7.1.8.3		*Plant vegetation to stabilize stream bank*				
SONCC-RedC.7.1.8.4		*Fence livestock out of riparian zones*				
SONCC-RedC.7.1.8.5		*Remove instream livestock watering sources*				
SONCC-RedC.7.1.9	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve timber harvest practices	Population wide	2
SONCC-RedC.7.1.9.1		*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-RedC.8.1.12	Sediment	No	Reduce delivery of sediment to streams	Reduce risk of catastrophic fire	Population wide	3
SONCC-RedC.8.1.12.1		*Identify forested stands for fire hazard reduction*				
SONCC-RedC.8.1.12.2		*Apply appropriate management techniques (e.g. thinning, burning) to reduce risks of high intensity fire*				
SONCC-RedC.8.1.13	Sediment	No	Reduce delivery of sediment to streams	Reduce erosion	Population wide	3
SONCC-RedC.8.1.13.1		*Inventory sediment sources, and prioritize for treatment*				
SONCC-RedC.8.1.14	Sediment	No	Reduce delivery of sediment to streams	Improve timber harvest practices	Population wide	3
SONCC-RedC.8.1.14.1		*Apply best management practices for timber harvest*				

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID		***Step Description***				
SONCC-RedC.8.1.15	Sediment	No	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	Population wide	3
SONCC-RedC.8.1.15.1		*Assess and prioritize road-stream connection, and identify appropriate treatment to meet objective*				
SONCC-RedC.8.1.15.2		*Decommission roads, guided by assessment*				
SONCC-RedC.8.1.15.3		*Upgrade roads, guided by assessment*				
SONCC-RedC.8.1.15.4		*Maintain roads, guided by assessment*				
SONCC-RedC.8.1.16	Sediment	No	Reduce delivery of sediment to streams	Improve regulatory mechanisms	Population wide	3
SONCC-RedC.8.1.16.1		*Develop grading ordinance for maintenance and building of private roads that minimizes the effects to coho*				