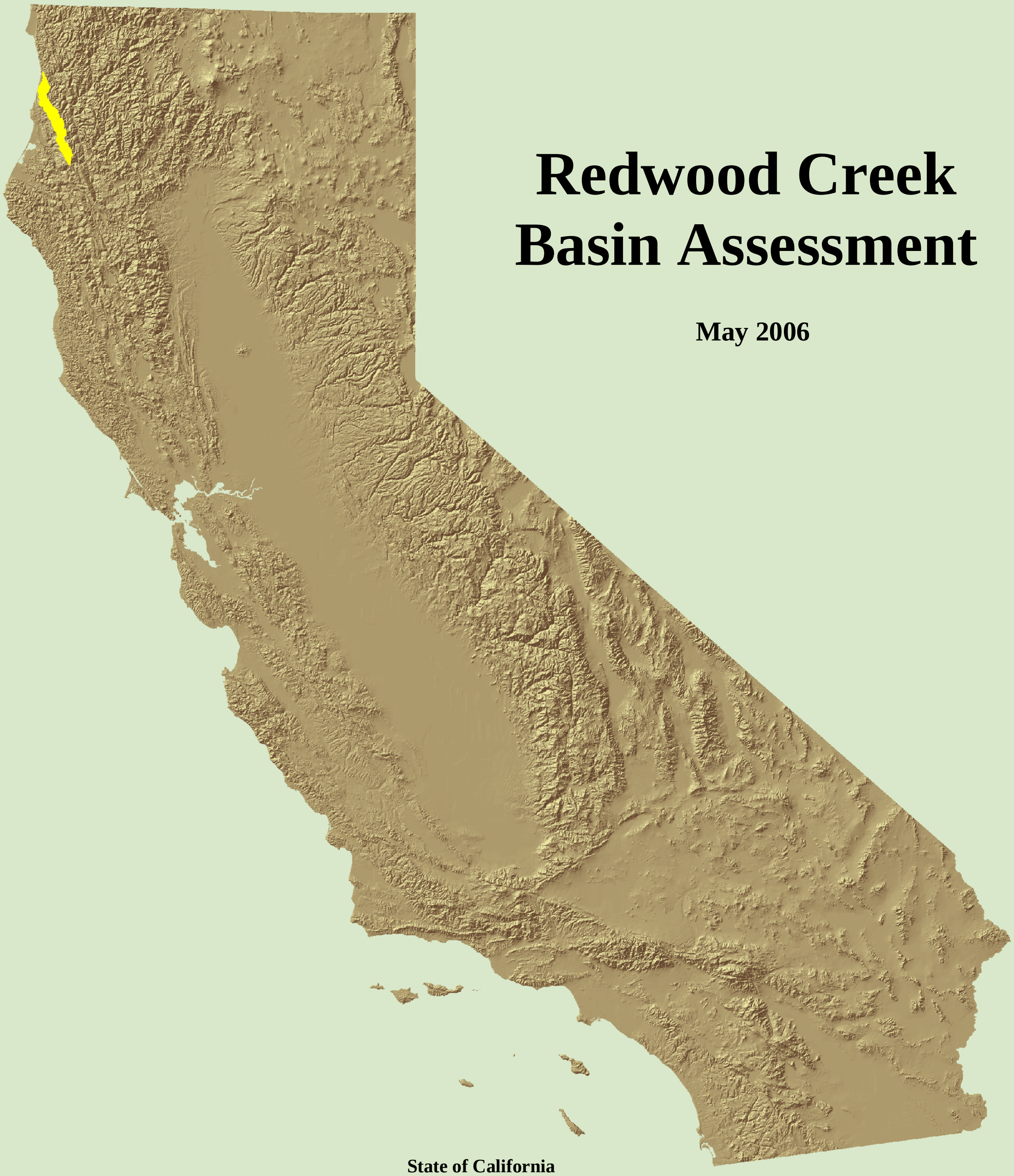
Coastal Watershed Planning and Assessment Program
and
North Coast Watershed Assessment Program



Redwood Creek Basin Assessment

May 2006

State of California

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California Resources Agency

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California Environmental Protection Agency

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Section III
Basin Profile and Overview
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Redwood Creek Profile and Synthesis

Redwood Creek flows into the Pacific Ocean near the town of Orick, approximately 35 miles north of Eureka, in northern Humboldt County, California Figure III- 1). The basin contains approximately 285 square miles (about 180,000 acres) of mostly forested and mountainous terrain. The basin's elongate shape is controlled by the Grogan Fault which extends in a NW/SE direction for approximately 65 miles. The basin averages only about 6 miles wide. Elevation ranges from sea level near the town of Orick up to 5,200 feet at headwaters near Board Camp Mountain, located at the south-east end of the basin. With the exception of Prairie Creek, most tributary streams are relatively short and steep, while the mainstem Redwood Creek is low gradient until rising to the headwaters. The basin provides approximately 125 miles of anadromous salmonid habitat.

Subbasin Scale

The complexity of large basins like Redwood Creek makes it difficult to address watershed assessment and recommendation issues except in very general terms. In order to be more specific and of value to planners, managers, and landowners, it is useful to subdivide the larger basin into smaller subbasin units whose size is determined by the commonality of many geographic attributes. Attributes that can distinguish subbasins include differences in elevation, geology, soil types, climate, vegetation, human population, and land use.

Redwood Creek basin was divided into five subbasins for assessment (Figure III- 2 and Table III- 1). The subbasins conform to CalWater 2.2 Planning Watershed boundaries when possible and the 22 planning watersheds as defined by the CalWater 2.2 system.

Estuary Subbasin: The Estuary Subbasin includes the drainage of Redwood Creek below the confluence with Prairie Creek, including Sand Cache Creek, Dorrance Creek and the lower Strawberry Creek basin.

Prairie Creek Subbasin: The Prairie Creek Subbasin contains all of Prairie Creek basin except for a small portion of Skunk Cabbage Creek. Ninety-eight percent of the Prairie Creek subbasin is managed by Redwood National and State Park (RNSP).

Lower Subbasin: The Lower Subbasin includes the area above the confluence of Redwood and Prairie Creeks to the confluence of Redwood and Devil's Creeks including Devil's Creek. The Lower Redwood Creek Subbasin is managed by RNSP.

Middle Subbasin: The Middle Subbasin includes the area above the confluence of Redwood/Devil's Creeks excluding Devil's Creek up to the confluence of Redwood and Lupton Creeks, including Lupton Creek. The Middle Subbasin includes the Park Protection Zone, Redwood Valley, and ends at the valley confinement upstream of State Highway 299 Bridge. This subbasin is predominantly managed for timber production and some cattle grazing.

Upper Subbasin: The Upper Subbasin is defined as the area above but not including Lupton Creek and covers the same area as the CalWater 2.2 Lake Prairie Hydrologic Area. This subbasin has the highest relief and the greatest proportion of natural prairies. This subbasin is predominantly managed for timber production and also has the greatest number of individual private ownerships per square mile of all Redwood Creek Subbasins.

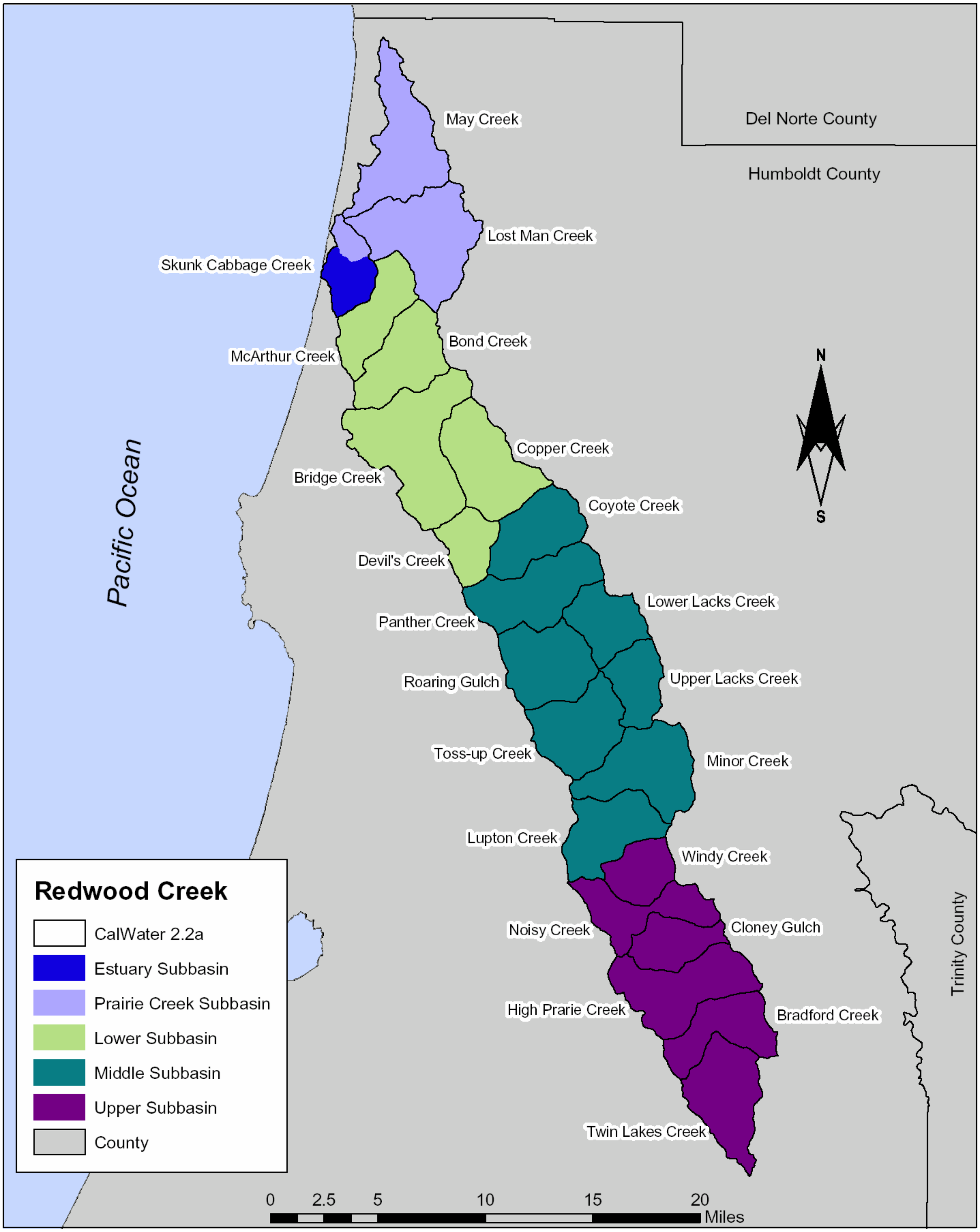

Figure III- 2. The five subbasins of the Redwood Creek basin and their planning watersheds.

The RNSP and USGS collected McNeil sediment core samples from five mainstem locations and eight tributaries between 1975 and 1995 using similar methods of collection and dry sieving the samples. These data are not comparable to the existing TMDL targets due to the method of analysis of the samples. Data from a 1974 study by Woods (1975), analyzed volumetrically, indicated that the percentage of fine sediments present in the <0.85mm size class exceeded TMDL targets for three tributaries to Redwood Creek. According to RNSP staff, the percentage of fine sediments tends to be higher in the lower basin (EPA 1998). It appears that fine sediment is moving through the system in waves, but without current and standardized streambed sediment data comparable to existing numeric targets, it is difficult to assess the status and impact of in-channel sediment on salmonid habitat in the basin.

Suspended Sediments and Turbidity

High turbidity levels in Redwood Creek are believed to occur more frequently and persist longer than in the past. Chronic turbidity and elevated levels of suspended sediments affect the ability of sight-oriented juvenile salmonids to locate food and may cause gill abrasions. A suppressed feeding ability may reduce the growth rate of juvenile fish and impair completion of successful smoltification and ultimately reduce survival rates upon entering the sea. Chronic turbidity may also reduce the reproductive cycle and growth of some aquatic invertebrates that serve as prey species for anadromous salmonids

It was shown that land use is responsible for increases in suspended sediment concentrations in managed areas within the Redwood Creek basin (Nolan and Janda 1995). Nolan and Janda (1995) found that suspended sediment discharge was roughly ten times greater from timber harvested terrain compared to unharvested terrain. Additionally, Klein (2001) found that the number of consecutive days that exceeded a turbidity target of 27 mg/l was four to five times greater in planning watersheds managed for timber harvest (Panther and Lacks creeks) when compared to unmanaged planning watersheds (Prairie and Little Lost Man creeks). While some of the differences may be explained by inherent sediment producing characteristics between the planning watersheds, the main factor for the higher turbidity levels in Lacks and Panther creeks is likely due to timber harvest and related management activities (Klein 2001).

Anadromous Salmonid Fishery Resources

Redwood Creek basin supports anadromous populations of fall run Chinook salmon (Oncorhynchus tshawytscha), coho salmon (O. kisutch), winter and summer runs of steelhead trout (O. mykiss), coast cutthroat trout (O. clarki clarki), and other valuable fisheries resources (Table III- 30). Although a recent estimate of the size of anadromous salmonid populations of the Redwood Creek basin has yet to be determined, a review of past fisheries studies, anecdotal information and data collected for this assessment indicates that the present populations are less abundant and less widely distributed compared to their historic presence (Hallock et al. 1952; Briggs 1953; USFWS 1960; Anderson 1988; Brown 1988; Busby et al. 1994; Van Kirk 1994; McEwan and Jackson 1996; NMFS 1998; McElhany et al. 2000; CDFG 2002). However, Redwood Creek's anadromous salmonid stocks should be viewed as critically valuable natural resources and increasing the abundance, diversity and distribution of these stocks are vital steps towards the restoration of viable salmonid populations to California.

There are approximately 135 miles of stream habitat accessible to anadromous salmonid in the Redwood Creek basin. The mainstem Redwood Creek provides approximately 65 miles and tributaries provide approximately 60 miles of stream of accessible habitat (Table III- 31).

Table III- 30. Fishery resources of the Redwood Creek basin.

Common Name	Scientific Name
Anadromous	
coho salmon	*Oncorhynchus kisutch*
Chinook salmon	*Oncorhynchus tshawytscha*
steelhead trout	*Oncorhynchus mykiss*
sea run coastal cutthroat trout	*Oncorhynchus clarki clarki*
Eulachon	*Thaleichthys pacificus*
Pacific lamprey	*Lampetra tridentata*
Freshwater	
rainbow trout	*Oncorhynchus mykiss irideus*
coastal cutthroat trout	*Oncorhynchus clarki clarki*
Coast range sculpin	*Cottus aluticus*
Humboldt sucker	*Catastomus occidentalis humboldtianus*
prickly sculpin	*Cottus asper*
Pacific brook lamprey	*Lampetra pacifica*
Three-spine stickleback	*Gasterosteus aculeatus*
Marine or Estuarine Dependent	
tidewater goby	*Eucyclogobius newberryi*
Pacific herring	*Clupea pallasi*
saddleback gunnel	*Pholis ornata*
surf smelt	*Hypomesus pretiosus*
night smelt	*Spirnchus starksi*
shiner surfperch	*Cymatogaster aggregata*
staghorn sculpin	*Leptocottus armatus*
starry flounder	*Platicthys stellatus*
Amphibians	
Pacific giant salamander	*Dicamptodon tenebrosus*
tailed Frog	*Ascaphus truei*
red-legged frog	*Rana aurora*
foothill yellow-legged frog	*Rana boylei*

Table III- 31. Number of stream miles accessible to anadromous salmonids in each of the Redwood Creek subbasins.

Subbasin	Redwood Creek Mainstem Miles Accessible to Anadromous Salmonids	Tributary Miles Accessible to Anadromous Salmonids
Estuary	3.5	1.5
Prairie Creek	0	24
Lower	19	9.5
Middle	24	19
Upper	19	5.5
Total	**65.5**	**59.5**

Streams in the Prairie Creek Subbasin provide anadromous salmonids the largest amount of tributary habitat of all the subbasins. The remainder of anadromous fish bearing tributary habitat is distributed between approximately 46 named tributary streams located in the Lower, Middle and Upper subbasins (Brown 1988) (Table III- 32). The steep channel gradient restricts access to only the lower reaches of most tributary streams in the Lower, Middle and Upper subbasins. The majority of suitable tributary habitat is found in only ten streams including Bridge, Emerald, and Tom McDonald creeks of the Lower Subbasin, Lacks, Minor, Coyote, Panther, and Wiregrass creeks of the Middle Subbasin, and Minon and Bradford creeks of the Upper Subbasin. Other tributary streams are still important as they cumulatively provide important habitat for anadromous populations and also contribute important water flows into Redwood Creek. In addition, resident populations of rainbow and coastal cutthroat trout exist in many tributaries above barriers to anadromous salmonids.

Table III- 32. Anadromous salmonid distribution in the Redwood Creek basin.

Subbasin and Streams	Steelhead	Cutthroat	Chinook	Coho
Estuary Subbasin Streams				
Redwood Creek	x	x	x	x
Strawberry Creek	x	x		x
Prairie Creek Subbasin Streams				
Prairie Creek	x	x	x	x
Skunk Cabbage Creek	x	x		x
Little Lost Man Creek	x	x	x	x
Lost Man Creek	x	x	x	x
Streelow Creek	x	x		x
May Creek	x	x		x
Godwood Creek	x	x	x	x
Boyes Creek	x	x	x	x
Brown Creek	x	x	x	x
Lower Redwood Creek Subbasin Streams				
Hayes Creek	x	x		
McArthur Creek	x	x		x
Elam Creek	x	x		
Bond Creek	x	x		
Cloquet Creek	x	x		
Miller Creek	x			
Forty Four Creek	x	x		
Tom McDonald Creek	x	x	x	x
Harry Wier (Emerald) Creek	x	x		x
Bridge Creek	x	x	x	x
Dolason Creek	x			
Copper Creek	x			
Devils Creek	x			
Redwood Creek	x	x	x	x
Middle Redwood Creek Subbasin Streams				
Coyote Creek	x	x		x
Panther Creek	x	x		x
Garrett Creek	x			
Lacks Creek	x	x	x	x
Karen Creek	x			x
Roaring Gulch	x			
Garcia Creek	x			
Cashmere Creek	x			
Beaver Creek	x			
Pilchuck Creek	x			x
Mill Creek	x			
Molasses Creek	x			
Toss-up Creek	x			
Wiregrass Creek	x			
Minor Creek	x		x	x
Loin Creek	x			
Santa Fe Creek	x			
Sweathouse Creek	x			
Captain Creek	x			
Lupton Creek	x			
Redwood Creek	x	x	x	x
Upper Redwood Creek Subbasin Streams				
Windy Creek	x			
Jena Creek	x			
Noisy Creek	x			
Squirrel Trail Creek	x			
Emmy Lou Creek	x			
Cut-off Meander	x			
Six Rivers Creek	x			
Gunrack Creek	x			
Simion Creek	x			
High Prairie Creek	x	x		
Minon Creek	x			
Lake Prairie Creek	x			
Upper Panther/Bradford Creek	x			
Pardee Creek	x			
Snowcamp/Smokehouse/ Twin Lakes	x			
Redwood Creek	x	x	x	x

From the long-term perspective, anadromous salmonids of Redwood Creek, show declines from historic numbers and in distribution across the basin. In 1960, the U.S. Fish and Wildlife Service estimated spawner escapement of 5,000 Chinook, 2,000 coho, and 10,000 steelhead (Figure III-34) (USFWS 1960). These estimates were made based on data collected from other streams and applied to Redwood Creek. They were meant to provide a general magnitude of anadromous salmonid runs are not indicative of larger runs of prior years (USFWS 1960; CDFG 1965; and RNSP 2000) The data needed to determine if populations are continuing to decline, have stabilized, or are on the rise across the basin are not available.

The decline in anadromous salmonids populations is not unique to Redwood Creek. For example, in 1984-85 the statewide total of natural coho salmon spawners was estimated at 6 to 15% of the level of the 1940s (CDFG 2002). In addition, coho and Chinook populations drastically declined in the Eel River according to adult salmon counts at Benbow Dam, South Fork Eel River (CDFG 2002).

In response to California's declining wild populations, Chinook, coho, and steelhead are listed as "threatened" under the Federal Endangered Species Act (FESA). In 2002, the California Fish and Game Commission found that North Coast coho salmon warranted listing as threatened, as defined under the California Endangered Species Act (CESA). In addition, several other plant and animal species living in the Redwood Creek basin receive special status protection under the FESA and CESA including coastal cutthroat trout, which is considered a California species of special concern by the Department of Fish and Game (Appendix D).

Freshwater and estuarine habitat degradation and has been identified as a leading factor in the decline of Redwood Creek's anadromous salmonids (Ricks 1982; Larson 1982; Hofstra 1983; Anderson 1988; Brown 1988; Madej 1991; and CDF&G 2002). Widespread declines of summer steelhead, sea run coastal cutthroat, coho and Chinook salmon is likely linked to their sensitivity to degradation of specific habitat components necessary to complete the freshwater and/or estuarine phase of their life cycle. Because steelhead tolerate a wider range of habitat conditions than the other anadromous species, they are more widely distributed in the basin and have persisted in streams where other species have declined or are now rarely observed.

Similar to most north coast streams, there has been neither basin-wide quantitative assessment nor coordinated long term monitoring of all Redwood Creek's anadromous salmonid stocks. There are recent population data such as downstream migrant studies and spawning surveys available for select streams. However these data are inconclusive because they lack of consistent effort across the study areas, or have not been ongoing for sufficient time to establish trends, and may require optimal environmental conditions to conduct observations. Coordinated studies such as downstream migrant trapping, spawner surveys, and other population assessment techniques may soon provide the level of information needed to make quantitative assessments of the current status and trends of Redwood Creek's anadromous salmonid populations.

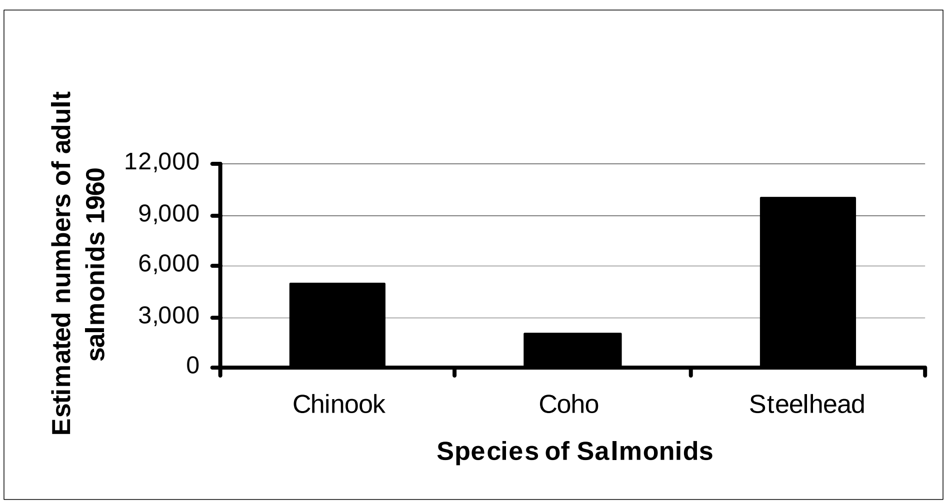

Figure III- 28. U.S. Fish and Wildlife Service estimates of adult salmonid populations in the Redwood Creek basin, 1960.

Historical Fishery Information

Historically, the salmon, steelhead, cutthroat trout, and other fishery resources of Redwood Creek were important food supply to Native Americans. The Chilula Tribe residing along Redwood Creek were reliant upon abundant runs of salmon, winter steelhead, summer steelhead, trout and lamprey (Van Kirk 1994). Beginning in the mid 1800s, the fishery resources of Redwood Creek provided sport and commercial fishing opportunities for early settlers and visitors to Humboldt County. In the late 1800s and early 1900s Chinook salmon of 50 to 60 pounds and occasionally 70-80 pounds were caught in the estuary. Coastal cutthroat in the four to six pound range were also caught (Meyer 1994). The abundant salmon, steelhead, and coast cutthroat trout made the estuary a favorite location for trolling by boat or fishing from shore.

Past accounts of large fish runs and catches were not limited to the estuary. References to large fall and winter salmon and steelhead runs and excellent coastal cutthroat fishing in spring and summer are presented in Van Kirk (1994). According to interviews with people who have lived for many years or generations in the Redwood Creek basin, a common theme occurred: large numbers of salmonids were present until the flood of 1964. Migrating salmon were described as “sounding like horses in the creek” or were so numerous that the kids felt like they were “swimming on top of fish” (Van Kirk 1994). A grandfather of a longtime resident said in the early 1900s: “there were so many fish in Redwood Creek that you could walk across the creek on their backs”. Another long time resident of middle Redwood Creek described how there use to be a “real good summer steelhead run”, which came in Redwood Creek soon after snowmelt in late February and early March. He mentioned “these fish used Lacks and Minor Creeks” and said “there are still a few, but not nearly as many as there used to be”(Van Kirk 1994). Another anecdote from a 1920 article in American Angler gave the following description of summer steelhead in upper Redwood Creek: “Every pool has ten to twenty five, and they run from twenty to thirty-six inches. Some of the pools were up to 20 feet deep” (Gerstrung 2001 Draft).

During spring and summer of the late 1800s to early 1900s, the sport fishing effort in Redwood Creek shifted to coastal cutthroat trout. Coastal cutthroat trout were referred to as “speckled beauties” (Van Kirk 1994). An excerpt from an article in the Arcata Union (July, 1910) reads “a magnificent lot of trout” were taken by two men. They caught “their limit of 25 pounds of speckled beauties every day for three days on Redwood Creek” (Van Kirk 94). Prairie Creek and the estuary also were popular areas to fish for the coastal cutthroat, but by 1925, the quality of the coastal cutthroat fishery had declined. Both the fish size and catches were smaller compared to the earlier days.

Local residents and visitors looked to hatchery production as a way to supplement the coast cutthroat fishery. A writer for the Arcata Union paper described the need for hatchery programs to assist in fish production in an July 1926 article: “The program of refilling the streams with fish was commenced following discovery recently that the Humboldt streams were ceasing to be a prolific source of fishing (for coastal cutthroat) and that anglers from the bay region lured north by the former fishing paradise were returning disappointed. If enough eggs can be obtained at the new hatchery, the streams of northern California will be kept well stocked. This would aid greatly in attracting tourist as the streams in this part of the state do not go dry in the summer time” (Van Kirk 94). In response to this decline in fish, a hatchery was established at Prairie Creek in 1927. Even with the enhancement attempts by the Prairie Creek Hatchery, the coastal cutthroat fishery never recovered to its former popularity or population levels.

There is also reference to what may be chum salmon caught in Redwood Creek (Van Kirk 1994) and infrequently observed pink salmon in Prairie Creek (CDFG 1952). Other interesting bits of anecdotal history by local residents provided in Van Kirk (1994) are stories of abundant crayfish populations prior to 1964, which are now rarely observed in Redwood Creek (D. Anderson, RNSP, personal communication). The decline of crayfish in Redwood Creek has never been investigated. Van Kirk (1994) also notes that Redwood Creek once supported large eulachon runs. For example, in April of 1973, an unusually large run of eulachon occurred for two to three days. Residents proclaimed “You could grab them out with your hands” (Van Kirk 1994).

Anecdotal physical descriptions of the Redwood Creek basin are more limited than fish related accounts. According to several longtime residents, Redwood Creek stream temperatures used to be much colder. One stated: “The water in Redwood used to be like ice, but warmed up after logging along the Creek.” Another resident added that the kids would "freeze" when they swam and that today the water is warmer because the creek is more "filled up" (Van Kirk 1994). Residents also expressed their views of how the creek had become shallower and how there "aren't as many holes as there used to be." Several people interviewed told of a "15-20 foot" hole at the mouth of Prairie Creek that is no longer present. Residents also commented on how canopy has diminished. One stated: "Redwood used to have a thick canopy" (Van Kirk 94).

Two CDFG reports provide descriptions of past conditions. In 1951, DFG collected salmonids by beach seine from Redwood Creek for a three-state fingerling marking program (Hallock et al. 1952). During fish collection efforts, it was noted that Redwood Creek was an "excellent silver salmon stream", but it "was not seined extensively because in the few places where they could be reached by road, the pools were so deep as to make netting impractical" (Hallock et al. 1952). Fisk et al. (1966) stated that the 1964 flood and associated hillslope and streambank erosion left Redwood Creek in a "severely damaged condition" and without much suitable anadromous salmonid habitat.

In summary, valuable historical information of the Redwood Creek fisheries was published in the Arcata Union Newspaper, which is presented along with interviews of long time residents and other anecdotal accounts in Van Kirk (1994). These anecdotal accounts describe the presence of large populations of salmon, summer and winter steelhead, and coastal cutthroat of Redwood Creek. Also, the economic importance of a viable fishery to local residents and significant revenues to the economy of Orick is noted. Information provided in CDFG reports substantiate many of the anecdotal accounts. Table III- 33 provides an additional brief summary of historical events.

Table III- 33. Historical events affecting fishery resources of Redwood Creek.

Year	Event
Pre-European Settlement	Yurok, Chilula and Whilkut people occupied Redwood Creek region.
1850s	Settlement of Orick with first white settlers. Conversion of spruce, redwood and hardwood forests for farm and grazing land.
1860s	Introduction of cattle and sheep into Redwood Creek region.
1920s	Establishment of Prairie Creek Redwood State Park. Save the Redwoods League purchases 14,000 acres of sanctuary old growth forests.
1927	Hatchery established on Prairie Creek (Prairie Creek Hatchery) for collection of coastal cutthroat trout, steelhead, and salmon eggs.
1936	Hatchery moved to its location on Lost Man Creek just upstream of its confluence with Prairie Creek.
1040s	Post WWII. Large scale logging with the use of tractors and gasoline-powered chainsaws.
1950	January cold spell with heavy snowfall followed by heavy rains caused Redwood Creek to overflow its banks and the residents of Orick had to flee their homes. Approximately 3 feet of water was reported in the center of town with up to 6 feet at the southern approach (Van Kirk 1994).
1955	December 22, 1955 flood carried a peak discharge of 50,000 cubic feet per second (cfs).
1964	December 22, 1964 flood had a peak discharge of 50,500 cfs on. Caused tremendous damage to the town of Orick and deposited tremendous sediment loads in middle and lower portions of Redwood Creek. Although peak discharge of the 1964 flood was only slightly higher than flood of 1955 on Redwood Creek, the total volume and damage to stream banks and hillslopes is considered the most damaging event of the century in the North Coast region (Harden et al. 1978).
1965	On January 22 the Arcata Union reports that silt and debris clog streams. "The recent flood was extremely damaging to wildlife" according to Captain Walter L. Gray of the Department of Fish and Game. "We know the loss of fish life was much greater than in 1955." "Many large fish were found in pastures buried in silt." "Streams were damaged by siltation, logging debris, and erosion. To make matters more complex, heavy runoff in many small tributaries have created deltas at the mouth which will go dry during periods of low water and will prevent fish from migrating"(Van Kirk 1994).
1968	Establishment of Redwood National Park. Completion of flood control levees along the lower 3.4 miles of Redwood Creek.
1973	New forest practice law established to improve protection of water quality, timber productivity, and other forest values.
1975	March 18, 1975 flood had a peak discharge of 50,200 cfs on and continued to deposit large sediment loads throughout Redwood Creek.
1978	Expansion of Redwood National Park.
1989	Construction of 101 By-Pass and related large sediment delivery to Prairie Creek basin.
1992	Closure of Prairie Creek Hatchery due to insufficient funding sources
1996	Flood re-charges upper basin with sediment.
1997	Coho salmon of the Southern Oregon/Northern California ESU listed "threatened" under the Federal Endangered Species Act.
1998	Total Maximum Daily Load allocation for sediment established for the Redwood Creek basin by EPA.
1999	Chinook Salmon of the California Coastal ESU listed as "threatened" under the Federal Endangered Species Act.
2000	Steelhead of the Northern California ESU listed as "threatened" under the Federal Endangered Species Act.
2002	Coho salmon warranted listing as threatened, as defined under the California Endangered Species Act.

Prairie Creek Hatchery

The Prairie Creek Hatchery is located just north of the town of Orick and operated from 1927 until 1993. Throughout its years in operation, the hatchery propagated Chinook, coho, steelhead, rainbow trout, and coastal cutthroat trout. The fish were released mostly in the Redwood Creek basin and other Humboldt County streams. The hatchery was originally intended to supplement the declining coastal cutthroat sportfishery.

Total adult fish counts returning to Prairie Creek were not made during the first fifty years of hatchery operations. The hatchery operations consisted of collecting the desired number of salmonid eggs for each year and then focused on hatching and releasing fry. Fish were only collected to meet demand for eggs from the early portion of the run. Late running fish were allowed to freely pass through the facility uncounted. The hatchery likely increased the numbers of coho and steelhead returning to Lost Man Creek. The coastal cutthroat fishery, for which the hatchery was originally intended, never returned to its former strength or popularity noted from the early 1900s (Van Kirk 1994). A more detailed summary of the Prairie Creek Hatchery operations is presented in the Prairie Creek Subbasin section below. Hatchery production records from 1927 to 1993 are presented in Appendix D, Attachment 3.

Anadromous Salmonid Status and Life History Notes

Chinook, coho, steelhead, and coastal cutthroat utilize an anadromous life history strategy. The term anadromous refers to fish that are born in freshwater, migrate to the ocean as juveniles, where they grow and mature before returning as adults to freshwater streams to spawn. Chinook, coho, steelhead and coastal cutthroat all have specific habitat requirements, but the general anadromous salmonid life history pattern includes adult upstream migrations from the sea, spawning, egg incubation, fry emergence, juvenile rearing, and downstream migration through estuaries to the sea where salmon reside until maturation and upstream migrations. Steelhead and coastal cutthroats may re-enter streams after a brief ocean residence and return to sea with out spawning.

Viable populations of anadromous salmonids exhibit a diversity of behavioral adaptations in terms of upstream and downstream migration timing and juvenile rearing strategies. Historically, large, protracted spawning runs and diverse instream rearing strategies were the best insurance for survival in environments as dynamic as freshwater streams, estuaries, and the Pacific Ocean. Today's salmonid populations are reduced in numbers, appear less diverse in run timing, and therefore are more vulnerable than past populations to short term habitat perturbations, such as effects from floods and droughts, and other stochastic events in both the freshwater and marine environments.

A summary of the life history strategies, historic and current status of anadromous salmonid population of Redwood Creek is provided below. Further information on fisheries and habitat status of Redwood Creek is provided in each subbasin section.

Chinook salmon

Redwood Creek supports a fall run of Chinook salmon. Chinook salmon, also referred to as "king salmon," is the largest of the Pacific salmonid species. Due to declining wild populations, Chinook salmon of Redwood Creek of the Coastal California Evolutionary Significant Unit (ESU) were listed as threatened under the Federal Endangered Species Act in 1999. The Coastal California ESU includes all naturally spawned populations of Chinook salmon from rivers and streams south of the Klamath River to the Russian River. The estimated distribution of Chinook salmon of Redwood Creek is presented in Figure III- 29.

In 1960, the U.S Fish and Wildlife service estimated 5,000 adult Chinook populated Redwood Creek. The USFWS also estimated that the available Chinook salmon spawning areas in the basin would accommodate approximately 5,400 redds (USFWS 1960). This estimate suggests that it would require over 10,000 Chinook salmon to fully utilize the available spawning habitat of the Redwood Creek basin. In 1979, the adult spawning population of Redwood Creek was estimated at 1,850 adults (Ridenhour and Hofstra 1994 Draft). The 1979 number was based on the number of juveniles estimated from the estuary population in early July 1980 (Ridenhour and Hofstra 1994 Draft).

The Chinook of Redwood Creek typically begin spawning migrations soon after fall rains breech the lagoon. The majority of spawning occurs from November through January and generally peaks in December). The best historical spawning areas are Prairie Creek, the middle reach of Redwood Creek including Lacks and Minor Creeks, and the upper reach of Redwood Creek (USFWS 1960). According to anecdotal accounts, the lower reach of Redwood Creek also is used for spawning during low flow years and when the river mouth opens late in the season (Van Kirk 1994).

Spawning occurs in gravel and cobble areas where females dig depressions or pits into the substrate by rapid beats of the tail fin. While the eggs are released into the pit, a male fertilizes them. Then the female will cover the fertilized eggs as she digs another pit just upstream, and the process continues until a mound called a redd is constructed containing one or more pits with eggs. It is important that water flows are sufficient through the redds because the developing embryos need dissolved oxygen for respiration and flow to remove metabolic wastes or they will die. As the newly hatched fry emerge from the redds in late winter or early spring they must find their way up through the spaces between the gravel and cobble substrate of the redd, which may be a distance of foot or more. It is important that the redd does not contain much fine sediment. Too much fine sediment can stop the water flow needed to sustain the fry or fill the passage spaces between the substrate leading to the stream above and trap the young salmon in the redd. Redd construction, egg incubation and fry emergence are similar for all anadromous salmonids.

Juvenile Chinook may begin seaward migrations soon after emerging from their redds or rear for some time in their natal stream. The peak downstream migration period is generally from mid April to early May (Sparkman 2000; 2001; 2002; 2003). Water temperatures in the mainstem Redwood Creek generally become too warm for rearing during the summer months so downstream migrations are usually completed by July. A few juvenile Chinook have been observed rearing in tributary streams during the summer months. The majority of the basin's juvenile Chinook arrive in the estuary/lagoon May to July where they may rear for weeks to months before entering the sea (Anderson 2000 and 2001and Wilzbach 2001). Rearing in the estuary allows Chinook to achieve important growth before entering the sea. However, estimates of only 7 to 15% of the Chinook population survives in the lagoon from July to September (Anderson 2000 and 2001). Juvenile Chinook use of the estuary/lagoon is discussed below.

An alternative to estuarine rearing for juvenile Chinook is summer stream rearing. There is evidence of over-summering Chinook in the basin, as 21 yearlings (in 2001) were collected in trapping efforts (Sparkman 2001). In addition juvenile Chinook were observed in Bridge and Tom McDonald Creeks during surveys in 2001 (D. McCann 2002 personal communications). In 2002 juvenile Chinook were observed in Coyote Creek and 70 were observed in Lacks Creek (B. Reisberger 2003 personal communications). These juvenile Chinook were rearing over summer and if they survive, may enter the ocean in late fall or the following year as yearlings. Over-summer stream rearing may be another important behavioral adaptation to maintain juvenile life history diversity for Chinook of Redwood Creek.

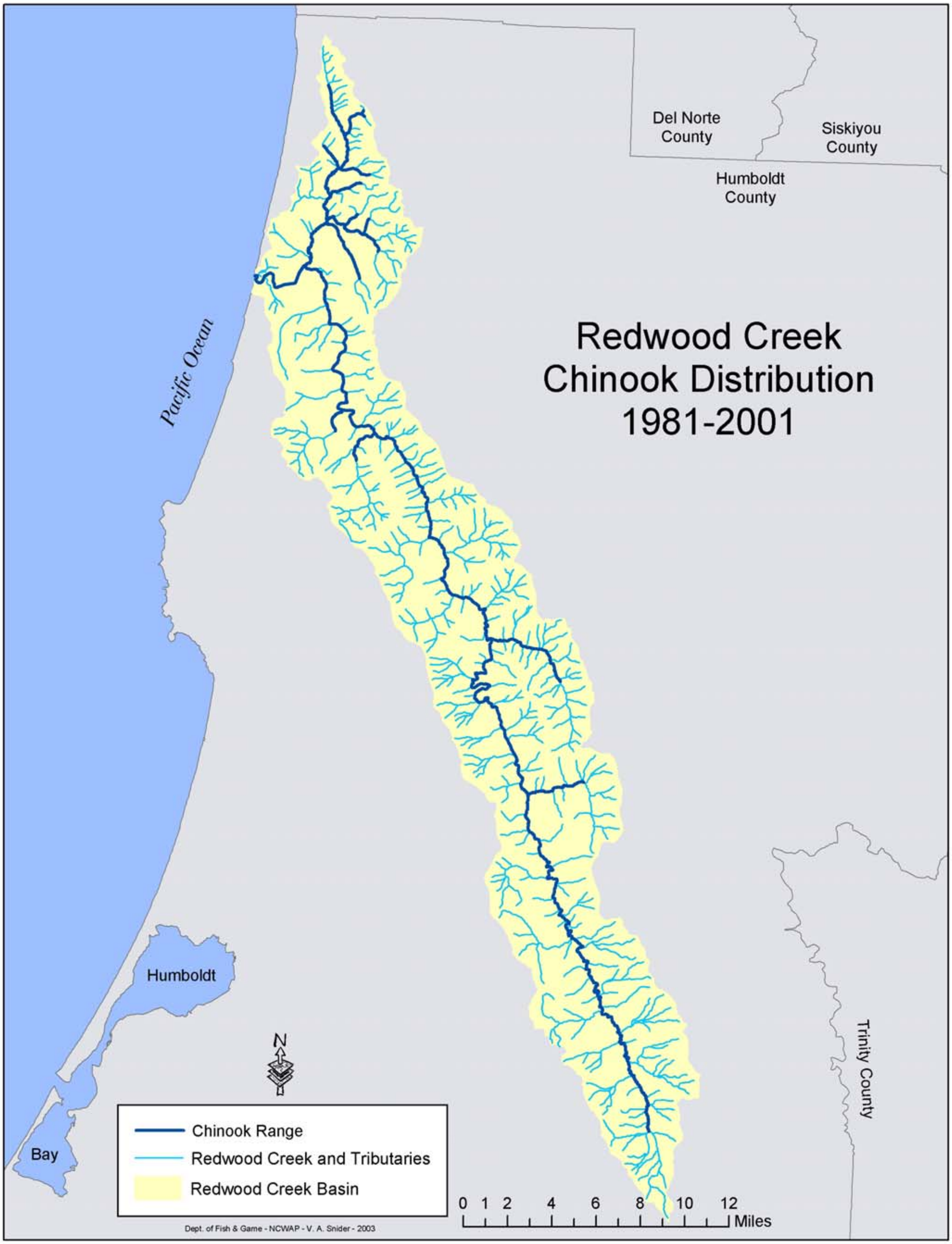

Figure III- 29. Stream habitat used by Chinook salmon for migration routes, spawning and juvenile rearing in the Redwood Creek basin. Adapted from Cal EPA and RNSP.

Chinook Downstream Migrant Trapping Studies and Spawner and Redd Surveys

Annual downstream migrant studies (March –August) of juvenile Chinook in Redwood Creek began in 2000. The studies use a rotary screw trap, located on Redwood Creek mainstem just below the confluence with Toss Up Creek, near river mile (RM) 37. These trapping efforts provide estimates of juvenile Chinook numbers produced from approximately 28 miles of mainstem Redwood Creek and eleven miles of tributary stream habitat located above the trap site. However, it is likely that the majority of spawning occurs in the mainstem reach.

The results from the trapping data indicate spawning success in the upper 1/3 of the Redwood Creek Basin during 2000-2002 but relatively low counts of juveniles were recorded in 2003 (Figure III- 30). The low counts of Chinook YOY in 2003 may be due to few adults returning to spawn or it may be due to redd scour associated with river flows that peaked at 23,000 cfs (at Orick) on December 28, 2003, after the majority of spawning was completed for that brood year. The moderately high flows may have buried or scoured the redds, leading to egg mortality. Spawning gravels located in aggraded stream reaches are highly mobile and redds built in such sites are at risk to scour from high flows (Meehan 1991) washing eggs and developing embryos from the protective gravel nests.

In addition, spawner and redd counts were conducted during December 2000 through February, 2001, along approximately twenty-seven miles of Redwood Creek located between the confluence of Lacks Creek (RM 28) in the Middle Subbasin and Minon Creek (RM 55) in the Upper Subbasin. A total of 208 redds, 413 live Chinook, 129 Chinook carcasses, and 2 live coho salmon was reported. One hundred thirty-eight redds (11.3 redds/mile) were observed in a 10 mile mainstem reach below the screw trap and 95 redds (5.3 redds/mile) were observed in an 18 mile reach above the trap. One survey in lower Lacks Creek found seven redds and one adult Chinook carcass (M. Farro 2002 personal communications). Optimal stream conditions were noted for counting redds, stream visibility was excellent, and crews were able to survey in a consistent manner. Adequate rainfall and ideal stream flows were present in 2000/2001 from the onset of the spawning season through fry emergence and into the early stages of the Chinook life cycle. The good flow conditions should have produced a high yield of eggs to fry (M. Farro personal communications).

Combined results from the downstream migrant studies and redd counts (collected from above the trap) were used to estimate survival of Chinook eggs to fry under good flow conditions. Using the 2000/2001 spawner survey data of 5.3 redds per mile, and assuming one female per redd, over the potential 28 miles of main stem habitat available, 148 females may have spawned above the screw trap in the 2000/2001 season. Assuming a 1:1.25 ratio of female to males provides an estimate of 172 males and a total of approximately 310 Chinook spawners above the screw trap based on redd counts.

Assuming 4000 eggs per female (M. Farro personal communication) and an escapement estimate of 148 females above the screw trap, approximately 64% (95 % CI range of 57-71%) of eggs survived to produce 378,000 (± 42,721) fry captured at the screw trap in 2001(more details can be found in Appendix D). This estimate assumes no mortality from time of emergence to capture at the trap. Once incubation is complete, Bjornn and Reiser (1991) reported that in laboratory studies, Chinook have difficulty emerging from gravel substrates when fine sediments exceeded 30% by volume and over 90% of swim-up fry emerged when less than 10% fine sediments were present. These escapement and egg to fry estimates should be used with caution but do provide insight into the magnitude of the run size into the upper reach of Redwood Creek and egg to fry survival for the 2000/2001 season.

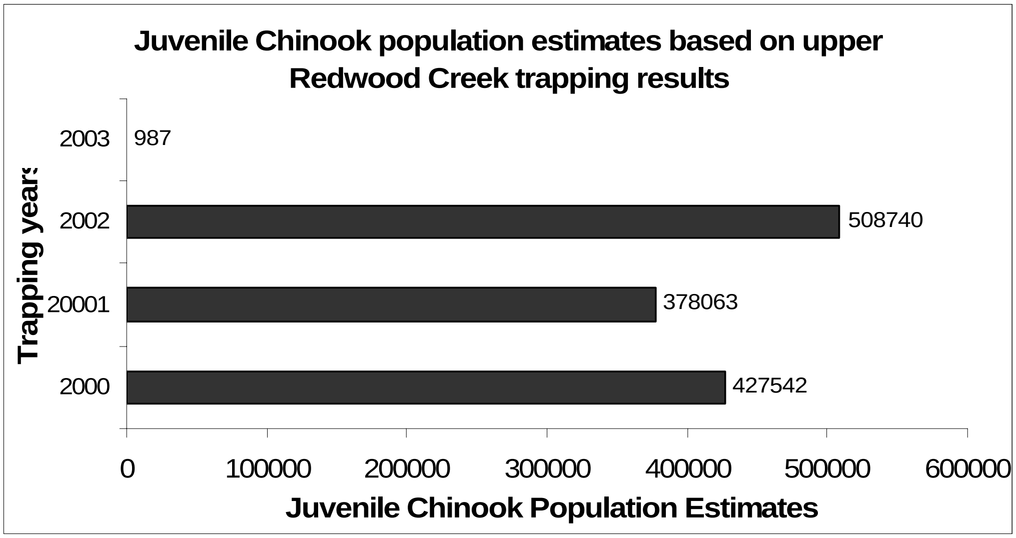

Figure III- 30. Yearly juvenile Chinook population estimates based on trapping results on Redwood Creek, 2000 to 2003.

From Sparkman 2000, 2001, 2002, and 2003. The 2000 effort trapped 123,633 young-of-the-year (YOY) Chinook and produced a population estimate of 427,542 ± 37,446 YOY. An additional 21 yearling Chinook were also captured (Sparkman 2001). In 2001, 120,692 juvenile Chinook salmon were trapped yielding a population estimate of 378,063 ± 42,721 YOY. The 2002 YOY population estimate is approximately 500,000 ± 23,000. However, the 2003 population estimate of YOY Chinook was only 987 ± 98.

A second rotary screw trap was operated by the Humboldt State University Cooperative Fishery Research Unit in 2001. The trap was located in the lower basin just downstream of the confluence with Prairie Creek (approximately three miles from the mouth of Redwood Creek) and approximately 30 miles from the middle Redwood Creek screw trap. This lower trap sampled fish moving downstream from both Prairie and Redwood creeks. A total of 21,383 YOY Chinook was captured with the trap. Population estimates could not be determined due to low mark recaptures during every week of trap operation (Wilzbach 2001). Trapping efficiencies were low due to the wide and shallow conditions of the channel, that allowed fish to escape capture by the trap.

A review of these trapping data suggests the majority of YOY Chinook move rather quickly downstream in May and do not grow much during the time they spend between the two trap locations. Peak YOY Chinook catches occurred during late May both screw traps (Figure III- 31). A second peak occurred in mid-June at the middle trap site, but this was not observed at the lower trap. The average size of juvenile Chinook captured at the lower trap was only slightly greater than those trapped approximately 30 miles upstream (Figure III- 32). Inspection of these data reveals that most YOY Chinook range from 40 mm (April) to 60 mm FL (July) at time of capture at both trap sites.

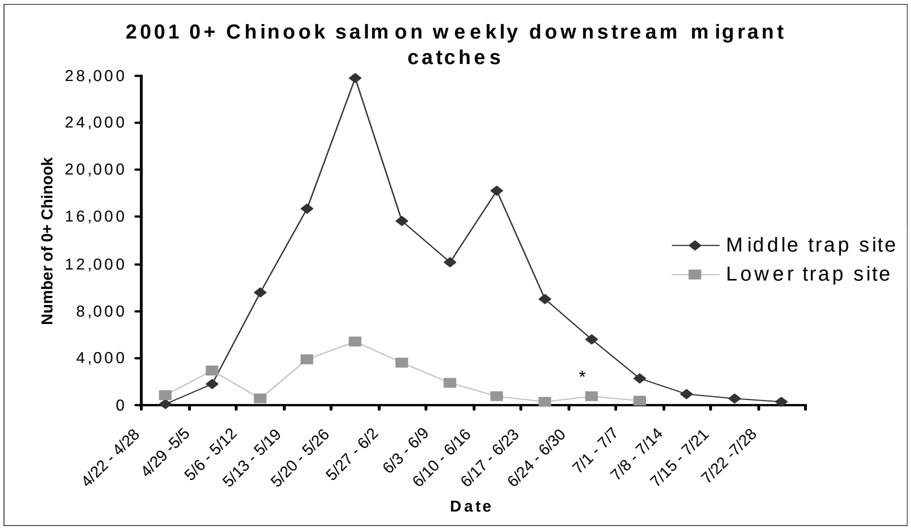

Figure III- 31. Temporal pattern of 0+ Chinook catches.

In middle Redwood Creek, trap located just downstream of Toss Up Creek and lower Redwood Creek (trap located just downstream of Prairie Creek) for the Summer of 2001. *Trapping on the lower trap ended July 4, 2001. (Adapted from Sparkman 2001 and Wilzbach 2001).

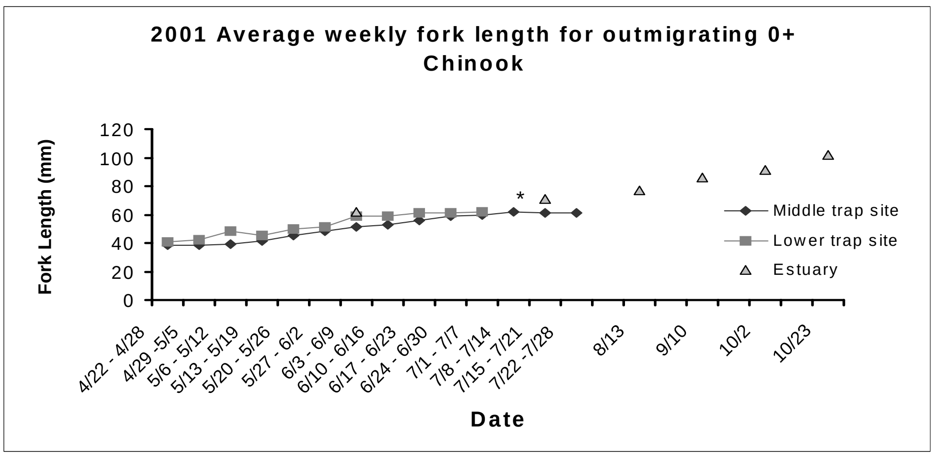

Figure III- 32. Average weekly fork lengths for 0+ Chinook.

In middle Redwood Creek (trap located just downstream of Toss Up Creek), lower Redwood Creek (trap located just downstream of Prairie Creek) and Estuary for the summer of 2001 (Adapted from Sparkman 2001 and Wilzbach 2001). *Trapping on the lower trap ended July 4, 2001. Average size of juvenile Chinook captured in the estuary is also provided.

Juvenile Chinook in the Estuary

Generally, estuaries are critical nursery habitat for juvenile Chinook for streams like Redwood Creek with temporally short mainstem rearing patterns. Estuaries provide a relatively sheltered, food rich environment where juveniles achieve important growth before entering the sea. Nicholas and Hankin (1988) reported that a great majority of Chinook returning to spawn in Oregon streams were greater than 100 mm when they entered the ocean as juveniles. In order to obtain the larger size, Chinook from many streams rear in estuaries and enter the ocean in late August through November (Reimers 1973, Nicholas and Hankin 1988, and Cannata and Hassler 1995). Ocean conditions also play an important role in determining the survival rate of juvenile salmonid smolts upon their first encounter with the marine environment however, it is generally accepted that larger juveniles have a survival advantage over smaller juveniles upon entering the sea.

The majority of juvenile Chinook arrive in the estuary from April to July. A review of two years of estuary sampling indicates an average size range of juvenile Chinook captured by beach seine is approximately 62-72 mm FL in early June before the sand bar closes the creek mouth and 70 -75 mm FL in mid-July after the mouth has closed (Table III- 34). The average size of these fish is below the desirable size for high survival rates upon ocean entry so they may remain in the estuary/lagoon to achieve further growth. The small size of juvenile Chinook arriving to the estuary may be due to the relatively short time spent migrating from spawning gravels to the estuary and/or low food availability in Redwood Creek.

It appears that in order for Redwood Creek Chinook to achieve 100 mm or greater size upon ocean entry, they must rear and grow in either riverine or estuarine habitats during the summer and early fall seasons. However, juvenile Chinook mortality rates are high in the lagoon under present conditions and only a small percentage of juveniles rearing in the lagoon survive to achieve the size of 100 mm. Estimates of 7 to 15% survival have been produced from studies conducted July to September in the lagoon during the summers of 2000 and 2001 (Table III- 34) (Anderson 2000 and 2001). The number that survive until fall rains breech the lagoon is likely even less.

Table III- 34. Comparison of Chinook fork length (FL) and population estimates.

Redwood Creek Screw Trap near Toss Up Creek- Spring/Summer 2000				**Redwood Creek Estuary - Summer/Fall 2000**				
Date	**Population est.**	**95% CI**	**Ave FL**	**Date**	**Mouth**	**Population est.**	**95% CI**	**Ave FL**
April	140,265	± 100,033	41.5	June 5,6,8	Open	55,640	37,930 - 73,360	72
May	109,903	± 30,597	51.2	July 17,18,20	Closed	18,350	490 – 38,840	74
June	159,297	± 29,142	59.3	Sept 11,12	Closed	2,910	1,960 – 3,860	94
July/Aug	18,075	± 4,200	66.5	Oct. 26	Closed	na*	na	111
Total:	**427,542**	**± 37,446**				**76,900**		
Redwood Creek Screw Trap near Toss Up Creek - Spring/Summer 2001				**Redwood Creek Estuary - Summer/Fall 2001**				
Date	**Population est.**	**95% CI**	**Ave FL**	**Date**	**Mouth**	**Population est.**	**95% CI**	**Ave FL**
4/22 - 5/5	48,220	na *	38.7	June 4	Open	58,633	± 19,531	62
5/6 - 6/2	260,400	na	44.1	July 16	Closed	34,259	± 27,032	71
6/3 - 6/30	62,553	na	53.8	Aug 13	Closed	3,616	± 3,035	77
7/1 - 8/4	6,890	na	60	Sept. 10	Closed	2,288	± 2,485	86
				Oct. 2	Closed	na	na	91
				Oct 23	Closed	na	na	102
Total:	**378,063**	**±42,721**				**175,696**	**±52,083**	

Collected from Redwood Creek screw trap (near Toss Up Creek) and by beach seine collections from the estuary/lagoon, 2000 and 2001. Ninety-five percent confidence intervals (95% CI) are included for population estimates (Anderson 2000 and 2001; Sparkman 2000 and 2001). * na= not available

Coho Salmon

Coho salmon (also known as silver salmon) of Redwood Creek typically exhibit a three-year life cycle, spending one year in freshwater streams and two years in the ocean before returning to spawn. However, each year 4 to 28% of the spawning run may be composed of 2-year old males called grilles (Shapovalov and Taft 1954). Most juvenile coho spend one year in streams before migrating to sea, but a proportion (estimates of 17%) of the juvenile coho population of Prairie Creek have been observed stream rearing for two years (Bell 2001 and W. Duffy personal communications 2001). These fish may not have achieved large enough size to migrate to sea as yearlings. Studies found that these were significantly smaller than other juvenile coho of the same age during their first winter in freshwater. Could this be a sign of habitat deficiencies? During their second winter and as outmigrants, these age 2+ coho were on average larger than age 1+ coho (Bell 2001). Coho that enter the ocean at age 2+ have returned to spawn as four year old adults (T. Weseloh, Cal Trout, personal communication).

Because coho spend a year or more in freshwater streams, they depend upon complex channels with woody debris, cool water, good shade canopy, and sufficient food to sustain them through their fry and juvenile stages. In addition to complex mainstem habitat, secondary channel habitats such as alcoves and backwater pools with large woody debris cover are highly preferred habitat conditions for juvenile coho salmon (CDFG 1991).

Coho populations in Redwood Creek, like in other California watersheds, have declined in numbers and distribution compared to their historic presence (CDFG 2002). Moyle et al. (1995) estimated that in the mid 1990s, 5,000 wild coho salmon (no hatchery influence) spawned in California each year. This is a dramatic decline from statewide estimates from the 1940s, which estimated there were anywhere from 200,000 to one million adult coho in California (Calif. Advisory Committee on Salmon and Steelhead Trout 1988).

In 1951, Redwood Creek was considered an excellent "silver salmon" stream by Hallock et al. (1952) and was considered a good release site for marked fish as part of a salmon fingerling marking program. As a result, over 10,000 marked young-of-the-year (YOY) coho were released (May through July 1951) into deep pools located on lower Redwood Creek (Hallock et al. 1952). Recent stream surveys (CDFG 2001 and 2002) failed to detect juvenile coho in the same area as Hallock considered excellent coho habitat in 1951.

The coho population of 1960 was estimated at 2,000 spawning adults (U.S. Fish and Wildlife 1960). This estimate was derived from data collected on other streams and applied to Redwood Creek and was meant to provide only the general magnitude of coho runs of the late 1950s. This estimate is not indicative of the larger runs of prior years (USFWS 1960; CDFG 1965; RNSP 2000). Coho of Redwood Creek belong to the Southern Oregon-Northern California (SONC) Coho Evolutionary Significant Unit (ESU).

In response to declining populations in California, coho of the SONC coho ESU were listed in 1997 as "threatened" under the Federal Endangered Species Act. In 2002, the California Fish and Game Commission found that in the region of Redwood Creek, coho salmon warranted listing as threatened, as defined under the California Endangered Species Act (CDFG 2002). The Department of Fish and Game has formed a coho recovery team that will aid the Department in planning recovery and implementing a recovery strategy for coho salmon north of San Francisco.

The Prairie Creek basin provides some of the most important coho habitat in the Redwood Creek basin. Outside of the Prairie Creek drainage, coho have recently been found in the lower and middle reaches of Redwood Creek and Tom McDonald Creek, Bridge Creek, McArthur Creek, Coyote Creek, Minor, Lacks, Panther, Karen, Strawberry, and Pilchuck Creek (Figure III- 33) (Anderson 1988; Brown 1988; Neillands 1990; PCFWWRA 1995; DFG 2001 surveys; DFG 2002; and RNSP unpublished data). However, electro-fishing conducted in the summer of 2001 did not produce any coho in Bridge, Coyote, Karen, and Pilchuck Creeks, nor in any other tributaries surveyed in the middle or upper portions of the basin (see Appendix D, Attachment 1). In addition, no coho were reported from the upper 1/3 of the Redwood Creek basin during downstream migrant studies conducted during 2000, 2001, and 2002 (Sparkman 2001 and personal communications 2002).

Current adult coho population estimates are not available for the Redwood Creek basin, but recent counts were collected from a weir located on Prairie Creek just above the confluence of Streelow Creek. The adult counts for 1995-96 and 1996-97 were only 115 and 124 coho salmon respectively (Roelofs and Klatte 1996 and 1997). These counts reflect approximately 14 of the 22.5 miles of habitat accessible to coho salmon in the Prairie Creek basin. A 1997 population estimate of 24,588 out migrating juvenile coho was made for the portion of the Prairie Creek basin above Streelow Creek (Klatte and Roelofs 1997).

Weekly downstream migrant trapping just below Prairie Creek data show peak migration of age 1+ coho occurred in mid May in 2001(Figure III- 34) and their average size ranged approximately between 105 and 115 mm FL (Figure III- 35) (Wilzbach 2001). The trapping effort had low capture efficiency, but likely reflects the low numbers of age 1+ coho salmon produced from the Redwood Creek basin. A smaller number of YOY coho were also captured from the trap. Several juvenile coho have been collected in the estuary (1,390 ± 630 in year 2000) and a few have resided in the lagoon over summer (Anderson 2000). Coho salmon redd and carcass counts from Prairie Creek 1983-2002 are provided in the Prairie Creek Subbasin section of this report.

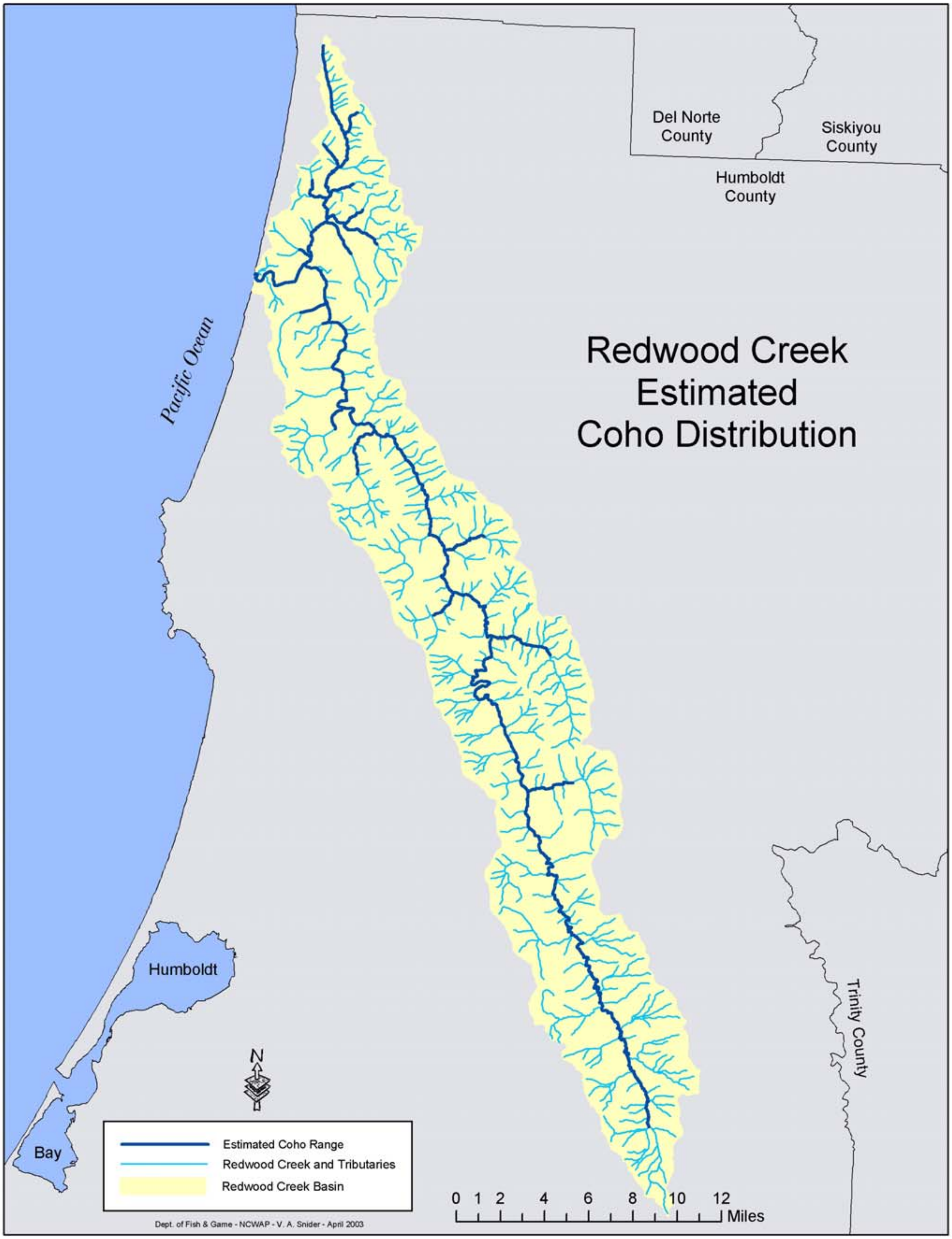

Figure III- 33. Estimated stream habitat used by coho salmon for migration routes, spawning and juvenile rearing in the Redwood Creek basin. Adapted from Cal EPA and RNSP.

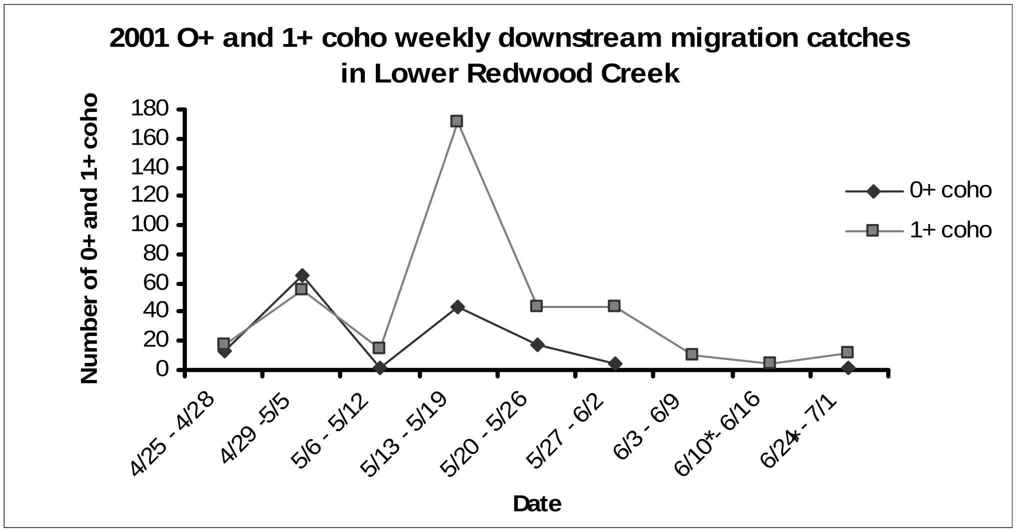

Figure III- 34. Weekly catches of 0+ and 1+ Coho in the lower Redwood Creek area, (Trap Located Just Downstream of Prairie Creek), 2001 (Wilzbach 2001).

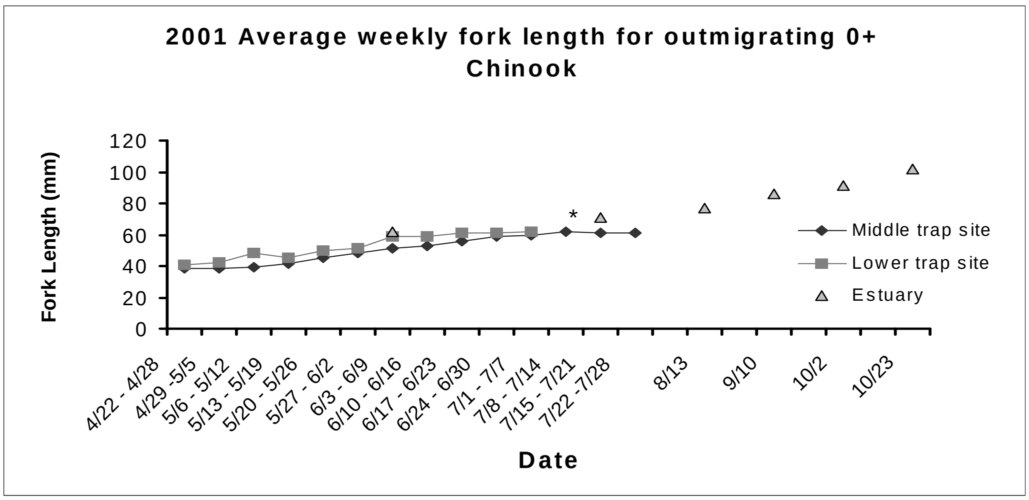

Figure III- 35. Average weekly fork lengths for age 0+ and 1 + Coho in the lower Redwood Creek area, (Trap Located Just Downstream of Prairie Creek), 2001 (Wilzbach 2001).

Steelhead

Redwood Creek supports two distinct runs of steelhead, a winter run, and a summer run. In addition, "half-pounder" steelhead, which may range in size from approximately 10 to 18 inches, return after a short period of ocean rearing.

A map showing the distribution of steelhead in Redwood Creek basin is presented in Figure III- 36. Although steelhead numbers have likely decreased from historic levels, their decline in numbers and distribution is not as significant as coho or sea run coastal cutthroat in the Redwood Creek basin. A map showing the distribution of steelhead in Redwood Creek basin is presented in Figure III- 36. This difference may be attributed to their ability to tolerate a broader range of habitat conditions compared to coho or coastal cutthroat, which share similar juvenile rearing strategies. Coho and coastal cutthroat are more sensitive to high water temperature and exhibit a greater affinity for complex habitat than steelhead (Rosenfeld et al. 2000). The summer run steelhead is considered a distinct stock and is discussed separately below.

Steelhead typically spend one to three years in inland waters before migrating to the ocean. Peak migration to the ocean occurs during March through May. Steelhead typically live in the ocean from one to four years before returning to freshwater streams to spawn. In contrast to all anadromous Pacific salmon, steelhead may not die after spawning. Incidence of repeat spawning by steelhead ranges from about 17.6% for small coastal streams to 63.6% for spring run of the Sacramento River system (Hopelain 1998). Steelhead may repeat spawning migrations as many as four times (Barnhart 1986 and Hopelain 1998).

The U.S Fish and Wildlife service estimated a run of approximately 10,000 steelhead populated Redwood Creek in 1960 (USFW 1960). This number was derived from data collected on other streams and applied to Redwood Creek. It was meant to provide only the general magnitude of steelhead runs of the late 1950s and is not indicative of the much larger runs of prior years (USFWS 1960; CDFG 1965; RNSP 2000). A review of available information suggests that the present populations of steelhead are less abundant compared to historic population levels and may be less abundant than the USFWS estimates of 1960.

Steelhead of Redwood Creek are included in the Northern California Evolutionary Significant Unit (ESU), which was listed as “threatened” in 2000 under the Federal Endangered Species Act. The Northern California ESU is defined as a distinctive group of steelhead that occupies coastal river watersheds from Redwood Creek south to the Gualala River. A rough estimate of the total adult steelhead population for California is 250,000 adults, less than half the population thirty years ago (McEwan and Jackson 1996). The major factor for the decline is freshwater habitat loss and degradation including inadequate stream flow, blocked access to historic spawning and rearing grounds, and human activities that generate and deliver sediment into watercourses (McEwan and Jackson 1996).

Steelhead were observed in 57 of 111 Redwood Creek tributaries surveyed for fish presence in 1980–1981 (Brown 1988). Steelhead also was the most widely distributed and numerous salmonid species observed in the Redwood Creek basin in the summer 2001 CDFG electrofishing surveys. Young of the year (YOY) trout was the most abundant age class found in all streams during 2001 surveys. The presence of YOY indicates successful spawning likely occurred in those streams. Alternatively, YOY may have moved into the area from other sites, or drifted downstream from above anadromous barriers. There were a number of streams (Panther Creek, Garrett Creek, Mill Creek, Molasses Creek, Minon Creek, and Lost Man Creek) in which the percentage of 1+ steelhead was relatively high (>25% of the total steelhead count) (DFG surveys 2001). The presence of 1+ and older steelhead may indicate a positive measure of steelhead habitat suitability. The absence or very low numbers of 1+ and older may indicate a habitat deficiency or habitat factor limiting the advancement of YOY to yearlings. Attachment 2 in Appendix D shows the results from electrofishing surveys in Redwood Creek. It is important to note that these qualitative surveys provide only a qualitative estimate of distribution, year class strength and population structure.

A portion of the basin’s steelhead population was sampled by a rotary screw trap during the spring to early summer seasons of 2000 to 2003 (Sparkman 2000, 2001, 2002, 2003). The trap was located on Redwood Creek, just downstream of the confluence with Toss Up Creek, and is the same trap described in the previous discussion of Chinook salmon. These data were used to estimate the numbers of age 1+ and 2+ steelhead moving downstream from approximately twenty-eight miles of mainstem Redwood Creek and eleven miles of tributary stream habitat of accessible habitat in the upper 1/3 of the Redwood Creek basin (Table III- 35 and Figure III- 37).

The results from the rotary screw trap data should be interpreted differently for steelhead compared to Chinook. This difference is primarily because the great majority of juvenile Chinook caught at the trap are undergoing seaward migrations where as not all juvenile steelhead are necessarily migrating to the sea. Steelhead exhibit diverse juvenile life history patterns, which may include upstream and downstream movements within the mainstem and tributary streams. In addition to seaward migrations, movements are often due to a density dependant response, behavior adaptations, or a change in environmental conditions. The estimates of age 1+ steelhead are likely influenced by these factors, while the age 2+ steelhead are more likely to be migrating towards the sea. Many downstream moving steelhead will take up summer residence in the estuary.

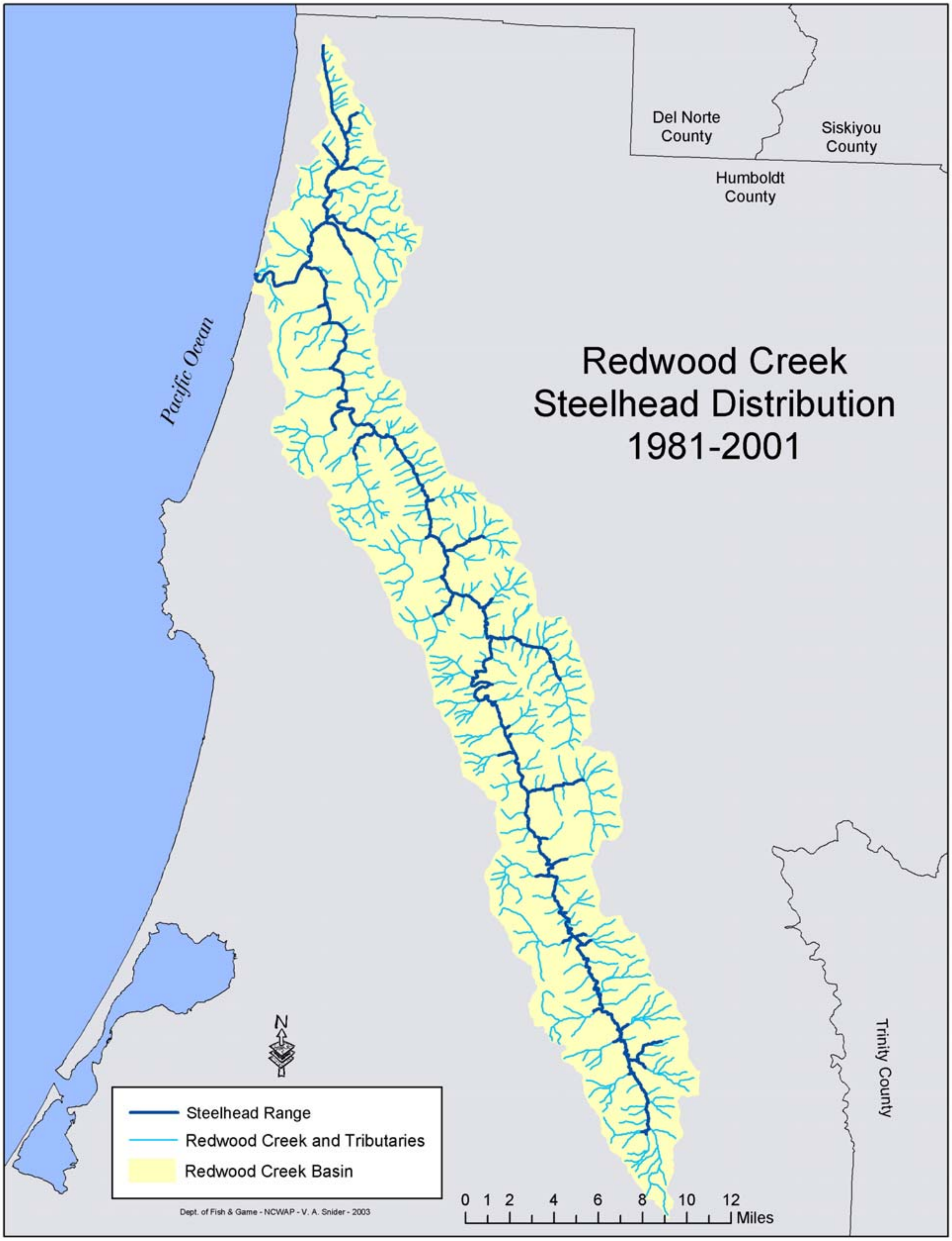

Figure III- 36. Stream habitat used by steelhead for migration routes, spawning and juvenile rearing in the Redwood Creek basin. Adapted from Cal EPA and RNSP.

Table III- 35. Number of captures and population estimates for juvenile steelhead and average fork lengths (FL) collected from Redwood Creek screw trap near Toss Up Creek (adapted from Sparkman 2000, 2001, 2002).

Redwood Creek Screw Trap - Spring/Summer 2000						
Date	**# of 1+ Steelhead**	**Population Estimate**	**Ave FL (mm)**	**# of 2+ Steelhead**	**Population Estimate**	**Ave FL (mm)**
4/5 - 4/29	9,159	11,062	79.9	341	2,171	169.1
4/30 - 5/27	5,550	30,262	88.4	247	1,360	165.4
5/28 - 7/1	3,256	24,996	100.8	71	678	150.1
7/2 - 7/29	188	1841	109	59	429	155.7
7/30 - 8/5	30	168	107.3	18	102	157.1
Total:	**12,263**	**68,328**	**92.4**	**736**	**4,740**	**164.4**
Redwood Creek Screw Trap - Spring/Summer 2001						
3/27 -3/31	1,298	2,789	83	107	703	154.5
4/1 - 4/28	6,816	16,153	86.4	461	3,603	156.5
4/29 - 5/26	4,507	15,338	93.6	376	3,290	151.8
5/27 - 6/30	2,037	15,016	98	287	4,483	138
7/1 - 8/4	117	1359	87	129	590	153.7
Total:	**14,775**	**50,654**	**91.9**	**1,360**	**12,669**	**151.2**
Redwood Creek Screw Trap - Spring/Summer 2002*						
Totals	12,217	28,501 +/- 6.3%	86.7mm	1,589	7,370 +14.7%	147.5mm

*Only total numbers of steelhead were available for 2002.

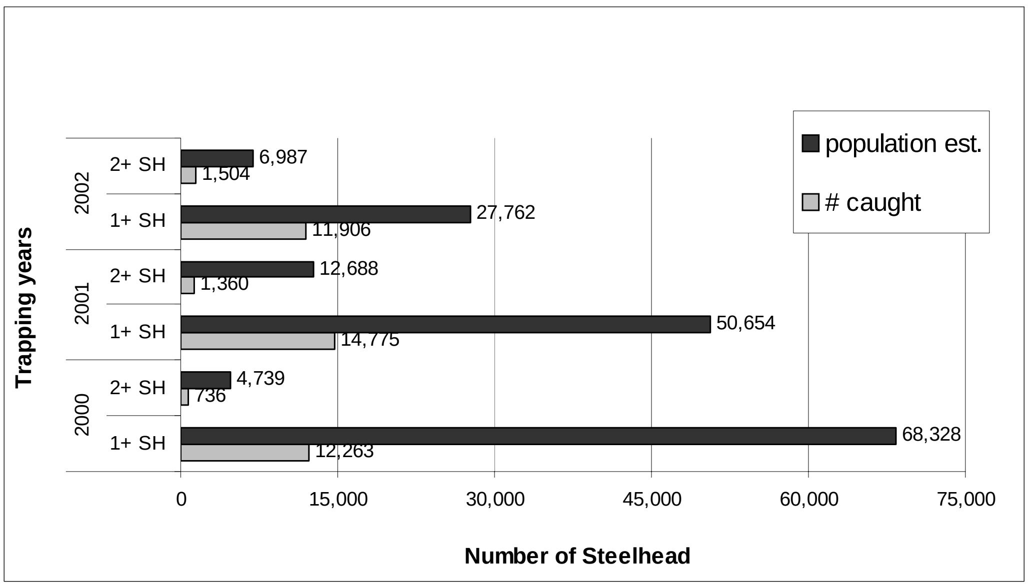

Figure III- 37. Yearly juvenile steelhead population estimates, 2000-2002. Adapted from trapping results on Redwood Creek (Sparkman 2000, 2001, and 2002).

An important juvenile rearing strategy used by steelhead, including Redwood Creek stocks utilizes the estuary/lagoon. Juvenile steelhead are known to rear in estuaries/lagoons for several months to one year or more before entering the ocean (Anderson 1988; Ridenhour and Hofstra 1994; Cannata 1998). Estuarine-reared juvenile salmonids often achieve growth rates greater than achieved in small streams because estuary/lagoon ecosystems usually provide an abundant amount of living space and are food rich environments. Like the juvenile Chinook, a high level of mortality occurs to the steelhead rearing in the Redwood Creek lagoon during summer and early fall (Table III- 36).

Table III- 36. Juvenile steelhead population estimates and average fork lengths.

Date	Mouth	Population est.	Ave FL
Steelhead population data Redwood Creek Estuary - Summer/Fall 2000			
5-June	OPEN	12,780	126
July 17,18,20	CLOSED	8,950	202
Sept 11,12	CLOSED	4,270	220
26-Oct	CLOSED	not available	
Steelhead population data Redwood Creek Estuary - Summer/Fall 2001			
4-Jun	OPEN	38,456	113
16-Jul	CLOSED	34,259	89
13-Aug	CLOSED	4,612	81
10-Sep	CLOSED	9,348	126
2-Oct	CLOSED	not available	118
23-Oct	CLOSED	not available	147

LF = Fork Length.
Collected from Redwood Creek estuary/lagoon 2000 and 2001 (Anderson 2000 and 2001).

Summer Steelhead

Summer steelhead migrate into freshwater streams from spring through early summer (Barnhart 1986). Currently, only 20 streams in Northern California are populated with summer steelhead including Redwood Creek (Gerstrung 2001 draft). These streams must provide cool, deep pools of sufficient size and complexity to support adults over the low flows and high water temperatures of summer and early fall seasons. The summer steelhead population of Redwood Creek is likely the most threatened by extirpation of all salmonids in the Redwood Creek basin.

Summer steelhead enter fresh water sexually immature and consequently must wait several months before spawning. They rely on the remaining high spring flows to allow passage upstream where they hold in deep pools over the summer and fall. The majority of adult summer steelhead of the Eel River Basin utilize pools from 10 to 20 feet deep for over summer habitat (Scott Harris, CDFG, Personal Communication). Similar conditions were once abundant in Redwood Creek. In addition to deep pools summer steelhead prefer water temperatures less than 66ºF (19ºC) (Baigun et al. 2000) and ample cover such as large rootwads, underwater ledges, caverns, and bubble curtains, which fish seek when disturbed. Spawning summer steelhead may be somewhat spatially and temporally segregated from winter steelhead. Generally, summer steelhead spawn December through February in smaller tributaries or in the headwaters of larger systems, further upstream than winter steelhead (Barnhart 1986).

Little is known about historical abundances of the Redwood Creek summer steelhead population because quantitative records date back only the two or three decades (Anderson 1993). But, there is a considerable amount of evidence depicting a relatively large historic population. Native Americans depended on summer steelhead of Redwood Creek for subsistence, and they were frequently harvested before the fall salmon runs, supplementing the harvest of big game (Moyle et al. 1995). Sport fisherman used to enjoy the abundance of Redwood Creek summer steelhead runs in the late 1800's to early 1900's. Interviews with long-time residents of Redwood Creek gave testimony to "real good" summer steelhead runs in the past. "There are still a few, but not nearly as many as there used to be" (Van Kirk 1994). A 1920 article in American Angler gave the following description of summer steelhead in upper Redwood Creek: "Every pool has ten to twenty five, and they run from twenty to thirty-six inches. Some of the pools were up to 20 feet deep" (Gerstrung 2001 Draft).

Today, Redwood Creek supports a small population of summer steelhead. Average numbers of fish observed during summer snorkel surveys performed from 1981 to 2000 are typically between 15 to 40 fish (Figure III-38). Counts have ranged from a high of 44 adults in 1984 and 1985 to a low of three adults in 2000 (Gerstrung 2001 draft). However, snorkel surveys have not been conducted over the same areas each year, which may contribute to the variability in these numbers. In the 1990s, the majority of the observations were made on Redwood Creek mainstem from the confluence of Lacks Creek upstream to Bradford Creek. Deeper, more numerous pools are located in this reach of Redwood Creek.

Summer steelhead are known to depend on deep and cool pools as habitat during summer months and fall months. Under present conditions, ambient water temperatures in Redwood Creek range from 68-80.6ºF (20-27ºC). Deep, stratified, cool pools may be necessary to provide summer refugia for adult summer steelhead (Nielsen et al. 1994, Ozaki et al. 1999). Fewer than 25 suitable pools have been observed in the 12-mile reach between Stover Creek and Chezem dam (Weseloh 1993). The lack of deep, complex pools reduces the suitability of Redwood Creek for summer steelhead.

The decline of summer steelhead illustrates how temporary loss of a critical habitat element such as adult over-summer habitat, may have long-term adverse impacts to survival of a stock. The large scale reduction of deep pools that occurred from excessive sedimentation during the 1964 flood likely had a dramatic adverse impact on the summer steelhead population of Redwood Creek. As a result, the current breeding population may be less than the minimum size needed to sustain a viable population (Meffe 1986), placing summer steelhead of Redwood Creek at a high risk of extinction (Nehlsen 1991). If habitat conditions improve in Redwood Creek, then the summer steelhead population may increase in size.

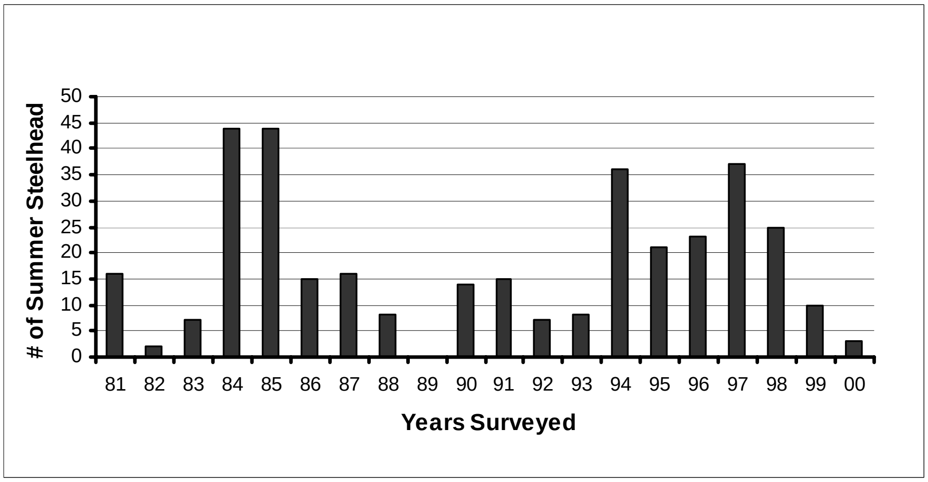

Figure III- 38. Summer steelhead dive counts on Redwood Creek, 1981-2000.

Adult summer steelhead numbers represent steelhead greater than sixteen inches in length. Survey efforts varied year to year. Full surveys (Hayes Creek upstream to Bradford Creek) were completed in 1987 and 1993 through 1998; three-fourths (Hayes Creek upstream to Highway 299 bridge) in 1981; and half surveys (Hayes Creek to Lacks Creek) were completed in 1983-1986, 1988-1992, and 1999 through 2000. In 1984 and 1985 adults and half-pounders were not counted separately; the adults were most numerous [Gerstrung 2001 (Draft)].

Coastal Cutthroat Trout

Coastal cutthroat trout range from the lower Eel River north to the southeastern portions of Alaska. Redwood Creek supports anadromous and resident forms of coastal cutthroats. Anadromous forms are often called sea run coastal cutthroat. However little is known about their use of ocean waters or their migratory habits (Gurstung 1996).

Coastal cutthroat trout are found in the estuary, Prairie Creek, Redwood Creek, and several tributaries throughout the basin (Brown 1988; Gerstrung 1996; and B. Michaels, Green Diamond, personal communication). The majority of the known anadromous population resides in the Prairie Creek drainage where nearly all tributaries support sea run coastal cutthroat (Gerstrung 1996). Historic records indicate that coastal cutthroats up to four pounds were commonly caught by sportfishers in the estuary (Snyder 1908 and Van Kirk 1994), but fish of that size are rarely observed from samples collected recently (D. Anderson, RNSP, personal communications 2002). Snyder (1907) described Redwood Creek as "fairly swarming" with coastal cutthroats. Today, coastal cutthroat trout are listed as a species of special concern in California and are also a candidate species for federal listing. "The coastal cutthroat has been compared to the "canary in the gold mine" because it is one of the first species to suffer from environmental degradation" (Gurstung 1996).

Coastal cutthroats exhibit a wide range of life history characteristics. In Northern California, coastal cutthroat begin migrations to spawning streams in August through October, following the first substantial rainfall. Ripe or nearly ripe females have been observed September through April, indicating a protracted spawning period (Moyle et al. 1995). They generally spawn in smaller tributaries or further upstream than steelhead trout and coho salmon where their offspring rear without competition from most other salmonids species (Pauly et al. 1989). Anadromous female cutthroat seldom spawn before the age of four years old and are capable of repeat spawning in subsequent years. Coastal cutthroat typically live from 4-7 years (Moyle et al. 1995). However, the mortality rates are generally high after the initial spawn. Most anadromous cutthroat trout juveniles migrate in spring to the ocean at age two, but seldom overwinter at sea; rather they return to rivers in the fall or winter of the same year (Trotter 1989). Many coastal cutthroat may reside in the estuary year round and many are likely long-term residents in streams.

Resident coastal cutthroats may utilize a potamodromous life history strategy. That is, they may use the estuary or larger streams for primary residence and ascend small streams for spawning. Resident coast cutthroat populations also occur above anadromous reaches of the tributaries to Redwood Creek throughout the basin (Ridenhour and Hofstra 1994; Brown 1988; and B. Michaels personal communication 2002). Little is known about the status of resident coastal cutthroats of the Redwood Creek basin.

In the late 1800s and into the early 1900s Redwood Creek and Prairie Creek the coastal cutthroat populations were harvested by many local and visiting sport anglers (Snyder 1907, Dewitt 1954, USDI 1960, Van Kirk 1994). As one local angler said "coastal cutthroat trout were abundant" and in some years, there were as many coastal cutthroat trout migrants as steelhead (Gerstrung 1996). The coastal cutthroats provided a popular summer fishery which attracted anglers from San Francisco and other areas. However, the fisheries popularity and the daily limit of 25 pounds were more than adequate to reduce populations. By 1925, the coastal cutthroats of lower Redwood Creek and Prairie Creek were over harvested. The number of visiting anglers coming to fish Redwood Creek also declined which affected the local economy (Van Kirk 1994).

In response to the decline in the fishery and the public's desire to supplement declining stocks, the Prairie Creek Hatchery was constructed in 1927. The facility's goals were to collect coastal cutthroat eggs for hatchery propagation and release fry back into the basin. The egg taking and stocking proved unsuccessful in restoring the cutthroat fishery. While their populations continued to decline slowly, it was not until later that coastal cutthroat populations in Redwood Creek crashed in response to detrimental habitat changes during the mid 1960s (Gerstrung 1996).

In the summer of 2001, five tributaries of Prairie Creek were sampled by electro-fishing for presence of fish species by CDFG survey crews. Coastal cutthroat were present in four of the tributaries, but they were few in numbers. The anadromous reaches of fifteen tributaries located in the Middle and Upper subbasins were also electro-fished by CDFG field crews. Only Panther Creek yielded a few coastal cutthroat. Dive surveys along the mainstem of Redwood Creek from 1991 to 1996 averaged 0.5 fish / kilometer (Gerstrung 1996). Dive counts increased in 1999 and 2000 from previous levels (Figure III- 39). Almost 85% of the cutthroat observed in 1999 and 2000 in mainstem Redwood Creek were counted between the confluences of Hayes Creek upstream to Coyote Creek.

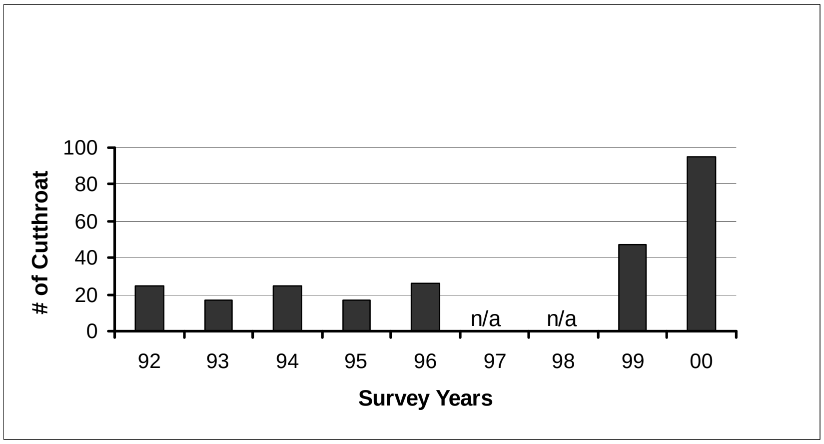

Figure III- 39. Number of coastal cutthroat trout observed during summer steelhead snorkel surveys on Redwood Creek mainstem, 1992-2000.

Surveys were typically from the confluence of Hayes Creek upstream to Lacks Creek. Most of the coastal cutthroat trout observed were adults. Counts of coastal cutthroat were not made in 1997-98.