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North Coast Watershed Assessment Program
Redwood Creek Watershed Synthesis Report

APPENDIX D

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**Assessments of Anadromous Salmonids and Stream
Habitat Conditions of the Redwood Creek Basin**

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Redwood Creek Basin Overview

The Redwood Creek basin is located north of Eureka in Humboldt County. The basin drains an area of approximately 285 square miles. The Basin is approximately 65 miles long from its headwaters to the Pacific Ocean with widths ranging from 4 to 7 miles, and a maximum relief of 5300 feet. The Redwood Creek basin is composed of a variety of geologic units, some of which are relatively unstable and generate highly erodible soils. The elongated shape is controlled by the presence of the Grogan Fault which passes along most of the Redwood Creek channel in a northwesterly direction. Sandstones and siltstones predominate on the east side of the basin and schist on the west (Madej and Ozaki 1995). The bedrock is part of the Franciscan Assemblage and is previously sheared and fractured (Madej and Ozaki 1995). Intense winter rains following long periods of moderate rain can initiate landslides, debris flows, and gullying which often deliver large quantities of sediment to the streams. As a result of sediment delivered from unstable soils, land use, and intense winter rains, Redwood Creek carries quantities of suspended sediment that are as high as any stream of its size in the United States (Madej and Ozaki 1995).

Climate

Annual precipitation in the Redwood Creek basin ranges in amount from 32 to 98 inches and falls mostly during the winter and spring. Average rainfall is approximately 70 to 80 inches per year, with frequent snow above 1600 feet during winter months. Temperatures vary only slightly along the coast, inland areas experience a greater fluctuation. Mean temperatures at Redwood Park are 47 in January and 59 in June. Fog is a dominant climatic feature along the coast, generally occurring daily in the summer and not infrequently throughout the year. Higher elevations and inland areas tend to be relatively fog free.

Geology

The Redwood Creek basin is formed mostly of sheared and fractured bedrock: sandstone deposits that were scraped off an ancient sea bed and uplifted over 2 million years ago by the North American Tectonic Plate. The Grogan fault bisects the basin and separates schist (west) from coherent sandstone and incoherent sandstone-mudstone units (east). Vegetation, stream gradient, and aquatic habitat vary with rock type. Geomorphic expression on schist varies. Slopes are gently convex; side-slope gradients average 25%; ridges are broad and flat; and typically streams are shallowly incised. Conversely, on the eastern resistant coherent unit sharp ridge crests, steep slopes, and narrow V-shaped canyons prevail. Subdued and rolling topography and less deeply incised drainages characterize the incoherent unit. Most prairies have developed on the incoherent unit.

Vegetation

The primary vegetation types within the Redwood Creek basin include coniferous forests (92%), oak woodland (9%) and prairie (9%). Distribution depends on available soil moisture during

summer months and is influenced by proximity to coast, soil types, land disturbance, and the occurrence of fire. The coast redwood (*Sequoia sempervirens*) is the dominant tree in the lower half of the basin, and is generally found in association with other tree species, principally Douglas-fir, Sitka spruce, big leaf maple, tanoak and red alder. Nine species of ferns decorate the redwood forest along with several flowering salal, oxalis, western azalea, rhododendron, trillium, huckleberry, salmonberry, blackberry and numerous flowering herbs.

Land Use

Public lands (79,452 acres) comprise 44% of the basin, mostly managed by Redwood National and State Park (73,316 acres). The remaining public lands (6,136 acres) are under Bureau of Land Management and U.S. Forest Service management. Private lands comprise 55% of the land ownership (101,142 acres), primarily upstream of the park boundaries with eight large ownerships (90%, each is >3000 acres) and numerous small ownerships (10%, each <3000 acres). Private lands below the confluence of Prairie Creek represents the remaining 1%.

Principle land use in the basin includes recreation, timber harvest, grazing, pasture, and roads. Fourteen percent of the basin remains as uncut redwood forests (24,315 acres), all protected within parks' boundary. Little Lost Man Creek is the least impacted tributary watershed where approximately 2,109 acres of old growth remains (89% of basin).

Redwood National Park was established to protect and restore all significant examples of old-growth coastal redwood forests, including anadromous fish as a keystone species. In 1978, Public Law 95-250 added 48,000 acres to Redwood National Park and authorized Congress to appropriate up to \$33 million to implement a watershed rehabilitation program. Restoration efforts concentrate on preventing human-induced erosion and encourages the return of natural vegetation patterns in the watershed. Redwood Creek has been the focus of significant ongoing scientific research in cooperation with USGS, Humboldt State, Redwood Sciences Laboratory and other partners. Redwood National and State Parks are jointly recognized as a World Heritage Site and one of the 337 International Biosphere Reserves designated by the United Nations Educational, Scientific and Cultural Organization (UNESCO) to maximize protection of resources cherished by citizens of many nations.

Fishery Resources

Redwood Creek basin supports 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 1.). Due to a lack of quantitative information, historical population estimates of anadromous salmonids are unknown. However, based on anecdotal information, expert opinion, amount of historical and current suitable habitat, qualitative assessments, and comparisons with other north coast streams, it is highly probable that populations have declined significantly compared to historical numbers. The U.S. Fish and Wildlife Service Redwood Creek (USFWS) produced the only published estimates of the salmonid population of Redwood Creek basin. In 1960, USFWS estimated

5,000 chinook, 2,000 coho, and 10,000 steelhead were present in the Redwood Creek basin (USFWS 1960). However, these estimates were based on fish numbers from other streams of similar size and characteristics as Redwood Creek and are also likely below historical levels.

In response to declining populations across their southern range, chinook, coho, and steelhead were listed in the late 1990's as "threatened" under the federal endangered species act. Coast Cutthroat is considered California species of special concern by the Department of Fish and Game. These protective measures are intended to help sustain viable populations and aid in the recovery of stocks at risk of extinction and avoid the status of Atlantic salmon presented below.

"The historic North American range of Atlantic salmon extended from the rivers of Ungava Bay, Canada, to Long Island Sound. As a consequence of industrial and agricultural development, most populations native to New England have been extirpated. Remnant native populations of Atlantic salmon in the United States now persist only in eastern Maine" (NMFS 2000).

There are approximately 50 miles of tributary streams (Brown 1988) and 65 miles of Redwood creek mainstem accessible to anadromous salmonids. Brown (1988) identified forty-six fish bearing tributary streams (excluding the Prairie Creek watershed) to Redwood Creek as it flows from its headwaters through a narrow, steep valley basin before entering the ocean near the town of Orick. The steep channel gradient of the tributaries limits anadromous fish habitat to only the lower segments of the tributary streams. Seventy-five percent of the tributary streams provide less than half a mile of anadromous fish (Brown 1988). Prairie Creek is the largest tributary to Redwood Creek and joins the main channel of Redwood Creek approximately 3.5 miles upstream from the estuary. Prairie Creek drains the northwestern, lower gradient portion of the Redwood basin and contains at least nine fish bearing tributary streams. A total of 22.5 miles of stream habitat is available to anadromous salmonids in the Prairie Creek watershed. Nearly half of all tributary streams accessible to anadromous salmonids of the Redwood Creek basin is located within the Prairie Creek watershed.

Historically, the salmon, steelhead, and cutthroat trout of Redwood Creek were important food supply to Native Americans and are still part of traditional culture. Beginning in the late 1800's, salmon, steelhead, and cutthroat trout provided sport fishing opportunities and food for early settlers and visitors to Humboldt County. During the early 1900's, commercial gillnetters operating in the estuary shipped their catches to canneries at Eureka and Klamath (FWS 1960). The salmonid fishery contributed significant revenues to the economy of Orick throughout the 1900's (Van Kirk 1994). Valuable historical information of the Redwood Creek fisheries were published in the Arcata Union Newspaper which are presented along with interviews of long term residents and other anecdotal accounts in Van Kirk (1994). Today, the salmon and steelhead of Redwood Creek are managed as "catch and release" only, which likely reduces the numbers of fishers and contributions from the fishing community to the local economy. The presence and health of salmonid populations are also considered by many non-fishers to have important esthetic values.

Table 1. – Fishery resources of Redwood Creek.

Common Name	Scientific Name
Anadromous	
Coho Salmon	<i>Oncorhynchus kisutch</i>
Chinook Salmon	<i>Oncorhynchus tshawytscha</i>
Steelhead Trout	<i>Oncorhynchus mykiss</i>
Summer Steelhead Trout	<i>Oncorhynchus mykiss irideus</i>
Coastal Cutthroat Trout	<i>Oncorhynchus clarki clarki</i>
Eulachon	<i>Thaleichthys pacificus</i>
Pacific Lamprey	<i>Lampetra tridentata</i>
Freshwater	
Rainbow Trout	<i>Oncorhynchus mykissirideus</i>
Coastal Cutthroat Trout	<i>Oncorhynchus clarki clarki</i>
Coastrange Sculpin	<i>Cottus aluticus</i>
Humboldt Sucker	<i>Catostomus occidentalis humboldtianus</i>
Prickly Sculpin	<i>Cottus asper</i>
Pacific Brook Lamprey	<i>Lampetra pacifica</i>
Threespine Stickleback	<i>Gasterosteus aculeatus</i>
Marine or Estuarine Dependent	
Tidewater Golby	<i>Eucyclogobius newberryi</i>
Surf Smelt	<i>Hypomesus pretiosus</i>
Night Smelt	<i>Spirinchus starksi</i>
Shiner Surfperch	<i>Cymatogaster aggregata</i>
Staghorn Sculpin	<i>Leptocottus armatus</i>
Starry Flounder	<i>Platichthys stellatus</i>
Amphibians	
Pacific Giant Salamander	<i>Dicamptodon tenebrosus</i>
Tailed Frog	<i>Ascaphus truei</i>
Red-legged Frog	<i>Rana aurora</i>
Foothill Yellow-Legged Frog	<i>Rana boylei</i>

In a joint policy statement on Pacific salmon and anadromous trout, the California Fish and Game Commission and the State Board of Forestry and Fire Protection announced a goal to “recover harvestable salmon and steelhead populations, restore watersheds, and so contribute to building healthy communities”. The first steps towards initiating such a fisheries management plan includes understanding the life history and habitat requirements of the species, assessing the

current conditions in the watershed, and identifying and weighing factors that may limit fish production. The next step is to address the factors or issues that may impair fish populations from reaching their desired status (Leopold 1933).

Chinook, coho, steelhead, and coast cutthroat utilize an anadromous life history strategy. The term anadromous refers fish that spawn in freshwater and migrate to the ocean to grow and mature before returning to freshwater streams to spawn. Anadromous salmonids utilize diverse interspecific and intraspecific life history strategies in order to reduce competition between species and also to increase the odds for survival of species encountering a wide range of environmental conditions in both the freshwater and marine environments. A summary of the life history strategies, and historic and current status the anadromous salmonid population of Redwood Creek is provided below. Further details are provided in each subbasin discussion. A detailed account of chinook salmon, coho salmon, steelhead and cutthroat trout life histories and status is presented below.

Steelhead

Steelhead trout is an anadromous strain of rainbow trout that migrate to sea and return to rivers and streams as adults to spawn. In contrast to all Pacific salmon, not all steelhead die after spawning. U.S Fish and Wildlife service stated that a run of approximately 10,000 steelhead occurred in Redwood Creek in 1960 (USFW 1960). This is an uncertain estimate, contrived from data relating to other streams of similar size and characteristics and applied to Redwood Creek. Redwood Creek supports three different stocks of steelhead: winter run, summer steelhead, and "half-pounders". The latter two are described in the Summer Steelhead portion of the report.

Generally, throughout their range in California, steelhead that are successful in surviving to adulthood spend at least two years in fresh water before emigrating downstream. In Redwood Creek, steelhead generally emigrate as 2-year old smolts during spring and early summer months. Emigration appears to be more closely associated with size than age, 6-8 inches being the size of most downstream migrants. Downstream migration has been correlated with spring freshets but also may be related to the instinctive behavior of anadromous fish to move prior to summer low flows.

In the Redwood Creek watershed, steelhead was the most widespread and numerous species of salmonids observed in 2001 electrofishing surveys as well as other surveys dating back to mid 1960's. Fifty-five streams surveyed in the watershed contained steelhead populations of various concentrations (Brown 1988; DFG stream surveys 1957 to 2001). Young of the year (YOY) steelhead were the dominant age class found. There were a number of streams (Panther Creek, Garrett Creek, Mill Creek, Molasses Creek, Minon Creek, and Lostman Creek) in which the fair numbers of age 1+ and older steelhead were observed. The presence of age 1+ and older steelhead indicates that habitat was suitable over a one-year or more time period.

Although steelhead numbers have certainly decreased from historic figures, their decline has not been as dramatic as other species of salmonids in the Redwood Creek watershed. This could be attributed to their ability to inhabit stream conditions that are available in many of the tributaries of Redwood Creek. These tributaries have steep gradients, migration barriers, lack of channel

complexity, and exhibit higher water temperatures that limit production of other salmonid species. Steelhead display more adaptability to these conditions.

Summer Steelhead

The summer steelhead is an anadromous rainbow trout which migrates to freshwater streams April through July. Summer steelhead enter fresh water sexually immature and consequently must spend several months in Redwood Creek before they are ready to spawn. They rely on the remaining high spring flows to ascend tributaries and smaller streams where they hold in deep pools over the summer and fall. In addition to deep pools (>3ft), summer steelhead prefer cool pool water temperatures (mean bottom temperature <19°C, (Baigun et al.2000) and ample cover such as large rootwads, underwater ledges, caverns, and bubble curtains, which fish seek when disturbed. Generally, summer steelhead spawn December through February in smaller tributaries or the in headwaters of larger systems, and farther upstream than winter run steelhead.

Summer Steelhead populations are only found in a small number of streams in northwest California and southern Oregon. Currently, only 20 streams in northern California are populated with summer steelhead. Little is known about historical abundances of summer steelhead due to the lack of quantitative records which date back only the past two or three decades (Roelofs 1983). Native Americans depended on summer steelhead of Redwood Creek for subsistence, and they were frequently harvested in the fall, supplementing the harvest of big game. 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 have given testimony to "real good" summer steelhead runs. "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; personal communication).

Today, Redwood Creek supports a very small population of summer steelhead (approximately 30-60 fish). Numbers ranged from a high of 74 adults in 1997 to a low of 3 adults in 2000 (Anderson 1999 and Moyle et al. 1995). These numbers reflects those seen during summer dives from 1981 to 2000, but not all portions of Redwood Creek have been equally surveyed each year, which may contribute to the variability in these numbers.

The low number of summer steelhead in redwood Creek presents an alarming problem for long-term survival of this stock. Because the actual number of spawning fish is probably below the number of fish seen, the "effective" breeding population sizes (sensu Meffe 1986) may be less than the minimum size need to sustain a population of summer steelhead. These low numbers combined with poor habitat conditions such as lack of deep pools and high water temperatures are continued threats to the viability to the summer steelhead population of Redwood Creek. Peak mainstem temperatures ranged from 20-27C from 1994'-98', (Ozaki et al 1999), lack of large woody debris (cover), and predation (river otters) on mainstem Redwood Creek underscores the need for proper monitoring and watershed management for this rare and unique race of fish.

The 1964 flood had a large adverse impact on this population. Large amounts of sediments were deposited in the stream channel which filled pools and buried cover elements required to sustain summer steelhead over the summer and fall months. Portions of middle and upper mainstem Redwood Creek appear to be slowly recovering, and there has been an increase in the number of summer steelhead, possibly reflecting these improved conditions. The majority of the stock seems to reside in these mid to upper portions (above Lacks Creek). Lower Redwood Creek, on the other hand, has shown a decrease in numbers of Summer Steelhead since 1985.

Coast Cutthroat

Under development

Chinook salmon

A fall run of Chinook is present in Redwood Creek. Chinook salmon, also referred to as "kings" are the largest of the salmonid species. Chinook spawning migrations typically occur from November through January. December marks the height of the spawning period (U.S. Fish and Wildlife, 1960). Approximately 69 miles of suitable Chinook habitat exist within the Redwood Creek basin with 48 miles being in the mainstem (FWS 1960, CDF&G 1965, and Brown 1988). The best historical spawning areas were identified as being in Prairie Creek, the middle reach of Redwood Creek including Minor, and the upper reach of Redwood Creek (FWS 1960). Chinook have also been found in both Bridge and Tom McDonald Creeks in the lower portions of the watershed.

U.S Fish and Wildlife service stated that a run of approximately 5,000 chinook occurred in Redwood Creek in 1960. This is an uncertain estimate, for it was contrived from data relating to other streams of similar size and characteristics, and applied to Redwood Creek. This number was significantly higher than a 1979 estimate of 1,850 adults during the fall run (Ridenhour et al. 1994). This estimate was based on the number of juveniles estimated to be in the estuary in early July 1980 (Larson et. al 1981). In 2000 and 2001, approximately 37 stream miles of accessible salmon and steelhead habitat of the upper 1/3 of the Redwood Creek watershed were sampled by a rotary screw trap. In 2001, a population estimate of 378,000 juvenile Chinook salmon was derived from the capture of 120,692 downstream migrants. An additional 21 yearling Chinook were also captured (Sparkman, 2001). These numbers indicate that successful spawning, incubation and fry emergence is occurring in the upper third of the basin.

Chinook use estuaries for crucial stages of their life history strategy, both as adults and juveniles. The present condition of the Redwood Creek estuary/lagoon has limited the biologic function and therefore the production of chinook salmon of Redwood Creek. Over the past 100 years, the physical structure of the estuary has been modified by levee construction, removal of riparian forests, conversion of wetlands to pasture lands, and artificial breeching. These modifications combined with excessive sediment accumulations have reduced the size of the estuary and wetland areas, reduced the tidal prism, and altered drainage patterns, all which impair the physical function and the ability of the estuary/lagoon to fully support salmonids. This in turn, had decreased important rearing and holding habitat for juvenile and adult chinook salmon.

Coho Salmon

California coho salmon (*Oncorhynchus kisutch*), also known as silver salmon, are listed as threatened under the Federal Endangered Species Act (ESA; NMFS 1995). This listing was initiated in response to declining numbers throughout their southern range. A 1995 estimate stated that less than 5,000 wild coho salmon (no hatchery influence) spawned in California each year (Moyle et. al 1995). This is a drastic decline from statewide estimates in the 1940's, which assumed there was anywhere from 200,000 to one million adult coho in California (Calif. Advisory Committee on Salmon and Steelhead Trout 1988). Essentially, coho populations are less than 6% of what they were in the 1940's.

Coho salmon typically exhibit a three-year life cycle and do not appear to have the genetically distinct and spatially separated runs that chinook salmon and steelhead trout have displayed. After spending two years in the ocean, coho return to spawn in late fall and early winter following seasonally significant rains. As with other species of salmon, coho die after spawning. Unlike other salmon species, coho salmon redds can be situated in substrates composed up to 10% fines (Emmett, et al, 1991), but typically spawning success and fry survival are favored by very clean gravel consisting of less than 5% fines (CDFG 1991).

Juvenile coho typically spend one year in the freshwater streams before migrating out to the ocean (a small proportion of the coho population of Redwood Creek spend two years rearing before migrating to sea). Consequently, adequate cover, cool water, high canopy density, and sufficient food to sustain them through their fry and juvenile stages become critical habitat components. Specifically, secondary channel habitats, such as cool, backwater pools with a large woody debris cover, are highly preferred habitat conditions for developing juvenile coho salmonids (CDFG 1991).

The Redwood Creek watershed, like other systems in California, has suffered declines in populations of coho. In 1960, the U.S. Fish and Wildlife Service estimated 2,000 adult coho returned to spawn annually (U.S. Fish and Wildlife 1960). Currently, it is thought that the Prairie Creek watershed contains the largest coho population in the Redwood Creek basin. However, Prairie Creek was stocked with coho from the Prairie Creek hatchery until 1992. So while the overall population totals may have remained fair for some time, the percentage of wild stock is assumed to have greatly decreased (D. Anderson, App.; S. Sanders, App.).

The most precise account of coho salmon in the Redwood basin comes from two years of studies conducted in the Prairie Creek watershed by Klatte and Roelofs in 1996 and 1997. They used a weir and fish trap, a rotary crew trap, spawning surveys, fyke nets, and other methods to compare populations among streams in the Prairie Creek watershed. During the 1995/96 spawning season 115 adult coho were trapped and in 1996/97, 124 adult coho were trapped. The adult trap consisted of a weir and fish trap in Prairie Creek located just above the confluence with Streelow Creek (Klatte and Roelofs 1997). In the spring of 1996 and 1997 they used a rotary screw trap to capture juvenile coho moving downstream past the confluence with Streelow Creek. In 1996 they captured 25,492 coho YOY and 2117 age 1+. In 1997 they captured 3113 YOY and 2302 age 1+ coho with the screw trap. Also, they produced a 1997 summer estimate of 24,588

juvenile coho from the portion of the watershed above Streelow Creek and below Ten Tapo Creek.

Outside of the Prairie Creek drainage, coho have populated portions of the mainstem and eight other tributaries to Redwood Creek. These include: Tom McDonald Creek, Bridge Creek, Harry Weir Creek, McArthur Creek, Coyote Creek, Karen, Strawberry, and Pilchuck Creek (Brown 1988, Neillands, 1990, DFG 2001 surveys). 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 in the middle or upper portions of the basin that were sampled (see Appendix). In addition, through the use of a rotary screw trap, which sampled approximately 37 stream miles of accessible salmon and steelhead habitat in the upper 1/3 of the Redwood Creek watershed in the summer of 2000, no coho were captured (Sparkman 2000).

The construction of the Highway 101 by-pass created a large sedimentation event in 1989 that impacted coho spawning and rearing habitat in the Prairie Creek watershed from Brown Creek to the confluence with Redwood Creek.

Prairie Creek Hatchery

The Prairie Creek Hatchery located a few miles north of the town of Orick was in operation from the late 1920's until its last year of propagating salmonids in 1993. Until its closure, the hatchery propagated large numbers of Chinook, Coho, Steelhead, rainbow, and Coastal Cutthroat trout fry that were released in various streams, lagoons, and Humboldt Bay throughout its years in operation.

The hatchery first began in 1928 at a site on Prairie Creek for the purpose of collecting Coast Cutthroat trout eggs (Save Prairie Creek Fish Hatchery Committee, 1984). This was a temporary operation with traps on Prairie Creek just below its confluence with Lostman Creek. The hatchery supplied fry to Humboldt and Del Norte counties through 1936. The hatchery was then rebuilt at its present location the following year.

The outdated facility was then closed in 1954 for extensive repairs and sat idle until 1957 when Humboldt County obtained a lease for five years. During these five years (1958-1963) production records have been unobtainable or there was no production of fish (Save Prairie Creek Hatchery Committee, 1984).

Humboldt County officially took over the title and operation of the hatchery in 1961 and eventually became what was believed to be the only county run hatchery in operation in the United States until its closure in 1993. The hatchery, in cooperation with Humboldt State University, improved its facilities to accommodate a large production of several different species of salmonids and rainbow trout. The hatchery supplied fish to multiple streams in and out of the Redwood Creek watershed as well as several lagoons, the Arcata Wastewater Facility, and Humboldt Bay. In addition, they assisted other private ponding programs such as Humboldt Fish Action Council and the Pacific Lumber Company by providing fish to these facilities.

During the hatchery's prime, mid-sixties to mid-seventies, immense numbers of fish were being propagated. In the 1973-1974 season approximately 1,589,581 fish totaling 31,603 pounds were produced. The 71-72 season was another big year with approximately 1,462,919 fish totaling 35,087 pounds were produced. The majority of these fish were Chinook and Coho salmon respectively. Steelhead propagation did not begin until the 1972-1973 season, but became the dominant species produced through the eighty's. With the exception of Steelhead, overall production of all species of fish decreased slightly during the eighty's and until the facility's closure in 1993. Approximately 25,000 Chinook, 81,000 Coho, 94,000 steelhead yearlings were released during the ten- year period of 1981 till 1991. Another 300-400 Coastal Cutthroat yearlings were released from 1988 to 1991.

Deficient funds from Humboldt County caused the hatchery to rely on state funding sources throughout the eighties into the nineties. State funding became unavailable to the hatchery "because instream habitat was not being improved to support fish the hatchery produced" (Farley, 1992). With state funding completely removed the county itself could not afford to maintain the hatchery operations and closed the facility in the spring of 1993.

Issues Affecting Fishery Resources of the Redwood Creek Basin

Issues affecting salmonids of Redwood Creek are similar to other North Coast streams. Generally, salmonid populations declined in concert with increased demand for water, fisheries, forest resources, and alterations of land and waterways to meet the demands of increasing human populations. A goal of the NCWAP is to identify and address factors that will help in the management and recovery of these valuable fishery resources.

The primary issues affecting salmonid populations of Redwood Creek are centered around land use activities that contribute to increasing sediment delivery to streams and decrease desirable functions of riparian vegetation. Naturally occurring events such as slope failures, floods, and drought are beyond our abilities to control. However, we can conduct our activities on the lands and waterways of Redwood Creek with oversight to reduce future adverse impacts to stream habitat conditions. Primary issues affecting Redwood Creek are:

- Recent flood events have played an important role in shaping the stream channel and aquatic habitat conditions of the Redwood Creek basin. The flood of 1964 likely has had the most significant and long-lasting adverse impacts to salmonid habitat in Redwood Creek and the entire north coast region. In the upper reach, channel widths increased by 150 to 300 percent and as much as 30 feet of channel fill were deposited above the 1994 thalweg elevation (Madej and Ozaki 1996). Although the upper reach has shown recovery, long-term channel surveys show sediment delivered to the stream system from landslides, debris slides, fluvial hill slope erosion, and road-related problems during the 1964 flood are still stored in the middle and lower reaches of Redwood Creek (Ozaki and Jones 1998 and 1999). Much of these stored sediments were transported from the upper reach and deposited in the lower reach and estuary. Approximately half of the sediment generated from 1954 to 1997 was associated with roads and skid trails and roughly 10-20% was associated with lands managed for timber harvests (USEPA 1998).

- Several factors that limit anadromous salmonid production or impair stream habitat conditions are related to excessive amounts of stored sediments. These include reducing the number, depth, and quality of pools, reducing surface flows, widening the stream channel which can spread a thin flow across the channel which also leads to increasing exposure to solar radiation and air temperature, resulting in elevated water temperature.
- The lack of high quality pool habitat was the most common factor (identified from the EMDS stream reach model results) affecting anadromous salmonid habitat in Redwood Creek basin streams. High quality pools provide sufficient depth and shelter elements for protection from predators, provide cover from high flows, and reduce density related competition. Deep pools may also provide thermal refugia in reaches where water temperature is unsuitable for maintaining healthy salmonid populations. The lack of pools observed in portions of the basin is in part due to the low gradient reaches that are still storing sediment delivered from 1964 flood.
- Intense winter rains and rain on snow events on unstable slopes can often initiate landslides, debris flows, watercourse crossing failures, and fluvial hill slope erosion. Roads built on marginally stable ground are more likely to fail during stressing storms. These processes can deliver large quantities of sediment directly to the stream system.

The following list presents factors that may affect stream habitat conditions and production of anadromous salmonids:

Climate Factors

Precipitation patterns
Floods
Droughts
Rain on snow

Land Use Factors

High road density
Road location/construction
Timber harvest activities
Livestock grazing
Agriculture
Recreation
Restoration

Geologic Factors

Landslides
Earthflows
Highly erodible soils
Fluvial hill slope erosion

Estuary Factors

Aggraded channel
Levee construction & maintenance
Reduced tidal prism
Water temperature
Drainage

Fishery Factors

Sport and commercial fishing
Impaired salmonid populations
Prairie Creek Hatchery

Stream Habitat Factors

Water Temperature
Stream flow
Channel gradient
Food supply
Habitat diversity
Shade canopy
Large woody debris
Widening stream channels
Riparian vegetation community structure

Methods

The Department of Fish and Game's role in the watershed assessments processes involved a tremendous amount of research and coordination with numerous community organizations, agencies, private industries, and landowners on top of the entire field work that was performed by the department.

In order to satisfy the department's goals for the watershed assessments, DFG personnel participated in an extensive literature review of existing studies and reports to gain insight to information that had already been gathered on the pertaining watersheds. This previously collected information helped direct the watershed study and prevented overlapping in certain studied areas. In addition, this provided for a broad participation from interested parties and led to a more encompassing report.

The Redwood Creek Watershed has been one of the most studied systems along the entire North Coast, so a tremendous amount of information was already in existence. It was the department's responsibility to narrow down its search in collecting pertinent information that could be incorporated into the current synthesis. A literature review was performed using National Park research, private timber companies' studies in cooperation with private landowner associations, Humboldt State University theses, Department of Water Quality Control research, material from Humboldt County, and the Department of Fish and Game records. In addition, numerous meetings were held with Environmental Protection Agency biologists, National Park scientists, University professors, and private consulting biologists to discuss previous studies, current conditions of the watershed, and methods of performing biologically studies.

Stream Surveys

The Redwood Creek watershed was surveyed during the 2001 assessment period through two different methods. Both of these methods included similar physical habitat data collection and a biological data collection.

The first method was conducted through stream habitat inventory surveys following the Department of Fish and Game (CDFG) protocol presented in the *California Salmonid Stream Habitat Restoration Manual* (Flossi and Reynolds 1988). The habitat inventory comprised the physical habitat data collection and was completed on eighteen tributaries and the mainstem of Redwood Creek above the park boundary. The biological data collection was performed through electrofishing to determine distribution and presence of salmonid species in the same tributaries.

Two person crews trained in standardized habitat inventory methods by the California Department of Fish and Game conducted the physical habitat data collection during the summer and fall of 2001. The inventory began just upstream of the Park at the confluence of Redwood Creek and Coyote Creek. Approximately 27.5 miles of mainstem Redwood Creek and approximately 21 miles of tributary streams were inventoried. The inventories were conducted at the reach scale. The Rosgen Channel Typing method was used to determine a survey reach. A new survey reach is begun when the crew encountered a change of channel type. Therefore each reach consists of a homogeneous channel type. Complete measurements occurred at approximately 10% of the habitat units within each survey reach (Hopelain, 1994), but every unit is measured by length and pool units had a maximum depth taken. Any habitat type encountered for the first time was measured for all parameters and characteristics.

There are nine components to the standard habitat assessment process. These are flow, channel type, temperature, habitat type, embeddedness, shelter rating, substrate composition, canopy and bank composition, and vegetation. Each of these is discussed in detail in the *California Salmonid Stream Habitat Restoration Manual* (Flosi and Reynolds 1988). Streams were surveyed until the end of anadromy was determined. Crews based this judgment on either physical barriers to fish passage or steeper gradient (8-10%) present for long continuous stretches of the creek. The crews also made visual observations for fish presence to determine the end of an anadromous fish bearing reach.

DFG fish biologists equipped with Smith Root Model 12 backpack electrofishing units performed the biological data collection. They sampled at least one pool, run and riffle per reach. Mainstem Redwood Creek was sampled only at a few sites due to the depths of pools that hinder the effectiveness of the electrofishing units. The salmonids were identified to species and age class was estimated based on size. Non-salmonid species were also recorded but not classified by age class.

The second method conducted was through the use of Environmental Protection Agency's (EPA) probabilistic sampling design (Olsen 2000). A fish distribution map of the Redwood Creek watershed was given to the EPA, in which they generated a set of random GPS coordinated sites (20 primary sites and 40 oversamples) of which 20 were surveyed. All of these sites were located on lower mainstem Redwood Creek and its tributaries within the RSNP. The same habitat stream inventory surveys were conducted following DFG protocols sampling 100% of the selected sites. The length of the sampling reach was determined by multiplying the average bank full width by 20. The product was the reach length surveyed. However, a minimum length of 500 feet and a maximum length of 1500 feet also was used for sites with extremely narrow or wide bank full widths (Gallo 2000). Average bankfull width was determined around the central location of the GPS coordinates.

DFG fisheries biologist performed the same biological data collection method using backpack electrofishing units to determine presence of salmonid species. At least one pool, run, and riffle were electrofished. The salmonids were measured for length and weight. Additionally, non-salmonid species were recorded but not weighed. All mainstem Redwood Creek sites were not electrofished for reasons stated above. Additionally, tributaries that have recently been sampled

by other fisheries studies, such as Humboldt State University, were not electrofished, but their results will be incorporated with the other sampled sites. In addition to standard tabulations and mapping typically provided with DFG stream habitat surveys, the primary use of fish habitat data will be for analysis of factors limiting fish production.

Limiting Factors Analysis

A main component of NCWAP is an analyses of stream habitat conditions to identify factors that limit production of anadromous salmonids in North Coast watersheds. The "limiting factors analysis" (LFA) provides a means to evaluate the status of a suite of key environmental factors that affect anadromous salmonid migration, spawning, and juvenile rearing. These analyses are based on comparing measures of habitat components such as water temperature and pool depth to a range of reference conditions determined from empirical studies and/or peer reviewed literature. If the component's condition does not fit within the range of the reference values, it may be viewed as a limiting factor. This information will be useful to identify the underlying causes of stream habitat deficiencies and help reveal if there is a linkage to watershed processes and land use activities. Table 1 presents potential habitat parameters and their roles in the LFA.

The concept that fish production is limited by a single factor or by interactions between discrete factors is fundamental to stream habitat management (Meehan 1991). A limiting factor can be anything that constrains, impedes, or limits the growth and survival of a population. Environmental factors considered to limit anadromous fish production include:

- Deficient Stream flow •High water temperature •Lack of deep pools
- Lack of shade canopy •Excessive turbidity •Lack of large wood
- Barriers •Excessive sediment yield •Lack of instream cover

Limiting Factors Analysis and the Ecological Management Decision Support Model (EMDS)

We used the Ecological Management Decision Support system (EMDS) (Reynolds 1999) to facilitate the limiting factors analysis (LFA) and improve our understanding of the complex relationships between environmental factors, human activities, and overall habitat quality for fish. The EMDS is composed of two knowledge bases 1) stream reach condition and 2) Upland condition. The Department of Fish and Game built and interpreted the results from the stream reach condition knowledge base. The Department of Forestry and Fire Protection built and interpreted the results from the upland condition knowledge base. Details of the EMDS model and knowledge bases are presented in Appendix X.

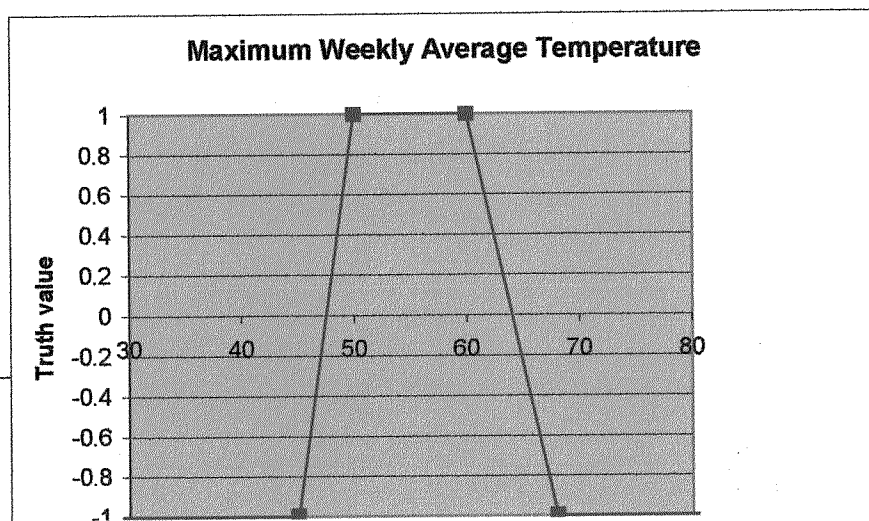
The stream reach condition knowledge base is composed from a suite of fundamental stream habitat factors that were identified by the NCWAP team and other scientist during the EMDS workshop held in June 2001. These factors were then arranged in the hierarchical network architecture required to run the EMDS stream reach model (see appendix). A reference curve or

"truth value" curve was also developed for each factor or parameter used in the model. Our goal was to first develop a basic version of the stream reach condition knowledge base that runs successfully and then refine it to include more complex features in subsequent versions. The model used in these analyses is the basic version 1.1. The stream reach condition knowledge base will continue to evolve as we add new parameters to describe complex features of stream ecosystems for evaluation and receive comments from a technical advisory team review.

The stream reach knowledge base is composed of a group of four logic networks which describe environmental factors that affect anadromous salmonid habitat conditions: 1) Water Temperature; 2) Riparian Vegetation Function; 3) Stream Flow; and 4) In Channel Conditions (Figure). Each of these networks is composed of a suite of stream habitat attributes and corresponding reference values, which provide a basis for evaluating field observations collected during stream habitat surveys. A proposition for each habitat attribute provides a linguistic statement to test the fitness of field observations when compared to the corresponding attribute reference value. Each attribute evaluated by the Stream Reach Condition model may be expressed separately and/or is integrated into its parent network evaluation and the overall group evaluation of the Stream Reach Condition.

These analyses are based on the comparison of key habitat components to a range of desirable conditions. If the component's condition does not fit within the range of desired values, it may be viewed as a limiting factor. These are tools that help scientists define how a complicated ecosystem, such as a watershed functions. The software allows scientists to combine data of different environmental factors, such as stream temperature and sediment composition to produce a synthesis of watershed conditions for salmonids. The tools make possible a consistent and repeatable approach to evaluating conditions across numerous watersheds in the region. The knowledge base modeling software requires scientists to be very specific about how they believe various environmental factors interact to create conditions for anadromous salmonids in California's north coast.

Figure 2 shows an example, where the proposition is "the stream temperature is suitable for salmon". The horizontal axis shows temperature in degrees Fahrenheit, while the vertical is labeled 'Truth Value' and ranges from -1 to +1. The line shows what are fully unsuitable temperatures (-1), fully suitable temperatures (+1) and those that are in-between (> -1 and $< +1$). In this way, similar graphic relations are created for all propositions in the EMDS evaluation.



Data used in the EMDS were collected by the Department of Fish and Game during the 2001 field surveys as well as recent previous surveys. These surveys included physical habitat data collection methods presented in the *California Salmonid Stream Restoration Manual* (Flosi and Reynolds 1998). These stream inventories used the Rosgen Channel Typing method to divide anadromous stream lengths into homogeneous reaches (e.g. Lacks Creek, tributary to Redwood Creek, was divided into eight reaches). The EMDS evaluates data at the stream reach scale. Each reach receives an evaluation of key stream habitat variables as well as a summation of all the variables to form an overall stream reach evaluation.

Input data for the model came directly from summaries presented in the Table 8 of Stream Habitat Inventory reports or was derived from raw field data. There were nine components to the standard habitat assessment process. Of these nine, water temperature, riparian vegetation, pool shelter complexity, and substrate composition were all directly incorporated into generating values for the EMDS model. EMDS also includes in channel conditions, pool conditions, refugia, and Large Woody Debris indices with various sub components. Descriptions of the EMDS components and how the reference values were determined are described in detail in the following section. Although some population data are available for the NCWAP assessment area, they are quite limited both spatially and temporally. Therefore, validation of the results of fish habitat studies and limiting factor analysis will depend on future population monitoring. The results from the LFA will assist habitat management decision making by ranking habitat factors by their influence on the overall habitat quality. The analysis also will help reveal if there is a linkage to watershed processes and land use activities. This information will be useful to identify the underlying causes of stream habitat deficiencies (limiting factors) and help focus restoration efforts and watershed management strategies to achieve the greatest salmonid production potential.

Analyses and Results by Subbasin

Estuary

The Redwood Creek estuary/lagoon provides critical habitat in the life cycle of anadromous salmonids and many other valuable fishery resources. Estuaries are the nexus between freshwater and marine environments which anadromous salmonids pass through as juveniles during seaward migrations and where adults gain access to their natal rivers during spawning migrations. Estuaries are recognized as valuable salmonid nursery areas because they provide abundant food supplies, they offer protection from predators, and are diverse habitat areas. Several fish species, have adopted an estuarine residency, particularly for reproduction and early stages of their life cycle. Some species deposit eggs or give live birth directly in estuaries, while others have evolved mechanisms which help the delivery of their young into estuaries by ocean tides or riverine currents. Fish including salmonids that utilize estuaries for an important part of

their life cycle are referred to as estuarine-dependant. The estuarine rearing is a strategy that adds diversity to juvenile salmonid life history patterns and likely increases the odds for survival of a species encountering a wide range of environmental conditions in both the freshwater and marine environments. An extended estuarine residency may be especially beneficial for salmonids from rivers where low summer flows or warm water temperatures severely limit summer rearing habitat.

The present condition of the Redwood Creek estuary/lagoon has limited the biologic function and therefore production of salmonids of Redwood Creek. Over the past 100 years, the physical structure of the estuary has been modified by levee construction, removal of riparian forests, conversion of wetlands to pasture lands, and artificial breaching. These modifications combined with excessive sediment accumulations have reduced the size of the estuary and wetland areas, reduced the tidal prism, and altered drainage patterns all which impair the physical function and the ability of the estuary/lagoon to fully support salmonids.

Management alternatives have been developed by RSNP and others to improve the estuarine habitat. Any plans will require private landowner and local stakeholders cooperation.

Prairie Creek Subbasin

The Prairie Creek watershed is largely under management by the Redwood National and State Parks (RNSP). Because much of the land in this watershed is relatively undisturbed, the Prairie Creek watershed offers some of the most undisturbed or refugia type fisheries habitat within the coastal redwood region. The Prairie Creek watershed supports populations of chinook salmon, coho salmon, steelhead, and coast cutthroat. Table 2 presents streams, species present, and number of stream miles accessible to anadromous salmonids in the Prairie Creek subbasin.

Table 2. Streams, species present, and number of stream miles accessible to anadromous salmonids in the Prairie Creek subbasin.

aine Creek subbasin.

<u>Stream</u>	<u>Species Observed</u>		<u>Stream Length (mi) Access</u>	<u>References</u>
Prairie Creek	coho chinook steelhead coastal cutthroat trout 3-spine stickleback coast range sculpin	Pacific lamprey brook lamprey tailed frog pacific giant-salamander prickley sculpin	11.8	DFG 2001 surveys Neilands 1990, Brown and Anderson 1998 Klatte and Roeloffs 1997
Lost Man	coho chinook steelhead coastal cutthroat trout	Pacific lamprey tailed frog pacific giant-salamander	2.92	DFG 2001 & 1966 Stream Surveys, carcass surveys 1984-1992, RPN/USFS barrier study notes F1995 notes, Neilands 1990, Brown 1988 (referencing CDFG stream surveys and Hofstra personal communication)

Little Lost Man	coho chinook steelhead pacific giant-salamander	pacific lamprey coastal cutthroat trout sculpin sp. tailed frog larvae	2.0	Klatte and Roelofs 1997, D.J. Manning, et al. 1996, HSU fisheries graduate student, USFS/RNP barrier study 1995, RNP/USFS-RSL revisit of 1981 thesis sites field notes, Neillands 1990, Brown
Brown Cr	coho steelhead coastal cutthroat trout pacific giant-salamander pacific lamprey	chinook tailed frog red legged frog sculpin sp. trout sucker	1.37	Klatte and Roelofs 1997, USFS/RNP barrier study 1995, Neillands 1990, Brown 1988, 1988 (referencing CDFG stream surveys)
Boyes Cr	coho chinook steelhead cutthroat/steelhead	coastal cutthroat trout 3 spine stickleback sculpin sp. sucker	0.87	Klatte and Roelofs 1997, Brown 1988, 1988 (referencing CDFG stream surveys and Chuck Warren personal communication)
Steelelow Cr.	coho steelhead coastal cutthroat trout pacific lamprey frog	cutthroat/steelhead sculpin sp. 3 spine stickleback pacific giant-salamander	1.30	RNP/USFS-RSL revisit of 1981 thesis sites field notes, Neillands 1990, Brown 1988,
Godwood Cr	coho steelhead cutthroat/steelhead sculpin sp.	chinook coastal cutthroat trout	1.30	Klatte and Roelofs 1997, Neillands 1990, Brown 1988,
Skunk Cabbage Cr	steelhead	coastal cutthroat trout	0.56	Brown 1988
May Cr.	steelhead coastal cutthroat trout pacific giant-salamander sucker	cutthroat/steelhead 3 spine stickleback sculpin sp. pacific lamprey	0.37	CDFG 2001, 80 & 76 stream surveys, Klatte and Roelofs 1997, USFS? RNP barrier study notes, Neillands 1990, Brown 1988 (ref. CDFG surveys, C Warren personal communication)

Overall habitat evaluations by the EMDS reach condition evaluation shows a lack of deep and complex pools combined with highly embedded spawning substrate may limit anadromus salmonid production in some stream reaches of the Prairie Creek subbasin (Table 3). Water temperature was generally within the fully supportive range.

Table 3 - Summary of the results from the EMDS stream reach evaluation for the Prairie Creek subbasin. With each stream of the lower sub-basin, the stream habitat components are assigned a general overall score with respect to suitability for anadromous salmonid production. The '+' scores gives a range of fair to fully acceptable conditions; where as, a '-' presents a range of poor to fully unacceptable conditions respectively. A '0' represents the range of conditions from poor to fair conditions. These overall scores provide a general overview of current stream conditions and may be used to focus on areas for habitat improvements

Stream	Reach Length (ft)	Reach number	Reach Condition	Canopy Density	MWAT	Pool Quality	Pool Depth	Pool Shelter	Embeddedness
Lostman Creek 1	962	1	-	+	+	--	---	--	-
Lostman Creek 2	634	1	-	+++		-	---	+	--
Lostman Creek 3	474	1	-	+++		--	---	-	-
Lostman Tributary	449	1	-	+++		0	---	+++	--
May Creek	508	1	-	+++		--	---	--	++
Boyes Creek	512	1	-	+++		--	---	--	-
Brown Creek	568	1	-	+++		--	---	--	--
Prairie Creek	544	1	-	+		-	+++	--	+++
Prairie Creek	844	1	-	++		--	---	-	+

Lower Redwood Creek

The lower Redwood Creek sub-basin supports populations of chinook salmon, coho salmon, steelhead, and coast cutthroat. There are approximately 5.3 miles of tributary streams and 19.2 miles of redwood Creek mainstem accessible to anadromous salmonids in the lower sub-basin. Table 4 presents streams, species present, and number of miles in each stream accessible to anadromous salmonids in the lower Redwood Creek subbasin.

Juvenile coho salmon were recently observed in Tom McDonald Creek, Bridge Creek, and Elam Creek (Dana McCanne unpublished data) during recent fish surveys conducted by the Department of Fish and Game and the Forest Sciences Project. Age 1+ and 2+ Coast cutthroat were observed in Forty-four Creek. Although no quantitative estimates are available, we generally feel that fish densities are relatively low in the streams we sampled. This is also true for juvenile steelhead, which is the most abundant and widely distributed salmonid species in the lower basin. Tom McDonald had the highest numbers of coho of all streams survey of the lower subbasin. Chinook were not observed, but they likely had migrated to the estuary or ocean prior to any fish surveys were conducted.

Fish habitat deficiencies of the lower Redwood Creek mainstem are generally related to the highly aggraded and wide condition of the stream channel, and sub-optimal water temperatures. The lack of channel complexity attributed to excessive amounts of stored sediments is expressed by the lack of deep pools, low pool shelter complexity, increased width to depth ratio, elevated water temperature, high embeddedness values, and reduced summer surface flows. The wide channel also inhibits the riparian canopy to effectively provide shade on the stream. The main channel of Redwood Creek flows through the center of large gravel deposits, which insulate the stream from the benefits of a riparian corridor. These characteristics impair stream habitat conditions and cumulatively, act to limit production of salmonid populations in the lower mainstem of Redwood Creek. In addition, changes in tree species composition, seral stage, and canopy structure adjacent to the tributaries and Redwood Creek associated with past timber harvest has also adversely affected stream habitat conditions. However, it is likely that much of this habitat is undergoing slow recovery. Efforts by RNSP to reduce sediment delivery to streams by decommissioning or improving many of the roads in this sub-basin will aid in recovery of fisheries habitat.

There is a notable difference in fisheries habitat between the lower mainstem Redwood Creek and its tributaries. Primarily, the quantity of anadromous salmonid habitat is limited by steep gradients of the tributary streams (5.3 miles) compared to the fully accessible reach of mainstem Redwood Creek (19.2 miles). Other differences are related to the smaller size, confined channel, and cooler water temperatures of the tributaries compared to the low gradient, unconfined channel, and warm water temperatures of the lower reach of mainstem Redwood Creek. Juvenile coho salmon were recently observed in Tom McDonald Creek, Bridge Creek, and Elam Creek (Dana McCanne unpublished data). Additionally, age 1+ and 2+ Coast cutthroat were observed in Forty-four Creek. These observations reflect higher quality of fish habitat conditions in the tributaries compared to the present state of the mainstem. No coho or cutthroat were noted from the mainstem. The impaired condition of the mainstem Redwood Creek limits production of anadromous salmonids in the lower subbasin. Presently, we feel that more production of anadromous salmonids is occurring in the relatively small amount of accessible habitat of the tributaries compared to the larger amount of accessible mainstem Redwood Creek.

We recommend continuing efforts such as road improvements and road decommissioning and upgrading throughout the basin aimed at reducing sediment delivery to Redwood Creek and tributary streams. In addition, implement stream protection zone management sufficient to help maintain bank stability on unstable geology and improve microclimate conditions to reduce air temperatures in the riparian zone and provide shade to help keep water temperatures cool.

In Summary, the current condition of the lower mainstem of Redwood Creek is partially due to legacy effects from past land use practices, major floods events, and natural processes. Fisk et al. (1966) noted that the lower mainstem of Redwood Creek was in a "severely damaged" condition and was "largely unsuitable" as a nursery for young salmon and steelhead following the major floods of 1955, 1964, and 1965. (Fisk et al. 1966). Anecdotal evidence that the lower mainstem was once a productive nursery area is found in a discussion of fish collecting for tagging experiments in the Redwood basin (Hallock et al. 1952). Hallock found that in 1951, they could

not collect fish for a tagging program from the mainstem Redwood Creek because the pools were too deep to effectively use beach seines to collect fish. The changes to the stream condition between 1951 and 1966 were obviously dramatic and still persist in the form of excessive amounts of stored sediments which adversely affect fish habitat suitability of the mainstem Redwood Creek reach of the lower subbasin.

In addition, changes in tree species composition, seral stage, and canopy structure adjacent to the tributaries and Redwood Creek associated with past timber harvest (prior to RSNP acquired these lands in 1978) also may adversely affect stream habitat conditions. However, it is likely that the riparian corridor is undergoing recovery as trees become re-established and grow along the lower subbasin tributaries. The monitoring of spatial and temporal relationships of the stream condition and fish populations in mainstem and tributaries of the lower subbasin will provide insight into processes of watershed succession.

Table 4. Streams, species present, and number of stream miles accessible to anadromous salmonids in the lower Redwood Creek subbasin

Stream	Species Observed	Stream Length (mi) Access	References
Bridge Cr	coho chinook steelhead coastal cutthroat trout pacific giant salamander bufo sp. sculpin sp. pacific lamprey yellow legged frog western toad	1.99	DFG 2001 & 1966 Stream Surveys, Brown 1988 (Hofstra personal communication), USFS/RNP barrier study notes, Field note book Anderson, Mclelland
Tom McDonald Cr	coho chinook steelhead cutthroat/steelhead pacific giant salamander pacific lamprey coastal cutthroat trout sculpin sp.	1.30	RNP 2000 surveys, Brown 1988, Neillands 1990, RNP/USFS-RSL revisit of 1981 thesis sites field notes, DFG 1966 stream survey

Macarthur Cr	coho steelhead coastal cutthroat trout pacific giant salamander	steelhead/steelhead tailed frog yellow legged frog sculpin sp.	0.50	Brown 1988, Neillands 1990, RNP/USFS-RSL barrier study - 1995 notes
Copper Cr	steelhead		0.31	Brown 1988
Elam Cr.	steelhead coastal cutthroat	cutthroat/rainbow sculpin sp.	0.31	Brown 1988, Neillands 1990
Devils Cr	steelhead pacific giant salamander	tailed frog yellow legged frog	0.19	Brown 1988, Neillands 1990
Forty Four Cr	steelhead pacific giant salamander	cutthroat trout sculpin sp.	0.19	Brown 1988, Neillands 1990, USFS/RNP barrier study notes, DFG 2001 stream surveys
Bond Cr.	steelhead cutthroat trout	cutthroat/rainbow trout	0.12	Neillands 1990, Brown 1988
Slide Cr	steelhead		0.12	Brown 1988
Dolason Cr	steelhead		0.12	Brown 1988
Miller Cr	steelhead		0.12	Brown 1988
Redwood Creek	steelhead chinook salmon	coast cutthroat coho salmon		

The overall stream condition in the lower subbasin from the EMDS watershed model was rated "somewhat unsuitable". Results from the stream reach condition network of the model are shown in Table 5. The somewhat unsuitable rating for stream condition is largely due to the lack of deep, complex pools observed from the tributaries (Elam, Bridge, and Forty-four Creeks) and lack of deep, complex pools and lack riparian canopy density affecting the stream observed from the lower mainstem of Redwood Creek. Maps showing EMDS results are presented in Appendix B.

Table 5 - Summary of the results from the Middle Sub-basin EMDS stream reach evaluation. The stream habitat components are assigned a general overall score with respect to suitability for anadromous salmonid production. The '+++' (+1.0) scores represents fully suitable conditions, ++ (.99 to .5) demonstrates moderately suitable conditions, and + (.49 to .01) displays somewhat suitable conditions respectively; where as, a '---' (-1.0) represents fully unsuitable conditions, a '--' (-.99 to -.5) demonstrates moderately unsuitable conditions, and '-' (-.49 to -.01) displays somewhat unsuitable conditions respectively. A '0' represents data which lies inbetween suitable and unsuitable conditions, or there is lacks any data to categorize. These overall scores provide a general overview of current stream conditions and may be used to focus on areas for habitat improvements.

Stream	Reach Length (ft)	Reach number	Reach Condition	Canopy Density	MWAT	Pool Quality	Pool Depth	Pool Shelter	Embeddedness
Elam Creek	513	1	-	+++		--	--	-	--
Forty Four	597	1	-	+++		--	---	-	--

Creek									
Bridge Creek	1373	1	-	++		--	--	0	--
Redwood Creek Lower1	1500	1	-	---		---	---	---	0
Redwood Creek Lower2	2065	1	-	---		--	---	--	0
Redwood Creek Lower3	1819	1	-	---		--	---	--	+++
Redwood Creek Lower4	1608	1	-	--		--	---	---	--
Redwood Creek Lower5	1566	1	-	---		--	---	--	0
Redwood Creek Lower6	1500	1	-	0		0	0	0	0
Redwood Creek Lower7	1508	1	-	---		---	---	---	-

Middle Redwood Creek

The middle Redwood Creek subbasin supports populations of chinook and coho salmon, steelhead and coastal cutthroat trout. There are approximately 24 miles of accessible anadromous fish mainstream habitat available as well as another 19 miles of accessible anadromous fish in 21 tributaries. Most of these tributaries consist of small populations of steelhead. Coho have been found in Coyote, Karen, and Pilchuck Creeks. Chinook have been found in the mainstem as well as Lacks and Minor Creeks. Coastal Cutthroat have been observed in the mainstem as well as Lacks and Panther Creeks. Table 6 presents streams, species present, and the number of stream miles accessible to anadromous salmonids in the middle Redwood Creek subbasin. Issues affecting fish production are adverse impacts to aquatic habitat related to a high road density, and other land use activities that reduce the shade canopy, affect the imminent and potential delivery of large woody debris entering the stream channels, increase water temperature, or increase sediment delivery to the tributaries and Redwood Creek (table 7). In addition, water temperature of some tributaries and most of the mainstem Redwood Creek are unsuitable for maintaining healthy salmonid populations.

Table 6.- Streams, species present, and number of stream miles accessible to anadromous salmonids in the middleRedwood Creek subbasin

Stream	Species Observed		Stream Length (mi) Access	References
Lacks Cr	steelhead coastal cutthroat trout pacific lamprey	rainbow trout pacific giant salamanders	4.54	DFG 2001 & 1966 Stream Surveys, Brown 1988, RNP/USFS-RSL revisit of 1981 thesis sites field notes
Minor Cr	steelhead		2.92	DFG 2001 & 1966 Stream Surveys, Brown 1988
Coyote Cr	coho steelhead pacific giant salamander	eastern brook trout pacific lamprey yellow legged frog	2.44	DFG 2001 & 1966 Stream Surveys, Brown 1988, USFS/RNP barrier study notes
Panther Cr	coastal cutthroat trout pacific giant salamander	rainbow trout steelhead	1.74	DFG 2001 Stream Surveys, Brown 1988, RNP/USFS-RSL revisit of 1981 thesis sites field notes
Dolly Varden Cr	trout		1.13	DFG 2001 Stream Surveys
Wiregrass Cr	steelhead		1.12	DFG 2001 Stream Surveys and Brown 1988
Garcia Cr.	steelhead		0.25	Brown 1988
Toss Up Cr	steelhead pacific giant salamander	yellow legged frog	0.75	DFG 2001 Stream Surveys, carcass surveys 1998,99, RNP/USFS-RSL revisit of 1981 thesis sites field notes, Brown 1988,
Garrett Cr	steelhead		0.56	DFG 2001 Stream Survey, Brown 1988
Lupton Cr.	steelhead		0.56	Brown 1988
Sweathouse Cr	steelhead		0.37	DFG 2001 Stream Surveys, Brown 1988
Mill Cr	steelhead	pacific giant salamanders	0.25	DFG 2001 Stream Surveys, carcass surveys 1998,99, RNP/USFS-RSL revisit of 1981 thesis sites field notes, Brown 1988
Molasses Cr	steelhead		0.25	DFG 2001 Stream Surveys, Brown 1988
Captain Cr	steelhead rainbow trout	pacific giant salamander	0.25	DFG 2001 Stream Survey, Brown 1988
Wiregrass Cr.	steelhead		0.25	DFG 2001 Stream Survey, Brown 1988
Beaver Cr.	steelhead	pacific giant salamanders	0.19	DFG 2001 Stream Survey, Brown 1988
Karen Cr.	coho	steelhead	0.50	Brown 1988
Pilchuck Cr.	steelhead		0.31	DFG 2001 Stream Survey Brown 1988
Cashmere Cr.	steelhead		0.25	Brown 1988
Roaring Gulch	steelhead		0.12	Brown 1988
Santa Fe Cr.	steelhead		0.06	Brown 1988

Redwood Creek	steelhead coastal cutthroat trout chinook salmon coho salmon		DFG 2001 Stream Surveys, Gerstrung 2001, Anderson, 2000, Brown 1988
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Comprehensive qualitative population estimates of the middle basin have not been performed. Although a screw trap has been in place for the summers of 2000 and 2001 downstream of Minor Creek, this covers only 10 miles of accessible salmonid habitat in the middle Redwood Creek subbasin, and it does not present fish population estimates pertinent to just this subbasin (see Upper Redwood Creek Subbasin synthesis for summary for specific numbers). It is important to note that no coho were captured in this trap.

DFG electro-fishing surveys were also performed on eleven tributaries in this subbasin for presence/absence of fish species. Steelhead were observed in relatively small population densities. For example Beaver Creek and Wiregrass Creek density estimates were 0.01 and 0.03 steelhead per foot electrofished. Toss up and Coyote Creeks displayed the by far greatest numbers per feet electrofished of 0.6 and 0.4 respectively. These were generally single pass surveys. Coastal cutthroat were found in small abundance only in Panther Creek. No coho were observed in any of the streams electro-fished. Chinook were not observed either, but surveys were performed in mid to late summer, possibly after juvenile chinook would have migrated down into mainstem Redwood Creek.

The lack of any coho being observed through either survey method might be an indication of unsuitable habitat conditions in the mainstem as well as tributaries in the Middle Redwood Creek subbasin. Historical numbers have certainly decreased, particularly in the mainstem. High mainstem water temperatures and lack of complex pools with large woody debris component may be critical factors in absence of coho being observed.

Summer Steelhead have also been observed in very few numbers, 2 to 21 from the years of 93 to 98 respectively (RNSP 2000) in mainstem Redwood Creek. The summer steelhead population is thought to be far below historical levels and may no longer have the numbers needed to insure sustaining viable population. No summer steelhead surveys have been conducted since 1998 in the most of the middle redwood Creek subbasin.

In summary, salmonid production of mainstem Redwood Creek and its tributaries in the middle Redwood Creek subbasin is limited by the lack of complex pools including a large woody debris component, riparian cover of adequate size, lack of pool depth in the tributaries, elevated water temperatures, and high embeddness in mainstem. Long term channel surveys show sediment delivered to streams from landslides, debris slides, and fluvial hill slope erosion during the 1964 flood are still stored in the middle reaches of Redwood Creek (Ozaki and Jones 1998 and 1999). We recommend the use of DFG stream inventory surveys to help prioritize stream habitat improvement projects in the middle subbasin.

We recommend that summer steelhead dives on the middle mainstem of Redwood Creek should be included in annual surveys and to expand monitoring of juvenile fish populations such as current trapping on mainstem Redwood Creek. The presence or absence and population density of coho in this subbasin should be studied more closely in the tributaries as well as mainstem.

Table 7 - Summary of the results from the Middle Sub-basin EMDS stream reach evaluation. The stream habitat components are assigned a general overall score with respect to suitability for anadromous salmonid production. The '+++' (+1.0) scores represents fully suitable conditions, ++ (.99 to .5) demonstrates moderately suitable conditions, and + (.49 to .01) displays somewhat suitable conditions respectively; where as, a '---' (-1.0) represents fully unsuitable conditions, a '--' (-.99 to -.5) demonstrates moderately unsuitable conditions, and '-' (-.49 to -.01) displays somewhat unsuitable conditions respectively. A '0' represents data which lies inbetween suitable and unsuitable conditions, or there is lacks any data to categorize. These overall scores provide a general overview of current stream conditions and may be used to focus on areas for habitat improvements.

Stream	Reach Length (ft)	Reach number	Reach Condition	Canopy Density	MWAT	Pool Quality	Pool Depth	Pool Shelter	Embeddedness
Coyote Creek	1567	1	-	+++		---	---	---	++
Coyote Creek	1691	2	-	+		---	---	---	++
Coyote Creek	1312	3	-	-		---	---	---	+++
Coyote Creek	1432	4	-	++		--	--	---	++
Coyote Creek	1710	5	-	-		-	-	-	++
Coyote Creek	1548	6	-	+++		---	--	---	+
Coyote Creek	2013	7	-	++		0	+++	---	+++
Coyote Creek Tributary	2106	1	-	++		-	---	+	+++
Panther Creek	2516	1	-	+++		--	---	--	-
Panther Creek	2897	2	-	+++		--	---	-	-

Panther Creek	7319	3	-	+++		--	---	-	-
Panther Creek	1857	4	-	+++		--	---	0	-
Garrett Creek	4779	1	-	+++		---	---	---	-
Lacks Creek	1882	1	-	+++		--	---	0	0
Lacks Creek	5175	2	-	+		--	---	--	++
Lacks Creek	2133	3	-	+		-	---	+	++
Lacks Creek	2090	4	-	+++		0	---	---	--
Lacks Creek	990	5	-	-		-	---	+	---
Lacks Creek	2022	6	-	++		--	---	0	0
Lacks Creek	8384	7	-	+		--	---	--	++
Lacks Creek	1586	8	0	++		--	---	-	+++
Dolly Varden Creek	4639	1	0	+++		-	0	-	-
Dolly Varden Creek	1194	2	0	+++		-	0	--	--
Beaver Creek	2177	1	-	+++		---	---	---	+
Beaver Creek	431	2	-	+++		---	---	---	0
Pilchuck Creek	1617	1	-	---		---	---	---	0
Mill Creek	931	1	-	+++		---	---	--	0
Mill Creek	1857	2	-	+++		--	---	-	-
Molasses Creek	2556	1	-	+++		---	---	---	++
Toss Up Creek	919	1	--	+++		---	---	---	---
Toss Up Creek	988	2	-	+++		--	---	--	+
Toss Up Creek	3555	3	-	+++		---	---	--	-
Wiregrass Creek	2000	1	-	+++		--	---	--	++
Minor Creek	3316	1	-	+++		--	---	--	++
Minor Creek	1725	2	-	+		++	---	+	0
Minor Creek	8139	3	-	+++		--	---	---	+++
Minor Creek	1238	4	-	+++		--	---	-	+++
Sweathouse Creek	1859	1	-	+++		---	---	---	--
Captain Creek	2360	1	-	++		---	---	---	++
Lupton Creek	3832	1	-	+++		-	-	---	-
Redwood Creek Mid	122095	1	-	---		-	+++	---	--
Redwood Creek Mid	8425	2	-	---		---	---	---	+

Habitat assessments and recommendations for fish habitat improvements for Beaver Creek is presented below. This is an example of what will be presented in future drafts of the Redwood Creek basin report. Further detail including maps, tables and charts will be available upon request of interested parties and will be available on the KRIS CD.

Upper Redwood Creek

The upper Redwood Creek sub-basin supports populations of chinook salmon, steelhead, and coastal cutthroat trout. There are approximately 23 miles of mainstem Redwood Creek and 5 miles of tributaries accessible to anadromous fish in the upper sub-basin. Fish access on the mainstem ends at Snow Camp Creek, approximately 63 miles from the river mouth. A 45-foot, impassible cascade exists above this point. Table 8 presents streams, species present, and number of miles in each stream accessible to anadromous salmonids in the lower Redwood Creek subbasin.

All the tributaries of the upper subbasin have anadromous fish access limited to less than one mile. Almost two-thirds of the tributaries have a quarter mile or less of accessible anadromous habitat. However this does necessarily diminish the importance of these tributaries because they generally provide some of the best habitat in the basin. Steelhead have been observed from fourteen tributaries of the upper subbasin. Additionally, coastal cutthroat have been observed in two of these tributaries. The tributaries also provide cooler water to help reduce water temperatures in the mainstem, which have been recorded at the "moderately suitable" range for salmonids. Table 9 presents summary results from EMDS evaluations of the stream reach condition model.

Quantitative estimates of upper basin salmonid populations were not available until a downstream trapping study began in the year 2000 by the Redwood Creek Land Owners Association. The first year of the trapping study monitored downstream movements of fish for a four-month period from April 5 to August 5, 2000. Fish moving downstream were collected with a rotary screw trap located on the mainstem Redwood Creek approximately 4 miles downstream of the confluence of Minor Creek. The study produced population estimates of downstream migrating chinook salmon and estimates of age 1+ and 2+ steelhead captured in the trap. These estimates reflect juvenile chinook and steelhead production from the upper one-third of the Redwood basin (approximately 37 stream miles accessible to anadromous salmonids) which includes the approximately 28 stream miles accessible to anadromous salmonids of the upper subbasin.

In 2000, there was a total of 123,633 juvenile chinook, 12,263 age 1+ steelhead, and 736 age 2+ steelhead trapped. These numbers expanded with trapping efficiency data resulted in a population estimate of $427,542 \pm 37,446$ juvenile chinook, $68,329 \pm 9,273$ age 1+ and $4,739 \pm 1,070$ age 2+ steelhead (Sparkman 2000). In 2001, a total 120,692 chinook and 21 1+ chinook was trapped and the population estimate was 378,000 (Sparkman pers. comm.) No coho were

observed from either year (Sparkman pers. comm.). Cutthroat trout were not mentioned in the trapping study report.

Table 8. Streams, species present, and number of stream miles accessible to anadromous salmonids in the upper Redwood Creek subbasin

Stream	Species Observed	Stream Length (mi) Access	References
Minon Cr	steelhead pacific giant salamander pacific lamprey	0.50	DFG 2001 & 1966 Stream Surveys, RNP/USFS-RSL revisit of 1981 thesis sites field notes, Brown 1988
Fern Prairie Cr	None	0.16	DFG 2001 Stream Surveys, Brown 1988
Bradford/Up. Panther Cr	steelhead	0.99	Brown 1988
Noisy Cr	steelhead	0.50	Brown 1988
Gunrack Cr.	steelhead coastal cutthroat trout	0.50	Brown 1988
High Prairie Cr	steelhead coastal cutthroat trout	0.43	Brown 1988
Lake Prairie Cr	steelhead pacific giant salamander tailed frog	0.31	RNP/USFS-RSL revisit of 1981 thesis sites field notes, Brown 1988
Emmy Lou Cr.	steelhead	0.25	Brown 1988
Windy Cr	steelhead	0.25	Brown 1988
Squirrel Tail Cr	steelhead	0.25	Brown 198
Snowcamp/Smokehouse Cr	steelhead	0.19	Brown 1988
Pardee Cr	steelhead	0.19	Brown 1988
Simion Cr	steelhead	0.19	Brown 1988
Cur-off Meander Cr	steelhead	0.19	Brown 1988
Jena Cr	steelhead	0.12	Brown 1988
Xmas Prairie Cr	None	0.06	Brown 1988
Redwood Creek	Steelhead coastal cutthroat trout chinook salmon		DFG 2001 Stream Surveys, Gerstrung 2001, Anderson, 2000, Brown 1988

Table 9 - Summary of the results from the upper sub-basin EMDS stream reach evaluation. The stream habitat components are assigned a general overall score with respect to suitability for anadromous salmonid production. The '+++' (+1.0) scores represents fully suitable conditions, ++ (.99 to .5) demonstrates moderately suitable conditions, and + (.49 to .01) displays somewhat suitable conditions respectively; where as, a '---' (-1.0)

represents fully unsuitable conditions, a '-' (-.99 to -.5) demonstrates moderately unsuitable conditions, and '0' (-.49 to -.01) displays somewhat unsuitable conditions respectively. A '0' represents data which lies inbetween suitable and unsuitable conditions, or there is lacks any data to categorize. These overall scores provide a general overview of current stream conditions and may be used to focus on areas for habitat improvements.

Stream	Reach Length (ft)	Reach number	Reach Condition	Canopy Density	MWAT	Pool Quality	Pool Depth	Pool Shelter	Embeddedness
Fern Prairie Creek	852	1	-	+++		---	---	---	0
Redwood Creek Upper	13996	1	-	++		---	---	---	+
Minon Creek	1101	1	-	+++		---	---	---	0
Minon Creek	1784	2	-	+++		--	---	--	0
Minon Creek	3294	3	-	-		--	---	--	-

Fisheries data collected from trapping studies indicate that chinook salmon are spawning in the upper third of the Redwood Creek basin which is largely composed from the mainstem Redwood Creek of the upper subbasin. It is difficult to translate the trapping results to the numbers of adult chinook that returned to spawn or interpret the successfulness of the incubation to emergence of fry from this data. However, these data do indicate that spawning conditions in portions of the upper third of the basin are in the suitable range for chinook salmon and the watershed is supporting fry as well. The trapping studies also indicate juvenile steelhead are utilizing the upper third of the basin. Perhaps the best interpretation of the steelhead data is in the numbers of age 2+ steelhead that are likely undergoing seaward migrations.

In addition to the presence and successful spawning of chinook and rearing habitat for juvenile steelhead, adult summer steelhead counts have slightly increased in the upper mainstem from 3 adults in 1993 to 10 adults in 1998. However, the summer steelhead population is thought to be far below historical levels and may no longer have the numbers needed to insure sustaining a viable population. No summer steelhead surveys have been conducted since 1998 in the upper subbasin.

We recommend that summer steelhead dives on the upper mainstem of Redwood Creek should be included in annual surveys and to continue monitoring juvenile fish population trends such as current trapping operations on mainstem Redwood Creek.

Redwood Creek Stream Sites Summary

Habitat assessments and recommendations for fish habitat improvements are presented below. Further detail including maps, tables and charts will be available upon request of interested parties and also will be available on the KRIS CD.

Point Sample Data Collected From Prairie and Lower Redwood Creek Subbasins

Forty Four (site 2)

A total of 597 feet of wetted stream were surveyed on October 1st, 2001. This is considered a 2nd order stream and a F3 channel type. The average stream width was 26ft. The survey began approximately 500ft upstream of the confluence with Redwood Creek. There was a major logjam consisting of 2 recently fallen old growth redwoods catching swd approximately 334 ft upstream of the start of the survey. This appeared to be a low flow barrier as well as a high flow barrier at times. However, there were many salmonids seen upstream of this barrier including yoy and 1+. Nine inches of silt were backed up behind this barrier. The creek was filled with silt above and below the log jam, but there was considerably more silt above the logjam. No good suitable spawning gravels were observed. The pool tailouts either consisted of hard bedrock or small gravels that were heavily embedded. Rearing habitat seemed to be average with a fair amount of large woody debris (lwd) and cool water temperature (55F), but the pools were not very deep with only one pool over 2ft deep. This seemed to be an unstable area for the amount of bank failures, fallen trees, and silt in the stream.

As mentioned above a decent amount of fish were observed. Twenty three fish were captured during electro-fishing. Of these 18 were yoy trout and 5 1+ and 2+ Cutthroat.

Prairie Creek (site 3)

A total of 568 ft. of wetted stream were surveyed on September 25, 2001. The survey began approximately 530 ft downstream of Boyes Creek which is a left bank tributary. This section was determined to be a F3 channel type. A flow measurement was taken and cfs was determined to be 1.4. Water temperatures were relatively cold at 54 F. No salmonid observations were noted. This reach had a good percent of pools by length - 40% and all of them were greater than 3 feet deep. Embeddness levels were low with 75% placing in the first category (0-25% embedded) and the remaining fitting in the second category (25-50% embedded).

Prairie Creek (site 6)

A total of 544 feet were surveyed on September 25, 2001. This section of the stream was a B4 channel type. The flow measurement used at site 3 was also used at this same site with a cfs of 1.4. Stream temperature was slightly higher at 56F. Canopy density was measured at 78% with a 62% coniferous component. There percentage of pool length for this reach was less at 21% and none of the pools were greater than 3feet deep. Embeddness values were good with 67 % falling in category # 1 and the rest in the mid range (50-75% embedded).

Lostman Creek (site 5)

A total of 844 ft were surveyed on September 25, 2001 on this third order stream. Both channel typing and electro-fishing were done at this site. Eight coho, one cutthroat, 15 steelhead, and 3 yoy trout were observed. There were many more salmonids observed in this reach that were not collected through e-fishing. The sizes ranged from 41 mm to 124 mm. Two pools and a riffle were e-fished. This was determined to be a C4 channel type. The average bankfull width was 45

feet. Water temperatures were relatively cool at 58 F. This reach was comprised of 48% pools by length. Only 13% of the pools were 3 ft or greater for this 3rd order stream. The pools did have a good shelter rating of 44 and there seemed to be a healthy amount of large woody debris. Spawning gravels were average to good with 63% of the tail outs were in the 25 - 50% embedded range (category #2). With the rest being in the 1st or 3rd category.

Lostman Creek (site 23)

On September 27, 2001 approximately 962 feet of a second order portion of Lostman Creek were surveyed and electro-fished. A total of 19 coho, 21 steelhead, 3 cutthroat and another 6 yoy presumed to be cutthroat and 7 yoy presumed to be steelhead and 12 yoy presumed to be rainbow trout. Four possible old redds were observed in this reach. The F4 channel type was broken down into fourteen units. Only 14% in length was in pools and none of these were greater than three feet deep. It did have good shelter rating of 74 and contained a large amount of Large Woody Debris. Water temperature was relatively cool at 57 -54 F. Embeddness values were fair with 34% falling into the 0-50% range and the rest being above 50% embedded.

Redwood Creek (site 15)

Approximately 634 feet were habitat typed and e-fished in this section of Lostman Creek. This portion was a second order stream and a F3 channel type. Twelve steelhead were netted throughout the whole stretch of this section. Their sizes ranged from 60 mm to 129mm. Water temperatures were relatively cool at 56-54F. Base flow were 1.5 cfs. There was a large woody debris accumulation 3/4 of the way into the survey which was most likely a result of a landslide immediately upstream of the accumulation. The landslide was recorded to be 100 feet in height, and approximately 60 ft in length. Pools comprised 19% of stream length in this reach. 17% of them were pools greater than 3 feet deep. Total mean pool depth was 1.4 ft and a good shelter rating of 63. Canopy density was 91% with a 58% coniferous component. Embeddness values were high with 73% of the tailouts being greater than 50% embedded.

Site 13 (unnamed tributary to Lostman Creek)

Approximately 474 feet were habitat typed and e-fished in this unnamed tributary to Lostman Creek. This was a second order stream and an E3 channel type. A total of 22 salmonids were captured. It took the entire 474 feet to come up with these 22 fish, so populations numbers within this section of the creek appeared to be rather low. Fifteen trout ranging in lengths from 34mm to 75mm were captured. At these sizes it was too hard to distinguish between steelhead and cutthroat because the maxillary was not fully developed and gill slits were not recognizable. Two steelhead were captured and measured at 205mm and 100mm respectively. Four cutthroat were identified ranging in lengths of 67mm and 145mm. Base flow was approximated at 0.8 cfs. The water temperature was relatively cool at 55-56 F. Pools comprised 28% of the stream length, but non of them were deeper than 3 feet. They did have a relatively high shelter rating of 103. The canopy density was 92% with a 52% coniferous component. Embeddness levels were rather high with 60% of the tailouts being greater than 50% embedded. So the overall spawning gravel were rather poor in this reach. Overall salmonid habitat was average.

Elam Creek (site 24)

Approximately 513 feet were surveyed in this second order stream. This was a B5 channel type. This section of the creek was begun just upstream the confluence with Redwood Creek. Which would partially account for the high accumulation of sand being the dominant substrate. The channel also widens here lessening the velocity and carrying capacity of the stream. This creek was just habitat typed and not electro-fished. A decent amount of salmonids were seen along this stretch of the creek, mostly in the young of the year category with a few 1+. Water temperatures were relatively cool at 57-56 F. The canopy density was 96% with only a 2% coniferous component. Pools accounted for 30% of the stream length. Of these 43% were greater than 3 feet deep. The pool shelter rating was average at 53. There were some very nice pools which covered a large area, were fairly deep and provided decent cover. Spawning gravels were rather poor with 63% of the tailouts being greater than 50% embedded.

Brown Creek (site 10)

Approximately 512 feet of this 1st order stream were habitat typed and a little over half of this was electro-fished. Nineteen trout were captured along with five cutthroat and one steelhead. This seemed to be a decent number of fish for the length that was electro-fished. Water temperature was cool at 55 F. Base flow was estimated to be 1.0 cfs. Canopy density was 96% with a coniferous component of 74%. The percentage of pools by stream length was rather poor at 21% and none of these pools were greater than 2 feet deep. The mean pool shelter rating was also poor at 44. Spawning gravels were average to good with 60% of the tailouts being in the 25-50% embedded category. This stream reach was located in old growth redwood forest in Prairie Creek State Park.

Bridge Creek (site 8)

Approximately 1,249 feet of this 3rd order stream were surveyed on October 2, 2001. The channel was a F4. The survey was begun approximately 465 feet from the confluence with Redwood Creek. This creek was e-fished in two separate locations because there was a major log jam in the middle of the reach and there was a question to whether it was a barrier. There were no coho seen above or below the log jam. A total of 45 trout, 11 steelhead, and 7 sculpin were measured and weighed. Below the log jam were 8 steelhead ranging from 95mm to 158mm in length. There were also 17 trout ranging from 59mm to 78mm in length. In addition 12 trout yoy were captured but not measured. Above the log jam there were 3 steelhead ranging from 123mm to 128mm. Sixteen trout were also measured ranging from 47mm to 90mm in length. The water temperatures were in the acceptable range of 60 to 56F. Canopy density was high at 84% and a 41% coniferous component. There weren't any pools over 3ft deep, but most of the pools were at least over 2 feet deep. The shelter rating was average at 65. Embedded levels were average to good with 45% of the tailouts fitting in the 0 to 50% embedded category.

This stream appeared to be a healthy stream for supporting salmonids. Trout were seen in very good numbers above and below the log jam. The creek has very good spawning gravels below

the log jam. Several old redds were observed within this section. Above the jam the spawning gravels are more silted in with more gravel and less cobble. There was an excellent amount of large woody debris and large rootwads, plus additional recruitment seems very likely in this watershed. Good rearing habitat was available with fairly deep pools containing decent cover and very good macroinvertebrate production was observed in the riffles and runs.

The log jam was 123 feet in length and 70 feet wide. Approximately 40 LWD pieces existed and hundreds of small woody debris scattered around as well. It appears the jam was caused by a right bank slide that goes up 150ft and 80 feet back into the hillside. There was also a smaller left bank slide that contributed LWD and SWD as well. There were lots of remnants of former man made structures (rebar) within this jam. It is mostly likely passable for there are yoy trout upstream, and 1+ stealhead.

Boyes Creek (site 11)

Approximately 508 feet were surveyed of this 1st order stream on September 26, 2001. Boyes creek is located in Prairie Creek State Park near the beginning of the parkway. It is a B3 channel type. This creek was just habitat typed and not e-fished. Water temperatures were cool at 57-56F. Base flows were estimated to be 0.5. The canopy density was 93% with a 11% coniferous component. This was such a low coniferous component because it was fairly far up the watershed out of the old growth forest that covers the lower part of the watershed. Salmonid rearing habitat was rather poor based on several factors. There were very few pools - 17% by stream length and none of these pools were greater than 2 feet deep. It also had a poor pool shelter rating of 36. There was very little large woody debris with this reach. Spawning gravels were fairly good considering 75% of the tailouts were withing the 25-50 embedded category.

May Creek (site 19)

Approximately 449 feet were habitat typed on this 1st order stream on September 25, 2001. It was determined to be a channel type of a B4. The survey was begun at the confluence with Prairie Creek. Water temperatures were rather cool at 58F. The canopy density was 96% with a 6% coniferous component. Pools made up 38% of the stream length with none of them being over 3 feet deep. It had a poor pool shelter rating of 35. Spawning gravels seemed to be very good for 67% of the tailouts had embedded levels less than 25%.

Redwood Creek (site 4)

On October 3, 2001 approximately 1,608 feet were surveyed on Redwood Creek. This survey's mid-point was at the confluence with Bond Creek. Bond Creek did not actually flow into Redwood Creek. It was stopped by two large 2nd growth redwoods and a large boulder approximately 50ft from the main channel of Redwood Creek. Salmonids were seen in Bond Creek - 1+ and yoy. Water temperature of Bond was 57F. There appeared to be a fair amount of sand and silt to be washing out of this system. There was a low flow barrier just downstream of the Bridge crossing the creek (approx 100ft from confl).

In the mainstem of Redwood Creek the channel type was a C4. The water temperature was 66F. The canopy density was 53% with a 28% coniferous component. Pools made up 1/3 of the

stream length. 56% of the pools were greater than 3 ft deep. It had a poor pool shelter rating of 15. Spawning gravels were fair to good with 54% of the tailouts in the 25-50% embedded category and the rest in the 50 to 75% category. This section had an extremely wide bankfull channel of 308 feet. Riparian consisted of alders bordering the creek with second an old growth redwoods approx 25ft up the bank. Gravel was the predominant overall substrate followed by sand and small cobble.

Redwood Creek (site 7)

Approximately 1,500 feet were surveyed on September 25, 2001. The entire reach consisted of subsurface flow and a dry channel bed. It was classified as a C4 channel type.

Redwood Creek (site 14)

Approximately 1,819 feet were surveyed on September 26, 2001. This was determined to be a C4 channel type. Water temperature was measured at 60F. This reach was made up of only four long units. There was just one pool, a lateral scour bedrock pool of 248ft. This long length was due to the pool turning into a run, but having pool-like for some distance. The rest of the unit consisted of flatwater (two runs and a pocketwater. The pool had a mean depth of 1.7 feet and a max of 6.8 feet. It had a fair to poor shelter rating of 45, but this is most likely because of the size of the pool. The tailout had a embeddness value of 1 (0-25% embedded). Canopy density was 33% with a 10% coniferous component.

Redwood Creek (site 18)

Approximately 1,566 feet were surveyed on October 5, 2001. This was a C4 channel. This reach began across from the Tall Trees Groove. Tom McDonald Creek came in about a little over halfway through the unit. This was an extremely wide section of the creek with an average bankfull width of 392 feet. Each unit was extremely long with a majority of it being flatwater. Only 2 pools. One was a nice backwater (bedrock) that was very deep and had nice cover. The rest of the reach had very little cover or shelter complexity. There were some spawning gravels and both tailouts were in the 2nd category - 25-50% embedded, but it seems unlikely fish would spawn here because of the lack of cover and distances between pools to hide out and escape high velocities. Slope was less than 1%. The water temperature was between 64 and 62F. Canopy density was poor at 30% with 59% coniferous component. These figures are easily explained due to the extremely wide channel and the fact that the left bank had been cut up until the formation of the park.

Redwood Creek (site 22)

Approximately 2,065 feet were survey on September 27, 2001. This reach was also electro-fished. Thirty yoy trout, 23 sculpin, and 3 stickleback were measured in a sampled area consisting of a pool, run and riffle with a second pass of a fast moving rifle. The trout lengths ranged from 51mm to 99mm. This was a C4 channel type. The water temperature was 61F. This reach was similar to site 14 in the way it only consisted of 6 different units. There was only

one pool that had a length of 67 feet. It had an average depth of 2.3 feet and a max of 4.8 feet. The shelter rating was 40 and had embeddness value in the 25-50% range. Canopy density was really poor at 7% and of this a 63% coniferous component. Most of the reach consisted of two long runs.

Redwood Creek (site 16 and 17)

Approximately 2,215 ft were surveyed combining the two sites together on October 4, 2001. Unit 16 ended approximately 300ft downstream of the beginning of site 17. The midpoint of 16 was basically at the beginning of the gorge or rocky gap of Redwood Creek where the channel becomes contained through a narrow chute consisting of a series of large boulders on the banks and in the channel. Huge pools were formed in the middle of the channel and around the large boulders. Deep units of pocket water were prominent throughout these sites. Two possible summer steelhead were seen in one huge mid-channel pool approximately 550 feet upstream of the midpoint of site 16. Other salmonids of all age classes were seen frequently throughout the reaches. Water temperatures were on the fairly warm side 66F, but there could have been cool water refugia in some of the deeper pools which had depths up to 12 feet. Large woody debris was lacking, but because of the high velocities, steeper gradient, and confined channel they would most likely be flushed out downstream of the gorge. Site 17 contained a large amount of flatwater units. Spawning gravels were present in some of these flatwater units. The reach ended where it appeared the massive boulder were becoming fewer and farther in-between. Pools comprised 1/3 of site 17 in length. 50% of them were greater than 3 feet deep. They had a low shelter rating of 25. There was a canopy density of 31% and a coniferous component of 39%. Embeddness value primarily (83%) were in the 25-50% embedded category.

Stream Surveys Summaries conducted in the Middle and Upper Redwood Creek Subbasins

Beaver Creek

Beaver Creek is a B3 channel type for the first 2,211 feet of stream surveyed and an A2 channel type for the remaining 520 feet. The suitability of B3 channel types for fish habitat improvement structures is as follows: excellent for plunge weirs, boulder clusters and bank placed boulder, single and opposing wing-deflectors, and log cover. Fish habitat improvement structure suitability for A2 channels is as follows: generally not suitable; high energy streams with stable stream banks, and poor gravel retention capabilities.

Flatwater habitat types comprised 43% of the total length of this survey of Beaver Creek, riffles 44%, and pools 11%. The pools are relatively shallow, with only 4 of the 19 (21.1%) pools having a maximum depth greater than 2 feet. In general, pool enhancement projects are considered when primary pools comprise less than 40% of the length of total stream habitat.

RECOMMENDATIONS

- 1) Beaver Creek should be managed as an anadromous, natural production stream.
- 2) The limited water temperature data available suggest that maximum temperatures are within the acceptable range for juvenile salmonids. To establish more complete and meaningful temperature regime information, 24-hour monitoring during the July and August temperature extreme period should be performed for 3 to 5 years.
- 3) Conduct a fish passage assessment of the culvert crossing under Redwood Valley Road. The culvert is located approximately 1,209 feet from the mouth of Beaver Creek. If it is determined that the culvert is blocking fish passage, options should be explored to replace the culvert with one that provides unimpeded fish passage.
- 4) Increase woody cover in the pools and flatwater habitat units. Most of the existing cover is from boulders. Adding high quality complexity with woody cover is desirable.
- 5) In the B3 channel type, design and engineer pool enhancement structures to increase the number of pools or deepen existing pools. This must be done where the banks are stable or in conjunction with stream bank armor to prevent erosion.
- 6) Increase the canopy on Beaver Creek by planting redwood, Douglas fir or other native conifers in the riparian zone. The tributaries to Beaver Creek and the reaches above this survey section should be inventoried and treated as well, since the water flowing here is affected by upstream activities.
- 7) Suitable size spawning substrate on Beaver Creek is limited to relatively few reaches. Projects should be designed at suitable sites to trap and sort spawning gravel.

Captain Creek

#8501

WATERSHED OVERVIEW

Captain Creek is a tributary to Redwood Creek, which is a tributary to the Pacific Ocean, located in Humboldt County, California (Map 1). Captain Creek's legal description at the confluence with Redwood Creek is T06N R03E S11. Its location is 40° 54' 50" north latitude and 123° 48' 47.64" west longitude. Captain Creek is an ephemeral stream and has approximately 1.8 miles of intermittent stream according to the USGS Lord-Ellis Summit 7.5 minute quadrangle. Captain Creek drains a watershed of approximately 2.1 square miles. Elevations range from about 997 feet at the mouth of the creek to 3,000 feet in the headwater areas. Redwood/Douglas fir and mixed hardwood forest dominates the watershed. The watershed is entirely privately owned and is managed for recreation. Vehicle access exists via Highway 299 to Chezem Road.

HABITAT INVENTORY RESULTS

The habitat inventory of July 12, 2001, was conducted by WSP/AmeriCorps members. The total length of the stream surveyed was 2,360 feet with an additional 18 feet of side channel. Stream flow was not measured on Captain Creek, but was estimated to be less than 1.0 cfs.

Captain Creek is an F3 channel type for the entire 2,360 feet of the stream surveyed. F3 channels are entrenched, meandering, riffle/pool channels on low gradients with high width/depth ratios and cobble-dominant substrates.

BIOLOGICAL INVENTORY RESULTS

Eleven sites were electrofished for species composition and distribution in Captain Creek on August 13, 2001. Water temperatures taken during the electrofishing period ranged from 60° to 70° Fahrenheit. Air temperatures was 62° Fahrenheit. The sites were sampled by DFG fisheries biologist and WSP/AmeriCorps.

The following chart displays the information yielded from these sites:

Date	Site #	Approx. Dist. from mouth (ft.)	Hab. Unit #	Hab. Type	Reach #	Channel type	Steelhead			
							YOY 1+	2+	3+	
08/13/01	1	25	001	3.2	1	F3	2	0	0	0
08/13/01	2	1,346	011	4.2	1	F3	6	0	0	0
08/13/01	3	1,398	013	3.4	1	F3	3	0	0	0
08/13/01	4	1,536	015	5.1	1	F3	2	0	0	0
08/13/01	5	1,592	017	4.2	1	F3	0	0	0	0
08/13/01	6	1,626	019	4.2	1	F3	4	0	0	0
08/13/01	7	1,709	020	4.2	1	F3	3	0	0	0
08/13/01	8	1,845	025	4.2	1	F3	2	0	1	1
08/13/01	9	1,997	028	4.2	1	F3	0	0	0	0
08/13/01	10	2,014	029	5.5	1	F3	0	0	0	0
08/13/01	11	2,203	036	4.2	1	F3	0	0	0	0

DISCUSSION

Captain Creek is an F3 channel type for the entire 2,360 feet of stream surveyed. The suitability of F3 channel types for fish habitat improvement structures is as follows: good for bank-placed boulders, single and opposing wing-deflectors.

The water temperatures recorded on the survey days July 12, 2001, ranged from 62° to 67° Fahrenheit. The water temperatures on August 13, 2001 ranged from 60° to 70° Fahrenheit. Air temperatures ranged from 71° to 77° Fahrenheit. These water temperatures are nearing the threshold stress level for juvenile salmonids. To make any further conclusions, temperatures would need to be monitored throughout the warm summer months, and more extensive biological sampling would need to be conducted.

Flatwater habitat types comprised 31% of the total length of this survey, riffles 60%, and pools 10%. The pools are relatively shallow, with only 3 of the 10 (33%) pools having a maximum depth greater than 2 feet. In general, pool enhancement projects are considered when primary pools comprise less than 40% of the length of total stream habitat. In first and second order streams, a primary pool is defined to have a maximum depth of at least two feet, occupy at least half the width of the low flow channel, and be as long as the low flow channel width.

Five of the 10 pool tail-outs measured had embeddedness ratings of 1 or 2. One of the pool tail-outs had embeddedness ratings of 3 or 4. Four of the pool tail-outs had a rating of 5, which is considered unsuitable for spawning. One of the five was unsuitable for spawning due to the dominant substrate being large cobble. The remainder of pool tails valued at 5 were dominated by boulders. Cobble embeddedness measured to be 25% or less, a rating of 1, is considered to indicate good quality spawning substrate for salmon and steelhead.

Four of the 10 pool tail-outs measured had gravel or small cobble as the dominant substrate. Suitable size spawning substrate is limited in Captain Creek.

The mean shelter rating for pools was 5. The shelter rating in the flatwater habitats was 12. A pool shelter rating of approximately 100 is desirable. The amount of cover that now exists is being provided primarily by boulders in all habitat types. Additionally, small woody debris contribute a small amount. Log and root wad cover structures in the pool and flatwater habitats would enhance both summer and winter salmonid habitat. Log cover structure provides rearing fry with protection from predation, rest from water velocity, and also divides territorial units to reduce density related competition.

The mean percent canopy density for the stream was 78%. In general, revegetation projects are considered when canopy density is less than 80% or the canopy composition is dominated by deciduous trees. The percentage of right and left bank covered with vegetation was low at 65% and 67.5%, respectively.

RECOMMENDATIONS

- 1) The limited water temperature data available suggest that maximum temperatures are nearing the threshold stress level for juvenile salmonids. To establish more complete and meaningful temperature regime information, 24-hour monitoring during the July and August temperature extreme period should be performed for 3 to 5 years.
- 2) Increase woody cover in the pools and flatwater habitat units. Most of the existing cover is from boulders. Adding high quality complexity with woody cover is desirable.
- 3) Where feasible, design and engineer pool enhancement structures to increase the number of pools or deepen existing pools. This must be done where the banks are stable or in conjunction with stream bank armor to prevent erosion.
- 4) Increase the canopy on Captain Creek by planting redwood, Douglas fir or other native conifers within the riparian zone. Tributaries to Captain Creek and the reaches above this survey section should be inventoried and treated as well, since the water flowing here is effected from upstream.
- 5) Suitable size spawning substrate on Captain Creek is limited to relatively few reaches. Projects should be designed at suitable sites to trap and sort spawning gravel.

Coyote Creek

3511

WATERSHED OVERVIEW

002

Coyote Creek is a tributary to the Redwood Creek, a tributary to the Pacific Ocean, located in Humboldt County, California (Map 1). Coyote Creek's legal description at the confluence with Redwood Creek is T8N R2E S2. Its location is 41°06'58.9" north latitude and 123°54'58.5" west longitude. Coyote Creek is a third order stream and has approximately 3.3 miles of blue line stream according to the USGS Panther Creek 7.5 minute quadrangle. Coyote Creek drains a watershed of approximately 7.9 square miles. Elevations range from about 400 feet at the mouth of the creek to 3000 feet in the headwater areas. Redwood/Douglas fir and mixed hardwood forest dominates the watershed. The watershed is entirely privately owned and is managed for timber production. Vehicle access is available through private land, via the Old K&K Road.

HABITAT INVENTORY RESULTS

The habitat inventory of June, 2001, was conducted by WSP/AmeriCorps members. The total length of the stream surveyed was 11,282 feet with an additional 1,481 feet of side channel.

Stream flow was measured at the bottom of the survey reach with a Marsh-McBirney Model 2000 flowmeter at 1.0 cfs on June 14, 2001.

Coyote Creek is a B2 channel type for 1,567 feet of the stream surveyed, an F3 channel type for 1,691 feet of the stream surveyed, an A2 channel type for 5,035 feet of the stream surveyed, a B4

channel type for 897 feet of the stream surveyed, and a B3 channel type for 1,557 feet of the stream surveyed. B2 channels are moderately entrenched, riffle/pool channels on medium gradients with moderate width/depth ratios and boulder-dominant substrates. F3 channels are entrenched, meandering, riffle/pool channels on low gradients with high width/depth ratios on cobble-dominant substrates. A2 channels are entrenched, with little meandering, riffle/pool channels on high gradients with low width/depth ratios and boulder-dominant substrates. B4 channels are moderately entrenched, riffle/pool channels on medium gradients with moderate width/depth ratios and gravel-dominant substrates. B3 channels are moderately entrenched, riffle/pool channels on medium gradients with moderate width/depth ratios and cobble-dominant substrates.

BIOLOGICAL INVENTORY RESULTS

Six reaches, for a total of 25 sites, were electrofished for species composition and distribution in Coyote Creek on September 18 and 19, 2001. Water temperatures taken during the electrofishing period ranged from 58° to 64° Fahrenheit. Air temperatures ranged from 58° to 75° Fahrenheit. The sites were sampled by DFG fisheries biologists and WSP/AmeriCorps members.

The following chart displays the information yielded from these sites:

Date	Site #	Approx. Dist. from mouth (ft.)	Hab. Unit #	Hab. Type	Reach #	Channel type	Steelhead			
							0+	1+	2+	3+
9/18/01	1	517	11	PLP	1	B2	5	1	2	0
9/18/01	2	704	14	PLP	1	B2	16	3	0	0
9/18/01	3	966	17	MCP	1	B2	4	2	0	0
9/18/01	4	1,241	21	MCP	1	B2	12	5	1	0
9/18/01	5	1,399	24	MCP	1	B2	31	1	0	0
9/18/01	6	1,624	30	MCP	2	F3	4	2	0	3
9/18/01	7	1,740	32	STP	2	F3	1	3	0	0
9/18/01	8	2,906	49	STP	2	F3	7	1	1	0
9/18/01	9	3,160	53	LSB	2	F3	11	4	0	0
9/18/01	10	3,568	57	LSB	3	A2	26	3	0	0

Date	Site #	Approx. Dist. from mouth (ft.)	Hab. Unit #	Hab. Type	Reach #	Channel type	Steelhead			
							0+	1+	2+	3+
9/18/01	11	3,725	59	MCP	3	A2	12	1	0	1
9/18/01	12	3,858	63	MCP	3	A2	7	4	0	0
9/18/01	13	4,297	70	MCP	3	A2	11	0	0	0
9/18/01	14	4,695	77	LSL	4	B4	9	4	0	0
9/18/01	15	5,021	85	LSB	4	B4	25	4	0	0
9/18/01	16	5,152	89	PLP	4	B4	42	9	1	0
9/19/01	17	5,537	95	MCP	5	A2	25	5	0	0
9/19/01	18	6,352	111	MCP	5	A2	9	3	0	0
9/19/01	19	6,604	116	MCP	5	A2	15	1	1	0
9/19/01	20	6,784	121	MCP	5	A2	30	3	2	2
9/19/01	21	7,023	126	PLP	5	A2	3	2	0	1

9/19/01	23	7,906	146	LSB	6	B3	0	3	1	0
9/19/01	24	8,400	155	MCP	6	B3	5	4	1	0
9/19/01	25	8,991	163	MCP	6	B3	4	2	0	0

DISCUSSION

Coyote Creek is a B2 channel type for 1,567 feet of stream surveyed, an F3 channel type for 1,691 feet of stream surveyed, an A2 channel type for 5,035 feet of stream surveyed, a B4 channel type for 1,432 feet of stream surveyed, and a B3 channel type for 1,557 feet of stream surveyed. The suitability of B2 channel types for fish habitat improvement structures is as follows: excellent for log cover. F3 channel types are good for bank placed boulders and single and opposing wing deflectors; fair for plunge weirs, boulder clusters, channel constrictors and log cover. A2 channel types are high energy streams with stable stream banks, and poor gravel retention capabilities and therefore are generally not suitable for fish habitat improvement

structures. B4 channel types are excellent for low-stage plunge weirs, boulder clusters, bank placed boulders and single and opposing wing deflectors. B3 channel types are excellent for plunge weirs, boulder clusters, bank placed boulder, single and opposing wing deflectors and log cover.

The water temperatures recorded on the survey days June, 2001, ranged from 54 to 64 degrees Fahrenheit. Air temperatures ranged from 50° to 77° Fahrenheit. This is a suitable water temperature range for salmonids. To make any further conclusions, temperatures would need to be monitored throughout the warm summer months, and more extensive biological sampling would need to be conducted.

Flatwater habitat types comprised 28% of the total length of this survey, riffles 33%, and pools 37%. The pools are relatively shallow, with 20 of the 85 (23.5%) pools having a maximum depth greater than 3 feet. In general, pool enhancement projects are considered when primary pools comprise less than 40% of the length of total stream habitat. In third and fourth order streams, a primary pool is defined to have a maximum depth of at least three feet, occupy at least half the width of the low flow channel, and be as long as the low flow channel width.

Seventy-seven of the 85 pool tail-outs measured had embeddedness ratings of 1 or 2. Eight of the pool tail-outs had embeddedness ratings of 3 or 4. None of the pool tail-outs had a rating of 5, which is considered unsuitable for spawning. Cobble embeddedness measured to be 25% or less, a rating of 1, is considered to indicate good quality spawning substrate for salmon and steelhead.

Forty-nine of the 85 pool tail-outs measured had gravel or small cobble as the dominant substrate. This is generally considered suitable for spawning salmonids.

The mean shelter rating for pools was 14. The shelter rating in the flatwater habitats was 23. A pool shelter rating of approximately 100 is desirable. The amount of cover that now exists is being provided primarily by boulders in all habitat types. Additionally, terrestrial vegetation contribute a small amount. Log and root wad cover structures in the pool and flatwater habitats would enhance both summer and winter salmonid habitat. Log cover structure provides rearing fry with protection from predation, rest from water velocity, and also divides territorial units to reduce density related competition.

The mean percent canopy density for the stream was 77%. Reach 1 had a canopy density of 87% while Reaches 2 and 3 had canopy densities of 69% and 67%, respectively, and Reaches 4, 5, 6, and 7 had canopy densities of 83%, 68%, 91%, and 78% respectively. In general, revegetation projects are considered when canopy density is less than 80% or the canopy composition is dominated by deciduous trees.

The percentage of right and left bank covered with vegetation was 58.3% and 62.0%, respectively. In areas of stream bank erosion or where bank vegetation is not at acceptable levels, planting endemic species of coniferous and deciduous trees, in conjunction with bank stabilization, is recommended.

RECOMMENDATIONS

- 1) The limited water temperature data available suggest that maximum temperatures are within the acceptable range for juvenile salmonids. To establish more complete and meaningful temperature regime information, 24-hour monitoring during the July and August temperature extreme period should be performed for 3 to 5 years.
- 2) Increase woody cover in the pools and flatwater habitat units. Most of the existing cover is from boulders. Adding high quality complexity with woody cover is desirable.
- 3) In the B3, B4 and F3 channel types design and engineer pool enhancement structures to increase the number of pools or deepen the existing pools. This must be done where the banks are stable or in conjunction with stream bank armor to prevent erosion.
- 5) Increase the coniferous component of the canopy on Coyote Creek by planting willow, alder, redwood, and Douglas fir along the stream where shade canopy is not at acceptable levels. The reaches above this surveyed section should be inventoried and treated as well, since the water flowing here is affected from upstream.

Dolly Varden Creek

8589

-003

WATERSHED OVERVIEW

Dolly Varden Creek is a tributary to Redwood Creek, a tributary to the Pacific Ocean, located in Humboldt County, California (Map 1). Dolly Varden Creek's legal description at the confluence with Redwood Creek is T8N R2E S36. Its location is 41°02'5.17" north latitude and 123°53'14.2" west longitude. Dolly Varden Creek is a second order stream and has approximately 1.8 miles of blue line stream according to the USGS Panther Creek 7.5 minute quadrangle. Dolly Varden Creek drains a watershed of approximately 3.3 square miles. Elevations range from about 540 feet at the mouth of the creek to 1,840 feet in the headwater areas. A mixed hardwood and conifer forests dominates the watershed. The watershed is entirely privately owned and is managed for timber production. Vehicle access exists via Highway 299 to Redwood Valley Road.

BIOLOGICAL INVENTORY

Biological sampling during the stream inventory is used to determine fish species and their distribution in the stream. Fish presence was observed from the stream banks in Dolly Varden Creek. No biological inventory was taken for Dolly Varden Creek.

HABITAT INVENTORY RESULTS

The habitat inventory of July 25, 26, and August 14, 23, 27, 2001 was conducted by WSP/AmeriCorps members. The total length of the stream surveyed was 5,968 feet with an additional 375 feet of side channel. Stream flow was not measured on Dolly Varden Creek.

Dolly Varden Creek is a B3 channel type for 4,639 feet and an F3 channel type for 1,204 feet. B3 channels are moderately entrenched, moderate gradient, riffle dominated channels with infrequently spaced pools; very stable plans and profiles; stable banks; with cobble channels. F3 channels are entrenched meandering riffle/pool channels, on low gradients, with high width/depth ratio, and cobble dominated.

DISCUSSION

Dolly Varden Creek is a B3 channel type for the first 4,639 feet of stream surveyed and a F3 channel type for the remaining 1,204 feet. The suitability of B3 channel types for fish habitat improvement structures is as follows: excellent for plunge weirs, boulder clusters, bank placed boulders, single and opposing wing-deflectors, and log cover. The suitability of F3 channel types for fish habitat improvement structures is as follows: good for bank-placed boulders, and single and opposing wing-deflectors; and fair for plunge weirs, boulder clusters, channel constrictors, and log cover.

The water temperatures recorded on the survey days July 25, 26 and August 14, 23 and 27, 2001, ranged from 56° to 64° Fahrenheit. Air temperatures ranged from 58° to 76° Fahrenheit. This is a suitable water temperature range for salmonids. To make any further conclusions, temperatures would need to be monitored throughout the warm summer months, and more extensive biological sampling would need to be conducted.

Flatwater habitat types comprised 47% of the total length of this survey, riffles 24%, and pools 28%. The pools are relatively shallow, with only 15 of the 81 (18.5%) pools having a maximum depth greater than 2 feet. In general, pool enhancement projects are considered when primary pools comprise less than 40% of the length of total stream habitat. In first and second order streams, a primary pool is defined to have a maximum depth of at least two feet, occupy at least half the width of the low flow channel, and be as long as the low flow channel width.

Forty-six of the 81 pool tail-outs measured had embeddedness ratings of 1 or 2. Twenty-nine of the pool tail-outs had embeddedness ratings of 3 or 4. 6 of the pool tail-outs had a rating of 5, which is considered unsuitable for spawning. Seven of the 81 were unsuitable for spawning due to the dominant substrate being silt/sand/clay or small gravel. The remainder of pool tails valued at 5 were dominated by boulders, or large cobble. Cobble embeddedness measured to be 25% or less, a rating of 1, is considered to indicate good quality spawning substrate for salmon and steelhead.

Sixty-four of the 81 pool tail-outs measured had gravel or small cobble as the dominant substrate. This is generally considered good for spawning salmonids.

The mean shelter rating for pools was 50. The shelter rating in the flatwater habitats was 36. A pool shelter rating of approximately 100 is desirable. The cover that now exists is being provided primarily by large woody debris and boulders in all habitat types. Log and root wad cover structures in the pool and flatwater habitats would enhance both summer and winter salmonid habitat. Log cover structure provides rearing fry with protection from predation, rest from water velocity, and also divides territorial units to reduce density related competition.

The mean percent canopy density for the stream was 90%. Reach 1 had a canopy density of 89% while Reach 2 had canopy density of 93%. In general, revegetation projects are considered when canopy density is less than 80%. The percentage of right and left bank covered with vegetation was high at 95.2% and 91.4%, respectively.

RECOMMENDATIONS

- 1) Increase woody cover in the pools and flatwater habitat units. Most of the existing cover is from large woody debris. Adding high quality complexity with woody cover is desirable.
- 2) Where feasible, design and engineer pool enhancement structures to increase the number of pools or deepen the existing pools. This must be done where the banks are stable or in conjunction with stream bank armor to prevent erosion.
- 3) There are several log debris accumulations (LDA's) present on Dolly Varden Creek that are retaining fine sediment. Monitor fish passage for three to five years to determine if these LDA's are preventing fish passage.

Fern Prairie Creek

9591

~~004~~
SKIP

WATERSHED OVERVIEW

Fern Prairie Creek is a tributary to Redwood Creek, tributary to the Pacific Ocean, located in Humboldt County, California (Map 1). Fern Prairie Creek's legal description at the confluence with Redwood Creek is T06N R03E S23. Its location is 40°53'37.68" north latitude and 123°48'35.5" west longitude. Fern Prairie Creek is a first order stream and has approximately one miles of blue line stream according to the USGS Lord-Ellis Summit 7.5 minute quadrangle. Fern Prairie Creek drains a watershed of approximately 0.5 square miles. Elevations range from about 900 feet at the mouth of the creek to 2140 feet in the headwater areas. Mixed hardwood forest dominates the watershed. The watershed is primarily privately owned and is managed for recreation and residence use. Vehicle access exists via Highway 299.

HABITAT INVENTORY RESULTS

The habitat inventory of July 26, 2001, was conducted by WSP/AmeriCorps members. The total length of the stream surveyed was 852 feet with 24 feet of side channel. Stream flow was not measured on Fern Prairie Creek.

Channel types were not taken for Fern Prairie Creek.

BIOLOGICAL INVENTORY RESULTS

No biological sampling was conducted on Fern Prairie Creek.

DISCUSSION

The water temperatures recorded on the survey days July 26, 2001, ranged from 57° to 60° Fahrenheit. Air temperatures ranged from 62° to 65° Fahrenheit. This is a suitable temperature range for juvenile salmonids. To make any further conclusions, temperatures would need to be monitored throughout the warm summer months, and more extensive biological sampling would need to be conducted.

Flatwater habitat types comprised 38% of the total length of this survey, riffles 54%, and pools 8%. The pools are relatively shallow, with none of the 5 pools having a maximum depth greater than 2 feet. In general, pool enhancement projects are considered when primary pools comprise less than 40% of the length of total stream habitat. In first and second order streams, a primary pool is defined to have a maximum depth of at least two feet, occupy at least half the width of the low flow channel, and be as long as the low flow channel width.

Three of the 5 pool tail-outs measured had embeddedness ratings of 1 or 2. One of the pool tail-outs had embeddedness ratings of 3 or 4. One of the pool tail-outs had a rating of 5, which is considered unsuitable for spawning. One of the five was unsuitable for spawning due to the dominant substrate being boulder. Cobble embeddedness measured to be 25% or less, a rating of 1, is considered to indicate good quality spawning substrate for salmon and steelhead.

All of the five pool tail-outs had silt/clay, large cobble or boulders as the dominant substrate. This is generally considered unsuitable for spawning salmonids.

The mean shelter rating for pools was 7. The shelter rating in the flatwater habitats was 10. A pool shelter rating of approximately 100 is desirable. The amount of cover was provided primarily by boulders in all habitat types. Additionally, small woody debris contributes a small amount. Log and root wad cover structures in the pool and flatwater habitats would enhance both summer and winter salmonid habitat. Log cover structure provides rearing fry with protection from predation, rest from water velocity, and also divides territorial units to reduce density related competition.

The mean percent canopy density for the stream was 93%. In general, revegetation projects are considered when canopy density is less than 80% or the canopy composition is dominated by

deciduous trees. The percentage of right and left bank covered with vegetation was 58% and 58%, respectively.

RECOMMENDATIONS

- 1) Fern Prairie Creek should be managed as an anadromous, natural production stream.
- 2) The limited water temperature data available suggest that maximum temperatures are within the acceptable range for juvenile salmonids. To establish more complete and meaningful temperature regime information, 24-hour monitoring during the July and August temperature extreme period should be performed for 3 to 5 years.
- 3) Increase woody cover in the pools and flatwater habitat units. Most of the existing cover is from boulder. Adding high quality complexity with woody cover is desirable.

Garrett Creek

8509

WATERSHED OVERVIEW

004

Garrett Creek is a tributary to Redwood Creek, a tributary to the Pacific Ocean, located in Humboldt County, California (Map 1). Garrett Creek's legal description at the confluence with Redwood Creek is T08N R03E S18. Its location is 41°04'52.5" north latitude and 123°52'43.14" west longitude. Garrett Creek is a second order stream and has approximately 3.6 miles of blue line stream according to the USGS Panther Creek 7.5 minute quadrangle. Garrett Creek drains a watershed of approximately 4.15 square miles. Elevations range from about 600 feet at the mouth of the creek to 3,000 feet in the headwater areas. Redwood/Douglas fir and mixed hardwood forest dominates the watershed. The watershed is entirely privately owned and is managed for timber production and rangeland. Vehicle access exists via Highway 299 to Redwood Valley Road.

HABITAT INVENTORY RESULTS

The habitat inventory of July 8, 9, 10, and 23, 2001, was conducted by WSP/AmeriCorps members. The total length of the stream surveyed was 4,779 feet with an additional 311 feet of side channel. Stream flow was measured at the bottom of the survey reach with a Marsh-McBirney Model 2000 flowmeter at 0.26 cfs on July, 8 2001.

Garrett Creek is a B4 channel type for the entire 4,779 feet of the stream surveyed. B4 channels are moderately entrenched, moderate gradient, riffle dominated channels with infrequently spaced pools, very stable plan and profile, stable banks, and gravel dominated channel.

BIOLOGICAL INVENTORY RESULTS

Thirteen sites were electrofished for species composition and distribution in Garrett Creek on September 5, 2001. Water temperature during the electrofishing period was 59 degrees

Fahrenheit. Air temperature was 64 degrees Fahrenheit. The sites were sampled by DFG fisheries biologist and WSP/AmeriCorps members.

The following chart displays the information yielded from these sites:

Date	Site #	Approx. Dist. from mouth (ft.)	Hab. Unit #	Hab. Type	Reach #	Channel type	Steelhead YOY 1+ 2+		
09/05/01	1	557	0015	5.5	1	B4	7	1	0
09/05/01	2	1,132	0034	5.5	1	B4	11	2	0
09/05/01	3	1,834	0048	4.2	1	B4	1	2	1
09/05/01	4	2,391	0062	4.2	1	B4	1	5	0
09/05/01	5	2,801	0073	4.2	1	B4	0	6	0
09/05/01	6	3,654	0094	4.2	1	B4	2	1	0
09/05/01	7	4,015	0106	5.3	1	B4	2	3	0
09/05/01	8	4,131	0108	5.2	1	B4	7	0	0
09/05/01	9	4,393	0117	5.2	1	B4	6	2	2
09/05/01	10	4,544	0121	4.2	1	B4	0	0	0
09/05/01	11	4,583	0122	4.2	1	B4	0	0	0
09/05/01	12	4,672	0125	5.6	1	B4	0	0	0
09/05/01	13	4,760	0128	4.2	1	B4	0	0	0

DISCUSSION

Garrett Creek is a B4 channel type for the entire 4,779 feet of the stream surveyed. The suitability of B4 channel types for fish habitat improvement structures is as follows: excellent for low-stage plunge weirs, boulder clusters, bank placed boulders, single and opposing wing deflectors, and log cover.

The water temperatures recorded on the survey days July 8, 9, 10 and 23, 2001, ranged from 58° to 63° Fahrenheit. Air temperatures ranged from 68° to 86° Fahrenheit. This is a suitable water

temperature range for salmonids. To make any further conclusions, temperatures would need to be monitored throughout the warm summer months, and more extensive biological sampling would need to be conducted.

Flatwater habitat types comprised 46% of the total length of this survey, riffles 21%, and pools 31%. The pools are relatively shallow, with only 26 of the 64 (40.6%) pools having a maximum depth greater than 2 feet. In general, pool enhancement projects are considered when primary pools comprise less than 40% of the length of total stream habitat. In first and second order streams, a primary pool is defined to have a maximum depth of at least two feet, occupy at least half the width of the low flow channel, and be as long as the low flow channel width.

Thirty-six of the 61 pool tail-outs measured had embeddedness ratings of 1 or 2. Eighteen of the pool tail-outs had embeddedness ratings of 3 or 4. Seven of the pool tail-outs had a rating of 5, which is considered unsuitable for spawning. Six of the 7 were unsuitable for spawning due to the dominant substrate being boulders and one of the seven had large cobble as the dominant substrate. Cobble embeddedness measured to be 25% or less, a rating of 1, is considered to indicate good quality spawning substrate for salmon and steelhead.

Twenty-eight of the 61 pool tail-outs had gravel or small cobble as the dominant substrate. Suitable size spawning substrate is lacking in Garrett Creek.

The mean shelter rating for pools was 25. The shelter rating in the flatwater habitats was 8. A pool shelter rating of approximately 100 is desirable. The relatively small amount of cover that now exists is being provided primarily by boulders in all habitat types. Additionally, whitewater contributed a small amount. Log and root wad cover structures in the pool and flatwater habitats would enhance both summer and winter salmonid habitat. Log cover structure provides rearing fry with protection from predation, rest from water velocity, and also divides territorial units to reduce density related competition.

The mean percent canopy density for the stream was 93%. In general, revegetation projects are considered when canopy density is less than 80%.

The percentage of right and left bank covered with vegetation was high at 86.6% and 88.1%, respectively. In areas of stream bank erosion or where bank vegetation is not at acceptable levels, planting endemic species of coniferous and deciduous trees, in conjunction with bank stabilization, is recommended.

RECOMMENDATIONS

- 1) Increase woody cover in the pools and flatwater habitat units. Most of the existing cover is from boulders. Adding high quality complexity with woody cover is desirable.
- 2) Where feasible, design and engineer pool enhancement structures to increase the number of pools or deepen existing pools. This must be done where the banks are stable or in conjunction with stream bank armor to prevent erosion.

- 3) Inventory and map sources of stream bank erosion and prioritize them according to present and potential sediment yield. Identified sites should then be treated to reduce the amount of fine sediments entering the stream.

Lacks Creek

8587

009-

WATERSHED OVERVIEW

Lacks Creek is a tributary to Redwood Creek which is a tributary to the Pacific Ocean, located in Humboldt County, California (Map 1). Lacks Creek's legal description at the confluence with Redwood Creek is T08N R03E S19. Its location is 41°03'10.42" north latitude and 123°52'20" west longitude. Lacks Creek is a third order stream and has approximately 18.6 miles of blue line stream according to the USGS Hupa Mountain 7.5 minute quadrangle. Lacks Creek drains a watershed of approximately 17.4 square miles. Elevations range from about 440 feet at the mouth of the creek to 3,200 feet in the headwater areas. Redwood/Douglas fir and mixed hardwood forest dominates the watershed. The watershed is entirely privately owned and is managed for timber production. Vehicle access exists via Highway 299 to Redwood Valley Road.

HABITAT INVENTORY RESULTS

The habitat inventory of June 28, July 5-7, 10, 23-24, and 31, was conducted by WSP/AmeriCorps members. The total length of the stream surveyed was 24,262 feet with an additional 968 feet of side channel. Stream flow was measured at the bottom of the survey reach with a Marsh-McBirney Model 2000 flowmeter at 6.9 cfs on June 27, 2001.

Lacks Creek is a B3 channel type for 1,882 feet of the stream surveyed, a B2 channel type for 5,175 feet, a A2 channel type for 2,133 feet, a F2 channel type for 2,090 feet, a B2 channel type for 990 feet, a B3 channel type for 2,022, a B2 channel type for 8,384 feet, and an A1 channel type for 1,586 feet. Channel types classified as "B" are moderately entrenched, with a moderate gradient, riffle dominated channel with infrequently spaced pools, a very stable plan and profile, and stable banks. B3 channel types are dominated by cobble substrate and B2 channel types are dominated by boulder substrate. Channel types classified as "A" are steep, narrow, cascading, step pool streams; high energy/debris transport associated with depositional soils. A2 channel types are dominated by boulder substrate and A1 channel types are dominated by bedrock. F2 channel types are entrenched meandering riffle/pool channels on low gradients with high width/depth ratios and boulder dominated channel.

BIOLOGICAL INVENTORY RESULTS

Twenty sites were electrofished for species composition and distribution in Lacks Creek on September 10 and 13, 2001. Water temperatures taken during the electrofishing period ranged

from 59 to 60 degrees Fahrenheit. Air temperatures ranged from 60 to 62 degrees Fahrenheit. The sites were sampled by DFG fisheries biologists and WSP/AmeriCorps members.

The following chart displays the information yielded from these sites:

Date	Site #	Approx. Dist. from mouth (ft.)	Hab. Unit #	Hab. Type	Reach #	Channel type	Steelhead YOY 1+ 2+		
9/10/01	1	688	0007	3.3	1	B3	7	0	0
9/10/01	2	1,002	0009	3.3	1	B3	7	4	0
9/10/01	3	1,687	0015	3.4	1	B3	12	2	0
9/10/01	4	1,882	0017	3.4	2	B2	6	1	0
9/10/01	5	2,315	0022	4.2	2	B2	3	1	1
9/10/01	6	2,636	0027	4.2	2	B2	19	0	0
9/10/01	7	3,002	0029	3.3	2	B2	2	1	0
9/10/01	8	3,389	0031	5.6	2	B2	4	2	1
9/10/01	9	4,323	0041	4.2	2	B2	18	4	0
9/10/01	10	4,937	0049	43.4	2	B2	1	1	2
9/10/01	11	5,097	00050	5.5	2	B2	6	0	1
9/10/01	12	6,574	0064	5.5	2	B2	3	2	0
9/13/01	13	6,757	0066	4.2	2	B2	23	2	0
9/13/01	14	7,134	0070	4.4	3	A2	19	2	1
9/13/01	15	7,241	0072	5.6	3	A2	9	4	1
9/13/00	16	7,547	0079	6.5	3	A2	19	2	0
9/13/01	17	7,797	0082	5.6	3	A2	2	4	2

Date	Site #	Approx. Dist. from mouth (ft.)	Hab. Unit #	Hab. Type	Reach #	Channel type	Steelhead YOY 1+ 2+		
9/13/01	18	8,055	0086	4.2	3	A2	1	2	0
9/13/01	19	8,419	0091	4.2	3	A2	3	1	1
9/13/01	20	8,811	0097	3.3	3	A2	7	2	0

DISCUSSION

Lacks Creek is a B3 channel type for 3,904 feet of stream surveyed, a B2 channel type for 14,549 feet, an A2 channel type for 2,133 feet, a F2 channel type for 2,090 feet, and an A1 channel type for the remaining 1,586 feet. The suitability of channel types for fish habitat improvement structures is as follows: B3 channel types are excellent for plunge weirs, boulder clusters, bank placed boulders, single and opposing wing deflectors, and log cover. B2 channel types are excellent for log cover. Channel types classified as "A" are generally not suitable for fish habitat improvement structures because they are high energy streams with stable banks and poor gravel retention capabilities. F2 channel types are fair for plunge weirs, single and opposing wing deflectors, and log cover.

The water temperatures recorded on the survey days June 28, July 5-7, 10, 23-24, and 31, ranged from 57 to 65 degrees Fahrenheit. Air temperatures ranged from 61 to 83 degrees Fahrenheit. A water temperature of 65 degrees Fahrenheit is nearing the threshold stress level for salmonids. To make any further conclusions, temperatures would need to be monitored throughout the warm summer months, and more extensive biological sampling would need to be conducted.

Flatwater habitat types comprised 29% of the total length of this survey, riffles 63%, and pools 8%. The pools are relatively deep, with 29 of the 44 (66%) pools having a maximum depth greater than 3 feet. If the channel type is suitable, pool enhancement projects are considered when primary pools comprise less than 40% of the length of total stream habitat. In third and fourth order streams, a primary pool is defined to have a maximum depth of at least three feet, occupy at least half the width of the low flow channel, and be as long as the low flow channel width.

Sixteen of the forty-four pool tail-outs measured had embeddedness ratings of 1 or 2. Two of the pool tail-outs had embeddedness ratings of 3 or 4. Twenty-six of the pool tail-outs had a rating of 5, which is considered unsuitable for spawning. Twenty of the 26 were unsuitable for spawning due to the dominant substrate being boulder. The remainder of pool tails valued at 5

were dominated by silt/clay and bedrock. Cobble embeddedness measured to be 25% or less, a rating of 1, is considered to indicate good quality spawning substrate for salmon and steelhead.

Eighteen of the 44 pool tail-outs measured had gravel or small cobble as the dominant substrate. Spawning substrate for salmonids is limited in Lacks Creek.

The mean shelter rating for pools was 56. The shelter rating in the flatwater habitats was 37. A pool shelter rating of approximately 100 is desirable. The amount of cover that now exists is being provided primarily by boulders in all habitat types. Additionally, small woody debris contributes a small amount. Log and root wad cover structures in the pool and flatwater habitats would enhance both summer and winter salmonid habitat. Log cover structure provides rearing fry with protection from predation, rest from water velocity, and also divides territorial units to reduce density related competition.

The mean percent canopy density for the stream was 77%. Reach 1 had a canopy density of 90% while Reaches 2, 3, 4, 5, 6, 7 and 8 had canopy densities of 72%, 76%, 89%, 62%, 82%, 74%, and 78%, respectively. In general, revegetation projects are considered when canopy density is less than 80% or the canopy composition is dominated by deciduous trees.

The percentage of right and left bank covered with vegetation was high at 76% and 84.8%, respectively. In areas of stream bank erosion or where bank vegetation is not at acceptable levels, planting endemic species of coniferous and deciduous trees, in conjunction with bank stabilization, is recommended.

RECOMMENDATIONS

- 1) Increase woody cover in the pools and flatwater habitat units. Most of the existing cover is from boulders. Adding high quality complexity with woody cover is desirable.
- 2) Increase the canopy on Lacks Creek by planting redwood, Douglas fir or other native conifers within the riparian zone. Tributaries to Lacks Creek and the reaches above this survey section should be inventoried and planted as well, since the water flowing here is effected from upstream.
- 3) Inventory and map sources of stream bank erosion and prioritize them according to present and potential sediment yield. Identified sites should then be treated to reduce the amount of fine sediments entering the stream.
- 4) In the B3 channel type, design and engineer pool enhancement structures to increase the number of pools, or deepen existing pools. This must be done where the banks are stable or in conjunction with stream bank armor to prevent erosion.
- 5) Suitable size spawning substrate on Lacks Creek is limited to relatively few reaches. Projects should be designed at suitable sites to trap and sort spawning gravel.

#8592

006

Lupton Creek

WATERSHED OVERVIEW

Lupton Creek is a tributary to Redwood Creek, a tributary to the Pacific Ocean, located in Humboldt County, California (Map 1). Lupton Creek's legal description at the confluence with Redwood Creek is T06N R03E S15. Its location is 40°54'1.71" north latitude and 123°50'55.65" west longitude. Lupton Creek is a first order stream and has approximately 3.1 miles of blue line stream according to the USGS Lord Ellis Summit 7.5 minute quadrangle. Lupton Creek drains a watershed of approximately 5.2 square miles. Elevations range from about 800 feet at the mouth of the creek to 2,600 feet in the headwater areas. Redwood/Douglas fir and mixed hardwood forest dominates the watershed. The watershed is entirely privately owned and is managed for timber production. Vehicle access exists via Highway 299 to Chezem Road.

HABITAT INVENTORY RESULTS

The habitat inventory of July 22, 23 and 24, 2001, was conducted by DFG fisheries technicians. The total length of the stream surveyed was 3,832 feet with an additional 68 feet of side channel. Stream flow was measured at the bottom of the survey reach with a Marsh-McBirney Model 2000 flowmeter at 0.6 cfs on July 31, 2001.

Lupton Creek is an F2 channel type for the entire stream surveyed. F2 channels are entrenched, meandering, riffle/pool channels on low gradients with high width/depth ratios and boulder-dominant substrates.

BIOLOGICAL INVENTORY

Biological sampling during the stream inventory is used to determine fish species and their distribution in the stream. Fish presence was observed from the stream banks in Lupton Creek. No biological sampling was conducted on Lupton Creek.

DISCUSSION

Lupton Creek is a F2 channel type for the entire 3,832 feet of stream surveyed. The suitability of F2 channel types for fish habitat improvement structures is as follows: good for bank-placed boulders and fair for log cover.

The water temperatures recorded on the survey days of July 22-24, 2001, ranged from 59° to 60° Fahrenheit. Air temperatures ranged from 67° to 79° Fahrenheit. This is a good water temperature for juvenile salmonids. To make any further conclusions, temperatures would need to be monitored throughout the warm summer months, and more extensive biological sampling would need to be conducted.

Flatwater habitat types comprised 18% of the total length of this survey, riffles 25%, and pools 42%. The pools are relatively shallow, with 6 of the 19 (31.6%) pools having a maximum depth greater than 2 feet. In general, pool enhancement projects are considered when primary pools comprise less than 40% of the length of total stream habitat. In first and second order streams, a primary pool is defined to have a maximum depth of at least two feet, occupy at least half the width of the low flow channel, and be as long as the low flow channel width.

Nine of the 19 pool tail-outs measured had embeddedness ratings of 1 or 2. Nine of the pool tail-outs had embeddedness ratings of 3 or 4. One of the pool tail-outs had a rating of 5, which is considered unsuitable for spawning. It was unsuitable for spawning due to the dominant substrate being boulder. Cobble embeddedness measured to be 25% or less, a rating of 1, is considered to indicate good quality spawning substrate for salmon and steelhead. Sediment sources in Lupton Creek should be mapped and rated according to their potential sediment yields, and control measures should be taken.

Thirteen of the 19 pool tail-outs measured had gravel or small cobble as the dominant substrate. This is generally considered good for spawning salmonids.

The mean shelter rating for pools was 28. The shelter rating in the flatwater habitats was 10. A pool shelter rating of approximately 100 is desirable. The amount of cover that now exists is being provided primarily by boulders in all habitat types. Additionally, small woody debris contributes a small amount. Log and root wad cover structures in the pool and flatwater habitats would enhance both summer and winter salmonid habitat. Log cover structure provides rearing fry with protection from predation, rest from water velocity, and also divides territorial units to reduce density related competition.

The mean percent canopy density for the stream was 96%. In general, revegetation projects are considered when canopy density is less than 80% or when the canopy composition is dominated by deciduous trees. The percentage of right and left bank covered with vegetation was 98.9% and 98.6%, respectively.

RECOMMENDATIONS

- 1) The limited water temperature data available suggest that maximum temperatures are within the acceptable range for juvenile salmonids. To establish more complete and meaningful temperature regime information, 24-hour monitoring during the July and August temperature extreme period should be performed for 3 to 5 years.
- 2) Increase woody cover in the pools and flatwater habitat units. Most of the existing cover is from boulders. Adding high quality complexity with woody cover is desirable.
- 3) Increase the canopy on Lupton Creek by planting redwood, Douglas fir or other native conifers within the riparian zone. Tributaries to Lupton Creek and reaches above this survey section should be inventoried and treated as well, since the water flowing here is affected from upstream.

8505
-007

Mill Creek

WATERSHED OVERVIEW

Mill Creek is a tributary to Redwood Creek, a tributary to the Pacific Ocean, located in Humboldt County, California (Map 1). Mill Creek's legal description at the confluence with Redwood Creek is T07N R03E S08. Its location is 41°00'10.74" north latitude and 123°51'31.22" west longitude. Mill Creek is a first order stream and has approximately 1.4 miles of blue line stream according to the USGS Hupa Mountain 7.5 minute quadrangle. Mill Creek drains a watershed of approximately 1.3 square miles. Elevations range from about 620 feet at the mouth of the creek to 1,920 feet in the headwater areas. Redwood/Douglas Fir and mixed hardwood forest dominates the watershed. The watershed is entirely privately owned and is managed for timber production and rangeland. Vehicle access exists via Highway 299 to Redwood Valley Road.

HABITAT INVENTORY RESULTS

The habitat inventory of June 4-5, 2001, was conducted by WSP/AmeriCorps members. The total length of the stream surveyed was 2,788 feet with an additional 92 feet of side channel. Stream flow was measured at the bottom of the survey reach with a Marsh-McBirney Model 2000 flowmeter at 0.5 cfs on June 6, 2001.

Mill Creek is a B4 channel type for 931 feet of the stream surveyed, and a B2 channel type for 1,857 feet. Channels types classified as "B" are moderately entrenched, with a moderate gradient, riffle dominated channel with infrequently spaced pools, very stable plan and profile and stable banks. B4 channels are dominated by gravel substrate and B2 channels are dominated by boulder substrate.

BIOLOGICAL INVENTORY RESULTS

Twelve sites were electrofished for species composition and distribution in Mill Creek on August 6, 2001. Water temperature during the electrofishing period was 60° Fahrenheit. Air temperatures ranged from 61° to 64° Fahrenheit. The sites were sampled by DFG fisheries biologists and WSP/AmeriCorps members.

The following chart displays the information yielded from these sites:

Date	Site #	Approx. Dist. from mouth (ft.)	Hab. Unit #	Hab. Type	Reach #	Channel type	Steelhead YOY 1+ 2+		
08/06/01	1	74	0003	4.2	1	B4	0	0	0
8/06/01	2	129	0005	4.2	1	B4	1	0	0
8/06/01	3	372	0010	4.2	1	B4	4	3	0
8/06/01	4	483	0012	4.2	1	B4	0	0	0
8/06/01	5	931	0019	5.6	2	B2	0	0	1
8/06/01	6	1,024	0021	4.2	2	B2	1	0	0
8/06/01	7	1,138	0023	4.2	2	B2	1	2	2
8/06/01	8	1,213	0025	4.4	2	B2	2	2	1
8/06/01	9	1,455	0027	5.6	2	B2	0	0	0
8/06/01	10	1,967	0034	5.6	2	B2	0	3	0
8/06/01	11	2,492	0039	5.6	2	B2	1	1	0
8/06/01	12	2,715	0045	4.2	2	B2	0	1	0

DISCUSSION

Mill Creek is a B4 channel type for the first 931 feet of stream surveyed and a B2 channel type for the remaining 1,857 feet. The suitability of B4 channel types for fish habitat improvement structures is as follows: excellent for low-stage plunge weirs, boulder clusters, bank placed boulders, single and opposing wing deflectors and log cover. The suitability of B2 channel types for fish habitat improvement structures is as follows: excellent for log cover.

The water temperatures recorded on the survey days June 4-5, 2001, ranged from 49 to 50 degrees Fahrenheit. Air temperatures ranged from 51 to 61 degrees Fahrenheit. This is a good water temperature range for salmonids. To make any further conclusions, temperatures would need to be monitored throughout the warm summer months, and more extensive biological sampling would need to be conducted.

Flatwater habitat types comprised 54% of the total length of this survey, riffles 35%, and pools 11%. The pools are relatively shallow, with only 4 of the 16 (25%) pools having a maximum depth greater than 2 feet. In general, pool enhancement projects are considered when primary

pools comprise less than 40% of the length of total stream habitat. In first and second order streams, a primary pool is defined to have a maximum depth of at least two feet, occupy at least half the width of the low flow channel, and be as long as the low flow channel width.

Nine of the sixteen pool tail-outs measured had embeddedness ratings of 1 or 2. Four of the pool tail-outs had embeddedness ratings of 3 or 4. Three of the pool tail-outs had a rating of 5, which is considered unsuitable for spawning. The pool tails valued at 5 were dominated by boulders or large cobble. Cobble embeddedness measured to be 25% or less, a rating of 1, is considered to indicate good quality spawning substrate for salmon and steelhead.

Twelve of the sixteen pool tail-outs measured had gravel or small cobble as the dominant substrate. This is generally considered good for spawning salmonids.

The mean shelter rating for pools was 53. The shelter rating in the riffle habitats was 39. A pool shelter rating of approximately 100 is desirable. The amount of cover that now exists is being provided primarily by boulders in all habitat types. Additionally, white water contribute a small amount. Log and root wad cover structures in the pool and flatwater habitats would enhance both summer and winter salmonid habitat. Log cover structure provides rearing fry with protection from predation, rest from water velocity, and also divides territorial units to reduce density related competition.

The mean percent canopy density for the stream was 96%. Reach 1 and Reach 2 had canopy density of 96%. In general, revegetation projects are considered when canopy density is less than 80% or the canopy composition is dominated by deciduous trees. The percentage of right and left bank covered with vegetation was 90.9% and 90.9%, respectively.

RECOMMENDATIONS

- 1) Increase woody cover in the pools and flatwater habitat units. Most of the existing cover is from boulders. Adding high quality complexity with woody cover is desirable.
- 2) Increase the canopy on Mill Creek by planting redwood, Douglas fir or other native conifers within the riparian zone. Tributaries to Mill Creek and the reaches above this survey section should be inventoried and treated as well, since the water flowing here is effected from upstream.
- 3). In the B4 channel type, design and engineer pool enhancement structures to increase the number of pools or deepen existing pools. This must be done where the banks are stable or in conjunction with stream bank armor to prevent erosion.

Minon Creek

#8504

WATERSHED OVERVIEW

008

Minon Creek is a tributary to the Redwood Creek, a tributary to the Pacific Ocean, located in Humboldt County, California (Map 1). Minon Creek's legal description at the confluence with Redwood Creek is T05N R04E S20. Its location is 40°48'24" north latitude and 123°44'52.4" west longitude. Minon Creek is a first order stream and has approximately 3.1 miles of blue line stream according to the USGS Grouse Mountain 7.5 minute quadrangle. Minon Creek drains a watershed of approximately 4.2 square miles. Elevations range from about 1,400 feet at the mouth of the creek to 4,850 feet in the headwater areas. Redwood/Douglas fir forest and grassland dominates the watershed. The watershed is entirely privately owned and is managed for rangeland and timber production. Vehicle access exists via Bald Mountain Road to Snow Camp Road to Guy Kerr Road.

HABITAT INVENTORY RESULTS

The habitat inventory of October 22-24, 2001, was conducted by California Conservation Corps and AmeriCorps members. The total length of the stream surveyed was 6,179 feet with an additional 616 feet of side channel. Stream flow was not measured on Minon Creek.

Minon Creek is a F4 channel type for the first 1,101 feet, a B2 channel type for 1,784 feet, and a F2 channel type for 3,294 feet of the stream channel. Channels types classified as "F" are entrenched, meandering, riffle/pool channels on low gradients with high width/depth ratios. F4 channels are gravel dominated and F2 channels are boulder dominated. B2 channels are moderately entrenched, moderate gradient, riffle dominated channel with infrequently spaced pools, very stable plan and profile, stable banks, and boulder dominated channel.

BIOLOGICAL INVENTORY RESULTS

Twelve sites were electrofished for species composition and distribution in Minon Creek on October 29, 2001. Water temperatures taken during the electrofishing period ranged from 51 to 52 degrees Fahrenheit. Air temperatures ranged from 54 to 58 degrees Fahrenheit. The sites were sampled by DFG fisheries biologist, California Conservation Corps and WSP/AmeriCorps members).

The following chart displays the information yielded from these sites:

Date	Site #	Approx. Dist. from mouth (ft.)	Hab. Unit #	Hab. Type	Reach #	Channel type	Steelhead YOY 1+ 2+		
10/29/01	1	230	0006	5.2	1	F4	7	2	0
10/29/01	2	360	0009	4.2	1	F4	3	1	0
10/29/01	3	510	0012	4.2	1	F4	8	2	0

Date	Site #	Approx. Dist. from mouth (ft.)	Hab. Unit #	Hab. Type	Reach #	Channel type	Steelhead YOY 1+ 2+		
10/29/01	4	580	0014	5.5	1	F4	6	6	0
10/29/01	5	735	0017	5.4	1	F4	1	2	1
10/29/01	6	895	0020	4.2	2	B2	17	5	0
10/29/01	7	1,506	0033	5.6	2	B2	2	0	0
10/29/01	8	1,717	0039	4.2	2	B2	4	3	0
10/29/01	9	1,839	0044	5.6	2	B2	4	2	0
10/29/01	10	2,267	0052	4.4	2	B2	8	2	0
10/29/01	11	2,638	0060	5.6	2	B2	9	5	1
10/29/01	12	2,911	0066	5.6	3	F2	4	4	0

DISCUSSION

Minon Creek is a F4 channel type for the first 1,101 feet of stream surveyed and a B2 channel type for 1,784 feet and a F2 channel type for the remaining 3,294 feet of the stream surveyed. The suitability of F4 channel types for fish habitat improvement structures is as follows: good for bank placed boulders, fair for plunge weirs, single and opposing wing-deflectors, channel constrictors, log cover; poor for boulder clusters. The suitability of B2 channel types for fish habitat improvement structures is: excellent for log cover. The suitability of F2 channel types is: fair for plunge weirs, single and opposing wing deflectors and log cover.

The water temperatures recorded on the survey days October 22-24, 2001, ranged from 50 to 52 degrees Fahrenheit. Air temperatures ranged from 50 to 62 degrees Fahrenheit. This is a good water temperature range for salmonids. To make any further conclusions, temperatures would need to be monitored throughout the warm summer months, and more extensive biological sampling would need to be conducted.

Flatwater habitat types comprised 52% of the total length of this survey, riffles 22%, and pools 17%. The pools are relatively shallow, with 18 of the 47 (38%) pools having a maximum depth greater than 2 feet. In general, pool enhancement projects are considered when primary pools comprise less than 40% of the length of total stream habitat. In first and second order streams, a

primary pool is defined to have a maximum depth of at least two feet, occupy at least half the width of the low flow channel, and be as long as the low flow channel width.

Thirty of the 47 pool tail-outs measured had embeddedness ratings of 1 or 2. Seven of the pool tail-outs had embeddedness ratings of 3 or 4. Ten of the pool tail-outs had a rating of 5, which is considered unsuitable for spawning. Nine of the ten were unsuitable for spawning due to the dominant substrate being boulder. The other pool tail valued at 5 was dominated by bedrock. Cobble embeddedness measured to be 25% or less, a rating of 1, is considered to indicate good quality spawning substrate for salmon and steelhead.

Thirty-one of the 47 pool tail-outs measured had gravel or small cobble as the dominant substrate. This is generally considered good for spawning salmonids.

The mean shelter rating for pools was 25. The shelter rating in the flatwater habitats was 12. A pool shelter rating of approximately 100 is desirable. The relatively small amount of cover that now exists is being provided primarily by boulders in all habitat types. Additionally, whitewater contributes a small amount. Log and root wad cover structures in the pool and flatwater habitats would enhance both summer and winter salmonid habitat. Log cover structure provides rearing fry with protection from predation, rest from water velocity, and also divides territorial units to reduce density related competition.

The mean percent canopy density for the stream was 90%. Reach 1 had a canopy density of 83% while Reaches 2 and 3 had canopy densities of 90% and 92%, respectively. In general, revegetation projects are considered when canopy density is less than 80% or the canopy composition is dominated by deciduous trees. The percentage of right and left bank covered with vegetation was 73% and 77%, respectively.

RECOMMENDATIONS

- 1) Increase woody cover in the pools and flatwater habitat units. Most of the existing cover is from boulders. Adding high quality complexity with woody cover is desirable.
- 2) In the F4 channel type design and engineer pool enhancement structures to increase the number of pools or deepen existing pools. This must be done where the banks are stable or in conjunction with stream bank armor to prevent erosion.
- 3) Increase the canopy on Minon Creek by planting redwood, Douglas fir or other native conifers within the riparian zone. Tributaries to Minon Creek and the reaches above this survey section should be inventoried and treated as well, since the water flowing here is effected from upstream.

Minor Creek

3500

009

WATERSHED OVERVIEW

Minor Creek is a tributary to Redwood Creek, a tributary to the Pacific Ocean, located in Humboldt County, California (Map 1). Minor Creek's legal description at the confluence with Redwood Creek is T07N R03E S28. Its location is 40° 57' 38" north latitude and 123° 50' 03" west longitude. Minor Creek is a second order stream and has approximately 6.5 miles of blue line stream according to the USGS Lord-Ellis Summit 7.5 minute quadrangle. Minor Creek drains a watershed of approximately 11.6 square miles. Elevations range from about 730 feet at the mouth of the creek to 2,800 feet in the headwater areas. Redwood/Douglas fir and mixed hardwood forest dominates the watershed. The watershed is entirely privately owned and is managed for timber production and rangeland. Vehicle access exists via Highway 299 to Redwood Valley Road.

HABITAT INVENTORY RESULTS

The habitat inventory of June 11 through June 20, 2001, was conducted by WSP/AmeriCorps members. The total length of the stream surveyed was 14,418 feet with an additional 333 feet of side channel. Stream flow was measured at the bottom of the survey reach with a Marsh-McBirney Model 2000 flowmeter at 2.3 cfs on June 22, 2001.

Minor Creek is an F4 channel type for the first 3,316 feet of the stream surveyed, an F2 for 1,725 feet, a B3 for 8,139 feet, and a B2 for the last 1,238 feet. Channel types classified "F" are entrenched, meandering, riffle/pool channels on low gradients with high width/depth ratios. F4 channels are dominated by gravel and F2 channels are dominated by boulder. Channel types classified as "B" are moderately entrenched, moderate gradient, riffle-dominated channel with infrequently spaced pools; very stable plan and profile and stable banks. B3 channels are dominated by cobble and B2 channels are dominated by boulder.

BIOLOGICAL INVENTORY RESULTS

Twenty six sites were electrofished for species composition and distribution in Minor Creek on August 8, 9, 13 and 15, 2001. Water temperatures taken during the electrofishing period ranged from 64° to 69° degrees Fahrenheit. The sites were sampled by DFG fisheries biologists and WSP/AmeriCorps members.

The following chart displays the information yielded from these sites:

Date	Site #	Approx. Dist. from mouth (ft.)	Hab. Unit #	Hab. Type	Reach #	Channel type	Steelhead YOY 1+ 2+ 3+			
8/8/01	1	322	006	RUN	1	F4	9	4	0	0

Date	Site #	Approx. Dist. from mouth (ft.)	Hab. Unit #	Hab. Type	Reach #	Channel type	Steelhead YOY 1+ 2+ 3+			
8/8/01	2	354	007	LGR	1	F4	3	1	0	0
8/8/01	3	381	008	MCP	1	F4	12	2	1	0
8/8/01	4	612	012	MCP	1	F4	5	1	0	0
8/8/01	5	921	014	LSBo	1	F4	7	3	1	0
8/9/01	6	1,280	019	STP	2	F2	6	3	1	0
8/9/01	7	1,649	023	STR	2	F2	5	0	0	0
8/9/01	8	1,947	024	BPR	2	F2	4	4	1	0
8/9/01	9	2,331	028	LGR	2	F2	16	0	0	0
8/9/01	10	2,418	029	MCP	2	F2	6	2	0	0
8/9/01	11	2,620	031	STP	2	F2	9	3	1	0
8/9/01	12	3,162	035	PLP	2	F2	3	0	0	0
8/9/01	13	3,293	037	LSBo	2	F2	7	0	1	0
8/9/01	14	3,673	041	STP	2	F2	10	0	0	0
8/9/01	15	4,075	045	PLP	2	F2	2	1	0	1
8/9/01	16	4,247	048	STP	2	F2	3	1	1	1
8/9/01	17	4,555	053	STP	2	F2	7	2	0	0
8/13/01	18	5,041	056	LGR	3	B3	4	0	0	0
8/13/01	19	5,132	057	RUN	3	B3	5	0	1	0
8/13/01	20	5,216	058	PLP	3	B3	0	1	1	1
8/15/01	21	13,180	109	PLP	4	B2	4	0	1	1
8/15/01	22	13,400	111	LSBo	4	B2	5	1	1	0
8/15/01	23	13,458	112	LGR	4	B2	2	0	0	0

Date	Site #	Approx. Dist. from mouth (ft.)	Hab. Unit #	Hab. Type	Reach #	Channel type	Steelhead YOY 1+ 2+ 3+			
8/15/01	24	13,521	113	SRN	4	B2	1	0	0	0
8/15/01	25	13,623	117	STP	4	B2	1	2	1	1
8/15/01	25	14,242	119	CAS	4	B2	0	0	0	0

DISCUSSION

Minor Creek is an F4 channel type for the first 3,316 feet of stream surveyed, an F2 channel type for 1,725 feet, a B3 for 8,139 feet, and a B2 for 1,238 feet. The suitability of F4 channel types for fish habitat improvement structures are as follows: good for bank-placed boulders; fair for plunge weirs, single and opposing wing-deflectors, channel constrictors and log cover; poor for boulder clusters. The suitability of F2 channel types for fish habitat improvement structures are as follows: fair for plunge weirs, single and opposing wing-deflectors and log cover. The suitability

of B3 channel types for fish habitat improvement structures are as follows: excellent for plunge weirs, boulder clusters, bank placed boulders, log cover and single and opposing wing deflectors. The suitability of B2 channel types for fish habitat improvement structures are as follows: excellent for plunge weirs, single and opposing wing-deflectors and log cover.

The water temperatures recorded on the survey days June 11 to June 20, 2001, ranged from 52° to 57° Fahrenheit. Air temperatures ranged from 55° to 74° Fahrenheit. The water temperatures taken during the biological sampling in August ranged from 64° to 69° Fahrenheit. The water temperatures recorded in August are nearing the threshold stress level for salmonids. To make any further conclusions, temperatures would need to be monitored throughout the warm summer months, and more extensive biological sampling would need to be conducted.

Flatwater habitat types comprised 38% of the total length of this survey, riffles 44%, and pools 17%. The pools are relatively deep, with 34 of the 35 (97%) pools having a maximum depth greater than 2 feet. In general, pool enhancement projects are considered when primary pools comprise less than 40% of the length of total stream habitat. In first and second order streams, a primary pool is defined to have a maximum depth of at least two feet, occupy at least half the width of the low flow channel, and be as long as the low flow channel width.

Twenty-five of the 35 pool tail-outs measured had embeddedness ratings of 1 or 2. Three of the pool tail-outs had embeddedness ratings of 3 or 4. Seven of the pool tail-outs had a rating of 5,

which is considered unsuitable for spawning. All of the seven were unsuitable for spawning due to the dominant substrate being boulders. Cobble embeddedness measured to be 25% or less, a rating of 1, is considered to indicate good quality spawning substrate for salmon and steelhead.

Twenty-six of the 35 pool tail-outs measured had gravel or small cobble as the dominant substrate. This is generally considered good for spawning salmonids.

The mean shelter rating for pools was 41. The shelter rating in the flatwater habitats was 26. A pool shelter rating of approximately 100 is desirable. The amount of cover that now exists is being provided primarily by boulders in all habitat types. Additionally, small woody debris contributes a small amount. Log and root wad cover structures in the pool and flatwater habitats would enhance both summer and winter salmonid habitat. Log cover structure provides rearing fry with protection from predation, rest from water velocity, and also divides territorial units to reduce density related competition.

The mean percent canopy density for the stream was 86%. Reach 1 had a canopy density of 84% while Reaches 2, 3 and 4 had canopy densities of 72%, 92% and 93%, respectively. In general, revegetation projects are considered when canopy density is less than 80% or the canopy composition is dominated by deciduous trees.

The percentage of right and left bank covered with vegetation was 91.1% and 89.4%, respectively. In areas of stream bank erosion or where bank vegetation is not at acceptable levels, planting endemic species of coniferous and deciduous trees, in conjunction with bank stabilization, is recommended.

RECOMMENDATIONS

- 1) The limited water temperature data available suggest that maximum temperatures are nearing the threshold stress level for juvenile salmonids. To establish more complete and meaningful temperature regime information, 24-hour monitoring during the July and August temperature extreme period should be performed for 3 to 5 years.
- 2) Where feasible, design and engineer pool enhancement structures to increase the number of pools. This must be done where the banks are stable or in conjunction with stream bank armor to prevent erosion.
- 3) Increase woody cover in the pools and flatwater habitat units. Most of the existing cover is from boulders. Adding high quality complexity with woody cover is desirable.
- 4) Inventory and map sources of stream bank erosion and prioritize them according to present and potential sediment yield. Identified sites should then be treated to reduce the amount of fine sediments entering the stream.

- 5) Increase the canopy on Minor Creek by planting redwood, and Douglas fir or other native conifers within the riparian zone. The tributaries to Minor Creek and the reaches above this survey section should be inventoried and treated as well, since the water flowing here is affected from upstream.

Molasses Creek

8504

-010

WATERSHED OVERVIEW

Molasses Creek is a tributary to the Redwood Creek, a tributary to the Pacific Ocean, located in Humboldt County, California (Map 1). Molasses Creek's legal description at the confluence with Redwood Creek is T07N R03E S17. Its location is 40°59'46" north latitude and 123°51'18" west longitude. Molasses Creek is a first order stream and has approximately 1.3 miles of blue line stream according to the USGS Hupa Mtn 7.5 minute quadrangle. Molasses Creek drains a watershed of approximately 1.6 square miles. Elevations range from about 600 feet at the mouth of the creek to 1,480 feet in the headwater areas. Redwood/Douglas fir and mixed hardwood forest dominates the watershed. The watershed is entirely privately owned and is managed for timber production. Vehicle access exists via Highway 299 to Redwood Valley Road.

HABITAT INVENTORY RESULTS

The habitat inventory of June 06, 2001, was conducted by DFG fisheries technicians and WSP/AmeriCorps members. The total length of the stream surveyed was 2,556 feet with an additional 101 feet of side channel. Stream flow was measured at the bottom of the survey reach with a Marsh-McBirney Model 2000 flowmeter at 0.30 cfs on June 05, 2001.

Molasses Creek is a B3 channel type for the entire 2,556 feet of the stream surveyed. B3 channels are moderately entrenched, riffle dominated channels on moderate gradients with infrequently spaced pools, stable banks and cobble-dominant substrates.

BIOLOGICAL INVENTORY RESULTS

Nine sites were electrofished for species composition and distribution in Molasses Creek on August 15, 2001. Water temperature taken during the electrofishing period was 61° Fahrenheit. Air temperature was 61° Fahrenheit. The sites were sampled by DFG fisheries biologists and WSP/AmeriCorps members.

The following chart displays the information yielded from these sites:

Date	Site #	Approx. Dist. from mouth (ft.)	Hab. Unit #	Hab. Type	Reach #	Channel type	Steelhead		
							YOY	1+	2+
08/15/01	1	684'	013	3.3	1	B3	12	0	0
08/15/01	2	823'	015	4.2	1	B3	5	1	1
08/15/01	3	1,001'	019	5.6	1	B3	6	0	0
08/15/01	4	1,789'	026	3.4	1	B3	5	0	0
08/15/01	5	1,982'	030	3.4	1	B3	6	1	0
08/15/01	6	2,199'	031	4.2	1	B3	5	4	1
08/15/01	7	2,292'	036	4.2	1	B3	3	2	0
08/15/01	8	2,316'	037	3.4	1	B3	2	3	0
08/15/01	9	2,513'	038	4.4	1	B3	4	4	0

DISCUSSION

Molasses Creek is a B3 channel type for the entire 2,556 feet of stream surveyed. The suitability of B3 channel types for fish habitat improvement structures is as follows: excellent for plunge weirs, boulder clusters and bank placed boulders, single and opposing wing deflectors and log cover.

The water temperatures recorded on the survey day of June 4, 2001, ranged from 55° to 60° Fahrenheit. Air temperatures ranged from 62° to 68° Fahrenheit. This is a good water temperature range for salmonids. To make any further conclusions, temperatures would need to be monitored throughout the warm summer months, and more extensive biological sampling would need to be conducted.

Flatwater habitat types comprised 62% of the total length of this survey, riffles 24%, and pools 13%. The pools are relatively shallow, with only 1 of the 12 (8.3%) pools having a maximum depth greater than 2 feet. In general, pool enhancement projects are considered when primary pools comprise less than 40% of the length of total stream habitat. In first and second order streams, a primary pool is defined to have a maximum depth of at least two feet, occupy at least half the width of the low flow channel, and be as long as the low flow channel width.

Eleven of the 12 pool tail-outs measured had embeddedness ratings of 1 or 2. One of the pool tail-outs had embeddedness ratings of 3 or 4. None of the pool tail-outs had a rating of 5, which is considered unsuitable for spawning. Cobble embeddedness measured to be 25% or less, a rating of 1, is considered to indicate good quality spawning substrate for salmon and steelhead.

Twelve of the 12 pool tail-outs measured had gravel or small cobble as the dominant substrate. This is generally considered good for spawning salmonids.

The mean shelter rating for pools was 18. The shelter rating in the flatwater habitats was 6. A pool shelter rating of approximately 100 is desirable. The amount of cover that now exists is being provided primarily by boulder in all habitat types. Additionally, small woody debris contributes a small amount. Log and root wad cover structures in the pool and flatwater habitats would enhance both summer and winter salmonid habitat. Log cover structure provides rearing fry with protection from predation, rest from water velocity, and also divides territorial units to reduce density related competition.

The mean percent canopy density for the stream was 91%. In general, revegetation projects are considered when canopy density is less than 80% or the canopy composition is dominated by deciduous trees. The percentage of right and left bank covered with vegetation was 95% and 92.1%, respectively.

RECOMMENDATIONS

- 1) Increase woody cover in the pools and flatwater habitat units. Most of the existing cover is from boulders. Adding high quality complexity with woody cover is desirable.
- 2) Design and engineer pool enhancement structures to increase the number of pools or deepen existing pools. This must be done where the banks are stable or in conjunction with stream bank armor to prevent erosion.
- 3) Increase the canopy on Molasses Creek by planting redwood, Douglas fir or other native conifers within the riparian zone. Tributaries to Molasses Creek and the reaches above this survey section should be inventoried and treated as well, since the water flowing here is effected from upstream.

Panther Creek

#8510

-011

WATERSHED OVERVIEW

Panther Creek is a tributary to Redwood Creek, a tributary to the Pacific Ocean, located in Humboldt County, California (Map 1). Panther Creek's legal description at the confluence with Redwood Creek is T08N R02E S14. Its location is 41°05'19.6" north latitude and 123°54'25.72" west longitude. Panther Creek is a second order stream and has approximately 5.27 miles of blue line stream according to the USGS Panther Creek 7.5 minute quadrangle.

Panther Creek drains a watershed of approximately 5.98 square miles. Elevations range from about 610 feet at the mouth of the creek to 2,400 feet in the headwater areas. Redwood/Douglas fir and mixed hardwood forest dominates the watershed. The watershed is entirely privately owned and is managed for timber production. Vehicle access exists from Korbel, through a locked gate, and via the K&K Road to the mouth of Panther Creek.

HABITAT INVENTORY RESULTS

The habitat inventory of June 13 through July 18, 2001, was conducted by DFG fisheries technicians. The total length of the stream surveyed was 14,504 feet with an additional 997 feet of side channel. Stream flow was measured at the bottom of the survey reach with a Marsh-McBirney Model 2000 flowmeter at 2.05 cfs on July 2, 2001.

Panther Creek is an F4 channel type for the first 2,516 feet of the stream surveyed, an F2 channel type for the next 2,812 feet, a B4 for 7,319 feet and an F2 for the remaining 1,857 feet surveyed. F4 channels are entrenched, meandering, riffle/pool channels on low gradients with high width/depth ratios and gravel-dominant substrates. F2 channels are entrenched meandering riffle/pool channel on low gradients with high width/depth ratio and boulder dominant substrates. B4 channels are moderately entrenched, moderate gradient, riffle dominated channel with infrequently spaced pools, very stable plan and profile, stable banks and gravel dominate substrates.

BIOLOGICAL INVENTORY RESULTS

Thirty-nine habitat units were electrofished for species composition and distribution in Panther Creek on August 8 - 22, 2001. Water temperatures taken during the electrofishing period ranged from 57 to 61 degrees Fahrenheit. Air temperatures ranged from 59 to 64 degrees Fahrenheit. The sites were sampled by DFG fisheries biologist and WSP/AmeriCorps members.

The following chart displays the information yielded from these sites:

Date	Site #	Approx. Dist. from mouth (ft.)	Hab. Unit #	Hab. Type	Reach #	Channel type	Steelhead/Cutthroat				
							0+ CT	1+	2+	3+	
08/08/01	1	482	0010	5.6	1	F4	20	2	1	0	0
08/08/01	2	521	0011	4.2	1	F4	12	4	0	1	0
08/08/01	3	740	0015	4.2	1	F4	6	5	0	0	0

Date	Site #	Approx. Dist. from mouth (ft.)	Hab. Unit #	Hab. Type	Reach #	Channel type	Steelhead/Cutthroat 0+ 1+ 2+ 3+ CT				
							0+	1+	2+	3+	CT
08/08/01	4	1,273	0022	4.2	1	F4	9	6	1	0	0
08/08/01	5	1,427	0026	4.2	1	F4	11	1	1	0	0
08/08/01	6	1,756	0037	4.2	1	F4	4	5	0	0	0
08/08/01	7	1,785	0038	5.6	1	F4	2	2	0	0	0
08/08/01	8	1,918	0040	5.6	1	F4	7	3	0	0	0
08/09/01	9	2,163	0043	5.6	1	F4	12	3	0	0	0
08/09/01	10	2,470	0047	5.6	1	F4	8	4	0	0	0
08/09/01	11	2,709	0054	5.5	2	F2	4	3	0	0	0
08/09/01	12	2,971	0059	4.2	2	F2	16	4	1	1	0
08/09/01	13	3,209	0064	5.6	2	F2	2	1	0	0	0
08/09/01	14	3,647	0073	5.6	2	F2	0	0	0	0	0
08/09/01	15	3,686	0074	4.2	2	F2	1	1	0	0	0
08/09/01	16	4,203	0089	4.2	2	F2	1	1	0	0	0
08/09/01	17	4,375	0095	4.2	2	F2	1	2	1	0	0
08/09/01	18	4,735	0105	4.2	2	F2	0	1	1	0	0
08/09/01	19	5,133	0116	4.2	2	F2	0	0	0	0	0
08/09/01	20	5,180	0117	4.4	2	F2	1	1	1	0	1
08/13/01	21	6,072	0133	4.4	3	B4	0	0	0	0	2
08/13/01	22	6,870	0140	4.2	3	B4	3	0	0	0	2
08/13/01	23	8,141	0164	4.2	3	B4	1	3	0	0	2
08/13/01	24	9,716	0194	5.6	3	B4	0	0	0	0	0
08/13/01	25	9,931	0197	4.4	3	B4	0	1	0	0	0

Date	Site #	Approx. Dist. from mouth (ft.)	Hab. Unit #	Hab. Type	Reach #	Channel type	Steelhead/Cutthroat CT				
							0+	1+	2+	3+	
08/13/01	26	11,011	0213	5.6	3	B4	0	0	0	0	1
08/13/01	27	11,459	0217	5.6	3	B4	0	0	0	1	0
08/22/01	28	12,112	0227	4.2	3	B4	0	0	0	0	0
08/22/01	29	12,320	0234	5.6	3	B4	0	0	1	0	0
08/22/01	30	12,388	0236	4.4	3	B4	4	1	0	0	0
08/22/01	31	12,719	0242	4.2	4	F2	0	0	0	0	0
08/22/01	32	12,742	0243	4.4	4	F2	2	0	0	0	0
08/22/01	33	12,875	0245	4.4	4	F2	0	0	0	0	0
08/22/01	34	13,029	0247	4.2	4	F2	0	0	1	0	1
08/22/01	35	13,359	0256	5.6	4	F2	0	0	0	0	0
08/22/01	36	13,516	0261	4.2	4	F2	1	0	0	0	3
08/22/01	37	13,885	0271	4.2	4	F2	0	0	0	0	0
08/22/01	38	14,272	0279	5.5	4	F2	0	0	0	0	0
08/22/01	39	14,390	0283	4.2	4	F2	0	0	0	0	0

DISCUSSION

Panther Creek is an F4 channel type for the first 2,516 feet of stream surveyed, an F2 channel type for 4,669 feet of stream surveyed and a B4 for 7,319 feet of stream surveyed. The suitability of F4 channel types for fish habitat improvement structures is as follows: good for bank-placed boulders; fair for plunge weirs, single and opposing wing-deflectors, channel constrictors and log cover; poor for boulder clusters. The suitability of F2 channel types for fish habitat improvement structures is as follows: fair for plunge weirs, single and opposing wing deflectors and log cover. The suitability of B4 channel types for fish habitat improvement structures is as follows: excellent for low-stage plunge weirs, boulder clusters, bank placed boulders, single and opposing wing-deflectors and log cover.

The water temperatures recorded on the survey days June 13 - July 18, 2001, ranged from 52 to 57 degrees Fahrenheit. Air temperatures ranged from 57 to 67 degrees Fahrenheit. This is a good water temperature range for salmonids. To make any further conclusions, temperatures would need to be monitored throughout the warm summer months, and more extensive biological sampling would need to be conducted.

Flatwater habitat types comprised 28% of the total length of this survey, riffles 37%, and pools 33%. The pools are relatively deep, with 71 of the 142 (50%) pools having a maximum depth greater than 2 feet. In general, pool enhancement projects are considered when primary pools comprise less than 40% of the length of total stream habitat. In first and second order streams, a primary pool is defined to have a maximum depth of at least two feet, occupy at least half the width of the low flow channel, and be as long as the low flow channel width.

Fifty-eight of the 142 pool tail-outs measured had embeddedness ratings of 1 or 2. Fifty-five of the pool tail-outs had embeddedness ratings of 3 or 4. Twenty-nine of the pool tail-outs had a rating of 5, which is considered unsuitable for spawning. Twenty-one of the 29 were unsuitable for spawning due to the dominant substrate being boulder. The remainder of pool tails valued at 5 were dominated by sand. Cobble embeddedness measured to be 25% or less, a rating of 1, is considered to indicate good quality spawning substrate for salmon and steelhead.

One-hundred-fourteen of the 143 pool tail-outs measured had gravel or small cobble as the dominant substrate. This is generally considered good for spawning salmonids.

The mean shelter rating for pools was 52. The shelter rating in the flatwater habitats was 17. A pool shelter rating of approximately 100 is desirable. The amount of cover that now exists is being provided primarily by boulders in all habitat types. Additionally, large woody debris contributes a small amount. Log and root wad cover structures in the pool and flatwater habitats would enhance both summer and winter salmonid habitat. Log cover structure provides rearing fry with protection from predation, rest from water velocity, and also divides territorial units to reduce density related competition.

The mean percent canopy density for the stream was 98%. Reach 1 had a canopy density of 96% while Reaches 2, 3, and 4 had canopy densities of 99%, 98% and 97%, respectively. This is a relatively high percentage of canopy. In general, revegetation projects are considered when canopy density is less than 80%. The percentage of right and left bank covered with vegetation was 94.7% and 95.3%, respectively.

RECOMMENDATIONS

- 1) The limited water temperature data available suggest that maximum temperatures are within the acceptable range for juvenile salmonids. To establish more complete and meaningful temperature regime information, 24-hour monitoring during the July and August temperature extreme period should be performed for 3 to 5 years.

- 2) Increase woody cover in the pools and flatwater habitat units. Most of the existing cover is from boulder. Adding high quality complexity with woody cover is desirable.
- 3) In the B4 and F4 channel types design and engineer pool enhancement structures to increase the number of pools or deepen existing pools. This must be done where the banks are stable or in conjunction with stream bank armor to prevent erosion.

Pilchuck Creek

8508

-012

WATERSHED OVERVIEW

Pilchuck Creek is a tributary to the Redwood Creek, a tributary to the Pacific Ocean, located in Humboldt County, California (Map 1). Pilchuck Creek's legal description at the confluence with Redwood Creek is T07N R03E S08. Its location is 41°00'13.72" north latitude and 123°51'36.11" west longitude. Pilchuck Creek is a first order stream and has approximately 1,177 feet of blue line stream according to the USGS Lord-Ellis Summit 7.5 minute quadrangle. Pilchuck Creek drains a watershed of approximately 1.6 square miles. Elevations range from about 640 feet at the mouth of the creek to 1,080 feet in the headwater areas. Redwood/Douglas fir and mixed hardwood forest dominates the watershed. The watershed is entirely privately owned and is managed for timber production. Vehicle access exists via highway 299 to Redwood Valley Road.

HABITAT INVENTORY RESULTS

The habitat inventory of July 2, 2001, was conducted by WSP/AmeriCorps members. The total length of the stream surveyed was 1,617 feet with an additional 114 feet of side channel. Stream flow was not measured on Pilchuck Creek, but was estimated to be less than 0.1 cfs.

Pilchuck Creek is a B3 channel type for the entire 1,617 feet of the stream surveyed. B3 channels are moderately entrenched, moderate gradient, riffle dominated channels with infrequently spaced pools, very stable plan and profile, stable banks and cobble channel.

BIOLOGICAL INVENTORY RESULTS

Nine sites were electrofished for species composition and distribution in Pilchuck Creek on August 02, 2001. Water temperatures taken during the electrofishing period ranged from 61° to 57° Fahrenheit. Air temperature was 77° Fahrenheit. The sites were sampled by DFG biologist and WSP/AmeriCorps members.

The following chart displays the information yielded from these sites:

Date	Site #	Approx. Dist. from mouth (ft.)	Hab. Unit #	Hab. Type	Reach #	Channel type	Steelhead YOY 1+ 2+		
8/02/01	1	148	6	4.2	1	B3	1	1	0
8/02/01	2	683	13	4.2	1	B3	2	0	0
8/02/01	3	887	17	3.4	1	B3	13	1	0

8/02/01	4	910	18	4.2	1	B3	1	0	0
8/02/01	5	1,039	21	4.2	1	B3	1	1	0
8/02/01	6	1,061	22	1.2	1	B3	0	1	0
8/02/01	7	1,169	23	3.4	1	B3	2	0	0
8/02/01	8	1,178	24	4.2	1	B3	0	0	0
8/02/01	9	1,369	30	5.6	1	B3	2	0	0

DISCUSSION

Pilchuck Creek is a B3 channel type for the entire 1,617 feet of stream surveyed. The suitability of B3 channel types for fish habitat improvement structures is as follows: excellent for plunge weirs, boulder clusters and bank placed boulders, single and opposing wing-deflectors and log cover.

The water temperatures recorded on the survey day July 02, 2001, ranged from 54° to 57° Fahrenheit. Air temperatures ranged from 62° to 66° Fahrenheit. This is a good water temperature range for salmonids. To make any further conclusions, temperatures would need to be monitored throughout the warm summer months, and more extensive biological sampling would need to be conducted.

Flatwater habitat types comprised 30% of the total length of this survey, riffles 52%, and pools 18%. The pools are relatively shallow, with only 2 of the 13 (15.0%) pools having a maximum depth greater than 2 feet. In general, pool enhancement projects are considered when primary pools comprise less than 40% of the length of total stream habitat. In first and second order streams, a primary pool is defined to have a maximum depth of at least two feet, occupy at least half the width of the low flow channel, and be as long as the low flow channel width.

Seven of the 13 pool tail-outs measured had embeddedness ratings of 1 or 2. None of the pool tail-outs had embeddedness ratings of 3 or 4. Six of the pool tail-outs had a rating of 5, which is considered unsuitable for spawning. Six of the pool tail-outs were unspawnable due to the dominant substrate being boulders. The remainder of pool tails valued at 5 were dominated by boulder. Cobble embeddedness measured to be 25% or less, a rating of 1, is considered to indicate good quality spawning substrate for salmon and steelhead.

Eleven of the 13 pool tail-outs had large cobble or boulders as the dominant substrate. This is generally considered unsuitable for spawning salmonids.

The mean shelter rating for pools was 8. The shelter rating in the flatwater habitats was 23. A pool shelter rating of approximately 100 is desirable. The amount of cover that now exists is being provided primarily by small woody debris in all habitat types. Additionally, boulders contribute a small amount. Log and root wad cover structures in the pool and flatwater habitats would enhance both summer and winter salmonid habitat. Log cover structure provides rearing fry with protection from predation, rest from water velocity, and also divides territorial units to reduce density related competition.

The mean percent canopy density for the stream was 97%. In general, revegetation projects are considered when canopy density is less than 80% or the canopy composition is dominated by deciduous trees. The percentage of right and left bank covered with vegetation was moderate at 52.9% and 57.9%, respectively.

RECOMMENDATIONS

- 1) Increase woody cover in the pools and flatwater habitat units. Most of the existing cover is from small woody debris. Adding high quality complexity with woody cover is desirable.
- 2) Increase the canopy on Pilchuck Creek by planting redwood, Douglas fir or other native conifers within the riparian zone. Tributaries to Pilchuck Creek and the reaches above this survey section should be inventoried and treated as well, since the water flowing here is affected from upstream.

Middle Redwood Creek

WATERSHED OVERVIEW

013

Redwood Creek is a tributary to the Pacific Ocean, located in Humboldt County, California. Redwood Creek's legal description at the confluence with the Pacific Ocean is T11N R01E S32. Its location is 41°17'33" north latitude and 124°05'26" west longitude. Redwood Creek is a fifth order stream and has approximately 63.83 miles of blue line stream according to the USGS Orick 7.5 minute quadrangle. Redwood Creek drains a watershed of approximately 281 square miles. Elevations range from about 40 feet at the mouth of the creek to 3,100 feet in the headwater areas. Redwood/Douglas fir forest and grassland dominates the watershed. The lower portion of the watershed is Redwood National Park while the middle and upper portion of the watershed is privately owned and is managed for timber production and rangeland. Vehicle access exists through Simpson Timber Company in Korb and also via Highway 299 to Bald Mountain Road, Redwood Valley Road or Chezem Road.

HABITAT INVENTORY RESULTS

The habitat inventory of June 13, 2001 through August 23, 2001, was conducted by WSP/AmeriCorps members. The total length of the stream surveyed was 130,874 feet

with an additional 17,466 feet of side channel. Stream flow was measured at the bottom of the survey reach with a Marsh-McBirney Model 2000 flowmeter at 51.48 cfs on June 12, 2001, at 30' upstream of the confluence with Coyote Creek (boundary of Redwood National Park). Flow was also measured to be 15 cfs on July 12, 2001, approximately 35,986 upstream of the boundary of Redwood National Park.

Redwood Creek is an F4 channel type for the first 122,095 feet of the channel surveyed, and an F3 channel type for the remaining 8,425 feet of the channel surveyed. Channel types classified as "F" are entrenched, meandering, riffle/pool channels on low gradients with high width/depth ratios. F4 channels are dominated by gravel and F3 channels are dominated by large cobble.

BIOLOGICAL INVENTORY

Biological sampling during the stream inventory is used to determine fish species and their distribution in the stream. Fish presence was observed from the stream banks in Redwood Creek. No sites were electrofished. These sampling techniques are discussed in the *California Salmonid Stream Habitat Restoration Manual*.

DISCUSSION

Redwood Creek is an F4 channel type for the first 122,095 feet of stream surveyed and an F3 channel type for the remaining 8,425 feet. The suitability of F4 channel types for fish habitat improvement structures is as follows: good for bank placed boulders; fair for plunge weirs, single and opposing wing-deflectors, channel constrictors, log cover; poor for boulder clusters. The suitability of F3 channel types for fish habitat improvement structures is as follows: good for bank placed boulders, single and opposing wing deflectors; fair for plunge weirs, boulder clusters, channel constrictors and log cover.

The water temperatures recorded on the survey days June 13, 2001 to August 23, 2001, ranged from 58° to 80° Fahrenheit. Air temperatures ranged from 56° to 95° Fahrenheit. Eighty degrees Fahrenheit, if sustained, is above the threshold stress level for salmonids. To make any further conclusions, temperatures would need to be monitored throughout the warm summer months, and more extensive biological sampling would need to be conducted.

Flatwater habitat types comprised 12% of the total length of this survey, riffles 36%, and pools 52%. The pools are relatively deep, with 296 of the 549 (53.9%) pools having a maximum depth greater than 3 feet. In general, pool enhancement projects are considered when primary pools comprise less than 40% of the length of total stream habitat. In third and fourth order streams, a primary pool is defined to have a maximum depth of at least three feet, occupy at least half the width of the low flow channel, and be as long as the low flow channel width.

Two-hundred-eighty-nine of the 549 pool tail-outs measured had embeddedness ratings of 1 or 2. Two-hundred-forty-nine of the pool tail-outs had embeddedness ratings of 3 or

4. Eleven of the pool tail-outs had a rating of 5, which is considered unsuitable for spawning. Six of the 11 were unsuitable for spawning due to the dominant substrate being boulder. The remainder of pool tails valued at 5 were dominated by small gravel or bedrock. Cobble embeddedness measured to be 25% or less, a rating of 1, is considered to indicate good quality spawning substrate for salmon and steelhead.

Four-hundred-sixty-four of the 549 pool tail-outs measured had gravel or small cobble as the dominant substrate. This is generally considered good for spawning salmonids.

The mean shelter rating for pools was 22. The shelter rating in the flatwater habitats was 14. A pool shelter rating of approximately 100 is desirable. The amount of cover that now exists is being provided primarily by boulder in all habitat types. Additionally, bedrock ledges contributes a small amount. Log and root wad cover structures in the pool and flatwater habitats would enhance both summer and winter salmonid habitat. Log cover structure provides rearing fry with protection from predation, rest from water velocity, and also divides territorial units to reduce density related competition.

The mean percent canopy density for the stream was 39%. Reach 1 had a canopy density of 38% while Reach 2 had a canopy density of 49%. In general, revegetation projects are considered when canopy density is less than 80% or the canopy composition is dominated by deciduous trees. The percentage of right and left bank covered with vegetation was moderate at 50.5% and 56.2%, respectively.

RECOMMENDATIONS

- 1) The limited water temperature data available suggest that maximum temperatures are above the acceptable range for juvenile salmonids. To establish more complete and meaningful temperature regime information, 24-hour monitoring during the July and August temperature extreme period should be performed for 3 to 5 years.
- 2) Increase woody cover in the pools and flatwater habitat units. Most of the existing cover is from boulders. Adding high quality complexity with woody cover is desirable.
- 3) Increase the canopy on Redwood Creek by planting willow, alder, redwood, and Douglas fir along the stream where shade canopy is not at acceptable levels or where the canopy composition is dominated by deciduous trees. The reaches above this survey section should be inventoried and treated as well, since the water flowing here is effected from upstream. Planting will need to be coordinated to following upslope erosion control projects.

Sweathouse Creek

8590

OTA
SKIP

WATERSHED OVERVIEW

Sweathouse Creek is a tributary to Redwood Creek, a tributary to the Pacific Ocean, located in Humboldt County, California (Map 1). Sweathouse Creek's legal description at the confluence with Redwood Creek is T06N R03E S03. Its location is 40°55'51" north latitude and 123°49'27.5" west longitude. Sweathouse Creek is a first order ephemeral stream and has approximately 1.5 miles stream according to the USGS Lord-Ellis Summit 7.5 minute quadrangle. Sweathouse Creek drains a watershed of approximately 0.6 square miles. Elevations range from about 780 feet at the mouth of the creek to 2,480 feet in the headwater areas. Redwood/Douglas fir and grassland dominates the watershed. The watershed is entirely privately owned and is managed for timber production and rangeland. Vehicle access exists via Highway 299 to Redwood Valley Road.

HABITAT INVENTORY RESULTS

* ALL TABLES AND GRAPHS ARE LOCATED AT THE END OF THE REPORT *

The habitat inventory of June 25, 2001, was conducted by WSP/AmeriCorps members. The total length of the stream surveyed was 1,859 feet. Stream flow was measured at the bottom of the survey reach with a Marsh-McBirney Model 2000 flowmeter at 0.6cfs on June 25, 2001.

Sweathouse Creek is a C3 channel type for the first 1,692 feet of the stream surveyed and a A3 channel type for the remaining 167 feet surveyed. C3 channel types are low gradient, meandering, point-bar, riffle/pool, alluvial channels with broad, well defined floodplain and cobble channel. A3 channel types are steep, narrow, cascading, step-pool streams; high energy/debris transport associated with depositional soils and cobble channel.

BIOLOGICAL INVENTORY RESULTS

No biological sampling was conducted on Sweathouse Creek.

DISCUSSION

Sweathouse Creek is a C3 channel type for the 1,692 feet of stream surveyed and a A3 channel type for the remaining 167 feet. The suitability of C3 channel types for fish habitat improvement structures is as follows: excellent for bank-placed boulders; good for plunge weirs, boulder clusters, single and opposing wing deflectors and log cover. The suitability of A3 channel types for fish habitat improvement structures is as follows: good for bank-placed boulders; fair for plunge weirs, opposing wing deflectors and log cover; poor for boulder clusters and single wing deflectors.

The water temperatures recorded on the survey days June 25, 2001, ranged from 54° to 57° Fahrenheit. Air temperatures ranged from 58° to 62° Fahrenheit. This is a good water temperature for juvenile salmonids. To make any further conclusions, temperatures would need to be monitored throughout the warm summer months, and more extensive biological sampling would need to be conducted.

Flatwater habitat types comprised 31% of the total length of this survey, riffles 41%, and pools 25%. The pools are relatively deep, with 4 of the 8 (50%) pools having a maximum depth greater than 2 feet. In general, pool enhancement projects are considered when primary pools comprise less than 40% of the length of total stream habitat. In first and second order streams, a primary pool is defined to have a maximum depth of at least two feet, occupy at least half the width of the low flow channel, and be as long as the low flow channel width.

Three of the 8 pool tail-outs measured had embeddedness ratings of 1 or 2. Four of the pool tail-outs had embeddedness ratings of 3 or 4. One of the pool tail-outs had a rating of 5, which is considered unsuitable for spawning. One of the 8 were unsuitable for spawning due to the dominant substrate being boulder. Cobble embeddedness measured to be 25% or less, a rating of 1, is considered to indicate good quality spawning substrate for salmon and steelhead.

Six of the 8 pool tail-outs measured had gravel or small cobble as the dominant substrate. This is generally considered good for spawning salmonids.

The mean shelter rating for pools was 13. The shelter rating in the flatwater habitats was 8. A pool shelter rating of approximately 100 is desirable. The amount of cover that now exists is being provided primarily by boulders in all habitat types. Additionally, small woody debris contributes a small amount. Log and root wad cover structures in the pool and flatwater habitats would enhance both summer and winter salmonid habitat. Log cover structure provides rearing fry with protection from predation, rest from water velocity, and also divides territorial units to reduce density related competition.

The mean percent canopy density for the stream was 85%. In general, revegetation projects are considered when canopy density is less than 80% or the canopy composition is dominated by deciduous trees. The percentage of right and left bank covered with vegetation was high at 91.6% and 91.3%, respectively.

RECOMMENDATIONS

- 1) The limited water temperature data available suggest that maximum temperatures are within the acceptable range for juvenile salmonids. To establish more complete and meaningful temperature regime information, 24-hour monitoring during the July and August temperature extreme period should be performed for 3 to 5 years.

- 2) Increase woody cover in the pools and flatwater habitat units. Most of the existing cover is from boulders. Adding high quality complexity with woody cover is desirable.
- 3) Increase the canopy on Sweathouse Creek by planting redwood, Douglas fir or other native conifers within the riparian zone. Tributaries to Sweathouse Creek and the reaches above this survey section should be inventoried and treated as well, since the water flowing here is affected from upstream.

Toss Up Creek

#10392 / #9503

-014

WATERSHED OVERVIEW

Toss-up Creek is a tributary to the Redwood Creek, a tributary to the Pacific Ocean, located in Humboldt County, California (Map 1). Toss-up Creek's legal description at the confluence with Redwood Creek is T07N R03E S20. Its location is 40°59'12" north latitude and 123°50'55" west longitude. Toss-up Creek is a first order stream and has approximately 1.5 miles of blue line stream according to the USGS Lord-Ellis Summit 7.5 minute quadrangle. Toss-up Creek drains a watershed of approximately 2.5 square miles. Elevations range from about 700 feet at the mouth of the creek to 2,000 feet in the headwater areas. Redwood/Douglas fir and mixed hardwood forest dominates the watershed. The watershed is entirely privately owned and is managed for timber production. Vehicle access exists via Highway 299 to Redwood Valley Road.

HABITAT INVENTORY RESULTS

* ALL TABLES AND GRAPHS ARE LOCATED AT THE END OF THE REPORT *

The habitat inventory of June 19-21, and 25-27, 2001 was conducted by WSP/AmeiCorps members and a DFG fisheries biologist. The total length of the stream surveyed was 5,462 feet with an additional 246 feet of side channel. Stream flow was measured at the bottom of the survey reach with a Marsh-McBirney 2000 Flowmeter at 0.7cfs on June 28, 2001.

Toss-up Creek is a F4 channel type for the first 919 feet of the stream surveyed, a B2 channel type for the next 988 feet of stream surveyed, and a B4 channel type for the remaining 3,555 feet of stream surveyed. F4 channels are entrenched meandering riffle/pool channels on low gradients with high width/depth ratio and gravel dominant substrate. Channel types classified as "B" are moderately entrenched, moderate gradient, riffle dominated channels with infrequently spaced pools, very stable plan and profile, and stable banks. B2 channels are dominated by boulders, whereas, B4 channels are dominated by gravel.

BIOLOGICAL INVENTORY RESULTS

Fourteen sites were electrofished for species composition and distribution in Toss-up Creek on July 30, 2001. Water temperatures taken during the electrofishing period ranged from 58° to 60° Fahrenheit. Air temperatures ranged from 67° to 70° Fahrenheit. The sites were sampled by DFG fisheries biologists and DFG fisheries technicians.

The following chart displays the information yielded from these sites:

Date	Site #	Approx. Dist. from mouth (ft.)	Hab. Unit #	Hab. Type	Reach #	Channel type	Steelhead		
							YOY	1+	2+
07/30/01	1	325	009	5.3	1	F4	86	2	0
07/30/01	2	453	011	5.5	1	F4	18	3	0
07/30/01	3	554	015	3.3	1	F4	16	0	0
07/30/01	4	615	016.02	5.2	1	F4	3	0	0
07/30/01	5	781	022	4.2	1	F4	3	2	0
07/30/01	6	823	024	4.2	1	F4	1	4	0
07/30/01	7	1,090	033	4.2	2	B4	2	0	0
07/30/01	8	1,415	036	1.1	2	B4	1	1	0
07/30/01	9	1,434	037	3.3	2	B4	4	0	0
07/30/01	10	1,656	045	5.6	2	B4	3	2	0
07/30/01	11	1,881	049	5.6	2	B4	0	1	0
07/30/01	12	2,145	057	5.5	2	B4	1	3	0
07/30/01	13	2,688	075	5.6	2	B4	0	2	1
07/30/01	14	2,988	086	4.2	2	B4	2	1	0

DISCUSSION

Toss-up Creek is a F4 channel type for the first 919 feet of stream surveyed, a B2 channel type for the next 988 feet surveyed, and a B4 channel type for the remaining 3,555 feet of

stream surveyed. The suitability of F4 channel types for fish habitat improvement structures is as follows: good for bank-placed boulders; fair for plunge weirs, single and opposing wing-deflectors, channel constrictors, log cover; poor for boulder clusters. The suitability of B2 channel types for fish habitat improvement structures is as follows: excellent for log cover. The suitability for B4 channel types for fish habitat improvement structures is as follows: excellent for low-stage plunge weirs, boulder cluster, bank placed boulder, single and opposing wing-deflectors, and log cover.

The water temperatures recorded on the survey days June 19-27, 2001, ranged from 54° to 57° Fahrenheit. Air temperatures ranged from 56° to 76° Fahrenheit. This is a good water temperature for juvenile salmonids. To make any further conclusions, temperatures would need to be monitored throughout the warm summer months, and more extensive biological sampling would need to be conducted.

Flatwater habitat types comprised 29% of the total length of this survey, riffles 48%, and pools 23%. The pools are relatively deep, with 26 of the 47 (55.3%) pools having a maximum depth greater than 2 feet. In general, pool enhancement projects are considered when primary pools comprise less than 40% of the length of total stream habitat. In first and second order streams, a primary pool is defined to have a maximum depth of at least two feet, occupy at least half the width of the low flow channel, and be as long as the low flow channel width.

Twenty-four of the 47 pool tail-outs measured had embeddedness ratings of 1 or 2. Eleven of the pool tail-outs had embeddedness ratings of 3 or 4. Twelve of the pool tail-outs had a rating of 5, which is considered unsuitable for spawning. All twelve were unsuitable for spawning due to the dominant substrate being boulder. Cobble embeddedness measured to be 25% or less, a rating of 1, is considered to indicate good quality spawning substrate for salmon and steelhead.

Twenty-nine of the 47 pool tail-outs measured had gravel or small cobble as the dominant substrate. This is generally considered good for spawning salmonids.

The mean shelter rating for pools was 23. The shelter rating in the flatwater habitats was 34. A pool shelter rating of approximately 100 is desirable. The amount of cover that now exists is being provided primarily by boulders in all habitat types. Additionally, large woody debris contributes a small amount. Log and root wad cover structures in the pool and flatwater habitats would enhance both summer and winter salmonid habitat. Log cover structure provides rearing fry with protection from predation, rest from water velocity, and also divides territorial units to reduce density related competition.

The mean percent canopy density for the stream was 96%. Reach 1 had a canopy density of 95% while Reaches 2 and 3 both had canopy densities of 96%. In general, revegetation projects are considered when canopy density is less than 80% or the canopy composition is dominated by deciduous trees. The percentage of right and left bank covered with vegetation was 75.2% and 69.5%, respectively.

RECOMMENDATIONS

- 1) The limited water temperature data available suggest that maximum temperatures are within the acceptable range for juvenile salmonids. To establish more complete and meaningful temperature regime information, 24-hour monitoring during the July and August temperature extreme period should be performed for 3 to 5 years.
- 2) Increase woody cover in the pools and flatwater habitat units. Most of the existing cover is from boulders. Adding high quality complexity with woody cover is desirable.
- 3) In the B4 channel type design and engineer pool enhancement structures to increase the number of pools or deepen existing pools. This must be done where the banks are stable or in conjunction with stream bank armor to prevent erosion.
- 4) Increase the canopy on Toss-up Creek by planting redwood, Douglas fir or other native conifers within the riparian zone. Tributaries to Toss-up Creek and the reaches above this survey section should be inventoried and treated as well, since the water flowing here is affected from upstream.

Wiregrass Creek

8502

015

WATERSHED OVERVIEW

Wiregrass Creek is a tributary to the Redwood Creek, a tributary to the Pacific Ocean, located in Humboldt County, California (Map 1). Wiregrass Creek's legal description at the confluence with Redwood Creek is T07N R3E S28. Its location is 40°58'4.23" N latitude and 123°50'30.3" W longitude. Wiregrass Creek is a first order stream and has approximately 3,745 feet of blue line stream according to the USGS Lord-Ellis Summit 7.5 minute quadrangle. Wiregrass Creek drains a watershed of approximately 1.6 square miles. Elevations range from about 700 feet at the mouth of the creek to 1,020 feet in the headwater areas. Redwood/Douglas fir and mixed hardwood forest dominates the watershed. The watershed is entirely privately owned and is managed for timber production. Vehicle access exists via highway 299 to Redwood Valley Road.

HABITAT INVENTORY RESULTS

The habitat inventory of June 20, 2001, was conducted by DFG fisheries technicians and WSP/AmeriCorps members. The total length of the stream surveyed was 2,000 feet with an additional 186 feet of side channel. Stream flow was measured at the bottom of the survey reach with a Marsh-McBirney Model 2000 flow meter at 0.23 cfs on June 28, 2001.

BIOLOGICAL INVENTORY RESULTS

Twelve sites were electrofished for species composition and distribution in Wiregrass Creek on August 8, 2001. Water temperature during the electrofishing period was 61° Fahrenheit. Air temperatures was 64° Fahrenheit. The sites were sampled by DFG fisheries biologist and WSP/AmeriCorps members.

The following chart displays the information yielded from these sites:

Date	Site #	Approx. Dist. from mouth (ft.)	Hab. Unit #	Hab. Type	Reach #	Channel type	Steelhead YOY 1+ 2+		
08/08/01	1	61	003	4.2	1	B4	3	2	0
08/08/01	2	96	004	3.4	1	B4	3	0	0
08/08/01	3	327	011	4.2	1	B4	2	0	0
08/08/01	4	490	014	4.2	1	B4	1	0	0
08/08/01	5	574	016	4.2	1	B4	0	0	0
08/08/01	6	716	019	4.2	1	B4	2	1	0
08/08/01	7	797	022	4.2	1	B4	0	0	0
08/0/01	8	809	023	4.2	1	B4	0	1	0
08/08/01	9	1,204	025	4.2	1	B4	0	0	0
08/08/01	10	1,312	029	4.2	1	B4	0	0	0
08/08/01	11	1,325	030	5.6	1	B4	0	1	0
08/08/01	12	1,979	044	5.6	1	B4	0	0	1

DISCUSSION

Wiregrass Creek is a B4channel type for the entire 2,000 feet of stream surveyed. The suitability of B4 a channel type for fish habitat improvement structures is as follows: excellent for low-stage plunge weirs, boulder clusters, bank placed boulders, single and opposing wing-deflectors and log cover.

The water temperatures recorded on the survey day, June 20, 2001, ranged from 54° to 55° Fahrenheit. Air temperatures ranged from 62° to 65° Fahrenheit. This is a good water temperature range for salmonids. To make any further conclusions, temperatures would need to be monitored throughout the warm summer months, and more extensive biological sampling would need to be conducted.

Flatwater habitat types comprised 71% of the total length of this survey, riffles 15%, and pools 13%. The pools are relatively shallow, with 7 of the 21 (33.3%) pools having a maximum depth greater than 2 feet. In general, pool enhancement projects are considered when primary pools comprise less than 40% of the length of total stream habitat. In first and second order streams, a primary pool is defined to have a maximum depth of at least two feet, occupy at least half the width of the low flow channel, and be as long as the low flow channel width.

Eleven of the 19 pool tail-outs measured had embeddedness ratings of 1 or 2. None of the pool tail-outs had embeddedness ratings of 3 or 4. Eight of the pool tail-outs had a rating of 5, which is considered unsuitable for spawning. Six of the eight were unsuitable for spawning due to the dominant substrate being boulders and the remaining two were dominated by gravel too small for spawning. Cobble embeddedness measured to be 25% or less, a rating of 1, is considered to indicate good quality spawning substrate for salmon and steelhead.

Ten of the 19 pool tail-outs measured had gravel or small cobble as the dominant substrate. This is generally considered good for spawning salmonids.

The mean shelter rating for pools was 40. The shelter rating in the flatwater habitats was 43. A pool shelter rating of approximately 100 is desirable. The amount of cover that now exists is being provided primarily by boulders in all habitat types. Additionally, whitewater contributed a small amount. Log and root wad cover structures in the pool and flatwater habitats would enhance both summer and winter salmonid habitat. Log cover structure provides rearing fry with protection from predation, rest from water velocity, and also divides territorial units to reduce density related competition.

The mean percent canopy density for the stream was 98%. In general, revegetation projects are considered when canopy density is less than 80% or the canopy composition is dominated by deciduous trees. The percentage of right and left bank covered with vegetation was high at 91.9% and 89.6%, respectively.

RECOMMENDATIONS

- 1) Increase woody cover in the pools and flatwater habitat units. Most of the existing cover is from boulders. Adding high quality complexity with woody cover is desirable.

- 2) Increase the canopy on Wiregrass Creek by planting redwood, Douglas fir or other native conifers within the riparian zones. The tributaries to Wiregrass Creek and the reaches above this survey section should be inventoried and treated as well, since the water flowing here is effected from upstream.