CALIFORNIA DEPARTMENT OF FISH AND GAME
STREAM INVENTORY REPORT
Redwood Creek
Report revised April 14, 2006
Report Completed 2005
Assessment Completed 2001

INTRODUCTION

A stream inventory was conducted during 7/10/2001 to 7/11/2001 on Redwood Creek. The survey began at the confluence with Jonive Creek and extended upstream 1.5 miles.

The Redwood Creek inventory was conducted in two parts: habitat inventory and biological inventory. The objective of the habitat inventory was to document the habitat available to anadromous salmonids in Redwood Creek. The objective of the biological inventory was to document the presence and distribution of juvenile salmonid species.

The objective of this report is to document the current habitat conditions and recommend options for the potential enhancement of habitat for Chinook salmon, coho salmon, and steelhead trout. Recommendations for habitat improvement activities are based upon target habitat values suitable for salmonids in California's north coast streams.

WATERSHED OVERVIEW

Redwood Creek is a tributary to Jonive Creek, a tributary to Atascadero Creek, a tributary to Green Valley Creek, a tributary to the Russian River, located in Sonoma County, California (Map 1). Redwood Creek's legal description at the confluence with Jonive Creek is T08N R10W S19. Its location is 38.52700982877 north latitude and 122.99969026996 west longitude, LLID number 1228847383898. Redwood Creek is a first order stream and has approximately 1.62 miles of blue line stream according to the USGS Camp Meeker 7.5 minute quadrangle. Redwood Creek drains a watershed of approximately 1.45 square miles. Elevations range from about 164 feet at the mouth of the creek to 738 feet in the headwater areas. Mixed conifer forest dominates the watershed. The watershed is entirely privately owned and is managed for timber production. Vehicle access exists via Bodega Road.

Endangered/Threatened/Sensitive Species: (California Natural Diversity Database, February 6, 2005 version)	
Common Name	**Scientific Name**
Northwestern pond turtle	*Emys (=Clemmys) marmorata marmorata*
California freshwater shimp	*Syncaris pacifica*
Sonoma alopecurus	*Alopecurus aequalis var. sonomensis*
Narrow-leaved daisy	*Erigeron angustatus*

METHODS

The habitat inventory conducted in Redwood Creek follows the methodology presented in the *California Salmonid Stream Habitat Restoration Manual* (Flosi et al, 1998). The California Conservation Corps (CCC) Technical Advisors and Watershed Stewards Project/AmeriCorps (WSP/AmeriCorps) Members that conducted the inventory were trained in standardized habitat inventory methods by the California Department of Fish and Game (DFG). This inventory was conducted by a two-person team.

SAMPLING STRATEGY

The inventory uses a method that samples approximately 10% of the habitat units within the survey reach. All habitat units included in the survey are classified according to habitat type and their lengths are measured. All pool units are measured for maximum depth, depth of pool tail crest (measured in the thalweg), dominant substrate composing the pool tail crest, and embeddedness. Habitat unit types encountered for the first time are measured for all the parameters and characteristics on the field form. Additionally, from the ten habitat units on each field form page, one is randomly selected for complete measurement. All pools except step-pools are fully sampled.

HABITAT INVENTORY COMPONENTS

A standardized habitat inventory form has been developed for use in California stream surveys and can be found in the *California Salmonid Stream Habitat Restoration Manual*. This form was used in Redwood Creek to record measurements and observations. There are eleven components to the inventory form.

1. Flow:

Flow is measured in cubic feet per second (cfs) near the bottom of the stream survey reach using a Marsh-McBirney Model 2000 flow meter.

2. Channel Type:

Channel typing is conducted according to the classification system developed and revised by David Rosgen (1994). This methodology is described in the *California Salmonid Stream Habitat Restoration Manual*. Channel typing is conducted simultaneously with habitat typing and follows a standard form to record measurements and observations. There are five measured parameters used to determine channel type: 1) water slope gradient, 2) entrenchment, 3) width/depth ratio, 4) substrate composition, and 5) sinuosity. Channel characteristics are measured using a clinometer, hand level, hip chain, tape measure, and a stadia rod.

3. Temperatures:

Both water and air temperatures are measured and recorded at every tenth habitat unit. The time of the measurement is also recorded. Both temperatures are taken in degrees Fahrenheit at the middle of the habitat unit and within one foot of the water surface. Additionally, a recording thermograph was deployed in Redwood Creek from 7/25/01 to 10/25/01 to record temperatures on a 24 hour basis during warm summer months.

4. Habitat Type:

Habitat typing uses the 24 habitat classification types defined by McCain and others (1990). Habitat units are numbered sequentially and assigned a type identification number selected from a standard list of 24 habitat types. Dewatered units are labeled "dry". Redwood Creek habitat typing used standard basin level measurement criteria. These parameters require that the minimum length of a described habitat unit must be equal to or greater than the stream's mean wetted width. All measurements are in feet to the nearest tenth. Habitat characteristics are measured using a clinometer, hip chain, and stadia rod.

5. Embeddedness:

The depth of embeddedness of the cobbles in pool tail-out areas is measured by the percent of the cobble that is surrounded or buried by fine sediment. In Redwood Creek, embeddedness was ocularly estimated. The values were recorded using the following ranges: 0 - 25% (value 1), 26 - 50% (value 2), 51 - 75% (value 3) and 76 - 100% (value 4). Additionally, a value of 5 was assigned to tail-outs deemed unsuited for spawning due to inappropriate substrate like bedrock, log sills, boulders or other considerations.

6. Shelter Rating:

Instream shelter is composed of those elements within a stream channel that provide juvenile salmonids protection from predation, reduce water velocities so fish can rest and conserve energy, and allow separation of territorial units to reduce density related competition for prey. The shelter rating is calculated for each fully-described habitat unit by multiplying shelter value and percent cover. Using an overhead view, a quantitative estimate of the percentage of the habitat unit covered is made. All cover is then classified according to a list of nine cover types. In Redwood Creek, a standard qualitative shelter value of 0 (none), 1 (low), 2 (medium), or 3 (high) was assigned according to the complexity of the cover. Thus, shelter ratings can range from 0-300 and are expressed as mean values by habitat types within a stream.

7. Substrate Composition:

Substrate composition ranges from silt/clay sized particles to boulders and bedrock elements. In all fully-described habitat units, dominant and sub-dominant substrate elements were ocularly estimated using a list of seven size classes and recorded as a one and two, respectively. In addition, the dominant substrate composing the pool tail-outs is recorded for each pool.

8. Canopy:

Stream canopy density was estimated using modified handheld spherical densiometers as described in the *California Salmonid Stream Habitat Restoration Manual*. Canopy density relates to the amount of stream shaded from the sun. In Redwood Creek, an estimate of the percentage of the habitat unit covered by canopy was made from the center of approximately every third unit in addition to every fully-described unit, giving an approximate 30% sub-sample. In addition, the area of canopy was estimated ocularly into percentages of coniferous or hardwood trees.

9. Bank Composition and Vegetation:

Bank composition elements range from bedrock to bare soil. However, the stream banks are usually covered with grass, brush, or trees. These factors influence the ability of stream banks to withstand winter flows. In Redwood Creek, the dominant composition type and the dominant vegetation type of both the right and left banks for each fully-described unit were selected from the habitat inventory form. Additionally, the percent of each bank covered by vegetation (including downed trees, logs, and rootwads) was estimated and recorded.

10. Large Woody Debris Count:

Large woody debris (LWD) is an important component of fish habitat and an element in channel forming processes. In each habitat unit all pieces of LWD partially or entirely below the elevation of bankfull discharge are counted and recorded. The minimum size to be considered is twelve inches in diameter and six feet in length. The LWD count is presented by reach and is expressed as an average per 100 feet.

11. Average Bankfull Width:

Bankfull width can vary greatly in the course of a channel type stream reach. This is especially true in very long reaches. Bankfull width can be a factor in habitat components like canopy density, water temperature, and pool depths. Frequent measurements taken at riffle crests (velocity crossovers) are needed to accurately describe reach widths. At the first appropriate velocity crossover that

occurs after the beginning of a new stream survey page (ten habitat units), bankfull width is measured and recorded in the appropriate header block of the page. These widths are presented as an average for the channel type reach.

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. In addition, one site was electrofished using a Smith-Root Model 12 electrofisher. These sampling techniques are discussed in the *California Salmonid Stream Habitat Restoration Manual*.

DATA ANALYSIS

Data from the habitat inventory form are entered into Stream Habitat 2.0.14, a Visual Basic data entry program developed by Karen Wilson, Pacific States Marine Fisheries Commission in conjunction with the California Department of Fish and Game. This program processes and summarizes the data, and produces the following ten tables:

- Riffle, Flatwater, and Pool Habitat Types
- Habitat Types and Measured Parameters
- Pool Types
- Maximum Residual Pool Depths by Habitat Types
- Mean Percent Cover by Habitat Type
- Dominant Substrates by Habitat Type
- Mean Percent Vegetative Cover for Entire Stream
- Fish Habitat Inventory Data Summary by Stream Reach (Table 8)
- Mean Percent Dominant Substrate / Dominant Vegetation Type for Entire Stream
- Mean Percent Shelter Cover Types for Entire Stream

Graphics are produced from the tables using Microsoft Excel. Graphics developed for Redwood Creek include:

- Riffle, Flatwater, Pool Habitat Types by Percent Occurrence
- Riffle, Flatwater, Pool Habitat Types by Total Length
- Total Habitat Types by Percent Occurrence

- Pool Types by Percent Occurrence
- Maximum Residual Depth in Pools
- Percent Embeddedness
- Mean Percent Cover Types in Pools
- Substrate Composition in Pool Tail-outs
- Mean Percent Canopy
- Dominant Bank Composition by Composition Type
- Dominant Bank Vegetation by Vegetation Type

HISTORICAL STREAM SURVEYS:

There were no historical habitat surveys conducted on Redwood Creek.

HABITAT INVENTORY RESULTS

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

The habitat inventory of 7/10/2001 to 7/11/2001, was conducted by J. Smith and C. Sangiacomo (CDFG). The total length of the stream surveyed was 7,849 feet with an additional 3179 feet of side channel.

Stream flow was not measured on Redwood Creek.

Redwood Creek is a F4 channel type for 7,849 feet of the stream surveyed (Reach 1). F4 channels are entrenched, meandering, riffle/pool channels on low gradients with high width/depth ratios and gravel-dominant substrates.

Water temperatures taken during the survey period ranged from 55 to 59 degrees Fahrenheit. Air temperatures ranged from 55 to 62 degrees Fahrenheit. Water temperatures taken with a recording thermograph deployed from 7/25/01 to 10/27/01, with measurements taken at 90 minute intervals, ranged from 49º to 62.2º Fahrenheit.

Table 1 summarizes the Level II riffle, flatwater, and pool habitat types. Based on frequency of **occurrence** there were 38% pool units, 35% flatwater units, 19% riffle units, 4% dry units, 4% no survey units, (Graph 1). Based on total **length** of Level II habitat types there were 13% pool units, 53% flatwater units, 15% riffle units, 1% dry units, 18% no survey units, (Graph 2).

Ten Level IV habitat types were identified (Table 2). The most frequent habitat types by percent **occurrence** were 27% Run units, 23% Mid-Channel Pool units, 13% Low Gradient Riffle units, 10% Lateral Scour Pool - Root Wad Enhanced units, 9% Glide units, 6% Bedrock Sheet units, 4% Dry units, 4% Not Surveyed units, 3% Corner Pool units, 1% Dammed Pool units, 1% Channel Confluence Pool units (Graph 3). Based on percent total **length**: 50% Run units, 18% Not Surveyed units, 7% Mid-Channel Pool units, 7% Low Gradient Riffle units,7% Bedrock Sheet units, 4% Lateral Scour Pool - Root Wad Enhanced units, 4% Glide units, 2% Dammed Pool units, 1% Dry units.

A total of 30 pools were identified (Table 3). Main Channel pools were the most frequently encountered, at 63%, and comprised 54% of the total length of all pools (Graph 4).

Table 4 is a summary of maximum residual pool depths by pool habitat types. Pool quality for salmonids increases with depth. Nineteen of the 30 pools (63%) had a residual depth of two feet or greater (Graph 5).

The depth of cobble embeddedness was estimated at pool tail-outs. Of the 27 pool tail-outs measured, twenty had a value of 1 (74.1%); four had a value of 2 (14.8%); one had a value of 3 (3.7%); two had a value of 4 (7.4%), (Graph 6). On this scale, a value of 1 indicates the best spawning conditions and a value of 4 the worst. Additionally, a value of 5 was assigned to tail-outs deemed unsuited for spawning due to inappropriate substrate like bedrock, log sills, boulders.

A shelter rating was calculated for each habitat unit and expressed as a mean value for each habitat type within the survey using a scale of 0-300. Riffle habitat types had a mean shelter rating of 10, flatwater habitat types had a mean shelter rating of 18, and pool habitats had a mean shelter rating of 44 (Table 1). Of the pool types, the Main Channel pools had a mean shelter rating of 37, Scour pools had a mean shelter rating of 61, Backwater pools had a mean shelter rating of 20 (Table 3).

Table 5 summarizes mean percent cover by habitat type. Undercut Banks are the dominant cover types in Redwood Creek. Graph 7 describes the pool cover in Redwood Creek. Undercut Banks is the dominant pool cover type followed by terrestrial vegetation.

Table 6 summarizes the dominant substrate by habitat type. Graph 8 depicts the dominant substrate observed in pool tail-outs.

The mean percent canopy density for the surveyed length of Redwood Creek was 93%. The mean percentages of hardwood and coniferous trees were 32% and 60%, respectively. Seven percent of the canopy was open. Graph 9 describes the mean percent canopy in Redwood Creek.

For the stream reach surveyed, the mean percent right bank vegetated was 77%. The mean percent left bank vegetated was 70%

(Table 7). The dominant elements composing the structure of the stream banks consisted of sand/silt/clay (Graph 10). Brush was the dominant vegetation type observed in 44% of the units surveyed. Additionally, 21.9% of the units surveyed had hardwood trees as the dominant vegetation type, and 31.3% had coniferous trees as the dominant vegetation (Graph 11).

BIOLOGICAL INVENTORY RESULTS

On 10/19/01 a biological inventory was conducted at one site on Redwood Creek to document fish species composition and distribution. The site was between Lat. N 38:23'38.2", Long. W 122:53'19.8" and Lat. N 38:23'39.0", Long. W 122:53'21.8". Fish from the site were counted by species, and returned to the stream. The air temperature was 70ºF and the water temperature ranged from 54-56ºF.

The inventory began at 1350 hours in Reach 1 and ended at 1600 hours 318' upstream. Habitat types surveyed were lateral scour pool - bedrock formed, mid-channel pools, runs and glides. The following table displays the information yielded from this site.

Species Observed	**Numbers Recorded at Site 1**
Steelhead YOY	19
Steelhead Y+	6
Steelhead 3+	3
Lamprey	6
Sculpin	16
Freshwater Shrimp	4

Historical records indicate that there have been no fish rescue/transfer operations or hatchery plantings of fish to or from Redwood Creek.

DISCUSSION

Redwood Creek is a F4 channel type for 7,867 feet of the stream surveyed (Reach 1). According to the DFG Salmonid Stream Habitat Restoration Manual, F4 channel types are good for bank-placed boulders; fair for plunge weirs, single and opposing wing deflectors, channel constrictors, and log cover; and poor for boulder clusters. Many site specific projects can be designed within this channel type, especially to increases pool frequency, volume and shelter. Any work considered will require careful design, placement, and construction that must included protection for any unstable banks.

The water temperatures recorded on the survey days 7/10/2001 to 7/11/2001, ranged from 55 to 59 degrees Fahrenheit. Air temperatures ranged from 55 to 62 degrees Fahrenheit. 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 53% of the total length of this survey, riffles 15% and pools 13%. The pools are relatively deep, with only 19 of the 30 (63%) pools having a maximum residual depth greater than two 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 residual 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. Installing structures that will increase or deepen pool habitat is recommended for locations where their installation will not be threatened by high stream energy, or where their installation will not conflict with the modification of the numerous log debris accumulations (LDA's) in the stream.

Twenty-four of the 27 pool tail-outs measured had embeddedness ratings of 1 or 2. Three 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. Sediment sources in Redwood Creek should be mapped and rated according to their potential sediment yields, and control measures should be taken.

Twenty-two of the 27 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 44. The shelter rating in the flatwater habitats was 18. A pool shelter rating of approximately 100 is desirable. The amount of cover that now exists is being provided primarily by Undercut Banks in Redwood Creek. Undercut Banks are the dominant cover type in pools followed by terrestrial vegetation. 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 moderate at 77% and 70%, respectively. In areas of stream bank erosion or where bank vegetation is sparse, planting endemic species of coniferous and hardwood trees, in conjunction with bank stabilization, is recommended.

GENERAL RECOMMENDATIONS

Redwood Creek should be managed as an anadromous, natural production stream.

Winter storms often bring down large trees and other woody debris into the stream, which increases the number and quality of pools. This woody debris, if left undisturbed, will provide fish shelter and rearing habitat, and offset channel incision. Landowners should be sensitive about the natural and positive role woody debris plays in the system, and encouraged not to remove woody debris from the stream, except under extreme buildup and only under guidance by a fishery professional.

RECOMMENDATIONS

1. Access for migrating is an ongoing potential problem in Redwood Creek, therefore, fish passage should be monitored, and improved where possible. Baffles should be installed in several culverts to facilitate easier fish access.

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 undercut banks. Adding high quality complexity with woody cover is desirable.

COMMENTS AND LANDMARKS

The following landmarks and possible problem sites were noted. All distances are approximate and taken from the beginning of the survey reach.

Redwood Creek

Position (ft.)	Habitat Unit #	Comments:
0	0001.00	1 YOY
358	0008.00	A lot of sand in channel
389	0009.00	RB - cement wall 6.5' x15', small water pump
443	0010.00	N 38°23'24.5" W 123°53'10.3"
556	0012.00	10 YOY
611	0013.00	1 Fresh water shrimp
648	0015.00	Mostly sand
825	0017.00	15 - 20 YOY
920	0020.00	N 38°23'28.0" W 122°53'12.0"

1196	0025.00	Large amount of silt formed by dam DAM H:5' L:4.5' W:10' No flashboards, no downcutting at sill Retaining gravel: 5'
1236	0026.00	RB - water pump 60' into unit
1373	0027.00	5 YOY 3 1' dams, made by E
1483	0028.00	16" Stealhead, water pump RB
1564	0029.00	Water pump RB
1589	0030.00	N 38°23'31.9" W 122°53'14.3"
1791	0035.00	Less than 5 YOY
2141	0040.00	N 38°23'33.6" W 122°53'14.4"
2219	0042.00	LWD protocal: RW/2/10/F/6
2507	0048.00	4 salmonids 4-6"; Pump @ 200' LB; Pump @ 400' RB, instream culvert; Pump @1330'; CULVERT Road Name: Furlong L:46' W:10' H:8' - instream Not downcutting, not retaining gravel, no maintenance required. Comments: There is a small culvert entering this one at 80° angle, it is 1.2' off the bottom of the large culvert and 2' diameter.
3980	0050.00	Pump in HU at 95'

4095	0052.00	Dry trib LB 50' riprap @ 200' RB
4170	0053.00	Wet trib RB
5120	0054.00	BRIDGE: H:7.5' W:18' L:13' Downcutting: 2' Height from water to sill: .5' Retaining gravel: 1' Comments: There are 30 1'x1' chunks of cement in the channel under bridge.
5208	0058.00	2 pumps RB 300' into unit
5918	0063.00	BRIDGE H: 5.1' W:11.4' L:56' Downcutting: 2.8' Height from water to sill:1.1' Not retaining gravel
5933	0064.00	Wet trib RB 190' into unit 1 6"salmonid 180' into unit
6520	0067.00	Good pool but it needs more shelter
6666	0070.00	3 culverts, 1 instream, 2 LB; 2-3 pumps; CULVERT Road name: Furlong L:78' W:3' H:3' – instream, Not downcutiing, not retaining gravel, no maintenance required. CULVERT: L:60' W:3' H:3' – instream Not retaining gravel Comments: Can't tell if it is downcutting because vision is blocked by overgrown brush. Furlong crosses creek.
6853	0072.00	Wet trib RB @79'
7072	0074.00	CULVERT L:46' W:4' H:4' - instream Downcutting: 2.5' Culvert lip to H2O level: 2.1' No maintenance is required
7269	0075.00	Culvert LB at beginning of HU

7593	0077.00	Wet trib RB 50' into HU
7752	0079.00	END OF SURVEY

REFERENCES

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