STREAM INVENTORY REPORT

Redwood Creek

INTRODUCTION

A stream inventory was conducted during the summer of 2001 on Redwood Creek. The survey began at the confluence with Coyote Creek and extended upstream 24.7 miles.

The objective of this report is to document the current habitat conditions and recommend options for the potential enhancement of habitat for 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 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 41.2925 degrees north latitude and 124.0906 degrees west longitude. Redwood Creek is a fourth order stream and has approximately 66 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 sea level at the mouth of the creek to 3,100 feet in the headwater areas. Redwood forest, Douglas fir forest and grassland dominate 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 Korbel and also via Highway 299 to Bald Mountain Road, Redwood Valley Road or Chezem Road.

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 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.

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 nine components to the inventory form.

1. Flow:

Flow is measured in cubic feet per second (cfs) at 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 (1985 rev. 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 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.

4. Habitat Type:

Habitat typing uses the 24 habitat classification types defined by McCain and others (1988). 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 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 not suitable for spawning due to inappropriate substrate particle size, bedrock, or other considerations.

6. Shelter Rating:

Instream shelter is composed of those elements within a stream channel that provide 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. 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 deciduous 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.

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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*.

DATA ANALYSIS

Data from the habitat inventory form are entered into Habitat, a dBASE 4.2 data entry program developed by Tim Curtis, Inland Fisheries Division, California Department of Fish and Game. This program processes and summarizes the data, and produces the following six tables:

- Riffle, flatwater, and pool habitat types
- Habitat types and measured parameters
- Pool types
- Maximum pool depths by habitat types
- Dominant substrates by habitat types
- Mean percent shelter by habitat types

Graphics are produced from the tables using Quattro Pro. Graphics developed for Redwood Creek include:

- Riffle, flatwater, pool habitats by percent occurrence
- Riffle, flatwater, pool habitats by total length
- Total habitat types by percent occurrence
- Pool types by percent occurrence
- Total pools by maximum depths
- Embeddedness
- Pool cover by cover type
- Dominant substrate in low gradient riffles
- Mean percent canopy
- Bank composition by composition type
- Bank vegetation by vegetation type

HABITAT INVENTORY RESULTS

The habitat inventory of June 13 through August 23, 2001, was conducted by B. Beaver and T. Hollingsworth (WSP/AmeriCorps). 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 51.5 cfs on June 12, 2001, 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 (Reach 1) and an F3 channel type for the remaining 8,425 feet of the channel surveyed (Reach 2). 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.

Water temperatures taken during the survey period ranged from 58 to 80 degrees Fahrenheit. Air temperatures ranged from 56 to 95 degrees Fahrenheit.

Table 1 summarizes the Level II riffle, flatwater, and pool habitat types. Based on frequency of occurrence there were 59% pool units, 25% flatwater units, and 16% riffle units (Graph 1). Based on total length of Level II habitat types there were 52% pool units, 36% flatwater units, and 12% riffle units (Graph 2).

Eighteen Level IV habitat types were identified (Table 2). The most frequent habitat types by percent occurrence were runs, 23%; boulder-formed lateral scour pools, 22%; and mid-channel pools, 18% (Graph 3). Based on percent total length, runs made up 33%, boulder-formed lateral scour pools 19%, and mid-channe1 pools 15%.

A total of 549 pools were identified (Table 3). Scour pools were the most frequently encountered, at 62%, and comprised 62% of the total length of all pools (Graph 4).

Table 4 is a summary of maximum pool depths by pool habitat types. Pool quality for salmonids increases with depth. Two hundred ninety-six of the 549 pools (53.9%) had a depth of three feet or greater (Graph 5).

The depth of cobble embeddedness was estimated at pool tail-outs. Of the 549 pool tail-outs measured, 62 had a value of 1 (11.3%); 227 had a value of 2 (41.3%); 224 had a value of 3 (40.8%); 25 had a value of 4 (4.6%); 11 had a value of 5 (2%), (Graph 6). On this scale, a value of 1 indicates the highest quality of spawning substrate. The breakdown of dominant substrate composition for the 11 pool tail-outs that had an embeddedness value of 5 were as follows: 55% boulders, 36% pea gravel, and 9% bedrock.

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 22, flatwater habitat types had a mean shelter rating of 14, and pool habitats had a mean shelter rating of 22 (Table 1). Of the pool types, the main channel pools had the highest mean shelter rating at 23. Scour pools had a mean shelter rating of 22 (Table 3).

Table 5 summarizes mean percent cover by habitat type. Boulders are the dominant cover types in Redwood Creek. Graph 7 describes the pool cover in Redwood Creek. Boulders are the dominant pool cover type followed by bedrock ledges.

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Table 6 summarizes the dominant substrate by habitat type. Graph 8 depicts the dominant substrate observed in pool tail-outs. Gravel was the dominant substrate observed in 76% of pool tail-outs while small cobble was the next most frequently observed substrate type, at 9%.

The mean percent canopy density for the surveyed length of Redwood Creek was 39%. The mean percentages of deciduous and coniferous trees were 83% and 17%, respectively. Graph 9 describes the mean percent canopy in Redwood Creek.

For the stream reach surveyed, the mean percent right bank vegetated was 51%. The mean percent left bank vegetated was 56%. The dominant elements composing the structure of the stream banks consisted of 68% cobble/gravel, 15% boulders, 9% sand/silt/clay, and 8% bedrock (Graph 10). Deciduous trees were the dominant vegetation type observed in 64% of the units surveyed. Additionally, 15% of the units surveyed had grass as the dominant vegetation type, and 10% had brush as the dominant vegetation (Graph 11).

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-defecters, 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 to August 23, 2001, ranged from 58 to 80 degrees Fahrenheit. Air temperatures ranged from 56 to 95 degrees Fahrenheit. Eighty degrees Fahrenheit, if sustained, is above the threshold stress level for salmonids. To make any further conclusions, temperatures need to be monitored throughout the warm summer months, and more extensive biological sampling needs 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 (54%) pools having a maximum depth greater than three 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 not suitable for spawning. Six of the 11 tail-outs were not suitable for spawning due to the dominant substrate being boulders. The remainder of pool tail-outs with embeddedness ratings of 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 boulders in all habitat types. Additionally, bedrock ledges 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 structures provide rearing fry with protection from predation, rest from water velocity, and also divide 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 51% and 56%, respectively.

RECOMMENDATIONS

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

2) 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.

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) 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.

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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.

Position (ft):	Comments:
0'	Start of survey at the confluence with Coyote Creek at Redwood National Park boundary. The channel is an F4.
831'	Right bank tributary enters stream.
6,824'	Right bank tributary enters stream.
7,595'	Left bank tributary enters stream.
8,885'	Left bank tributary enters stream.
9,785'	Left bank tributary enters stream.
12,090'	Panther Creek enters from left bank.
12,132'	Old road crossing. Bridge has been removed.
14,845'	Left bank tributary enters stream.
16,548'	Right bank tributary enters stream.
17,493'	Right bank tributary enters stream.
19,928'	Left bank tributary enters stream.
21,504'	Garrett Creek enters stream from right bank.
21,986'	Slide on right bank approximately 100' long.
23,949'	Slide on right bank approximately 30' long.
24,538'	Left bank tributary enters stream.
29,735'	Left bank tributary enters stream.
31,967'	Lacks Creek enters from right bank.
36,804'	Right bank tributary enters stream.

39,466'	Dam across stream, 100' long x 15' high x 25' wide. Dam is seasonal and is made out of gravel.
47,533'	Left bank tributary enters stream.
50,130'	Left bank tributary enters stream.
54,960'	Roaring Gulch enters stream on right bank.
59,628'	Left bank tributary enters stream.
60,995'	Slide on left bank approximately 10' long.
61,364'	Left bank tributary enters stream.
62,096'	Cashmere Creek enters stream from left bank.
64,750'	Right bank tributary enters stream.
65,098'	Culvert, 20' long x 5' wide.
68,201'	Rock dam in creek, 50' long x 2' high x 2' wide.
70,647'	Left bank tributary enters stream.
73,474'	Foot bridge crosses creek 15' above creek and measures 70' long x 2' wide.
74,107'	Pilchuck Creek enters from left bank.
74,983'	Right bank tributary enters stream.
76,908'	Left bank tributary enters stream.
77,631'	Cobble dam approximately 2' high x 3' wide x 27' long.
80,119'	Department of Fish and Game Steelhead Research and Monitoring Program screw trap.
80,204'	Weir for screw trap. Approximately 1.4' high x 2' wide x 50' long.
82,806'	Toss-Up Creek enters from left bank.
86,043'	Moon Creek enters from right bank.
89,600'	Wiregrass Creek enters from left bank.

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89,753' Slide on left bank. 24' long x 40' high.

91,706' Redwood Valley Road Bridge crosses 14' above creek.

93,729' Bridge crosses 29' above creek.

93,307' Minor Creek enters from right bank.

101,518' Santa Fe Creek enters from left bank.

103,204' Greenpoint creek enters from left bank.

106,820' Sweathouse creek enters right bank.

115,682' Gravel dam, 20' high x 111' long x 40' wide. Also, small cobble weir at end of pool, 25' long x 1.6' high x 1.2' wide.

119,534' Cobble/boulder weir, 3.2' high x 2' wide x 20' long.

120,124' Lupton Creek enters from left bank.

121,003' USGS gaging station.

121,006' Cable car crosses above creek.

121,618' Right bank tributary enters stream.

122,084' Corrugated metal pipe, 20' long x 8' wide.

122,449' Channel type changes from F2 to F3.

123,008' Corrugated metal pipe, 15' long x 10' wide.

124,106' Highway 299/ Don O'Kane bridge crosses 80' above creek.

124,246' Boulder weir, 17' long x 2' wide x 1.8' high.

125,328' Right bank tributary enters stream.

127,737' Fern Prairie Creek enters stream from left bank.

128,989' Left bank tributary enters stream.

130,874' End of survey due to lack of access upstream.

REFERENCES

Flosi, G., Downie, S., Hopelain, J., Bird, M., Coey, R., and Collins, B. 1998. *California Salmonid Stream Habitat Restoration Manual*, 3rd edition. California Department of Fish and Game, Sacramento, California.

LEVEL III and LEVEL IV HABITAT TYPES

RIFFLE			
Low Gradient Riffle	(LGR)	[1.1]	{ 1}
High Gradient Riffle	(HGR)	[1.2]	{ 2}
CASCADE			
Cascade	(CAS)	[2.1]	{ 3}
Bedrock Sheet	(BRS)	[2.2]	{24}
FLATWATER			
Pocket Water	(POW)	[3.1]	{21}
Glide	(GLD)	[3.2]	{14}
Run	(RUN)	[3.3]	{15}
Step Run	(SRN)	[3.4]	{16}
Edgewater	(EDW)	[3.5]	{18}
MAIN CHANNEL POOLS			
Trench Pool	(TRP)	[4.1]	{ 8}
Mid-Channel Pool	(MCP)	[4.2]	{17}
Channel Confluence Pool	(CCP)	[4.3]	{19}
Step Pool	(STP)	[4.4]	{23}
SCOUR POOLS			
Corner Pool	(CRP)	[5.1]	{22}
Lateral Scour Pool - Log Enhanced	(LSL)	[5.2]	{10}
Lateral Scour Pool - Root Wad Enhanced	(LSR)	[5.3]	{11}
Lateral Scour Pool - Bedrock Formed	(LSBk)	[5.4]	{12}
Lateral Scour Pool - Boulder Formed	(LSBo)	[5.5]	{20}
Plunge Pool	(PLP)	[5.6]	{ 9}
BACKWATER POOLS			
Secondary Channel Pool	(SCP)	[6.1]	{ 4}
Backwater Pool - Boulder Formed	(BPB)	[6.2]	{ 5}
Backwater Pool - Root Wad Formed	(BPR)	[6.3]	{ 6}
Backwater Pool - Log Formed	(BPL)	[6.4]	{ 7}
Dammed Pool	(DPL)	[6.5]	{13}
ADDITIONAL UNIT DESIGNATIONS			
Dry	(DRY)	[7.0]	
Culvert	(CUL)	[8.0]	
Not Surveyed	(NS)	[9.0]	
Not Surveyed due to a marsh	(MAR)	[9.1]	