

# STREAM INVENTORY REPORT

## Redwood Creek

### INTRODUCTION

A stream inventory was conducted from July 9 to July 25, 2012 on Redwood Creek. The survey began at the confluence with South Fork Ten Mile River and extended upstream four miles. Stream inventories and reports were also completed for two tributaries to Redwood Creek.

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 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 South Fork Ten Mile River, tributary to Ten Mile River, which drains to the Pacific Ocean. It is located in Mendocino County, California (Map 1). Redwood Creek's legal description at the confluence with South Fork Ten Mile River is T19N R16W S23. Its location is 39.4926 degrees north latitude and 123.6073 degrees west longitude, LLID number 1236061394926. Redwood Creek is a second order stream and has approximately 4.6 miles of blue line stream according to the USGS Sherwood Peak 7.5 minute quadrangle. Redwood Creek drains a watershed of approximately 7.3 square miles. Elevations range from about 350 feet at the mouth of the creek to 1,800 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 Camp One Ten Mile Road, north of Fort Bragg.

### 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 Department of Fish and Wildlife (CDFW) personnel and Watershed Stewards Project/AmeriCorps (WSP) members that conducted the inventory were trained in standardized habitat inventory methods by the CDFW. 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

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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 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.

#### 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.

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### 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 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. Using an overhead view, a quantitative estimate of the percentage of the habitat unit covered is made. All cover is 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. The shelter rating is then calculated for each fully-described habitat unit by multiplying shelter value and percent 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 densimeters 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.

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### 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, underwater observations were made at 12 sites using techniques discussed in the *California Salmonid Stream Habitat Restoration Manual*.

## DATA ANALYSIS

Data from the habitat inventory form are entered into Stream Habitat 2.0.19, a Visual Basic data entry program developed by Karen Wilson, Pacific States Marine Fisheries Commission in conjunction with the California Department of Fish and Wildlife. 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

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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

### HABITAT INVENTORY RESULTS

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

The habitat inventory of July 9 to July 25, 2012 was conducted by M. Zee and C. Tiffany (WSP), and B. Leonard (CDFW). The total length of the stream surveyed was 21,205 feet.

Stream flow was measured near the bottom of the survey reach with a Marsh-McBirney Model 2000 flowmeter at 1.54 cfs on July 10, 2012.

Redwood Creek is an F4 channel type for 20,875 feet of the stream surveyed (Reach 1), and an A6 channel type for 330 feet of the stream surveyed (Reach 2). F4 channel types are entrenched meandering riffle/pool channels on low gradients with high width/depth ratios and gravel-dominant substrates. A6 channels are steep, narrow, cascading, step-pool, high energy debris transporting channels associated with depositional soils, and silt-dominant substrates.

Water temperatures taken during the survey period ranged from 54 to 58 degrees Fahrenheit. Air temperatures ranged from 56 to 72 degrees Fahrenheit.

Table 1 summarizes the Level II riffle, flatwater, and pool habitat types. Based on frequency of occurrence there were 41% pool units, 31% flatwater units, 27% riffle units, and 1% unsurveyed units (Graph 1). Based on total length of Level II habitat types there were 51% flatwater units, 34% pool units, 14% riffle units, and 1% unsurveyed units (Graph 2).

Twelve Level IV habitat types were identified (Table 2). The most frequent habitat types by percent occurrence were mid-channel pool units, 32%; step run units, 24%; and low gradient riffle units, 19% (Graph 3). Based on percent total length, step run units made up 46%, mid-channel pool units 27%, and low gradient riffle units 9%.

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A total of 214 pools were identified (Table 3). Main channel pools were the most frequently encountered at 85% (Graph 4), and comprised 86% of the total length of all pools (Table 3).

Table 4 is a summary of maximum residual pool depths by pool habitat types. Pool quality for salmonids increases with depth. Seventy-three of the 214 pools (34%) had a residual depth of two feet or greater (Graph 5).

The depth of cobble embeddedness was estimated at pool tail-outs. Of the 214 pool tail-outs measured, 54 had a value of 1 (25.2%); 128 had a value of 2 (59.8%); 26 had a value of 3 (12.1%); five had a value of 4 (2.3%); one had a value of 5 (0.5%) (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 not suitable for spawning due to inappropriate substrate such as bedrock, log sills, boulders, or other considerations.

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 29, flatwater habitat types had a mean shelter rating of 28, and pool habitats had a mean shelter rating of 35 (Table 1). Of the pool types, the backwater pools had the highest mean shelter rating at 46. Main channel pools had a mean shelter rating of 35 and scour pools had a mean shelter rating of 31 (Table 3).

Table 5 summarizes mean percent cover by habitat type. Boulders are the dominant cover type in Redwood Creek. Graph 7 describes the pool cover in Redwood Creek. Large woody debris is the dominant pool cover type followed by boulders.

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 87% of the pool tail-outs. Small cobble was the next most frequently observed dominant substrate type and occurred in 8% of the pool tail-outs

The mean percent canopy density for the surveyed length of Redwood Creek was 94%. Six percent of the canopy was open. Of the canopy present, the mean percentages of hardwood and coniferous trees were 46% and 54%, respectively. Graph 9 describes the mean percent canopy in Redwood Creek.

For the stream reach surveyed, the mean percent right bank vegetated was 98%. The mean percent left bank vegetated was 98%. The dominant elements composing the structure of the stream banks consisted of 44% sand/silt/clay, 43% cobble/gravel, 7% bedrock, and 6% boulders (Graph 10). Coniferous trees were the dominant vegetation type observed in 67% of the units surveyed. Additionally, 33% of the units surveyed had deciduous trees as the dominant vegetation type (Graph 11).

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### BIOLOGICAL INVENTORY RESULTS

Survey teams conducted a snorkel survey at 12 sites for species composition and distribution in Redwood Creek on September 26, 2012. The sites were sampled by I. Mikus and M. Groff (CDFW).

In Reach 1, which comprised the first 20,875 feet of stream, 12 sites were sampled. The reach sites yielded 108 young-of-the-year (YOY) steelhead/rainbow trout (SH/RT), six age 1+ SH/RT, one age 2+ SH/RT, and two YOY coho salmon.

The following chart displays the information yielded from these sites:

2012 Redwood Creek underwater observations.

Date	Survey Site #	Habitat Unit #	Habitat Type	Approx. Dist. from mouth (ft.)	SH/RT			Coho	
					YOY	1+	2+	YOY	1+
Reach 1: F4 Channel Type									
09/26/12	1	002	Pool	175	8	1	0	2	0
	2	006	Pool	502	7	0	0	0	0
	3	009	Pool	931	12	0	0	0	0
	4	012	Run	1,096	13	0	0	0	0
	5	017	Pool	1,450	11	0	1	0	0
	6	038	Pool	2,716	14	0	0	0	0
	7	042	Pool	2,892	2	2	0	0	0
	8	049	Pool	3,500	28	2	0	0	0
	9	194	Pool	11,572	3	1	0	0	0
	10	220	Pool	12,491	7	0	0	0	0
	11	222	Pool	12,578	1	0	0	0	0
	12	228	Pool	13,004	2	0	0	0	0

### DISCUSSION

Redwood Creek is an F4 channel type for the first 20,875 feet of stream surveyed and an A6 channel type for the remaining 330 feet. The suitability of F4 and A6 channel types for fish habitat improvement structures is as follows: F4 channel types are good for bank-placed boulders and fair for plunge weirs, single and opposing wing-deflectors, channel constrictors, and log cover. A6 channels are generally not suitable for fish habitat improvement projects.

The water temperatures recorded on the survey days July 9 to July 25, 2012 ranged from 54 to 58 degrees Fahrenheit. Air temperatures ranged from 56 to 72 degrees Fahrenheit. This is a good

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

Flatwater habitat types comprised 51% of the total length of this survey, riffles 14%, and pools 34%. Seventy-three of the 214 (34%) pools had a maximum residual 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 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.

One hundred eighty-two of the 214 pool tail-outs measured had embeddedness ratings of 1 or 2. Thirty-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. Cobble embeddedness measured to be 25% or less, a rating of 1, is considered to indicate good quality spawning substrate for salmon and steelhead.

Two hundred three of the 214 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 is 35. The shelter rating in the flatwater habitats is 28. A pool shelter rating of approximately 100 is desirable. The amount of cover that now exists is being provided primarily by boulders in Redwood Creek. Large woody debris is the dominant cover type in pools followed by boulders. 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 94%. Reach 1 had a canopy density of 94% and Reach 2 had a canopy density of 95%. The percentage of right and left bank covered with vegetation was 98% and 98%, 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 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 in the pools is from large woody debris. Adding high quality complexity with woody cover in the pools is desirable.



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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):	Habitat unit #:	Comments:
0	0001.00	Start of survey at the confluence with South Fork Ten Mile River. The channel is an F4.
278	0005.00	"Gulch 1" (Tributary #01) enters on the left bank. It contributes approximately 5% to Redwood Creek's flow. The water temperature of the tributary is 56 degrees Fahrenheit, the water temperature downstream of the tributary is 56 degrees Fahrenheit, and the water temperature upstream of the confluence is 57 degrees Fahrenheit. The slope of the tributary is approximately 10%. The tributary may be accessible to salmonids, but no fish were observed.
2689	0038.00	Erosion site on left bank measures 50' high x 100' long.
2963	0044.00	There is a 2' high plunge.
3521	0051.00	Gauging station.
3634	0052.00	Road 14000 crosses the channel. The crossing is a 13' wide x 9' high x 55' long steel bridge.
3663	0053.00	"Gulch 2" (Tributary #02) enters on the right bank. It contributes approximately 1% to Redwood Creek's flow. The water temperature of the tributary is 54 degrees Fahrenheit; the water temperature downstream and upstream of the tributary is 56 degrees Fahrenheit. The slope of the tributary is approximately 5%. The first 250' of the tributary are accessible to salmonids, but no fish were observed.
3957	0055.00	Remnants of railroad trestle in channel and on banks.
4326	0058.00	There is a 1' high plunge.
5273	0075.00	North Fork Redwood Creek (Tributary #03) enters on the right bank. It contributes approximately 10% to Redwood Creek's flow. The water temperature of the tributary is 56 degrees Fahrenheit; the water temperature downstream and upstream of the tributary is 56 degrees Fahrenheit. For more information, see the 2012 North Fork Redwood Creek Stream Habitat Inventory Report.

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5567	0079.00	Remnants of railroad trestle.
6938	0110.00	Log debris accumulation (LDA) #01 contains 17 pieces of large woody debris (LWD) and measures 9' high x 50' wide x 11' long. Water flows through the LDA and there are visible gaps in it. Retained sediment ranges from silt to cobble and measures 50' wide x 30' long x 4' deep. Fish are present above the LDA.
7059	0115.00	Dry left bank tributary.
8477	0142.00	Tributary #04 enters on the left bank. It contributes approximately 5% to Redwood Creek's flow. The water temperature of the tributary is 54 degrees Fahrenheit; the water temperature downstream and upstream of the tributary is 56 degrees Fahrenheit. The slope of the tributary is approximately 15%. The tributary is not accessible to salmonids.
9347	0150.00	Tributary #05 enters on the right bank. It contributes approximately 5% to Redwood Creek's flow. The water temperature of the tributary is 55 degrees Fahrenheit; the water temperature downstream of the tributary is 57 degrees Fahrenheit. The slope of the tributary is approximately 10%. The tributary is not accessible to salmonids.
10337	0169.00	Left bank erosion.
10534	0175.00	LDA #02 contains 11 pieces of LWD and measures 9' high x 50' wide x 30' long. Water flows through the LDA and there are no visible gaps in it. Retained sediment ranges from silt to cobble and measures 50' wide x 50' long x 4' deep. Fish are present above the LDA.
11634	0197.00	"South Fork Redwood Creek" (Tributary #06) enters on the right bank. It contributes approximately 40% to Redwood Creek's flow. The water temperature of the tributary is 56 degrees Fahrenheit; the water temperature downstream and upstream of the tributary is 57 degrees Fahrenheit. The slope of the tributary is approximately 2%. Salmonids were observed in the tributary.
11687	0199.00	LDA #03 contains 12 pieces of LWD and measures 5' high x 20' wide x 12' long. Water flows through the LDA and there are no visible gaps in it. Retained sediment ranges from silt to gravel and measures 13' wide x 35' long x 3' deep. Fish are present above the LDA.
11880	0207.00	LDA #04 contains eight pieces of LWD and measures 6' high x 25' wide x 9' long. Water flows through the LDA and there are no visible gaps in it. Retained sediment ranges from silt to gravel and measures 25' wide x 4' deep. There is a 4' high plunge over the LDA. Fish are present above the LDA.

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12391	0218.00	A logging road crosses the channel. The crossing is an 11' wide x 28' long x 5.5' high steel and wood bridge.
12864	0224.00	Woody debris is accumulating in the channel. It has the potential to become an LDA.
13537	0247.00	Woody debris is accumulating in the channel. It has the potential to become an LDA.
13569	0248.00	Tributary #07 enters on the left bank. It contributes approximately 20% to Redwood Creek's flow. The water temperature of the tributary is 55 degrees Fahrenheit; the water temperature downstream and upstream of the tributary is 57 degrees Fahrenheit. The slope of the tributary is 10-15%. The tributary goes dry a couple hundred feet upstream of the mouth.
14185	0268.00	LDA #05 contains 13 pieces of LWD and measures 8' high x 25' wide x 13' long. Water flows through the LDA and there are visible gaps in it. Retained sediment ranges from silt to cobble and measures 17' wide x 40' long x 4' deep. Fish are present above the LDA.
14485	0278.00	Remnants of railroad trestle.
14549	0279.00	Erosion site on right bank measures 40' high x 35' long and is contributing sediment ranging in size from silt to boulders to the channel.
14556	0280.00	Remnants of railroad trestle.
14636	0285.00	Remnants of railroad trestles are accumulating LWD. LDA #06 contains 10 pieces of LWD and measures 5' high x 20' wide x 11' long. Water flows through the LDA and there are visible gaps in it. Retained sediment ranges from silt to cobble and measures 20' wide x 55' long x 2' deep. There is a 3' high plunge over the LDA. Fish are present above the LDA.
14824	0293.00	LDA #07 contains 12 pieces of LWD and measures 5' high x 22' wide x 14' long. Water flows through the LDA and there are visible gaps in it. Retained sediment ranges from silt to gravel and measures 22' wide x 70' long x 4' deep. The LDA consists of two steps: the first is 1' high, the second is 3' high. Fish are present above the LDA.
15068	0302.00	Dry left bank tributary with 10-15% slope.
15675	0321.00	There is a 1' high plunge.

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15809	0328.00	Tributary #08 enters on the left bank. It contributes approximately 1% to Redwood Creek's flow. The water temperature of the tributary is 55 degrees Fahrenheit; the water temperature downstream and upstream of the tributary is 57 degrees Fahrenheit. The slope of the tributary is approximately 5%. The tributary is mostly dry.
16230	0346.00	LDA #08 contains eight pieces of LWD and measures 6' high x 50' wide x 20' long. Water flows through the LDA and there are visible gaps in it. Retained sediment ranges from silt to cobble and measures 20' wide x 60' long x 5' deep. Fish are present above the LDA.
17206	0382.00	An erosion site on the left bank measures 70' high x 100' long.
17320	0385.00	There is a 1' high plunge.
17499	0391.00	Tributary #09 enters on the left bank. It contributes approximately 5% to Redwood Creek's flow. The water temperature of the tributary is 55 degrees Fahrenheit; the water temperature downstream and upstream of the tributary is 56 degrees Fahrenheit. The slope of the tributary is approximately 20%. The tributary is not accessible to salmonids.
18764	0435.00	There is a 1.2' high plunge.
18788	0436.00	Tributary #12 enters on the left bank. It contributes approximately 10% to Redwood Creek's flow. The water temperature of the tributary is 56 degrees Fahrenheit; the water temperature downstream and upstream of the tributary is 54 degrees Fahrenheit. The slope of the tributary is approximately 5% for the first 500' then the slope increases to 30%. The first 500' of the tributary may be accessible to salmonids.
18891	0438.00	LDA #09 contains 12 pieces of LWD and measures 5' high x 25' wide x 14' long. Water flows through the LDA and there are visible gaps in it. Retained sediment ranges from silt to cobble and measures 9' wide x 30' long x 4' deep. Fish are present above the LDA.
19791	0465.00	Tributary #10 enters on the right bank. It contributes less than 1% to Redwood Creek's flow. The water temperature of the tributary is 55 degrees Fahrenheit; the water temperature downstream and upstream of the tributary is 55 degrees Fahrenheit. The slope of the tributary is approximately 20%. The tributary goes dry 100' upstream from the mouth. There is a 6' high plunge 200' upstream from the mouth.
20143	0477.00	LDA #10 contains 19 pieces of LWD and measures 4' high x 12' wide x 16' long. Water flows through the LDA and there are visible gaps in it. Retained sediment ranges from silt to cobble and measures 5' wide x 15' long x 1' deep. Fish are present above the LDA.

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- 20875 0503.00 The channel changes from an F4 to an A6.
- 20889 0504.00 Tributary #11 enters on the left bank. It contributes approximately 5% to Redwood Creek's flow. The water temperature of the tributary is 52 degrees Fahrenheit; the water temperature downstream and upstream of the tributary is 54 degrees Fahrenheit. The slope of the tributary is approximately 45%. The tributary is not accessible to salmonids.
- 20978 0510.00 There is a 1' high plunge.
- 21088 0514.00 There is a 2' high plunge.
- 21152 0517.00 There is a 2' high plunge.
- 21186 0519.00 End of survey at 9' high plunge over boulders, fallen trees, and associated accumulated sediment. The plunge consists of two steps: the first step measures 3' high and there is a pool with a maximum depth of 1' below it. The second step measures 5' high and has no jump pool below it. No fish were observed within the first 400' upstream of the plunge.

## 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.

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### 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]	

**Table 1 - Summary of Riffle, Flatwater, and Pool Habitat Types**

Stream Name: Redwood Creek

LLID: 1236061394926 Drainage: Rockport

Survey Dates: 7/9/2012 to 7/25/2012

Confluence Location: Quad: SHERWOOD PEAK Legal Description: T19NR16WS23 Latitude: 39:29:33.0N Longitude: 123:36:22.0

Habitat Units	Units Fully Measured	Habitat Type	Habitat Occurrence (%)	Mean Length (ft.)	Total Length (ft.)	Total Length (%)	Mean Width (ft.)	Mean Depth (ft.)	Mean Max Depth (ft.)	Mean Area (sq.ft.)	Estimated Total Area (sq.ft.)	Mean Volume (cu.ft.)	Estimated Total Volume (cu.ft.)	Mean Residual Pool Vol (cu.ft.)	Mean Shelter Rating
159	21	FLATWATER	30.6	69	10894	51.4	8.8	0.4	0.8	488	77530	231	36807		28
4	0	NOSURVEY	0.8	30	120	0.6									
214	214	POOL	41.2	34	7169	33.8	12.5	0.9	1.9	434	92834	568	121471	448	35
142	24	RIFFLE	27.4	21	3022	14.3	9.8	0.3	0.6	186	26458	63	8911		29
<b>Total Units</b>	<b>Total Units Fully Measured</b>				<b>Total Length (ft.)</b>					<b>Total Area (sq.ft.)</b>			<b>Total Volume (cu.ft.)</b>		
519	259				21205					196823			167189		

**Table 2 - Summary of Habitat Types and Measured Parameters**

Stream Name: Redwood Creek

LLID: 1236061394926

Drainage: Rockport

Survey Dates: 7/9/2012 to 7/25/2012

Confluence Location: Quad: SHERWOOD PEAK Legal Description: T19NR16WS23 Latitude: 39:29:33.0N Longitude: 123:36:22.0W

Habitat Units	Units Fully Measured	Habitat Type	Habitat Occurrence (%)	Mean Length (ft.)	Total Length (ft.)	Total Length (%)	Mean Width (ft.)	Mean Depth (ft.)	Max Depth (ft.)	Mean Area (sq.ft.)	Estimated Total Area (sq.ft.)	Mean Volume (cu.ft.)	Estimated Total Volume (cu.ft.)	Mean Residual Pool Vol (cu.ft.)	Mean Shelter Rating	Mean Canopy (%)
98	17	LGR	18.9	20	1972	9.3	9	0.3	0.7	131	12828	33	3252		17	95
43	6	HGR	8.3	24	1014	4.8	12	0.4	1	316	13572	116	4981		57	95
1	1	CAS	0.2	36	36	0.2	14	0.7	1.2	353	353	247	247		60	98
37	6	RUN	7.1	32	1178	5.6	8	0.5	1.1	222	8221	110	4055		7	96
122	15	SRN	23.5	80	9716	45.8	9	0.4	1.3	594	72441	280	34190		37	94
168	168	MCP	32.4	34	5711	26.9	13	0.9	5.6	445	74700	574	96366	448	35	94
2	2	CCP	0.4	30	60	0.3	10	0.5	1.3	310	620	217	434	155	40	91
11	11	STP	2.1	37	402	1.9	10	0.9	2.7	352	3877	449	4938	352	36	92
10	10	CRP	1.9	35	347	1.6	8	0.6	2.2	288	2877	252	2520	179	21	94
1	1	LSBo	0.2	16	16	0.1	12	0.4	1.4	192	192	134	134	77	10	98
18	18	PLP	3.5	23	406	1.9	13	0.9	5.7	317	5700	422	7588	340	38	92
4	4	DPL	0.8	57	227	1.1	20	1.4	3.9	1217	4868	2373	9490	2102	46	95
4	0	NS	0.8	30	120	0.6										

Total Units  
519

Total Units Fully Measured  
259

Total Length (ft.)  
21205

Total Area (sq.ft.)  
200249

Total Volume (cu.ft.)  
168196



**Table 3 - Summary of Pool Types**

Stream Name: Redwood Creek

LLID: 1236061394926

Drainage: Rockport

Survey Dates: 7/9/2012 to 7/25/2012

Confluence Location: Quad: SHERWOOD PEAK

Legal Description: T19NR16WS23

Latitude: 39:29:33.0N

Longitude: 123:36:22.0W

Habitat Units	Units Fully Measured	Habitat Type	Habitat Occurrence (%)	Mean Length (ft.)	Total Length (ft.)	Total Length (%)	Mean Width (ft.)	Mean Residual Depth (ft.)	Mean Area (sq.ft.)	Estimated Total Area (sq.ft.)	Mean Residual Pool Vol (cu.ft.)	Estimated Total Resid.Vol. (cu.ft.)	Mean Shelter Rating
181	181	MAIN	85	34	6173	86	12.6	0.9	438	79197	439	79429	35
29	29	SCOUR	14	27	769	11	11.1	0.8	302	8769	276	7990	31
4	4	BACKWATER	2	57	227	3	19.5	1.4	1217	4868	2102	8407	46

Total Units	Total Units Fully Measured	Total Length (ft.)	Total Area (sq.ft.)	Total Volume (cu.ft.)
214	214	7169	92834	95826

**Table 4 - Summary of Maximum Residual Pool Depths By Pool Habitat Types**

Stream Name: Redwood Creek

LLID: 1236061394926

Drainage: Rockport

Survey Dates: 7/9/2012 to 7/25/2012

Confluence Location: Quad: SHERWOOD PEAK

Legal Description: T19NR16WS23

Latitude: 39:29:33.0N

Longitude: 123:36:22.0W

Habitat Units	Habitat Type	Habitat Occurrence (%)	< 1 Foot Maximum Residual Depth	< 1 Foot Percent Occurrence	1 < 2 Feet Maximum Residual Depth	1 < 2 Feet Percent Occurrence	2 < 3 Feet Maximum Residual Depth	2 < 3 Feet Percent Occurrence	3 < 4 Feet Maximum Residual Depth	3 < 4 Feet Percent Occurrence	>= 4 Feet Maximum Residual Depth	>= 4 Feet Percent Occurrence
168	MCP	79	17	10	93	55	39	23	16	10	3	2
2	CCP	1	0	0	2	100	0	0	0	0	0	0
11	STP	5	1	9	5	45	5	45	0	0	0	0
10	CRP	5	2	20	6	60	2	20	0	0	0	0
1	LSBo	0	0	0	1	100	0	0	0	0	0	0
18	PLP	8	3	17	10	56	2	11	2	11	1	6
4	DPL	2	0	0	1	25	1	25	2	50	0	0

Total Units	Total < 1 Foot Max Resid. Depth	Total < 1 Foot % Occurrence	Total 1< 2 Foot Max Resid. Depth	Total 1< 2 Foot % Occurrence	Total 2< 3 Foot Max Resid. Depth	Total 2< 3 Foot % Occurrence	Total 3< 4 Foot Max Resid. Depth	Total 3< 4 Foot % Occurrence	Total >= 4 Foot Max Resid. Depth	Total >= 4 Foot % Occurrence
214	23	11	118	55	49	23	20	9	4	2

Mean Maximum Residual Pool Depth (ft.): 1.9

**Table 5 - Summary of Mean Percent Cover By Habitat Type**

Stream Name: Redwood Creek

LLID: 1236061394926

Drainage: Rockport

Survey Dates: 7/9/2012 to 7/25/2012

Dry Units: 0

Confluence Location: Quad: SHERWOOD PEAK

Legal Description: T19NR16WS23

Latitude: 39:29:33.0N

Longitude: 123:36:22.0W

Habitat Units	Units Fully Measured	Habitat Type	Mean % Undercut Banks	Mean % SWD	Mean % LWD	Mean % Root Mass	Mean % Terr. Vegetation	Mean % Aquatic Vegetation	Mean % White Water	Mean % Boulders	Mean % Bedrock Ledges
98	17	LGR	0	11	4	0	7	0	0	78	0
43	6	HGR	0	6	2	0	5	0	5	82	0
1	1	CAS	0	10	0	0	0	0	15	75	0
142	24	TOTAL RIFFLE	0	9	3	0	6	0	3	79	0
37	6	RUN	0	18	21	0	0	0	0	61	0
122	15	SRN	4	20	12	0	4	1	1	51	6
159	21	TOTAL FLAT	3	20	14	0	3	1	1	53	4
168	168	MCP	8	23	31	2	2	0	2	27	5
2	2	CCP	20	40	30	0	5	0	0	5	0
11	11	STP	10	20	37	0	0	0	6	21	5
10	10	CRP	34	31	14	0	6	0	0	16	0
1	1	LSBo	0	10	20	0	0	0	0	70	0
18	18	PLP	8	16	40	0	0	0	11	24	1
4	4	DPL	10	18	40	3	13	0	0	15	3
214	214	TOTAL POOL	9	23	32	2	2	0	3	26	4
4	0	NS									
519	259	TOTAL	8	21	28	1	3	0	2	32	4

**Table 6 - Summary of Dominant Substrates By Habitat Type**

Stream Name: Redwood Creek

LLID: 1236061394926

Drainage: Rockport

Survey Dates: 7/9/2012 to 7/25/2012

Dry Units: 0

Confluence Location: Quad: SHERWOOD PEAK

Legal Description: T19NR16WS23

Latitude: 39:29:33.0N

Longitude: 123:36:22.0W

Habitat Units	Units Fully Measured	Habitat Type	% Total Silt/Clay Dominant	% Total Sand Dominant	% Total Gravel Dominant	% Total Small Cobble Dominant	% Total Large Cobble Dominant	% Total Boulder Dominant	% Total Bedrock Dominant
98	17	LGR	0	0	24	41	29	6	0
43	6	HGR	0	0	17	67	0	17	0
1	1	CAS	0	0	0	0	0	100	0
37	6	RUN	17	0	50	33	0	0	0
122	15	SRN	0	0	27	47	13	7	7
168	168	MCP	11	26	25	30	7	1	0
2	2	CCP	0	50	50	0	0	0	0
11	11	STP	9	18	36	18	18	0	0
10	10	CRP	0	10	20	60	10	0	0
1	1	LSBo	0	0	0	100	0	0	0
18	18	PLP	11	22	50	6	11	0	0
4	4	DPL	0	25	25	25	0	25	0

**Table 7 - Summary of Mean Percent Canopy for Entire Stream**

Stream Name: Redwood Creek

LLID: 1236061394926

Drainage: Rockport

Survey Dates: 7/9/2012 to 7/25/2012

Confluence Location: Quad: SHERWOOD PEAK

Legal Description: T19NR16WS23

Latitude: 39:29:33.0N

Longitude: 123:36:22.0W

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Mean Percent Canopy	Mean Percent Conifer	Mean Percent Hardwood	Mean Percent Open Units	Mean Right Bank % Cover	Mean Left Bank % Cover
94	54	46	0	98	98

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Note: Mean percent conifer and hardwood for the entire reach are means of canopy components from units with canopy values greater than zero.

Open units represent habitat units with zero canopy cover.

**Table 8 - Fish Habitat Inventory Data Summary**

Stream Name: Redwood Creek LLID: 1236061394926 Drainage: Rockport  
 Survey Dates: 7/9/2012 to 7/25/2012 Survey Length (ft.): 21205 Main Channel (ft.): 21205 Side Channel (ft.): 0  
 Confluence Location: Quad: SHERWOOD PEAK Legal Description: T19NR16WS23 Latitude: 39:29:33.0N Longitude: 123:36:22.0W

**Summary of Fish Habitat Elements By Stream Reach**

**STREAM REACH: 1**

Channel Type: F4	Canopy Density (%): 94.0	Pools by Stream Length (%): 33.8
Reach Length (ft.): 20875	Coniferous Component (%): 53.0	Pool Frequency (%): 41.2
Riffle/Flatwater Mean Width (ft.): 9.4	Hardwood Component (%): 47.0	Residual Pool Depth (%):
BFW:	Dominant Bank Vegetation: Coniferous Trees	< 2 Feet Deep: 66
Range (ft.): 10 to 30	Vegetative Cover (%): 97.8	2 to 2.9 Feet Deep: 23
Mean (ft.): 20	Dominant Shelter: Boulders	3 to 3.9 Feet Deep: 10
Std. Dev.: 5	Dominant Bank Substrate Type: Sand/Silt/Clay	>= 4 Feet Deep: 2
Base Flow (cfs.): 1.5	Occurrence of LWD (%): 27	Mean Max Residual Pool Depth (ft.): 1.9
Water (F): 54 - 58 Air (F): 56 - 72	LWD per 100 ft.:	Mean Pool Shelter Rating: 34
Dry Channel (ft): 0	Riffles: 6	
	Pools: 11	
	Flat: 4	
Pool Tail Substrate (%): Silt/Clay: 0 Sand: 1 Gravel: 87 Sm Cobble: 8 Lg Cobble: 0 Boulder: 3 Bedrock: 0		
Embeddedness Values (%): 1. 24.6 2. 60.4 3. 12.1 4. 2.4 5. 0.5		

**STREAM REACH: 2**

Channel Type: A6	Canopy Density (%): 95.2	Pools by Stream Length (%): 34.2
Reach Length (ft.): 330	Coniferous Component (%): 78.9	Pool Frequency (%): 41.2
Riffle/Flatwater Mean Width (ft.): 6.6	Hardwood Component (%): 21.1	Residual Pool Depth (%):
BFW:	Dominant Bank Vegetation: Coniferous Trees	< 2 Feet Deep: 71
Range (ft.): 13 to 14	Vegetative Cover (%): 98.9	2 to 2.9 Feet Deep: 29
Mean (ft.): 14	Dominant Shelter: Boulders	3 to 3.9 Feet Deep: 0
Std. Dev.: 0	Dominant Bank Substrate Type: Cobble/Gravel	>= 4 Feet Deep: 0
Base Flow (cfs.): 1.5	Occurrence of LWD (%): 33	Mean Max Residual Pool Depth (ft.): 1.6
Water (F): 54 - 54 Air (F): 62 - 63	LWD per 100 ft.:	Mean Pool Shelter Rating: 41
Dry Channel (ft): 0	Riffles: 12	
	Pools: 24	
	Flat: 9	
Pool Tail Substrate (%): Silt/Clay: 0 Sand: 0 Gravel: 71 Sm Cobble: 14 Lg Cobble: 0 Boulder: 14 Bedrock: 0		
Embeddedness Values (%): 1. 42.9 2. 42.9 3. 14.3 4. 0.0 5. 0.0		

**Table 9 - Mean Percentage of Dominant Substrate and Vegetation**

Stream Name: Redwood Creek

LLID: 1236061394926

Drainage: Rockport

Survey Dates: 7/9/2012 to 7/25/2012

Confluence Location: Quad: SHERWOOD PEAK

Legal Description: T19NR16WS23

Latitude: 39:29:33.0N

Longitude: 123:36:22.0W

**Mean Percentage of Dominant Stream Bank Substrate**

Dominant Class of Substrate	Number of Units Right Bank	Number of Units Left Bank	Total Mean Percent (%)
Bedrock	24	12	6.9
Boulder	12	18	5.8
Cobble / Gravel	114	108	42.9
Sand / Silt / Clay	109	121	44.4

**Mean Percentage of Dominant Stream Bank Vegetation**

Dominant Class of Vegetation	Number of Units Right Bank	Number of Units Left Bank	Total Mean Percent (%)
Grass	0	0	0.0
Brush	0	0	0.0
Hardwood Trees	92	77	32.6
Coniferous Trees	167	182	67.4
No Vegetation	0	0	0.0

**Total Stream Cobble Embeddedness Values:**

2

**Table 10 - Mean Percent of Shelter Cover Types For Entire Stream**

StreamName: Redwood Creek

LLID: 1236061394926

Drainage: Rockport

Survey Dates: 7/9/2012 to 7/25/2012

Confluence Location: Quad: SHERWOOD PEAK

Legal Description: T19NR16WS23

Latitude: 39:29:33.0N

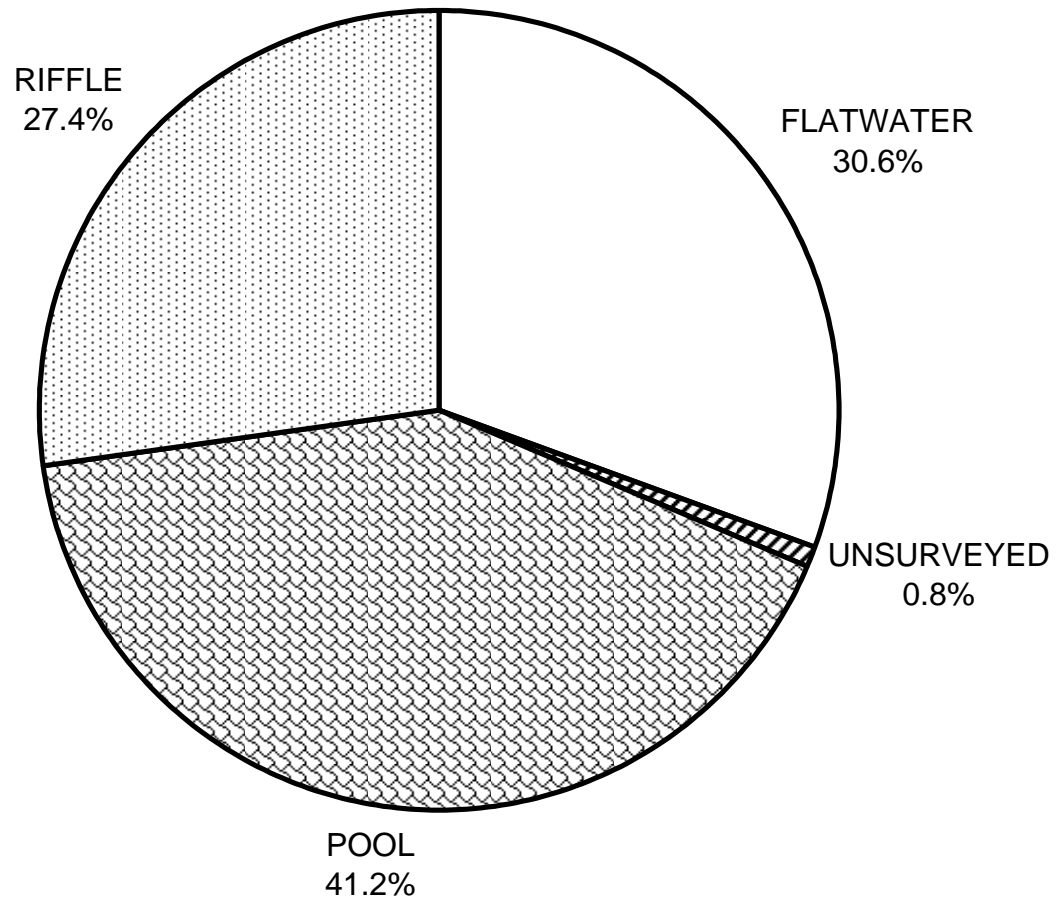
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	<b>Riffles</b>	<b>Flatwater</b>	<b>Pools</b>
UNDERCUT BANKS (%)	0	3	9
SMALL WOODY DEBRIS (%)	9	20	23
LARGE WOODY DEBRIS (%)	3	14	32
ROOT MASS (%)	0	0	2
TERRESTRIAL VEGETATION (%)	6	3	2
AQUATIC VEGETATION (%)	0	1	0
WHITEWATER (%)	3	1	3
BOULDERS (%)	79	53	26
BEDROCK LEDGES (%)	0	4	4

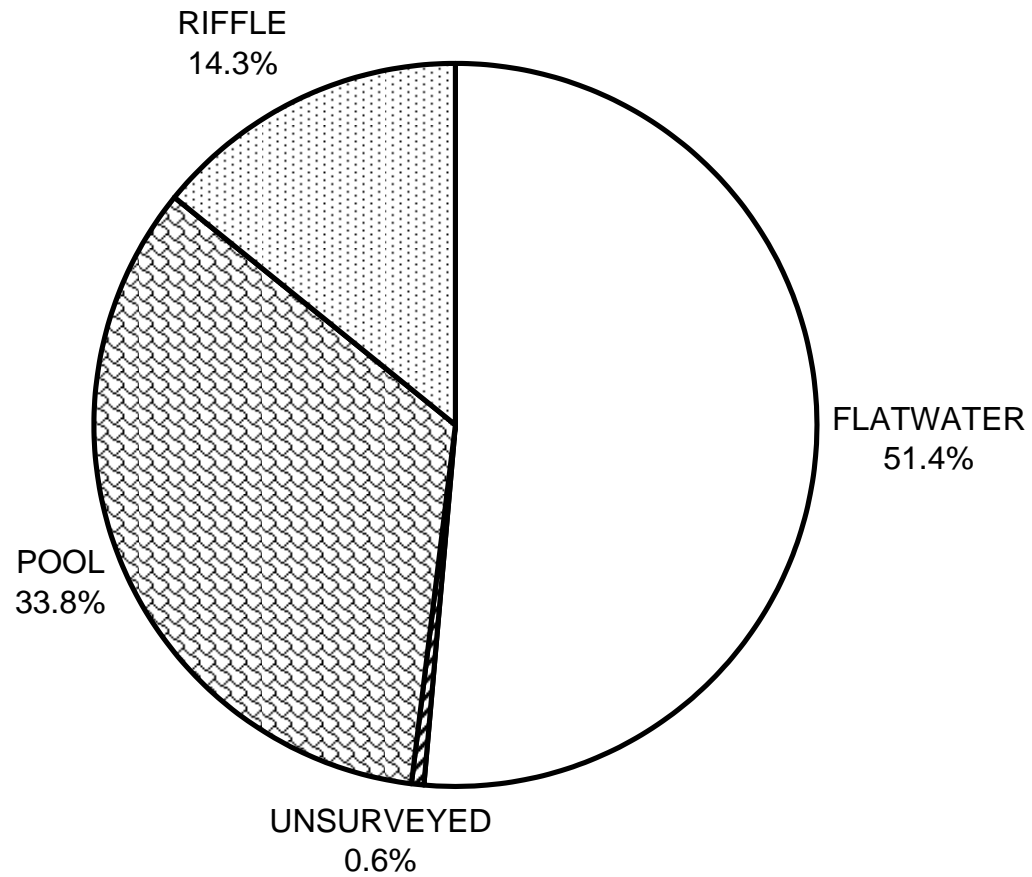


# REDWOOD CREEK 2012 HABITAT TYPES BY PERCENT OCCURRENCE



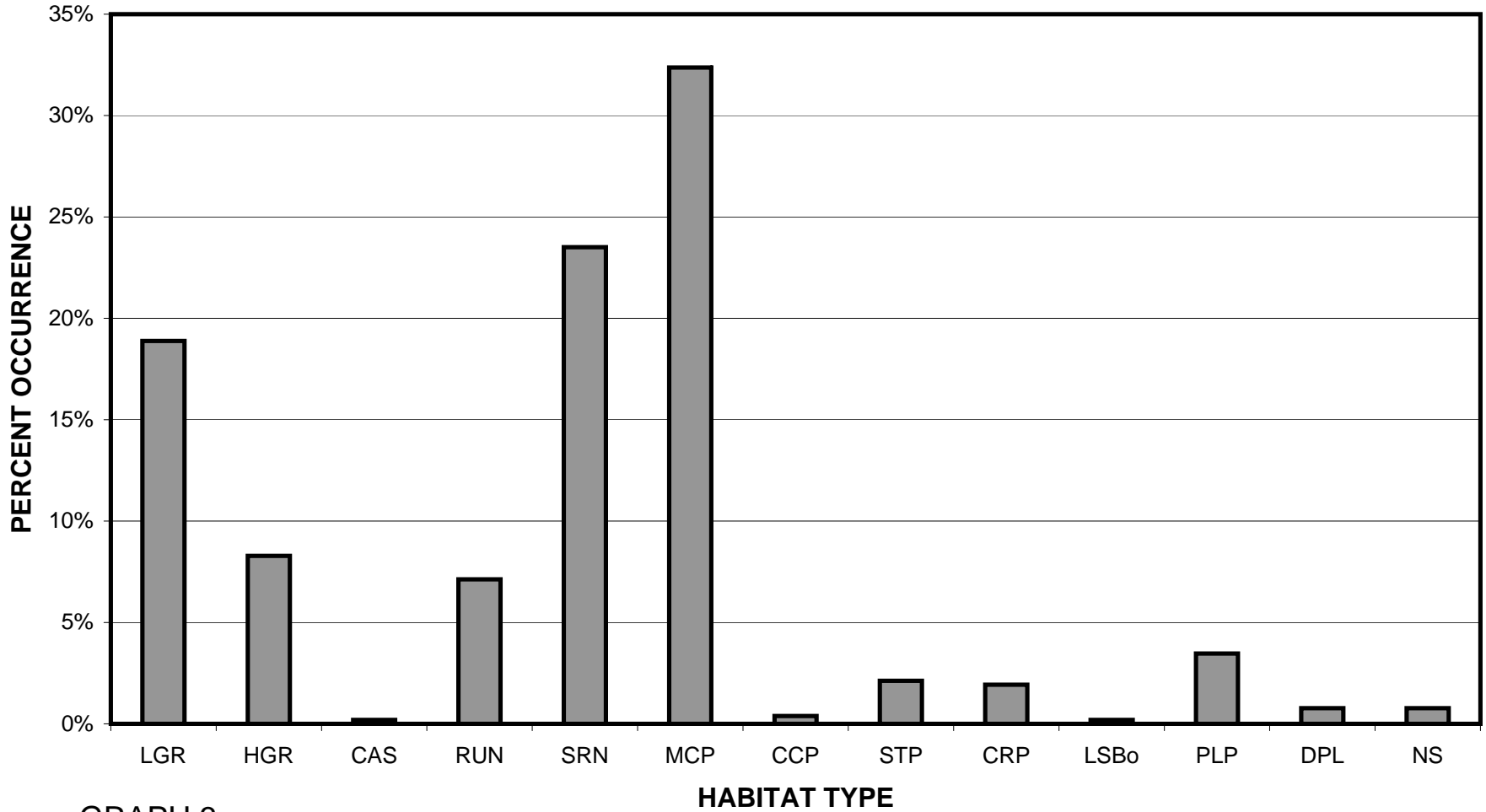
GRAPH 1

# REDWOOD CREEK 2012 HABITAT TYPES BY PERCENT TOTAL LENGTH



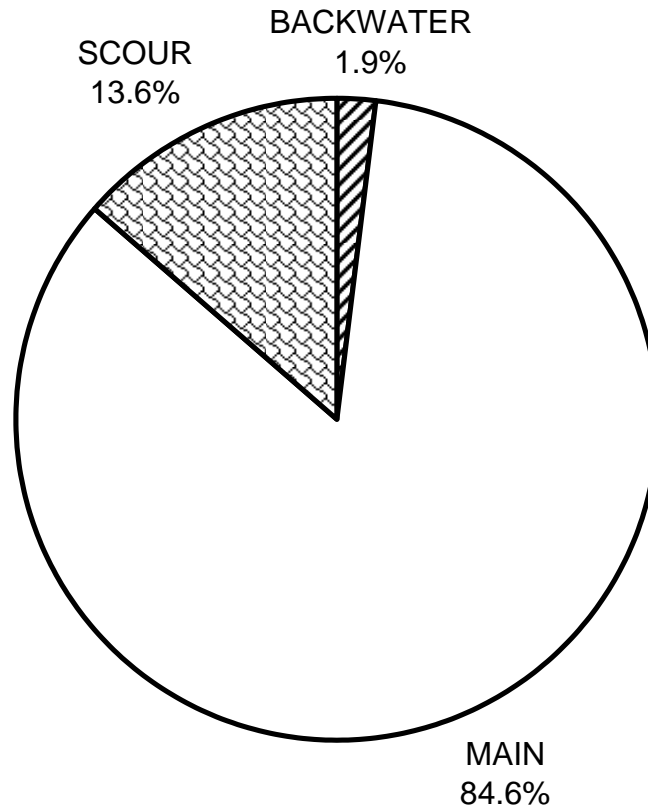
GRAPH 2

# REDWOOD CREEK 2012 HABITAT TYPES BY PERCENT OCCURRENCE



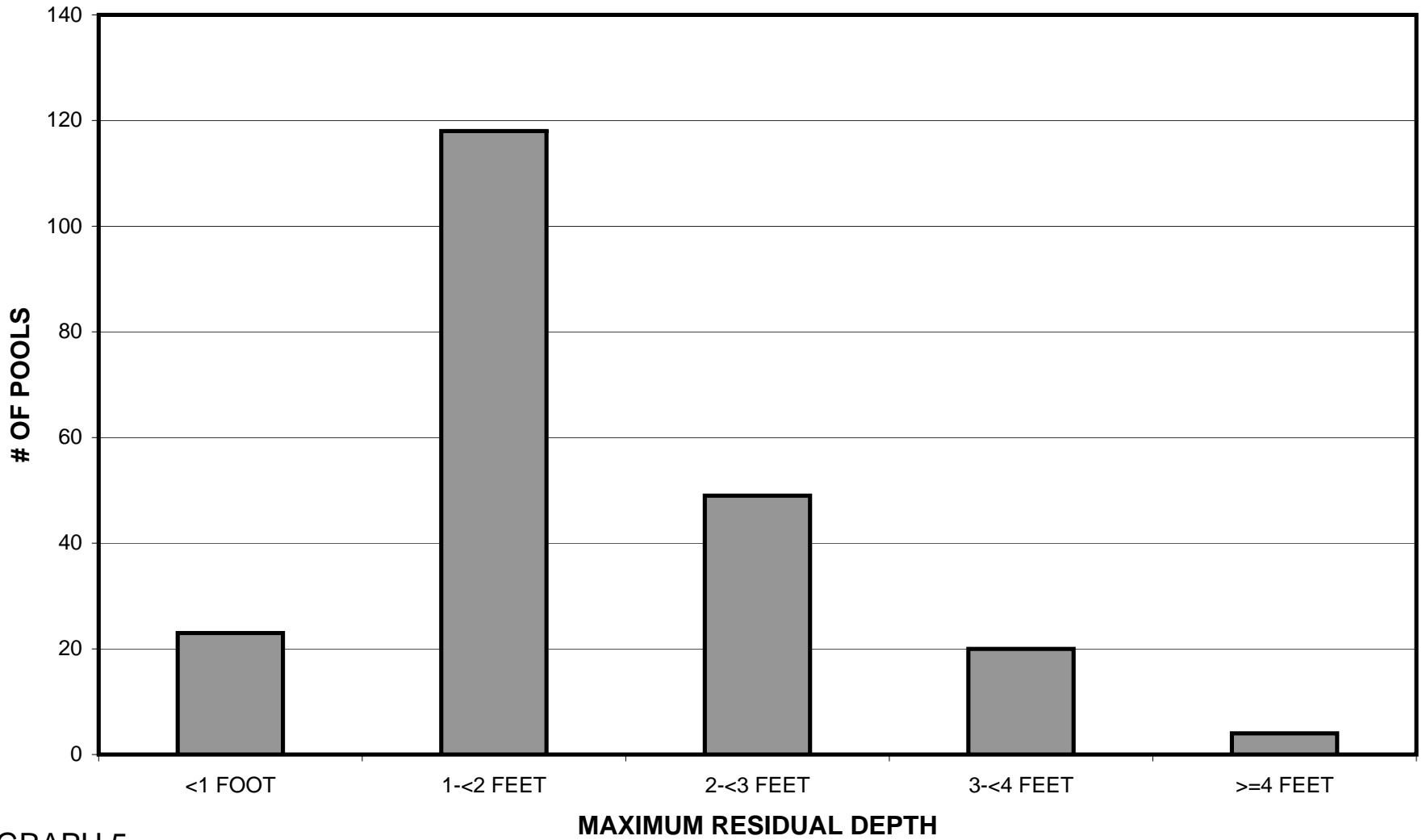
GRAPH 3

# REDWOOD CREEK 2012 POOL TYPES BY PERCENT OCCURRENCE



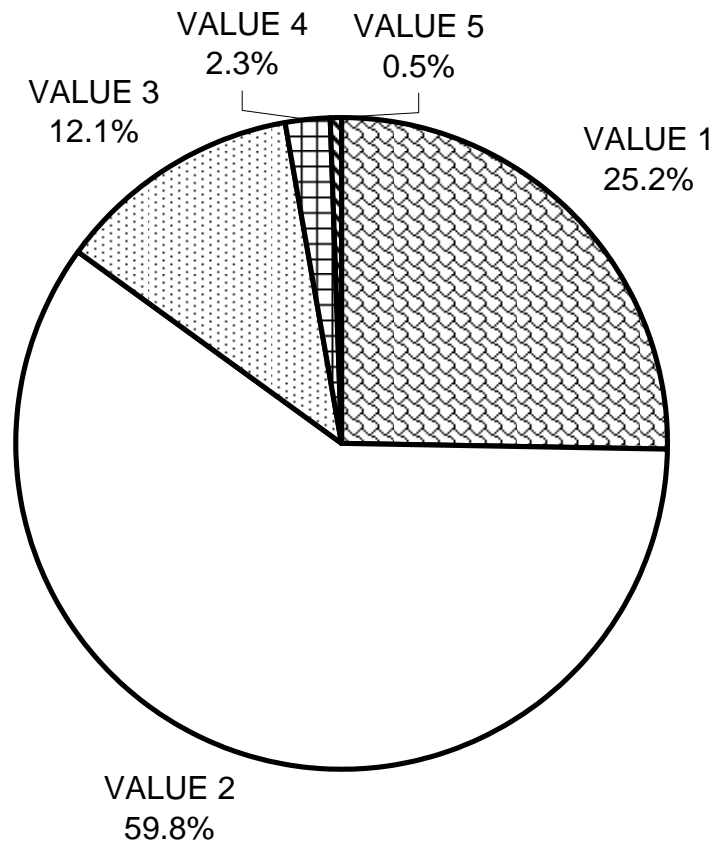
GRAPH 4

# REDWOOD CREEK 2012 MAXIMUM DEPTH IN POOLS



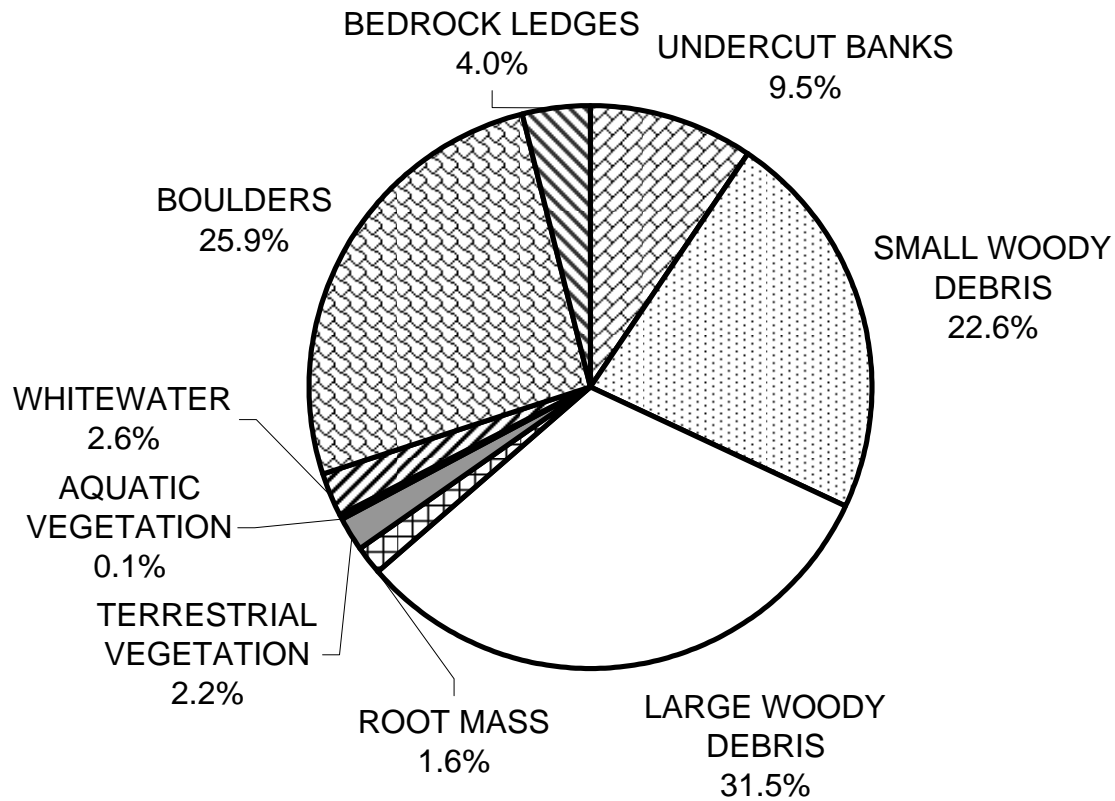
GRAPH 5

# REDWOOD CREEK 2012 PERCENT EMBEDDEDNESS



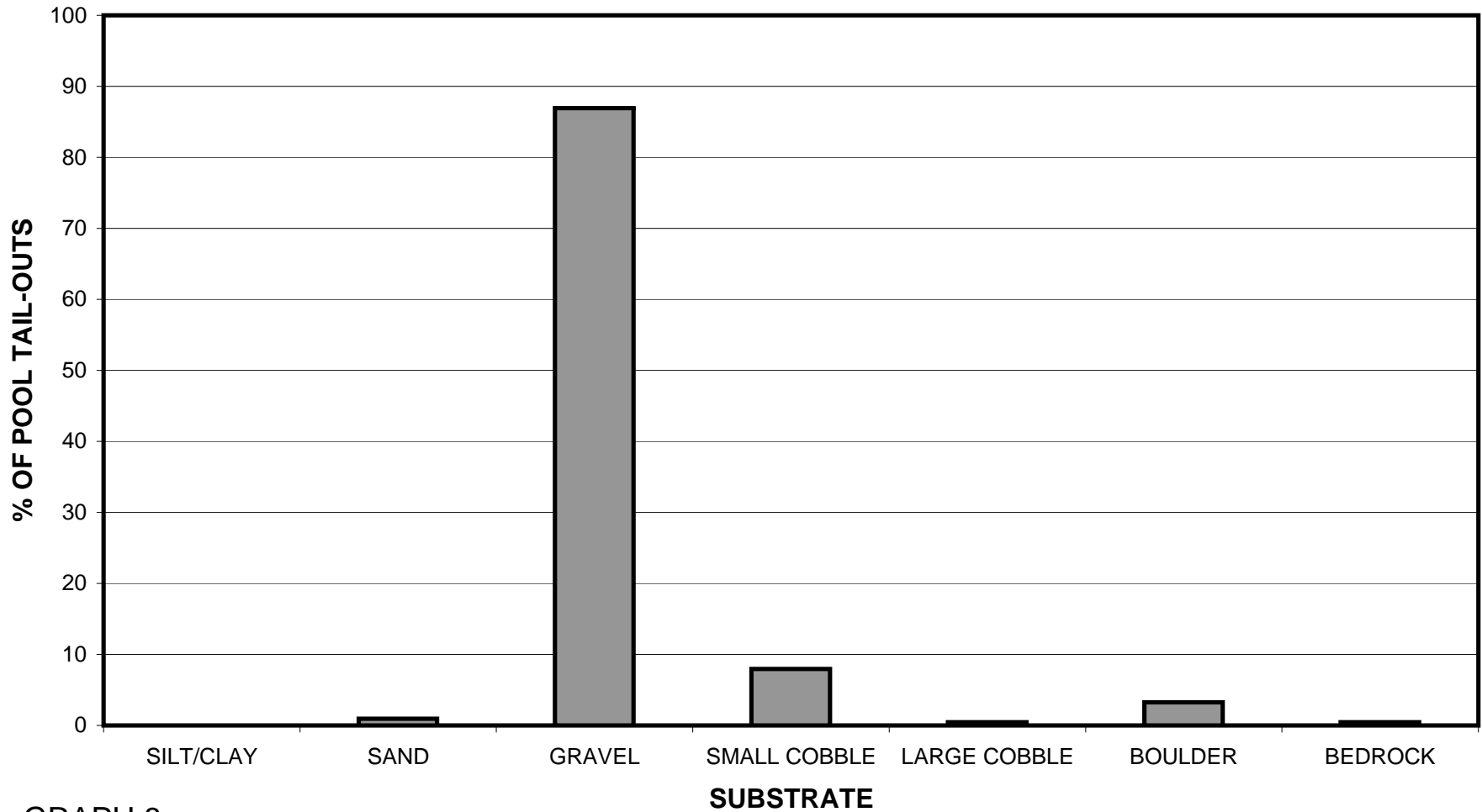
GRAPH 6

# REDWOOD CREEK 2012 MEAN PERCENT COVER TYPES IN POOLS



GRAPH 7

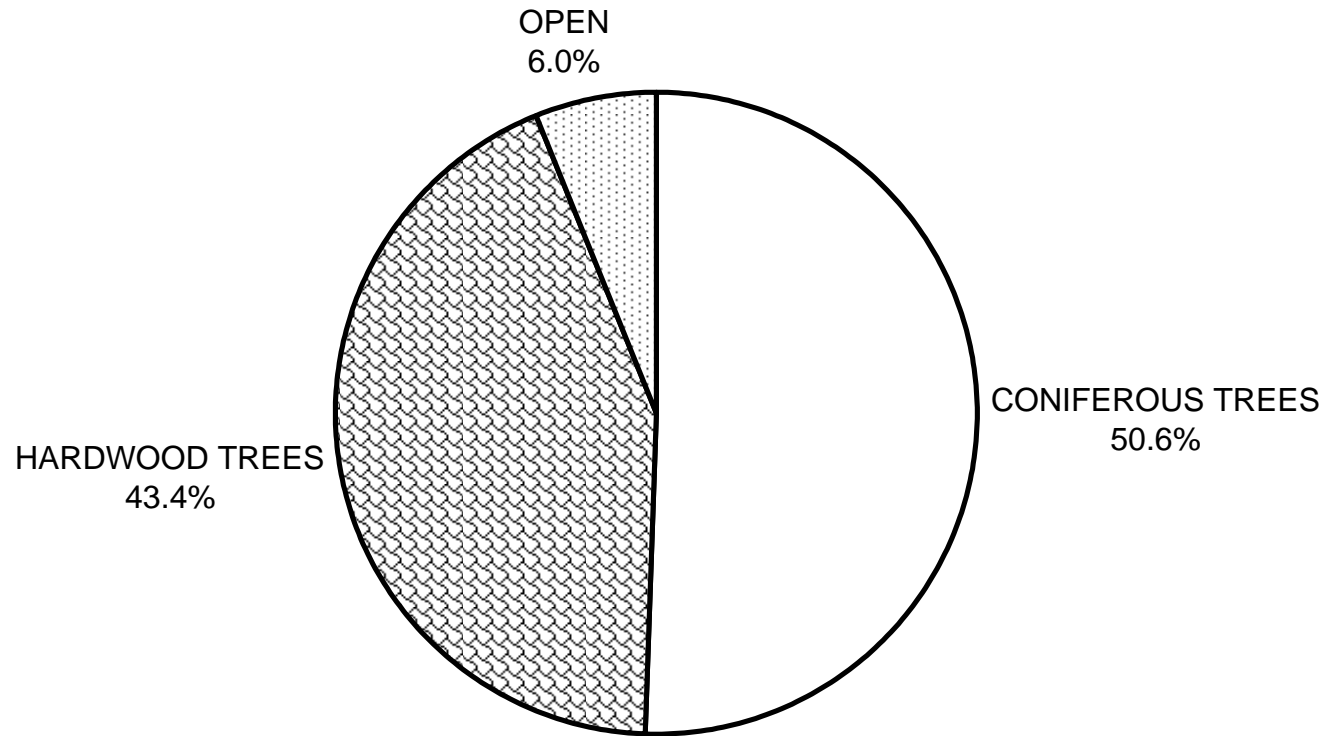
# REDWOOD CREEK 2012 SUBSTRATE COMPOSITION IN POOL TAIL-OUTS



GRAPH 8

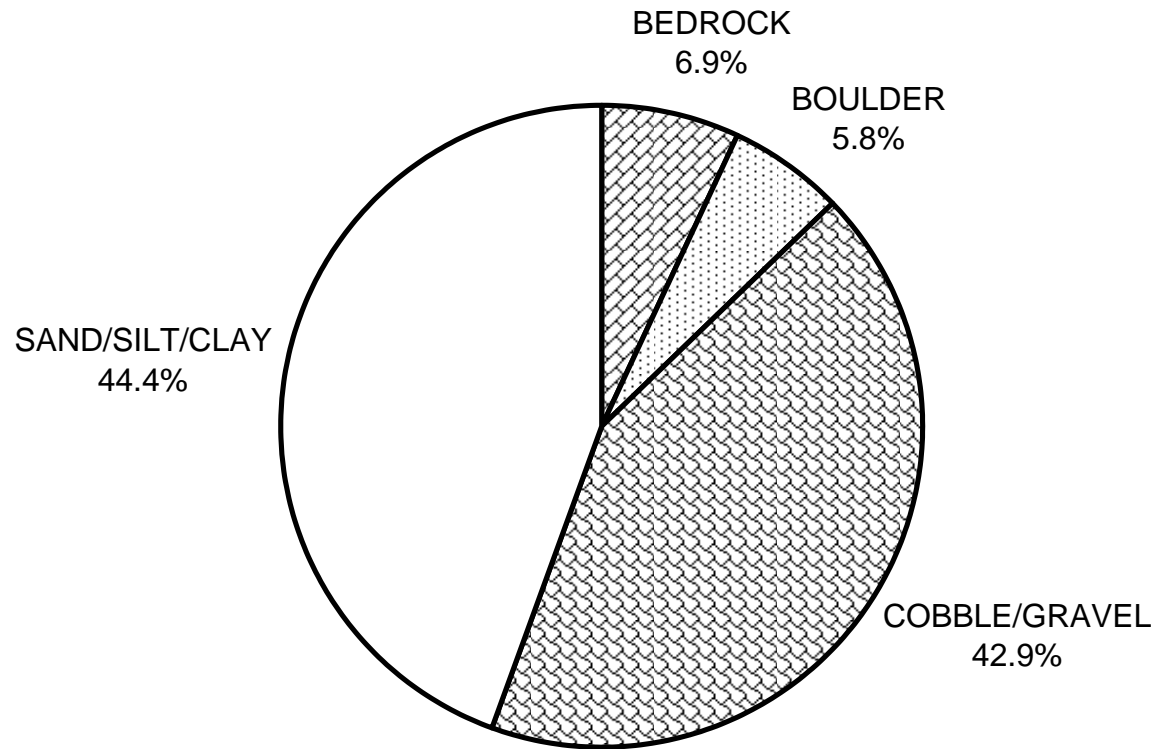


# REDWOOD CREEK 2012 MEAN PERCENT CANOPY



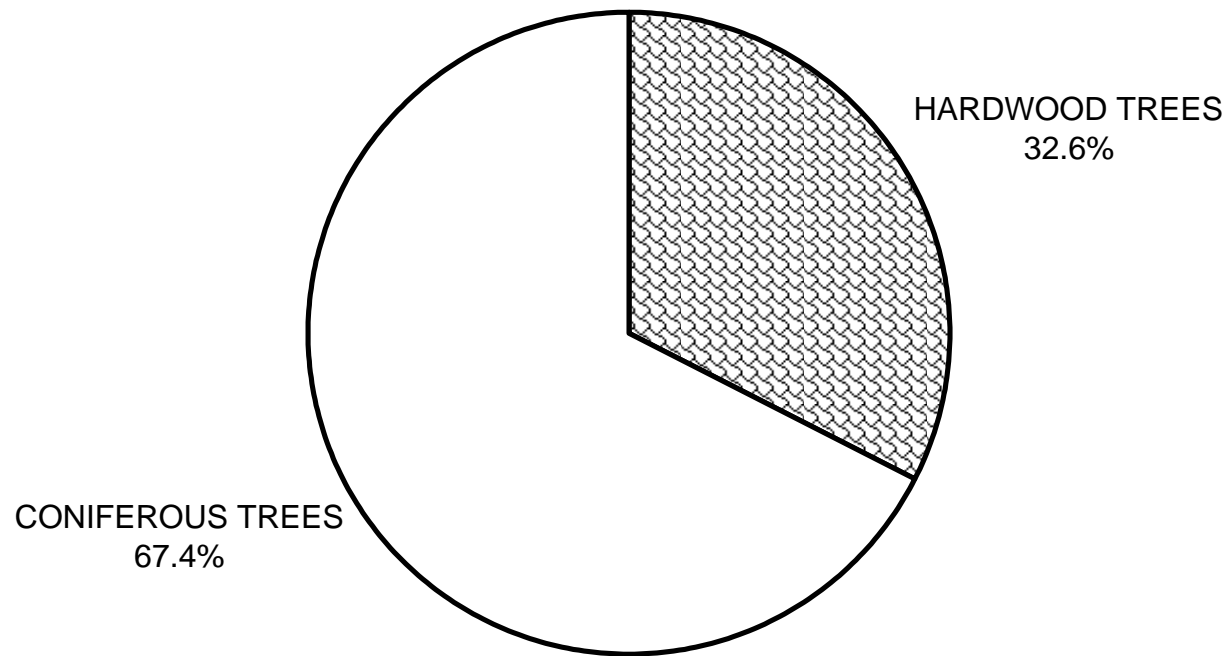
GRAPH 9

# REDWOOD CREEK 2012 DOMINANT BANK COMPOSITION IN SURVEY REACH



GRAPH 10

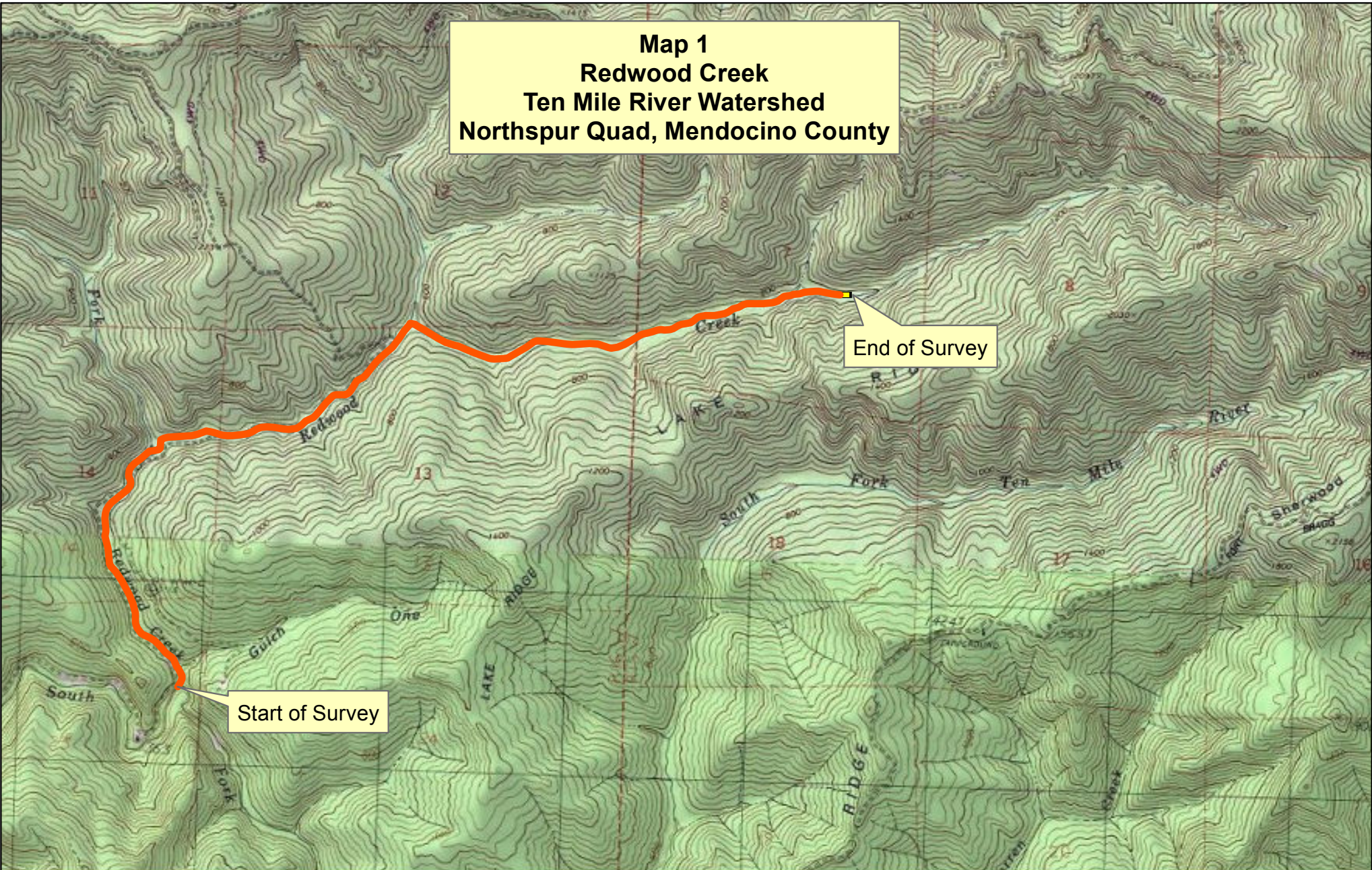
**REDWOOD CREEK 2012  
DOMINANT BANK VEGETATION IN SURVEY REACH**



GRAPH 11





**Map 1**  
**Redwood Creek**  
**Ten Mile River Watershed**  
**Northspur Quad, Mendocino County**



Start of Survey

End of Survey



-  Reach 1, Channel Type F4
-  Reach 2, Channel Type A6

