

Ross Creek



**California Department of Fish and Wildlife  
East Marin County  
San Francisco Bay Watersheds  
Stream Habitat Assessment Reports**

**Ross Creek**

*Surveyed 2009  
Report Completed in 2013*

## Ross Creek

# STREAM INVENTORY REPORT

## Ross Creek

*Survey complete October 2009*

### INTRODUCTION

A stream inventory was conducted during 10/26/2009 to 10/27/2009 on Ross Creek. The survey began at the confluence with Corte Madera Creek and extended upstream 1.6 miles.

The Ross 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 Ross 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 steelhead trout. Recommendations for habitat improvement activities are based upon target habitat values suitable for salmonids in California's north coast streams.

### WATERSHED OVERVIEW

Ross Creek is a tributary to Corte Madera Creek, which is a tributary to Pacific Ocean, located in Marin County, California (Map 1). Ross Creek's legal description at the confluence with Corte Madera Creek is T02N R06W S31. Its location is 37°57'59" north latitude and 122°33'30" west longitude, LLID number 1225583379663. Ross Creek is a third order stream and has approximately 6.8 miles of blue line stream within its catchment boundary according to the USGS National Hydrography Dataset (NHD). Ross Creek drains a watershed of approximately 3.05 square miles. Elevations range from about 30 feet at the mouth of the creek to 2,510 feet in the headwater areas. Mixed hardwood/coniferous forest dominates the watershed. The watershed is primarily owned by local government and land use is considered 90.7% natural and 9.3% low intensity residential. Vehicle access exists via Sir Francis Drake Blvd in the town of Ross.

### METHODS

The habitat inventory conducted in Ross Creek follows the methodology presented in the *California Salmonid Stream Habitat Restoration Manual* (Flosi et al, 1998). The Watershed Stewards Project/AmeriCorps (WSP) Members that conducted the inventory were trained in standardized habitat inventory methods by the California Department of Fish and Wildlife (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 fully measured. All other habitat unit types encountered for the first time in each reach 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 Ross 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". Ross 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

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the cobble that is surrounded or buried by fine sediment. In Ross 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 Ross 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 densimeters as described in the *California Salmonid Stream Habitat Restoration Manual*. Canopy density relates to the amount of stream shaded from the sun. In Ross 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 Ross 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 Ross Creek. In addition, two sites were 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 2.0.18, 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 Ross 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 10/26/2009 to 10/27/2009, was conducted by A. Villalobos and C. Bell (WSP). The total length of the stream surveyed was 8,673 feet.

Stream flow was measured near the bottom of the survey reach with a Marsh-McBirney Model 2000 flowmeter at 0.28 cfs on 10/26/2009

Ross Creek is an F4 channel type for the entire 8,673 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 56 to 60 degrees Fahrenheit. Air temperatures ranged from 51 to 72 degrees Fahrenheit.

Table 1 summarizes the Level II riffle, flatwater, and pool habitat types. Based on frequency of occurrence there were 40% flatwater units, 19% riffle units, 27% pool units, and 14% culvert units (Graph 1). Based on total length of Level II habitat types there were 58% flatwater units, 23% riffle units, 17% pool units, 3% culvert units (Graph 2).

Eleven Level IV habitat types were identified (Table 2). The most frequent habitat types by percent occurrence were 15% Step Run units, 18% Low Gradient Riffle units, 15% Glide units (Graph 3). Based on percent total length of level II habitat types there were 35% Step Run units, 22% Low Gradient Riffle units, and 15% Glide units.

A total of 25 pools were identified (Table 3). Main Channel pools were the most frequently

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encountered, at 52%, and comprised 59% 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. Twenty-three of the 25 pools (92%) had a residual depth of two feet or greater (Graph 5).

The depth of cobble embeddedness was estimated at pool tail-outs. Of the 24 pool tail-outs measured, 4 had a value of 1 (16.7%); 13 had a value of 2 (54.2%); 3 had a value of 3 (12.5%); 4 had a value of 4 (16.7%); (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 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 0, flatwater habitat types had a mean shelter rating of 3, and pool habitats had a mean shelter rating of 11 (Table 1). Of the pool types, the Scour pools had a mean shelter rating of 14, Main Channel pools had a mean shelter rating of 8 (Table 3).

Table 5 summarizes mean percent cover by habitat type. Boulders are the dominant cover types in Ross Creek. Graph 7 describes the pool cover in Ross Creek. Boulders are 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. Gravel dominance was observed in 75% of pool tail-outs, and small cobble dominance was observed in 12% of pool tail-outs.

The mean percent canopy density for the surveyed length of Ross Creek was 76%. The mean percentages of hardwood and coniferous trees were 89% and 11%, respectively. Twenty-four percent of the canopy was open. Graph 9 describes the mean percent canopy in Ross Creek.

For the stream reach surveyed, the mean percent right bank vegetated was 46%. The mean percent left bank vegetated was 51%. The dominant elements composing the structure of the stream banks consisted of 29% bedrock, 4% boulder, 67% sand/silt/clay (Graph 10). Hardwood trees were the dominant vegetation type observed in 46% of the units surveyed. Additionally, 37% of the units surveyed had brush as the dominant vegetation type, and 8% had coniferous trees as the dominant vegetation (Graph 11).

## **BIOLOGICAL INVENTORY RESULTS**

Two sites were electrofished for species composition and distribution in Ross Creek on October 28, 2009. Water temperatures taken during the electrofishing period ranged from 55 to 58 degrees Fahrenheit. Air temperatures ranged from 52 to 64 degrees Fahrenheit. The sites were sampled by C. Bell, T. Macias, A. Villalobos (WSP), as well as D. Acomb and D. Resnik (CDFW).

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The first electrofishing site began at the Phoenix lake dam and extended downstream about 300 feet. This site yielded two young-of-the-year steelhead/rainbow trout (SH/RT), and one age 2+ SH/RT, thirty-six California roach, twenty-four largemouth bass, and one crayfish.

The second electrofishing site extended upstream several hundred feet from the Shady Lane bridge. This site yielded three age 1+ SH/RT, one age 2+ SH/RT, thirty-three California roach, four threespine stickleback, one Sacramento sucker, one sculpin, and one largemouth bass.

The following chart displays the information yielded from these sites:

2009 Ross Creek e-fish observations

Date	Site #	Reference Point	Distance From Reference Point (ft.)	Steelhead/Rainbow Trout			Non Salmonids Name species
				0+	1+	2+	
10/28/2009	751	Phoenix Lake Dam	300	2	0	1	36 California roach, 24 largemouth bass, 1 crayfish

2009 Ross Creek e-fish observations

Date	Site #	Reference Point	Distance From Reference Point (ft.)	Steelhead/Rainbow Trout			Non Salmonids Name species
				0+	1+	2+	
10/28/2009	750	Shady Lane Bridge	0	0	3	1	33 California roach, 4 stickleback, 1 Sacramento sucker, 1 sculpin, 1 largemouth bass



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### DISCUSSION

Ross Creek is an F4 channel type for the entire 8,673 feet of stream surveyed. The suitability of F4 channel types for fish habitat improvement structures is as follows: Bank-placed boulders are good for this channel type. Plunge weirs single and opposing wing deflectors, channel constrictors and log cover are less effective. Boulder clusters are the least effective.

The water temperatures recorded on the survey days 10/26/2009 to 10/27/2009, ranged from 56 to 60 degrees Fahrenheit. Air temperatures ranged from 51 to 72 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 58% of the total length of this survey, riffles 23%, and pools 17%. The pools are relatively deep, with 23 of the 25 (92%) pools having 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 for locations where their installation will not be threatened by high stream energy, or where their installation will not conflict with the modification of any log debris accumulations (LDA's) in the stream.

Seventeen of the 24 pool tail-outs measured had embeddedness ratings of 1 or 2. Seven 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 Ross Creek should be mapped and rated according to their potential sediment yields, and control measures should be taken.

Twenty-one of the 24 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 11. The shelter rating in the flatwater habitats was 3. A pool shelter rating of approximately 100 is desirable. The amount of cover that now exists is being provided primarily by Boulders in Ross Creek. Boulders 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 76%. Reach 1 had a canopy density of 75.6%, Reach 2 had a canopy density of 77.1%. In general, revegetation projects are considered when canopy density is less than 80%.

The percentage of right and left bank covered with vegetation was 46% and 51%, respectively.

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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

Ross 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) Increase woody cover in the pools and flatwater habitat units. Most of the existing cover in the pools is from Boulders. Adding high quality complexity with woody cover in the pools is desirable.
- 2) Increase the canopy on Ross Creek by planting appropriate native vegetation like willow, alder, redwood, and Douglas fir along the stream where shade canopy is not at acceptable levels. The reaches above this survey section should be inventoried and treated as well, since the water flowing here is affected from upstream. In many cases, planting will need to be coordinated to follow bank stabilization or upslope erosion control projects.
- 3) Ross Creek would benefit from utilizing bio-technical vegetative techniques to re-establish floodplain benches and a defined low flow channel. This would discourage lateral migration of the base flow channel and decrease bank erosion.
- 4) Access for migrating salmonids should be assessed at all road crossings and dams. Specific sites of concern include the Norwood Lane and Park Drive Road Bridges located in the town of San Anselmo, California, as well as the In-stream box Culvert located roughly 350ft. upstream of the Park Drive road bridge. A small Dam was surveyed in the middle of Marin County Phoenix Lake Park and the upstream Bill Williams Road/ Phoenix Lake Road Ford crossing should also be assessed for fish passage. All fish passage assessments should be done according to Part 9 of the California Salmonid Stream Habitat Restoration Manual (Flosi et al, 1998). Where needed, crossings should be replaced or modified to improve fish passage.
- 5) 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.
- 6) The limited water temperature data available suggest that maximum temperatures are

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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.

### 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 Corte Madera Creek and Ross Creek.
669	0008.00	Bridge #1 is on Shady Lane, which is a county road. The bridge length is 28 ft, the height is 10 ft, and the width is 20 ft. The bridge is made of concrete and was not retaining gravel, nor was it down cutting. The bridge is not likely a barrier to salmonids.
1,727	0017.00	Bridge #2 is on Norwood Lane, which is a county road. The bridge length is 24 ft, the height is 15 ft, and the width is 24 ft. The bridge is made of concrete and was not retaining gravel, nor was it down cutting. The bridge is not likely a barrier to salmonids.
3,683	0037.00	Bridge #3 is on Park Drive, which is a county road. The bridge length is 21 ft, the height is 14 ft, and the width is 16 ft. The height from the water to the sill is 0.2 ft. The bridge is made of concrete and was not retaining gravel, nor was it down cutting. The bridge is a possible barrier to salmonids.
3,931	0041.00	There was a possible steelhead/rainbow trout (SH/RT) observed.
4,030	0043.00	Culvert #1 is a single concrete box culvert, on a private road. Its condition is good. The culvert height is 8 ft, the width is 12 ft, the length is 72 ft, and the plunge height is 0 ft. The maximum depth within 5 feet of outlet is 2.5 ft. The culvert slope is estimated to be less than 2%. The culvert is a possible barrier to juvenile and adult salmonids.
4,195	0046.00	Bridge #4 is on a private road (the name is unknown). The bridge length is 10 ft, the height is 11 ft, and the width is 17 ft. The bridge is made of wood and was not retaining gravel, nor was it down cutting. The bridge is not likely a barrier to salmonids.
4,748	0049.00	Bridge #5 is on Glenwood Drive, which is a county road. The bridge length is 23 ft, the height is 13 ft, and the width is 35 ft. The bridge is made of concrete and was not retaining gravel, nor was it down cutting. The bridge is not likely a barrier to salmonids.
4771	0050.00	There was one unidentified fish observed.

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Position (ft.)	Habitat Unit #	Comments
5,265	0055.00	Bridge #6 is a private footbridge. The bridge length is 5 ft, the height is 11 ft, and the width 25 ft. The bridge is made of wood and was not retaining gravel, nor was it down cutting. The bridge is not likely a barrier to salmonids.
5,656	0058.00	One SH/RT young-of-the-year was observed.
6,850	0068.00	One unidentified fish observed.
7,280	0071.00	Bridge #7 is a footbridge to a trail on the Open Space District. The bridge length is 17 ft, the height is 11 ft, and the width is 27 ft. The bridge is made of steel and was not retaining gravel, nor was it down cutting. The bridge is not likely a barrier to salmonids.
7,432	0074.00	Bridge #8 is a footbridge to the trail on the Open Space District. The bridge length is 14 ft, the height is 8 ft, and the width is 11 ft. The bridge is made of wood and was not retaining gravel, nor was it down cutting. The bridge is not likely a barrier to salmonids.
7,688	0078.00	Bridge #9 is a footbridge to the trail on the Open Space District. The bridge length is 9 ft, the height is 4 ft, and the width is 21 ft. The bridge is made of wood and was not retaining gravel, nor was it down cutting. The bridge is not likely a barrier to salmonids.
7,697	0079.00	Dam #1 is a flashboard dam. The dam length is 2 ft, the height is 2 ft, the entire width is 21 ft, and the flashboard width is 8 ft. The dam is not retaining gravel, nor is it down cutting. It is not likely a barrier to fish.
7,699	0080.00	Tributary #1 on the left bank has an estimated discharge less than 1 cfs. It is estimated to contribute 10% of flow to the stream. The water temperature downstream is 56F, the water temperature upstream is 57F, and the tributary temperature is 55F. It is accessible to fish (determined by checking 100 ft up the tributary). The estimated slope less than 5% and there were no fish observed.
7,829	0082.00	Bridge #10 is a footbridge to the trail on the Marin Open Space District. The bridge length is 5 ft, the height is 7 ft, and the width is 22 ft. The bridge is made of wood and was not retaining gravel, nor was it down cutting. The bridge is not likely a barrier to salmonids.
7,869	0084.00	One unidentified fish was observed.
8,398	0090.00	Bridge #11 is a ford crossing with a length of 15 ft, a height of 0 ft, and a width of 30 ft. The bridge was not retaining gravel, nor was it down cutting. The bridge is not likely a barrier to fish.
8,656	0093.00	One SH/RT was observed.
8,673	0093.00	End of the survey at the Phoenix Dam (end of anadromous fish passage upstream).

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### 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.

McCain, M., D. Fuller, L. Decker and K. Overton. 1990. Stream habitat classification and inventory procedures for northern California. FHC Currents. No.1. U.S. Department of Agriculture. Forest Service, Pacific Southwest Region.

Rosgen, D.L., 1994. A Classification of Natural Rivers. *Catena*, Vol 22: 169-199, Elsevier Science, B. V. Amsterdam.

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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

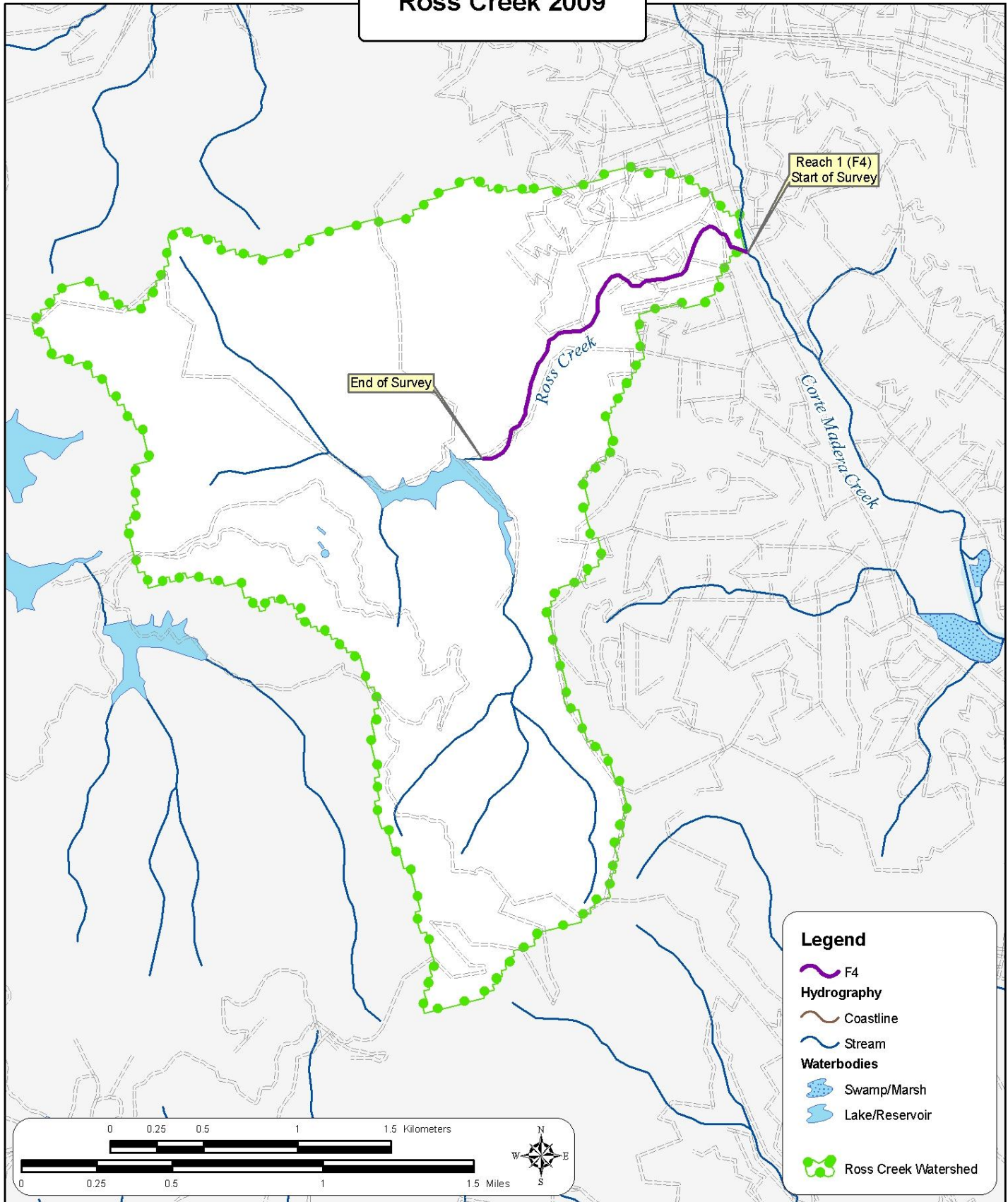
Secondary Channel Pool	(SCP)	[6.1]	{ 4 }
Backwater Pool - Boulder Formed	(BPB)	[6.2]	{ 5 }
Backwater Pool - Root Wad Formed	(BPR)	[6.3]	{ 6 }
Backwater Pool - Log Formed	(BPL)	[6.4]	{ 7 }
Dammed Pool	(DPL)	[6.5]	{13}

#### 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]	

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

Stream Name:		Ross Creek										LLID:		1225583379663				Drainage:		San Rafael															
Survey		10/26/2009 to 10/27/2009										Confluence Location:		Quad: SAN RAFAEL				Legal Description:		T02NR06WS31				Latitude:		37:57:59.0N				Longitude:		122:33:30.0W			
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																				
13	0	CULVERT	14.0	19	245	2.8																													
37	37	FLATWATER	39.8	135	5007	57.7	8.2	0.6	1.3	1069	39547	726	26871		3																				
25	25	POOL	26.9	59	1467	16.9	12.4	1.5	3.3	773	19319	1300	32512	1183	11																				
18	18	RIFFLE	19.4	109	1954	22.5	10.9	0.3	0.6	1059	19054	331	5962		0																				
Total Units	Total Units Fully Measured				Total Length (ft.)						Total Area (sq.ft.)		Total Volume (cu.ft.)																						
93	80				8673						77920		65345																						



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

**Stream Name:** Ross Creek

**LLID:** 1225583379663

**Drainage:** San Rafael

**Survey** 10/26/2009 to 10/27/2009

**Confluence Location: Quad:** SAN RAFAEL

**Legal Description:** T02NR06WS31

**Latitude:** 37:57:59.0N

**Longitude:** 122:33:30.0W

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	Mean Canopy (%)
17	17	LGR	18.3	113	1915	22.1	11.0	0.3	1.1	1086	18469	347	5904		0	70
1	1	BRS	1.1	39	39	0.4	15.0	0.1	0.1	585	585	59	59		0	58
14	14	GLD	15.1	93	1308	15.1	9.0	0.8	3.0	801	11216	615	8611		3	76
9	9	RUN	9.7	78	699	8.1	7.0	0.4	1.5	616	5544	273	2456		5	85
14	14	SRN	15.1	214	3000	34.6	8.0	0.6	2.0	1628	22787	1129	15804		2	89
12	12	MCP	12.9	62	747	8.6	14.0	1.2	3.9	909	10909	1432	17184	1304	9	77
1	1	STP	1.1	119	119	1.4	15.0	1.8	4.4	1785	1785	3570	3570	3213	5	22
6	6	CRP	6.5	58	351	4.0	11.0	1.6	3.9	633	3795	1183	7101	1104	11	92
3	3	LSR	3.2	45	135	1.6	10.0	1.0	2.9	444	1332	500	1499	442	18	71
3	3	PLP	3.2	38	115	1.3	13.0	2.5	9.8	499	1498	1053	3158	922	17	60
13	0	CUL	14.0	19	245	2.8										
<b>Total Units</b>	<b>Total Units Fully Measured</b>				<b>Total Length (ft.)</b>						<b>Total Area (sq.ft.)</b>		<b>Total Volume</b>			
93	80				8673						77920		65345			

**Ross Creek**

**Table 3 - Summary of Pool Habitat Types**

**Stream Name:** Ross Creek

**LLID:** 1225583379663

**Drainage:** San Rafael

**Survey** 10/26/2009 to 10/27/2009

**Confluence Location: Quad:** SAN RAFAEL

**Legal Description:** T02NR06WS31

**Latitude:** 37:57:59.0N

**Longitude:** 122:33:30.0W

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
13	13	MAIN	52	67	866	59	13.6	1.3	976	12694	1450	18856	8
12	12	SCOUR	48	50	601	41	11.1	1.7	552	6625	893	10714	14
Total Units	Total Units Fully Measured				Total Length (ft.)					Total Area (sq.ft.)		Total Volume (cu.ft.)	
25	25				1467					19319		29570	

**Ross Creek**

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

**Stream Name:** Ross Creek

**LLID:** 1225583379663

**Drainage:** San Rafael

**Survey:** 10/26/2009 to 10/27/2009

**Confluence Location: Quad:** SAN RAFAEL

**Legal Description:** T02NR06WS31

**Latitude:** 37:57:59.0N

**Longitude:** 122:33:30.0W

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
12	MCP	48	0	0	2	17	6	50	4	33	0	0
1	STP	4	0	0	0	0	0	0	0	0	1	100
6	CRP	24	0	0	0	0	2	33	4	67	0	0
3	LSR	12	0	0	0	0	3	100	0	0	0	0
3	PLP	12	0	0	0	0	1	33	1	33	1	33
<b>Total Units</b>			<b>Total &lt; 1 Foot Max Resid. Depth</b>	<b>Total &lt; 1 Foot % Occurrence</b>	<b>Total 1 &lt; 2 Feet Max Resid. Depth</b>	<b>Total 1 &lt; 2 Feet % Occurrence</b>	<b>Total 2 &lt; 3 Feet Max Resid. Depth</b>	<b>Total 2 &lt; 3 Feet % Occurrence</b>	<b>Total 3 &lt; 4 Feet Max Resid. Depth</b>	<b>Total 3 &lt; 4 Feet % Occurrence</b>	<b>Total &gt;= 4 Feet Max Resid. Depth</b>	<b>Total &gt;= 4 Feet % Occurrence</b>
25			0	0	2	8	12	48	9	36	2	8

Mean Maximum Residual Pool Depth (ft.): 3

**Ross Creek**

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

**Stream Name:** Ross Creek

**Dry Units:**

**LLID:** 1225583379663

**Drainage:** San Rafael

**Survey** 10/26/2009 to 10/27/2009

**Confluence Location: Quad:** SAN RAFAEL

**Legal Description:** T02NR06WS31

**Latitude:** 37:57:59.0N

**Longitude:** 122:33:30.0W

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
17	8	LGR	0	0	0	0	0	0	0	0	0
1	1	BRS	0	0	0	0	0	0	0	0	0
18	9	TOTAL RIFFLE	0	0	0	0	0	0	0	0	0
14	6	GLD	0	0	5	5	0	0	0	23	0
9	2	RUN	0	0	0	0	0	0	0	50	0
14	6	SRN	10	2	0	3	0	0	0	2	0
37	14	TOTAL FLAT	4	1	2	4	0	0	0	18	0
12	12	MCP	0	19	0	12	0	0	0	44	0
1	1	STP	0	0	0	0	0	0	10	90	0
6	6	CRP	23	7	0	18	35	0	0	17	0
3	3	LSR	13	3	0	17	67	0	0	0	0
3	3	PLP	0	0	0	0	33	0	0	67	0
25	25	TOTAL POOL	7	11	0	12	20	0	0	37	0
13	0	CUL									
93	48	TOTAL	5	6	1	7	11	0	0	24	0

**Ross Creek**

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

**Stream Name:** Ross Creek

**Dry Units:**

**LLID:** 1225583379663

**Drainage:** San Rafael

**Survey** 10/26/2009 to 10/27/2009

**Confluence Location:** Quad: SAN RAFAEL **Legal Description:** T02NR06WS31 **Latitude:** 37:57:59.0N **Longitude:** 122:33:30.0W

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
17	6	LGR	0	0	67	33	0	0	0
1	1	BRS	0	0	0	0	0	0	100
14	6	GLD	0	0	67	17	0	0	17
9	2	RUN	0	0	100	0	0	0	0
14	5	SRN	0	0	100	0	0	0	0
12	12	MCP	8	25	50	8	0	8	0
1	1	STP	0	0	100	0	0	0	0
6	6	CRP	0	0	83	17	0	0	0
3	3	LSR	0	0	100	0	0	0	0
3	3	PLP	0	33	0	0	0	33	33
13	0	CUL	0	0	0	0	0	0	0

## Ross Creek

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

**Stream Name:** Ross Creek

**LLID:** 1225583379663

**Drainage:** San Rafael

**Survey** 10/26/2009 to 10/27/2009

**Confluence Location: Quad:** SAN RAFAEL

**Legal Description:** T02NR06WS31

**Latitude:** 37:57:59.0N

**Longitude:** 122:33:30.0W

Mean Percent Canopy	Mean Percent Conifer	Mean Percent Hardwood	Mean Percent Open Units	Mean Right Bank % Cover	Mean Left Bank % Cover
76	11	89	0	46	51

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.

# Ross Creek

## Table 8 - Fish Habitat Inventory Data Summary

Stream: Ross Creek      LLID: 1225584379662      Drainage: San Rafael  
Survey Dates: 10/26/2009 to 10/27/2009      Survey Length (ft.): 8673      Main Channel (ft.): 8673      Side Channel (ft.): 0  
Confluence Location: Quad SAN RAFAEL      Legal Description: T02NR06WS31      Latitude: 37:57:58.2N      Longitude: 122:33:30.0W

### Summary of Fish Habitat Elements By Stream Reach

#### STREAM REACH: 1

Channel Type: F4	Canopy Density (%): 75.8	Pools by Stream Length: 16.9
Reach Length (ft.): 8673	Coniferous Component (%): 10.6	Pool Frequency (%): 26.9
Riffle/Flatwater Mean Width (ft.): 9.1	Hardwood Component: 89.4	Residual Pool Depth (%):
BFW:	Dominant Bank: Hardwood Trees	< 2 Feet Deep: 8.0
Range (ft.): 10.00 to 40.00	Vegetative Cover (%): 48.7	2 to 2.9 Feet Deep: 48.0
Mean (ft.): 20.60	Dominant: Boulders	3 to 3.9 Feet Deep: 36.0
Std. Dev.: 8.12	Dominant Bank Substrate: Sand/Silt/Clay	>= 4 Feet Deep: 8.0
Base Flow (cfs): 0.28	Occurrence of LWD (%): 0.6	Mean Max Residual Pool Depth: 3.276
Water (F): 56 - 60    Air (F): 51 - 72	LWD per 100 ft.:	Mean Pool Shelter: 11
Dry Channel (ft.): 0	Riffles: 0	
	Pools: 0	
	Flat: 0	
Pool Tail Substrate (%): Silt/Clay: 0.0    Sand: 8.3    Gravel: 75.0    Sm Cobble: 12.5    Lg Cobble: 0.0    Boulder: 0.0    Bedrock: 4.2		
Embeddedness Values (%):    1. 16.7    2. 54.2    3. 12.5    4. 16.7    5. 0.0		

## Ross Creek

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

**Stream Name:** Ross Creek **LLID:** 1225583379663 **Drainage:** San Rafael  
**Survey** 10/26/2009 to 10/27/2009  
**Confluence Location: Quad:** SAN RAFAEL **Legal Description:** T02NR06WS31 **Latitude:** 37:57:59.0N **Longitude:** 122:33:30.0W

#### Mean Percentage of Dominant Stream Bank Substrate

Dominant Class of Substrate	Number of Units Right Bank	Number of Units Left Bank	Total Mean Percentage (%)
Bedrock	12	10	28.9
Boulder	2	1	3.9
Cobble/Gravel	0	0	0.0
Sand/Silt/Clay	24	27	67.1

#### Mean Percentage of Dominant Stream Bank Vegetation

Dominant Class of Vegetation	Number of Units Right Bank	Number of Units Left Bank	Total Mean Percentage
Grass	1	1	2.6
Brush	15	13	36.8
Hardwood	17	18	46.1
Coniferous	3	3	7.9
No Vegetation	2	3	6.6

**Total Stream Cobble Embeddedness Values:** 2



**Ross Creek**

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

**Stream Name:** Ross Creek

**LLID:** 1225583379663

**Drainage:** San Rafael

**Survey** 10/26/2009 to 10/27/2009

**Confluence Location: Quad:** SAN RAFAEL

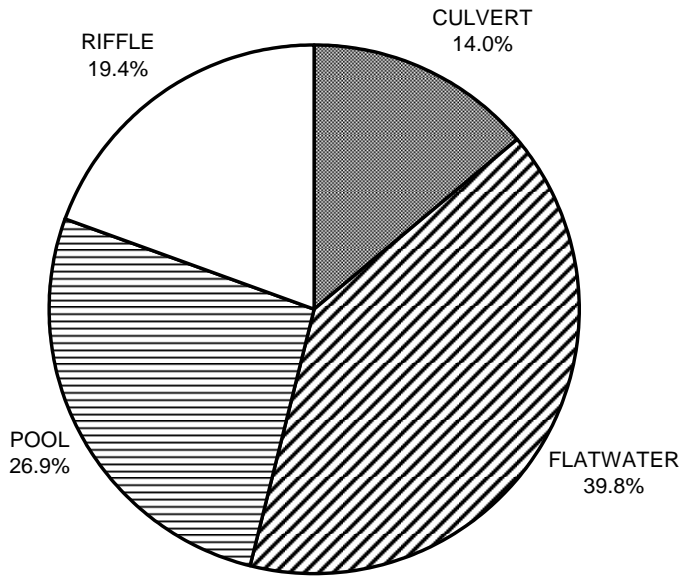
**Legal Description:** T02NR06WS31

**Latitude:** 37:57:59.0N

**Longitude:** 122:33:30.0W

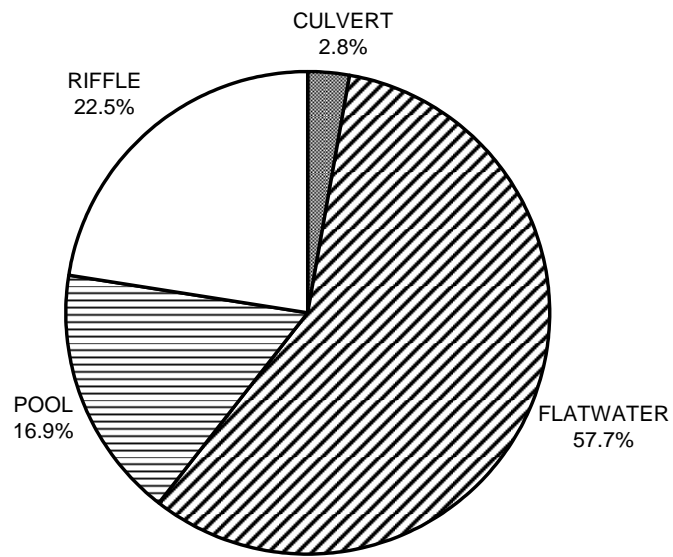
	<b>Riffles</b>	<b>Flatwater</b>	<b>Pools</b>
UNDERCUT BANKS (%)	0	4	7
SMALL WOODY DEBRIS (%)	0	1	11
LARGE WOODY DEBRIS (%)	0	2	0
ROOT MASS (%)	0	4	12
TERRESTRIAL VEGETATION	0	0	20
AQUATIC VEGETATION (%)	0	0	0
WHITEWATER (%)	0	0	0
BOULDERS (%)	0	18	37
BEDROCK LEDGES (%)	0	0	0

**ROSS CREEK 2009  
HABITAT TYPES BY PERCENT OCCURRENCE**



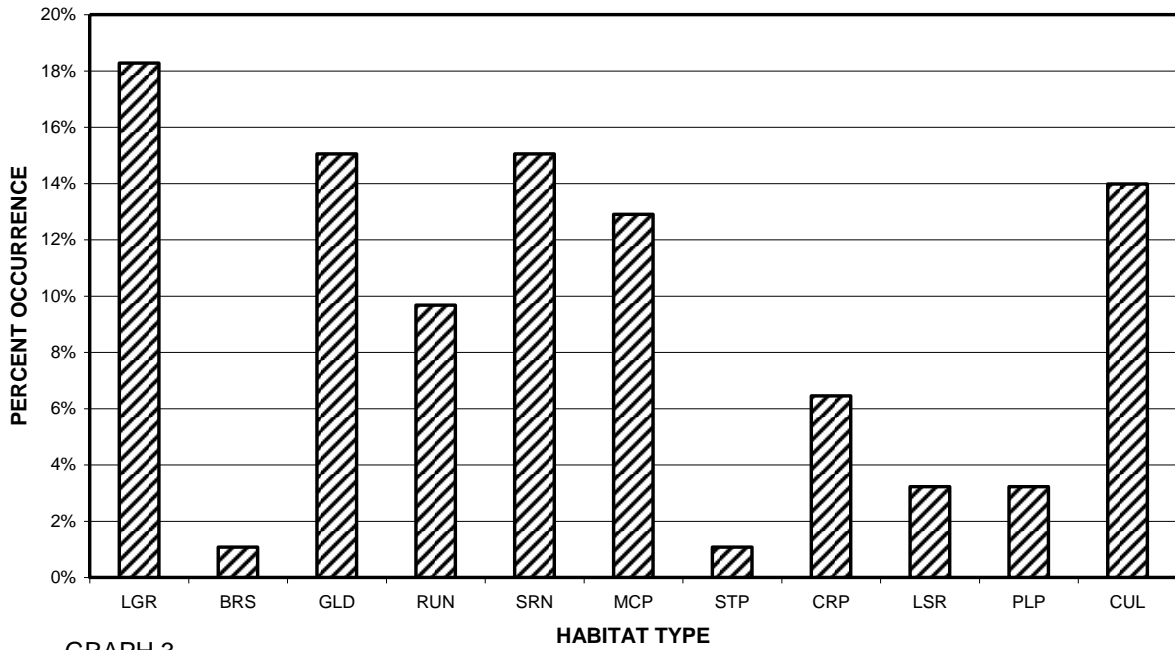
GRAPH 1

**ROSS CREEK 2009  
HABITAT TYPES BY PERCENT TOTAL LENGTH**



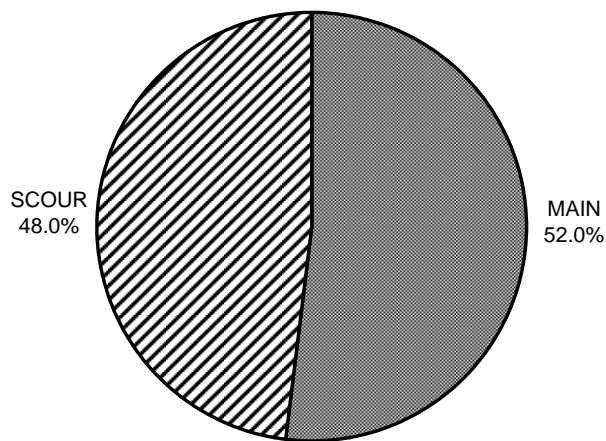
GRAPH 2

### ROSS CREEK 2009 HABITAT TYPES BY PERCENT OCCURRENCE



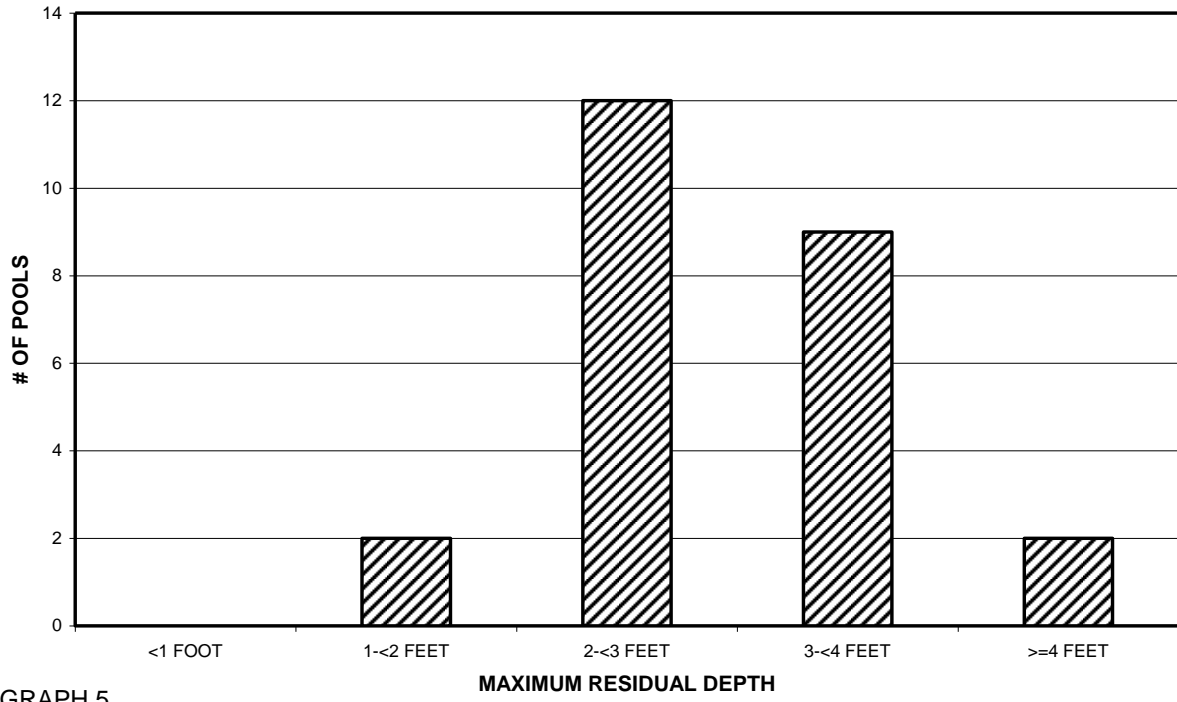
GRAPH 3

### ROSS CREEK 2009 POOL TYPES BY PERCENT OCCURRENCE



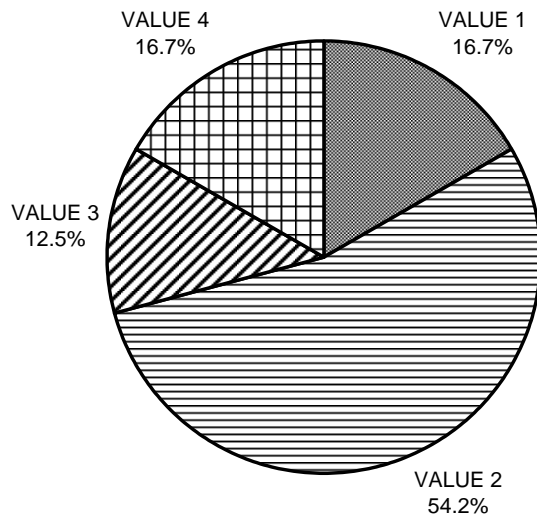
GRAPH 4

**ROSS CREEK 2009  
MAXIMUM DEPTH IN POOLS**



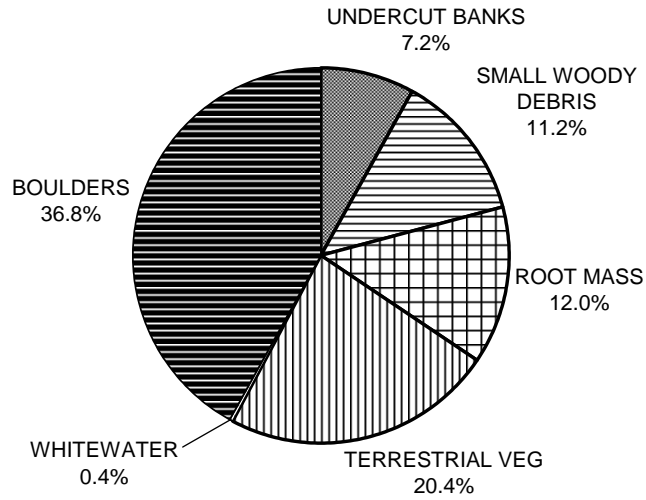
GRAPH 5

**ROSS CREEK 2009  
PERCENT EMBEDDEDNESS**



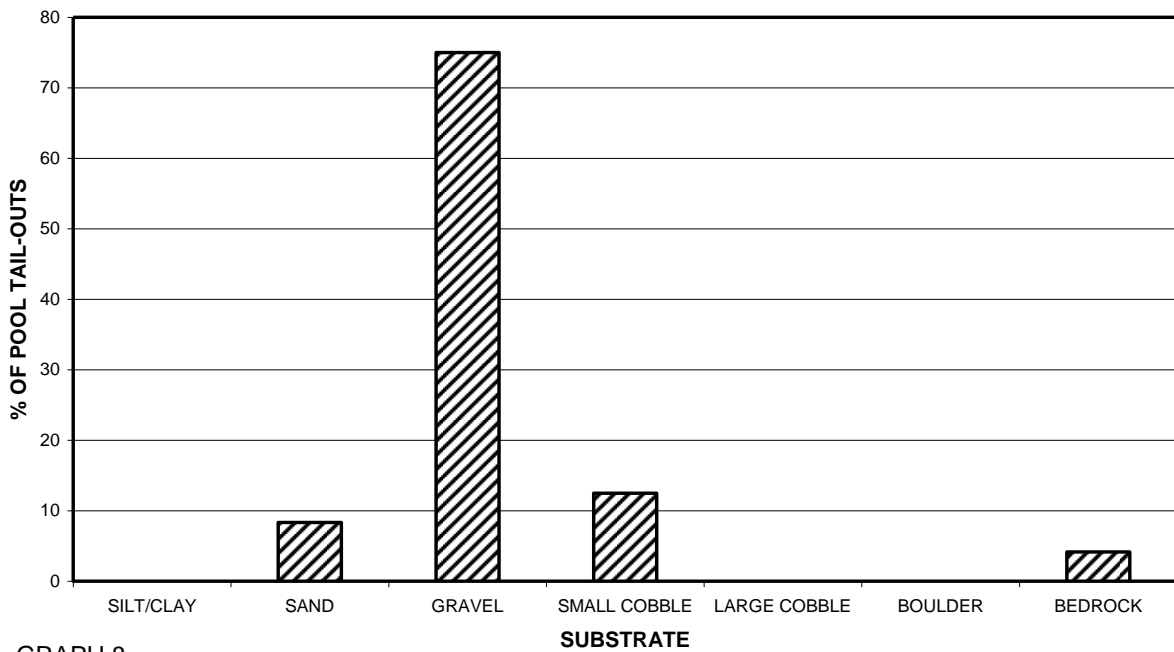
GRAPH 6

### ROSS CREEK 2009 MEAN PERCENT COVER TYPES IN POOLS



GRAPH 7

### ROSS CREEK 2009 SUBSTRATE COMPOSITION IN POOL TAIL-OUTS



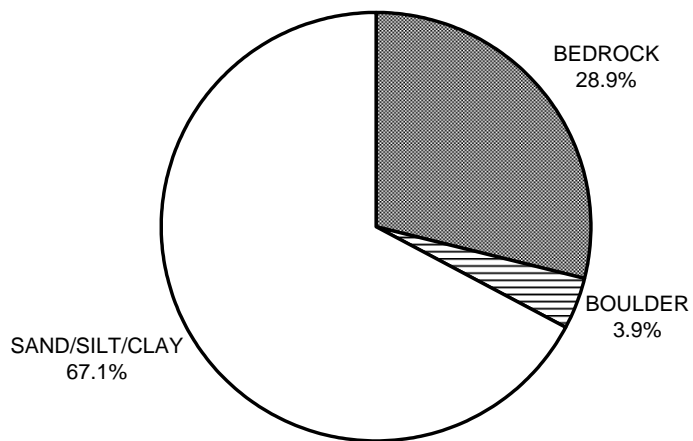
GRAPH 8

**ROSS CREEK 2009  
MEAN PERCENT CANOPY**



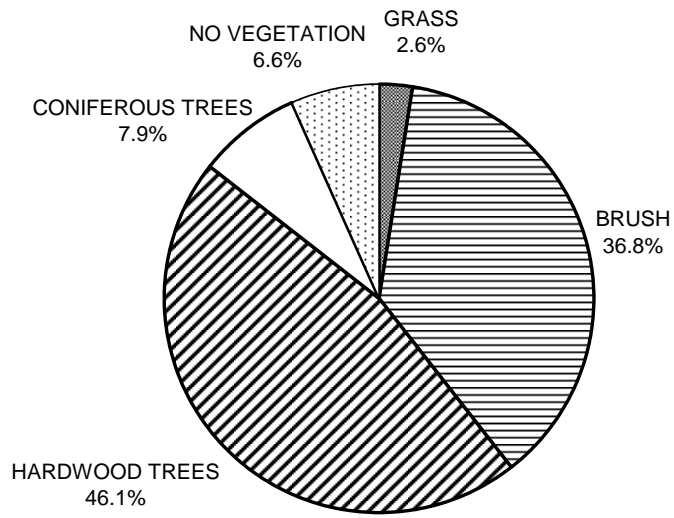
GRAPH 9

**ROSS CREEK 2009  
DOMINANT BANK COMPOSITION IN SURVEY REACH**



GRAPH 10

**ROSS CREEK 2009  
DOMINANT BANK VEGETATION IN SURVEY REACH**



GRAPH 11