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

Coyote Creek

Surveyed 2009

Report Completed in 2013

STREAM INVENTORY REPORT

Coyote Creek

INTRODUCTION

A stream inventory was conducted during 10/15/2009 on Coyote Creek. The survey began at the confluence with Richardson Bay and extended upstream 1.3 miles.

The Coyote 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 Coyote 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

Coyote Creek is a tributary to Richardson Bay, which flows into San Francisco Bay, located in Marin County, California (Map 1). Coyote Creek's legal description at the confluence with Richardson Bay is T01N R06W S34. Its location is 37°52'58.4" north latitude and 122°31'08.0" west longitude, LLID number 1225272378790. Coyote Creek is a third order stream and has approximately 5.2 miles of blue line stream within its catchment boundary according to the USGS National Hydrography Dataset (NHD). Coyote Creek drains a watershed of approximately 2.34 square miles. Elevations range from about sea level at the mouth of the creek to 1,024 feet in the headwater areas. Mixed hardwood forest dominates the watershed. The watershed is primarily privately owned which accounts for 65% of the land area. Fifty-five percent of the land is considered natural and forty-five percent is urban. Vehicle access exists via HWY 101 to HWY 1.

METHODS

The habitat inventory conducted in Coyote Creek follows the methodology presented in the *California Salmonid Stream Habitat Restoration Manual* (Flosi et al, 1998). The California Conservation Corps (CCC) Technical Advisors and Watershed Stewards Project/AmeriCorps (WSP) 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 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 Coyote 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". Coyote Creek habitat typing used standard basin level measurement criteria. These parameters require that the minimum length of a described habitat unit must be equal to or greater than the stream's mean wetted width. All measurements are in feet to the nearest tenth. Habitat characteristics are measured using a clinometer, hip chain, and stadia rod.

5. Embeddedness:

The depth of embeddedness of the cobbles in pool tail-out areas is measured by the percent of the cobble that is surrounded or buried by fine sediment. In Coyote 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 Coyote 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 Coyote 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 Coyote Creek, the dominant composition type and the dominant vegetation type of both the right and left banks for each fully-described unit were selected from the habitat inventory form. Additionally, the percent of each bank covered by vegetation (including downed trees, logs, and rootwads) was estimated and recorded.

10. Large Woody Debris Count:

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

11. Average Bankfull Width:

Bankfull width can vary greatly in the course of a channel type stream reach. This is especially true in very long reaches. Bankfull width can be a factor in habitat components like canopy density, water temperature, and pool depths. Frequent measurements taken at riffle crests (velocity crossovers) are needed to accurately describe reach widths. At the first appropriate velocity crossover that occurs after the beginning of a new stream survey page (ten habitat units), bankfull width is measured and recorded in the appropriate header block of the page. These widths are presented as an average for the channel type reach.

BIOLOGICAL INVENTORY

Biological sampling during the stream inventory is used to determine fish species and their distribution in the stream. Fish presence was observed from the stream banks in Coyote Creek.

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

Graphics are produced from the tables using Microsoft Excel. Graphics developed for Coyote 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 10/15/2009, was conducted by T. Macias (WSP) and A. Villalobos (WSP). The total length of the stream surveyed was 6,885 feet.

Stream flow was measured near the bottom of the survey reach with a Marsh-McBirney Model 2000 flowmeter at 0.035 cfs on 10/15/2009.

Coyote Creek is an F1 channel type for 1,404 feet of the stream surveyed (Reach 1), a NA channel type for 2,360 feet of the stream not surveyed (Reach 2), and a G4 channel type for 3,121 feet of the stream surveyed (Reach 3).

F1 channel types are entrenched meandering riffle/pool channels on low gradients with high width/depth ratios, very stable if bedrock controlled channel. G4 channels are entrenched gully step-pool and low width/depth ratio on moderate gradient.

Water temperatures taken during the survey period ranged from 59 to 64 degrees Fahrenheit. Air temperatures ranged from 66 to 68 degrees Fahrenheit.

Table 1 summarizes the Level II riffle, flatwater, and pool habitat types. Based on frequency of occurrence there were 52% riffle units, 27% culvert units, 2% no survey units, 15% flatwater units and 4% pool units (Graph 1). Based on total length of Level II habitat types there were 49% riffle units, 8% culvert units, 34% no survey units, 9% flatwater units and 0.2% pool units (Graph 2).

Nine Level IV habitat types were identified (Table 2). The most frequent habitat types by percent occurrence were 27% Culvert units, 25% Low Gradient Riffle units and 21% Bedrock Sheet units (Graph 3). Based on percent total length the most frequent were 34% Not Surveyed units, 32% Low Gradient Riffle units and 16% Bedrock Sheet units.

A total of 2 pools were identified (Table 3). Main Channel and Scour Pools were both encountered at 50% (Graph 4). The Main Channel pool comprised 38% while the Scour pool comprised 62% of the total length of all pools.

Table 4 is a summary of maximum residual pool depths by pool habitat types. Pool quality for salmonids increases with depth. None of the 2 pools had a residual depth of three feet or greater (Graph 5).

The depth of cobble embeddedness was estimated at pool tail-outs. Of the 2 pool tail-outs measured, 1 had a value of 1 (50%) and 1 had a value of 4 (50%) (Graph 6). On this scale, a value of 1 indicates the best spawning conditions and a value of 4 the worst.

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 11, flatwater habitat types had a mean shelter rating of 53, and pool habitats had a mean shelter rating of 5 (Table 1). Of the pool types, the Main Channel pools had a mean shelter rating of 5, Scour pools had a mean shelter rating of 5 (Table 3).

Table 5 summarizes mean percent cover by habitat type. Terrestrial vegetation is the dominant cover types in Coyote Creek. Graph 7 describes the pool cover in Coyote Creek. Terrestrial vegetation 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. A silt/clay substrate type was observed in 50% of pool tail-outs, and gravel substrate was observed in 50% of pool tail-outs.

The mean percent canopy density for the surveyed length of Coyote Creek was 65%. The mean percentages of hardwood and coniferous trees were 92% and 8%, respectively. Thirty-five percent of the canopy was open. Graph 9 describes the mean percent canopy in Coyote Creek.

For the stream reach surveyed, the mean percent right bank vegetated was 33%. The mean percent left bank vegetated was 47%. The dominant elements composing the structure of the stream banks consisted of 8.3% bedrock, 8.3% boulder, 33.3% cobble/gravel and 50% sand/silt/clay (Graph 10). Hardwood trees were the dominant vegetation type observed in 66.7% of the units surveyed. Additionally, 20.8% of the units surveyed had brush as the dominant vegetation type, and 12.5% was dominated by no vegetation (Graph 11).

DISCUSSION

Coyote Creek is an F1 channel type for the first 1,404 feet of the stream surveyed (Reach 1), a NA channel type for 2,360 feet of the stream surveyed (Reach 2), and a G4 channel type for the remaining 3,121 feet of the stream surveyed (Reach 3). The suitability of F1/G4 channel types for fish habitat improvement structures is as follows: The F1 channel type is good for bank-placed boulders. It is fair for single wing-deflectors and log cover. It is poor for plunge weirs, boulder clusters and opposing wing-deflectors. The G4 channel type is good for bank placed boulders. It is fair for plunge weirs, opposing wing-deflectors and log cover. It is poor for

boulder clusters and single-wing deflectors.

The water temperatures recorded on the survey day 10/15/2009, ranged from 59 to 64 degrees Fahrenheit. Air temperatures ranged from 66 to 68 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 9% of the total length of this survey, riffles 49%, and pools 0.2%. The pools are relatively shallow, with none of the 2 (0%) pools having a maximum residual depth greater than 3 feet. In general, pool enhancement projects are considered when primary pools comprise less than 40% of the length of total stream habitat. In 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.

One of the 2 pool tail-outs measured 1 had an embeddedness ratings of 1 or 2. One of the pool tail-outs had embeddedness ratings of 3 or 4. None of the pool tail-outs had a rating of 5, which is considered unsuitable for spawning. Cobble embeddedness measured to be 25% or less, a rating of 1, is considered to indicate good quality spawning substrate for salmon and steelhead. Sediment sources in Coyote Creek should be mapped and rated according to their potential sediment yields, and control measures should be taken.

One of the 2 pool tail-outs measured 1 had gravel or small cobble as the dominant substrate which is generally considered good for spawning salmonids. One pool tail-out had Silt/Clay as the dominat substrate which generally is not considered good for spawning salmonids.

The mean shelter rating for pools was 5. The shelter rating in the flatwater habitats was 53. A pool shelter rating of approximately 100 is desirable. The amount of cover that now exists is being provided primarily by terrestrial vegetation in Coyote Creek. Terrestrial vegetation 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 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 65%. Reach 1 had a canopy density of 21.6%, Reach 2 had a canopy density of 77.2%. In general, revegetation projects are considered when canopy density is less than 80%.

The percentage of right and left bank covered with vegetation was 33% and 47%, respectively. In areas of stream bank erosion or where bank vegetation is sparse, planting endemic species of coniferous and hardwood trees, in conjunction with bank stabilization, is recommended.

GENERAL RECOMMENDATIONS

Coyote 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) 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.

2) Increase woody cover in the pools and flatwater habitat units. Most of the existing cover in the pools is from Terrestrial Vegetation. Adding high quality complexity with woody cover in the pools is desirable.

3) Access for migrating salmonids should be assessed at all road crossings and dams. Particular sites of concern include the ford crossing just upstream of Northern Avenue just west of the town of Marin City, California. All in-stream culverts including the Laurel Way, Poplar Street, Pine Street, Spruce Street, Ash Street, and Marin Avenue in-stream culverts, need to be regularly assessed for fish passage. Other assessments should be made for the privately owned culvert located under an in-stream structure upstream of the Marin Avenue road crossing. 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.

4) Increase the canopy on Coyote 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.

5) Coyote 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.

6) 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.

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 just upstream of the tidal influence and 70 feet downstream of Laurel Way road crossing.
0	0001.00	Creek is channelized by concrete.
70	0002.00	Culvert #1 is a single in-stream concrete culvert in good condition, at Laurel Way. The culvert height is 8 ft, the width is 15 ft, and the length is 158 ft. The maximum depth within 5 ft of the outlet is 0.1 ft. The culvert slope is <2%. The culvert is not likely a barrier to juveniles or adults.
386	0004.00	Culvert #2 is a single in-stream concrete culvert in good condition, at Poplar Street. The culvert height is 8 ft, the width is 15 ft, and the length is 46 ft. The maximum depth within 5 ft of the outlet is 0.1 ft. The culvert slope <2%. The culvert is not likely a barrier to juveniles or adults.
717	0006.00	Culvert #3 is a single in-stream concrete culvert in good condition, at Pine Street. The culvert height is 8 ft, the width is 15 ft, and the length is 33 ft. The maximum depth within 5 ft of the outlet is 0.1 ft. The culvert slope is <2%. The culvert is not likely a barrier to juveniles or adults.
828	0008.00	Culvert #4 is a single in-stream concrete culvert in good condition, at a private road. The culvert height is 8 ft, the width is 15 ft, and the length is 15 ft. The maximum depth within 5 ft of the outlet is 0.1 ft. The culvert slope is <2%. The culvert is not likely a barrier to juveniles or adults.
924	0010.00	Culvert #5 is a single in-stream concrete culvert in good condition, at a private road. The culvert height is 8 ft, the width is 15' ft, and the length is 15 ft. The maximum depth within 5 ft of the outlet is 0.1 ft. The culvert slope is <2%. The culvert is not likely a barrier to juveniles or adults.
1,039	0012.00	Culvert #6 is a single in-stream concrete culvert in good condition, at Spruce Street. The culvert height is 8 ft, the width is 15 ft, and the length is 32 ft. The maximum depth within 5 ft of the outlet is 0.1 ft. The culvert slope is <2%. The culvert is not likely a barrier to juveniles or adults.
1,362	0014.00	Culvert #7 is a single in-stream concrete culvert in good condition, at Ash Street. The culvert height is 8 ft, the width is 15 ft, and the length is 42 ft. The maximum depth within 5 ft of the outlet is 0.1 ft. The culvert slope is <2%. The culvert is not likely a barrier to juveniles or adults.

Position (ft.)	Habitat Unit #	Comments:
1,404	0015.00	In this unit, survey crew did not have access in this section of the creek, and thus Reach 2 was not surveyed. Left bank tributary #1 contributes about 50% of the flow to the stream. The water temperatures were not taken due to a large fence. It looks accessible to fish (checked 10 ft up the tributary); however, no fish were observed while there.
4,101	0021.00	Right bank Tributary #1 contributes about 40% of flow to the stream. The water temperature downstream was 60F, the temperature upstream was 61F, and tributary was 60F. It is likely accessible to fish. The tributary slope is about 20%, and there were no fish observed. The coordinate point at this location is N37.87926 W122.54545.
4,547	0027.00	Culvert #8 is a single in-stream concrete culvert in good condition, at Marin Ave. The culvert height is 5 ft, the width is 5 ft, the length is 87 ft, the diameter is 5 ft, and the plunge height is 3 ft. The maximum depth within 5 ft of the outlet is 0.4 ft. The culvert slope is <2%. It is a possible barrier to juveniles or adults. The coordinate point of the culvert is N37.87865 W122.54647.
4,754	0030.00	Culvert #9 is a single in-stream plastic culvert in good condition, at a private road. The culvert height is 4 ft, the width is 3.4 ft, the length is 31 ft, and the plunge height is 0.5 ft. The maximum depth within 5 ft of the outlet is 0.2 ft. The culvert slope is <7%. The culvert is a possible barrier to juveniles and adults.
4,840	0033.00	Culvert #10 is a single in-stream corrugated metal pipe culvert in good condition, at a private road. The culvert height is 4 ft, the width is 4 ft, the length is 25 ft, the diameter is 4 ft, and the plunge height 0.4 ft. The maximum depth within 5 ft of the outlet is 0.2 ft. The culvert slope is <2%. The culvert is a possible barrier to juveniles or adults.
4,916	0035.00	Culvert #11 is a single in-stream metal culvert in rusted condition, at a private road. The culvert height is 3.5 ft, the width is 5 ft, and the length is 44 ft. The maximum depth within 5 ft of the outlet is 0.8 ft. The culvert slope is <5%. The culvert is a possible barrier to juveniles or adults.
5,131	0039.00	Right bank tributary #2 contributes about 20% of the flow to the stream. The water temperature downstream is 59F, the temperature upstream is 59F, and the tributary is 59F. It is not accessible to fish (we checked 50 ft up the tributary). The slope is estimated at 30%, and there were no fish observed.
5,363	0041.00	Right bank tributary #3 contributes about 5% of the flow to the stream. The water temperature downstream is 59F, the temperature upstream is 59F, and the tributary is 59F. It is not accessible to fish (we checked 10 ft up the tributary). The slope estimated to be 10%, and there were no fish observed.
5,700	0042.00	Bridge #1 is an unknown road. The length is 7 ft, the height is 0 ft, and the width is 14 ft. There was also a ford crossing made of concrete. The height from the water to sill is 0.7 ft. There was no down cutting or gravel retention and is a possible barrier to fish. The coordinate point of the bridge is:

Position (ft.)	Habitat Unit #	Comments:
		N37.87600 W122.54765.
6,368	0044.00	Bridge #2, which is a private wooden footbridge, has a length of 3 ft, a height of 1.2 ft, and the width is 11 ft. There was no down cutting or gravel retention. The bridge is not likely a barrier to fish.
6,885	0048.00	End of survey due to steep waterfall. Survey crew could not continue upstream. This location could be the potential end of anadromy. The coordinate point is: N37.87329 W122.54734.

REFERENCES

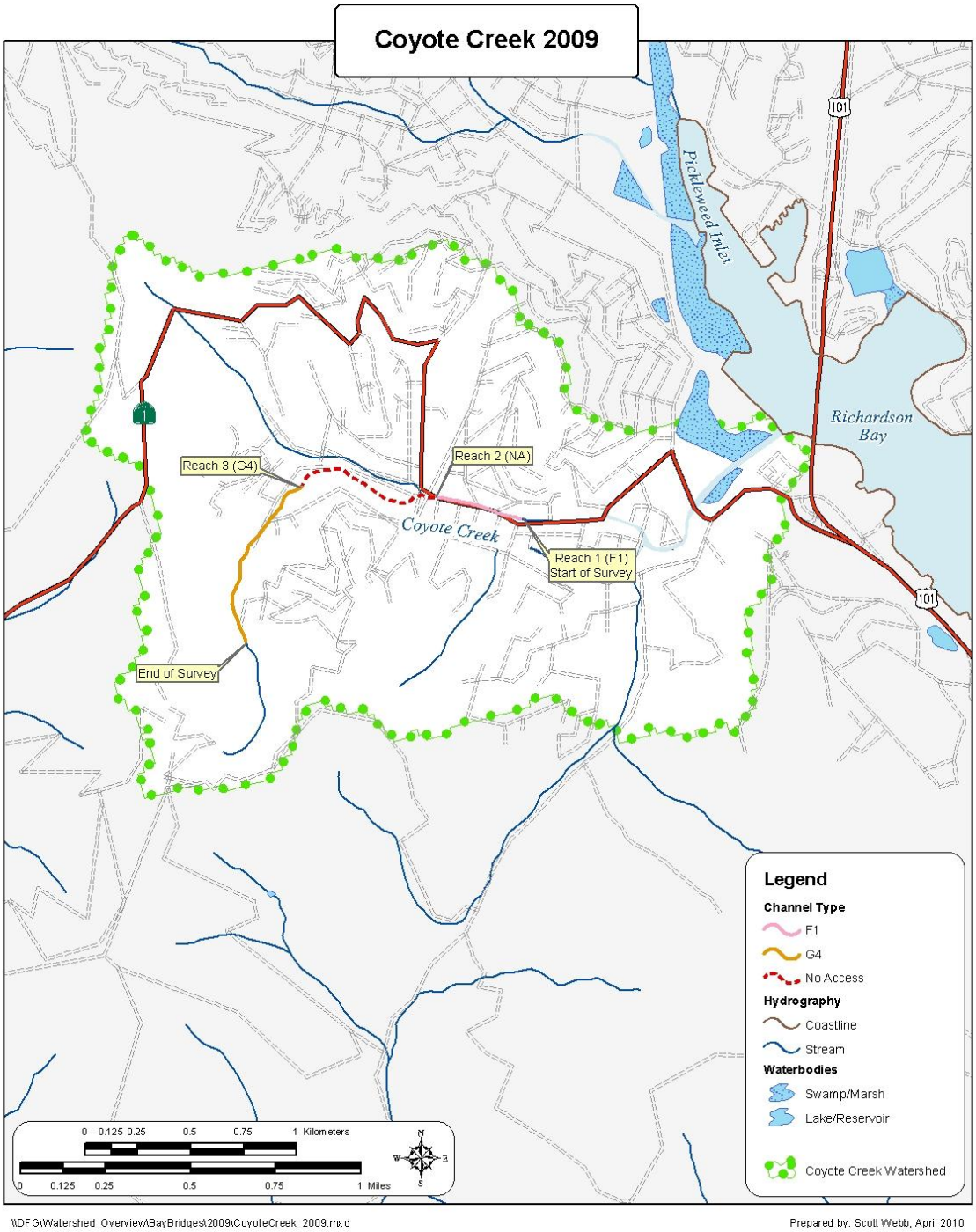
Flosi, G., Downie, S., Hopelain, J., Bird, M., Coey, R., and Collins, B. 1998. *California Salmonid Stream Habitat Restoration Manual*, 3rd edition. California Department of Fish and Game, Sacramento, California.

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.

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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Prepared by: Scott Webb, April 2010

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

Stream Name: Coyote Creek **LLID:** 1225272378790 **Drainage:** San Rafael

Survey 10/15/2009 to 10/15/2009

Confluence Location: **Quad:** SAN RAFAEL **Legal Description:** T01NR06WS34 **Latitude:** 37:52:58.7N **Longitude:** 122:31:04.1W

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	27.1	41	538	7.8									
7	7	FLATWATER	14.6	90	628	9.1	3.6	0.1	0.5	332	2323	48	333		53
1	0	NOSURVEY	2.1	2360	2360	34.3									
2	2	POOL	4.2	8	16	0.2	4.5	0.7	1.1	39	78	34	68	27	5
25	25	RIFFLE	52.1	134	3343	48.6	6.8	0.1	0.3	1003	25087	102	2548		11

Total Units	Total Units Fully Measured	Total Length (ft.)	Total Area (sq.ft.)	Total Volume (cu.ft.)
48	34	6885	27488	2950

Table 2 - Summary of Habitat Types and Measured Parameters

Stream Name: Coyote Creek **LLID:** 1225272378790 **Drainage:** San Rafael

Survey 10/15/2009 to 10/15/2009

Confluence Location: **Quad:** SAN RAFAEL **Legal Description:** T01NR06WS34 **Latitude:** 37:52:58.7N **Longitude:** 122:31:04.1W

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 (%)
12	12	LGR	25.0	181	2171	31.5	4.0	0.1	0.9	737	8845	77	923		15	77
3	3	CAS	6.3	28	83	1.2	3.0	0.1	0.5	69	207	7	22		10	77
10	10	BRS	20.8	109	1089	15.8	12.0	0.1	0.1	1604	16035	160	1604		0	28
4	4	RUN	8.3	70	279	4.1	2.0	0.1	0.9	168	672	19	75		20	82
3	3	SRN	6.3	116	349	5.1	5.0	0.2	0.9	550	1651	86	258		120	96
1	1	MCP	2.1	6	6	0.1	3.0	0.7	1.2	18	18	14	14	13	5	60
1	1	PLP	2.1	10	10	0.1	6.0	0.7	1.0	60	60	54	54	42	5	82
13	0	CUL	27.1	41	538	7.8										38
1	0	NS	2.1	2360	2360	34.3										

Total Units	Total Units Fully Measured	Total Length (ft.)	Total Area (sq.ft.)	Total Volume
48	34	6885	27488	2950

Table 3 - Summary of Pool Habitat Types

Stream Name: Coyote Creek **LLID:** 1225272378790 **Drainage:** San Rafael

Survey 10/15/2009 to 10/15/2009

Confluence Location: **Quad:** SAN RAFAEL **Legal Description:** T01NR06WS34 **Latitude:** 37:52:58.7N **Longitude:** 122:31:04.1W

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
1	1	MAIN	50	6	6	38	3.0	0.7	18	18	13	13	5
1	1	SCOUR	50	10	10	63	6.0	0.7	60	60	42	42	5

Total Units	Total Units Fully Measured	Total Length (ft.)	Total Area (sq.ft.)	Total Volume (cu.ft.)
2	2	16	78	55

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

Stream Name: Coyote Creek **LLID:** 1225272378790 **Drainage:** San Rafael

Survey 10/15/2009 to 10/15/2009

Confluence Location: **Quad:** SAN RAFAEL **Legal Description:** T01NR06WS34 **Latitude:** 37:52:58.7N **Longitude:** 122:31:04.1W

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 Occurence	3 < 4 Feet Maximum Residual Depth	3 < 4 Feet Percent Occurrence	>= 4 Feet Maximum Residual Depth	>= 4 Feet Percent Occurrence
1	MCP	50	0	0	1	100	0	0	0	0	0	0
1	PLP	50	0	0	1	100	0	0	0	0	0	0

Total Units	Total < 1 Foot Max Resid. Depth	Total < 1 Foot % Occurrence	Total 1< 2 Feet Max Resid. Depth	Total 1< 2 Feet % Occurrence	Total 2< 3 Feet Max Resid. Depth	Total 2< 3 Feet % Occurrence	Total 3< 4 Feet Max Resid. Depth	Total 3< 4 Feet % Occurrence	Total >= 4 Feet Max Resid. Depth	Total >= 4 Feet % Occurrence
2	0	0	2	100	0	0	0	0	0	0

Mean Maximum Residual Pool Depth (ft.): 1

Table 5 - Summary of Mean Percent Cover By Habitat Types

Stream Name: Coyote Creek **Dry Units:** **LLID:** 1225272378790 **Drainage:** San Rafael

Survey 10/15/2009 to 10/15/2009

Confluence Location: **Quad:** SAN RAFAEL **Legal Description:** T01NR06WS34 **Latitude:** 37:52:58.7N **Longitude:** 122:31:04.1W

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
12	3	LGR	0	0	10	0	78	0	0	12	0
3	3	CAS	0	0	0	0	33	0	0	33	0
10	1	BRS	0	0	0	0	0	0	0	0	0
25	7	TOTAL RIFFLE	0	0	4	0	48	0	0	19	0
4	2	RUN	0	0	0	0	50	0	0	0	0
3	1	SRN	0	0	10	0	30	30	0	30	0
7	3	TOTAL FLAT	0	0	3	0	43	10	0	10	0
1	1	MCP	0	0	0	0	100	0	0	0	0
1	1	PLP	0	0	0	0	20	0	0	80	0
2	2	TOTAL POOL	0	0	0	0	60	0	0	40	0
13	0	CUL									
1	0	NS									
48	12	TOTAL	0	0	3	0	49	3	0	20	0

Table 6 - Summary of Dominant Substrates By Habitat Type

Stream Name: Coyote Creek **Dry Units:** **LLID:** 1225272378790 **Drainage:** San Rafael

Survey 10/15/2009 to 10/15/2009

Confluence Location: **Quad:** SAN RAFAEL **Legal Description:** T01NR06WS34 **Latitude:** 37:52:58.7N **Longitude:** 122:31:04.1W

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
12	3	LGR	0	0	100	0	0	0	0
3	3	CAS	0	0	67	0	0	0	33
10	1	BRS	0	0	0	0	0	0	100
4	2	RUN	50	0	50	0	0	0	0
3	1	SRN	0	0	100	0	0	0	0
1	1	MCP	0	0	100	0	0	0	0
1	1	PLP	0	0	100	0	0	0	0
13	0	CUL	0	0	0	0	0	0	0
1	0	NS	0	0	0	0	0	0	0

Table 7 - Summary of Mean Percent Canopy for Entire Stream

Stream Name: Coyote Creek **LLID:** 1225272378790 **Drainage:** San Rafael

Survey 10/15/2009 to 10/15/2009

Confluence Location: **Quad:** SAN RAFAEL **Legal Description:** T01NR06WS34 **Latitude:** 37:52:58.7N **Longitude:** 122:31:04.1W

Mean Percent Canopy	Mean Percent Conifer	Mean Percent Hardwood	Mean Percent Open Units	Mean Right Bank % Cover	Mean Left Bank % Cover
65	8	92	9	33	47

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: Coyote Creek LLID: 1225272378790 Drainage: San Rafael

Survey Dates: 10/15/2009 to 10/15/2009 Survey Length (ft.): 6885 Main Channel (ft.): 6885 Side Channel (ft.): 0

Confluence Location: Quad: SAN RAFAEL Legal Description: T01NR06WS34 Latitude: 37:52:58.7N Longitude: 122:31:04.1W

Summary of Fish Habitat Elements By Stream Reach

STREAM REACH: 1

Channel Type: F1
Reach Length (ft.): 1404
Riffle/Flatwater Mean Width (ft.): 15.0
BFW:
Range (ft.): 15.00 to 15.00
Mean (ft.): 15.00
Std. Dev.: 0.00
Base Flow (cfs): 0.03
Water (F): 62 - 64 Air (F): 67 - 67
Dry Channel (ft.): 0

Canopy Density (%): 21.6
Coniferous Component (%): 0.0
Hardwood Component (%): 100.0
Dominant Bank Vegetation:
Vegetative Cover (%): 0.0
Dominant Shelter:
Dominant Bank Substrate Type: Bedrock
Occurrence of LWD (%): 0.0
LWD per 100 ft.:
Riffles: 0
Pools:
Flat:

Pools by Stream Length (%): 0.0
Pool Frequency (%): 0.0
Residual Pool Depth (%):
< 2 Feet Deep:
2 to 2.9 Feet Deep:
3 to 3.9 Feet Deep:
>= 4 Feet Deep:
Mean Max Residual Pool Depth (ft.):
Mean Pool Shelter Rating:

Pool Tail Substrate (%):	Silt/Clay:	Sand:	Gravel:	Sm Cobble:	Lg Cobble:	Boulder:	Bedrock:
Embeddedness Values (%):	1.	2.	3.	4.	5.	0.0	

STREAM REACH: 2

Channel Type: NA
Reach Length (ft.): 2360
Riffle/Flatwater Mean Width (ft.):
BFW:
Range (ft.): 15.00 to 15.00
Mean (ft.): 15.00
Std. Dev.: 0.00
Base Flow (cfs): 0.03
Water (F): 62 - 62 Air (F): 67 - 67
Dry Channel (ft.): 0

Canopy Density (%):
Coniferous Component (%):
Hardwood Component (%):
Dominant Bank Vegetation:
Vegetative Cover (%): 0.0
Dominant Shelter:
Dominant Bank Substrate Type:
Occurrence of LWD (%):
LWD per 100 ft.:
Riffles:
Pools:
Flat:

Pools by Stream Length (%): 0.0
Pool Frequency (%): 0.0
Residual Pool Depth (%):
< 2 Feet Deep:
2 to 2.9 Feet Deep:
3 to 3.9 Feet Deep:
>= 4 Feet Deep:
Mean Max Residual Pool Depth (ft.):
Mean Pool Shelter Rating:

Pool Tail Substrate (%):	Silt/Clay:	Sand:	Gravel:	Sm Cobble:	Lg Cobble:	Boulder:	Bedrock:
Embeddedness Values (%):	1.	2.	3.	4.	5.	0.0	

Summary of Fish Habitat Elements By Stream Reach

STREAM REACH: 3

Channel Type: G4
Reach Length (ft.): 3121
Riffle/Flatwater Mean Width (ft.): 3.6
BFW:
Range (ft.): 6.00 to 15.00
Mean (ft.): 9.48
Std. Dev.: 3.87
Base Flow (cfs): 0.03
Water (F): 59 - 62 Air (F): 66 - 68
Dry Channel (ft.): 0

Canopy Density (%): 77.2
Coniferous Component (%): 9.4
Hardwood Component (%): 90.6
Dominant Bank Vegetation: Hardwood Trees
Vegetative Cover (%): 43.6
Dominant Shelter: Terrestrial Veg.
Dominant Bank Substrate Type: Sand/Silt/Clay
Occurrence of LWD (%): 3.6
LWD per 100 ft.:
Riffles: 0
Pools: 0
Flat: 0

Pools by Stream Length (%): 0.5
Pool Frequency (%): 6.1
Residual Pool Depth (%):
< 2 Feet Deep: 100.0
2 to 2.9 Feet Deep: 0.0
3 to 3.9 Feet Deep: 0.0
>= 4 Feet Deep: 0.0
Mean Max Residual Pool Depth (ft.): 1.1
Mean Pool Shelter Rating: 5

Pool Tail Substrate (%): Silt/Clay: 50.0 Sand: 0.0 Gravel: 50.0 Sm Cobble: 0.0 Lg Cobble: 0.0 Boulder: 0.0 Bedrock: 0.0
Embeddedness Values (%): 1. 50.0 2. 0.0 3. 0.0 4. 50.0 5. 0.0

Table 9 -Mean Percentage of Dominant Substrate and Vegetation

Stream Name: Coyote Creek **LLID:** 1225272378790 **Drainage:** San Rafael
Survey 10/15/2009 to 10/15/2009
Confluence Location: **Quad:** SAN RAFAEL **Legal Description:** T01NR06WS34 **Latitude:** 37:52:58.7N **Longitude:** 122:31:04.1W

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	1	1	8.3
Boulder	1	1	8.3
Cobble/Gravel	4	4	33.3
Sand/Silt/Clay	6	6	50.0

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	0	0	0.0
Brush	2	3	20.8
Hardwood	8	8	66.7
Coniferous	0	0	0.0
No Vegetation	2	1	12.5

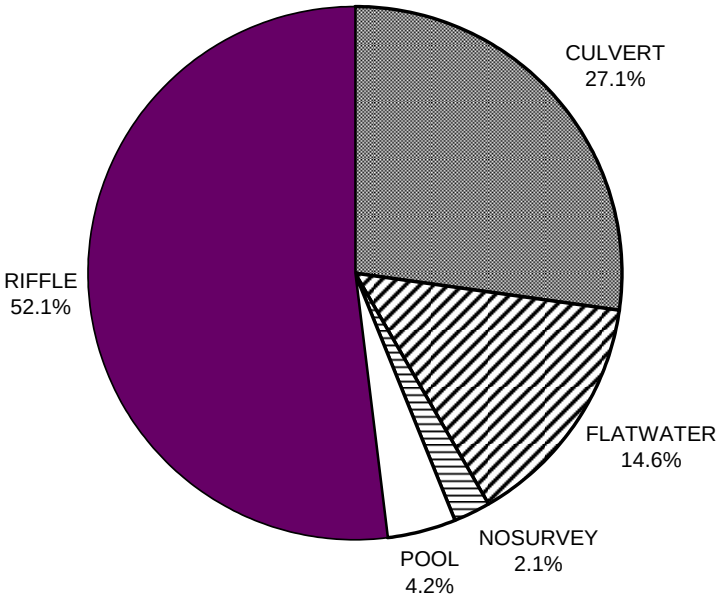
Total Stream Cobble Embeddedness Values: 3

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

Stream Name: Coyote Creek **LLID:** 1225272378790 **Drainage:** San Rafael
Survey 10/15/2009 to 10/15/2009
Confluence Location: **Quad:** SAN RAFAEL **Legal Description:** T01NR06WS34 **Latitude:** 37:52:58.7N **Longitude:** 122:31:04.1W

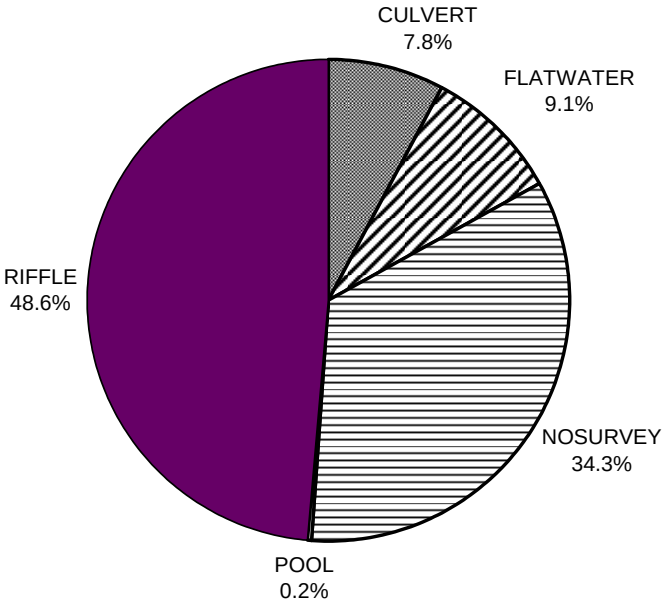
	Riffles	Flatwater	Pools
UNDERCUT BANKS (%)	0	0	0
SMALL WOODY DEBRIS (%)	0	0	0
LARGE WOODY DEBRIS (%)	4	3	0
ROOT MASS (%)	0	0	0
TERRESTRIAL VEGETATION	48	43	60
AQUATIC VEGETATION (%)	0	10	0
WHITEWATER (%)	0	0	0
BOULDERS (%)	19	10	40
BEDROCK LEDGES (%)	0	0	0

COYOTE CREEK 2009
HABITAT TYPES BY PERCENT OCCURRENCE



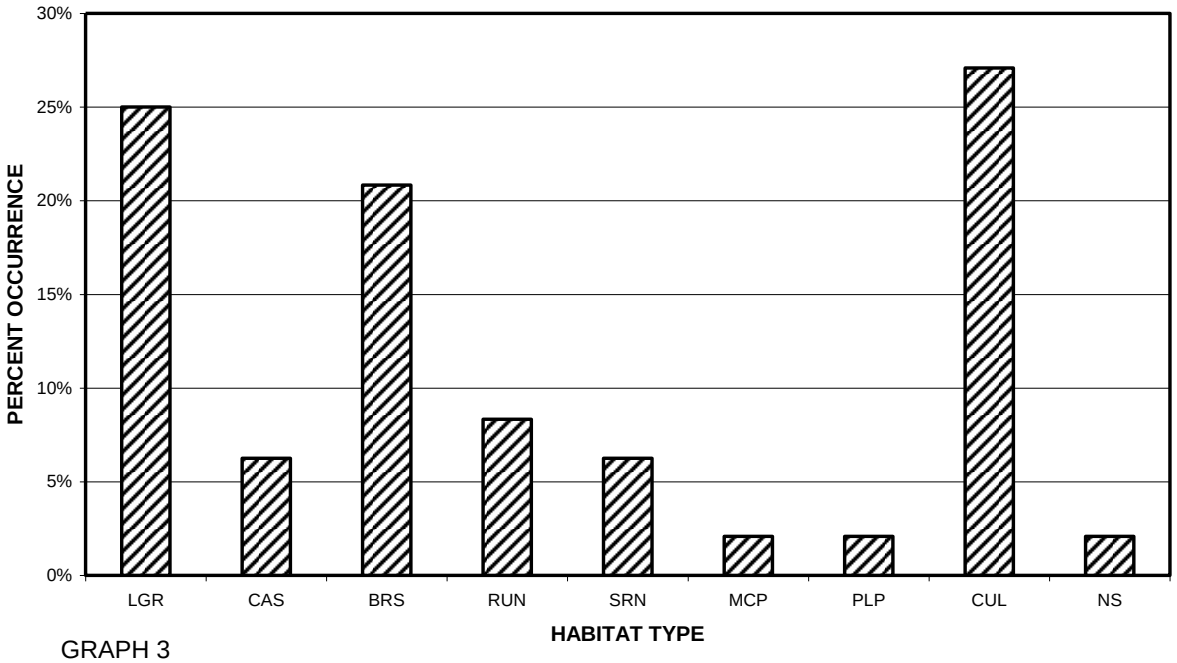
GRAPH 1

COYOTE CREEK 2009
HABITAT TYPES BY PERCENT TOTAL LENGTH



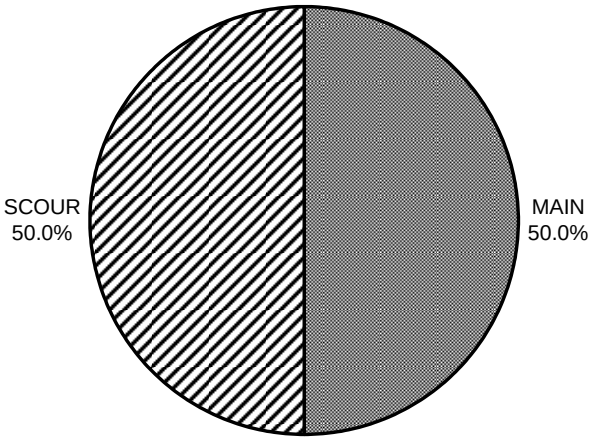
GRAPH 2

COYOTE CREEK 2009
HABITAT TYPES BY PERCENT OCCURRENCE



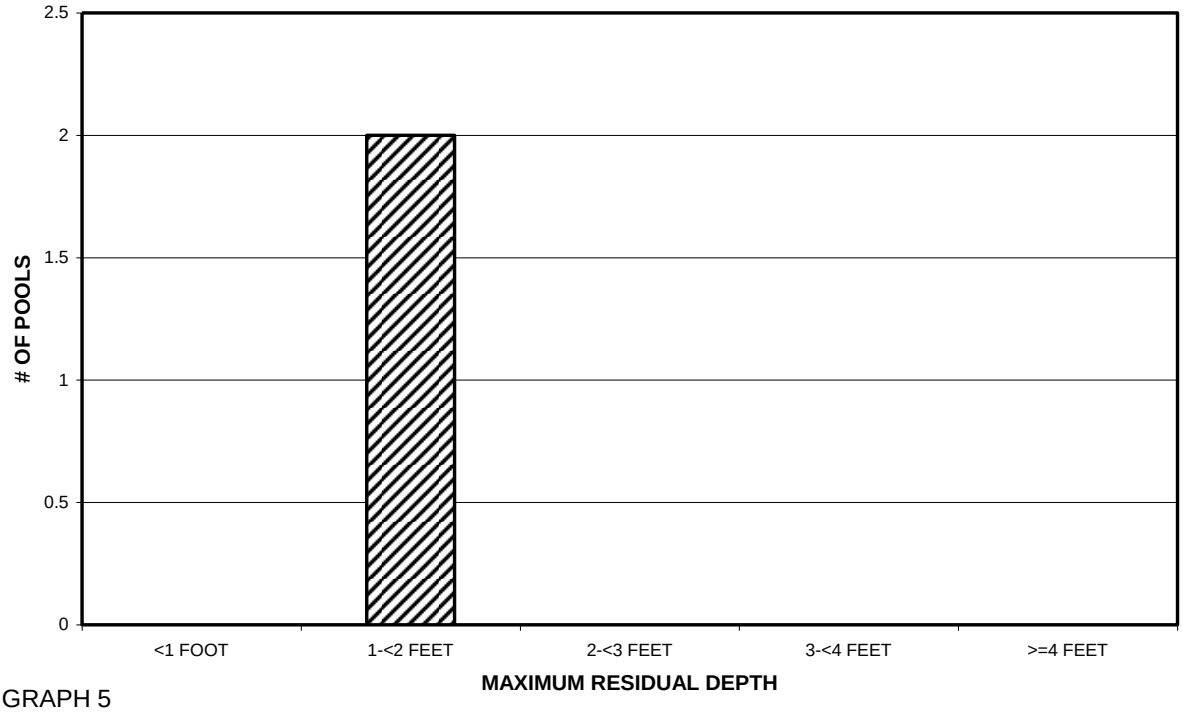
GRAPH 3

COYOTE CREEK 2009
POOL TYPES BY PERCENT OCCURRENCE



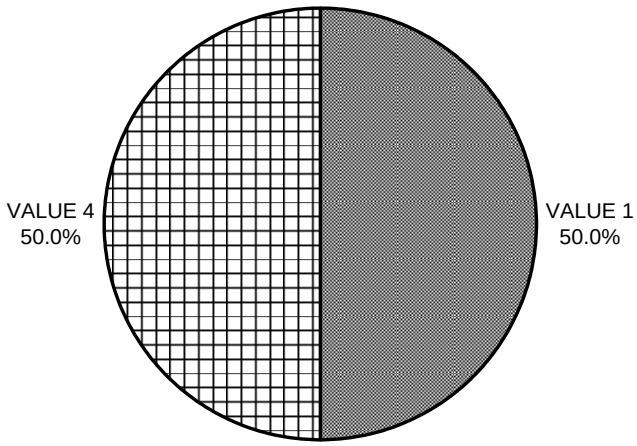
GRAPH 4

COYOTE CREEK 2009
MAXIMUM DEPTH IN POOLS



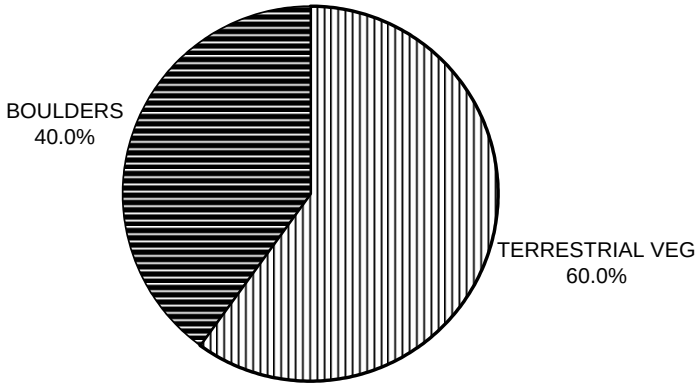
GRAPH 5

COYOTE CREEK 2009
PERCENT EMBEDDEDNESS



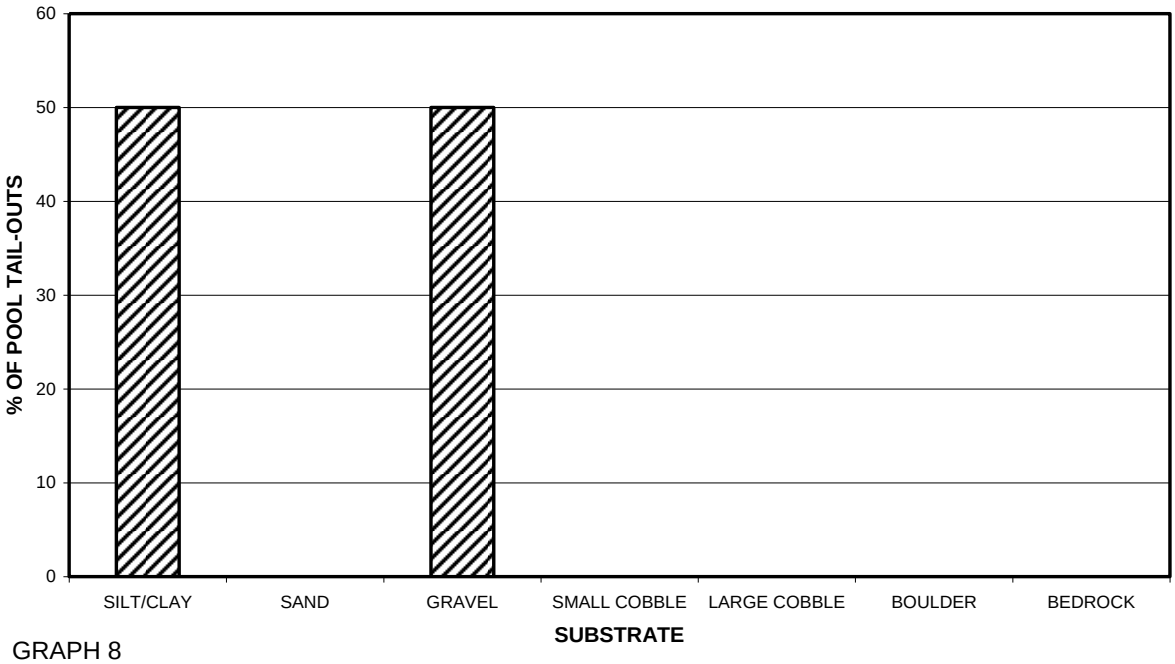
GRAPH 6

COYOTE CREEK 2009
MEAN PERCENT COVER TYPES IN POOLS



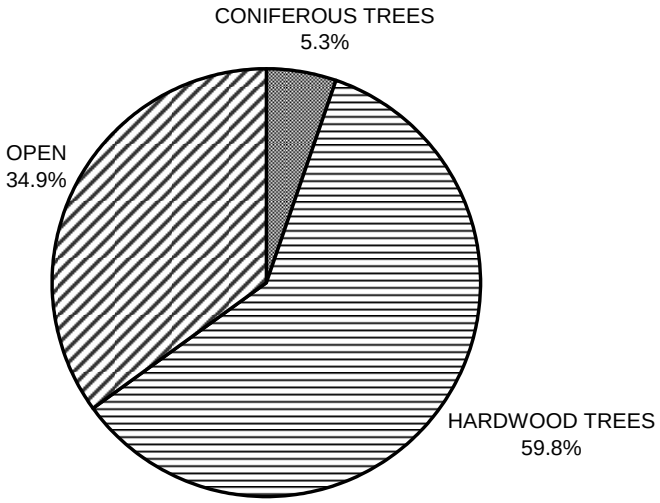
GRAPH 7

COYOTE CREEK 2009
SUBSTRATE COMPOSITION IN POOL TAIL-OUTS



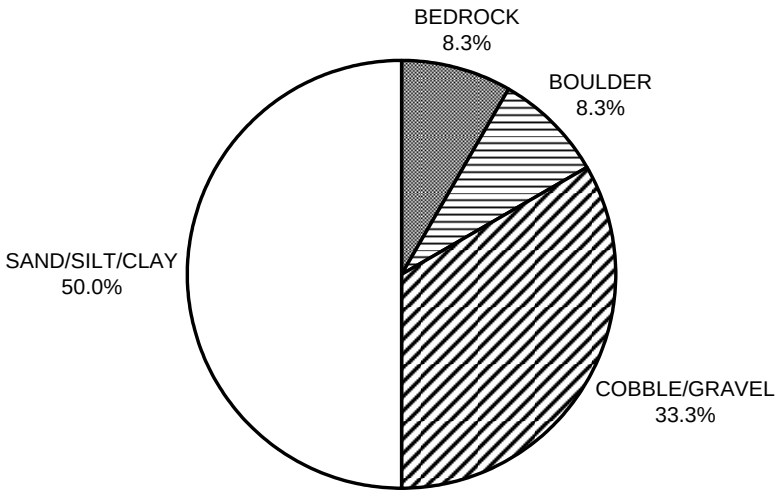
GRAPH 8

COYOTE CREEK 2009
MEAN PERCENT CANOPY



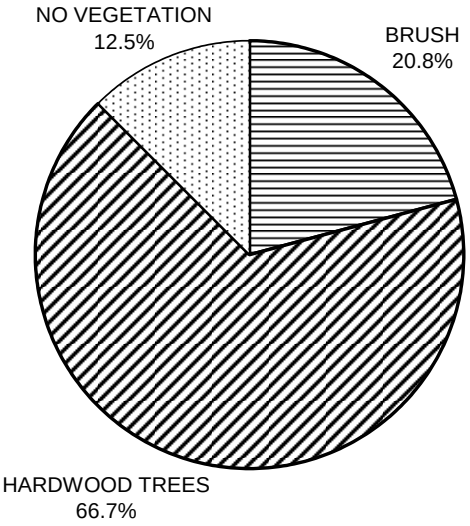
GRAPH 9

COYOTE CREEK 2009
DOMINANT BANK COMPOSITION IN SURVEY REACH



GRAPH 10

COYOTE CREEK 2009
DOMINANT BANK VEGETATION IN SURVEY REACH



GRAPH 11