STREAM INVENTORY REPORT

Pauma Creek

INTRODUCTION

A stream habitat inventory was conducted on Pauma Creek by Pacific States Marine Fisheries Commission (PSMFC) fisheries crew on July 18 & 25, 2007 and January 18, 2008. The survey began 19,008 feet upstream of the confluence with the San Luis Rey River in the Cleveland National Forest. This survey was performed in three separate reaches totaling approximately 6,159 feet with the last reach ending in Palomar Mountain State Park.

The objective of the habitat inventory was to document the quality of habitat currently available to the native, self-sustaining population of rainbow trout (*Oncorynchus mykiss*) in Pauma Creek. The baseline data acquired through this survey can provide insight to the type of habitat conditions rainbow trout inhabit in southern California and the potential for steelhead to utilize Pauma Creek if man-made barriers were removed/modified in the lower watershed, such as the Highway 76 Bridge crossing (approximately ¾ of mile upstream of Pauma Creek's confluence with the San Luis Rey River) and a concrete wall barrier located an addition 2.4 miles upstream of the Highway 76 Bridge.

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 south coast streams.

WATERSHED OVERVIEW

Pauma Creek is a tributary to San Luis Rey River (SLR River), is a tributary to Pacific Ocean, located in San Diego County, California (Map 1). Pauma Creek's legal description at the confluence with San Luis Rey River is T10S R01W S08. Its location is 33.31766 north latitude and -117.00928 west longitude, LLID number 1170084333176. Pauma Creek is a second order stream and has approximately 26.8 miles of blue line stream according to the USGS 7.5 minute quadrangle. Pauma Creek drains a watershed of approximately 24.3 square miles. Elevations range from about 730 feet at the mouth of the creek to 5,300 feet in the headwater areas (average elevation of headwaters, not highest point). Mixed hardwood forest dominates the watershed. The watershed is composed mostly of national forest and Indian Tribal Reservation lands with the remaining property in state park and private ownership. The watershed is primarily managed for recreation and agriculture.

METHODS

The habitat inventory conducted in Pauma Creek follows the methodology presented in the *California Salmonid Stream Habitat Restoration Manual* (Flosi et al, 1998). The Pacific State Marine Fisheries Commission (PSMFC) fisheries biologist and fisheries technicians that conducted the inventory were trained in standardized habitat inventory methods by the California Department of Fish and Game (DFG). This inventory was conducted by a three person team.

SAMPLING STRATEGY

The inventory uses a method that samples approximately 10% of the habitat units within the survey reach. All habitat units included in the survey are classified according to habitat type and their lengths are measured. All pool units are measured for maximum depth, depth of pool tail crest (measured in the thalweg), dominant substrate composing the pool tail crest, and embeddedness. Habitat unit types encountered for the first time are measured for all the parameters and characteristics on the field form.

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 Pauma Creek to record measurements and observations. There are eleven components to the inventory form.

1. Flow:

Flow was visually estimated in cubic feet per second (cfs) at all three reaches, considering the survey was conducted at different times of the year. These estimates were arrived through consensus of the survey members and based on their previous experience with stream flow measurements.

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". Pauma 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 Pauma 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 Pauma 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 Pauma 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 Pauma 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. 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

Various methods of biological sampling can be employed during a stream inventory to determine fish species and their distribution in the stream. Fish sampling methods were limited to visual observations while walking/conducting the habitat inventory of the creek. Although fish presence was not observed in the lower reach, this methodology is limited in its effectiveness, especially during the late fall/winter months when native trout species are relatively inactive and difficult to observe. Further presence/absence studies should be conducted to determine the current status of fish populations in the system. Focused surveys were not performed for reptiles, amphibians, mammals, or birds but observations were noted and, if possible, fauna was identified to species.

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 Game. This program processes and summarizes the data, and produces the following ten tables:

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

Graphics are produced from the tables using Microsoft Excel. Graphics developed for Pauma 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 was performed on three separate dates: July 18 and 25th, 2007 and again on January 18th, 2008. This survey was conducted by D. Kajtaniak, K. Snyder, and I. Delgado (PSMFC fisheries biologist and fisheries technicians). The total length of the stream surveyed was 6,159 feet with an additional 70 feet of side channel. The survey began upstream of the Cleveland National Forest Service boundary and was divided into five reaches (Reaches 1, 2, 3, 4 & 5) to gain an overview of habitat throughout the watershed (Map 1). Habitat data was recorded for Reaches 1, 3, and 5; Reaches 2 & 4 were walked but no data was recorded (Map 2). The entire survey was performed above the limits of anadromy for steelhead. Currently, the Highway 76 Bridge crossing of Pauma Creek is a complete barrier to steelhead. The survey ended at the confluence of French and Doane Creek in Mount Palomar State Park (this is the beginning of Pauma Creek).

Stream flow was estimated at 1 cfs during the summer surveys (Reach 3 & 5) and 4.5 cfs during the January survey date (Reach 1; Photo 1).

Pauma Creek is a B2 channel type for 1,373 feet of the stream surveyed (Reach 1), a A2 channel type for 1,463 feet of the stream surveyed (Reach 2), and a B2 channel type for 3,323 feet of the stream surveyed (Reach 3). The data included in this report is for the 6,159 feet actually surveyed.

B2 channels are moderately entrenched riffle dominated channels with infrequently spaced pools, very stable plan and profile, stable banks on moderate gradients with low width /depth ratios and boulder-dominant substrates. A2 channels are steep, narrow, cascading, step-pool, high energy debris transporting channels associated with depositional soils, and boulder-dominant substrates.

Water temperatures taken during the survey period ranged from 41 to 67 degrees Fahrenheit. Air temperatures ranged from 48 to 84 degrees Fahrenheit.

Table 1 summarizes the Level II riffle, flatwater, and pool habitat types. Based on frequency of occurrence there were 39% riffle units, 26% pool units, 33% flatwater units, 2% no survey units, and 1% dry units (Graph 1). Based on total length of Level II habitat types there were 43% riffle units, 21% pool units, and 36% flatwater units (Graph 2).

Ten Level IV habitat types were identified (Table 2). The most frequent habitat types by percent occurrence were 25% run units, 22% mid-channel pool units, and 20% low gradient riffle units (Graph 3). Based on percent total length, 26% were run units, 22% were high gradient riffle units, and 21% were low gradient riffle units.

A total of 45 pools were identified (Table 3). Main Channel pools were the most frequently

encountered, at 96% (Graph 4), and comprised 97% 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. Twelve of the 44 pools (9%) had a residual depth of three feet or greater (Graph 5).

The depth of cobble embeddedness was estimated at pool tail-outs. Of the 44 pool tail-outs measured, 9 had a value of 1 (20.5%); 8 had a value of 2 (18.2%); 8 had a value of 3 (18.2%); 2 had a value of 4 (4.5%); and 17 had a value of 5 (38.6%), (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 57, flatwater habitat types had a mean shelter rating of 42, and pool habitats had a mean shelter rating of 33 (Table 1). Of the pool types, the main channel pools had a mean shelter rating of 36, scour pools had a mean shelter rating of 20, (Table 3).

Table 5 summarizes mean percent cover by habitat type. Boulders are the dominant cover type in Pauma Creek. Graph 7 describes the pool cover in Pauma Creek. Boulders are the dominant pool cover type followed by whitewater.

Table 6 summarizes the dominant substrate by habitat type. Graph 8 depicts the dominant substrate observed in pool tail-outs. Large cobble was observed in 32% of pool tail-outs, and boulders were observed in 20% of pool tail-outs.

The mean percent canopy density for the surveyed length of Pauma Creek was 83%. Seventeen percent of the canopy was open. Of the canopy present, the mean percentages of hardwood and coniferous trees were 90% and 10%, respectively. Graph 9 describes the mean percent canopy in Pauma Creek.

For the stream reach surveyed, the mean percent right bank vegetated was 55%. The mean percent left bank vegetated was 62%. The dominant elements composing the structure of the stream banks consisted of 12% bedrock, 44% boulder, 2% cobble/gravel, and 42% sand/silt/clay, (Graph 10). Hardwood trees were the dominant vegetation type observed in 100% of the units surveyed (Graph 11).

BIOLOGICAL INVENTORY RESULTS

The survey crew observed numerous rainbow trout of all age classes in reaches 3 and 5 during the July surveys of 2007. Some large, deep pools easily contained more than 20 trout per pool. Only a few trout were observed in the reach 4 and no trout were observed through bank observation in reaches 1 and 2. However, considering the time of year, winter, and the cold water temperatures, it is not unusual for fish, even if present, to go undetected under these type of conditions. In addition, there were numerous deep pools with sufficient cover that made detection of fish very difficult. Electrofishing and snorkeling of deeper pools in the spring/summer should be performed to verify the presence/absence of fish. No other species of fish were detected for the entire survey length of the survey. Brown trout are known to inhabit

Doane and French Creeks and are most likely in the upper reaches of Pauma Creek.

DISCUSSION

The entire length of the Pauma Creek stream survey lied within the Cleveland National Forest and Palomar Mountain State Park, and there is very little access to the creek except in the headwaters and below the canyon, near Highway 76. The start of the survey began at an elevation of 2,500 feet and rose to an elevation of 4,460 feet in approximately 3 ¾ miles. Pauma Creek mostly flows through a moderate to steep canyon-like setting with numerous natural waterfalls and bedrock chutes. The survey crew observed stretches of creek that had a gradient of 10% or higher. There is a mature riparian canopy along the majority of the creek. The associated canopy is composed of deciduous trees (alders, willows, and oaks) in the lower elevations and a mix of hardwoods and conifers (Douglas fir, white fir, sugar pine, etc.) in the upper elevations.

The water temperatures recorded on the survey days 7/18 & 25/2007 and 1/18/2008, ranged from 41 to 67 degrees Fahrenheit. Air temperatures ranged from 48 to 84 degrees Fahrenheit. The colder temperatures were recorded during the January survey date. Based on observed conditions and the number of rainbow trout in the creek it appeared that water temperatures were suitable for successful completion of all stages of their lifecycle. However, to verify this assumption, 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 36% of the total length of this survey, riffles 43%, and pools 21%. While the majority of the pools measured were relatively shallow, with only 12 of the 44 (34%) pools having a maximum residual depth greater than 3 feet, there were still numerous pools observed throughout the creek that had maximum pool depths greater than 3 feet deep. Moreover, reach 1 was surveyed a couple of months after the 2007 Poomacha Fire and the majority of the pools in this reach contained sediment input as a result of the fire. In time, these sediment levels will be reduced and greater pool depths will be restored.

Seventeen of the 44 (39%) pool tail-outs measured had embeddedness ratings of 1 or 2. Cobble embeddedness measured to be 25% or less, a rating of 1, is considered to indicate good quality spawning substrate for salmon and steelhead. Ten (23%) of the pool tail-outs had embeddedness ratings of 3 or 4. Seventeen (39%) of the pool tail-outs had silt, sand, boulders or bedrock as the dominant substrate, rating of 5, which is considered unsuitable for spawning. Sediment sources in Pauma Creek are generally a result of steep slopes and the effects of recent fires (the 2007 Poomacha Fire). Road density is low with only a few roads traversing the watershed.

The mean shelter rating for pools was 33. The shelter rating in the flatwater habitats was 42. A pool shelter rating of approximately 100 is desirable. The amount of cover that now exists is being provided primarily by boulders in Pauma Creek. Boulders are the dominant cover type in pools followed by whitewater. 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 83%. Reach 1 had a canopy density of 82%, Reach 3 had a canopy density of 93%, and Reach 5 had a canopy density of 76%. In general,

revegetation projects are considered when canopy density is less than 80%; therefore, revegetation projects are not necessary in the surveyed area.

The percentage of right and left bank covered with vegetation was 55% and 62%, 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.

Barriers

As discussed previously the Highway 76 Bridge, located approximately ¾ of a mile upstream of Pauma Creek's confluence with the SLR River, is a complete barrier to all fish passage (Map 1; Photo 3). It consists of three concrete box culverts with a four to five feet high boulder rip rap configuration on the downstream end. Upstream of the culverts is a gently sloped concrete apron that is impassible to steelhead/trout. This apron is approximately 40 feet in length and dissipates the stream flow over a wide area (30-35 feet), creating a thin sheet of water, depending on stream flow. A ten-foot high, concrete wall located 2.4 miles upstream of Highway 76 is also complete barrier to fish passage (Map 1; Photo 4). Numerous partial barriers consisting of bedrock chutes and small waterfalls are located just upstream of this concrete wall (Photo 3). Additional waterfalls that are most likely impassible to steelhead/trout are within a ½ mile of this concrete wall.

RECOMMENDATIONS

1) Pauma Creek should be managed as a potential steelhead and wild trout, natural production stream. Suitable water temperature and flow regimes exist in the stream, and it offers good conditions for spawning and rearing fish.

2) The Highway 76 Bridge crossing needs to be modified in order to allow adult steelhead to migrate to potential spawning and rearing habitat. The crossing also prevents juvenile rainbow trout from moving downstream into the SLR River. The concrete dam, located approximately 2.4 miles upstream of Highway 76 would also need to be modified to allow steelhead further access into Pauma Creek. Due to the high gradient of the stream within the canyon, particularly upstream of river mile 4, access for migrating salmonids is an ongoing potential problem.

3) Perform biological fish surveys in the lower canyon to determine the range and population of rainbow trout in the lower watershed.

4) Survey the stretch of Pauma Creek from its confluence with the SLR River to the mouth of the canyon.

5) Where feasible, design and engineer pool enhancement structures to increase the number of pools in the lower end of the canyon and, if necessary, periodically throughout the corridor between the canyon and the SLR River. This is a long, open stretch of Pauma Creek (approximately 2.75 miles) that steelhead/trout would need to migrate through and resting pools may be needed during migration. Any enhancement structure must be done where the banks are stable or in conjunction with stream bank armor to prevent erosion.

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: Survey began upstream of the Forest Service boundary, approximately 19,008 feet upstream of the confluence with the San Luis Rey River.
67	0005.00	Good tailout for spawning.
109	0007.00	Suitable spawning gravels.
173	0010.00	Tributary entering from the right bank, which contains a 30-foot waterfall within the first 300 feet.
258	0014.00	Pool was moderately filled in with sediments.
427	0022.00	This unit looks like a pool that has filled in with sediment from the Poomacha Fire.
530	0025.00	Photo taken of run and a pool filled in with sediments.
569	0026.00	This unit would be a barrier at low flows.
687	0031.00	Channel type taken at this unit.
727	0032.00	There was a photo taken of this unit.
1257	0047.00	This unit is a low flow barrier.
3839	0054.00	A trout was observed.
4379	0074.00	Photo taken.
4467	0077.00	A resident trout was observed.
4550	0080.00	Approximately 15 trout were observed in this pool, ranging in age from young of the year to 3 year olds.
4584	0081.00	There were approximately 20 trout of all age classes in this pool.
4891	0087.00	There was a good spawning bed at this pool's tailout.
4970	0089.00	There were good spawning gravels in this unit.
5161	0095.00	Six 1 and 2 year old trout were observed in this unit.
22556	0099.00	Three resident trout were observed.

22784	0108.00	Three young of the year and 2 6" trout were observed.
23195	0117.00	Ten 4 inch trout were observed.
23344	0120.00	Twelve young of the year were observed.
23418	0123.00	Three young of the year were observed.
23695	0128.00	Five 4 inch fish were observed.
24241	0139.00	One 1 foot long trout was observed.
24281	0140.00	This unit has a possible fish passage barrier, a photo was taken.
24320	0141.00	Five six inch trout were observed.
24596	0147.00	Possible barrier, picture taken.
24690	0150.00	Six 5 inch trout were observed.
25452	0165.00	Six 4 inch trout were observed.
25566	0168.00	Three 5 inch trout were observed.
25789	0173.00	The survey ended at French Creek.

REFERENCES

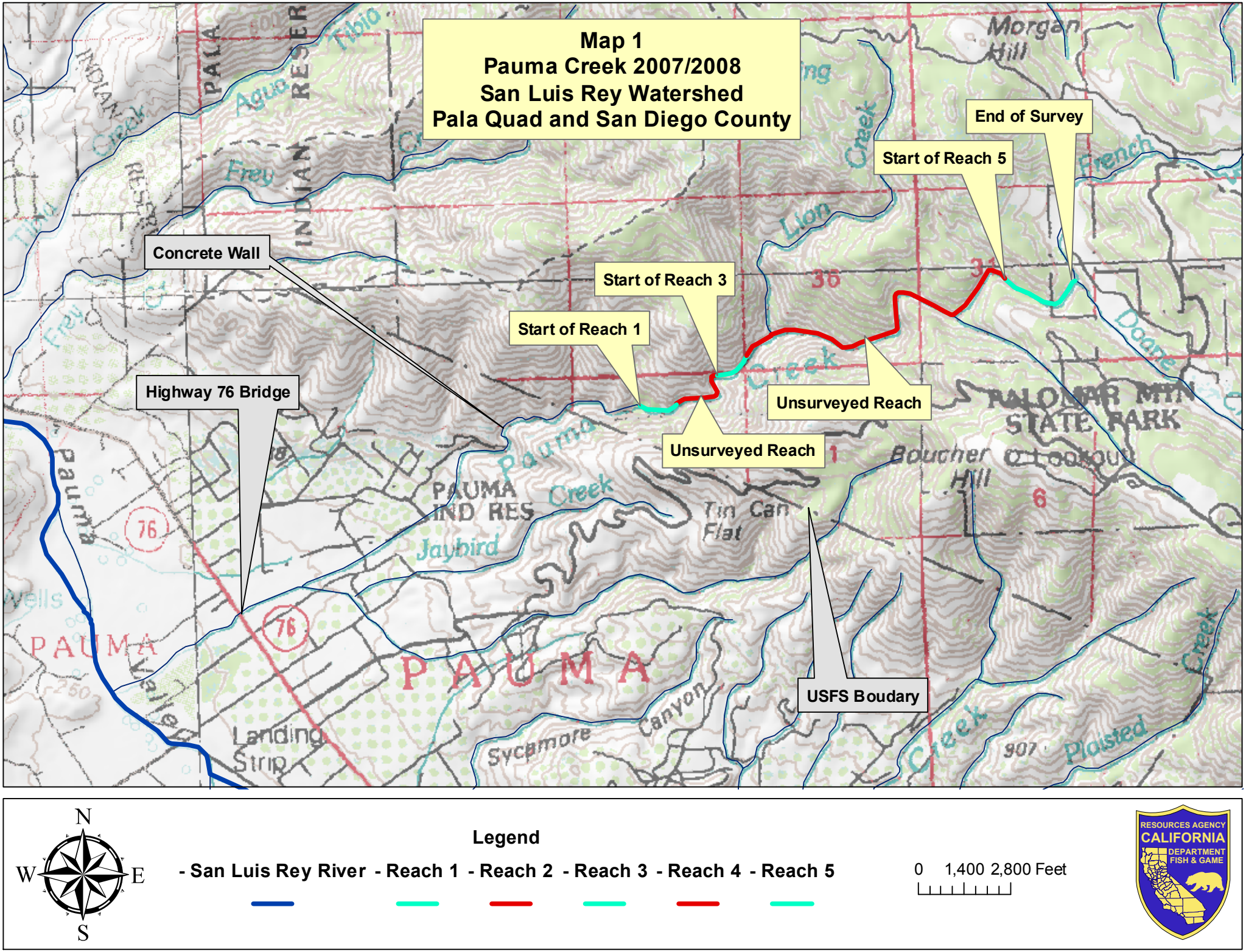
Flosi, G., Downie, S., Hopelain, J., Bird, M., Coey, R., and Collins, B. 1998. *California Salmonid Stream Habitat Restoration Manual*, 3rd edition. California Department of Fish and Game, Sacramento, California.

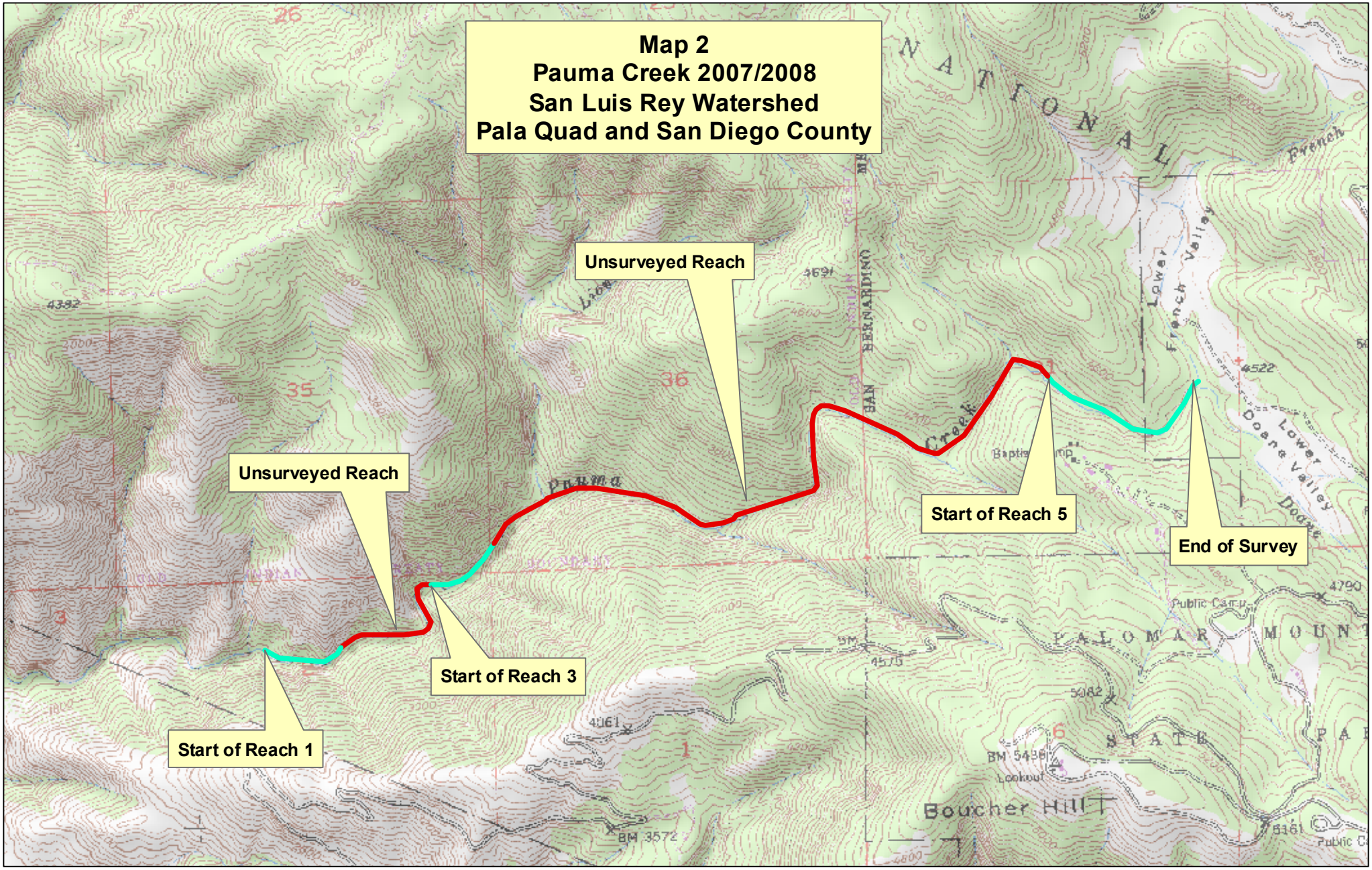
McCain, M., D. Fuller, L. Decker and K. Overton. 1990. Stream habitat classification and inventory procedures for northern California. FHC Currents. No.1. U.S. Department of Agriculture. Forest Service, Pacific Southwest Region.

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]	


Map 1
Pauma Creek 2007/2008
San Luis Rey Watershed
Pala Quad and San Diego County
End of Survey
Start of Reach 5
Concrete Wall
Start of Reach 3
Start of Reach 1
Highway 76 Bridge
Unsurveyed Reach
Unsurveyed Reach
USFS Boudary
PALOMAR MTN STATE PARK
PAUMA IND RES
PAUMA
Morgan Hill
Boucher Hill
Tin Can Flat
Sycamore Canyon
Landing Strip
Pauma Creek
Jaybird
Lion Creek
Frey
Agua Tibia
Doane
Plaisted
Creek
N
S
E
W
Legend
- San Luis Rey River
- Reach 1
- Reach 2
- Reach 3
- Reach 4
- Reach 5
0 1,400 2,800 Feet
RESOURCES AGENCY
CALIFORNIA
DEPARTMENT FISH & GAME



N
W E
S

Legend

Reach 1 Reach 2 Reach 3 Reach 4 Reach 5

0 710 1,420 Feet

RESOURCES AGENCY
CALIFORNIA
DEPARTMENT
FISH & GAME

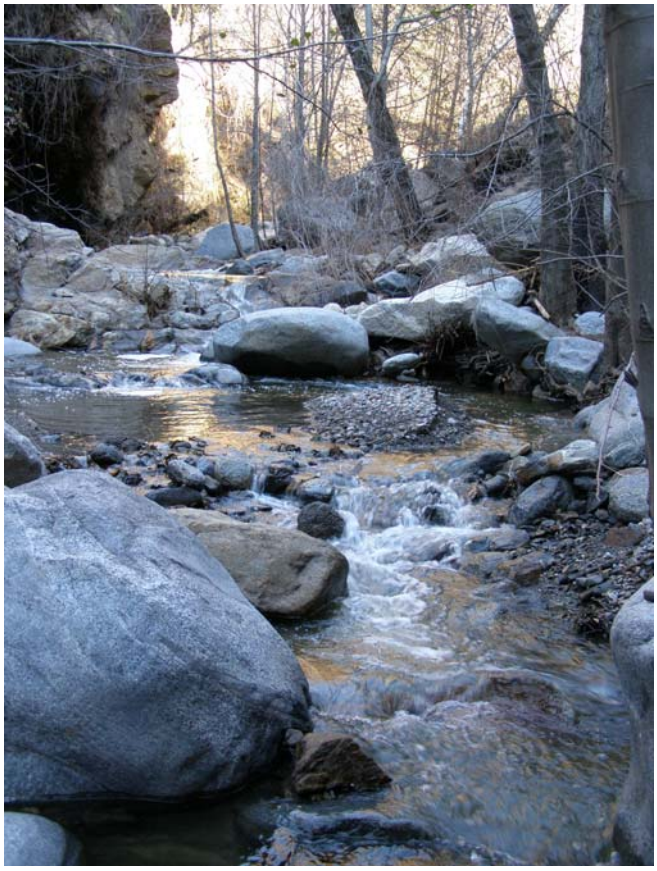


Photo 1. View of lower Pauma Creek, Reach 1 (January, 2008).
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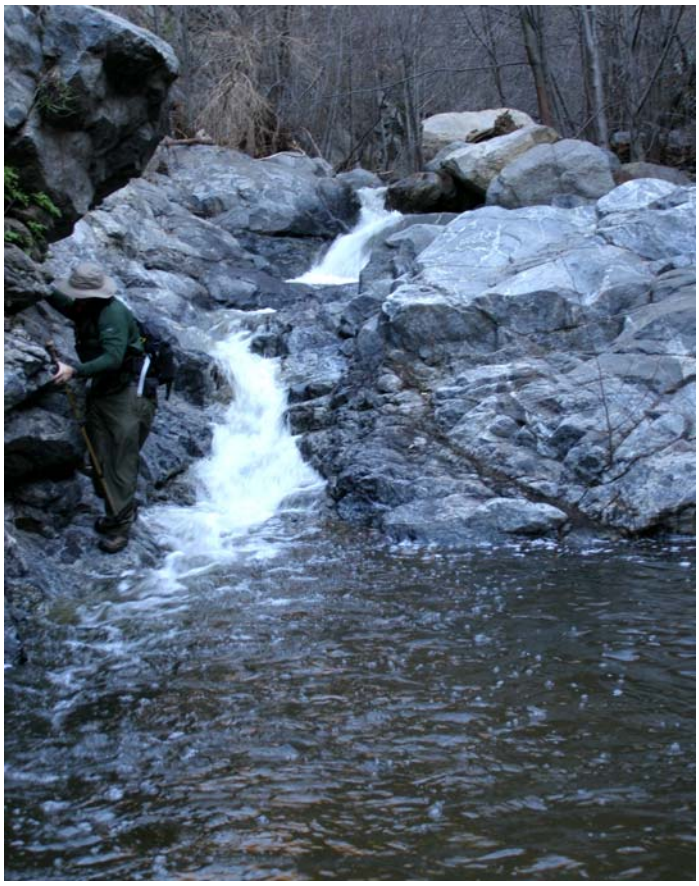


Photo 2. Partial fish passage barrier, located downstream of Reach 1 (January 2008).

Photo 3. Pauma Creek at Highway 76 (January, 2008).

Photo 4. Concrete wall barrier located approximately 2.4 miles upstream of Highway 76 (January, 2008).

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

Stream Name: Pauma Creek LLID: 1170084333176 Drainage: San Luis Rey

Survey Dates: 7/18/2007 to 1/18/2008

Confluence Location: Quad: Legal Description: T000R000S00 Latitude: 33:19:03.0N Longitude: 117:00:30.0

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
1	0	DRY	0.6	9	9	0.1									
58	14	FLATWATER	33.0	37	2173	35.6	7.3	0.5	0.9	271	15739	168	9054		42
3	0	NOSURVEY	1.7	6584	19753										
45	10	POOL	25.6	28	1280	21.0	10.7	0.6	1.8	201	9040	231	10410	173	33
69	12	RIFFLE	39.2	38	2644	43.3	5.5	0.4	0.8	93	6448	36	2458		57

Total Units	Total Units Fully Measured	Total Length (ft.)	Total Area (sq.ft.)	Total Volume (cu.ft.)
176	36	25859	31226	21922

Table 2 - Summary of Habitat Types and Measured Parameters

Stream Name: Pauma Creek LLID: 1170084333176 Drainage: San Luis Rey

Survey Dates: 7/18/2007 to 1/18/2008

Confluence Location: Quad: Legal Description: T000R000S00 Latitude: 33:19:03.0N Longitude: 117:00:30.0W

Habitat Units	Units Fully Measured	Habitat Type	Habitat Occurrence (%)	Mean Length (ft.)	Total Length (ft.)	Total Length (%)	Mean Width (ft.)	Mean Depth (ft.)	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 (%)
36	5	LGR	20.5	36	1282	21.0	5	0.4	1.2	102	3680	38	1362		40	89
32	6	HGR	18.2	42	1344	22.0	6	0.5	1.4	94	3009	37	1174		73	90
1	1	BRS	0.6	18	18	0.3	3	0.4	0.9	46	46	18	18		40	79
44	9	RUN	25.0	36	1589	26.0	7	0.5	1.4	196	8628	95	4181		39	82
14	5	SRN	8.0	42	584	9.6	8	0.6	1.5	407	5696	333	3725		48	81
39	6	MCP	22.2	28	1087	17.8	11	0.6	5.8	234	9124	285	11115	237	38	80
4	2	STP	2.3	40	159	2.6	9	0.9	1.7	147	589	179	716	141	30	60
1	1	LSBk	0.6	13	13	0.2	12	0.2	1.8	140	140	126	126	28	20	
1	1	LSBo	0.6	21	21	0.3	9	0.4	0.9	170	170	119	119	68	20	88
1	0	DRY	0.6	9	9	0.1										
3	0	NS	1.7	6584	19753											

Total Units	Total Units Fully Measured	Total Length (ft.)	Total Area (sq.ft.)	Total Volume (cu.ft.)
176	36	25859	31084	22536

Table 3 - Summary of Pool Types

Stream Name: Pauma Creek LLID: 1170084333176 Drainage: San Luis Rey

Survey Dates: 7/18/2007 to 1/18/2008

Confluence Location: Quad: Legal Description: T000R000S00 Latitude: 33:19:03.0N Longitude: 117:00:30.0W

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
43	8	MAIN	96	29	1246	97	10.8	0.6	212	9129	209	7873	36
2	2	SCOUR	4	17	34	3	10.5	0.3	155	311	48	96	20

Total Units	Total Units Fully Measured	Total Length (ft.)	Total Area (sq.ft.)	Total Volume (cu.ft.)
45	10	1280	9439	7969

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

Stream Name: Pauma Creek LLID: 1170084333176 Drainage: San Luis Rey

Survey Dates: 7/18/2007 to 1/18/2008

Confluence Location: Quad: Legal Description: T000R000S00 Latitude: 33:19:03.0N Longitude: 117:00:30.0W

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
39	MCP	89	8	21	16	41	11	28	2	5	2	5
3	STP	7	0	0	3	100	0	0	0	0	0	0
1	LSBk	2	0	0	1	100	0	0	0	0	0	0
1	LSBo	2	1	100	0	0	0	0	0	0	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
44	9	20	20	45	11	25	2	5	2	5

Mean Maximum Residual Pool Depth (ft.): 1.8

Table 5 - Summary of Mean Percent Cover By Habitat Type

Stream Name: Pauma Creek LLID: 1170084333176 Drainage: San Luis Rey

Survey Dates: 7/18/2007 to 1/18/2008 Dry Units: 1

Confluence Location: Quad: Legal Description: T000R000S00 Latitude: 33:19:03.0N Longitude: 117:00:30.0W

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
36	5	LGR	0	5	0	0	2	0	24	67	2
32	6	HGR	0	8	2	1	3	0	8	79	0
1	1	BRS	0	0	0	0	0	0	5	95	0
69	12	TOTAL RIFFLE	0	6	1	0	2	0	15	75	1
44	9	RUN	0	6	2	0	19	0	6	68	0
14	4	SRN	0	5	0	0	3	0	11	80	1
58	13	TOTAL FLAT	0	6	1	0	14	0	7	72	0
39	8	MCP	0	4	0	1	2	1	11	81	0
4	2	STP	0	30	0	0	0	0	25	38	8
1	1	LSBk	0	0	0	0	0	0	55	45	0
1	1	LSBo	15	0	0	5	0	0	55	25	0
45	12	TOTAL POOL	1	8	0	1	1	1	21	66	1
3	0	NS									
176	37	TOTAL	0	6	1	1	6	0	14	71	1

Table 6 - Summary of Dominant Substrates By Habitat Type

Stream Name: Pauma Creek LLID: 1170084333176 Drainage: San Luis Rey

Survey Dates: 7/18/2007 to 1/18/2008 Dry Units: 1

Confluence Location: Quad: Legal Description: T000R000S00 Latitude: 33:19:03.0N Longitude: 117:00:30.0W

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
36	5	LGR	0	0	0	0	40	40	20
32	6	HGR	0	17	0	0	33	50	0
1	1	BRS	0	0	0	0	0	100	0
44	8	RUN	0	38	13	0	13	25	13
14	5	SRN	0	0	0	0	20	80	0
39	7	MCP	0	57	0	0	14	14	14
4	2	STP	0	100	0	0	0	0	0
1	1	LSBk	0	100	0	0	0	0	0
1	1	LSBo	0	0	100	0	0	0	0

Table 7 - Summary of Mean Percent Canopy for Entire Stream

Stream Name: Pauma Creek LLID: 1170084333176 Drainage: San Luis Rey

Survey Dates: 7/18/2007 to 1/18/2008

Confluence Location: Quad: Legal Description: T000R000S00 Latitude: 33:19:03.0N Longitude: 117:00:30.0W

Mean Percent Canopy	Mean Percent Conifer	Mean Percent Hardwood	Mean Percent Open Units	Mean Right Bank % Cover	Mean Left Bank % Cover
83	10	90	0	55	62

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: Pauma Creek | LLID: 1170084333176 | Drainage: San Luis Rey

Survey Dates: 7/18/2007 to 1/18/2008 | Survey Length (ft.): 25859 | Main Channel (ft.): 25789 | Side Channel (ft.): 70

Confluence Location: Quad: | Legal Description: T000R000S00 | Latitude: 33:19:03.0N | Longitude: 117:00:30.0W

Summary of Fish Habitat Elements By Stream Reach

STREAM REACH: 1

Channel Type: B2
Reach Length (ft.): 1373
Riffle/Flatwater Mean Width (ft.): 9.3
BFW:
Range (ft.): to
Mean (ft.):
Std. Dev.:
Base Flow (cfs.): 4.5
Water (F): 41 - 42 Air (F): 48 - 54
Dry Channel (ft): 0

Canopy Density (%): 81.7
Coniferous Component (%): 0.0
Hardwood Component (%): 100.0
Dominant Bank Vegetation: Hardwood Trees
Vegetative Cover (%): 31.6
Dominant Shelter: Whitewater
Dominant Bank Substrate Type: Boulder
Occurrence of LWD (%): 0
LWD per 100 ft.:
Riffles:
Pools:
Flat:

Pools by Stream Length (%): 27.2
Pool Frequency (%): 30.0
Residual Pool Depth (%):
< 2 Feet Deep: 80
2 to 2.9 Feet Deep: 20
3 to 3.9 Feet Deep: 0
>= 4 Feet Deep: 0
Mean Max Residual Pool Depth (ft.): 1.4
Mean Pool Shelter Rating: 28

Pool Tail Substrate (%): Silt/Clay: 0 Sand: 13 Gravel: 27 Sm Cobble: 13 Lg Cobble: 7 Boulder: 27 Bedrock: 13

Embeddedness Values (%): 1. 6.7 2. 33.3 3. 6.7 4. 0.0 5. 53.3

STREAM REACH: 2

Channel Type: NA
Reach Length (ft.): 2414
Riffle/Flatwater Mean Width (ft.):
BFW:
Range (ft.): to
Mean (ft.):
Std. Dev.:
Base Flow (cfs.):
Water (F): 0 - 0 Air (F): 0 - 0
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: A2
Reach Length (ft.): 1393
Riffle/Flatwater Mean Width (ft.): 4.7
BFW:
Range (ft.): to
Mean (ft.):
Std. Dev.:
Base Flow (cfs.): 1.0
Water (F): 66 - 67 Air (F): 79 - 84
Dry Channel (ft): 9

Canopy Density (%): 93.0
Coniferous Component (%): 1.0
Hardwood Component (%): 99.0
Dominant Bank Vegetation: Hardwood Trees
Vegetative Cover (%): 30.3
Dominant Shelter: Boulders
Dominant Bank Substrate Type: Boulder
Occurrence of LWD (%): 0
LWD per 100 ft.:
Riffles:
Pools:
Flat:

Pools by Stream Length (%): 26.9
Pool Frequency (%): 25.5
Residual Pool Depth (%):
< 2 Feet Deep: 25
2 to 2.9 Feet Deep: 50
3 to 3.9 Feet Deep: 8
>= 4 Feet Deep: 17
Mean Max Residual Pool Depth (ft.): 2.8
Mean Pool Shelter Rating: 38

Pool Tail Substrate (%): Silt/Clay: 0 Sand: 0 Gravel: 8 Sm Cobble: 15 Lg Cobble: 38 Boulder: 38 Bedrock: 0
Embeddedness Values (%): 1. 0.0 2. 23.1 3. 46.2 4. 7.7 5. 23.1

STREAM REACH: 4

Channel Type: NA
Reach Length (ft.): 17286
Riffle/Flatwater Mean Width (ft.):
BFW:
Range (ft.): to
Mean (ft.):
Std. Dev.:
Base Flow (cfs.):
Water (F): 0 - 0 Air (F): 0 - 0
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: 5

Channel Type: B2
Reach Length (ft.): 3323
Riffle/Flatwater Mean Width (ft.): 5.8
BFW:
Range (ft.): to
Mean (ft.):
Std. Dev.:
Base Flow (cfs.): 0.0
Water (F): 59 - 62 Air (F): 64 - 78
Dry Channel (ft): 0

Canopy Density (%): 75.6
Coniferous Component (%): 23.5
Hardwood Component (%): 76.5
Dominant Bank Vegetation: Hardwood Trees
Vegetative Cover (%): 96.1
Dominant Shelter: Boulders
Dominant Bank Substrate Type: Sand/Silt/Clay
Occurrence of LWD (%): 2
LWD per 100 ft.:
Riffles:
Pools:
Flat:

Pools by Stream Length (%): 15.5
Pool Frequency (%): 23.4
Residual Pool Depth (%):
< 2 Feet Deep: 82
2 to 2.9 Feet Deep: 12
3 to 3.9 Feet Deep: 6
>= 4 Feet Deep: 0
Mean Max Residual Pool Depth (ft.): 1.4
Mean Pool Shelter Rating: 37

Pool Tail Substrate (%): Silt/Clay: 0 Sand: 25 Gravel: 6 Sm Cobble: 13 Lg Cobble: 50 Boulder: 0 Bedrock: 6

Embeddedness Values (%): 1. 50.0 2. 0.0 3. 6.3 4. 6.3 5. 37.5

Table 9 - Mean Percentage of Dominant Substrate and Vegetation

Stream Name: Pauma Creek LLID: 1170084333176 Drainage: San Luis Rey

Survey Dates: 7/18/2007 to 1/18/2008

Confluence Location: Quad: Legal Description: T000R000S00 Latitude: 33:19:03.0N Longitude: 117:00:30.0W

Mean Percentage of Dominant Stream Bank Substrate

Dominant Class of Substrate	Number of Units Right Bank	Number of Units Left Bank	Total Mean Percent (%)
Bedrock	7	1	12.1
Boulder	12	17	43.9
Cobble / Gravel	1	0	1.5
Sand / Silt / Clay	13	15	42.4

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	33	33	100.0
Coniferous Trees	0	0	0.0
No Vegetation	0	0	0.0

Total Stream Cobble Embeddedness Values: 3

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

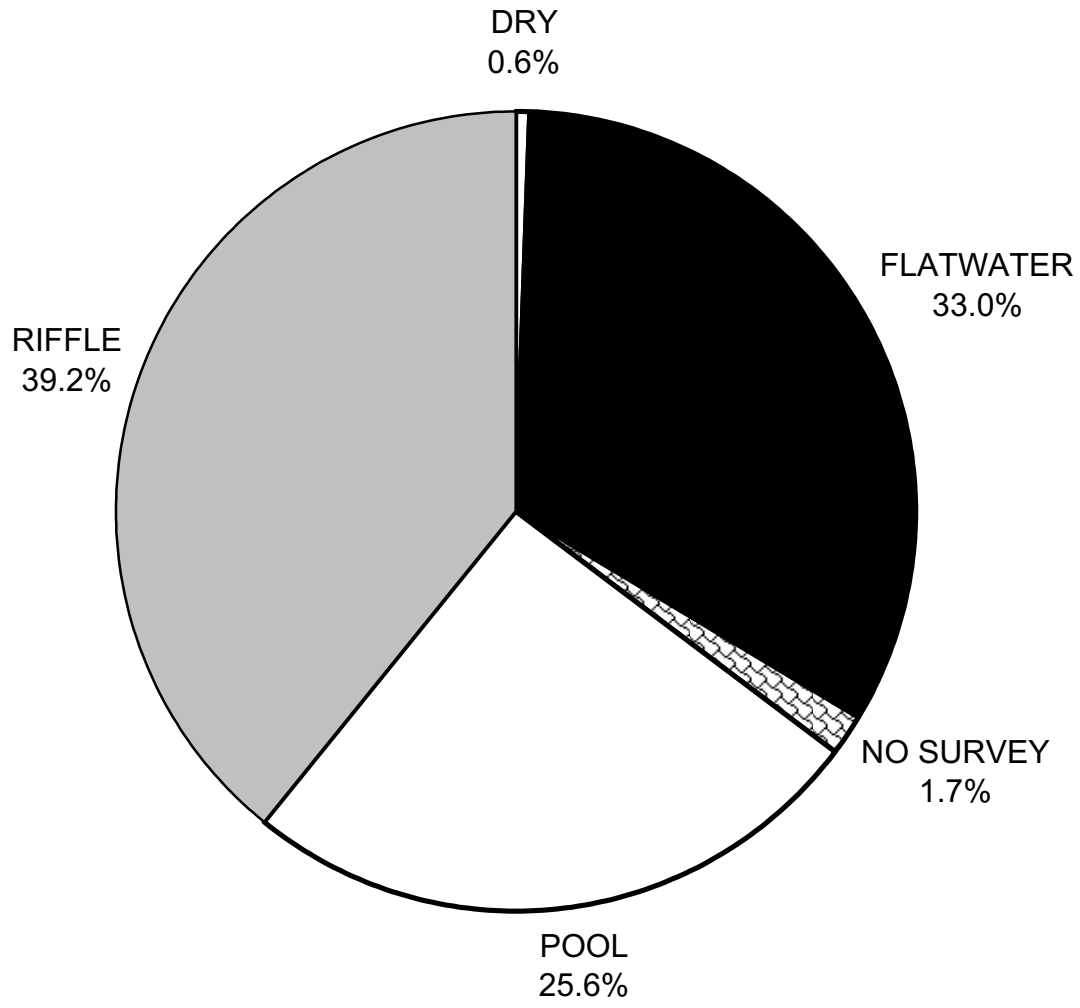
StreamName: Pauma Creek LLID: 1170084333176 Drainage: San Luis Rey

Survey Dates: 7/18/2007 to 1/18/2008

Confluence Location: Quad: Legal Description: T000R000S00 Latitude: 33:19:03.0N Longitude: 117:00:30.0W

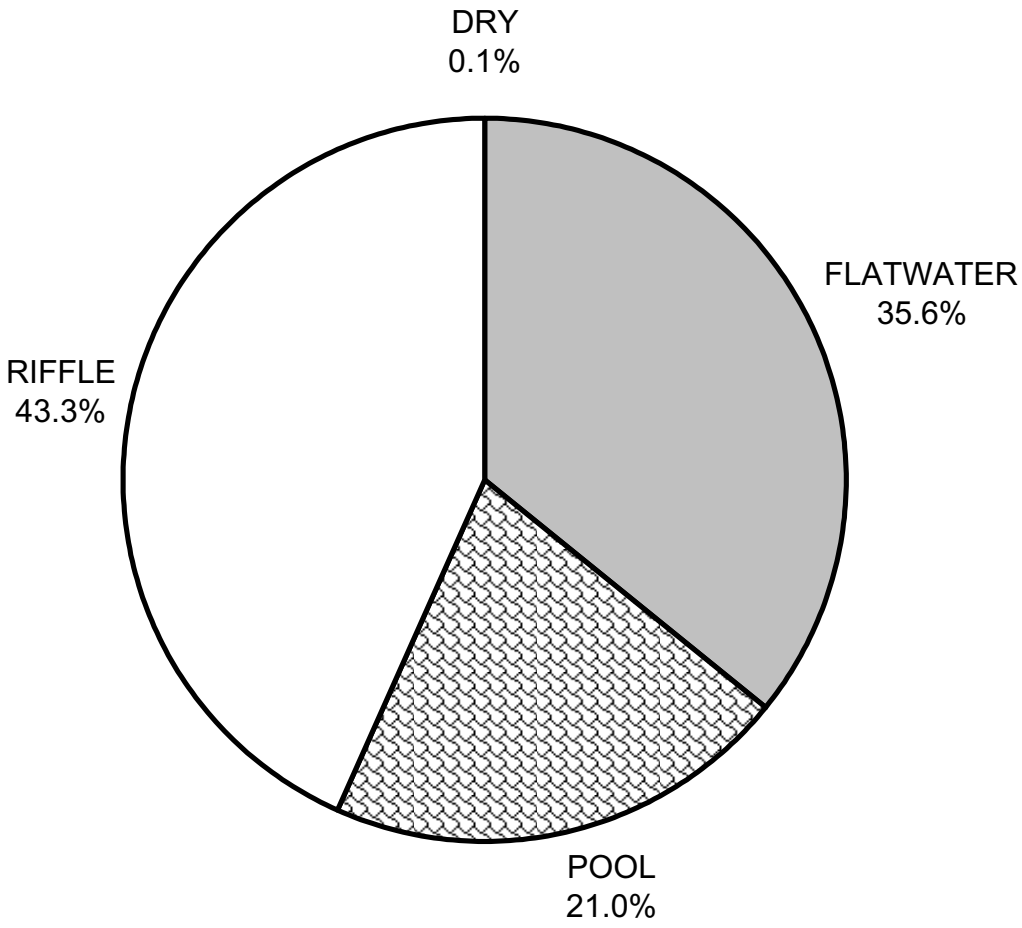
	Riffles	Flatwater	Pools
UNDERCUT BANKS (%)	0	0	1
SMALL WOODY DEBRIS (%)	6	6	8
LARGE WOODY DEBRIS (%)	1	1	0
ROOT MASS (%)	0	0	1
TERRESTRIAL VEGETATION (%)	2	14	1
AQUATIC VEGETATION (%)	0	0	1
WHITEWATER (%)	15	7	21
BOULDERS (%)	75	72	66
BEDROCK LEDGES (%)	1	0	1

PAUMA CREEK 2007
HABITAT TYPES BY PERCENT OCCURRENCE



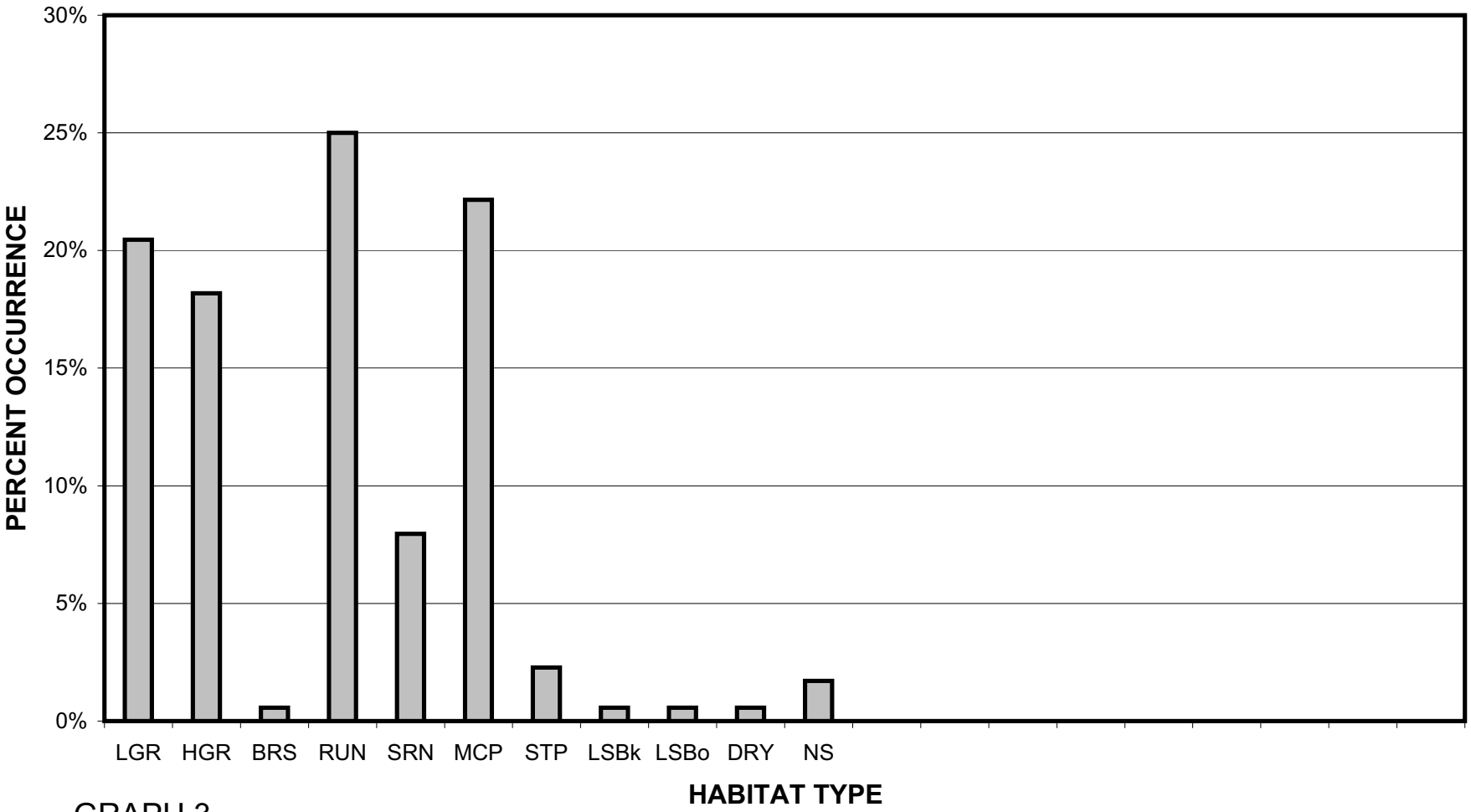
GRAPH 1

PAUMA CREEK 2007
HABITAT TYPES BY PERCENT TOTAL LENGTH



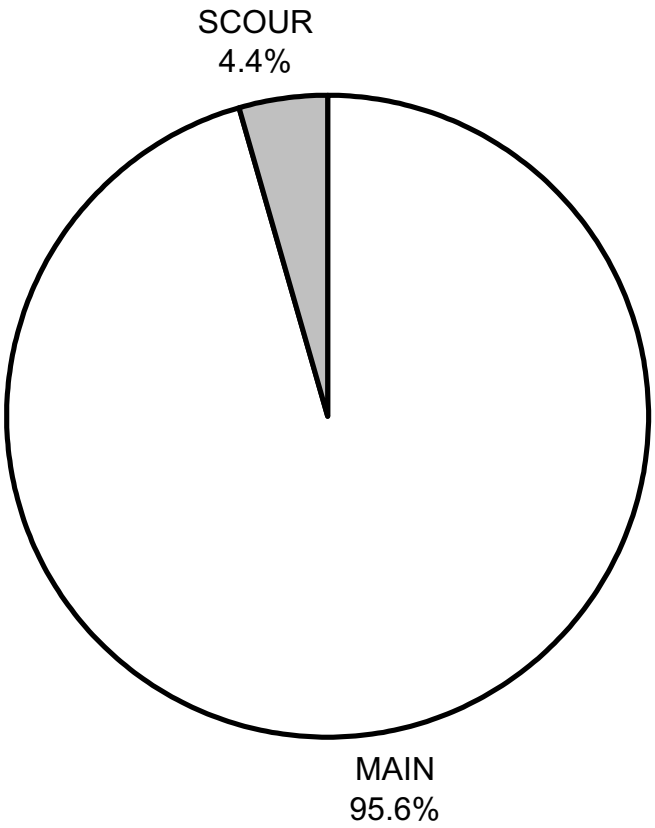
GRAPH 2

PAUMA CREEK 2007
HABITAT TYPES BY PERCENT OCCURRENCE



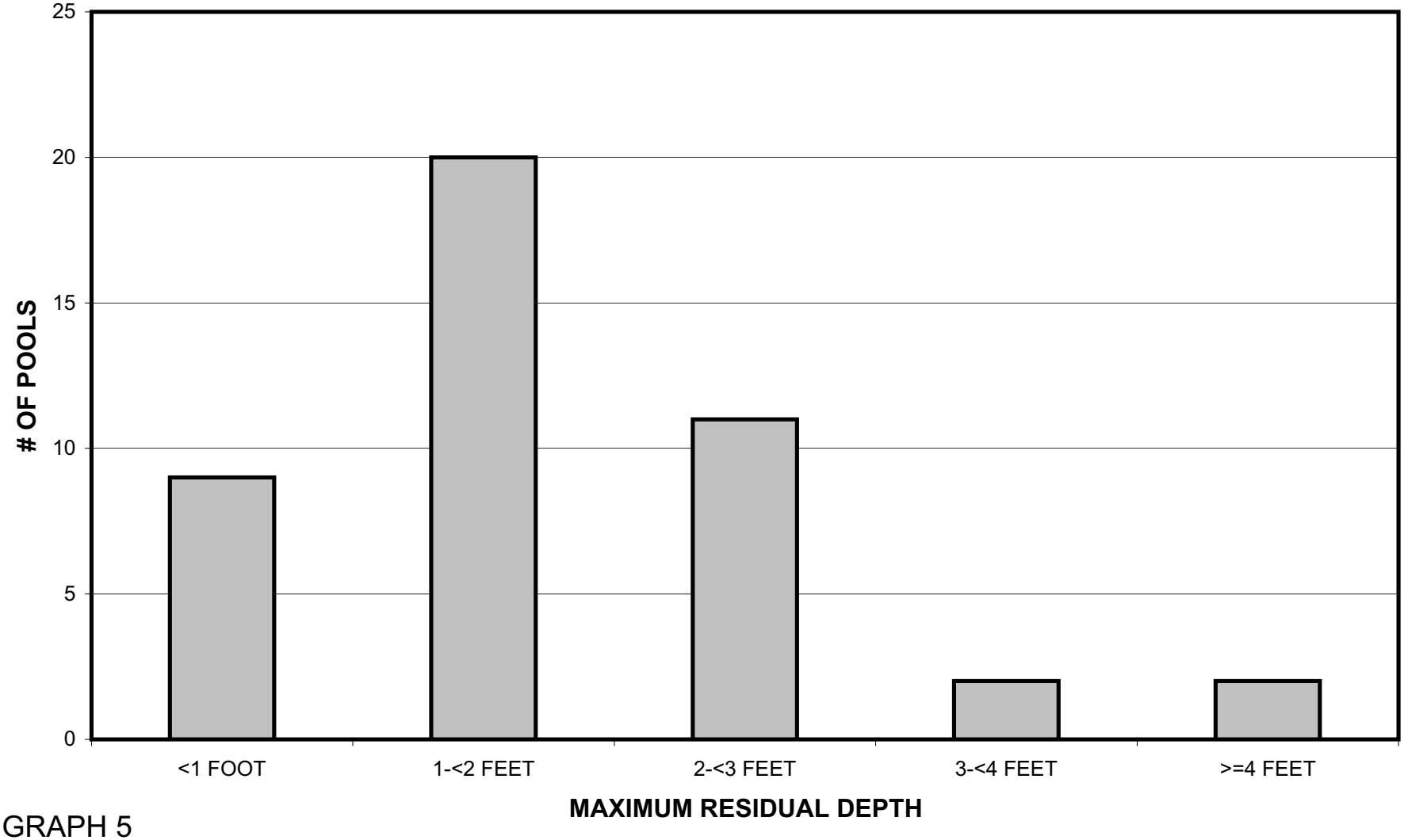
GRAPH 3

PAUMA CREEK 2007
POOL TYPES BY PERCENT OCCURRENCE



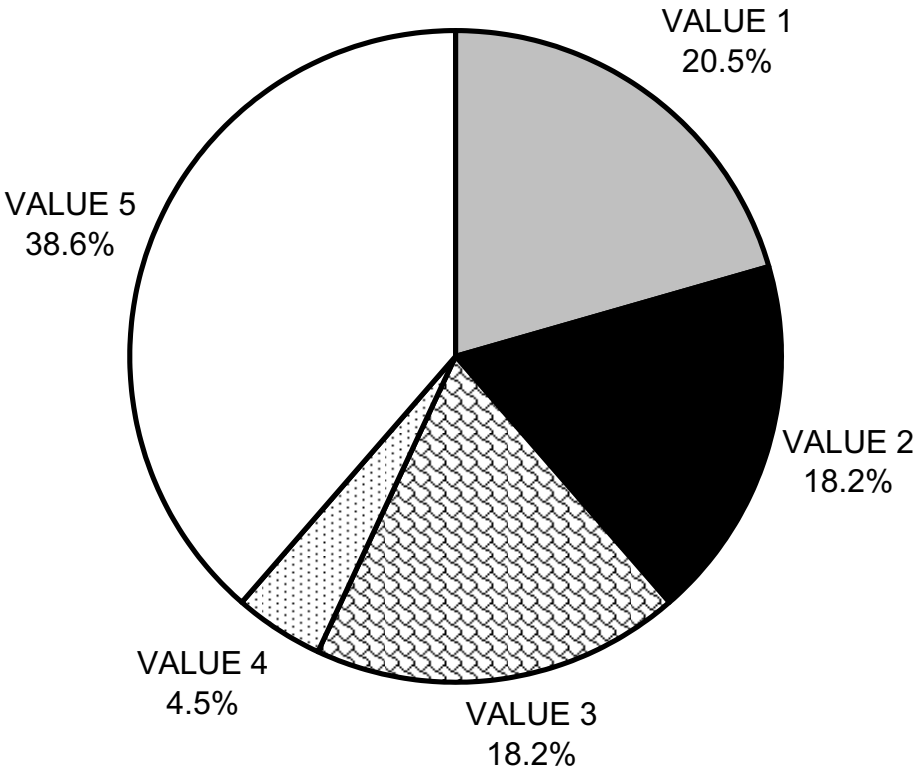
GRAPH 4

PAUMA CREEK 2007
MAXIMUM DEPTH IN POOLS



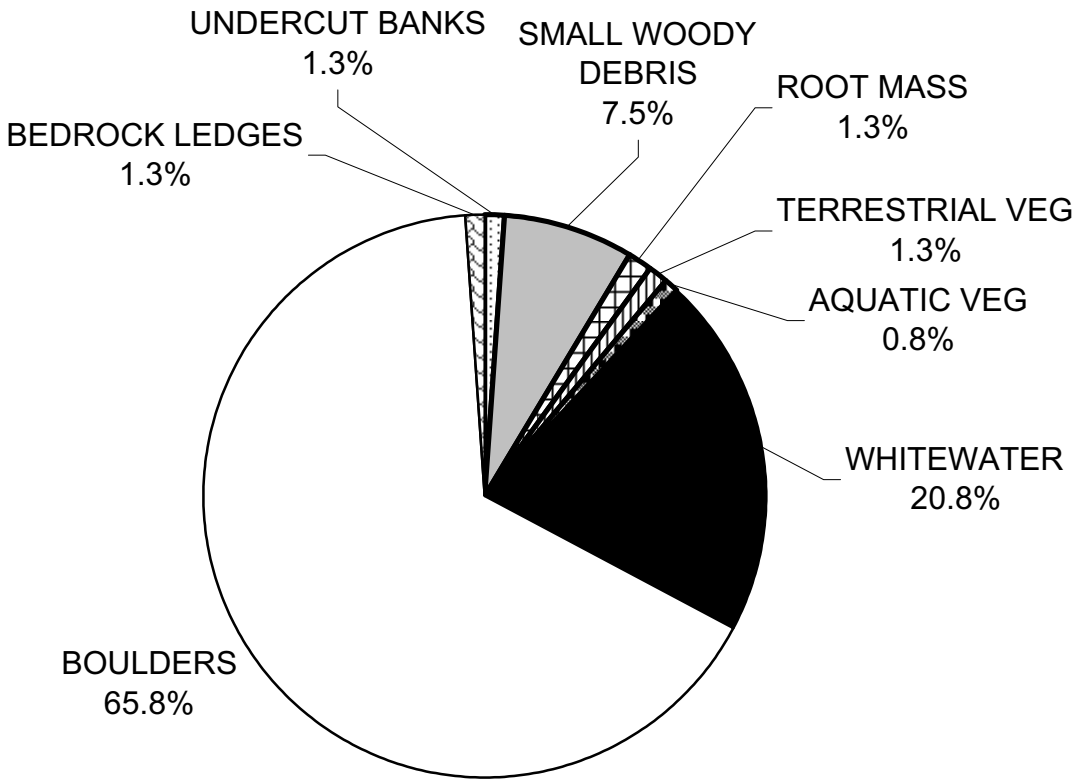
GRAPH 5

PAUMA CREEK 2007
PERCENT EMBEDDEDNESS



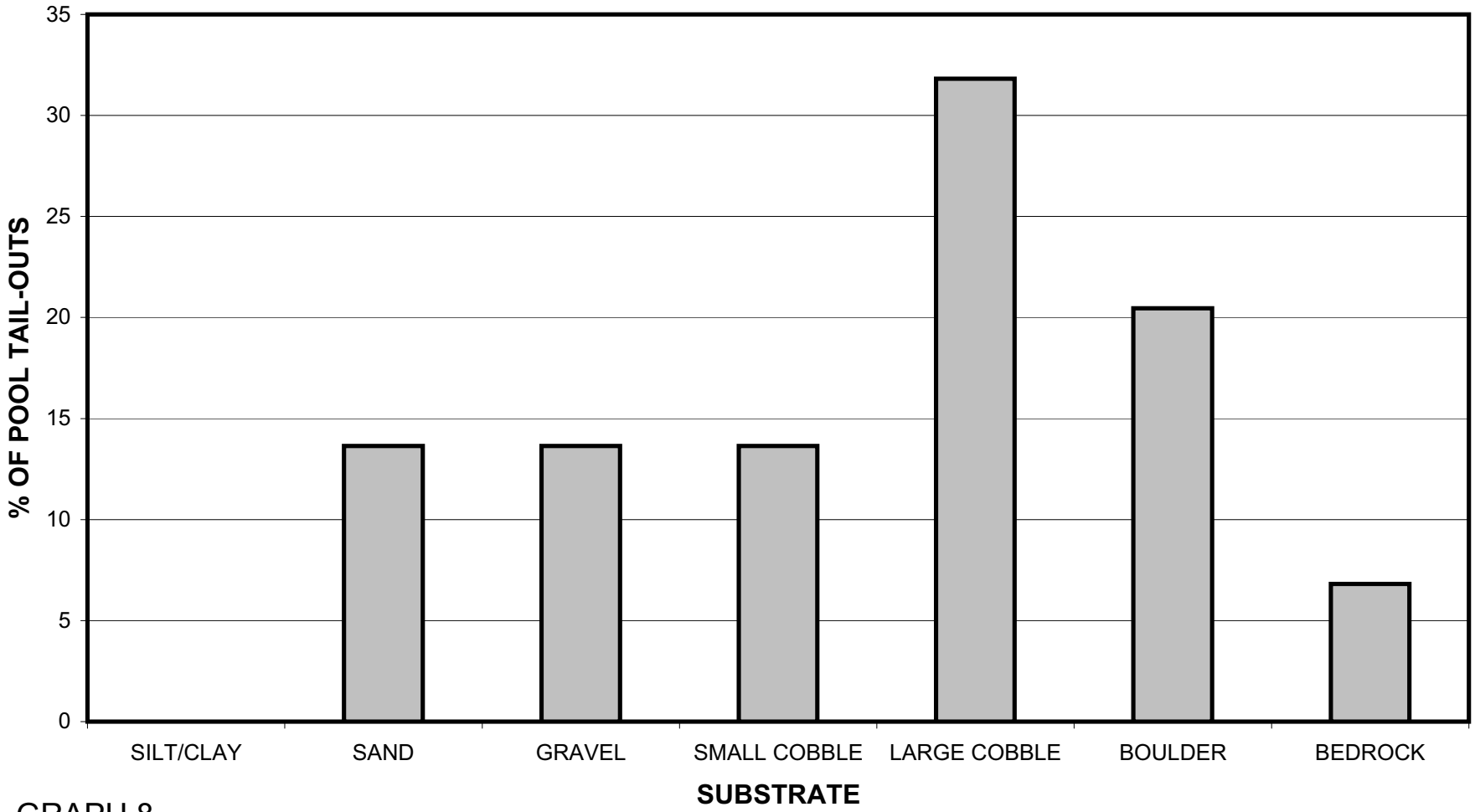
GRAPH 6

PAUMA CREEK 2007
MEAN PERCENT COVER TYPES IN POOLS



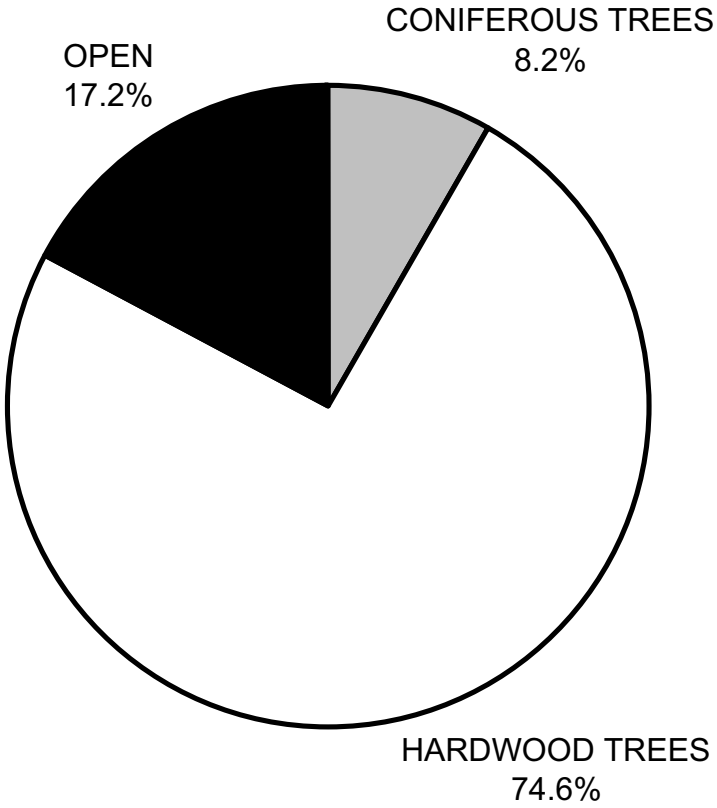
GRAPH 7

PAUMA CREEK 2007
SUBSTRATE COMPOSITION IN POOL TAIL-OUTS



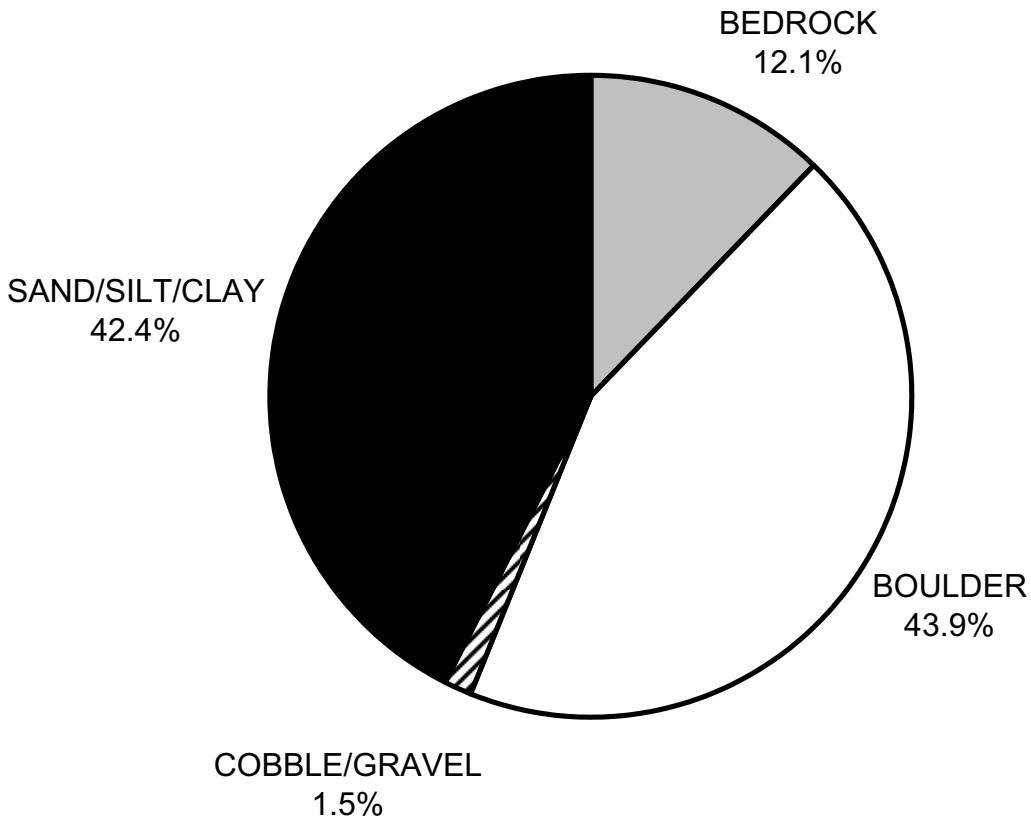
GRAPH 8

PAUMA CREEK 2007
MEAN PERCENT CANOPY



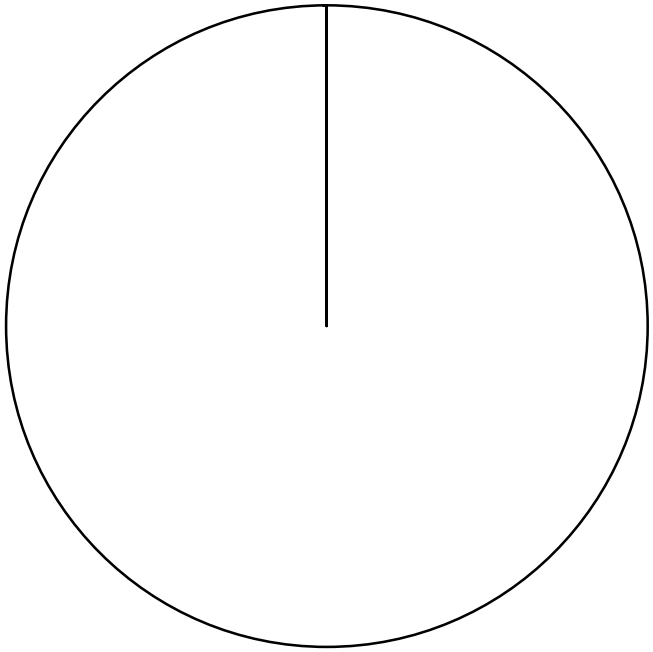
GRAPH 9

PAUMA CREEK 2007
DOMINANT BANK COMPOSITION IN SURVEY REACH



GRAPH 10

PAUMA CREEK 2007
DOMINANT BANK VEGETATION IN SURVEY REACH



HARDWOOD TREES
100.0%

GRAPH 11