California Department of Fish and Game
Lagunitas Watershed
Stream Habitat Assessment Reports

Upper San Geronimo Creek

STREAM INVENTORY REPORT
Upper San Geronimo Creek

Assessment completed 2007
Report Completed 2009

INTRODUCTION

A stream inventory was conducted on 9/27/2007 on the upper reaches of San Geronimo Creek. The survey began at the confluence of San Geronimo Creek and Woodacre Creek (38°00'48.0" N 122°38'47.0" W) near the intersection of Railroad Avenue and San Geronimo Valley Drive in Woodacre, California and extended upstream 1.8 miles.

The Upper San Geronimo 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 Upper San Geronimo 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 Chinook salmon, coho salmon, and steelhead trout. Recommendations for habitat improvement activities are based upon target habitat values suitable for salmonids in California's north coast streams.

WATERSHED OVERVIEW

San Geronimo Creek is located in Marin County, California (Map 1), and is a tributary to Lagunitas Creek, which runs into Tomales Bay, before heading out to the Pacific Ocean. Upper San Geronimo Creek's legal description at the confluence with its unnamed tributary is T02N R07W S17. Its location is 38° 00'48.0" north latitude and 122° 38'47.0" west longitude, LLID number 1226462380132. Upper San Geronimo Creek is considered a second order stream, its upper reaches and has approximately 1.6 miles of blue line stream according to the USGS National Hydrography Dataset (NHD). Upper San Geronimo Creek drains a watershed of approximately 2.98 square miles. Elevations range from about 334 feet at the start of the survey to 1,299 feet in the headwater areas. Mixed hardwood forest dominates the watershed. The watershed is mostly privately owned which accounts for 99.3% of the land area. The local government owns about 0.7%. Approximately 98 % of the land is considered natural and 7.9% of the land is also considered urban. Vehicle access exists via Sir Francis Drake Blvd. and San Geronimo Valley Drive near Woodacre, in Marin County, California.

METHODS

The habitat inventory conducted in upper reaches of San Geronimo Creek follows the methodology presented in the *California Salmonid Stream Habitat Restoration Manual* (Flosi et al, 1998). The California Department of Fish and Game (DFG) personnel 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 Game. This inventory was conducted by a two-person team.

SAMPLING STRATEGY

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

HABITAT INVENTORY COMPONENTS

A standardized habitat inventory form has been developed for use in California stream surveys and can be found in the *California Salmonid Stream Habitat Restoration Manual*. This form was used in Upper San Geronimo 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". Upper San Geronimo 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 Upper San Geronimo 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 Upper San Geronimo 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 Upper San Geronimo 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 Upper San Geronimo 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 Upper San Geronimo Creek. In addition, 2 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 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 Upper San Geronimo 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 carried out on 9/27/2007 was conducted by B. Nedland and J. Hanson (WSP-AmeriCorps). The total length of the stream surveyed was 9,311 feet. Stream flow was not measured on Upper San Geronimo Creek.

Upper San Geronimo Creek is an F4 channel type for 1,881 feet of the stream surveyed (Reach 1), another F4 channel type for 2,967 feet of the stream surveyed (Reach 2), an E6 channel type for 1,876 feet of the stream surveyed (Reach 3), and an F4 channel type for the remaining 2,587 feet of the stream surveyed (Reach 4).

F4 channels are entrenched, meandering, riffle/pool channels on low gradients with high width/depth ratios and gravel-dominant substrates. E6 channels are low gradient, meandering riffle/pool streams as well, but they have low width/depth ratios and little deposition.

Water temperatures taken during the survey period ranged from 52 to 56 degrees Fahrenheit. Air temperatures ranged from 56 to 76 degrees Fahrenheit.

Table 1 summarizes the Level II riffle, flatwater, and pool habitat types. Based on frequency of occurrence there were 43% dry units, 23% flatwater units, 23% pool units, 10% culvert units, and 2% riffle units (Graph 1). Based on total length of Level II habitat types there were 78% dry units, 11% flatwater units, 5% pool units, 5% culvert units, and less than 1% riffle units (Graph 2).

Eleven Level IV habitat types were identified (Table 2). The most frequent habitat types by

percent occurrence were 43% Dry units, 21% Glide units, and 10% Culvert units (Graph 3). Similarly, based on percent total length, there were 78% Dry units, 11% Glide units, and 5% Culvert units.

A total of 14 pools were identified (Table 3). Scour pools were the most frequently encountered, at 71%, and comprised 67% 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. Nine of the 13 pools (69%) had a residual depth of two feet or greater (Graph 5).

The depth of cobble embeddedness was estimated at pool tail-outs. Of the 13 pool tail-outs measured, 5 had a value of 2 (38.5%); 2 had a value of 3 (15.4%); 6 had a value of 5 (46.2%); (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 7 , and pool habitats had a mean shelter rating of 18 (Table 1). Of the pool types, the scour pools had a mean shelter rating of 16, and main channel pools had a mean shelter rating of 21 (Table 3).

Table 5 summarizes mean percent cover by habitat type. Boulders are the dominant cover types in Upper San Geronimo Creek. Graph 7 describes the pool cover in Upper San Geronimo 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. A gravel-dominant substrate was observed in 23% of pool tail-outs, while small cobble was observed in 31% of pool tail-outs.

The mean percent canopy density for the surveyed length of Upper San Geronimo Creek was 78%. The mean percentages of hardwood and coniferous trees were 88% and 12%, respectively. Twenty-two percent of the canopy was open. Graph 9 describes the mean percent canopy in Upper San Geronimo Creek.

For the stream reach surveyed, the mean percent right bank vegetated was 70%. The mean percent left bank vegetated was 75%. The dominant elements composing the structure of the stream banks consisted of 100% sand/silt/clay (Graph 10). Mixed hardwood trees was the dominant vegetation type observed in 83% of the units surveyed. Additionally, 14% of the units surveyed had brush as the dominant vegetation type, and 4% had grass as the dominant vegetation (Graph 11).

BIOLOGICAL INVENTORY RESULTS

Two sites were electrofished for species composition and distribution in Upper San Geronimo Creek on September 27, 2007. Water temperatures taken during the electrofishing period 9:30-

11:50 ranged from 49 to 52 degrees Fahrenheit. Air temperatures ranged from 54 to 69 degrees Fahrenheit. The sites were sampled by Derek Acomb (DFG) and Henning Fett (DFG).

In reach one, 1 site was sampled consisting of eight pools. The reach sites yielded ten young-of-the-year steelhead/rainbow trout (SH/RT) and three young-of-the-year Coho salmon.

In reach two, 1 site was sampled consisting of 3 pools starting approximately 300 feet above the dam. The reach sites yielded 2 Red Skin Newt and one larvae of the Red Skin Newt.

The following chart displays the information yielded from these sites:

2007 Upper San Geronimo Creek e-fish observations.

Date	Site #	Reference Point	Distance From Reference Point (ft.)	Steelhead/ Rainbow Trout			Coho Salmon	Non Salmonids Name species
				0+	1+	2+	0+ and 1+	
09/27/07	1	Ended at Dam	Indicate upstream or downstream	10	0	0	3	
09/27/07	2	Start approximately 300' above Dam.		0	0	0	0	3 Newts

DISCUSSION

Upper San Geronimo Creek is an F4 channel type for the first 1,881 feet of stream surveyed, another F4 channel type for the next 2,967 feet, an E6 channel type for the following 1,876 feet, and an F4 channel for the remaining 2,587 feet. The suitability of F4 channel types for fish habitat improvement structures is rated "Good" for bank-placed boulders, "Fair" for plunge weirs, channel constrictors, log cover, and single and opposing wing-deflectors, and "Poor" for boulder clusters. The suitability of E6 channel types is rated "Good" for bank-placed boulders, "Fair" for opposing wing-deflectors, and "Poor" for plunge weirs, boulder clusters, and single wing-deflectors.

The water temperatures recorded on 9/27/2007, ranged from 52 to 56 degrees Fahrenheit. Air temperatures ranged from 56 to 76 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 11% of the total length of this survey, pools made up 5%, and

riffles less than 1%. The pools are relatively deep, with only 9 of the 13 (69%) 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 the numerous log debris accumulations (LDA's) in the stream.

Five of the 13 pool tail-outs measured had embeddedness ratings of 1 or 2. Two of the pool tail-outs had embeddedness ratings of 3 or 4. Six 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 Upper San Geronimo Creek should be mapped and rated according to their potential sediment yields, and control measures should be taken.

Seven of the 13 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 18. The shelter rating in the flatwater habitats was 7. A pool shelter rating of approximately 100 is desirable. The amount of cover that now exists is being provided primarily by Boulders in Upper San Geronimo 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 78%. Reach 1 had a canopy density of 73%, Reach 2 had a canopy density of 89%, Reach 3 had a canopy density of 33%, and Reach 4 had a canopy density of 91%. In general, revegetation projects are considered when canopy density is less than 80%.

The percentage of right and left bank covered with vegetation was high at 70% and 75%, 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

Upper San Geronimo Creek should be managed as an anadramous, 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) Fish passage for adult and juvenile salmonids needs to be improved at two sites on Upper San Geronimo Creek.
-The grade control weir in habitat unit 0035 is a fish barrier and should be removed or modified to allow fish passage of all life stages of salmonids. Designs should address stream bed instability and should prevent downcutting of the upstream stream channel which could cause bank instability and loss of mature riparian trees upstream of the weir.

-The culvert under Railroad Avenue in habitat unit 006 is a partial barrier to salmonids and should be replaced or modified to allow for passage of all salmonid life stages.

-In habitat unit 0053 there is a grade control structure that marks the current end of anadromy for salmonids. This site should be maintained as a grade control structure. Due to lack of water and upstream habitat it is unlikely that improved passage at this location would benefit salmonids. This site appears to serve an important role in stabilizing the upstream channel, preventing severe channel downcutting and habitat degradation.

2) There are sections where the stream is being impacted from cattle trampling the riparian zone. Riparian fencing should be installed to keep livestock out of the stream channel in reach two. Livestock should be managed so as to not degrade riparian vegetation and water quality in all reaches.

3) In reaches one and two, it is recommended to implement pool and shelter enhancement projects that include the following elements:
-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.
-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 bioengineering stream bank stabilization.
-Suitable size spawning substrate on Upper San Geronimo Creek is limited to relatively few reaches. Projects should be designed at suitable sites to trap and sort spawning gravel.

4) Active and potential sediment sources related to the road system need to be identified, mapped, and treated according to their potential for sediment yield to the stream and its tributaries.

5) 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 May through October temperature extreme period should be performed for 3 to 5 years.

6) Upper San Geronimo Creek appears to be limited by a lack wetted habitat. Springs in reach

three appear to be an important source of instream flow in reaches one and two. It is recommended that measures to maintain and enhance instream summer base flows be implemented.

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	Habitat Unit #	Comments
0	0001.00	Start of Survey: Beginning of Survey at the confluence of San Geronimo and Woodacre Creek (38°00’48.0” N 122°38’47.0” W) near the intersection of Redwood Drive and San Geronimo Valley Drive in Woodacre, California. Reach1 is an F4 channel type.
278	0005.00	General Comment: 4.5' jump at top of unit.
295	0006.00	Structures: Culvert #1, Railroad Avenue., single culvert, concrete, H.:8', W.: 10', L.: 130', plunge height 4.5', max depth w/in 5ft of outlet: 2', culvert slope ~0%, good condition, possible barrier for juveniles, temporal or partial barrier for Adults. Juvenile fish observed upstream.
863	0016.00	Structures: Bridge #1, private drive, H.: 10', W.: 13', L.: 15'.
1088	0022.00	Bio Sample (E-fish) Bio-inventory location, coho and steelhead observed.
1407	0027.00	Structures: Bridge #2, private drive, H.: 9', W.: 14', L.: 16'.
1835	0035.00	General Comment: Reach change from 1 to 2 Channel type remains F4, Dam starts at top of this unit.
1835	0035.00	Structures: Dam #1, H.: 4.5' (in center), L.: 1', W. (0): 4.5', W. (D): 26', no flash boards, downcutting at sill: 1', H. sill to H2O level: 4.5', 8' high on the sides, there is a 17' long apron below the Dam.
2062	0038.00	Tributaries: Trib #1 on right bank at top of unit, not flowing, accessible to fish, checked up the tributary for ~100', slope <2%, no fish observed.
2302	0041.00	Tributaries: Trib #2 on right bank, not flowing, accessible to fish, slope <2%, no fish observed.
3159	0045.00	Tributaries: Trib #3 on right bank at top of unit, not flowing, slope < 2%, no fish observed.
4052	0048.00	Fish Passage: (LDA) Debris accumulation #1, D.: 9', L.: 27', W.: 15', not retaining gravel, no fish observed upstream, scour pool under LDA, no erosion/down cutting, there is not much gravel above the accumulation but there are boulders. Below there is bedrock.

Position	Habitat Unit #	Comments
4069	0049.00	General Comment: Cattle in creek.
4069	0049.00	Tributaries: Trib #4 on right bank, not flowing, no fish observed, not flagged, marked on topo map.
4646	0051.00	Tributaries: Trib #5 on right bank at end of unit, not flowing, currently not accessible to fish, slope > 4%, no fish observed, not flagged and not marked on topo map.
4784	0052.00	General Comment: Channel change from F4 to E6, Reach change from 2 to 3.
4848	0053.00	General Comment: After 400' into unit, the creek is becoming undefined.
4848	0053.00	Structures: Long chute, L.: 40', H.: 9.3', slope: 23.2%, cement inlet on top, the chute is carrying all the H2O of the creek, fish barrier, current end of anadromy.
5783	0054.00	Structures: Culvert #2, single culvert, concrete, H.: 2.5', W.:8.0', L.: 66', good condition, does not appear to be a barrier at this time.
6649	0056.00	General Comment: Channel change from E6 to F4, Reach change from 3 to 4.
6649	0056.00	Structures: Culvert #3, single, concrete, 4' diameter, good condition, does not appear to be a barrier at this time.
6724	0057.00	General Comment: Cattle presence in creek, channel is becoming less defined.
7176	0058.00	Tributaries: Trib #6 on left bank at end of unit, not flowing, no fish observed.
8511	0060.00	Structures: Culvert #4, no road or driveway, metal, 5' diameter, very rusted, possible barrier to juveniles but not to adults.
9311	0061.00	End of Survey: EOS due to lack of defined channel, headwaters consist of a few small braids, creek is pinched off by road and mountain side.

REFERENCES

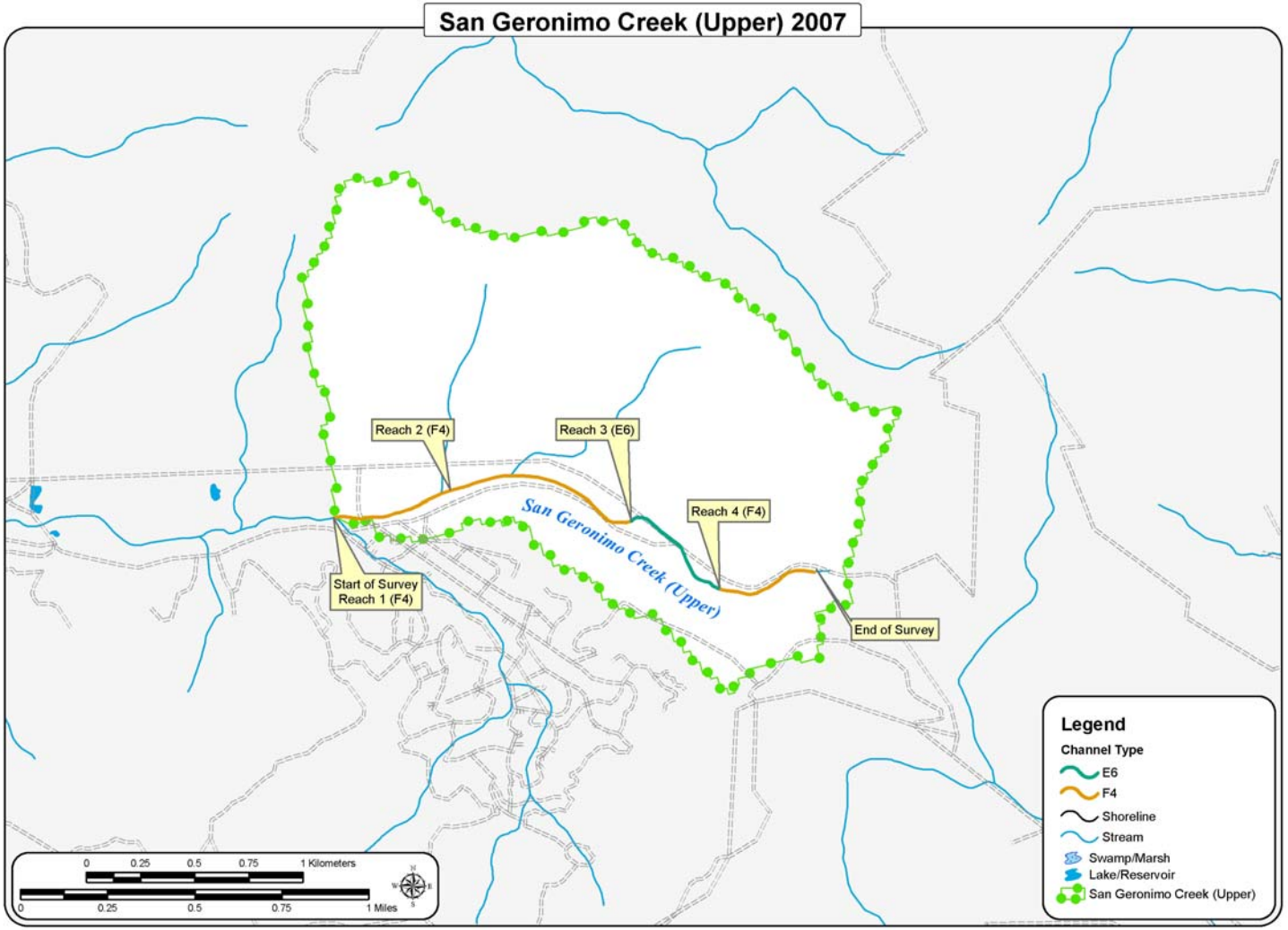
Flosi, G., Downie, S., Hopelain, J., Bird, M., Coey, R., and Collins, B. 1998. *California Salmonid Stream Habitat Restoration Manual*, 3rd edition. California Department of Fish and Game, Sacramento, California.

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]	


San Geronimo Creek (Upper) 2007
Reach 2 (F4)
Reach 3 (E6)
Reach 4 (F4)
San Geronimo Creek (Upper)
Start of Survey
Reach 1 (F4)
End of Survey
0 0.25 0.5 0.75 1 Kilometers
0 0.25 0.5 0.75 1 Miles
Legend
Channel Type
E6
F4
Shoreline
Stream
Swamp/Marsh
Lake/Reservoir
San Geronimo Creek (Upper)
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Prepared by: Scott Webb, February 2008

Map 1.

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

Stream Name: San Geronimo (Upper) **LLID:** 1226462380132 **Drainage:** Tomales Bay

Survey Dates: 9/27/2007 to 9/27/2007

Confluence Location: **Quad:** SAN GERONIMO **Legal Description:** T02NR07WS17 **Latitude:** 38:00:48.0N **Longitude:** 122:38:46.0W

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
6	0	CULVERT	9.8	84	502	5.4									
26	0	DRY	42.6	279	7251	77.9									0
14	14	FLATWATER	23.0	73	1024	11.0	4.2	0.5	0.9	273	3822	132	1842		7
14	14	POOL	23.0	37	512	5.5	7.3	1.3	2.3	273	3821	428	5561	416	18
1	1	RIFFLE	1.6	22	22	0.2	2.0	0.1	0.2	44	44	4	4		0

Total Units	Total Units Fully Measured	Total Length (ft.)	Total Area (sq.ft.)	Total Volume (cu.ft.)
61	29	9311	7687	7407

Table 2 - Summary of Habitat Types and Measured Parameters

Stream Name: San Geronimo (Upper) **LLID:** 1226462380132 **Drainage:** Tomales Bay

Survey Dates: 9/27/2007 to 9/27/2007

Confluence Location: Quad: SAN GERONIMO **Legal Description:** T02NR07WS17 **Latitude:** 38:00:48.0N **Longitude:** 122:38:46.0W

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 (%)
1	1	LGR	1.6	22	22	0.2	2.0	0.1	0.2	44	44	4	4		0	86
13	13	GLD	21.3	77	995	10.7	4.0	0.5	1.6	290	3764	141	1830		7	84
1	1	SRN	1.6	29	29	0.3	2.0	0.2	0.6	58	58	12	12		5	79
1	1	TRP	1.6	44	44	0.5	4.0	0.7	1.7	167	167	134	134	117	10	74
3	3	MCP	4.9	42	125	1.3	7.0	1.3	3.4	313	939	528	1583	481	25	48
4	4	CRP	6.6	51	204	2.2	8.0	1.5	3.2	458	1832	712	2847	712	20	80
1	1	LSL	1.6	22	22	0.2	4.0			88	88				30	78
1	1	LSR	1.6	22	22	0.2	4.0	0.7	2.1	88	88	62	62	62	10	12
1	1	LSBk	1.6	41	41	0.4	5.0	0.7	1.1	195	195	136	136	136	10	88
3	3	PLP	4.9	18	54	0.6	10.0	1.5	3.0	170	511	266	798	266	10	92
26	0	DRY	42.6	279	7251	77.9									0	78
6	0	CUL	9.8	84	502	5.4										

Total Units	Total Units Fully Measured	Total Length (ft.)	Total Area (sq.ft.)	Total Volume (cu.ft.)
61	29	9311	7687	7407

Table 3 - Summary of Pool Types

Stream Name: San Geronimo (Upper) **LLID:** 1226462380132 **Drainage:** Tomales Bay

Survey Dates: 9/27/2007 to 9/27/2007

Confluence Location: **Quad:** SAN GERONIMO **Legal Description:** T02NR07WS17 **Latitude:** 38:00:48.0N **Longitude:** 122:38:46.0W

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
4	4	MAIN	29	42	169	33	6.3	1.2	277	1106	390	1561	21
10	10	SCOUR	71	34	343	67	7.7	1.3	271	2714	427	3844	16

Total Units	Total Units Fully Measured	Total Length (ft.)	Total Area (sq.ft.)	Total Volume (cu.ft.)
14	14	512	3821	5405

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

Stream Name: San Geronimo (Upper) **LLID:** 1226462380132 **Drainage:** Tomales Bay

Survey Dates: 9/27/2007 to 9/27/2007

Confluence Location: Quad: SAN GERONIMO **Legal Description:** T02NR07WS17 **Latitude:** 38:00:48.0N **Longitude:** 122:38:46.0W

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
3	PLP	23	0	0	1	33	1	33	1	33	0	0
3	MCP	23	0	0	1	33	1	33	1	33	0	0
1	TRP	8	0	0	1	100	0	0	0	0	0	0
4	CRP	31	0	0	0	0	2	50	2	50	0	0
1	LSR	8	0	0	0	0	1	100	0	0	0	0
1	LSBk	8	0	0	1	100	0	0	0	0	0	0
0	LSL	0	0	0	0	0	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
13	0	0	4	31	5	38	4	31	0	0

Mean Maximum Residual Pool Depth (ft.): 2.3

Table 5 - Summary of Mean Percent Cover By Habitat Type

Stream Name: San Geronimo (Upper) **LLID:** 1226462380132 **Drainage:** Tomales Bay

Survey Dates: 9/27/2007 to 9/27/2007 **Dry Units:** 26

Confluence Location: **Quad:** SAN GERONIMO **Legal Description:** T02NR07WS17 **Latitude:** 38:00:48.0N **Longitude:** 122:38:46.0W

Habitat Units	Units Fully Measured	Habitat Type	Mean % Undercut Banks	Mean % SWD	Mean % LWD	Mean % Root Mass	Mean % Terrestrial Vegetation	Mean % Aquatic Vegetation	Mean % White Water	Mean % Boulders	Mean % Bedrock Ledges
1	1	LGR	0	0	0	0	0	0	0	0	0
1	1	TOTAL RIFFLE	0	0	0	0	0	0	0	0	0
13	13	GLD	0	0	0	19	17	0	0	22	3
1	1	SRN	0	0	0	0	0	0	0	50	50
14	14	TOTAL FLAT	0	0	0	18	16	0	0	24	6
1	1	TRP	0	0	0	0	0	0	0	50	50
3	3	MCP	43	0	0	0	40	0	0	17	0
4	4	CRP	0	23	13	10	24	0	0	31	0
1	1	LSL	60	0	0	40	0	0	0	0	0
1	1	LSR	0	100	0	0	0	0	0	0	0
1	1	LSBk	0	0	0	0	0	0	0	100	0
3	3	PLP	0	0	0	33	0	0	33	33	0
14	14	TOTAL POOL	14	14	4	13	15	0	7	30	4
6	0	CUL									
61	30	TOTAL	6	6	2	14	15	0	3	26	5

Table 6 - Summary of Dominant Substrates By Habitat Type

Stream Name: San Geronimo (Upper) **LLID:** 1226462380132 **Drainage:** Tomales Bay

Survey Dates: 9/27/2007 to 9/27/2007 **Dry Units:** 26

Confluence Location: **Quad:** SAN GERONIMO **Legal Description:** T000R000S00 **Latitude:** 38:00:48.0N **Longitude:** 122:38:46.0W

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
1	1	LGR	0	0	0	0	0	0	100
13	13	GLD	31	15	8	23	8	0	15
1	1	SRN	0	0	0	0	0	0	100
1	1	TRP	0	0	0	0	0	0	100
3	3	MCP	33	0	33	33	0	0	0
4	4	CRP	25	25	25	25	0	0	0
1	1	LSL	0	100	0	0	0	0	0
1	1	LSR	0	100	0	0	0	0	0
1	1	LSBk	0	0	0	0	0	100	0
3	3	PLP	67	33	0	0	0	0	0
6	0	CUL	0	0	0	0	0	0	0

Table 7 - Summary of Mean Percent Canopy for Entire Stream

Stream Name: San Geronimo (Upper) **LLID:** 1226462380132 **Drainage:** Tomales Bay

Survey Dates: 9/27/2007 to 9/27/2007

Confluence Location: **Quad:** SAN GERONIMO **Legal Description:** T02NR07WS17 **Latitude:** 38:00:48.0N **Longitude:** 122:38:46.0W

Mean Percent Canopy	Mean Percent Conifer	Mean Percent Hardwood	Mean Percent Open Units	Mean Right Bank % Cover	Mean Left Bank % Cover
78	12	88	0	70	75

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: San Geronimo (Upper) LLID: 1226462380132 Drainage: Tomales Bay
Survey Dates: 9/27/2007 to 9/27/2007 Survey Length (ft.): 9311 Main Channel (ft.): 9311 Side Channel (ft.): 0
Confluence Location: Quad: SAN GERONIMO Legal Description: T02NR07WS17 Latitude: 38:00:48.0N Longitude: 122:38:46.0W

Summary of Fish Habitat Elements By Stream Reach

STREAM REACH: 1

Channel Type: F4
Reach Length (ft.): 1881
Riffle/Flatwater Mean Width (ft.): 4.0
BFW:
Range (ft.): 16 to 24
Mean (ft.): 20.29
Std. Dev.: 2.86
Base Flow (cfs): 0
Water (F): 52 - 56 Air (F): 56 - 61
Dry Channel (ft.): 751

Canopy Density (%): 73.0
Coniferous Component (%): 0.0
Hardwood Component (%): 100.0
Dominant Bank Vegetation: Hardwood Trees
Vegetative Cover (%): 77.6
Dominant Shelter: Boulders
Dominant Bank Substrate Type: Sand/Silt/Clay
Occurrence of LWD (%): 0.0
LWD per 100 ft.:
Riffles: 0
Pools: 0
Flat: 0

Pools by Stream Length (%): 18.8
Pool Frequency (%): 25.7
Residual Pool Depth (%):
< 2 Feet Deep: 33.3
2 to 2.9 Feet Deep: 44.4
3 to 3.9 Feet Deep: 22.2
>= 4 Feet Deep: 0.0
Mean Max Residual Pool Depth (ft.): 2.24
Mean Pool Shelter Rating: 16

Pool Tail Substrate (%): Silt/Clay: 22.2 Sand: 11.1 Gravel: 11.1 Sm Cobble: 33.3 Lg Cobble: 0.0 Boulder: 0.0 Bedrock: 22.2
Embeddedness Values (%): 1. 0.0 2. 33.3 3. 11.1 4. 0.0 5. 55.6

STREAM REACH: 2

Channel Type: F4
Reach Length (ft.): 2967
Riffle/Flatwater Mean Width (ft.): 4.3
BFW:
Range (ft.): 18 to 24
Mean (ft.): 20.35
Std. Dev.: 2.37
Base Flow (cfs): 0
Water (F): 52 - 52 Air (F): 56 - 75
Dry Channel (ft.): 2378

Canopy Density (%): 88.9
Coniferous Component (%): 37.6
Hardwood Component (%): 62.4
Dominant Bank Vegetation: Hardwood Trees
Vegetative Cover (%): 69.3
Dominant Shelter: Root masses
Dominant Bank Substrate Type: Sand/Silt/Clay
Occurrence of LWD (%): 6.3
LWD per 100 ft.:
Riffles: N/A
Pools: 2
Flat: 0

Pools by Stream Length (%): 5.3
Pool Frequency (%): 29.4
Residual Pool Depth (%):
< 2 Feet Deep: 25.0
2 to 2.9 Feet Deep: 25.0
3 to 3.9 Feet Deep: 50.0
>= 4 Feet Deep: 0.0
Mean Max Residual Pool Depth (ft.): 2.575
Mean Pool Shelter Rating: 21

Pool Tail Substrate (%): Silt/Clay: 25.0 Sand: 0.0 Gravel: 50.0 Sm Cobble: 25.0 Lg Cobble: 0.0 Boulder: 0.0 Bedrock: 0.0
Embeddedness Values (%): 1. 0.0 2. 50.0 3. 25.0 4. 0.0 5. 25.0

Summary of Fish Habitat Elements By Stream Reach

STREAM REACH: 3

Channel Type: E6
Reach Length (ft.): 1876
Riffle/Flatwater Mean Width (ft.):
BFW:
Range (ft.): 18 to 18
Mean (ft.): 18
Std. Dev.: 0
Base Flow (cfs):
Water (F): [DRY] Air (F): 75 - 75
Dry Channel (ft.): 1735

Canopy Density (%): 32.5
Coniferous Component (%): 0.0
Hardwood Component (%): 100.0
Dominant Bank Vegetation: Grass
Vegetative Cover (%): 31.3
Dominant Shelter:
Dominant Bank Substrate Type: Sand/Silt/Clay
Occurrence of LWD (%):
LWD per 100 ft.:
Riffles: N/A
Pools: N/A
Flat: N/A

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.

STREAM REACH: 4

Channel Type: F4
Reach Length (ft.): 2587
Riffle/Flatwater Mean Width (ft.):
BFW:
Range (ft.): 10 to 18
Mean (ft.): 14.8
Std. Dev.: 3.92
Base Flow (cfs):
Water (F): [DRY] Air (F): 75 - 76
Dry Channel (ft.): 2387

Canopy Density (%): 90.5
Coniferous Component (%): 3.8
Hardwood Component (%): 96.3
Dominant Bank Vegetation: Hardwood Trees
Vegetative Cover (%): 61.3
Dominant Shelter:
Dominant Bank Substrate Type: Sand/Silt/Clay
Occurrence of LWD (%):
LWD per 100 ft.:
Riffles: N/A
Pools: N/A
Flat: N/A

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.

Table 9 -Mean Percentage of Dominant Substrate and Vegetation

Stream Name: San Geronimo (Upper) **LLID:** 1226462380132 **Drainage:** Tomales Bay

Survey Dates: 9/27/2007 to 9/27/2007

Confluence Location: **Quad:** SAN GERONIMO **Legal Description:** T02NR07WS17 **Latitude:** 38:00:48.0N **Longitude:** 122:38:46.0W

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	0	0	0.0
Boulder	0	0	0.0
Cobble/Gravel	0	0	0.0
Sand/Silt/Clay	55	55	100.0

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	2	2	3.6
Brush	9	6	13.6
Hardwood Trees	44	47	82.7
Coniferous Trees	0	0	0.0
No Vegetation	0	0	0.0

Total Stream Cobble Embeddedness Values: 4

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

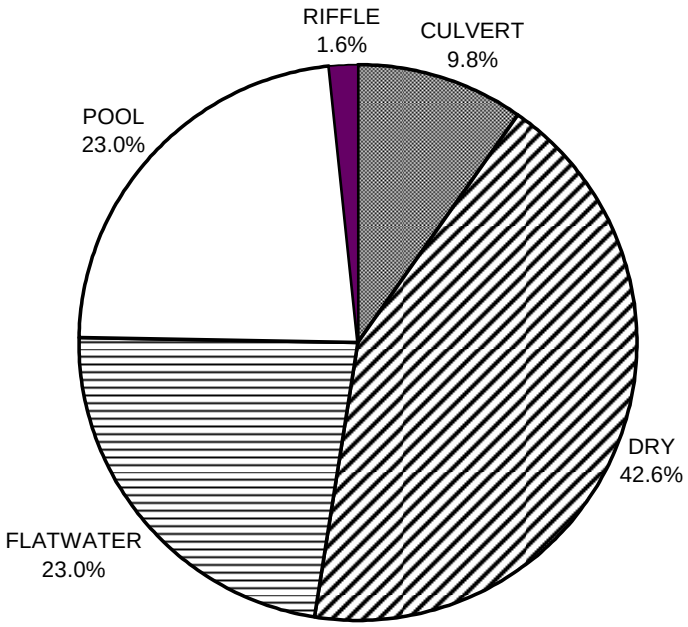
Stream Name: San Geronimo (Upper) **LLID:** 1226462380132 **Drainage:** Tomales Bay

Survey Dates: 9/27/2007 to 9/27/2007

Confluence Location: Quad: SAN GERONIMO **Legal Description:** T02NR07WS17 **Latitude:** 38:00:48.0N **Longitude:** 122:38:46.0W

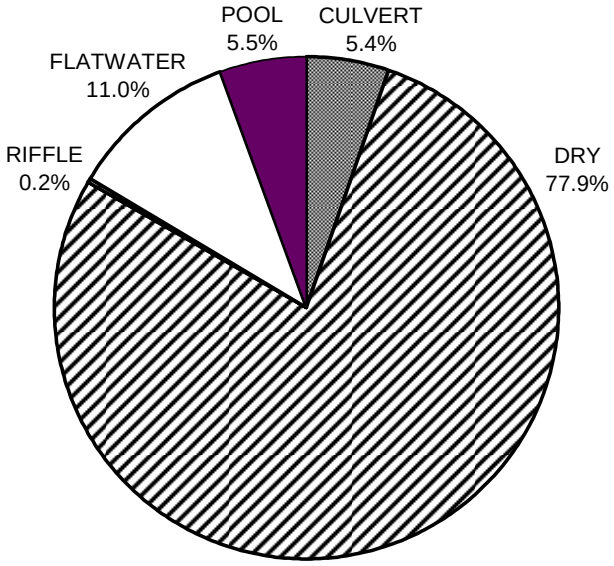
	Riffles	Flatwater	Pools
UNDERCUT BANKS (%)	0	0	14
SMALL WOODY DEBRIS (%)	0	0	14
LARGE WOODY DEBRIS (%)	0	0	4
ROOT MASS (%)	0	18	13
TERRESTRIAL VEGETATION (%)	0	16	15
AQUATIC VEGETATION (%)	0	0	0
WHITEWATER (%)	0	0	7
BOULDERS (%)	0	24	30
BEDROCK LEDGES (%)	0	6	4

San Geronimo (Upper) 2007
HABITAT TYPES BY PERCENT OCCURRENCE



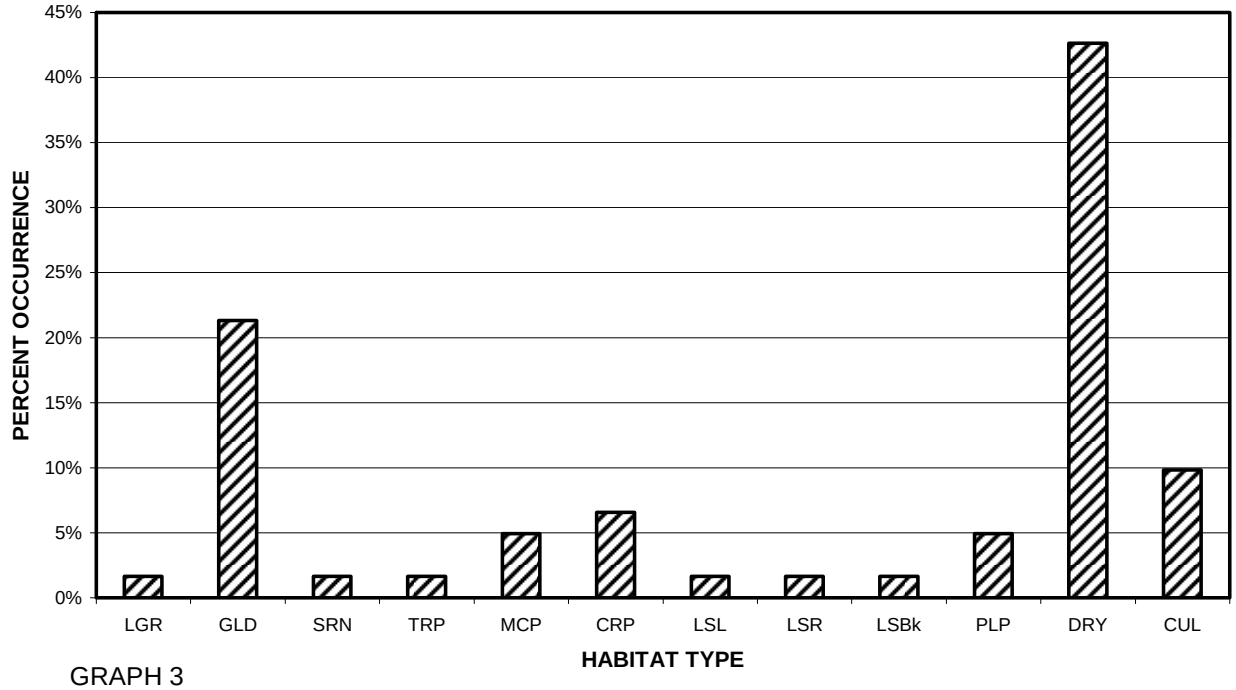
GRAPH 1

San Geronimo (Upper) 2007
HABITAT TYPES BY PERCENT TOTAL LENGTH



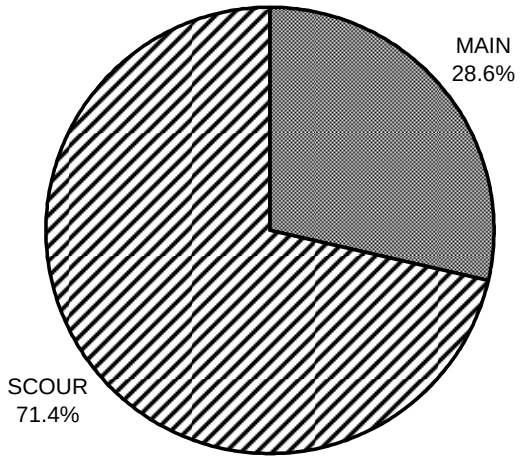
GRAPH 2

San Geronimo (Upper) 2007
HABITAT TYPES BY PERCENT OCCURRENCE



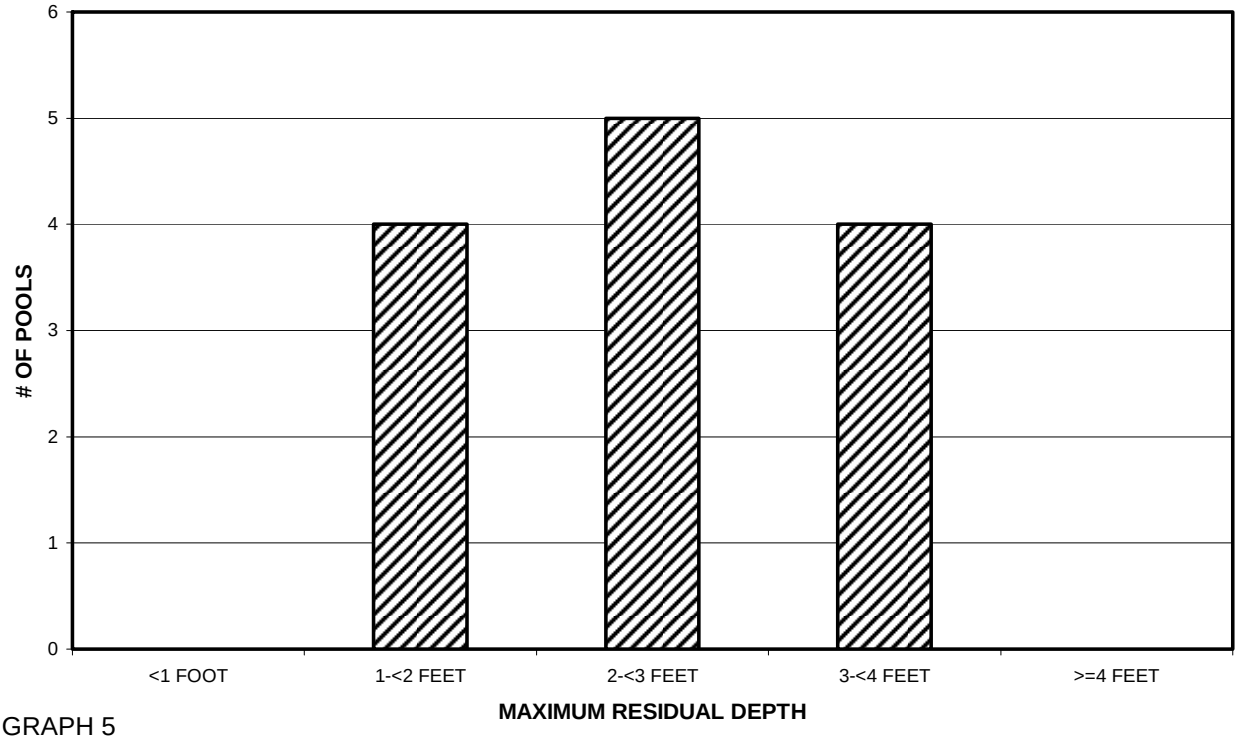
GRAPH 3

San Geronimo (Upper) 2007
POOL TYPES BY PERCENT OCCURRENCE



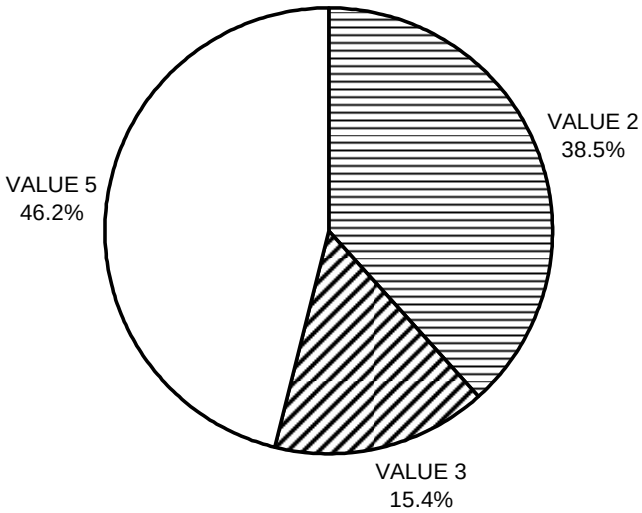
GRAPH 4

San Geronimo (Upper) 2007
MAXIMUM DEPTH IN POOLS



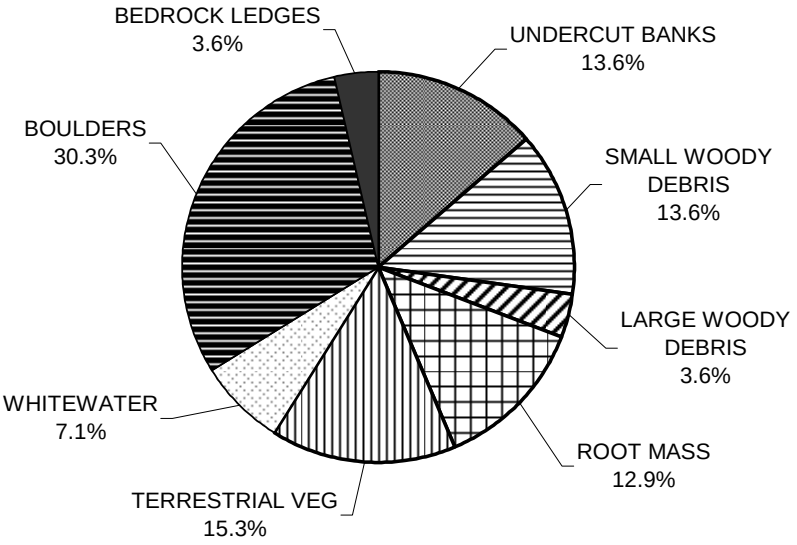
GRAPH 5

San Geronimo (Upper) 2007
PERCENT EMBEDDEDNESS



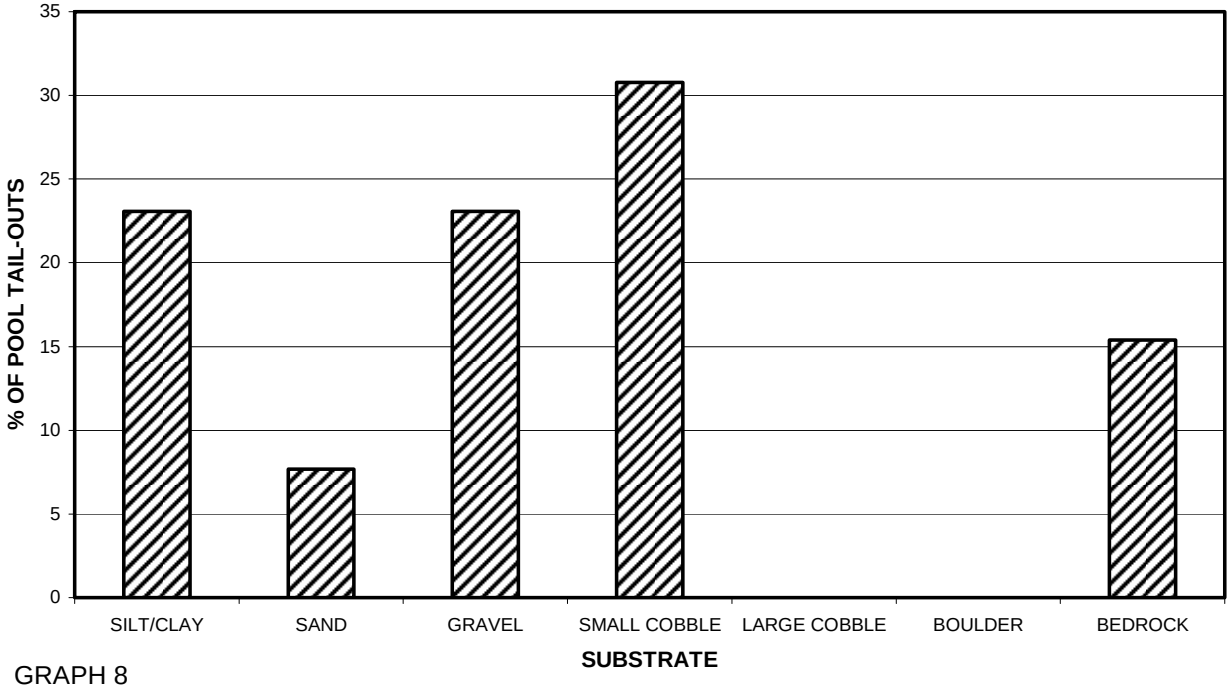
GRAPH 6

San Geronimo (Upper) 2007
MEAN PERCENT COVER TYPES IN POOLS



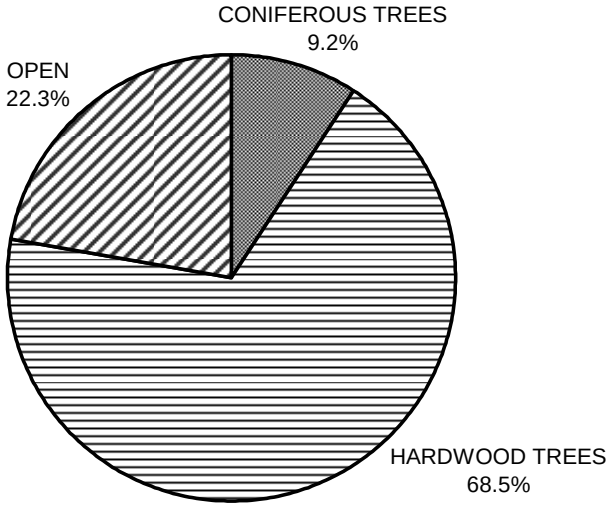
GRAPH 7

San Geronimo (Upper) 2007
SUBSTRATE COMPOSITION IN POOL TAIL-OUTS



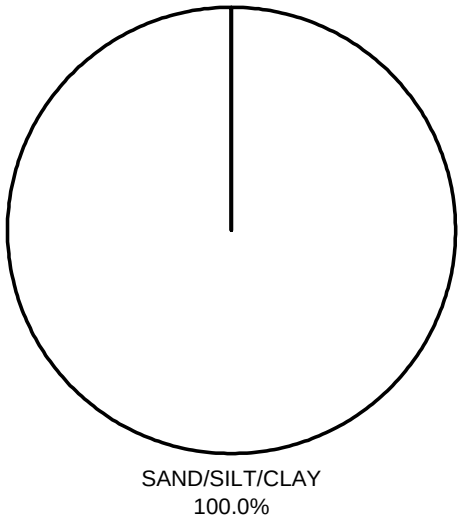
GRAPH 8

San Geronimo (Upper) 2007
MEAN PERCENT CANOPY



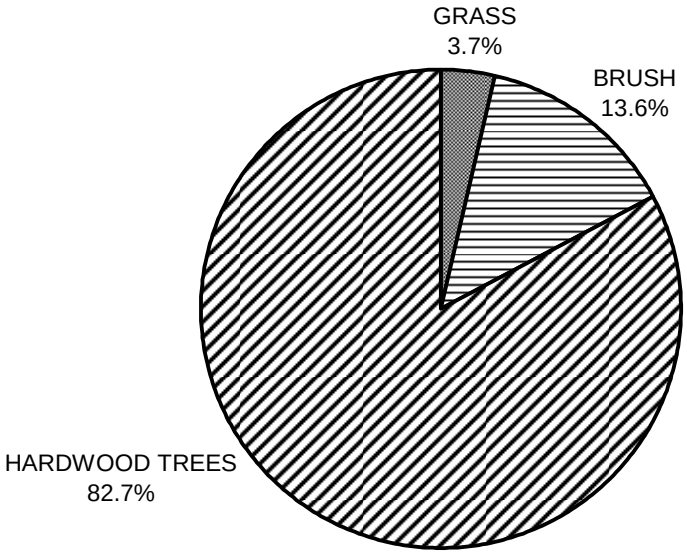
GRAPH 9

San Geronimo (Upper) 2007
DOMINANT BANK COMPOSITION IN SURVEY REACH



GRAPH 10

San Geronimo (Upper) 2007
DOMINANT BANK VEGETATION IN SURVEY REACH



GRAPH 11

Dam #1 Long Profile, HU 035, Upper San Geronimo Creek