



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

Novato Creek

Surveyed 2009

STREAM INVENTORY REPORT

Novato Creek

Survey Completed 2009

Report Completed Feb. 2011

INTRODUCTION

A stream inventory was conducted during 6/11/2009 to 6/25/2009 on Novato Creek. The survey began at the confluence with San Pablo Bay and extended upstream 5.5 miles. Stream inventories and reports were also completed for two tributaries to Novato Creek (Arroyo Avichi Creek and Warner Creek).

The Novato 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 Novato Creek. The objective of the biological inventory was to document the presence and distribution of juvenile salmonid species.

The objective of this report is to document the current habitat conditions and recommend options for the potential enhancement of habitat for steelhead trout. Recommendations for habitat improvement activities are based upon target habitat values suitable for salmonids in California's north coast streams.

WATERSHED OVERVIEW

Novato Creek is a tributary to San Pablo Bay, located in Marin County, California (Map 1). Novato Creek's legal description at the confluence with Pacific Ocean is T03N R06W S14. Its location is 38°05'57.4" north latitude and 122°29'13.8" west longitude, LLID number 1224871380974. Novato Creek is a third order stream and has approximately 107 miles of blue line stream within its catchment boundary according to the USGS National Hydrography Dataset (NHD). Novato Creek drains a watershed of approximately 47.37 square miles. Elevations range from about 0 feet at the mouth of the creek to 1,886 feet in the headwater areas. Mixed hardwood forest dominates the watershed. The watershed is primarily privately owned and land use is considered 72% natural, 19% urban, and 8% agricultural. Vehicle access exists via Diablo Avenue in the city of Novato.

METHODS

The habitat inventory conducted in Novato Creek follows the methodology presented in the *California Salmonid Stream Habitat Restoration Manual* (Flosi et al, 1998). The Watershed Stewards Project/AmeriCorps (WSP) Members that conducted the inventory were trained in standardized habitat inventory methods by the California Department of Fish and Game (DFG). This inventory was conducted by a two-person team.

SAMPLING STRATEGY

Novato Creek 2009

The inventory uses a method that samples approximately 10% of the habitat units within the survey reach. All habitat units included in the survey are classified according to habitat type and their lengths are measured. All pool units are fully measured. All other habitat unit types encountered for the first time in each reach are measured for all the parameters and characteristics on the field form. Additionally, from the ten habitat units on each field form page, one is randomly selected for complete measurement.

HABITAT INVENTORY COMPONENTS

A standardized habitat inventory form has been developed for use in California stream surveys and can be found in the *California Salmonid Stream Habitat Restoration Manual*. This form was used in Novato 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". Novato 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.

Novato Creek 2009

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 Novato 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 Novato Creek, a standard qualitative shelter value of 0 (none), 1 (low), 2 (medium), or 3 (high) was assigned according to the complexity of the cover. Thus, shelter ratings can range from 0-300 and are expressed as mean values by habitat types within a stream.

7. Substrate Composition:

Substrate composition ranges from silt/clay sized particles to boulders and bedrock elements. In all fully-described habitat units, dominant and sub-dominant substrate elements were ocularly estimated using a list of seven size classes and recorded as a one and two, respectively. In addition, the dominant substrate composing the pool tail-outs is recorded for each pool.

8. Canopy:

Stream canopy density was estimated using modified handheld spherical densimeters as described in the *California Salmonid Stream Habitat Restoration Manual*. Canopy density relates to the amount of stream shaded from the sun. In Novato 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 Novato 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.

Novato Creek 2009

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 Novato Creek. In addition, two sites were electrofished using a Smith-Root Model 12 electrofisher. These sampling techniques are discussed in the *California Salmonid Stream Habitat Restoration Manual*.

DATA ANALYSIS

Data from the habitat inventory form are entered into Stream Habitat 2.0.18, a Visual Basic data entry program developed by Karen Wilson, Pacific States Marine Fisheries Commission in conjunction with the California Department of Fish and 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

Novato Creek 2009

Graphics are produced from the tables using Microsoft Excel. Graphics developed for Novato Creek include:

- Riffle, Flatwater, Pool Habitat Types by Percent Occurrence
- Riffle, Flatwater, Pool Habitat Types by Total Length
- Total Habitat Types by Percent Occurrence
- Pool Types by Percent Occurrence
- Maximum Residual Depth in Pools
- Percent Embeddedness
- Mean Percent Cover Types in Pools
- Substrate Composition in Pool Tail-outs
- Mean Percent Canopy
- Dominant Bank Composition by Composition Type
- Dominant Bank Vegetation by Vegetation Type

HABITAT INVENTORY RESULTS

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

The habitat inventory of 6/11/2009 to 6/25/2009, was conducted by T Macias, C Bell, and A Villalobos (WSP). The total length of the stream surveyed was 29,103 feet with an additional 94 feet of side channel.

Stream flow was measured near the bottom of the survey reach with a Marsh-McBirney Model 2000 flowmeter at 0.87 cfs on June 11th, 2009.

Novato Creek is an F4 channel type for the entire 29,103 feet of the stream surveyed.

F4 channels are entrenched, meandering, riffle/pool channels on low gradients with high width/depth ratios and gravel-dominant substrates

Water temperatures taken during the survey period ranged from 56 to 66 degrees Fahrenheit. Air temperatures ranged from 51 to 83 degrees Fahrenheit.

Table 1 summarizes the Level II riffle, flatwater, and pool habitat types. Based on frequency of occurrence there were 38.6% flatwater units, 3.6% culvert units, 37.6% pool units, and 20.2% riffle units (Graph 1). Based on total length of Level II habitat types there were 50.3% flatwater units, 1.9% culvert units, 33.3% pool units, and 14.4% riffle units (Graph 2).

Eleven Level IV habitat types were identified (Table 2). The most frequent habitat types by percent occurrence were 21.9% Mid-Channel Pool units, 20.6% Run units, and 20.2% Low Gradient Riffle units (Graph 3). Based on percent total length there were 23% Glide units, 21% Mid-Channel Pool units, and 27.3% Run units.

Novato Creek 2009

A total of 175 pools were identified (Table 3). Main Channel pools were the most frequently encountered, at 60%, and comprised 65% 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. Seventy-six of the 174 pools measured (44%) had a residual depth of two feet or greater (Graph 5).

The depth of cobble embeddedness was estimated at pool tail-outs. Of the 174 pool tail-outs measured, 2 had a value of 1 (1.1%); 29 had a value of 2 (16.7%); 59 had a value of 3 (33.9%); 84 had a value of 4 (48.3%) (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 2, flatwater habitat types had a mean shelter rating of 18, and pool habitats had a mean shelter rating of 39 (Table 1). Of the pool types, the Main Channel pools had a mean shelter rating of 29, Scour pools had a mean shelter rating of 54, (Table 3).

Table 5 summarizes mean percent cover by habitat type. Terrestrial Vegetation is the dominant cover type in Novato Creek. Graph 7 describes the pool cover in Novato Creek. Root Mass is the dominant pool cover type followed by small woody debris.

Table 6 summarizes the dominant substrate by habitat type. Graph 8 depicts the dominant substrate observed in pool tail-outs. Sand dominance was observed in 17.2% of pool tail-outs, gravel dominance was observed in 79.9% of pool tail-outs.

The mean percent canopy density for the surveyed length of Novato Creek was 86%. The mean percentages of hardwood and coniferous trees were 99% and 1%, respectively. Fourteen percent of the canopy was open. Graph 9 describes the mean percent canopy in Novato Creek.

For the stream reach surveyed, the mean percent right bank vegetated was 52%. The mean percent left bank vegetated was 50%. The dominant elements composing the structure of the stream banks consisted of 2.2% bedrock, 8.7% boulder, 0.9% cobble/gravel, and 88.2% sand/silt/clay (Graph 10). Hardwood trees were the dominant vegetation type observed in 70.5% of the units surveyed. Additionally, 24.9% of the units surveyed had brush as the dominant vegetation type, and 2.7% had grass as the dominant vegetation (Graph 11).

BIOLOGICAL INVENTORY RESULTS

Two sites were electrofished for species composition and distribution in Novato Creek on October 27th, 2009. Water temperatures taken during the electrofishing period was 58 degrees Fahrenheit. Air temperatures ranged from 52 to 58 degrees Fahrenheit. The sites were sampled by T. Macias (WSP), D. Resnik (DFG) and D. Acomb (DFG).

Novato Creek 2009

In reach 1, which comprised the entire 29,103 feet of stream, two sites were sampled. The first site yielded two age 2+ steelhead/rainbow trout (SH/RT), thirteen three-spine stickleback, seventy-one California roach, and four Sacramento suckers.

The second site yielded one young-of-the-year SH/RT, two age 1+ SH/RT, thirteen three-spine stickleback, thirty-three California roach, and six Sacramento suckers.

The following chart displays the information yielded from these sites:

2009 Novato Creek e-fish observations

Date	Site #	Reference Point	Distance From Reference Point (ft.)	Steelhead/Rainbow Trout			Non Salmonids Name species
				0+	1+	2+	
10/27/2009	743	Habitat Unit 0120.00	150	0	0	2	13 three-spine stickleback, 71 CA roach, 4 Sacramento sucker

2009 Novato Creek e-fish observations

Date	Site #	Reference Point	Distance From Reference Point (ft.)	Steelhead/Rainbow Trout			Non Salmonids Name species
				0+	1+	2+	
10/27/2009	742	Habitat Unit 120.00	150	1	2	0	13 three-spine stickleback, 33 CA roach, 6 Sacramento suckers

Novato Creek 2009

DISCUSSION

Novato Creek is an F4 channel type for the entire 29,103 feet of stream surveyed. The suitability of F4 channel types for fish habitat improvement structures is as follows: Good for bank-placed boulders; Fair for plunge weirs, single and opposing wing-deflectors, channel constrictors, and log cover; and poor for boulder clusters.

The water temperatures recorded on the survey days 6/11/2009 to 6/25/2009, ranged from 56 to 66 degrees Fahrenheit. Air temperatures ranged from 51 to 83 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 50.3% of the total length of this survey, riffles 14.4%, and pools 33.3%. The pools are relatively shallow, with only 76 of the 174 (44%) pools having a maximum residual depth greater than 2 feet. In general, pool enhancement projects are considered when primary pools comprise less than 40% of the length of total stream habitat. In first and second order streams, a primary pool is defined to have a maximum residual depth of at least two feet, occupy at least half the width of the low flow channel, and be as long as the low flow channel width. Installing structures that will increase or deepen pool habitat is recommended for locations where their installation will not be threatened by high stream energy, or where their installation will not conflict with the modification of any log debris accumulations (LDA's) in the stream.

Thirty-one of the 174 pool tail-outs measured had embeddedness ratings of 1 or 2. One hundred forty-three of the pool tail-outs had embeddedness ratings of 3 or 4. None of the pool tail-outs had a rating of 5, which is considered unsuitable for spawning. Cobble embeddedness measured to be 25% or less, a rating of 1, is considered to indicate good quality spawning substrate for salmon and steelhead. Sediment sources in Novato Creek should be mapped and rated according to their potential sediment yields, and control measures should be taken.

One hundred thirty-nine of the 174 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 39. The shelter rating in the flatwater habitats was 18. A pool shelter rating of approximately 100 is desirable. The amount of cover that now exists is being provided primarily by Terrestrial Vegetation in Novato Creek. Root Mass is the dominant cover type in pools followed by small woody debris. 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 86%. In general, revegetation projects are considered when canopy density is less than 80%.

Novato Creek 2009

The percentage of right and left bank covered with vegetation was 52% and 50%, 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

Novato Creek should be managed as an anadromous, natural production stream.

Winter storms often bring down large trees and other woody debris into the stream, which increases the number and quality of pools. This woody debris, if left undisturbed, will provide fish shelter and rearing habitat, and offset channel incision. Landowners should be sensitive about the natural and positive role woody debris plays in the system, and encouraged not to remove woody debris from the stream, except under extreme buildup and only under guidance by a fishery professional.

RECOMMENDATIONS

- 1) Access for migrating salmonids should be assessed at all road crossings and other structures that could be a possible barrier including old dams and utility crossings. Where needed, crossings should be replaced or modified to improve fish passage.
- 2) Increase woody cover in the pools and flatwater habitat units. Most of the existing cover in the pools is from Root Mass. Adding high quality complexity with woody cover in the pools is desirable.
- 3) Inventory and map sources of stream bank erosion and potential sediment sources related to the road system. These sites should be prioritized according to present and potential sediment yield. Identified sites should then be treated to reduce the amount of fine sediments entering the stream and its tributaries.
- 4) Novato Creek would benefit from utilizing bio-technical vegetative techniques to re-establish floodplain benches and a defined low flow channel. This would discourage lateral migration of the base flow channel and decrease bank erosion.
- 5) Invasive species such as Cape Ivy, Arrundo Donax and Scotch Broom should be removed and replaced with native riparian species.

COMMENTS AND LANDMARKS

The following landmarks and possible problem sites were noted. All distances are approximate and taken from the beginning of the survey reach.

Position (ft.)	Habitat Unit #	Comments
0	0001.00	Start of Survey at confluence with Warner Creek, in the tidal influence of the Bay. N38.0999, W122.5687.

Novato Creek 2009

Position (ft.)	Habitat Unit #	Comments
620	0002.00	Structures: Dam #1: Dimensions: L=5.4 ft, H=1.3 ft, W(o)=28 ft, W(d)=28 ft, no flashboards. Downcutting and gravel retention are occurring. Possible barrier to juvenile salmonids. Possible utility crossing or grade control for bridge upstream.
660	0004.00	Structures: Bridge #1: Concrete bridge, Private owner. Dimensions: W=50 ft, H=10.5 ft, L=31 ft. Down cutting is not occurring. Not likely a barrier to salmonids, Novato Fair Shopping Center entry road.
1,240	0015.00	General Comment: There is a concrete obstruction spanning width of bridge #2, 5ft long, 2.5ft deep, and is a likely salmonid barrier. It should be assessed for fish passage. There is a second concrete obstruction: L2 ft, D0.9 ft near upstream edge.
1,240	0015.00	Structures: Bridge #2: concrete bridge, Diablo Ave crossing. Dimensions: W=30 ft, H=11ft, L=101 ft. water to sill height is 1.1 ft. Down cutting is occurring. Possible barrier to salmonids.
3,007	0033.00	General Comment: Failing rock weirs, banks eroding.
3,809	0039.00	Structures: Bridge #3: concrete bridge for Tamalpais Ave. crossing. Dimensions: W=30ft, H=10ft, L=90ft, This is a natural bottom bridge with no gravel retention. Down cutting is not occurring. Not likely a barrier to salmonids.
4,265	0043.00	Structures: Bridge #4: Wooden footbridge with natural bottom in Lee Gerner Park. Dimensions: L=8', W=58', H=16'. Not likely a barrier to salmonids and not down cutting.
4,847	0049.00	Structures: Rock weir at downstream edge of unit.
5,817	0058.00	Structures: Bridge #5: Concrete bridge for Grant Ave. has natural bottom. Dimensions: L=43', W=32', H=15'. Gravel is not being retained, and down cutting is not occurring. Not likely barrier to salmonids.
6,296	0065.00	Erosion Site: (Bank) Large root wad sliding into creek and bank eroding
6,820	0074.00	Structures: Begin metal retaining wall on right bank.
6,922	0075.00	Structures: Right bank metal retaining wall continues. Left bank concrete structure.
7,119	0078.00	Structures: Right bank metal retaining wall ends at top of this unit.
8,945	0101.00	Erosion Site: (Bank) Right bank is eroded.
9,280	0106.00	Structures: Bridge #6: natural bottom concrete bridge carries Simmons Road. Dimensions: L=48', W=32', H=12'. Down cutting is not occurring. Not a barrier to salmonids.
10,300	0120.00	General Comment: E-fishing surveys conducted
10,999	0128.00	General Comment: Old flash board dam no longer in use.
11,361	0133.00	Tributaries: Left bank tributary #1 enters Novato Creek. Contributes estimated 5% of flow to receiving stream. Water temps: upstream =61, downstream =61, tributary =64F. Is accessible to fish. Checked 60 feet up tributary: ends at double culvert. Unidentified minnows observed.

Novato Creek 2009

Position (ft.)	Habitat Unit #	Comments
12,432	0150.00	Tributaries: Left bank tributary #2 enters Novato Creek. Contributes estimated 5% of flow to receiving stream. Water temps: downstream =64, upstream =63, tributary =59F. Not accessible to fish. Checked up tributary 20 ft, ends at culvert.
13,547	0167.00	Bio Sample: (Other) crayfish observed.
13,745	0170.00	Structures: Bridge #7: Concrete and steel footbridge in Miwok Park. Dimensions: L=10', W=50', H=14'. Not down cutting. Not likely a barrier to salmonids.
13,755	0171.00	Tributaries: Left bank tributary #3 enters Novato Creek. Contributes estimated 5% of flow to receiving stream. Water temps: downstream: 65, upstream: 65, tributary: 60F. Checked up tributary: 20 feet, ends at double culvert. Not accessible to fish.
13,813	0172.00	General Comment: Right bank covered with cape ivy.
14,052	0176.00	Structures: Dam #2: City park dam. Dimensions: L=2', H=4.7', W=40', W(o)=20'. Gravel is being retained, but there is no down cutting. Not likely a barrier to salmonids. It is a currently unused flashboard dam.
15,314	0202.00	General Comment: Scotch broom on right bank.
15,314	0202.00	Structures: Dam #3: Utility crossing. Dimensions: L=5', H=1', W=20', W(o)=7'. Not a flashboard dam. Not retaining gravel, but down cutting is occurring. Height of downcut is 0.5'. Possible barrier to juvenile salmonids.
15,354	0204.00	Structures: Bridge #8: Metal and concrete bridge carries cars on Eucalyptus/Novato Road. Dimensions: W=100', H=12', L=50'. Gravel is being retained, but down cutting is not occurring. Not likely a barrier to salmonids.
16,084	0217.00	Structures: Bridge #9: Steel bridge: Thorsson Court. Dimensions: W=78', H=16', L=27'. Gravel is being retained, and there is a 2ft downcut. Possible barrier to salmonids. Old broken abutments under bridge.
16,308	0222.00	General Comment: Right bank bay tree in creek creating best habitat in creek seen so far.
16,750	0232.00	Structures: Bridge #10: Private wood and steel footbridge. Dimensions: W=40', H=14', L=12'. Gravel is being retained, but there is no down cutting. Not a likely possible barrier to salmonids.
17,307	0242.00	Structures: Bridge #11: Steel bridge spans creek. Dimensions: W=40', H=11', L=12'. Not down cutting. Not likely a barrier to salmonids.
17,568	0246.00	Tributaries: Right bank tributary #1. Unnamed enters Novato Creek. Not flowing. Not accessible to fish, and fence prevented check up tributary.
17,605	0247.00	General Comment: Well on right bank, concrete on left bank, horse stable near stream.
18,051	0254.00	General Comment: Dam #4: flashboard dam. Dimensions: L=0.5', H=4.5', W=33', W(o)=0'. Not retaining gravel, and not down cutting. Not likely a barrier to salmonids, located under bridge (see bridge #12). Not used recently but water stain visible on concrete.
18,051	0254.00	Structures: Bridge #12: Suro Ave Bridge. Dimensions: W=33', H=12', L=55'.

Novato Creek 2009

Position (ft.)	Habitat Unit #	Comments
		Gravel is being retained, and down cutting is occurring. Possible barrier to salmonids. Possible depth and velocity issues at low flows, also holds flashboard dam#4.
18,370	0259.00	General Comment: Evidence of fishing in creek
18,436	0260.00	Bio Sample: (Other) Crawfish observed in stream.
18,917	0264.00	General Comment: Horses have access to the stream.
21,381	0305.00	Structures: Bridge #13: Steel and concrete bridge. Owned by the city. Dimensions: W=30', H=16', L=12'. Not retaining gravel, and not down cutting. Not a barrier to salmonids.
21,991	0315.00	Structures: Dam #5: Made of rip rap. Dimensions: L=12', H=16', W=30'. 2 feet of down cutting. Height from water to sill is 2 ft. Possible barrier to salmonids
25,492	0388.00	Bio Sample: (Other) Dead 4 inch steelhead observed in stream.
25,952	0397.00	General Comment: Cattle have access to the stream.
26,403	0409.00	General Comment: Cattle have access to the stream.
28,080	0444.00	General Comment: Right bank arundo
29,034	0460.00	General Comment: Rip rap on right bank.
29,052	0461.00	Tributaries: Left bank tributary #4 enters Novato Creek. Not flowing. Accessible to fish. Checked up tributary 50 ft, ends at culvert. Broken 2 inch PVC pipe along thalweg.
29,103	0463.00	End of Survey: Ends at a culvert at coordinates N38.1195, W122.636 just below Stafford Lake dam.

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.

Novato Creek 2009

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 }

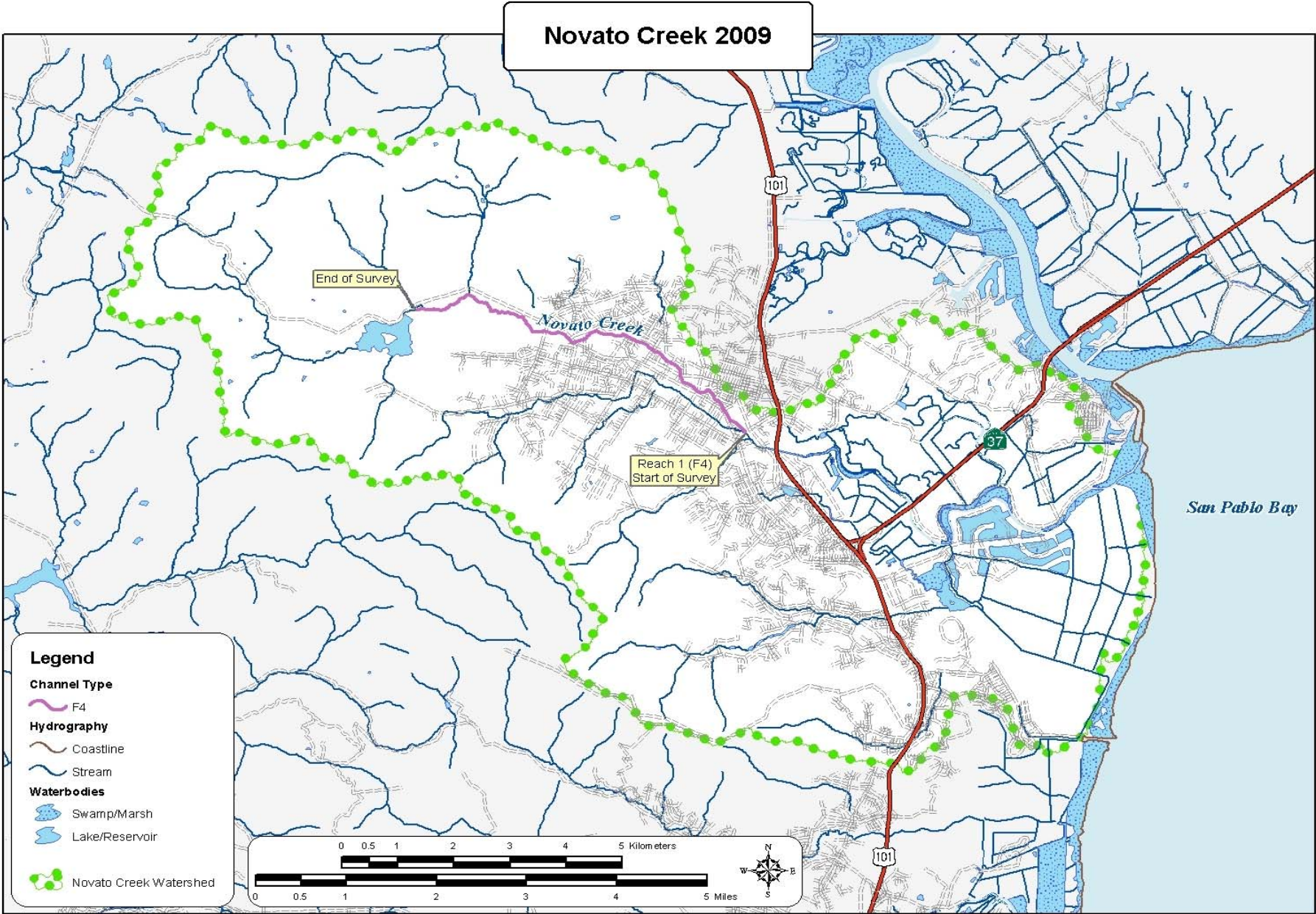
BACKWATER POOLS

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]	

Novato Creek 2009



Novato Creek 2009

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

Stream Name: Novato Creek **LLID:** 1224871380974 **Drainage:** Novato
Survey 6/11/2009 to 6/25/2009

Confluence Location: Quad: PETALUMA **Legal Description:** T03NR06WS14 **Latitude:** 38:05:57.4N **Longitude:** 122:29:13.8W

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
17	0	CULVERT	3.6	32	542	1.9									
180	178	FLATWATER	38.6	82	14700	50.3	10.4	0.5	1.1	824	148258	457	81852		18
175	175	POOL	37.6	56	9737	33.3	11.6	0.7	2.0	652	114167	638	110960	438	39
94	94	RIFFLE	20.2	45	4218	14.4	9.6	0.3	0.6	392	36832	117	11037		2
Total Units	Total Units Fully Measured				Total Length (ft.)						Total Area (sq.ft.)		Total Volume (cu.ft.)		
466	447				29197						299257		203849		

Novato Creek 2009

Table 2 - Summary of Habitat Types and Measured Parameters

Stream Name: Novato Creek

LLID: 1224871380974

Drainage: Novato

Survey 6/11/2009 to 6/25/2009

Confluence Location: Quad: PETALUMA

Legal Description: T03NR06WS14

Latitude: 38:05:57.4N

Longitude: 122:29:13.8W

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 (%)
94	94	LGR	20.2	45	4218	14.4	10.0	0.3	1.8	392	36832	117	11037		2	89
84	82	GLD	18.0	80	6717	23.0	12.0	0.6	3.0	859	72132	546	45884		21	84
96	96	RUN	20.6	83	7983	27.3	9.0	0.5	1.9	794	76196	381	36151		15	87
102	102	MCP	21.9	60	6129	21.0	12.0	0.7	5.2	707	72112	712	71868	494	29	85
2	2	CCP	0.4	66	131	0.4	14.0	0.6	3.1	951	1902	789	1578	317	23	81
1	1	STP	0.2	99	99	0.3	10.0	0.4	1.5	842	842	505	505	337	0	94
9	9	CRP	1.9	63	563	1.9	10.0	0.8	3.4	671	6039	767	6899	592	26	79
24	24	LSL	5.2	41	990	3.4	11.0	0.7	4.5	449	10764	425	10197	307	68	87
30	30	LSR	6.4	48	1436	4.9	13.0	0.5	3.4	624	18724	550	16507	348	63	86
3	3	LSBk	0.6	74	222	0.8	9.0	0.5	1.9	649	1947	524	1572	340	2	90
4	4	LSBo	0.9	42	167	0.6	10.0	0.6	2.7	460	1838	458	1833	289	14	93
17	0	CUL	3.6	32	542	1.9										
Total Units	Total Units Fully Measured				Total Length (ft.)						Total Area (sq.ft.)		Total Volume			
466	447				29197						299327		204032			

Novato Creek 2009

Table 3 - Summary of Pool Habitat Types

Stream Name: Novato Creek

LLID: 1224871380974

Drainage: Novato

Survey 6/11/2009 to 6/25/2009

Confluence Location: Quad: PETALUMA

Legal Description: T03NR06WS14

Latitude: 38:05:57.4N

Longitude: 122:29:13.8W

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
105	105	MAIN	60	61	6359	65	11.6	0.7	713	74855	489	50376	29
70	70	SCOUR	40	48	3378	35	11.6	0.6	562	39312	362	24962	54
Total Units	Total Units Fully Measured				Total Length (ft.)					Total Area (sq.ft.)		Total Volume (cu.ft.)	
175	175				9737					114167		75338	

Novato Creek 2009

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

Stream Name: Novato Creek

LLID: 1224871380974

Drainage: Novato

Survey: 6/11/2009 to 6/25/2009

Confluence Location: Quad: PETALUMA

Legal Description: T03NR06WS14

Latitude: 38:05:57.4N

Longitude: 122:29:13.8W

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
101	MCP	58	3	3	49	49	38	38	7	7	4	4
2	CCP	1	0	0	0	0	0	0	2	100	0	0
1	STP	1	0	0	1	100	0	0	0	0	0	0
9	CRP	5	0	0	5	56	3	33	1	11	0	0
24	LSL	14	1	4	14	58	6	25	2	8	1	4
30	LSR	17	1	3	18	60	8	27	3	10	0	0
3	LSBk	2	1	33	2	67	0	0	0	0	0	0
4	LSBo	2	0	0	3	75	1	25	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
174			6	3	92	53	56	32	15	9	5	3
Mean Maximum Residual Pool Depth (ft.):			2									

Novato Creek 2009

Table 5 - Summary of Mean Percent Cover By Habitat Type

Stream Name: Novato Creek

Dry Units:

LLID: 1224871380974

Drainage: Novato

Survey 6/11/2009 to 6/25/2009

Confluence Location: Quad: PETALUMA

Legal Description: T03NR06WS14

Latitude: 38:05:57.4N

Longitude: 122:29:13.8W

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
94	92	LGR	0	2	1	3	6	2	0	2	0
94	92	TOTAL RIFFLE	0	2	1	3	6	2	0	2	0
84	82	GLD	4	13	3	11	24	4	0	11	1
96	96	RUN	3	13	5	7	13	3	0	11	0
180	178	TOTAL FLAT	3	13	4	9	18	3	0	11	0
102	97	MCP	17	9	4	18	16	3	0	21	1
2	2	CCP	0	25	5	15	5	0	0	0	0
1	1	STP	0	0	0	0	0	0	0	0	0
9	9	CRP	2	3	11	4	28	6	0	13	11
24	23	LSL	2	34	44	5	6	5	0	0	4
30	29	LSR	11	23	8	45	8	4	0	0	0
3	3	LSBk	33	0	0	0	0	0	0	0	0
4	4	LSBo	11	48	0	15	11	0	0	15	0
175	168	TOTAL POOL	13	16	10	19	13	3	0	13	2
17	0	CUL									
466	438	TOTAL	6	12	6	12	14	3	0	10	1

Novato Creek 2009

Table 6 - Summary of Dominant Substrates By Habitat Type

Stream Name: Novato Creek

Dry Units:

LLID: 1224871380974

Drainage: Novato

Survey 6/11/2009 to 6/25/2009

Confluence Location: Quad: PETALUMA

Legal Description: T03NR06WS14

Latitude: 38:05:57.4N

Longitude: 122:29:13.8W

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
94	94	LGR	0	24	63	13	0	0	0
84	82	GLD	16	46	35	2	0	0	0
96	96	RUN	6	23	61	6	0	0	3
102	101	MCP	6	54	39	1	0	0	0
2	2	CCP	0	100	0	0	0	0	0
1	1	STP	0	0	100	0	0	0	0
9	9	CRP	0	11	89	0	0	0	0
24	24	LSL	21	67	13	0	0	0	0
30	29	LSR	31	55	14	0	0	0	0
3	3	LSBk	0	67	33	0	0	0	0
4	4	LSBo	25	75	0	0	0	0	0
17	0	CUL	0	0	0	0	0	0	0

Novato Creek 2009

Table 7 - Summary of Mean Percent Canopy for Entire Stream

Stream Name: Novato Creek

LLID: 1224871380974

Drainage: Novato

Survey 6/11/2009 to 6/25/2009

Confluence Location: Quad: PETALUMA

Legal Description: T03NR06WS14

Latitude: 38:05:57.4N

Longitude: 122:29:13.8W

Mean Percent Canopy	Mean Percent Conifer	Mean Percent Hardwood	Mean Percent Open Units	Mean Right Bank % Cover	Mean Left Bank % Cover
86	1	99	0	52	50

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.

Novato Creek 2009

Table 8 - Fish Habitat Inventory Data Summary

Stream: Novato Creek LLID: 1224871380974 Drainage: Novato
 Survey Dates: 6/11/2009 to 6/25/2009 Survey Length (ft.): 29197 Main Channel (ft.): 29103 Side Channel (ft.): 94
 Confluence Location: Quad PETALUMA Legal Description: T03NR06WS14 Latitude: 38:05:57.4N Longitude: 122:29:13.8W

Summary of Fish Habitat Elements By Stream Reach

STREAM REACH: 1

Channel Type: F4	Canopy Density (%): 86.1	Pools by Stream Length: 33.3
Reach Length (ft.): 29103	Coniferous Component (%): 1.0	Pool Frequency (%): 37.6
Riffle/Flatwater Mean Width (ft.): 10.1	Hardwood Component: 99.0	Residual Pool Depth (%):
BFW:	Dominant Bank: Hardwood Trees	< 2 Feet Deep: 56.3
Range (ft.): 17.00 to 36.00	Vegetative Cover (%): 50.6	2 to 2.9 Feet Deep: 32.2
Mean (ft.): 27.19	Dominant: Terrestrial Veg.	3 to 3.9 Feet Deep: 8.6
Std. Dev.: 4.29	Dominant Bank Substrate: Sand/Silt/Clay	>= 4 Feet Deep: 2.9
Base Flow (cfs): 0.87	Occurrence of LWD (%): 5.8	Mean Max Residual Pool Depth: 2.00
Water (F): 56 - 66 Air (F): 51 - 83	LWD per 100 ft.:	Mean Pool Shelter: 39
Dry Channel (ft.): 0	Riffles: 0	
	Pools: 1	
	Flat: 1	
Pool Tail Substrate (%): Silt/Clay: 2.3 Sand: 17.2 Gravel: 79.9 Sm Cobble: 0.0 Lg Cobble: 0.6 Boulder: 0.0 Bedrock: 0.0		
Embeddedness Values (%): 1. 1.1 2. 16.7 3. 33.9 4. 48.3 5. 0.0		

Novato Creek 2009

Table 9 -Mean Percentage of Dominant Substrate and Vegetation

Stream Name: Novato Creek **LLID:** 1224871380974 **Drainage:** Novato
Survey 6/11/2009 to 6/25/2009
Confluence Location: Quad: PETALUMA **Legal Description:** T03NR06WS14 **Latitude:** 38:05:57.4N **Longitude:** 122:29:13.8W

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	14	6	2.2
Boulder	39	39	8.7
Cobble/Gravel	4	4	0.9
Sand/Silt/Clay	391	399	88.2

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	13	11	2.7
Brush	98	125	24.9
Hardwood	333	299	70.5
Coniferous	0	1	0.1
No Vegetation	4	12	1.8

Total Stream Cobble Embeddedness Values: 3

Novato Creek 2009

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

Stream Name: Novato Creek

LLID: 1224871380974

Drainage: Novato

Survey 6/11/2009 to 6/25/2009

Confluence Location: Quad: PETALUMA

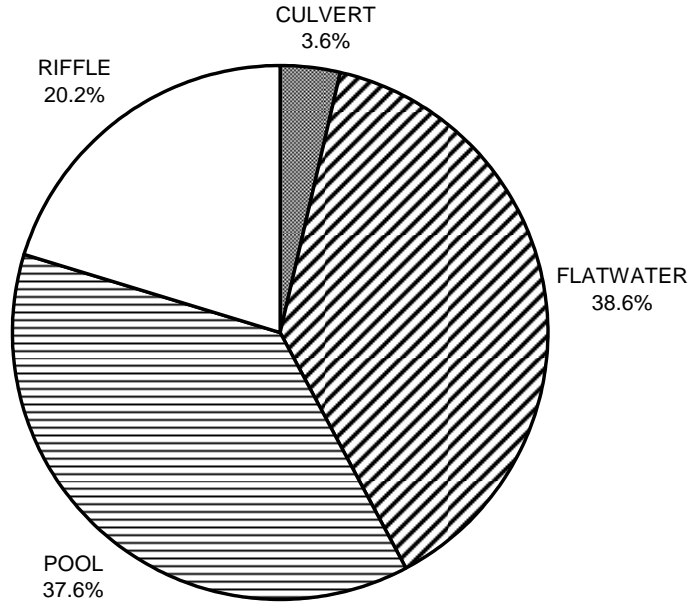
Legal Description: T03NR06WS14

Latitude: 38:05:57.4N

Longitude: 122:29:13.8W

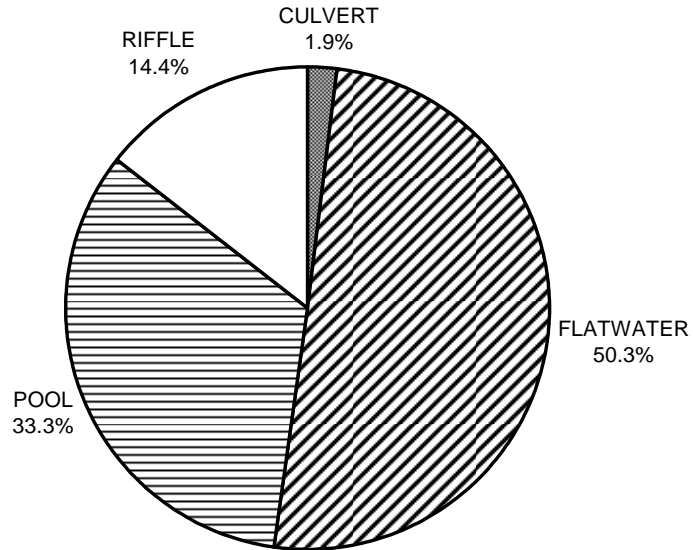
	Riffles	Flatwater	Pools
UNDERCUT BANKS (%)	0	3	13
SMALL WOODY DEBRIS (%)	2	13	16
LARGE WOODY DEBRIS (%)	1	4	10
ROOT MASS (%)	3	9	19
TERRESTRIAL VEGETATION	6	18	13
AQUATIC VEGETATION (%)	2	3	3
WHITEWATER (%)	0	0	0
BOULDERS (%)	2	11	13
BEDROCK LEDGES (%)	0	0	2

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



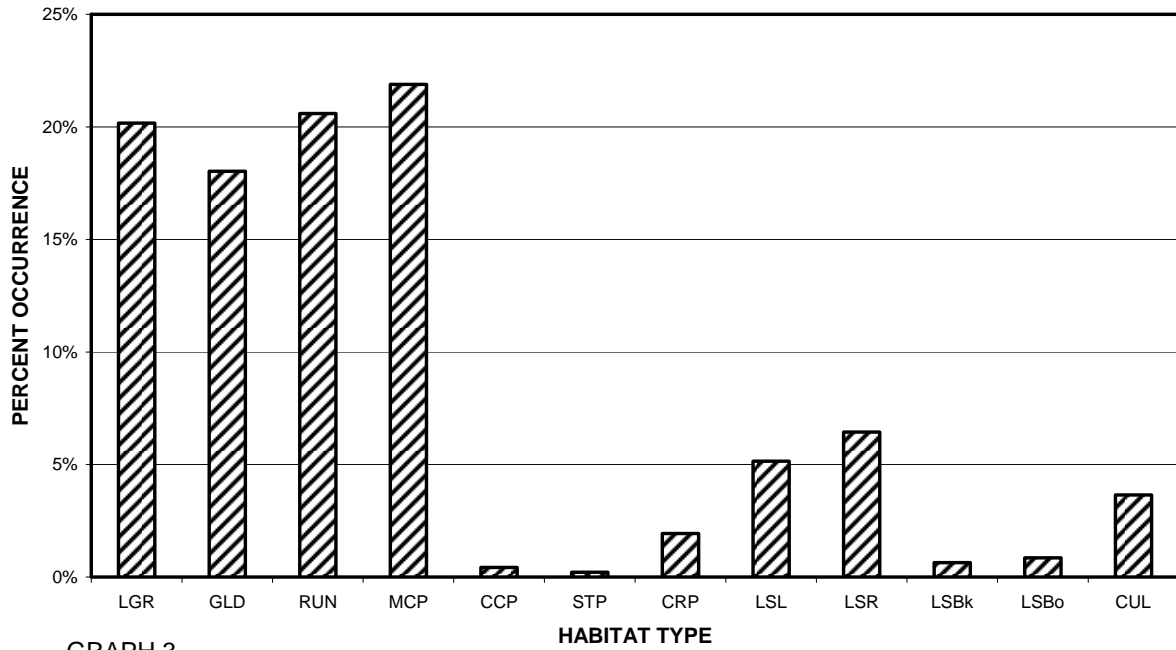
GRAPH 1

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



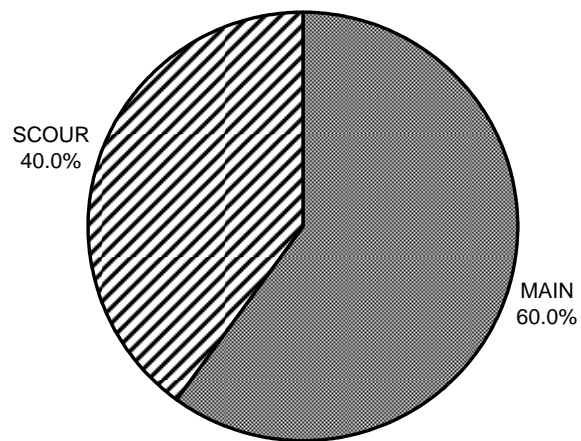
GRAPH 2

NOVATO CREEK 2009 HABITAT TYPES BY PERCENT OCCURRENCE



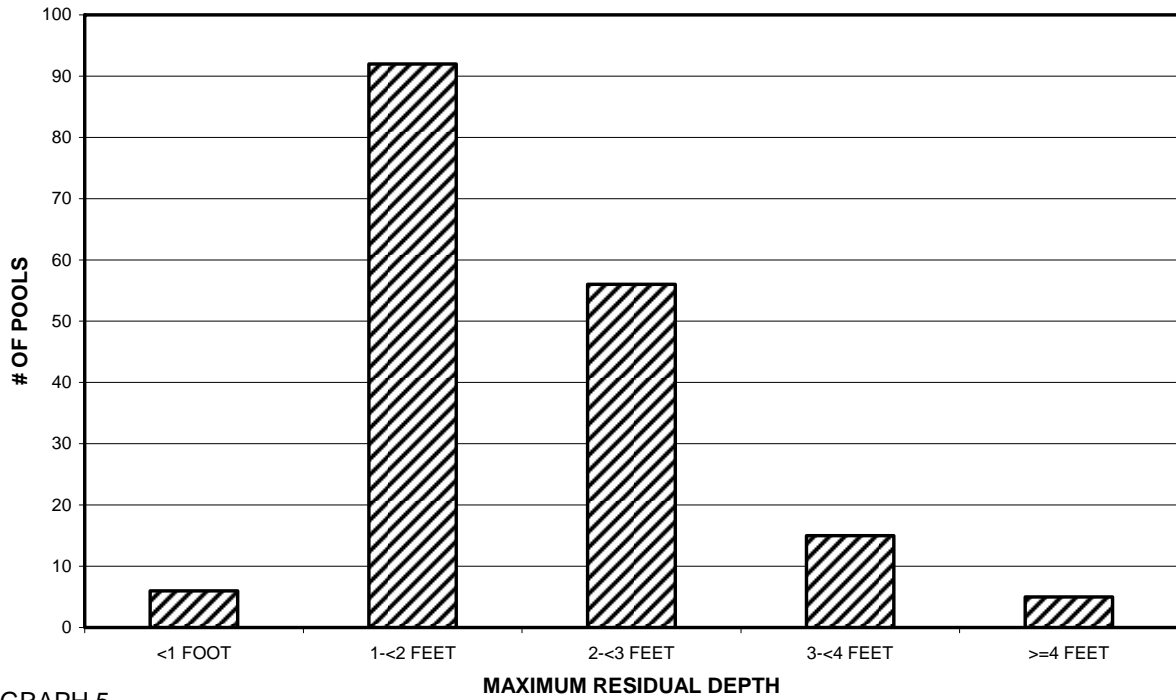
GRAPH 3

NOVATO CREEK 2009 POOL TYPES BY PERCENT OCCURRENCE



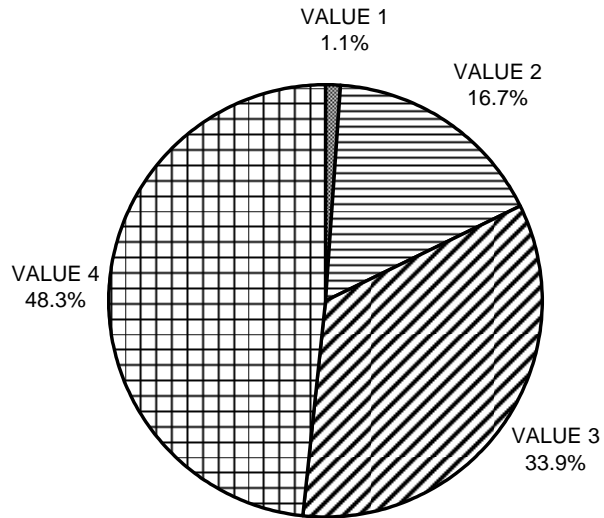
GRAPH 4

NOVATO CREEK 2009 MAXIMUM DEPTH IN POOLS



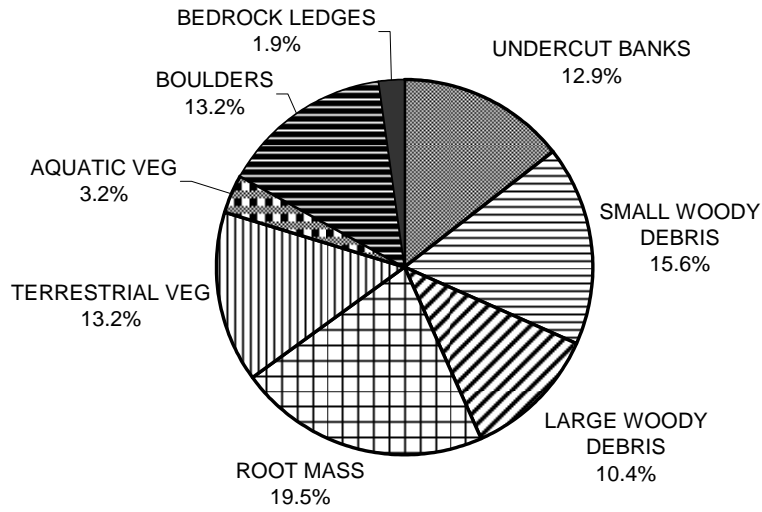
GRAPH 5

NOVATO CREEK 2009 PERCENT EMBEDDEDNESS



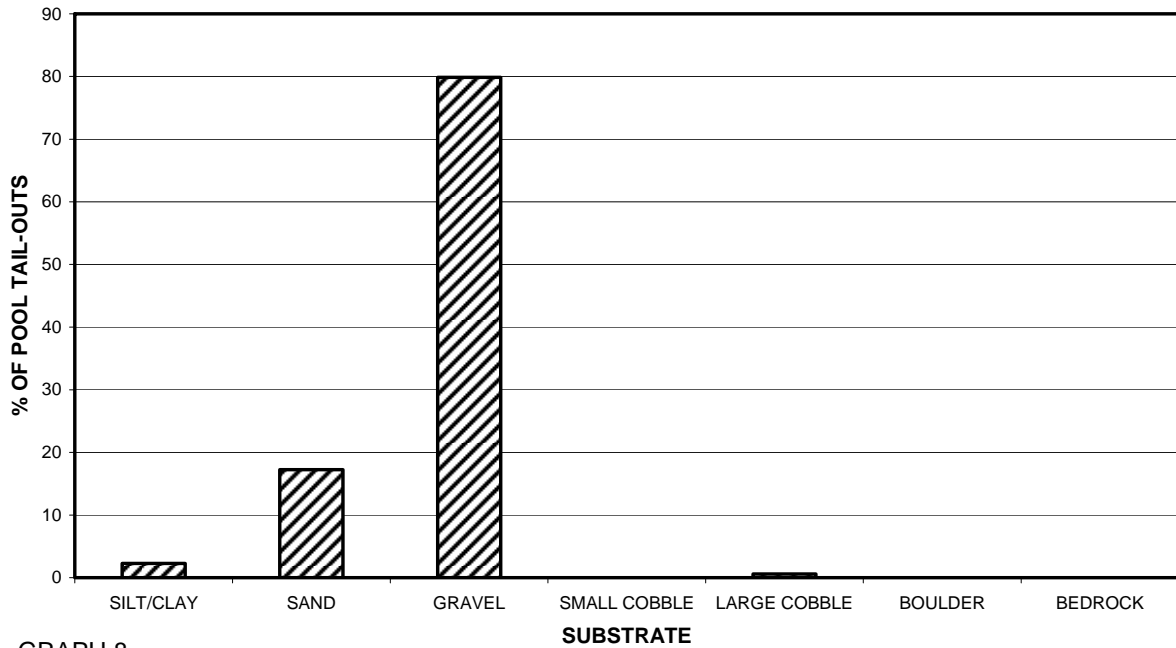
GRAPH 6

**NOVATO CREEK 2009
MEAN PERCENT COVER TYPES IN POOLS**



GRAPH 7

**NOVATO CREEK 2009
SUBSTRATE COMPOSITION IN POOL TAIL-OUTS**



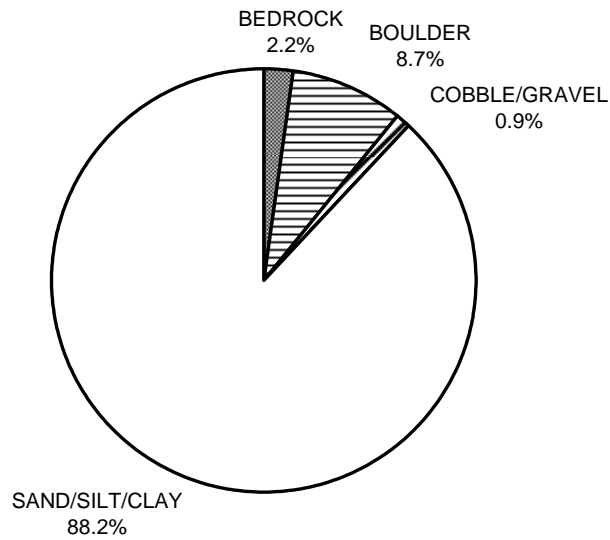
GRAPH 8

**NOVATO CREEK 2009
MEAN PERCENT CANOPY**



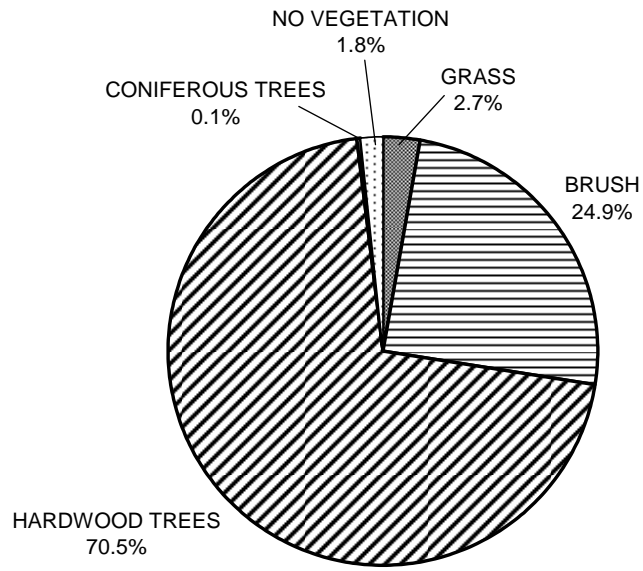
GRAPH 9

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



GRAPH 10

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



GRAPH 11