SANTA ROSA CREEK
STEELHEAD HABITAT AND POPULATION SURVEY

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2005

Historically, Santa Rosa Creek supported one of the largest, self-sustaining populations of steelhead (*Oncorhynchus mykiss*) in San Luis Obispo County. However, in the past few decades, significant land development in the town of Cambria and adjacent areas and a concurrent increase in the demand for water resources have adversely impacted instream habitat and the steelhead population which resides there. Excessive sediment deposition, modified stream banks, and reduced or altered riparian areas have also degraded steelhead habitat. Stream habitat degradation is not unique to Santa Rosa Creek. What is unique is that most of the fifteen miles of creek are perennial; the bank altering development is confined to the lower 3 miles of the watershed, and only one impediment to migration exists on the mainstem. Most other watersheds in San Luis Obispo County either have greatly reduced perennial reaches, development throughout the entire watershed, and/or several barriers or impediments located throughout the migration corridor. Because of the relatively few issues on Santa Rosa Creek, the restoration or enhancement potential for steelhead is greater than in other areas.

In order to determine current habitat conditions and the population status of steelhead, habitat typing, outmigrant trapping and juvenile fish sampling was conducted in Santa Rosa Creek during the spring, summer, and fall of 2005. The habitat inventory documented the quantity and quality of spawning and rearing habitat available for steelhead rainbow trout and determined some of the limiting factors depressing the population. The juvenile steelhead population monitoring determined the distribution and relative abundance of fish throughout the creek while the outmigrant trapping for steelhead smolts in the spring determined run timing and gathered information on smolt morphological characteristics.

This report discusses the results of the survey and includes recommendations for habitat enhancement or further studies that are needed to thoroughly describe watershed processes.

Watershed Overview

Santa Rosa Creek is a small coastal stream located in north western San Luis Obispo County. It originates in the south western portion of the Santa Lucia Mountain Range at elevations ranging between 1,000 and 1,900 feet and flows in a northwesterly direction for approximately 15 miles before entering the Pacific Ocean at San Simeon State Beach (N35° 34' 07.0", W121° 06' 38.1")(Figures 1, 2, 3, and 4). Santa Rosa Creek is a third order stream with several springs and tributaries located throughout the watershed, the most significant of which are Perry Creek which enters Santa Rosa Creek at stream mile 3.0 on the eastern edge of the town Cambria, Curti Creek which enters at stream mile 8.1, and two unnamed perennial tributaries that enter Santa Rosa Creek at approximately stream miles 10.5 and 13. Total drainage area, including Perry Creek, is 47 square miles. The watershed area not including Perry Creek is 24 square miles (Chatham, 1993).

From the headwaters down to stream mile 7.8, the creek flows through a sinuous confined canyon where oaks, California bay and alder are the dominant tree species. Grasses, sedges and other herbaceous species comprised the understory. At stream mile 7.8, the creek abruptly discharges from the narrow canyon into a broad valley with a poorly defined creek channel, extensive gravel bars and flood plains, short, denuded stream banks and intermittent willow trees, mule fat and grasses. It is in this section of the channel that the creek will be seasonally dry or go sub-surface. From stream mile 6.5 downstream to stream mile 3, the valley floor is still broad, however the stream channel is incised. Riparian species include alder, willow, cottonwood, sycamore and a dense herbaceous understory. Downstream of this point the valley constricts somewhat and the town Cambria surrounds the creek. Much of channel in this area is lined with rip rap and the riparian has been encroached upon by development. The native vegetation along the creek includes willow, poison oak, stinging nettle and blackberry, however extensive stands of non-native trees, shrubs and ivy dominate the riparian zone to the exclusion of native vegetation. This is a very general description of the watershed. Specific information can be found in the Comments and Landmarks section at the end of the report.

Ninety percent of the watershed is privately owned with variable land use. Most of the commercial and residential development is concentrated in the lower 3.5 miles of the watershed within the town of Cambria. Cattle grazing, rural residential, irrigated agriculture, vineyards, mining and private property without current land use activity comprises the remainder of the privately owned portion of the watershed. Ten percent of the watershed is publicly owned and is managed for preservation or limited recreation (Duff, 2007).

Habitat Evaluation Methods

In order to assess habitat conditions in Santa Rosa Creek, several parameters were evaluated including habitat features, channel form, stream flow, and stream temperatures.

Habitat Features

To evaluate instream habitat features several parameters were noted including habitat type, average length, width, and depth, maximum depth of the unit, abundance and type of instream shelter, substrate composition, embeddedness of the substrate at the pool tail crest, canopy, bank composition, vegetation coverage, and comments on landmarks or issues that may be impacting instream habitat.

Every habitat unit was classified according to habitat type and measured for average length. In all pool units, maximum depth, depth at the pool tail crest (measured in the thalweg), dominant substrate at the pool tail crest, and embeddedness of that substrate were also measured. However, only 10% of the habitat units are measured for all the parameters mentioned previously including those habitat types encountered for the first time and one randomly selected unit on each page. A detailed description of the habitat typing method can be found in the *California Salmonid Stream Habitat Restoration Manual* (Flosi et al, 1998).

1) Habitat Typing

To describe the stream, the method used the 24 habitat types defined by McCain et.al. (1990). Habitat units were numbered sequentially starting at 0001 and assigned a type identification number selected from the list of 24 habitat types (Appendix A). For a particular habitat unit to be classified as a discreet unit the minimum length of the unit must have been equal to or greater than, the stream's mean wetted width.

2) Measuring dimensions

Once a unit was identified as a particular habitat type, the average length was measured. For those units that were measured for average width and depth, the number of measurements made to obtain an average depended upon the uniformity of the channel with more measurements being taken if the channel was irregular. All measurements were in feet to the nearest half foot and the dimensions were measured using a laser range finder and stadia rod.

3. Shelter Rating

Instream shelter components included wood (logs, roots, tree's, stumps), boulders, undercut banks, and other elements within a stream channel that could provide juvenile and adult salmonids protection from predation, reduce water velocities so fish could rest and conserve energy, and allow for the separation of territorial units to reduce density related competition. At each fully measured unit, the type of shelter present and the percentage of that type relative to other shelter components was recorded. In addition, percent cover was derived by estimating how much of the volume of a particular unit contained cover components.

4. Substrate Composition

Substrate composition ranged from silt/clay sized particles to boulders and bedrock. In all fully-described habitat units, dominant and sub-dominant substrate elements were estimated using a list of seven size classes and recorded as a one and two, respectively.

5. Substrate Composition and Embeddedness at Pool Tail Crests

The dominant or primary substrate composing the pool tail crest was recorded at each pool. In addition, the depth of fine sediment surrounding or burying the cobbles at the crest was estimated. This figure is expressed as a value and the following criteria were used: 0 - 25% buried (value 1), 26 - 50% (value 2), 51 - 75% (value 3), and 76 - 100% (value 4). A value of 5 was assigned to tail-outs deemed unsuitable for spawning because of an inappropriate substrate such as bedrock, log sills, or boulders.

6. Canopy

Canopy was considered to be anything hanging or situated over the creek (e.g. vegetation, bridges) that would provide shade on the water. It was measured by standing in the center of the unit and visually estimating how much of the unit is covered. Canopy does not take into account topographic shade or other upslope features which may be shading a stream. Estimates of canopy were made at every third unit in addition to every fully-described unit, giving an approximate 30% sub-sample.

7. Bank Composition and Vegetation

For every fully described unit, the dominant bank composition type (e.g. bedrock, cobble, soil) and vegetation type (e.g. grass, brush, and trees) was recorded for both the right and left banks. Additionally, the percent of each bank covered by vegetation (including downed trees, logs, and root wads) was estimated and recorded.

8. Comments and Landmarks

In addition to collecting data on the specific habitat units, comments on adjacent land use, water quality, erosion sources, non-native vegetation, impediments, and other issues which may be impacting stream habitat were noted. Landmarks such as tributaries, road or bridge crossings, buildings, or other structures which are not likely to move were noted to facilitate locating certain areas of the stream for future sampling.

Habitat Typing Data Analysis

Data from the habitat inventory was entered into Stream Habitat 2.0.16, 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.

Channel Typing

Channel typing was conducted according to the classification system developed and revised by David Rosgen (1994) and is described in the *California Salmonid Stream Habitat Restoration*

Manual (Flosi et al, 1998). Channel typing was conducted simultaneously with habitat typing and followed a standard form to record measurements on: 1) water slope gradient, 2) sinuosity, 3) entrenchment, 4) width/depth ratio, and 5) substrate composition.

Stream Flow

Stream flow was measured weekly from April 20, 2005 through September 20, 2005 with additional measurements made on October 5, 2005, October 24, 2005, November 11, 2005 and December 6, 2005. All measurements were taken at a fixed transect site located approximately 3,000 feet downstream from Highway 1 (Figure 1).

Stream flow was measured by setting a transect line perpendicular to flow and recording velocity measurements at one foot increments (or at 0.5 foot increments if the stream was less than 20 feet wide). Because maximum depth never exceeded two feet, the six-tenths depth method was used. All velocity measurements were taken using a Model 2000 Marsh-McBirney Flow-Mate and stream flow was calculated using the Velocity Area method.

Temperatures

Water and air temperatures were measured and recorded during the habitat typing survey at the start of a new page or every tenth habitat unit. Water temperatures were taken within one foot of the surface of the water and air temperatures were taken in the shade.

In addition to collecting temperature data during habitat typing, three Hobo® temperature data loggers were deployed on June 6, 2005 and began taking measurements every half hour starting at 12:00 midnight on June 7, 2005 until they were retrieved on October 25, 2005. The data loggers were placed instream at stream miles 0.6, 8.0, and 14.5 (Figures 1, 2 and 3).

Fish Sampling Methods

Fish sampling included out-migrant trapping in the spring to determine steelhead smolt characteristics and timing of emigration and quantitative electrofishing in the fall to ascertain juvenile steelhead densities at ten locations in Santa Rosa Creek.

Out-migrant Trapping Methods

In order to determine the timing and general morphological characteristics of steelhead smolts moving downstream, an out-migrant trap and attached weir were placed in Santa Rosa Creek from April 18, 2005 through May 25, 2005 at stream mile 0.35. The trap was a twelve foot long seven hoop trap constructed of treated quarter inch mesh. The attached weir was also constructed of treated quarter inch mesh with floats along the top edge at one foot intervals. The weir extended slightly upstream to the stream banks to form a V-shape that would facilitate fish movement into the trap (Figure 5). The weir was secured by fastening it to fence posts at two to three foot intervals depending on water velocities. The bottom of the weir was lined with rock in order to prevent fish from swimming underneath.

The trap was operational from Monday afternoon through Friday afternoon (four nights) with one side of the weir folded back into the trap during the weekends to allow unimpeded fish movement.

Figure 5. Hoop trap and weir on Santa Rosa Creek, 2005.

On the days when the trap was operational, the trap and weir were cleared of debris and checked to assure that it remained secure and that it was fishing effectively. Trap and weir conditions, air temperature, water temperature, weather conditions, and sandbar condition were recorded daily.

Captured steelhead were measured for fork length and total length to the nearest millimeter and wet weight to the nearest 0.1 gram. A scale sample was taken from the left side beneath the dorsal fin and above the lateral line if the steelhead was longer than 100 millimeters. Steelhead were also categorized as parr (fish with rainbow trout coloration and conspicuous parr marks), pre-smolt (silver coloration with faded parr marks), smolt (fish exhibiting silver coloration, no parr marks, low condition factors and deciduous scales), rainbow trout morph (trout with olive-green coloration on the dorsal surface, a distinct pink stripe along the lateral line and no parr marks), or kelts (adults which have spawned). Additionally, captured steelhead were checked for black spot disease, *Salmonicula* and other parasites or abnormalities.

All other fish species, amphibians, reptiles, and crustaceans in the trap were identified and enumerated.

From the length and weight data, Fulton Condition Factors were calculated using the formula "Condition = (weight (g)/length (mm)^3)*100,000" (Murphy and Willis, 1996).

Electrofishing Survey Methods

Using the habitat typing data collected during the summer of 2005 ten sample sites were chosen in order to obtain steelhead densities. Sites were chosen by how well they represented the habitat within a particular section of stream. Length of each site varied to ensure that whole habitat units were included in the sampling. To enclose the population, block nets were placed at the upper and lower ends of the sampling site. Once the nets were in place and the water cleared, sampling began at the lower net, working upstream until the upper net was reached. All fish and amphibians observed were captured using a Smith-Root Model 12 backpack electrofishing unit. Fish and amphibians were held in buckets or placed in flow-through live cars until the upper net was reached. Total time that the anode was functioning was recorded and effort was made to keep time consistent between each pass. Electrofishing settings were also fixed between passes to assure that capture probabilities remained constant. Protocols designed to meet the assumptions of the multiple pass removal/depletion method as described by Zippin (1958) were used to analyze the population at each site.

At the end of each pass, steelhead were measured for fork length and/or total length to the nearest millimeter, weighed to the nearest 0.1 gram and checked for obvious signs of parasites and disease. Other fish species and amphibians captured were identified and enumerated. After each pass, fish were held in a live car upstream of the upper block net until the sampling was completed after which all fish were re-distributed back into the sample station.

With the paucity of information regarding age/length relationships of juvenile steelhead in the central coast region, age classes defined by Shapovalov and Taft (1954) were used for assigning the steelhead captured in Santa Rosa Creek to certain age classes. While conducting an extensive year round upmigrant and outmigrant trapping program for nine years on Waddell Creek in Santa Cruz County, Shapovalov and Taft analyzed scales from juvenile and adult steelhead captured in the traps in order to determine age, length of time spent in freshwater and saltwater, and spawning history. Juvenile fish captured in the trap during September and October that were less than 105 millimeters fork length were age 0+ or young-of-the-year. Steelhead measuring 105 to 165 millimeters were age 1+ and fish that were 165 to 220 millimeters were age 2+. Obviously, there will be variability in the length ranges for a given age class depending upon timing of emergence, food availability, stream flow, competition, temperature and other rearing conditions. However, until more discreet, stream specific information becomes available the age/length categories defined by Shapovalov and Taft will be used.

Population estimates for each site were calculated using the Microfish 3.0 program (VanDevanter and Platts, 1989). Fulton Condition Factors were calculated using the method described in the outmigrant trapping method section.

Channel Typing Results

In Santa Rosa Creek, channel types changed often primarily because of substrate composition and the degree of entrenchment. To simplify the classification of reaches, the most prevalent channel type was used to designate reaches. For example, if there was a short reach of a “C” channel type in an otherwise “F” dominated channel, the “C” channel was not called out separately. Using this criterion, reach 1 within Santa Rosa Creek extended from the upper end of the lagoon upstream 26,399 feet and was primarily a F3/F4 channel type. Reach 2 was a C3/C4 channel for the next 16,411 feet before switching back to a F3 channel for 5,455 feet and reach 4 was a C2 channel type for the remaining 28,208 feet. The “F” type channels are entrenched, low gradient, meandering, with riffle/pool sequences and high width/depth ratios. The “C” channel type is a low gradient, meandering, alluvial channel with point-bars, riffle/pool sequences and broad, well defined floodplains. The 2, 3, and 4 refer to the dominant substrate with 2 referring to boulder, 3 referring to cobble, and 4 being gravel.

Habitat Typing Results

The mainstem Santa Rosa Creek was surveyed from the upper end of the lagoon up to stream mile 11.2 where the mainstem makes a 90˚ turn off to the south. The survey continued for another 3.2 miles in the unnamed tributary that runs adjacent to Santa Rosa Creek Road which at the time of the survey contained three quarters of the flow. Approximately 1,452 feet of stream were not surveyed because of access issues. Access was also denied on an additional 5,050 feet of stream, but habitat mapping was conducted from the road. Depth, width, instream shelter and pool tail crest information was not able to be obtained on those units, however.

A total of 894 discreet habitat units were identified in the 79,843 feet of channel surveyed; however 3,370 feet were side channel units so the actual length of stream surveyed was 76,473 feet. Based on frequency of occurrence, 44% of the units were pools, 37% were flatwater units, 15% were riffles, 3% consisted of side channel units, 0.1% of the units were dry, 0.1% was a culvert, 0.5% was not surveyed, and 0.1% was the lagoon (Table 1 and Figure 6).

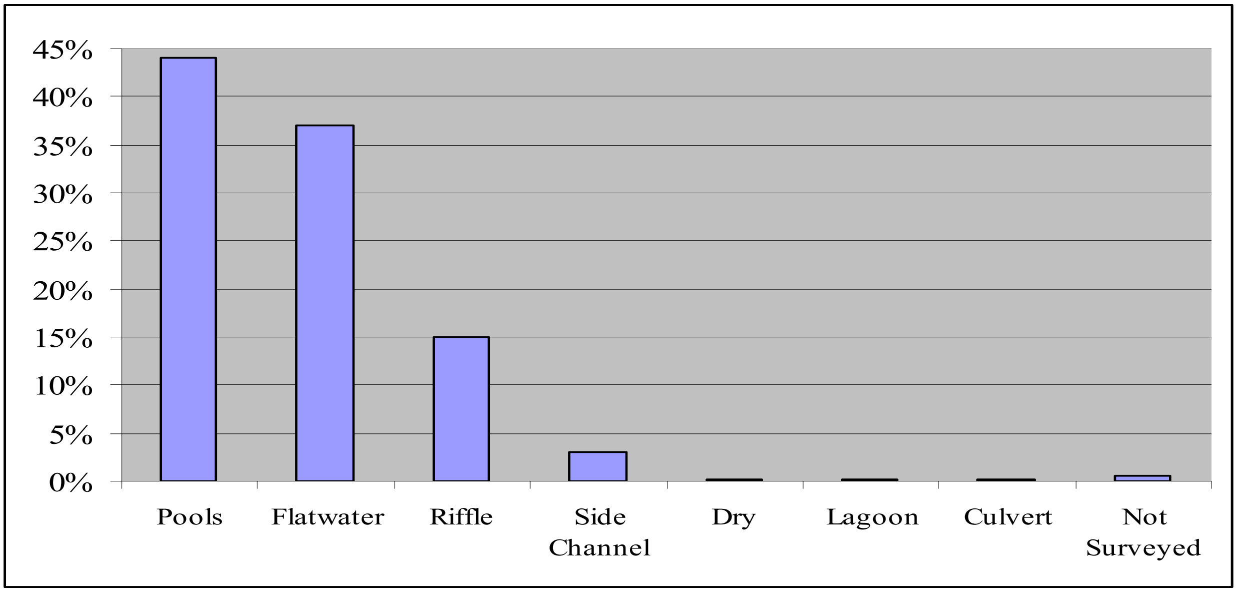

Figure 6. Percent frequency occurrence of habitat units in Santa Rosa Creek, 2005.

Based on total stream length, 34.1% (27,238 feet) was pool habitat, 46.2% (36,924 feet) was flatwater, 8.2% (6,546 feet) were riffles, 3.3% (2,625 feet) was dry, 1.8% (1,452 feet) was not surveyed, 1.9% (1,548 feet) was lagoon habitat, 0.06% (50 feet) of the creek went through a culvert and 4.3% (3,370 feet) were side channel units (Table 1 and Figure 7).

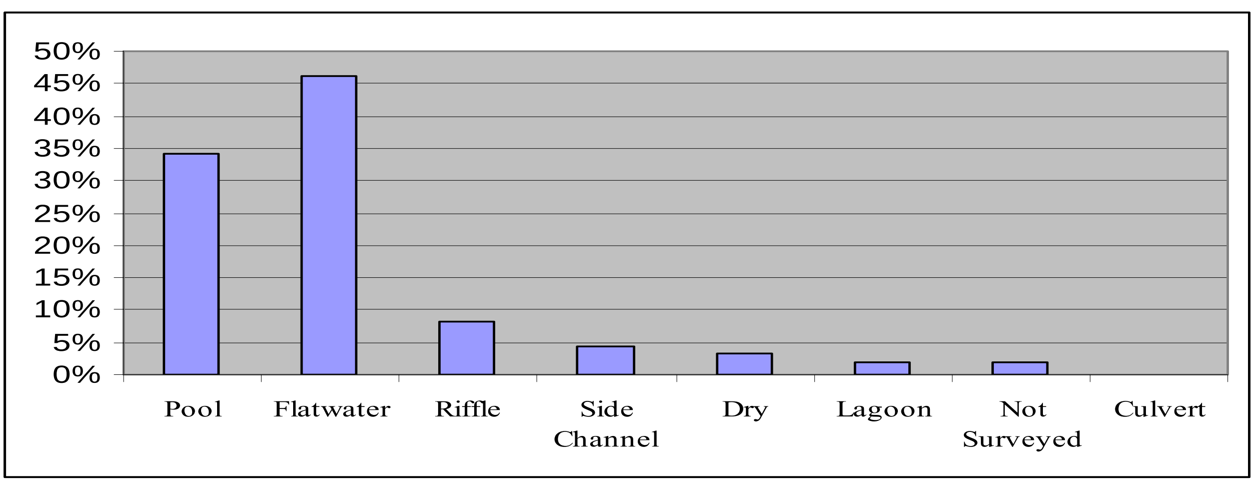

Figure 7. Percent total length of each category of habitat, Santa Rosa Creek, 2005.

Pool Results

Of the 894 units identified, 397 of these units were pools. Pool types found in Santa Rosa Creek include mid-channel pools (84 pools), lateral scour boulder pools (83 pools), lateral scour root pools (80 pools), lateral scour bedrock pools (74 pools), lateral scour log pools (58 pools), corner pools (11 pools), and step pools (7 pools). Fifty-eight percent or 231 pools were located upstream of the dry reach while the remaining 166 pools (42%) were dispersed downstream of the dry reach.

Average lengths, widths, and depths of each of these pools types can be found in Table 2. Maximum depths of all pool types measured ranged from less than one foot (61 pools) to over 4 feet (1 pool). An additional 212 pools ranged between 1 and 2 feet maximum depth, 71 pools ranged between 2 and 3 feet, and 13 pools ranged between 3 and 4 feet deep (Table 3 and Figure 8). Pools upstream of the dry reach had a slightly higher average maximum depth of 1.92 feet while downstream of the dry reach the average maximum depth of pools was 1.88 feet.

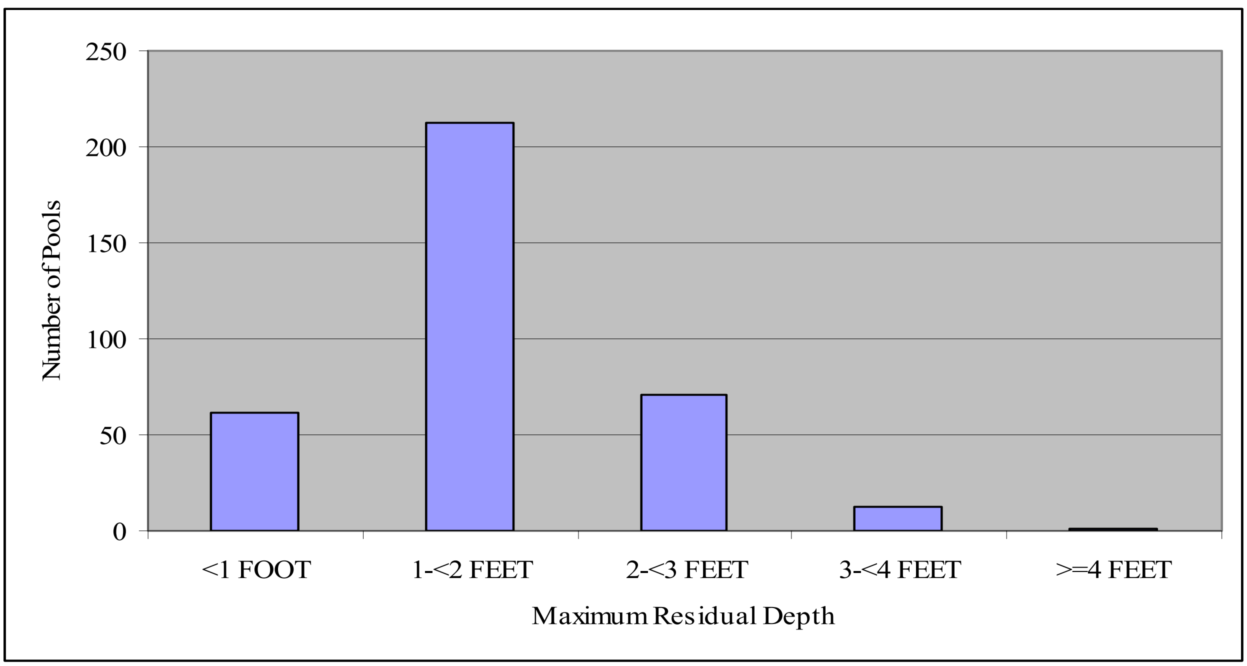

Figure 8. Distribution of maximum residual depths in measured pools, Santa Rosa Creek, 2005.

Instream cover or shelter was diverse and included root mass (26%), terrestrial vegetation (17%), small woody debris (13%), boulders (18%), undercut banks (10%), aquatic vegetation (12%), large woody debris (3%), and white water (1%) (Table 4 and Figure 9). The percentage of pool volume with instream shelter ranged from 5% and 90% in the 42 pools that were fully measured (Table 5).

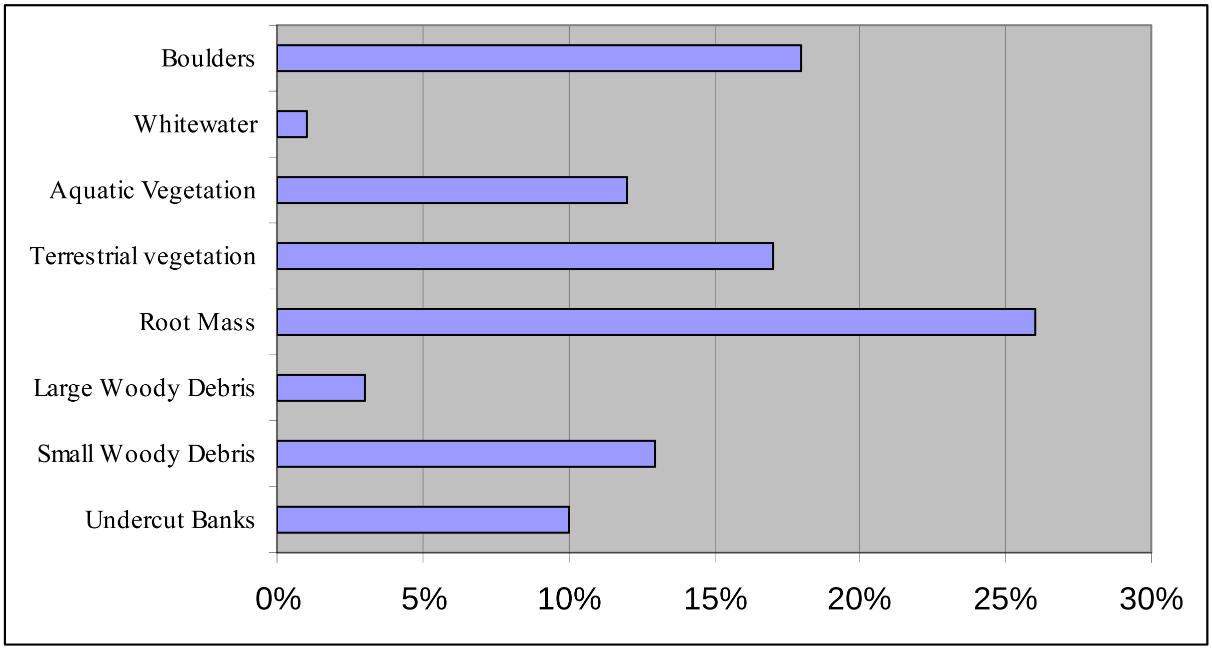

Figure 9. Percentage of each cover type in pool habitat, Santa Rosa Creek, 2005.

Percentage of Pool Volume with Cover	Percentage of Pools
0% – 10%	28 %
11% - 20%	49 %
21% - 30%	10%
31% - 40%	2.5%
41% - 50%	5%
51% - 60%	2.5%
61% - 70%	
71% - 80%	
81% - 90%	3%
91% - 100%	

Table 5. Percentage of pool volume with cover components, Santa Rosa Creek, 2005.

The pools in stream miles one, five, six, seven, and ten had the highest percentages of instream cover with 42% cover in stream mile one, 20% in stream mile five, 21% in stream mile six, 37% in stream mile seven and 30% in stream mile ten. Cover in stream mile one was provided primarily by emergent aquatic vegetation that covered the channel. Cover was more diverse in stream miles five, six, seven and ten. All remaining pools had cover in 5% and 15% of the volume. It is suspected that the pools that were identified but not surveyed throughout stream miles 12 and 13 would significantly increase the percentage of cover for those two stream miles.

Primary substrate within pools consisted of sand (34.5% of the pools), gravel (22%), silt (17.5%), boulder 16%, small cobble and large cobble (5% each) (Table 6).

<u>Substrate Composition and Embeddedness at Pool Tail Crests</u>

Of the 381 pool tail crests measured, 79 consisted of silt/clay, sand, or boulders and since these substrate types could not be used for spawning, they had a rating of 5. The remaining 302 pool tail crests consisted of gravel (164 pools), small cobble (107 pools), or large cobble (31 pools) (Figure10). Gravel (0.08 – 2.5 inches in diameter) and small cobble (2.5 – 5.0 inches in diameter) can be used for spawning, however the large cobble (5 – 10 inches in diameter) would most likely need to be mixed with smaller sized substrate in order to be used for spawning.

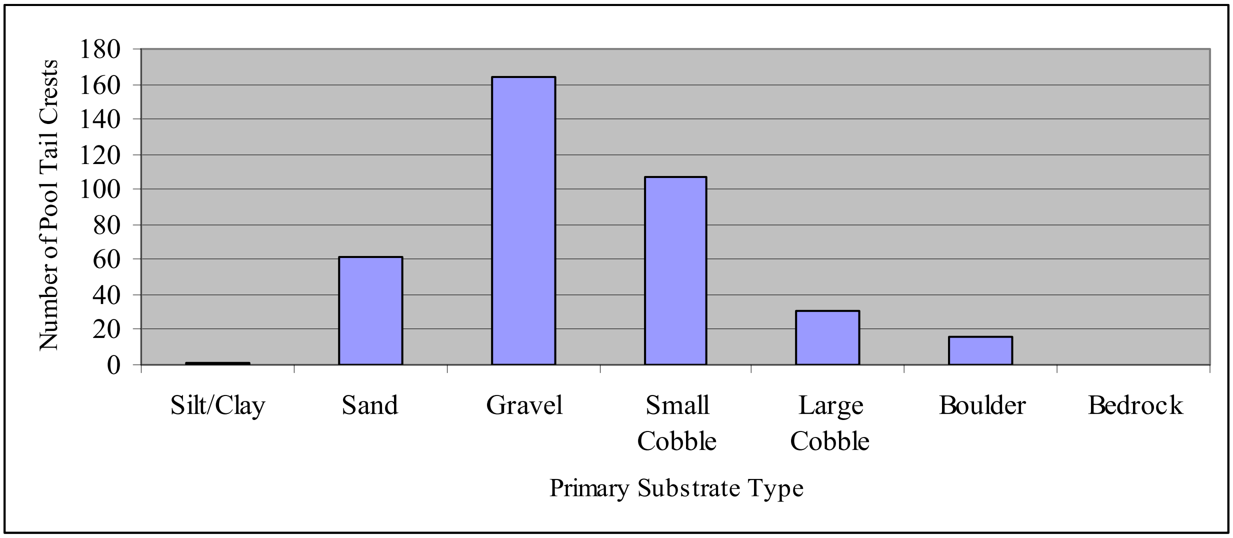

Figure 10. Distribution of the primary substrate at 381 of the pool tail crests, Santa Rosa Creek.

The pool tail crests that consisted of gravel, small cobble and large cobble were also measured for embeddedness. It was found that 61 of the pools tail crests were less than 25% embedded (Value 1), 138 were between 26 – 50% embedded (Value 2), 66 were embedded between 51 – 75% (Value 3), and 36 were embedded more than 75% (Value 4) (Table7).

Substrate at pool crests	Number of Pools	Value 1 (< 25%)	Value 2 (26 – 50%)	Value 3 (51 – 75%)	Value 4 (>75%)	Value 5 (Cannot use)
Silt/Clay	1					1
Sand	62					62
Gravel	164	57	69	22	18	
Small Cobble	107	3	53	32	15	
Large Cobble	31	1	16	12	3	
Boulder	16					16

Table 7. Embeddedness of substrate at pool tail crests

Of those pool tail crests consisting of either gravel or small cobble, 112 spawning sites were located downstream of the dry area and 139 sites were above the dry area. The number of spawning sites above the dry reach is most likely much higher since it does not include any spawning areas that may have been located in the 6,502 feet that were not surveyed. Using the criteria of appropriate substrate and low embeddedness (< 50%), 175 sites were available (81 below the dry reach and 94 above). Fifty-seven of those sites had the optimum combination of gravel/small cobble substrate and embeddedness less than 25% (25 below the dry reach and 31 above). Stream miles 5 through 7, 9, 10, 11 and 14 had the highest quality and quantity of spawning habitat. Stream miles 1 through 4 had three optimal sites.

There were 183 other potential spawning sites that are not located at the pool tail crests. Of these, 91 were above the dry area and 92 were below. Within the dry reach spawning substrate was available as well. The locations of these sites are identified in the Comments and Landmarks section.

Riffle Results

In Santa Rosa Creek, 128 low gradient riffles and three cascades were identified. Most of the riffles (99 units) were located above the dry reach. Detailed information of the average length, width, and depth of these units can be found in Tables 1 and 2. Average maximum depth in the riffles and cascades was 0.9 feet.

Instream shelter in riffles consisted primarily of white water (29.5%) and boulders (29%) however, aquatic vegetation (16%), small woody material (8%), terrestrial vegetation (7.5%), root mass (7.5%), bedrock ledge (2%) and large woody material (0.5%) were also present (Table 4). The volume of riffle habitat with instream shelter ranged from 0% to 90% with most of the riffles (81%) having shelter between 0% and 10% of the volume. An additional 12.5% of the riffles had shelter in 11% to 20%, 6% of the riffles had shelter in 31% to 40% of the volume, and the remaining 12.5% of the riffles had shelter in 81% to 90% of the volume.

Primary substrate within low gradient riffles included gravel (31%), small cobble (31%), large cobble (25%), and boulders (13%). The three cascades surveyed consisted of boulders (Table 6).

When looked at individually and cumulatively, the boulder cascades were not considered to be impediments or barriers to migration.

Flatwater Results

The flatwater habitat in Santa Rosa Creek included glides, runs, and step-runs. Within the approximate 14.5 miles of stream surveyed, 254 runs, 59 glides, and 16 step-runs were identified. Average length, width and depth of these units can be found in Table 2. Maximum depth was 2.2 feet in the runs, 1.3 feet in the glides, and 1.2 feet in the step-runs.

Instream shelter in all flatwater units combined included boulders (31%), root mass (22%), submerged terrestrial vegetation (16%), aquatic vegetation (10%), small woody material (8%), white water (8%), undercut banks (4%) and large woody material (1%) (Table 4). The volume of flatwater habitat with instream shelter ranged from 0% to 50% with 58% of the flatwater units having shelter in 0% to 10% of the volume, 31% of the units had shelter in 11% to 20%, 8% of the units had shelter in 21% to 30%, and 3% of the units had shelter between 41% to 50% of the volume. Generally, the runs and step-runs had diverse shelter and the shelter was distributed throughout the entire unit. Cover in the glides consisted primarily of submerged terrestrial vegetation and it was confined to the margins of the stream.

Primary substrate within glides consisted of gravel (66%), silt (17%), and small cobble (17%). Primary substrate within runs consisted of gravel (36%), small cobble (24%), sand (16%), boulder (12%), and large cobble (12%). Step-runs consisted of boulders (75%) and small cobble (25%)(Table 6). The locations of the glides which could be potential spawning sites are identified in the Landmarks and Comments section.

Side Channel Habitat

Side channel habitat were those units that flowed parallel to one or more main channel units, but at low flow are separated from the main channel by a cobble bar. In Santa Rosa Creek, the side channels that were identified had less flow than the main channel units, but were going to remain perennial. Twenty-nine side channel units were identified and included five backwater boulder scour pools (546 feet), two bedrock scour pools (277 feet), seven riffles (948 feet), six glides (807 feet), eight runs (581 feet), and one step-run (211 feet).

Canopy

Canopy density was measured in approximately one-third of all the habitat units (Table 8). In addition, general native riparian vegetation communities and non-native species locations were noted, but an extensive vegetation survey was not conducted. For all of Santa Rosa Creek, canopy averaged 39% and was provided by willows, alder, California bay, sycamore, oaks, cottonwood, Monterey pine, and eucalyptus. From stream mile 7.9 downstream to the lagoon, canopy density was low with an average density of 35% (range: 17% in stream mile one to 46% in stream mile six). Canopy measurements were not taken over the dry area and if that area were included, the average for the reach would be much lower. From stream mile 8 to the end of the survey, canopy averaged 42% (range: 23% in stream mile 8 to 57% in stream mile 14).

Non-native plant species located in the riparian zone included eucalyptus, cape ivy, english ivy, pampas grass, arundo, nasturtiums, redwood, castor bean, French broom, walnut, palm tree's, cow parsnips, and Jimsonweed. Stream mile 2 had the most extensive coverage and species diversity including most of the non-native vegetation mentioned, in addition to vegetable gardens and succulents planted on the stream banks as well as on the top of the bank. Cape ivy was found from stream mile 10 downstream, but was most extensive in stream miles 5 and 6. With the exception of one private garden in stream mile 12 and one patch of arundo in stream mile 14 no other non-native plant species were observed from stream mile 11 to 14. Specific locations of non-native plant species can be found in the Comments and Landmarks section.

Stream Bank Composition

Of the habitat units fully surveyed, stream banks were composed of sand/silt/clay (42% of the units), cobble/gravel (39%), boulder (12%), and bedrock (7%). The stream bank area with vegetation was relatively high with 71% of the right bank and 64% of the left bank covered with vegetation. Vegetation types consisted of hardwood trees (88%), brush (6%), and grass (4%). An additional 1.1% of the stream banks had no vegetation (Table 8).

Although stream banks were relatively well vegetated in those units that were fully measured, vertical denuded banks were common in certain reaches of the stream (Figure 11). Downstream of stream 7.9, approximately 6,040 feet of the left bank and 7,770 feet of the right bank were denuded and actively eroding. Upstream of stream mile 7.9, approximately 8,353 feet of the left bank and 5,760 feet of the right bank were eroding. Only those sites greater than 50 feet in length were included in these measurements.

Descriptions and locations of stream bank erosion sites are in the Comments and Landmarks section.

Figure 11. One of several vertical denuded banks observed along Santa Rosa Creek, 2005.

Potential Impediments

During the summer and fall months, stream flow at approximately stream mile 6.7 (unit 363) goes subsurface leaving a portion of Santa Rosa Creek dry for a part of the year. The dry unit was 2,625 feet long at the time of the survey (Sept. 21, 2005) although that distance and the length of the dry period may vary from year to year depending on the amount of rainfall the previous winter. The flood plain width in this section ranges from 250 to 350 feet with the potential wetted channel being 70 to 100 feet wide. These channel characteristics extend 3,304 feet upstream of the current dry channel. The stream banks throughout the dry reach and extending to stream mile 7.9 are 15 to 20 feet high, vertical, denuded, and are actively eroding in many areas (Figure 12). This section of dry creek severs the upper watershed from the lower watershed and can delay or prevent upstream migration of adult steelhead and downstream migration of smolts during drier years.

Figure 12. A portion of the dry section in Santa Rosa Creek, 2005.

Another impediment and occasional barrier to upstream adult and juvenile migration is Ferrasci Road crossing located at stream mile 3.4 (N35˚ 24′ 05.0″ W121˚ 03′ 55.3″). The crossing is a 10 foot high concrete ford that spans the 45 foot wide channel at an angle and has three culverts and a fish ladder through the center (Figure 13). The culverts are 4 feet in diameter and are perched approximately five feet above the pool at the base of the structure (Figures 14 and 15). The fish ladder is 4 feet in width and the flow is run-like through the ladder during the low flow season. During high flow events, water flows completely over the structure (Figure 16).

Figure 13. Ferrasci Road crossing at stream mile 3.4.

Figure 14. Looking upstream to Ferrasci Road crossing, Santa Rosa Creek.

Figure 15. Looking downstream to Ferrasci Road crossing, Santa Rosa Creek

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Figure 16. Ferrasci Road crossing during high flows in the spring of 2005.

Stream Flow Results

The stream flow site on Santa Rosa Creek was located approximately 3,000 feet downstream from Highway 1 at N35˚ 33′ 57.6″ W121˚ 06′ 05.8″ (Figure 1.). Stream flow measurements were taken on a weekly basis from April 20, 2005 through September 20, 2005 with additional measurements taken on October 5, 2005, November 11, 2005 and December 6, 2005 (Table 9 and Figure 17).

Date	Stream Flow (cfs)
April 20, 2005	23.0
April 28, 2005	25.3
May 4, 2005	15.3
May 11, 2005	14.94
May 18, 2005	11.14
May 24, 2005	8.77
June 2, 2005	7.82
June 7, 2005	6.75
June 14, 2005	5.3
June 21, 2005	4.2
June 28, 2005	3.86
July 5, 2005	4.08
July 12, 2005	3.5
July 19, 2005	3.36
July 26, 2005	3.14
August 2, 2005	2.98
August 9, 2005	2.36
August 16, 2005	2.47
August 23, 2005	2.15
August 30, 2005	1.45
September 8, 2005	1.73
September 13, 2005	1.66
September 20, 2005	1.90
October 5, 2005	1.35
October 24, 2005	1.56
November 11, 2005	1.18
December 6, 2005	2.85

Table 9. Stream flow results from the spring, summer, and fall on Santa Rosa Creek. 2005.

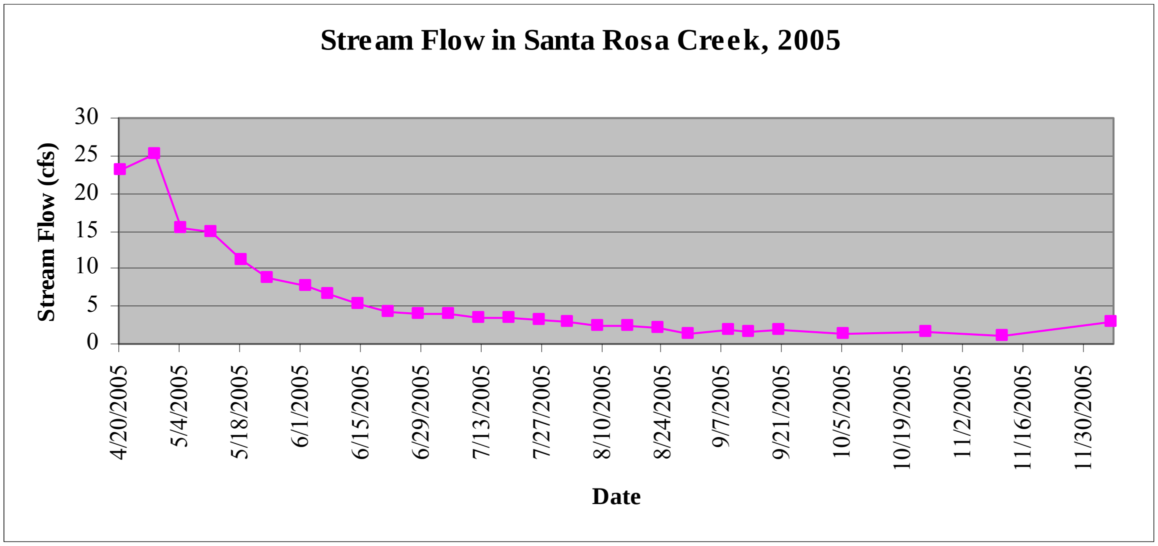

Figure 17. Stream flow results from Santa Rosa Creek, 2005.

A fairly significant rain event occurred overnight on April 27 which increased stream flow approximately 2 cubic feet per second (cfs) on April 28th and compromised the outmigrant trap. Rain events also occurred on May 5th and 9th, but the flow had receded somewhat by the time streamflow was measured on May 11th.

Temperatures Results

Air and water temperatures taken during the habitat survey ranged from 54°F to 87°F and 55°F to 70°F, respectively. Air temperatures were highest and water temperatures coolest in the inland areas compared to the coast where the marine influence cooled the air, but water temperatures were consistently higher than inland areas.

In addition to temperatures recorded during the habitat survey, data loggers were installed at three sites in Santa Rosa Creek in order to continuously monitor stream temperatures from June 2nd through October 25th 2005.

Site 1 was located at stream mile 0.6 and the data logger was placed in a pool approximately 1.5 feet beneath the surface of the water under the right stream bank (Figure 1). It was at this location that stream temperatures were highest and experienced the greatest diurnal fluctuations

(Figure 18). On thirteen occasions throughout August and early September stream temperatures rose above 75˚F and on one occasion reached 79.4˚F. On three of the days with higher temperatures (77.3˚ - 79.4˚F), the data logger may have been dewatered for a brief period of time. The temperatures leading up to the highs on those three days were rising steadily with an increase of 1.5˚F to 2.0˚F from 10:00 in the morning until 2:30 in the afternoon when the temperature jumped 7˚ to 8.5˚F at 3:00 and then decreased back down to the same temperature that was recorded at 2:30 by the next reading.

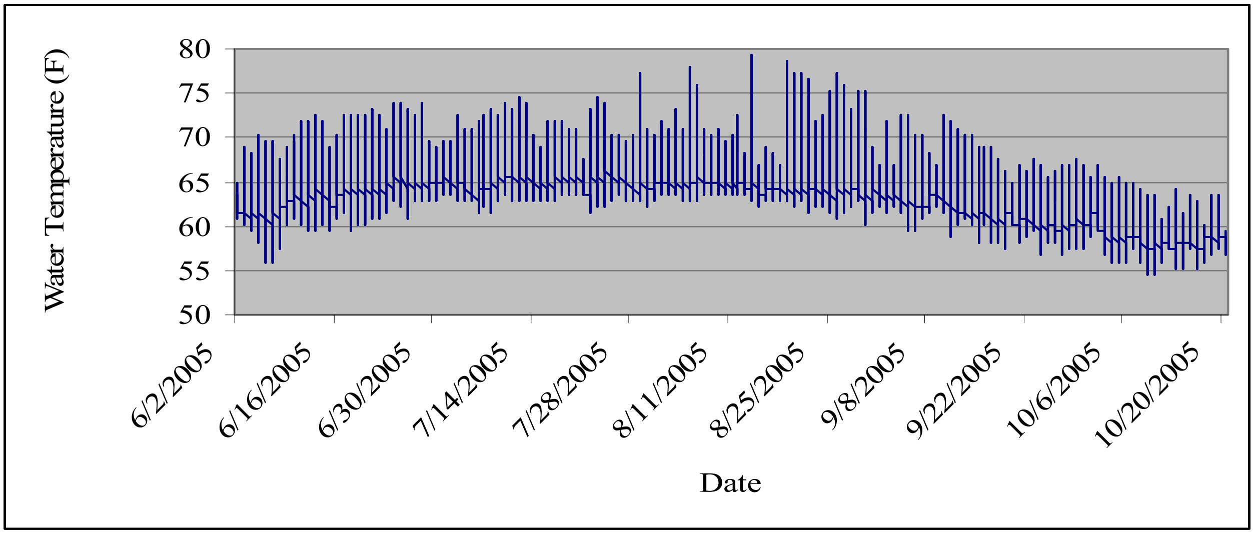

Figure 18. Recorded water temperatures at Site 1 from June 2 through October 20, 2005.

Excluding the three suspect high temperatures, 71 days from June through mid September exceeded 70˚F. Without exception stream temperatures peaked at 3:00 p.m. and stayed elevated (above 70˚F) for three to eight hours before eventually decreasing down to the lower 60's. In late September, stream temperatures remained elevated for 2.5 to 3 hours before rapidly decreasing to the lower 60's or high 50's.

Diurnal fluctuations ranged 5˚F to 16˚F with the warmer days from June through August having the greatest fluctuations.

Site 2 was located at stream mile 8.0 and the data logger was placed approximately one foot beneath the surface of the water under willow vegetation (Figure 2). Stream temperatures at this location were cooler than at Site 1, but daily temperature fluctuations were still relatively broad (Figure 19). Temperatures reached or exceeded 70˚F on fourteen days with the highest temperature of 71˚F recorded on June 13 and July 13. Like at Site 1, stream temperatures peaked by 3:00 p.m., but unlike Site 1 temperatures began decreasing by the next reading one half hour later and after four hours temperatures were in the low 60's.

The greatest daily fluctuations occurred in early to mid June and ranged from 12˚ to 14˚F.

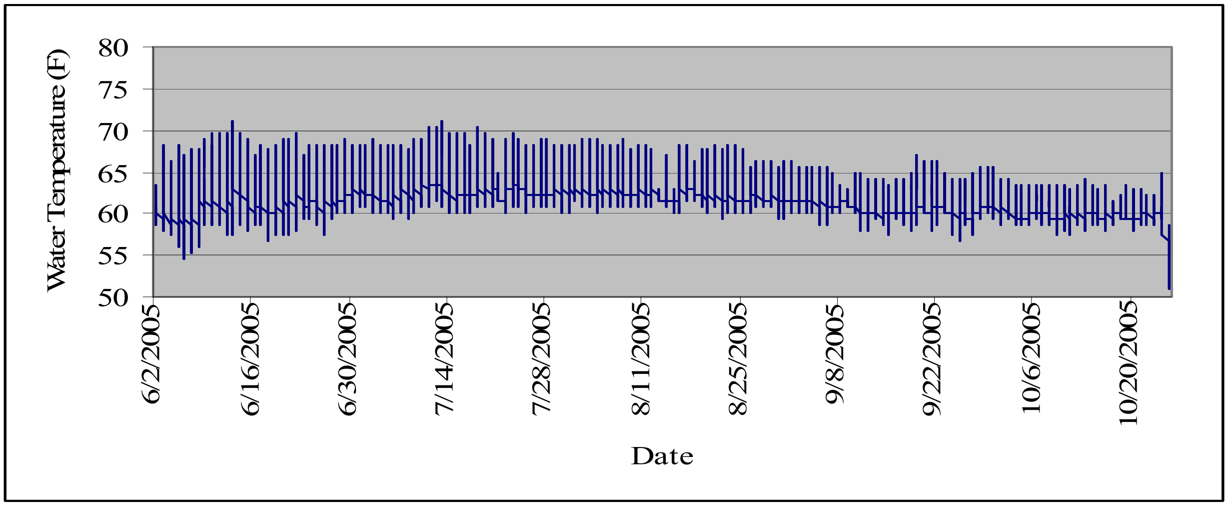

Figure 19. Recorded water temperatures at Site 2 from June 2 through August 25, 2005.

Site 3 was located at stream mile 14.5 and the data logger was placed 1.5 feet beneath the surface of the water under an alder root (Figure 3). Stream temperatures were coolest and daily fluctuations narrowest at this site (Figure 20). The highest temperature of 69.7˚F was reached on July 23rd although there were four other occasions when temperatures reached 68˚F. Peak temperatures were again reached by 3:00 p.m., but by the next reading one half hour later stream temperatures had begun to decrease. Daily fluctuations throughout the entire study period ranged from 2.5˚ to 6.5˚ F.

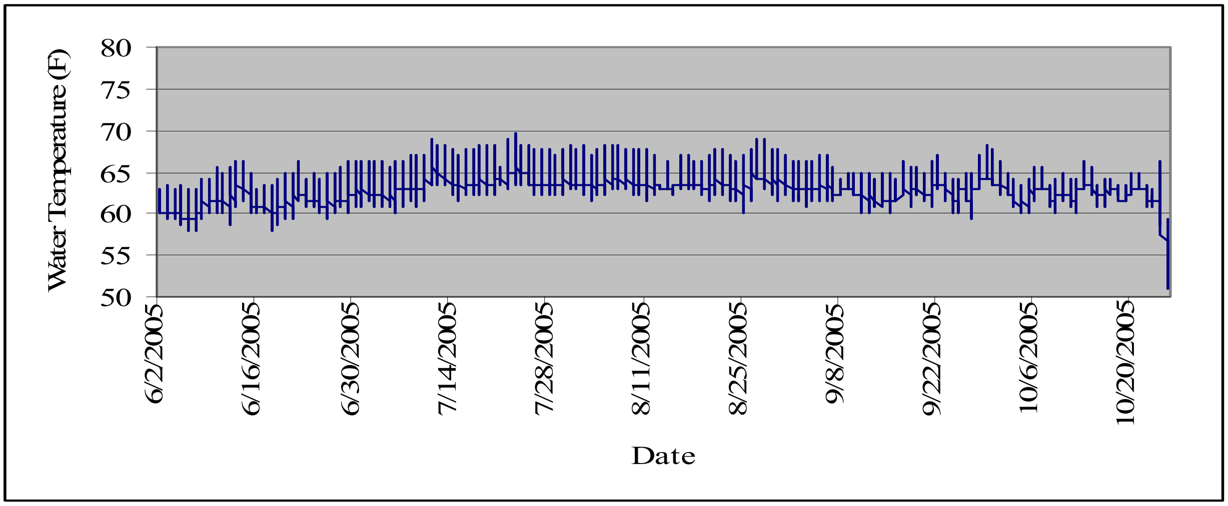

Figure 20. Recorded water temperatures at Site 3 from June 2 through October 25, 2005.

Outmigrant Trapping Results

The outmigrant trap and attached weir installed at stream mile 0.35 from April 18, 2005 to May 25, 2005 was operational on 21 days. Weekends and rain events which significantly increased streamflow precluded us from trapping the other 17 days. Over the approximate six weeks of trapping, 355 steelhead were captured including 79 parr, 11 rainbow trout morphs, 199 partial smolts, 65 smolts, and one kelt (Table 10). Over the course of trapping, peak emigration was during the weeks of April 18 and 25 where 100 fish were captured during the week April 18 and 140 were captured during the week of April 25. However, only 24% of the fish were smolts. Sixty-five percent of the fish captured over this time frame were partial smolts.

Week	Parr	Partial Smolt	Smolt	Rainbow trout coloration	Kelt
April 18	12	52	36		1
April 25	11	107	23	2	
May 2	9	11			
May 9	13	12	1	2	
May 16	29	8		1	
May 23	5	9	5	6	

Table10. Number of parr, partial smolts, smolts, rainbow trout morphs and kelts captured in the outmigrant trap on Santa Rosa Creek, 2005.

The 79 parr that were captured averaged 92 millimeters fork length (range: 59 – 138 millimeters). The 199 partial smolts averaged 146 millimeters fork length (range: 109 – 207 millimeters) and the 65 smolts averaged 165 millimeters fork length (range: 130 - 247). The 11 fish with rainbow trout coloration averaged 175 millimeters fork length (range: 138 – 239 millimeters) (Figure 21). The kelt was only measured for total length and was 526 millimeters.

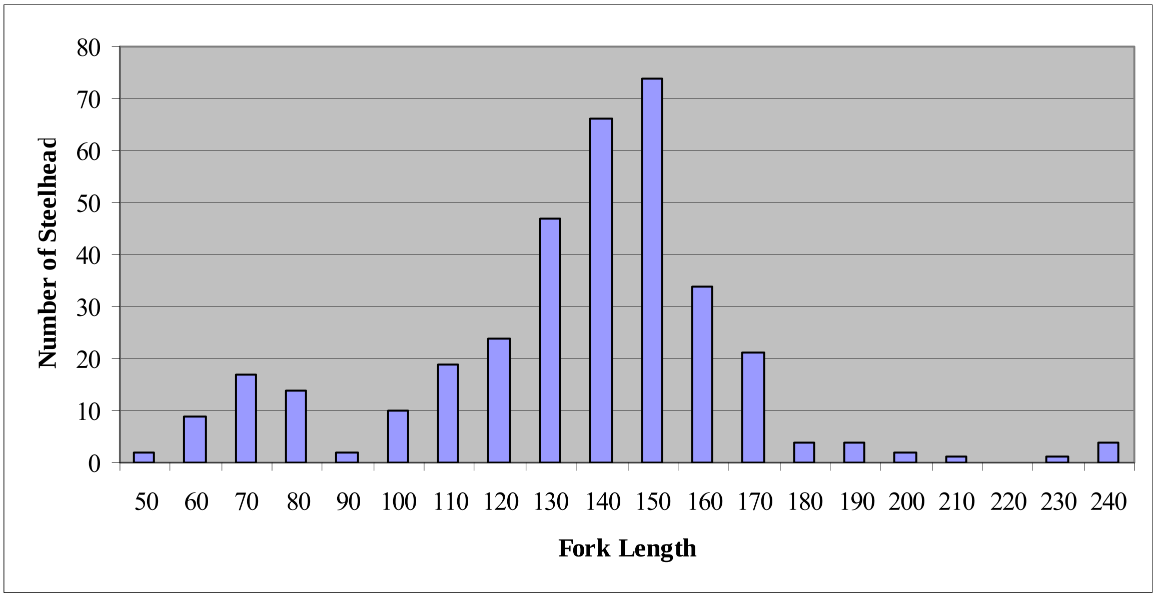

Figure 21. Length frequency distribution of the parr, partial smolts, smolts and rainbow trout captured in the outmigrant trap, Santa Rosa Creek, 2005.

Fulton condition factors (K) are a measure of "fitness" or how much mass a fish has relative to its length. Higher numbers indicate better fitness or greater plumpness. The Fulton condition factors for the parr, partial smolts, smolts, and rainbow trout morphs captured in the outmigrant trap are summarized in Tables 11, 12, 13, and 14. Generally, smolts and partial smolts had the lowest condition factors and the parr had the highest. Condition factors of the rainbow trout were more similar to the partial smolts and smolts.

Fork Length (mm)	Number of Fish	Weight Range (grams)	K-Factor Range	Average K-Factor
50 - 59	2	2.5	1.22	1.22
60 - 69	9	2.5 – 4.0	1.04 – 1.52	1.14
70 - 79	17	3.5 - 6.5	0.91 – 1.54	1.13
80 - 89	14	5.5 – 8.0	1.07 – 1.36	1.14
90 - 99	2	11.0 – 12.0	1.17 – 1.27	1.22
100 - 109	9	11.0 - 16.0	0.98 – 1.23	1.08
110 - 119	15	11.5 – 20.5	0.84 – 1.28	1.09
120 - 129	6	16.5 - 22.0	0.95 – 1.16	1.09
130 - 139	3	25.0 – 28.0	0.95 – 1.20	1.12

Table 11. Summary of condition factors for those steelhead exhibiting parr coloration, Santa Rosa Creek, 2005.

Fork Length (mm)	Number of Fish	Weight Range (grams)	K-Factor Range	Average K-Factor
100 - 109	1	13.5	1.04	1.04
110 - 119	4	15.5 – 18.0	1.03 – 1.18	1.04
120 - 129	18	17.0 – 25.5	0.94 – 1.44	1.09
130 - 139	40	10.0 – 30.5	0.82 – 1.31	1.00
140 - 149	56	20.0 – 35.0	0.75 – 1.24	0.96
150 - 159	54	27.0 – 46.0	0.74 – 1.28	0.97
160 - 169	17	29.5 – 49.0	0.67 – 1.13	0.98
170 - 179	8	37.0 – 57.0	0.75 – 1.12	0.91
180 - 189				
190 - 199				
200 - 209	1	93.5	1.05	1.05

Table 12. Summary of condition factors for those steelhead exhibiting partial smolt coloration, Santa Rosa Creek, 2005.

Fork Length (mm)	**Number of Fish**	**Weight Range (grams)**	**K-Factor Range**	**Average K-Factor**
130 - 139	3	21.0 - 24.0	0.87 – 1.00	0.94
140 - 149	9	26.5 – 33.0	0.87 – 1.06	0.94
150 - 159	18	21.0 – 48.5	0.61 – 1.21	0.92
160 - 169	16	34.5 – 54.5	0.82 – 1.15	0.94
170 - 179	11	42.5 – 63.5	0.84 – 1.11	0.96
180 - 189	3	53.5 – 59.0	0.90 – 1.01	0.94
190 - 199	3	58.5 – 79.0	0.85 – 1.00	.093
200 - 209	1	80.5	1.01	1.01
210 - 219				
220 - 229				
230 - 239				
240 - 249	1	94.5	0.63	0.63

Table 13. Summary of condition factors for those steelhead exhibiting smolt coloration, Santa Rosa Creek, 2005.

Fork Length (mm)	**Number of Fish**	**Weight Range (grams)**	**K-Factor Range**	**Average K-Factor**
130 - 139	1	28.0	1.06	1.06
140 - 149	1	27.0	0.96	0.96
150 - 159	2	43.0 - 44.0	1.11 - 1.16	1.13
160 - 169	1	50.0	1.11	1.11
170 - 179	2	49.5 – 57.5	1.00 – 1.07	1.035
180 - 189	1	73.5	1.20	1.20
190 - 199	1	78.5	1.14	1.14
200 - 209				
210 - 219	1	91	0.98	0.98
220 - 229				
230 - 239	1	162	1.19	1.19

Table 14. Summary of condition factors for those steelhead exhibiting rainbow trout coloration, Santa Rosa Creek, 2005.

One hundred seventy four of the steelhead captured in the trap were infected with black spot disease including 22 parr, 115 partial smolts, 31 smolts and 6 of the rainbow trout morphs. No other parasites or obvious signs of disease were observed.

In addition to steelhead, coast range sculpin (Cottus aleuticus), prickly sculpin (*Cottus asper*), stickleback (*Gasterosteus aculeatus*), red legged frogs (*Rana aurora*), crayfish (*Pacifastacus leniusculus*), western pond turtles (*Clemmys marmorata*), green sunfish (*Lepomis cyanellus*), and bullfrogs (*Rana catesbeiana*) were also captured.

Fish Sampling Results

Results for each electrofishing site will be presented separately.

Site 1

The first sample site was located at approximately stream mile 0.27 or 100 feet upstream from Windsor Road Bridge crossing (Figure 1). The total survey length was 150 feet and included an 85 foot long mid-channel pool and a 65 foot long glide. Maximum depths of the pool and glide were 1.5 feet and 0.5 feet, respectively. Aquatic vegetation (cattails and watercress) covered approximately 60% of the site. Air and water temperatures ranged from 62˚ to 65˚F and 57˚F, respectively.

At this site, three steelhead were captured with an average fork length of 206 millimeters (range: 201 - 214 mm). Biomass within Site 1 was 0.08 g/ft^2 and the number of steelhead per linear foot was 0.02 (Table 15). Using age/length criteria described previously, all three steelhead were considered to be age 2+ and all three were partial smolts. One steelhead was infected with black spot disease. Table 16 summarizes the Fulton condition factors for the three steelhead captured at Site 1.

Location (Stream Mile)	Total Number of Fish Captured	Fish Per Linear Foot	Total Weight of all Captured Fish (Grams)	Biomass (grams/foot^2)
Site 1 (0.27)	3	0.02	318.5	0.088
Site 2 (0.5)	12	0.07	974	0.72
Site 3 (2.3)	27	0.07	2,070	0.24
Site 4 (3.2)	50	0.12	2,761	0.82
Site 5 (4.3)	156	0.53	8,091	3.2
Site 6 (5.5)	44	0.13	1,304	0.3
Site 7 (8.8)	174	0.52	2,965	0.61
Site 8 (11.0)	341	1.16	4,180	2.19
Site 9 (12.7)	235	0.75	2,769.5	0.73
Site 10 (14.0)	231	0.77	1,832	0.93

Table 15. Biomass and the number of steelhead per linear foot at the 10 sample locations in Santa Rosa Creek, 2005.

Fork Length (mm)	Number of Fish	Weight Range (g)	K-Factor Range	Average K-Factor
200-209	2	96 – 101.5	1.16 – 1.25	1.20
210-219	1	121	1.23	1.23

Table 16. Condition factors (K) of the 3 steelhead captured at Site 1, Santa Rosa Creek, 2005.

In addition to steelhead, prickly sculpin and stickleback were captured and one red legged frog and one crayfish were observed.

Site 2

The second sample site was located at stream mile 0.5 and was 169 feet in length (Figure 1). The site included two log scour pools (104 feet), two glides (38 feet), and one low gradient riffle (27 feet). Maximum depths in the pools were 1.0 and 1.2 feet and instream shelter was provided by willow roots, branches and watercress. The glides were both 0.5 feet in maximum depth and one glide had submerged willow branches for shelter and the other had no shelter. Maximum depth in the riffle was 0.4 feet and shelter was provided by watercress and cobble. Air and water temperatures ranged from 66˚ to 69˚F and 58˚ to 59˚, respectively.

At site 2, twelve steelhead were captured with a calculated abundance of 13 steelhead. Biomass within Site 2 was 0.72 g/ft^2 and the number of steelhead per linear foot was 0.07 (Table 15). Five of the steelhead captured were considered to be age 1+ with an average fork length of 150 millimeters (range: 120 – 164 mm); five were age 2+ with an average fork length of 180 millimeters (range: 169 – 209 mm); and two were age 3+ (225 and 252 millimeters in fork length)(Figure 22). The steelhead that was 225 millimeters in length was a silvery parr while all other fish were parr. All three steelhead that were greater than 200 millimeters in fork length had black spot disease. Table 17 summarizes the Fulton condition factors for the twelve steelhead captured at Site 2.

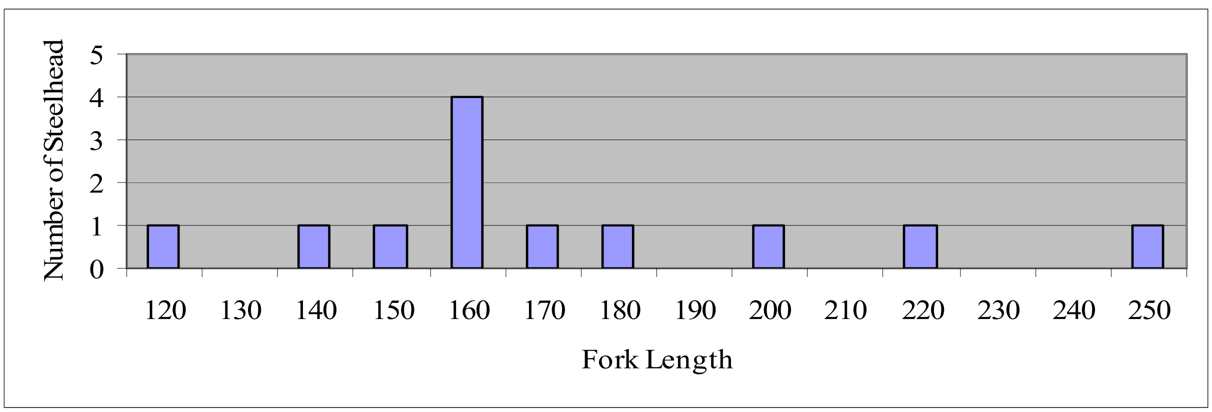

Figure 22. Length frequency distribution of steelhead captured at Site 2, Santa Rosa Creek, October 2005.

Fork Length (mm)	Number of Fish	Weight Range (g)	K-Factor Range	K-Factor Average
120 - 129	1	20.0	1.16	1.16
130 - 139				
140 - 149	1	35.5	1.12	1.12
150 - 159	1	51	1.34	1.34
160 - 169	4	56.5 - 66	1.28 – 1.37	1.33
170 - 179	1	73	1.46	1.46
180 - 189	1	68	1.18	1.18
190 - 199				
200 - 209	1	131	1.43	1.43
210 - 219				
220 - 229	1	160	1.40	1.40
230 - 239				
240 - 249				
250 - 259	1	191	1.19	1.19

Table 17. Condition factors of the 12 steelhead captured at Site 2, Santa Rosa Creek, October 2005.

Prickly sculpin were also captured in Site 2.

Site 3

The third sample site was located at approximately stream mile 2.3 (Figure 1). The total survey length was 379 feet and included two boulder scour pools (76 feet), one run (138 feet), one glide (121 feet) and two riffles (44 feet). Maximum depths in the pools were 1.7 and 2.0 feet and shelter included boulders (rip rap) and submerged willow branches. Maximum depths in the run and glide were 0.7 feet and 0.6 feet, respectively. Minimal shelter was provided by dislodged riprap. The riffles had a maximum depth of 0.3 feet and shelter was provided by cobble and undercut bank. During the sampling air temperatures ranged from 56˚ to 60˚F and water temperature was 57˚F.

At this site, 27 steelhead were captured and the calculated abundance was also 27. Biomass in Site 3 was 0.24 g/ft^2 and the number of steelhead per linear foot was 0.07 (Table 15). One steelhead measuring 105 millimeters was placed in the young-of-the-year category, but could very well have been age 1+. Ten additional steelhead placed in the age 1+ category averaged 139 millimeters fork length (range: 108 – 161 mm) and twelve were age 2+ with an average fork length of 193 millimeters (range: 172 – 216 mm). The remaining 4 steelhead were age 3+ with an average fork length of 234 millimeters (range: 224 - 255 mm)(Figure 23). Twelve steelhead ranging in length from 108 to 225 millimeters were silvery parr. Ten were infected with black spot disease. Fulton condition factors for the 27 steelhead captured in Site 3 are summarized in Table 18.

In addition to steelhead, prickly sculpin, coast range sculpin, and stickleback were also captured.

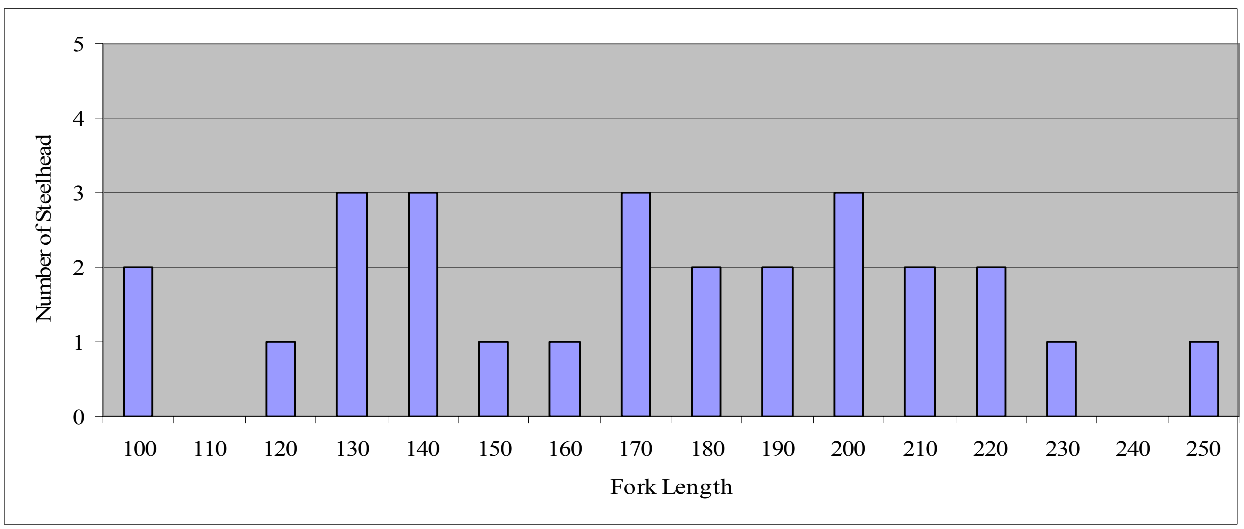

Figure 23. Length frequency distribution of steelhead captured at Site 3, October 2005.

Fork Length (mm)	Number of Fish	Weight Range (g)	K-Factor Range	K-Factor Average
100 - 109	2	15.5 - 16.5	1.31 - 1.34	1.33
110 - 119				
120 - 129	1	24.5	1.25	1.25
130 - 139	3	26 - 33.5	1.11 – 1.33	1.26
140 - 149	3	33.5 - 43	1.17 – 1.38	1.31
150 - 159	1	52.5	1.31	1.31
160 - 169	1	47.5	1.14	1.14
170 - 179	3	57.5 - 72	1.11 – 1.41	1.25
180 - 189	2	66 - 66.5	1.06 – 1.14	1.1
190 - 199	2	87 - 88.5	1.14 – 1.23	1.19
200 - 209	3	96 - 120.5	1.18 – 1.34	1.28
210 - 219	2	112 - 121	1.16 – 1.20	1.18
220 - 229	2	146.5 - 148	1.29 – 1.32	1.31
230 - 239	1	146.5	1.16	1.16
240 - 249				
250 - 259	1	197.5	1.19	1.19

Table 18. Condition factors of the 27 steelhead captured at Site 3, Santa Rosa Creek, October 2005.

Site 4

The fourth sample site on Santa Rosa Creek was located at stream mile 3.2 and was 398 feet in length (Figure 1). Habitat included two root scour pools (118 feet), one log scour pool (70 feet), and two runs (210 feet). Maximum depths in the log scour and two root pools were 1.1 feet, 1.7 feet and 1.5 feet, respectively. Instream cover was provided by a fallen pine tree and submerged willow branches. Maximum depths in the runs were 0.9 and 1.1 feet and cover was provided by cobble, willow branches, and small woody debris. Air and water temperatures ranged from 46° to 68°F and 52° to 61°F, respectively.

At Site 4, fifty steelhead were captured with a calculated abundance of 58 steelhead. Calculated biomass was 0.82 g/ft^2 and there were 0.12 steelhead per linear foot (Table15). One steelhead with a fork length of 103 millimeters was considered to be age 0+. Thirty-five steelhead averaging 144 millimeters fork length (range: 111 – 163 mm) were placed in the age 1+ category; twelve steelhead were age 2+ with an average fork length of 181 millimeters (range: 168 - 205 mm); and two were age 3+ (223 and 229 millimeters) (Figure 24). Seventeen of the steelhead were silvery parr (fork length range: 119 to 190 mm); six had distinct rainbow trout coloration (fork length range: 162 – 229 mm); and the remaining twenty-seven were parr (fork length range: 103 – 223 mm). Thirty seven steelhead captured at this location were infected with black spot disease. Table 19 summarizes the Fulton condition factors.

In addition to steelhead, prickly sculpin, coastrange sculpin, stickleback, and crayfish were captured.

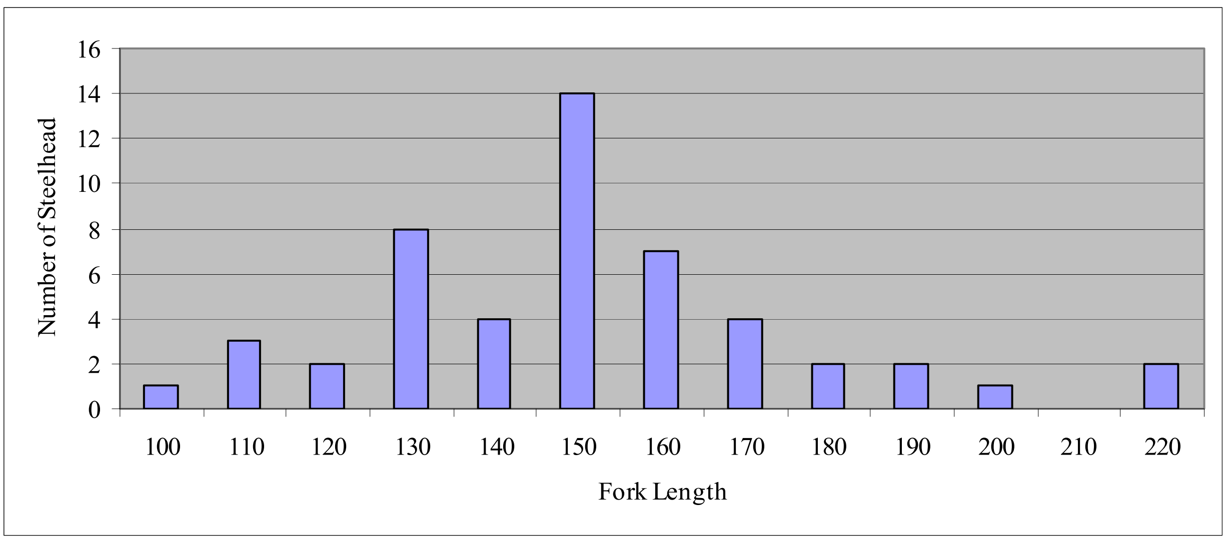

Figure 24. Length frequency distribution of steelhead captured at Site 4, Santa Rosa Creek, October 2005.

Fork Length (mm)	Number of Fish	Weight Range (g)	K-Factor Range	K-Factor Average
100 – 109	1	13.5	1.24	1.24
110 – 119	3	16 - 24	1.14 – 1.42	1.26
120 – 129	2	26	1.21 – 1.43	1.32
130 – 139	8	25.5 - 34	1.13 – 1.38	1.28
140 – 149	4	35.5 - 46	1.19 – 1.43	1.32
150 – 159	14	38 - 60	1.10 – 1.52	1.36
160 – 169	7	48.5 - 80.5	1.16 – 1.93	1.39
170 – 179	4	69 - 80	1.27 – 1.47	1.39
180 – 189	2	79.5 - 82.5	1.26 – 1.32	1.29
190 – 199	2	91.5 - 107	1.33 – 1.54	1.44
200 – 209	1	121	1.40	1.40
210 – 219				
220 - 229	2	154.5 – 164.5	1.29 – 1.48	1.39

Table 19. Condition factors of the 50 steelhead captured in Site 4, October 2005.

Site 5

The fifth site on Santa Rosa Creek was located at stream mile 4.3 and was 293 feet in length (Figure 2). This site included one mid-channel pool (43 feet), one log scour pool (29.5 feet), one bedrock scour pool (32.5 feet), and two runs (188 feet). Maximum depths in the mid-channel, log scour and bedrock scour pools were 2.0 feet, 1.5 feet and 2.5 feet, respectively. Instream shelter was provided by large woody debris, bedrock shelves and overhanging and submerged willow trees. Maximum depth in the runs was 1.1 feet and 0.8 feet and instream shelter consisted of cobble and overhanging riparian vegetation. Air temperatures during sampling ranged from 56°F to 61°F and the water temperature was 59°F.

Within this site, 156 steelhead were captured with a calculated abundance of 158 steelhead. Biomass was 3.2 g/ft^2 and there were 0.53 steelhead per linear foot (Table 15). Three steelhead measuring 98 millimeters in fork length were age 0+; 92 steelhead were age 1+ with an average fork length of 138 millimeters (range: 108 – 165 mm); 57 were age 2+ with an average fork length of 187 millimeters (range: 169 – 218 mm); and four were age 3+ (average fork length: 242 mm, range: 224 – 260 mm) (Figure 25). Forty-seven of the steelhead ranging in fork length from 124 to 230 millimeters were silvery parr; eleven of the fish ranging in fork length between 113 and 175 millimeters had rainbow trout coloration; and the remaining 98 were parr. Fifty two of the steelhead captured were infected with black spot disease. Table 20 summarizes the Fulton condition factors for steelhead captured at Site 5.

In addition to steelhead, stickleback and one prickly sculpin were captured.

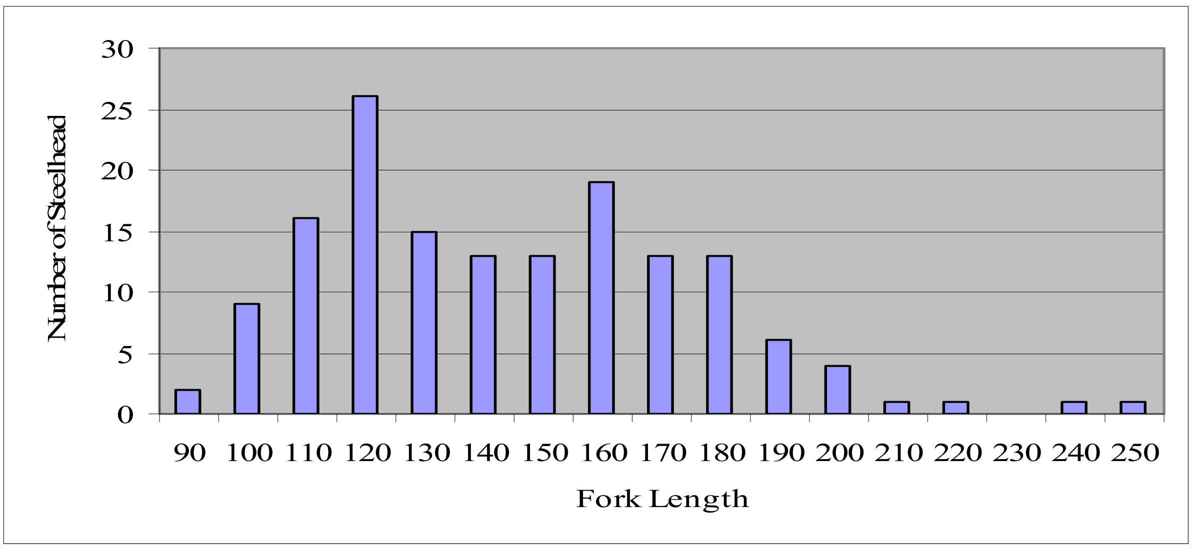

Figure 25. Length frequency distribution of steelhead captured at Site 5, October 2005.

Fork Length (mm)	Number of Fish	Weight Range (g)	K-Factor Range	K-Factor Average
90 – 99	3	11 - 13	1.17 – 1.38	1.26
100 – 109	2	15 – 15.5	1.19 – 1.2	1.20
110 – 119	9	15.5 - 20	1.07 – 1.32	1.20
120 – 129	16	21 - 31	1.05 – 1.61	1.27
130 – 139	25	20 - 35	0.85 – 1.33	1.18
140 – 149	15	29.5 - 44	1.03 – 1.54	1.21
150 – 159	13	37.5 - 54	1.09 – 1.40	1.23
160 – 169	13	45 – 60.5	1.01 – 1.34	1.18
170 – 179	19	50.5 - 71	1.01 – 1.37	1.18
180 – 189	13	59.5 - 87	1.02 – 1.29	1.17
190 – 199	13	75 - 97	1.04 – 1.33	1.18
200 – 209	6	92 – 121.5	1.10 – 1.33	1.19
210 – 219	4	114.5 - 124	1.15 – 1.25	1.21
220 – 229	1	123	1.09	1.09
230 – 239	1	133.5	1.10	1.10
240 – 249				
250 – 259	1	224.5	1.37	1.37
260 – 269	1	211	1.20	1.20

Table 20. Condition factors of 154 of the 156 steelhead captured at Site 5, Santa Rosa Creek, October 2005. (Note: Two additional fish were captured but not measured)

<u>Site 6</u>

The sixth sample site on Santa Rosa Creek was located at approximately stream mile 5.5 (Figure 2). This site was 347 feet long and included three log scour pools (215 feet) and two runs (132 feet). Maximum pool depths were 1.3 feet, 2.1 feet and 1.2 feet and instream shelter was provided by large and small wood debris, undercut bank and root mass. Maximum depth in the runs was 0.6 feet and 0.9 feet and instream shelter was provided by undercut bank and willow vegetation. Air and water temperatures ranged from 68°F to 77°F and 58°F to 63°F, respectively.

Within this site, 44 steelhead were captured with a calculated abundance of 45. Biomass was 0.3

g/ft^2 and there were 0.13 steelhead per linear foot (Table 15). Five steelhead captured were age 0+ with an average fork length of 99 millimeters (range: 88 – 104 mm); 33 were age 1+ with an average fork length of 128 millimeters (range: 108 – 155 mm); and six were age 2+ with an average fork length of 182 millimeters (range: 167 – 207 mm) (Figure 26). Five steelhead ranging in length from 128 to 173 millimeters were silvery parr and the remainder were parr. Sixteen steelhead were infected with black spot disease. Table 21 summarizes the Fulton condition factors for 43 of the 44 steelhead captured at Site 6.

Threespine stickleback were also captured.

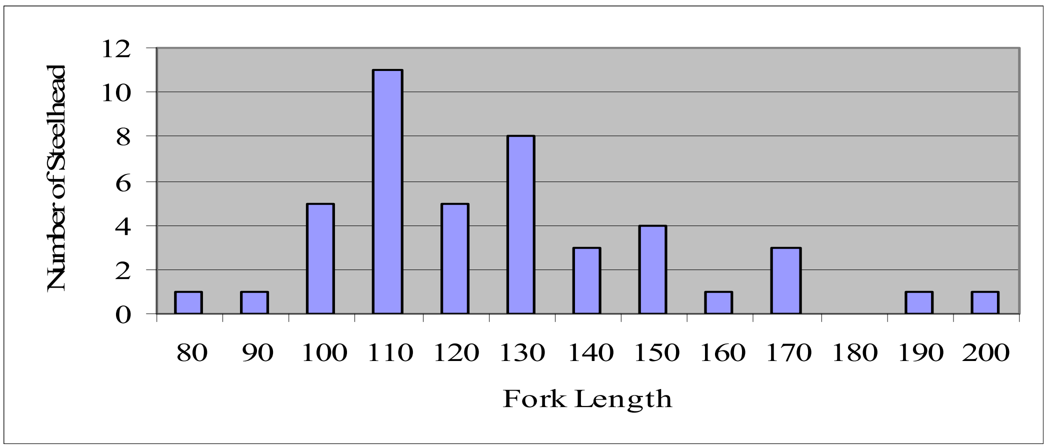

Figure 26. Length frequency distribution of steelhead captured at Site 6, October 2005.

Fork Length (mm)	Number of Fish	Weight Range (g)	K-Factor Range	K-Factor Average
80 – 89	1	7.5	1.10	1.10
90 – 99	1	11.5	1.19	1.19
100 – 109	5	12.5 - 15	1.11 – 1.21	1.17
110 – 119	11	14 – 19.5	1.05 – 1.22	1.13
120 – 129	5	23.5 – 25.5	1.12 – 1.22	1.17
130 – 139	7	26 – 31.5	1.07 – 1.20	1.14
140 – 149	3	29 – 42.5	1.01 – 1.42	1.20
150 – 159	4	41 – 51.5	1.12 – 1.38	1.21
160 – 169	1	57.5	1.23	1.23
170 – 179	3	60 - 64	1.12 – 1.21	1.16
180 – 189				
190 – 199	1	80.5	1.12	1.12
200 - 209	1	108	1.22	1.22

Table 21. Condition factors for 43 of the 44 steelhead captured at Site 6, October 2005.

Site 7

The seventh sampling site on Santa Rosa Creek was located at approximately stream mile 8.8 and was 334 feet in length (Figure 3). The site included one boulder scour pool (96 feet), one mid channel pool (36 feet), two riffles (60 feet), one run (106 feet), and one glide (36 feet). Maximum depths in the boulder scour pool and mid-channel pool were 2.7 feet and 1.8 feet, respectively. Instream shelter was provided by boulder rip rap, terrestrial vegetation and root mass. Riffles had maximum depths of 0.5 and 0. 4 feet and shelter consisted of cobble and willow vegetation. The run and glide were 0.9 and 1.2 feet in maximum depth and shelter was provided by boulders and terrestrial vegetation in the run and undercut bank in the glide. Air and water temperatures ranged from 62°F to 66°F and 59°F to 64°F, respectively.

Within Site seven, 174 steelhead were captured with a calculated abundance of 188 steelhead. Biomass was 0.61 g/ft^2 and there were 0.52 steelhead per linear foot (Table 15). Ninety-two steelhead were age 0+ with an average fork length of 91 millimeters (range: 67 – 105 mm); 78

were age 1+ with an average fork length of 127 millimeters (range: 106 – 165 mm); and four were age 2+ with an average fork length of 174 millimeters (range: 167 – 180 mm) (Figure 27). Three steelhead were silvery parr (fork lengths: 128, 143, 143), one had rainbow trout coloration (165 millimeters) and the remainder of the fish were parr. One hundred fifteen steelhead captured at this location were infected with black spot disease. Table 22 summarizes the Fulton condition factors for the steelhead captured at Site 7.

In addition to steelhead, stickleback were also captured and two red legged frogs were observed (one adult and one juvenile).

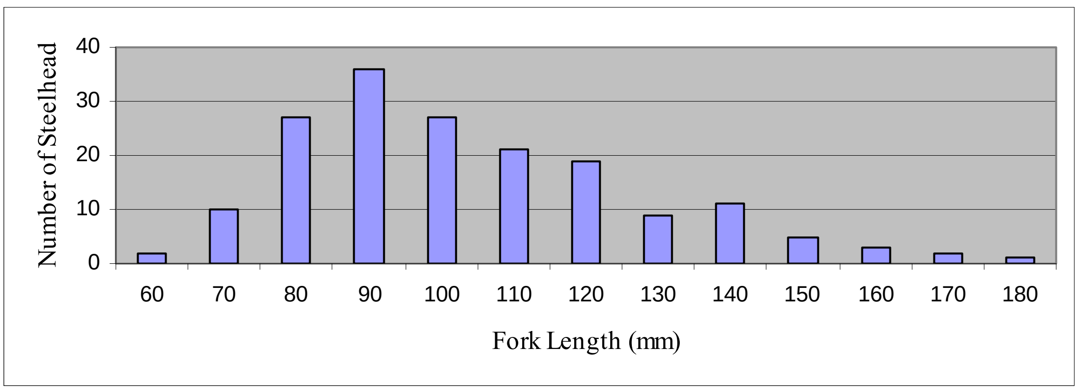

Figure 27. Length frequency distribution of steelhead captured at Site 7, October 2005.

Fork Length (mm)	Number of Fish	Weight Range (g)	K-Factor Range	K-Factor Average
60 – 69	2	3.5 - 4	1.11 – 1.33	1.22
70 – 79	10	4 - 6	1.16 – 1.31	1.23
80 – 89	27	5.5 – 9.5	1.06 – 1.44	1.20
90 – 99	36	7.5 – 13.5	0.93 – 1.53	1.19
100 – 109	27	10.5 - 16	0.99 – 1.36	1.17
110 – 119	21	13.5 – 20.5	1.00 – 1.31	1.17
120 – 129	19	18 – 27	0.91 – 1.26	1.13
130 – 139	9	26 – 32.5	1.01 – 1.26	1.12
140 – 149	11	30 - 38	1.03 – 1.25	1.12
150 – 159	5	36.5 – 45.5	1.04 – 1.18	1.11
160 – 169	3	50 – 54.5	1.07 – 1.21	1.14
170 – 179	2	60.5 – 67.5	1.13 – 1.26	1.20
180 - 189	1	68.5	1.17	1.17

Table 22. Condition factors of the 174 steelhead captured at Site 7, October 2005.

Site 8

The eighth sample site was located at approximately stream mile 11 and was 293 feet in length (Figure 3). The site included two root scour pools (188 feet) and one run (105 feet). Maximum depths in the pools were 2.6 feet and 2.1 feet and instream shelter was provided by undercut bank, root mass, boulders and bedrock ledge. Maximum depth in the run was 0.9 feet and shelter was provided by boulders and undercut bank. Air and water temperatures ranged from 73°F to 77°F and 59°F to 62°F, respectively.

A total of 341 steelhead were captured with a calculated abundance of 365 steelhead. Calculated biomass in Site 8 was 2.19 g/ft^2 and there were 1.16 steelhead per linear foot (Table 15). Of the 341 fish captured, 255 were age 0+ with an average fork length of 84 millimeters (range: 59 – 105 mm); 79 were age 1+ with an average fork length of 125 millimeters (range: 106 – 161 mm); and seven were 2+ with an average fork length of 188 millimeters (range: 175 – 210 mm) (Figure 28). All fish captured at this site had parr coloration. One hundred eleven steelhead were infected with black spot disease. Table 23 summarizes the Fulton condition factors.

In addition to steelhead, stickleback were also captured and two newts (*Taricha torosa*) were observed.

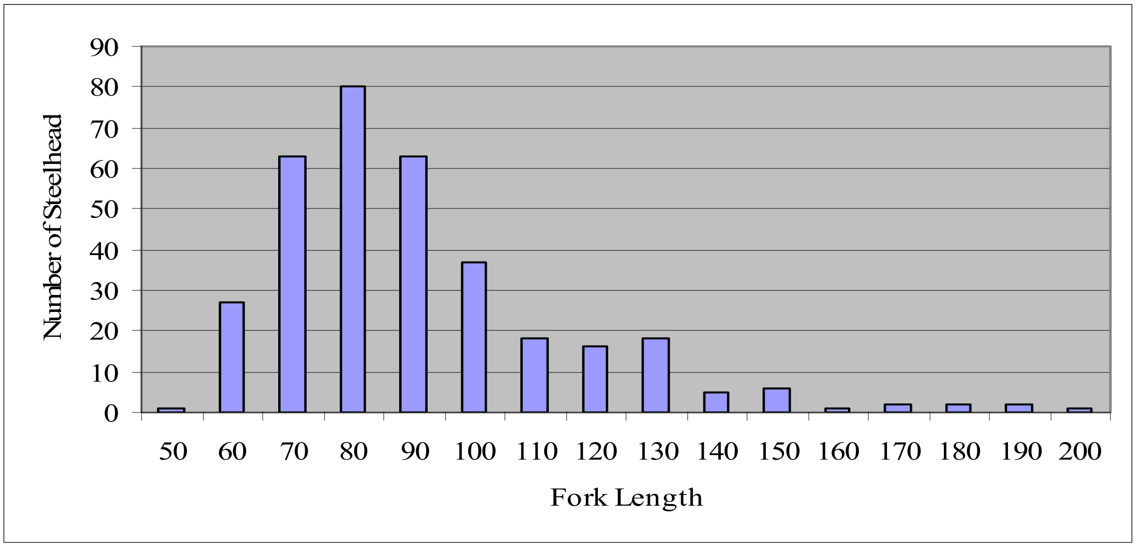

Figure 28. Length frequency distribution of steelhead captured at Site 8, November 2005.

Fork Length (mm)	Number of Fish	Weight Range (g)	K-Factor Range	K-Factor Average
50 – 59	1	2	0.97	0.97
60 – 69	26	2.5 - 4	1.07 – 1.46	1.17
70 – 79	64	3.5 – 6.5	1.02 – 1.34	1.17
80 – 89	78	4.5 – 9.5	0.81 – 1.55	1.12
90 – 99	62	7 - 12	0.90 – 1.33	1.12
100 – 109	37	10 - 16	0.86 – 1.33	1.16
110 – 119	18	14 - 21	0.97 – 1.25	1.13
120 – 129	16	17.5 – 26.5	0.98 – 1.53	1.14
130 – 139	18	22 – 33.5	0.94 – 1.25	1.11
140 – 149	5	32 - 35	1.01 – 1.15	1.09
150 – 159	6	36.5 – 44.4	1.06 – 1.23	1.14
160 – 169	1	53.5	1.28	1.28
170 - 179	2	59.5 – 62.5	1.11 – 1.17	1.14
180 – 189	2	66.5 – 70.5	1.11	1.11
190 – 199	2	85.5 - 90.5	1.10 - 1.15	1.13
200 - 209	1	90.5	1.11	1.11

Table 23. Condition factors of 339 of the 341 steelhead captured at Site 8, November 2005. (Note: Two additional fish were caught but not measured)

Site 9

The ninth sample site was located at approximately stream mile 12.7 and was 314 feet in length. This site included a boulder scour pool (80 feet), a root scour pool (93 feet), and a run (141 feet). Maximum depth in the boulder scour pool and root scour pool were 1.9 feet and 3.2 feet, respectively and instream shelter consisted of boulders, root mass and undercut bank. The maximum depth in the run was 0.6 feet and instream shelter was provided by undercut bank and boulders. Air and water temperatures ranged from 57°F to 59°F and 56°F to 59°F, respectively.

Within this site, 235 steelhead were captured with a calculated abundance of 334 steelhead. Biomass was 0.73 g/ft^2 and there were 0.75 steelhead per linear foot (Table 15). Of the 235 steelhead captured, 175 were age 0+ with an average fork length of 79 millimeters (range: 54 105 mm); 53 were age 1+ with an average fork length of 125 millimeters (range: 106 – 164 mm); and seven were age 2+ with an average fork length of 194 millimeters (range: 171 – 215 mm) (Figure 29). One steelhead measuring 161 millimeters in fork length was a silvery parr, but all others had parr coloration. Forty steelhead were infected with black spot disease. Table 24 summarizes the Fulton condition factors for the steelhead captured at Site 9.

Because of the habitat complexity and difficulty capturing fish in the cover, the results drastically underestimate the number of steelhead at this location. In addition, only two passes were done at this site because it was thought that further sampling would cause unacceptable mortalities.

Stickleback were also captured at this location.

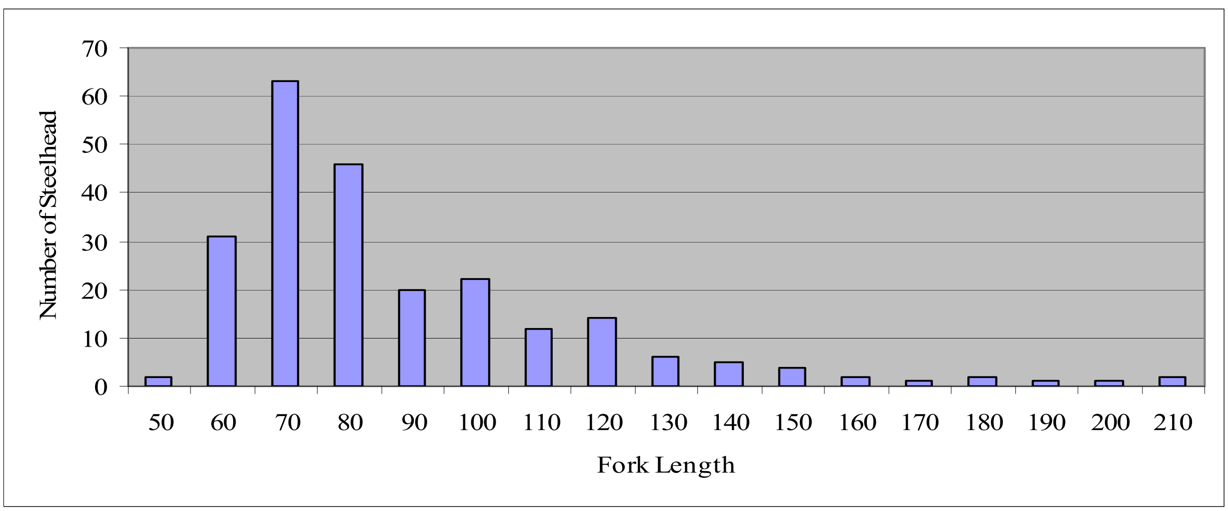

Figure 29. Length frequency distribution of steelhead captured at Site 9, November 2005.

Fork Length (mm)	Number of Fish	Weight Range (g)	K-Factor Range	K-Factor Average
50 – 59	2	2	1.03 – 1.27	1.15
60 – 69	31	2.5 - 4	0.91 – 1.39	1.14
70 – 79	63	3.5 - 6	0.90 – 1.40	1.16
80 – 89	46	5 – 8.5	0.91 – 1.43	1.11
90 – 99	20	7.5 – 10.5	0.99 – 1.19	1.10
100 – 109	22	10.5 – 15.5	1.04 – 1.27	1.13
110 – 119	12	13.5 – 19.5	0.93 – 1.19	1.08
120 – 129	14	17 - 26	0.98 – 1.27	1.08
130 – 139	6	23 – 28.5	0.97 – 1.11	1.04
140 – 149	5	27 - 35	0.97 – 1.10	1.02
150 – 159	4	32 - 45	0.93 – 1.26	1.09
160 – 169	2	42 – 45.5	0.95 – 1.09	1.02
170 – 179	1	50	1.00	1.00
180 – 189	2	59.6 – 75.5	0.96 – 1.21	1.09
190 – 199	1	72	1.02	1.02
200 – 209	1	87	1.07	1.07
210 - 219	2	103.5 - 116	1.06 – 1.17	1.11

Table 24. Condition factors of 234 of the 235 steelhead captured at Site 9, November 2005. (Note: One additional fish was caught but not measured).

Site 10

The last sample site on Santa Rosa Creek was located at approximately stream mile 14 and was 297 feet in length. The site included a bedrock scour pool (36 feet), root scour pool (69 feet), a run (51 feet), step-run (96 feet), and a riffle (45 feet). Maximum depths in the bedrock and root scour pools were 1.6 feet and 2.7 feet, respectively, and shelter was provided by boulders, bedrock ledges, roots and undercut bank. The run and step-run had maximum depths of 1.2 feet and 1.0 foot, respectively, and shelter was provided by boulders, root mass, small woody debris, and bubble curtain. The riffle had a maximum depth of 0.7 feet and boulders, terrestrial vegetation, aquatic vegetation and bubble curtain provided shelter. Air and water temperatures ranged from 53°F to 62°F and 55°F to 59°F, respectively.

At site ten, 231steelhead were captured with a calculated abundance of 244 steelhead. Biomass was 0.93 g/ft^2 and there were 0.77 steelhead per linear foot (Table 15). Of the steelhead captured, 193 were age 0+ with an average fork length of 77 millimeters (range: 53 – 105 mm); 31 were age 1+ with an average fork length of 126 millimeters (range: 107 – 159 mm); and seven were age 2+ with an average fork length of 187 millimeters (range: 168 – 210 mm) (Figure 30). Fifty-five of the steelhead (fork length range: 96 – 192 mm) at this site had rainbow trout coloration while the remaining 176 steelhead were parr. Nineteen steelhead captured at this location were infected with black spot disease. Table 25 summarizes the Fulton condition factors for the steelhead captured at Site10.

In addition to steelhead, one coastrange sculpin was captured and one newt was observed.

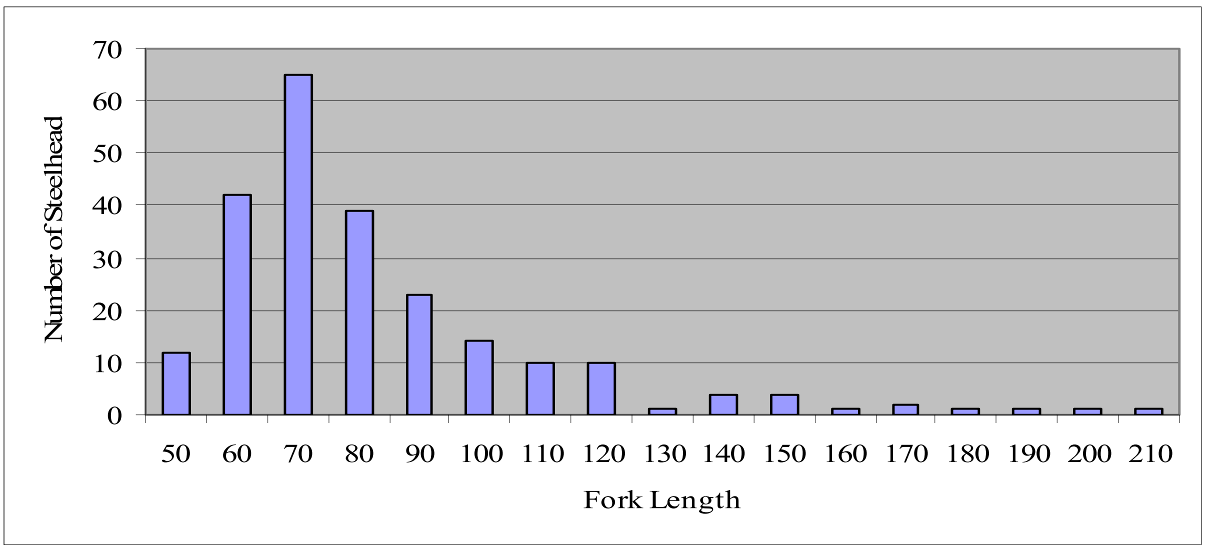

Figure30. Length frequency distribution of steelhead captured at Site 10, November 2005.

Fork Length (mm)	Number of Fish	Weight Range (g)	K-Factor Range	K-Factor Average
50 – 59	12	1.5 - 3	0.95 – 1.46	1.20
60 – 69	42	2 – 4.5	0.83 – 1.64	1.15
70 – 79	64	3 – 6.5	0.83 – 1.48	1.13
80 – 89	39	5 – 8.5	0.98 – 1.38	1.12
90 – 99	23	7.5 – 11.5	0.96 – 1.38	1.12
100 – 109	13	10.5 - 15	0.99 – 1.22	1.10
110 – 119	9	13.5 – 20.5	0.97 – 1.22	1.06
120 – 129	10	16 – 23.5	0.90 – 1.15	1.02
130 – 139	1	25.5	1.11	1.11
140 – 149	4	27.5 - 35	1.00 – 1.15	1.06
150 – 159	4	31 – 40.5	0.82 – 1.05	0.95
160 – 169	1	49	1.03	1.03
170 – 179	2	55.5 – 56.5	1.00 – 1.09	1.05
180 – 189	1	54	0.91	0.91
190 – 199	1	69.5	0.98	0.98
200 – 209	1	96	1.08	1.08
210 - 219	1	93.5	1.01	1.01

Table 25. Condition factors of 228 of the 231 steelhead captured at Site 10, November 2005. (Note: Three additional fish were caught but not measured).

Discussion

The purpose of habitat mapping Santa Rosa Creek was to determine the quantity and quality of rearing and spawning habitat available for steelhead and to identify habitat deficiencies or limiting factors in order to make recommendations on remediation actions. In 2005, Santa Rosa Creek had perennial flow in the lower 6.7 miles and upstream of stream mile 7.2 with a seasonal dry reach extending for approximately one-half mile in between that disconnected the upper watershed from the lower watershed. During winters with average and above average precipitation, that reach will have surface flow after the groundwater has been recharged and adult and smolt steelhead migration through the area is most likely not an issue. But during drier winters, the increased groundwater recharge time in the dry reach may significantly delay, abbreviate, or prevent adult steelhead from accessing the headwaters and smolts from emigrating from the headwaters. A prolonged drought may prevent adult steelhead access to the headwaters for several successive years. For this reason, it is imperative that high quality rearing and spawning habitat is abundant in the lower watershed as well as in the upper watershed.

Rearing habitat preference is variable depending on the size of the juvenile steelhead. Upon emergence from the gravel, steelhead fry will seek low velocity shallow areas along the stream margins in glides or pocket water habitat moving to riffles as they get bigger. As they grow and develop into fingerling size, fish will move into deeper, faster water taking refuge behind boulders, logs and other cover. Pre-smolt size steelhead will also utilize the faster water habitat, but ideal habitat for larger fish are deeper pools, with abundant instream cover and a riffle or run leading into the pool which provides drifting invertebrates for feeding. The larger the fish, the larger the territory it needs to survive and it is often the habitat for the larger individuals that is limiting.

In all of Santa Rosa Creek, 44% of the habitat units were pools and they comprised 34% (27,328 feet) of the total length. Approximately 39% more pool habitat (3,015 feet) was located upstream of the dry reach compared to downstream of dry reach providing significantly more habitat for larger fish upstream. Of those pool units that were able to be measured 76% were less than two feet maximum depth and although deeper pools were located throughout the entire stream, pools were consistently deeper in stream miles 1, 10 and 11. Pools that were shallow were so because of fine sediment deposition. Substrate within 52% of the pools was silt or sand. An additional 22% consisted of gravel and although gravel is a preferred substrate for spawning, its deposition in pool habitat reduces rearing space. In the remaining pools, the substrate consisted of boulders, small cobble, and large cobble and these units will only be scoured under very high flows.

Instream cover in most pools was diverse with many types of cover found in each unit. Only some pools in the lower watershed had only one or two types of cover present. Instream cover that would protect juveniles from displacement during high winter flows such as undercut banks, all woody material, larger boulders, and some terrestrial vegetation was more prevalent upstream of stream mile three. In addition to the types of cover present, the amount of cover within pools was also evaluated. When the percentage of cover for all pools within a particular stream mile was averaged, it was found that the pools in stream miles 6, 7, and 10 had the greatest quantity of cover in the pools (21%, 37%, and 30%, respectively) while all remaining areas had cover in less than 16% of the volume.

While pools themselves are used for rearing, most spawning occurs at the pool tail crests or the glides at the downstream end of pools. In Santa Rosa Creek, more potential spawning sites were located upstream of the dry reach (139 upstream compared to 112 below) with the highest number of sites (20 to 25 sites) in stream miles 9 through 11 and 14. Stream miles 6 and 7 also had a relatively high number of sites.

Those pool tail crests that were considered to be potential spawning sites were located in an area of the stream channel where intra gravel velocities were thought to be sufficient to aerate and remove metabolic wastes from the eggs incubating in the redds. These areas can only be used for spawning if the substrate is relatively small (5.5 inches in diameter or less) and loose enough for an adult steelhead to move. The “looseness” quality is a direct effect of how much fine sediment (sand and silt) surrounds or covers the gravels and cobbles. The greater the quantity of fine sediment deposition the harder it is to dislodge or move the substrate. In addition to hampering substrate mobility, excessive fine sediment deposition decreases spawning success by filling interstitial spaces between the gravels preventing aeration of the eggs and waste removal from the redds, and in some cases impedes emergence of fry from the gravels. Several researchers have found that survival of fry to emergence was significantly reduced when fine sediment in the gravels exceeded 12 to 14% (Cederholm et.al., 1979). In laboratory experiments conducted by Reiser and White (1988), it was found that a 30 to70 percent ratio of fine sediment to gravel was lethal to developing embryos. The percentage of fines within potential spawning gravels was not measured during this survey, however the high embeddedness of gravels by fine material indicates that excessive fine sediment deposition is occurring.

Although there were several spawning sites in stream miles 5 through 7, 9 through 11, and 14, that had the optimum combination of gravel or small cobble and a low percentage of fines, there were far more locations where excessive fine sediment deposition was degrading spawning habitat.

The low velocity pool habitat that has been described is essential rearing habitat for juvenile steelhead, especially larger juveniles. But high velocity riffle and run habitat are critical rearing areas for fry and fingerlings and for benthic macro invertebrate production. The riffle habitat in Santa Rosa Creek was almost twice as abundant upstream of the dry reach (83 riffles upstream compared to 46 below) and comprised over twice the length upstream compared to downstream of the dry reach (5,019 feet upstream versus 2,063 below). Run habitat was more comparable with 144 units (13,350 feet) upstream of the dry reach and 110 units downstream (13,010). Stream mile 8, by far, had the greatest amount of riffle habitat (2,284 feet) and stream mile 6 had the greatest amount of run habitat (3,342 feet) although other areas of the stream had extensive run habitat as well.

Prime substrate conditions for optimum benthic macro invertebrate production include streambed particle sizes ranging from 1.25 inches to 12 inches in diameter (gravel, small cobble, and large cobble) with low embeddedness (Reiser, 1979). Most of the riffles (87%) and runs (72%) consisted of optimal particle sizes for invertebrate production and these sites were located throughout the watershed. Although high velocity areas are not typical sites for fine sediment deposition, 16% of the runs consisted of sand. These sites were primarily located in the lower three miles where the creek is lower gradient and fine sediment is more apt to settle out.

Canopy, non-native plant species, and bank erosion were other variables that are noted during the habitat typing survey. Canopy density over the first 6.7 miles of the watershed was considerably lower than upstream. This was primarily due to the greater channel width, relatively flatter topography adjacent to the stream, the numerous denuded bank erosion sites, and the willows and other riparian vegetation in the lower watershed was not always tall enough or expansive enough to extend over the channel. Those locations that had good canopy coverage had willows on the banks, but cottonwood, sycamore, and alders were further upslope creating a multi-level canopy that extended over the channel. The extensive non-native plant species in some locations also precluded native vegetation from growing. Stream mile 2 had the most extensive coverage of non-native species because the vegetation growing in the back yards of stream side residents often extended down the banks. In some cases the stream banks were planted with palm trees, aloe vera and other plant species which not only don't provide shade, but make stream banks susceptible to erosion. In other areas of the stream, cape ivy was so extensive that it blanketed the banks and upslope areas preventing any other tree or plant species from rooting and because cape ivy is a vine it does not provide the extensive root system that holds the soil together which makes the banks beneath the ivy susceptible to erosion and failure.

Cumulatively, at least 2.6 miles of stream banks in the lower watershed were vertical, denuded, and actively eroding. Some erosion sites were associated with cape ivy and eucalyptus locations, cattle grazing activities, or across from or adjacent to riprap sites. However, it is suspected that many of the bank failures are either from past land use activities or a consequence of previous severe winter storm events and because the banks are vertical, it is difficult for vegetation to become re-established.

In 2005, the dry reach extended from stream miles 6.7 to 7.2 and although willows line portions of the (dry) low flow channel, no overhead canopy was present. Stream banks in this section were also vertical, denuded and actively eroding.

Starting at stream mile 7.9, the alluvial valley narrows into a canyon where the creek is incised between the surrounding steeper slopes. Obviously in this upper section the steeper slopes provide shade or prevent the stream from receiving direct sun exposure. However, the narrower canyon also allows trees to hang over the channel and the structure of the oaks, sycamore, and California bay laurel sprawl out instead of growing linearly; consequently the canopy over the creek is much greater than lower in the watershed. The topographic features, increased canopy, and numerous springs in the upper watershed also account for the significantly lower water temperatures even though air temperatures can be 20˚F to 35˚F warmer than the coast.

While canopy increased in the canyon reach, the diversity and abundance of non-native plant species in the riparian zone decreased substantially with one patch of arundo in stream mile 14, and scattered patches of nasturtiums adjacent to home sites. Eroding banks, however, were still prevalent with 2.7 miles of stream bank denuded and actively eroding. Cattle grazing is more extensive in the upper watershed which may account for more of the bank issues than the lower watershed, but the same consequences of severe winter storm events apply here.

In addition to the habitat mapping, outmigrant trapping was conducted in the spring of 2005, to determine peak run timing and smolt characteristics. Unfortunately, the outmigrant trap was placed late in the spring and the true peak of smolt emigration may have been missed. Significant high flow events starting on March 19th and extending throughout the week of March 21st may have been the time when most of the smolts migrated to sea. However, for the time frame that was monitored the peak migration for smolts occurred during the week of April 18th; however the greatest quantity of steelhead were passed through the trap the week of April 25th. It is assumed that the partial smolts that were captured were either far enough along in the smoltification process that they could survive in the ocean or they were going to finish the process in the lagoon or lower watershed before migrating out before the sand bar closed on May 25th. The parr and rainbow trout morphs that were captured were most likely going to reside in the lower watershed until the spring of 2006 before migrating to the ocean; however rearing conditions in the stream below the trap and lagoon were poor, if not prohibitive.

Although steelhead, stickleback, and other native species were the most abundant species captured while trapping, non-native green sunfish, bullfrogs and crayfish were also captured. Crayfish can consume salmonid eggs, but the full impact of their presence is not understood. They are also ubiquitous in Santa Rosa Creek and across the region making their complete eradication difficult at best. Bullfrogs can also be common, especially in ponds or pond-like habitat, but they aren't so common in small coastal streams making their presence in Santa Rosa Creek disconcerting. The same is true for green sunfish. Given the warm water temperatures in the lower watershed both of these non-native species will thrive during the summer months. It is doubtful that the sunfish could withstand the higher winter flows, but the adult bullfrogs will move to higher ground during these flow events, re-occupying the creek when flows subside. Eradication of these species from their "seed source" may be more effective in the long run.

The other biological parameter evaluated during the 2005 field season was instream juvenile densities. The ten sites selected for sampling were chosen from the data sheets by how well they represented the prevalent habitat types in certain areas. Habitat quality was not a factor. If only the higher quality habitat was sampled the fish densities would be skewed higher and not reflective of what the entire stream could support. For example, if only the deeper pools and run habitat were sampled yet that represents less than 10% of the habitat, unrealistic assumptions about the carrying capacity of the creek would prevail.

The results of the fish sampling mirrored what was observed during the habitat survey. Small numbers of primarily older (larger) fish were scattered throughout the lower 3.5 miles, but increasing densities of steelhead fry, fingerling, yearling and older fish were observed upstream. During the fish sampling, Site 5 (stream mile 4.3) had the highest biomass due to the large numbers of yearling and smolt sized fish; however Site 8 had the greatest number of fish per linear foot and the second highest biomass due to the large numbers of fry. Sites 9 and 10 (stream miles 12.7 and 14, respectively) also had high numbers of fry but when the number of fish per linear foot of stream was calculated, the numbers were much lower (0.75 and 0.77 fish/ft, respectively) than for Site 8 (1.16 fish/ft).

Based on the limited and widely spaced sampling, the most successful spawning occurred above the dry reach in 2005. The spring of 2005 had several late and significant storm events that provided sustained surface flow through the seasonal dry reach and allowed prolonged passage of adult steelhead to the headwaters. The late rain events also provided a longer time frame for adult steelhead to pass Ferrasci Road crossing. If flows are flashy during rain events, passage at the crossing could be significantly delayed or prevented making adult steelhead susceptible to poaching or forced to spawn below the crossing. Considering very few spawning sites and low quality rearing habitat exist downstream of the crossing, it is imperative that adult steelhead be able to pass this crossing.

In summary, much of the spawning and rearing habitat was impacted to some degree by excessive fine sediment deposition. Many sediment sources were observed and documented during the survey, however upslope and tributary sources also need to be identified. Habitat quality was higher in the upper watershed and was reflected by the greater numbers of juvenile steelhead captured during sampling. The lower watershed was more impacted by excessive sediment deposition, warmer water temperatures, non-native plant species, and a managed riparian zone. Passage through Ferrasci Road crossing and the dry reach may be problematic or prohibitive during drought years which is why the lower watershed needs to be just as capable as the upper watershed of supporting spawning adults and rearing juveniles.

Recommendations

1) Remove Ferrasci Road (ford) crossing and replace with a bridge.

Ferrasci Road crossing is an impediment under high and low flows and if flows are flashy during winter rain events this crossing can greatly impede or prevent adult steelhead from migrating upstream. Santa Rosa Creek is unique in San Luis Obispo County in that there is only one anthropogenic impediment on the mainstem and because Santa Rosa Creek is still one of the most important steelhead streams in the county, removal of this structure should be the highest priority project.

2) Active and potential sources of sediment throughout the watershed should be identified, mapped and prioritized according to the volume of sediment that is, or could be delivered to Santa Rosa Creek.

Excessive fine sediment generated from throughout the watershed and deposited in Santa Rosa Creek is adversely impacting spawning habitat by filling interstitial spaces, embedding gravels and in some cases, burying the gravel completely. It is also reducing the rearing space by filling pools and burying instream cover.

Sources to be mapped include, but are not limited to landslides, bank failures, roads (county, private and state owned roads), and all land use activities on the floodplains and on slopes which have a potential for delivering sediment to a watercourse which enters Santa Rosa Creek.

3) Develop an action plan for dealing with the sediment sources.

Miles of Santa Rosa Creek’s stream banks are covered in riprap. Most of the riprap was probably placed during or right after emergency events. However, the erosion continues and many of the sites have shifted upstream and downstream of the riprap or to the opposite bank. The portion of Santa Rosa Creek which flows through Cambria is entirely riprapped and that was most likely the only option since housing and commercial development is located at the top of the bank. However, most areas of Santa Rosa Creek could use biotech options that allow for some semblance of a natural riparian corridor. Reducing the angle of repose of the steeper banks, planting with diverse native vegetation, and/or other innovative biotech options are preferred over hardscape.

To define a long term solution to chronic bank failures, a geomorphologist or geologist should be consulted in order to determine the most effective solution for maintaining stream bank integrity and fish habitat values.

4) Work with landowners to install exclusionary cattle fencing along Santa Rosa Creek.

Working with willing landowners to install exclusionary fencing for cattle should occur as soon as opportunities arise. Many seemingly "natural" bank erosion sites in Santa Rosa Creek need to be evaluated in a watershed context; however the cause of bank erosion in the areas where cattle are grazing does not need to be evaluated. Excluding cattle from the riparian corridor would not only decrease the quantity of sediment entering the creek, but would also decrease nutrient loading and potential water quality issues. Several grants are available to fund fencing, re-vegetating, and developing alternative water sources for cattle.

5) Protest future water right applications which could jeopardize adult and juvenile passage, summer-fall juvenile rearing, and spawning.

Reduced summer and fall stream flows have a direct impact on the quantity and quality of rearing space, food production and availability, and water quality. With cessation of continuous stream flow, pools and some flatwater habitat may remain, but the volume within these units would be greatly diminished, thereby decreasing rearing space and juvenile steelhead populations. Decreased stream flows also cause riffles to be dewatered which would preclude aquatic insect production and use by steelhead fry.

Water quality degradation also accelerates at decreased stream flows. A reduction in the volume of water allows water temperatures to increase at a faster rate which could be directly lethal to salmonids and indirectly affect survival by increasing their susceptibility to disease. Higher water temperatures decrease oxygen solubility and with lower D.O. levels the extraction of dissolved oxygen by salmonids becomes increasingly difficult causing growth, food conversion and swimming ability to become adversely affected (Bjornn and Reiser, 1979).

6) Remove non-native vegetation from the riparian zone and re-vegetate with a variety of native species which would create a multi-level canopy.

Several non-native plant species were noted during the habitat survey. Removal of the seed sources in the upper watershed should be a priority. This obviously does not mean digging up private gardens, but there are areas of non-natives that are not associated with development that might be targeted. Willow species are usually the preferred alternative to use for re-vegetating, but if other native tree species are available and appropriate for the area, that would preferred.

7) Enhance riparian corridors wherever possible.

Enhancing or increasing the width of riparian corridors would buffer the stream and filter sediment derived from land use activity. There are many locations in Santa Rosa Creek watershed where this would be effective and beneficial. Developing easements or other landowner agreements would be essential.

8) Survey Perry Creek sub-watershed.

Perry Creek sub-watershed has not been surveyed to determine its fishery value or restoration potential. It absolutely needs to be included in a sediment assessment. It may also be the source of non-native fish species in Santa Rosa Creek, so the headwater impoundments would need to assessed to determine species composition.

9) Determine lagoon quality for rearing and enhancement potential.

Santa Rosa Creek lagoon was not assessed during this survey. The rearing potential of the lagoon during the summer and fall months needs to be determined as does what, if anything, limits rearing. Elsewhere along the coast of California lagoons are proving to be essential rearing habitat for steelhead. So much so, that it is thought most adults that survive in the ocean and return to spawn reared in lagoons as opposed to streams. These studies have been conducted in northern California and may not be applicable to central California, but the role of the lagoon in the life history of steelhead needs to be ascertained.

Water quality, stream flow, depth, sand bar status, tides, and salt water influx throughout the spring, summer and fall are a few of the parameters that need to be analyzed to determine if the lagoon is habitable. A multi year marking and trapping program would determine steelhead use and the lagoons relative importance.

10) Determine age length relationships for juvenile steelhead along the south central California coast.

Most reference material relating to steelhead life history is from northern populations of salmonids residing in streams in redwood forests and is not applicable to populations of steelhead residing in south central California. The age length relationship that was used to categorize steelhead during this study is one example of a reference that may not be valid. In order to properly manage and restore steelhead populations in the southern areas, it will be necessary to develop the information for local populations.

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Level III and Level IV Habitat Types

RIFFLE			
Low Gradient Riffle	(LGR)	[1.1]	{ 1}
High Gradient Riffle	(HGR)	[1.2]	{ 2}
CASCADE			
Cascade	(CAS)	[2.1]	{ 3}
Bedrock Sheet	(BRS)	[2.2]	{24}
FLATWATER			
Pocket Water	(POW)	[3.1]	{21}
Glide	(GLD)	[3.2]	{14}
Run	(RUN)	[3.3]	{15}
Step Run	(SRN)	[3.4]	{16}
Edgewater	(EDW)	[3.5]	{18}
MAIN CHANNEL POOLS			
Trench Pool	(TRP)	[4.1]	{ 8 }
Mid-Channel Pool	(MCP)	[4.2]	{17}
Channel Confluence Pool	(CCP)	[4.3]	{19}
Step Pool	(STP)	[4.4]	{23}
SCOUR POOLS			
Corner Pool	(CRP)	[5.1]	{22}
Lateral Scour Pool - Log Enhanced	(LSL)	[5.2]	{10}
Lateral Scour Pool - Root Wad Enhanced	(LSR)	[5.3]	{11}
Lateral Scour Pool - Bedrock Formed	(LSBk)	[5.4]	{12}
Lateral Scour Pool - Boulder Formed	(LSBo)	[5.5]	{20}
Plunge Pool	(PLP)	[5.6]	{ 9 }
BACKWATER POOLS			
Secondary Channel Pool	(SCP)	[6.1]	{ 4 }
Backwater Pool - Boulder Formed	(BPB)	[6.2]	{ 5 }
Backwater Pool - Root Wad Formed	(BPR)	[6.3]	{ 6 }
Backwater Pool - Log Formed	(BPL)	[6.4]	{ 7 }
Dammed Pool	(DPL)	[6.5]	{13}
<u>ADDITIONAL UNIT DESIGNATIONS</u>			
Dry	(DRY)	[7.0]	
Culvert	(CUL)	[8.0]	
Not Surveyed	(NS)	[9.0]	
Not Surveyed due to a marsh	(MAR)	[9.1]	