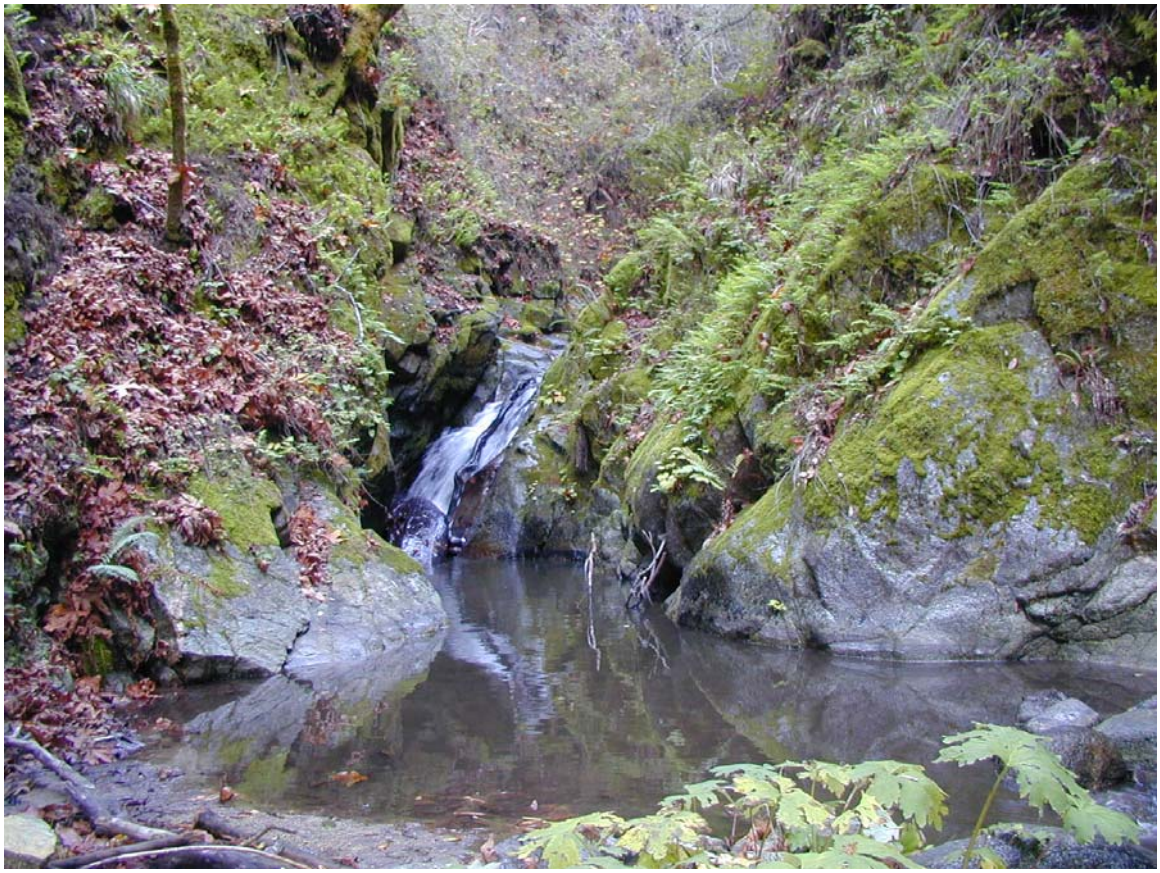
State of California
The Resources Agency
Department of Fish and Game

Garrapata Creek Steelhead Population Assessment

October 2005



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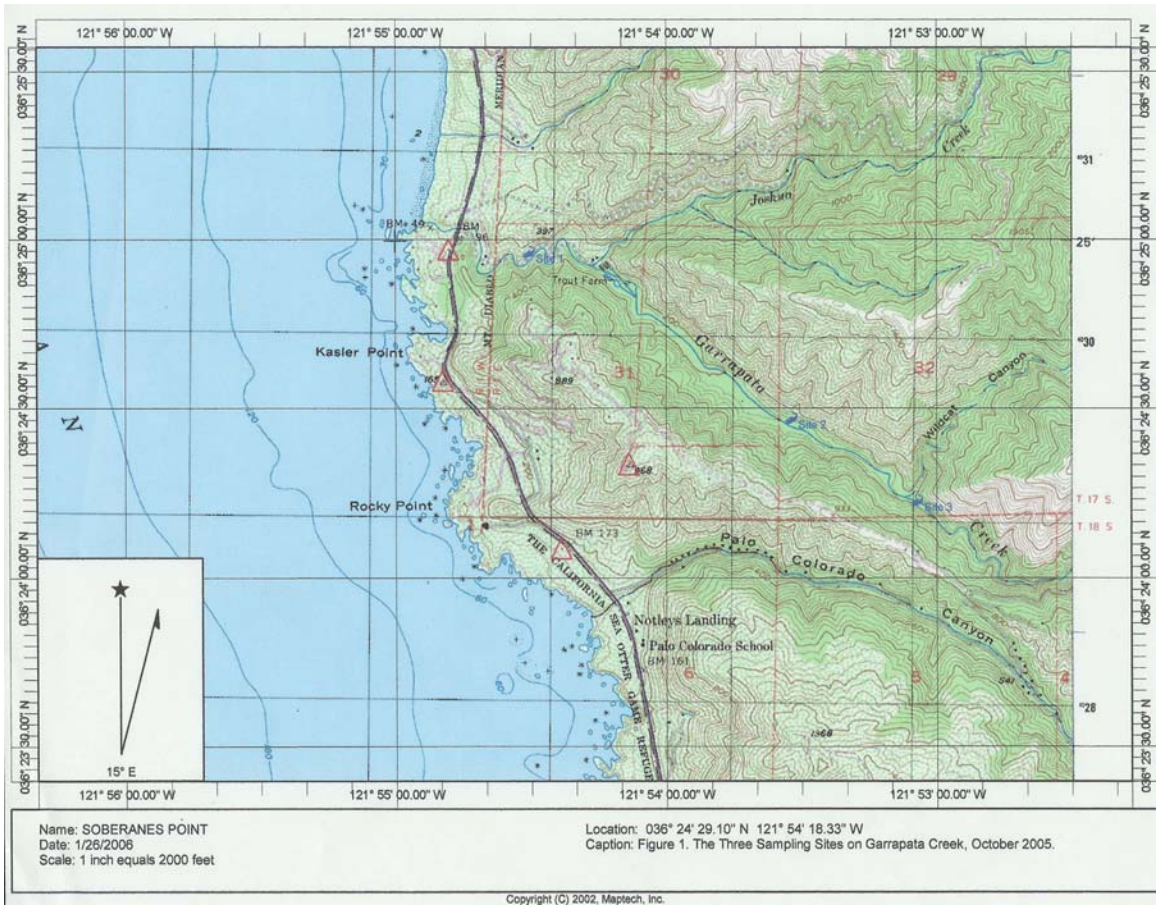

Figure 1. Garrapata Creek and October 2005 steelhead sampling locations.

Garrapata Creek is a small coastal stream located on the Big Sur Coast approximately 9.8 miles south of Carmel Valley. The mainstem of Garrapata Creek originates in the Santa Lucia Mountain Range at an elevation of approximately 3,480 feet and flows in a north-westerly direction for approximately 8.7 miles before discharging into the Pacific Ocean at T. 17 E., R.1 S.(036° 25’ 03.00”N, 121° 54’ 54.85”W). Several springs and tributaries enter Garrapata Creek, the most significant of which are Joshua Creek, which enters at stream mile 1.05, and Wildcat Creek, which enters at stream mile 2.7. Total drainage area for the watershed is 10.7 square miles.

Although the length of Garrapata Creek is 8.7 miles, the anadromous reach only extends upstream approximately 2.9 miles where a series of massive logjams prevent adult steelhead from further migration upstream. At stream mile 3.4, a bedrock fall approximately 27 feet in height is the ultimate barrier preventing steelhead from accessing the headwaters.

Historically, the watershed was logged and a road infrastructure was constructed to facilitate extraction of the logs. Currently, however, land use in the watershed consists of relatively low-density rural development. In 2000, the residents and other property owners in the watershed began meetings to discuss various aspects of the watershed that pertain to both the residents and the environment. The group is formally known as the Garrapata Creek Watershed Council and in the five years of existence, they have obtained

funding to study or assess stream flow, hydrology, lagoon function, sediment transport, vegetation composition, instream barriers, and the road network. This list is far from inclusive, but these aspects provide a solid foundation for a watershed restoration plan (www.garrapatacreek.org).

One other aspect of study for inclusion in the restoration report is a fish population census to determine the distribution and relative population abundance of steelhead rainbow trout (*Oncorhynchus mykiss*). This report describes the steelhead population census that was conducted in October, 2005.

Methods

Sampling reaches were defined by dominant riparian vegetation type (e.g. hardwood or redwood). Ideally, reaches would have been further defined by stream gradient; however channel typing data was unavailable for this stream. The three reaches identified for sampling included the lower reach consisting exclusively of hardwood species; a middle reach that was transitioning from hardwood species to redwood; and the upper reach which was dominated by redwood. Once reaches were delineated, specific sampling sites were chosen based on access and how well the habitat appeared to represent the reach.

At most sampling locations, stream habitat was inventoried, flow was monitored, and a steelhead population estimate was obtained.

Stream habitat within the sample station was inventoried utilizing the methodology described in the California Salmonid Stream Habitat Restoration Manual (Flosi et.al, 1998). A level four classification of all distinct habitat units was used whereby riffles are separated on the basis of water surface gradient; flatwater habitat is differentiated on the basis of depth and velocity; and pools are categorized based on either their location in the channel or the method of scour (i.e. boulder, bedrock, root wad, log). Once a unit is classified, mean width, depth, length, and maximum depth are measured. Other parameters measured include instream shelter complexity and percentage of unit cover; primary and secondary substrate components; percent exposed substrate; percent total canopy and the percentage of canopy that is either deciduous and coniferous vegetation; dominate substrate on the right and left banks and the percent of the banks with vegetation coverage; depth and substrate embeddedness at the pool tail crest; and comments regarding adjacent land use activities, eroded banks, passage impediments, and diversions. The data was compiled and summarized utilizing the program Habitat 8.

Stream flow was taken within sampling sites 1 and 3. To measure stream flow, a transect line was set perpendicular to flow and velocity measurement were taken at 0.5 foot increments across the channel. The six-tenths depth method was used since maximum depth never exceeded two feet. All measurements were taken using a Model 2000 Marsh-McBirney Flow-mate and total discharge was calculated using the Simple Average method.

To delineate fish sampling locations in each reach of the three reaches, a minimum distance of 100 meters was measured along the stream and block nets were placed at the lower and upper ends of the sampling station to enclose the population. Distances varied slightly to assure that whole habitat units were included in the sampling. Once the nets were placed, a crew of three or four people started sampling at the lower net and worked

upstream to the upper net. Fish were captured using a Smith-Root Model 12 backpack electrofishing unit and held in buckets or flow through live cars until the upper net was reached. Protocols of the multiple pass removal/depletion method as described by Zippin (1958) were used to sample each unit.

At the end of each pass, steelhead were measured for fork and total length to the nearest millimeter and weighed to the nearest 0.1 gram. Other fish species captured were identified and enumerated. After each pass, fish were held in a live car until the sampling was completed, after which, all fish were re-distributed back into the sampling station.

Population estimates for each site were calculated using the Microfish 3.0 program (Van Deventer and Platts, 1989). Fulton-type condition factors were calculated using the equation "Condition = (weight/length^3)*100,000" (Anderson, et. al., 1993)

Results

Results for each of the three sampling stations will be presented separately.

Site 1 Results

Sites 1 was located approximately 0.6 mile upstream of the ocean in a low gradient section of stream with a riparian zone dominated with willow and alder (Figure 1). Stream flow at the time of sampling was 1.4 cubic feet per second (cfs) and air and water temperatures were 59°F and 54°F, respectively. The sampling site was 341 feet in length and included four mid-channel pools (35% of the habitat), one high gradient riffle (2%), four runs (29%), and four low gradient riffles (33%).

Mid-channel pools averaged 30 feet in length (range: 21 – 39 feet), 8 feet in width (range: 4 – 11 feet), and 1.4 feet in maximum depth (range: 0.6 – 2.1 feet). Instream cover was provided by boulders, undercut banks, small and large woody material, and root mass but no more that 15% of the volume of each pool contained cover.

Riffles averaged 24 feet in length (range: 7 – 46 feet), 9 feet in width (range: 4.5 – 16 feet) and 1.4 feet in maximum depth (range: 0.5 - 0.9 feet). Instream shelter was provided by boulders, woody material, and bubble curtain and 5% to 15% of the riffle habitat had shelter.

Run habitat averaged 25 feet in length (range: 18 – 34 feet), 10 feet in width (range: 5.5 – 18 feet), and 1 foot in maximum depth (range: 0.6 – 1.3 feet). Instream shelter consisted of boulders, small woody material, and root mass and approximately 10% of the run volume had shelter.

Canopy over the site averaged 87% and consisted of willow and alder. No spawning substrate (e.g. gravel or small cobble) was located within the sampling area.

At site one, a total of sixty-four steelhead were captured with a calculated abundance of 65 steelhead. Because of the paucity of age/length data for steelhead in the central coast region, somewhat arbitrary size-breaks were used to delineate age classes. Because of the time of year the sampling was done, steelhead less than 90 millimeters fork length are considered to be young-of-the-year or age 0+; fish between 91 to 165 millimeters are considered to be age 1+; fish between 166 and 250 millimeters are in the category of age 2+; and fish up to 350 are in the 3+ category. Using this criteria, twenty-six of the sixty-

four steelhead captured were considered age 0+ with an average fork length of 74 millimeters (range: 57 – 85 millimeters), thirty were age 1+ with an average length of 119 millimeters (range: 93 -165 millimeters) and eight fish were age 2+ with an average fork length of 201 millimeters (range: 177 – 246 millimeters)(Figure 2).

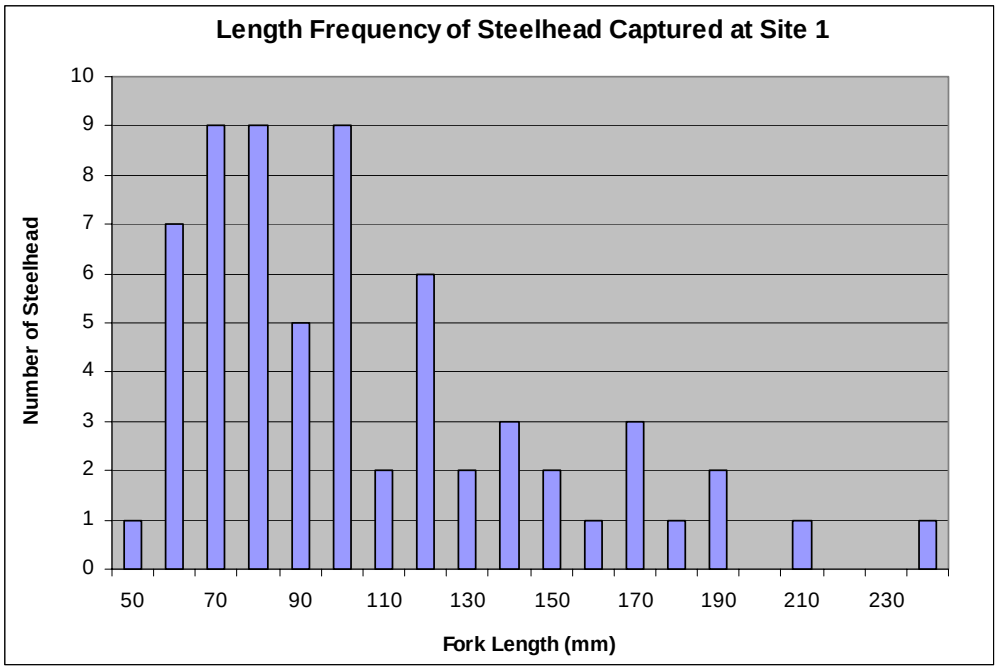

Figure 2. Fork length frequency of steelhead captured at site 1 on Garrapata Creek, October 2005.

Fulton condition factors are a measure of "fitness" or how much mass a fish has relative to its length. Higher numbers indicate better fitness. With the exception of the steelhead in the 50 to 69 millimeter range and the one fish in 180 to 189 millimeter range, condition factors are lower than would be expected for fish rearing in an area of the creek where the riparian zone consists of exclusively of hardwoods.

Fork Length (mm)	Number Of Fish	Weight Range (g)	K-Factor Range	Average K-Factor
50 – 59	1	2.5		1.16
60 – 69	7	2.5 – 4.5	0.64 – 1.25	1.02
70 – 79	9	2.5 - 6.0	0.51 – 1.17	0.87
80 – 89	9	5.0 - 7.5	0.75 – 1.06	0.91
90 – 99	5	8.5 – 10.0	0.76 – 0.93	0.86
100 – 109	9	9.5 – 14.0	0.75 – 0.98	0.87
110 - 119	2	14.5 – 15.0	0.78 – 0.89	0.83
120 – 129	6	17.0 – 21.0	0.79 – 1.00	0.87
130 – 139	2	24.0		0.84
140 – 149	3	24.5 – 32.5	0.70 – 0.94	0.83
150 – 159	2	38.0 – 38.5	0.84 - 0.88	0.86
160 - 169	1	43.5		0.83
170 -179	3	48 – 60.5	0.82 – 0.96	0.90
180 – 189	1	83.5		1.03
190 – 199	2	74.0 – 79.0	0.88 – 0.97	0.93
200 – 209				
210 - 219	1	104.5		0.91
220 - 229				
230 - 239				
240 - 249	1	132		0.77

Table 1. Condition factors of the 64 steelhead captured at site 1 on Garrapata Creek, October 2005.

In addition to steelhead, 217 sculpin were captured. Most sculpin captured were coastrange sculpin (*Cottus aleuticus*); however a few prickly sculpin (*Cottus asper*) were also captured.

Site 2 Results

Site 2 was located approximately 2 miles upstream from the ocean in a moderate gradient reach with a riparian consisting predominately of hardwoods but a few redwood trees could also be found adjacent to the stream (Figure 1). Air and water temperatures at the time of the survey ranged from 64° to 68°F and 52° to 54°F, respectively. This site was 310 feet in length and included two mid-channel pools (21% of the length), two glides (19%), one riffle (10%) and two runs (50%).

Mid-channel pools averaged 32.5 feet in length (range: 20 – 45 feet), 9.5 feet in width (range: 9 – 10 feet), and both pools had a maximum depth of 1.2 feet. Instream shelter

consisted of woody material, submerged terrestrial vegetation, and boulders. Instream shelter occupied approximately 10% of the pools volume.

The two glides averaged 30.5 feet in length (range: 21 – 40 feet), 8.75 feet in width (range: 6 – 11.5 feet), and 1.0 foot in maximum depth (range: 0.9 – 1.2 feet). Fifteen percent of the volume in both glides had shelter components that included boulders, root mass, terrestrial vegetation, and small woody material.

The one riffle in site 2 was 30 feet in length, 11 feet in width and 0.5 feet in maximum depth. Approximately 10% of the riffle unit had boulder shelter.

The two runs averaged 77 feet in length (range: 26 – 128 feet), 13 feet in width (range: 11 – 15 feet), and 1.1 feet in maximum depth (range: 0.9 - 1.3 feet). Instream shelter in the two runs consisted primarily of boulders, but small quantities of woody material, root mass, and terrestrial vegetation were also present.

Canopy over the site averaged 66% and consisted of 70% hardwoods (alder, big leaf maple, and bay laurel) and 30% conifers (redwood). There were no suitable spawning areas within station 2.

In site 2, a total of forty-two steelhead were captured and the calculated abundance was also forty-two. Seventeen of the steelhead captured were considered young-of-the-year or age 0+ with an average fork length of 75 millimeters (range: 57 –88 millimeters), twenty-one were age 1+ with an average fork length of 111 millimeters (range: 93 – 131 millimeters), and four steelhead were age 2+ with an average fork length of 189 millimeters (range: 173 – 205 millimeters)(Figure 3).

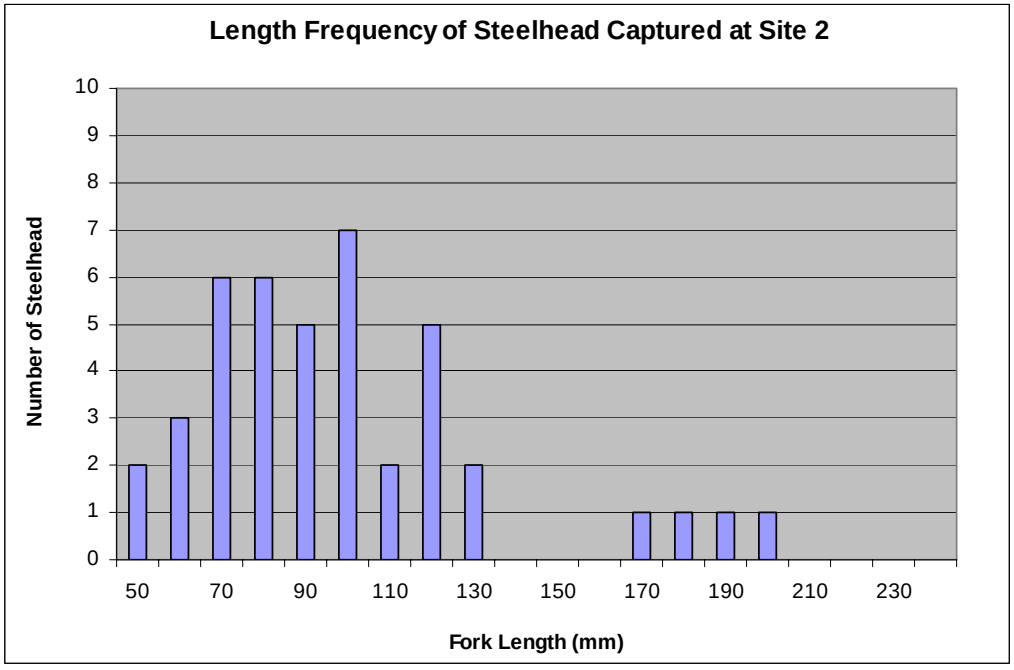

Figure 3. Length frequency distribution of steelhead captured at site 2 on Garrapata Creek, October 2005.

With the exception of the two fish in the 130 to 139 range and the one fish in the 180 to 189 millimeter range, condition factors were slightly higher at site two than they were in site one (Table 2).

Fork Length (mm)	Number Of Fish	Weight Range (g)	K- Factor Range	Average K-Factor
50 – 59	2	2.5		1.16
60 – 69	3	3.0 – 4.5	0.90 – 1.16	1.02
70 – 79	6	4.0 – 6.0	0.91 – 1.22	1.04
80 – 89	6	6.5 - 7.5	0.90 – 1.00	0.945
90 – 99	5	8.0 – 10.5	0.88 – 1.02	0.96
100 – 109	7	11.5 – 13.5	0.88 – 1.03	0.93
110 - 119	2	15.0 – 17.0	0.91 – 0.98	0.94
120 – 129	5	21.0 – 24.0	0.86 – 1.02	0.95
130 – 139	2	25.0	0.85 – 0.89	0.84
140 – 149				
150 – 159				
160 - 169				
170 -179	1	55	0.82 – 0.96	0.90
180 – 189	1	83.5		0.87
190 – 199	1	81.5		0.96
200 – 209	1	102.5		0.98

Table 2. Condition factors of the 42 steelhead captured at site 2, Garrapata Creek, October 2005.

In addition to steelhead, 102 sculpin (*Cottus spp.*) were also captured in site two.

Site 3 Results

The lower net for site 3 was placed 215 feet upstream of the confluence with Wildcat Creek which enters Garrapata Creek approximately 2.7 miles upstream from the ocean. This site had a moderate stream gradient with an adjacent riparian and upland area consisting of redwood, tan oak and big leaf maple. Stream flow at time of the survey was 0.76 cfs and air and water temperatures were 59°F and 52°F, respectively. This site was 305 feet in length and included two mid-channel pools (15% of the habitat sampled), one high gradient and three low gradient riffles (24%), two runs (53%) and one step-pool (8%).

Mid-channel pools averaged 23.5 feet in length (range: 23 – 24 feet), 10 feet in width (range: 8 – 12 feet), and 1.4 feet in maximum depth (range: 1.3 – 1.5 feet). Instream shelter consisted almost exclusively of boulders with a small amount of undercut bank and the shelter components occupied approximately 5% of the pools volume.

The four riffles averaged 18.5 feet in length (10 – 26 feet), 10 feet in width (range: 6 – 12 feet), and 0.7 feet in maximum depth (range: 0.4 – 0.9 feet). Approximately 10% of the riffle unit had shelter consisting of boulders and woody material.

The two runs averaged 81 feet in length (range: 46 – 115 feet), 12 feet in width, and 0.9 feet in maximum depth. Instream shelter in the two runs consisted primarily of boulders, but small quantities of root mass and terrestrial vegetation were also present. Approximately 25% of the run volume had shelter.

The one step-pool was 23 feet in length, 5 feet in width and had a maximum depth of 1.1 feet. Instream shelter occupied 15% of the unit and included boulders, terrestrial vegetation, and large woody material.

Canopy over site 3 averaged 84% and consisted of 80% conifers (redwood) and 20% hardwood (tanoak and big leaf maple). There were no suitable spawning areas within site three and of the three areas sampled; this site had the greatest volume of fines deposited within pools.

In site 3, a total of thirty-six steelhead were captured and the calculated abundance was thirty-seven steelhead. Twenty-five of the steelhead captured were considered young-of-the-year or age 0+ with an average fork length of 68 millimeters (range: 50 – 89 millimeters), nine were age 1+ with an average fork length of 111 millimeters (range: 93 – 156 millimeters), and two steelhead were age 2+ with a fork length of 182 millimeters (range: 168 – 192 millimeters) (Figure 4).

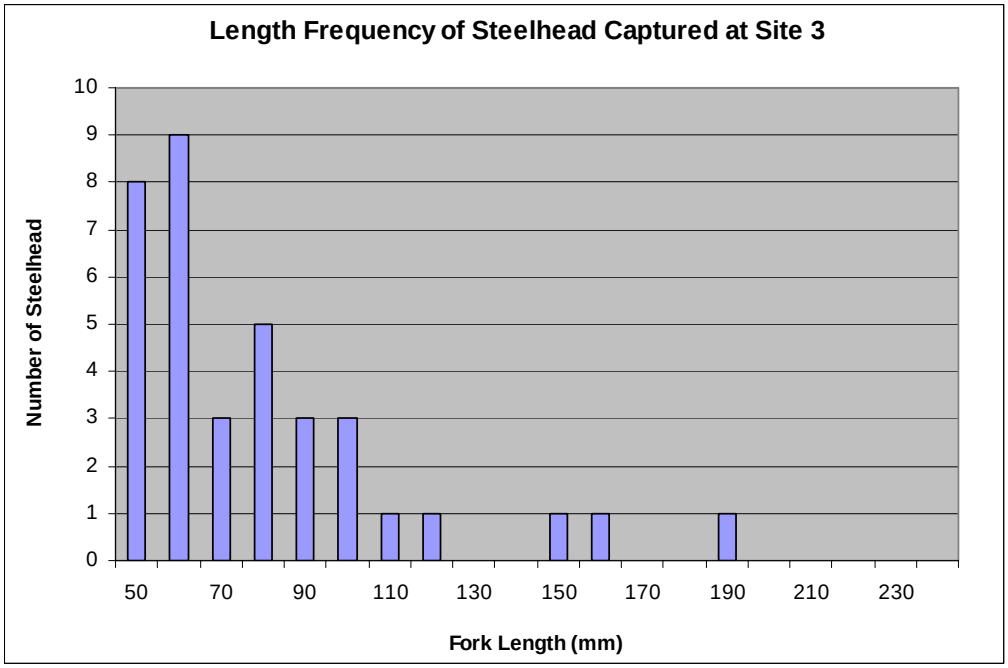

Figure 4. Length frequency distribution of steelhead captured at site 3 on Garrapata Creek, October 2005.

As with the young-of-the-year steelhead in sites one and two, condition factors were slightly higher for them than the older fish (Table 3).

Length (mm)	Number Of Fish	Weight Range (g)	K- Factor Range	Average K-Factor
50 – 59	8	1.5 – 2.5	0.84 – 1.10	1.00
60 – 69	9	3.0 – 4.0	0.90 – 1.16	1.00
70 – 79	3	4.0 – 4.5	0.91 – 1.12	1.03
80 – 89	5	6.0 – 8.0	0.90 – 1.12	1.01
90 – 99	3	8.5 – 11.0	0.82 – 0.92	0.88
100 – 109	3	10.5 – 15.0	0.79 – 0.99	0.88
110 - 119	1	15.0 – 17.0	0.91 – 0.98	0.94
120 – 129	1	18.0		0.90
130 – 139				
140 – 149				
150 – 159	1	47.0		1.03
160 - 169	1	48.0		0.84
170 -179				
180 – 189				
190 – 199	1	72.5		0.84

Table 3. Condition factors for the thirty-six steelhead captures at Site 3 on Garrapata Creek, October 2005.

Thirty-nine sculpin (*Cottus spp.*) were also captured in site 3.

Discussion

Historically, very little quantitative fishery population data was collected for steelhead streams along the central coast. However, in 1990 sampling was conducted at three locations within the anadromous reach on Garrapata Creek and one location on Wildcat Creek. All sampling locations were 46 meters (150 feet) in length and juvenile steelhead abundance was estimated by conducting an electrofishing survey and using a mark-recapture method. It is unknown what type of habitat was sampled in 1990, but at that time densities of steelhead in the lower, middle and upper locations were 26, 1, and 13 trout per 150 feet, respectively. Corresponding mean fork lengths at each location were 107.2 mm (range: 81 – 191 mm), 163 mm, and 79.7 mm (range: 50 – 164 mm) (CDFG,1990).

Comparing current densities from the lower, middle, and upper sites to the 1990 data, the middle site had the most dramatic increase in steelhead density from 0.007 fish/ foot of stream in 1990 to 0.13 fish/foot in 2005. Densities at the lower site was almost the same

with 0.17 fish/foot in 1990 to 0.19 fish/foot in 2005 and densities at the upper site almost doubled 0.09 fish/foot to 0.12 fish/foot.

The higher number of larger steelhead in the lower watershed during both sampling events is similar to what has been observed in other watersheds during fall sampling. It is thought that larger (older) steelhead are moving downstream in anticipation of smolting over the winter and leaving in the system in the spring.

Detailed habitat typing information describing the condition of the stream channel and adjacent riparian areas was not collected in 1990, however the report did state that there was perennial flow and excessive sedimentation was limiting spawning and rearing potential in the stream. Because the 1990 survey was conducted in the middle of a prolonged drought and it is unknown what type of habitat was sampled, that data may not serve as the best "base line" for which to judge the current population.

Information on steelhead condition factors was also not collected during the 1990 survey and to compare steelhead condition from this watershed to steelhead in another watershed would not be valid. Comparing condition factors from similar age groups throughout the same watershed is valid and it was thought that steelhead from the lower station on Garrapata Creek would have higher condition factors because willow, alder and other deciduous trees provide more nutrients to the stream and have more terrestrial insects associated with them than conifers (Meehan, 1991). However, condition factors at all three locations were similar among age groups.

Since Garrapata Creek has baseline data on the steelhead population for drought conditions and for a normal water year (CDFG, 1990 and 2005) and habitat typing (McKnight, 2002) it may be worthwhile continuing some level of sampling every three to five years. Since steelhead populations can be so variable from year to year, the sampling could be habitat based whereby certain habitat features are measured annually against some standard that has been identified.

If fish population sampling is repeated at some time interval, there are two different sampling strategies that could be employed. For both strategies channel typing would need to be conducted and the habitat would need to be re-typed at level four. Level four habitat typing provides more information on the scouring elements of pools, riffle gradient and substrate composition of the flatwater units.

If the long term goal of sampling is to obtain population estimates from fixed transects that are representative of a reach, then transects would be chosen based on the prevalent habitat in the different channel types. For example, if you are in a steeper gradient channel, which is referred to as a "B" channel, and 85% of the habitat is step-run habitat, 10% is riffle and 5% is pool habitat, a transect would be chosen which is predominately step-run habitat. At some defined time interval, the same transects would be sampled and the results from each transect compared from year to year. This would provide relative abundance of steelhead within the transect sites.

If the goal of sampling is to obtain a population estimate of the entire stream, then a percentage of each of the 24 habitat types in the level four survey would need to be sampled and the estimate extrapolated for the entire channel type. For example, if there are ten lateral scour log pools (LSL), thirty riffles and twelve glides in the flatter "C"

channel and 20% of each type of habitat is sampled then two pools, six riffles and two glides would sampled in the C channel reach. Using only the pool habitat to explain further, once the two pools were sampled, the two population estimates would be averaged (e.g. if 50 steelhead were estimated for pool 1 and 60 from pool 2, the average pool density would be 55) and then extrapolated for all 10 pools, so the LSL pool population in that reach would be 550 steelhead. This would then be repeated for each different type of habitat and each reach or channel type (Doloff et.al., 1993).

In both cases, the sampling requires a considerable amount of man-power, equipment and time. If monitoring is a long term goal in the watershed, it is recommended that fish population sampling be done every five years and to pick habitat features such as percentage of fines in spawning areas and pools, or biological studies, such as macroinvertebrate analysis, to measure annually.

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