STREAM INVENTORY REPORT

SENECA CREEK

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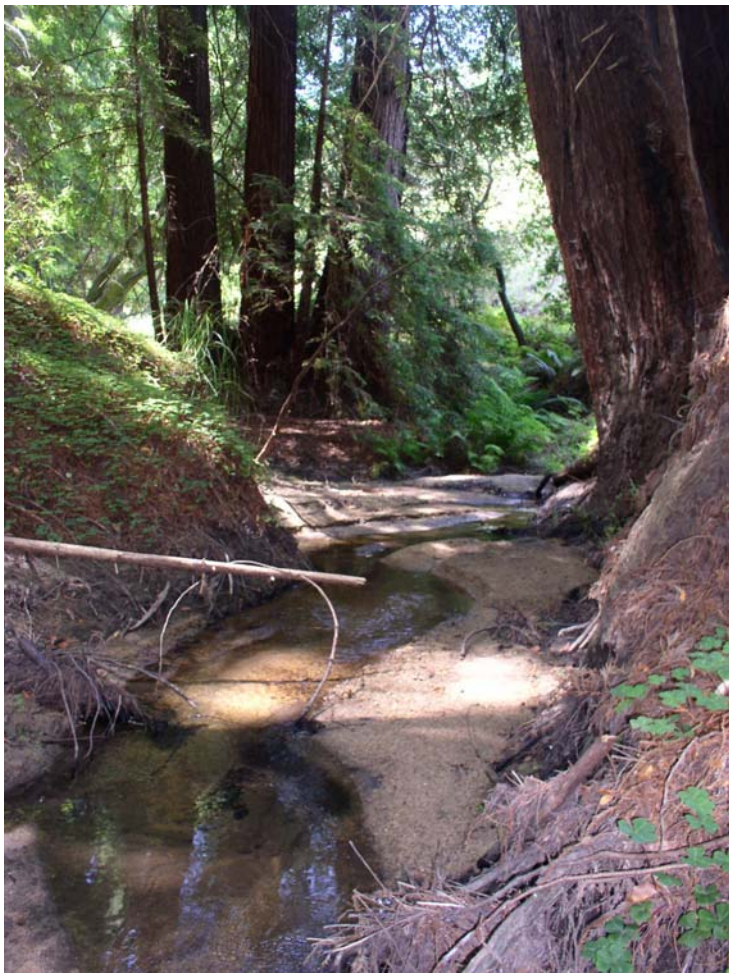

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CA Conservation Corps

2006

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INTRODUCTION

A stream habitat inventory was conducted on Seneca Creek from July 11, 2006 through July 19, 2006 by Tim Kahles and Eileen Baglivio, Special Corps Members of the California Conservation Corps (CCC). The survey began at the confluence with San Jose Creek and the survey extended two miles upstream. The objective of the habitat inventory was to document the quantity and quality of spawning and rearing habitat available for steelhead rainbow trout (*Oncorhynchus mykiss*) and coho salmon (*Oncorhynchus kisutch*) and to determine potential limiting factors for production.

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

WATERSHED OVERVIEW

Seneca Creek is a tributary to San Jose Creek which enters the Pacific Ocean approximately 3 miles south of Carmel in Monterey County, California (Figure1). Seneca Creek enters San Jose Creek at stream mile 4.3. Seneca Creek's legal description at the confluence with San Jose Creek is T16S R01E S32. Its location is N36° 30' 08.5" W121° 52' 52.4". Seneca Creek is a second order stream that is approximately 3 miles in length according to the USGS Woodside 7.5 minute quadrangle and drains an area of approximately 2.32 square miles. Elevations range from 660 feet at the confluence with San Jose Creek to 2,500 feet in the headwater areas. The riparian consisted of mostly coniferous forest, specifically redwood. All of the watershed is publicly owned and is managed for preservation and potential limited recreation.

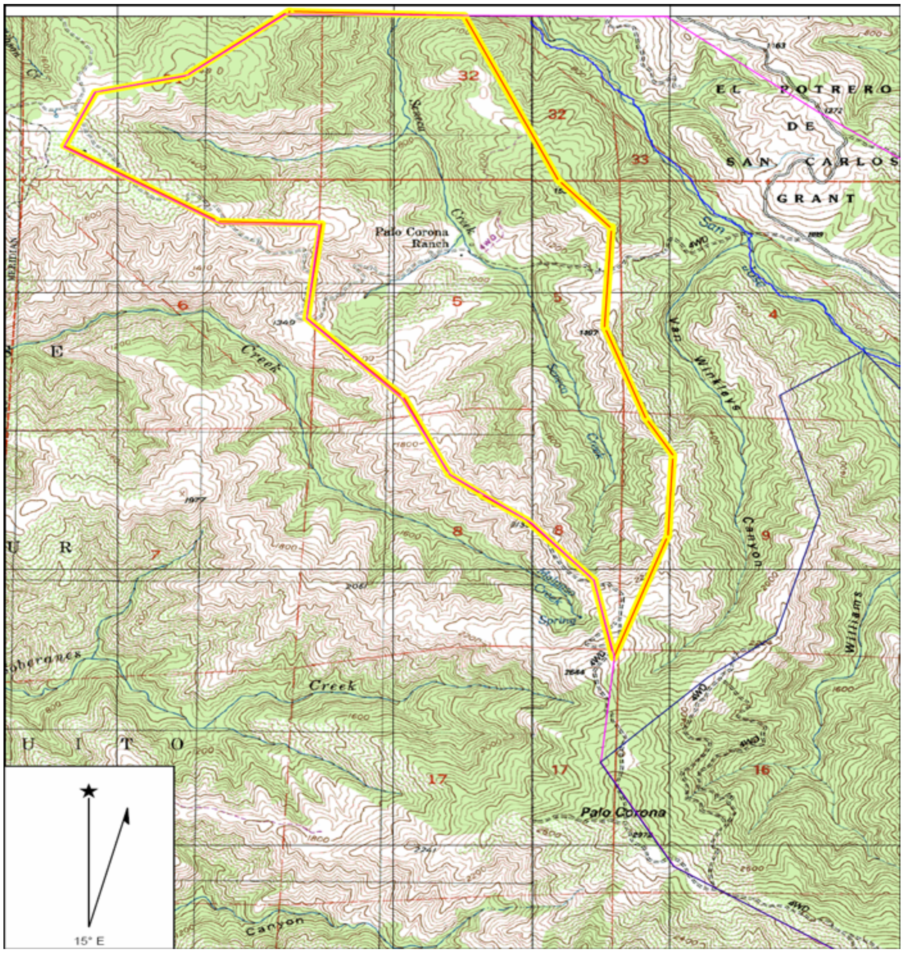


Figure 1. Seneca Creek watershed.

METHODS

Sampling Strategy

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

Habitat Typing Components

The habitat inventory conducted on Seneca Creek follows the methodology described in the *California Salmonid Stream Habitat Restoration Manual* (Flosi et al, 1998). A standardized habitat inventory form has been developed which allows for the following nine parameters to be recorded in a systematic format. All ten parameters were recorded during this survey however, not all measurements were taken to determine the various channel types. A two member team trained in standardized habitat typing conducted the survey.

1. Flow

To measure stream flow, a transect line was set perpendicular to flow and velocity measurements were taken at one foot increments (or at 0.5 foot increments if the stream was less than 20 feet wide). The six-tenths depth method was used since maximum depth never exceeded 2 feet. All velocity measurements were taken using a Model 2000 Marsh-McBirney Flow-Mate and stream flow was calculated using the Centroid method.

2. Channel Type

Channel typing is conducted according to the classification system developed and revised by David Rosgen (1994). This methodology is described in the *California Salmonid Stream Habitat Restoration Manual*. Channel typing is conducted simultaneously with habitat typing and follows a standard form to record measurements and observations. There are five measured parameters used to determine channel type: 1) water slope gradient, 2) entrenchment, 3) width/depth ratio, 4) substrate composition, and 5) sinuosity.

3. Temperatures

Both water and air temperatures are measured and recorded at the start of a new page or every tenth habitat unit. The time of the measurement is also recorded. Water temperatures are taken within one foot of the water surface and air temperatures are taken in the shade.

4. Habitat Typing

Habitat typing uses the 24 habitat classification types defined by McCain and others (1990). Habitat units are numbered sequentially and assigned a type identification number selected from a standard list of 24 habitat types (Attachment 1). For a particular habitat unit to be identified as a discreet unit, the minimum length of the unit must be equal to or greater than the stream's mean wetted width. Once a unit has been identified the average length, width and depth are measured in addition to the maximum depth. All measurements are in feet to the nearest tenth. Habitat dimensions are measured using a laser range finder and stadia rod.

5. Shelter Rating

Instream shelter is composed of those elements within a stream channel that provide juvenile salmonids protection from predation, reduce water velocities so fish can rest and conserve energy, and allow separation of territorial units to reduce density related competition for prey. The shelter rating is calculated for each fully-described habitat unit by multiplying shelter value and percent cover. Using an overhead view, a quantitative estimate of the percentage of the habitat unit covered is made. All cover is then classified according to a list of nine cover types. A standard qualitative shelter value of 0 (none), 1 (low), 2 (medium), or 3 (high) was assigned according to the complexity of the cover. Thus, shelter ratings can range from 0-300 and are expressed as mean values by habitat types within a stream.

6. Substrate Composition

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

7. Substrate Composition and Embeddedness at Pool Tail Crests

The dominant or primary substrate composing the pool tail crest is recorded for each pool. In addition, the depth of fine sediment surrounding or burying the cobbles at the crest is ocularly estimated. This figure is expressed as percent embedded 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 like bedrock, log sills, or boulders.

8. Canopy

Canopy is 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. In addition, the percentage of shade provided by coniferous versus hardwood trees was also estimated.

9. Bank Composition and Vegetation

The dominant bank composition type (e.g. bedrock, cobble, soil) and vegetation type (e.g. grass, brush, tree's) on both the right and left banks for each fully-described unit were selected from the habitat inventory form. Additionally, the percent of each bank covered by vegetation (including downed trees, logs, and rootwads) was estimated and recorded.

10. Comments and Landmarks

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

DATA ANALYSIS

Data from the habitat inventory form were 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. This program processes and summarizes the data, and produces the following ten tables:

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

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

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

Tables and graphs developed by this program are located at the end of the report.

RESULTS

Stream Flow

Stream flow was measured at the beginning of the survey on July 19, 2006 and was 0.176 cubic feet per second (cfs).

Channel Typing

Seneca Creek is a G5 channel type for the entire length of survey (2 miles). G5 channels are entrenched "gully" step-pool habitat and has low width/depth ratio on moderate gradient. The dominant substrate is primarily sand.

Temperatures

Air and water temperatures taken during the survey period ranged from 62°F – 78°F and 54°F to

68°F, respectively.

Habitat Typing

A total of 433 discreet habitat units were identified in the 10,524.7 feet of main channel surveyed. Based on frequency of occurrence, 41.1% pool units, 29.1% flatwater units, 27.7% were riffle units, 0.7% dry units, and 1.4% was not surveyed (Graph 1). Based on total length, 44% (4,723 feet) flatwater, 31% (3,351 feet) pools, 22% (2,380 feet) consisted of riffles, 0.3% (37 feet) was dry, and 1.8% (188 feet) was not surveyed (Table 1 and Graph 2).

Riffle Results

Riffle habitat includes high and low gradient riffles, cascades, and bedrock sheets. Four high gradient riffles, 112 low gradient riffles, and 4 bedrock sheets were identified during the survey. Detailed information of the average length, width, and depth of the riffles is in Table 2. Average maximum depth in the low gradient riffles was 1.0 foot~~~We thought that this number should either be max depth(0.5 ft) or mean depth (0.2) ft.

Instream shelter for all riffle units consisted of small woody material (35%), boulders (28%), root mass (27%), submerged terrestrial vegetation (8%), and bubble curtain (2%) (Tables 5 and 10). The volume of riffle habitat with instream shelter ranged from 0% to 20%. Approximately 62 riffles contained shelter between 0% and 10% of the volume. The remaining 39 units had shelter within 11% to 20% of the volume. Refer to tables 5 and 10.

Primary substrate within low gradient riffles was sand (33% of the units). Of the remaining low gradient riffles, the substrate consisted of gravel (20%), large cobble (20%), small cobble (20%), and boulder (7%). Primary substrate within high gradient riffles and bedrock sheets consisted of boulders (100%). (Table 6)

Flatwater Results

Flatwater habitat includes glides, runs, step-runs, pocket water, and edgewater. Within Seneca Creek , there were 77 runs, 36 step-runs, 12 glides, and 1 pocket water were identified. Average length, width and depth of these units can be found in Table 2. Average maximum depth was 0.7

feet in the runs, 0.8 feet in the step-runs, 0.5 feet in the glides, and 0.8 feet in pocket water habitat.

Instream shelter in all flatwater units combined included root mass (55%), boulders (15%), small woody material (15%), undercut bank (6%), submerged terrestrial vegetation (5%), large woody material (2%), and bubble curtain (1%). (Tables 5 and 10). Within all of the measured flatwater units, 60% of them had shelter in 10% of the volume. The remaining 40% of the units had shelter in 11% to 20% of the volume.

Primary substrate within glide units consisted of sand (67%) and silt/clay (33%). Primary substrate within runs consisted of sand (83%) and large cobble (17%). Step-runs consisted of gravel (50%) and boulder (50%). The one fully measured pocket water consisted entirely of boulder (100%). (Table 6).

Pool Results

Out of the 433 units identified, 178 of these units were pools. The majority of pools were mid-channel pools (125). Other pool types identified in Seneca Creek include lateral scour root pools (23 pools), plunge pools (11), corner pools (11), step-pools (5), lateral scour log pools (2), and a lateral scour bedrock pool (1). Average lengths, widths and depths of each of these pools types can be found in Table 2.***Didn't include percents because it is not on a graph/table and flatwater and riffle sections didn't have percents.

Maximum depths over all pool types ranged from less than one foot up to the 2-3 foot range. There were 107 pools (63%) with a max depth of 1 foot or less, 55 pools (33%) were included in the 1-2 foot range, and 7 pools (4%) in the 2-3 foot category. (Table 4 and Graph 5).

The percentage of pool volume with instream shelter ranged between 0% and 50% in those pools that were fully measured. Shelter components ranged between 0 – 10% of the volume in 12.5% (22) of the pools, 11% to 20% in 71% (121) pools, 21% to 30% in 12.5% (22) pools, and 4% (6) pools had shelter within 41% to 50% of the volume. Shelter components included root mass (33%), small woody material (23%), undercut banks (23%), boulders (14%), large woody material (3%), bubble curtain (2%), and terrestrial vegetation (2%). (Tables 5 and 10)(Graph 7).

Substrate Composition and Embeddedness at Pool Tail Crests

Out of the pool tail crests surveyed, 33.3% percent (59) consisted of sand, 28.7% (51) pools had boulder, and 2.9% (5) had bedrock at the pool tail crests. These substrates could not be used for spawning and have a rating of 5. The pool tail crests at the remaining pools had 21.8% (39) gravel, 8.1% (14) small cobble, and 5.2% (9) large cobble. (Graph 8). Actual pool numbers were manually equated from graph (data out of 483 pools-due to , we don't know what value to base off, 446? Or total pools 483? **Should only put percents, don't know total # percents taken from.**

At those 62 pool tail crests that consisted of gravel, small cobble or large cobble, the embeddedness of the substrate was estimated. Twenty-three or 13.1% of the pool tail crests were embedded up to 25% (value of 1), 30 (17.1%) were embedded between 26% and 50% (value of 2), and the remaining 9 (5.1%) were embedded between 51% and 75% (value of 3) (Graph 6).

Other potential spawning sites that are not located at the pool tail crests are identified in the Comments and Landmarks section.

Canopy

Canopy density for the surveyed area averaged 82% and consisted of 89% conifers and 11% hardwoods. (Table 7 and Graph 9).

Stream Bank Composition

Of the habitat units fully surveyed, stream banks were composed of sand/silt/clay (85.8% of the units), cobble/gravel (6.6%), bedrock (4.7%), or boulder (2.8%) (Graph 10). In those units that were fully surveyed, the mean percent right bank vegetated was 80% and the left bank was 81%. The mean percentage of stream bank vegetation included coniferous trees (67.9%), hardwood trees (16%), brush (14.2), and grass (1.9%) (Table 9 and Graph 11).

Although stream banks were well vegetated in those units that were fully measured, many slides, vertical denuded banks and slumps were identified and descriptions of those areas are in the comments and landmarks section. check this

Potential Impediments

Four bedrock sheets were identified within Seneca Creek. The 4 bedrock sheets ranged in length from 7 feet to 12 feet and were low gradient. Individually, none of the bedrock sheets were considered to be impediments nor were they considered an impediment when looked at cumulatively.

In addition to the bedrock sheets, there were also multiple log jams. Approximately 50 log jams (composed of small and/or large woody debris) were identified within the surveyed reach, the majority of which would not impede fish passage or become barriers to upstream migration. In most cases the jams were slightly aggraded with flow through sediment or woody debris. There were also some instances of head cutting that created a log jam, and jams that were considered “floaters” with flow under jam. Three log jams that have the potential to become impediments or barriers are located in habitat units 271, 321, and 414. The unit 321 jam, located at stream mile 1.5, was a 5.5 feet jump over a downed redwood. There is an overflow channel around the downed tree on the LB side. Refer to figure 2.

Figure 2. Problematic log jam, unit 321, Seneca Creek, 2006.

There was a jam at unit 414, stream mile 1.9. This jam includes downed large woody debris off of the right bank and bucked up wood in the channel creating a 5-7 foot high barrier. Refer to figure 3.

Figure 3. Problematic log jam, unit 414, Seneca Creek, 2006.

A jam at habitat unit 271 (stream mile 1.3) consisted of a 5 foot high jump over small woody debris and redwood roots. The jam was aggraded 4 feet with no jump pool below.

There is a road that follows Seneca Creek in close proximity for most of the survey. The creek flows under the road in three locations through metal culverts (units 235, 237, and 296). Two of these are potential impediments at the time of survey. In unit 235 (stream mile 1.1), there is a squashed culvert that is 39 inches in diameter. The main channel makes a right turn into the culvert, eroding the left bank. The flow on the upstream side is partially under the culvert. Below the culvert, there is a pool with a 2.5ft jump over woody debris that is aggraded 4 feet. Refer to figure 4.

Figure 4. Culvert in unit 235, Seneca Creek, 2006

The second culvert that may be an impediment is located in unit 296 at stream mile 1.4. This culvert is 20 feet long and the road prism above is only 14 feet wide, the culvert ends are exposed. Culvert dimension in notes. There is a woody debris pile on the upstream side of the culvert due to no debris rack. The culvert has no gradient, making adult steelhead migration problematic. On the road above the culvert, there are 1 to 2 foot high sidecast dirt piles with the potential to add large quantities of soft sediment to the creek. Refer to figure 5.

Figure 5. Culvert in unit 296, Seneca Creek, 2006

Another possible impediment to upstream fish migration is the defunct flash board dam and concrete apron located at unit 377 (stream mile 1.7). The lower 4 feet of the concrete apron is broken into slabs with an additional 7 foot piece connected to the dam. The apron has a gradient increase of 3 percent. At the top of the apron, there is a 4 inch high concrete jump onto a concrete bar that is 2 feet wide. The concrete flashboard abutments are 4.2 feet high; the righ abutment is 8 feet long and the left one is 10.5 feet wide. Fish passage could be possible with more flow. Refer to figure 6.

Figure 6. Concrete flashboard dam, unit 377, Seneca Creek, 2006.

Throughout Seneca Creek, there were a few areas with bank erosion adding sediment to the creek. Only one of these denuded sections was significant, having a length of over 50 feet. The erosion mentioned in unit 311 consisted of two sections of denuded banks. The first section was 12 feet high by 20 feet long and appeared to be slide material. The upper area was a 15 feet high by 100 feet long sediment wall. In addition to the denuded banks, the creek had a couple of other distinguishing characteristics. These include channels with large deposits of sand and decomposed granite on the banks and in the creek. Refer to figure 7. The other feature was exceedingly sinuous channels in certain areas. These factors may be due to heavy geological activity.

Figure 7. Meandering channels with sand deposits along banks, Seneca Creek, 2006.

BIOLOGICAL INVENTORY RESULTS

Methods

From July 11, 2006 through July 19, 2006, stream habitat on Seneca Creek was quantified using the habitat typing techniques described in the *California Salmonid Stream Habitat Restoration Manuel* (Flosi et.al., 1998). Using this data, a sampling site was chosen to obtain baseline assessment of the steelhead population status. The site was selected based upon how well it represented the habitat within the reach and the location relative to possible barriers to upstream migration or tributaries. Once the site was selected, a population estimate for an approximate 100 meter reach was obtained.

An approximate distance of 100 meters was measured along the stream bank and block nets were placed at the upper and lower ends of the sampling station to enclose the population. Distance varied slightly to ensure that whole habitat units were included in the sampling. 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 and 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 during 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 the end of each pass, steelhead were measured for fork length and total length to the nearest millimeter and weighed to the nearest 0.1 gram. 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 complete, 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 Devanter and Platts, 1989). Fulton type condition factors were calculated using the equation "Condition = (weight/length^3)*100,000" (Murphy and Willis, 1996).

Stream flow was also taken downstream of the survey area.

Results

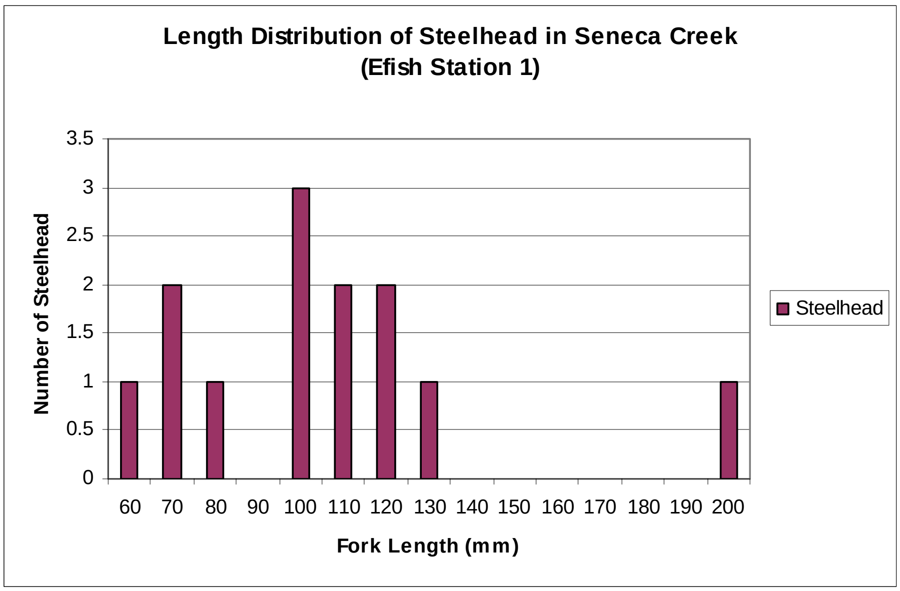
Station 1

The sampling site on Seneca Creek was located approximately 2,092 meters upstream from the confluence with San Jose Creek. This site was in a reach of stream that is entrenched or "gully-like" step pool and has low width/depth ratio on moderate gradient. Substrate consists primarily of sand. (G5 channel type). Riparian vegetation consisted mainly of redwood. Stream flow at the time of the sampling was Air and water temperatures were 14° and 11°C respectively.

The total survey length was 324 feet and included seven riffles (50% of the length), two runs (14%), one glide (7%), one corner pool (7%), one bedrock scour pool (7%), one root wad scour pool (7%), and one mid-channel pool (7%).

The seven riffles averaged 29 feet in length (range: 6-61 feet), the two runs averaged 23 feet (range: 11-35), the glide was 42 feet in length, the corner pool was 21 feet in length, the bedrock scour pool was 16 feet in length, the root wad scour pool was 12 feet in length, and the mid-channel pool was 27 feet in length. Over all the units, the average width was 8.75 feet. The average depth was 2.1 feet for the pools, with an average max depth of This data is not in the notes, did not fully type section?? Canopy info also???

At station one, 13 steelhead were captured with a calculated abundance of 13 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 in fork length are considered to be young-of-the-year or age 0+ fish; fish between 91 to 165 millimeters are considered to be age 1+; and fish between 166 and 250 millimeters are in the category of age 2+. Using this criteria, 4 of the steelhead captured were considered to be age 0+ with an average fork length of 74mm (range: 68-87mm), 8 of the steelhead captured were 1+ with an average fork length of 116mm (range: 103-134), and 1 of the steelhead was age 2+ with a fork length of 205mm.



Graph 12. Length frequency distribution of steelhead captured in Seneca Creek, October 2006.

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. Table 11 summarizes the Fulton condition factors for the steelhead captures at Station 1.

Fork Length (mm)	Number of Fish	Weight (g) Range	K-Factor Range	Average K-Factor
60-69	1	4	1.27	1.27
70-79	2	4	1.12	1.12
80-89	1	9	1.37	1.37
90-99	0	0	0	0
100-109	3	12 - 14.5	1.10 - 1.15	1.13
110-119	2	16.5 - 17	1.06 - 1.11	1.09
120-129	2	19.5 - 22	1.07 - 1.1	1.09
130-139	1	29	1.21	1.21
140-149	0	0	0	0
150-159	0	0	0	0
160-169	0	0	0	0
170-179	0	0	0	0
180-189	0	0	0	0
190-199	0	0	0	0
200-209	1	98.5	1.14	1.14

Table 11. Condition factors of the 13 steelhead captured in Seneca Creek, October 2006.

DISCUSSION

The two miles of stream surveyed on Seneca Creek is a G5 channel type which has moderate gradient which most likely can be utilized by steelhead but not coho salmon. Steelhead could ascend the G channel but the numerous log jams will preclude some portion of adult steelhead population.

Riffle and run habitat are the primary locations where aquatic insects are produced. Aquatic insects, in addition to terrestrial insects falling from the riparian vegetation, are the food sources for salmonids. Aquatic insect production is highest on substrate consisting of cobble with a low percentage of fines by volume and higher water velocities (Crouse et.al. 1981). With 40% of the riffle substrate consisting of cobble, insect production would be moderate. Twenty percent of the riffles contained gravel which could be used for spawning if the pool tail crests do not have suitable substrate. Thirty three percent of the riffles contained sand which cannot be utilized for spawning and the remaining 7% of riffle habitat consisted of boulder which would not be utilized by steelhead for spawning but can incur aquatic insect production.

Pool habitat is the primary rearing area for juvenile coho salmon and larger steelhead trout. Ideal pools for rearing are relatively deep (greater than 1 foot) with abundant instream and bank cover (e.g. logs, undercut, roots, boulders) and are located downstream from a riffle (Ruggles 1966, Nickelson et.al 1979). Thirty one percent of the total length surveyed consisted of pool habitat which is considered ideal, especially for streams where coho salmon rear. Thirty seven percent of the pools had a maximum depth greater than one foot (33% with 1-2 foot depth, 4% with 2-3 foot depth) while the remaining 63 percent consisted of depths of less then one foot. Usually with the deeper pools, they have more potential rearing habitat. There are no specific targets for how much instream cover there should be in pool habitat. In Seneca Creek, cover in most of the pools (87%) exceeded 11% of the volume and much of the cover was provided by various woody material, undercut banks, and boulders.

Of the pool tail crests measured, 65% of them could not be used for spawning due to an inappropriate substrate (i.e. boulder, bedrock, sand/silt). An additional 5% of pool tail crests consisting of large cobble (5 to 10 inches in diameter) may be used by a few large fish but even that size substrate is beyond what most coho salmon and steelhead will use for spawning. The remaining pool tail crests (30%) did have the appropriate substrate for spawning. Embeddedness greater than 25% will not only take female salmonids longer to move and clean the embedded gravel than loose material but excessive sedimentation will also decrease the survival and emergence of embryos and fry.

Coho salmon and steelhead will use areas other than pool tail crests for spawning if that is all that is available. The aforementioned riffles with gravel could be used in addition to those other locations mentioned in the Comments and Landmarks section. The twelve glides identified during this survey consisted of sand or silt/clay and could not be used for spawning. Also, intragravel water velocities may not be sufficient to keep eggs aerated and remove waste material in these other locations, survival rates may be lower.

Canopy over the stream channel was 82%. At some of the log jam locations the channel was over widened so streamside vegetation no longer extended over the channel. In addition to the canopy cover that stream side vegetation provides, it also serves to protect stream banks from erosion and filter sediment generated from upland sources. Many eroding or denuded banks were identified during the survey. Most, if not all of the banks, appeared to be the result of large scale land movement or the sites of old log jams. Other failing banks consisted of mudstone and were naturally eroding. Because of the erosive nature of the geology, background levels of sediment production may be high so any other anthropogenic sources of sediment added to the system overburden the system quickly.

Although the riparian is untouched for the most part, there are a few road crossings over and through the creek. Alleviating sediment from these sources in addition to any other upland sources would improve spawning and rearing conditions for coho salmon and steelhead in Seneca Creek.

In summary, pool habitat is abundant and relatively deep with good cover in most areas. Riffle habitat for food production and in some cases, spawning, was also abundant. Spawning areas were somewhat limited and many were embedded with fine sediment. The canopy coverage was good, but in only one case would active re-vegetation seem appropriate.

The multiple log jams, culverts, and possibly the flashboard dam may cumulatively limit anadromy. It is very difficult to tell if fish could make it through or over some of the obstacles on Seneca Creek. Some very large steelhead may be able to leap over or swim up some of the cascades and the smaller steelhead may make it through the log jams. But at every impediment encountered some portion of the population will not be able to go through, so cumulatively these impediments may be limiting anadromy.

In summary, it would never be recommended to modify the natural bedrock/boulder features. However, one or two of the log jams may be worth modifying if the larger wood could remain intact. There is not a shortage of large wood in Seneca Creek, so any large wood that could make it there without being "bucked" up would improve salmonid habitat on the mainstem as well.

RECOMMENDATIONS

1) Seneca Creek should be managed for coho salmon and steelhead spawning and rearing.

2) The water temperature data gathered during this survey indicated that maximum temperatures are acceptable for juvenile salmonids. To establish more complete and

meaningful temperature regime information, 24-hour monitoring from May through October should be performed.

3) Active and potential sediment sources related to the road system have already been identified and mapped during a previous inventory. Any treatments that have been proposed to decrease the amount of sediment generated from the road system are highly encouraged to be implemented.

4) The three significant log jams that were mentioned under the potential impediment section should be surveyed every other summer to determine if adult salmonids are still able to pass upstream. If not, and the log jams are not serving the purpose of stabilizing a slide, then CDFG should be contacted for possible modification of the sites.

5) Six road crossing were located within the survey reach. Three of these crossings included culverts under the road. If the road crossings are not used they should be graded and revegetated. If they are used, they should be rocked to the top of the slope or some other way stabilized to prevent sediment from entering during rain events.

6) Recently bucked up wood was found in some of the log jams. If the trees remain whole they are less likely to float downstream and accumulate in one jam. If at all possible, leave the trees that fall into the channel untouched.

7) Bank revetment may be worthwhile in those locations that are not eroding due to large scale land movement. Most banks will revegetate quickly on their own, but if banks are identified that actively eroding or wasting and are adding large quantities of sediment to the channel every year, some type of revetment may be warranted.

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