STREAM INVENTORY REPORT

Mill Creek

INTRODUCTION

A stream inventory was conducted during the summer of 1998 on Mill Creek and two tributaries Meyers Gulch and Hungry Hollow Creek. The inventory was conducted in two parts: habitat inventory and biological inventory. The objective of the habitat inventory was to document the habitat available to anadromous salmonids in Mill Creek. The objective of the biological inventory was to document the presence and distribution of juvenile salmonid species.

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

WATERSHED OVERVIEW

Mill Creek is tributary to the Navarro River, tributary to the Pacific Ocean, located in Mendocino County, California (Map 1). Mill Creek's legal description at the confluence with the Navarro River is T14N R15W S03. Its location is 39°06′03″ north latitude and 123°30′08″ west longitude. Mill Creek is a second order stream and has approximately 11.7 miles of blue line stream according to USGS Baily Ridge, Navarro, Philo, and Cold Springs 7.5 minute quadrangles. Mill Creek drains a watershed of approximately 12.1 square miles. Elevations range from about 110 feet at the mouth of the creek to 2400 feet in the headwater areas. Mixed conifer forest dominates the watershed. The watershed is entirely privately owned and is managed for rural subdivision, grazing, and timber production. Vehicle access exists via Highway 128.

METHODS

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

SAMPLING STRATEGY

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, dominant substrate composing the pool tail crest, and embeddedness. Habitat unit types encountered for the first time are further measured for all the parameters and characteristics on the field form. Additionally, from the ten habitat units on each field form page, one is randomly selected for complete measurement.

HABITAT INVENTORY COMPONENTS

A standardized habitat inventory form has been developed for use in California stream surveys and can be found in the *California Salmonid Stream Habitat Restoration Manual*. This form was used in Mill Creek to record measurements and observations. There are nine components to the inventory form.

1. Flow:

Flow is measured in cubic feet per second (cfs) at the bottom of the stream survey reach using standard flow measuring equipment, if available. In some cases flows are estimated.

2. Channel Type:

Channel typing is conducted according to the classification system developed and revised by David Rosgen (1985 rev. 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 every tenth habitat unit. The time of the measurement is also recorded. Both temperatures are taken in degrees Fahrenheit at the middle of the habitat unit and within one foot of the water surface.

4. Habitat Type:

Habitat typing uses the 24 habitat classification types defined by McCain and others (1988). Habitat units are numbered sequentially and assigned a type identification number selected from a standard list of 24 habitat types. Dewatered units are labeled "dry". Mill Creek habitat typing used standard basin level measurement criteria. These parameters require that the minimum length of a described habitat unit must be equal to or greater than the stream's mean wetted width. Channel dimensions were measured using hip chains, range finders, tape measures, and stadia rods. All units were measured for mean length; additionally, the first occurrence of each unit type and a randomly selected 10% subset of all units were sampled for all features on the sampling form. Pool tail crest depth at each pool unit was measured in the thalweg. All measurements were in feet to the nearest tenth.

5. Embeddedness:

The depth of embeddedness of the cobbles in pool tail-out reaches is measured by the percent of the cobble that is surrounded or buried by fine sediment. In Mill Creek, embeddedness was ocularly estimated. The values were recorded using the following ranges: 0 - 25% (value 1), 26 - 50% (value 2), 51 - 75% (value 3) and 76 - 100% (value 4). Additionally, a value of 5 was assigned to tail-outs deemed unsuited for spawning due to inappropriate substrate particle size, having a bedrock tail-out, or other considerations.

6. Shelter Rating:

Instream shelter is composed of those elements within a stream channel that provide 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. The shelter rating is calculated for each fully-described habitat unit by multiplying shelter value and percent cover. Using an overhead view, a quantitative estimate of the percentage of the habitat unit covered is made. All cover is then classified according to a list of nine cover types. In Mill Creek, a standard qualitative shelter value of 0 (none), 1 (low), 2 (medium), or 3 (high) was assigned according to the complexity of the cover. Thus, shelter ratings can range from 0-300 and are expressed as mean values by habitat types within a stream.

7. Substrate Composition:

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

8. Canopy:

Stream canopy density was estimated using modified handheld spherical densiometers as described in the *California Salmonid Stream Habitat Restoration Manual*. Canopy density relates to the amount of stream shaded from the sun. In Mill Creek, an estimate of the percentage of the habitat unit covered by canopy was made from the center of approximately every third unit in addition to every fully-described unit, giving an approximate 30% sub-sample. In addition, the area of canopy was estimated ocularly into percentages of coniferous or deciduous trees.

9. Bank Composition and Vegetation:

Bank composition elements range from bedrock to bare soil. However, the stream banks are usually covered with grass, brush, or trees. These factors influence the ability of stream banks to withstand winter flows. In Mill Creek, the dominant composition type and the dominant vegetation type of both the right and left banks for each fully-described unit were selected from the habitat inventory form. Additionally, the percent of each bank covered by vegetation was estimated and recorded.

BIOLOGICAL INVENTORY

Biological sampling during stream inventory is used to determine fish species and their distribution in the stream. In Mill Creek fish presence was observed from the stream banks, and **four** sites were electrofished using a Smith-Root Model 12 electrofisher. These sampling techniques are discussed in the *California Salmonid Stream Habitat Restoration Manual*.

DATA ANALYSIS

Data from the habitat inventory form are entered into Habitat, a dBASE 4.2 data entry program developed by Tim Curtis, Inland Fisheries Division, California Department of Fish and Game. This program processes and summarizes the data, and produces the following six tables:

- Riffle, flatwater, and pool habitat types
- Habitat types and measured parameters
- Pool types
- Maximum pool depths by habitat types
- Dominant substrates by habitat types
- Mean percent shelter by habitat types

Graphics are produced from the tables using Quattro Pro. Graphics developed for Mill Creek include:

- Riffle, flatwater, pool habitats by percent occurrence
- Riffle, flatwater, pool habitats by total length
- Total habitat types by percent occurrence
- Pool types by percent occurrence
- Total pools by maximum depths
- Embeddedness
- Pool cover by cover type
- Dominant substrate in the pool tail-outs
- Percent canopy
- Bank composition by composition type
- Bank vegetation by vegetation type

HABITAT INVENTORY RESULTS

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

The habitat inventory of July 22, 23, August 5, 6, 7, 11 and 12, 1998, was conducted by Andrew MacMillan (CCC), Michelle Hofmann, Lisa Campbell, and Paul Retherford (WSP/AmeriCorps). The total length of the stream surveyed was 34,100 feet with an additional 22 feet of side channel.

Flow was measured at the bottom of the survey reach with a Marsh-McBirney Model 2000 flowmeter at 1.06 cfs on August 19, 1998.

Mill Creek is an F4 channel type for the first 32,253 feet of stream reach surveyed. F4 channels are entrenched, meandering, riffle/pool channels on low gradients with high width/depth ratios and gravel-dominant substrates. The next 855 feet of surveyed stream is a G4 channel type. G4 channels are characterized by "gully" step-pools and low width/depth ratio on moderate gradient and gravel-dominant substrates. The last 992 feet of surveyed stream is an A3 channel which is steep, narrow, cascading step-pool stream with high energy and debris transport associated with depositional soils and cobble-dominate substrates.

Water temperatures taken during the survey period ranged from 60 to 69 degrees Fahrenheit. Air temperatures ranged from 63 to 89- degrees Fahrenheit.

Table 1 summarizes the Level II riffle, flatwater, and pool habitat types. Based on frequency of **occurrence** there were 33% riffle units, 40% flatwater units, and 26% pool units (Graph 1). Based on total **length** of Level II habitat types there were 18% riffle units, 60% flatwater units, and 22% pool units (Graph 2).

Sixteen Level IV habitat types were identified (Table 2). The most frequent habitat types by percent **occurrence** were low gradient riffles, 31%; step-runs, 20%; and runs, 19% (Graph 3). Based on percent total **length**, step runs made up 41%, low gradient riffles, 17%, and runs 16%. A total of 142 pools were identified (Table 3). Main channel pools were most frequently encountered at 69% and comprised 72% of the total length of all pools (Graph 4).

Table 4 is a summary of maximum pool depths by pool habitat types. Pool quality for salmonids increases with depth. One-hundred-twenty-four of the 142 pools (87%) had a depth of two feet or greater (Graph 5).

The depth of cobble embeddedness was estimated at pool tail-outs. Of the 142 pool tail-outs measured, 9 had a value of 1 (6.3%); Seventy-eight had a value of 2 (54.2%); Thirty-five had a value of 3 (24.3%); Fifteen had a value of 4 (10.4%) and 7 had a value of 5 (4.9%) (Graph 6). On this scale, a value of 1 indicates the highest quality of spawning substrate and a value of 5 indicates the tail-out is not suitable for spawning. In Mill Creek, 1 of the 7 pool tail-outs which were valued at 5 had silt/clay/sand too small to be suitable for spawning as the substrate. The other tail-outs were unsuitable for spawning due to the tail-outs being comprised of boulder, bedrock or wood.

A shelter rating was calculated for each habitat unit and expressed as a mean value for each habitat type within the survey using a scale of 0-300. Riffle habitat types had a mean shelter rating of 13, flatwater habitat types had a mean shelter rating of 26, and pool habitats had a mean shelter rating of 52 (Table 1). Of the pool types, the backwater pools had the highest mean shelter rating at 150. Main channel pools had a mean shelter rating of 49 (Table 3).

Table 5 summarizes mean percent cover by habitat type. Boulders are the dominant cover type in Mill Creek. Large and small woody debris are lacking in nearly all habitat types. Graph 7 describes the pool cover in Mill Creek.

Table 6 summarizes the dominant substrate by habitat type. Of the twenty-one low gradient riffles fully measured, 13 had gravel as the dominant substrate, and 6 had small cobble as the dominant substrate. Gravel was the dominant substrate observed in 114 of the 144 pool tail-outs measured (79%). Small cobble was the next most frequently observed dominant substrate type and occurred in 13% of the pool tail-outs (Graph 8).

The mean percent canopy density for the stream reach surveyed was 86%. The mean percentages of deciduous and coniferous trees were 58% and 42%, respectively. Graph 9 describes the canopy in Mill Creek.

For the stream reach surveyed, the mean percent right bank vegetated was 61%. The mean percent left bank vegetated was 59%. The dominant elements composing the structure of the stream banks consisted of 24.4% bedrock, 4.2% boulder, 36.9% cobble/gravel, and 34.5% sand/silt/clay (Graph 10). Deciduous trees was the dominant vegetation type observed in 43% of the units surveyed. Additionally, 20.8% of the units surveyed had coniferous trees, including down trees, logs, and root wads as the dominant vegetation type, and 14.9% had grass as the dominant vegetation (Graph 11).

BIOLOGICAL INVENTORY RESULTS

Four sites were electrofished on August 19, 1998, in Mill Creek. The sites were sampled by Paul Retherford and Tristan Behm (WSP/AmeriCorps).

The first site sampled included habitat units 60-62, a riffle, glide, mid-channel pool series approximately 6,413 feet from the confluence with the Navarro River. This site had an area of 253 sq ft and a volume of 254 cu ft. The site yielded 12 steelhead.

The second site included habitat units 278-280, a step run, mid-channel pool, riffle series located approximately 19,314 feet above the creek mouth. This site had an area of 1,568 sq ft and a volume of 1,882 cu ft. The site yielded 6 steelhead.

The third site sampled included habitat units 515-516, a run, mid-channel pool series located approximately 32,999 feet above the creek mouth. The site had an area of 795 sq ft and a volume of 1,510 cu ft. The site yielded 5 steelhead.

The fourth site sampled included habitat units 521-522, a step run, and step pool located approximately 33,166 feet above the creek mouth. The site had an area of 1,410 sq ft and a volume of 1,974 cu ft. The site yielded 8 steelhead and one Pacific giant salamander.

DISCUSSION

Mill Creek is an F4 channel type for the first 32,253 feet of stream surveyed, a G4 channel for 855 feet and an A3 for the remaining 992 feet. The suitability of F4 channel types for fish habitat improvement structures is: good for bank-placed boulders; fair for weirs, single and opposing wing-deflectors, channel constrictors and log cover; and poor for boulder clusters. The suitability of a G4 channel type for fish habitat improvement structures is as follows: good for bank-placed boulders; fair for weirs, opposing wing-deflectors, and log cover; and poor for boulder clusters and single wing-deflectors. A3 channel types are suitable for: bank-placed boulders; fair for weirs, opposing wing-deflectors and log cover; and poor for boulder clusters and single wing-deflectors.

The water temperatures recorded on the survey days of July 22, 23, August 5, 6, 7, 11 and 12, 1998, ranged from 60 to 69 degrees Fahrenheit. Air temperatures ranged from 63 to 89 degrees Fahrenheit. This is a marginal water temperature range for salmonids. To make any further conclusions, temperatures would need to be monitored throughout the warm summer months, and more extensive biological sampling would need to be conducted.

Flatwater habitat types comprised 60% of the total **length** of this survey, riffles 18%, and pools 22%. The pools are relatively deep, with 127 of the 144 (88.2%) pools having a maximum depth greater than 2 feet. In general, pool enhancement projects are considered when primary pools comprise less than 40% of the length of total stream habitat. In first and second order streams, a primary pool is defined to have a maximum depth of at least two feet, occupy at least half the width of the low flow channel, and be as long as the low flow channel width. Installing structures that will increase pool habitat is recommended.

Nine of the 144 pool tail-outs measured had an embeddedness rating of 1. Fifty of the pool tail-outs had embeddedness ratings of 3 or 4. Seven of the pool tail-outs had a rating of 5 or were considered unsuitable for spawning. One of the 7 were unsuitable for spawning due to the dominant substrate being silt/sand/clay. Cobble embeddedness measured to be 25% or less, a rating of 1, is considered to indicate good quality spawning substrate for salmon and steelhead. In Mill Creek, sediment sources should be mapped and rated according to their potential sediment yields, and control measures should be taken.

The mean shelter rating for pools was 52. The shelter rating in the flatwater habitats was 26. A pool shelter rating of approximately 100 is desirable. The cover that now exists is being provided primarily by boulders in all habitat types. Log and root wad cover structures in the pool and flatwater habitats are needed to improve both summer and winter salmonid habitat. Log cover structure provides rearing fry with protection from predation, rest from water velocity, and also divides territorial units to reduce density related competition.

One-hundred-thirty-two of the 144 pool tail-outs measured had gravel or small cobble as the dominant substrate. This is generally considered good for spawning salmonids.

The mean percent canopy density for the stream was 86%. In general, revegetation projects are considered when canopy density is less than 80%.

The percentage of right and left bank covered with vegetation was low at 61% and 59%, respectively. In areas of stream bank erosion or where bank vegetation is not at acceptable levels, planting endemic species of coniferous and deciduous trees, in conjunction with bank stabilization, is recommended.

RECOMMENDATIONS

1) Mill Creek should be managed as an anadromous, natural production stream.

2) The limited water temperature data available suggest that maximum temperatures are nearing the threshold of stress level for juvenile salmonids. To establish more complete and meaningful temperature regime information, 24-hour monitoring during the July and August temperature extreme period should be performed for 3 to 5 years. The Mendocino County Water Agency has deployed water temperature monitoring probes at various locations in the Mill Creek drainage since 1995.

3) Where feasible, design and engineer pool enhancement structures to increase the number of pools. This must be done where the banks are stable or in conjunction with stream bank armor to prevent erosion.

4) Increase woody cover in the pools and flatwater habitat units. Most of the existing cover is from boulders. Adding high quality complexity with woody cover is desirable.

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

6) There are several road crossings through the creek bed which are adding sediment to the creek. Projects should be designed to minimize the impact to the creek.

COMMENTS AND LANDMARKS

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

0'	Begin survey at the confluence with the Navarro River. Channel type is an F4.
3,023'	Road crossing.
3,123'	Road crossing.
4,336'	Old log stringer bridge.
5,151'	Old bridge.
5,463'	State Route 128 bridge crossing.
6,469'	Left bank tributary, 59*F.
6,507'	Steel flatcar bridge, 90' long x 10' wide x 20' high.
7,953'	Tributary, not accessible to fish enters right bank, 59*F.
8,327'	Left bank dry, steep tributary not accessible to fish.
9,041'	Dry tributary, not accessible to fish enters right bank.
9,235'	Suspension foot bridge, 50' long x 5' wide x 20' high.
9,643'	Dry steep tributary, not accessible to fish with a culvert upstream about 75'.
10,229'	Left bank dry steep tributary not accessible to fish.
10,814'	Right bank culvert up bank 40', not accessible to fish.
11,205'	Left and right bank erosion, 20' long x 15' high.
11,324'	Boxcar bridge driveway, 12' long x 40' wide x 15' high.
11,759'	Steel boxcar bridge, 12' long x 80' wide x 35' high.
11,794'	Meyer Gulch enters from the right bank (see subsection report).
12,092'	Right bank road drainage not accessible to fish.
13,655'	Steep dry right bank tributary not accessible to fish.
13,903'	Right bank dry steep tributary not accessible to fish.

14,444'	Right bank dry steep tributary not accessible to fish.
14,452'	Left bank failure, 46' long x 40' high.
15,202'	Right bank dry steep tributary not accessible to fish.
15,801'	Log debris accumulation, 61' long x 30' wide x 5' high with associated left bank failure 65' long.
16,359'	Right bank tributary dry for first 45' then steep and not accessible for fish.
16,623'	Left bank tributary not accessible for fish.
16,794'	Private road boxcar bridge, 12' long x 35' wide x 12' high.
17,415'	Right bank dry steep tributary not accessible to fish.
18,111'	Right bank tributary, less than 0.01 cfs, 63* F, with a culvert 200' upstream. No fish observed.
18,239'	Log bridge, 10' long x 40' wide x 12' high.
19,582'	Left bank dry tributary not accessible to fish.
19,788'	Left bank road to gate.
20,058'	Little Mill Creek enters from the left bank.
20,492'	Right bank dry tributary not accessible to fish.
21,022'	Left bank dry tributary not accessible to fish.
21,086'	Left bank dry tributary not accessible to fish.
21,318'	Left bank access road 300' from Nash Mill Rd.
21,421'	Right bank drainage not accessible to fish.
21,504'	Old log bridge, 17' wide x 50' long x 20' high.
21,532'	Double 10' diameter culverts one smashed to 5' diameter and the other 7' diameter. Road crossing.
21,984'	Right bank tributary, 60* F. Observed fish for 50', then became steep and not accessible to fish.

22,361'	Left bank failure, 15' long x 10' high.
23,101'	Right bank dry tributary not accessible to fish.
23,151'	Left bank failure, 25' long x 25' high.
23,442'	Log debris accumulation, 7' long x 30' wide x 8' high, retaining 5' of sediment with associated left bank failure, 45' long x 100' high.
23,764'	Right bank dry tributary not accessible to fish.
23,956'	Old, nonfunctional wooden bridge, 12' wide x 100' long x 40' high.
24,799'	Right bank dry tributary not accessible to fish.
24,968'	Left bank dry tributary not accessible to fish.
25,326'	Left bank erosion, 150' long x 20' high contributing fine sediment.
25,482'	Log debris accumulation, 10' long x 30' wide x 8' high retaining 3' gravel.
25,852'	Left bank failure, 50' long x 100' high contributing small cobble and woody debris.
26,047'	Right bank failure, 5' long x 100' high contributing gravel and cobble.
26,527'	Right bank dry tributary not accessible to fish.
27,341'	Left bank erosion, 40' long x 15' high.
27,412'	Road crossing through creek bed 10' long.
27,667'	Left bank residence 40' up the bank.
28,177'	Left bank tributary not accessible to fish.
28,253'	Right bank dry tributary not accessible to fish.
28,609'	Left bank tributary, steep and not accessible to fish.
28,624'	Left bank failure, 25' long x 40' wide x 8' high.
28,826'	Several year classes of salmonids; amphibians, and crayfish observed.

29,897' Road crossing through creek bed 10' long.

29,925' Left bank tributary not accessible to fish.

31,190' Right bank tributary not accessible to fish.

31,500' Right bank road 20' up the bank.

32,081' Wooden foot bridge, 12' wide x 35' long x 9' high, appears that a shelter is in the process of being constructed over the creek.

32,397' Bank failure, 25' long x 9' high contributing fines.

32,549' Left bank dry tributary not accessible to fish.

32,725' Wooden footbridge, 3' wide x 35' long x 5' high.

32,819' Road crossing through creek bed 10' long.

33,062' Hungry Hollow Creek enters from the right bank (**see subsection report).**

33,638' Left bank tributary not accessible to fish.

33,836' Right bank failure, 30' long x 100' high.

34,087' Twelve foot jump formed by a bedrock sheet with a 3' jump pool. End of survey. Jump appears to be impassable. Immediately following the jump there are three consecutive log jams with high gradient, greater than 4%. No fish seen for 500'. Creek becomes pinched and extremely steep.

REFERENCES

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

LEVEL III and LEVEL IV HABITAT TYPE KEY

HABITAT TYPE	LETTER	NUMBER
RIFFLE		
Low Gradient Riffle	[LGR]	1.1
High Gradient Riffle	[HGR]	1.2
CASCADE		
Cascade	[CAS]	2.1
Bedrock Sheet	[BRS]	2.2
FLATWATER		
Pocket Water	[POW]	3.1
Glide	[GLD]	3.2
Run	[RUN]	3.3
Step Run	[SRN]	3.4
Edgewater	[EDW]	3.5
MAIN CHANNEL POOLS		
Trench Pool	[TRP]	4.1
Mid-Channel Pool	[MCP]	4.2
Channel Confluence Pool	[CCP]	4.3
Step Pool	[STP]	4.4
SCOUR POOLS		
Corner Pool	[CRP]	5.1
Lateral Scour Pool - Log Enhanced	[LSL]	5.2
Lateral Scour Pool - Root Wad Enhanced	[LSR]	5.3
Lateral Scour Pool - Bedrock Formed	[LSBk]	5.4
Lateral Scour Pool - Boulder Formed	[LSBo]	5.5
Plunge Pool	[PLP]	5.6
BACKWATER POOLS		
Secondary Channel Pool	[SCP]	6.1
Backwater Pool - Boulder Formed	[BPB]	6.2
Backwater Pool - Root Wad Formed	[BPR]	6.3
Backwater Pool - Log Formed	[BPL]	6.4
Dammed Pool	[DPL]	6.5