STREAM INVENTORY REPORT

Mill Creek

INTRODUCTION

A stream inventory was conducted during the summer of 2001 on Mill Creek. The survey began at the confluence with Redwood Creek and extended upstream 0.5 miles.

The Mill Creek inventory was conducted in two parts: habitat inventory and biological inventory. The objective of the habitat inventory was to document the habitat available to anadromous salmonids in 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 chinook salmon, 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 a tributary to Redwood Creek, a tributary to the Pacific Ocean, located in Humboldt County, California (Map 1). Mill Creek's legal description at the confluence with Redwood Creek is T07N R03E S08. Its location is 41°00′10.74″ north latitude and 123°51′31.22″ west longitude. Mill Creek is a first order stream and has approximately 1.4 miles of blue line stream according to the USGS Hupa Mountain 7.5 minute quadrangle. Mill Creek drains a watershed of approximately 1.3 square miles. Elevations range from about 620 feet at the mouth of the creek to 1,920 feet in the headwater areas. Redwood/Douglas Fir and mixed hardwood forest dominates the watershed. The watershed is entirely privately owned and is managed for timber production and rangeland. Vehicle access exists via Highway 299 to Redwood Valley Road.

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 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 (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 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 a Marsh-McBirney Model 2000 flow meter.

2. Channel Type:

Channel typing is conducted according to the classification system developed and revised by David Rosgen (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. Channel characteristics are measured using a clinometer, hand level, hip chain, tape measure, and a stadia rod.

3. Temperatures:

Both water and air temperatures are measured and recorded at every tenth habitat unit. The time of the measurement is also recorded. Both temperatures are taken in degrees Fahrenheit at the middle of the habitat unit and within one foot of the water surface.

4. Habitat Type:

Habitat typing uses the 24 habitat classification types defined by McCain and others (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.   All measurements are in feet to the nearest tenth. Habitat characteristics are measured using a clinometer, hip chain, and stadia rod.

5. Embeddedness:

The depth of embeddedness of the cobbles in pool tail-out areas is measured by the percent of the cobble that is surrounded or buried by fine sediment. In 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, bedrock, 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 (including downed trees, logs, and rootwads) was estimated and recorded.

BIOLOGICAL INVENTORY

Biological sampling during the stream inventory is used to determine fish species and their distribution in the stream. Fish presence was observed from the stream banks in Mill Creek. In addition, twelve 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 low gradient riffles
- Mean 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 June 4-5, 2001, was conducted by D. Resnik and T. Saunders (WSP). The total length of the stream surveyed was 2,788 feet with an additional 92 feet of side channel.

Stream flow was measured at the bottom of the survey reach with a Marsh-McBirney Model 2000 flowmeter at 0.5 cfs on June 6, 2001.

Mill Creek is a B4 channel type for 931 feet of the stream surveyed, and a B2 channel type for 1,857 feet. Channels types classified as "B" are moderately entrenched, with a moderate gradient, riffle dominated channel with infrequently spaced pools, very stable plan and profile and stable banks. B4 channels are dominated by gravel substrate and B2 channels are dominated by boulder substrate.

Water temperatures taken during the survey period ranged from 49 to 50 degrees Fahrenheit. Air temperatures ranged from 51 to 61 degrees Fahrenheit.

Table 1 summarizes the Level II riffle, flatwater, and pool habitat types. Based on frequency of **occurrence** there were 30% riffle units, 36% flatwater units, and 34% pool units (Graph 1). Based on total **length** of Level II habitat types there were 35% riffle units, 54% flatwater units, and 11% pool units (Graph 2).

Eight Level IV habitat types were identified (Table 2). The most frequent habitat types by percent **occurrence** were step run, 28%; mid-channel pools, 17%; and low gradient riffles, 15% (Graph 3). Based on percent total **length**, step runs made up 51%, low gradient riffles 17%, and high gradient riffles 16%.

A total of 16 pools were identified (Table 3). Main channel pools were the most frequently encountered, at 69%, and comprised 75% 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. Four of the sixteen pools (25%) had a depth of two feet or greater (Graph 5).

The depth of cobble embeddedness was estimated at pool tail-outs. Of the 16 pool tail-outs measured, 1 had a value of 1 (6.25%); 8 had a value of 2 (50%); 4 had a value of 3 (25%); 0 had a value of 4; and 3 had a value of 5 (18.75%) (Graph 6). On this scale, a value of 1 indicates the highest quality of spawning substrate. The dominant substrate composition for the 3 pool tail-outs that had a embeddedness value of 5 was boulder.

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 39, flatwater habitat types had a mean shelter rating of 30, and pool habitats had a mean

shelter rating of 53 (Table 1). Of the pool types, the scour pools had the highest mean shelter rating at 90. Main channel pools had a mean shelter rating of 44 (Table 3).

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

Table 6 summarizes the dominant substrate by habitat type. Graph 8 depicts the dominant substrate observed in pool tail-outs. Gravel was the dominant substrate observed in 69% of pool tail-outs while boulder was the next most frequently observed substrate type, at 19%.

The mean percent canopy density for the surveyed length of Mill Creek was 96%. The mean percentages of deciduous and coniferous trees were 100% and 0%, respectively. Graph 9 describes the mean percent canopy in Mill Creek.

For the stream reach surveyed, the mean percent right bank vegetated was 90.9%. The mean percent left bank vegetated was 90.9%. The dominant elements composing the structure of the stream banks consisted of 81.3% cobble/gravel%, 9.4% boulder, 6.3% bedrock and 3.1% silt/clay (Graph 10). Deciduous trees were the dominant vegetation type observed in 71.9% of the units surveyed. Additionally, 21.9% of the units surveyed had brush as the dominant vegetation type and 6.3% had grass as the dominant vegetation type (Graph 11).

BIOLOGICAL INVENTORY RESULTS

Twelve sites were electrofished for species composition and distribution in Mill Creek on August 6, 2001. Water temperature during the electrofishing period was 60° Fahrenheit. Air temperatures ranged from 61° to 64° Fahrenheit. The sites were sampled by T. Tollefson (DFG), J. Martin and D. Resnik (WSP/ameriCorps).

The first site sampled was habitat unit 003, a mid-channel pool located approximately 74 feet from the confluence with Redwood Creek. The site yielded no fish.

The second site was habitat unit 005, a mid-channel pool located approximately 129 feet above the creek mouth. The site yielded 1 young-of-the-year steelhead and 1 age one-plus steelhead.

The third site sampled was habitat unit 010, a mid-channel pool located approximately 372 feet above the creek mouth. The site yielded 4 young-of-the-year steelhead and 3 age one-plus steelhead.

The fourth site sampled was habitat unit 012, a mid-channel pool located approximately 483 feet above the creek mouth. The site yielded no fish.

The fifth site sampled was habitat unit 019, a plunge pool located approximately 931 feet above the creek mouth. The site yielded 1 age two-plus steelhead.

The sixth site sampled was habitat unit 021, a mid-channel pool located approximately 1,024 feet above the creek mouth. The site yielded 1 young-of-the-year steelhead.

The seventh site sampled was habitat unit 023, a mid-channel pool located approximately 1,138 feet above the creek mouth. The site yielded 1 young-of-the-year steelhead, 2 age one-plus steelhead and 1 age two-plus steelhead.

The eighth site sampled was habitat unit 025, a step pool located approximately 1,213 feet above the creek mouth. The site yielded 2 young-of-the-year steelhead, 2 age one-plus steelhead and one age two-plus steelhead.

The ninth site sampled was habitat unit 027, a plunge pool located approximately 1,455 feet above the creek mouth. The site yielded no fish.

The tenth site sampled was habitat unit 034, a plunge pool located approximately 1,967 feet above the creek mouth. The site yielded 3 age one-plus steelhead.

The eleventh site sampled was habitat unit 039, a plunge pool located approximately 2,492 feet above the creek mouth. The site yielded 1 young-of-the-year steelhead and 1 age one-plus steelhead.

The twelfth site sampled was habitat unit 045, a mid-channel pool located approximately 2,715 feet above the creek mouth. The site yielded 1 age one-plus steelhead.

The following chart displays the information yielded from these sites:

Date	Site #	Approx. Dist. from mouth (ft.)	Hab. Unit #	Hab. Type	Reach #	Channel type	Steelhead YOY 1+ 2+		
08/06/01	1	74	0003	4.2	1	B4	0	0	0
8/06/01	2	129	0005	4.2	1	B4	1	0	0
8/06/01	3	372	0010	4.2	1	B4	4	3	0
8/06/01	4	483	0012	4.2	1	B4	0	0	0
8/06/01	5	931	0019	5.6	2	B2	0	0	1
8/06/01	6	1,024	0021	4.2	2	B2	1	0	0
8/06/01	7	1,138	0023	4..2	2	B2	1	2	2

Date	Site #	Approx. Dist. from mouth (ft.)	Hab. Unit #	Hab. Type	Reach #	Channel type	Steelhead YOY 1+ 2+		
8/06/01	8	1,213	0025	4.4	2	B2	2	2	1
8/06/01	9	1,455	0027	5.6	2	B2	0	0	0
8/06/01	10	1,967	0034	5.6	2	B2	0	3	0
8/06/01	11	2,492	0039	5.6	2	B2	1	1	0
8/06/01	12	2,715	0045	4.2	2	B2	0	1	0

DISCUSSION

Mill Creek is a B4 channel type for the first 931 feet of stream surveyed and a B2 channel type for the remaining 1,857 feet. The suitability of B4 channel types for fish habitat improvement structures is as follows: excellent for low-stage plunge weirs, boulder clusters, bank placed boulders, single and opposing wing deflectors and log cover. The suitability of B2 channel types for fish habitat improvement structures is as follows: excellent for log cover.

The water temperatures recorded on the survey days June 4-5, 2001, ranged from 49 to 50 degrees Fahrenheit. Air temperatures ranged from 51 to 61 degrees Fahrenheit. This is a good 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 54% of the total **length** of this survey, riffles 35%, and pools 11%. The pools are relatively shallow, with only 4 of the 16 (25%) 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.

Nine of the sixteen pool tail-outs measured had embeddedness ratings of 1 or 2. Four of the pool tail-outs had embeddedness ratings of 3 or 4. Three of the pool tail-outs had a rating of 5, which is considered unsuitable for spawning. The pool tails valued at 5 were dominated by boulders or large cobble. Cobble embeddedness measured to be 25% or less, a rating of 1, is considered to indicate good quality spawning substrate for salmon and steelhead.

Twelve of the sixteen pool tail-outs measured had gravel or small cobble as the dominant substrate. This is generally considered good for spawning salmonids.

The mean shelter rating for pools was 53. The shelter rating in the riffle habitats was 39. A pool shelter rating of approximately 100 is desirable. The amount of cover that now exists is being provided primarily by boulders in all habitat types. Additionally, white water contribute a small amount. Log and root wad cover structures in the pool and flatwater habitats would enhance both summer and winter salmonid habitat. Log cover structure provides rearing fry with protection from predation, rest from water velocity, and also divides territorial units to reduce density related competition.

The mean percent canopy density for the stream was 96%. Reach 1 and Reach 2 had canopy density of 96%. In general, revegetation projects are considered when canopy density is less than 80% or the canopy composition is dominated by deciduous trees. The percentage of right and left bank covered with vegetation was 90.9% and 90.9%, respectively.

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 within the acceptable range 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.

3)   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.

4)   Increase the canopy on Mill Creek by planting redwood, Douglas fir or other native conifers within the riparian zone. Tributaries to Mill Creek and the reaches above this survey section should be inventoried and treated as well, since the water flowing here is effected from upstream.

5)   In the B4 channel type, design and engineer pool enhancement structures to increase the number of pools or deepen existing pools. This must be done where the banks are stable or in conjunction with stream bank armor to prevent erosion.

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 confluence with Redwood Creek. Channel type is B4.

    18'   Redwood Valley Road crosses over creek. Bridge measures 25' long x 26' wide x

9' high.

74'	Electrofishing site #1.
129'	Electrofishing site #2.
372'	Electrofishing site #3.
483'	Electrofishing site #4.
931'	Channel type changes from B4 to B2. Electrofishing site #5.
1,024'	Electrofishing site #6.
1,138'	Electrofishing site #7.
1,213'	Electrofishing site #8.
1,455'	Electrofishing site #9.
1,967'	Electrofishing site #10.
2,492'	Electrofishing site #11.
2'715'	Electrofishing site #12.
2,788'	End of survey due to 120 feet of high gradient section with cascades and few resting pools. There is a 8 foot plunge created by a log that spans the creek at the top of high gradient section. The surveyors walked approximately 1/4 mile above end of survey and observed no fish.

REFERENCES

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

LEVEL III and LEVEL IV HABITAT TYPES

RIFFLE

Low Gradient Riffle	(LGR)	[1.1]	{ 1}
High Gradient Riffle	(HGR)	[1.2]	{ 2}

CASCADE

Cascade	(CAS)	[2.1]	{ 3}
Bedrock Sheet	(BRS)	[2.2]	{24}

FLATWATER

Pocket Water	(POW)	[3.1]	{21}
Glide	(GLD)	[3.2]	{14}
Run	(RUN)	[3.3]	{15}
Step Run	(SRN)	[3.4]	{16}
Edgewater	(EDW)	[3.5]	{18}

MAIN CHANNEL POOLS

Trench Pool	(TRP)	[4.1]	{ 8}
Mid-Channel Pool	(MCP)	[4.2]	{17}
Channel Confluence Pool	(CCP)	[4.3]	{19}
Step Pool	(STP)	[4.4]	{23}

SCOUR POOLS

Corner Pool	(CRP)	[5.1]	{22}
Lateral Scour Pool - Log Enhanced	(LSL)	[5.2]	{10}
Lateral Scour Pool - Root Wad Enhanced	(LSR)	[5.3]	{11}
Lateral Scour Pool - Bedrock Formed	(LSBk)	[5.4]	{12}
Lateral Scour Pool - Boulder Formed	(LSBo)	[5.5]	{20}
Plunge Pool	(PLP)	[5.6]	{ 9}

BACKWATER POOLS

Secondary Channel Pool	(SCP)	[6.1]	{ 4}
Backwater Pool - Boulder Formed	(BPB)	[6.2]	{ 5}
Backwater Pool - Root Wad Formed	(BPR)	[6.3]	{ 6}
Backwater Pool - Log Formed	(BPL)	[6.4]	{ 7}
Dammed Pool	(DPL)	[6.5]	{13}

ADDITIONAL UNIT DESIGNATIONS

Dry	(DRY)	[7.0]
Culvert	(CUL)	[8.0]
Not Surveyed	(NS)	[9.0]
Not Surveyed due to a marsh	(MAR)	[9.1]