STREAM INVENTORY REPORT

Flume Gulch

INTRODUCTION

A stream inventory was conducted during the summer of 1996 on Flume Gulch. 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 Flume Gulch. 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

Flume Gulch is tributary to the Navarro River, tributary to the Pacific Ocean, located in Mendocino County, California (Map 1). Flume Gulch's legal description at the confluence with Navarro River is T15N R16W S07. Its location is 39°10'26" north latitude and 123°40'35" west longitude. Flume Gulch is a first order stream and has approximately 3.5 miles of blue line stream according to the USGS Elk 7.5 minute quadrangle. Flume Gulch drains a watershed of approximately 2.07 square miles. Elevations range from about 30 feet at the mouth of the creek to 1000 feet in the headwater areas. Redwood forest dominates the watershed. The watershed is entirely privately owned and is managed for timber production. Vehicle access exists via State Route 128.

METHODS

The habitat inventory conducted in Flume Gulch follows the methodology presented in the *California Salmonid Stream Habitat Restoration Manual* (Flosi and Reynolds, 1991 rev. 1994). 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 (Hopelain, 1994). 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, 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 Flume Gulch 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". Flume Gulch 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 (Hopelain, 1995). 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 Flume Gulch, 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 Flume Gulch, 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.

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 Flume Gulch, 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 Flume Gulch, 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 Flume Gulch fish presence was observed from the stream banks, and three 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 Flume Gulch 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
- 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 13,14, 19, and 20, 1996, was conducted by Chris Coyle (CCC) and

Amber Siglar (WSP\AmeriCorps). The total length of the stream surveyed was 7,620 feet with an additional 115 feet of side channel.

Flow was measured at the bottom of the survey reach with a Marsh-McBirney Model 2000 flowmeter at 0.8 cfs on December 12, 1996.

Flume Gulch is an F4 channel type for the first 1,424 feet of stream reach surveyed. Flume Gulch is a B3 channel type for the next 1,117 feet and an F4 channel type for the remaining 5,079 feet. F4 channels are entrenched, meandering, riffle/pool channels on low gradients with high width/depth ratios and gravel-dominant substrates. B3 channels are moderately entrenched, moderate gradient, riffle dominated channels, with infrequently spaced pools; very stable plan and profile, stable banks, and a cobble channel.

Water temperatures taken during the survey period ranged from 52 to 55 degrees Fahrenheit. Air temperatures ranged from 55 to 70 degrees Fahrenheit.
Table 1 summarizes the Level II riffle, flatwater, and pool habitat types. Based on frequency of **occurrence** there were 35% riffle units, 23% flatwater units, and 42% pool units (Graph 1). Based on total **length** of Level II habitat types there were 34% riffle units, 29% flatwater units, and 37% 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, 32%; mid-channel, 18%; and runs and step runs, 10% each (Graph 3). Based on percent total **length**, low gradient riffles made up 31%, step runs 19%, and mid-channel pools 18%.

A total of 129 pools were identified (Table 3). Main channel pools were most frequently encountered at 48% and comprised 55% 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. Thirty-one of the one-hundred-twenty-nine pools (24%) had a depth of two feet or greater (Graph 5).

The depth of cobble embeddedness was estimated at pool tail-outs. Of the 129 pool tail-outs measured, 1 had a value of 1 (1%); 67 had a value of 2 (52%); 48 had a value of 3 (37%); 4 had a value of 4 (3%) and 10 had a value of 5 (8%) (Graph 6). On this scale, a value of 1 indicates the highest quality of spawning substrate.

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 7, flatwater habitat types had a mean shelter rating of 12, and pool habitats had a mean shelter rating of 52 (Table 1). Of the pool types, the main channel pools had the highest mean shelter rating at 67. Scour pools had a mean shelter rating of 46 (Table 3).

Table 5 summarizes mean percent cover by habitat type. Large and small woody debris are the dominant cover types in Flume Gulch. Graph 7 describes the pool cover in Flume Gulch.

Table 6 summarizes the dominant substrate by habitat type. Gravel was the dominant substrate observed in 8 of the 10 low gradient riffles measured (80%). Small and large cobble was the next most frequently observed dominant substrate type and both occurred in one of the low gradient riffles measured (Graph 8).

The mean percent canopy density for the stream reach surveyed was 92%. The mean percentages of deciduous and coniferous trees were 46% and 54%, respectively. Graph 9 describes the canopy in Flume Gulch.

For the stream reach surveyed, the mean percent right bank vegetated was 81%. The mean percent left bank vegetated was 81%. The dominant elements composing the structure of the stream banks consisted of 1.8% bedrock, 12.3% boulder, 45.6% cobble/gravel, and 40.4% sand/silt/clay (Graph 10). Coniferous trees were the dominant vegetation type observed in 38.6% of the units surveyed. Additionally, 21.9% of the units surveyed had deciduous trees as the dominant vegetation type, including down trees, logs, and root wads (Graph 11).

BIOLOGICAL INVENTORY RESULTS

Three sites were electrofished on July 16, 1996, in Flume Gulch. The sites were sampled by Andrew MacMillan (WSP\AmeriCorps) and David Jones (CCC).

The first site sampled included habitat units 15 through 29, a run, low gradient riffle, mid-channel pool, step run, low gradient riffle, mid-channel pool, low gradient riffle, corner pool, low gradient riffle, run, low gradient riffle, glide, corner pool, low gradient riffle and mid-channel pool, 450 feet from the confluence with the Navarro River. The site yielded a total of 16 steelhead, 16 sculpin, and 3 Pacific giant salamanders.

The second site included habitat units 50 through 56, a step pool, high gradient riffle, mid-channel pool, low gradient riffle, plunge pool, step run and plunge pool, located 1,628 feet from the confluence. The site yielded a total of 17 steelhead, 12 sculpin, and 3 Pacific giant salamanders.

The third site sampled included habitat units 126 through 133, a low gradient riffle, backwater pool - log formed, lateral scour pool - root wad enhanced, low gradient riffle, glide, mid-channel pool, run and mid-channel pool, located 3,422 feet from the confluence. The site yielded a total of 25 steelhead.

DISCUSSION

Flume Gulch is a F4 channel type for the first 1,424 feet of stream surveyed, a B3 for the next 1,117 feet, and an F4 for the remaining 5,079 feet. The suitability of F4 channel types for fish habitat improvement structures is as follows: good for bank placed boulders, fair for low-stage

weirs, single and opposing wing deflectors, channel constrictors and log cover and poor medium stage weirs and boulder clusters. B3 channel types are excellent for low stage plunge weirs, boulder clusters, bank placed boulders, single and opposing wing deflectors and log cover, and good for medium stage plunge weirs.

The water temperatures recorded on the survey days June 13, 14, 19, and 20, 1996, ranged from 52 to 55 degrees Fahrenheit. Air temperatures ranged from 55 to 70 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 29% of the total **length** of this survey, riffles 34%, and pools 37%. The pools are relatively shallow, with only 31 of the 129 (24%) 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 or deepen pool habitat is recommended.

Sixty-two of the one-hundred-twenty-nine pool tail-outs measured had embeddedness ratings of 3, 4 or 5. Only one had a 1 rating. 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 Flume Gulch, 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 low with a rating of 52. The shelter rating in the flatwater habitats was slightly lower at 12. A pool shelter rating of approximately 100 is desirable. The cover that now exists is being provided by large and small woody debris. Additional log and root wad cover structure 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.

Nine of the ten low gradient riffles 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 92%. This is a relatively high percentage of canopy. In general, revegetation projects are considered when canopy density is less than 80%.

RECOMMENDATIONS

1) Flume Gulch 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) 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 coniferous trees. Adding high quality complexity with woody cover is desirable.

5) Inventory and map sources of stream bank erosion and prioritize them according to present and potential sediment yield. Identified sites should then be treated to reduce the amount of fine sediments entering the stream.

6) 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.

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 Navarro River. Channel type is F4.
348'	Log debris accumulation (LDA), 8' high x 40' wide x 15' long. No sediment, no barrier.
447'	Louisiana-Pacific (LP) haul road bridge, flatcar over log stringers, 8' high x 30' wide x 21' long.
450'	First electrofishing site.
1,424'	Channel type change to B3.
1,628'	Second electrofishing site.
2,249'	LDA, 5' high x 25' wide x 5' long.
2,257'	LDA, 4' high x 40' wide x 3' long, retaining sediment 4' high x 20' wide x 75' long. No barrier.
2,541'	Channel type changes to F4.
3,348'	Old bridge site.

3,422' Third electrofishing site.

3,646' Left bank erosion, 6' high x 15' long.

4,623' LDA, 4' high x 20' wide x 13' long.

5,740' Bridge.

6,345' LDA, 8' high x 30' wide x 15' long, retaining sediment 6' high x 20' wide. Possible barrier.

6,596' LDA, 5' high x 30' wide x 10' long.

6,865' Left bank tributary, <0.1 cfs. Not accessible to fish due to gradient.

7,422' Left bank erosion, 50' long. Channel is blocked, possible barrier. Sediment retention extends 50' upstream.

7,459' Right bank tributary, <0.1 cfs. Not accessible to fish due to gradient.

7,519' Left bank tributary, <0.1 cfs. Not accessible to fish due to gradient.

7,620' End of survey. Boulder falls 10' high, formed by 7' high and 3' high jumps. No jump pool for 3' jump. Probable natural barrier. High gradient boulder cascade continues upstream an undetermined distance.

REFERENCES

Flosi, G., and F. Reynolds. 1994. California salmonid stream habitat restoration manual, 2nd edition. California Department of Fish and Game, Sacramento, California.

Hopelain, J. 1995. Sampling levels for fish habitat inventory, unpublished manuscript. California Department of Fish and Game, Inland Fisheries Division, 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