STREAM INVENTORY REPORT

Hare Creek

INTRODUCTION

A stream inventory was conducted during the summer of 1999 on Hare Creek. The survey began at the confluence with Covington Gulch (approximately 19,047 feet above the mouth of Hare Creek) and extended upstream 3.8 miles.

The Hare 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 Hare 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

Hare Creek is a tributary to the Pacific Ocean, located in Mendocino County, California (Map 1). Hare Creek's legal description at the confluence with Pacific Ocean is T18N R18W S13. Its location is 39°25′02″ north latitude and 123°48′42″ west longitude. Hare Creek is a second order stream, and has approximately 10.7 miles of blue line stream, including tributaries according to the USGS Fort Bragg, CA 7.5 minute quadrangle. Hare Creek drains a watershed of approximately 10 square miles. Elevations range from 0 feet at Pacific Ocean to 1,000 feet in the headwater areas. Redwood/Douglas fir forest dominates the watershed. The watershed is primarily state owned by the California Department of Forestry and Fire Protection (CDF) as part of the Jackson Demonstration State Forest and is managed for timber production. Vehicle access exists via Highway 1, CDF Road 400 and Highway 20.

METHODS

The habitat inventory conducted in Hare 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.

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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 Hare 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*. 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". Hare 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 were 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 Hare 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 Hare 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 Hare 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 Hare 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 Hare Creek. In addition, four sites were electrofished using a Smith-Root Model 12 electrofisher. These sampling techniques are discussed in the *California Salmonid Stream Habitat Restoration Manual*.

LARGE WOODY DEBRIS (LWD) STREAM AND RIPARIAN INVENTORY

In Hare Creek a large woody debris (LWD) and riparian inventory was conducted using the methodology as described in the *California Salmonid Stream Habitat Restoration Manual*. The Hare Creek LWD Inventory Report is included in this report as Appendix A.

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 Hare 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
- Mean percent canopy
- Bank composition by composition type
- Bank vegetation by vegetation type

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HABITAT INVENTORY RESULTS

The habitat inventory of September 8, 9 and 10, 1999, was conducted by Toni Beaumont and Chris Ramsey (WSP/AmeriCorps). The total length of the stream surveyed was 19,897 feet.

Flow was measured at the bottom of the survey reach with a Marsh-McBirney Model 2000 flowmeter at 2.35 cfs on September 8, 1999.

Hare Creek is an F4 channel type for the entire 19,897 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.

Water temperatures taken during the survey period ranged from 53 to 58 degrees Fahrenheit. Air temperatures ranged from 56 to 71 degrees Fahrenheit.

Table 1 summarizes the Level II riffle, flatwater, and pool habitat types. Based on frequency of occurrence there were 20% riffle units, 25% flatwater units, and 55% pool units (Graph 1). Based on total length of Level II habitat types there were 11% riffle units, 30% flatwater units, and 59% pool units (Graph 2).

Thirteen Level IV habitat types were identified (Table 2). The most frequent habitat types by percent occurrence were low gradient riffles, 20%; runs, 20%; lateral scour pools - bedrock formed, 18%; and lateral scour pools - log enhanced, 16% (Graph 3). Based on percent total length, runs made up 23%; lateral scour pools - bedrock formed, 22%; and lateral scour pools - log enhanced, 16%.

A total of 176 pools were identified (Table 3). Scour pools were the most frequently encountered, at 77% and comprised 74% 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-eighteen of the 176 pools (67%) had a depth of two feet or greater (Graph 5).

The depth of cobble embeddedness was estimated at pool tail-outs. Of the 176 pool tail-outs measured, 25 had a value of 1 (14%); 81 had a value of 2 (46%); none had a value of 3 or 4; and 70 had a value of 5 (40%) (Graph 6). On this scale, a value of 1 indicates the highest quality of spawning substrate. The breakdown of dominant substrate composition for the 70 pool tail-outs that had a embeddedness value of 5 were as follows: 61% silt/clay/sand or small gravel, 20% bedrock, 16% large cobble , and 3% 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 5, flatwater habitat types had a mean shelter rating of 6, and pool habitats had a mean shelter rating of 21 (Table 1). Of the pool types, the scour pools had the highest mean shelter rating at 26. Main channel pools had a mean shelter rating of 9 (Table 3).

Table 5 summarizes mean percent cover by habitat type. Boulders were the dominant cover type

in Hare Creek. Graph 7 describes the pool cover in Hare Creek. Bedrock ledges are the dominant pool cover type followed by large woody debris.

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 75% of pool tail-outs while large cobble was the next most frequently observed substrate type, at 8%.

The mean percent canopy density for the length of Hare Creek was 91%. The mean percentages of deciduous and coniferous trees were 60% and 40%, respectively. Graph 9 describes the mean percent canopy in Hare Creek.

For the stream reach surveyed, the mean percent right bank vegetated was 88%. The mean percent left bank vegetated was 87%. The dominant elements composing the structure of the stream banks consisted of 44% cobble/gravel, 26% sand/silt/clay, 27% bedrock, and 2% boulder (Graph 10). Coniferous trees were the dominant vegetation type observed in 80% of the units surveyed. Additionally, 11% of the units surveyed had deciduous trees as the dominant vegetation type, and 9% had brush as the dominant vegetation (Graph 11).

BIOLOGICAL INVENTORY RESULTS

Four sites were electrofished on September 21 and 22, 1999 in Hare Creek. The sites were sampled by Barry Collins (DFG), Don Rehberg, and Paul Ferns (WSP\AmeriCorps). An abundance estimation by depletion electrofishing method was used on Hare Creek.

The first site sampled was approximately 2,414 feet from the confluence with Covington Gulch the site had an area of 3,880.8 sq ft and a volume of 3,725 cu ft. The total catch for three passes was 21 steelhead, 15 coho, 6 stickleback, 5 salamanders, 2 sculpin, 2 crayfish, and 1 lamprey.

The second site was approximately 7,614 feet above the confluence with Covington Gulch. This site had an area of 3,586 sq ft and a volume of 2,151.6 cu ft. The total catch for three passes was 44 steelhead, 10 coho, 7 salamanders, 6 sticklebacks, 2 lamprey, and 1 crayfish.

The third site sampled was approximately 12,865 feet above the confluence with Covington Gulch. The site had an area of 2,741.6 sq ft and a volume of 2,028.8 cu ft. The total catch for two passes was 104 steelhead, 20 coho, 5 salamanders, 3 sculpin, and 3 sticklebacks.

The fourth site sampled was approximately 15,760 feet above the confluence of Covington Gulch. The site had an area of 1,836.8 sq ft and a volume of 979.6 cu ft. The total catch for three passes was 38 steelhead, 7 salamanders, 2 coho, and 1 stickleback.

DISCUSSION

Hare Creek is an F4 channel type for the entire 19,897 feet of stream surveyed. The suitability of fish habitat improvement structures in F4 channels is as follows: good for bank-placed boulders; fair for plunge weirs, single and opposing wing deflectors, channel constrictors, and

log cover; and poor for boulder clusters.

The water temperatures recorded on the survey days of September 8-10, 1999, ranged from 53 to 58 degrees Fahrenheit. Air temperatures ranged from 56 to 71 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.

Pool habitat types comprised 59% of the total length of this survey, flatwater 30%, and riffles 11%. The pools are relatively deep, with 118 of the 176 (67%) 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.

Twenty-five of the pool tail-outs measured had an embeddedness rating of 1. Eighty-one of the 176 tail-outs measures had an embeddedness of 2. None of the pool tail-outs had embeddedness ratings of 3 or 4. Seventy of the pool tail-outs had a rating of 5, which is considered unsuitable for spawning. Forty-three of the 70 were unsuitable for spawning due to the dominant substrate being silt/sand/clay or small gravel. Cobble embeddedness measured to be 25% or less, a rating of 1, is considered to indicate good quality spawning substrate for salmon and steelhead. Sediment sources in Hare Creek should be mapped and rated according to their potential sediment yields and control measures should be taken.

One-hundred-forty-four of the 176 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 low with a rating of 21. The shelter rating in the flatwater habitats was slightly lower at 6. A pool shelter rating of approximately 100 is desirable. The relatively small amount of cover that now exists is being provided primarily by boulders in all habitat types. Additionally, large woody debris contributes a small amount. 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.

The mean percent canopy density for the stream was 91%. In general, revegetation projects are considered when canopy density is less than 80%. The percentage of right and left bank covered with vegetation was high at 88% and 87%, respectively.

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RECOMMENDATIONS

1) Hare 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) 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. Right and left bank refers to the sides of the channel when one is facing downstream.

Position (ft):	Comments:
0'	Begin survey at confluence with Covington Gulch (approximately 19,047 feet above the mouth of Hare Creek). Channel type is F4.
80'	Six foot diameter pipe.
114'	Six foot diameter flagged pipe running along bank.
321'	Old road bed on right bank.
510'	Log debris accumulation on right bank 10' long x 10' wide.
515'	Left bank failure.
643'	Left bank failure, 20' long x 10' high.
1,008'	Root wad in creek.
1,061'	Left bank tributary, steep, bedrock dominant, 56 degrees F.
1,128'	Log debris accumulation, 50' wide x 45' long x 10' high, contains 30 pieces of

	wood including a root wad, retaining sediment.
1,398'	Right bank failure recruiting rootwad into the creek.
1,565'	CCC habitat survey 1995 flag, #338.
1,570'	Right bank tributary. Left bank failure, 7' high.
1,666'	Right bank failure, 15' long x 10' high.
2,330'	Log debris accumulation, 20' wide x 10' long x 5' high, retaining sediment and gravel.
2,414'	First electrofishing site.
2,686'	Trail to road crosses creek.
2,797'	Left bank tributary, 55 degrees F.
2,826'	Bridge posts, old crossing and bridge abutment.
2,966'	Right bank tributary enters through culvert.
3,067'	Road following along right bank.
3,033'	Left bank wood structure, part of old crossing.
3,056'	Right bank wood structure, part of old crossing.
3,153'	CCC habitat survey 1995 flag, #363.
3,205'	Turtle survey flag.
3,222'	Left bank failure, 15' high x 10' wide.
3,424'	Left bank failure including trees and root wad fallen into creek.
3,570'	Start of unanchored large woody debris recruitment/survey.
3,607'	Unanchored large woody debris. Left bank failure.
3,633'	Log debris accumulation, 20' long x 30' wide x 7' high, containing 30 pieces of large woody debris.
3,668'	Culvert 8' up right bank, 1.5' diameter.
3,729'	Sediment backed up on right bank caused by previous debris accumulation.

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3,864'	Right bank failure.
4,012'	Right bank tributary, dry.
4,132'	Right bank tributary enters from 1.5' culvert. Rip-rap below culvert outlet to stabilize bank.
4,365'	Right bank failure.
4,377'	Posts on right bank.
4,481'	Right bank tributary, flowing out of 1.5 ' culvert 20' above creek, 59 degrees F.
4,484'	Right bank failure influenced by tributary.
4,551'	Log debris accumulation, 20' long, mostly buried, retaining 3' sediment.
4,755'	Left bank failure including downed tree and root wad.
5,096'	Right bank tributary, flowing from 1.5' diameter culvert 5' above creek.
5,262'	Right bank failure, 10' high x 10' long.
5,383'	Right bank tributary, flowing from 1.5' diameter culvert 4' above creek. Rip rap below culvert.
5,533'	Right bank failure, 15' long x 15' high.
5,686'	Dry culvert / tributary 6' above creek.
5,884'	Left bank tributary/spring.
5,949'	Right bank failure, 10' long x 15' high.
6,048'	Left bank tributary, steep and bedrock dominated, 54 degrees F.
6,138'	Unanchored large woody debris.
6,178'	Unanchored large woody debris.
6,265'	Unanchored large woody debris.
6,425'	Unanchored large woody debris.
6,545'	Unanchored large woody debris.

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6,631'	Unanchored large woody debris.
6,658'	Unanchored large woody debris.
6,760'	Right bank tributary, enters from culvert.
6,865'	Unanchored large woody debris.
6,869'	Unanchored large woody debris.
6,928'	Unanchored large woody debris.
6,956'	Right bank failure.
7,007'	Right bank tributary, 54 degrees F.
7,065'	Old posts in creek.
7,160'	Unanchored large woody debris.
7,290'	Unanchored large woody debris.
7,304'	Unanchored large woody debris.
7,329'	Unanchored large woody debris.
7,349'	Unanchored large woody debris.
7,380'	Left bank tributary, 54 degrees F. Right bank tributary flowing from 1.5' diameter culvert 6' above creek. Rip-rap at bottom of culvert.
7,395'	Unanchored large woody debris.
7,445'	Wood structure, 30' long x 10' high.
7,465'	Unanchored large woody debris.
7,597'	Unanchored large woody debris.
7,714'	Second electrofishing site.
7,640'	Unanchored large woody debris.
7,698'	Unanchored large woody debris.
7,721'	Unanchored large woody debris.

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7,737'	Unanchored large woody debris.
7,854'	Left bank tributary.
7,917'	Left bank tributary, dry.
7,975'	Unanchored large woody debris.
8,025'	Unanchored large woody debris.
8,091'	CCC 1995 habitat survey flag, #447.
8,458'	Old bridge posts.
8,581'	Log retaining 2' sediment.
8,872'	Rip-rap 10' long.
8,894'	Right bank failure.
9,077'	Left bank failure, 40' long x 15' high.
9,117'	CCC 1995 habitat survey flag, #457.
9,216'	Left bank tributary, 54 degrees F.
9,324'	Right bank wood structure failure, 20' long.
9,344'	Right bank rip-rap, 37' long.
9,381'	Left bank structure on top of bedrock, 35' long.
9,464'	Timber harvest boundary flag on left bank.
9,572'	Right bank tributary flowing from 1.5' diameter culvert 10' above creek. Log debris accumulation, 60' wide x 25' long x 10' high, containing 10 large pieces, retaining sediment 3-4' high and approximately 150' upstream.
9,804'	Right bank wood structure, 35' long.
10,106'	CCC 1995 habitat survey flag, #476.
10,131'	Left bank failure, 20' long x 20' high.
10,164'	Left bank failure, 10' high x 10' long.
10,547'	Rip-rap, 20' long.

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11,037'	Right bank failure, 10' high x 10' long.
11,211'	Left bank failure, 25' high x 10 long.
12,028'	Right bank tributary, 56 degrees F.
12,133'	Left bank failure, 20' long x 16' high.
12,243'	Right bank failure, 50' long.
12,418'	Wood structures on right bank.
12,632'	Right bank failure, 25' high x 15' wide.
12,680'	Right bank tributary, 59 degrees F.
12,856'	Right bank failure, 20' long x 15' high.
12,865'	Third electrofishing site.
13,041'	Culvert, 1.5' diameter, 10' above creek.
13,227'	Right bank failure recruiting tree/root wad into creek.
13,551'	Right bank failure, 20' long x 10' high.
13,647'	Right bank failure, 16' long x 10' high.
13,768'	Old 2.5' diameter culvert in creek.
14,645'	Rusted 2.5' diameter culvert in creek.
14,756'	End of unanchored large woody debris recruitment/survey.
14,849'	Right bank tributary, 55 degrees F. Small dams placed every 10'.
14,931'	Left bank erosion.
15,017'	Right bank failure, 30' high x 15' long.
15,144'	Bridge, 15' wide x 10' high.
15,455'	Right bank failure including tree/root wad.
15,656'	Pink and blue flagging for next 1,200'.

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15,760'	Fourth electrofishing site.
15,857'	Left bank tributary, 54 degrees F, contributing sediment.
15,981'	Old crossing posts.
16,223'	CCC 1995 habitat survey flag, #592.
16,304'	Right bank tributary coming from 6" half culvert.
16,919'	Posts from old structure. Logs at top of unit retaining sediment and gravel.
17,129'	Timber Harvest Boundary pink flagging on left bank.
17,205'	Road following along right bank.
17,925'	Right bank diameter, 1.5' diameter, 8' above creek.
18,491'	Confluence with South Fork Hare Creek, 55 degrees F.
18,524'	Old posts.
18,628'	Right bank failure.
18,774'	CCC 1995 survey flag, #636.
18,948'	Log debris accumulation, 48' wide x 20' long x 5' high, with associated left bank failure 17' long x 20' high.
19,048'	Right bank, 1.5' diameter culvert 15' above creek with rip-rap below.
19,897'	End of survey at the confluence with Bunker Gulch. This corresponds with the CCC 1995 survey habitat unit #658.

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 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

Appendix A
California Department of Fish and Game

Large Woody Debris (LWD) Riparian Inventory

Hare Creek
September 1999

BACKGROUND

The importance of large woody debris (LWD) in the development of a stream's morpholoical and biological productivity has been well documented over the last 20 years. It strongly influences stream habitat characteristics and biotic composition. LWD is often the structural element associated with pool formation. LWD is considered one of the major elements that creates complex fish habitat vital to juvenile salmonid survival. Habitat complexity is particularly important for coho salmon and steelhead trout juveniles which remain in the stream for at least one year before migrating to the ocean.

LWD inventories describe the present relative abundance of LWD elements providing, or with the potential to provide, fish habitat within the stream channel. LWD inventories also describe the relative abundance of recruitable LWD existing out of the stream channel but having a high potential of entering the stream channel sometime in the future.

METHODS

Prior to conducting the LWD inventory the LWD Placement Project reach (Project Reach) was habitat typed and stream channel typed employing the methods described by Flosi, et al (1998). The Project Reach began at the confluence with Covington Gulch (approximately 19,047 feet above the mouth of Hare Creek) and extended upstream 3.8 miles. The survey area was divided into three LWD inventory reaches (all within the F4 channel type) corresponding with 3 treatments within the Project Reach. Reach 1 begins at the start of the Project Reach and extends upstream 3, 570 feet with no added wood (downstream of the added wood section). Reach 2 extends 11,186 feet with added wood, and reach 3 continues upstream 5,141 feet without added wood (upstream of the added wood section).

LWD inventory methods, data recording forms, and database structure for this inventory are described in Flosi, et al (1998). LWD minimum size was 12 inches in diameter and 6 feet in length. Root wads had the 12-inch minimum diameter criteria but had no minimum length requirement . Diameter and length categories consisted of the following:

Diameter Category
1. 1-2 feet
2. 2-3 feet
3. 3-4 feet
4. Over 4 feet

Length Category
1. 6 to 20 feet
2. Over 20 feet

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Condition or status categories included: a) dead and down, b) dead and standing, c) perched for eminent delivery to the stream channel, d) live coniferous trees, and e) live broad leaf trees (a.k.a. deciduous).

The sampling strategy consisted of selecting a random starting point near the beginning of the Project Reach and systematically sampling 200 foot sections every 1,000 feet of stream length surveyed. The first 1,200 feet of stream was segmented into 200 foot sections and consecutively numbered 1 through 6, beginning at the confluence. One of these six 200 foot sections was randomly selected as the beginning of the first sample section. After conducting the inventory survey in the initial 200 foot section surveyors proceeded upstream 800 feet and began surveying the next 200 feet as the second sample section. The third sample section began 800 feet upstream of the end of the second sample section, and so on. Systematic sampling continued upstream until the end of the Project Reach. This method produced a sampling level of approximately 20 percent.

Inventory data of 200 foot sample sections were segregated by reach number. A LWD abundance index expressed as "number of pieces per 100 feet" was calculated for each reach.

RESULTS

The Hare Creek section surveyed consisted of one channel type, F4, divided into 3 reaches for evaluating 3 different management schemes (no added wood downstream, added wood, and no added wood upstream). Reach 1 contained 16.8 pieces of LWD per 100 ft of linear stream on both banks and 9.7 pieces per 100 ft within the stream channel. Reach 2 contained 21.3 pieces of LWD per 100 ft of stream on both banks and 5.3 pieces per 100 ft within the stream channel. Reach 3 contained 20.8 pieces of LWD per 100 ft of stream on both banks and 2.9 pieces per 100 ft within the stream channel (Table 2 and Figure 1).

The type of LWD pieces found within the bankfull channel was almost exclusively "dead and down" (87%-98%) in all reaches. The type of LWD pieces found on the banks was primarily "live coniferous trees" (57%-74%).

DISCUSSION

In reach 1 (no added wood), the dominate LWD category on the banks is "live coniferous trees" and the dominate category in the stream is "dead and down". The 1 to 2 foot diameter size category is the most common size for all LWD pieces in both the stream channel and bank zones. In reach 2 (added wood), the dominate LWD category on the banks is "live coniferous trees" and the dominant category in the stream is "dead and down". The 1 to 2 foot diameter size categoryy is the most common size for all LWD pieces in both the stream channel and bank zones. In reach 3 (no added wood), the dominate LWD category on the banks is "live coniferous trees" and the dominate category in the stream is "dead and down". The 1 to 2 foot diameter size category is the most common size for all LWD pieces in both the stream channel and bank zones.

Hare Creek

Within the Hare Creek Project Reach, levels of LWD within the stream channel and on the banks were similar. Reach 1 and Reach 2 both had 27 pieces of LWD per 100 linear feet within the stream channel and on the banks. Reach 3 had 24 pieces of LWD per 100 feet within the stream channel and on the banks. LWD quantity in the channel was highest in reach 1 with 9.7 pieces per 100 linear feet followed by reach 2 with 5.3 pieces and reach 3 with 2.5 pieces. LWD composition in the channel was dominated by "dead and down" in all reaches (87%-98%) (Figure 1). On the banks, live tree composition was conifer dominated (57%-74%). Reach 1 had 9.7 live conifer trees per 100 linear feet on both banks, reach 2 had 14.7 live conifers per 100 feet on both banks and reach 3 had 15.4 live conifers per 100 feet on both banks.

Regression analysis indicates no significant/significant correlation between the total number of pieces per 100 feet of stream channel present on both banks and the total number of pieces per 100 feet present within the bankfull channel (r^2 =).

The Hare Creek drainage was LWD inventoried in 1995. LWD relative abundance in Hare Creek comparisons were performed between the Hare Creek drainage 1995 and Hare Creek Project Reach 1999 inventories.

There were no significant/significant differences (T-test, P>???) in the number of pieces per 100 feet of stream channel between similar LWD type categories within Hare Creek drainage 1995 and Hare Creek Project 1999.