STREAM INVENTORY REPORT

Graham Gulch

INTRODUCTION

A stream inventory was conducted during June 2004 on Graham Gulch. The survey began at the confluence with Freshwater Creek and extended upstream 1.3 miles.

The Graham Gulch 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 Graham 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

Graham Gulch is a tributary to Freshwater Creek, a tributary to Freshwater Slough, a tributary to Eureka Slough, a tributary to Humboldt Bay, which drains to the Pacific Ocean. It is located in Humboldt County, California (Map 1). Graham Gulch's legal description at the confluence with Freshwater Creek is T04N R01E S03. Its location is 40.7539 degrees north latitude and 124.0475 degrees west longitude, LLID number 1240474407538. Graham Gulch is a second order stream and has approximately 3.4 miles of blue line stream according to the USGS Arcata South 7.5 minute quadrangle. Graham Gulch drains a watershed of approximately 2.5 square miles. Elevations range from about 70 feet at the mouth of the creek to 880 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 Freshwater road to Pacific Lumber Camp Road.

METHODS

The habitat inventory conducted in Graham Gulch follows the methodology presented in the *California Salmonid Stream Habitat Restoration Manual* (Flosi et al, 1998). The California Conservation Corps (CCC) Technical Advisors 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 100% of the habitat units within the survey reach. All habitat units are classified according to habitat type and are measured for all the parameters and

characteristics on the field form. 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 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 Graham Gulch to record measurements and observations. There are eleven components to the inventory form.

1. Flow:

Flow is measured in cubic feet per second (cfs) near 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 (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 (1990). 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". Graham 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. 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 Graham 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 not suitable for spawning due to inappropriate substrate like bedrock, log sills, boulders or other considerations.

6. Shelter Rating:

Instream shelter is composed of those elements within a stream channel that provide juvenile salmonids protection from predation, reduce water velocities so fish can rest and conserve energy, and allow separation of territorial units to reduce density related competition for prey. The shelter rating is calculated for each fully-described habitat unit by multiplying shelter value and percent cover. Using an overhead view, a quantitative estimate of the percentage of the habitat unit covered is made. All cover is then classified according to a list of nine cover types. In Graham 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. 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 Graham 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 hardwood 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 Graham 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 (including downed trees, logs, and rootwads) was estimated and recorded.

10. Large Woody Debris Count:

Large woody debris (LWD) is an important component of fish habitat and an element in channel forming processes. In each habitat unit all pieces of LWD partially or entirely below the

elevation of bankfull discharge are counted and recorded. The minimum size to be considered is twelve inches in diameter and six feet in length. The LWD count is presented by reach and is expressed as an average per 100 feet.

11. Average Bankfull Width:

Bankfull width can vary greatly in the course of a channel type stream reach. This is especially true in very long reaches. Bankfull width can be a factor in habitat components like canopy density, water temperature, and pool depths. Frequent measurements taken at riffle crests (velocity crossovers) are needed to accurately describe reach widths. At the first appropriate velocity crossover that occurs after the beginning of a new stream survey page (ten habitat units), bankfull width is measured and recorded in the appropriate header block of the page. These widths are presented as an average for the channel type reach.

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 Graham Gulch. In addition, selected sites were sampled using a Smith-Root Model 12 electrofisher and underwater observations, as discussed in unpublished data from the Juvenile Salmonid Abundance Summer Survey Report, 2004 (Ricker, S., McCanne, D. 2004).

DATA ANALYSIS

Data from the habitat inventory form are entered into Stream Habitat 2.0.9, a Visual Basic data entry program developed by Karen Wilson, Pacific States Marine Fisheries Commission in conjunction with the California Department of Fish and Game. This program processes and summarizes the data, and produces the following ten tables:

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

Graphics are produced from the tables using Microsoft Excel. Graphics developed for Graham Gulch include:

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

HABITAT INVENTORY RESULTS

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

The habitat inventory of June 7 to June, 16 2004 was conducted by L. Selvaggio, E. Pope, and C. Hines (CCC). The total length of the stream surveyed was 6,906 feet with an additional 85 feet of side channel.

Stream flow was measured near the bottom of the survey reach with a Marsh-McBirney Model 2000 flowmeter at 0.11 cfs on July 6, 2004.

Graham Gulch is an F3 channel type for 1,974 feet of the stream surveyed (Reach 1), an F4 channel type for 4,072 feet of the stream surveyed (Reach 2), and an A3 channel type for the remaining 860 feet of the stream surveyed (Reach 3). F3 channels are entrenched, meandering, riffle/pool channels on low gradients with high width/depth ratios and cobble-dominant substrates; F4 channels have gravel-dominant channels. A3 channels are steep, narrow, cascading, step-pool, high energy debris transporting channels associated with depositional soils, and cobble dominant substrates.

Water temperatures taken during the survey period ranged from 56 to 65 degrees Fahrenheit. Air temperatures ranged from 54 to 68 degrees Fahrenheit.

Table 1 summarizes the Level II riffle, flatwater, and pool habitat types. Based on frequency of occurrence there were 35% flatwater units, 33% riffle units, 30% pool units, 2% dry units, and 1% culvert units (Graph 1). Based on total length of Level II habitat types there were 48% flatwater units, 31% riffle units, 20% pool units, 1% culvert units and 1% dry units (Graph 2).

Twelve Level IV habitat types were identified (Table 2). The most frequent habitat types by percent occurrence were 20% mid-channel pool units, 20% low gradient riffle units, and 18% step run units (Graph 3). Based on percent total length, 33% were step run units, 20% low

gradient riffle units and 15% were run units.

A total of 57 pools were identified (Table 3). Main channel pools were the most frequently encountered, at 67%, and comprised 70% of the total length of all pools (Graph 4).

Table 4 is a summary of maximum residual pool depths by pool habitat types. Pool quality for salmonids increases with depth. Twenty-five of the 57 pools (44%) had a residual depth of two feet or greater (Graph 5).

The depth of cobble embeddedness was estimated at pool tail-outs. Of the 57 pool tail-outs measured, one had a value of 1 (2%); 32 had a value of 2 (56%); 23 had a value of 3 (40%); one had a value of 5 (2%); (Graph 6). On this scale, a value of 1 indicates the best spawning conditions and a value of 4 the worst. Additionally, a value of 5 was assigned to tail-outs deemed not suitable for spawning due to inappropriate substrate such as bedrock, log sills, boulders, or other considerations.

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 31, flatwater habitat types had a mean shelter rating of 39, and pool habitats had a mean shelter rating of 74 (Table 1). Of the pool types, the main channel pools had the highest mean shelter rating at 83. Scour pools had a mean shelter rating of 54 (Table 3).

Table 5 summarizes mean percent cover by habitat type. Large woody debris is the dominant cover types in Graham Gulch. Graph 7 describes the pool cover in Graham Gulch. Large woody debris is the dominant pool cover type followed by small woody debris.

Table 6 summarizes the dominant substrate by habitat type. Graph 8 depicts the dominant substrate observed in pool tail-outs. Gravel was observed in 53% of pool tail-outs and small cobble was dominant in 37% of pool tail-outs.

The mean percent canopy density for the surveyed length of Graham Gulch was 87%. The mean percentages of hardwood and coniferous trees were 60% and 40%, respectively. Thirteen percent of the canopy was open. Graph 9 describes the mean percent canopy in Graham Gulch.

For the stream reach surveyed, the mean percent right bank vegetated was 87%. The mean percent left bank vegetated was 89%. The dominant elements composing the structure of the stream banks consisted of 57% sand/silt/clay, 32% cobble/gravel, 10% bedrock and 1% boulders (Graph 10). Hardwood trees were the dominant vegetation type observed in 57% of the units surveyed. Additionally, 27% of the units surveyed had coniferous trees as the dominant vegetation type, and 17% had brush as the dominant vegetation (Graph 11).

BIOLOGICAL INVENTORY RESULTS

A biological survey was conducted by the Institute for River Ecosystems in cooperation with the Department of Fish and Game. The sample reach included 6,906 feet. Coho were observed throughout Reach 1 and approximately 609 feet into Reach 2, a total distance of 2,583 feet. In

this survey trout species were not distinguished and include cutthroat trout and steelhead/rainbow trout, both resident and anadromous forms. Trout were observed throughout Reach 1 and approximately 3,760 feet into Reach 2, a total distance of 5,734 feet (Ricker, S., McCanne, D. Unpublished Data, 2004).

Juvenile salmonids were observed from the stream banks up to a distance of 6,464 feet in Graham Gulch.

DISCUSSION

Graham Gulch is an F3 channel type for the first 1,974 feet of stream surveyed, an F2 channel type for the next 4,072 feet, and an A3 channel type for the remaining 860 feet. The suitability of these channel types for fish habitat improvement structures is as follows: F3 channels are good for bank placed boulders and single and opposing wing deflectors; fair for plunge weirs, boulder clusters, channel constrictors and log cover. F2 channels are fair for plunge weirs, single and opposing wing deflectors, and log cover. A3 channels are generally not suitable for fish habitat improvement structures.

The water temperatures recorded on the survey days June 7 to June 16, 2004 ranged from 56 to 65 degrees Fahrenheit. Air temperatures ranged from 54 to 68 degrees Fahrenheit. This is a suitable temperature range for juvenile salmonids. To make any further conclusions, temperatures need to be monitored throughout the warm summer months, and more extensive biological sampling needs to be conducted.

Flatwater habitat types comprised 48% of the total length of this survey, riffles 31%, and pools 20%. The pools are relatively shallow, with 25 of the 57 (44%) pools having a maximum residual depth greater than two 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 residual 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.

Thirty-three of the 57 pool tail-outs measured had embeddedness ratings of 1 or 2. Twenty-three of the pool tail-outs had embeddedness ratings of 3 or 4. One of the pool tail-outs had a rating of 5, which is considered not suitable for spawning. 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 Graham Gulch should be mapped and rated according to their potential sediment yields, and control measures should be taken.

Fifty-one of the 57 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 74. The shelter rating in the flatwater habitats was 39. A pool shelter rating of approximately 100 is desirable. The amount of cover that now exists is being provided primarily by large woody debris in Graham Gulch. Large woody debris is the dominant cover type in pools followed by small woody debris. Log and root wad cover

structures in the pool and flatwater habitats would enhance both summer and winter salmonid habitat. Log cover structures provide rearing fry with protection from predation, rest from water velocity, and also divide territorial units to reduce density related competition.

The mean percent canopy density for the stream was 87%. Reach 1 had a canopy density of 85%, Reach 2 had a canopy density of 90%, and Reach 3 had a canopy density of 79%. In general, revegetation projects are considered when canopy density is less than 80%.

The percentage of right and left bank covered with vegetation was 87% and 89%, respectively. In areas of stream bank erosion or where bank vegetation is sparse, planting endemic species of coniferous and hardwood trees, in conjunction with bank stabilization, is recommended.

RECOMMENDATIONS

1) Graham 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) In the "F" channel reaches, 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 in the pools is from large woody debris. Adding high quality complexity with woody cover in the pools 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.

COMMENTS AND LANDMARKS

Position (ft):	Habitat unit #:	Comments:
0	0001.00	Start of survey at the confluence with Freshwater Creek. Channel type is an F3 (Reach 1).
76	0003.00	Fourteen foot culvert with baffles present, 8.5% slope, potential barrier. This culvert is scheduled to be replaced in the summer of 2005 with a structure that meets DFG and NOAA fish passage criteria.

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173	0005.00	Fish habitat improvement structure.
226	0007.00	Fish habitat improvement structure.
336	0010.00	Humboldt Fish Action Council (HFAC) 100 meter marker on left bank.
366	0011.00	Fish habitat improvement structure.
537	0016.00	Old culvert pipe with large woody debris.
658	0020.00	HFAC 200 meter mark on right bank 23' into habitat unit. Fish habitat improvement structure. Salmonids observed in Habitat Units #011 through #020.
774	0023.00	Right bank culvert with boulders.
896	0027.00	DFG downstream migrant trap box in middle of unit.
925	0028.00	Downstream migrant trap pipe.
957	0029.00	Downstream migrant trap pipe.
957	0029.00	Right bank access to road.
984	0030.00	Downstream migrant trap pipe begins in middle of unit. Unit has been altered by sandbags and sediment collection. HFAC 300 meter marker on left bank 25' into unit. Salmonids observed last 10 units.
1287	0035.00	HFAC 400 meter mark 28' into unit.
1346	0036.00	Palco gaging station. Footbridge 6' into unit, measures 5' wide x 30' long x 8.7' high.
1369	0037.00	Water quality (turbidity) station in middle of pool.
1663	0043.00	Log debris accumulation (LDA) measures 7' high x 25' wide x 25' long and is composed of 14 pieces of large wood. It is accumulating small woody debris.
1806	0047.00	Old metal bridge parts 58' into habitat unit. HFAC 600 meter marker. LDA measures 7' high x 25' wide x 20' long and is composed of seven pieces of large wood.
1974	0048.00	Channel type changes to an F2.
1992	0049.00	LDA measures 10' high x 20' wide x 30' long and is composed of 14 pieces of large wood.

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2006	0050.00	Salmonids observed last 10 units.
2259	0058.00	LDA measures 8’ high x 22’ wide x 55’ long and is composed of 18 pieces of large wood.
2378	0060.00	Salmonids observed last 10 units.
2410	0061.00	Three foot high plunge due to large woody debris.
2460	0062.00	HFAC 700 meter marker 13’ into unit on left bank. Tributary enters left bank 16’ into unit. The temperature of Graham Gulch downstream and upstream of the tributary was 58 degrees Fahrenheit. The temperature of tributary was 56 degrees Fahrenheit. It is accessible to fish at mouth for 50’ upstream. No fish observed.
2620	0067.00	LDA measures 8’ high x 22’ wide x 8’ long and is composed of 11 pieces of large woody debris. During the biological sampling no coho were observed above this LDA.
2644	0068.00	Spring enters from left bank 13’ into unit.
2717	0070.00	HFAC 800 meter marker 50’ into unit.
2922	0073.00	HFAC 900 meter marker 27’ into unit on left bank. Salmonid young-of-the-year observed the last three habitat units. LDA measures 5’ high x 23’ wide x 20’ long and is composed of 16 pieces of large wood. Stored sediment measures 2’ deep.
3329	0084.00	Left bank tributary. The temperature of Graham Gulch downstream and upstream of the tributary was 58 degrees Fahrenheit. The temperature of the tributary was 56 degree Fahrenheit. Not accessible to anadromous fish.
3391	0086.00	HFAC 1,100 meter marker 85’ into unit.
3514	0087.00	LDA measures 10’ high x 28’ wide x 15’ long and is composed of 17 pieces of large wood. Stored sediment measures 4’ deep.
3607	0090.00	Old car 56’ into unit on right bank.
3773	0096.00	HFAC 1,200 meter marker.
4021	0103.00	LDA measures 10’ high x 23’ wide x 56’ long and is composed of 23 pieces of large wood. Nine pieces of the wood come from a failed Humboldt crossing. Sediment stored measures 5’ deep.

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4078	0105.00	Left bank tributary enters 25’ into unit. The temperature of Graham Gulch downstream and upstream of the tributary was 58 degrees Fahrenheit. The temperature of tributary was 56 degrees Fahrenheit. Accessible to fish for at least 75’, but no fish observed. LDA measures 9' high x 18' wide x 40' long and is composed of nine pieces of large wood. Stored sediment measures 3' deep.
4121	0106.00	HFAC 1300 meter marker 16’ into habitat unit.
4218	0108.00	Large woody debris from bridge.
4419	0110.00	Thirteen foot undercut bank/log.
4463	0112.00	HFAC 1,400 meter marker 5’ into unit.
4496	0113.00	Two pieces of large woody debris accumulating small woody debris 50’ into unit.
4686	0115.00	Four salmonids observed.
4775	0119.00	HFAC 1,500 meter marker 16’ into unit.
5063	0126.00	Log bridge at bottom of unit.
5090	0127.00	HFAC 1,600 meter marker at top of unit.
5305	0138.00	HFAC 1,700 meter marker 47’ into unit.
5305	0138.00	LDA measures 12' high x 23' wide x 15' long and is composed of 12 pieces of large wood. Stored sediment measures 3' deep. Notable decrease in flow upstream.
5445	0142.00	Young-of-the-year salmonids observed.
5546	0146.00	Half of the flow goes subsurface.
5569	0147.00	HFAC 1,800 meter marker 48’ into unit on left bank.
5649	0148.00	Tributary enters 36' into unit, dry.
5734	0150.00	Last observation of trout during biological sampling.
5960	0156.00	HFAC 1,900 meter marker 25' into unit.
6046	0160.00	Channel type changes to an A3.

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6269	0168.00	High gradient section of Graham Gulch.
6464	0173.00	Last observation of fish during bank observation.
6675	0178.00	Channel has a 15% slope with areas of 30% slope.
6698	0179.00	Landslide approximately 400' long x 40' wide x 60' high, on both banks. Channel has a slope of 20%.
6706	0180.00	LDA measures 12' high x 28' wide x 18' long at end of landslide, and is composed of 18 pieces of large wood. The LDA is not a barrier, but the gradient of the stream appears to be.
6760	0183.00	Six foot high plunge at top of unit.
6906	0187.00	End of survey due to slope, lack of flow, and landslide/log jam.

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.

Richer, S., McCanne, D., 2004. Unpublished data from the *Juvenile Salmonid Abundance Summer Survey Report 2004.* Anadromous Fisheries Research and Monitoring Program (AFRAMP), California Department of Fish and Game and Institute for River Ecosystems (IRE), Humboldt State University, Arcata, 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]	

Appendix A

California Department of Fish & Game

Large Woody Debris (LWD) Riparian Inventory

Freshwater Basin, Humboldt County

BACKGROUND

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

Large woody debris inventories describe the present relative abundance of LWD elements providing, or with the potential to provide, fish habitat within the stream channel. Large woody debris inventories also describe the relative abundance of "recruitable" LWD. Recruitable LWD is the large wood existing out of the stream channel that has a high potential of entering the stream channel in the future.

METHODS

Prior to conducting the LWD inventory, the stream was habitat-typed employing the methods described by Flosi, et al (1998). The Graham Gulch habitat-typing survey delineated 3 stream reaches. The start and end points for the LWD inventory reaches correspond to stream reach start and end points of the habitat survey.

Large woody debris inventory methods, data recording forms, and database structure are described in Flosi, et al (1998). Large woody debris minimum size criteria 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	**Length Category**
1. 1-2 feet 2. 2-3 feet 3. 3-4 feet 4. Over 4 feet	1. 6-20 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 imminent delivery to the stream channel
d) live coniferous trees
e) live broadleaf trees (a.k.a. deciduous/hardwood)

The sampling strategy consisted of selecting a random starting point near the beginning of the LWD survey reach, and then systematically sampling 200 foot sections out of every 1,000 feet of stream length surveyed. The first 1,200 feet of the LWD survey reach was segmented into 200 foot sections and consecutively numbered 1 through 6. 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 surveyed 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 the next 200 feet were surveyed, and so on. Systematic sampling continued upstream until the end of the LWD survey reach. This method produced a sampling level of approximately 20 percent. For channel type reaches that were less than 1000 feet, the entire reach was surveyed.

RESULTS

*Tables 1 and 2 are located at the end of this report.

Table 3. Large Woody Debris Inventory for Graham Gulch, Humboldt County, California 2004.

REACH	CHANNEL TYPE	TOTAL LENGTH	DEAD DOWN	DEAD STANDING	PERCHED	--LIVE TREES-- CONIFER	BROADLEAF	TOTAL
			Number of pieces per 100 linear feet of stream out of channel on right and left banks					
1	F3	1974	0.5	0.5	2	1.5	9.5	14
2	F4	4072	2.6	1.3	0.4	9.4	0.3	14
3	A3	860	2.5	1	1.5	10	0.5	15.5
			Number of pieces per 100 linear feet of stream within the bankfull channel					
1	F3	1974	4.5	0		0	0	4.5
2	F4	4072	12.8	1		0	0	13.8
3	A3	860	5	0		0	0	5
			Number of pieces per 100 linear feet of stream out of channel on right and left banks and within the bankfull channel					
1	F3	1974	5	0.5	2	1.5	9.5	18.5
2	F4	4072	15.4	2.3	0.4	9.4	0.3	27.8
3	A3	860	7.5	1	1.5	10	0.5	20.5
			Percentage of LWD pieces found out of channel on right and left banks					

Graham Gulch

Table 3. Large Woody Debris Inventory for Graham Gulch, Humboldt County, California 2004.

1	F3	1974	3.5	3.5	14.2	10.7	67.8	99.7
2	F4	4072	18.5	9.2	2.8	67.1	2.1	99.7
3	A3	860	16.1	6.4	9.6	64.5	3.2	99.8
			Percentage of LWD pieces found within the bankfull channel					
1	F3	1974	100.0	0.0	0.0	0.0	0.0	100
2	F4	4072	92.8	7.2	0.0	0.0	0.0	100
3	A3	860	100.0	0.0	0.0	0.0	0.0	100
			Percentage of LWD pieces found out of channel on right and left banks and within the bankfull channel					
1	F3	1974	27.0	2.7	10.8	8.1	51.4	100
2	F4	4072	55.4	8.3	1.4	33.8	1.1	100
3	A3	860	36.6	4.9	7.3	48.8	2.4	100

The Graham Gulch LWD inventory consisted of 3 inventory reaches.
Reach 1, a F3 channel type extended upstream approximately 1974 feet from the mouth. This reach contained 14 pieces of LWD on both the right and the left banks per 100 linear feet of stream. In descending proportions, the condition of the pieces were 9.5% live broadleaf, 2.0% perched, 1.5% live coniferous, 0.5% dead and down, and 0.5% dead standing (Table 3). Within the bankfull channel, reach 1 contained 4.5 pieces of LWD per 100 linear feet of stream. The conditions of the pieces were 4.5% dead and down and 0% live coniferous, 0% live broadleaf, 0% dead and standing, and 0% perched. The total number of pieces per 100 linear feet for both the banks and bankfull channel were 8.5, of which 9.5% were live broadleaf 5.0% were dead and down, 2.0% perched,1.5% were live coniferous, and 0.5% dead and standing. Of the pieces in reach 1, 59.5% were in LWD size category of 1-2 feet in diameter, 35.1% were in the 2-3 foot category, 2.7% were in the 3-4 foot category and, 2.7 % were in the >4 foot category (Figure 1).

Reach 2, a F4 channel type started 1974 feet from the mouth and extended upstream approximately 6046 feet from the mouth. This reach contained 14 pieces of LWD on both the right and the left banks per 100 linear feet of stream. In descending proportions, the condition of the pieces were 9.4% live coniferous, 2.6% dead and down, 1.3% dead and standing, 0.4% perched, and 0.3% live broadleaf (Table 3). Within the bankfull channel, reach 2 contained 13.8 pieces of LWD per 100 linear feet of stream. The conditions of the pieces were 12.8% dead and down, 1.0% dead and standing, 0% live coniferous, 0% live broadleaf, and 0% perched. The total number of pieces per 100 linear feet for both the banks and bankfull channel were 27.8, of which 15.4% were dead and down, 9.4% live coniferous, 2.3% dead and standing, 0.4% perched and 0.3% live broadleaf. Of the pieces in reach 2, 63.3% were in the LWD size category of 1-2 feet in diameter, 27.1% were in the 2-3 foot category, 7.2% were in the 3-4 foot category, and 2.3% were in the >4 foot category.

Reach 3, an A3 channel type started 6046 feet from the mouth and extended upstream approximately 6906 feet from the mouth. This reach contained 15.5 pieces of LWD on both the right and the left banks per 100 linear feet of stream. In descending proportions, the condition of the pieces were 64.5% live coniferous, 16.1% dead and down, 9.6% perched, 6.4% dead and

standing, and 3.2% live broadleaf. Within the bankfull channel, reach 3 contained 5 pieces of LWD per 100 linear feet of stream. The conditions of the pieces were 100% dead and down, 0% live coniferous, 0% perched, 0% dead and standing, and 0% live broadleaf. The total number of pieces per 100 linear feet for both the banks and bankfull channel were 20.5, if which 51.4% live broadleaf, 27% dead and down, 10.8% perched, 8.1% live coniferous, and 2.7% dead and standing. Of the pieces in reach 3, 75.6% were in the LWD size category 1-2 feet in diameter, 12.2% were in the 2-3 foot category, 7.3% were in the 3-4 foot category, and 4.9% were in the >4 foot category.

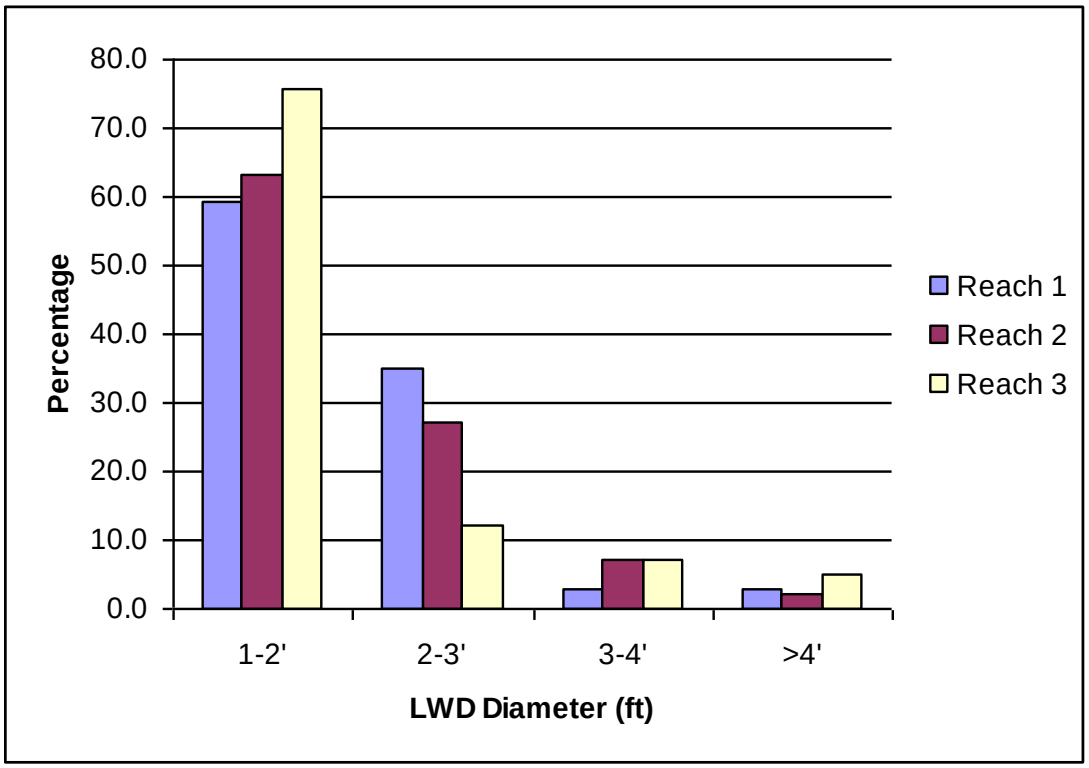

Figure 1. Percent of LWD according to diameter size class and stream reach.

DISCUSSION

Reach 1, a F3 channel type had a bankfull width of 25 feet. LWD on the banks was dominated by live deciduous, greater than 20 feet long, and 1-2 feet in diameter. While dead and down, less than 20 feet long, and 2-3 feet in diameter dominated the stream channel. The 1-2 feet diameter size class was the most common for all LWD pieces in both the stream channel and the bank zones (Table 1). In the stream channel, there were 4.5 pieces of dead and down LWD per 100 linear feet of stream observed (Table 2).

Reach 2, a F4 channel type had a bankfull width of 19 feet. LWD on the banks was dominated by live coniferous, greater than 20 feet long, and 1-2 feet in diameter. While dead and down, less than 20 feet long, and 1-2 feet in diameter dominated the stream channel. The 1-2 feet diameter size class was the most common for all LWD pieces in both the stream channel and the

bank zones (Table 1). In the stream channel, there were 12.8 pieces of dead and down LWD per 100 linear feet of stream observed (Table 2).

Reach 3, an A3 channel type had a bankfull width of 15 feet. LWD on the banks was dominated by live coniferous, greater than 20 feet long, and 1-2 feet in diameter. While dead and down, less than 20 feet long, and 1-2 feet in diameter dominated the stream channel. The 1-2 feet diameter size class was the most common for all LWD pieces in both the stream channel and the bank zones (Table 1). In the stream channel, there were 5.0 pieces of dead and down LWD per 100 linear feet of steam observed (Table 2).

One goal of conducting LWD inventories is to provide data that, along with fish population and habitat type data, will enable resource managers to characterize the quality of available and potential fish habitat. Although, the relationship between the number, size, and type of LWD pieces per 100 feet, and quality of fish habitat has not been fully established, it is generally accepted that LWD in the stream channel plays a vital role in contributing to the quality of fish habitat. Large woody debris within the bank zone is the source for future instream LWD and addresses the issue of LWD recruitment to the stream channel. Information in this report will enable resource managers to identify areas lacking in LWD, subsequently leading to planning and prioritizing prescriptions for improvement. This information will also be useful in detecting changes in LWD relative abundance with relation to land use practices or riparian zone restoration projects.