STREAM INVENTORY REPORT

South Fork Freshwater Creek

INTRODUCTION

A stream inventory was conducted during the summer of 2004 on South Fork Freshwater Creek. The survey began at the confluence with Freshwater Creek and extended upstream 2.1 miles. The objective of the habitat inventory was to document the habitat available to anadromous salmonids in South Fork Freshwater Creek.

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

South Fork Freshwater Creek 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). South Fork Freshwater Creek's legal description at the confluence with Freshwater Creek is T04N R01E S15. Its location is 40.7314 degrees north latitude and 124.0467 degrees west longitude, LLID number 1240467407315. South Fork Freshwater Creek is a first order stream and has approximately 3.0 miles of blue line stream according to the USGS McWhinney Creek 7.5 minute quadrangle. South Fork Freshwater Creek drains a watershed of approximately 3.2 square miles. Elevations range from about 180 feet at the mouth of the creek to 970 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 a logging road accessed by a locked gate off of Pal Camp Road.

METHODS

The habitat inventory conducted in South Fork Freshwater Creek 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 measures all habitat units within the survey reach, classifying each according to habitat type. Each habitat unit is 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 South Fork Freshwater Creek 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". South Fork Freshwater Creek habitat typing used standard basin level measurement criteria. These parameters require that the minimum length of a described habitat unit must be equal to or greater than the stream's mean wetted width. All measurements are in feet to the nearest tenth. Habitat characteristics are measured using a clinometer, hip chain, and stadia rod.

5. Embeddedness:

The depth of embeddedness of the cobbles in pool tail-out areas is measured by the percent of the cobble that is surrounded or buried by fine sediment. In South Fork Freshwater 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 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 South Fork Freshwater 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 South Fork Freshwater 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 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 South Fork Freshwater 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.

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 Cloney 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 (Richer, 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

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Graphics are produced from the tables using Microsoft Excel. Graphics developed for South Fork Freshwater Creek 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 22 to July 14, 2004 was conducted by Janelle Breton, Elizabeth Pope, and Cassie Simons (CCC). The total length of the stream surveyed was 11,065 feet with an additional 20 feet of side channel.

Stream flow was measured near the bottom of the survey reach with a Marsh-McBirney Model 2000 flowmeter at 0.2 cfs on July 8, 2004.

South Fork Freshwater Creek is an F4 channel type for 2,970 feet of the stream surveyed (Reach 1); a B3 channel type for 1,182 feet of the stream surveyed (Reach 2); a B2 channel type for 693 feet of the stream surveyed (Reach 3); an F4 channel type for 684 feet of the stream surveyed (Reach 4); a B4 channel type for 1,292 feet of the stream surveyed (Reach 5); an F4 channel type for 1,467 feet of the stream surveyed (Reach 6); and a B4 channel type for the remaining 2,777 feet of the stream surveyed (Reach 7). F4 channels are entrenched, meandering, riffle/pool channels on low gradients with high width/depth ratios and gravel-dominant substrates. B channels are moderately entrenched riffle dominated channels with infrequently spaced pools, very stable plan and profile, stable banks on moderate gradients with low width /depth ratios. B2, B3 and B4 channels have boulder, cobble and gravel dominant substrates, respectively.

Water temperatures taken during the survey period ranged from 57 to 62 degrees Fahrenheit. Air temperatures ranged from 53 to 76 degrees Fahrenheit.

Table 1 summarizes the Level II riffle, flatwater, and pool habitat types. Based on frequency of occurrence there were 46% pool units, 30% riffle units, 22% flatwater units, and 2% dry units (Graph 1). Based on total length of Level II habitat types there were 47% pool units, 27% flatwater units, 26% riffle units, and 1% dry units (Graph 2).

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Ten Level IV habitat types were identified (Table 2). The most frequent habitat types by percent occurrence were 43% mid-channel pool units, 29% low gradient riffle units and 18% run units (Graph 3). Based on percent total length, 44% were mid-channel pool units, 24% were low gradient riffle units and 20% were run units.

A total of 132 pools were identified (Table 3). Main channel pools were the most frequently encountered, at 93%, and comprised 95% 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. Fifty-four of the 130 pools (42%) had a residual depth of two feet or greater (Graph 5).

The depth of cobble embeddedness was estimated at pool tail-outs. Of the 131 pool tail-outs measured, 47 had a value of 1 (36%); 48 had a value of 2 (37%); 22 had a value of 3 (17%); four had a value of 4 (3%); 10 had a value of 5 (8%); (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 23, flatwater habitat types had a mean shelter rating of 34, and pool habitats had a mean shelter rating of 80 (Table 1). Of the pool types, main channel pools had a mean shelter rating of 81 and scour pools had a mean shelter rating of 66 (Table 3).

Table 5 summarizes mean percent cover by habitat type. Large woody debris is the dominant cover type in South Fork Freshwater Creek. Graph 7 describes the pool cover in South Fork Freshwater Creek. 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 in 34%.

The mean percent canopy density for the surveyed length of South Fork Freshwater Creek was 87%. The mean percentages of hardwood and coniferous trees were 34% and 66%, respectively (Table 7). Thirteen percent of the canopy was open. Graph 9 describes the mean percent canopy in South Fork Freshwater Creek.

For the stream reach surveyed, the mean percent right bank vegetated was 91%. The mean percent left bank vegetated was 92%. The dominant elements composing the structure of the stream banks consisted of 45% sand/silt/clay, 42% cobble/gravel, 7% boulders, and 5% bedrock (Graph 10). Coniferous trees were the dominant vegetation type observed in 58% of the units surveyed. Additionally, 24% of the units surveyed had hardwood trees as the dominant vegetation type, and 13% had brush as the dominant vegetation (Graph 11).

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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 9,966 feet. Coho were observed throughout Reaches 1 and 2, and approximately 440 feet into Reach 3, a total distance of 4,592 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 Reaches 1 through 6 and approximately 1,678 feet into Reach 7, a total distance of 9,966 feet (Ricker, S., McCanne, D. Unpublished Data, 2004). Juvenile salmonids were also observed from the stream banks up to a distance of approximately 10,823 feet in South Fork Freshwater Creek

DISCUSSION

South Fork Freshwater Creek is an F4 channel type for the first 2,970 feet of stream surveyed, a B3 channel type for the next 1,182 feet, a B2 channel type for the next 693 feet, an F4 channel type for the next 684 feet, a B4 channel type for the next 1,292 feet, an F4 channel type for the next 1,467 feet, and a B4 channel type for the remaining 2,777 feet of the stream surveyed. The suitability of these channel types for fish habitat improvement structures is as follows: F4 channel types are good for bank-placed boulders; fair for plunge weirs, single and opposing wing-deflectors, channel constrictors and log cover; and poor for boulder clusters. B3 channel types are excellent for plunge weirs, boulder clusters and bank placed boulder, single and opposing wing-deflectors and log cover. B2 channel types are excellent for plunge weirs, single and opposing wing-deflectors, and log cover. B4 channel types are excellent for low-stage plunge weirs, boulder clusters, bank placed boulders, single and opposing wing-deflectors, and log cover.

The water temperatures recorded on the survey days June 22 to July 14, 2004 ranged from 57 to 62 degrees Fahrenheit. Air temperatures ranged from 53 to 76 degrees Fahrenheit. This is a suitable water temperature 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 27% of the total length of this survey, riffles 26%, and pools 47%. Fifty-four of the 130 (42%) pools had 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.

Ninety-five of the 131 pool tail-outs measured had embeddedness ratings of 1 or 2. Twenty-six of the pool tail-outs had embeddedness ratings of 3 or 4. Ten 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.

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One-hundred-thirteen of the 131 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 80. The shelter rating in the flatwater habitats was 34. 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 South Fork Freshwater Creek. 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 81%, Reach 2 had a canopy density of 83%, Reach 3 had a canopy density of 85%, Reach 4 had a canopy density of 90%, Reach 5 had a canopy density of 86%, Reach 6 had a canopy density of 91%, and Reach 7 had a canopy density of 90%. In general, revegetation projects are considered when canopy density is less than 80%.

The percentage of right and left bank covered with vegetation was 91% and 92%, 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) South Fork Freshwater 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) There is several log debris accumulations (LDA's) present on South Fork Freshwater Creek that are retaining large quantities of fine sediment. Monitor fish passage associated with these LDA's. The modification of these LDA's is only desirable, if they are determined to impede fish passage.

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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.

Position (ft):	Habitat unit #:	Comments:
0	0001.00	Start of survey at the confluence with Freshwater Creek. Humboldt Fish Action Council (HFAC) 0 meter marker.
45	0002.00	CCC fish habitat improvement structure.
120	0004.00	Stream gauge site. CCC fish habitat improvement structure on left bank. Footbridge.
300	0008.00	Approximately 14 pieces of large woody debris in a pile. A 100’ long section of the right bank is failing; there are fallen trees and some erosion.
366	0011.00	HFAC 100 meter marker.
418	0012.00	Log debris accumulation (LDA) measures 5’ high x 27’ wide x 27’ long and is composed of approximately nine pieces of large wood. Stored sediment measures 2’ deep. Fish were seen above the LDA.
491	0014.00	Flag SF00103011 M.C. T.S. 7.3.
564	0015.00	HFAC 200 meter marker. Flag LWD recruitment MRC '03'.
647	0016.00	Juvenile coho observed.
805	0020.00	Tributary on left bank is not accessible to fish.
845	0021.00	HFAC 300 meter marker.
1069	0025.00	LDA measures 8' high x 35' wide x 14' long and is composed of approximately 17 pieces of large wood. Stored sand and gravel measures 4' deep. Fish were observed above the LDA.
1157	0026.00	LDA measures 10' high x 40' wide x 29' long and is composed of approximately 23 pieces of large wood. Stored sand and gravel measures 6' deep. Vegetation growing on the LDA.
1236	0028.00	Juvenile salmonids observed.

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1296	0030.00	Freshly fallen redwood, with a 2' diameter, on the right bank and in the creek, covering the unit.
1402	0034.00	Flag: MCRB 0224063. Flag: Habitat Unit 20 '98.
1449	0035.00	HFAC 400 meter marker. LDA measures 12' high x 24' wide x 27' long and is composed of approximately 22 pieces of large wood. Stored gravel and cobble measures 4' deep. Fish were observed above the LDA.
1493	0037.00	Juvenile salmonids observed.
1528	0038.00	HFAC 500 meter marker. LDA measures 14' high x 42' wide x 34' long and is composed of approximately 37 pieces of large wood. Stored sand and gravel measures 3' deep. Fish observed above the LDA.
1767	0042.00	HFAC 600 meter marker.
2145	0051.00	HFAC 700 meter marker.
2468	0056.00	HFAC 800 meter marker.
2589	0059.00	Small spring on left bank, 36' into unit.
2735	0061.00	LDA measures 18' high x 47' wide x 40' long and is composed of approximately 23 pieces of large wood. Stored silt, sand, and gravel measures 8' deep. There is a 6' high plunge over the LDA.
2970	0068.00	Channel type change to B3. Two live redwoods from the right bank spanning the channel.
3051	0069.00	Juvenile salmonids observed.
3113	0070.00	LDA measures 15' high x 30' wide x 30' long and is composed of approximately 20 pieces of large wood. Stored sediment measures 2' deep. Fish were seen above the LDA.
3206	0071.00	HFAC 900 meter marker.
3797	0086.00	HFAC 1200 meter marker.
3870	0088.00	LDA on the right bank, not spanning the channel.
3927	0090.00	LDA measures 7' high x 15' wide x 30' long and is composed of approximately 14 pieces of large wood. Stored sediment, mostly gravel, measures 2' deep. Fish were observed above the LDA.

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4152	0095.00	Channel type change to B4. HFAC 1,300 meter marker.
4170	0096.00	LDA measures 9' high x 36' wide x 13' long and is composed of approximately 12 pieces of large wood. Stored sand and gravel measures 3' deep. Fish were observed above the LDA.
4241	0098.00	Bank erosion site measures 50' high x 30' wide x 30' deep.
4362	0103.00	LDA measures 12' high x 50' wide x 30' long and is composed of approximately 23 pieces of large wood. Stored sand and gravel measures 3' deep. Fish observed above the LDA.
4592	0110.00	LDA measures 9' high x 30' wide x 20' long and is composed of 11 pieces of large wood. Stored sand and gravel measures 2' deep. No coho salmon observed above this LDA.
4644	0111.00	Gradient of channel is 4%.
4818	0114.00	LDA measures 10' high x 40' wide x 12' long and is composed of 15 pieces of large wood. Stored silt measures 4' deep. Fish observed above the LDA. Bank erosion site measures 30' high x 35' wide x 6' deep, contributing sediment.
4845	0115.00	Channel type change to F4.
4949	0117.00	Left bank spring.
5096	0121.00	HFAC 1,600 meter marker. LDA measures 7' high x 15' wide x 10' long and is composed of eight pieces of large wood. Stored sediment, in the form of gravel, measures 2' deep. Fish observed above the LDA.
5329	0127.00	HFAC 1,700 meter marker.
5429	0128.00	Cabled log present.
5529	0130.00	Channel type change to B4.
5693	0133.00	Channel full of wood, sediment and pockets of pools.
5727	0134.00	HFAC 1,800 meter marker.
5739	0135.00	Juvenile salmonids observed.
5813	0137.00	Access trail flag. LDA measures 9' high x 40' wide x 40' long and is composed of approximately 23 pieces of large wood. Stored silt, sand, and gravel measures 6' deep. Fish observed above the LDA.

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5883	0138.00	HFAC 1,900 meter marker.
6237	0144.00	LDA measures 7' high x 40' wide x 10' long and is composed of nine pieces of large wood. Stored silt, sand, and gravel measures 5' deep. It is a possible barrier to salmonids. There are also 8’ diameter boulders and a 6’ high plunge.
6254	0145.00	LDA measures 15' high x 40' wide x 30' long and is composed of 15 pieces of large wood. Stored sand and gravel measures 15' deep. Flow is subsurface throught the LDA. Juvenile salmonids observed above it.
6304	0146.00	Eighteen feet of dry channel. Channel clogged with large wood.
6426	0152.00	LDA measures 5' high x 30' wide x 12' long and is composed of seven pieces of large wood. Stored silt, sand, and gravel measures 3' deep. Root wads, live trees, and boulders are clogging the channel. The channel is narrow.
6466	0153.00	Juvenile salmonids observed.
6646	0158.00	Horizontal maples spanning channel.
6821	0161.00	Channel type change to F4. LDA measures 11' high x 50' wide x 36' deep and is composed of 21 pieces of large wood. Stored sediment 5' deep, with sediment size ranging from silt to gravel. Fish were observed above the LDA. Vegetation growing throughout.
6984	0166.00	HFAC 2,200 meter marker. LDA measures 7' high x 30' wide x 12' long and is composed of 13 pieces of large wood.
7030	0168.00	LDA measures 8' high x 20' wide x 22' long and is composed of eight pieces of large wood. Stored sand and gravel measures 2' deep. Fish observed above the LDA.
7170	0173.00	Left bank erosion site measures 10' high x 15' wide x 2' deep and is contributing some sediment to the channel.
7236	0174.00	Dry right bank tributary.
7387	0177.00	LDA measures 8' high x 50' wide x 40' long and is composed of 18 pieces of large wood. Stored sediment measures 2' deep.
7433	0178.00	Left bank dry tributary.
7539	0181.00	HFAC 2,400 meter marker. LDA measures 7' high x 35' wide x 36' long and is composed of 18 pieces of large wood. Stored gravel measures 2' deep. The stream flows under the LDA or goes subsurface.

7874	0193.00	LDA measures 6' high x 20' wide x 12' long and is composed of seven pieces of large wood. Stored silt measures 1' deep.
7906	0194.00	HFAC 2,500 meter marker.
7928	0195.00	Three foot log spanning dry channel.
7945	0196.00	LDA measures 7' high x 20' wide x 90' long and is composed of 24 pieces of large wood. Stored silt, sand and gravel measures 2' deep.
8129	0199.00	HFAC 2,600 meter marker. LDA measures 10' high x 4' wide x 60' long and is composed of 25 pieces of large wood. Stored sand and gravel above the LDA measures 2' deep. Fish observed above the LDA.
8288	0201.00	Channel type change to B4.
8459	0205.00	HFAC 2,700 meter marker. LDA measures 8' high x 22' wide x 12' long and is composed of 12 pieces of large wood. Stored sand and gravel measures 4' deep. Fish observed above the LDA. Water goes subsurface.
8556	0208.00	LDA measures 7' high x 30' wide x 60' long and is composed of approximately 14 pieces of large wood. Stored gravel measures 2' deep. Dry left bank tributary.
8630	0210.00	Left bank fallen redwood in creek, still green, clogging the channel.
8679	0212.00	HFAC 2,800 meter marker.
8910	0219.00	HFAC 2,900 meter marker. LDA from trees that have fallen from the left bank.
8957	0220.00	Access trail marked by a blue flag.
9066	0221.00	LDA measures 5' high x 30' wide x 10' long. Stored gravel measures 2' deep.
9259	0224.00	LDA measures 10' high x 20' wide x 22' long and is composed of approximately 14 pieces of large wood. Stored silt, sand and gravel measures 4' deep. Fish observed above the LDA.
9303	0226.00	LDA measures 6' high x 20' wide x 22' long and is composed of approximately 16 pieces of large wood. Stored silt, sand and gravel measures 3' deep. Fish observed above the LDA.
9329	0227.00	HFAC 3,000 meter marker.

9396	0229.00	LDA measures 10' high x 48' wide x 30' long and is composed of approximately 30 pieces of large wood. Stored silt, sand and gravel measures 3' deep. Water goes subsurface.
9423	0230.00	Left bank tributary contributing approximately 15% to the flow of South Fork Freshwater Creek. It is accessible to fish and has a slope of 5%, measured with a hand level.
9485	0232.00	LDA measures 4' high x 50' long x 20' wide.
9568	0234.00	LDA measures 6' high x 8' wide x 40' long and is composed of approximately 12 pieces of large wood. Stored gravel measures 2' deep. Fish observed above the LDA.
9669	0238.00	HFAC 3,100 meter marker. LDA measures 10' high x 27' wide x 30' long and is composed of approximately 19 pieces of large wood. Stored gravel measures 6' deep. There is a 6' high plunge over the LDA with a 2' deep jump pool below it.
9873	0245.00	LDA measures 8' high x 18' wide x 18' long and is composed of approximately 12 pieces of large wood. Stored sand and gravel measures 4' deep.
9966	0251.00	HFAC 3,200 meter marker. End of spawner survey reach. Channel clogged with wood.
10022	0252.00	Log spanning creek retaining sediment 2' deep.
10161	0256.00	Left bank erosion. LDA measures 6' high x 20' wide x 40' long and is composed of approximately 24 pieces of large wood. Stored silt, sand and gravel measures 4' deep. Fish observed above the LDA.
10301	0260.00	Left bank erosion site measures 20' long x 5' wide x 20' deep and is contributing sediment to the creek.
10351	0262.00	LDA measures 9' high x 20' wide x 30' long and is composed of 14 pieces of large wood. Stored silt, sand and gravel measures 3' deep. Fish observed above the LDA. Access trail on the left bank.
10406	0263.00	Log retaining sediment 3' deep.
10443	0265.00	Creek clogged with wood, alders, and brush.
10563	0270.00	LDA measures 7' high x 30' wide x 30' long and is composed of 14 pieces of large wood. Stored sand and gravel measures 3' deep. Fish observed above the LDA.

10672	0275.00	LDA measures 6' high x 12' wide x 60' long and is composed of approximately 22 pieces of large wood. Stored gravel measures 4' deep.
10850	0281.00	LDA measures 4' high x 10' wide x 20' long and is composed of four pieces of large wood. Stored sediment measures 3' deep.
10907	0283.00	LDA measures 8' high x 20' wide x 30' long and is composed of approximately 16 pieces of large wood. Stored gravel measures 2' deep.
11065	0286.00	End of survey. Creek very clogged with large woody debris for over 200'. Water flows subsurface at times.

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 South Fork of Freshwater habitat-typing survey delineated seven 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

South Fork Freshwater Creek

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

Table 3. Large Woody Debris Inventory of South Fork Freshwater Creek, 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	F4	2970	0.7	1	1	9.8	5.7	18.2
2	B3	1182	4.5	2	1	15	1	23.5
3	B2	693	n/a					
4	F4	684	1	5.5	0	21.5	1.5	29.5
5	B4	1292	2	1.5	0	10.5	0	14
6	F4	1467	1.3	2.8	0	22.8	4.3	31.2
7	B4	2797	3.8	0.8	0.8	23.5	2.5	31.4
			Number of pieces per 100 linear feet of stream within the bankfull channel					
1	F4	2970	7.7	0.3		0.8	0.2	9
2	B3	1182	17	0		0	0	17
3	B2	693	n/a					
4	F4	684	6.5	0		0	0	6.5
5	B4	1292	1.5	0		0	0	1.5
6	F4	1467	8	0.3		0	0	8.3
7	B4	2797	14.5	0	0	0.3	0	14.8
			Number of pieces per 100 linear feet of stream out of channel on right and left banks and within the bankfull channel					

South Fork Freshwater Creek

1	F4	2970	8.3	1.3	1	10.7	5.8	27.1
2	B3	1182	21.5	2	1	15	1	40.5
3	B2	693	n/a					
4	F4	684	7.5	5.5	0	21.5	1.5	36
5	B4	1292	3.5	1.5	0	10.5	0	15.5
6	F4	1467	9.3	3	0	22.8	4.3	39.4
7	B4	2797	18.3	0.8	0.8	23.8	2.5	46.2
			Percentage of LWD pieces found out of channel on right and left banks					
1	F4	2970	3.8	5.5	5.5	53.8	31.3	100
2	B3	1182	19.1	8.5	4.3	63.8	4.3	100
3	B2	693	n/a					
4	F4	684	3.4	18.6	0.0	72.9	5.1	100
5	B4	1292	14.3	10.7	0.0	75.0	0.0	100
6	F4	1467	4.2	9.0	0.0	73.1	13.8	100
7	B4	2797	12.1	2.5	2.5	74.8	8.0	100
			Percentage of LWD pieces found within the bankfull channel					
1	F4	2970	85.6	3.3	0.0	8.9	2.2	100
2	B3	1182	100.0	0.0	0.0	0.0	0.0	100
3	B2	693	n/a					
4	F4	684	100.0	0.0	0.0	0.0	0.0	100
5	B4	1292	100.0	0.0	0.0	0.0	0.0	100
6	F4	1467	96.4	3.6	0.0	0.0	0.0	100
7	B4	2797	98.0	0.0	0.0	2.0	0.0	100
			Percentage of LWD pieces found out of channel on right and left banks and within the bankfull channel					
1	F4	2970	30.6	4.8	3.7	39.5	21.4	100
2	B3	1182	53.1	4.9	2.5	37.0	2.5	100
3	B2	693	n/a					
4	F4	684	20.8	15.3	0.0	59.7	4.2	100
5	B4	1292	22.6	9.7	0.0	67.7	0.0	100
6	F4	1467	23.6	7.6	0.0	57.9	10.9	100
7	B4	2797	39.6	1.7	1.7	51.5	5.4	100

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

The South Fork of Freshwater LWD inventory consisted of seven inventory reaches. Reach 1, a F4 channel type extended upstream approximately 2970 feet from the mouth. This reach contained 18.2 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 53.8% live coniferous, 31.3% live broadleaf, 5.5% dead and standing, 5.5% perched, and 3.8% dead and down (Table 3). Within the bankfull channel, reach 1 contained 9 pieces of LWD per 100 linear feet of stream. The conditions of the pieces were 85.6% dead and down and 8.9% live coniferous, 2.2% live broadleaf, 3.3% dead and standing, and 0% perched. The total number of pieces per 100 linear feet for both the banks and bankfull channel were 27.1, of which 30.6% were dead and down, 39.5% were live coniferous, 21.4% live broadleaf, 4.8% dead and standing, and 3.7% perched. Of the pieces in reach 1, 73.6% were in LWD size category of 1-2 feet in diameter,

17.8% were in the 2-3 foot category, 5.5% were in the 3-4 foot category, and 3.1% were in the >4 foot category (Figure 1).

Reach 2, a B3 channel type, starts at 2970 feet from the mouth and extended upstream approximately 4152 feet from the mouth. This reach contained 23.5 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 63.8% live coniferous, 19.1% dead and down, 8.5% dead and standing, 4.3% perched, and 4.3% live broadleaf (Table 3). Within the bankfull channel, reach 2 contained 17 pieces of LWD per 100 linear feet of stream. The conditions of the pieces were 100% dead and down, 0% dead and standing, 0% perched, 0% live coniferous, and 0% live broadleaf. The total number of pieces per 100 linear feet for both the banks and the bankfull channel were 40.5, of which 53.1% were dead and down, 37% live coniferous, 4.9% dead and standing, 2.5% perched, and 2.5% live broadleaf. Of the pieces in reach 2, 66.7% were in the LWD size category of 1-2 feet in diameter, 17.3% were in the 2-3 foot category, 3.7% were in the 3-4 foot category, and 12.3% were in the >4 foot category (Figure 1).

Reach 3, a B2 channel type, starts at 4152 feet upstream from the mouth and extended upstream approximately 4845 feet from the mouth. There was no data collected for this reach.

Reach 4, a F4 channel type, starts at 4845 feet from the mouth and extended upstream approximately 5529 feet from the mouth. This reach contained 29.5 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 72.9% live coniferous, 18.6% dead and standing, 5.1% live broadleaf, 3.4 dead and down, and 0% perched (Table 3). Within the bankfull channel, reach 4 contained 6.5 pieces of LWD per 100 linear feet of stream. The conditions of the pieces were 100% dead and down, 0% dead and standing, 0% perched, 0% live coniferous, and 0% live broadleaf. The total number of pieces per 100 linear feet for both the banks and the bankfull channel were 36, of which 59.7% were live coniferous, 20.8% dead and down, 15.3% dead and standing, 4.2% live broadleaf, and 0% perched. Of the pieces in reach 4, 69.4% were in the LWD size category of 1-2 feet in diameter, 18.1% were in the 2-3 foot category, 8.3% were in the 3-4 foot category, and 4.2% were in the >4 foot category (Figure 1).

Reach 5, a B4 channel type, starts at 5529 feet from the mouth and extended upstream approximately 6821 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 75% live coniferous, 14.3% dead and down, 10.7% dead and standing, 0% perched, and 0% live broadleaf (Table 3). Within the bankfull channel, reach 5 contained 1.5 pieces of LWD per 100 linear feet of stream. The conditions of pieces were 100% dead and down, 0% dead and standing, 0% perched, 0% live coniferous, and 0% live broadleaf. The total number of pieces per 100 linear feet for both the banks and the bankfull channel were 15.5, of which 67.7% were live coniferous, 22.6% dead and down, 9.7% dead and standing, 0% perched, and 0% broadleaf. Of the pieces in reach 5, 74.2% were in the LWD size category of 1-2 feet in diameter, 12.9% were in the 2-3 foot category, 9.7% were in the 3-4 foot category, and 3.2% were in the >4 foot category (Figure 1).

Reach 6, a F4 channel type, starts at 6821 feet from the mouth and extended upstream approximately 8288 feet from the mouth. This reach contained 31.2 pieced 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 73.1% live coniferous, 13.8% live broadleaf, 9% dead and standing, 4.2% dead and down, and 0% perched (Table 3). Within the bankfull channel, reach 6 contained 8.3 pieces of LWD per 100 linear feet of stream. The conditions of pieces were 96.4% dead and down, 3.6% dead and standing, 0% perched, 0% live broadleaf, and 0% live coniferous. The total number of pieces per 100 linear feet for both the banks and the bankfull channel were 8.3, of which 57.9% were live coniferous, 23.6% dead and down, 10.9% live broadleaf, 7.6% dead and standing, and 0% perched. Of the pieces in reach 6, 79% were in the LWD size category of 1-2 feet in diameter, 15.9% were in the 2-3 foot category, 3.2% were in the 3-4 foot category, and 1.9% were in the >4 foot category (Figure 1).

Reach 7, a B4 channel type, starts at 8288 feet from the mouth and extended upstream approximately 11085 feet from the mouth. This reach contained 184 pieces of LWD on both the right and left banks per 100 linear feet of stream. In descending proportions, the condition of the pieces were 51.6% live coniferous, 39.7% dead and down, 5.4% live broadleaf, 1.6% dead and standing, and 1.6% perched (Table 3). With in the bankfull channel, reach 7 contained 31.4 pieces of LWD per 100 linear feet of stream. The conditions of pieces were 74.8% live coniferous, 12.1% dead and down, 8% live broadleaf, 2.5% dead and standing, and 0% perched. The total number of pieces per 100 linear feet for both banks and the bankfull channel were 14.8, of which 98% were dead and down, 2% live coniferous, 0% dead and standing, 0% perched, and 0% live broadleaf. Of the pieces in reach 6, 69.6% were in the LWD size category of 1-2 feet in diameter, 25% were in the 2-3 foot category, 3.8% were in the 3-4 foot category, and 1.6% were in the >4 foot category (Figure 1).

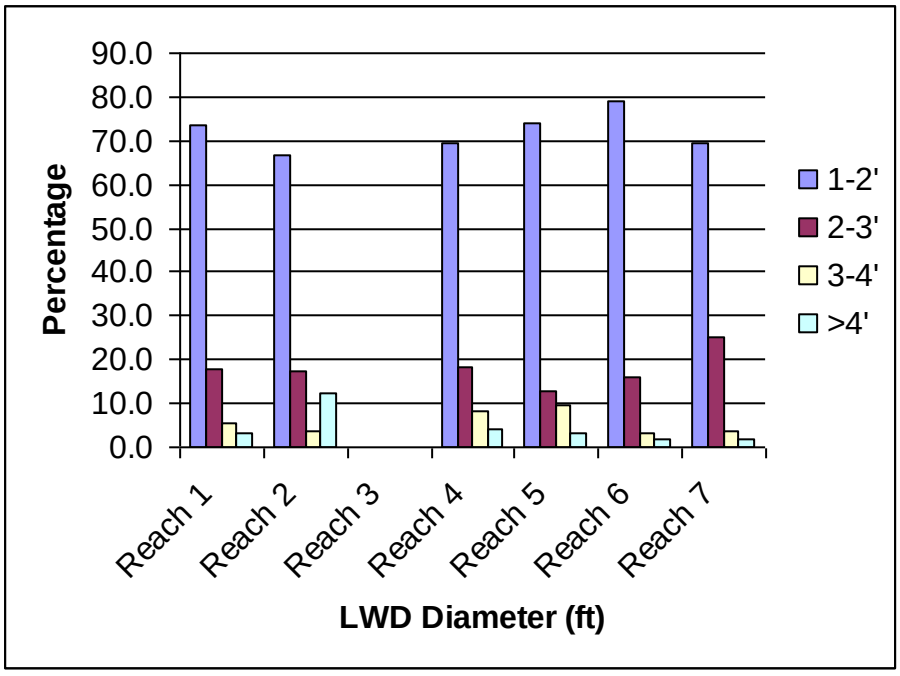

Figure 1. Percent of LWD according to diameter size class and reach

South Fork Freshwater Creek

DISCUSSION

The South Fork of Freshwater had 7 reaches. Reach 1, a F4 channel type had a bankfull width of 19. LWD on the banks was dominated by live, 1-2 feet diameter, greater than 20 feet tall coniferous trees. While 1-2 feet diameter, less than 20 feet tall dead and down LWD 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 7.7 pieces of dead and down LWD per 100 linear feet of stream observed (Table 2).

Reach 2, a B3 channel type had a bankfull width of 18. LWD on the banks was dominated by live, 1-2 feet diameter, greater than 20 feet tall coniferous trees. While 1-2 feet diameter, less than 20 feet tall dead and down LWD 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 17.0 pieces of dead and down LWD per 100 linear feet of stream observed (Table 2).

Reach 1, an F4 channel type had a bankfull width of 19. LWD on the banks was dominated by live, 1-2 feet diameter, greater than 20 feet tall coniferous trees. While 1-2 feet diameter, less than 20 feet tall dead and down LWD 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 7.7 pieces of dead and down LWD per 100 linear feet of stream observed (Table 2).

Reach 3 is a B2 channel type and there was no data was collected for this reach.

Reach 4, an F4 channel type had a bankfull width of 24. LWD on the banks was dominated by live, 1-2 feet diameter, greater than 20 feet tall coniferous trees. While 1-2 feet diameter, less than 20 feet tall dead and down LWD 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 6.5 pieces of dead and down LWD per 100 linear feet of stream observed (Table 2).

Reach 5, a B4 channel type had a bankfull width of 18. LWD on the banks was dominated by live, 1-2 feet diameter, greater than 20 feet tall coniferous trees. While 2-3 feet diameter, less than 20 feet tall dead and down LWD 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 1.5 pieces of dead and down LWD per 100 linear feet of stream observed (Table 2).

Reach 6, an F4 channel type had a bankfull width of 14. LWD on the banks was dominated by live, 1-2 feet diameter, greater than 20 feet tall coniferous trees. While 1-2 feet diameter, less than 20 feet tall dead and down LWD 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 8.0 pieces of dead and down LWD per 100 linear feet of stream observed (Table 2).

South Fork Freshwater Creek

Reach 7, a B4 channel type had a bankfull width of 17. LWD on the banks was dominated by live, 1-2 feet diameter, greater than 20 feet tall coniferous trees. While 1-2 feet diameter, less than 20 feet tall dead and down LWD dominated the stream channel. The 2-3 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 14.5 pieces of dead and down LWD per 100 linear feet of stream 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.