# STREAM INVENTORY REPORT

## Bond Creek

## INTRODUCTION

A stream inventory was conducted during the summer of 1991 on Bond Creek to assess habitat conditions for anadromous salmonids. The inventory was conducted in two parts: habitat inventory and biological inventory. The objective of the habitat inventory was to document the habitat available to anadromous salmonids in Bond Creek. The objective of the biological inventory was to document the salmonid species present and their distribution. After analysis of the information and data gathered, stream restoration and enhancement recommendations are presented.

Adult carcass surveys were conducted in Bond Creek in January and December, 1988. In January 1988, 13 live Chinook salmon and six redds were observed in Bond Creek. No other survey found adults or redds. Juvenile coho salmon and steelhead were sampled during summer electrofishing in 1989 and 1990 (DFG file data). 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.

## WATERSHED OVERVIEW

Bond Creek is a tributary to Hollow Tree Creek, a tributary to the South Fork Eel River, a tributary to the Eel River, which drains to the Pacific Ocean. It is located in Mendocino County, California. Bond Creek's legal description at the confluence with Hollow Tree Creek is T22N R17W S15. Its location is 39.7667 degrees north latitude and 123.7372 degrees west longitude. Bond Creek is a first order stream and has approximately 3.2 miles of blue line stream, according to the USGS Leggett 7.5 minute quadrangle. Bond Creek drains a watershed of approximately 2.7 square miles. Elevations range from about 1,200 feet at the mouth of the creek to 2,200 feet in the headwater areas. Redwood forest dominates the watershed. The watershed is owned by the Louisiana-Pacific Corporation, and is managed for timber production. Vehicle access exists from State Highway 1 at Hales Grove, via Westside Road.

## METHODS

The habitat inventory conducted in Bond Creek follows the methodology presented in the *California Salmonid Stream Habitat Restoration Manual* (Flosi and Reynolds, 1991). 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). Bond Creek personnel were trained in May, 1991, by Gary Flosi and Scott Downie. This inventory was conducted by two person teams.

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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 Bond 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 standard flow measuring equipment, if available. In some cases flows are estimated. Flows should also be measured or estimated at major tributary confluences.

2. Channel Type:

Channel typing is conducted according to the classification system developed by David Rosgen (1985). 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 four measured parameters used to determine channel type: 1) water slope gradient, 2) channel confinement, 3) width/depth ratio, 4) substrate composition.

3. Temperatures:

Both water and air temperatures are taken and recorded at each tenth unit typed. The time of the measurement is also recorded. Both temperatures are taken in 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". Bond 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. Channel dimensions were measured using hip chains, range finders, tape measures, and stadia rods. Unit measurements included mean length, mean width, mean depth, and maximum depth. Pool tail crest depth at each pool unit was measured in the thalweg. All measurements were taken in feet to the nearest tenth.

5. Embeddedness:

The depth of embeddedness of the cobbles in pool tail-out reaches is measured by the percent of the cobble that is surrounded or buried by fine sediment. In Bond 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), 76 - 100% (value 4).

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 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 Bond 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 habitat units, dominant and sub-dominant substrate elements were ocularly estimated using a list of seven size classes.

8. Canopy:

Stream canopy is estimated using handheld spherical densiometers and is a measure of the water surface shaded during periods of high sun. In Bond Creek, an estimate of the percentage of the habitat unit covered by canopy was made from the center of each unit. The area of canopy was further analyzed to estimate its percentages of coniferous or deciduous trees, and the results recorded.

9. Bank Composition:

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 Bond Creek, the dominant composition type in both the right and left banks was selected from a list of eight options on the habitat inventory form. Additionally, the percent of each bank covered by vegetation was estimated and recorded.

## BIOLOGICAL INVENTORY

Biological sampling during stream inventory is used to determine fish species and their distribution in the stream. Biological inventory is conducted using one or more of three basic methods: 1) stream bank observation, 2) underwater observation, 3) electrofishing. These sampling techniques are discussed in the *California Salmonid Stream Habitat Restoration Manual*.

Biological inventory was conducted in Bond Creek to document the fish species composition and distribution. Three sites were electrofished in Bond Creek using one Smith Root Model 12

electrofisher. Each site was end-blocked with nets to contain the fish within the sample reach. Fish from each site were counted by species, measured, and returned to the stream.

## DATA ANALYSIS

Data from the habitat inventory form are entered into Habitat Runtime, a dBASE 4.1 data entry program developed by the California Department of Fish and Game (DFG). This program also processes and summarizes the data.

The Habitat Runtime program produces the following 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 Lotus 1,2,3. Graphics developed for Bond Creek include:

- Riffle, flatwater, pool habitats by percent occurrence
- Riffle, flatwater, pool habitats by total length
- Total habitat types by percent occurrence
- Pool types by percent occurrence
- Total pools by maximum depths
- Embeddedness
- Pool cover by cover type
- Dominant substrate in low gradient riffles
- Percent canopy
- Bank composition by composition type

## HABITAT INVENTORY RESULTS

The habitat inventory of July 25 through October 7, 1991 was conducted by Brian Humphrey, Steve Liebhardt and Erick Elliot (CCC). The total length of the stream surveyed was 9,679 feet, with an additional 65 feet of side channel.

Flow was not measured on Bond Creek.

Bond Creek is a B3 channel type for 5,405 feet of stream surveyed (Reach 1), an A3 channel type for 389 feet of stream surveyed (Reach 2), a B4 channel type for 3,120 feet of stream surveyed (Reach 3), a B3 channel type for 271 feet of stream surveyed (Reach 4), and a C3 for 494 feet of stream surveyed (Reach 5). C3 channels are low gradient (<1%), meandering gravel bed

channels. B3 channels are moderate gradient (1.0-4.0%), well confined, cobble/boulder channels. B4 channels are moderate gradient (1.5-4.0%), well confined gravel/sand channels. A3 types are high gradient (4-10%), very well confined streams, with unstable stream banks.

Water temperatures ranged from 50 to 65 degrees Fahrenheit. Air temperatures ranged from 52 to 75 degrees Fahrenheit.

Table 1 summarizes the Level II riffle, flatwater, and pool habitat types. By percent occurrence, pools made up 38%, flatwater 33%, and riffles 29% (Graph 1). Flatwater habitat types made up 48% of the total survey length, riffles 28%, and pools 24% (Graph 2).

Seventeen Level IV habitat types were identified. The data are summarized in Table 2. The most frequent habitat types by percent occurrence were low gradient riffles, 27%; step runs, 23%; and mid-channel pools, 15% (Graph 3). By percent total length, step runs made up 41%, low gradient riffles 26%, and mid-channel pools 9% (Table 2).

Ninety pools were identified (Table 3). Main channel pools were most often encountered at 48%, and comprised 51% of the total length of pools (Graph 4).

Table 4 is a summary of maximum pool depths by pool habitat types. Depth is an indicator of pool quality. Sixty-two of the 90 pools (69%) had a depth of less than two feet (Graph 5).

The depth of cobble embeddedness was estimated at pool tail-outs. Of the 81 pool tail-outs measured, eight had a value of 1 (10%); 23 had a value of 2 (28%); 28 had a value of 3 (35%); and 22 had a value of 4 (27%). On this scale, a value of one is the best for fisheries (Graph 6).

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. Pool habitat types had the highest shelter rating at 59. Flatwater habitats followed with a rating of 26 (Table 1). Of the pool types, the scour pools had the highest mean shelter rating at 59. Main channel pools had a mean shelter rating of 59. Backwater pools had a mean shelter rating of 58 (Table 3).

Table 5 summarizes mean percent cover by habitat type. Large woody debris is the dominant cover type in Bond Creek. Boulders are the next most common dominant cover type. Graph 7 describes the pool cover in Bond Creek.

Table 6 summarizes the dominant substrate by habitat type. Gravel was the dominant substrate observed in 38 of the 64 low gradient riffles (59%). Small cobble was the next most frequently observed dominant substrate type, and occurred in 25% of the low gradient riffles (Graph 8).

Fifty percent of the survey reach lacked shade canopy. Of the 50% of the stream covered with canopy, 85% was composed of deciduous trees, and 15% was composed of coniferous trees. Graph 9 describes the canopy in Bond Creek.

Table 2 summarizes the mean percentage of the right and left stream banks covered with vegetation by habitat type. For the stream reach surveyed, the mean percent right bank vegetated

was 63%. The mean percent left bank vegetated was 65%. The dominant elements composing the structure of the stream banks consisted of 15% bedrock, 10% grass, 9% bare soil, 8% brush 6% boulders, and 2% cobble/gravel. Additionally, 36% of the banks were covered with deciduous trees, and 16% with coniferous trees, including downed trees, logs, and root wads (Graph 10).

## BIOLOGICAL INVENTORY RESULTS

Three sites were electrofished on October 17, 1991 in Bond Creek. The units were sampled by Erick Elliot and Brian Humphrey (CCC). All measurements are fork lengths unless noted otherwise.

The first site sampled was Habitat Units #003 through #005, a combination log enhanced scour pool, low gradient riffle and boulder formed scour pool, approximately 100 feet from the confluence with Hollow Tree Creek. This site had a combined area of 368 square feet, and volume of 220 cubic feet. The site yielded 15 steelhead/rainbow trout, ranging from 38 mm to 87 mm long.

The second site sampled was Habitat Unit #153, a corner pool, located approximately 6,117 feet above the creek mouth. This site had an area of 252 square feet, and a volume of 353 cubic feet. Thirteen steelhead/rainbow trout were sampled. They ranged from 54 mm to 159 mm long.

The third site sampled was Habitat Unit #239, a mid-channel pool, located approximately 9,679 feet above the creek mouth. The site had an area of 184 square feet, and a volume of 147 cubic feet. No fish were found.

## DISCUSSION

Bond Creek has four channel types: A3, B3, B4 and C3. The A3, B3, and B4 channel types are generally not suitable for instream enhancement structures due to their unstable stream banks. However, within these channel types are usually zones with stable stream banks where enhancement structures may be constructed. Any work considered will require careful design, placement, and construction that must include protection for the unstable banks.

The C3 channel type has a low gradient (0.5-1.0%), meandering gravel bed channel with unstable, fine textured banks. This channel type is generally not suitable for instream enhancement structures. However, bank placed boulders, bank cover, overhead log cover and shelter structures in straight reaches are often appropriate. Any work considered must take the unstable stream banks into account.

The water temperatures recorded on the survey days July 25 through October 7, 1991 ranged from 50 to 65 degrees Fahrenheit. Air temperatures ranged from 52 to 75 degrees Fahrenheit. This is a very good water temperature regime for salmonids. However, 65 degrees Fahrenheit, if sustained, is near the threshold stress level for 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 28%, and pools 24%. The pools are relatively shallow with only 28 of the 90 pools having a maximum depth greater than two feet. However, in coastal coho and steelhead streams, it is generally desirable to have primary pools comprise approximately 50% of total habitat. Therefore, installing structures that will increase or deepen pool habitat is recommended for locations where their installation will not interfere with the unstable steam banks.

Fifty of the 81 pool tail-outs measured had embeddedness ratings of 3 or 4. Only eight had embeddedness ratings of 1. Embeddedness in excess of 26%, a rating of 2 or more, is considered poor quality for fish habitat. In Bond Creek, sediment sources should be mapped and rated according to their potential sediment yields, and control measures taken.

The mean shelter rating for pools was moderate with a rating of 59. The shelter rating in the flatwater habitats was lower at 26. 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 all habitat types. Additionally, boulders and root mass contribute a small amount. Log and rootwad cover structures in the flatwater habitats are needed to improve 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.

Fifty-four of the 64 low gradient riffles had gravel or small cobble as the dominant substrate. This is generally considered good for spawning salmonids.

The mean percent canopy for the stream was 50%. This is a moderate percentage of canopy, since 80% is generally considered optimum in these north coast streams. In areas of stream bank erosion, planting endemic species of coniferous and deciduous trees, in conjunction with bank stabilization, is recommended.

## RECOMMENDATIONS

1) Bond Creek should be managed as an anadromous, natural production stream.

2) Where feasible, design and engineer pool enhancement structures to increase the number of pools. This must be done where the banks are stable or in conjunction with stream bank armor to prevent erosion.

3) Increase woody cover in the pool and flatwater habitat units. Most of the existing cover is from boulders. Adding high quality complexity with woody cover is desirable and in some areas the material is at hand.

4) Increase the canopy on Bond Creek by planting willow, alder, redwood, and Douglas fir along the stream where shade canopy is at unacceptable levels. The reaches above this

survey section should be inventoried and treated as well, since the water flowing here is effected from upstream. In many cases, planting will need to be coordinated to follow bank stabilization or upstream erosion control projects.

5) Inventory and map sources of stream bank erosion, and prioritize them according to present and potential sediment yield. Identified sites, like the site at 4486', should then be treated to reduce the amount of fine sediments entering the stream.

6) Active and potential sediment sources related to the road system need to be identified, mapped, and treated according to their potential for sediment yield to the stream and its tributaries.

## PROBLEM SITES AND LANDMARKS

The following landmarks and possible problem sites were noted. All the distances are approximate and taken from the beginning of the survey reach.

| Position (ft): | Comments: |
|---|---|
| 0' | Start of survey at confluence with Hollow Tree Creek. Reach 1 is a B3 channel type. |
| 173' | Right bank eroding, fallen trees in and above stream. |
| 874' | Fallen bridge, logs in stream. |
| 1346' | Cabled logs on left bank causing backwater measures 5' x 15' x 0.4' deep. |
| 1866' | Both banks have bare soil and fallen trees for next 125' on left bank and 150' on right bank. |
| 2635' | Cut and cabled logs on left bank. |
| 3109' | Cabled logs along both banks. |
| 3397' | Slide at end of unit measures 50' high x 30' wide. |
| 3526' | Cabled logs to bedrock on right bank. |
| 3683' | Road on right bank. Cut logs on both banks. |
| 4383' | Left bank erosion site measures 15' high x 30' wide and is contributing fine sediment to the channel. Young-of-the-year steelhead (YOY) observed. |

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4486' Right bank erosion site measures 25' high x 50' wide and is contributing fine sediment to the channel.

4733' Right bank erosion site measures 50' high x 75' wide and is contributing fine sediment to the channel.

5192' Right bank erosion site measures 15' high x 30' wide.

5334' Dry tributary enters on right bank. Culvert 50' above stream under road.

5405' Right bank erosion site measures 75' high x 35' wide and is contributing fine sediment to the channel. Channel type changes to A3 (Reach 2).

5475' Left bank erosion site measures 25' high x 5' wide. Right bank erosion site measures 60' high x 30' wide.

5688' Left bank erosion site measures 95' high x 50' wide and is contributing cobble and gravel to the channel.

5794' Channel type changes to B4 (Reach 3).

6319' Right bank erosion site measures 20' high x 70' wide and is contributing fine sediment to the channel.

6875' Left bank erosion site measures 75' high x 4' wide. CCC bank protection preventing most fines from entering stream.

7319' Right bank erosion site measures 20' high x 50' wide. Road narrows because of erosion.

8365' Left bank erosion site measures 20' high x 40' wide and is contributing fine sediment to the channel.

8556' Left bank erosion site measures 9' high x 70' wide.

8584' Left bank erosion site measures 20' high x 23' wide.

8914' Channel type changes to B3 (Reach 4).

9185' Left bank erosion site measures 55' high x 84' wide and is contributing fine sediment to the channel. Channel type changes to C3 (Reach 5).

9679' End of survey. Stream has dried up, scattered stagnant pools above this point.

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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 |