STREAM INVENTORY REPORT

BELL CREEK

INTRODUCTION

A stream inventory was conducted during the summer of 1991 on
Bell 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 Bell 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.

There is no known record of adult spawning surveys having been
conducted on Bell Creek. The objective of this report is to
document the current habitat conditions, and recommend options
for the enhancement of habitat for chinook salmon, coho salmon
and steelhead trout.

WATERSHED OVERVIEW

Bell Creek is tributary to Lawrence Creek, tributary to Yager
Creek, tributary to the Van Duzen River, tributary to the Eel
River, located in Humboldt County, California (Figure 1). Bell
Creek's legal description at the confluence with Lawrence Creek
is T3N R2E S04. Its location is 40°40'24" N. latitude and
123°57'23" W. longitude. Bell Creek is a second order stream.
The total length of blue line stream, according to the USGS
Iaqua Buttes quadrangle is 4.2 miles.

Bell Creek drains a watershed of approximately 4.72 square
miles. Elevations range from about 1,120 feet at the mouth of
the creek to 2,500 feet in the headwater areas. Redwood,
Douglas Fir and mixed hardwood forest comprise the watershed.
The watershed is owned by the Pacific Lumber Company and other
private interests, and is managed for timber production. Year
round vehicle access exists from State Highway 36 near Carlotta,
via Fisher Road, to Pacific Lumber Company's Yager Camp. The
main Yager-Lawrence Haul Road leads to Road Nine and Bell Creek,
14 miles from Yager Camp.

METHODS

The habitat inventory conducted in Bell Creek follows the methodology as presented in the California Salmonid Stream Habitat Restoration Manual (Flosi and Reynolds). The California Conservation Corps (CCC) Technical Advisors conducting the inventory were trained in standardized habitat inventory methods by the California Department of Fish and Game (DFG). Bell Creek personnel were trained in May and June, 1991, by Gary Flosi and Scott Downie. This inventory was conducted by a two person team.

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 Bell 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 was 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 operations 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. 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 used 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". Bell 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 measurements were accomplished using hip chains, range finders,

tape measures, and stadia rods. Unit measurements included mean length, mean width, mean depth, and maximum depth. Depth of the pool tail crest at each pool habitat unit was measured at 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 Bell 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 Bell 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 Bell Creek, an estimate of the percentage of the

habitat unit covered by canopy was made from the center of each
unit. The percentages of the total canopy area was then further
analyzed and recorded according to whether it was composed of
either coniferous or deciduous trees.

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 Bell 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.

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 Bell Creek to document the
salmonid species composition and distribution. Two sites were
electrofished in Bell Creek using one Smith Root Model 12
electrofisher. Fish from each site were counted by species,
measured, and returned to the stream.

SUBSTRATE SAMPLING

Gravel sampling is conducted using either a 6 or 9 inch diameter
standard McNeil gravel sampler. Sample sites are identified
numerically beginning at the most upstream site in the stream.

Gravel samples are separated and measured to determine
respective percent volume using five sieve sizes (25.4, 12.5,
4.7, 2.37, and 0.85 mm). During field analysis, fine sediment
suspended in the liquid portion of the sample is settled in
Imhoff cones for one hour, measured, and recorded on a standard
field form. The remainder of the sample is sealed in plastic
bags with an identification and information ribbon, then taken
to the laboratory for final processing.

In the laboratory the samples are wet sieved using standard

Tyler screens. All particles greater than 0.85 mm diameter are
measured by displacement in graduated cylinders. The volume of
fine sediment less than 0.85 mm is measured following one hour
of settling in graduated cylinders or Imhoff cones. The fines
measured in the field are added to these results.

Gravel sampling is conducted to determine the percentage of fine
sediment present in probable fish spawning areas. These areas
are generally found in low gradient riffles, at the tail-out of
a pool, in the thalweg. The higher the percent of fine
sediment, the lower the probability for eggs to survive to
hatch. This is due to the reduced quantity of oxygenated water
able to be percolated through the gravel, or because of the fine
sediment capping the redd and preventing fry from emerging from
the gravel.

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 Bell 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

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

The habitat inventory of September 9 and 10, 1991, was conducted by Shea Monroe and Jerry Suissa (CCC). The total length of the stream surveyed was 4,171 feet.

Flow was not measured on Bell Creek.

Bell Creek is an A3 channel type for the entire stream reach surveyed. A3 channels are steep (4-10% gradient), very well confined, coarse-grained streams, with erodible stream banks.

Water temperatures ranged from 56 to 59 degrees fahrenheit. Air temperatures ranged from 63 to 72 degrees fahrenheit.

Table 1 summarizes the riffle, flatwater, and pool habitat types. By percent **occurrence**, riffles made up 15.7%, flatwater types were 40.0%, and pools 41.4% (Graph 1). Riffles made up 14.9% of the total **length**, flatwater habitats were 56.8%, and pools 26.7% (Graph 2).

Ten habitat types were identified. The data are summarized in Table 2. The most frequent habitat types by percent **occurrence** were mid-channel pools, 31.4%; step runs, 27.1%; and low gradient riffles, 15.7% (Graph 3). By percent total **length**, step runs made up 46.7%, mid-channel pools 21.0%, and low gradient riffles pools 14.9%.

Table 3 summarizes the pool habitat types. Of these pools, 75.9% were main channel pools. These main channel pool types comprised 78.7% of the total length for all pools (Graph 4).

Table 4 (Graph 5) is a summary of maximum pool depths by pool habitat types. Depth is an indicator of pool quality. The maximum depth for 27 of the 29 pools (93%) was two feet or deeper. This level indicates a good quality of pool habitat in Bell Creek.

The depth of cobble embeddedness was estimated at the pool tail-outs. Of the 27 pool tail-outs measured, 1 had a value of 1 (3.7%); 7 had a value of 2 (25.9%); 16 had a value of 3 (59.3%); and 3 had a value of 4 (11.1%). Graph 6 describes embeddedness.

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 types had the highest shelter rating at 46.4 (Table 1). For the pool types, the backwater pools had the highest mean shelter rating at 52.5, main channel pools had a mean shelter rating of 49.6, and scour pools had a rating of 30.0 (Table 3).

Table 5 summarizes mean percent cover by habitat type. Boulders
are the dominant cover type in Bell Creek and are extensive.
Large and small woody debris are the next most common cover
types. Graph 7 describes the pool cover in Bell Creek.

Table 6 (Graph 8) describes the dominant substrate by habitat
type. Gravel was the dominant substrate observed in 45.5% of
the low gradient riffles. Large cobble was the next most
frequently observed dominant substrate type, and occurred in
27.3% of the 11 low gradient riffles.

Approximately 31% of Bell Creek lacked shade canopy. Of the 69%
of the stream that was covered with canopy, 66% was composed of
deciduous trees, and 34% was composed of coniferous trees.
Graph 9 describes the canopy in Bell Creek.

Table 2 summarizes the mean percent of the right and left stream
banks covered with vegetation by habitat unit type. For the
stream reach surveyed, the mean percent right bank vegetated was
70.2%. The mean percent left bank vegetated was 76.3%. The
elements composing the structure of the stream banks consisted
of 21.4% bedrock, 1.4% boulder, 21.4% brush, and 8.6% grass.
Additionally, 37.1% of the banks were composed of deciduous
trees, and 10.0% of coniferous trees, including downed trees,
logs, and root wads (Graph 10).

BIOLOGICAL INVENTORY RESULTS

Three sites were electrofished on Bell Creek, September 16 and
19, 1991 by Shea Monroe, Erick Elliot, and Brian Humphrey (CCC).
A total of sixty steelhead were sampled at the three sites.

The first site sampled was habitat unit 002, a glide,
approximately 63 feet above the confluence with Lawrence Creek
and just below an 8-10 foot plunge. The unit had an area of 150
sq ft and a volume of 105 cubic feet. Forty-five steelhead were
sampled. They ranged from 35 to 78 mm fork length.

The second sample site was habitat unit 004, a corner pool,
approximately 105 feet above the confluence with Lawrence Creek,
and just above an 8-10 foot plunge.   The unit had an area of
480 sq ft and a volume of 672 cubic feet. Two steelhead were
sampled. They ranged from 43 to 62 mm fork length.

The third site was a mid-channel pool, approximately 13,000 feet
upstream from the confluence with Lawrence Creek, and 8,800 feet
above the survey reach. This is also above numerous quite large
debris accumulations surveyed. Thirteen steelhead/ rainbow trout

were sampled. They ranged from 73 to 144 mm fork length.

GRAVEL SAMPLING RESULTS

No gravel samples were taken on Bell Creek.

DISCUSSION

The A3 channel type is generally not suitable for fish habitat
improvement structures. A3 channels are found in high energy,
steep gradient stream reaches. These channels are dominated by
coarse-grained materials, do not retain gravels very well, and
have unstable stream banks. Usually within the A3 channel there
are zones of lower gradient where structures designed to trap
gravels, if needed, can be constructed. This seems to be the

case in Bell Creek, but any structure sites must be selected
with care because of the high stream energy which can create
problems with stream bank erosion and structure stability.

The water temperatures recorded on the survey days Sep. 9-10,
1991 ranged from 56° F to 59° F. Air temperatures ranged from
63° F to 72° F. This is a very good water temperature regime for
salmonids. However, to make any further conclusions,
temperatures would need to be monitored throughout the warm
summer months, and more extensive biological sampling conducted.

Flatwater habitat types comprised 56.8% of the total **length** of
this survey, riffles 14.9%, and pools 26.7%. The pools are
relatively deep with 27 of the 29 pools having a maximum depth
greater than 2 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
be threatened by high stream energy, or where their installation
will not conflict with the modification of the numerous log
debris accumulations (LDA's) in the stream. The LDA's in the
system are retaining needed gravels. Any necessary
modifications to them should be done with the intent of metering
the gravels out to downstream reaches that will trap the gravel
for future spawning use. Therefore, gravel retention features
may need to be developed prior to any LDA modification.

Nineteen of the 27 pool tail-outs measured had embeddedness
ratings of 3 or 4. Only one had a 1 rating. Embeddedness in
excess of 26%, a rating of 2 or more, is considered poor quality
for fish habitat. In Bell Creek, sediment sources should be
mapped and rated according to their potential sediment yields,

and control measures taken.

The mean shelter rating for flatwater habitats was relatively
low with a rating of 38.6. The shelter rating in the pools was
slightly better at 46.4. However, a pool shelter rating of
approximately 100 is desirable. The relatively small amount of
cover that now exists is being provided primarily by boulders in
all habitat types. Additionally, large and small woody debris
contribute a small amount. Log and root wad cover structures in
the pool and flatwater habitats are needed to improve both
summer and winter salmonid habitat. Log cover structure
provides rearing fry with protection from predation, rest from
water velocity, and also divides territorial units to reduce
density related competition.

Six of the 11 low gradient riffles had gravel or small cobble as
the dominant substrate. This is acceptable to spawning
salmonids.
The mean percent canopy for the stream was 69%. This is a
relatively high percentage of canopy, since 80 percent is
generally considered desirable. In areas of stream bank erosion
the planting of endemic species of coniferous and deciduous
trees, in conjunction with bank stabilization, is recommended.

RECOMMENDATIONS

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

2)   Due to the high gradient and many LDA in the stream, access
     for migrating salmonids is an ongoing potential problem.
     The cascade 115' above the mouth is probably at least a
     selective barrier for adults, and it can be modified
     relatively easily. Since good water temperature and flow
     regimes exist in the stream, and it offers good conditions
     for rearing fish, fish passage should be monitored and
     improved where possible.

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

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

5)   There are several log debris accumulations present on Bell

Creek that are retaining large quantities of fine sediment.
They also are creating selective barriers to migrating
adult salmonids. The modification of these debris
accumulations is desirable, but must be done over time and
in a manner that will not release an overabundance of fine
sediment into the system.

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

7)   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.

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.

     0'   Survey begins at the confluence with Lawrence Creek.
           Channel type is A3 for the entire stream reach
           surveyed.

   115'   Plunge over bedrock, 8-10' high.

   299'   Log debris accumulation (LDA) 15' high x 40' wide x
           20' long, retaining gravel.

   462'   LDA 5' high x 30' wide x 5' long, retaining gravel.

   830'   Plunge over bedrock, 2.5' high, with right bank
           overflow channel.

  1095'   Channel is braided, with 60% exposed boulders.

  1202'   LDA 15' high x 50' wide x 15' long, retaining gravel.

  1573'   Left bank slump flow 70' long x 30' high, contributing
           fir and alder trees into the channel.

  1916'   LDA 7' high x 40' wide x 15' long; no barrier.

  2044'   LDA along the left bank 12' high x 15' long x 35'
           wide, retaining gravel.

2804'   LDA 15' high x 40' wide x 15' long, retaining gravel.

2864'   LDA 15' high x 40' wide x 15' long.

3079'   LDA 15' high x 70' wide x 15' long, retaining gravel.
         Channel is dry for 50'.

3094'   LDA 15' high x 50' wide x 20' long, retaining gravel.
         Channel is dry for 30'.

3383'   LDA 10' high x 10' wide x 40' long, retaining gravel.

3442'   LDA 6' high x 40' wide x 10' long, retaining gravel.

3536'   Tributary enters from the right bank.

3665'   LDA 10' high x 40' wide x 10' long, retaining gravel.

3937'   LDA 15' high x 30' wide x 12' long, retaining gravel.

4171'   Only two fish have been observed since 1,100'.
         End of survey.