STREAM INVENTORY REPORT

Benmore Creek

INTRODUCTION

A stream inventory was conducted during the summer of 1998 on Benmore Creek. 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 Benmore Creek. The objective of the biological inventory was to document the presence and distribution of juvenile salmonid species.

The objective of this report is to document the current habitat conditions, and recommend options for the potential enhancement of habitat for 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

Benmore Creek is a tributary to the Eel River, which drains to the Pacific Ocean. It is located in Lake County, California (Map 1). Benmore Creek's legal description at the confluence with the Eel River is T18N R10W S21. Its location is 39.4139 degrees north latitude and 122.9925 degrees west longitude. Benmore Creek is a second order stream and has approximately 2.5 miles of blue line stream according to the USGS Lake Pillsbury 7.5 minute quadrangle. Benmore Creek drains a watershed of approximately 6.1 square miles. Elevations range from about 1,680 feet at the mouth of the creek to 3,080 feet in the headwater areas. Mixed Conifer forest dominates the watershed. The watershed is entirely national forest and is managed for timber production and recreation. Vehicle access exists via M-8, off M-1, off Highway 20. From there, foot access is available from a trail running near the creek and providing access at two crossings at approximately habitat unit #100 and habitat unit#150.

METHODS

The habitat inventory conducted in Benmore Creek follows the methodology presented in the *California Salmonid Stream Habitat Restoration Manual* (Flosi and Reynolds, 1991 rev. 1994). The California Conservation Corps (CCC) Technical Advisors and Watershed Stewards Project/AmeriCorps (WSP/AmeriCorps) Members that conducted the inventory were trained in standardized habitat inventory methods by the California Department of Fish and Game (DFG). This inventory was conducted by a two-person team.

SAMPLING STRATEGY

The inventory uses a method that samples approximately 10% of the habitat units within the survey reach (Hopelain, 1994). All habitat units included in the survey are classified according

to habitat type and their lengths are measured. All pool units are measured for maximum depth, depth of pool tail crest, dominant substrate composing the pool tail crest, and embeddedness. Habitat unit types encountered for the first time are further measured for all the parameters and characteristics on the field form. Additionally, from the ten habitat units on each field form page, one is randomly selected for complete measurement.

HABITAT INVENTORY COMPONENTS

A standardized habitat inventory form has been developed for use in California stream surveys and can be found in the *California Salmonid Stream Habitat Restoration Manual*. This form was used in Benmore 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.

2. Channel Type:

Channel typing is conducted according to the classification system developed and revised by David Rosgen (1985 rev. 1994). This methodology is described in the *California Salmonid Stream Habitat Restoration Manual*. 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.

3. Temperatures:

Both water and air temperatures are measured and recorded at every tenth habitat unit. The time of the measurement is also recorded. Both temperatures are taken in degrees Fahrenheit at the middle of the habitat unit and within one foot of the water surface.

4. Habitat Type:

Habitat typing uses the 24 habitat classification types defined by McCain and others (1988). Habitat units are numbered sequentially and assigned a type identification number selected from a standard list of 24 habitat types. Dewatered units are labeled "dry". Benmore 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. All units were measured for mean length; additionally, the first occurrence of each unit type and a randomly selected 10% subset of all units were sampled for all features on the sampling form (Hopelain, 1995). Pool tail crest depth at each pool unit was measured in the thalweg. All measurements were 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 Benmore 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 particle size, having a bedrock tail-out, or other considerations.

6. Shelter Rating:

Instream shelter is composed of those elements within a stream channel that provide salmonids protection from predation, reduce water velocities so fish can rest and conserve energy, and allow separation of territorial units to reduce density related competition. The shelter rating is calculated for each fully-described habitat unit by multiplying shelter value and percent cover. Using an overhead view, a quantitative estimate of the percentage of the habitat unit covered is made. All cover is then classified according to a list of nine cover types. In Benmore 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 hand held 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 Benmore Creek, an estimate of the percentage of the habitat unit covered by canopy was made from the center of approximately every third unit in addition to every fully-described unit, giving an approximate 30% sub-sample. In addition, the area of canopy was estimated ocularly into percentages of coniferous or deciduous trees.

9. Bank Composition and Vegetation:

Bank composition elements range from bedrock to bare soil. However, the stream banks are usually covered with grass, brush, or trees. These factors influence the ability of stream banks to withstand winter flows. In Benmore 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 was

estimated and recorded.

BIOLOGICAL INVENTORY

Biological sampling during stream inventory is used to determine fish species and their distribution in the stream. In Benmore Creek fish presence was observed from the stream banks, and one site was electrofished using a Smith-Root Model 12 electrofisher. These sampling techniques are discussed in the *California Salmonid Stream Habitat Restoration Manual*.

DATA ANALYSIS

Data from the habitat inventory form are entered into Habitat, a dBASE 4.2 data entry program developed by Tim Curtis, Inland Fisheries Division, California Department of Fish and Game. This program processes and summarizes the data, and produces the following six tables:

- Riffle, flatwater, and pool habitat types
- Habitat types and measured parameters
- Pool types
- Maximum pool depths by habitat types
- Dominant substrates by habitat types
- Mean percent shelter by habitat types

Graphics are produced from the tables using Quattro Pro. Graphics developed for Benmore Creek include:

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

HABITAT INVENTORY RESULTS

The habitat inventory of October 6 through October 13, 1998 was conducted by Janet Lester (WSP), Paul Retherford (WSP) and Chris Ramsey (CCC). The total length of the stream surveyed was 14,950 feet.

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Flow was estimated to be less than 0.05 cfs during the survey period.

Benmore Creek is a B4 channel type for 11,348 feet of stream surveyed (Reach 1), and an A4 channel type for 3,460 feet of stream reach surveyed (Reach 2). B4 channels are moderately entrenched, moderate gradient, riffle dominated channel, with infrequently spaced pools; very stable plan and profile; stable banks and gravel dominated substrate.

Water temperatures taken during the survey period ranged from 50 to 59 degrees Fahrenheit. Air temperatures ranged from 44 to 77 degrees Fahrenheit.

Table 1 summarizes the Level II riffle, flatwater, and pool habitat types. Based on frequency of occurrence there were 40% flatwater units, 38% riffle units, and 21% pool units (Graph 1). Based on total length of Level II habitat types there were 49% flatwater units, 39% riffle units, and 11% pool units (Graph 2).

Twelve Level IV habitat types were identified (Table 2). The most frequent habitat types by percent occurrence were low gradient riffles, 27%; step runs, 25%; and runs and mid-channel pools, 12% each (Graph 3). Based on percent total length, step runs made up 36%, low gradient riffles, 29%, and runs 9%.

A total of 51 pools were identified (Table 3). Main channel pools were most frequently encountered at 61% and comprised 64% of the total length of all pools (Graph 4).

Table 4 is a summary of maximum pool depths by pool habitat types. Pool quality for salmonids increases with depth. Forty of the 51 pools (78%) had a depth of two feet or greater (Graph 5).

The depth of cobble embeddedness was estimated at pool tail-outs. Of the 51 pool tail-outs measured, three had a value of 1 (6%); 13 had a value of 2 (25%); 27 had a value of 3 (53%); three had a value of 4 (6%) and five had a value of 5 (10%); (Graph 6). On this scale, a value of 1 indicates the highest quality of spawning substrate and a value of 5 indicates the tail-out is not suitable for spawning.

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 18, flatwater habitat types had a mean shelter rating of 15, and pool habitats had a mean shelter rating of 32 (Table 1). Of the pool types, the backwater pools had the highest mean shelter rating at 85. Main channel pools had a mean shelter rating of 34 (Table 3).

Table 5 summarizes mean percent cover by habitat type. Boulders are the dominant cover type in Benmore Creek. Large and small woody debris are lacking in nearly all habitat types. Graph 7 describes the pool cover in Benmore Creek.

Table 6 summarizes the dominant substrate by habitat type. Gravel was the dominant substrate observed in 22 of the 51 pool tail outs measured (43%). Boulder was the next most frequently observed dominant substrate type and occurred in 20% of the pool tail outs (Graph 8).

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The mean percent canopy density for the stream reach surveyed was 72%. The mean percentages of deciduous and coniferous trees were 79% and 21%, respectively. Graph 9 describes the canopy in Benmore Creek.

For the stream reach surveyed, the mean percent right bank vegetated was 33%. The mean percent left bank vegetated was 37%. The dominant elements composing the structure of the stream banks consisted of 46% cobble/gravel, 32% sand/silt/clay, 18% boulders, and 4% bedrock (Graph 10). Deciduous trees were the dominant vegetation type observed in 88% of the units surveyed. Additionally, 5% of the units surveyed had brush as the dominant vegetation type, and 5% had coniferous trees as the dominant vegetation, including down trees, logs, and root wads (Graph 11).

BIOLOGICAL INVENTORY RESULTS

One site was electrofished on October 13, 1998 in Benmore Creek. The site was sampled by Janet Lester (WSP) and Chris Ramsey (CCC).

The first site sampled included Habitat Unit 11, a mid-channel pool approximately 749 feet from the confluence with the Eel River. The site yielded two young of the year steelhead/rainbow trout and 11 age 1+ steelhead/rainbow trout.

DISCUSSION

Benmore Creek is a B4 channel type for the first 11,348 feet of stream surveyed and an A4 channel type for the remaining 3,460 feet of stream surveyed. The suitability of B4 and A4 channel types for fish habitat improvement structures is as follows: B4 channel types are excellent for low-stage plunge weirs, boulder clusters, bank placed boulders, single and opposing wing-deflectors, and log cover. A4 channels are generally not suitable for fish habitat improvement projects.

The water temperatures recorded on the survey days October 6 through October 13 1998 ranged from 44 to 77 degrees Fahrenheit. Air temperatures ranged from 50 to 59 degrees Fahrenheit. This is a moderate water temperature range for salmonids. However, 60 degrees Fahrenheit, if sustained, is near the threshold stress level for salmonids. This does not seem to be the case here, and Benmore Creek seems to have temperatures favorable to 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 39% of the total length of this survey, riffles 49%, and pools 11%. The pools are relatively deep, with 40 of the 51 (78%) pools having a maximum 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 depth of at least two feet, occupy at least half the width of the low flow channel, and be as long as the low flow channel width. Installing

structures that will increase or deepen pool habitat is recommended 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 gravel. Any necessary modifications to them should be done with the intent of metering the gravel 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.

Three of the 51 pool tail-outs measured had an embeddedness rating of 1. Thirty of the pool tail-outs had embeddedness ratings of 3 or 4. Five of the pool tail-outs had a rating of 5, which is considered not suitable for spawning. One of the five was not suitable for spawning due to the dominant substrate being silt/sand/clay or gravel being too small to be suitable. Cobble embeddedness measured to be 25% or less, a rating of 1, is considered to indicate good quality spawning substrate for salmon and steelhead. In Benmore Creek, sediment sources should be mapped and rated according to their potential sediment yields, and control measures should be taken.

The mean shelter rating for pools was low with a rating of 32. The shelter rating in the flatwater habitats was slightly lower at 15. 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, terrestrial vegetation contributed 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 structures provide rearing fry with protection from predation, rest from water velocity, and also divide territorial units to reduce density related competition.

Thirty of the 51 pool tail outs measured had gravel or small cobble as the dominant substrate. This is generally considered good for spawning salmonids.

The mean percent canopy density for the stream was 72%. This is a relatively low percentage of canopy. In general, revegetation projects are considered when canopy density is less than 80%.

The percentage of right and left bank covered with vegetation was low at 33% and 37%, respectively. In areas of stream bank erosion or where bank vegetation is at unacceptable levels, planting endemic species of coniferous and deciduous trees, in conjunction with bank stabilization, is recommended.

RECOMMENDATIONS

1) Benmore 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) 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.

5) 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.

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.

7) Increase the canopy on Benmore Creek by planting willow, alder, redwood, and Douglas fir along the stream where shade canopy is not at acceptable 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 upslope erosion control projects.

8) Suitable size spawning substrate on Benmore Creek is limited to relatively few reaches. Projects should be designed at suitable sites to trap and sort spawning gravel.

9) There are several **(3?)** log debris accumulations present on Benmore Creek that are retaining large quantities of fine sediment. The modification of these debris accumulations is desirable, but must be done carefully, over time, to avoid excessive sediment loading in downstream reaches.

10) There are sections where the stream is being impacted from cattle trampling the riparian zone. Alternatives should be explored with the grazier and developed if possible.

11) Due to the high gradient of the stream, access for migrating salmonids is an ongoing potential problem. 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.

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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):	Comments:
0'	Start of survey at confluence with Eel River. Channel type is B4.
196'	Approximately 20’ right and left banks covered with sand bags.
235'	Bridge approx. 40' above creek.
749'	Electrofishing site #1.
996'	Crayfish observed.
1093'	Salmonids observed.
1838'	41' long left bank failure.
1898'	Salmonids observed.
3708'	Age 2+, age 1+ and young-of-the-year salmonids observed.
4073'	Dry tributary left bank.
4542'	Right bank failure depositing debris and holding sediment measures 80' high x 80' long.
4696'	Log debris accumulation (LDA) measures 10' high x 10' long and holding approx. 8' of sediment.
4809'	Salmonids observed.
5787'	Salmonids observed.
6160'	Salmonids observed.
7005'	Age 1+ Salmonids observed.
7436'	Bank failure measures 80' long x 20' high.
7779'	LDA measures 6' high x 20' wide x 10' long. Right bank failure.

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8329' Trail enters creek right bank.

8382' Dry tributary right bank.

8554' Left bank tributary.

10149' 20’ high cascade with no jump pool below it.

12405' LDA is composed of five pieces of large woody debris (LWD) and measures 5' high x 5' long x 30' wide. It is retaining sediment.

12470' LDA is composed of two pieces of LWD and measures 4' high x 30' wide x 5' long.

12546' Right bank tributary.

13040' LDA measures 3' high x 15' wide x 10' long.

13210' Right bank tributary.

13304' LDA is composed of two pieces of LWD and measures 5' high x 15' wide x 5' long. Right bank failure.

13982' Tributary.

14238' LDA measures 6.5' high x 7' wide x 5' long and is retaining sediment.

14385' LDA is composed of 15 pieces of LWD and measures 5' high x 15' wide x 20' long. It is retaining sediment.

14607' Creek forks, tributary enters right bank.

14847' End of survey, becomes very steep, no water.

REFERENCES

Flosi, G., and F. Reynolds. 1994. *California Salmonid Stream Habitat Restoration Manual*, 2nd edition. California Department of Fish and Game, Sacramento, California.

Hopelain, J. 1995. Sampling levels for fish habitat inventory, unpublished manuscript. California Department of Fish and Game, Inland Fisheries Division, Sacramento, California.

Valentine, B. 1995. Stream substrate quality for salmonids: guidelines for sampling, processing, and analysis, unpublished manuscript. California Department of Forestry and Fire Protection, Santa Rosa, California.

LEVEL III and LEVEL IV HABITAT TYPE KEY

HABITAT TYPE	LETTER	NUMBER
RIFFLE		
Low Gradient Riffle	[LGR]	1.1
High Gradient Riffle	[HGR]	1.2
CASCADE		
Cascade	[CAS]	2.1
Bedrock Sheet	[BRS]	2.2
FLATWATER		
Pocket Water	[POW]	3.1
Glide	[GLD]	3.2
Run	[RUN]	3.3
Step Run	[SRN]	3.4
Edgewater	[EDW]	3.5
MAIN CHANNEL POOLS		
Trench Pool	[TRP]	4.1
Mid-Channel Pool	[MCP]	4.2
Channel Confluence Pool	[CCP]	4.3
Step Pool	[STP]	4.4
SCOUR POOLS		
Corner Pool	[CRP]	5.1
Lateral Scour Pool - Log Enhanced	[LSL]	5.2
Lateral Scour Pool - Root Wad Enhanced	[LSR]	5.3
Lateral Scour Pool - Bedrock Formed	[LSBk]	5.4
Lateral Scour Pool - Boulder Formed	[LSBo]	5.5
Plunge Pool	[PLP]	5.6
BACKWATER POOLS		
Secondary Channel Pool	[SCP]	6.1
Backwater Pool - Boulder Formed	[BPB]	6.2
Backwater Pool - Root Wad Formed	[BPR]	6.3
Backwater Pool - Log Formed	[BPL]	6.4
Dammed Pool	[DPL]	6.5