STREAM INVENTORY REPORT

Broaddus Creek

INTRODUCTION

A stream inventory was conducted during the summer of 1995 on Broaddus 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 Broaddus 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 on Broaddus Creek by the California Department of Fish and Game (DFG) from 1987 through 1989. The table below describes the results of those surveys:

Broaddus Creek Carcass Surveys 1987 1989

	Chinook Salmon				Other		
Year	# of Surveys	Live Fish	# of Carcass	Adipose ClipCWT	Redds seen	Coho seen	SH/RT seen
1987	1	26	12	2	0	24	0
1988	1	0	1	0	1	0	0
1989	1	0	0	0	4	0	0

Two carcasses found on a survey December 18, 1987 had adipose fin clips; of these, both had coded wire tags (CWT) # H-60701 in their snouts. This CWT brood lot originated in Outlet Creek in 1985, were reared at the Silverado facility near Yountville, and released into Outlet Creek as smolts. The objective of this report is to document the current habitat conditions in Broaddus Creek, and recommend options for the enhancement of habitat for chinook salmon, coho salmon and steelhead trout.

WATERSHED OVERVIEW

Broaddus Creek is tributary to Outlet Creek, tributary to the Mainstem Eel River, located in Mendocino County, California. Broaddus Creek's legal description at the confluence with

Outlet Creek is T18N R13W S18. Its location is 39°25'14" N. latitude and 123°20'22" W. longitude. Broaddus Creek is a second order stream and has approximately 6.27 miles of blue line stream according to the USGS Willits and Burbeck 7.5 minute quadrangles. Broaddus Creek drains a watershed of approximately 7.95 square miles. Summer base runoff is approximately 0.47 cubic feet per second (cfs) at the mouth. Elevations range from about 1340 feet at the mouth of the creek to 2000 feet in the headwater areas. Mixed hardwood forest dominates the watershed. The watershed is privately owned and is managed for rangeland. Approximately one fifth of the watershed is within Willits city limits. Vehicle access exists via Highway 101, Commercial St, East Valley Rd, and Highway 20.

METHODS

The habitat inventory conducted in Broaddus 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 members that conducted the inventory were trained in standardized habitat inventory methods by the California Department of Fish and Game (DFG). The two person Broaddus Creek survey team were trained in May, 1995, by Scott Downie and Ruth Goodfield.

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 Broaddus 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 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 each tenth unit typed. 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". Broaddus 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 measured for mean width, mean depth, and maximum depth (*Sampling Levels for Fish Habitat Inventory*, Hopelain, 1995). 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 Broaddus 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). Additionally, a rating of "not suitable" (NS) was assigned to tail-outs deemed unsuited 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 Broaddus 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.

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 Broaddus 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. The area of canopy was further analyzed to estimate its percentages of coniferous or deciduous trees, and the results were recorded.

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 Broaddus Creek, the dominant composition type (options 1-4) and the dominant vegetation type (options 5-9) 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. Biological inventory is conducted using one or more of three basic methods: 1) stream bank observation, 2) underwater observation, or 3)

electrofishing. These sampling techniques are discussed in the *California Salmonid Stream Habitat Restoration Manual*.

Biological inventory was conducted in Broaddus Creek to document the fish species composition and distribution. One site was electrofished in Broaddus Creek using one Smith-Root Model 12 electrofisher. A single electrofishing pass was made at this site. Fish were counted by species and age class and returned to the stream.

SUBSTRATE SAMPLING

Gravel sampling is conducted using a 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 0.85mm (*Stream Substrate Quality for Salmonids: Guidelines for Sampling, Processing, and Analysis*, Valentine, 1995).

DATA ANALYSIS

Data from the habitat inventory form are entered into Habitat7.2, 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 4. Graphics developed for Broaddus 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

- Bank vegetation by vegetation type

HABITAT INVENTORY RESULTS

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

The habitat inventory of July 7, 19, and 25, 1995, was conducted by Brie Darr (CCC), and Jennifer Terwilliger (AmeriCorps/WSP). The total length of the stream surveyed was 14,697 feet with an additional 207 feet of side channel.

Flow was measured at the bottom of the survey reach with a Marsh-McBirney Model 2000 flowmeter at 0.47 cfs on July 20, 1995.

Broaddus Creek is a G5 channel type for the first 7,037 feet, and an F4 for the remaining 7,660 feet of stream reach surveyed. G5 channels have a moderate gradient (2-4% gradient), with entrenched "gully" stream banks. F4 channel types have a low gradient (less than 2%), with well entrenched stream banks.

Water temperatures ranged from 58 to 75° Fahrenheit. Air temperatures ranged from 60 to 85° Fahrenheit.

Table 1 summarizes the Level II riffle, flatwater, and pool habitat types. By percent **occurrence**, pools made up 38%, flatwater types 32%, and riffles 30% (Graph 1). Pool habitat types made up 41% of the total survey **length**, flatwater 40%, and riffles 19% (Graph 2).

Three hundred and fifty Level IV habitat types were identified. These data are summarized in Table 2. The most frequent habitat types by percent **occurrence** were mid-channel pools, 31%; low gradient riffles, 30%; and runs, 29% (Graph 3). By percent total **length**, mid-channel pools made up 36%, runs 28%, and low gradient riffles 19%.

One hundred and thirty-two pools were identified (Table 3). Main pools were most often encountered at 83% and comprised 88% 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 132 pools (47%) had a 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, 40 had a value of 1 (30%); 24 had a value of 2 (18%); 33 had a value of 3 (25%); and 34 had a value of 4 (26%). On this scale, a value of 1 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 range of 0-300. Pool habitat types had the highest shelter rating at 11. Flatwater habitats followed with a rating of 10 (Table 1). Of the pool types, the main pools had the highest mean shelter rating at 11, and backwater pools rated 10.
Table 5 summarizes mean percent cover by habitat type. Terrestrial vegetation is the dominant cover type in Broaddus Creek. Large woody debris is lacking in nearly all habitat types. Graph 7 describes the pool cover in Broaddus Creek.

Table 6 summarizes the dominant substrate by habitat type. Gravel was the dominant substrate observed in 13 of the 17 low gradient riffles measured (76%). Sand was the next most frequently observed dominant substrate type and occurred in 18% of the low gradient riffles (Graph 8).

The mean percent canopy for the stream reach surveyed was 74%. The mean percentages of deciduous and coniferous trees were 72.5% and 1.5%, respectively. Graph 9 describes the canopy in Broaddus Creek.

For the stream reach surveyed, the mean percent right bank vegetated was 66%. The mean percent left bank vegetated was 65%. The dominant elements composing the structure of the stream banks consisted of 2% bedrock, 33% cobble/gravel, and 65% sand/silt/clay (Graph 10). Deciduous trees were the dominant vegetation type observed in 59% of the units surveyed. Additionally, one percent of the units surveyed had coniferous trees as the dominant vegetation, including down trees, logs, and root wads (Graph 11).

BIOLOGICAL INVENTORY RESULTS

One site was electrofished on July 20, 1995, in Broaddus Creek. The units were sampled by Ruth Goodfield (DFG) and Brie Darr (CCC).

The site sampled was habitat unit 6, a lateral scour pool, root wad enhanced approximately 120 feet from the confluence with Outlet Creek. This site had an area of 396 sq ft and a volume of 237 cu ft. The unit yielded two steelhead young-of-year (YOY), six Sacramento squawfish fry, nine roach, and 17 shiner.

GRAVEL SAMPLING RESULTS

No gravel samples were taken on Broaddus Creek.

DISCUSSION

Broaddus Creek is a G5 channel type for the first 7,037 feet of stream surveyed and an F4 for the remaining 7,660 feet. The suitability of G5 channel types for fish habitat improvement structures is good for bank-placed boulders, fair for low-stage weirs, opposing wing-deflectors, and log cover structures. F4 channel types are good for bank-placed boulders, and fair for low-stage weirs and log cover structures.

The water temperatures recorded on the survey days July 7, 19, and 25, 1995, ranged from 58 to 75° Fahrenheit. Air temperatures ranged from 60 to 85° Fahrenheit. This is a poor water temperature range for salmonids. These higher water temperatures, if sustained, are near the threshold stress level for salmonids. To make any further conclusions, temperatures would need to be monitored throughout the warm summer months, and more extensive biological sampling would need to be conducted.

Flatwater habitat types comprised 40% of the total **length** of this survey, riffles 19%, and pools 41%. The pools are relatively deep, with 62 of the 132 pools having a maximum depth greater than 2 feet. In coastal coho and steelhead streams, it is generally desirable to have primary pools comprise approximately 50% of total 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.

Seventy-seven of the 131 pool tail-outs measured had embeddedness ratings of 3 or 4. Only 40 had a 1 rating. Cobble embeddedness measured to be 25% or less, a rating of 1, is considered best for the needs of salmon and steelhead. In Broaddus 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 11. The shelter rating in the flatwater habitats was slightly lower at 10. A pool shelter rating of approximately 100 is desirable. The relatively small amount of cover that now exists is being provided primarily by terrestrial vegetation in all habitat types. Additionally, root wads 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.

Fourteen of the 17 low gradient riffles measured 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 74%. This is a relatively high percentage of canopy, since 80 percent is generally considered optimum in these north coast streams.

The percentage of right and left bank covered with vegetation was moderate at 66% and 65%, respectively. In areas of stream bank erosion or where bank vegetation is not at acceptable levels, planting endemic species of coniferous and deciduous trees, in conjunction with bank stabilization, is recommended.

RECOMMENDATIONS

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

2) Temperatures in this section of Broaddus Creek, as well as upstream, should be monitored to determine if they are having a deleterious effect upon juvenile salmonids. To achieve this, biological sampling is also required.

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

4) Inventory and map sources of stream bank erosion and prioritize them according to present and potential sediment yield. Identified sites, like the site at 11,333', should then be treated to reduce the amount of fine sediments entering the stream.

5) 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.

6) There is at least one sections where the stream is being impacted from sheep trampling the riparian zone and defecating in the water. Alternatives should be explored

with the grazier and developed if possible.

PROBLEM SITES AND LANDMARKS

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

0'	Begin survey at confluence with Outlet Creek. Reach 1 is a G5 channel type.
120'	Bioinventory site #1.
461'	A structure utilizing concrete slabs is in the stream.
651'	Armoring on the left bank (LB).
1771'	Overflow culvert on the right bank (RB).
3463'	Drainage gate or "culvert" on the LB.
3661'	Drainage pipe on the LB.
3878'	Culvert on the RB, two feet in diameter.
3928'	Commercial Road bridge crosses creek.
4223'	Sporadic armoring on both banks.
4522'	An old culvert two feet in diameter is on the RB.
5095'	A small tributary enters from the LB.
5372'	Railroad bridge crosses creek.
5559'	Fish habitat structure observed. Origin unknown.
5613'	East Valley Road bridge crosses creek - there is also a small rock weir in the stream.
5900'	Culvert on the LB, one foot in diameter.
5966'	Rip rap on the RB.
6590'	Highway 101 bridge.
7037'	The channel type changes from a G5 to an F4 (reach 2) for the remaining 7660' of stream surveyed.

7164' The RB is starting to slide into the stream.

8117' Bank stabilization structure on the RB.

9044' Structure instream.

9127' Structure instream.

9190' Structure instream.

9270' Highway 20 bridge crosses creek.

9505' Gravel mining operation on the RB.
9545' Structure instream.

9863' Two foot diameter culvert on the RB.

9915' Blosser Lane Bridge crosses creek.

10026' Structure instream.

10084' Structure instream.

10136' Structure instream.

10283' Structure instream.

10485' Rip rap on the RB, structure instream.

10588' Structure instream.

10700' Structure instream.

10810' Railroad bridge crosses creek.

11097' Structure instream.

11247' Structure instream.

11290' Cropley Rd bridge.

11333' Slide on the RB, 10'H X 15'W.

11492' Structure instream.

11717' Evidence of sheep grazing.

14697' Access denied by landowner. End of survey.

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