STREAM INVENTORY REPORT

Outlet Creek

INTRODUCTION

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

Adult carcass surveys were conducted on Outlet Creek by the California Department of Fish and Game (DFG) from 1987 through 1989. The table below describes the results of those surveys:

Outlet 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	76	63	0	2	3	0
1988	3	386	693	11	98	40	0
1989	1	3	51	0	1	0	2

Six carcasses found on the surveys of 12/08/88 and 12/19/88 had adipose fin clips; five of these fish bore coded wire tag (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. One of the adipose clipped carcasses bore CWT # 065013 in its snout. This brood lot originated in Hollow Tree Creek in 1983, were reared at the Van Arsdale facility, and released into the South Fork Eel River near Leggett. No coded wire tags were found in five of the adipose fin clips.

The drought related low flows during prime migration periods from 1989 through 1992 made Outlet Creek, typical of many Eel River streams, inaccessible to most chinook salmon. The objective of this report is to document the current habitat conditions in

Outlet Creek, and recommend options for the enhancement of habitat for chinook salmon, coho salmon and steelhead trout.

WATERSHED OVERVIEW

Outlet Creek is tributary to the Eel River, located in Mendocino County, California. Outlet Creek's legal description at the confluence with the Eel River is T21N R13W S31. Its location is 39°37'36" N. latitude and 123°20'37" W. longitude. Outlet Creek is a third order stream and has approximately 52 miles of blue line stream according to the USGS Dos Rios, Willis Ridge, Longvale, Burbeck, and Willits 7.5 minute quadrangles. Outlet Creek drains a watershed of approximately 158 square miles. Summer base runoff is approximately 1.0 cubic feet per second (cfs) at the mouth, but over 500 cfs is not unusual during winter storms. Elevations range from about 360 feet at the mouth of the creek to 1,400 feet in the headwater areas. Mixed conifer forest dominates the watershed. The watershed is privately owned and is managed for urban development, timber production, and rangeland. Vehicle access exists from Longvale on Highway 101 east via state Highway 162, approximately 12 miles to the mouth of Outlet Creek.

METHODS

The habitat inventory conducted in Outlet 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). Outlet Creek personnel were trained in May, 1995, by Gary Flosi. 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. 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 Outlet 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. Additionally, two recording thermographs were deployed in Outlet Creek from August 17 to 31 (lower reach), and from September 12 to October 9, 1995 (upper reach), to record temperatures on a 24 hour basis during warm summer months.

4. Habitat Type:

Outlet Creek

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". Outlet 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 Outlet 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 Outlet 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 density was estimated using modified handheld spherical densiometers as described in the *California Salmonid Stream Habitat Restoration Manual*, 1994. Canopy density relates to the amount of stream shaded from the sun. In Outlet 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 Outlet 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. In Outlet Creek fish presence was observed from the stream banks, and two sites were electrofished using one Smith-Root Model 12 electrofisher. These sampling techniques are discussed in the *California Salmonid Stream Habitat Restoration Manual*.

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 0.85 mm)(Valentine, 1995).

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 Lotus 1,2,3. Graphics developed for Outlet 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

Outlet Creek

HABITAT INVENTORY RESULTS

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

The habitat inventory of August 17 to September 20, 1995, was conducted by Jeffrey Jahn, Kyra Short, Dylan Brown, and Ray Bevitori (AmeriCorps and PCFWWRA). The survey began at the confluence with the Eel River. The total length of the stream surveyed was 91,874 feet with an additional 5,515 feet of side channel.

Flow was estimated to be 1.0 cfs during the survey period.

Outlet Creek is an F3 channel type for the first 82,240 feet of stream reach surveyed, and a G4 channel type for the remaining 9,634 feet surveyed. F3 channels are entrenched, meandering, riffle/pool channels on low gradients with high width/depth ratios and cobble-dominant substrates. G4 channels are entrenched, "gully" step-pool type streams, with a low width/depth ratio on a moderate gradient.

Water temperatures taken during the survey period ranged from 58 to 80 degrees Fahrenheit. Air temperatures ranged from 56 to 94 degrees Fahrenheit. Water temperatures taken with recording thermographs deployed from August 17 to October 9, 1995, ranged from a low of 61° to a high of 77° Fahrenheit.

Table 1 summarizes the Level II riffle, flatwater, and pool habitat types. Based on frequency of **occurrence** there were 38% flatwater units, 31% pool units, 30% riffle units, and 1% dry units (Graph 1). Based on total **length** of Level II habitat types there were 58% pool units, 29% flatwater units, 9% riffle units, and 4% dry units (Graph 2).

Sixteen Level IV habitat types were identified (Table 2). The most frequent habitat types by percent **occurrence** were runs, 33%; riffles, 30%; and mid-channel pools, 28% (Graph 3). Based on percent total **length**, mid-channel pools made up 57%, runs 19%, and low gradient riffles 9%.
A total of two hundred and twenty-five pools were identified (Table 3). Mid-channel pools were most frequently encountered at 92% and comprised 98% of the total length of all pools (Graph 4).

Outlet Creek

Table 4 is a summary of maximum pool depths by pool habitat types. Pool quality for salmonids increases with depth. Two hundred and eleven of the 225 pools (98%) had a depth of two feet or greater (Graph 5).

The depth of cobble embeddedness was estimated at pool tail-outs. Of the 164 pool tail-outs measured, 14 had a value of 1 (9%); 45 had a value of 2 (27%); 53 had a value of 3 (32%); and 52 had a value of 4 (32%) (Graph 6). On this scale, a value of 1 indicates the highest quality of spawning substrate.

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 a mean shelter rating of 26, and flatwater habitats had a mean shelter rating of 17 (Table 1). Of the pool types, the scour pools had the highest mean shelter rating at 35. Main channel pools had a mean shelter rating of 26 (Table 3).

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

Table 6 summarizes the dominant substrate by habitat type. Gravel was the dominant substrate observed in 23 of the 29 low gradient riffles measured (79%). Small cobble was the next most frequently observed dominant substrate type and occurred in 14% of the low gradient riffles (Graph 8).

The mean percent canopy density for the stream reach surveyed was 54%. Of that canopy 85% was deciduous, and 15% coniferous. Graph 9 describes the canopy in Outlet Creek.

For the stream reach surveyed, the mean percent right bank vegetated was 50%. The mean percent left bank vegetated was 55%. The dominant elements composing the structure of the stream banks consisted of 10.6% bedrock, 15.0% boulder, 39.8% cobble/gravel, and 34.6% sand/silt/clay (Graph 10). Grass was the dominant vegetation type observed in 12% of the units surveyed. Additionally, 75.2% of the units surveyed had deciduous trees as the dominant vegetation type, and 0.4% had coniferous trees as the dominant vegetation, including down

trees, logs, and root wads (Graph 11).

BIOLOGICAL INVENTORY RESULTS

Two sites were electrofished on September 7 and 13, 1995, in Outlet Creek. The sites were sampled by Jeffrey Jahn and Ruth Goodfield (AmeriCorps and DFG).

The first site sampled included habitat units 162-163, a run/riffle sequence, approximately 42,330 feet from the confluence with the Eel River. This site had an area of 2,852 sq ft and a volume of 1,996 cu ft. The site yielded 52 California roach, ranging from 41mm to 71mm FL; four amocetes; and four juvenile steelhead, ranging from 43mm to 117mm FL.

The second site included habitat unit 639, a mid-channel pool, located approximately 60 feet below the stream gaging station east of the City of Willits sewage treatment plant. This site had an area of 1,224 sq ft and a volume of 1,224 cu ft. The site yielded one amocete measured at 100mm; 144 stickleback, approximately 30mm each; 17 steelhead, ranging from 65mm to 122mm FL.

GRAVEL SAMPLING RESULTS

No gravel samples were taken on Outlet Creek.

DISCUSSION

Outlet Creek is an F3 channel type for the first 82,240 feet of stream surveyed and a G4 for the remaining 9,634 feet. The suitability of both F3 and G4 channel types for fish habitat improvement structures is good for bank-placed boulders and single or opposing wing-deflectors; and fair for channel constrictors, low-stage weirs, and log cover structures.

The water temperatures recorded on the survey days August 17 to September 20, 1995, ranged from 58 to 80 degrees Fahrenheit. Air temperatures ranged from 56 to 94 degrees Fahrenheit. This is a warm water temperature range for salmonids. These warmer

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 38% of the total **length** of this survey, riffles 30%, and pools 31%. The pools are relatively deep, with 156 of the 225 (69%) pools having a maximum depth greater than 3 feet. In general, pool enhancement projects are considered when primary pools comprise less than 40% of the length of total stream habitat. In third and fourth order streams, a primary pool is defined to have a maximum depth of at least three 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 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.

One hundred and five of the 164 pool tail-outs measured had embeddedness ratings of 3 or 4. Only 14 had a 1 rating. 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 Outlet 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 26. The shelter rating in the flatwater habitats was slightly lower at 17. 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 and aquatic vegetation 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.

Twenty-seven of the 29 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 density for the stream was 54%. This is a relatively low percentage of canopy. In general, re-vegetation projects are considered when canopy density is less than 80%.

The percentage of right and left bank covered with vegetation was moderate at 50% and 55%, 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) Outlet Creek should be managed as an anadromous, natural production stream.

2) The limited water temperature data available suggest that maximum temperatures are above 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) Increase the canopy on Outlet 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.

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 locally available.

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.

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 the Eel River. Channel type is an F3 for the first 82,240' of survey.
352'	Railroad trestle spans creek.
1248'	Channel type taken in this unit.
3465'	Numerous Sacramento squawfish observed by surveyors.
4412'	Small intake hose in creek.
6099'	Tributary enters from right bank (RB). Temperature is 60° F.
9425'	Recording thermograph placement from 9/12 to 10/9/95.
10461'	Spring on left bank (LB). Temperature is 74° F.
13068'	Railroad trestle spans creek.
13808'	Railroad trestle spans creek.
14576'	Tributary enters from LB - 74° F.
16891'	Intake hose from small pump observed in stream.
20169'	Railroad flatcar bridge spans creek.
26688'	Numerous Sacramento squawfish observed by surveyors.

Outlet Creek

32943' Large gravel extraction operation on RB. Dry units in Outlet Creek due to water being pumped into gravel yard.

33849' Water from Corral Creek being pumped into gravel extraction operation to wash gravel.

38021' Small gravel pits observed.

39038' Dirt road fords stream.

40876' Highway 162 bridge spans stream.

41657' Railroad flatcar bridge spans stream.

44891' Confluence with Long Valley Creek. Jeffrey Jahn and Ruth Goodfield continue survey.

45139' Boulder rip-rap on LB for the next 400'.

47796' Lateral erosion on RB - contributing fines directly into the stream.

49051' Dry tributary enters from LB.

49611' Highway 101 bridge spans creek.

51516' Boulder rip-rap observed on RB for the next 700'.

56454' Railroad trestle spans creek.
56630' Dry tributary enters from LB.

57465' Spring on LB. 1+ steelhead rainbow trout observed.

57549' Spring on LB.

58004' Small tributary enters from LB.

Outlet Creek

58431' Large debris accumulation (LDA) on RB - not a barrier for migrating fish.

59683' Steelhead, 14-18 inches, observed by surveyors. Fish was very beat-up, lethargic.

60277' Dry tributary enters from RB.

60599' Dry tributary enters from RB.

62249' Spring on LB.

62580' Dirt road fords stream.

62655' Dirt road fords stream.

64887' Boulder rip-rap on RB along freeway.

66646' Railroad flatcar bridge spans stream.

67568' Dry tributary enters from LB.

68796' Tributary enters from LB.

69711' Railroad flatcar bridge spans stream.

70176' Small tributary enters from LB.

71148' Dry tributary enters from RB.

72331' Channel type measurements taken here.

72776' Spring on RB.

75510' Railroad mile marker 146.

77256' Railroad trestle spans stream.

79388' Boulder rip-rap on RB.

80119' Dry tributary on RB. Ryan Creek also enters from RB - dry at the mouth.

81219' Dry tributary enters from RB.

Outlet Creek

82510' Outlet Creek begins to look more like a series of duck ponds than a creek. Cattails, duckweed are dominant cover type.

84859' Dry tributary enters from RB. Railroad flatcar bridge spans creek.

84870' Dry tributary enters from LB.

87065' Dry tributary enters from RB. Lateral erosion on LB, approximately 75'. Several bay trees fallen into channel.

87500' Railroad trestle spans stream.

87612' Highway 101 bridge spans stream.

91317' Dry tributary enters from RB. Water in Outlet Creek is small, intermittent pools.

91454' LDA - approximately 25' long X 20' wide X 4' high. Doesn't appear to be a barrier to fish.

91874' Dry tributary enters from LB. Very little water, even in the pools. Area becomes a shallow lake in the winter, and drains away quickly in the summer. End of survey.

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