SALMON AND STEELHEAD RESTORATION AND ENHANCEMENT PROGRAM

NORTH COAST

WATERSHED PLANNING and COORDINATION PROJECT

STREAM INVENTORY REPORT

COOPER MILL CREEK, EEL RIVER, 1996

CALIFORNIA DEPARTMENT OF FISH AND GAME

SPORT FISH RESTORATION ACT

1996

STREAM INVENTORY REPORT

NORTH COAST WATERSHED PLANNING and COORDINATION PROJECT

The North Coast Watershed Planning and Coordination Project (NCWPCP), formerly the Basin Planning Project (BPP), was begun in 1991 to develop salmon and steelhead restoration and enhancement programs in North Coast watersheds for the Department of Fish and Game (DFG). The objectives of the project conform with the goals of California's Salmon and Steelhead Restoration and Enhancement Program of 1988. The Restoration Program strives to enhance the status of anadromous salmonid populations and improve the fishing experience for Californians. The program intends to achieve a doubling of the population of salmon and steelhead by the year 2000. The project is supported by the Sport Fish Restoraion Act, which uses sport fishermen's funds to improve sport fisheries.

The NCWPCP conducts stream and habitat inventories according to the standart methodologies discussed in the *California Salmonid stream Habitat Restoration Manual,* (Flosi et.al., 1998). Biological sampling is conducted using electrofishbing and direct observation to determine species presence and distribution; selected streams are electrofished for population estimates. Some streams are also sampled for sediment composition. Collected information is used for base-line data, public cooperation development, restoraion program planning, specific project design and implementation, and for project evaluation.

The Eel River system was identified as the initial basin for project planning activities. Most anadromous tributaries to the Van Duzen, South Fork Eel, Mainstem Eel, Middle Fork Eel, and the North Fork Eel rivers have been inventoried since 1991. Initial field inventory of the Eel River system should be essentially complete in 1996. NCWPCP personnel have also worked in cooperation with the DFG Salmon Restoration Project's staff to inventory streams on the Mattole River, Mendocino Coast, and Humboldt Bay.

STREAM INVENTORY REPORT
COOPER MILL CREEK, EEL RIVER

INTRODUCTION

A stream inventory was conducted during the summer of 1995 on Cooper Mill 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 Cooper Mill 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 improvement recommendations are presented.

Adult carcass surveys were conducted on Cooper Mill Creek by the California Department of Fish and Game (DFG) from 1987 through 1995. The table below describes the results of those surveys:

Cooper Mill Creek Carcass Surveys 1987-1995

		Chinook Salmon				Other	
Year	# of Surveys	Live Fish	# of Carcass	AdiposeClipCWT	Redds seen	Coho seen	SH/RT seen
1987-88	1	0	41	0	20	0	0
1988-89	3	14	21	0	14	0	0
1989-90	1	0	0	0	1	0	0
1990-91	0	0	0	0	0	0	0
1991-92	0	0	0	0	0	0	0
1992-93	4	37	6	0	34	0	8
1993-94	0	0	0	0	0	0	0
1994-95	1	0	0	0	0	0	0

No carcasses with adipose fin clips or coded wire tags (CWT) have been found on Cooper Mill Creek. The drought related low flows during prime migration periods from 1989 through 1992 made Cooper Mill Creek, typical of many Van Duzen tributaries, inaccessible to most chinook salmon. However, in 1992-93 plenitful access flows occurred. Additionally, a fishway was constructed at the mouth of the creek during the summer of 1990 to promote passage of fish at a wider range of flows. In January, 1991 three chinook were found in Cooper Mill Creek by an employee of Pacific Lumber Company. A great deal of bank stabilization and barrier modification work has been carried out in Cooper Mill Creek during the past five years. The objective of this report is to document the current habitat conditions in Cooper Mill Creek, and recommend options for the enhancement of habitat for chinook salmon, coho salmon and steelhead trout.

WATERSHED OVERVIEW

Cooper Mill Creek is tributary to the Yager Creek, Van Duzen River, tributary to the Eel River, located in Humboldt County, California. Cooper Mill Creek's legal description at the confluence with Yager Creek is T02N R01E S15. Its location is 40°33'34" N. latitude and 124°03'23" W. longitude. Cooper Mill Creek is a first order stream and has approximately 3.0 miles of blue line stream according to the USGS Hydesville 7.5 minute quadrangle. Cooper Mill Creek drains a watershed of approximately 6.0 square miles. Summer base flow is approximately 0.25 cubic feet per second (cfs) at the mouth, but over 300 cfs is not unusual during winter storms. Elevations range from about 240 feet at the mouth of the creek to 1800 feet in the headwater areas. Redwood forest dominates the watershed. The watershed is privately owned and is managed for timber production. Vehicle access exists from State Highway 36 near Carlotta, via Fisher Road to Pacific Lumber's Yager Camp.

METHODS

The habitat inventory conducted in Cooper Mill Creek follows the methodology presented in the *California Salmonid Stream Habitat Restoration Manual* (Flosi et.al., 1998). The California Conservation Corps (CCC) Technical Advisors and Watershed Stewards Project AmeriCorps (WSP) members that conducted the inventory were trained in standardized habitat inventory methods by the California Department of Fish and Game (DFG). Cooper Mill Creek personnel were trained in May, 1995, by Ruth Goodfield. A two-person team conducted this inventory.

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 Cooper Mill 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". Cooper Mill 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 Cooper Mill 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 Cooper Mill 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 Cooper Mill 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 Cooper Mill 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*.

SUBSTRATE SAMPLING

Gravel sampling is conducted using a 9 inch diameter 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 (*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 Lotus 1,2,3. Graphics developed for Cooper Mill 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

Cooper Mill Creek, 1996, Eel River

HABITAT INVENTORY RESULTS

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

The habitat inventory of May 28, 29, 30, 31 and June 4, 5, 6 and 10 1995, was conducted by T. Kraemer and D. Melton (AmeriCorps) and J. Terwilliger (CCC). The total length of the stream surveyed was 13,152 feet with an additional 706 feet of side channel.

Flows were not measured on Cooper Mill Creek.

Cooper Mill Creek is an F4 channel type for the first 1466 feet of stream reach surveyed, then it changes to a C4 channel type for the next 2965 feet, then it changes to an F4 channel type for the next 2830 feet, then it changes to a B3 channel type for the next 3383 feet, then it changes to an F4 channel type for the remaining 2508 feet of the survey reach. F4 streams are entrenched, meandering riffle/pool channels (<2% gradient) with high width/depth ratio; gravel channels. C4 streams are meandering, point-bar, riffle/pool, alluvial (<2% gradient) channels with broad, well defined floodplains; predominantly gravel channels. B3 streams are moderately entrenched, (2-4% gradient) riffle dominated with infrequently spaced pools; very stable plan and profile; stable banks; gravel channels.

Water temperatures ranged from 49° to 55° F. Air temperatures ranged from 52° to 78°F.

Table 1 summarizes the Level II riffle, flatwater, and pool habitat types. By percent occurrence, riffles made up 30%, flatwater types 25%, and riffles 40% (Graph 1). Flatwater habitat types made up 33% of the total survey length, pools 41%, and riffles 27% (Graph 2).

Thirteen 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, 34%; low gradient riffles, 30%; and runs, 19% (Graph 3). By percent total length, mid-channel pools made up 31%, low gradient riffles 26%, runs 21% and step runs 12%.

Two-hundred thirty-one pools were identified (Table 3). Main pools were most often encountered at 79% and comprised 80% 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. One-hundred seven of the 231 pools (46.3%) had a depth of two feet or greater (Graph 5).

The depth of cobble embeddedness was estimated at pool tail-outs. Of the 231 pool tail-outs measured, 62 had a value of 1 (27%); 77 had a value of 2 (33%); 43 had a value of 3 (19%); four had a value of 4 (2%); and 45 had a value of 5 (19%). 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 scale of 0-300. Pool habitat types had the highest shelter rating at 66. Flatwater habitats followed with a rating of 26 (Table 1). Of the pool types, the Main and scour pools had the highest mean shelter rating at 67, and backwater pools rated 22 (Table 3).

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

Table 6 summarizes the dominant substrate by habitat type. Small cobble was the dominant substrate observed in 80 of the 157 low gradient riffles measured (51%). Gravel was the next most frequently observed dominant substrate type and occurred in 29% of the low gradient riffles (Graph 8).

The mean percent canopy for the stream reach surveyed was 84%. The mean percentages of deciduous and coniferous trees were 53% and 31%, respectively. Graph 9 describes the canopy in Cooper Mill Creek.

For the stream reach surveyed, the mean percent right bank vegetated was 63.7%. The mean percent left bank vegetated was 56.5%. The dominant elements composing the structure of the stream banks consisted of 1% bedrock, 3% boulder, 42% cobble/gravel, and 54% sand/silt/clay (Graph 10). The dominant elements composing the structure of the stream banks consisted of 10% grass, 13% brush, 7% not vegetated. Additionally, 53% of the units surveyed had deciduous trees as the dominant vegetation type, and 17% had coniferous trees as the dominant vegetation, including down trees, logs, and root wads (Graph 11).

BIOLOGICAL INVENTORY RESULTS

Two sites were electrofished on Nov. 20, 1990, in Cooper Mill Creek. The units were sampled by Greg Moody and Steve Holzerland (CCC).

The first site sampled was a glide, approximately 995 feet from the confluence with Yager Creek. The unit yielded 12 steelhead, ranging from 50 to 85 mm FL.

The second site was a step pool, approximately 2379 feet above the confluence with Yager Creek. Twenty-five steelhead were sampled. They ranged from 50 to 107 mm FL.

Cooper Mill Creek, 1996, Eel River

GRAVEL SAMPLING RESULTS

No gravel samples were taken on Cooper Mill Creek.

DISCUSSION

Cooper Mill Creek has three channel types: F4, C4 and B3. B3 streams have moderate gradients; however, their unstable stream banks make them generally unsuitable for instream enhancement structures. C4 streams are low gradient channels, meandering on noncohesive gravel beds which have poorly consolidated and unstable stream banks. They are generally not suitable for instream enhancement structures. However, bank placed boulders, bank cover, overhead log cover and shelter structures in straight reaches are often appropriate. Any work considered will require careful design, placement, and construction that must include protection for the unstable banks. F4 streams are low gradient, entrenched, meandering, gravel channels, generally unsuitable for instream enhancement structures due to poorly consolidated stream banks.

The water temperatures recorded on the survey days May 28, 29, 30, 31 and June 4, 5, 6 and 10 1995, ranged from 49° to 55° F. Air temperatures ranged from 52° to 78° F. This is a favorable water temperature range 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 34.5% of the total length of this survey, riffles 28.1%, and pools 42.8%. The pools are relatively shallow, with only 107 of the 231 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. 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.

Forty-seven of the 231 pool tail-outs measured had embeddedness ratings of 3 or 4. Sixty-two 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 Cooper Mill Creek, sediment sources should be mapped and rated according to their potential sediment yields, and control measures should be taken.

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The mean shelter rating for pools was low with a rating of 66. The shelter rating in the flatwater habitats was slightly lower at 26. A pool shelter rating of approximately 100 is desirable. The amount of cover that now exists is being provided primarily by large woody debris and boulders in all habitat types. Additionally, undercut banks 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.

One-hundred-twenty-five of the 157 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 84%. 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 63.7% and 56.5%, 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) Cooper Mill 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) Inventory and map sources of stream bank erosion and prioritize them according to present and potential sediment yield. Identified sites, like the site at 6355', should then be treated to reduce the amount of fine sediments entering the stream.

4) 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.

5) Spawning gravel on Cooper Mill Creek are limited to relatively few reaches. Crowding and/or superimposition of redds have been observed during winter surveys. Projects should be designed at suitable sites to trap and sort spawning gravel in order to expand redd site distribution in the stream.

6) There are several log debris accumulations present on Cooper Mill 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.

7) 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.

PROBLEM SITES AND LANDMARKS

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

0' Begin survey at confluence with Yager Creek.

393' Yager haul road bridge.

629' Large debris accumulation (LDA) retaining silt, sand and gravel.

1174' Fish Ladder-PALCO hatchery, and foot bridge.

1391' Bridge, 6ft. high and 4" PVC crossing.

1579' Road parallels stream at ten feet away.

1645' Rock wall on left bank (LB) for road.

1671' Road parallels stream at two feet.

1719' Rip rap ends.

1805' Concrete bridge abutment on right bank.

1830' Parking lot and buildings.

2117' Log structure.

2220' Log weir with sediment dam built behind.

2492' Pool caused by boulder cable weirs.

Cooper Mill Creek, 1996, Eel River

2523' Boulder cable and boulder rip rap on LB.

2826' LDA in channel with scour beneath.

2847' Log-cable bank armor causing pool scour.

3321' Cable and log structure trapping LDA.

3659' Gravel road on the LB.

3731' Cable and log structure armors bank and traps sediment and woody debris.

3890' LDA instream, approximately 30 logs.

3919' Road at 25 feet on the left bank.

4060' Right bank (RB) failure, large conifers span creek, 5% cover.

4257' Logs line banks.

4729' Logs line both banks in aggregates.

4753' LDA caused by log bolted to root.

4972' Man-made log weir creating LDA trapping sediment.

5015' Plunge weir trapping sediment.

5092' Landslide on the right bank.

5265' Pool formed by log weir.

5723' Landslide extends upstream 120 feet.

5895' Landslide, 100 feet long, contributes fines, boulders and woody debris.

6065' LDA of 100+ pieces block channel; stream flows under it.

6254' LDA spans channel, 25 feet high, with 50+ conifers.

6355' 150 foot long slump with 25% cover.

6456' Slump is continuous with 60% cover.

Cooper Mill Creek, 1996, Eel River

6525' Logjam 60 foot long.

6556' Large slump.

6606' Cobbles and sediment dam.

6649' LB cut, 0% vegetation cover, 150% slope.

6873' LDA of 20 logs.

6989' Bank cut on the left.

7261' Two pools formed by old log jam debris.

7363' Stream cuts around LDA with trapped sediment behind.

7441' LDA 10 feet long.

7569' Stream cuts around 40 foot long LDA.

7895' Small failure on the LB, 5% cover.

7945' Bank scour and cut 15 feet high from LDA.

8440' LDA with 40 foot sediment dam following.

8648' LDA undercut by 4 feet.

8680' Sediment dam.

8730' Bankcut 15 feet high and continuous.

8833' 4+ foot diameter V-notch weir pours into enormous pool.

8874' 4+ foot dia. V-notch weir into plunge pool.

8913' Log jam to 8 foot plunge with preceding sediment dam.

9029' LDA with 4 foot plunge creating sediment dam.

9161' Large dam of fines for 100 feet.

9393' LDA right bank; sediment dam precedes.

Cooper Mill Creek, 1996, Eel River

9902' Stream drops approximately 10' into the middle of a LDA.

10242' Many logs crossing the stream, including an undercut single log plunge weir.

10453' Pool is under LDA with LDA's continuing to 10520' mark.

10962' Bankcuts, LDA's and a sediment dam throughout braided channels.

11014' LDA continues with 30+ logs 20' high.

11051' Sediment dam of sediments-gravel and fines.

11087' Timber harvest on the left bank for 1000 feet.

11218' Sediment dam 4' high.

11416' Massive sediment build-up and log accumulation.

12203' Cut banks 6' high with 80% cover.

12476' LDA with sediment dam preceding it.

12807' RB failure, 400x100; slip is dammed behind enormous log jam.

12883' Two cabled bank stabilizers.

12898' Banks cut, LDA's and sediment dams continue to 13050.

12992' Washed out bridge.

13152' END OF SURVEY. NO FISH.

REFERENCES

Flosi, G., S. Downie, J. Hopelain, M. Bird, R. Coey, and B. Collins. 1998. California salmonid stream habitat restoration manual, 3rd 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