STREAM INVENTORY REPORT

DEEP HOLE CREEK

INTRODUCTION

A stream inventory was conducted during the summer of 2002 on Deep Hole Creek. The survey began at the confluence with Elk Creek and extended upstream 2.0 miles. The objective of the habitat inventory was to document the habitat available to anadromous salmonids in Deep Hole Creek.

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.

WATERSHED OVERVIEW

Deep Hole Creek is a tributary to Elk Creek, a tributary to the Middle Fork Eel River, located in Mendocino County, California (Map 1). Deep Hole Creek's legal description at the confluence with Elk Creek is T 20N R10W S05. Its location is 39E37N15O North latitude and 123E06N21 O West longitude. Deep Hole Creek is a second order stream based upon approximately 7.0 miles of solid blue line stream according to the USGS Sanhedrin Mountain 7.5 minute quadrangle. Deep Hole Creek drains a watershed of approximately 9.2 square miles. Elevations range from about 1,397 feet at the mouth of the creek to 4,115 feet in the headwater areas. Mixed hardwood, forest, mixed conifer forest, and grassland dominates the watershed. The watershed is a mix of private ownership, National Forest, and Bureau of Land Management owned. It is managed for timber production, rangeland, and recreation.

METHODS

The habitat inventory conducted in Deep Hole Creek follows the methodology presented in the *California Salmonid Stream Habitat Restoration Manual* (Flosi et al, 1998). The California Department of Fish and Game (DFG) Scientific Aides and/or Pacific States Marine Fisheries Commission (PSMFC) Watershed Technicians that conducted the inventory were trained in standardized habitat inventory methods by 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. 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 (measured in the thalweg), dominant substrate composing the pool tail crest, and embeddedness. Habitat unit types encountered for the first time are 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. All pools except step-pools are fully sampled.

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 Deep Hole 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 a Marsh-McBirney Model 2000 flow meter.

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. Channel characteristics are measured using a clinometer, hand level, hip chain, tape measure, and a stadia rod.

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". Deep Hole 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. All measurements are in feet to the nearest tenth. Habitat characteristics are measured using a clinometer, hip chain, and stadia rod.

5. Embeddedness:

The depth of embeddedness of the cobbles in pool tail-out areas is measured by the percent of the cobble that is surrounded or buried by fine sediment. In Deep Hole 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 unsuited for spawning due to inappropriate substrate particle size, bedrock, 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 Deep Hole 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 handheld 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 Deep Hole 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 Deep Hole 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 (including downed trees, logs, and rootwads) was estimated and recorded.

10. Large Woody Debris Count:

Large woody debris (LWD) is an important component of fish habitat and an element in channel forming processes. In each habitat unit all pieces of LWD partially or entirely below the elevation of bankfull discharge are counted and recorded. The minimum size considered is twelve inches in diameter and six feet in length. The LWD count is presented by reach and is expressed as an average per 100'.

11. Average Bankfull Width:

Bankfull width can vary greatly in the course of a channel type stream reach. This is especially true in very long reaches. Bankfull width can be a factor in habitat components like canopy

density, water temperature, and pool depths. Frequent measurements taken at riffle crests (velocity crossovers) are needed to accurately describe reach widths. At the first appropriate velocity crossover that occurs after the beginning of a new stream survey page (ten habitat units), bankfull width is measured and recorded in the appropriate header block of the page. These widths are presented as an average for the channel type reach.

BIOLOGICAL INVENTORY

Salmonids were detected using streambank observation techniques during the Deep Hole Creek stream survey. No additional biological sampling was conducted.

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 Deep Hole 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
- Mean 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 June 26-28, 2002, was conducted by Frank Humphrey and David Snider (DFG). The total length of the stream surveyed was 10,366 feet with an additional 685 feet of side channel.

Stream flow was measured at the bottom of the survey reach with a Marsh-McBirney Model 2000 flowmeter at 0.9 cfs on June 26, 2002.

Deep Hole Creek is an F4 channel type for the first 2,496 feet of the stream surveyed with an average bankfull width of 17.5'; it is a B2 for the next 2,861 feet with an average bankfull width of 19.0', and is an F4 for the remaining 5,009 feet of stream surveyed with an average bankfull width of 18.4'. F4 channels are entrenched, meandering, riffle/pool channels on low gradients with high width/depth ratios and gravel-dominant substrates. B2 channel types are moderately entrenched, moderate gradient, riffle-dominated channels with infrequently spaced pools; very stable plan and profile; stable banks; with boulder-dominated substrates.

Water temperatures taken during the survey period ranged from 66 to 78 degrees Fahrenheit. Air temperatures ranged from 70 to 88 degrees Fahrenheit.

Table 1 summarizes the Level II riffle, flatwater, and pool habitat types. Based on frequency of occurrence there were 15% riffle units, 40% flatwater units, 43% pool units, and 2% dry units (Graph 1). Based on total length of Level II habitat types there were 9% riffle units, 51% flatwater units, 39% pool units, and 1% dry units (Graph 2).

11 Level IV habitat types were identified (Table 2). The most frequent habitat types by percent occurrence were step run, 35%; mid-channel pool, 26%; and low-grade riffle and step pool, both 14% (Graph 3). Based on percent total length, step run made up 48%, step pool 21%, and mid-channel pool 17%.

A total of 84 pools were identified (Table 3). Main channel pools were the most frequently encountered, at 93%, and comprised 96% 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. 37 of the 84 pools (44%) had a depth of two feet or greater (Graph 5).

The depth of cobble embeddedness was estimated at pool tail-outs. Of the 79 pool tail-outs measured, 10 had a value of 1 (12.7%); 40 had a value of 2 (50.6%); 24 had a value of 3 (30.4%); and 5 had a value of 5 (6.3%) (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. Riffle habitat types had a mean shelter rating of 24, flatwater habitat types had a mean shelter rating of 29, and pool habitats had a mean shelter rating of 27 (Table 1). Of the pool types, the main channel pools had the highest mean shelter rating at 27. Backwater pools had a mean shelter rating of 25 (Table 3).

In reach one, Deep Hole Creek had an average of 0.7 pieces of LWD per 100'; in reach two, 1.8 pieces; and in reach three, there were 1.1 pieces of LWD per 100'.

Table 5 summarizes mean percent cover by habitat type. Boulders are the dominant cover types in Deep Hole Creek. Graph 7 describes the pool cover in Deep Hole Creek. Boulders are the dominant pool cover type followed by root mass.

Table 6 summarizes the dominant substrate by habitat type. Graph 8 depicts the dominant substrate observed in pool tail-outs. Gravel was the dominant substrate observed in 50.6% of pool tail-outs while boulder was the next most frequently observed substrate type, at 22.8%.

The mean percent canopy density for the surveyed length of Deep Hole Creek was 55%. The mean percentages of deciduous and coniferous trees were 97% and 3%, respectively. Graph 9 describes the mean percent canopy in Deep Hole Creek.

For the stream reach surveyed, the mean percent right bank vegetated was 44.8%. The mean percent left bank vegetated was 41.0%. The dominant elements composing the structure of the stream banks consisted of 64.1% boulder, 22.3% cobble/gravel, 10.5% bedrock, and 3.2% sand/silt/clay (Graph 10). Deciduous trees were the dominant vegetation type observed in 85% of the units surveyed. Additionally, 8.6% of the units surveyed had brush as the dominant vegetation type, and 5% had grass as the dominant vegetation (Graph 11).

DISCUSSION

Deep Hole Creek is an F4 channel type for the first 2,496 feet of stream surveyed, a B2 channel type for the next 2,861 feet, and an F4 for the remaining 5,009. The suitability of F4 channel types for fish habitat improvement structures is good for bank-placed boulders; fair for plunge weirs, single and opposing wing-deflectors, channel constrictors, and log cover; and poor for boulder clusters. The suitability of B2 channel types for fish habitat improvement structures is excellent for plunge weirs, single and opposing wing-deflectors, and log cover.

The water temperatures recorded on the survey days June 26-28, 2002, ranged from 66 to 78 degrees Fahrenheit. Air temperatures ranged from 70 to 88 degrees Fahrenheit. This is a high water temperature range for salmonids. 68° F, if sustained, is near the threshold stress level for salmonids. Deep Hole Creek seems to have summer water temperatures deliterious to salmonids. To make 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 51% of the total length of this survey, riffles 9%, pools 39%, and dry units 1%. The pools are relatively moderate in depth, with only 37 of the 84 (44%) pools having a maximum depth greater than 2 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.

50 of the 79 pool tail-outs measured had embeddedness ratings of 1 or 2. 24 of the pool tail-outs had embeddedness ratings of 3 or 4. 5 of the pool tail-outs had a rating of 5, which is considered unsuitable for spawning. Cobble embeddedness measured to be 25% or less, a rating of 1, is considered to indicate good quality spawning substrate for salmon and steelhead. Sediment sources in Deep Hole Creek should be mapped and rated according to their potential sediment yields, and control measures should be taken.
48 of the 79 pool tail-outs measured had gravel or small cobble as the dominant substrate. This is generally considered good for spawning salmonids.

The mean shelter rating for pools was 27. The shelter rating in the flatwater habitats was 29. A pool shelter rating of approximately 100 is desirable. The amount of cover that now exists is being provided primarily by boulders in all habitat types. Additionally, root mass contribute a small amount. Log and root wad cover structures in the pool and flatwater habitats would enhance 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.

The mean percent canopy density for the stream was 55%. Reach 1 had a canopy density of 35% while Reaches 2 and 3 had canopy densities of 40% and 74%, respectively. 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 44.8% and 41.0%, 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) Deep Hole 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 Deep Hole Creek by planting willow, white alder, cedar/pine, 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 affected 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.

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

7) Active and potential sediment sources related to the road system need to be identified, mapped, and treated according to their potential for sediment yield to the stream and its tributaries.

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.

0' Begin survey at confluence with Elk Creek. Channel type is F4.

277' Road crossing.

935' 4" steelhead observed.

2,617' Channel type change – F4 to B2.

2,989' 10-20 juvenile steelhead observed.

3,545' Right bank landslide – 40' high x 50' long, contributing sediment.

3,981' Several 1+ steelhead observed.

4,155' Right bank landslide – 40' high x 75' long, contributing sediment.

4,221' Channel type change – B2 to B4.

6,711' Large number of steelhead trout.

10,366' Very large boulders in channel, 15' high waterfall. 35% channel gradient. This is a probable barrier to anadromy. End Survey.

REFERENCES

Flosi, G., Downie, S., Hopelain, J., Bird, M., Coey, R., and Collins, B. 1998. *California Salmonid Stream Habitat Restoration Manual*, 3rd edition. California Department of Fish and Game, Sacramento, California.

LEVEL III and LEVEL IV HABITAT TYPES

RIFFLE			
Low Gradient Riffle	(LGR)	[1.1]	{ 1}
High Gradient Riffle	(HGR)	[1.2]	{ 2}
CASCADE			
Cascade	(CAS)	[2.1]	{ 3}
Bedrock Sheet	(BRS)	[2.2]	{24}
FLATWATER			
Pocket Water	(POW)	[3.1]	{21}
Glide	(GLD)	[3.2]	{14}
Run	(RUN)	[3.3]	{15}
Step Run	(SRN)	[3.4]	{16}
Edgewater	(EDW)	[3.5]	{18}
MAIN CHANNEL POOLS			
Trench Pool	(TRP)	[4.1]	{ 8}
Mid-Channel Pool	(MCP)	[4.2]	{17}
Channel Confluence Pool	(CCP)	[4.3]	{19}
Step Pool	(STP)	[4.4]	{23}
SCOUR POOLS			
Corner Pool	(CRP)	[5.1]	{22}
Lateral Scour Pool - Log Enhanced	(LSL)	[5.2]	{10}
Lateral Scour Pool - Root Wad Enhanced	(LSR)	[5.3]	{11}
Lateral Scour Pool - Bedrock Formed	(LSBk)	[5.4]	{12}
Lateral Scour Pool - Boulder Formed	(LSBo)	[5.5]	{20}
Plunge Pool	(PLP)	[5.6]	{ 9}
BACKWATER POOLS			
Secondary Channel Pool	(SCP)	[6.1]	{ 4}
Backwater Pool - Boulder Formed	(BPB)	[6.2]	{ 5}
Backwater Pool - Root Wad Formed	(BPR)	[6.3]	{ 6}
Backwater Pool - Log Formed	(BPL)	[6.4]	{ 7}
Dammed Pool	(DPL)	[6.5]	{13}
ADDITIONAL UNIT DESIGNATIONS			
Dry	(DRY)	[7.0]	
Culvert	(CUL)	[8.0]	
Not Surveyed	(NS)	[9.0]	
Not Surveyed due to a marsh	(MAR)	[9.1]	