STREAM INVENTORY REPORT

Hardy Creek

INTRODUCTION

A stream inventory was conducted during the summer of 1997 on Hardy Creek. The lower portion of the creek was not surveyed due to lack of access. The inventory began at the third right bank tributary upstream from the ocean (Map 1). 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 Hardy Creek. The objective of the biological inventory was to document the presence and distribution of juvenile salmonid species.

The objective of this report is to document the current habitat conditions, and recommend options for the potential enhancement of habitat for coho salmon and steelhead trout. Recommendations for habitat improvement activities are based upon target habitat values suitable for salmonids in California's north coast streams.

WATERSHED OVERVIEW

Hardy Creek is tributary to the Pacific Ocean, located in Mendocino County, California (Map 1). Hardy Creek's legal description at the confluence with the Pacific Ocean is T21N R18W S01. Its location is 39°42′39″ north latitude and 123°48′25″ west longitude. Hardy Creek is a second order stream and has approximately 6.9 miles of blue line stream according to the USGS Westport and Lincoln Ridge 7.5 minute quadrangles. Hardy Creek drains a watershed of approximately 5.0 square miles. Elevations range from sea level at the mouth of the creek to 1800 feet in the headwater areas. Mixed conifer forest dominates the watershed. The watershed is privately owned, and managed for timber production. Vehicle access exists via Highway 1.

METHODS

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

SAMPLING STRATEGY

The inventory uses a method that samples approximately 10% of the habitat units within the survey reach (Hopelain, 1994). All habitat units included in the survey are classified according to habitat type and their lengths are measured. All pool units are measured for maximum depth, depth of pool tail crest, dominant substrate composing the pool tail crest, and embeddedness.

Habitat unit types encountered for the first time are further measured for all the parameters and characteristics on the field form. Additionally, from the ten habitat units on each field form page, one is randomly selected for complete measurement.

HABITAT INVENTORY COMPONENTS

A standardized habitat inventory form has been developed for use in California stream surveys and can be found in the *California Salmonid Stream Habitat Restoration Manual*. This form was used in Hardy Creek to record measurements and observations. There are nine components to the inventory form.

1. Flow:

Flow is measured in cubic feet per second (cfs) at the bottom of the stream survey reach using standard flow measuring equipment, if available. In some cases flows are estimated.

2. Channel Type:

Channel typing is conducted according to the classification system developed and revised by David Rosgen (1985 rev. 1994). This methodology is described in the *California Salmonid Stream Habitat Restoration Manual*. Channel typing is conducted simultaneously with habitat typing and follows a standard form to record measurements and observations. There are five measured parameters used to determine channel type: 1) water slope gradient, 2) entrenchment, 3) width/depth ratio, 4) substrate composition, and 5) sinuosity.

3. Temperatures:

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

4. Habitat Type:

Habitat typing uses the 24 habitat classification types defined by McCain and others (1988). Habitat units are numbered sequentially and assigned a type identification number selected from a standard list of 24 habitat types. Dewatered units are labeled "dry". Hardy 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 Hardy 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, 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 Hardy 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 Hardy 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 Hardy Creek, the dominant composition type and the dominant vegetation type of both the right and left banks for each fully-described unit were selected from the habitat inventory form. Additionally, the percent of each bank covered by vegetation was estimated and recorded.

BIOLOGICAL INVENTORY

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

DATA ANALYSIS

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

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

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

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

HABITAT INVENTORY RESULTS

The habitat inventory of October 17, 1997, was conducted by Tara Cooper and Craig Mesman (CCC). The total length of the stream surveyed was 6,274 feet with an additional 107 feet of side channel.

Flow was measured at three locations with a Marsh-McBirney Model 2000 flowmeter on September 19, 1997. The first flow taken at the confluence of Hardy Creek and South Fork Hardy Creek measured 0.89 cfs. The second flow taken in Middle Fork Hardy Creek, 100 feet

above the confluence with Hardy Creek, measured 0.39 cfs. The third flow taken 30 feet above the confluence of Hardy Creek and North Fork Hardy Creek, measured 0.30 cfs.

Hardy Creek is a B4 channel type for the entire 6,274 feet of stream reach surveyed. B4 channels are moderately entrenched and have riffle dominated channels with infrequently spaced pools. B4 channels have a moderate gradient and also contain stable banks, plans, and profiles. B4 channels have gravel-dominant substrates.

Water temperatures taken during the survey period ranged from 53 to 56 degrees Fahrenheit. Air temperatures ranged from 47 to 61 degrees Fahrenheit.

Table 1 summarizes the Level II riffle, flatwater, and pool habitat types. Based on frequency of **occurrence** there were 40% riffle units, 15% flatwater units, and 45% pool units (Graph 1). Based on total **length** of Level II habitat types there were 41% riffle units, 19% flatwater units, and 39% pool units (Graph 2).

Ten Level IV habitat types were identified (Table 2). The most frequent habitat types by percent **occurrence** were low gradient riffles, 40%; mid-channel pools, 23%; and runs, 10% (Graph 3). Based on percent total **length**, low gradient riffles made up 41%, mid-channel pools 17%, lateral scour pools - log enhanced 13%, and runs 10%.

A total of 74 pools were identified (Table 3). Main channel pools were most frequently encountered at 54% and comprised 47% 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. Thirty-four of the 74 pools (46%) had a depth of two feet or greater (Graph 5).

The depth of cobble embeddedness was estimated at pool tail-outs. Of the 74 pool tail-outs measured, 25 had a value of 1 (33.7%); 30 had a value of 2 (40.5%); 17 had a value of 3 (22.9%); 0 had a value of 4; and 2 had a value of 5 (2.7%) (Graph 6). On this scale, a value of 1 indicates the highest quality of spawning substrate and a value of 5 indicates the tail-out is not suitable for spawning. In Hardy Creek, the two pool tail-outs which were valued at 5 had bedrock as the 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 6, flatwater habitat types had a mean shelter rating of 5, and pool habitats had a mean shelter rating of 55 (Table 1). Of the pool types, the backwater pools had the highest mean shelter rating at 120. Scour pools had a mean shelter rating of 74 and main channel pools had a rating of 32 (Table 3).

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

Table 6 summarizes the dominant substrate by habitat type. All seven low gradient riffles fully sampled had gravel or small cobble as the dominant substrate. Gravel was the dominant

substrate observed in 67 of the 74 pool tail outs measured (90%). Small cobble was the next most frequently observed dominant substrate type and occurred in 7% of the pool tail outs (Graph 8).

The mean percent canopy density for the stream reach surveyed was 79%. The mean percentages of deciduous and coniferous trees were 41% and 59%, respectively. Graph 9 describes the canopy in Hardy Creek.

For the stream reach surveyed, the mean percent right bank vegetated was 95%. The mean percent left bank vegetated was also 95%. The dominant elements composing the structure of the stream banks consisted of 2% bedrock, 72% cobble/gravel, and 26% sand/silt/clay (Graph 10). Deciduous trees were the dominant vegetation type observed in 70% of the units surveyed. Additionally, 12% of the units surveyed had grass as the dominant vegetation type, and 18% had coniferous trees as the dominant vegetation, including down trees, logs, and root wads (Graph 11).

BIOLOGICAL INVENTORY RESULTS

Two sites were electrofished on October 7, 1997. The sites were sampled by Tara Cooper and Craig Mesman.

The first site was at the confluence of Hardy, Middle Fork Hardy and North Fork Hardy Creeks. The site began at a channel confluence pool, included a run riffle combination and ended at a mid-channel pool. The length of the sample was approximately 360 feet. The site yielded 36 steelhead and 4 salamanders.

The second site was approximately 270 feet up North Fork Hardy Creek above a probable barrier. The site yielded 36 salamanders.

DISCUSSION

Hardy Creek is a B4 channel type for the entire 6,274 feet of stream surveyed. The suitability of B4 channel types for fish habitat improvement structures is as follows: excellent for plunge weirs, boulder clusters, bank-placed boulders, single and opposing wing-deflectors, and log cover.

The water temperatures recorded on the survey day, October 15, 1997, ranged from 53 to 56 degrees Fahrenheit. Air temperatures ranged from 47 to 61 degrees Fahrenheit. This is a good 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 19% of the total **length** of this survey, riffles 41%, and pools 39%. The pools are relatively shallow, with 34 of the 74 (46%) 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 deepen pool habitat is recommended.

Twenty-five of the 74 pool tail-outs measured had an embeddedness rating of 1. Forty-seven of the pool tail-outs had embeddedness ratings of 2 or 3. Two of the pool tail-outs had a rating of 5 or were 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.

The mean shelter rating for pools was moderate with a rating of 55. The shelter rating in the flatwater habitats was 5. A pool shelter rating of approximately 100 is desirable. The cover that now exists is being provided primarily by large and small woody debris in all habitat types. Additional log and root wad cover structure in the pool and flatwater habitats is 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.

Seventy-two of the 74 pool tail outs measured had gravel or small cobble as the dominant substrate. This is good for spawning salmonids.

The mean percent canopy density for the stream was 79%. The percentage of right and left bank covered with vegetation was 95%. In general, revegetation projects are considered when canopy density is less than 80%.

RECOMMENDATIONS

1) Hardy 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) Increase woody cover in the pools and flatwater habitat units. Adding high quality complexity with woody cover is desirable.

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.

Hardy Creek

Position (ft):	Comments:
0'	Begin survey at the third right bank tributary upstream from the confluence with the Pacific Ocean (Map 1). Channel type is an B4.
1,397'	Left bank tributary.
1,681'	Log debris accumulation, 16' long x 30' wide x 7' high.
2,940'	Left bank tributary.
3,608'	Log debris accumulation, 58' long x 35' wide x 9' high.
3,748'	Left bank tributary, dry.
5,023'	Flow taken on September 19, 1997, 0.89cfs.
5,162'	Confluence with South Hardy Creek.
5,270'	Culvert, 12' diameter.
6,274'	End of survey at the confluence with Middle Fork and North Fork Hardy Creeks. Electrofishing site #1.

REFERENCES

Flosi, G., and F. Reynolds. 1994. California salmonid stream habitat restoration manual, 2nd edition. California Department of Fish and Game, Sacramento, California.

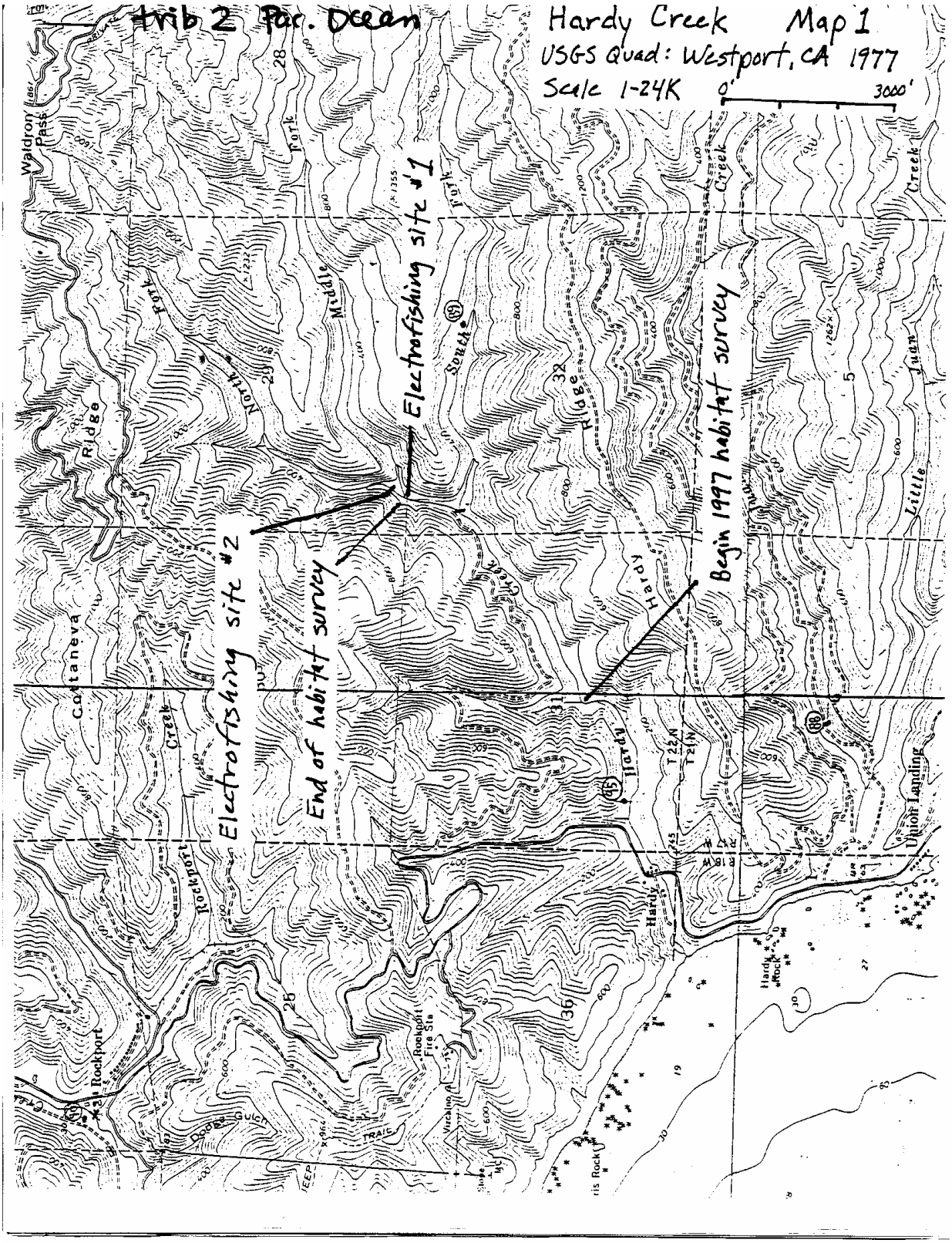
Hopelain, J. 1995. Sampling levels for fish habitat inventory, unpublished manuscript.

California Department of Fish and Game, Inland Fisheries Division, Sacramento, California.

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

Hardy Creek


trib 2 Par. Ocean
Hardy Creek Map 1
USGS Quad: Westport, CA 1977
Scale 1-24K 0' 3000'
Electrofishing site #1
Begin 1997 habitat survey
End of habitat survey
Electrofishing site #2
Waldron Pass
Ridge
North Fork
Middle Fork
South Fork
Cottaneva Creek
Rockport
Rockport Fire Sta
Dodge Gulch
Hardy Creek
Little Juan Creek
Union Landing
Hardy Rock
TRAIL
JEEP