STREAM INVENTORY REPORT

Middle Fork Hardy Creek

INTRODUCTION

A stream inventory was conducted during the summer of 1998 on Middle Fork Hardy Creek. 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 Middle Fork 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

Middle Fork Hardy Creek is tributary to the Hardy Creek, tributary to the Pacific Ocean located in Mendocino County, California (Map 1). Middle Fork Hardy Creek's legal description at the confluence with Hardy Creek is T22N R17W S29. Its location is 39°43′13″ north latitude and 123°46′49″ west longitude. Middle Fork Hardy Creek is a 1st order stream and has approximately 2.0 miles of blue line stream according to the USGS Westport 7.5 minute quadrangle. Middle Fork Hardy Creek drains a watershed of approximately 1.7 square miles. Elevations range from about 200 feet at the mouth of the creek to 1400 feet in the headwater areas. Redwood and Douglas fir dominate the watershed. The watershed is entirely privately owned and is managed for timber production. Vehicle access exists via State Highway 1.

METHODS

The habitat inventory conducted in Middle Fork Hardy 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/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. 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 Middle Fork 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". Middle Fork 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. 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 Middle Fork 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 Middle Fork 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 Middle Fork 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 Middle Fork 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 Middle Fork 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 Middle Fork 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 September 22, 1998 and September 23, 1998, was conducted by Paul Retherford and Janet Lester (WSP\AmeriCorps). The total length of the stream surveyed was 5,575 feet.

Flow was measured at the bottom of the survey reach with a Marsh-McBirney Model 2000 flowmeter at 0.25 cfs on September 22, 1998.

Middle Fork Hardy Creek

Middle Fork Hardy Creek is an G4 channel type for the entire 5,575 feet of stream reach surveyed. G4 channels are entrenched "gully" step-pool and low width/depth ratio on moderate gradient.

Water temperatures taken during the survey period ranged from 54 to 57 degrees Fahrenheit. Air temperatures ranged from 63 to 71 degrees Fahrenheit.

Table 1 summarizes the Level II riffle, flatwater, and pool habitat types. Based on frequency of occurrence there were 22% riffle units, 50% flatwater units, and 27% pool units (Graph 1). Based on total length of Level II habitat types there were 17% riffle units, 70% flatwater units, and 12% pool units (Graph 2).

Ten Level IV habitat types were identified (Table 2). The most frequent habitat types by percent occurrence were step run, 35%; low gradient riffle, 20%; and run, 15% (Graph 3). Based on percent total length, step run made up 58%, low gradient riffle made up 16%, and runs made up 12%.

A total of 38 pools were identified (Table 3). Scour pools were most frequently encountered at 53% 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 of the 38 pools (79%) had a depth of two feet or greater (Graph 5).

The depth of cobble embeddedness was estimated at pool tail-outs. Of the 38 pool tail-outs measured, 11 had a value of 1 (29%); 9 had a value of 2 (24%); 11 had a value of 3 (29%); 7 had a value of 4 (18%) and 0 had a value of 5 (0%) (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.

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 9, flatwater habitat types had a mean shelter rating of 29, and pool habitats had a mean shelter rating of 82 (Table 1). Of the pool types, the scour pools had the highest mean shelter rating at 98. Main channel pools had a mean shelter rating of 64 (Table 3).

Table 5 summarizes mean percent cover by habitat type. Large woody debris is the dominant cover type in Middle Fork Hardy Creek. Graph 7 describes the pool cover in Middle Fork Hardy Creek.

Table 6 summarizes the dominant substrate by habitat type. Of the two low gradient riffles fully measured on had a dominant substrate of gravel and one had a dominant substrate of small gravel. Gravel was the dominant substrate observed in 33 of the 38 pool tail-outs measured (87%). Small cobble was the next most frequently observed dominant substrate type and occurred in 13% of the pool tail-outs (Graph 8).

Middle Fork Hardy Creek

The mean percent canopy density for the stream reach surveyed was 94%. The mean percentages of deciduous and coniferous trees were 54% and 46%, respectively. Graph 9 describes the canopy in Middle Fork Hardy Creek.

For the stream reach surveyed, the mean percent right bank vegetated was 58%. The mean percent left bank vegetated was 61%. The dominant elements composing the structure of the stream banks consisted of 28% bedrock, 0% boulder, 9% cobble/gravel, and 63% sand/silt/clay (Graph 10). Brush was the dominant vegetation type observed in 41% of the units surveyed. Additionally, 20% of the units surveyed had deciduous trees as the dominant vegetation type, and 24% 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 1, 1998, in Middle Fork Hardy Creek. The sites were sampled by Paul Retherford and Janet Lester.

The first site sampled included habitat units 2-4, a pool and step run sequence approximately 50 feet from the confluence with Hardy Creek. This site had an area of 225 sq ft and a volume of 210 cu ft. The site yielded 3 steelhead and 1 salamander.

The second site included habitat units 10-12, a riffle, pool, run sequence located approximately 275 feet above the creek mouth. This site had an area of 704 sq ft and a volume of 563 cu ft. The site yielded 3 steelhead and 3 salamanders.

DISCUSSION

Middle Fork Hardy Creek is a G4 channel type for the entire 5,575 feet of stream surveyed. The suitability of G4 channel types for fish habitat improvement structures is as follows: good for bank-placed boulders; fair for plunge weirs, opposing wing-deflectors and log cover; poor for boulder clusters and single wing-deflectors

The water temperatures recorded on the survey days September 22, 1998 and September 23, 1998, ranged from 54 to 57 degrees Fahrenheit. Air temperatures ranged from 63 to 71 degrees Fahrenheit. This is a good 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 70% of the total length of this survey, riffles 17%, and pools 12%. The pools are relatively deep, with 30 of the 38 (79%) 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 pool habitat is recommended.

Eleven of the 38 pool tail-outs measured had an embeddedness rating of 1. Twenty-seven of the pool tail-outs had embeddedness ratings of 2, 3 or 4. None 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. In Middle Fork Hardy 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 82. The shelter rating in the flatwater habitats was 29. A pool shelter rating of approximately 100 is desirable. The relatively small amount of cover that now exists is being provided primarily by large woody debris in all habitat types. Additionally, 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.

All of the 38 pool tail-outs 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 94%. 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 58% and 61%, 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) Middle Fork 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) 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.

4) Increase woody cover in the pools and flatwater habitat units. Most of the existing cover is from large woody debris. Adding high quality complexity with woody cover is desirable.

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.

7) There are several log debris accumulations present on Middle Fork Hardy 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.

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.

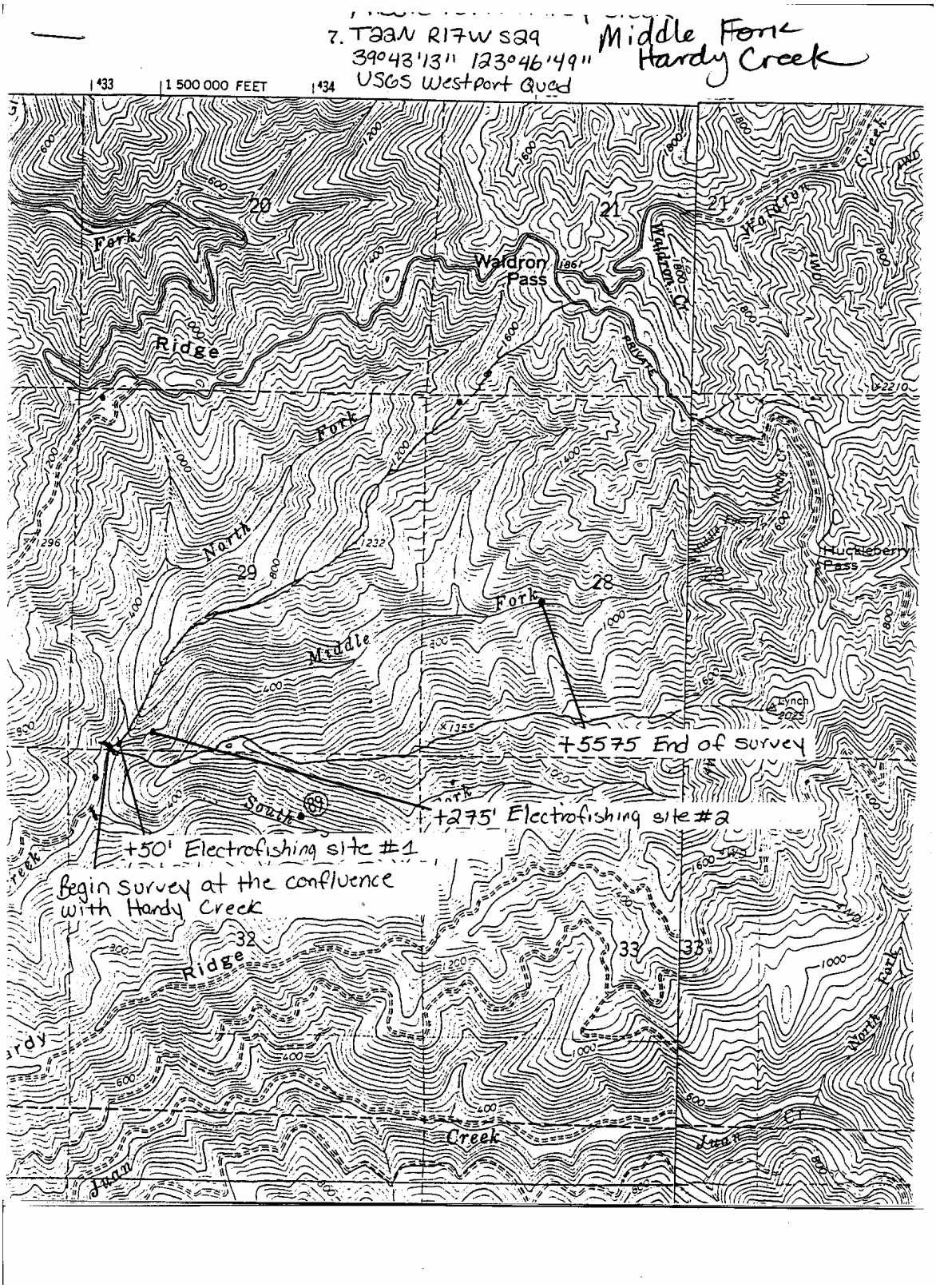
Position (ft):	Comments:
0'	Begin survey at confluence with Hardy Creek. Channel type is a G4.
50'	First electrofishing site.
275'	Second electrofishing site.
586'	Six foot jump caused by large woody debris, retaining 6' gravel/sand.
730'	Log debris accumulation (LDA) 15' long x 20' wide x 8' high, retaining 5' of gravel.
1,559'	LDA, 30' long x 30' wide x 7' high, retaining 5' of gravel/sand.
1,758'	Right bank erosion, 40' long x 80' high.
2,241'	Five feet of gravel retained behind a log plunge pool.
2,331'	Five foot jump with 6' of gravel retained.
3,183'	Nine foot jump with 9' of gravel/sand retained.
4,197'	Right bank erosion, 20' long x 40' high. Ten foot jump with 9' of gravel retained. No salmonids observed beyond this point.

4,390'	LDA, 10' long x 20' wide x 10' high, retaining 7' gravel/sand.
4,654'	Nine foot jump with 10' of gravel/sand retained.
4,958'	A series of three 8'H jumps coupled with large amounts of retained gravel (7' to 10' high), large woody debris, and two 10' long dry units. No fish seen since 4,197'.
5,418'	Left bank dry tributary not accessible to fish.
5,572'	Left bank dry tributary not accessible to fish.
5,575'	End of survey. Middle Fork Hardy Creek dries up at this point. The surveyors walked 500' above the last unit and no water or fish observed.

REFERENCES

Flosi, Gary, Scott Downie, James Hopelain, Michael Bird, Robert Coey and Barry Collins. 1998. California salmonid stream habitat restoration manual, 3rd edition. California Department of Fish and Game, Sacramento, California.

Middle Fork Hardy Creek



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