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CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE

STREAM INVENTORY REPORT

Miller Creek

INTRODUCTION

A stream inventory was conducted August 31 to September 11, 2017 on Miller Creek. The survey began at the confluence with Redwood Creek and extended upstream 3.8 miles

The Miller Creek 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 Miller 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 Chinook and 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. This report was finalized in March, 2018.

WATERSHED OVERVIEW

Miller Creek, located in southern Humboldt County, is a tributary to Redwood Creek, which is a tributary to South Fork Eel River, which is a tributary to the Eel River which drains into the Pacific Ocean in northern California (Map 1). Miller Creek's legal description at the confluence with Redwood Creek is T04S R03E S19. Its location is 40.0616° north latitude and 123.5406° west longitude, LLID number 1239016401045. Miller Creek is a third order stream and has approximately 4.5 miles of blue line stream according to the USGS Ettersburg 7.5 minute quadrangle. Miller Creek drains a watershed of approximately 3.7 square miles. Elevations range from about 550 feet at the mouth of the creek to about 1,700 feet in the headwaters. Grasslands and Douglas fir/oak forest dominate the watershed. The watershed is privately owned and is subdivided mostly into large parcels with a mixture of agricultural ranch and timberlands. There are also scattered private residences located throughout the lower two-thirds of the watershed. Vehicle access exists west from Redway via the Shelter Cove Road to Briceland. Miller Creek is 0.2 miles west of Briceland, and is crossed by the county road approximately 1,700 feet above the stream's mouth.

METHODS

The habitat inventory conducted in Miller Creek follows the methodology presented in the *California Salmonid Stream Habitat Restoration Manual* (Flosi et al, 1998). The Watershed Stewards Program (WSP) members and California Department of Fish and Wildlife (CDFW) personnel that conducted the inventory were trained in standardized habitat inventory methods by CDFW. 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.

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 Miller Creek to record measurements and observations. There are eleven components to the inventory form.

1. Flow:

Flow is measured in cubic feet per second (cfs) near 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 (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 hand level, hip chain, tape measure, and a stadia rod.

3. Temperatures:

Water and air temperatures are measured and recorded at every tenth habitat unit using a hand-held thermometer. Both temperatures are taken in degrees (º) Fahrenheit and the time of the measurement is also recorded. Air temperatures are recorded within one foot of the water surface, while water temperatures are recorded (where possible) in flowing water within the habitat unit.

4. Habitat Type:

Habitat typing uses the 24 habitat classification types defined by McCain and others (1990). 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". Miller 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 Miller 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 unsuitable for spawning due to inappropriate substrate like bedrock, log sills, boulders or other considerations.

6. Shelter Rating:

Instream shelter is composed of those elements within a stream channel that provide juvenile 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 for prey. 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 Miller 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. The shelter rating is then calculated by multiplying the qualitative shelter value by the percent of the unit covered. 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 Miller 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 hardwood 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 Miller 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 to be 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 feet.

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

Biological sampling during the stream inventory is used to determine fish species and their distribution in the stream. Fish presence was observed from the stream banks in Miller Creek. In addition, underwater mask and snorkel observations were made at 10 sites using techniques discussed in the *California Salmonid Stream Habitat Restoration Manual*.

DATA ANALYSIS

Data from the habitat inventory form are entered into Stream Habitat 2.0.18, a Visual Basic data entry program developed by Karen Wilson, Pacific States Marine Fisheries Commission in conjunction with the California Department of Fish and Wildlife. This program processes and summarizes the data, and produces the following ten tables:

- Riffle, Flatwater, and Pool Habitat Types
- Habitat Types and Measured Parameters
- Pool Types
- Maximum Residual Pool Depths by Habitat Types
- Mean Percent Cover by Habitat Type
- Dominant Substrates by Habitat Type
- Mean Percent Vegetative Cover for Entire Stream
- Fish Habitat Inventory Data Summary by Stream Reach (Table 8)
- Mean Percent Dominant Substrate / Dominant Vegetation Type for Entire Stream
- Mean Percent Shelter Cover Types for Entire Stream

Graphics are produced from the tables using Microsoft Excel. Graphics developed for Miller Creek include:

- Riffle, Flatwater, Pool Habitat Types by Percent Occurrence
- Riffle, Flatwater, Pool Habitat Types by Total Length

- Total Habitat Types by Percent Occurrence
- Pool Types by Percent Occurrence
- Maximum Residual Depth in Pools
- Percent Embeddedness
- Mean Percent Cover Types in Pools
- Substrate Composition in Pool Tail-outs
- Mean Percent Canopy
- Dominant Bank Composition by Composition Type
- Dominant Bank Vegetation by Vegetation Type

HABITAT INVENTORY RESULTS

* ALL TABLES AND GRAPHS ARE LOCATED IN APPENDIX I *

The habitat inventory of August 31 to September 11, 2017 was conducted by Nicole Bejar (CDFW), Ryan Bernstein (CDFW), and Chris Tevini (CCC). The total length of the stream surveyed was 20,136 feet with an additional 173 feet of side channel.

Stream flow was not measured on Miller Creek. The creek consisted of isolated pools.

Miller Creek is a B4 channel type for 11,327 feet of the stream surveyed (Reach 1) and an F4 channel type for 8,982 feet of the stream surveyed (Reach 2). B4 channel types are moderately entrenched, moderate gradient, riffle dominated channel with infrequently spaced pools, very stable plan and profile, stable banks and gravel-dominant substrates. F4 channel types are entrenched meandering riffle/pool channels on low gradients with high width/depth ratios, very stable with gravel-dominant substrates.

Water temperatures taken during the survey period ranged from 53° to 75° Fahrenheit. Air temperatures ranged from 61° to 85° Fahrenheit.

Table 1 summarizes the Level II riffle, flatwater, and pool habitat types. Based on frequency of occurrence there were 41% dry units, 32% pool units, 26% flatwater (Graph 1). Based on total length of Level II habitat types there were 52% dry units, 24% pool units, 17% flatwater units, and 6% no survey units (Graph 2).

Eleven Level IV habitat types were identified (Table 2). The most frequent habitat types by percent occurrence were dry units (41%), mid-channel pool units (27%), and run units (22%) (Graph 3). Based on percent total length, dry units made up 52%, mid-channel pool units 21%, and run units 13%.

A total of 113 pools were identified (Table 3). Main channel pools were the most frequently encountered at 85% (Graph 4), and comprised 89% of the total length of all pools (Table 3).

Table 4 is a summary of maximum residual pool depths by pool habitat types. Pool quality for salmonids increases with depth. Twenty-four of the 113 pools (21%) had a residual depth of three feet or greater (Graph 5).

The depth of cobble embeddedness was estimated at pool tail-outs. Of the 113 pool tail-outs

measured, 21 had a value of 1 (18.6%), 52 had a value of 2 (46%), 15 had a value of 3 (13.3%), and 25 had a value of 5 (22.1%) (Graph 6). On this scale, a value of 1 indicates the best spawning conditions and a value of 4 the worst. Additionally, a value of 5 was assigned to tail-outs deemed not suitable for spawning due to inappropriate substrate such as bedrock, log sills, boulders, or other considerations.

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. Flatwater habitat types had a mean shelter rating of 4 and pool habitats had a mean shelter rating of 22 (Table 1). Of the pool types, the main channel pools had the highest mean shelter rating of 22. Scour pools had a mean shelter rating of 19 (Table 3).

Table 5 summarizes mean percent cover by habitat type. Undercut banks are the dominant cover type in Miller Creek. Graph 7 describes the pool cover in Miller Creek. Undercut banks are the dominant pool cover type followed by small woody debris.

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 42% of pool tail-outs. Small cobble was the next most frequently observed dominant substrate type and occurred in 32% of the pool tail-outs.

The mean percent canopy density for the surveyed length of Miller Creek was 92%. Eight percent of the canopy was open. Of the canopy present, the mean percentages of hardwood and coniferous trees were 79% and 21%, respectively. Graph 9 describes the mean percent canopy in Miller Creek.

For the stream reach surveyed, the mean percent right bank and left bank vegetated was 100%. The dominant elements composing the structure of the stream banks consisted of 77% sand/silt/clay, 13% bedrock, 9% cobble/gravel, and 2% boulder (Graph 10). Deciduous trees were the dominant vegetation type observed in 52% of the units surveyed. Additionally, 41% of the units surveyed had brush as the dominant vegetation type, and 5% had coniferous trees as the dominant vegetation type (Graph 11).

BIOLOGICAL INVENTORY RESULTS

Survey teams conducted a mask and snorkel survey at 10 sites for species composition and distribution in Miller Creek on September 13, 2017 (Table A. Water temperatures were taken at the beginning survey period at 10:50 AM and was 62° Fahrenheit. Air temperature was 72°Fahrenheit. The sites were sampled by Nicole Bejar (CDFW) and Chris Tevni (CCC).

In Reach 1, which comprised the first 11,327 feet of stream, six sites were sampled. The reachsites yielded 17 young-of-the-year (YOY) steelhead (SH/RT), 8 age 1+ SH, 3 age 2+ SH, and 30California Roach (RCH).

In Reach 2, four sites were sampled starting approximately 13,764 from the confluence with Redwood Creek and continuing upstream 3,719 feet. The reach sites yielded 10 young-of-the-year SH, 1 age 1+ SH, and 1 age 2+ SH.

During the survey, the upstream-most observation of juvenile steelhead trout occurred at 40.12639° north latitude, -123.92371° west longitude, approximately 17,483 feet upstream from the confluence with Redwood Creek (Map 1). No coho salmon were observed during the stream inventory or the snorkel survey.

Table A. Summary of results for a fish composition and distribution survey within Miller Creek, September 13, 2017.

Date	Survey Site #	Habitat Unit #	Habitat Type	Approx. Dist. from mouth (ft.)	Steelhead Trout			Coho Salmon		Additional Aquatic Species Observed
					YOY	1+	2+	YOY	1+	
Reach 1: B4 Channel Type										
09/13/17	1	18	Pool	681	3	0	0	0	0	30 RCH
	2	22	Pool	831	3	1	0	0	0	
	3	34	Pool	1,192	5	3	0	0	0	
	4	82	Pool	4,391	2	0	1	0	0	
	5	156	Pool	8,006	2	0	0	0	0	
	6	162	Pool	8,327	2	4	2	0	0	
Reach 2: F4 Channel Type										
09/13/17	7	269	Pool	13,764	4	1	1	0	0	
	8	317	Pool	15,917	3	0	0	0	0	
	9	320	Pool	15,980	1	0	0	0	0	
	10	354	Run	17,483	2	0	0	0	0	

Species abbreviations: RCH = California roach

DISCUSSION

Miller Creek is a B4 channel type for the first 11,327 feet of the stream surveyed (Reach 1), and an F4 channel type for the remaining 8,982 feet of the stream surveyed (Reach 2). The suitability of B2 and F4 channel types for fish habitat improvement structures is as follows: B2 channel types excellent for plunge weirs, single and opposing wing-deflectors, and log cover. F4 channel types are good for bank-placed boulders and fair for plunge weirs, single and opposing wing-deflectors, channel constrictors, and log cover.

The water temperatures recorded on the survey days August 31 to September 11, 2017 ranged from 53° to 75° Fahrenheit. Air temperatures ranged from 61° to 85° Fahrenheit. Prolonged water temperatures >65° Fahrenheit are considered unsuitable for salmonids. To make any further conclusions, temperatures need to be monitored throughout the warm summer months, and more extensive biological sampling needs to be conducted.

Flatwater habitat types comprised 17% of the total length of this survey and pools 24%. Sixty-one of the 113 (54%) pools had a maximum residual depth greater than two 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 residual depth of at least three feet, occupy at least half the width of the low

flow channel, and be as long as the low flow channel width. Installing structures that will increase or deepen pool habitat is recommended.

Seventy-three of the 113 pool tail-outs measured had embeddedness ratings of 1 or 2. Fifteen of the pool tail-outs had embeddedness ratings of 3 or 4. Twenty-five 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 Miller Creek should be mapped and rated according to their potential sediment yields, and control measures should be taken.

Eighty-three of the 113 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 is 22. The shelter rating in the flatwater habitats is 4. A pool shelter rating of approximately 100 is desirable. The amount of cover that now exists is being provided primarily by undercut banks in Miller Creek. Undercut banks are the dominant cover type in pools followed by small woody debris. Log and rootwad cover structures in the pool and flatwater habitats would enhance both summer and winter salmonid habitat. Log cover structures provide rearing fry with protection from predation, rest from water velocity, and also divide territorial units to reduce density related competition.

The mean percent canopy density for the stream was 92%. Reach 1 had a canopy density of 91%. Reach 2 had a canopy density of 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 100%. In areas of stream bank erosion or where bank vegetation is sparse, planting endemic species of coniferous and hardwood trees, in conjunction with bank stabilization, is recommended.

RECOMMENDATIONS

Miller Creek should be managed as an anadromous, natural production stream. Recommendations for potential habitat improvement activities are based on target habitat values suitable for salmonids in California's north coast streams. Considering the results from this stream habitat inventory, factors that affect salmonid productivity and CDFW's professional judgment, the following list prioritizes habitat improvement activities in Miller Creek. Keep in mind, watershed and stream ecosystem processes, land use alterations, changes in land ownership, and other factors could potentially change the order of these recommendations or create the need to remove/add recommendations in the future.

1) Increase woody cover in the pools and flatwater habitat units. Most of the existing cover in the pools is from Undercut Banks. Adding high quality complexity with woody cover in the pools is desirable.

2) Pools are disconnected and sections of the stream are dry/subsurface. Since 2015, the Salmonid Restoration Federation has had grant funding to conduct a low flow stream discharge study in Redwood Creek, including a site in Miller Creek. Streamflow should continue be monitored to determine if it is limiting for salmonids and augment low flows

to optimize benefits to juvenile salmonids.

3) 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.

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) Suitable size spawning substrate on Miller Creek is limited to relatively few reaches. Projects should be designed at suitable sites to trap and sort spawning gravel.

6) 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.

7) 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.

8) While overall canopy density is above 90% on Miller Creek, this canopy density is composed mainly of hardwood trees (80%). In order to provide more structure to the canopy, reduce water temperatures, and increase LWD recruitment consider planting appropriate native coniferous species like redwood and Douglas fir along the riparian corridor. Also where site conditions are appropriate consider cautious thinning of hardwoods to hasten the development of denser and more extensive coniferous canopy component. 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.

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):	Habitat unit #:	Comments:
0	0001.00	Start of survey at the confluence with Redwood Creek.
367	0008.00	The creek is out of the influence of the confluence with Redwood Creek. There is non-active erosion on the right bank, it measures 222' long x 14' high.

831	0023.00	There is non-active erosion on the LB bank, it measures 76' long x 14' high.
1064	0031.00	There is non-active erosion on the left bank, it measures 139' long x 8' high.
1610	0047.00	Culvert #1 is a named public road, and is 13'high x 10.5' wide x 62' long. It is composed of 1 culvert, and is made of concrete. The culvert is square, its plunge height is1.2', and it has a maximum depth of 1.9' within 5' of the outlet. The slope is <1%, and its condition is good. It is not a possible barrier to juvenile and adult salmonids.
1672	0048.00	Stopped survey due to houses and grow right next to stream and dogs barking. Did not hear back from landowners so did not feel comfortable continuing survey in creek.
3167	0053.00	There is non-active erosion on the left bank, it measures 80' long x 14' high.
4319	0082.00	Bridge #1 is the crossing for Miller Creek Road, and is 10.5' high x 14' wide x 26' long. It is an automobile bridge (made of wood and metal) and is not a barrier to salmonids.
4431	0084.00	2' of undercut.
5122	0099.00	Small woody debris pileup behind large woody debris.
5225	0102.00	There is non-active erosion on the left bank, it measures 51' long x 9’high.
5248	0103.00	Tree leaning over channel from left bank.
5376	0108.00	There is non-active erosion on the left bank, it measures 26' long x 10' high.
5485	0113.00	Small woody debris pileup behind large woody debris.
5623	0116.00	Large woody debris at top of pool forms weir like structure.
5706	0118.00	There is non-active erosion on the right bank, it measures 36' long x 8' high.
5750	0119.00	Side channel starts 83' into unit.

6019	0124.00	Log debris accumulation (LDA) #1 is 9' high x 32' wide x 22' long and contains 5 pieces of large woody debris (LWD). Water flows through the LDA and there are visible gaps in it. Sediment is being retained in the approximate dimensions of 18' wide x 21' long x 2' deep. The sediment ranges in size from sand to small coble. The LDA is not a possible barrier to salmonids. Fish were observed above the LDA.
6195	0126.00	Approximately 3' culvert at the top of right bank at the top of the unit.
7485	0150.00	LDA #2 is 6' high, 20' wide, 19' long and contains 10 pieces of LWD. Water flows through the LDA and there are visible gaps in it. Sediment is being retained in the approximate dimensions of 11' wide, 14' long and 2' deep. The sediment ranges in size from sand to small coble. The LDA is not a possible barrier to salmonids. Fish were observed above the LDA.
8006	0157.00	Bridge #2 is the crossing for Miller Creek Road, and is 6' high x 10' wide x 25' long. It is an automobile bridge (made of wood and metal) and is not a barrier to salmonids.
8374	0164.00	Small woody debris pileup behind large woody debris.
11143	0209.00	Bridge #3 is the crossing for Miller Creek road, and is 5' high x 10' wide x 25' long. It is an automobile bridge (made of wood and metal) and is not a barrier to salmonids. Channel type changes to a F4 at Habitat Unit (HU) #209. Channel type cross-section location is at HU#321.
11766	0224.00	Small woody debris pileup.
11847	0226.00	4' undercut bank.
12118	0233.00	Algae overgrowth.
12301	0239.00	SWD and LWD pileup.
13532	0265.00	3.5' undercut bank.
13717	0269.00	Tributary #1 enters on the left bank. It contributes to approximately <1% of Miller Creek's flow. The water temperature of the tributary was 61° Fahrenheit, the water temperature downstream of the confluence was 61° Fahrenheit, and the water temperature upstream of the confluence was 61° Fahrenheit. The slope of the tributary is 1%. The tributary is accessible to salmonids. Fish were observed in the tributary.

14028	0277.00	3' plunge over LWD into 2.2' pool LDA #3 is 3' high, 18' wide, 3' long and contains 4 pieces of LWD. Water flows through the LDA and there are no visible gaps in it. Sediment is being retained in the approximate dimensions of 18' wide, 8' long and 2' deep. The sediment ranges in size from sand to cobble. The LDA is not a possible barrier to salmonids. Fish were observed above the LDA. There is erosion on the right bank, it measures 20' long x 14' high.
14345	0285.00	There is erosion on the right bank, it measures 40' long x 20' high.
14685	0294.00	Old landslide on right bank.
14749	0295.00	LDA #4 is 5.5' high, 20' wide, 10' long and contains 6 pieces of LWD. Water does not flow through the LDA and there are visible gaps in it. Sediment is being retained in the approximate dimensions of 16' wide, 14' long and 1.5' deep. The sediment ranges in size from sand to cobble. The LDA is not a possible barrier to salmonids. Fish were observed above the LDA. SWD pileup behind LDA.
14845	0299.00	Bridge #4 is the crossing for an unnamed road and is 7' high x 5' wide x 20' long. It is an automobile bridge (made of wood) and is not a barrier to salmonids.
15303	0301.00	Bridge #5 is the crossing for an unnamed private road, and the measurements are unknown. It is an ATV bridge (made of wood) and is not a barrier to salmonids.
16264	0327.00	Bedrock substrate.
16347	0330.00	There is an old landslide on left bank, it measures 119' long and 20' high.
16744	0337.00	SWD pileup behind LWD.
17094	0345.00	LDA #5 is 7' high, 22' wide, 6' long and contains 5 pieces of LWD. Water flows through the LDA and there are visible gaps in it. Sediment is being retained in the approximate dimensions of 8' wide, 10' long and 2.5' deep. The sediment ranges in size from sand to cobble. The LDA is not a possible barrier to salmonids. Fish were observed above the LDA.
17321	0348.00	Tributary #2 enters on the left bank and is dry.
17636	0357.00	End of survey due to dry creek bed. Checked upstream for over 2,500' and only found two shallow puddles under log jams.

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.

REPORT CONTACT INFORMATION

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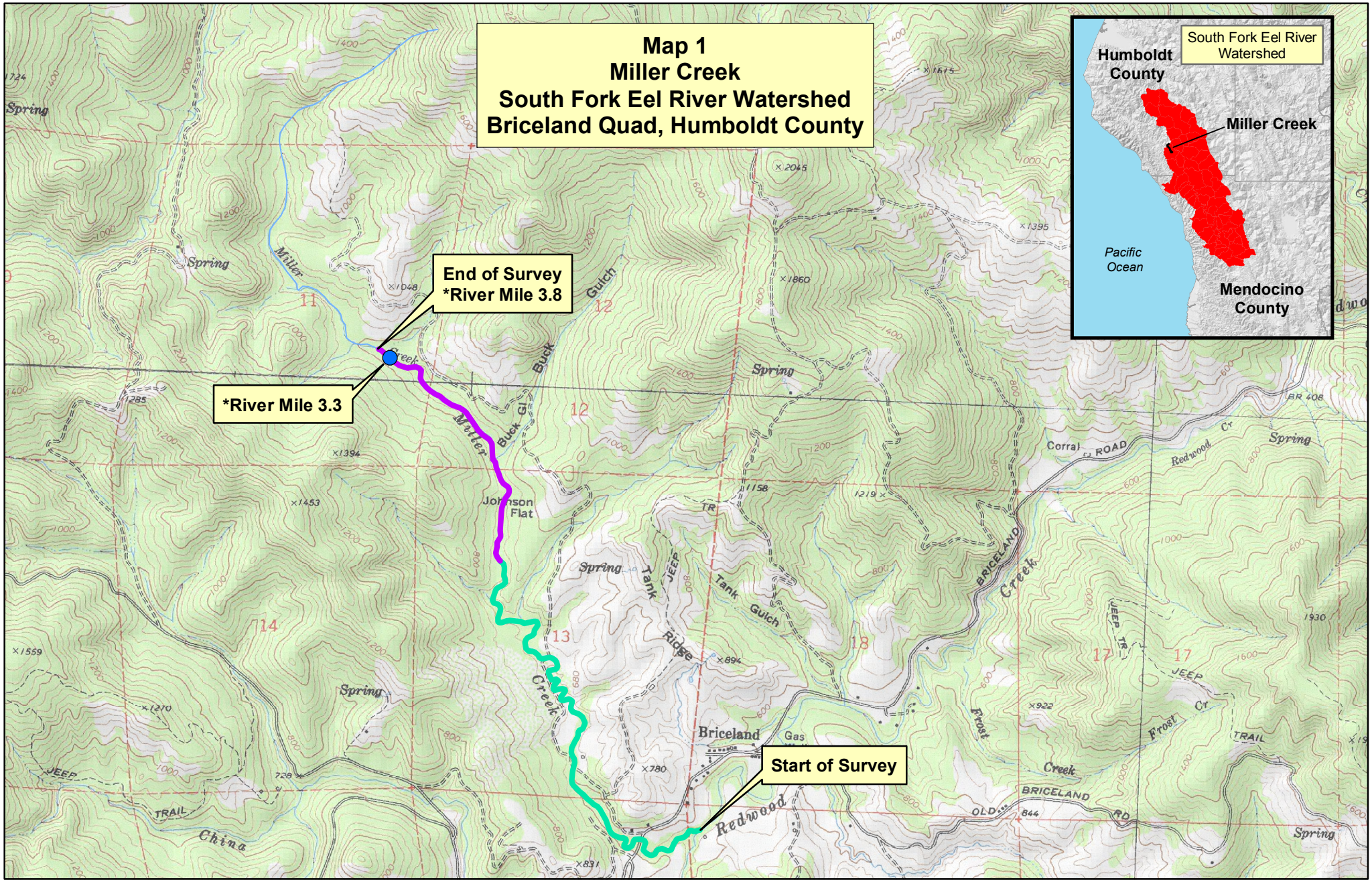
LEVEL III and LEVEL IV HABITAT TYPES

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 - Rootwad 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 - Rootwad 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]	



Coordinate System: NAD 1983 California Teale Albers
Data Sources: CDFW, USGS, CalWater 2.21, CDF 24k

*River Mile indicates distance from the confluence with Redwood Creek

APPENDIX I

TABLES AND GRAPHS

Table 1 - Summary of Riffle, Flatwater, and Pool Habitat Types

Stream Name: Miller Creek LLID: 1239016401045 Drainage: Eel River - South Fork

Survey Dates: 8/31/2017 to 9/11/2017

Confluence Location: Quad: ETTERSBURG Legal Description: T04SR03ES19 Latitude: 40:06:16.0N Longitude: 123:54:06.0

Habitat Units	Units Fully Measured	Habitat Type	Habitat Occurrence (%)	Mean Length (ft.)	Total Length (ft.)	Total Length (%)	Mean Width (ft.)	Mean Depth (ft.)	Mean Max Depth (ft.)	Mean Area (sq.ft.)	Estimated Total Area (sq.ft.)	Mean Volume (cu.ft.)	Estimated Total Volume (cu.ft.)	Mean Residual Pool Vol (cu.ft.)	Mean Shelter Rating
1	0	CULVERT	0.3	62	62	0.3									
146	0	DRY	40.8	72	10562	52.0									
93	14	FLATWATER	26.0	37	3460	17.0	5.4	0.3	0.7	126	11727	47	4350		4
1	0	NOSURVEY	0.3	1280	1280	6.3									
113	113	POOL	31.6	43	4874	24.0	11.2	1.1	2.2	499	56420	643	72651	636	22
4	0	RIFFLE	1.1	18	71	0.3									

Total Units	Total Units Fully Measured	Total Length (ft.)	Total Area (sq.ft.)	Total Volume (cu.ft.)
358	127	20309	68147	77001

Table 2 - Summary of Habitat Types and Measured Parameters

Stream Name: Miller Creek LLID: 1239016401045 Drainage: Eel River - South Fork

Survey Dates: 8/31/2017 to 9/11/2017

Confluence Location: Quad: ETTERSBURG Legal Description: T04SR03ES19 Latitude: 40:06:16.0N Longitude: 123:54:06.0W

Habitat Units	Units Fully Measured	Habitat Type	Habitat Occurrence (%)	Mean Length (ft.)	Total Length (ft.)	Total Length (%)	Mean Width (ft.)	Mean Depth (ft.)	Max Depth (ft.)	Mean Area (sq.ft.)	Estimated Total Area (sq.ft.)	Mean Volume (cu.ft.)	Estimated Total Volume (cu.ft.)	Mean Residual Pool Vol (cu.ft.)	Mean Shelter Rating	Mean Canopy (%)
4	0	LGR	1.1	18	71	0.3										
80	11	RUN	22.3	33	2638	13.0	5	0.4	1.1	128	10201	50	4024		5	96
13	3	SRN	3.6	63	822	4.0	6	0.2	0.6	121	1572	34	440		0	96
95	95	MCP	26.5	45	4285	21.1	12	1.2	4.5	538	51078	712	67671	707	23	91
1	1	CCP	0.3	47	47	0.2	11	0.9	1.9	517	517	517	517	465	0	100
7	7	CRP	2.0	35	246	1.2	7	0.8	2	279	1952	267	1870	262	9	98
5	5	LSL	1.4	17	83	0.4	8	0.8	2	138	691	117	585	117	39	93
1	1	LSR	0.3	31	31	0.2	12	0.7	1.5	372	372	298	298	260	10	97
3	3	LSBk	0.8	54	162	0.8	11	0.8	2.2	517	1551	397	1191	367	2	98
1	1	PLP	0.3	20	20	0.1	13	2.0	3.3	260	260	520	520	520	45	89
146	0	DRY	40.8	72	10562	52.0										
1	0	CUL	0.3	62	62	0.3										
1	0	NS	0.3	1280	1280	6.3										

Total Units	Total Units Fully Measured	Total Length (ft.)	Total Area (sq.ft.)	Total Volume (cu.ft.)
358	127	20309	68193	77115

Table 3 - Summary of Pool Types

Stream Name: Miller Creek LLID: 1239016401045 Drainage: Eel River - South Fork

Survey Dates: 8/31/2017 to 9/11/2017

Confluence Location: Quad: ETTERSBURG Legal Description: T04SR03ES19 Latitude: 40:06:16.0N Longitude: 123:54:06.0W

Habitat Units	Units Fully Measured	Habitat Type	Habitat Occurrence (%)	Mean Length (ft.)	Total Length (ft.)	Total Length (%)	Mean Width (ft.)	Mean Residual Depth (ft.)	Mean Area (sq.ft.)	Estimated Total Area (sq.ft.)	Mean Residual Pool Vol (cu.ft.)	Estimated Total Resid.Vol. (cu.ft.)	Mean Shelter Rating
96	96	MAIN	85	45	4332	89	11.7	1.2	537	51595	704	67620	22
17	17	SCOUR	15	32	542	11	8.8	0.9	284	4825	253	4300	19

Total Units	Total Units Fully Measured	Total Length (ft.)	Total Area (sq.ft.)	Total Volume (cu.ft.)
113	113	4874	56420	71919

Table 4 - Summary of Maximum Residual Pool Depths By Pool Habitat Types

Stream Name: Miller Creek LLID: 1239016401045 Drainage: Eel River - South Fork

Survey Dates: 8/31/2017 to 9/11/2017

Confluence Location: Quad: ETTERSBURG Legal Description: T04SR03ES19 Latitude: 40:06:16.0N Longitude: 123:54:06.0W

Habitat Units	Habitat Type	Habitat Occurrence (%)	< 1 Foot Maximum Residual Depth	< 1 Foot Percent Occurrence	1 < 2 Feet Maximum Residual Depth	1 < 2 Feet Percent Occurrence	2 < 3 Feet Maximum Residual Depth	2 < 3 Feet Percent Occurrence	3 < 4 Feet Maximum Residual Depth	3 < 4 Feet Percent Occurrence	>= 4 Feet Maximum Residual Depth	>= 4 Feet Percent Occurrence
95	MCP	84	1	1	37	39	34	36	20	21	3	3
1	CCP	1	0	0	1	100	0	0	0	0	0	0
7	CRP	6	0	0	6	86	1	14	0	0	0	0
5	LSL	4	0	0	4	80	1	20	0	0	0	0
1	LSR	1	0	0	1	100	0	0	0	0	0	0
3	LSBk	3	0	0	2	67	1	33	0	0	0	0
1	PLP	1	0	0	0	0	0	0	1	100	0	0

Total Units	Total < 1 Foot Max Resid. Depth	Total < 1 Foot % Occurrence	Total 1< 2 Foot Max Resid. Depth	Total 1< 2 Foot % Occurrence	Total 2< 3 Foot Max Resid. Depth	Total 2< 3 Foot % Occurrence	Total 3< 4 Foot Max Resid. Depth	Total 3< 4 Foot % Occurrence	Total >= 4 Foot Max Resid. Depth	Total >= 4 Foot % Occurrence
113	1	1	51	45	37	33	21	19	3	3

Mean Maximum Residual Pool Depth (ft.): 2.2

Table 5 - Summary of Mean Percent Cover By Habitat Type

Stream Name: Miller Creek

Survey Dates: 8/31/2017 to 9/11/2017 Dry Units: 146

Confluence Location: Quad: ETTERSBERG Legal Description: T04SR03ES19 Lati 40:06:16.0N Longitud 123:54:06.0W

Habitat Units	Units Fully Measured	Habitat Type	Mean % Undercut Banks	Mean % SWD	Mean % LWD	Mean % Root Mass	Mean % Terr. Vegetation	Mean % Aquatic Vegetation	Mean % White Water	Mean % Boulders	Mean % Bedrock Ledges
4	0	LGR									
4	0	TOTAL RIFFLE									
80	11	RUN	0	11	39	0	0	0	0	0	50
13	3	SRN	0	0	0	0	0	0	0	0	0
93	14	TOTAL FLAT	0	7	43	0	0	0	0	0	50
95	95	MCP	22	19	15	8	3	1	0	14	18
1	1	CCP	0	0	0	0	0	0	0	0	0
7	7	CRP	59	24	5	12	0	0	0	0	0
5	5	LSL	0	33	58	10	0	0	0	0	0
1	1	LSR	0	10	90	0	0	0	0	0	0
3	3	LSBk	0	0	0	0	0	0	0	79	21
1	1	PLP	40	20	20	20	0	0	0	0	0
113	113	TOTAL POOL	23	20	19	8	1	0	0	13	16
1	0	CUL									
1	0	NS									
358	127	TOTAL	22	21	19	7	1	0	0	13	16

Table 6 - Summary of Dominant Substrates By Habitat Type

Stream Name: Miller Creek LLID: 1239016401045 Drainage: Eel River - South Fork

Survey Dates: 8/31/2017 to 9/11/2017 Dry Units: 146

Confluence Location: Quad: ETTERSBURG Legal Description: T04SR03ES19 Latitude: 40:06:16.0N Longitude: 123:54:06.0W

Habitat Units	Units Fully Measured	Habitat Type	% Total Silt/Clay Dominant	% Total Sand Dominant	% Total Gravel Dominant	% Total Small Cobble Dominant	% Total Large Cobble Dominant	% Total Boulder Dominant	% Total Bedrock Dominant
4	0	LGR	0	0	0	0	0	0	0
80	11	RUN	0	18	36	18	9	9	9
13	3	SRN	0	0	0	0	0	67	33
95	95	MCP	1	25	42	11	7	4	9
1	1	CCP	0	0	100	0	0	0	0
7	7	CRP	0	29	29	14	29	0	0
5	5	LSL	0	40	60	0	0	0	0
1	1	LSR	0	0	100	0	0	0	0
3	3	LSBk	0	0	33	0	0	0	67
1	1	PLP	0	0	100	0	0	0	0

Table 7 - Summary of Mean Percent Canopy for Entire Stream

Stream Name: Miller Creek LLID: 1239016401045 Drainage: Eel River - South Fork

Survey Dates: 8/31/2017 to 9/11/2017

Confluence Location: Quad: ETTERSBURG Legal Description: T04SR03ES19 Latitude: 40:06:16.0N Longitude: 123:54:06.0W

Mean Percent Canopy	Mean Percent Conifer	Mean Percent Hardwood	Mean Percent Open Units	Mean Right Bank % Cover	Mean Left Bank % Cover
92	21	79	0	100	100

Note: Mean percent conifer and hardwood for the entire reach are means of canopy components from units with canopy values greater than zero.

Open units represent habitat units with zero canopy cover.

Table 8 - Fish Habitat Inventory Data Summary

Stream Name: Miller Creek LLID: 1239016401045 Drainage: Eel River - South Fork

Survey Dates: 8/31/2017 to 9/11/2017 Survey Length (ft.): 20309 Main Channel (ft.): 20136 Side Channel (ft.): 173

Confluence Location: Quad: ETTERSBURG Legal Description: T04SR03ES19 Latitude: 40:06:16.0N Longitude: 123:54:06.0W

Summary of Fish Habitat Elements By Stream Reach

STREAM REACH: 1

Channel Type: B4
Reach Length (ft.): 11154
Riffle/Flatwater Mean Width (ft.): 6.1
BFW:
Range (ft.): 15 to 37
Mean (ft.): 24
Std. Dev.: 6
Base Flow (cfs.): 0.0
Water (F): 53 - 75 Air (F): 67 - 85
Dry Channel (ft): 5328

Canopy Density (%): 90.8
Coniferous Component (%): 19.7
Hardwood Component (%): 80.3
Dominant Bank Vegetation: Hardwood Trees
Vegetative Cover (%): 99.7
Dominant Shelter: Undercut Banks
Dominant Bank Substrate Type: Sand/Silt/Clay
Occurrence of LWD (%): 9
LWD per 100 ft.:
Riffles:
Pools: 3
Flat: 1

Pools by Stream Length (%): 27.3
Pool Frequency (%): 33.3
Residual Pool Depth (%):
< 2 Feet Deep: 41
2 to 2.9 Feet Deep: 36
3 to 3.9 Feet Deep: 19
>= 4 Feet Deep: 4
Mean Max Residual Pool Depth (ft.): 2.2
Mean Pool Shelter Rating: 22

Pool Tail Substrate (%): Silt/Clay: 0 Sand: 16 Gravel: 44 Sm Cobble: 33 Lg Cobble: 0 Boulder: 1 Bedrock: 6

Embeddedness Values (%): 1. 12.9 2. 54.3 3. 10.0 4. 0.0 5. 22.9

STREAM REACH: 2

Channel Type: F4
Reach Length (ft.): 8982
Riffle/Flatwater Mean Width (ft.): 4.9
BFW:
Range (ft.): 13 to 30
Mean (ft.): 22
Std. Dev.: 6
Base Flow (cfs.): 0.0
Water (F): 58 - 62 Air (F): 61 - 74
Dry Channel (ft): 5234

Canopy Density (%): 93.9
Coniferous Component (%): 22.1
Hardwood Component (%): 77.9
Dominant Bank Vegetation: Brush
Vegetative Cover (%): 99.7
Dominant Shelter: Large Woody Debris
Dominant Bank Substrate Type: Sand/Silt/Clay
Occurrence of LWD (%): 19
LWD per 100 ft.:
Riffles: 0
Pools: 3
Flat: 1

Pools by Stream Length (%): 19.8
Pool Frequency (%): 29.1
Residual Pool Depth (%):
< 2 Feet Deep: 53
2 to 2.9 Feet Deep: 28
3 to 3.9 Feet Deep: 19
>= 4 Feet Deep: 0
Mean Max Residual Pool Depth (ft.): 2.1
Mean Pool Shelter Rating: 22

Pool Tail Substrate (%): Silt/Clay: 0 Sand: 14 Gravel: 37 Sm Cobble: 30 Lg Cobble: 12 Boulder: 5 Bedrock: 2

Embeddedness Values (%): 1. 27.9 2. 32.6 3. 18.6 4. 0.0 5. 20.9

Table 9 - Mean Percentage of Dominant Substrate and Vegetation

Stream Name: Miller Creek LLID: 1239016401045 Drainage: Eel River - South Fork

Survey Dates: 8/31/2017 to 9/11/2017

Confluence Location: Quad: ETTERSBURG Legal Description: T04SR03ES19 Latitude: 40:06:16.0N Longitude: 123:54:06.0W

Mean Percentage of Dominant Stream Bank Substrate

Dominant Class of Substrate	Number of Units Right Bank	Number of Units Left Bank	Total Mean Percent (%)
Bedrock	20	12	12.6
Boulder	3	2	2.0
Cobble / Gravel	10	12	8.7
Sand / Silt / Clay	94	101	76.8

Mean Percentage of Dominant Stream Bank Vegetation

Dominant Class of Vegetation	Number of Units Right Bank	Number of Units Left Bank	Total Mean Percent (%)
Grass	4	2	2.4
Brush	54	51	41.3
Hardwood Trees	63	68	51.6
Coniferous Trees	6	6	4.7
No Vegetation	0	0	0.0

Total Stream Cobble Embeddedness Values: 3

Table 10 - Mean Percent of Shelter Cover Types For Entire Stream

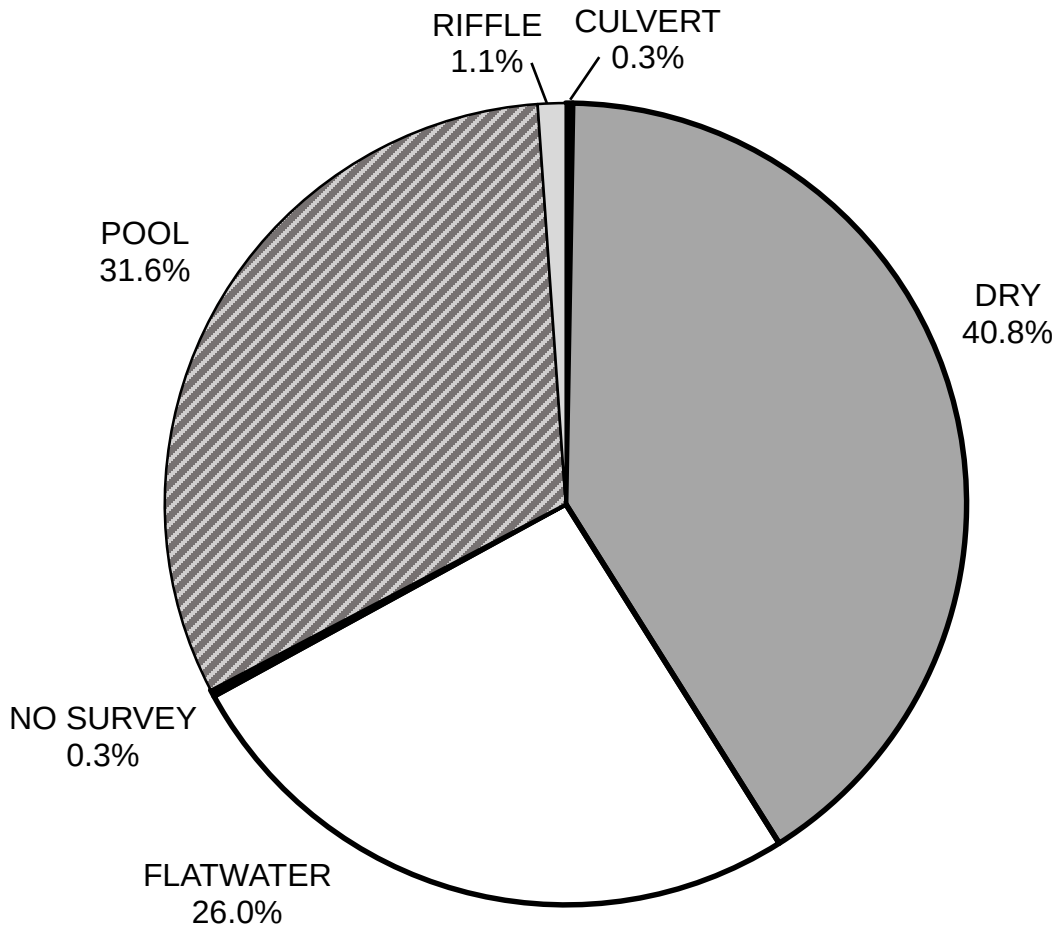
StreamName: Miller Creek LLID: 12390164045 Drainage: Eel River-South Fork

Survey Dates: 8/31/2017 to 9/11/2017

Confluence Location: Quad: ETTERSBERG Legal Description: T04SR03ES19 Latitude: 40:06:16.0N Longitude: 123:54:06.0W

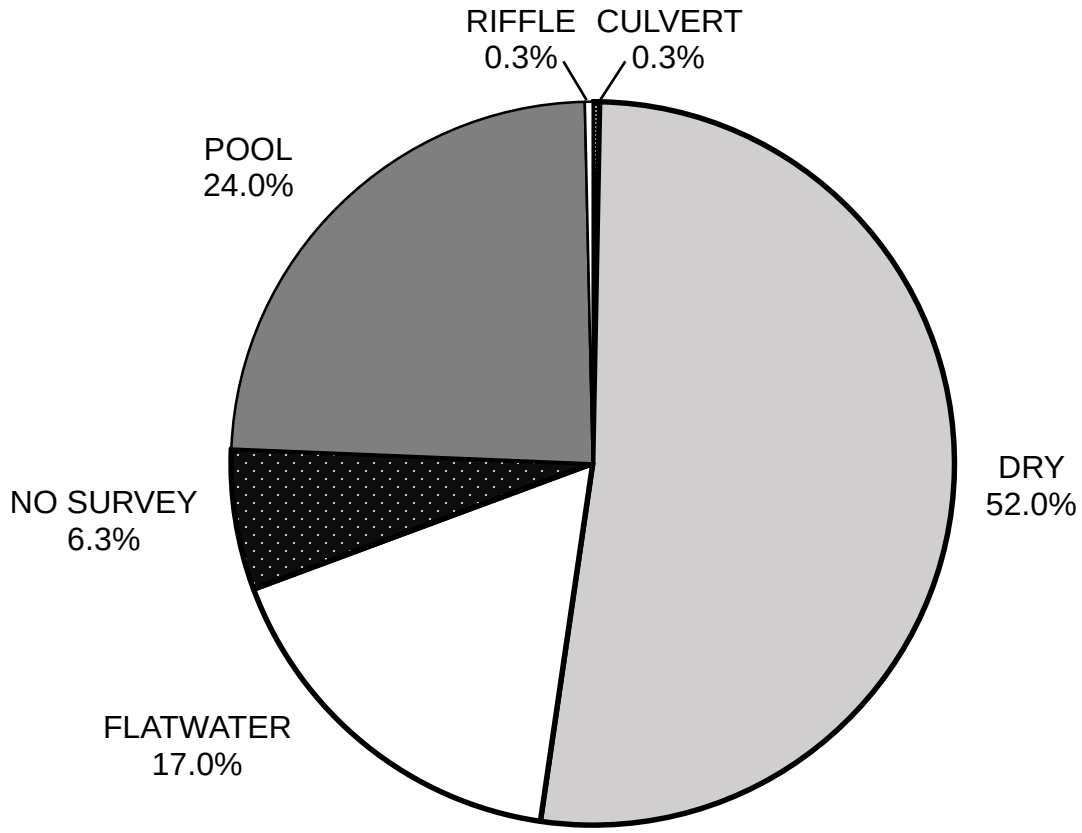
	Riffles	Flatwater	Pools
UNDERCUT BANKS(%)		0	23
SMALL WOODY DEBRIS (%)		13	20
LARGE WOODY DEBRIS (%)		76	19
ROOT MASS (%)		0	8
TERRESTRIAL VEGETATION (%)		0	1
AQUATIC VEGETATION (%)		0	0
WHITEWATER (%)		0	0
BOULDERS (%)		0	13
BEDROCK LEDGES (%)		11	16

MILLER CREEK 2017
HABITAT TYPES BY PERCENT OCCURRENCE



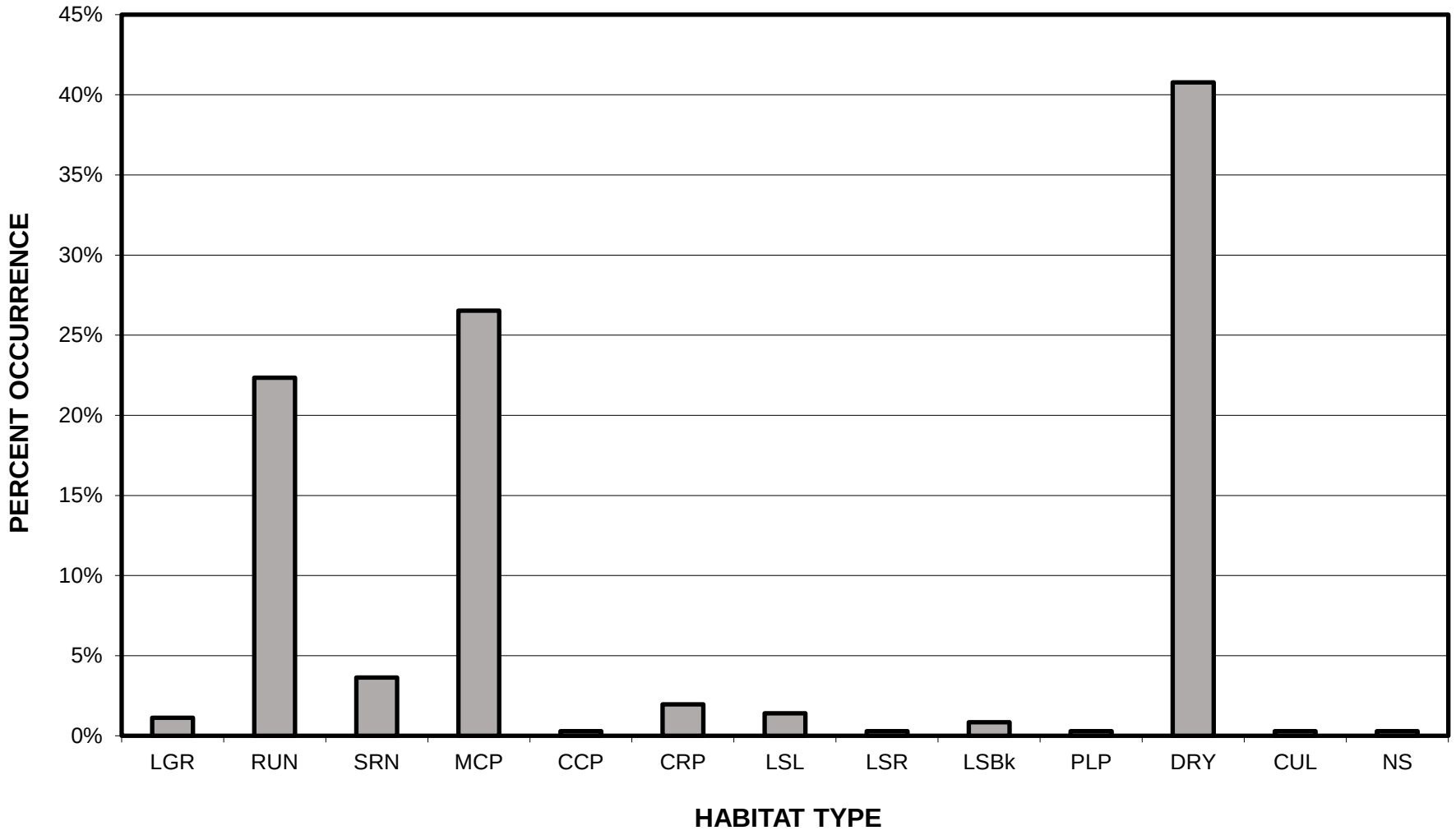
GRAPH 1

MILLER CREEK 2017
HABITAT TYPES BY PERCENT TOTAL LENGTH



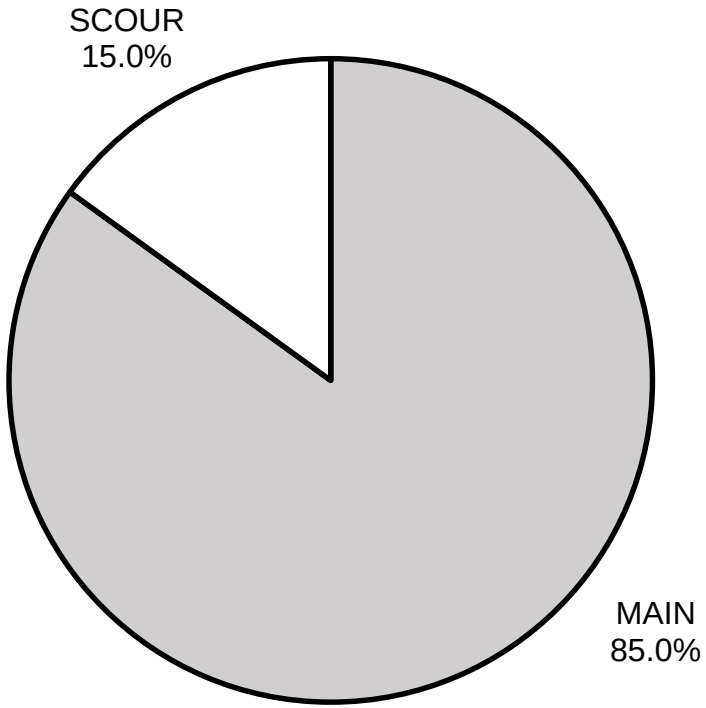
GRAPH 2

MILLER CREEK 2017
HABITAT TYPES BY PERCENT OCCURRENCE



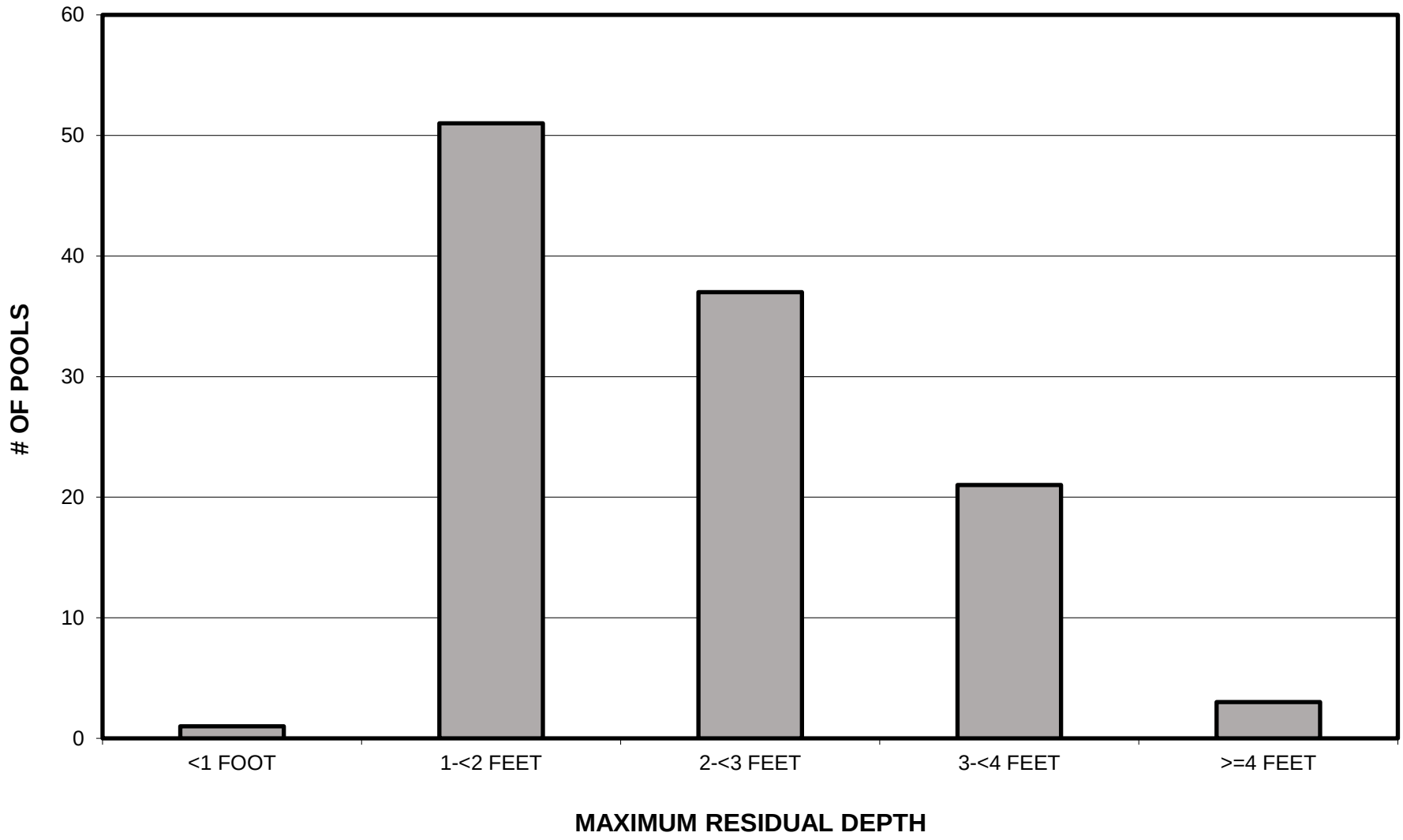
GRAPH 3

MILLER CREEK 2017
POOL TYPES BY PERCENT OCCURRENCE



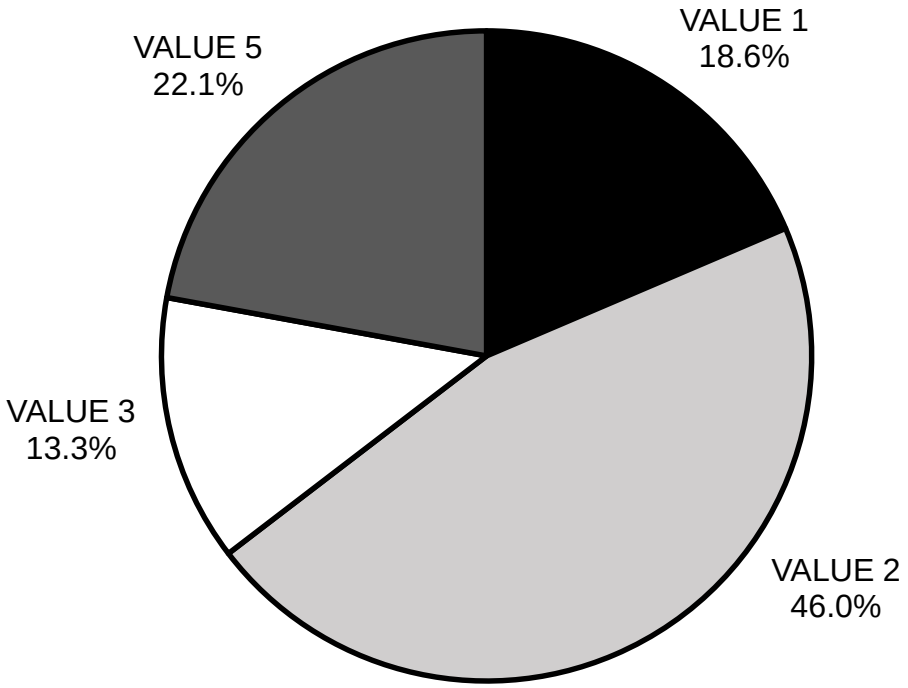
GRAPH 4

MILLER CREEK 2017
MAXIMUM DEPTH IN POOLS



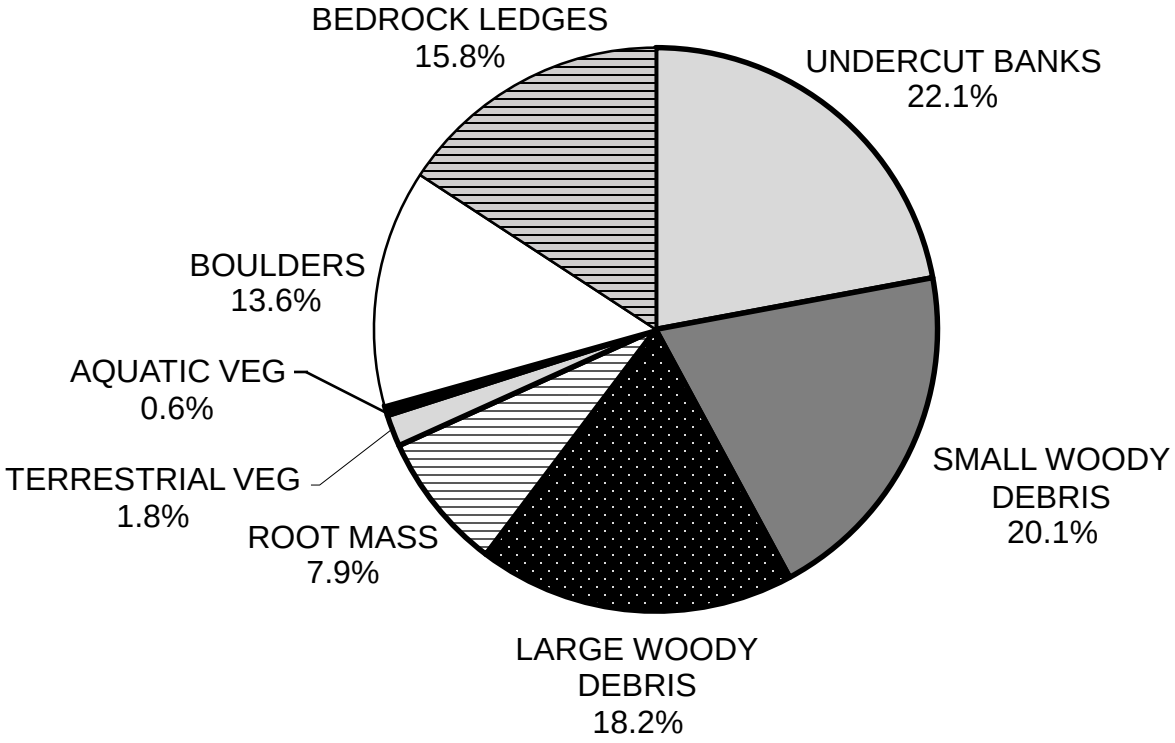
GRAPH 5

MILLER CREEK 2017
PERCENT EMBEDDEDNESS



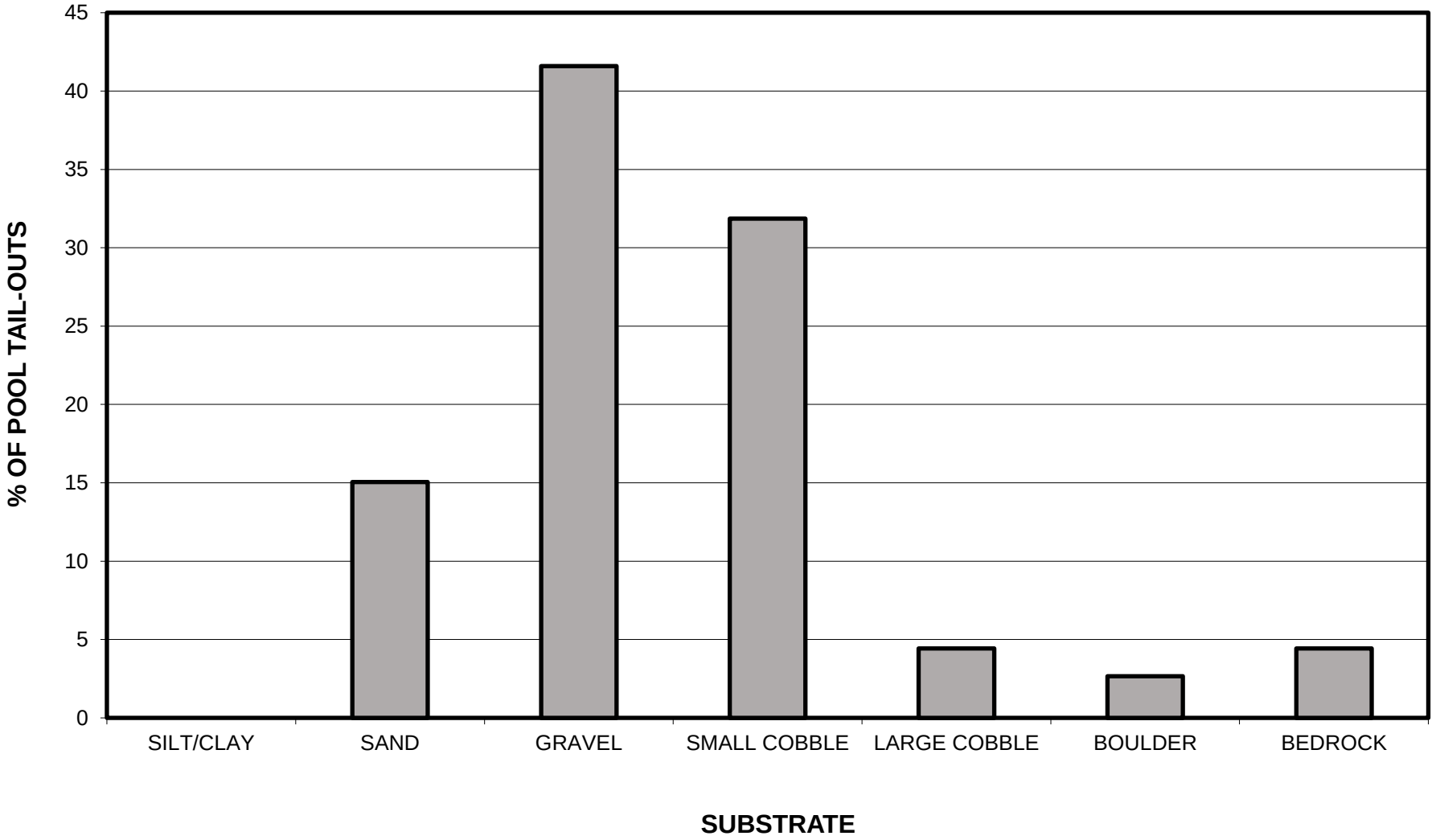
GRAPH 6

MILLER CREEK 2017
MEAN PERCENT COVER TYPES IN POOLS



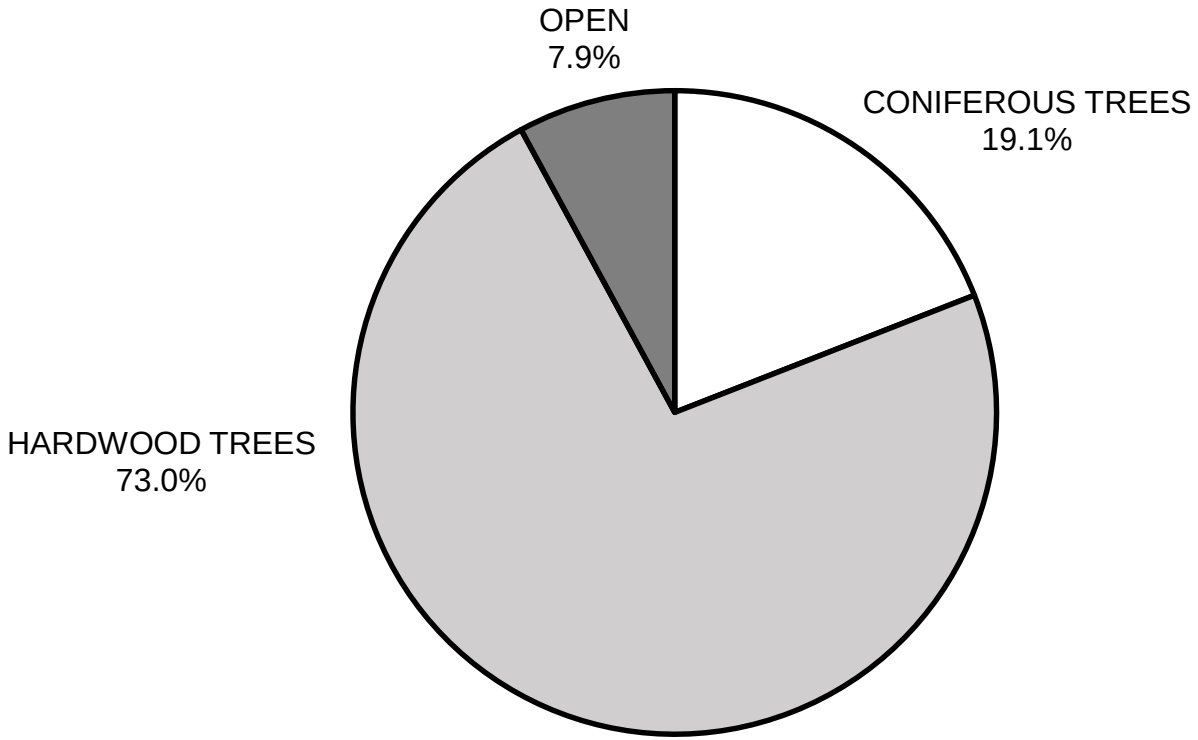
GRAPH 7

MILLER CREEK 2017
SUBSTRATE COMPOSITION IN POOL TAIL-OUTS



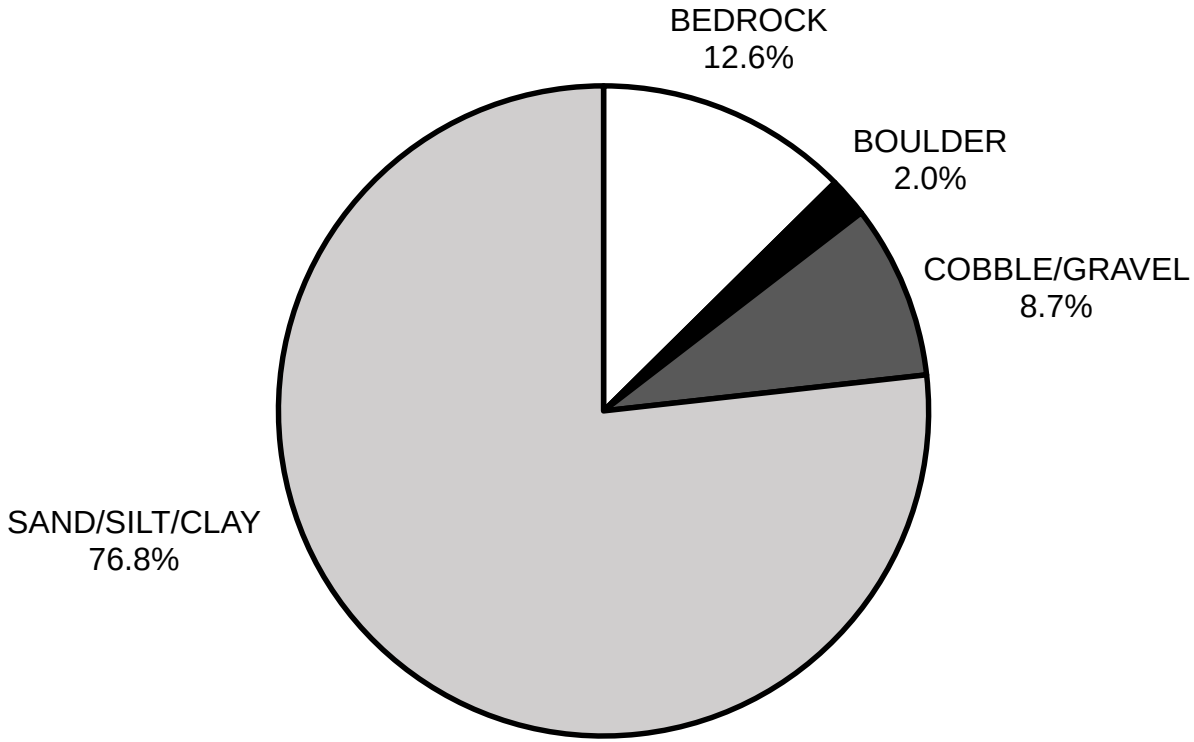
GRAPH 8

MILLER CREEK 2017
MEAN PERCENT CANOPY



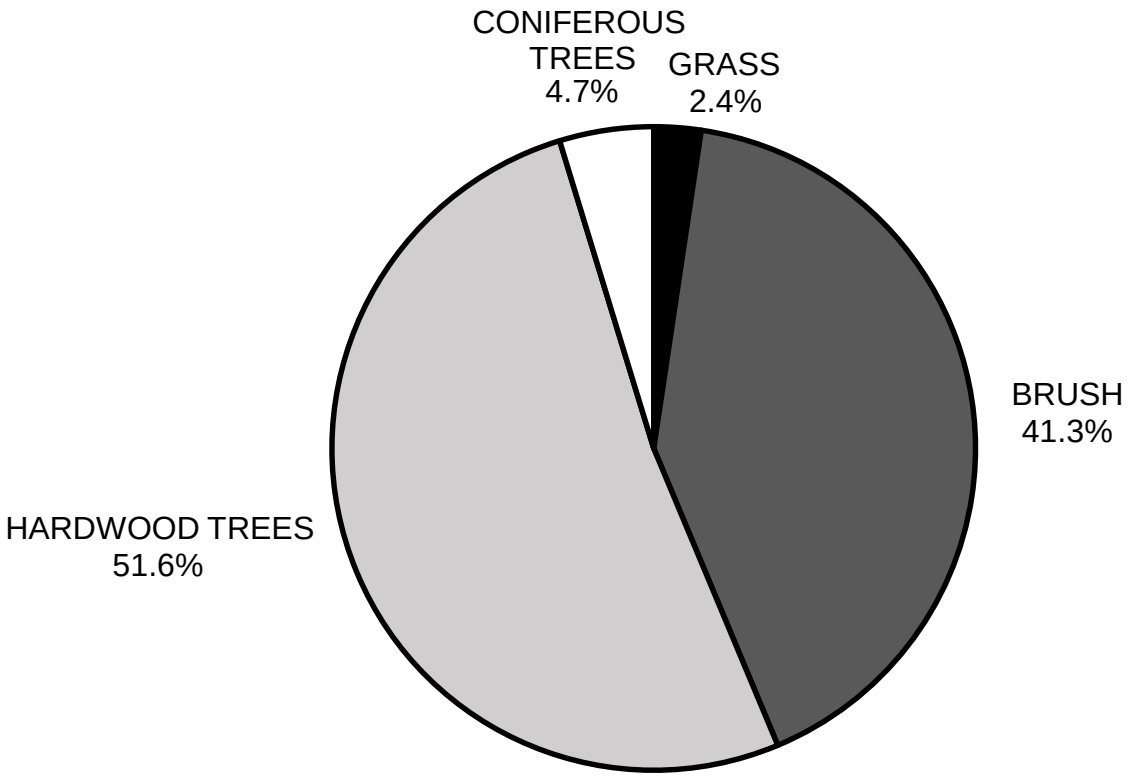
GRAPH 9

MILLER CREEK 2017
DOMINANT BANK COMPOSITION IN SURVEY REACH



GRAPH 10

MILLER CREEK 2017
DOMINANT BANK VEGETATION IN SURVEY REACH



GRAPH 11