

STREAM INVENTORY REPORT

Murray Gulch

INTRODUCTION

A stream inventory was conducted from July 26 to August 3, 2011 on Murray Gulch. The survey began at the confluence with the Navarro River and extended upstream 0.8 miles.

The Murray Gulch 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 Murray Gulch. 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

Murray Gulch is a tributary to the Navarro River, which drains to the Pacific Ocean. It is located in Mendocino County, California (Map 1). Murray Gulch's legal description at the confluence with the Navarro River is T15N R17W S12. Its location is 39.1783 degrees north latitude and 123.7021 degrees west longitude, LLID number 1237007391786. Murray Gulch is a first order stream and has approximately two miles of blue line stream according to the USGS Elk 7.5 minute quadrangle. Murray Gulch drains a watershed of approximately 1.1 square miles. Elevations range from about 10 feet at the mouth of the creek to 1,100 feet in the headwater areas. Mixed conifer forest dominates the watershed. The watershed is entirely privately owned and is managed for timber production. Vehicle access exists via a private logging road off Philo-Greenwood Road.

METHODS

The habitat inventory conducted in Murray Gulch follows the methodology presented in the *California Salmonid Stream Habitat Restoration Manual* (Flosi et al, 1998). The Watershed Stewards Project/AmeriCorps (WSP) members that conducted the inventory were trained in standardized habitat inventory methods by the 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

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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 Murray Gulch 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 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 (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". Murray Gulch 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 Murray Gulch, embeddedness was

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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 not suitable 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. In Murray Gulch, a standard qualitative shelter value of 0 (none), 1 (low), 2 (medium), or 3 (high) was assigned according to the complexity of the cover. Next, 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. The shelter rating is calculated for each fully-described habitat unit by multiplying shelter value and percent 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 Murray Gulch, 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 Murray Gulch, 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

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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 Murray Gulch. In addition, underwater observations were made at 14 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 2.0.19, a Visual Basic data entry program developed by Karen Wilson, Pacific States Marine Fisheries Commission in conjunction with the California Department of Fish and Game. 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 Murray Gulch include:

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

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- 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 AT THE END OF THE REPORT *

The habitat inventory of July 26 to August 3, 2011 was conducted by G. Goforth and E. Kantorski, (WSP). The total length of the stream surveyed was 4,148 feet with an additional 165 feet of side channel.

Stream flow was measured near the bottom of the survey reach with a Marsh-McBirney Model 2000 flowmeter at 0.33 cfs on July 27, 2011.

Murray Gulch is a C4 channel type for 1,791 feet of the stream surveyed (Reach 1), and an A4 channel type for 2,522 feet of the stream surveyed (Reach 2). C4 channels are meandering point-bar, riffle/pool, alluvial channels with broad well defined floodplain on low gradients and gravel-dominant substrates. A4 channels are steep, narrow, cascading, step-pool, high energy debris transporting channels associated with depositional soils, and gravel-dominant substrates.

Water temperatures taken during the survey period ranged from 53 to 59 degrees Fahrenheit. Air temperatures ranged from 59 to 64 degrees Fahrenheit.

Table 1 summarizes the Level II riffle, flatwater, and pool habitat types. Based on frequency of occurrence there were 38% pool units, 37% riffle units, and 25% flatwater units (Graph 1). Based on total length of Level II habitat types there were 47% flatwater units, 32% riffle units, and 21% pool units (Graph 2).

Eleven Level IV habitat types were identified (Table 2). The most frequent habitat types by percent occurrence were mid-channel pool units, 29%; low gradient riffle units, 23%; and step run units, 21% (Graph 3). Based on percent total length, step run units made up 44%, mid-channel pool units 17%, low gradient riffle units 15%, and high gradient riffle units 15%. A total of 51 pools were identified (Table 3). Main channel pools were the most frequently encountered at 78% (Graph 4), and comprised 84% 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. Four of the 51 pools (8%) had a residual depth of two feet or greater (Graph 5).

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The depth of cobble embeddedness was estimated at pool tail-outs. Of the 51 pool tail-outs measured, five had a value of 1 (9.8%); 28 had a value of 2 (54.9%); 17 had a value of 3 (33.3%); one had a value of 5 (2%) (Graph 6). On this scale, a value of 1 indicates the highest quality of spawning substrate. 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. Riffle habitat types had a mean shelter rating of 8, flatwater habitat types had a mean shelter rating of 4, and pool habitats had a mean shelter rating of 24 (Table 1). Of the pool types, the scour pools had the highest mean shelter rating at 52. Backwater pools had a mean shelter rating of 25. Main channel pools had a mean shelter rating of 18 (Table 3).

Table 5 summarizes mean percent cover by habitat type. Large woody debris is the dominant cover type in Murray Gulch. Graph 7 describes the pool cover in Murray Gulch. Large woody debris is 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 71% of the pool tail-outs. Small cobble was the next most frequently observed dominant substrate type and occurred in 22% of the pool tail-outs.

The mean percent canopy density for the surveyed length of Murray Gulch was 94%. Six percent of the canopy was open. Of the canopy present, the mean percentages of hardwood and coniferous trees were 61% and 39%, respectively. Graph 9 describes the mean percent canopy in Murray Gulch.

For the stream reach surveyed, the mean percent right bank vegetated was 94%. The mean percent left bank vegetated was 93%. The dominant elements composing the structure of the stream banks consisted of 56% cobble/gravel, 23% sand/silt/clay, 20% boulder, and 1% bedrock (Graph 10). Deciduous trees were the dominant vegetation type observed in 51% of the units surveyed. Additionally, 44% of the units surveyed had coniferous trees as the dominant vegetation type, and 5% had brush as the dominant vegetation type (Graph 11).

BIOLOGICAL INVENTORY RESULTS

Survey teams conducted a snorkel survey at 14 sites for species composition and distribution in Murray Gulch on August 22, 2011. The water temperature taken during the survey period of 1445 hours to 1600 hours was 56 degrees Fahrenheit. The air temperature was 66 degrees Fahrenheit. The sites were sampled by I. Mikus and M. Groff (DFG).

In reach 1, which comprised the first 1,791 feet of stream, 10 sites were sampled. The reach sites yielded three age 1+ steelhead/rainbow trout (SH/RT), one age 2+ SH/RT, one age 1+ coho salmon, and 25 sculpin.

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In reach 2, four sites were sampled starting approximately 1,780 feet from the confluence with the Navarro River and continuing upstream 398 feet. The reach sites yielded two age 2+ SH/RT.

The following chart displays the information yielded from these sites:

2011 Murray Gulch underwater observations.

Date	Survey Site #	Habitat Unit #	Habitat Type	Approx. Dist. from mouth (ft.)	SH/RT			Coho	
					YOY	1+	2+	YOY	1+
Reach 1: C4 Channel Type									
08/22/11	1	006	Pool	461	0	1	0	0	0
	2	008	Pool	551	0	0	0	0	0
	3	010	Pool	578	0	0	0	0	0
	4	016	Pool	740	0	0	0	0	0
	5	023	Pool	818	0	0	0	0	0
	6	025	Pool	854	0	1	0	0	0
	7	030	Pool	985	0	0	0	0	0
	8	038	Pool	1,248	0	1	1	0	1
	9	044	Pool	1,534	0	0	0	0	0
	10	048	Pool	1,604	0	0	0	0	0
Reach 2: A4 Channel Type									
	11	054	Pool	1,800	0	0	0	0	0
	12	058	Pool	1,869	0	0	1	0	0
	13	060	Pool	1,950	0	0	1	0	0
	14	069	Pool	2,178	0	0	0	0	0

DISCUSSION

Murray Gulch is a C4 channel type for the first 1,791 feet of stream surveyed, and an A4 channel type for the remaining 2,522 feet. The suitability of C4 and A4 channel types for fish habitat improvement structures is as follows: C4 channels are good for bank placed boulders and fair for plunge weirs, single and opposing wing-deflectors, channel constrictors, and log cover. A4 channels are generally not suitable for fish habitat improvement projects.

The water temperatures recorded on the survey days July 26 to August 3, 2011, ranged from 53 to 59 degrees Fahrenheit. Air temperatures ranged from 59 to 64 degrees Fahrenheit. This is a suitable water temperature range for salmonids. To make any conclusions, temperatures need to be monitored throughout the warm summer months, and more extensive biological sampling needs to be conducted.

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Flatwater habitat types comprised 47% of the total length of this survey, riffles 32%, and pools 21%. Four of the 51 (8%) pools had a maximum residual 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 residual 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 log structures that will increase or deepen pool habitat is recommended for Reach 1, the C4 channel type.

Thirty-three of the 51 pool tail-outs measured had embeddedness ratings of 1 or 2. Seventeen of the pool tail-outs had embeddedness ratings of 3 or 4. One 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 Murray Gulch should be mapped and rated according to their potential sediment yields, and control measures should be taken.

Forty-seven of the 51 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 24. 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 large woody debris in Murray Gulch. Large woody debris is the dominant cover type in pools followed by small woody debris. Log and root wad 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 94%. Reach 1 had a canopy density of 95% and Reach 2 had a canopy density of 93%. In general, revegetation projects are considered when canopy density is less than 80%.

The percentage of right and left bank covered with vegetation was 94% and 93%, respectively. 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

- 1) Murray Gulch 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. Most of the existing cover in the pools is from large woody debris. Adding high quality complexity with woody cover in the pools is desirable.

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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 the Navarro River. The channel is a C4.
232	0003.00	A logging road crosses the channel. The crossing is a 10' high x 14' wide x 30' long railcar bridge.
1581	0048.00	There is a 1.9' high plunge.
1791	0055.00	The channel changes from a C4 to an A4.
1811	0056.00	Log debris accumulation (LDA) #01 contains 11 pieces of large woody debris (LWD) and measures 2.3' high x 18' wide x 16' long. Water flows through the LDA and there are visible gaps in it. Retained sediment ranges from silt to large cobble and measures 20' wide x 30' long x 2' deep. It is a possible barrier to juvenile and adult salmonids. Fish are present above the LDA.
1854	0058.00	There is a 1.9' high plunge.
2013	0063.00	Woody debris is accumulating in the channel creating a potential plunge barrier; the debris creates three steps, each with a 1' high plunge.
2077	0065.00	LDA #02 contains 10 pieces of LWD and measures 8' high x 14' wide x 21' long. Water flows through the LDA and there are visible gaps in it. Retained sediment ranges from silt to large and measures 13' wide x 40' long x 3' deep.
2484	0078.00	LDA #03 contains 13 pieces of LWD and measures 9' high x 33' wide x 34' long. Water flows through the LDA and there are visible gaps in it. Retained sediment ranges from silt to large cobble and measures 16' wide x 20' long x 5' deep.

Tributary #01 enters on the left bank. The water temperature of the tributary is 55 degrees Fahrenheit, the water temperature downstream of the tributary is 55 degrees Fahrenheit, and the water temperature upstream of the confluence is 56 degrees Fahrenheit. The tributary is accessible to salmonids, but no fish were observed.

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- 2605 0084.00 Tributary #02 enters on the left bank. The water temperature of the tributary is 55 degrees Fahrenheit, the water temperature downstream of the tributary is 56 degrees Fahrenheit, and the water temperature upstream of the confluence is 55 degrees Fahrenheit. The tributary is accessible to salmonids, but no fish were observed.
- 2622 0085.00 LDA #04 contains four pieces of LWD and measures 4' high x 13' wide x 18' long. Water flows through the LDA and there are visible gaps in it. Retained sediment ranges from silt to large cobble and measures 11' wide x 18' long x 3' deep.
- 2708 0090.00 LDA #05 contains four pieces of LWD and measures 6' high x 11' wide x 22' long. Water flows through the LDA and there are no visible gaps in it. Retained sediment ranges from silt to large cobble and measures 13' wide x 20' long x 3' deep.
- 3432 0111.00 LDA #06 contains one pieces of LWD and measures 3' high x 10' wide x 4' long. Water flows through the LDA and there are no visible gaps in it. Retained sediment ranges from silt to large cobble and measures 10' wide x 14' long x 1' deep.
- 3621 0117.00 LDA #07 contains five pieces of LWD and measures 5' high x 20' wide x 26' long. Water flows through the LDA and there are visible gaps in it. Retained sediment ranges from silt to large cobble and measures 20' wide x 20' long x 3' deep.
- 3781 0122.00 Landslide.
- 3990 0128.00 Landslide on left bank. LDA #08 contains three pieces of LWD and measures 4' high x 15' wide x 7' long. Water flows through the LDA and there are no visible gaps in it. Retained sediment ranges from silt to small cobble and measures 11' wide x 15' long x 3' deep.
- 4031 0130.00 Tributary #03 enters on the left bank. The water temperature of the tributary is 50 degrees Fahrenheit; the water temperature downstream and upstream of the tributary is 55 degrees Fahrenheit.
- 4148 0131.00 End of 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.

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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 - 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]	

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

Stream Name: Murray Gulch

LLID: 1237007391786 Drainage: Navarro River

Survey Dates: 7/26/2011 to 8/3/2011

Confluence Location: Quad: ELK

Legal Description: T15NR17WS12 Latitude: 39:10:43.0N Longitude: 123:42:03.0

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
33	10	FLATWATER	24.8	61	2028	47.0	6.0	0.4	0.7	276	9098	98	3229		4
51	51	POOL	38.3	18	909	21.1	8.6	0.5	1.2	136	6943	106	5403	70	24
49	10	RIFFLE	36.8	28	1376	31.9	8.6	0.4	0.7	151	7407	63	3074		8
Total Units	Total Units Fully Measured				Total Length (ft.)					Total Area (sq.ft.)			Total Volume (cu.ft.)		
133	71				4313					23448			11707		

Table 2 - Summary of Habitat Types and Measured Parameters

Stream Name: Murray Gulch

LLID: 1237007391786

Drainage: Navarro River

Survey Dates: 7/26/2011 to 8/3/2011

Confluence Location: Quad: ELK

Legal Description: T15NR17WS12

Latitude: 39:10:43.0N

Longitude: 123:42:03.0W

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 (%)
30	5	LGR	22.6	21	641	14.9	6	0.3	0.6	123	3688	45	1357		1	95
17	3	HGR	12.8	39	660	15.3	8	0.3	0.7	139	2361	44	749		5	93
2	2	CAS	1.5	38	75	1.7	16	0.6	1.4	240	481	135	269		28	90
5	2	RUN	3.8	23	114	2.6	8	0.3	0.6	307	1533	115	577		5	96
28	8	SRN	21.1	68	1914	44.4	5	0.4	1.2	268	7504	93	2618		4	89
38	38	MCP	28.6	19	724	16.8	9	0.5	2.7	145	5524	107	4073	70	17	95
2	2	STP	1.5	22	43	1.0	5	0.4	1	94	188	71	141	33	20	90
4	4	LSL	3.0	14	56	1.3	8	0.4	1.9	90	359	57	228	37	73	92
5	5	PLP	3.8	14	72	1.7	11	0.8	2.1	150	749	178	891	135	35	93
1	1	BPL	0.8	6	6	0.1	14	0.3	1.4	84	84	42	42	25	10	96
1	1	DPL	0.8	8	8	0.2	5	0.6	1.2	40	40	28	28	24	40	100

Total Units
133

Total Units Fully Measured
71

Total Length (ft.)
4313

Total Area (sq.ft.)
22508

Total Volume (cu.ft.)
10972

Table 3 - Summary of Pool Types

Stream Name: Murray Gulch

LLID: 1237007391786

Drainage: Navarro River

Survey Dates: 7/26/2011 to 8/3/2011

Confluence Location: Quad: ELK

Legal Description: T15NR17WS12

Latitude: 39:10:43.0N

Longitude: 123:42:03.0W

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
40	40	MAIN	78	19	767	84	8.4	0.5	143	5712	68	2720	18
9	9	SCOUR	18	14	128	14	9.4	0.6	123	1107	91	821	52
2	2	BACKWATER	4	7	14	2	9.5	0.5	62	124	25	49	25

Total Units	Total Units Fully Measured	Total Length (ft.)	Total Area (sq.ft.)	Total Volume (cu.ft.)
51	51	909	6943	3591

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

Stream Name: Murray Gulch

LLID: 1237007391786

Drainage: Navarro River

Survey Dates: 7/26/2011 to 8/3/2011

Confluence Location: Quad: ELK

Legal Description: T15NR17WS12

Latitude: 39:10:43.0N

Longitude: 123:42:03.0W

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
38	MCP	75	13	34	22	58	3	8	0	0	0	0
2	STP	4	0	0	2	100	0	0	0	0	0	0
4	LSL	8	1	25	3	75	0	0	0	0	0	0
5	PLP	10	1	20	3	60	1	20	0	0	0	0
1	BPL	2	0	0	1	100	0	0	0	0	0	0
1	DPL	2	0	0	1	100	0	0	0	0	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
51	15	29	32	63	4	8	0	0	0	0

Mean Maximum Residual Pool Depth (ft.): 1.2

Table 5 - Summary of Mean Percent Cover By Habitat Type

Stream Name: Murray Gulch

LLID: 1237007391786

Drainage: Navarro River

Survey Dates: 7/26/2011 to 8/3/2011

Dry Units: 0

Confluence Location: Quad: ELK

Legal Description: T15NR17WS12

Latitude: 39:10:43.0N

Longitude: 123:42:03.0W

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
30	5	LGR	0	100	0	0	0	0	0	0	0
17	3	HGR	0	0	0	0	0	0	2	98	0
2	2	CAS	0	0	13	0	0	0	13	75	0
49	10	TOTAL RIFFLE	0	20	5	0	0	0	6	69	0
5	2	RUN	5	50	45	0	0	0	0	0	0
28	8	SRN	0	4	38	8	25	0	1	24	0
33	10	TOTAL FLAT	1	16	39	6	19	0	1	18	0
38	38	MCP	10	20	42	11	0	0	3	13	0
2	2	STP	0	0	38	0	0	0	13	50	0
4	4	LSL	9	9	58	25	0	0	0	0	0
5	5	PLP	5	1	49	5	0	0	16	24	0
1	1	BPL	0	0	100	0	0	0	0	0	0
1	1	DPL	80	20	0	0	0	0	0	0	0
51	51	TOTAL POOL	10	16	44	11	0	0	4	14	0
133	71	TOTAL	8	16	40	9	3	0	4	19	0

Table 6 - Summary of Dominant Substrates By Habitat Type

Stream Name: Murray Gulch

LLID: 1237007391786

Drainage: Navarro River

Survey Dates: 7/26/2011 to 8/3/2011

Dry Units: 0

Confluence Location: Quad: ELK

Legal Description: T15NR17WS12

Latitude: 39:10:43.0N

Longitude: 123:42:03.0W

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
30	5	LGR	0	0	60	40	0	0	0
17	3	HGR	0	0	33	33	0	33	0
2	2	CAS	0	0	0	0	0	100	0
5	2	RUN	0	0	100	0	0	0	0
28	8	SRN	0	0	50	13	25	13	0
38	38	MCP	11	58	11	8	3	11	0
2	2	STP	0	0	50	0	0	50	0
4	4	LSL	50	50	0	0	0	0	0
5	5	PLP	0	20	0	0	0	80	0
1	1	BPL	100	0	0	0	0	0	0
1	1	DPL	0	0	100	0	0	0	0

Table 7 - Summary of Mean Percent Canopy for Entire Stream

Stream Name: Murray Gulch

LLID: 1237007391786

Drainage: Navarro River

Survey Dates: 7/26/2011 to 8/3/2011

Confluence Location: Quad: ELK

Legal Description: T15NR17WS12

Latitude: 39:10:43.0N

Longitude: 123:42:03.0W

Mean Percent Canopy	Mean Percent Conifer	Mean Percent Hardwood	Mean Percent Open Units	Mean Right Bank % Cover	Mean Left Bank % Cover
94	39	61	0	94	93

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: Murray Gulch LLID: 1237007391786 Drainage: Navarro River
 Survey Dates: 7/26/2011 to 8/3/2011 Survey Length (ft.): 4313 Main Channel (ft.): 4148 Side Channel (ft.): 165
 Confluence Location: Quad: ELK Legal Description: T15NR17WS12 Latitude: 39:10:43.0N Longitude: 123:42:03.0W

Summary of Fish Habitat Elements By Stream Reach

STREAM REACH: 1

Channel Type: C4	Canopy Density (%): 95.5	Pools by Stream Length (%): 26.0
Reach Length (ft.): 1791	Coniferous Component (%): 33.4	Pool Frequency (%): 44.4
Riffle/Flatwater Mean Width (ft.): 6.5	Hardwood Component (%): 66.6	Residual Pool Depth (%):
BFW:	Dominant Bank Vegetation: Hardwood Trees	< 2 Feet Deep: 96
Range (ft.): 8 to 16	Vegetative Cover (%): 94.3	2 to 2.9 Feet Deep: 4
Mean (ft.): 11	Dominant Shelter: Large Woody Debris	3 to 3.9 Feet Deep: 0
Std. Dev.: 4	Dominant Bank Substrate Type: Cobble/Gravel	>= 4 Feet Deep: 0
Base Flow (cfs.): 0.3	Occurrence of LWD (%): 30	Mean Max Residual Pool Depth (ft.): 1.2
Water (F): 53 - 59 Air (F): 59 - 64	LWD per 100 ft.:	Mean Pool Shelter Rating: 25
Dry Channel (ft): 0	Riffles: 4	
	Pools: 5	
	Flat: 1	
Pool Tail Substrate (%): Silt/Clay: 0 Sand: 0 Gravel: 75 Sm Cobble: 21 Lg Cobble: 4 Boulder: 0 Bedrock: 0		
Embeddedness Values (%): 1. 12.5 2. 50.0 3. 37.5 4. 0.0 5. 0.0		

STREAM REACH: 2

Channel Type: A4	Canopy Density (%): 92.6	Pools by Stream Length (%): 17.6
Reach Length (ft.): 2357	Coniferous Component (%): 43.2	Pool Frequency (%): 34.2
Riffle/Flatwater Mean Width (ft.): 7.8	Hardwood Component (%): 56.8	Residual Pool Depth (%):
BFW:	Dominant Bank Vegetation: Coniferous Trees	< 2 Feet Deep: 89
Range (ft.): 8 to 13	Vegetative Cover (%): 92.9	2 to 2.9 Feet Deep: 11
Mean (ft.): 10	Dominant Shelter: Large Woody Debris	3 to 3.9 Feet Deep: 0
Std. Dev.: 2	Dominant Bank Substrate Type: Cobble/Gravel	>= 4 Feet Deep: 0
Base Flow (cfs.): 0.3	Occurrence of LWD (%): 42	Mean Max Residual Pool Depth (ft.): 1.3
Water (F): 53 - 56 Air (F): 59 - 64	LWD per 100 ft.:	Mean Pool Shelter Rating: 22
Dry Channel (ft): 0	Riffles: 5	
	Pools: 18	
	Flat: 4	
Pool Tail Substrate (%): Silt/Clay: 0 Sand: 0 Gravel: 67 Sm Cobble: 22 Lg Cobble: 7 Boulder: 4 Bedrock: 0		
Embeddedness Values (%): 1. 7.4 2. 59.3 3. 29.6 4. 0.0 5. 3.7		

Table 9 - Mean Percentage of Dominant Substrate and Vegetation

Stream Name: Murray Gulch

LLID: 1237007391786

Drainage: Navarro River

Survey Dates: 7/26/2011 to 8/3/2011

Confluence Location: Quad: ELK

Legal Description: T15NR17WS12

Latitude: 39:10:43.0N

Longitude: 123:42:03.0W

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	1	0	0.7
Boulder	17	12	20.4
Cobble / Gravel	37	42	55.6
Sand / Silt / Clay	16	17	23.2

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	0	0	0.0
Brush	4	3	4.9
Hardwood Trees	33	39	50.7
Coniferous Trees	34	29	44.4
No Vegetation	0	0	0.0

Total Stream Cobble Embeddedness Values: 2

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

StreamName: Murray Gulch

LLID: 1237007391786

Drainage: Navarro River

Survey Dates: 7/26/2011 to 8/3/2011

Confluence Location: Quad: ELK

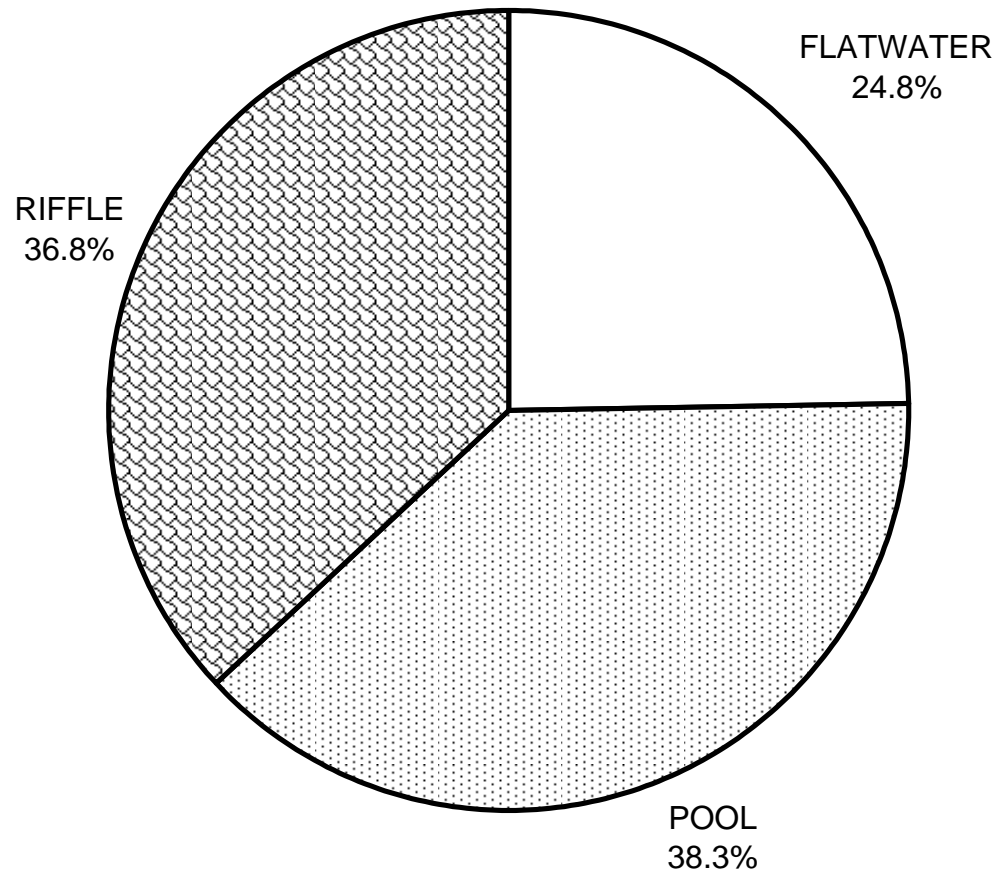
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Longitude: 123:42:03.0W

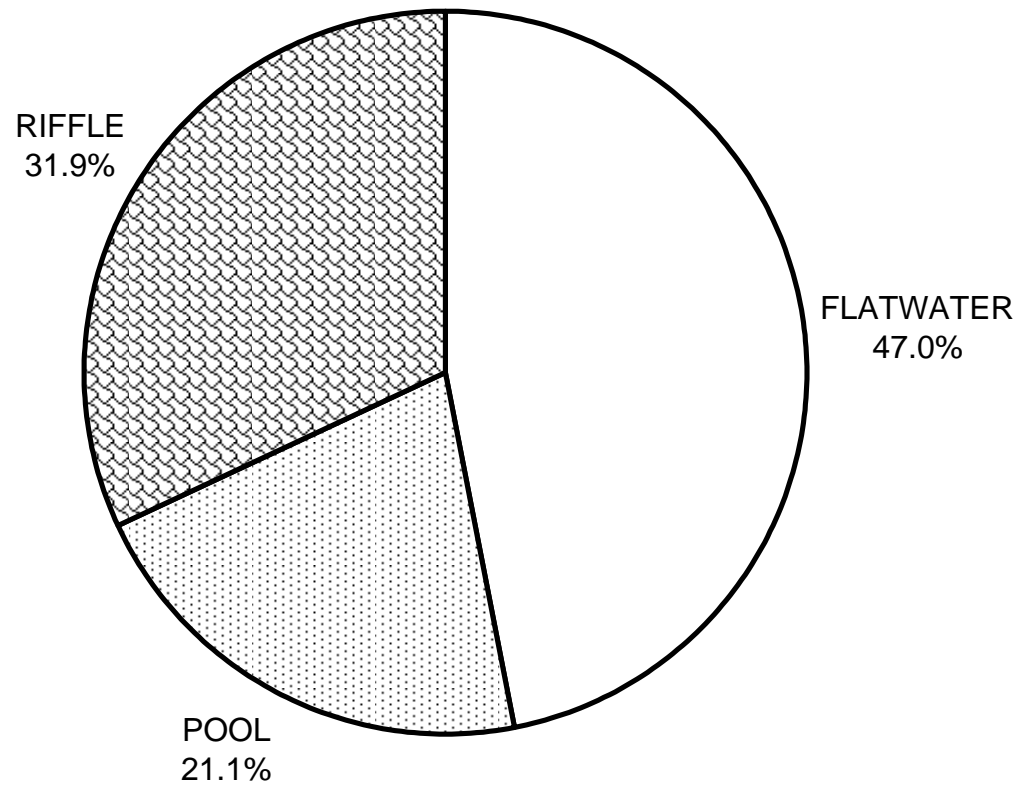
	Riffles	Flatwater	Pools
UNDERCUT BANKS (%)	0	1	10
SMALL WOODY DEBRIS (%)	20	16	16
LARGE WOODY DEBRIS (%)	5	39	44
ROOT MASS (%)	0	6	11
TERRESTRIAL VEGETATION (%)	0	19	0
AQUATIC VEGETATION (%)	0	0	0
WHITEWATER (%)	6	1	4
BOULDERS (%)	69	18	14
BEDROCK LEDGES (%)	0	0	0

MURRAY GULCH 2011 HABITAT TYPES BY PERCENT OCCURRENCE



GRAPH 1

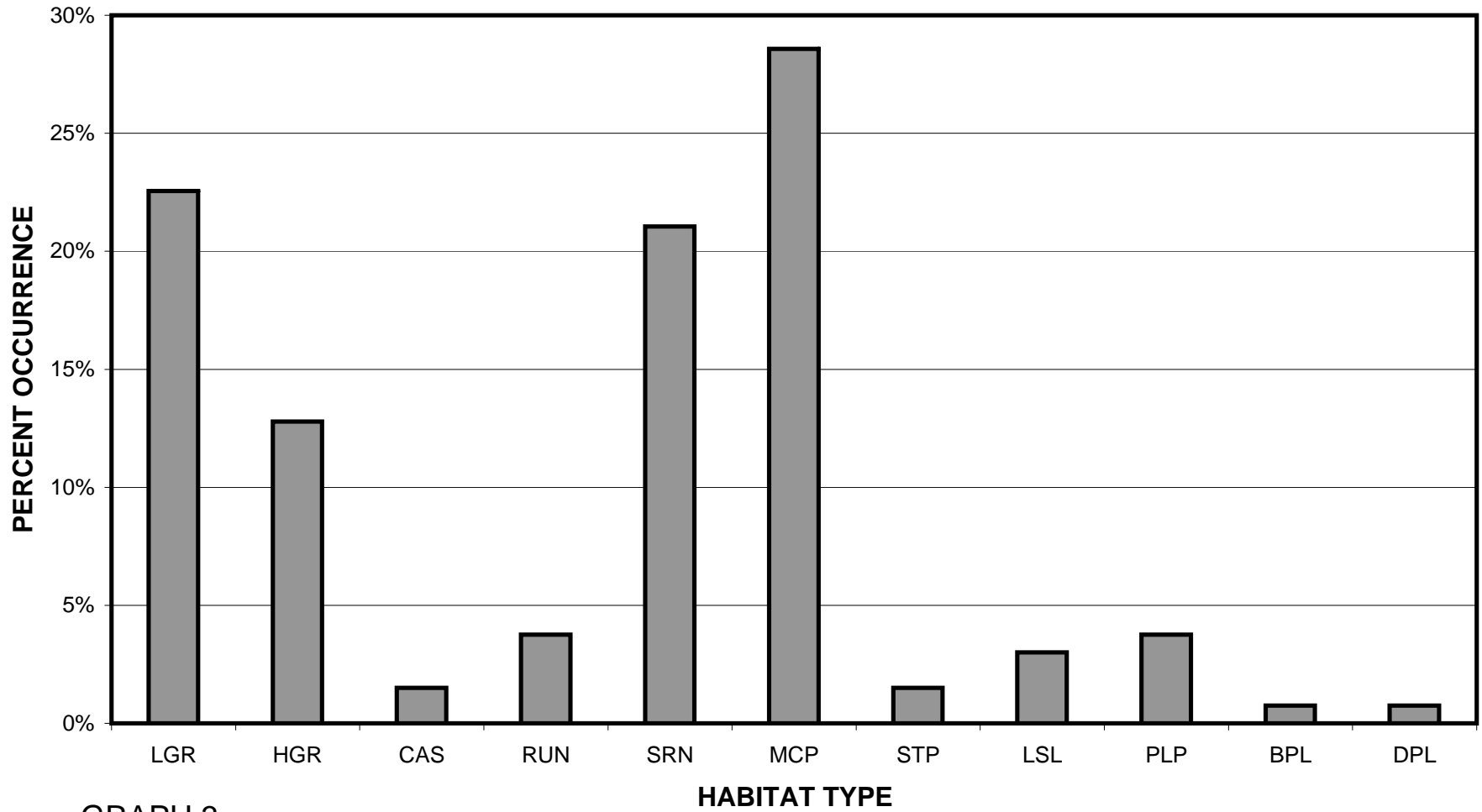
MURRAY GULCH 2011 HABITAT TYPES BY PERCENT TOTAL LENGTH



GRAPH 2

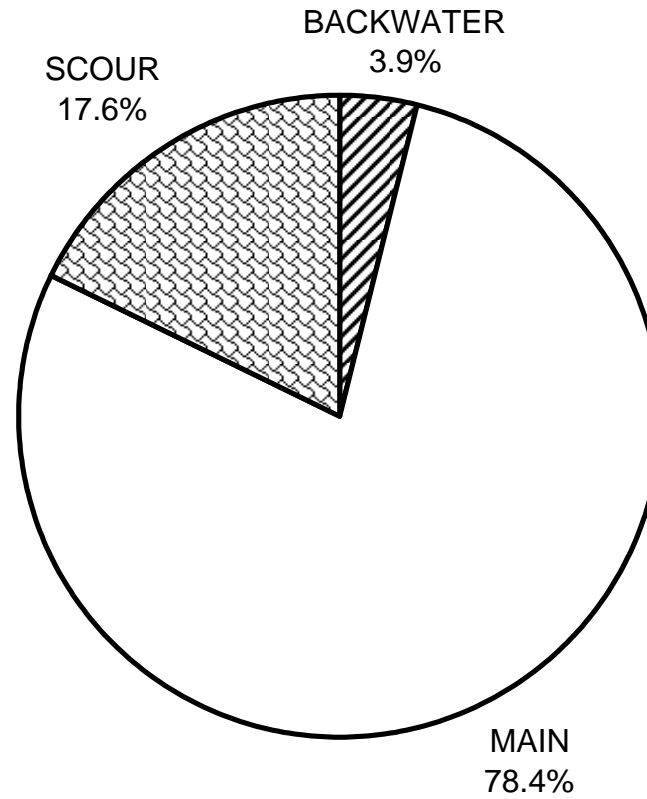
MURRAY GULCH 2011

HABITAT TYPES BY PERCENT OCCURRENCE



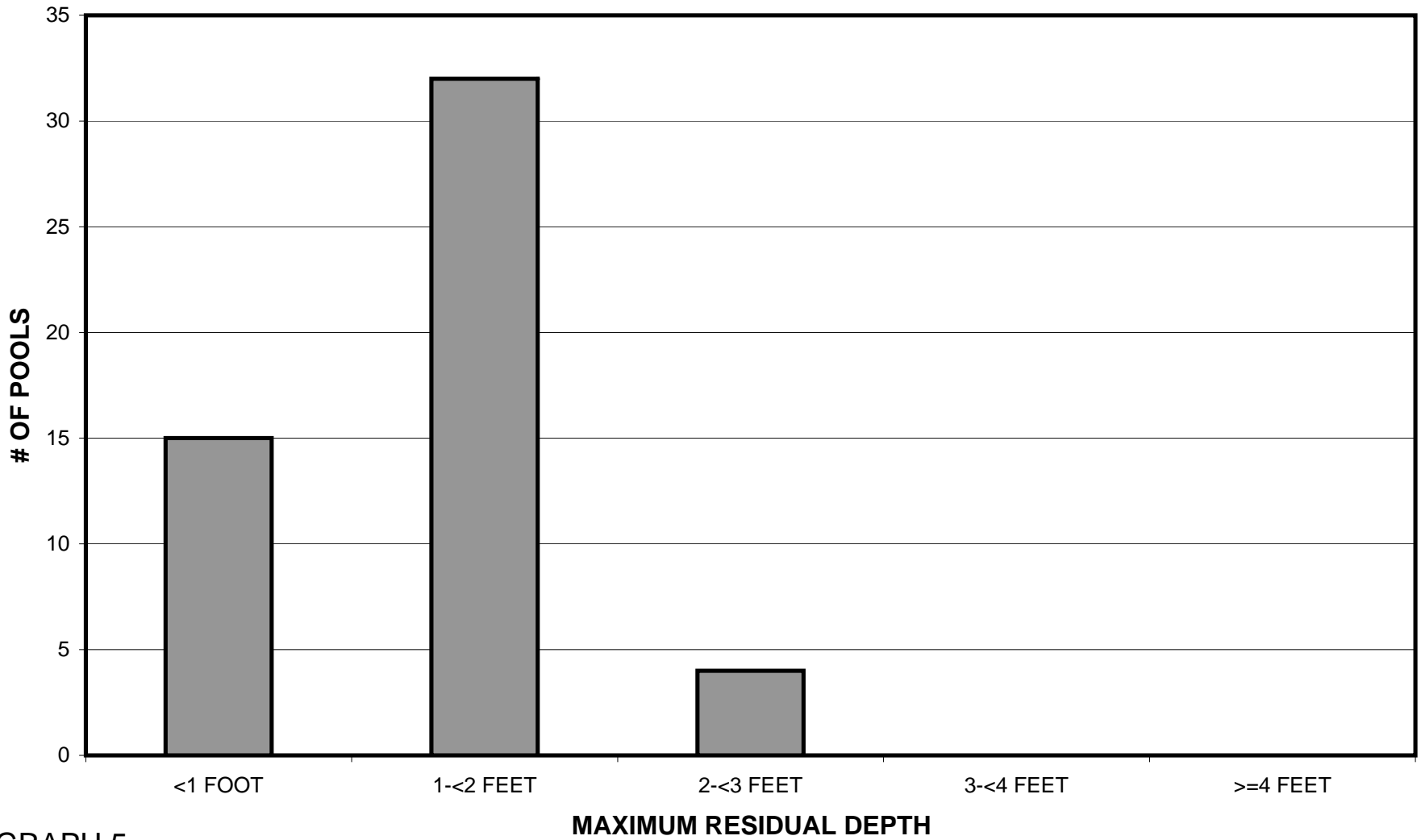
GRAPH 3

MURRAY GULCH 2011 POOL TYPES BY PERCENT OCCURRENCE



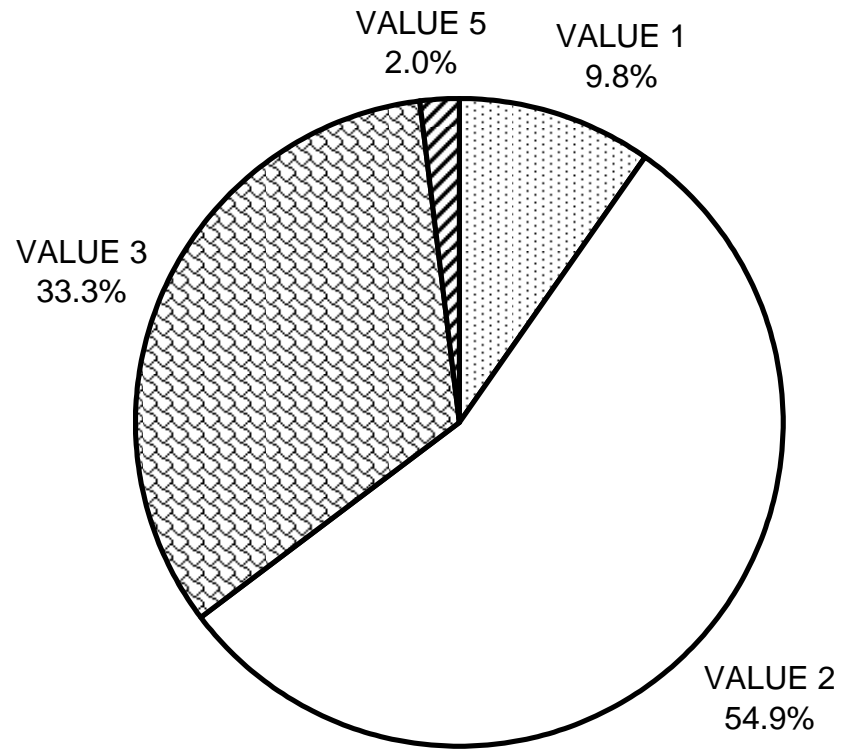
GRAPH 4

MURRAY GULCH 2011 MAXIMUM DEPTH IN POOLS



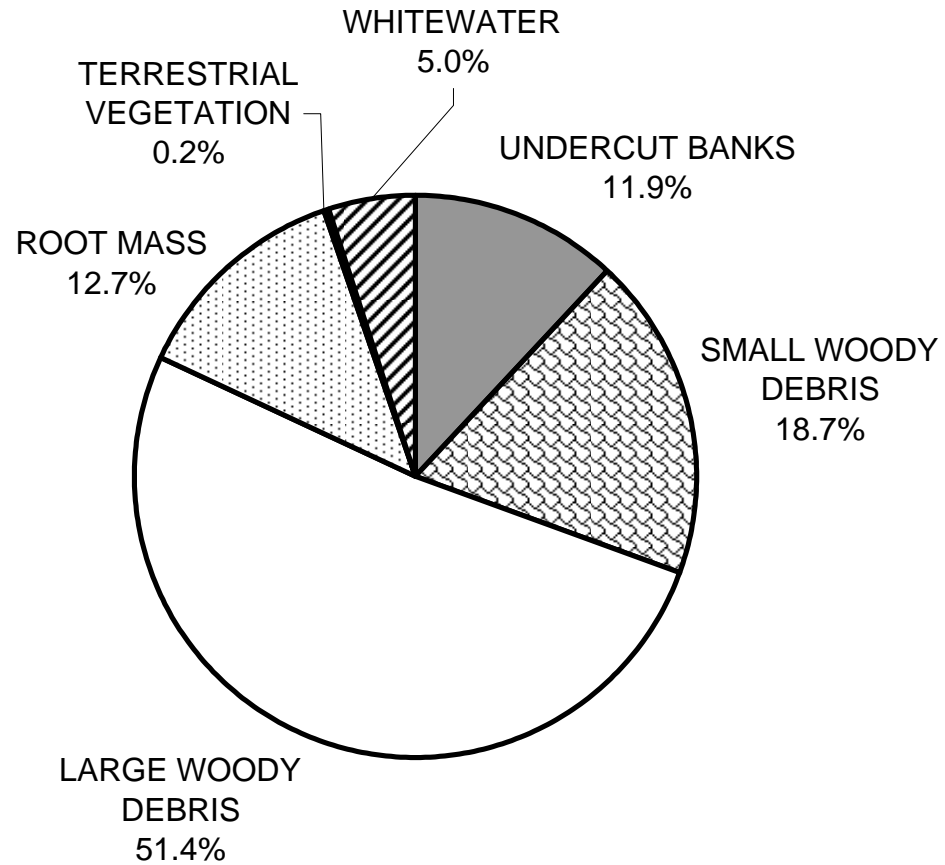
GRAPH 5

MURRAY GULCH 2011 PERCENT EMBEDDEDNESS



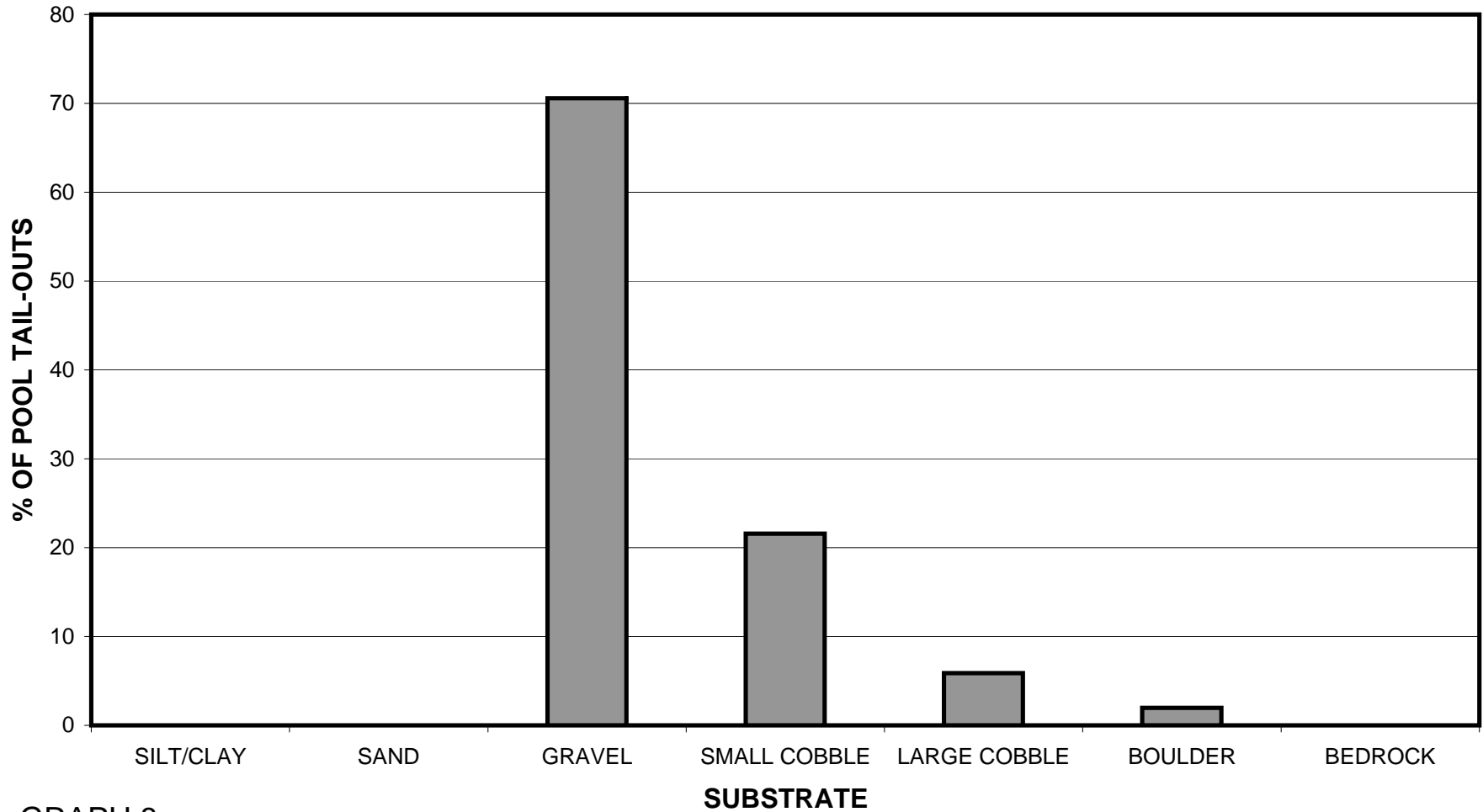
GRAPH 6

MURRAY GULCH 2011 MEAN PERCENT COVER TYPES IN POOLS



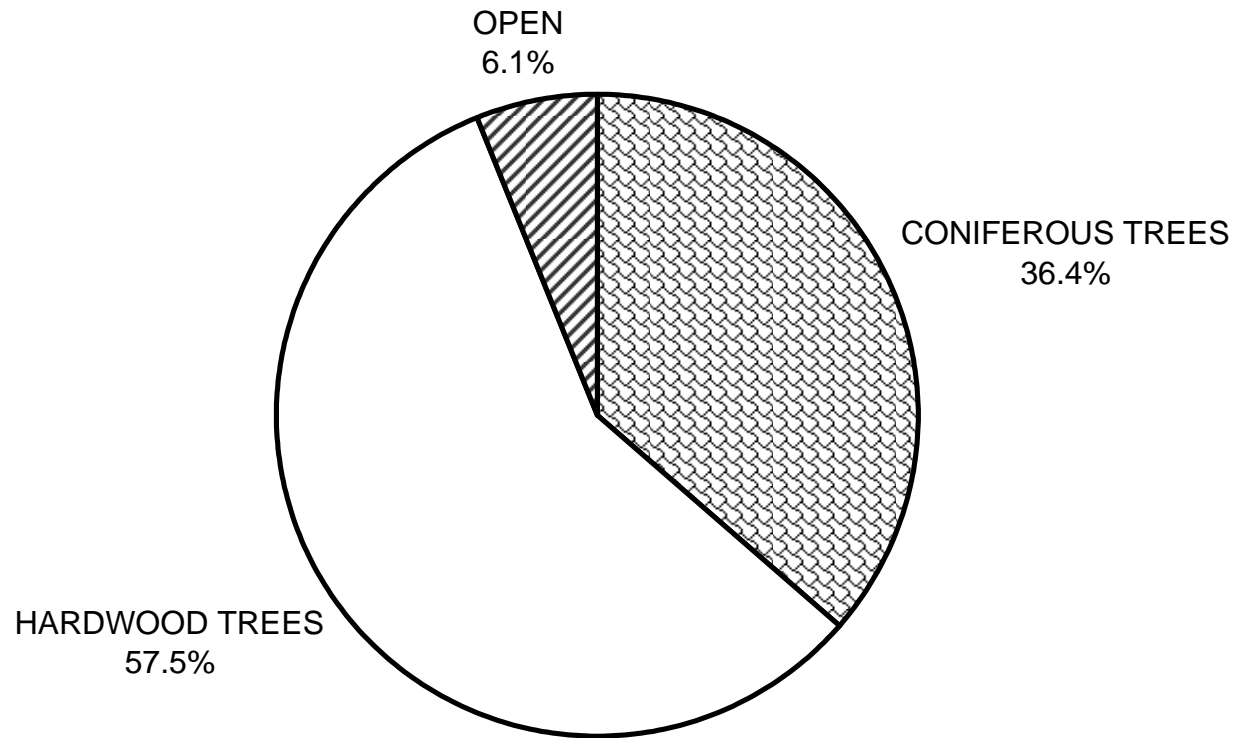
GRAPH 7

MURRAY GULCH 2011 SUBSTRATE COMPOSITION IN POOL TAIL-OUTS



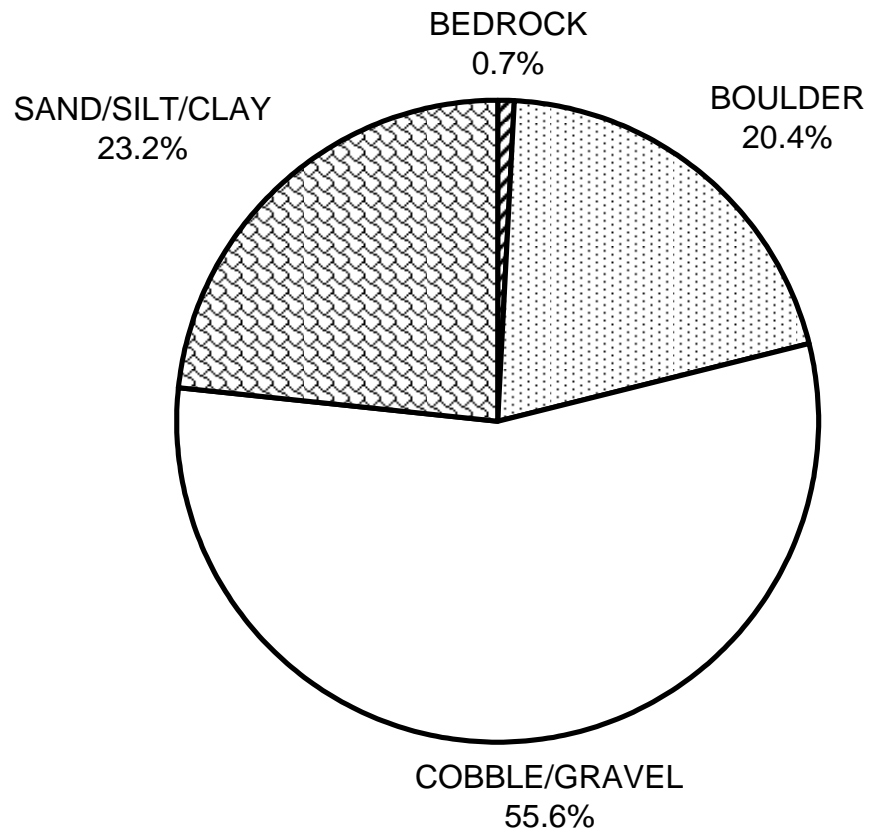
GRAPH 8

MURRAY GULCH 2011 MEAN PERCENT CANOPY



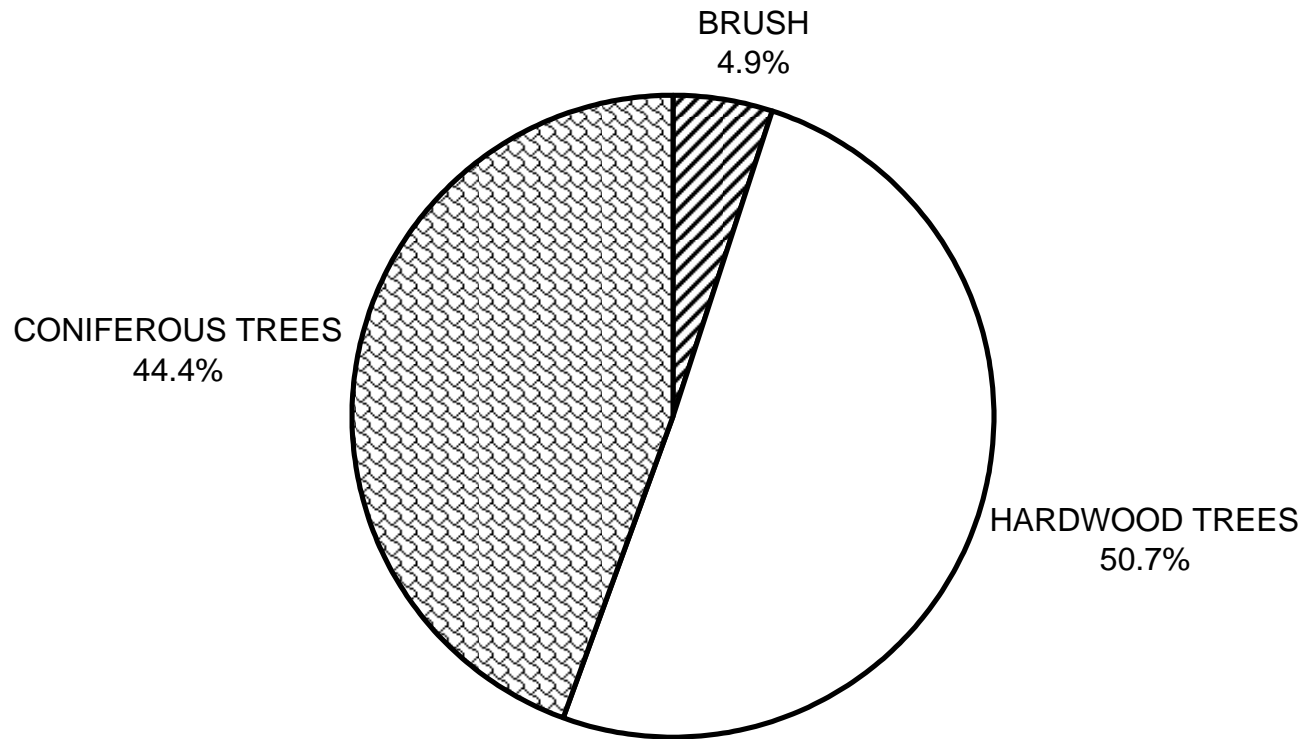
GRAPH 9

MURRAY GULCH 2011 DOMINANT BANK COMPOSITION IN SURVEY REACH



GRAPH 10

MURRAY GULCH 2011 DOMINANT BANK VEGETATION IN SURVEY REACH



GRAPH 11

