

STREAM INVENTORY REPORT

Marsh Gulch

INTRODUCTION

A stream inventory was conducted August 23, 2011 on Marsh Gulch. The survey began at the confluence with the Navarro River and extended upstream 0.6 miles.

The Marsh 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 Marsh 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

Marsh Gulch is a tributary to the Navarro River, which drains to the Pacific Ocean. It is located in Mendocino County, California (Map 1). Marsh Gulch's legal description at the confluence with the Navarro River is T15N R17W S11. Its location is 39.1784 degrees north latitude and 123.7090 degrees west longitude, LLID number 1237078391783. Marsh Gulch is a first order stream and has approximately 1.8 miles of blue line stream according to the USGS Elk 7.5 minute quadrangle. Marsh Gulch drains a watershed of approximately 1.8 square miles. Elevations range from about 10 feet at the mouth of the creek to 1,000 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 Marsh Gulch follows the methodology presented in the *California Salmonid Stream Habitat Restoration Manual* (Flosi et al, 1998). The California Department of Fish and Game (DFG) personnel 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 Marsh 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". Marsh 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 Marsh 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 Marsh 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 Marsh 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 Marsh 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 elevation of bankfull discharge are counted and recorded. The minimum size to be considered is

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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 Marsh Gulch. In addition, underwater observations were made at 15 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 Marsh Gulch 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

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- 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 August 23, 2011 was conducted by M. Groff and I. Mikus (DFG). The total length of the stream surveyed was 3,279 feet.

Stream flow was measured near the bottom of the survey reach with a Marsh-McBirney Model 2000 flowmeter at 0.6 cfs on August 24, 2011.

Marsh Gulch is a G4 channel type for 1,233 feet of the stream surveyed (Reach 1) and an A4 channel type for 2,046 feet of the stream surveyed (Reach 2). G4 channels are entrenched “gully” step-pool channels on moderate gradients with low width /depth ratios 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 54 to 56 degrees Fahrenheit. Air temperatures ranged from 58 to 64 degrees Fahrenheit.

Table 1 summarizes the Level II riffle, flatwater, and pool habitat types. Based on frequency of occurrence there were 40% pool units, 39% riffle units, and 21% flatwater units (Graph 1). Based on total length of Level II habitat types there were 54% riffle units, 27% pool units, and 19% flatwater units (Graph 2).

Ten Level IV habitat types were identified (Table 2). The most frequent habitat types by percent occurrence were high gradient riffle units, 25%; mid-channel pool units, 23%; and run units, 15% (Graph 3). Based on percent total length, high gradient riffle units made up 36%, low gradient riffle units 19%, and mid-channel pool units 17%.

A total of 50 pools were identified (Table 3). Main channel pools were the most frequently encountered at 62% (Graph 4), and comprised 67% 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. Five of the 50 pools (10%) had a residual depth of two feet or greater (Graph 5).

The depth of cobble embeddedness was estimated at pool tail-outs. Of the 50 pool tail-outs measured, three had a value of 1 (6%); 18 had a value of 2 (36%); 18 had a value of 3 (36%);

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five had a value of 4 (10%); six had a value of 5 (12%); (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 3, flatwater habitat types had a mean shelter rating of 7, and pool habitats had a mean shelter rating of 9 (Table 1). Of the pool types, the scour pools had the highest mean shelter rating at 13. Main channel pools had a mean shelter rating of 7 (Table 3).

Table 5 summarizes mean percent cover by habitat type. Boulders are the dominant cover type in Marsh Gulch. Graph 7 describes the pool cover in Marsh Gulch. Boulders are the dominant pool cover type followed by whitewater.

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 52% of the pool tail-outs. Boulders were 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 Marsh Gulch was 96%. Four percent of the canopy was open. Of the canopy present, the mean percentages of hardwood and coniferous trees were 27% and 73%, respectively. Graph 9 describes the mean percent canopy in Marsh Gulch.

For the stream reach surveyed, the mean percent right bank vegetated was 94%. The mean percent left bank vegetated was 95%. The dominant elements composing the structure of the stream banks consisted of 50% sand/silt/clay, 34% boulder, 14% cobble/gravel, and 2% bedrock (Graph 10). Brush was the dominant vegetation type observed in 48% of the units surveyed. Additionally, 35% of the units surveyed had coniferous trees as the dominant vegetation type, and 17% had deciduous trees as the dominant vegetation type (Graph 11).

BIOLOGICAL INVENTORY RESULTS

Survey teams conducted a snorkel survey at 15 sites for species composition and distribution in Marsh Gulch on August 24, 2011. The water temperature taken during the survey period of 0840 hours to 0930 hours was 54 degrees Fahrenheit. The air temperature ranged was 57 degrees Fahrenheit. The sites were sampled by I. Mikus and M. Groff (DFG).

In reach 1, which comprised the first 1,233 feet of stream, five sites were sampled. The reach sites yielded two young-of-the-year (YOY) steelhead/rainbow trout (SH/RT), 24 YOY coho salmon, three age 1+ coho salmon, and 11 sculpin.

In reach 2, 10 sites were sampled starting approximately 1,314 feet from the confluence with the Navarro River and continuing upstream 885 feet. The reach sites yielded two YOY SH/RT, two age 1+ SH/RT, four YOY coho salmon, and two age 1+ coho salmon.

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The following chart displays the information yielded from these sites:

2011 Marsh 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: G4 Channel Type									
08/24/11	1	012	Pool	347	1	0	0	7	2
	2	022	Pool	635	0	0	0	6	0
	3	027	Pool	743	0	0	0	3	0
	4	033	Pool	1,074	1	0	0	7	0
	5	040	Pool	1,233	0	0	0	1	1
Reach 2: A4 Channel Type									
	6	043	Pool	1,333	0	0	0	2	2
	7	048	Pool	1,462	2	0	0	2	0
	8	054	Pool	1,588	0	0	0	0	0
	9	060	Pool	1,731	0	0	0	0	0
	10	061	Pool	1,749	0	0	0	0	0
	11	064	Pool	1,835	0	0	0	0	0
	12	066	Pool	1,860	0	0	0	0	0
	13	069	Pool	1,994	0	2	0	0	0
	14	074	Pool	2,097	0	0	0	0	0
	15	080	Pool	2,199	0	0	0	0	0

DISCUSSION

Marsh Gulch is a G4 channel type for the first 1,233 feet of stream surveyed and an A4 channel type for the remaining 2,046 feet. The suitability of G4 and A4 channel types for fish habitat improvement structures is as follows: G4 channels are good for bank-placed boulders and fair for plunge weirs, opposing wing-deflectors, and log cover. A4 channels are generally not suitable for fish habitat improvement projects.

The water temperatures recorded on the survey day August 23, 2011 ranged from 54 to 56 degrees Fahrenheit. Air temperatures ranged from 58 to 64 degrees Fahrenheit. This is a suitable water temperature range 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 19% of the total length of this survey, riffles 54%, and pools 27%. Five of the 50 (10%) pools had a maximum residual depth greater than 2 feet. In general,

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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 structures that will increase or deepen pool habitat is recommended for Reach 1.

Twenty-one of the 50 pool tail-outs measured had embeddedness ratings of 1 or 2. Twenty-three of the pool tail-outs had embeddedness ratings of 3 or 4. Six 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 Marsh Gulch should be mapped and rated according to their potential sediment yields, and control measures should be taken.

Thirty of the 50 pool tail-outs measured had gravel or small cobble as the dominant substrate. This is generally considered suitable for spawning salmonids.

The mean shelter rating for pools is 9. The shelter rating in the flatwater habitats is 7. A pool shelter rating of approximately 100 is desirable. The amount of cover that now exists is being provided primarily by boulders in Marsh Gulch. Boulders are the dominant cover type in pools followed by whitewater. 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 96%. Reach 1 had a canopy density of 98% and Reach 2 had a canopy density of 96%. 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 95%, 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) Marsh 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) In reach 1, 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.

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- 4) Increase woody cover in the pools and flatwater habitat units. Most of the existing cover in the pools is from boulders. Adding high quality complexity with woody cover in the pools is desirable.
- 5) Active and potential sediment sources related to the road system need to be identified, mapped, and treated according to their potential for sediment yield to the stream and its tributaries.

COMMENTS AND LANDMARKS

The following landmarks and possible problem sites were noted. All distances are approximate and taken from the beginning of the survey reach.

Position (ft):	Habitat Unit #:	Comment:
0	0001.00	Start of survey at the confluence with the Navarro River. The first 50 feet of stream flow is over the Navarro river's gravel bank. The channel is a G4.
190	0008.00	A bridge crosses the channel. The crossing is a 11' wide x 50' long x 13.6' high railcar bridge with an old log stringer bridge below it. The cables connecting the logs of the string bridge are beginning to sag into the channel.
1233	0041.00	The channel changes from a G4 to an A4.
1314	0043.00	There is a 1.5' high plunge.
1405	0047.00	Tributary #01 enters on the left bank. It contributes approximately 15% to Marsh Gulch's flow. The water temperature of the tributary is 54 degrees Fahrenheit, the water temperature downstream of the tributary is 54 degrees Fahrenheit, and the water temperature upstream of the confluence is 55 degrees Fahrenheit. The slope of the tributary is approximately 6%. The tributary is accessible to salmonids, but there is a 4' high jump approximately 50' upstream that may hinder fish. No fish were observed in the tributary.
1982	0069.00	There is a 2.5' high plunge over boulders.
2177	0080.00	There is a 2.5' high plunge over a bedrock step.
2488	0090.00	Tributary #02 enters on the left bank. It contributes approximately 5% to Marsh Gulch's flow. The water temperature of the tributary is 56 degrees Fahrenheit; the water temperature downstream and upstream of

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the tributary is 56 degrees Fahrenheit. The slope of the tributary is approximately 15%.

2854	0103.00	There is a 2.8' high plunge over boulders and woody debris.
3035	0113.00	There is a 2.8' high plunge over boulders.
3085	0116.00	There is a 4.3' foot high plunge over bedrock with no jump pool below.
3184	0118.00	There is a 1.5' high plunge over boulders.
3210	0120.00	There is a 2.4' high plunge over boulders.
3244	0123.00	There is a 3.3' high plunge over boulders.
3266	0124.00	End of survey due to high gradient. There is a 5.2' high plunge into a 1.3' deep pool. The slope was measured to 18% over the last 291' of the survey. The number of fish observed dropped greatly above Habitat Unit #050.

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: Marsh Gulch

LLID: 1237078391783 Drainage: Navarro River

Survey Dates: 8/23/2011 to 8/23/2011

Confluence Location: Quad: ELK

Legal Description: T15NR17WS11

Latitude: 39:10:42.0N

Longitude: 123:42:28.0

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
26	6	FLATWATER	21.0	24	615	18.8	6.2	0.5	1.0	133	3448	65	1695		7
50	50	POOL	40.3	18	886	27.0	10.3	0.5	1.3	162	8111	134	6712	96	9
48	4	RIFFLE	38.7	37	1778	54.2	7.5	0.3	0.6	153	7340	44	2118		3
Total Units	Total Units Fully Measured				Total Length (ft.)					Total Area (sq.ft.)			Total Volume (cu.ft.)		
124	60				3279					18899			10525		

Table 2 - Summary of Habitat Types and Measured Parameters

Stream Name: Marsh Gulch

LLID: 1237078391783

Drainage: Navarro River

Survey Dates: 8/23/2011 to 8/23/2011

Confluence Location: Quad: ELK

Legal Description: T15NR17WS11

Latitude: 39:10:42.0N

Longitude: 123:42:28.0W

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 (%)
17	2	LGR	13.7	36	611	18.6	9	0.3	0.6	206	3504	58	991		0	96
31	2	HGR	25.0	38	1167	35.6	6	0.3	0.8	100	3092	30	928		5	93
18	3	RUN	14.5	21	372	11.3	6	0.5	1	133	2388	67	1203		0	95
8	3	SRN	6.5	30	243	7.4	6	0.5	1.1	133	1060	64	509		13	97
29	29	MCP	23.4	19	547	16.7	9	0.5	2.3	162	4711	130	3763	93	6	96
2	2	STP	1.6	22	44	1.3	10	0.8	1.7	196	391	231	461	172	23	98
3	3	LSL	2.4	21	62	1.9	10	0.3	1.2	177	532	94	283	47	20	96
1	1	LSR	0.8	16	16	0.5	6	0.4	1.4	96	96	58	58	38	5	99
3	3	LSBo	2.4	11	32	1.0	17	0.2	1.5	142	425	70	209	33	2	97
12	12	PLP	9.7	15	185	5.6	12	0.7	2.1	163	1957	162	1939	123	15	96

Total Units
124

Total Units Fully Measured
60

Total Length (ft.)
3279

Total Area (sq.ft.)
18155

Total Volume (cu.ft.)
10343

Table 3 - Summary of Pool Types

Stream Name: Marsh Gulch

LLID: 1237078391783

Drainage: Navarro River

Survey Dates: 8/23/2011 to 8/23/2011

Confluence Location: Quad: ELK

Legal Description: T15NR17WS11

Latitude: 39:10:42.0N

Longitude: 123:42:28.0W

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
31	31	MAIN	62	19	591	67	9.1	0.5	165	5102	98	3051	7
19	19	SCOUR	38	16	295	33	12.2	0.6	158	3009	92	1756	13

Total Units	Total Units Fully Measured	Total Length (ft.)	Total Area (sq.ft.)	Total Volume (cu.ft.)
50	50	886	8111	4807

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

Stream Name: Marsh Gulch LLID: 1237078391783 Drainage: Navarro River
 Survey Dates: 8/23/2011 to 8/23/2011
 Confluence Location: Quad: ELK Legal Description: T15NR17WS11 Latitude: 39:10:42.0N Longitude: 123:42:28.0W

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
29	MCP	58	6	21	21	72	2	7	0	0	0	0
2	STP	4	0	0	2	100	0	0	0	0	0	0
3	LSL	6	1	33	2	67	0	0	0	0	0	0
1	LSR	2	0	0	1	100	0	0	0	0	0	0
3	LSBo	6	1	33	2	67	0	0	0	0	0	0
12	PLP	24	0	0	9	75	3	25	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
50	8	16	37	74	5	10	0	0	0	0

Mean Maximum Residual Pool Depth (ft.): 1.3

Table 5 - Summary of Mean Percent Cover By Habitat Type

Stream Name: Marsh Gulch

LLID: 1237078391783

Drainage: Navarro River

Survey Dates: 8/23/2011 to 8/23/2011

Dry Units: 0

Confluence Location: Quad: ELK

Legal Description: T15NR17WS11

Latitude: 39:10:42.0N

Longitude: 123:42:28.0W

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
17	2	LGR	0	0	0	0	0	0	0	0	0
31	2	HGR	0	0	0	0	0	0	100	0	0
48	4	TOTAL RIFFLE	0	0	0	0	0	0	100	0	0
18	3	RUN	0	0	0	0	0	0	0	0	0
8	3	SRN	0	0	0	0	0	0	55	45	0
26	6	TOTAL FLAT	0	0	0	0	0	0	55	45	0
29	29	MCP	12	20	10	1	0	0	4	54	0
2	2	STP	0	0	0	0	0	0	38	63	0
3	3	LSL	0	28	72	0	0	0	0	0	0
1	1	LSR	100	0	0	0	0	0	0	0	0
3	3	LSBo	0	0	0	0	0	0	0	100	0
12	12	PLP	0	0	7	0	0	0	45	48	0
50	50	TOTAL POOL	9	12	12	1	0	0	18	48	0
124	60	TOTAL	8	12	12	1	0	0	21	47	0

Table 6 - Summary of Dominant Substrates By Habitat Type

Stream Name: Marsh Gulch

LLID: 1237078391783

Drainage: Navarro River

Survey Dates: 8/23/2011 to 8/23/2011

Dry Units: 0

Confluence Location: Quad: ELK

Legal Description: T15NR17WS11

Latitude: 39:10:42.0N

Longitude: 123:42:28.0W

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
17	2	LGR	0	0	50	50	0	0	0
31	2	HGR	0	0	50	50	0	0	0
18	3	RUN	0	0	100	0	0	0	0
8	3	SRN	0	0	67	0	0	33	0
29	29	MCP	0	38	48	0	3	10	0
2	2	STP	0	0	50	0	0	50	0
3	3	LSL	0	33	67	0	0	0	0
1	1	LSR	0	0	100	0	0	0	0
3	3	LSBo	0	0	33	0	0	67	0
12	12	PLP	0	8	83	0	0	8	0

Table 7 - Summary of Mean Percent Canopy for Entire Stream

Stream Name: Marsh Gulch

LLID: 1237078391783

Drainage: Navarro River

Survey Dates: 8/23/2011 to 8/23/2011

Confluence Location: Quad: ELK

Legal Description: T15NR17WS11

Latitude: 39:10:42.0N

Longitude: 123:42:28.0W

Mean Percent Canopy	Mean Percent Conifer	Mean Percent Hardwood	Mean Percent Open Units	Mean Right Bank % Cover	Mean Left Bank % Cover
96	73	27	0	94	95

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: Marsh Gulch LLID: 1237078391783 Drainage: Navarro River
 Survey Dates: 8/23/2011 to 8/23/2011 Survey Length (ft.): 3279 Main Channel (ft.): 3279 Side Channel (ft.): 0
 Confluence Location: Quad: ELK Legal Description: T15NR17WS11 Latitude: 39:10:42.0N Longitude: 123:42:28.0W

Summary of Fish Habitat Elements By Stream Reach

STREAM REACH: 1

Channel Type: G4	Canopy Density (%): 97.5	Pools by Stream Length (%): 29.8
Reach Length (ft.): 1233	Coniferous Component (%): 42.5	Pool Frequency (%): 37.5
Riffle/Flatwater Mean Width (ft.): 5.3	Hardwood Component (%): 57.5	Residual Pool Depth (%):
BFW:	Dominant Bank Vegetation: Hardwood Trees	< 2 Feet Deep: 93
Range (ft.): 15 to 22	Vegetative Cover (%): 86.2	2 to 2.9 Feet Deep: 7
Mean (ft.): 19	Dominant Shelter: Large Woody Debris	3 to 3.9 Feet Deep: 0
Std. Dev.: 3	Dominant Bank Substrate Type: Sand/Silt/Clay	>= 4 Feet Deep: 0
Base Flow (cfs.): 0.6	Occurrence of LWD (%): 20	Mean Max Residual Pool Depth (ft.): 1.2
Water (F): 54 - 54 Air (F): 58 - 61	LWD per 100 ft.:	Mean Pool Shelter Rating: 9
Dry Channel (ft): 0	Riffles: 2	
	Pools: 8	
	Flat: 2	
Pool Tail Substrate (%): Silt/Clay: 0 Sand: 0 Gravel: 60 Sm Cobble: 20 Lg Cobble: 7 Boulder: 13 Bedrock: 0		
Embeddedness Values (%): 1. 6.7 2. 33.3 3. 40.0 4. 20.0 5. 0.0		

STREAM REACH: 2

Channel Type: A4	Canopy Density (%): 95.5	Pools by Stream Length (%): 25.4
Reach Length (ft.): 2046	Coniferous Component (%): 87.8	Pool Frequency (%): 41.7
Riffle/Flatwater Mean Width (ft.): 7.7	Hardwood Component (%): 12.2	Residual Pool Depth (%):
BFW:	Dominant Bank Vegetation: Brush	< 2 Feet Deep: 89
Range (ft.): 14 to 26	Vegetative Cover (%): 98.2	2 to 2.9 Feet Deep: 11
Mean (ft.): 20	Dominant Shelter: Boulders	3 to 3.9 Feet Deep: 0
Std. Dev.: 4	Dominant Bank Substrate Type: Boulder	>= 4 Feet Deep: 0
Base Flow (cfs.): 0.6	Occurrence of LWD (%): 3	Mean Max Residual Pool Depth (ft.): 1.4
Water (F): 54 - 56 Air (F): 58 - 64	LWD per 100 ft.:	Mean Pool Shelter Rating: 9
Dry Channel (ft): 0	Riffles: 8	
	Pools: 13	
	Flat: 14	
Pool Tail Substrate (%): Silt/Clay: 0 Sand: 0 Gravel: 49 Sm Cobble: 3 Lg Cobble: 9 Boulder: 40 Bedrock: 0		
Embeddedness Values (%): 1. 5.7 2. 37.1 3. 34.3 4. 5.7 5. 17.1		

Table 9 - Mean Percentage of Dominant Substrate and Vegetation

Stream Name: Marsh Gulch

LLID: 1237078391783

Drainage: Navarro River

Survey Dates: 8/23/2011 to 8/23/2011

Confluence Location: Quad: ELK

Legal Description: T15NR17WS11

Latitude: 39:10:42.0N

Longitude: 123:42:28.0W

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	2	0	1.7
Boulder	21	20	34.2
Cobble / Gravel	11	6	14.2
Sand / Silt / Clay	26	34	50.0

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	27	31	48.3
Hardwood Trees	11	9	16.7
Coniferous Trees	22	20	35.0
No Vegetation	0	0	0.0

Total Stream Cobble Embeddedness Values: 3

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

StreamName: Marsh Gulch

LLID: 1237078391783

Drainage: Navarro River

Survey Dates: 8/23/2011 to 8/23/2011

Confluence Location: Quad: ELK

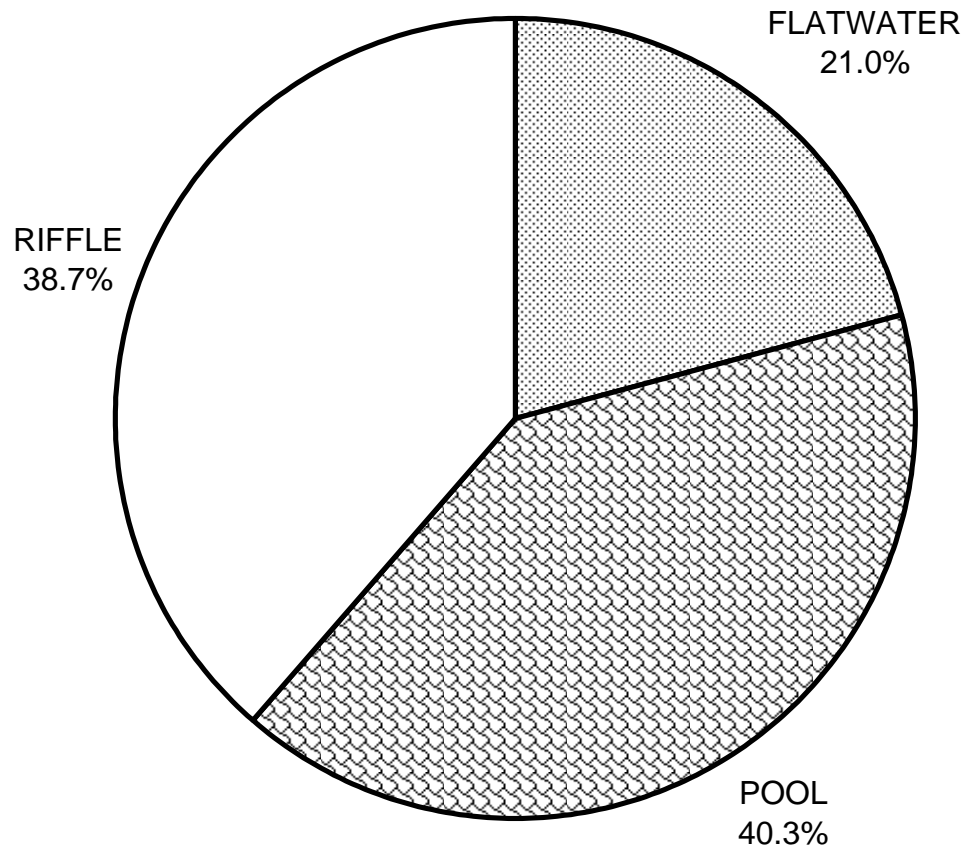
Legal Description: T15NR17WS11

Latitude: 39:10:42.0N

Longitude: 123:42:28.0W

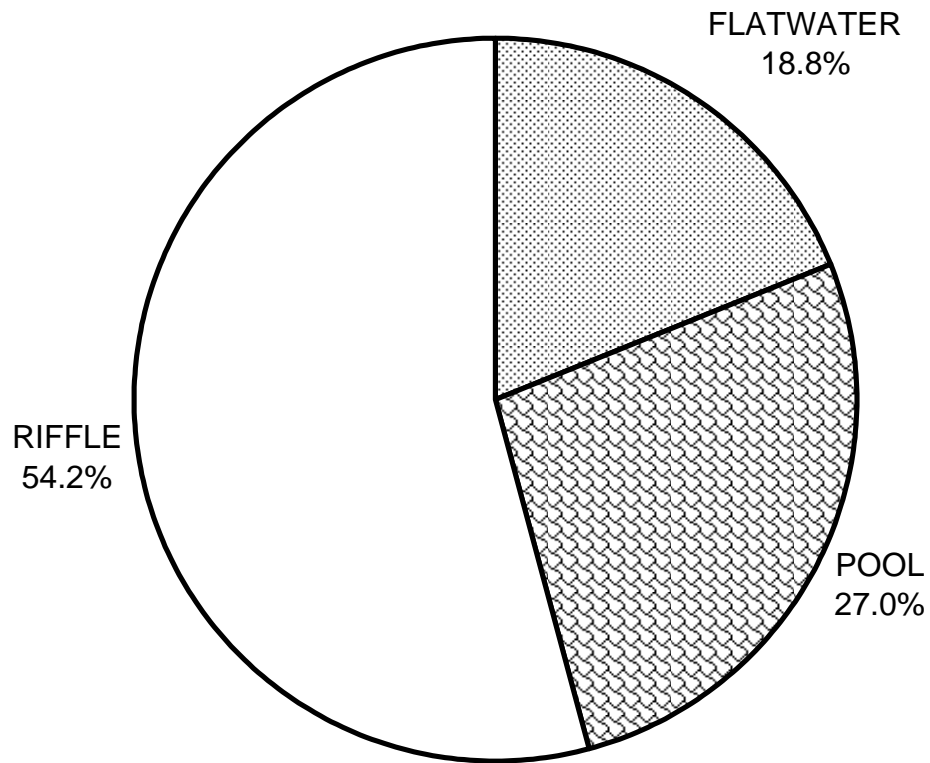
	Riffles	Flatwater	Pools
UNDERCUT BANKS (%)	0	0	9
SMALL WOODY DEBRIS (%)	0	0	12
LARGE WOODY DEBRIS (%)	0	0	12
ROOT MASS (%)	0	0	1
TERRESTRIAL VEGETATION (%)	0	0	0
AQUATIC VEGETATION (%)	0	0	0
WHITEWATER (%)	100	55	18
BOULDERS (%)	0	45	48
BEDROCK LEDGES (%)	0	0	0

**MARSH GULCH 2011
HABITAT TYPES BY PERCENT OCCURRENCE**



GRAPH 1

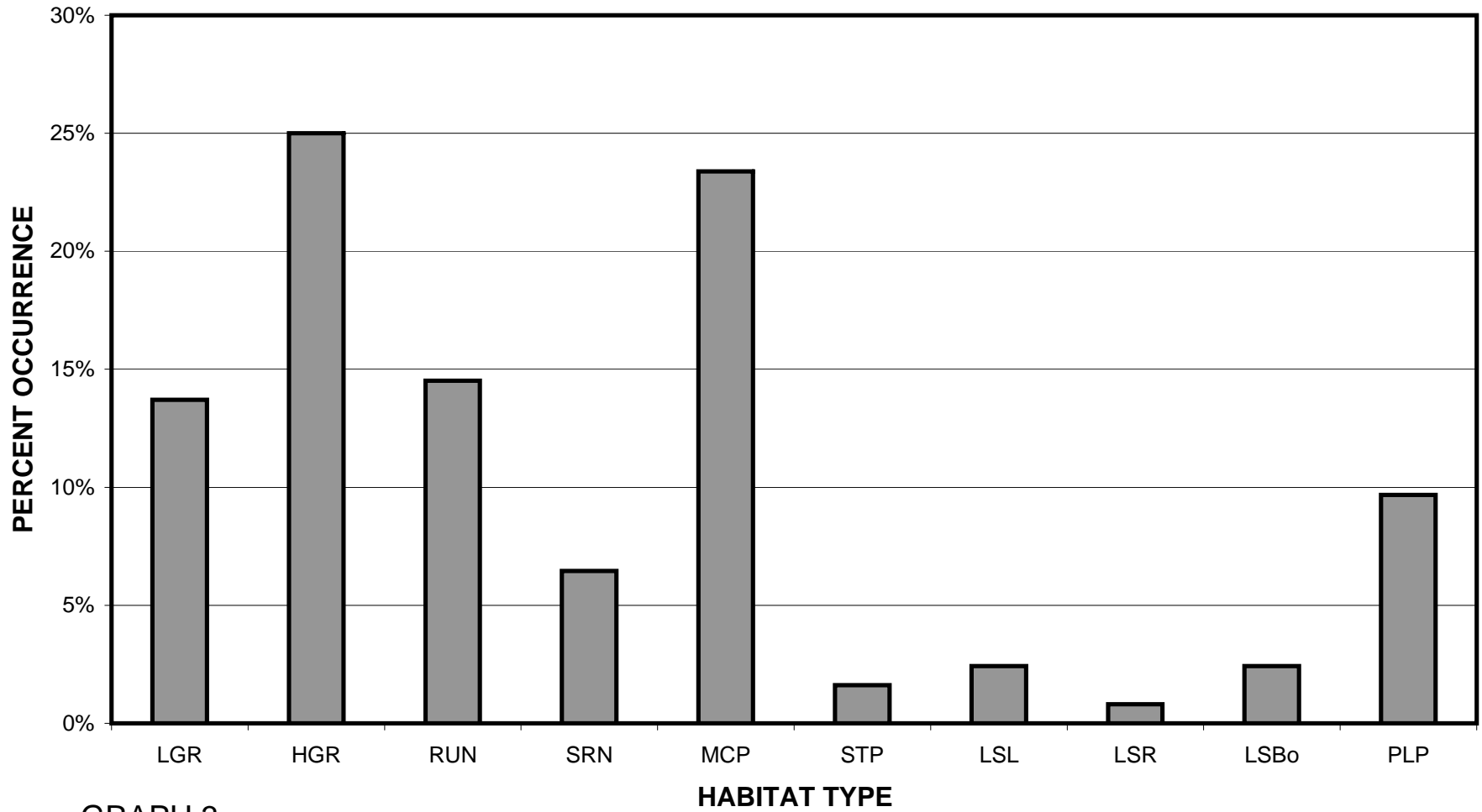
**MARSH GULCH 2011
HABITAT TYPES BY PERCENT TOTAL LENGTH**



GRAPH 2

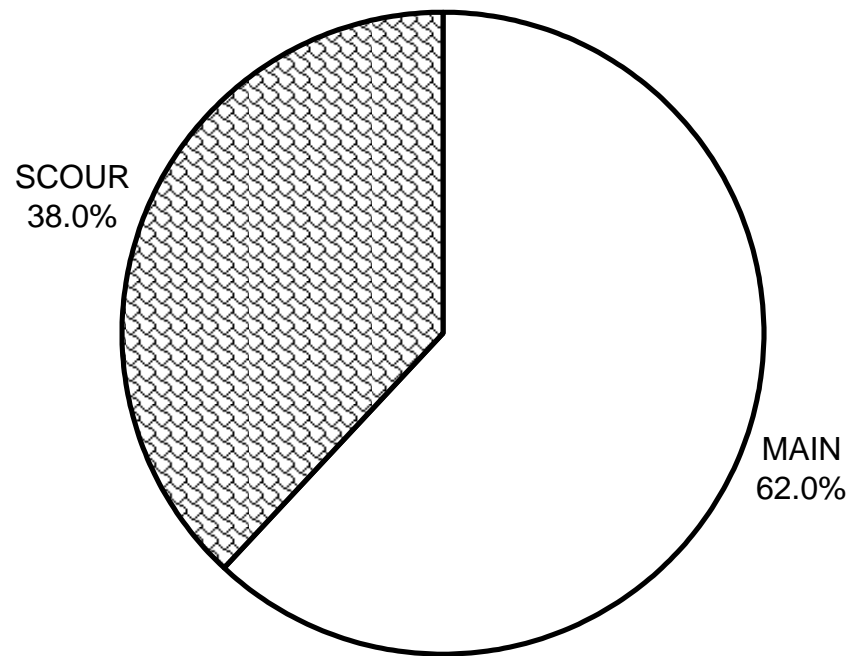
MARSH GULCH 2011

HABITAT TYPES BY PERCENT OCCURRENCE



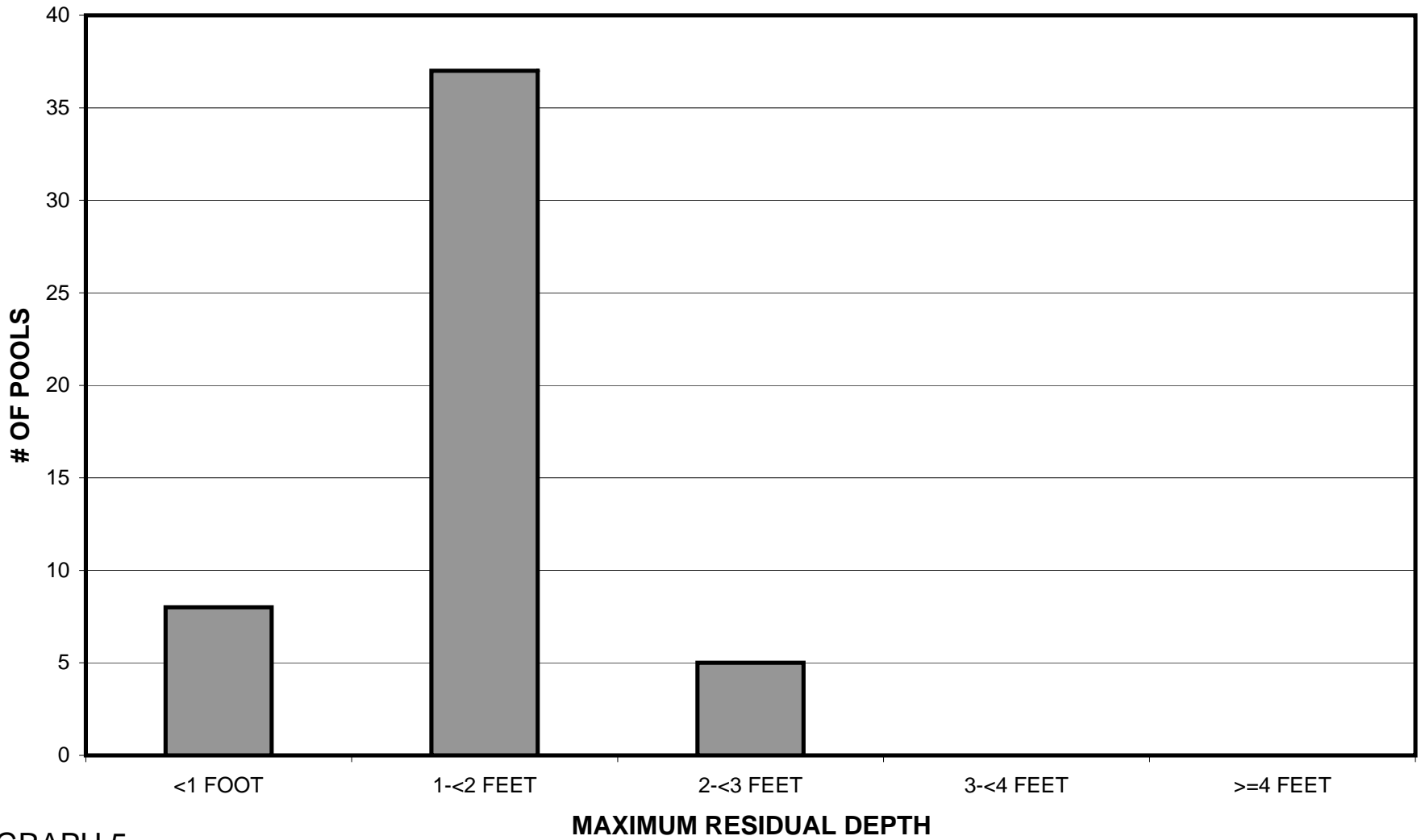
GRAPH 3

**MARSH GULCH 2011
POOL TYPES BY PERCENT OCCURRENCE**



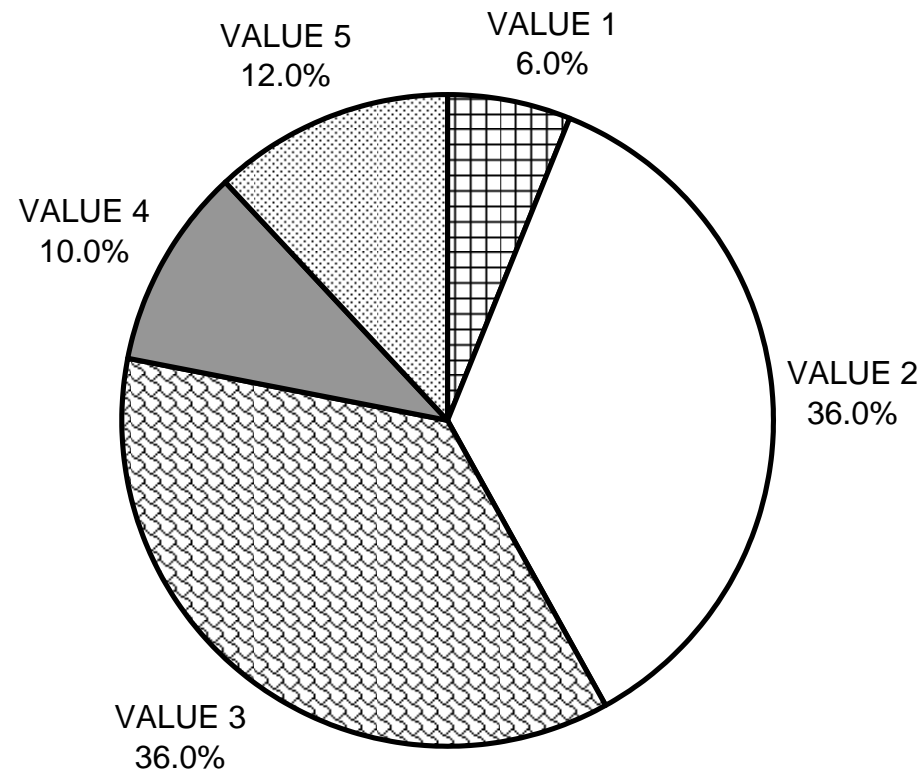
GRAPH 4

MARSH GULCH 2011 MAXIMUM DEPTH IN POOLS



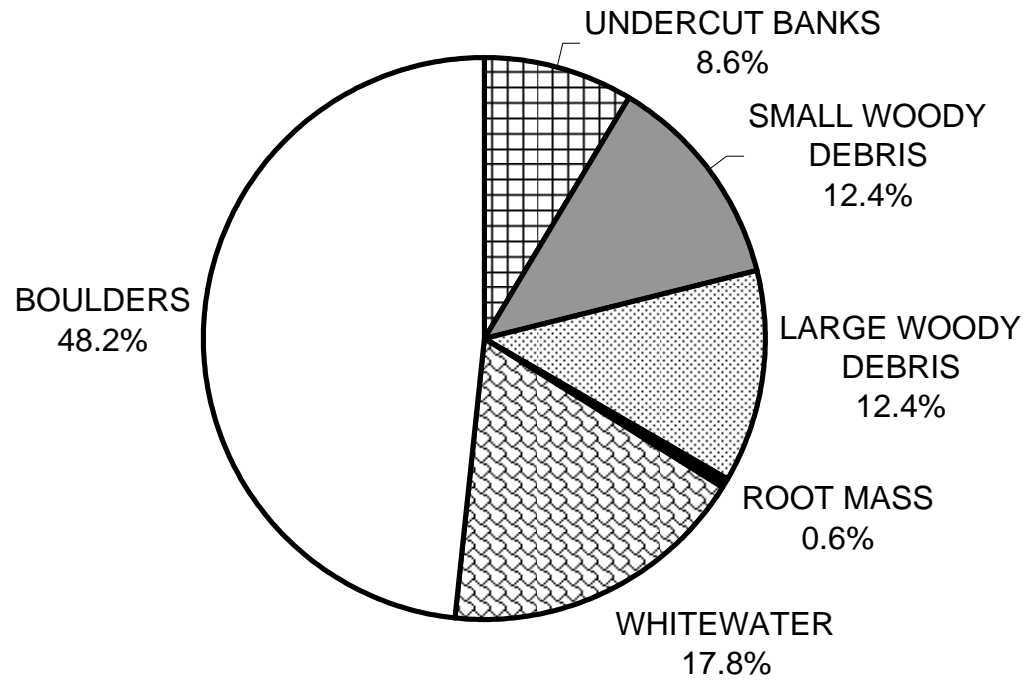
GRAPH 5

MARSH GULCH 2011 PERCENT EMBEDDEDNESS



GRAPH 6

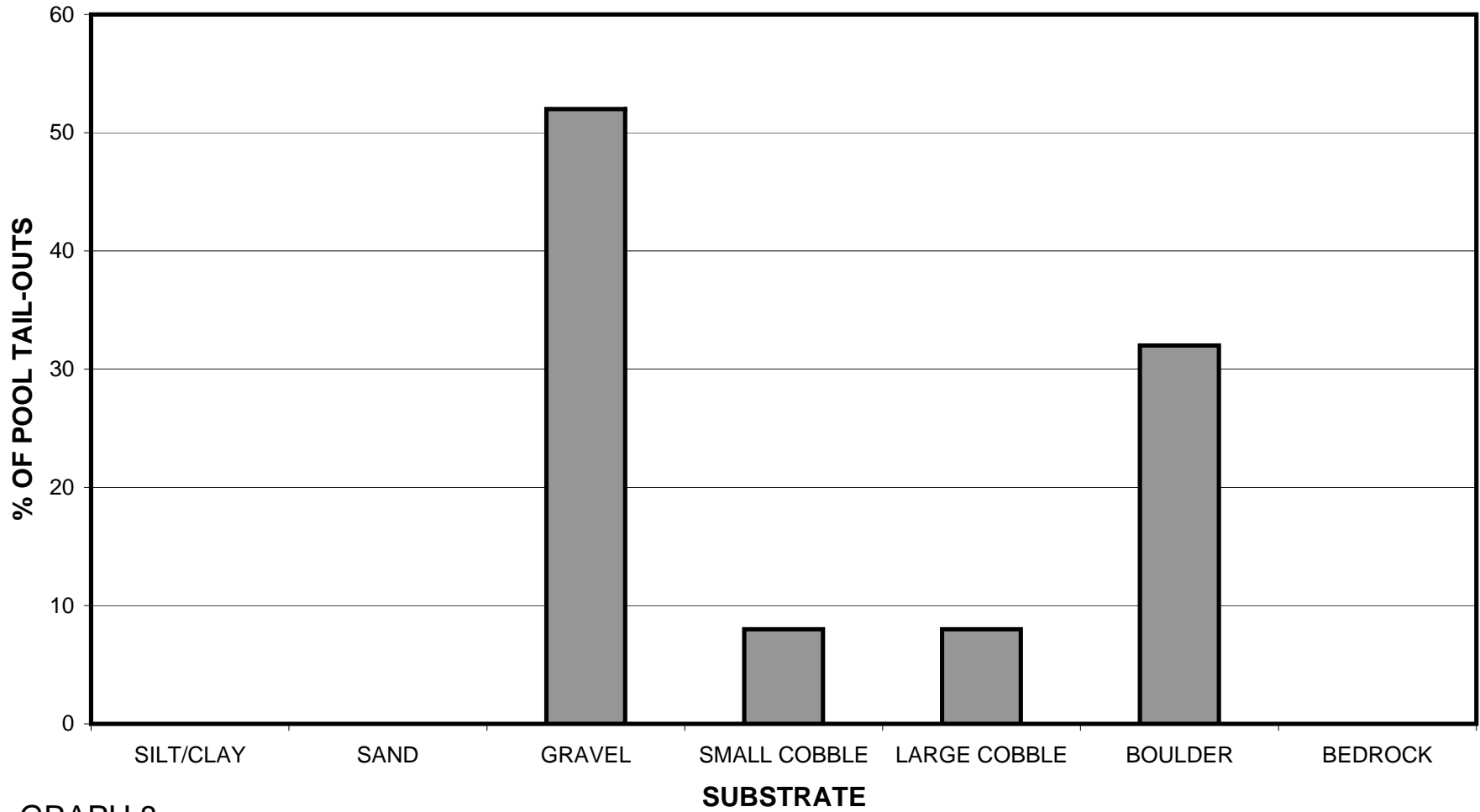
MARSH GULCH 2011 MEAN PERCENT COVER TYPES IN POOLS



GRAPH 7

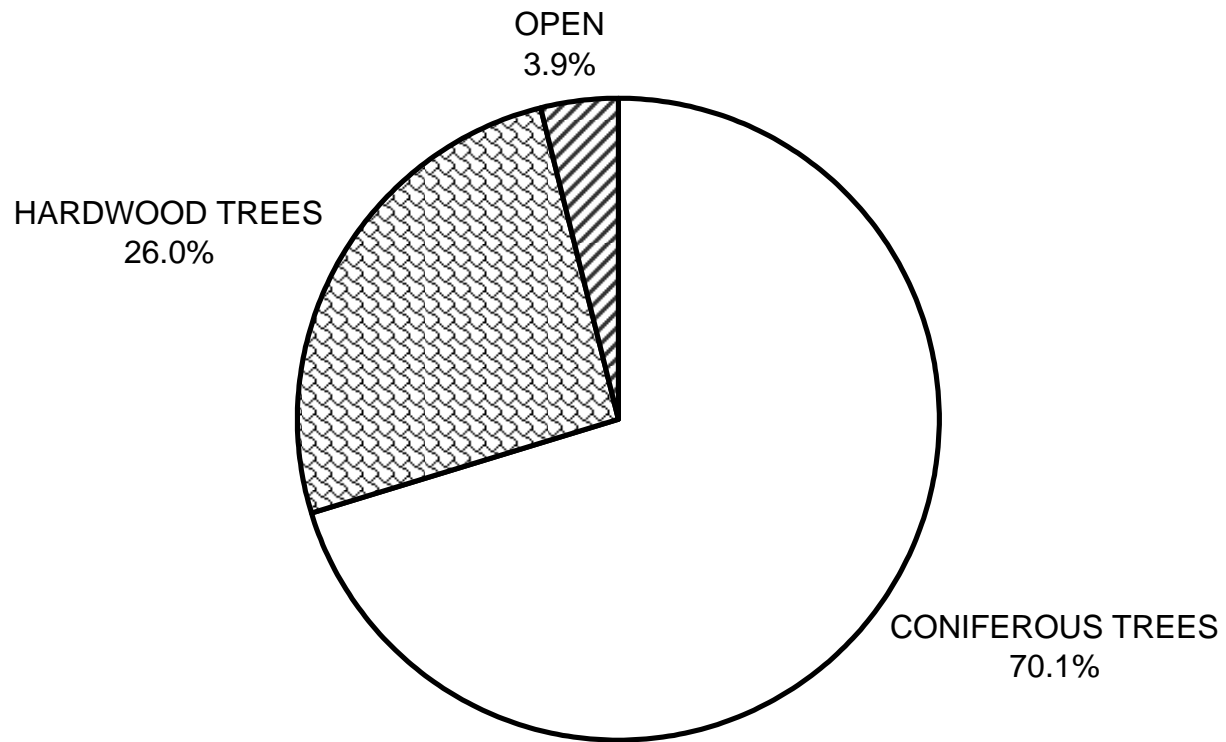
MARSH GULCH 2011

SUBSTRATE COMPOSITION IN POOL TAIL-OUTS



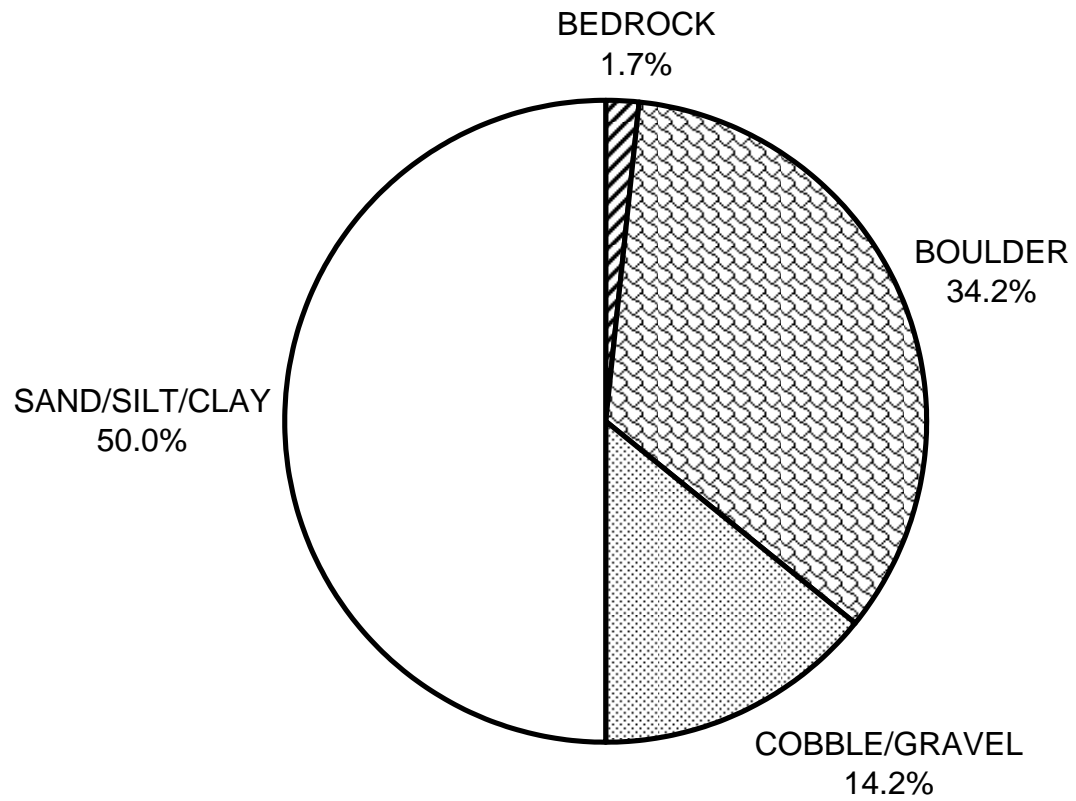
GRAPH 8

MARSH GULCH 2011 MEAN PERCENT CANOPY



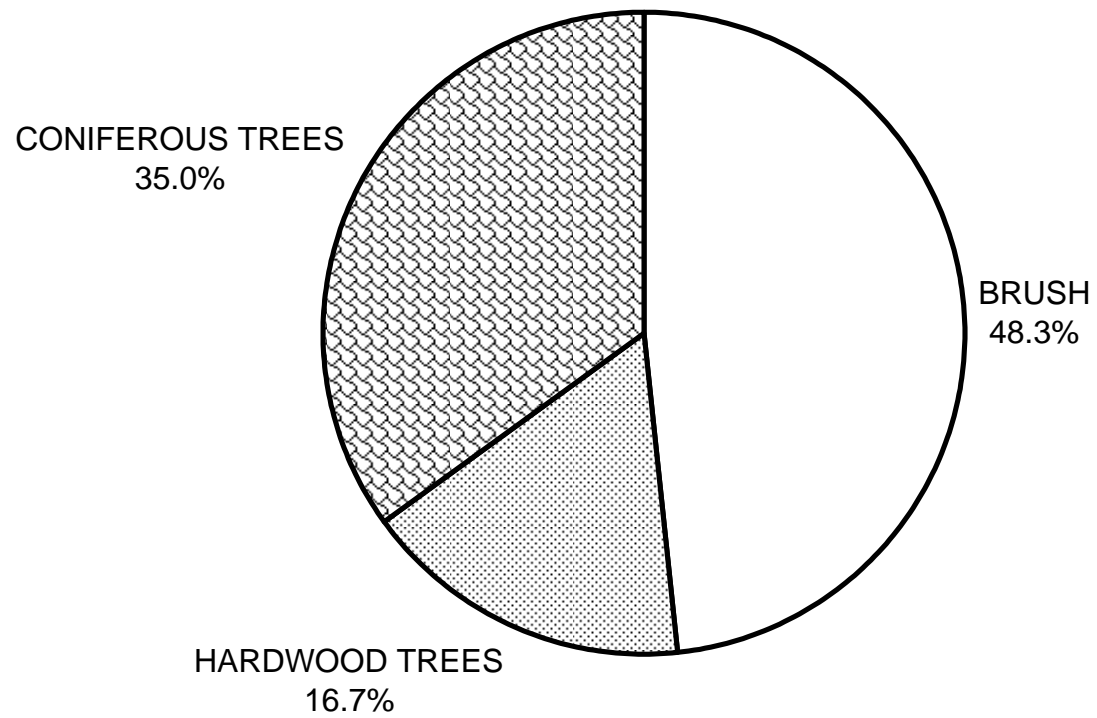
GRAPH 9

**MARSH GULCH 2011
DOMINANT BANK COMPOSITION IN SURVEY REACH**



GRAPH 10

MARSH GULCH 2011 DOMINANT BANK VEGETATION IN SURVEY REACH



GRAPH 11

