APPENDIX J.

STREAM INVENTORY REPORT

JUGHANDLE CREEK

INTRODUCTION

A stream inventory was conducted during the fall of 1996 on Jughandle Creek. The survey began at the confluence with an intermittent left bank tributary in the center of section 5; 55 minutes walking distance downstream from the rock quarry. The inventory was conducted in two parts: habitat inventory and biological inventory. The objective of the habitat inventory was to document the habitat available to anadromous salmonids in Jughandle Creek. The objective of the biological inventory was to document the presence and distribution of juvenile salmonid species.

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

WATERSHED OVERVIEW

Jughandle Creek is a tributary to the Pacific Ocean, located in Mendocino County, California (Map 1). Jughandle Creek's legal description at the confluence with the Pacific Ocean is T18N R18W S36. Its location is 39E22'37" north latitude and 123E48'55" west longitude. Jughandle Creek is a first order stream and has approximately 4.3 miles of blue line stream according to the USGS Fort Bragg, Mathison Peak, and Mendocino 7.5 minute quadrangles. Jughandle Creek drains a watershed of approximately 3.1 square miles. Elevations range from sea level at the mouth of the creek to 800 feet in the headwater areas. Redwood forest dominates the watershed. The watershed is primarily owned by the Jackson Demonstration State Forest and is managed by the California Department of Forestry and Fire Protection for timber production. Vehicle access exists via Road 530. Foot access is available from the rock quarry at the bottom of the road.

METHODS

The habitat inventory conducted in Jughandle Creek follows the methodology presented in the *California Salmonid Stream Habitat Restoration Manual* (Flosi and Reynolds, 1991 rev. 1994). The California Conservation Corps (CCC) Technical Advisors and Watershed Stewards Project/AmeriCorps (WSP/AmeriCorps) Members that conducted the inventory were trained in standardized habitat inventory methods by the California Department of Fish and Game (DFG). This inventory was conducted by a two-person team.

SAMPLING STRATEGY

The inventory uses a method that samples approximately 10% of the habitat units within the survey reach (Hopelain, 1994). All habitat units included in the survey are classified according to habitat type and their lengths are measured. All pool units are measured for maximum depth. Habitat unit types encountered for the first time are further measured for all the parameters and characteristics on the field form. Additionally, from the ten habitat units on each field form page, one is randomly selected for complete measurement.

HABITAT INVENTORY COMPONENTS

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

1. Flow:

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

2. Channel Type:

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

3. Temperatures:

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

4. Habitat Type:

Habitat typing uses the 24 habitat classification types defined by McCain and others (1988). Habitat units are numbered sequentially and assigned a type identification number selected from a standard list of 24 habitat types. Dewatered units are labeled "dry". Jughandle Creek habitat typing used standard basin level measurement criteria. These parameters require that the minimum length of a described habitat unit must be equal to or greater than the stream's mean wetted width. Channel dimensions were measured using hip chains, tape measures, and stadia rods. All units were measured for mean length; additionally, the first occurrence of each unit type and a randomly selected 10% subset of all units were sampled for all features on the sampling form (Hopelain, 1995). Pool tail crest depth at each pool unit was measured in the thalweg. All measurements were in feet to the nearest tenth.

5. Embeddedness:

The depth of embeddedness of the cobbles in pool tail-out reaches is measured by the percent of the cobble that is surrounded or buried by fine sediment. In Jughandle Creek, embeddedness was ocularly estimated. The values were recorded using the following ranges: 0 - 25% (value 1), 26 - 50% (value 2), 51 - 75% (value 3) and 76 - 100% (value 4). Additionally, a value of 5 was assigned to tail-outs deemed unsuited for spawning due to inappropriate substrate particle size, having a bedrock tail-out, or other considerations.

6. Shelter Rating:

Instream shelter is composed of those elements within a stream channel that provide salmonids protection from predation, reduce water velocities so fish can rest and conserve energy, and allow separation of territorial units to reduce density related competition. The shelter rating is calculated for each fully-described habitat unit by multiplying shelter value and percent cover. Using an overhead view, a quantitative estimate of the percentage of the habitat unit covered is made. All cover is then classified according to a list of nine cover types. In Jughandle Creek, a standard qualitative shelter value of 0 (none), 1 (low), 2 (medium), or 3 (high) was assigned according to the complexity of the cover. Thus, shelter ratings can range from 0-300 and are expressed as mean values by habitat types within a stream.

7. Substrate Composition:

Substrate composition ranges from silt/clay sized particles to boulders and bedrock elements. In all fully-described habitat units, dominant and sub-dominant substrate elements were ocularly estimated using a list of seven size classes and recorded as a one and two respectively.

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 Jughandle Creek, an estimate of the percentage of the habitat unit covered by canopy was made from the end of approximately every third unit in addition to every fully-described unit, giving an approximate 30% sub-sample. In addition, the area of canopy was estimated ocularly into percentages of coniferous or deciduous trees.

9. Bank Composition and Vegetation:

Bank composition elements range from bedrock to bare soil. However, the stream banks are usually covered with grass, brush, or trees. These factors influence the ability of stream banks to withstand winter flows. In Jughandle Creek, the dominant composition type and the dominant vegetation type of both the right and left banks for each fully-described unit were selected from the habitat inventory form. Additionally, the percent of each bank covered by vegetation was estimated and recorded.

BIOLOGICAL INVENTORY

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

DATA ANALYSIS

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

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

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

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

HABITAT INVENTORY RESULTS

* ALL TABLES AND GRAPHS ARE LOCATED AT THE END OF THE REPORT *

The habitat inventory of October 28, 29, and 30, 1996, was conducted by Craig Mesman (CCC) and Dionne Wrights (WSP/AmeriCorps). The total length of the stream surveyed was 8,327 feet with an additional 265 feet of side channel.

Flow was estimated to be 0.35 cfs during the survey period with a Marsh-McBirney Model 2000 flowmeter on October 30, 1996.

Jughandle Creek is an F4 channel type for 8,028 feet and an A4 channel type for 299 feet of stream reach surveyed. F4 channels are entrenched, meandering, riffle/pool channels on low gradients with high width/depth ratios and gravel-dominant substrates. A4 channel types are steep, narrow, cascading, step pool streams with high energy/debris transport associated with depositional soils and gravel-dominant substrates.

Water temperatures taken during the survey period ranged from 48 to 50 degrees Fahrenheit. Air temperatures ranged from 42 to 56 degrees Fahrenheit.

Table 1 summarizes the Level II riffle, flatwater, and pool habitat types. Based on frequency of **occurrence** there were 38% pool units, 31% riffle units, 29% flatwater units, and 2% was dry (Graph 1). Based on total **length** of Level II habitat types there were 44% flatwater units, 32% pool units, 22% riffle units, and 1% was dry (Graph 2).

Twelve Level IV habitat types were identified (Table 2). The most frequent habitat types by percent **occurrence** were low gradient riffle units, 30%; mid-channel pool units, 25%; and step run units, 17% (Graph 3). Based on percent total **length**, step run units made up 34%, mid-channel pool units 22%, and low gradient riffle units 21%.

A total of 127 pools were identified (Table 3). Main channel pools were most frequently encountered at 69% and comprised 76% of the total length of all pools (Graph 4).

Table 4 is a summary of maximum pool depths by pool habitat types. Pool quality for salmonids increases with depth. Thirty-four of one hundred and twenty-seven pools (26.8%) had a depth of two feet or greater (Graph 5).

The depth of cobble embeddedness was estimated at pool tail-outs. Of the 127 pool tail-outs measured, 6 had a value of 1 (5%); 27 had a value of 2 (21%); 29 had a value of 3 (23%); 30 had a value of 4 (24%); and 35 had a value of 5 (27%), or were not suitable for spawning (Graph 6). On this scale, a value of 1 indicates the highest quality of spawning substrate.

A shelter rating was calculated for each habitat unit and expressed as a mean value for each habitat type within the survey using a scale of 0-300. Pool habitat types had a mean shelter rating of 37, and flatwater habitats had a mean shelter rating of 32 (Table 1). Of the pool types, the backwater pools had the highest mean shelter rating at 48. Main channel pools had a mean shelter rating of 37 (Table 3).

Table 5 summarizes mean percent cover by habitat type. Small woody debris is the dominant cover type in Jughandle Creek. Boulders are the next most common cover type. Graph 7 describes the pool cover in Jughandle Creek.

Table 6 summarizes the dominant substrate by habitat type. Gravel was the dominant substrate observed in 82% of the low gradient riffles measured. Small cobble was the next most frequently observed dominant substrate type and occurred in 18% of the low gradient riffles (Graph 8).

The mean percent canopy density for the stream reach surveyed was 98%. The mean percentages of deciduous and coniferous trees were 64% and 36%, respectively. Graph 9 describes the canopy in Jughandle Creek.

For the stream reach surveyed, the mean percent right bank vegetated was 93.8%. The mean percent left bank vegetated was 93.2%. The dominant elements composing the structure of the stream banks consisted of 3.3% bedrock, 3.3% boulder, 45.6% cobble/gravel, and 45.6% sand/silt/clay (Graph 10). Brush was the dominant vegetation type observed in 53.3% of the units surveyed. Additionally, 6.5% of the units surveyed had deciduous trees as the dominant vegetation type, and 13.0% had coniferous trees as the dominant vegetation, including down trees, logs, and root wads (Graph 11).

BIOLOGICAL INVENTORY RESULTS

Three sites were electrofished on October 24, 1996, in Jughandle Creek. The sites were sampled by Craig Mesman and Dionne Wrights.

The first site sampled included habitat units 243 through 251, a step run, low gradient riffle, step run, lateral scour pool - root wad enhanced, low gradient riffle, mid-channel pool, low gradient riffle and step run, approximately 6,869 feet from the beginning of the survey and above an LDA approximately 134 feet long. The site yielded a total of 5 steelhead.

The second site included habitat units 292 through 298, a plunge pool, low gradient riffle, run, mid-channel pool, step run, low gradient riffle and plunge pool, approximately 7,866 feet from the beginning of the survey. The site yielded a total of 7 steelhead.

The third site sampled was the mid-channel pool at the end of the survey 8,327 feet from the beginning, and 275 feet above the confluence with a left bank tributary that enters Jughandle Creek at the upper end. The site yielded 1 steelhead.

DISCUSSION

Jughandle Creek is an F4 channel type for the first 8,028 feet of stream surveyed and an A4 for the remaining 299 feet. The suitability of F4 and A4 channel types for fish habitat improvement structures is as follows: F4 channels are good for bank placed boulders, single and opposing wing deflectors, channel constrictors and log cover. A4 channels are good for bank-placed boulders, fair for low stage weirs, opposing wing deflectors and log cover and poor for medium stage weirs, boulder clusters, single wing deflectors and log cover.

The water temperatures recorded on the survey days October 28 through 30, 1996, ranged from 48 to 50 degrees Fahrenheit. Air temperatures ranged from 42 to 56 degrees Fahrenheit. This is a good water temperature range for salmonids. To make any further conclusions, temperatures would need to be monitored throughout the warm summer months, and more extensive biological sampling would need to be conducted.

Flatwater habitat types comprised 44% of the total **length** of this survey, riffles 22%, and pools 32%. The pools are relatively shallow, with only 34 of the 127 (27%) pools having a maximum depth greater than 2 feet. In general, pool enhancement projects are considered when primary pools comprise less than 40% of the length of total stream habitat. In first and second order streams, a primary pool is defined to have a maximum depth of at least two feet, occupy at least half the width of the low flow channel, and be as long as the low flow channel width. Installing structures that will increase or deepen pool habitat is recommended.

Ninety-four of the 127 pool tail-outs measured had embeddedness ratings of 3, 4 or 5. Only 6 had a 1 rating. Cobble embeddedness measured to be 25% or less, a rating of 1, is considered to indicate good quality spawning substrate for salmon and steelhead. In Jughandle Creek, sediment sources should be mapped and rated according to their potential sediment yields, and control measures should be taken.

The mean shelter rating for pools was low with a rating of 37. The shelter rating in the flatwater habitats was slightly lower at 32. A pool shelter rating of approximately 100 is desirable. The relatively small amount of cover that now exists is being provided primarily by small woody debris in all habitat types. Additionally, boulders contribute a small amount. Log and root wad cover structure in the pool and flatwater habitats are needed to improve both summer and winter salmonid habitat. Log cover structure provides rearing fry with protection from predation, rest from water velocity, and also divides territorial units to reduce density related competition.

All of the low gradient riffles measured had gravel or small cobble as the dominant substrate. This is generally considered good for spawning salmonids.

The mean percent canopy density for the stream was 98%. This is a relatively high percentage of canopy. In general, revegetation projects are considered when canopy density is less than 80%.

The percentage of right and left bank covered with vegetation was high at 93.8% and 93.2%, respectively. In areas of stream bank erosion or where bank vegetation is not at acceptable levels, planting endemic species of coniferous and deciduous trees, in conjunction with bank stabilization, is recommended.

RECOMMENDATIONS

1) Jughandle Creek should be managed as an anadromous, natural production stream.

2) Increase woody cover in the pools and flatwater habitat units. Most of the existing cover is from small woody debris. Adding high quality complexity with woody cover is desirable and in some areas the material is locally available.

3) 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.

4) 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.

5) 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.

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.

0' Begin survey at confluence with intermittent left bank tributary (center of section 5). This is a 55 minute walk downstream from the "rock pit." Channel type is an F4.

61' Flow in tributary is <0.10 cubic feet per second (cfs). Accessible to fish.

1,259' Flowing right bank tributary <0.10 cfs. Very steep and full of wood. Not accessible to anadromous fish.

1,727' Stump on right bank with a sign: "State Park Boundary."

2,256' Left bank tributary, <0.10 cfs. Small, narrow, steep. Not accessible to anadromous fish.

2,755' Log debris accumulation (LDA), 15' long x 15' wide x 4' high retains approximately 3' deep gravel. Not a barrier.

3,326' Left bank tributary at top of unit, <0.10 cfs. Small, no distinct channel. Not accessible to anadromous fish. Large ravine.

4,009' Four logs parallel to flow catching small woody debris and filling the channel. Retaining little sediment. Right bank tributary comes into top of unit. Flow is <0.10 cfs. Narrow, steep, with no distinct channel.

4,748' Garbage in the stream and on left bank.

4,855' Left bank tributary, <0.10 cfs. Flows through a rock pit. Not accessible to anadromous fish. Lined with garbage.

4,957' Garbage ends here.

5,184' Right bank tributary <0.10 cfs. Narrow with no distinct channel. Not accessible to anadromous fish.

5,533' Small woody debris (SWD) accumulation clogs channel.

5,642' Left bank tributary, <0.10 cfs. Narrow, steep, and not accessible to anadromous fish. Tributary flows through a large ravine.

5,710' Corrugated metal pipe under old road crossing, 8' wide x 8' high. Good condition.

6,025' LDA, 15' long x 25' wide x 5' high. Retaining sediment 4' high.

6,227' Three logs parallel to flow retaining gravel approximately 3' deep. Not a barrier.

6,380' Root wad retaining 4.5' of sediment.

6,443' Gradient begins increasing here.

6,692' Water percolates through woody debris and gravel. Debris retains 5' of gravel.

6,706' LDA retaining 4.5' of sediment creating a 4.5' high jump.

6,734' LDA retaining 3' of sediment and creating a 3.5 high jump.

6,784' LDA across channel. The material came from a slide and fallen trees.

6,869' First electrofishing site.

6,897' Channel back to low gradient with gravel dominant.

7,130' Right bank tributary.

7,798' LDA, 8' long x 15' wide x 4' high. Retaining sediment, may hinder passage.

7,866' Second electrofishing site.

8,052' Channel type changes to A4.

8,056' Left bank tributary, <0.10 cfs. Steep, narrow, not accessible to anadromous fish.

8,232' LDA, retaining sediment 5' deep and creating a 5' high jump.

8,327' End of Survey. Last electrofishing site and the highest fish observation. The channel above here becomes narrow and choked with vegetation. The channel is also steep (4-10%). The stream flow is also becoming intermittent.

Table J-1. Summary of riffle, flatwater, and pool habitat types.

JUGHANDLE CREEK Drainage: PACIFIC OCEAN

Table 1 - SUMMARY OF RIFFLE, FLATWATER, AND POOL HABITAT TYPES Survey Dates: 10/28/96 to 10/30/96

Confluence Location: QUAD: FORT BRAGG LEGAL DESCRIPTION: LATITUDE:39°22'37" LONGITUDE:123°48'55"

HABITAT UNITS	UNITS FULLY MEASURED	HABITAT TYPE	HABITAT PERCENT OCCURRENCE	MEAN LENGTH (ft.)	TOTAL LENGTH (ft.)	PERCENT TOTAL LENGTH	MEAN WIDTH (ft.)	MEAN 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
103	13	RIFFLE	31	18	1900	22	5.5	0.2	114	11762	35	3573	0	12
97	10	FLATWATER	29	39	3819	44	6.6	0.4	171	16560	61	5878	0	32
127	23	POOL	38	22	2761	32	7.7	0.8	169	21409	153	19471	118	37
5	0	DRY	2	15	74	1	0.0	0.0	0	0	0	0	0	0
1	0	CULVERT	0	38	38	0	0.0	0.0	0	0	0	0	0	0

TOTAL UNITS	TOTAL UNITS	TOTAL LENGTH (ft.)	TOTAL AREA (sq. ft.)	TOTAL VOL. (cu. ft.)
333	46	8592	49731	28921

Table J-2. Summary of habitat types and measured parameters.

JUGHANDLE CREEK Drainage: PACIFIC OCEAN

Table 2 - SUMMARY OF HABITAT TYPES AND MEASURED PARAMETERS Survey Dates: 10/28/96 to 10/30/96

Confluence Location: QUAD: FORT BRAGG LEGAL DESCRIPTION: LATITUDE:39°22'37" LONGITUDE:123°48'55"

HABITAT UNITS #	UNITS FULLY MEASURED	HABITAT TYPE	HABITAT OCCURRENCE %	MEAN LENGTH ft.	TOTAL LENGTH ft.	TOTAL LENGTH %	MEAN WIDTH ft.	MEAN DEPTH ft.	MAXIMUM DEPTH ft.	MEAN AREA sq.ft.	TOTAL AREA EST. sq.ft.	MEAN VOLUME cu.ft.	TOTAL VOLUME EST. cu.ft.	MEAN RESIDUAL POOL VOL cu.ft.	MEAN SHELTER RATING	MEAN CANOPY %
100	11	LGR	30	18	1828	21	5	0.2	0.7	93	9270	21	2149	0	6	99
1	1	HGR	0	8	8	0	8	0.1	0.3	45	45	5	5	0	10	100
2	1	CAS	1	32	64	1	10	0.5	1.1	420	840	210	420	0	70	92
41	6	RUN	12	21	860	10	7	0.4	0.9	179	7357	60	2462	0	12	97
56	4	SRN	17	53	2959	34	6	0.4	0.7	158	8828	61	3440	0	63	99
3	1	TRP	1	57	170	2	6	1.0	2.6	366	1098	366	1098	183	10	100
84	12	MCP	25	23	1915	22	8	0.8	2.7	162	13645	141	11858	113	40	98
4	2	LSL	1	20	81	1	10	1.1	2.3	212	848	224	898	171	38	100
5	2	LSR	2	21	105	1	7	1.0	2.1	136	680	173	866	157	40	100
2	1	LSBk	1	26	51	1	8	0.7	1.9	224	448	157	314	134	5	100
23	3	PLP	7	14	331	4	6	0.8	2.3	91	2101	76	1746	63	35	98
6	2	BPL	2	18	108	1	8	0.7	1.9	184	1104	143	859	102	48	98
5	0	DRY	2	15	74	1	0	0.0	0.0	0	0	0	0	0	0	0
1	0	CUL	0	38	38	0	0	0.0	0.0	0	0	0	0	0	0	0

TOTAL UNITS	TOTAL UNITS	LENGTH (ft.)	AREA (sq.ft)	TOTAL VOL. (cu.ft)
333	46	8592	46264	26114

Table J-3. Summary of pool types.

JUGHANDLE CREEK Drainage: PACIFIC OCEAN

Table 3 - SUMMARY OF POOL TYPES Survey Dates: 10/28/96 to 10/30/96

Confluence Location: QUAD: FORT BRAGG LEGAL DESCRIPTION: LATITUDE:39°22'37" LONGITUDE:123°48'55"

HABITAT UNITS	UNITS FULLY MEASURED	HABITAT TYPE	HABITAT PERCENT OCCURRENCE	MEAN LENGTH (ft.)	TOTAL LENGTH (ft.)	PERCENT TOTAL LENGTH	MEAN WIDTH (ft.)	MEAN DEPTH (ft.)	MEAN AREA (sq.ft.)	TOTAL AREA EST. (sq.ft.)	MEAN VOLUME (cu.ft.)	TOTAL VOLUME EST. (cu.ft.)	MEAN RESIDUAL POOL VOL. (cu.ft.)	MEAN SHELTER RATING
87	13	MAIN	69	24	2085	76	7.8	0.9	178	15495	158	13786	118	37
34	8	SCOUR	27	17	568	21	7.5	0.9	149	5075	147	5014	122	33
6	2	BACKWATER	5	18	108	4	8.0	0.7	184	1104	143	859	102	48

TOTAL UNITS	TOTAL UNITS	TOTAL LENGTH (ft.)	TOTAL AREA (sq.ft.)	TOTAL VOL. (cu.ft.)
127	23	2761	21673	19660

Table J-4. Summary of maximum pool depths by pool habitat types.

JUGHANDLE CREEK

Drainage: PACIFIC OCEAN

Table 4 - SUMMARY OF MAXIMUM POOL DEPTHS BY POOL HABITAT TYPES

Survey Dates: 10/28/96 to 10/30/96

Confluence Location: QUAD: FORT BRAGG LEGAL DESCRIPTION:

LATITUDE:39°22'37" LONGITUDE:123°48'55"

UNITS MEASURED	HABITAT TYPE	HABITAT PERCENT OCCURRENCE	<1 FOOT MAXIMUM DEPTH	<1 FOOT PERCENT OCCURRENCE	1-<2 FT. MAXIMUM DEPTH	1-<2 FOOT PERCENT OCCURRENCE	2-<3 FT. MAXIMUM DEPTH	2-<3 FOOT PERCENT OCCURRENCE	3-<4 FT. MAXIMUM DEPTH	3-<4 FOOT PERCENT OCCURRENCE	>=4 FEET MAXIMUM DEPTH	>=4 FEET PERCENT OCCURRENCE
3	TRP	2	0	0	1	33	2	67	0	0	0	0
84	MCP	66	4	5	61	73	16	19	3	4	0	0
4	LSL	3	0	0	2	50	2	50	0	0	0	0
5	LSR	4	3	60	1	20	1	20	0	0	0	0
2	LSBk	2	0	0	2	100	0	0	0	0	0	0
23	PLP	18	0	0	14	61	8	35	0	0	1	4
6	BPL	5	0	0	5	83	1	17	0	0	0	0

TOTAL
UNITS
127

Table J-5. Summary of mean percent cover by habitat type.

JUGHANDLE CREEK
Drainage: PACIFIC OCEAN

Table 5 - SUMMARY OF MEAN PERCENT COVER BY HABITAT TYPE
Survey Dates: 10/28/96 to 10/30/96

Confluence Location: QUAD: FORT BRAGG LEGAL DESCRIPTION:
LATITUDE:39°22'37" LONGITUDE:123°48'55"

UNITS MEASURED	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
100	8	LGR	0	69	0	0	9	0	0	23	0
1	1	HGR	0	0	0	0	0	0	0	100	0
2	1	CAS	0	0	10	0	0	0	0	90	0
41	4	RUN	15	25	30	0	13	0	0	18	0
56	4	SRN	25	13	38	0	0	0	0	25	0
3	1	TRP	30	70	0	0	0	0	0	0	0
84	12	MCP	3	28	54	3	0	0	1	11	0
4	2	LSL	0	15	85	0	0	0	0	0	0
5	2	LSR	30	25	45	0	0	0	0	0	0
2	1	LSBk	0	100	0	0	0	0	0	0	0
23	3	PLP	13	0	23	17	0	0	3	43	0
6	2	BPL	25	40	35	0	0	0	0	0	0
5	0	DRY	0	0	0	0	0	0	0	0	0
1	0	CUL	0	0	0	0	0	0	0	0	0

Table J-6. Summary of dominant substrate by habitat type.

JUGHANDLE CREEK   Drainage: PACIFIC OCEAN

Table 6 - SUMMARY OF DOMINANT SUBSTRATES BY HABITAT TYPE   Survey Dates: 10/28/96 to 10/30/96

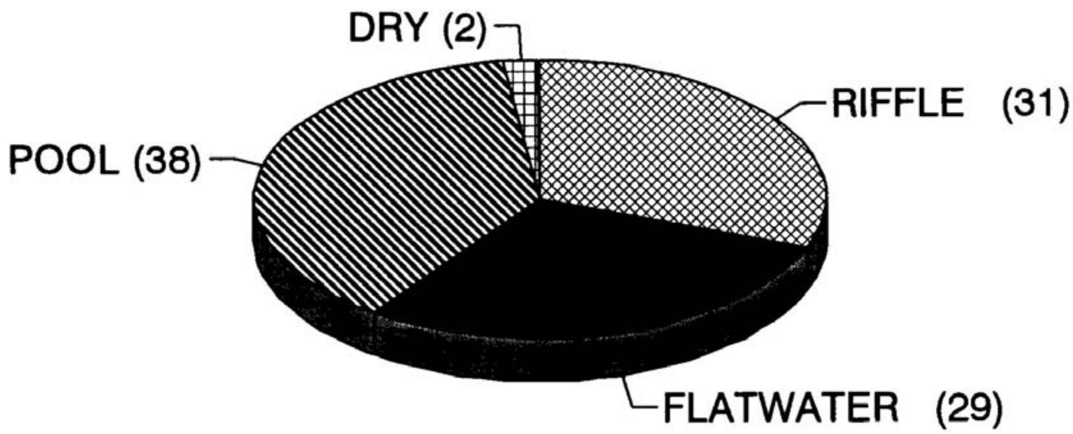
Confluence Location: QUAD: FORT BRAGG LEGAL DESCRIPTION: LATITUDE:39°22'37" LONGITUDE:123°48'55"

TOTAL HABITAT UNITS	UNITS FULLY MEASURED	HABITAT TYPE	% TOTAL SILT/CLAY DOMINANT	% TOTAL SAND DOMINANT	% TOTAL GRAVEL DOMINANT	% TOTAL SM COBBLE DOMINANT	% TOTAL LG COBBLE DOMINANT	% TOTAL BOULDER DOMINANT	% TOTAL BEDROCK DOMINANT
100	11	LGR	0	0	82	18	0	0	0
1	1	HGR	0	0	0	100	0	0	0
2	1	CAS	0	0	0	0	0	100	0
41	5	RUN	0	20	80	0	0	0	0
56	4	SRN	0	25	75	0	0	0	0
3	1	TRP	0	0	100	0	0	0	0
84	12	MCP	25	33	42	0	0	0	0
4	2	LSL	0	50	50	0	0	0	0
5	2	LSR	0	50	50	0	0	0	0
2	1	LSBk	0	0	100	0	0	0	0
23	3	PLP	33	67	0	0	0	0	0
6	2	BPL	0	0	100	0	0	0	0
5	0	DRY	0	0	0	0	0	0	0
1	0	CUL	0	0	0	0	0	0	0

Table J-7. Fish habitat inventory data summary.

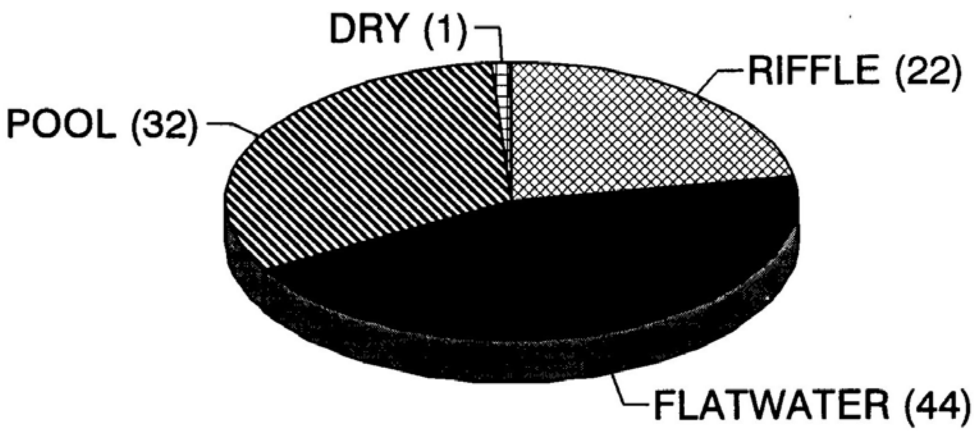
```
STREAM NAME: JUGHANDLE CREEK
SAMPLE DATES: 10/28/96 to 10/30/96
STREAM LENGTH: 8327 ft.
LOCATION OF STREAM MOUTH:
  USGS Quad Map: FORT BRAGG              Latitude: 39°22'37"
  Legal Description:                     Longitude: 123°48'55"


          SUMMARY OF FISH HABITAT ELEMENTS BY STREAM REACH

STREAM REACH 1
  Channel Type: F4                       Canopy Density: 98%
  Channel Length: 8028 ft.               Coniferous Component: 38%
  Riffle/flatwater Mean Width: 6 ft.     Deciduous Component: 62%
  Total Pool Mean Depth: 0.8 ft.         Pools by Stream Length: 33%
  Base Flow: 0.4 cfs                     Pools >=3 ft.deep: 3%
  Water: 048- 050°F  Air: 042-056°F      Mean Pool Shelter Rtn: 38
  Dom. Bank Veg.: Brush                  Dom. Shelter: Large Woody Debris
  Vegetative Cover: 96%                  Occurrence of LOD: 36%
  Dom. Bank Substrate: Cobble/Gravel     Dry Channel: 26 ft.

  Embeddness Value: 1. 5%   2.20%   3. 23%  4. 25%   5.  27%

STREAM REACH 2
  Channel Type: A4                       Canopy Density: 98%
  Channel Length: 299 ft.                Coniferous Component: 10%
  Riffle/flatwater Mean Width: 9 ft.     Deciduous Component: 90%
  Total Pool Mean Depth: 1.0 ft.         Pools by Stream Length: 24%
  Base Flow: 0.4 cfs                     Pools >=3 ft.deep: 0%
  Water: 049- 049°F  Air: 049-049°F      Mean Pool Shelter Rtn: 27
  Dom. Bank Veg.: Brush                  Dom. Shelter: Boulders
  Vegetative Cover: 94%                  Occurrence of LOD: 8%
  Dom. Bank Substrate: Cobble/Gravel     Dry Channel: 48 ft.

  Embeddness Value: 1. 0%   2.50%   3. 17%  4. 0%   5.  33%
```

JUGHANDLE CREEK
HABITAT TYPES BY PERCENT OCCURRENCE

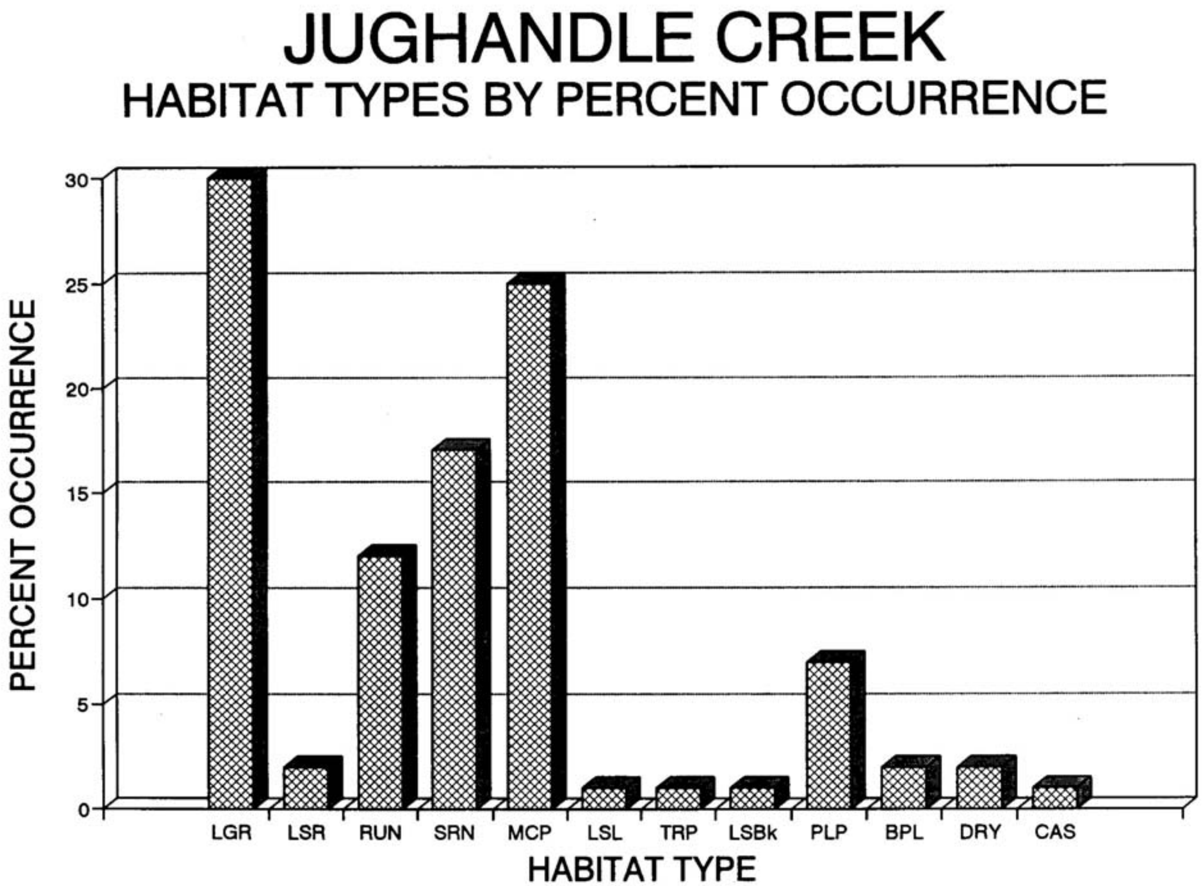


Graph J-1. Habitat types by percent occurrence.

JUGHANDLE CREEK
HABITAT TYPES BY PERCENT TOTAL LENGTH



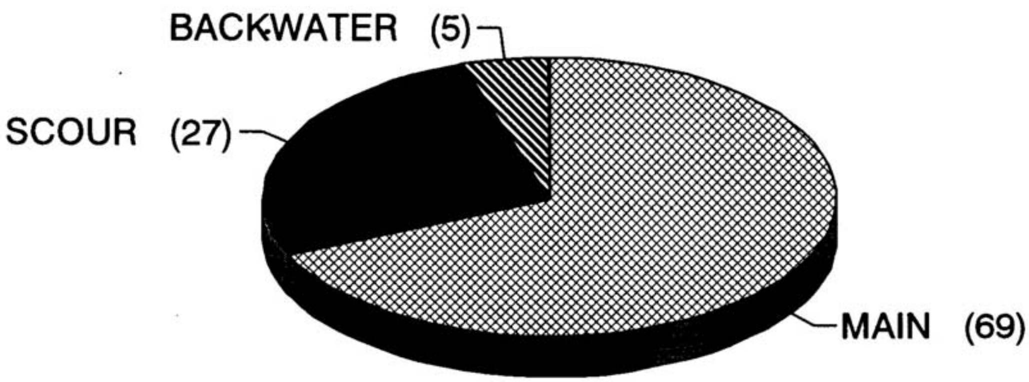
Graph J-2. Habitat types by percent total length.



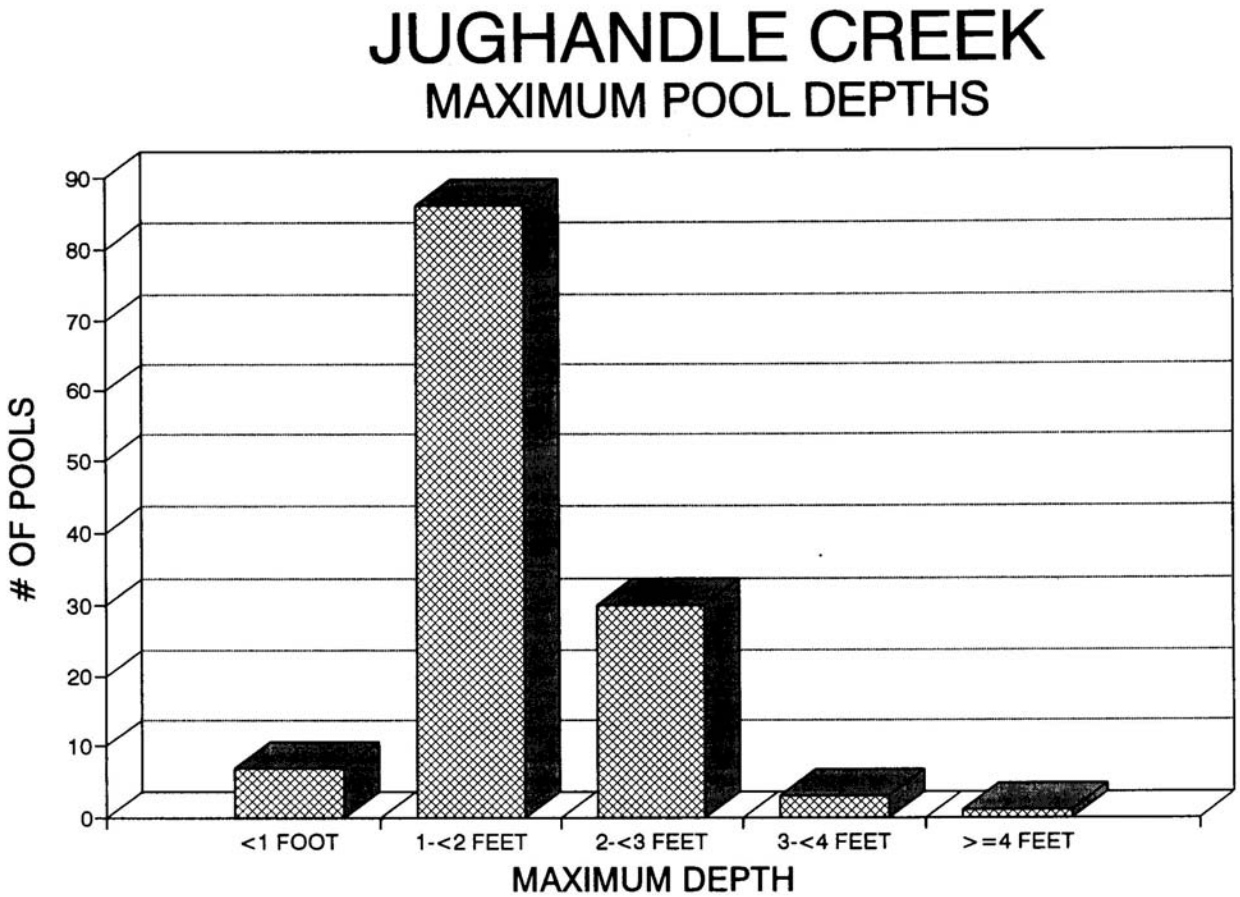
Graph J-3. Habitat types by percent occurrence.

JUGHANDLE CREEK

POOL HABITAT TYPES BY PERCENT OCCURRENCE

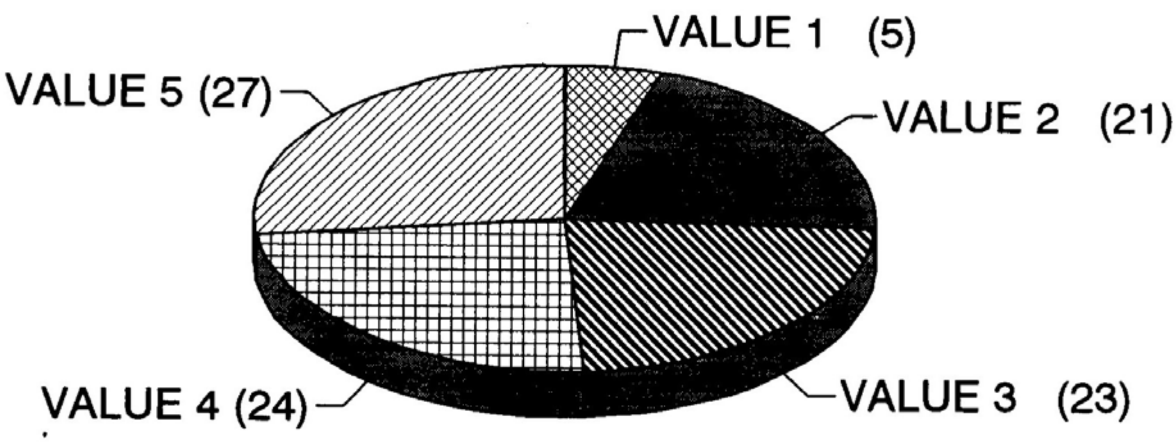


Graph J-4. Pool habitat types by percent occurrence.



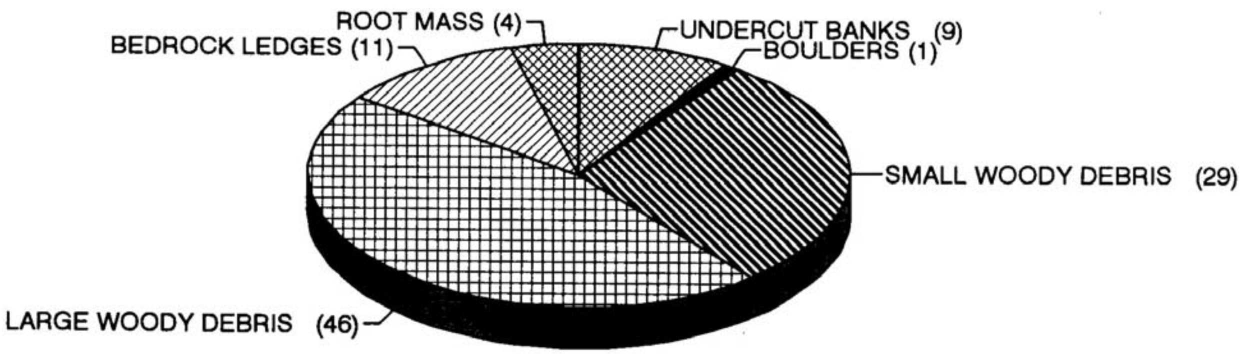
Graph J-5. Maximum pool depths.

JUGHANDLE CREEK
PERCENT EMBEDDEDNESS

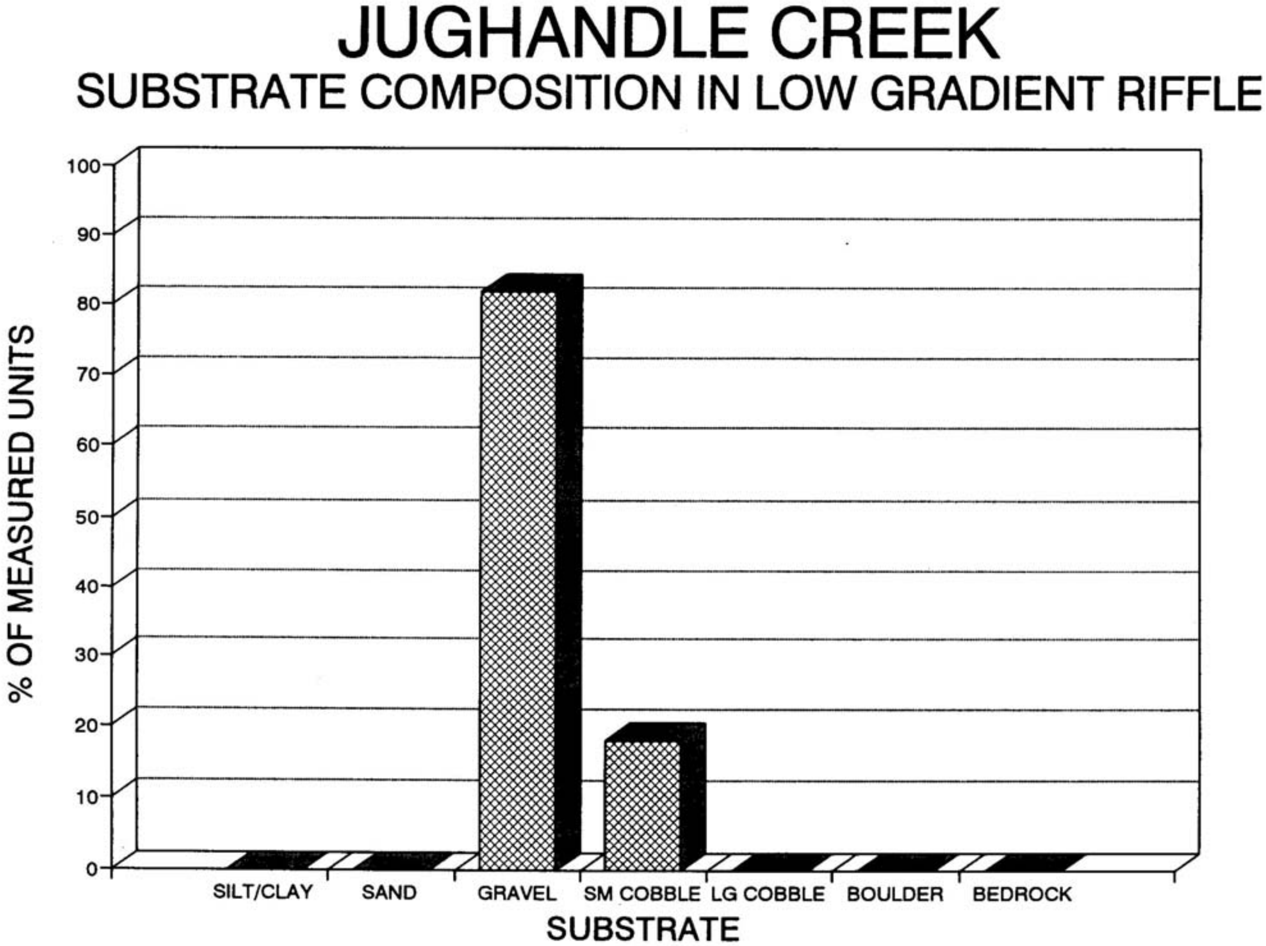


Graph J-6. Percent embeddedness.

JUGHANDLE CREEK
MEAN PERCENT COVER TYPES IN POOLS

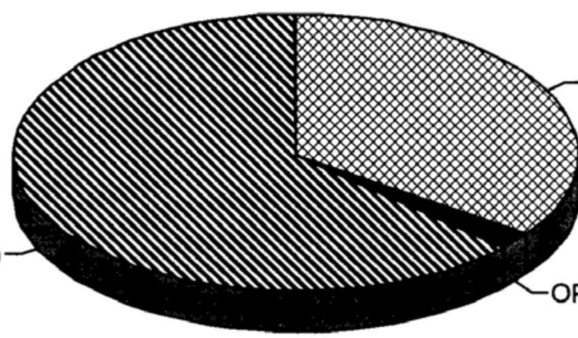


Graph J-7. Mean percent cover types in pools.



Graph J-8. Substrate composition in low gradient riffles.

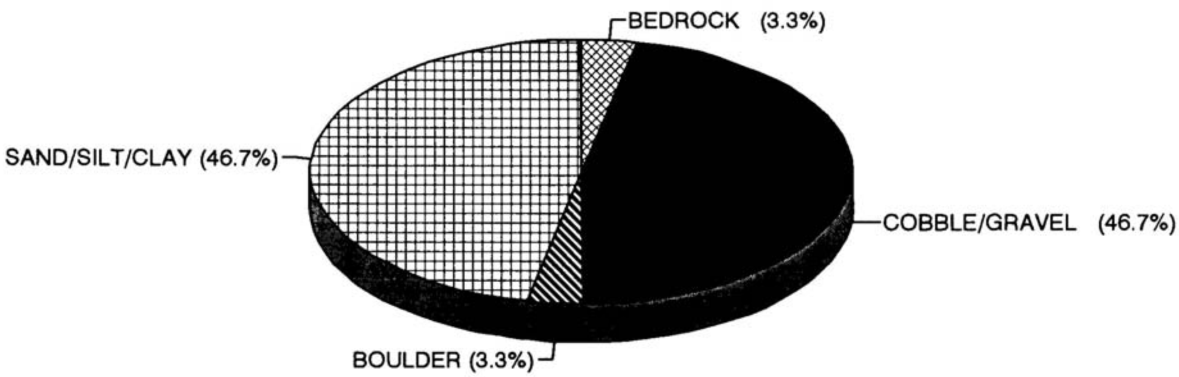
JUGHANDLE CREEK
PERCENT CANOPY



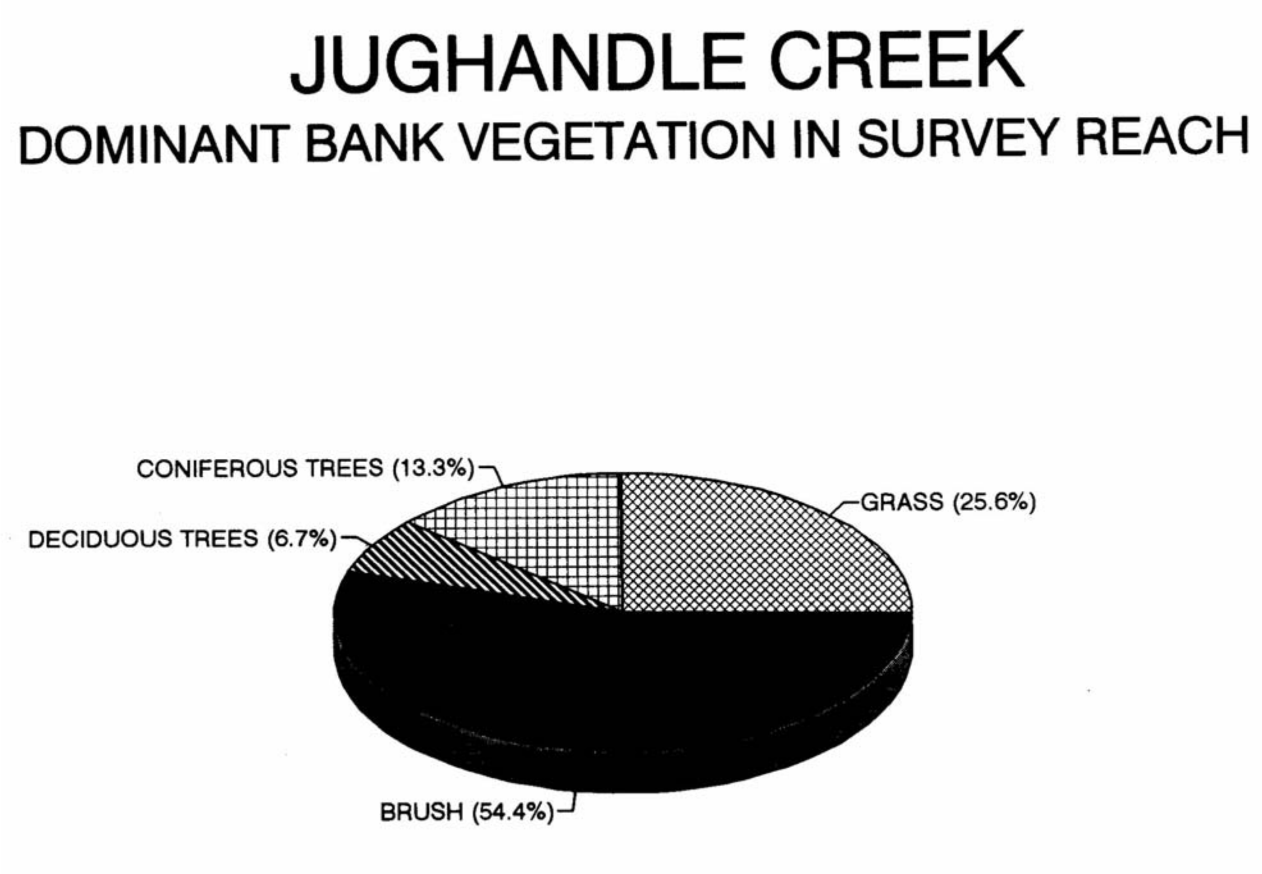
Graph J-9. Percent canopy.

JUGHANDLE CREEK

DOMINANT BANK COMPOSITION IN SURVEY REACH



Graph J-10. Dominant bank composition in survey reach.



Graph J-11. Dominant bank vegetation in survey reach.

APPENDIX K.

TOOLS

Following is a check list of the most commonly used tools for stream enhancement/restoration projects. The tools needed will depend on the specific project. Before traveling to the work site a check of the tools must be done to insure that everything is available when needed.

Hand tools include:
shovels
rock bars
sledge hammers
splitting mauls
picks
pulaski's
peeves
pliers
wire cutters
tape measures
files for the tools
fence post/rebar driver
cable cutter (guillotine type)
log carriers

Power tools include:
chain saws including:
- extra chain
- extra bars
- plastic wedges
- file guide with file
- chain depth gauge
- raker file
- extra spark plugs
- extra air filter
- tool for adjusting chain and bar
- grease gun for roller nose or sprocket nose bar
- can spray degreaser
- can for mixed gas and bar oil
- auto parts brush
- rags
- fire extinguisher
- single bit axe

various spare parts (bar nuts, gas filters, etc.)
backpack for carrying equipment and supplies

chain saw winch

skill saw with metal cutting blade

gas powered drills: These come in a variety of sizes for various applications.
The largest gas powered drills are used to drill rock for chipping and blasting. Smaller gas powered drills are available to drill rock. Some gas powered drills are only used to drill wood. Each has its place and function. Correct selection depends on the needs of the project.

electric rotary hammer with carbide tipped rock drills:

gas powered generator
heavy duty outdoor extension cord
ground fault interrupter

electric drill with drill bits (wood augers)

Griphoist including:
tool box containing:
handle puller
spare shear pins
claw hammer
crescent wrench
socket set (standard and metric)
screwdriver set
allen wrenches
hack saw with extra blades
snatch blocks (two per griphoist)
shackles (to attach cable straps or chains together)
chokers (three per griphoist)
chain (12 ft. minimum to anchor the griphoist)
cable straps (various sizes from 10 to 100 feet long)
extra mainline
rock nets (these can be made from chain or bought pre-made)
cable gripper

Safety equipment including:
first aid kit
hard hats
earplugs
gloves
boots
eye and face protection
chaps for use with chain saws

Shuttling equipment
backpacks
wheelbarrows
hand carried stretchers
all terrain vehicles with trailer

APPENDIX L.

TWO-PIN METHOD

Procedure

The two-pin method is useful to locate natural and human influenced features within a project site relative to two permanent reference points (Miller, O'Brien, Koonce, 1988). It can used to describe and map existing geomorphic channel conditions of a proposed restoration site. It is useful during restoration project design, layout, and construction phases, and during subsequent project phases of monitoring and evaluation.

The two-pin method is based on establishing a reference pin at the upstream and downstream ends of a given enhancement site. These pins are placed on one side of the stream, with each pin located further upstream and downstream than the extent of the enhancement structure. By convention, Pin 1 is downstream of Pin 2.

Enhancement sites along the channel are referenced according to a curvilinear traverse line along one side of the stream. For example, Site 12+50 is equivalent to a distance of 1,250 feet upstream from an assigned starting point. By convention, references begin at the downstream end of an enhancement section and progress upstream. Generally, the traverse line simply follows the course of the stream. Bearings and azimuths are not recorded for meander curvature. Specific locations on the traverse line could be referenced to a nearby stadia or route survey (i.e., a road centerline) by recording distance and bearings from specific points along such surveys.

All the important channel features are located using triangulation of intersecting horizontal distances from the reference pins. Once the pins are in place, a tape measure is stretched from each pin. The intersection of the two tapes defines a measuring point (Figure L-1). A scale map is drawn for each site showing large woody debris, instream boulders, etc. (Figure L-2).

Each enhancement structure is laid out on the ground using wire flags so that the structures can be triangulated and accurately mapped. The triangulation distances are recorded in a standardized table (Table L-1). The design elevations for the top of the log or boulder ends are also measured from the reference pins. By convention the elevation of pin 1 is recorded as 0 (Table L-1).

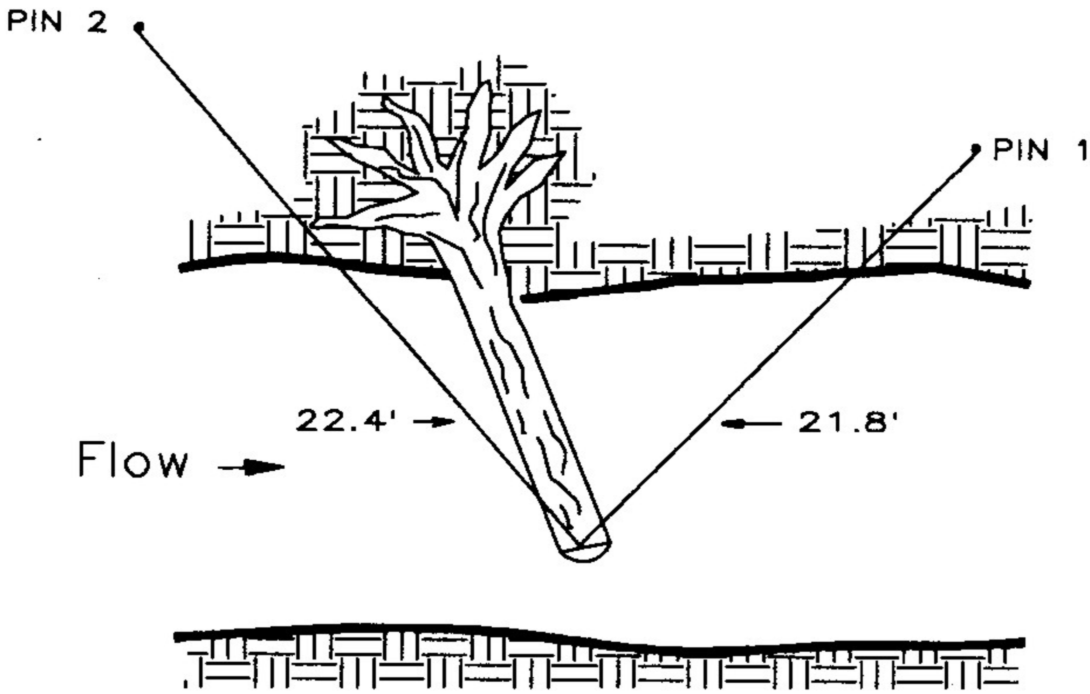


Figure L-1. Location of the left bank end of a downed tree as determined by the intersection of the distances from two reference pins (Miller, O'Brien, Koonce, 1988).

Table L-1. Measured distances and elevations of existing and prescribed structural components relative to the two reference pins at station 171+20 along Tarup Creek, Del Norte County, California. Existing features are described by numbers: prescribed features by letters: all corresponding with those in Figure 2. (Adapted from Inter-Fluve, 1987)

Item			Distance(ft)		Elevation(ft)[a/]	
			Pin 1	Pin 2	Pin 1	Pin 2
Pin 1			57		-0.4	
Pin 2			57		+0.4	
Log 1,		instream end	19	57		
Log 2,		instream end	37	41		
Log 3,		instream end	47	34		
Log 4,		instream end	50	20		
Boulder 5,	center		36	51		
Boulder 6,	center		31	48		
Log A,		upstream end, top	49	16	-3.5	-3.9
Log A,		downstream end, to	30	44	-4.9	-5.3
Log B,		bank end	41	67		
Log B,		instream end	29	56	-5.4	-5.8
Log C,		bank end	33	65		
Log C,		instream end	31	58	-5.7	-6.1
Boulder D,	center		28	45	-4.9	-5.3
Boulders E,	left bank edge		10	54		

a/ Elevation from pin: + above; - below

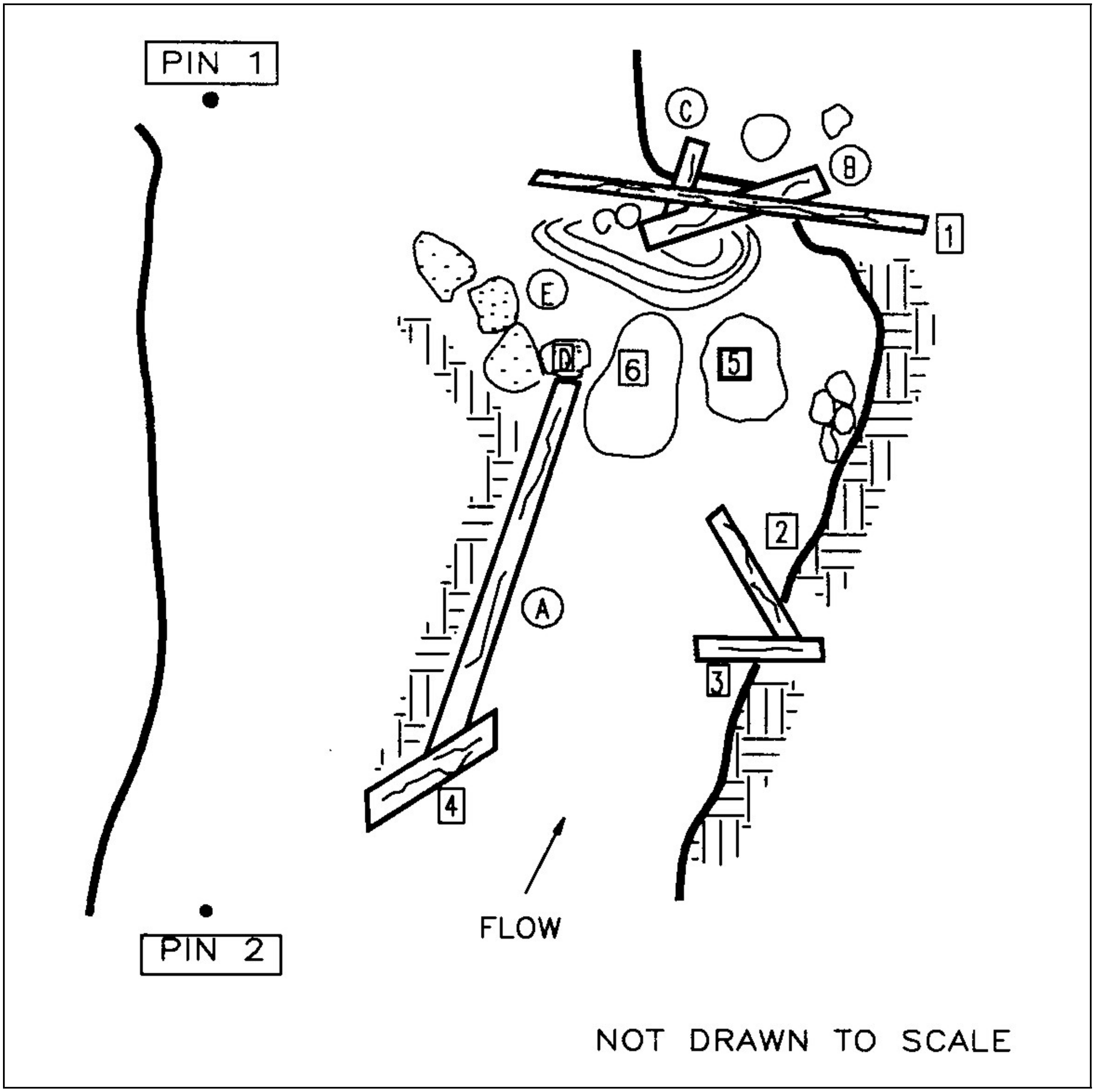


Figure L-2. Typical to-scale plan schematic depicting existing (numbered) and prescribed (lettered) features relative to reference pins. Features correspond with those in Table L-1 (Miller, O'Brien, Koonce, 1988).

At each site notes should be taken describing the condition of the channel. For each enhancement structure the anticipated results of the project are noted. Materials available on site are also recorded. A table of materials and availability is developed (Table L-2). This information helps the construction crew conceptualize what has been designed.

Table L-2. Materials, with estimated dimensions and quantities, required for a station 171+20 along Tarup Creek, Del Norte County, California. The sources for individual items are indicated as available on-site, near to the site or through a specified supplier. Lettered items correspond with those in Figure L-2.

Material	Size		Quantity	Source
	Diameter	Length		
Log A, redwood	2 ft.	32 ft.	1	onsite
Log B, redwood	1.5 ft.	14 ft.	1	nearsite
Log C, redwood	1.5 ft.	7 ft.	1	nearsite
Galvanized cable	3/8 in.	35 ft.	1	supplier
Galvanized cable	1/2 in.	20 ft.	1	supplier
Cable clamps	3/8 in.		4	supplier
Cable clamps	1/2 in.	4		supplier
Rock	2 ft.			near & offsite
Willow cuttings	1/2 in.	2 ft.	100	near & offsite

Construction

Following the enhancement designs during construction involves the simple reversal of the scaled plan map and dimension table preparation process. Fiberglass tapes are stretched from each reference pin to the distances noted in the structure location table. The intersection designates a structural feature, such as the bank end of a log or the center of a boulder. Temporary wire-flags are placed at each intersection point until all important features are delineated. In this way, the location and orientation of a log weir can be identified, and the log can be related to other elements of the design. Once the scaled plan map is verified, construction can begin. The amount of excavation or fill for prescribed features is determined by measuring the appropriate depths using a hand-held Abney level, a tripod-based builders level, or in simple cases, a string level.

Inherent Error In The Methodology. Under ideal conditions, the two-pin method allows little room for error between design intention and construction implementation. Aside from simple misinterpretation, any errors are the result of limits in the measurement system. Elevations can be established to a level of accuracy by extending measurement precision to a higher level of magnitude. For example, if 0.5 foot is an acceptable margin of error, measurements should be recorded in the structure location table to within 0.1 foot.

The plan location of enhancement features is based on intersecting distances from two fixed points. The intersection of two non-parallel lines defines only one position. The two-pin method is similar to that used in maritime navigation, where a "fix" is determined by the intersection of two distance circles. Error can arise in prescribed feature locations due to the inherent short-comings of the triangulation method. Because measurements occur twice, once for design and once for construction, errors can be compounded.

While measuring from reference pins using the two-pin method, a small intersecting angle would occur in two scenarios: 1) when a measured position is quite far from the reference points (Figure L-3); and 2) when a position does not fall roughly between the reference points (Figure L-4).

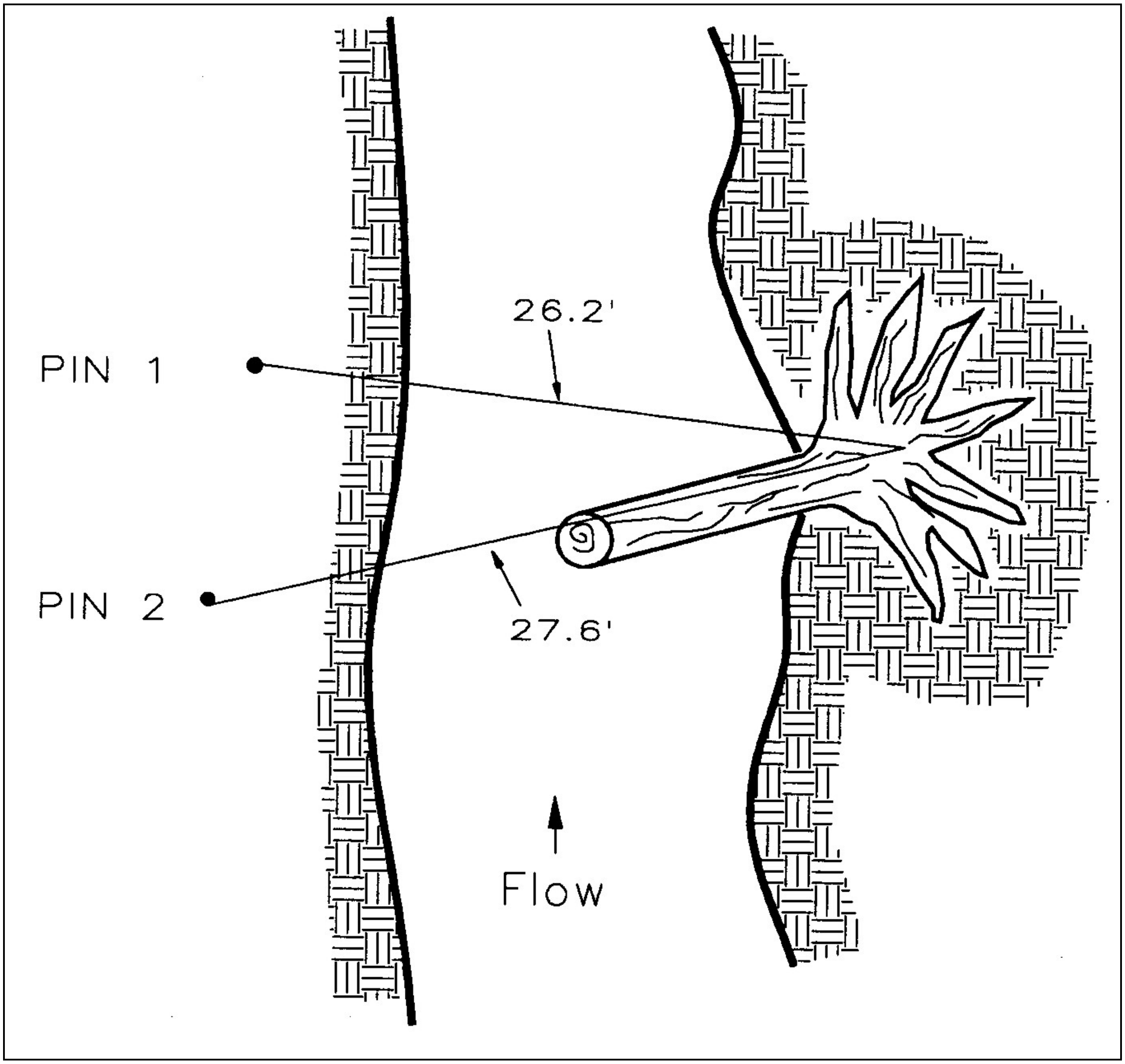


Figure L-3. Measured position quite far from reference pins results in an acute angle with a high potential for measurement error (Miller, O'Brien, Koonce, 1988).

Two important guidelines should be followed to reduce the amount of fix error:

1) Reference pins should always be placed upstream and downstream from the furthest extent of the prescribed enhancement structure. In this way, position lines from the downstream pin never extend downstream and those from the upstream pin never extend upstream (Figure L-4). More than 2 pins may be utilized on very large scale sites, or those sites occurring on tight radius bends.

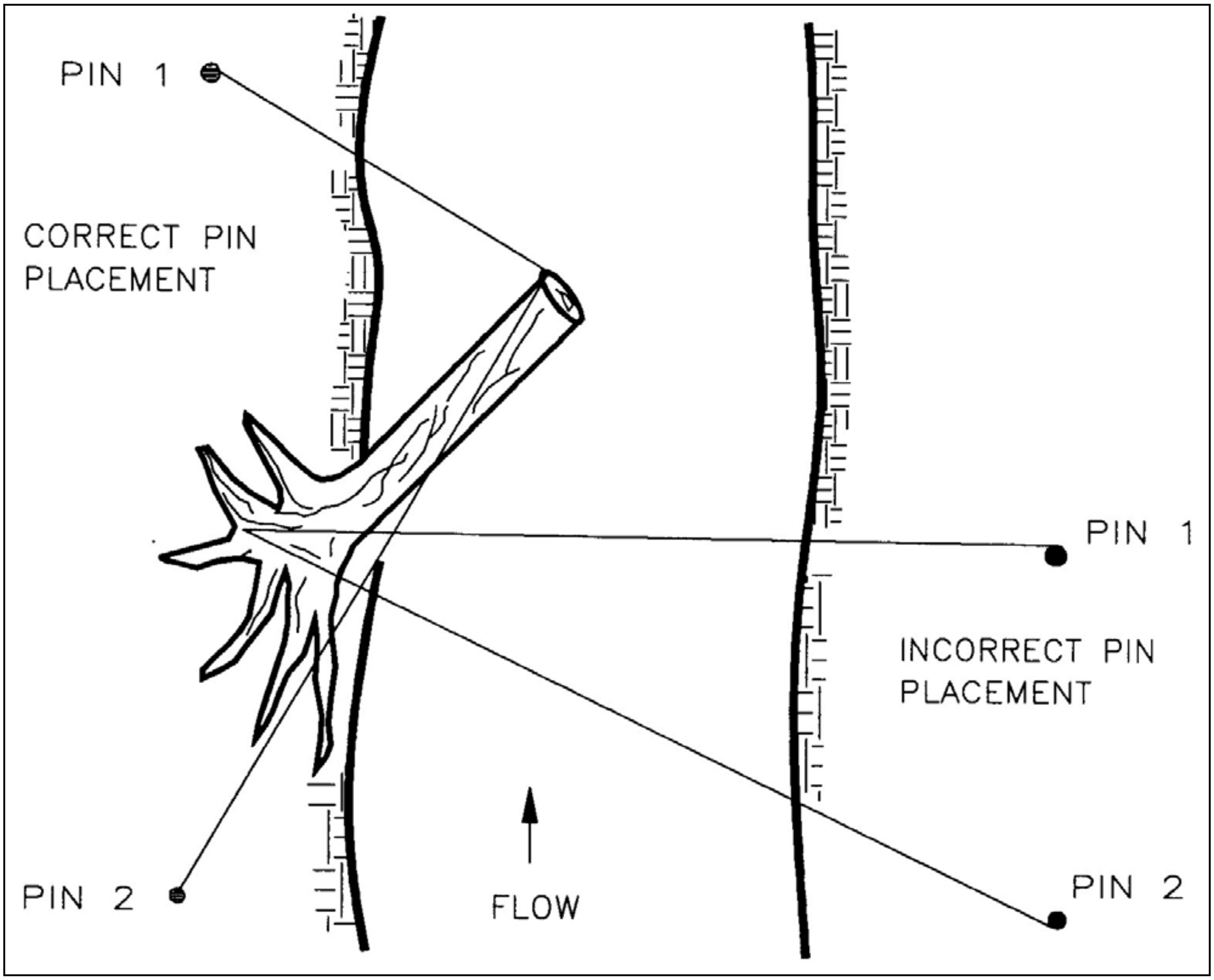


Figure L-4. Reference pins should be placed well upstream and downstream of the area to be measured. In this way, the intersecting angle approaches 90 degrees (Miller, O'Brien, Koonce, 1988).

2) Reference pins should be placed so that the longest measurement across the channel does not exceed 1/2 of the distance between pins. Usually, acceptable results are given if the pins are located so the distance between them is slightly more than twice the channel width (Figure L-5).

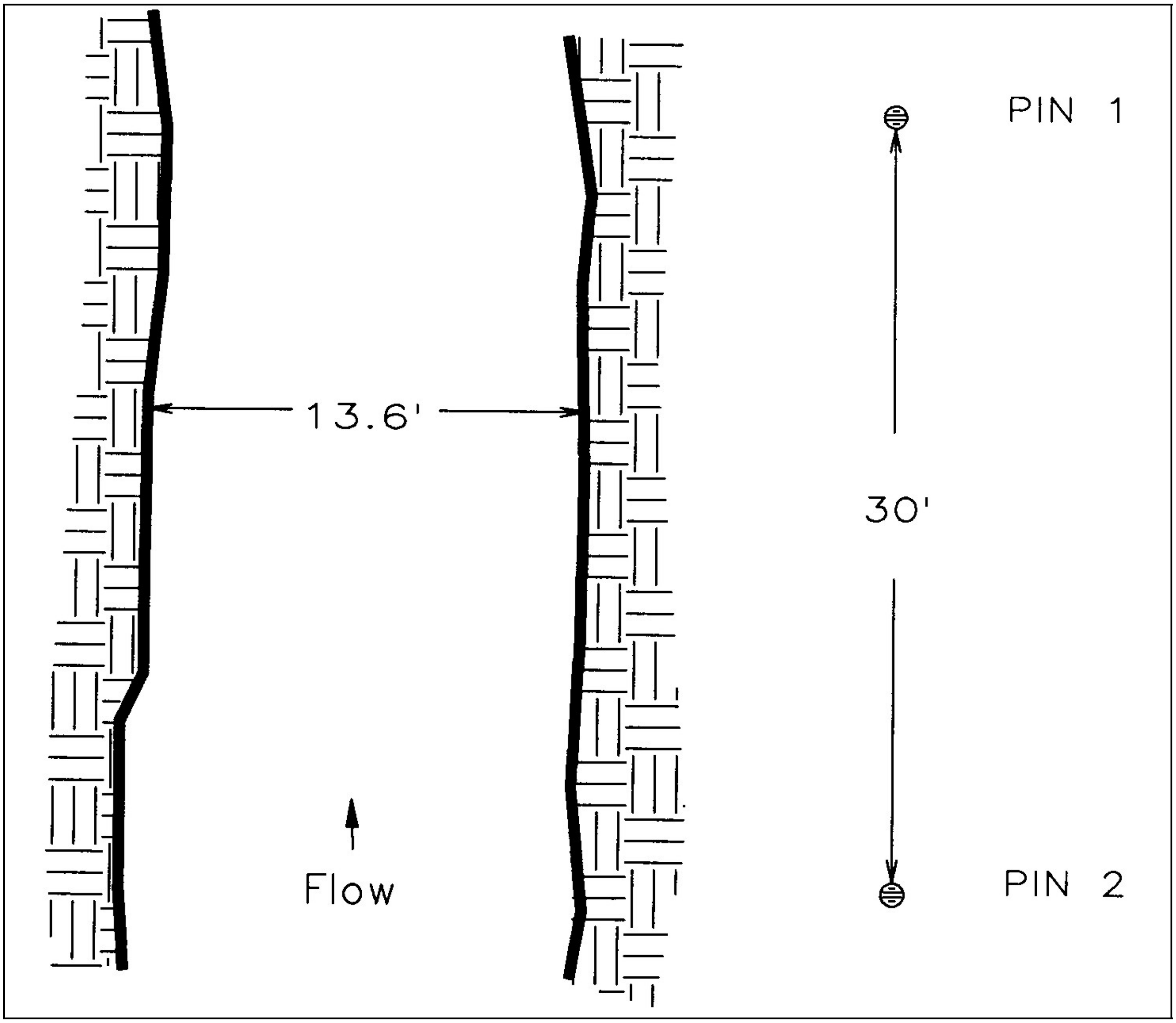


Figure L-5. Proper spacing of reference pins is slightly greater than twice the channel length (Miller, O'Brien, Koonce, 1988).

Management Implications

Stability Analysis. The two-pin method is a relatively precise, inexpensive means to evaluate the long-term stability of enhancement structures. Post-construction documentation of selected locations of structural components can be compared with measurements following annual high flow periods or even specific runoff events. For example, the plan and profile location of a group of boulders in an instream cluster can be documented by measuring the fix and elevation at the center of each boulder. With such records, any movement of the boulders following runoff events can be readily qualified.

Habitat and Bedform Mapping. Where sampling occurs over a short area, a plan schematic can be developed using the two-pin method to depict the location of different parameter measurement sites. For example, the location of benthic invertebrate, substrate and water quality sampling sites can be illustrated on a plan map. General geomorphic maps of bedforms such as pools, riffles and bars of stream channels can be developed utilizing the two-pin method.

Contract Specifications. Managers involved with the setup and coordination of instream habitat construction who prepare typical engineering-style blueprint design documents may find the two-pin method more cost efficient and easily implemented by work crews. Similarly, projects which stipulate background biological sampling may use the two-pin method to identify specific sample sites for contractors. In some cases, design details or sampling areas identified with this methodology could result in more specific proposals from bidders, thereby allowing more accurate comparison of contract line items.

Location maps for each project reach, which show the stream section and any roads or trails associated with it, are versatile tools. They can be constructed by tracing on mylar or acetate the area and features necessary from a map or an aerial photograph. Photocopies are then taken of the transparency and can be reduced or enlarged as needed for field maps. During the field layout, all on site construction materials and access routes for work crews, equipment, and materials should be located on these maps and thoroughly described.

Photographic documentation of the project site, using established photo points, is desirable during the layout phase (Part VIII). It is the most cost-effective means of recording site conditions at any particular time and should be used frequently throughout a project's lifetime. Photographs taken during pre-project phases can be taken out in the field in clear plastic protective cases and used to help compare views and align new photographs.

The actual project site layout is the transition between the planning phase and the construction phase and is a critically important stage for any project. If adequate time is used to set it up right in the field, using all the tools available to you, the actual construction phase will run smoothly and cost-effectively. Thorough documentation is strongly recommended using field notebooks, site location maps, stream reach maps, cross section diagrams, and photographs. It is recommended to establish photo points, using the two-pin method if necessary, to document the progress and effects of the project. Photo documentation is best when aspect, light, camera, and lens selection is consistent.

REFERENCES

Koonce, Gregory P. 1990. Two-Pin Method for the Layout of Stream Habitat Enhancement Designs. Proceedings of the Eighth Annual California Salmon, Steelhead and Trout Restoration Conference. Eureka, California, USA.

Miller, Dale E., R. J. O'Brien, and G. P. Koonce. 1988. Two-Pin Method for the Implementation of Instream Habitat Enhancement Designs. Presented at the 1988 Fisheries Bioengineering Symposium in Portland, Oregon, USA.

APPENDIX M.

SPECIALTY INSTRUMENTS

Geographic Information System (GIS)

The generally accepted definition of a GIS is an automated system that inputs, manages, manipulates, analyzes, and displays geographic data in digital form. Data in a GIS are spatially referenced, that is, defined by their location on the earth, and can be mapped. Each object is identified by a specific geographic location using latitude and longitude coordinates, described by single or multiple characteristics, and related to other features in the GIS. Therefore, three pieces of information are essential for each feature entered into a GIS database: where it is, what it is, and how it relates to other features (e.g., which streams link to form a river basin).

A GIS system has the capability of making maps and analyzing data within spatial parameters. For example, a GIS containing the appropriate data can produce a map of all restoration projects involving instream structures in tributaries to the South Fork Eel River. A similar, but more specific query of, "show only those projects in tributaries known to contain coho", would produce another map. Another query might ask to either list or display on a map all salmonid rearing projects within 50 miles of Fort Bragg.

Uses of spatial data within a GIS format provide resource managers, specialists, and planners a variety of analytical and monitoring tools. GIS capabilities include: 1) the geographic display of environmental, infrastructure, and social features, 2) display maps of geographic characteristics needed for analysis, 3) visually present changes of environmental or other features based on monitoring data, and 4) model alternative scenarios for management plans.

The GIS software presently in use by the California Department of Fish and Game is ARC/INFO.

The key component for entering data into the GIS system is location. Location is defined by latitude and longitude coordinates determined from USGS maps and a "Coordinator" tool, or a Global Positioning System (GPS) instrument.

Coordinator

The Coordinator is designed to enable the user to precisely determine the north latitude and west longitude of any point on all United States Geological Survey (USGS) and Canadian Department of Mines Topographic maps currently available and produced to the following scales: 1:20,000; 1:24,000; 1:25,000; 1:30,000; 1:50,000; 1:62,500; 1:63,600; 1:100,000 and 1:250,000.

The following steps are used to determine latitude and longitude of any point selected on USGS topographic maps.

Step 1. Carefully mark the point on the map for which the latitude and longitude is to be determined.

Step 2. Determine the scale to which the map has been produced. The scale referred to is printed in the white border area of every topographic map, generally either in the center of the lower border or, occasionally, in one of the four corners of the map. The most commonly used USGS topographic maps by DFG are the 7.5 minute quadrangle series at a 1:24,000 scale. The 15 minute series USGS topographic maps at a 1:62,500 scale are no longer produced but still exist in most offices. **BE CERTAIN YOU USE THE CORRECT SCALE FOR THE MAP YOU HAVE**.

Step 3. Select the scale on the Coordinator that corresponds to the map scale determined in Step 2. Each Coordinator scale designation appears on the extreme left of the Coordinator, at the base of and at right angle to the scale to which it pertains. (Note that 1:20,000 is shown as 1:20K, 1:24,000 as 1:24K, etc.)

Step 4. Observe that every topographic map has a beginning north latitude printed on the bottom left and right border of the map area and an ending north latitude printed on the top left and right border of the map area. The beginning west longitude of every map is printed on the top and bottom of the right map border and the ending west longitude is printed on the top and bottom of the left map border.

Step 5. Additionally, there are intermediate points every 2'30" between the beginning and ending north latitude and west longitude printed along the corresponding vertical and horizontal borders of the map area on 1:20K, 1:24K, 1:25K and 1:30K maps. Intermediate points are at 5'00" intervals on 1:50K, 1:62.5K and 1:63.6K maps and at 15'00" intervals on 1:100K and 1:250K maps.

Step 6. Furthermore, within the map area itself, note that where hypothetical lines that would connect corresponding intermediate latitude and longitude points would intersect, there exist + marks.

IN USING YOUR COORDINATOR, IT IS IMPORTANT TO REMEMBER THAT LONGITUDE ALWAYS INCREASES IN AN EAST TO WEST (from right to left) DIRECTION AND, IN THE NORTHERN HEMISPHERE, LATITUDE ALWAYS INCREASES IN A SOUTH TO NORTH (going up) DIRECTION.

Step 7. DETERMINING NORTH LATITUDE. Create a line across the map at the nearest intermediate points (Step 5) above and below the point you have marked in Step 1. These lines will hereafter be referred to as "framing lines." If your Step 1 point falls between the bottom edge of the map area and the first intermediate point, or between the top edge of the map area and the first intermediate point below, it is only necessary to create a single framing line as the map area edge will serve as the other framing line.

Step 8. Using the Coordinator scale selected in Step 3, lay the Coordinator on the map so that the scale begins on the framing line below your Step 1 point, and ends on the framing line above it AND that your Step 1 point falls on the Coordinator scale itself.

Step 9. Reading the Scale. Each scale on the Coordinator has two sets of incremental designations, the LEFT beginning at 30" and the RIGHT beginning at 00". It is essential in reading the scale, if your lower framing line is at 30", that you read from the left scale that begins at 30" and if the lower framing line is at 00", that you read from the right scale that begins at 00".

Having determined the correct incremental scale designation to use, note that as you read up the scale, each time you would reach the 00" point on the Coordinator scale, you must add 1' to the beginning north latitude at your lower framing line.

Step 10. DETERMINING WEST LONGITUDE. West longitude is determined in a generally similar manner as north latitude (i.e., by creating framing lines running north and south at the intermediate (Step 5) points on either side of your Step 1 point). Similar to determining north latitude, if your Step 1 point falls between either edge of the map area and the first intermediate point, only a single framing line need be created. Unlike the "imaginary" latitude lines which are ALWAYS equidistant and absolutely parallel between the equator and the north pole, LONGITUDE "LINES" are furthest apart at the equator and gradually converge to zero separation at the north pole. For this reason, the Coordinator must be positioned DIAGONALLY between your north-south Longitudinal framing lines.

Reading the Scale. The same scale on the Coordinator is used for determining BOTH north latitude and west longitude. MAKE CERTAIN that the Coordinator is positioned with the scale reading from right to left (east to west) as this is the direction in which longitude increases. Read the appropriate incremental scale designations as in Step 5, being careful to note whether your beginning intermediate longitude is at 30" or 00".

NOTE: Some Step 1 points near the edges of any topographic map dictate that one framing line be created past the edge of the map for computing west longitude ONLY, due to the diagonal positioning of the Coordinator required.

Global Positioning System (GPS)

GPS is a satellite-based positioning system operated by the U.S. Department of Defense (DOD). The system consists of 24 satellites orbiting the earth every 12 hours at an altitude of 12,600 nautical miles. Four satellites orbit in each of six different planes. Each satellite contains several high-precision atomic clocks and constantly transmits radio signals using its own unique identifying code.

When locating a position on earth, a GPS unit receives radio signals from "visible" satellites and computes the distance from each satellite to the receiver. The GPS computer uses triangulation to calculate a location point and displays this point in latitude and longitude. The satellites act as reference points for position fixes. Good quality fixes require signal reception from four satellites, a satellite constellation. Distance measurements from each satellite to the GPS receiver are performed within the receiver by timing how long it takes a radio signal to reach the GPS unit, and then calculating the distance based on time and the speed of radio waves (speed of light x time = distance). Most receivers measure time in nanoseconds, one-billionth of a second.

GPS accuracy depends on geometric position of satellites within a constellation, atmospheric conditions, and if DOD is introducing error into the system for national security purposes. Software is available to correct for DOD error. Uncorrected error can result in fix errors of ±300 feet (100 meters); corrected positions are accurate to within 12 feet (2 meters) or less.

GPS can be used to obtain fixes for defining points, lines or areas. Locations of specific sites (e.g., bridges, stream confluences, project sites, problem areas) can be determined by collecting 150 to 200 points or fixes and averaging them to obtain a mean latitude and longitude. Most receivers record a fix every one to two seconds. Longer fix intervals can be selected. Stream courses can be tracked by walking along the stream channel and recording GPS fixes every one to five seconds. GPS points recorded while walking the perimeter of a lake will provide a perimeter line and surface area calculation of the lake. Fix data can be recorded within the GPS unit and later downloaded onto computer disks. Software enables averaging for point fixes, line drawing indicating points along a route (e.g., a stream course), area measurements, distances between points, and other measurements using data points. GPS data can be exported to a GIS system for further analysis.

GPS technology is rapidly being developed and improved. Early GPS units were three-channel receivers. Most GPS units produced today are five- to eight-channel receivers. More channels reduces satellite acquisition time and provides better signal "lock" in vegetative cover. Newer GPS units also have improved displays and are more user-friendly than earlier models.

The primary drawback to using GPS in streams is the difficulty in receiving and maintaining satellite signals under vegetation or stream canopy. GPS radio signals travel "line-of-sight" and do not penetrate solid objects well. Basically, if you cannot see the sky, the GPS unit will not receive the satellite signal. This problem is overcome by using "offsets" when determining a fix. Offsets require the GPS unit to be located in an adjacent open area where a fix can be obtained, at a measured distance and direction from the stream. Remote antennas have also proven useful to acquire signals under stream canopy cover. The antenna, attached to a pole, is moved and tilted around until satellites are "locked on".

Spherical Densiometer

The spherical densiometer can be used as a hand held instrument to estimate relative vegetative canopy closure or canopy density caused by vegetation. Vegetation canopy closure is the area of the sky over the selected stream channel that is bracketed by vegetation (regardless of density). Canopy density is the amount of the sky blocked within the closure by vegetation. Canopy closure can be constant throughout the season if fast growing vegetation is not dominant, but density can change drastically if canopy vegetation is deciduous.

Spherical densiometers are produced with either convex or concave reflecting surfaces. These instructions are for a convex (Model A) spherical densiometer. The mirror surface of the densiometer has 37 grid intersections forming 24 squares. At a probability level of 95 percent, tests show the average measurements of the same overstory area can be excepted to be within ±2.4 percent of the mean. Because the instrument has a curved (convex or concave) reflecting surface resulting in a field the includes lateral as well as overhead positions, an overlap of side readings occurs when readings are taken from the same point. To account for this bias, the modifications developed by Strichler (1959) are used and modified to more accurately measure canopy closure and density. Strichler uses only 17 of the line intersects as observation points by taping a right angle on the mirror surface (Figure M- 1).

For Stream Orders 1 Through 4 - Stand in the middle of the habitat type area and in the center of the stream facing downstream. The densiometer is held in the hand, in front of the body at about waist level, with the arm from the hand to the elbow parallel to the water surface. The convex densiometer is held away from the observer's body with the apex of the V pointed toward the observer. The observer's eye reflection should seen along the margin of the original grid (Figure M-1). Level the densiometer using the bubble indicator and maintain the level and standard eye positions while recording. The grid between the V formed by the tape encloses 17 observation points. Each point has a value of 1.5 percent when four different recordings are made. The number of points (line grid intersects) that are covered by vegetation are counted when measuring canopy density. The number of points surrounded by vegetation are counted when measuring canopy closure. Measurements are taken in the four quadrants while standing on the same point (facing downstream, right bank, upstream, left bank).

The points counted for each reading are totaled and multiplied by 1.5 to obtain the percentage of canopy density or closure.

If all possible observation points are counted the total value will be 102 percent (68 × 1.5 = 102). Although this error is small and not considered important for comparisons of relative values, the following correction factor can be applied to determine the correct percentile:

Calculated value	Subtract from Calculated value
less than 30	0
30 to 60	-1
over 60	-2

Example: (8+11+7+12)(1.5) = 57% subtract 1% = 56% density

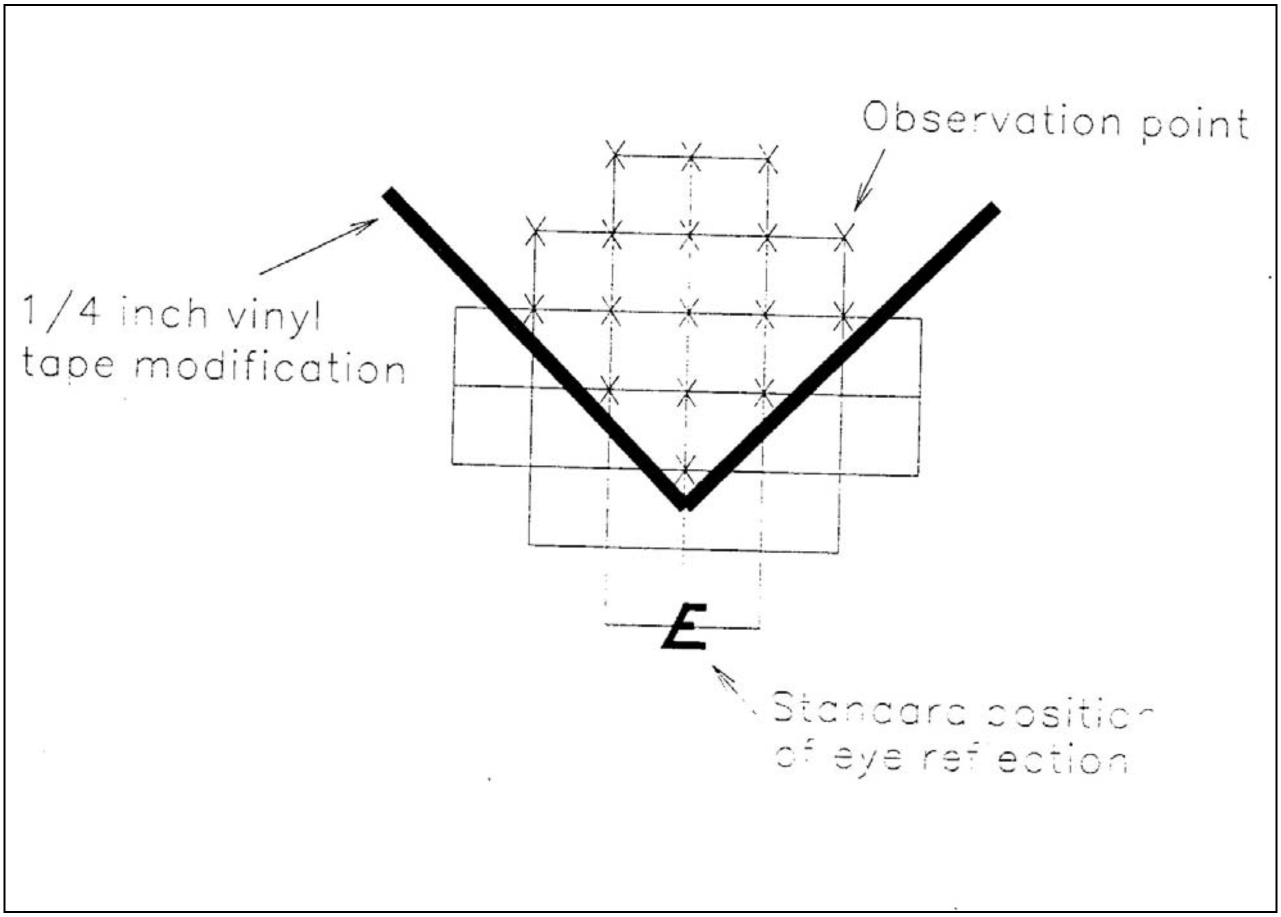


Figure M-1. Modified grid of convex spherical densiometer showing the 17 observations points (X's) and the position of the observer's eye reflection.

REFERENCES

Platts, W.S., D. Amour, G.D. Booth, M. Gryant, J.L. Bufford, P. Culpin, S. Jensen, G.W. Lienkaemper, G.W. Minshall, S.B. Monsen, R.L. Nelson, J.R. Sedell, and J.S. Tuhy. 1987. Methods for Evaluating Riparian Habitats with Applications to Management. US Dept of Agriculture, Forest Service, Intermountain Research Station, General Technical Report INT-221.

Strichler, G.S. 1959. Use of the densiometer to estimate density of forest canopy on permanent sample plots. Research Note INT-180. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station, 5p.