CALIFORNIA DEPARTMENT OF FISH AND GAME
STREAM INVENTORY REPORT
Ward Creek
Report Revised April 14, 2006
Report Completed *2000*
Assessment 1996

INTRODUCTION

A stream inventory was conducted during the summer of 1996 on Ward Creek. The inventory was conducted in two parts: habitat inventory and biological inventory. The objective of the habitat inventory was to document the amount and condition of available habitat to fish, and other aquatic species with an emphasis on anadromous salmonids in Ward Creek. The objective of the biological inventory was to document the salmonid and other aquatic species present and their distribution.

The objective of this report is to document the current habitat conditions, and recommend options for the potential enhancement of habitat for Chinook salmon, 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

Ward Creek is a tributary to Big Austin Creek, a tributary of the Russian River, located in Sonoma County, California (see Ward Creek map, page 2). The legal description at the confluence with Big Austin Creek is T8N, R11W, S16. Its location is 38°32'29" N. latitude and 123°6'39" W. longitude. Year round vehicle access to the lower reaches exists from Fort Ross Road near Cazadero, the upper reaches are only accessible through locked private roads.

Ward Creek and its tributaries drain a basin of approximately 13.8 square miles. Ward Creek is a third order stream and has approximately 7.3 miles of blue line stream, according to the USGS Cazadero and Fort Ross 7.5 minute quadrangles. Major tributaries including Blue Jay Creek and Pole Mountain Creek were also habitat typed and both are described in separate stream reports. Big Oat Creek, another tributary, was not habitat typed because an impassable natural barrier exists at the mouth. Three minor unnamed tributaries were habitat typed and are included in this report. They are referred to as unnamed tributary #1, #2, and #3 in respect to their relative location from the mouth of Ward Creek. Elevations range from about 120 feet at the mouth of the creek to 2,040 feet in the headwaters. The upper section of Ward Creek

flows through a wide U-shaped canyon. The vegetation is mixed, consisting of redwood, douglas fir, California laurel, willow, oak, and blackberry. The watershed is privately owned and is managed for timber production.

METHODS

The habitat inventory conducted in Ward Creek follows the methodology presented in the California Salmonid Stream Habitat Restoration Manual (Flosi and Reynolds, 1994). The NEAP crew 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 and was supervised by Bob Coey, Russian River Basin Planner (DFG).

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 Ward Creek to record measurements and observations. There are nine components to the inventory form: flow, channel type, temperatures, habitat type, embeddedness, shelter rating, substrate composition, canopy, and bank composition.

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. Flows were also measured or estimated at major tributary confluences.

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:

Water and air temperatures, and time, are measured by crew members with hand held thermometers and recorded at each tenth unit typed.

Temperatures are measured in Fahrenheit at the middle of the habitat unit and within one foot of the water surface. Temperatures are also recorded using remote temperature recorders which log temperatures every two hours, 24 hours/day.

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". Ward Creek habitat typing used standard basin level measurement criteria. These parameters require that the minimum length of a described habitat unit must be equal to or greater than the stream's mean wetted width. All unit lengths were measured, additionally, the first occurrence of each unit type and a randomly selected 10% subset of all units were completely sampled (length, mean width, mean depth, maximum depth and pool tail crest depth). 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 Ward Creek, embeddedness was visually estimated. The values were recorded using the following ranges: 0 - 25% (value 1), 26 - 50% (value 2), 51 - 75% (value 3), 76 - 100% (value 4). Additionally, a rating of "not suitable" (NS) 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. Using an overhead view, a quantitative estimate of the percentage of the habitat unit covered is made. All shelter is then classified according to a list of nine shelter types. In Ward Creek, a standard qualitative shelter value of 0 (none), 1 (low), 2 (medium), or 3 (high) was assigned according to the complexity of the shelter. The shelter rating is calculated for each habitat unit by multiplying shelter value and percent covered. Thus, shelter ratings can range from 0-300, and are expressed as mean values by habitat types within a stream.

7. Substrate Composition:

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

8. Canopy:

Stream canopy density was estimated using modified handheld spherical densiometers as described in the California Salmonid Stream Habitat Restoration Manual, 1994. Canopy density relates to the amount of stream shaded from the sun. In Ward Creek, an estimate of the percentage of the habitat unit covered by canopy was made from the center of approximately every third unit in addition to every fully-described unit, giving an approximate 30% sub-sample. In addition, the area of canopy was estimated ocularly into percentages of evergreen or deciduous trees.

9. Bank Composition:

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 Ward Creek, the dominant composition type and the dominant vegetation type of both the right and left banks for each fully measured 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. Biological inventory is conducted using one or more of three basic methods: 1) stream bank observation, 2) underwater observation, 3) electrofishing. These sampling techniques are discussed in the California Salmonid Stream Habitat Restoration Manual.

IMPACT INVENTORY & ANALYSIS

Problems such as migration barriers, streambed erosion, poor water quality or temperatures are noted and mapped. In some cases measurements are taken, an analysis of what caused the problem is made and restoration potential and alternatives are recommended.

DATA ANALYSIS

Data from the habitat inventory form are entered into Habitat, a dBASE IV 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 tables and appendices:

- Riffle, flatwater, and pool habitat types
- Habitat types and measured parameters
- Pool types
- Maximum pool depths by habitat types
- Shelter by habitat types
- Dominant substrates by habitat types
- Vegetative cover and dominant bank composition
- Fish habitat elements by stream reach

Graphics are produced from the tables using Lotus 1,2,3. Graphics developed for Ward Creek include:

- Level II Habitat Types by % Occurrence and % Total Length
- Level IV Habitat Types by % Occurrence
- Pool Habitat Types by % Occurrence
- Maximum Depth in Pools
- Pool Shelter Types by % Area
- Substrate Composition in Low Gradient Riffles
- Percent Cobble Embeddedness by Reach
- Mean Percent Canopy
- Mean Percent Canopy by Reach
- Percent Bank Composition and Bank Vegetation

HISTORICAL STREAM SURVEYS:

The Department of Fish and Game conducted previous surveys of Ward Creek in September 1965, October 1968, December 1970, July 1977, and June 1982. A brief summary of each survey follows. The 1965 survey started at the mouth and continued to the headwaters. The flow was estimated at 1.7 cfs near the mouth, 1.2 cfs 3.1 miles from the mouth, .5 cfs 4.3 miles from the mouth, .3 cfs 1.5 miles from the mouth of Blue Jay Creek, and .25 cfs near the upper fish limit. The average depth was 5" and the average wetted width was 5'.

The substrate consisted of approximately 10% boulders, 20% large cobble, 25% small cobble, 40% gravel, and 5% sand. Spawning area was estimated to cover 22% of the stream. Pools were estimated to cover 40% of the stream and shelter consisted of undercut banks, boulders, roots and logs.

Partial barriers included nine log jams, a 6' bedrock falls, a wooden dam of unknown use, a gravel bedrock summer dam for domestic use, and a 15' bedrock boulder falls with a natural winter fish ladder. Complete barriers included 3 log jams. Most of the log jams were recommended to be removed. No pollution was observed and 5 springs were noted.

The 1970 survey started at the mouth and ended at the upper fish limit 8 miles upstream. The flow was estimated to average 1/10 cfs. The average wetted width was 2' for riffles and 8' for pools and the average depth was 3" for riffles and 1.5' for pools. The highest temperatures were taken at the mouth of Blue Jay Creek on August 12 at 1500 hrs. The air temperature was 78°F and the water temperature was 70°F.

Spawning area was estimated to cover 50% of the stream. Pools had a 60% frequency throughout the stream and the shelter was good in the lower section of the creek, but poor in the upper section. The substrate consisted of 15% silt, 25% sand, 30% gravel, 10% small cobble, 10% large cobble, and 10% boulders.

Barriers consisting of eight complete jams, 17 incomplete, but potential jams, and 1 summer dam were noted. Removal was recommended for all 26 barriers. No pollution or diversions and few springs were noted.

The 1977 survey started at the mouth and continued to the headwaters. The flow was visually estimated at 0.8 cfs. from the mouth to just below Big Oat Creek. Thereafter, the creek was intermittent. The wetted width ranged from 1" to 60' and averaged 1'. The depth ranged from 1" to 4' and averaged 1.5". Air temperatures ranged from 90-95°F and water temperatures ranged from 73-79°F.

Spawning area was estimated to cover 55% of the stream with "loose and clean" gravel in most areas. The substrate consisted of approximately 5% bedrock, 18% boulder, 30% cobble, 30% gravel, and 15% sand. Pools were created by boulders, bedrock, log jams, and undercut banks, and the average size was 15'L x 8'W x 9'D. Shelter consisted of boulders, logs, and undercut banks. Canopy provided an average of 25% overhead cover.

In the 1977 survey, there were 4 complete and 8 partial barriers. The complete barriers consisted of a 15' bedrock falls, a steep gradient that prevented fish from using the extreme headwaters, and 2 log jams. The partial barriers consisted of 6 log jams, a 50' x

40' x 10' boulder, bedrock and log jam area, and a boulder and bedrock roughs area 80' long with a vertical rise of approximately 15'. Removal was recommended for all of the log jams. Three springs were observed in the headwaters area, and 3 diversions used for domestic use were observed directly upstream from the mouth.

In the 1982 survey, seven log jams were noted. Of the seven log jams, only one was considered to be a complete fish barrier. The substrate consisted mostly of gravel to cobble interspersed with large boulders.

HABITAT INVENTORY RESULTS FOR WARD CREEK

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

The habitat inventory of July 18 - August 26, 1996 was conducted by Bob and Nancy Barney (NEAP) and data analyzed by Ken Bunzel (DFG). The survey began at the confluence with Big Austin Creek and extended up Ward Creek until fish were no longer seen. The total length of the stream surveyed was 37,828 feet, with an additional 2,049 feet of side channel.

There are 6 different channel types in Ward Creek: C3, B2, F1, F2, F3 and F4. Appendix C lists the channel types and lengths for each of the 9 reaches. A change in channel type defines a reach. C3 channel types are low gradient (<2%), meandering, point-bar, riffle/pool, alluvial channels with a broad, well defined floodplain and a predominantly cobble substrate.

B2 channel types are moderately entrenched, moderate gradient (2-4%), riffle dominated channels, with infrequently spaced pools, a very stable plan and profile, stable banks and have a predominantly boulder substrate.

F1 channel types are entrenched meandering riffle/pool channels on low gradients (<2%) with a high width/depth ratio and a predominantly bedrock substrate. F2, F3 and F4 types are similar to F1 types except with boulder, cobble and gravel substrates, respectively.

Water temperatures ranged from 57-77°F. Air temperatures ranged from 50-97°F. Summer temperatures were also measured using a remote temperature recorder placed in a pool (see Temperature Summary graph at end of report). The recorder was placed in a pool at the confluence of the first tributary on the right bank and logged temperatures every 2 hours from July 16 - October 6, 1996. The highest temperature recorded was 73°F in August and the lowest was

55°F in October. The mean of the daily highs was 69°F for the month of July, 68°F for August and 62°F for September.

Table 1 summarizes the Level II riffle, flatwater, and pool habitat types. Based on frequency of **occurrence** there were 41% pool units, 32% riffle units, and 27% flatwater units. Based on total **length** there were 40% riffle units, 34% pool units, and 26% flatwater units.

One thousand, ninety habitat units were measured and 27% were completely sampled. Twenty-four Level IV habitat types were identified. The data is summarized in Table 2. The most frequent habitat types by percent **occurrence** were low gradient riffles at 26%, mid-channel pools 12%, glides 10% and runs 9% (Graph 2). By percent total **length**, low gradient riffles made up 31%, glides 9%, mid-channel pools 9%, and runs 8%.

Four hundred, forty-five pools were identified (Table 3). Scour pools were most often encountered at 57%, and comprised 57% of the total length of pools (Graph 3).

Table 4 is a summary of maximum pool depths by pool habitat types. Pool quality for salmonids increases with depth. Seventy-four of the 445 pools (17%) had a depth of three feet or greater (Graph 4). These deeper pools comprised 8% of the total length of stream habitat.

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 types had the highest shelter rating at 24. Flatwater had the lowest rating with 13 and riffles rated 23 (Table 1). Of the pool types, the scour pools had the highest mean shelter rating at 26, backwater pools rated 23, and main channel pools rated 21 (Table 3).

Table 5 summarizes fish shelter by habitat type. By percent area, the dominant pool shelter types were boulders at 54% and small woody debris at 11%. Graph 5 describes the pool shelter in Ward Creek.

Table 6 summarizes the dominant substrate by habitat type. Gravel was the dominant substrate observed in 9 of the 48 low gradient riffles measured. Small cobble was dominant in 18 of the low gradient riffles (Graph 6).

The depth of cobble embeddedness was estimated at pool tail-outs. Of the 414 pool tail-outs measured, 139 had a value of 1 (34%); 156

had a value of 2 (38%); 55 had a value of 3 (13%); and 64 had a value of 4 (15%). On this scale, a value of one is best for fisheries. Graph 7 describes percent embeddedness by reach.
The mean percent canopy density for the stream reach surveyed was 70%. The mean percentages of deciduous and evergreen trees were 51% and 49%, respectively. Graph 8 describes the canopy for the entire survey and graph 9 describes the canopy by reach.

For the entire stream reach surveyed, the mean percent right bank vegetated was 24% and the mean percent left bank vegetated was 23%. For the habitat units measured, the dominant vegetation types for the stream banks were: 36% deciduous trees, 24% evergreen trees, 23% grass, 9% brush and 7% bare soil. The dominant substrate for the stream banks were: 38% cobble/gravel, 32% boulder, 28% bedrock and 1% silt/clay/sand (Graph 10).

During the inventory, streambank erosion areas, log jams and migration barriers were noted and measured. See comments for listing and location.

HABITAT INVENTORY RESULTS FOR UNNAMED TRIBUTARY #1

The habitat inventory of August 8, 1996 was conducted by Nancy and Bob Barney (NEAP) and data analyzed by Ken Bunzel (DFG). The survey began at the confluence with Ward Creek and extended up the tributary until flow was diminished and fish were no longer found. The total length of the stream surveyed was 1,426 feet, with an additional 20 feet of side channel. The total length of the stream is approximately 2,500 feet.

This section of the tributary has 2 channel types: from the mouth to 185 feet an F4 and the upper 1,242 feet an F3. For channel type descriptions, see Habitat Inventory Results for Ward Creek. Water temperatures ranged from 62-65°F. Air temperatures ranged from 74-87°F.

*Forty habitat units were measured and 30% were completely sampled. Based on total **length** there were 68% riffle units, 24% pool units, 7% flatwater units, and 1% dry streambed units. Twelve Level IV habitat types were identified. By percent total **length**, low gradient riffles made up 65%, mid-channel pools 15%, step runs 4%, and plunge pools 3%.*

Eighteen pools were identified. Main Channel pools were most often encountered at 61%, and comprised 74% of the total length of pools. Two of the 18 pools (11%) had a depth of two feet or greater. These deeper pools comprised 2% of the total length of stream

habitat.

Riffle types had the highest shelter rating at 20. Flatwater had the lowest rating with 6 and pools rated 19. Of the pool types, the scour pools had the highest mean shelter rating at 33 and main channel pools rated 12. No backwater pools were identified. By percent area, the dominant pool shelter types were boulders at 40%, large woody debris 31%, small woody debris 12%, and undercut banks 8%.

Small cobble was the dominant substrate observed in the 1 low gradient riffle measured. Of the 16 pool tail-outs measured, none had a value of 1; 6 had a value of 2 (38%); 7 had a value of 3 (44%); and 3 had a value of 4 (19%).

The mean percent canopy density for the stream reach surveyed was 83%. The mean percentages of deciduous and evergreen trees were 37% and 63%, respectively. The mean percent right bank vegetated was 29% and the mean percent left bank vegetated was 48%. For the habitat units measured, the dominant vegetation types for the stream banks were: 46% deciduous trees, 32% evergreen trees, 18% brush, and 4% grass. The dominant substrate for the stream banks were: 71% cobble/gravel, 21% silt/clay/sand, and 7% boulder.

HABITAT INVENTORY RESULTS FOR UNNAMED TRIBUTARY #2

The habitat inventory of August 20, 1996 was conducted by Nancy and Bob Barney (NEAP) and data analyzed by Ken Bunzel (DFG). The survey began at the confluence with Ward Creek and extended up the tributary 105 ft. until the stream went dry. The total length of the stream is approximately 3,000 feet. This tributary was not channel typed. The water temperature was 69°F and the air temperature was 82°F.

Three habitat units were measured: a low gradient riffle, a bedrock sheet and a mid-channel pool. Salmonids were observed only in the mid-channel pool located at the mouth. This pool had an embeddedness level of 2.

The mean percent canopy density for the stream reach surveyed was 63%. For the habitat units measured, the dominant types for the stream banks were: 33% grass, 33% deciduous trees, 83% bedrock and 17% boulder.

HABITAT INVENTORY RESULTS FOR UNNAMED TRIBUTARY #3

The habitat inventory of August 27, 1996 was conducted by Nancy and Bob Barney (NEAP) and data analyzed by Ken Bunzel (DFG). The survey began at the confluence with Ward Creek and extended up the tributary to the end of anadromous fish passage 188 feet upstream. The total length of the stream is approximately 3,000 feet. This tributary was not channel typed. The water temperature was 61°F and the air temperature was 64°F.

Five habitat units were measured: 2 low gradient riffles, 1 log scour pool, 1 run and 1 dry unit. The pool was less than 1 foot deep, and had an embeddedness rating of 2. Only 1 fish was observed in this pool.

The mean percent canopy density for the stream reach surveyed was 83%. For the habitat units measured, the dominant types for the stream banks were: 67% brush, 33% evergreen trees, 67% cobble/gravel and 33% boulder.

BIOLOGICAL INVENTORY

JUVENILE SURVEYS:

In the 1965 survey, steelhead were visually estimated at 60/100' from the mouth to Devil's Canyon, and 150/100' from Devil's Canyon to upper fish value. Of the 54 fingerlings caught and identified, all were steelhead. Frogs, newts, and garter snakes (unidentified by species) were also observed during the survey.

In October 1968, a survey was conducted to check for the presence of juvenile coho salmon. Steelhead Trout and California Roach were observed, but no Coho Salmon were seen.

In the 1970 survey, both coho salmon and 0+ and 1+ steelhead were observed. Coho salmon and steelhead combined were observed at a rate of 100+/100'. Sacramento Suckers, California Roach, and Sacramento Squawfish were observed in the lower 1/4 mile of the stream. Frogs and salamanders were also noted during the survey.

In the 1977 survey, California roach were observed at a rate of 20/100' from the mouth to 0.3 miles upstream; Three-spined Stickleback were observed at a rate of 15/100' from the mouth to 0.5 miles upstream; and 0+ and 1+ steelhead were observed at a rate of 15/100' from the mouth to 0.7 miles downstream from the headwaters. Frogs, newts, garter snakes, deer, and evidence of feral pigs were also observed during the survey.

During the 1982 foot survey, steelhead were present the entire length of the survey. Salamanders and tadpoles were also observed during the survey.

On August 22, 1996 a biological inventory was conducted in three sites of Ward Creek to document fish species composition and distribution. Each site was single pass electrofished using one Smith Root Model 12 electrofisher. Fish from each site were counted by species, and returned to the stream. The air temperature was 60°F and the water temperature ranged from 56-67°F. The observers were Barney, Barney (NEAP) and Coey (DFG).

The inventory of Reach 2 started near the mouth in habitat unit 9 and ended in habitat unit 28. In riffle and pool habitat types 52 0+ and 16 1+ steelhead (9/100') were observed along with 2 coho, 53 sculpin, 4 Sacramento Squawfish, and 1 crayfish. This section had an approximate length of 709 feet.

The inventory of Reach 4 started 60 feet upstream from habitat unit 108 and ended in habitat unit 117. In pool and riffle habitat types 60 0+, 28 1+ and 4 2+ steelhead (13/100') were observed along with 4 crayfish. This section had an approximate length of 608 feet.

The inventory of Reach 5 started in habitat unit 401 and ended in unit 418. In pool and riffle habitat types 338 0+, 34 1+ and two 2+ steelhead (65/100') were observed along with 11 crayfish. This section had an approximate length of 568 feet.

A summary of historical and recent data collected appears in the table below.

Species Observed in Historical and Recent Surveys

YEARS	SPECIES	SOURCE	Native/Introduced
1965,1968,1970,1977,1982,1996	Steelhead Trout	DFG	N
1970,1996	Coho Salmon	DFG	N
1996	Sculpin (Cottus sp.)	DFG	N
1968,1970,1977	California Roach	DFG	N

Species Observed in Historical and Recent Surveys			
YEARS	**SPECIES**	**SOURCE**	**Native/Introduced**
1977	Three-spined Stickleback	DFG	N
1970,1996	Sacramento Squawfish	DFG	N
1970	Sacramento Sucker	DFG	N

No introduced fish species have been documented during any of the survey years and historical records indicate no hatchery stocking, transfers or known rescues have occurred in Ward Creek watershed. However, Big Austin Creek has been stocked frequently with both steelhead and coho hatchery fish in the past (see Big Austin Creek report for details).

DISCUSSION FOR WARD CREEK

Ward Creek has 4 channel types: C3, B2, F2 and F3. There are 402 feet of C3 channel type in Reach 1. According to the DFG Salmonid Stream Habitat Restoration Manual, C3 channel types are excellent for bank-placed boulders and good for low-stage weirs, boulder clusters, single and opposing wing deflectors and log cover. They are fair for medium-stage weirs.

There are 4,810 feet of B2 channel type in Reaches 2, 6 and 9. B2 channel types are excellent for low and medium-stage plunge weirs, single and opposing wing deflectors and bank cover.

There are 14,794 feet of F2 channel type in Reaches 4 and 8. F2 channel types are fair for low-stage weirs, single and opposing wing-deflectors and log cover.

There are 7,311 feet of F3 channel type in Reach 3, 5 and 7. F3 channel types are good for bank-placed boulders as well as single and opposing wing-deflectors. They are fair for low-stage weirs, boulder clusters, channel constrictors and log cover.

All channel types of Ward Creek have suitable gradients and the stable stream banks that are necessary for the installation of instream structures designed to increase pool habitat, trap spawning gravels, and provide protective shelter for fish. Any work considered will require careful design, placement, and construction that must include protection for any unstable banks.

The water temperatures recorded on the survey days July 18 - August 28, 1996 ranged from 57-77°F. Air temperatures ranged from 50-97°F. Summer temperatures using a remote temperature recorder placed in a pool at the confluence of the first tributary on the right bank ranged from 55°F to 73°F. Water temperatures above the threshold stress level for salmonids (65°F) were recorded in all but Reaches 1 and 4. The air temperatures recorded in Reaches 1 and 4 were in the 50's and taken in the early mornings, while the other reaches had air temperatures as high as the 80's and 90's. To make any further conclusions, temperatures need to be monitored for a longer period of time through the critical summer months, and more extensive biological sampling conducted.

Pools comprised 34% of the total **length** of this survey. In third and fourth order streams a primary pool is defined to have a maximum depth of at least three feet, occupy at least half the width of the low flow channel, and be as long as the low flow channel width. In Ward Creek, the pools are relatively shallow with 17% having a maximum depth of at least 3 feet. These pools comprised 8% of the total length of stream habitat. In coastal coho and steelhead streams, it is generally desirable to have primary pools comprise approximately 50% of total habitat length. Landowners indicate many large logs were removed from the stream for lumber and firewood. This practice has lead to a decline in pool depth and shelter and likely increased stream velocities which exasperate erosion and flooding downstream.

The mean shelter rating for pools was 24. However, a pool shelter rating of approximately 80 is desirable. The relatively small amount of pool shelter that now exists is being provided primarily by boulders and small woody debris. Log and root wad cover structures in the pool and flatwater habitats are needed to improve 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.

Fifty-six percent of the low gradient riffles measured had either gravel or small cobble as the dominant substrate. This is generally considered good for spawning salmonids.

Twenty-nine percent of the pool tail-outs measured had embeddedness ratings of either 3 or 4. Seventy-one percent had a rating of 1 or 2. This is considered "fair" since cobble embeddedness measured to be 25% or less, a rating of 1, is considered best for the needs of salmon and steelhead. Reaches 1, 6 and 14 had high levels of silt

with more than half the pool tail-outs having either a 3 or 4 embeddedness rating.

The higher the percent of fine sediment, the lower the probability that eggs will survive to hatch. This is due to the reduced quantity of oxygenated water able to percolate through the gravel, or because of fine sediment capping the redd and preventing fry emergence. In Reaches 1, 6 and 14 sediment sources should be mapped and rated according to their potential sediment yields, and control measures taken.

The mean percent canopy for the entire survey was only 70%, which is low since 80 percent is generally considered desirable. All reaches had canopy levels less than 80%. Elevated water temperatures could be reduced by increasing stream canopy. Cooler water temperatures are desirable in Ward Creek. The large trees required for adequate stream canopy would also eventually provide a long term source of large woody debris needed for instream structure and bank stability.

Four major LWD accumulations were identified which have the potential for becoming barriers or causing erosion. Three major erosion sites and eight diversions were also noted.

DISCUSSION FOR UNNAMED TRIBUTARY #1

This tributary has F4 and F3 channel types (see Discussion For Ward Creek for project type suitability). The relatively cool water temperatures (62-65°F) and high canopy density (83%) are good for salmonids. Pools comprised 24% of the total ***length*** *of this survey. In first and second order streams primary pools have a maximum depth of at least two feet. In this tributary, primary pools comprised only 2% of the total length of stream habitat. The mean shelter rating for pools was 19. The relatively small amount of pool shelter that now exists is being provided primarily by boulders and large woody debris.*

The one low gradient riffle measured had small cobble as the dominant substrate, however, sixty-three percent of the pool tail-outs measured had embeddedness ratings of either 3 or 4, with Reach 2 having the poorest ratings.

DISCUSSION FOR UNNAMED TRIBUTARY #2

This tributary had only one pool and went dry after 100 feet. A lack of adequate flow is the main limiting factor for salmonid habitat. In addition, the water temperature recording of 69°F is

above the threshold stress level (65°F) for salmonids and the mean percent canopy for the survey was only 63%.

DISCUSSION FOR UNNAMED TRIBUTARY #3

This tributary is small with low flows, and has a natural fish barrier about 100 feet from the mouth. The relatively cool water temperature (61°F) and high canopy density (83%) are good for salmonids.

SUMMARY

Biological surveys were conducted to document fish distribution and are not necessarily representative of population information. Steelhead were documented consistently during each past survey year and coho only in 1970 and 1996. This is likely because physiological and environmental requirements for coho are more stringent than for steelhead, or coho were absent or present only in small numbers in some years. The 1996 summer surveys documented many 0+ fish indicating successful spawning. However, few 1+ fish were observed indicating poor holding-over conditions in general.

Stream shade canopy is moderately low and water temperatures are higher then desirable. High water temperatures were also recorded in all historical surveys, back to 1965. The mean shade canopy of 70% is an improvement since 1970 when the mean shade canopy was estimated at 25%.

There are adequate quantities of gravel in Ward Creek, however, a few reaches have high levels of fine sediment making the gravel unusable for spawning salmonids. Spawning habitat has been recorded as good in all past surveys. Pool shelter ratings are very low and there is a lack of large woody debris and root wad shelter. In addition, there is a shortage of pools, especially the deep pools needed for 1 and 2+ steelhead and coho rearing habitat.

The three un-named tributaries provide little habitat, but are important in providing cooler water temperatures to Ward Creek.

GENERAL RECOMMENDATIONS

Ward Creek should be managed as an anadromous, natural production stream.

The winter 1995/96 storms brought down many large trees and other woody debris into the stream, which increased the number and quality of pools since the drought years. This woody

debris, if left undisturbed, will provide fish shelter and rearing habitat, and offset channel incision. Many signs of recent and historic tree and log removal were evident in the active channel during our survey. Efforts to increase flood protection or improve fish access in the short run, have led to long term problems in the system. Landowners should be sensitive about the natural and positive role woody debris plays in the system, and encouraged not to remove woody debris from the stream, except under extreme buildup and only under guidance by a fishery professional.

SPECIFIC FISHERY ENHANCEMENT RECOMMENDATIONS

1) Identified sites from the road survey should be treated to reduce the amount of fine sediments entering the stream. Near-stream riparian planting along any portion of the stream should be encouraged to provide bank stability.

2) There are 3 sites in Ward Creek with major bank erosion problems. These sites should be treated with bank stabilization structures and/or revegetation techniques to reduce the amount of fine sediment entering the stream. In addition, a bank culvert in habitat unit 517 (Reach 9) is downcutting and may need rip rap underneath.

3) Increase the canopy on Ward Creek by planting willow, alder, redwood, and Douglas fir along Reach 2, 4, 6, 7, 8, and 9. In many cases, planting will need to be coordinated to follow bank stabilization or upslope erosion control projects.

4) Where feasible, design and engineer pool enhancement structures to increase the number of and depth of pools in Ward Creek. Many long riffle habitats could be broken up by adding simple and complex digger log structures. Due to the size of this creek, placement and/or anchoring of debris is crucial.

5) Where feasible, increase woody cover in the pool and flatwater habitat units along the entire stream. Most of the existing shelter is from vegetation and undercut banks. Adding high quality complexity with larger woody cover is desirable. Combination cover/scour structures constructed with boulders and woody debris would be effective in many flatwater and pool locations in the upper reaches. This must be only done where the banks are stable or in conjunction with stream bank armor to prevent erosion. In some areas the material is at hand.

6) There are 4 log debris accumulations present on Ward Creek

that have the potential for causing bank erosion and could be possible fish barriers (specifically, Reaches 4 and 6). The modification of these debris accumulations may be desirable to decrease erosion or improve fish access. If modification becomes necessary, it should be done carefully to preserve the benefit of habitat provided by the woody debris.

RESTORATION IMPLEMENTED

1) In Ward Creek and un-named tributary #1, map sources of upslope erosion related to the road system, and prioritize them according to present and potential sediment yield.

PROBLEM SITES AND LANDMARKS - WARD CREEK SURVEY COMMENTS

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

HABITAT UNIT #	STREAM LEN (FT.)	COMMENTS
2.00	90	SEE BRIDGE FORM
8.10	365	NO FISH
13.00	523	2" PUMP RT BANK- NOT IN WATER
15.00	656	RT BANK SIDE- LOW GRADIENT RIFFLE
28.00	1076	SEVERAL LARGE FISH 9-10". 2" PUMP LF BANK IN WATER
31.00	1208	DRY TRIB RT BANK
32.20	1224	SEE FORM. CONCRETE PUMP CASING LF BANK
34.00	1280	UNSTABLE RT BANK
38.00	1449	CAN'T GET IN POOL. VISQUINE BOTTOM LOG PLYWOOD DAM. SEE FORM
47.10	1767	DRY TRIB RT BANK
62.00	2205	LARGE FISH
66.00	2462	KINGFISHER
69.00	2568	MANY BIG FISH
73.00	2741	MAN MADE ROCK BARRIER ACROSS STREAM- WATER GOING UNDER
74.00	2863	ROCK DAM
77.00	2972	DRY TRIB LF BANK
85.00	3456	SEE FORM; HWY CULVERT AND BRIDGE- OLD FORT ROSS RD. 200'
88.00	3595	GOOD COVER
116.00	5064	SEE FORM- LOG JAM
118.00	5187	AT LEAST THREE 4.5" FISH
120.00	5302	LF BANK- WET TRIB, 100 YDS. UP- NO

		FISH
122.00	5363	DRY TRIB- RT BANK
126.00	5526	DRY TRIB RT BANK
128.00	5638	BLOW OUT LF SIDE- SEE FORM; ROOT MASS- GOOD SHELTER
129.00	5660	POOL ENHANCED BY ROCK DAM- MAN MADE
135.00	5846	BIG SCHOOL OF 1ST YR. FISH; NUMEROUS 2ND YEAR FISH
138.10	5979	SHALLOW- WITH FISH
141.00	6107	2 POOLS- EXTENSIVE SCOUR ON EITHER SIDE OF BANK; BOULDER CAUSED- BIG BOULDER IN CENTER OF POOL
143.00	6253	DEEP SIDE POOL TO MAIN STREAM
144.00	6286	3.5' WATERFALL; BIG BOULDERS IN STREAM
147.10	6376	BIG SECONDARY POOL OFF MAIN STREAM- 3 SECOND YEAR FISH
148.00	6400	MANY 1ST YEAR FISH
149.00	6426	DEEP POOL AT END OF GLIDE
150.00	6471	CORNER POOL CAUSED BY BEDROCK AND LARGE BOULDER; LOG JAM- SEE FORM
164.00	7093	MULTI BOULDER SCOUR POOLS; FLOWING TRIB LF BANK- NO FISH
172.00	7527	MULTI DEEP POCKETS OF WATER- BOULDER CAUSED; DEEPEST HOLE 4.5'
175.00	7653	SMALL WET TRIB RT SIDE; NO FISH ABOVE
180.00	7834	OLD SLIDE LF SIDE
182.00	7887	IMMATURE NEWTS
192.00	8398	CHANNEL CHANGE- SEE FORM; MAN MADE DAM- SEE FORM
195.00	8525	DRY TRIB RT BANK
196.00	8564	NATURAL DAM POOL
201.00	8727	BOULDER IN CENTER OF STREAM CAUSED POOL ON BOTH SIDES- CREATED 2 MID-CHANNEL POOLS
210.00	8943	DRY TRIB LF BANK
216.00	9157	DRY TRIB RT BANK
225.00	9650	DRY TRIB LF BANK
226.00	9750	LF BANK OLD SLIDE
227.00	9789	MANY FISH- SEVERAL 3-4" FISH
228.00	9848	LF BANK OLD SLIDE
234.10	10202	SEVERAL FISH- SOME 2ND YR; WATER TEMP 83°F
235.00	10264	NUMEROUS 2ND YR FIS
247.00	10697	SMALL WATERFALL LF BANK
253.00	11091	SEE FORM
274.00	11872	SUBMERGED PUMP RT BANK- NOT IN

		STREAM, APPEARS TO BE SUBTERMINAL
288.00	12357	SCOUR CAUSED BY WET TRIB CASCADING INTO LF BANK- BEDROCK POOLS; FISH UP 150 YDS.; BIG OAT CREEK?
294.00	12596	SEE FORM; PICTURE
301.10	12815	DRY TRIB LF BANK
309.00	13106	POOL CAUSED BY BOULDER, ROOT WAD, & LOG; SAW APPROX. TEN 11" FISH; SEVERAL 6-7" FISH
313.00	13212	DRY TRIB RT BANK; 75' UP- 1ST POOL HAD FISH; DRY BEYOND
334.00	13622	MAN MADE DAM- SEE FORM
335.00	13632	PICTURE- 4.5' WATERFALL
347.00	13932	ROAD CROSSES STREAM; CONCRETE SILL 1.5' HIGH; 26' LONG- BRYANT?
352.00	14180	DRY TRIB RT BANK
355.00	14342	GOOD UNDERCUT BANK- 5 FT.
357.00	14511	OLD SLIDE LF BANK- SEE FORM
378.10	15144	UNSTABLE ROOT MASS- UPPER LF BANK
386.00	15422	MID-CHANNEL- BOULDER, BEDROCK, AND LATERAL CAUSED
389.10	15586	FLOW FROM SPRING LF BANK; SPLITS FROM MAIN CHANNEL; NO FISH
418.00	16396	POLE MT. CREEK- RT BANK
426.00	16615	ODD FISH- BLUE COLOR ON TOP; RUST SPOT; STAYS AROUND ROCKS & CURLS TAIL WHEN STOPPED
434.00	16782	LF BANK- BLUE JAY CREEK
468.00	17617	BOULDER IN CENTER CAUSED POOL
484.00	18081	DRY TRIB RT BANK
496.00	18425	ROAD GOES THROUGH STREAM
500.00	18549	BRIDGE OVER UNIT- SEE FORM
510.00	18898	CONCRETE WELL CASING LF BANK
511.00	18925	LAST UNIT ON NAYLOR PROPERTY- NO ACCESS THROUGH NEXT PROPERTY; TAGGED AT PROPERTY LINE
538.10	19857	RT SIDE CUTTING AROUND TREE- UNSTABLE
541.00	19995	WET TRIB RT BANK- WENT UP 200'- NO FISH; BRIDGE OVER TRIB- SEE FORM
566.00	21059	FEWER FISH
573.00	21271	DRY CREEK LF BANK
583.00	21658	RT BANK UNSTABLE
585.00	21712	DRAW LF BANK
587.00	21759	TWO 4-6" FISH
620.00	22966	DRY TRIB LF BANK
632.00	23352	SEVERAL LARGE FISH
636.00	23580	BIG SCOUR POOL- W/ POOR SHELTER
638.00	23706	SEE FORM

639.00	23751	DRY TRIB LF BANK; SEE FORM
640.10	23776	DRY ON EITHER SIDE
655.00	24295	WET TRIB RT BANK?
681.00	25390	SEVERAL BIG FISH
683.00	25514	POOL 40% MOSSED
689.00	25649	MANY FISH
691.00	25702	DRY TRIB RT BANK
700.00	26147	WET SPRING LF BANK
716.00	26577	16" CULVERT APPROX. 50' UP BANK
728.00	27008	LARGE FISH
731.00	27077	ONLY SEEING LARGE FISH- MAY BE RESIDENTS
733.00	27168	LARGE FISH ONLY
736.00	27238	PICTURE #18
743.00	27476	SEE FORM- LOG JAM; DRY TRIB RT BANK
745.00	27530	SPRINGS LF BANK; SEE FORM-
753.00	27789	SPRING RT BANK
770.00	28373	MANY 1ST AND 2ND YEAR FISH
776.00	28484	DRY TRIB LF BANK
806.00	29414	TRIB RT BANK- SEE NEW SHEET
811.00	29513	LOG JAM- SEE FORM; PICTURE #20 & 21
840.00	30442	DRY TRIB LF BANK
854.00	30879	DRY TRIB RT BANK
856.00	30932	SPRING LF BANK
870.00	31491	SPRING RT BANK
890.00	32188	DRY TRIB LF BANK
894.00	32305	SEE FORM, BLOW OUT LF BANK
901.00	32560	WET TRIB RT BANK
912.00	33003	ONE LARGE FISH SEVERAL MED. FISH
932.00	33776	LF BANK STABLE LG. BLOW OUT
933.00	33809	PORTION OF BEDROCK FELL
936.00	33883	PICTURE 17 OR 18 OUR FILM PROJECT UNDERCUT
943.00	34146	CROSS LOG TRAPPED DEBRIS CHANNEL NOT OBSTRUCTED
944.00	34170	ONE FISH
947.00	34249	DRY TRIB RT BANK
972.00	35566	30 0+ FISH SEVERAL 1+
973.00	35596	DRY TRIB LF BANK
975.00	35657	NO FISH
985.00	35883	DRY TRIB RT BANK
989.00	36046	SOME FISH
1001.00	36379	SPRING LF BANK
1002.00	36391	2 LARGE FISH, NO SMALL FISH
1007.00	36641	SPRING LF BANK
1011.00	36742	NO FISH
1017.00	37808	NO FISH DRY TRIB RT BANK

1019.00	37930	NO FISH
1021.00	37982	NO FISH SEE PICTURE #22

PROBLEM SITES AND LANDMARKS - UNNAMED TRIB. #1 SURVEY COMMENTS

HABITAT UNIT #	STREAM LEN (FT.)	COMMENTS
1.00	59	THIS TRIB IS ON THE RIGHT BANK OF WARD CRK, STARTS AT ROAD FORK AT UNIT 546, CULVERT- SEE FORM
9.00	185	UNSTABLE RT BANK, MARKED UNIT 555 ON FLAGGING
10.00	383	LESS FISH
10.10	383	NO FISH IN POOL
13.00	551	FEWER FISH
18.00	717	MARKED #564 ON FLAGGING
19.00	732	HAVE SEEN ONLY ONE FISH PER POOL
22.00	892	SPRING LEFT BANK
23.00	906	NICE POOL, VERY FEW FISH
25.00	934	NO TAIL CREST, DRY CHANNEL ABOVE, LOG JAM, SEE FORM
26.00	948	NO FISH, STREAM GETTING MUCH SMALLER
27.00	1002	NO FISH, UNIT MARKED #573
30.00	1072	ONE FISH
31.00	1247	SEVERAL FISH
33.00	1284	NO FISH
36.00	1382	WET TRIB LEFT BANK, ONE FISH IN POOL, WENT UP 200 FT. VERY LOW FLOW. ONE SMALL STAGNANT POOL.
37.00	1420	MARKED UNIT #583 ON FLAGGING

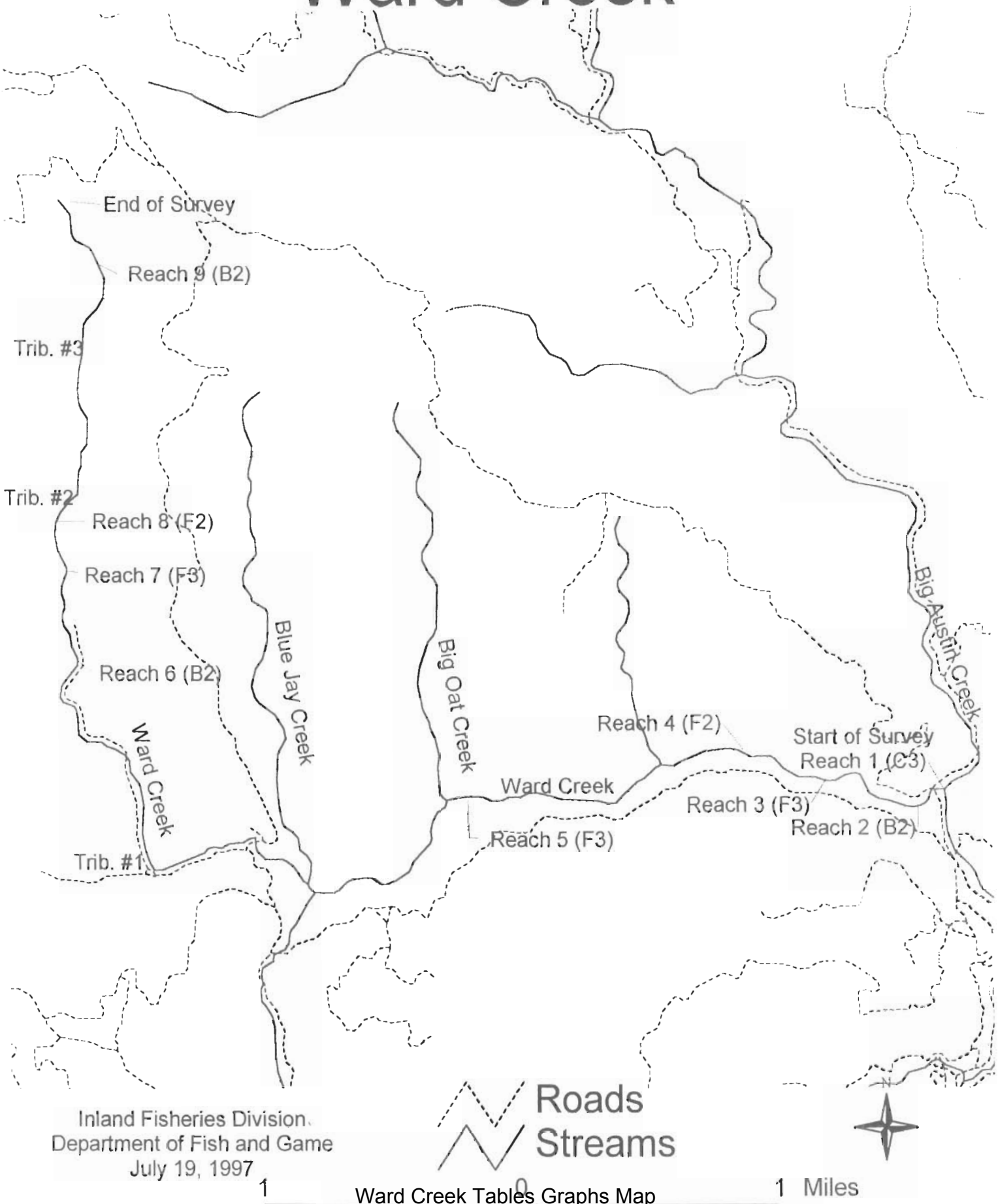
PROBLEM SITES AND LANDMARKS - UNNAMED TRIB. #2 SURVEY COMMENTS

HABITAT UNIT #	STREAM LEN (FT.)	COMMENTS
1.00	10	FISH IN POOL,TRIB ON RIGHT BANK OF WARD CREEK IN UNIT 806, DID NOT CHANNEL TYPE, FIRST SECTION BEDROCK.
2.00	45	NO FISH
3.00	105	SURVEY ENDED HERE BECAUSE ABOVE HERE STREAM IS DRY

PROBLEM SITES AND LANDMARKS - UNNAMED TRIB. #3 SURVEY COMMENTS

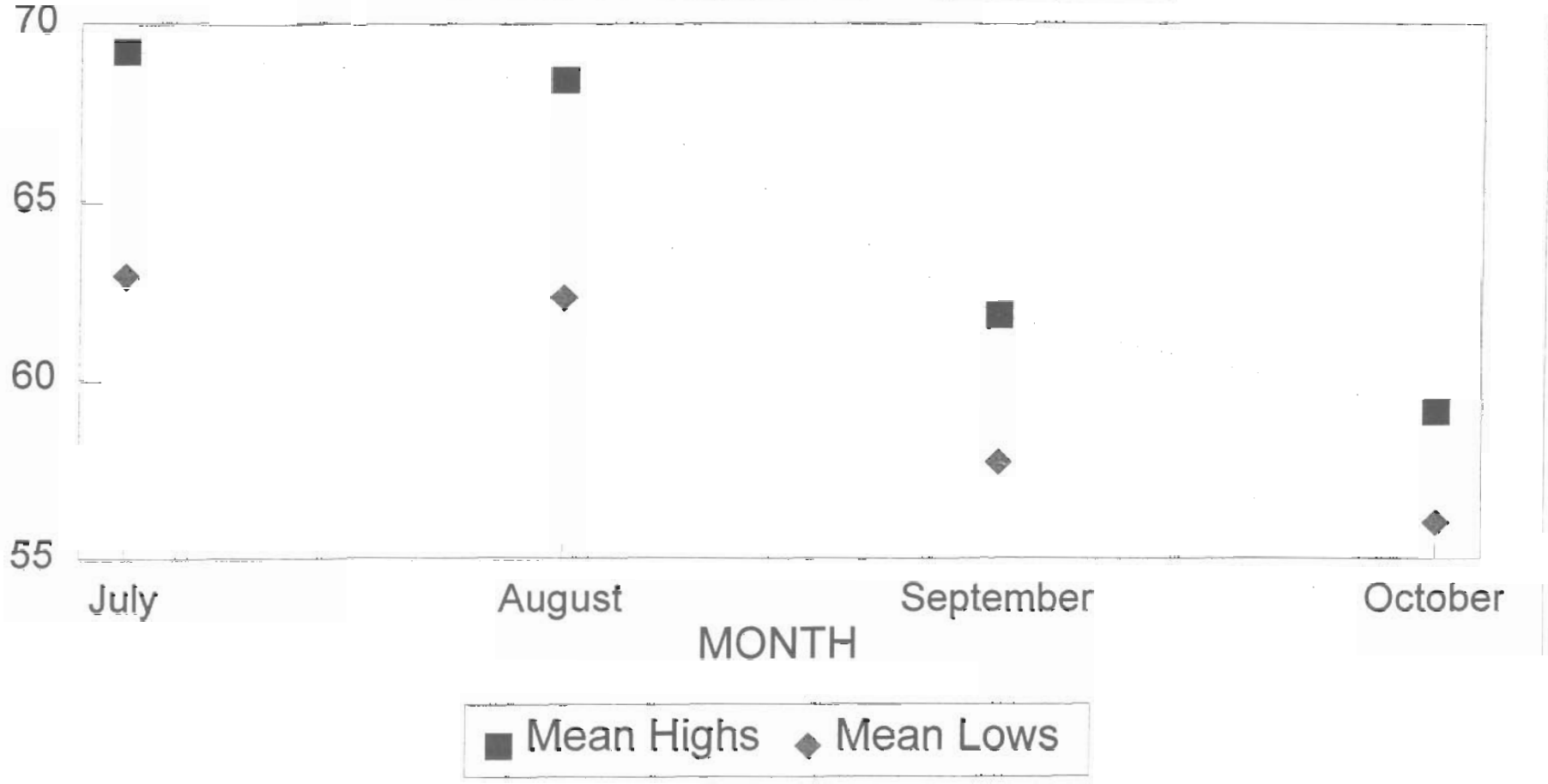
HABITAT UNIT #	STREAM LEN (FT.)	COMMENTS
1.00	31	TRIB OF WARD CREEK OFF UNIT #901 ON RIGHT BANK
2.00	50	ONE FISH
3.00	83	NO FISH
5.00	189	NO FISH, FISH BARRIER, SEE PICTURES #22 AND 23, END OF LINE, SPRING RT BANK INTO POOL- NO FISH

Ward Creek


End of Survey
Reach 9 (B2)
Trib. #3
Trib. #2
Reach 8 (F2)
Reach 7 (F3)
Reach 6 (B2)
Ward Creek
Trib. #1
Blue Jay Creek
Big Oat Creek
Reach 4 (F2)
Start of Survey
Reach 1 (C3)
Ward Creek
Reach 3 (F3)
Reach 2 (B2)
Reach 5 (F3)
Big Austin Creek
Roads
Streams
1 0 1 Miles
Inland Fisheries Division
Department of Fish and Game
July 19, 1997

Tempmentor Summary

Ward creek



Sample Period: Jul 16 - Oct 06, 1996
Location: Confl of 1st trib on rt bk

APPENDIX C. FISH HABITAT INVENTORY DATA SUMMARY

STREAM NAME: Ward Creek
SAMPLE DATES: 07/18/96 to 08/28/96
STREAM LENGTH: 37828 ft.
LOCATION OF STREAM MOUTH:
USGS Quad Map: Fort Ross — Latitude: 38°32'29"
Legal Description: T8NR11WS16 — Longitude: 123°6'39"

SUMMARY OF FISH HABITAT ELEMENTS BY STREAM REACH

STREAM REACH 1 (Units 1-9)

Channel Type: C3	Mean Canopy Density: 79%
Channel Length: 402 ft.	Evergreen Component: 25%
Riffle/Flatwater Mean Width: 17 ft.	Deciduous Component: 75%
Total Pool Mean Depth: 0.8 ft.	Pools by Stream Length: 16%
Base Flow: 0.0 cfs	Pools >=3 ft. deep: 0%
Water: 61-61°F Air: 50-50°F	Mean Pool Shelter Rtn: 5
Dom. Bank Veg.: Deciduous Trees	Dom. Shelter: Boulders
Bank Vegetative Cover: 55%	Occurrence of LOD: 0%
Dom. Bank Substrate: Cobble/Gravel	Dry Channel: 0 ft.

Embeddness Value: 1. 0% 2. 0% 3. 100% 4. 0%

STREAM REACH 2 (Units 10-72)

Channel Type: B2	Mean Canopy Density: 59%
Channel Length: 2302 ft.	Evergreen Component: 49%
Riffle/Flatwater Mean Width: 16 ft.	Deciduous Component: 51%
Total Pool Mean Depth: 1.2 ft.	Pools by Stream Length: 50%
Base Flow: 0.0 cfs	Pools >=3 ft. deep: 31%
Water: 62-70°F Air: 57-81°F	Mean Pool Shelter Rtn: 27
Dom. Bank Veg.: Deciduous Trees	Dom. Shelter: Boulders
Bank Vegetative Cover: 27%	Occurrence of LOD: 26%
Dom. Bank Substrate: Cobble/Gravel	Dry Channel: 0 ft.

Embeddness Value: 1. 21% 2. 29% 3. 24% 4. 26%

STREAM REACH 3 (Units 73-91)

Channel Type: F3	Mean Canopy Density: 70%
Channel Length: 1065 ft.	Evergreen Component: 61%
Riffle/Flatwater Mean Width: 13 ft.	Deciduous Component: 39%
Total Pool Mean Depth: 1.6 ft.	Pools by Stream Length: 22%
Base Flow: 0.0 cfs	Pools >=3 ft. deep: 50%
Water: 66-70°F Air: 81-83°F	Mean Pool Shelter Rtn: 5
Dom. Bank Veg.: Deciduous Trees	Dom. Shelter: Boulders
Bank Vegetative Cover: 37%	Occurrence of LOD: 0%
Dom. Bank Substrate: Cobble/Gravel	Dry Channel: 0 ft.

Embeddness Value: 1. 0% 2. 50% 3. 50% 4. 0%

STREAM REACH 4 (Units 92-263)

Channel Type: F2	Mean Canopy Density: 66%
Channel Length: 7656 ft.	Evergreen Component: 62%
Riffle/Flatwater Mean Width: 14 ft.	Deciduous Component: 38%
Total Pool Mean Depth: 1.2 ft.	Pools by Stream Length: 38%
Base Flow: 0.0 cfs	Pools >=3 ft. deep: 28%
Water: 61-72°F Air: 55-93°F	Mean Pool Shelter Rtn: 20
Dom. Bank Veg.: Deciduous Trees	Dom. Shelter: Boulders
Bank Vegetative Cover: 15%	Occurrence of LOD: 32%
Dom. Bank Substrate: Cobble/Gravel	Dry Channel: 0 ft.

Embeddness Value: 1. 19% 2. 42% 3. 18% 4. 21%

STREAM REACH 5 (Units 264-726)

Channel Type: F3
Channel Length: 15441 ft.
Riffle/Flatwater Mean Width: 9 ft.
Total Pool Mean Depth: 1.1 ft.
Base Flow: 0.0 cfs
Water: 57-71°F Air: 52-97°F
Dom. Bank Veg.: Deciduous Trees
Bank Vegetative Cover: 25%
Dom. Bank Substrate: Cobble/Gravel
Embeddness Value: 1. 39% 2. 44% 3. 8% 4. 9%

Mean Canopy Density: 78%
Evergreen Component: 32%
Deciduous Component: 68%
Pools by Stream Length: 35%
Pools >=3 ft. deep: 15%
Mean Pool Shelter Rtn: 23
Dom. Shelter: Boulders
Occurrence of LOD: 39%
Dry Channel: 44 ft.

STREAM REACH 6 (Units 727-746)

Channel Type: B2
Channel Length: 629 ft.
Riffle/Flatwater Mean Width: 6 ft.
Total Pool Mean Depth: 1.0 ft.
Base Flow: 0.0 cfs
Water: 67-70°F Air: 80-87°F
Dom. Bank Veg.: Deciduous Trees
Bank Vegetative Cover: 9%
Dom. Bank Substrate: Cobble/Gravel
Embeddness Value: 1. 29% 2. 29% 3. 0% 4. 43%

Mean Canopy Density: 62%
Evergreen Component: 70%
Deciduous Component: 30%
Pools by Stream Length: 28%
Pools >=3 ft. deep: 0%
Mean Pool Shelter Rtn: 11
Dom. Shelter: Boulders
Occurrence of LOD: 18%
Dry Channel: 23 ft.

STREAM REACH 7 (Units 747-790)

Channel Type: F3
Channel Length: 1319 ft.
Riffle/Flatwater Mean Width: 7 ft.
Total Pool Mean Depth: 0.9 ft.
Base Flow: 0.0 cfs
Water: 58-77°F Air: 56-90°F
Dom. Bank Veg.: Deciduous Trees
Bank Vegetative Cover: 27%
Dom. Bank Substrate: Cobble/Gravel
Embeddness Value: 1. 25% 2. 33% 3. 8% 4. 33%

Mean Canopy Density: 51%
Evergreen Component: 72%
Deciduous Component: 28%
Pools by Stream Length: 21%
Pools >=3 ft. deep: 9%
Mean Pool Shelter Rtn: 25
Dom. Shelter: Boulders
Occurrence of LOD: 44%
Dry Channel: 0 ft.

STREAM REACH 8 (Units 791-991)

Channel Type: F2
Channel Length: 7137 ft.
Riffle/Flatwater Mean Width: 8 ft.
Total Pool Mean Depth: 0.9 ft.
Base Flow: 0.0 cfs
Water: 60-76°F Air: 64-90°F
Dom. Bank Veg.: Deciduous Trees
Bank Vegetative Cover: 22%
Dom. Bank Substrate: Cobble/Gravel
Embeddness Value: 1. 51% 2. 27% 3. 11% 4. 11%

Mean Canopy Density: 65%
Evergreen Component: 63%
Deciduous Component: 37%
Pools by Stream Length: 24%
Pools >=3 ft. deep: 7%
Mean Pool Shelter Rtn: 33
Dom. Shelter: Boulders
Occurrence of LOD: 29%
Dry Channel: 0 ft.

STREAM REACH 9 (Units 992-1021)

Channel Type: B2
Channel Length: 1879 ft.
Riffle/Flatwater Mean Width: 6 ft.
Total Pool Mean Depth: 0.8 ft.
Base Flow: 0.0 cfs
Water: 62-66°F Air: 70-87°F
Dom. Bank Veg.: Deciduous Trees
Bank Vegetative Cover: 55%
Dom. Bank Substrate: Cobble/Gravel
Embeddness Value: 1. 0% 2. 0% 3. 25% 4. 45%

Mean Canopy Density: 69%
Evergreen Component: 76%
Deciduous Component: 24%
Pools by Stream Length: 10%
Pools >=3 ft. deep: 0%
Mean Pool Shelter Rtn: 35
Dom. Shelter: Boulders
Occurrence of LOD: 0%
Dry Channel: 0 ft.

Ward Creek

Drainage: Big Austin Creek, Russian River

Table 1 - SUMMARY OF RIFFLE, FLATWATER, AND POOL HABITAT TYPES

Survey Dates: 07/18/96 to 08/28/96

Confluence Location: QUAD: Fort Ross LEGAL DESCRIPTION: T8NR11WS16 LATITUDE: 38°32'29" LONGITUDE: 123°6'39"

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
349	63	RIFFLE	32	46	16000	40	9.3	0.4	297	103682	136	47543	0	23
293	85	FLATWATER	27	35	10365	26	11.1	0.6	411	120354	264	77351	156	13
445	149	POOL	41	30	13445	34	12.0	1.0	387	172239	484	215487	364	24
3	0	DRY	0	22	67	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.)
1090	297	39877	396275	340381

Ward Creek

Drainage: Big Austin Creek, Russian River

Table 2 - SUMMARY OF HABITAT TYPES AND MEASURED PARAMETERS

Survey Dates: 07/18/96 to 08/28/96

Confluence Location: QUAD: Fort Ross LEGAL DESCRIPTION: T8NR11WS16 LATITUDE: 38°32'29" LONGITUDE: 123°6'39"

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 %
286	39	LGR	26	44	12487	31	8	0.3	1.5	313	89538	135	38709	0	13	68
46	14	HGR	4	63	2904	7	9	0.4	1.6	279	12840	125	5762	0	35	67
17	10	CAS	2	36	610	2	12	0.7	2.6	258	4387	154	2622	0	47	68
53	17	POW	5	40	2138	5	13	0.7	3.4	574	30410	494	26198	156	21	74
112	27	GLD	10	33	3707	9	12	0.5	2.9	417	46735	192	21450	0	5	77
98	27	RUN	9	31	3080	8	11	0.5	2.5	335	32820	203	19889	0	15	69
23	9	SRN	2	56	1280	3	9	0.5	1.6	420	9665	236	5430	0	18	65
7	5	EDW	1	23	161	0	6	0.7	3.3	155	1084	178	1249	0	9	77
2	2	TRP	0	21	43	0	5	0.8	1.6	114	228	97	194	57	3	73
132	36	MCP	12	28	3665	9	12	1.0	9.6	373	49288	448	59071	326	21	68
1	0	CCP	0	24	24	0	17	0.9	1.4	368	368	332	332	258	0	95
12	9	STP	1	50	606	2	12	0.8	2.2	447	5363	350	4204	185	32	65
5	4	CRP	0	35	177	0	12	1.1	6.2	498	2488	823	4115	681	44	71
15	10	LSL	1	29	437	1	12	1.1	3.9	389	5830	479	7181	367	50	78
41	12	LSR	4	26	1086	3	12	1.1	3.3	306	12550	342	14028	284	31	77
64	16	LSBk	6	41	2592	7	12	1.1	5.1	495	31703	637	40789	495	10	74
80	20	LSBo	7	29	2350	6	13	1.0	32.0	429	34331	562	44963	364	22	66
47	14	PLP	4	21	1004	3	12	1.1	5.1	253	11874	310	14578	212	42	65
20	9	SCP	2	33	659	2	9	0.8	5.3	325	6492	382	7640	414	14	62
18	11	BPB	2	22	398	1	11	0.9	4.5	233	4185	237	4264	181	19	73
1	1	BPR	0	31	31	0	6	0.7	1.6	183	183	128	128	110	60	85
1	1	BPL	0	23	23	0	10	1.8	3.3	219	219	393	393	350	120	70
6	4	DPL	1	59	355	1	18	1.5	7.5	1148	6886	2100	12598	2465	42	57
3	0	DRY	0	22	67	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)
1090	297	39877	399468	335784

Ward Creek

Drainage: Big Austin Creek, Russian River

Table 3 - SUMMARY OF POOL TYPES

Survey Dates: 07/18/96 to 08/28/96

Confluence Location: QUAD: Fort Ross LEGAL DESCRIPTION: T8NR11WS16 LATITUDE: 38°32'29" LONGITUDE: 123°6'39"

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
147	47	MAIN	33	30	4337	32	12.2	1.0	376	55251	434	63744	315	21
252	76	SCOUR	57	30	7644	57	12.1	1.1	393	98967	501	126131	362	26
46	26	BACKWATER	10	32	1464	11	10.9	1.0	392	18032	559	25698	663	23

TOTAL UNITS	TOTAL UNITS	TOTAL LENGTH (ft.)	TOTAL AREA (sq.ft.)	TOTAL VOL. (cu.ft.)
445	149	13445	172249	215573

Ward Creek — Drainage: Big Austin Creek, Russian River

Table 4 - SUMMARY OF MAXIMUM POOL DEPTHS BY POOL HABITAT TYPES — Survey Dates: 07/18/96 to 08/28/96

Confluence Location: QUAD: Fort Ross LEGAL DESCRIPTION: T8NR11WS16 LATITUDE: 38°32'29" LONGITUDE: 123°6'39"

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
2	TRP	0	0	0	2	100	0	0	0	0	0	0
132	MCP	30	5	4	62	47	45	34	12	9	8	6
1	CCP	0	0	0	1	100	0	0	0	0	0	0
12	STP	3	1	8	9	75	2	17	0	0	0	0
5	CRP	1	0	0	2	40	1	20	0	0	2	40
15	LSL	3	0	0	6	40	4	27	5	33	0	0
41	LSR	9	1	2	25	61	12	29	3	7	0	0
64	LSBk	14	0	0	21	33	30	47	6	9	7	11
80	LSBo	18	2	3	41	51	23	29	9	11	5	6
47	PLP	11	1	2	16	34	21	45	5	11	4	9
20	SCP	4	6	30	9	45	1	5	3	15	1	5
18	BPB	4	3	17	7	39	7	39	0	0	1	6
1	BPR	0	0	0	1	100	0	0	0	0	0	0
1	BPL	0	0	0	0	0	0	0	1	100	0	0
6	DPL	1	0	0	0	0	4	67	0	0	2	33

TOTAL UNITS 445

Ward Creek

Drainage: Big Austin Creek, Russian River

Table 5 - Summary of Shelter by Habitat Type

Survey Dates: 07/18/96 to 08/28/96

Confluence Location: QUAD: Fort Ross LEGAL DESCRIPTION: T8NR11WS16 LATITUDE: 38°32'29" LONGITUDE: 123°6'39"

UNITS MEASURED	UNITS SHELTER MEASURED	HABITAT TYPE	SQ. FT. UNDERCUT BANKS	SQ. FT. SWD	SQ. FT. LWD	SQ. FT. ROOT MASS	SQ. FT. TERR. VEGETATION	SQ. FT. AQUATIC VEGETATION	SQ. FT. WHITE WATER	SQ. FT. BOULDERS	SQ. FT. BEDROCK LEDGES
286	46	LGR	6	8	0	45	494	0	223	558	0
46	16	HGR	0	0	20	0	91	15	261	769	0
17	11	CAS	0	63	0	0	13	0	270	768	0
53	24	POW	0	2	13	3	52	0	78	1212	1
112	28	GLD	85	16	0	13	117	0	0	205	0
98	27	RUN	44	68	30	0	114	27	3	504	0
23	10	SRN	0	0	0	0	31	0	10	446	0
7	6	EDW	6	0	22	6	0	0	0	79	0
2	2	TRP	0	0	0	0	0	0	0	8	0
132	130	MCP	143	626	443	148	311	247	84	3724	43
1	1	CCP	0	0	0	0	0	0	0	0	0
12	11	STP	0	43	14	0	39	0	51	657	0
5	5	CRP	207	136	281	2	89	0	0	136	6
15	15	LSL	0	876	696	57	26	0	0	232	0
41	41	LSR	438	196	100	828	94	0	0	251	5
64	63	LSBk	183	103	14	137	78	29	28	1104	776
80	80	LSBo	178	299	199	138	76	61	30	2861	0
47	46	PLP	22	118	160	0	27	58	467	1792	86
20	20	SCP	83	32	27	62	35	0	0	403	0
18	18	BPB	1	47	20	0	15	112	0	223	0
1	1	BPR	0	0	0	52	3	0	0	0	0
1	1	BPL	0	26	105	0	0	0	0	0	0
6	6	DPL	0	0	0	0	7	2	2	1402	856
3	0	DRY	0	0	0	0	0	0	0	0	0
TOTAL 1090	608		1396	2659	2144	1491	1712	551	1507	17334	1773
			5%	9%	7%	5%	6%	2%	5%	57%	6%
TOTAL FOR POOLS 445	440		1255	2502	2059	1424	800	509	662	12793	1772
			5%	11%	9%	6%	3%	2%	3%	54%	7%

Ward Creek

Drainage: Big Austin Creek, Russian River

Table 6 - SUMMARY OF DOMINANT SUBSTRATES BY HABITAT TYPE

Survey Dates: 07/18/96 to 08/28/96

Confluence Location: QUAD: Fort Ross LEGAL DESCRIPTION: T6NR11WS16 LATITUDE: 38°32'29" LONGITUDE: 123°6'39"

TOTAL HABITAT UNITS	UNITS SUBSTRATE 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
286	48	LGR	0	0	19	38	31	13	0
46	17	HGR	0	0	0	0	35	59	6
7	10	CAS	0	0	0	0	20	60	20
3	20	POW	0	10	30	10	25	20	5
8	30	GLD	0	10	57	30	3	0	0
8	28	RUN	0	4	11	36	32	14	4
3	10	SRN	0	0	0	10	40	20	30
7	6	EDW	0	33	0	67	0	0	0
2	2	TRP	0	0	0	0	0	0	100
2	51	MCP	0	16	31	16	10	18	10
1	0	CCP	0	0	0	0	0	0	0
2	10	STP	0	10	10	0	10	60	10
0	4	CRP	0	25	0	50	25	0	0
5	10	LSL	0	10	60	10	20	0	0
6	12	LSR	0	8	33	42	0	17	0
4	19	LSBk	0	11	37	11	11	16	16
80	22	LSBo	0	27	50	14	0	5	5
47	21	PLP	0	10	38	10	14	19	10
20	10	SCP	0	10	50	0	20	10	10
18	12	BPB	0	8	42	8	17	25	0
1	1	BPR	0	0	0	100	0	0	0
1	1	BPL	0	100	0	0	0	0	0
6	5	DPL	0	40	0	0	0	20	40
3	0	DRY	0	0	0	0	0	0	0

Ward Creek

APPENDIX A. Summary of Mean Percent Vegetative Cover for Entire Stream

Mean Percent Canopy	Mean Percent Evergreen	Mean Percent Decidous	Mean Right bank % Cover	Mean Left Bank % Cover
69.80	48.95	50.97	24.38	23.23

APPENDIX B.

Mean Percentage of Dominant Substrate

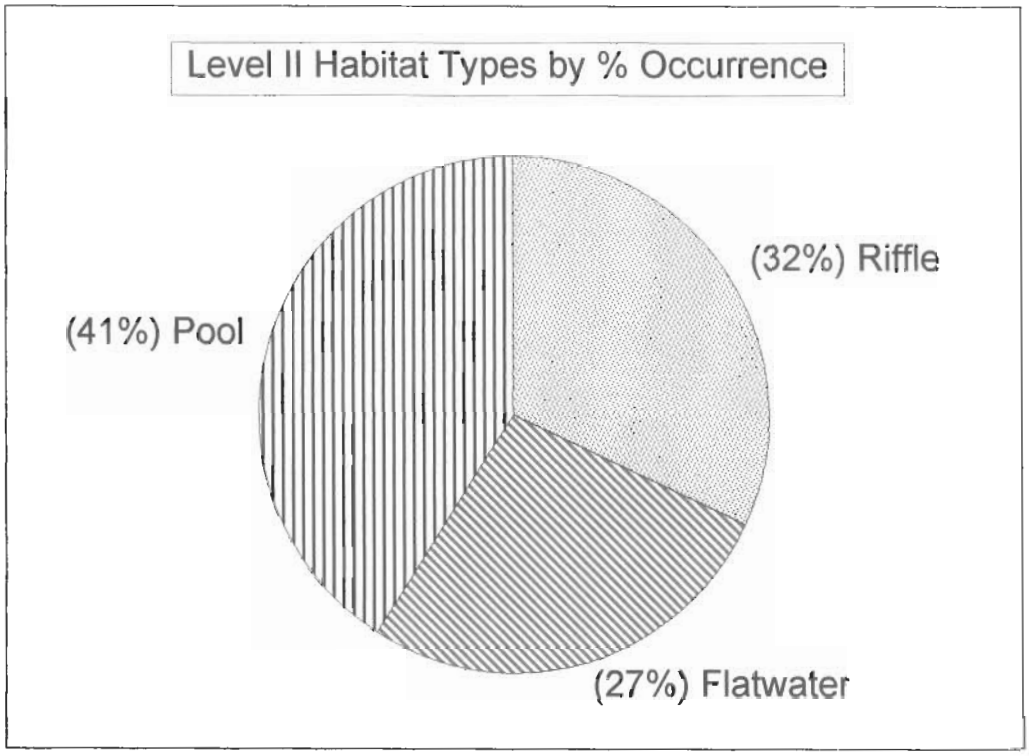
Dominant Class of Substrate	Number Units Right Bank	Number Units Left Bank	Total Mean Percent
Bedrock	93	94	28.33
Boulder	110	103	32.27
Cobble/Gravel	120	131	38.03
Silt/clay	7	2	1.36

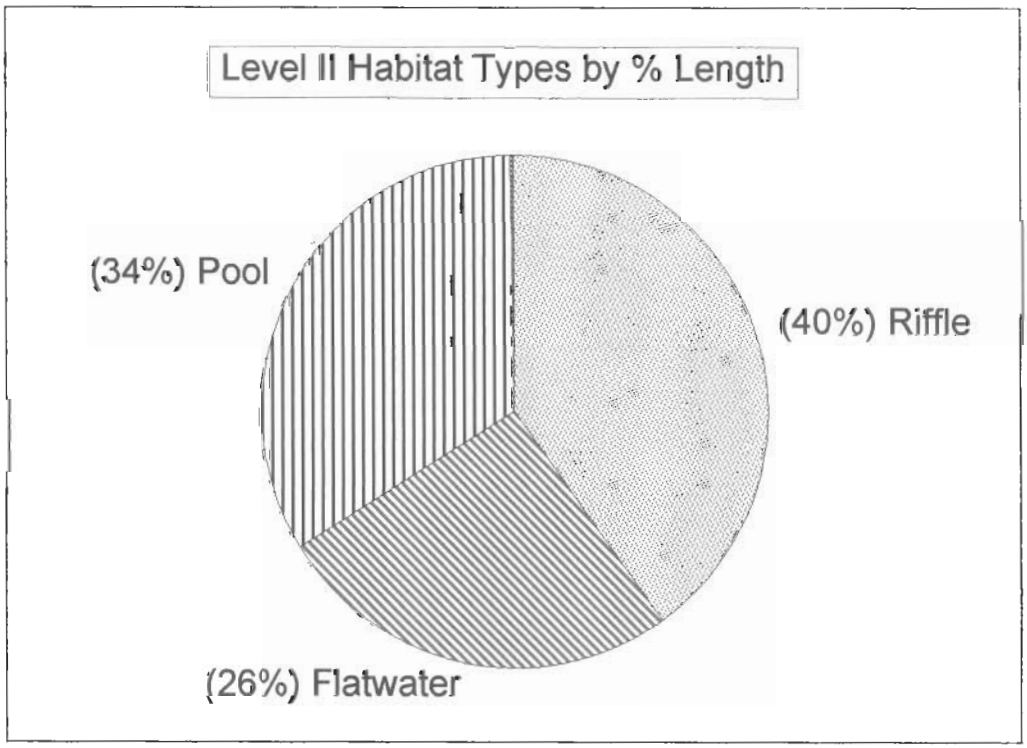
Mean Percentage of Dominant Vegetation

Dominant Class of Vegetation	Number Units Right Bank	Number Units Left Bank	Total Mean Percent
Grass	86	69	23.48
Brush	27	35	9.39
Deciduous Trees	106	134	36.36
Evergreen Trees	94	65	24.09
No Vegetation	17	27	6.67

Ward Creek

Level II Habitat Types

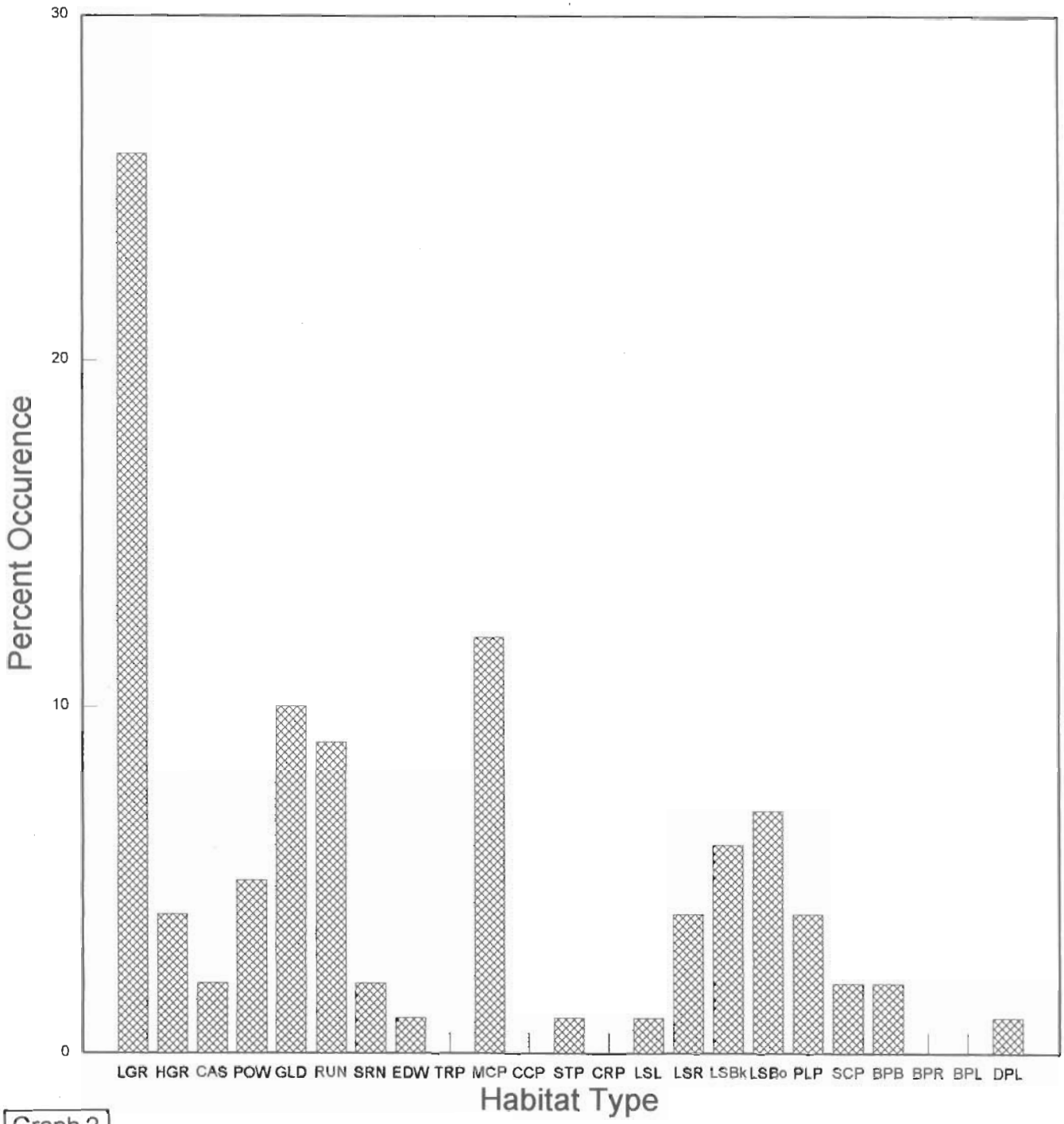




Graph 1

Ward Creek

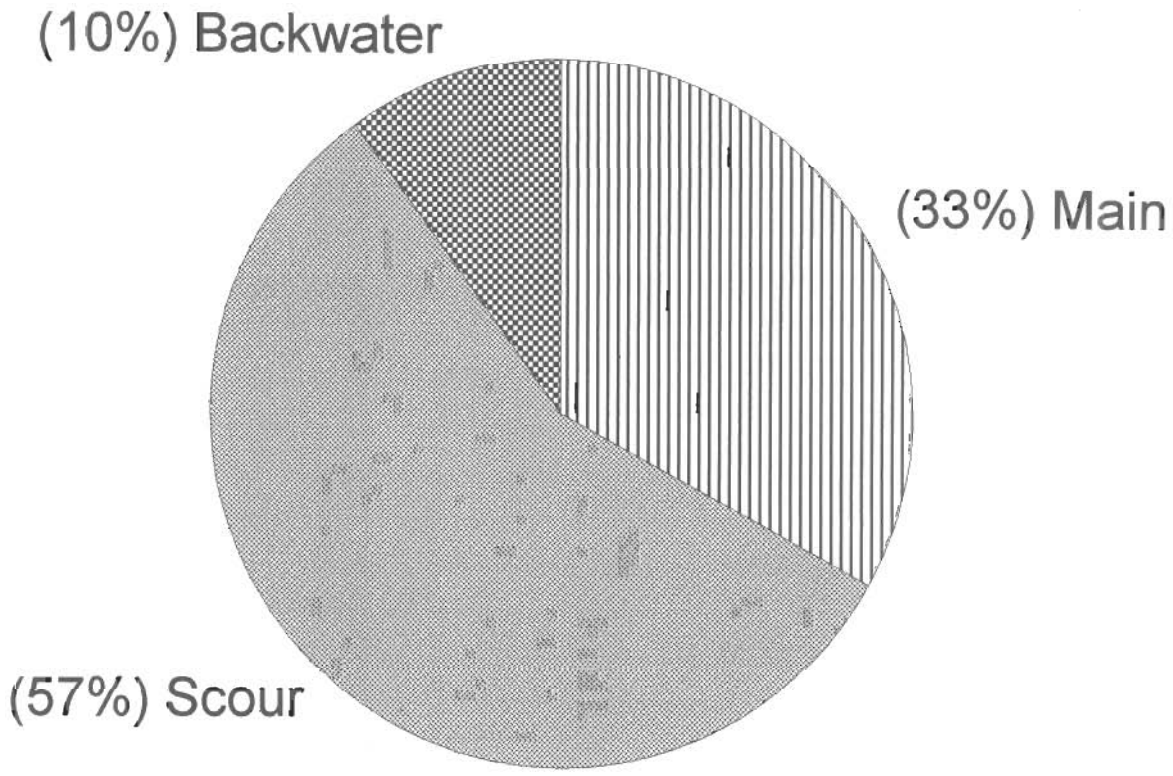
Level IV Habitat Types by % Occurrence



Graph 2

Ward Creek

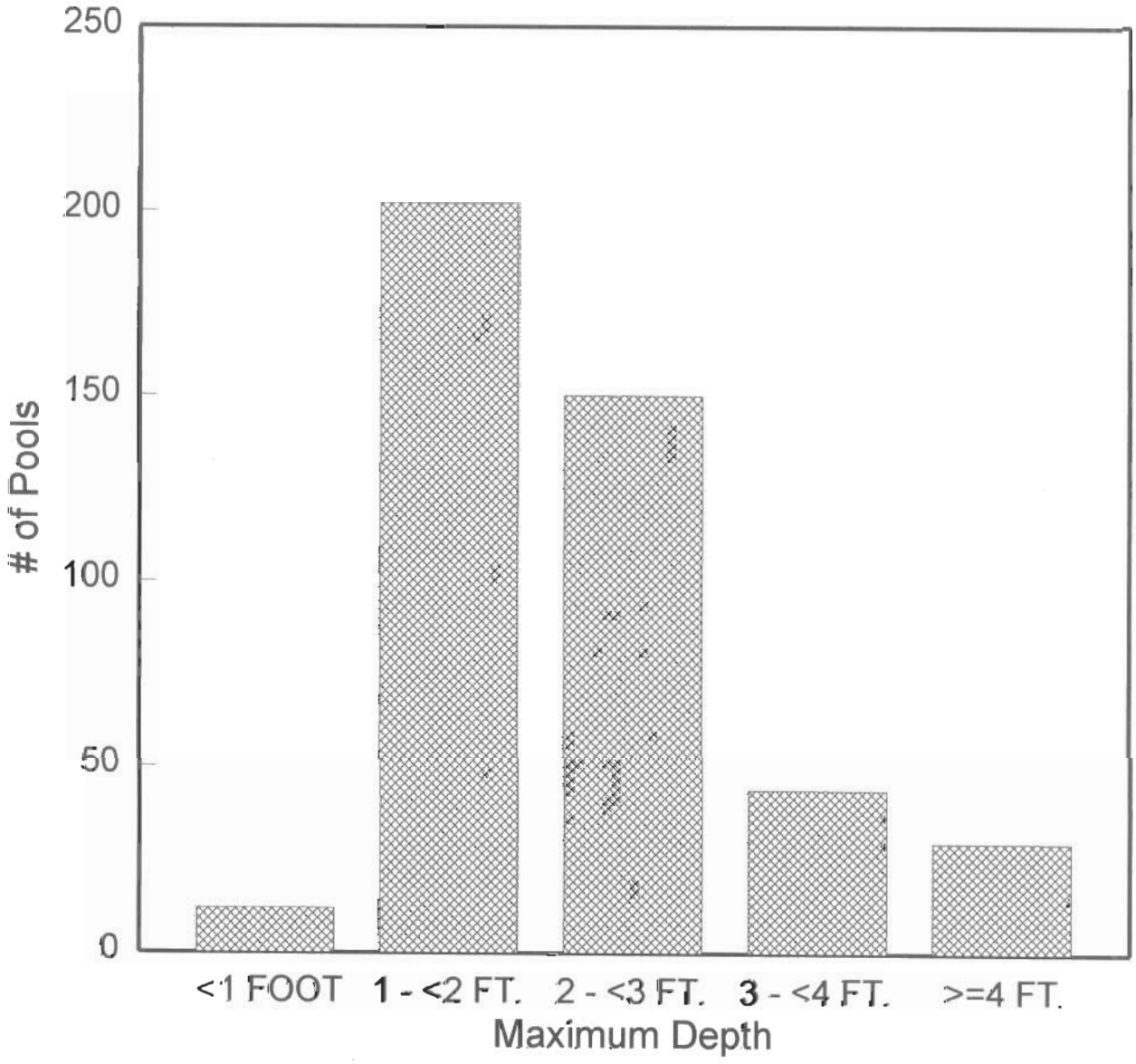
Pool Habitat Types by % Occurrence



Graph 3

Ward Creek

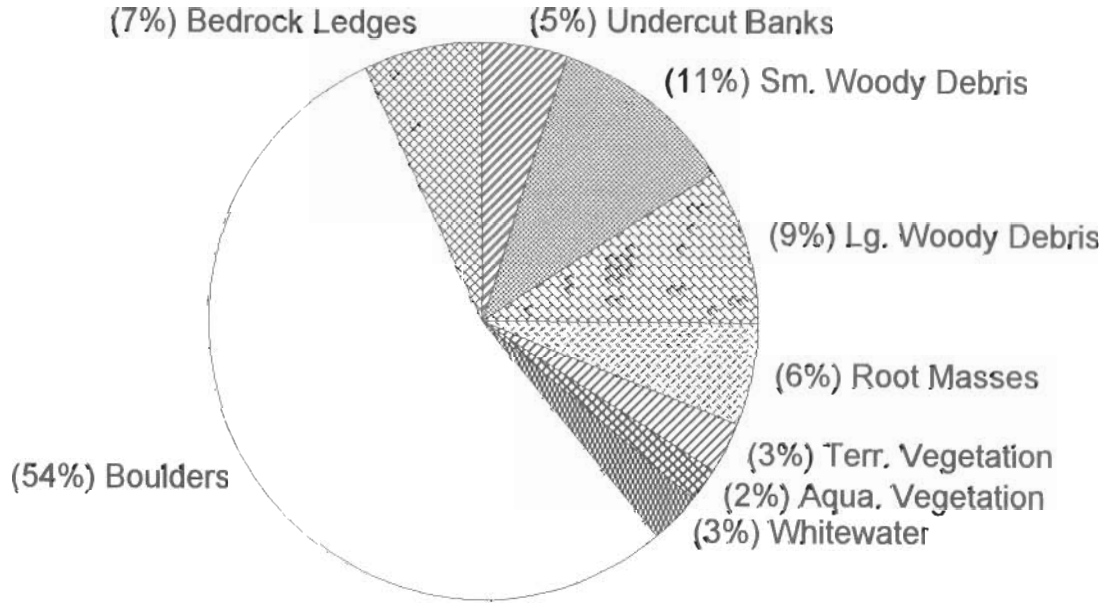
Maximum Depth in Pools



Graph 4

Ward Creek

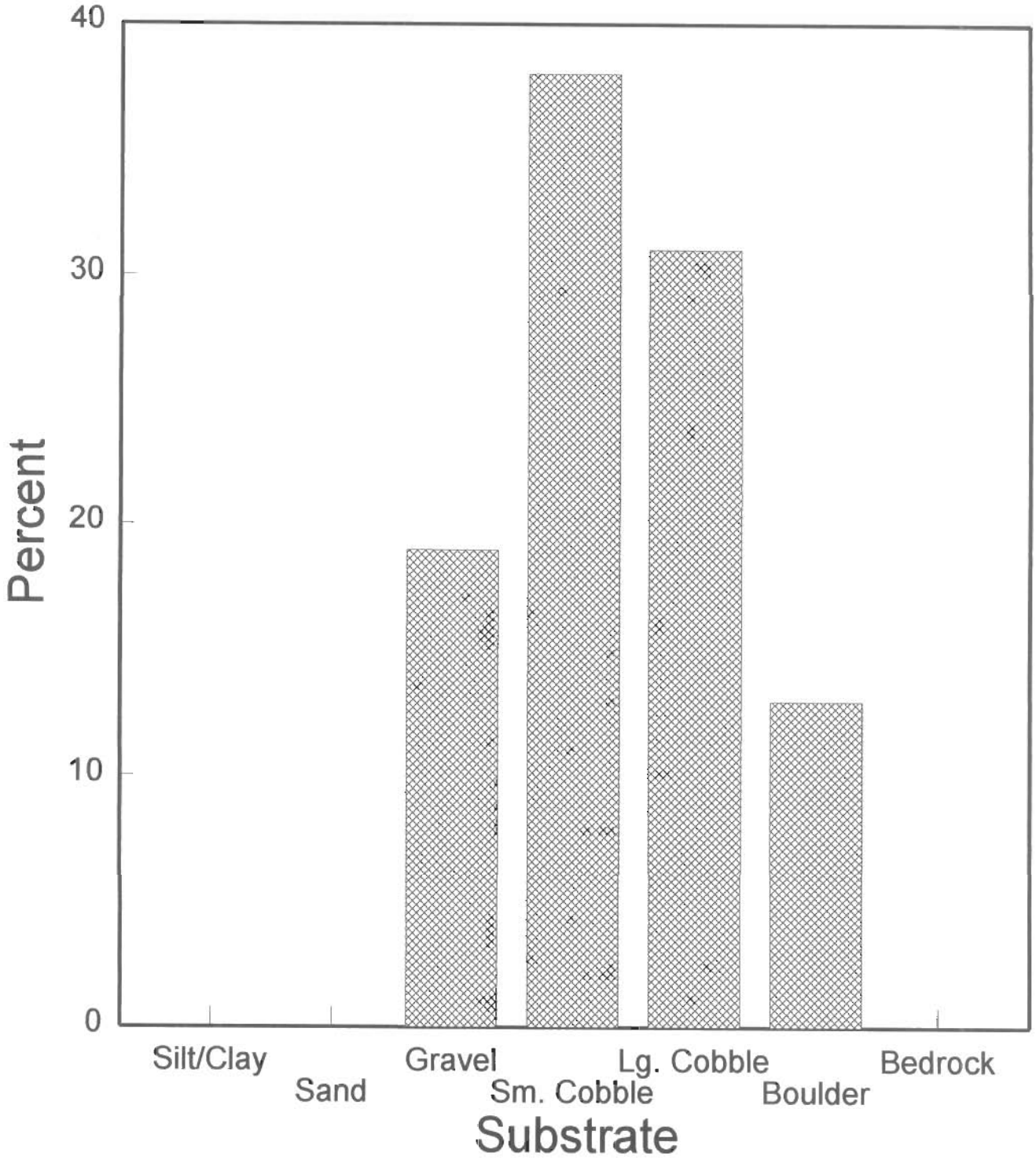
Pool Shelter Types by % Area



Graph 5

Ward Creek

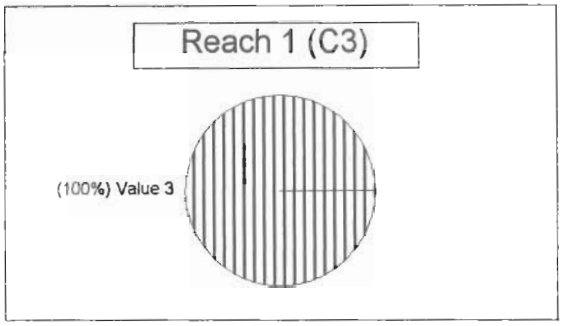
Substrate Composition in Low Gradient Riffles

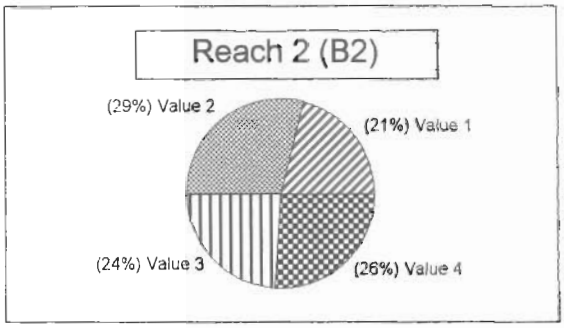


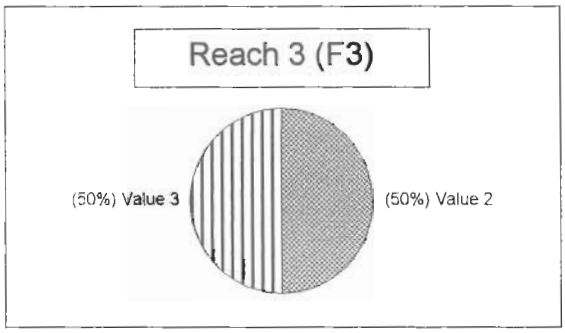
Graph 6

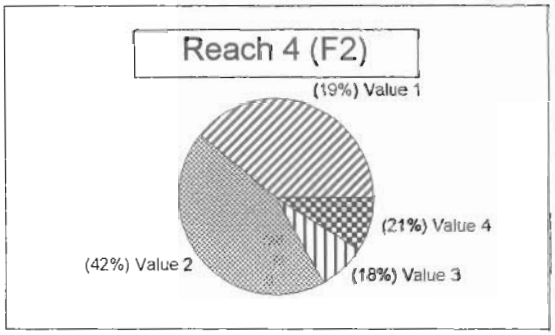
Ward Creek

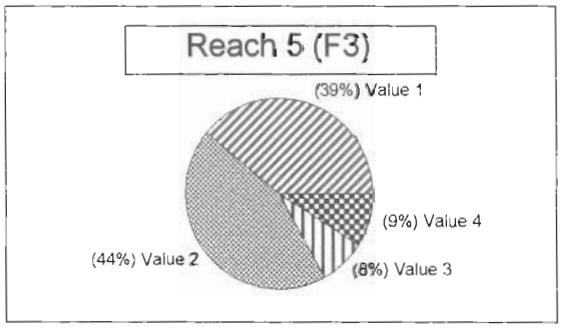
Percent Cobble Embeddedness by Reach

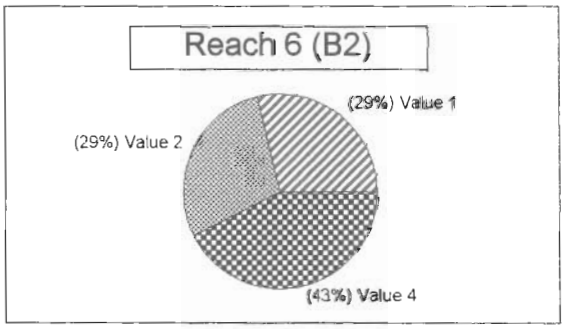


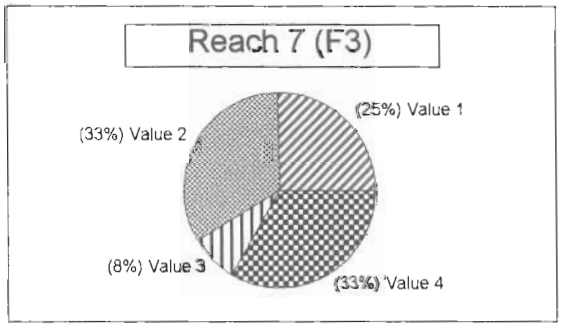


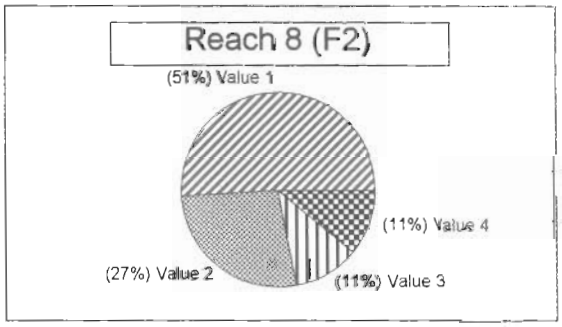


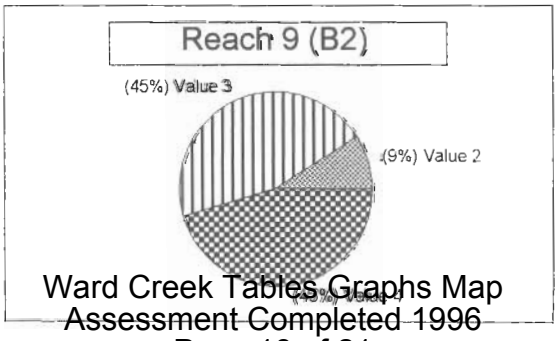








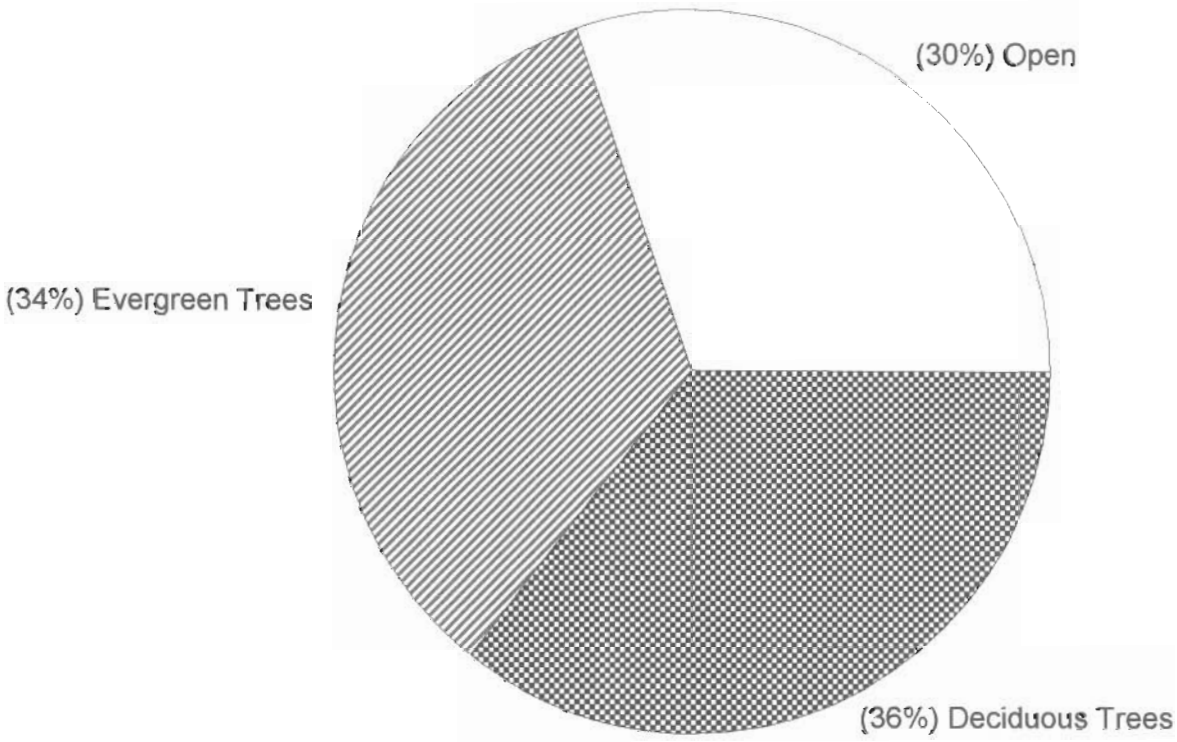




Graph 7

Ward Creek

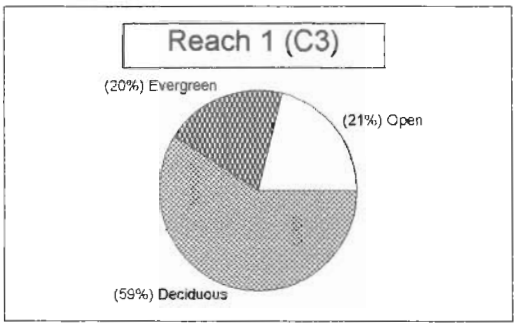
Mean Percent Canopy

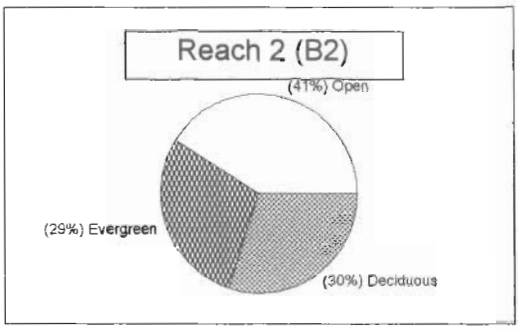


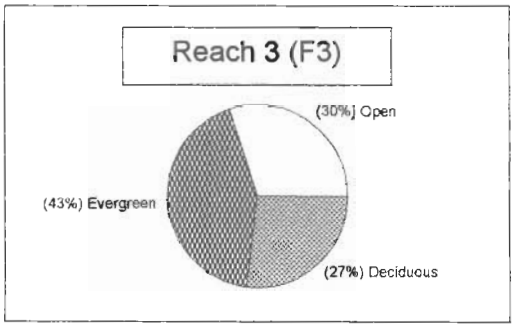
Graph 8

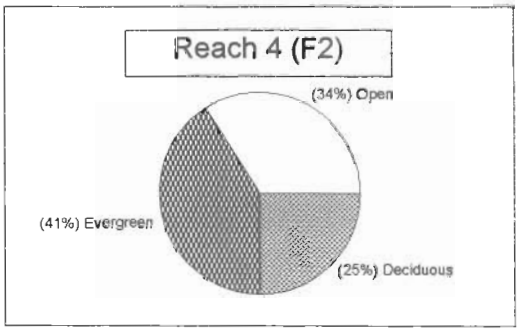
Ward Creek

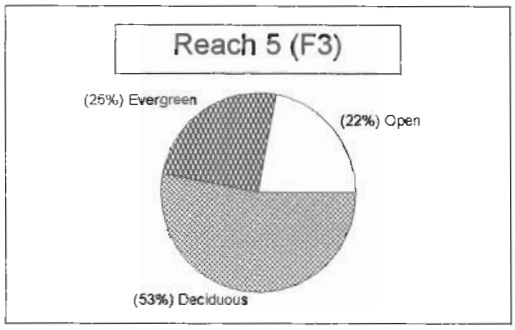
Percent Canopy By Reach

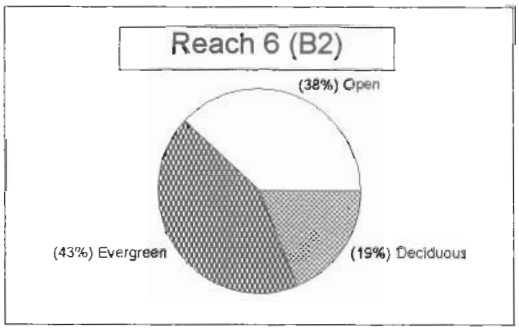


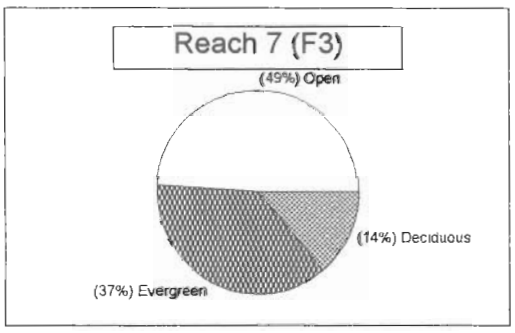


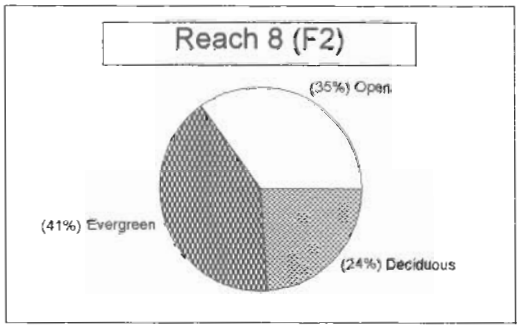


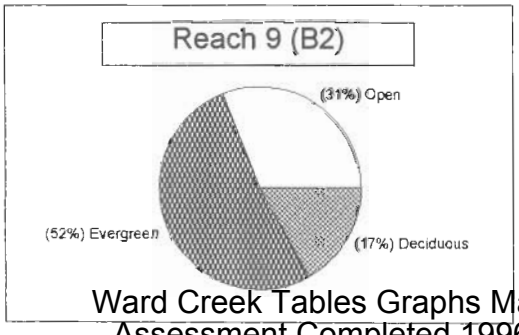








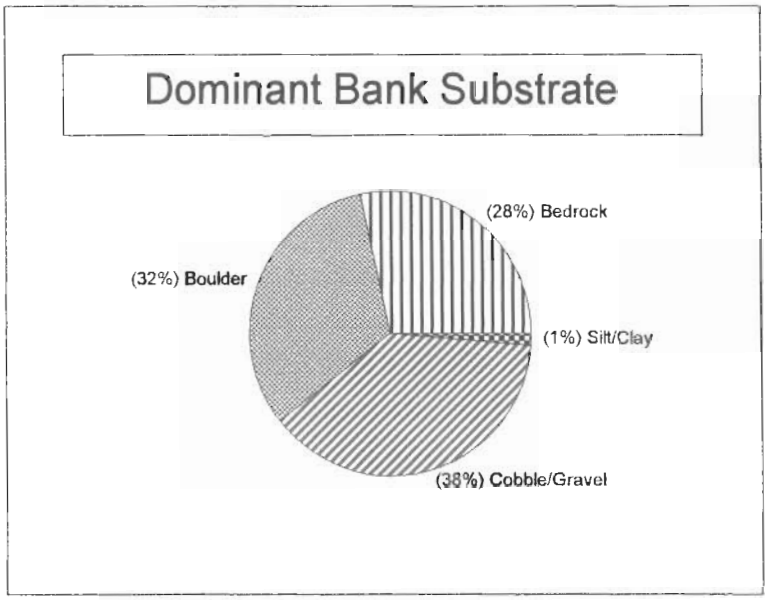


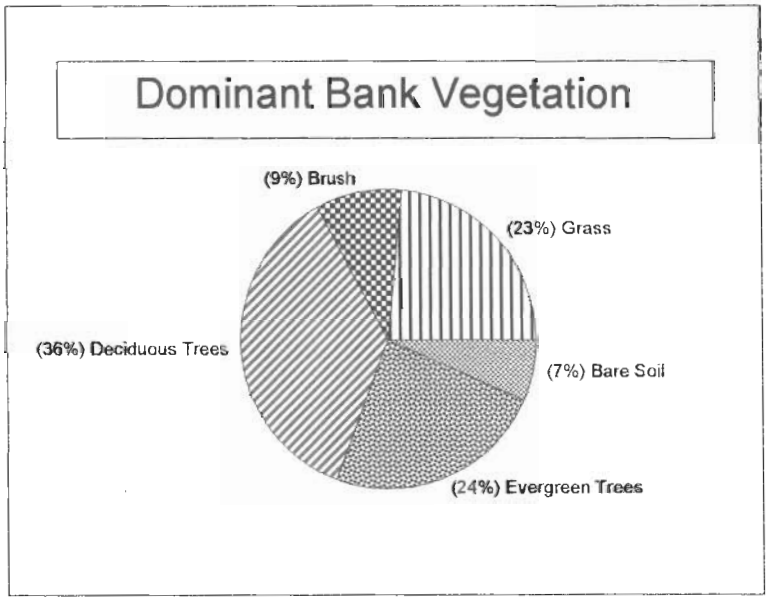


Graph 9

Ward Creek

Percent Bank Composition





Graph 10