

# STREAM INVENTORY REPORT

## Indian Creek

### INTRODUCTION

A stream inventory was conducted during July 2, 2007 to September 21, 2007 on Indian Creek. The survey began at the confluence with Navarro River and extended upstream 7.5 miles.

The objective of the habitat inventory was to document the habitat available to anadromous salmonids in Indian Creek.

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

Indian Creek is a tributary to Navarro River, and is a tributary to Pacific Ocean, located in Mendocino County, California. Indian Creek's legal description at the confluence with Indian Creek is T14N R14W S17. Its location is 39.0690 north latitude and 123.4322 west longitude, LLID number 1234414390578. Indian Creek is a second order stream and has approximately 32.79 miles of blue line stream according to the USGS Philo 7.5 minute quadrangle. Indian Creek drains a watershed of approximately 39.6 square miles. Elevations range from about 180 feet at the mouth of the creek to 3,040 feet in the headwater areas. Mixed hardwood forest dominates the watershed. The watershed is primarily privately owned and managed for recreation. Vehicle access exists via Indian Creek Road.

### METHODS

The habitat inventory conducted in Indian Creek follows the methodology presented in the *California Salmonid Stream Habitat Restoration Manual* (Flosi et al, 1998). The California Conservation Corps (CCC) Technical Advisors and Watershed Stewards Project/AmeriCorps (WSP) 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. All habitat units included in the survey are classified according to habitat type and their lengths are measured. All pool units are measured for maximum depth, depth of pool tail crest (measured in the thalweg), dominant substrate composing the pool tail crest, and embeddedness. Habitat unit types encountered for the first time are measured for all the

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

#### 1. Flow:

Flow is measured in cubic feet per second (cfs) near the bottom of the stream survey reach using a Marsh-McBirney Model 2000 flow meter.

#### 2. Channel Type:

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

#### 3. Temperatures:

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

#### 4. Habitat Type:

Habitat typing uses the 24 habitat classification types defined by McCain and others (1990). Habitat units are numbered sequentially and assigned a type identification number selected from a standard list of 24 habitat types. Indian Creek habitat typing used standard basin level measurement criteria. These parameters require that the minimum length of a described habitat unit must be equal to or greater than the stream's mean wetted width. All measurements are in feet to the nearest tenth. Habitat characteristics are measured using a clinometer, hip chain, and stadia rod.

#### 5. Embeddedness:

The depth of embeddedness of the cobbles in pool tail-out areas is measured by the percent of the cobble that is surrounded or buried by fine sediment. In Indian Creek, embeddedness was ocularly estimated. The values were recorded using the following ranges: 0 - 25% (value 1), 26

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- 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 like bedrock, log sills, boulders or other considerations.

### 6. Shelter Rating:

Instream shelter is composed of those elements within a stream channel that provide juvenile salmonids protection from predation, reduce water velocities so fish can rest and conserve energy, and allow separation of territorial units to reduce density related competition for prey. 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 Indian 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. In addition, the dominant substrate composing the pool tail-outs is recorded for each pool.

### 8. Canopy:

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

### 9. Bank Composition and Vegetation:

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

### 10. Large Woody Debris Count:

Large woody debris (LWD) is an important component of fish habitat and an element in channel forming processes. In each habitat unit all pieces of LWD partially or entirely below the elevation of bankfull discharge are counted and recorded. The minimum size to be considered is

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twelve inches in diameter and six feet in length. The LWD count is presented by reach and is expressed as an average per 100 feet.

### 11. Average Bankfull Width:

Bankfull width can vary greatly in the course of a channel type stream reach. This is especially true in very long reaches. Bankfull width can be a factor in habitat components like canopy density, water temperature, and pool depths. Frequent measurements taken at riffle crests (velocity crossovers) are needed to accurately describe reach widths. At the first appropriate velocity crossover that occurs after the beginning of a new stream survey page (ten habitat units), bankfull width is measured and recorded in the appropriate header block of the page. These widths are presented as an average for the channel type reach.

## DATA ANALYSIS

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

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

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

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

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### HABITAT INVENTORY RESULTS

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

The habitat inventory of July 2, 2007 to September 21, 2007 was conducted by J. Scriven, J. D. Bertsch, and L. Leland. The total length of the stream surveyed was 62,252 feet with an additional 1,577 feet of side channel. The first 319 feet of Indian Creek was not surveyed due to the influence with Navarro River. A section of Indian Creek from 19,696 feet to 28,856 feet and another section from 37,858 feet to 50,858 feet was not surveyed do to lack of landowner access permission. The data included in this report is for the 40,492 feet actually surveyed.

Stream flow was measured near the bottom of the survey reach with a Marsh-McBirney Model 2000 flow meter at 0.01 cfs on July 6, 2007.

Indian Creek is an F4 channel type for 8,973 feet of the stream surveyed (Reach 1), an F3 channel type for 3,485 feet of the stream surveyed (Reach 2), a B2 channel type for 5,090 feet of the stream surveyed (Reach 3), a B3 channel type for 2,196 feet of the stream surveyed (Reach 4), an undetermined channel type for 9,160 feet of the stream surveyed (Reach 5), an F4 channel type for 9,511 feet of the stream surveyed (Reach 6) an undetermined channel type for 13,000 feet of the stream surveyed (Reach 7) a B4 channel type (Reach 8), a B2 channel type (Reach 9), and a B4 channel type (Reach 10).

F4 channels are entrenched, meandering, riffle/pool channels on low gradients with high width/depth ratios and gravel-dominant substrates. F3 channels are entrenched meandering riffle/pool channel on low gradients with high width/depth ratio and cobble-dominant substrates. B2 channels are moderately entrenched, moderate gradient, riffle dominated channels with infrequently spaced pools, a very stable plan and profile, stable banks and bedrock-dominant substrates. B3 channels are moderately entrenched, moderate gradient, riffle dominated channels with infrequently spaced pools, a very stable plan and profile, stable banks and cobble-dominant substrates.

Water temperatures taken during the survey period ranged from 52 to 81 degrees Fahrenheit. Air temperatures ranged from 53 to 86 degrees Fahrenheit.

Table 1 summarizes the Level II riffle, flatwater, and pool habitat types. Based on frequency of occurrence there were 39% flatwater units, 33% riffle units 26% pool units, and 1% dry units (Graph 1). Based on total length of Level II habitat types there were 43% flatwater units, 32% riffle units, 22% pool units, and 2% dry units (Graph 2).

Twenty-two Level IV habitat types were identified (Table 2). The most frequent habitat types by percent occurrence were mid-channel pool units, 22%; low gradient riffle units, 19%; and glide units, 14% (Graph 3). Based on percent total length, low gradient riffle units made up 23%, glide units 20%, and mid-channel pool units 19%.

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A total of 181 pools were identified (Table 3). Main channel pools were the most frequently encountered at 85%, and comprised 87% of the total length of all pools (Graph 4).

Table 4 is a summary of maximum residual pool depths by pool habitat types. Pool quality for salmonids increases with depth. One hundred nineteen of the 181 pools (66%) had a residual depth of two feet or greater (Graph 5).

The depth of cobble embeddedness was estimated at pool tail-outs. Of the 181 pool tail-outs measured 10.2% was in category 1 and 52.9% was in 2 (Graph 6). On this scale, a value of 1 indicates the best spawning conditions and a value of 4 the worst. Additionally, a value of 5 was assigned to tail-outs deemed unsuited for spawning due to inappropriate substrate like bedrock, log sills, boulders or other considerations.

A shelter rating was calculated for each habitat unit and expressed as a mean value for each habitat type within the survey using a scale of 0-300. Riffle habitat types had a mean shelter rating of 8, flatwater habitat types had a mean shelter rating of 16, and pool habitats had a mean shelter rating of 23 (Table 1). Of the pool types, the main channel pools had a mean shelter rating of 23, scour pools had a mean shelter rating of 23, and backwater pools had a mean shelter rating of 22 (Table 3).

Table 5 summarizes mean percent cover by habitat type. Boulders are the dominant cover types in Indian Creek. Graph 7 describes the pool cover in Indian Creek. Boulders are the dominant pool cover type followed by bedrock ledges.

Table 6 summarizes the dominant substrate by habitat type. Graph 8 depicts the dominant substrate observed in pool tail-outs. Gravel was the dominant substrate type observed in 50% of pool tail-outs measured. Small cobble was the next most dominant substrate type observed in 22% of pool tail-outs.

The mean percent canopy density for the surveyed length of Indian Creek was 72%. Of the canopy present, the mean percentages of hardwood and coniferous trees were 70% and 30%, respectively. Twenty-eight percent of the canopy was open. Graph 9 describes the mean percent canopy in Indian Creek.

For the stream reach surveyed, the mean percent right bank vegetated was 32%. The mean percent left bank vegetated was 31%. The dominant elements composing the structure of the stream banks consisted of 41% boulder, 27% cobble/gravel, 22% bedrock, and 10% sand/silt/clay (Graph 10). Hardwood trees were the dominant vegetation type observed in 58% of the units surveyed. Additionally, 11% of the units surveyed had coniferous trees as the dominant vegetation type (Graph 11).

## **DISCUSSION**

Indian Creek is an F4 channel type for 8,973 feet of the stream surveyed (Reach 1), an F3 channel type for 3,485 feet of the stream surveyed (Reach 2), a B2 channel type for 5,090 feet of the stream surveyed (Reach 3), a B3 channel type for 2,196 feet of the stream surveyed (Reach

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4), and an F4 channel type for 9,511 feet of the stream surveyed (Reach 5).

The suitability of the channel types on Indian Creek for fish habitat improvement structures is as follows: F4 channels are good for bank-placed boulders and fair for plunge weirs, single and opposing wing-deflectors, channel constrictors, and log cover. F3 channels are good for bank-placed boulders, single and opposing wing deflectors, and fair for plug weirs, boulder clusters, channel constrictors, and log cover. B2 channels are excellent for plunge weirs, single and opposing wing-deflectors, and log cover. B3 channels are excellent for plunge weirs, boulder clusters and bank placed boulder, single and opposing wing-deflectors and log cover.

The water temperatures recorded on the survey days July 2, 2007 to September 21, 2007 ranged from 52 to 81 degrees Fahrenheit. Air temperatures ranged from 53 to 86 degrees Fahrenheit. Water temperatures appear to be unsuitable, however 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 43% of the total length of this survey, riffles 32%, and pools 22%. The pools are relatively deep, with 119 of the 181 (66%) pools having a maximum residual depth greater than 2 feet. In general, pool enhancement projects are considered when primary pools comprise less than 40% of the length of total stream habitat. In first and second order streams, a primary pool is defined to have a maximum residual depth of at least two feet, occupy at least half the width of the low flow channel, and be as long as the low flow channels width. Installing structures that will increase or deepen pool habitat is recommended for locations where their installation will not be threatened by high stream energy, or where their installation will not conflict with the modification of the numerous log debris accumulations (LDA's) in the stream.

Twenty percent of the pool tail-outs measured had embeddedness ratings of 1 or 2. Eighty percent of the pool tail-outs had embeddedness ratings of 3 or 4. Zero percent of the pool tail-outs had a rating of 5, which is considered unsuitable for spawning. Cobble embeddedness measured to be 25% or less, a rating of 1, is considered to indicate good quality spawning substrate for salmon and steelhead. Sediment sources in Indian Creek should be mapped and rated according to their potential sediment yields, and control measures should be taken.

One hundred thirty-five of the 187 pool tail-outs measured had gravel or small cobble as the dominant substrate. This is generally considered good for spawning salmonids.

The mean shelter rating for pools was 23. The shelter rating in the flatwater habitats was 16. A pool shelter rating of approximately 100 is desirable. The amount of cover that now exists is being provided primarily by boulders in Indian Creek. Boulders are the dominant cover type in pools followed by bedrock ledges. Log and root wad cover structures in the pool and flatwater habitats would enhance 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.

The mean percent canopy density for the stream was 72%. Reach 1 had a canopy density of 61%, Reach 2 had a canopy density of 79%, Reach 3 had a canopy density of 72%, Reach 4 had

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a canopy density of 59%, and Reach 5 had a canopy density of 69%. In general, revegetation projects are considered when canopy density is less than 80%.

The percentage of right and left bank covered with vegetation was low at 32% and 31%, respectively. In areas of stream bank erosion or where bank vegetation is sparse, planting endemic species of coniferous and hardwood trees, in conjunction with bank stabilization, is recommended.

### RECOMMENDATIONS

- 1) See DFG FRGP final report for agreement number P0530406 for specific site recommendations.
- 2) Indian Creek should be managed as an anadromous, natural production stream.
- 3) Increase woody cover in the pools and flatwater habitat units. Most of the existing cover is from boulders. Adding high quality complexity with woody cover is desirable.
- 4) Increase the canopy on Indian Creek by planting appropriate native vegetation like willow, alder, redwood, and Douglas fir along the stream where shade canopy is not at acceptable levels. The reaches above this survey section should be inventoried and treated as well, since the water flowing here is affected from upstream. In many cases, planting will need to be coordinated to follow bank stabilization or upslope erosion control projects.
- 5) Inventory and map sources of stream bank erosion and prioritize them according to present and potential sediment yield. Identified sites should then be treated to reduce the amount of fine sediments entering the stream.
- 6) There are several log debris accumulations present on Indian Creek that are retaining large quantities of fine sediment. The modification of these debris accumulations is desirable, but must be done carefully, over time, to avoid excessive sediment loading in downstream reaches.
- 7) The limited water temperature data available suggest that maximum temperatures are above the acceptable range for juvenile salmonids. To establish more complete and meaningful temperature regime information, 24-hour monitoring during the July and August temperature extreme period should be performed for 3 to 5 years.
- 8) 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.
- 9) Remove periwinkle, ivy and blackberry from stream banks.
- 10) Remove LDAS and barriers to upstream and downstream migration.



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- 11) Replanting unstable stream banks with alder seedlings and willow cuttings.

### COMMENTS AND LANDMARKS

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

Position (ft.):	Habitat Unit #:	Comments:
0	0001.00	Start of survey 319 feet upstream of the confluences of Indian Creek and the Navarro River.
13646	0165.00	Left bank tributary enters at top of the unit.
14284	0176.02	There is an 8% gradient taken with a clinometer.
14446	0180.00	There are two, 4 inch salmonids seen in right bank tributary at the top of the unit.
14649	0184.00	Right bank tributary enters at the bottom of unit.
15211	0194.00	Salmonid 1+ observed in unit.
15367	0197.00	Decommissioned road enters from right bank and is very overgrown with brush.
15707	0207.00	Two, 6" salmonids observed in unit.
15782	0208.00	Right bank tributary enters unit at 15'.
15867	0210.00	Salmonid redd evidence in pooltail.
16014	0212.00	Three large logs suspended 11' above channel.
16110	0213.02	Slide on left bank is 40' high x 60' long.
16278	0218.00	Left bank slide is 200' high x 80' long.
17070	0235.00	Decommissioned road on right bank.
17208	0239.00	Spring and land slide on left bank.
17642	0248.00	Spring and decommissioned road on right bank.

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18203	0259.00	Confluence with the West Branch of Indian Creek
18759	0267.00	Decommissioned road on right bank.
19297	0276.00	Start of Calvert Property Line, there is no access for 9,160 feet or until the Libeu Property Line.
28457	0277.00	Left bank slide at bottom and top of the unit.
28594	0278.00	Left bank slide for continues for the entire unit.
29264	0285.00	Libeu Camp on right bank.
30431	0297.00	Left bank class 3 tributary near top of unit. There are old cabins on top of hill above the stream.
31353	0307.00	Left bank slide is actively eroding.
32147	0317.00	Left bank is vertical approximately 10' to 15' high.
33052	0327.00	Active left bank slide will eventually deliver maple tree into the stream channel.
33123	0328.00	There are slides on both stream banks and the top of the unit.
33503	0332.00	Downed redwood spanning stream channel.
33796	0336.00	Redwood in channel from left bank.
33848	0337.00	Redwood actively sliding into channel from left bank.
33965	0339.00	Salmonid mandible found in this unit.
34223	0341.00	Confluence with North Fork of Indian Creek.
34369	0343.00	Right bank erosion starts here.
34484	0345.00	End of vertical right bank erosion at the top of the unit.
35583	0358.00	Salmonid observed in unit.
35938	0363.00	Left bank tributary enters near the top of the unit. Gradient of the tributary is 17% and it had very low flow.
36237	0365.00	Salmonid young-of-the-year (YOY) with visible parasite on pelvic fin.
36447	0369.00	There is a left bank slide in this unit.

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36539	0370.00	The slide continues through this unit.
36649	0372.00	Left bank slide ends in this unit.
37128	0378.00	There is an eroding hillside on the right bank.
37494	0382.00	Beginning of no access on the Seven Springs Ranch for 13,000 feet or until the USA-Mayer Property Line.
50494	0383.00	Re-start of the survey at USA-Mayer Property Line.
51233	0403.00	Left bank tributaries enter at top of unit.
51370	0406.00	Sculpin observed in this unit.
51394	0407.00	Left bank slide in this unit.
51506	0410.00	Left bank slide with fallen Douglas fir trees.
52533	0429.00	Doug fir tree fell across top of unit from left bank.
52932	0438.00	Left bank tributary enters at the top of the unit.
53580	0447.00	Redd observed in the pool tail.
55432	0499.00	Slide on the right bank in this unit.
55498	0501.00	Slide on the right bank in this unit.
55644	0505.00	Active slide on the left bank throughout the entire unit.
56341	0516.00	Left bank tributary enters in this unit.
56553	0522.00	A 6" salmonid was observed in this unit.
56793	0529.00	Large woody debris crosses at top of unit.
57068	0537.00	Right bank tributary enters at the bottom of the unit.
58230	0563.00	Channel type change in this unit.
58296	0566.00	There is a 6' vertical gain in unit.
59707	0603.00	Left bank tributary enters at the bottom of the unit.
60143.4	0611.00	Humboldt crossing logs on left bank at the top of the unit.

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60373.4 0615.00 Confluence with un-named right bank tributary to Indian Creek: LLID 1233141390572.

60696.4 0627.00 Left bank tributary is flowing in this unit at 365'.

61765.4 0641.00 Dry right bank tributary in this unit.

61798.4 0642.00 Salmonid YOY observed in this unit.

62252.4 0646.00 End of survey.

## REFERENCES

Flosi, G., Downie, S., Hopelain, J., Bird, M., Coey, R., and Collins, B. 1998. *California Salmonid Stream Habitat Restoration Manual*, 3rd edition. California Department of Fish and Game, Sacramento, California.

McCain, M., D. Fuller, L. Decker and K. Overton. 1990. Stream habitat classification and inventory procedures for northern California. FHC Currents. No.1. U.S. Department of Agriculture. Forest Service, Pacific Southwest Region.

Rosgen, D.L., 1994. A Classification of Natural Rivers. *Catena*, Vol 22: 169-199, Elsevier Science, B. V. Amsterdam.

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### LEVEL III and LEVEL IV HABITAT TYPES

#### RIFFLE

Low Gradient Riffle	(LGR)	[1.1]	{ 1 }
High Gradient Riffle	(HGR)	[1.2]	{ 2 }

#### CASCADE

Cascade	(CAS)	[2.1]	{ 3 }
Bedrock Sheet	(BRS)	[2.2]	{24}

#### FLATWATER

Pocket Water	(POW)	[3.1]	{21}
Glide	(GLD)	[3.2]	{14}
Run	(RUN)	[3.3]	{15}
Step Run	(SRN)	[3.4]	{16}
Edgewater	(EDW)	[3.5]	{18}

#### MAIN CHANNEL POOLS

Trench Pool	(TRP)	[4.1]	{ 8 }
Mid-Channel Pool	(MCP)	[4.2]	{17}
Channel Confluence Pool	(CCP)	[4.3]	{19}
Step Pool	(STP)	[4.4]	{23}

#### SCOUR POOLS

Corner Pool	(CRP)	[5.1]	{22}
Lateral Scour Pool - Log Enhanced	(LSL)	[5.2]	{10}
Lateral Scour Pool - Root Wad Enhanced	(LSR)	[5.3]	{11}
Lateral Scour Pool - Bedrock Formed	(LSBk)	[5.4]	{12}
Lateral Scour Pool - Boulder Formed	(LSBo)	[5.5]	{20}
Plunge Pool	(PLP)	[5.6]	{ 9 }

#### BACKWATER POOLS

Secondary Channel Pool	(SCP)	[6.1]	{ 4 }
Backwater Pool - Boulder Formed	(BPB)	[6.2]	{ 5 }
Backwater Pool - Root Wad Formed	(BPR)	[6.3]	{ 6 }
Backwater Pool - Log Formed	(BPL)	[6.4]	{ 7 }
Dammed Pool	(DPL)	[6.5]	{13}

#### ADDITIONAL UNIT DESIGNATIONS

Dry	(DRY)	[7.0]	
Culvert	(CUL)	[8.0]	
Not Surveyed	(NS)	[9.0]	
Not Surveyed due to a marsh	(MAR)	[9.1]	

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

**Stream Name:** Indian Creek

**LLID:** 1234414390578

**Drainage:** Navarro River

**Survey Dates:** 7/2/2007 to 9/21/2007

**Confluence**

**Quad:** PHILO

**Legal**

T14NR14WS19

**Latitude:** 39:03:28.0N

**Longitude:** 123:26:29.0W

Habitat Units	Units Fully Measured	Habitat Type	Habitat Occurrence (%)	Mean Length (ft.)	Total Length (ft.)	Total Length (%)	Mean Width (ft.)	Mean Depth (ft.)	Mean Max Depth (ft.)	Mean Area (sq.ft.)	Estimated Total Area (sq.ft.)	Mean Volume (cu.ft.)	Estimated Total Volume (cu.ft.)	Mean Residual Pool Vol (cu.ft.)	Mean Shelter Rating
7	0	DRY	1.0	141	984	2.4									
269	64	FLATWATER	39.3	66	17717	42.8	14.9	0.5	1.3	988	265896	530	142678		16
3	0	NOSURVEY	0.4	1	3	0.0									
181	177	POOL	26.4	51	9261	22.4	16.8	0.8	2.6	982	177731	1126	203772	812	23
224	39	RIFFLE	32.7	60	13427	32.4	16.7	0.3	0.9	755	169149	206	46148		8

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## Table 2 - Summary of Habitat Types and Measured

**Stream Name:** Indian Creek

**LLID:** 1234414390578

**Drainage:** Navarro River

**Survey Dates:** 7/2/2007 to 9/21/2007

<b>Confluence</b>		<b>Quad:</b> PHILO		<b>Legal</b>			T14NR14WS19			<b>Latitude:</b> 39:03:28.0N		<b>Longitude:</b> 123:26:29.0W				
Habitat Units	Units Fully Measured	Habitat Type	Habitat Occurrence (%)	Mean Length (ft.)	Total Length (ft.)	Total Length (%)	Mean Width (ft.)	Mean Depth (ft.)	Mean Max Depth (ft.)	Mean Area (sq.ft.)	Estimated Total Area (sq.ft.)	Mean Volume (cu.ft.)	Estimated Total Volume (cu.ft.)	Mean Residual Pool Vol (cu.ft.)	Mean Shelter Rating	Mean Canopy (%)
133	20	LGR	19.4	71	9386	22.7	22.0	0.2	1.6	1242	165211	329	43709		7	64
85	15	HGR	12.4	46	3904	9.4	11.0	0.3	2.3	265	22542	83	7068		4	80
5	3	CAS	0.7	24	118	0.3	10.0	0.4	2.1	130	648	64	318		50	69
1	1	BRS	0.1	19	19	0.0	21.0	0.1	0.9	239	239	24	24		2	78
61	12	POW	8.9	47	2885	7.0	15.0	0.7	2.5	825	50350	467	28500		34	78
94	25	GLD	13.7	86	8123	19.6	18.0	0.5	2.2	1428	134262	718	67491		9	68
45	11	RUN	6.6	45	2017	4.9	13.0	0.5	1.7	533	24003	274	12342		12	75
67	15	SRN	9.8	69	4643	11.2	11.0	0.6	5.4	772	51716	487	32657		13	73
2	1	EDW	0.3	24	49	0.1	7.0	0.3	1.2	203	406	61	122		10	81
3	2	TRP	0.4	45	135	0.3	7.0	1.9	3.7	424	1272	991	2974	940	10	79
148	146	MCP	21.6	52	7678	18.5	17.0	0.8	22.9	1028	152184	1193	176524	871	23	73
2	2	STP	0.3	108	215	0.5	16.0	0.4	1.9	1426	2853	1387	2774	383	15	85
2	2	CRP	0.3	69	138	0.3	14.0	1.4	4.1	991	1982	2287	4573	1919	70	66
1	1	LSL	0.1	91	91	0.2	2.0	0.7	3.1	228	228	228	228	159	60	54
3	3	LSR	0.4	27	82	0.2	11.0	0.6	2.7	280	840	309	927	225	28	71
5	5	LSBk	0.7	47	235	0.6	18.0	0.7	3.9	904	4518	728	3642	426	11	84
7	7	LSBo	1.0	55	387	0.9	23.0	0.3	5.0	1249	8744	933	6529	410	12	72
1	0	PLP	0.1	25	25	0.1			2.2						10	82
7	7	SCP	1.0	28	193	0.5	14.0	0.6	3.8	414	2897	517	3616	419	16	59

# Indian Creek

**Table 3 - Summary of Pools**

**Stream Name:** Indian Creek

**LLID:** 1234414390578

**Drainage:** Navarro River

**Survey Dates:** 7/2/2007 to 9/21/2007

**Confluence**

**Quad:** PHILO

**Legal**

T14NR14WS19

**Latitude:** 39:03:28.0N

**Longitude:** 123:26:29.0W

Habitat Units	Units Fully Measured	Habitat Type	Habitat Occurrence (%)	Mean Length (ft.)	Total Length (ft.)	Total Length (%)	Mean Width (ft.)	Mean Residual Depth (ft.)	Mean Area (sq.ft.)	Estimated Total Area (sq.ft.)	Mean Residual Pool Vol (cu.ft.)	Estimated Total Resid. Vol (cu.ft.)	Mean Shelter Rating
153	150	MAIN	85	52	8028	87	17.0	0.8	1026	156905	865	130620	23
19	18	SCOUR	10	50	958	10	17.6	0.6	906	17218	544	9756	23
9	9	BACKWATER	5	31	275	3	12.8	0.7	407	3664	395	3158	23
Total Units	Total Units Fully Measured				Total Length (ft.)					Total Area (sq.ft.)		Total Volume (cu.ft.)	
181	177				9261					177786		143533	



# Indian Creek

**Table 4 - Summary of Maximum Residual Pool Depths By**

**Stream Name:** Indian Creek

**LLID:** 1234414390578

**Drainage:** Navarro River

**Survey Dates:** 7/2/2007 to 9/21/2007

<b>Confluence</b>		<b>Quad: PHILO</b>			<b>Legal</b>			<b>T14NR14WS19</b>		<b>Latitude: 39:03:28.0N</b>		<b>Longitude: 123:26:29.0W</b>	
Habitat Units	Habitat Type	Habitat Occurrence (%)	< 1 Foot Maximum Residual Depth	< 1 Foot Percent Occurrence	1 < 2 Feet Maximum Residual Depth	1 < 2 Feet Percent Occurrence	2 < 3 Feet Maximum Residual Depth	2 < 3 Feet Percent Occurrence	3 < 4 Feet Maximum Residual Depth	3 < 4 Feet Percent Occurrence	>= 4 Feet Maximum Residual Depth	>= 4 Feet Percent Occurrence	
148	MCP	82	5	3	47	32	53	36	30	20	13	9	
1	LSL	1	0	0	0	0	0	0	1	100	0	0	
2	CRP	1	0	0	1	50	0	0	0	0	1	50	
3	LSR	2	0	0	1	33	2	67	0	0	0	0	
7	SCP	4	0	0	3	43	2	29	2	29	0	0	
7	LSBo	4	0	0	2	29	4	57	0	0	1	14	
2	STP	1	0	0	2	100	0	0	0	0	0	0	
5	LSBk	3	0	0	0	0	4	80	1	20	0	0	
3	TRP	2	0	0	0	0	2	67	1	33	0	0	
1	PLP	1	0	0	0	0	1	100	0	0	0	0	
1	BPB	1	0	0	1	100	0	0	0	0	0	0	
1	BPR	1	0	0	0	0	1	100	0	0	0	0	

**Indian Creek**

**Table 5 - Summary of Mean Percent Cover By Habitat Type**

**Stream Name:** Indian Creek

**LLID:** 1234414390578

**Drainage:** Navarro River

**Survey Dates:** 7/2/2007 to 9/21/2007

<b>Confluence</b>		<b>Quad:</b> PHILO	<b>Legal</b>			T14NR14WS19	<b>Latitude:</b> 39:03:28.0N	<b>Longitude:</b> 123:26:29.0W				
Habitat Units	Units Fully Measured	Habitat Type	Mean % Undercut Banks	Mean % SWD	Mean % LWD	Mean % Root Mass	Mean % Terr. Vegetation	Mean % Aquatic Vegetation	Mean % White Water	Mean % Boulders	Mean % Bedrock Ledges	
133	19	LGR	1	23	3	6	29	1	3	33	2	
85	12	HGR	0	2	2	3	3	1	11	63	0	
5	2	CAS	0	10	0	0	0	0	35	55	0	
1	1	BRS	0	0	0	0	0	0	80	20	0	
61	12	POW	0	6	0	0	7	3	0	84	0	
94	22	GLD	0	21	3	4	25	0	4	35	3	
45	10	RUN	0	20	2	2	17	0	1	41	7	
67	16	SRN	1	11	3	2	4	0	9	67	4	
2	1	EDW	0	10	20	0	10	0	0	60	0	
3	3	TRP	0	7	0	0	0	0	7	33	53	
148	146	MCP	1	12	5	7	8	0	1	51	15	
2	2	STP	0	5	0	5	5	0	10	70	5	
2	2	CRP	0	50	5	10	15	0	0	15	5	
1	1	LSL	0	20	30	10	40	0	0	0	0	
3	3	LSR	3	42	7	33	7	0	0	8	0	
5	5	LSBk	0	0	0	0	6	2	0	48	44	
7	7	LSBo	0	13	3	1	0	0	10	70	3	
1	1	PLP	0	10	0	0	0	0	30	60	0	
7	7	SCP	0	9	3	10	4	17	1	42	0	
1	1	BPB	0	20	0	0	30	10	0	40	0	
1	1	BPR	25	25	0	25	0	0	0	25	0	
3	0	NS										

# Indian Creek

## Table 6 - Summary of Dominant Substrates By Habitat

**Stream Name:** Indian Creek

**LLID:** 1234414390578

**Drainage:** Navarro River

**Survey Dates:** 7/2/2007 to 9/21/2007

<b>Confluence</b>		<b>Quad:</b> PHILO	<b>Legal</b>		T14NR14WS19	<b>Latitude:</b> 39:03:28.0N	<b>Longitude:</b> 123:26:29.0W		
Habitat Units	Units Fully Measured	Habitat Type	% Total Silt/Clay Dominant	% Total Sand Dominant	% Total Gravel Dominant	% Total Small Cobble Dominant	% Total Large Cobble Dominant	% Total Boulder Dominant	% Total Bedrock Dominant
133	87	LGR	0	0	45	45	8	2	0
85	20	HGR	0	0	10	15	20	50	5
5	3	CAS	0	0	0	0	0	100	0
1	1	BRS	0	0	0	0	0	0	100
61	22	POW	0	0	18	5	14	55	9
94	69	GLD	1	0	70	23	1	1	3
45	32	RUN	0	0	41	34	9	16	0
67	28	SRN	0	0	18	11	18	43	11
2	2	EDW	0	0	50	50	0	0	0
3	3	TRP	0	0	67	0	0	0	33
148	147	MCP	0	1	61	13	3	13	8
2	2	STP	0	0	0	0	0	100	0
2	2	CRP	0	0	50	50	0	0	0
1	1	LSL	0	0	100	0	0	0	0
3	3	LSR	33	0	33	33	0	0	0
5	5	LSBk	0	0	60	0	0	0	40
7	7	LSBo	0	0	71	14	14	0	0
1	1	PLP	0	0	0	0	0	0	100
7	7	SCP	29	0	43	14	0	14	0
1	1	BPB	0	0	100	0	0	0	0

# Indian Creek

**Table 7 - Summary of Mean Percent Canopy for Entire**

<b>Stream Name:</b>	Indian Creek	<b>LLID:</b>	1234414390578	<b>Drainage:</b>	Navarro River		
<b>Survey Dates:</b>	7/2/2007 to 9/21/2007						
<b>Confluence</b>	<b>Quad:</b> PHILO	<b>Legal</b>	T14NR14WS19	<b>Latitude:</b>	39:03:28.0N	<b>Longitude:</b>	123:26:29.0W
Habitat Units	Mean Percent Conifer	Mean Percent Hardwood	Mean Percent Open Units	Mean Right Bank % Cover	Mean Left Bank % Cover		
72	30	70	0	32	31		

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

Open units represent habitat units with zero canopy cover.

# Indian Creek

**Table 8 - Fish Habitat Inventory Data**

Stream Name: Indian Creek LLID: 1234414390578 Drainage:  
 Navarro River  
 Survey Dates: 7/2/2007 to 9/21/2007 Survey Length (ft.): 41411 Main Channel (ft.): 39834 Side Channel  
 (ft.): 1577  
 Confluence Location: Quad: PHILO Legal T14NR14WS19 Latitude 39:03:28.0N  
 Longitude: 123:26:29.0W

## Summary of Fish Habitat Elements By Stream Reach

**STREAM REACH: 1**

Channel Type: F4	Canopy Density (%): 61.5	Pools by Stream Length
(%): 21.7		
Reach Length (ft.): 8630	Coniferous Component (%): 24.0	Pool Frequency (%):
28.6		
Riffle/Flatwater Mean Width (ft.): 14.9	Hardwood Component (%): 76.0	Residual Pool Depth (%):
BFW:	Dominant Bank Vegetation: Hardwood Trees	< 2 Feet Deep: 12.5
Range (ft.): 68 to 68	Vegetative Cover (%): 58.9	2 to 2.9 Feet Deep: 40.6
Mean (ft.): 68	Dominant Shelter: Small Woody Debris	3 to 3.9 Feet Deep: 34.4
Std. Dev.: 0	Dominant Bank Substrate Type: Cobble/Gravel	>= 4 Feet Deep: 12.5
Base Flow (cfs): 0	Occurrence of LWD (%): 10.9	Mean Max Residual Pool
Depth (ft.): 2.90		
Water (F): 61 - 74 Air (F): 71 - 86	LWD per 100 ft.:	Mean Pool Shelter Rating: 24
Dry Channel (ft.): 0	Riffles: 1	
	Pools: 2	
	Flat: 1	
Pool Tail Substrate (%): Silt/Clay: 0.0 Sand: 0.0 Gravel: 68.8 Sm Cobble: 28.1 Lg Cobble: 3.1 Boulder: 0.0		
Bedrock: 0.0		
Embeddedness Values (%): 1. 21.9 2. 71.9 3. 6.3 4. 0.0 5. 0.0		

**STREAM REACH: 2**

Channel Type: F3	Canopy Density (%): 79.3	Pools by Stream Length
(%): 22.3		
Reach Length (ft.): 3437	Coniferous Component (%): 28.3	Pool Frequency (%):
25.0		
Riffle/Flatwater Mean Width (ft.): 24.1	Hardwood Component (%): 71.7	Residual Pool Depth (%):
BFW:	Dominant Bank Vegetation: Hardwood Trees	< 2 Feet Deep: 50.0
Range (ft.): to	Vegetative Cover (%): 33.3	2 to 2.9 Feet Deep: 40.0
Mean (ft.):	Dominant Shelter: Boulders	3 to 3.9 Feet Deep: 10.0
Std. Dev.:	Dominant Bank Substrate Type: Cobble/Gravel	>= 4 Feet Deep: 0.0
Base Flow (cfs): 0	Occurrence of LWD (%): 2.6	Mean Max Residual Pool
Depth (ft.): 2.22		
Water (F): 66 - 72 Air (F): 65 - 84	LWD per 100 ft.:	Mean Pool Shelter Rating: 16
Dry Channel (ft.): 0	Riffles: 0	
	Pools: 1	
	Flat: 1	
Pool Tail Substrate (%): Silt/Clay: 0.0 Sand: 0.0 Gravel: 90.0 Sm Cobble: 0.0 Lg Cobble: 0.0 Boulder: 10.0		
Bedrock: 0.0		
Embeddedness Values (%): 1. 10.0 2. 80.0 3. 0.0 4. 0.0 5. 10.0		

# Indian Creek

## STREAM REACH: 3

Channel Type: B2 (%): 41.6	Canopy Density (%): 72.2	Pools by Stream Length
Reach Length (ft.): 4716 41.0	Coniferous Component (%): 36.2	Pool Frequency (%):
Riffle/Flatwater Mean Width (ft.): 19.1	Hardwood Component (%): 63.8	Residual Pool Depth (%):
BFW:	Dominant Bank Vegetation: Hardwood Trees	< 2 Feet Deep: 20.9
Range (ft.): 22 to 47	Vegetative Cover (%): 15.8	2 to 2.9 Feet Deep: 46.5
Mean (ft.): 33.2631578947368	Dominant Shelter: Boulders	3 to 3.9 Feet Deep: 20.9
Std. Dev.: 6.88279399558025	Dominant Bank Substrate Type: Boulder	>= 4 Feet Deep: 11.6
Base Flow (cfs): 0	Occurrence of LWD (%): 1.9	Mean Max Residual Pool
Depth (ft.): 2.67	LWD per 100 ft.:	Mean Pool Shelter Rating: 18
Water (F): 61 - 74	Riffles: 1	
Air (F): 55 - 85	Pools: 1	
Dry Channel (ft.): 0	Flat: 1	
Pool Tail Substrate (%): Silt/Clay: 0.0 Bedrock: 4.3	Sand: 0.0	Gravel: 47.8
	Sm Cobble: 21.7	Lg Cobble: 0.0
	Boulder: 26.1	
Embeddedness Values (%): 1. 0.0	2. 43.5	3. 21.7
	4. 6.5	5. 28.3

## STREAM REACH: 4

Channel Type: B3 (%): 33.6	Canopy Density (%): 68.5	Pools by Stream Length
Reach Length (ft.): 2196 32.5	Coniferous Component (%): 42.5	Pool Frequency (%):
Riffle/Flatwater Mean Width (ft.): 22.7	Hardwood Component (%): 57.5	Residual Pool Depth (%):
BFW:	Dominant Bank Vegetation: Hardwood Trees	< 2 Feet Deep: 15.4
Range (ft.): 31 to 35	Vegetative Cover (%): 21.6	2 to 2.9 Feet Deep: 46.2
Mean (ft.): 32.3	Dominant Shelter: Boulders	3 to 3.9 Feet Deep: 23.1
Std. Dev.: 1.61554944214035	Dominant Bank Substrate Type: Boulder	>= 4 Feet Deep: 15.4
Base Flow (cfs): 0	Occurrence of LWD (%): 2.3	Mean Max Residual Pool
Depth (ft.): 2.83	LWD per 100 ft.:	Mean Pool Shelter Rating: 22
Water (F): 61 - 72	Riffles: 1	
Air (F): 66 - 72	Pools: 1	
Dry Channel (ft.): 0	Flat: 1	
Pool Tail Substrate (%): Silt/Clay: 0.0 Bedrock: 0.0	Sand: 0.0	Gravel: 69.2
	Sm Cobble: 15.4	Lg Cobble: 7.7
	Boulder: 7.7	
Embeddedness Values (%): 1. 7.7	2. 53.8	3. 23.1
	4. 0.0	5. 15.4

## STREAM REACH: 5

Channel Type: F4 (%): 20.2	Canopy Density (%): 58.8	Pools by Stream Length
Reach Length (ft.): 9037 23.5	Coniferous Component (%): 41.6	Pool Frequency (%):
Riffle/Flatwater Mean Width (ft.): 19.0	Hardwood Component (%): 58.4	Residual Pool Depth (%):
BFW:	Dominant Bank Vegetation: Hardwood Trees	< 2 Feet Deep: 25.9
Range (ft.): 21 to 42	Vegetative Cover (%): 27.9	2 to 2.9 Feet Deep: 33.3
Mean (ft.): 32.2130434782609	Dominant Shelter: Boulders	3 to 3.9 Feet Deep: 29.6

## Indian Creek

Std. Dev.:	7.32596955137509	Dominant Bank Substrate Type:	Cobble/Gravel	>= 4 Feet Deep:	11.1	
Base Flow (cfs):	0	Occurrence of LWD (%):	3.9	Mean Max Residual Pool		
Depth (ft.):	2.64	LWD per 100 ft.:		Mean Pool Shelter Rating:	32	
Water (F):	65 - 81	Air (F):	62 - 86	Riffles:	0	
Dry Channel (ft.):	0			Pools:	1	
				Flat:	0	
Pool Tail Substrate (%):	Silt/Clay: 0.0	Sand: 0.0	Gravel: 55.6	Sm Cobble: 37.0	Lg Cobble: 7.4	Boulder: 0.0
Bedrock:	0.0					
Embeddedness Values (%):	1. 0.0	2. 25.9	3. 63.0	4. 3.7	5. 7.4	

## Indian Creek

**Table 9 -Mean Percentage of Dominant Substrate and Vegetation**

**Stream Name:** Indian Creek **LLID:** 1234414390578 **Drainage:** Navarro River  
**Survey Dates:** 7/2/2007 to 9/21/2007  
**Confluence** **Quad:** PHILO **Legal** T14NR14WS19 **Latitude:** 39:03:28.0N **Longitude:** 123:26:29.0W

### Mean Percentage of Dominant Stream Bank

Dominant Class of Substrate	Number of Units Right Bank	Number of Units Left Bank	Total Mean Percentage (%)
Bedrock	59	69	22.6
Boulder	109	121	40.6
Cobble/Gravel	81	72	27.0
Sand/Silt/Cla	34	21	9.7

### Mean Percentage of Dominant Stream Bank

Dominant Class of Vegetation	Number of Units Right Bank	Number of Units Left Bank	Total Mean Percentage
Grass	32	40	12.7
Brush	44	39	14.7
Hardwood Trees	168	164	58.7
Coniferous	34	31	11.5
No	4	8	2.1

**Total Stream Cobble Embeddedness** 2



## Indian Creek

**Table 10 - Mean Percent of Shelter Cover Types For Entire System**

**Stream Name:** Indian Creek

**LLID:** 1234414390578

**Drainage:** Navarro River

**Survey Dates:** 7/2/2007 to 9/21/2007

**Confluence**

**Quad:** PHILO

**Legal**

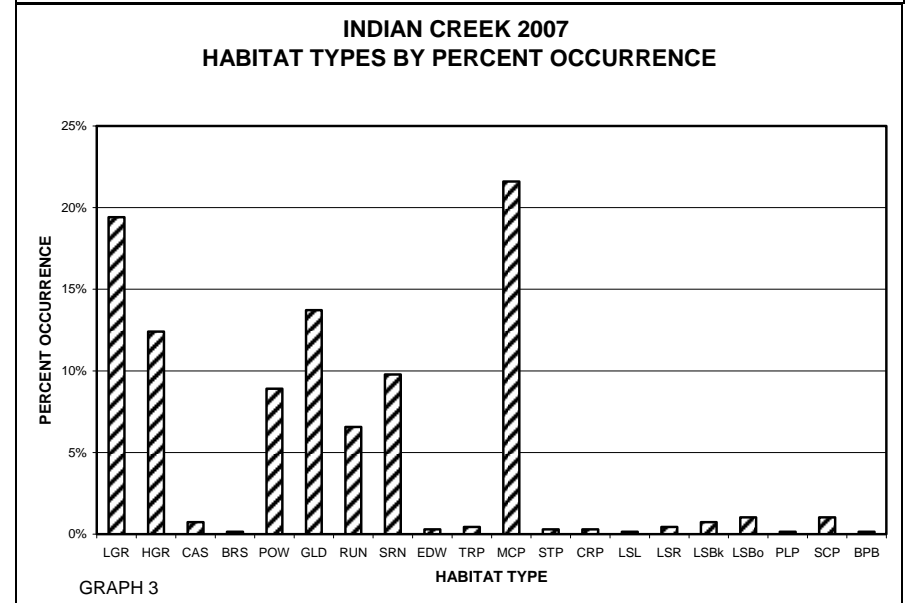
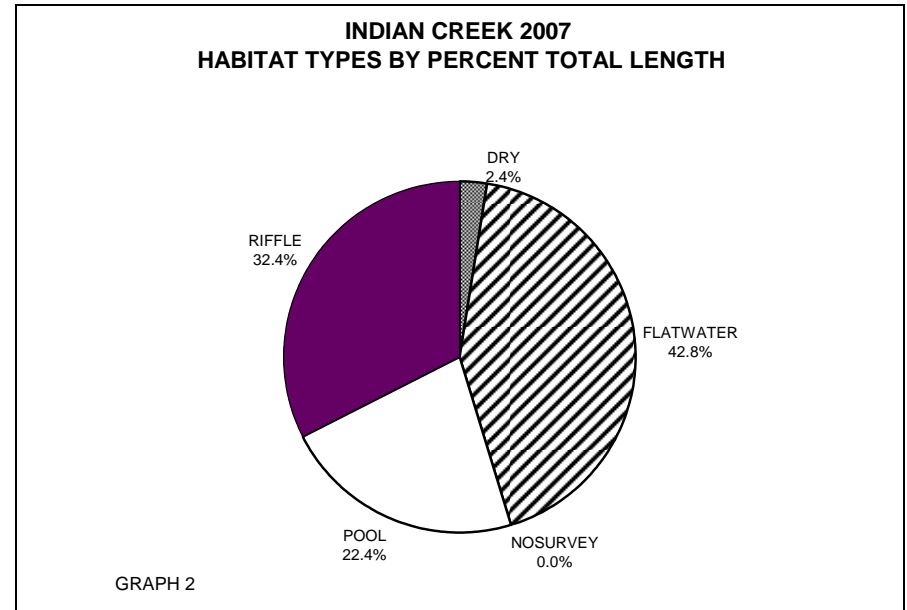
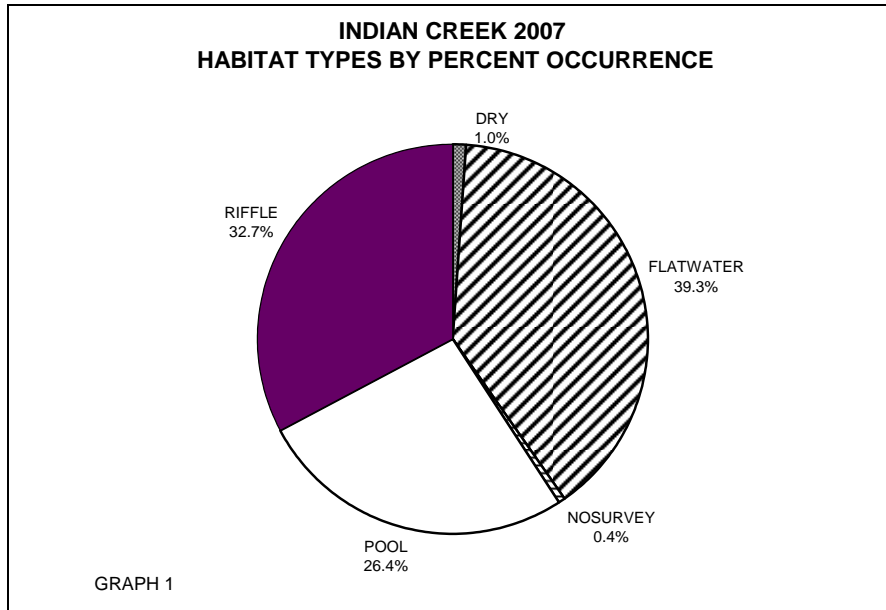
T14NR14WS19

**Latitude:** 39:03:28.0N

**Longitude:** 123:26:29.0W

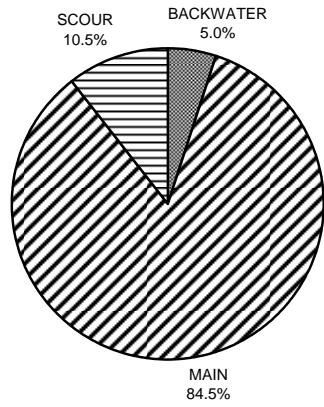
	<b>Riffles</b>	<b>Flatwater</b>	<b>Pools</b>
UNDERCUT BANKS (%)	0	0	1
SMALL WOODY DEBRIS (%)	14	15	12
LARGE WOODY DEBRIS (%)	2	3	4
ROOT MASS (%)	4	2	7
TERRESTRIAL VEGETATION (%)	17	14	7
AQUATIC VEGETATION (%)	1	0	1
WHITEWATER (%)	10	4	2
BOULDERS (%)	44	54	50
BEDROCK LEDGES (%)	1	3	14

# Indian Creek



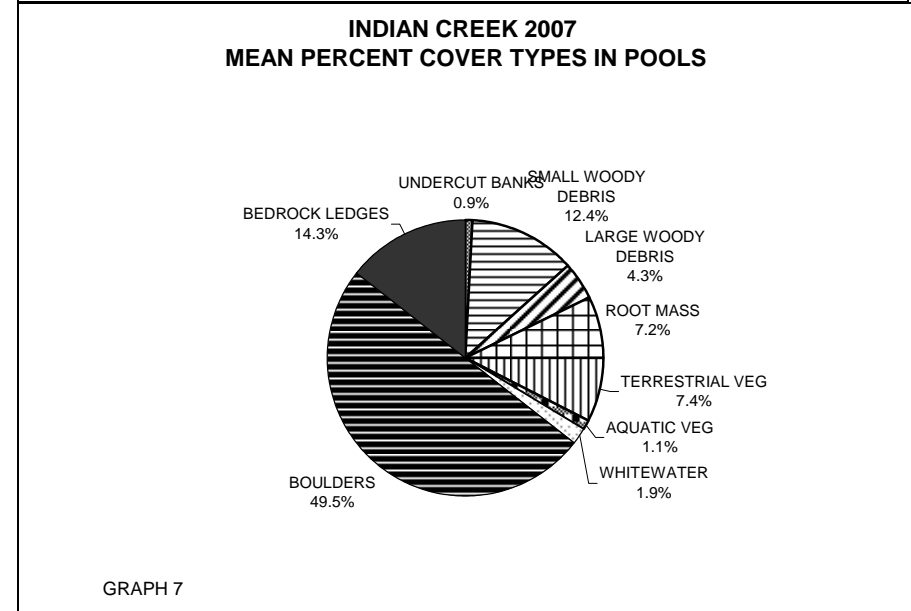
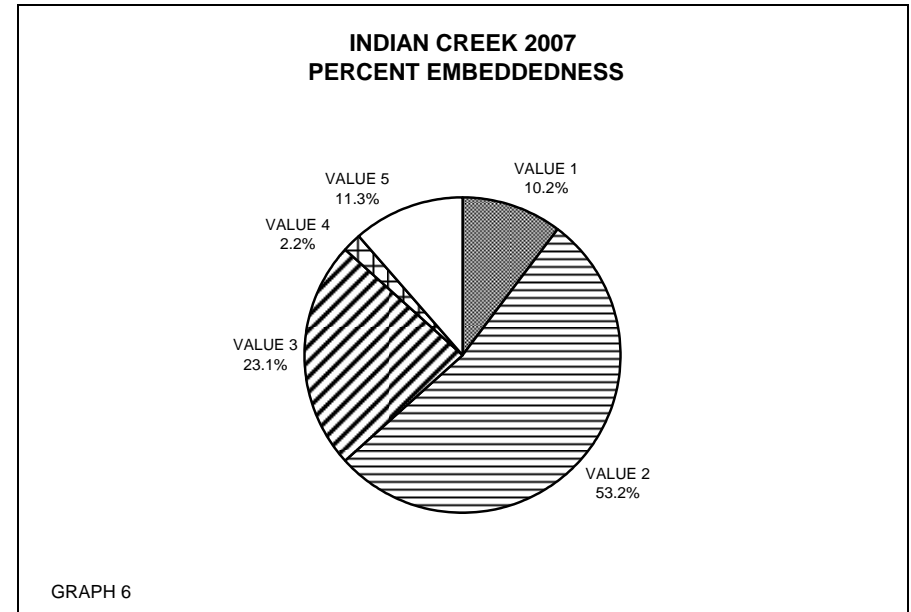
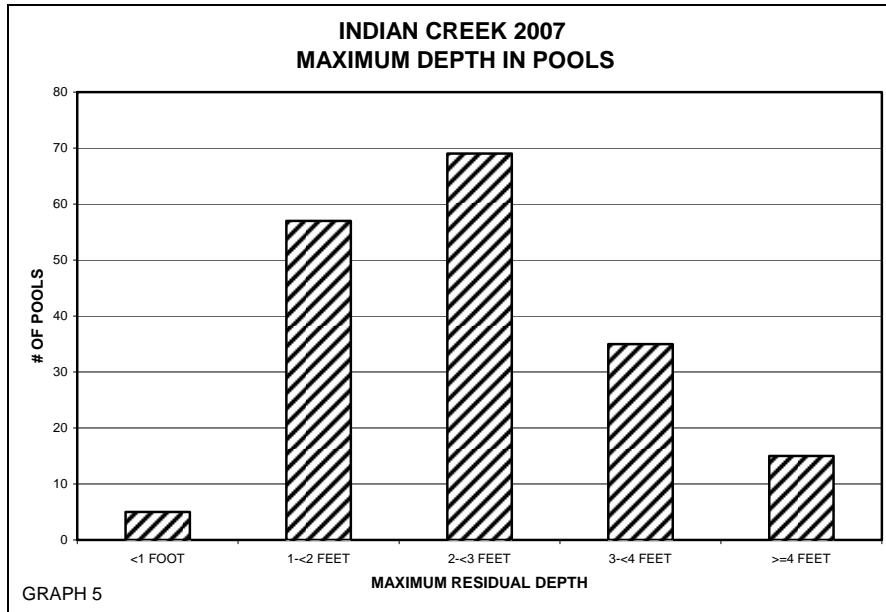
# Indian Creek

**INDIAN CREEK 2007  
POOL TYPES BY PERCENT OCCURRENCE**

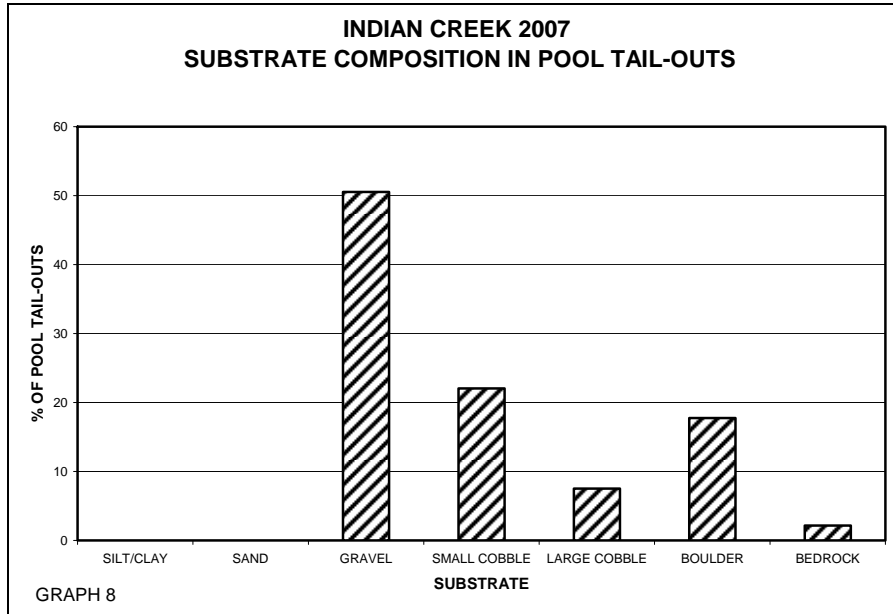


GRAPH 4

# Indian Creek



# Indian Creek



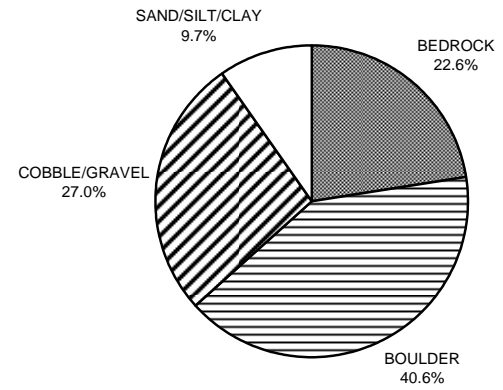
# Indian Creek

**INDIAN CREEK 2007  
MEAN PERCENT CANOPY**



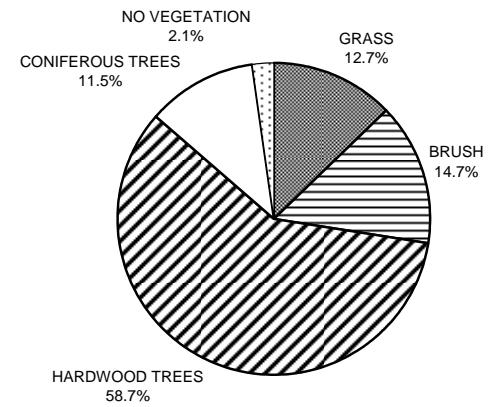
GRAPH 9

**INDIAN CREEK 2007  
DOMINANT BANK COMPOSITION IN SURVEY REACH**



GRAPH 10

**INDIAN CREEK 2007  
DOMINANT BANK VEGETATION IN SURVEY REACH**



GRAPH 11