APPENDIX B

Aquatic Biology Monitoring Report for the Willow Creek Coal Mine

1997 Fish and Macroinvertebrate Studies

Prepared for:

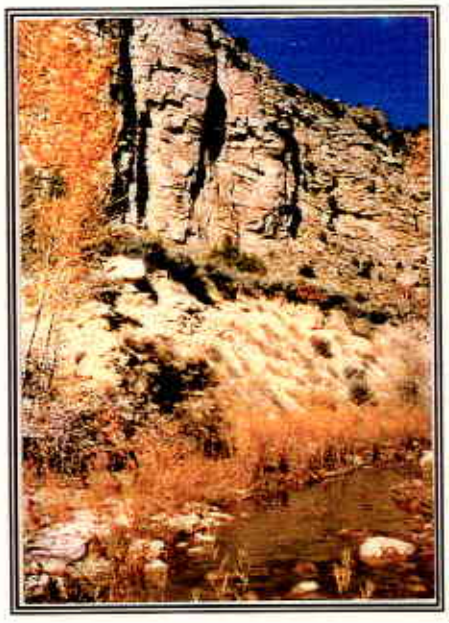
CYPRUS PLATEAU MINING CORPORATION

Helper, Utah

Prepared by:

HYDROBIOS CONSULTANTS

Fort Collins, Colorado



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1.0 INTRODUCTION

Cyprus Plateau Mining Corporation (Cyprus) began operating the Willow Creek Coal Mine in May 1996. The mine, which is located approximately 4 miles north of Helper, Utah, is situated in the lower portion of Willow Creek Canyon (Figure 1-1). Two segments of Willow Creek were relocated in June through August of 1996 to allow additional area for mine facilities. The design of the new diversion segments was approved by the Utah Division of Oil, Gas, & Mining (UDOGM), the U.S. Army Corps of Engineers (COE), the State Water Rights Engineer, and the Utah Division of Wildlife Resources (UDWR). The lengths of the upper and lower diversion segments were approximately 300 and 800 feet (ft), respectively.

The following information provides a summary of flow conditions in the diversion segments and Willow Creek from August 1996 through April 1997. After construction was completed in August 1996, surface flow was resumed and continued throughout the year in the upper diversion segment. However, when the surface water reached the lower diversion segment, flow moved into the subsurface materials due to a design consisting of rock substrate without fine materials. Water flowed beneath the rock surface in the lower diversion segment for portions of the remainder of the year. During rainfall events in August and September, the lower segment exhibited surface flow for short periods of time (typically one to three days); otherwise, surface flow was lacking. In mid-August 1996, a portion of the lower segment was sealed with a soil and bentonite mixture in an attempt to seal the interstitial spaces around the rocks and restore surface flow. Although the soil/bentonite mixture was effective in a localized area, the agencies decided that the same effort was not justified for the entire lower segment. Since natural flow in Willow Creek during the post-construction period was low due to lack of precipitation, sufficient surface flow was not available to fill the void spaces and deposit sediments that would seal the spaces. In total, surface flow was absent or extremely low in the lower diversion segment for approximately seven months (August 1996 through early March 1997).

Flow in Willow Creek from the lower diversion segment downstream to the Price River also was very low due to water loss in the lower relocated segment and minimal natural runoff conditions. At times from August through December 1996, flow was absent all the way to the Price River. Significant flow was not resumed in Willow Creek until spring runoff began in early March 1997. The winter of 1996/1997 was relatively mild and wet, which resulted in an earlier than normal runoff; typically runoff in Willow Creek begins in April. The high spring

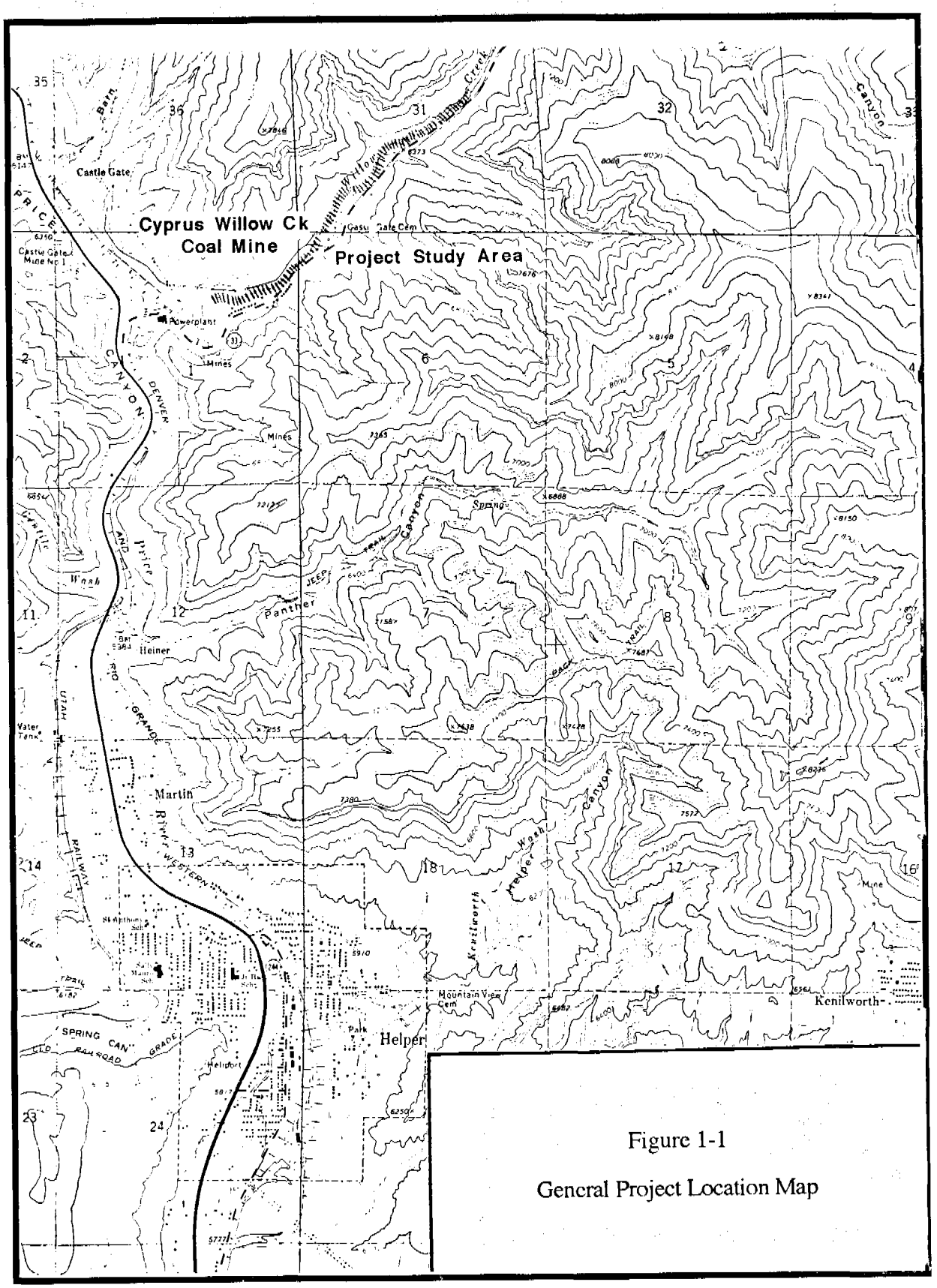

Figure 1-1

General Project Location Map

flows in 1997 carried the necessary silt that sealed the rock interstitial spaces. Since March 1997, continuous flow existed in Willow Creek all the way to the Price River.

Willow Creek, which is a perennial stream located adjacent to the Cyprus Willow Creek Coal Mine, is considered a Class 4 stream by the UDWR. This classification is defined as a stream with low recreational fishing potential. Based on previous baseline sampling, the stream contained low numbers of two game fish species, rainbow trout and Yellowstone cutthroat trout. Sampling in 1997 resulted in one additional game fish species, brown trout.

Fish, benthic macroinvertebrate, and habitat studies were conducted in 1994 and 1995 to provide baseline information for the UDOGM permit. As part of required monitoring for the Willow Creek Coal Mine, fish and benthic macroinvertebrate studies were conducted in 1997. The UDWR provided field assistance during both fish surveys in 1997. Previous surveys conducted in 1994 and 1995 were completed solely by HydroBios Consultants. The studies repeated the same sampling methods that were used in 1995. The purpose of the monitoring studies was twofold: (1) determine if any dramatic changes have occurred in the fish and macroinvertebrate communities in Willow Creek; and (2) evaluate if aquatic communities have become established in the diversion segments. Potential factors that may have affected fish and macroinvertebrate communities are discussed in this report.

The remaining sections of this report describe the methods (2.0), results and discussion (3.0), and summary and conclusions (4.0). The 1997 results are compared to previous sampling efforts in 1995 for fish and 1995 and 1994 studies for macroinvertebrates.

2.0 METHODS

Fish and benthic macroinvertebrate sampling was conducted in July and October 1997 at six locations in Willow Creek. One reference location (WC-1R) was established upstream of the project study area, while five locations were sampled in Willow Creek in an area adjacent to the Cyprus Willow Creek Coal Mine. Two locations, WC-4D (upper diversion) and WC-5D (lower diversion), were new locations that were established in the diversion channels in 1997. In 1995, locations WC-4 and WC-5 were situated in Willow Creek prior to construction of the diversion channels. Location of the sampling segments are listed below (township, range, section) and shown in Figure 2-1:

- WC-1R - T12S, R10E, S31, NE 1/4, NE 1/4
- WC-2 - T12S, R10E, S31, SW 1/4, NE 1/4
- WC-3 - T12S, R10E, S31, SW 1/4, SW 1/4
- WC-4D - T13S, R10E, S6, NW 1/4, NW 1/4
- WC-5D - T13S, R9E, S1, NE 1/4, SE 1/4
- WC-6 - T13S, R9E, S1, NE 1/4, SW 1/4

The following information describes the sampling methodologies that were used in the monitoring studies.

2.1 FISH

Fish population surveys were conducted on July 22 and 23 and October 22, 1997. Sampling at each location consisted of electroshocking the entire length of the segment (about 100 feet [ft] long). The fish population studies began in the lower portion of Willow Creek at location WC-6 and proceeded in an upstream direction to minimize any disturbance to the sampling locations. After marking the upper and lower ends of the segment with wooden stakes, a fine mesh seine net was used to block the ends of the segment. A two-pass removal method (Seber and LeCren 1967) was used to estimate fish numbers at each location. Three biologists electrofished the segment by walking slowly in an upstream direction starting at the lower block net. All stunned fish were netted and placed in a plastic bucket for processing. After completing the initial pass through the segment, all fish were identified and enumerated. Non-trout species such as speckled dace (*Rhinicthys osculus*) and mountain sucker (*Catostomus platyrhynchus*) were enumerated by general age classifications such as young-of-the-year (YOY), juvenile, and adult. No weights were taken for non-trout species. All trout were identified and enumerated by species and measured for total lengths in millimeters and weights in grams. After processing fish from the first pass, they were returned to an area

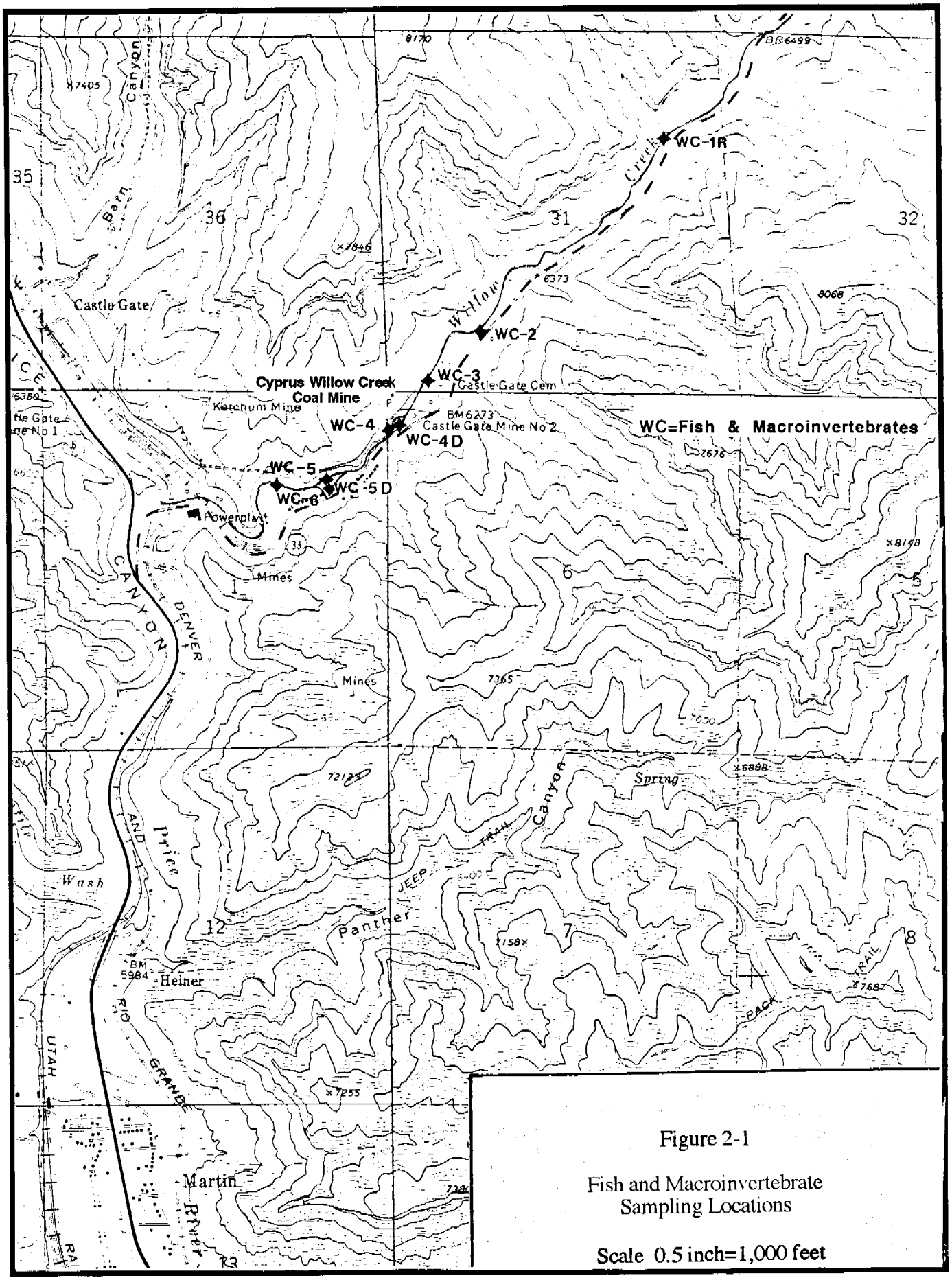

Figure 2-1

Fish and Macroinvertebrate Sampling Locations

Scale 0.5 inch=1,000 feet

located at least 100 ft downstream of the lower block net. Care was taken to minimize handling of the fish and complete field processing in a timely manner to reduce possible fish mortalities. The second pass was made through the segment to collect and process fish in the same manner as described for the first pass. The presence of any state listed or federal candidate species was noted during both passes. All information was recorded on field data sheets.

The following equation was used for estimating populations for each species at each sampling location:

$$N = \frac{(U_1)^2}{(U_1 - U_2)}$$

Where: N = population estimate;
U_1= number of fish removed during the first pass; and
U_2= number of fish removed during the second pass.

Data resulting from the fish population surveys included population estimates at each location, composition by general age classifications, and length/weight summaries for trout species. Population estimates were expressed as the number of fish per 100 ft length of stream. Trout biomass was expressed as pounds per 1,000 ft^2.

Qualitative sampling for trout also was conducted on July 23 and October 22, 1997 in a 500-ft section of Willow Creek. The lower portion of the site was located approximately 900 ft downstream of WC-6. Trout were identified and measured for total length (millimeters) and weight (grams). The presence of other fish species was noted.

2.2 BENTHIC MACROINVERTEBRATES

Macroinvertebrate sampling was conducted on July 24 and October 21, 1997. Two replicate samples were collected at each site using a Surber sampler. The sampler consisted of a 1 ft^2 frame and an attached net with a bucket (0.5 mm mesh). Each sample was collected in a riffle area by rubbing all rock surfaces within the frame in front of the net opening. A wooden stake then was used to stir the small substrate material located within the sampling frame. All organisms and substrate material drifted into the net end of the sampler. After the material had drifted into the net, it was removed from the stream and rinsed from the top towards the bottom

end. Rinsing continued until all material on the sides of the net had been washed into the attached bucket. The contents of the bucket were concentrated and placed into a sample jar and then preserved. Samples were preserved by adding several drops of formalin to an approximate 70 percent water/ethanol mixture. Laboratory processing consisted of "sorting and picking" all macroinvertebrates into labeled vials, followed by identification and enumeration of all organisms in each sample. Densities were presented as the number of each taxon/ft^2. Data analyses consisted of a species list, mean percent composition, mean densities, species diversity, and evenness for each sampling site. The Shannon-Wiener species diversity index was calculated in base e, as discussed in Brower and Zar (1977).

3.0 RESULTS AND DISCUSSION

3.1 FISH

Based on sampling in 1995 and 1997, the fish community in Willow Creek was represented by eight species and one hybrid trout (Table 3-1). Qualitative sampling in lower Willow Creek during 1997 revealed two species, brown trout and Utah chub, that were not previously collected in 1995. Bluehead sucker was collected only in 1995. The other fish species were collected during both years. The following sections discuss the results of the 1997 sampling effort for trout and native nongame species. Comparisons also were made between the 1995 and 1997 studies.

Table 3-1
Fish Species Collected in Willow Creek, 1995 and 1997

Species		1995		1997	
Common Name	**Scientific Name**	**June**	**Oct**	**July**	**Oct**
Trout	Salmonidae				
Cutthroat Trout	*Oncorhynchus clarki*		X		
Rainbow Trout	*Oncorhynchus mykiss*	X	X	X	X
Rainbow X Cutthroat Hybrid	*O. clarki X O. mykiss*				X
Brown Trout	*Salmo trutta*				X
Suckers	Catostomidae				
Bluehead sucker	*Catostomus discobolus*	X			
Mountain sucker	*Catostomus platyrhynchus*	X	X	X	X
Minnows	Cyprinidae				
Utah chub	*Gila atraria*				X
Speckled dace	*Rhinichthys osculus*	X	X	X	X
Redside shiner	*Richardsonius balteatus*	X	X	X	X

3.1.1 TROUT

Three trout species (rainbow, cutthroat, and brown) were collected at least once during the 1995 and 1997 surveys. One hybridized cutthroat/rainbow trout also was collected in 1997. Rainbow trout was present during both summer and fall sampling efforts, while cutthroat and brown trout were limited to the fall (Table 3-1). Rainbow trout and cutthroat trout were collected in both 1995 and 1997. Brown trout was collected for the first time in October 1997. Of the three trout species, rainbow trout was the only species that was found at five of the six sampling locations in 1997 (Tables 3-2 and 3-3).

Trout numbers were relatively low in both 1995 and 1997 (Table 3-4). In 1997, total trout numbers ranged from 0 to 3/100 ft segment, which was similar to numbers reported in 1995. In both years, trout numbers were slightly higher in the fall compared to the summer. Trout numbers by individual species in 1997 are shown in Tables 3-2 and 3-3 (see Appendix C for the 1995 results). When present, rainbow trout was the dominant trout species at all sampling locations. Lengths and weights of trout collected in 1997 are provided in Appendix A. Trout populations were comprised almost entirely of adults. One notable exception occurred in October 1997, when one juvenile rainbow was found at location WC-4D. All trout collected in 1995 and 1997 appeared to be in good health, with no evidence of disease or parasites.

Trout biomass in Willow Creek varied between 0 and 0.75 pounds (lb.)/1,000 ft^2 in 1997 and 0 and 1.74 lb./1,000 ft^2 in 1995 (Table 3-5). The higher biomass in 1995 was mainly a reflection of the relatively smaller areas sampled in 1995, when low flow conditions resulted in narrower stream widths.

3.1.2 NATIVE NONGAME SPECIES

Of the five native nongame species collected in Willow Creek, the most common and widespread species included speckled dace and mountain sucker (Table 3-1). These two species were present at all six population locations and the qualitative reach during both 1995 and 1997. Bluehead sucker was collected at locations WC-1R, WC-2, and WC-4 in June 1995, but it was not present during the remaining three sampling efforts. Redside shiner was found at the lower three population locations in 1995, but it was absent from these sites in 1997. However, redside shiner was present in the qualitative reach in both years. The occurrence of Utah chub was limited to one specimen that was collected in the qualitative reach in 1997.

Table 3-2

Fish Population Survey Conducted in Willow Creek, July 22 and 23, 1997

Species/Life Stage	WC-1R			WC-2			WC-3		
	1st	2nd	No./100 Ft.	1st	2nd	No./100 Ft.	1st	2nd	No./100 Ft.
Mountain sucker									
YOY	1	1		0	0		1	0	
Juvenile	0	0		3	1		2	0	
Adult	13	6		7	1		3	0	
Total	14	7	28	10	2	12	6	0	6
Speckled dace									
YOY	2	0		0	1		0	5	
Juvenile	2	2		4	3		2	3	
Adult	19	12		8	5		12	0	
Total	23	14	59	12	9	48	14	8	33
Rainbow trout									
Adult	0	0	0	0	0	0	0	1	1
TOTAL FISH[1]	37	21	87	22	11	60	20	9	40

Species/Life Stage	WC-4D			WC-5D			WC-6		
	1st	2nd	No./100 Ft.	1st	2nd	No./100 Ft.	1st	2nd	No./100 Ft.
Mountain sucker									
YOY	1	0		0	0		1	0	
Juvenile	3	1		0	0		1	1	
Adult	2	5		7	2		4	0	
Total	6	6	36	7	2	10	6	1	7
Speckled dace									
YOY	0	0		0	0		1	0	
Juvenile	1	0		0	0		2	0	
Adult	5	3		2	0		9	4	
Total	6	3	13	2	0	2	12	4	18
Rainbow trout									
Adult	1	0	1	1	0	1	1	0	1
TOTAL FISH[1]	12	9	50	10	2	13	19	5	26

[1]Total fish/100 ft segment was calculated by summing the population estimates for each species.

Table 3-3
Fish Population Survey Conducted in Willow Creek, October 22, 1997

Species/Life Stage	WC-1R			WC-2			WC-3		
	1st	2nd	No./100 Ft.	1st	2nd	No./100 Ft.	1st	2nd	No./100 Ft.
Mountain sucker									
YOY	0	0		0	0		0	0	
Juvenile	0	0		0	0		3	0	
Adult	5	4		7	2		0	4	
Total	5	4	25	7	2	10	3	4	9
Speckled dace									
YOY	0	0		0	0		0	0	
Juvenile	1	1		0	0		0	0	
Adult	19	10		5	3		10	7	
Total	20	11	44	5	3	13	10	7	33
Rainbow trout									
Adult	1	0	1	0	0	0	2	0	2
TOTAL FISH[1]	26	15	70	12	5	23	15	11	44

Species/Life Stage	WC-4D			WC-5D			WC-6		
	1st	2nd	No./100 Ft.	1st	2nd	No./100 Ft.	1st	2nd	No./100 Ft.
Mountain sucker									
YOY	0	0		0	0		0	0	
Juvenile	1	0		1	1		0	1	
Adult	4	6		1	0		2	0	
Total	5	6	25	2	1	4	2	1	4
Speckled dace									
YOY	1	0		0	1		0	2	
Juvenile	0	0		1	0		0	0	
Adult	1	1		1	0		2	0	
Total	2	1	4	2	1	4	2	2	4
Rainbow trout									
Juvenile	1	0		0	0		0	0	
Adult	1	0		1	0		1	0	
Total	2	0	2	1	0	1	1	0	1
Cutthroat/Rainbow Hybrid									
Adult	1	0	1	0	0	0	0	0	0
TOTAL FISH[1]	10	7	32	5	2	9	5	3	9

[1]Total fish/100 ft segment was calculated by summing the population estimates for each species.

Table 3-4
Total Trout Numbers (Number/100 Ft Segment) in Willow Creek

Sampling Locations	1995		1997	
	June	Oct	July	Oct
WC-1R	0	1	0	1
WC-2	0	0	0	0
WC-3	1	1	1	2
WC-4	0	3	Not Sampled	Not Sampled
WC-4D	Not Sampled	Not Sampled	1	3
WC-5	3	2	Not Sampled	Not Sampled
WC-5D	Not Sampled	Not Sampled	1	1
WC-6	0	3	1	1

Table 3-5
Trout Biomass (Pounds/1,000 Ft^2) in Willow Creek

Sampling Locations	1995		1997	
	June	Oct	July	Oct
WC-1R	0	1.15	0	0.62
WC-2	0	0	0	0
WC-3	0.42	1.56	0.53	0.75
WC-4	0	1.74	Not Sampled	Not Sampled
WC-4D	Not Sampled	Not Sampled	0.32	0.62
WC-5	0.88	1.05	Not Sampled	Not Sampled
WC-5D	Not Sampled	Not Sampled	0.23	0.21
WC-6	0	1.63	0.23	0.35

As shown in Tables 3-2 and 3-3, total fish densities were dominated by speckled dace and mountain sucker. These two species collectively accounted for over 90 percent of the fish densities at all sampling locations. In 1997, population estimates ranged from 4 to 36 mountain sucker/100 ft segment and 2 to 59 speckled dace/100 ft segment. The highest densities for both species occurred in July 1997. In terms of density distribution in 1997, the upper three population locations (WC-1R, WC-2, or WC-3) exhibited the highest number of speckled dace. In contrast, the highest mountain sucker densities occurred at the reference location (WC-1R) and the upper diversion segment (WC-4D). In most instances, populations

for both species were dominated by adults at all sampling locations. Densities for the other nongame species were ≤ 5 individuals/100 ft segment.

Comparisons of fish densities revealed different trends, depending upon the sampling locations and time of year. Total fish densities were grouped so that summer and fall sampling efforts could be compared (Table 3-6; Figure 3-1). When comparing 1997 to 1995 summer densities, total fish numbers increased at locations WC-2, WC-3, and WC-4, while values were only slightly lower at the reference location (WC-1R) (Table 3-6). In contrast, fish densities declined in 1997 at locations WC-5 and WC-6 in comparison to 1995 summer densities. Comparisons of fall densities indicated that fish populations in 1997 declined at four of the sampling locations (WC-2, WC-3, WC-5, and WC-6). Fish densities were slightly higher at location WC-1R and similar at WC-4, when comparing 1997 to 1995 fall population estimates. Speckled dace and mountain sucker accounted for the changes in fish densities.

Table 3-6
Total Fish Density Comparisons (Number/100 Ft Segment) in Willow Creek

Sampling Locations	June 1995	July 1997	Oct 1995	Oct 1997
WC-1R	94	87	61	70
WC-2	38	60	62	23
WC-3	29	40	52	44
WC-4	43	Not Sampled	33	Not Sampled
WC-4D	Not Sampled	50	Not Sampled	32
WC-5	45	Not Sampled	49	Not Sampled
WC-5D	Not Sampled	13	Not Sampled	9
WC-6	48	26	39	9

It is known that fish population densities can fluctuate considerably due to natural factors such as predation, disease, and annual differences in spawning and hatching success. Although natural factors may have contributed to changes in Willow Creek fish densities, sufficient information was not available to evaluate these types of population parameters. However, other possible factors that may have contributed to reduced fish numbers at locations WC-5D and WC-6 were evaluated as part of this monitoring study.

The periodic absence of surface flow from August 1996 through early March 1997 in the lower diversion segment and lower portion of Willow Creek downstream to the Price River may have contributed to the reduced fish densities at WC-5D and WC-6. The flow reductions resulted in habitat loss for fish, particularly during the periods when the stream was dry. In addition, upstream fish movement into reaches represented by WC-6 was limited by low water

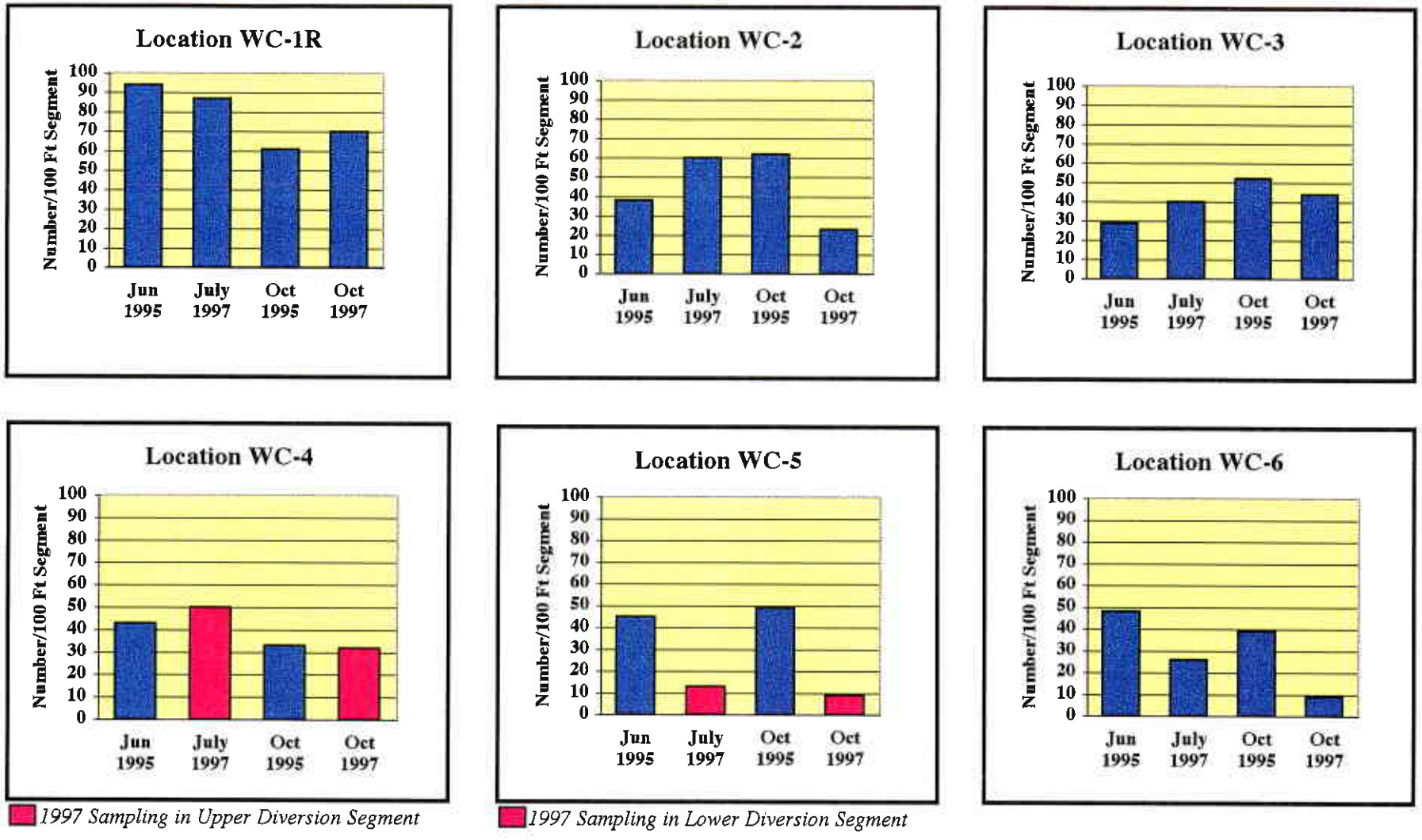

Figure 3-1

Fish Densities at Willow Creek Sampling Locations

levels in the lower portion of Willow Creek. Downstream movement was temporarily impeded beyond the lower portion of the upper diversion segment. After flow was restored in the lower diversion segment in March, downstream fish movement could resume into the lower reaches of Willow Creek. The combination of the temporary loss of habitat and impedance to fish movement in the fall and winter probably contributed to reduced fish numbers at WC-5D and WC-6.

Another factor that was considered in the evaluation was water quality. Based on quarterly sampling conducted by Cyprus in 1997, no water quality concerns were identified that could have caused fish mortalities. If toxic conditions existed in 1997 when water quality sampling had not been conducted, it seems likely that trout populations would have been affected. Trout species are considered to be more sensitive to sedimentation and most other toxicants than speckled dace and mountain sucker. In 1997, trout occurred at similar densities compared to 1995. Therefore, the reduced number of fish at WC-5D and WC-6 (i.e., speckled dace and mountain sucker) were not likely caused by habitat or water quality conditions.

3.1.3 RECOVERY STATUS

Fish density and composition data also provided information regarding the recovery and recolonization of the new diversion segments. Fish densities and composition in the upper diversion segment (WC-4D) were similar to the results obtained at location WC-4 in 1995 (Figure 3-1). However, the lower diversion segment (WC-5D) exhibited relatively lower densities in 1997 in comparison to densities at WC-5 in 1995. Based on these comparisons, fish communities the upper diversion segment have recolonized to levels comparable to other locations in lower Willow Creek. In contrast, fish populations have not yet recolonized the lower diversion segment to comparable levels.

3.2 BENTHIC MACROINVERTEBRATES

Based on quantitative sampling in 1997, information was provided for benthic macroinvertebrate communities at six locations in Willow Creek. Four of these sampling locations (WC-1R, WC-2, WC-3, and WC-6) were previously sampled in 1994 and 1995. The other two locations (WC-4D and WC-5D), which were situated in the diversion segments, replaced two sites located in adjacent portions of the old stream channel. Detailed results of macroinvertebrate densities and composition for 1997 sampling efforts are presented in Appendix B. The following information summarizes the results of the 1997 sampling in terms

of densities, number of taxa, and taxa composition. These data also were compared to previous sampling to identify any notable changes or trends.

3.2.1 DENSITIES AND NUMBER OF TAXA

In 1997, macroinvertebrate communities exhibited relatively low productivity at most sampling locations. The only notable exception was the reference site (WC-1R), which supported a moderately productive macroinvertebrate community in October 1997, with a mean density of 295.5 individuals/ft^2. Total mean densities in July 1997 ranged from 37.5 to 110.5 individuals/ft^2 (Table 3-7). In October 1997, mean densities increased at five of the six sampling locations, with values ranging between 82.5 and 295.5 individuals/ft^2 (Table 3-8). Using a rating system developed by Binns (1982) for macroinvertebrate productivity in trout streams (i.e., 0 to 4 with 4 being the highest rating), scores were either *1* (25 to 99 individuals/ft^2) or *2* (100 to 249 individuals/ft^2) at all of the Willow Creek sampling locations except WC-1R. The score at this location was *3* (250 to 500 individuals/ft^2). Similarly, Wisseman (1996) used relatively low scores in rating macroinvertebrate densities that were less than 93 individuals/ft^2.

Although macroinvertebrate communities were characterized as having low productivity in 1997 at five sampling locations, densities were higher than values shown in 1994 and 1995. Since the initial sampling was conducted in October 1994, a consistent trend in increasing October densities was evident at all sampling locations (Figure 3-2; Table 3-9). Binns (1982) density scores were *0* or *1* in 1994 and *1* or *2* in 1995.

The number of macroinvertebrate taxa (or richness) in Willow Creek also was relatively low compared to diverse communities in western mountain streams. In July 1997, a total of 15 to 19 taxa was collected at the Willow Creek sampling locations (Table 3-7). Similar results were shown in October 1997, when 15 to 18 taxa were collected. The number of taxa collected in 1997 compared to 1994 and 1995 were generally similar at four of the six sampling locations (WC-1R, WC-2, WC-3, and WC-6). The only notable differences were evident in 1994 at locations WC-4 and WC-5, when considerably fewer taxa were collected (Figure 3-3; Table 3-10). Wisseman (1996) used the lowest rating of *0* for streams with less than 30 macroinvertebrate taxa.

Table 3-7
Summary of Macroinvertebrate Survey in Willow Creek, July 24, 1997

Type of Information	Sampling Locations					
	WC-1R	WC-2	WC-3	WC-4D[3]	WC-5D[4]	WC-6
Total Number of Taxa	19	15	16	18	17	18
EPT Index[1]	11	8	10	9	9	7
EPT Abundance (No./Ft^2)	77.5	58.5	41.5	29.0	52.0	54.5
Total Mean Density (No./Ft^2)	98.5	110.5	47.5	37.5	78.0	75.5
Mean Species Diversity (Base e)	1.92	1.61	1.69	2.31	2.06	1.68
Dominant Taxa[2]	• *Baetis tricaudatus* (mayfly) [46.7 %] • *Hydropsyche* sp. (caddisfly) [13.2 %] • *Brachycentrus occidentalis* (caddisfly) [9.6 %] • Orthocladiinae (midges) [6.6 %] • *Optioservus* (Elmid beetle) [5.6 %]	• Oligochaetes (worms) [41.6 %] • *Baetis tricaudatus* (mayfly) [27.1 %] • *Hydropsyche* sp. (caddisfly) [17.2 %]	• *Baetis tricaudatus* (mayfly) [55.8 %] • *Hydropsyche* sp. (caddisfly) [15.8 %]	• *Baetis tricaudatus* (mayfly) [36.0 %] • *Nixe criddlei* (mayfly) [12.0 %] • *Heptagenia* sp. (mayfly) [8.0 %] • *Tricorythodes minutus* (mayfly) [6.7 %] • *Hydropsyche* sp. (caddisfly) [6.7 %]	• *Baetis tricaudatus* (mayfly) [40.4 %] • *Hydropsyche* sp. (caddisfly) [15.4 %] • Oligochaetes (worms) [10.3 %] • Tanypodinae (midges) [6.4 %] • Tanytarsini (midges) [5.1 %]	• *Baetis tricaudatus* (mayfly) [56.9 %] • Oligochaetes (worms) [10.6 %] • Hydracarina (water mites) [6.6 %] • *Hydropsyche* sp. (caddisfly) [6.6 %]

[1]EPT Index= Number of Ephemeroptera (mayfly), Plecoptera (stonefly), and Trichoptera (caddisfly) taxa.
[2]Dominant Taxa= Comprised $\geq$ 5 percent of the total macroinvertebrate density.
[3]WC-4D was located in the upper diversion segment.
[4]WC-5D was located in the lower diversion segment.

Table 3-8
Summary of Macroinvertebrate Survey in Willow Creek, October 21, 1997

Type of Information	Sampling Locations					
	WC-1R	WC-2	WC-3	WC-4D[3]	WC-5D[4]	WC-6
Total Number of Taxa	17	18	17	16	15	17
EPT Index[1]	10	12	10	10	10	11
EPT Abundance (No./Ft^2)	267.5	82.5	85.5	79.5	67.5	113.5
Total Mean Density (No./Ft^2)	295.5	105.5	99.5	82.5	96.5	149.5
Mean Species Diversity (Base e)	1.61	2.19	1.50	1.80	1.80	2.04
Dominant Taxa[2]	• *Hydropsyche* sp. (caddisfly) [53.0 %] • *Baetis tricaudatus* (mayfly) [18.3 %] • *Ephemerella* sp. (mayfly) [9.0 %] • *Heptagenia* sp. (mayfly) [5.4 %]	• *Baetis tricaudatus* (mayfly) [24.2 %] • *Heptagenia* sp. (mayfly) [20.4 %] • Oligochaetes (worms) [15.6 %] • *Capnia* sp. (stonefly) [11.5 %] • *Hydropsyche* sp. (caddisfly) [6.6 %] • *Ephemerella* sp. (mayfly) [5.2 %]	• *Baetis tricaudatus* (mayfly) [61.3 %] • *Hydropsyche* sp. (caddisfly) [10.5 %] • Oligochaetes (worms) [10.5 %]	• *Baetis tricaudatus* (mayfly) [32.7 %] • *Hydropsyche* sp. (caddisfly) [30.9 %] • *Heptagenia* sp. (mayfly) [12.1 %] • *Capnia* sp. (stonefly) [8.5 %] • *Rhithrogena* sp. (mayfly) [6.1 %]	• *Hydropsyche* sp. (caddisfly) [41.4 %] • Oligochaetes (worms) [21.8 %] • *Baetis tricaudatus* (mayfly) [12.4 %] • *Heptagenia* sp. (mayfly) [7.2 %]	• *Hydropsyche* sp. (caddisfly) [34.4 %] • *Baetis tricaudatus* (mayfly) [19.7 %] • Oligochaetes (worms) [14.4 %] • *Heptagenia* sp. (mayfly) [7.7 %] • *Optioservus* sp. (Elmid beetle) [5.0 %]

[1]EPT Index= Number of Ephemeroptera (mayfly), Plecoptera (stonefly), and Trichoptera (caddisfly) taxa.
[2]Dominant Taxa= Comprised ≥ 5 percent of the total macroinvertebrate density.
[3]WC-4D was located in the upper diversion segment.
[4]WC-5D was located in the lower diversion segment.

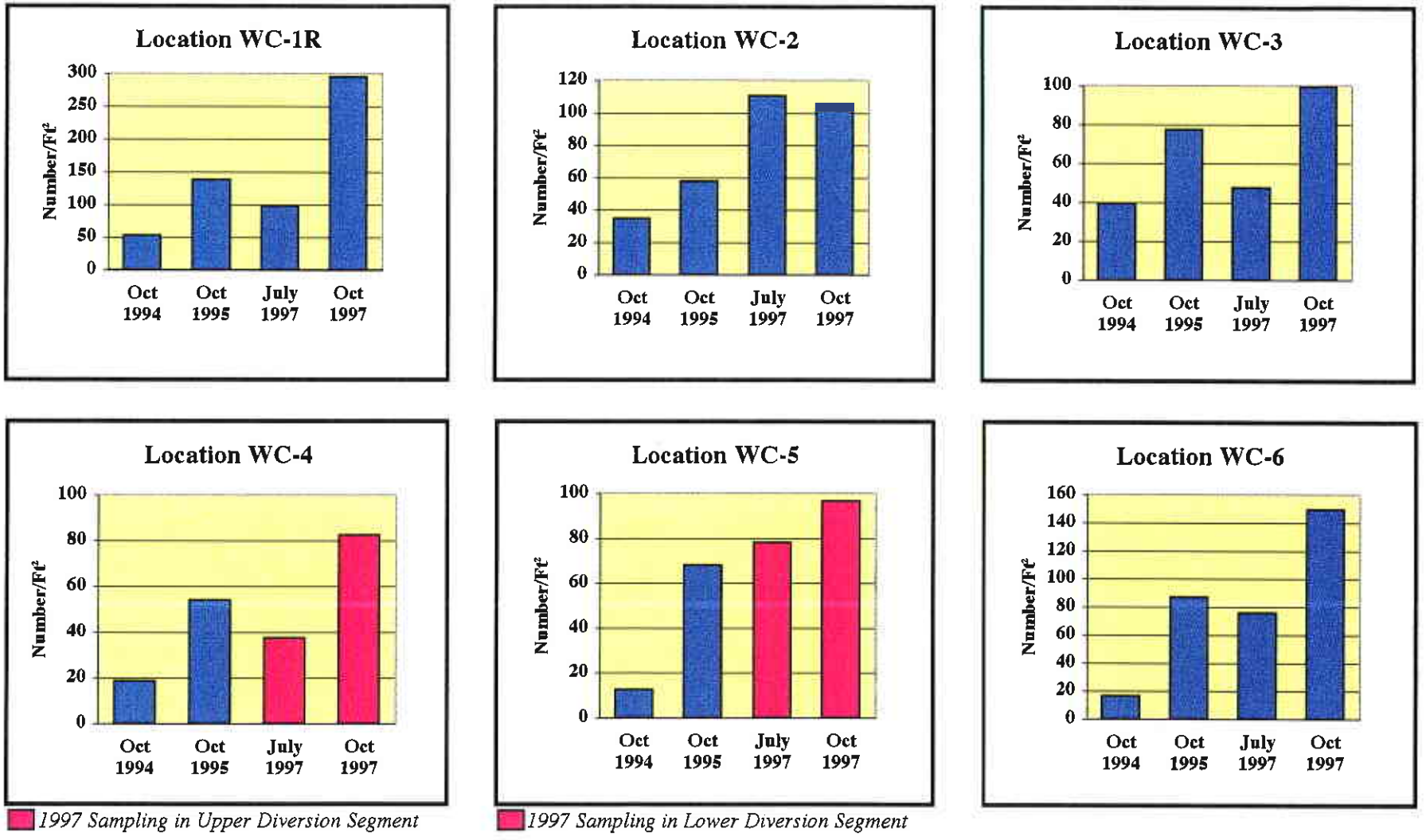

Figure 3-2

Mean Macroinvertebrate Densities at Willow Creek Sampling Locations

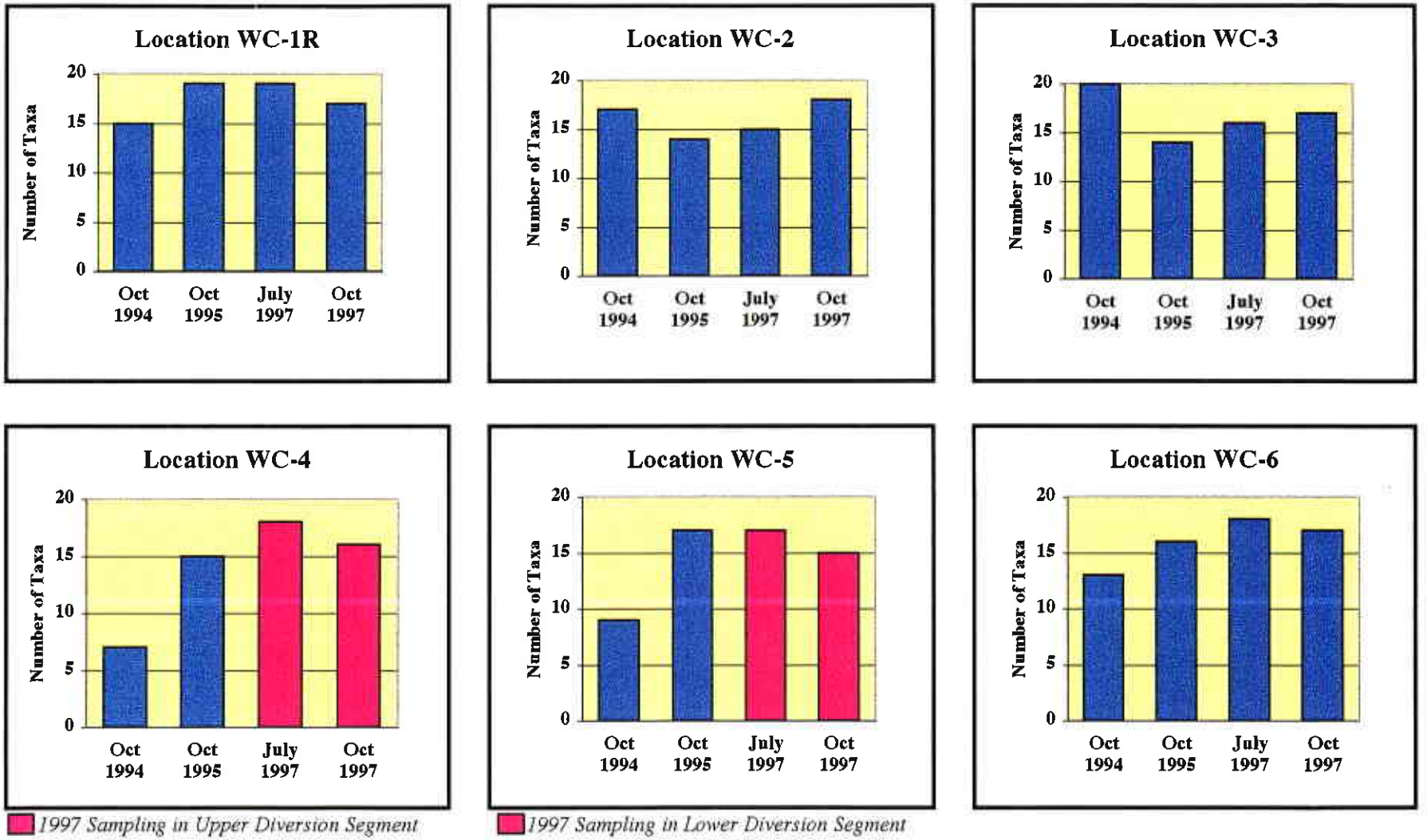

Figure 3-3

Number of Macroinvertebrate Taxa Collected at Willow Creek Sampling Locations

Table 3-9
Mean Macroinvertebrate Densities (Number/Ft²) in Willow Creek

Sampling Locations	Oct 1994	Oct 1995	Jul 1997	Oct 1997
WC-1R	53.0	138.0	98.5	295.5
WC-2	34.5	57.5	110.5	105.5
WC-3	39.5	77.5	47.5	99.5
WC-4	18.5	54.0	Not Sampled	Not Sampled
WC-4D	Not Sampled	Not Sampled	37.5	82.5
WC-5	12.5	68.0	Not Sampled	Not Sampled
WC-5D	Not Sampled	Not Sampled	78.0	96.5
WC-6	16.5	87.0	75.5	149.5

Table 3-10
Total Number of Macroinvertebrate Taxa in Willow Creek

Sampling Locations	Oct 1994	Oct 1995	Jul 1997	Oct 1997
WC-1R	15	19	19	17
WC-2	17	14	15	18
WC-3	20	14	16	17
WC-4	7	15	Not Sampled	Not Sampled
WC-4D	Not Sampled	Not Sampled	18	16
WC-5	9	17	Not Sampled	Not Sampled
WC-5D	Not Sampled	Not Sampled	17	15
WC-6	13	16	18	17

3.2.2 COMPOSITION

Three major macroinvertebrate groups, Ephemeroptera (mayflies), Trichoptera (caddisflies), and Diptera (flies, midges) contributed the majority of the taxa collected in Willow Creek. The EPT Index, which is the number of Ephemeroptera, Plecoptera (stoneflies), and Trichoptera, ranged from 7 to 11 in July 1997 and 10 to 12 in October 1997 (Tables 3-7 and 3-8). This index is often used in bioassessment studies, since some of these taxa are generally sensitive to poor water quality conditions (Plafkin et al. 1989). The EPT Index in previous sampling efforts ranged from 8 to 14 in 1995 and 1 to 8 in 1994. Although the number of EPT taxa collected in 1997 and 1995 increased in comparison to 1994, the index is still considered to be relatively low. The rating system used by Wisseman (1996) scores this parameter as *0*, if the EPT Index is less than 20.

Macroinvertebrate communities in Willow Creek were represented by six insect (Ephemeroptera, Plecoptera, Trichoptera, Coleoptera, Diptera, and Odonata) and four non-insect groups (Hydracarina, Oligochaeta, Gastropoda, and Other Miscellaneous). Densities for

these major groups are shown in Table 3-11. In July 1997, Ephemeroptera was the most abundant group at all locations except WC-2, where Oligochaeta worms were dominant. Ephemeroptera continued to be the most abundant major group in October 1997 at four of the six sampling locations. In addition, Trichoptera was the most abundant major group at the other two locations, and it shared dominance with Ephemeroptera at WC-6. Ephemeroptera and Trichoptera also were the most abundant major groups in 1995 and 1994. Relatively higher densities for these two groups in October 1997 accounted for most of the increased macroinvertebrate abundance compared to 1995 and 1994.

Dominant taxa that individually comprised at least 5 percent of the total mean macroinvertebrate density at a particular sampling location in 1997 are listed in Tables 3-7 and 3-8. In July 1997, the mayfly, *Baetis tricaudatus*, ranked first in abundance at five of the six sampling locations. The other location (WC-2) was dominated by oligochaete worms. Other dominant taxa in July 1997 included the caddisflies, *Hydropsyche* sp. and *Brachycentrus occidentalis*; mayflies, *Heptagenia* sp., *Nixe criddlei*, and *Tricorythodes minutus*; midges; elmid beetles; and water mites. The most notable change in October 1997 was the increased abundance of caddisflies, which was reflected in the dominance of *Hydropsyche* sp. at three of the six sampling locations. *Baetis tricaudatus* continued to be the most abundant taxon at the other three locations. Most of the other dominant taxa in October 1997 were mayflies and caddisflies (Table 3-11). One stonefly, *Capnia* sp. was a dominant taxon in Willow Creek for the first time during the three years of sampling. In general, the most abundant taxa in 1997 were similar to results in 1995, when mayflies (*Baetis tricaudatus*) and caddisflies (*Heptagenia* sp. and *Hydropsyche* sp.) were ranked first in abundance. In contrast, the mayfly, *Tricorythodes minutus*, was the most abundant taxon in 1994.

In general, most of the dominant taxa collected in Willow Creek are indicative of species that are able to tolerate considerable fluctuations in flow, sediment, and temperature (Merritt and Cummins 1984). Of the various taxa that were collected in the three years of sampling, only the stonefly, *Capnia*, and the mayfly, *Rhithrogena*, are considered indicators of high quality habitat and water chemistry. Both of these taxa were present in low numbers in October 1997.

3.2.3 RECOVERY STATUS

An analysis of the macroinvertebrate data in 1997 also provided an indication on the status of recovery and recolonization by this aquatic community in the new diversion segments. In

Table 3-11
Summary of Macroinvertebrate Densities (Number/Ft²) by Major Groups

Major Group	July 1997						October 1997					
	WC-1R	WC-2	WC-3	WC-4D	WC-5D	WC-6	WC-1R	WC-2	WC-3	WC-4D	WC-5D	WC-6
Ephemeroptera	51.5	35.0	30.5	26.0	35.5	43.5	100.5	59.0	69.5	45.0	23.5	53.5
Plecoptera	2.0	4.0	0.5	0	2.5	3.5	9.5	15.5	4.5	8.5	3.0	6.5
Trichoptera	24.0	19.5	10.5	3.0	14.0	7.5	157.5	8.0	11.5	26.0	41.0	53.5
Coleoptera	5.5	2.0	2.5	1.5	0.5	1.0	12.5	4.5	1.0	1.0	2.5	7.5
Diptera	11.0	3.5	1.5	4.0	14.5	7.0	2.5	1.5	1.5	1.5	0.5	1.5
Odonata	0	0	0	1.5	0	0	0	0	0.5	0	0	0
Hydracarina	0	0	0	1.5	3.0	5.0	3.5	0.5	0.5	0	4.5	5.5
Oligochaeta	4.5	46.0	2.0	0	8.0	8.0	9.0	16.5	10.5	0.5	21.0	21.5
Gastropoda	0	0	0	0	0	0	0.5	0	0	0	0.5	0
Other Non-Insects	0	0.5	0	0	0	0	0	0	0	0	0	0
TOTAL	98.5	110.5	47.5	37.5	78.0	75.5	295.5	105.5	99.5	82.5	96.5	149.5

Major Group	October 1995						October 1994					
	WC-1R	WC-2	WC-3	WC-4	WC-5	WC-6	WC-1R	WC-2	WC-3	WC-4	WC-5	WC-6
Ephemeroptera	75.0	36.5	39.5	28.0	15.5	36.0	24.5	22.0	12.5	8.0	9.0	5.0
Plecoptera	3.5	1.0	3.0	3.5	3.5	6.0	0	0.5	0	1.5	0	0
Trichoptera	52.5	15.0	15.0	14.0	43.0	17.0	3.0	1.0	9.5	5.5	0.5	2.5
Coleoptera	3.0	2.5	5.0	1.5	2.0	4.5	5.0	2.5	3.0	2.0	0.5	3.0
Diptera	0.5	0.5	2.0	2.0	3.0	9.0	17.0	7.5	6.0	0	0	3.0
Odonata	0.5	0	0	0	0	0.5	0	0	1.5	0	1.5	1.0
Hydracarina	0	1.0	0	0	0	0	0	0	0	0	0	2.0
Oligochaeta	3.0	1.0	13.0	5.0	0.0	14.0	3.0	0.5	6.5	1.5	0	0
Gastropoda	0	0	0	0	1.0	0	0	0	0.5	0	1.0	0
Other Non-Insects	0	0	0	0	0	0	0.5	0.5	0.0	0	0	0
TOTAL	138.0	57.5	77.5	54.0	68.0	87.0	53.0	34.5	39.5	18.5	12.5	16.5

terms of the total number of taxa, EPT Index, and composition, the diversion segments (WC-4D and WC-5D) were similar to the other sampling locations (Tables 3-7 and 3-8). However, macroinvertebrate productivity was lower in the diversion segments in comparison to the other sampling locations. Mean densities at the upper diversion segment (WC-4D) ranked as the lowest of the six sampling locations during both sampling efforts in 1997. The lower diversion segment (WC-5D) also exhibited densities in the low end of the range, although values were higher than WC-4D and only slightly lower than WC-3. Based on these results, the diversion segments have not fully recovered to comparable levels as shown at the other sampling locations. Although the number of taxa and composition were similar, productivity was lower than shown at the other locations.

In general, macroinvertebrate communities usually recover to similar densities and composition in new stream segments within one to two years. In relation to the October 1997 sampling effort, continuous surface flow occurred in the upper and lower diversion segments for approximately 14 and 8 months, respectively. Additional time may be required for densities to return to levels exhibited at the other sampling locations.

Another factor that may have affected macroinvertebrate development in the diversion segments is the relatively low amount of riffle habitat. Most of the insect groups require flowing water over a diverse substrate mixture. Riffle habitat represented approximately 18 to 22 percent of the total area within the diversion segments in 1997. In contrast, riffles comprised 70 to 80 percent of the total area in adjacent channel segments in 1995 prior to diversion.

4.0 SUMMARY AND CONCLUSIONS

4.1 FISH

Based on comparisons between 1997 and 1995 sampling in Willow Creek, the following summary and conclusions were made for fish communities.

- Willow Creek supports relatively low game fish densities, which are dominated by rainbow trout. Trout populations exhibited similar densities and composition in both 1997 and 1995.

- Willow Creek supports relatively low numbers of native nongame fish populations that are dominated by speckled dace and mountain sucker.

- Comparisons of fish densities revealed different trends depending upon the sampling location and time of year. When comparing 1997 to 1995 summer densities, total fish numbers increased at three locations, decreased at two locations, and were similar at one location. Comparisons of fall densities indicated that the 1997 populations declined at four locations, increased at one location, and were similar at one location. The most notable changes occurred at two locations in the lower portion of Willow Creek (WC-5D and WC-6) during the fall of 1997, when total numbers were less than 10 fish/100 ft segment at each site.

- When considering possible reasons that may have affected fish population numbers, the lack of water in the lower diversion segment and lower section of Willow Creek during a seven-month period probably contributed to reduced densities at WC-5D and WC-6. This resulted in the temporary loss of habitat and impedance to fish movement. There were no obvious changes in water quality conditions that were related to the reduced numbers at these locations.

- Fish density and composition data for 1997 and 1995 indicated that fish populations have recolonized the upper diversion segment, but recolonization to similar densities has not occurred in the lower diversion segment.

4.2 BENTHIC MACROINVERTEBRATES

Based on comparisons between 1997 and previous sampling in 1995 and 1994, the following summary and conclusions were made for macroinvertebrate communities in Willow Creek.

- Macroinvertebrate communities have shown improvement in terms of densities. In October 1997, macroinvertebrate densities were approximately 1.2 to 9 times higher than values in 1994 and 1995, when numbers were extremely low. Although the 1997 densities were considerably higher than previous values, the numbers were still considered low compared to productive mountain streams.

- The total number of macroinvertebrate taxa continued to be relatively low in taxa richness. However, considerable improvement was shown at several of the sampling locations in comparison to 1994, when 6 and 9 fewer taxa were collected at WC-5 and WC-4, respectively.

- The total number of mayfly, stonefly, and caddisfly taxa (EPT Index) increased in 1997 compared to 1994. However, the index still indicated low diversity for these groups, with less than 13 taxa at the six locations.

- Macroinvertebrate composition continued to be dominated by mayflies and caddisflies in 1997. These two groups accounted for most of the increased densities in 1997. Most of the dominant taxa are able to tolerate fluctuations in sediment, flow, and temperature. Two moderately sensitive taxa, a mayfly *Rhithrogena*, and stonefly, *Capnia*, were collected for the first time in 1997. This indicates that conditions may have improved since sampling was initiated in 1994.

- Based on relatively lower densities in the diversion segments, it was concluded that macroinvertebrate communities have not fully recovered to comparable levels as shown at the other sampling locations. The relatively low amount of riffle habitat (18 to 22 percent of the total area) is suspected to be a limiting factor for macroinvertebrate development in the diversion segments.

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Appendix A

Trout Length and Weight Data

Table A-1

Length (Milliliters)) and Weight (Grams) Data for Trout Collected in Willow Creek, October 22, 1997

Species	WC-1R		WC-2		WC-3		WC-4D		WC-5D		WC-6		Qualitative	
	Length	Weight	Length	Weight	Length	Weight	Length	Weight	Length	Weight	Length	Weight	Length	Weight
Rainbow Trout	310	310			214	105	273	240	223	104	248	143	252	160
					253	208	93	18					193	85
													230	102
													254	160
													204	100
Yellowstone Cutthroat X Rainbow Trout Hybrid							198	85						
Brown Trout													282	287

Table A-2

Length (Milliliters)) and Weight (Grams) Data for Trout Collected in Willow Creek, July 22 and 23, 1997

Species	WC-1R		WC-2		WC-3		WC-4D		WC-5D		WC-6		Qualitative	
	Length	Weight	Length	Weight	Length	Weight	Length	Weight	Length	Weight	Length	Weight	Length	Weight
Rainbow Trout					276	240	266	202	234	121	220	84	253	160
													245	136
													250	NM[1]
													260	NM

[1]NM = Weight not measured.

Appendix B

Macroinvertebrate Composition and Densities, July and October 1997

Table B-1

Benthic Macroinvertebrate Densities and Composition at Location WC-1R in Willow Creek, July 24, 1997

Order/Family (Common Name)	Genus/Species (**Subfamily or ***Tribe)	Feeding Group*	WC-1R Rep 1 No./ft²	WC-1R Rep 2 No./ft²	WC-1R Mean No./ft²	WC-1R Percent Composition
Ephemeroptera (Mayflies)						
Baetidae	*Baetis tricaudatus*	CG	67	25	46.0	46.70%
Baetidae	*Procloeon* sp.	CG	2	0	1.0	1.02%
Heptageniidae	*Heptagenia* sp.	CG	2	0	1.0	1.02%
Heptageniidae	*Nixe criddlei*	CG	3	1	2.0	2.03%
Leptophlebiidae	*Paraleptophlebia* sp.	CG	2	0	1.0	1.02%
Tricorythidae	*Tricorythodes minutus*	CG	0	1	0.5	0.51%
Total Ephemeroptera			76	27	51.5	52.28%
Plecoptera (Stoneflies)						
Perlodidae	*Isogenoides* sp.	P	4	0	2.0	2.03%
Total Plecoptera			4	0	2.0	2.03%
Trichoptera (Caddisflies)						
Brachycentridae	*Brachycentrus occidentalis*	FC	8	11	9.5	9.64%
Hydropsychidae	*Hydropsyche* sp.	FC	21	6	13.5	13.71%
Hydroptilidae	*Mayatrichia* sp.	Sc	0	1	0.5	0.51%
Hydroptilidae	*Metrichia* sp.	CG	0	1	0.5	0.51%
Total Trichoptera			29	19	24.0	24.37%
Coleoptera (Beetles)						
Elmidae (larvae)	*Optioservus* sp.	Sc	6	5	5.5	5.58%
Total Coleoptera			6	5	5.5	5.58%
Diptera (Flies, Mosquitos, Midges)						
Ceratopogonidae	---	P	1	0	0.5	0.51%
Empididae	*Chelifera* sp.	P	1	0	0.5	0.51%
Chironomidae	Tanypodinae**	P	1	1	1.0	1.02%
Chironomidae	Orthocladiinae**	CG	2	11	6.5	6.60%
Chironomidae	Chironomini***	CG	1	2	1.5	1.52%
Chironomidae	Tanytarsini***	FC	1	1	1.0	1.02%
Total Diptera			7	15	11.0	11.17%
Oligochaeta (Worms, Polychaetes)	---	CG	6	3	4.5	4.57%
TOTAL DENSITIES			128	69	98.5	100.00%
TOTAL TAXA			16	13	19	
SPECIES DIVERSITY					1.924	

*Feeding Groups: Collector Gatherers (CG), Filterer Collectors (FC), Predators (P), Scrapers (Sc), Piercers Herbivores (PH), and Shredders (Sh).

Table B-2

Benthic Macroinvertebrate Densities and Composition at Location WC-2 in Willow Creek, July 24, 1997

Order/Family (Common Name)	Genus/Species (**Subfamily or *** Tribe)	Feeding Group*	WC-2 Rep 1 No./ft²	WC-2 Rep 2 No./ft²	WC-2 Mean No./ft²	WC-2 Percent Composition
Ephemeroptera (Mayflies)						
Baetidae	*Baetis tricaudatus*	CG	40	20	30.0	27.15%
Baetidae	*Diphetor hageni*	CG	0	2	1.0	0.90%
Heptageniidae	*Heptagenia* sp.	CG	0	3	1.5	1.36%
Heptageniidae	*Nixe criddlei*	CG	3	1	2.0	1.81%
Tricorythidae	*Tricorythodes minutus*	CG	1	0	0.5	0.45%
Total Ephemeroptera			44	26	35.0	31.67%
Plecoptera (Stoneflies)						
Perlodidae	*Isogenoides* sp.	P	3	5	4.0	3.62%
Total Plecoptera			3	5	4.0	3.62%
Trichoptera (Caddisflies)						
Brachycentridae	*Brachycentrus occidentalis*	FC	1	0	0.5	0.45%
Hydropsychidae	*Hydropsyche* sp.	FC	12	26	19.0	17.19%
Total Trichoptera			13	26	19.5	17.65%
Coleoptera (Beetles)						
Elmidae (larvae)	*Optioservus* sp.	Sc	2	1	1.5	1.36%
Elmidae (adult)	*Optioservus* sp.	Sc	0	1	0.5	0.45%
Total Coleoptera			2	2	2	1.81%
Diptera (Flies, Mosquitos, Midges)						
Chironomidae	Orthocladiinae**	CG	2	0	1.0	0.90%
Chironomidae	Chironomini***	CG	1	1	1.0	0.90%
Simuliidae	*Simulium* sp.	FC	1	2	1.5	1.36%
Total Diptera			4	3	3.5	3.17%
Nematoda	---	P	0	1	0.5	0.45%
Oligochaeta (Worms, Polychaetes)	---	CG	57	35	46.0	41.63%
TOTAL DENSITIES			123	98	110.5	100.00%
TOTAL TAXA			11	12	15	
SPECIES DIVERSITY					1.615	

*Feeding Groups: Collector Gatherers (CG), Filterer Collectors (FC), Predators (P), Scrapers (Sc), Piercers Herbivores (PH), and Shredders (Sh).

Table B-3

Benthic Macroinvertebrate Densities and Composition at Location WC-3 in Willow Creek, July 24, 1997

Order/Family (Common Name)	Genus/Species (**Subfamily or *** Tribe)	Feeding Group*	WC-3 Rep 1 No./ft²	WC-3 Rep 2 No./ft²	WC-3 Mean No./ft²	WC-3 Percent Composition
Ephemeroptera (Mayflies)						
Baetidae	*Baetis tricaudatus*	CG	28	25	26.5	55.79%
Baetidae	*Diphetor hageni*	CG	0	2	1.0	2.11%
Heptageniidae	*Heptagenia* sp.	CG	0	3	1.5	3.16%
Heptageniidae	*Nixe criddlei*	CG	1	1	1.0	2.11%
Tricorythidae	*Tricorythodes minutus*	CG	0	1	0.5	1.05%
Total Ephemeroptera			29	32	30.5	64.21%
Plecoptera (Stoneflies)						
Perlodidae	*Isogenoides* sp.	P	1	0	0.5	1.05%
Total Plecoptera			1	0	0.5	1.05%
Trichoptera (Caddisflies)						
Brachycentridae	*Brachycentrus occidentalis*	FC	0	3	1.5	3.16%
Hydropsychidae	*Hydropsyche* sp.	FC	2	13	7.5	15.79%
Hydroptilidae	*Mayatrichia* sp.	Sc	0	2	1.0	2.11%
Hydroptilidae	*Metrichia* sp.	CG	0	1	0.5	1.05%
Total Trichoptera			2	19	10.5	22.11%
Coleoptera (Beetles)						
Elmidae (larvae)	*Optioservus* sp.	Sc	0	3	1.5	3.16%
Elmidae (adult)	*Optioservus* sp.	Sc	0	2	1.0	2.11%
Total Coleoptera			0	5	2.5	5.26%
Diptera (Flies, Mosquitos, Midges)						
Chironomidae	Tanypodinae**	P	0	1	0.5	1.05%
Chironomidae	Tanytarsini***	FC	0	1	0.5	1.05%
Simuliidae	*Simulium* sp.	FC	0	1	0.5	1.05%
Total Diptera			0	3	1.5	3.16%
Oligochaeta (Worms, Polychaetes)	---	CG	0	4	2.0	4.21%
TOTAL DENSITIES			32	63	47.5	100.00%
TOTAL TAXA			4	15	16	
SPECIES DIVERSITY					1.690	

*Feeding Groups: Collector Gatherers (CG), Filterer Collectors (FC), Predators (P), Scrapers (Sc), Piercers Herbivores (PH), and Shredders (Sh).

Table B-4

Benthic Macroinvertebrate Densities and Composition at Location WC-4D in Willow Creek, July 24, 1997

Order/Family (Common Name)	Genus/Species (**Subfamily or *** Tribe)	Feeding Group*	WC-4D Rep 1 No./ft²	WC-4D Rep 2 No./ft²	WC-4D Mean No./ft²	WC-4D Percent Composition
Ephemeroptera (Mayflies)						
Baetidae	*Baetis tricaudatus*	CG	20	7	13.5	36.00%
Baetidae	*Diphetor hageni*	CG	1	1	1.0	2.67%
Baetidae	*Procloeon* sp.	CG	0	2	1.0	2.67%
Heptageniidae	*Heptagenia* sp.	CG	2	4	3.0	8.00%
Heptageniidae	*Nixe criddlei*	CG	3	6	4.5	12.00%
Leptophlebiidae	*Paraleptophlebia* sp.	CG	0	1	0.5	1.33%
Tricorythidae	*Tricorythodes minutus*	CG	4	1	2.5	6.67%
Total Ephemeroptera			30	22	26.0	69.33%
Trichoptera (Caddisflies)						
Brachycentridae	*Brachycentrus occidentalis*	FC	1	0	0.5	1.33%
Hydropsychidae	*Hydropsyche* sp.	FC	5	0	2.5	6.67%
Total Trichoptera			6	0	3.0	8.00%
Coleoptera (Beetles)						
Elmidae (larvae)	*Optioservus* sp.	Sc	2	0	1.0	2.67%
Elmidae (adult)	*Optioservus* sp.	Sc	1	0	0.5	1.33%
Total Coleoptera			3	0	1.5	4.00%
Diptera (Flies, Mosquitos, Midges)						
Ceratopogonidae (pupa)	---	P	1	0	0.5	1.33%
Chironomidae	Orthocladiinae**	CG	0	2	1.0	2.67%
Chironomidae	Chironomini***	CG	0	2	1.0	2.67%
Chironomidae	Tanytarsini***	FC	2	0	1.0	2.67%
Simuliidae	*Simulium* sp.	FC	1	0	0.5	1.33%
Total Diptera			4	4	4	10.67%
Hydracarina (Water Mites)	---	P	1	2	1.5	4.00%
Oligochaeta (Worms, Polychaetes)	---	CG	3	0	1.5	4.00%
TOTAL DENSITIES			47	28	37.5	100.00%
TOTAL TAXA			14	10	18	
SPECIES DIVERSITY					2.311	

*Feeding Groups: Collector Gatherers (CG), Filterer Collectors (FC), Predators (P), Scrapers (Sc), Piercers Herbivores (PH), and Shredders (Sh).

Table B-5

Benthic Macroinvertebrate Densities and Composition at Location WC-5D in Willow Creek, July 24, 1997

Order/Family (Common Name)	Genus/Species (**Subfamily or *** Tribe)	Feeding Group*	WC-5D Rep 1 No./ft²	WC-5D Rep 2 No./ft²	WC-5D Mean No./ft²	WC-5D Percent Composition
Ephemeroptera (Mayflies)						
Baetidae	*Baetis tricaudatus*	CG	40	23	31.5	40.38%
Baetidae	*Procloeon* sp.	CG	1	0	0.5	0.64%
Heptageniidae	*Heptagenia* sp.	CG	1	1	1.0	1.28%
Heptageniidae	*Nixe criddlei*	CG	1	3	2.0	2.56%
Tricorythidae	*Tricorythodes minutus*	CG	0	1	0.5	0.64%
Total Ephemeroptera			43	28	35.5	45.51%
Plecoptera (Stoneflies)						
Perlodidae	*Isogenoides* sp.	P	2	3	2.5	3.21%
Total Plecoptera			2	3	2.5	3.21%
Trichoptera (Caddisflies)						
Brachycentridae	*Brachycentrus occidentalis*	FC	1	1	1.0	1.28%
Hydropsychidae	*Hydropsyche* sp.	FC	12	12	12.0	15.38%
Hydroptilidae	*Mayatrichia* sp.	Sc	0	2	1.0	1.28%
Total Trichoptera			13	15	14.0	17.95%
Coleoptera (Beetles)						
Elmidae (larvae)	*Optioservus* sp.	Sc	0	1	0.5	0.64%
Total Coleoptera			0	1	0.5	0.64%
Diptera (Flies, Mosquitos, Midges)						
Empididae	*Chelifera* sp.	P	0	1	0.5	0.64%
Chironomidae	Tanypodinae**	P	2	8	5.0	6.41%
Chironomidae	Orthocladiinae**	CG	1	6	3.5	4.49%
Chironomidae	Chironomini***	CG	0	3	1.5	1.92%
Chironomidae	Tanytarsini***	FC	2	6	4.0	5.13%
Total Diptera			5	24	14.5	18.59%
Hydracarina (Water Mites)	---	P	3	3	3.0	3.85%
Oligochaeta (Worms, Polychaetes)	---	CG	6	10	8.0	10.26%
TOTAL DENSITIES			72	84	78	100.00%
TOTAL TAXA			12	16	17	
SPECIES DIVERSITY					2.058	

*Feeding Groups: Collector Gatherers (CG), Filterer Collectors (FC), Predators (P), Scrapers (Sc), Piercers Herbivores (PH), and Shredders (Sh).

Table B-6

Benthic Macroinvertebrate Densities and Composition at Location WC-6 in Willow Creek, July 24, 1997

Order/Family (Common Name)	Genus/Species (**Subfamily or *** Tribe)	Feeding Group*	WC-6 Rep 1 No./ft²	WC-6 Rep 2 No./ft²	WC-6 Mean No./ft²	WC-6 Percent Composition
Ephemeroptera (Mayflies)						
Baetidae	*Baetis tricaudatus*	CG	48	38	43.0	56.95%
Baetidae	*Diphetor hageni*	CG	0	1	0.5	0.66%
Total Ephemeroptera			48	39	43.5	57.62%
Plecoptera (Stoneflies)						
Perlodidae	*Isogenoides* sp.	P	5	2	3.5	4.64%
Total Plecoptera			5	2	3.5	4.64%
Trichoptera (Caddisflies)						
Brachycentridae	*Brachycentrus occidentalis*	FC	2	1	1.5	1.99%
Hydropsychidae	*Hydropsyche* sp.	FC	4	6	5.0	6.62%
Hydroptilidae	*Hydroptila* sp.	PH	0	1	0.5	0.66%
Hydroptilidae	*Mayatrichia* sp.	Sc	1	0	0.5	0.66%
Total Trichoptera			7	8	7.5	9.93%
Coleoptera (Beetles)						
Elmidae (larvae)	*Optioservus* sp.	Sc	1	0	0.5	0.66%
Elmidae (adult)	*Optioservus* sp.	Sc	1	0	0.5	0.66%
Total Coleoptera			2.0	0.0	1.0	1.32%
Diptera (Flies, Mosquitos, Midges)						
Empididae	*Chelifera* sp.	P	1	0	0.5	0.66%
Chironomidae	Diamesinae**	CG	0	1	0.5	0.66%
Chironomidae	Tanypodinae**	P	1	0	0.5	0.66%
Chironomidae	Orthocladiinae**	CG	4	1	2.5	3.31%
Chironomidae	Chironomini***	CG	2	0	1.0	1.32%
Chironomidae	Tanytarsini***	FC	1	2	1.5	1.99%
Simuliidae	*Simulium* sp.	FC	1	0	0.5	0.66%
Total Diptera			10	4	7	9.27%
Hydracarina (Water Mites)	---	P	6	4	5.0	6.62%
Oligochaeta (Worms, Polychaetes)	---	CG	1	15	8.0	10.60%
TOTAL DENSITIES			79.0	72.0	75.5	100.00%
TOTAL TAXA			15	11	18	
SPECIES DIVERSITY					1.685	

*Feeding Groups: Collector Gatherers (CG), Filterer Collectors (FC), Predators (P), Scrapers (Sc), Piercers Herbivores (PH), and Shredders (Sh).

Table B-7

Benthic Macroinvertebrate Densities and Composition at Location WC-1R in Willow Creek, October 21, 1997

Order/Family (Common Name)	Genus/Species (**Subfamily or *** Tribe)	Feeding Group*	WC-1R Rep 1 No./ft²	WC-1R Rep 2 No./ft²	WC-1R Mean No./ft²	WC-1R Percent Composition
Ephemeroptera (Mayflies)						
Baetidae	*Baetis tricaudatus*	CG	36	72	54.0	18.27%
Heptageniidae	*Heptagenia* sp.	CG	2	30	16.0	5.41%
Heptageniidae	*Rhithrogena* sp.	CG	0	1	0.5	0.17%
Ephemerellidae	*Ephemerella* sp.	CG	18	35	26.5	8.97%
Tricorythidae	*Tricorythodes minutus*	CG	2	5	3.5	1.18%
Total Ephemeroptera			58	143	100.5	34.01%
Plecoptera (Stoneflies)						
Capniidae	*Capnia* sp.	Sh	0	5	2.5	0.85%
Perlodidae	*Isogenoides* sp.	P	1	4	2.5	0.85%
Perlodidae	*Isoperla* sp.	P	4	5	4.5	1.52%
Total Plecoptera			5	14	9.5	3.21%
Trichoptera (Caddisflies)						
Brachycentridae	*Brachycentrus occidentalis*	FC	0	2	1.0	0.34%
Hydropsychidae	*Hydropsyche* sp.	FC	112	201	156.5	52.96%
Total Trichoptera			112	203	157.5	53.30%
Coleoptera (Beetles)						
Elmidae (larvae)	*Optioservus* sp.	Sc	10	13	11.5	3.89%
Elmidae (adults)	*Optioservus* sp.	Sc	0	2	1.0	0.34%
Total Coleoptera			10	15	12.5	4.23%
Diptera (Flies, Mosquitos, Midges)						
Empididae	*Chelifera* sp.	P	1	3	2.0	0.68%
Empididae	*Hemerodromia* sp.	P	0	1	0.5	0.17%
Total Diptera			1	4	2.5	0.85%
Hydracarina (Water Mites)		P	2	5	3.5	1.18%
Oligochaeta (Worms, Polychaetes)	...	CG	14	4	9.0	3.05%
Gastropoda (Snails)						
Planorbidae	...	Sc	0	1	0.5	0.17%
TOTAL DENSITIES			202	389	295.5	100%
TOTAL TAXA			11	17	17	
SPECIES DIVERSITY					1.608	

*Feeding Groups: Collector Gatherers (CG), Filterer Collectors (FC), Predators (P), Scrapers (Sc), Piercers Herbivores (PH), and Shredders (Sh).

Table B-8

Benthic Macroinvertebrate Densities and Composition at Location WC-2 in Willow Creek, October 21, 1997

Order/Family (Common Name)	Genus/Species (**Subfamily or *** Tribe)	Feeding Group*	WC-2 Rep 1 No./ft²	WC-2 Rep 2 No./ft²	WC-2 Mean No./ft²	WC-2 Percent Composition
Ephemeroptera (Mayflies)						
Baetidae	*Baetis tricaudatus*	CG	23	28	25.5	24.17%
Baetidae	*Diphetor hageni*	CG	1	0	0.5	0.47%
Heptageniidae	*Heptagenia* sp.	CG	34	9	21.5	20.38%
Heptageniidae	*Rhithrogena* sp.	CG	0	4	2.0	1.90%
Ephemerellidae	*Ephemerella* sp.	CG	6	5	5.5	5.21%
Tricorythidae	*Tricorythodes minutus*	CG	2	6	4.0	3.79%
Total Ephemeroptera			66	52	59.0	55.92%
Plecoptera (Stoneflies)						
Capniidae	*Capnia* sp.	Sh	16	9	12.5	11.85%
Perlodidae	*Isogenoides* sp.	P	1	3	2.0	1.90%
Perlodidae	*Isoperla* sp.	P	1	1	1.0	0.95%
Total Plecoptera			18	13	15.5	14.69%
Trichoptera (Caddisflies)						
Brachycentridae	*Brachycentrus occidentalis*	FC	0	1	0.5	0.47%
Hydropsychidae	*Hydropsyche* sp.	FC	2	12	7.0	6.64%
Leptoceridae	*Oecetis* sp.	P	0	1	0.5	0.47%
Total Trichoptera			2	14	8.0	7.58%
Coleoptera (Beetles)						
Dryopidae (adult)	*Helichus striatus*	Sc	2	0	1.0	0.95%
Elmidae (larvae)	*Optioservus* sp.	Sc	3	4	3.5	3.32%
Total Coleoptera			5	4	4.5	4.27%
Diptera (Flies, Mosquitos, Midges)						
Empididae	*Hemerodromia* sp.	P	0	1	0.5	0.47%
Chironomidae	Tanypodinae**	P	1	1	1.0	0.95%
Total Diptera			1	2	1.5	1.42%
Hydracarina (Water Mites)	---	P	0	1	0.5	0.47%
Oligochaeta (Worms, Polychaetes)	---	CG	21	12	16.5	15.64%
TOTAL DENSITIES			113	98	105.5	100%
TOTAL TAXA			13	16	18	
SPECIES DIVERSITY					2.191	

*Feeding Groups: Collector Gatherers (CG), Filterer Collectors (FC), Predators (P), Scrapers (Sc), Piercers Herbivores (PH), and Shredders (Sh).

Table B-9

Benthic Macroinvertebrate Densities and Composition at Location WC-3 in Willow Creek, October 21, 1997

Order/Family (Common Name)	Genus/Species (**Subfamily or *** Tribe)	Feeding Group*	WC-3 Rep 1 No./ft²	WC-3 Rep 2 No./ft²	WC-3 Mean No./ft²	WC-3 Percent Composition
Ephemeroptera (Mayflies)						
Baetidae	*Baetis tricaudatus*	CG	44	78	61.0	61.31%
Heptageniidae	*Heptagenia* sp.	CG	0	4	2.0	2.01%
Heptageniidae	*Rhithrogena* sp.	CG	7	0	3.5	3.52%
Ephemerellidae	*Drunella grandis*	CG	0	1	0.5	0.50%
Ephemerellidae	*Ephemerella* sp.	CG	3	2	2.5	2.51%
Total Ephemeroptera			54	85	69.5	69.85%
Plecoptera (Stoneflies)						
Capniidae	*Capnia sp.*	Sh	2	2	2.0	2.01%
Perlodidae	*Isogenoides* sp.	P	0	2	1.0	1.01%
Perlodidae	*Isoperla* sp.	P	1	2	1.5	1.51%
Total Plecoptera			3	6	4.5	4.52%
Trichoptera (Caddisflies)						
Brachycentridae	*Brachycentrus occidentalis*	FC	2	0	1.0	1.01%
Hydropsychidae	*Hydropsyche* sp.	FC	5	16	10.5	10.55%
Total Trichoptera			7	16	11.5	11.56%
Odonata						
Coenagrionidae (Dragonflies and Damselflie	---	P	1	0	0.5	0.50%
Coleoptera (Beetles)						
Elmidae (larvae)	*Optioservus* sp.	Sc	1	1	1.0	1.01%
Total Coleoptera			1	1	1	1.01%
Diptera (Flies, Mosquitos, Midges)						
Empididae	*Hemerodromia* sp.	P	0	1	0.5	0.50%
Chironomidae	Tanypodinae**	P	1	0	0.5	0.50%
Chironomidae	Tanytarsini***	FC	0	1	0.5	0.50%
Total Diptera			1	2	1.5	1.51%
Hydracarina (water mites)	---	P	0	1	0.5	0.50%
Oligochaeta (Worms, Polychaetes)	---	CG	18	3	10.5	10.55%
TOTAL DENSITIES			85	114	99.5	100%
TOTAL TAXA			11	13	17	
SPECIES DIVERSITY					1.503	

*Feeding Groups: Collector Gatherers (CG), Filterer Collectors (FC), Predators (P), Scrapers (Sc), Piercers Herbivores (PH), and Shredders (Sh).

Table B-10

Benthic Macroinvertebrate Densities and Composition at Location WC-4D in Willow Creek, October 21, 1997

Order/Family (Common Name)	Genus/Species (**Subfamily or *** Tribe)	Feeding Group*	WC-4D Rep 1 No./ft²	WC-4D Rep 2 No./ft²	WC-4D Mean No./ft²	WC-4D Percent Composition
Ephemeroptera (Mayflies)						
Baetidae	*Baetis tricaudatus*	CG	27	27	27.0	32.73%
Heptageniidae	*Heptagenia* sp.	CG	11	9	10.0	12.12%
Heptageniidae	*Rhithrogena* sp.	CG	5	5	5.0	6.06%
Ephemerellidae	*Ephemerella* sp.	CG	2	2	2.0	2.42%
Tricorythidae	*Tricorythodes minutus*	CG	1	1	1.0	1.21%
Total Ephemeroptera			46	44	45.0	54.55%
Plecoptera (Stoneflies)						
Capniidae	*Capnia* sp.	Sh	4	10	7.0	8.48%
Perlodidae	*Isogenoides* sp.	P	0	1	0.5	0.61%
Perlodidae	*Isoperla* sp.	P	1	1	1.0	1.21%
Total Plecoptera			5	12	8.5	10.30%
Trichoptera (Caddisflies)						
Brachycentridae	*Brachycentrus occidentalis*	FC	1	0	0.5	0.61%
Hydropsychidae	*Hydropsyche* sp.	FC	38	13	25.5	30.91%
Total Trichoptera			39	13	26.0	31.52%
Coleoptera (Beetles)						
Elmidae (larvae)	*Optioservus* sp.	Sc	0	1	0.5	0.61%
Elmidae (adults)	*Optioservus* sp.	Sc	1	0	0.5	0.61%
Total Coleoptera			1	1	1	1.21%
Diptera (Flies, Mosquitos, Midges)						
Chironomidae	Tanypodinae**	P	1	0	0.5	0.61%
Tipulidae	*Hexatoma* sp.	P	1	0	0.5	0.61%
Tipulidae	*Tipula* sp.	Sh	0	1	0.5	0.61%
Total Diptera			2	1	1.5	1.82%
Oligochaeta (Worms, Polychaetes)	---	CG	0	1	0.5	0.61%
TOTAL DENSITIES			93	72	82.5	100%
TOTAL TAXA			12	12	16	
SPECIES DIVERSITY					1.808	

*Feeding Groups: Collector Gatherers (CG), Filterer Collectors (FC), Predators (P), Scrapers (Sc), Piercers Herbivores (PH), and Shredders (Sh).

Table B-11

Benthic Macroinvertebrate Densities and Composition at Location WC-5D in Willow Creek, October 21, 1997

Order/Family (Common Name)	Genus/Species (**Subfamily or *** Tribe)	Feeding Group*	WC-5D Rep 1 No./ft²	WC-5D Rep 2 No./ft²	WC-5D Mean No./ft²	WC-5D Percent Composition
Ephemeroptera (Mayflies)						
Baetidae	*Baetis tricaudatus*	CG	18	6	12.0	12.44%
Heptageniidae	*Heptagenia* sp.	CG	4	10	7.0	7.25%
Heptageniidae	*Rhithrogena* sp.	CG	0	1	0.5	0.52%
Ephemerellidae	*Ephemerella* sp.	CG	1	0	0.5	0.52%
Tricorythidae	*Tricorythodes minutus*	CG	1	6	3.5	3.63%
Total Ephemeroptera			24	23	23.5	24.35%
Plecoptera (Stoneflies)						
Capniidae	*Capnia* sp.	Sh	1	1	1.0	1.04%
Perlodidae	*Isogenoides* sp.	P	2	0	1.0	1.04%
Perlodidae	*Isoperla* sp.	P	1	1	1.0	1.04%
Total Plecoptera			4	2	3.0	3.11%
Trichoptera (Caddisflies)						
Brachycentridae	*Brachycentrus occidentalis*	FC	2	0	1.0	1.04%
Hydropsychidae	*Hydropsyche* sp.	FC	79	1	40.0	41.45%
Total Trichoptera			81	1	41.0	42.49%
Coleoptera (Beetles)						
Elmidae (larvae)	*Optioservus* sp.	Sc	5	0	2.5	2.59%
Total Coleoptera			5	0	2.5	2.59%
Diptera (Flies, Mosquitos, Midges)						
Tipulidae	*Hexatoma* sp.	P	1	0	0.5	0.52%
Total Diptera			1	0	0.5	0.52%
Hydracarina (Water Mites)		P	8	1	4.5	4.66%
Oligochaeta (Worms, Polychaetes)	---	CG	13	29	21.0	21.76%
Gastropoda (Snails)						
Physidae	---	Sc	0	1	0.5	0.52%
TOTAL DENSITIES			136	57	96.5	100%
TOTAL TAXA			13	10	15	
SPECIES DIVERSITY					1.803	

*Feeding Groups: Collector Gatherers (CG), Filterer Collectors (FC), Predators (P), Scrapers (Sc), Piercers Herbivores (PH), and Shredders (Sh).

Table B-12

Benthic Macroinvertebrate Densities and Composition at Location WC-6 in Willow Creek, October 21, 1997

Order/Family (Common Name)	Genus/Species (**Subfamily or *** Tribe)	Feeding Group*	WC-6 Rep 1 No./ft²	WC-6 Rep 2 No./ft²	WC-6 Mean No./ft²	WC-6 Percent Composition
Ephemeroptera (Mayflies)						
Baetidae	*Baetis tricaudatus*	CG	35	24	29.5	19.73%
Heptageniidae	*Heptagenia* sp.	CG	19	4	11.5	7.69%
Heptageniidae	*Rhithrogena* sp.	CG	5	4	4.5	3.01%
Ephemerellidae	*Ephemerella* sp.	CG	6	5	5.5	3.68%
Tricorythidae	*Tricorythodes minutus*	CG	1	4	2.5	1.67%
Total Ephemeroptera			66	41	53.5	35.79%
Plecoptera (Stoneflies)						
Capniidae	*Capnia* sp.	Sh	1	2	1.5	1.00%
Perlodidae	*Isogenoides* sp.	P	2	3	2.5	1.67%
Perlodidae	*Isoperla* sp.	P	0	3	1.5	1.00%
Pteronarcyidae	*Pteronarcella badia*	Sh	2	0	1.0	0.67%
Total Plecoptera			5	8	6.5	4.35%
Trichoptera (Caddisflies)						
Brachycentridae	*Brachycentrus occidentalis*	FC	3	1	2.0	1.34%
Hydropsychidae	*Hydropsyche* sp.	FC	55	48	51.5	34.45%
Total Trichoptera			58	49	53.5	35.79%
Coleoptera (Beetles)						
Elmidae (larvae)	*Optioservus* sp.	Sc	8	7	7.5	5.02%
Total Coleoptera			8	7	7.5	5.02%
Diptera (Flies, Mosquitos, Midges)						
Athericidae	*Atherix pachypus*	P	0	1	0.5	0.33%
Empididae	*Hemerodromia* sp.	P	0	1	0.5	0.33%
Tipulidae	*Tipula* sp.	Sh	0	1	0.5	0.33%
Total Diptera			0	3	1.5	1.00%
Hydracarina (Water Mites)	---	P	4	7	5.5	3.68%
Oligochaeta (Worms, Polychaetes)	---	CG	5	38	21.5	14.38%
TOTAL DENSITIES			146	153	149.5	100%
TOTAL TAXA			13	16	17	
SPECIES DIVERSITY					2.040	

*Feeding Groups: Collector Gatherers (CG), Filterer Collectors (FC), Predators (P), Scrapers (Sc), Piercers Herbivores (PH), and Shredders (Sh).

Appendix C

Results of Fish Population Surveys Conducted in 1995

Table C-1

Fish Population Survey Conducted in Willow Creek, June 28 and 29, 1995

Species/Life Stage	WC-1R			WC-2			WC-3		
	1st	2nd	No./100 Ft.	1st	2nd	No./100 Ft.	1st	2nd	No./100 Ft.
Mountain sucker									
Juvenile	3	2		3	4		6	1	
Adult	17	10		15	3		5	2	
Total	20	12	50	18	7	29	11	3	15
Bluehead sucker									
Adult	4	0	4	0	1	1	0	0	0
Speckled dace									
Juvenile	2	1		0	0		1	1	
Adult	7	6		4	2		7	2	
Total	9	7	40	4	2	8	8	3	13
Redside shiner									
Adult	0	0	0	0	0	0	0	0	0
Rainbow trout									
Adult	0	0	0	0	0	0	1	0	1
TOTAL FISH[1]	33	19	94	22	10	38	20	6	29

Species/Life Stage	WC-4			WC-5			WC-6		
	1st	2nd	No./100 Ft.	1st	2nd	No./100 Ft.	1st	2nd	No./100 Ft.
Mountain sucker									
Juvenile	3	3		0	0		0	0	
Adult	9	2		5	2		3	2	
Total	12	5	21	5	2	8	3	2	9
Bluehead sucker									
Adult	3	0	3	0	0	0	0	0	0
Speckled dace									
Juvenile	0	0		0	0		0	0	
Adult	16	2		14	8		21	8	
Total	16	2	18	14	8	33	21	8	34
Redside shiner									
Adult	1	0	1	1	0	1	5	0	5
Rainbow trout									
Adult	0	0	0	3	0	3	0	0	0
TOTAL FISH[1]	32	7	43	23	10	45	29	10	48

[1]Total fish/100 ft segment was calculated by summing the population estimates for each species.

Table C-2

Fish Population Survey Conducted in Willow Creek, October 9 and 10, 1995

Species/Life Stage	WC-1R			WC-2			WC-3		
	1st	2nd	No./100 Ft.	1st	2nd	No./100 Ft.	1st	2nd	No./100 Ft.
Mountain sucker									
Juvenile	9	1		14	5		18	6	
Adult	11	4		7	4		3	2	
Total	20	5	27	21	9	37	21	8	34
Redside shiner									
Adult	0	0	0	0	0	0	0	0	0
Speckled dace									
Juvenile	5	1		1	0		4	1	
Adult	5	6		4	4		11	1	
Total	10	7	33	5	4	25	15	2	17
Cutthroat trout									
Adult	0	0	0	0	0	0	0	0	0
Rainbow trout									
Adult	1	0	1	0	0	0	1	0	1
TOTAL FISH[1]	31	12	61	26	13	62	37	10	52

Species/Life Stage	WC-4			WC-5			WC-6		
	1st	2nd	No./100 Ft.	1st	2nd	No./100 Ft.	1st	2nd	No./100 Ft.
Mountain sucker									
Juvenile	9	4		9	4		4	1	
Adult	6	1		8	4		9	1	
Total	15	5	22	17	8	32	13	2	15
Redside shiner									
Adult	0	0	0	0	0	0	1	0	1
Speckled dace									
Juvenile	3	2		12	1		14	2	
Adult	1	0		1	1		1	2	
Total	4	2	8	13	2	15	15	4	20
Cutthroat trout									
Adult	0	0	0	1	0	1	0	0	0
Rainbow trout									
Adult	3	0	3	1	0	1	3	0	3
TOTAL FISH[1]	22	7	33	32	10	49	32	6	39

[1]Total fish/100 ft segment was calculated by summing the population estimates for each species.