TROUT DIET IN THE GUADALUPE RIVER

HONORS THESIS

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By

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ABSTRACT

Diet composition of stomach contents of young-of-the-year and older rainbow (Oncorhynchus mykiss) and brown trout (Salmo trutta) of the Guadalupe River, Texas, were analysed and compared. The contents were compared with invertebrate faunal compositions at several riffle sites in the river. Both age groups showed a variety of invertebrates consumed.

The most abundant insects in the stomachs were members of the orders Ephemeroptera (mayflies), Trichoptera (caddisflies) and Lepidoptera (aquatic moths). Several caddisfly larvae were found still within their sand or gravel cases. Burrowing mayflies (Hexagenia sp.) were predominant in several stomachs, suggesting that the trout were not feeding exclusively on invertebrates in the drift.

INTRODUCTION

The survival of hatchery-raised trout upon introduction into temperate or mountain streams that provide habitat for wild populations of trout, or for which hatchery introductions are supplemental to the resident trout, has been well documented (Nicholls 1957; Ersbak and Haase 1983; Bachman 1984). Since central Texas is subtropical and historically has never had a trout fishery because water temperatures are too warm, few opportunities have been available for studying the relationships between trout and stream invertebrates that exist in this region. Since the impoundment of the Guadalupe River in 1960 resulting in the formation of Canyon Reservoir, the hypolimnetic release at the dam has made a cold-water trout fishery possible.

There is some question of the stream's ability to sustain the relatively new fishery, although annual stockings and surveys have been used to provide a successful put-and-take sport fishery to date. This seems to be a common concern in many fisheries. Nicholls (1959), showed that in some systems, only 10 percent of brown trout had survived after 9 months from the time of release, and only 2 percent survived to takeable size at three years of age. Bachman (1984) reported that released brown trout used more energy to capture prey than wild trout did in similar situations. He also suggested that released trout may require time to learn to capture living prey if natural food was not a part of the hatchery diet, although some authors believe that most hatchery trout are capable of recognizing natural food sources upon release (Ersbak and Haase 1983). The purpose of this study was to examine the diet of rainbow and brown trout and to compare it to the invertebrate fauna community in the Guadalupe River.

STUDY SITE

This study was conducted in the Guadalupe River, Comal County, Texas, in an area extending 1.8 to 10 miles below Canyon Reservoir (Figure 1). The four sampling sites were at Kanz Lease, BK Tubes, Beans Camp and Rocking R in Gruene, Texas. Temperatures at the upstream sample site below the dam at Sattler, Texas, average 13°C in the spring and 20°C in the fall. The average discharge since 1963 is about 414 ft^3/s (USGS 1991).

METHODS AND MATERIALS

Young-of-year rainbow trout were collected, by electroshocking from a boat, in stream pools at Bean's Camp on 8 June 1994. The trout were frozen and the stomachs were later analysed in the lab. On 19 July 1995, a second sampling trip was conducted. Trout were collected at BK Tubes and Bean's Camp in the above manner while benthic samples were being collected in upstream riffles.

Four riffles were used for benthic invertebrate sampling in the stream. The three upstream sites were release areas for hatchery trout, and the downstream site in Gruene, Texas is believed to be the lower boundary of the trout range. Invertebrates were collected at each site on 19 July 1995. One five-minute dipnet sample and two replicate samples were collected with the Hess Sampler (250 micron). The samples were preserved with ethanol in the field. The invertebrates were identified in the lab.

RESULTS

STOMACH CONTENTS:

A total of 11 rainbow trout and 2 brown trout stomachs were examined. All but one rainbow trout and one brown trout had full stomachs (Table 1), and ower gut of all trout collected contained fragments of invertebrates that were too small to identify. The most common taxa found in the stomachs were the mayflies Hexagenia sp. and Isonychia sp. and the lepidopteran Petrophila sp.

BENTHIC SURVEY:

Sample data collected from individual sites produced a profile of the community present (Table 2). The most abundant mayflies were the genera *Isonychia, Tricorythodes,* and *Baetis.* The damselfly *Argia* sp. was common in three of the sites. The caddisflies *Hydroptila sp.* and *Helicopsyche* were abundant at most of the sites. Riffle beetles (*Elmidae spp.*) were present at each site. Chironomids and amphipods were also common. The lepidopteran *Petrophila* was numerous at BK Tubes and Beans Camp.

DISCUSSION

The majority of the prey taken by the trout were aquatic insects belonging to the mayfly, dipteran and lepidopteran families. Although many aquatic insects and other invertebrates (Oligochaeta, Amphipoda, Isopoda, Gastropoda) were available in the stream, they do not seem to be as important in trout diet in the Guadalupe River. However, the presence of many different kinds of invertebrates found in each stomach was a common characteristic of most of the trout. The young-of-year trout had an average of approximately 6 different taxa per stomach, while the older trout had approximately 9 taxa per stomach. This appears to agree with Elliot's (1970) findings that diversity of diet generally increases with trout age, although the difference in the numbers of taxa in this case is small. The trout in the Guadalupe River, however, are still relatively close to the same age, and if they are allowed to grow to maximum size, I suspect the difference would increase further. The small size of the trout samples may misrepresent the actual relationships between the trout species and the number of taxa they consume. Elliot (1973) found that the diets of rainbow trout and brown trout are similar, but without additional brown trout stomachs to examine, it is difficult to draw a conclusion in this case.

One of the concerns for this hatchery-raised trout fishery is if there is sufficient macroinvertebrate production of the right species to sustain a carryover trout fishery. It would be helpful to determine the type of foraging behavior that the trout use in the Guadalupe River. It is generally accepted that rainbow and brown trout are visual predators, feeding selectively on visible epibenthic fauna or capturing invertebrates in the stream drift (Elliot 1970,1973; LaVoie and Hubert 1994). Ware's (1972) observations led him to hypothsize that trout are "obligate visual predators." However,studies by Reimers (1957) and Tippets and Moyle (1978), in which large amounts of detritus were found in the stomachs of trout, suggest that trout may also be benthic foragers. Although no detritus was found in the stomachs, several other discoveries during lab analysis led me to believe that the trout in the Guadalupe River may be benthic foragers. Several caddisflies were found still in their cases, specifically Helicopsyche. Healey (1984) noted that caddisfly cases are often either crushed before they are swallowed, or are not ingested at all. Petrophila individuals also live in cases, usually firmly anchored to the underside of rocks in a riffle. Both of these scrapers would seem to be unattainable to the trout, yet they were both found in the stomachs. Although an exuviae was present, no burrowing mayflies were found in the benthic samples, although they were predominant in several trout stomachs. One possible explanation is that they were not living in the riffles. Hexagenia individuals construct burrows in the silt sediments (Merrit and Cummins 1984), which would also make them somewhat invisible to visual foragers. A subsequent sampling trip was made to specifically locate burrowing mayflies in the upstream shoreline silt sediments. LaVoie and Hubert (1994) observed that young of the year brown trout were more likely to feed in the stream margins during the day, and found no reason to leave the margins at night, due to the greater abundance of drift organisms in that area as well. Some mayflies may have adapted their behavior to drift predominantly by night (Allan 1978), which may also be why no burrowing mayflies were collected during the day. Allan found that as prey size increased, resulting in the threat of increased predation by visual predators, organisms are more likely to drift at night. Ensign and Strange (1990) report that if food is limited, changes in trout foraging behavior may occur. This possiblity may account for the presence of some of these other organisms that were found in the stomachs.

The scope of this study was limited in several ways. The small sample size made statistical analysis impractical. More trout would need to be collected before any real quantitative work could be done on trout diet in the river. Additional sampling year round would help create a better seasonal picture of the relationships trout have with various taxa of invertebrate prey. Also, most of the invertebrate sampling was benthically oriented; drift samples would be helpful in establishing a better description of the availability of prey in the stream.

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Works Cited

Allan, J.D. 1978. Trout predation and the size composition of stream drift. *Limnol. Oceanogr.* 23(6): 1231-1237.

Bachman, R.A. 1984. Foraging behavior of free-ranging wild and hatchery brown trout in a stream. *Transactions of the American Fisheries Society* 113:1-32.

Elliot, J.M. 1970. Diel changes in invertebrate drift and the food of trout *Salmo trutta* L. *J. Fish Biol.* 2:161-165.

__________ 1973. The food of brown and rainbow trout (*Salmo trutta* and *S. gairdneri*) in relation to the abundance of drifting invertebrates in a mountain stream. *Oecologia* 12:329-347.

Ensign, W.E. and R.J. Strange. 1990. Summer food limitation reduces brook and rainbow trout biomass in a southern appalachian stream. *Transactions of the American Fisheries Society.* 119:894-901.

Ersbak K. and B.L. Haase. 1983. Nutritional depriation after stocking as a possible mechanism leading to mortality in stream-stocked brook trout. *North American Journal of Fisheries Management* 3:142-151.

Healey, M. Fish predation of aquatic insects. in: V.H. Resche and D. M. Rosenberg (eds.). *Ecology of Aquatic Insects* 1984 Praeger 625pp.

LaVoie, W.J. IV and W. A. Hubert. 1994. Use of drifting invertebrates by young-of-year brown trout in stream-margin habitat. *Journal of Freshwater Ecology* 9(1):37-43.

Merritt, R.W. and K.W. Cummins. 1984. *An introduction to the aquatic insects of North America.* 2nd ed. Kendall/Hunt, Iowa. 722 pp.

Nichols, A.G. The population of a trout stream and the survival of released fish. 1959. *Australian Journal of Marine and Freshwater Research.* 9(3):319-350.

Reimers, N. 1957. Some aspects of the relation between stream foods and trout survival. *California Fish and Game* 43:43-69.

Tippets, W.E. and P.B. Moyle. 1978. Epibenthic feeding by rainbow trout (*Salmo gairdneri*) in the McCloud River, California. Journal of Animal Ecology 47:549-559.

Ware, D.M. 1972. Predation by rainbow trout (*Salmo gairdneri*): the influence of hunger prey density, and prey size. J. Fish. Res. Bd. Canada 29:1193-1201.

APPENDIX

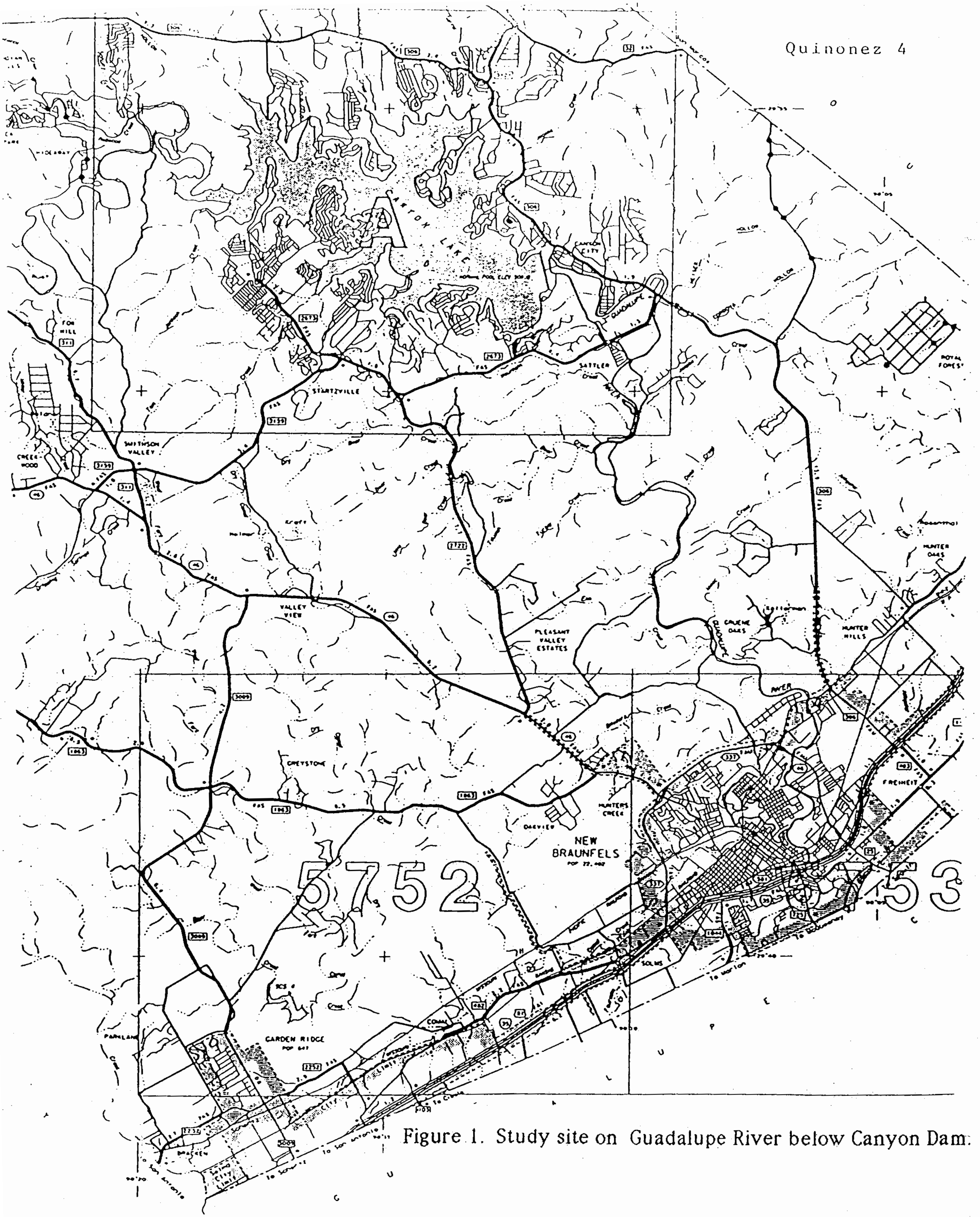

Figure 1. Study site on Guadalupe River below Canyon Dam.

Table 1. Numbers of Invertebrate Taxa Collected from the Stomachs of Brown (BT) and Rainbow Trout (RB). Each of the young-of-year trout stomach amounts are shown separately. Older trout were measured in millimeters (mm). Asterisks indicate presence of uncounted, fragmented invertebrates.

TAXA	Rainbow trout (Young of year) 1,2,3,4,5	RB 198 mm	RB 220 mm	RB 225 mm	RB 310 mm	BT 329 mm	RB 384 mm	RB 391 mm	# per Taxa
Ephemeroptera									
Oligoneuridae									
Isonychia	1,2,0,0,0	3	*	3	11	1	3	1	26*
Tricorythidae									
Tricorythodes	6,0,0,1,0	0	0	0	0	0	0	0	7
Ephemeridae									
Hexagenia	0,0,1,0,0	1	4	5	5	0	1	25	42
Baetidae									
Baetis	0,0,0,0,5	0	2	0	1	0	0	0	8
Odonata (Zygoptera)									
Coenagrionidae									
Argia	0,0,0,0,1	0	0	0	0	0	0	1	2
Megaloptera									
Corydalus									
Corydalidae	0,0,0,0,0	0	0	0	0	1	0	0	1
Trichoptera									
Hydrobiosidae	0,0,0,0,0								
Atopsyche		1	0	2	1	1	0	0	4
Hydropsychidae									
Parapsyche	1,0,0,0,0	0	0	0	0	0	0	0	1
Cheumopsyche	0,0,0,1,1	0	0	0	0	0	0	0	2
Hydropsyche	0,0,0,0,1	0	0	0	0	0	0	0	1
Hydroptilidae									
Hydroptila	0,0,0,1,0	0	0	0	0	0	0	0	1
Helicopsychidae									
Helicopsyche	0,0,0,0,2	0	2	0	0	0	0	4	8
Polycentropodidae									
Neuriclipsis	0,0,0,0,0	0	0	1	0	0	0	0	1

Table 1 continued.

TAXA	Rainbow trout (Young of year)	RB 198 mm	RB 220 mm	RB 225 mm	RB 310 mm	BT 329 mm	RB 384 mm	RB 391 mm	# per Taxa
	1,2,3,4,5								
Polycentropodidae									
Polycentropus	0,0,0,0,0	0	0	0	0	0	1	0	1
Diptera									
Chironomidae	0,0,0,0.*	4	11	1	17	2	7	6	48
Ceratopongonidae	0,0,0,0,0	0	1	0	0	0	0	1	2
Simuliidae									
Simulium	0,0,0,1,2	2	0	5	3	0	0	2	15
Pupae/adults	1,5,0,0,2	0	*	0	1	2	0	1	10*
other	0,0,0,0,1	0	0	1	0	0	0	0	2
Hemiptera									
Notonectidae									
Notonecta	0,2,0,0,0	0	0	0	0	0	0	0	2
Isopoda	0,1,0,0,0	0	0	1	0	0	0	1	3
Decapoda	0,1,0,0,0	0	0	0	1	0	1	1	2
Terrestrial									
Ant	0,1,0,0,0	0	0	0	1	0	1	0	3
Spider	0,0,0,0,0	1	0	0	1	1	0	0	3
Other								1	1
Coleoptera	0,0,0,0,0	0	0	0	0	1	0	0	1
Lepidoptera									
Pyralidae									
Petrophila	2,0,0,2,3	9	33	30	24	8	24	16	141
Other	0,*,*,1,0	0	1	0	1	0	1	0	4
TOTAL CONSUMED	11,12,1*,7,18	21	54	49	66	17	38	60	
TOTAL # TAXA	5,7,2,6,10	7	9	10	11	9	7	12	

Table 2. Taxa of Invertebrates Collected in Benthic Samples at Four Sites. Average numbers from Hess Samples followed in parentheses by numbers from dipnet samples.

TAXA	Kanz Lease	BK Tubes	Beans Camp	Rocking R	
EPHEMEROPTERA					
Oligoneuridae					
Isonychia		(3)	1 (22)	3 (3)	
Tricorythidae					
Tricorythodes	4	5 (10)	7 (1)		
Baetidae					
Baetis	15	4 (3)	6 (1)	10 (7)	
Dactylobaetis				3	
Heptageniidae					
Heptagenia		4	1		
Leptophlebiidae					
Thraulodes			1		
ODONATA					
Zygoptera					
Coenagrionidae					
Argia		5	(6)	2	
Calopterigidae			1		
MEGALOPTERA					
Corydalidae					
Corydalus	1		1 (1)		
TRICHOPTERA	4**	(1)**	2		
Hydrobiosidae					
Atopsyche		1	3		
Hydropsychidae	4		4	1	
Hydroptilidae					
Hydroptila	15	7 (8)	4	3	
Helicopsychidae					
Helicopsyche	26	14 (34)	* (*)		
Polycentropodidae					
Neureclipsis		2	1		
Polycentropus					
Philopotamidae					
COLEOPTERA				3	
Elmidae	1	(1)	1 (1)	5 (2)	
DIPTERA					
Chironomidae	9	10 (7)	28 (1)	10 (5)	

Table 2 continued.					
TAXA	Kanz Lease	BK Tubes	Beans Camp	Rocking R	
Simuliidae					
Simulium	6		1	6 (3)	
Pupa	2	(1)	4	(1)	
LEPIDOPTERA					
Pyralidae					
Petrophila	1	26 (4)	11 (5)	1	
AMPHIPODA	4	9 (3)	11 (3)	3	
MOLLUSCA			(*)	*(*)	
OSTRACODA	*			*(*)	
PLANARIA/OLIGOCHAET/	*	* (*)	*	*(*)	
HYDRACARINA	*			(*)	
DECAPODA			(1)		
TOTAL INDIVIDUALS	**102**	**87 (75)**	**88 (42)**	**50 (21)**	
TOTAL # TAXA	16	12 (12)	20 (12)	15 (10)	
* presence noted, but not counted					
** fragmentation of organism did not allow for positive identification					