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FEEDING ECOLOGY AND LIFE HISTORY ASPECTS OF THE ROCK BASS, (Ambloplites rupestris), IN THE RED CEDAR RIVER, MICHIGAN

presented by

Mr. William T. Green

has been accepted towards fulfillment
of the requirements for

Master of Science degree in Fisheries & Wildlife

Charles R. Liston

Major professor

Date 9/25/84

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FEEDING ECOLOGY AND LIFE HISTORY ASPECTS OF THE ROCK BASS, *AMBLOPLITES RUPESTRIS*, IN THE RED CEDAR RIVER, MICHIGAN

By

William Thomas Green

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF SCIENCE

Department of Fisheries and Wildlife

1984

ABSTRACT

FEEDING ECOLOGY AND LIFE HISTORY ASPECTS
OF THE ROCK BASS, AMBLOPLITES RUPESTRIS, IN
THE RED CEDAR RIVER, MICHIGAN

By

William Thomas Green

The feeding ecology, length-weight relationships, condition, and age and growth of rock bass was studied from September, 1979 to November, 1980. This study was conducted on a small section of a warm water stream in southern Michigan. Both fish and invertebrates were sampled from this section.

This species exhibited no apparent habitat differences by size and foraged mainly in the pools and macrophyte regions along the river banks.

Diet overlap between the different size-groups was relatively high. Though high, a feeding shift from a chironomid - mayfly diet among the smaller rock bass to predominantly a crayfish diet for the largest was noted.

The rock bass in this stream section are in excellent health as seen by the high condition factor values (up to 5.06). This apparent health could be due to the large populations of mayflies, chironomids and crayfish.

ACKNOWLEDGEMENTS

I would like to thank Dr. Charles Liston, major professor, without whose assistance this study would not have been undertaken. My appreciation goes to Dr. Stan Zarnoch, Dr. Edward Grafius, Dr. Eugene Roelofs, Dr. Niles Kevern and Ms. Diane Ashton for many ideas that contributed to this research. I would also like to thank my field workers, Andy Raddant, Joe Leonardi, Bob Platte, Martha Hardy and Jay Gooch. Acknowledgement is made to the Department of Fisheries and Wildlife, Michigan State University, for providing facilities and equipment. The Michigan Agricultural Experiment Station is especially thanked for providing assistantship monies. Special thanks are extended to Ms. Barb Poppema for professional typing service.

I dedicate this study to my wife, Cathy Green, who helped in all aspects of this research.

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INTRODUCTION

The rock bass, Ambloplites rupestris, is the primary organism used in this study. Taxonomically, the rock bass is in the sunfish family Centrarchidae. Scott and Crossman (1973) state that the native range of the rock bass is restricted to the fresh waters of east-central North America. This range has been significantly enlarged through introductions into the eastern coastal plain, Colorado, Wyoming and other western states.

The rock bass generally inhabits rocky areas in shallow water in relatively cold lakes, and the lower, warm reaches of streams. Hallman (1959) stated in his study of an Ontario stream that rock bass occurred in open downstream waters of relatively high temperature and large volume of flow with much quiet water. This species was generally found in pools or other quiet areas of a stream (Hallman 1959).

An interesting aspect of poikilotherms at cold temperature latitudes is the simultaneous presence in the population of several distinct age-groups. It would be advantageous to a species if each age-group could be channeled toward different resources or habitats, thus lessening the likelihood of intraspecific competition. Yet such divergence might complicate relationships with other species. Successful integration into an ecological system then must also involve a compromise between these two factors (Keast 1978).

Pianka (1974) notes that intraspecific and interspecific competition may often have opposite effects on a population's tolerance as well as on its use of resources and its phenotypic variability. Intraspecific competition can often act to increase the variety of resource and habitats utilized by a population. Interspecific competition, in contrast, generally tends to restrict the range of habitats and resources a population uses. Since these two forces oppose each other, in theory at equilibrium the sum total of intraspecific competition should be balanced by the sum of all interspecific competition. Actually, this is not quite true because inherent genetic and physiological limitations must also restrict the range of habitats and resources used by an organism (Pianka 1974).

One of the most important resources "competed" for in an environment, both intraspecifically and interspecifically, is food. Yet, studies on the feeding ecology of fishes have rarely emphasized seasonal aspects and the diets of individual age (size) groups within species. Further, few researchers have attempted to explain feeding shifts by the simultaneous study of flucuations in the food resource base. These questions are addressed here for the rock bass.

Since several life-history parameters, particularly age, growth and condition, can indicate the suitability of a certain environment for a species, these parameters are also investigated.

Although dietary studies have been carried out on fish from the Great Lakes region for over 50 years, the food niches of relatively few have been properly delineated. This is a prerequisite to an understanding of interspecific relationships, proper management, and future studies on secondary productivity.

DESCRIPTION OF THE STUDY AREA

The Red Cedar River, a tributary of the Grand River, is a slow-flowing warm water stream located in the south-central portion of the Lower Peninsula of Michigan. The river rises in Cedar Lake (285 m above sea level), Marion township, Livingston County (T1E, R3E) and flows in a northwesterly direction about 31 km through Livingston County and then flows for about 47 km westward through Ingham County, reaching its confluence with the Grand River (249 m above sea level) within the city of Lansing (Figures 1 and 2). The Red Cedar River receives the waters of twelve major tributaries, the largest being Sycamore Creek, and drains a total area of about 1,222 km^2 (Linton 1964).

The section of the river chosen as a study area was near the M-43 bridge, 8 km east of East Lansing, Michigan. This area is 300 m long bounded downstream by a log jam and upstream by a sharp bend in the river. The average width was approximately 18 m (Figures 1 and 3).

The bottom of this site consisted mainly of sand and gravel with detritus and silt found primarily in the pools. This collecting site has been described by others (Linton 1964, 1967; Vannote 1961; King 1962; Horton 1969) and has been referred to as Zone II. In those studies the Red Cedar River was divided into five zones which were believed to represent somewhat distinct ecological communities. Zone II was described as the cleanest of the five zones.

Figure 1. Map of the Red Cedar River in Michigan showing study site and major -ributaries.

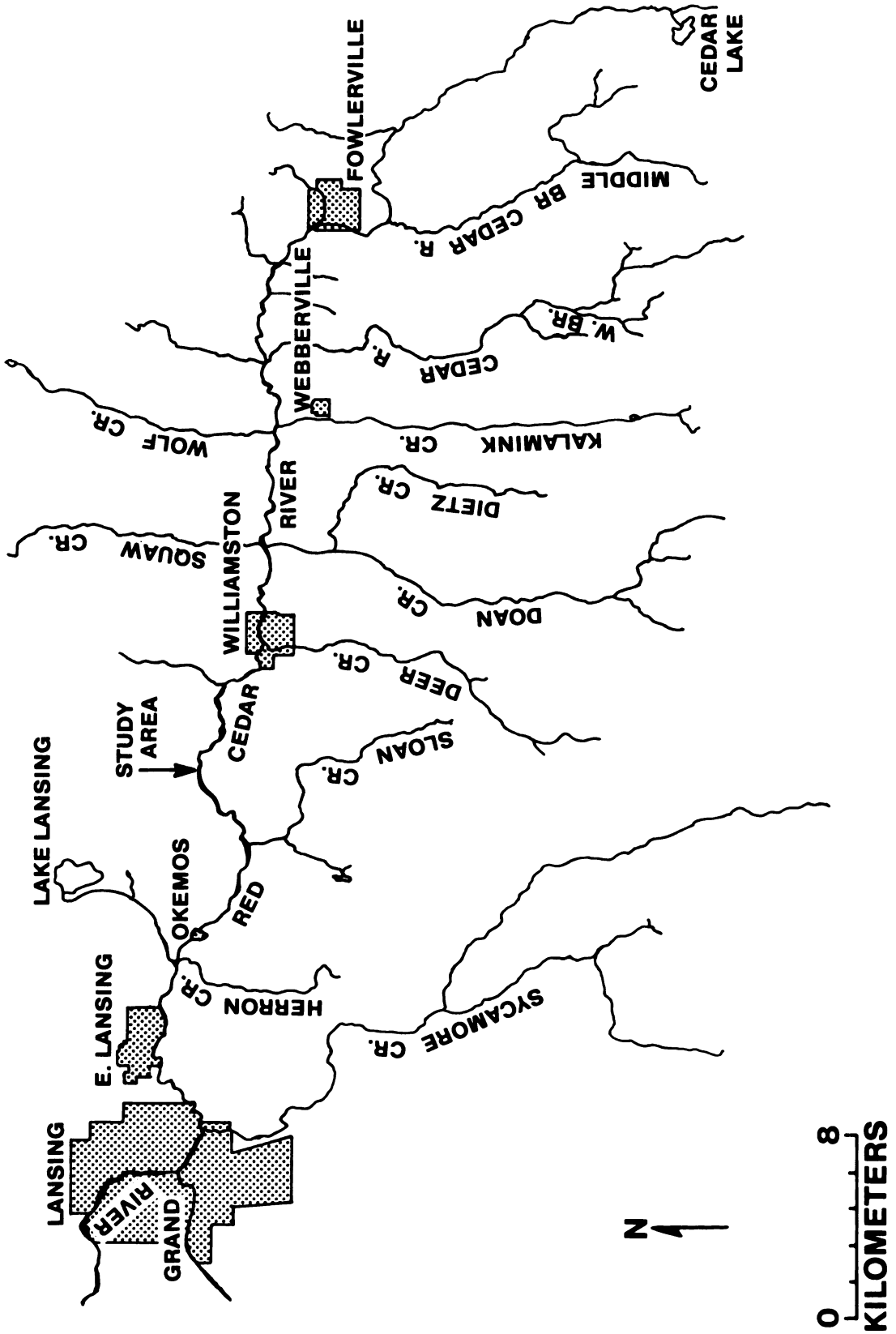
CEDAR LAKE
FOWLERVILLE
MIDDLE BR CEDAR R.
W. BR. CEDAR R.
WEBBERVILLE
WOLF CR.
KALAMINK CR.
DIETZ CR.
SQUAW CR.
WILLIAMSTON
RIVER
DOAN CR.
DEER CR.
CEDAR
STUDY AREA
SLOAN CR.
LAKE LANSING
OKEMOS
RED
HERRON CR.
E. LANSING
SYCAMORE CR.
LANSING
GRAND RIVER
N
0
8
KILOMETERS

Figure 1.

Figure 2. Map of lower Michigan showing general location of study area.

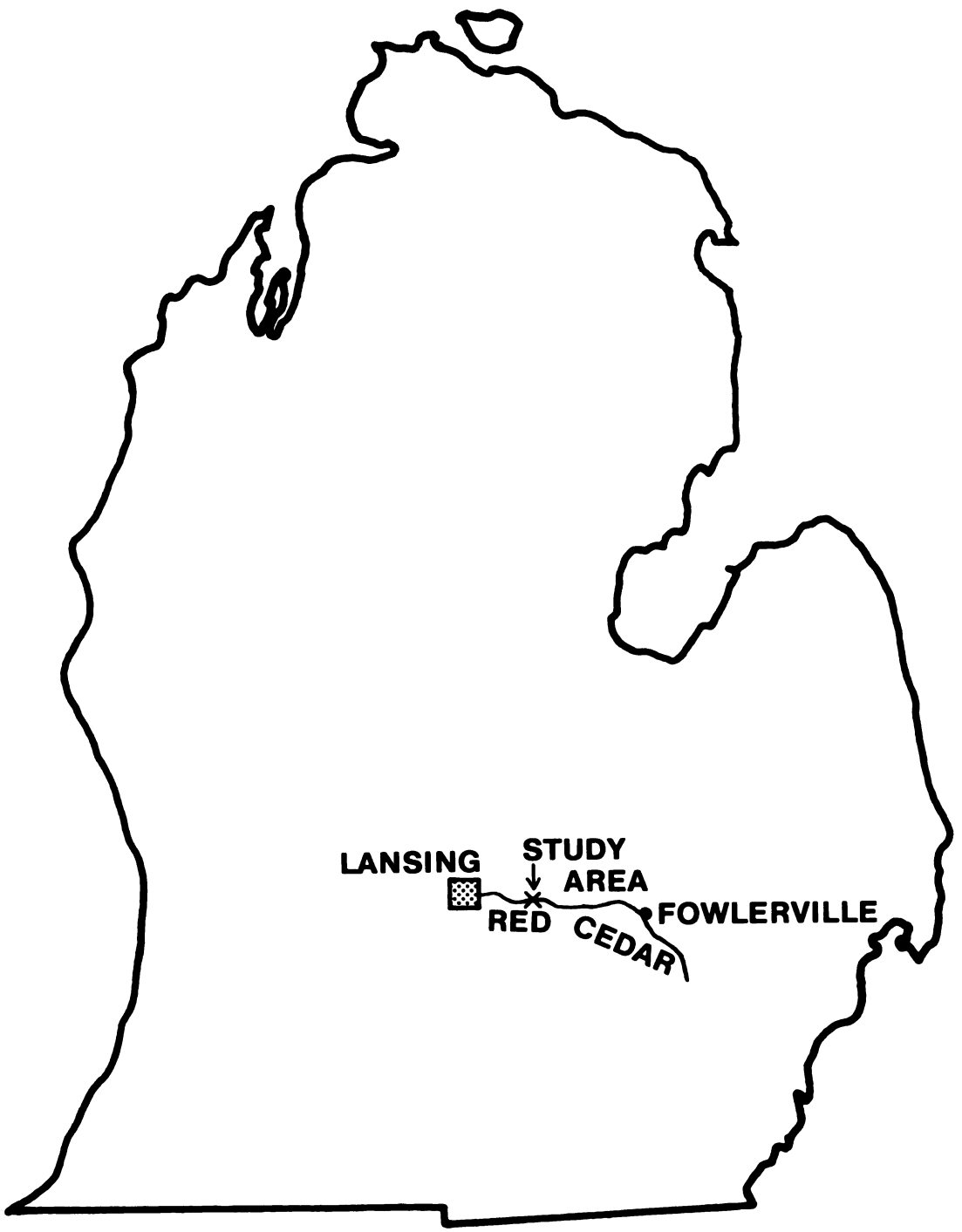

Figure 2.

Figure 3. Map of the study area on the Red Cedar River.

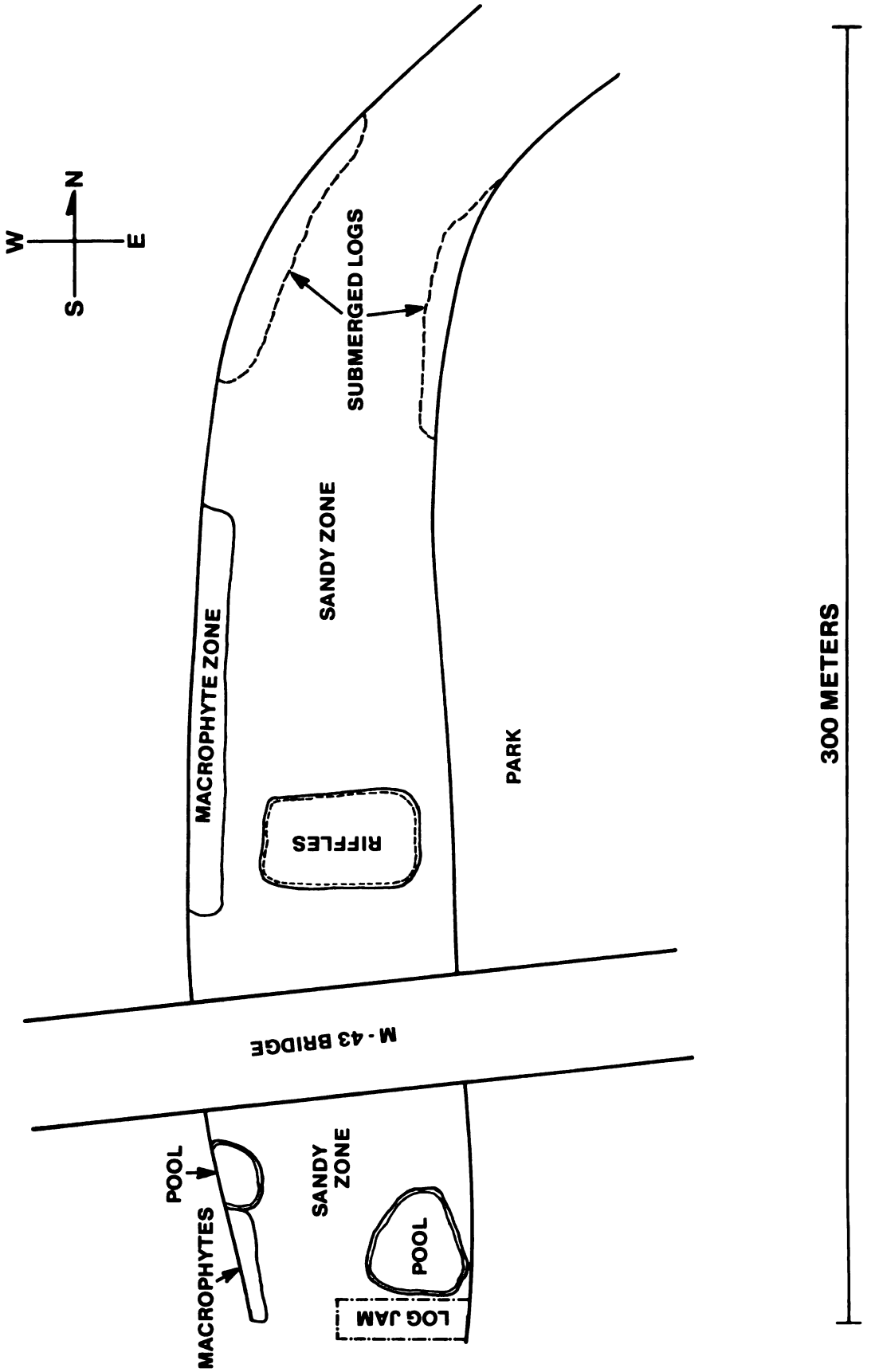
N
W
E
S
SUBMERGED LOGS
SANDY ZONE
MACROPHYTE ZONE
RIFFLES
PARK
M - 43 BRIDGE
POOL
MACROPHYTES
SANDY ZONE
POOL
LOG JAM
300 METERS

Figure 3.

This site was chosen for its abundance of rock bass and its variety of distinct habitats which included a riffle area, several pools, a large area of lizard's tail (Saururus cernuus) along the river's edge, a large sandy bottom zone and an abundance of submerged logs.

Cladophora spp. and Fontinalis novae-angliae were attached to the rocks in the riffle area and also on some submerged logs. In the sandy bottom zone small beds of Sagittaria spp. were noted and also Sagittaria spp. was found around the edge of the pools. The river banks were predominately wooded with a small roadside park found along the eastern bank.

Smallmouth bass (Micropterus dolomieui) were abundant in the study area. Other fish noted were the yellow bullhead (Ictalurus natalis), pumpkinseed (Lepomis gibbosus), bluegill (Lepomis macrochirus), silver lamprey (Ichthyomyzon unicuspis), black crappie (Poxomis nigromaculatus), northern pike (Esox lucius), white sucker (Catostomus commersoni), northern hogsucker (Hypentelium nigricans) and several species of darters (Percidae) and minnows (Cyprinidae).

Water temperatures and flow rates of the Red Cedar River during various sampling dates are given in Table 1.

Table 1. Stream temperature and flow on the Red Cedar River during various sampling dates in 1980.

Date	Stream temperature (°C)	[1]Flow at Williamston (CFS)	[2]Flow at East Lansing (CFS)
5-3-80	14	120	283
5-24-80	17	183	283
6-21-80	16	61	152
7-19-80	23	29	44
8-16-80	19	34	65
9-20-80	16	123	254
10-25-80	9	66	170
11-22-80	2	48	100

[1]Flow determined by USGS approximately 6 km upstream of study site; maximum flow was 455 CFS on 3-21-80.

[2]Flow determined by USGS approximately 8 km downstream of the study site; maximum flow was 1000 CFS on 3-19-80.

METHODS AND MATERIALS

Invertebrate Food Resources

The purpose of the invertebrate sampling was to describe fluctuations in the seasonal abundance of potential fish food organisms. The sampling area was divided into five habitats: (Site A) the edge of the stream lacking macrophytes, (Site B) the edge of the stream where lizard's tail predominated, (Site C) a riffle area, (Site D) pools, and (Site E) the sandy bottom zones found in the middle of the stream. Submerged wood was considered separately.

A Surber sampler (area enclosed = .093 m^2) was used in sampling sites D and E and an Eckman dredge (area enclosed = .023 m^2) was used in sampling sites A, B, and C to quantify the invertebrates in these various habitats (Hynes 1970). Submerged wood was hand picked with each sample comprising approximately 1 m^2 of wood surface. In addition, four drift nets were set two hours before sunrise and removed at sunrise on each fish sampling date. Though no attempt was made to quantify drift samples, a good qualitative record emerged. Sampling was monthly from 5/4/80 to 11/23/80. Table 2 gives the total number of samples taken from each habitat.

The Surber samples were washed into white enamel pans and hand picked in the field. The dredge samples were sieved and all organisms

Table 2. Total number of invertebrate samples taken monthly from each habitat in the Red Cedar River, 1980.

Date	Drift	Wood	Sites A	Sites B	Sites C	Sites D	Sites E
5/4	4	4	8	3	3	4	5
5/25	4	4	8	3	3	4	5
6/22	4	4	8	3	3	4	5
7/20	4	4	8	3	3	4	5
8/17	4	4	8	3	3	4	5
9/21	4	4	8	3	3	4	5
10/26	4	4	8	3	3	4	5
11/23	4	4	8	3	3	4	5
Total number	32	32	64	24	24	32	40

not passing through a number 18 sieve (mesh size 1 mm) were preserved. All invertebrates were preserved in 75% ETOH.

All organisms were identified to family and many were identified to generic or species level using the following taxonomic references: Hilsenhoff 1975; Merrit and Cummins 1978; Usinger 1956; Brown 1976; Pennak 1978; Wiggins 1977; Edmunds et al. 1976; Borror et al 1976. Numbers per square meter were calculated for all habitats except submerged wood.

Rock Bass

Field Sampling

Fish were collected monthly from 5/3/80 through 11/22/80. Sampling began at 30 minutes before sunrise and continued until a predetermined number of individuals were taken or until stream conditions curtailed sampling. Keast and Welsh (1968) determined that maximum feeding takes place during two periods of the day: several hours after sunrise and several hours before sunset. In a pilot conducted on 11/23/79, I compared weight of stomach contents to body weight and arrived at basically the same conclusion since the largest ratios occurred at approximately the same times Keast and Welsh noted.

Rock bass were sampled with a Smith-Root, Type VII, backpack electroshocker. Upon capture, fish were immediately placed on ice to prevent further food digestion and regurgitation of the stomach contents (Doxtater 1963). Fish were then killed by puncturing the brain with a probe, 10% formalin was injected into the abdominal cavity to further hinder food digestion, and whole fish were preserved in 10% formalin.

An attempt was made to capture 25 rock bass per sampling period, but because of high water and lack of visibility this was not accomplished during the fall.

Individuals were weighed on a spring scale (g), and standard lengths (mm) and total lengths (mm) were recorded. Scale samples were removed from the side of the rock bass, just below the lateral line, directly under the spiny-dorsal fin. The scales were put in standard scale envelopes with data on both standard and total length, weight and the date of collection recorded on the envelope.

Laboratory

Food Analysis. In the laboratory the stomachs were excised and the very small fish were reweighed for accuracy. The stomachs were opened and all food organisms were identified to family level whenever possible. Data from each food type were analyzed as follows: percent frequency of occurrence of a food item, percent of total number of all food items eaten, and the percent of the total weight of all foods eaten. These three methods all contain biases which limit the usefulness of any one method. For example, the percent of total numbers method gives high values to small, frequently eaten food items such as cladocerans, but yields very low values for large items such as crayfish eaten in small numbers. The percent weight method gives values biased in the opposite direction. George and Hadley (1979) in an attempt to decrease these biases by offsetting them against one another used a single index termed the relative importance index (RI).

George and Hadley (1979) state that the relative importance index for (a) (RI_a) is derived from the absolute importance index for (a)

(AI_a) as follows: AI_a = % frequency of occurrence + % total numbers + % total volume for food item (a); $RI_a = 100\ AI_a / \sum_{a=1}^{n} AI_a$ where n is the number of different food types. In this study, weight was used instead of volume.

The denominator used in this study was comprised of broad taxonomic categories (generally classes), though the numerator was often comprised of a narrower taxonomic category. For example, the RI_a of Ephemeridae may use in the denominator the AI_a's of Insecta, Arachnida and Crustacea, instead of using the AI_a's of Ephemeridae, Libellulidae, Elmidae, Hyallela azteca, Orconectes spp., Hydracarina etc. This leads to a more stable index than one that uses the narrower taxonomic categories in the denominator. The index in the latter case is variable depending on the taxonomic divisions used. A weakness of this index is the use of equal weights for the three combined indices which might not reflect the importance of each food item.

Mean annual and seasonal dietary (niche) overlap between five different size classes were determined as follows:

$$\alpha ji \text{ (niche overlap)} = \sum_{h=1}^{s} P_{ih}\ P_{jh} / \sum_{h=1}^{s} Pi^2 h$$

where αji is the overlap of species j on species i relative to the niche breath of species i for all h sample types of resources s; P_{ij} is the proportion of a particular item h in the diet of species i; P_{jh} is the proportion of a particular item h in the diet of species j (Levins 1968). Relative importance index values were used in these dietary overlap calculations. In the above mentioned formula, size class was substituted for species wherever applicable (Keast 1978).

Age, Growth and Condition. The scales from each standard scale envelope were pressed between two glass slides, then examined on a microprojector and annuli were counted. The distance from the center of the focus to each annulus and to the extreme anterior edge of the scale were marked on a straight ruled sheet of paper. Ages were marked on each scale envelope as the number of annuli present on the scale.

Using the Lee method, $L_n = a + S_n\left(\frac{L_T - a}{S_T}\right)$.

a linear equation was derived. L_n is equal to the length of the fish at a given age; L_T is the length of the fish at the time of capture; S_n is the length of the scale to the annulus of interest; S_T is the length of the entire scale at the time of capture, and (a) is a constant (y - intercept) which has been frequently interpreted as the body length at which scales first appear on the fish. Lagler (1956) states that this interpretation is approximately correct, but it cannot be accepted as a generalization, since the intercept is negative in certain species.

The Lee method assumes a linear relationship between body length and scale length which was verified in this sample (the correlation coefficient of the linear regression was 0.9776). Back-calculated total lengths were derived using Lee's method, and an (a) value of 20.667 mm was used. Also calculated were the weighted total length averages for each age class. Mean annual increments and relative growths were calculated between each age class.

The rock bass were sorted into 10 mm incremental classes for length - frequency analysis and length - frequency was compared with fish age.

The length - weight relationship of rock bass was calculated using $W = aL^n$, where W = weight (g), L = standard length (mm), and (a) and

(n) are constants. When expressed in logarithmic form, a linear equation is formed: $\log W = \log a + n \log L$.

The coefficient of condition was calculated for each age group and for each season using the formula $K = W/L^3$ where W = weight (g) and L = standard length (mm).

RESULTS AND DISCUSSION

Invertebrate Food Resources

Appendix A (Tables A1-A9) summarizes the invertebrate distribution by season and habitat and by month and habitat.

Seasonal variations among the non-insect invertebrates were generally not noted. The only fluctuation noted was with the seasonal size variation of the crayfish (Orconectes spp.). Many small, presumably young of the year, crayfish were captured after May, whereas in May predominantly larger crayfish were taken. This may be due to the release of third instar crayfish from the pleopods of the female crayfish (Pennak 1978) between my sampling dates of 5/25 and 6/22.

Some seasonal abundance changes were noted among the mayflies (Ephemeroptera). Hexagenia spp. naiads were most prevalent in the spring, although they were found during all seasons. Tricorythodes naiads, Baetis spp. naiads and Caenis spp. naiads were found in large numbers in the spring with only a slight reduction of their numbers noted in the summer, but they virtually disappeared from fall samples. The opposite occurred with Leptophlebia spp. naiads and Paraleptophlebia spp. naiads where their spring and summer numbers are quite small, but their fall populations were large.

Two genera of stoneflies (Plecoptera) showed extreme seasonal numerical variations. Taeniopteryx spp. naiads were found only in the

fall samples and were quite numerous during this season. Perlesta spp. naiads, in marked contrast, were found almost only in the spring samples.

Though many of the invertebrate groups at the family and generic levels seemed to have no gross habitat preference, some did show a marked preference for one or two types of habitats.

Of the non-insect invertebrates, the leeches (Hirudinea) showed a strong preference for the quiet water area of the pools, as did the snails (Gastropoda) and worms (Oligochaeta).

A strong habitat preference was noted among some of the mayflies. Hexagenia spp. naiads, Caenis spp. naiads and Tricorythodes spp. naiads were found predominantly in pool areas, whereas Isonychia spp. naiads, Baetis spp. naiads, and Pseudocloeon spp. naiads were most numerous in the large riffle area. Though the family Heptageniidae was found in several habitats, naiads of this family were quite common on submerged wood.

Of the stoneflies, Perlesta spp. naiads showed a slight preference for the riffle area.

Among the Odonata, Calopteryx spp. naiads were found both in the macrophytes of the pools as well as along the bank. Stylurus spp. naiads were mainly found in the sediments along the banks and in the pools.

The true bugs (Hemiptera), except for the family Corixidae, were found too rarely to determine any habitat preference. Corixidae did show a marked preference for the pools.

Of the Megaloptera, Sialis spp. was found in the sediments of the pools and river's edge.

Several groups of Caddisflies (Tricoptera) showed habitat preferences. Hydropsychidae larvae, though found in all habitats, were most numerous in the Cladophora spp., which was attached to the rocks in the riffle area. Leptoceridae larvae were most common on the submerged wood and also on the lizard's tail along the river's edge.

Of the beetles (Coleoptera), both the adult and larval stages of Macronychus glabratus were found predominately on the submerged wood.

Paraponyx spp. a moth larvae (Lepidoptera) was found mainly on the macrophytes along the river's bank.

Some invertebrates, such as crayfish were not sampled in relation to their abundance due to their mobility. Other groups such as Gyrinidae and Gerridae were not captured due to the benthic nature of most of the sampling.

Zooplankton, an unimportant component of most streams (Hynes 1970), was not sampled.

To further summarize the invertebrate distribution by season and habitat, the seven most abundant invertebrates are listed in decreasing numbers in Tables 3, 4, and 5.

Rock Bass

Feeding Ecology

The mean seasonal and mean annual diets of five different size classes of rock bass expressed as percent of occurrence, numbers, and weights, and the relative importance index are given in Tables 6-10. Fall values should be cautiously interpreted because of the small numbers of rock bass used in the analysis. Also soft bodied organisms may be under-represented because of differential digestion rates.

Table 3. Major invertebrate taxa listed in decreasing order of abundance for each habitat, Red Cedar River, Spring, 1980.

Drift	Wood
Leptophlebia spp.	Hydropsychidae
Hyallela azteca	Chironomidae
Pseudocloeon spp.	*Hyallela azteca*
Chironomidae	*Stenonema* spp.
Hydropsychidae	(Adult) *Macronychus glabratus*
Perlesta spp.	Limnephilidae
Limnephilidae/Corixidae	Polycentropodidae

Edge without Macrophytes	Edge with Macrophytes
Chironomidae	Chironomidae
Hyallela azteca	*Hyallela azteca*
Oligochaeta	Hydropsychidae
(Larvae) *Dubiraphia* spp.	*Hexagenia* spp./Limnephilidae
Ceratopogonidae	Simuliidae
Limnephilidae	*Tricorychodes* spp.
Tricorychodes spp.	

Riffles	Pools
Hydropsychidae	Chironomidae
Hyallela azteca	Oligochaeta
Chironomidae	*Hyallela azteca*
Perlesta spp.	*Hexagenia* spp.
(Adult) *Stenelmis* spp.	*Tricorychodes* spp.
(Adult) *Dubiraphia* spp.	Ceratopogonidae
Baetis spp.	Sphaeriidae

Sandy Zones
Chironomidae
Sphaeriidae
Hyallela azteca
Hydropsychidae
Leptoceridae
(Adult) *Stenelmis* spp./ Gastropoda

Table 4. Major invertebrate taxa listed in decreasing order of abundance for each habitat, Red Cedar River, Summer, 1980.

Drift

Hyallela azteca
Chironomidae
Hydropsychidae
Paraleptophlebia spp.
Baetis spp.
Simuliidae
Tricorythodes spp.

Wood

Hyallea azteca
Hydropsychidae
(adult) Macronychus glabratus
Stenacron
Baetis spp.
Stenonema spp.
Chironomidae

Edge without Macrophytes

Chironomidae
Hydropsychidae
Hyallela azteca
Sphaeriidae
(larvae) Dubiraphia spp.
Sialisspp.
Gastropoda

Edge with Macrophytes

Hyallela azteca
Chironomidae
Hydropsychidae
Limnephilidae
Polycentropodidae
Gastropoda
Simuliidae

Riffles

Hydropsychidae
Chironomidae
Hyallela azteca
Simuliidae
Baetis spp.
Pseudocloeon spp.
(adult) Stenelmis spp.

Pools

Oligochaeta
Hyallela azteca
Chironomidae
(Larvae) Dubiraphia spp.
Sialis spp.
Gastropoda
Sphaeriidae

Sandy Zones

Chironomidae
Simuliidae
Sphaeriidae
Hydropshchidae
Baetis spp.
Gastropoda
Oligochaeta

Table 5. Major invertebrate taxa listed in decreasing order of abundance for each habitat, Red Cedar River, Fall, 1980.

Drift

Taeniopteryx spp./Simuliidae
Hydropsychidae
Hyallela azteca/ Baetis spp./
(adult) Gyrinus spp.
Sialis spp./ (adult) Liodessus spp./
Chironomidae

Wood

Chironomidae
Hyallela azteca
Hydropsychidae
(adult) Macronychus glabratus
Stenonema spp.
Stenacron spp.

Edge without Macrophytes

Oligochaeta
Leptophlebia spp.
Chironomidae
Taeniopteryx spp.
Paraleptophlebia spp.
Hyallela azteca
Limnephilidae

Edge with Macrophytes

Leptophlebia spp.
Hyallela azteca
Paraleptophlebia spp.
Chironomidae
Taeniopteryx spp.
Sialis spp.
Polycentropodidae

Riffles

Chironomidae
Hydropsychidae
Taeniopteryx spp.
(adult) Stenelmis spp.
(adult) Dubiraphia spp.
Simuliidae spp.
Hyallela azteca

Pools

Oligochaeta
Taeniopteryx
Leptophlebia /Chironomidae
Hyallela azteca
Hirudinea/ Hydropsychidae

Sandy Zones

Chironomidae
Ceratopogonidae
Taeniopteryx spp.
Sphaeriidae
Hydropsychidae
Oligochaeta
(larvae) Dubiraphia spp./ Tipulidae

Table 6. Food analysis of rock bass (total length 30-74 mm) taken from the Red Cedar River, Michigan (R.I., relative importance index; F.O., frequency of occurence; P.T.N., percent of total number of food items; P.T.W., percent of total weight of food items).

	Spring (12)[1]				Summer (22)				Fall (5)				Year (39)			
	R.I.	F.O.	P.T.N.	P.T.W.	R.I.	F.O.	P.T.N.	P.T.W.	R.I.	F.O.	P.T.N.	P.T.W.	R.I.	F.O.	P.T.N.	P.T.W.
ARTHROPODA	96.26	100	98.31	98.47	89.00	100	95.73	91.49	100	100	100	100	96.25	100	96.79	93.24
Crustacea	3.71	8.33	1.69	2.04	17.23	18.18	4.27	35.14	14.81	20.00	18.18	6.25	14.30	15.38	4.28	27.04
Orconectes spp.	3.71	8.33	1.69	2.04	13.95	9.09	2.56	34.98	0	0	0	0	11.02	7.69	2.14	26.18
Isopoda	0	0	0	0	1.66	4.55	.85	.15	0	0	0	0	.99	2.56	.53	3.50
Copepoda	0	0	0	0	1.62	4.55	.85	0	0	0	0	0	.95	2.56	.53	0
Hyallela azteca	0	0	0	0	0	0	0	0	14.81	20.00	18.18	6.25	1.15	2.56	1.07	.12
Arachnida	5.30	8.33	8.47	.41	0	0	0	0	0	0	0	0	1.63	2.56	2.67	.09
Hydracarina	5.30	8.33	8.47	.41	0	0	0	0	0	0	0	0	1.63	2.56	2.67	.09
Insecta	87.44	100	88.14	96.02	72.15	95.45	91.45	54.33	85.19	80.00	81.81	93.75	76.32	94.87	89.84	64.59
Ephemeroptera	44.37	66.67	33.90	43.62	34.31	50.00	37.61	27.09	50.68	60.00	54.55	37.5	38.23	56.41	37.43	31.06
Baetidae	23.22	33.33	13.56	28.57	8.23	18.18	8.55	.77	0	0	0	0	8.27	10.26	9.63	7.11
Ephemeridae	4.50	8.33	1.69	4.59	10.48	22.73	4.27	8.05	0	0	0	0	7.88	15.38	3.21	7.11
Hexagenia spp.	4.50	8.33	1.69	4.59	10.48	22.73	4.27	8.05	0	0	0	0	7.88	15.38	3.21	7.11
Leptaphlebiidae	0	0	0	0	0	0	0	0	38.9	40.00	45.45	31.25	2.57	5.13	2.67	.58
Heptageniidae	3.16	8.33	1.69	.26	14.22	22.73	17.09	7.74	0	0	0	0	9.95	15.38	11.23	5.89
Stenacron spp.	0	0	0	0	2.36	4.55	2.56	.77	0	0	0	0	1.45	2.56	1.60	.58
Tricorythidae	10.35	16.67	11.86	5.10	0	0	0	0	0	0	0	0	3.07	5.13	3.74	1.17
Tricorythodes spp.	10.35	16.67	11.86	5.10	0	0	0	0	0	0	0	0	3.07	5.13	3.74	1.17
Caeidae	0	0	0	0	3.28	9.09	1.71	.15	0	0	0	0	1.93	5.13	1.07	.12
Caenis	0	0	0	0	3.28	9.09	1.71	.15	0	0	0	0	1.93	5.13	1.07	.12
Siphloneuridae	0	0	0	0	3.74	9.09	1.71	1.70	0	0	0	0	2.29	5.13	1.07	1.28
Isonychia spp.	0	0	0	0	3.74	9.09	1.71	1.70	0	0	0	0	2.29	5.13	1.07	1.28

Table 6. (cont'd.).

	Spring (12)[1]				Summer (22)				Fall (5)				Year (39)			
	R.I.	F.O.	P.T.N.	P.T.W.	R.I.	F.O.	P.T.N.	P.T.W.	R.I.	F.O.	P.T.N.	P.T.W.	R.I.	F.O.	P.T.N.	P.T.W.
Ephemerellidae	0	0	0	0	3.62	9.09	2.56	.46	0	0	0	0	2.17	5.13	1.60	.35
Ephemerella spp.	0	0	0	0	3.62	9.09	2.56	.46	0	0	0	0	2.17	5.13	1.60	.35
(Adult) Ephemeroptera	0	0	0	0	3.65	4.55	.85	6.81	0	0	0	0	2.52	2.56	.53	5.13
Ephemeridae	0	0	0	0	3.65	4.55	.85	6.81	0	0	0	0	2.52	2.56	.53	5.13
Plecoptera	7.38	8.33	8.47	7.14	0	0	0	0	0	0	0	0	2.10	2.56	2.67	1.63
Perlidae	7.38	8.33	8.47	7.14	0	0	0	0	0	0	0	0	2.10	2.56	2.67	1.63
Perlesta spp.	7.38	8.33	8.47	7.14	0	0	0	0	0	0	0	0	2.10	2.56	2.67	1.63
Odonata	6.32	8.33	5.08	4.59	0	0	0	0	0	0	0	0	1.59	2.56	1.60	1.05
Coenagrionidae	6.32	8.33	5.08	4.59	0	0	0	0	0	0	0	0	1.59	2.56	1.60	1.05
Enallagma spp.	6.32	8.33	5.08	4.59	0	0	0	0	0	0	0	0	1.59	2.56	1.60	1.05
Hemiptera	6.49	16.67	3.39	1.02	26.88	40.91	26.50	22.45	11.78	20.00	9.09	6.25	20.27	30.77	18.18	17.25
Corixidae	6.49	16.67	3.39	1.02	26.88	40.91	26.50	22.45	11.78	20.00	9.09	6.25	20.27	30.77	18.18	17.25
(Adult) Tricoptera	3.40	8.33	1.69	1.02	1.71	4.55	.85	.31	29.39	20.00	18.18	50.00	3.44	7.69	2.16	1.40
(Pupae) Tricoptera	10.72	8.33	5.08	21.43	0	0	0	0	0	0	0	0	2.78	2.56	1.62	4.90
Tricoptera	8.06	16.67	3.39	6.12	12.60	22.73	15.38	4.02	0	0	0	0	10.16	17.95	10.81	4.43
Hydropsychidae	8.06	16.67	3.39	6.12	12.60	22.73	15.38	4.02	0	0	0	0	10.16	17.95	10.81	4.43
(Adult) Coleoptera	0	0	0	0	1.62	4.55	.85	0	0	0	0	0	.95	2.56	.53	0
(Pupae) Diptera	13.78	33.33	10.17	1.28	1.62	4.55	.85	0	0	0	0	0	5.17	12.82	3.78	.29
Chironomidae	13.78	33.33	10.17	1.28	1.62	4.55	.85	0	0	0	0	0	5.17	12.82	3.78	.29
Diptera	15.26	33.33	15.25	1.02	5.96	13.64	5.98	.31	0	0	0	0	8.29	17.95	8.65	.47
Chironomidae	15.26	33.33	15.25	1.02	5.66	13.64	5.13	.15	0	0	0	0	8.08	17.95	8.11	.35
Simuliidae	0	0	0	0	1.66	4.55	.85	.15	0	0	0	0	.98	2.56	.53	.12
Plant Material	0	0	0	0	7.42	13.64	2.56	7.74	0	0	0	0	5.02	7.69	1.62	5.83
Wood	3.74	8.33	1.67	1.53	0	0	0	0	0	0	0	0	1.14	2.56	.53	.35
Fish	0	0	0	0	1.72	4.55	.85	.15	0	0	0	0	1.07	2.56	.53	.12

Table 7. Food analysis of rock bass (total length 75-104) taken from the Red Cedar River, Michigan (R.I., relative importance index; F.O., frequency of occurence; P.T.N., percent of total number of food items; P.T.W., percent of total weight of food items.

	Spring (12)[1]				Summer (22)				Fall (5)				Year (39)			
	R.I.	F.O.	P.T.N.	P.T.W.	R.I.	F.O.	P.T.N.	P.T.W.	R.I.	F.O.	P.T.N.	P.T.W.	R.I.	F.O.	P.T.N.	P.T.W.
Arthopoda	93.74	95.24	98.45	92.20	91.21	100	96.69	98.83	100	100	100	100	92.99	97.96	97.54	96.82
Crustacea	15.47	28.57	4.65	22.55	25.23	48.00	11.26	36.96	0	0	0	0	20.77	36.73	8.07	32.48
Orconectes spp.	13.65	23.81	3.88	21.51	25.23	48.00	11.26	36.96	0	0	0	0	20.04	34.69	7.72	32.16
Isopoda	1.82	4.76	.76	1.04	0	0	0	0	0	0	0	0	.73	2.04	.35	.32
Arachnida	7.53	19.05	3.10	4.99	1.58	4.00	1.32	.72	0	0	0	0	4.39	12.24	2.11	1.98
Araneae	7.53	19.05	3.10	4.99	1.58	4.00	1.32	.72	0	0	0	0	4.39	12.24	2.11	1.98
Insecta	71.71	95.24	90.70	72.55	65.71	96.00	84.11	70.46	100	100	100	100	68.93	97.76	87.37	71.18
Ephemeroptera	24.96	52.38	25.58	12.02	37.68	68.00	37.75	37.93	46.67	66.67	40.00	33.33	33.20	61.22	32.28	30.04
Baetidae	3.20	9.52	1.55	.45	0	0	0	0	0	0	0	0	1.32	4.08	.70	.14
Caenidae	3.53	9.52	2.33	.89	1.60	4.00	1.99	.13	23.33	33.33	20.00	16.67	3.51	10.20	2.46	.41
Caenis spp.	3.53	9.52	2.33	.89	1.60	4.00	1.99	.13	0	0	0	0	2.86	8.16	2.11	.36
Siphloneuridae	3.23	9.52	1.55	.74	0	0	0	0	0	0	0	0	1.35	4.08	.70	.23
Isonychia spp.	3.23	9.52	1.55	.74	0	0	0	0	0	0	0	0	1.35	4.08	.70	.23
Heptageniidae	3.94	9.52	2.33	2.37	10.00	28.00	9.27	.85	0	0	0	0	6.89	18.37	5.96	1.31
Stenacron spp.	1.66	4.76	.76	.45	0	0	0	0	0	0	0	0	.68	2.04	.35	.14
Tricorythidae	6.79	9.52	13.18	1.78	1.41	4.00	1.32	.07	0	0	0	0	3.60	6.12	6.67	.59
Tricorythodes spp.	6.79	9.52	13.18	1.78	1.41	4.00	1.32	.07	0	0	0	0	3.60	6.12	6.67	.59
Ephemeridae	5.64	14.29	2.33	3.71	27.48	48.00	23.18	33.62	0	0	0	0	18.44	30.61	13.33	24.67
Hexagenia spp.	5.64	14.29	2.33	3.71	27.48	48.00	23.18	33.62	0	0	0	0	18.44	30.61	13.33	24.67
Leptophlebiidae	0	0	0	0	0	0	0	0	23.33	33.33	20.00	16.67	.66	2.04	.35	.05
Odonata	5.60	14.29	2.33	3.56	4.35	12.00	1.99	2.60	0	0	0	0	4.63	12.24	2.11	2.89
Unidentified Zygoptera	0	0	0	0	1.39	4.00	.66	.65	0	0	0	0	.76	2.04	3.5	.45
Coenagrionidae	1.98	4.76	.76	1.63	2.96	8.00	1.32	1.95	0	0	0	0	2.42	6.12	1.05	1.85
Hemiptera	19.54	38.10	20.16	12.17	14.33	36.00	13.91	4.75	0	0	0	0	15.63	34.69	16.49	6.99
Corixidae	17.83	33.33	19.38	11.57	10.95	28.00	12.58	1.17	0	0	0	0	12.99	28.57	15.44	4.33

Table 7. (cont'd.)

	Spring (12)[1]				Summer (22)				Fall (5)				Year (39)			
	R.I.	F.O.	P.T.N.	P.T.W.	R.I.	F.O.	P.T.N.	P.T.W.	R.I.	F.O.	P.T.N.	P.T.W.	R.I.	F.O.	P.T.N.	P.T.W.
Gerridae	1.69	4.76	.76	.59	0	0	0	0	0	0	0	0	.69	2.04	.35	.18
Veliidae	0	0	0	0	1.24	4.00	.66	.07	0	0	0	0	.66	.204	.35	.05
Belostomatidae	0	0	0	0	2.14	4.00	.66	3.51	0	0	0	0	1.30	2.04	.35	2.44
(Adult) Tricoptera	7.40	14.29	4.65	7.72	3.30	8.00	1.32	3.25	0	0	0	0	4.73	10.20	2.81	4.60
Tricoptera	6.63	14.29	3.10	6.53	17.90	44.00	21.85	2.41	53.33	33.33	60.00	66.67	13.03	30.61	14.04	3.83
Polycentropodidae	3.20	9.52	1.55	.45	0	0	0	0	0	0	0	0	1.32	4.08	.70	.14
Limnephilidae	3.44	4.76	1.55	6.08	0	0	0	0	53.33	33.33	60.00	66.67	2.11	4.08	1.75	2.03
Hydropsychidae	0	0	0	0	17.90	44.00	21.85	2.41	0	0	0	0	9.59	22.45	11.58	1.67
(Pupae) Tricoptera	1.66	4.76	.76	.45	0	0	0	0	0	0	0	0	.68	2.04	.35	.14
Lepidoptera	1.78	4.76	.76	.89	0	0	0	0	0	0	0	0	.71	2.04	.35	.27
(Adult) Coleoptera	0	0	0	0	2.46	8.00	1.32	.07	0	0	0	0	1.30	4.08	.70	.05
Nitidulidae	0	0	0	0	1.24	4.00	.66	.07	0	0	0	0	.66	2.04	.35	.05
Coleoptera	8.41	23.81	6.20	.30	2.51	8.00	1.32	.33	0	0	0	0	4.87	14.29	3.51	.32
Gyrinidae	3.07	9.52	1.55	0	1.24	4.00	.66	.07	0	0	0	0	1.94	6.12	1.05	.05
Gyrinus spp.	3.07	9.52	1.55	0	0	0	0	0	0	0	0	0	1.28	4.08	.70	0
Dineutus spp.	0	0		0	1.24	4.00	.66	.07	0	0	0	0	.66	2.04	.35	.05
Dytiscidae	5.34	14.29	4.65	.30	1.29	4.00	.66	.26	0	0	0	0	2.93	8.16	2.46	.27
Hydroporus spp.	5.34	14.29	4.65	.30	0	0	0	0	0	0	0	0	2.24	6.12	2.11	.09
(Adult) Hymenoptera	0	0	0	0	2.65	8.00	1.32	.78	0	0	0	0	1.43	4.08	.70	.54
Vespidae	0	0	0	0	1.34	4.00	.66	.46	0	0	0	0	.73	2.04	.35	.32
Formicidae	0	0	0	0	1.31	4.00	.66	.33	0	0	0	0	.70	2.04	.35	.23
Diptera	15.95	42.86	12.40	2.22	0	0	0	0	0	0	0	0	6.63	18.37	5.61	.68
Chironomidae	15.95	42.86	12.40	2.22	0	0	0	0	0	0	0	0	6.63	18.37	5.61	.68
(Pupae) Diptera	9.64	23.81	9.30	1.63	0	0	0	0	0	0	0	0	4.01	10.20	4.21	.50
Chironomidae	9.64	23.81	9.30	1.63	0	0	0	0	0	0	0	0	4.01	10.20	4.21	.50
(Adult) Diptera	0	0	0	0	1.22	4.00	.66	0	0	0	0	0	.64	2.04	.35	0
Wood	0	0	0	0	7.29	20.00	2.65	.98	0	0	0	0	3.91	10.20	1.40	.68
Fish	6.26	9.52	1.55	8.01	1.50	4.00	.66	.20	0	0	0	0	3.10	6.12	1.05	2.57

[1]Number of fish examined

Table 8. Food analysis of rock bass (total length 105-135 mm) taken from the Red Cedar River, Michigan (R.I., relative importance index; F.O., frequency of occurence; P.T.N., percent of total number of food items; P.T.W., percent of total weight of food items).

	Spring (12)[1]				Summer (19)				Fall (4)				Year (35)			
	R.I.	F.O.	P.T.N.	P.T.W.	R.I.	F.O.	P.T.N.	P.T.W.	R.I.	F.O.	P.T.N.	P.T.W.	R.I.	F.O.	P.T.N.	P.T.W.
Arthopoda	91.16	100	97.30	91.37	82.72	94.73	94.67	92.53	89.23	100	90.00	100	86.64	97.14	95.30	92.24
Crustacea	33.89	58.33	21.62	50.88	27.44	68.42	11.33	37.42	0	0	0	0	28.06	57.14	14.10	41.46
Orconectes spp.	24.43	41.67	6.76	45.88	24.28	57.89	8.67	37.10	0	0	0	0	23.15	45.71	7.69	39.55
Isopoda	10.87	25.00	12.16	4.80	3.16	10.53	2.67	.31	0	0	0	0	5.40	14.29	5.56	1.84
Hyallela azteca	5.07	16.67	2.70	.20	0	0	0	0	0	0	0	0	1.64	5.71	.85	.07
Arachnida	5.42	16.67	2.70	1.57	2.82	10.53	1.33	.16	13.90	25.00	10.00	13.64	4.30	14.29	2.14	.84
Araneae	5.42	16.67	2.70	1.57	2.82	10.53	1.33	.16	13.90	25.00	10.00	13.64	4.30	14.29	2.14	.84
Diplopoda	0	0	0	0	3.16	10.53	2.67	.31	0	0	0	0	1.90	5.71	1.71	.20
Insecta	53.43	91.67	75.68	38.92	52.78	94.73	76.00	54.64	76.10	100	80.00	86.36	54.81	94.29	76.07	49.75
Ephemeroptera	25.96	66.67	24.32	9.22	35.10	68.42	42.00	39.44	21.30	50.00	20.00	4.55	32.32	65.71	35.47	28.62
Heptageniidae	7.85	25.00	4.05	1.27	16.25	47.37	18.00	4.00	0	0	0	0	12.48	34.29	12.82	3.01
Siphloneuridae	9.04	16.67	12.16	6.08	1.81	5.26	2.00	.47	0	0	0	0	4.00	8.57	5.13	2.37
Isonychia spp.	9.04	16.67	12.16	6.08	1.81	5.26	2.00	.47	0	0	0	0	4.00	8.57	5.13	2.37
Baetidae	2.58	8.33	1.35	.29	0	0	0	0	0	0	0	0	.84	2.86	.43	.10
Ephemeridae	3.30	8.33	1.35	3.04	23.65	47.37	19.33	34.30	10.78	25.00	10.00	2.72	16.90	31.43	13.25	23.17
Hexagenia spp.	3.30	8.33	1.35	3.04	23.65	47.37	19.33	34.30	10.78	25.00	10.00	2.72	16.90	31.43	13.25	23.17
Ephemerellidae	2.58	8.33	1.35	.29	0	0	0	0	0	0	0	0	6.59	2.86	.43	.10
Ephemerella spp.	2.58	8.33	1.35	.29	0	0	0	0	0	0	0	0	6.59	2.86	.43	.10
Tricorythidae	0	0	0	0	4.94	15.79	4.67	.62	0	0	0	0	2.98	8.57	2.99	.40
Tricorythodes spp.	0	0	0	0	4.94	15.79	4.67	.62	0	0	0	0	2.98	8.57	2.99	.40
Leptophlebiidae	0	0	0	0	0	0	0	0	10.78	25.00	10.00	2.72	1.46	2.86	2.99	.03
Plecoptera	2.58	8.33	1.35	.29	0	0	0	0	11.30	25.00	10.00	4.55	1.68	5.71	.85	.17
Perlidae	2.58	8.33	1.35	.29	0	0	0	0	0	0	0	0	.84	2.86	.43	.10
Perlesta spp.	2.58	8.33	1.35	.29	0	0	0	0	0	0	0	0	.84	2.86	.43	.10
Taeniopterygidae	0	0	0	0	0	0	0	0	11.30	25.00	10.00	4.55	.84	2.86	.43	.07
Taeniopteryx spp.	0	0	0	0	0	0	0	0	11.30	25.00	10.00	4.55	.84	2.86	.43	.07

Table 8. (cont'd.)

	Spring (12)				Summer (19)				Fall (4)				Year (35)			
	R.I.	F.O.	P.T.N.	P.T.W.	R.I.	F.O.	P.T.N.	P.T.W.	R.I.	F.O.	P.T.N.	P.T.W.	R.I.	F.O.	P.T.N.	P.T.W.
Odonata	6.03	16.67	4.05	2.55	2.90	10.53	1.33	.52	0	0	0	0	3.68	11.43	2.14	1.20
Calopterygidae	3.16	8.33	2.70	1.18	0	0	0	0	0	0	0	0	1.02	2.86	.85	.40
Calopteryx spp.	3.16	8.33	2.70	1.18	0	0	0	0	0	0	0	0	1.02	2.86	.85	.40
Coenagrionidae	2.86	8.33	1.35	1.37	2.90	10.53	1.33	.52	0	0	0	0	2.65	8.57	1.28	.80
Hemiptera	5.14	16.67	2.70	.49	11.75	36.84	5.33	7.99	27.79	50.00	20.00	27.27	10.53	31.43	5.13	5.72
Corixidae	5.14	16.67	2.70	.49	7.12	26.32	4.00	.10	27.79	50.00	20.00	27.27	7.62	25.71	4.27	.63
Gerridae	0	0	0	0	3.98	10.53	.67	5.81	0	0	0	0	2.46	5.71	.43	3.74
Belostomatidae	0	0	0	0	1.88	5.26	.67	2.08	0	0	0	0	1.15	2.86	.43	1.34
(Adult) Tricoptera	3.01	8.33	2.70	.59	1.47	5.26	.67	.36	0	0	0	0	1.85	5.71	1.28	.43
(Pupae) Tricoptera	6.44	8.33	8.11	8.43	0	0	0	0	0	0	0	0	2.07	2.86	2.56	2.88
Limnephilidae	6.44	8.33	8.11	8.43	0	0	0	0	0	0	0	0	2.07	2.86	2.56	2.88
Tricoptera	2.56	8.33	1.35	.20	13.08	36.84	17.33	1.66	23.90	50.00	20.00	13.64	10.53	28.57	12.39	1.34
Hydropsychidae	2.56	8.33	1.35	.20	13.08	36.84	17.33	1.66	23.90	50.00	20.00	13.64	10.53	28.57	12.39	1.34
Megaloptera	0	0	0	0	1.39	5.26	.67	0	0	0	0	0	.82	2.86	.43	0
Sialidae	0	0	0	0	1.39	5.26	.67	0	0	0	0	0	.82	2.86	.43	0
Sialis spp.	0	0	0	0	1.39	5.26	.67	0	0	0	0	0	.82	2.86	.43	0
(Adult) Coleoptera	10.93	25.00	9.46	7.75	3.28	10.53	1.33	2.13	20.39	25.00	10.00	36.36	6.46	17.14	4.27	4.55
Elateridae	2.89	8.33	1.35	1.47	0	0	0	0	0	0	0	0	.94	2.86	.43	.50
Staphylinidae	3.57	8.33	1.35	4.12	0	0	0	0	0	0	0	0	1.17	2.86	.43	1.40
Carabidae	5.42	16.67	2.70	1.57	0	0	0	0	0	0	0	0	1.17	5.71	.85	.53
Nitidulidae	2.53	8.33	1.35	.10	1.88	5.26	.67	2.08	0	0	0	0	1.97	5.71	.85	1.37
Dytiscidae	0	0	0	0	0	0	0	0	20.39	25.00	10.00	36.36	.95	2.86	.43	.53
Coleoptera	2.56	8.33	1.35	.20	1.40	5.26	.67	.05	0	0	0	0	1.66	5.71	.86	.10
Psephenidae	2.56	8.33	1.35	.20	0	0	0	0	0	0	0	0	.84	2.86	.43	.07
Psephenus herricki	2.56	8.33	1.35	.20	0	0	0	0	0	0	0	0	.84	2.86	.43	.07
Dytiscidae	0	0	0	0	1.40	5.26	.67	.05	0	0	0	0	.83	2.86	.43	.07
(Adult) Diptera	0	0	0	0	1.39	5.26	.67	0	0	0	0	0	.82	2.86	.43	.03
Chironomidae	0	0	0	0	1.39	5.26	.67	0	0	0	0	0	.82	2.86	.43	0
(Pupae) Diptera	2.52	8.33	1.35	.06	0	0	0	0	0	0	0	0	.82	2.86	.43	.02
Chironomidae	2.52	8.33	1.35	.06	0	0	0	0	0	0	0	0	.82	2.86	.43	.02

Table 8. (cont'd.)

	Spring (12)				Summer (19)				Fall (4)				Year (35)			
	R.I.	F.O.	P.T.N.	P.T.W.	R.I.	F.O.	P.T.N.	P.T.W.	R.I.	F.O.	P.T.N.	P.T.W.	R.I.	F.O.	P.T.N.	P.T.W.
Diptera	5.81	16.67	5.41	.33	4.50	15.79	3.33	.10	0	0	0	0	4.56	14.29	3.85	.18
Chironomidae	5.81	16.67	5.41	.33	4.50	15.79	3.33	.10	0	0	0	0	4.56	14.29	3.85	.18
Annelidae	0	0	0	0	1.74	5.26	.67	0	0	0	0	0	1.00	2.86	.43	0
Oligochaeta	0	0	0	0	1.74	5.26	.67	0	0	0	0	0	1.00	2.86	.43	0
Wood	7.25	16.67	2.70	8.63	6.19	21.05	2.67	2.70	0	0	0	0	7.42	17.14	2.56	4.68
Rock	0	0	0	0	1.77	5.26	.67	.10	0	0	0	0	1.02	2.86	.43	.07
Plant Material	0	0	0	0	2.97	5.26	2.67	2.18	0	0	0	0	1.43	2.86	.43	1.40

[1]Number of fish examined.

Table 9. Food analysis of rock bass (total length 135-174 mm) taken from the Red Cedar River, Michigan (R.I., relative importance index; F.O., frequency of occurence; P.T.N., percent of total number of food items; P.T.W., percent of total weight of food items).

	Spring (8)[1]				Summer (14)				Fall (1)				Year (23)			
	R.I.	F.O.	P.T.N.	P.T.W.	R.I.	F.O.	P.T.N.	P.T.W.	R.I.	F.O.	P.T.N.	P.T.W.	R.I.	F.O.	P.T.N.	P.T.W.
Arthropoda	82.39	100.00	91.38	86.69	84.00	100.00	91.67	97.75	100.00	100.00	100.00	100.00	83.77	100.00	92.00	92.77
Crustacea	49.76	75.00	17.24	75.87	42.19	71.43	25.00	73.02	0	0	0	0	41.06	69.57	20.00	73.20
Orconectes spp.	39.15	62.50	10.34	75.70	42.19	71.43	25.00	73.02	0	0	0	0	39.13	65.22	16.80	73.13
Hyallela azteca	7.58	25.00	5.17	.12	0	0	0	0	0	0	0	0	2.81	8.70	2.40	.05
Isopoda	3.57	12.50	1.72	.05	0	0	0	0	0	0	0	0	1.30	4.35	.80	.02
Diplopoda	4.01	12.50	3.54	.10	0	0	0	0	0	0	0	0	1.51	4.35	1.60	.04
Insecta	39.12	75.00	70.69	10.73	44.09	85.71	66.67	24.73	100.00	100.00	100.00	100.00	43.52	82.61	70.40	19.52
Ephemeroptera	16.16	37.50	22.41	4.72	28.08	64.29	36.67	11.83	40.95	100.00	14.29	8.57	23.68	56.52	28.80	8.56
Siphloneuridae	4.48	12.50	5.17	.24	0	0	0	0	0	0	0	0	1.73	4.35	2.40	.11
Isonychia spp.	4.48	12.50	5.17	.24	0	0	0	0	0	0	0	0	1.73	4.35	2.40	.11
Heptageniidae	4.00	12.50	3.45	.22	8.38	28.57	5.00	.10	0	0	0	0	6.53	21.74	4.00	.15
Ephemeridae	7.64	12.50	13.79	4.26	23.25	50.00	31.67	11.73	40.95	100.00	14.29	8.57	17.61	39.13	22.40	8.30
Hexagenia spp.	7.64	12.50	13.79	4.26	23.25	50.00	31.67	11.73	40.95	100.00	14.29	8.57	17.61	39.13	22.40	8.30
Plecoptera	12.96	37.50	13.79	.53	0	0	0	0	0	0	0	0	4.96	13.04	6.40	.24
Perlidae	12.96	37.50	13.79	.53	0	0	0	0	0	0	0	0	4.96	13.04	6.40	.24
Perlesta spp.	12.96	37.50	13.79	.53	0	0	0	0	0	0	0	0	4.96	13.04	6.40	.24
(Adult) Odonata	0	0	0	0	2.24	7.14	1.67	.20	0	0	0	0	1.33	4.35	.80	.11
Coenagrionidae	0	0	0	0	2.24	7.14	1.67	.20	0	0	0	0	1.33	4.35	.80	.11
Odonata	7.16	25.00	3.45	.19	0	0	0	0	0	0	0	0	2.62	8.70	1.60	.09
Calopterygidae	3.57	12.50	1.72	.05	0	0	0	0	0	0	0	0	1.30	4.35	.80	.02
Calopteryx spp.	3.57	12.50	1.72	.05	0	0	0	0	0	0	0	0	1.30	4.35	.80	.02
Coenagrionidae	3.59	12.50	1.72	.14	0	0	0	0	0	0	0	0	1.32	4.35	.80	.07
Enallagma spp.	3.59	12.50	1.72	.14	0	0	0	0	0	0	0	0	1.32	4.35	.80	.07
Hemiptera	7.13	25.00	3.45	.07	0	0	0	0	69.05	100.00	42.86	64.29	4.55	13.04	4.00	1.01
Corixidae	7.13	25.00	3.45	.07	0	0	0	0	48.09	100.00	28.57	15.71	4.16	13.04	3.20	.27
Belostomatidae	0	0	0	0	0	0	0	0	54.29	100.00	14.29	48.57	1.49	4.35	.80	.74
Megaloptera	0	0	0	0	4.60	7.14	1.67	9.65	47.14	100.00	28.57	12.86	3.04	4.35	2.40	5.32
Corydalidae	0	0	0	0	4.60	7.14	1.67	9.65	0	0	0	0	2.59	4.35	.80	5.12
Corydalus spp.	0	0	0	0	4.60	7.14	1.67	9.65	0	0	0	0	2.59	4.35	.80	5.12
Sialidae	0	0	0	0	0	0	0	0	47.14	100.00	28.57	12.86	1.55	4.35	1.60	.20
Sialis spp.	0	0	0	0	0	0	0	0	47.14	100.00	28.57	12.86	1.55	4.35	1.60	.20

Table 9. (cont'd.)

	Spring (8)				Summer (14)				Fall (1)				Year (23)			
	R.I.	F.O.	P.T.N.	P.T.W.	R.I.	F.O.	P.T.N.	P.T.W.	R.I.	F.O.	P.T.N.	P.T.W.	R.I.	F.O.	P.T.N.	P.T.W.
(Adult) Tricoptera	3.55	12.50	1.72	0	2.20	7.14	1.67	.02	0	0	0	0	2.60	8.70	1.60	.01
Tricoptera	3.67	12.50	1.72	.45	9.28	28.57	8.33	.39	42.86	100.00	14.29	14.29	8.15	26.09	5.60	.63
Hydropsychidae	0	0	0	0	9.28	28.57	8.33	.39	0	0	0	0	5.45	17.39	4.00	.21
Limnephilidae	3.67	12.50	1.72	.45	0	0	0	0	0	0	0	0	1.35	4.35	.80	.21
(Adult) Coleoptera	13.24	37.50	12.07	3.35	0	0	0	0	0	0	0	0	5.09	13.04	5.60	1.52
Dytiscidae	3.94	12.50	1.72	1.53	0	0	0	0	0	0	0	0	1.47	4.35	.80	.69
Haliplidae	3.63	12.50	1.72	.29	0	0	0	0	0	0	0	0	1.33	4.35	.80	.13
Curculionidae	3.56	12.50	1.72	.02	0	0	0	0	0	0	0	0	1.30	4.35	.80	.01
Lepidoptera	3.60	12.50	1.72	.19	0	0	0	0	0	0	0	0	1.32	4.35	.80	.09
(Adult) Diptera	0	0	0	0	2.61	7.14	3.33	.02	0	0	0	0	1.50	4.35	1.60	.01
Chironomidae	0	0	0	0	2.61	7.14	3.33	.02	0	0	0	0	1.50	4.35	1.60	.01
(Pupae) Diptera	7.13	25.00	3.45	.07	0	0	0	0	0	0	0	0	2.61	8.70	1.60	.03
Chironomidae	7.13	25.00	3.45	.07	0	0	0	0	0	0	0	0	2.61	8.70	1.60	.03
Diptera	3.99	12.50	3.45	.02	0	0	0	0	0	0	0	0	1.51	4.35	1.60	.03
Chironomidae	3.99	12.50	3.45	.02	0	0	0	0	0	0	0	0	1.51	4.35	1.60	.03
(Adult) Hymenoptera	0	0	0	0	2.34	7.14	1.67	.57	0	0	0	0	1.37	4.35	.80	.30
Vespidae	0	0	0	0	2.34	7.14	1.67	.57	0	0	0	0	1.37	4.35	.80	.30
Annelida	9.04	12.50	5.17	12.83	0	0	0	0	0	0	0	0	3.17	4.35	2.40	5.82
Oligochaeta	9.04	12.50	5.17	12.83	0	0	0	0	0	0	0	0	3.17	4.35	2.40	5.82
Wood	7.24	25.00	3.45	.48	16.00	42.86	10.00	2.25	0	0	0	0	10.74	34.78	6.50	1.41

[1]Number of fish examined.

Table 10. Food analysis of rock bass (total length 175-214 mm) taken from the Red Cedar River, Michigan (R.I., relative importance index, F.O., frequency of occurence; P.T.N., percent of total number of food items, P.T.W., percent of total weight of food items).

	Spring (4)[1]				Summer (4)				Year (8)			
	R.I.	F.O.	P.T.N.	P.T.W.	R.I.	F.O.	P.T.N.	P.T.W.	R.I.	F.O.	P.T.N.	P.T.W.
Arthropoda	75.19	100.00	72.22	90.94	88.98	100.00	90.91	98.27	81.18	100.00	79.31	94.65
Crustacea	50.83	75.00	38.89	89.44	71.93	100.00	54.55	97.22	60.19	87.50	44.83	93.38
Orconectes spp.	50.83	75.00	38.89	89.44	71.93	100.00	54.55	97.22	60.19	87.50	44.83	93.38
Arachnida	7.69	25.00	5.56	.22	0	0	0	0	4.28	12.50	3.45	.11
Araneae	7.69	25.00	5.56	.22	0	0	0	0	4.28	12.00	3.45	.11
Insecta	19.77	50.00	27.78	1.29	17.83	25.00	36.36	1.05	18.59	37.50	31.03	1.17
Ephemeroptera	16.72	50.00	16.67	.22	0	0	0	0	9.45	25.00	10.34	.11
Siphloneuridae	9.08	25.00	11.11	.22	0	0	0	0	5.20	12.50	6.90	.11
Isonychia spp.	9.08	25.00	11.11	.22	0	0	0	0	5.20	12.50	6.90	.11
Heptageniidae	7.64	25.00	5.56	0	0	0	0	0	4.25	12.50	3.45	0
Hemiptera	0	0	0	0	12.55	25.00	18.18	.73	5.27	12.50	6.90	.37
Mollusca	10.43	25.00	11.11	.40	11.02	25.00	9.09	1.73	10.79	25.00	10.34	1.07
Gastropoda	10.43	25.00	11.11	.40	11.02	25.00	9.09	1.73	10.79	25.00	10.34	1.07
Fish	14.38	25.00	16.67	8.65	0	0	0	0	8.03	12.50	10.34	4.27

[1]Number of fish examined.

The diet of the 30-74 mm size-class, made up of primarily one year old fish, is summarized as follows:

1. In the spring major food items were mayfly naiads, predominantly Baetidae and Tricorythidae, Chironomidae, both pupal and larval stages, were also important food items.
2. In the summer mayfly naiads were again important, though a feeding shift to different families occurred (Ephemeridae and Heptageniidae) although Baetids were still a major food component. This change does not seem to follow from a changing mayfly fauna as Table A1 indicates. Other important food items were Corixidae, Hydropsychidae larvae and crayfish. A large amount of plant material also was noted in the stomachs. Crayfish young-of-the-year had appeared between June and July samples and thus were small enough for the larger fish of this size-group to feed on.
3. In the fall, Leptophlebiidae naiads became a large food component, which patterns the seasonal nature of Leptophlebiidae. Corixidae, Hyallela azteca, and adult Tricopterans were other important dietary components.
4. The yearly summary shows that mayflies of the familes previously noted were the most important food component. Other organisms that made up much of this size-group's diet were crayfish, Corixidae, Hydropsychidae larvae and Chironomidae larvae and pupae.
5. It appears that this size-group of rock bass was foraging predominately in the macrophyte areas along the river banks

and in the pool areas. Some utilization of the invertebrates on submerged wood was noted.

The diet of the 75-104 mm size-class, made up primarily of two and three year old fish, is summarized as follows:

1. In the spring mayfly naiads were an important food item for this size-class though no particular family was preferred. Crayfish increased in importance as a food item. Corixids and both the larval and pupal stages of chironomidae were noted as major food items. Fish comprised an intermediate position in dietary value.
2. In the summer mayfly naiads and crayfish were the major food items. Heptageniidae and Hexagenia spp. were the major mayfly groups consumed, although corixids and larval hydropsychids were also of importance. A large amount of wood was also noted in the stomachs.
3. In the fall mayfly naiads were the most prevalent food item. This component was made up of the families Caenidae and Leptophlebiidae. The only other food item noted was larval limnephilids.
4. The yearly summary shows that mayfly naiads were the largest dietary component of 75-104 mm rock bass, with Hexagenia spp. predominating. Crayfish closely rivaled the mayflies in importance. Larval hydropsychids and corixids were also important food items.
5. The 75-104 mm rock bass appeared to be foraging in the same areas as the previous 30-74 mm size-group, for example, the still water areas of the pools and macrophytes.

The diet of 105-135 mm rock bass, made up primarily of three and four year old fish, is summarized as follows:

1. In the spring, mayfly naiads were a major food component, though less in importance than with the 30-74 mm and 75-104 mm rock bass. Isonychia spp. was the most prevalent mayfly consumed. Crayfish increased in the rock bass diet and were equal in importance to the mayflies. Many terrestrial invertebrates, adult beetles (Coleoptera) and sowbugs (Isopoda), comprised a major portion of the 105-135 mm rock bass diet. Wood appeared as a large component in many stomachs.

   The 105-135 mm rock bass seem to be feeding higher in the water column then the other two smaller size-groups and closer to the banks as indicated by the larger number of terrestrial invertebrates found in the stomachs. This group appeared to have utilized the pools and areas adjacent to the submerged logs in greater frequency than the smaller size-groups.

2. In the summer mayfly naiads (Heptageniidae and Hexagenia spp.) and crayfish were the food items of most importance. Corixidae and Hydropsychidae larvae were also major dietary components. A large amount of wood was found in the stomachs.

3. In the fall two seasonal invertebrate groups (Taeniopteryx spp.) and Leptophlebiidae naiads) made up a major portion of the rock bass diet. Spiders (Araneae), presumably taken from the water column, were an important item in the diet, Corixidae, Hexagenia spp. naiads, Hydropsychidae larvae and Dytiscidae adults were also major food items.

4. The yearly summary shows that the major food components were crayfish, mayfly naiads (Heptageniidae and Hexagenia spp.), Corixidae, and larval hydropsychids. Wood was found in many of the stomachs throughout the year.
5. The 105-135 mm rock bass were foraging in the same areas as the smaller size-groups, though feeding seemed to be less in the macrophytes and more in the pool areas adjacent to the submerged wood.

The diet of the 135-174 mm size-class, made up equally of three, four and five year old fish, is summarized as follows:

1. In the spring crayfish were as important to the diet of these rock bass as all other food items combined. Many terrestrial adult beetles and terrestrial earthworms (Oligochaeta) were consumed. Mayflies diminish greatly in dietary importance when compared to the smaller rock bass. Perlesta spp. naiads were an important food item.
2. In the summer crayfish again dominated the diet. Other invertebrates of dietary importance were Hexagenia spp. naiads and Hydropsychidae larvae. Wood appeared as a major item in the stomachs.
3. Since only one fish in this size-group was captured during the fall, no summary will be made concerning fall diet.
4. The yearly summary shows that crayfish were the most important food item. The only other major items eaten were Hexagenia spp. naiads. Wood appeared in many of the stomachs.
5. Since crayfish are quite mobile, no habitat foraging information can be deduced from this prey. But since Hexagenia

sp. were also taken quite frequently and much incidental wood appeared in the stomachs, the same areas as the other size-groups are presumably being foraged.

The diet of the 175-214 mm size-class, primarily six year old fish is summarized. Care must be taken in drawing generalized dietary conclusions about this size-class because of the small number of fish used.

1. In the spring crayfish were the most important food item. Snails (Gastropoda), Isonychia naiads and fish were of lesser dietary importance.
2. In the summer crayfish were of greatest dietary importance, with snails also an important food item.
3. No fish were captured in this size-group during the fall.
4. The yearly summary shows crayfish as the major food component. Other important food items were snails and fish.
5. No foraging information could be gathered from the small amount of dietary information gathered.

In this study dietary shifts are seen between the smallest size-groups to the largest. But these dietary shifts are not as drastic as has been recorded in other studies (Keast 1977, Keast and Webb 1966). The rock bass in this study went from a predominately mayfly - chironomid diet for the smallest size-groups to finally a crayfish diet for the largest size-groups. These partial dietary similarities are born out by the relatively high dietary overlap figures found in Table 11. Though the overlap figures are relatively high, the seasonal figures in general are lower than the yearly averages. Since only

Table 11. Dietary overlap between size-classes of rock bass (Levins index). The first figure represents α_{ij}, and the second figure α_{ji}.

Spring

	Fish length (mm)	(j) 75-104	105-134	135-174	175-214
	30-74	.34/.62	.35/.40	.37/.26	.14/.07
(i)	75-104		.59/.63	.75/.44	.70/.29
	105-134			1.06/.61	1.18/.46
	135-174				.94/.65

Summer

	Fish length (mm)	(j) 75-104	105-134	135-174	175-214
	30-74	.76/.65	.78/.68	.68/.40	.83/.25
(i)	75-104		.90/1.01	1.03/.75	.94/.37
	105-134			1.07/.65	1.02/.35
					1.09/.56

Fall

	Fish length (mm)	(j) 75-104	105-134	135-174
	30-74	.25/.28	.27/.32	.21/.06
(i)	75-104		.06	0/0
	105-134			.77/.19

Year

	Fish length (mm)	(j) 75-104	105-134	135-174	175-214
	30-74	.91/.76	.87/.65	.80/.39	.75/.20
(i)	75-104		.99/.91	1.09/.63	1.11/.38
	105-134			1.09/.70	1.08/.40
	135-174				1.13/.63

taxonomic categories are considered, intraspecific competition may be lessened by feeding on different sizes from the same taxon of prey. Keast (1977) states, "Prey size selection is extremely important. Even though two or more age classes may be taking a single resource, they are commonly selecting individuals of different sizes. There are some cases of an earlier growth stage being taken by younger fish and a later one by the next oldest age class of fish."

Several other explanations may account for these relatively high overlap figures. If the food items preferred by the rock bass were extremely abundant then dietary separation between the size-classes would be drastically lessened. This seems to be at least a partial explanation as can be seen from the invertebrate estimates (Appendix). Also, since most organisms found in the stomach were only identified to family level, different genera may be consumed by different size-groups and hence food separation would be maintained.

Keast and Webb (1966) listed the food in Lake Opinicon, Ontario, taken by rock bass as follows: Up to 70 mm - chironomids (found in 50% of the specimens examined), Ephemeroptera (35%), Odonata (30%), Cladocera (40%), Amphipoda (30%), Isopoda (15%), surface insects (35%); between 71 mm and 199 mm - Odonata (75%), Ephemeroptera (35%), Tricoptera (35%), fish (30%), Crayfish (15%); between 120 mm and 200 mm - almost entirely Crayfish and Anisoptera. This study shows many similarities to the diet of Red Cedar rock bass. Major differences are due to a lack of age 0 fish in the Red Cedar study and the possible lack of a major zooplankton component in the Red Cedar River.

Green (1979) in a study conducted on the St. Mary's River, a large river in Michigan, found three major diet changes in the life cycle of the rock bass. In small rock bass, (18-47 mm) zooplankton and small amphipods dominated the food; in medium sized rock bass (48-115 mm) a shift was seen toward large insects; and in the large fish (116-199 mm), crayfish were the dominant food item.

Thus both in the studies conducted by Green (1979) and Keast and Webb (1966) a much greater dietary shift is seen than in this study.

The habitats used for foraging are primarily the still areas of the stream, such as the pools and the banks with macrophytes. Invertebrates are being consumed directly from the submerged wood. Some feeding is being done on the surface, as noted by a large number of terrestrial organisms found in the rock bass diet.

Almost all rock bass captured were from areas of high cover such as under submerged wood and the macrophyte areas of the pools and banks. Generally, smaller rock bass were captured in the macrophytes, whereas larger rock bass were taken from under submerged wood.

Dewberry (1978) states that seldom was a rock bass found in the riffles. The rock bass were usually captured in the quieter areas of the stream especially in areas with abundant cover. This conclusion is born out very well in this study.

The rock bass appears to be a generalist in feeding behavior as concluded from the vast number of different food items eaten. Though primarily feeding on benthos, surface organisms were also consumed. Keast and Webb (1966) state that rock bass specialize on large bottom

living insects. One peculiarity was noted in the diet of rock bass. Though the adult riffle beetle (Macronychus glabratus) was found in large numbers on submerged wood, not one was found in the stomach of a rock bass.

Rock bass were found at 2°C with food in their stomachs, a contradiction to a report by Keast (1968) that stated that rock bass cease feeding below 7.0°C. This indicates that the growing season of rock bass may be longer than previously noted.

Any follow up study should use a larger section of the stream, from which a greater number of rock bass could be captured and their stomach contents analyzed. This would give a clearer picture of the diets of the rock bass for all seasons. An effort should be made to capture young-of-the-year and to determine their frequency in the population. Since crayfish were the major dietary component of the larger rock bass a better assessment of the crayfish population and habitat preference should be made.

Finally an attempt should be made to take all invertebrates consumed by the rock bass and identify them to generic level. This should also be done with all invertebrate samples. This along with a size analysis of the prey consumed should answer the question: are the different size-groups of rock bass segregating their prey items by size and genera?

Length-Frequency Distribution

The length-frequency distribution of a sample of rock bass is summarized in Table 12. The smaller size categories are not a reflection of the relative numbers in the sample area but show the bias

Table 12. Length-frequency of each age class of a sample of rock bass taken from the Red Cedar River, 1979-1980.

TL (mm) at capture	0	I	II	III	IV	V	VI	VII	VIII
15-24	1								
25-34	2								
35-44	4	1							
45-54	1	5							
55-64		11	2						
65-74		13	3						
75-84		5	18						
85-94			14	2					
95-104			11	13					
105-114			6	11	1				
115-124			2	11	3				
125-134				3	8				
135-144				6	15	2			
145-154				4	2				
155-164					1	3			
165-174				1	1	5	4		
175-184						3	2		
185-194							2		
195-204							1		
205-214							1		2

of the sampling method. Age 0 fish (< 45 mm in total length) were not visible for netting after electroshock and hence were undersampled. Each age group encompasses many different size categories. Many of the size categories encompass three different age groups.

Length-Weight Relationship

The relationship between weight in grams and standard length in millimeters for a sample of 208 rock bass taken in 1979 and 1980 was log W = -4.200 + 2.912 log S.L.. The correlation coefficient was .9874. The relationship can also be expressed as $W = (6.31 \times 10^{-5})$ $(S.L.)^{2.912}$ This compares quite well with a sample of rock bass taken from the same area in 1978 $W = (5.37 \times 10^{-5})$ $(S.L.)^{2.97}$ (Green 1978). Thus a 100 mm standard length rock bass would, using the first equation, weigh 42.1 grams whereas the latter formula would give the same length fish a weight of 46.7 grams.

Hile (1941) found the weight-standard length relationship to be log W = -4.54 + 3.003 log S.L. for rock bass in Nebish Lake, Wisconsin. Thus a 100 mm long fish would weigh 29.2 grams.

Scott (1949) found the weight-standard length relationship to be log W = -4.153 + 2.908 S.L. for the Tippecanoe River, Indiana. A 100 mm long fish using this formula would weigh 46.0 grams.

The relationship between standard length and weight within the same species is influenced by many factors. Variability in water temperature, flow rate, food availability as well as temporal differences all would influence this parameter.

Condition Factor

Seasonal condition factors for a sample of rock bass are summarized in Tables 13, 14, and 15. The coefficient of condition as an expression of robustness has been used to indicate the suitability of an environment for a species. Carlander (1944) developed a Minnesota standard for condition (K): if K was under 3.1 the condition was poor, if the average was between 3.5 - 4.1 the condition was average, and if the condition factor was over 4.3 the population's health was deemed excellent.

Using those standards this sample of rock bass was in excellent health during the spring with values between 4.09 - 5.06. Since sampling did not begin until 5/3 the possible winter stress that may have lead to lower values has been suppressed. Thus this population of rock bass seems to be in good condition for the spawning season.

The summer condition values ranged from 3.65 - 4.16 and were the lowest seasonal values. This may be due to the energy expenditure used in spawning. Also, lower flow rates and warmer water temperatures may influence this parameter.

In the fall, condition increased to values between 4.11 - 4.51. Flow rates increased and the water temperature had decreased. Because of the autumnal leaf fall, the aquatic invertebrate community has increased in activity and thus food availability for the rock bass may have increased. This would then be reflected in a higher K value.

Age and Growth

Table 16 summarizes the growth history of a sample of rock bass taken from the Red Cedar River between 9/79 and 11/80. Caution is

Table 13. Condition factors of a sample of rock bass taken from the Red Cedar River, Spring 1980.

Age	Number of fish	SL Range (mm)	SL Mean (mm)	Weight Range (g)	Weight Mean (g)	Condition Factor Mean: std. deviation in parenthesis
I	10	60-35	49	8-2	5	4.62 (2.11)
II	23	83-45	63	30-4	13	5.06 (1.03)
III	13	115-69	90	71-19	35	4.61 (0.82)
IV	9	140-94	108	110-38	60	4.56 (0.48)
V	3	142-112	132	120-62	101	4.26 (0.13)
VI	3	165-146	152	222-143	171	4.76 (0.17)
VII	0	-	-	-	-	-
VIII	1	172	172	208	208	4.09

Table 14. Condition factors of a sample of rock bass taken from the Red Cedar River, Summer 1980.

Age	Number of fish	SL Range (mm)	SL Mean (mm)	Weight Range (g)	Weight Mean (g)	Condition factor Mean: std. deviation in parenthesis
I	17	58-43	50	10-3	5	3.93 (0.94)
II	19	81-62	73	22-10	16	4.12 (0.44)
III	24	105-71	87	50-16	28	4.15 (0.41)
IV	15	120-88	107	64-34	50	4.05 (0.46)
V	4	140-130	134	104-78	92	3.84 (0.37)
VI	6	155-139	145	159-100	128	4.16 (0.28)
VII	0	-	-	-	-	-
VIII	1	165	165	164	164	3.65

Table 15. Condition factors of a sample of rock bass taken from the Red Cedar River, Fall 1979-1980.

Age	Number of fish	SL Range (mm)	SL Mean (mm)	Weight Range (g)	Weight Mean (g)	Condition factor Mean: std. deviation in parenthesis
I	8	62-38	51	12-2	6	4.11 (0.69)
II	14	95-60	77	36-10	21	4.29 (0.57)
III	14	135-82	106	90-28	52	4.23 (0.48)
IV	7	125-97	107	82-40	53	4.28 (0.43)
V	6	140-103	128	124-57	95	4.51 (0.37)
VI	1	133	133	100	100	4.25
VII	0	-	-	-	-	-
VIII	0	-	-	-	-	-

Table 16. Summary of age and growth of a sample of rock bass taken from the Red Cedar River between September, 1979 and November, 1980.

Age	Number of fish	T.L. at capture (mm)	I	II	III	IV	V	VI	VII	VIII
0	8	35.3 (6.3)[1]								
I	35	63.7 (9.4)	43.6 (4.9)							
II	56	88.6 (13.3)	45.2 (5.4)	70.0 (7.7)						
III	51	116.9 (18.2)	45.4 (6.2)	70.2 (8.6)	93.7 (12.1)					
IV	31	136.1 (12.2)	45.7 (7.3)	72.7 (10.9)	95.2 (10.9)	113.2 (22.5)				
V	13	164.6 (12.5)	48.3 (7.2)	74.0 (10.9)	97.0 (10.2)	120.9 (10.8)	142.5 (10.3)			
VI	10	183.3 (13.3)	44.4 (4.6)	66.4 (10.0)	86.7 (10.5)	110.4 (8.0)	130.8 (11.5)	154.8 (11.0)		
VII	0									
VIII	2	210.5 (5.0)	44.0 (2.2)	60.5 (6.9)	79.8 (13.0)	95.2 (16.0)	108.8 (16.4)	134.5 (22.1)	166.9 (22.1)	174.8 (10.9)
Weighted Average			43.4	70.6	93.6	113.8	135.2	151.2	166.9	174.8
Mean Annual Increment			27.2	23.0	20.2	21.4	16.2	15.5	7.9	
Relative Growth (%)			62.7	32.6	21.6	18.8	12.0	10.2	4.7	

[1] Standard deviation

advised in arriving at any general conclusions for the length of age seven and eight year old fish because of the samll sample size utilized in the back calculations.

Table 17 compares mean back-calculated total lengths for rock bass from four studies. Three of the studies, Green (present study), Linton (1964) and Green (1978) are from approximately the same section of the Red Cedar River. Beckman's (1941) data is from Standard Lake, Michigan. Green (present study) and Green (1978) have very similar values, which would be expected since these studies were done in the same area with only a one to two year difference in sampling times. Though Linton's (1964) data were collected in the same area, the 16 year separation makes his calculations no closer than Beckman's (1941) data to this study.

Growth histories between different bodies of water and even within the same body but from different years may differ for many reasons. Growth is an end product of the environment the rock bass is living in. Thus when environmental factors that impinge upon growth vary temporally or spatially, the consequences are differing growth histories. Some of these environmental factors would be different water temperatures which could affect the rate of growth as well as the length of the growing season, different flow rates for rivers, and the multiple differences between rivers and lakes. The abundance of food organisms for each stage in the fish's life history which could promote growth in certain stages but not in others must also be taken into account. The population densities and even genetic capacities for growth of the fish must be considered.

Table 17. Mean back-calculated total lengths (mm) for rock bass from four studies.

Study	Number of Fish	Mean back-calculated total lengths for rock bass I	II	III	IV	V	VI
Green (Present study)	198	43.4	70.6	93.6	113.8	135.2	151.4
Linton (1964)	1285	40.9	71.3	109.7	144.9	166.3	
Green (1978)	219	45.0	69.4	92.1	116.7	144.5	172.2
Beckman (1941)	583	39.6	67.8	93.6	121.0	153.1	186.9

Linton (1964) states, "It has become obvious during the course of this study that the direct comparison of calculated lengths of fish from one area with those of another area is of little value when based on small, localized samples. The observed growth of fish in the five zones of the Red Cedar River varied enough so that sampling from one station in the river could not be considered even a good represention of this river."

Annuli formation occurred between 5/3 and 5/24 for most rock bass. This corresponds quite well with Linton's (1964) approximation. May 1 was assumed to be the date of annulus formation by Linton. Linton (1964) states that Beckman (1943) arrived at this date for south-central Michigan. Annulus formation begins at approximately 11.7^{o}C (Beckman 1943). Linton (1964) concluded that the growing season on the Red Cedar lasts six months. In this study annulus formation occurred at higher water temperatures, somewhere between 13.9^{o}C and 16.7^{o}C. These temperatures were only for the two sampling dates 5/3 and 5/24, and temperature may have been lower for the three weeks between these sampling dates, though it seems unlikely.

SUMMARY AND CONCLUSIONS

The feeding ecology, length composition, length-weight relationships, condition and age-growth of rock bass were studied from a small section of a warm water stream in Michigan from September, 1979 to November, 1980.

This species exhibited no apparent habitat difference by size, and foraged mainly in pools and macrophyte regions along the river banks. Invertebrates were also consumed directly from submerged wood. Rock bass avoided foraging in areas with little cover such as the sandy zones found in the middle of the stream and in areas with a swift current, such as riffle areas.

Diet overlap between the different size-groups was relatively high. Though high, a feeding shift from smallest rock bass to largest was apparent. The smallest (30-105 mm) fed predominately on chironomids and mayfly naiads. Intermediate size fish (105-174 mm) consumed mainly crayfish and mayfly naiads, whereas the largest individuals (175-214 mm) consumed almost exclusively crayfish.

The relationship between weight in grams and standard length in millimeters was low W = 04.200 + 2.912 log S.L.

The condition factors (K) varies by season. The spring condition values were between 4.09 - 5.06. Summer values were lower and ranged from 3.65 - 4.16. The fall condition factors were between 4.11 - 4.51.

The average mean back-calculated total lengths as expressed in millimeters for this sample of rock bass were: age I - 43.4, age II - 70.6, age III - 93.6, age IV - 113.8, age V - 135.2, age VI - 154.4, age VII - 166.9, and age VII - 174.8.

In this section of the Red Cedar River, the rock bass seem to be in excellent condition as indicated by high condition factor values. Also, the large size attained by the different age-classes points to this same conclusion.

The robust health of this rock bass population must be related to the large populations of the major food items: mayflies, chironomids and crayfish. This great abundance of food would explain the high overlap figures since intraspecific competition for food would be lessened if the food items competed for are in large numbers.

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LITERATURE CITED

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APPENDIX

Table A1. Abundance estimates for macroinvertebrates (numbers/m^2 for A - E; average number per sample for drift and wood) collected from the Red Cedar River. First line under each taxonomic heading pertains to spring 1980; second line, summer 1980; third line, fall 1980.[1]

Taxa	Drift	Wood	Habitat[2] A	B	C	D	E
ISOPODA							
Ascellus spp.	0	0	2	0	0	0	0
	0	0	7	0	0	4	0
	0	0	0	0	0	0	0
AMPHIPODA							
Hyallela azteca	6.9	12.1	678	285	572	268	53
	5.6	49.3	72	119	116	199	12
	.3	27.4	117	112	31	196	3
TURBELLARIA	0	5.4	2	7	3	4	0
	0	1.7	5	12	4	4	6
	0	2.0	0	0	0	0	0
ARANEAE	0	0	0	0	0	0	0
	0	0	0	5	0	0	0
	0	0	0	0	0	17	0
GASTROPODA	0	1.2	7	33	10	29	9
	.2	1.4	19	28	5	42	25
	0	.6	44	3	2	60	1
CHILOPODA	0	.1	0	0	0	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
PELECYPODA	0	0	0	0	0	11	0
	0	0	0	2	0	0	2
	0	0	0	0	0	0	0
Sphaeriidae	0	0	14	12	30	47	84
	0	0	67	18	17	36	80
	0	0	25	6	29	6	47
DECAPODA							
Orconectes spp.	.1	.3	2	10	8	0	0
	.1	0	8	2	1	7	5
	0	0	3	0	0	0	0
OLIGOCHAETA	.2	0	345	33	13	647	3
	.1	0	544	11	2	1486	23
	0	0	278	9	10	468	26

Continued

Table A1. (Continued)

Taxa	Drift	Wood	Habitat[2] A	B	C	D	E
HIRUDINEA	0	0	0	9	0	11	6
	0	0	2	6	0	26	0
	0	0	0	2	0	87	0
HYDRACARINA	0	.1	2	7	13	11	0
	.2	0	2	0	7	0	7
	0	0	14	0	0	0	0
EPHEMEROPTERA							
Adult	.1	0	0	0	0	0	0
	0	.1	0	0	0	0	1
	0	0	0	0	0	0	0
Adult Ephemeridae							
Hexagenia spp.	0	0	0	0	0	0	0
	.1	0	0	0	0	0	0
	0	0	0	0	0	0	0
Ephemeridae							
Hexagenia spp.	.5	.1	26	60	5	173	0
	.2	0	4	9	0	11	9
	0	0	8	7	0	22	0
Heptageniidae							
Stenacron spp.	.3	5.0	2	6	1	0	0
	.3	10.4	6	23	18	0	3
	0	2.3	6	3	9	0	0
Stenonema spp.	0	11.0	2	14	17	0	0
	.2	8.0	0	12	45	0	6
	0	2.6	4	0	18	0	6
Heptagenia spp.	0	0	0	1	2	0	0
	.1	.1	0	0	0	0	0
	0	0	0	0	0	0	0
Adult Heptageniidae	0	0	0	0	0	7	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
Siphlonuridae							
Isonychia spp.	.6	2.5	0	0	18	0	0
	.1	2.9	0	2	16	4	1
	0	0	0	0	2	0	0

Continued

Table A1. (Continued)

Taxa	Drift	Wood	Habitat[2] A	B	C	D	E
Tricorythidae							
Tricorythodes spp.	.9	1	27	49	13	80	0
	.4	2.5	16	11	8	22	5
	0	.3	0	0	0	0	0
Ephemerellidae							
Ephemerella spp.	.2	.3	0	12	30	7	0
	0	.2	0	0	0	0	0
	0	0	0	0	0	0	0
Baetidae							
Baetis spp.	.2	1.0	5	27	36	4	0
	2.2	8.8	5	0	53	11	32
	.3	.5	0	0	4	0	0
Centroptilum spp.	0	0	2	0	0	0	0
	.1	.1	0	0	0	4	1
	0	0	0	0	0	0	0
Cloeon spp.	0	0	0	0	0	0	0
	.1	0	2	2	0	0	0
	0	0	0	0	0	0	0
Pseudocloeon spp.	4.1	0	0	8	27	0	0
	.3	.1	0	0	49	0	7
	0	0	0	0	9	0	0
Caenidae							
Caenis spp.	.1	.1	8	17	21	40	0
	0	0	4	3	4	22	2
	0	0	6	0	0	6	0
Brachycercus spp.	0	0	0	0	0	0	0
	0	0	2	0	0	4	0
	0	0	0	0	0	0	0
Polymitarycidae							
Ephoron spp.	0	0	4	0	0	0	0
	.1	0	5	0	2	0	9
	0	0	0	0	0	0	0
Leptophlebiidae							
Leptophlebia spp.	7.9	.2	0	0	0	0	0
	0	0	0	0	0	0	0
	0	.8	237	304	11	212	9

Continued

Table A1. (Continued)

Taxa	Drift	Wood	Habitat[2] A	B	C	D	E
Paraleptophlebia spp.	0	0	0	0	0	0	0
	2.3	0	4	6	0	4	0
	0	.2	120	64	8	6	2
PLECOPTERA							
Perlidae	.1	0	4	22	0	0	0
	0	0	0	1	0	0	0
	0	0	0	0	0	0	0
Acroneuria spp.	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0	0	14	0	0	0	0
Perlesta spp.	1.1	2.5	6	46	135	1	0
	0	.1	0	0	0	0	1
	0	0	0	0	0	0	0
Phasgonophora spp.	0	.1	0	1	1	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
Perlinella spp.	0	0	0	0	0	0	0
	0	0	0	0	1	0	0
	0	.1	3	2	0	0	0
Taeniopterygidae							
Taeniopteryx	0	0	0	0	1	0	0
	0	0	0	0	0	0	0
	.7	.7	153	41	231	283	65
Perlodidae							
Isoperla spp.	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
	.1	0	0	0	0	0	0
ODONATA							
Coenagrionidae	0	0	0	0	0	0	0
	0	0	0	0	3	0	0
	0	0	0	0	0	0	0
Enallagma spp.	.4	.1	6	8	16	0	3
	.3	.1	1	6	1	0	0
	0	0	4	10	0	0	0
Argia spp.	0	.1	0	0	0	0	0
	0	.3	0	2	3	0	0
	0	0	0	0	18	0	0

Continued

Table A1. (Continued)

Taxa	Drift	Wood	Habitat[2] A	B	C	D	E
Calopterygidae	0	0	0	0	0	0	0
	0	0	0	1	0	0	0
	0	0	0	0	0	0	0
Calopteryx spp.	0	0	0	1	1	0	0
	.1	0	0	10	0	4	1
	0	0	0	8	0	6	0
Gomphidae							
Gomphurus spp.	0	0	7	0	1	0	6
	0	0	4	1	0	4	0
	0	0	8	0	0	0	1
Gomphus spp.	0	0	2	0	0	0	0
	0	0	0	0	0	4	0
	0	0	3	0	0	0	0
Stylurus spp.	0	0	3	0	0	7	0
	0	0	4	0	0	7	0
	0	0	3	0	0	11	0
Aeshnidae							
Basiaeschna spp.	0	0	0	0	0	0	0
	0	0	0	1	0	0	0
	0	0	0	0	0	0	0
Bayeria spp.	0	0	0	0	0	0	0
	0	0	0	1	0	0	0
	0	0	0	2	0	0	0
HEMIPTERA							
Corixidae	1	.2	2	0	1	4	0
	.3	0	2	2	0	29	0
	.3	0	3	6	0	38	3
Nepidae	0	0	0	0	0	0	0
	.2	0	0	0	0	0	0
	0	0	0	3	0	0	0
Belostomatidae	0	0	0	0	0	0	0
	.1	0	0	2	0	0	0
	0	0	0	4	0	0	0
Gerridae	0	0	0	0	0	0	0
	.2	0	0	1	0	0	0
	0	0	0	0	0	0	0

Continued

Table A1. (Continued)

Taxa	Drift	Wood	Habitat[2] A	B	C	D	E
Pleidae	0	0	0	0	0	0	0
	0	0	0	1	0	0	1
	0	0	0	2	0	0	0
Veliidae	0	0	0	0	0	0	0
	0	0	0	2	0	0	0
	0	0	0	0	0	0	0
Tingidae	0	0	0	0	0	0	0
	0	0	0	0	1	0	0
	0	0	0	0	0	0	0
HOMOPTERA							
Aphidae	0	0	0	0	0	0	0
	0	0	1	0	0	0	0
	0	0	0	2	2	6	0
Psyllidae	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0	.2	0	0	0	0	0
MEGOLOPTERA							
Sialidae							
Sialis spp.	.4	0	22	7	1	18	0
	.1	.2	33	9	3	76	5
	.2	0	30	19	9	44	1
Corydalidae							
Corydalus spp.	0	.1	0	0	0	0	0
	0	0	0	0	3	0	0
	0	0	0	0	0	0	0
Sisyridae							
Sisyra spp.	0	0	0	0	0	0	0
	0	.1	0	0	0	0	0
	0	0	0	0	0	0	0
TRICHOPTERA							
Pupae	0	.4	0	2	28	0	5
	0	0	1	0	6	0	0
	0	0	0	0	0	0	0
Adult	0	0	2	0	0	0	3
	.1	0	0	0	0	0	0
	0	0	0	0	0	0	0

Continued

Table A1. (Continued)

Taxa	Drift	Wood	Habitat[2] A	B	C	D	E
Adult Hydropsychidae	.3	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
Hydropsychidae	1.2	69.3	25	99	712	40	35
	2.8	20.1	77	76	1411	11	44
	.4	25.8	26	10	345	87	39
Limnephilidae	1.0	7.5	37	60	22	33	9
	0	1.3	4	59	3	0	17
	0	.2	71	13	0	38	1
Pupae Limnephilidae	0	0	0	37	0	0	0
	0	2	0	0	1	0	1
	0	0	0	0	0	0	1
Adult Limnephilidae	.1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
Helicopsychidae	0	0	0	0	4	0	3
	0	.5	0	0	0	0	0
	0	.3	2	0	6	6	0
Pupae Helicopsychidae	0	0	0	0	0	0	3
	0	0	0	0	0	0	0
	0	0	0	0	0	0	9
Adult Helicopsychidae	0	0	0	0	1	0	0
	.1	0	0	0	0	0	0
	0	0	0	0	0	0	0
Hydroptilidae	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0	0	1	0	2	0	0
Leptoceridae	.2	.1	22	7	6	15	12
	.2	.1	9	2	3	4	0
	0	0	0	2	0	0	0
Polycentropodidae	0	6.3	1	8	13	4	0
	0	2.7	2	31	1	0	1
	0	4.5	3	18	6	11	2
Glossosomatidae	0	0	2	1	2	0	0
	0	0	0	0	13	0	0
	0	0	0	0	0	0	0

Continued

Table A1. (Continued)

Taxa	Drift	Wood	Habitat[2] A	B	C	D	E
Molannidae	0	0	2	0	0	0	0
	0	.1	0	0	0	4	7
	0	0	0	0	0	0	0
Philopotamidae	0	0	0	0	1	0	0
	0	.2	0	0	1	0	0
	0	0	0	0	0	0	0
Psychomyiidae	0	0	0	0	0	0	0
	0	0	0	0	1	0	0
	0	0	0	0	0	0	0
Brachycentridae	0	0	0	0	0	0	0
	0	0	4	0	0	0	0
	0	0	0	0	2	6	0
Odontoceridae	0	0	0	0	0	0	0
	0	0	0	0	0	14	0
	0	0	0	0	0	0	0
COLEOPTERA							
Adult Elmidae							
Stenelmis spp.	.2	.5	15	6	90	17	9
	.1	1.4	0	15	29	4	1
	0	1.1	0	0	72	0	3
Dubiraphia spp.	0	.3	13	5	39	4	0
	.1	1.2	12	12	26	0	0
	0	1.8	0	4	54	0	1
Macronychus glabratus	.8	10.7	2	2	0	0	0
	.1	18.4	0	6	0	0	0
	0	3.9	0	2	0	0	0
Ancyronyx variegata	.2	.1	0	0	0	0	0
	0	1.1	0	1	0	0	0
	0	0	0	0	0	0	0
Elmidae							
Stenelmis spp.	0	.2	10	1	20	12	1
	.2	1.1	15	6	26	4	16
	0	0	4	0	13	6	4
Dubiraphia spp.	.2	0	77	7	6	33	0
	0	0	35	10	1	138	9
	0	.6	22	7	0	6	10

Continued

Table A1. (Continued)

Taxa	Drift	Wood	Habitat[2] A	B	C	D	E
Macronychus glabratus	0	2.1	0	0	0	0	0
	.1	1.5	0	0	0	0	0
	0	.5	0	0	0	0	0
Ancyronyx variegata	0	0	0	0	0	0	0
	0	.3	0	0	0	0	0
	0	.2	0	0	0	0	0
Adult Haliplidae							
Peltodytes spp.	.7	.1	0	0	0	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
Haliplus spp.	0	0	0	0	0	0	0
	.1	0	0	0	0	0	0
	0	0	0	0	0	0	0
Haliplidae							
Peltodytes spp.	0	0	0	0	0	0	0
	0	0	0	1	0	0	0
	0	0	0	0	0	0	0
Adult Gyrinidae							
Gyrinus spp.	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
	.3	0	0	0	0	0	0
Dineutus spp.	0	0	0	0	0	0	0
	.1	0	0	0	0	0	0
	0	0	0	0	0	0	0
Gyrindae							
Gyrinus spp.	.1	0	0	1	0	4	0
	0	0	0	3	0	0	2
	0	0	0	0	0	0	0
Dineutus spp.	0	0	0	4	0	0	0
	0	.1	0	0	6	0	3
	0	0	0	0	0	0	0
Psephenidae							
Psephenus spp.	.3	0	0	0	1	4	0
	0	0	0	1	1	0	0
	0	0	0	0	4	0	0

Continued

Table A1. (Continued)

Taxa	Drift	Wood	Habitat[2] A	B	C	D	E
Adult Dytiscidae	0	0	0	0	0	0	0
	0	.1	0	0	0	0	0
	0	0	0	0	0	0	0
Hydroporus spp.	0	0	0	0	0	0	0
	0	.2	0	0	0	0	0
	0	0	0	0	0	0	0
Liodessus spp.	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
	.2	.3	0	0	0	0	0
Dytiscidae							
Hydroporus spp.	0	.1	0	0	0	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
Adult Staphylinidae	0	0	2	0	1	4	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
Adult Trogositidae	0	0	0	0	0	4	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
Helodidae							
Cyphon spp.	0	0	0	0	0	0	0
	0	.1	0	0	0	0	0
	0	0	0	0	0	0	0
Adult Hydrophilidae	0	0	0	0	0	0	1
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
Hydrobius spp.	0	0	0	0	0	0	0
	0	0	2	0	0	0	0
	0	0	0	0	0	0	0
Crenitis spp.	0	0	0	0	0	0	0
	0	0	0	1	0	0	0
	0	0	0	0	0	0	0
Adult Carabidae	0	0	0	0	0	0	0
	.1	0	0	0	0	0	0
	0	0	0	0	0	0	0

Continued

Table A1. (Continued)

Taxa	Drift	Wood	Habitat[2] A	B	C	D	E
Adult Curculionidae	0	0	2	0	0	1	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
Adult Nitidulidae	0	0	2	0	1	4	0
	.1	.1	0	0	0	0	1
	0	0	0	0	0	0	0
Adult Cleridae	0	0	0	0	2	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
Adult Chrysomelidae	0	0	0	0	0	0	0
	0	0	2	0	0	4	1
	0	0	0	0	0	0	0
LEPIDOPTERA							
Noctuidae	0	0	2	0	0	4	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
Geometridae	.1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
Pyralidae							
Paraponyx spp.	0	0	0	0	0	0	0
	0	0	0	1	1	0	0
	0	0	3	8	0	0	1
DIPTERA							
Pupae	.1	0	0	1	0	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
Adult Chironomidae	.2	.2	0	0	0	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	4
Pupae Chironomidae	.9	.3	11	3	10	15	3
	0	.1	2	2	4	4	2
	0	0	0	0	2	0	0
Chironomidae	1.4	18.7	705	513	510	855	217
	3.2	7.0	119	109	330	196	144
	.2	34.9	174	42	692	212	291

Continued

Table A1. (Continued)

Taxa	Drift	Wood	Habitat[2] A	B	C	D	E
Pupae Simuliidae	0	0	0	0	0	0	0
	.1	.1	0	1	14	0	8
	0	0	0	0	0	0	0
Simuliidae	1.0	.2	0	53	28	0	1
	.8	.4	0	24	76	29	140
	.7	0	0	0	38	0	1
Tipulidae	0	.1	5	6	7	4	7
	0	0	1	0	7	0	1
	0	0	4	0	2	0	10
Pupae Tipulidae	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0	0	1	0	0	0	0
Stratiomyiidae	0	.1	2	0	0	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	1
Ceratopogonidae	0	.2	47	3	5	65	4
	0	0	7	0	0	29	6
	0	0	8	0	2	22	74
Tabanidae	0	0	11	0	1	0	0
	0	0	7	0	0	0	0
	0	0	14	3	0	6	0
Ptycopteridae	0	0	0	1	0	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
Empididae	0	0	2	1	1	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
Pupae Empididae	0	0	0	0	0	0	0
	0	0	0	0	2	0	0
	0	0	0	0	0	0	0
Muscidae	0	0	0	3	0	0	0
	0	0	0	1	0	0	0
	0	0	0	0	0	0	0
Adult Culicidae	0	0	0	0	0	0	0
	0	0	2	0	0	0	0
	0	0	0	0	0	0	0

Continued

Table A1. (Concluded)

Taxa	Drift	Wood	Habitat[2] A	B	C	D	E
Scatophagidae	0	0	0	0	0	0	0
	0	0	0	3	0	0	0
	0	0	3	3	0	0	0
HYMENOPTERA							
Formicidae	.1	0	0	0	0	0	0
	.1	0	0	0	0	0	0
	0	0	0	0	0	0	0

[1]Seasons were designated as follows: Spring = 5/4-6/22; Summer = 7/20-9/21; Fall = 10/26-11/23.

[2]Habitats were designated as follows: A = edge of stream without macrophytes; B = edge of stream with macrophytes; C = riffle; D = pools; E = sandy areas towards middle of stream.

Table A2. Abundance estimates for macroinvertebrates (numbers/m^2 for A - E; average number per sample for drift and wood) collected from the Red Cedar River, 5/4/80.

Taxa	Drift	Wood	Habitat[1] A	B	C	D	E
ISOPODA							
Ascellus spp.	0	0	5	0	0	0	0
AMPHIPODA							
Hyallela azteca	5	29	1223	239	351	239	73
DECAPODA							
Orconectes spp.	0	.5	0	4	0	0	0
TURBELLARIA	0	0	0	0	0	11	0
GASTROPODA	0	2.3	11	0	4	0	2
CHILOPODA	0	.3	0	0	0	0	0
PELECYPODA							
Sphaeriidae	0	0	0	0	0	54	35
OLIGOCHAETA	0	0	234	51	36	587	9
HIRUDINEA	0	0	0	0	0	0	17
HYDRACARINA	0	0	5	14	14	33	0
EPHEMEROPTERA							
Leptophlebiidae							
Leptophlebia spp.	23.3	.5	0	0	0	0	0
Baetidae							
Baetis spp.	.5	1.8	16	58	14	0	0
Centroptilum spp.	0	0	5	0	0	0	0
Siphlonuridae							
Isonychia spp.	1.3	0	0	0	39	0	0
Heptageniidae							
Stenacron spp.	0	7	5	0	4	0	0
Stenonema spp.	0	.3	5	0	7	0	0
Caenidae							
Caenis spp.	0	.3	0	14	7	65	0
Ephemeridae							
Hexagenia spp.	0	0	22	87	11	269	0

Continued

Table A2. (Continued)

Taxa	Drift	Wood	Habitat[1] A	B	C	D	E
PLECOPTERA							
Perlidae	.3	0	11	65	0	0	0
Phasganophora spp.	0	.3	0	0	4	0	0
Perlesta spp.	0	2.3	0	0	40	0	0
Taeniopterygidae							
Taeniopteryx spp.	0	0	0	0	4	0	0
ODONATA							
Coenagrionidae							
Enallagma spp.	.3	0	11	14	11	0	9
Gomphidae							
Stylurus spp.	0	0	5	0	0	0	0
Gomphus spp.	0	0	5	0	0	0	0
Gomphurus spp.	0	0	5	0	4	0	0
HEMIPTERA							
Corixidae	2	0	5	0	4	11	0
MEGALOPTERA							
Sialidae							
Sialis spp.	.5	0	0	14	4	11	0
TRICHOPTERA							
Adult	0	0	0	0	0	0	9
Pupae	0	0	0	0	47	0	17
Hydropsychidae	.8	.5	38	7	491	0	78
Limnephilidae	2.8	7.5	22	47	25	54	19
Polycentropodidae	0	2	0	0	18	11	0
Glossosomatidae	0	0	0	0	7	0	0
Helicopsychidae	0	0	0	0	7	0	9
COLEOPTERA							
Adult Elmidae							
Dubiraphia spp.	0	.5	16	0	90	0	0
Ancyronyx variegata	0	.3	0	0	0	0	0
Macronychus glabratus	0	2	5	0	0	0	0
Stenelmis spp.	0	.3	33	4	86	0	17

Continued

Table A2. (Concluded)

Taxa	Drift	Wood	Habitat[1] A	B	C	D	E
Elmidae							
Dubiraphia spp.	.5	0	11	14	4	22	0
Stenelmis spp.	0	0	0	0	7	0	0
Adult Haliplidae							
Peltodytes spp.	.5	.3	0	0	0	0	0
Adult Staphylinidae	0	0	0	0	0	22	0
Adult Trogositidae	0	0	0	0	0	11	0
Adult Hydrophilidae	0	0	0	0	0	0	2
LEPIDOPTERA							
Noctuidae	0	0	0	0	0	11	0
DIPTERA							
Pupae	.3	0	0	0	0	0	0
Adult Chironomidae	.3	0	0	0	0	0	9
Pupae Chironomidae	0	0	0	0	14	11	0
Chironomidae	.3	19.5	880	344	545	1043	441
Simuliidae	1.8	0	0	7	47	0	0
Tipulidae	0	.3	0	18	4	11	9
Stratiomyiidae	0	.3	0	0	0	0	0
Ceratopogonidae	0	.3	38	0	14	44	2
Tabanidae	0	0	5	0	0	0	0
Ptycopteridae	0	0	0	4	0	0	0

[1]Habitats were designated as follows: A = edge of stream without macrophytes; B = edge of stream with macrophytes; C = riffle; D = pools; E = sandy areas towards middle of stream.

Table A3. Abundance estimates for macroinvertebrates (numbers/m^2 for A - E; average number per sample for drift and wood) collected from the Red Cedar River 5/25/82.

Taxa	Drift	Wood	Habitat[1] A	B	C	D	E
ISOPODA							
Ascellus	0	0	1	0	0	0	0
AMPHIPODA							
Hyallela azteca	12.3	2.7	643	315	1172	43	50
DECAPODA							
Orconectes spp.	0	0	0	3	14	0	0
TURBELLARIA	0	15.3	0	6	4	0	0
GASTROPODA	0	.5	11	19	18	0	17
PELECYPODA	0	0	0	0	0	33	0
Sphaeriidae	0	0	16	0	25	0	174
OLIGOCHAETA	.5	0	181	38	4	159	0
HIRUDINEA	0	0	0	16	0	11	0
HYDRACARINA	0	0	0	0	6	0	0
EPHEMEROPTERA							
Adult	.3	0	0	0	0	0	0
Leptophlebiidae							
Leptophlebia spp.	.5	0	0	0	0	0	0
Baetidae							
Pseudocloeon spp.	12.3	0	0	22	82	0	0
Baetis spp.	0	0	0	6	93	0	0
Heptageniidae							
Stenacron spp.	.5	6.3	0	3	0	0	0
Stenonema spp.	0	2.8	1	0	22	0	0
Heptagenia spp.	0	0	0	3	0	0	0
Adult Heptageniidae	0	0	0	0	0	22	0
Caenidae							
Caenis spp.	.3	.5	19	19	57	11	0
Ephemeridae							
Hexagenia spp.	.8	.3	7	78	4	76	0

Continued

Table A3. (Continued)

Taxa	Drift	Wood	Habitat[1] A	B	C	D	E
Siphlonuridae							
Isonychia spp.	0	0	0	0	11	0	0
PLECOPTERA							
Perlidae							
Perlesta spp.	3.3	4.5	18	137	366	3	0
Phasganophora spp.	0	0	0	3	0	0	0
ODONATA							
Coenagrionidae							
Enallagma spp.	.8	.3	8	3	29	0	0
Argia spp.	0	.3	0	0	0	0	0
Gomphidae							
Gomphurus spp.	0	0	11	0	0	0	0
Stylurus spp.	0	0	5	0	0	11	0
Calopterygidae							
Calopteryx spp.	0	0	0	3	4	0	0
HEMIPTERA							
Corixidae	2	.5	0	0	0	0	0
MEGALOPTERA							
Sialidae							
Sialis spp.	.3	0	0	0	0	0	0
TRICHOPTERA							
Pupae	0	.5	0	6	18	0	2
Adult Hydropsychidae	1	0	0	0	0	0	0
Hydropsychidae	.8	32.5	3	44	434	0	19
Limnephilidae	.3	14	83	105	4	33	9
Polycentropodidae	0	12.5	3	22	18	0	0
Molannidae	0	0	5	0	0	0	0
Glossosomatidae	0	0	0	3	0	0	0
Pupae Hylicopsychidae	0	0	0	0	0	0	9
Leptoceridae	0	0	0	0	0	3	11
Philopotamidae	0	0	0	0	4	0	0

Continued

Table A3. (Continued)

Taxa	Drift	Wood	Habitat[1] A	B	C	D	E
COLEOPTERA							
Adult Elmidae							
Macronychus glabratus	2.5	5.5	0	0	0	0	0
Ancyronyx variegata	.3	0	0	0	0	0	0
Stenelmis spp.	.5	0	0	11	50	50	9
Dubiraphia spp.	0	.3	11	3	133	0	0
Elmidae							
Macronychus glabratus	0	1	0	0	0	0	0
Dubiraphia spp.	0	0	29	0	11	0	0
Stenelmis spp.	0	0	18	0	25	35	2
Adult Haliplidae							
Peltodytes spp.	1.3	0	0	0	0	0	0
Dytiscidae							
Hydroporus spp.	0	.3	0	0	0	0	0
Adult Nitidulidae	0	0	5	0	4	11	0
Adult Curculionidae	0	0	0	0	0	3	0
Psephenidae							
Psephenus spp.	0	0	0	0	0	11	0
LEPIDOPTERA	.3	0	0	0	0	0	0
Geometridae	.3	0	0	0	0	0	0
DIPTERA							
Chironomidae	1.8	6.5	522	223	455	1054	124
Pupae Chironomidae	2.8	.3	22	8	11	11	9
Adult Chironomidae	.3	.3	0	0	0	0	0
Simuliidae	.8	0	0	102	15	0	2
Ceratopogonidae	0	.3	72	8	0	76	9
Tabanidae	0	0	16	0	4	0	0
Stratiomyidae	0	0	5	0	0	0	0
Tipulidae	0	0	5	0	18	0	11

Continued

Table A3. (Concluded)

Taxa	Drift	Wood	Habitat[1] A	B	C	D	E
Empididae	0	0	5	3	4	0	0
Muscidae	0	0	0	8	0	0	0
HYMENOPTERA							
Formicidae	.3	0	0	0	0	0	0

[1]Habitats were designated as follows: A = edge of stream without macrophytes; B = edge of stream with macrophytes; C = riffle; D = pools; E = sandy areas towards middle of stream.

APPENDIX

Table A1. Abundance estimates for macroinvertebrates (numbers/m^2 for A - E; average number per sample for drift and wood) collected from the Red Cedar River. First line under each taxonomic heading pertains to spring 1980; second line, summer 1980; third line, fall 1980.[1]

Taxa	Drift	Wood	Habitat[2] A	B	C	D	E
ISOPODA							
Ascellus spp.	0	0	2	0	0	0	0
	0	0	7	0	0	4	0
	0	0	0	0	0	0	0
AMPHIPODA							
Hyallela azteca	6.9	12.1	678	285	572	268	53
	5.6	49.3	72	119	116	199	12
	.3	27.4	117	112	31	196	3
TURBELLARIA	0	5.4	2	7	3	4	0
	0	1.7	5	12	4	4	6
	0	2.0	0	0	0	0	0
ARANEAE	0	0	0	0	0	0	0
	0	0	0	5	0	0	0
	0	0	0	0	0	17	0
GASTROPODA	0	1.2	7	33	10	29	9
	.2	1.4	19	28	5	42	25
	0	.6	44	3	2	60	1
CHILOPODA	0	.1	0	0	0	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
PELECYPODA	0	0	0	0	0	11	0
	0	0	0	2	0	0	2
	0	0	0	0	0	0	0
Sphaeriidae	0	0	14	12	30	47	84
	0	0	67	18	17	36	80
	0	0	25	6	29	6	47
DECAPODA							
Orconectes spp.	.1	.3	2	10	8	0	0
	.1	0	8	2	1	7	5
	0	0	3	0	0	0	0
OLIGOCHAETA	.2	0	345	33	13	647	3
	.1	0	544	11	2	1486	23
	0	0	278	9	10	468	26

Continued

Table A1. (Continued)

Taxa	Drift	Wood	Habitat[2] A	B	C	D	E
HIRUDINEA	0	0	0	9	0	11	6
	0	0	2	6	0	26	0
	0	0	0	2	0	87	0
HYDRACARINA	0	.1	2	7	13	11	0
	.2	0	2	0	7	0	7
	0	0	14	0	0	0	0
EPHEMEROPTERA							
Adult	.1	0	0	0	0	0	0
	0	.1	0	0	0	0	1
	0	0	0	0	0	0	0
Adult Ephemeridae							
Hexagenia spp.	0	0	0	0	0	0	0
	.1	0	0	0	0	0	0
	0	0	0	0	0	0	0
Ephemeridae							
Hexagenia spp.	.5	.1	26	60	5	173	0
	.2	0	4	9	0	11	9
	0	0	8	7	0	22	0
Heptageniidae							
Stenacron spp.	.3	5.0	2	6	1	0	0
	.3	10.4	6	23	18	0	3
	0	2.3	6	3	9	0	0
Stenonema spp.	0	11.0	2	14	17	0	0
	.2	8.0	0	12	45	0	6
	0	2.6	4	0	18	0	6
Heptagenia spp.	0	0	0	1	2	0	0
	.1	.1	0	0	0	0	0
	0	0	0	0	0	0	0
Adult Heptageniidae	0	0	0	0	0	7	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
Siphlonuridae							
Isonychia spp.	.6	2.5	0	0	18	0	0
	.1	2.9	0	2	16	4	1
	0	0	0	0	2	0	0

Continued

Table A1. (Continued)

Taxa	Drift	Wood	Habitat[2] A	B	C	D	E
Tricorythidae							
Tricorythodes spp.	.9	1	27	49	13	80	0
	.4	2.5	16	11	8	22	5
	0	.3	0	0	0	0	0
Ephemerellidae							
Ephemerella spp.	.2	.3	0	12	30	7	0
	0	.2	0	0	0	0	0
	0	0	0	0	0	0	0
Baetidae							
Baetis spp.	.2	1.0	5	27	36	4	0
	2.2	8.8	5	0	53	11	32
	.3	.5	0	0	4	0	0
Centroptilum spp.	0	0	2	0	0	0	0
	.1	.1	0	0	0	4	1
	0	0	0	0	0	0	0
Cloeon spp.	0	0	0	0	0	0	0
	.1	0	2	2	0	0	0
	0	0	0	0	0	0	0
Pseudocloeon spp.	4.1	0	0	8	27	0	0
	.3	.1	0	0	49	0	7
	0	0	0	0	9	0	0
Caenidae							
Caenis spp.	.1	.1	8	17	21	40	0
	0	0	4	3	4	22	2
	0	0	6	0	0	6	0
Brachycercus spp.	0	0	0	0	0	0	0
	0	0	2	0	0	4	0
	0	0	0	0	0	0	0
Polymitarycidae							
Ephoron spp.	0	0	4	0	0	0	0
	.1	0	5	0	2	0	9
	0	0	0	0	0	0	0
Leptophlebiidae							
Leptophlebia spp.	7.9	.2	0	0	0	0	0
	0	0	0	0	0	0	0
	0	.8	237	304	11	212	9

Continued

Table A1. (Continued)

Taxa	Drift	Wood	Habitat[2] A	B	C	D	E
Paraleptophlebia spp.	0	0	0	0	0	0	0
	2.3	0	4	6	0	4	0
	0	.2	120	64	8	6	2
PLECOPTERA							
Perlidae	.1	0	4	22	0	0	0
	0	0	0	1	0	0	0
	0	0	0	0	0	0	0
Acroneuria spp.	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0	0	14	0	0	0	0
Perlesta spp.	1.1	2.5	6	46	135	1	0
	0	.1	0	0	0	0	1
	0	0	0	0	0	0	0
Phasgonophora spp.	0	.1	0	1	1	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
Perlinella spp.	0	0	0	0	0	0	0
	0	0	0	0	1	0	0
	0	.1	3	2	0	0	0
Taeniopterygidae							
Taeniopteryx	0	0	0	0	1	0	0
	0	0	0	0	0	0	0
	.7	.7	153	41	231	283	65
Perlodidae							
Isoperla spp.	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
	.1	0	0	0	0	0	0
ODONATA							
Coenagrionidae	0	0	0	0	0	0	0
	0	0	0	0	3	0	0
	0	0	0	0	0	0	0
Enallagma spp.	.4	.1	6	8	16	0	3
	.3	.1	1	6	1	0	0
	0	0	4	10	0	0	0
Argia spp.	0	.1	0	0	0	0	0
	0	.3	0	2	3	0	0
	0	0	0	0	18	0	0

Continued

Table A1. (Continued)

Taxa	Drift	Wood	Habitat[2] A	B	C	D	E
Calopterygidae	0	0	0	0	0	0	0
	0	0	0	1	0	0	0
	0	0	0	0	0	0	0
Calopteryx spp.	0	0	0	1	1	0	0
	.1	0	0	10	0	4	1
	0	0	0	8	0	6	0
Gomphidae							
Gomphurus spp.	0	0	7	0	1	0	6
	0	0	4	1	0	4	0
	0	0	8	0	0	0	1
Gomphus spp.	0	0	2	0	0	0	0
	0	0	0	0	0	4	0
	0	0	3	0	0	0	0
Stylurus spp.	0	0	3	0	0	7	0
	0	0	4	0	0	7	0
	0	0	3	0	0	11	0
Aeshnidae							
Basiaeschna spp.	0	0	0	0	0	0	0
	0	0	0	1	0	0	0
	0	0	0	0	0	0	0
Bayeria spp.	0	0	0	0	0	0	0
	0	0	0	1	0	0	0
	0	0	0	2	0	0	0
HEMIPTERA							
Corixidae	1	.2	2	0	1	4	0
	.3	0	2	2	0	29	0
	.3	0	3	6	0	38	3
Nepidae	0	0	0	0	0	0	0
	.2	0	0	0	0	0	0
	0	0	0	3	0	0	0
Belostomatidae	0	0	0	0	0	0	0
	.1	0	0	2	0	0	0
	0	0	0	4	0	0	0
Gerridae	0	0	0	0	0	0	0
	.2	0	0	1	0	0	0
	0	0	0	0	0	0	0

Continued

Table A1. (Continued)

Taxa	Drift	Wood	Habitat[2] A	B	C	D	E
Pleidae	0	0	0	0	0	0	0
	0	0	0	1	0	0	1
	0	0	0	2	0	0	0
Veliidae	0	0	0	0	0	0	0
	0	0	0	2	0	0	0
	0	0	0	0	0	0	0
Tingidae	0	0	0	0	0	0	0
	0	0	0	0	1	0	0
	0	0	0	0	0	0	0
HOMOPTERA							
Aphidae	0	0	0	0	0	0	0
	0	0	1	0	0	0	0
	0	0	0	2	2	6	0
Psyllidae	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0	.2	0	0	0	0	0
MEGOLOPTERA							
Sialidae							
Sialis spp.	.4	0	22	7	1	18	0
	.1	.2	33	9	3	76	5
	.2	0	30	19	9	44	1
Corydalidae							
Corydalus spp.	0	.1	0	0	0	0	0
	0	0	0	0	3	0	0
	0	0	0	0	0	0	0
Sisyridae							
Sisyra spp.	0	0	0	0	0	0	0
	0	.1	0	0	0	0	0
	0	0	0	0	0	0	0
TRICHOPTERA							
Pupae	0	.4	0	2	28	0	5
	0	0	1	0	6	0	0
	0	0	0	0	0	0	0
Adult	0	0	2	0	0	0	3
	.1	0	0	0	0	0	0
	0	0	0	0	0	0	0

Continued

Table A1. (Continued)

Taxa	Drift	Wood	Habitat[2] A	B	C	D	E
Adult Hydropsychidae	.3	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
Hydropsychidae	1.2	69.3	25	99	712	40	35
	2.8	20.1	77	76	1411	11	44
	.4	25.8	26	10	345	87	39
Limnephilidae	1.0	7.5	37	60	22	33	9
	0	1.3	4	59	3	0	17
	0	.2	71	13	0	38	1
Pupae Limnephilidae	0	0	0	37	0	0	0
	0	2	0	0	1	0	1
	0	0	0	0	0	0	1
Adult Limnephilidae	.1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
Helicopsychidae	0	0	0	0	4	0	3
	0	.5	0	0	0	0	0
	0	.3	2	0	6	6	0
Pupae Helicopsychidae	0	0	0	0	0	0	3
	0	0	0	0	0	0	0
	0	0	0	0	0	0	9
Adult Helicopsychidae	0	0	0	0	1	0	0
	.1	0	0	0	0	0	0
	0	0	0	0	0	0	0
Hydroptilidae	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0	0	1	0	2	0	0
Leptoceridae	.2	.1	22	7	6	15	12
	.2	.1	9	2	3	4	0
	0	0	0	2	0	0	0
Polycentropodidae	0	6.3	1	8	13	4	0
	0	2.7	2	31	1	0	1
	0	4.5	3	18	6	11	2
Glossosomatidae	0	0	2	1	2	0	0
	0	0	0	0	13	0	0
	0	0	0	0	0	0	0

Continued

Table A1. (Continued)

Taxa	Drift	Wood	Habitat[2] A	B	C	D	E
Molannidae	0	0	2	0	0	0	0
	0	.1	0	0	0	4	7
	0	0	0	0	0	0	0
Philopotamidae	0	0	0	0	1	0	0
	0	.2	0	0	1	0	0
	0	0	0	0	0	0	0
Psychomyiidae	0	0	0	0	0	0	0
	0	0	0	0	1	0	0
	0	0	0	0	0	0	0
Brachycentridae	0	0	0	0	0	0	0
	0	0	4	0	0	0	0
	0	0	0	0	2	6	0
Odontoceridae	0	0	0	0	0	0	0
	0	0	0	0	0	14	0
	0	0	0	0	0	0	0
COLEOPTERA							
Adult Elmidae							
Stenelmis spp.	.2	.5	15	6	90	17	9
	.1	1.4	0	15	29	4	1
	0	1.1	0	0	72	0	3
Dubiraphia spp.	0	.3	13	5	39	4	0
	.1	1.2	12	12	26	0	0
	0	1.8	0	4	54	0	1
Macronychus glabratus	.8	10.7	2	2	0	0	0
	.1	18.4	0	6	0	0	0
	0	3.9	0	2	0	0	0
Ancyronyx variegata	.2	.1	0	0	0	0	0
	0	1.1	0	1	0	0	0
	0	0	0	0	0	0	0
Elmidae							
Stenelmis spp.	0	.2	10	1	20	12	1
	.2	1.1	15	6	26	4	16
	0	0	4	0	13	6	4
Dubiraphia spp.	.2	0	77	7	6	33	0
	0	0	35	10	1	138	9
	0	.6	22	7	0	6	10

Continued

Table A1. (Continued)

Taxa	Drift	Wood	Habitat[2] A	B	C	D	E
Macronychus glabratus	0	2.1	0	0	0	0	0
	.1	1.5	0	0	0	0	0
	0	.5	0	0	0	0	0
Ancyronyx variegata	0	0	0	0	0	0	0
	0	.3	0	0	0	0	0
	0	.2	0	0	0	0	0
Adult Haliplidae							
Peltodytes spp.	.7	.1	0	0	0	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
Haliplus spp.	0	0	0	0	0	0	0
	.1	0	0	0	0	0	0
	0	0	0	0	0	0	0
Haliplidae							
Peltodytes spp.	0	0	0	0	0	0	0
	0	0	0	1	0	0	0
	0	0	0	0	0	0	0
Adult Gyrinidae							
Gyrinus spp.	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
	.3	0	0	0	0	0	0
Dineutus spp.	0	0	0	0	0	0	0
	.1	0	0	0	0	0	0
	0	0	0	0	0	0	0
Gyrindae							
Gyrinus spp.	.1	0	0	1	0	4	0
	0	0	0	3	0	0	2
	0	0	0	0	0	0	0
Dineutus spp.	0	0	0	4	0	0	0
	0	.1	0	0	6	0	3
	0	0	0	0	0	0	0
Psephenidae							
Psephenus spp.	.3	0	0	0	1	4	0
	0	0	0	1	1	0	0
	0	0	0	0	4	0	0

Continued

Table A1. (Continued)

Taxa	Drift	Wood	Habitat[2] A	B	C	D	E
Adult Dytiscidae	0	0	0	0	0	0	0
	0	.1	0	0	0	0	0
	0	0	0	0	0	0	0
Hydroporus spp.	0	0	0	0	0	0	0
	0	.2	0	0	0	0	0
	0	0	0	0	0	0	0
Liodessus spp.	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
	.2	.3	0	0	0	0	0
Dytiscidae							
Hydroporus spp.	0	.1	0	0	0	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
Adult Staphylinidae	0	0	2	0	1	4	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
Adult Trogositidae	0	0	0	0	0	4	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
Helodidae							
Cyphon spp.	0	0	0	0	0	0	0
	0	.1	0	0	0	0	0
	0	0	0	0	0	0	0
Adult Hydrophilidae	0	0	0	0	0	0	1
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
Hydrobius spp.	0	0	0	0	0	0	0
	0	0	2	0	0	0	0
	0	0	0	0	0	0	0
Crenitis spp.	0	0	0	0	0	0	0
	0	0	0	1	0	0	0
	0	0	0	0	0	0	0
Adult Carabidae	0	0	0	0	0	0	0
	.1	0	0	0	0	0	0
	0	0	0	0	0	0	0

Continued

Table A1. (Continued)

Taxa	Drift	Wood	Habitat[2] A	B	C	D	E
Adult Curculionidae	0	0	2	0	0	1	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
Adult Nitidulidae	0	0	2	0	1	4	0
	.1	.1	0	0	0	0	1
	0	0	0	0	0	0	0
Adult Cleridae	0	0	0	0	2	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
Adult Chrysomelidae	0	0	0	0	0	0	0
	0	0	2	0	0	4	1
	0	0	0	0	0	0	0
LEPIDOPTERA							
Noctuidae	0	0	2	0	0	4	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
Geometridae	.1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
Pyralidae							
Paraponyx spp.	0	0	0	0	0	0	0
	0	0	0	1	1	0	0
	0	0	3	8	0	0	1
DIPTERA							
Pupae	.1	0	0	1	0	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
Adult Chironomidae	.2	.2	0	0	0	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	4
Pupae Chironomidae	.9	.3	11	3	10	15	3
	0	.1	2	2	4	4	2
	0	0	0	0	2	0	0
Chironomidae	1.4	18.7	705	513	510	855	217
	3.2	7.0	119	109	330	196	144
	.2	34.9	174	42	692	212	291

Continued

Table A1. (Continued)

Taxa	Drift	Wood	Habitat[2] A	B	C	D	E
Pupae Simuliidae	0	0	0	0	0	0	0
	.1	.1	0	1	14	0	8
	0	0	0	0	0	0	0
Simuliidae	1.0	.2	0	53	28	0	1
	.8	.4	0	24	76	29	140
	.7	0	0	0	38	0	1
Tipulidae	0	.1	5	6	7	4	7
	0	0	1	0	7	0	1
	0	0	4	0	2	0	10
Pupae Tipulidae	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0	0	1	0	0	0	0
Stratiomyiidae	0	.1	2	0	0	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	1
Ceratopogonidae	0	.2	47	3	5	65	4
	0	0	7	0	0	29	6
	0	0	8	0	2	22	74
Tabanidae	0	0	11	0	1	0	0
	0	0	7	0	0	0	0
	0	0	14	3	0	6	0
Ptycopteridae	0	0	0	1	0	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
Empididae	0	0	2	1	1	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
Pupae Empididae	0	0	0	0	0	0	0
	0	0	0	0	2	0	0
	0	0	0	0	0	0	0
Muscidae	0	0	0	3	0	0	0
	0	0	0	1	0	0	0
	0	0	0	0	0	0	0
Adult Culicidae	0	0	0	0	0	0	0
	0	0	2	0	0	0	0
	0	0	0	0	0	0	0

Continued

Table A1. (Concluded)

Taxa	Drift	Wood	Habitat[2] A	B	C	D	E
Scatophagidae	0	0	0	0	0	0	0
	0	0	0	3	0	0	0
	0	0	3	3	0	0	0
HYMENOPTERA							
Formicidae	.1	0	0	0	0	0	0
	.1	0	0	0	0	0	0
	0	0	0	0	0	0	0

[1]Seasons were designated as follows: Spring = 5/4-6/22; Summer = 7/20-9/21; Fall = 10/26-11/23.

[2]Habitats were designated as follows: A = edge of stream without macrophytes; B = edge of stream with macrophytes; C = riffle; D = pools; E = sandy areas towards middle of stream.

Table A2. Abundance estimates for macroinvertebrates (numbers/m^2 for A - E; average number per sample for drift and wood) collected from the Red Cedar River, 5/4/80.

Taxa	Drift	Wood	Habitat[1] A	B	C	D	E
ISOPODA							
Ascellus spp.	0	0	5	0	0	0	0
AMPHIPODA							
Hyallela azteca	5	29	1223	239	351	239	73
DECAPODA							
Orconectes spp.	0	.5	0	4	0	0	0
TURBELLARIA	0	0	0	0	0	11	0
GASTROPODA	0	2.3	11	0	4	0	2
CHILOPODA	0	.3	0	0	0	0	0
PELECYPODA							
Sphaeriidae	0	0	0	0	0	54	35
OLIGOCHAETA	0	0	234	51	36	587	9
HIRUDINEA	0	0	0	0	0	0	17
HYDRACARINA	0	0	5	14	14	33	0
EPHEMEROPTERA							
Leptophlebiidae							
Leptophlebia spp.	23.3	.5	0	0	0	0	0
Baetidae							
Baetis spp.	.5	1.8	16	58	14	0	0
Centroptilum spp.	0	0	5	0	0	0	0
Siphlonuridae							
Isonychia spp.	1.3	0	0	0	39	0	0
Heptageniidae							
Stenacron spp.	0	7	5	0	4	0	0
Stenonema spp.	0	.3	5	0	7	0	0
Caenidae							
Caenis spp.	0	.3	0	14	7	65	0
Ephemeridae							
Hexagenia spp.	0	0	22	87	11	269	0

Continued

Table A2. (Continued)

Taxa	Drift	Wood	Habitat[1] A	B	C	D	E
PLECOPTERA							
Perlidae	.3	0	11	65	0	0	0
Phasganophora spp.	0	.3	0	0	4	0	0
Perlesta spp.	0	2.3	0	0	40	0	0
Taeniopterygidae							
Taeniopteryx spp.	0	0	0	0	4	0	0
ODONATA							
Coenagrionidae							
Enallagma spp.	.3	0	11	14	11	0	9
Gomphidae							
Stylurus spp.	0	0	5	0	0	0	0
Gomphus spp.	0	0	5	0	0	0	0
Gomphurus spp.	0	0	5	0	4	0	0
HEMIPTERA							
Corixidae	2	0	5	0	4	11	0
MEGALOPTERA							
Sialidae							
Sialis spp.	.5	0	0	14	4	11	0
TRICHOPTERA							
Adult	0	0	0	0	0	0	9
Pupae	0	0	0	0	47	0	17
Hydropsychidae	.8	.5	38	7	491	0	78
Limnephilidae	2.8	7.5	22	47	25	54	19
Polycentropodidae	0	2	0	0	18	11	0
Glossosomatidae	0	0	0	0	7	0	0
Helicopsychidae	0	0	0	0	7	0	9
COLEOPTERA							
Adult Elmidae							
Dubiraphia spp.	0	.5	16	0	90	0	0
Ancyronyx variegata	0	.3	0	0	0	0	0
Macronychus glabratus	0	2	5	0	0	0	0
Stenelmis spp.	0	.3	33	4	86	0	17

Continued

Table A2. (Concluded)

Taxa	Drift	Wood	Habitat[1] A	B	C	D	E
Elmidae							
Dubiraphia spp.	.5	0	11	14	4	22	0
Stenelmis spp.	0	0	0	0	7	0	0
Adult Haliplidae							
Peltodytes spp.	.5	.3	0	0	0	0	0
Adult Staphylinidae	0	0	0	0	0	22	0
Adult Trogositidae	0	0	0	0	0	11	0
Adult Hydrophilidae	0	0	0	0	0	0	2
LEPIDOPTERA							
Noctuidae	0	0	0	0	0	11	0
DIPTERA							
Pupae	.3	0	0	0	0	0	0
Adult Chironomidae	.3	0	0	0	0	0	9
Pupae Chironomidae	0	0	0	0	14	11	0
Chironomidae	.3	19.5	880	344	545	1043	441
Simuliidae	1.8	0	0	7	47	0	0
Tipulidae	0	.3	0	18	4	11	9
Stratiomyiidae	0	.3	0	0	0	0	0
Ceratopogonidae	0	.3	38	0	14	44	2
Tabanidae	0	0	5	0	0	0	0
Ptycopteridae	0	0	0	4	0	0	0

[1]Habitats were designated as follows: A = edge of stream without macrophytes; B = edge of stream with macrophytes; C = riffle; D = pools; E = sandy areas towards middle of stream.

Table A3. Abundance estimates for macroinvertebrates (numbers/m^2 for A - E; average number per sample for drift and wood) collected from the Red Cedar River 5/25/82.

Taxa	Drift	Wood	Habitat[1] A	B	C	D	E
ISOPODA							
Ascellus	0	0	1	0	0	0	0
AMPHIPODA							
Hyallela azteca	12.3	2.7	643	315	1172	43	50
DECAPODA							
Orconectes spp.	0	0	0	3	14	0	0
TURBELLARIA	0	15.3	0	6	4	0	0
GASTROPODA	0	.5	11	19	18	0	17
PELECYPODA	0	0	0	0	0	33	0
Sphaeriidae	0	0	16	0	25	0	174
OLIGOCHAETA	.5	0	181	38	4	159	0
HIRUDINEA	0	0	0	16	0	11	0
HYDRACARINA	0	0	0	0	6	0	0
EPHEMEROPTERA							
Adult	.3	0	0	0	0	0	0
Leptophlebiidae							
Leptophlebia spp.	.5	0	0	0	0	0	0
Baetidae							
Pseudocloeon spp.	12.3	0	0	22	82	0	0
Baetis spp.	0	0	0	6	93	0	0
Heptageniidae							
Stenacron spp.	.5	6.3	0	3	0	0	0
Stenonema spp.	0	2.8	1	0	22	0	0
Heptagenia spp.	0	0	0	3	0	0	0
Adult Heptageniidae	0	0	0	0	0	22	0
Caenidae							
Caenis spp.	.3	.5	19	19	57	11	0
Ephemeridae							
Hexagenia spp.	.8	.3	7	78	4	76	0

Continued

Table A3. (Continued)

Taxa	Drift	Wood	Habitat[1] A	B	C	D	E
Siphlonuridae							
Isonychia spp.	0	0	0	0	11	0	0
PLECOPTERA							
Perlidae							
Perlesta spp.	3.3	4.5	18	137	366	3	0
Phasganophora spp.	0	0	0	3	0	0	0
ODONATA							
Coenagrionidae							
Enallagma spp.	.8	.3	8	3	29	0	0
Argia spp.	0	.3	0	0	0	0	0
Gomphidae							
Gomphurus spp.	0	0	11	0	0	0	0
Stylurus spp.	0	0	5	0	0	11	0
Calopterygidae							
Calopteryx spp.	0	0	0	3	4	0	0
HEMIPTERA							
Corixidae	2	.5	0	0	0	0	0
MEGALOPTERA							
Sialidae							
Sialis spp.	.3	0	0	0	0	0	0
TRICHOPTERA							
Pupae	0	.5	0	6	18	0	2
Adult Hydropsychidae	1	0	0	0	0	0	0
Hydropsychidae	.8	32.5	3	44	434	0	19
Limnephilidae	.3	14	83	105	4	33	9
Polycentropodidae	0	12.5	3	22	18	0	0
Molannidae	0	0	5	0	0	0	0
Glossosomatidae	0	0	0	3	0	0	0
Pupae Hylicopsychidae	0	0	0	0	0	0	9
Leptoceridae	0	0	0	0	0	3	11
Philopotamidae	0	0	0	0	4	0	0

Continued

Table A3. (Continued)

Taxa	Drift	Wood	Habitat[1] A	B	C	D	E
COLEOPTERA							
Adult Elmidae							
Macronychus glabratus	2.5	5.5	0	0	0	0	0
Ancyronyx variegata	.3	0	0	0	0	0	0
Stenelmis spp.	.5	0	0	11	50	50	9
Dubiraphia spp.	0	.3	11	3	133	0	0
Elmidae							
Macronychus glabratus	0	1	0	0	0	0	0
Dubiraphia spp.	0	0	29	0	11	0	0
Stenelmis spp.	0	0	18	0	25	35	2
Adult Haliplidae							
Peltodytes spp.	1.3	0	0	0	0	0	0
Dytiscidae							
Hydroporus spp.	0	.3	0	0	0	0	0
Adult Nitidulidae	0	0	5	0	4	11	0
Adult Curculionidae	0	0	0	0	0	3	0
Psephenidae							
Psephenus spp.	0	0	0	0	0	11	0
LEPIDOPTERA	.3	0	0	0	0	0	0
Geometridae	.3	0	0	0	0	0	0
DIPTERA							
Chironomidae	1.8	6.5	522	223	455	1054	124
Pupae Chironomidae	2.8	.3	22	8	11	11	9
Adult Chironomidae	.3	.3	0	0	0	0	0
Simuliidae	.8	0	0	102	15	0	2
Ceratopogonidae	0	.3	72	8	0	76	9
Tabanidae	0	0	16	0	4	0	0
Stratiomyidae	0	0	5	0	0	0	0
Tipulidae	0	0	5	0	18	0	11

Continued

Table A3. (Concluded)

Taxa	Drift	Wood	Habitat[1] A	B	C	D	E
Empididae	0	0	5	3	4	0	0
Muscidae	0	0	0	8	0	0	0
HYMENOPTERA							
Formicidae	.3	0	0	0	0	0	0

[1]Habitats were designated as follows: A = edge of stream without macrophytes; B = edge of stream with macrophytes; C = riffle; D = pools; E = sandy areas towards middle of stream.

Table A4. Abundance estimates for macroinvertebrates (numbers/m^2 for A - E; average number per sample for drift and wood) collected from the Red Cedar River, 6/22/82.

Taxa	Drift	Wood	Habitat[1] A	B	C	D	E
ISOPODA	0	0	0	0	0	0	0
AMPHIPODA							
Hyallela azteca	3.3	4.5	169	301	193	522	35
DECAPODA							
Orconectes spp.	.3	.5	5	22	11	0	0
TURBELLARIA	0	.8	5	14	4	11	0
GASTROPODA	0	.8	0	81	7	87	9
PELECYPODA							
Sphaeriidae	0	0	27	35	61	87	43
OLIGOCHAETA	0	0	620	11	0	1196	0
HIRUDINEA	0	0	0	11	0	22	0
HYDRACARINA	0	.3	0	6	18	0	0
EPHEMEROPTERA							
Ephemeridae							
Hexagenia spp.	.8	0	49	14	0	174	0
Heptageniidae							
Stenacron spp.	.3	.3	0	14	0	0	0
Stenonema spp.	0	29.8	0	41	22	0	0
Heptagenia spp.	0	0	0	0	7	0	0
Tricorythidae							
Tricorythodes spp.	2.8	2	81	146	39	239	0
Siphlonuridae							
Isonychia spp.	.5	7.5	0	0	4	0	0
Ephemerellidae							
Ephemerella spp.	.5	1	0	35	89	22	0
Caenidae							
Caenis spp.	0	.3	5	19	0	44	0
Baetidae							
Baetis spp.	0	1.3	0	16	0	11	0
Pseudocloeon spp.	0	0	0	3	0	0	0

Continued

Table A4. (Continued)

Taxa	Drift	Wood	Habitat[1] A	B	C	D	E
Polymitarcyidae							
Ephoron spp.	0	0	11	0	0	0	0
PLECOPTERA							
Perlidae							
Perlesta spp.	0	.8	0	0	0	0	0
ODONATA							
Gomphidae							
Gomphurus spp.	0	0	5	0	0	0	17
Stylurus spp.	0	0	0	0	0	11	0
Coenagrionidae							
Enallagma spp.	0	0	0	6	7	0	0
HEMIPTERA							
Corixidae	0	0	0	0	0	0	0
MEGALOPTERA							
Sialidae							
Sialis spp.	.3	0	65	8	0	43	0
Corydalidae							
Corydalus spp.	0	.3	0	0	0	0	0
TRICHOPTERA							
Pupae	0	.8	0	0	18	0	0
Adult	0	0	5	0	0	0	0
Limnephilidae	0	1	5	27	7	11	0
Pupae Limnephilidae	0	0	0	110	0	0	0
Adult Limnephilidae	.3	0	0	0	0	0	0
Leptoceridae	.5	.3	65	22	18	43	26
Polycentropidae	0	4.5	0	3	4	0	0
Glossosomatidae	0	0	5	0	0	0	0
Helicopsychidae	0	0	0	0	4	0	0
Adult Helicopsychidae	0	0	0	0	4	0	0
Hydropsychidae	2	175	33	245	1211	120	9

Continued

Table A4. (Continued)

Taxa	Drift	Wood	Habitat[1] A	B	C	D	E
COLEOPTERA							
Adult Elmidae							
Ancyronyx variegata	.3	0	0	0	0	0	0
Macronychus glabratus	.3	24.5	0	6	0	0	9
Stenelmis spp.	0	1.3	0	3	50	0	0
Dubiraphia spp.	0	0	11	11	15	11	0
Elmidae							
Macronychus glabratus	0	5.3	0	0	0	0	0
Stenelmis spp.	0	.3	11	3	29	0	0
Dubiraphia spp.	0	0	190	6	4	76	0
Adult Cleridae	0	0	0	0	7	0	0
Gyrinidae							
Gyrinus spp.	.3	0	0	3	0	11	0
Dineutus spp.	0	0	0	11	0	0	0
Haliplidae							
Pelodytes spp.	.3	0	0	0	0	0	0
Psephenidae							
Psephenus spp.	.8	0	0	0	4	0	0
Adult Curculionidae	0	0	5	0	0	0	0
Adult Staphylinidae	0	0	5	0	4	0	0
Adult Hydrophilidae							
Hydrobius spp.	0	0	5	0	0	0	0
LEPIDOPTERA							
Noctuidae	0	0	5	0	0	0	0
DIPTERA							
Pupae	0	0	0	3	0	0	0
Chironomidae	2	29.8	712	973	538	468	87
Pupae Chironomidae	0	.5	11	0	4	22	0
Adult Chironomidae	0	.3	0	0	0	0	0
Simuliidae	.3	.5	0	49	22	0	0

Continued

Table A4. (Concluded)

Taxa	Drift	Wood	Habitat[1] A	B	C	D	E
Ceratopogonidae	0	0	32	0	0	76	0
Tipulidae	0	0	11	0	0	0	0
Tabanidae	0	0	11	0	0	0	0

[1]Habitats were designated as follows: A = edge of stream without macrophytes; B = edge of stream with macrophytes; C = riffle; D = pools; E = sandy areas towards middle of stream.

Table A5. Abundance estimates for macroinvertebrates (numbers/m^2 for A - E; average number per sample for drift and wood) collected from the Red Cedar River, 7/20/80.

Taxa	Drift	Wood	Habitat[1] A	B	C	D	E
ISOPODA							
Ascellus spp.	0	0	0	0	0	11	0
AMPHIPODA							
Hyallela azteca	9.5	134.3	38	188	333	239	7
DECAPODA							
Orconectes spp.	.3	0	11	4	4	0	4
TURBELLARIA	0	1.5	11	14	7	0	4
GASTROPODA	.3	3	12	43	4	29	34
ARANEAE	0	0	0	16	0	0	0
PELECYPODA	0	0	0	6	0	0	7
Sphaeriidae	0	0	43	19	32	22	63
OLIGOCHAETA	0	0	5	16	7	1924	17
HIRUDINEA	0	0	5	8	0	22	0
HYDRACARINA	.3	0	1	0	0	0	11
EPHEMEROPTERA							
Adult	0	0	0	0	0	0	2
Baetidae							
Cloeon spp.	0	0	0	6	0	0	0
Baetis spp.	.5	5	11	0	36	11	17
Pseudocloeon spp.	.3	0	0	0	86	0	9
Centroptilum spp.	0	.3	0	0	0	11	4
Ephemeridae							
Hexagenia spp.	.5	0	11	14	0	22	11
Tricorythidae							
Tricorythodes spp.	.3	5	29	14	25	43	2
Heptageniidae	0	0	0	0	0	0	6
Stenonema spp.	0	17	0	35	79	0	15
Stenacron spp.	0	13	16	46	25	0	7
Hexagenia spp.	0	2	0	0	0	0	0

Continued

Table A5. (Continued)

Taxa	Drift	Wood	Habitat[1] A	B	C	D	E
Ephemerellidae							
Ephemerella spp.	0	.5	0	0	0	0	0
Siphlonuridae							
Isonychia spp.	0	7.3	1	0	29	11	0
Polymitarycidae							
Ephoron spp.	0	0	16	0	7	0	11
Caenidae							
Caenis spp.	0	0	5	3	4	44	7
Brachycerus spp.	0	0	0	0	0	11	0
PLECOPTERA	0	0	0	0	0	0	0
ODONATA							
Gomphidae							
Gomphurus spp.	0	0	11	0	0	0	0
Stylurus spp.	0	0	0	0	0	11	0
Coenagrionidae							
Argia spp.	0	0	0	6	4	0	0
Calopterygidae							
Calopteryx spp.	0	0	0	0	0	11	0
HEMIPTERA							
Corixidae	.3	0	5	4	0	87	0
Gerridae	.3	0	0	0	0	0	0
Veliidae	0	0	0	6	0	0	0
Tingidae	0	0	0	0	4	0	0
MEGALOPTERA							
Sialidae							
Sialis spp.	0	.3	49	11	4	152	7
Sisyridae							
Sisyra spp.	0	.3	0	0	0	0	0
TRICHOPTERA							
Pupae	0	0	3	0	0	0	0
Adult	.3	0	0	0	0	0	0

Continued

Table A5. (Continued)

Taxa	Drift	Wood	Habitat[1] A	B	C	D	E
Hydropsychidae	5.5	13	224	94	1763	0	90
Adult Helicopsychidae	.3	0	0	0	0	0	0
Leptoceridae	.5	.3	27	6	4	0	0
Limnephilidae	0	.3	11	172	4	0	52
Pupae Limnephilidae	0	0	0	0	4	0	0
Polycentropodidae	0	.8	16	280	22	0	24
Brachycentridae	0	0	11	0	0	0	0
Philopotomidae	0	0	0	0	4	0	0
Odontoceridae	0	0	0	0	0	43	0
Molannidae	0	0	0	0	0	0	22
COLEOPTERA							
Adult Elmidae							
Macronychus glabratus	.3	11	0	0	0	0	0
Dubiraphia spp.	.3	1.5	33	4	61	0	0
Stenelmis spp.	.3	.5	0	11	25	0	2
Ancyronx variegata	0	3.3	0	0	0	0	0
Elmidae							
Macronychus glabratus	.3	.8	0	0	0	0	0
Stenelmis spp.	0	.3	41	6	22	11	19
Dubiraphia spp.	0	0	27	0	4	218	20
Adult Chrysomelidae	0	0	0	0	0	11	0
Adult Dytiscidae	0	.3	0	0	0	0	0
Adult Nitidulidae	0	.3	0	0	0	0	2
Helodidae							
Cyphon spp.	0	.3	0	0	0	0	0
Psephenidae							
Psephenus spp.	0	0	1	0	0	0	0
Adult Staphylinidae	0	0	1	0	0	0	0
Adult Hydrophilidae							
Crenitis spp.	0	0	0	3	0	0	0

Continued

Table A5. (Concluded)

Taxa	Drift	Wood	Habitat[1] A	B	C	D	E
Gyrinidae							
Gyrinus spp.	0	0	0	6	0	0	0
Dineutus spp.	0	0	0	0	18	0	7
LEPIDOPTERA	0	0	0	0	0	0	0
DIPTERA							
Chironomidae	1.5	5.3	217	164	607	283	183
Pupae Chironomidae	0	.3	5	4	4	11	5
Simuliidae	.3	0	0	0	7	0	4
Ceratopogonidae	0	0	16	0	0	11	0
Muscidae	0	0	0	4	0	0	0
Pupae Empididae	0	0	0	0	7	0	2
Pupae Simuliidae	0	0	0	0	0	0	26
HYMENOPTERA							
Formicidae	.3	0	0	0	0	0	0

[1]Habitats were designated as follows: A = edge of stream without macrophytes; B = edge of stream with macrophytes; C = riffle; D = pools; E = sandy areas towards middle of stream.

Table A6. Abundance estimates for macroinvertebrates (numbers/m^2 for A - E; average number per sample for drift and wood) collected from the Red Cedar River, 8/17/80.

Taxa	Drift	Wood	Habitat[1] A	B	C	D	E
ISOPODA	0	0	0	0	0	0	0
AMPHIPODA							
Hyallela azteca	3.3	2.8	80	86	7	272	30
DECAPODA							
Orconectes spp.	0	0	1	3	0	22	11
TURBELLARIA	0	1.3	0	22	0	0	15
GASTROPODA	.3	.8	11	3	0	44	41
PELECYPODA							
Sphaeriidae	0	0	129	24	11	65	130
OLIGOCHAETA	0	0	359	6	0	1294	26
HIRUDINEA	0	0	0	11	0	11	0
HYDRACARINA	0	0	0	0	7	0	0
EPHEMEROPTERA							
Adult	0	.3	0	0	0	0	0
Adult Ephemeridae							
Hexagenia spp.	.3	0	0	0	0	0	0
Ephemeridae							
Hexagenia spp.	0	0	0	22	0	11	17
Heptageniidae	0	0	1	0	0	0	0
Stenonema spp.	.5	5.3	0	0	32	0	0
Stenacron spp.	.3	17.3	0	6	7	0	2
Baetidae	0	0	1	0	0	0	0
Baetis spp.	1.8	16.5	0	0	115	22	80
Centroptilum spp.	.3	0	0	0	0	0	0
Pseudocloeon spp.	0	0	0	0	54	0	13
Siphlonuridae							
Isonychia spp.	.3	1.3	0	6	18	0	2
Polymitarcyidae							
Ephoron spp.	.3	0	0	0	0	0	17

Continued

Table A6. (Continued)

Taxa	Drift	Wood	Habitat[1] A	B	C	D	E
Tricorythidae							
Tricorythodes spp.	0	0	4	6	0	11	13
Caenidae							
Caenis spp.	0	0	8	6	0	22	0
Brachycercus spp.	0	0	5	0	0	0	0
PLECOPTERA							
Perlidae							
Perlesta spp.	0	.3	0	0	0	0	2
Perlinella spp.	0	0	0	0	4	0	0
ODONATA							
Coenagrionidae	0	0	0	8	0	0	0
Argia spp.	0	1	0	0	4	0	0
Calopterygidae	0	0	0	3	0	0	0
Calopteryx spp.	0	0	0	0	0	0	2
Gomphidae							
Gomphurus spp.	0	0	0	3	0	11	0
Stylurus spp.	0	0	0	0	0	11	0
Aeshnidae							
Basiaeschna spp.	0	0	0	3	0	0	0
HEMIPTERA							
Corixidae	.3	0	0	3	0	0	0
Gerridae	.3	0	1	3	0	0	0
Belostomatidae	.3	0	0	0	0	0	0
Pleidae	0	0	0	3	0	0	2
MEGALOPTERA							
Sialidae							
Sialis spp.	0	.3	26	6	4	33	9
Corydalidae							
Corydalus spp.	0	0	0	0	4	0	0
TRICHOPTERA							
Hydropsychidae	.5	12.8	3	35	1290	33	32
Limnephilidae	0	3.5	0	6	4	0	0

Continued

Table A6. (Concluded)

Taxa	Drift	Wood	Habitat[1] A	B	C	D	E
Pupae Limnephilidae	0	5	0	0	0	0	4
Polycentropodidae	0	3	0	14	4	0	4
Helicopsychidae	0	1.5	0	0	0	0	0
COLEOPTERA							
Adult Elmidae							
Macronychus glabratus	0	30.5	0	16	0	0	0
Dubiraphia spp.	0	.3	3	19	11	0	0
Stenelmis spp.	0	.5	1	19	32	11	0
Elmidae							
Macronychus glabratus	0	2.8	0	0	0	0	0
Ancyronyx variegata	0	.5	0	0	0	0	0
Stenelmis spp.	0	.3	5	0	18	0	11
Dubiraphia spp.	0	0	35	16	0	141	6
Adult Dytiscidae							
Hydroporus spp.	0	.5	0	0	0	0	0
Gyrinidae							
Dineutus spp.	0	.3	0	0	0	0	2
Gyrinus spp.	0	0	0	3	0	0	7
Haliplidae							
Peltodytes spp.	0	0	0	3	0	0	0
Adult Chrysomelidae	0	0	0	0	0	0	2
LEPIDOPTERA							
Pyralidae							
Paraponyx spp.	0	0	0	3	0	0	9
DIPTERA							
Chironomidae	.8	6.5	108	14	226	272	222
Pupae Chironomidae	0	0	0	0	0	0	2
Simuliidae	1	0	0	11	136	87	411
Pupae Simuliidae	.3	0	0	0	0	0	24
Tipulidae	0	0	1	0	18	0	2
Ceratopogonidae	0	0	0	0	0	22	0

[1]Habitats were designated as follows: A = edge of stream without macrophytes; B = edge of stream with macrophytes; C = riffle; D = pools; E = sandy areas towards middle of stream.

Table A7. Abundance estimates for macroinvertebrates (numbers/m^2 for A - E; average number per sample for drift and wood) collected from the Red Cedar River, 9/21/80.

Taxa	Drift	Wood	Habitat[1] A	B	C	D	E
ISOPODA							
Ascellus spp.	0	0	22	0	0	0	0
AMPHIPODA							
Hyallela azteca	4	10.8	97	84	7	87	0
DECAPODA							
Orconectes spp.	0	0	1	0	0	0	0
TURBELLARIA	0	2.3	5	0	4	11	0
GASTROPODA	0	.3	33	38	11	54	0
PELECYPODA							
Sphaeriidae	0	0	28	10	7	22	46
OLIGOCHAETA	.3	0	1269	11	0	1239	26
HIRUDINEA	0	0	1	0	0	44	0
HYDRACARINA	.3	0	5	0	14	0	9
EPHEMEROPTERA							
Baetidae							
Baetis spp.	4.3	5	5	0	7	0	0
Cloeon spp.	.3	0	5	0	0	0	0
Pseudocloeon spp.	.5	.3	0	0	7	0	0
Tricorythidae							
Tricorythodes spp.	.8	2.5	14	14	0	11	0
Leptophlebiidae							
Paraleptophlebia spp.	6.8	0	12	17	0	11	0
Heptageniidae							
Stenonema spp.	0	1.8	0	0	25	0	2
Stenacron spp.	.5	.8	1	16	22	0	0
Heptagenia spp.	.3	0	0	0	0	0	0
Caenidae							
Caenis spp.	0	0	0	0	7	0	0
PLECOPTERA							
Perlidae	0	0	0	3	0	0	0

Continued

Table A7. (Continued)

Taxa	Drift	Wood	Habitat[1] A	B	C	D	E
ODONATA							
Coenagrionidae							
Enallagma spp.	.8	.3	3	19	4	0	0
Calopterygidae							
Calopteryx spp.	.3	0	0	30	0	0	0
Gomphidae							
Stylurus spp.	0	0	11	0	0	0	0
Gomphus spp.	0	0	0	0	0	11	0
Aeschidae							
Bayeria spp.	0	0	0	3	0	0	0
HEMIPTERA							
Corixidae	.3	0	1	0	0	0	0
Nepidae	.5	0	0	0	0	0	0
Belostamidae	0	0	0	6	0	0	0
HOMOPTERA							
Aphidae	0	0	3	0	0	0	0
MAGALOPTERA							
Sialidae							
Sialis spp.	.3	0	24	11	0	44	0
Corydalidae							
Corydalus spp.	0	0	0	0	4	0	0
TRICHOPTERA							
Pupae	0	0	0	0	18	0	0
Hydropsychidae	2.3	34.5	5	100	1179	0	9
Polycentropodidae	0	5	5	78	0	0	0
Philopotamidae	0	.5	0	0	0	0	0
Molannidae	0	.3	0	0	0	11	0
Phryganeidae	0	0	1	0	0	0	0
Psychomyiidae	0	0	0	0	4	0	0

Continued

Table A7. (Continued)

Taxa	Drift	Wood	Habitat[1] A	B	C	D	E
Leptoceridae	0	0	0	0	4	11	0
Glossosomatidae	0	0	0	0	39	0	0
COLEOPTERA							
Adult Elmidae							
Stenelmis spp.	0	3.3	0	14	29	0	0
Dubiraphia spp.	0	1.8	1	14	7	0	0
Macronychus glabratus	0	13.8	0	3	0	0	0
Ancyronyx variegata	0	0	0	3	0	0	0
Elmidae							
Stenelmis spp.	.5	2.5	0	11	39	0	17
Dubiraphia spp.	0	0	44	14	0	54	0
Macronychus glabratus	0	1	0	0	0	0	0
Ancyronyx variegata	0	.5	0	0	0	0	0
Psephemidae							
Psephenus spp.	0	0	0	3	4	0	0
Adult Carabidae	.3	0	0	0	0	0	0
Adult Nitidulidae	.3	0	0	0	0	0	0
Adult Gyrinidae							
Dineutus spp.	.3	0	0	0	0	0	0
Adult Haliplidae							
Haliplus spp.	.3	0	0	0	0	0	0
Adult Chrysomelidae	0	0	5	0	0	0	0
LEPIDOPTERA							
Pyralidae							
Paraponyx spp.	0	0	0	0	4	0	0
DIPTERA							
Chironomidae	7.3	9.3	32	148	158	32	26
Pupae Chironomidae	0	0	1	3	7	0	0
Simuliidae	1	1.3	0	62	86	0	4
Pupae Simuliidae	0	.3	0	3	43	0	0
Tipulidae	0	0	3	0	4	0	0

Continued

Table A7. (Concluded)

Taxa	Drift	Wood	Habitat[1] A	B	C	D	E
Tabaniidae	0	0	22	0	0	0	0
Ceratopogonidae	0	0	5	0	0	54	17
Adult Culicidae	0	0	5	0	0	0	0
Scatophagidae	0	0	0	8	0	0	0

[1]Habitats were designated as follows: A = edge of stream without macrophytes; B = edge of stream with macrophytes; C = riffle; D = pools; E = sandy areas towards middle of stream.

Table A8. Abundance estimates for macroinvertebrates (numbers/m^2 for A - E; average number per sample for drift and wood) collected from the Red Cedar River, 10/26/80.

Taxa	Drift	Wood	Habitat[1] A	B	C	D	E
ISOPODA	0	0	0	0	0	0	0
AMPHIPODA							
Hyallela azteca	.5	20.7	103	49	50	228	6
DECAPODA							
Orconectes spp.	0	0	5	0	0	0	0
TURBELLARIA	0	2.3	0	0	0	0	0
GASTROPODA	0	.8	49	0	4	54	0
ARANEAE	0	0	0	0	0	33	0
PELECYPODA							
Sphaeriidae	0	0	11	3	57	11	56
OLIGOCHAETA	0	0	359	11	25	739	30
HIRUDINEA	0	0	0	3	0	109	0
HYDRACARINA	0	0	0	0	0	0	0
EPHEMEROPTERA							
Baetidae							
Baetis spp.	.5	.5	0	0	7	0	0
Pseudocloeon spp.	0	0	0	0	18	0	0
Leptophlebiidae							
Leptophlebia spp.	0	.5	49	97	18	87	11
Paraleptophlebia spp.	0	0	190	97	11	0	4
Tricorythidae							
Tricorythodes spp.	0	.5	0	0	0	0	0
Heptageniidae							
Stenonema spp.	0	3.3	0	0	18	0	0
Stenacron spp.	0	1.5	11	0	11	0	0
Ephemeridae							
Hexagenia spp.	0	0	5	8	0	44	0
Caenidae							
Caenis spp.	0	0	0	0	0	11	0

Continued

Table A8. (Continued)

Taxa	Drift	Wood	Habitat[1] A	B	C	D	E
PLECOPTERA							
Taeniopterygidae							
Taeniopteryx spp.	.8	.3	174	19	412	348	110
Perlodidae							
Isoperla spp.	.3	0	0	0	0	0	0
Perlidae							
Perlinella spp.	0	.3	0	0	0	0	0
Acroneuria spp.	0	0	11	0	0	0	0
ODONATA							
Gomphidae							
Stylurus spp.	0	0	5	0	0	11	0
Gomphurus spp.	0	0	5	0	0	0	2
Aeshnidae							
Bayeria spp.	0	0	0	4	0	0	0
Calopterygidae							
Calopteryx spp.	0	0	0	8	0	0	0
Coenagrionidae							
Enallagma spp.	0	0	0	4	0	0	0
Argia spp.	0	0	0	0	29	0	0
HEMIPTERA							
Corixidae	.3	0	5	4	0	65	8
Belostomatidae	0	0	0	4	0	0	0
HOMOPTERA							
Psyllidae	0	.3	0	0	0	0	0
Aphidae	0	0	0	4	4	11	0
MEGALOPTERA							
Sialidae							
Sialis spp.	0	0	22	8	18	22	2
TRICHOPTERA							
Hydropsychidae	.8	27.8	7	0	391	109	56
Polycentropodidae	0	7.5	0	3	0	22	4
Leptoceridae	0	0	0	3	0	0	0

Continued

Table A8. (Concluded)

Taxa	Drift	Wood	Habitat[1] A	B	C	D	E
Limnephilidae	0	0	0	3	0	0	2
Brachycentridae	0	0	0	0	4	11	0
COLEOPTERA							
Adult Elmidae							
Stenelmis spp.	0	1.3	0	0	108	0	2
Dubiraphia spp.	0	.8	0	0	29	0	0
Macronychus glabratus	0	7	0	0	0	0	0
Elmidae							
Stenelmis spp.	0	0	0	0	18	0	6
Dubiraphia spp.	0	.3	16	6	0	11	2
Macronychus glabratus	0	.5	0	0	0	0	0
Ancyronyx variegata	0	.3	0	0	0	0	0
Adult Gyrinidae							
Dineutus spp.	.5	0	0	0	0	0	0
Adult Dytiscidae							
Liodessus spp.	.3	0	0	0	0	0	0
Psephenidae							
Psephenus spp.	0	0	0	0	4	0	2
LEPIDOPTERA	0	0	5	0	0	0	0
Pyralidae							
Paraponyx spp.	0	0	5	16	0	0	2
DIPTERA							
Chironomidae	.3	15	71	3	617	76	22
Simuliidae	.5	0	0	0	68	0	0
Tipulidae	0	0	0	0	0	0	4
Tabaniidae	0	0	5	0	0	0	0
Scatophagidae	0	0	0	3	0	0	0
Tipulidae	0	0	0	0	7	0	0
Ceratopogonidae	0	0	0	0	4	0	0
Stratiomyiidae	0	0	0	0	0	0	2

[1]Habitats were designated as follows: A = edge of stream without macrophytes; B = edge of stream with macrophytes; C = riffle; D = pools; E = sandy areas towards middle of stream

Table A9. Abundance estimates for macroinvertebrates (numbers/m^2 for A - E; average number per sample for drift and wood) collected from the Red Cedar River, 11/23/80.

Taxa	Drift	Wood	Habitat[1] A	B	C	D	E
ISOPODA	0	0	0	0	0	0	0
AMPHIPODA							
Hyallela azteca	0	34	130	174	11	163	0
DECAPODA							
Orconectes spp.	0	0	0	0	0	11	0
TURBELLARIA	0	1.3	0	0	0	0	0
GASTROPODA	0	.3	38	6	0	65	2
PELECYPODA							
Sphaeriidae	0	0	38	8	0	0	37
OLIGOCHAETA	0	0	196	6	7	196	22
HIRUDINEA	0	0	0	0	0	65	0
HYDRACARINA	0	0	28	0	0	0	0
EPHEMEROPTERA							
Leptophlebiidae							
Paraleptophlebia spp.	0	.3	49	30	4	11	0
Leptophlebia spp.	0	1	424	511	4	337	8
Heptageniidae							
Stenacron spp.	0	3	0	6	7	0	0
Stenonema spp.	0	1.8	7	0	18	0	11
Baetidae							
Baetis spp.	0	.5	0	0	0	0	0
Caenidae							
Caenis spp.	0	0	11	0	0	0	0
Ephemeridae							
Hexagenia spp.	0	0	11	6	0	0	0
Siphlonuridae							
Isonychia spp.	0	0	0	0	4	0	0

Continued

Table A9. (Continued)

Taxa	Drift	Wood	Habitat[1] A	B	C	D	E
PLECOPTERA							
Taeniopterygidae							
Taeniopteryx spp.	.5	1	132	62	50	217	19
Perlidae							
Acroneuria spp.	0	0	16	0	0	0	0
Perlinella spp.	0	0	5	3	0	0	0
ODONATA							
Gomphidae							
Gomphurus spp.	0	0	11	0	0	0	0
Gomphus spp.	0	0	5	0	0	0	0
Stylurus spp.	0	0	0	0	0	11	0
Coenagrionidae							
Enallagma spp.	0	0	7	16	0	0	0
Argia spp.	0	0	0	0	7	0	0
Calopterygidae							
Calopteryx spp.	0	0	0	8	0	11	0
HEMIPTERA							
Corixidae	.3	0	0	8	0	11	2
Pleidae	0	0	0	3	0	0	0
Nepidae	0	0	0	6	0	0	0
Belostomatidae	0	0	0	3	0	0	0
MEGALOPTERA							
Sialidae							
Sialis spp.	.3	0	38	30	0	65	0
TRICHOPTERA							
Hydropsychidae	0	23.8	45	19	298	65	22
Helicopsychidae	0	.5	3	0	11	11	0
Polycentropodidae	0	1.5	5	33	11	0	0
Limnephilidae	0	.3	141	22	0	76	0
Pupae Limnephilidae	0	0	0	0	0	0	2

Continued

Table A9. (Concluded)

Taxa	Drift	Wood	Habitat[1] A	B	C	D	E
Hydroptilidae	0	0	1	0	4	0	0
Pupae Helicopsychidae	0	0	0	0	0	0	17
COLEOPTERA							
Adult Elmidae							
Stenelmis spp.	0	.8	0	0	36	0	0
Dubiraphia spp.	0	2.8	0	8	0	0	0
Macronychus glabratus	0	.8	0	3	0	0	0
Elmidae							
Stenelmis spp.	0	0	8	0	7	11	2
Dubiraphia spp.	0	.8	27	8	0	0	17
Macronychus glabratus	0	.5	0	0	0	0	0
Adult Dytiscidae							
Liodessus spp.	0	.5	0	6	0	0	0
Psepheniidae							
Psephenus spp.	0	0	0	0	4	0	0
LEPIDOPTERA	0	0	0	0	0	0	0
DIPTERA							
Chironomidae	0	54.8	277	81	767	348	560
Pupae Chironomidae	0	0	0	0	4	0	0
Adult Chironomidae	0	0	0	0	0	0	8
Simuliidae	.8	0	0	0	7	0	2
Tipulidae	0	0	7	0	4	11	15
Pupae Tipulidae	0	0	1	0	0	0	0
Ceratopogonidae	0	0	16	0	0	44	148
Tabanidae	0	0	22	6	0	11	0
Scatophagidae	0	0	5	6	0	0	0

[1]Habitats were designated as follows: A = edge of stream without macrophytes; B = edge of stream with macrophytes; C = riffle; D = pools; E = sandy areas towards middle of stream

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