STREAMFLOW, WATER-QUALITY, AND BIOLOGICAL DATA ON STREAMS IN AN AREA OF LONGWALL COAL MINING, SOUTHERN OHIO, WATER YEARS 1987-89

By Alban W. Coen, III

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For additional information
write to:

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975 W. Third Avenue
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CONTENTS

ILLUSTRATIONS

TABLES

TABLES--Continued

CONVERSION FACTORS AND VERTICAL DATUM

Multiply	By	To obtain
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
square mile (mi^2)	2.590	square kilometer
gallon per minute (gal/min)	0.06309	liter per second

Degrees Celsius (°C) can be converted to degrees Fahrenheit (°F) by use of the following equation:

$$°F = 9/5 (°C + 32)$$

Sea level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929--a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

STREAMFLOW, WATER-QUALITY, AND BIOLOGICAL DATA ON STREAMS IN AN AREA OF LONGWALL COAL MINING, SOUTHERN OHIO, WATER YEARS 1987-89[1]

By Alban W. Coen, III

ABSTRACT

This report presents data on the first 3 years of a 5-year study of the effects of longwall coal mining on six streams near a mining complex in Meigs, Gallia, and Vinton Counties, Ohio. Longwall coal mining is a method of underground mining in which 75 to 90 percent of the coal is removed; conventional methods, such as room-and-pillar mining, remove only about 50 percent of the coal. Use of the longwall method is expected to increase in Ohio. Collapse or subsidence of the overburden and land surface occurs immediately after the removal of the coal. Such collapse can disrupt surface drainage and the recharge of ground water.

The data include streamflow, water quality, and the abundance and diversity of aquatic macroinvertebrates and fish. The data were collected from eight sites on six streams from July 1987 through September 1989. The drainage areas of these sites range from 2.04 to 80.8 square miles and include the major drainages of the area being mined.

Total precipitation in 1987 and 1988 in the study area was 78 and 81 percent, respectively, of the annual average (from 1939 to 1989) of 39.59 inches. The total precipitation in 1989 was 135 percent of the annual average. Streams at six of the eight sites were dry for parts of the first 2 years.

Specific conductance ranged from 180 to 3,500 microsiemens per centimeter at 25 degrees Celsius, pH ranged from 6.9 to 8.0, and the concentration of total recoverable iron ranged from 80 to 1,800 micrograms per liter. Macroinvertebrate and fish populations indicate a warmwater-habitat rating of fair to good according to Ohio Environmental Protection Agency standards.

This information will help provide a data base from which the effects of longwall mining on streams in southern Ohio can be evaluated. Correlations of surface-water quality and quantity with longwall mining were not attempted in this study.

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[1] Water year in U.S. Geological Survey reports is the 12-month period, October 1 through September 30. The water year is designated by the calendar year in which it ends. For example, the water year ending on September 30, 1980, is called the "1980 water year." Any year not specified as "water year" in this report is a calendar year.

INTRODUCTION

The responsibility of permitting and regulating coal mining in Ohio, including longwall mining, belongs to the Division of Reclamation of the Ohio Department of Natural Resources (ODNR). In 1987, the U.S. Geological Survey (USGS), in cooperation with the ODNR, began a 5-year study to determine the effects of longwall coal mining on streamflow, water quality, and biology of streams near an area of longwall coal mining in Meigs, Gallia, and Vinton Counties in southern Ohio.

Longwall coal mining is an efficient means of coal production that requires less time and personnel per ton of coal removed than do conventional methods of underground mining, such as the room-and-pillar method (Rauch, 1989). Many areas in the coal-mining region of Ohio are geologically suited for longwall mining, and its use is expected to increase.

Longwall mining causes immediate collapse or subsidence of the ground over the mined area. The hydrologic effects of this subsidence on nearby streams is not fully understood. Landowners near areas of longwall mining have complained of a reduction or loss of water in streams, farm ponds, and wells (Harry Payne, Ohio Department of Natural Resources, oral commun., 1987).

Purpose and Scope

This report presents the first 3 years of data for a 5-year study to determine the quantity and quality of water and the abundance and diversity of aquatic macroinvertebrates and fish at eight stream sites near an active longwall coal mine in southern Ohio. The report also describes the longwall mining technique, the study area, the precipitation during the 3-year data-collection period, and the study methodology. The discharge data in this report are from three continuous-record stations and five partial-record stations in the area of the mine, and from one continuous-record station in an adjacent unmined basin. The water-quality and biological data are from yearly samples or surveys at the eight sites.

Overview of Longwall Coal Mining

Conventional room-and-pillar mining can remove only about 50 percent of the coal in a seam because pillars are left to support the roof. Longwall mining is a method of underground mining that removes 75 to 90 percent of the coal from the coal seam, and the roof is allowed to collapse (Burgess and Niple, Ltd., 1986). Conventional room-and-pillar mining is commonly used first, and the area to be longwall mined is left intact in rectangular-shaped panels. The panels in southern Ohio are about 9,000 ft long and 1,000 ft wide.

The coal is mined by use of a shearer, which is moved continuously back and forth across the width of the longwall panel (fig. 1). Each pass of the shearer advances the working face about 18 in. The coal falls onto the stage loader and is carried to the surface.

The shearer and the operators are protected by a series of hydraulic roof supports. The roof supports advance as the working face progresses across the longwall panel, and the roof rocks and overburden collapse behind them. Room-and-pillar mines also can collapse; however, the collapse usually takes place years after the mines have been abandoned.

Four zones of disturbance associated with the collapse from longwall mining (Rauch, 1989)--caving, deep fracturing, aquiclude, and surface-rock fracturing--are shown in figure 2. The number and extent of these zones depend on the thickness and composition of the overburden.

The zone of caving is formed by the collapse of the roof and overburden and is 4 to 6 times as thick as the mined seam (fig. 2). This zone of caving has an increased porosity and permeability. Above the caved zone, new fractures can form, and existing fractures or joints can widen into the zone of deep fracturing. The zone of deep fracturing can extend upward as much as 60 times the mined thickness. Layers of rock can slide along bedding planes as the rocks sag. Competent rocks, such as limestone and sandstone, can fracture, whereas incompetent deposits such as shales and clays can deform. The aquiclude zone is above the zone of deep fracturing. In the aquiclude zone, rocks may be horizontally compressed, may have poor vertical permeability, and may not show any new fractures. At the surface, fractures due to tension can form above the margins of the panels, and compression joints can form above centers of the panels. These tension fractures and compression joints can increase the permeability of the rock. In time, precipitation can wash material into surface cracks and reseal the fissures (Rauch, 1989).

The surface expression of mine subsidence depends on the surface topography and the types and thickness of the overlying rocks and soil (Peng and Chiang, 1984). Subsidence of the surface in southern Ohio can be as much as 3 ft (Harry Payne, Ohio Department of Natural Resources, oral commun., 1987).

Subsidence associated with longwall mining can affect surface- and ground-water supplies. The length of time water supplies can be affected can range from days to years. Streams can be dewatered. Springs can dry up or be reduced in flow. New springs can form at lower elevations. Water levels in wells can be lowered, and aquifer permeabilities can be increased as a result of fracturing. Previous reports on longwall mining in the study area include those of Burgess and Niple (1986), Tieman and Rauch (1986), and Ground Water Associates, Inc. (1984).

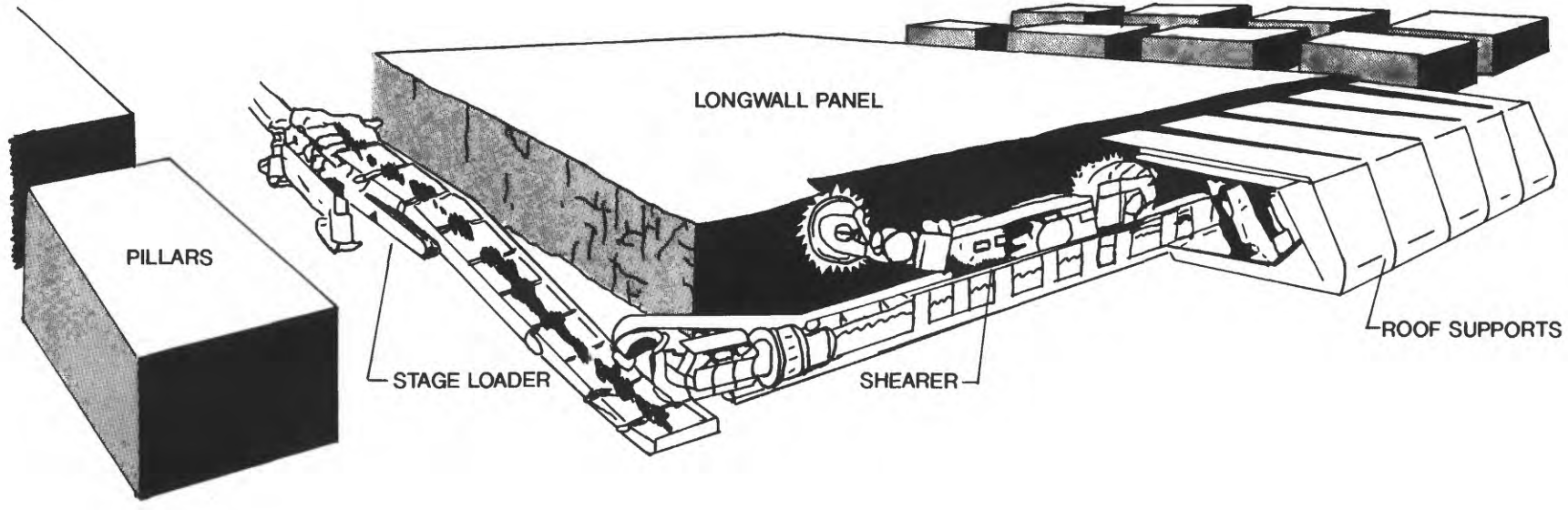


Figure 1.--Schematic diagram showing longwall-mining process from The Columbus Dispatch, January 24, 1988; reproduced by permission.

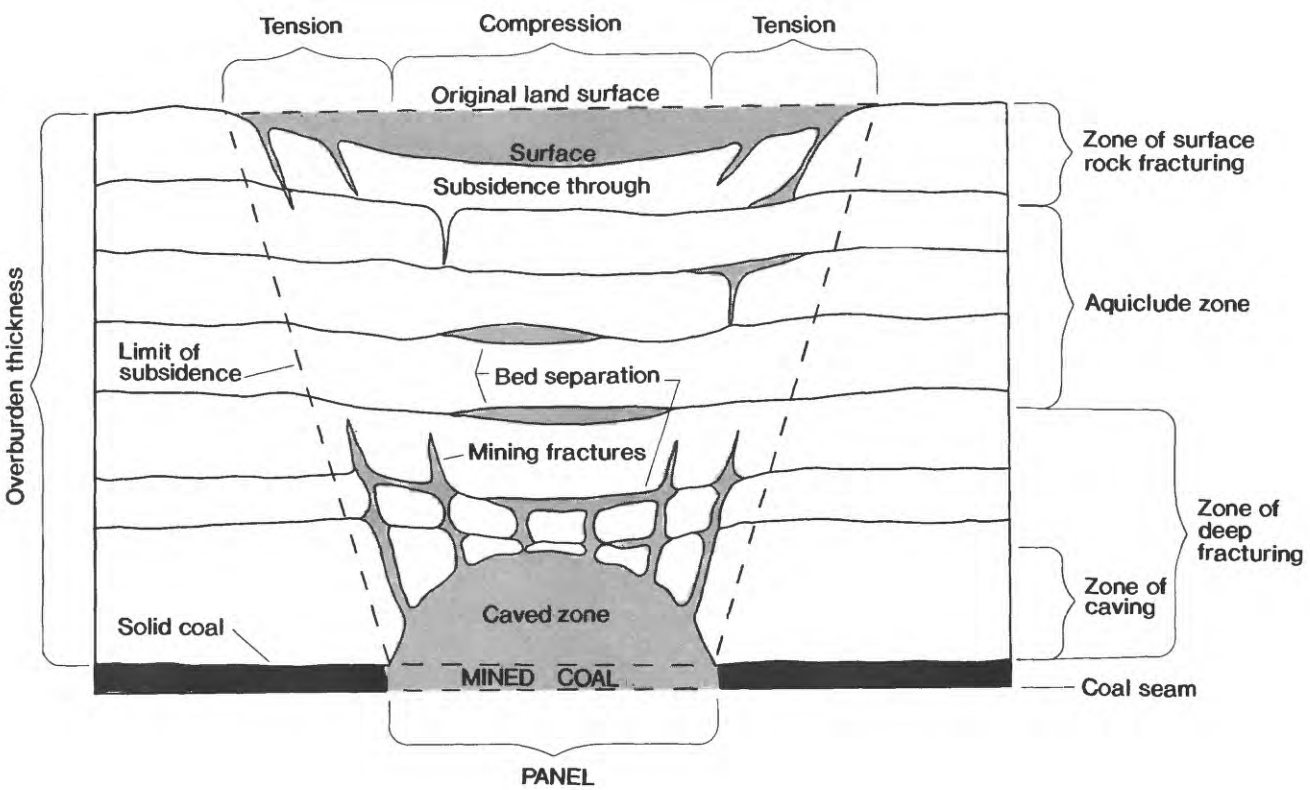


Figure 2.--Fracture zones in overburden above a longwall panel (modified from Rauch, 1989).

These reports note localized dewatering (sometimes of short duration) of streams and wells, and they suggest that longer studies are needed. Cifelli and Rauch (1986) and Shultz (1989) discuss dewatering of surface- and ground-water supplies near a longwall mining operation in West Virginia.

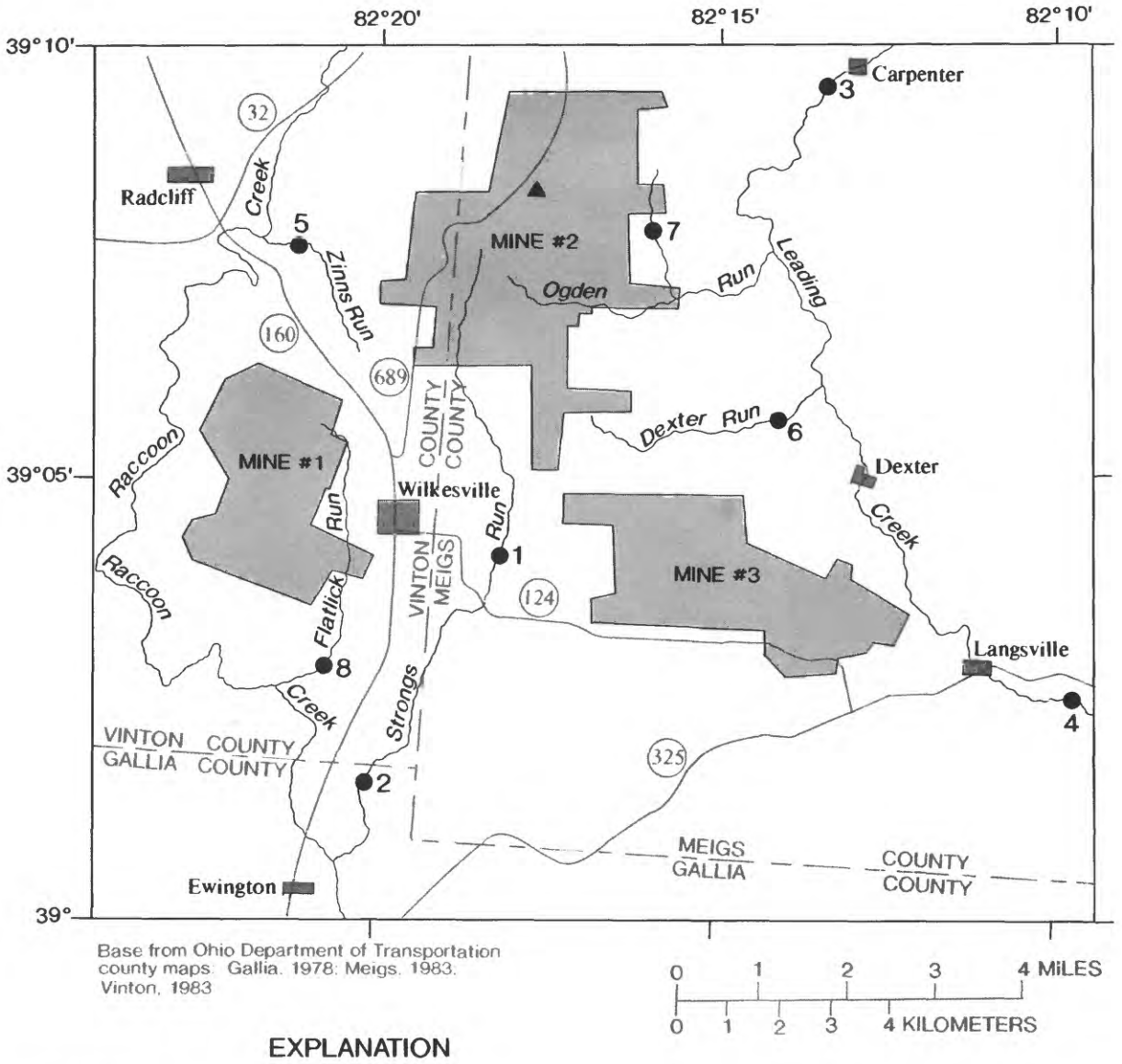
Description of the Study Area

The study area (fig. 3) encompasses about 400 mi^2 and includes parts of Meigs, Gallia, and Vinton Counties in southern Ohio. It includes three underground coal mines near Wilkesville, Ohio, an area of farms and forest. The study area is characterized by a dissected landscape of steep rounded hills and narrow, V-shaped valleys (Stout, 1927). Elevations range from 560 ft to more than 900 ft above sea level, and local relief averages about 200 ft. The area lies between, and is drained by, Raccoon and Leading Creeks. Both streams discharge into the Ohio River.

The rock in the area consists of Pennsylvanian sedimentary rocks that dip gently to the southeast. A generalized geologic column is shown in figure 4. The rocks contain repetitive sequences (or cyclothems) of sandstone, shale, claystone, limestone, and coal. The thicknesses and areal extent of individual members are not uniform; in other words, individual members may not underlie the entire study area. The hills and most of the valley floors are underlain by shales, sandstone, and limestone, all of the Conemaugh Formation, and contain little economically minable coal. The Conemaugh Formation is underlain by the Allegheny Formation, which contains several minable coals. The Clarion (number 4A) coal, for example, is mined in the study area. The coal is 50 to 450 ft below the surface, depending on the topography, and is usually 4 to 5 1/2 ft thick. The coal, however, is not present in all places. Sandstone members in the Conemaugh and Allegheny Formations form a series of stacked, perched aquifers. Seeps or springs form at sandstone outcrops. Yields from dug or drilled wells completed in the sandstone average about 4 gal/min (Ground Water Associates, Inc., 1984).

Precipitation during the Study Period

A general drought occurred in Ohio during the summers of 1987 and 1988. The spring and summer of 1989, on the other hand, were wet in most of Ohio. The average annual precipitation for the study area during 1931-89 is 39.59 in. (unpublished data, Southern Ohio Coal Company, 1990). Precipitation totals for 1987, 1988, and 1989 (table 1) were 79.8, 83.0, and 139 percent, respectively, of the average annual precipitation during 1931-89.



EXPLANATION

APPROXIMATE BOUNDARIES OF MINE COMPLEXES

LOCATIONS OF DATA-COLLECTION SITES

▲ Precipitation

● Streamflow and water quality

1 Strongs Run near Wilkesville
2 Strongs Run near Ewington
3 Leading Creek below Carpenter
4 Leading Creek near Langsville
5 Zinns Run near Radcliff
6 Dexter Run near Dexter
7 Unnamed Trib to Ogden Run near Carpenter
8 Flatlick Run near Wilkesville

Figure 3.--Study area and location of data-collection sites.

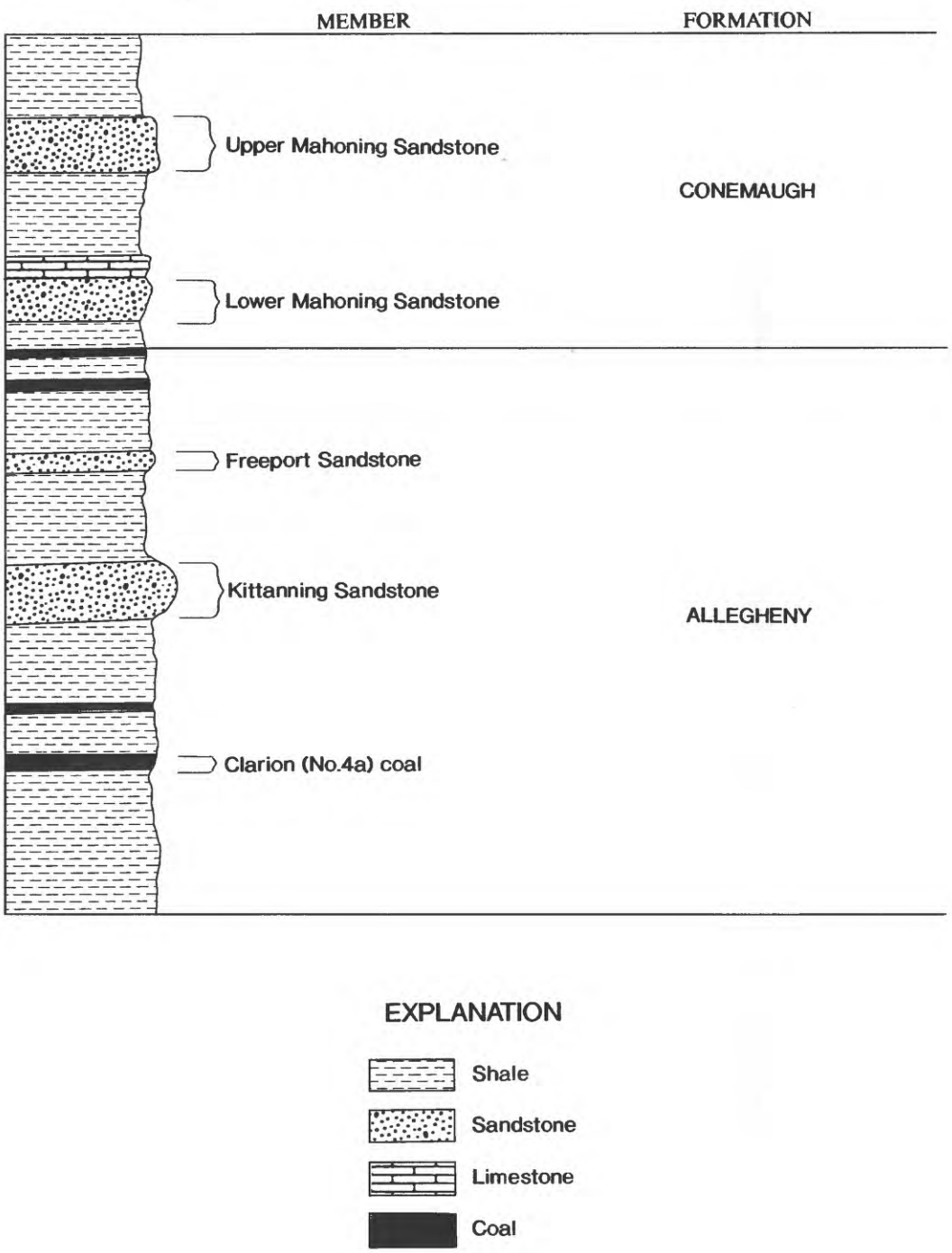


Figure 4.--Generalized geologic column for study area (thickness of members is variable, and all members are not present in all areas).

Table 1.--Selected precipitation data, Meigs County, Ohio

[Location of precipitation gage shown in figure 3. All data in inches. Unpublished data from Southern Ohio Coal Company]

Year	Monthly total												Departure from average	Annual total
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.		
1931-89 average--	2.97	2.49	3.62	3.54	3.94	4.14	4.37	3.84	2.99	2.33	2.64	2.72	0	39.59
1987------	1.70	1.07	3.20	3.87	2.18	2.18	4.34	3.39	2.47	1.29	2.30	3.61	-7.99	31.60
1988------	3.58	3.06	1.53	2.87	2.84	.23	3.31	3.10	2.57	2.05	4.20	3.52	-6.73	32.86
1989------	3.79	7.16	6.63	5.80	6.62	5.27	2.97	4.30	4.28	4.76	1.35	2.10	15.44	55.03

Acknowledgments

The author expresses thanks to the Ohio Department of Natural Resources Division of Reclamation for maps and assistance in establishing the study and to Jack Freda of the Ohio Environmental Protection Agency (OEPA) for biological sampling. Thanks are also expressed to the Southern Ohio Coal Company for data and to the landowners in the study area for access to their properties during this study.

METHODS OF STUDY

Streamflow was measured, and water-quality and biological samples were collected at eight sites (fig. 3). The sites were selected to include the major drainage basins in the mined areas. Drainage areas ranged from 2.04 to 80.8 mi^2 (table 2).

Streamflow Measurement

Streamflow-gaging stations equipped to collect continuous gage-height data were installed at three sites. Data collection at these three sites began in October 1987. Frequent streamflow measurements were made to develop a relation between gage height and streamflow. Although the gage height was recorded at Strongs Run near Ewington throughout the year, the stations at Zinns Run near Radcliff and at Leading Creek below Carpenter were not operated during the winter months of the 1989 water year. Measurement of instantaneous streamflow at the remaining five sites began in 1988. Periodic streamflow measurements were made during base flow, three times each in water years 1988 and 1989. A stream is at base flow when all or virtually all the water in a stream originates from ground-water discharge to the stream.

Streamflow also was measured at the USGS continuous-record streamflow-gaging station at Shade River near Chester, about 20 mi east of the study area (figure 5). The Shade River flows through terrain similar to that in the study area, except that the area near Chester contains no longwall mining. Streamflow in the mined area was compared with the streamflow from the unmined area. More than 20 years of streamflow record for the Shade River site was available at the date of writing.

Water-Quality Sampling

Water samples from each site were collected by use of the Office of Water Data Coordination (1977) in the spring of each year according to USGS sampling techniques. The pH, specific conductance, alkalinity, dissolved oxygen concentration, and temperature of each sample were determined in the field.

Table 2.--Characteristics of data-collection sites

Number and name of site	Latitude	Longitude	Drainage area	Type of data collected: Partial streamflow record	Type of data collected: Continuous - streamflow record	Type of data collected: Water quality
390413082180900 Strongs Run near Wilkesville[1]	39°04'13"N	82°18'09"W	5.60	X		X
03201947 Strongs Run near Ewington[1]	39°01'35"N	82°20'16"W	15.8		X	X
390545082135300 Dexter Run near Dexter[1]	39°05'45"N	82°13'53"W	7.60	X		X
03160007 Leading Creek below Carpenter[1]	39°09'44"N	82°13'12"W	13.3		X	X
390222082092200 Leading Creek near Langsville[1]	39°02'22"N	82°09'22"W	80.8	X		X
03201929 Zinns Run near Radcliff[1][1]	39°07'39"N	82°21'08"W	3.41		X	X
390248082204100 Flatlick Run near Wilkesville[1]	39°02'48"N	82°20'41"W	7.00	X		X
390759082155100 Unnamed Tributary to Ogden Run near Carpenter[1]	39°07'59"N	82°15'51"W	2.04	X		X
03159540 Shade River near Chester[2] (Index station)[1]	39°03'49"N	81°52'55"W	156		X	X

[1] Continuous discharge data collected from May through October each year.

[2] This station is in an area similar to the study area but does not contain longwall mining.

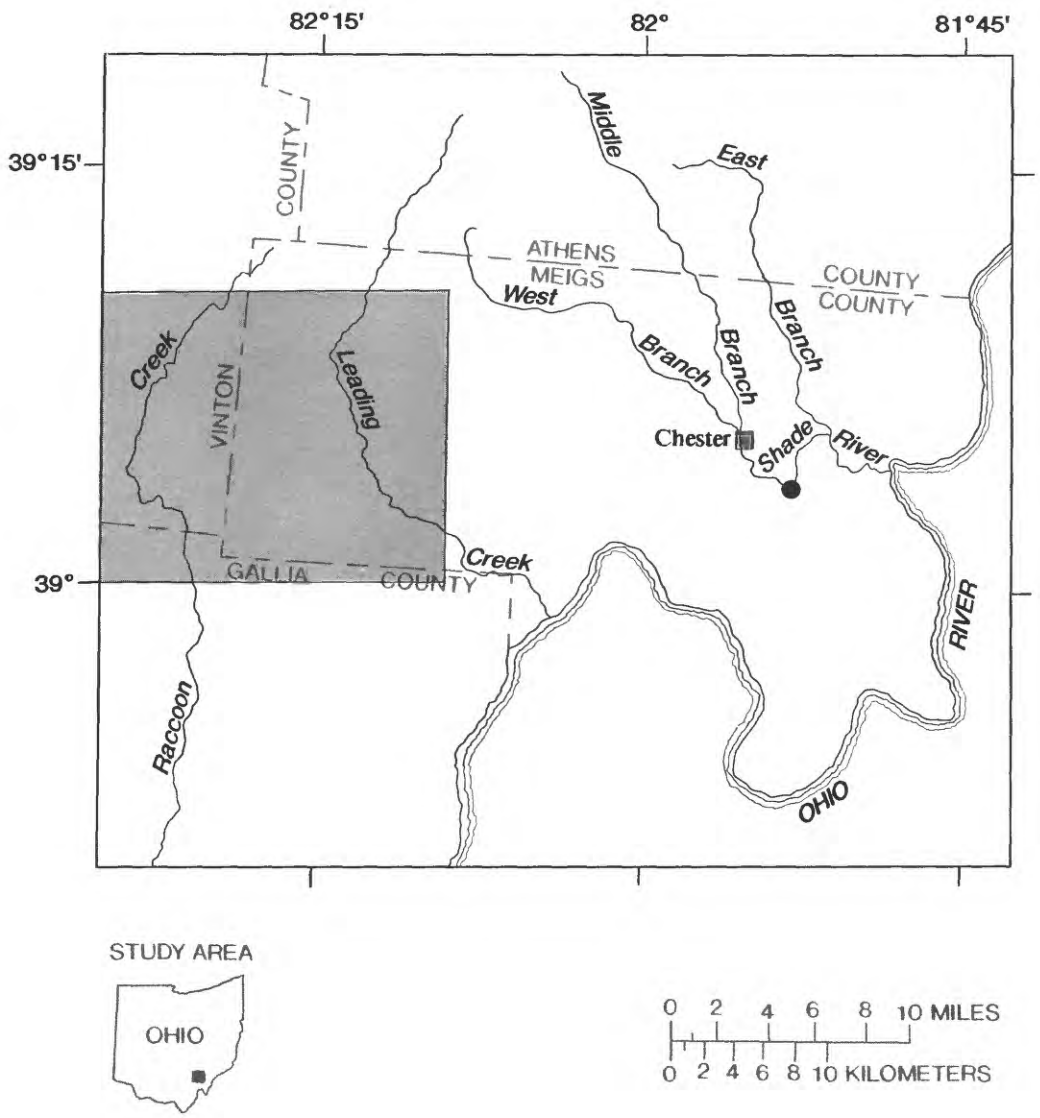


Figure 5.—Location of gaging station at Shade River near Chester, Ohio, in relation to study area.

Concentrations of dissolved and total iron, dissolved and total manganese, dissolved and total aluminum, and dissolved sulfate were determined at the USGS National Water Quality Laboratory (Fishman and Friedman, 1989).

Streams were dry and were not sampled at three of the eight sites in 1987. All eight sites were sampled in 1988. Streams at two sites were dry and were not sampled in 1989.

Collection of Stream-Biology Data

The abundance and diversity of aquatic macroinvertebrates (such as insects, crayfish, and worms) in the stream channel were inventoried by personnel from the OEPA. Hester-Dendy Multiplate[2] samplers were placed on the streambeds in shallow water at each of the sites yearly in late spring. The samplers are a series of 3-inch-square fiberboard plates that function as an artificial substrate to which aquatic organisms can attach. The samplers were retrieved 6 weeks later, and any attendant macroinvertebrate organisms were preserved with alcohol (Ohio Environmental Protection Agency, 1987).

When the samplers were retrieved, an additional sample of macroinvertebrates from rocks, weeds, and substrate in the stream channel was collected by use of nets and scrapers. Stream conditions and a description of the surrounding habitat were recorded at each site (Ohio Environmental Protection Agency, 1987).

The macroinvertebrate samples were examined in the OEPA Division of Water Quality, Planning and Assessment laboratory, where they were identified and counted (Ohio Environmental Protection Agency, 1989a). An Invertebrate Community Index (ICI) value was determined for each sample. ICI values are determined by comparison of the abundance and diversity of the species found in the sample with data from reference sites of varying water quality. The ICI value can be compared with ICI values for other streams in the OEPA Western Allegheny Plateau ecoregion (of which these streams are a part) and can be used as a general indicator of water quality (Ohio Environmental Protection Agency, 1987, 1989b). ICI values above 36 indicate good warmwater habitat, values from 11 to 36 indicate fair habitat, and values below 11 indicate poor habitat.

In 1987, six of the eight samplers were unable to be analyzed because the streams dried up before the samplers were retrieved. In 1988, in anticipation of continuing dry weather, the samplers were installed earlier in the spring. All plates

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[2] Use of brand names in this report is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.

were recovered. The organisms were at a younger stage of development than is ideal for identification and for comparison with other samples in the OEPA's data base. In 1989, two of the eight samplers were buried by shifts in streambeds.

The abundance and diversity of fish in the streams at the eight sites were inventoried by personnel from ODNR, Division of Natural Areas and Preserves. Fish were collected by use of a 1,750-watt electroshocker, nets, and seines, and were identified, counted, and returned to the stream. Fish counts were made only in 1987.

STREAMFLOW DATA

Daily mean streamflows at the three gaged sites and at Shade River near Chester are presented in table 4 (at back of report); instantaneous discharges for the remaining five sites are listed in table 3. Streams at six of the eight sites were dry for parts of the 1987 and 1988 water years.

A comparison of monthly mean streamflows for water years 1987-89 with mean monthly streamflows for 25 years of record for Shade River near Chester, Ohio indicates that streamflows were below average for most of 1987 and 1988 and that streamflows in most of 1989 were above average (fig. 6).

These abnormal precipitation and streamflow conditions could make it difficult to determine changes in streamflow, water quality, and biology resulting from longwall mining during these years.

WATER-QUALITY DATA

Water-quality analyses for the eight sites are listed in table 5 (at back of report). Streams at some sites were nearly dry or dry during 1987 and (or) 1988. Specific conductance ranged from 156 to 3,500 µS/cm. The pH ranged from 6.9 to 8.0. Concentration of total recoverable iron ranged from 80 to 1,800 µg/L. Concentration of dissolved sulfate ranged from 15 to 1,500 mg/L. Concentration of dissolved aluminum ranged from less than 10 to 50 µg/L. Concentration of dissolved manganese ranged from 30 to 2,200 µg/L.

BIOLOGICAL DATA

The Invertebrate Community Index (ICI) values for each of the sites are shown in figure 7. The ICI values ranged from 16 to 40. Two samples indicated "good" warmwater habitat in 1989.

Table 3.--Instantaneous streamflows at study sites, 1987-89

[mi^2, square miles; ft^3/s, cubic feet per second]

Site number	Site name	Drainage area (mi^2)	Date	Streamflow (ft^3/s)
390545082135300	Dexter Run near Dexter	7.60	July 21, 1987	0
			May 25, 1988	2.02
			June 23, 1988	0
			July 12, 1988	0
			August 3, 1989	<.01
			September 21, 1989	.28
390248082204100	Flatlick Run near Wilkesville	7.00	July 21, 1987	.04
			October 8, 1987	.01
			May 26, 1988	1.09
			June 22, 1988	<.10*
			July 13, 1988	0
			August 3, 1989	.15
			September 21, 1989	.58
390222082092200	Leading Creek near Langsville	80.8	July 21, 1987	.33
			October 8, 1987	.04
			May 26, 1988	15.94
			June 23, 1988	8.26
			July 13, 1988	<.10*
			August 3, 1989	6.04
			September 21, 1989	9.59
390413082180900	Strongs Run near Wilkesville	5.60	July 21, 1987	0
			May 25, 1988	2.63
			June 22, 1988	0
			July 13, 1988	0
			August 3, 1989	0
			September 21, 1989	.99
390759082155100	Unnamed Tributary to Ogden Run near Carpenter	2.04	July 21, 1987	0
			May 25, 1988	.40
			June 22, 1988	0
			July 13, 1988	0
			August 3, 1989	<.01
			September 21, 1989	.051

*Estimate

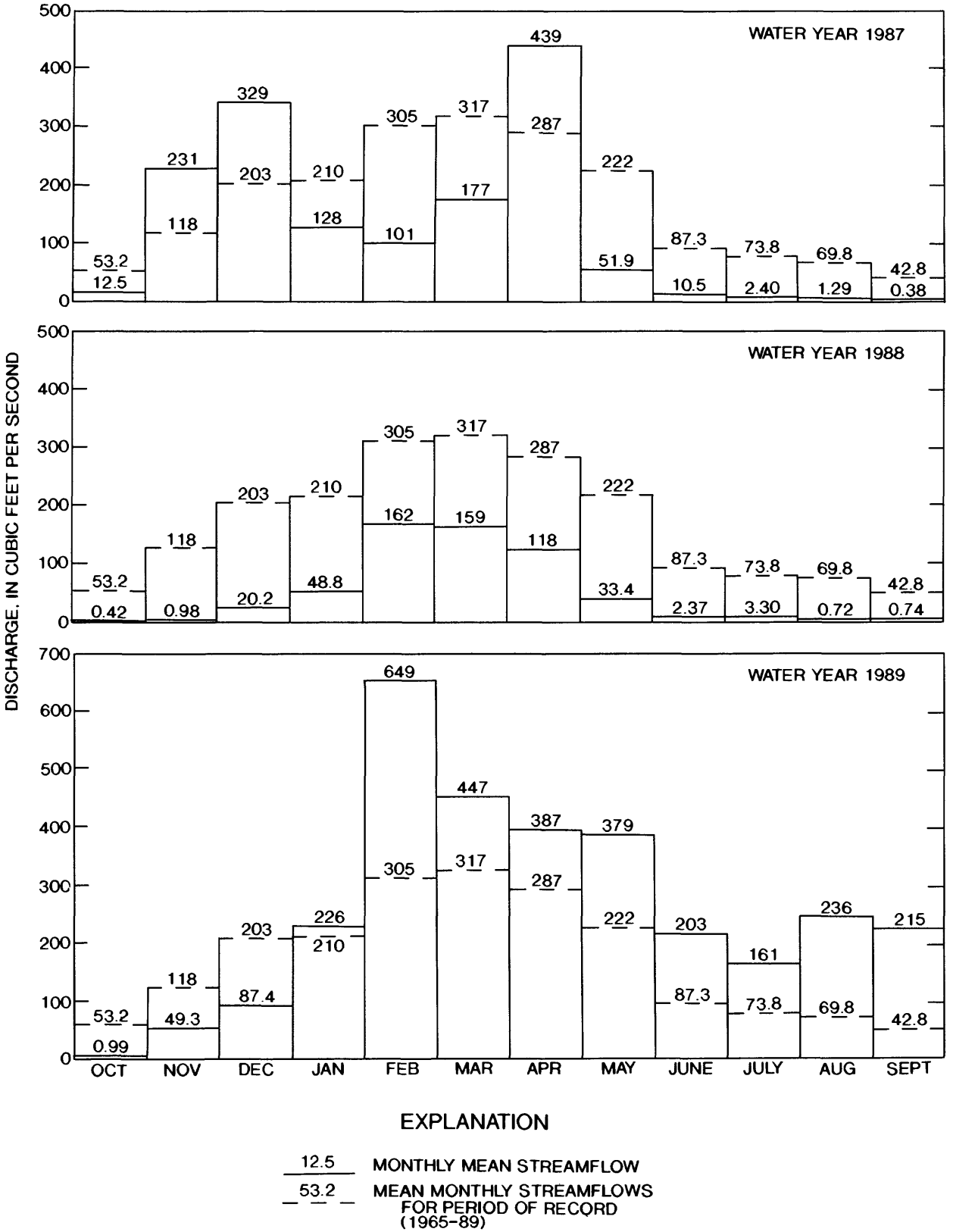

Figure 6.--Monthly streamflows of Shade River near Chester, Ohio, water years 1987-89.

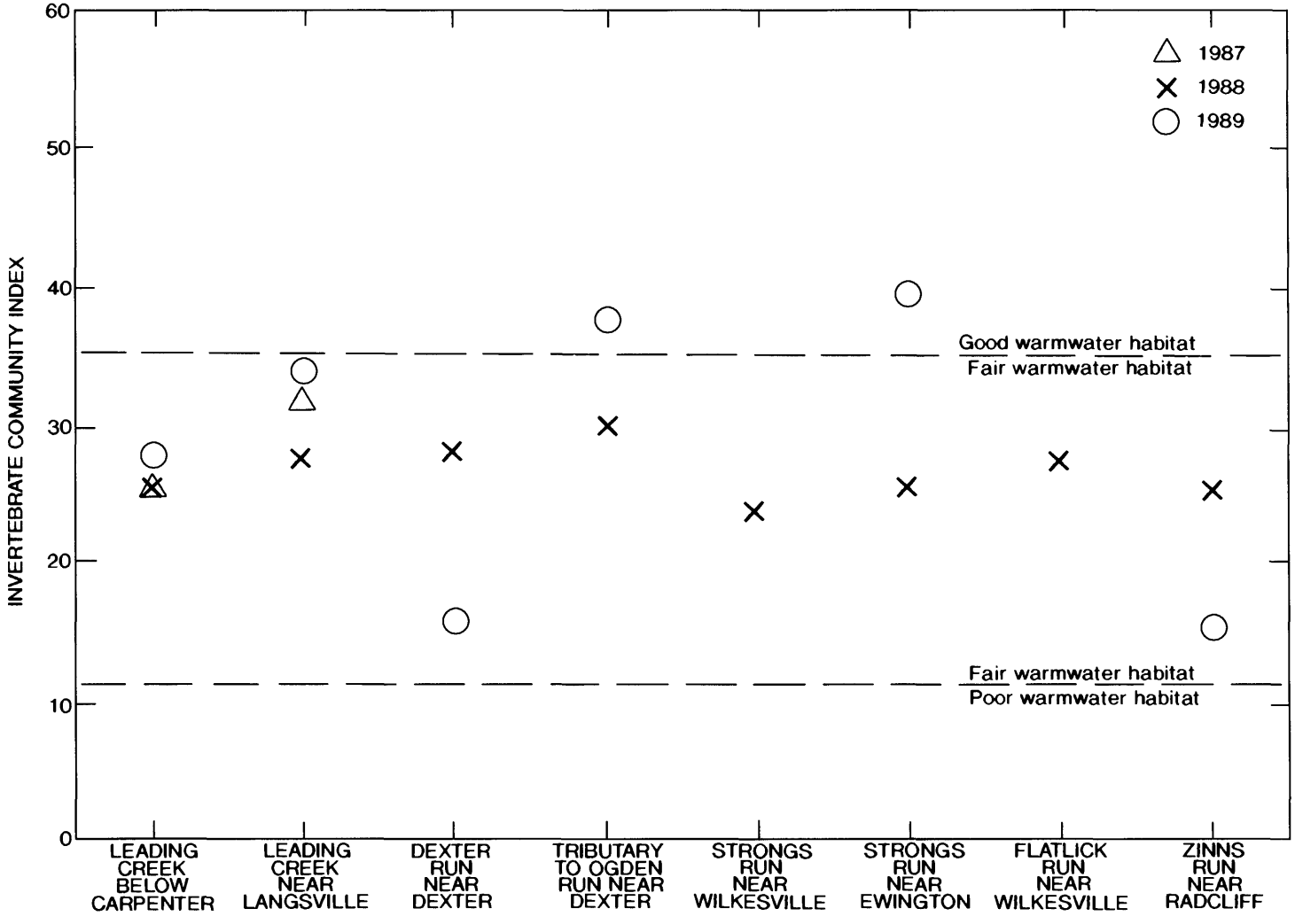

Figure 7.--Invertebrate Community Indexes at study sites, water years 1987-89 (as calculated by methods in Ohio Environmental Protection Agency, 1987).

The remaining 1989 samples and all the samples from 1987 and 1988 indicated "fair" warmwater habitat. The range in the 1989 sample (16-40) could be attributed to the variable effect of sediment-laden water, which could affect the ability of macroinvertebrates to attach to the samplers.

The number of fish species identified at each site ranged from 8 to 29. The total number of individual fish counted at each site ranged from 30 to 965.

Macroinvertebrate species found at each site are listed in table 6 (at back of report). Fish species found at each site are listed in table 7 (at back of report).

SUMMARY

Data on streamflow, water quality, and abundance and diversity of macroinvertebrates and fish were collected at eight sites during the first 3 years of a 5-year study of the effects of longwall coal mining on streams near an active mining complex in southern Ohio. The data collected are the beginnings of a data base documenting streamflow, stream-water quality, and stream biology of eight streams in an area of longwall coal mining. Eventually, these data will provide a base from which the effects of longwall mining on streams in southern Ohio can be determined. Correlations between streamflow, stream-water quality, and stream biology and longwall mining have not been attempted.

Precipitation in 1987, 1988, and 1989 was 80, 83, and 139 percent, respectively, of the 39.59-in. average for the study area. Several streams were dry for periods in 1987 and 1988.

Specific conductance ranged from 180 to 3,500 µS/cm. The pH ranged from 6.9 to 8.0. Concentration of total recoverable iron ranged from 80 to 1,800 µg/L. Concentration of dissolved sulfate ranged from 15 to 1,500 mg/L. Concentration of dissolved aluminum ranged from less than 10 to 50 µg/L. Concentration of dissolved manganese ranged from 30 to 2,200 µg/L.

The ICI values for macroinvertebrates ranged from 16 to 40. Two samples in 1989 indicated "good" warmwater habitat. The remaining 1989 samples and all the samples from 1987 and 1988 indicated "fair" warmwater habitat. The number of fish species identified for sites in the study area ranged from 8 to 29. The total number of individual fish counted at each site ranged from 30 to 965.

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Table 4.--Daily mean streamflows at study sites, water years 1988-89

[Dashes indicate no data available]

Day	Daily mean streamflow, in cubic feet per second, water year 1988 (October 1987 to September 1988), mean values											
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
				03201947 STRONGS RUN NEAR EWINGTON, OHIO								
1	0.00	0.00	0.00	1.9	2.8	1.6	4.1	2.9	0.69	0.21	0.00	0.00
2	.00	.00	.00	1.9	246	1.3	4.0	2.6	.62	.20	.00	.00
3	.00	.00	.00	1.8	70	2.3	5.0	2.4	.56	.18	.00	.00
4	.00	.00	.00	1.2	54	189	98	2.2	.54	.15	.00	.00
5	.00	.00	.00	.80	23	98	22	2.5	.56	.11	.00	.00
6	.00	.00	.00	.50	2.5	22	15	4.3	.51	.06	.00	.00
7	.00	.00	.00	.31	4.0	22	16	3.5	.48	.01	.00	.00
8	.00	.00	.00	.28	8.1	39	14	2.9	.48	.00	.00	.00
9	.00	.00	.00	.27	6.9	22	11	2.7	.47	.00	.00	.00
10	.00	.00	.00	.25	5.9	8.5	9.5	3.3	.48	.25	.00	.00
11	.00	.00	.01	.24	5.3	6.9	8.4	2.7	.47	.30	.00	.00
12	.00	.00	.00	.23	5.2	6.5	7.2	2.2	.45	.23	.00	.00
13	.00	.00	.00	.22	4.1	12	6.2	1.9	.46	.20	.00	.00
14	.00	.00	.05	.22	2.0	9.2	5.2	1.9	.61	.18	.00	.00
15	.00	.00	.53	.21	3.7	7.6	4.4	1.8	.41	.16	.00	.00
16	.00	.00	.96	1.1	3.2	6.8	3.9	1.6	.34	.07	.00	.00
17	.00	.00	.94	1.5	2.7	6.4	3.7	1.4	.33	.00	.00	.00
18	.00	.00	.85	2.1	2.3	6.3	7.1	1.2	.32	.00	.00	.00
19	.00	.00	.82	3.8	2.9	8.1	10	1.2	.30	.00	.00	.00
20	.00	.00	1.1	37	5.8	7.1	7.2	1.1	.30	.16	.00	.00
21	.00	.00	1.2	11	4.2	6.0	6.3	1.1	.30	.30	.00	.00
22	.00	.00	1.1	7.1	3.5	5.3	6.3	1.8	.30	.20	.00	.00
23	.00	.00	1.1	5.1	3.7	5.0	6.6	1.6	.28	.18	.00	.00
24	.00	.00	1.1	3.7	3.4	4.9	5.5	11	.27	.16	.00	.00
25	.00	.00	1.4	3.2	2.9	4.6	4.8	5.4	.24	.11	.00	.00
26	.00	.00	7.7	2.4	2.2	5.5	4.4	3.0	.24	.05	.00	.00
27	.00	.00	5.3	2.2	2.3	5.3	1.9	1.9	.22	.02	.00	.00
28	.00	.00	3.4	2.0	2.1	4.5	3.6	1.4	.20	.00	.00	.00
29	.00	.00	2.7	1.9	1.8	4.5	3.6	1.1	.19	.00	.00	.00
30	.00	.00	2.2	2.0	--	4.1	3.2	.92	.21	.00	.00	.00
31	.00	--	1.9	2.2	--	4.0	--	.75	--	.00	.00	--
Total	0.00	0.00	34.36	98.63	486.5	536.3	308.1	76.27	11.83	3.49	0.00	0.00
Mean	.000	.000	1.11	3.18	16.8	17.3	10.3	2.46	.39	.11	.000	.000
Maximum	.00	.00	7.7	37	246	189	98	11	.69	.30	.00	.00
Minimum	.00	.00	.00	.21	1.8	1.3	1.9	.75	.19	.00	.00	.00

Table 4.--Daily mean streamflows at study sites, water years 1988-89--Continued

Day	Daily mean streamflow, in cubic feet per second, water year 1989 (October 1988 to September 1989), mean values											
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
	03201947 STRONGS RUN NEAR EWINGTON, OHIO--Continued											
1	0.00	0.00	0.50	15	5.7	19	84	104	6.1	6.5	0.18	3.3
2	.00	.00	.34	15	5.4	15	37	81	4.9	5.2	.15	5.2
3	.00	.00	.28	10	80	13	36	50	4.6	6.3	.14	1.9
4	.00	.00	.25	8.4	56	12	89	30	6.5	28	.14	1.2
5	.00	.01	.22	7.3	30	345	107	64	127	153	.20	1.0
6	.00	.02	.18	20	17	300	36	36	32	16	.28	.95
7	.00	.02	.13	19	11	80	28	25	14	9.4	.21	.98
8	.00	.02	.11	61	9.9	40	25	19	9.1	6.7	.18	1.0
9	.00	.00	.09	22	7.4	25	28	126	11	5.1	.17	1.1
10	.00	.00	.09	12	6.4	20	19	122	9.4	3.4	.17	1.1
11	.00	.00	.09	9.4	5.8	17	15	40	6.5	2.6	.12	1.1
12	.00	.00	.09	151	5.2	13	12	27	7.4	2.4	.10	1.1
13	.00	.00	.09	63	5.0	12	11	23	10	2.3	.10	1.1
14	.00	.00	.09	23	4.8	10	9.3	51	8.9	1.9	.10	1.3
15	.00	.00	.09	74	4.5	9.8	9.7	154	17	1.4	.10	2.7
16	.00	.00	.09	46	600	8.1	9.2	56	21	1.0	.10	2.1
17	.00	.00	.13	35	300	7.6	8.0	30	13	.74	.10	3.8
18	.00	.00	.10	25	60	9.2	8.6	20	8.0	.64	.15	2.1
19	.00	.07	.09	17	20	9.5	104	15	6.9	1.5	.19	1.5
20	.00	40	.08	11	18	21	26	12	214	3.3	.19	1.2
21	.00	25	.09	7.6	195	155	17	12	33	1.2	.66	1.1
22	.00	4.9	.50	5.4	54	37	13	9.0	24	.70	.29	6.2
23	.00	1.8	3.8	5.0	25	22	10	13	16	.45	11	158
24	.00	1.1	108	5.7	18	17	8.8	16	10	.34	19	134
25	.00	.84	43	5.4	15	14	9.0	23	7.3	.29	9.5	25
26	.00	.75	11	5.2	18	11	745	187	6.2	.19	3.3	10
27	.00	.68	8.2	7.8	24	10	198	42	4.6	.15	1.4	5.4
28	.00	.68	15	6.4	20	9.0	542	19	87	.40	1.7	4.3
29	.00	.90	16	5.6	--	16	593	14	16	.23	4.7	3.7
30	.00	.68	9.7	5.6	--	200	371	11	8.8	.17	115	3.2
31	.00	--	7.8	7.0	--	251	--	7.8	--	.24	5.8	--
Total	0.00	77.47	226.22	710.8	1621.1	1728.2	3208.6	1438.8	750.2	261.74	175.42	386.63
Mean	.000	2.58	7.30	22.9	57.9	55.7	107	46.4	25.0	8.44	5.66	12.9
Maximum	.00	40	108	151	600	345	745	187	214	153	115	158
Minimum	.00	.00	.08	5.0	4.5	7.6	8.0	7.8	4.6	.15	.10	.95

Table 4.--Daily mean streamflows at study sites, water years 1988-89--Continued

Daily mean streamflow, in cubic feet per second, water year 1988 (October 1987 to September 1988), mean values

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
					201929 ZINNS RUN NEAR RADCLIFF, OHIO							
1	0.00	0.00	0.00	0.63	1.6	0.73	0.00	0.64	0.18	0.05	0.00	0.00
2	.00	.00	.00	.65	53	.72	.00	.59	.18	.05	.00	.00
3	.00	.00	.00	.52	29	1.9	15	.56	.18	.05	.00	.00
4	.00	.00	.00	.40	30	67	59	.54	.17	.05	.00	.00
5	.00	.00	.00	.36	18	280	17	.87	.16	.02	.00	.00
6	.00	.00	.00	.32	13	654	7.5	1.4	.15	.00	.00	.00
7	.00	.00	.00	.28	13	680	6.4	1.0	.14	.00	.00	.00
8	.00	.00	.00	.26	9.0	401	4.7	.81	.13	.00	.00	.00
9	.00	.00	.00	.23	4.4	11	3.4	.81	.13	.00	.00	.00
10	.00	.00	.00	.21	1.2	2.3	2.6	.70	.14	.06	.00	.00
11	.00	.00	.00	.20	.99	1.6	2.0	.55	.11	.09	.00	.00
12	.00	.00	.00	.19	1.3	1.7	1.7	.51	.13	.13	.00	.00
13	.00	.00	.00	.18	1.3	3.3	1.4	.48	.17	.05	.00	.00
14	.00	.00	.00	.13	1.1	2.0	1.3	.50	.20	.05	.00	.00
15	.00	.00	.00	.12	1.2	1.4	1.1	.42	.15	.04	.00	.00
16	.00	.00	.00	.21	1.0	.98	.94	.35	.11	.00	.00	.00
17	.00	.00	.00	.45	.96	.74	1.2	.29	.08	.00	.00	.00
18	.00	.00	.00	.81	.97	.83	2.0	.26	.08	.00	.00	.00
19	.00	.00	.00	2.6	1.5	1.1	3.3	.30	.07	.00	.00	.00
20	.00	.00	.00	9.5	3.0	.69	2.5	.33	.07	.05	.00	.00
21	.00	.00	.00	2.2	1.9	.37	2.0	.33	.07	.09	.00	.00
22	.00	.00	.00	1.3	1.6	.21	1.6	.38	.07	.06	.00	.00
23	.00	.00	.00	1.0	1.5	.16	1.5	.85	.07	.04	.00	.00
24	.00	.00	.00	.84	1.3	.11	1.6	1.6	.06	.04	.00	.00
25	.00	.00	.00	.71	1.1	.07	1.3	.60	.06	.03	.00	.00
26	.00	.00	2.3	.69	1.1	.12	1.1	.38	.06	.00	.00	.00
27	.00	.00	.78	.62	1.0	.03	.96	.29	.05	.00	.00	.00
28	.00	.00	.62	.51	.87	.00	.86	.24	.05	.00	.00	.00
29	.00	.00	.57	.52	.81	.00	.85	.22	.05	.00	.00	.00
30	.00	.00	.46	.53	--	.00	.73	.19	.05	.00	.00	.00
31	.00	--	.43	.52	--	.00	--	.18	--	.00	.00	--
Total	0.00	0.00	5.16	27.69	196.70	2114.06	145.54	17.17	3.32	0.95	0.00	0.00
Mean	.000	.000	.17	.89	6.78	68.2	4.85	.55	.11	.031	.000	.000
Maximum	.00	.00	2.3	9.5	53	680	59	1.6	.20	.13	.00	.00
Minimum	.00	.00	.00	.12	.81	.00	.00	.18	.05	.00	.00	.00

Table 4.--Daily mean streamflows at study sites, water years 1988-89--Continued

Day	Daily mean streamflow, in cubic feet per second, water year 1989 (October 1988 to September 1989), mean values											
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
	03201929 ZINNS RUN NEAR RADCLIFF, OHIO--Continued											
1	0.00	0.00	--	--	--	--	201	310	1.4	1.3	0.00	1.4
2	.00	.00	--	--	--	--	201	412	1.8	1.1	.00	1.3
3	.00	.00	--	--	--	--	117	162	1.3	3.7	.00	.74
4	.00	.00	--	--	--	--	29	6.8	1.2	2.9	.00	.49
5	.00	.00	--	--	--	--	15	12	8.8	2.5	.00	.38
6	.00	.00	--	--	--	--	7.4	7.1	3.4	1.6	3.8	.29
7	.00	--	--	--	--	--	6.0	5.4	1.9	1.2	55	.23
8	.00	--	--	--	--	--	5.7	4.4	1.4	.88	94	.21
9	.00	--	--	--	--	--	5.8	25	1.7	.67	50	.12
10	.00	--	--	--	--	--	4.2	19	1.2	.56	.29	.09
11	.00	--	--	--	--	--	3.5	12	.98	.45	.00	.11
12	.00	--	--	--	--	--	2.9	7.3	1.3	.41	.00	.08
13	.00	--	--	--	--	--	2.2	5.8	1.5	.83	.00	.03
14	.00	--	--	--	--	--	1.9	5.5	1.3	.47	.00	.12
15	.00	--	--	--	--	--	2.0	11	7.5	.21	.00	.37
16	.00	--	--	--	--	--	1.7	8.0	5.3	.15	.00	.44
17	.00	--	--	--	--	--	1.5	5.6	2.9	.09	.00	.52
18	.00	--	--	--	--	--	2.7	4.3	1.7	.04	.00	.26
19	.00	--	--	--	--	--	19	3.4	1.5	.46	.00	.16
20	.00	--	--	--	--	--	5.5	3.0	34	.53	.00	.11
21	.00	--	--	--	--	31	3.8	5.3	6.0	.20	.43	.06
22	.00	--	--	--	--	9.9	2.8	3.2	7.5	.10	.78	.57
23	.00	--	--	--	--	5.2	2.1	7.0	3.8	.03	3.5	13
24	.00	--	--	--	--	4.0	1.8	8.3	2.5	.00	2.0	3.7
25	.00	--	--	--	--	3.3	2.2	4.9	1.7	.00	1.3	1.8
26	.00	--	--	--	--	2.7	83	26	1.3	.00	.67	1.2
27	.00	--	--	--	--	2.1	116	65	2.0	.00	.43	.79
28	.00	--	--	--	--	1.9	87	102	8.6	.09	.28	.66
29	.00	--	--	--	--	13	195	77	2.7	.00	.20	.57
30	.00	--	--	--	--	28	285	6.6	1.7	.00	3.8	.51
31	.00	--	--	--	--	106	--	1.9	--	.00	.79	--
Total	0.00	--	--	--	--	--	1413.7	1336.8	119.88	20.47	217.27	30.31
Mean	.000	--	--	--	--	--	47.1	43.1	4.00	.66	7.01	1.01
Maximum	.00	--	--	--	--	--	285	412	34	3.7	94	13
Minimum	.00	--	--	--	--	--	1.5	1.9	.98	.00	.00	.03

Table 4.--Daily mean streamflows at study sites, water years 1988-89--Continued

Daily mean streamflow, in cubic feet per second, water year 1988 (October 1987 to September 1988), mean values

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
				03160007 LEADING CREEK BELOW CARPENTER, OHIO								
1	0.00	0.00	48	1.9	2.2	1.7	3.6	2.0	22	0.78	2.0	0.00
2	.00	.00	48	2.3	170	1.5	3.7	1.7	17	.62	1.7	.00
3	.00	.00	48	1.6	38	3.6	20	1.5	16	.48	1.4	.02
4	.00	.00	49	.90	50	171	164	1.2	16	.35	1.2	.15
5	.00	.00	57	.82	18	64	32	1.9	14	.25	1.0	.04
6	.00	.00	52	.70	15	30	23	4.4	11	.14	1.1	.01
7	.00	.00	50	.62	15	19	28	2.6	9.4	.06	1.1	.00
8	.00	.01	50	.54	9.9	14	22	1.8	8.3	.02	.93	.00
9	.00	.23	49	.47	3.4	12	14	1.6	7.5	.00	.73	.00
10	.00	3.4	50	.42	2.4	13	11	1.5	7.0	.00	.58	.00
11	.00	16	51	.37	2.2	9.3	8.5	1.1	6.7	.00	.41	.00
12	.00	25	52	.35	2.7	8.5	6.9	.84	6.0	.00	.29	.00
13	.00	31	51	.34	2.7	21	5.8	.71	5.5	.00	.25	.00
14	.00	35	51	.33	2.3	13	5.0	.68	5.2	.00	.24	.00
15	.00	37	55	.32	2.6	9.7	4.5	.84	4.8	.00	.13	.00
16	.00	38	60	.45	2.8	8.3	4.0	.41	4.4	.00	.11	.00
17	.00	39	58	.49	3.3	7.7	3.8	.39	4.0	.00	.04	.00
18	.00	43	56	1.7	2.1	8.3	16	.33	3.7	.00	.01	.00
19	.00	46	55	18	4.8	15	15	.47	3.4	.00	.04	.00
20	.00	46	57	46	17	11	8.2	.58	3.2	.22	.12	.00
21	.00	46	58	8.6	8.1	7.6	6.3	.91	2.9	2.5	.05	.00
22	.00	45	58	3.6	5.1	5.9	7.1	1.1	2.7	13	.01	.00
23	.00	41	57	2.3	4.8	5.2	7.5	1.6	2.5	9.2	.04	.07
24	.00	40	56	1.6	4.6	4.8	6.6	6.9	2.3	6.5	.08	.26
25	.00	40	60	1.2	3.4	4.5	5.1	3.2	2.1	5.0	.02	2.5
26	.00	41	45	1.1	2.4	7.9	4.4	1.6	1.8	4.3	.00	5.0
27	.00	43	6.9	1.1	2.0	6.6	3.7	1.1	1.5	3.9	.00	4.7
28	.00	45	4.1	.74	1.9	5.0	3.3	1.9	1.3	3.4	.00	4.1
29	.00	46	3.5	.43	1.9	4.4	3.1	15	1.1	3.0	.00	3.6
30	.00	47	1.9	.49	--	3.9	2.5	28	.96	2.6	.00	3.1
31	.00	--	1.2	.51	--	3.4	--	23	--	2.4	.00	--
Total	0.00	793.64	1398.6	100.29	400.6	500.8	448.6	110.86	194.26	58.72	13.58	23.55
Mean	.000	26.5	45.1	3.24	13.8	16.2	15.0	3.58	6.48	1.89	.44	.78
Maximum	.00	47	60	46	170	171	164	28	22	13	2.0	5.0
Minimum	.00	.00	1.2	.32	1.9	1.5	2.5	.33	.96	.00	.00	.00

Table 4.--Daily mean streamflows at study sites, water years 1988-89--Continued

Day	Daily mean streamflow, in cubic feet per second, water year 1989 (October 1988 to September 1989), mean values											
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
			03160007	LEADING CREEK BELOW CARPENTER, OHIO--Continued								
1	2.8	5.4	1.3	--	--	--	46	43	4.8	6.0	1.2	12
2	2.5	5.1	1.1	--	--	--	23	36	3.9	4.0	.68	12
3	2.3	4.7	1.0	--	--	--	23	24	3.6	4.7	.63	4.9
4	2.0	4.6	.90	--	--	--	71	18	3.6	6.9	.60	2.9
5	1.7	20	.80	--	--	--	57	43	75	6.3	28	1.9
6	1.4	35	.70	--	--	--	24	24	31	5.0	28	1.5
7	1.3	19	.60	--	--	--	18	19	9.7	3.0	5.5	1.3
8	1.1	14	.54	--	--	--	16	16	5.8	2.2	2.8	1.1
9	.99	6.0	.46	--	--	--	17	100	6.3	1.6	1.6	1.0
10	.89	3.2	.40	--	--	--	12	62	8.6	1.3	.98	.77
11	.82	1.7	.36	--	--	--	9.6	48	4.3	1.2	.64	.82
12	.74	.98	.31	--	--	--	8.1	33	6.4	59	.50	.80
13	.64	1.2	.27	--	--	--	7.0	22	45	17	.38	.65
14	.55	.98	.24	--	--	--	6.2	21	38	8.4	.38	.83
15	.49	1.1	--	--	--	--	6.6	40	62	3.4	.33	2.3
16	.42	1.2	--	--	--	--	6.6	29	39	2.1	.30	4.5
17	.40	.90	--	--	--	--	5.3	21	19	1.5	.29	16
18	.51	.60	--	--	--	--	6.7	17	11	1.1	.62	3.3
19	.49	2.5	--	--	--	--	62	13	7.7	3.4	1.1	2.1
20	.42	7.0	--	--	--	--	17	11	58	6.8	.60	1.6
21	.51	5.5	--	--	--	--	11	19	19	2.5	20	1.1
22	.66	5.0	--	--	--	--	8.0	12	12	1.6	6.1	22
23	.66	2.7	--	--	--	--	6.5	27	8.7	1.1	124	133
24	.88	2.0	--	--	--	--	5.6	33	5.8	.85	90	24
25	4.4	1.5	--	--	--	--	6.5	14	4.2	.79	25	9.4
26	6.9	1.7	--	--	--	--	135	139	13	.62	9.7	6.2
27	6.5	1.8	--	--	--	--	75	30	5.0	1.5	5.3	3.4
28	6.0	2.0	--	--	--	--	152	18	222	11	3.6	2.6
29	5.5	1.7	--	--	--	--	134	10	24	2.6	3.0	2.1
30	5.4	1.5	--	--	--	--	46	8.6	10	1.2	57	2.0
31	5.4	--	--	--	--	--	--	6.3	--	1.7	8.3	--
Total	65.27	160.56	--	--	--	--	1021.7	956.9	766.4	170.36	427.13	278.07
Mean	2.11	5.35	--	--	--	--	34.1	30.9	25.5	5.50	13.8	9.27
Maximum	6.9	35	--	--	--	--	152	139	222	59	124	133
Minimum	.40	.60	--	--	--	--	5.3	6.3	3.6	.62	.29	.65

Table 4.--Daily mean streamflows at study sites, water years 1988-89--Continued

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
	Daily mean streamflow, in cubic feet per second, water year 1988 (October 1987 to September 1988), mean values											
				03159540 SHADE RIVER NEAR CHESTER, OHIO								
1	0.46	0.63	2.1	23	46	32	48	34	8.6	0.46	1.1	0.36
2	.41	.69	3.1	24	901	28	49	29	7.3	.45	1.4	.36
3	.38	.70	2.4	14	1280	33	50	26	6.0	.42	1.1	.41
4	.31	.70	3.5	9.4	634	764	687	26	5.2	.47	.93	1.1
5	.24	.70	3.8	6.8	440	1590	585	71	5.1	1.9	.86	1.4
6	.25	.70	5.5	5.2	143	392	205	99	4.7	.31	.89	1.2
7	.39	.82	4.9	4.0	100	211	200	79	3.9	.30	.95	.98
8	.54	.85	3.9	3.8	66	133	205	57	3.3	.31	1.1	.86
9	.63	1.3	3.3	3.6	54	104	138	46	2.8	.30	.99	.75
10	.50	2.3	3.2	3.5	47	97	99	43	2.6	.30	.96	.66
11	.45	3.2	3.1	3.4	42	82	81	39	2.2	.46	.89	.59
12	.39	1.8	4.2	3.3	40	72	69	32	2.0	.46	.76	.55
13	.39	1.1	3.8	3.3	38	120	59	26	1.8	.40	.63	.67
14	.39	.80	3.6	3.3	37	130	53	22	1.6	.37	.56	.58
15	.39	.68	4.9	3.2	36	92	48	20	1.4	.37	.55	.51
16	.38	.63	5.0	3.2	35	77	43	19	1.2	.42	.60	.52
17	.34	.72	6.6	4.4	35	70	39	16	1.4	.40	.54	.63
18	.31	1.0	6.1	13	37	67	57	13	1.2	.44	.57	.61
19	.31	.92	4.9	47	46	81	202	12	1.1	.75	.59	.57
20	.39	.77	5.1	509	123	82	104	18	.87	1.8	.66	.76
21	.41	.60	5.6	285	110	70	72	26	.80	42	.64	.73
22	.39	.50	8.5	123	67	59	63	31	.80	27	.62	.64
23	.41	.48	8.5	86	66	54	68	26	.81	7.2	.61	.67
24	.43	.49	6.5	69	65	51	61	47	.80	3.3	.62	.78
25	.43	.56	11	59	55	48	54	62	.68	1.9	.51	.87
26	.43	.73	167	45	44	75	49	40	.64	1.4	.46	.85
27	.46	.84	162	37	44	85	45	24	.59	1.1	.45	.86
28	.48	.85	70	27	40	71	41	17	.54	.96	.41	.84
29	.50	1.4	50	24	36	60	41	14	.54	.84	.43	.82
30	.56	2.1	34	30	--	55	39	12	.53	4.1	.42	.97
31	.63	--	21	37	--	49	--	9.8	--	1.5	.39	--
Total	12.98	29.56	627.1	1512.4	4707	4934	3554	1035.8	71.00	102.39	22.19	22.10
Mean	.42	.99	20.2	48.8	162	159	118	33.4	2.37	3.30	.72	.74
Maximum	.63	3.2	167	509	1280	1590	687	99	8.6	42	1.4	1.4
Minimum	.24	.48	2.1	3.2	35	28	39	9.8	.53	.30	.39	.36

Table 4.--Daily mean streamflows at study sites, water years 1988-89--Continued

Day	Daily mean streamflow, in cubic feet per second, water year 1989 (October 1988 to September 1989), mean values											
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
	03159540 SHADE RIVER NEAR CHESTER, OHIO--Continued											
1	0.93	0.64	16	113	61	169	1010	488	75	100	80	189
2	.84	.72	14	184	54	142	431	543	62	74	56	244
3	.76	.75	11	108	432	127	319	357	52	61	41	153
4	.68	.79	9.3	81	739	124	309	235	58	100	31	105
5	.62	20	8.7	54	279	480	688	387	100	101	77	76
6	.57	35	7.6	138	182	2350	431	444	492	75	306	59
7	.54	20	6.8	286	134	2490	299	265	126	70	152	49
8	.52	9.2	6.0	281	91	447	242	197	80	46	84	41
9	.48	7.6	5.4	360	77	271	245	308	71	36	54	36
10	.46	5.6	4.7	145	79	219	212	1390	99	33	36	30
11	.49	4.6	4.2	97	60	191	162	524	70	64	26	37
12	.50	3.7	3.7	553	55	160	136	346	55	423	21	29
13	.45	4.4	3.2	707	53	133	119	283	148	211	17	24
14	.39	3.7	3.3	367	959	121	105	286	153	208	14	47
15	.36	4.0	4.2	1770	2900	115	98	618	155	80	12	157
16	.36	4.5	5.1	554	4640	104	99	805	368	48	15	264
17	.36	3.7	6.3	208	1860	88	89	375	218	34	41	445
18	4.6	3.4	5.0	137	406	95	82	231	116	27	81	161
19	1.8	4.8	4.3	107	261	159	440	168	84	128	176	97
20	1.9	492	4.3	89	199	139	340	143	320	187	110	67
21	2.4	460	19	76	1690	1070	178	203	276	82	93	48
22	2.2	117	61	56	1640	604	134	148	155	45	333	89
23	1.7	75	91	51	407	265	110	265	165	30	1040	1780
24	1.4	49	653	56	223	194	95	495	101	26	1520	1370
25	.95	33	1030	55	155	165	85	264	92	38	508	284
26	.96	24	184	54	168	138	635	479	378	24	229	183
27	.75	21	92	64	196	119	542	886	138	374	144	131
28	.72	24	87	65	174	106	667	244	1240	1750	106	101
29	.66	26	175	56	--	103	2060	152	481	286	85	86
30	.63	21	108	60	--	1310	1250	118	151	133	1250	74
31	.64	--	76	68	--	1660	--	94	--	103	571	--
Total	30.62	1479.10	2709.1	7000	18174	13858	11612	11741	6079	4997	7309	6456
Mean	.99	49.3	87.4	226	649	447	387	379	203	161	236	215
Maximum	4.6	492	1030	1770	4640	2490	2060	1390	1240	1750	1520	1780
Minimum	.36	.64	3.2	51	53	88	82	94	52	24	12	24

Table 5.--Water quality at study sites, water years 1987-89

[ft^3/s, cubic feet per second; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degrees Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter]

Date	Stream-flow, instan-taneous (ft^3/s)	Spe-cific con-duc-tance (µS/cm)	pH	Temper-ature, water (°C)	Oxygen, dis-solved (mg/L)	Alka-linity, field (mg/L as $CaCO_3$)	Sul-fate, dis-solved (mg/L as SO_4)
	03160007 LEADING CREEK BELOW CARPENTER, OHIO						
MAY 1988							
26...	1.7	525	7.9	12.5	8.2	158	87
AUG 1989							
03...	0.45	460	7.7	16.5	5.7	80	58
	03201929 ZINNS RUN NEAR RADCLIFF, OHIO						
MAY 1988							
25...	0.49	260	7.3	13.0	9.3	42	50
	03201947 STRONGS RUN NEAR EWINGTON, OHIO						
MAY 1988							
26...	3.0	215	7.5	14.0	8.8	41	68
AUG 1989							
04...	0.18	220	7.9	19.0	6.2	78	25

tab5head

Table 5.--Water quality at study sites, water years 1987-89--Continued

Date	Stream-flow, instan-taneous (ft^3/s)	Spe-cific con-duc-tance ($\mu S/cm$)	pH	Temper-ature, water (°C)	Oxygen, dis-solved (mg/L)	Alka-linity, field (mg/L as $CaCO_3$)	Sul-fate, dis-solved (mg/L as SO_4)
390222082092200 LEADING CREEK NEAR LANGSVILLE, OHIO							
JUL 1987 21...	0.33	1060	7.7	24.5	--	110	270
OCT 1987 08...	0.04	1850	7.9	10.0	--	122	550
MAY 1988 26...	16	440	7.8	16.0	9.1	73	48
AUG 1989 03...	6.0	3500	7.7	17.0	10.2	96	1500
390248082204100 FLATLICK RUN NEAR WILKESVILLE, OHIO							
JUL 1987 21...	0.04	180	7.6	25.5	--	45	15
OCT 1987 08	0.01	156	7.2	9.5	--	36	19
MAY 1988 26...	1.09	220	7.2	12.5	9.2	33	87
AUG 1989 04...	0.15	1750	6.9	18.0	6.0	39	22
390413082180900 STRONGS RUN NEAR WILKESVILLE, OHIO							
JUL 1987 21...	0.0	--	--	--	--	--	--
MAY 1988 25...	2.6	180	7.3	14.0	10.5	24	110

tab5head

Table 5.--Water quality at study sites, water years 1987-89--Continued

Date	Stream-flow, instan-taneous (ft^3/s)	Spe-cific con-duc-tance (µS/cm)	pH	Temper-ature, water (°C)	Oxygen, dis-solved (mg/L)	Alka-linity, field (mg/L as $CaCO_3$)	Sul-fate, dis-solved (mg/L as SO_4)
390545082135300 DEXTER RUN NEAR DEXTER, OHIO							
JUL 1987							
21...	0.0	--	--	--	--	--	--
MAY 1988							
25	2.02	295	7.5	16.0	10.0	59	49
AUG 1989							
03...	<0.01	570	7.3	17.0	--	105	130
390759082155100 UNNAMED TRIBUTARY TO OGDEN RUN NEAR CARPENTER, OHIO							
JULY 1987							
21...	0.0	--	--	--	--	--	--
MAY 1988							
25...	0.40	380	8.0	18.5	9.5	85	53
AUG 1989							
03...	<0.01	400	7.3	17.0	5.4	111	61

tab5head

Table 5.--Water quality at study sites, water years 1987-89--Continued

Date	Aluminum, total recoverable (µg/L)	Aluminum, dissolved (µg/L)	Iron, total recoverable (µg/L)	Iron, dissolved (µg/L)	Manganese, total recoverable (µg/L)	Manganese, dissolved (µg/L)
03160007 LEADING CREEK BELOW CARPENTER, OHIO						
MAY 1988 26...	20	20	1300	80	490	430
AUG 1989 03...	490	20	990	60	410	400
03201929 ZINNS RUN NEAR RADCLIFF, OHIO						
MAY 1988 25...	160	40	550	160	150	140
03201947 STRONGS RUN NEAR EWINGTON, OHIO						
MAY 1988 26...	190	30	600	60	180	160
AUG 1989 04...	40	<10	1200	370	1100	1200
390222082092200 LEADING CREEK NEAR LANGSVILLE, OHIO						
JUL 1987 21...	490	50	760	90	450	340
OCT 1987 08...	170	<10	450	120	670	690
MAY 1988 26...	140	50	510	110	150	140
AUG 1989 03...	280	30	830	50	790	330

tab5head

Table 5.--Water quality at study sites, water years 1987-89--Continued

Date	Aluminum, total recoverable (µg/L)	Aluminum, dissolved (µg/L)	Iron, total recoverable (µg/L)	Iron, dissolved (µg/L)	Manganese, total recoverable (µg/L)	Manganese, dissolved (µg/L)
390248082204100 FLATLICK RUN NEAR WILKESVILLE, OHIO						
JUL 1987 21...	240	10	1300	200	740	720
OCT 1987 08...	130	<10	940	160	210	100
MAY 1988 26...	130	30	300	40	40	30
AUG 1989 04...	130	10	1800	280	2400	2200
390413082180900 STRONGS RUN NEAR WILKESVILLE, OHIO						
JUL 1987 21...	--	--	--	--	--	--
MAY 1988 25...	650	20	80	40	230	180
390545082135300 DEXTER RUN NEAR DEXTER, OHIO						
JUL 1987 21...	--	--	--	--	--	--
MAY 1988 25	180	<10	910	130	210	200
AUG 1989 03...	160	20	600	90	1200	1100

tab5head

Table 5.--Water quality at study sites, water years 1987-89--Continued

Date	Aluminum, total recoverable (µg/L)	Aluminum, dissolved (µg/L)	Iron, total recoverable (µg/L)	Iron, dissolved (µg/L)	Manganese, total recoverable (µg/L)	Manganese, dissolved (µg/L)
390759082155100 UNNAMED TRIBUTARY TO OGDEN RUN NEAR CARPENTER, OHIO						
JULY 1987						
21...	--	--	--	--	--	--
MAY 1988						
25...	150	10	1000	190	850	830
AUG 1989						
03...	350	10	780	80	330	660

Table 6.--Macroinvertebrate identification and abundance data at study sites, 1987-89

[biological data collected by the Ohio Environmental Protection Agency from 1987 through 1989 at the eight sites shown in figure 3]

Collection date: 07/06/89
River code:[1] 09-200
River: Leading Creek
River mile: 26.0

Taxa code[2]	Taxa	Quantity/ Quality[3]
01320	*Hydra* sp.	4
03360	*Plumatella* sp.	1
03600	*Oligochaeta*	90+
07820	*Cambarus (Cambarus) bartonii cavatus*	0+
07850	*Cambarus (Lacunicambarus) diogenes diogenes*	1
08200	*Orconectes* sp.	1+
08601	*Hydracarina*	2
11100	*Baetis* sp.	0+
13580	*Stenonema tripunctatum*	26+
15000	*Paraleptophlebia* sp.	66
45400	*Trichocorixa* sp.	0+
47600	*Sialis* sp.	20
51001	*Polyc bentropodidae*	4
52200	*Cheumatopsyche* sp.	0+
53501	*Hydroptilidae*	0+
68708	*Dubiraphia vittata*	0+
68901	*Macronychus glabratus*	0+
74100	*Simulium* sp.	1+
77120	*Ablabesmyia mallochi*	23
77500	*Conchapelopia* sp.	8+
77750	*Hayesomyia senata*	23
77800	*Helopelopia* sp.	8+
79400	*Zavrelimyia* sp.	23
80410	*Cricotopus (C.)* sp.	8
80420	*Cricotopus (C.) bicinctus*	8
80430	*Cricotopus (C.) tremulus* group	8
82050	*Symposiocladius* sp.	0+
82141	*Thienemanniella* prob. *xena*	0+
82730	*Chironomus decorus* group	8+
82820	*Cryptochironomus* sp.	16
83000	*Dicrotendipes* sp.	8
83040	*Dicrotendipes neomodestus*	16
83840	*Microtendipes pedellus* group	16
84210	*Paratendipes albimanus*	125+
84302	*Phaenopsectra* Type 2	8
84450	*Polypedilum (P.) convictum*	0+
84460	*Polypedilum (P.) fallax* group	101
84520	*Polypedilum (Tripodura) halterale* group	0+
85500	*Paratanytarsus* sp.	156
85615	*Rheotanytarsus distinctissimus* group	0+
85625	*Rheotanytarsus exiquus* group	16+
85814	*Tanytarsus glabrescens* group	62
85840	*Tanytarsus guerlus* group	16
98600	*Sphaerium* sp.	1

No. Quality Taxa: 27 — No. organisms 874
No. Quality Taxa: 21 — ICI: 28
Total Taxa: 44

1

2 Ohio Environmental Protection Agency code for the river.

3 Ohio Environmental Protection Agency parameter code for taxonomic classification.

Number indicates the organisms counted from artificial substrate sampler and indicates presence in an independently collected qualitative sample.

Table 6.--Macroinvertebrate identification and abundance data at study sites, 1987-89--Continued

Collection date: 07/17/89
River code: 09-200
River: Leading Creek
River mile: 10.3

Taxa code	Taxa	Quantity/ Quality
03600	*Oligochaeta*	32+
05800	*Asellus* sp.	1
08260	*Orconectes (Crokerinus) sanbornii sanbornii*	0+
11100	*Baetis* sp.	8
13580	*Stenonema tripunctatum*	0+
17200	*Caenis* sp.	1+
23804	*Basiaeschna janata*	0+
27512	*Somatochlora linearis*	0+
27610	*Tetragoneuria cynosura*	0+
34130	*Acroneuria evoluta*	4+
43300	*Ranatra* sp.	0+
47600	*Sialis* sp.	2+
48620	*Nigronia serricornis*	2+
52200	*Cheumatopsyche* sp.	59+
52530	*Hydropsyche (H.) depravata* group	0+
52570	*Hydropsyche (H.) simulans*	0+
60300	*Dineutus* sp.	0+
68130	*Helichus* sp.	0+
68601	*Ancyronyx variegata*	8
68708	*Dubiraphia vittata*	0+
69400	*Stenelmis* sp.	0+
71100	*Hexatoma* sp.	0+
74100	*Simulium* sp.	4+
77120	*Ablabesmyia mallochi*	19
77500	*Conchapelopia* sp.	0+
77750	*Hayesomyia senata*	39
77800	*Helopelopia* sp.	19
78140	*Labrundinia pilosella*	19
80370	*Corynoneura taris*	58
80410	*Cricotopus (C.)* sp.	19+
80430	*Cricotopus (C.) tremulus* group	0+
81825	*Rheocricotopus robacki*	39
82820	*Cryptochironomus* sp.	0+
83050	*Dicrotendipes lucifer*	19
83051	*Dicrotendipes simpsoni*	19
84210	*Paratendipes albimanus*	0+
84450	*Polypedilum (P.) convictum*	19+
84460	*Polypedilum (P.) fallax* group	77+
84470	*Polypedilum (P.) illinoense*	0+
84540	*Polypedilum (Tripodura) scalaenum* group	96+
84700	*Stenochironomus* sp.	77
84800	*Tribelos jucundum*	0+
84960	*Pseudochironomus* sp.	19
85500	*Paratanytarsus* sp.	19
85615	*Rheotanytarsus distinctissimus* group	251
85625	*Rheotanytarsus exiquus* group	946+
85800	*Tanytarsus* sp.	77+
85814	*Tanytarsus glabrescens* group	347+
85840	*Tanytarsus guerlus* group	19
96900	*Ferrissia* sp.	16
97601	*Corbicula manilensis*	0+
98600	*Sphaerium* sp.	0+

No. Quantity Taxa: 31
No. Quality Taxa: 35
Total Taxa: 52

No. organisms: 2,334
ICI: 34

Table 6.--Macroinvertebrate identification and abundance data at study sites, 1987-89--Continued

Collection date: 07/17/89
River code: 09-205
River: Dexter Run
River mile: 0.7

Taxa code	Taxa	Quantity/ Quality
03600	*Oligochaeta*	13+
04685	*Placobdella ornata*	0+
07850	*Cambarus (Lacunicambarus) diogenes diogenes*	2+
11100	*Baetis* sp.	0+
11400	*Cloeon* sp.	0+
15000	*Paraleptophlebia* sp.	0+
22001	*Coenagrionidae*	0+
23909	*Boyeria vinosa*	0+
27512	*Somatochlora linearis*	0+
30000	*Plecoptera*	4
45300	*Sigara* sp.	0+
47600	*Sialis* sp.	1+
52200	*Cheumatopsyche* sp.	0+
52530	*Hydropsyche (H.) depravata* group	0+
68708	*Dubiraphia vittata*	0+
69400	*Stenelmis* sp.	0+
72700	*Anopheles* sp.	0+
74100	*Simulium* sp.	0+
77120	*Ablabesmyia mallochi*	44
77500	*Conchapelopia* sp.	0+
78100	*Labrundinia* sp.	4
78401	*Natarsia* species A	17
78650	*Procladius* sp.	9+
79400	*Zavrelimyia* sp.	22
80370	*Corynoneura taris*	9
81650	*Parametriocnemus* sp.	0+
82730	*Chironomus decorus* group	48
82770	*Chironomus riparius* group	0+
82820	*Cryptochironomus* sp.	4+
83000	*Dicrotendipes* sp.	48
83840	*Microtendipes pedellus* group	4+
84210	*Paratendipes albimanus*	57+
84302	*Phaenopsectra* Type 2	4
84315	*Phaenopsectra flavipes*	4
84460	*Polypedilum (P.) fallax* group	91
84470	*Polypedilum (P.) illinoense*	4+
84540	*Polypedilum (Tripodura) scalaenum* group	9
84700	*Stenochironomus* sp.	0+
84750	*Stictochironomus* sp.	0+
84800	*Tribelos jucundum*	13+
85500	*Paratanytarsus* sp.	17
85615	*Rheotanytarsus distinctissimus* group	0+
85625	*Rheotanytarsus exiquus* group	0+
85800	*Tanytarsus* sp.	26+
85814	*Tanytarsus glabrescens* group	17
95100	*Physella* sp.	5+
95501	*Planorbidae*	1
98200	*Pisidium* sp.	0+
98600	*Sphaerium* sp.	1

No. Quantity Taxa: 27 No. organisms: 478
No. Quality Taxa: 33 ICI: 16
Total Taxa: 49

Table 6.--Macroinvertebrate identification and abundance data at study sites, 1987-89--Continued

Collection date: 07/17/89
River code: 09-215
River: Tributary to Ogden Run
River mile: 1.0

Taxa code	Taxa	Quantity/ Quality
03600	*Oligochaeta*	0+
07820	*Cambarus (Cambarus) bartonii cavatus*	0+
07850	*Cambarus (Lacunicambarus) diogenes diogenes*	2+
11300	*Centroptilum* sp.	0+
11400	*Cloeon* sp.	40+
13580	*Stenonema tripunctatum*	2
15000	*Paraleptophlebia* sp.	46
17200	*Caenis* sp.	3
26100	*Cordulegaster* sp.	0+
27512	*Somatochlora linearis*	0+
45300	*Sigara* sp.	0+
47600	*Sialis* sp.	1+
52200	*Cheumatopsyche* sp.	0+
53800	*Hydroptila* sp.	4+
63300	*Hydroporus* sp.	0+
63900	*Laccophilus* sp.	1+
67800	*Tropisternus* sp.	0+
72700	*Anopheles* sp.	0+
74100	*Simulium* sp.	0+
77120	*Ablabesmyia mallochi*	30
77500	*Conchapelopia* sp.	15+
78650	*Procladius* sp.	7+
79400	*Zavrelimyia* sp.	66
80410	*Cricotopus (C.)* sp.	7
80420	*Cricotopus (C.) bicinctus*	0+
82200	*Tvetenia bavarica* group	0+
82300	*Xylotopus par*	0+
82770	*Chironomus riparius* group	44+
82820	*Cryptochironomus* sp.	7
83040	*Dicrotendipes neomodestus*	52
83840	*Microtendipes pedellus* group	15
83900	*Milothauma* sp.	7
84210	*Paratendipes albimanus*	59+
84450	*Polypedilum (P.) convictum*	0+
84460	*Polypedilum (P.) fallax* group	0+
84470	*Polypedilum (P.) illinoense*	0+
84750	*Stictochironomus* sp.	0+
84790	*Tribelos fuscicorne*	0+
85261	*Cladotanytarsus vanderwulpi* group Type 1	0+
85500	*Paratanytarsus* sp.	59
85615	*Rheotanytarsus distinctissimus* group	184+
85625	*Rheotanytarsus exiquus* group	0+
85800	*Tanytarsus* sp.	52+
85801	*Tanytarsus* Type 1	7
85802	*Tanytarsus* Type 2	22
85814	*Tanytarsus glabrescens* group	15+
85840	*Tanytarsus guerlus* group	15
95100	*Physella* sp.	25+

No. Quantity Taxa: 27 No. organisms: 787
No. Quality Taxa: 34 ICI: 38
Total Taxa: 48

Table 6.--Macroinvertebrate identification and abundance data at study sites, 1987-89--Continued

Collection date: 07/07/89
River code 09-546
River: Strongs Run
River mile: 5.9

Taxa code	Taxa	Quantity/ Quality
07800	*Cambarus* sp.	0+
11300	*Centroptilum* sp.	0+
27512	*Somatochlora linearis*	0+
44501	*Corixidae*	0+
47600	*Sialis* sp.	0+
52315	*Diplectrona modesta*	0+
74100	*Simulium* sp.	0+
78350	*Meropelopia* sp.	0+
82141	*Thienemanniella* prob. *xena*	0+
82730	*Chironomus decorus* group	0+
84450	*Polypedilum (P.) convictum*	0+
84750	*Stictochironomus* sp.	0+
95100	*Physella* sp.	0+

No. Quantity Taxa: 0
No. Quality Taxa: 13
Total Taxa: 13

No. organisms: 0
ICI:

Table 6.--Macroinvertebrate identification and abundance data at study sites, 1987-89--Continued

Collection date: 07/06/89
River code: 09-546
River: Strongs Run
River mile: 1.5

Taxa code	Taxa	Quantity/ Quality
03600	*Oligochaeta*	104
05800	*Asellus* sp.	3+
07820	*Cambarus (Cambarus) bartonii cavatus*	0+
07850	*Cambarus (Lacunicambarus) diogenes diogenes*	2
08200	*Orconectes* sp.	1
11300	*Centroptilum* sp.	4+
13400	*Stenacron* sp.	1
13580	*Stenonema tripunctatum*	0+
15000	*Paraleptophlebia* sp.	146
17200	*Caenis* sp.	9
27512	*Somatochlora linearis*	0+
28908	*Perithemis tenera*	1
47600	*Sialis* sp.	16+
48620	*Nigronia serricornis*	2
51001	*Polycentropodidae*	8
52200	*Cheumatopsyche* sp.	47+
52500	*Hydropsyche (H.)* sp.	0+
60400	*Gyrinus* sp.	1
63300	*Hydroporus* sp.	0+
68130	*Helichus* sp.	0+
68708	*Dubiraphia vittata*	0+
71900	*Tipula* sp.	0+
74100	*Simulium* sp.	0+
74501	*Ceratopogonidae*	1
74650	*Atrichopogon* sp.	0+
77120	*Ablabesmyia mallochi*	137+
77500	*Conchapelopia* sp.	0+
77750	*Hayesomyia senata*	14
77800	*Helopelopia* sp.	69+
78140	*Labrundinia pilosella*	1
80370	*Corynoneura taris*	55
81825	*Rheocricotopus robacki*	14
82141	*Thienemanniella* prob. *xena*	14+
82820	*Cryptochironomus* sp.	27+
83000	*Dicrotendipes* sp.	14
83900	*Nilothauma* sp.	41
84210	*Paratendipes albimanus*	14
84310	*Phaenopsectra* prob. *dyari*	137
84315	*Phaenopsectra flavipes*	0+
84450	*Polypedilum (P.) convictum*	0+
84460	*Polypedilum (P.) fallax* group	41+
84540	*Polypedilum (Tripodura) scalaenum* group	41
84790	*Tribelos fuscicorne*	0+
84800	*Tribelos jucundum*	137+
85500	*Paratanytarsus* sp.	3
85615	*Rheotanytarsus distinctissimus* group	151+
85625	*Rheotanytarsus exiquus* group	41
85800	*Tanytarsus* sp.	233
85801	*Tanytarsus* Type 1	27

Table 6.--Macroinvertebrate identification and abundance data at study sites, 1987-89--Continued

Collection date: 07/06/89
River code: 09-546
River: Strongs Run
River mile: 1.5

Taxa code	Taxa	Quantity/ Quality
85802	*Tanytarsus* Type 2	67
85814	*Tanytarsus glabrescens* group	151
85840	*Tanytarsus guerlus* group	96+
86100	*Chrysops* sp.	0+
87501	*Empididae*	33
95100	*Physella* sp.	2+
98600	*Sphaerium* sp.	0+

No. Quantity Taxa: 40
No. Quality Taxa: 29
Total Taxa: 56
No. organism 1,929
ICI: 40

Table 6.--Macroinvertebrate identification and abundance data at study sites, 1987-89--Continued

Collection date: 07/07/89
River code: 09-549
River: Flatlick Run
River mile: 0.6

Taxa code	Taxa	Quantity/ Quality
03360	*Plumatella* sp.	0+
07860	*Cambarus (Puncticambarus) robustus*	0+
11100	*Baetis* sp.	0+
22001	*Coenagrionidae*	0+
27512	*Somatochlora linearis*	0+
43501	*Pleidae*	0+
45300	*Sigara* sp.	0+
45501	*Notonectidae*	0+
47600	*Sialis* sp.	0+
63300	*Hydroporus* sp.	0+
68708	*Dubiraphia vittata*	0+
74100	*Simulium* sp.	0+
77001	*Tanypodinae*	0+
82141	*Thienemanniella* prob. *xena*	0+
82820	*Cryptochironomus* sp.	0+
85615	*Rheotanytarsus distinctissimus* group	0+

No. Quantity Taxa: 0
No. Quality Taxa: 16
Total Taxa: 16

No. organisms: 0
ICI:

Table 6.--Macroinvertebrate identification and abundance data at study sites, 1987-89--Continued

Collection date: 07/06/89
River code: 09-554
River: Zinns Run
River mile: 0.5

Taxa code	Taxa	Quantity/ Quality
03600	*Oligochaeta*	24+
05800	*Asellus* sp.	2
07820	*Cambarus (Cambarus) bartonii cavatus*	0+
07850	*Cambarus (Lacunicambarus) diogenes diogenes*	2
08200	*Orconectes* sp.	3+
11400	*Cloeon* sp.	1+
15000	*Paraleptophlebia* sp.	62+
27512	*Somatochlora linearis*	0+
47600	*Sialis* sp.	4+
52200	*Cheumatopsyche* sp.	0+
63300	*Hydroporus* sp.	10+
69400	*Stenelmis* sp.	0+
74100	*Simulium* sp.	0+
77120	*Ablabesmyia mallochi*	42
77800	*Helopelopia* sp.	24
78401	*Natarsia* species A	12
79400	*Zavrelimyia* sp.	96+
80370	*Corynoneura taris*	6+
80410	*Cricotopus (C.)* sp.	6+
80430	*Cricotopus (C.) tremulus* group	6
80550	*Dipocladius cultriger*	0+
81650	*Parametriocnemus* sp.	6+
82141	*Thienemanniella* prob. *xena*	0+
82770	*Chironomus riparius* group	6+
83840	*Microtendipes pedellus* group	12
83900	*Nilothauma* sp.	24
84210	*Paratendipes albimanus*	24+
84315	*Phaenopsectra flavipes*	0+
84460	*Polypedilum (P.) fallax* group	270
84470	*Polypedilum (P.) illinoense*	36+
84750	*Stictochironomus* sp.	0+
84800	*Tribelos jucundum*	24+
85400	*Micropsectra* sp.	6
85800	*Tanytarsus* sp.	18
85802	*Tanytarsus* Type 2	18
85803	*Tanytarsus* Type 3	30+
85814	*Tanytarsus glabrescens* group	54

No. Quantity Taxa: 28 No. organisms: 828
No. Quality Taxa 24 ICI: 16
Total Taxa: 37

Table 6.--Macroinvertebrate identification and abundance data at study sites, 1987-89--Continued

Collection date: 05/26/88
River code: 09-200
River: Leading Creek
River mile: 26.0

Taxa code	Taxa	Quantity/ Quality
01320	*Hydra* sp.	88
03600	*Oligochaeta*	210+
07820	*Cambarus (Cambarus) bartonii cavatus*	0+
10600	*Siphlonurus* sp.	0+
11400	*Cloeon* sp.	0+
11700	*Pseudocloeon* sp.	9
13000	*Leucrocuta* sp.	1+
13120	*Nixe perfida*	8+
15000	*Paraleptophlebia* sp.	2+
22001	*Coenagrionidae*	0+
23909	*Boyeria vinosa*	2
26100	*Cordulegaster* sp.	0+
27500	*Somatochlora* sp.	0+
32205	*Amphinemura delosa*	0+
34500	*Perlesta* sp.	44+
35570	*Isoperla transmarina*	0+
47600	*Sialis* sp.	12
52200	*Cheumatopsyche* sp.	1
63300	*Hydroporus* sp.	0+
63900	*Laccophilus* sp.	0+
67500	*Laccobius* sp.	0+
67800	*Tropisternus* sp.	0+
68201	*Scirtidae*	0+
68708	*Dubiraphia vittata*	0+
68901	*Macronychus glabratus*	2
69400	*Stenelmis* sp.	0+
71100	*Hexatoma* sp.	0+
71700	*Pilaria* sp.	0+
71900	*Tipula* sp.	0+
71910	*Tipula abdominalis*	0+
72700	*Anopheles* sp.	0+
77120	*Ablabesmyia mallochi*	15
77500	*Conchapelopia* sp.	30+
78450	*Nilotanypus fimbriatus*	8
80200	*Brillia* sp.	15
80370	*Corynoneura taris*	68
80410	*Cricotopus (C.)* sp.	8
80420	*Cricotopus (C.) bicinctus*	0+
81270	*Nanocladius (N.) spiniplenus*	8
81660	*Parametriocnemus lundbecki*	0+
81825	*Rheocricotopus robacki*	15
82141	*Thienemanniella* prob. *xena*	23
82730	*Chironomus decorus* group	8+
83051	*Dicrotendipes simpsoni*	8+
83840	*Microtendipes pedellus* group	60+
84310	*Phaenopsectra* prob. *dyari*	90
84315	*Phaenopsectra flavipes*	75
84460	*Polypedilum (P.) fallax* group	60
84470	*Polypedilum (P.) illinoense*	15+
84540	*Polypedilum (Tripodura) scalaenum* group	23+

Table 6.--Macroinvertebrate identification and abundance data at study sites, 1987-89--Continued

Collection date: 05/26/88
River code: 09-200
River: Leading Creek
River mile: 26.0

Taxa code	Taxa	Quantity/ Quality
84750	*Stictochironomus* sp.	15+
85500	*Paratanytarsus* sp.	8
85625	*Rheotanytarsus exiquus* group	90
85800	*Tanytarsus* sp.	8
85840	*Tanytarsus guerlus* group	15
89501	*Ephydridae*	0+
95100	*Physella* sp.	10+
98200	*Pisidium* sp.	0+
98600	*Sphaerium* sp.	13+

No. Quantity Taxa: 36
No. Quality Taxa: 38
Total Taxa: 60

No. organisms: 1,120
ICI: 26

Table 6.--Macroinvertebrate identification and abundance data at study sites, 1987-89--Continued

Collection date: 05/26/88
River code: 09-200
River: Leading Creek
River mile: 10.3

Taxa code	Taxa	Quantity/ Quality
01320	*Hydra* sp.	4
03360	*Plumatella* sp.	0+
03600	*Oligochaeta*	303+
05800	*Asellus* sp.	0+
06700	*Crangonyx* sp.	0+
08260	*Orconectes (Crokerinus) sanbornii sanbornii*	0+
11100	*Baetis* sp.	0+
11300	*Centroptilum* sp.	0+
11400	*Cloeon* sp.	5+
11700	*Pseudocloeon* sp.	32+
13000	*Leucrocuta* sp.	1+
13120	*Nixe perfida*	0+
17200	*Caenis* sp.	2+
17608	*Baetisca bajkovi*	0+
21200	*Calopteryx* sp.	0+
22300	*Argia* sp.	0+
23909	*Boyeria vinosa*	0+
24900	*Gomphus* sp.	0+
32205	*Amphinemura delosa*	0+
34130	*Acroneuria evoluta*	6+
34500	*Perlesta* sp.	8+
47600	*Sialis* sp.	10+
48620	*Nigronia serricornis*	1+
52200	*Cheumatopsyche* sp.	4+
52530	*Hydropsyche (H.) depravata* group	0+
53800	*Hydroptila* sp.	0+
57900	*Pycnopsyche* sp.	0+
60300	*Dineutus* sp.	1+
68130	*Helichus* sp.	2+
68708	*Dubiraphia vittata*	0+
68901	*Macronychus glabratus*	9+
69400	*Stenelmis* sp.	0+
71100	*Hexatoma* sp.	0+
72160	*Psychoda* sp.	8
74100	*Simulium* sp.	0+
74501	*Ceratopogonidae*	0+
77120	*Ablabesmyia mallochi*	34+
77500	*Conchapelopia* sp.	0+
77750	*Hayesomyia senata*	7
78450	*Nilotanypus fimbriatus*	7
78650	*Procladius* sp.	0+
80370	*Corynoneura taris*	224
80420	*Cricotopus (C). bicinctus*	17
80440	*Cricotopus (C.) trifascia group*	0+
81631	*Parakiefferiella* Type 1	69
81660	*Parametriocnemus lundbecki*	0+
81825	*Rheocricotopus robacki*	17
82141	*Thienemanniella* prob. *xena*	259+
82730	*Chironomus decorus* group	17+
82770	*Chironomus riparius* group	34+
82820	*Cryptochironomus* sp.	0+

Table 6.--Macroinvertebrate identification and abundance data at study sites, 1987-89--Continued

Collection date: 05/26/88
River code: 09-200
River: Leading Creek
River mile: 10.3

Taxa code	Taxa	Quantity/ Quality
83002	*Dicrotendipes modestus*	103
83004	*Dicrotendipes* Type 4	17
83300	*Glyptotendipes* sp.	52+
83840	*Microtendipes pedellus* group	17+
84310	*Phaenopsectra* prob. *dyari*	69
84450	*Polypedilum (P.) convictum*	17+
84460	*Polypedilum (P.) fallax*	7
85500	*Paratanytarsus* sp.	52
85800	*Tanytarsus* sp.	103
85814	*Tanytarsus glabrescens* group	86
85840	*Tanytarsus guerlus* group	34
95100	*Physella* sp.	17+
96900	*Ferrissia* sp.	0+
97601	*Corbicula manilensis*	0+
98600	*Sphaerium* sp.	0+

No. Quantity Taxa: 38
No. Quality Taxa: 50
Total Taxa: 68
No. organisms: 1,737
ICI: 28

Table 6.--Macroinvertebrate identification and abundance data at study sites, 1987-89--Continued

Collection date: 05/25/88
River code: 09-205
River: Dexter Run
River mile: 0.7

Taxa code	Taxa	Quantity/ Quality
01320	*Hydra* sp.	38
01801	*Turbellaria*	0+
03360	*Plumatella* sp.	0+
03600	*Oligochaeta*	6+
05800	*Asellus* sp.	15+
07800	*Cambarus* sp.	0+
10550	*Ameletus* sp.	0+
11100	*Baetis* sp.	0+
11200	*Callibaetis* sp.	0+
11300	*Centroptilum* sp.	0+
11400	*Cloeon* sp.	10+
13000	*Leucrocuta* sp.	21
13120	*Nixe perfida*	17+
15000	*Paraleptophlebia* sp.	87+
26100	*Cordulegaster* sp.	0+
27500	*Somatochlora* sp.	0+
32205	*Amphinemura delosa*	0+
33100	*Leuctra* sp.	0+
34500	*Perlesta* sp.	7+
35570	*Isoperla transmarina*	0+
53112	*Rhyacophila lobifera*	0+
57900	*Pycnopsyche* sp.	0+
60900	*Peltodytes* sp.	0+
61001	*Dytiscidae*	9+
63300	*Hydroporus* sp.	0+
66200	*Cymbiodyta*	0+
68130	*Helichus* sp.	0+
68708	*Dubiraphia vittata*	+
69400	*Stenelmis* sp.	0+
71700	*Pilaria* sp.	0+
74501	*Ceratopogonidae*	0+
77120	*Ablabesmyia mallochi*	4
78650	*Procladius* sp.	0+
79400	*Zavrelimyia* sp.	36
80350	*Corynoneura* sp.	4
80370	*Corynoneura taris*	18
80420	*Cricotopus (C.) bicinctus*	0+
80550	*Dipocladius cultriger*	4
81631	*Parakiefferiella* Type 1	11
81825	*Rheocricotopus robacki*	4
82730	*Chironomus decorus* group	22
82780	*Chironomus staegeri* group	4
83158	*Endochironomus nigricans*	4
83840	*Microtendipes pedellus* group	36
84310	*Phaenopsectra* prob. *dyari*	22
84315	*Phaenopsectra flavipes*	25
84460	*Polypedilum (P.) fallax* group	4
84750	*Stictochironomus* sp.	33
85501	*Paratanytarsus* Type 1	4
85625	*Rheotanytarsus exiquus* group	4
85802	*Tanytarsus* Type 2	4
85814	*Tanytarsus glabrescens* group	11
86100	*Chrysops* sp.	0+
94603	*Pseudosuccinea columella*	0+
98200	*Pisidium* sp.	0+

No. Quantity Taxa: 29 No. organisms: 475
No. Quality Taxa: 35 ICI: 28
Total Taxa: 56

Table 6.--Macroinvertebrate identification and abundance data at study sites, 1987-89--Continued

Collection date: 05/25/88
River code: 09-215
River: Tributary to Ogden Run
River mile: 1.0

Taxa code	Taxa	Quantity/ Quality
01320	*Hydra* sp.	18
03600	*Oligochaeta*	7+
06700	*Crangonyx* sp.	0+
07820	*Cambarus (Cambarus) bartonii cavatus*	0+
10600	*Siphlonurus* sp.	0+
11100	*Baetis* sp.	0+
11300	*Centroptilum* sp.	0+
11400	*Cloeon* sp.	17+
11700	*Pseudocloeon* sp.	0+
13120	*Nixe perfida*	51+
15000	*Paraleptophlebia* sp.	47+
21700	*Lestes* sp.	0+
22001	*Coenagrionidae*	0+
26100	*Cordulegaster* sp.	1+
27500	*Somatochlora* sp.	0+
32205	*Amphinemura delosa*	0+
34500	*Perlesta* sp.	2+
35210	*Cultus decisus*	1
35570	*Isoperla transmarina*	0+
44501	*Corixidae*	0+
53100	*Rhyacophila* sp.	0+
53704	*Dibusa angata*	0+
57000	*Ironoquia* sp.	0+
60900	*Peltodytes* sp.	0+
63300	*Hydroporus* sp.	10+
63900	*Laccophilus* sp.	0+
67800	*Tropisternus* sp.	0+
69400	*Stenelmis* sp.	0+
71700	*Pilaria* sp.	0+
71910	*Tipula abdominalis*	1
74501	*Ceratopogonidae*	1+
77120	*Ablabesmyia mallochi*	3
77500	*Conchapelopia* sp.	7+
78650	*Procladius* sp.	3+
79400	*Zavrelim yia* sp.	37+
79720	*Diamesa* sp.	0+
80370	*Corynoneura taris*	56+
80430	*Cricotopus (C.) tremulus* group	3
81270	*Nanocladius (N.) spiniplenus*	0+
81631	*Parakiefferiella* Type 1	14
81632	*Parakiefferiella* Type 2	3
81712	*Psectrocladius psilopterus* group	7
81825	*Rheocricotopus robacki*	3+
82730	*Chironomus decorus* group	24
83040	*Dicrotendipes neomodestus*	10
83300	*Glyptotendipes* sp.	3
83840	*Microtendipes pedellus* group	3
84210	*Paratendipes albimanus*	0+
84315	*Phaenopsectra flavipes*	64
84460	*Polypedilum (P.) fallax* group	7

Table 6.--Macroinvertebrate identification and abundance data at study sites, 1987-89--Continued

Collection date: 05/25/88
River code: 09-215
River: Tributary to Ogden Run
River mile: 1.0

Taxa code	Taxa	Quantity/ Quality
84470	*Polypedilum (P.) illinoense*	3
84750	*Stictochironomus* sp.	3+
84790	*Tribelos fuscicorne*	17
85501	*Paratanytarsus* Type 1	3
85802	*Tanytarsus* Type 2	3
85814	*Tanytarsus glabrescens* group	10
85840	*Tanytarsus guerlus* group	14
86200	*Tabanus* sp.	0+
89501	*Ephydridae*	0+
95100	*Physella* sp.	2+

No. Quantity Taxa: 37
No. Quality Taxa: 42
Total Taxa: 63
No. organisms: 469
ICI: 30

Table 6.--Macroinvertebrate identification and abundance data at study sites, 1987-89--Continued

Collection date: 05/25/88
River code: 09-546
River: Strongs Run
River mile: 5.9

Taxa code	Taxa	Quantity/ Quality
01320	*Hydra* sp.	24
03360	*Plumatella* sp.	0+
03600	*Oligochaeta*	28+
06700	*Crangonyx* sp.	2+
07820	*Cambarus (Cambarus) bartonii cavatus*	0+
10550	*Ameletus* sp.	0+
11100	*Baetis* sp.	0+
11200	*Callibaetis* sp.	0+
11300	*Centroptilum* sp.	0+
11400	*Cloeon* sp.	1+
11700	*Pseudocloeon* sp.	0+
13120	*Nixe perfida*	13
15000	*Paraleptophlebia* sp.	2+
26100	*Cordulegaster* sp.	0+
27500	*Somatochlora* sp.	0+
34500	*Perlesta* sp.	10+
35570	*Isoperla transmarina*	4+
61001	*Dytiscidae*	3
61400	*Agabus* sp.	0+
63300	*Hydroporus* sp.	0+
68130	*Helichus* sp.	0+
71700	*Pilaria* sp.	1+
72160	*Psychoda* sp.	4
72900	*Culex* sp.	0+
74501	*Ceratopogonidae*	6+
79400	*Zavrelimyia* sp.	18
80370	*Corynoneura taris*	30
81631	*Parakiefferiella* Type 1	18
81660	*Parametriocnemus lundbecki*	30
82141	*Thienemanniella* prob. *xena*	4
82730	*Chironomus decorus* group	67
83000	*Dicrotendipes* sp.	6
83840	*Microtendipes pedellus* group	67+
84210	*Paratendipes albimanus*	6
84310	*Phaenopsectra* prob. *dyari*	30
84315	*Phaenopsectra flavipes*	165
84750	*Stictochironomus* sp.	18
85501	*Paratanytarsus* Type 1	18
85625	*Rheotanytarsus exiquus* group	6
85800	*Tanytarsus* sp.	12
85802	*Tanytarsus* Type 2	6
86100	*Chrysops* sp.	0+
89501	*Ephydridae*	0+
95100	*Physella* sp.	8+

No. Quantity Taxa: 29 No. organisms: 607
No. Quality Taxa: 26 ICI: 24
Total Taxa: 44

Table 6.--Macroinvertebrate identification and abundance data at study sites, 1987-89--Continued

Collection date: 05/20/88
River code 09-546
River: Strongs Run
River mile: 0.6

Taxa code	Taxa	Quantity/ Quality
01320	*Hydra* sp.	96
03600	*Oligochaeta*	598
07820	*Cambarus (Cambarus) bartonii cavatus*	1+
11100	*Baetis* sp.	1+
11300	*Centroptilum* sp.	0+
11400	*Cloeon* sp.	12+
11700	*Pseudocloeon* sp.	1+
13120	*Nixe perfida*	13+
15000	*Paraleptophlebia* sp.	22+
27500	*Somatochlora* sp.	0+
28955	*Plathemis lydia*	0+
34500	*Perlesta* sp.	21+
35570	*Isoperla transmarina*	0+
44501	*Corixidae*	0+
52200	*Cheumatopsyche* sp.	4+
61400	*Agabus* sp.	0+
63300	*Hydroporus* sp.	0+
67000	*Helophorus* sp.	0+
68708	*Dubiraphia vittata*	0+
71700	*Pilaria* sp.	0+
74501	*Ceratopogonidae*	+
77120	*Ablabesmyia mallochi*	12+
78650	*Procladius* sp.	0+
80370	*Corynoneura taris*	25
80400	*Cricotopus* sp.	61
80420	*Cricotopus (C.) bicinctus*	0+
80430	*Cricotopus (C.) tremulus* group	0+
81400	*Orthocladius* sp.	0+
81631	*Parakiefferiella* Type 1	74+
81650	*Parametriocnemus* sp.	0+
81825	*Rheocricotopus robacki*	0+
82141	*Thienemanniella* prob. *xena*	49+
82730	*Chironomus decorus* group	172+
82770	*Chironomus riparius* group	0+
82780	*Chironomus stageri* group	12+
83002	*Dicrotendipes modestus*	12+
83040	*Dicrotendipes neomodestus*	25
83050	*Dicrotendipes lucifer*	12
83051	*Dicrotendipes simpsoni*	61+
83158	*Endochironomus nigricans*	0+
83300	*Glyptotendipes* sp.	12+
83840	*Microtendipes pedellus* group	49+
84310	*Phaenopsectra* prob. *dyari*	86+
84315	*Phaenopsectra flavipes*	74
84470	*Polypedilum (P.) illinoense*	25+
84540	*Polypedilum (Tripodura) scalaenum* group	25
84750	*Stictochironomus* sp.	0+
85500	*Paratanytarsus* sp.	25
85800	*Tanytarsus* sp.	37+
85802	*Tanytarsus* Type 2	49
85814	*Tanytarsus glabrescens* group	37
85840	*Tanytarsus guerlus* group	25+
86100	*Chrysops* sp.	0+
95100	*Physella* sp.	48+

No. Quantity Taxa: 33
No. Quality Taxa: 44
Total Taxa: 55

No. organisms: 1,776
ICI: 26

Table 6.--Macroinvertebrate identification and abundance data at study sites, 1987-89--Continued

Collection date: 05/26/88
River code: 09-549
River: Flatlick Run
River mile: 0.6

Taxa code	Taxa	Quantity/ Quality
01320	*Hydra* sp.	24
03360	*Plumatella* sp.	1
03600	*Oligochaeta*	364+
05800	*Asellus* sp.	8+
07800	*Cambarus* sp.	0+
08200	*Orconectes* sp.	1+
11100	*Baetis* sp.	2+
11200	*Callibaetis* sp.	0+
11300	*Centroptilum* sp.	0+
11400	*Cloeon* sp.	5+
11700	*Pseudocloeon* sp.	1+
15000	*Paraleptophlebia* sp.	175+
16240	*Eurylophella lutulenta*	0+
17200	*Caenis* sp.	0+
18700	*Hexagenia* sp.	0+
22001	*Coenagrionidae*	0+
23909	*Boyeria vinosa*	0+
24900	*Gomphus* sp.	0+
25410	*Progomphus obscurus*	0+
27400	*Neurocordulia* sp.	1
32205	*Amphinemura delosa*	0+
34500	*Perlesta* sp.	13+
35570	*Isoperla transmarina*	0+
43570	*Neoplea* sp.	0+
44501	*Corixidae*	0+
47600	*Sialis* sp.	16
48620	*Nigronia serricornis*	1
52200	*Cheumatopsyche* sp.	8
57900	*Pycnopsyche* sp.	0+
60300	*Dineutus* sp.	0+
60400	*Gyrinus* sp.	1
60900	*Peltodytes* sp.	0+
61001	*Dytiscidae*	1+
63300	*Hydroporus* sp.	0+
67500	*Laccobius* sp.	0+
67750	*Sperchopsis tesselatus*	0+
67800	*Tropisternus* sp.	0+
68130	*Helichus* sp.	0+
68708	*Dubiraphia vittata*	0+
70700	*Dicranota* sp.	0+
71910	*Tipula abdominalis*	0+
74501	*Ceratopogonidae*	8+
77120	*Ablabesmyia mallochi*	0+
77500	*Conchapelopia* sp.	14
78650	*Procladius* sp.	0+
80370	*Corynoneura taris*	72
80420	*Cricotopus (C.) bicinctus*	0+
81631	*Parakiefferiella* Type 1	14
81660	*Parametriocnemus lundbecki*	0+

Table 6.--Macroinvertebrate identification and abundance data at study sites, 1987-89--Continued

Collection date: 05/26/88
River code: 09-549
River: Flatlick Run
River mile: 0.6

Taxa code	Taxa	Quantity/ Quality
82141	*Thienemanniella* prob. *xena*	8
82730	*Chironomus decorus* group	113+
82770	*Chironomus riparius* group	56+
83002	*Dicrotendipes modestus*	+
83050	*Dicrotendipes lucifer*	197
83840	*Microtendipes pedellus* group	211+
84100	*Paracladopelma* sp.	0+
84210	*Paratendipes albimanus*	0+
84315	*Phaenopsectra flavipes*	14
84440	*Polypedilum (P.) aviceps*	0+
84460	*Polypedilum (P.) fallax* group	28
84470	*Polypedilum (P.) illinoense*	0+
84520	*Polypedilum (Tripodura) halterale* group	0+
85501	*Paratanytarsus* Type 1	28
85800	*Tanytarsus* sp.	28
85802	*Tanytarsus* Type 2	85
85814	*Tanytarsus glabrescens* group	155
95100	*Physella* sp.	100+
96002	*Helisoma anceps anceps*	54+
98200	*Pisidium* sp.	1+
98600	*Sphaerium* sp.	8+

No. Quantity Taxa: 35
No. Quality Taxa: 53
Total Taxa: 71
No. organisms: 1,816
ICI: 28

Table 6.--Macroinvertebrate identification and abundance data at study sites, 1987-89--Continued

Collection date: 05/25/88
River code: 09-554
River: Zinns Run
River mile: 0.5

Taxa code	Taxa	Quantity/ Quality
01320	*Hydra* sp.	6
03600	*Oligochaeta*	0+
05800	*Asellus* sp.	0+
06700	*Crangonyx* sp.	0+
07820	*Cambarus (Cambarus) bartonii cavatus*	0+
08260	*Orconectes (Crokerinus) sanbornii sanbornii*	0+
10600	*Siphlonurus* sp.	0+
11300	*Centroptilum* sp.	0+
11400	*Cloeon* sp.	9+
13120	*Nixe perfida*	87+
15000	*Paraleptophlebia* sp.	3+
21700	*Lestes* sp.	0+
27500	*Somatochlora* sp.	0+
32205	*Amphineura delosa*	0+
34500	*Perlesta* sp.	0+
35210	*Cultus decisus*	2+
35570	*Isoperla transmarina*	0+
53100	*Rhyacophila* sp.	0+
53704	*Dibusa angata*	0+
57000	*Ironoquia* sp.	0+
59700	*Triaenodes* sp.	0+
63300	*Hydroporus* sp.	0+
68130	*Helichus* sp.	0+
69400	*Stenelmis* sp.	0+
70800	*Erioptera* sp.	0+
71700	*Pilaria* sp.	0+
72700	*Anopheles* sp.	0+
74501	*Ceratopogonidae*	1+
78200	*Larsia* sp.	1
80370	*Corynoneura taris*	3
80400	*Cricotopus* sp.	0+
82730	*Chironomus decorus* group	12
82770	*Chironomus riparius* group	6+
83840	*Microtendipes pedellus* group	3
84210	*Paratendipes albimanus*	3
84310	*Phaenopsectra* prob. *dyari*	1
84315	*Phaenopsectra flavipes*	10
86100	*Chrysops* sp.	0+
95100	*Physella* sp.	5+

No. Quantity Taxa: 15
No. Quality Taxa: 31
Total Taxa: 39

No. organisms: 162
ICI: 26

Table 6.--Macroinvertebrate identification and abundance data at study sites, 1987-89--Continued

Collection date: 06/30/87
River code: 09-200
River: Leading Creek
River mile: 24.3

Taxa code	Taxa	Quantity/ Quality
03360	*Plumatella* sp.	3
07820	*Cambarus (Cambarus) bartonii cavatus*	0+
08200	*Orconectes* sp.	0+
13400	*Stenacron* sp.	5+
13580	*Stenonema tripunctatum*	0+
15000	*Paraleptophlebia* sp.	4
47600	*Sialis* sp.	4+
48620	*Nigronia serricornis*	0+
51400	*Nyctiophylax* sp.	1
52200	*Cheumatopsyche* sp.	0+
52530	*Hydropsyche (H.) depravata* group	0+
63300	*Hydroporus* sp.	1
67000	*Helophorus* sp.	0+
67700	*Paracymus* sp.	0+
69400	*Stenelmis* sp.	4+
71100	*Hexatoma* sp.	0+
74501	*Ceratopogonidae*	4
77120	*Ablabesmyia mallochi*	24
77500	*Conchapelopia* sp.	12
77750	*Hayesomyia senata*	24
77800	*Helopelopia* sp.	0+
78401	*Natarsia* species A	0+
78650	*Procladius* sp.	12
80370	*Corynoneura taris*	24
81825	*Rheocricotopus robacki*	0+
82121	*Thienemanniella* nr. *fusca*	12
82820	*Cryptochironomus* sp.	36+
83004	*Dicrotendipes* Type 4	12
83051	*Dicrotendipes simpsoni*	96
83820	*Microtendipes caelum*	48+
84210	*Paratendipes albimanus*	12
84315	*Phaenopsectra flavipes*	12
84450	*Polypedilum (P.) convictum*	0+
84460	*Polypedilum (P.) fallax* group	191
84470	*Polypedilum (P.) illinoense*	0+
84540	*Polypedilum (Tripodura) scalaenum* group	24+
84790	*Tribelos fuscicorne*	12
85500	*Paratanytarsus* sp.	108
85615	*Rheotanytarsus distinctissimus* group	0+
85625	*Rheotanytarsus exiquus* group	0+
85800	*Tanytarsus* sp.	84
85814	*Tanytarsus glabrescens* group	191+
85840	*Tanytarsus guerlus* group	24+
86100	*Chrysops* sp.	0+
87501	*Empididae*	4
95100	*Physella* sp.	1+
96900	*Ferrissia* sp.	11
98600	*Sphaerium* sp.	0+

No. Quantity Taxa: 30 No. organisms: 1,000
No. Quality Taxa: 27 ICI: 26
Total Taxa: 48

Table 6.--Macroinvertebrate identification and abundance data at study sites, 1987-89--Continued

Collection date: 06/30/87
River code 09-200
River: Leading Creek
River mile: 10.3

Taxa code	Taxa	Quantity/ Quality
03600	*Oligochaeta*	8
08200	*Orconectes* sp.	0+
11400	*Cloeon* sp.	3
21300	*Hetaerina* sp.	8
23909	*Boyeria vinosa*	0+
34130	*Acroneuria evoluta*	2+
47600	*Sialis* sp.	4
50315	*Chimarra obscura*	0+
51600	*Polycentropus* sp.	4
52200	*Cheumatopsyche* sp.	0+
52530	*Hydropsyche (H.) depravata* group	0+
53800	*Hydroptila* sp.	8
60300	*Dineutus* sp.	0+
60400	*Gyrinus* sp.	3
68130	*Helichus* sp.	0+
68601	*Ancyronyx variegata*	9
68708	*Dubiraphia vittata*	0+
68901	*Macronychus glabratus*	24
71100	*Hexatoma* sp.	0+
74100	*Simulium* sp.	0+
74501	*Ceratopogonidae*	4
77120	*Ablabesmyia mallochi*	117
77130	*Ablabesmyia rhamphe* group	26
77750	*Hayesomyia senata*	0+
77800	*Helopelopia* sp.	13
78140	*Labrundinia pilosella*	26
78650	*Procladius* sp.	26
80370	*Corynoneura taris*	4
82141	*Thienemanniella* prob. *xena*	0+
82820	*Cryptochironomus* sp.	39
82826	*Cryptochironomus blarina* Type	13
83051	*Dicrotendipes simpsoni*	13
83410	*Harnischia curtilamellata*	13
83900	*Nilothauma* sp.	13
84310	*Phaenopsectra* prob. *dyari*	26
84460	*Polypedilum (P.) fallax* group	13
84470	*Polypedilum (P.) illinoense*	13+
84540	*Polypedilum (Tripodura) scalaenum* group	78
84790	*Tribelos fuscicorne*	13
84800	*Tribelos jucundum*	13
85625	*Rheotanytarsus exiquus* group	0+
85800	*Tanytarsus* sp.	13+
85802	*Tanytarsus* Type 2	91
85814	*Tanytarsus glabrescens* group	247
85840	*Tanytarsus guerlus* group	39
86100	*Chrysops* sp.	12
87501	*Empididae*	24+
95100	*Physella* sp.	0+
97601	*Corbicula manilensis*	0+
98200	*Pisidium* sp.	75
98600	*Sphaerium* sp.	0+

No. Quantity Taxa: 35
No. Quality Taxa: 20
Total Taxa: 51

No. organisms: 1,037
ICI: 32

Table 6.--Macroinvertebrate identification and abundance data at study sites, 1987-89--Continued

Collection date: 06/30/87
River code: 09-205
River: Dexter Run
River mile: 0.7

Taxa code	Taxa	Quantity/ Quality
08260	*Orconectes (Crokerinus) sanbornii sanbornii*	0+
13580	*Stenonema tripunctatum*	0+
18700	*Hexagenia* sp.	0+
27500	*Somatochlora* sp.	0+
34100	*Acroneuria* sp.	0+
47600	*Sialis* sp.	0+
95100	*Physella* sp.	0+

No. Quantity Taxa: 0
No. Quality Taxa: 7
Total Taxa: 7

No. organisms: 0
ICI:

Table 6.--Macroinvertebrate identification and abundance data at study sites, 1987-89--Continued

Collection date: 07/01/87
River code: 09-546
River: Strongs Run
River mile: 0.6

Taxa code	Taxa	Quantity/ Quality
03600	*Oligochaeta*	0+
08260	*Orconectes (Crokerinus) sanbornii sanbornii*	0+
18700	*Hexagenia* sp.	0+
45300	*Sigara* sp.	0+
47600	*Sialis* sp.	0+
52200	*Cheumatopsyche* sp.	0+
63300	*Hydroporus* sp.	0+
67300	*Hydrochus* sp.	0+
67500	*Laccobius* sp.	0+
67700	*Paracymus* sp.	0+
67800	*Tropisternus* sp.	0+
68700	*Dubiraphia* sp.	0+
70501	*Tipulidae*	0+
74501	*Ceratopogonidae*	0+
78650	*Procladius* sp.	0+
80410	*Cricotopus (C.)* sp.	0+
82730	*Chironomus decorus* group	0+
84470	*Polypedilum (P.) illinoense*	0+
84520	*Polypedilum (Tripodura) halterale* group	0+
84540	*Polypedilum (Tripodura) scalaenum* group	0+
86100	*Chrysops* sp.	0+
98200	*Pisidium* sp.	0+
98600	*Sphaerium* sp.	0+

No. Quantity Taxa: 0
No. Quality Taxa: 23
Total Taxa: 23

No. organisms: 0
ICI:

Table 6.--Macroinvertebrate identification and abundance data at study sites, 1987-89--Continued

Collection date: 07/01/87
River code: 09-549
River: Flatlick Run
River mile: 0.6

Taxa code	Taxa	Quantity/ Quality
08200	*Orconectes* sp.	0+
11100	*Baetis* sp.	0+
11400	*Cloeon* sp.	0+
17200	*Caenis* sp.	0+
22300	*Argia* sp.	0+
23600	*Aeshna* sp.	0+
23909	*Boyeria vinosa*	0+
24900	*Gomphus* sp.	0+
25410	*Progomphus obscurus*	0+
26100	*Cordulegaster* sp.	0+
47600	*Sialis* sp.	0+
52200	*Cheumatopsyche* sp.	0+
65700	*Anacaena* sp.	0+
67000	*Helophorus* sp.	0+
67500	*Laccobius* sp.	0+
68130	*Helichus* sp.	0+
68700	*Dubiraphia* sp.	0+
77120	*Ablabesmyia mallochi*	0+
77500	*Conchapelopia* sp.	0+
77800	*Helopelopia* sp.	0+
82820	*Cryptochironomus* sp.	0+
84210	*Paratendipes albimanus*	0+
84540	*Polypedilum (Tripodura) scalaenum* group	0+
84750	*Stictochironomus* sp.	0+
84800	*Tribelos jucundum*	0+
85264	*Cladotanytarsus vanderwulpi* group Type 4	0+
85800	*Tanytarsus* sp.	0+
85802	*Tanytarsus* Type 2	0+
85814	*Tanytarsus glabrescens* group	0+
85815	*Tanytarsus glabrescens* group Type 1	0+
87501	*Empididae*	0+
94400	*Fossaria* sp.	0+
95100	*Physella* sp.	0+
98600	*Sphaerium* sp.	0+

No. Quantity Taxa: 0
No. Quality Taxa: 36
Total Taxa: 36

No. organisms: 0
ICI:

Table 7.--Fish abundance and diversity at study sites, 1987-89

[biological data collected by the Ohio Department of Natural Resources from 1987 through 1989 at the eight sites shown in figure 3]

River: Leading Creek below Carpenter, Ohio

Date collected: 05/21/87

River mile: 24.30

Comments:

Time: Day

Location: Leading Creek at bridge on Township Road 13 (Stoneart Road) north of Dyesville, Columbia Township, Meigs County.

Collectors: D. Rice, H. Payne

Equipment: 1,750-watt electroshocker

Conditions: Water levels at normal spring flows. Stream entrenched with poor riffle development. Substrates primarily sand and fine gravels; some shale also present. Sampled a distance of 150 meters.

Species Collected

Scientific name	Common name	Number of individuals
Hypentelium nigricans	Northern hog sucker	3
Catostomus commersoni	White sucker	28
Rhinichthys atratulus	Blacknose dace	10
Semotilus atromaculatus	Creek chub	150
Notropis ardens	Rosefin shiner	85
Notropis chrysocephalus	Striped shiner	64
Ericymba buccata	Silverjaw minnow	24
Pimephales notatus	Bluntnose minnow	70
Campostoma anomalum	Central stoneroller	16
Percopsis omiscomaycus	Trout-perch	40
Micropterus punctulatus	Spotted bass	1
Lepomis megalotis	Longear sunfish	10
Percina maculata	Blackside darter	4
Percina caprodes	Logperch	3
Etheostoma nigrum	Johnny darter	31
Etheostoma flabellare	Fantail darter	17

Table 7.--Fish abundance and diversity at study sites, 1987-89--Continued

River: Leading Creek below Carpenter, Ohio

Date collected: 10/06/87

River mile: 24.30

Comments:

Time: Afternoon

Location: Leading Creek at bridge on Township Road 13 (Stoneart Road) north of Dyesville, Columbia Township, Meigs County.

Collectors: D. Rice, G. Phinney

Equipment: 6' x 8', 3/16" ace mesh seine

Conditions: Water levels low, very little flow over riffle areas. Stream essentially a series of pools. Depths varied from 6 to 18 inches in the pools sampled. Worked a distance of 150 meters. There wasn't enough water in the stream to use the shocker this time.

Species Collected

Scientific name	Common name	Number of individuals
Catostomus commersoni	White sucker	9
Rhinichthys atratulus	Blacknose dace	1
Semotilus atromaculatus	Creek chub	87
Notropis ardens	Rosefin shiner	226
Notropis chrysocephalus	Striped shiner	167
Ericymba buccata	Silverjaw minnow	76
Pimephales notatus	Bluntnose minnow	102
Campostoma anomalum	Central stoneroller	14
Ictalurus natalis	Yellow bullhead	2
Percopsis omiscomaycus	Trout-perch	26
Pomoxis annularis	White crappie	2
Lepomis cyanellus	Green sunfish	1
Lepomis megalotis	Longear sunfish	10
Percina maculata	Blackside darter	9
Etheostoma nigrum	Johny darter	21
Etheostoma flabellare	Fantail darter	2

Table 7.--Fish abundance and diversity at study sites, 1987-89--Continued

River: Leading Creek near Langsville, Ohio

Date collected: 05/14/87

River mile: 10.30

Comments:

Time: Morning

Location: Leading Creek at bridge on Township Road 41 east of Rutland, Ohio, Rutland Township, Meigs County.

Collectors: D. Rice, H. Payne

Equipment: 1,750-watt electroshocker and 12' boat

Conditions: Water levels at what appears to be a normal spring flow. Riffles had 12 to 18 inches of water on them. Riffle and pool substrates a mixture of sand, gravel, and small cobble. Riffle development relatively poor in this stretch. A long, deep pool extending upstream from the bridge was too deep to wade in places. Water was moderately turbid. Sampled 200 meters, 115 below the bridge and 85 above. Adult silver lampreys were collected on the first riffle below the bridge. Three lampreys were sighted, but only two were collected (both were preserved).

Species Collected

Scientific name	Common name	Number of individuals
Ichthyomyzon unicuspis	Silver lamprey	2
Dorosoma cepedianum	Gizzard shad	8
Carpiodes cyprinus	Quillback carpsucker	1
Moxostoma erythrurum	Golden redhorse	12
Hypentelium nigricans	Northern hog sucker	57
Minytrema melanops	Spotted sucker	1
Semotilus atromaculatus	Creek chub	96
Phenacobius mirabilis	Suckermouth minnow	2
Notropis atherinoides	Emerald shiner	34
Notropis chrysocephalus	Striped shiner	2
Notropis spilopterus	Spotfin shiner	1
Notropis stramineus	Sand shiner	15
Notropis volucellus	Mimic shiner	489

Species Collected--Continued

Scientific name	Common name	Number of individuals
Ericymba buccata	Silverjaw minnow	16
Pimephales notatus	Bluntnose minnow	79
Campostoma anomalum	Central stoneroller	55
Ictalurus natalis	Yellow bullhead	2
Percopsis omiscomaycus	Trout-perch	2
Pomoxis annularis	White crappie	1
Micropterus dolomieui	Smallmouth bass	2
Micropterus punctulatus	Spotted bass	6
Micropterus salmoides	Largemouth bass	1
Lepomis macrochirus	Bluegill sunfish	2
Lepomis megalotis	Longear sunfish	24
Percina maculata	Blackside darter	1
Percina caprodes	Logperch	1
Etheostoma nigrum	Johnny darter	5
Etheostoma flabellare	Fantail darter	39
Aplodinotus grunniens	Freshwater drum	5

Table 7.--Fish abundance and diversity at study sites, 1987-89--Continued

River: Leading Creek near Langsville, Ohio

Date collected: 09/21/87

River mile: 10.30

Comments:

Time: Morning

Location: Leading Creek at bridge on Township Road 41 east of Rutland, Ohio, Rutland Township, Meigs County.

Collectors: D. Rice, G. Phinney

Equipment: 1,750-watt electroshocker and 6' x 10', 3/16" ace mesh seine

Conditions: Sampled a total of 200 meters (85 above and 115 below the bridge). Streamflow greatly reduced with barely a trickle on the riffles. Stream itself is relatively entrenched with poor riffle development. Riffles are short and composed of gravel and small cobble. Pool substrates composed of sand, gravel, and silt. One large pool extends from the bridge upstream. Depths went from 4 feet in the bridge pool to an average of about 2 feet in downstream pools. Some submerged roots and limbs provided additional cover. Stream banks were relatively steep, 10 to 15 feet, with a thin riparian corridor.

Species Collected

Scientific name	Common name	Number of individuals
Dorosoma cepedianum	Gizzard shad	54
Moxostoma erythrurum	Golden redhorse	15
Hypentelium nigricans	Northern hog sucker	15
Catostomus commersoni	White sucker	5
Minytrema melanops	Spotted sucker	3
Cyprinus carpio	Common carp	4
Rhinichthys atratulus	Blacknose dace	8
Semotilus atromaculatus	Creek chub	138
Notropis atherinoides	Emerald shiner	7
Notropis rubellus	Rosyface shiner	1
Notropis ardens	Rosefin shiner	1
Notropis chrysocephalus	Striped shiner	5

Species Collected--Continued

Scientific name	Common name	Number of individuals
Notropis spilopterus	Spotfin shiner	3
Notropis stramineus	Sand shiner	27
Ericymba buccata	Silverjaw minnow	3
Pimephales notatus	Bluntnose minnow	175
Campostoma anomalum	Central stoneroller	105
Ictalurus natalis	Yellow bullhead	15
Percopsis omiscomaycus	Trout-perch	1
Micropterus dolomieui	Smallmouth bass	1
Micropterus punctulatus	Spotted bass	9
Lepomis macrochirus	Bluegill sunfish	1
Lepomis megalotis	Longear sunfish	30
Percina caprodes	Logperch	1
Etheostoma nigrum	Johnny darter	13
Etheostoma flabellare	Fantail darter	24
Aplodinotus grunniens	Freshwater drum	2

Table 7.--Fish abundance and diversity at study sites, 1987-89--Continued

River: Dexter Run near Dexter, Ohio

Date collected: 05/21/87

River mile: 0.80

Comments:

Time: Day

Location: Dexter Run at bridge on County Road 4 (Bowles Road), Section 11, Salem Township, Meigs County.

Collectors: D. Rice, Scott

Equipment: 6' x 10', 3//16" ace mesh seine

Conditions: Started sampling below the bridge where a small tributary enters at the base of the hill. The stream flows along the base of a wooded hillside with sandstone outcrops. The stream bottom varies between bedrock, gravels, sand, and silt. Riffles are poorly developed and composed primarily of fine gravels. Deepest pool went to 3 feet with bedrock substrates. Some roots and other debris present. Stream width averages 10 feet. Also sampled long pool right at the bridge. Pool was 3 feet deep and stagnant. Most of the shoreline woody vegetation had been removed, and there was an oil scum on the surface. The only fish caught here were 2 carp and 2 green sunfish. Sampled for 150 meters below the pool.

Species Collected

Scientific name	Common name	Number of individuals
Catostomus commersoni	White sucker	1
Semotilus atromaculatus	Creek chub	18
Notropis rubellus	Rosyface shiner	48
Notropis ardens	Rosefin shiner	32
Notropis chrysocephalus	Striped shiner	17
Pimephales notatus	Bluntnose minnow	4
Micropterus punctulatus	Spotted bass	2
Lepomis megalotis	Longear sunfish	1
Etheostoma nigrum	Johnny darter	1

Table 7.--Fish abundance and diversity at study sites, 1987-89--Continued

River: Flatlick Run near Wilkesville, Ohio

Date collected: 05/14/87

River mile: 0.60

Comments:

Time: Day

Location: Flatlick Run at bridge on County Road 8, Section 8, Wilkesville Township, Vinton County.

Collectors: D. Rice, H. Payne

Equipment: 1,750-watt electroshocker and longline

Conditions: Sampled a distance of 145 meters downstream from the bridge. Stream is entrenched and meanders through bottomland forest in this area. Banks were steep and 10 to 15 feet in height. Stream characterized by pools interconnected by short, poorly developed riffles. Substrates were primarily sand and gravel with silt and organic debris in the pools. Logs and woody debris provided additional cover in the stream channel. Pool depths went to about 3 1/2 feet at time of sample.

Species Collected

Scientific name	Common name	Number of individuals
Lampetra aepyptera	Least brook lamprey	4
Esox americanus	Grass pickerel	3
Catostomus commersoni	White sucker	8
Minytrema melanops	Spotted sucker	3
Notemigonus crysoleucas	Golden shiner	1
Rhinichthys atratulus	Blacknose dace	8
Semotilus atromaculatus	Creek chub	52
Notropis ardens	Rosefin shiner	29
Notropis chrysocephalus	Striped shiner	4
Ericymba buccata	Silverjaw minnow	24
Pimephales notatus	Bluntnose minnow	118
Lepomis cyanellus	Green sunfish	3
Lepomis macrochirus	Bluefill sunfish	3
Lepomis megalotis	Longear sunfish	15
Percina sciera sciera	Dusky darter	1

Species Collected--Continued

Scientific name	Common name	Number of individuals
Percina maculata	Blackside darter	8
Etheostoma nigrum	Johnny darter	4
Etheostoma flabellare	Fantail darter	9

Table 7.--Fish abundance and diversity at study sites, 1987-89--Continued

River: Strongs Run near Ewington, Ohio

Date collected: 05/14/87

River mile: 0.60

Comments:

Time: Day

Location: Strongs Run at the bridge on Adney Road, south edge of Section 1, Huntington Township, Gallia County.

Collectors: D. Rice, H. Payne

Equipment: 1,750-watt electroshocker and longline

Conditions: Channel substrates composed entirely of loose, shifting sand. Roots and logs in the channel provided some fish structure. Pool's depth went to 3 feet, but averaged about 12 inches. Silt was present on most bottom areas. The riparian zone was rather narrow at this point. A distance of 140 meters was sampled above and below the bridge. One ammocoete collected, presumed to be a least brook lamprey.

Species Collected

Scientific name	Common name	Number of individuals
Lampetra aepyptera	Least brook lamprey	1
Catostomus commersoni	White sucker	4
Minytrema melanops	Spotted sucker	3
Semotilus atromaculatus	Creek chub	36
Notropis ardens	Rosefin shiner	37
Notropis chrysocephalus	Striped shiner	4
Ericymba buccata	Silverjaw minnow	17
Pimephales notatus	Bluntnose minnow	128
Ictalurus natalis	Yellow bullhead	3
Lepomis cyanellus	Green sunfish	4
Lepomis megalotis	Longear sunfish	21
Percina sciera sciera	Dusky darter	5
Percina maculata	Blackside darter	3
Etheostoma nigrum	Johnny darter	2
Etheostoma flabellare	Fantail darter	4

Table 7.--Fish abundance and diversity at study sites, 1987-89--Continued

River: Strongs Run near Wilkesville, Ohio

Date collected: 05/21/87

River mile: 5.90

Comments:

Time: Day

Location: Strongs Run at bridge on Township Road 24 (Tower Road), Section 33, Salem Township, Meigs County.

Collectors: D. Rice, Scott

Equipment: 6' x 10', 3/16" ace mesh seine

Conditions: Stream bordered primarily by pasture in this section. Channel is very narrow (5-10 feet) and shallow, average depth varying from 1 to 6 inches. Channel substrates almost all loose, shifting sand. Pools were small and relatively shallow, the deepest about 2 feet. Riffles were short, poorly developed, and widely spaced. Riffle substrates included some fine gravels. Some roots and logs in the channel provided additional cover for fish. Hybrids appeared to be rosefin shiner and creek chub. Sampled total distance of 150 meters above the bridge.

Species Collected

Scientific name	Common name	Number of individuals
Semotilus atromaculatus	Creek chub	6
Notropis ardens	Rosefin shiner	11
Notropis chrysocephalus	Striped shiner	6
Campostoma anomalum	Central stoneroller	1
HYBRID	Hybrid x minnow	3
Lepomis cyanellus	Green sunfish	1
Lepomis megalotis	Longear sunfish	1
Percina maculata	Blackside darter	1