

# An Evaluation of the Fisheries of the Mackinaw River Basin in Central Illinois

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## ABSTRACT

In 1987, on the Mackinaw River Basin in central Illinois, fish data were collected as part of an ongoing effort by the Illinois Department of Conservation (IDOC) Streams Program to assess statewide stream quality. Fifty-nine fish species were collected from 22 sites. On the Mackinaw River, stations downstream of the town of Mackinaw showed generally lower evenness, lower species richness and lower "biotic integrity" as indicated by the Alternate Index of Biotic Integrity (AIBI), compared to stations upstream. More intensive investigations are warranted to isolate the habitat or water quality parameters responsible for this change and to determine the potential for implementation of habitat enhancement techniques in this downstream section.

Several tributaries including Panther Creek, Walnut Creek and Henline Creek were very high quality as seen with the IBI and appear to be smallmouth bass (*Micropterus dolomieu*) nurseries. Fish body condition as estimated by relative weight (Wr), was good for carp (values near 100) and fair for smallmouth bass (values ranging from 80 to 95).

With its diverse fish fauna, aesthetic value, multiple recreational uses including fishing, swimming, canoeing, and hiking, the Mackinaw River represents one of the highest quality streams in Illinois and it is within the public interest to protect this stream from deleterious impacts.

## INTRODUCTION

The Mackinaw River is a major tributary of the Illinois River in central Illinois. Historically the quality of stream fisheries in this Basin has been rated "good to excellent" with 100 fish species present (Smith, 1971). At the same time dredging, siltation and agricultural pollution were also noted as factors negatively impacting the quality of the streams. Since Smith's comments nearly twenty years ago, few stream fisheries investigations have been conducted in the Mackinaw Basin. The most recent comprehensive survey of stream fisheries was conducted by Stinauer (1966, Unpubl.). Duyvejonck (1978) examined fish use of channelized and natural sections of Buck Creek and one of its unnamed tributaries. A small survey encompassing a section of the Mackinaw River and Panther Creek was conducted in 1986 (Sallee, 1986 Unpubl.).

Thus, with a limited historical perspective, the primary objective of the study was to assess the quality of the Mackinaw River Basin with respect to fish community and value as a sport fishery as part of an ongoing effort by the IDOC Stream's Program to characterize major watersheds in Illinois.

## METHODS AND MATERIALS

### Study Area

The Mackinaw River (Fig. 1) drains an area of approximately 1163 square miles (1516 km<sup>2</sup>) (Healy, 1979) of the Grand Prairie Division of central Illinois (Schwegman, 1973). From its headwaters in Ford County east of Bloomington, the Mackinaw River flows 129 miles (219 km) (IDOC-Illinois Streams Information System-ISIS, 1989) in a generally westerly direction and empties into the Illinois River south of Peoria. Soils are primarily loess (Iverson, 1987) and range from brownish-gray bordering the stream to dark soils in the remainder of the watershed with non-calcareous subsoils (IL. St. Planning Comm., 1940). No major urban centers directly impact the river though several small municipalities discharge effluent into tributaries (Short, pers. comm. 1988). Channelization has occurred on 15.4% (19.9 miles) of the mainstem river (IDOC-ISIS, 1989). Land use in the watershed consists primarily of row crop agriculture with some pasture and forests along stream drainages. The Mackinaw River provides multiple recreational opportunities including fishing, swimming and canoeing.

### Fish Collection

Fish were collected from 22 stations in the Mackinaw Basin from 27 July to 31 July 1987 (Fig. 1). Stations were selected based upon several criteria: amount of historical data (fish, macroinvertebrates or water quality), proximity to adjacent stations and size of stream reflecting habitat diversity and accessibility for sampling.

Boat electrofishing was conducted at 8 mainstem stations using a 12 ft. V bow boat with three booms extending from the bow. A 3-phase 3000 Watt, 230 V.A.C. generator was the power source. Both the boat operator and person at

the bow netted fish. Supplemental seine hauls were taken at 5 of these stations using a 30 ft. x 4 ft. x 0.25 in. mesh bag seine. The seine was pulled through pool or run areas while riffles were sampled by spreading the seine across the downstream end of the riffle and moving fish into the seine by kicking and turning rocks upstream of the seine.

A 30 foot electric seine, similar to one described by Larimore and Smith (1963), powered by a single phase 1400 W generator, was used at the two uppermost mainstem stations and at all tributary stations. With this method, four netters followed the seine as it was moved upstream by two persons.

Fish lengths were recorded to the nearest mm or placed in 10 mm size groups. Fish less than one kilogram were weighed to the nearest gram while larger fish were weighed to the nearest 10 grams. Small specimens were preserved in 10% formalin and identified in the laboratory according to Pflieger (1975), Smith (1979) or Becker (1983). In a few cases, often due to the small size of the specimen (usually < 30 mm) or indistinct characteristics, identification was limited to the family level.

### Data Analysis

Sampling effort varied between stations thus total number and total weight for each species were converted to number/hour and grams/hour respectively. Due to difficulty in standardization, seine haul data are included only in determination of the Index of Biotic Integrity (IBI) (Karr, 1981; 1986) and in comparison of species composition with comparable historical data. Fish condition factors were calculated using relative weight ( $W_r$ ) (Johnson and Nielsen, 1985) with parameters determined by Bertrand (Unpubl. IDOC data). Community similarity was evaluated using Horn's Index (Horn, 1966) which determines the amount of overlap or similarity both in number of taxa and distribution of individuals among the taxa. Values range from 0 (no similarity) to 1 (identical). Using these community similarity values, a cluster analysis was developed based upon an unweighted pair group with arithmetic averages (Sneath and Sokal, 1973). Brillouin's diversity index was recommended by Kaesler and Herricks (1976) and calculated using the BASIC program of Brower and Zar (1984).

## RESULTS AND DISCUSSION

### Relative Abundance and Species Composition

Fifty-nine fish species and a total of 63 taxa (includes ammocoetes, hybrids and fish identified to family) were collected in the Mackinaw Basin. Fifty-one species were collected from 10 stations on the Mackinaw River (Table 1). Catch per Unit Effort (CPUE) ranged from 237.0 fish/hour (DK-18) to 740.0 fish/hour (DK-21), while number of taxa ranged from 15 to 38 with the two furthest downstream stations DK-01 and DK-12, yielding the fewest taxa 17 and 15, respectively.

At tributary stations, CPUE ranged from 192 fish/hour to 9224.0 fish/hour (Table 2). The highest values were obtained on the Little Mackinaw River (DKE-

01) and Mud Creek (DKG-01) with 2788.0 fish/hour and 9244.0 fish/hour, respectively. Since both stations were pooled at the time of sampling, these values may reflect the concentration of fish under drought conditions as well as a related increase in sampling efficiency. Number of taxa on the tributaries ranged from 10 to 36 per station, but only 2 stations DKP-02 (Money Creek) and DKT-01 (Crooked Creek) had fewer than 22 species.

### Fish Weights

On the Mackinaw River, aggregate fish weight/hour ranged from 39.8 kg/hour at (DK-20) to 83.7 kg/hour at (DK-16) and showed no longitudinal trends. Based upon weight/hour, carp (*Cyprinus carpio*) comprised the greatest proportion (26.1%) by weight of combined electrofishing samples. Other species contributing to the sample weight included river carpsucker (*Carpionodes carpio*) (18.4%), golden redhorse (*Moxostoma erythrurum*) (14.4%), gizzard shad (*Dorosoma cepedianum*) (8.0%), quillback (*Carpionodes cyprinus*) (6.5%) and smallmouth buffalo (*Ictiobus bubalus*) (5.6%).

On the tributaries, total sample weights ranged from 0.118 kg/hour at Crooked Creek (DKT-01) to 59.098 kg/hour at Panther Creek (DKK-02-A). As on the mainstem river, carp, river carpsucker, golden redhorse and quillback were generally the major constituents of aggregate weight where they occurred. However at 3 stations, Walnut Creek (DKJ-01) and PantherCreek (DKK-02, DKK-02-A) one species, gizzard shad was the major single constituent of total fish weight. At DKK-02-A this species accounted for over 40% of the fish weight. Downstream at DKK-01, gizzard shad were not collected potentially reflecting the unequal distribution of satisfactory habitat. Gizzard shad were collected in only one additional tributary, Hickory Grove Ditch (DKB-01), where conditions were apparently marginal for its existence as it comprised only about 2% of the total fish weight.

### Diversity

Brillouin's diversity index assumes the entire population has been sampled (Kaesler and Herricks, 1976). For each sample, the maximum diversity may change depending upon the number of taxa and number of individuals. To normalize diversity, actual diversity is divided by the maximum diversity to obtain the evenness value (Brower and Zar, 1977). Evenness thus indicates the distribution of individuals among the taxa, relative to maximum diversity which could be obtained from a sample.

On the Mackinaw River, evenness was moderately high. With two exceptions, DK-01 (0.565) and DK-19 (0.691) in the lower reaches of the River, evenness values ranged from 0.773 to 0.858 (Table 1). Gizzard shad and emerald shiners (*Notropis atherinoides*) were the most abundant fish at stations DK-01 and DK-19, for a combined total of 75.3% of all fish in DK-01 and 49.2% in DK-19.

On the tributaries, evenness values ranged from 0.589 on Mud Creek (DKG-01) to 0.834 on Hickory Grove Ditch (DKB-01), but were typically between 0.700 and 0.800 (Table 2). At DKG-01, three species, the bluntnose minnow

(*Pimephales notatus*), common stoneroller (*Campeostoma anomalum*) and sand shiner (*Notropis stramineus*) accounted for a total of 75.6% of fish distributed among 24 species in the sample.

### Community Similarity

Based on community similarity, stations DK-01, DK-04, DK-12, DK-19, the most downstream stations, are more closely clustered compared to the six upstream stations (Fig. 2). Based upon percent composition, the five most abundant species in the four downstream stations were emerald shiners, gizzard shad, river carpsucker, golden redhorse and carp. In the upstream stations, golden redhorse, sand shiner, common stoneroller, red shiner (*Notropis lutrensis*) and bluntnose minnow were the five most prevalent species.

Community similarity analysis of tributary stations shows no consistent patterns (Fig. 2). This may be due to heterogeneity of fish communities both within and between these tributary basins.

### Fish Condition

Relative abundance, evenness, community similarity and aggregate weight assess community composition, but do not directly reflect the condition of individual fish. Fish condition as assessed by relative weight  $W_r$  reflects food availability and general habitat suitability (Nielsen and Johnson, 1985).

Relative weight condition factors for smallmouth bass (*Micropterus dolomieu*) and common carp were calculated (Nielsen and Johnson, 1985) using a standardized equation determined by Bertrand (Unpubl. data). Only smallmouth bass  $\geq 18$  cm and carp  $\geq 28$  cm were used in the analyses. For specific size groups, relative weight values deviating substantially from 100 reflect either insufficient forage (values much less than 100) or inadequate use of available forage (values much greater than 100) (Nielsen and Johnson, 1985).

On the Mackinaw River, smallmouth bass condition ( $W_r$ ) was usually between 80 and 95, but ranged as high as 112.1. On the tributaries, smallmouth bass condition ranged from a mean of 80.5 on Panther Creek (DKK-01) to 97.7 on Henline Creek (DKV-01) (Fig. 3). Carp in both the Mackinaw River and tributaries were in very good condition with  $W_r$  values approaching 100 at most stations (Fig. 4).

### Index of Biotic Integrity

In comparison to preceding analyses, the Index of Biotic Integrity (IBI) examines the fish community based upon trophic composition, abundance and overall fish condition. Proposed by Karr (1981), and examined by Fausch et al. (1984) and Karr (1984; 1986) for midwestern streams, the IBI is based upon 12 factors or metrics of the fish community with total scores ranging from 12 (poor) to 60 (excellent). These values reflect the relative amount of change from optimal conditions of streams of similar size within a given IBI region. The IBI provides a consistent regional comparison of the quality of stream fisheries. As used in the Illinois Stream's Program, when condition information (i.e. % diseased, tumors,

etc.) is unavailable, an Alternate Index of Biotic Integrity (AIBI) is calculated (Bertrand, Pers. Comm. 1987). For this, the mean of the other 11 metrics is used for the condition metric.

On the Mackinaw River, AIBI values ranged from 40 (fair) to 56 (excellent). Again, lower rated stations (DK-01, DK-12) occur in the downstream reaches of the river. The highest rated samples were collected from stations DK-15, DK-17, DK-20 and DK-21 (Table 3).

AIBI values on tributaries ranged from 34 to 58. The highest quality streams included Walnut, Panther and Henline Creeks. Money and Crooked Creeks with AIBI values of 34 were the lowest rated streams sampled during the survey. Species richness for these stations was the lowest obtained in the Basin.

### Historical data

An analysis of fish species composition/abundance over time can provide valuable information concerning changes in water and habitat quality. In the Mackinaw River Basin, 44 species were common between the 1966 and 1987 surveys. Eight of the 52 species collected in 1966 were not found in 1987 while 15 of the 59 species collected in 1987 were not found in 1966 (Table 4; Table 5).

Three species were collected in 1986 and not collected in 1987; however 13 species were found in 1987 and not found in 1986 (Table 5). This must be qualified by noting only seven stations (five Mackinaw River; two Panther Creek) were sampled in 1986 compared to 22 in 1987. Forty-six species common to both the 1986 and 1987 surveys were collected at these seven stations (Table 4; Table 5). Collection in 1987 of the black redhorse (*Moxostoma duquesnei*), pugnose minnow (*Notropis emiliae*), spottin shiner (*N. spilopterus*), blacknose dace (*Rhinichthys atratulus*), and walleye (*Stizostedion vitreum*) suggests improved conditions as these are "intolerant" species not found in 1966.

Of special interest is the increase in the black redhorse. Two previous collections have been recorded from this Basin (L. Page, Pers. Comm. 1988). Compared to other sucker species, the black redhorse is less tolerant of siltation (Smith, 1979). Though impact from point-source pollution has historically been minimal on the Mackinaw River (Short, 1988 Pers. Comm.) the presence of the black redhorse and the other sensitive species suggests even further improvement in water quality within the past 20 years. With reference to AIBI values, there were no substantial differences on the Mackinaw River between 1986 and 1987 (Table 3). Differences in Panther Creek values may be attributable to sampling methods where minnow seine hauls were taken in 1986 while the newly acquired electric seine was used the following year.

## CONCLUSIONS

On the Mackinaw River, distinct differences were apparent in the fish community with respect to river reach. Species richness, AIBI, and evenness values indicate lower quality stations in the reach downstream of the town of Mackinaw. Community similarity analysis showed samples from the four downstream stations were more similar to each other than to samples from the six

upstream stations. Often habitat parameters are interrelated as shown by Sheldon (1968) in examining species diversity and longitudinal succession in stream fishes. Thus, a more intensive sampling effort is needed to isolate specific factors impacting this downstream section to determine methods for habitat restoration.

The 1987 survey findings support the assessment of Smith (1971), rating the Mackinaw Basin fish community as "good to excellent". In comparison to historical collections, increases in occurrence of species intolerant of poor water quality or habitat impacted by suspended sediments or siltation also corroborate with this evaluation. The mainstem above the town of Mackinaw along with several tributaries (Panther, Henline and Walnut Creeks) are among the most valuable fisheries in the region. These streams provide valuable sportfish nurseries as typified by Henline Creek where 84.8% of the smallmouth bass collected were less than 100 mm.

Body condition for carp was good with  $W_r$  values (near 100) indicating optimal use of food resources, while condition of smallmouth bass was fair, indicating some stress due to insufficient forage or habitat limitations.

The collection of 49 species from five Mackinaw River stations and two Panther Creek stations in 1986 elucidates the ecological value of this section of the Basin. Impoundment of this reach of the river, as has been proposed in recent years would result in a substantial loss to our state's aquatic resources. Due to their diverse fish fauna, aesthetic and recreational values, the Mackinaw River and its tributaries should receive protection from any development or land-use practices which might have deleterious impacts.

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Table 1. Relative abundance (Number/Hour) diversity and evenness values for fish from Mackinaw River stations. Stations are arranged in longitudinal order from downstream (DK-01) to upstream (DK-21). Seine haul data "SH" indicates total number of fish collected for number of hauls ( ).

Minutes of electrofishing Method(a) Station	60		30		67		50		60		47		60		45		30	
	EF/AC DK-01	SH(1) DK-12	EF/AC DK-12	SH(2) DK-19	EF/AC DK-19	SH(2) DK-04	EF/AC DK-04	SH(2) DK-04	EF/AC DK-15	SH(2) DK-15	EF/AC DK-16	SH(9) DK-16	EF/AC DK-17	EF/AC DK-18	ES/AC DK-20	ES/AC DK-21		
1 American eel <u>Anguilla rostrata</u>	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
2 Longnose gar <u>Lepisosteus osseus</u>	0.0	0.0	2.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0	1.5	0.0	0.0		
3 Shortnose gar <u>Lepisosteus platostomus</u>	2.0	0.0	4.0	0.0	9.0	0.0	2.4	0.0	2.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0		
4 Gizzard shad <u>Dorosoma cepedianum</u>	147.0	30.0	12.0	13.0	68.4	0.0	81.6	0.0	18.0	0.0	35.1	15.0	22.5	2.6	0.0	0.0		
5 Carp <u>Cyprinus carpio</u>	16.0	0.0	16.0	0.0	15.3	0.0	20.4	0.0	15.0	0.0	42.9	16.0	9.0	11.7	4.0	0.0		
6 Creek chub <u>Semotilus atromaculatus</u>	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	2.6	0.0		
7 Hornyhead chub <u>Nocomis biguttatus</u>	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	1.0	2.0	0.0	14.0	0.0	11.7	80.0		
8 Silver chub <u>Hypobysis storeriana</u>	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
9 Suckermouth minnow <u>Phenacobius mirabilis</u>	0.0	0.0	2.0	6.0	2.7	0.0	0.0	0.0	2.0	47.0	3.0	0.0	35.0	0.0	1.3	4.0		
10 Emerald shiner <u>Notropis atherinoides</u>	216.0	79.0	94.0	54.0	177.3	31.0	46.8	18.0	32.0	226.0	2.6	1.0	0.0	0.0	0.0	0.0		
11 Striped shiner <u>Notropis chrysocephalus</u>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.7	8.0		
12 Bigmouth shiner <u>Notropis dorsalis</u>	8.0	27.0	12.0	79.0	19.8	58.0	18.0	104.0	27.0	211.0	11.7	44.0	4.5	45.5	24.0	0.0		
13 Red shiner <u>Notropis lutrensis</u>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	5.2	18.0		
14 Rosyface shiner <u>Notropis rubellus</u>	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	7.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0		
15 Spottfin shiner <u>Notropis spilopterus</u>	0.0	5.0	20.0	12.0	1.8	19.0	3.6	17.0	76.0	46.0	23.4	30.0	12.0	89.7	28.0	0.0		
16 Sand shiner <u>Notropis stramineus</u>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	3.9	4.0	0.0		
17 Redfin shiner <u>Notropis umbratilis</u>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.2	0.0		
18 Steelcolor shiner <u>Notropis whipplei</u>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
19 Bluntnose minnow <u>Pimephales notatus</u>	0.0	0.0	0.0	30.0	7.2	48.0	15.6	4.0	34.0	1.0	5.2	12.0	13.5	14.3	54.0	0.0		
20 Common stoneroller <u>Camptostoma anomalum</u>	0.0	0.0	0.0	3.0	0.0	0.0	1.2	7.0	8.0	8.0	1.3	91.0	0.0	16.9	138.0	0.0		
21 Smallmouth buffalo <u>Ictiobus bubalus</u>	6.0	0.0	14.0	0.0	9.9	0.0	6.0	0.0	7.0	0.0	9.1	4.0	10.5	0.0	0.0	0.0		
22 Bigmouth buffalo <u>Ictiobus cyprinellus</u>	0.0	0.0	0.0	0.0	1.8	0.0	1.2	0.0	0.0	0.0	0.0	4.0	0.0	0.0	0.0	0.0		
23 Black buffalo <u>Ictiobus cyprinellus</u>	0.0	0.0	0.0	0.0	0.0	0.0	2.4	0.0	5.0	0.0	3.9	4.0	3.0	0.0	0.0	0.0		
24 River carpsucker <u>Carpiodes carpio</u>	28.0	1.0	42.0	13.0	45.0	0.0	50.4	0.0	34.0	0.0	18.2	9.0	15.0	16.9	8.0	0.0		
25 Quillback <u>Carpiodes cyprinus</u>	9.0	2.0	0.0	10.0	19.8	0.0	0.0	0.0	3.0	1.0	6.5	4.0	16.5	9.1	44.0	0.0		
26 Highfin carpsucker <u>Carpiodes velifer</u>	0.0	0.0	0.0	0.0	0.0	0.0	2.4	0.0	1.0	0.0	2.6	0.0	0.0	0.0	1.3	0.0		
27 Silver redbreast <u>Moxostoma valenciennesi</u>	0.0	0.0	0.0	1.0	5.4	1.0	4.8	0.0	2.0	0.0	1.3	5.0	3.0	1.3	0.0	0.0		
28 Black redbreast <u>Moxostoma valenciennesi</u>	0.0	1.0	0.0	0.0	10.8	0.0	7.2	0.0	6.0	0.0	10.4	6.0	25.5	2.6	0.0	0.0		
29 Golden redbreast <u>Moxostoma erythrurum</u>	15.0	0.0	14.0	4.0	27.0	1.0	34.8	0.0	31.0	1.0	37.7	25.0	31.5	46.8	122.0	0.0		
30 Shorthead redbreast <u>Moxostoma macrolepidotum</u>	8.0	0.0	6.0	0.0	12.6	0.0	18.0	0.0	9.0	1.0	3.9	9.0	9.0	6.5	4.0	0.0		

31 Northern hog sucker	<u>Hypentelium nigricans</u>	1.0	0.0	0.0	0.0	1.2	5.0	41.0	9.0	7.8	25.0	9.0	1.3	34.0		
32 White sucker	<u>Catostomus commersoni</u>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.0		
33 Channel catfish	<u>Ictalurus punctatus</u>	2.0	0.0	20.0	0.0	4.5	0.0	8.0	0.0	1.3	1.0	0.0	0.0	0.0		
34 Flathead catfish	<u>Pylodictis olivaris</u>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	1.3	0.0		
35 Stonecat	<u>Noturus flavus</u>	0.0	0.0	0.0	0.0	0.0	2.0	4.0	7.0	0.0	29.0	0.0	6.5	4.0		
36 White bass	<u>Morone chrysops</u>	4.0	0.0	0.0	0.0	0.9	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0		
37 Smallmouth bass	<u>Micropterus dolomieu</u>	0.0	0.0	0.0	2.0	6.3	0.0	17.0	3.0	6.5	6.0	3.0	3.9	32.0		
38 Largemouth bass	<u>Micropterus salmoides</u>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	1.0	0.0	0.0	0.0		
39 Green sunfish	<u>Lepomis cyanellus</u>	3.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0	7.8	4.0	0.0	3.9	6.0		
40 Bluegill	<u>Lepomis macrochirus</u>	3.0	0.0	0.0	0.0	0.9	0.0	14.4	0.0	2.6	6.0	0.0	0.0	0.0		
41 Longear sunfish	<u>Lepomis megalotis</u>	0.0	0.0	0.0	0.0	0.0	2.0	9.6	0.0	3.9	19.0	30.0	18.2	48.0		
42 Rock bass	<u>Ambloplites rupestris</u>	0.0	0.0	0.0	0.0	0.9	0.0	6.0	0.0	6.5	12.0	7.5	20.8	10.0		
43 White crappie	<u>Pomoxis annularis</u>	0.0	0.0	0.0	0.0	0.9	0.0	1.0	0.0	2.6	1.0	1.5	0.0	0.0		
44 Walleye	<u>Stizostedion vitreum</u>	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
45 Blackside darter	<u>Percina maculata</u>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.5	0.0		
46 Slenderhead darter	<u>Percina phoxocephala</u>	0.0	0.0	0.0	1.0	0.0	2.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0		
47 Fantail darter	<u>Etheostoma flabellare</u>	0.0	0.0	0.0	0.0	0.0	1.0	0.0	1.0	0.0	2.0	0.0	0.0	0.0		
48 Johnny darter	<u>Etheostoma nigrum</u>	0.0	0.0	0.0	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0		
49 Orangethroat darter	<u>Etheostoma spectabile</u>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	1.5	0.0	4.0		
50 Banded darter	<u>Etheostoma zonale</u>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	0.0	5.2	0.0		
51 Freshwater drum	<u>Aplodinotus grunniens</u>	15.0	0.0	16.0	0.0	24.3	0.0	7.2	0.0	3.9	1.0	6.0	1.3	0.0		
Amocoetes		0.0	0.0	0.0	0.0	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Green X Longear sunfish hybrid		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0		
Unidentified Carpiodes		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Unidentified Centrarchidae		0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Unidentified Cyprinidae		0.0	0.0	2.0	2.0	7.2	28.0	4.8	5.0	0.0	0.0	0.0	0.0	0.0		
Total number of Fish/Hour (b)		482.0	146.0	276.0	467.0	498.6	205.0	382.8	174.0	448.0	1543.0	263.9	1449.0	237.0	395.2	740.0
Total number of Species		17	8	14	16	30	12	27	13	31	16	27	38	22	31	24
Total number of Taxa (c)		17	8	15	17	32	15	28	13	31	17	28	38	22	31	24
Number of Species (All methods)				17	34			28	35			33				
Number of Taxa (All methods)				18	36			31	35			35				
Brillouin's Diversity (Base e)(b)		1.576	2.090		2.362		2.604		2.698		2.695	2.805	2.637	2.722	2.556	
Brillouin's Evenness (Base e)		0.565	0.780		0.691		0.791		0.801		0.840	0.773	0.858	0.802	0.802	

(a) EF/AC = Boat electrofishing (A.C. current), ES/AC = Electric Seine (A.C. current), SH = Seine Hauls  
(b) Calculated for electrofishing data only. (c) Includes hybrids, amocoetes and unidentified categories





Table 3. Alternate Index of Biotic Integrity values for stations sampled in 1986 and 1987. Mackinaw River stations are in longitudinal order from downstream to upstream.

<u>Stream</u>	<u>Station Code</u>	<u>1986</u>	<u>1987</u>
Mackinaw River	DK-01	--	40
	DK-12	--	40
	DK-19	--	47
	DK-04	--	47
	DK-15	51	56
	DK-16	47	50
	DK-17	49	56
	DK-18	47	45
	DK-20	--	53
	DK-21	--	56
	Hickory Grove Ditch	DKB-01	--
Little Mackinaw River	DKE-01	--	47
Mud Creek	DKG-01	--	45
Walnut Creek	DKJ-01	--	53
Panther Creek	DKK-01	36	53
	DKK-02	34	53
	DKK-02-A	--	42
West Br. Panther Creek	DKKB-01	--	49
East Br. Panther Creek	DKKC-02	--	49
Money Creek	DKP-02	--	34
Crooked Creek	DKT-01	--	34
Henline Creek	DKV-01	--	58

Table 4. Number of stations sampled and number of species collected in 1966, 1986 and 1987 from streams in the Mackinaw basin. Number of species is from all methods used at the station(s).

<u>Stream</u>	<u>Stations<sup>a</sup></u>			<u>Species<sup>b</sup></u>		
	<u>1966</u>	<u>1986</u>	<u>1987</u>	<u>1966</u>	<u>1986</u>	<u>1987</u>
Mackinaw River	5	5	10	44	45	51
Mud Creek	1	0	1	20	-	24
Walnut Creek	1	0	1	23	-	34
Panther Creek	1	2	3	27	17	45
W. Br. Panther Creek	1	0	1	20	-	20
E. Br. Panther Creek	1	0	1	1	-	22
Money Creek	1	0	1	19	-	16
Henline Creek	1	0	1	19	-	22
Crooked Creek	0	0	1	--	-	10
Hickory Grove Ditch	0	0	1	--	-	24
Little Mackinaw R.	0	0	1	--	-	23
<b>Total</b>	<b>12</b>	<b>7</b>	<b>22</b>	<b>52</b>	<b>49</b>	<b>59</b>

<sup>a</sup> Includes only streams sampled in 1987; additional streams were sampled in 1966.

<sup>b</sup> Excludes misc. minnows, hybrids, ammocoetes and unidentified taxa.

Table 5. Historical changes in species composition from three surveys of the Mackinaw River Basin.

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Species found in 1966 and not found in 1987 (8 Species)

Common shiner ( <i>Notropis cornutus</i> )	Goldfish ( <i>Carassius auratus</i> )
Creek chubsucker ( <i>Erimyzon oblongus</i> )	Orangespotted sunfish ( <i>Lepomis humilis</i> )
Fathead minnow ( <i>Pimephales promelas</i> )	Tadpole madtom ( <i>Noturus gyrinus</i> )
Freckled madtom ( <i>Noturus nocturnus</i> )	Yellow bass ( <i>Morone mississippiensis</i> )

Species found in 1987 and not found in 1966 (15 Species)

American eel ( <i>Anguilla rostrata</i> )	Silver chub ( <i>Hybopsis storeriana</i> )
Black rehorse ( <i>Moxostoma duquesnei</i> )	Silvery minnow ( <i>Hybognathus nuchalis</i> )
Black buffalo ( <i>Ictiobus niger</i> )	Spotfin shiner ( <i>Notropis spilopterus</i> )
Blacknose dace ( <i>Rhinichthys atratulus</i> )	Steelcolor shiner ( <i>Notropis whipplei</i> )
Blackstripe topminnow ( <i>Fundulus olivaceus</i> )	Striped shiner ( <i>Notropis chrysocephalus</i> )
Brook silverside ( <i>Labidesthes sicculus</i> )	Walleye ( <i>Stizostedion vitreum</i> )
Logperch ( <i>Percina caprodes</i> )	White Bass ( <i>Morone chrysops</i> )
Pugnose minnow ( <i>Notropis emiliae</i> )	

Species found in 1986 and not found in 1987 (3 Species)

Common shiner ( <i>Notropis cornutus</i> )	Skipjack herring ( <i>Alosa chrysochloris</i> )
Sauger ( <i>Stizostedion canadense</i> )	

Species found in 1987 and not found in 1986 (13 Species)

American eel ( <i>Anguilla rostrata</i> )	Silver chub ( <i>Hybopsis storeriana</i> )
Banded darter ( <i>Etheostoma zonale</i> )	Silvery minnow ( <i>Hybognathus nuchalis</i> )
Black buffalo ( <i>Ictiobus niger</i> )	Steelcolor shiner ( <i>Notropis whipplei</i> )
Blacknose dace ( <i>Rhinichthys atratulus</i> )	Walleye ( <i>Stizostedion vitreum</i> )
Brook silverside ( <i>Labidesthes sicculus</i> )	White sucker ( <i>Catostomus commersoni</i> )
Fantail darter ( <i>Etheostoma flabellare</i> )	Yellow bullhead ( <i>Ictalurus natalis</i> )
Pugnose minnow ( <i>Notropis emiliae</i> )	

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Figure 1. Stations sampled during the 1987 Mackinaw River Basin fish investigation

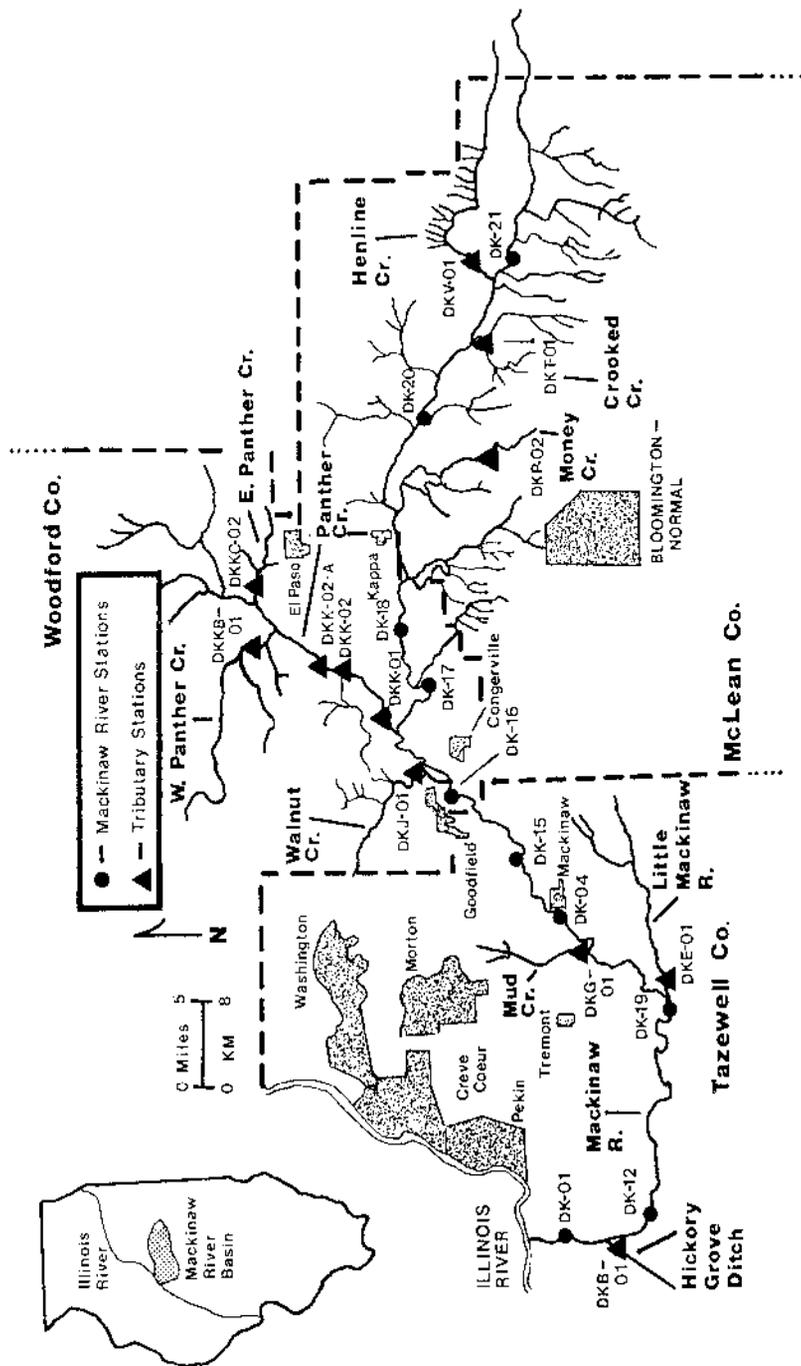


Figure 2. Coefficient of similarity based upon Horn's Index, using number of fish per hour.

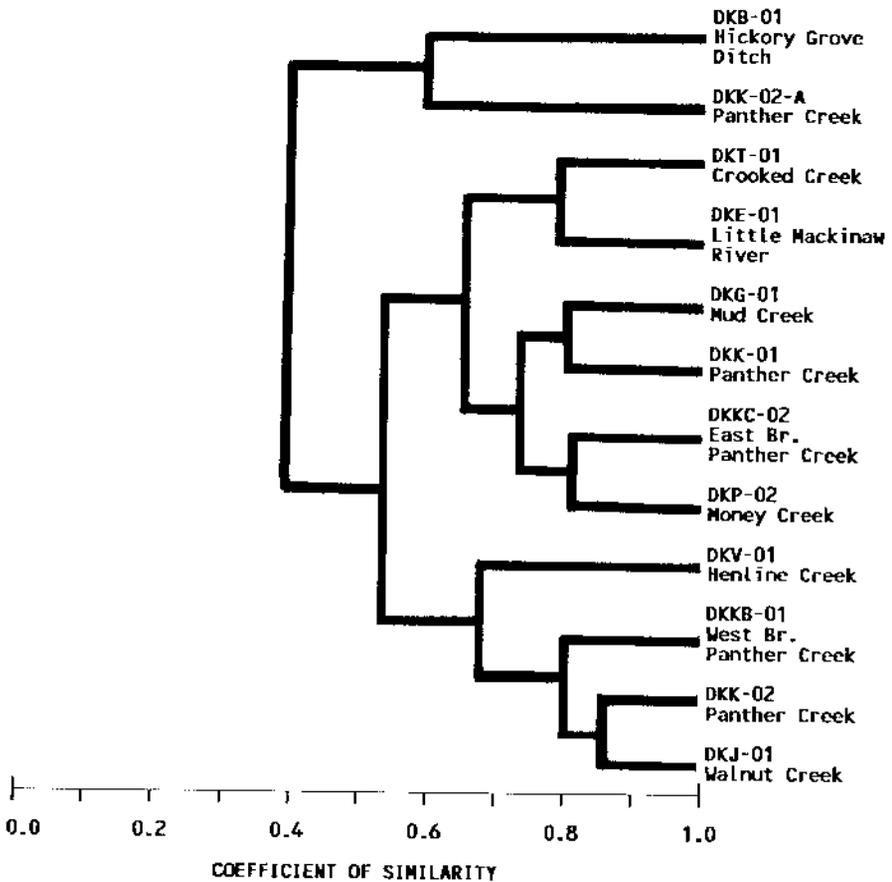
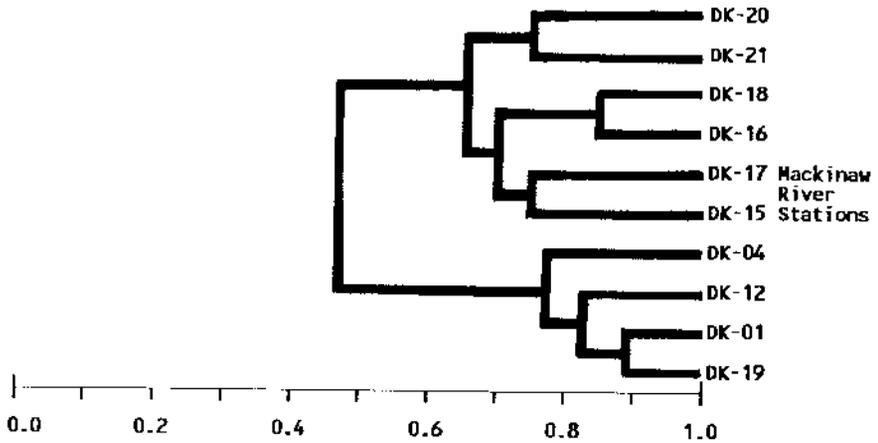


Figure 3. Relative weight ( $W_r$ ) for smallmouth bass in the Mackinaw River Basin. Sample size is indicated within each bar.

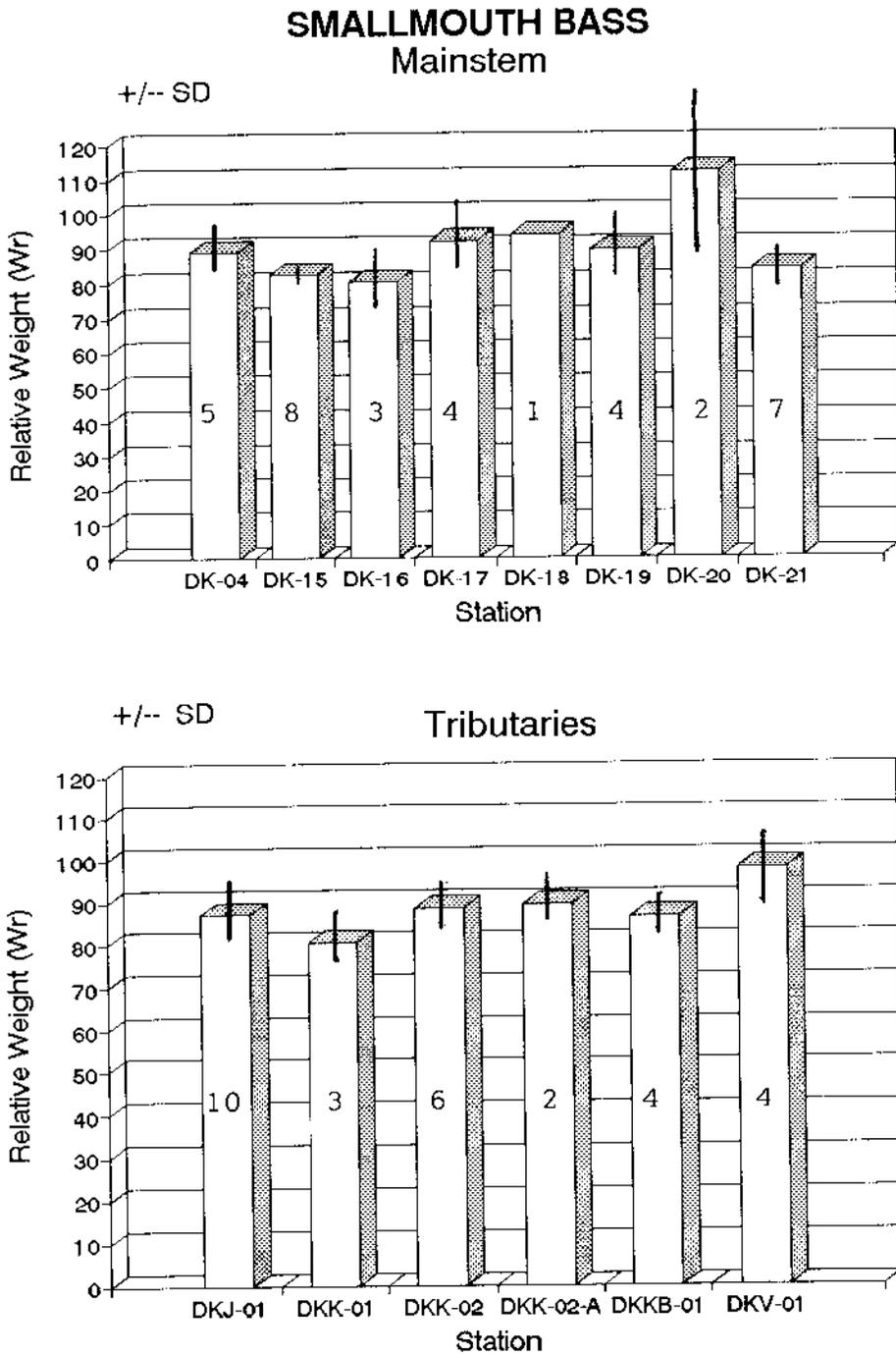


Figure 4. Relative weight (Wr) for carp in the Mackinaw River Basin. Sample size is indicated within each bar.

