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ILLINOIS NATURAL HISTORY SURVEY

THE LONG-TERM ILLINOIS RIVER FISH POPULATION MONITORING PROGRAM

Project F-101-R

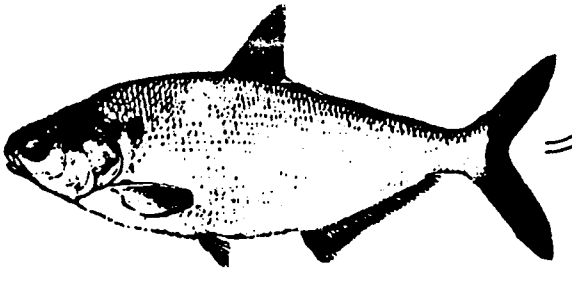
Annual Report to
Illinois Department of Conservation

Center for Aquatic Ecology

T. V. Lerczak, R. E. Sparks, and K. D. Blodgett

Illinois Natural History Survey

May 1995



Aquatic Ecology Technical Report 95/4

The Long-Term Illinois River Fish Population Monitoring Program

F-101-R-6

Annual Report

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DISCLAIMER

The findings, conclusions, and views expressed herein are those of the researchers and should not be considered as the official position of the United States Fish and Wildlife Service or the Illinois Department of Conservation.

ACKNOWLEDGMENT OF SUPPORT

The Long-Term Illinois River Fish Population Monitoring Program (F-101-R) is supported by the Federal Aid in Sport Fish Restoration Act (P.L. 81-681, Dingell-Johnson/Wallop-Breaux).

EXECUTIVE SUMMARY

Fish population monitoring by electrofishing was successfully completed at all stations between 22 August and 29 September 1994, during low water and while water temperatures remained above 58 °F (14.4 °C). Fish distributions and abundances in 1994 showed patterns similar to those identified in data collected during the most recent five years (federal aid project F-101-R segments 1 through 5). Bluegill was by far the most abundant species in catches from the lower river (Alton Reach, river mile [RM] 0, at the Mississippi River, to RM 80) and from the middle river (La Grange Reach, RM 80-158; and Peoria Reach, RM 158-231). Upper waterway (Starved Rock, RM 231-247; Marseilles, RM 247-271.5; and Dresden Reaches, RM 271.5-286) catches were numerically dominated by small cyprinids including emerald shiner and bluntnose minnow. Common carp was a minor numerical component of catches (less than 10% of the total), except in La Grange Reach (18.6%), but ranked first in catch biomass in Alton, La Grange, Marseilles, and Dresden Reaches and ranked second to bigmouth buffalo (a species absent from upper waterway catches) in Peoria and second to smallmouth buffalo in Starved Rock.

Species richness was analyzed by the rarefaction statistical method, which calculates the number of species to be expected in different communities all at "n" individuals, where n is equal to the total number of individuals collected from the community having the least individuals of all the communities being compared. At n = 146 (for Starved Rock Reach), no reach could be considered to have uniquely high richness. Species richness by rarefaction did not exhibit a directional trend on the upper waterway, but steadily declined from Peoria to Alton. Species evenness was considered low because for all reaches at least one species represented over 20% of the total catch.

Catch data by species for 1994 were arranged in descending order of individuals and weight collected for each reach. Fish communities were defined by identifying species that in sum made up 95% of both total individuals and weight or accounted for at least 5% of either. Seven species were of widespread importance to all river reaches in abundance and by weight: gizzard shad, carp, smallmouth buffalo, channel catfish, bluegill, largemouth bass, and freshwater drum. Cluster analysis of stations based on fish collected per hr showed that upper river stations were dissimilar enough from lower/middle river stations to be considered as having a somewhat distinct fish community; in fact, eight species were of unique importance (but not necessarily of unique presence or absence) to the upper waterway: bluntnose and bullhead minnow, carp x goldfish hybrid, sand and spottail shiner, golden redhorse, flathead catfish, and smallmouth bass. Bigmouth buffalo, shorthead redhorse, and black crappie were uniquely important to the lower/middle river community. Because of biases associated with using a single gear type, these data provide only a first approximation of actual river fish communities. Factors responsible for fish community differences most likely include general habitat differences (amount of contiguous backwater available, presence of submersed aquatic vegetation, hydrography) as well as the degree to which habitats have been degraded from siltation plus industrial and municipal wastes. Because water quality measurements made on this project are not extensive enough to make meaningful correlations among environmental and habitat data and fish catch rates, environmental data need to be compiled from other sources and entered into a computer data base. An analysis of these data are scheduled for a future report.

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[a]Job numbers and titles refer to the F-101-R-6 annual work plan dated 20 January 1994.

ACKNOWLEDGMENTS

Project F-101-R is supported by the Federal Aid in Sport Fish Restoration Act (P.L. 81-681, Dingell-Johnson/Wallop-Breaux), with funds administered by the U.S. Fish and Wildlife Service and the Illinois Department of Conservation (IDOC). Mr. Larry Dunham (IDOC), Mr. Bill Bertrand (IDOC), Mr. Michael Sweet (IDOC), Dr. Lorin Nevling, Chief of the Illinois Natural History Survey (INHS), Dr. Robert A. Herendeen Acting Director of the Center for Aquatic Ecology (INHS), and Dr. David Philipp, Director of the Center for Aquatic Ecology (INHS), provided administrative support. Staff of the Long Term Resource Monitoring Program (LTRMP) at Havana (Mr. Steve Stenzel, Mr. Paul Raibley, Mr. Kevin Irons, Mr. Matt O'Hara, Mr. Rick Wright, Mr. Thad Cook, and Ms. Stephanie Wickman) and INHS River Research Laboratory at Havana (Ms. Cammy Smith, Ms. Denise Stoeckel, and Mr. Curt Elderkin) provided technical or secretarial support. Mr. Daniel Moorehouse assisted with most of the field work.

This survey was originally conceived and initiated by the late Dr. William C. Starrett in 1957.

INTRODUCTION

Results from the long-term Illinois River fish population monitoring program were previously summarized by Sparks and Starrett (1975), Sparks (1977), Sparks and Lerczak (1993), and Lerczak et al. (1994). Details on the environmental history of the Illinois River which can be related to changes in river fish populations and community structure over time can be found in many publications, including the following: Kofoid (1903), Forbes and Richardson (1919), Thompson (1928), Mills et al. (1966), Starrett (1971), Starrett (1972), Bellrose et al. (1979), Sparks (1984), and Colten (1994). This report summarizes data collected in 1994 during segment 6 of federal aid project F-101-R. In addition, the 1994 data are examined in relation to long-term trends identified in the previous five-year summary report (Lerczak et al. 1994). Future annual reports will follow a similar format. Major analyses of long-term data are scheduled for the next five-year summary report (end of segment 10).

STUDY AREA AND METHODS

Fish populations were sampled on this survey at 24 stations on the Illinois River, at two stations on the Des Plaines River, and at one station on the Mississippi River (Figure 1). Seventeen stations were located within side channels; the rest of the stations were in other habitats, including the main channel border, or in a combination of habitats types (see Lerczak et al. 1994:9).

To simplify data summaries, sampling stations were placed into three groups that were defined by their location along the river and by the amount of off-channel habitat available to fish per unit length of river (Lerczak et

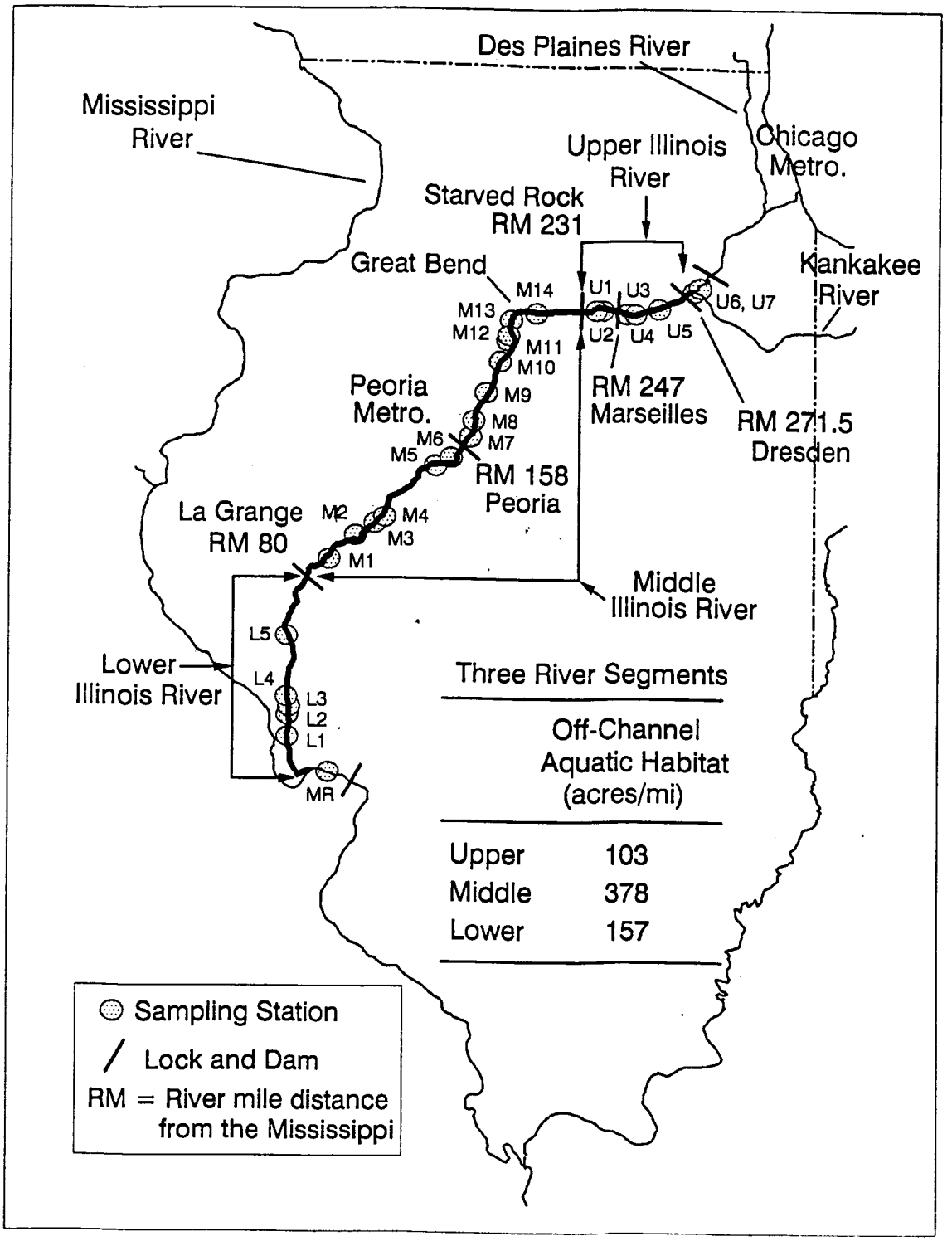


Figure 1. Map of Illinois showing some of the major rivers. Electrofishing stations are labeled consecutively for each of the three river segments according to Table 1.

al. 1994:5). The river segments were further subdivided into reaches defined by navigation dams (Figure 1) as follows: Alton Reach, river mile (RM) 0-80; La Grange, RM 80-158; Peoria, RM 158-231; Starved Rock, RM 231-247; Marseilles, RM 247-271.5; and Dresden, RM 271.5-286. Geomorphology and hydrography of the Illinois River-floodplain complex are described in Kofoid (1903), Willman (1973), Lerczak et al. (1993), and Sparks (1995).

After water quality measurements (e.g., dissolved oxygen concentration [DO], surface water velocity) were completed at each station, fish populations were sampled by electrofishing from a 16-ft (5-m) aluminum boat using a 3000-watt, three-phase AC generator. Sampling at each station typically lasted for one hour. Stunned fish were gathered with a dip net (1/4-in [0.64-cm] mesh) and stored in a livewell until sampling was completed. They were then identified to species, measured, inspected for external abnormalities, and returned to the water. More details on the electrofishing method and equipment are included in the last F-101-R five-year summary report (Lerczak et al. 1994:10-13, 91-96).

DATA ANALYSIS

Analyses for this report were on 1994 data only. Fish catch rates were calculated as the number of individuals collected per hour of electrofishing (number catch rates) and as weight in pounds collected per hour of electrofishing (weight catch rates). Catch rate data were grouped by navigation reach. For each reach, species were ranked by relative abundance (i.e., percent of total catch). Those species that together made up 95% of the total catch were listed separately in tables. Fish communities for navigation reaches were defined by listing the most important species in terms

of their contribution to total number of individuals and weight. The less abundant species or those contributing minimally to total catch weight were assumed to be of minor importance in terms of biotic interactions capable of significantly influencing fish community structure. Cluster analysis (Ludwig and Reynolds 1988, Rohlf 1993) of number catch rates was used to characterize fish communities in terms of upstream-to-downstream differences. For this analysis, chord distance, recommended by Ludwig and Reynolds (1988:175) as being the most useful over a wide range of ecological data sets, was used together with a flexible strategy (Ludwig and Reynolds 1988:191).

Species diversity of catches for each navigation reach was investigated by separately analyzing its two component parameters (Peet 1974): richness (number of species collected) and evenness (degree of equitability among each species' contribution to the total). Several investigators (Hurlbert 1971, James and Rathbun 1981, Ludwig and Reynolds 1988) recommended this approach because of limitations inherent in commonly used diversity indices (e.g., Shannon-Weaver index).

Species richness can only be meaningfully compared among different communities when sample sizes are equal (Hurlbert 1971). When this is not the case, Hurlbert (1971) suggested using the rarefaction statistical method, which calculates the expected number of species for a smaller number of individuals (n) than was actually collected. The expected number of species for different communities, all at "n" individuals, can then be compared, where n is equal to the total number of individuals collected from the community having the least individuals. Expected values were calculated using the following formula:

$$E[S_n] = \sum_{i=1}^{s} \left[1 - \frac{\binom{N - N_i}{n}}{\binom{N}{n}} \right]$$

where $E[S_n]$ is the expected number of species for a random sample of n individuals, N is the total number of individuals actually collected, S is the total number of species collected, and N_i is the number of individuals collected of the ith species (Hurlbert 1971).

To compare species richness among reaches, the expected number of species for each reach, $E[S_n]$, was calculated for n = 146 individuals, the number of individual fish collected from Starved Rock Reach. Evenness was examined by the use of species-abundance curves, where relative abundances for each species in terms of individuals collected were plotted against each species' rank for each navigation reach.

The percentage of fish with external abnormalities was calculated separately for benthic species (those that mostly forage on bottom substrates) and pelagic species (those that mostly forage in the water column) (see **APPENDIX A**). Data are presented separately for each group and river segment.

RESULTS AND DISCUSSION (Job 4)

Before the fish sampling season began, all equipment was tested and repaired as necessary, and staff were given a review in safety procedures and electrofishing methods **(Job 1)**.

All stations were successfully sampled between 22 August and 29 September, taking 27.95 hr (Table 1) **(Job 2)**. Data were then entered into the computerized data base and entry errors corrected **(Job 3)**. Weight-length plots were made for the more abundant species to check for outliers indicating possible errors introduced during field data entry. Outliers were then examined and corrected as necessary. Original data sheets were stored in the flame-resistent vault at the Forbes Biological Station at Havana **(Job 3)**.

A. CONDITIONS DURING ELECTROFISHING RUNS

Sampling was conducted in full daylight between the hours of 8:45 AM and 6:45 PM. The ranges for physical measurements were as follows: air temperature, 57.9-91.4 °F; water temperature, 66.2-83.1 °F; dissolved oxygen concentration, 4.5-11.3 ppm; Secchi disk transparency, 5.9-27.6 in; conductivity, 350-700 umhos; surface velocity, 0.0-1.4 ft/s; water depth, 0.3-6.6 ft (Table 1). All values of physical measurements were within the ranges expected based upon previous sampling (see Lerczak et al. 1994:17-24).

All stations except Turkey Island (river mile [RM] 148) were sampled with water temperatures and river levels within our established criteria (see Lerczak et al. 1994:10-13). At Turkey Island the river stage was 1.85 ft above flat pool, which is 0.35 ft (4.2 in) above our criterion for that station (1.5 ft above flat pool, i.e., 431.20 ft above sea level). At river levels of 431.20 ft or less the side channel at Turkey Island has been too

Table 1. Station information and characteristics during sampling for 1994. All stations except where noted are on the Illinois River. Stations are listed in upstream-to-downstream order and numbered by reach.

Order by Date	Date	Station (Fig.1 label)[a]	River Mile Lower	River Mile Upper	End Time (CST)	Sample Time (hr)	Temperature Air (°F)	Temperature Water (°F)	DO (ppm)	Secchi (in)	Cond. (umhos)	Surface Vel. (ft/s)	Depth[b] Min. (ft)	Depth[b] Max. (ft)	River Stage[c] (ft)
27	14 SEP	Treats Island[d] (U7)	279.5	280.0	14:30	1.00	80.1	83.1	7.5	26.8	650	0.7	0.3	6.6	504.85
26	14 SEP	Mouth of Du Page River[d] (U6)	276.8	277.8	12:10	1.00	76.1	78.8	7.6	27.6	700	0.0	0.7	4.9	504.85
25	13 SEP	Waupecan Island (U5)	260.2	261.1	15:10	1.00	77.7	79.0	9.3	27.6	700		0.3	6.6	484.01
24	13 SEP	Johnson Island (U4)	249.7	249.8	11:45	0.50	78.8	76.6	9.2	21.7	650		0.7	4.9	483.50
23	13 SEP	Ballards Island (U3)	247.7	248.2	10:00	1.00	70.3	75.2	9.0	16.5	650	0.0	0.3	3.3	483.50
21	12 SEP	Bulls Island Bend (U2)	241.1	241.6	14:35	1.00	77.0	77.9	9.9	20.5	650	0.7	0.7	6.6	459.18
22	12 SEP	Bulls Island (U1)	240.3	241.0	16:45	1.00	84.2	78.8	10.8	21.3	650	1.3	0.7	6.6	459.18
11	01 SEP	Clark Island (M14)	214.9	215.6	15:00	1.00	72.0	75.6	9.5	11.0	450	0.9	0.3	6.6	440.77
12	02 SEP	Hennepin Island (M13)	207.6	208.1	9:15	0.50	57.9	73.9	8.5	11.8	475	0.4	0.3	6.6	440.71
8	31 AUG	Upper Twin Sister (M12)	203.0	203.5	12:40	1.00	72.9	76.6	8.2	14.6	450	0.7	0.7	6.6	440.90
9	31 AUG	Lower Twin Sister (M11)	202.6	203.2	15:03	0.75	73.4	76.5	8.7	13.8	450	0.7	0.7	6.6	440.90
10	01 SEP	Henry Island (M10)	193.2	194.5	10:00	1.00	68.0	74.1	7.3	9.8	600	0.7	0.3	6.6	440.77
3	24 AUG	Chillicothe (M9)	180.6	181.1	12:29	1.00	75.2	75.9	6.1	9.8	450		0.7	3.3	441.03
2	23 AUG	Lambies Boat Harbor (M8)	170.6	170.8	12:45	1.00	75.4	75.0	10.5	8.3	600	0.0	0.7	2.6	440.62
1	22 AUG	Peoria Lake (M7)	163.4	163.5	15:00	0.70	77.7	77.9	11.3	7.1	600	0.0	0.7	4.9	440.80
20	09 SEP	Pekin (M6)	154.3	155.3	13:10	1.00	72.5	74.8	8.7	9.8	650	0.8	0.7	6.6	430.90
13	02 SEP	Turkey Island (M5)	148.0	148.4	14:30	0.50	75.7	72.7	7.0	5.9	350	1.0	0.7	6.6	431.55
4	25 AUG	Upper Bath Chute (M4)	112.8	113.2	12:20	1.00	83.7	77.2	4.5	8.7	425	0.8	0.7	4.9	430.50
5	25 AUG	Lower Bath Chute (M3)	106.9	107.3	16:30	1.00	91.4	78.6	4.8	7.5	350	0.8	0.7	4.9	430.50
6	26 AUG	Sugar Creek Island (M2)	95.5	96.3	12:10	1.00	74.7	77.4	6.3	7.1	450	0.6	0.7	6.6	429.68
7	26 AUG	Grape-Bar Islands (M1A)	85.7	87.0	17:00	1.00	79.7	78.1	6.7	7.9	475	0.7	0.7	6.6	429.68
28	16 SEP	Grape-Bar Islands (M1B)	85.9	87.0	13:40	1.00	77.5	77.9	5.8	8.7	700	0.7	0.3	4.9	429.56
29	23 SEP	Grape-Bar Islands (M1C)	85.7	87.0	12:15	1.00	58.1	70.7	4.8	7.5	650	0.5	0.3	4.9	429.60
30	29 SEP	Grape-Bar Islands (M1D)	85.7	87.0	13:20	1.00	64.8	66.2	7.0		600	0.7	0.3	4.9	429.42
14	06 SEP	Big Blue Island (L5)	58.0	59.0	14:50	1.00	77.0	72.9	5.8	8.7	425	1.4	0.3	6.6	420.05
15	06 SEP	Crater-Willow Islands (L4)	29.2	30.8	18:45	1.00	78.8	74.5	5.7	10.2	425	0.5	0.7	6.6	420.05
18	08 SEP	Hurricane Island (L3)	27.0	27.9	10:10	1.00	68.0	73.6	4.8	8.7	625	0.8	0.7	4.9	420.32
19	08 SEP	Dark Chute (L2)	24.5	25.5	12:30	1.00	77.4	73.9	5.0	8.7	625	0.7	0.7	4.9	420.32
17	07 SEP	Mortland Island (L1)	18.1	19.5	16:00	1.00	75.2	75.4	5.3	9.8	625	1.0	0.7	3.3	420.46
16	07 SEP	Brickhouse Slough (MR)	204.9	205.3	11:30	1.00	66.2	73.4	9.9	10.2	400	0.0	0.3	3.3	420.46
Total elasped time						27.95									

[a]U = upper Waterway, which includes Dresden, Marseilles, Starved Rock Reaches; M = middle river, which includes Peoria and La Grange Reaches; L = lower river or Alton Reach; MR = Mississippi River.
[b]Estimated.
[c]Feet above sea level at the U.S. Army Corps of Engineers river gage nearest to the sampling station.
[d]Des Plaines River.

shallow for the electrofishing boat to enter since 1991. Sampling during slightly higher river stages allowed some access to the side channel while not grossly deviating from the usual practice of sampling only during low river stages.

B. ELECTROFISHING RESULTS

The following data summaries proceed through several levels of detail. First, data on the number of individual fish collected at each electrofishing station are presented. Next, catch rates of the number of individuals and weight collected per hour of electrofishing, totaled for each navigation reach, are presented. Fish communities are then defined based on species that were highly ranked in terms of number of individuals and weight by navigation reach.

Individual Fish Catch Data by Station.

In 1994 we collected from the Illinois Waterway 3,421 fish representing 42 species (plus two hybrids) from 12 families (Tables 2 though 5). At Brickhouse Slough on the Mississippi River (RM 204.9), we collected 111 fish representing 15 species from 8 families (Table 2). Catches from this station have steadily declined since 1990 (Lerczak et al. 1994) with this year's catch being the lowest.

On the lower river, 609 fish were collected, representing 18 species (Table 2), the lowest number of species collected on this segment of the river on this project during the last five years of sampling (see Lerczak et al. 1994). The number of species collected at each station ranged from 11 at Dark Chute (RM 24.5) to 15 at Hurricane Island (RM 27.0).

Table 2. Number of individuals of each fish species collected on the Mississippi River (Brickhouse Slough) and the lower Illinois River (RM 0-80) in 1994.

	River Mile and Hours Fished						
	Miss. River	Lower Illinois River					
Species	204.9 1.00	18.1 1.00	24.5 1.00	27.0 1.00	29.2 1.00	58.0 1.00	Lower River Total 5.00
Bowfin	0	0	0	1	0	0	1
Gizzard Shad	7	12	4	18	2	26	62
Threadfin Shad	0	0	0	1	0	1	2
Common Carp	3	1	0	3	17	13	34
Emerald Shiner	4	2	0	3	1	3	9
Silver Chub	1	0	0	0	0	0	0
Bigmouth Buffalo	0	0	1	4	3	2	10
Smallmouth Buffalo	4	5	0	1	7	5	18
Channel Catfish	1	4	4	5	50	18	81
Flathead Catfish	0	1	0	0	0	0	1
Yellow Bullhead	0	1	0	1	0	0	2
Black Crappie	12	4	4	13	17	8	46
Bluegill	33	77	25	26	66	29	223
Green Sunfish	1	0	1	0	1	2	4
Largemouth Bass	12	9	7	10	7	4	37
Orangespotted Sunfish	2	0	0	0	0	0	0
Redear Sunfish	1	0	0	0	0	0	0
Warmouth	0	0	2	1	0	0	3
White Bass	2	1	1	2	7	2	13
Sauger	1	0	1	0	0	0	1
Freshwater Drum	27	9	10	9	29	5	62
Total individuals	111	126	60	98	207	118	609
Total species	15	12	11	15	12	13	16

Table 3. Number of individuals of each fish species collected on the La Grange Reach (RM 80-158) of the Middle Illinois River (RM 80-231) in 1994.

	River Mile and Hours Fished										
Species	85.9[a] 1.00	85.9[b] 1.00	85.9[c] 1.00	85.9[d] 1.00	95.5 1.00	106.9 1.00	112.8 1.00	148.0 0.50	154.3 1.00	La Grange Reach Total 8.50	Middle River Total 15.45
Longnose Gar	0	0	1	0	0	0	0	0	0	1	1
Gizzard Shad	3	8	11	2	29	0	10	6	22	91	136
Threadfin Shad	0	0	0	0	0	0	0	0	0	0	44
Skipjack Herring	0	0	0	0	0	0	0	0	0	0	6
Goldeye	0	0	0	0	0	0	0	1	1	2	4
Bullhead Minnow	0	0	0	1	0	0	0	0	0	1	5
Common Carp	13	3	11	12	57	28	47	30	4	205	253
Emerald Shiner	1	1	11	0	1	0	0	0	0	14	143
Goldfish	0	0	0	0	0	1	0	0	0	1	4
Minnow (unid.)	0	0	0	0	0	0	0	0	0	0	2
Red Shiner	0	0	0	11	0	0	0	0	0	11	11
Silver Chub	0	0	0	0	0	0	0	0	0	0	7
Spottail Shiner	0	0	0	0	0	0	0	0	0	0	3
Bigmouth Buffalo	0	2	8	4	0	19	15	3	2	53	82
Golden Redhorse	0	1	0	0	0	0	0	0	0	1	4
Quillback	0	0	0	0	0	0	0	0	0	0	1
River Carpsucker	0	0	1	0	0	0	0	0	0	1	22
Shorthead Redhorse	2	2	4	5	2	0	0	1	0	16	33
Smallmouth Buffalo	7	4	5	5	1	3	5	8	3	41	82
Channel Catfish	9	7	5	2	1	1	4	13	0	42	54
Flathead Catfish	1	0	0	0	1	1	1	0	0	4	5
White Bass	5	4	4	2	0	7	15	9	42	88	124
Black Crappie	17	0	12	22	8	32	6	0	0	97	112
Bluegill	52	17	76	48	17	21	30	0	0	261	483
Bluegill x Green Sunfish	0	0	0	0	0	0	0	0	0	0	4
Green Sunfish	1	0	0	1	1	1	0	1	0	5	95
Largemouth Bass	4	2	1	6	5	7	11	1	0	37	73
Orangespotted Sunfish	0	0	0	0	1	0	0	0	0	1	2
Smallmouth Bass	1	0	0	0	0	0	0	0	0	1	4
Warmouth	1	0	1	0	1	0	0	0	0	3	3
White Crappie	0	0	0	1	0	3	4	0	0	8	10
Sauger	0	0	2	1	1	2	0	0	0	6	11
Freshwater Drum	33	20	19	8	9	7	7	3	3	109	187
Total individuals	150	71	172	131	135	133	155	76	77	1100	2010
Total species/hybrids	15/0	12/0	16/0	16/0	15/0	14/0	12/0	11/0	7/0	26/0	31/1

[a]First sampling on 26 August.
[b]Second sampling on 16 September.
[c]Third sampling on 23 September.
[d]Fourth sampling on 29 September.

Table 4. Number of individuals of each fish species collected on the Peoria Reach (RM 158-231) of the Middle Illinois River (RM 80-231) in 1994.

	River Mile and Hours Fished									
Species	163.4 0.70	170.6 1.00	180.6 1.00	193.2 1.00	202.6 0.75	203.0 1.00	207.6 0.50	214.9 1.00	Peoria Reach Total 6.95	Middle River Total 15.45
Longnose Gar	0	0	0	0	0	0	0	0	0	1
Gizzard Shad	0	13	1	18	1	0	0	12	45	136
Threadfin Shad	0	0	9	0	28	4	2	1	44	44
Skipjack Herring	0	1	0	2	1	1	1	0	6	6
Goldeye	0	0	1	0	0	1	0	0	2	4
Bullhead Minnow	0	0	0	0	3	0	0	1	4	5
Common Carp	27	4	4	2	0	1	4	6	48	253
Emerald Shiner	0	26	5	1	15	6	9	67	129	143
Goldfish	0	3	0	0	0	0	0	0	3	4
Minnow (unid.)	0	0	0	1	0	0	0	1	2	2
Red Shiner	0	0	0	0	0	0	0	0	0	11
Silver Chub	0	0	0	3	0	0	2	2	7	7
Spottail Shiner	0	0	0	1	0	0	0	2	3	3
Bigmouth Buffalo	0	0	4	1	1	10	4	9	29	82
Golden Redhorse	1	0	0	0	0	1	0	1	3	4
Quillback	0	0	0	0	0	0	0	1	1	1
River Carpsucker	10	1	3	0	0	3	2	2	21	22
Shorthead Redhorse	1	0	2	1	2	2	0	9	17	33
Smallmouth Buffalo	5	4	5	5	3	8	5	6	41	82
Channel Catfish	5	0	3	2	2	0	0	0	12	54
Flathead Catfish	0	0	1	0	0	0	0	0	1	5
White Bass	6	0	10	7	4	2	3	4	36	124
Black Crappie	3	3	1	2	0	3	0	3	15	112
Bluegill	36	70	18	13	23	19	12	31	222	483
Bluegill x Green Sunfish	4	0	0	0	0	0	0	0	4	4
Green Sunfish	44	37	4	0	0	0	0	5	90	95
Largemouth Bass	2	13	4	2	3	8	3	1	36	73
Orangespotted Sunfish	0	1	0	0	0	0	0	0	1	2
Smallmouth Bass	0	1	0	0	0	0	1	1	3	4
Warmouth	0	0	0	0	0	0	0	0	0	3
White Crappie	0	1	0	0	0	1	0	0	2	10
Sauger	0	2	0	2	0	1	0	0	5	11
Freshwater Drum	15	29	21	7	2	3	1	0	78	187
Total individuals	159	209	96	70	88	74	49	165	910	2010
Total species/hybrids	12/1	16/0	17/0	16/0	13/0	17/0	13/0	19/0	28/1	31/1

Table 5. Number of individuals of each fish species collected on the Upper Illinois Waterway (RM 231-280) in 1994.

	River Mile and Hours Fished							
Species	240.3 1.00	241.1 1.00	247.7 1.00	249.7 0.50	260.2 1.00	276.8 1.00	279.5 1.00	Upper Waterway Total 6.50
Gizzard Shad	5	9	28	3	6	18	27	96
Skipjack Herring	0	0	0	1	0	0	0	1
Bluntnose Minnow	1	2	37	5	25	84	53	207
Bullhead Minnow	4	12	0	0	3	5	3	27
Carp x Goldfish	0	0	2	0	0	7	0	9
Common Carp	3	5	6	3	0	6	13	36
Emerald Shiner	18	24	44	2	32	16	4	140
Golden Shiner	0	0	0	2	0	5	0	7
Goldfish	0	0	0	0	0	1	0	1
Minnow (unid.)	0	0	0	1	0	0	0	1
Red Shiner	2	0	0	6	0	0	0	8
Sand Shiner	1	7	6	0	11	0	0	25
Spottail Shiner	0	0	0	1	2	16	15	34
Golden Redhorse	0	1	0	0	4	1	1	7
Highfin Carpsucker	0	1	0	0	0	0	0	1
Northern Hog Sucker	0	0	0	0	1	0	0	1
River Carpsucker	0	1	0	1	3	0	1	6
Shorthead Redhorse	0	0	0	0	0	1	1	2
Smallmouth Buffalo	10	8	0	4	0	0	0	22
Channel Catfish	1	8	1	1	1	0	0	12
Flathead Catfish	0	0	0	0	0	1	0	1
Brook Silverside	0	0	0	0	0	0	1	1
White Bass	4	3	1	2	3	0	0	13
Black Crappie	0	0	0	0	0	0	2	2
Bluegill	4	3	17	1	6	19	1	51
Bluegill x Green Sunfish	0	0	0	0	0	1	0	1
Green Sunfish	2	0	2	0	2	9	20	35
Largemouth Bass	0	1	13	1	5	2	0	22
Orangespotted Sunfish	0	1	0	0	0	0	1	2
Pumpkinseed	0	0	0	0	0	1	0	1
Rock Bass	0	0	0	0	0	2	0	2
Smallmouth Bass	4	1	3	0	3	9	1	21
Slenderhead Darter	0	0	1	0	0	0	0	1
Freshwater Drum	0	0	3	0	2	1	0	6
Total individuals	59	87	164	34	109	205	144	802
Total species/hybrids	13/0	16/0	13/1	15/0	16/0	18/2	15/0	31/2

On the middle river, 2,010 fish were collected, representing 31 species plus one hybrid (Tables 3 and 4), a number consistent with collections made since 1989 (see Lerczak et al. 1994). The number of species collected at each station ranged from 7 at Pekin (RM 154.3), the lowest for the entire river, to 19 at Clark Island (RM 214.9), the highest for the entire river. The homogeneous habitat (lack of structure) of the Pekin station, mostly along the main channel border, is reflected in the low species count and total lack of centrarchids, which are usually found near rip-rap and woody debris. In contrast, the Clark Island station had an abundance of brush piles and undercut banks with exposed roots, which provided a fair diversity of structure sought by many fishes.

The Grape-Bar Islands station (RM 85.9) was sampled four times. Data from the second sampling on 16 September, however, may be less useful for comparison to data from the other three runs due to unusually unfavorable conditions during the electrofishing: first, it was an extremely windy day which made precise maneuvering of the electrofishing boat difficult; second, several vee-bottomed cruisers repeatedly caused large swells, which tossed the electrofishing boat about in the shallow water. In fact, at one point, the boat was forced onto the beach and swamped by waves, causing us to temporarily shut down all our equipment. The smaller number of species and individuals collected on the second run compared with the other three reflects the difficult conditions encountered while sampling. The other three sampling runs at this station were done under calm conditions with no interruptions. Although the small sample sizes for each species contributed much to catch variability, there seemed to be fairly good agreement among catches from the first, third, and fourth sampling runs (Table 3), insofar as relative

abundance of species. A further discussion of the Grape-Bar Island data is in the section of this report entitled "**Fish Communities as Derived from Electrofishing Catches.**"

On the upper waterway, 798 individual fish were collected representing 31 species plus two hybrids (Table 5), a number consistent with collections made since 1989 (see Lerczak et al. 1994). The number of species collected at each station ranged from 13 at Bulls Island (RM 240.3) to 18 at the Mouth of the Du Page River (RM 276.8). Two species never before collected during this project (begun in 1957) were single specimens of the slenderhead darter at Ballards Island (RM 247.7) and northern hog sucker at Waupecan Island (RM 260.2).

Catch Rates in Number of Individuals Collected per Hour by Reach.

In the following data summary, discussion is restricted either to species that each separately accounted for over 10% of the total catch or to species that were of special significance.

Alton (lower river). Ten species accounted for 96.2% of the total catch (Table 6 and 7). Bluegill was the most abundant (44.60 per hr), making up just over one-third of the total. Catches of channel catfish (16.20 per hr @ 13.3%), gizzard shad (12.40 per hr @ 10.2%), and freshwater drum (12.40 per hr @ 10.2%) were each at least one-third higher than catches of any other species. Gizzard shad remained a highly ranked species in 1994 (3rd), although catches were still well below the recent (since 1989) high of 1991 (29.56 per hr @ 20.1%). Catches of carp are of note for being uniquely consistent with those from other years of this project beginning with 1989, excepting 1990: 6.80 per hr @ 5.0% in 1989; 15.53 per hr @ 17.2% in 1990; 6.50 per hr @ 4.4% in 1991; 7.16 per hr @9.5% in 1992; no sampling in 1993;

Table 6. Number of individuals of each species collected per hour of electrofishing in 1994 arranged by waterway reach.

	Reach and Number of Hours Fished					
Species	Alton 5.00	La Grange 8.50	Peoria 6.95	Starved Rock 2.00	Marseilles 2.50	Dresden 2.00
Longnose Gar		0.12				
Bowfin	0.20					
Gizzard Shad	12.40	10.71	6.47	7.00	14.80	22.50
Skipjack Herring			0.86		0.40	
Threadfin Shad	0.40		6.33			
Goldeye		0.24	0.29			
Bluntnose Minnow				1.50	26.80	68.50
Bullhead Minnow		0.12	0.58	8.00	1.20	4.00
Carp x Goldfish					0.80	3.50
Common Carp	6.80	24.12	6.91	4.00	3.60	9.50
Emerald Shiner	1.80	1.65	18.56	21.00	31.20	10.00
Golden Shiner					0.80	2.50
Goldfish		0.12	0.43			0.50
Minnow (unid.)			0.29		0.40	
Red Shiner		1.29		1.00	2.40	
Sand Shiner				4.00	6.80	
Silver Chub			1.01			
Spottail Shiner			0.43		1.20	15.50
Bigmouth Buffalo	2.00	6.24	4.17			
Golden Redhorse		0.12	0.43	0.50	1.60	1.00
Highfin Carpsucker				0.50		
Northern Hog Sucker					0.40	
Quillback			0.14			
River Carpsucker		0.12	3.02	0.50	1.60	0.50
Shorthead Redhorse		1.88	2.45			1.00
Smallmouth Buffalo	3.60	4.82	5.90	9.00	1.60	
Channel Catfish	16.20	4.94	1.73	4.50	1.20	
Flathead Catfish	0.20	0.47	0.14			0.50
Yellow Bullhead	0.40					
Brook Silverside						0.50
White Bass	2.60	10.35	5.18	3.50	2.40	
Black Crappie	9.20	11.41	2.16			1.00
Bluegill	44.60	30.71	31.94	3.50	9.60	10.00
Bluegill x Green Sunfish			0.58			0.50
Green Sunfish	0.80	0.59	12.95	1.00	1.60	14.50
Largemouth Bass	7.40	4.35	5.18	0.50	7.60	1.00
Orangespotted Sunfish		0.12	0.14	0.50		0.50
Pumpkinseed						0.50
Rock Bass						1.00
Smallmouth Bass		0.12	0.43	2.50	2.40	5.00
Warmouth	0.60	0.35				
White Crappie		0.94	0.29			
Sauger	0.20	0.71	0.72			
Slenderhead Darter					0.40	
Freshwater Drum	12.40	12.82	11.22		2.00	0.50
Total number per hr	121.80	129.41	130.94	73.00	122.80	174.50
Number of species/hybrids	18/0	26/0	28/1	18/0	22/1	22/2

Table 7. Species ranked by relative abundance in number of fish collected per hr for 1994. Species were added to the list in descending order of abundance until 95% of the total catch rate for that reach was obtained. Percentages in parentheses are below the ranks.

	Rankings by Reach					
Species	Alton	La Grange	Peoria	Starved Rock	Marseilles	Dresden
Gizzard Shad	3 (10.2)	5 (8.3)	6 (4.9)	4 (9.6)	3 (12.1)	2 (12.9)
Threadfin Shad			7 (4.8)			
Bluntnose Minnow				9 (2.1)	2 (21.8)	1 (39.3)
Bullhead Minnow				3 (11.0)		8 (2.3)
Carp x Goldfish						9 (2.0)
Common Carp	6 (5.6)	2 (18.6)	5 (5.3)	6 (5.5)	7 (2.9)	6 (5.4)
Emerald Shiner		12 (1.3)	2 (14.2)	1 (28.8)	1 (25.4)	5 (5.7)
Golden Shiner						10 (1.4)
Red Shiner				10 (1.4)	8 (2.0)	
Sand Shiner				6 (5.5)	6 (5.5)	
Silver Chub			15 (0.8)			
Spottail Shiner						3 (8.9)
Bigmouth Buffalo	9 (1.6)	7 (4.8)	10 (3.2)			
Golden Redhorse					10 (1.3)	
River Carpsucker			11 (2.3)		10 (1.3)	
Shorthead Redhorse		11 (1.5)	12 (1.9)			
Smallmouth Buffalo	7 (3.0)	9 (3.7)	8 (4.5)	2 (12.3)	10 (1.3)	
Channel Catfish	2 (13.3)	8 (3.8)	14 (1.3)	5 (6.2)	11 (0.6)	

Table 7. Continued.

Species	Rankings by Reach					
	Alton	La Grange	Peoria	Starved Rock	Marseilles	Dresden
White Bass	8 (2.1)	6 (8.0)	9 (4.0)	7 (4.8)	8 (2.0)	
Black Crappie	4 (7.6)	4 (8.8)	13 (1.6)			11 (1.0)
Bluegill	1 (36.6)	1 (23.7)	1 (24.4)	7 (4.8)	4 (7.8)	5 (5.7)
Green Sunfish			3 (9.9)		10 (1.3)	4 (8.3)
Largemouth Bass	5 (6.1)	10 (3.4)	9 (4.0)		5 (6.2)	
Smallmouth Bass				8 (3.4)	8 (2.0)	7 (2.9)
Freshwater Drum	3 (10.2)	3 (9.9)	4 (8.6)		9 (1.6)	
Number of fishes accounting for 95%	10	12	16	12	16	12

and 6.80 per hr @ 5.6% in 1994.

La Grange (middle river). Twelve species accounted for 95.8% of the total catch (Tables 6 and 7). Similar to Alton Reach, bluegill was the most abundant species (30.71 per hr) making up 23.7% of the total. Catches of carp (24.12 per hr @ 18.6%) were over twice the carp catch rate of any other reach. Unlike the Peoria Reach, gizzard shad appeared to have recovered from a steady five-year decline, from 37.89 per hr in 1989 to a low of 5.80 per hr in 1992 (Lerczak et al. 1994:28-32), increasing to 10.71 per hr in 1994. La Grange Reach catches are discussed further in the section entitled "**Fish Communities as Derived from Electrofishing Catches**" and compared to catches made by the Long Term Resource Monitoring Program.

Peoria (middle river). Sixteen species accounted for 95.6% of the total catch (Tables 6 and 7). Similar to catches from Alton and La Grange Reaches, bluegill was the most abundant (31.94 per hr), making up 24.4% of the total. The second highest catch was for emerald shiner at 18.56 per hr (14.2%). Although the green sunfish represented 9.9% of the catch in the Peoria reach, they were abundant only at Lower Peoria Lake (RM 163.4) and Lambies Boat Harbor (RM 170.6), and were collected in small numbers or were absent elsewhere (Table 4). Much of the sampling at these two stations, in contrast to other stations of this reach, occurred along rip-rap, a structure favored by small green sunfish and other centrarchids. Catches of gizzard shad have declined steadily since 1990 (56.09 per hr @ 39.0%) to 6.47 per hr in 1994, representing only 4.9% of the total.

Starved Rock (upper river). Twelve species accounted for 95.2% of the total catch (Tables 6 and 7). Emerald shiner was the most numerous (21.00 per hr) making up 28.8% of the total. Together with smallmouth buffalo (9.00 per

hr @ 12.3%) and bullhead minnow (8.00 per hr @ 11.0%), these three species represented slightly over one-half of the total. Catches of gizzard shad (7.00 per hr) improved from the six-year low of 0.50 per hr in 1993, but were still on the low side relative to catches from other recent years (Lerczak et al. 1994:26-34).

Marseilles (upper river). Sixteen species accounted for 95.4% of the total catch (Table 6 and 7). Emerald shiner was the most abundant (31.20 per hr) making up one-quarter of the total. Bluntnose minnow (26.80 per hr @ 21.8%) and gizzard shad (14.80 per hr @ 12.1%) also made substantive contributions to the total. Catches of largemouth bass (7.60 per hr) represented only 6.2% (5th ranked) of the total for this reach, but were the highest catch for this species for any reach (Table 6). Catches of carp (3.60 per hr @2.9%) were the lowest for any reach (Table 6).

Dresden (Des Plaines River). Eleven species plus one hybrid accounted for 95.4% of the total catch (Tables 6 and 7). Bluntnose minnow was the most abundant (68.5 per hr) making up 39.3% of the total. Gizzard shad was second in abundance (22.50 per hr @ 12.9%), and was over twice as numerous as any other species except spottail shiner (15.50 per hr @ 8.9%) and green sunfish (14.50 per hr @8.3%). Although carp x goldfish were collected in relatively small numbers (3.50 per hr @ 2.0%), they are an expected yearly component of Dresden Reach catches, having been collected in every year since 1989. As this fish may be considered the quintessential indicator of a polluted ecosystem (Karr et al. 1986), its yearly presence is noteworthy, especially as species less tolerant of pollution (e.g., largemouth and smallmouth bass) have recently (last 15 years) become more abundant (Lerczak et al. 1994).

Species Richness by Rarefaction. At n = 146, no reach was unique for having yielded an exceptionally large number of expected species (Table 8). Marseilles and Peoria Reaches both had $E[S_{146}]$ equal to 20, even though the latter reach has over nine times the amount of off-channel aquatic habitat (46 and 425 acres per mile, respectively). Similarly, $E[S_{146}]$ for Marseilles Reach was 25% greater than $E[S_{146}]$ for La Grange Reach (16), where the amount of off-channel aquatic habitat for the latter is 334 acres per mile (Lerczak et al. 1994:5). Although no overall upstream-downstream pattern was evident for $E[S_{146}]$, values declined steadily from Peoria to Alton Reach, which stands out for its low value of 14 (Table 8).

Species Evenness. James and Rathbun (1981) indicated that the shape of the relative abundance curves (e.g., degree of steepness) may serve as a qualitative index to species evenness. Austen (1992) applied this technique to compare fish community structures among a variety of Illinois Lakes. For the hypothetical case of maximum evenness, all species are equally abundant and will be equally ranked with all data points having the same coordinates. For each graph in Figure 2, a horizontal line was drawn at the percentage of maximum evenness where each species would represent an equal percentage of the community. A highly even community would have most of the data points near this line. Conversely, for a community dominated by only a few species, the curve will initially be steep for the most common species and then may become more horizontal for the rare species, several of which may occupy the same coordinates (i.e., equal ranks and equal percentages).

No reach exhibited a high degree of evenness (Figure 2). In all reaches, there was at least one species that represented over 20% of the catch, which tended to make the initial part of each curve rather steep. Each reach was

Table 8. Fish community statistics by navigation reach for 1994 with the expected number of species, $E[S_n]$, at n = 146.

Reach	Number of Species/Hybrids	Number of Individuals	$E[S_{146}]$
Dresden	22/2	349	18
Marseilles	22/1	306	20
Starved Rock	18/0	146	18
Peoria	28/1	908	20
La Grange	26/0	1100	16
Alton	18/0	609	14

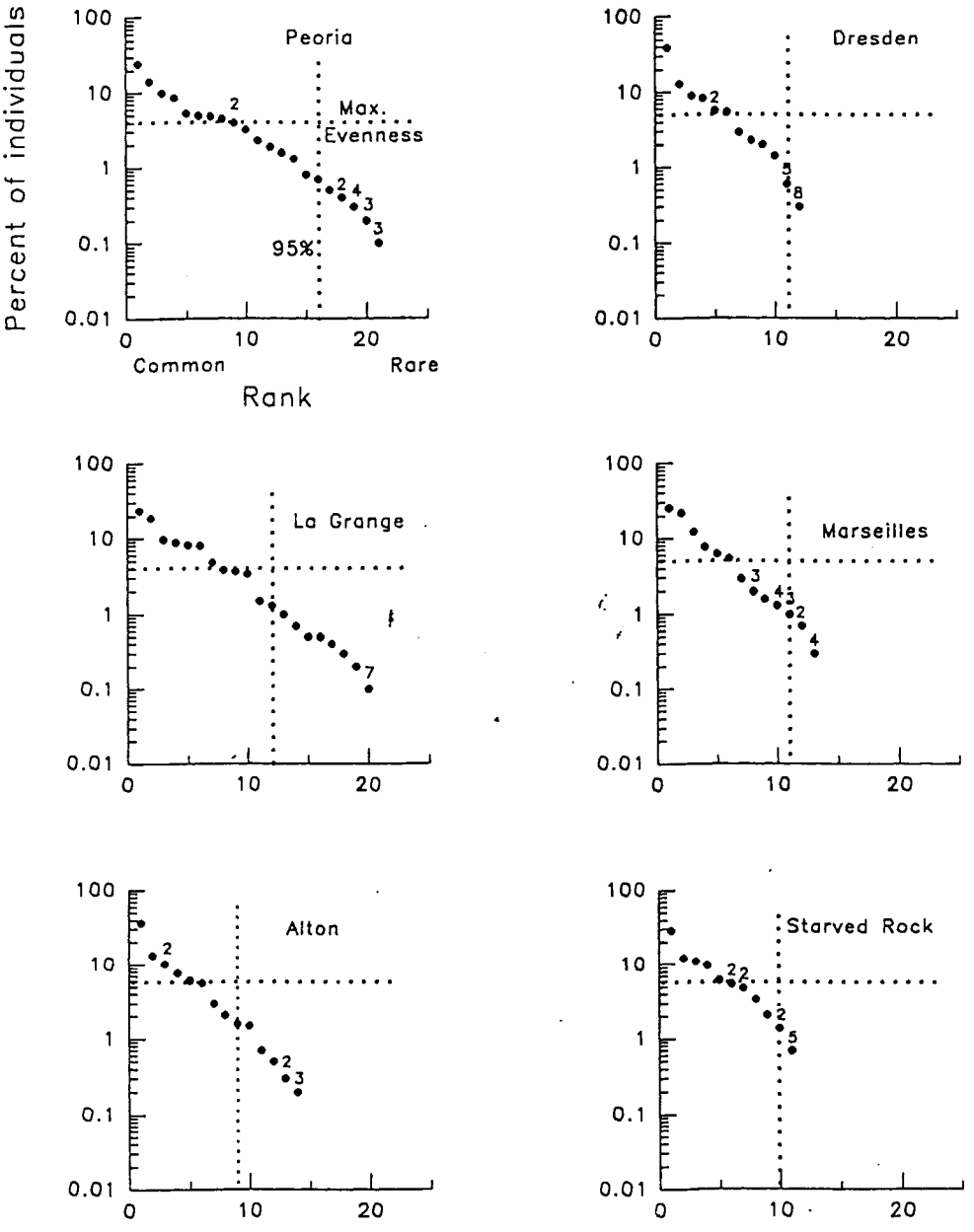


Figure 2. Species abundance plots by navigation reach for 1994. Vertical lines were drawn at the species rank where individuals in sum made up approximately 95% of the total catch for each reach. Horizontal lines show the case of maximum evenness where each species represents the same percentage of the total catch for each reach. Numerals above data points indicate the number of tied ranks.

also represented by many rare species (i.e., data points to the right of the vertical 95% line). The results of Figure 2 and Table 7 suggest that species evenness was low throughout the river.

Analyses of species richness and evenness do not account for size differences among individuals. To more fully describe fish community characteristics, therefore, it is necessary to examine the distribution of weight among the various species.

Catch Rates in Weight (pounds) Collected per Hour by Reach.

In the following data summary, discussion is restricted to species that each separately accounted for over 10% of the total catch and to species that were of special significance.

Alton (lower river). Eight species accounted for 95.7% of the total catch by weight (Tables 9 and 10). The catch rate of carp was highest (21.87 lb per hr) representing slightly over one-third of the total. At 18.59 lb per hr (29.8%), the catch rate of channel catfish was not much less than carp. The catch rate of largemouth bass (6.43 lb per hr @ 10.3%) was the highest for this species for all reaches, although as a percentage of the total, was exceeded by the Marseilles Reach catch (20.0%). Bigmouth buffalo (4.37 lb per hr), normally a large part of weight catch rates on the lower/middle river, accounted for only 7% of the total. Although this was the lowest percentage for the last six years, the lowest bigmouth buffalo catch on the lower river (3.58 lb per hr @ 9.4%) was in 1991 (Lerczak et al. 1994:38-44).

La Grange (middle river). Nine species accounted for 95.5% of the total catch by weight (Tables 9 and 10). The catch rate of carp was highest (47.71 lb per hr) representing one-half of the total, greatly exceeding catches of

Table 9. Pounds of each fish species collected per hour of electrofishing in 1994 arranged by waterway reach. Blanks indicate weight data were not available or the species was not taken (see Table 6). Pounds per hour less than 0.01 are indicated by 0.00.

	Reach and Number of Hours Fished					
Species	Alton 5.00	La Grange 8.50	Peoria 6.95	Starved Rock 2.00	Marseilles 2.50	Dresden 2.00
Longnose Gar		0.04				
Bowfin	0.44					
Gizzard Shad	0.99	1.49	0.74	1.85	1.75	1.98
Skipjack Herring			0.24		0.02	
Threadfin Shad	0.01		0.02			
Goldeye		0.05	0.11			
Bluntnose Minnow				0.00	0.06	0.21
Bullhead Minnow		0.00	0.00	0.02	0.00	0.02
Carp x Goldfish					0.86	4.38
Common Carp	21.91	47.95	12.30	9.14	5.46	20.97
Emerald Shiner	0.00	0.00	0.03	0.07	0.10	0.07
Golden Shiner					0.00	0.05
Goldfish		0.12	0.15			0.12
Minnow (unid.)			0.00		0.00	0.00
Red Shiner		0.00		0.00	0.00	
Sand Shiner				0.01	0.01	
Silver Chub			0.02			
Spottail Shiner			0.00		0.01	0.10
Bigmouth Buffalo	4.37	18.50	12.36			
Golden Redhorse		0.00	0.35	0.22	0.61	0.52
Highfin Carpsucker				0.37		
Northern Hog Sucker					0.02	
Quillback			0.17			
River Carpsucker		0.16	4.14	0.38	1.37	0.85
Shorthead Redhorse		0.64	1.27			0.03
Smallmouth Buffalo	1.05	3.18	5.15	12.11	3.26	
Channel Catfish	18.59	7.11	2.48	4.51	1.27	
Flathead Catfish	0.56	1.44	0.44			4.35
Yellow Bullhead	0.17					
Brook Silverside						0.00
White Bass	0.41	1.56	1.23	0.47	0.46	
Black Crappie	2.40	3.67	0.30			0.38
Bluegill	2.70	1.90	2.20	0.03	0.54	0.77
Bluegill x Green Sunfish			0.19			0.00
Green Sunfish	0.04	0.04	1.23	0.06	0.17	0.36
Largemouth Bass	6.43	5.53	3.02	0.21	4.20	0.21
Orangespotted Sunfish		0.00	0.01	0.00		0.01
Pumpkinseed						0.06
Rock Bass						0.18
Smallmouth Bass		0.00	0.02	0.07	0.11	0.80
Warmouth	0.05	0.01				
White Crappie		0.33	0.12			
Sauger	0.03	0.14	0.12			
Slenderhead Darter					0.00	
Freshwater Drum	2.28	1.29	2.15		0.66	0.88
Total	62.42	95.17	50.56	29.50	20.95	37.24

Table 10. Species ranked by relative abundance in pounds collected per hr for 1994. Species were added to the list in descending order of abundance until 95% of the total catch rate for that reach was obtained. Percentages in parentheses are below the ranks.

	Rankings by Reach					
Species	Alton	La Grange	Peoria	Starved Rock	Marseilles	Dresden
Gizzard Shad		9 (1.6)	11 (1.4)	4 (6.3)	4 (8.4)	4 (5.3)
Carp x Goldfish					7 (4.1)	2 (11.8)
Common Carp	1 (35.1)	1 (50.4)	2 (24.3)	2 (31.0)	1 (26.1)	1 (56.3)
Bigmouth Buffalo	4 (7.0)	2 (19.4)	1 (24.4)			
Golden Redhorse					9 (2.9)	9 (1.4)
River Carpsucker			4 (8.2)		5 (6.5)	6 (2.3)
Shorthead Redhorse			9 (2.5)			
Smallmouth Buffalo	8 (1.7)	6 (3.3)	3 (10.2)	1 (41.1)	3 (15.6)	
Channel Catfish	2 (29.8)	3 (7.5)	6 (4.9)	3 (15.3)	6 (6.1)	
Flathead Catfish						3 (11.7)
White Bass		8 (1.7)	10 (2.4)	5 (1.6)		
Black Crappie	6 (3.8)	5 (3.9)				
Bluegill	5 (4.3)	7 (2.0)	7 (4.4)		10 (2.6)	8 (2.1)
Green Sunfish			10 (2.4)			
Largemouth Bass	3 (10.3)	4 (5.8)	5 (6.0)		2 (20.0)	
Smallmouth Bass						7 (2.1)
Freshwater Drum	7 (3.7)		8 (4.3)		8 (3.2)	5 (2.4)
Number of fishes accounting for 95%	8	9	12	5	10	9

other species. Catches of bigmouth buffalo ranked second (18.50 lb per hr) making up just under one-fifth of the total, and were the highest catch of this species by weight for any reach or year since 1989; the previous high for any reach was also on La Grange in 1992 (12.29 lb per hr @ 24.2%). In fact, weight catch rates of bigmouth buffalo were consistently highest on La Grange Reach for all sampling years since 1989 except for 1991 where they were highest in Peoria Reach (11.19 lb per hr @22.4%).

Peoria (middle river). Twelve species accounted for 95.4% of the total catch by weight (Tables 9 and 10). The catch rate of bigmouth buffalo was highest (12.36 lb per hr), followed closely by carp (12.01 lb per hr), with each making up just under one-fourth of the total. Together with smallmouth buffalo (5.15 lb per hr @10.2%) and river carpsucker (4.14 lb per hr @8.2%) these four species accounted for two-thirds of the total.

Starved Rock (upper river). Five species accounted for 95.2% of the total catch by weight (Tables 9 and 10), the lowest number of species on a weight 95% list for any reach and year except Starved Rock in 1990, 1991, and 1993, all of which listed five species. The catch rate of smallmouth buffalo was highest (12.11 lb per hr) representing 41.1% of the total, and was also the highest smallmouth buffalo catch by weight for any reach. Carp was second highest at 9.14 lb per hr (31.0%). Channel catfish also contributed significantly to the total weight (4.51 lb per hr @ 15.3%).

Marseilles (upper river). Nine species plus one hybrid accounted for 95.4% of the total catch by weight (Tables 9 and 10). The catch rate of carp again was highest (5.46 lb per hr) representing 26.1% of the total; they were not, however, greatly in excess of the next two highly ranked species, largemouth bass (4.20 lb per hr @ 20.0%) and smallmouth buffalo (3.26 lb per

hr @ 15.6%). In fact, the weight catch rate of carp was the lowest for this reach since 1989 (Lerczak et al 1994:38-46), and was, except for the catch from Starved Rock Reach in 1990 (0.81 lb per hr @ 2.8%), the lowest for any reach since 1989.

Dresden (Des Plaines River). Eight species plus one hybrid accounted for 95.3% of the total catch by weight (Tables 9 and 10). Carp represented much more of the total catch than any other species at 20.97 lb per hr or 56.3% of the total. As with other years since 1989, carp x goldfish made a substantial contribution to the total (4.38 lb per hr @ 11.8%). Flathead catfish was of unique importance in 1994 at 4.35 lb per hr (11.7%), because it had not been collected from this reach before on this survey.

These analyses indicate that fish communities of the Illinois River in 1994 in terms of weight were dominated by a few massive species such as carp, buffalofishes, channel catfish, and largemouth bass. This was also the case during the past several years (Lerczak et al. 1994:38-44).

Fish Communities as Derived from Electrofishing Catches.

For this analysis, fish communities were defined similar to Austen (1992:2) as an aggregation of fish populations over a defined area that interact to an unknown degree. By definition, a fish community includes all species in a given area; but because not all species present in the community are equally susceptible to electroshocking, some may be over- or under-represented or even absent from our electrofishing catches (Austen 1992:19-25). Even so, electrofishing is efficient at collecting a wide variety of the species actually present in a given area (Austen 1992:21-22). As long as

biases due to gear selectivity are accounted for, electrofishing catches can provide a useful index to describing actual fish communities, at least as far as which species are most important to community structure.

Sampling stations were ordered by cluster analysis into pairs or groups of pairs based on their similarity in species composition and abundance. The results were summarized into a dendrogram that shows which stations are most similar based on chord distance between pairs (Ludwig and Reynolds 1988:170). Similarity between pairs is inversely related to chord distance. Using this technique and number catch rates from 1991 and 1992, Lerczak et al. (1994:52-56) suggested Illinois River fish populations were roughly organized into two or perhaps three fish communities which corresponded in a general way to the lower/middle river segments and the upper river segment including Dresden Reach (see Figure 1).

Figure 3 shows a dendrogram resulting from a cluster analysis of 1994 number catch rates by station. Stations are labeled according to Figure 1 and Table 1. The dashed line at chord distance 1.65 (see Lerczak et al. 1994:53-54) defines three clusters. Cluster III contains all upper river stations plus two middle river stations (M14 and M6). Cluster II consists of four of the six La Grange Reach stations. Cluster I contains the rest of the stations including the four Grape-Island repeat samples (M1A, M1B, M1C, M1D). Although these four stations were not clustered directly together, all are in a sub-cluster of cluster I at chord distance 0.826, which also contains three lower river stations (L1, L2, and L4) and the Mississippi River station (MR). This suggests the Grape-Bar Island samples were more similar to lower river catches and to each other than they were to catches from other nearby stations of La Grange Reach (cluster II). In the same way, most lower and middle river

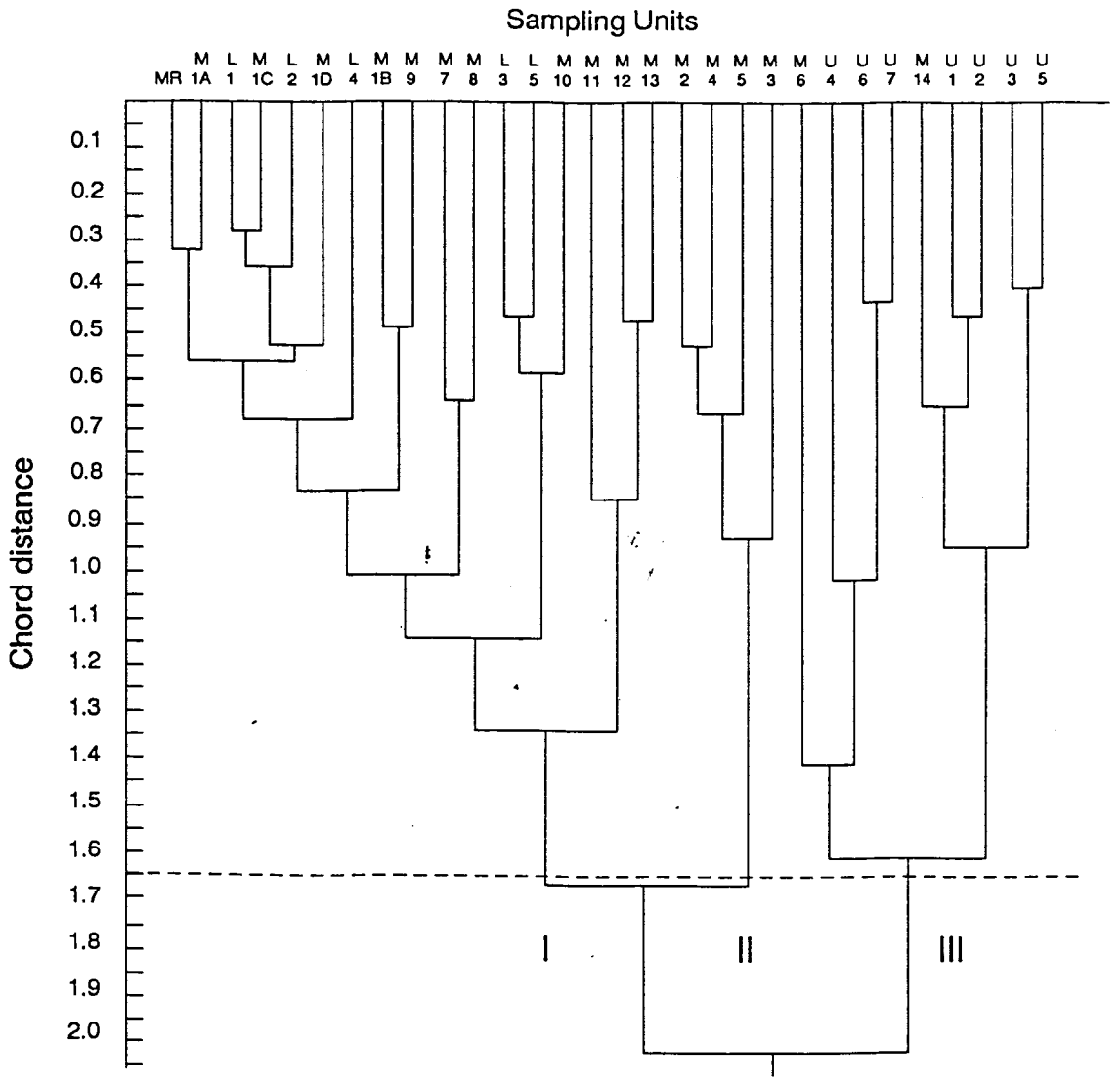


Figure 3. Cluster analysis (flexible strategy, Beta = -0.25) of electrofishing stations (sampling units) based on the number of fish collected per hour at each station in 1994. Sampling unit labels correspond to station labels in Figure 1 and Table 1. L = lower, M = middle, U = upper.

catches were more similar to each other than to catches from upper river stations (cluster III).

Catches from 1994 indicated that Illinois River fish communities exhibited low species evenness (Figure 2), while, at the same time, total fish biomass was dominated by a small number of species (Table 10). Species represented by high percentages of both number and weight catch rates are probably primary users of food resources and habitat space in a given area. Species which represent a majority of community biomass but are not highly abundant (e.g., largemouth bass) or highly abundant species with low population biomass (e.g., emerald shiner) may be of secondary importance. Those species not in the above two broad categories are probably inconsequential in terms of identifying significant long-term trends in community structure.

Table 11 shows a list of species by reach that represented at least 5% of weight or number catch rates or were on both types (weight and number) of 95% lists (Tables 7 and 10). Seven species were of widespread importance to fish communities either in number of individuals, weight, or both (Table 11). Carp and gizzard shad were the only species on both weight and number 95% lists for all reaches.

The upper waterway fish community consisted of the seven widespread species plus eight that were important only to the upper waterway (Table 11). Small cyprinids (minnow and shiner species) were an important component of the upper waterway fish community. Along with gizzard shad, these species probably provide an ample forage base for largemouth and smallmouth bass and other carnivorous fishes of the upper waterway that include fish as a part of their diet: black crappie, rock bass, green sunfish, channel catfish (Forbes

Table 11. Fish communites of the Illinois Waterway in 1994. Species were listed with an "X" only if they were on 95% lists of Tables 7 and 10 for both catches by weight and individuals collected per hour or if they represented at least 5% of the total catch by reach on either list.

	Lower	Middle		Upper		
Species of 95% Lists	Alton	La Grange	Peoria	Starved Rock	Marseilles	Dresden
Widespread						
Gizzard Shad	X	X	X	X	X	X
Common Carp	X	X	X	X	X	X
Smallmouth Buffalo	X	X	X	X	X	
Channel Catfish	X	X	X	X	X	
Bluegill	X	X	X		X	X
Largemouth Bass	X	X	X		X	
Freshwater Drum	X	X	X		X	
Upper Only						
Bluntnose Minnow					X	X
Bullhead Minnow				X		
Carp x Goldfish						X
Sand Shiner				X	X	
Spottail Shiner						X
Golden Redhorse					X	
Flathead Catfish[a]						X
Smallmouth Bass						X
Upper/Middle Only						
Emerald Shiner			X	X	X	X
River Carpsucker			X		X	
White Bass		X	X	X		
Green Sunfish			X			X
Lower/Middle Only						
Bigmouth Buffalo	X	X	X			
Shorthead Redhorse			X			
Black Crappie	X	X				

[a]Represented by one large individual (30 in [75.5 cm] TL, 9 lb [3940 g]).

1880, Pflieger 1975, Austen 1992).

Cluster analysis of the 1994 data (Figure 3) did not clearly distinguish between the lower and middle river, and there were no species on the 95% lists of unique importance to the lower river (Table 11). For these reasons, only two overlapping assemblages of fishes could reasonably be defined.

The upper/middle river community consisted of the seven widespread species plus four that were important only in reaches above La Grange Lock and Dam (Table 11 and Figure 1). The lower/middle community consisted of the seven widespread species plus three species that were of importance only to the lower/middle river (Table 11). The emerald shiner was the only small cyprinid significant in the middle river, which suggests that gizzard shad and small individuals of other species, particularly bluegill due to its abundance (Table 6), may be of greater importance than small cyprinids as forage for lower/middle river piscivores.

To determine which species' catch rates might be less truly representative of their actual relative abundance in the river, catch data from La Grange Reach collected on our project (the long-term electrofishing survey [LTEF]) were compared with catch data collected by the more intensive sampling of the Long Term Resource Monitoring Program (LTRMP) at Havana. Because of the greater amount of sampling done by LTRMP, their data are probably a better approximation of the actual fish community. All LTRMP sampling runs were at randomly chosen sites; all LTEF sites were fixed. In addition to pulsed D.C. electrofishing conducted for 48 15-min runs during daylight and 49 15-min runs at night, LTRMP personnel made 140 net sets of several types (e.g., fyke nets, hoop nets) plus conducted 30 seine and 10 trawl samples from 15 June through October 1994. Although the number of

species obtained by LTRMP (57 plus 3 hybrids) was much greater than we collected (26), the 95% lists (i.e., the most important species in defining fish communities) for the two surveys showed many similarities (Table 12). For example, the 95% list for LTRMP consisted of 13 species where 10 were the same as ours. Though only the red shiner was ranked the same (13th), others were similar (e.g., ranks 3 through 6). The higher ranking of sauger in LTRMP catches suggests that sauger were under-represented in our catches. Channel catfish also seemed to be somewhat under-represented in our catches. Another discrepancy occurred with bluegill, which ranked highest in our catches (23.73% of the total), but only eighth (4.05%) in LTRMP catches. One possible explanation may be related to different sampling methodologies: for LTEF, electroshocking is focused on areas with structure (likely hiding places for bluegill), while with LTRMP the randomly chosen sites that were electroshocked and where nets were set may not contain any structure, and may, therefore, have had few bluegill. Of note is the fact that all species on the LTRMP list (Table 12) except grass carp were, at some time in the past, collected during the LTEF project (Appendix A). As the grass carp is now thought to be reproducing in the Illinois River (Raibley et al. 1995), we expect them to show up in catches in the near future. The low rankings of most small cyprinid species (except red and emerald shiners) were consistent in both projects. This comparison suggests that LTEF data are useful in providing a first approximation of Illinois River fish communities, but that caution should be exercised when interpreting the data.

Table 12. Fish catches from La Grange Reach for main- and side-channel habitats collected during the LTEF survey (project F-101-R) and by LTRMP in 1994. Numbers preceded by an asterisk in sum accounted for approximately 95% of the total.

	LTEF			LTRMP		
Species	Number	Percent	Rank	Number	Percent	Rank
Bluegill	*261	23.73	1	*1172	4.05	8
Common Carp	*205	18.64	2	*8351	28.86	1
Freshwater Drum	*109	9.91	3	*1552	5.36	6
Black Crappie	*97	8.82	4	*2014	6.96	5
Gizzard Shad	*91	8.27	5	*2301	7.95	4
White Bass	*88	8.00	6	*3493	12.07	3
Bigmouth Buffalo	*53	4.82	7	*419	1.45	11
Channel Catfish	*42	3.82	8	*4946	17.09	2
Smallmouth Buffalo	*41	3.73	9	*1519	5.25	7
Largemouth Bass	*37	3.36	10	287	0.99	14
Shorthead Redhorse	*16	1.45	11	79	0.27	16
Emerald Shiner	*14	1.27	12	*569	1.97	10
Red Shiner	11	1.00	13	*301	1.04	13
White Crappie	8	0.73	14	*820	2.83	9
Sauger	6	0.55	15	*309	1.07	12
Green Sunfish	5	0.45	16	28	0.10	25
Flathead Catfish	4	0.36	17	66	0.23	19
Warmouth	3	0.27	18	6	0.02	36
Goldeye	2	0.18	19	18	0.06	29
Orangespotted Sunfish	1	0.09	20	5	0.02	37
Bullhead Minnow	1	0.09	20	25	0.09	26
Goldfish	1	0.09	20	12	0.04	30
Longnose Gar	1	0.09	20	11	0.04	31
Golden Redhorse	1	0.09	20	2	0.01	39
Smallmouth Bass	1	0.09	20			
River Carpsucker	1	0.09	20	71	0.25	17
Threadfin Shad				104	0.36	15
Shortnose Gar				70	0.24	18
Black Buffalo				51	0.18	20
Skipjack Herring				48	0.17	21
Yellow Bass				38	0.13	22
Silver Chub				35	0.12	23
Spottail Shiner				33	0.11	24
Carp x Goldfish				23	0.08	27
Black Bullhead				22	0.08	28
Brown Bullhead				22	0.08	28
Mosquitofish				18	0.06	29
Blackstripe Topminnow				12	0.04	30
Northern Pike				12	0.04	30
Golden Shiner				11	0.04	31
Blue Catfish				10	0.03	32
White Perch				9	0.03	33
Striped x White Bass				8	0.03	34
Walleye				7	0.02	35
Grass Carp				5	0.02	37
Bowfin				3	0.01	28
Brook Silverside				3	0.01	38
Bluntnose Minnow				2	0.01	39
Silverband Shiner				2	0.01	39
American Eel				1	0.00	40
Bluegill x Green Sunfish				1	0.00	40
Grass Pickerel				1	0.00	40
Johnny Darter				1	0.00	40
Northern Hog Sucker				1	0.00	40
Quillback				1	0.00	40
Silver Redhorse				1	0.00	40
Striped Bass				1	0.00	40
Yellow Perch				1	0.00	40
Total individuals	1100			28933		
Number of species/hybrids	26/0			57/3		

Some Possible Causes for Upstream-Downstream Differences in Fish Communities.

What are the factors responsible for shaping fish communities in the Illinois River? To answer this question at the level of complexity it deserves requires a long-term perspective and is, for the most part, beyond the scope of this report. Certain general statements, however, can be made.

We know that fish communities in the Illinois River in recent years are very different from those that occurred three decades ago at the beginning of the LTEF survey (Sparks and Starrett 1975, Lerczak et al. 1993, Lerczak et al. 1994). The explanation given for the changes has been that improvements in municipal and industrial pollution control over the last twenty years have resulted in better water quality (Butts 1987), which allowed species less tolerant of pollution to expand their populations and ranges (Lerczak et al. 1994). One example of this phenomenon was the increase in centrarchids on the upper waterway from near zero per hour in the early 1960s to a consistent catch of about 15 per hour (less the green sunfish) since 1990. Therefore, predation on small fish by truly piscivorous species such as smallmouth and largemouth bass and also to a lesser extent by other carnivorous fishes may, in recent years, be a biotic interaction on the upper waterway virtually absent thirty years ago.

Other environmental factors that could influence fish populations are the availability of suitable spawning and overwintering habitats, proper timing of spawning with spring floods that allow access to backwaters and tributaries, and presence or absence of submersed aquatic vegetation (SAV) as a substrate for an invertebrate food resource and as refuge from predators for young-of-the-year or small species. Though more work needs to be done to examine each of these factors, cursory observations made during electrofishing runs of the

last several years indicate an abundance of SAV at sampling stations above the Starved Rock dam and a virtual lack of SAV at stations below the dam, with the exception of the Grape-Bar Islands station (RM 86) in La Grange Reach. These observations are suggestive that perhaps the high abundance of small cyprinids on the upper waterway is related to the presence of SAV.

It is well known that excessive sedimentation, another factor that shows strong upstream-to-downstream differences, has the effect of reducing spatial heterogeneity of aquatic landscapes (Buck 1956, Bellrose et al. 1979, National Research Council 1992:195-197). The lower/middle river reaches receive much higher sediment loads than upper river reaches (Demissie et al. 1992:23). And, of course, the Alton Reach, being the farthest downstream, receives the most. This is supported by our measurements of Secchi disk transparency, which generally decreased in the downstream direction in 1994 (Table 1) and in other years of this project (Lerczak et al. 1994:18-21). Because species diversity is thought to be directly related to habitat diversity (Schlosser 1991), as habitats become simplified, fewer species may be expected. If the amount of sediment loading in the river is directly correlated with the degree of habitat simplification, with everything else (e.g., municipal and industrial waste loading) being equal, species richness might be expected to decrease in the downstream direction, as it did in 1994. However, this has generally not been the case during other recent years of this project (Lerczak et al. 1994:26-34).

The recent development of zebra mussel (Dreissena polymorpha) populations in the Illinois River might be a new factor with the potential to influence fish community composition. Sparks (1994) suggested that extremely low levels of dissolved oxygen (e.g, 1.5 ppm on 29 June 1994) measured on the lower river

during the 1994 summer may be a result of increased oxygen demands from decomposition of dead zebra mussels following a widespread population crash. If this hypothesis is true and zebra mussel population crashes regularly occur, excessively low DO levels on the lower river may become more common. Should this phenomenon occur often over a wide area and for an extended time, the fish community might then shift toward dominance by species more tolerant of low DO, such as carp and gar. Catches of carp on the lower river in 1994, however, were very consistent with catches from 1989 to 1992 (Table 6 and Lerczak et al. 1994:58-59), indicating such a community composition shift has not begun. Changes in gar populations, unfortunately, are harder to monitor because they are rarely taken by electrofishing (Sparks and Starrett 1975, Table 12). Even so, we will be watching this situation closely over the next several years of this project.

Environmental data collected on this survey have not been extensive enough nor included the type of information needed to examine how influential a particular habitat or environmental factor may be on fish populations and community structure. In order to examine correlations between fish catches and environmental variables, data must be obtained from elsewhere. Some long-term water quality data are available from the U.S. Geological Survey and the Illinois Environmental Protection Agency for a few selected dates and sites, which, after being compiled and entered into a computer database, will be analyzed and compared to fish catches for presentation in a future report.

Fish Health Determined by External Visual Inspection.

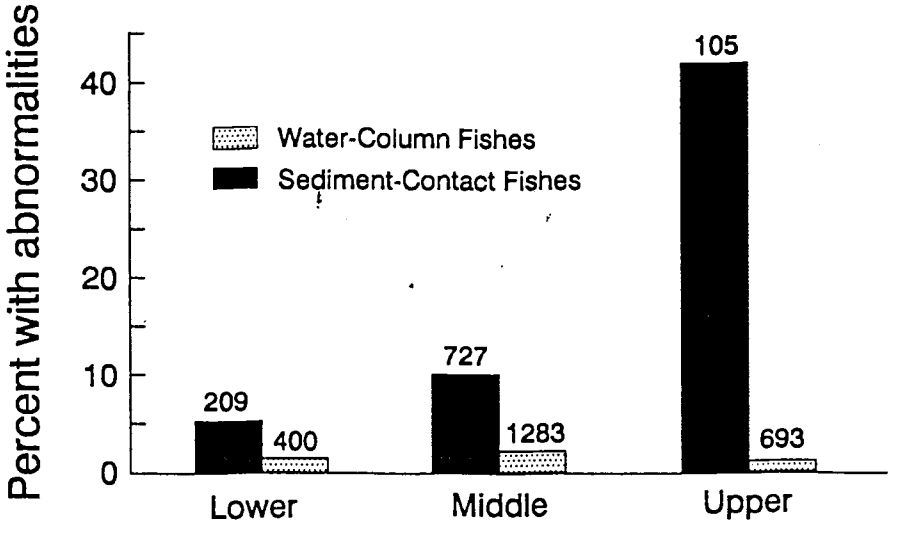
For all three river segments, sediment-contact fishes (e.g, carp) had a higher incidence of external abnormalities (sores, eroded fins) than water-

column fishes (e.g., bluegill) (Figure 4). In addition, the percentage of sediment-contact fishes with abnormalities increased in the upstream direction toward the Chicago area. There did not appear to be a longitudinal trend for water-column species. These findings are consistent with results from other years of this survey (Lerczak et al. 1994). Speculations on the possible cause(s) of the abnormalities have appeared elsewhere (Sparks and Lerczak 1993, Lerczak et al. 1994).

CONCLUSIONS

The best use of data collected on this survey is for a long-term perspective on trends occurring in Illinois River fish populations and environmental quality. Taken in isolation, analysis of data from any one particular year tells us nothing about year-to-year dynamics in fish distributions and abundances. Though this report focused mostly on data collected in 1994, the intention was to provide a "snapshot" in time of fish communities to identify patterns which could then be compared with data from other years in future reports.

Most of the patterns in distribution and abundance of Illinois River fishes identified in this report were consistent with findings outlined in the last F-101-R five-year summary report (Lerczak et al. 1994). For example, overall species evenness was low, with fish communities of all reaches being dominated numerically by only a few species, with one or more species in each reach representing at least 20% of the catch. The most abundant species, though, were not the same for all river segments. The upper waterway catches had a higher number of species and abundance of small cyprinids compared with the lower/middle river, while the bluegill was by far the most abundant fish



Note: Numbers above each bar correspond to the total number of fish collected in each catagory for the specified river segment.

Figure 4. Incidence of externally-visible abnormalities (e.g., sores, eroded fins) on fish collected from the Illinois Waterway in 1994. Data are grouped by river segment according to Figure 1. Habitat associations for species are defined in **APPENDIX A**.

in lower/middle river catches. This pattern was also evident in data collected during segments 1 through 5 (1989-1993) of this project. Of the 42 species (plus 2 hybrids) collected in 1994, only seven were of widespread importance in terms of the number of individuals and weight collected; and seven species (plus one hybrid) were of unique importance to the upper waterway. These upstream-downstream differences made it possible to define fish communities of the lower/middle, middle/upper, and upper river segments. These definitions should prove to be a useful reference point for making comparisons with data from previous years and for tracking trends.

Comparisons of species richness by rarefaction indicated that richness of the upper waterway was comparable to Peoria Reach and exceeded La Grange and Alton Reaches. As in other years of this survey, common carp tended to dominate catches by weight, ranging from 24.3 to 56.3% of the total; however, bigmouth buffalo and channel catfish on the lower/middle river and smallmouth buffalo, channel catfish, and largemouth bass on the upper waterway also made important contributions to catch biomass (over 15% of the total in at least one reach).

Species that are an indication of improved water quality in the upper waterway compared with the early 1960s (smallmouth and largemouth bass, golden redhorse) were present in catches in recent years and in 1994; at the same time, catches of carp x goldfish and green sunfish, indicators of a degraded ecosystem (Karr et al. 1986), were also significant (Table 6). This may indicate the upper waterway fish community is still in a transition phase from being dominated by pollution-tolerant species (carp and goldfish) to a more balanced community including fishes intolerant of the effects of pollution (e.g., low DO); on the other hand, the high consistency of carp and

centrarchid catches over the last six years suggests a degree of community stability. Some degree of stability was also evident for the lower/middle river fish community over the last few years in that the same species assemblage tended to dominate catches, though the low species richness on the lower river segment in 1994 suggests cause for some concern. Of continuing concern is the high incidence of external abnormalities on benthic fish collected from the upper waterway (Figure 4).

When attempting to assign causation for the patterns observed in fish communities, it became evident that better habitat and environmental data than that collected on this survey are needed. Water quality data collected on this survey have been intended to only identify unusual conditions during sampling and cannot be extrapolated to make broad statements about overall environmental quality. In addition, the comparison of data from this study with LTRMP data from La Grange Reach indicates additional gear types other than electrofishing are necessary to move beyond a first approximation description of fish communities. This comparison underscores the need for better communication and sharing of information among researchers and managers interested in or working with the Illinois River.

Because of the many studies currently being conducted on the Illinois River by various agencies, steps should be taken to make research data and other such information more readily accessible. Rather than a formal symposium, though, it would probably be more time and cost efficient to arrange an annual meeting at a central location where everyone could make their latest reports available and to exchange ideas in an informal setting of round table discussions. Perhaps one person could work as a contact with the various agencies and universities (and private consulting firms?) and also be

responsible for printing an annual Illinois River research clearinghouse newsletter. The time has arrived for greater synthesis and exchange of information (see **APPENDIX B** for a list of manuscripts in preparation based on LTEF data).

LITERATURE CITED

Austen D.J. 1992. Analysis of fish communities in Illinois Lakes. Ph.D. Dissertation. Iowa State University, Ames Iowa. 263 pp.

Bellrose, F.C., F.L. Paveglio, Jr., and D.W. Steffeck. 1979. Waterfowl and the changing environment of the Illinois River valley. Illinois Natural History Survey Bulletin 32(1):1-54.

Buck, D.H. 1956. Effects of turbidity on fish and fishing. Report No. 56. Oklahoma Fisheries Research Laboratory, Norman, Oklahhoma.

Butts, T.A. 1987. Illinois River water quality. Past, present, future. Pages 195-209 in H. Korab, ed. Proceedings Governor's Conference on the Management of the Illinois River System: the 1990's and beyond. Special Report No. 16. Water Resources Center, University of Illinois, Urbana.

Colton, C.E. 1994. Commercial fisheries and sewage treatment: conflicting uses of the Illinois River. Pages 112-122 in H. Korab, ed. Proceedings 1993 Governor's Conference on the Management of the Illinois River System. Special Report No. 20. Water Resources Center, University of Illinois, Urbana. 195 pp.

Demissie, M., L. Keefer, and R. Xia. 1992. Erosion and sedimentation in the Illinois River basin. Report No. ILENR-RE-WR-92/04 prepared for Illinois Department of Energy and Natural Resources. Illinois State Water Survey, Champaign. 112 pp.

Forbes, S.A. 1880. The food of fishes. Bulletin of the Illinois State Laboratory of Natural History 1(3):18-65.

Forbes, S.A., and R.E. Richardson. 1919. Some recent changes in Illinois River biology. Illinois State Natural History Survey Bulletin 13(6):139-156.

Hurlbert, S.H. 1971. The nonconcept of species diversity: a critique and alternative parameters. Ecology 52:577-586.

James, F.C., and S. Rathbun. 1981. Rarefaction, relative abundance, and diversity of bird communites. The Auk 98:785-800.

Karr, J.R., K.D. Fausch, P.L. Angermeier, P.R. Yant, and I.J. Schlosser. 1986. Assessing biological integrity in running waters: a method and its rationale. Illinois Natural History Survey Special Publication 5, Champaign. 28 pp.

Kofoid, C.A. 1903. Plankton studies. IV. The plankton of the Illinois River, 1894-1899, with introductory notes upon the hydrography of the Illinois River and its basin. Part I. Quantitative investigations and general results. Illinois State Laboratory of Natural History Bulletin 6(2):95-635.

Lerczak, T.V., R.E. Sparks, and K.D. Blodgett. 1993. The long-term Illinois River fish population monitoring program (F-101-R-4). Annual Report to the Illinois Department of Conservation. Aquatic Ecology Technical Report 93/3. Illinois Natural History Survey, Champaign, Illinois. 76 pp.

Lerczak, T.V., R.E. Sparks, and K.D. Blodgett. 1994. The long-term Illinois River fish population monitoring program (F-101-R). Final Report to the Illinois Department of Conservation. Aquatic Ecology Technical Report 94/5. Illinois Natural History Survey, Champaign, Illinois. 105 pp.

Ludwig, J.A., and J.F. Reynolds. 1988. Statistical ecology. John Wiley and Sons, New York. 377 pp.

Mills, H.B., W.C. Starrett, and F.C. Bellrose. 1966. Man's effect on the fish and wildlife of the Illinois River. Illinois Natural History Survey Biological Notes No. 57. 24 pp.

National Research Council. 1992. Restoration of aquatic ecosystems: science, technology, and public policy. National Academy Press, Washington D.C. 552 pp.

Page, L.M., and B.M. Burr. 1991. A field guide to freshwater fishes. Houghton Mifflin Company, Boston. 432 pp.

Peet, R.K. 1974. The measurement of species diversity. Annual Review of Ecology and Systematics 5:285-307.

Pflieger, W.L. 1975. The fishes of Missouri. Missouri Department of Conservation. 343 pp.

Rohlf, F.J. 1993. NTSYS-pc Numerical taxonomy and multivariate analysis system, version 1.80. Exeter Software, Setauket, New York.

Schlosser, I.J. 1991. Stream fish ecology: a landscape perspective. BioScience 41:704-712.

Smith, P.W. 1979. The fishes of Illinois. University of Illinois Press, Urbana, Illinois. 314 pp.

Sparks, R.E. 1984. The role of contaminants in the decline of the Illinois River: implications for the Upper Mississippi. Pages 25-66 in J.G. Wiener, R.V. Anderson, and D.R. McConville, eds. Contaminants in the Upper Mississippi River. Butterworth Publishers, Boston. 368 pp.

Sparks, R.E. 1994. Gateway to invasion. Illinois Natural History Survey Reports No. 330.

Sparks, R.E. 1995. Need for ecosystem management of large rivers and their floodplains. BioScience 45:168-182

Sparks, R.E., and W.C. Starrett. 1975. An electrofishing survey of the Illinois River, 1959-1974. Illinois Natural History Survey Bulletin 31:317-380.

Sparks, R.E., and T.V. Lerczak. 1993. Recent trends in the Illinois River indicated by fish populations. Aquatic Ecology Technical Report 93/16. Illinois Natural History Survey, Champaign. 34 pp.

Starrett, W.C. 1971. A survey of the mussels (Unionacea) of the Illinois River: a polluted stream. Illinois Natural History Survey Bulletin 30(5):267-403.

Starrett, W.C. 1972. Man and the Illinois River. Pages 131-169 in R.T. Oglesby, C.A. Carlson, and J.A. McCann, eds. River ecology and man. Academic Press, New York. 465 pp.

Thompson, D.H. 1928. The "knothead" carp of the Illinois River. Illinois Natural History Survey Bulletin 17(8):285-320.

Willman, H.B. 1973. Geology along the Illinois Waterway--a basis for environmental planning. Illinois State Geological Survey Circular 478. 48 pp.

APPENDIX A. Fish species collected during the Long-Term Electrofishing Survey of the Illinois Waterway, 1957-1994[a]. Common names preceded by an asterisk indicate species that were collected from 1989 through 1994 during federal aid project F-101-R.

Family Name	Common Name	Scientific Name	Habitat Association[b] (B = benthic, blank = pelagic)
Lepisosteidae	*Longnose Gar	Lepisosteus osseus	
	*Shortnose Gar	Lepisosteus platostomus	
	*Spotted Gar	Lepisosteus oculatus	
Amiidae	*Bowfin	Amia calva	
Anguillidae	American Eel	Anguilla rostrata	
Clupeidae	*Gizzard Shad	Dorosoma cepedianum	
	*Skipjack Herring	Alosa chrysochloris	
	*Threadfin Shad	Dorosoma petenense	
Hiodontidae	*Goldeye	Hiodon alosoides	
	*Mooneye	Hiodon tergisus	
Salmonidae	Rainbow Trout	Oncorhynchus mykiss	
Esocidae	*Grass Pickerel	Esox americanus	
	Northern Pike	Esox lucius	
Cyprinidae	*Bigmouth Shiner	Hybopsis dorsalis	B
	*Bluntnose Minnow	Pimephales notatus	
	*Bullhead Minnow	Pimephales vigilax	
	*Common Carp	Cyprinus carpio	B
	*Carp x Goldfish	Cyprinus carpio x Carassius auratus	B
	*Central Stoneroller	Campostoma anomalum	B
	Common Shiner	Luxilius cornutus	
	Creek Chub	Semotilus atromaculatus	
	*Emerald Shiner	Notropis atherinoides	
	*Fathead Minnow	Pimephales promelas	
	Ghost Shiner	Notropis buchanani	
	*Golden Shiner	Notemigonus crysoleucas	
	*Goldfish	Carassius auratus	B
	Hornyhead Chub	Nocomis biguttatus	
	Pugnose Minnow	Opsopoeodus emiliae	
	*Red Shiner	Cyprinella lutrensis	
	Redfin Shiner	Lythrurus umbratilis	
	Ribbon Shiner	Lythrurus fumeus	
	*River Shiner	Notropis blennius	
	*Sand Shiner	Notropis ludibundus	
	Spotfin Shiner	Cyprinella spiloptera	
	*Silver Chub	Macrhybopsis storeriana	B
	Silverband Shiner	Notropis shumardi	
	Silverjaw Minnow	Ericymba buccata	B
	Silvery Minnow	Hybognathus nuchalis	B
	*Spottail Shiner	Notropis hudsonius	
	Steelcolor Shiner	Cyprinella whipplei	
	Striped Shiner	Luxilus chrysocephalus	
	Suckermouth Minnow	Phenacobius mirabilis	B
Catostomidae	*Bigmouth Buffalo	Ictiobus cyprinellus	B
	*Black Buffalo	Ictiobus niger	B
	Black Redhorse	Moxostoma duquesnei	B

Continued.

Family Name	Common Name	Scientific Name	Habitat Association[b] (B = benthic, blank = pelagic)
Catostomidae	*Golden Redhorse	Moxostoma erythrurum	B
	*Highfin Carpsucker	Carpiodes velifer	B
	*Northern Hog Sucker	Hypentelium nigricans	B
	*Quillback	Carpiodes cyprinus	B
	*River Carpsucker	Carpiodes carpio	B
	*River Redhorse	Moxostoma carinatum	B
	*Shorthead Redhorse	Moxostoma macrolepidotum	B
	Silver Redhorse	Moxostoma anisurum	B
	*Smallmouth Buffalo	Ictiobus bubalus	B
	*White Sucker	Catostomus commersoni	B
Ictaluridae	*Black Bullhead	Ameiurus melas	B
	Blue Catfish	Ictalurus furcatus	B
	*Brown Bullhead	Ameiurus nebulosus	B
	*Channel Catfish	Ictalurus punctatus	B
	*Flathead Catfish	Pylodictis olivaris	B
	Freckled Madtom	Noturus nocturnus	B
	Tadpole Madtom	Noturus gyrinus	B
	White Catfish	Ameiurus catus	B
	*Yellow Bullhead	Ameiurus natalis	B
Percopsidae	Trout-Perch	Percopsis omiscomaycus	B
Fundulidae	*Blackstripe Topminnow	Fundulus notatus	
Poeciliidae	Mosquitofish	Gambusia affinis	
Atherinidae	*Brook Silverside	Labidesthes sicculus	
Moronidae	*Striped Bass x White Bass	Morone saxatilis x M. chrysops	
	Striped Bass	Morone saxatilis	
	*White Bass	Morone chrysops	
	*Yellow Bass	Morone mississippiensis	
	*White Perch	Morone americana	
Centrarchidae	*Black Crappie	Pomoxis nigromaculatus	
	*Bluegill	Lepomis macrochirus	
	*Green Sunfish	Lepomis cyanellus	
	*Green Sunfish x Bluegill	Lepomis cyanellus x L. macrochirus	
	Green x Orangespotted Sunfish	Lepomis cyanellus x L. humilis	
	*Largemouth Bass	Micropterus salmoides	
	*Longear Sunfish	Lepomis megalotis	
	*Orangespotted Sunfish	Lepomis humilis	
	Orangespotted Sunfish x Bluegill	Lepomis humilis x L. macrochirus	
	Green Sunfish x Pumpkinseed	Lepomis cyanellus x L. gibbosus	
	*Pumpkinseed	Lepomis gibbosus	
	*Redear Sunfish	Lepomis microlophus	
	*Rock Bass	Ambloplites rupestris	
	*Smallmouth Bass	Micropterus dolomieu	
	*Spotted Sunfish	Lepomis punctatus	
	*Warmouth	Lepomis gulosus	
	*White Crappie	Pomoxis annularis	

Continued.

Family Name	Common Name	Scientific Name	Habitat Association[b] (B = benthic, blank = pelagic)
Percidae	Bluntnose Darter	Etheostoma chlorosomum	B
	Johnny Darter	Etheostoma nigrum	B
	*Log perch	Percina caprodes	B
	*Sauger	Stizostedion canadense	
	*Slenderhead Darter	Percina phoxocephala	B
	*Walleye	Stizostedion vitreum	
	*Yellow Perch	Perca flavescens	
Sciaenidae	*Freshwater Drum	Aplodinotus grunniens	B

[a]Scientific names are from Page and Burr (1991).
[b]Based on behavioral descriptions from Pflieger (1975) and communications with INHS fisheries biologists.

Appendix B (Job 5). Publications, reports, and presentations which resulted, wholly or in part, from research conducted during segment 6 of project F-101-R, The Long-Term Illinois River Fish Population Monitoring Program (funded under Federal Aid in Sport Fish Restoration Act, P.L. 81-681, Dingell-Johnson-Wallop-Breaux).

I. Publications.

Lerczak, T.V. Submitted. Fish community changes in the Illinois River, 1962-1994. American Currents.

Lerczak, T.V., and R.E. Sparks. 1995. Fish populations in the Illinois River. Pages 7-9 in G.S. Farris, editor. Our living resources 1994. National Biological Survey, Washington D.C.

Lerczak, T.V., R.E. Sparks, and K.D. Blodgett. 1994. Some upstream-to-downstream differences in Illinois River fish communities. Transactions of the Illinois State Academy of Science 87(Supplement):53. (Abstract)

Raibley, P.T., K.D. Blodgett, and R.E. Sparks. 1995. Evidence of grass carp (Ctenopharyngodon idella) reproduction in the Illinois and upper Mississippi Rivers. Journal of Freshwater Ecology 10:65-74.

Sparks, R.E. 1995. Value and need for ecosystem management of large rivers and their floodplains. BioScience 45:168-182.

Sparks, R.E. 1995. Environmental effects. Pages xx-xx in S.A. Changnon, ed. The great flood of 1993. University Corporation for Atmospheric Research (UCAR) and Westview Press.

II. Technical Papers (presenter in bold).

Lerczak, T.V., R.E. Sparks, and K.D. Blodgett. Some upstream-to-downstream differences in Illinois River fish communities. Contributed paper presented at the Illinois State Academy of Science Annual Meeting, Galesburg, Illinois, 7 October 1994.

Sparks, R.E. Large river-floodplain ecosystems of the midwest: status, trends, and management needs. Presented at the U.S. Environmental Protection Agency's "Ecological Seminar Series" held in Chicago, Illinois 14 March.

III. Poster Presentations (presenter in bold).

Lerczak, T.V., R.E. Sparks, and K.D. Blodgett. Long-term trends (1959-1993) in fish populations of the Illinois River. Poster presented at the 56th Midwest Fish and Wildlife Conference, Indianapolis, Indiana, 4-7 December 1994.

V. Popular Presentations.

Lerczak, T.V. Wintering bald eagles along the Illinois River and factors affecting their environment. Invited presentation to the Peoria Audubon Society, Peoria, Illinois, 8 March 1995.

Lerczak, T.V. Seminar on Illinois River environmental issues. Conducted for Biology 140 (Human Ecology) at Spoon River College, 27 June 1994.

VI. Manuscripts in Preparation.

Lerczak, T.V. et al. Recent status of fish communities of the Illinois River. Target journal: Transactions of the Illinois Academy of Science.

Lerczak, T.V. et al. Fish population trends in the Illinois River, 1962-1994. Target journal: Journal of Freshwater Ecology.

Lerczak, T.V. et al. Fish community analysis using an index of well-being. Target journal: Ecological Applications.