ILLINOIS NATURAL HISTORY SURVEY

The Long-Term Illinois River Fish Population Monitoring Program

Annual Report, F-101-R-3

Center for Aquatic Ecology

Thomas V. Lerczak, Richard E. Sparks, K. Douglas Blodgett

May 1992

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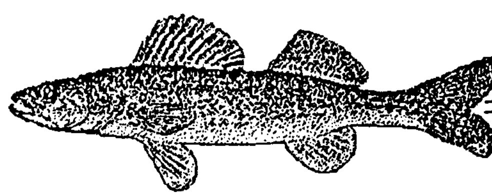

Aquatic Ecology Technical Report 92/9

The Long-Term Illinois River Fish Population
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DISCLAIMER

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ABSTRACT

An electrofishing survey has been conducted on the entire length of the Illinois River, mostly in side channels, 27 out of 35 years since 1957. During this period, many changes have occurred on the Illinois River watershed including improved wastewater treatment, increased erosion and accumulation of silt in the river and its backwaters, and massive expansion of urban areas. The overall trend, though, has been one of improved conditions in the water column, especially on the upper river (in this report, above river mile 210). This has resulted in increased fish populations; for example, largemouth bass, sauger, smallmouth bass, and bluegill on the upper river. However, as in previous years, upper river pools yielded much lower relative abundances than lower river pools; perhaps because of a lack of backwater spawning areas and higher amounts of pollution in the upper river pools.

To examine long-term changes, 1963, 1975, and 1991 were chosen for more detailed analyses. Data for the other years have been computerized, but not yet verified. For these three years, fish that came into frequent contact with bottom sediments consistently showed a higher incidence of external abnormalities than other fish. In addition, mean relative weights (W_r) for carp (a bottom feeder) for these three years were consistently less than 1.0 whereas mean W_r for bluegill and largemouth bass (non-bottom feeders) were

consistently close to 1.0, indicating a sediment quality problem.

Continued data collection and analysis of the 35-year data set should provide additional information for managers concerning previous trends and future directions in the environmental state of the Illinois River.

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ACKNOWLEDGMENTS

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INTRODUCTION

During this century, the Illinois River's environmental condition has been characterized by alternating periods of degradation and improvement. These changes have been well documented by many investigators (Mills et al. 1966, Starrett 1972, Bellrose et al. 1979, Sparks 1984). In 1900, raw sewage and industrial wastes from Chicago were discharged into the river via the newly opened Chicago Sanitary and Ship Canal. Soon after, Forbes and Richardson (1913) described areas of the upper river (defined in this report as that part of the river above river mile 210) which were essentially devoid of higher forms of life. The river showed substantial improvements in the 1930s after sewage treatment plants were constructed, only to experience degradation in the 1950s (Sparks 1984). During the 1950s, the expansion of row cropping caused increased erosion on the watershed; the resulting turbidity contributed to the widespread loss of aquatic vegetation (Bellrose et al. 1979). Turbidity remains excessively high today, especially on the lower river (Figure 1). Sediments are continually resuspended by towboat-barge traffic (Bhowmik 1989) and recreational boats (Johnson and Davis 1992). Barges are also responsible for directly killing an unknown number of fish (Todd et al. 1989). In 1988, 3,202 towboats passed through the La Grange lock (river mile 80); and traffic is expected to increase by 1.2 to 2.5 percent per year to the

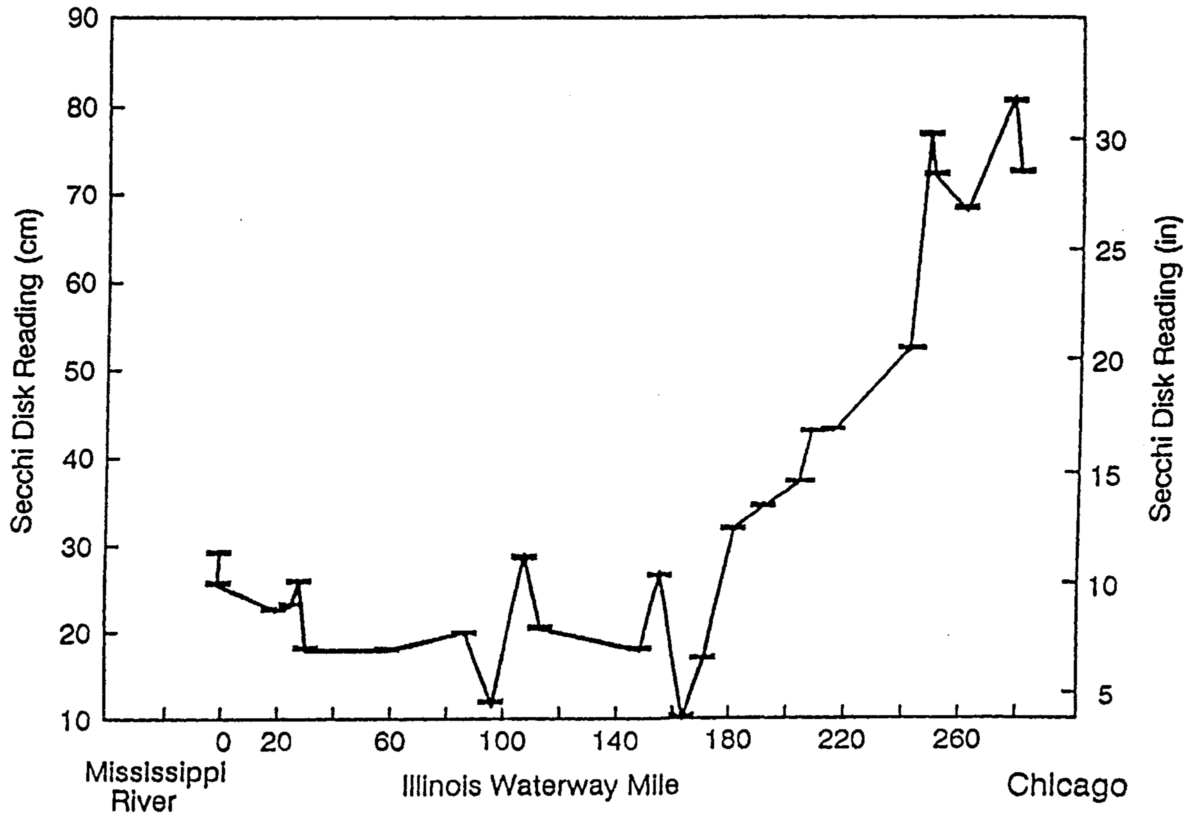


Figure 1. Secchi disk readings (water transparency) obtained in the 1991 electrofishing survey. A steady decline occurs in the downstream direction, where tributaries introduce erosion silt from agricultural areas. Submersed aquatic plants are virtually absent from the river downstream of mile 220, at least partly because of the reduced light penetration.

year 2000 (U.S. Army Corps of Engineers 1989).

In addition to these problems, toxic substances in the river continue to be a concern. High concentrations of heavy metals (Essig 1991) and pesticides (Schmidt 1991) occur in the river's sediments and toxic levels of un-ionized ammonia continue to occur near Chicago, although improvements in wastewater treatment have substantially reduced the amount of total ammonia N present in the water column (Figure 2).

The long-term electrofishing (LTEF) survey initiated by William Starrett in 1957 has been conducted during a time when many changes have occurred on the Illinois River and its watershed (e.g., improved sewage treatment, massive expansion of urban areas, increased erosion). Fish populations manifest these changes.

This report summarizes the findings from the 1991 LTEF survey in addition to presenting preliminary evidence from the long-term data set (which was just recently converted to a computerized database) that indicate conditions have improved in the Illinois River.

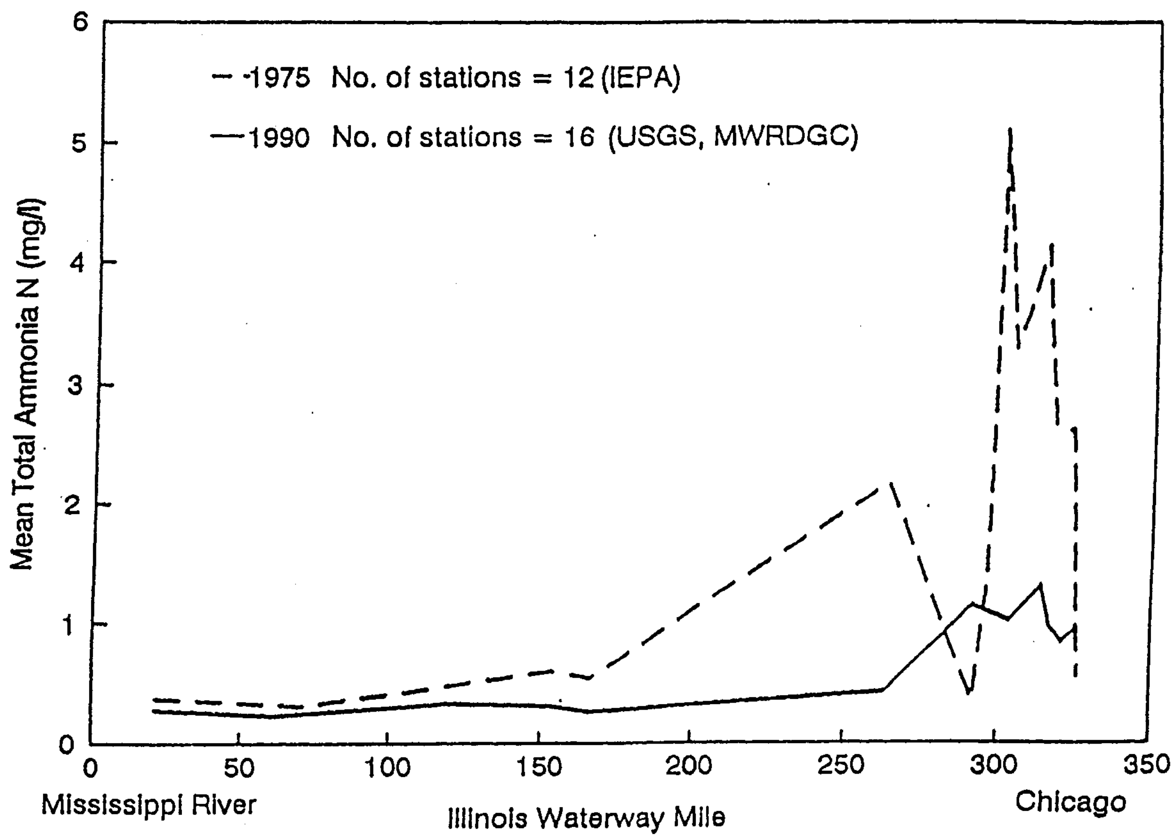


Figure 2. Total ammonia concentrations on the Illinois Waterway. An increase occurs in the upstream direction, toward Chicago. Between 1975 and 1990 concentrations have substantially declined. IEPA = Illinois Environmental Protection Agency. USGS = U.S. Geological Survey. MWRDGC = Metropolitan Water Reclamation District of Greater Chicago.

STUDY AREA AND METHODS

Electrofishing Sites

The LTEF survey currently samples at 28 sites (Figure 3). Two of these sites are located on the Mississippi River and serve as references that historically have been subjected to less pollution than other LTEF sites. The rest of the sites are located on the Illinois Waterway, which contains 327 miles of channel maintained by the U.S. Army Corps of Engineers for navigational purposes and includes the entire Illinois River, parts of the Des Plaines and Chicago Rivers, and the Chicago Sanitary and Ship Canal (U.S. Army Corps of Engineers 1989). Most of the sites are located in side channels, all of which are continuously connected to the river.

Sampling Method

Electrofishing is conducted at each site using the same generator and methods as the original survey. A comprehensive description of the electrofishing method can be found in the 1989-1990 Annual Report (F-101-R-1) (Sparks and Blodgett 1990). The methods have been standardized insofar as possible to increase the probability that changes in catch-per-unit-effort reflect fish population changes more so than changes in electrofishing efficiency or effort. During high water levels, fish disperse in the expanded habitats; conversely, during low water levels, many fish species (e.g., centrarchids) concentrate around the few

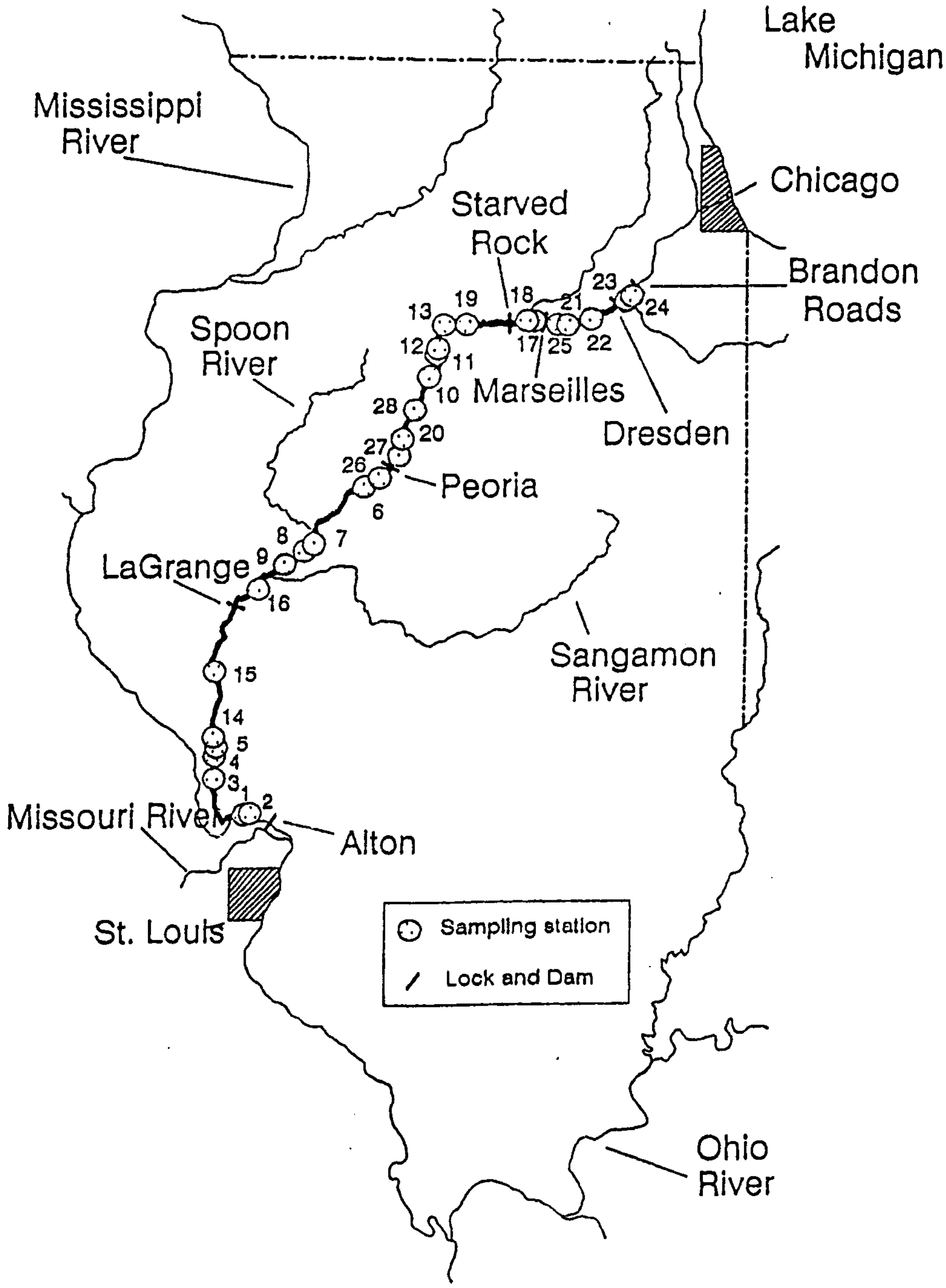


Figure 3. Locations of the 28 sampling stations along the Illinois Waterway and Mississippi River. Stations 1 and 2 are on the Mississippi River, just below the confluence with the Illinois River. Stations 23 and 24 are on the Des Plaines River. The rest of the stations are on the Illinois River. Collection numbers refer to the order in which the stations were sampled.

structures (woody debris and riprap) which still remain submersed (Angermeier and Karr 1984). In late summer, young-of-the-year fish are large enough to be seen by the dipper and collected with 1/4-in. mesh dip nets, which have been used in all LTEF surveys. In an attempt to maximize sampling efficiency, the LTEF survey is only conducted during times of low water in late summer (Figure 4). In addition, sampling is generally conducted only when the water temperature is 58^0 F or above. Below 58^0 F, fish probably begin moving toward wintering areas. Although sampling biases do occur [for example, electrofishing is biased against darters and catfish (Bayley and Dowling 1990)], they should remain the same from year to year and hence should not influence effects of population changes (Schlosser 1985), which are reflected in relative abundance changes. Therefore, the LTEF survey provides an index of fish population changes through changes in relative abundances.

Data Analysis

The catch-per-unit-effort for each species was calculated as numbers of fish caught per hour (numbers/hr) and pounds of fish caught per hour (lb/hr) of electrofishing for each Illinois Waterway navigation pool as well as for the two Mississippi River sites. Because verification of the computerized LTEF data set has yet to be completed, a

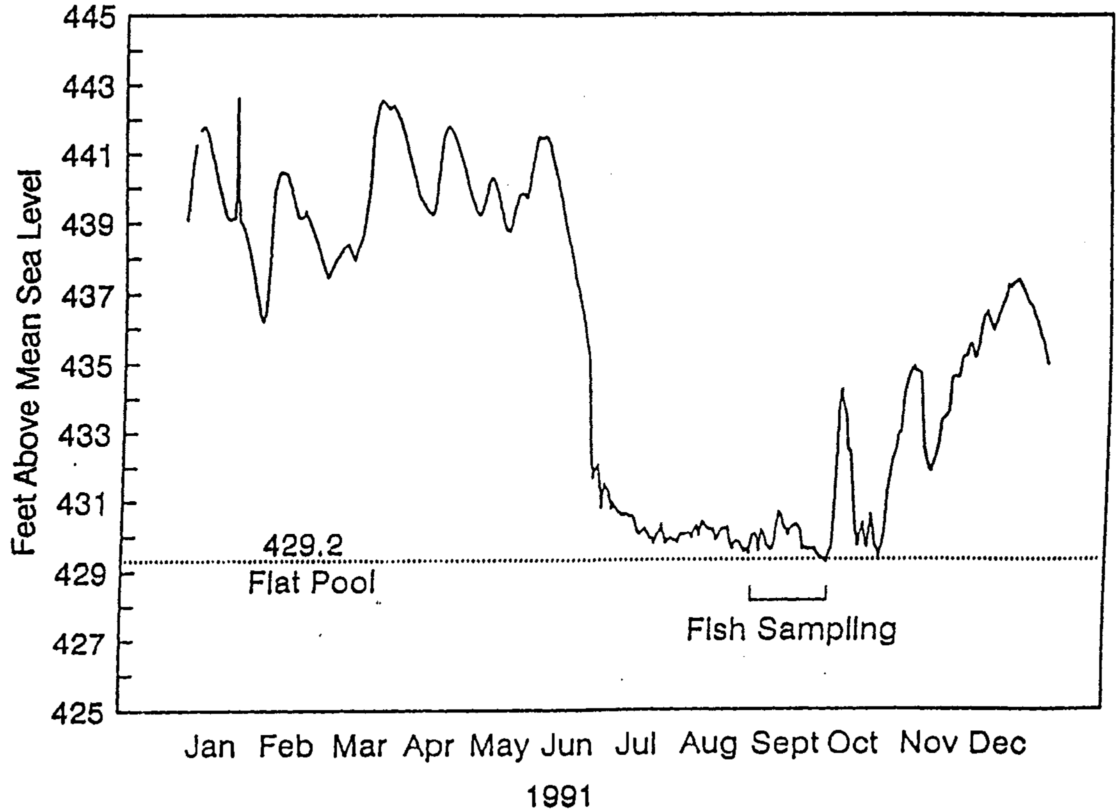


Figure 4. Water surface elevation of the Illinois River at Havana during 1991 as reported by the U.S. Army Corps of Engineers. The LTEF survey is conducted during the relatively constant and low water levels which typically occur from late summer to early autumn.

full analysis of all the years was not possible. The years 1963 and 1975 were chosen for a more detailed data analysis for selected fish species to give a broad span of years for comparison to 1991.

The bluegill toxicity index (BTI) was developed by Lubinski et al. (1974) and can be used to compare the relative toxicities of different substances to a reference organism, the bluegill. Calculation of the BTI requires values for pH, water temperature, dissolved oxygen concentration (DO), fish weight, and concentration of the toxicant. The BTI is measured in bluegill toxicity units (BGTU). A BTI of 1.0 BGTU was defined as that which would be lethal to 50% of the bluegills exposed for 96 hr (Lubinski et al. 1974). Furthermore, experience has shown a BTI of 0.2 marks a transition state above which bluegill-largemouth bass communities change to a carp-dominated community (BTI > 0.2) (Lubinski and Sparks 1981).

Un-ionized ammonia is toxic to fish (Reinbold and Pescitelli 1982) and is a primary contributor to toxicity of the Illinois River (Lubinski and Sparks 1981). Measured water column values of total ammonia N concentrations, water temperature, pH, and DO for specific sites along the Illinois Waterway were compiled for 1975 and 1990 from reports by the Illinois Environmental Protection Agency, the U.S. Geological Survey, and the Metropolitan Water Reclamation District of Greater Chicago (Illinois

Environmental Protection Agency 1976; Richards et al. 1991; Patterson Schafer, Inc. 1991; Polls et al. 1991a; Polls et al. 1991b). These data were used to calculate BTI values for those sites for each year. The mean weight of bluegill obtained in the 1991 LTEF survey (0.091 lb) was used in the calculations.

During LTEF sampling, each fish is examined for external abnormalities such as sores and deformities. Data collected in 1963, 1975, and 1991 for fish with external abnormalities were separated into two categories: fish likely to have frequent contact with bottom sediments and fish that do not. The percent of fish in each category were then arranged by year and navigation pool to make comparisons.

Relative weight (W_r) was calculated for carp, bluegill, and largemouth bass for 1963, 1975, and 1991 using equations that were developed in the midwestern region of the U.S. (Murphy et al. 1991). Because of inaccuracies associated with measuring weights of small fish in the field and because growth forms of juvenile fish differ from adults, only fish equal to or greater than the minimum recommended length for W_r analysis by Murphy et al. (1991) were used in our calculations.

RESULTS AND DISCUSSION

Equipment Changes

Because the boat previously used leaked and was beyond repair, a new boat was purchased. This boat was modified so the original electrofishing equipment with the identical electrode configuration could still be used. All of the equipment was field tested before the actual sampling began to verify that all equipment was functional.

Sampling Schedule and Site Information

Following an electrofishing training period for T.V. Lerczak, sampling began on 4 September and was completed on 30 September. All sampling was conducted in full daylight between the hours of 8:50 AM and 5:50 PM.

The locations and physical characteristics at sampling of each of the stations are listed in Table 1. The ranges for physical measurements are as follows: surface velocity, 0.0-1.1 ft/s; water temperature, 52.5-82.4^0 F; DO, 5.6-11.1 ppm; secchi disk reading, 3.9-31.9 in.; conductivity, 452-700 umhos; voltage, 160-215 V; depth, 0.5-4 ft.

For three stations, water temperatures were below the 58^0 F criterion: Lambies Boat Harbor (20 September), 52.5^0 F; Pekin (26 September), 57.7^0 F; and lower Peoria Lake (26 September), 55.4^0 F. There was a cold snap between 17 and 27 September, as indicated by mean daily air temperatures

Table 1. Site Information For 1991 LTEF Survey.

Collection Number	Date	Station Name	Pool	River Mile Lower	River Mile Upper	River Mile Mean	Time CST	Time Elapsed (hr)	Surface Velocity (ft/s)	Temperature Air (°F)	Temperature Water (°F)	DO (ppm)	Secchi (in)	Conductivity (umhos)	Volts	Depth (ft) min.	Depth (ft) max.	Depth (ft) ave.
1991-03	05-Sep-91	Hortland Island	8	18.1	19.5	18.8	08:50 AM	1.07	0.7	60.3	73.8	5.6	8.9	690	160	0.5	3.0	1.0
1991-04	05-Sep-91	Dark Chute	8	23.8	25.5	24.7	11:00 AM	1.07	0.8	70.7	80.1	6.3	9.1	690	200	0.5	2.5	1.0
1991-05	05-Sep-91	Hurricane Island Chute	8	27.0	27.9	27.5	04:20 PM	1.03	0.8	87.8	76.6	8.0	10.2	700	190	0.5	3.0	1.5
1991-14	16-Sep-91	Crater Willow Islands	8	29.2	30.8	30.0	01:00 PM	1.06	0.8	73.4	76.1	5.7	7.1	650	200	0.5	3.0	1.5
1991-15	17-Sep-91	Big Blue Island	8	57.9	59.0	58.5	09:15 AM	0.54	1.1	61.0	77.0	6.0	7.1	650	210	0.5	3.0	1.5
1991-16	17-Sep-91	Grape Bar Islands	7	85.7	87.0	86.4	01:40 PM	0.74	0.8	66.6	74.3	6.0	7.9	650	205	0.5	2.0	1.0
1991-09	10-Sep-91	Sugar Creek Island	7	95.7	96.3	96.0	02:05 PM	0.63	0.8	79.2	73.4	6.1	4.5	550	200	0.5	3.0	1.5
1991-08	10-Sep-91	Lower Bath Chute	7	106.6	107.3	107.0	10:15 AM	0.60	0.3	71.2	73.2	6.3	11.4	625	190	0.5	3.0	1.5
1991-07	09-Sep-91	Upper Bath Chute	7	112.8	113.2	113.0	02:00 PM	1.09	1.0	86.3	73.8	6.7	8.1	650	190	0.5	3.0	1.5
1991-06	06-Sep-91	Turkey Island	7	148.0	148.4	148.2	10:51 AM	0.49	0.9	89.6	78.4	6.6	7.1	700	170	0.5	3.5	1.0
1991-26	26-Sep-91	Pekin	7	154.5	155.3	154.9	12:15 PM	0.91	0.7	55.9	57.7	10.7	10.6	550	205	0.5	3.0	1.0
1991-27	26-Sep-91	Lower Peoria Lake	6	163.0	163.5	163.3	03:25 PM	0.54	0.0	55.2	55.4	11.1	3.9	500	210	0.5	2.0	0.8
1991-20	20-Sep-91	Lambies Boat Harbor	6	170.6	170.8	170.7	01:05 PM	0.75	0.0	----	52.5	6.1	6.7	600	210	1.5	2.5	2.0
1991-28	30-Sep-91	Chillicothe Island	6	180.6	181.1	180.9	12:05 PM	0.93	0.0	77.0	59.0	11.0	12.6	550	205	0.5	2.0	1.5
1991-10	11-Sep-91	Henry Island	6	193.3	194.5	193.9	01:05 PM	0.69	0.5	70.0	75.6	11.0	13.8	650	200	0.5	4.0	1.0
1991-11	12-Sep-91	Lower Twin Sisters	6	202.6	203.2	202.9	09:00 AM	0.67	0.4	65.3	74.1	7.1	14.6	650	200	0.5	3.0	1.5
1991-12	12-Sep-91	Upper Twin Sisters	6	203.0	203.5	203.3	10:22 AM	0.55	0.5	65.3	74.1	7.1	14.6	650	195	0.5	3.0	1.5
1991-13	12-Sep-91	Hennepin Island	6	207.5	208.1	207.8	12:10 PM	0.36	0.5	84.2	74.3	10.2	16.9	680	200	0.5	3.0	1.5
1991-19	18-Sep-91	Clark Island	6	214.9	215.6	215.3	05:05 PM	0.73	0.0	54.3	70.0	9.0	16.9	650	210	0.5	2.0	1.0
1991-18	19-Sep-91	Bulls Island	5	240.2	240.8	240.5	11:00 AM	0.92	0.0	44.1	67.1	7.3	20.5	600	210	0.5	2.0	1.0
1991-17	19-Sep-91	Bulls Island Bend	5	241.1	241.6	241.4	09:15 AM	0.51	0.0	44.1	67.1	7.3	20.5	600	215	0.5	2.0	1.0
1991-25	25-Sep-91	Ballards Island	4	247.6	248.2	247.9	04:40 PM	0.57	0.0	57.0	61.2	9.8	30.3	580	215	0.5	3.0	1.0
1991-21	24-Sep-91	Johnson Island	4	249.7	249.8	249.7	09:20 AM	0.44	0.2	50.5	61.0	9.3	28.3	500	215	0.5	3.0	2.0
1991-22	24-Sep-91	Waupecan Island	4	260.2	261.1	260.7	01:05 PM	0.91	0.3	61.5	62.8	10.1	26.8	600	210	0.5	3.0	1.0
1991-23	25-Sep-91	Mouth of DuPage River	3	276.8	277.8	277.3	09:20 AM	0.79	0.0	50.0	67.1	7.5	31.9	600	215	0.5	3.0	1.0
1991-24	25-Sep-91	Treats Island	3	279.4	280.0	279.7	12:40 PM	1.00	0.0	----	70.7	7.6	28.5	600	195	0.5	3.0	1.0
1991-02	04-Sep-91	[a]Below Brickhouse Slough	26	204.9	205.0	205.0	05:50 PM	0.50	0.0	73.8	82.4	11.1	11.4	452	180	1.0	3.5	2.0
1991-01	04-Sep-91	[a]Lower Brickhouse Slough	26	205.1	205.3	205.2	02:54 PM	0.50	0.0	78.3	81.5	9.7	10.0	470	190	.8	3.0	1.5
Total Elapsed Time								20.59										

[a] Brickhouse Slough Sites are located on the Mississippi River

(Figure 5). Although we do not have weekly water temperature records for the sampling sites at Lambies (mile 170.7), lower Peoria Lake (mile 163.0) and Pekin (mile 154.9), the water temperature downstream at mile 121.2 declined also, but not to the lows observed in Peoria Lake (Figure 5). Catch data from these three sites are included in the 1991 results in this report; however, we will exclude these data from subsequent reports if statistical tests show them to be significantly different from catch rates obtained from the same stations during 5-10 previous years, excluding the 1988-1989 drought years.

Lambies Boat Harbor on the east side of the river was chosen as a replacement for the original upper Peoria Lake site at Detweiller Park (river mile 170.9) on the west side of the river, which is no longer accessible because of shallow water. Both sites are in boat harbors with some riprapping on the shores, although the riprapping is much more extensive at Detweiller. Even though these two sites appeared to be equivalent, more detailed comparisons are necessary. It is possible cool spring water entering Lambies Boat Harbor may have been partly responsible for the low water temperature on 20 September; spring water does not enter the original site at Detweiller Park. Springs and seeps occur along the sandy eastern bluffs and shores of Peoria Lake, but not on the west side.

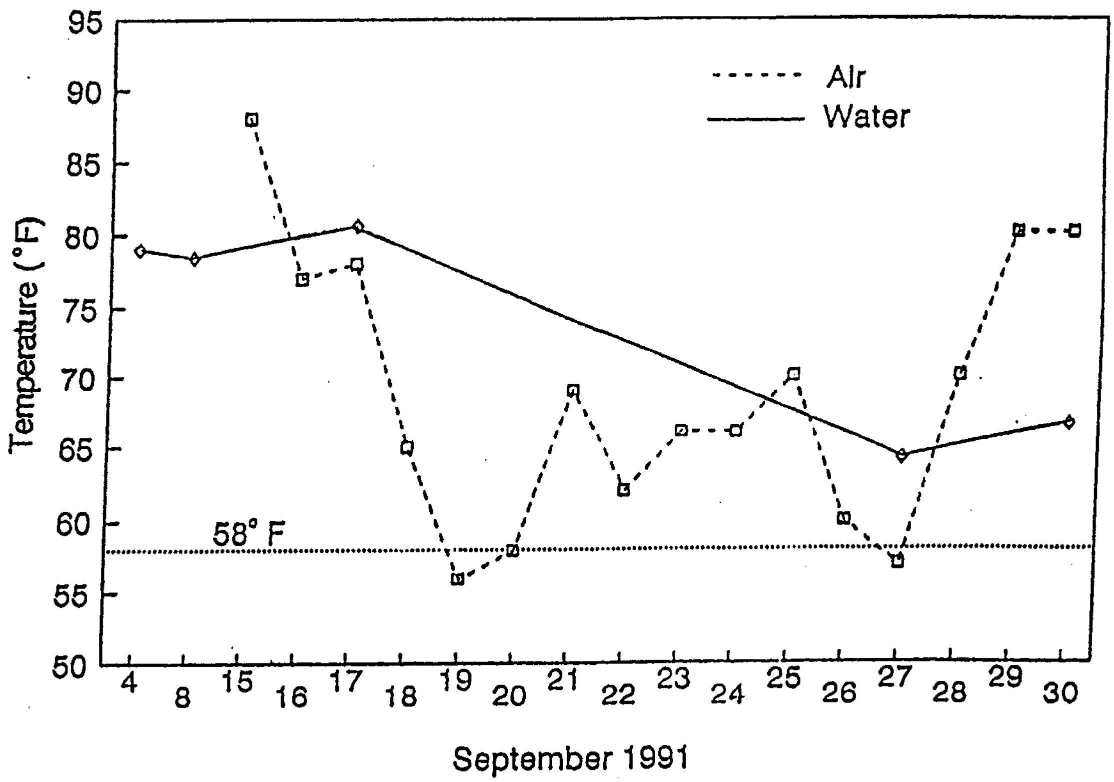


Figure 5. Mean daily air temperatures at Peoria (Source: National Weather Bureau, Peoria) and Illinois River water temperatures in the main channel at river mile 121.2 (Source: Long-Term Resource Monitoring Program, Havana, Il) during September 1991.

Fish Relative Abundances

There were 2,840 individuals and 43 species of fishes collected during the 1991 electrofishing survey (Appendix A). The number of species collected at each site ranged from eight at Hennepin Island (river mile 207.8) to 17 at Lambies Boat Harbor (river mile 170.7)(Appendix A).

The numbers of fish collected per hour of electrofishing arranged by species and navigation pool are listed in Table 2. In the 1991 survey, bluegill were overwhelmingly more abundant than any other species. Freshwater drum were more numerous at the Mississippi River sites than on the Illinois River. The Mississippi River sites yielded many more fish than any of the Illinois River pools. Consistent with previous years, the lower river pools yielded substantially more fish than the upper river pools, perhaps because of the greater spawning and nursery habitat available in the downstream pools (Sparks and Starrett 1975) and because fish are subjected to greater levels of pollution on the upper river compared to the lower river. Essig (1991) showed that zinc, mercury, and PCB concentrations in sediments increase in the upstream direction on the upper river, particularly near Chicago. A similar trend was apparent for total ammonia N in the water column (Figure 2).

Pounds of fish collected per hour (lb/hr) of electrofishing arranged by species and navigation pool are

Table 2. Number of individuals of each species obtained per hour of electrofishing in 1991 arranged by navigation pool.

Species	Pools And Number Of Hours Fished							
	Alton 4.77	La Grange 4.46	Peoria 5.22	Starved Rock 1.43	Marseilles 1.92	Dresden 1.79	Mississippi 1.00	Total 20.59
Bigmouth Buffalo	0.629	3.363	4.789	0.000	0.000	0.000	1.000	2.137
Bluegill x Green sunfish	0.000	0.448	0.575	0.000	0.000	0.000	0.000	0.243
Black Buffalo	0.210	0.000	0.000	0.000	0.000	0.000	0.000	0.049
Black Bullhead	0.000	0.000	0.000	0.000	0.521	0.000	0.000	0.049
Black Crappie	5.870	13.453	4.023	1.399	2.083	1.117	4.000	5.877
Bluegill	58.910	58.744	35.057	3.497	7.292	7.263	61.000	39.777
Bluntnose minnow	0.000	0.000	0.000	2.098	3.125	15.642	0.000	1.797
Bullhead minnow	0.000	0.000	0.000	2.797	11.979	0.000	5.000	1.554
Carp	6.499	5.381	9.004	2.797	3.125	5.587	6.000	6.217
Channel Catfish	6.289	1.345	1.341	1.399	0.521	1.117	1.000	2.380
Carp x Goldfish	0.210	0.000	0.383	0.000	0.521	1.676	0.000	0.340
Emerald Shiner	0.210	0.448	1.724	26.573	9.896	14.525	3.000	4.760
Flathead Catfish	0.629	0.224	0.000	0.000	0.000	0.000	0.000	0.194
Freshwater Drum	7.547	12.556	8.238	0.000	0.000	0.000	31.000	8.062
Goldfish	0.419	0.000	0.192	0.000	0.000	0.000	0.000	0.146
Golden Redhorse	0.000	0.000	0.000	0.000	0.521	0.559	0.000	0.097
Golden Shiner	0.000	0.000	0.000	0.000	0.521	0.559	0.000	0.097
Green Sunfish	2.306	4.260	19.540	4.895	8.333	12.849	0.000	8.645
Gizzard Shad	29.560	20.179	40.230	9.790	22.396	16.201	84.000	29.675
Largemouth Bass	13.627	9.193	6.322	2.098	2.604	6.145	2.000	7.771
Longear Sunfish	0.000	0.000	0.000	0.000	0.000	0.559	0.000	0.049
Minnow (unidentified)	0.419	0.000	0.000	0.000	0.000	0.000	0.000	0.097
Orangespotted Sunfish	0.000	0.000	0.192	0.000	0.000	0.000	1.000	0.097
Red Shiner	0.000	0.000	0.000	16.084	16.146	0.000	0.000	2.623
Rock Bass	0.000	0.000	0.000	0.000	0.000	2.235	0.000	0.194
Redear Sunfish	0.000	0.000	0.192	0.000	0.000	0.559	1.000	0.146
River Carpsucker	0.629	0.673	4.981	0.000	0.000	0.000	0.000	1.554
Smallmouth Buffalo	2.306	1.570	3.640	1.399	0.000	0.000	7.000	2.234
Sauger	0.210	0.000	0.192	0.000	0.000	0.000	0.000	0.097
Shortnose Gar	0.419	0.224	0.000	0.000	0.000	0.000	0.000	0.146
Shorthead Redhorse	0.419	0.448	0.766	0.000	0.521	0.000	0.000	0.437
Skipjack Herring	1.468	0.448	0.766	0.000	0.000	0.559	0.000	0.680
Smallmouth Bass	0.000	0.000	0.000	0.699	0.521	0.000	0.000	0.097
Spottail Shiner	0.000	0.000	0.383	0.000	0.000	0.000	1.000	0.146
Sunfish (unidentified)	0.629	0.224	0.575	0.000	0.000	0.000	2.000	0.437
Silver Chub	0.419	0.000	0.000	0.000	0.000	0.000	0.000	0.097
Threadfin Shad	4.822	5.605	1.916	0.000	0.521	5.587	6.000	3.643
Quillback	0.000	0.000	0.383	0.000	0.521	0.000	0.000	0.146
Warmouth	0.419	0.673	0.000	0.000	0.000	0.000	0.000	0.243
White Bass	1.887	6.726	4.598	0.000	0.000	0.000	9.000	3.497
White Crappie	0.419	1.794	0.383	0.000	0.000	0.000	5.000	0.826
White Perch	0.000	0.000	0.192	0.000	0.000	0.000	0.000	0.049
White Sucker	0.000	0.000	0.575	0.000	0.000	0.559	0.000	0.194
Yellow Bullhead	0.000	0.000	0.383	0.000	0.000	0.000	0.000	0.097
Yellow Bass	0.000	0.000	0.766	0.699	0.000	0.000	0.000	0.243
Totals	147.379	147.982	152.299	76.224	91.667	93.296	230.000	137.931

listed in Table 3. In the 1991 survey, carp, bigmouth buffalo and largemouth bass had the three largest catch rates (lb/hr), far exceeding catch rates for other species (Table 3). The catch rate for largemouth bass in Dresden pool (5.037 lb/hr) was similar to the catch rate in Peoria pool (4.917 lb/hr); this contrasts strongly with data from the 1960s and early 1970s when catch rates of largemouth bass on the upper river pools were much less than on lower river pools (Sparks and Starrett 1975). Collections of rock bass, smallmouth bass, and sauger on the upper river indicate improving conditions (Appendix A). Sparks and Blodgett (1991) reported on the return of sauger to the Illinois River in the mid-1970s.

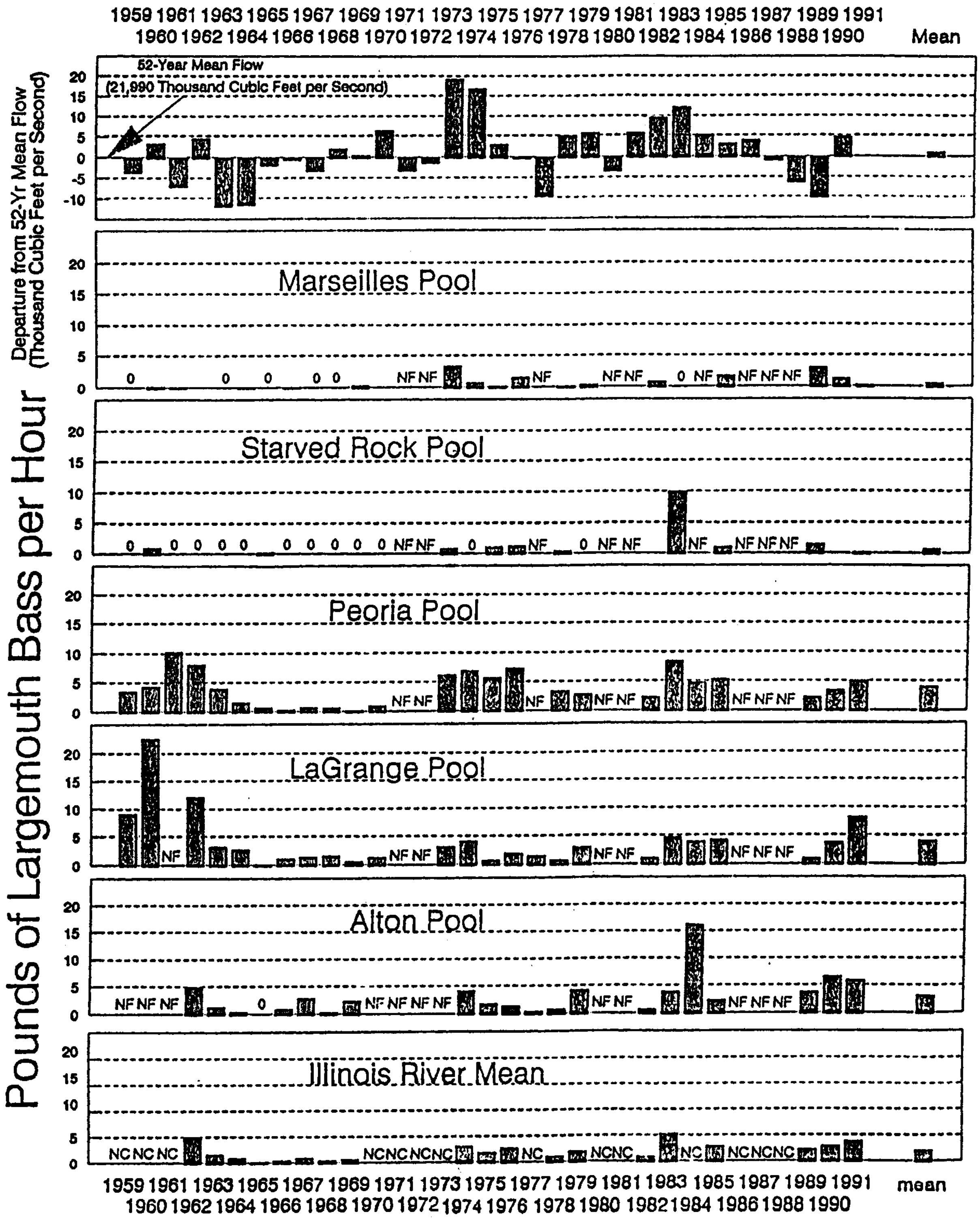
An interesting comparison can be made between total lb/hr and total numbers/hr for gizzard shad and carp. While gizzard shad had the second highest numbers/hr by far, lb/hr were modest. This indicates most of the gizzard shad were small in size relative to other species. In contrast, while carp overwhelmingly had the highest lb/hr, the numbers/hr were modest, although still substantial relative to other species. This indicates there were few very small carp in comparison to gizzard shad or other species. Indeed, few carp less than 11 in. were taken.

Largemouth bass. Since 1959, largemouth bass catch rates (lb/hr) roughly followed departures from the 52-year mean flow (Figure 6). Following the low water years of

Table 3. Biomass (lb) per hour of electrofishing for each species obtained in 1991 arranged by navigation pool.

Species	Pool and Number of Hours Fished							
	Alton 4.77	LaGrange 4.46	Peoria 5.22	Starved Rock 1.43	Marseilles 1.92	Dresden 1.79	Mississippi 1.00	Total 20.59
Bigmouth Buffalo	3.582	7.313	11.190	0.000	0.000	0.000	1.973	5.347
Bluegill x Green Sunfish	0.000	0.027	0.072	0.000	0.000	0.000	0.000	0.024
Black Buffalo	0.249	0.000	0.000	0.000	0.000	0.000	0.000	0.058
Black Bullhead	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003
Black Crappie	0.906	3.353	0.630	0.570	0.034	0.000	0.639	1.277
Bluegill	3.336	4.392	1.902	0.015	0.637	0.585	1.956	2.384
Bluntnose Minnow	0.000	0.000	0.000	0.003	0.202	0.721	0.000	0.008
Bullhead Minnow	0.000	0.000	0.000	0.004	0.021	0.073	0.008	0.003
Carp	13.435	6.332	13.971	9.559	0.029	0.000	14.672	11.430
Channel Catfish	4.920	3.621	1.482	1.287	9.984	12.612	0.003	2.536
Carp x Goldfish	0.098	0.000	0.084	0.000	0.115	1.564	0.000	0.431
Emerald Shiner	0.001	0.000	0.010	0.115	0.574	3.830	0.002	0.023
Flathead Catfish	0.283	0.059	0.000	0.000	0.062	0.077	0.000	0.078
Freshwater Drum	0.429	1.399	1.554	0.000	0.000	0.000	0.798	0.835
Goldfish	0.183	0.000	0.030	0.000	0.000	0.000	0.000	0.050
Golden Redhorse	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.049
Golden Shiner	0.000	0.000	0.000	0.000	0.522	0.000	0.000	0.002
Green Sunfish	0.101	0.218	1.123	0.139	0.008	0.010	0.000	0.427
Gizzard Shad	1.118	1.008	1.824	0.837	0.322	0.369	7.452	1.656
Largemouth Bass	5.919	8.225	4.917	0.177	1.656	1.632	0.231	4.885
Longear Sunfish	0.000	0.000	0.000	0.000	0.253	5.037	0.000	0.002
Minnow (unidentified)	0.000	0.000	0.000	0.000	0.000	0.025	0.000	0.000
Orangespotted Sunfish	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.001
Red Shiner	0.000	0.000	0.000	0.039	0.000	0.000	0.000	0.008
Rock Bass	0.000	0.000	0.000	0.000	0.058	0.000	0.000	0.052
Redear Sunfish	0.000	0.000	0.001	0.000	0.000	0.597	0.013	0.002
River Carpsucker	0.675	0.808	3.350	0.000	0.000	0.015	0.000	1.181
Smallmouth Buffalo	1.629	0.801	3.241	1.775	0.000	0.000	4.233	1.701
Sauger	0.016	0.000	0.338	0.000	0.000	0.000	0.000	0.089
Shortnose Gar	0.213	0.237	0.000	0.000	0.000	0.000	0.000	0.101
Shorthead Redhorse	0.225	0.279	0.750	0.000	0.000	0.000	0.000	0.350
Skipjack Herring	0.028	0.005	0.117	0.000	0.511	0.000	0.000	0.042
Smallmouth Bass	0.000	0.000	0.000	0.054	0.000	0.060	0.000	0.031
Spottail Shiner	0.000	0.000	0.003	0.000	0.287	0.000	0.000	0.001
Sunfish (unidentified)	0.004	0.002	0.060	0.000	0.000	0.000	0.022	0.018
Silver Chub	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.001
Threadfin Shad	0.062	0.116	0.014	0.000	0.000	0.000	0.046	0.055
Quillback	0.000	0.000	0.013	0.000	0.006	0.099	0.000	0.003
Warmouth	0.032	0.119	0.000	0.000	0.000	0.000	0.000	0.033
White Bass	0.607	3.328	2.226	0.000	0.000	0.000	0.228	1.437
White Crappie	0.065	0.610	0.100	0.000	0.000	0.000	3.693	0.352
White Perch	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.000
White Sucker	0.000	0.000	0.374	0.000	0.000	0.000	0.000	0.113
Yellow Bullhead	0.000	0.000	0.245	0.000	0.000	0.209	0.000	0.062
Yellow Bass	0.000	0.000	0.291	0.123	0.000	0.000	0.000	0.082
Totals	38.118	42.255	49.915	14.697	15.281	27.515	35.969	37.223

Figure 6. Pounds of largemouth bass collected per hour on the Illinois River, 1959-1991. Catch rates generally followed departures from the 52-year mean flow rate. Following the 1963-1964 drought, catch rates did not rebound for approximately ten years, despite a lack of severe negative departures from the mean flow rate. In 1990, catch rates in the lower river pools increased directly following the 1988-1989 drought, possibly due to improvements in waste treatment and water quality compared to the 1960s.



NF = Not Fished
NC = Not Calculated

1963-1964, it took approximately ten years before catch rates began to increase in Peoria and La Grange pools. In contrast, in the two years immediately following the 1988-1989 drought, catch rates in these two lower river pools increased--presumably in response to the higher water levels of 1990--while catch rates in the Starved Rock and Marseilles pools decreased.

The immediate increases in catch rates of largemouth bass in the lower river pools following the most recent drought may result from improved water quality associated with improvements in wastewater treatment. In the upper river, the higher amounts of pollution [e.g., ammonia (Figure 2)], more concentrated in the water column during drought conditions, may still be creating conditions stressful enough to result in lower catch rates, even with a return to higher flows and greater dilution (Figure 6).

In the time between the droughts in 1963-1964 and 1988-1989, a quantum leap in pollution control occurred in the Chicago area as the Tunnel and Reservoir Plan (TARP) became operational (Singh et al. 1989). The TARP consists of a system of underground tunnels and reservoirs designed to catch and hold combined storm and sewer wastewaters, transfer the water to a treatment plant and then gradually release the treated water to area waterways. This should help reduce the amount of raw sewage being discharged during large storms, when overflows occur. All this flow eventually reaches the Illinois River.

Threadfin shad. Threadfin shad were first collected by the LTEF survey in 1983 from the Peoria pool (Figure 7). By 1991, threadfin shad had been collected from all pools. Since threadfin shad were historically not found northward much beyond southern Illinois (Smith 1979:34), the fact they first appeared in the middle reaches of the Illinois River implies an artificial introduction. In fact, the Illinois Department of Conservation began stocking threadfin shad as a forage fish in power plant lakes approximately 15 years ago (Illinois Department of Conservation 1992). Although these fish cannot survive in temperatures much below 45^0 F (Pflieger 1975:80), a permanent reproducing population in the river may exist if threadfin shad survive in warmwater plumes downstream of power plants.

Fish Condition and Environmental Factors

In the following section, the 1991 data were compared to data from 1963 and 1975 to determine whether changes in environmental conditions are associated with changes in relative abundance and condition of selected fish species.

Acute toxicity due to un-ionized ammonia. Toxicity in the water column due to un-ionized ammonia was much less in 1990 than in 1975 (Figure 8). [There were many more sampling stations in 1990 (66) than in 1975 (16). For this reason, the 1990 curve shows more detail.] However, the

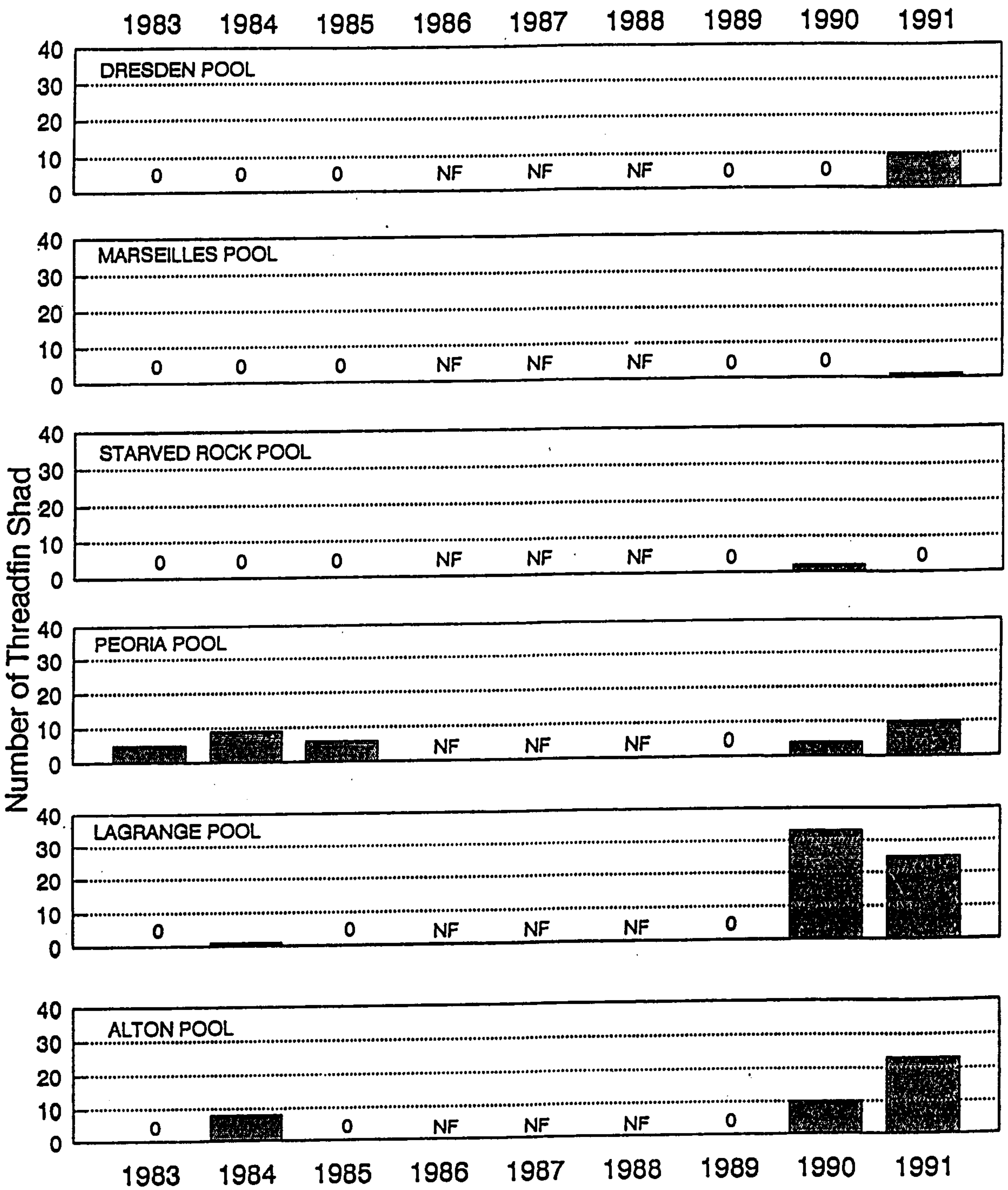


Figure 7. Number of threadfin shad obtained from 1983 through 1991. Threadfin shad began appearing in LTEF samples in 1983 from the Peoria Pool. NF = not fished.

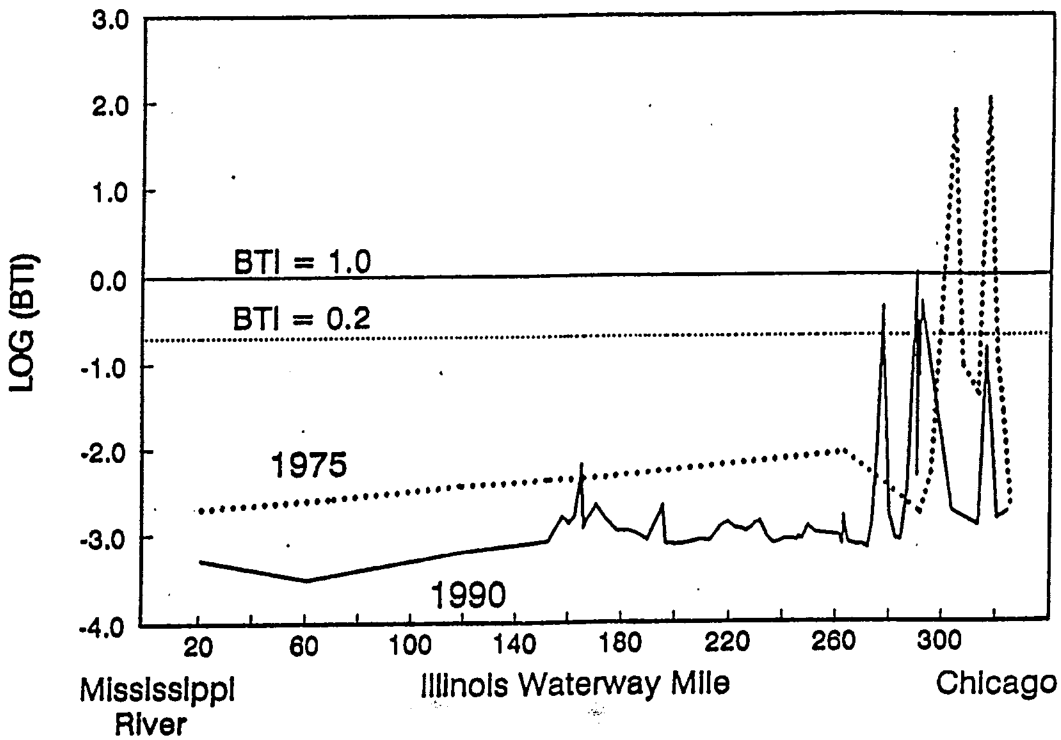


Figure 8. Mean BTI calculated for 1975 (16 stations) and 1990 (66 stations). There was a decline in ammonia toxicity between 1975 and 1990. A BTI of 1.0 is the lethal threshold; 0.2 is the threshold at which the fish community becomes dominated by ammonia-tolerant species. For values below 0.2, the fish community would be characterized as a largemouth bass-bluegill community. Above 0.2, carp and goldfish dominate the community.

historic trend of increasing toxicity toward the Chicago area is still evident. The percent of ammonia in the un-ionized state increases with pH and temperature. Fish are more sensitive to a given concentration of un-ionized ammonia at lower temperatures (Wedemeyer et al. 1976:94, Roseboom and Richey 1977, Reinbold and Pescitelli 1982) and low DO concentrations (Lubinski et al. 1974); therefore, the BTI increases with decreasing temperature or DO. In addition, the BTI increases as the size of the fish decreases, probably due, in part, to an increase in gill surface-to-body-volume ratio; hence, an increase in the surface for uptake of toxicants. Table 4 shows the effects of these influences using three dominant size classes of bluegill, as determined from the 1991 LTEF data. Illinois Pollution Control Board (IPCB) standards (Polls et al. 1991a:35) were used in the calculations to create the hypothetical worst case situation still considered tolerable by law. It is clear from Table 4 that present IPCB standards allow for extremely toxic situations, especially for small size classes.

During the 1990 LTEF survey, only two fish were taken at the Hennepin Island station (river mile 208). Sparks and Blodgett (1991) hypothesized that a noxious material may have caused the fish to avoid the area. Examination of data from Polls et al. (1991a:40) showed a steady increase in un-ionized ammonia at river mile 195.9 beginning in April 1990

Table 4. Bluegill toxicity indices (BTI) calculated for the mean weight of three size classes as determined from LTEF data[a].

	BTI	
Size class (in.)	4^0 C	32^0 C
2.2	22.7	7.2
3.9	8.2	2.6
5.9	0.31	0.10

[a]IPCB standards were used in the calculations:

total ammonia = 15 mg/l
DO = 5 mg/l
pH = 9.0

and peaking in late August at 0.06 mg/l (the IPCB standard is 0.04 mg/l), just prior to the LTEF sampling date of 11 September. Lubinski (1976) showed that bluegill do not actively avoid areas with sub-lethal concentrations of un-ionized ammonia, which implies that a stressful situation might be endured until it is lethal. If ammonia levels at Hennepin had increased to levels that immobilized fish, the fish might be carried downstream, away from the site. Fish were more abundant at the Hennepin Island station in 1991 than in 1990 (Appendix A); although of all the stations in 1991, this station produced the lowest number of species (8) and the lowest number of individuals (18) (Appendix A).

Even though the BTI values in Table 4 represent hypothetical possibilities, they are based on existing standards. Regulators need to reevaluate standards that appear insufficient to protect the biotic integrity of the environment for which they were enacted.

Incidence of external abnormalities. The percent of bottom contact fish exhibiting external abnormalities for 1963 increases toward the Chicago area (Figure 9). Although the situation improved by 1975, there seems only slight improvement since. Hughes and Gammon (1987) also documented an increase in external abnormalities in fish from the Willamette River, Oregon, increasing from the cleaner headwaters to the more polluted and urbanized downstream reaches. In contrast to the bottom-contact fishes, few (10%

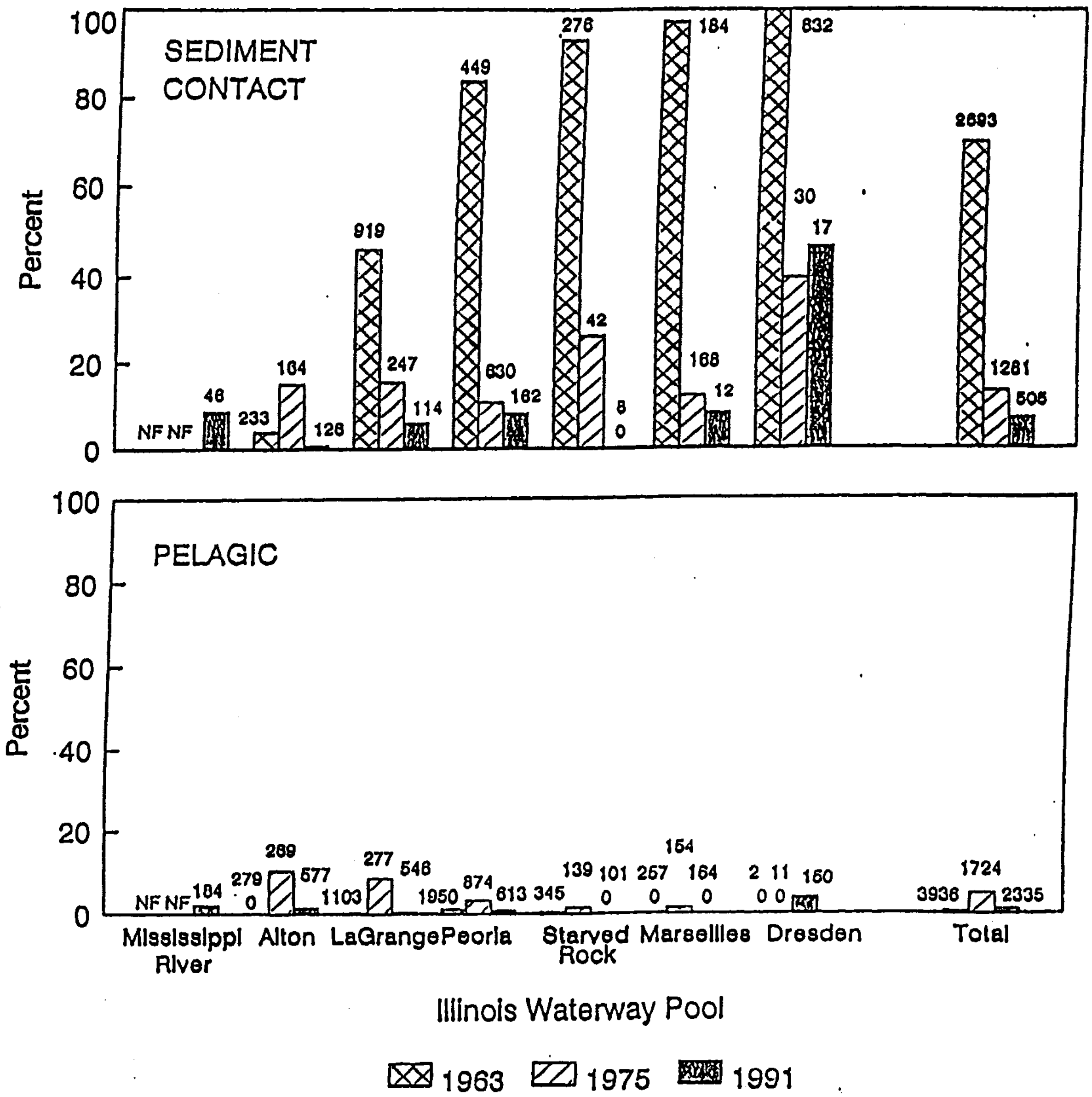


Figure 9. Incidence of externally-visible abnormalities on fish which are likely to come into frequent contact with bottom sediments (top) and on fish which are mainly pelagic (bottom) for 1963, 1975, and 1991. Numbers above each bar represent the total number of fish caught for the specified year and location. NF = not fished.

or less) of the pelagic fishes exhibited external abnormalities (Figure 9). In 1975, there was a increase in external abnormalities from upstream to downstream pools. A more detailed analysis of these data is necessary to determine trends for specific abnormalities.

Relative weight. Changes in W_r of fish are thought to be directly coupled to biotic and abiotic conditions. Although no temporal or spatial trends are evident, mean W_r for carp in 1963, 1975, and 1991 were substantially less than 1.0 (Figure 10). This indicates the environment inhabited by these bottom-feeding fish is less than conducive to healthy growth, or that the food supply is limited in quantity or quality.

Mean W_r values for bluegill and largemouth bass, have remained fairly constant for 1963, 1975, and 1991 (Figures 11 and 12), indicating that the food supply may not be a major limiting factor for these insectivorous and piscivorous species. It is noteworthy that these two species appear to be slowly re-colonizing the upper river pools, a possible indication of improved conditions.

Recovery and Limitations

The results of our analyses show that, since the early 1960s, the Illinois River, particularly the upper river, is showing clear signs of recovery which closely parallel improvements in pollution control. The following discussion

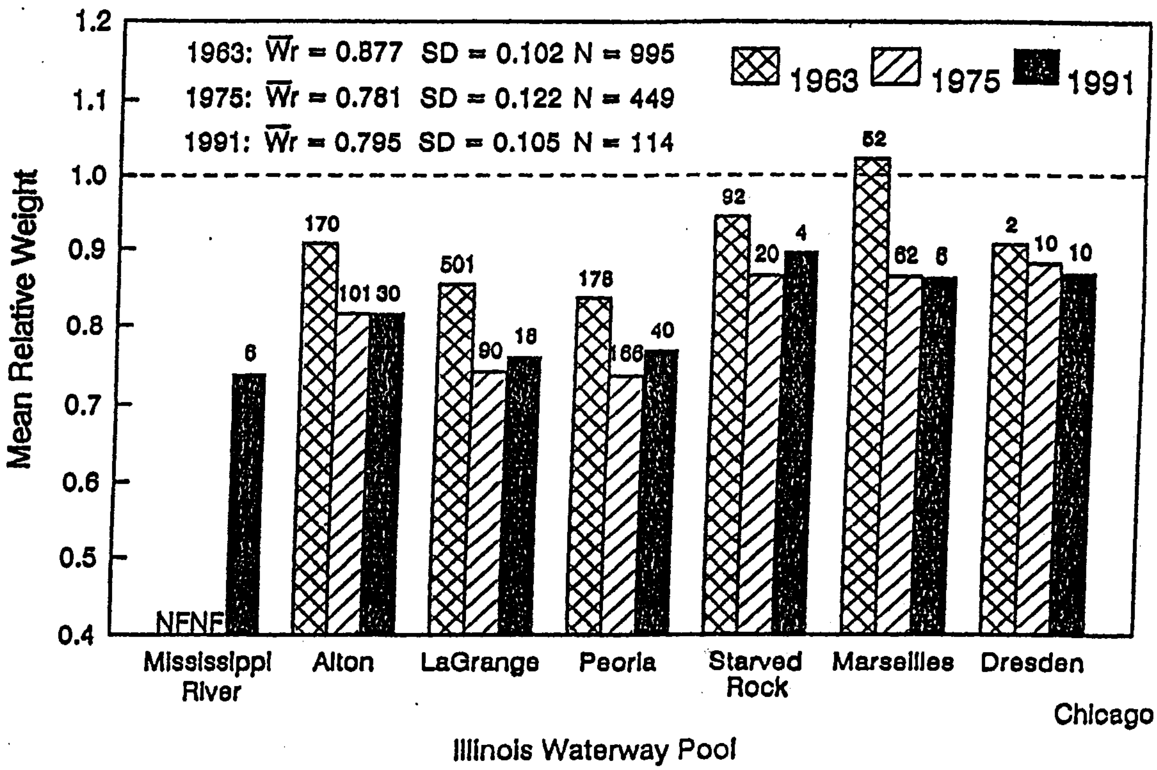


Figure 10. Mean relative weight for carp along the Illinois Waterway for 1963, 1975, and 1991. Only fish greater than or equal to 11 in. were used. Numbers above each bar represent the number of individuals used in the calculation. The mean values for all three years are much less than 1.0, indicating that a persistent problem exists within carp habitats. NF = not fished.

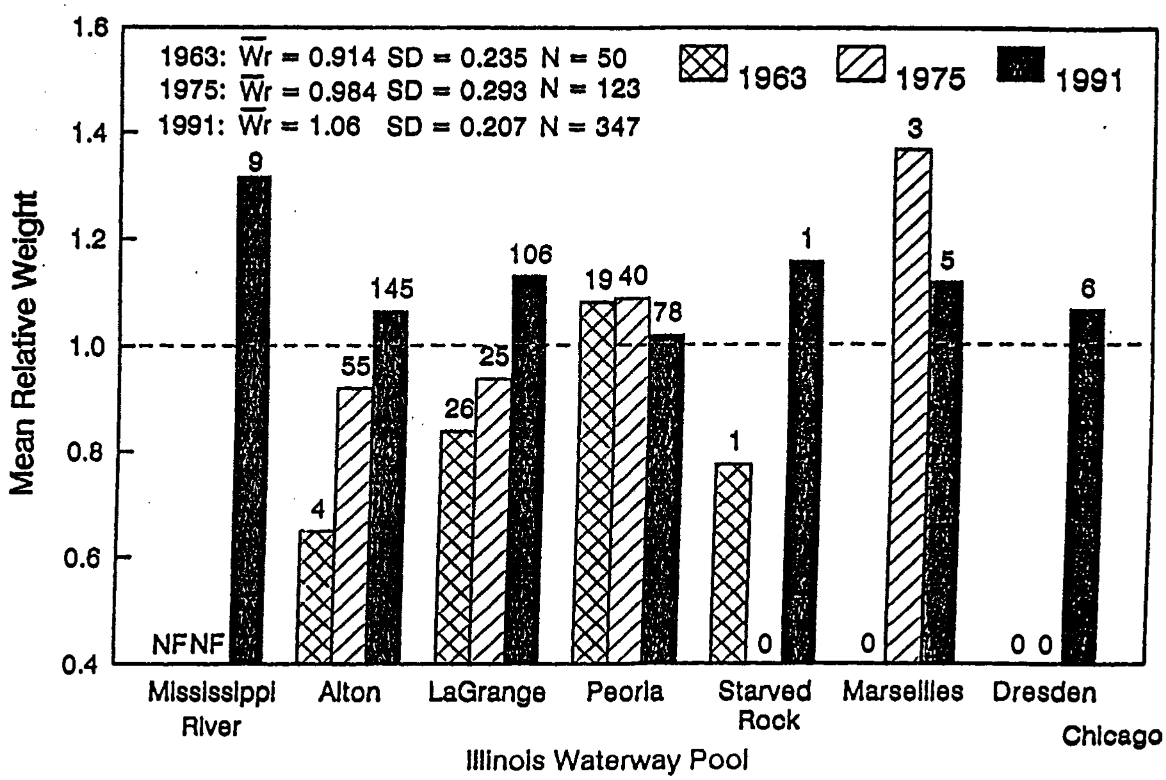


Figure 11. Mean relative weight for bluegill in the Illinois Waterway for 1963, 1975, and 1991. Only fish greater than or equal to 3.2 in. were used. Numbers above each bar represent the number of individuals used in the calculation. Mean values for all three years are close to 1.0. Bluegill appear to be slowly re-colonizing the upper river pools. NF = not fished.

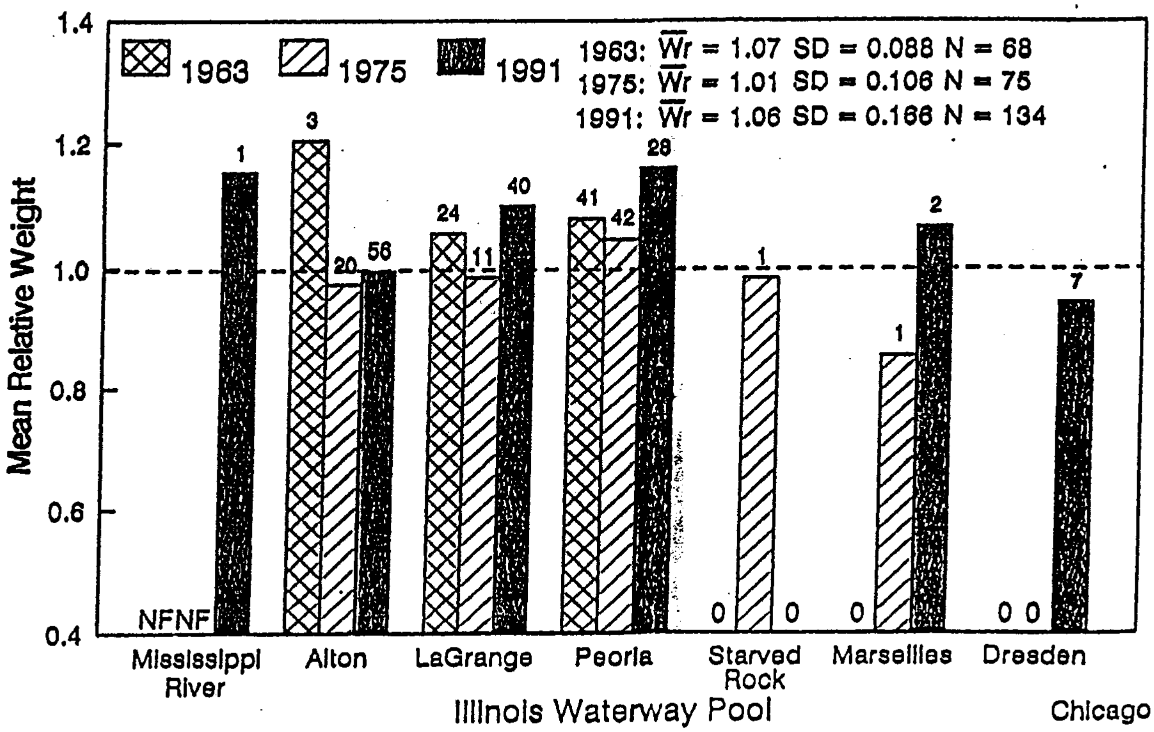


Figure 12. Mean relative weight for largemouth bass along the Illinois Waterway for 1963, 1975, and 1991. Only fish greater than or equal to 5.9 in. were used. Numbers above each bar represent the number of individuals used in the calculation. Mean values for all three years are close to 1.0. As with bluegill, largemouth bass appear to be slowly re-colonizing the upper river pools. NF = not fished.

will address some of the limitations to recovery as well as identify reasons for optimism.

One obstacle limiting further recovery is the permanent loss of backwaters: between 1903 and 1920, half of the floodplain acreage below La Salle (river mile 223) was drained (Mills et al. 1966). Richardson (1913) long ago reported on the importance of backwater areas for fish nurseries, just before many of these areas were converted to agriculture (Mills et al. 1966). Guillory (1979) documented substantial lateral migration of fish on the lower Mississippi River during spring floods. Ross and Baker (1983) defined certain fish species as flood-exploitative; that is, fish whose life history requires access to the resources of the floodplain, which can only be obtained during floods. The bigmouth buffalo is such a fish (Johnson 1963); and it is conspicuously absent in the upper river pools (Table 2), which generally lack large areas of backwaters.

The annual extension of water over the floodplain is so significant that Bayley (1991) refers to the "flood pulse advantage" of large floodplain rivers. A gradual rise in water levels over the floodplain provides fish access to resources resulting in larger year classes than if water levels were constant. For rises faster or slower than some optimum, year class strength is less. Obviously, managing water levels to maintain a navigation channel and diversions from Lake Michigan can interfere with this process. This is not to say the natural flood pulse could not be mimicked, given the proper management priorities.

The Illinois River and its floodplain are the ultimate expression of conditions on the watershed (Lotspeich 1980). Thus, backwater areas continue to lose their volume due to excessive sedimentation resulting from increased erosion in the watershed (Bellrose et al. 1983, Demissie and Bhowmik 1987). Even though efforts to reduce soil erosion on the uplands and on tributary streams are occurring (Sparks 1992), Peoria Lake, for example, has lost over two-thirds of its original volume (Demissie 1989).

Backwaters that are already degraded by sediment deposits will not be restored by controlling soil erosion on the watershed, although the rate of volume loss would be slowed. A positive feedback loop exists in most backwater areas whereby sediments are constantly resuspended by boat- and wind-generated wave action that normally would be diminished by aquatic plants, which in turn are prevented from growing due to turbidity and lack of a firm substrate for roothold (Sparks et al. 1990). This situation most likely developed gradually until a critical threshold was reached, at which point the self-sustaining feedback process was established (Sparks et al. 1990). As these turbid environments are now less than optimal for the reproduction and survival of virtually all the gamefishes (basses, sunfishes, yellow perch), a management imperative should be to identify this turbidity or sediment loading threshold and other critical thresholds and prevent them from being reached.

The problem of sporadic episodes of toxicity due to un-ionized ammonia may be exacerbated by the loss of aquatic vegetation. Plants take up ammonia as a nutrient; therefore, the absence of aquatic vegetation may allow for the build-up of ammonia in the sediments (Sparks 1992), which can diffuse into the water column (Cordone and Kelly 1961). Thus, it appears that the restoration of aquatic vegetation in the Illinois River may be necessary to help control ammonia toxicity. It is not clear if further substantial improvements in the restoration of fish communities could proceed without this important ecosystem component.

Although this report has been directed toward the condition of fish communities, waterfowl use of the Illinois River and its backwaters is another important issue. The strategies for managing the backwater lakes for waterfowl include drawing down the water to encourage moist soil plant growth (Sparks 1992). The levees and pumps that allow for the control of water levels may inhibit fish movements out of the impoundments during falling water levels. Clearly, the effects of moist soil impoundments on fish should be investigated.

However, current habitat rehabilitation projects (HREP) on the Illinois River may address the necessary issues. A key component is the re-establishment of aquatic vegetation. Habitat rehabilitation plans in Lake Peoria include the creation of artificial islands using material dredged from the lake bottom (Demissie 1989). This would contribute toward the reduction of wind fetch and hence wave action and turbidity, which should facilitate aquatic plant growth. These improved conditions should benefit fish species that are intolerant of turbidity (e.g., yellow perch) or that require aquatic vegetation for spawning (e.g., bigmouth buffalo). The LTEF survey has been shown to be effective at detecting changes in fish populations and should prove useful in assessing the success of HREP projects.

The exotic zebra mussel (Dreissena polymorpha) has been found throughout the Illinois Waterway (Sparks and Marsden 1991). This could have devastating effects on native mussel populations (Sparks and Marsden 1991), which could have widespread cascading effects on the food web. Indeed, mussel beds may be very important to fish communities by providing a refuge for small fish from predators and substrates for use by lithophilic spawners, and by concentrating resources (Moy and Sparks 1991). Zebra mussels, because of their much different morphology and life history, might not form the same types of mussel bed ecosystems as native mussels (Moy and Sparks 1991). On the other hand, Snyder (1992) reported increased water clarity and subsequent macrophyte growth in areas of Lake Erie with large numbers of zebra mussels. If fish communities are being impacted by the spread of the zebra mussel, it should be possible to monitor the degree of impact by examining relative abundance changes, although separating changes due to the presence of the zebra mussel from other influences will be difficult.

An encouraging sign in the Chicago and Peoria areas is the slowing of population growth in recent decades (Figure 13). Projects such as TARP will have a better chance to make substantive strides in pollution control with less population growth. At the same time, a redistribution of people in the Chicago area from the central city to the widespread collar communities has occurred. This has resulted in a 45-65% increase in the urban area of this region between 1970 and 1990, with about the same number of people (Northeastern Illinois Planning Commission 1991). Although these changes may seem far removed from a discussion of fish populations, they will, however, result in changes in water quality (e.g., increased non-point source pollution from more paved areas) and water regime (more rapid runoff and sharper flood peaks), which cause changes in fish communities. Again, the LTEF survey should be capable of detecting these changes.

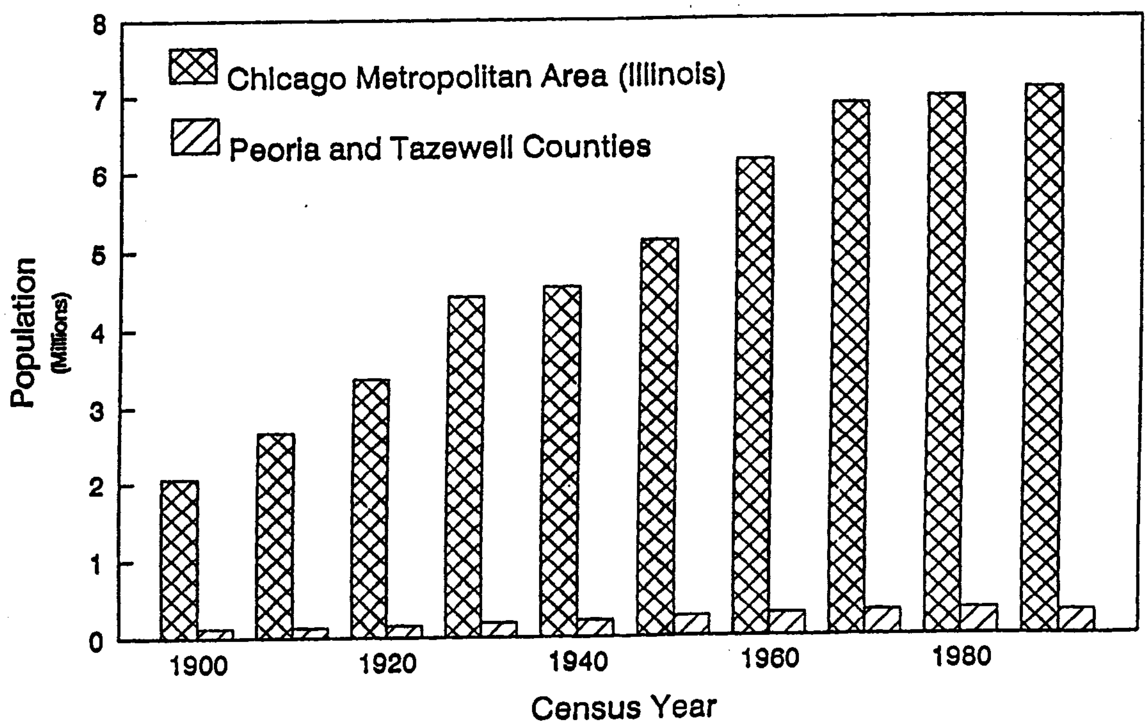


Figure 13. Human populations for the two largest urban areas along the Illinois Waterway (Source: U.S. Census of Population). Improvements in waste treatment are no longer offset by large increases in the number of humans.

Future Plans

Because the Homelite generator is unreliable and it is difficult to find replacement parts, a new generator will be used on subsequent LTEF surveys. Since the interpretation of relative abundance data requires that catch efficiencies remain the same from year to year, the electric field of the new generator will be adjusted until it is comparable to the old.

A more detailed analysis of the LTEF data set is being planned in order to better understand long-term trends and to provide usable information for environmental managers. This analysis has awaited the complete conversion of the data set into a computerized format.

An area that shows great promise in identifying spatial and temporal trends is the examination of longitudinal gradients (Rahel and Hubert 1991). This requires the use of advanced statistical techniques that can only be done on a computer. Hughes and Gammon (1982) used a cluster analysis technique which effectively identified changes in the longitudinal distribution of fishes in the Willamette River, Oregon, resulting from improvements in environmental quality. The LTEF data set is much more extensive and continuous than that used by Hughes and Gammon (1982) and should provide new insights into long-term trends on the Illinois River.

SUMMARY AND CONCLUSIONS

The findings of this year's investigations can be summarized as follows:

1. We collected a total of 2,840 individuals and 43 species of fishes. For all sites combined, the catch rate as numbers per hour was the highest for bluegill, while the biomass catch rate (pounds per hour) was highest for carp.
2. Overall, collections on the upper river pools produced less fish (numbers/hr and lb/hr) than lower river pools. This finding is consistent with previous years. In 1991, the catch rate for largemouth bass in Dresden pool (5.037 lb/hr) was similar to the catch rate in Peoria pool (4.917 lb/hr). This in an indication of improved conditions in the upper Illinois Waterway.
3. Largemouth bass catch rates (lb/hr) from 1959-1991 generally parallel discharge departures from the 52-year mean flow. In the 1960s, the catch rate took as long as ten years to show partial recovery from low water years; whereas in the 1990s, the beginnings of catch rate recovery on the lower river were coincident with a return to higher water levels after the 1988-1989 drought. This quicker recovery following drought may be attributable to recent improvements in water

quality in the downstream pools. At the same time, excessive turbidity from erosion in the watershed is still a problem in the lower river.

4. The threadfin shad, whose historic range does not extend northward much beyond southern Illinois, first appeared in 1983 LTEF collections from the Peoria pool. Stocking of this fish into power plant lakes by the Illinois Department of Conservation began approximately 15 years ago. By 1991, threadfin shad had been collected from all pools.
5. The introduction of threadfin shad can be contrasted with the recolonization of the upper river pools by sauger, bluegill, largemouth bass, and smallmouth bass, probably because of improved water quality on the upper river since the early 1960s.
6. In spite of clear signs of a recovering fish community, analysis of water quality data using the bluegill toxicity index (BTI) shows there are toxic conditions due to un-ionized ammonia, although much less so in 1990 than in 1975. Furthermore, calculations of the BTI using current IPCB standards showed those standards permit lethal conditions and should, therefore, be reevaluated.

7. The incidence of external abnormalities on fish has decreased from 28.7% in 1963 to 2.3% in 1991. Even so, fish that come into frequent contact with bottom sediments show a much higher incidence of external abnormalities (7.1% in 1991) than fish that mainly inhabit the water column (1.2% in 1991), especially on the upper Illinois Waterway.

8. In 1963, 1975, and 1991 the mean W_r for carp was consistently less than 1.0, while the mean W_r for bluegill and largemouth bass have remained close to 1.0. The low W_r for carp (a bottom-feeder) together with a higher incidence of external abnormalities on bottom-feeding fish compared to non-bottom feeding fish indicate that a problem exists with sediment quality.

9. The several analyses applied to the LTEF data are consistent in demonstrating a recovery of fish populations since the early 1960s in the Illinois River, especially in the upper river. Limitations on this recovery include the presence of toxicants in the sediments and in the water column, and continued siltation and consequent loss and/or degradation of important backwater habitats.

The LTEF data set has detected long-term trends in fish populations. This type of trend analysis is especially important now that so many pronounced changes (completion of the Tunnel and Reservoir Plan, habitat rehabilitation projects, soil erosion control, increases in urbanized areas) are occurring on the Illinois River and its watershed.

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Appendix A. Species and number of individuals collected at each site (located by mean river mile). Scientific names for each species are listed in Appendix B.

Species	Lower River Mile																		Sub-total	Total
	18.8	24.7	27.5	30.0	58.5	86.4	96.0	107.0	113.0	148.2	154.9	163.3	170.7	180.9	193.9	202.9	203.3	207.8		
Bigmouth Buffalo	0	0	0	3	0	0	0	2	7	2	4	0	0	0	0	2	5	7	32	44
Bluegill x Green Sunfish	0	0	0	0	0	0	1	0	0	0	1	2	0	1	0	0	0	0	5	5
Black Buffalo	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Black Bullhead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Black Crappie	8	2	7	10	1	4	31	9	15	0	1	1	4	11	1	2	1	0	108	121
Bluegill	43	75	103	43	17	28	53	48	89	7	37	15	42	68	20	16	13	1	718	819
Bluntnose Minnow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	37
Bullhead Minnow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32
Carp	5	3	7	15	1	1	3	5	11	1	3	22	10	10	3	0	1	0	101	128
Channel Catfish	13	1	5	2	9	1	1	3	0	1	0	2	0	5	0	0	0	0	43	49
Carp x Goldfish	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	3	7
Emerald Shiner	0	1	0	0	0	0	0	1	0	1	0	0	1	0	0	6	0	1	11	98
Flathead Catfish	0	0	2	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	4	4
Freshwater Drum	13	7	10	5	1	7	6	18	8	11	6	8	13	14	5	2	0	0	134	166
Goldfish	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	3	3
Golden Redhorse	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Golden Shiner	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Green Sunfish	0	6	4	0	1	1	2	5	4	1	6	10	74	13	1	3	0	0	131	178
Gizzard Shad	9	106	15	9	2	13	35	23	2	1	16	1	9	15	151	11	14	3	435	611
Largemouth Bass	16	19	11	14	5	0	12	9	12	0	8	2	7	13	4	1	1	2	136	160
Longear Sunfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Minnow unid.	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
Orangespotted Sunfish	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	2
Red Shiner	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	54
Rock Bass	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Redear Sunfish	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	3
River Carpsucker	0	0	0	3	0	1	1	0	1	0	0	10	0	9	1	1	4	0	31	32
Smallmouth Buffalo	4	0	4	3	0	0	0	2	2	0	3	5	3	1	1	0	2	2	32	46
Sauger	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
Shortnose Gar	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	3	3
Shorthead Redhorse	0	1	0	1	0	0	0	1	1	0	0	0	0	0	0	1	1	1	7	9
Skipjack Herring	2	4	0	0	1	1	0	1	0	0	0	1	0	0	2	1	0	0	13	14
Smallmouth Bass	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Spottail Shiner	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	3
Sunfish unid.	0	0	3	0	0	0	0	0	1	0	0	0	2	0	0	0	0	0	6	9
Silver Chub	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
Threadfin Shad	2	7	8	3	3	0	0	0	0	3	22	0	0	2	8	0	0	0	58	75
Quillback	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	3
Warmouth	1	0	0	1	0	0	2	0	1	0	0	0	0	0	0	0	0	0	5	5
White Bass	1	2	2	2	2	3	2	4	3	3	15	1	1	4	2	10	5	1	63	72
White Crappie	1	0	0	0	1	1	7	0	0	0	0	0	2	0	0	0	0	0	12	17
White Perch	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1
White Sucker	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	3	4
Yellow Bullhead	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	2
Yellow Bass	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	5
Totals	122	237	185	115	44	61	157	132	157	31	122	83	176	170	199	56	48	18	2113	2840
Number of Species	16	15	14	15	12	11	14	15	13	10	12	15	17	16	12	12	11	8	34	43

Appendix A. Continued.

Species	Upper River Mile									Mississippi River Mile		
	215.3	240.5	241.4	247.9	249.7	260.7	277.3	279.7	Sub-total	204.0	205.0	Total
Bigmouth Buffalo	11	0	0	0	0	0	0	0	11	1	0	44
Bluegill x Green Sunfish	0	0	0	0	0	0	0	0	0	0	0	5
Black Buffalo	0	0	0	0	0	0	0	0	0	0	0	1
Black Bullhead	0	0	0	0	0	1	0	0	1	0	0	1
Black Crappie	1	1	1	0	0	4	1	1	9	4	0	121
Bluegill	8	3	2	4	4	6	11	2	40	21	40	819
Bluntnose Minnow	0	0	3	2	0	4	24	4	37	0	0	37
Bullhead Minnow	0	3	1	5	18	0	0	0	27	0	5	32
Carp	1	4	0	2	1	3	1	9	21	3	3	128
Channel Catfish	0	1	1	0	0	1	2	0	5	0	1	49
Carp x Goldfish	0	0	0	1	0	0	0	3	4	0	0	7
Emerald Shiner	1	16	22	5	9	5	18	8	84	0	3	98
Flathead Catfish	0	0	0	0	0	0	0	0	0	0	0	4
Freshwater Drum	1	0	0	0	0	0	0	0	1	12	19	166
Goldfish	0	0	0	0	0	0	0	0	0	0	0	3
Golden Redhorse	0	0	0	1	0	0	0	1	2	0	0	2
Golden Shiner	0	0	0	0	0	1	1	0	2	0	0	2
Green Sunfish	1	5	2	3	2	11	2	21	47	0	0	178
Gizzard Shad	6	8	6	7	33	3	11	18	92	49	35	611
Largemouth Bass	3	2	1	2	2	1	3	8	22	1	1	160
Longear Sunfish	0	0	0	0	0	0	0	1	1	0	0	1
Minnow unid.	0	0	0	0	0	0	0	0	0	0	0	2
Orangespotted Sunfish	0	0	0	0	0	0	0	0	0	1	0	2
Red Shiner	0	16	7	2	16	13	0	0	54	0	0	54
Rock Bass	0	0	0	0	0	0	3	1	4	0	0	4
Redear Sunfish	0	0	0	0	0	0	1	0	1	0	1	3
River Carpsucker	1	0	0	0	0	0	0	0	1	0	0	32
Smallmouth Buffalo	5	2	0	0	0	0	0	0	7	3	4	46
Sauger	1	0	0	0	0	0	0	0	1	0	0	2
Shortnose Gar	0	0	0	0	0	0	0	0	0	0	0	3
Shorthead Redhorse	1	0	0	0	1	0	0	0	2	0	0	9
Skipjack Herring	0	0	0	0	0	0	0	1	1	0	0	14
Smallmouth Bass	0	0	1	0	0	1	0	0	2	0	0	2
Spottail Shiner	0	0	0	0	0	0	0	0	0	1	0	3
Sunfish unid.	1	0	0	0	0	0	0	0	1	0	2	9
Silver Chub	0	0	0	0	0	0	0	0	0	0	0	2
Threadfin Shad	0	0	0	0	1	0	10	0	11	1	5	75
Quillback	0	0	0	0	1	0	0	0	1	0	0	3
Warmouth	0	0	0	0	0	0	0	0	0	0	0	5
White Bass	0	0	0	0	0	0	0	0	0	1	8	72
White Crappie	0	0	0	0	0	0	0	0	0	5	0	17
White Perch	0	0	0	0	0	0	0	0	0	0	0	1
White Sucker	0	0	0	0	0	0	0	1	1	0	0	4
Yellow Bullhead	0	0	0	0	0	0	0	0	0	0	0	2
Yellow Bass	3	0	1	0	0	0	0	0	4	0	0	5
Totals	45	61	48	34	88	54	88	79	497	103	127	2840
Number of Species	14	11	12	11	11	13	13	14	30	13	12	43

Appendix B

Scientific Name	Common Name
Ictiobus cyprinellus	bigmouth buffalo
Lepomis macrochirus x L. cyanellus	bluegill x green sunfish
Ictiobus niger	black buffalo
Ictalurus melas	black bullhead
Pomoxis nigromaculatus	black crappie
Lepomis macrochirus	bluegill
Pimephales notatus	bluntnose minnow
Pimephales vigilax	bullhead minnow
Cyprinus carpio	carp
Ictalurus punctatus	channel catfish
Cyprinus carpio x Carassius auratus	carp x goldfish
Notropis atherinoides	emerald shiner
Pylodictis olivaris	flathead catfish
Aplodinotus grunniens	freshwater drum
Carassius auratus	goldfish
Moxostoma erythrurum	golden redhorse
Notemigonus crysoleucas	golden shiner
Lepomis cyanellus	green sunfish
Dorosoma cepedianum	gizzard shad
Micropterus salmoides	largemouth bass
Lepomis megalotis	longear sunfish
Lepomis humilis	orangespotted sunfish
Notropis lutrensis	red shiner
Ambloplites rupestris	rock bass
Lepomis microlophus	redear sunfish
Carpiodes carpio	river carpsucker
Ictiobus bubalus	smallmouth buffalo
Stizostedion canadense	sauger
Lepisosteus platostomus	shortnose gar
Moxostoma macrolepidotum	shorthead redhorse
Alosa chrysochloris	skipjack herring
Micropterus dolomieui	smallmouth bass
Notropis hudsonius	spotail shiner
Lepomis sp.	sunfish
Hybopsis storeriana	silver chub
Dorosoma petenense	threadfin shad
Carpiodes cyprinus	quillback
Lepomis gulosus	warmouth
Morone chrysops	white bass
Pomoxis annularis	white crappie
Morone americana	white perch
Catostomus commersoni	white sucker
Ictalurus natalis	yellow bullhead
Morone mississippiensis	yellow bass