UILU-WRC-77-0005
SPECIAL REPORT NO. 5

Environmental Inventory and Assessment of Navigation Pools 24, 25, and 26, Upper Mississippi and Lower Illinois Rivers

An Electrofishing Survey of the Illinois River

By Richard E. Sparks

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WATER RESOURCES
CENTER

JUNE 1977

This report is the second edition.
The first edition was published by
the U.S. Army Engineer Waterways
Experiment Station as Contract
Report Y-75-4, dated December 1975.

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Funding for reprinting was provided with support from the Illinois Institute for Environmental Quality.

June 1977

PREFACE

The 1974 electrofishing survey, the preparation of the report, and the publication of the first edition were sponsored by the U. S. Army Engineer District, St. Louis, through the U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi, as part of an overall investigation entitled "Environment Inventory and Assessment of Navigation Pools 24, 25, and 26, Upper Mississippi and Lower Illinois Rivers: An Electrofishing Survey of the Illinois River."

The Water Resources Center with partial support from the Illinois Institute for Environmental Quality, is pleased to reprint this valuable inventory and assessment since the document should be useful to other people interested in the Illinois River. The original distribution was quite limited due to a small initial printing, limited funds of the contract, and a loss in the mailing of a number of copies to the sponsor.

The report demonstrates the importance of the long-term sampling program of the State Natural History Survey in evaluating the changing environmental conditions of the Illinois River. It also illustrates the magnitude of man's influence on the river, and the complexity of water problems.

Glenn E. Stout
Director
Water Resources Center

ABSTRACT

The effect of municipal and industrial discharges from the Chicago-Joliet area was evident in electrofishing catches from the Des Plaines River--only the introduced carp and goldfish and hybrids of these two pollution-tolerant species were abundant, and most were diseased. There was a greater variety and abundance of fishes in the Illinois, compared to the Des Plaines, and the fish were generally in better condition. The Upper Illinois River has improved for fish life since the 1920's, when no fish were taken throughout much of this section. The improvement is attributable to improved oxygen levels as a result of improved waste treatment. From the 1900's to the 1950's, the backwater areas and bottomland lakes along the river served as nurseries and havens for fish and fish food organisms. In the mid-1950's, the aquatic plants and food organisms in many of these areas died out, and the areas have been seriously diminished and degraded by accumulations of sediment, with a consequent decline in the fisheries. During a drought period in the mid-1960's oxygen and water levels were low, and game fish populations declined. A resurgence in the fish populations occurred in 1973 and 1974, following high water levels and greater dilution of pollution from 1971 through the spring of 1973.

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Special Report No. 5, Water Resources Center, University of Illinois, June 1977, Urbana, Illinois
KEYWORDS--electro-fishing/ fish population/fish harvest/turbidity/navigation/ fish food organism/Illinois River/pollution effects

ACKNOWLEDGEMENTS

The electrofishing survey of the Illinois River was conceived in 1957 and was carried out, for the most part, by Dr. William C. Starrett, Aquatic Biologist, Havana Field Laboratory, Illinois Natural History Survey. Mr. Dennis L. Dooley worked on the electrofishing survey and other Illinois River studies, for 11 years. Following Dr. Starrett's death in December 1971, the electrofishing survey was resumed in 1973 by the writer and Mr. Kenneth Walker, with assistance in locating stations and information on previously established methods from Mr. Dooley. Mr. Carl M. Thompson assisted with the 1974 electrofishing and helped compile and analyze data for this report. Miss Judith L. Breckenridge did the typing. We are grateful to all the students and other assistants who helped with the program from 1959 to 1974. Finally, the electrofishing survey could not have been continued in 1974 without the support of the U. S. Army Corps of Engineers, St. Louis District, and the Waterways Experiment Station, Vicksburg, Mississippi. Special thanks for advice and editing are due to the project supervisors from the Waterways Experiment Station, Mr. R. Charles Solomon and Mr. Billy K. Colbert.

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PART I: INTRODUCTION

Background

For as far back as historical accounts date, the Illinois River Valley has been described as unusually productive of fish and wildlife. The French explorer Marquette wrote in 1673 (Mills, et al., 1966):

> "We have seen nothing like this river that we enter, as regards to its fertility of soil, its prairies and woods; its cattle, elk, deer, wildcats, bustards, swans, ducks, parroquets, and even beaver."

When Illinois was a territory, the Illinois River Valley was considered one of the most important sources of furs in the Northwest part of the United States (Starrett, 1972). During the early part of this century, the Illinois River ranked as a major inland commercial fishery. The economic importance of fish and wildlife to river towns was evidenced by the regular transport of live fish to Chicago, Boston, and New York, and by a train scheduled especially to bring sportsmen into the area. Many people made a living outfitting and guiding fishermen and duck hunters.

The previously abundant wildlife in the Illinois Valley has also contributed much to the development of local folklore of the Havana area. President Benjamin Harrison came there several times to hunt duck. Fishing was so good that the railroad put on the Fisherman's Special, a regularly scheduled train that ran between Springfield and Havana. The gangster Al Capone belonged to the gun club at Patterson's Bay and shot duck there.

From 1874 to 1927, the Illinois State Laboratory of Natural History and its successor, the State Natural History Survey, intensively studied the resources of the Illinois River and its bottomland lakes (Richardson, 1928). Fish population surveys have been conducted regularly from the 1940's to the present. The Natural History Survey therefore welcomed the opportunity to contribute to an environmental inventory of the lower portion of the Illinois River, undertaken by the St. Louis District, U. S. Army Corps of Engineers.

The Study Area

The Illinois River begins at the confluence of the Des Plaines and Kankakee Rivers. Navigational locks and dams along the rivers impound waters, called pools, which provide convenient reference to the geographic location of various sections of the study area (see Figures 1 and 2).

The lower part of the Illinois, the area of principal interest in this study, is influenced by the Alton Dam on the Mississippi. In the middle portion are the pools formed by the LaGrange Dam and the Peoria Dam. Pools sampled in the upper portion are, in upstream order, Starved Rock, Marseilles, and Dresden. The Dresden Dam is located 1.4 miles from the rivers' confluence and the Dresden Pool actually extends into the Des Plaines and Kankakee Rivers. The one sampling station in the Dresden Pool is located in the Des Plaines River.

The Illinois River, the Des Plaines River, the Chicago Sanitary and Ship Canal, and the Chicago River form the Illinois Waterway, which provides a navigation channel 9 ft deep and 160-300 ft wide, connecting the Mississippi River and Lake Michigan. Charts of the Illinois Waterway have been prepared by the U. S. Army Engineer District, Chicago (1970) and locations are given in river miles, starting from mile 0.0 at the confluence of the Illinois and Mississippi Rivers, at Grafton, Illinois, and proceeding upstream to Chicago. Along the river itself, mileages are often given on navigation aids such as buoys, markers, and lights. River mileages provide an accurate means of locating sites along the Illinois Waterway, and are used throughout the text.

The Des Plaines River receives municipal and industrial effluents from the Chicago area, while the Kankakee is relatively unpolluted. The Des Plaines also contributes more to the total flow of the Upper Illinois River than the Kankakee. During the lowest flows expected for

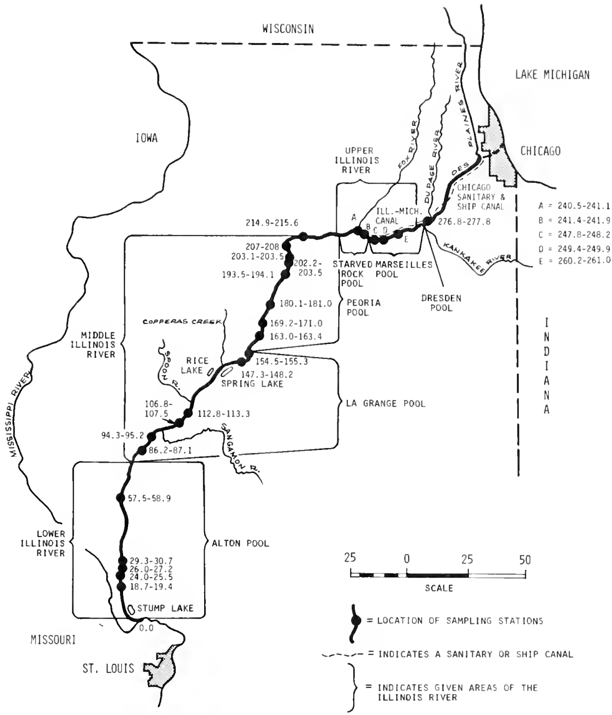

Figure 1. Map of study area, showing sampling stations, navigation pools, and sections of the river.

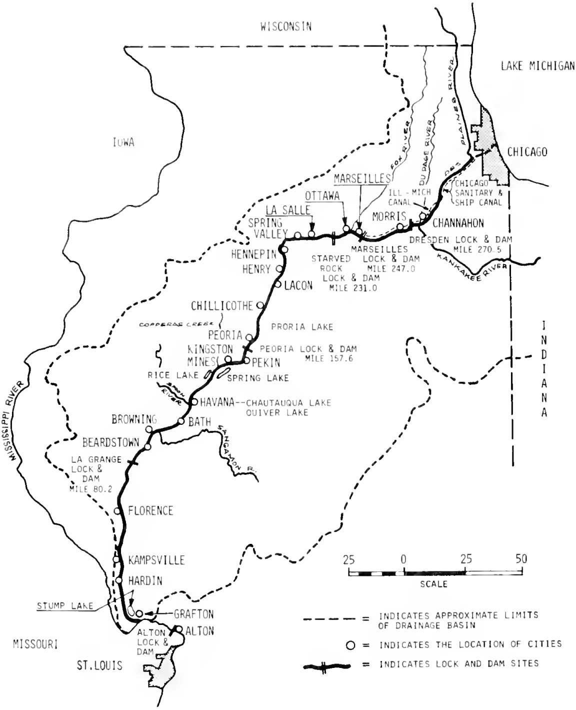

Figure 2. Map of study area, showing cities, lock and dam sites, and the drainage basin.

a 7-day period at a recurrence interval of 10 years, the Illinois State Water Survey (Singh and Stall, 1973) calculated that the Des Plaines and Kankakee would contribute 1926 and 455 cfs of water, respectively, to the Illinois.

Approximately 93 percent by volume of all waste flowing to the upper portion of the Illinois Waterway (mile 179.0 at Chillicothe to mile 292.1 at Lockport), including all of the Upper Illinois River, originates from three treatment plants of the Metropolitan Sanitary District of Greater Chicago (Butts, et al., 1975). As a consequence, thick oxygen consuming sludge and sediment deposits exist in the Dresden and Starved Rock Pools, and a portion of the Peoria Pool; there is a significant carbonaceous oxygen demand exerted in the Dresden Pool; and a significant nitrogenous oxygen demand exerted in much of the Illinois River (Butts, et al., 1975; Butts, et al., 1970). These demands cause low oxygen levels to occur in much of the Illinois River during summer low-flow periods, with the upper and middle sections more severely affected than the lower section. Thermal effluents in the vicinity of Joliet (mile 284.0) raise the whole temperature profile of the Des Plaines and Upper Illinois Rivers downstream to miles 200-180 (Butts, et al., 1975).

The upper section of the Illinois River may also be differentiated from the other two sections by its lower turbidity. Turbidity is less there because above Hennepin (mile 207.5) the river bottom is generally rocky, although in some sections the rock is overlain with sediment. In contrast, the Alton, LaGrange, and Peoria Pools are more turbid because of soft mud bottoms and heavy silt loads from tributary streams that have drained agricultural areas. These muds are kept in suspension by current and wave action produced by wind, towboats, and pleasure craft.

For fish and wildlife, the most productive portions of the Illinois are the middle and lower sections below Hennepin. Here, the river flows through a large, late Pleistocene valley: lateral levee lakes, side channels, backwaters, and marshes fill the valley and provide an excellent habitat for fish and wildlife.

PART II: METHODS

Sampling Stations and Schedules

Twenty-four sampling stations were selected in 1959 and a twenty-fifth, Big Blue Island Chute, was fished once, in 1974. A listing and description of the stations is given in Table 1. In considering locations for sampling, those that provide a desirable habitat for adult fish and a good distribution along the river were chosen. There are fewer stations in the upstream pools because those pools are shorter than downstream ones.

The stations are located most accurately by river mile. The river mile designation indicates the approximate area fished: for example, at the first station listed, that part of Mortland Island Chute extending from mile 18.7 to 19.4 was fished (Table 1).

Most of the stations were in chutes (i.e. side channels of the river), and contained habitats (brushpiles, undercut banks, and holes) where a variety of fish were expected to congregate. The four stations not in chutes were: (1) the station above Pekin, where both sides of the main channel were fished; (2) the station along the shore of lower Peoria Lake; (3) the station in middle Peoria Lake, where docks and riprapping in various marinas were fished in the 1960's and where riprapping at a State conservation landing in Detweiller Park was fished in the 1970's; and (4) a station in the Des Plaines River, where the wide mouth of the DuPage River and a boat yard were fished.

The Des Plaines River station was fished only in 1959, 1962, 1973, and 1974. Since it is not part of the Illinois River proper, the station was omitted whenever sampling time was limited. Results from the Des Plaines station were excluded when computing averages for the whole Illinois River.

In order to sample under similar environmental conditions each year, electrofishing was conducted from late August to mid-October, but only when the river was at pool stage behind the navigation dams. The dams help to maintain a 9-ft-deep navigation channel by impounding water during low-flow periods. When impounded, the river is said to be in pool. All stations could not be fished every year because of high-water levels; no stations were sampled in 1971 and 1972.

Fish Population Sampling

Fish populations were sampled by means of electrofishing. Fish were stunned by an electric current produced by a 230-volt, 180 cycles/sec, AC generator (Homelite 9HY-1), and transmitted through the water via 3 cables suspended from booms in the front of an 18-ft aluminum boat. Electrofishing was conducted in 15-minute segments, and a total of 60 minutes was spent electrofishing at most stations. In small chutes, or where an abundance of fish was collected quickly, only 30 minutes was spent electrofishing.

The stunned fish were dipped from the water and placed in plastic garbage cans containing water. Fish were identified, counted, weighed, checked for disease, and returned to the river. The few fish that died were buried on shore.

There are problems associated with any sampling technique, including electrofishing. In a turbid river such as the Illinois, fish must be within a few inches of the surface to be seen and netted. Bottom-dwelling species such as catfish and bullhead do not always surface when shocked, and they are underrepresented in electrofishing catches. Gars, such as the short-nose gar, and bigmouth buffalo are not as vulnerable to electric shock as other species, such as sunfish. Gizzard shad are often only momentarily stunned and occur in such large numbers that it is impossible to net them all before they recover. Since the electrofishing program was designed to sample populations of adult fish, dip nets of ¼-in. mesh size were used; hence, small fish such as minnows often were not retained in the nets. In addition, electrofishing was conducted only in areas that were connected to the river at all times of the year, so that species occurring primarily in lateral lakes which were either permanently or intermittently cut off from the river were not represented or were underrepresented in electrofishing collections.

Although the present report concerns the electrofishing survey, other sampling techniques such as trawling, seining, and trapping in both the river and lateral lakes were used during the same period, and information on the relative abundance of certain species in commercial catches was obtained from commercial fishermen. Hence, it was possible to judge whether a low number of a certain species in the electrofishing catch was due to low populations in the river or to biases in the sampling technique.

Physical-Chemical Measurements

In 1974, before sampling fish populations, several physical-chemical measurements were made at each station. Dissolved oxygen (DO) concentrations at a depth of 3 ft and at the bottom in the deepest part of the station were measured by the Winkler method or with YSI Model 57 dissolved oxygen meter. Surface water and air temperatures were measured with a mercury thermometer. Wind direction and velocity and cloud cover were noted. Transparency was measured with a Secchi disk.

The same measurements were made during some of the electrofishing surveys prior to 1974. In addition, turbidity of the river was measured with a Jackson turbidimeter during earlier surveys.

PART III: RESULTS

Physical-Chemical Measurements

The data for water temperature, dissolved oxygen, and transparency obtained in 1974 are given in Table 2.

Water temperature

The water temperatures in Starved Rock, Marseilles, and Dresden Pool were generally higher than in the upper part of Peoria Pool, even though the readings in the upper pools were taken two weeks later and the weather had turned colder. The upper river is evidently warmer because of warm industrial and municipal discharges. Starrett (1971) reported the same trend of warmer temperatures in the upper river in July and August, 1966; Butts, et al. (1975) report data collected in 1971 which show that the mean temperature profile of the Upper Illinois and Des Plaines Rivers was significantly increased by thermal discharges near Joliet (mile 284.0).

Dissolved oxygen

Since the DO levels at both the 3-ft depth and at the bottom were approximately the same within each station, the water was presumably well-mixed.

In the Lower Illinois (Alton Pool), the DO concentration was 77 to 97 percent of saturation ; in the Middle Illinois (LaGrange and Peoria Pools), it ranged from 56 to 122 percent of saturation; and in the Upper Illinois (Starved Rock, Marseilles, and Dresden Pools), it ranged from 47 to 104 percent of saturation.

The untypically high oxygen values exceeding saturation at Ballard Island Chute and in Lower Peoria Lake were probably due to algal photosynthesis, which was also indicated by the greenish or brownish color of the water. Ballard Island Chute is shallow and, with its large surface area, slow current, dissected shoreline, and numerous marshy pockets, provides an environment suitable for phytoplanktonic development.

Transparency

The Secchi disk visibility measurements indicated that generally, the Upper Illinois was more transparent than the lower portions of the river. The anomalously low measurements at Ballard Island Chute on the Upper Illinois can be attributed to the effects of wave action on the shallow bottom and to phytoplankton. During the period 1963 to 1966, similar observations were recorded by a Jackson turbidimeter: turbidity readings were higher in the lower three pools than in the upper three pools (Starrett, 1971). The softer mud bottoms and influx of silt from agricultural activities, particularly below Hennepin (mile 207.5), contribute to the higher turbidity of the Lower Illinois.

Electrofishing Results, (1959-1974)

A total of 67 species of fishes were taken from the Illinois River by electrofishing from 1959 to 1974 (Table 3). The list includes 16 commercial species, 16 sport species, 8 species considered as both commercial and sport fish, and 27 other species. This categorization of the species is based upon lists contained in *1974-1975 Illinois Fishing Information*, published by the Illinois Department of Conservation (1974), and upon the author's personal knowledge of the species sought by sport fishermen along the Illinois River. For example, the Department of Conservation publication does not specifically mention bullheads as sport fish, yet there are sport fishermen who seek bullheads. (As with many common names used by fishermen, the name "bullhead," actually includes several species: the black, yellow, and brown bullheads.)

During approximately the same period covered by the electrofishing survey, a total of 101 fish species have been taken by Illinois Natural History Survey crews employing various types of sampling gear, or by commercial fishermen. Not all 101 species were taken by electrofishing, due to sampling biases, which were discussed in Part II.

Scientific collections of fishes of the Illinois River were made well before the electrofishing survey commenced. This background data was used by Starrett (1972) in a summary assessment of changes that had occurred in fish populations of the Illinois River:

> "During the past hundred years 121 species of fishes have been collected from the Illinois River and its bottomland lakes (Starrett and Smith, unpublished). Between 1957 and 1970 we took 101 species, nine of which had not been taken in the period before 1908 (including two species not recognized in 1908 and three exotic species). Twenty species of fishes were extirpated from the river between 1908 and 1970. Several of the extirpated species were considered rare or accidental species in the river. On the other hand, many species of fishes common in the river before 1908, including the walleye (Stizostedion vitreum vitreum) and northern pike (Esox lucius), now are rare or limited in their distribution. The changes which have occurred in the fish fauna of the Illinois River reflect some of the drastic effects modern man has had on the ecology of the river."*

The fish species extirpated from the river between 1908 and 1970 are listed on Table 4. The impacts of both natural environmental changes and man-made changes on the fishes of the Illinois River are discussed in Part IV.

Detailed electrofishing results are given in Tables 5 through 29, and are summarized below by species, in phylogenetic order. Not all the 67 species listed in Table 3 are discussed below because the sampling technique was not appropriate for these species and because they occurred in a few collections by chance, as when small fish happened to be retained in the dip nets, as a result of the ¼-in. mesh nets becoming plugged with leaves. Tables are not presented for species represented by only a few individuals from the entire river.

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* An error was probably made in totaling the number of species in 1970. A total of 100 species had been obtained from 1957 through 1970. A species believed extirpated by 1970, the longear sunfish (Lepomis megalotis), was taken in the 1973 electrofishing survey, making the total 101, as of 1974.

Gar (Lepisosteus spp.)

Shortnose gar were taken infrequently in the three lower pools of the river (Table 5). Other members of the gar family occur, or once occurred, in the Illinois River, but were rare or absent from the electrofishing collections. Gar are not as vulnerable to electrofishing as other species and both shortnose and longnose gar are probably more abundant in the river and backwaters than the collections indicate. A few longnose gar (*Lepisosteus osseus*) were taken by electrofishing before 1970. No spotted gar (*Lepisosteus oculatus*) have been taken by electrofishing, but two have been taken by a commercial fisherman at Havana. One taken during a high-water period on February 26, 1973 at Havana was the largest spotted gar reported for the state (7.5 lbs, 32.8 in. total length) and was a female full of ripe eggs, indicating that she was ready to spawn. Alligator gar (*Lepisosteus spatula*) were probably extirpated from the Illinois River prior to 1970 (Starrett, 1972).

Shortnose gar are found in areas where there is a current, such as the main channel, or side channel, whereas the other species favor clear weedy backwaters and bottomland lakes. Since most electrofishing was conducted in side channels, it was not surprising that more shortnose than longnose gar were taken.

Gar are generally considered a nuisance by sport and commercial fishermen because they are not commonly used as food, become entangled in nets, and prey on other fishes. Actually, such predation helps stabilize the abundance of prey-species at a moderate level and is probably advantageous to the prey-species. Gar are considered sight-predators, and would thus be disadvantaged in turbid waters. Increasing turbidity in the Illinois River and its lakes and backwaters probably accounts for the decline in numbers of members of the gar family. Gar possess an air bladder, open to the esophagus, and are capable of "air-breathing" when dissolved oxygen levels are low, so low oxygen levels in the river and lakes wouldnot be expected to have as drastic an effect on gar as on other species.

Bowfin (*Amia calva*)

Bowfin is a commercial species that was not common in the Illinois River collections (Table 6). Bowfin were taken as far upstream as Peoria Pool only in 1961 and otherwise were taken in collections from LaGrange and Alton Pools. Bowfin numbers have been drastically reduced. Forbes and Richardson (1908) reported that bowfin were abundant in sloughs and lakes adjoining the Illinois River. In 1903 commercial fishermen took 1,097,050 lbs of bowfin from the Illinois River and its tributaries; at the time the Illinois River furnished nearly all the bowfin marketed in the United States (Forbes and Richardson, 1908).

Bowfin have a cellular air bladder, connected to the esophagus, which can be used for "air-breathing" when dissolved oxygen levels in the water are low. In addition, bowfin can use their highly vascularized gill covers as an accessory respiratory organ (Lagler, et al., 1962). Bowfin construct nests for spawning on silt-free bottoms, often in beds of vegetation.

Increasing turbidity, sedimentation, and the gradual loss of aquatic vegetation in the Illinois River and backwaters were probably responsible for the decline of this species. Trautman (1957) writes about the bowfin in Ohio:

> "The bowfin was not adverse to waters made cloudy by the abundance of plankton but normally occurred sparingly or as strays in waters habitually turbid with clayey silts. It displayed the greatest decreases in abundance in those Ohio waters which formerly were clear and contained much vegetation, but which during the survey had become silty and almost vegetationless."

American eel (*Anguilla rostrata*)

American eels were rarely taken. One was taken from Alton Pool at mile 19 and two from Peoria Lake in 1974. None were taken in 1973. A few were taken prior to 1973. Forbes and Richardson (1908) reported that eels were taken regularly in small numbers from the Illinois River at Havana.

Considering the remarkable migration of the eel, and the present obstacles to its movement, it is not surprising that it is rare. Eels spend most of their lives in freshwater streams and rivers. When they are approximately a dozen years old, 2½ to 4 ft long, 3½ to 6 lb in weight, they migrate downstream to the sea. They spawn in certain parts of the Sargasso Sea, between the West Indies and the Azores, then die. The young swim and drift back to continental waters, then ascend the Mississippi River system. Physical or chemical barriers such as navigation dams and effluents may hinder the migration of eels.

Skipjack herring (*Alosa chrysochloris*)

Skipjack herring were taken sporadically throughout the river. Large numbers apparently moved up the Illinois River during the spring flood of 1973, and sport fishermen were catching them on minnows at Havana.

Gizzard shad (*Dorosoma cepedianum*)

Gizzard shad were abundant in collections in all pools of the river. The numbers and pounds reported in Table 7 do not begin to reflect the actual abundance of the species for the following two reasons: (1) small gizzard shad are stunned only momentarily by the electric shock and usually get away before they can be netted; and (2) so many gizzard shad usually appear that it is futile to try to net them all, and so netting efforts were concentrated on other species.

Gizzard shad are neither a commercial nor a game species, but small shad are valuable forage for largemouth bass, crappies, and even species, such as drum, that ordinarily prefer mollusks when they are available.

Shad are sensitive to low dissolved oxygen and probably sensitive to cold temperatures. Die-offs of gizzard shad as a result of low dissolved oxygen levels sometimes occur in the bottomland lakes and backwaters in mid-summer and usually occur in winter because of low temperatures and perhaps low oxygen levels also. Nevertheless, because of their high reproductive capacity, gizzard shad populations do not seem to be much affected by these die-offs.

Goldeye (Hiodon alosoides) and Mooneye (Hiodon tergisus)

These two species are the only members of their genus and of their family, Hiodontidae. Both species are called mooneye by fishermen, and both are considered commercial species (Illinois Department of Conservation, 1974). Adults are up to 15 in. in length and will take lures or bait and furnish good sport for anglers.

Mooneye were taken infrequently and only from the Alton Pool until 1974, when one was taken from upper Peoria Pool at mile 215 (Table 8). Goldeye (Table 9) were taken more frequently and ranged farther upstream than their relative, the mooneye. However, in 1974 only two goldeye were taken, all from one station at mile 261 in Marseilles Pool.

Mooneye were once caught fairly regularly in the Ohio and Mississippi Rivers, but mooneye populations declined prior to 1908 (Forbes and Richardson, 1908). Mooneye and goldeye have unusually large eyes, and the "eye shine" is caused by a reflective layer in the retina which may assist vision at night or in dim light in deep water. Since both species appear to be sight predators, they have probably been adversely affected by increasing turbidity. Trautman (1957) thought that goldeye were more tolerant of turbid water than mooneye. Both species inhabit the swift, open water of large rivers, and spawn in flowing water over rocky and gravelly bottoms. High-water levels and swift currents in the years 1972-1973 may have been temporarily beneficial to mooneye and goldeye. The impounding of water behind navigation dams with the attendent reduction in current and increasing siltation has probably contributed to the reduction in mooneye and goldeye populations.

Grass pickerel (Esox americanus vermiculatus)

Grass pickerel were taken rarely by electrofishing from the Illinois River, and were never very abundant.

Northern pike (Esox lucius)

Northern pike were taken by sport fishermen in the river below Marseilles Dam in 1973 and were netted in Lake Chautauqua in 1973 (river mile 126.0), but have never been taken by electrofishing. Northern pike were common in the river before 1908 (Starrett, 1972). In the 1870's and earlier, 1,000 lbs of northern pike were caught at a time at Havana (Forbes and Richardson, 1908).

Pike are sight predators and often lie in ambush for prey in weed beds in clear, shallow water. They spawn in marshes and backwaters where the water is clear and there is abundant aquatic and flooded terrestrial vegetation. The decline in northern pike populations is probably attributable to increasing turbidity and to loss of suitable habitat due to leveeing and siltation. The sporadic abundance of young northerns in 1973 is attributable to favorable high-water conditions in 1972 and 1973.

Goldfish (*Carassius auratus*) and goldfish x carp hybrids

Goldfish were probably introduced to the Illinois River between 1908 and 1935 because Forbes and Richardson did not mention them in *The Fishes of Illinois* (1908) and O'Donnell (1935) mentioned that they occur infrequently in the Illinois River. O'Donnell (1935) also mentioned that two carp x goldfish hybrids were taken at Peoria.

Goldfish were abundant in the electrofishing collections from the polluted Upper Illinois River and the Des Plaines River (Table 10). In 1962 for example, 101 goldfish were taken in 30 minutes of electrofishing in the Des Plaines.

Goldfish are more tolerant of low oxygen concentrations than many native species, and appear to thrive where populations of native species are sparse or absent. Goldfish are sometimes used as bait, so it is possible that native predators reduce goldfish populations in relatively unpolluted areas. It is also possible that goldfish do not compete well with native species of similar ecological habits in unpolluted areas, but thrive in polluted environments where there is absence of competition.

If one uses goldfish as a pollution indicator and judges the quality of the Upper Illinois by the catch of goldfish, then the low goldfish catches in 1973 and 1974 in the Marseilles and Starved Rock pools indicate that conditions improved during, and following, a high-water period. However, conditions in the Des Plaines River did not improve to an extent that there was a marked reduction in goldfish.

Trautman (1957) reported that hybrids might be expected wherever carp and goldfish occur together, and that in some areas in and near Lake Erie the number of hybrids exceeds the number of both parent species. In the Illinois electrofishing collections, goldfish were most abundant in the Dresden Pool, carp in LaGrange Pool, and carp x goldfish hybrids in Starved Rock Pool and Peoria Pool (Tables 10, 11, and 12).

Virtually all the goldfish and carp x goldfish hybrids taken in the Des Plaines River had one or both eyes protruding, a condition referred to as "popeye" by fishermen. In the course of weighing and measuring these fish, some of the eyes would fall out. Some individuals had evidently survived a considerable time after losing one or both eyes, because the empty sockets had filled with scar tissue. The cause of this popeye disease is not known, although the disease appears to be associated with polluted water in the Upper Illinois River. The incidence of popeye disease decreases in the downstream direction, away from Chicago.

<u>Carp (Cyprinus carpio)</u>

Carp and gizzard shad were the only species that occurred abundantly in the electrofishing collections in all pools of the river. Carp were introduced into the Illinois River in 1885. By 1898, carp brought more money to commercial fishermen along the Illinois River than all other fishes combined. The carp catch was 6 to 8 million pounds per year and was worth more than $200,000 (Forbes and Richardson 1908). In 1908 the catch was over 15 million pounds, according to Thompson (1928). At present, carp and bigmouth buffalo comprise the bulk of the commercial catch in the Illinois River, although carp have decreased from 4,041,000 lbs in 1950 to 213,000 in 1973. Mills, et al., (1966) discussed the decline in the carp catch:

> "Much of the decline in the commercial catch since 1950 has resulted from the scarcity of carp of commercial size (17 inches or more in total length) in the middle section of the river. Small carp are often abundant in this section but most of them disappear before attaining commercial size.

> The commercial catch of carp in the Alton Pool has changed little since 1950....two factors--loss of fingernail clams plus low dissolved oxygen--could explain the dearth of commercial-size carp in the middle and upper reaches of the Illinois River."

Mills, et al., (1966) also used carp as an indicator of the effects of pollution:

> "These are two noticeable effects of pollution on this species. First, the length-depth ratio of individuals goes up with increasing pollution. By dividing the depth into the standard length, an index is obtained which, if 3 or greater, indicates that the fish is too thin for commercial uses. Any index under 3 would indicate a satisfactory commercial fish. Second, carp exhibit a rachitic bone malformation (an abnormality characterized by malformed heads and gill covers) known as a "knothead" condition. This becomes more conspicuous with increased pollution."

The study suggested a relationship between the die-off of fingernail clams that occurred in the middle section of the Illinois River in 1955, and the decline on carp, which like other bottom-feeding fishes, find fingernail clams a nutritious food. Mills, et al., (1966) found that the length-depth ratios of carp in the 1963 electrofishing collection indicated a marked difference between fish taken above and below Beardstown (mile 88.5). Carp caught below Beardstown had ratios less than 3, while above Beardstown the ratios were 3 or more. The difference appeared to be attributable to the loss of fingernail clams above Beardstown. The Sangamon River enters the Illinois River at Beardstown, and may dilute some type of pollution which is responsible for the absence or paucity of fingernail clams in the middle and upper sections of the river. In 1973 and 1974, the length-depth ratios of carp appeared to show the same trend of relatively thinner fish above Beardstown as in 1963. More will be said in Part IV about the impact of the die-off of fingernail clams in 1955.

In 1973 and 1974, the incidence of knothead among carp was remarkably reduced in the upper river compared to 1926-27 and 1963. In the older collections, more than 50 percent of the carp taken above

Peoria Lock and Dam were knotheads, whereas in 1973 and 1974, the incidence had dropped to about 10 percent. Thompson (1928) theorized that knothead was a rachitic disease, possibly caused by lack of vitamin D, like rickets in mammals.

At Sugar Creek Island (mile 94.3-95.2), carp with an abnormality in coloration were frequently taken. The bronze color seemed to be missing and the fish appeared predominantly pink, purple, and light yellow. The pink muscles overlying the anterior and ventral edges of the operculum could be seen through the skin and scales. The fish appeared to be in good health. Hansen and Shoemaker (1943) found that color-deficient carp comprised the following percentages of their total carp catch in 1942; 2 percent at Meredosia (mile 71.0), 5 percent at Browning (mile 97.0), and 2 percent at Havana (mile 120.0). Commercial fishermen refer to these fish as "chicken carp." The cause of this color variation is unknown.

Minnows, Family Cyprinidae

The electrofishing survey was not designed to sample minnow populations, although some minnows were taken sporadically. The emerald shiner, *Notropis atherinoides*, was abundant throughout the river--hundreds would often be driven ahead of the electrofishing boat until they reached shallow water, where they would be stunned and lie strewn over the bottom.

Carpsuckers (Carpoides, spp.)

Identification of the species is often difficult because they are extremely variable in their morphological characters, and to compound the difficulty, they probably hybridize (Trautman, 1957). The quillback carpsucker, *Carpiodes cyprinus*, has no dentary nipple at the tip of the lower jaw, and identifications of this species in the course of the electrofishing survey were probably accurate. Both the river carpsucker, *Carpiodes carpio*, and the highfin carpsucker, *Carpiodes velifer*, possess dentary nipples. The anterior dorsal fin rays of the highfin carpsucker are drawn out into a long point, in contrast to the shorter dorsal fin of the river carpsucker, and if the long rays are present, the fish can be positively identified as a highfin carpsucker.

However, the long point is easily and commonly broken or eroded, so that positive identification is difficult. Also, young fish (less than 3 in. long) of both species resemble each other. Therefore, carpsuckers without high dorsal fins were divided into two classes: quillback carpsuckers and Carpiodes spp. Most of the fish in the latter group were probably river carpsuckers. Carpsuckers with dentary nipples and high dorsal fins were identified as highfin carpsuckers.

The three species of the genus Carpoides were all found in the Illinois River (Tables 13 and 14). Most of the fish in the Carpiodes spp. group were taken from the three lower pools of the river, Alton, LaGrange, and Peoria, prior to 1973. For 1973 and 1974 combined, most were taken in Starved Rock Pool, so their distribution in the river may have changed after the high-water period of 1971-1973.

Carpiodes spp. populations do not appear to have changed greatly since 1908. Forbes and Richardson (1908) reported that Carpiodes carpio were found mainly in the Illinois and Mississippi Rivers and were not anywhere abundant. At that time, most of the river carpsuckers from the Illinois River were taken at Havana and Meredosia, in what today are the LaGrange and Alton pools.

River carpsucker (Carpiodes carpio). River carpsuckers feed on diatoms, desmids, filamentous algae, rotifers, microcrustaceans, and midge larvae (Bucholz, 1957), so they were not noticeably affected by the die-off of fingernail clams and rooted aquatic vegetation which occurred in the middle section of the Illinois River in the mid-1950's.

Quillback carpsucker (Carpiodes cyprinus). In 1957, Trautman listed two species of Carpiodes, C. cyprinus and C. forbesi, and two subspecies of C. cyprinus, the eastern quillback carpsucker (C. c. cyprinus) and the central quillback carpsucker (C. c. hinei), but indicated that environmental factors strongly influenced the morphological characteristics of these fishes:

> "Central quillbacks, living in large waters of relatively low turbidity having an abundance of food, such as at Buckeye Lake, grow very rapidly, are excessively fat, deep-bodied and small-eyed,

> and because of these characteristics they resemble the eastern carpsucker, often to a remarkable degree. On the other hand individuals from turbid waters containing little food, and others heavily parasitized, grow slowly, are terete and large-eyed and resemble *Carpiodes forbesi*, a form inhabiting turbid streams west of the Mississippi River." (Trautman, 1957:237)

The latest *List of Common and Scientific Names of Fishes* (American Fisheries Society, 1970) does not list subspecies of *C. cyprinus*, and *C. forbesi* has been synonymized with *C. cyprinus*. There is a considerable range of variation in morphology of quillback taken in the Illinois River electrofishing survey, and some of the variation is undoubtedly due to factors such as nutrition, mentioned by Trautman.

The greatest number of quillback carpsuckers (*Carpiodes cyprinus*) was usually taken in three pools of the Illinois River: Marseilles, Starved Rock, and Peoria, so the quillbacks apparently preferred the upstream portions of the Illinois River more so than did their close relative, the river carpsucker (Table 14).

Highfin carpsucker (Carpiodes verlifer). Two highfin carpsuckers were taken in Starved Rock Pool in 1960 and one from the same pool in 1965. Highfin carpsuckers may have comprised a portion of the *Carpiodes* spp. group mentioned above.

Smallmouth buffalo (Ictiobus bubalus)

Like the bigmouth buffalo, the smallmouth buffalo was most common in the collections from Peoria and LaGrange Pools (Table 15). An unusually large number of smallmouth buffalo were taken from Starved Rock Pool in 1974. The smallmouth buffalo is a commercial species.

Bigmouth buffalo (Ictiobus cyprinellus)

The largest numbers of bigmouth buffalo were taken in Peoria and LaGrange Pools (Table 16). No bigmouth buffalo had ever been taken from Dresden Pool by electrofishing and none had been taken from Marseilles Pool prior to 1974. Bigmouth buffalo had been taken in Starved Rock Pool in only one year, 1966. In 1974, they were taken in both Starved Rock and Marseilles Pools. It is surprising that few individuals of the three species of buffalo were ever taken in Alton Pool and that none were taken in 1974. Several commercial fishermen at Kampsville landing and Godar landing on the Alton Pool said that they too were catching very few bigmouth buffalo in 1974. Bigmouth buffalo rank second to carp in the commercial catch from the Illinois River.

Black buffalo (Ictiobus niger)

The black buffalo is a commercial species. It was not abundant in the Illinois River electrofishing collections and was taken only in the lower three pools prior to 1974 (Table 17). In 1974, the few black buffalo taken came from Starved Rock Pool.

Shorthead redhorse (Moxostoma macrolepidotum)

The shorthead redhorse occurred sporadically in the collections throughout the river (Table 18).

White catfish (Ictalurus catus)

The white catfish is a native of brackish to fresh waters along the East Coast from Pennsylvania to Florida. It has been introduced widely in the Midwest, and several have been taken from the Illinois River by commercial fishermen at Havana, including one on 13 May 1974. White catfish have never been taken in our electrofishing surveys. White catfish seem to exist in the Illinois River at a stable, low density.

Black bullhead (Ictalurus melas)

The black bullhead is considered a commercial species, but most of the bullheads in the electrofishing collections were small. Most of the black bullheads were taken from one station (Table 19), Ballard Island Chute (river mile 247.8-248.2) in Marseilles Pool. As described earlier this location is an unusually shallow, broad, marsh-fringed area with very little current; the black bullhead prefers this type of habitat.

Black bullhead were collected occasionally in the main navigation channel, by means of an otter trawl. For example, On 26 August 1964, 51 black bullheads averaging 7 in. in total length were taken in 49 minutes of trawling at mile 193.

Yellow bullhead (Ictalurus natalis)

The yellow bullhead was uncommon in the collections and has been taken only from the three lower pools: Alton, LaGrange, and Peoria (Table 20).

Channel catfish (Ictalurus punctatus)

Prior to 1973, the numbers and pounds of channel catfish taken appear to be unrelated to water levels. Channel catfish were taken in Marseilles Pool for the first time in 1974 (Table 21). The largest number and pounds of fish were also taken in the entire river in 1974. Most channel catfish were taken below Beardstown (river mile 88.5). Channel catfish were taken occasionally from the main channel by trawling. On 13 November 1964, 68 young channel catfish averaging 3½ in. in total length were taken in 53 minutes of trawling in the channel at mile 156.

Channel catfish have declined in the Illinois River since 1899 as evidenced by the following commercial fishing statistics for the entire Illinois River: 241,000 lbs in 1899; 105,554 lbs in 1950; and about 98,000 lbs in 1964 (Mills, et al., 1966), and 45,000 lbs in 1973 (Personal Communication, December 1974, Mr. Larry Dunham, Fishery Biologist, Illinois State Department of Conservation, Aledo, Illinois). At present, channel catfish bring the highest market price of all the commercial species.

Flathead catfish (Pylodictis olivaris)

Flathead catfish are a desirable commercial species and often attain weights of 20 to 40 lbs. Flathead catfish were never abundant in the electrofishing collections and were taken only in the lower two pools (Table 22). An 18-lb individual was taken in LaGrange Pool. The following numbers of one- and two-year-old flatheads were taken from the five stations in Alton Pool and the six stations in LaGrange Pool: 0 (mile 18.7), 2 (mile 24.0), 1 (mile 26.0), 2 (mile 29.3), 0 (mile 57.5), 3 (mile 86.2), 1 (mile 94.3), 3 (mile 106.8), 0 (mile 112.8), 0 (mile 147.3), 0 (mile 154.5).

White bass (*Morone chrysops*)

The white bass is a game species. The largest number of white bass was taken from the river in 1974, but the greatest catch in pounds was in 1968 (Table 23). White bass populations generally increase in the downstream direction, with the largest number and most pounds usually being taken in Alton Pool.

White bass spawn in shallow water where currents remove sediments and expose a firm, clean bottom. Such spawning habitat is not now generally available in the Illinois River.

Yellow bass (*Morone mississippiensis*)

Yellow bass were infrequently taken, and only from Peoria, LaGrange, and Alton Pools. For example, only two were taken from the entire Illinois River in 1973, and none in 1974. The largest number, 40, was taken in 1964: 28 from Alton Pool and 12 from LaGrange Pool.

Yellow bass were once much more abundant in the Illinois River. Forbes and Richardson (1908) reported that yellow bass were common in the commercial catches at Havana, Meredosia, and Peoria, and that the combined catch of yellow and white bass from the Illinois River in 1899 was 92,931 lbs, of which yellow bass comprised the greatest part.

Rock bass (*Ambloplites rupestris*)

The rock bass usually inhabits clear, rocky streams, and its occurrence in the Illinois River is probably accidental. One rock bass was taken from LaGrange Pool in 1960, one from Marseilles Pool in 1966, and one from Peoria Pool in 1969.

Green sunfish (*Lepomis cyanellus*)

Green sunfish are considered game fish by some people, although they do not grow as large as their relative, the bluegill. The green sunfish was taken in the Des Plaines River in two of the four years this station was sampled; whereas the bluegill was never taken from this station (Tables 24 and 25). The largest number of green sunfish was generally taken in Peoria Pool. The number of green sunfish taken did not increase dramatically after the high-water period 1971-1973, as did the bluegill.

Pumpkinseed (Lepomis gibbosus)

Forbes and Richardson (1908) reported that pumpkinseeds were most abundant in the northern part of the state (Lake and McHenry Counties) and were present along the Illinois River. Very few pumpkinseeds have been taken by electrofishing: one from Peoria Pool in each year from 1960 to 1963, and two in 1962; one in 1967; one in 1968; and two in 1974, from Marseilles Pool.

Warmouth (Lepomis gulosus)

A total of 126 warmouths were taken during the entire electrofishing survey. Most of the fish were taken from Alton and LaGrange Pools. One was taken from Peoria Pool in 1963 and another in 1974. Two were taken from Marseilles Pool in 1974.

The warmouth's principal habitat is ponded, often turbid water, where bottoms are soft mud (Larimore, 1957). With a habitat preference such as this, one might expect warmouths to be more abundant in the Illinois River than they are. However, they also prefer dense weed beds and feed on larval insects, including species which are associated with weed beds, such as damselflies and dragonflies (Larimore, 1957). Since weed beds and the associated weed fauna have been eliminated from most of the middle and lower sections of the Illinois River, and since other insect food organisms, such as mud-burrowing mayflies, are also less abundant than they once were, the relative paucity of warmouths in the electrofishing collections is not surprising.

Orangespotted sunfish (Lepomis humilis)

A total of 343 orangespotted sunfish were taken during the electrofishing survey, with the numbers taken per pool as follows: Dresden, 0; Marseilles, 38; Starved Rock, 4; Peoria, 240; LaGrange, 39; and Alton, 22.

Forbes and Richardson (1908) reported that this species was often taken along the shore of the Illinois River and in adjacent lakes and sloughs. Orangespotted sunfish appear to tolerate turbid water, water level fluctuations, and silt bottoms (Trautman, 1957; Cross, 1967).

Bluegill (Lepomis macrochirus)

The largest number and most pounds of bluegill per 30 minutes of electrofishing were taken in 1974 (Table 25). Bluegill populations generally increased in the downstream direction, with either Alton or LaGrange Pools having the greatest number and most pounds. However, more were taken in Marseilles Pool than in the next pool downstream, Starved Rock; only in 1969 were more bluegill obtained in Starved Rock than in Marseilles.

Longear sunfish (Lepomis megalotis)

One species, the longear sunfish (*Lepomis megalotis*), believed by Starrett and Smith (Starrett, 1972) to have been extirpated from the Illinois River and its bottomland lakes between 1908 and 1970, was taken from LaGrange Pool, Turkey Island Chute (mile 147.3-148.2) on September 5, 1973. Three adults, ranging in total length from 4.2 to 6.1 in., were taken.

One of these fish was preserved and later examined by Dr. Phillip W. Smith, Taxonomist, Illinois Natural History Survey, who assigned it to the subspecies known as the central longear sunfish (*Lepomis megalotis megalotis*). A subspecies known as the northern longear sunfish (*Lepomis megalotis peltastes*) occurs in northern tributaries of the Illinois River, but has not been taken from the Illinois.

Smallmouth bass (Micropterus dolomieui)

The few smallmouth bass (*Micropterus dolomieui*) were probably introduced from tributary streams that are smaller and colder than the Illinois River. Thirty-two smallmouth were taken from 1959 to 1974: two from Marseilles Pool, one from Starved Rock Pool, and 29 from Peoria Pool.

Largemouth bass (Micropterus salmoides)

The largemouth bass is a game species. Largemouth populations generally increase in the river in a downstream direction. However, fewer bass were taken at the two stations in Starved Rock Pool than in the three stations in the next pool upstream, Marseilles Pool (Table 26). Bass populations in the river were high in 1960 and 1961, then showed a drastic decline during and following the drought years, 1962-1964. The recent increase in largemouth populations followed the high-water years, 1971-1973. Largemouth bass were more numerous in Marseilles Pool in 1973 and 1974 than they ever had been previously.

White crappie (*Pomoxis annularis*) and Black crappie (*Pomoxis nigromaculatus*)

The largest catch of both black and white crappie, in pounds and numbers, was taken in the river in 1974, following the high-water years 1971-1973 (Tables 27 and 28). Populations of both species showed a steady decline in the years 1962-1965, during a drought period. Prior to 1973, few crappies were taken in the upper three navigation pools, but substantial numbers of both species were taken in the Starved Rock and Marseilles Pools in 1974. In 1962, 1964, 1966-1969, and 1974, more black crappies were taken in LaGrange Pool than Alton Pool, perhaps because more backwater and side channel areas with brush piles (a favorite habitat of crappie) were usually available in LaGrange Pool. In 1974, a larger number of white crappie were taken in LaGrange Pool than in Alton Pool, but a larger number of pounds of white crappie were taken in Alton, showing that the white crappie in Alton were of larger size. Both species are popular game fish.

Yellow perch (*Perca flavescens*)

Two yellow perch were taken during the electrofishing survey; one from Peoria Pool in 1964, and one from Marseilles Pool in 1965. Yellow perch were once common in the Illinois River. Forbes and Richardson (1908) reported that yellow perch were taken in considerable numbers from the Illinois River as far south as Meredosia (mile 71.2). Yellow perch were commonly taken by pole-and-line fishing in backwaters and lakes in the Havana area (mile 120), until 1943. In 1943 and 1944, floods deposited a great deal of silt in the lakes and backwaters. Following the floods, the once-abundant aquatic vegetation disappeared. The yellow perch population declined drastically, probably as a result of the loss of aquatic vegetation that perch use for spawning (Starrett and McNeil, 1952).

Sauger (*Stizostedion canadense*) and Walleye (*Stizostedion vitreum vitreum*)

Only two saugers were taken from the Illinois River by electrofishing. Both came from the Alton Pool, one in 1965 and one in 1974. During a 10-year biological investigation of the fishes of Lake Chautauqua (mile 124-130) from 1950-1959, Starrett and Fritz (1965) obtained just three sauger, and the same authors reported that saugers were caught occasionally in the river by commercial fishermen. Sauger are reported to be more tolerant of turbid water and silted bottoms than their close relative, the walleye (Trautman, 1957). In spite of this tolerance, sauger are much less abundant in the Illinois River now than prior to 1908.

Walleye were once common in the Illinois River, but not a single specimen was taken during the electrofishing survey or during the 10-year study of Lake Chautauqua mentioned above. By contrast, in 1899, 11,000 lbs of walleye were taken by commercial fishermen from the Illinois River, and approximately 100 walleye could be taken per year along each few miles of river (Forbes and Richardson, 1908). Trautman (1957) attributed reductions in walleye populations in Ohio to turbidity, the silting over of hard bottoms, and dams which hindered the movements of this highly migratory species.

Freshwater drum (*Aplodinotus grunniens*)

Freshwater drum is a commercial species. Every year, most were taken in LaGrange and Alton Pools (Table 29). The largest number of individuals and the second greatest number of pounds were taken in 1974, following a high-water period.

Discussion of Electrofishing Results

There are several patterns to the distribution of fishes in the Illinois River in both space and time. Although one might think that the total number or total weight of fish taken from the various navigation pools should provide a good summary of changes in fish populations through time and space, such summaries tend to obscure, rather than elucidate, patterns exhibited by particular species, because the total abundance can remain constant while some species increase and others decline.

Temporal distribution

Table 30 shows the average number of fish of all species taken per 30 minutes of electrofishing in the years 1959 through 1974. The greatest number of fish was taken in 1962 from Peoria Pool. This peak in numbers is attributable to a peak in the abundance of one species, gizzard shad, due to unknown causes. More fish were taken from Marseilles Pool in the years 1960-1963, than in subsequent years. Again, this peak is primarily attributable to the abundance of one species, goldfish, although more largemouth bass, bluegills, green sunfish, and white crappie occurred in Marseilles Pool in 1960, than in the years immediately following.

Table 31 shows the average weight of fish of all species taken per 30 minutes of electrofishing from 1959 through 1974. No consistent patterns are evident, except that for five of the six years, 1960-1965, more pounds of fish (primarily carp) were taken from Starved Rock Pool than from the pools immediately above or below it, while just the reverse relationship has existed since 1965. Within memory of several residents along the Fox River, fishing has gone from excellent to poor. It is likely that the lower end of the Fox River may once have supplied a haven for fishes, some of which found their way into the Illinois and the electrofishing collections. Now it appears that fish are no longer recruited to Starved Rock Pool from the Fox River.

When one looks at the distribution of certain species of fish through time (Table 32) a consistent and interpretable pattern is evident. Largemouth bass, black crappie, and white crappie populations declined from 1962 through 1965, a drought period when water levels were low. The maximum numbers of these three species were taken in the fall of 1973, following a period of high-water levels from 1971 through the spring of 1973. In addition, the lowest numbers of bluegill and

and flathead catfish were taken in 1965, and the maximum numbers of bluegill, flathead catfish, white bass, and bigmouth buffalo were taken in 1973 or 1974.

The list of species which benefited from high-water levels includes desirable game fish, such as largemouth bass, bluegill, black crappie, and white crappie, which are in the sunfish family (Centrarchidae) and have similar life histories. All of these sunfishes lay their eggs in nests which are constructed in shallow water. They prefer to construct nests on firm, rather than muddy substrates. The fry feed first on zooplankton, then largely on aquatic insects and fish. The sunfishes are generally less tolerant of low dissolved oxygen levels than species such as carp and black bullhead.

Increased flow of water in the Illinois has several beneficial effects on fishes. Flooded areas often provide good spawning sites, with firm bottoms, whereas the bottom in much of the river and its bottomland lakes is covered with flocculent mud. Several people reported that sunfishes were spawning on flooded gravel roads and areas of firm mud or sand in the spring of 1973. Flooded areas also provide good nursery areas for juvenile fish, provided the water does not retreat too soon. An increased current velocity in the river stimulates spawning migrations of species such as white bass. An increased rate of water flow (discharge) can dilute oxygen-demanding or toxic wastes. Butts, et al. (1975) report that increased flows in the Upper Illinois River initially result in reduced dissolved oxygen levels because combined storm and sanitary sewers overflow to the river, but that during sustained high flows, the oxygen levels are higher than during sustained low flows.

Carlson and Seifert (1974) have shown that oxygen levels at 35 percent saturation reduce the survival of larval largemouth bass by 13.7 percent, and oxygen levels at 70 percent saturation and below retard the growth of larval largemouth bass. The tolerances of the other members of the sunfish family to low dissolved oxygen are probably much the same. The relationships among discharge, dissolved oxygen levels, and largemouth bass populations in Chillicothe Island Chute are shown in Figure 3. Chillicothe Island Chute is an area of prime largemouth bass habitat in Peoria Pool. Midsummer oxygen levels were at 35 percent saturation or below four years out of the eight-year period from 1963-1970. Since the May-August water levels at Peoria did not fluctuate greatly from 1963 through 1970, the decline in the largemouth bass population is probably attributable to low oxygen levels, perhaps acting in combination with other stresses, such as the presence of toxicants.

Spatial distribution

Tables 33 and 34 show the numbers and pounds of fish of selected species taken in the various pools of the river during the period 1959-1974.

The following species were more numerous in the two middle pools of the river, LaGrange and Peoria Pools, which have the most connecting lake acreage, than in the other pools: gizzard shad, carp, river carpsucker, smallmouth buffalo, bigmouth buffalo, black buffalo, yellow bullhead, green sunfish, bluegill, largemouth bass, white crappie, black crappie, and freshwater drum. The bottomland lakes and backwaters provide fish habitat and an invertebrate fauna which supplies food for many fish species. Fish produced in areas lateral to the river are recruited to the river, where they show up in the electrofishing collections.

The following species showed a trend of increasing abundance in the downstream direction, away from Chicago, with the largest number occurring in Alton Pool: shortnose gar, bowfin, goldeye, mooneye, channel catfish, flathead catfish, white bass (Table 33). Bowfin apparently have always been more abundant in the southern part of Illinois than in the northern part (Forbes and Richardson, 1908). Goldeye and mooneye both appear to be more common in the Mississippi than in the Illinois, and both species probably enter the Illinois from the Mississippi. In 1974, goldeye were taken only from Marseilles Pool and mooneye only from Peoria Pool, so these fish may have run up the Illinois during the high flows of 1971-1973. Other factors which may influence the distribution of fishes whose populations increase in the

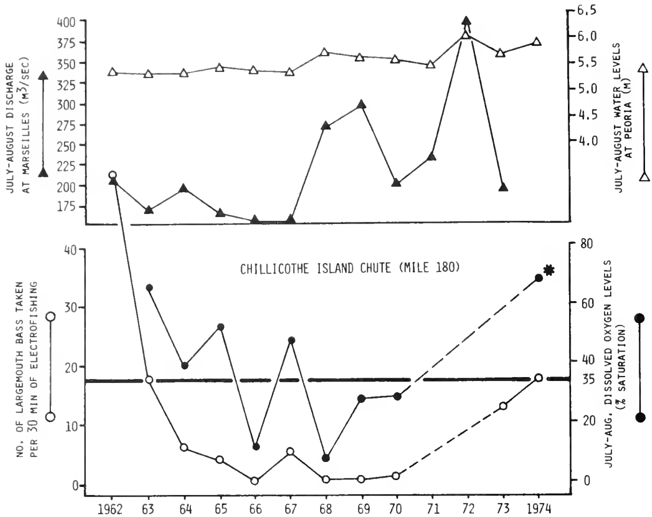

Figure 3. Mean water levels, mean discharge, and mean dissolved oxygen levels during July and August and the number of largemouth bass taken per 30 minutes of electrofishing in the fall at Chillicothe Island Chute (mile 180) on the Illinois River.

Chillicothe Island Chute is in the Peoria Pool. Discharge was measured at Marseilles (mile 247), water levels at Peoria (mile 163), and oxygen levels in the chute. The oxygen reading marked with an asterisk was taken on September 30. Water levels were obtained from the "Missouri-Mississippi River Summary and Forecasts," issued daily by the National Weather Service, River Forecast Center, Kansas City, Missouri. Discharge was obtained from an annual publication, "Water Resources Data for Illinois," by the U. S. Geological Survey District, Champaign, Illinois. The other data were obtained by the Natural History Survey.

downstream direction are: the increased abundance of food organisms such as mayflies, snails, and fingernail clams in the Lower Illinois as compared to the Middle and Upper Illinois; the relatively higher oxygen levels in the Alton Pool as compared to the upstream pools; and the proximity to the relatively unpolluted Upper Mississippi River.

Black bullhead were abundant at one station, Ballard Island Chute, Marseilles Pool (mile 247.8-248.2), which apparently provides preferred habitat for this species.

Northern pike, yellow perch, and walleye were once abundant in the river, but are now rare or limited in their distribution. Yellow perch populations have declined probably as the result of the dissappearance of beds of aquatic plants and disappearance of clean sand or pebble substrates perch use for spawning.

Gizzard shad and carp were generally abundant throughout the river.

Goldfish showed a trend of increasing abundance in the upstream direction, toward Chicago. Goldfish can tolerate the low dissolved oxygen levels which are found in the Upper Illinois River. Moreover, there is an absence of predators in the upper river, such as largemouth bass, which are known to feed on goldfish. The fish populations of the polluted Des Plaines River show the classic response of a community of organisms to pollutional stress. The number of species is reduced as pollution eliminates the intolerant organisms. Populations of the remaining tolerant species often expand, because of reduced competition and predation.

The incidence of disease and deformities among all the fish, observed to increase in the upstream direction, is probably related to chemicals and pathogenic organisms in effluents from the Chicago area. "Knothead" has been discussed earlier, under carp. Species other than carp, such as bigmouth buffalo sometimes exhibit knothead, and the incidence appears to increase upstream as for carp. Virtually all the goldfish taken from the Des Plaines in 1973 had "popeye" (swollen, protruding eyes) or missing eyes. The incidence of sores on the fins and body, tumors, frayed fins, and abnormal spinal curvature was higher among fishes from the Upper Illinois than from the middle and lower sections.

The abundance of certain species in the electrofishing collections from Starved Rock Pool, in relation to other pools, indicates a localized pollution problem of some sort, perhaps associated with the entry of the Fox River into this pool. Carp, goldfish, and carp x goldfish hybrids were more abundant here than in pools immediately above and below it. All three of these fish can tolerate low oxygen levels. Members of the sunfish family, including largemouth bass, bluegill, and white crappie, require higher oxygen levels, and were generally less abundant in Starved Rock Pool than in pools immediately above and below. Although dissolved oxygen levels in the Fox River are generally close to saturation, the entry of the Fox into the Illinois causes only a fraction of a milligram per liter increase in dissolved oxygen (Butts, et al., 1975). During low flows, an oxygen sag develops in the next pool upstream from Starved Rock Pool, Marseilles Pool, and continues into Starved Rock Pool, so that Starved Rock Pool has lower oxygen levels during low flows than Marseilles Pool or the upper end of Peoria Pool (Butts, et al., 1975). Reaeration of river water does not take place at Marseilles dam during low flows, because the entire flow of the river is diverted through a power plant (Butts, et al., 1975).

Table 35 summarizes the commercial catch of fish from the Illinois River and for comparison, the catch from the Mississippi River bordering Illinois. In spite of the improvement in the electrofishing catch in 1973 and 1974, apparently due to high-water levels in 1971-1973, the commercial catch of fish in the Illinois River continued its historical decline in the 1970's. There was a slight increase in the catch in 1974, probably due to fish spawned in 1971-1973, which were of large enough size in 1974 to be taken commercially. Nevertheless, the general trend since 1950 has been downward, and depending on whether the Illinois Department of Conservation or the "Fisheries Statistics of the United States (1950-1971)" are used, the catch dipped under one million pounds for the first time in 1971 or 1972. The decline is not explained by a decline in the number of commercial fishermen--there were 13 full-time and 56 part-time Illinois River commercial fishermen in 1973, and 9 full-time and 47 part-time in 1971. Nor is it explained by a decline in economic value of the catch. The catch from the Mississippi River bordering Illinois has been relatively constant from 1950-1973. A general decline in profits would be reflected in a general decline in fishing effort in both the Illinois and Mississippi Rivers and a corresponding decline in catch.

Some of the reasons for the changing distribution patterns and abundance of Illinois River fishes will be discussed in more detail in the next section.

PART IV: IMPACTS ON THE FISH POPULATIONS OF THE ILLINOIS RIVER

Historical Impacts

The Illinois-Michigan Canal (1848)

The Illinois-Michigan Canal along the Upper Illinois River was completed in 1848, before any biological data were collected on the Illinois River. It is unlikely that this canal had much of an impact on the middle and lower sections of the river, below Hennepin (river mile 208), which are the sections most productive of fish and wildlife. The reason they are the most productive is that the Illinois River below Hennepin follows a large valley developed in the late Pleistocene epoch, and the Illinois has developed lateral levee lakes, side channels, backwaters, and marshes, which fill this ancient valley and provide excellent habitat for fish and wildlife.

Chicago River reversal (1871)

In 1871, the flow of the Chicago River was reversed in order to conduct sanitary wastes from the city of Chicago away from Lake Michigan, which served as the drinking water supply for the city. The polluted waters of the Chicago River were directed through the Illinois-Michigan Canal into the Des Plaines River, thence into the Illinois River. Some of the polluted water apparently backed up into the lower reaches of the Kankakee. The effect of the polluted water on the fishes of the Kankakee and Illinois Rivers was dramatic according to a report of the U. S. Commissioner of Fish and Fisheries (Nelson, 1878):*

> "Previously to the opening of the Chicago River into the canal in 1871, rockbass, (Ambloplites rupestris); largemouth bass, (Micropterus salmoides); white bass, (Morone chrysops); walleye, (Stizostedion vitreum vitreum); mud-pike, (?); northern pike, (Esox lucius); mud eel, (lamprey?); American eel, (Anguilla rostrata); buffalo,

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* Modern scientific and common names of fishes have been substituted for older names in the following quotation, wherever possible.

(Ictiobus --?); shorthead redhorse, (Moxostoma macrolepidotum); suckers, (Catostomus --?); bullheads (Ictalurus --?); paddlefish, (Polyodon spathula); sunfish, (Lepomis --?); catfish, (Ictalurus --?); bowfin, (Amia calva); longnose gar, (Lepisosteus osseus); yellow perch, (Perca flavescens), were caught in both these rivers, and also in the Du Page River, which flows 6 miles east of Joliet, and empties into the Des Plaines 8 miles south of that town; also in Hickory Creek which rises about 14 miles east of Joliet, and empties into the Des Plaines just south of the town, and in any of the streams of sufficient size in this vicinity.

"When the current of Chicago River was first turned through the canal and the rivers, it caused the fish in them to bloat to a large size, and rising to the surface they floated down the stream in large numbers. It was estimated at the time that several tons of dead fish passed through one of the canal locks just after the foul water commenced running through the canal.

"When these bloated fish chanced to float into the clear water at the mouth of some tributary of the river they would revive and swim up the clear stream. Such large numbers of the fish revived in this manner that all the small streams flowing into the Des Plaines and Kankakee rivers were filled with fish in such numbers that many were taken with hook and line, one man taking over 300 in a day in this manner at that time.

"When the spring freshets occur the current is so rapid and the amount of pure water in the river is so great, that the foul water does not have much effect upon the fishes, and large numbers of the species mentioned ascend the rivers and are caught with hook and line. Later in the season as the water subsides, and the water from Chicago River predominates, the fish which came up in the spring die and are floated down the river. In July and August when the water is the worst even the mud turtles leave the river in disgust and seek less odorous homes."

Water from the Illinois-Michigan Canal also entered the Illinois River at LaSalle, (mile 226) but the wastes were sufficiently decomposed at that point that there was only a slight impact on the ecosystem of the Illinois River below LaSalle (Starrett, 1972).

Low navigation dams (1871-1899)

Forbes, in describing the man-made changes which affected "the biological system of the river" (in Richardson, 1928) does not mention the construction of low navigation dams at Marseilles, Henry, Copperas Creek, LaGrange, and Kampsville. He does mention the introduction of the carp, *Cyprinus carpio*, the opening of the Chicago Sanitary and Ship Canal, and draining and leveeing of bottomlands and bottomland lakes.

Nelson (1878) was of the opinion that a dam at Seneca (mile 252.5) hindered the upstream movement of fishes.

European carp (1885)

The European carp was introduced to the Illinois River in 1885, from stock brought to the United States a few years earlier (Forbes and Richardson, 1908). By 1889, the carp catch exceeded the total value of all other commercial fishes from the Illinois River (Thompson, 1928). Forbes and Richardson (1908) reported fishery statistics indicating that increased carp populations did not adversely affect the populations of other species. Forbes and Richardson (1908) did feel that carp might compete with the native drum and buffalo fishes, which have the same food preferences as carp. Competition for food does not appear to have markedly affected populations of bigmouth buffalo--bigmouth buffalo and carp comprise the bulk of the commercial catch from the Illinois River and both species are abundant in the electrofishing collections from Peoria and LaGrange Pools. Bigmouth buffalo are not abundant in the other pools of the river, probably because of poor water quality in the upper pools, and the relative paucity of backwaters in the Alton Pool, rather than because of competition from carp. Forbes and Richardson (1908) did not feel that carp, by their rooting habit of bottom feeding, had increased the turbidity of the water in the Illinois River. In contrast, Jackson and Starrett (1959) observed local areas of heavy turbidity produced by schools of carp in Lake Chautauqua, a bottomland lake along the middle section of the river. They felt that some instances of carp activity may have been stimulated by low oxygen levels. More recently, carp activities may have had a greater effect on turbidity because of the increased presence of flocculent bottom muds that have been carried into the bottomland lakes by the river (Starrett and Fritz, 1965).

Sanitary and Ship Canal (1900)

On January 1, 1900, the Sanitary and Ship Canal was opened at Chicago, connecting the Des Plaines and Illinois Rivers with Lake Michigan. The canal was used to flush municipal and industrial wastes into the Illinois River system and away from Chicago's municipal water intakes in Lake Michigan.

The quantity and quality of water diverted through the canal had a tremendous impact on the Illinois River. Water levels at Havana, Illinois rose an average of 2.8 ft and, during the normal low-flow period between June and September, rose 3.6 ft (Forbes and Richardson, 1919).

As a result the tree line along the river retreated and the loss of mature pin oak and pecan trees meant a loss of food for mallard and wood ducks (Mills, et al., 1966). Populations of cavity-nesting tree swallows and prothonotary warblers increased as a result of the increase in nesting sites in zones of dead trees bordering the river and lakes. When the last of the dead trees collapsed during the 1940's, populations of these species declined markedly. (Personal Communication, September 1974, Dr. Frank C. Bellrose, Waterfowl Biologist, Illinois Natural History Survey, Havana, Illinois).

One beneficial effect of the diversion was to increase the surface area of water in lakes and backwaters, which apparently improved the fishery (Forbes and Richardson, 1919). It is also likely that stumps and snags, left after the trees had died, temporarily provided cover for certain species such as largemouth bass, sunfish, and crappie. The increased shallow water areas and nutrient loading of the Illinois River and its bottomland lakes initially may have increased the plankton populations and the biomass of bottom fauna in the middle and lower river (Forbes and Richardson, 1913). In the river proper, populations of molluscs, especially fingernail clams, probably increased the most, with a beneficial effect on mollusc-consuming species of adult fish, such as carp, catfish, buffalo, and drum.

Increased sewage pollution beginning c. 1910

After approximately 1910, as the pollution load increased, critically low dissolved oxygen levels in the water and putrescent conditions in the bottom muds occurred farther and farther downstream with detrimental effect on food organisms and fish (Richardson, 1921*b*). Richardson believed that in the 1915-1920 period the area in which the bottom fauna was drastically reduced or obliterated was expanding downstream at the rate of 16 miles per year. By 1920, the bottom fauna in the river and bottomland lakes as far downstream as Browning (mile 97.0) had been affected. The aquatic plants (*Potamogeton*, *Ceratophyllum*, *Scirpus*, and *Vallisneria*) which once covered up to 50 percent of the total surface acreage of bottomland lakes near Havana and several square miles of Peoria Lake had practically disappeared. The weed fauna (aquatic insects and snails which inhabit aquatic vegetation) had disappeared with the aquatic plants. (Richardson 1921*b*) reported the following changes in the bottom fauna of Peoria Lake:

> "(1) Disappearance of most species and genera and of several families of small Mollusca, along with important average decrease in numbers of the more tolerant forms still surviving; (2) enormous increase in larval midges (Chironomidae), with invasion of several more or less distinctly pollutional species, and similar or even greater increase in sludge-worms (Tubificidae); and (3) disappearance throughout Peoria Lake, except immediately along shore or in the short, half-mile, stretch of swifter water in Peoria Narrows, of all "other insects" (Ephemeridae, Odonata, Phryganeidae, Corixidae, etc.), as well as of planarians and leeches, Amphipoda, Isopoda, sponges, and Bryozoa."

In the river channel upstream from Havana, he noted these changes (Richardson, 1921*b*):

> "While the average weight of the channel haul here was over 5,000 pounds per acre in 1915, in 1920 it was less than 250 pounds--a net loss of 95.3 percent. In the 4--7ft. zone for the same five-year period the average haul showed a shrinkage of 95.9 percent, or from 2,122 pounds to only 87 pounds per acre.

> The change in the composition of the small bottom-fauna, in turn, includes the disappearance since 1915 of five out of seven families of snails; of more than half a dozen species of bottom-dwelling larval midges; and of twelve out of thirteen or fourteen families of "other insects," worms, small Crustacea, and other small bottom-invertebrates."

Richardson (1921b) estimated that the midsummer standing crop of bottom and weed fauna had been reduced by a total of 34,500,000 lbs in the additional 103-mile section of the Illinois River affected by Chicago effluents between 1915 and 1920. He estimated that this drastic reduction in food organisms represented a loss of about 7,000,000 lbs of potential fish-yield.

Leveeing and draining (1903-1926)

One of the major impacts on the Illinois River below Hennepin was the leveeing and draining of bottomland areas, primarily in the period 1903-1926. Of 400,000 bottomland acres subject to overflow by the river, approximately 200,000 are now behind levees with a consequent reduction in wildlife and fish habitat (Mills et al., 1966). The backwaters and bottomland lakes of the Illinois River were, and are, critically important to fish and wildlife production. Richardson (1921a) reported that the largest poundages of fish per acre were taken in reaches of the river where the largest quotas of connecting lake acreage existed:

> "Taking the year 1908 as an illustration, and using the figures for separate shipping points obtained by the Illinois Fish Commission in that year, we find for the 59.3 miles of river and lakes between Copperas Creek dam (river mile 136.9) and LaGrange dam (River mile 77.6), with about 90% of its acreage consisting of lakes and ponds, an average fish-yield per acre for water levels prevailing half the year, of 178.4 pounds; for the 87 miles from LaSalle (river mile 223.9) to Copperas Creek dam, with about 83% lakes, 130.4 pounds; and for the lower 77 miles, LaGrange to Grafton, with around 63% lakes, only 69.8 pounds."

Richardson indicates that well over 80 percent of the total fish yield came from the lakes and that much less than 20 percent came from the river itself (Richardson, 1921*a*). The bottomland lakes supported an abundant aquatic weed-inhabiting invertebrate fauna, which supplied food for sunfish, crappie, largemouth bass, northern pike, and yellow perch.

Two important conclusions can be drawn from Richardson's work (1921*a*) regarding the bottom fauna and fish production in the lower 80 miles of the Illinois River. First, this section of the river channel had a less abundant bottom fauna than the section immediately upstream because of a lack of soft mud substrate (Richardson, 1921*a*) relatively more frequent dredging operations for channel maintenance (Richardson, 1921*a*), and because the absence of backwater areas (as a result of leveeing) concentrated the feeding activities of the annual upstream runs of large carp and buffalo in the spring (Richardson, 1921*a*). Second, as a result of more extensive levees along the lower 80 miles of river, there was a paucity of the connecting lake acreage necessary to support an abundant weed fauna and consequently, a high level of fish production was not possible.

High navigation dams (1930's)

In the 1930's, high navigation dams were constructed at Dresden Heights (22 ft), Marseilles (24 ft), Starved Rock (19 ft), Peoria (11 ft), and LaGrange (10 ft). The navigation dam on the Mississippi at Alton raised water levels in the Illinois River as far north as Hardin, mile 21.0 (Mills, et al., 1966). Timber and brush were cleared from areas due to be inundated by the new dams. Clearing operations probably did not markedly reduce the amount of mast available for waterfowl because nut-bearing trees such as oaks, grow further from the water's edge than softwood, according to Dr. Frank C. Bellrose, Waterfowl Biologist, Illinois Natural History Survey, Havana, Illinois. Starrett (1971) indicated that the reduction of diversion from Lake Michigan after 1938 coupled with the higher dams on the river have resulted in a decrease of average current velocity from about 1.25-2.50 miles per hour prior to 1908 to 0.6 miles per hour in 1966.

Richardson (1921*a*) indicated that abundant populations of fingernail clams in the Illinois River were generally found in areas of reduced current and favorable conditions for sedimentation. Gale (1971) reported that fingernail clams select mud substrates in preference to sandy mud and sand. Abundant populations of fingernail clams over soft mud bottoms in navigation pool number 19 on the Mississippi River were reported by Gale (1969) and have been observed by the author.

If the high navigation dams constructed in the 1930's did reduce the current and increase sedimentation in parts of the Illinois River, then the habitat suitable for fingernail clams may have increased, with a benefit to the mollusc-eating fish. It is puzzling that conditions have been so dramatically different since 1955, when a die-off of fingernail clams and snails occurred in the middle section of the Illinois River (Mills, et al., 1966). As late as 1973, the fingernail clams had not returned to areas of the river where empty shells indicated they had formerly been abundant.

The high navigation dams have a significant influence on dissolved oxygen (DO) levels and waste assimilative capacity in the Illinois River, according to Butts et al. (1975):

> "The dams are significant reaeration sources for waters overflowing them. The extent of the aeration establishes the bases for the configurations of the DO sag curves. However, the dams should not be considered wholly beneficial. On the contrary, their existence lessens the capability of the waterway to assimilate organic waste by: 1) Increasing the time-of-travel and thus lengthening incubation periods in each pool, 2) Increasing the depth of flow and decreasing stream velocities thus lowering the reaeration capability of the pooled water, 3) Encouraging deposition and accumulation of solids on the pool bottom thereby creating benthic biochemical oxygen demands."

<u>Changing agricultural practices beginning c. 1940</u>

Starrett felt that the increased sluggishness of the river and the increased planting of row crops in the Illinois basin in the last 30 years have made siltation an important factor adversely affecting the survival of mussels and other organisms in the Illinois River and its bottomland lakes (Starrett, 1971).

Sediment deposits in the Upper Illinois River are primarily of urban origin (Butts, 1974), while agricultural sources probably make the major sediment contribution in the middle and lower sections of the river.

Many farmers have removed vegetation from fence rows and stream borders in order to obtain additional space for row crops. Erosion from fields planted in row crops such as corn and soybeans is greater than from field planted in crops such as wheat or hay. More powerful tractors and wider tillage equipment make it possible for individual farmers to farm increasingly large acreages, but it becomes increasingly inconvenient to leave fence rows, grass waterways, marshy areas, or meandering streams. The common practice of fall plowing leaves the ground bare and subject to erosion during rains and snowmelt. Wind erosion is probably also significant in moving soil into ditches where it is later washed into streams and rivers.

Sediment physically removes habitat by filling in areas; for example, Lake Chautauqua, near Havana (river mile 124-130), lost 18.3 percent of its storage capacity in a period of 23.8 years (Stall and Melsted, 1951). Areas in Quiver Lake, near Havana, where boats could formerly be launched are now only a few inches deep during low-water stages, and willows are encroaching on the lake.

Sediments can also cause undesirable habitat modification by blanketing firm bottoms, increasing turbidity, and reducing dissolved oxygen levels. As pointed out earlier, many gamefish prefer to spawn on firm, rather than flocculent bottoms. Many bottomland lakes and backwater areas along the Illinois River have filled with a flocculent sediment that has been described by Starrett (1959):

> "The sediments in Lake Chautauqua are mostly of a fine texture and form a loose, flocculent 'false bottom' (not similar to the type found in bog lakes) over the original lake bottom. A slight disturbance of the 'false bottom' causes particles to become resuspended and so increases the turbidity of the water."

Jackson and Starrett (1959) found that an increase in wind velocity from light to strong increased turbidity from 162 to 700 Jackson turbidity units (JTU) and that a calm period of 7 to 12 days was necessary for much of this sediment to settle from Lake Chautauqua. As a consequence, this lake and other bottomland lakes remain highly turbid most of the time.

The turbidity levels in bottomland lakes and backwaters along the Illinois River are within the range that reduces fish production. Buck (1956) studied fish production in farm ponds, hatchery ponds, and reservoirs in Oklahoma which had a wide range of turbidities. The farm ponds were rotenoned, then restocked with largemouth bass and bluegills or largemouth bass and redear sunfish. A total of 12 farm ponds was divided into 3 turbidity classes. After two growing seasons, the average total weights of fish were:

clear ponds (less than 25 JTU)	161.5 lb/acre
intermediate ponds (25-100 JTU)	94.0 lb/acre
muddy ponds (100 JTU)	29.3 lb/acre

The redear and bluegill sunfish reproduced more abundantly and grew faster in clear water. Survival of bass was greater in intermediate ponds than in clear ponds, perhaps due to competition with abundant sunfish populations in the clear ponds. However, the surviving bass grew faster in clear ponds:

	average weight gain	average length increase
clear ponds	14.0x	6.9 in.
intermediate ponds	7.1x	5.1 in.
muddy ponds	2.5x	2.4 in.

The results from hatchery ponds, where turbidities were artificially controlled, and from the reservoirs, generally paralleled the results from the farm ponds.

Ellis (1936) found that organic matter mixed with erosion silt created an oxygen demand in water and that the oxygen demand was maintained 10 to 15 times as long as the oxygen demand created by the same amount of organic material mixed with sand. The oxygen demand can increase many-fold when sediment containing organic material and bacteria is resuspended by waves or currents (Butts, 1974; Baumgartner and Palotas, 1970). For example, Butts (1974) found that under quiescent conditions the sediment oxygen demand in the Illinois River at mile 198.8 in Peoria Pool was 2.8 $g/m^2/day$, while the demand was 20.7 $g/m^2/day$ when the sediment was disturbed. At three sampling stations in Meredosia Lake (mile 72-78) the sediment oxygen demand under quiescent conditions ranged from 2.58 to 4.32 $g/m^2/day$, and from 12.92 to 83.0 $g/m^2/day$ under disturbed conditions (Personal Communication, 2 September 1975, Mr. Thomas A. Butts, Associate Professional Scientist, Illinois State Water Survey, Peoria, Illinois). The oxygen demand exerted by sediment in some reaches of the river and in some bottomland lakes is great enough to seriously diminish the oxygen supply in the water.

In August 1974, dissolved oxygen levels in Meredosia Lake were 3 mg/l, while oxygen levels in the river on the same date were 6 mg/l. The readings were taken in the middle of the afternoon on an overcast day, and waves produced by a strong wind were resuspending bottom sediments in the lake. In the lake, a die-off of gizzard shad was occurring, and almost all the fingernail clams maintained in plastic cages on the bottom of the lake had died since they had last been checked in mid-July.

Fingernail clam die-off (1955)

Starrett (1972) documented the die-off of fingernail clams and summarized the drastic effect on fish and waterfowl:

> "Fingernail clams (Sphaeriidae) virtually disappeared from the river above Beardstown in the mid-1950's (Paloumpis and Starrett, 1960 and unpublished). These organisms were an important food item in the river and its bottomland lakes for carp and diving ducks (Aythyinae), particularly the lesser scaup duck (*Aythya affinis*). Following the disappearance of the fingernail clams, a sharp decline occurred in the numbers of lesser scaups using the middle

> section of the river and its lakes during migration (Mills et al., 1966). In the 1960's fingernail clams formed 50.2% (volume) of the food items taken by carp collected in the river between Beardstown and its mouth (Starrett and Paloumpis, unpublished). Only one fingernail clam was found in the food contents of the carp examined from the remainder of the river. Tubificidae worms comprised only 4.3% (volume) of the food ingested by carp taken from the section of the river between Beardstown and the mouth, whereas in the upper river (source to Starved Rock dam), where there was a virtual absence of fingernail clams, carp fed heavily upon Tubificidae worms (30.5% volume). Carp collected during the early 1960's from the lower section of the river, where fingernail clams formed an important part of their diet, were deeper bodied than those taken from the remainder of the river (Mills et al., 1966)."

Paloumpis and Starrett (1960) reported that the population of fingernail clams in lower Quiver Lake (mile 122) dropped from 1,115 individuals per square foot in 1952 to 54 per square foot in 1953 and to 0 in 1954. Snail populations in lower Quiver Lake also declined during this period.

As recently as the spring of 1973, no living fingernail clams were collected at several stations in Quiver Lake (mile 122-124) where dead shells indicated they had formerly been abundant.

Although the reason for the die-off is unknown, it appears that the Sangamon River, which enters the Illinois at Beardstown, may be diluting some material in the river which is toxic to fingernail clams. Fingernail clams may have died out in some bottomland lakes because of low oxygen levels due to sediment oxygen demand (mentioned above) or because flocculent sediments make it impossible for the clams to maintain themselves at the mud--water interface, or because the sediments interfere with normal feeding activities.

<u>Aquatic vegetation die-offs (1920's and 1950's)</u>

The backwaters and bottomland lakes of the Illinois River were once veritable aquatic gardens, as described by Kofoid (1903):

> "The aquatic environment at Havana impresses the visiting biologist who for the first time traverses its river, lakes, and marshes, as one of exceedingly

abundant vegetation, indeed almost tropic in its luxuriance. The aquatic flora of the ponds, lakes, and streams of New England, of the Middle States, and of the north central region is, as a rule, but sparse in comparison with that which here constantly meets his eyes . . . . he will find acres upon acres of "moss", as the fishermen call it--a dense mat of mingled Ceratophyllum and Elodea choking many of the lakes from shore to shore, and rendering travel by boat a tedious and laborious process. Beds of lotus (Nelumbo lutea) and patches of Azolla will suggest warmer climes, while the fields of rushes (Scirpus fluviatilis), and patches of water-lilies (Nymphaea reniformis), arrowleaf (Sagittaria variabilis), and pickerel-weed (Pontederia cordata) will recall familiar scenes in northern waters. The carpets of Lemnaceae will be surprising, and the gigantic growths of the semiaquatic Polygonums will furnish evidence of the fertility of their environment."

In the same report, Kofoid (1903) provided a list of "only the most common and most important members of the aquatic flora" in and along the Illinois River--48 species of emergent and submergent plants comprise the list. In wider parts of the river above both Peoria and Havana, there were extensive areas that were permanently occupied by aquatic plants (Kofoid, 1903). As mentioned earlier, the aquatic vegetation disappeared from much of the middle and upper sections of the Illinois River in the 1920's, as a result of increasing pollution originating from Chicago.

Improved waste treatment in Chicago apparently resulted in improved conditions for aquatic plants, and between the late 1930's and the mid-1950's, the growth was again luxuriant in Peoria Lake and elsewhere along the middle section of the river (Mills, et al., 1966).

Since the mid-1950's, aquatic plants have again disappeared from the river proper and from most backwaters and bottomland lakes which are overflowed by the river (Starrett, 1972). The plants may have disappeared from the bottomland lakes because turbidity has reduced light penetration or because flocculent bottoms make anchorage against wave action impossible. Starrett (1972) and Mills, et al. (1966) were of the opinion that some additional factors were responsible for the disappearance of plants from the river proper. Coontail, longleaf and sago pondweeds, and wild celery have disappeared from the Starved Rock Pool since the 1940's, even though the transparency of the water has been adequate for their growth in many years since then (Mills, et al. 1966).

Summary

In the early part of the 20th century, the bottomland lakes and backwaters along the Illinois River produced most of the fish because they contained most of the food, which in turn was associated with the aquatic weeds that were abundant in the shallow, clear waters. Approximately half the bottomland acreage subject to overflow was drained or leveed. The river became increasingly polluted, with low dissolved oxygen levels occurring farther downstream, while some of the lakes, which were fed by springs or tributaries, continued to offer havens for fish and food organisms. More recently, some of the lakes have developed periodic low dissolved oxygen levels during the summer, while the oxygen levels in the middle and upper sections of the river have improved somewhat due to more and better waste treatment by industries and municipalities in the drainage basin.

The number of fish and duck food organisms in the lakes have declined in recent years, probably because of low oxygen levels, absence of aquatic plants, and presence of flocculent sediments. The once-abundant rooted aquatic plants may have also served to lock up nutrients that are now available to bacteria and plankton. Bacteria and plankton, and the biochemical oxygen demand exerted by the sediments, are probably responsible for low oxygen levels in the lakes during overcast days or at night when photosynthesis does not occur.

Present Impacts

Many of the factors which have had a detrimental impact on the biota of the Illinois River in the past continue to have an impact at the present time. Two major factors are wastes from urban areas and sediment originating from both agricultural and urban sources. Pesticides may not be having a direct effect on fishes in the Illinois River, but pesticides in some fish from the Illinois exceed levels allowed by the Food and Drug Administration (FDA) in fish for human consumption.

Industrial and municipal wastes

Figure 4 shows the critically low dissolved oxygen levels in the Illinois River during low flows in the summers of 1965 and 1966. Oxygen levels were generally below saturation throughout the entire length of the river; levels below 1.0 mg/l occurred in Dresden, Peoria, and LaGrange pools.

Increases in dissolved oxygen are apparent below the navigation dams (due to reaeration by the dams) and in lower Peoria Lake (perhaps due to plankton, reduction of oxygen demand, and reaeration by turbulence of the river). The decreases in dissolved oxygen occur because organisms living in the water, in the sediments, and attached to substrates (such as rocks or navigation locks) utilize oxygen as they feed on organic wastes (Butts, et al., 1975).

The reduction in dissolved oxygen levels so far downstream of the Chicago-Joliet and Peoria-Pekin metropolitan areas results from the oxygen demand created as bacteria convert ammonia in sewage effluent to nitrate. The rate at which populations of these nitrifying bacteria develop is relatively slow, so that ammonia oxidation on the Upper Illinois commences approximately three days time-of-travel below the Lockport dam (mile 291.0): at mile 196 in the Peoria Pool during high flows, and at mile 273 in the Dresden Pool during low flows (Butts, et al., 1975).

Ammonia places aquatic organisms in double jeopardy: it not only causes a reduction in oxygen levels, it is also toxic. It is only the un-ionized form of ammonia which is toxic, approximately 5 percent of the total ammonia concentration in the Illinois River. Lubinski, et al. (1974) reported that un-ionized ammonia concentrations in the Upper Illinois River and Des Plaines River on occasion reached 40 to 60 percent of a lethal level for bluegills. Un-ionized ammonia is more toxic

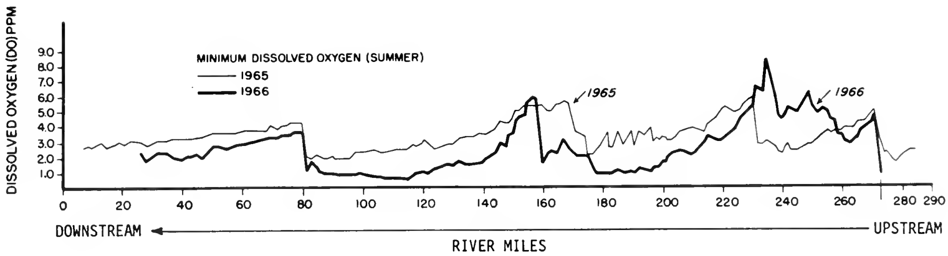

Figure 4. Minimum dissolved oxygen levels in the Illinois River in 1965 and 1966. Water samples for the oxygen determinations were taken three feet below the surface in the navigation channel. Increases in the dissolved oxygen content of the river are apparent below the various navigation dams and in Peoria Lake.

to aquatic organisms when dissolved oxygen levels are low than when oxygen levels are high. The combination of low dissolved oxygen and high un-ionized ammonia levels in the Upper Illinois River is probably stressful to fish.

Low dissolved oxygen levels are also partially attributable to oxygen utilization by microorganisms, tubificid worms, and midge larvae living in sediment deposits on the bottom of river. Sediments in many parts of the river are high in organic content and resemble primary sewage sludge (Butts, 1974; Butts, et al., 1975).

Stormwater probably contributes considerable oxygen-demanding waste and sediment to the river. This waste is washed from streets, gutters, parking lots, etc., during storms. In addition, stormwater overloads sewage systems, so that raw sewage mixed with stormwater is discharged directly to the river. The lowest dissolved oxygen levels (1.1 mg/1) observed in the Upper Illinois River during a 1971-1972 study by the Illinois Water Survey occurred in Peoria Pool while water levels were rising to a flood crest (Butts, et al., 1975). During persistently high flows, the oxygen levels recover, because streets, gutters, and sewers are swept clean by the initial rainfall and there is a dilution effect.

Industrial effluents presently enter the river directly, or indirectly, through municipal sewage systems. Domestic wastes contain materials such as LAS detergents and fluoride (added to drinking water), which can be toxic to aquatic organisms at certain concentrations.

Lubinski, et al. (1974) expressed the concentrations of individual toxicants in the Illinois River as fractions of the lethal concentrations (96-hr LC50's) to bluegills. To do this, Lubinski, et al. (1974) used chemical monitoring data, gathered by the Illinois Environmental Protection Agency (EPA), for 17 stations on the Illinois River and bioassay information available in the literature or from their (Lubinski, et al.) own experiments. They used the bluegill as a reference organism because it is found in the Illinois River and a great deal of information is available on the toxicity of chemicals to bluegills. Certain assumptions and calculations were made (as detailed in Lubinski, et al., 1974 and in Lubinski, 1975), in order to estimate what proportion of certain chemical concentrations reported by the Illinois EPA actually existed in a toxic form. Seven chemicals were estimated to have made the following average contributions to the toxicity of the Illinois River in 1972 and 1975: hydrogen cyanide, 3.0 percent of a lethal concentration (96-hr LC50); un-ionized ammonia, 2.4 percent of a lethal concentration; LAS detergent, 1.9 percent; fluoride, 1.0 percent; copper, 0.6 percent; zinc, 0.3 percent; and phenol 0.2 percent. When the average toxicities contributed by each toxicant were added together, the estimated total toxicity ranged from a low of 4.5 percent of a lethal level at mile 56.0 to 16.8 percent of a lethal level at mile 119.7.

Lubinski, et al. (1974) concluded that the toxicants normally do not occur at levels high enough to cause fish in the Illinois River to die. This was partially verified by field tests using caged bluegills. However, hydrogen cyanide and un-ionized ammonia periodically occurred at high enough concentrations (63 percent of a lethal level of un-ionized ammonia, at mile 277.8; an estimated 47 percent of a lethal level of hydrogen cyanide, at mile 119.7) to stress fish, although the lengths of time fish were exposed to these toxicants, and hence their possible lethal effects, could not be determined (Lubinski, et al., 1974).

Brown, et al. (1973) found that 4.38 percent of 2121 fish taken from the Fox River (a tributary of the Illinois) had tumors compared to 1.03 percent of 4639 fish taken from an unpolluted watershed in Canada. Brown, et al. (1973) felt that various organic and inorganic chemicals and viruses were responsible for the greater frequency of tumors in Fox River fish.

Pesticides

Starrett (1971) had 14 mussels representing 7 species collected from 5 locations in the Illinois River in 1966 analyzed for the presence of organochlorine pesticides. In no instance did the total concentration of organochlorine pesticides exceed 0.0585 ppm, and the average content was 0.0331 ppm. Since freshwater mussels can concentrate organochlorine pesticides several thousandfold from water (Bedford and

Zabik, 1973), Starrett's results indicate that organochlorine pesticide levels in the Illinois River were fairly low in 1966.

The U. S. Fish and Wildlife Service has analyzed fish taken from the Illinois River at Beardstown (mile 88.0) for pesticides, as part of the Nationwide fish monitoring program. Fish have been collected for analysis once or twice a year since 1967. Whole fish are analyzed, and the results are expressed as milligrams of pesticide per kilograms wet weight of the whole fish. The results for the years 1967 through 1969 are summarized in Table 36. Inconsistencies were apparent in the results reported by five different laboratories on subsamples of the same fish homogenate in 1967 and 1968 (Henderson, et al., 1969). For example, the analyses of DDT and its metabolities in bigmouth buffalo from the Illinois River ranged from .05 to .54 ppm--an order of magnitude difference (Henderson, et al., 1969). Nevertheless, Henderson, et al. (1971) felt that the 1969 values for DDT and dieldrin were reliable. Henderson, et al. (1971) did not place much significance on the results of heptachlor and heptachlor epoxide and the results from these compounds are not reported in Table 36. Food and Drug Administration limits for dieldrin in fish were exceeded in carp, bigmouth buffalo, and channel catfish from the Illinois River.

The possible adverse effects on fish and wildlife of the pesticide and mercury levels reported in Table 36 are largely unknown. Lubinski, et al. (1974) reported that aldrin was present in the Kankakee River (a tributary of the Illinois) at concentrations ranging from 0.34 to 3.00 micrograms per liter, and that this represented approximately 13 percent of a lethal concentration for bluegills. Pesticide levels which are too low to have a direct effect on fish may affect fish-eating birds or other animals.

Snails (Physa sp.) which were reared in the laboratory under conditions designed to reduce their exposure to pesticides as much as possible, rapidly accumulated dieldrin when exposed in cages to Illinois River water at mile 87 and mile 120 for a period of 8 days in August 1974. The snails at mile 87 increased in dieldrin content from

0.1797 ppm wet weight-whole organism to 0.8156 ppm; those at mile 120 increased from 0.1797 to 0.5408 ppm (Sparks and Walter, unpublished data).

Sediment

The past detrimental impacts of sediment on aquatic vegetation, fish habitat, fish food organisms, and the fishes of the Illinois River were described in a previous section. At the present time, sediment continues to enter the river and to fill bottomland lakes and backwaters with each influx of sediment-laden water from the river.

Sediment affects many uses of the river, in addition to fishing. Many residents of Quiver and Baldwin beaches near Havana bought lake-front property because they enjoy water-based recreation. During the prime months for water recreation, the summer months, the water levels are low and Quiver Lake is now so filled with sediment that it is impossible to launch a boat in the upper two-thirds of the lake. The annual speedboat races at De Pue Lake (mile 211-213) were cancelled in 1974 because the water had become too shallow. Mr. Bruce Hillemeyer, co-owner of the Tall Timbers Marina at Havana (mile 120.5), reported in 1974 that it cost approximately $50,000 to dredge the channel to the marina every 2 to 3 years, and that this increasing expense, added to other expenses, was forcing him to sell his business. The navigation channel in the vicinity of Kingston Mines (mile 146) was closed to two-way barge traffic for several weeks in 1974 because extensive dredging operations were necessary.

Once the sediment is in the river and lakes, it can be resuspended by boat traffic or waves produced by wind. The increased barge traffic (Starrett, 1972) associated with the improved navigation channel increases the turbidity of the river. The turbulence produced in mid-channel, as well as the washing action along shore, resuspends sediment and thereby increases the turbidity. Starrett (1971) made numerous observations of the effect of barges on turbidity of the river:

> "A towboat underway causes a strong current and washing action on the silt bottom ("false bottom") in shore, which resuspends the silt particles, there-

> by increasing the turbidity. The increase in turbidity is more noticeable in the lower three pools, particularly in the Alton Pool, than it is upstream because of differences in bottom types....The outrush of water from shore toward the channel caused by a towboat also temporarily exposes the shallow areas. On November 18, 1964, in the Alton Pool at river mile 65.1, the turbidity just prior to the passing of two towboats was 108 units (Jackson turbidity units), and within 6 minutes after the tows had passed, the turbidity was 320 units. Sixteen minutes later the turbidity had dropped to 240 units."

Figure 5 shows that the turbidity in mid-channel at mile 25.9 was increased by approximately 100 Jackson turbidity units (JTU) as towboats passed on three occasions. It took approximately 2½ hours for the turbidity to return to background levels following passage of towboats.

In addition to increasing turbidity, the resuspended sediment exerts an oxygen demand. Butts (1974) reported that the oxygen demand of sediment in the Upper Illinois River increased several-fold when the sediment was disturbed. The oxygen measurements plotted in Figure 5 suggest that resuspension of sediment by barge traffic significantly depresses oxygen levels. The oxygen levels at the bottom and surface declined following passage of a towboat. The oxygen levels at mid-depth increased slightly. The decline of 0.4 mg/l oxygen at the bottom is significant, because the standard deviation of the method used to measure dissolved oxygen (azide modification of the Winkler method) is 0.1 mg/l. The present impact of boat traffic and the potential impact of increased traffic on dissolved oxygen levels and turbidity in the river should be investigated further.

Future Impacts

Improvements in waste treatment

The Illinois State Water Survey has developed a model to predict dissolved oxygen levels in the middle and upper sections of the Illinois River under various waste loads during low-flow conditions (Butts, et al. 1975). Under extreme low-flow conditions likely to occur once

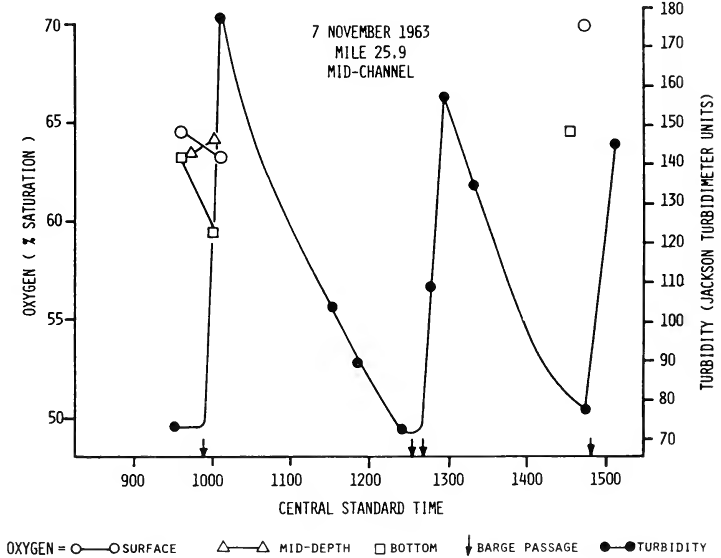

Figure 5. Dissolved oxygen concentrations and turbidity in the middle of the navigation channel of the Illinois River at mile 25.9, during passage of towboats on three occasions on November 7, 1963. The time at which each towboat passed mile 25.9 is marked by an arrow.

every 10 years and to persist for at least 7 days, the dissolved oxygen levels under existing waste loads would be below the Illinois standard of 5 mg/l in Marseilles, Starved Rock, and Peoria Pools (Butts, et al., 1975). Moreover, the oxygen levels would be between 0 and 1 mg/l in substantial portions of these pools. Such low oxygen levels would drastically reduce the fish populations in the river. In order to meet the State dissolved oxygen standard in the Upper Illinois River during 7-day 10-year low-flow conditions, Butts et al. (1975) estimate that 97.5 percent of the carbonaceous biochemical oxygen demand must be removed from waste at the West Southwest treatment plant of the Metropolitan Sanitary District of Greater Chicago. Moreover, all other carbonaceous discharges between the Lockport Dam and the Kankakee River must be reduced 50 percent, and 98 percent of the nitrogenous waste load above mile 273 must be removed.

Some steps are planned, or have already been taken, to reduce waste loads in the upper river. In 1971, the Chicago Metropolitan Sanitary District began a large-scale sludge recycling project near the Illinois River at St. David. In 1974, the district began aerating a section of the Chicago Sanitary and Ship Canal, and more of the canal will be aerated in succeeding years. In the future, all Chicago storm waters probably will be captured and stored in a deep tunnel under Chicago, instead of discharged to the canal, and will be treated before being released to the canal. Advanced waste treatment plants should be capable of removing the ammonia that now exerts an oxygen demand as far as 140 miles down river. All of these improvements in waste treatment will certainly have a beneficial impact on the aquatic life in the river by reducing the oxygen demand on the river and by improving oxygen levels during critical low-flow periods. Waste treatment probably will also be improved in the Pekin-Peoria metropolitan area.

Proposed channel improvements

After measuring sediment oxygen demand in the Upper Illinois River under both disturbed and quiescent conditions, Butts (1974) concluded that improved waste treatment alone would not greatly restore the aquatic ecology of the upper river:

"Because of the areal extent and depths of bottom sediments, particularly in the Brandon Road and Dresden Island pools, coupled with the periodic resuspension of the sediments by barge tows, it is doubtful that the aquatic ecology of the waterway can be measurably enhanced solely by achieving current water quality standards. A program for the removal of undesirable sediments in critical zones probably will have to be devised and implemented. However, any such program should be preceded by a study designed to predict the impact of resuspended sediments on downstream DO (dissolved oxygen) resources that would result from sediment removal operations."

Butts (1974) felt that, "The resuspension of sediments by barge traffic may increase short-term localized oxygen demand loads by seven or eight fold." If the depth of the navigation channel of the Illinois River is increased from 9 to 12 ft, as has been proposed, the increased size of the towboats using the improved navigation channel and the increased number of tows would keep more sediment in suspension, with a consequent increase in oxygen demand and turbidity. Figure 5 shows that if towboats pass a point on the river more frequently than once every 2½ hours, the resuspended sediment will not have a chance to settle out, and the mean amount of suspended sediment in the river will increase. It is likely that river traffic will increase to some extent in the future, whether or not the channel is improved, but it is certain that traffic will increase to a much greater extent if the proposed improvements are undertaken.

The proposed increase in channel depth would be accomplished by a combination of raising low-flow water levels and dredging. Depending on local topography, the water surface area might be increased. Judging by the increased fishery in the Illinois River following a rise in water levels in 1900 as a result of water diversion from Lake Michigan, one might expect a beneficial effect. However, bottomland lakes that now have a chance to clear during periods when they are cut off from the river might then become permanently connected to the river and receive a continuous, rather than intermittent, input of oxygen-demanding silt. Some of the bottomland lakes on the east side of the Illinois River between Kingston Mines (mile 145.3) and Meredosia (mile 71.1) recover from turbidity and the blanketing effects of sediment when they are cut off from the river during low flows. An influx of groundwater from the sandy eastern bluffs and sandy lake bottoms flushes away sediment deposited by the river. According to an Illinois Water Survey report (Singh and Stall, 1973), this influx amounts to 309 cu ft/sec, or about one-twelfth of the total input to this 73-mile section of the river, during the lowest flow expected for a 7-day period at a recurrence interval of 10 years. Matanzas Lake (mile 114.5-117.0) still exhibits a recovery pattern, but mud now blankets the sandy bottoms in other lakes such as Quiver Lake (mile 121.0-124.0), which once received spring water (Richardson, 1921a). The influx of groundwater to these latter lakes might still be sufficient to provide clear water if the bottoms could be stabilized against wave action and the influx of sediment from the river reduced or prevented.

Another detrimental impact of the proposed increase in the depth of the navigation channel would be the reduction in the capability of the river to assimilate organic waste, due to increased time-of-travel, reduced reaeration, and increased sedimentation (Butts, et al., 1975).

Land use in the drainage basin

If predictive studies indicate that a reduction of sediment input would actually reduce sedimentation in the river and the lakes and backwaters, the most practicable solution to the sediment problem in the future may be to reduce the amount entering the river. It is possible that once sediment is in the river and lakes, it is recycled and resuspended there, and no reduction in turbidity or oxygen demand would be achieved by reduction of sediment input, without the physical removal of sediment or the use of restoration techniques, such as drying out lakes. However, it is possible that reduced sediment input to the river may cause the river to flush out backwater areas and lakes during periods of high flow, thus bringing about a natural restoration of these areas. Once the turbidity was reduced, fringing marshes and beds of aquatic plants might appear again, further accelerating restoration by acting as sediment filters and nutrient traps.

The sediment input to the river could be reduced in the future by wide adoption of soil conservation practices in the Illinois basin, including such new practices as no-till farming, where row crops are planted directly in stubble or some other ground cover, without greatly disturbing the soil. The ground cover breaks the impact of raindrops, and holds water, soil, and nutrients, rather than allowing all three to run rapidly into tributary streams, thence into the river.

Before no-tillage or minimum tillage is practiced on a wide scale, the total energy requirements (including the energy for the manufacture of agricultural chemicals) of various alternative farming methods need to be determined, and the environmental impact of the herbicides that must be used with present no-till farming methods needs to be assessed. In the future, it may be possible to reduce the amount of herbicide used in no-till farming by choosing the proper sequence of crops and by breeding varieties of row crops that can compete with weed species. No-till farming does reduce the energy required by farm machinery, since there is little or no plowing, harrowing, or cultivating. No-till farming also enables farmers to get on their land earlier in the spring for planting, because sod is not as slippery or soft as bare ground.

Proposed increase in diversion

The city of Chicago and lakefront residents whose property has been damaged as a result of recent high-water levels in Lake Michigan have requested an increased diversion of Lake Michigan water into the Illinois River. Since Lake Michigan water is good quality water, it probably would improve the quality of the upper river by simple dilution, if diversion occurred during the summer months.

However, increased diversion would probably raise water levels, with some of the detrimental effects discussed earlier. In addition, if ammonia removal is not achieved by the Chicago Metropolitan Sanitary District, the effect of increased diversion would be to push this oxygen- demanding waste further downstream before its oxygen demand could be satisfied.

Introduced species

Two introduced species have entered the Illinois River recently and will probably become more abundant, just as the introduced carp, goldfish, and white catfish have. It is difficult to predict whether the latest arrivals will increase explosively, as carp and goldfish did, or whether they will barely maintain themselves, as white catfish have. White catfish are only occasionally taken from the Illinois River and do not seem to reproduce abundantly in the river.

The white amur (Ctenopharyngodon idella), a plant-eating fish introduced from Asia, is now being taken regularly by commercial fishermen from the Mississippi River at Crystal City, Missouri, and from the Missouri River (Personal Communication, October 1974, William L. Pflieger, Fishery Biologist, Missouri Department of Conservation, Jefferson City, Missouri; and Peter Paladino, District Fishery Biologist, Illinois Department of Conservation, Aledo, Illinois), and has probably entered the Lower Illinois River. If rooted aquatic vegetation could be restored to the Illinois River and its bottomland lakes by the lake restoration techniques discussed above, or by a reduction of silt loads in the river as a result of improved soil conservation practices in the basin, the white amur might have a detrimental impact. On the other hand, white amur from the Mississippi are being marketed in small quantities commercially and their flavor is reported to be excellent. White amur in the Mississippi grow to a large size (10 to 14 lb) in 2 years (Personal Communications, October 1974, Pflieger and Paladino). They might become useful commercial species in the Illinois River.

Another exotic species, the Asiatic clam (Corbicula manilensis) was found at three locations on the Illinois in the course of the 1974 electrofishing survey: at Kampsville (river mile 32.0), Bath Chute (mile 106.7), and Turkey Island Chute (mile 148.4). Judging by the size of the shells, the oldest clams were four years old. Asiatic clams probably first occurred in the Illinois River in 1970-1971 (Thompson and Sparks, in press). The Asiatic clam is a serious nuisance, because it has blocked condensor tubes of power plants in Illinois and elsewhere. In addition, it may possibly displace the native fingernail clams.

Recommendations

Restore lakes

Past surveys of fish populations in the Illinois River and the present electrofishing survey demonstrate that the most fish and the most desirable kinds of fish are generally produced in the reaches of the river with the most lateral lakes and backwaters. Marshes, lakes, and backwaters are essential for fish production in the Illinois River, because they serve as fish nurseries. The lakes have been degraded by sediment, and fish and wildlife production has declined.

The Illinois Department of Conservation has taken two approaches to restoration of lakes along the Illinois River. One approach is to keep the Illinois River from entering and degrading the lakes, and to rely on groundwater and rainfall to maintain the water level. This is the approach that will be taken in Banner Marsh. The Department of Conservation is currently purchasing the Banner Special Drainage and Levee District (mile 138-145.5), a former strip mine on the flood plain of the river. The Department plans to restore the natural lake and marsh habitat within the Banner district. The existing high levees which surround the district will be maintained in order to keep the river out of the restored area.

The other approach to lake restoration is exemplified by Rice Lake (mile 133-137) and Stump Lake (approximately mile 5). The Department of Conservation has been able to restore aquatic vegetation in these lakes by pumping water out of the lakes or allowing them to dry out naturally (Personal Communication, September 1973, Mr. Robert L. Glesenkamp, Area Wildlife Manager, Illinois Department of Conservation, Havana, Illinois). Midsummer drying was a natural occurrence in this type of shallow lake, during low-flow years, prior to Lake Michigan diversion and construction of navigation dams (Richardson, 1921a). On drying, the bottom muds compact, and when the lakes are reflooded, the turbid water generally clears, and the plants can gain roothold in the firm bottom. This approach represents a temporary restoration only. The sediment storage capacity of a lake is limited and the river deposits more sediment during each period of overbank flow.

Private duck clubs and Federal wildlife refuges along the Illinois River also attempt to reduce water levels in the summer in order to expose mud flats and encourage the growth of moist soil food plants for waterfowl. Once again, a natural drying cycle has had to be replaced or supplemented by pumping, because water levels do not attain the low levels they once did. Such management techniques require energy, equipment, and manpower, but are necessary if fish and wildlife populations are to be maintained at existing levels, or if they are to recover to some proportion of the population levels which once existed in the Illinois valley.

Refuges, unpolluted lakes, and unpolluted tributary streams must be maintained or restored if the river is to be capable of the recovery pattern in the future that it exhibited in 1973-1974, following the high-water period and improved oxygen levels from 1971-1973. When formerly degraded areas are restored, they can be recolonized rapidly by species that are desirable to man, if reservoirs of such species and reservoirs of food organisms for desirable species are available in undegraded pockets here and there in the ecosystem. The refuges maintained by man have precisely this function.

Predict impacts

Information and methodologies need to be developed to predict the impact of man's future activities on the Illinois River system, so that a rational choice of alternatives can be made. For example, the effects of various future channel improvement schemes and various levels of barge traffic on oxygen levels and turbidity in the main channel and backwaters needs to be predicted. The expected life span and probable future condition of bottomland lakes and marshes should be predicted so that conservation agencies can make a wise selection of new refuge areas, and develop scientific restoration and management methods for existing areas.

The impact of present and future waste loads on the river system must be estimated so that a rational method of utilizing the waste assimilative capacity of the river, without further degrading the river can be developed. The relative impact on aquatic life of pollutants from both nonpoint and point sources needs to be assessed, so that pollution abatement measures can be directed, on a priority basis, toward those pollutants which are actually doing the most damage to the Illinois River system. Such a priority system would assure the greatest tangible return possible, in terms of improved fishery and wildlife values, per dollar spent on pollution control.

Coordinate management for multiple use

Once the capability is developed for assessing and predicting the impacts of man's activities on the Illinois River system, it will be possible to manage the system in a more coordinated fashion than now occurs. For example, it is possible at present for one arm of the Federal Government and for State governments to spend resources in improving and restoring refuge areas while another arm of Government engages in practices which degrade such areas. There is little point in the Metropolitan Sanitary District of Greater Chicago and other municipalities and industries expending millions of dollars in improved waste treatment if the river and its bottomland lakes are degraded largely by sediment from nonpoint sources.

The river and its bottomland lakes, backwaters, marshes, and tributaries need to be managed as a system rather than piecemeal. The river system has been managed as a series of arbitrary administrative and jurisdictional units. Upstream users of the entire river's assimilative capacity, such as the Metropolitan Sanitary District of Greater Chicago (MSDGC) are responsible only for impacts which occur within their jurisdiction. Agencies develop plans independently of each other, although it is clear that their activities will interact and perhaps conflict. For example, it is possible that the proposed increase in diversion of Lake Michigan water at Chicago may have a positive impact on navigation, making it possible for the present navigation channel to accommodate deeper-draft barges in certain areas, without additional dredging or higher dams, yet plans for a greater channel depth and for increased diversion are pursued independently. Increased diversion would conflict with attempts to manage and restore bottomland lakes by dewatering, yet downstream effects do not seem to weigh heavily in the controversy over diversion.

It is likely that some of the conflicts existing in the present piecemeal management of the Illinois River system could be resolved or ameliorated by interagency cooperation and coordination. If management of the river can be coordinated, and if methodologies and information can be developed to predict the future of the Illinois River system under a variety of development, restoration, and pollution abatement programs, it should be possible to determine what portion of the fish and wildlife production of the past could be bought back in the future. The 1973-1974 recovery in the game fish populations of the Illinois River, in response to temporarily improved conditions in the river, demonstrates that the past can be redeemed--to what extent depends upon man's willingness to spend resources in restoring habitat and improving water quality.

PART V: SUMMARY

The Upper Illinois River is warmer than the lower river, as a result of warm municipal and industrial effluents.

The upper river is less turbid because the bottom is generally rocky, whereas the lower portion, including Peoria, La Grange, and Alton Pools contains flocculent muds that have entered the river and are kept in suspension by the river current and by wave action resulting from wind, towboats, and pleasurecraft.

Dissolved oxygen levels at the surface and the bottom of the river were virtually the same in the fall of 1974, and dissolved oxygen levels were 77-97 percent of saturation in Alton Pool, 56-122 percent of saturation in Ia Grange and Peoria Pools, and 47-104 percent of saturation in the upper pools of Starved Rock, Marseilles, and Dresden. Local areas of super-saturation occurred where plankton blooms appeared to be in progress. In an area that provided good physical habitat for largemouth bass, Chillicothe Island Chute, Peoria Pool (mile 180), midsummer oxygen levels were at 35-percent saturation or below for 4 years out of the 8-year period 1963-1970. During this period, the number of largemouth bass taken by electrofishing in Chillicothe Island Chute decreased considerably. Laboratory experiments have shown that oxygen levels below 35-percent saturation reduce the survival of larval largemouth bass and that levels below 70 percent retard their growth.

The number of fish species taken by electrofishing in the Dresden Pool, Des Plaines River portion of the Illinois Waterway during the period 1959-1974 was consistently low. Only carp and goldfish and hybrids of these two pollution-tolerant species were commonly taken.

The following species showed a trend of increasing abundance in the downstream direction, away from Chicago, with the largest number occurring in Alton Pool: shortnose gar, bowfin, goldeye, mooneye, channel catfish, flathead catfish, and white bass.

Goldfish showed a trend of increasing abundance in the upstream direction, toward Chicago.

The following species were most abundant in one or both of the two middle pools of the river, La Grange and Peoria Pools, which have the most connecting lake area: gizzard shad, carp, river carpsucker, smallmouth buffalo, bigmouth buffalo, black buffalo, yellow bullhead, green sunfish, bluegill, largemouth bass, white crappie, black crappie, and freshwater drum.

Gizzard shad and carp were generally abundant throughout the river.

Black bullheads were abundant at one station, Ballard Island Chute, Marseilles Pool (mile 247.8-248.2), which apparently provides preferred habitat for this species.

Gamefish populations declined during the low water years 1962-1964, and recovered following the high water years 1971-1973. Largemouth bass populations in La Grange and Peoria pools did not recover to 1959-1962 levels. The recovery appears attributable to improved oxygen levels in the river, and perhaps to increased dilution of toxic materials, and demonstrates how rapidly fish populations respond to improved conditions in the river.

The commercial and sport fisheries in the Illinois River have generally declined from levels around the turn of the century. The decline is attributable to a loss of habitat and increasing pollution. Habitat was lost due to leveeing and draining of bottomland areas in the period 1903-1926 and due to sedimentation in the remaining areas. Sedimentation has resulted in undesirable habitat modification, as well as habitat reduction.

Northern pike, yellow perch, and walleye (Stizostedion vitreum vitreum) were once abundant in the river but are now rare or limited in their distribution. Yellow perch populations have declined probably as the result of the disappearance of beds of aquatic plants and disappearance of clean sand or pebble substrates perch use for spawning.

In the past, the bottomland lakes and backwater areas offered havens for fish and fish food organisms, as the river became increasingly polluted. Now dissolved oxygen levels in the upper river seem to have improved somewhat, while the lakes have filled with sediment that apparently exerts an oxygen demand, keeps aquatic plants from growing, and does not support an abundance of food organisms.

More and better waste treatment facilities are being constructed by industries and municipalities in the drainage basin of the Illinois River. However, the production of fish and wildlife in the Illinois River and its bottomland lakes is not likely to improve unless sediment pollution is also brought under control.

The consequences of future uses of land in the drainage basin and the consequences of future uses of the river must be predicted, so that a wise selection of alternatives can be made. If the river is to be managed in the future for a variety of beneficial uses, then the various State, Federal, and private agencies charged with managing land and water within the drainage basin must work in a coordinated fashion, rather than at cross purposes.

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Table 1

Electrofishing Sampling Stations on the Illinois Waterway, 1959-1974

River Section	Pool	Station	Location	Area Fished Mile No.*
Lower Illinois	Alton	Mortland Island Chute	Below Hardin	18.7- 19.4
		Diamond Island Chute	Above Hardin	24.0- 25.5
		Hurricane Island Chute	Above Hardin	26.0- 27.2
		Crater, Willow Island Chutes	Below Kampsville	29.3- 30.7
		Big Blue Island Chute**	Above Florence	57.5- 58.9
Middle Illinois	LaGrange	Bar, Grape Island Chutes	Below Beardstown	86.2- 87.1
		Sugar Creek Island Chute	Below Browning	94.3- 95.2
		Lower Bath Chute	Above Browning	106.8-107.5
		Upper Bath Chute	Above Bath	112.8-113.3
		Turkey Island Chute	Above Kingston Mines	147.3-148.2
		Illinois River, proper	Above Pekin	154.5-155.3
	Peoria	Lower Peoria Lake	Near East Peoria	163.0-163.4
		Middle Peoria Lake	Near Peoria Heights	169.2-171.0
		Chillicothe Island Chute	Above Chillicothe	180.1-181.0
		Henry Island Chute	Below Henry	193.5-194.1
		Lower Twin Sisters Island Chute	Above Henry	202.2-203.5
		Upper Twin Sisters Island Chute	Above Henry	203.1-203.5
		Hennepin Island Chute	At Hennepin	207.0-208.0
		Clark Island Chute	Below Spring Valley	214.9-215.6
Upper Illinois	Starved Rock	Bulls Island Chute	Above Ottawa	240.5-241.1
		Bulls Island Bend Section	Above Ottawa	241.4-241.9
	Marseilles	Ballard Island Chute	Above Marseilles	247.8-248.2
		Johnson Island Chute	Above Marseilles	249.4-249.9
		Sugar Island Chute	Below Morris	260.2-261.0
Des Plaines River	Dresden	DuPage River Mouth and Rapp's Boat Yard	Above Channahon	276.8-277.8

* Distance upstream from the mouth of the Illinois River at Grafton, Illinois.

** Site sampled only in 1974.

Table 2

Physical-Chemical Measurements, Illinois River, 1974

Location					Dissolved Oxygen Concentration**			
				Water Temp.	3-ft Depth		Bottom	Transparency
Section of River	Pool	Station*	Date-Time CST	°C	ppm	%sat.	ppm	cm+
Lower Illinois	Alton	Mortland Island	21 Aug-0930	27.9	6.18	80.5	6.12	18
		Diamond Island	21 Aug-1520	29.5	7.31	97.3	7.09	18
		Hurricane Island	22 Aug-0835	27.9	6.18	84.4	6.78	23
		Crater, Willow Islands	23 Aug-0855	27.4	6.13	77.2	6.10	19
		Big Blue Island	27 Aug-1430	27.5	6.18	80.5	6.02	19
Middle Illinois	LaGrange	Bar, Grape Islands	30 Aug-1130	25.8	5.36	67.5	5.21	20
		Sugar Creek Island	16 Sep-1100	20.9	5.69	64.8	5.42	15
		Bath Chute-Lower	12 Sep-1000	22.2	7.18	83.7	7.10	20
		Upper	12 Sep-1430	23.5	7.85	95.2	7.69	20
		Turkey Island	18 Sep-1100	22.5	7.61	89.4	++	18
		Illinois River Proper	19 Sep-1345	21.3	8.21	93.2	8.20	18
	Peoria	Peoria Lake-Lower	29 Aug-1915	24.2	10.10	121.7	10.13	18
		Middle	10 Oct-1015	13.4	8.61	82.7	8.60	22
		Chillicothe Island	30 Sep-1415	16.5	6.50	68.4	5.20	17
		Henry Island	1 Oct-0940	16.1	5.42	55.7	5.43	16
		Lower Twin Sisters	2 Oct-0900	16.1	6.31	64.9	6.21	17
		Hennepin Island	3 Oct-0920	15.5	6.51	67.0	6.49	28
		Clark Island	18 Oct-0900	15.0	7.83	78.0	7.62	42
Upper Illinois	Starved Rock	Bulls Island	17 Oct-0845	17.5	4.41	47.3	4.38	36
	Marseilles	Ballard Island	16 Oct-1300	14.5	10.40	104.0	++	14
		Johnson Island	16 Oct-0915	18.5	4.51	48.9	4.44	46
		Sugar Island	15 Oct-1000	19.7	5.46	61.1	5.42	41
Des Plaines River	Dresden	DuPage River Mouth and Rapp's Boat Yard	14 Oct-1245	22.0	5.09	59.3	++	32

* River mile locations given in Table 1.

** Readings 21 August-19 September, Winkler Azide Method; 30 September-18 October Oxygen Analyzer.

\+ Secchi disk visibility measurements.

++ Only one dissolved oxygen reading made, because water depth was 3 ft or less.

Note: Some of the electrofishing stations in Table 1 were adjoining and therefore physical-chemical measurements were made at only one of the adjoining stations.

Table 3

Phylogenetic Listing of Fish Species Taken by Electrofishing, 1959-1974

Common Name	Scientific Name	Category**		
		Commercial	Sport	Other
Longnose gar*	Lepisosteus osseus	X		
Shortnose gar	Lepisosteus platostomus	X		
Bowfin	Amia calva	X		
American eel*	Anguilla rostrata	X		
Skipjack herring*	Alosa chrysochloris			X
Gizzard shad	Dorosoma cepedianum			X
Goldeye*	Hiodon alosoides	X		
Mooneye*	Hiodon tergisus	X		
Grass pickerel*	Esox americanus vermiculatus		X	
Northern pike*	Esox lucius		X	
Goldfish	Carassius auratus			X
Carp	Cyprinus carpio	X	X	
Carp x goldfish hydrid	C. carpio x C. auratus			X
Silverjaw minnow*	Ericymba buccata			X
Silvery minnow*	Hybognathus nuchalis			X
Silver chub*	Hybopis storeriana			X
Golden shiner*	Notemigonus crysoleucas			X
Emerald shiner*	Notropis atherinoides			X
Ghost shiner*	Notropis buchanani			X
Striped shiner*	Notropis chrysocephalus			X
Pugnose minnow*	Notropis emiliae			X
Spottail shiner*	Notropis hudsonius			X

* Denotes species which were infrequently taken, due to sampling technique or to low population size.

** Based upon 1974-1975 Illinois Fishing Information, published by the Illinois Department of Conservation. "Other" includes forage and bait species.

Table 3 (continued)

Common Name	Scientific Name	Category**		
		Commercial	Sport	Other
Red shiner*	Notropis lutrensis			X
Spotfin shiner*	Notropis spilopterus			X
Sand shiner*	Notropis stramineus			X
Suckermouth minnow*	Phenacobius mirabilis			X
Bluntnose minnow*	Pimephales notatus			X
Fathead minnow*	Pimephales promelas			X
Bullhead minnow*	Pimephales vigilax			X
Creek chub*	Semotilus atromaculatus			X
River carpsucker	Carpiodes carpio	X		
Quillback carpsucker	Carpiodes cyprinus	X		
Highfin carpsucker*	Carpiodes velifer	X		
White sucker*	Catostomus commersoni	X		
Smallmouth buffalo	Ictiobus bubalus	X		
Bigmouth buffalo	Ictiobus cyprinellus	X		
Black buffalo	Ictiobus niger	X		
Silver redhorse	Moxostoma anisurum	X		
Golden redhorse*	Moxostoma erythrurum	X		
Shorthead redhorse*	Moxostoma macrolepidotum	X		
Blue catfish*	Ictalurus furcatus	X	X	
Black bullhead	Ictalurus melas	X	X	
Yellow bullhead	Ictalurus natalis	X	X	
Brown bullhead*	Ictalurus nebulosus	X	X	
Channel catfish	Ictalurus punctatus	X	X	
Tadpole madtom*	Noturus gyrinus			X
Flathead catfish	Pylodictis olivaris	X	X	
Trout-perch*	Percopsis omiscomaycus			X
Mosquitofish*	Gambusia affinis			X

Table 3 (concluded)

Common Name	Scientific Name	Category**		
		Commercial	Sport	Other
Brook silverside*	Labidesthes sicculus			X
White bass	Morone chrysops		X	
Yellow bass*	Morone mississippiensis		X	
Rock bass*	Ambloplites rupestris		X	
Green sunfish	Lepomis cyanellus		X	
Pumpkinseed*	Lepomis gibbosus		X	
Warmouth*	Lepomis gulosus		X	
Orangespotted sunfish*	Lepomis humilis		X	
Bluegill	Lepomis macrochirus		X	
Longear sunfish*	Lepomis megalotis		X	
Smallmouth bass*	Micropterus dolomieui		X	
Largemouth bass	Micropterus salmoides		X	
White crappie	Pomoxis annularis		X	
Black crappie	Pomoxis nigromaculatus		X	
Yellow perch*	Perca flavescens	X	X	
Logperch*	Percina caprodes			X
Sauger*	Stizostedion canadense		X	
Freshwater drum	Aplodinotus grunniens	X		

Table 4

Fish Species Extirpated from the Illinois River and its Bottomland Lakes Between 1908 and 1970*

Common Name	Scientific Name
American brook lamprey	*Lampetra lamottei*
Alligator gar	*Lepisosteus spatula*
Cisco	*Coregonus artedii*
Ozark minnow	*Dionda nubila*
Pugnose shiner	*Notropis anogenus*
Common shiner	*N. cornutus*
Blackchin shiner	*N. heterodon*
Blacknose shiner	*N. heterolepis*
Rosyface shiner	*N. rubellus*
Weed shiner	*N. texanus*
Blacknose dace	*Rhinichythys atratulus*
Creek chubsucker	*Erimyzon oblongus*
Spotted sucker	*Minytrema melanops*
River redhorse	*Moxostoma carinatum*
Black redhorse	*M. duquesnei*
Freckled madtom	*Noturus nocturnus*
Bantam sunfish	*Lepomis symmetricus*
Iowa darter	*Etheostoma exile*
Fantail darter	*E. flabellare*

* Taken from Starrett, 1972.

Notes for Tables of Electrofishing Results
(Tables 5-29)

1. Fish species are listed in phylogenetic order. All common and scientific names are taken from A List of Common and Scientific Names of Fishes from the United States and Canada, 3rd edition, 1970, American Fisheries Society Special Publication No. 6. Species that were rarely taken by electrofishing are not shown in the Tables, but are discussed in the text. The values in the body of each Table are determined by summing the number of fish or weight of fish obtained at all stations in the navigation pool and dividing the sum by the total number of half-hour intervals fished in that pool. Thus the values are average catches per unit effort for each pool. The number of electrofishing stations in each pool are as follows: Alton Pool (4-5), LaGrange Pool (6), Peoria Pool (8), Starved Rock Pool (2), Marseilles Pool (3), and Dresden Pool (1).

2. Values in the last two columns are the total number of fish or total weight of fish taken during the designated year in the Illinois River divided by the total number of half-hour intervals fished. The Dresden Pool, Des Plaines River, is excluded from this tabulation.

3. An asterisk denotes that less than 0.01 fish were taken per 30 minutes fished.

4. Zeros indicate that electrofishing was conducted, but no fish of the designated species were taken.

5. Dashes indicate that no electrofishing was conducted.

6. NWT indicates that no weights were taken.

Table 5

Shortnose Gar (Lepisosteus platostomus) Taken by Electrofishing

		Number and Weight Taken per 30 Minutes													
	No. of	Des Plaines R.		Illinois River Pools											
	Hours	Dresden Pool		Marseilles		Starved Rock		Peoria		LaGrange		Alton		Illinois R.	
Year	Fished	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.
1959	12.0	0	0	0	0	0	0	0.25	0.45	0	0	--	--	0.10	0.18
1960	12.5	--	--	0	0	0	0	0.20	0.38	0	0	--	--	0.08	0.15
1961	10.0	--	--	0	0	0	0	0	0	--	--	--	--	0	0
1962	44.5	0	0	0	0	0	0	0.15	0.26	0.08	0.07	0	0	0.07	0.10
1963	23.5	--	--	0	0	0	0	0	0	0.15	0.29	0	0	0.04	0.08
1964	23.5	--	--	0	0	0	0	0	0	0	0	0	0	0	0
1965	26.0	--	--	0	0	0	0	0	0	0.31	0.19	0.27	0.11	0.15	0.08
1966	21.5	--	--	0	0	0	0	0	0	0.17	0.09	0	0	0.05	0.03
1967	22.0	--	--	0	0	0	0	0.07	0.04	0	0	0	0	0.02	0.01
1968	22.0	--	--	0	0	0	0	0.07	0.02	0	0	0	0	0.02	0.01
1969	22.0	--	--	0	0	0	0	0	0	0	0	0	0	0	0
1970	13.5	--	--	0	0	0	0	0	0	0.10	0.23	--	--	*	0.07
1973	19.5	0	0	0	0	0	0	0	0	0	0	--	--	--	--
1974	21.8	0	0	0	0	0	0	0	0	0.10	0.20	0.40	0.15	0.12	0.09

Table 6

Bowfin (*Amia calva*) Taken by Electrofishing

Year	No. of Hours Fished	Number and Weight Taken per 30 Minutes													
		Des Plaines R.		Illinois River Pools											
		Dresden Pool		Marseilles		Starved Rock		Peoria		LaGrange		Alton		Illinois R.	
		No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.
1959	12.0	0	0	0	0	0	0	0	0	0	0	--	--	0	0
1960	12.5	--	--	0	0	0	0	0	0	0	0	--	--	0	0
1961	10.0	--	--	0	0	0	0	0.07	0.26	--	--	--	--	0.05	0.18
1962	44.5	0	0	0	0	0	0	0	0	0.04	0.11	0	0	0.01	0.03
1963	23.5	--	--	0	0	0	0	0	0	0	0	0	0	0	0
1964	23.5	--	--	0	0	0	0	0	0	0	0	0	0	0	0
1965	26.0	--	--	0	0	0	0	0	0	0	0	0	0	0	0
1966	21.5	--	--	0	0	0	0	0	0	0	0	0	0	0	0
1967	22.0	--	--	0	0	0	0	0	0	0	0	0	0	0	0
1968	22.0	--	--	0	0	0	0	0	0	0.08	0.45	0.13	0.20	0.05	0.16
1969	22.0	--	--	0	0	0	0	0	0	0	0	0	0	0	0
1970	13.5	--	--	0	0	0	0	0	0	0.10	0.87	--	--	*	0.26
1973	19.5	0	0	0	0	0	0	0	0	0	0	--	--	0	0
1974	21.8	0	0	0	0	0	0	0	0	0	0	0.50	0.86	0.01	0.02

Table 7

Gizzard Shad (*Dorosoma cepedianum*) Taken by Electrofishing

Year	No. of Hours Fished	Des Plaines R. Dresden Pool		Number and Weight Taken per 30 Minutes — Illinois River Pools: Marseilles		Starved Rock		Peoria		LaGrange		Alton		Illinois R.	
		No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.
1959	12.0	0	0	2.50	0.77	1.50	0.82	21.63	2.25	137.75	3.17	--	--	37.00	1.85
1960	12.5	--	--	4.67	1.40	1.60	0.71	45.90	7.20	9.00	0.70	--	--	21.76	3.39
1961	10.0	--	--	5.50	1.90	4.00	1.04	26.00	2.25	--	--	--	--	19.70	2.06
1962	44.5	0	0	7.29	0.15	8.60	0.57	218.63	2.37	99.00	2.02	34.10	1.87	103.62	1.64
1963	23.5	--	--	14.16	1.34	13.00	1.51	59.12	4.80	62.93	3.51	25.00	0.75	44.71	3.03
1964	23.5	--	--	14.00	2.44	24.00	2.44	92.31	0.69	41.23	0.53	40.88	0.96	53.62	0.83
1965	26.0	--	--	13.83	0.04	2.75	0.11	103.73	1.38	29.25	2.65	2.27	0.20	41.21	1.27
1966	21.5	--	--	20.83	0.81	13.67	0.11	81.21	1.45	23.50	1.99	14.25	1.08	39.51	1.35
1967	22.0	--	--	22.17	1.62	13.00	0.92	69.20	0.59	35.25	2.32	29.50	0.72	42.48	1.23
1968	22.0	--	--	7.49	0.64	12.00	1.86	43.59	0.55	38.92	2.28	4.12	0.21	28.07	1.06
1969	22.0	--	--	20.50	1.01	15.00	0.77	74.00	0.55	22.33	2.69	6.13	*	36.25	1.11
1970	13.5	--	--	24.70	1.68	0.30	0.19	11.40	0.95	47.60	0.88	--	--	29.90	1.01
1973	19.5	3.33	0.17	4.60	0.40	10.67	0.50	21.87	1.07	10.00	1.09	--	--	14.25	0.94
1974	21.8	7.30	0.10	13.00	2.08	9.00	0.72	16.20	1.76	9.40	1.53	6.60	0.55	11.26	1.37

Table 8

Mooneye (Hiodon tergisus) Taken by Electrofishing

		Number and Weight Taken per 30 Minutes													
		Des Plaines R. Dresden Pool		Illinois River Pools											
				Marseilles		Starved Rock		Peoria		LaGrange		Alton		Illinois R.	
Year	No. of Hours Fished	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.
1959	12.0	0	0	0	0	0	0	0	0	0	0	--	--	0	0
1960	12.5	--	--	0	0	0	0	0	0	0	0	--	--	0	0
1961	10.0	--	--	0	0	0	0	0	0	--	--	--	--	0	0
1962	44.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1963	23.5	--	--	0	0	0	0	0	0	0	0	0.12	0.10	0.02	0.02
1964	23.5	--	--	0	0	0	0	0	0	0	0	0	0	0	0
1965	26.0	--	--	0	0	0	0	0	0	0	0	0.36	0.06	0.08	0.01
1966	21.5	--	--	0	0	0	0	0	0	0	0	0	0	0	0
1967	22.0	--	--	0	0	0	0	0	0	0	0	0	0	0	0
1968	22.0	--	--	0	0	0	0	0	0	0	0	0	0	0	0
1969	22.0	--	--	0	0	0	0	0	0	0	0	0	0	0	0
1970	13.5	--	--	0	0	0	0	0	0	0	0	--	--	0	0
1973	19.5	0	0	0	0	0	0	0	0	0	0	--	--	0	0
1974	21.8	0	0	0	0	0	0	0.10	0.01	0	0	0	0	0.02	*

Table 9

Goldeye (Hiodon alosoides) Taken by Electrofishing

		Number and Weight Taken per 30 Minutes													
		Des Plaines R.		Illinois River Pools											
	No. of Hours	Dresden Pool		Marseilles		Starved Rock		Peoria		LaGrange		Alton		Illinois R.	
Year	Fished	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.
1959	12.0	0	0	0	0	0	0	0	0	0	0	--	--	0	0
1960	12.5	--	--	0	0	0	0	0.10	0.03	0	0	--	--	0.04	0.01
1961	10.0	--	--	0	0	0	0	0	0	--	--	--	--	0	0
1962	44.5	--	--	0.07	0.07	0	0	0	0	0.04	*	0	0	0.02	0.01
1963	23.5	--	--	0	0	0	0	0	0	0	0	0.13	0.01	0.02	*
1964	23.5	--	--	0	0	0	0	0	0	0	0	1.13	1.11	0.19	0.02
1965	26.0	--	--	0	0	0	0	0.13	0.06	0	0	0.64	0.16	0.17	0.05
1966	21.5	--	--	0	0	0	0	0	0	0	0	0	0	0	0
1967	22.0	--	--	0	0	0	0	0	0	0	0	1.50	0.15	0.27	0.03
1968	22.0	--	--	0	0	0	0	0.07	0.02	0	0	0	0	0.02	0.01
1969	22.0	--	--	0	0	0	0	0	0	0	0	0.25	0.02	0.05	0.01
1970	13.5	--	--	0	0	0	0	0	0	0.10	0.05	--	--	*	0.01
1973	19.5	0	0	0	0	0	0	0	0	0.08	0.04	--	--	0.03	0.02
1974	21.8	0	0	0.04	0.12	0	0	0	0	0	0	0	0	0.05	0.01

Table 8

Mooneye (Hiodon tergisus) Taken by Electrofishing

		Number and Weight Taken per 30 Minutes													
				Illinois River Pools											
	No. of Hours	Des Plaines R. Dresden Pool		Marseilles		Starved Rock		Peoria		LaGrange		Alton		Illinois R.	
Year	Fished	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.
1959	12.0	0	0	0	0	0	0	0	0	0	0	--	--	0	0
1960	12.5	--	--	0	0	0	0	0	0	0	0	--	--	0	0
1961	10.0	--	--	0	0	0	0	0	0	--	--	--	--	0	0
1962	44.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1963	23.5	--	--	0	0	0	0	0	0	0	0	0.12	0.10	0.02	0.02
1964	23.5	--	--	0	0	0	0	0	0	0	0	0	0	0	0
1965	26.0	--	--	0	0	0	0	0	0	0	0	0.36	0.06	0.08	0.01
1966	21.5	--	--	0	0	0	0	0	0	0	0	0	0	0	0
1967	22.0	--	--	0	0	0	0	0	0	0	0	0	0	0	0
1968	22.0	--	--	0	0	0	0	0	0	0	0	0	0	0	0
1969	22.0	--	--	0	0	0	0	0	0	0	0	0	0	0	0
1970	13.5	--	--	0	0	0	0	0	0	0	0	--	--	0	0
1973	19.5	0	0	0	0	0	0	0	0	0	0	--	--	0	0
1974	21.8	0	0	0	0	0	0	0.10	0.01	0	0	0	0	0.02	*

Table 9

Goldeye (Hiodon alosoides) Taken by Electrofishing

Year	No. of Hours Fished	Number and Weight Taken per 30 Minutes													
		Des Plaines R.		Illinois River Pools											
		Dresden Pool		Marseilles		Starved Rock		Peoria		LaGrange		Alton		Illinois R.	
		No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.
1959	12.0	0	0	0	0	0	0	0	0	0	0	--	--	0	0
1960	12.5	--	--	0	0	0	0	0.10	0.03	0	0	--	--	0.04	0.01
1961	10.0	--	--	0	0	0	0	0	0	--	--	--	--	0	0
1962	44.5	--	--	0.07	0.07	0	0	0	0	0.04	*	0	0	0.02	0.01
1963	23.5	--	--	0	0	0	0	0	0	0	0	0.13	0.01	0.02	*
1964	23.5	--	--	0	0	0	0	0	0	0	0	1.13	1.11	0.19	0.02
1965	26.0	--	--	0	0	0	0	0.13	0.06	0	0	0.64	0.16	0.17	0.05
1966	21.5	--	--	0	0	0	0	0	0	0	0	0	0	0	0
1967	22.0	--	--	0	0	0	0	0	0	0	0	1.50	0.15	0.27	0.03
1968	22.0	--	--	0	0	0	0	0.07	0.02	0	0	0	0	0.02	0.01
1969	22.0	--	--	0	0	0	0	0	0	0	0	0.25	0.02	0.05	0.01
1970	13.5	--	--	0	0	0	0	0	0	0.10	0.05	--	--	*	0.01
1973	19.5	0	0	0	0	0	0	0	0	0.08	0.04	--	--	0.03	0.02
1974	21.8	0	0	0.04	0.12	0	0	0	0	0	0	0	0	0.05	0.01

Table 10

Goldfish (Carassius Auratus) Taken by Electrofishing

		Number and Weight Taken per 30 Minutes													
	No. of Hours	Des Plaines R. Dresden Pool		Illinois River Pools											
				Marseilles		Starved Rock		Peoria		LaGrange		Alton		Illinois R.	
Year	Fished	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.
1959	12.0	16.50	5.22	18.00	7.07	2.50	0.74	0.37	0.10	0	0	--	--	4.25	1.60
1960	12.5	--	--	34.33	13.43	24.40	6.09	0.60	0.15	0.14	0.04	--	--	9.28	2.90
1961	10.0	--	--	33.75	12.60	64.50	14.79	3.07	0.35	--	--	--	--	15.35	4.24
1962	44.5	101.25	NWT	12.64	5.46	30.50	9.91	0.15	0.02	0.42	0.06	0	0	5.84	2.09
1963	23.5	--	--	19.50	7.74	17.75	6.35	0	0	1.16	0.11	0	0	4.32	1.56
1964	23.5	--	--	7.00	2.57	16.75	4.39	2.56	0.16	0.62	0.20	0	0	3.36	0.81
1965	26.0	--	--	9.50	3.51	32.75	9.22	1.07	0.14	1.81	0.55	0	0	4.48	1.32
1966	21.5	--	--	6.66	2.51	6.33	2.35	0.50	0.06	0.25	0.13	0	0	1.61	0.57
1967	22.0	--	--	7.16	3.32	6.33	2.61	0.33	0.03	0.08	0.01	0	0	1.55	0.63
1968	22.0	--	--	3.83	0.54	10.67	4.61	0.13	0.03	0	0	0	0	1.30	0.40
1969	22.0	--	--	6.33	2.56	7.00	3.08	1.07	0.10	0.17	0.02	0	0	1.75	0.60
1970	13.5	--	--	6.50	2.92	15.40	7.23	0.20	0.05	0.10	0.05	--	--	3.30	1.49
1973	19.5	34.67	9.98	0.40	0.23	3.33	1.97	0.13	0.03	0	0	--	--	0.39	0.21
1974	21.8	18.60	5.00	2.70	0.44	0	0	0.10	0.21	0	0	0	0	0.14	0.12

Table 11

Carp x Goldfish (Cyprinus carpio x Carassius auratus) Taken by Electrofishing

		Number and Weight Taken per 30 Minutes													
	No. of	Des Plaines R.		Illinois River Pools											
	Hours	Dresden Pool		Marseilles		Starved Rock		Peoria		LaGrange		Alton		Illinois R.	
Year	Fished	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.
1959	12.0	2.50	1.73	2.50	2.87	0.75	1.62	0	0	0.25	0.29	--	--	0.70	0.96
1960	12.5	--	--	0.67	0.42	4.00	8.93	0.40	0.40	0	0	--	--	1.04	2.00
1961	10.0	--	--	0.75	0.60	0.50	1.25	0.71	0.40	--	--	--	--	0.70	0.52
1962	44.5	1.00	NWT	2.79	3.86	3.50	4.51	0.81	0.63	0.04	0.01	0	0	1.14	1.37
1963	23.5	--	--	1.00	1.81	3.25	3.85	0.81	0.44	0.15	0.01	0	0	0.73	0.71
1964	23.5	--	--	0.83	2.19	1.25	1.81	1.12	0.59	0.62	0.27	0	0	0.77	0.71
1965	26.0	--	--	0.83	1.19	4.75	6.86	1.53	0.95	0.25	0.15	0	0	0.98	0.99
1966	21.5	--	--	0.50	0.55	1.67	1.76	2.71	1.73	0.34	0.18	0	0	1.16	0.81
1967	22.0	--	--	0.16	0.12	3.33	4.86	2.27	1.38	0.25	0.18	0	0	1.09	0.88
1968	22.0	--	--	0.33	1.90	1.67	2.46	1.60	0.92	0	0	0	0	0.70	0.74
1969	22.0	--	--	0.33	0.46	1.00	1.38	1.67	1.01	0.17	0.10	0	0	0.73	0.53
1970	13.5	--	--	0.50	0.37	1.30	1.52	2.60	1.77	0	0	--	--	1.20	0.91
1973	19.5	0	0	0	0	0.67	0.79	1.60	0.85	0	0	--	--	0.72	0.42
1974	21.8	0.70	0.57	0	0	0.70	0.88	1.60	0.72	0.30	0.11	0.10	0.08	0.64	0.34

Table 12

Carp (Cyprinus carpio) Taken by Electrofishing

		Number and Weight Taken per 30 Minutes													
	No. of	Des Plaines R.		Illinois River Pools											
	Hours	Dresden Pool		Marseilles		Starved Rock		Peoria		LaGrange		Alton		Illinois R.	
Year	Fished	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.
1959	12.0	8.00	14.03	10.00	16.61	3.00	4.60	13.25	15.01	15.00	17.02	--	--	10.90	13.65
1960	12.5	--	--	5.33	9.80	28.60	38.03	11.20	14.77	20.71	32.48	--	--	16.64	23.79
1961	10.0	--	--	20.25	27.34	53.00	28.64	36.00	22.63	--	--	--	--	34.55	24.17
1962	44.5	18.25	NWT	9.07	14.70	25.00	44.35	17.70	18.04	28.42	41.08	10.70	21.65	19.34	27.51
1963	23.5	--	--	19.33	29.42	26.75	39.04	17.56	17.64	51.69	64.94	24.50	59.30	29.19	41.14
1964	23.5	--	--	15.17	27.62	11.00	10.36	18.81	12.77	77.39	82.69	36.63	92.31	36.92	47.34
1965	26.0	--	--	21.00	36.82	31.50	26.11	14.53	12.60	14.63	17.04	12.55	24.67	16.19	20.35
1966	21.5	--	--	12.00	25.47	19.67	13.44	19.72	15.21	61.75	52.03	21.87	45.71	30.77	32.47
1967	22.0	--	--	19.50	36.39	15.33	20.38	18.13	17.15	37.59	34.43	20.88	40.10	23.93	28.62
1968	22.0	--	--	13.17	21.85	9.00	13.18	17.73	15.92	38.91	34.91	16.00	28.43	21.98	24.00
1969	22.0	--	--	10.00	17.44	9.67	12.51	20.60	22.42	27.58	27.20	19.50	35.67	20.11	24.79
1970	13.5	--	--	16.70	32.86	18.00	16.97	18.20	31.16	21.60	28.46	--	--	18.90	29.16
1973	19.5	6.00	8.96	14.80	19.10	4.00	6.94	10.60	10.66	25.23	32.88	--	--	15.92	19.55
1974	21.8	16.00	15.54	13.80	19.31	10.30	10.81	27.40	21.57	30.50	33.58	15.70	29.27	22.74	25.54

Table 13

River Carpsucker (Carpiodes carpio) Taken by Electrofishing

		Number and Weight Taken per 30 Minutes													
	No. of Hours	Des Plaines R. Dresden Pool		Illinois River Pools											
				Marseilles		Starved Rock		Peoria		LaGrange		Alton		Illinois R.	
Year	Fished	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.
1959	12.0	0	0	0	0	0	0	0.12	0.12	0.75	0.94	--	--	0.20	0.24
1960	12.5	--	--	0	0	0.60	0.38	0.70	0.33	0.43	0.07	--	--	0.52	0.23
1961	10.0	--	--	0	0	0	0	1.71	0.30	--	--	--	--	1.20	0.21
1962	44.5	0	0	0	0	0.10	0.11	0.19	0.12	0.08	0.05	0.30	0.15	0.13	0.08
1963	23.5	--	--	0	0	0	0	0	0	0.15	0.19	0.25	0.21	0.09	0.09
1964	23.5	--	--	0	0	0	0	0	0	0.15	0.09	0	0	0.04	0.03
1965	26.0	--	--	0	0	0	0	0.07	0.02	0.81	0.51	0.64	0.47	0.40	0.26
1966	21.5	--	--	0	0	0.33	0.40	0.07	*	0	0	0.62	0.60	0.16	0.14
1967	22.0	--	--	0.17	0.10	0	0	0.67	0.46	0.17	0.49	0.12	0.05	0.59	0.32
1968	22.0	--	--	0	0	0.33	0.49	0.40	0.30	1.08	0.56	0.50	0.41	0.55	0.36
1969	22.0	--	--	0	0	0	0	0.13	0.20	0.09	0.11	0	0	0.07	0.10
1970	13.5	--	--	0	0	0	0	0.10	0.14	0	0	--	--	0.01	0.05
1973	19.5	0	0	0	0	1.00	0.95	0.73	0.47	0.31	0.32	--	--	0.50	0.39
1974	21.8	0	0	0.40	0.52	2.40	1.95	1.30	0.68	0.10	0.05	0	0	0.67	0.43

Table 14

Quillback Carpsucker (Carpiodes cyprinus) Taken by Electrofishing

		Number and Weight Taken per 30 Minutes													
	No. of Hours	Des Plaines R.		Illinois River Pools											
		Dresden Pool		Marseilles		Starved Rock		Peoria		LaGrange		Alton		Illinois R.	
Year	Fished	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.
1959	12.0	0	0	0	0	0	0	0	0	0	0	--	--	0	0
1960	12.5	--	--	0	0	0.40	0.27	0.30	0.08	0	0	--	--	0.20	0.08
1961	10.0	--	--	0.25	0.08	0	0	0.36	0.09	--	--	--	--	0.30	0.08
1962	44.5	0	0	0	0	0.60	0.51	0.22	0.16	0.08	0.09	0	0	0.16	0.14
1963	23.5	--	--	0.17	0.16	1.75	1.42	1.13	0.75	0.54	0.10	0.25	0.17	0.75	0.45
1964	23.5	--	--	1.33	1.31	2.75	2.15	0.88	0.21	0.23	0.07	0	0	0.77	0.44
1965	26.0	--	--	0	0	3.00	2.09	0.33	0.19	0.19	0.13	0.09	0.02	0.40	0.26
1966	21.5	--	--	0.50	0.45	2.00	1.44	0.79	0.44	0.25	0.14	0	0	0.54	0.35
1967	22.0	--	--	2.00	0.76	1.67	1.43	0.60	0.29	0	0	0	0	0.59	0.30
1968	22.0	--	--	1.33	0.63	2.67	1.81	1.33	0.88	0.33	0.11	0.13	0.06	0.93	0.55
1969	22.0	--	--	1.17	0.83	1.00	0.79	1.13	0.96	0.34	0.18	0.38	0.27	0.77	0.59
1970	13.5	--	--	1.50	0.70	1.40	1.55	0.10	0.07	0	0	--	--	0.50	0.35
1973	19.5	0	0	1.00	0.80	0.67	0.83	0.13	0.14	0.15	0.06	--	--	0.31	0.26
1974	21.8	0	0	0.70	0.59	1.40	1.16	0	0	0	0	0.10	NWT	0.19	0.15

Table 15

Smallmouth Buffalo (*Ictiobus bubalus*) Taken by Electrofishing

Year	No. of Hours Fished	Number and Weight Taken per 30 Minutes													
		Des Plaines R.		Illinois River Pools											
		Dresden Pool		Marseilles		Starved Rock		Peoria		LaGrange		Alton		Illinois R.	
		No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.
1959	12.0	0	0	0	0	0	0	0.13	0.23	5.25	3.66	--	--	1.10	0.82
1960	12.5	--	--	0	0	0.60	1.42	0.20	0.09	0	0	--	--	0.20	0.32
1961	10.0	--	--	0	0	0	0	0.36	0.64	--	--	--	--	0.25	0.45
1962	44.5	0	0	0	0	0	0	0.56	0.74	1.54	1.60	0.60	0.28	0.68	0.72
1963	23.5	--	--	0	0	0	0	0.75	1.14	2.31	1.60	0.13	0.06	0.91	1.74
1964	23.5	--	--	0	0	0	0	1.87	2.27	0.62	0.84	0	0	0.81	1.00
1965	26.0	--	--	0	0	0	0	0.13	0.30	0.25	0.39	0	0	0.12	0.21
1966	21.5	--	--	0	0	0	0	0.79	0.78	0.25	0.20	0	0	0.33	0.31
1967	22.0	--	--	0.17	0.04	0.33	0.19	1.47	1.18	0.83	0.47	0.12	0.09	0.80	0.58
1968	22.0	--	--	0	0	0	0	1.20	1.00	0.17	0.11	0	0	0.45	0.37
1969	22.0	--	--	0	0	0	0	0.60	0.69	1.34	1.26	0.12	0.23	0.59	0.62
1970	13.5	--	--	0.10	0	0.30	0.30	0.20	0.21	0.60	0.84	--	--	0.30	0.36
1973	19.5	0	0	0.20	0.04	0.33	0.93	0.40	0.47	0.08	0.04	--	--	0.25	0.29
1974	21.8	0	0	0	0	2.00	2.43	0.70	0.72	0.30	0.54	0	0	0.45	0.55

Table 16

Bigmouth Buffalo (Ictiobus cyprinellus) Taken by Electrofishing

Year	No. of Hours Fished	Number and Weight Taken per 30 Minutes													
		Des Plaines R. Dresden Pool		Illinois River Pools											
				Marseilles		Starved Rock		Peoria		LaGrange		Alton		Illinois R.	
		No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.
1959	12.0	0	0	0	0	0	0	2.25	2.24	9.75	22.30	--	--	2.85	5.36
1960	12.5	--	--	0	0	0	0	0.70	1.60	3.29	10.51	--	--	1.20	3.58
1961	10.0	--	--	0	0	0	0	2.57	8.09	--	--	--	--	1.80	5.67
1962	44.5	0	0	0	0	0	0	3.89	10.97	5.21	9.42	0.60	1.04	2.78	6.27
1963	23.5	--	--	0	0	0	0	4.56	13.13	9.54	18.16	0.50	1.56	4.28	9.76
1964	23.5	--	--	0	0	0	0	5.12	13.40	8.92	19.11	0.62	1.90	4.32	10.17
1965	26.0	--	--	0	0	0	0	5.00	13.62	1.44	3.99	0	0	1.88	5.15
1966	21.5	--	--	0	0	0.33	0.42	9.22	21.98	3.33	8.11	0.37	2.23	4.03	9.86
1967	22.0	--	--	0	0	0	0	12.20	28.90	5.25	15.39	0.63	1.72	5.70	14.69
1968	22.0	--	--	0	0	0	0	6.87	18.42	1.33	3.16	0.13	0.30	2.73	7.20
1969	22.0	--	--	0	0	0	0	6.20	17.87	0.83	2.59	0.12	0.73	2.36	6.93
1970	13.5	--	--	0	0	0	0	0.90	2.61	0.40	1.50	--	--	0.50	1.41
1973	19.5	0	0	0	0	0	0	4.33	5.08	1.92	2.51	--	--	2.50	3.02
1974	21.8	0	0	0.20	0.15	0.30	0.26	17.20	17.96	3.50	3.84	0	0	6.48	6.81

Table 17

Black Buffalo (Ictiobus niger) Taken by Electrofishing

		Number and Weight Taken per 30 Minutes													
	No. of	Des Plaines R.		Illinois River Pools											
	Hours	Dresden Pool		Marseilles		Starved Rock		Peoria		LaGrange		Alton		Illinois R.	
Year	Fished	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.
1959	12.0	0	0	0	0	0	0	0	0	0.50	0.69	--	--	0.10	0.14
1960	12.5	--	--	0	0	0	0	0.10	0.01	0	0	--	--	0.04	0.01
1961	10.0	--	--	0	0	0	0	0.50	1.28	--	--	--	--	0.35	0.89
1962	44.5	0	0	0	0	0	0	0.52	1.51	0.33	0.71	0	0	0.26	0.68
1963	23.5	--	--	0	0	0	0	0.06	0.26	1.08	2.62	0	0	0.32	0.82
1964	23.5	--	--	0	0	0	0	0.07	0.24	0.46	1.37	0.12	0.48	0.17	0.55
1965	26.0	--	--	0	0	0	0	0	0	0.06	0.04	0	0	0.02	0.01
1966	21.5	--	--	0	0	0	0	0.22	0.26	0.08	0.13	0.12	0.46	0.12	0.21
1967	22.0	--	--	0	0	0	0	0	0	0.33	0.90	0	0	0.09	0.24
1968	22.0	--	--	0	0	0	0	0.33	0.71	0.08	0.31	0.13	0.25	0.16	0.37
1969	22.0	--	--	0	0	0	0	0.40	0.93	0	0	0	0	0.14	0.32
1970	13.5	--	--	0	0	0	0	0.40	1.01	0	0	--	--	0.20	0.37
1973	19.5	0	0	0	0	0	0	0	0	0.15	0.36	--	--	0.06	0.13
1974	21.8	0	0	0	0	0.30	0.48	0	0	0	0	0	0	0.01	0.01

Table 18

Shorthead Redhorse (*Moxostoma macrolepidotum*) Taken by Electrofishing

		Number and Weight Taken per 30 Minutes													
	No. of	Des Plaines R.		Illinois River Pools											
	Hours	Dresden Pool		Marseilles		Starved Rock		Peoria		LaGrange		Alton		Illinois R.	
Year	Fished	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.
1959	12.0	--	0.11	0	0	0	0	0.13	0.23	0.75	0.12	--	--	0.20	0.12
1960	12.5	--	--	0	0	0.80	0.36	0.10	0.04	0.29	0.03	--	--	0.28	0.09
1961	10.0	--	--	0	0	0	0	0.07	0.07	--	--	--	--	0.05	0.05
1962	44.5	0	0	0.07	0.03	0.20	0	0.11	0.07	0.04	0	0	0	0.08	0.03
1963	23.5	--	--	0.17	0.03	0	0	0.06	*	0	0	0	0	0.04	*
1964	23.5	--	--	0	0	0	0	0.13	0.04	0.08	0.01	0	0	0.07	0.02
1965	26.0	--	--	0.16	0.09	0	0	0.07	0.03	0.44	0.10	0	0	0.17	0.05
1966	21.5	--	--	0.17	0.01	0	0	0	0	0.17	0.06	0	0	0.07	0.02
1967	22.0	--	--	0.17	0.09	0	0	0	0	0	0	0	0	0.02	0.01
1968	22.0	--	--	0	0	0	0	0	0	0.08	*	0.13	0.02	0.04	*
1969	22.0	--	--	0	0	0	0	0.07	*	0.08	0.03	0	0	0.05	0.01
1970	13.5	--	--	0	0	0.30	0.21	0.10	0.01	0.40	0.04	--	--	0.20	0.04
1973	19.5	0.33	0.11	0	0	0.67	0.51	0.33	0.11	0.15	0.13	--	--	0.25	0.13
1974	21.8	0.70	0.33	0	0	0	0	0.10	0.07	0.30	0.12	0.60	0.50	0.26	0.17

Table 19

Black Bullhead (Ictalurus melas) Taken by Electrofishing

		Number and Weight Taken per 30 Minutes													
	No. of Hours	Des Plaines R. Dresden Pool		Illinois River Pools											
Year	Fished			Marseilles		Starved Rock		Peoria		LaGrange		Alton		Illinois R.	
		No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.
1959	12.0	0	0	0.50	0.30	0	0	0.13	0.08	0	0	--	--	0.15	0.09
1960	12.5	--	--	2.00	0.68	0.60	0.24	1.00	0.32	0	0	--	--	0.76	0.26
1961	10.0	--	--	2.00	0.65	2.00	0.31	1.21	0.47	--	--	--	--	1.45	0.49
1962	44.5	0	0	1.36	0.27	0.20	0.06	1.00	0.26	0	0	0	0	0.56	0.13
1963	23.5	--	--	2.17	0.32	0	0	0.56	0.11	0.08	*	0	0	0.49	0.08
1964	23.5	--	--	2.17	0.14	0	0	0.12	0.01	0	0	0	0	0.32	0.02
1965	26.0	--	--	4.67	0.53	2.25	0.49	0.13	0.01	0.19	0.02	0	0	0.81	0.11
1966	21.5	--	--	4.33	0.40	0	0	0.22	0.06	0.75	0.03	0	0	0.88	0.08
1967	22.0	--	--	3.50	0.36	0.33	0.10	0.13	*	0.42	0.08	0	0	0.66	0.08
1968	22.0	--	--	6.50	0.78	0	0	0	0	0.08	0.01	0	0	0.91	0.11
1969	22.0	--	--	2.50	0.44	0	0	0.06	0.02	0.08	0.01	0	0	0.39	0.07
1970	13.5	--	--	3.50	0.81	0	0	0.10	0.05	0	0	--	--	0.80	0.20
1973	19.5	0	0	6.60	0.77	0	0	0.07	0.05	0	0	--	--	0.94	0.13
1974	21.8	0	0	19.60	1.17	0	0	0.10	0.03	0	0	0	0	2.12	0.14

Table 20

Yellow Bullhead (Ictalurus natalis) Taken by Electrofishing

		Number and Weight Taken per 30 Minutes													
	No. of	Des Plaines R.		Illinois River Pools											
	Hours	Dresden Pool		Marseilles		Starved Rock		Peoria		LaGrange		Alton		Illinois R.	
Year	Fished	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.
1959	12.0	0	0	0	0	0	0	0	0	0	0	--	--	0	0
1960	12.5	--	--	0	0	0	0	0	0	0.72	0.19	--	--	0.20	0.05
1961	10.0	--	--	0	0	0	0	0	0	--	--	--	--	0	0
1962	44.5	0	0	0	0	0	0	0.15	0.04	0.04	0.02	0	0	0.06	0.02
1963	23.5	--	--	0	0	0	0	0.06	0.02	0.08	0.02	0	0	0.04	0.01
1964	23.5	--	--	0	0	0	0	0.06	0.02	0.15	0.07	0.12	0.04	0.08	0.03
1965	26.0	--	--	0	0	0	0	0.07	0.04	0	0	0	0	0.02	0.01
1966	21.5	--	--	0	0	0	0	0.21	0.15	0.08	0.01	0	0	0.09	0.05
1967	22.0	--	--	0	0	0	0	0.07	0.01	0.08	0.04	0	0	0.05	0.01
1968	22.0	--	--	0	0	0	0	0.07	0.02	0	0	0	0	0.02	0.01
1969	22.0	--	--	0	0	0	0	0.13	0.03	0.08	0.02	0	0	0.07	0.02
1970	13.5	--	--	0	0	0	0	0	0	0	0	--	--	0	0
1973	19.5	0	0	0	0	0	0	0.07	0.05	0	0	--	--	0.03	0.02
1974	21.8	0	0	0	0	0	0	0.10	0.07	0.10	0.07	0	0	0.07	0.04

Table 21

Channel Catfish (Ictalurus punctatus) Taken by Electrofishing

		Number and Weight Taken per 30 Minutes													
	No. of Hours	Des Plaines R. Dresden Pool		Illinois River Pools: Marseilles		Starved Rock		Peoria		LaGrange		Alton		Illinois R.	
Year	Fished	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.
1959	12.0	0	0	0	0	0	0	0	0	0	0	--	--	0	0
1960	12.5	--	--	0	0	0.20	0.10	0.20	0.06	4.00	1.25	--	--	1.24	0.39
1961	10.0	--	--	0	0	0	0	0.14	0.05	--	--	--	--	0.10	0.03
1962	44.5	0	0	0	0	0.70	0.75	0.19	0.15	0.46	0.77	3.50	1.94	0.96	0.58
1963	23.5	--	--	0	0	0	0	0	0	2.69	1.74	8.50	4.70	2.19	1.28
1964	23.5	--	--	0	0	0	0	0	0	0.31	0.27	2.37	2.22	0.51	0.45
1965	26.0	--	--	0	0	1.25	0.38	0.13	0.03	0.25	0.15	2.00	0.56	0.64	0.20
1966	21.5	--	--	0	0	0.33	0	0.07	0.03	2.67	0.61	3.00	3.24	1.35	0.78
1967	22.0	--	--	0	0	0	0	0.13	0.08	2.42	0.93	1.63	1.50	1.00	0.54
1968	22.0	--	--	0	0	0	0	0.20	0.10	2.51	1.00	4.75	1.85	1.62	0.64
1969	22.0	--	--	0	0	0	0	0.47	0.69	1.42	0.56	2.75	1.98	1.05	0.75
1970	13.5	--	--	0	0	0.30	0.04	0	0	1.10	0.97	--	--	0.40	0.29
1973	19.5	0	0	0	0	2.00	1.45	0.40	0.47	0.62	1.01	--	--	0.56	0.68
1974	21.8	0	0	0.20	0.41	0	0	0.40	0.41	1.30	0.96	5.30	4.21	1.74	1.43

Table 22

Flathead Catfish (*Pylodictis olivaris*) Taken by Electrofishing

		Number and Weight Taken per 30 Minutes													
	No. of	Des Plaines R.		Illinois River Pools											
	Hours	Dresden Pool		Marseilles		Starved Rock		Peoria		LaGrange		Alton		Illinois R.	
Year	Fished	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.
1959	12.0	0	0	0	0	0	0	0	0	0	0	--	--	0	0
1960	12.5	--	--	0	0	0	0	0	0	0	0	--	--	0	0
1961	10.0	--	--	0	0	0	0	0	0	--	--	--	--	0	0
1962	44.5	0	0	0	0	0	0	0	0	0	0	0.30	0.09	0.04	0.01
1963	23.5	--	--	0	0	0	0	0	0	0.15	0.47	0.13	0.03	0.06	0.14
1964	23.5	--	--	0	0	0	0	0	0	0	0	0	0	0	0
1965	26.0	--	--	0	0	0	0	0	0	0	0	0	0	0	0
1966	21.5	--	--	0	0	0	0	0	0	0	0	0	0	0	0
1967	22.0	--	--	0	0	0	0	0	0	0	0	0.25	0.02	0.05	*
1968	22.0	--	--	0	0	0	0	0	0	0	0	0.25	0.13	0.05	0.02
1969	22.0	--	--	0	0	0	0	0	0	0	0	0.25	0.05	0.05	0.01
1970	13.5	--	--	0	0	0	0	0	0	0.40	3.13	--	--	0.10	0.93
1973	19.5	0	0	0	0	0	0	0	0	0.08	0.11	--	--	0.03	0.04
1974	21.8	0	0	0	0	0	0	0	0	0.60	2.38	0.50	0.23	0.29	0.68

Table 23

White Bass (Roccus chrysops) Taken by Electrofishing

		Number and Weight Taken per 30 Minutes													
	No. of	Des Plaines R.		Illinois River Pools											
	Hours	Dresden Pool		Marseilles		Starved Rock		Peoria		LaGrange		Alton		Illinois R.	
Year	Fished	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.
1959	12.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1960	12.5	--	--	0	0	0.20	0.01	0.10	0.05	0.29	0.29	--	--	0.16	0.10
1961	10.0	--	--	0	0	0	0	0	0	--	--	--	--	0	0
1962	44.5	0	0	0	0	0.20	0.13	0.44	0.21	0.33	0.19	4.40	2.27	0.78	0.40
1963	23.5	--	--	0	0	0	0	0	0	0.46	0.13	2.62	1.76	0.58	0.34
1964	23.5	--	--	0	0	0	0	0.25	0.16	0.15	0	1.62	0.57	0.40	0.15
1965	26.0	--	--	0.17	0.01	0.75	0.15	1.26	0.34	0.94	0.32	1.27	0.56	1.00	0.33
1966	21.5	--	--	0	0	1.00	0.47	0.93	0.57	0.75	0.43	1.00	0.31	0.77	0.39
1967	22.0	--	--	0	0	0.33	0.21	0.66	0.59	0.58	0.45	2.00	1.37	0.77	0.59
1968	22.0	--	--	0	0	0	0	0.40	0.42	0.25	0.20	3.49	2.82	0.84	0.71
1969	22.0	--	--	0	0	0	0	0.47	0.27	0	0	5.75	2.52	1.20	0.55
1970	13.5	--	--	0.20	0.01	1.70	0.16	1.30	0.35	0.80	0.59	--	--	0.60	0.32
1973	19.5	0	0	0.20	0.02	1.33	0.14	0.93	0.11	0.08	0.01	--	--	0.56	0.08
1974	21.8	0	0	0.40	0.19	0.60	0.18	2.20	0.46	0.80	0.27	1.70	1.10	1.41	0.51

Table 24

Green Sunfish (*Lepomis cyanellus*) Taken by Electrofishing

		Number and Weight Taken per 30 Minutes													
	No. of	Des Plaines R.		Illinois River Pools											
	Hours	Dresden Pool		Marseilles		Starved Rock		Peoria		LaGrange		Alton		Illinois R.	
Year	Fished	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.
1959	12.0	0.25	*	0.25	0.01	0	0	1.00	0.08	0	0	--	--	0.45	0.03
1960	12.5	--	--	0.33	0.01	0	0	0	0	2.72	NWT	--	--	0.80	0.18
1961	10.0	--	--	0.25	0.06	0	0	1.36	0.07	--	--	--	--	1.00	0.06
1962	44.5	0	0	0.07	*	0.20	*	0.74	0.07	1.00	0.07	0.10	*	0.56	0.05
1963	23.5	--	--	0	0	0.25	*	3.50	0.07	0.77	0.03	0.25	*	1.47	0.03
1964	23.5	--	--	0	0	0	0	1.56	0.01	1.15	0.03	1.12	--	1.04	0.01
1965	26.0	--	--	0	0	0	0	0.27	0.01	0.19	0.01	0	0	0.13	0.01
1966	21.5	--	--	0.17	0.01	0.33	0.02	5.00	0.20	0.33	0.03	0.63	0.02	1.88	0.08
1967	22.0	--	--	0.33	0.04	0.33	0.02	2.27	0.13	0.58	0.03	0.12	*	1.02	0.06
1968	22.0	--	--	0.33	0.02	1.66	0.18	4.80	0.23	2.25	0.15	0	0	2.41	0.13
1969	22.0	--	--	0.67	0.01	1.33	0.11	7.20	0.31	7.50	0.45	1.50	0.05	4.95	0.25
1970	13.5	--	--	2.00	0.12	0	0	1.50	0.12	2.00	0.11	--	--	1.60	0.10
1973	19.5	0.67	*	1.80	0.11	3.33	0.25	7.20	0.39	3.54	0.23	--	--	4.81	0.28
1974	21.8	0	0	8.00	0.19	1.70	0.11	4.30	0.23	1.00	1.12	1.00	0.09	2.83	0.14

Table 25

Bluegill (*Lepomis macrochirus*) Taken by Electrofishing

		Number and Weight Taken per 30 Minutes													
	No. of Hours	Des Plaines R. Dresden Pool		Illinois River Pools											
				Marseilles		Starved Rock		Peoria		LaGrange		Alton		Illinois R.	
Year	Fished	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.
1959	12.0	0	0	0.25	*	0	0	1.75	0.18	0.25	0.01	--	--	0.80	0.08
1960	12.5	--	--	1.00	0.08	0.20	0.03	0.20	0.01	24.71	1.97	--	--	7.16	0.57
1961	10.0	--	--	0	0	0	0	3.93	0.50	--	--	--	--	2.75	0.35
1962	44.5	0	0	0.14	*	0	0	3.07	0.24	11.13	0.66	4.30	0.27	4.65	0.29
1963	23.5	--	--	0.17	0.01	0	0	7.31	0.10	7.54	0.13	3.50	0.02	5.19	0.08
1964	23.5	--	--	0	0	0	0	5.06	0.07	6.92	0.09	5.13	0.03	4.51	0.05
1965	26.0	--	--	0	0	0	0	0.20	0.01	0.06	*	0	*	0.08	*
1966	21.5	--	--	0	0	0	0	3.14	0.05	3.34	0.23	4.38	0.11	2.77	0.10
1967	22.0	--	--	0	0	0	0	1.80	0.03	3.08	0.15	3.12	0.26	2.02	0.10
1968	22.0	--	--	0.17	*	0	0	1.80	0.01	5.09	0.39	3.75	0.35	2.70	0.18
1969	22.0	--	--	0	0	0.67	0.04	1.80	0.07	3.08	0.16	7.25	0.81	2.82	0.21
1970	13.5	--	--	2.00	0.06	0	0	1.90	0.12	7.90	0.45	--	--	3.50	0.19
1973	19.5	0	0	0	0	0	0	2.20	0.08	4.92	0.26	--	--	2.69	0.13
1974	21.8	0	0	0.90	0.08	0	0	9.30	0.40	14.60	1.12	12.70	1.10	9.93	0.69

Table 26

Largemouth Bass (*Micropterus salmoides*) Taken by Electrofishing

		Number and Weight Taken per 30 Minutes													
	No. of	Des Plaines R.		Illinois River Pools											
	Hours	Dresden Pool		Marseilles		Starved Rock		Peoria		LaGrange		Alton		Illinois R.	
Year	Fished	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.
1959	12.0	0	0	0	0	0	0	2.13	1.76	8.00	4.55	--	--	2.45	1.61
1960	12.5	--	--	0.67	0.09	0.60	0.51	3.20	2.16	20.71	11.27	--	--	7.28	4.13
1961	10.0	--	--	0.50	0.02	0	0	10.36	5.12	--	--	--	--	7.35	3.59
1962	44.5	0	0	0.07	0.01	0	0	4.85	4.04	8.71	6.05	3.70	2.44	4.45	3.28
1963	23.5	--	--	0	0	0	0	2.69	1.98	2.15	1.61	0.62	0.65	1.62	1.23
1964	23.5	--	--	0.17	0.03	0	0	1.13	0.79	2.15	1.42	0.63	0.26	1.11	0.71
1965	26.0	--	--	0	0	0.25	0.13	0.27	0.34	0.06	0.03	0	0	0.12	0.12
1966	21.5	--	--	0.17	0.03	0	0	0.21	0.16	0.92	0.60	1.13	0.48	0.56	0.31
1967	22.0	--	--	0	0	0	0	0.87	0.33	1.17	0.72	2.50	1.41	1.07	0.56
1968	22.0	--	--	0.17	0	0	0	0.67	0.30	1.42	0.81	0.63	0.21	0.75	0.36
1969	22.0	--	--	0.50	0.17	0	0	0.27	0.09	1.25	0.31	1.75	1.17	0.82	0.35
1970	13.5	--	--	0.10	0.01	0	0	0.80	0.49	2.50	0.69	--	--	1.10	0.39
1973	19.5	0	0	2.40	1.68	1.00	0.46	6.20	3.10	3.38	1.59	--	--	4.19	2.14
1974	21.8	0	0	1.78	0.34	0	0	5.78	3.47	2.55	2.03	4.30	2.08	3.74	2.18

Table 27

White Crappie (Pomoxis annularis) Taken by Electrofishing

Year	No. of Hours Fished	Des Plaines R. Dresden Pool		Illinois River Pools: Marseilles		Starved Rock		Peoria		LaGrange		Alton		Illinois R.	
		No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.
1959	12.0	0	0	0	0	0	0	0.25	0.03	0	0	--	--	0.10	0.01
1960	12.5	--	--	1.67	0.31	0.40	0.06	0	0	4.29	0.72	--	--	1.48	0.25
1961	10.0	--	--	0	0	0	0	1.36	0.34	--	--	--	--	0.95	0.24
1962	44.5	0	0	0	0	0	0	1.41	0.37	3.63	0.68	0.50	0.22	1.53	0.34
1963	23.5	--	--	0	0	0	0	1.31	0.40	0.62	0.19	0.88	0.23	0.77	0.23
1964	23.5	--	--	0	0	0	0	0.63	0.24	1.00	0.33	0.88	0.29	0.64	0.22
1965	26.0	--	--	0	0	0	0	0.20	0	0.13	0.07	0.64	0.18	0.23	0.06
1966	21.5	--	--	0.33	0.13	0	0	2.64	0.87	2.08	0.44	1.00	0.59	1.68	0.53
1967	22.0	--	--	0	0	0	0	1.80	0.61	3.17	0.92	1.37	0.55	1.73	0.56
1968	22.0	--	--	0	0	0	0	0.33	0.17	3.08	1.04	1.99	0.75	1.32	0.48
1969	22.0	--	--	0	0	0	0	0.47	0.15	1.25	0.28	1.63	0.49	0.80	0.21
1970	13.5	--	--	0.50	0.13	0	0	1.30	0.47	1.50	0.50	--	--	1.00	0.35
1973	19.5	0	0	0	0	0	0	3.33	1.10	0.46	0.12	--	--	1.56	0.51
1974	21.8	0	0	2.00	0.45	0.30	0.16	5.50	2.25	1.50	0.28	0.70	0.42	2.57	0.96

Note: columns 3–16 are headed "Number and Weight Taken per 30 Minutes".

Table 28

Black Crappie (*Pomoxis nigromaculatus*) Taken by Electrofishing

		Number and Weight Taken per 30 Minutes													
	No. of	Des Plaines R.		Illinois River Pools											
	Hours	Dresden Pool		Marseilles		Starved Rock		Peoria		LaGrange		Alton		Illinois R.	
Year	Fished	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.
1959	12.0	0	0	0	0	0	0	0	0	0.75	0.17	--	--	0.20	0.03
1960	12.5	--	--	0	0	0	0	0	0	8.71	2.56	--	--	2.44	0.72
1961	10.0	--	--	0	0	0	0	2.36	0.67	--	--	--	--	1.65	0.47
1962	44.5	0	0	0	0	0.10	0.04	7.56	3.48	5.67	2.39	0	0.75	4.30	1.88
1963	23.5	--	--	0	0	0	0	1.75	0.63	1.15	0.27	2.50	0.56	1.34	0.38
1964	23.5	--	--	0	0	0	0	0.56	0.22	1.85	0.19	1.50	0.55	0.96	0.22
1965	26.0	--	--	0	0	0	0	0	0	0.44	0.15	0.45	0.07	0.23	0.06
1966	21.5	--	--	0	0	0	0	1.64	0.53	5.00	1.11	1.75	0.53	2.26	0.58
1967	22.0	--	--	0	0	0	0	2.33	1.17	8.00	2.13	3.63	0.57	3.64	1.08
1968	22.0	--	--	0	0	0	0	1.34	0.56	11.50	3.04	6.88	1.99	4.85	1.38
1969	22.0	--	--	0.17	0.04	0	0	1.53	0.68	8.42	1.80	8.38	3.26	4.36	1.32
1970	13.5	--	--	0.10	0	0	0	2.60	1.05	6.90	2.01	--	--	3.00	0.98
1973	19.5	0	0	0	0	1.00	0.27	4.47	1.15	4.23	1.24	--	--	3.47	0.95
1974	21.8	0	0	0.40	0.10	1.40	0.72	8.00	3.01	9.50	1.63	1.80	0.50	5.62	1.58

Table 29

Freshwater Drum (Aplodinotus grunniens) Taken by Electrofishing

		Number and Weight Taken per 30 Minutes													
	No. of Hours	Des Plaines R.		Illinois River Pools											
		Dresden Pool		Marseilles		Starved Rock		Peoria		LaGrange		Alton		Illinois R.	
Year	Fished	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.
1959	12.0	0	0	0	0	0	0	0.38	0.06	3.25	0.73	--	--	0.80	0.17
1960	12.5	--	--	0	0	0	0	0.10	0.01	2.00	0.84	--	--	0.60	0.24
1961	10.0	--	--	0	0	0	0	0.79	0.20	--	--	--	--	0.55	0.14
1962	44.5	0	0	0.07	0.07	0.10	0.12	0.40	0.13	0.92	0.22	0.30	0.03	0.45	0.13
1963	23.5	--	--	0	0	0	0	0.06	0.07	0.69	0.25	0.87	0.20	0.36	0.13
1964	23.5	--	--	0	0	0	0	0.31	0.32	0.54	0.12	0	0	0.26	0.14
1965	26.0	--	--	0	0	0	0	0.07	*	1.56	0.53	3.55	0.45	1.25	0.26
1966	21.5	--	--	0	0	0	0	0	0	1.33	0.31	0.38	0.11	0.44	0.11
1967	22.0	--	--	0	0	0	0	0.13	*	3.50	0.55	0.38	0.05	1.07	0.16
1968	22.0	--	--	0.50	0	0	0	0.20	0.12	2.75	0.53	1.12	0.25	1.09	0.23
1969	22.0	--	--	0.33	0	0.33	0.22	0.53	0.40	3.92	1.36	1.12	0.26	1.52	0.57
1970	13.5	--	--	0.70	*	0	0	0.50	0.21	2.30	0.65	--	--	1.00	0.27
1973	19.5	0	0	0	0	0	0	0.73	0.03	4.62	1.14	--	--	1.97	0.42
1974	21.8	0	0	0.40	*	0	0	0.60	0.06	5.00	1.02	5.70	1.08	2.90	0.54

Table 30

Average Number of Fish (Including Adult and Young) Taken Per 30 Minutes of Electrofishing, by Year, in each Navigation Pool of the Illinois River, 1959-1974

	Des Plaines River	Illinois River Pools				
Year	Dresden Pool	Marseilles	Starved Rock	Peoria	LaGrange	Alton
1959	31.00	57.00	25.75	57.63	198.50	--
1960	--	214.33	144.20	95.40	106.29	--
1961	--	125.50	205.50	175.07	--	--
1962	122.00	155.79	175.30	730.48	369.79	76.20
1963	--	106.50	106.00	144.19	155.62	79.50
1964	--	46.67	68.50	142.88	151.69	98.13
1965	--	63.83	261.00	160.33	55.44	27.55
1966	--	57.83	79.33	168.64	116.50	52.88
1967	--	83.00	125.00	137.67	121.25	71.13
1968	--	45.67	54.67	105.53	139.83	47.88
1969	--	61.83	54.00	169.73	283.17	67.25
1970	--	77.00	206.00	88.10	105.80	--
1973	49.33	51.40	37.00	75.12	70.63	--
1974	44.00	70.00	36.00	102.70	82.10	59.00

Dashes indicate that no electrofishing was conducted.

Table 31

Average Pounds of Fish (Adult Only) Taken Per 30 Minutes of Electrofishing, by Year, in each Navigation Pool of the Illinois River, 1959-1974

	Des Plaines River	Illinois River Pools				
Year	Dresden Pool	Marseilles	Starved Rock	Peoria	LaGrange	Alton
1959	21.38	28.07	8.09	22.97	53.70	--
1960	--	27.42	61.63	27.78	63.94	--
1961	--	43.79	46.59	43.84	--	--
1962	21.10	24.73	61.42	43.96	66.60	33.43
1963	--	40.84	52.24	41.55	99.82	70.45
1964	--	34.62	21.18	32.37	107.81	99.76
1965	--	42.27	46.04	30.29	27.09	27.53
1966	--	30.52	20.41	44.55	67.24	55.56
1967	--	43.13	30.73	53.11	60.19	48.61
1968	--	26.39	24.59	40.91	49.10	38.47
1969	--	23.12	18.97	47.67	39.34	47.56
1970	--	40.06	28.40	41.02	42.02	--
1973	19.22	23.30	16.01	25.63	43.31	--
1974	22.10	26.94	19.93	54.50	49.93	42.64

Dashes indicate that no electrofishing was conducted.

Table 32

Average Number of Fish of Selected Species Taken Per 30 Minutes of Electrofishing on the Illinois River (Marseilles, Starved Rock, Peoria, LaGrange, and Alton Pools Inclusive), 1959-1974

Year	Largemouth Bass	Black Crappie	White Crappie	Bluegill	Flathead Catfish	White Bass	Bigmouth Buffalo
1959	2.45	0.15	0.10	0.80	0.00	0.00	2.85
1960	7.28	2.44	1.48	7.16	0.00	0.16	1.20
1961	7.35	1.65	0.95	2.75	0.00	0.00	1.80
1962	4.45	4.30	1.53	4.65	0.04	0.78	2.78
1963	1.62	1.34	0.77	5.19	0.06	0.58	4.28
1964	1.11	0.96	0.64	4.51	0.00	0.40	4.32
1965	0.12	0.23	0.23	0.08	0.00	1.00	1.88
1966	0.56	2.26	1.68	2.77	0.00	0.77	4.03
1967	1.07	3.64	1.73	2.02	0.05	0.77	5.70
1968	0.75	4.85	1.32	2.70	0.05	0.84	2.73
1969	0.82	4.36	0.80	2.82	0.05	1.20	2.36
1970	1.10	3.00	1.00	3.50	0.10	0.90	0.50
1973	8.61*	6.94*	3.11*	5.39	0.06	1.11	5.00
1974	3.74	5.62	2.57	9.93*	0.29*	1.40*	6.48*

*Indicates the greatest number of fish taken per 30 minutes from 1959 through 1974.

Table 33

Average Number of Fish, by Species, Taken Per 30 Minutes of Electrofishing in Each Navigation Pool of the Illinois River, 1959-1974

Ref. Table No.	Species	Des Plaines River	Illinois River Pools				
		Dresden Pool	Marseilles	Starved Rock	Peoria	LaGrange	Alton
5	Shortnose gar	0.00	0.00	0.00	0.05	0.07*	0.07*
6	Bowfin	0.00	0.00	0.00	0.01	0.02	0.07*
7	Gizzard shad	2.66	12.52	9.22	63.20*	43.55	18.09
9	Goldeye	0.00	0.03	0.00	0.02	0.02	0.41*
8	Mooneye	0.00	0.00	0.00	0.01	0.00	0.05*
10	Goldfish	42.76*	12.02	17.02	0.73	0.37	0.00
11	Carp x goldfish	1.05	0.80	2.02*	1.39	0.18	0.01
12	Carp	12.06	14.29	18.92	18.67	34.69*	19.81
13	River carpsucker	0.00	0.04	0.34	0.44*	0.39	0.27
14	Quillback carpsucker	0.00	0.71	1.38*	0.52	0.16	0.11
15	Smallmouth buffalo	0.00	0.03	0.25	0.67	1.04*	0.11
16	Bigmouth buffalo	0.00	0.01	0.05	5.79*	4.21	0.33
17	Black buffalo	0.00	0.00	0.02	0.19	0.24*	0.04
18	Shorthead redhorse	0.34	0.05	0.14	0.09	0.21	0.08
19	Black bullhead	0.00	4.39*	0.38	0.35	0.12	0.00
20	Yellow bullhead	0.00	0.00	0.00	0.07	0.10*	0.01
21	Channel catfish	0.00	0.01	0.34	0.17	1.60	3.76*
22	Flathead catfish	0.00	0.00	0.00	0.00	0.09	0.19*
23	White bass	0.00	0.07	0.44	0.64	0.42	2.65*
24	Green sunfish	0.23	1.01	0.65	2.91*	1.77	0.52
25	Bluegill	0.00	0.33	0.06	3.10	7.12*	4.90
26	Largemouth bass	0.00	0.47	0.13	2.82	4.23*	1.70
27	White crappie	0.00	0.32	0.05	1.47	1.75*	1.07
28	Black crappie	0.00	0.04	0.18	2.44	5.55*	2.99
29	Freshwater drum	0.00	0.14	0.03	0.34	2.49*	1.49

* Indicates the pool or pools where the maximum number of individuals of each species was taken in the period 1959-1974.

Table 34

Average Number of Pounds of Fish, by Species, Taken Per 30 Minutes of Electrofishing in Each Navigation Pool of the Illinois River, 1959-1974

Ref. Table No.	Species	Des Plaines River	Illinois River Pools				
		Dresden Pool	Marseilles	Starved Rock	Peoria	LaGrange	Alton
5	Shortnose gar	0.00	0.00	0.00	0.08*	0.08*	0.03
6	Bowfin	0.00	0.00	0.00	0.02	0.11	0.12*
7	Gizzard shad	0.07	1.16	0.88	1.99*	1.95	0.79
9	Goldeye	0.00	0.01	0.00	0.01	0.01	0.05*
8	Mooneye	0.00	0.00	0.00	**	0.00	0.02*
10	Goldfish	6.73	4.64	5.24	0.10	0.09	0.00
11	Carp x goldfish	0.77	1.17	3.03*	0.84	0.10	0.01
12	Carp	12.84	23.91	20.38	17.68	38.36	41.90*
13	River carpsucker	0.00	0.04	0.31*	0.22	0.26	0.21
14	Quillback carpsucker	0.00	0.45	1.10*	0.30	0.07	0.06
15	Smallmouth buffalo	0.00	0.01	0.38	0.75	0.88	0.07
16	Bigmouth buffalo	0.00	0.01	0.05	12.56*	9.28	1.05
17	Black buffalo	0.00	0.00	0.03	0.44	0.55*	0.13
18	Shorthead redhorse	0.14	0.02	0.08	0.05	0.05	0.06
19	Black bullhead	0.00	0.54*	0.09	0.11	0.01	0.00
20	Yellow bullhead	0.00	0.00	0.00	0.03*	0.03*	**
21	Channel catfish	0.00	0.03	0.19	0.15	0.79	2.47*
22	Flathead catfish	0.00	0.00	0.00	0.00	0.47*	0.06
23	White bass	0.00	0.02	0.10	0.25	0.22	1.48*
24	Green sunfish	**	0.04	0.05	0.14	0.19*	0.02
25	Bluegill	0.00	0.02	0.01	0.13	0.43*	0.33
26	Largemouth bass	0.00	0.17	0.08	1.72	2.44*	0.97
27	White crappie	0.00	0.07	0.02	0.50*	0.43	0.41
28	Black crappie	0.00	0.01	0.07	0.94	1.44*	0.98
29	Freshwater drum	0.00	0.01	0.02	0.12	0.63*	0.27

* Indicates the pools where the maximum number of pounds of each species was taken in the period 1959-1974.
** Less than 0.01 lb taken.

Table 35

Summary of the Commercial Catch of Fish from the Illinois River and the Mississippi River Bordering Illinois, and the Number of Illinois River Fishermen, 1950-1974
(Catch in thousands of pounds)

Illinois River	1950	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Species: Bowfin	10	4	2	3	3	8	7	2	7	7	1	2	--	1	1	1	3	1	1	1	--	--
Buffalo	1372	1250	1034	804	1022	882	1071	834	921	759	986	658	615	722	943	849	833	435	460	260	118	--
Carp	4041	1780	2367	1876	1381	1593	1315	1155	1072	1183	1072	742	728	780	783	543	875	355	755	312	213	--
Catfish & bullheads	193	188	299	311	234	208	158	164	137	163	132	130	82	89	100	96	148	94	66	61	61	--
Garfish	--	--	--	--	--	2	--	--	--	--	1	7	3	2	--	5	1	1	--	--	--	--
Paddlefish	26	3	8	7	1	4	--	2	1	1	--	--	--	9	3	2	7	6	--	4	--	--
Quillback	--	5	171	--	--	3	6	7	--	--	3	3	--	--	2	6	--	1	--	--	--	--
Sheepshead	114	198	97	181	124	138	53	69	46	60	40	39	21	21	37	20	44	26	45	17	7	--
Sturgeon (Shovelnose)	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Suckers	2	--	2	1	--	--	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Yellow bass	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Crappie	--	--	25	35	26	33	29	25	31	32	5	--	--	--	--	--	--	--	--	--	--	--
Carpsucker	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Yellow perch	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
White bass	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total	5760	3430	4006	3218	2791	2871	2639	2260	2215	2205	2240	1581	1449	1624	1869	1522	1911	919	1327	655	399	571
Mississippi River																						
Total	2923	2726	3893	3310	3224	4208	4349	4224	3175	3464	3669	3238	3470	3455	2904	2670	2889	3178	3041	3247	3610	--
Illinois River Fishermen																						
Full-time	106	111	96	88	105	70	61	69	65	50	48	56	44	23	43	38	30	22	9	13	13	15
Part-time	169	134	176	103	100	142	118	73	76	88	76	59	90	74	72	63	59	46	47	42	56	38

Note: Most of the statistics were obtained from statistical digests published by the U. S. Department of Commerce. The 1972-1974 data and the number of full-time and part-time commercial fishermen on the Illinois River were provided by Mr. Larry Dunham, Fisheries Biologist, Illinois Department of Conservation.

Table 36

Organochlorine Insecticide and Mercury Levels in Fish from the Illinois River*
(in mg/kg, wet weight whole fish)

	Insecticide																		
	DDT and Metabolites					Dieldrin					Chlordane			Lindane			PCB's	Mercury+	
Fish Species	Spring 1967	Fall 1967	Spring 1968	Fall 1968	Fall 1969	Spring 1967	Fall 1967	Spring 1968	Fall 1968	Fall 1969	Spring 1967	Fall 1967	Fall 1968	Fall 1967	Fall 1968	Fall 1969	Fall 1969	Fall 1969	Fall 1970
Carp	0.67	--	--	--	4.56**	0.30++	--	--	--	0.49++	0.50	--	--	--	--	0.06	11.3**	0.09	0.10
Bigmouth buffalo	--	0.16	--	0.60	0.43	--	0.52++	--	0.35++	0.42++	--	0.24	0.17	0.02	0.07	0.07	1.21	0.07	0.08
Carpsucker	--	--	0.43	--	--	--	--	0.20	--	--	--	--	--	--	--	--	--	--	--
Channel catfish	0.95	--	--	--	--	--	--	0.38++	--	--	0.65	--	--	--	--	--	--	--	--
White crappie	--	--	--	--	0.65	--	--	--	--	0.27	--	--	--	--	--	0.09	1.79	0.13	0.21

* Data obtained from Henderson, et al., 1969; Henderson, et al., 1971; Henderson, et al., 1972.

** A separate analysis by another laboratory, using a superior sample clean-up technique, indicated that DDT and its metabolites were present at a concentration of 0.29 ppm and PCB's at a concentration of 3.8 ppm.

+ Henderson, et al., (1972) reported that 90 percent and possibly more of the mercury in the fish was in the form of methyl mercury.

++ Exceeds levels permitted by the Food and Drug Administration in fish for human consumption. (FDA action levels are as follows: 5 ppm DDT; 0.5 ppm mercury; 0.3 ppm dieldrin).

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GEORGE SPRUGEL, JR., *Chief*

Nov 1, 1978

Dear Folks,

I've enclosed a copy of my latest quarterly progress report, plus some articles about our research in the Illinois Natural History Survey Reports, so you will know what it is your son is doing! Under separate cover I'm sending you a copy of our latest full length publication, "Rapid Assessment of Water Quality Using the Fingernail Clam".

We all enjoyed your visit and hope you can ~~m~~ make it an annual event — Fall is a good, cool time to travel in the Midwest. I hope I can get enough grant funds and staff together that I don't have to be out on the rivers the entire summer. ~~Aff~~ If I can, ~~Aff~~ we could travel to Vermont at least once a year in the summer. Amy and Carolyn would like to have our houses joined together so that they could visit Grandma and Paw Paw everyday and we could all have supper together. Hope you had a safe trip home and did not get too tired. Perhaps you'd mail me Bob's thesis when you're done reading it.

Love,
Rip