BULLETIN
of the
ILLINOIS NATURAL HISTORY SURVEY
HARLOW B. MILLS, *Chief*

Commercial and Sport Fishes of the Mississippi River

Between Caruthersville, Missouri, and Dubuque, Iowa

PAUL G. BARNICKOL
WILLIAM C. STARRETT

Printed by Authority of the
STATE OF ILLINOIS
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URBANA, ILLINOIS

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Urbana, Illinois

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This paper is a contribution from the Section of Aquatic Biology.

(30208—3M—5-51)

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Channel catfish, one of the species important to the commercial catch of the Mississippi River.

Commercial and Sport Fishes of the Mississippi River

*Between Caruthersville, Missouri, and Dubuque, Iowa**

PAUL G. BARNICKOL†
WILLIAM C. STARRETT‡

IN December, 1943, conservation representatives from the states of Illinois, Iowa, Missouri, Minnesota, and Wisconsin, from the United States Fish and Wildlife Service, and from other interested agencies met at Dubuque, Iowa, and formed the Upper Mississippi River Conservation Committee (Smith 1949). This group was organized for the purpose of sponsoring studies of the fishery and wildlife resources of the Mississippi River from Caruthersville, Missouri, to Hastings, Minnesota. The studies were designed to serve as a basis for making scientifically sound recommendations for the management of these resources. At that time the fish and game codes of the member states were at variance with one another in certain provisions, and some practices that were legal in the waters of the Mississippi bordering one state were illegal in the waters within the jurisdiction of another immediately across the river.

To facilitate the actual projection of biological investigations, two technical committees were formed within the Conservation Committee. These were the Technical Committee for Fisheries and the Technical Game Committee. To them were assigned the duties of planning research and reporting the progress of research to the Conservation Committee at its annual meetings.

Basic to a sound management program for the upper Mississippi fishery was a knowledge of the status of various species of fish present in the river. Commercial fishery statistics were not adequate because they included several species under single groupings, as buffalofishes and catfishes, and because in recent years they failed to include sport fishes and other species closed to commercial fishing.

Because state agencies were restricted in their research activities by state boundaries (the United States Fish and Wildlife Service was the only agency involved that was free to finance projects without regard to state boundaries), it became necessary to subdivide the upper Mississippi River fishery investigations into upper and lower co-operative units—the upper unit involving Wisconsin, Minnesota, and northern Iowa, and the lower unit involving Missouri, southern Iowa, and Illinois.

Actual field operations were begun in the Missouri-Illinois part of the southern unit in March, 1944, with the Conservation Commission of Missouri, the Illinois Department of Conservation, and the Illinois Natural History Survey participating. Two years later, in March, 1946, field operations were begun in the Iowa-Illinois part of the river with the Iowa Conservation Commission and the two Illinois agencies co-operating.

The entire investigation reported here was conducted under the auspices of the Technical Committee for Fisheries.

This paper is based on an analysis of the data relative to the species composition

* This investigation was conducted under the auspices of the Technical Committee for Fisheries of the Upper Mississippi River Conservation Committee.
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of the fishes appearing in test-net collections taken in 1944 and 1946 with various types of commercial gear at 31 sampling stations between Caruthersville, Missouri, and Dubuque, Iowa. The gear included types that could not be used legally by commercial fishermen in some or all of the co-operating states.

The discussion is limited largely to the commercial and sport fishes of the river. The smaller-sized fishes, such as the minnows (Cyprinidae), seldom occurred in the test-net collections, as the minimum mesh used was 1 inch square. Minnow collections were made at many of the stations, and a list of the species appearing in these collections was recorded but is not presented here.

The writers believe that, regardless of any shortcomings of the sampling methods employed in this study, the data are extensive enough to allow a rough estimate of the status of the various commercial and game fishes now occurring in the Caruthersville-Dubuque section of the Mississippi.

Acknowledgment is made to the following persons for their various contributions to the progress of the researches reported in this paper: Mr. W. E. Albert, Mr. Daniel Avery, Mr. James S. Ayars, Dr. Reeve M. Bailey, Dr. George W. Bennett, Mr. Leonard Durham, Dr. T. H. Frison (now deceased), Dr. B. Vincent Hall, Dr. Donald F. Hansen, Dr. G. B. Herndon and associates, Mr. Don W. Kelley, Mr. Jacob H. Lemm, Dr. Harlow B. Mills, Mr. Sam A. Parr, Dr. Hurst H. Shoemaker, Mr. Everett B. Speaker and associates, and Dr. David H. Thompson.

Financial support of this investigation was given by the conservation departments of the states of Illinois, Iowa, and Missouri, and by the Illinois Natural History Survey, all co-operating under the Upper Mississippi River Conservation Committee program.

THE MISSISSIPPI RIVER

The length of the Mississippi River from its source at Lake Itasca to its mouth at Head of Passes is 2,470 miles (Mississippi River Commission 1940:1). This great river and its tributaries drain a total area of about 1,244,000 square miles, including all or parts of 31 states and 2 Canadian provinces: New York and Pennsylvania farthest east, Wyoming and Montana farthest west, Alberta and Saskatchewan farthest north. The investigation reported here covers that part of the Mississippi River between Caruthers

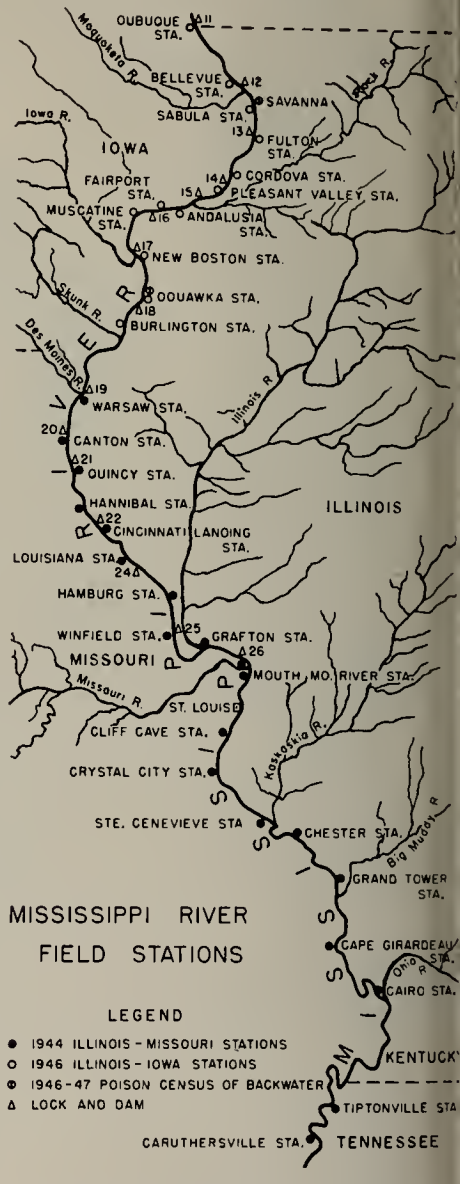

Fig. 1.—The Mississippi River between Caruthersville, Missouri, and Dubuque, Iowa; shown is the location of field sampling stations used during the fisheries survey of 1944 and 1946. The river distance between Caruthersville and Dubuque is 689 miles.

ville, Missouri, and Dubuque, Iowa, a distance of 689 miles or 28 per cent of the total length of the river, fig. 1. This section of the river includes 306 miles of the lower Mississippi, designated hereafter as MR-C (mouth of the Missouri River to Caruthersville), and 383 miles of the upper Mississippi, designated as D-MR (Dubuque to the mouth of the Missouri River).

Early Descriptions

The Mississippi River was discovered in the sixteenth century by an expedition headed by Hernando de Soto. Later explorations were made on the Mississippi by such well-known historical personages as D'Iberville, Joliet, Marquette, and La Salle.

The "Gentleman of Elvas," a Portuguese member of the De Soto expedition, stated that "The river was of great depth and of a strong current. The water was always muddy. There came down the river continually many trees and timber, which the force of the water and stream brought down. There was a great store of fish in it of sundry sorts, and most of it differing from the fresh water fish of Spain" (Saxon 1927:78).

Thomas Jefferson (1801:11) wrote the following description of the river in about 1780: "The Missisippi, below the mouth of the Missouri, is always muddy and abounding with sand bars, which frequently change their places. However, it carries 15 feet water to the mouth of the Ohio, to which place it is from one and a half to two miles wide, and thence to Kaskaskia from one mile to a mile and a quarter wide. Its current is so rapid, that it never can be stemmed by the force of the wind alone, acting on sails. Any vessel, however, navigated with oars, may come up at any time, and receive much aid from the wind."

Reclus (1859:262) in his paper on the Mississippi mentioned the yellow water of the Missouri River and the blue water of the Mississippi at the confluence of the two rivers.

Prior to the construction of locks and dams, two rapids were present in the river between Dubuque and the mouth of the Missouri River. The upper were between Le Claire, Iowa, and Rock Island, Illinois, and the lower at Keokuk, Iowa.

Glazier (1891:314) in describing his trip down the Mississippi in 1881 stated that "We found the current of the Mississippi below the mouth of the Missouri much stronger than we had observed it to be since passing the Keokuk Rapids."

Floods and Levees

Floods along the Mississippi have been reported since the river's discovery. A member of the De Soto expedition in 1543 wrote the first description known of a Mississippi flood. The flood began about the tenth of March and reached its peak about 40 days later. "The inundated areas are said to have extended for twenty leagues on each side of the river" (Mississippi River Commission 1940:8).

Jefferson (1801:11–2) wrote the following regarding floods on the Mississippi: "These floods begin in April, and the river returns into its banks early in August. The inundation extends further on the western than eastern side, covering the lands in some places for 50 miles from its banks. Above the mouth of the Missouri, it becomes much such a river as the Ohio, like it clear, and gentle in its current, not quite so wide, the period of its floods nearly the same, but not rising to so great a height."

The delta with its fertile land early attracted many settlers. This alluvial valley extends up the river as far as Cape Girardeau, Missouri. "In the Alluvial Valley the Mississippi River is an aggrading, or soil-building stream. In time of flood the river goes out of its banks, dropping its load of sediment as it goes. This action is due to the slowing up of the waters as they leave the river's channel; and the larger share of this material settles on or near the edges of the stream. For this reason the banks are generally from 10 to 15 feet above the lowlands away from the river. The slope away from the river is usually steepest for the first mile away from the river banks" (Mississippi River Commission 1940:9).

For more than two centuries man has used levees in defense of his rich soil and cities against the flooding torrents of the Mississippi. By 1727, a levee along the

Table 1.—Stations where fish collections were taken during 1944 and 1946 on the Mississipp River between Caruthersville, Missouri, and Dubuque, Iowa, with inclusive dates, pool numbers number of net days at each station, and river stages in feet.*

STATION	INCLUSIVE DATES	MILES BELOW DUBUQUE STATION	POOL NO.	NUMBER OF NET DAYS	RIVER STAGE AT MUSCATINE	RIVER STAGE AT CAPE GIRARDEAU
	1944					
Caruthersville, Mo.	April 6–12	689	—	42.54	7.7	19.2
Tiptonville, Tenn.	April 15–May 10	665	—	111.70	11.3	38.9
Cairo, Ill.	May 18–24	573	—	54.10	14.2	27.1
Cape Girardeau, Mo.	May 26–31	529	—	61.94	16.7	28.8
Grand Tower, Ill.	June 2–9	499	—	73.13	12.3	30.3
Chester, Ill.	June 11–15	468	—	38.99	11.5	26.5
Ste. Genevieve, Mo.	June 18–24	454	—	46.14	15.8	27.5
Crystal City, Mo.	June 25–30	429	—	62.19	17.5	30.4
Cliff Cave, Mo.	July 2–8	412	—	61.36	15.0	29.0
Mouth Missouri R., Mo.	July 10–15	383	—	62.86	10.8	25.8
Grafton, Ill.	March 22–30	358	26	42.64	9.8	24.9
Grafton, Ill.	July 17–25	358	26	74.30	9.4	21.8
Grafton, Ill.	Sept. 22–27	358	26	93.31	5.7	13.5
Winfield, Mo.	July 27–Aug. 2	337	25, 26	85.92	7.9	18.8
Hamburg, Ill.	Aug. 3–9	320	25	96.60	6.9	16.3
Louisiana, Mo.	Aug. 12–17	295	24	66.71	6.6	15.5
Cincinnati Landing, Ill.	Aug. 19–23	281	24	64.90	6.3	15.1
Hannibal, Mo.	Aug. 25–30	267	22	82.97	5.7	16.2
Quincy, Ill.	Sept. 2–6	256	22	105.20	6.2	20.7
Canton, Mo.	Sept. 8–13	236	21	100.82	5.5	15.9
Warsaw, Ill.	Sept. 14–19	218	20	99.99	6.0	13.0
	1946					
Burlington, Iowa	April 10–22	178	19	143.72	10.2	20.6
Oquawka, Ill.	April 24–May 5	159	18	135.80	7.3	16.6
New Boston, Ill.	May 7–18	143	18	155.00	6.4	22.1
Muscatine, Iowa	May 19–30	134	17	160.00	5.9	19.8
Fairport, Iowa	June 2–13	118	16	158.85	6.8	17.4
Andalusia, Ill.	April 1–7	103	16	98.18	15.0	27.8
Andalusia, Ill.	June 18–26	103	16	155.67	11.4	22.8
Andalusia, Ill.	Sept. 15–24	103	16	196.53	6.0	12.7
Pleasant Valley, Iowa	June 28–July 9	87	15	151.68	10.0	21.3
Cordova, Ill.	July 11–22	75	14	150.17	9.9	18.8
Fulton, Ill.	July 24–Aug. 4	57	14	152.39	5.6	13.0
Sabula, Iowa	Aug. 6–17	44	13	160.31	5.3	11.6
Bellevue, Iowa	Aug. 19–30	17	12	188.40	5.0	17.6
Dubuque, Iowa	Sept. 1–12	0	12	192.83	6.1	10.2

* The 1944 river stage data from the United States Department of Commerce (1946); the 1946 river stage data furnished by Ray K. Linsley, Jr., Acting Chief of Division, Climatological and Hydrologic Services, Washington, D. C. Flood stage is 32 feet at Cape Girardeau, Mo.; 15 feet at Muscatine, Iowa.

Mississippi at New Orleans had been completed to a length of 5,400 feet (Mississippi River Commission 1940:10).

In 1850 the Federal Government approved an act which encouraged the reclaiming of the alluvial land along the Mississippi below the mouth of the Ohio River (Saxon 1927:261). In 1879 the Mississippi River Commission was created and placed in charge of flood control on the Mississippi (Saxon 1927:266).

In that part of the Mississippi River covered by the present investigation, levees and drainage districts border much of the stream up as far as Muscatine, Iowa. Below the mouth of the Missouri River the levees are more apparent than along the upper river and they give the observer an impression that the river is hemmed in by them.

High-water conditions prevailed throughout the 1944 investigation of the MR-C section of the river, as shown in table 1. In several instances during this survey, test-netting was done over flooded land formerly planted in corn or cotton.

Improvements for Navigation

The exciting days of steamboating on the Mississippi described by Mark Twain and others are just about gone. Steamboats are being replaced by diesel-powered towboats capable of pushing huge barges loaded with coal, grain, oil, and other commodities. During the period of World War II approximately 1,980 war

Fig. 2.—Lock and Dam No. 25 just above the Winfield, Missouri, sampling station. The swiftness of the current below the dam is quite perceptible. Photo by courtesy of the United States Army Corps of Engineers, Upper Mississippi Valley Division, St. Louis, Missouri.

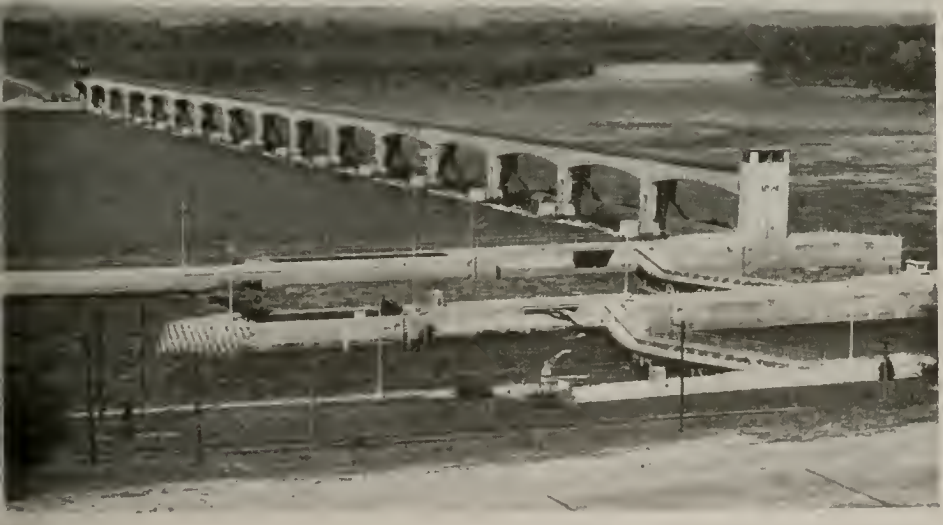

Fig. 3.—Lock and Dam No. 24 just below the Louisiana, Missouri, sampling station on the Mississippi River. Photo by courtesy of the United States Army Corps of Engineers, Upper Mississippi Valley Division, St. Louis, Missouri.

Fig. 4.—Lock and Dam No. 22 just below the Cincinnati Landing, Illinois, sampling station. Photo by courtesy of the United States Army Corps of Engineers, Rock Island District.

Fig. 5.—Lock and Dam No. 11, and Pool No. 12, from Eagle Point Park, near Dubuque, Iowa. Photo by courtesy of the United States Army Corps of Engineers, Rock Island District.

vessels were passed through the lock at Alton, Illinois (War Department Corps of Engineers 1946:7). These vessels were constructed inland and outfitted for sea at New Orleans, Louisiana.

The use of the river for navigation and the construction of levees for drainage districts and flood control have brought about many changes on the river. As early as 1824 an act was passed by Congress appropriating $75,000 for the improvement of the Mississippi by "snagging" from the mouth of the Missouri River to New Orleans. The first permanent improvement on the river came in the building of a pier at St. Louis, Missouri, to give direction of current. This construction was authorized by acts passed in 1836 and 1837. Later, the Keokuk and Rock Island rapids were improved for naviga-

tion. An act in 1872 authorized improvement of the river between Alton and the mouth of the Meramec River by obtaining channel depths through revetments, solid dikes, and dams. A comprehensive project was approved in 1881 for continuous improvement of the river between the mouth of the Ohio River and St. Louis to secure a minimum depth of 8 feet by using revetments, permeable dikes, and contraction of the low water channels to an approximately uniform width of 2,500 feet. This project was modified by acts passed in 1895 and 1896 providing for the maintenance of a channel 250 feet wide and 9 feet deep by regulating works and dredging. The project was again modified in 1905, providing that the use of regulating works be supplanted by extensive dredging operations. Later, dredging alone proved unsatisfactory; in 1910 regulating works were again approved, and channel depths of 6 feet from the mouth of the Missouri to St. Louis and 8 feet from St. Louis to the mouth of the Ohio were authorized. In 1927 and 1930, acts of Congress authorized a channel depth of 9 feet between St. Louis and the mouth of the Ohio, with a channel width of 300 feet, and a channel depth of 9 feet from the mouth of the Illinois River to St. Louis, with a channel width of 200 feet (War Department Corps of Engineers 1940:5–6). A project for the improvement of the Chain of Rocks Reach in the St. Louis area was approved in 1945. In this 7-mile reach, at low water the stream gradient averaged approximately 1.5 feet per mile in contrast to 0.5 foot above the Chain of Rocks and 0.6 foot from St. Louis to Cairo, Illinois (Smyser 1947:5).

General improvement of the upper Mississippi for navigation between the mouth of the Missouri and St. Paul, Minnesota, was authorized by Congress in 1878. This was to be accomplished by the use of wing dams and closure of chutes to secure a depth of 4.5 feet, eventually to be increased to 6 feet. In the period 1888 to 1906 "the rock cut through Rock Island Rapids was improved to a width of 400 feet and a depth of 6 feet." In 1905 an act was passed to replace the locks and lateral canal at Keokuk with a power dam and navigation locks (War Department Corps of Engineers 1940:6). This project was practically completed in 1913 (Coker 1914:5). An act passed in 1907 provided for a 6-foot channel from Minneapolis, Minnesota, to the mouth of the Missouri River to be accomplished by contraction works, as in the project of 1878, supplemented by dredging and a lateral canal with a navigation lock around the upper portion of the Rock Island rapids at Le Claire (War Department Corps of Engineers 1940:6).

The Board of Engineers for Rivers and Harbors concluded after an investigation that canalization of the Mississippi from the mouth of the Illinois to Minneapolis was the most feasible and economical method of obtaining a dependable 9-foot channel for navigation; plans included the construction of approximately 24 locks and dams (United States 72d Congress, 1st Session, 1932:2, 27). An act of 1930, as modified in 1935, authorized improvement of the Mississippi River from Minneapolis to the mouth of the Missouri River by means of locks and dams supplemented with dredging to provide a channel 9 feet in depth (War Department Corps of Engineers 1940:6). The upper Mississippi from Alton north was canalized by the time the present investigation was started in 1944, figs. 2, 3, 4, and 5. In the Alton-Dubuque section there were 14 locks and dams (Nos. 12–26, excluding 23).

Influence of the Missouri

In the above discussion the descriptions of several early writers were quoted regarding the confluence of the Missouri and Mississippi rivers and the influence of the Missouri on the Mississippi. Prior to agricultural development of the prairies, the upper Mississippi was apparently a relatively clear river, and below the mouth of the Missouri it was always muddy. The D-MR section of the Mississippi was found by the survey party in 1944 and 1946 to be quite muddy; however, it appeared less muddy than the MR-C section. In 1944 Platner (1946:16) found that the turbidity of the Mississippi just above the mouth of the Missouri averaged 300 ppm, whereas, below the mouth of the Missouri it increased to an average reading of 1,880 ppm. At Caruthersville, 306 miles below the mouth of the Missouri

this high turbidity had diminished only slightly. The turbidity of the Mississippi, according to Platner (1946:12), is caused largely by erosion silt with some detritus. In 1921 Galtsoff (1924:371) found the water in the upper Mississippi muddy even at low water stages and progressively more turbid as he moved downstream.

The current of the Mississippi is swifter below the mouth of the Missouri than above. This difference in current was apparent before canalization, as evidenced by Glazier (1891:314).

According to the War Department Corps of Engineers (1940:3) the velocities in the current of the Mississippi between the mouth of the Wisconsin River and Alton may vary from about 2 miles per hour at usual pool stages to about 4 miles per hour at high water. In the uncanalized or open-river section below Alton, the velocities range from 2.0 to 5.5 miles per hour, except through the Chain of Rocks near St. Louis. In this region velocities as high as 8 miles per hour may occur at both extreme high- and extreme low-water stages. In the pools formed by the locks and dams in the Alton-Dubuque section, the swiftest current appears in the upper parts of the pools.

The bottom of the river proper in the MR-C section is largely sand with occasional silt or mud. The flooded areas in which netting operations were conducted had chiefly mud bottom. The bottom of the canalized D-MR section of the Mississippi varies with location in the pools. In the upper parts of the pools where the current is swift, the bottoms are sand and gravel, whereas, in the middle and lower reaches of the pools, the bottoms are largely silt. The silting in the canalized section of the river is a result of reduction in current caused by the dams. Ellis (1931:4–5) made oxygen determinations of the Mississippi River in the Keokuk area prior to the canalization of the river above the dam at Keokuk (Lock and Dam No. 19). He found that the water before reaching the Lake Keokuk basin was carrying over 20 per cent more oxygen than after it was impounded in the basin. Some 30 miles below Dam No. 19, at La Grange, Missouri, the oxygen content of the water was 10 to 15 per cent less than above the impoundment.

Platner (1946:26) found that the river has a distinct seasonal oxygen pulse. In midwinter, when the river was frozen over with 4 to 8 inches of ice, the dissolved oxygen ranged from 12.40 ppm to 14.95 ppm. During times of low water, in August and September, it ranged from 3.00 to 7.10 ppm. In periods of high water it ranged from 4.30 to 11.50 ppm.

The flooded bottomlands in the canalized D-MR section of the river are less encroached upon by drainage districts, and they seem to provide more suitable backwater and sloughs for spawning, than the bottomlands in the extensive levee and drainage districts of the MR-C section.

On the silt bottom of Lake Keokuk (Pool No. 19), Ellis (1931:8–9) found a few fresh-water mussels near shore; otherwise, on this bottom he found little besides sludge worms, bloodworms, *Corethra* (*Chaoborus*), a few snails of the pulmonate group, tiny bivalves of the genus *Musculium*, and several species of leeches. In the area free of silt, such as on cinders, stones, and water-logged portions of trees, he found large numbers of caddisfly and Neuroptera larvae, flatworms, beetle larvae, and occasionally a few specimens of crayfish, gomphids (dragonfly nymphs), and leeches.

Pollution

Erosion silt is a constant form of pollution in the Caruthersville-Dubuque section of the Mississippi River. Although this form of pollution has long been associated with that part of the Mississippi below the mouth of the Missouri, it was not generally noted in the upper part of the river until after the development of intensive farming in the Middle West.

That silting tends to limit the reproduction of aquatic life has been demonstrated previously. Silting was pointed out as having a detrimental effect on trout and salmon eggs (Smith 1940:229) and on aquatic insects and other invertebrates (Ellis 1931, 1936). In the Des Moines River, high water combined with the river's increased silt load in a period of flood was shown to be an important limiting factor in the spawning success of minnows and other kinds of fishes (Starrett 1951:23).

The impounding of the upper Mississippi with a series of dams created favorable conditions for silting in that section of the river. This impounding was done largely during the thirties, and the present investigation was made perhaps too soon following this period to demonstrate the possible maximum effects that siltation may have on the upper Mississippi fishery.

Platner (1946:71–2) found pollution on the Mississippi limited largely to local areas below cities and industrialized sections. "Even though the volume of water is large enough and the dilution is great enough to render these pollutants harmless to the present fish fauna of the Mississippi River, one must remember that each small amount of material narrows the safety margin of the river." Platner concluded from his chemical studies that the river was not in a critical condition. He further concluded that in the upper section of the river, that is, north of the 420-mile mark above the mouth of the Ohio River (about 4 miles above Oquawka, Illinois), a more "favorable position" existed than in the lower section below mile 420. "Comparing the water quality of the Mississippi River with waters producing good fish fauna, it would be rated as good."

Ellis (1943) conducted a pollution study on the Mississippi River between Chain of Rocks (St. Louis area) and Cairo. He made this study in relation to garbage introduced into the river at St. Louis. In September of 1931 and 1934, during periods of low water, he found that the Mississippi lost a considerable portion of its dissolved oxygen load in the immediate vicinity of St. Louis. Below the city it made a temporary recovery, and between Crystal City, Missouri, and Cape Girardeau it again lost a large amount of its oxygen load. Between Crystal City and Claryville, Missouri, Ellis (1943:8) recorded a maximum of 3.86 ppm of total ammonia. He stated that "This total ammonia of approximately 4 p.p.m. represents a considerable nitrogenous load and shows definitely that the nitrogenous wastes from the St. Louis area are projected downstream 65 or 70 miles before the maximum ammonia production is reached." Below the mouth of the Ohio River, at Wickliffe, Kentucky, the total ammonia content dropped to 1.28 ppm. In 1944 Platner (1946:39) determined that from mile 580 above the mouth of the Ohio to mile 170 above (St. Louis area) the ammonia value ranged from 0.0 to 0.1 ppm and averaged 0.06 ppm. Below St. Louis the ammonia value increased slightly to an average of 0.12 ppm.

During the Caruthersville-Dubuque investigation, notes were taken on obvious pollution conditions existing in this section of the river. The fishery studies in the MR-C section were carried out largely during a period of high water, and in such a period the relative amount of pollutant other than silt is reduced. Commercial fishermen at Ste. Genevieve, Missouri, which is about 55 miles below St. Louis, complained that fishes they catch during the summer low-water stage frequently have an oily or gassy flavor. In the opinion of the fishermen this flavor is attributable to wastes discharged into the river at St. Louis. At Crystal City, also, fishermen registered complaints regarding pollution. In the vicinity of Cliff Cave (12 miles below St. Louis) test nets set in channels became clogged with masses of paper and partially disintegrated ground garbage discharged through the sewers of St. Louis. There, also, commercial fishermen reported that the fish in the area have an oily or gassy flavor; however, fish taken there in early July (Cape Girardeau gage 29.0 feet, table 1) which were served to members of the research party did not appear to have such a flavor. Perhaps this foreign taste is discernible only at low stages of the river when dilution is not sufficient to overcome the effect of the causal agent.

In 1947 commercial fishermen in the vicinity of Valmeyer, Illinois (28 miles below St. Louis), complained that often half of their catches were discarded because of an unpleasant taste resulting from pollution.

Recently Starrett & Harth (1950:8) reported that since 1948 a serious pollution problem has existed on the Mississippi from below Dam 26 to Cairo, and that commercial fishing is now almost nonexistent from the St. Louis area to the mouth of the Kaskaskia River.

Above the mouth of the Missouri River, pollution was observed in the vicinity of

two Illinois stations, Warsaw and Cordova. Warsaw is located about 1.5 miles below the mouth of the Des Moines River. This river receives a rather heavy load of pollution from the city of Keokuk, as was evidenced by the accumulation of sewage and other debris on the test nets. A large portion of this pollution in the Des Moines evidently comes from packing plants. Across the Mississippi River from Keokuk and just below Hamilton, Illinois, the malt wastes from a brewery are discharged into the river. It was obvious from the poor catches of commercial fishes in the test nets that the fish population is adversely affected by the pollution for several miles below Keokuk. According to local reports, commercial fishermen avoid setting their nets within the first few miles downstream from Keokuk on the Iowa side because of the unhealthy appearance of fishes that have been taken at that location. Carp taken in the test nets there appeared to have a rather milky coloration, and many of them showed a form of popeye. It was reported locally that, during the winter season, fishermen operate their nets on the Illinois side of the river near Warsaw to catch carp that apparently feed upon brewery waste and become very fat.

Commercial fishermen at Cordova complained that their hoop nets sometimes became clogged with a slimy substance that was later reported to be a filamentous organism attributed to conditions produced by wastes discharged from plants at Clinton, Iowa, 15 miles upstream. Seines became so loaded with this filamentous growth that they could not be hauled to shore and landed. No ill effect from the filamentous growth or the waste material supposedly responsible for it was observed on the fish at Cordova; in fact, the fish taken there appeared to be more plump than those in the usual catches taken elsewhere on the river. The local fishermen reported no mortality of fish or ill flavor of fish as a result of the waste material.

MATERIALS AND METHODS

In the 2 years of this investigation, collections were taken at 31 different field stations, fig. 1. One station in each year was designated as a key station, Grafton in 1944 and Andalusia in 1946, table 1. Each of the key stations was sampled three times during an 8-month period of field operations as a means of obtaining data on changes in a local fishery.

Usually sampling at a station covered 5 days. However, at some stations more time was spent because of certain unforeseen difficulties, such as those involving bad weather, poor catches, mechanical trouble, or the locating of fishing areas.

Descriptions of the habitats at the field stations are given in Appendix A. Data on the catches made at these stations are presented in tables 2, 3, 4, and 5 and Appendix B, tables 1 and 2.

Netting Operations

The Illinois Natural History Survey's laboratory boat, the *Anax,* was used as field headquarters during this investigation. All fish caught were brought to the laboratory boat. Aboard the boat, technicians measured and weighed each fish, removed scales or vertebrae for growth studies, and recorded the sex and gonad condition of the fish. The haul made with each type of gear, from each station, and in each fishing period was tabulated as an individual catch, and a record was made of specific information on habitat in which gear was fished.

The following types of fishing gear were used during the survey:

25-foot *Common Sense* minnow seine (mesh ¼ inch)

100-yard trammel nets (mesh 1½, 2, and 3 inches)

100-yard or 200-yard seine (mesh 1 inch)

Hoop nets (mesh 1, 2½, and 3 inches)

Wing nets, with and without leads (mesh 1, 1½, and 2½ inches)

Trap net (mesh 1¼ inches)

Basket trap

Trotline

The poundage and numbers of fishes caught by the various types of fishing gear are summarized in tables 2, 3, 4, and 5. Data on the fishes taken in the minnow seine hauls are not included in this paper. Selections of fishing sites were made by two field assistants of the Illinois Natural History Survey, Jacob H. Lemm and Daniel Avery, who had previously been commercial fishermen. Conversation with

Table 2.—Numbers of fish caught with various types of fishing gear in 1944 test-net operations in the Mississippi River at stations from Caruthersville, Missouri, to Warsaw, Illinois, inclusive.

Station	1-Inch Mesh Wing Nets With Leads	1-Inch Mesh Wing Nets Without Leads	1½-Inch Mesh Wing Nets	2½-Inch Mesh Wing Nets	2½-Inch Mesh Hoop Nets	Unclassified Wing Nets and Hoop Nets	Total Wing Nets and Hoop Nets	Trammel Nets	Angling	Basket Traps	Seines	Total Number of Specimens
Caruthersville, Mo.	60	153	—	2	—	243	458	—	—	—	—	458
Tiptonville, Tenn.	89	183	—	4	23	345	644	—	—	—	—	644
Cairo, Ill.	416	196	26	—	7	—	645	—	—	—	—	645
Cape Girardeau, Mo.	—	233	—	57	—	—	290	—	—	4	—	294
Grand Tower, Ill.	262	330	88	38	—	—	718	—	—	23	—	741
Chester, Ill.	216	85	53	—	—	—	354	—	—	3	—	357
Ste. Genevieve, Mo.	137	191	132	133	—	—	593	—	—	1	—	594
Crystal City, Mo.	157	174	58	69	21	—	479	—	—	—	—	479
Cliff Cave, Mo.	—	200	64	87	14	—	365	—	—	3	—	368
Missouri River (mouth)	190	871	81	67	34	—	1,243	—	1	13	—	1,257
Grafton, Ill. (March)	1,139	82	—	22	—	—	1,243	—	—	—	—	1,243
Grafton, Ill. (July)	434	381	174	31	5	—	1,025	9	—	—	—	1,034
Grafton, Ill. (Sept.)	—	493	48	7	6	—	554	—	—	—	—	554
Winfield, Mo.	—	572	56	56	13	—	697	—	—	9	361	1,067
Hamburg, Ill.	89	490	50	49	11	—	689	12	—	4	43	748
Louisiana, Mo.	—	247	33	11	2	—	293	—	—	13	31	337
Cincinnati Landing, Ill.	60	140	23	19	4	—	246	—	—	—	—	246
Hannibal, Mo.	29	208	26	17	13	—	293	—	—	—	38	331
Quincy, Ill.	—	506	33	46	11	—	596	103	—	—	283	982
Canton, Mo.	—	363	19	33	57	—	472	—	—	—	70	542
Warsaw, Ill.	—	326	64	87	59	—	536	3	—	—	53	592
Total	*3,278*	*6,424*	*1,028*	*835*	*280*	*588*	*12,433*	*127*	*1*	*73*	*879*	*13,513*

Table 3.—Pounds of fish caught with various types of fishing gear in 1944 test-net operations in the Mississippi River at stations from Caruthersville, Missouri, to Warsaw, Illinois, inclusive.

Station	1-Inch Mesh Wing Nets With Leads	1-Inch Mesh Wing Nets Without Leads	1½-Inch Mesh Wing Nets	2½-Inch Mesh Wing Nets	2½-Inch Mesh Hoop Nets	Unclassified Wing Nets and Hoop Nets	Total Wing Nets and Hoop Nets	Trammel Nets	Angling	Basket Traps	Seines	Total Pounds Caught
Caruthersville, Mo.	36.66	156.24	—	2.30	—	122.61	317.81	—	—	—	—	317.81
Tiptonville, Tenn.	72.05	142.71	—	6.05	32.29	270.50	523.60	—	—	—	—	523.60
Cairo, Ill.	522.34	196.14	32.27	—	12.28	—	763.03	—	—	—	—	763.03
Cape Girardeau, Mo.	—	502.20	—	246.92	—	—	749.12	—	—	4.05	—	753.17
Grand Tower, Ill.	344.36	355.43	99.71	118.48	—	—	917.98	—	—	12.69	—	930.67
Chester, Ill.	309.45	157.72	115.97	—	—	—	583.14	—	—	2.16	—	585.30
Ste. Genevieve, Mo.	211.79	341.45	226.83	283.42	—	—	1,063.49	—	—	2.23	—	1,065.72
Crystal City, Mo.	137.35	254.28	121.07	196.49	80.12	—	789.31	—	—	—	—	789.31
Cliff Cave, Mo.	—	367.73	152.51	242.85	37.30	—	800.39	—	—	8.00	—	808.39
Missouri River (mouth)	133.82	574.26	141.22	169.59	97.79	—	1,116.68	—	0.12	11.41	—	1,128.21
Grafton, Ill. (March)	631.51	62.83	—	51.44	—	—	745.78	—	—	—	—	745.78
Grafton, Ill. (July)	222.47	239.46	72.82	71.59	16.28	—	622.62	10.15	—	—	—	632.77
Grafton, Ill. (Sept.)	—	276.41	36.31	13.55	11.29	—	337.56	—	—	—	—	337.56
Winfield, Mo.	—	425.60	46.88	116.49	25.32	—	614.29	—	—	6.88	245.27	866.44
Hamburg, Ill.	35.97	302.29	37.22	74.57	33.08	—	483.13	14.45	—	1.07	35.46	534.11
Louisiana, Mo.	—	216.32	36.24	19.32	2.47	—	274.35	—	—	13.95	46.10	334.40
Cincinnati Landing, Ill.	49.15	211.99	42.53	30.07	14.50	—	348.24	—	—	—	—	348.24
Hannibal, Mo.	28.17	237.60	32.59	42.34	77.82	—	418.52	—	—	—	29.57	448.09
Quincy, Ill.	—	392.42	55.84	125.58	65.44	—	639.28	185.22	—	—	380.51	1,205 01
Canton, Mo.	—	275.46	24.75	57.31	95.82	—	453.34	—	—	—	70.89	524.23
Warsaw, Ill.	—	353.76	74.90	187.47	152.41	—	768.54	6.94	—	—	59.44	834.92
Total	*2,735.09*	*6,042.30*	*1,349.66*	*2,055.83*	*754.21*	*393.11*	*13,330.20*	*216.76*	*0.12*	*62.44*	*867.24*	*14,476.76*

Table 4.—Numbers of fish caught with various types of fishing gear in 1940 test-net operations in the Mississippi River at stations from Burlington, Iowa, to Dubuque, Iowa, inclusive.

Station	1-Inch Mesh Wing Nets	1-Inch Mesh Hoop Nets	2½-Inch Mesh Wing Nets	2½-Inch Mesh Hoop Nets	3-Inch Mesh Hoop Nets	Total Wing Nets and Hoop Nets	1¼-Inch Mesh Traps	Trammel Nets	Seines	Trot-lines	Total Number of Specimens
Burlington, Ia.	873	24	47	50	—	994	—	75	—	—	1,069
Oquawka, Ill.	412	5	43	63	—	523	—	—	—	—	523
New Boston, Ill.	1,095	33	54	52	—	1,234	—	41	50	2	1,327
Muscatine, Ia.	420	6	26	121	—	573	—	262	133	—	968
Fairport, Ia.	351	1	55	30	—	437	—	69	85	—	591
Andalusia, Ill. (April)	286	6	28	5	—	325	—	146	—	—	471
Andalusia, Ill. (June)	561	30	90	124	—	805	—	56	101	—	962
Andalusia, Ill. (Sept.)	387	13	27	24	45	496	69	335	167	—	1,067
Pleasant Valley, Ia.	481	9	33	57	—	580	—	29	—	—	609
Cordova, Ill.	440	35	23	31	—	529	—	72	58	—	659
Fulton, Ill.	1,522	46	41	124	—	1,733	—	79	—	—	1,812
Sabula, Ia.	698	16	15	41	—	770	—	48	—	—	818
Bellevue, Ia.	458	7	15	29	—	509	107	65	—	—	681
Dubuque, Ia.	727	20	29	37	—	813	73	81	—	—	967
Total	*8,711*	*251*	*526*	*788*	*45*	*10,321*	*249*	*1,358*	*594*	*2*	*12,524*

Table 5.—Pounds of fish caught with various types of fishing gear in 1946 test-net operations in the Mississippi River at stations from Burlington, Iowa, to Dubuque, Iowa, inclusive.

Station	1-Inch Mesh Wing Nets	1-Inch Mesh Hoop Nets	2½-Inch Mesh Wing Nets	2½-Inch Mesh Hoop Nets	3-Inch Mesh Hoop Nets	Total Wing Nets and Hoop Nets	1¼-Inch Mesh Traps	Trammel Nets	Seines	Trot-lines	Total Pounds Caught
Burlington, Ia.	396.48	12.01	165.91	116.27	—	690.67	—	231.53	—	—	922.20
Oquawka, Ill.	274.36	11.50	124.83	139.16	—	549.85	—	—	—	—	549.85
New Boston, Ill.	625.83	10.47	162.51	159.41	—	958.22	—	116.18	21.62	2.60	1,098.62
Muscatine, Ia.	198.32	2.29	65.76	266.41	—	532.78	—	847.82	41.56	—	1,422.16
Fairport, Ia.	352.81	0.18	124.73	137.11	—	614.83	—	190.85	123.01	—	928.69
Andalusia, Ill. (April)	181.08	2.06	87.24	9.73	—	280.11	—	194.38	—	—	474.49
Andalusia, Ill. (June)	569.54	38.69	240.22	471.36	—	1,319.81	—	81.22	86.90	—	1,487.93
Andalusia, Ill. (Sept.)	192.69	20.28	83.30	72.10	138.18	506.55	112.58	854.66	171.25	—	1,645.04
Pleasant Valley, Ia.	446.76	6.65	112.00	241.24	—	806.65	—	47.22	—	—	853.87
Cordova, Ill.	317.83	16.86	71.63	169.62	—	575.94	—	189.74	10.50	—	776.18
Fulton, Ill.	768.51	58.80	109.42	349.91	—	1,286.64	—	105.70	—	—	1,392.34
Sabula, Ia.	320.10	21.80	43.92	164.06	—	549.88	—	108.24	—	—	658.12
Bellevue, Ia.	255.55	10.29	51.02	126.84	—	443.70	112.14	140.63	—	—	696.47
Dubuque, Ia.	426.96	6.30	116.97	151.67	—	701.90	55.84	153.79	—	—	911.53
Total	*5,326.82*	*218.18*	*1,559.46*	*2,574.89*	*138.18*	*9,817.53*	*280.56*	*3,261.96*	*454.84*	*2.60*	*13,817.49*

Fig. 6.—Commercial fishermen setting a trammel net around a school of carp on the Mississippi River. This type of net was used at several test-net stations.

cal commercial fishermen often proved value in locating a good fishing ground id in selecting effective types of fishing ar. The best available fishing sites were lected, rather than particular types of bitat at each station.

Hoop nets and wing nets usually were ted after one overnight set. The number of nets used varied with fishing conditions and season.

Trammel-net sets were made at several ations primarily for taking carp and ffalo, fig. 6.

Trammel-net floats were made at stations having smooth bottom and sufficient current to float the nets downstream. hese proved to be effective for catching urgeon.

Basket traps, usually baited with cheese rapings, were not very satisfactory since was necessary to take the traps from e water when moving upstream to a new ation. The traps are considered by me fishermen to be effective for catch when left in the water over long riods.

Seines could be used only at stations aving sufficient beach to permit efficient nding.

The difficulty of obtaining bait discouraged the use of trotlines.

Two rowboats powered with outboard motors were used in carrying out fishing operations from the *Anax*. When the survey party was traveling between stations these boats were loaded with fishing gear and towed astern of the *Anax*.

Effectiveness of Gear

Each of the various types of gear employed by commercial fishermen is designed for use in a particular type of habitat and for catching a selected kind of fish. The effectiveness and selectivity of gear are mentioned here merely to manifest some of the difficulties encountered in determining the species composition of the fishes in the river, on the basis of catches taken with commercial gear.

The efficiency of hoop nets and wing nets in catching fish decreases during the warm months of the year. The actual poundages and numbers of fish taken at the various stations in the Caruthersville-Dubuque investigation are therefore not indicative necessarily of the abundance of a species at a particular station. Perhaps

Table 6.—Accepted common, scientific, and local names of fishes occurring in Mississippi River test-net or other survey collections between Caruthersville, Missouri, and Dubuque, Iowa, 1944 and 1946.*

Accepted Common Name	Scientific Name	Local Names
Shovelnose sturgeon	*Scaphirhynchus platorynchus* (Rafinesque)	Hackleback, switchtail, sand sturgeon
Paddlefish	*Polyodon spathula* (Walbaum)	Spoonbill cat, spoony
Longnose gar	*Lepisosteus osseus* (Linnaeus)	Garpike, billfish, billy gar
Shortnose gar	*Lepisosteus platostomus* Rafinesque	Duckbill gar
Alligator gar	*Lepisosteus spatula* Lacépède	Mississippi alligator gar
Bowfin	*Amia calva* Linnaeus	Dogfish, grindle, cypress trout, mudfish
Mooneye	*Hiodon tergisus* Le Sueur	Toothed herring, white shad
Goldeye	*Amphiodon alosoides* Rafinesque	Mooneye
Skipjack	*Pomolobus chrysochloris* Rafinesque	Golden shad, river herring, blue herring
Gizzard shad	*Dorosoma cepedianum* (Le Sueur)	Hickory shad
American eel	*Anguilla bostoniensis* (Le Sueur)	Freshwater eel
Blue sucker	*Cycleptus elongatus* (Le Sueur)	Missouri sucker, bluefish, blackhorse, gourdseed sucker
Bigmouth buffalo	*Megastomatobus cyprinella* (Valenciennes)	Redmouth buffalo, stubnose buffalo, roundhead buffalo, brown buffalo, goarhead, bullhead buffalo, bullmouth buffalo, hullnose buffalo, slough buffalo, trumpet buffalo
Black buffalo	*Ictiobus niger* (Rafinesque)	Mongrel buffalo, bugler, rooter, reefer, round buffalo, sheepshead buffalo, blue buffalo
Smallmouth buffalo	*Ictiobus bubalus* (Rafinesque)	Razorback buffalo, roachback buffalo, humpback buffalo, channel buffalo, liner buffalo, quillback buffalo
Quillback	*Carpiodes cyprinus* (Le Sueur)	Silver carp, carpsucker, coldwater carp
River carpsucker	*Carpiodes carpio* (Rafinesque)	Silver carp, carpsucker
Highfin sucker	*Carpiodes velifer* (Rafinesque)	Silver carp, river carp, carpsucker
White sucker	*Catostomus commersonnii* (Lacépède)	Common sucker, fine-scaled sucker
Spotted sucker	*Minytrema melanops* (Rafinesque)	Striped sucker
Silver redhorse	*Moxostoma anisurum* (Rafinesque)	Silver mullet
Northern redhorse	*Moxostoma aureolum* (Le Sueur)	Des Moines plunger, mullet, common redhorse

Golden shiner	*Notemigonus crysoleucas* (Mitchill)	American bream, roach
Channel catfish	*Ictalurus lacustris* (Walbaum)	Fiddler, catfish, channel cat, spotted cat
Blue catfish	*Ictalurus furcatus* (Le Sueur)	Fulton cat, Mississippi cat, chucklehead cat, coal boater
Yellow bullhead	*Ameiurus natalis* (Le Sueur)	Yellow-bellied cat, greaser
Brown bullhead	*Ameiurus nebulosus* (Le Sueur)	Speckled bullhead
Black bullhead	*Ameiurus melas* (Rafinesque)	Bullhead
Flathead catfish	*Pilodictis olivaris* (Rafinesque)	Hoosier, goujon, shovelnose cat, mudcat, yellow cat, Johnny cat, Morgan cat, flat belly
Pike	*Esox lucius* Linnaeus	Pickerel, great northern pike, northern pike, northern
Grass pickerel	*Esox vermiculatus* Le Sueur	Little pickerel, grass pike, mud pickerel
Yellow pikeperch	*Stizostedion vitreum vitreum* (Mitchill)	Walleye, jack, jack salmon
Sauger	*Stizostedion canadense* (Smith)	Sandpike, jack salmon
Smallmouth black bass	*Micropterus dolomieu* Lacépède	Smallmouth
Spotted black bass	*Micropterus punctulatus* (Rafinesque)	Kentucky bass
Largemouth black bass	*Micropterus salmoides* (Lacépède)	Black bass, bigmouth bass, line side, green bass, green trout
Green sunfish	*Lepomis cyanellus* Rafinesque	Black perch
Organgespotted sunfish	*Lepomis humilis* (Girard)	
Bluegill	*Lepomis macrochirus* Rafinesque	Bream, sunfish
Warmouth	*Chaenobryttus coronarius* (Bartram)	Goggle-eye, warmouth bass
Flier	*Centrarchus macropterus* (Lacépède)	Round sunfish, longfinned sunfish, round bass
White crappie	*Pomoxis annularis* Rafinesque	Crappie, newlight
Black crappie	*Pomoxis nigro-maculatus* (Le Sueur)	Calico bass, strawberry bass
White bass	*Lepibema chrysops* (Rafinesque)	Silver bass, striped bass, streaker
Yellow bass	*Morone interrupta* Gill	Streaker, barfish
Freshwater drum	*Aplodinotus grunniens* Rafinesque	White perch, perch, sheepshead, gaspergou, grunting perch, croaker

* Because of the pressure of field work, most of the fish handled in the test-net collections could be classified only to species. Some, however, could be classified further, and the following subspecies are believed to have been represented in the sampling: *Lepisosteus osseus oxyurus* Rafinesque, northern longnose gar; *Carpiodes carpio carpio* (Rafinesque), northern carpsucker; *Catostomus commersonnii commersonnii* (Lacépède), white sucker; *Notemigonus crysoleucas auratus* (Rafinesque), western golden shiner; *Ictalurus lacustris punctatus* (Rafinesque), southern channel catfish; *Ictalurus furcatus furcatus* (Valenciennes), blue catfish; *Ameiurus natalis natalis* (Le Sueur), northern yellow bullhead; *Ameiurus nebulosus marmoratus* (Holbrook), brown bullhead; *Ameiurus melas melas* (Rafinesque), northern black bullhead; *Stizostedion canadense canadense* (Smith), eastern sauger; *Micropterus dolomieu dolomieu* Lacépède, northern smallmouth black bass; *Micropterus punctulatus punctulatus* (Rafinesque), northern spotted black bass; *Lepomis macrochirus macrochirus* Rafinesque, common bluegill. Accepted common and scientific names in the table are from Special Bulletin No. 1 of the American Fisheries Society (1948); most subspecific names in the footnote are from Hubbs & Lagler (1947).

only if the efficiency of the nets remained constant throughout the year could a just comparison on a pounds-per-net-day basis be made of the catches at various stations.

The seasonal activities and habitat preferences of various fishes complicate sampling with commercial gear. For example, a type of gear that is very effective for catching a certain species in the spring may be ineffective later in the year.

Throughout this investigation various types of gear were used and every effort was made to obtain a large catch at each station. To obtain large catches during the summer, it was usually necessary to increase the amount of fishing effort, table 1.

The composition of the catch at each station in the Caruthersville-Dubuque section of the Mississippi is presented in Appendix B. The data do not permit further valid statistical treatment. Difficulties encountered in netting preclude the assumption that a random sample was obtained.

Classification of Fishes

Among fishermen, the species of fishes found in the Mississippi River are known by many names. These names are often local in use and are of little value to fishermen or scientists working in another area. Among scientists, also, confusion of names exists. In an attempt to bring order out of the confusion of common and scientific names, the American Fisheries Society (1948) issued a special publication listing the generally accepted common and scientific names of the better-known fishes of the United States and Canada. In the present paper, most of the names—both common and scientific—adhere to those given in this special publication. The accepted common and scientific names and the widely used vernacular names of fishes taken in the Caruthersville-Dubuque survey are included in table 6.

The Mississippi River fishes of direct importance to man are treated as either commercial or sport fishes. It will be noted that certain species, particularly bullheads and other catfishes, included with the commercial fishes are also of importance to the sport fishery.

In the MR-C section of the river the mooneye (*Hiodon tergisus*) and the goldeye (*Amphiodon alosoides*) are of little importance commercially, whereas in parts of the D-MR section they are of some economic value. The data pertaining to these fishes are included in 1944 with the forage fishes and in 1946 with the commercial fishes. In tables where data are presented for both years, these fishes are considered as forage fishes.

The forage fishes may be defined usually as those of value only as food for other fishes. This group is composed largely of minnows (Cyprinidae); however, a member of the herring family, the gizzard shad (*Dorosoma cepedianum*), forms an important part of forage in the Mississippi River.

The gars (*Lepisosteus* spp.) and the bowfin (*Amia calva*) are not considered of sufficient commercial value to be included with the commercial fishes. They are regarded as a group known to prey upon other fishes and are presented as predators. Many of the other fishes, such as catfishes (Ameiuridae), black basses (*Micropterus* spp.), white bass (*Lepibema chrysops*), crappies (*Pomoxis* spp.), sauger (*Stizostedion canadense*), yellow pikeperch (*Stizostedion vitreum vitreum*), and pike (*Esox lucius*), are predatory fishes; however, superficially at least they are of more importance to man as commercial or sport fishes.

COMMERCIAL FISHES

Commercial fishes amounted to 76.4 per cent by weight of all fishes caught in the Caruthersville-Dubuque test-net survey of the Mississippi River. In 1946, the Mississippi River catch reported by commercial fishermen of Missouri, Iowa, and Illinois had a market value, based on local prices, of $396,824. If all the commercial fishermen of these states had reported all their Mississippi River catches and if the calculations had been based on prices actually received, rather than on local prices, the calculated value of the catch would have been higher. Many small operators who sold their fish locally did not report their catches, and many large operators shipped their fish to distant markets where they received prices higher than those prevailing in the local markets.

The species composition of the commercial catch in the Caruthersville-Dubuque

Table 7.—Commercial catches of some species of fishes from the Mississippi River for the years 1894, 1899, 1931, and 1946 as recorded for the states of Illinois, Missouri, and Iowa.* For purposes of comparison, catches are further expressed as per cents of the 1899 catch.

Year and State	Carp		Buffalo		Catfish and Bullhead		Freshwater Drum		Shovelnose Sturgeon		Lake Sturgeon		Paddlefish		Eel	
	Weight in Pounds	Per Cent of 1899 Catch	Weight in Pounds	Per Cent of 1899 Catch	Weight in Pounds	Per Cent of 1899 Catch	Weight in Pounds	Per Cent of 1899 Catch	Weight in Pounds	Per Cent of 1899 Catch	Weight in Pounds	Per Cent of 1899 Catch	Weight in Pounds	Per Cent of 1899 Catch	Weight in Pounds	Per Cent of 1899 Catch
1894																
Illinois	235,848	16.30	1,937,596	122.87	806,120	172.10	421,722	166.23	40,297	38.51	37,366	120.64	117,446	79.24	17,781	110.79
Missouri	47,289	11.31	1,178,745	154.41	546,986	157.42	163,665	143.25	30,189	39.82	37,877	521.08	106,976	100.38	6,241	191.68
Iowa	163,309	16.61	1,064,166	129 10	849,001	126.92	658,364	215.69	7,572	108.02	43,312	135.06	45,201	219.00	19,250	192.92
1899																
Illinois	1,446,698	100.00	1,576,998	100.00	468,403	100.00	253,696	100.00	104,644	100.00	30,974	100.00	148,216	100.00	16,050	100.00
Missouri	417,980	100.00	763,386	100 00	347,479	100 00	114.255	100.00	75,810	100.00	7,269	100.00	106,576	100.00	3,256	100.00
Iowa	983,305	100.00	824,291	100.00	668,935	100 00	305,230	100.00	7,010	100.00	32,068	100.00	20,640	100 00	9,978	100.00
1931																
Illinois	562,999	38.92	252,632	16 02	296,374	63.27	105,982	41.78	25,366	24.24	0	—	23,485	15.85	835	5.20
Missouri	265,005	63 40	112,140	14 69	†	—	26,845	23 50	14,239	18.78	0	—	37,388	35.08	1,055	32.40
Iowa	1,506,654	153 22	738,015	89 53	446,790	66.79	329,049	107.80	17,500	249.64	0	—	9,400	45.54	325	3.26
1946																
Illinois	792,250	54 76	398,515	25.27	259,686	55 44	173,429	68.36	12,493	11.94	0	—	26,853	18.12	‡	—
Missouri	217,909	52 13	83,255	10 91	†	—	55,432	48.52	4,361	5.75	0	—	10,213	9.58	566	17.38
Iowa	800,332	81.39	628,549	76.25	342,345	51 18	244.960	80 25	13,327	190 11	0	—	**	—	1,525	15.28

* 1894 (Smith 1898); 1899 (Townsend 1902); 1931 (Fiedler 1933); 1946 (unpublished records of the Illinois, Iowa, and Missouri conservation departments). The 1946 figures are based on yield reports submitted by commercial fishermen to their respective state conservation departments. The Iowa figure includes reports from more than 90 per cent of the state's licensed commercial fishermen, whereas the Illinois figure includes reports from only 26.5 per cent and the Missouri figure 55.5 per cent of the commercial fishermen of the respective states. Although the number of returns from the latter two states is small, it is believed that the statistics include most of the large operators and represent a large part of the actual catch.

† Channel catfish illegal to take commercially.

‡ No data.

** Illegal to take.

Table 8.—Commercial catches in pounds of the more important fishes from the Mississippi River at Lake Keokuk, or Pool No. 19 (Illinois and Iowa), and between the northern border of Illinois and Lake Keokuk (Illinois) for various years for which data are available, 1914–1946.*

Year	Lake Keokuk (Illinois and Iowa)						Northern Illinois Border to Lake Keokuk (Illinois)					
	Carp	Buffalo-fishes	Catfishes and Bullheads	Freshwater Drum	Paddlefish	Shovelnose Sturgeon	Carp	Buffalo-fishes	Catfishes and Bullheads	Freshwater Drum	Paddlefish	Shovelnose Sturgeon
1914	302,365	249,900	71,535	26,860	0	0	—	—	—	—	—	—
1917	762,259	696,543	109,904	160,554	927	0	—	—	—	—	—	—
1922	276,431	113,946	183,919	65,040	27,405	600	—	—	—	—	—	—
1927	291,199	67,872	140,343	27,538	1,249	0	—	—	—	—	—	—
1931	170,149	112,365	119,670	72,829	7,100	300	—	—	—	—	—	—
1932	209,750	82,500	87,500	91,750	1,300	1,100	456,500	183,100	148,700	139,500	500	2,400
1933	213,000	75,800	88,500	87,500	0	875	351,600	166,800	107,950	131,500	500	10,200
1934	352,500	84,600	108,500	133,500	14,400	0	396,800	183,300	162,600	199,700	2,100	7,000
1935	386,200	102,500	120,500	119,600	10,700	225	373,000	191,000	155,800	129,900	2,250	0
1936	480,200	131,000	184,800	127,400	4,400	0	623,200	334,700	237,700	167,800	2,100	1,000
1937	527,000	195,000	170,500	166,300	13,200	1,300	356,000	177,500	146,900	134,500	3,700	0
1938	348,700	112,400	70,200	77,300	2,400	0	359,400	197,200	94,100	104,100	0	0
1946	247,506	92,774	95,703	68,422	397	2,265	239,647	151,286	69,206	47,371	3,753	3,172

* 1914, 1917, 1922, and 1927 (Coker 1929); 1931 (Fiedler 1933); 1932 (Fiedler, Manning, & Johnson 1934); 1933 (Fiedler 1935); 1934 (Fiedler 1936); 1935 (Fiedler 1938*a*); 1936 (Fiedler 1938*b*); 1937 (Fiedler 1940); 1938 (Fiedler 1941); and 1946 (unpublished records of the Illinois and Iowa conservation departments, as explained in first footnote to table 7).

Table 9.—Species composition of Mississippi River commercial catches based on per cents of total weights published in commercial fishery reports for Illinois and Missouri for 1894, 1899, 1931, and 1946.*

YEAR AND STATE	PER CENT CARP	PER CENT BUFFALO-FISHES	PER CENT CATFISHES AND BULLHEADS	PER CENT FRESH-WATER DRUM	PER CENT GAME FISHES	PER CENT STURGEON	PER CENT PADDLE-FISH	PER CENT PIKE	PER CENT YELLOW PIKE-PERCH AND SAUGER	PER CENT MISCELLANEOUS†	TOTAL WEIGHT IN POUNDS
1894											
Illinois	5.93	48.70	20.26	10.60	2.53	1.95	2.95	0.25	0.45	6.39	3,978,731
Missouri	2.04	50.90	23.62	7.07	1.37	2.94	4.62	0.01	0.52	6.92	2,315,996
1899											
Illinois	33.43	36.44	10.82	5.86	2.78	3.13	3.42	0.13	0.35	3.64	4,327,766
Missouri	21.63	39.51	17.98	5.91	1.01	4.30	5.52	0.00	0.23	3.91	1,932,296
1931											
Illinois	44.02	19.75	23.17	8.29	Illegal‡	1.98	1.84	Illegal	Illegal	0.94	1,278,928
Missouri	49.08	20.77	9.81	4.97	Illegal	2.64	6.92	Illegal	Illegal	5.84	539,997
1946											
Illinois	46.19	23.24	15.14	10.11	Illegal	0.73	1.57	Illegal	Illegal	3.03	1,715,133
Missouri	49.14	18.78	13.03	12.50	Illegal	0.98	2.30	Illegal	Illegal	3.26	443,423

* 1894 (Smith 1898); 1899 (Townsend 1902); 1931 (Fiedler 1933); and 1946 (unpublished reports of the Illinois, Iowa, and Missouri conservation departments as explained in first footnote to table 7).

† The 1946 Illinois catch does not include the eel.

‡ Two hundred pounds of white bass reported by Fiedler (1933) are included in total weight figure for Illinois, 1931.

section of the Mississippi has changed considerably during the past 50 years. Commercial catch statistics relative to that section of the river bordering Missouri, Illinois, and Iowa are given in tables 7, 8, and 9. In 1894, carp (*Cyprinus carpio*) represented only 5.9 per cent by weight of the Mississippi River commercial catch by Illinois fishermen, table 9, whereas in 1946 carp amounted to 46.2 per cent of this catch. In 1894 the buffalofishes (Catostomidae) dominated the catch, as does the carp today. In table 7 the 1899 commercial report is used as a basis for interpreting trends in the catch of several commercial fishes. From these data it is apparent that the carp, buffalofishes, catfishes, and freshwater drum (*Aplodinotus grunniens*) have not been so greatly affected by man's modification of the river as have the paddlefish (*Polyodon spathula*), lake sturgeon (*Acipenser fulvescens*), and American eel (*Anguilla bostoniensis*).

The various species of buffalofishes and catfishes are difficult to distinguish, and commercial fishermen usually refer to them by local names, which sometimes are meaningless to fish technicians. This practice has necessitated that workers compiling statistics of commercial catches of Mississippi River fishes rely on the inclusive groupings of these fishes rather than on individual species. These fishes are discussed here on the basis of the inclusive groupings and their constituent species as determined during the survey.

Sturgeons

ACIPENSERIDAE

This family of fishes has a wide distribution in the northern parts of Asia, Europe, and North America. Some members are marine and ascend fresh-water rivers to spawn, whereas others are wholly confined to fresh water. Only three species of the seven known to occur in North American waters are found in the Caruthersville-Dubuque section of the Mississippi River.

The shovelnose sturgeon (*Scaphirhynchus platorynchus*) is now the only sturgeon of any commercial importance in the river. In 1946 a total of 30,181 pounds of this fish were reported as taken commercially from the Mississippi by Illinois, Iowa, and Missouri fishermen. As shown in table 7, the Mississippi River commercial catch of this sturgeon reported for Illinois and Missouri in 1946 was only 11.9 and 5.8 per cent, respectively, of the amounts reported for these states in 1899. The 1946 catch reported for Iowa was 190.1 per cent of the amount of the 1899 catch; however, it will be noted in table 7 that the 1899 catch for Iowa was very low as compared with that for Illinois and Missouri. From these statistics it must be concluded that the shovelnose sturgeon is much less abundant than it was prior to 1900.

It would be impossible to ascertain all of the contributing factors causing the decline of this fish. As determined by trammel netting, the shovelnose sturgeon is found most commonly over a sand or gravel bottom in the presence of some current. This type of habitat in the D-MR section of the Mississippi has been reduced by canalization and siltation. Several stomachs of the shovelnose sturgeon were examined from specimens taken at Andalusia and were found to contain mayfly nymphs of the genus *Hexagenia*. The siltation has reduced suitable habitats for many of the insect nymphs and larvae which form a part of the sturgeon diet. According to Coker (1930: 152), fish of this species were once considered a nuisance in the Mississippi and many of them were destroyed by fishermen when taken in nets.

Very little is known regarding the habits of the shovelnose sturgeon, and a lack of knowledge of this fish has been a handicap in formulating legislation to protect it.

In the Caruthersville-Dubuque survey all of the catches of shovelnose sturgeon, with the exception of one, were taken by trammel-net floating. As tables 2 and 3 indicate, no trammel-net floating was done below the mouth of the Missouri River, which apparently explains the absence of the shovelnose sturgeon from catches in the MR-C section. That this sturgeon still is present in this section is evidenced by commercial reports and by specimens seen during the survey. At Hickman, Kentucky, in 1944, fishermen were seen catching shovelnose sturgeons on trotlines baited with worms. In the section of the

Table 10.—Length-frequency distribution, average lengths,* and average weights of shovelnose sturgeons taken from the Mississippi River at Burlington, Iowa, and Andalusia, Illinois, in 1946.

STANDARD LENGTH IN INCHES	BURLINGTON, IOWA† APRIL 12, 1946	ANDALUSIA, ILL. APRIL, 1946	ANDALUSIA, ILL. JUNE, 1946	ANDALUSIA, ILL. SEPTEMBER, 1946	TOTAL
13.8–14.7	—	—	1	—	1
14.8–15.7	—	—	—	1	1
15.8–16.7	—	1	—	6	7
16.8–17.7	—	1	—	5	6
17.8–18–7	—	5	—	1	6
18.8–19.7	2	11	3	4	20
19.8–20.7	2	7	8	5	22
20.8–21.7	3	18	6	9	36
21.8–22.7	—	18	7	12	37
22.8–23.7	3	22	11	6	42
23.8–24.7	9	18	5	13	45
24.8–25.7	2	18	3	7	30
25.8–26.7	4	11	4	3	22
26.8–27.7	2	7	2	1	12
27.8–28.7	1	5	3	3	12
28.8–29.7	—	1	2	—	3
29.8–30.7	—	1	1	1	3
30.8–31.7	—	2	—	—	2
31.8–32.7	2	—	—	—	2
32.8–33.7	—	1	—	—	1
Total number	*30*	*147*	*56*	*77*	*310*
Average length	24.5	23.4	23.3	22.2	23.2
Average weight in pounds	1.69	1.34	1.45	1.07	1.33

* Length from tip of snout to base of caudal filament.
† The specimens were taken near Burlington by J. O. Kurrle, a commercial fisherman.

river between Burlington and Dubuque the shovelnose sturgeon amounted to 2.6 per cent by weight of the total catch. This figure indicates that the species is not scarce in this section of the river and that it is able to maintain itself in spite of canalization. The commercial take of this species for intermittent years, 1914 through 1946, at Lake Keokuk (Pool No. 19) and, 1932 through 1946, in that part of the river between Lake Keokuk and the northern border of Illinois is given in table 8. For the years included in this table the shovelnose sturgeon formed only a small portion of the commercial catch.

Sex determinations were made of 307 of the 310 shovelnose sturgeons caught in 1946. In April the males predominated in the collections taken in the channel of the river by trammel-net floating. During this month males made up 93 per cent of the catch of this species at Burlington and 99 per cent at Andalusia. At Andalusia in June males represented only 41 per cent of the catch and in September 57 per cent. The predominance of males in the channel in April indicates that the females seek another habitat during this season, returning to the channel by June. According to Harry E. Finley, a commercial fisherman at Andalusia, female shovelnose sturgeons are seldom taken by commercial fishermen during April and May, which he believes are the months of the spawning season. During this period, in his opinion, the females seek cover and consequently do not occur in the open water of the channel where trammel nets are normally drifted.

Observations on size and condition of gonads of the shovelnose sturgeon indicate that the males reach maturity at lengths of 19.5 to 22 inches (standard length, which is length from tip of snout to base of caudal filament); the smallest mature female examined was 25 inches in length. The length-frequency distribution of the fishes taken at Burlington and Andalusia, table 10, indicates that trammel nets catch many sturgeons less than 25 inches in

length. The adoption of a legal minimum length of 25 inches would afford some protection to immature shovelnose sturgeons.

The average weight of shovelnose sturgeons taken during the survey was only 1.3 pounds (excluding the Burlington catch). Fish of this species are not known to attain such great weights as the lake sturgeon.

The fishery statistics for 1894 and 1899, table 7, indicate that the lake sturgeon (*Acipenser fulvescens*) was once rather common in the Mississippi River. Forbes & Richardson (1920: 25), writing in 1908 or before, stated that this species was steadily decreasing and only rarely was taken in the Mississippi on the borders of Illinois. No lake sturgeon was caught in the test nets in 1944 or 1946. A lake sturgeon weighing 32 pounds was taken May 6, 1946, in a hoop net of a commercial fisherman at New Boston, Illinois. This was the only specimen of this species observed by the work party during the 2 years of the field investigation. The lake sturgeon is now taken only occasionally by commercial fishermen of the area.

More than 45 years ago, Forbes & Richardson (1905:38) described as *Parascaphirhynchus albus* a species of sturgeon taken from the Mississippi River near Alton and Grafton. They gave it the common name white sturgeon, the term by which it was known to fishermen of the locality. Later, Forbes & Richardson (1920: 29) stated that this sturgeon was known to them only from the Mississippi River at Grafton and Alton, where it was rare, but that it was said by a commercial fisherman to be somewhat commoner in the lower part of the Missouri.

In 1944 one specimen of this species was procured from an angler fishing in the Mississippi River just above the mouth of the Missouri. It weighed only 0.12 pound. According to fishermen in the Alton area, fish of this species are taken occasionally by them along with the shovelnose sturgeon. These fish are not known from the Mississippi other than near its confluence with the Missouri. The specimen mentioned above was the only one of this species observed between Caruthersville and Dubuque.

This specimen was submitted for identification to Dr. Reeve M. Bailey of the University of Michigan Museum of Zoology who (personal communication) determined it as *Scaphirhynchus album* (Forbes & Richardson). The species is at present without a recognized common name. The term white sturgeon is recognized (American Fisheries Society 1948) as the common name for *Acipenser transmontanus,* with which the species of the Mississippi River should not be confused. To Mississippi River fishermen *S. album* is known as the white hackleback and the white shovelnose, as well as the white sturgeon. Dr. Bailey (personal communication) recently suggested the vernacular name pallid sturgeon for *S. album.*

Paddlefish

POLYODONTIDAE

This interesting fish was recorded by the first white expedition that reached the Mississippi River. Nuttall (1821: 254) mentioned that at Pacaha members of the De Soto expedition, fishing with nets, included in their catch "the Pele-fish, destitute of scales, and with the upper jaw extended in front a foot in length, in the form of a peel or spatula." Jefferson (1801:12) included in his list of Mississippi River fishes a spatula-fish of 50 pounds weight.

The paddlefish, which is often referred to as the spoonbill cat by commercial fishermen, has long attracted the attention of zoologists. The skeleton of this primitive fish is largely of cartilage, and the external appearance of the fish is quite sharklike. The paddlefish family (Polyodontidae) is composed of only two genera, each containing a single species, one found in China, the other in North America (Forbes & Richardson 1920: 15). The North American species is limited in distribution to the Mississippi basin and other tributaries of the Gulf of Mexico (Coker 1930: 142). According to Eddy & Surber (1947: 74), the paddlefish once ranged in the quiet waters of the Mississippi River from Minneapolis to the Gulf; it is now much more abundant in the southern part of its range than farther north. In the Caruthersville-Dubuque survey the paddlefish was not taken above Canton; however, in 1946 a commercial catch of 1,204 pounds was taken in one seine haul near

New Boston. Many of these specimens were examined by the survey party and the data and gonad material were assigned to Dr. R. Weldon Larimore of the Illinois Natural History Survey for histological study. Paddlefish were caught at 40 per cent of the stations below the mouth of the Missouri River and 42 per cent of the stations between the mouth of the Missouri and Warsaw. Fish of this species were usually taken with a seine, and the average weight of specimens was 2.17 pounds.

On August 19, 1944, at the Cincinnati Landing station, a large school of paddlefish was sighted by the survey crew at about 5 P. M. These fish appeared to be large and apparently were feeding in the shallow water over sand bottom. They were swimming so near the surface that the tailfins of the larger ones extended several inches above the water, and, as they swam about in what appeared to be an aimless manner, some of them frequently thrust their paddles above the surface. Plans were immediately made to seine the area; however, before a seine could be obtained a half hour had elapsed and, much to the disappointment of the crew, the large school had completely vanished.

At the Quincy and New Boston stations paddlefish were observed traveling in schools and feeding in shallow water over sand bottom. In the canalized section of the river this type of habitat is largely confined to the upper sections of the pools. In all catches and observations made during the survey the paddlefish was associated with sand bottom.

At the Cape Girardeau station on May 29, 1944, four specimens of a post-larval stage of paddlefish were taken along the sandy shore of an island. The post-larval forms collected by Thompson (1933:31) near Grand Tower, Illinois, in May, 1932, also were taken over a hard sand bottom.

In 1946 the commercial value of paddlefish in the round was 15 cents per pound. About 20 years ago Coker (1930: 142) stated that the roe of the paddlefish was sometimes worth more than $2.00 a pound and that a large female might have considerable value, as its roe might weigh 10 to 15 pounds. Since 1899 the commercial take of paddlefish in the upper Mississippi has decreased considerably, as shown in tables 7, 8, and 9. This species in the Caruthersville-Dubuque section is becoming relatively scarce. It has been placed on the protected list by the state of Iowa in the hope that its abundance will be increased. If full protection were rendered the paddlefish, it probably would continue to be reduced in numbers by commercial fishermen since this fish often dies after being handled.

American Eel

ANGUILLIDAE

The American eel spawns in the sea. The young eels ascend rivers and streams where they remain for several years. Upon reaching mature size, they return to the sea where they spawn and die.

According to Eddy & Surber (1947: 192) the American eel was at one time fairly common up the Mississippi River at least as far as St. Anthony Falls, Minnesota, but it has now become almost extinct in Minnesota and Wisconsin. These writers stated that the dams on the river are undoubtedly responsible for the scarcity of the eel in the upper Mississippi. The commercial reports show a decline in the eel fishery in the Illinois-Iowa-Missouri section of the Mississippi since 1894, table 7. Even in 1894 this fishery was small, the recorded commercial catch amounting to only 43,272 pounds. In 1931 the catch was only 2,215 pounds. In 1946 very few eels were taken commercially in the section of the river adjacent to Missouri. In that year the largest recorded catch was in the canalized Iowa section; no catch data for Illinois were available.

Coker (1930:173) concluded from his studies at Lake Keokuk that the eel must virtually disappear from the Mississippi River and tributaries above the Keokuk dam (Lock and Dam No. 19). He mentioned that the eel had been decreasing steadily for 30 years in the Mississippi and he was unable to attribute the decline to a single cause, particularly since the decline started prior to the construction of the Keokuk Dam, practically completed in 1913.

In the Caruthersville-Dubuque survey, eels were taken at a larger percentage of

the stations above the mouth of the Missouri River than below. In the canalized section of the river between Burlington and Dubuque, eels amounted to 0.1 per cent of the total number of fishes taken; below the mouth of the Missouri, 0.2 per cent. At Dubuque, the uppermost station on the river, three eels were taken weighing a total of 9.1 pounds. At the Hannibal station six eels were caught; this was the largest number taken at a single station. This station was situated in Pool No. 22, which is above four locks and dams. The eel, as evidenced by these catches, moves upstream into the canalized section even though its passage is hindered by a series of locks and dams. On the basis of this investigation, the eel appears not to be common anywhere in the river, and its scarcity is such as to make it of little or no commercial importance.

Suckers and Redhorses

CATOSTOMIDAE

The fishes in this family, other than the carpsuckers, are too scarce to be of much commercial importance in the Caruthersville-Dubuque section of the Mississippi. The carpsuckers (*Carpiodes* spp.) constituted one of the more abundant groups of fishes taken during the survey. They were taken at all stations, usually in considerable numbers. Because of the difficulties encountered in the separation of the species of carpsuckers, no attempt was made to distinguish the species afield. Names of the three species identified from the collections are listed in table 6. Carpsuckers amounted to 7.2 per cent of the total weight of the 1944 catch between Caruthersville and Warsaw and 14.2 per cent of the total weight of the 1946 catch between Burlington and Dubuque, Appendix B.

At Keokuk, Coker (1930: 184) found the river carpsucker (*Carpiodes carpio*) the only carpsucker constituting a notable fishery product. The commercial fishery statistics pertaining to the 1946 Mississippi River catch of Illinois, Iowa, and Missouri indicate that in total weight the carpsuckers ranked fifth. The catch of carpsuckers in the test-netting survey indicates that these fish form a larger percentage of the catch than is shown by the commercial statistics. In the canalized section of the river between Burlington and Dubuque, the three species of carpsuckers ranked second by weight in the test-net catches, and in the lower section of the river they ranked third, Appendix B. During these 2 years the average weight of carpsuckers was 1.24 pounds. According to Coker (1930: 185) carpsuckers of substantial size (above 4 pounds) are considered of commercial value, "usually selling as No. 1 fish, some others selling as No. 2 fish, and still others being thrown away." Because of this large size requirement, and because the flesh of carpsuckers is favorless and soft (Forbes & Richardson 1920: 77) and is said not to keep well in warm weather (Coker 1930: 184), many of the carpsuckers actually taken are not marketed and therefore do not appear in the commercial reports. Methods of processing for better utilization of the carpsuckers are sorely needed on the Mississippi as well as on other large rivers in the central states.

Forbes & Richardson (1920:66), about 50 years ago, found that the blue sucker (*Cycleptus elongatus*) was confined to the Ohio and Mississippi rivers and some of its tributaries. In the Mississippi they rarely found this sucker above Quincy at the time of their survey. However, several years later Greene (1935:57) mentioned that the blue sucker was reported to be common in the river near Lansing, Iowa, which is about 337 miles above Quincy, and Coker (1930: 182) cited "oral reports of fishermen at many points on the Mississippi, as far north as Wisconsin, that until 10 or 15 years ago there were important spring runs and lesser fall runs of blue suckers." In the spring, blue suckers formerly were caught quite easily by commercial fishermen. These catches were made in the swifter parts of the river. By 1926, however, according to Coker (1930: 183), commercial fishermen held an almost unanimous opinion that the blue sucker had virtually disappeared from the upper river. That same year Coker encountered practically no fishermen in the Keokuk area who had seen more than two or three blue suckers a year.

In the Caruthersville-Dubuque survey the blue sucker was taken infrequently. No adult blue sucker was caught in the

MR-C section of the river, although at the Cairo station 28 small blue suckers were taken with a minnow seine. Forbes & Richardson (1920:66) noted in the early part of this century that the blue sucker frequently was taken in the Cairo area during the spring. This species was not abundant enough at the time of the survey to be of any commercial importance in the Cairo area, even though it still occurred there.

On April 11, 1951, Herbert J. Fisher of the Missouri Conservation Commission and the junior author examined five blue suckers at Bennett Brothers' fish market at Ste. Genevieve, Missouri. The fishermen had caught about 100 pounds of this species in hoop nets on April 10 and 11.

All specimens of this sucker taken by the survey party in the D-MR section of the river were caught at or above the Cincinnati Landing station. At this station in August, 1944, an adult blue sucker weighing 2.8 pounds was caught in a test net set in a small slough. The flow into this slough passed over a rock wing-dam at the head of an island. The slough was approximately 150 yards in width, and the current was moderately swift over a sand bottom. At the Canton station two blue suckers weighing in aggregate 3.62 pounds were taken in test nets. Only five blue suckers were taken in the 1946 collections between Burlington and Dubuque, Appendix B, table 2. The scarcity of the blue sucker in the Caruthersville-Dubuque section of the river as shown by the test-net collections confirms the pessimistic opinions of commercial fishermen concerning the present status of this fish.

The removal of the Le Claire and Keokuk rapids in the river and construction of the Keokuk Dam have been considered as factors contributing to the decline of the blue sucker population in the D-MR section of the river. According to Coker (1930:184, 187), however, the blue sucker also declined in the MR-C section of the river—indicating that some other factor or factors contributed to its decline.

The northern redhorse (*Moxostoma aureolum*) was netted more frequently than the silver redhorse (*Moxostoma anisurum*), the only other species of redhorse taken in the test-net survey. It appeared in the collection at only one station in the MR-C section of the river, whereas it was taken at all stations above Burlington in the D-MR section. The largest catches of the northern redhorse were made at the Bellevue station, where they amounted to 15.9 per cent of the total weight of all fish taken there.

In the Burlington-Dubuque section the total weight of the northern redhorse catch was 1.5 per cent of the total catch for the section. In the section between Burlington and the mouth of the Missouri, the northern redhorse amounted to only 0.27 per cent of the total weight of the catch there. These data indicate that the northern redhorse is more abundant in the river above Burlington than below.

The commercial fishery statistics for suckers in the Mississippi basin show a sharp decline since 1899 (Coker 1930: 187). The various species of redhorses and suckers are now too scarce in the Caruthersville-Dubuque section of the river to be of commercial importance.

Buffalofishes

CATOSTOMIDAE

Three species of buffalofishes occur in the Caruthersville-Dubuque section of the Mississippi River. In aggregate, these fishes now rank second to carp in the Mississippi River commercial fishery catch of Illinois, Iowa, and Missouri. Prior to the appearance of the carp, the buffalofishes comprised the largest part of the commercial catch. In 1894 the buffalofishes constituted 48.7 per cent of the weight of the Illinois catch in the Mississippi River and 50.9 per cent of the Missouri catch in the Mississippi, table 9. In 1899 the catch of buffalofishes still held a weight advantage over the catch of carp, which by that year were becoming very abundant in the river.

As shown in table 8, the catch of carp at Lake Keokuk (Pool No. 19) in 1914 exceeded that of buffalofishes by more than 50,000 pounds.

At Lake Keokuk the carp made its greatest gains over the buffalofishes between 1922 and 1927. By 1931 the buffalofishes represented only 19.8 per cent of the weight of the Mississippi River catch by Illinois commercial fishermen and 20.8 per

cent of that by Missouri fishermen, table 9. Commercial catches of buffalofishes in that part of the Mississippi bordering Illinois, Iowa, and Missouri have been much smaller in most recent years than in years previous to 1900; however, the decrease in catch, as shown by 1946 figures in table 7, has not been so great as to cause alarm. Commercial reports indicate that the buffalofish catches in Iowa have remained high and have decreased only slightly below the 1899 catch. In 1950 the Mississippi River catch of buffalofishes by commercial fishermen of Illinois was larger than the catch of carp and amounted to 36.6 per cent of the total commercial catch from the Mississippi by these fishermen.

During the past 50 years extensive levee and drainage districts have been developed in the MR-C section of the river—more extensive than in the D-MR section. The development in the lower section has resulted in a scarcity of backwaters and sloughs attached to this section. The buffalofishes are known to use backwaters and sloughs for spawning grounds, and perhaps the reduction of such areas in the lower section accounts for much of the decrease in the buffalo fishery there during the past half century. At Lake Keokuk (Pool No. 19) Coker (1930:194) noted an upward trend in the commercial take of buffalofishes in 1917 and a discouraging decline in 1922. Between these years, Coker writes, extensive areas evidently suitable for spawning and nursery purposes were reclaimed for farming. In table 8 the commercial catches from Lake Keokuk are given for several years. The catches of buffalofishes from this impoundment have never recovered since connecting shallow waters were reclaimed for agricultural purposes.

The buffalofishes ranked fourth in total weight among the commercial fishes taken in the test-net collections, fig. 7, rather than second as might be expected from the commercial fishery statistics. This difference in rank was due probably to fishing effort and type of gear employed and to the inclusion in survey data of all carpsuckers taken during the survey; carpsuckers are a group of fishes not invariably reported by commercial fishermen.

The average weight of buffalofishes taken between Caruthersville and Warsaw in 1944 was 1.65 pounds; between Burlington and Dubuque in 1946 it was 1.78 pounds. The over-all average was 1.72 pounds.

On a numerical basis the buffalofishes ranked fifth among the commercial fishes taken in the test-net collections, fig. 7.

In the commercial statistics, for reasons previously discussed, the catches of the three species of buffalofishes are presented in aggregate. An attempt has been made to appraise the relative abundance of the three species and their distribution in the MR-C and D-MR sections of the river, fig. 8. Such information should be of value in the management of the buffalo fishery. The meager information concerning these fishes indicates the existence of certain differences in the habits of the three species.

The black buffalo (*Ictiobus niger*) was taken in greater numbers in the collections from the MR-C section than in those from the D-MR section of the river, fig. 8. Coker (1930:191) noted that the black buffalo (bugler) was chiefly southern in distribution and that at the time of his study it was not abundant in the river above Muscatine. He found that it appeared "rather prominently in the region of New Boston and southward," and just below Keokuk it seemed to rank in abundance with the smallmouth buffalo or roachback (*Ictiobus bubalus*).

At the Warsaw station, which was below Keokuk, the buffalo test-net catch in 1944 was predominantly smallmouth, Appendix B, table 1. Here 59 specimens of the smallmouth buffalo were taken in contrast to 1 specimen of the black buffalo and 3 of the bigmouth buffalo (*Megastomatobus cyprinella*). At Caruthersville no black buffaloes were taken in the survey nets; however, according to a Mr. Boyer, a local commercial fisherman, this species and the other buffalofishes usually are taken in catches in about equal numbers. One black buffalo weighing 19.5 pounds was examined from a commercial fisherman's catch at Caruthersville. The average weight of the black buffaloes taken in the survey was 4.06 pounds, an average much greater than that of the other species of buffalofishes.

The bigmouth buffalo appeared to be more abundant than the black buffalo. However, the average weight of the big-

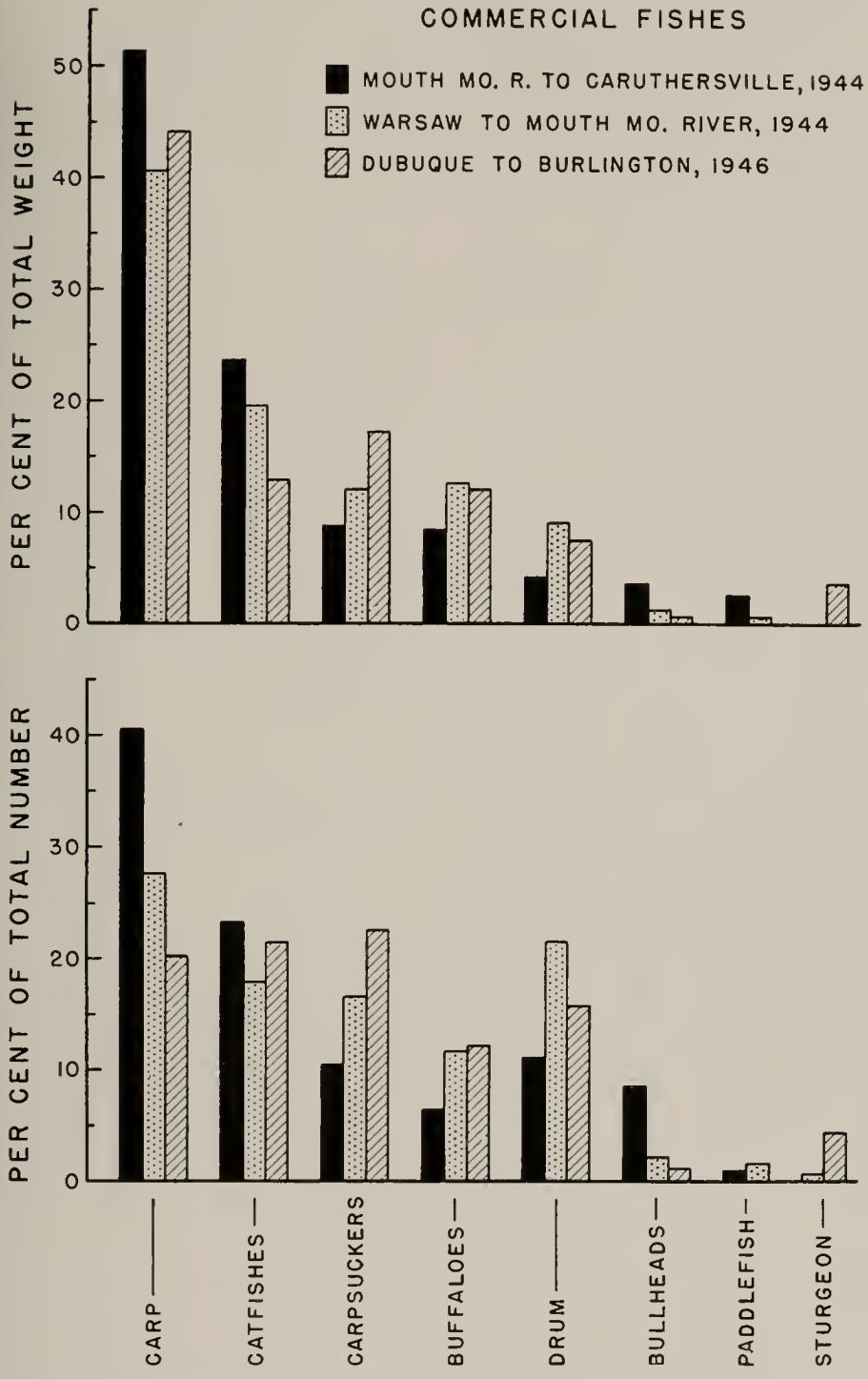

Fig. 7.—The relative abundance and the relative weight of each of various commercial fish groups taken in the test-net collections from three sections of the Mississippi River, 1944 and 1946.

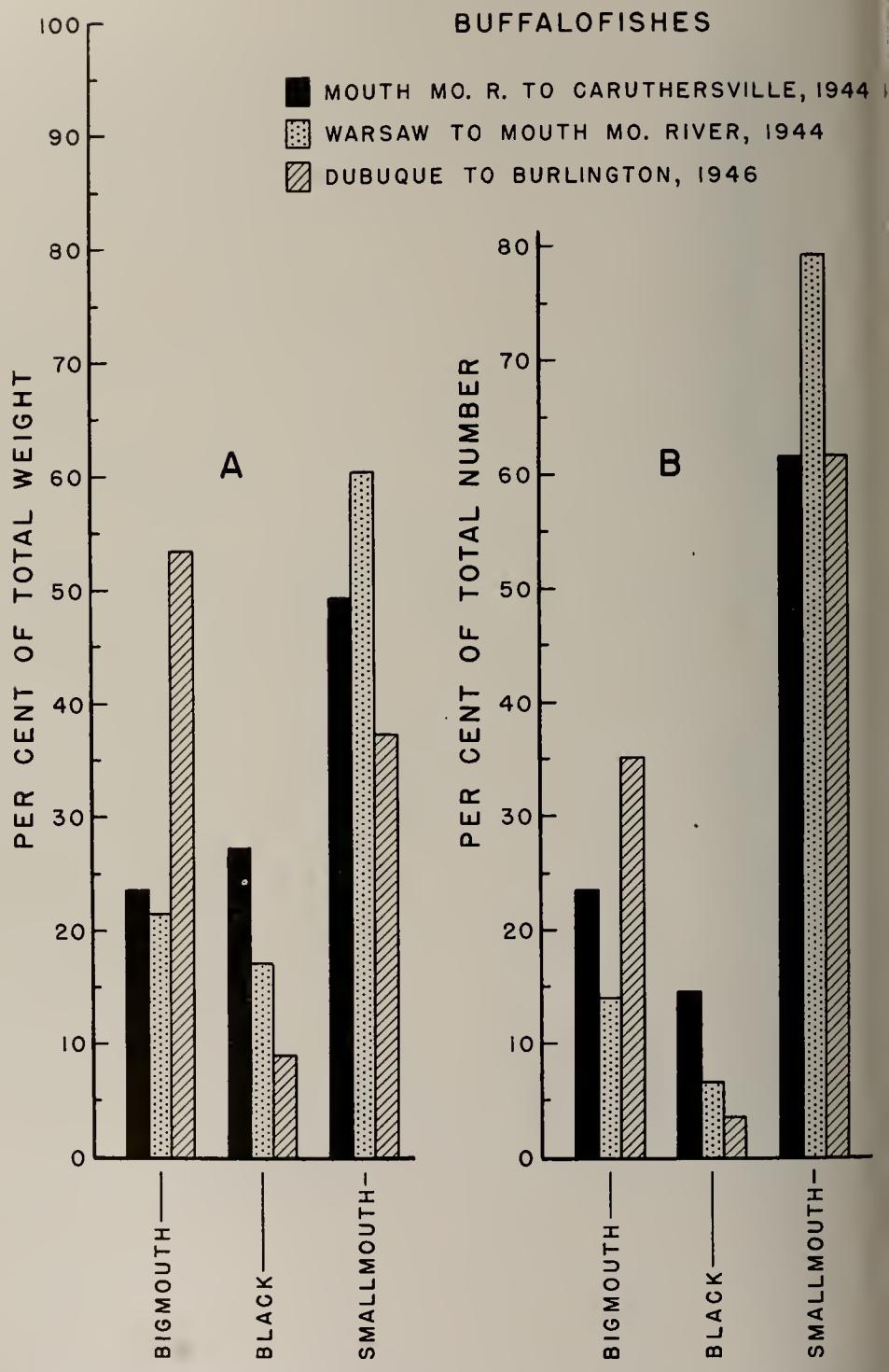

Fig. 8.—The relative weight and the relative abundance of each of three species of buffalofishes taken in the test-net collections from three sections of the Mississippi River, 1944 and 1946.

mouth collected was 2.57 pounds, much less than that of the black buffalo.

The smallmouth buffalo was by far the most abundant buffalofish taken in the survey; however, the average weight of 1.17 pounds for this species was considerably less than that for the other species. From a study of fig. 8, it becomes quite evident that on a weight basis the smallmouth buffalo was dominant in the survey catches in the MR-C section and that part of the D-MR section investigated in 1944, and that the bigmouth buffalo dominated the 1946 catches, which were in the Burlington-Dubuque section of the river. Numerically, the smallmouth buffalo dominated the collections in all three sections of the river referred to in fig. 8.

The average lengths of the black buffalo and the bigmouth buffalo in the test-net collections were greater than the average length of the smallmouth buffalo, table 11.

Examination of a large number of specimens indicated that the smallmouth buffalo and the bigmouth buffalo become sexually mature at about 15 inches in length. So few specimens of black buffalo were examined that maturity size for this species was not determined; the smallest ripe female noted was 18.5 inches long.

In the test-net collections only 24 per cent of the smallmouth buffaloes but 75 per cent of the other buffalofishes equaled or exceeded 15 inches in length. Commercial fishermen using nets of legal mesh

Table 11.—Length-frequency distribution of buffalofishes (most of them in test-net collections) from the Mississippi River between Caruthersville, Missouri, and Dubuque, Iowa, in 1944 and 1946.

Total Length in Inches	Smallmouth Buffalo			Black Buffalo*			Bigmouth Buffalo		
	MR–C Section 1944	D–MR Section 1944	D–MR Section 1946	MR–C Section 1944	D–MR Section 1944	D–MR Section 1946	MR–C Section 1944	D–MR Section 1944	D–MR Section 1946
3 8– 4 7	—	—	24	—	—	—	—	—	1
4 8– 5 7	3	4	30	2	—	—	1	—	1
5 8– 6 7	7	5	21	—	—	—	—	1	3
6 8– 7 7	7	14	36	—	—	—	1	1	1
7 8– 8 7	5	29	56	3	—	1	1	—	2
8 8– 9 7	16	26	34	—	—	—	1	1	2
9 8–10 7	16	44	22	1	1	—	1	2	4
10 8–11 7	17	63	25	1	—	1	6	1	6
11 8–12 7	4	48	28	1	2	—	14	1	5
12 8–13 7	10	36	40	1	2	1	6	3	10
13 8–14 7	7	15	50	3	3	1	2	12	12
14 8–15 7	5	20	61	1	1	4	—	7	31
15 8–16 7	4	13	36	1	4	2	2	16	63
16 8–17 7	6	10	18	2	4	2	3	9	47
17 8–18 7	9	6	15	—	3	1	—	4	50
18 8–19 7	3	3	1	1	2	5	1	2	25
19 8–20 7	2	2	3	3	—	1	3	—	25
20 8–21 7	2	—	1	1	2	4	3	—	4
21 8–22 7	1	1	—	—	1	1	2	—	1
22 8–23 7	—	—	—	3	2	1	1	1	1
23 8–24 7	—	2	—	5	—	5	—	—	—
24 8–25 7	—	—	1	—	—	3	—	—	1
25 8–26 7	—	—	2	—	—	1	—	—	—
26 8–27 7	—	—	—	1	1	—	—	—	—
27 8–28 7	1	—	1	—	—	1	—	—	—
28 8–29 7	—	—	—	—	—	1	—	—	—
29 8–30 7	1	—	—	—	—	1	—	—	—
30 8–31 7	—	—	—	—	—	—	—	—	—
31 8–32 7	1	—	—	—	—	—	—	—	—
Total number	*127*	*341*	*505*	*30*	*28*	*37*	*48*	*61*	*295*
Average length	12 6	11 8	11 6	17 0	17 3	20 3	14 2	15 3	16 6

* The D-MR 1946 data include 19 specimens of smallmouth buffalo, 8 of black buffalo, and 18 of bigmouth buffalo caught with commercial gear by J. O. Kurrle in the Burlington area.

sizes catch a higher percentage of smallmouth buffaloes of 15 inches or more in length than was taken in this investigation, in which some nets of smaller mesh sizes were used.

Carp

CYPRINIDAE

The carp is a native of neither Europe nor America. According to Hessel (1878: 865–6), in all probability it was introduced into Europe from Central Asia many centuries ago. Europeans have reared and cultivated it at least since 1227, and they consider it as an excellent food fish. During the nineteenth century many of our forefathers, then recent immigrants from Europe, clamored for the introduction of carp into North America. Various attempts evidently were made in carp plantings; in 1877 the United States Fish Commission was successful in importing a shipment of 345 carp, of which 227 were of the mirror and leather varieties. These carp were released in ponds at Washington, D. C., where they multiplied rapidly. In 1879, 12,000 young produced in the Washington ponds were distributed among more than 300 persons in 25 states and territories (Forbes & Richardson 1920:105).

Carp apparently were not planted directly by man into the Mississippi but escaped from nearby carp ponds during floods. Reports of carp in the Caruthersville-Dubuque section of the Mississippi came in 1883 from Hannibal, Missouri, and Quincy, Illinois (Cole 1905:549). Garman (1890:143) studied the fish fauna of the Mississippi bottoms near Quincy in August, 1888, and from his observations there wrote the following regarding the carp: "This hardy fish seems destined to become a permanent part of our fauna." In this 1888 investigation Garman found the carp widely distributed throughout the bottomland lakes.

The carp did not increase in the commercial catch of the Mississippi as rapidly as in its more productive tributary, the Illinois River. In 1899 nearly six times as many pounds of carp were taken from the Illinois River as were taken by Illinois commercial fishermen from the Mississippi (Townsend 1902:681).

The commercial statistics in tables 7 and 9 reveal the importance of the carp in the Mississippi River commercial fishery. The carp is now the most important commercial fish in the river and it would be only a matter of speculation as to what the size of the catch of the other fishes would be if carp were not in the present fauna.

The survey catch of carp in 1944 and 1946 was high at most of the stations, ranging from 12 to 70 per cent by weight of the catch of all the commercial fishes. Fig. 7, in which the catch of carp is presented as a per cent of the total weight of the commercial fishes caught in the test nets, demonstrates the significance of the carp to the commercial fishery. The carp was by far the most important commercial species, as such groups as catfishes, carpsuckers, and buffalofishes are composed of more than one species. The position of the carp in relation to all fishes taken at the several survey stations is shown graphically in fig. 9.

In fishery management the size and age of the fishes comprising the catch are basic to an analysis of the condition of a fishery. The average lengths and weights of carp taken by test netting at the various stations were recorded and are given in table 12. Carp have been reported from Europe as attaining weights of 42 to 67 pounds (Hessel 1878:874) and some of the scales from a 67-pound fish were said to measure 2.5 inches in diameter. Occasionally carp weighing 25 to 35 pounds are taken by commercial fishermen from the Mississippi; however, the average weight of the carp appearing in the survey catch was 2.65 pounds.

The difference between the average weights of the carp taken in 1944 and the average weights of those taken in 1946 appears by inspection of table 12 to be associated with the presence of relatively few small carp in the 1946 collections and relatively large numbers of small ones in 1944. A difference of this kind might be expected in any population after a lapse of 2 years and might be the result of differential survival of year classes.

The difficulties involved in attempting to determine by the scale method the age of summer-caught carp from a heterogeneous carp population composed of a

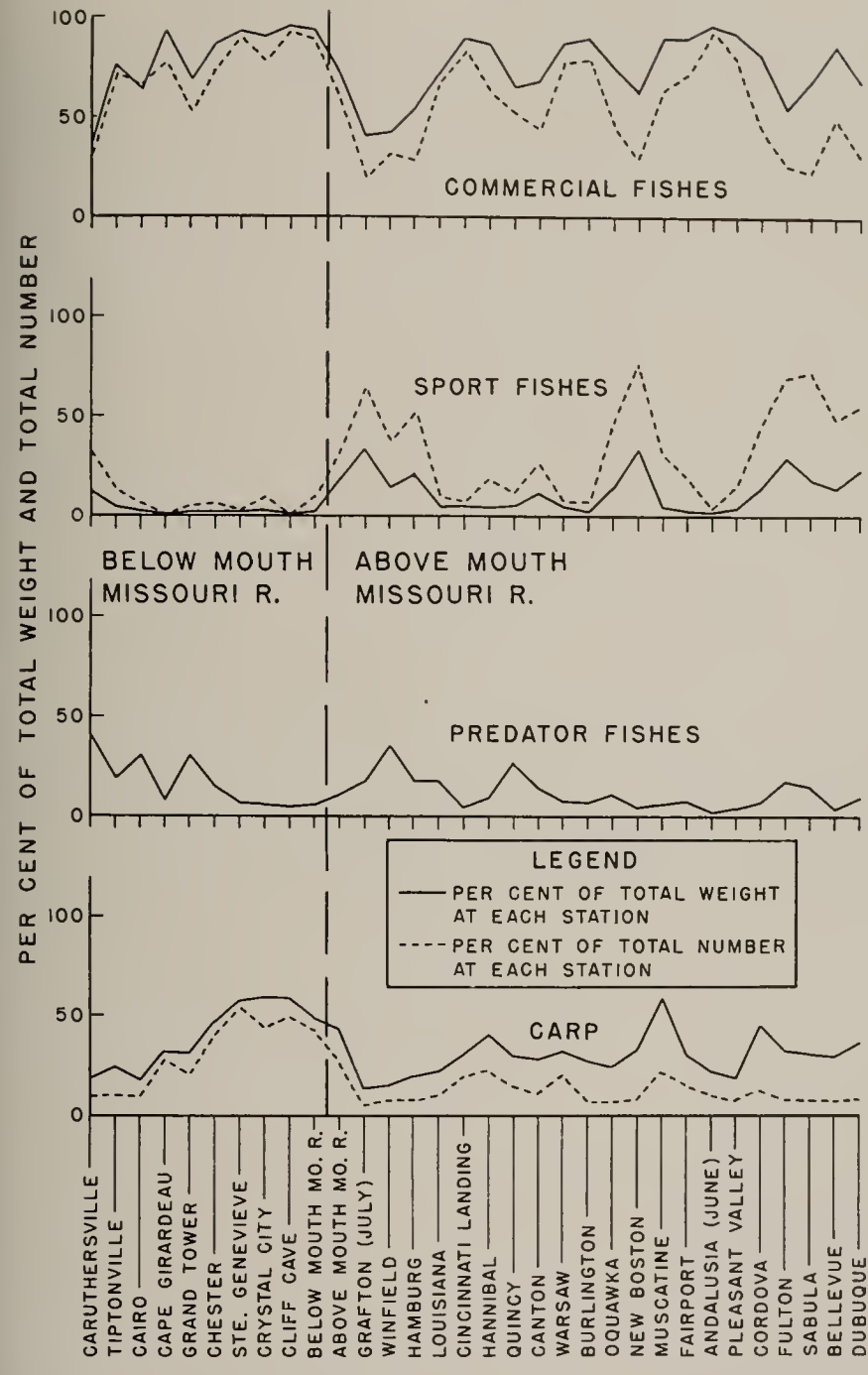

Fig. 9.—The relative weight and the relative abundance of each of several groups of fishes taken in test-net collections in the Caruthersville-Dubuque section of the Mississippi River. The curves are based on the per cents of total weight and of total number of all the fish collected at each station. Sampling was conducted at stations between Caruthersville and Warsaw in 1944 and between Burlington and Dubuque in 1946.

Table 12.—Length-frequency distribution and average lengths and weights of carp in test-net collections from the Mississippi River between Caruthersville, Missouri, and Dubuque, Iowa, in 1944 and 1946.

Total Length in Inches	Caruthersville, Mo. April 6–12, 1944	Tiptonville, Tenn. April 15–May 10	Cairo, Ill. May 18–25	Cape Girardeau, Mo. May 26–31	Grand Tower, Ill. June 2–9	Chester, Ill. June 11–15	Ste. Genevieve, Mo. June 18–24	Crystal City, Mo. June 25–30	Cliff Cave, Mo. July 2–8	Below Mouth of Missouri River July 10–15	Above Mouth of Missouri River July 10–15	Grafton, Ill. March 22–30	Grafton, Ill. July 15–25	Grafton, Ill. Sept. 22–27	Winfield, Mo. July 27–Aug. 2	Hamburg, Ill. Aug. 3–9	Louisiana, Mo. Aug. 12–17	Cincinnati Log., Ill. Aug. 19–23	Hannibal, Mo. Aug. 25–30
3.8– 4.7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4.8– 5.7	—	—	—	—	—	8	3	—	—	—	—	2	—	—	—	—	—	—	—
5.8– 6.7	—	1	—	—	—	13	6	—	—	—	—	—	—	—	1	—	—	—	—
6.8– 7.7	1	1	—	—	3	6	8	—	—	—	—	—	—	—	—	1	—	—	—
7.8– 8.7	4	2	—	—	2	1	3	—	—	—	4	—	—	—	1	—	—	—	—
8.8– 9.7	2	1	3	—	2	4	2	—	—	—	24	2	3	—	1	1	1	—	—
9.8–10.7	1	1	1	—	5	—	2	2	—	—	49	—	3	—	2	—	1	—	3
10.8–11.7	—	4	3	1	6	—	5	—	1	2	34	—	6	—	2	1	1	—	3
11.8–12.7	2	6	5	6	16	6	9	6	2	—	37	4	2	1	14	1	1	1	1
12.8–13.7	2	3	7	1	23	22	53	15	11	4	51	14	7	2	12	7	1	2	12
13.8–14.7	6	7	10	7	38	17	65	26	23	8	43	9	6	2	20	15	5	2	12
14.8–15.7	3	16	10	14	24	16	62	44	44	6	34	9	4	3	11	11	4	13	15
15.8–16.7	10	6	5	13	25	12	52	43	33	10	16	3	4	4	6	6	4	7	8
16.8–17.7	4	2	2	13	7	11	26	37	30	10	7	4	1	1	4	4	5	10	4
17.8–18.7	1	4	4	4	3	10	10	19	17	7	2	2	2	3	2	3	3	2	3
18.8–19.7	1	3	1	5	1	5	5	4	6	5	3	—	3	1	—	3	3	2	1
19.8–20.7	—	3	4	6	1	2	3	7	7	1	2	—	—	—	2	—	1	4	2
20.8–21.7	—	—	4	3	1	1	—	2	2	—	2	—	1	—	—	1	1	—	2
21.8–22.7	—	1	—	3	2	—	—	3	3	—	—	1	2	—	1	—	2	1	1
22.8–23.7	—	1	—	4	1	1	3	1	3	—	—	—	—	1	—	—	—	1	3
23.8–24.7	—	—	1	—	2	2	1	—	1	—	—	1	1	—	—	—	—	—	1
24.8–25.7	—	1	—	2	—	1	1	—	—	—	—	—	—	—	—	—	—	—	1
25.8–26.7	—	—	—	—	—	2	—	1	—	—	1	—	—	—	—	—	—	—	1
26.8–27.7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
27.8–28.7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—
28.8–29.7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
29.8–30.7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
30.8–31.7	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
31.8–32.7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
32.8–33.7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total number	*37*	*63*	*60*	*82*	*162*	*140*	*320*	*210*	*183*	*54*	*309*	*51*	*45*	*18*	*79*	*55*	*33*	*45*	*75*
Average length	14.1	15 0	15.3	17.2	14.5	13.8	14.7	16.2	16.4	16.3	12.9	14 3	14.6	16.3	14.1	15.3	16.3	16 7	16.3
Average weight in pounds	1.62	2.03	2.21	3.01	1.85	1.94	1.93	2.35	2.57	2.48	1.21	1.73	1.79	2.28	1.50	1.79	2.28	2.31	2.38

Table 12.—Concluded.

Total Length in Inches	Quincy, Ill. Sept. 2–6	Canton, Mo. Sept. 8–13	Warsaw, Ill. Sept. 14–19	Burlington, Ia. April 10–22, '46	Oquawka, Ill. April 24–May 5	New Boston, Ill. May 7–18	Muscatine, Ia. May 19–30	Fairport, Ia. June 2–13	Andalusia, Ill. April 1–7	Andalusia, Ill. June 18–26	Andalusia, Ill. Sept. 15–24	Pleasant Valley, Ia. June 28–July 9	Cordova, Ill. July 11–22	Fulton, Ill. July 24–Aug. 4	Sabula, Ia. Aug. 6–17	Bellevue, Ia. Aug. 19–30	Dubuque, Ia. Sept. 1–12	Total or Average
3.8– 4.7	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1
4.8– 5.7	1	—	—	8	—	—	—	—	—	—	—	—	—	—	—	—	—	22
5.8– 6.7	—	—	—	6	—	—	—	—	—	—	—	—	1	—	—	—	—	28
6.8– 7.7	—	1	—	3	1	—	—	1	—	—	—	—	—	—	—	—	—	26
7.8– 8.7	—	—	1	2	—	—	2	—	—	—	—	—	—	—	—	—	—	22
8.8– 9.7	2	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	50
9.8–10.7	2	1	5	2	—	—	—	—	—	—	2	1	—	1	—	—	—	84
10.8–11.7	3	2	4	1	—	2	—	—	—	—	4	—	—	1	—	—	—	86
11.8–12.7	3	—	6	—	—	2	—	—	—	—	19	—	1	5	—	—	3	159
12.8–13.7	3	1	11	1	—	—	4	—	—	1	3	—	1	6	—	3	2	285
13.8–14.7	11	3	10	1	—	—	19	9	—	1	5	—	3	10	1	—	3	397
14.8–15.7	23	6	19	—	—	4	11	8	—	4	11	—	—	5	4	3	1	442
15.8–16.7	23	7	19	5	2	10	8	7	1	4	35	3	9	13	5	—	—	418
16.8–17.7	20	5	10	5	—	11	26	8	3	14	73	5	10	10	7	2	5	396
17.8–18.7	18	7	10	6	6	12	36	19	2	18	62	3	11	14	5	11	11	352
18.8–19.7	10	7	5	4	10	14	38	11	2	16	38	4	6	14	2	5	8	246
19.8–20.7	8	6	6	7	5	9	32	9	3	13	24	1	7	14	8	6	6	209
20.8–21.7	1	3	4	6	3	9	16	4	1	9	18	9	10	7	8	3	9	140
21.8–22.7	3	1	2	3	4	7	11	4	1	6	14	5	5	11	4	1	3	106
22.8–23.7	1	1	—	2	1	6	7	—	—	2	9	3	4	8	1	2	3	69
23.8–24.7	2	1	1	5	1	5	5	—	—	—	6	1	3	3	—	—	1	44
24.8–25.7	1	—	—	2	—	—	1	2	—	1	5	1	2	3	2	2	—	28
25.8–26.7	1	—	—	1	—	—	2	—	—	1	2	—	—	5	5	—	2	24
26.8–27.7	1	—	—	1	—	—	—	—	—	—	2	—	2	2	—	2	3	13
27.8–28.7	—	—	1	—	—	—	1	—	—	1	—	—	2	—	—	1	1	8
28.8–29.7	—	—	—	—	—	—	—	1	1	—	—	1	—	—	—	—	—	3
29.8–30.7	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	1	1	5
30.8–31.7	—	—	—	—	—	—	—	—	—	1	—	—	1	—	—	—	2	5
31.8–32.7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1
32.8–33.7	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	1
Total number	*137*	*52*	*114*	*72*	*33*	*91*	*210*	*83*	*14*	*93*	*333*	*38*	*70*	*132*	*52*	*42*	*65*	*3,670*
Average length	16.8	17.4	16.0	15.9	19.5	18.8	18.7	18.1	19.8	19.4	18.2	19.9	19.5	17.8	19.9	20.2	20.4	16.5
Average weight in pounds	2.52	2.68	2.23	3.37	3.85	3.56	3.71	3.17	3.61	3.62	3.35	4.13	4.37	3.54	4.19	4.70	4.96	2.65

Table 13.—Ranges and averages of Indices of Condition (C) of two length-groups of carp in test-net collections from the Mississippi River between Caruthersville, Missouri, and Dubuque, Iowa, in 1944 and 1946.

Station	Carp With Total Length of 14.6 Inches to 15.5 Inches			Carp With Total Length of 16.6 Inches to 17.5 Inches		
	Number	Range of C	Average C	Number	Range of C	Average C
1944						
Caruthersville	3	4.77–5.20	4.96	1	—	6.32
Tiptonville	16	4.32–6.80	5.43	3	4.83–6.30	5.37
Cairo	12	5.13–6.60	5.83	1	—	5.37
Cape Girardeau	9	4.65–5.64	5.22	9	4.68–6.37	5.59
Grand Tower	18	4.56–6.07	5.46	3	4.15–5.36	4.82
Chester	18	5.20–7.11	5.83	13	3.38–6.49	5.15
Ste. Genevieve	55	3.38–6.36	5.51	26	4 63–6.60	5.44
Crystal City	35	4.56–5.78	5.33	15	4.23–6.39	5.36
Cliff Cave	14	4.15–5.98	5.37	24	4.86–6.26	5.39
Mouth Missouri	26	4.81–5.82	5.16	8	4.55–5.63	4.93
Grafton (March)	3	5.12–5.32	5.19	3	4.87–5.42	5.18
Grafton (July)	6	4.60–5.06	4.85	2	4.26–5.04	4.65
Grafton (Sept.)	5	4.54–5 11	4.79	1	—	5.10
Winfield	14	3.24–5.72	4.76	4	4.57–5.56	5.11
Hamburg	14	3.46–5.94	4.65	6	4.11–5.07	4.57
Louisiana	5	4.18–5.17	4.61	5	4.09–4.70	4.47
Cincinnati Landing	10	4.35–5.00	4.63	9	3.51–5.13	4.56
Hannibal	15	4.05–5.07	4.68	2	4.56–5.09	4.82
Quincy	12	2.87–5.56	4.65	23	4.21–5.52	4.93
Canton	6	4.56–5.10	4.81	5	4.44–5.20	4.80
Warsaw	0	—	—	14	4.29–5.92	5.08
1946						
Burlington	0	—	—	6	2.63–5.84	4.87
Oquawka	0	—	—	0	—	—
New Boston	2	4.68–4.89	4.79	8	4.03–6.11	4.99
Muscatine	18	4.74–6.55	5.59	22	4.43–6.38	5.06
Fairport	9	4.63–5.67	5.20	8	4.56–5 54	4.96
Andalusia (April)	0	—	—	2	5.27–5.43	5.35
Andalusia (June)	3	4.95–5.98	5.46	12	4.81–5.68	5.22
Andalusia (Sept.)	7	5.03–5.78	5.30	66	4.27–6.23	5.09
Pleasant Valley	0	—	—	3	4.30–5.54	4.75
Cordova	2	3.83–4.88	4.36	6	4.50–5.93	4.94
Fulton	7	4.72–5.27	4.99	11	4.51–5.52	4.97
Sabula	3	4.35–4.87	4.57	11	4.22–5.32	4.73
Bellevue	2	4.94–5.53	5.24	2	4.57–6.09	5.33
Dubuque	1	—	4 93	2	4.32–5.18	4.75

number of year classes overlapping in length ranges have been discussed by Frey (1942:217). Because of these difficulties, it was necessary to rely on the length-frequency method of aging even though it, too, has limitations and is not well suited for use on carp populations. From the data given in table 12, it appears that the bulk of the carp catch was composed of 2- and 3-year-old fish.

It was determined by examining the gonad condition of carp taken in the survey that sexual maturity was reached in the females at lengths of 14 to 15 inches, in most males at lengths of 12.5 to 14.5 inches. However, some males as small as 8.5 inches were mature. The catches made by test-netting indicate that many carp below these lengths are taken in commercial type gear. The over-all average length of carp taken in both years of the survey was 16.5 inches, a figure a little over the minimum maturity length.

The Index of Condition (C)* is often used as an indicator of the relative plumpness of a fish. In table 13 the ranges and averages of Indices of Condition are given for two length groups of carp. At many

* The formula $C = \frac{W\ 10{,}000}{L^3}$ suggested by Thompson & Bennett (1939:17) was used in computing the Index of Condition.

stations too few specimens of the selected length groups were taken to permit direct comparison; however, where 10 or more specimens were taken it seemed justifiable to make comparisons. The Index of Condition, or C, ranged from 2.63 to 7.11. Carp having a C below 3.50 gave an outward appearance of being in poor condition and most of them were emaciated. Inspection of table 13 indicates that the average C is a little less than 5.00. Most of the carp taken in the spring and early summer (in the MR-C section) had a C above this value; most of those taken later in the season of the same year (in the D-MR section) had a C below 5.00. A similar seasonal difference was noted also at the two key stations. The upper C range at the key stations, as well as at the majority of the other stations, was above 5.00. The average C of carp taken in the polluted waters below St. Louis was much higher than that for carp taken above St. Louis. This difference may be attributed partly or entirely to seasonal changes. In the section of this paper on "Pollution" mention is made that the carp on the Illinois side of the Mississippi near Warsaw appeared very fat; their condition was attributed to their feeding upon brewery waste. It is of interest to note in table 13 that the average Index of Condition was higher at Warsaw than at the preceding stations below it sampled in late summer.

Catfishes and Bullheads

AMEIURIDAE

The catfishes are considered by many to be the finest-tasting fresh-water fishes in North America. Their white, firm flesh has long made them leaders in demand at midwestern river commercial fish markets. Commercial fishermen frequently are unable to meet the local public demand for these food fishes. The catfishes are popular with anglers, also. It is often said that an angler who has never tried fishing with a light rod for the channel catfish (*Ictalurus lacustris*) has "just never

Fig. 10.—A Mississippi River commercial fisherman dressing a catfish. An experienced fisherman can dress a catfish in less than a minute.

Fig. 11.—Raising a small-mesh hoop net on the Mississippi River. The small-mesh nets are particularly effective for catfish.

fished." The flathead catfish (*Pilodictis olivaris*) and the blue catfish (*Ictalurus furcatus*) are regularly taken by anglers either by trotline fishing or by jug fishing.

In the Mississippi the three species of catfishes mentioned above form an important part of the commercial catch, figs. 10, 11, and 12. The species of catfishes and bullheads, like the species of buffalofishes, are usually lumped together in commercial fisheries statistics. The commercial catch of Mississippi River catfishes and bullheads reported for Illinois and Iowa in 1946 amounted to a little more than 50 per cent of the comparable catch reported in 1899, table 7. This table shows the

Fig. 12.—Removing catfish from a basket trap. In the spring commercial fishermen often "bait" this type of trap with a ripe female catfish.

large decline that occurred in the commercial take of these fishes between 1894 and 1899. The Illinois catch of catfishes and bullheads from the Mississippi, table 9, amounted to 20.3 per cent of the weight of the total commercial catch in 1894 and 15.1 per cent of that catch in 1946. These figures are hardly comparable in view of the change in abundance of other commercial fishes. At Lake Keokuk the largest commercial catch of catfishes and bullheads since 1914 was taken in 1936, table 8. This table indicates that in 1936 a large increase in catch occurred on the Illinois side of the Mississippi from Lake Keokuk to the northern boundary of the state. The following year the catch in that part of the river was reduced by almost one-half.

The test-net data obtained between Caruthersville and Dubuque reveal that the relative abundance of the catfish species is not constant in the three sections of the Mississippi indicated in fig. 13. By weight, the flathead was the most important catfish in all three sections, fig. 13. Numerically, the flathead was the most important catfish in the MR-C section and the channel catfish the most important in the other two sections. The blue catfish was more abundant in the MR-C section than in the D-MR section. No specimen of this species was taken in test nets above Warsaw. About 20 years ago Coker (1930:175) noted that Keokuk, which is 4 miles above Warsaw, was about the northern limit of the summer range of the blue catfish.

The channel catfish was reported by Forbes & Richardson (1920:181) as occasionally attaining a weight of 15 to 20 pounds. The largest specimen of this species observed during the 2 years of this investigation was taken at Burlington; it weighed 13.06 pounds. The average weight of the channel catfish in the test-net catches was 0.45 pound, Appendix B.

The flathead catfish was reported by Forbes & Richardson (1920:194) as frequently reaching a weight of 50 to 75 pounds and by Evermann (1899:293) as attaining a weight of 50 to 60 pounds and, rarely, 100 pounds. At Cincinnati Landing a flathead catfish weighing 42.56 pounds was taken by the 1944 survey party in a wing net. The average weight of the flathead in the test-net collections was 3.08 pounds, Appendix B.

The average weight of the blue catfish in the test-net collections was surprisingly

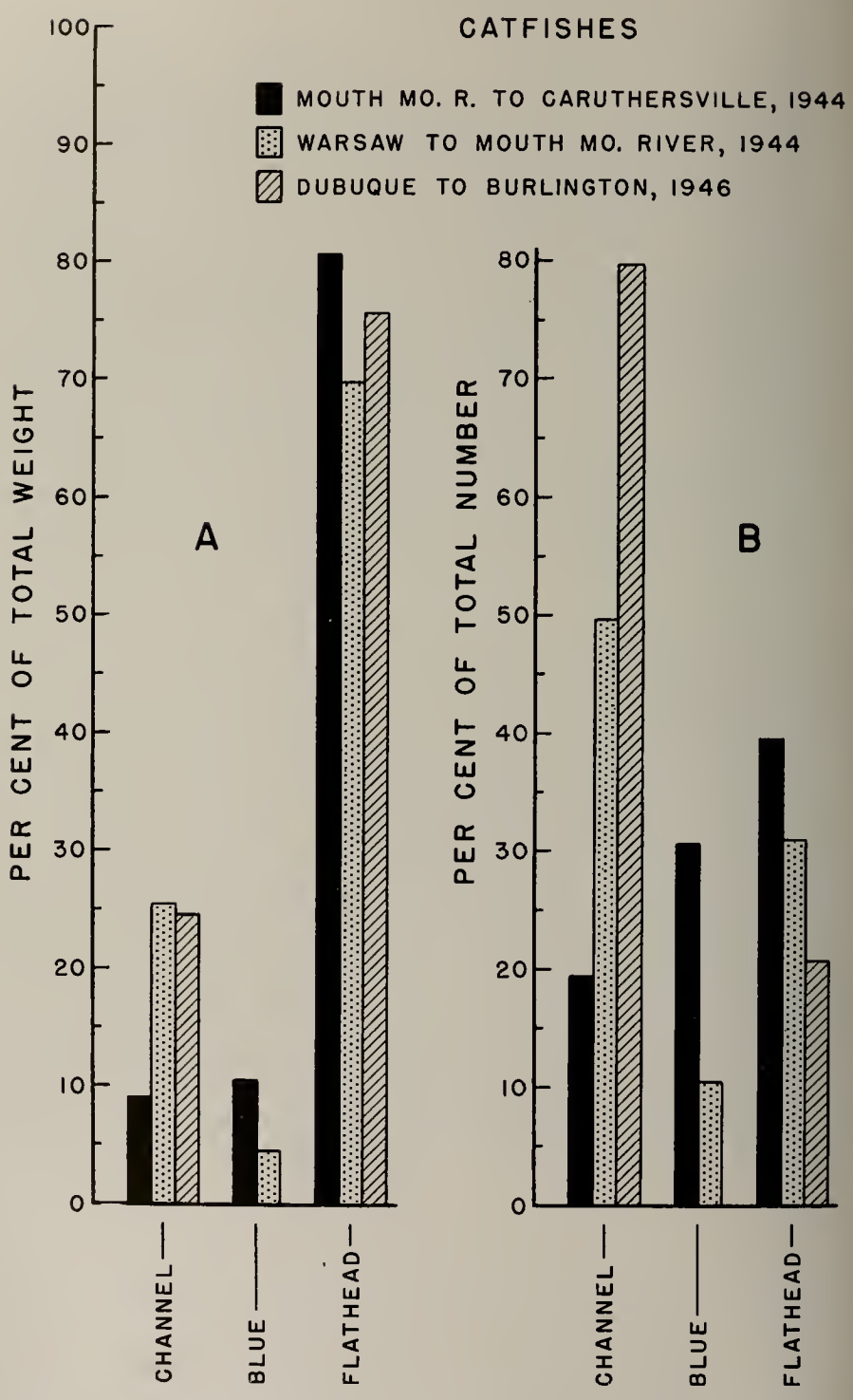

Fig. 13.—The relative weight and the relative abundance of each of three species of catfishes taken in test-net collections from three sections of the Mississippi River, 1944 and 1946.

low, only 0.57 pound, Appendix B, table 1. This species is principally southern in distribution and evidently forms a substantial part of the catch in the lower part of the Mississippi, particularly in Louisiana. Evermann (1899:292) stated more

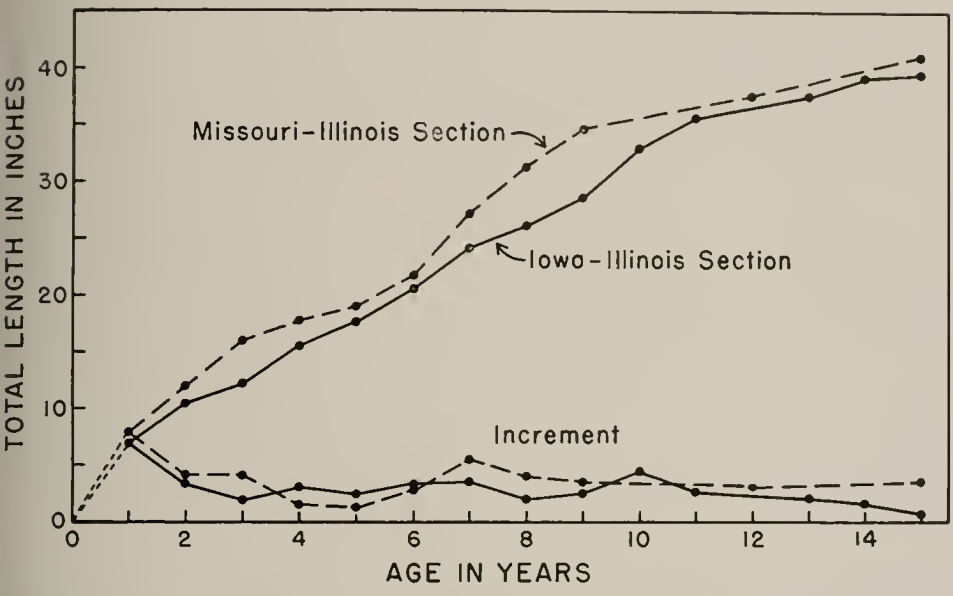

Fig. 14.—Average growth rates of flathead catfish taken in the Missouri-Illinois and Iowa-Illinois sections of the Mississippi River as determined from test-net collections, 1944 and 1946.

than 50 years ago that at Morgan City and Melville, Louisiana, the blue catfish and the flathead catfish constituted probably 98 per cent of the entire catch. Later Gowanloch (1933:421) mentioned that blue catfish weighing 150 pounds were caught occasionally and quoted Evermann as having been informed of one specimen weighing 185 pounds and another 250 pounds. Reports by commercial fishermen of 75- and 90-pound blue catfish were not uncommon in the section of the river near Caruthersville. No catfish of these large sizes were taken in the test nets.

Age determinations of the channel catfish and flathead catfish were made from specimens collected during the survey; they were based on the number of rings or annuli on the vertebrae. The number of annuli on the vertebrae of the blue catfish could not be discerned with any degree of accuracy. From the growth studies it appears that channel catfish and flathead catfish do not mature until they are 4 or 5 years old. The size at which they attain maturity was found to vary considerably. A few mature female flathead catfish less than 15 inches total length were noted; however, the majority of mature females were 18 inches or more in length. The channel catfish was found to mature at lengths between 12 and 15 inches. Too few blue catfish were examined to determine maturity size for this species.

Growth of the channel catfish and flathead catfish was faster in the Missouri-Illinois section of the river than in the Iowa-Illinois section, fig. 14.

The length-frequency distribution of the catfishes from the test-netting collections is given in table 14. A line of demarcation is drawn on table 14 to set off the approximate size at which maturity is attained among the catfishes. The 15-inch set-off for the blue catfish is purely arbitrary.

Three species of bullheads were taken from the river during the 2 years of test-netting. As shown in table 15, the black bullhead (*Ameiurus melas*) made up 5.6 per cent of the total number of all fishes taken in the MR-C section in 1944. In that part of the D-MR section sampled that same year the black bullhead dropped

to an insignificant 0.6 per cent and in that part sampled in 1946 to 0.5 per cent. Black bullheads were taken in numbers at only four of the stations in the MR-C section, Appendix B, table 1. The black bullheads taken at these stations represented 82 per cent of the number of this species caught in 1944 and 68 per cent of all the black bullheads taken in the entire survey. At the six stations immediately below the canalized section of the river (stations south of Grafton) only five black bullheads were caught, numerically 1.6 per cent of the 1944 catch of black bullheads.

Table 14.—Length-frequency distribution of the catfishes in test-net collections from the Mississippi River between Caruthersville, Missouri, and Dubuque, Iowa, in 1944 and 1946. The horizontal broken rule marks the approximate dividing line between immature and mature fish; the line for the blue catfish is based on little evidence and is therefore questionable.

Total Length in Inches	Channel Catfish			Flathead Catfish			Blue Catfish	
	MR-C Section 1944	D-MR Section 1944	D-MR Section 1946*	MR-C Section 1944	D-MR Section 1944	D-MR Section 1946*	MR-C Section 1944	D-MR Section 1944
2.8– 3.7	—	1	6	—	—	—	—	—
3.8– 4.7	—	—	3	—	—	1	—	1
4.8– 5.7	—	1	2	—	—	2	—	—
5.8– 6.7	—	4	99	—	—	2	7	—
6.8– 7.7	4	14	221	—	3	12	15	4
7.8– 8.7	24	14	228	5	6	3	22	17
8.8– 9.7	34	20	210	5	2	11	30	19
9.8–10.7	15	29	111	7	7	11	40	5
10.8–11.7	11	42	69	9	8	17	41	6
11.8–12.7	5	60	34	13	13	20	23	4
12.8–13.7	4	32	27	18	19	20	13	4
13.8–14.7	8	23	32	22	15	17	9	10
14.8–15.7	11	26	33	35	29	22	13	5
15.8–16.7	4	15	18	42	28	22	4	—
16.8–17.7	11	14	10	46	28	26	6	2
17.8–18.7	3	7	12	42	24	18	1	2
18.8–19.7	6	8	2	34	17	5	3	—
19.8–20.7	1	4	7	17	12	11	2	—
20.8–21.7	1	2	1	17	5	12	—	—
21.8–22.7	2	1	2	12	6	3	—	1
22.8–23.7	1	1	2	11	2	7	1	—
23.8–24.7	3	—	3	8	1	3	—	—
24.8–25.7	—	—	1	7	4	11	—	—
25.8–26.7	—	1	—	5	7	7	—	—
26.8–27.7	—	—	—	5	1	4	—	—
27.8–28.7	—	—	1	2	1	5	—	—
28.8–29.7	—	—	—	2	1	1	—	—
29.8–30.7	—	1	1	3	—	1	—	—
30.8–31.7	—	—	1	1	1	1	—	—
31.8–32.7	—	—	—	—	1	5	1	—
32.8–33.7	—	—	—	—	1	2	—	—
33.8–34.7	—	—	—	—	—	1	—	—
34.8–35.7	—	—	—	1	1	2	—	—
35.8–36.7	—	—	—	2	—	2	—	—
36.8–37.7	—	—	—	1	1	5	—	—
37.8–38.7	—	—	—	—	—	1	—	—
38.8–39.7	—	—	—	—	—	2	—	—
39.8–40.7	—	—	—	—	—	—	—	—
40.8–41.7	—	—	—	—	1	—	—	—
Total number	*148*	*320*	*1,136*	*372*	*245*	*295*	*231*	*80*
Average length	12.3	12.8	9.6	17.9	17.0	17.5	11.3	11.0
Per cent mature length	29.1	25.0	8.3	45.7	35.5	36.9	13.4	12.5

* The 1946 D-MR data include 24 channel catfish and 2 flathead catfish caught near Burlington, Iowa, by J. O. Kurrle, a commercial fisherman.

Table 15.—Species composition of Mississippi River fishes taken above and below the mouth the Missouri River between Caruthersville, Missouri, and Dubuque, Iowa, 1944 and 1946.

Species	Mouth of Missouri River to Caruthersville, 1944			Warsaw to Mouth of Missouri River, 1944			Dubuque to Burlington (Above Mouth of Missouri River), 1946		
	Per Cent of Total Stations (10) at Which Listed Species Were Taken	Number of Specimens	Per Cent of Total Number of All Fish	Per Cent of Total Stations (12) at Which Listed Species Were Taken	Number of Specimens	Per Cent of Total Number of All Fish	Per Cent of Total Stations (14) at Which Listed Species Were Taken	Number of Specimens	Per Cent of Total Number of All Fish
Commercial Fishes									
caphirhynchus album	—	0	—	8	1	0.01	—	0	—
hovelnose sturgeon	—	0	—	8	3	0.03	29	281	2.24
addlefish	40	24	0.51	42	52	0.59	—	0	—
merican eel	30	10	0.21	75	27	0.31	79	17	0.14
lue sucker	—	0	—	17	3	0.03	21	5	0.04
igmouth buffalo	70	48	1.02	92	61	0.69	100	277	2.21
lack buffalo	60	30	0.64	83	28	0.32	86	29	0.23
mallmouth buffalo	80	127	2.69	100	341	3.88	93	486	3.88
arpiodes spp.	100	334	7.08	100	605	6.88	100	1,491	11.90
hite sucker	—	0	—	—	0	—	21	6	0.05
potted sucker	—	0	—	—	0	—	14	2	0.02
ilver redhorse	—	0	—	—	0	—	7	1	0.01
Northern redhorse	10	7	0.15	58	13*	0.15	93	104	0.83
Carp	100	1,311	27.80	100	1,014	11.53	100	1,347	10.76
Channel catfish	100	148	3.14	100	320	3.64	100	1,115	8.90
Blue catfish	100	231	4.90	100	80	0.91	—	0	—
Yellow bullhead	20	4	0.08	50	24	0.27	29	10	0.08
Brown bullhead	10	1	0.02	17	5	0.06	—	0	—
Black bullhead	70	262	5.56	50	48	0.55	79	65	0.52
Flathead catfish	100	372	7.89	92	245	2.78	100	294	2.35
Freshwater drum	100	348	7.38	100	768	8.73	100	1,088	8.69
Subtotal		*3,257*	*69.08*		*3,638*	*41.35*		*6,018*	*52.85*
Sport Fishes									
Pike	—	0	—	—	0	—	36	35	0.28
Grass pickerel	—	0	—	8	2	0.02	—	0	—
Yellow pikeperch	—	0	—	17	2	0.02	57	17	0.14
Sauger	60	21	0.45	75	46	0.52	71	68	0.54
Spotted black bass	10	2	0.04	—	0	—	7	2	0.02
Largemouth black bass	50	10	0.21	58	123	1.40	64	18	0.14
Green sunfish	20	18	0.38	—	0	—	21	3	0.02
Bluegill	70	39	0.83	67	556	6.32	86	308	2.46
Warmouth	30	15	0.32	25	52	0.59	36	10	0.08
Flier	10	1	0.02	—	0	—	—	0	—
White crappie	70	119	2.52	100	879	9.99	100	2,677	21.38
Black crappie	70	123	2.61	100	1,392	15.82	100	1,452	11.60
White bass	50	24	0.51	83	193	2.19	93	162	1.29
Yellow bass	20	2	0.04	33	4	0.05	57	258	2.06
Subtotal		*374*	*7.93*		*3,249*	*36.93*		*5,010*	*40.00*
Predatory Fishes									
Longnose gar	90	51	1.08	100	143	1.63	93	38	0.30
Shortnose gar	100	602	12.77	100	809	9.20	100	209	1.67
Alligator gar	40	84	1.78	8	1	0.01	—	0	—
Bowfin	50	29	0.62	67	81	0.92	93	154	1.23
Subtotal		*766*	*16.25*		*1,034*	*11.75*		*401*	*3.20*
Forage Fishes									
Mooneye†	70	43	0.91	92	66	0.75	79	174	1.39
Goldeye†	—	—	—	—	—	—	64	84	0.67
Skipjack	30	11	0.23	17	4	0.05	—	0	—
Gizzard shad	70	264	5.60	100	805	9.15	86	237	1.89
Golden shiner	—	0	—	8	2	0.02	—	0	—
Subtotal		*318*	*6.74*		*877*	*9.97*		*495*	*3.95*
Total		*4,715*	*100.00*		*8,798*	*100.00*		*12,524*	*100.00*

* Includes one specimen of an undetermined species of redhorse (*Moxostoma*).
† The goldeye is included with the mooneye in the 1944 collections.

In July, 1944, at the Grafton station, 14 specimens of black bullheads were taken, Appendix B, table 1. As mentioned in Appendix A, some of the sampling done at this station was in the lower part of the Illinois River and adjoining bottomland lakes, and the catch there may not have been typical of the fish population in the Mississippi. At the next station above Grafton on the Mississippi, five black bullheads were taken, and at the next four stations none was caught. In the aggregate only four specimens were taken at the remaining three uppermost stations used in 1944. The number of black bullheads was low throughout that part of the D-MR section investigated in 1946. The largest number caught at one station in 1946 was 16, at Andalusia in June. The data for the various stations are contained in Appendix B.

The yellow bullhead (*Ameiurus natalis*) was taken at less than half of the stations and was plentiful at none, Appendix B. More specimens were taken at the upper than at the lower stations; however, considerably more than half of the yellow bullheads taken in the survey were caught at the Grafton station, and, as suggested above, the sampling there was not confined to the Mississippi.

Only six brown bullheads (*Ameiurus nebulosus*) were taken in 1944 and none in 1946, Appendix B. Of these only one was taken in the lower river and the remainder were caught at the Grafton station.

The scarcity of bullheads in the D-MR section of the river is reflected by the Iowa commercial catch between 1944 and 1948, table 16. For a few years following canalization of the upper Mississippi the commercial catch of bullheads increased, and it did not show a severe decline until 1944–45. The reason for the decline is not known. The test-net catch of bullheads in 1944 was low at the six sampling stations below the canalized section of the river. According to E. B. Speaker of the Iowa Conservation Commission (letter, August 19, 1949) there again is apparently some increase in the bullhead population in the Iowa section of the Mississippi.

Since so few bullheads were taken in 1946, the length-frequency data of only the 1944 catch are included in table 17. In Illinois the present minimum legal length for bullheads is 9 inches. Age determinations made from vertebrae of the Mississippi River bullheads taken in 1944 tend to indicate that the majority of the black bullheads did not reach the maturity length of approximately 10 inches before the age of 3 years. The yellow bullheads, however, seem to have a more rapid growth rate and attained this length within 2 years. In the 1944 test-net samples, 70 per cent of the black bullheads were 10 inches or more in length. Of the 28 specimens of yellow bullheads taken, 82

Table 16.—Commercial catch of bullheads from the Iowa section of the Mississippi River, 1938–1948.*

YEAR	POUNDS CAUGHT
1938–39	74,246
1939–40	98,577
1940–41	189,129
1941–42	215,675
1942–43	203,040
1943–44	138,385
1944–45	52,158
1945–46	7,679
1946–47	15,618
1947–48	20,306

* Data furnished by E. B. Speaker, Superintendent of Biology Section, Iowa Conservation Commission.

Table 17.—Length-frequency distribution of bullheads in test-net collections from the Mississippi River between Caruthersville, Missouri, and Warsaw, Illinois, in 1944. The horizontal broken rule marks the approximate dividing line between immature and mature fish.

TOTAL LENGTH IN INCHES	BLACK BULLHEAD	YELLOW BULLHEAD	BROWN BULLHEAD
5.8– 6.7	4	—	—
6.8– 7.7	9	1	—
7.8– 8.7	28	2	1
8.8– 9.7	52	2	—
9.8–10.7	98	13	2
10.8–11.7	68	6	—
11.8–12.7	35	3	1
12.8–13.7	11	1	1
13.8–14.7	3	—	1
14.8–15.7	1	—	—
15.8–16.7	1	—	—
Total number	*310*	*28*	*6*
Average length	10.4	10.5	11.4

per cent equaled or exceeded 10 inches in length.

The catfish and bullhead fishery between Caruthersville and Dubuque as demonstrated by the 2 years of test netting is largely a channel cat–flathead fishery. The only other important species of this group, the black bullhead and the blue catfish, are more numerous in the MR-C section than above. The great abundance of the channel catfish in the upper river perhaps compensates somewhat for the small numbers of bullheads in that section and the scarcity of the blue catfish in the river above Warsaw. Yellow bullheads and brown bullheads are too scarce in the river to be of any commercial importance.

Freshwater Drum

SCIAENIDAE

In the Midwest commercial market the freshwater drum is usually called white perch. In the Mississippi River this fish is of great importance commercially and of some value as a sport fish. According to Forbes & Richardson (1920:324), weights of 50 to 60 pounds were in their time not uncommon for this fish. In the opinion of these writers the freshwater drum "becomes tough and strong with age, but is at its best when weighing from three-quarters of a pound to three pounds. . . . This fish is of a sluggish habit, living on the bottom of muddy waters, where it feeds especially on mollusks, the shells first being crushed by the powerful, paved, millstone-like, pharyngeal jaws. Often the stomach contains only the soft bodies and opercula of gastropod mollusks, the crushed shells evidently having been thrown out. Crawfishes are also sometimes found in the food. Half-grown specimens feed largely on aquatic insects, especially the larvae of May-flies, mingling larger and larger proportions of mollusks with this food as they increase in size, until they come finally to depend almost wholly upon water-snails and the relatively thin-shelled clams."

Although the increased silt load and canalization have modified the Mississippi as an invertebrate habitat, the freshwater drum has evidently been able to withstand the changes and is still one of the most abundant fishes in the river. In the test-netting study the freshwater drum was found to be abundant at all the sampling stations between Caruthersville and Dubuque.

In 1946 the freshwater drum ranked fourth in weight of catch among Mississippi River fish groups reported by commercial fishermen of Illinois, Iowa, and Missouri, table 7. It ranked second among species in the test-net survey, as the buffalofish, carpsucker, catfish, and bullhead groups were each composed of more than one species. Its relative abundance in the three sections of the river indicated in table 15 did not vary appreciably.

The average weight of the freshwater drum in the survey catches was 0.67 pound, Appendix B. As shown in table 18 the average length for individuals of this species varied somewhat in the three sections indicated. Many more large individuals, that is, fish 14 inches or more in length, were taken in 1946 than in 1944.

Table 18.—Length-frequency distribution of the freshwater drum in test-net collections from the Mississippi River between Caruthersville, Missouri, and Dubuque, Iowa, in 1944 and 1946. The horizontal broken rule marks the approximate dividing line between immature and mature fish.

Total Length in Inches	MR–C Section 1944	D–MR Section 1944	D–MR Section 1946*
3.8– 4.7	—	12	25
4.8– 5.7	4	36	121
5.8– 6.7	28	44	59
6.8– 7.7	34	117	80
7.8– 8.7	24	99	122
8.8– 9.7	36	82	129
9.8–10.7	43	80	70
10.8–11.7	39	69	70
11.8–12.7	58	99	77
12.8–13.7	51	81	92
13.8–14.7	11	40	125
14.8–15.7	10	10	86
15.8–16.7	—	4	54
16.8–17.7	—	4	20
17.8–18.7	1	—	7
18.8–19.7	—	—	7
21.8–22.7	—	—	1
Total number	*339*	*777*	*1,145*
Average length	10.5	9.9	10.6
Per cent mature fish	6.5	7.5	26.2

* The 1946 D-MR data include 58 specimens caught near Burlington, Iowa, by J. O. Kurrle, a commercial fisherman.

Studies made on the scales of the freshwater drum from the Mississippi indicate that, on the average, the drum does not attain a length of 14 inches until it is 5 years of age in the Illinois-Missouri section and 6 years of age in the Illinois-Iowa section. The minimum legal length limit of 10 inches, which has been in effect for some time in the state of Illinois, appears to have allowed a favorable take without seriously depleting the population.

The length at which the freshwater drum matures was found to be variable. A female 10.5 inches in length was found spent, and individuals of 15.0 and 15.5 inches were determined as immature or developing. Probably length variation within a group is associated with the age of that group, since a wide length range for each age group was common.

In 1946 the freshwater drum commanded a price along the Mississippi about equal to that of the buffalofishes, approximately 10 cents a pound, undressed weight. In that year, undressed carp brought about 5 cents a pound and undressed catfish approximately 20 cents a pound.

SPORT FISHES

The sport fishery of the Mississippi River between Caruthersville and Dubuque is confined largely to the D-MR section. There sport fishing is, for the most part, conducted in the pools immediately below the dams and in backwaters and bottomland lakes adjoining the river.

Bluegills (*Lepomis macrochirus*) and crappies were by far the most abundant species of sport fishes in the test-net collections. Black basses, pike, sauger, and yellow pikeperch (walleye) were taken in only limited numbers. Experience has demonstrated that the black basses are not so susceptible to being caught in nets and seines as are most of the other fishes. This possibly explains the scarcity of black basses in many of the collections.

Fig. 9 portrays the abundance of sport fishes in the collections from test-net stations in the Caruthersville-Dubuque section of the river. In this figure it may be clearly seen that the sport fishes made up a smaller part of the total catch in the MR-C section of the river than in the

Table 19.—Relative abundance of individuals of the several groupings of Mississippi River fishes associated with upper, middle, and lower reaches of navigation pools between Burlington and Dubuque, Iowa, in 1946, expressed as per cents of total numbers and total weights of fishes.

Location in Pool and Station	Commercial		Sport		Predator		Forage		Total	
	Per Cent of Total Number	Per Cent of Total Weight	Per Cent of Total Number	Per Cent of Total Weight	Per Cent of Total Number	Per Cent of Total Weight	Per Cent of Total Number	Per Cent of Total Weight	Number of Fish	Pounds
Upper Part (New Boston, Ill., Pleasant Valley, Ia., Fulton, Ill., Dubuque, Ia.)	35.91	67.25	57.56	23.03	3.14	8.55	3.39	1.17	4,715	4,256.36
Middle Part (Burlington, Ia., Oquawka, Ill., Muscatine, Ia., Andalusia, Ill., Cordova, Ill., and Sabula, Ia.)	67.57	89.19	28.45	5.48	2.95	5.08	1.02	0.25	6,537	7,935.97
Lower Part (Fairport, Ia., and Bellevue, Ia.)	60.22	88.96	34.28	5.69	4.72	5.32	0.79	0.03	1,272	1,625.16

D-MR section. Because of the scarcity of adjoining backwaters and bottomland lakes, together with a high degree of turbidity in the channel, the MR-C section is visibly less satisfactory as a habitat for most of the sport fishes than the D-MR section. A much more favorable habitat for these fishes is provided by the D-MR section; however, the increased silt load of the river, silting above the dams, and the draining of adjoining bottomland lakes have contributed toward reducing the potentialities of this section of the river for sport fishes.

Netting operations in the various parts of the pools formed by the dams in the D-MR section revealed that the game fishes were most abundant in the upper reaches. The catches of all fishes in the upper, middle, and lower reaches of the pools are summarized in tables 19 and 20. A relative increase in the catch of commercial fishes occurred in the middle and lower reaches as the intensity of fishing was increased there, although the total catch (all species combined) per net-day actually dropped. The relative increase in the catch of commercial fishes as reflected by table 19 is due partly to the scarcity of sport fishes in catches from the middle and lower reaches. The upper reaches of the pools provide a more favorable habitat for sport fishes than the middle and lower reaches in that the bottoms in the upper reaches are comparatively free of silt. Here probably more food is available in the form of aquatic insects and minnows than over the silt-covered bottoms in the middle and lower reaches of the pools. Deep holes and shallow sand bars are rather numerous in the upper reaches of the pools, and this type of habitat is usually considered favorable for sport fishes.

Early in this century, and before, sport fishes were taken commercially from the Mississippi. During the year 1899, Townsend (1902:681) reports, 18,744 pounds of "black bass" were caught commercially by Illinois fishermen from the Mississippi and 102,579 pounds from the Illinois

Table 20.—The 1946 hoop-net and wing-net catches expressed in average numbers and weight of fish per net-day in relation to location in navigation pools of the Mississippi River between Burlington and Dubuque, Iowa.

Location in Pool and Station	1-Inch Mesh Wing Net		2½-Inch Mesh Wing Net		1-Inch Mesh Hoop Net		2½-Inch Mesh Hoop Net	
	Average Number of Fish per Net-Day	Average Weight of Fish per Net-Day	Average Number of Fish per Net-Day	Average Weight of Fish per Net-Day	Average Number of Fish per Net-Day	Average Weight of Fish per Net-Day	Average Number of Fish per Net-Day	Average Weight of Fish per Net-Day
Upper								
New Boston	17 66	10.09	1.68	5 07	4.12	1 13	0 98	3 01
Pleasant Valley	7.71	7.15	1 24	4 22	1 14	0 84	1.04	4.38
Fulton	24 91	12 59	1 33	3.55	6 05	7.73	2.30	6.60
Dubuque	10 16	5 97	0.91	3 68	2 22	0 70	0 59	2.42
Average for upper part	*15 11*	*8.95*	*1.29*	*4.13*	*3 38*	*2 60*	*1.23*	*4.10*
Middle								
Burlington	13 92	6.32	1 50	5 29	4 21	2 10	1.13	2.64
Oquawka	7 58	5.05	1 58	4 58	0.73	1 89	1 32	2 92
Muscatine	6 56	3 09	0 81	2 05	0 75	0 28	2 16	4 75
Sabula	11 01	5 04	0 51	1 39	1 76	2 39	0 47	2 91
Andalusia (April)	6.99	4 43	1 44	4 50	1 18	0 40	0.15	0 30
Andalusia (June)	9 02	9.16	2.76	7.37	5.33	6 87	4 45	8.53
Andalusia (Sept.)	6 32	3 14	0 88	2 65	1.70	2 72	0.51	1 55
Cordova	7 48	5.40	0.79	2 45	4 49	2 16	0 57	3 12
Average for middle part	*8.61*	*5.20*	*1.28*	*3 79*	*2 52*	*2 35*	*1.35*	*3 34*
Lower								
Fairport	5.51	5 54	1 71	3 89	0 11	0 02	0 55	2 52
Bellevue	6.76	3.77	0.43	1 47	0.80	1 18	0 47	2 49
Average for lower part	*6 13*	*4 66*	*1.07*	*2.68*	*0 46*	*0 60*	*0.51*	*2 51*

River; 33,641 pounds of "sunfish" were taken from the Mississippi and 507,680 pounds from the Illinois. These statistics indicate that the section of the Mississippi bordering Illinois was not then a great producer of sport fishes, at least when compared with the Illinois River.

Pike and Pickerel

ESOCIDAE

Pike are often referred to by Midwest fishermen as pickerel. In the Mississippi River a species of pickerel, as well as the pike (*Esox lucius*), was taken in the test nets. The grass pickerel (*Esox vermiculatus*) seldom attains a length over 15 inches. This little pickerel was taken in the test-net collections only at the Grafton station and it is of no importance as either a commercial or sport fish.

Pike, popularly known as northern pike, did not appear in the test-net collections below the station at New Boston, where a single specimen weighing 3.49 pounds was taken. The absence of pike in the collections below this station substantiates the statement of Coker (1930:214) that Keokuk, which is 69 miles below New Boston, "is evidently south of the common range of the true pike in the Mississippi River." More than 91 per cent of the pike taken during the entire survey were caught at the four uppermost 1946 sampling stations.

Commercial fishery statistics suggest that the pike has not been common in the Missouri section of the Mississippi River for at least a half century. In 1894 pike represented 0.01 per cent of the total Missouri commercial catch from the Mississippi, and no pike was reported for the year 1899, table 8. In the Illinois section of the Mississippi, the pike was rather common in the commercial catch for 1894 and 1899. In the Iowa section, the catch of pike by commercial fishermen amounted to 25,042 pounds in 1899. Forbes & Richardson (1920:209), writing nearly a half century ago, stated that the number of pike had greatly decreased in Illinois waters during the previous 25 years.

The taking of pike is now restricted in the Caruthersville-Dubuque section of the river to sport fishing, and the species is too scarce in this section, other than in the upper part, to be of much importance even as a sport fish.

Perches

PERCIDAE

Three species of sport fishes belonging to the perch family have been reported to occur in the Mississippi River. The yellow perch, *Perca flavescens* (Mitchill), according to Forbes & Richardson (1920: 227), is essentially a lake fish but occurs also in running water, most abundantly in the larger rivers. Townsend (1902: 684, 721) gave the 1899 commercial take of the yellow perch from the Mississippi River by Illinois fishermen as 1,521 pounds and by Iowa fishermen as 9,665 pounds. He did not report a yield of perch for the Missouri section of the river. Coker (1930:204) wrote several years later that the yellow perch was apparently not common in the vicinity of Keokuk, but suggested that it might become more abundant in the impoundment at Keokuk since it is "essentially a lake fish." He reported that the expected increase had not occurred up to 1926.

In the Caruthersville-Dubuque survey not a single specimen of yellow perch was taken. This fish is usually not considered "net shy" and it appears that if the species occurred in numbers in the parts of the river investigated at least a few specimens would have been netted. Although the yellow perch formerly occurred abundantly enough in the Iowa section of the Mississippi to be of some value commercially, the draining of bottomland lakes and backwaters in the valley may have had the effect of reducing the population. These former lakes probably abounded in aquatic vegetation and, according to Greene (1935: 162), one of the most potent ecological factors in the distribution of the yellow perch is aquatic vegetation, a usual necessity for successful spawning. Large perch populations frequently are associated with extensive sandy shoals, and silting of such areas may limit the numbers of perch.

The pikeperches are of some importance to the sport fishery of the Mississippi River, and large catches of these fishes are not uncommon from the upper part of the D-MR section of the river. Experienced anglers usually make their catches in the fall. In

Table 21.—Length-frequency distribution of the sauger and the yellow pikeperch in test-net collections from the Mississippi River between Caruthersville, Missouri, and Dubuque, Iowa, in 1944 and 1946.

TOTAL LENGTH IN INCHES	SAUGER			YELLOW PIKEPERCH	
	MR-C Section 1944	D-MR Section 1944	D-MR Section 1946	D-MR Section 1944	D-MR Section 1946
8 8- 9 7	—	—	4	—	3
9 8-10 7	—	—	1	—	2
10 8-11 7	2	1	9	—	—
11 8-12 7	5	1	9	—	5
12 8-13 7	9	10	13	—	1
13 8-14 7	4	7	17	—	1
14 8-15 7	1	13	11	1	—
15 8-16 7	—	14	4	—	1
16 8-17 7	—	—	—	—	—
17 8-18 7	—	—	—	—	1
18 8-19 7	—	—	—	—	—
19 8-20 7	—	—	—	—	—
20 8-21 7	—	—	—	—	—
21 8-22 7	—	—	—	1	—
22 8-23 7	—	—	—	—	2
23 8-24 7	—	—	—	—	—
24 8-25 7	—	—	—	—	1
Total number	*21*	*46*	*68*	*2*	*17*
Average length	13 1	14.8	13.3	18.8	14.3

those sections of the Mississippi surveyed, two species of pikeperches were taken, namely, sauger (*Stizostedion canadense*) and yellow pikeperch, known also as walleye (*S. vitreum vitreum*). The sauger was much more abundant in the Caruthersville-Dubuque section of the river than the yellow pikeperch. In the Caruthersville-Warsaw section 67 specimens of sauger were taken as compared with only 2 specimens of yellow pikeperch. The yellow pikeperch did not occur in any of the collections from the MR-C section. In the Burlington-Dubuque section the sauger continued to be more abundant than the yellow pikeperch. From this section of the river 68 saugers and 17 yellow pikeperches were taken. According to Coker (1930:204), the sauger was evidently much more common than the yellow pikeperch at Keokuk 20 or more years ago. On the basis of the distribution and abundance of the pikeperches it appears that the sauger is much more tolerant of turbid waters than the yellow pikeperch.

Table 21 indicates that the sauger is usually smaller than the yellow pikeperch. The largest yellow pikeperch taken during the survey was 24.9 inches in length and weighed 6.25 pounds.

Black Basses and Other Sunfishes

CENTRARCHIDAE

The black crappie (*Pomoxis nigromaculatus*) and the white crappie (*Pomoxis annularis*) were the most abundant sunfishes taken in the survey. Crappies were taken at all but three of the stations; however, they were much more common in the D-MR section than in the section below, Appendix B. In the MR-C section crappies accounted for only 5.1 per cent of the total number of all fishes caught in test nets, whereas in the lower D-MR section, that part surveyed in 1944, crappies represented 25.8 per cent of the total test-net catch. In the Burlington-Dubuque section, surveyed in 1946, crappies accounted for 33.0 per cent of all fishes in the test-net collections. The abundance of the crappies relative to the other species of sport fishes is expressed graphically in fig. 15. It may be seen from this graph that at the majority of the stations crappies were more abundant in the collections than all the other sport fishes combined. At the stations where other sport fishes predominated, there were only small total catches of sport fishes. Usually at such stations the sauger and white bass domi-

nated the sport fish catch. In the MR-C collections the black crappie appeared to be slightly more abundant than the white. In the 1944 D-MR collections, the black crappie was almost twice as abundant as the white; however, the dominant black crappie populations were confined to the station just above the mouth of the Missouri River, the next station upstream, which is Grafton, and Cincinnati Landing. At the last of these stations only 7 crappies were taken, a number too small to be of any significance. At Grafton the black crappie was extremely abundant as compared with the white. At Winfield, the next station upstream from Grafton, the crappie population was predominantly white. This dominance of white crappies continued at the remaining upper river stations in 1944 and 1946 with the exception of Cincinnati Landing.

Hansen (1951:224), in his study of the biology of the white crappie, observed that crappie samples taken in hoop nets did not necessarily indicate the relative abundance of the two species. At Lake Chautauqua, near Havana, Illinois, he found that a dominance of black crappies or white crappies shifted in an erratic manner from week to week. In view of Hansen's study, the actual status of the species of crappie that is dominant in the test nets of a given section of river becomes uncertain. However, the constant dominance of the black crappie in catches during the three sampling periods at Grafton tends to substantiate the belief that it is more abundant there than the white. The dominance of the white crappie in most of the upper river collections between Winfield and Dubuque (1944 and 1946) indicates that this species is probably more abundant than the

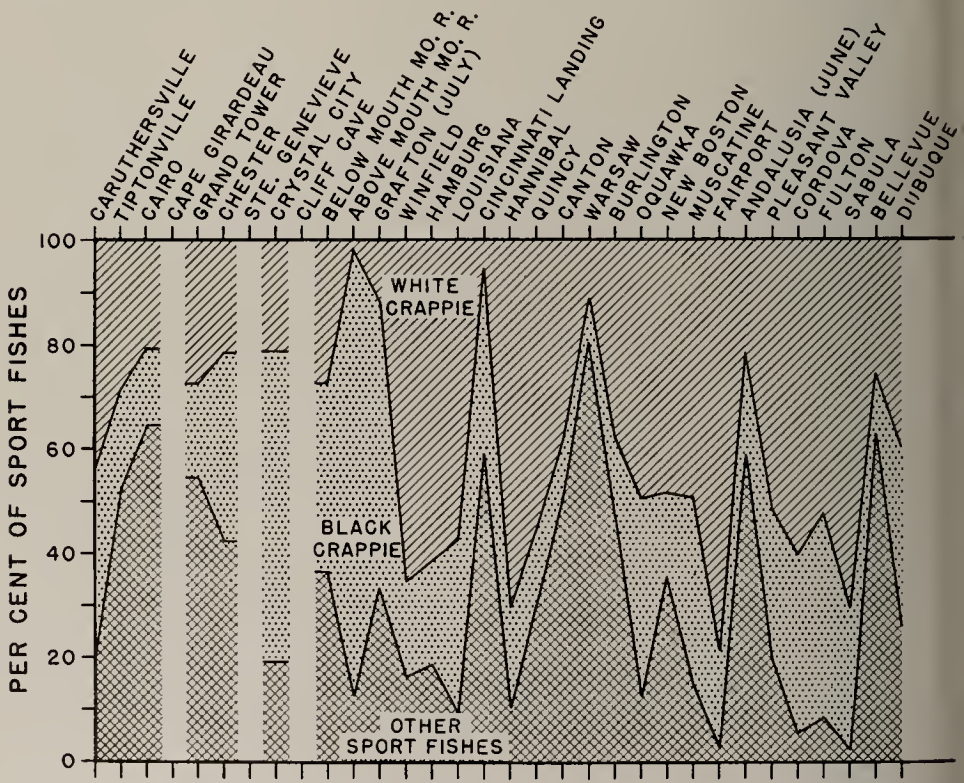

Fig. 15.—The relative abundance, as determined by test-netting, of the white crappie, black crappie, and other sport fishes at the various field stations on the Mississippi River between Caruthersville and Dubuque, 1944 and 1946. The percentages are based on the total number of sport fishes taken at each station. No sport fishes were taken at Cape Girardeau nor at Cliff Cave. The number taken at Ste. Genevieve, two, was considered too small to be significant.

Table 22.—Length-frequency distribution of the black crappie and the white crappie in test-net collections from the Mississippi River between Caruthersville, Missouri, and Dubuque, Iowa, in 1944 and 1946.

TOTAL LENGTH IN INCHES	BLACK CRAPPIE			WHITE CRAPPIE		
	MR-C Section 1944	D-MR Section 1944	D-MR Section 1946	MR-C Section 1944	D-MR Section 1944	D-MR Section 1946*
2.8- 3.7	—	—	56	—	—	32
3.8- 4.7	—	3	257	1	7	463
4.8- 5.7	1	21	149	—	40	394
5.8- 6.7	41	121	142	21	148	212
6.8- 7.7	48	291	217	37	191	239
7.8- 8.7	18	369	194	34	219	392
8.8- 9.7	11	418	288	17	147	446
9.8-10.7	4	145	128	4	100	358
10.8-11.7	—	21	16	3	24	152
11.8-12.7	—	2	3	2	3	33
12.8-13.7	—	1	1	—	—	4
13.8-14.7	—	—	1	—	—	—
Total number	*123*	*1,392*	*1,452*	*119*	*879*	*2,725*
Average length	7.3	8.4	7.1	7.9	8.0	7.5
Per cent 8 inches or more	26.8	68.7	43.5	50.4	56.1	50.8

* D-MR 1946 data include 51 white crappies from a catch with a 1½-inch hoop net by J. S. Barnett, a commercial fisherman at Oquawka, Illinois.

black in the D-MR section. Coker (1930: 202) found the white crappie was apparently about three times as abundant as the black at Keokuk.

The length-frequency distributions of the black crappies and white crappies taken in the test nets are presented in table 22. Slightly more than 50 per cent of the white crappies taken were 8 inches or more in length; with the exception of individuals taken in the 1944 D-MR section, a smaller proportion of the black crappies were of these lengths. Age and growth studies made from the scales of these fishes showed that the white crappies grew faster than the blacks, which probably accounts for the greater percentages of large white crappies.

It is difficult to determine the abundance of the largemouth black bass (*Micropterus salmoides*) from net and seine collections. As anyone who has attempted the netting of this bass realizes, it is not easily taken in numbers even where a large population may be present. Therefore, very little can be said regarding the status of the largemouth in the river. In the poisoning censuses of fish populations made in backwaters adjoining the Mississippi at Oquawka and Savanna, the largemouth population was rather low. Since these censuses pertain to only two localities, they do not necessarily indicate the overall status of the bass population. The largemouth black bass formed only an insignificant part of the test-net collections in the MR-C section in 1944 and of those in the D-MR section in 1946. In the D-MR section in 1944 the largemouth amounted to 1.4 per cent of the total number of fishes caught. Of these, 76.4 per cent were taken at Grafton. As was stated previously, some of the nets were set in bottomland lakes and sloughs of the Grafton area, long known as excellent for bass fishing. Anglers usually fish for bass in backwater lakes and sloughs of the Mississippi rather than in the river proper.

As shown in table 23, the average length of largemouth black bass taken in the test-net collections was more than 10 inches.

In each year of the survey, two spotted black bass (*Micropterus punctulatus*) were taken in the collections. This species of bass is too scarce in the Caruthersville-Dubuque section of the river to be of any importance to the sport fishery. The 1944 specimens were taken at Caruthersville and the 1946 at Fulton, Illinois.

No specimen of the smallmouth black bass (*Micropterus dolomieu*) was taken

in the test-net collections; however, one small specimen was taken with a minnow seine at Claryville, Missouri. The absence of this species from the test-net collections indicates that it is probably scarce in the area investigated, and that the largemouth is the only representative of the black basses that occurs in large enough numbers to be of any importance to the sport fishery.

The green sunfish (*Lepomis cyanellus*) appeared to be quite scarce in the Mississippi. In 1944, 18 fish of this species were taken in the test-net collections at Tiptonville and Crystal City, both MR-C stations. Only 3 were taken in test nets in the D-MR section in 1946. Green sunfish were taken in minnow seine collections at Louisiana, New Boston, Sabula, and Muscatine.

The orangespotted sunfish (*Lepomis humilis*) was not taken in the test-net collections; however, it was taken in minnow seine collections at Grafton and Warsaw. This species seldom attains a length of over 4 inches (Eddy & Surber 1947: 237) and it consequently has little value as a sport fish.

The flier (*Centrarchus macropterus*), according to Forbes & Richardson (1920: 242), is southern in distribution, "occurring in lowland streams and bayous of the lower Mississippi Valley, and in the south Atlantic region from Florida to Virginia." In the Mississippi survey one specimen of this species was taken in a minnow seine haul at Caruthersville and another in a test-net collection at Cairo. This species, like the orangespotted, does not attain a sufficient size to make it of much value as a sport fish.

The bluegill (*Lepomis macrochirus*) was taken at the majority of the survey stations. This species was collected in greater abundance in the D-MR section than in the MR-C. The largest collections of bluegills were taken at Grafton and Dubuque.

The average size of the bluegills collected, as shown in table 24, was over 6 inches. Such a size is usually considered by midwestern anglers as fair for bluegills. Age and growth studies on bluegills collected during the survey show that, on the

Table 23.—Length-frequency distribution of the largemouth black bass in test-net collections from the Mississippi River between Caruthersville, Missouri, and Dubuque, Iowa, in 1944 and 1946.

Total Length in Inches	MR-C Section 1944	D-MR Section 1944	D-MR Section 1946
6.8– 7.7	1	1	—
7.8– 8.7	1	2	1
8.8– 9.7	1	3	1
9.8–10.7	1	15	1
10.8–11.7	2	22	4
11.8–12.7	3	40	3
12.8–13.7	—	17	3
13.8–14.7	1	7	3
14.8–15.7	—	8	—
15.8–16.7	—	6	—
16.8–17.7	—	—	2
17.8–18.7	—	2	—
Total number	*10*	*123*	*18*
Average length	10.9	12.4	12.6

Table 24.—Length-frequency distribution of the bluegill in test-net collections from the Mississippi River between Caruthersville, Missouri, and Dubuque, Iowa, in 1944 and 1946.

Total Length in Inches	MR-C Section 1944	D-MR Section 1944	D-MR Section 1946
2.8– 3.7	—	—	6
3.8– 4.7	6	11	60
4.8– 5.7	5	87	59
5.8– 6.7	20	231	75
6.8– 7.7	7	204	75
7.8– 8.7	—	23	33
8.8– 9.7	—	—	—
9.8–10.7	1	—	—
10.8–11.7	—	—	—
Total number	*39*	*556*	*308*
Average length	6.1	6.5	6.1

Table 25.—Length-frequency distribution of the warmouth in test-net collections from the Mississippi River between Caruthersville, Missouri, and Dubuque, Iowa, in 1944 and 1946.

Total Length in Inches	MR-C Section 1944	D-MR Section 1944	D-MR Section 1946
3.8–4.7	1	—	—
4.8–5.7	2	4	3
5.8–6.7	6	23	—
6.8–7.7	5	25	3
7.8–8.7	1	—	4
Total number	*15*	*52*	*10*
Average length	6.5	6.7	7.1

average, 6-inch fish were about 3 years of age, indicating rather slow growth.

The warmouth (*Chaenobryttus coronarius*), according to Coker (1930:204), was never very abundant in the Keokuk area of the Mississippi. This species was not taken abundantly anywhere during the Caruthersville-Dubuque survey. As in the case of the other sport fishes, the warmouth was taken more abundantly in the D-MR collections than in the collections farther south. It was taken less abundantly in the Burlington-Dubuque section than in the lower part of the D-MR section, that part surveyed in 1944.

Age and growth studies of specimens taken from the Illinois-Missouri section of the Mississippi in 1944 tended to show that growth of the warmouth, table 25, was a little slower than that of the bluegill. Bluegills 3 years of age averaged 6.64 inches, whereas warmouths of this age averaged 6.16 inches. The warmouth is probably not abundant enough in the Caruthersville-Dubuque section of the river to be considered of much importance to the sport fishery.

Sea Basses

SERRANIDAE

The white bass (*Lepibema chrysops*) and the yellow bass (*Morone interrupta*) are the only members of this large family, principally composed of marine fishes, occurring in the Caruthersville-Dubuque section of the Mississippi River. The white bass, according to Greene (1935: 160), is more northern in range than the yellow bass. In this survey both species were taken at the lowermost station, Caruthersville, and only the white bass in the Dubuque collections; however, one specimen of yellow bass was taken at Bellevue, 17 miles below Dubuque, indicating that the species probably occurs at the geographic extremes of this survey. The test-net collections indicate that the white bass is more widely distributed than the yellow bass in that part of the river surveyed.

The white bass was taken in greater numbers than the yellow bass in the MR-C section of the river; however, neither species was common there. In the D-MR section both species were much more abundant than in the MR-C section, Appendix B. The white bass accounted for 2.19 per cent of the total number of all fishes in the 1944 D-MR collections, the yellow bass for 0.05 per cent. In the total catch at the stations fished in 1946, the yellow bass was one and one-half times as abundant as the white bass. This reversal in abundance was due to the large catch of yellow bass at New Boston, where 84.1 per cent of the 1946 catch of this fish was taken. One wing net (1-inch mesh) in a backwater area at New Boston produced 198 yellow bass, amounting to 91.2 per cent of the 217 yellow bass caught at this station. Sex determinations made of these fish revealed that 96.5 per cent were ripe males. From this catch it appears that the males possibly are attracted during the spawning season by a few ripe females in the net. A more nearly accurate picture of abundance and distribution of white bass and yellow bass in the D-MR section can be obtained when the New Boston figures are omitted from the 1946 data for both species. When this is done the white bass appears to be three times as abundant as the yellow bass. The abundance of these fishes in the upper river has been discussed by several investigators. In 1888 near Quincy, Garman (1890: 137) found the white bass more abundant than the yellow bass, and, many years later at Keokuk, Coker (1930:207) found the white bass more common than the yellow bass.

The former status of these fishes in Illinois is discussed by Forbes & Richardson (1920:320). In discussing conditions of about 50 years ago these authors wrote the following regarding the white bass in the Mississippi: "It was formerly much more common than now. We are informed by Mr. H. L. Ashlock that a dozen years ago one could easily get a hundred pounds of it in an afternoon at Alton with a hundred-yard trammel-net, but that it has now almost disappeared." At the same time these authors (1920:321) found the yellow bass about twice as abundant as the white bass in Illinois.

The average sizes of the white bass and the yellow bass in the test-net collections differed only slightly, table 26. The white bass, however, attains greater sizes than the yellow bass. Both of these fishes

Table 26.—Length-frequency distribution of the white bass and the yellow bass in test-net collections from the Mississippi River between Caruthersville, Missouri, and Dubuque, Iowa, in 1944 and 1946.

Total Length in Inches	White Bass			Yellow Bass		
	MR–C Section 1944	D–MR Section 1944	D–MR Section 1946	MR–C Section 1944	D–MR Section 1944	D–MR Section 1946
3.8– 4.7	—	—	17	—	—	1
4.8– 5.7	—	10	23	—	—	3
5.8– 6.7	2	17	9	—	—	22
6.8– 7.7	6	30	13	1	—	18
7.8– 8.7	5	25	27	1	1	131
8.8– 9.7	5	18	19	—	3	68
9.8–10.7	—	41	17	—	—	9
10.8–11.7	1	24	22	—	—	5
11.8–12.7	2	9	10	—	—	1
12.8–13.7	1	7	3	—	—	—
13.8–14.7	2	9	—	—	—	—
14.8–15.7	—	2	2	—	—	—
15.8–16.7	—	1	—	—	—	—
Total number	*24*	*193*	*162*	*2*	*4*	*258*
Average length	9.2	9.4	8.4	7.8	9.0	8.4

are considered as excellent sport fishes, and they often form an important part of the angler's catch.

PREDATORY FISHES

In the present report the gars and the bowfin are grouped as predatory fishes. These fishes feed to a large extent upon other fishes and they have little commercial value. Many of the species designated in this report as commercial or sport fishes are also predatory in habits. The catfishes, black basses, and pikeperches are examples.

Gars

LEPISOSTEIDAE

The shortnose gar (*Lepisosteus platostomus*)* occurred much more frequently in the test-net collections than did the other species of gars. This gar was abundant in the MR-C and D-MR sections of the river.

The longnose gar (*Lepisosteus osseus*) also was common in both sections of the river; however, it occurred much less frequently in the test-net collections than the shortnose gar.

Eighty-five specimens of the alligator gar (*Lepisosteus spatula*) were taken during the survey. Of these, 84 were from the MR-C section. The single specimen from the D-MR section was taken at Grafton. As shown in Appendix B, table 1, in the MR-C section the alligator gar was netted at only four stations. Eighty of the 84 specimens were taken at Cairo. Forbes & Richardson (1920:35) state that: "The home of the alligator-gar is in the streams of the Gulf of Mexico, from Mexico to Cuba. It ascends the Mississippi above St. Louis, and has occasionally been taken in the lower Illinois River."

The length-frequency distribution of the gars taken in the test-net collections is given in table 27.

The largest gar taken during the survey was an alligator gar measuring 5 feet 5 inches total length and weighing 54.81 pounds. This specimen was taken in a 1-inch-mesh wing net at the Grand Tower station. The alligator gar, according to Dr. David Starr Jordan, reaches a length of 20 feet (Forbes & Richardson 1920: 35). The average length of the alligator gar in the MR-C collections was 23.5 inches, an average less than that determined for the longnose gar. The shortnose gar, as shown in table 27, averaged much less in length than the other gars.

In some areas gars are sought by anglers merely for sport. The larger specimens,

* In this investigation the spotted gar, *Lepisosteus productus* Cope, if present, was not separated from the shortnose gar.

particularly of alligator gars, provide a challenge to an angler using only moderately heavy tackle.

Bowfin

AMIIDAE

The bowfin in the Midwest is considered by some anglers as an excellent sport fish. This fish will, on occasion, strike a spinner-bucktail combination or a plug. The vicious runs of the bowfin after striking an artificial lure are something to be remembered, even by the experienced angler. The value of the bowfin as a food fish seems to be a debatable subject; however, the smoked flesh of a bowfin is considered a delicacy by some.

Fewer bowfins were taken in the collections from the MR-C section than in those from the D-MR section of the river. Catches of 41 bowfins at Winfield and 62

Table 27.—Length-frequency distribution of the gars and the bowfin in test-net collections from the Mississippi River between Caruthersville, Missouri, and Dubuque, Iowa, in 1944 and 1946.

Total Length in Inches	Shortnose Gar			Longnose Gar			Alligator Gar		Bowfin		
	MR-C Sec. 1944	D-MR Sec. 1944	D-MR Sec. 1946	MR-C Sec. 1944	D-MR Sec. 1944	D-MR Sec. 1946	MR-C Sec. 1944	D-MR Sec. 1944	MR-C Sec. 1944	D-MR Sec. 1944	D-MR Sec. 1946
6 8- 7 7	—	—	—	—	1	—	—	—	—	—	—
8 8- 9.7	—	1	—	—	—	—	—	—	—	—	—
11 8-12 7	1	—	—	—	—	—	—	—	1	—	—
12.8-13 7	7	—	—	—	—	—	—	—	1	—	—
13.8-14 7	53	8	—	—	—	—	—	—	2	1	1
14.8-15.7	116	52	—	1	—	—	1	—	—	3	1
15 8-16.7	108	87	9	—	—	—	—	—	3	4	3
16.8-17.7	51	102	6	2	2	1	—	—	4	11	5
17 8-18 7	38	123	7	2	16	1	—	—	2	8	6
18 8-19 7	32	119	30	2	20	1	2	—	4	12	20
19 8-20 7	18	109	32	2	8	3	3	—	8	14	32
20.8-21.7	37	91	45	2	7	1	7	—	2	5	34
21.8-22.7	26	59	33	2	6	3	26	—	1	9	24
22 8-23.7	36	29	26	—	13	1	19	—	—	3	12
23.8-24 7	33	19	15	—	7	5	14	—	—	2	5
24 8-25.7	26	5	4	1	11	6	7	—	—	4	5
25.8-26.7	11	1	1	—	13	1	3	—	—	1	3
26 8-27.7	8	3	1	2	4	2	1	1	—	1	3
27.8-28 7	1	1	—	1	5	3	—	—	—	2	—
28 8-29.7	—	—	—	4	3	3	—	—	1	1	—
29.8-30.7	—	—	—	2	6	1	—	—	—	—	—
30.8-31.7	—	—	—	—	3	1	—	—	—	—	—
31.8-32 7	—	—	—	6	1	—	—	—	—	—	—
32 8-33.7	—	—	—	1	1	—	—	—	—	—	—
33.8-34 7	—	—	—	3	2	—	—	—	—	—	—
34 8-35.7	—	—	—	4	3	1	—	—	—	—	—
35.8-36.7	—	—	—	4	2	—	—	—	—	—	—
36.8-37.7	—	—	—	2	1	—	—	—	—	—	—
37 8-38.7	—	—	—	1	—	—	—	—	—	—	—
38.8-39.7	—	—	—	—	1	—	—	—	—	—	—
39 8-40.7	—	—	—	2	2	2	—	—	—	—	—
40 8-41.7	—	—	—	3	3	—	—	—	—	—	—
41.8-42.7	—	—	—	—	—	—	—	—	—	—	—
42 8-43.7	—	—	—	1	1	—	—	—	—	—	—
43 8-44 7	—	—	—	—	1	—	—	—	—	—	—
44 8-45.7	—	—	—	—	—	—	—	—	—	—	—
45 8-46.7	—	—	—	1	—	—	—	—	—	—	—
46 8-47.7	—	—	—	—	—	1	—	—	—	—	—
50.8-51 7	—	—	—	—	—	1	—	—	—	—	—
64 8-65-7	—	—	—	—	—	—	1	—	—	—	—
Total number	*602*	*809*	*209*	*51*	*143*	*38*	*84*	*1*	*29*	*81*	*154*
Average length	18.5	19.1	21.1	30 6	24.8	27.1	23.5	—	18 7	20.3	21 1

Table 28.—Length-frequency distribution of the goldeye, the mooneye, and the gizzard shad in test-net collections from the Mississippi River between Caruthersville, Missouri, and Dubuque, Iowa, in 1944 and 1946.

Total Length in Inches	Goldeye	Mooneye		Gizzard Shad	
	D-MR Section 1946	D-MR Section 1946	MR-C Section 1944*	D-MR Section 1944	D-MR Section 1946
2.8- 3.7	—	—	—	7	1
3.8- 4.7	—	—	1	9	26
4.8- 5.7	2	31	3	35	72
5.8- 6.7	18	22	24	12	13
6.8- 7.7	12	52	21	27	7
7.8- 8.7	8	38	31	50	26
8.8- 9.7	7	19	32	35	28
9.8-10.7	7	9	43	86	22
10.8-11.7	12	2	28	146	8
11.8-12.7	2	1	28	184	6
12.8-13.7	2	—	23	126	8
13.8-14.7	5	—	18	62	10
14.8-15.7	6	—	6	22	4
15.8-16.7	—	—	5	4	6
16.8-17.7	3	—	1	—	—
Total number	*84*	*174*	*264*	*805*	*237*
Average length	9.7	7.4	10.3	11.2	8.0

* The goldeye was not separated from the mooneye at all of the 1944 stations and was included with the mooneye in the 1944 data.

at Fulton were the largest taken at any of the stations. Both of these stations were in the D-MR section. The average lengths of the specimens taken in the test-net collections are shown in table 27.

FORAGE FISHES

The forage fishes are of little or no commercial value, but they serve as food for other fishes. They are usually very numerous as compared with the predatory fishes that feed upon them. Minnows (Cyprinidae) and the gizzard shad (*Dorosoma cepedianum*) are quite abundant in the Mississippi River and undoubtedly serve as food for many of the carnivorous fishes. The term forage fishes as applied here in not particularly satisfactory since the specimens caught in nets were too large to serve as prey for all but very large carnivorous fishes.

The various species of minnows taken during the survey were caught in most cases with a minnow seine; catches with this gear are not considered in this paper.

The goldeye (*Amphiodon alosoides*) and the mooneye (*Hiodon tergisus*), included with the forage fishes in 1944 and with the commercial fishes in 1946, Appendix B, lack commercial importance in the MR-C section and parts of the D-MR section. The goldeye was not separated from the mooneye at all the 1944 stations and was included with the mooneye in the 1944 data, Appendix B, table 1. In the 1946 survey these two species were separated, table 15 and Appendix B, table 2. The mooneye was taken in much greater abundance than the goldeye in the 1946 collections. These two species formed a more important part of the catch in the Burlington-Dubuque section of the river than they did in the parts of the river fished in 1944. The length-frequency distribution of the goldeye and mooneye is given in table 28. As indicated by this table the goldeyes were of larger sizes than the mooneyes. Neither of these species was collected in sufficient numbers to indicate that they are of potential importance as commercial fishes in the Caruthersville-Dubuque section of the river.

Only two specimens of the golden shiner (*Notemigonus crysoleucas*) were taken in the test-net collections. They were collected in 1944 at Grafton.

The gizzard shad formed a much more important part of the test-net catch in 1944 than it did in 1946. Along with the drop in the 1946 catch of gizzard shad, table 28, there was also a noticeable reduction in size of these fish. In two backwater areas poisoned in 1946, near Savanna, there were low populations of gizzard shad; only 196 individuals per acre and an average of 4.69 pounds per acre were recovered. Two similar backwater areas poisoned in 1947, near Oquawka, contained a per acre average of 8,201 gizzard shad that in the aggregate weighed 284.5 pounds.

The gizzard shad is so bony that it is seldom used as a food fish by man; however, when small it is considered as an important link in the food chain of other fishes.

The skipjack (*Pomolobus chrysochloris*) was taken occasionally in the collections between Caruthersville and Warsaw. No specimen was collected above Warsaw. Coker (1930:169) noted that during the first few years following construction of the power dam at Keokuk the abundance of the skipjack declined rapidly in the upper part of the river. He presented evidence to show that the skipjack is migratory but does "not necessarily go to extreme northern or extreme southern waters, and that the breeding places from which the upper river was formerly chiefly stocked are no longer accessible to a great number of herring (skipjack)." Eddy & Surber (1947:91) state that the skipjack is very rare, if not extinct, above the Keokuk dam. The scarcity of the skipjack in the collections of the 1944 survey tends to indicate that this fish may have been affected by the locks and dams constructed below Keokuk since the time Coker made his studies on the river.

The skipjack is too bony to be of much value as a food fish; however, it is considered by some anglers as a very gamy fish when taken on light tackle. The importance of the skipjack, according to Coker (1930:166), is as a host for the young (glochidia) of the niggerhead mussel. This mussel was formerly of great economic importance to the button industry, but appeared to decline in abundance with the decrease of the skipjack in the upper river.

DISCUSSION

Poor land management in the upper Mississippi drainage basin has changed the section of the river from Dubuque to the mouth of the Missouri from a clear to a coffee-colored stream in less than a century. With the promotion of drainage schemes under the guise of agricultural development, the Mississippi River was leveed out of most of its natural flood plain reservoirs, which were evidently once the spawning and rearing grounds of many fishes. This encroachment upon the flood plain of the river by man, combined with intensive agricultural practices in the uplands, has brought about many of the present flood control problems. The canalization of the upper river evidently is responsible for the disappearance or reduction in numbers of certain fishes and has produced fisheries problems associated with draw-downs and silt-laden navigation pools. City and manufacturers' wastes also have contributed to the deterioration of the river as a fish habitat.

Although commercial fishing may have contributed to the reduction of certain fishes, the decline in the fishery as a whole appears to have followed the change in habitat rather than any intensification of commercial fishing activities. Such findings given in this paper as pertain to the abundance, size, and maturity age of the important commercial and sport fishes may be of some value in developing fishing regulations that are biologically sound. However, the problem of the Mississippi River fishery is more than one of legal restrictions. Perhaps legal restrictions will aid some species, but, with an environment that is unfavorable, other species probably will continue to dwindle. The decline in the catch of the buffalofishes, catfishes, pike, sturgeons, paddlefish, and others has been pointed out. The future of the paddlefish and the blue sucker appears in doubt. The status of the freshwater eel and the skipjack has been seriously affected, probably by the installation of locks and dams in the upper river. Perhaps other fishes have been and will be affected by the dams.

The differences in the abundance of fishes in the several parts of the pools, as evidenced by the 1946 test-net collections,

clearly demonstrate the effect canalization has on the habitat in the river. Evidently the silt-covered bottoms and reduced currents observed in the lower and middle reaches of the pools are less favorable for many species, particularly of the sport fishes, than conditions existing in the upper reaches. On the other hand, some of the impoundments have provided more backwater areas, which are usually considered favorable to fish production. The inundation of forest land has resulted in the formation of habitat containing hollow logs, suitable for catfish spawning.

The MR-C section of the river appeared to be much less productive of fish than the D-MR section. Greater scarcity of spawning grounds, turbidity of water, and swiftness of current in the MR-C section, as compared with the D-MR section, appear to be factors accounting for some of the productivity differences of the two sections. These factors are reflected in the distribution and abundance of sport fishes in the test-net collections.

Since the end of the last century the catch of carp has annually compensated for some of the losses in poundage of declining species. Commercial values of carp, however, are not so high as those of some of the declining species. Some of these losses might be compensated for if proper utilization could be made of certain abundant species in the river. Crappies, particularly the white, are quite abundant in the D-MR section of the river. Probably only a small portion of these fishes are taken annually by anglers. Crappies are not a long-lived fish, and as a result most of this resource is lost. The commercial fishery would benefit if crappies were placed on the commercial list, since these fishes are netted easily and would bring a good price. It is doubtful if commercial fishing would deplete the crappie population to such an extent that the sport fishery would suffer. Reduced crappie populations might permit better growth and furnish anglers with larger fish than are now being taken.

Development of better methods for handling river carpsuckers in warm months would benefit commercial fishermen.

The smoking of carp and bowfins has possibilities of further increasing values of these fishes.

Poor fishing in some instances may be a result of the decrease in natural predators (Bennett 1947:278). In the Mississippi River gars may be important predators. These fishes are possibly filling a gap left by the decreases in populations of pike, yellow pikeperch, and fish-eating ducks. Further biological studies on gars might establish the possibility that gars are beneficial to the fishery rather than harmful, as is commonly believed by fishermen.

SUMMARY

1. A survey of the fishes occurring in the Mississippi River between Caruthersville, Missouri, and Dubuque, Iowa, was made in 1944 and 1946. Thirty-one sampling stations were used. The following types of commercial fishing gear were employed: 25-foot *Common Sense* minnow seines, 100-yard trammel nets, 100-yard seines, hoop nets, wing nets, trap nets, basket traps, and trotlines.

2. The lengths and weights of fishes and the condition of their gonads were recorded afield for all individuals captured in the test nets. The length-frequency distribution of the more abundant fishes was recorded in tabular form. Altogether 26,037 fishes having a total weight of 28,294.25 pounds were taken in the 1944 and 1946 operations.

3. Observations on the various species of fishes taken by test netting were recorded. The numbers and weights of fishes caught at each station were listed by species, Appendix B.

4. Characteristics of the Mississippi River and the sampling stations were studied. Comparisons were made, in relation to the habitat and fishery, between two sections of the Mississippi River: one extending from Dubuque to the mouth of the Missouri River (D-MR section) and the other from the mouth of the Missouri to Caruthersville (MR-C section).

5. The carp, freshwater drum, flathead catfish, channel catfish, carpsuckers, smallmouth buffalo, shortnose gar, longnose gar, and gizzard shad were taken abundantly from both sections of the river.

6. The blue catfish, alligator gar, black bullhead, and black buffalo were collected principally in the MR-C section.

The alligator gar was taken only once in the D-MR section.

7. Sport fishes, bigmouth buffalo, and channel catfish were taken more abundantly in the D-MR section than in the other section.

8. Carp, buffalofishes, catfishes, carpsuckers, and freshwater drum were the most abundant commercial fishes taken during the survey. The shovelnose sturgeon was found to be the only sturgeon still abundant enough in the river to be of any commercial importance. The paddlefish was much less common than formerly.

9. The blue sucker, skipjack, and American eel were not numerous at any of the sampling stations. The skipjack was not taken above Warsaw, Illinois.

10. The crappies were the most abundant game fishes in the test-net collections. The black crappie was taken more abundantly than the white between the mouths of the Illinois and Missouri rivers. Above the mouth of the Illinois the white crappie was taken more abundantly than the black. The bluegill was second in abundance to the crappies among the game fishes. The sauger was collected in greater abundance than the yellow pikeperch (walleye). The yellow pikeperch was not taken in the MR-C section. No specimen of yellow perch was taken, although old records list this species as once fairly common in the sections of the river surveyed. White bass were more abundant than yellow bass.

11. Fishes, particularly game fishes, were collected more abundantly in the upper reaches of the navigation pools than in the middle and lower reaches.

12. The principal factors limiting the Mississippi River fishery are related to soil erosion of the watershed, levee and drainage works, and industrial and municipal pollution.

APPENDIX A

MISSISSIPPI RIVER FIELD STATIONS

BELOW are descriptions of the Mississippi River field stations at which test-net fishing was done in 1944 and 1946 between Caruthersville, Missouri, and Dubuque, Iowa.

Following the name of each station is the designation of the section of the river in which the station was located and the dates on which test-net fishing was done at the station. MR-C designates that section of the Mississippi River between the mouth of the Missouri River and Caruthersville; D-MR designates that section between Dubuque and the mouth of the Missouri River.

1.—Caruthersville, Missouri (MR-C section, April 6–12, 1944). The river at this station was at flood stage and out of its banks. Nets were set along the Missouri bank of the river wherever possible. Also nets were set in a large levee borrow pit, the water of which, as a result of the flood, was continuous with the water in the main channel. To enter the borrow pits, the powered fishing boat passed over a barbed wire fence without difficulty. Toward the end of the sampling period the river receded, and two nets were set in small streams connecting the borrow pit with the river channel. The river dropped enough to allow making several minnow seine hauls on sand bars near the ferry landing on the Tennessee side of the river. At the time of departure of the fishing boat from Caruthersville the river had again begun to rise.

2.—Tiptonville, Tennessee (MR-C section, April 15–May 10, 1944). Here the river was at flood stage, and the flood was considered locally as of major proportions. A small fleet of United States Army Corps of Engineers boats and the Tiptonville ferry were moored in a slough close to the town of Tiptonville and approximately three-quarters of a mile from the river channel. Normally this slough is dry for part of each year. The current at this station was swift. Towboats carrying loaded barges upstream were unable to push their entire complements of barges. Instead they pushed half their tows to points upstream, where the barges were tied up to trees or other stalwart objects; then the towboats returned downstream to pick up the remaining barges.

Because of mechanical difficulties the expedition was delayed here for about 20 days.

It was impossible to set nets in or near the river channel. All sets were made in flooded cornfields or cotton fields or within the margin of woody vegetation adjacent to the river channel. Several of the net sets were made in a flooded slough in which the *Anax* and other boats were moored, and in a temporarily inundated, shallow levee borrow pit. The disparities in habitats fished at this station were too great to make the data comparable to those of other stations. However, it appears logical to assume that fish normally confined to the river channel were distributed temporarily over a large expanse of water. The river was reported unofficially to have been 3 miles wide at Tiptonville during the flood.

3.—Cairo, Illinois (MR-C section, May 18–24, 1944). At this station, the water was high but it fell more than 13 feet during 5 days of netting. On the Illinois side of the Mississippi River, levees have been built to protect the city of Cairo. The levees on the Missouri side are some distance back from the river.

Sampling was done on the Illinois side of the Mississippi, 5 to 6 miles above the mouth of the Ohio River, just above Cairo, in shallow water adjacent to and within 50 to 100 yards of the river channel, and in a levee borrow pit. The rapid fall in water level necessitated moving the nets to deeper water nearly every day.

4.—Cape Girardeau, Missouri (MR-C section, May 26–31, 1944). Netting was done along both banks of the river just south of Cape Girardeau in an area called Cape Bend. There were several sand islands here, covered mainly with willows, and a number of log jams. Several wing nets with leads were set at the mouth and several 100 yards up the Little River Diversion Canal. This

canal lies at the upper end of a huge drainage system that covers the entire southeast section of Missouri, including the so-called "boot heel."

5.—**Grand Tower, Illinois** (MR-C section, June 2–9, 1944). The river stage was high here, as at Cape Girardeau; however, it is believed that fishing at this station was not so greatly influenced by high water as at stations below Cape Girardeau.

Nets were set along the Grand Tower waterfront and in the chute around the east side of Grand Tower Island. The current in the chute around the island was strong. At normal river stage the flow in the chute around Grand Tower Island is supposed to be much reduced and at times it is cut off entirely.

Because of the narrow constriction in the river channel just above Grand Tower, the current in the main channel (and in the chute around the island during flood stage) is very swift. The Missouri bank of the river at this station is a precipitous rock bluff, and the low flood plain on the Illinois side is subject to flooding even at a moderately high stage of water. Vegetation along the Illinois shore and on the island consists principally of willow and cottonwood. During the work at this station, early in June, typical warm summer weather began.

6.—**Chester, Illinois** (MR-C section, June 11–15, 1944). The river was high during the sampling period at this station. Nets were set in the vicinity of Horse Island at the mouth of Old River and several miles up Old River in the vicinity of Kaskaskia Island. At these locations the current was swift. Some netting was done in quiet backwaters just above Chester and across the river from Menard, Illinois. The Missouri side and Kaskaskia Island are in levee districts. Minnow seining was done in the vicinity of Claryville, Missouri.

7.—**Ste. Genevieve, Missouri** (MR-C section, June 18–24, 1944). Netting was done on both sides of an island almost across the river from Ste. Genevieve. Minnow seining was done in shallow water along the shore line of two islands at Ste. Genevieve. (See section on "Pollution" regarding this station.)

8.—**Crystal City, Missouri** (MR-C section, June 25–30, 1944). The river stage was higher at this station than at Ste. Genevieve. The river was backed up in Platin Creek enough to provide harbor for a fleet of large quarter boats operated by the United States Army Corps of Engineers.

Fishing operations were carried on in Platin Creek—from 200 to 300 yards from its mouth to about a mile from its mouth—and in the river between Platin Creek and Hug Landing. The mouth of Platin Creek is just below the city limits of Crystal City, and Hug Landing is a mile distant, just above Crystal City. Nets were set along the Missouri shore of the river. Here the bank is low, but steep, and bordered by a narrow margin of willows and cottonwood trees.

At the upper net sets in Platin Creek the water was clear, and aquatic vegetation was present. Because of the high river stage, there was virtually no flow in the creek here. The creek was about 100 feet wide at this upper point and it was nearly bank full. It was well shaded by overhanging trees. Minnow seine hauls were taken in Platin Creek.

9.—**Cliff Cave, Missouri** (MR-C section, July 2–8, 1944). The river stage was high at this station. Netting was carried on between Cliff Cave and White House Creek on the Missouri side of the river and at the mouth of Columbia Creek on the Illinois side. This stretch covered about 4 miles by river channel. Most of the sets were made among small, partially submerged willows. Minnow seining was done around sand bars formed in the river along the Illinois side just below the Jefferson Barracks Highway Bridge and in shallow water along the Missouri side just below the submarine cable crossing.

10.—**Mouth of Missouri River, Missouri** (MR-C and D-MR sections, July 10–15, 1944). The mixing of the waters of the Missouri and the Mississippi rivers presents an impressive sight. As the water of the muddy Missouri billows into the Mississippi it appears like rolling clouds of smoke against a clear sky. The water of the Mississippi is far from clear, but that of the Missouri is so much more turbid that the contrast is quite marked.

Netting was divided into two units at this station. Equivalent numbers of wing nets and hoop nets were operated at two stations, one above and one below the mouth of the Missouri River. The nets operated below the Missouri River were set along the

Missouri shore between the mouth of the Missouri and the Chain of Rocks Bridge. The nets operated in the upstream unit were set along the Missouri shore in the vicinity of Mobile Island. At the time netting operations were begun here, the river was high, nearly bank full. While netting was being done at this station the water receded considerably.

11.—Grafton, Illinois (D-MR section, March 22–30, July 17–25, and September 22–27, 1944). Grafton was used as the key station during 1944. It was the lowermost station in the impounded section of the river. Obviously, certain physical characteristics of the river at Grafton vary considerably from those of the unimpounded river, which begins just below Lock and Dam No. 26 at Alton, Illinois.

At the lower ends of navigation pools in the impounded section, the river assumes some of the characteristics of a lake. It is somewhat comparable in appearance to the MR-C section in flood stage, although it lacks the swift current that usually accompanies flood waters. In the upper few miles of these pools the river appears to have more nearly the characteristics of a large river—somewhat swollen or slightly out of bank but with moderate current velocity. The velocity of the current in the pool is dependent upon the operation of the dam that creates this pool as well as the dam at its upstream reach. The operation of each dam, that is, the position of the gates, depends upon the volume of water to be passed down the river or the amount required for the maintenance of a 9-foot channel for navigation.

Fishing operations at the Grafton station during March were carried on primarily in the sloughs and lakes adjoining the last few miles of the Illinois River. Since the fish habitat in these lakes and sloughs differed widely in appearance from that in the Mississippi River, it is assumed for two reasons that the catch of fish in this area was not typical of that in the Mississippi. First, the water of this area was relatively clear as compared with that of the Mississippi, and, second, the lakes and sloughs had no current, although they were connected directly with the Illinois River channel.

Most of these lakes and sloughs were marked by a tangle of fallen and decaying trees, some by the remaining stumps of a once dense river-bottom forest. Some were merely enlargements of water areas that were present before the Alton dam was built. Others were bodies of water created by the impoundment.

In March, net sets were made on the Illinois side of the Mississippi River just below the mouth of the Illinois River along the waterfront at Grafton; sets were made on the Missouri side of the river off the northwest shore of Perry Island and in the lower end of the small chute between Perry Island and the mainland. The water-level was at full-pool stage and the current was slow as compared with that of the unimpounded waters below Pool No. 26. Although a definite routine of lifting all the nets each day usually was followed, it became impossible on the Missouri side of the river when for 2 days extremely high winds prevented the lifting of nets there.

In the July sampling period at Grafton, most of the fishing effort was concentrated in the Mississippi River, although some test netting was done in the backwater sloughs and lakes between the Illinois and the Mississippi, in which netting had been done in March. In July, sets were made on the Illinois side of the Mississippi along steep-sided earth banks between Squaw Island and Calhoun Point, and on the Missouri side of the river along the northwest shore of Perry Island and the gently sloping Missouri shore approximately a mile above. The water-level of the area was at full-pool stage. It appeared to be the policy of the Army Engineers to maintain Pool No. 26 at or near full level.

The operations at this station in September were similar to those in July. The net sets were made in approximately the same locations.

12.—Winfield, Missouri (D-MR section, July 27–August 2, 1944). Fishing operations at this station were carried on primarily below Lock and Dam No. 25, although two or three nets were set for several days in the pool above the dam, fig. 2. The nets operated below the dam were set along the east side of Maple Island, on the Illinois side near the Winfield ferry landing, and on the Missouri side in Cuivre Slough, at the upper end and channel side of Turkey Island, and at the mouth of Bobs Creek.

Farm land on the Missouri side of the river in this section is low and is subject to

flooding. It is maintained in an arable condition through a series of drainage districts and levees.

13.—**Hamburg, Illinois** (D-MR section, August 3–9, 1944). A number of years ago, Hamburg was an important shipping center for Calhoun County apples. It and a great number of other small towns along the river were important during the days of packet steamers when river shipping was the main activity of many of these towns. Now there is virtually no shipping from any of these towns except those having grain elevators located to fill barges. Outside of grain shipping, commercial fishing is probably the only industry associated with the river.

Netting at the Hamburg station was in about the middle of Pool No. 25. Nets were set in Westport Chute, around Kelly Island, in Thomas Chute, and in the mouth of Bryants Creek. The main channel is divided at the head of Westport Island, and part of the flow is carried by the Westport Chute. Although the water is deflected away from Westport Chute by wing dams, it is rather deep there. It carries enough current to allow the operation of hoop nets. Wing nets were set along the west margin of the chute and near the head of Westport Island. The narrow strip of land between Westport Chute and the Elsberry Drainage District Levee was low and swampy and was dissected by several sloughs; the entire area was covered by a dense growth of willow and cottonwood trees. Other net sets were made on the east shore of Westport Island, where the current was moderately swift. The sets around Kelly Island were located over a sandy bottom. Several seine hauls were made on a long, wide sand bar extending in an upstream direction from the head of Westport Island.

An extensive area along the river a few miles above Hamburg is wide river-bottom bordered on the Illinois side by high bluffs. The Illinois bottom area, which lies at the lower end of Sny Island Levee and Drainage District, is dissected by sloughs, backwater lakes, and the Sny. This area was once considered excellent for waterfowl.

14.—**Louisiana, Missouri** (D-MR section, August 12–17, 1944). This station was located in the middle section of Pool No. 24, fig. 3. Nets were set on the Illinois side of the river below the Alton Railroad bridge and in a cove just above the highway bridge; on the Missouri side of Blackburn Island, in the mouth of Salt River, and at the lower end of Angle Island. The areas above the railroad and highway bridges were essentially identical. Both were shallow backwaters in the lowland between the Illinois levee and the river channel. Before the construction of Lock and Dam No. 24, the areas were in dense growth of small woody vegetation, but at the time of the survey only stumps remained.

In Salt River the nets were set about one-fourth to one-half mile above its mouth. There was very little flow in the stream in this area.

15.—**Cincinnati Landing, Illinois** (D-MR section, August 19–23, 1944). Netting operations were carried out here in the upper section of Pool No. 24, within an approximate radius of 2 miles below Lock and Dam No. 22, fig. 4. Nets were set in a slough near Taylor Island. This slough, which carried a moderately swift current, produced the first adult blue sucker taken in 1944. Sets were made also in the narrow neck of water between Cottel Island and the mainland just below the Saverton Dam. The navigation channel shores of these islands consist of heavy sand deposits, which are typical of the channel shores below the locks and dams. Between Cottel and Taylor islands was a broad expanse of water which covered a continuous sandy bottom to a depth ranging from 2 to 3 feet.

16.—**Hannibal, Missouri** (D-MR section, August 25–30, 1944). Netting operations were carried on here in the vicinity of Glaucous Island, which is about 2 miles above Hannibal. This area is in the middle section of Pool No. 22, 13 miles below Lock and Dam No. 21. Nets were set in the slough between Glaucous Island and the Missouri shore and on the channel side of Glaucous Island. The slough was approximately 150 yards in width and in some places reached a depth of 10 feet or more. At other points it was quite shallow. Along most of the Missouri shore of the slough, the bottom sloped off abruptly into deep water. Some of the sets on the channel side of the island were made in deep water and others in relatively shallow bays. The current here was moderately swift.

17.—**Quincy, Illinois** (D-MR section, September 2–6, 1944). The Quincy station was located at the upper end of Pool No. 22,

about 3 miles below Lock and Dam No. 21. Nets were set in a slough between two islands (Ward Island and Island No. 432) and the Illinois shore. This slough was typical of river backwaters, having mud banks and shallow water. The river-channel shore, or the west shore, of Ward Island was covered by deposits of sand and protected by a number of wing dams. The current in the river channel opposite Ward Island was quite swift.

Minnow seining was done along the river-channel side of Ward Island, Island No. 432, and a small unnamed island just below 432.

The main pumping station for the South Quincy Drainage and Levee District is located just outside of the levee at the head of Island No. 432. During high river stages, this station pumps water from a network of lakes and drainage ditches on the outside of the levee. It was reported locally that these ditches and lakes furnish good bass and crappie fishing at certain times of the year. During the stay of the survey party here in 1944, this area was fished by a large number of sport fishermen from Quincy.

18.—**Canton, Missouri** (D-MR section, September 8–13, 1944). This station was located in the upper end of Pool No. 21. Test-netting was done at the head of Canton Chute along the east shore of Island No. 416, in Smoots Chute, and along the west shore of Island No. 416. Several nets were set along the Missouri shore below the Canton waterfront. The water in Canton Chute was quite clear as compared with that of the river channel, and the current in the chute was relatively slow. Canton Chute carries drainage from the Lima Lake Drainage District through Bear Creek diversion channel. While the survey party was at this station, the upper part of Canton Chute was being dredged, apparently for the purpose of facilitating drainage of water from the lowland on the Illinois side.

The upper end of Canton Chute is bordered by low but steep mud banks, which apparently are characteristic throughout its length. The connecting channel between the upper end of Canton Chute and the main stem of the river has a sandy bottom, and the shores of the upper end of Island No. 416 are covered with heavy deposits of sand. The channel into Canton Chute is flanked on its upstream side by a large, broad sand bar which obstructs the flow of water from the river channel into Canton Chute. The upper end of Island No. 416 is only a little more than a mile below Lock and Dam No. 20, and, as with similar formations in the upper reaches of other pools, the islands and shore line are characterized by deep deposits of sand. In fact, some of the islands are nothing more than large sand bars. The wing dams opposite the west shore of Island No. 416 are permanent rock structures. It appears that, in the canalized section of the river, the temporary wing dams constructed of piling are being replaced with permanent rock structures. Since it seems to be characteristic of the temporary wing dams in the lower river to collect great piles of driftwood that tend to create deep water holes just downstream from these dams, it might be that the temporary structures offer cover for fishes which the permanent ones do not. Large deposits of sand were found near the permanent structures, but no driftwood. The water flows between the piles of the temporary dams, while it is completely deflected around the permanent ones. Consequently, driftwood is washed away from the permanent dams but is pinned against and above the temporary ones by the force of the current.

19.—**Warsaw, Illinois** (D-MR section, September 14–19, 1944). This was the uppermost point on the river studied in 1944. Here netting operations were conducted in the upper part of Pool No. 20: along the Iowa border in the vicinity of the mouth of the Des Moines River and around Island No. 404 above the city of Warsaw; along the Missouri border below Alexandria and in the upper end of the slough between Fox Island and the mainland.

The current was quite sluggish near the mouth of the Des Moines River. The Mississippi from just above the mouth of the Des Moines to the head of Fox Island is confined by steep mud banks, which are protected from erosion by riprapping at several places. The shore line of Island No. 404 and the islands below Keokuk Dam (Lock and Dam No. 19) are covered with deep deposits of sand. The slough between Fox Island and the Missouri mainland carries a moderately swift current and is bordered on both sides by mud banks.

The upper end of Pool No. 20 is subject

to daily fluctuations of approximately 12 inches resulting from the operation of the Keokuk Dam, which, with its hydroelectric plant, was constructed by the Union Power and Light Corporation. Power produced at Keokuk is used to supplement production at other plants, and this plant is operated only during the day. Consequently, at the end of a day's operation, when the turbines are shut off, the flow of water through the dam is decreased, and the water level in the upper part of Pool No. 20 recedes. Operations at the dam are resumed daily, and by noon the water level in Pool No. 20 has again reached the maximum of the previous day. While this daily fluctuation may not affect the fish population, it does, however, affect the method of fishing. Coker (1914, 1929, 1930) made detailed studies of the effects this dam has had on the local fishery at Lake Keokuk, Pool No. 19.

An earlier discussion of the Warsaw station is included under the section titled "Pollution."

20.—Burlington, Iowa (D-MR section, April 10–22, 1946). This station was about 40 miles upstream from the uppermost area worked in 1944. It was located in the middle section of Pool No. 19, 9 to 15 miles below Lock and Dam No. 18 and 2 to 8 miles below the city of Burlington.

The river stage at the time test netting was begun was lower than in the previous week and it continued to fall during the sampling period here. However, the water level was still quite high, and much of the netting was done in backwater lakes and sloughs that are normally dry later in the season. Netting operations were confined largely to an area just above the mouth of Skunk River in the vicinity of Sullivan Slough and the lower end of Burlington Island. The bottom here was mud, and the water, which had little or no current, varied in depth from 3.5 to 6.0 feet. Some sets were made in the river channel. Trammel netting was carried on by drifting the net in the channel downstream. This type of fishing was conducted at stations having clean sand bottoms and water with current and with depths of 5 to 15 feet.

21.—Oquawka, Illinois (D-MR section, April 24–May 5, 1946). The river between Oquawka and Keithsburg, a distance of 12 miles, was dotted with many islands and sloughs. The west side of the river here was backed by an extensive levee system forming several drainage districts. The sloughs and backwaters on the Illinois side created good habitat for fish, particularly the sport species. This area was quite similar to the Grafton station described earlier. Above Keithsburg and below Oquawka both sides of the river were backed by levees. According to a local commercial fisherman the current in the river here had been greatly reduced since the installation of Lock and Dam No. 18. Nets were set several miles above Oquawka, in a chute formed by Benton Island, and also below Oquawka, in a chute formed by Island No. 369.

Beginning on September 8, 1947, two poison censuses of fish inhabiting two of the backwaters of this station were made. The backwaters poisoned were sloughs of 1.07 and 1.76 acres.

22.—New Boston, Illinois (D-MR section, May 7–18, 1946). This station was located in the upper section of Pool No. 18, just above New Boston. The mouth of the Iowa River is directly across the Mississippi River from New Boston. On the Iowa side of the Mississippi, netting was done in the chutes above and below the mouth of the Iowa River. Here the current was strong, the water varied in depth from 5 to 10 feet, and the bottom was of mud. On the Illinois side nets were set in the impounded backwaters in the Boston Bay area. A fairly swift current existed here from the discharge of the pumping station of the Bay Island Drainage and Levee District.

23.—Muscatine, Iowa (D-MR section, May 19–30, 1946). This station, located several miles below Muscatine, extended from the mouth of Copperas Creek Diversion channel to Bogus Island. The upper area in the chute by Blanchard Island had been highly recommended by local fishermen for fishing; however, netting here was unsatisfactory. Nets were set at various locations in the steamboat channel in the Blanchard Island locality. The channel sets were made in water of 15-foot depth over sand bottom. There are extensive drainage districts on both sides of the river here, largely confining the river to its channel; however, in the area of Bogus Island on the Iowa side there are some stretches of backwater.

The mussel fishery of the Mississippi River is not within the scope of this paper;

however, it is of interest in relation to fish habitat to mention that no activity in the shell or mussel fishery was observed below the Muscatine area. At Muscatine, on days when favorable weather prevailed, there were usually 12 to 15 shell-fishing boats in view from the Muscatine waterfront. Some activity of shell fishermen was noted upstream as far as Clinton, Iowa. In this stretch of water there is some clean gravel bottom, which apparently furnishes a more suitable habitat for mussels of economic importance than does the lower section of the river visited during the fishery investigation.

24.—Fairport, Iowa (D-MR section, June 2–13, 1946). This station and the one at Bellevue were the only sampling sites in the lower reaches of the pools. As discussed earlier the lower part of a navigation pool differs from the upper by having slower current and a more extensive silt bottom. The netting at the Fairport station was done in the region of Hershey Slough and Wyoming Slough near the mouth of Sweetheart Creek. This site was 2 to 3 miles above Lock and Dam No. 16 and 3 miles below Fairport. The nets were set in water ranging from 3 to 15 feet in depth.

25.—Andalusia, Illinois (D-MR section, April 1–7, June 18–26, and September 15–24, 1946). The Andalusia area, in the middle part of Pool No. 16, was used as the key station in 1946. This station was centrally located in relation to the other stations, and the habitats of the Andalusia area were more like those of the other 1946 stations than the Grafton habitats were like the habitats of the other 1944 stations. The general conditions at Andalusia were typical of those of the canalized section of the river.

River stages at Andalusia were high during April and June as compared with those during September. Netting during the three periods was done in the river channel, sloughs, and chutes near islands numbered 317, 318, and 319. The bottom in the sloughs and chutes was mud and the channel bottom was sand and sand-mud. The bottom of the channel and the current were satisfactory for trammel-net-float fishing. The sloughs here were confined to the Illinois side and the channel followed the Iowa side.

26.—Pleasant Valley, Iowa (D-MR section, June 28–July 9, 1946). This station, located in the upper part of Pool No. 15, was immediately below Pleasant Valley and 1 to 2 miles below Lock and Dam No. 14. Netting was done in the channel and chutes adjacent to Spencer Island and Campbell Island. The current in the channel was rather strong and the bottom was sand. In the chutes the bottom was of mud and some sand, and the depth of water there varied from 3.5 to 12.0 feet.

Above Lock and Dam No. 14 is the location of the former Le Claire Rapids. The site of these once great rapids is now merely a part of Pool No. 14. The elimination of the Le Claire and Keokuk rapids has greatly improved navigation on the river; however, its effect on spawning grounds for such fish as the blue sucker is not measurable.

27.—Cordova, Illinois (D-MR section, July 11–22, 1946). This station, in the middle reach of Pool No. 14, was located one-half mile to 2 miles above Cordova and 3 miles below the mouth of one of the noted smallmouth bass streams in Iowa, the Wapsipinicon River. Here the Mississippi channel hugged the Illinois shore. On the Iowa side were many bays and sloughs formed by the impoundment. These were dotted with dead trees killed by high water, 2 to 6 feet deep there, with no current; the bottoms were of mud. Netting operations were carried on in an area back as far as 1 mile from the river channel and also in the river channel and sloughs above the mouth of Pinneo Creek.

28.—Fulton, Illinois (D-MR section, July 24–August 4, 1946). The netting at this station was carried on above Fulton and Clinton, on opposite banks of the Mississippi, and was confined within the upper 1.5 miles of Pool No. 14. The current in the channel was swift; the bottom was principally sand but with some rock. The backwater areas were numerous and they were rather shallow, varying in depth from 3 to 4 feet. Sampling was done in the backwaters, the channel, and its adjoining sloughs and chutes.

29.—Sabula, Iowa (D-MR section, August 6–17, 1946). The Sabula station was located in the middle reach of Pool No. 13. The river here was too sluggish to float a trammel net efficiently. The bottom in the channel was mud and sand. Much of the netting at this station was done in the backwaters, a levee borrow pit, and chutes. Stumps, both submerged and protruding,

were numerous in the backwaters. Netting was done also in Savanna Slough. A period of netting was conducted near Savanna, above Sabula, in a levee borrow pit adjacent to the river. Water in this pit was about 4 feet in depth and the bottom was mud. Width of the water area varied from 50 to 75 feet. Following the netting period in this borrow pit a census was made of the fish population, August 13–17, by blocking off the outlet to the river with a seine and introducing a fish poison. The area covered in the poison census was 2.16 acres. Near this location, part of another levee borrow pit was treated with poison. This part was the blind end of the pit, 100 or more feet in width, and 0.964 acre in area. Fish had access to the river from this pit.

30.—Bellevue, Iowa (D-MR section, August 19–30, 1946). This station was located in the lower part of Pool No. 12. As at other stations in the lower parts of navigation pools, the current here was sluggish and the bottom predominantly silt or mud. Netting in the channel was done in the vicinity of islands numbered 242 and 243, 3 to 4 miles above Bellevue and Lock and Dam No. 12. Some nets were set in the channel in water as deep as 15 feet.

In the lower part of this pool, aquatic vegetation was quite abundant. Much of the shore line of the islands was covered with heavy growths of arrowhead, *Sagittaria* sp. Some of the backwater areas had 1- to 2-acre beds of American lotus, *Nelumbo lutea* (Willd.) Pers. The numerous shallow sloughs and small lakes in the area were covered with abundant growths of rice cutgrass, *Leersia oryzoides* (L.) Sw. Some netting was done in the backwaters near the mouth of Small Pox Creek.

31.—Dubuque, Iowa (D-MR section, September 1–12, 1946). This was the uppermost station in that part of the Mississippi River studied in the Caruthersville-Dubuque survey. It was at the northern boundary of the state of Illinois. The river above this station up to Prescott, Wisconsin, was investigated by the states bordering the upper section of the upper Mississippi River, namely, Iowa, Minnesota, and Wisconsin.

The Dubuque station was in the upper part of Pool No. 12, fig. 5, located 1 to 4 miles below the city of Dubuque. Netting was done in the backwaters adjoining Lake Frentress, in chutes, and in channels in the area. The netting sites in backwaters and lakes were in shallow water ranging from 3.5 to 5.0 feet in depth and having mud bottoms. The chutes sampled had sand and mud bottoms, and the channel had a sand bottom. The current in the channel was only moderately swift. Above the sampling area to Lock and Dam No. 11 the river is rather closely confined. The bluffs on both sides of the river in this region are quite high and steep. This section of Illinois and Iowa is referred to by geologists as unglaciated or driftless area.

Appendix B, Table 1.—Number, weight, and per cent of total weight by station of variou
River survey in 1944 between Caruthers

Species	Caruthersville, Mo. April 6–12, 1944			Tiptonville, Tenn. April 15–May 10, 1944		
	Number	Weight, Pounds	Per Cent of Weight	Number	Weight, Pounds	Per Cent of Weight
Commercial Fishes						
*Scaphirhynchus album**	0	—	—	0	—	—
Shovelnose sturgeon	0	—	—	0	—	—
Paddlefish	0	—	—	7	2.65	0.51
American eel	0	—	—	0	—	—
Blue sucker	0	—	—	0	—	—
Bigmouth buffalo	2	1.68	0.53	27	30.62	5.85
Black buffalo	0	—	—	7	2.58	0.49
Smallmouth buffalo	6	2.90	0.91	23	32.24	6.16
Carpsuckers†	6	3.86	1.21	28	25.63	4.89
Northern redhorse	0	—	—	0	—	—
Carp	37	60.10	18.91	63	127.65	24.38
Channel catfish	5	1.68	0.53	81	23.30	4.45
Blue catfish	16	4.19	1.32	92	39.83	7.61
Yellow bullhead	0	—	—	3	2.50	0.48
Brown bullhead	0	—	—	1	0.54	0.10
Black bullhead	48	21.42	6.74	94	72.30	13.81
Flathead catfish	14	14.74	4.64	5	12.93	2.47
Freshwater drum	8	1.78	0.56	24	16.11	3.08
Subtotal	*142*	*112.35*	*35.35*	*455*	*388.88*	*74.28*
Sport Fishes						
Grass pickerel	0	—	—	0	—	—
Yellow pikeperch	0	—	—	0	—	—
Sauger	1	0.58	0.18	3	2.21	0.42
Spotted black bass	2	1.21	0.38	0	—	—
Largemouth black bass	4	2.91	0.92	1	1.51	0.29
Green sunfish	0	—	—	17	1.98	0.38
Bluegill	8	1.40	0.44	9	1.54	0.29
Warmouth	4	0.89	0.28	10	2.90	0.55
Flier	0	—	—	0	—	—
White crappie	63	17.41	5.48	23	6.97	1.33
Black crappie	57	8.87	2.79	16	3.99	0.76
White bass	6	2.66	0.84	2	0.25	0.05
Yellow bass	1	0.16	0.05	1	0.32	0.06
Subtotal	*146*	*36.09*	*11.36*	*82*	*21.67*	*4.13*
Predatory Fishes						
Longnose gar	1	0.20	0.06	14	60.99	11.65
Shortnose gar	69	124.09	39.05	17	28.47	5.43
Alligator gar	0	—	—	0	—	—
Bowfin	0	—	—	0	—	—
Subtotal	*70*	*124.29*	*39.11*	*31*	*89.46*	*17.08*
Forage Fishes						
Mooneye and goldeye	4	1.37	0.43	5	1.51	0.29
Skipjack	3	1.59	0.50	3	1.19	0.23
Gizzard shad	93	42.12	13.25	68	20.89	3.99
Golden shiner	0	—	—	0	—	—
Subtotal	*100*	*45.08*	*14.18*	*76*	*23.59*	*4.51*
Total	*458*	*317.81*	*100.00*	*644*	*523.60*	*100.00*

* None taken in test nets but one procured from angler at time of survey.
† *Carpiodes* spp.

species of fish (except those in minnow seine collections) taken during the Mississippi ville, Missouri, and Warsaw, Illinois.

CAIRO, ILL. MAY 18–24, 1944			CAPE GIRARDEAU, MO. MAY 26–31, 1944			GRAND TOWER, ILL. JUNE 2–9, 1944			CHESTER, ILL. JUNE 11–15, 1944		
Number	Weight, Pounds	Per Cent of Weight	Number	Weight, Pounds	Per Cent of Weight	Number	Weight, Pounds	Per Cent of Weight	Number	Weight, Pounds	Per Cent of Weight
0	—	—	0	—	—	0	—	—	0	—	—
0	—	—	0	—	—	0	—	—	0	—	—
14	17.89	2.34	0	—	—	1	1.10	0.12	2	2.98	0.51
4	5.45	0.71	0	—	—	0	—	—	0	—	—
0	—	—	0	—	—	0	—	—	0	—	—
8	34 08	4 47	2	10 57	1.40	5	18.57	2 00	1	3.17	0.54
1	1.87	0.25	7	60.76	8.07	7	34 39	3.70	0	—	—
22	38.20	5.01	0	—	—	14	31.55	3.39	2	0.48	0.08
40	53.18	6.97	7	13.22	1.76	77	123 18	13 23	7	4 07	0.69
0	—	—	0	—	—	0	—	—	0	—	—
60	132.72	17 39	82	247 08	32 81	162	299 65	32 20	140	271.74	46 43
12	10.18	1 33	4	6.92	0.92	6	6.51	0.70	2	2.32	0.40
20	11.18	1.47	20	19.31	2.56	26	11.11	1.19	10	19.66	3 36
1	1 02	0.13	0	—	—	0	—	—	0	—	—
0	—	—	0	—	—	0	—	—	0	—	—
81	69.42	9 10	2	1.80	0 24	32	18.40	1 98	2	1.26	0 22
33	59.00	7.73	88	327.67	43 50	26	65.46	7.03	88	186.06	31.79
114	46 68	6.12	17	17.55	2 33	30	23.68	2.54	10	7.32	1.25
410	*480 87*	*63.02*	*229*	*704.88*	*93.59*	*386*	*633.60*	*68.08*	*264*	*499.06*	*85.27*
0	—	—	0	—	—	0	—	—	0	—	—
0	—	—	0	—	—	0	—	—	0	—	—
8	5 16	0.68	0	—	—	5	3.14	0.34	2	1.60	0 27
0	—	—	0	—	—	0	—	—	0	—	—
0	—	—	0	—	—	2	1.23	0.13	2	0.95	0 16
0	—	—	0	—	—	0	—	—	0	—	—
1	0.35	0.05	0	—	—	10	2.23	0.24	3	0.65	0.11
0	—	—	0	—	—	1	0.22	0.02	0	—	—
1	0.10	0.01	0	—	—	0	—	—	0	—	—
7	1.86	0.24	0	—	—	9	2.70	0 29	4	1.09	0.19
5	1 49	0.20	0	—	—	6	1.59	0.17	7	2.29	0.39
12	5.34	0.70	0	—	—	0	—	—	1	0.40	0 07
0	—	—	0	—	—	0	—	—	0	—	—
34	*14 30*	*1.88*	*0*	—	—	*33*	*11.11*	*1.19*	*19*	*6.98*	*1.19*
5	10.32	1.35	3	10.56	1.40	8	12.08	1.30	3	7 55	1 29
33	31 38	4 11	60	35.02	4.65	268	147.39	15.84	62	59 76	10 21
80	182 29	23 89	1	1.66	0.22	2	58.86	6 32	1	2.38	0.41
1	1 65	0.22	1	1.05	0.14	23	53 49	5.75	2	7.17	1.22
119	*225 64*	*29.57*	*65*	*48.29*	*6.41*	*301*	*271.82*	*29 21*	*68*	*76.86*	*13 13*
6	2.72	0 36	0	—	—	4	1 26	0 14	2	0.76	0 13
5	3.16	0.41	0	—	—	0	—	—	0	—	—
71	36 34	4 76	0	—	—	17	12.88	1 38	4	1 64	0.28
0	—	—	0	—	—	0	—	—	0	—	—
82	*42.22*	*5.53*	*0*	—	—	*21*	*14.14*	*1.52*	*6*	*2.40*	*0.41*
645	*763 03*	*100 00*	*294*	*753.17*	*100 00*	*741*	*930.67*	*100.00*	*357*	*585.30*	*100 00*

Appendix B, Table 1.—

Species	Ste. Genevieve, Mo. June 18–24, 1944			Crystal City, Mo. June 25–30, 1944		
	Number	Weight, Pounds	Per Cent of Weight	Number	Weight, Pounds	Per Cent of Weight
Commercial Fishes						
*Scaphirhynchus album**	0	—	—	0	—	—
Shovelnose sturgeon	0	—	—	0	—	—
Paddlefish	0	—	—	0	—	—
American eel	0	—	—	3	7.95	1.01
Blue sucker	0	—	—	0	—	—
Bigmouth buffalo	0	—	—	0	—	—
Black buffalo	1	5.94	0.56	0	—	—
Smallmouth buffalo	14	29.98	2.81	21	14.52	1 84
Carpsucker†	89	148.91	13.97	41	43.44	5.50
Northern redhorse	0	—	—	7	4.20	0.53
Carp	320	616.70	57.87	210	494.07	62 60
Channel catfish	27	49.96	4.69	6	11.62	1.47
Blue catfish	8	3.72	0.35	14	13.48	1.71
Yellow bullhead	0	—	—	0	—	—
Brown bullhead	0	—	—	0	—	—
Black bullhead	0	—	—	3	1.53	0.19
Flathead catfish	28	106.11	9.96	38	106.81	13.53
Freshwater drum	45	39.00	3.66	34	26.79	3.40
Subtotal	*532*	*1,000.32*	*93.87*	*377*	*724.41*	*91.78*
Sport Fishes						
Grass pickerel	0	—	—	0	—	—
Yellow pikeperch	0	—	—	0	—	—
Sauger	2	1.66	0.16	0	—	—
Spotted black bass	0	—	—	0	—	—
Largemouth black bass	0	—	—	1	0.77	0.10
Green sunfish	0	—	—	1	0.32	0.04
Bluegill	0	—	—	4	0.73	0.09
Warmouth	0	—	—	0	—	—
Flier	0	—	—	0	—	—
White crappie	0	—	—	10	2.57	0.33
Black crappie	0	—	—	28	9.13	1.16
White bass	0	—	—	3	1.59	0.20
Yellow bass	0	—	—	0	—	—
Subtotal	*2*	*1.66*	*0.16*	*47*	*15.11*	*1.92*
Predatory Fishes						
Longnose gar	7	19.65	1.84	6	20.79	2.63
Shortnose gar	49	42.03	3.94	20	17.07	2.16
Alligator gar	0	—	—	0	—	—
Bowfin	0	—	—	0	—	—
Subtotal	*56*	*61.68*	*5.78*	*26*	*37.86*	*4.79*
Forage Fishes						
Mooneye and goldeye	2	1.22	0.11	20	8.93	1.13
Skipjack	0	—	—	0	—	—
Gizzard shad	2	0.84	0.08	9	3.00	0.38
Golden shiner	0	—	—	0	—	—
Subtotal	*4*	*2.06*	*0.19*	*29*	*11.93*	*1.51*
Total	*594*	*1,065.72*	*100.00*	*479*	*789.31*	*100.00*

* None taken in test nets but one procured from angler at time of survey.
† *Carpiodes* spp.

Continued.

Cliff Cave, Mo. July 2–8, 1944			Below Mouth of Missouri River July 10–15, 1944			Above Mouth of Missouri River July 10–15, 1944			Grafton, Ill. March 22–30, 1944		
Number	Weight, Pounds	Per Cent of Weight	Number	Weight, Pounds	Per Cent of Weight	Number	Weight, Pounds	Per Cent of Weight	Number	Weight, Pounds	Per Cent of Weight
0	—	—	0	—	—	1	0.12	0.01	0	—	—
0	—	—	0	—	—	0	—	—	0	—	—
0	—	—	0	—	—	0	—	—	1	0.85	0.11
3	6.50	0.81	0	—	—	3	7.40	0.87	0	—	—
0	—	—	0	—	—	0	—	—	0	—	—
3	10.42	1.29	0	—	—	7	19.58	2.30	13	19.13	2.57
7	20.27	2.51	0	—	—	0	—	—	9	31.55	4.23
25	79.38	9.82	0	—	—	6	2.19	0.26	21	13.29	1.78
33	52.57	6.50	6	10.32	3.70	17	16.35	1.92	20	12.44	1.67
0	—	—	0	—	—	0	—	—	0	—	—
183	470.87	58.25	54	133.79	48.00	309	372.35	43.83	51	88.08	11.81
4	5.44	0.67	1	2.40	0.86	23	28.75	3.39	22	4.09	0.55
19	12.85	1.59	6	0.52	0.19	14	5.23	0.62	8	5.96	0.80
0	—	—	0	—	—	0	—	—	1	0.50	0.07
0	—	—	0	—	—	0	—	—	2	0.69	0.09
0	—	—	0	—	—	0	—	—	25	14.49	1.94
25	88.91	11.00	27	101.75	36.50	44	81.92	9.64	0	—	—
41	30.82	3.81	25	14.23	5.11	227	81.33	9.58	73	17.55	2.35
343	*778.03*	*96.25*	*119*	*263.01*	*94.36*	*651*	*615.22*	*72.42*	*246*	*208.62*	*27.97*
0	—	—	0	—	—	0	—	—	2	1.05	0.14
0	—	—	0	—	—	0	—	—	0	—	—
0	—	—	0	—	—	1	1.04	0.12	0	—	—
0	—	—	0	—	—	0	—	—	0	—	—
0	—	—	0	—	—	11	16.66	1.96	30	47.20	6.33
0	—	—	0	—	—	0	—	—	0	—	—
0	—	—	4	0.64	0.23	31	8.72	1.03	288	65.79	8.82
0	—	—	0	—	—	0	—	—	36	10.81	1.45
0	—	—	0	—	—	0	—	—	0	—	—
0	—	—	3	1.01	0.36	4	1.14	0.13	74	35.23	4.72
0	—	—	4	1.87	0.67	303	116.27	13.69	331	146.17	19.60
0	—	—	0	—	—	1	0.56	0.07	3	1.69	0.23
0	—	—	0	—	—	0	—	—	1	0.38	0.05
0	—	—	*11*	*3.52*	*1.26*	*351*	*144.39*	*17.00*	*765*	*308.32*	*41.34*
4	9.64	1.19	0	—	—	7	7.34	0.87	5	12.23	1.64
21	20.72	2.56	3	2.76	0.99	100	71.45	8.41	76	90.09	12.08
0	—	—	0	—	—	0	—	—	0	—	—
0	—	—	2	9.46	3.39	2	3.94	0.46	8	28.18	3.78
25	*30.36*	*3.75*	*5*	*12.22*	*4.38*	*109*	*82.73*	*9.74*	*89*	*130.50*	*17.50*
0	—	—	0	—	—	6	3.70	0.44	7	1.86	0.25
0	—	—	0	—	—	0	—	—	0	—	—
0	—	—	0	—	—	5	3.42	0.40	134	95.81	12.85
0	—	—	0	—	—	0	—	—	2	0.67	0.09
0	—	—	*0*	—	—	*11*	*7.12*	*0.84*	*143*	*98.34*	*13.19*
368	*808.39*	*100.00*	*135*	*278.75*	*100.00*	*1,122*	*849.46*	*100.00*	*1,243*	*745.78*	*100.00*

Appendix B, Table 1.—

Species	Grafton, Ill. July 17–25, 1944			Grafton, Ill. Sept. 22–27, 1944		
	Number	Weight, Pounds	Per Cent of Weight	Number	Weight, Pounds	Per Cent of Weight
Commercial Fishes						
*Scaphirhynchus album**	0	—	—	0	—	—
Shovelnose sturgeon	0	—	—	0	—	—
Paddlefish	0	—	—	0	—	—
American eel	3	7.28	1.15	5	11.51	3.41
Blue sucker	0	—	—	0	—	—
Bigmouth buffalo	12	19.11	3.02	0	—	—
Black buffalo	4	28.04	4.43	1	2.80	0.83
Smallmouth buffalo	39	18.24	2.88	22	15.21	4.51
Carpsuckers†	35	26.74	4.23	14	10.43	3.09
Northern redhorse	0	—	—	3	3.84	1.14
Carp	46	82.21	12.99	18	41.00	12.15
Channel catfish	5	7.42	1.17	11	4.02	1.19
Blue catfish	2	0.27	0.04	2	1.33	0.39
Yellow bullhead	6	2.93	0.46	13	7.71	2.28
Brown bullhead	3	3.45	0.55	0	—	—
Black bullhead	14	7.64	1.21	0	—	—
Flathead catfish	14	23.46	3.71	6	12.56	3.72
Freshwater drum	33	16.13	2.55	25	11.28	3.34
Subtotal	*216*	*242.92*	*38.39*	*120*	*121.69*	*36.05*
Sport Fishes						
Grass pickerel	0	—	—	0	—	—
Yellow pikeperch	0	—	—	0	—	—
Sauger	1	1.36	0.21	2	2.56	0.76
Spotted black bass	0	—	—	0	—	—
Largemouth black bass	36	34.03	5.38	28	25.83	7.65
Green sunfish	0	—	—	0	—	—
Bluegill	132	30.81	4.87	17	3.20	0.95
Warmouth	13	3.89	0.62	3	1.00	0.30
Flier	0	—	—	0	—	—
White crappie	74	16.84	2.66	58	16.00	4.74
Black crappie	353	113.73	17.97	185	80.13	23.74
White bass	32	16.71	2.64	30	16.93	5.02
Yellow bass	1	0.45	0.07	1	0.23	0.07
Subtotal	*642*	*217.82*	*34.42*	*324*	*145.88*	*43.23*
Predatory Fishes						
Longnose gar	13	30.42	4.81	1	2.68	0.79
Shortnose gar	43	43.92	6.94	4	4.30	1.27
Alligator gar	1	4.10	0.65	0	—	—
Bowfin	12	29.00	4.58	8	29.11	8.62
Subtotal	*69*	*107.44*	*16.98*	*13*	*36.09*	*10.68*
Forage Fishes						
Mooneye and goldeye	6	6.14	0.97	3	2.91	0.86
Skipjack	0	—	—	0	—	—
Gizzard shad	101	58.45	9.24	94	30.99	9.18
Golden shiner	0	—	—	0	—	—
Subtotal	*107*	*64.59*	*10.21*	*97*	*33.90*	*10.04*
Total	*1,034*	*632.77*	*100.00*	*554*	*337.56*	*100.00*

* None taken in test nets but one procured from angler at time of survey.
† *Carpiodes* spp.

Continued.

Winfield, Mo. July 27–Aug. 2, 1944			Hamburg, Ill. Aug. 3–9, 1944			Louisiana, Mo. Aug. 12–17, 1944			Cincinnati Landing, Ill. Aug. 19–23, 1944		
Number	Weight, Pounds	Per Cent of Weight	Number	Weight, Pounds	Per Cent of Weight	Number	Weight, Pounds	Per Cent of Weight	Number	Weight, Pounds	Per Cent of Weight
0	—	—	0	—	—	0	—	—	0	—	—
0	—	—	0	—	—	0	—	—	0	—	—
7	4 96	0 57	1	0 22	0.04	0	—	—	0	—	—
0	—	—	2	5.37	1 01	0	—	—	3	4 98	1 43
0	—	—	0	—	—	0	—	—	1	2.80	0 80
7	17.60	2 03	2	5.29	0.99	3	6.64	1.99	5	10.23	2 94
3	8 79	1 01	3	10.74	2.01	1	2 26	0 68	2	3 34	0 96
57	47.72	5 51	24	28.26	5 29	23	15.81	4.73	30	21 42	6 15
11	8 04	0.93	36	34 29	6 42	22	18.36	5 49	8	7.64	2.19
0	—	—	1	1.85	0 35	0	—	—	3	6.02	1.73
79	118 76	13.71	55	98 56	18 45	33	75.25	22 50	45	104.04	29.88
24	27.36	3 16	34	33 89	6 35	18	20.81	6.22	13	9 39	2.70
24	16.23	1 87	3	2.48	0 46	9	1.64	0.49	8	3 62	1 04
1	0.16	0.02	2	2.06	0.39	0	—	—	0	—	—
0	—	—	0	—	—	0	—	—	0	—	—
5	3.72	0.43	0	—	—	0	—	—	0	—	—
39	67.16	7.75	15	40 17	7 52	19	36.39	10.88	33	106.49	30.58
79	48 69	5 62	34	28.37	5.31	98	61.67	18.44	52	32.77	9 41
336	*369 19*	*42.61*	*212*	*291 55*	*54.59*	*226*	*238 83*	*71.42*	*203*	*312.74*	*89 81*
0	—	—	0	—	—	0	—	—	0	—	—
1	1 43	0 17	0	—	—	0	—	—	0	—	—
2	1 64	0 19	0	—	—	3	3.38	1.01	7	6.59	1 89
0	—	—	0	—	—	0	—	—	0	—	—
10	10.23	1 18	5	5 53	1 03	0	—	—	0	—	—
0	—	—	0	—	—	0	—	—	0	—	—
28	5.76	0 66	42	9 40	1.76	0	—	—	0	—	—
0	—	—	0	—	—	0	—	—	0	—	—
0	—	—	0	—	—	0	—	—	0	—	—
254	62 21	7.18	236	61.79	11.57	19	7 40	2 21	1	0.45	0.13
70	20 52	2.37	77	25 84	4 84	11	3 80	1 14	6	2.01	0.58
23	16.50	1 90	26	12.89	2 41	0	—	—	3	6.91	1.98
1	0.34	0.04	0	—	—	0	—	—	0	—	—
389	*118 63*	*13.69*	*386*	*115.45*	*21.61*	*33*	*14.58*	*4.36*	*17*	*15.96*	*4.58*
18	50.47	5 83	4	8 91	1.67	9	28 65	8 57	2	3.34	0.96
136	121 50	14.02	71	60 04	11.24	22	24 13	7.22	6	8 42	2 42
0	—	—	0	—	—	0	—	—	0	—	—
41	128 05	14 78	7	25 42	4.76	2	5 43	1 62	0	—	—
195	*300.02*	*34.63*	*82*	*94 37*	*17.67*	*33*	*58 21*	*17.41*	*8*	*11 76*	*3 38*
5	2 17	0.25	1	0.17	0.03	1	0.55	0.16	0	—	—
0	—	—	0	—	—	0	—	—	0	—	—
142	76 43	8 82	67	32 57	6 10	44	22 23	6 65	18	7.78	2.23
0	—	—	0	—	—	0	—	—	0	—	—
147	*78 60*	*9.07*	*68*	*32.74*	*6.13*	*45*	*22.78*	*6.81*	*18*	*7.78*	*2.23*
1.067	*866 44*	*100 00*	*748*	*534 11*	*100.00*	*337*	*334.40*	*100.00*	*246*	*348 24*	*100 00*

Appendix B, Table 1.—

Species	Hannibal, Mo. Aug. 25–30, 1944			Quincy, Ill. Sept. 2–6, 1944		
	Number	Weight, Pounds	Per Cent of Weight	Number	Weight, Pounds	Per Cent of Weight
Commercial Fishes						
*Scaphirhynchus album**	0	—	—	0	—	—
Shovelnose sturgeon	0	—	—	3	4.78	0.40
Paddlefish	0	—	—	25	104.70	8.69
American eel	6	14.26	3.18	2	3.25	0.27
Blue sucker	0	—	—	0	—	—
Bigmouth buffalo	2	6.85	1.53	6	12.24	1.01
Black buffalo	2	3.25	0.72	2	3.72	0.31
Smallmouth buffalo	6	15.98	3.57	31	26.26	2.18
Carp suckers†	30	25.52	5.70	120	105.46	8.75
Northern redhorse	1	1.27	0.28	‡1	1.18	0.10
Carp	75	178.52	39.84	137	345.79	28.70
Channel catfish	18	9.73	2.17	126	67.74	5.62
Blue catfish	1	0.31	0.07	7	1.53	0.13
Yellow bullhead	0	—	—	0	—	—
Brown bullhead	0	—	—	0	—	—
Black bullhead	0	—	—	2	1.97	0.16
Flathead catfish	21	88.97	19.86	24	83.51	6.93
Freshwater drum	45	36.54	8.15	36	25.33	2.10
Subtotal	*207*	*381.20*	*85.07*	*522*	*787.46*	*65.35*
Sport Fishes						
Grass pickerel	0	—	—	0	—	—
Yellow pikeperch	0	—	—	1	4.00	0.33
Sauger	4	4.69	1.05	4	5.59	0.46
Spotted black bass	0	—	—	0	—	—
Largemouth black bass	0	—	—	0	—	—
Green sunfish	0	—	—	0	—	—
Bluegill	0	—	—	6	1.02	0.08
Warmouth	0	—	—	0	—	—
Flier	0	—	—	0	—	—
White crappie	41	7.88	1.76	61	27.19	2.26
Black crappie	11	3.56	0.79	26	12.02	1.00
White bass	2	0.80	0.18	11	6.72	0.56
Yellow bass	0	—	—	0	—	—
Subtotal	*58*	*16.93*	*3.78*	*109*	*56.54*	*4.69*
Predatory Fishes						
Longnose gar	4	8.73	1.95	38	65.81	5.46
Shortnose gar	25	28.14	6.28	209	249.16	20.68
Alligator gar	0	—	—	0	—	—
Bowfin	0	—	—	1	2.71	0.22
Subtotal	*29*	*36.87*	*8.23*	*248*	*317.68*	*26.36*
Forage Fishes						
Mooneye and goldeye	9	4.48	1.00	6	3.27	0.27
Skipjack	0	—	—	0	—	—
Gizzard shad	28	8.61	1.92	97	40.06	3.33
Golden shiner	0	—	—	0	—	—
Subtotal	*37*	*13.09*	*2.92*	*103*	*43.33*	*3.60*
Total	*331*	*448.09*	*100.00*	*982*	*1,205.01*	*100.00*

* None taken in test nets but one procured from angler at time of survey.
† *Carpiodes* spp.
‡ Undetermined species of redhorse (*Moxostoma*).

Concluded.

Canton, Mo. Sept. 8–13, 1944			Warsaw, Ill. Sept. 14–19, 1944			Total Number of Fish Caught	Total Weight in Pounds	Per Cent of Total Weight
Number	Weight, Pounds	Per Cent of Weight	Number	Weight, Pounds	Per Cent of Weight			
0	—	—	0	—	—	1	0.12	0.00
0	—	—	0	—	—	3	4.78	0.03
18	29.92	5.71	0	—	—	76	165.27	1.14
2	3.62	0.69	1	2.67	0.32	37	80.24	0.55
2	3.70	0.71	0	—	—	3	6.50	0.05
1	3.03	0.56	3	6.04	0.72	109	234.85	1.62
0	—	—	1	5.37	0.64	58	225.67	1.56
23	30.25	5.77	59	124.05	14.86	468	587.93	4.06
81	78.97	15.06	211	219.46	26.29	939	1,042.08	7.20
1	1.84	0.35	3	4.69	0.56	20	24.89	0.17
52	139.11	26.54	114	254.47	30.48	2,325	4,752.51	32.83
10	8.73	1.67	16	10.21	1.22	468	352.47	2.43
1	0.19	0.04	1	3.68	0.44	311	178.32	1.23
1	0.44	0.08	0	—	—	28	17.32	0.12
0	—	—	0	—	—	6	4.68	0.03
1	1.45	0.28	1	0.46	0.06	310	215.86	1.49
19	38.57	7.36	11	60.61	7.26	617	1,709.25	11.81
30	24.12	4.60	36	32.80	3.93	1,116	640.54	4.43
242	*363.94*	*69.42*	*457*	*724.51*	*86.78*	*6,895*	*10,243.28*	*70.75*
0	—	—	0	—	—	2	1.05	0.01
0	—	—	0	—	—	2	5.43	0.04
0	—	—	22	21.35	2.56	67	62.55	0.43
0	—	—	0	—	—	2	1.21	0.01
2	1.32	0.25	1	1.08	0.13	133	149.25	1.03
0	—	—	0	—	—	18	2.30	0.02
12	2.21	0.42	0	—	—	595	134.45	0.93
0	—	—	0	—	—	67	19.71	0.14
0	—	—	0	—	—	1	0.10	0.00
53	25.91	4.94	4	1.90	0.23	998	297.55	2.06
16	10.20	1.95	3	1.42	0.17	1,515	564.90	3.90
56	15.85	3.02	6	3.93	0.47	217	109.73	0.76
0	—	—	0	—	—	6	1.88	0.01
139	*55.49*	*10.58*	*36*	*29.08*	*3.56*	*3,623*	*1,350.11*	*9.34*
26	14.27	2.72	16	18.70	2.24	194	403.33	2.79
76	57.39	10.95	41	39.94	4.78	1,411	1,307.17	9.03
0	—	—	0	—	—	85	249.29	1.72
0	—	—	0	—	—	110	324.66	2.24
102	*71.66*	*13.67*	*57*	*58.64*	*7.02*	*1,800*	*2,284.45*	*15.78*
4	1.93	0.37	18	9.69	1.16	109	54.64	0.38
1	1.09	0.21	3	2.12	0.25	15	9.15	0.06
54	30.12	5.75	21	10.28	1.23	1,069	534.46	3.69
0	—	—	0	—	—	2	0.67	0.00
59	*33.14*	*6.33*	*42*	*22.09*	*2.64*	*1,195*	*598.92*	*4.13*
542	*524.23*	*100.00*	*592*	*834.92*	*100.00*	*13,513*	*14,476.76*	*100.00*

Appendix B, Table 2.—Number, weight, and per cent of total weight by station of various species of fish (except those in minnow seine collections) taken during the Mississippi River survey in 1946 between Burlington and Dubuque, Iowa.

Species	Burlington, Iowa April 10–22, 1946			Oquawka, Ill. April 24–May 5, 1946			New Boston, Ill. May 7–18, 1946			Muscatine, Iowa May 19–30, 1946			Fairport, Iowa June 2–13, 1946			Anoalusia, Ill. April 1–7, 1946		
	Number	Weight, Pounds	Per Cent of Weight	Number	Weight, Pounds	Per Cent of Weight	Number	Weight, Pounds	Per Cent of Weight	Number	Weight, Pounds	Per Cent of Weight	Number	Weight, Pounds	Per Cent of Weight	Number	Weight, Pounds	Per Cent of Weight
Commercial Fishes																		
Shovelnose sturgeon	0	—	—	0	—	—	0	—	—	0	—	—	0	—	—	147	197.10	41.54
Mooneye	83	10.41	1.13	3	0.23	0.04	12	1.74	0.15	1	0.18	0.01	1	0.33	0.03	50	10.24	2.16
Goldeye	28	10.44	1.13	0	—	—	1	0.34	0.03	0	—	—	5	5.76	0.62	11	8.80	1.85
American eel	0	—	—	0	—	—	1	3.25	0.30	2	4.39	0.31	2	3.34	0.36	0	—	—
Blue sucker	0	—	—	0	—	—	0	—	—	0	—	—	0	—	—	0	—	—
Bigmouth buffalo	87	237.73	25.78	22	59.73	10.86	7	26.50	2.41	11	11.87	0.84	12	37.12	4.00	6	14.09	2.97
Black buffalo	3	22.52	2.44	2	6.58	1.20	2	9.42	0.86	0	—	—	0	—	—	1	2.08	0.44
Smallmouth buffalo	175	76.90	8.34	42	54.91	9.99	12	11.71	1.07	27	49.27	3.46	19	31.00	3.34	32	63.61	13.41
Carpsuckers*	139	144.21	15.64	109	142.76	25.96	181	238.05	21.67	211	298.66	21.00	159	247.26	26.62	38	33.99	7.16
White sucker	1	0.68	0.07	0	—	—	0	—	—	0	—	—	0	—	—	0	—	—
Spotted sucker	0	—	—	0	—	—	1	0.91	0.08	0	—	—	0	—	—	0	—	—
Silver redhorse	0	—	—	0	—	—	0	—	—	0	—	—	0	—	—	0	—	—
Northern redhorse	0	—	—	1	4.07	0.74	2	3.53	0.32	1	2.20	0.15	5	7.78	0.84	2	1.70	0.36
Carp	72	242.32	26.28	33	127.18	23.13	91	324.26	29.52	220	816.55	57.42	83	263.01	28.32	14	50.56	10.66
Channel catfish	189	41.33	4.48	14	7.80	1.42	55	16.28	1.48	78	21.23	1.49	103	57.22	6.16	104	25.79	5.43
Yellow bullhead	0	—	—	5	1.82	0.33	3	1.72	0.16	1	0.71	0.05	0	—	—	0	—	—
Black bullhead	10	1.67	0.18	6	3.50	0.64	5	2.88	0.26	1	0.50	0.04	0	—	—	7	1.75	0.37
Flathead catfish	3	1.62	0.18	3	1.11	0.20	8	30.96	2.82	4	4.43	0.31	29	180.52	19.44	1	2.45	0.52
Freshwater drum	164	52.51	5.69	13	7.97	1.45	19	5.22	0.48	64	75.24	5.29	15	18.42	1.98	8	10.48	2.21
Subtotal	*954*	*842.34*	*91.34*	*253*	*417.66*	*75.96*	*400*	*676.77*	*61.61*	*621*	*1,285.23*	*90.37*	*433*	*851.76*	*91.71*	*421*	*422.64*	*89.08*

SPORT FISHES																		
Pike	0	—	—	0	—	—	1	3.49	0.32	0	—	—	0	—	—	0	—	—
Yellow pikeperch	1	2.15	0.23	0	—	—	0	—	—	0	—	—	0	—	—	2	1.15	0.24
Sauger	0	—	—	0	—	—	0	—	—	3	1.58	0.11	3	3.58	0.38	3	2.23	0.47
Spotted black bass	0	—	—	0	—	—	0	—	—	0	—	—	0	—	—	0	—	—
Largemouth black bass	0	—	—	3	4.46	0.81	2	1.48	0.13	1	2.47	0.18	0	—	—	0	—	—
Green sunfish	0	—	—	1	0.14	0.02	0	—	—	1	0.11	0.01	0	—	—	0	—	—
Bluegill	10	2.91	0.32	20	4.23	0.77	34	7.27	0.66	31	8.30	0.58	0	—	—	1	0.24	0.05
Warmouth	0	—	—	4	1.57	0.29	1	0.50	0.05	3	1.05	0.07	0	—	—	1	0.11	0.02
White crappie	30	6.66	0.72	120	37.27	6.78	403	202.58	18.44	155	15.11	1.06	84	3.21	0.35	5	0.89	0.19
Black crappie	11	2.56	0.28	92	19.53	3.55	138	52.55	4.78	113	27.19	1.91	20	0.80	0.09	5	0.91	0.19
White bass	21	1.60	0.17	1	0.12	0.02	39	13.63	1.24	8	2.68	0.19	0	—	—	14	8.11	1.71
Yellow bass	6	0.67	0.07	2	0.38	0.07	217	67.22	6.12	0	—	—	0	—	—	0	—	—
Subtotal	*79*	*16.55*	*1.79*	*243*	*67.70*	*12.31*	*835*	*348.72*	*31.74*	*315*	*58.49*	*4.11*	*107*	*7.59*	*0.82*	*31*	*13.61*	*2.87*
PREDATORY FISHES																		
Longnose gar	3	25.45	2.76	0	—	—	1	8.00	0.73	4	6.68	0.47	2	2.19	0.24	3	15.24	3.21
Shortnose gar	28	32.79	3.56	1	1.88	0.34	10	10.27	0.93	9	8.74	0.62	26	56.45	6.08	12	14.14	2.98
Bowfin	1	3.37	0.37	16	55.09	10.02	6	22.35	2.03	19	63.02	4.43	3	10.70	1.15	3	8.05	1.70
Subtotal	*32*	*61.61*	*6.69*	*17*	*56.97*	*10.36*	*17*	*40.62*	*3.69*	*32*	*78.44*	*5.52*	*51*	*69.34*	*7.47*	*18*	*37.43*	*7.89*
FORAGE FISHES																		
Gizzard shad	4	1.70	0.18	19	7.52	1.37	75	32.51	2.96	0	—	—	0	—	—	1	0.78	0.16
Total	*1,069*	*922.20*	*100.00*	*523*	*549.85*	*100.00*	*1,327*	*1098.62*	*100.00*	*968*	*1,422.16*	*100.00*	*591*	*928.69*	*100.00*	*471*	*474.49*	*100.00*

* *Carpiodes* spp.

Appendix B, Table 2.—Continued.

Species	Andalusia, Ill. June 18–26, 1946			Andalusia, Ill. Sept. 15–24, 1946			Pleasant Valley, Iowa June 28–July 9, 1946			Cordova, Ill. July 11–22, 1946			Fulton, Ill. July 24–Aug. 4, 1946			Sabula, Iowa Aug. 6–17, 1946		
	Number	Weight, Pounds	Per Cent of Weight	Number	Weight, Pounds	Per Cent of Weight	Number	Weight, Pounds	Per Cent of Weight	Number	Weight, Pounds	Per Cent of Weight	Number	Weight, Pounds	Per Cent of Weight	Number	Weight, Pounds	Per Cent of Weight
COMMERCIAL FISHES																		
Shovelnose sturgeon	56	81.22	5.46	77	82.44	5.01	0	—	—	0	—	—	0	—	—	0	—	—
Mooneye	4	1.43	0.10	8	1.78	0.11	2	0.35	0.04	9	1.69	0.22	1	0.30	0.02	0	—	—
Goldeye	2	0.51	0.03	23	3.77	0.23	5	2.96	0.35	6	0.73	0.09	3	0.94	0.07	0	—	—
American eel	3	8.21	0.55	1	2.68	0.16	1	1.75	0.21	1	3.83	0.49	1	3.00	0.22	1	5.25	0.80
Blue sucker	0	—	—	3	9.09	0.55	1	3.54	0.41	1	3.58	0.46	0	—	—	0	—	—
Bigmouth buffalo	45	112.19	7.54	6	18.84	1.15	18	50.07	5.86	7	23.21	2.99	12	15.22	1.09	10	43.14	6.55
Black buffalo	2	15.05	1.01	2	7.95	0.48	3	10.31	1.21	2	14.11	1.82	3	3.43	0.25	4	14.40	2.19
Smallmouth buffalo	49	80.27	5.39	33	44.11	2.68	40	66.64	7.80	28	18.64	2.40	11	4.80	0.34	0	—	—
Carpsuckers*	291	407.04	27.36	122	144.11	8.76	124	154.55	18.10	36	65.76	8.47	44	45.22	3.25	16	21.70	3.30
White sucker	0	—	—	0	—	—	3	5.41	0.63	0	—	—	0	—	—	0	—	—
Spotted sucker	0	—	—	0	—	—	0	—	—	0	—	—	0	—	—	0	—	—
Silver redhorse	0	—	—	1	2.57	0.16	0	—	—	0	—	—	0	—	—	0	—	—
Northern redhorse	9	11.51	0.77	15	21.39	1.30	7	7.58	0.89	2	5.30	0.68	1	2.99	0.22	3	6.62	1.00
Carp	93	336.50	22.61	333	1,115.82	67.83	38	157.03	18.39	79	345.12	44.46	132	467.26	33.56	52	217.81	33.09
Channel catfish	183	47.84	3.21	45	6.70	0.41	84	32.17	3.77	57	29.70	3.83	74	17.58	1.26	13	4.72	0.72
Yellow bullhead	1	0.15	0.01	0	—	—	0	—	—	0	—	—	0	—	—	0	—	—
Black bullhead	16	2.98	0.20	1	0.13	0.01	2	0.76	0.09	1	0.86	0.11	3	0.62	0.04	0	—	—
Flathead catfish	33	229.10	15.40	17	43.82	2.66	54	231.72	27.14	18	68.25	8.79	23	43.89	3.15	31	92.58	14.07
Freshwater drum	112	109.48	7.36	86	73.05	4.44	109	77.83	9.11	66	49.87	6.43	181	158.70	11.40	53	51.90	7.89
Subtotal	*899*	*1,443.48*	*97.00*	*773*	*1,578.25*	*95.94*	*491*	*802.67*	*94.00*	*313*	*630.65*	*81.24*	*489*	*763.95*	*54.87*	*183*	*458.12*	*69.61*

SPORT FISHES																		
Pike	0	—	—	0	—	—	2	2.20	0.26	0	—	—	14	35.01	2.51	5	17.07	2.59
Yellow pikeperch	4	3.29	0.22	4	5.51	0.33	1	0.24	0.03	0	—	—	1	0.31	0.02	0	—	—
Sauger	19	14.13	0.95	19	16.57	1.01	8	5.01	0.59	1	1.55	0.20	3	2.49	0.18	0	—	—
Spotted black bass	0	—	—	0	—	—	0	—	—	0	—	—	2	0.93	0.07	0	—	—
Largemouth black bass	0	—	—	1	0.61	0.04	1	0.68	0.08	0	—	—	3	3.63	0.26	2	1.97	0.30
Green sunfish	0	—	—	0	—	—	1	0.06	0.01	0	—	—	0	—	—	0	—	—
Bluegill	0	—	—	1	0.08	0.01	3	0.66	0.08	4	1.76	0.23	69	19.87	1.43	7	1.45	0.22
Warmouth	0	—	—	0	—	—	0	—	—	0	—	—	0	—	—	0	—	—
White crappie	10	0.73	0.05	180	13.12	0.80	46	10.01	1.17	186	55.72	7.18	656	205.36	14.75	410	61.60	9.36
Black crappie	9	0.54	0.04	25	4.41	0.27	25	3.62	0.42	105	29.00	3.74	493	132.68	9.53	156	30.25	4.60
White bass	2	0.26	0.02	5	3.02	0.18	1	0.19	0.02	5	3.27	0.42	9	3.42	0.25	1	0.26	0.04
Yellow bass	2	0.99	0.07	22	8.68	0.53	1	0.64	0.08	7	2.50	0.32	0	—	—	0	—	—
Subtotal	*46*	*19.94*	*1.35*	*257*	*52.00*	*3.17*	*89*	*23.31*	*2.74*	*308*	*93.80*	*12.09*	*1,250*	*403.70*	*29.00*	*581*	*112.60*	*17.11*
PREDATORY FISHES																		
Longnose gar	3	4.70	0.32	2	3.00	0.18	6	6.48	0.76	3	5.33	0.69	1	0.56	0.04	1	2.81	0.43
Shortnose gar	10	10.94	0.73	9	10.59	0.64	17	17.53	2.05	30	41.72	5.38	3	2.97	0.21	12	12.72	1.93
Bowfin	2	6.55	0.44	0	—	—	1	3.02	0.35	1	3.30	0.42	62	217.67	15.63	21	66.96	10.17
Subtotal	*15*	*22.19*	*1.49*	*11*	*13.59*	*0.82*	*24*	*27.03*	*3.16*	*34*	*50.35*	*6.49*	*66*	*221.20*	*15.88*	*34*	*82.49*	*12.53*
FORAGE FISHES																		
Gizzard shad	2	2.32	0.16	26	1.20	0.07	5	0.86	0.10	4	1.38	0.18	7	3.49	0.25	20	4.91	0.75
Total	*962*	*1,487.93*	*100.00*	*1,067*	*1,645.04*	*100.00*	*609*	*853.87*	*100.00*	*659*	*776.18*	*100.00*	*1,812*	*1,392.34*	*100.00*	*818*	*658.12*	*100.00*

* *Carpiodes* spp.

Appendix B, Table 2.—Concluded.

Species	Bellevue, Iowa Aug. 19–30, 1946			Dubuque, Iowa Sept. 1–12, 1946			Total Number of Fish Caught	Total Weight in Pounds	Per Cent of Total Weight
	Number	Weight, Pounds	Per Cent of Weight	Number	Weight, Pounds	Per Cent of Weight			
Commercial Fishes									
Shovelnose sturgeon	0	—	—	1	4.22	0.46	281	364.98	2.64
Mooneye	0	—	—	0	—	—	174	28.68	0.21
Goldeye	0	—	—	0	—	—	84	34.25	0.25
American eel	1	2.35	0.34	3	9.10	1.00	17	47.15	0.34
Blue sucker	0	—	—	0	—	—	5	16.21	0.12
Bigmouth buffalo	26	68.71	9.86	8	38.06	4.18	277	756.48	5.47
Black buffalo	2	10.24	1.47	3	11.22	1.23	29	127.31	0.92
Smallmouth buffalo	5	10.77	1.55	13	11.01	1.21	486	523.64	3.79
Carpsuckers*	13	11.31	1.62	8	7.50	0.82	1,491	1,962.12	14.20
White sucker	2	3.18	0.46	0	—	—	6	9.27	0.07
Spotted sucker	0	—	—	1	1.43	0.16	2	2.34	0.02
Silver redhorse	0	—	—	0	—	—	1	2.57	0.02
Northern redhorse	47	110.74	15.90	9	21.66	2.38	104	207.07	1.50
Carp	42	197.38	28.34	65	322.22	35.35	1,347	4,983.02	36.06
Channel catfish	52	30.00	4.31	64	18.24	2.00	1,115	356.60	2.58
Yellow bullhead	0	—	—	0	—	—	10	4.40	0.03
Black bullhead	0	—	—	13	3.78	0.41	65	19.43	0.14
Flathead catfish	49	85.99	12.35	21	82.31	9.03	294	1,098.75	7.95
Freshwater drum	94	63.27	9.08	101	88.11	9.67	1,088	842.05	6.09
Subtotal	*333*	*593 94*	*85 .28*	*313*	*618 86*	*67 90*	*6,876*	*11,386.32*	*82 40*

SPORT FISHES									
Pike	0	—	—	13	33 15	3 64	35	90.92	0 66
Yellow pikeperch	1	0.62	0 09	3	11.71	1.28	17	24 98	0.18
Sauger	3	1.64	0 23	6	5 18	0 57	68	53.96	0.39
Spotted black bass	0	—	—	0	—	—	2	0 93	0.01
Largemouth black bass	1	1.02	0 15	4	4.40	0.48	18	20.72	0.15
Green sunfish	0	—	—	0	—	—	3	0.31	0.00
Bluegill	27	2.86	0.41	101	21 68	2.38	308	71.31	0 52
Warmouth	0	—	—	1	0.61	0.07	10	3.84	0.03
White crappie	175	42 25	6.07	217	51.16	5.61	2,677	705.67	5.11
Black crappie	77	18.31	2 63	183	71.90	7.89	1,452	394 25	2.85
White bass	44	17 57	2.52	12	4.87	0.53	162	59.00	0.43
Yellow bass	1	0.66	0.09	0	—	—	258	81.74	0.59
Subtotal	*329*	*81.93*	*12.19*	*540*	*204.66*	*22.45*	*5,010*	*1,507.63*	*10 92*
PREDATORY FISHES									
Longnose gar	1	2 70	0.39	8	10.33	1.13	38	93.47	0 68
Shortnose gar	5	6.76	0.97	17	18.51	2.03	209	246.01	1.78
Bowfin	3	7.73	1 11	16	46.34	5.08	154	514.15	3.72
Subtotal	*9*	*17.19*	*2 47*	*41*	*75.18*	*8.24*	*401*	*853 63*	*6.18*
FORAGE FISHES									
Gizzard shad	10	0.41	0 06	73	12 83	1.41	237	69.91	0.50
Total	*681*	*696.47*	*100.00*	*967*	*911.53*	*100 00*	*12,524*	*13,817.19*	*100.00*

* *Carpiodes* spp.

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