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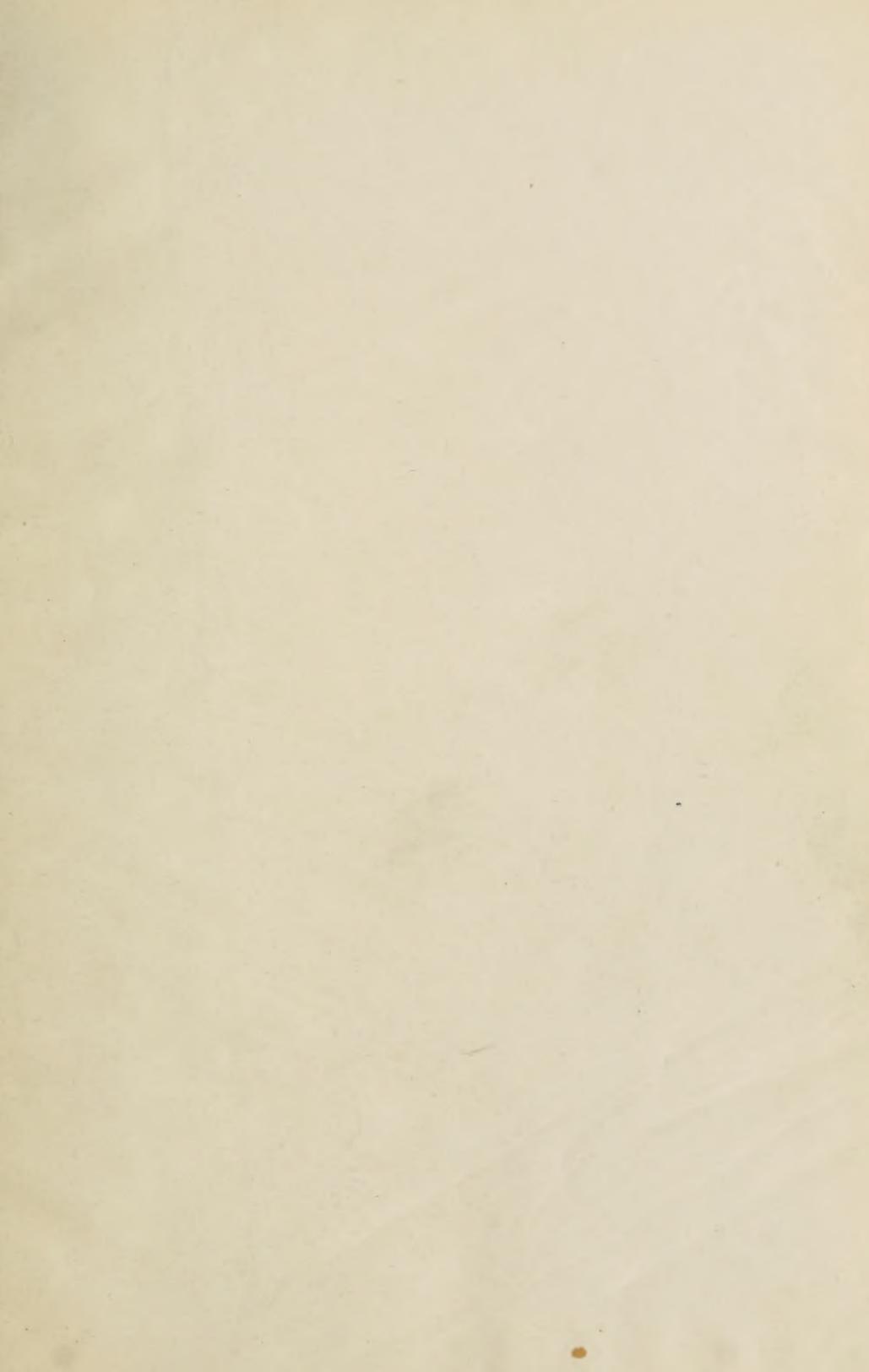
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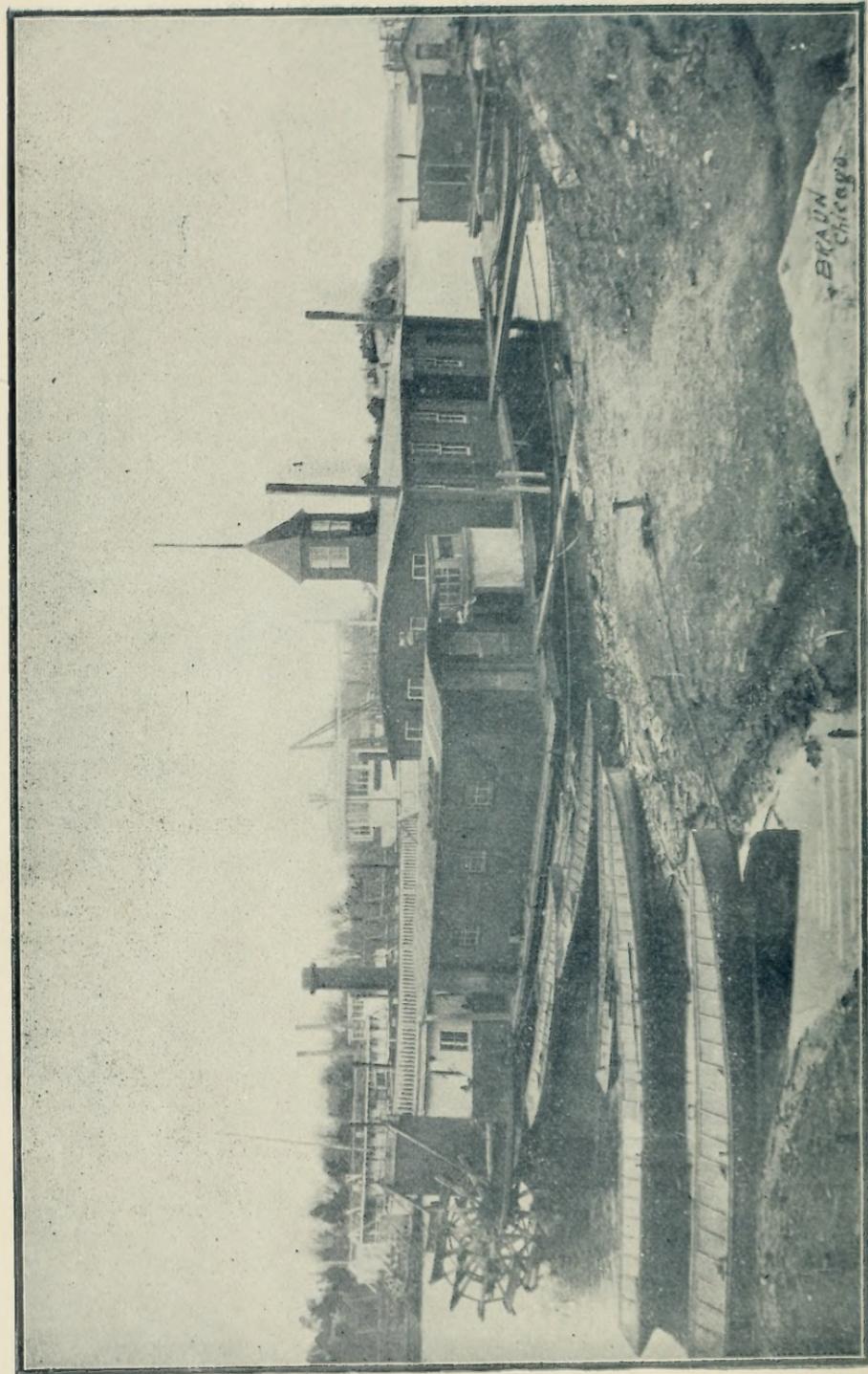
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REPORT OF BOARD

OF

ILLINOIS STATE FISH COMMISSIONERS,

TO THE

GOVERNOR OF ILLINOIS.

SEPTEMBER 30, 1890.

SPRINGFIELD, ILL.:
H. W. ROKKER, STATE PRINTER AND BINDER,
1891.

REPORT OF THE COMMISSIONERS.

To His Excellency, GOVERNOR JOSEPH W. FIFER:

We beg leave to submit herewith our report as Board of State Fish Commissioners, from October 1, 1888, to September 30, 1890.

In reviewing the work of the Commission during the past two years, we consider that there has been a more decided progress made than during any previous period since the creation of the Commission. Not only is this true of the work itself, which has shown largely increased practical results, but there has been manifested, all over the State, a growing interest in the enforcement of the laws relating to the protection of fish and maintaining of proper fishways. Much of the success in this direction has been due to the active co-operation rendered by the various fish clubs, and others interested in fish protection throughout the State. Particularly during the year last passed has this interest manifested itself, and the creation of the system of fish wardens has met with decided approval all over the State, requests for the appointment of such coming from every section, and the result of their work being satisfactory to the community and the Commission, in most instances.

DISTRIBUTION OF INDIGENOUS FISHES.

The utilization of the fish left in the over-flows by the high water has proven, during the past two seasons, to be a very successful and satisfactory part of our work. Aided by the use of the U. S. Fish Commission cars, so generously provided by Commissioner McDonald, we have been enabled to make plants in the greater proportion of the streams of the State, and the practical results following, in the increase of fish in such streams, has, we are pleased to state, been generally noted. We append herewith letters bearing upon this increase.

For the past two seasons the distribution of the smaller fish only, has been abandoned, and the larger and breeding fish have largely predominated in the plants. During these two seasons we have procured our fish from the flats along the Illinois river, as the Mississippi river has not, for three seasons

past, been out of its banks at such seasons of the year as made it possible for the breeding fish to go out and find spawning grounds, while, on the other hand, the Illinois river has, every season, overflowed its banks before the spawning season. As a result the fish have sought that river and gone into it in search of such breeding grounds. This has given it a very plentiful supply, and left in the overflowed places millions of fish.

The extremely hot weather early in the summer caused a rapid diminution of the water in these places, and they soon became correspondingly low, many of them becoming entirely dry very early in the season, and that so rapidly that we could not take fish out and furnish transportation for them fast enough to utilize all. It should be remembered that the fish planted were, for the greater part, from four to fourteen inches in length, and therefore fully capable of protecting themselves against their natural enemies, and that the planting of such sized fish naturally presupposes a large increase in the spring following such plant.

We regard the rescuing and distributing of the fish from these drying ponds, where otherwise they would inevitably perish, as one of the most economical and practical methods of re-stocking our streams ever used. All the fish so planted are adapted to any of the waters of our State, and the cost of taking, planting, etc., is very small when compared with that of artificial propagation.

During the season last past the bass and croppie have predominated in the plants, and no more valuable and satisfactory varieties could be found.

Some idea of the number of fish that must perish annually may be had when it is known that from one point of operation alone, viz.: Along the Wabash Railway, opposite Meredosia, where the overflow of the Illinois river covers thousands of acres when at its height, but which, when the river falls within its banks, is drawn down into a series of lakes and flats covering but a few acres, we took, during this and last season, over thirty carloads of game fish for distribution, besides hundreds of thousands of fish which we put into the river itself. At the present writing this place is perfectly dry, so that if the fish had been left there they must all have died. This is, of course, but one of numberless points of overflow, only a few of which we were able to work successfully, owing in part to the difficulty of getting transportation, and, in some cases, to their being too far from the river to permit our handling them at all.

In the early summer the extreme heat prevented any long hauls for fish. On one or two days the thermometer showed the temperature of the water in the river at Meredosia to be 90 degrees, and in Meredosia Bay, 93 degrees. The fish in live-boxes during this extreme weather simply cooked, but this state of affairs did not exist for any considerable length of time, and the black bass, when placed in the tanks in cars, where the temperature could be regulated by the use of ice, carried well,

the loss in transit being merely nominal. Croppie, and many of the other varieties, could not be carried at all, at that time, though later the croppie became one of the best to transport.

As before stated, we have had the use of three of the U. S. Fish Commission cars to transport our fish. The transportation of the cars has, in the main, been furnished free by the various railroads over which our routes laid. The work accomplished would have been simply impossible had it not been for this generous assistance.

By another season we hope to be able to arrange our boat, the steamer "Lotus," so that fish can be carried any distance, by the use of pumps and attachments which will supply a constant stream or jets of water over the fish while they are held in tanks, arranged for that purpose, along guards and fore-castle of the boat. By this means we hope we shall not be compelled to confine our operations to any one locality, but be able to move from place to place, on both rivers, and cover a much larger territory. As it is, we are compelled to work within towing distance of some point which can be conveniently reached for loading.

In this connection, we would say that a party of men, working under the direction of Mr. D. J. Webb, for the Fish Commission, rescued and put into the river, near Rapids City, Ill., 441,700 fish, in twelve days' time. A report of the work will be found under head of Fish Distributed.

In the proper place in this report will be found tables, showing the extent of the work of distribution of native fish, and where the plants have been made for the past two seasons.

CARP.

The demand for carp has not been so great during the last two years as in those preceding, although our list of applicants was still large.

The success attending the introduction of carp culture in Illinois cannot be estimated in dollars and cents, and has never been fairly placed before the people. Adverse criticism has, in many instances had the effect of creating an undue prejudice against the fish. Lack of care, and ignorance as to methods of culture have done much more to cause the impression that carp are not profitable to raise. Still, the facts are that a very large number of those who prepared ponds for their reception, and gave them ordinary care, are successfully producing a profitable supply of fish, every year, as food,—and good food,—at a trifling comparative expense. In addition to this, evidences are numerous to show that our streams are full of these fish, and they are entering into the supply of food at almost every point where fish are taken for market. Hundreds of very large carp have been taken this season from the pools along the Illi-

nois river, and the fishermen report large catches from the river itself, very often. These are the product of the planting, by the Commission, of carp furnished us by the U. S. Fish Commission, in the public waters of the State, a report of which plant, with list of streams planted, was published in a former report.

At our ponds at Centralia we have a large supply of young and mature carp, which will be turned into public waters, after applicants are supplied.

Many applicants throughout the State have been liberally supplied by the U. S. Fish Commission direct, besides those who have been supplied by the State Commission.

ENFORCEMENT OF THE LAWS.

The most knotty problem the Commissioners have had to solve has been how to enforce the existing laws relating to the protection of the fish. True, as each year passes, the public sentiment is growing in favor of a better enforcement of these laws, and a large number of clubs have been organized with that purpose in view. The appointment of fish wardens has also been of great help, but with all these aids, the law has been openly and flagrantly violated in almost every part of the State. The Illinois river, with its tributaries, which has no superior in the State, or indeed in any of the states, has, for this very reason, been the scene of the greatest amount of illegal fishing.

For several seasons past it has been carried on to such an extent that even the fishermen themselves remonstrated, and the Commissioners, finding that they could not depend upon local assistance to stop these violations, concluded to take the matter in hand, and bring to bear all of their resources to check the wholesale violations, prevalent the entire length of the river. Everywhere the river was filled with fike-nets, with wings from fifty to one hundred feet in length, and in one instance, wings and leads were seen one thousand feet long. In many places only the channel of the river was open, all else being winged off, leaving barely room for boats to run between the stakes.

The Commissioners put into service the little steamer, "Hannibal Eagle," and barge, which had been used by them for past three years in towing live-boxes, etc., in gathering the young native fish, and sent her from Meredosia, where she had been laid up over winter, to Pekin, Ill., where Fish Wardens James Haines and George Ayers took charge of her, and the work of taking up the nets was begun. A few days' work with the boat demonstrated the fact that she was too small for such work, as two or three nets would constitute a load for her. So, after a trip to LaSalle, warning all fishermen to take up nets, Messrs. George E. Cole, President, and Henry Hertz, of the Fox River Fish and Game Association, were taken on board, and the boat returned to Peoria. Here, upon consultation, and after reviewing the work done, and that necessary to be done, it was

clearly demonstrated that, if the work were to be effective, a larger and faster steamer must be employed. As the Commission did not have money available for the purpose, Mr. Cole volunteered to purchase such a boat, and put her to work, provided the consent of the governor could be had. Upon presenting the facts to the governor, he readily assented to the proposition, and the steamer "Lotus," a stern-wheel boat of 72 feet length, 12 feet beam, double engine, and complete outfit, was purchased for \$1,250.00. The expense of running such a boat was but little more than that of the smaller one, the employing of a cook being the only necessary addition to the crew.

From the date of purchase until the work of taking the young native fish was commenced, the steamer was kept on the Illinois river, patrolling that stream and taking up nets, etc. The nets, when taken up, were labeled, stating where taken, and then stored and advertised, the owners being thus notified that they could have their nets by proving property. But few were ever claimed, and we have, at present time, a large number of such nets on hand.

The wardens elsewhere have done splendid work, and in another part of this report will be found a clear statement of just what has been done by them, under head of Reports of Fish Wardens.

Serving, as they do, without further compensation than that which may accrue from the fines attending convictions, in almost every instance they are largely out financially. The law, by its provisions, prevents any compensation other than as stated.

The warden system can be made very effective, but some plan of compensation should be arranged, and funds sufficient to compensate for actual expenses incurred, and time employed, should be made available. The work is of a disagreeable and dangerous character, as many gangs of fishermen have shown, both by threats and acts, that they would not hesitate to add outlawry to their violations of the fish laws, should occasion offer.

The Fox River Fish and Game Association have set an example worthy of emulation, but, unfortunately, one which can hardly be expected to be followed very generally, as such work requires a lavish expenditure of both time and money, which all clubs can not give.

The Fox river association requested that a man, whom they selected, be appointed as fish warden to take care of Fox river, and they have paid him a salary. The results of his work will be apparent when we state that almost the entire length of the Fox river is practically free from violations.

The work thus begun throughout the State should be carried on vigorously, and boats kept on the river continually, during the close season, in charge of competent wardens, and every violation should be followed up promptly. The work of the

past season has demonstrated its value, in that never in the history of the Illinois river have fish been as plenty as during the past two months.

We believe the people at large want the fish protected, and that even the responsible fishermen themselves are in favor of laws that will prevent the practical extinction of the fish. Our laws, with slight modification, are sufficiently strong. What we want now is means and methods to enforce them.

FISHWAYS.

Since the last report there has been a very active enforcement of the law upon this subject. Locally, those interested in the preservation of food and game fish have shown a decided activity in assisting the Commissioners in freeing the rivers from obstructions to the passage of fish. Foremost in the work in this State has been the Fox River Fish and Game Club. Their efficient President, Mr. George E. Cole, deserves more than passing mention from us for his vigorous and successful work in this direction. He has, personally, a number of times, gone the entire length of Fox river in Illinois, giving the dams a careful inspection, and familiarizing himself with their needs as regards an open way for fish. He and his representatives have, by persistent work and able co-operation with the Commissioners, succeeded in causing to be placed in every dam on Fox river, in the State of Illinois, a good and sufficient fishway.

The work upon that river has been accomplished without recourse to legal measures, and we think without entailing upon any of the parties in interest any unnecessary expense or hardship, while the advantage to the waters themselves and those deriving any benefit from them has been of incalculable value.

Not alone upon Fox river has this work been carried on. In the proper place in this report will be found a list of dams provided with fishways, and a proper report in each case.

We regard the question of the removal of obstructions in the rivers for the free passage of fish as one of the great essentials for the successful repopulation of the waters of such rivers. Argument in its favor is unnecessary; it is only a plain question of the statement of a fact. An obstruction sufficient to prevent the passage of fish at all seasons of the year, whether it be a dam or anything else, means, under ordinary circumstances, a depletion of all waters above such obstructions, of fish, and this permanently, unless restocked by artificial methods; while upon the other hand, a free course for fish means an ever-increasing supply of young for the whole length of the stream, providing proper protection is given them.

List of dams provided with fishways during years of 1889 and 1890:

State dam at Dayton	Feeder for canal
Dam at Yorkville	Fox River
Dam at Oswego	"
Dam at Montgomery	"
Dam at Aurora	"
Dam at North Aurora	"
Dam at Batavia	"
Dam at Geneva	"
Dam at St. Charles	"
Dam at Clintonville	"
Dam at Elgin	"
Dam at Carpenterville	"
Dam at Algonquin	"
Dam at Newton	Embarras River
Dam at Rockford	Rock River
Dam at Lincoln	Salt Creek
Dam at Lamoine	Crooked Creek
Dam at Rockford	Rock River

OFFICE.

Since our last report we have been enabled, by appropriation made, to enlarge and repair our office at Quincy, Ill., adding some very much needed improvements, such as a safe, desk, office chairs, letter press, pigeon-hole cases, and other conveniences made necessary by our largely increased business. One new hull was placed under office boat, and the other repaired. New lines and fastenings were put on, and we now have comfortable and convenient quarters on Quincy Bay.

In the proper place will be found an exhibit of expenditure of appropriation.

PROTECTIVE ASSOCIATIONS.

As before stated, the past two seasons have developed an unusual amount of interest in the protection of fish, and the enforcement of the laws.

Organizations for that purpose had been formed, and active co-operation with the Commissioners has resulted in a more systematic enforcement of the laws, both as to fish and fishways.

At the head of the list—and we feel sure that place will be cheerfully accorded them by every club in the State, both for the character and extent of the organization, and the practical good which has attended their efforts—stands the Fox River Fish and Game Association.

Mr. George E. Cole, their efficient president, has spent a large amount of money and time in the enforcement of the laws, and through his efforts has obtained a considerable amount of money outside of the organization for the same purpose. The efforts of this association were not confined to Fox river alone, but the Illinois river as well, has been the gainer by the active assistance they have given the Commissioners in this work.

This association is composed of citizens of almost every town and city along the Fox river valley and Fox lake, as well as a number in Chicago.

But while the Fox River Fish and Game Association has been active in its work, other associations have not been idle, and we are glad to acknowledge our appreciation of the favorable results following the efforts of the following named clubs:

Charleston Fish Protective Association.....	Charleston, Ill.....
Springfield Fishing Club.....	Springfield, Ill.....
Danville Fish Club.....	Danville, Ill.....
Bluff City Fish Club.....	Alton, Ill.....
Beaver Dam Lake Fishing Club.....	Carlinville, Ill.....
Schorr Lake Fish Club.....	Waterloo, Ill.....
Island Pond Fishing Club.....	Waterloo, Ill.....
Lake Bartlett Fishing Club.....	Waterloo, Ill.....
Decatur Fishing Club.....	Decatur, Ill.....
Galesburg Fishing Club.....	Galesburg, Ill.....
Murdock Lake Fishing Club.....	Galesburg, Ill.....
Olney Hunting and Fishing Club.....	Olney, Ill.....
Eagle Lake Fishing Club.....	Gladstone, Ill.....
Quincy Fish and Game Club.....	Quincy, Ill.....

LIST OF NATIVE FISH DISTRIBUTED.

The distribution of native fish comprises, for the greater part, mature, breeding game fish, such as bass, all varieties, croppie, strawberry bass, pickerel, pike, spotted and channel catfish, wall-eyed pike, ringed perch and the sunfishes. A carload contains from 5,000 early in the season, to from 1,000 to 1,500 later on. The plants were made, as nearly as possible, in such portions of rivers or lakes as were best adapted to their reception.

During the season of 1889 two cars were used, while for season of 1890, three cars, Nos. 1, 2 and 3, were in service at various times during the season.

The fish distributed were from four to fourteen inches in length, and it is a fair presumption to suppose that the spring following plant would show a large increase.

LIST OF NATIVE FISH DISTRIBUTED IN 1889.

Stream.	Near.	County.	Number.
Maekinaw.....	.....	McLean.....	2,500
Kankakee.....	Kankakee.....	Kankakee.....	3,500
Park Lakes.....	Chicago.....	Cook.....	2,100
Long Lake.....	Mitchell.....	Madison.....	2,000
Reno Lake.....	Shelbyville.....	Shelby.....	2,600
Embarras.....	Charleston.....	Colos.....	5,000
Berlin Lake.....	Berlin.....	Sangamon.....	1,500
Wabash Ry. Reservoir.....	Lanesville.....	Sangamon.....	2,200
C. B. & Q. Reservoir.....	Galesburg.....	Knox.....	1,500
Fox Lake.....	McHenry.....	McHenry.....	2,200
Crystal Lake.....	Crystal Lake.....	.....	2,500
Sangamon.....	Decatur.....	Macon.....	2,500
Sangamon.....	Riverton.....	Sangamon.....	1,500
Des Plaines.....	Riverside.....	Cook.....	3,500
Pistauqua Lake.....	McHenry.....	McHenry.....	2,200
Fox Lake.....	.....	.....	3,100

List of Native Fish Distributed in 1889.—Continued.

Stream.	Near.	County.	Number.
Reservoir (30 acres).....	Belleville.....	St. Clair.....	1,800
Island Lake.....	".....	".....	1,200
Schorrs Lake.....	".....	".....	900
Mill Lake.....	Red Bud.....	Randolph.....	1,000
Kipple Creek.....	Plymouth.....	Hancock.....	2,500
Crooked Creek.....	Macomb.....	McDonough.....	1,575
Bigger Lake.....	Bardolph.....	".....	500
Little Wabash.....	Louisville.....	Clay.....	2,500
City Reservoir.....	Litchfield.....	Montgomery.....	1,000
Saylor Springs.....	Flora.....	Clay.....	2,100
Illinois Central Reservoir.....	Clinton.....	De Witt.....	2,000
Ponds in county.....	Potomac.....	Vermilion.....	250
Insane Asylum Reservoir.....	Jacksonville.....	Morgan.....	3,000
Deaf and Dumb Asylum Reservoir.....	Jacksonville.....	".....	1,000
Beaver Dam Lake.....	Macoupin.....	Macoupin.....	2,600
Macoupin River.....	".....	".....	1,500
City Reservoir.....	Monmouth.....	Warren.....	500
Rock River.....	Dixon.....	Lee.....	2,600
Rock River.....	Rock Island.....	Rock Island.....	5,500
Fox River.....	Aurora.....	Kane.....	3,600
Du Page.....	Naperville.....	Du Page.....	5,000
Kiswaukee.....	De Kalb.....	De Kalb.....	2,500
Big Muddy River.....	De Soto.....	Jackson.....	2,700
Kaskaskia.....	Wheaton.....	Monroe.....	3,500
Macoupin.....	Riverdale.....	Greene.....	1,500
Kankakee.....	Wilmington.....	Will.....	2,250
Salt Creek.....	Lake Fork.....	Logan.....	1,250
Sangamon River.....	Pete sburg.....	Menard.....	1,000
Vermilion River.....	Potomac.....	Livingston.....	1,500
Spoon River.....	Seville.....	Knox.....	2,500
Clear Lake.....	Springfield.....	Sangamon.....	500
Iroquois River.....	Watseka.....	Iroquois.....	1,500
Rock River.....	Prophetstown.....	Whiteside.....	3,100
Rock River.....	Byron.....	Ogle.....	2,600
Kaskaskia.....	Venedy.....	Washington.....	3,100
Mississippi River.....	Various points.....	".....	*
Illinois River.....	".....	".....	*

* Wherever work was carried on, the surplus over and above those used for distribution was put into the river, or nearest deep water in the vicinity. The fish so planted would aggregate many hundreds of thousands, and would comprise all varieties of native fish.

LIST OF NATIVE FISH DISTRIBUTED IN 1890.

Streams.	Near.	County.	Number.
C., B. & Q. Reservoir.....	Rio.....	Knox.....	2,465
Lake Geneva.....	".....	".....	2,000
Sangamon River.....	Riverton.....	Sangamon.....	2,060
Sangamon.....	Decatur.....	Macou.....	2,500
Lakes in county.....	Virginia.....	Cass.....	1,500
Embaras River.....	Charleston.....	Coles.....	2,280
Fox Lake.....	McHenry.....	McHenry.....	2,494
Fox River.....	".....	".....	1,496
Pistauqua Lake.....	".....	".....	1,240
Taylor's Lake.....	Grays Lake.....	Lake.....	1,500
Second Lake.....	".....	".....	1,250
DuPage River.....	Naperville.....	DuPage.....	1,900
Lakes in county.....	Macomb.....	McDonough.....	1,500
".....	Greenville.....	Bond.....	900
".....	Lebanon.....	St. Clair.....	600
".....	Clinton.....	De Witt.....	500
".....	Shirley.....	McLean.....	900
Kaskaskia River.....	Kaysport.....	Clinton.....	1,100
Big Muddy.....	De Soto.....	Jackson.....	1,500
Lakes in county.....	Carbondale.....	".....	900
".....	Anna.....	Union.....	800
Cache River.....	Ullin.....	Pulaski.....	1,500
Fox River.....	Aurora.....	Kane.....	2,500
".....	Geneva.....	".....	1,500
Spoon River.....	Seville.....	Fulton.....	1,500
Des Plaines.....	Riverside.....	Cook.....	2,500

List of Native Fish Distributed in 1890—Continued.

Streams.	Near.	County.	Number.
Vermilion River.....	Danville.....	Vermilion.....	2,000
Kankakee.....	Kankakee.....	Kankakee.....	5,000
Green River.....	Colona.....	Henry.....	2,100
Edwards River.....	Opheim.....	.....	1,500
Lakes in county.....	Gladstone.....	Henderson.....	5,000
Queens Lake.....	Venedy.....	Washington.....	1,500
Little Wabash River.....	Clay City.....	Clay.....	1,200
Lake Fork Salt Creek.....	Lake Fork.....	Logan.....	1,500
Saline River.....	Texas City.....	Saline.....	1,000
Henderson River.....	Henderson.....	Henderson.....	2,200
Lakes in county.....	Waterloo.....	St. Clair.....	1,700
.....	Lebanon.....	.....	1,000
Wabash River.....	Vincennes.....	.....	2,500
Kaskaskia River.....	Carlyle.....	Clinton.....	2,100

Report of D. J. Webb of twelve days' work rescuing native fish near Rapids City, Ill.:

RAPIDS CITY, ILL., October 18, 1890.

S. P. BARTLETT, ESQ., *Secretary*:

DEAR SIR:—Herewith please find vouchers and report for the work done here. Estimating the hauls at about the same, we have transferred from the drying pools to the river, in all, about as follows:

Bullheads.....	13,350
Bass.....	19,000
Croppies.....	25,000
Sunfish.....	12,200
Carp.....	14,600
Buffalo.....	12,200
Pickrel and pike.....	11,550
Hickory shad and miscellaneous fish.....	333,000
Making total of.....	441,700

The hickory shad were very thick, and I presume we put in more than the number estimated. The bass, croppie, sunfish and pickrel were in fine condition; and all went off into the deep water at once. We did not get over one-sixth of our territory.

Yours very truly,

(Signed.)

D. J. WEBB.

PIKE PERCH DISTRIBUTION.

The U. S. Fish Commission gave us, in 1889, one car load of the fry of the pike perch (wall-eyed pike) for distribution in the public waters of the State, and another car load was sent us in 1890. These fish were brought to Illinois from the U. S. Commission Hatching Station at Sandusky, O., in the cars of the U. S. Fish Commission, the use of which, with their crews, was furnished us free, for our distribution, by the U. S. Fish Commission. The transportation of the car and crew to Illinois was furnished by the U. S. Commission, and our railroads furnished us free transportation for car and crew within the State, for the distribution. We submit herewith a list of the plants made.

Car load of pike perch fry deposited in public waters in Illinois, by car No. 2, Mr. W. A. Dunnington in charge, under the direction of State Board of Fish Commissioners, May, 1889:

Stream.	Location.	Number.
Sangamon River	Decatur, Ill	200,000
Kankakee River	Kankakee, Ill	6,000,000
Sangamon River	Barclay, Ill	200,000
near	Springfield, Ill	1,000,000
Lake Whittemore	Lanesville, Ill	1,000,000
Lake Henderson	Cass County, Ill	100,000
Embaras River	St. Marys, Ill	100,000
Fox Lake	Olney, Ill	100,000
Lake Delasmutt	Martinsville, Ill	100,000
Illinois River	Meredosia, Ill	1,300,000
Mississippi River	Quincy, Ill	1,300,000
Total		11,400,000

Car load of pike perch fry deposited in public streams in Illinois, by car No. 1, Mr. Newton W. Simmons in charge, under the direction of the State Board of Fish Commissioners, May, 1890:

Stream.	Location.	Number.
Sangamon River	Virginia, Ill	1,000,000
Spring Lake	Pekin, Ill	500,000
Mackinac River	Pekin, Ill	500,000
Sangamon River	Petersburg, Ill	300,000
Kankakee River	Kankakee, Ill	3,378,000
Embaras River	Charleston, Ill	1,500,000
Total		7,178,000

FISH WARDENS.

We submit herewith a list of the fish wardens appointed by your Excellency, upon the recommendation of the Commissioners; also the reports of such wardens.

Taking into consideration the fact that a large proportion of the work reported has been done without compensation, other than that received from the fines collected from an occasional conviction, we feel that the work makes a good showing.

LIST OF FISH WARDENS.

NAME.	LOCATION.	DATE.
Wm. C. Loomis	Richmond	October 4, 1889
C. M. Partlow	Springfield	October 4, 1889
John Elder	Carthage	October 4, 1889
M. L. Kelley	Wilmington	November 6, 1889
Joseph S. Juda	Collinsville	January 28, 1890
Wm. H. Henley	Yorkville	January 28, 1890
E. F. Derr	Beardstown	March 19, 1890
F. L. Buck	Elgin	March 29, 1890
M. D. Green	Momence	April 2, 1890
Thos. Wright	Lacon	April 4, 1890
H. C. McClung	Keithsburg	April 11, 1890
Geo. W. Ayers	Spring Lake	April 25, 1890

List of Fish Wardens—Continued.

NAME.	LOCATION.	DATE.
Jas. Haines, Jr	Pekin	April 25, 1890
Jas. Sampson	Bachtown	April 25, 1890
J. A. Amsley	Peoria	May 9, 1890
John D. Trew	Colchester	May 9, 1890
Geo. Kamper	Danville	May 9, 1890
C. A. Woodruff	Riverside	May 13, 1890
Walter D. Hodgson	New Boston	May 19, 1890
Clark Blackwell	Griggsville	May 29, 1890
John Dickson	Sterling	June 3, 1890
Jas. H. Nazworthy	Sullivan	June 5, 1890
Thos. Perry	Terre Haute	June 6, 1890
Thos. R. Mullins	Anna	July 8, 1890
James P. Campbell	Browning	July 8, 1890
F. M. Parker	Charleston	July 15, 1890
Richard Harkness	Decatur	August 5, 1890
L. C. Schwerdtfeger	Lincoln	August 6, 1890
Chas. P. Bronson	Pullman	August 30, 1890
Oliver C. Easton	Havana	August 30, 1890
Henry H. Turner	Virginia	September 18, 1890
J. E. Stevens	Noble	October 13, 1890

Fish Warden Thos. Wright removed by Governor Fifer for cause. ———
 ———, 1890.

REPORT OF STATE FISH WARDEN JOHN D. TREW, COLCHESTER, ILL.

Was appointed May 9, 1890. I have had notices regarding fish laws inserted in county papers, and have spoken to all whom I knew were interested in fish culture in regard to same. I have taken up no nets. Where I had reason to believe seining had been done all promised obedience. I feel sure all seining has been stopped. I have made one arrest for failure to put in fishway. No convictions, though I had one party arrested and tried before justice of peace. Defendant chose a jury and was acquitted. I have served seven fishway notices, to wit: Pleasant Valley, Lamoine, Birmingham, Brooklyn, Morell, Scott and Hoffman's Mills. Have put in three fishways, to wit: Pleasant Valley, Lamoine and Birmingham, the latter mill situated in Schuyler county. There are four dams in Schuyler county unprovided with fishways, viz: Brooklyn, Morell, Scott and Hoffman.

In McDonough county the main stream is Crooked creek. Tributaries are Spring creek, Troublesome creek and Camp creek.

I believe there are few, if any, violations of fish laws. Crooked creek is a fine stream for game fish. For want of fishways fish are becoming very scarce. People of Schuyler county complain about there being no fishways in dam across Illinois river at La Grange.

REPORT OF STATE FISH WARDEN LOUIS C. SCHWERDTFEGER, LINCOLN, ILL.

Was appointed August 6, 1890. Have notified no one in regard to fish laws. Have taken up no nets. Have made five arrests, viz: Wm. Scott, Matthew Wortman, John Hopp, Jacob Hopp and John Rantt, and secured conviction in each case.

Have served no fishway notices. Have had one fishway put in, which was done by the Lincoln Water Works Co.

No dams in county unprovided with fishways.

The streams in our county are Salt creek, Kickapoo creek, Sugar creek, Deer creek and Prairie creek.

Violations of the law have decidedly diminished since my appointment. I do not think that any more will occur very soon.

REPORT OF STATE FISH WARDEN THOS. R. MULLINS, ANNA, ILL.

Was appointed August 1st, 1890. Have notified no one to obey the law. Have posted notices. Have taken up no nets. Have made no arrests. No convictions. No fishways put in. No dams in my county unprovided with fishways. No violations since my appointment, but frequent before.

REPORT OF STATE FISH WARDEN O. C. EASTON, HAVANA, ILL.

Was appointed August 13, 1890. Have notified three persons to obey the law. Have taken up no nets. No arrests have been made. No convictions. Have served no fishway notices. No fishways put in. No dams in my county unprovided with fishways. I have not learned of any violations of the law. I have examined several seines, and found them according to the law. Streams in this county: Illinois river, Quiver river, and bordering on the Sangamon river.

REPORT OF STATE FISH WARDEN C. F. DERR, BEARDSTOWN, ILL.

Was appointed March 18, 1890. Have notified seven fishermen to obey the law. Have taken up no nets. Have made no arrests. No convictions. Have served no fishway notices. Have put in no fishways. The Illinois river has one dam unprovided with fishway, the La Grange locks. Everything here is in good shape. There are, and have been no violations of the fish laws.

REPORT OF STATE FISH WARDEN J. A. AMSLEY, PEORIA, ILL.

Appointed May 9, 1890. Have notified twenty-two persons to obey the law. Have taken up twenty-eight nets. Have made five arrests. Have secured four convictions: one case appealed, suit pending. Have served no fishway notices and none have been put in. There are no dams in the county of Peoria.

Fishing in this locality is much better this fall than for several former seasons. Violations much less frequent, there being occasional violations, but generally the fishermen are complying with requests of the State law.

REPORT OF STATE FISH WARDEN CLARK BLACKWELL, GRIGGSVILLE, ILL.

Appointed May 29, 1890. Have notified thirty persons to obey the law. Have taken up eleven nets. Have made nine arrests, and secured seven convictions. There are four dams unprovided with fishways in this county. Violations are frequent, but owing to the expense of the work I cannot secure convictions, as there is no way to secure reimbursement for expenses.

REPORT OF STATE FISH WARDEN J. E. STEVENS, NOBLE, ILL.

Was appointed October 13, 1890. Have notified twenty-five persons to obey the law. Have taken up no nets, but have taken out two traps and dams. Have made five arrests. Have secured no convictions. Have served no fishway notices. No fishways put in. There is one dam on Fox river unprovided with fishway. It is an old mill-dam.

Violations of the law are frequent, though I have them considerably diminished since my appointment. The streams are Little Wabash, Fox and Big Muddy rivers.

REPORT OF STATE FISH WARDEN RICHARD HARKNESS, DECATUR, ILL.

Appointed August 5, 1890. Have had notice to obey the fish laws inserted in all the papers. Have taken up no nets but have removed six traps. Have made thirty arrests and secured six convictions: the other

cases were compromised by State's attorney. Have served two fishway notices. There have been no fishways put in. The city here has promised to build one. There are two dams unprovided with fishways.

Violations have ceased since my appointment. I found, in October, below the dam here, a large number of fish that had died from the effects. I think, of the city sewer and gas works.

REPORT OF STATE FISH WARDEN F. L. BUCK, ELGIN, KANE COUNTY, ILL.

Appointed March 29, 1890. Have notified more than two hundred persons to obey the law; in fact, all I met while patrolling the river. Have taken up seventy nets. Have made fifteen arrests for violations of the fish laws. Have secured thirteen convictions. I have served no fishway notices, as they had been served before my appointment. There have been eight fishways put in since my appointment. There are no dams in the county unprovided with fishways, except the west dam at Aurora, where there are two at the same place, divided by an island.

The fishing in my district, Fox lake and Fox river, has never been better than this summer, and there have been very few violations since I commenced to arrest violators. The only stream with fish in this county is Fox river.

REPORT OF STATE FISH WARDEN JAMES SAMPSON, CALHOUN COUNTY, ILL.

Appointed April 25, 1890. Have taken up one net. Have made no arrests. Have served no fishway notices. None put in. The fishing grounds in this county are the Mississippi and Illinois rivers, the Hamburg, Gillead and Cape Au Gris bayous. Unlawful fishing is less frequent since my appointment.

REPORT OF STATE FISH WARDEN JAMES HAINES, JR., PEKIN, ILL.

Was appointed April 25, 1890. Have notified all fishermen from Henry, Ill., to Meredosia, Ill., to obey the law. About fifty nets were destroyed without taking up. Have seven in storage house at Pekin at this date. Have made one arrest for illegal seining in Kingston lake, Peoria county, Ill. Have secured conviction in one case. Have served one fishway notice on owner of Fisher's mill, on Mackinaw river, Tazewell county, Ill. Have put in no fishways. I do not know the number of dams in this county, but none of them have the proper fishways.

The violations are considerably less frequent since my appointment, and I could, if properly recompensed for the work, time and money expended, stop all violations.

The Mackinaw river, Farm creek, Ten Mile creek, Sugar creek and Crane creek are the principal streams containing fish to any great number.

REPORT OF STATE FISH WARDEN H. C. M'CLUNG, KEITHSBURG, ILL.

Appointed April 11, 1890. Have notified thirty-five persons to obey the law. Have taken up two nets. Have made six arrests and secured three convictions, three having taken change of venue, and trial set for 28th of November. Have served no fishway notices, and none have been put in. There are three dams unprovided with fishways in this county.

Violations are considerably less since my appointment. The streams are Pope creek, Edwards creek and Eliza creek. The first has two dams and the second one.

REPORT OF STATE FISH WARDEN GEORGE KEMPER, DANVILLE, ILL.

Appointed May 9, 1890. Have notified all persons to obey the law. Have taken up no nets, as no set nets are used in our county. Have arrested two gangs of fishermen, one having six seines in their possession and the other four. Have secured six convictions.

The Vermilion river and its tributaries, North, Middle and Salt Forks, are the principal streams in Vermilion county. Illegal fishing has been done by three different methods, viz: The square dip-net, formerly used a great deal during spring freshets below the dam; but this was not practiced so much last spring, especially after I caught and convicted a man in April, before my appointment as Fish Warden. The second method was the seine or drag-net. There are upwards of twenty seines owned in Vermilion county, and these nets are being used whenever the owners see a chance to do so without being caught, and the catching is very difficult. The convictions of the gang on November 28, for seining, were made possible only because they fell out with each other, and one man was anxious for revenge on the rest of the gang, and even then the head of the gang and owner of the seine could not be convicted, because he did not happen to go this particular time on which the other convictions were had. The third method is the use of explosives, giant powder or dynamite. Even the seiners and dip-netters hate the dynamiter, and I think there have been no violations of that kind since June, 1890. We had so many watching all over the county for dynamiters that I think we succeeded in frightening them.

REPORT OF STATE FISH WARDEN GEORGE W. AYERS, SPRING LAKE, ILL.

Appointed April 25, 1890. Have notified all the fishermen in the district to obey the laws. Have taken up and have now in my possession about thirty-six nets, and have destroyed about twenty-five more without removing them. Have made two arrests and have an indictment pending in another case. Have secured two convictions with fines assessed at \$30 and costs in each case. Total fines paid \$130.60 in county court of Tazewell county. Have served one fishway notice on owner of dam at Fisher's Mill, on the Mackinaw river. No fishways have been put in. There are no fishways in any of the dams in Tazewell county. Violations are few and far between since my appointment. The Mackinaw is the principal stream in this county, and should have all dams on it (and there are several) supplied with suitable fishways, and that before next spring, so that the fish can get up to it to spawn.

REPORT OF STATE FISH WARDEN THOS. PERRY, TERRE HAUTE, ILL.

Was appointed June 6, 1890. Have notified eight persons to obey the laws. Have taken up four nets. Have made no arrests and secured no convictions. Have served no fishway notices. Have put in no fishways. There are no dams in the county unprovided with fishways. The violations of fish laws are less frequent since my appointment, but there are still occasional instances, but we fail so far to obtain the necessary proof for conviction.

REPORT OF STATE FISH WARDEN F. M. PARKER, CHARLESTON, ILL.

Appointed July 15, 1890. Have notified twenty-six persons to obey the law. Have taken up no nets. Have made four arrests and have secured three convictions. Have served no fishway notices. One fishway has been put in, viz.: at Newton, Jasper county, Ill. There is one dam at Lawrenceville, Lawrence county, unprovided with a fishway. Violations of the fish laws have been frequent in the past but have materially decreased since my appointment. The streams are the Embarras river and its tributaries.

REPORT OF STATE FISH WARDEN CHAS. T. BRONSON, PULLMAN, ILL.

Appointed August 30, 1890. Have notified fourteen persons to obey the law. Have taken up twenty-four nets. Have made three arrests and secured three convictions. Have served no fishway notices. No fishways put in. There are no dams unprovided with fishways in this county. The

—2 F. C.

streams in my district are Grand Calumet and Little Calumet rivers and Lake Calumet, Lake Hyde and Wolf Lake. These waters have been stocked with fish by the Fish Commission, but there has been so much unlawful fishing that the fish have nearly disappeared. Since my appointment I have returned nearly two tons of fish to the waters taken from nets.

REPORT OF STATE FISH WARDEN M. L. KELLEY, WILMINGTON, ILL.

Appointed November 6, 1889. Have notified sixteen persons to obey the law. Have made eight arrests and convictions secured in three cases. Have served no fishway notices. There are five dams in the county unprovided with fishways. There has been a great deal of seining in the Kankakee river, but it is almost stopped now. The streams are Kankakee river, DesPlaines river and DuPage river.

REPORT OF STATE FISH WARDEN JAMES H. NAZWORTHY, SULLIVAN, ILL.

Appointed June 5th, 1890. Have served notices on about fifteen persons to obey the law. Have taken up one net. Have made five arrests, but failed in convicting on account of justice of the peace deciding that trammel nets were no violation of the law.

Have served two fishway notices. Only found three fish traps in state of operation. Notified two of the owners; the other was torn out before I learned the owner's name.

No fishways have been put in, as owners promptly destroyed dams when notice was served. There are now no dams unprovided with fishways.

Violations were of frequent occurrence, but have materially diminished since my appointment.

The streams in county are Kaskaskia river, Jonathan and Whitley creeks, Little Kaskaskia river, and Wolf, Marrowbone and Kilborn creeks.

After receiving my commission I went diligently to work to inspect streams and look for violators of law. I found a number of fish traps and dams built across streams, but as the water was very high at the time, could not ascertain whether they were in repair or not. As soon as water subsided, I found only three that had stood the freshet, and were in good repair, two of which I promptly notified the owners of to remove, or construct fishway. They removed the obstructions, and have not since rebuilt. The other was torn out before I learned owner's name. Since then I have diligently patrolled the streams often, without being able to find violators of law.

REPORT OF STATE FISH WARDEN H. H. TURNER, VIRGINIA, ILL.

Was appointed September 19th, 1890. Have notified twelve persons to obey fish laws. Have taken up no nets. I have made four arrests, and have secured convictions in all cases. Have served no fishway notices and put in no fishways. There are no dams in the county unprovided with fishways. There are frequent violations of the law, but it is difficult to get evidence to convict. Open violations are not so numerous as before my appointment.

The streams in which fishing is done are the Sangamon river, and a chain of lakes along same, and the Illinois river.

REPORT OF STATE FISH WARDEN JOHN ELDER, CARTHAGE, ILL.

Appointed October 4th, 1889. I have notified about thirty persons to obey the law. Have taken up no nets. Have made no arrests. Have served no fishway notices. No fishways put in. There are no dams requiring fishways unprovided. There are several old dams, which have washed out so that they are no obstruction to the passage of fish.

Violations of the law have been frequent, and seining was general until my appointment, but has considerably diminished. Most of the seining

has been done at night. I have had men out for the purpose of securing evidence against the violators, but the whole community here is against the law, but we hope for greater success next year, as there are a number of our anglers who are taking an active interest in having violators punished.

We have a splendid stream here, Crooked creek, which furnishes about thirty-five miles of good fishing grounds. The only disadvantages we have to contend with being the seining and trapping of fish, and the Lamoine and Birmingham mill dams, which have no fishways over them. The anglers here request me to write to the fish commissioners, and insist that these fishways be constructed as soon as can possibly be done, so that the fish can come up the stream next spring.

Within the last two years I have had as fine black bass and salmon fishing in Crooked creek as I have had in the famous fishing ground of Wisconsin and the north. This is saying a great deal, but it is an actual fact.

The streams in Hancock county are Crooked creek and the Mississippi river sloughs.

REPORT OF STATE FISH WARDEN C. M. PARTLOW, SPRINGFIELD, ILL.

Appointed October 4th, 1889. Have served notices on one hundred persons regarding fish laws. Have not taken up any nets. Have made eight arrests, and have secured five convictions, and have one now pending. Have served no fishway notices, but have taken out four fish-dams, and have caused two others to be removed. No fishways have been put in. There are three dams in this county still unprovided with fishways.

Violations are frequent, though they have diminished since appointment. The streams in this county are Sangamon, north and south forks, and several lakes, and Sugar creek.

REPORT OF STATE FISH WARDEN M. D. GREEN, LA SALLE, ILL.

Appointed April 2d, 1890. Have notified about thirty-five persons to obey the law. Have cut loose six nets. Have made one arrest, but the case is still unsettled. I have served two fishway notices, but no fishways have been put in. The dam of one of the parties notified changed hands, and the new owners positively refuse to put in a fishway. There is only one dam in La Salle county unprovided with a fishway, but a number in my territory, seven in all.

In Kankakee county, where I was appointed, on the Kankakee and Iroquois rivers the law is respected. In La Salle county, where I am now located, we have the Illinois river, Fox river, Big and Little Vermilion rivers.

On the Illinois river, from La Salle down, the law is violated in every possible manner.

REPORT OF STATE FISH WARDEN JOSEPH S. JUDA, COLLINSVILLE, ILL.

Appointed January 28th, 1889. Have notified 200 persons to obey the law. Have taken up no nets. Have made no arrests. Have secured no convictions. Have served no fishway notices. No fishways have been put in. There is one dam at the stockyard unprovided with a fishway, but the dam is low.

The principal waters in our county are Long lake, Horseshoe lake, Cahokia creek, Silver creek, Sugar creek, Wood river, and Choteau slough.

I have expended at least \$25.00 of my own money, besides my time. I cannot well afford to work in that way. I am compelled to catch violators in the act, and that takes time. The violations have diminished since my appointment. No netting going on, but some fish have been killed by the use of dynamite.

REPORT OF STATE FISH WARDEN W. D. HODGSON, NEW BOSTON, ILL.

Appointed May 19, 1890. Have notified seventy-five or more persons regarding fish laws. Have taken up no nets. Have made thirteen arrests and secured seven convictions. Other cases not yet tried, but will be when we can secure the State's Attorney's attention to them. Have served no fishway notices. There are three dams as yet unprovided with fishways in this county. Two are on very small streams, and the other is a very low dam which over flows with three or four feet rise.

Violations are very frequent, though a great deal more seldom than before my appointment. There are but three streams in this county, viz: Edwards river, which runs through Henry and Mercer counties. Pope creek, which runs through this county, and Eliza creek which runs nearly through.

REPORT OF STATE FISH WARDEN J. P. CAMPBELL, BROWNING, ILL.

Date of appointment July 8, 1890. Have notified all fishermen in the county to obey law. Have taken up or removed no nets. Have made no arrests. Have secured no convictions. Have served no fishway notices. No fishways have been put in. There are no dams in the county unprovided with fishways, to my knowledge. The streams in our county are Illinois river and Crooked creek.

REPORT OF STATE FISH WARDEN C. A. WOODRUFF, RIVERSIDE, ILL.

Appointed May 1, 1890. Have notified about twenty persons to obey the law. Have taken up no nets. Have made no arrests. Have secured no convictions. Have served one fishway notice. One fishway to go in by March next. There is one dam in county unprovided with fishway.

Violations along the Des Plaines are diminished since appointment, and all parties seem interested in the protection of fish. I hear of no complaints along the Calumet river in any way.

REPORT OF STATE FISH WARDEN JOHN DICKSON, STERLING, WHITESIDE COUNTY, ILLINOIS.

Was appointed June 6, 1890. Have notified fifteen persons to obey the law. Have taken up no nets. Have made twelve arrests. Have secured eleven convictions. Have served one fishway notice. No fishway put in. There are five dams unprovided with fishways in our county. The violations are somewhat lessened since my appointment. The sale of fish taken by seine has been entirely stopped, in this town. The streams are Mississippi river, Rock creek, Elkhorn creek, Rock river, Sugar creek, Spring creek and Green river.

TRANSPORTATION.

The facilities given us for moving the cars in making our distribution, have been of such liberal character as to deserve more recognition than simple mention. Not only have our cars been hauled free over all roads, but assistance of any kind that would help us in our work has been generously given us at all times, and to the various railroads of this State, more than to anything else, is due the success of our large distribution. And this assistance has not been given grudgingly, but in such a way as to make it almost a pleasure to ask for favors: and the managements have, in a number of instances, been pleased to say that they regard the work as a good one, and of so much bene-

fit to the people at large, that they are not only willing, but take pleasure in rendering us any assistance they can. They have made it possible, by giving free transportation to cars and crews over their lines, to cover a very large portion of our State in our distribution, which we could not have reached, if we had been compelled to pay for such transportation with the small amount of money at our command.

To the employès of the roads, as well, are we indebted for valuable assistance, cheerfully given at all times, and under circumstances, often, that made it an inconvenience to them, in handling our fish, and we are glad to acknowledge our appreciation of their uniform courtesy. To the Chicago, Burlington & Quincy R. R. Co. and the Wabash R. R., are we indebted to a greater extent than to any others, for the reason that we have been compelled to get in and out over their lines almost every trip.

We give herewith a list of the railroads giving us transportation, or otherwise assisting us in our work:

Chicago, Burlington & Quincy R. R.
 Wabash Railroad Co.
 Illinois Central R. R. Co.
 Chicago & Northwestern Ry. Co.
 Chicago, Milwaukee & St. Paul R. R. Co.
 Chicago, Burlington & Northern R. R. Co.
 Louisville, Evansville & St. Louis R. R. Co.
 Cleveland, Cincinnati, Chicago & St. Louis R. R. Co.
 Louisville, New Albany & Chicago Ry.
 Terre Haute & Peoria R. R. Co.
 Toledo, Peoria & Western R. R. Co.
 Chicago, Rock Island & Pacific R. R. Co.
 Rock Island & Peoria R. R. Co.
 Ohio & Mississippi Ry. Co.
 Jacksonville Southeastern R. R. Co.
 Fulton County Narrow Gauge R. R. Co.
 Louisville & Nashville R. R. Co.
 Indiana, Illinois & Iowa R. R. Co.
 St. Louis, Keokuk & Northwestern R. R. Co.
 Hannibal & St. Joseph R. R. Co.
 Wabash, Chester & Western R. R. Co.
 Grand Tower & Carbondale R. R. Co.
 St. Louis Bridge Co.
 Indianapolis, Decatur & Western R. R. Co.
 Chicago & Alton R. R. Co.

ACKNOWLEDGMENTS.

We desire to express our grateful appreciation of the interest taken in our work by the United States Commissioner of Fish and Fisheries, Col. M. McDonald, and the valuable assistance given us in the use of the cars and crews of the Commission, for our distribution of indigenous fish, and to express our thanks for the generous allotment of wall-eyed pike fry for our public waters.

We would also acknowledge our indebtedness to the railroad managements of the State for the generous assistance given us in transporting our cars free, over their lines.

To the employés of the various roads over which cars have worked, for prompt and courteous assistance rendered our messengers, and cheerful compliance with every reasonable request.

To the press of the State for extended and fair notice of our work, and valuable assistance given us in the use of their columns.

And to the various fishing clubs and protective associations of the State for their hearty co-operation, and substantial aid extended us in our work of distribution and propagation.

SUMMARY.

In concluding our report, a brief summary of our work may not be out of place. During the past two seasons, with the assistance of the U. S. Fish Commission and our railroads, we have put into the public waters of this State thousands of breeding fish, not one variety of which was so planted as an experiment, but all indigenous, at one time, to our waters. Already the effect of these plants is noticeable in the largely increased supply of the young of the varieties planted. And the fish planted in the interior streams represent but a very small proportion of the whole number, as the larger streams, along which we worked, are the richer by hundreds of thousands of fish rescued from places where their extinction was as certain as the advancing of the season, if left there.

The distribution of the pike perch, (wall-eyed pike), in our waters has been productive of great results, and the effect of former plants has been practically demonstrated the past two seasons. The fry so generously donated by the U. S. Fish Commission, has been distributed over as wide a range of territory as time and facilities for transporting it safely would permit. The total plant of the two seasons was, 1889, 11,400,000; 1890, 7,178,000; which, if only a small percentage of the fry come to maturity, will give to our waters a very large and valuable amount of food supply.

The carp distribution has not been so large, yet the interest in their culture has assumed proportions that will give greater aggregate results than the indiscriminate experiments of the earlier years of their introduction, since it is based upon an experience which has taught that good results only follow practical methods. The increase of carp in public waters has been marked, and everywhere throughout the State they are taken in fair proportion to the indigenous fish.

The enforcement of the laws regarding fish and fishways shows a remarkable degree of interest in the matter, throughout the State, and it is but fair to presume that a part, at least, of such education of the public sentiment in that direction, has grown out of the work of the Commission.

The appointment of fish wardens has given much needed assistance to the Commissioners, and marks an era in the increase of our natural food supply, worthy of notice.

Taken as a whole we feel that the work has shown results that are, at least, encouraging to those to whom it has been intrusted, and we leave it with the people, for whose benefit we have worked, to judge of its value. It should be its own recommendation, deserving of recognition in substantial appropriation for its further progress, if its practical results commend it as worthy, to them whose duty it is to enact laws for the maintenance of the various interests of the State.

With an appropriation sufficient for all branches of the work, and with some slight modification of the existing laws, the future work of the Commission might be more effective in its results, and more universal in its benefits than ever before.

We would respectfully recommend that section 4 of the fish laws be amended by striking out the clause "but such wardens shall receive no fees except in cases where convictions are obtained." This would enable the Commissioners to pay wardens engaged in enforcing the laws for time used, and expenses incurred. As it now stands, we can not compensate for such service, and as the fines resulting from conviction seldom pay the expense of obtaining the necessary evidence for such conviction, to say nothing of compensation for the time given by the warden to such work, it can readily be seen that it is far from remunerative to these officers. Many of these are men who can not afford to give even their time, without compensation, for this work, and when after days spent in trying to secure evidence, and the expenditure of money necessary for same work, they find that from one or another cause the prosecution of such cases has not been effective, they have nothing to show for their expenditure of time and money but its loss. This is not just nor right, nor do we believe the people expect it of them. The work done can not possibly be of benefit to them, personally, and we do not believe it is public policy, or to the interest of the work itself, to exact from them work, uncompensated. We would recommend the appropriation of a sum sufficient to cover such expense, and make the laws relating to the protection of fish fully operative, and to enable the Commissioners, with them, to patrol the principal rivers of our State, by the use of one or more of our boats, during the entire season.

With this patrol, it would be possible to see that such rivers were free, at all times, from obstructions of nets, etc., and effectually prevent the wholesale violation of the laws that has been common to our waters in the past.

With a sufficient appropriation for this purpose to make the work of the wardens effective, and with as generous appropriations for the other branches of our work as have been given us heretofore, we feel that we can safely promise largely increased results in the seasons to follow.

Respectfully submitted,

N. K. FAIRBANK, *President.*

S. P. BARTLETT, *Secretary.*

GEO. BREUNING,

Commissioners.

APPENDIX.

Recapitulation of Expenditures by Illinois State Fish Commissioners from October 1, 1888, to September 30, 1890.

BILLS OF PARTICULARS AND SUB-VOUCHERS ON FILE WITH THE
AUDITOR.

To amount to credit of Commission, October 1, 1888	\$5,239 15	
" appropriation for 1889	7,500 00	
" earnings steamer "Eagle"	190 00	
	<u>\$12,929 15</u>	
CR.		
By expenditures for October, 1888		\$817 94
" November, 1888		431 36
" December, 1888		233 35
" January, 1889		104 25
" February, 1889		297 60
" March, 1889		408 81
" April, 1889		669 78
" May, 1889		820 86
" June, 1889		878 32
By paid H. W. Rokker		54 00
By expenditures for July, 1889		823 68
" August, 1889		1,021 68
" September, 1889		808 25
	<u>7,370 51</u>	<u>\$7,370 51</u>
To amount to credit of Commission, October 1, 1889	\$5,558 64	
" appropriation for 1890	7,500 00	
" earnings steamer "Lotus"	25 00	
" "Eagle"	40 00	
" amount paid by H. S. Brown 1/2 C. B. & Q. lease	50 00	
	<u>\$13,173 64</u>	
CR.		
By expenditures for October 1889		\$844 82
" November, 1889		744 50
" December, 1889		484 01
" paid C. B. & Q. R. R. lease		100 00
" expenditures for January, 1890		242 00
" February, 1890		230 00
" March and April, 1890		641 20
" May, 1890		549 40
" amount payment on steamer "Lotus"		750 00
" expenditures for June, 1890		748 56
" July, 1890		628 18
" amount payment steamer "Lotus"		500 00
" expenditures for August, 1890		334 87
" September, 1890		385 62
	<u>7,383 16</u>	<u>\$7,383 16</u>
	<u>\$5,790 48</u>	

Appropriation for Personal and Traveling Expenses of the Commission, or such Persons as may be authorized by them in enforcing the Laws relating to Fishways over Dams and for the Protection of Fish.

BILLS OF PARTICULARS AND SUB-VOUCHERS ON FILE WITH THE AUDITOR.

To amount to credit of Commission, October 1, 1888.★	\$2,770 00	
To appropriation for 1889	2,000 00	
	\$4,770 00	
<i>Cr.</i>		
By expenditures for October, 1888		\$123 23
“ November, 1888		219 10
“ December, 1888		100 95
“ January, 1889		43 29
“ February, 1889		62 05
By amount paid Geo. E. Cole		19 00
By expenditures for March, 1889		168 00
“ April, 1889		125 60
“ May, 1889		411 83
“ June, 1889		83 75
“ July, 1889		87 85
“ August, 1889		263 22
“ September, 1889		29 91
	1,737 69	\$1,737 69
	\$3,032 31	
Amount lapsed by limitation	936 12	
To amount to credit of Commission, October 1, 1889	\$2,196 19	
To amount appropriation for 1890	2,000 00	
	\$4,196 19	
<i>Cr.</i>		
By expenditures for October, 1889		\$67 70
“ November, 1889		183 91
“ December, 1889		91 13
“ January, 1890		171 04
“ February, 1890		20 95
“ March and April, 1890		259 72
“ May, 1890		606 12
“ June, 1890		396 50
By amount paid H. T. Brown, Fox River		72 98
By expenditures for July, 1890		372 37
“ August, 1890		340 93
“ September, 1890		31 45
	2,614 80	\$2,614 80
To amount to credit of Commission, October 1, 1890	\$1,571 39	

NOTE.—The amounts expended in May, June, July and August, 1890, include pay-roll of Steamer "Lotus," while patrolling Illinois River, enforcing law, removing nets, etc.

Appropriation for Furnishing, Equipping and Maintaining Office and Storage Boat.

BILLS OF PARTICULARS AND SUB-VOUCHERS ON FILE WITH THE
AUDITOR.

To appropriation office boat.....	\$500 00	
<i>Cr.</i>		
By amount paid for anchors, etc., Nov., 1888.....		\$15 77
“ repairs and one new hull, Aug., 1889.....		130 00
“ furnishing, Sept., 1889.....		21 37
“ safe, desk and repairs, Jan., 1890.....		102 00
“ repairs, Feb., 1890.....		30 50
“ repairs, April, 1890.....		12 00
“ roof and cordage, July, 1890.....		70 55
“ spuds, hull, etc., Aug., 1890.....		59 40
	441 59	\$441 59
To amount to credit Commission, October, 1, 1890.....	\$68 41	

LIST OF FISH COMMISSIONERS OF UNITED STATES AND CANADA.

THE UNITED STATES—

Col. Marshall McDonald, Commissioner	Washington, D. C.
Capt. J. W. Collins, Assistant in charge of Fisheries Division	Washington, D. C.
Richard Rathbone, Assistant in charge of Scientific Inquiry	Washington, D. C.
J. F. Ellis, Superintendent Car Service	Washington, D. C.

ALABAMA—

Col. D. R. Hundley	Madison.
Hon. Chas. S. G. Doster	Prattsville.

ARIZONA—

J. J. Gosper	Prescott.
Richard Rule	Tombstone.
J. H. Taggart, Business Manager	Yuma.

ARKANSAS—

H. H. Rottaken, President	Little Rock.
W. B. Worthen, Secretary	Little Rock.
J. W. Calloway	Little Rock.

(This State has never made an appropriation for Fishculture).

DOMINION OF CANADA—

Hon. John Tilton, Deputy Minister of Fisheries	Ottawa.
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Inspectors of Fisheries for the Dominion of Canada, 1888:

W. H. Rogers	Amherst, N. S.
A. C. Bertram	North Sidney, C. B. N. S.
W. H. Venning	St. John, N. B.
William Wakeman	Gaspé Basin, P. Q.
J. H. Duvay	Alberton, P. E. I.
Thomas Mowat	New Westminster, B. C.
Alex. McQueen	Winnipeg, Man.

Officers in charge of fish breeding establishments:

S. Wilmot, Superintendent of Fishculture	Newcastle, Ont.
Chas. Wilmot, officer in charge	Newcastle Hatchery, Ont.
Wm. Parker	Sandwich, Ont.
L. N. Catellier	Tadoussac, Q.
Philip Vibert	Gaspé, Q.
A. H. Moore	Mag. E. Q.
Alex. Mowat	Ristigouche, Matapedia, P. Q.
A. B. Wilmot	Bedford, N. S.
C. A. Farquharson	Sydney, N. S.
Isaac Sheasgreen	Miramichi, N. B.
Charles McCluskey	St. John River, Grand Falls, N. B.
Henry Clark	Dunk River, P. E. I.
Thomas Mowat	B. C. Hatchery, New Westminster, B. C.

CALIFORNIA—

Joseph Routier	Sacramento.
J. D. Harvey	Los Angeles.

(Commissioner T. J. Sherwood resigned March 15, 1888.)

COLORADO—

G. F. Whitehead	Denver.
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CONNECTICUT—

Dr. Wm. M. Hudson.....	Hartford.
Robert G. Pike.....	Middletown.
James A. Bill.....	Lyme.
(The State has no official superintendent, most of the hatching being done by Henry J. Fenton, Poquonnock.)	

DELAWARE—

Charles Schubert.....	Odessa.
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GEORGIA—

J. H. Henderson.....	Atlanta.
Superintendent:	
Dr. H. H. Cary.....	La Grange.

ILLINOIS—

N. K. Fairbank, President.....	Chicago.
S. P. Bartlett, Secretary.....	Quincy.
Geo. Brouning.....	Centralia.

INDIANA—

W. T. Dennis.....	Richmond.
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IOWA—

E. D. Carlton.....	Spirit Lake.
Superintendent, Ole Bjorenson.	

KANSAS—

S. Fee.....	Wamego.
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KENTUCKY—

Wm. Griffith, President.....	Louisville.
P. H. Darby.....	Princeton.
John B. Walker.....	Madisonville.
Hon. C. J. Walton.....	Mumfordsville.
Hon. John A. Steele.....	Midway.
C. Price.....	Danville.
Hon. J. M. Chambers.....	Independence.
A. H. Goble.....	Catlettsburg.
J. H. Mallory.....	Bowling Green.

MAINE—

E. M. Stillwell.....	Bangor.
Henry O. Stanley.....	Dixfield.
B. W. Counce, Sea and Shore Fisheries.....	Thomaston.

MARYLAND—

Dr. E. W. Humphries.....	Salisbury.
G. W. Delawder.....	Oakland.

MASSACHUSETTS—

E. A. Brackett.....	Winchester.
E. W. Putnam.....	Cambridge.
E. H. Lathrop.....	Springfield.

MICHIGAN—

John H. Bissell.....	Detroit.
(Term expires January 1, 1889.)	
Herschel Whitaker.....	Detroit.
(Term expires January 1, 1891.)	
Joel C. Parker, M. D.....	Grand Rapids.
(Term expires January 1, 1893.)	
Walter D. Marks, Superintendent.....	Paris.
George D. Mussey, Secretary.....	Detroit.
Wm. A. Butler, Jr., Treasurer.....	Detroit.

MINNESOTA—

William Bird.....	Fairmount.
Niles Carpenter.....	Rushford.
Robert Ormsby Sweeny, President.....	St. Paul.
S. S. Watkins, Superintendent.....	Willow Brook, St. Paul.

MISSOURI—

H. M. Garliehs, Chairman	St. Joseph.
J. L. Smith	Jefferson City.
H. C. West	St. Louis.
A. P. Campbell, Secretary	St. Joseph.

Superintendents:

Philip Kopplin, Jr.	St. Louis.
Elias Cottrill	St. Joseph:

NEBRASKA—

William L. May	Fremont.
R. R. Livingston	Plattsmouth.
B. E. B. Kennedy	Omaha.

Superintendent:

M. E. O'Brien	South Bend.
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NEVADA—

W. M. Cary	Carson City.
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NEW HAMPSHIRE—

Geo. W. Riddle	Manchester.
Elliott B. Hodge	Plymouth.
John H. Kimball	Marlborough.

Superintendent of Plymouth and Sunapee Hatcheries:

Com. E. B. Hodge	Plymouth.
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NEW JERSEY—

William Wright	Newark.
Frank M. Ward	Newton.
J. R. Elkinton	Pennsgrove.

NEW YORK—

E. G. Blackford, President	New York.
Gen. R. U. Sherman	New Hartford.
Wm. H. Bowman	Rochester.
A. S. Joline	Tottenville.
Henry Burden	Troy.

Secretary:

E. P. Doyle, Room 311 Potter Building	New York City.
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Superintendents:

Fred Mather	Cold Spring Harbor.
Monroe A. Green	Caledonia.
James H. Marks	Etouningdale.
E. L. Marks	Fulton Chain.
E. F. Boehm	Mill Creek.

Shellfish Commission:

E. G. Blackford, Commissioner; Wm. G. Ford, Engineer; J. W. Merserau, Oyster Protector, 80 Fulton Market, New York.

NORTH CAROLINA—

Wm. J. Griffin, Chairman	Elizabeth City.
J. B. Watson	Englehard.
Wm. T. Cahoon	Bayboro.

OHIO—

C. V. Osborn, President	Dayton.
A. C. Williams, Secretary	Chagrin Falls.
J. C. Hofer	Be laire.
John H. Law	Cincinnati.
Hon. Emory D. Potter	Toledo.

Superintendent:

Henry Douglass	Sandusky.
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Chief Warden:

L. K. Buntain	Dayton.
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OREGON—

F. C. Reed, President	Clackamas.
E. P. Thompson	Portland.
R. C. Campbell	Rainier.

(Terms expire in February, 1889.)

PENNSYLVANIA—

Henry C. Ford, President, 524 Walnut street.....	Philadelphia.
James V. Long, Corresponding Secretary, 75 Fifth avenue	Pittsburg.
H. C. Demuth, Secretary of Board.....	Lancaster.
S. B. Stilwell.....	Scranton.
A. S. Dickson.....	Meadville.
W. L. Powell, Treasurer	Harrisburg.

Superintendents:

John P. Creveling	Allentown.
William Buller	Corry.

RHODE ISLAND—

John H. Barden, President.....	Rockland.
Henry T. Root, Treasurer.....	Providence.
Wm. P. Morton, Secretary.....	Johnston.

SOUTH CAROLINA—

Hon. A. P. Butler.....	Columbia.
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TENNESSEE—

W. W. McDowell.....	Memphis.
H. H. Sneed.....	Chattanooga.
Edward D. Hicks.....	Nashville.

UTAH—

A. Milton Musser.....	Salt Lake City.
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VERMONT—

Herbert Brainard	St. Albans.
F. H. Atherton.....	Waterbury.

VIRGINIA—

Dr. J. T. Wilkins.....	Bridgetown.
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WEST VIRGINIA—

C. S. White, President.....	Romney.
F. J. Baxter, Treasurer.....	Sutton.
James H. Miller, Secretary.....	Hinton.

WISCONSIN—

The Governor, <i>ex-officio</i> .	
Philo Dunning, President.....	Madison.
C. L. Valentine, Secretary and Treasurer.....	Janesville.
Mark Douglas.....	Melrose.
A. V. H. Carpenter.....	Milwaukee.
Calvert Spensley.....	Mineral Point.
E. S. Miner.....	Sturgeon Bay.

Superintendent:

James Nevin.....	Madison.
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WYOMING TERRITORY—

Louis Miller	Laramie.
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LIST OF CARP DISTRIBUTION.

Name.	Location.	No.
Wm. H. Dove	Harisburg, Saline county	25
Gab. Trago	Cisne, Wayne county	26
Jos. Hanke	Trenton, Clinton county	27
B. Roeddler		28
G. I. Cohlmaier	Richview, Washington county	29
Sebastin Wolf	Farina, Fayette county	30
Perry Hill	Virden, Macoupin county	31
M. Young	Arlington, Cook county	32
Martin Casper	Dongola, Union county	33
B. Thompson	Canton, Fulton county	34
J. L. Conway	Preemption, Mercer county	35
C. C. Keune	Carlinville, Macoupin county	36
D. C. Enslow	MeVey, Macoupin county	37
E. J. Enslow		38
E. E. Irwin	Pleasant Plains, Sangamon county	39
Harry Irwin		40
Michael Ruebel	Grafton, Jersey county	41
John Deihle	Martinsville, Clark county	42
B. J. Hobbs	New Burnside, Johnson county	43
J. H. Hobbs		44
Thos. Kennel	Morton, Tazewell county	45
W. H. Neil	Tower Hill, Shelby county	46
J. D. Paige	Joliet, Will county	47
J. G. Felters	LaSalle, LaSalle county	48
E. J. Zimmer	Mount Greenwood, Cook county	49
G. W. Rietz	Kankakee, Kankakee county	50
E. Rietz		51
W. A. Towse	Carlinville, Macoupin county	52
David Hudson	Cowden, Shelby county	53
J. S. Young	Carlinville, Macoupin county	54
G. J. Castle		55
D. Belzer	Lebanon, St. Clair county	56
P. McGuire	Alsey, Scott county	57
Frank Perrin	Mascoutah, St. Clair county	58
J. V. Smith	Hayes, Douglas county	59
L. Weinman	Richton, Cook county	60
Gustave Schubert	Brighton, Macoupin county	61
Wm. Deutche	Richton, Cook county	62
F. Deutche		63
John Schroeder	Huntley, McHenry county	64
Henry Krummer	Brighton, Macoupin county	65
Nichlas Barker	Stanford, McLean county	66
John Schroeder	Huntley, McHenry county	67
L. Burke	Golden, Adams county	68
H. G. Whitehouse	Litchfield, Montgomery county	69
A. Newton	Cuba, Fulton county	70
C. J. Pfeffer	Lebanon, St. Clair county	71
Madison Koontz	La Prairie, Adams county	72
H. P. Bozarth	Omaha, Gallatin county	73
T. W. Thacker	Nilwood, Macoupin county	74
J. D. Miller	Carthage, Hancock county	75
Phil Pastal	Mascoutah, St. Clair county	76
J. H. Burnett	Wrightsville, Greene county	77
Eli Cook	Martinsville, Clark county	78
Eli M. Farland		79
Caleb Baird		80
Jas. M. Hill		81
Chris. Schmidt	Red Bud, Saline county	82
J. T. McCaffney		83
Melle Bros		84
Anton Hengle		85
J. B. Mathew	M. Auburn, Christian county	86
John Diek	Quincy, Adams county	87
Wm. Stillman	Bensonville, DuPage county	88
Diedrich Schmidt		89
Aug. D. Schmidt	Manheim, McLean county	90
W. B. Hewitt	Chicago, Cook county	91

Carp Distribution—Continued.

Name.	Location.	No.
Jos. Huber.....	Peoria, Peoria county.....	30
M. V. Taylor.....	Barkley, Sangamon county.....	30
W. H. Cline and ten others.....	Woodstock, McHenry county.....	275
J. A. Kirby.....	Kenney, DeWitt county.....	20
D. A. Schmidt.....	Manheim, Cook county.....	20
Ed. Ehlers.....	.....	20
Jos. Hunke.....	Trenton, Clinton county.....	20
B. Riddler.....	.....	25
John W. Warren.....	Poplar Grove, Boone county.....	25
Wahl Bros.....	Chicago, Cook county.....	25
Edgar Morris.....	Danville, Vermilion county.....	20
J. E. Brady.....	Toulon, Stark county.....	25
J. E. Brady.....	.....	25
J. N. Hornbeck.....	Lakewood, Shelby county.....	25
Leon S. Dorsey.....	Moro, Madison county.....	25
J. C. Armantrout.....	Gays, Moultrie county.....	25
Jas. Langston.....	.....	25
Chas. Zeigler.....	Cowden, Shelby county.....	25
D. W. Bellamy.....	Vienna, Johnson county.....	25
Jas. W. Johnson.....	Arcadia, Morgan county.....	25
C. B. Dorsey.....	Moro, Madison county.....	25
H. E. Dorsey.....	.....	25
S. E. Dorsey.....	.....	25
B. F. Bowler.....	.....	25
L. Bowler.....	.....	25
C. Bowler.....	.....	25
M. B. Mitchell.....	.....	25
Rilla Bowler.....	.....	25
S. H. Moffett.....	Kansas, Edgar county.....	25
Sam Burke.....	Golden, Adams county.....	25
D. D. Parkinson.....	Willow, Jo Daviess county.....	20
John Kramer.....	Brighton, Macoupin county.....	20
Y. Fisher.....	Geneseo, Henry county.....	25
Y. Fisher.....	.....	25
Chas. Manning.....	Ellery, Stephenson county.....	25
Chas. Manning.....	.....	25
Geo. Roberts.....	Mt. Pulaski, Logan county.....	25
Ernst Tosette, B. Co.....	Chicago, Cook county.....	25
T. R. McDonald.....	Mt. Sterling, Brown county.....	25
N. V. Crissey.....	Avon, Fulton county.....	25
Andrew Seiter.....	Lemont, Cook county.....	25
Judge J. B. Crowley.....	Robinson, Crawford county.....	25
Henry Warfield.....	Thompson, Carroll county.....	25
Shelton Thompson.....	Cowden, Macoupin county.....	25
Geo. Rasmeyer.....	Henry, Marshall county.....	25
Jas. Mushrush.....	Chauncey, Lawrence county.....	25
J. R. Penneman.....	Libertyville, Lake county.....	25
S. D. Parkinson.....	Willow, Jo Daviess county.....	25
A. Cover.....	Tunnel Hill, Johnson county.....	25
Jacob Zeh.....	Notia, Hancock county.....	25
E. G. Reitz.....	Kankakee, Kankakee county.....	25
J. E. Hart.....	Palmyra, Macoupin county.....	25
W. H. Cook.....	Jerseyville, Jersey county.....	25
R. B. Rutherford.....	Maltoon, Coles county.....	25
John H. Warren.....	Poplar Grove, Boone county.....	25
Ira Webster.....	.....	25
T. T. Wheeler.....	.....	25
Wm. Redinhorn.....	Vienna, Johnson county.....	25
Thos. Utley.....	.....	25
J. C. Bellamy.....	.....	25

LIST OF APPLICANTS FOR CARP IN ILLINOIS, SUPPLIED
BY THE U. S. FISH COMMISSION, IN 1890.

Name.	Location.	No.
O. G. Forrer.....	Belvidere.....	150
John W. Warren.....	Poplar Grove, Boone county.....	30
Ira A. Webster.....	.....	30
T. T. Wheeler.....	.....	30
Joshua Ackers.....	Mattoon, Coles county.....	30
J. G. Bodenschatz.....	Lemont, Cook county.....	30
George N. Parker.....	Robinson, Crawford county.....	30
A. D. McCallen.....	Effingham, Effingham county.....	30
John J. Sidwell.....	Brownstown, Fayette county.....	30
J. G. Holland.....	Belle Rive, Jefferson county.....	30
D. C. Holland.....	.....	30
W. P. Wheeler.....	.....	30
J. H. Wheeler.....	.....	30
Marie P. Mitchell.....	Mt. Vernon,	30
James A. Stone.....	Bradfordtown, Sangamon county.....	30
W. H. Dove.....	Harrisburg, Saline county.....	30
S. K. Deans.....	Lincoln Green, Johnson county.....	30
R. D. Erickson.....	Princeville, Peoria county.....	30
J. G. Genter.....	Wokena, Will county.....	30
Samuel W. Parris.....	Alto Pass, Union county.....	30
Wm. Carey.....	Winchester, Scott county.....	30
E. D. Herbert.....	Freeport, Stephenson county.....	30
Joseph Backer.....	Trenton, Clinton county.....	30
L. Rieman.....	.....	30
John Roedler.....	.....	30
D. Noonan.....	Morrisonville, Christian county.....	30

STREAMS CROSSED BY RAILROADS IN THE STATE.

Streams crossed by Chicago, Burlington & Quincy Railroad in Illinois.

Points on Railroad.	Streams.	County.
Chicago to Burlington.....	Chicago River	Cook
	DesPlaines River.....	"
	Salt Creek	"
	East DuPage River.....	DuPage
	West	"
	St. Jo Run.....	"
	Indian Creek.....	"
	Fox River.....	Kane
	Blackberry Creek	Kendall
	Rob Roy Creek	"
	Big Rock Creek	"
	Little Rock Creek	"
	Somonauk Creek.....	DeKalb
	Little Indian Creek.....	"
	Main Bureau.....	LaSalle
Coal Creek	Bureau	
Pilot Creek.....	Knox	
Henderson River.....	Henderson	
<i>Geneva Branch.</i>		
Aurora to Geneva.....	Mills Creek.....	Kane
	Nelson Lake	"
	Head of Blackberry Creek.....	"
<i>Fox River Branch.</i>		
Aurora to Streator.....	Fox River	Kendall
	Illinois River.....	LaSalle
	Indian Creek	"
	Buck Creek	"
	Covil Creek	"
	DuPage River.....	DuPage
<i>Rock Falls Branch.</i>		
Shabbona to Sterling	Blackberry Creek	Kane
	Big Rock Creek	"
	Squaw Creek	DeKalb
	Somonauk Creek	"
	Green River.....	Lee
	Rock River.....	Whiteside
	Elkhorn Creek.....	"
	Rock Creek	"
<i>Clinton Branch.</i>		
Mendota to Fulton	Main Bureau.....	Bureau
	Pike Creek.....	"
	Walnut Creek.....	"
	Spring Creek	Whiteside
	Big Rock Creek.....	"
	Little Rock Creek	"

Streams Crossed—Continued.

Points on Railroad.	Streams.	County.
<i>Rushville Branch.</i>		
Buda to Rushville.....	Coal Creek.....	Bureau.....
	Spoon River.....	Stark.....
	Cooper's Creek.....	Peoria.....
	Nile Creek.....	Schuyler.....
	Sugar Creek.....	Fulton.....
	Spudaway Creek.....	
	Otter Creek.....	
<i>Peoria Branch.</i>		
Peoria to Galesburg.....	Spoon River.....	Knox.....
	French Creek.....	Peoria.....
	Nile Creek.....	
	Kickapoo Creek.....	
<i>Quincy Branch.</i>		
Galesburg to Quincy.....	Cedar Creek.....	Knox.....
	Centre Creek.....	McDonough.....
	Kepple Creek.....	".....
	Crooked Creek.....	".....
	Flour Creek.....	".....
	Bear Creek.....	".....
<i>Keithsburg Branch.</i>		
Galva to Gladstone.....	Edward's Creek.....	Henry.....
	West Mud Creek.....	".....
	Edward's River.....	Mercer.....
	Henderson's River.....	Henderson.....
<i>Hannibal & Louisiana Branch.</i>		
Quincy to Hannibal and Fall Creek to Louisiana.....	Mill Creek.....	Adams.....
	Pigeon Creek.....	Pike.....
	Hadley Creek.....	".....
	McCramy Creek.....	".....
	Kaiser Creek.....	".....
	Dutch Creek.....	".....
(Near Hannibal).....	Sny Ecarte.....	".....
(Near Rockport).....		".....
<i>Carthage Branch.</i>		
Burlington to Quincy.....	Bear Creek.....	Hancock.....
	Rock Creek.....	Adams.....
	Panther Creek.....	Hancock.....
<i>St. Louis Division.</i>		
East St. Louis to Rock Island.....	Rock River.....	Rock Island.....
	Edward's River.....	Henry.....
	Pope Creek.....	Knox.....
	N. Henderson Creek.....	".....
	Middle Henderson Creek.....	Warren.....
	Cedar Creek.....	".....
	Sugar Creek.....	".....
	Swan Creek.....	".....
	Illinois River.....	Cass.....
	Mauvaisterre Creek.....	Scott.....
	Indian Creek.....	Cass.....
	Big Sandy Creek.....	Scott.....
	Apple Creek.....	Green.....
	Taylor Creek.....	".....
	Macoupin Creek.....	Jersey.....
	Wood River.....	Madison.....

Streams crossed by Chicago & Alton Railway in Illinois.

Streams.	Points on Railroad.	County.
Kankakee River.....	Near Wilmington.....	Will.....
Mackinaw River.....	Lexington.....	McLean.....
Salt Creek.....	Lincoln.....	Logan.....
Kickapoo Creek.....	Lawndale.....	.....
Sangamon River.....	Springfield.....	Sangamon.....
Maconpin Creek.....	Maconpin.....	Maconpin.....
Wood River.....	Alton.....	Madison.....
Long Lake.....	Mitchell.....	.....
Kahokia Creek.....	E. St. Louis.....	St. Clair.....
Maconpin Creek.....	Riverdale.....	Greene.....
Sangamon River.....	Petersburg.....	Menard.....
Illinois River.....	At Pearl.....	Pike.....
Vermilion River.....	Pontiac.....	Livingston.....

Streams crossed by Illinois Central Railroad in Illinois.

CHICAGO TO MAIN LINE JUNCTION.

Streams.	Points on Railroad.	Towns.
North Calumet River.....	Near.....	Riverdale.....
South Calumet River.....	At.....	South Lawn.....
Kankakee River.....	At.....	Kankakee.....
Bushy Creek.....	Near.....	Neoga.....
Green Creek.....	.....	Sigel.....
Little Wabash River.....	.....	Mason.....
Dismal Creek.....	.....	Laclede.....

Cairo to East Dubuque.

Lower Cache.....	1 mile north of.....	Mounds.....
Upper Cache.....	At.....	Ulm.....
Drury Creek.....	.....	Waukanda.....
Drury Creek.....	$\frac{1}{4}$ mile north of.....	Waukanda.....
Big Muddy River.....	2 miles north of.....	DeSoto.....
Little Muddy River.....	2 miles north of.....	DuBois.....
Crooked Creek.....	$\frac{3}{4}$ mile north of.....	Central City.....
E. Fork Kankaskia River.....	1 miles north of.....	Patoka.....
N. Fork Kankaskia River.....	$1\frac{1}{2}$ miles north of.....	.....
Flat Creek.....	1 mile north of.....	Vernon.....
Branch of Kankaskia.....	2 miles north of.....	Shabonier.....
Hickory Creek.....	$2\frac{3}{4}$ miles south of.....	Vandalia.....
Bear Creek.....	$1\frac{3}{4}$ miles south of.....	Vera.....
Ramsey Creek.....	$1\frac{3}{4}$ miles south of.....	Ramsey.....
Ash Creek.....	$2\frac{1}{2}$ miles south of.....	.....
Opossum Creek.....	$3\frac{1}{4}$ miles north of.....	Ocoonee.....
Coal Creek.....	$1\frac{1}{2}$ miles south of.....	Pana.....
Trauber Creek.....	$1\frac{1}{2}$ miles north of.....	Moweaqua.....
Sangamon River.....	$1\frac{1}{2}$ miles south of.....	Deatur.....
Salt Creek.....	$3\frac{1}{2}$ miles south of.....	Clinton.....
Kickapoo Creek.....	1 mile north of.....	Heyworth.....
Sugar Creek.....	1 mile north of.....	Bloomington.....
Mackinaw River.....	1 mile south of.....	Kappa.....
South Panther Creek.....	$1\frac{1}{2}$ miles south of.....	Panola.....
North Panther Creek.....	$1\frac{1}{2}$ miles north of.....	Panola.....
South Fork Sandy Creek.....	$1\frac{1}{2}$ miles south of.....	Wenona.....
North Fork Sandy Creek.....	$2\frac{3}{4}$ miles south of.....	Wenona.....
Illinois River.....	At.....	LaSalle.....
Bureau Creek.....	$\frac{3}{4}$ miles south of.....	Sublette.....
Inlet Creek.....	$\frac{1}{4}$ mile south of.....	Amboy.....
Rock River.....	$\frac{1}{2}$ mile north of.....	Dixon.....
Buffalo Creek.....	$\frac{1}{2}$ mile north of.....	Polo.....
Leaf River.....	2 miles north of.....	Forreston.....
Yellow Creek.....	2 miles south of.....	Preepert.....
Preston's Creek.....	3 miles north of.....	.....
Apple Creek.....	$1\frac{1}{2}$ miles north of.....	Apple River.....
E. Fork Galena River.....	1 mile east of.....	Council Hill.....
E. Fork Galena River.....	$2\frac{3}{4}$ miles west of.....	.....
Galena River.....	At.....	Galena.....
Sinsinway River.....	$1\frac{1}{2}$ miles east of.....	Monominee.....
Little Monominee River.....	At.....	.....
Big Monominee River.....	4 miles west of.....	.....

Streams Crossed.—Continued.

Streams.	Points on Railroad.	Towns.
<i>Middle Division from Chicago.</i>		
Vermilion River.....	1½ miles north of.....	Charlotte.....
Vermilion River.....	1½ miles west of.....	Pontiac.....
<i>From Springfield.</i>		
Sangamon River.....	Near.....	Springfield.....
Salt Creek.....	1¾ miles north of.....	Kennett.....
Salt Creek.....	3 miles south of.....	DeWitt.....

Streams crossed by Peoria, Pekin & Jacksonville Railway in Illinois.

Kickapoo Creek.....	3½ miles south of.....	Pekin.....
Illinois River.....	At.....	".....
Lost Creek.....	2 miles south of.....	".....
Mackinaw River.....	2 miles south of.....	Grand Bluff.....
Mud Creek.....	2 miles south of.....	Pekin.....
Quiver Creek.....	1¼ miles south of.....	Topeka.....
Sangamon River.....	1¼ miles north of.....	Chandler'sville.....
Little Indian Creek.....	1¼ miles south of.....	Little Indian.....
Big Indian Creek.....	1¼ miles south of.....	Petersburg.....
Mauvaisterre Creek.....	1 mile north of.....	Jacksonville.....

Streams Crossed by Wabash, St. Louis & Pacific Railway in Illinois.

Little Wabash River.....	Between Shumway and.....	Efingham.....
Okaw River.....	" Windsor.....	Bruce.....
Vermilion River.....	" Pontiac.....	Dorrell.....
Kankakee River.....	" Essex.....	Ritchie.....
Forked Creek.....	" Ritchie.....	Symerton.....
Horse Creek.....	" Essex.....	Ritchie.....
Hickory Creek.....	" New Lenox.....	Marley.....
Salt Creek.....	East of.....	Clinton.....
Sangamon River.....	Between Sangamon.....	Decatur.....
" ".....	" Riverton.....	Springfield.....
" ".....	" Decatur.....	Boody.....
" ".....	" Monticello.....	Lodge.....
" ".....	" Woods.....	White Heath.....
" ".....	" Monticello.....	Argenta.....
" ".....	" Taylor.....	Clarksdale.....
Illinois River.....	At.....	Meredonia.....
Hadley Creek.....	Between Barry and.....	Valley City.....
Shoal Creek.....	" Raymond.....	Kinderhook.....
Kahoka Creek.....	Near.....	Honey Bend.....
		Edwardsville.....

Streams Crossed by Ohio & Mississippi Railway in Illinois.

Wabash River.....	At.....	Vincennes.....
Embarras River.....	1 mile east of.....	Lawrenceville.....
Little Wabash River.....	1 mile east of.....	Clay City.....
Kaskaskia River.....	At.....	Carlyle.....
<i>Springfield Division.</i>		
Illinois River.....	At.....	Beardstown.....
Spring Creek.....	3 miles south of.....	Springfield.....
South Fork of Sangamon.....	2 miles northwest of.....	Rocheater.....
Flat Branch.....	1½ miles southeast of.....	Taylorville.....
Okaw River.....	2 miles southeast of.....	Cowden.....
Skillet Fork.....	1½ miles south of.....	Mill Shoal.....

Streams Crossed by Peoria, Decatur & Evansville Railway in Illinois.

Streams.	Points on Railroad.	Towns.
Illinois River.....	At	Peekin.....
Mackinaw River.....	8 miles south of.....	“.....
Sugar Creek.....	5 miles northwest of.....	Lincoln.....
Kickapoo Creek.....	2 miles northwest of.....	“.....
Salt Creek.....	3 miles south of.....	Mt. Pulaski.....
Sangamon River.....	1 mile south of.....	Decatur.....
Okaw (W. Fork) River.....	5 miles northwest of.....	Sullivan.....
Okaw (E. Fork) River.....	3 miles southeast of.....	Sullivan.....
Embarrass River.....	At	Greenup.....
Embarrass River.....	At	Grayville.....
Wabash River.....	At	Newton.....

Streams Crossed by Lake Erie & Western Railway in Illinois.

Kickapoo River.....	In.....	Sangamon County.....
Sangamon River.....	“.....	“.....
West Fork Vermilion.....	“.....	Ford.....
North Fork Vermilion.....	“.....	Vermilion.....

Streams Crossed by Chicago & Northwestern Railway in Illinois.

Rock River.....	.....	.....
Fox River.....	.....	.....
DesPlaines River.....	At.....	Maywood.....
DuPage River.....	1½ miles west of.....	Winfield.....
West Kishwaukee River.....	At.....	DeKalb.....
Elkhorn River.....	1 mile west of.....	Galt.....
East Kishwaukee River.....	At.....	C. Valley.....
Nippersink River.....	3 miles south of.....	Richland.....
Pecatonica River.....	At.....	Freeport.....

Streams Crossed by Illinois, Bloomington & Western Railway in Illinois.

Vermilion River.....	At.....	Danville.....
Salt Fork.....	.....	Oakwood.....
Mid Fork Vermilion.....	Near.....	Danville.....
Sangamon River.....	At.....	Mahomet.....
Mackinaw River.....	“.....	Mackinaw.....
St. Joseph's River.....	“.....	St. Joseph.....

Streams Crossed by Chicago & E. Illinois Railway in Illinois.

Streams.	Points on Railroads.	Towns.
Calumet River	1 mile north of	Dalton
Calumet River	2 miles south of	
Kankakee River	At	Momence
Iroquois River		Watseka
Sugar Creek	Between Watseka and	Woodland
Little Vermilion	2 miles south of	Danville

Streams Crossed by the Jacksonville Southeastern Railway in Illinois.

Shoal Creek	In	Bond County
Kankakee .....	.....	Clinton County

MISSISSIPPI RIVER AND ITS TRIBUTARIES WHOLLY OR PARTLY
WITHIN THE STATE OF ILLINOIS.

<i>Ohio River.</i>	<i>Illinois River.</i>	<i>Rock River.</i>
<i>Big Muddy River.</i>	<i>Fox River,</i>	<i>Plum River.</i>
<i>Kaskaskia River.</i>	<i>Henderson River.</i>	<i>Apple River.</i>
<i>Mary's River.</i>	<i>Edwards River.</i>	<i>Sny Ecarte River.</i>

CREEKS TRIBUTARY TO MISSISSIPPI RIVER:

Clear Creek.
Fountain Creek.
Cahokia Creek.
Piasa Creek.
Kiset Creek.
Mill Creek.
Rock Creek.
Bear Creek.
Honey Creek.
Dugout Creek.
Cedar Creek.
Ursa Creek.
Pope Creek.
Eliza Creek.
Copper Creek.
Johnson Creek.
Big Rush Creek.
Small Pox Creek.

TRIBUTARIES TO OHIO RIVER.

Saline River.
North Fork of Saline River.
South Fork of Saline River,
Embarras River.

TRIBUTARY TO BIG MUDDY RIVER.

Kingkaid Creek.
Beaucoup Creek.
Pipe Stone Creek.
Galum Creek.
Little Beaucoup Creek.
Swanwick Creek.
Locust Creek.
Painter Creek.
Big Crab Orchard Creek.
Crab Orchard Creek.
Little Muddy River.
Carson Creek.

Middle Fork of Big Muddy River.
 Ewings Creek.
 Gum Creek.
 Casey Fork.
 Atchinson's Fork.
 Ray's Creek.

TRIBUTARIES TO KASKASKIA RIVER.

Nine Mile Creek.
 Plumb Creek.
 Silver Creek.
 East Fork.
 Big Muddy Creek.
 Elk Horn Creek.
 Sugar Creek.
 Shoal Creek.
 Beaver Creek.
 Flat Branch.
 East Fork of Shoal Creek.
 Dry Creek.
 Middle Fork of Shoal Creek.
 West Fork of Shoal Creek.
 Crooked Creek.
 Lost Creek.
 Great Point Creek.
 Prairie Creek.
 Coles Creek.
 Gibbs Creek.
 East Fork Kaskaskia River.
 Bear Creek.
 Hurricane Creek.
 Hickory Creek.
 Camp Creek.
 Booz Creek.
 Suck Creek.
 Big Creek.
 Beck's Creek.
 Richland Creek.
 Brush Creek.
 Robinson Creek.
 Sand Creek.
 West Fork of Kaskaskia River.
 Apple Creek.
 Lake Fork.

TRIBUTARIES TO ILLINOIS RIVER:

Otter Creek.
 Macoupin Creek.
 Taylor's Creek.
 Joe's Creek.
 Solomon's Creek.
 Otter Creek.
 Bear Creek.
 Honey Creek.
 Apple Creek.
 Big Grassy Lake.
 Big Sandy Creek.
 Little Sandy Creek.
 Walnut Slough.
 Bay Creek.
 Mauvaisterre Creek.

McKie's Creek.
 Willow Creek.
 Indian Creek.
 Prairie Creek.
 Crooked Creek.
 Little Missouri Creek.
 Cedar Creek.
 Grindstone Creek.
 Carter's Creek.
 Camp Creek.
 Troublesome Creek.
 Panther River.
 Bronson's Creek.
 Middle Creek.
 Long Creek.
 North Branch of Crooked Creek.
 Spring Creek.
 Sangamon River.
 Big Panther Creek.
 Clary's Creek.
 Crane Creek.
 Salt River.
 Prairie Creek.
 Sugar Creek.
 Kickapoo Creek.
 Deer Creek.
 Salt Creek.
 North Branch Salt Creek.
 Lake Fork Salt Creek.
 Rock Creek.
 Spring Creek.
 Lick Creek.
 Sugar Creek.
 Brush Creek.
 South Fork.
 Bear Creek.
 Flat Branch.
 Lake Fork.
 Willow Branch.
 Goose Creek.
 Camp Creek.
 Madden Creek.
 Stevens Creek.
 Otter Creek.
 Spoon River.
 Big Creek.
 Putnam Creek.
 Coal Creek.
 Cedar Creek.
 Swan Creek.
 French Creek.
 Sugar Creek.
 Walnut Creek.
 Quiver Creek.
 Bucklin Creek.
 Mackinaw Creek.
 Mill Creek.
 Walnut Creek.
 Panther Creek.
 Northwestern Branch Mackinaw River.
 East Branch.
 Six-Mile Creek.
 Honey Creek.
 Bray's Creek.

Henline Creek.
 Kickapoo Creek.
 Richland Creek.
 Crow Creek.
 North Branch of Crow Creek.
 South Branch of Crow Creek.
 Strawn's River.
 Crow Creek.
 Sandy Creek.
 Clear Creek.
 Big Bureau Creek.
 West Bureau Creek.
 Negro Creek.
 Vermilion River.
 Wolf Creek.
 Otter Creek.
 Scattering Point Creek.
 Rook's Creek.
 South Fork Vermilion River.
 North Fork Vermilion River.
 Covel Creek.
 Fox River.
 Big Indian Creek.
 Indian Creek.
 Mission Creek.
 Somonauk Creek.
 Battle Creek.
 Blackberry Creek.
 Fox Lake.
 Squaw Creek.
 Nippersink Lake and Creek.
 Nettle Creek.
 Waupcan Creek.
 Mazon River.
 West Fork of Mazon River.
 East Fork of Mazon River.
 Gooseberry Creek.
 Au Sable Creek.
 Saratoga Creek.
 Kankakee River.
 Prairie Creek.
 Forked Creek.
 Rock Creek.
 Iroquois River.
 Sangamon River.
 Prairie Creek.
 Spring Creek.
 Sugar Creek.
 Exline Slough.
 Trim Creek.
 DuPage River.
 Lilly Cache River.
 West Branch of DuPage River
 Jackson's Creek.
 Des Plaines River.
 Calumet River.
 Little Calumet River.
 Salt Creek.
 Mill Creek.

TRIBUTARIES TO ROCK RIVER:

Mill Creek.
 Greene River.
 Mineral Creek.
 Spring Creek.
 Mud Creek.
 Coal Creek.
 Hickory Creek.
 Willow Creek.
 Rock Creek.
 Little Creek.
 Sugar Creek.
 Spring Creek.
 Elkhorn Creek.
 Five-Mile Creek.
 Three-Mile Creek.
 Pine Creek.
 Clear Creek.
 Kite River.
 Leaf River.
 Kishwaukee River.
 Piasa Creek.
 Coon Creek.
 Rush Creek.
 North Branch of Kent's Creek.
 Pecatonica River.
 Rock Run.
 Pillow Creek.
 Sugar Creek.
 Otter Creek.

TRIBUTARY TO HENDERSON RIVER:

Cedar Creek.

TRIBUTARIES TO EDWARDS RIVER:

Camp Creek.
 East Branch.
 West Branch.

TRIBUTARY TO APPLE RIVER:

Irish Hollow Creek.

CORRESPONDENCE RELATIVE TO ENFORCING THE FISH AND FISHWAY LAWS.

LINCOLN, ILL., Nov. 10, 1890.

S. P. Bartlett, Secretary Illinois State Fish Commission:

DEAR SIR—After receiving my commission as a State Fish Warden in this county, and within a week of qualifying, had the pleasure of convicting five men who had seined in Salt Creek, making hauls of fish to the amount of four hundred pounds. The case was hotly contested, on both sides, but the jury brought in a verdict of guilty, assessing a fine of ten dollars, which added to the costs made it twenty dollars each had to pay. Not having a desire to hold the office of warden for revenue only, I remitted to each of the men the one-half of the fine coming to me, believing it to be the best for the cause to do so.

I have had no occasion to regret my action, as I have been informed that there would be no more seining in that camp.

Some of the wealthy farmers over whose farms the creeks flow felt disposed at first to be ugly, and protested that their private rights were interfered with: that seining was one of the appurtenances and hereditaments appertaining and belonging to their real estate. Avoiding open rupture by moral suasion, I have succeeded in allaying rebellious feelings, and think that the majority will submit to the law. Those who do not *must*, if I detect them violating it.

In regard to the litigation against the Lincoln Water Works for erecting a dam across Salt Creek, I would say that they have put in the prescribed fishway. Generally there is a disposition to comply with the fish laws, and the fact that a Fish Warden has been appointed has much to do with it.

Yours respectfully,

L. C. SCHWERDTFEGER.

CHARLESTON, ILL., Sept. 22, 1890.

S. P. Bartlett, Esq., Quincy, Ill.:

DEAR SIR—We had a trial last Friday of a man who was with a party of netters, and secured conviction. We have had two plead guilty, and this makes the third one. Have others on the string, and think that there will be no more trials, but that all will plead guilty.

I think our plan to take them one at a time and make the balance of the party witnesses and compel them to testify, a good one, and would suggest that you advise other associations to practice it.

Notwithstanding violations of the law, a good many fish are being caught. Parker, Ficklin, Chilton and myself were down yesterday and caught 58 fish, mostly bass, some croppie, goggle-eye, and catfish, among

them a blue catfish weighing seven pounds. I think we have got the violaters scared now, and that next season we will have splendid fishing.

Awaiting your commands, am very truly yours,

WEISS WOOLEN CO.

per OTTO WEISS, *Pres.*

CHARLESTON, ILL., April 3, 1890.

S. P. Bartlett, Esq., Quincy, Ill.:

DEAR SIR—Our club recommends F. M. Parker as Fish Warden. He fishes a great deal and will make a good officer. Will you have the kindness to recommend his appointment to the governor and have his commission here soon as possible. The pamphlets received all right, and am distributing them. Our club offers fifty dollars reward for conviction for seining, netting or trapping, and one hundred dollars for using trammel nets. I believe that we can stop it this season entirely. Please notify us a few days ahead when pike will be here, so we can look after them.

Yours truly,

OTTO WEISS, *Sec'y.*

CHARLESTON, ILL., May 10, 1890.

S. P. Bartlett, Esq., Quincy, Ill.:

DEAR SIR—Mr. F. P. Hagan arrived yesterday at 2 P. M. with the wall-eyed pike in excellent condition, and we got them safely into the river. Your allowance to us was a very liberal one, and our members are very grateful for them, and wish me to thank you for them, and say that if we can be of service to you to command us. We will make inquiries about the Newton dam and advise you. There are a good many fish being caught, and many more croppie then before. We attribute this largely to your plants, and partially to absence of trammel-nets.

I will write to towns along our river, and endeavor to get them to organize. Have written to Joseph Ryan, of Greenup, Ill., an attorney and fisherman, on this subject. Always ready to be of service to you, I am,

Yours truly,

OTTO WEISS, *Sec'y.*

GRIGGSVILLE, ILL., Aug. 2, 1890.

S. P. Bartlett, Esq.

DEAR SIR—I had a case at Shepherd, a few day ago, for violation of the fish law. The State's Attorney failed to appear, or send any one to prosecute for me. The parties had counsel and demanded a jury. The jury was composed entirely of fishermen, and discharged the defendant. They then had me arrested for disturbing the peace in making the arrest. My trial is set for one o'clock Monday, August 4th, at Shepherd, and I want you to meet me there at that time with counsel.

I want to see you on other business, also.

CLARK BLACKWELL.

STERLING, ILL., Nov. 9, 1890.

S. P. Bartlett, Quincy, Ill.:

DEAR SIR—Yours of Sept. 18 was duly received. In reply will say I went down to Henry county, and prosecuted the parties I spoke of in my letter. They plead guilty, and were fined ten dollars and costs. I have more to follow. I have the warrants out for three more I caught a week ago, and I have still others awaiting the State's Attorney's attention. I

have had prosecutions in his hands, but have not been able to get him to prosecute, but probably will after court adjourns, which I think will be this week.

I enclose some clippings. I think I have got this illegal seining pretty well broken up. After we have had a few more convictions I think there will not be much more seining done in Rock river.

Yours truly,

JOHN DICKSON, *Fish Warden.*

NOBLE, ILL., Oct. 22, 1890.

S. P. Bartlett, Quincy, Ill.:

DEAR SIR—I received my commission as Fish Warden on Saturday, 25th. The law is being violated every day in this and Wayne county, in the Little Wabash river. It is full of fish traps and nets, and some of the parties say there is no law to make them take their traps out. They claim they own the river that runs through their land. These traps extend the entire width of the river, and fish can not pass without being caught.

Please instruct me what steps to take in regard to this matter at your earliest convenience.

Yours respectfully,

J. E. STEVENS.

VIRGINIA, ILL., Sept. 23, 1890.

S. P. Bartlett, Quincy, Ill.:

DEAR SIR—Through Senator Leeper I received my commission as Fish Warden, for which allow me to thank you in behalf of fish protecting people of our county. There is a chain of lakes on each side of the Sangamon river, which Beardstown and Mason county fishermen have been in the habit of seining contrary to law. I have prosecuted six of the parties successfully, and I have hopes of the business being stopped in the lakes in this particular vicinity.

The place where the most trouble will be is above and below Beardstown. I am informed there are seines and nets in several of the lakes there, and I think it would be a good idea to make a raid on them sometime soon, then I don't think there will be much more trouble with them.

I would like to have your idea as to the best way to proceed in the matter, as I am new in the field.

Yours respectfully,

H. H. TURNER.

GENEVA, ILL., 2, 1890.

S. P. Bartlett, Quincy, Ill.:

DEAR SIR—I am here investigating the destruction of fish by the Pope Mfg. Co. This company has been shut down for several months, but started up about two weeks ago, and yesterday at Batavia, three miles below here, the fish commenced to die by the thousands, so that to-day they have taken from the river four wagon loads, and there are thousands between here and there dead now. I went to see Mr. Pope, Jr., to-night, and he said that they had put nothing in the river but the corn after the gluten had been extracted, and he did not think that could have killed the fish. But I have been along the river above here, and there

are no dead fish above, and the water is covered below with them, so it must be that, and no other cause. They will have to be stopped or no fish will get up the river above this place. I return to the lakes in the morning, and would like to have you investigate this, as it is of a very serious nature.

Yours respectfully,

F. L. BUCK, *Fish Warden.*

PULLMAN, ILL., September 25, 1890.

S. P. Bartlett, Esq., Quincy, Ill.

DEAR SIR—I am pleased to report that I am having good luck so far, have taken seven nets, and have them locked up, and have posted notice. Yesterday I found an owner for one of them. He has offered to plead guilty to save expense. Will you please send me a few copies of the fish law? What can I do to the distilleries that are killing the fish along the Calumet river?

Yours truly,

CHAS. T. BRONSON.

PULLMAN, ILL., November 8, 1890.

S. P. Bartlett, Quincy, Ill.

DEAR SIR—Since my last report to you I have made three arrests, taken up ten nets, and have now twenty-three nets stowed away.

Today I discovered three men with gill nets, and lowered my boat to get them, but they got away leaving over one-fourth mile of one and one-fourth inch mesh gill nets in the water, which I have. They had over five hundred pounds of fish. I have not had very good luck in choosing the justice. The first case I had was a bad one. I caught him in the act. He had six hundred pounds of fish. He proved to be a neighbor of the justice, and he let friendship interfere with duty.

There was a man fishing with two inch mesh nets, but by putting two of them together in such a position was only one inch, he claimed that his net was all right. I said "No." Was I not right?

Yours truly,

CHAS. T. BRONSON.

Clipping from Danville Press, November 29, 1890.

It is an old adage, but nevertheless it is a very true one, that murder will out, and it has never been more fully illustrated than in the trial and conviction of Middleton McMillan, George McMillan,—father and son,—Charles Grimes and Charles McMillan for violation of the fish law.

For a long time these people have been regularly seining the North Fork, but like the maiden of old, they carried the pitcher once too often to the well, and the pitcher was broken, and the cost thereof was terrible to the unfortunate ones. In August last they seined the stream from the Denmark ford to one and one-half miles north, and it is said the catch was very large. Some one, possibly the fellow who was angling along the placid waters of the North Fork, had no luck, informed Fish Warden George Kamper, whose ears are always open to the cry of distress of the festive finny tribe. The better feelings of the warden were aroused, the warrant for their arrest was issued by Justice Hollowell, and Constable Thompson brought them into court yesterday afternoon, where they were arraigned. George and Charles McMillan and Charles Grimes pleaded guilty and were fined ten dollars and costs, amounting in all to \$17.50 each. Middleton McMillan, however, concluded to stand trial. When put

on the witness stand he admitted that he had gone to the creek with the seiners, and watched them catch the fish; and had seen them dividing them into four piles and had taken his share home with him. He claimed that he was not violating the law, for the reason that the creek ran through his farm, and was his property. In total disregard of his feelings and protestations, however, the court fined him \$10.00 and costs, amounting to \$20.30.

The result of the trial gives general satisfaction to all sportsmen, and it is the desire of every lover of law and order that all violators be punished.

MISCELLANEOUS CORRESPONDENCE.

INCREASE OF FISH, CARP, PROTECTIVE ASSOCIATIONS, ETC.

FAIRBURY, ILL., August 11, 1890.

Mr. S. P. Bartlett, Quincy, Ill.:

DEAR SIR—Yours of the 21st of July was duly received, but have not yet received publication on "Pond Culture," as stated in your letter you would send. I shall be very glad to receive information and help on stocking ponds. I caught an eight-pound German Carp with line two weeks ago; it was a very nice fish. Please send what information you can, and oblige.

Yours very truly,

N. B. CLAUDON.

CARLINVILLE, ILL., December 15, 1890.

Col. S. P. Bartlett, Secretary Illinois State Fish Commission:

DEAR SIR—It will perhaps interest you to hear something in regard to the fish which you so kindly furnished to stock the "Beaver Dam Lake," and from your many friends composing the members of the "Beaver Dam Lake Club."

The lake, no doubt, at an early day, was formed by the work of beavers, and was naturally about four feet deep, and covered quite a large tract, hence the name. The club, at an expense of about \$2,500, have built a dam at each end of the lake, and the water now covers about eighty acres, and is about seven to eight feet deep. This water is surrounded by beautiful wooded hills, upon one of which is situated our club house, at an elevation of fifty feet or more, and overlooking the entire lake. The house, lot and picnic grounds cover about ten acres, which is enclosed by a wire fence, and the underbrush nicely trimmed out, and covered by forest trees, affording a fine shade.

We usually hold two club picnics each year, summer and fall, and nearly every day during the summer some of the club, with their families and friends, are enjoying the delights of boating and fishing at this beautiful resort.

Our club consists of the following named persons, viz.: Henry Brayford, Henry C. Yeager, Hon. C. A. Walker, Gen. John L. Rinaker, Dr. J. P. Mathews, Don A. Burke, Wm. F. Burgdorff, Chas. H. Burgdorff, Thos. Rinaker, Rob't B. Shirley, F. W. Burton, Prof. Chas. Robertson, Alex. H. Bell, Wm. L. Mounts, M. L. Keplinger, A. H. Hoblett, Alex. Boring and H. W. Burton.

The fish received from you seem to be doing well. At any rate we do not find any dead ones, and we hope to have, in the near future, the finest stocked private lake in the State of Illinois.

We have taken but very few bass the present summer of regulation size (our by-laws prohibit bass under three-quarter pound weight). The largest bass yet taken weighed 5 lbs. and 2 oz., and quite a number have been caught weighing 2 to 4 lbs. each. I think I represent the club in expressing the opinion that the work you are engaged in should be encouraged, and many more artificial lakes made and stocked with fish all over the State, thereby adding greatly to the food and pleasure of the people.

During the present dry season, when the waters in the shallow creeks and sloughs have dried up, millions of small fish have been destroyed that could, with proper effort, have been planted in lakes that could be made with little expense, if the people interested would do it. I think that nearly every farmer has a place on his farm where a fish pond could be made, and when stocked with fish would be a source of pleasure and profit to himself and family.

The "Beaver Dam Lake" is situated about a half mile west of Macoupin Station, on the C. & A. R. R., of easy access, and about seven miles from Carlinville. A pleasant buggy ride, or ten minutes by the cars, and a short walk lands us at the grounds. Our dams are in good condition and will stand for years, and in all probability this lake will be a permanent and popular resort for all time. I send you herewith a photograph, showing a view of part of the lake and its surroundings.

With the kindest regards of the club.

Respectfully,

H. W. BURTON, *President.*

CARLINVILLE, ILL., May 27, 1889.

Hon. S. P. Bartlett, Secretary Fish Commission:

DEAR SIR—We have taken from the fish sent us by you one bass weighing 5 pounds 2 ounces, one weighing 3 pounds 14 ounces, and several of 2 pounds this spring. We trust you can be with us to demonstrate further the rapid growth of the bass under favorable surroundings.

Respectfully,

THOS. RINAKER, *Secretary.*

CHARLESTON, ILL., January 2, 1890.

S. P. Bartlett, Esq., Quincy, Ill:

DEAR SIR—We have your favor of December 28, 1889, and our members request me to thank you for allotment of wall-eyed pike, and ask that you give us all you can and do justice to others. Since our organization we find that there are many more game fish in our little stream than before, and if weather is at all favorable any angler is sure of a good string of bass. Our stream was formerly full of croppies, but these were cleaned out by the trammel-net, and for several years they have been very scarce and only a few caught. Channel cat have been very plentiful, and notwithstanding great numbers have been caught in traps, are numerous yet, and afford excellent sport. The night before the 4th of July a party of four caught over 80 on trot-lines, some weighing four pounds. Before we organized it was a common thing to organize, publicly, a seining party, and owners of trammel-nets made no secret of using them and bringing fish to town for sale. Since then there has been some of this illegal seining done, but very quietly, and we have not been able to obtain evidence to convict. These men are, however, beginning to realize that the association means business, and as soon as the nets and seines now here are worn out I think the business will be discontinued altogether. Dynamite has done us much harm, and, unfortunately, we have not been able to catch any of the offenders. It is our intention, however, to call a meeting in February, make it as public and enthusiastic as possible, and offer reward of \$100 for conviction for use of dynamite, and rewards for netting.

trapping or seining. You told me when here that we could have a fish warden appointed, and would like to have you send me a copy of the section, so we can go about it right, and will send you name.

The carload of fish you gave us pleased all our members, and others who fish, and particularly because there are so many croppie and strawberry bass in it. Please advise us what progress you have made. We feel that the fish laws will have some difficulties to overcome, as game laws had. When those were first enacted nobody paid any attention to them, and game was killed at all seasons. Now, however, the laws are obeyed, in this vicinity at least, and we are confident it will be the same with fish laws in time. To sum up the situation here, we have increased the stock of fish materially, the size is very much greater, and we have inspired a respect for the law among the piratical fishermen.

Yours truly,

OTTO WEISS, Sec'y.

PULLMAN, ILL., Dec. 19, 1890.

S. P. BARTLETT, ESQ., *Sec'y Ill. State Fish Com.*

DEAR SIR:—Enclosed you will please find a report of my work from the date of my commission to date. You will see that I have taken thirty nets. These nets, with the exception of the ones belonging to Paul Fisher and Louis Anderson, I still have on hand. One net taken on November 7th, was 1,800 feet long—a gill-net. The parties came from Lake Michigan, and escaped me. The four men arrested November 30th were the ones that were rescued by the Hegewisch police.

Hoping the report will meet your approval, I remain,

Yours truly,

CHAS. T. BRONSON.

IUKA, ILL., May 28, 1889.

MR. S. P. BARTLETT.

DEAR SIR:—The twenty German mirror carp that I received through the Fish Commission November 11, 1885, I put in a pond as directed. Two years thereafter I had occasion to drain the pond and found they had all escaped through the overflow, except five. They tipped the beam at 6½ pounds each. There had been no increase up to that time. I cleaned out of pond two barrels of sun and catfish, put the five carp back, and at this date, May 28, 1889, they weigh ten pounds each. I have a pond stocked with scaled carp, but think the mirror much the better variety, as they grow more rapidly, have fewer bones, and are the best food fish by all odds. My mirror carp spawned last year and the young now weigh one pound, at less than a year old.

Yours truly,

JAMES B. COLLINS.

ILLUSTRATIONS.

The illustrations show our fleet, boats and mode of work, also the different varieties of fish distributed during the past two seasons.

The frontispiece shows our fleet at Quincy, in winter quarters. It consists of office boat, steamers "Lotus" and "Hannibal Eagle," quarter boats and small boats or skiffs.

GATHERING NATIVE FISH.

This series of illustrations exemplifies our work in gathering the fish for distribution, and a brief description of the work may enable the reader to better understand them.

Nearly all the flat ponds along the Illinois river which become filled with fish during the high water, or over-flow of the river, are left full of fish when the water recedes. These ponds dry up and the fish die if left there during the summer. It is from such places that we get our supply. Our mode of work is, briefly, as follows: We first clean the pond of moss and obstructions, by means of a heavily leaded sea-line, drawn over the bottom of the pond, catching the moss and rubbish and dragging it to the shore. The seine, which is of small mesh, could not be used without cleaning the pond in this way. After the pond is so cleaned, the seine, which has previously been "laid in" evenly and regularly into the stern of a flat bottomed boat, so that it will "lay out" without tangling, is fastened to the shore by one of its brails; it is then allowed to go into the water for its whole length in a semi-circle. A long line is fastened to the outer brail, and it is drawn to the shore, describing as large an arc of a circle as possible. When the outer brail has reached the shore, the lead or bottom line and the top or cork line are gradually pulled in, working towards the starting point. When about one half of the distance has been accomplished the other end of the seine is taken up and treated in the same way. The seine being eight feet deep, and the water ordinarily very shallow, quite a bag is thus formed. When the seine has been brought near enough to the shore so that a section of it can be handled by the men, the fish are worked into a pocket, as it were, and carried out into deeper water, where, by a vibrating motion through the water, the mud is washed from the seine, and the fish are sorted out, such as are wanted for distribution are put into the live-box,—which is a kind of cage made of slats, through which the water runs,—and the residue taken to the river or nearest deep water and turned into it. After the live-boxes have been filled the fish are carried in large cans to the river and placed in storage live-boxes, and in them are either floated or towed to the point of shipment, where they are loaded on cars and transported to place of deposit.

This mode, however, only applies to the ponds of large area, where more than one haul of the seine is necessary. Frequently, a pond is cleaned out by one haul, in which case what is called an "end-haul" is made, the pond having first been cleaned as before described.

The illustrations of the fish comprise the following:

THE SMALL-MOUTH BLACK BASS.

The greater proportion of the black bass distributed during the seasons of 1889 and 1890 has been of this variety, as it predominates in the Illinois river valley, is indigenous to almost all the waters of our State, but found in greater numbers in the Illinois river and its tributaries than in any other portion.

STRAWBERRY BASS, BLACK CRAPPIE, CALICO BASS.

This fish is found almost everywhere throughout the State now, having been distributed by our Commission for the past eight years. It was at one time, undoubtedly, indigenous to all its waters, but had become practically extinct in many parts of the State. It is one of the best table varieties, very prolific, rapid in growth and gamey.

WALL-EYED PIKE, PIKE-PERCH.

This fish is found in large numbers and of large size in the Illinois river, but few are caught in the overflows. We have distributed during the seasons of 1889 and 1890, respectively, 12,000,000 and 7,000,000 of the fry of this fish, which were given us by the U. S. Fish Commission. They are gamey, fairly rapid in growth and prolific. They are indigenous to the principal streams of the State.

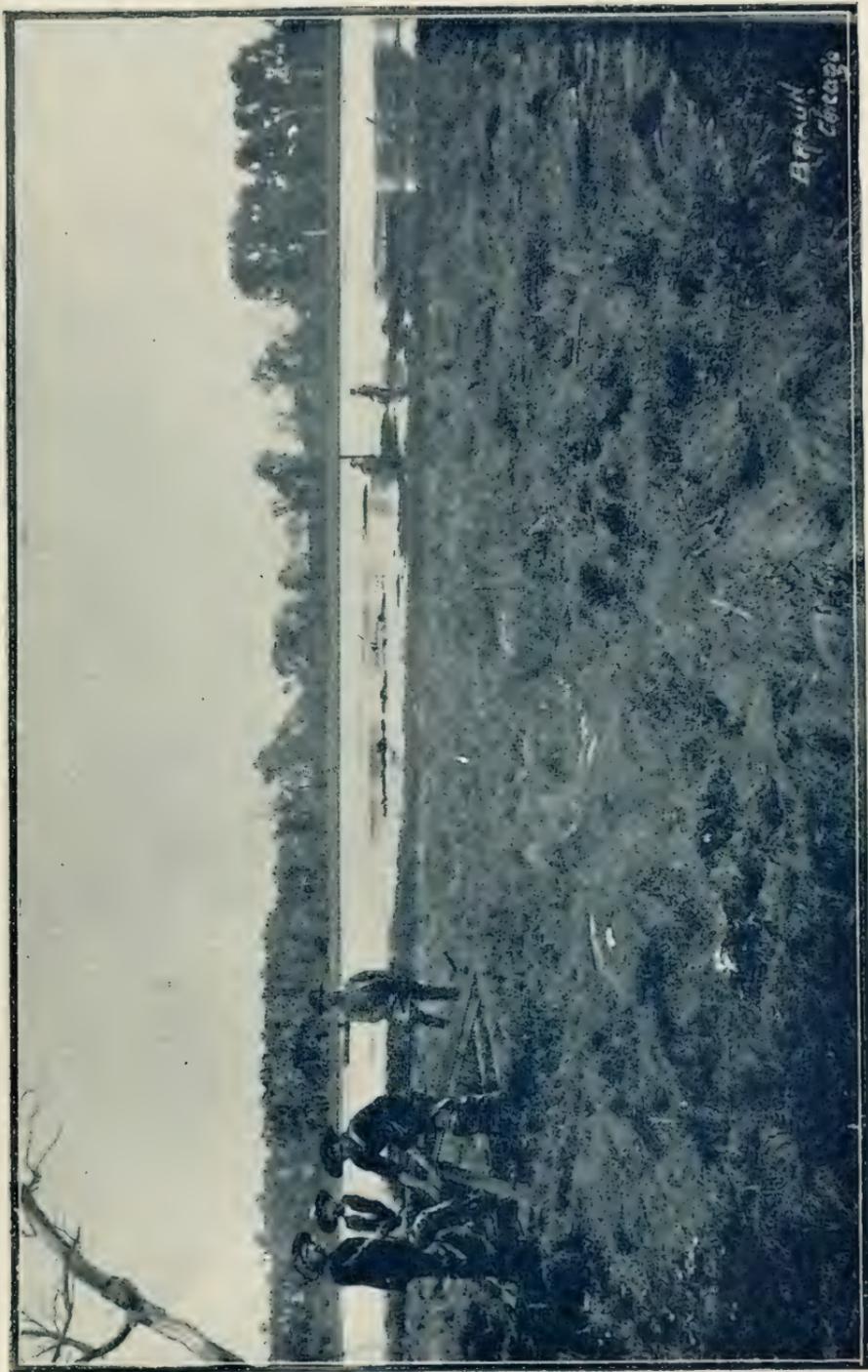
ROCK BASS, RED-EYE.

These are taken in large numbers from the overflows. They form a large percentage of our distribution. They are quite gamey, prolific and highly esteemed for the table.

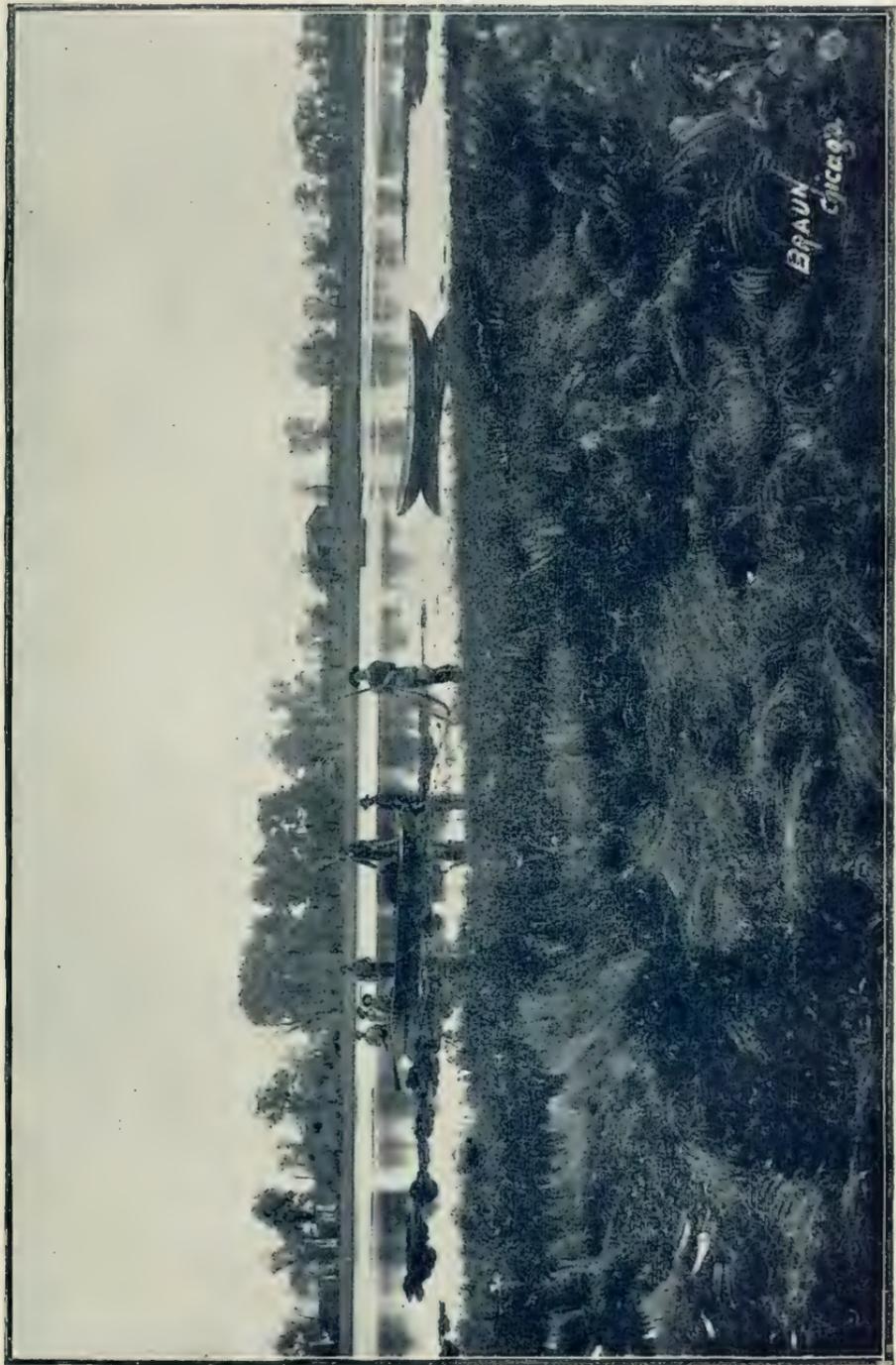
CRAPPIE.

This fish is indigenous to almost all of the waters of our State. Late in the season a large percentage of our distribution was of this variety. Quite prolific and an excellent fish for food.

In former reports very full descriptions have been given of the nature, habits, food and distribution of these and all other varieties of our indigenous fishes in the able papers furnished by Prof. Forbes, one of the best known authorities on fish in America.

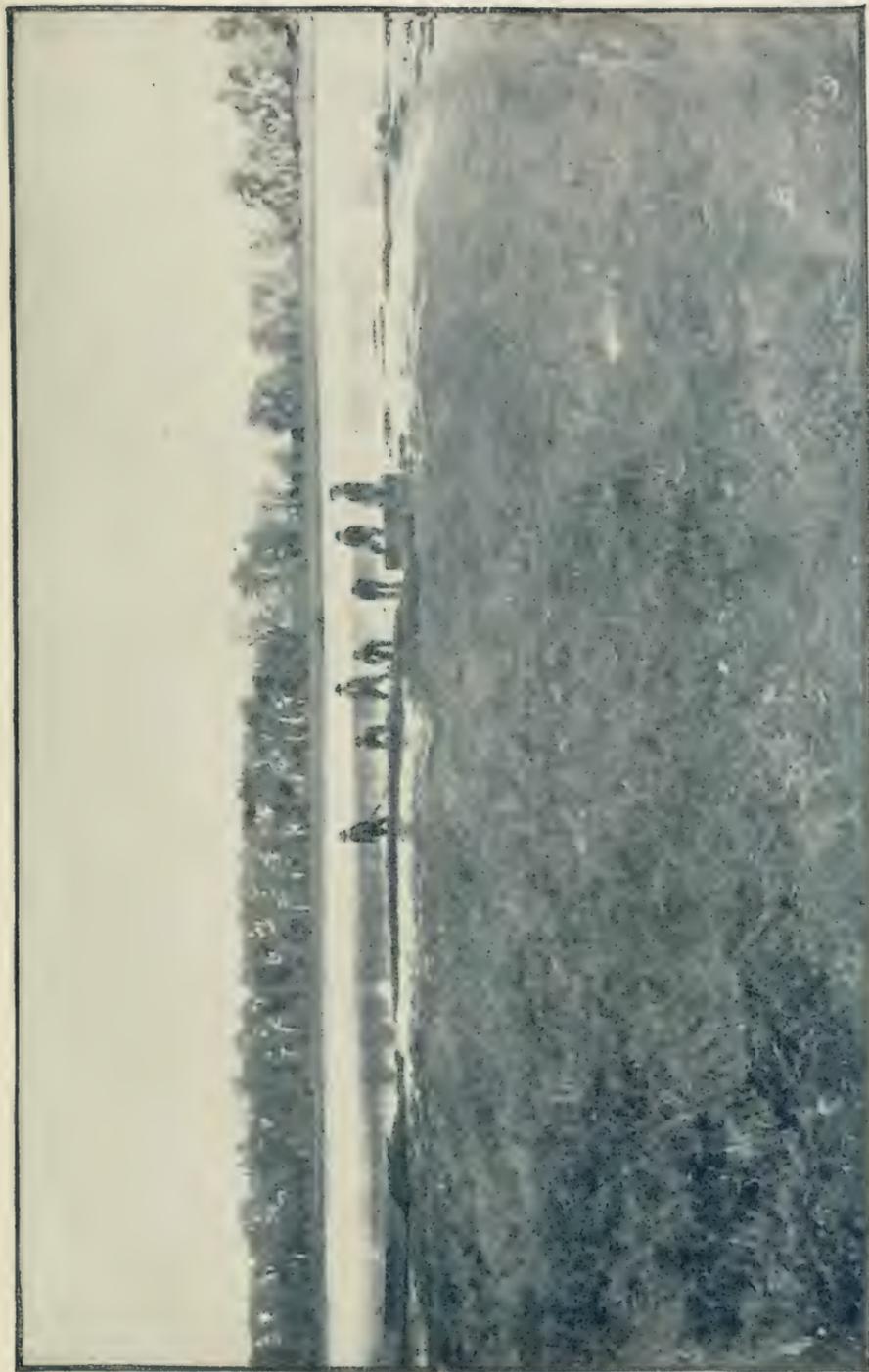


GATHERING NATIVE FISH



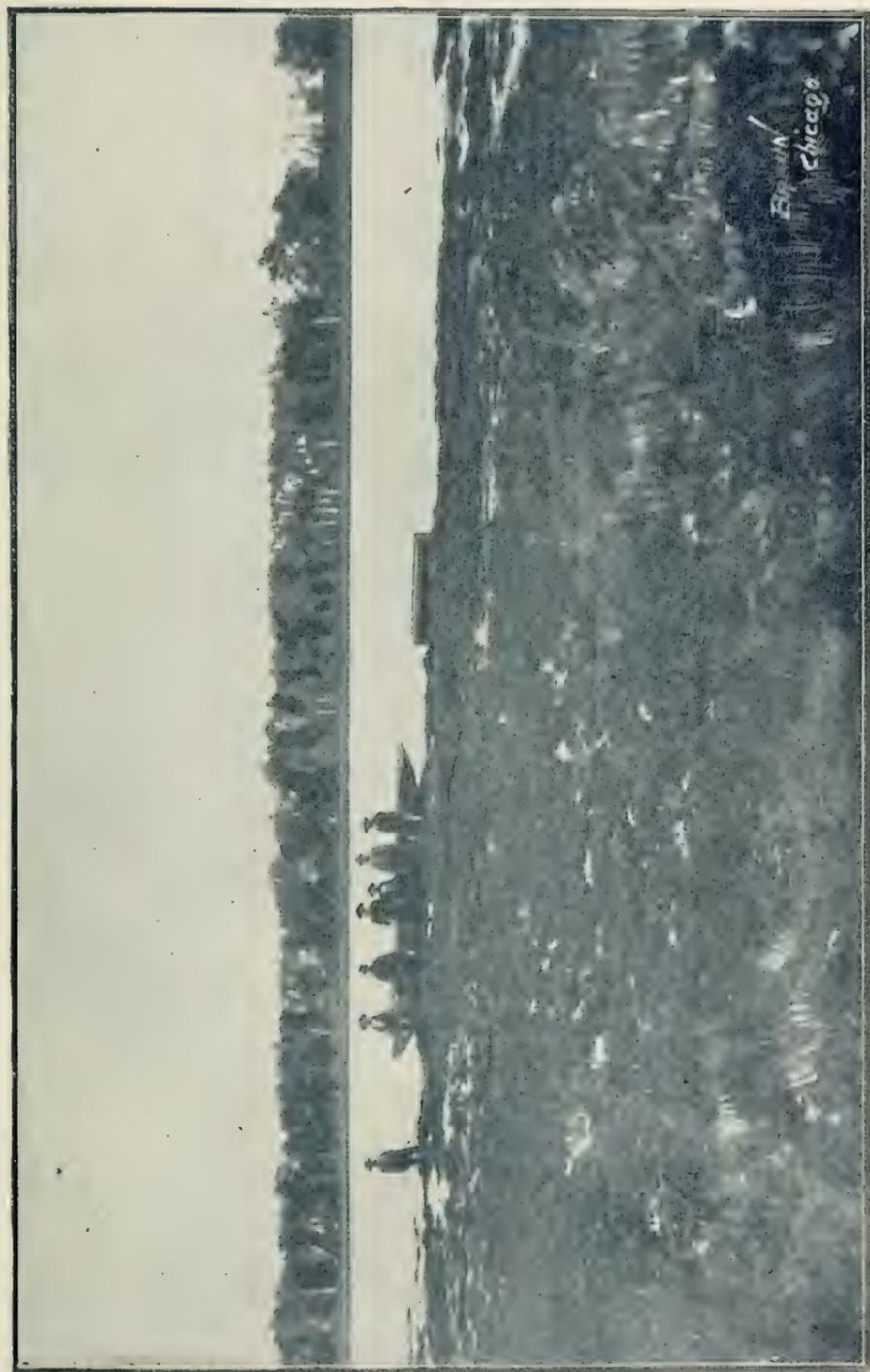
GATHERING NATIVE FISH

START TO LAY OUT SEINE



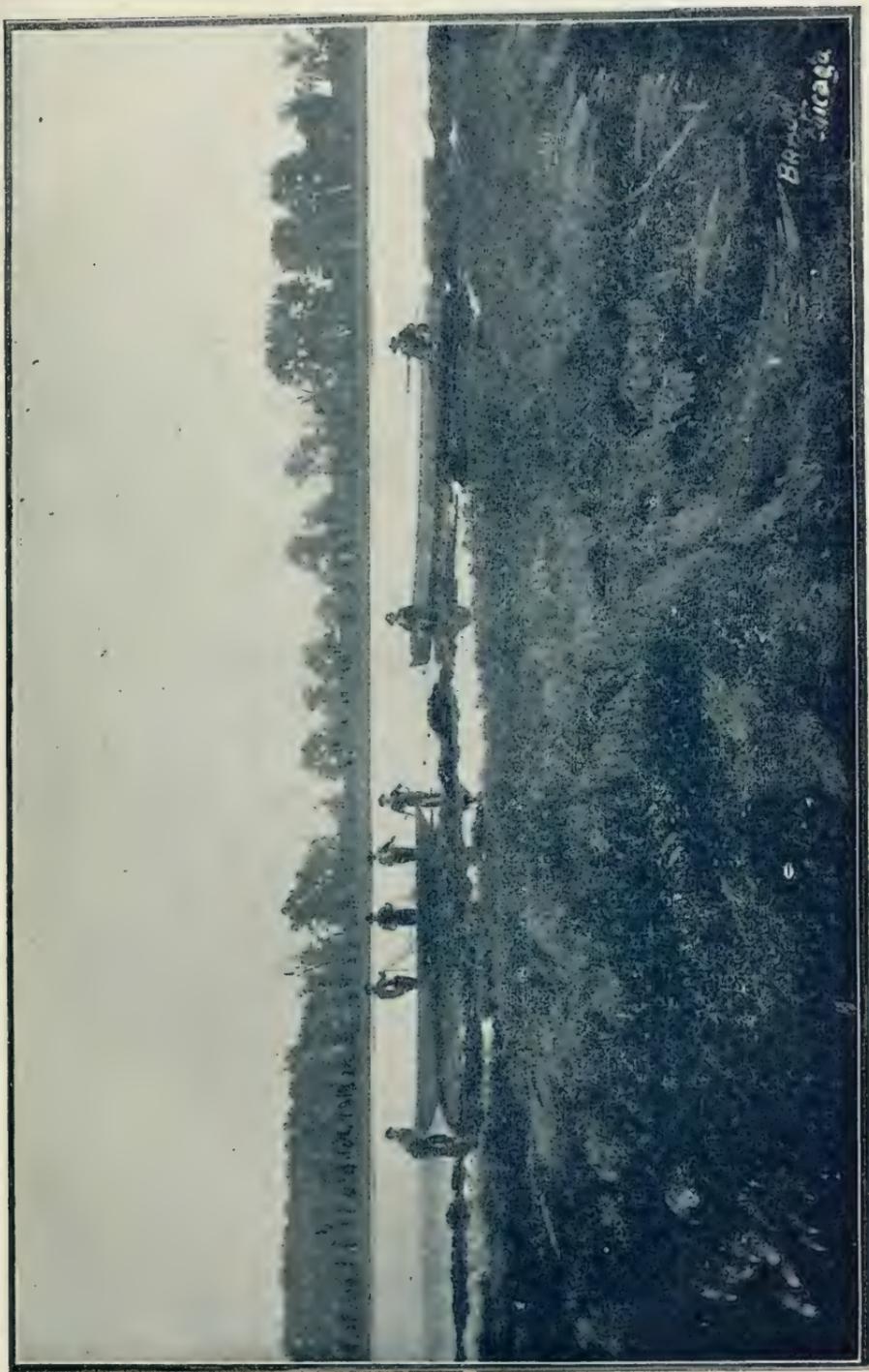
GATHERING NATIVE FISH

SORTING FISH



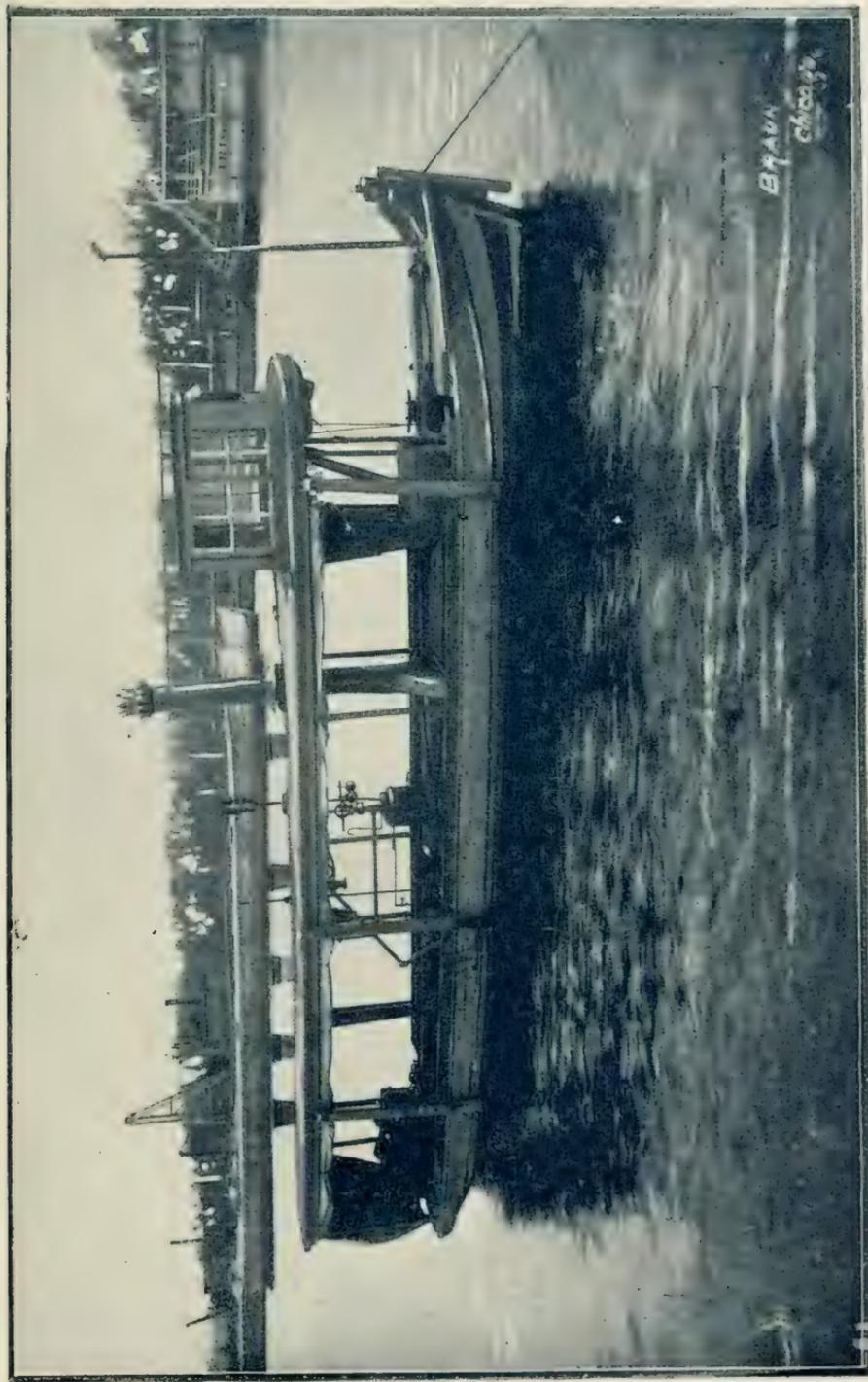
GATHERING NATIVE FISH

HAUL COMPLETED

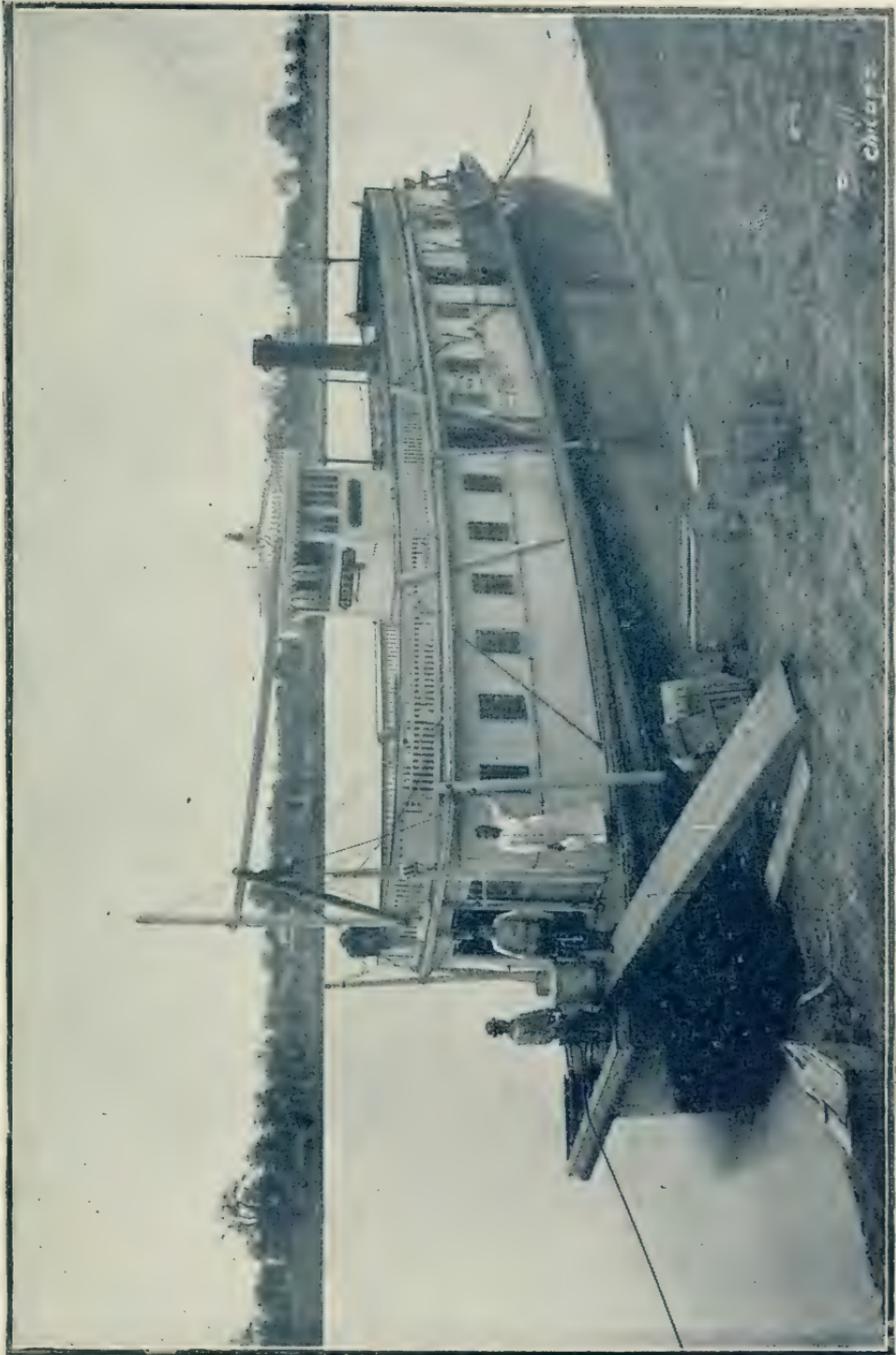


GATHERING NATIVE FISH

TAKING UP SEINE



STEAMER HANNIBAL EAGLE



STEAMER LOTUS

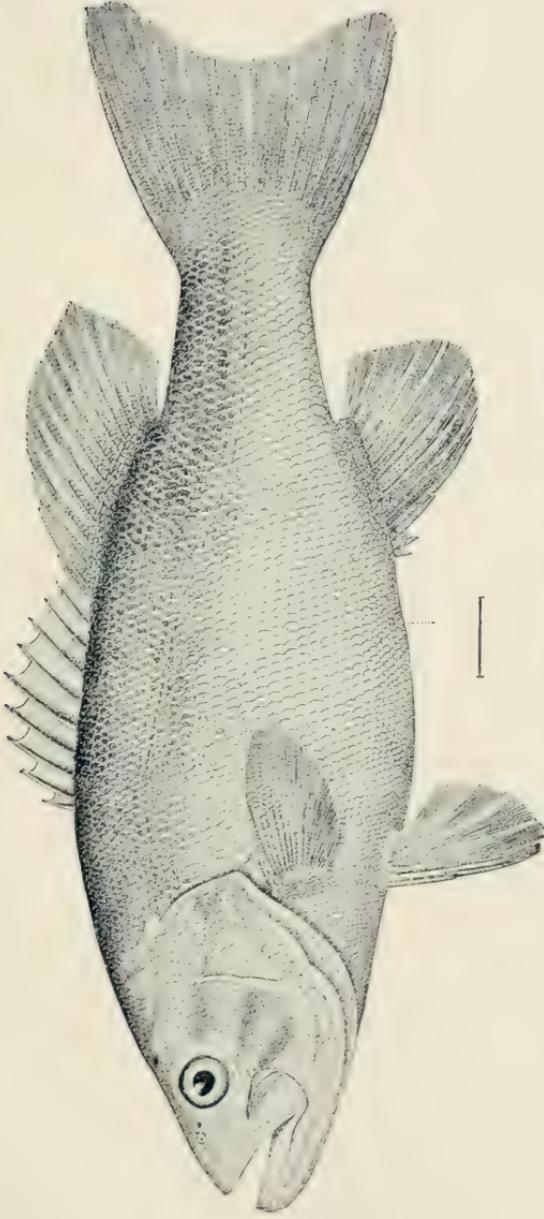
Chicago



WHITTEMORE LAKE, LANESVILLE, ILL.

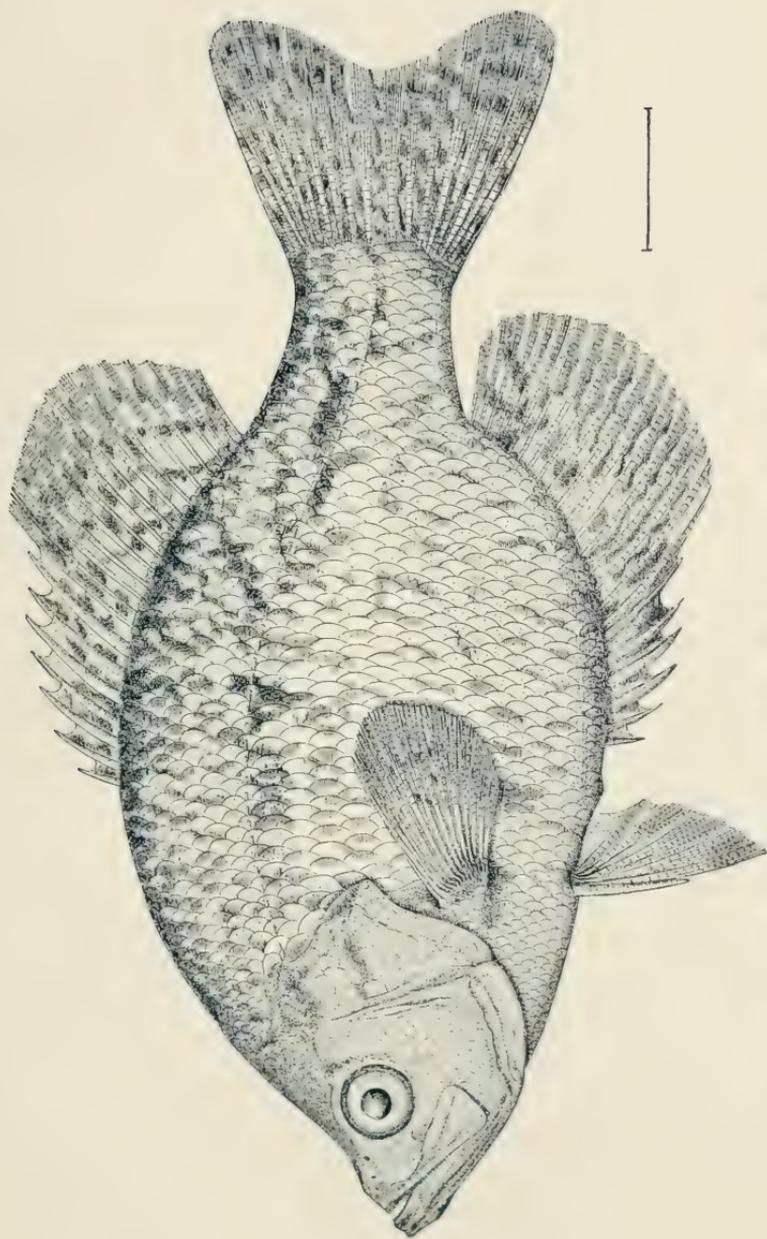


SCHORR LAKE, NEAR WATERLOO, ILL.



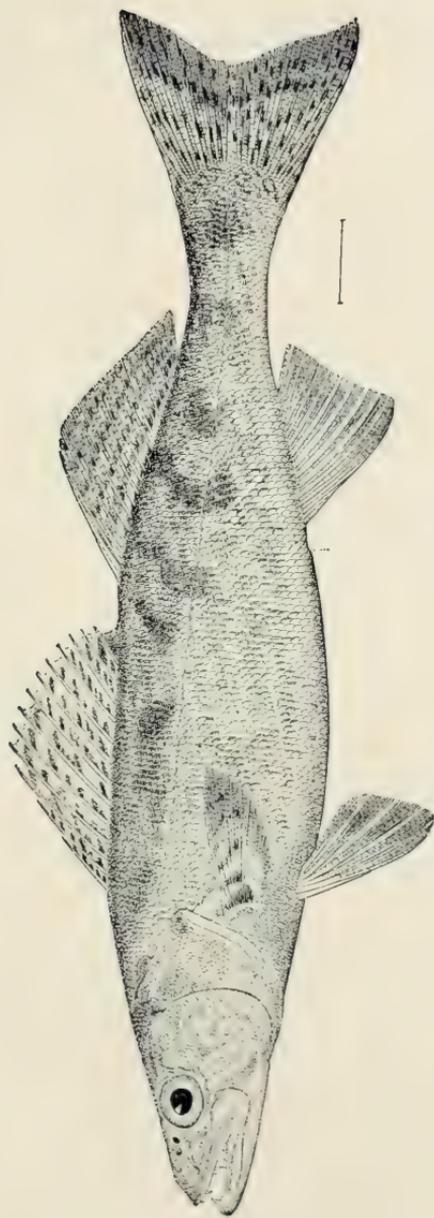
THE SMALL-MOUTH BLACK BASS.

Micropterus Dolomieu.



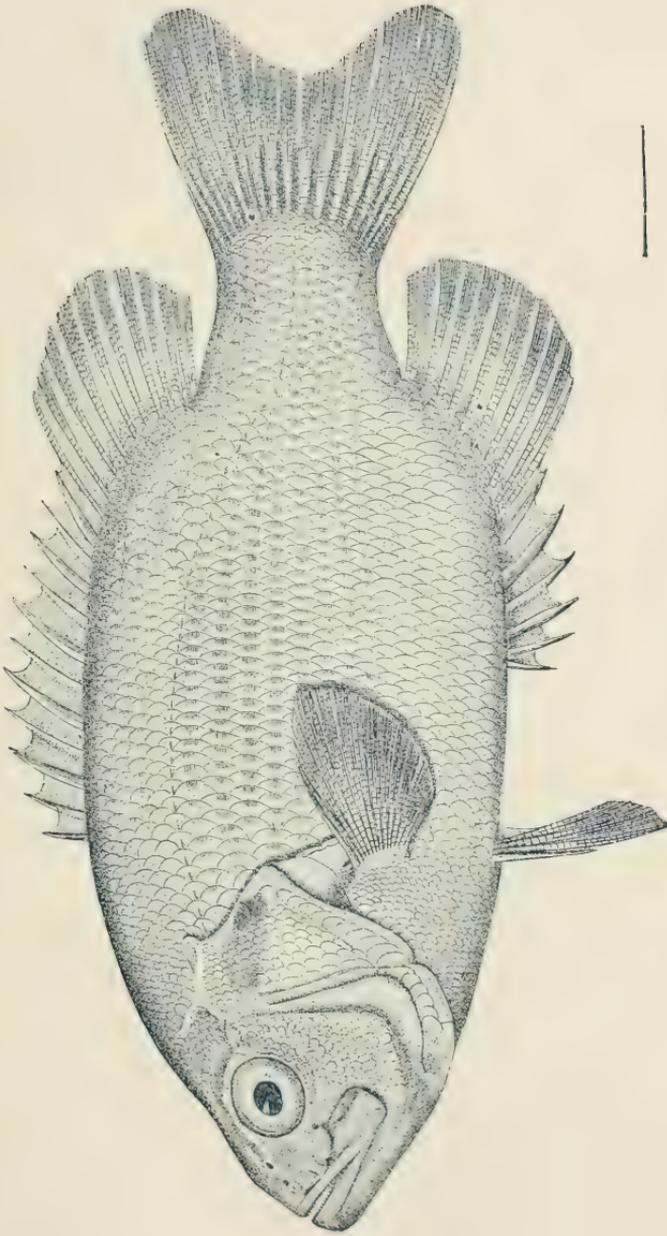
THE CALICO BASS, OR STRAWBERRY BASS.

Pomoxis sparoides.



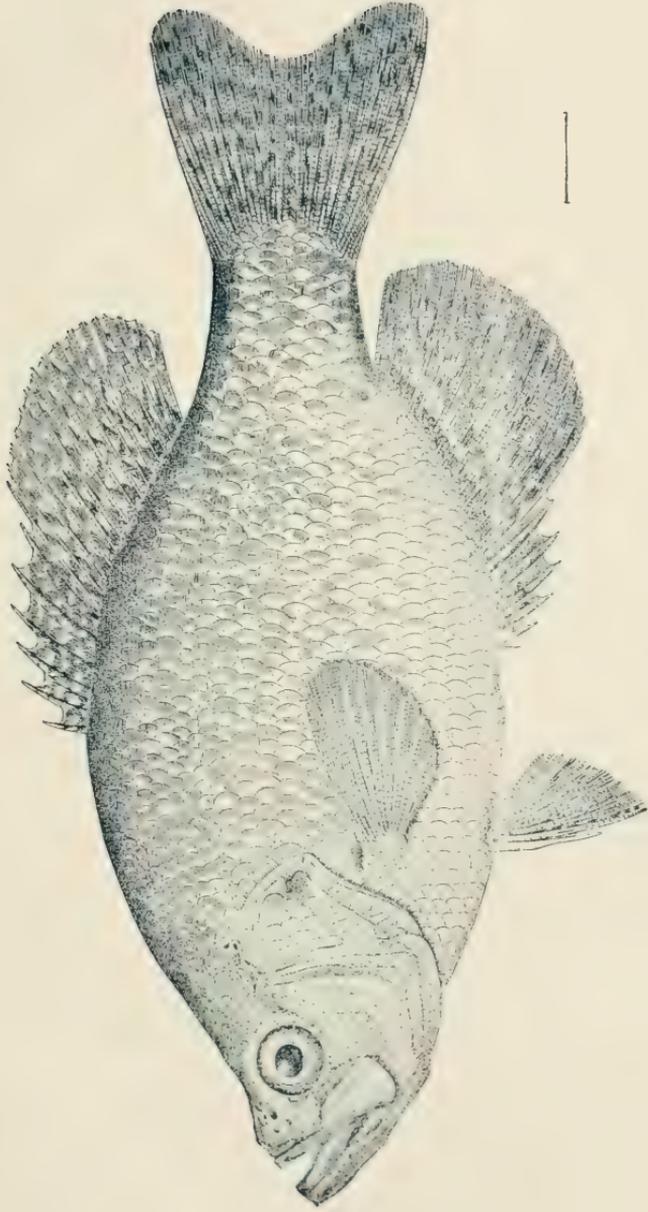
THE WALL-EYED PIKE.

Stizostedion vitreum.



THE ROCK-BASS OR RED EYE.

Ambloplites rupestris.



THE CRAPPIE.
Pomoxis annularis.



APPENDIX.

ON THE FOOD RELATIONS OF FRESH-WATER FISHES.

A SUMMARY AND DISCUSSION.*—By *S. A. Forbes.*

The principal object of the research reported in the series of papers† of which this is the concluding number, is to determine more precisely than has hitherto been done the relations to nature of the various genera and families of the fishes of an interior region. This purpose has led especially to a study of the *food relations* of the groups, for through these, chiefly, fishes exert their influence on the outer world, and are themselves impressed in turn; and thus have appeared a number of subordinate considerations having a bearing, more or less direct, on the main intention of the study.

An examination of the special relations of their food and feeding structures gives us clues, not only to the present significance of fishes, but also to their past effect on life at large, showing how they must have modified the course of evolution; and the occasional occurrence in a fish of food prehensile structures out of present relation to its feeding habits, may throw light on the history of its group, indicating conditions of existence once normal to it but now outgrown. Evidence of similar application may also be obtained by a comparison of the food of the young and of the adult.

The feeding apparatus exhibits some of the most significant examples of correlation of structure, important to an acquaintance with the course of development in fishes, but not comprehensible without a knowledge of the food for whose appropriation it is adapted. I need hardly recall the fact that the defensive apparatus of one species may have its explanation only in the offensive structures of another.

We shall find also in a study of the food evidence of the indirect but powerful action of a number of external conditions which take effect only through the food relation, and are incomprehensible or perhaps unnoticed unless this is understood—conditions of climate, season, locality, and the like; and especially may we hope for this when we remember that the distribution and abundance of a species may be determined, not so much by ordinary conditions, as by those prevailing at critical intervals, periods of stress, when a slight advantage or a trivial disability may have prolonged and multiplied effects. As the range of a plant is often limited, not by the average temperature of the year, but by the extremes of cold or heat, so the existence of an animal may be decided by the presence or absence of some structural modification adapted to carry it safely through a single brief period of unusual scarcity or of extraordinary competition.

* Reprint of Article VIII, Vol. II, Bull. Ill. State Lab. Nat. Hist.

† Published at intervals from 1877 to 1888, in the first and second volumes of the Bulletin of this Laboratory, as follows: "The Food of Illinois Fishes" (Vol. I, No. 2, pp. 71-89), "The Food of Fishes" (No. 3, pp. 18-65; reprinted in report Ill. State Fish Commission, 1884, pp. 90-127), "On the Food of Young Fishes" (No. 3, pp. 66-79), "The Food of the Smaller Fresh-Water Fishes" (No. 6, pp. 65-94), "The First Food of the Common White-fish, (No. 6, pp. 95-109), and "Studies of the Food of Fresh-Water Fishes" (Vol. II, Art. VII, pp. 433-473).

That the study here set forth should give us details not to be otherwise obtained of the struggle for existence among fishes themselves, goes without saying; and that it may thus explain some peculiarities of distribution, seems also probable. I have thought it not impossible that by taking into account all the data collected, and the mass of related facts, structural, biological, and other, that materials might be found bearing on the interesting question of the precedence in time and the relative evolutionary importance of desire and effort on the one hand and structural aptitudes on the other.

Among the purely practical results to be anticipated, are a more accurate knowledge of the conditions favorable to the growth and multiplication of the more important species; the ability to judge intelligently of the fitness of any body of water to sustain a greater number or a more profitable assemblage of fishes than those occurring there spontaneously; guidance as to the new elements of food and circumstance which it will be necessary to supply to insure the successful introduction into any lake or stream of a fish not native there; and a clear recognition of the fact that intelligent fish culture must take into account the necessities of the species whose increase is desired, through all ages and all stages of their growth, at every season of the year, and under all varieties of condition likely to arise. We should derive, in short, from these and similar researches, a body of full, precise, and significant knowledge to take the place of the guess work and empiricism upon which we must otherwise depend as the basis of our efforts to maintain the supply of food and the incitement to healthful recreation afforded by the waters of the State.

As a contribution to the general subject, I present herewith a summary account of the food of twelve hundred and twenty-one fishes obtained from the waters of Illinois at intervals from 1876 to 1887, and in various months from April to November. These fishes belonged to eighty-seven species of sixty-three genera and twenty-five families. They were derived from waters of every description, ranging from Lake Michigan to weedy stagnant ponds and temporary pools, and from the Mississippi and Ohio rivers to the muddy prairie creeks, and the rocky rivulets of the hilly portions of the State. Nine hundred and fourteen of the examples studied were practically adult, so far as the purposes of this investigation are concerned, the remaining three hundred and seven being young, in the first stage of their food and feeding habits. More than half these young belonged to a single species,—the common lake white-fish,—but the remainder were well distributed.

I have arranged the matter under the following general heads: (1) a summary statement of the food, so made as to exhibit *a*) the kinds and relative importance of the principal competitions among fishes and *b*) the relative value to the principal species of fishes of the major elements of their food; (2) a brief account of the food of the young; (3) an examination of the permanency and definiteness of distinctions with respect to food, between different species, and also between higher groups; (4) a review of the structures of fishes related to food prehension and to their feeding habits; and, finally, (5) a classified list of the objects detected in the food of fishes, with a statement, against each object, of the species feeding on it and the number of specimens in which it was found.

THE FOOD OF ADULT FISHES.

An analysis of our facts made with reference to the kinds of fishes eating each of the principal articles in the dietary of the class, and showing the relative importance of these elements in the food of the various species, will exhibit the competitions of fishes for food more clearly and precisely than my earlier discussions, and also the nature and the energy of the restraints imposed by fishes on the multiplication of their principal food species.

PISCIVOROUS FISHES.

The principal fish-eaters among our species—those whose average food in the adult stage consists of seventy-five per cent. or more of fishes—are the burbot¹, the pike-perch² or wall-eyed pike, the common pike³ or "pickereel," the large-mouthed black bass⁴, the channel cat⁵, the mud cat⁶, and the gars⁷. Possibly also the golden shad⁸ will be found strictly ichthyophagous, this being the case with the four specimens which I studied.

Those which take fishes in moderate amount—the ratios ranging in my specimens from twenty-five to sixty-five per cent.—are the war-mouth (*Chanobryttus*), the blue-cheeked sunfish⁹, the grass pickerel¹⁰, the dog-fish¹¹, the spotted cat¹², and the small miller's thumb¹³. The white¹⁴ and striped bass¹⁵, the common perch¹⁶, the remaining sunfishes (those with smaller mouths), the rock bass¹⁷, and the croppie¹⁸, take but few fishes, these making, according to my observations, not less than five nor more than twenty-five per cent. of their food.

Those which capture living fishes, to a trivial extent, at most, are the white perch or sheepshead¹⁹, gizzard shad²⁰, the suckers²¹, and the shovel fish²² among the larger species; the darters²³, the brook silversides²⁴, the stickleback²⁵, the mud minnows²⁶, the top minnows²⁷, the stonecats²⁸, and the common minnows²⁹ generally, among the smaller kinds.

Our eight specimens of the toothed herring³⁰ had taken no fishes whatever; while our nineteen examples of the pirate perch³¹ had eaten only two per cent.

Rough-scaled fishes with spiny fins (*Acanthopteri*) were eaten by the miller's thumb, the common pike, the wall-eyed pike, the large-mouthed black bass, the croppies, the dog-fish, the common perch, the burbot, the bull-head³², the common sunfish (*Lepomis pallidus*), the small-mouthed black bass³³, the grass pickerel, the gar, and the mud cat (*Leptops*). Among these, the common perch and the sunfishes³⁴ were most frequently taken—doubtless owing to their greater relative abundance—the perch occurring in the food of the burbot, the large-mouthed black bass, and the bull-head; and sunfishes in both species of the wall-eyed pike, the common pike, the gars, pickerel, bull-heads, and mud cat. Black bass were taken from the common pike (*Esox*), the wall-eyed pike (*Stizostedion*), and the gar. Croppie and rock bass I recognized only in the pike. Even the catfishes (*Siluridae*) with their stout, sharp, and poisoned spines, were more frequently eaten than would be expected—taken, according to my notes, by the wall-eyed pike, both black bass, and the mud cat (the latter a fellow species of the family).

The soft-finned fishes were not very much more abundant, on the whole, in the stomachs of other species than were those with ctenoid scales, spiny fins, and other defensive structures,—an unexpected circumstance which I cannot at present explain, because I do not know whether it expresses a normal and fixed relation, or whether it may not be due to human interference. It will be shown, however, under another head, that even when the primitive order of nature prevails, the relative numbers of soft-finned and pedaceous fishes vary greatly from year to year under the influence of varying circumstances.

Only the catfishes seem to have acquired defensive structures equal to their protection, the predatory apparatus of the carnivorous fishes having elsewhere outrun in development the protective equipment of the best-defended species.

¹*Lota maculosa*. ²*Stizostedion vitreum*. ³*Esox lucius*. ⁴*Micropterus salmoides*. ⁵*Ictalurus furcatus*. ⁶*Leptops olivaris*. ⁷*Lepidosteus*. ⁸*Clupea chrysochloris*. ⁹*Lepomis cyanellus*. ¹⁰*Esox vermiculatus*. ¹¹*Amia calva*. ¹²*Ictalurus punctatus*. ¹³*Uranidea richardsoni*. ¹⁴*Roccus chrysops*. ¹⁵*Roccus interruptus*. ¹⁶*Percia lutea*. ¹⁷*Ambloplites rupestris*. ¹⁸*Pomoxys*. ¹⁹*Aplodinotus*. ²⁰*Dorosoma cepedianum*. ²¹*Catostomatida*. ²²*Polyodon spathula*. ²³*Etheostomatinae*. ²⁴*Laoidesthes sicculus*. ²⁵*Eucalia inconstans*. ²⁶*Umbralimi*. ²⁷*Zygonectes*. ²⁸*Noturus*. ²⁹*Cyprinida*. ³⁰*Hyodon tergisus*. ³¹*Aphredoderus sayanus*. ³²*Amiurus nebulosus*. ³³*Micropterus dolomieu*. ³⁴*Centrarenidae*.

Among the soft-finned fishes the most valuable as food for other kinds is the gizzardshad (*Dorosoma*).—this single fish being about twice as common in adults as all the minnow family taken together. It made forty per cent. of the food of the wall-eyed pike; a third that of the black bass; nearly half that of the common pike or "pickereel"; two-thirds that of the four specimens of golden shad examined; and a third of the food of the gars. The only other fishes in whose stomachs it was recognized were the yellow cat (*Ameiurus natalis*) and the young white bass (*Roccus*). It thus seems to be the especial food of the large game fishes and other particularly predateous kinds.

The minnow family (*Cyprinidae*) are in our waters especially appropriated to the support of half-grown game fishes, and the smaller carnivorous species. They were found in the wall-eyed pike, the perch, the black bass, the blue-cheeked sunfish, the croppie, the pirate perch, the pike, the little pickereel¹, the chub minnow², the yellow cat, the mud cat, the dog-fish, and the gar.

Suckers (*Catostomatidae*) I determined only from the pike, the sheephead, the blue-checked sunfish, the yellow cat, and the dog-fish (*Ameia*). Buffalo³ and carp⁴ occurred in the pike, the dog-fish, and the above sunfish.

MOLLUSK EATERS.

The ponds and muddy streams of the Mississippi Valley are the native home of mollusks in remarkable variety and number, and these form a feature of the fauna of the region not less conspicuous and important than its characteristic and leading groups of fishes. We might, therefore, reasonably expect to find these dominant groups connected by the food relation; and consistently with this expectation, we observe that the sheephead, the catfishes, the suckers, and the dog-fish find an important part of their food in the molluscan forms abundant in the waters which they themselves most frequent. The class as a whole makes about one-fourth of the food of the dog-fish and the sheephead,—taking the latter as they come, half-grown and adults together, about half that of the cylindrical suckers,—rising to sixty per cent. in the red horse¹,—and a considerable ratio (fourteen to sixteen per cent.) of the food of the perch, the common catfishes (*Ameiurus* and *Ictalurus*), the small-mouthed sunfishes, the top minnows, and the shiner (*Notemigonus*). Notwithstanding the abundance of the fresh water clams or river mussels (*Unio* and *Anodonta*), only a single river fish is especially adapted to their destruction, viz., the white perch or sheephead; and this species derives, on the whole, a larger part of its food from univalve than from bivalve mollusks, the former being eaten especially by half-grown specimens, and the latter being the chief dependence of the adults.

The ability of the catfishes to tear the less powerful clams from their shells has been especially discussed in another paper* containing the details of the food of the family. Even the very young *Unios* were rarely encountered in the food of fishes, my notes recording their presence in only three sunfishes, a brook silversides, and a perch. Large clams were eaten freely by the full-grown sheephead—whose enormous and powerful pharyngeal jaws with their solid pavement teeth are adapted to crushing the shells of mollusks—and by the bull-heads (*Ameiurus*), especially the marbled cat². The small and thin-shelled *Sphaerium*s are much more frequent objects in the food of mollusk-eating fishes than are the *Unios*. This genus alone made twenty-nine per cent. of the food of our one hundred and seven specimens of the sucker family, and nineteen per cent. of that of a dozen dog-fishes. Among the suckers it was eaten greedily by both the cylindrical and the deep-bodied species, although somewhat more freely by the former. Even the river carp³, with its weak pharyngeal jaws and delicate teeth,

¹*Esox vermiculatus*. ²*Semotilus*. ³*Ictiobus*. ⁴*Carpiodes*.

*Bull. Ill. St. Lab. Nat. Hist., Vol. II., pp. 457, 458.

¹*Moxostoma*. ²*Ameiurus marmoratus*. ³*Carpiodes*.

finds these sufficient to crush the shells of *Sphaerium*, and our nineteen specimens had obtained about one-fourth of their food from this genus. Besides the above families, smaller quantities of the bivalve mollusks occurred in the food of one of the sunfishes (*Lepomis pallidus*) and—doubtless by accident only—in the gizzard shad.

The gasteropod mollusks (snails of various descriptions) were more abundant than bivalve forms in the sheepshead and the sunfishes and all the smaller fishes which feed upon Mollusca, but less abundant in the suckers and the catfishes. In the sheepshead, they made one-fifth of the food of the twenty-five specimens examined, but the greater part of these had not yet passed the insectivorous stage, this being much longer continued in the sheepshead than in many other fishes. A few of these univalve Mollusca occurred in the food of the common perch and in certain species of sunfishes, especially in the super-abundant bream or pumpkin-seed. They made fifteen per cent. of the food of the minute top minnows, and occurred in smaller quantities among the darters, the grass pickerel, the mud minnows, and the cyprinoids. The heavier river snails, *Vivipara* and *Melantho*, were eaten especially by the cylindrical suckers, and the catfishes. The delicate pond snails (*Succinea*, *Limnaea*, and *Physa*) were taken chiefly by the smaller mollusk-eating fishes,—a few of them also by the catfishes and the suckers.

Further particulars concerning the molluscan food may be obtained by the interested reader from the list of food elements at the end of this article.

INSECTIVOROUS SPECIES.

It is from the class of insects that adult fishes derive the most important portion of their food, this class furnishing, for example, forty per cent. of the food of all the adults which I examined.

The principal insectivorous fishes are the smaller species, whose size and food structures, when adult, unfit them for the capture of Entomostraca, and yet do not bring them within reach of fishes or Mollusca. Some of these fishes have peculiar habits which render them especially dependent upon insect life,—the little minnow *Phanacobius*, for example, which, according to my studies, makes nearly all its food from insects (ninety-eight per cent.) found under stones in running water. Next are the pirate perch, *Aphredoderus* (ninety-one per cent.), then the darters (eighty-seven per cent.), the croppies (seventy-three per cent.), half grown sheepshead (seventy-one per cent.), the shovel fish (fifty-nine per cent.), the chub minnow (fifty-six per cent.), the black warrior sunfish, *Chaenobryttus* and the brook silversides (each fifty-four per cent.), and the rock bass and the cyprinoid genus *Notropis*, (each fifty-two per cent.)

Those which take few insects or none are mostly the mud-feeders and the ichthyophagous species, *Amia* (the dog-fish) being the only exception noted to this general statement. Thus we find insects wholly or nearly absent from the adult dietary of the burbot, the pike, the gar, the black bass, the wall-eyed pike, and the great river catfish, and from that of the hickory shad¹ and the mud-eating minnows (the shiner, the fat-head², etc.). It is to be noted, however, that the larger fishes all go through an insectivorous stage, whether their food when adult be almost wholly other fishes, as with the gar and the pike, or mollusks, as with the sheepshead. The mud-feeders, however, seem not to pass through this stage, but to adopt the limnophagous habit as soon as they cease to depend upon Entomostraca.

Terrestrial insects, dropping into the water accidentally or swept in by rains, are evidently diligently sought and largely depended upon by several species, such as the pirate perch, the brook minnow, the top minnows or killifishes (cyprinodonts), the toothed herring and several cyprinoids (*Semotilus*, *Pimephales*, and *Notropis*).

¹ *Dorosoma*. ² *Pimephales*.

Among aquatic insects, minute slender dipterous larvæ, belonging mostly to Chironomus, Corethra, and allied genera, are of remarkable importance, making, in fact, nearly one-tenth of the food of all the fishes studied. They are most abundant in Phenacobius and Etheostoma, which genera, have become especially adapted to the search for these insect forms in shallow rocky streams. Next I found them most generally in the pirate perch, the brook silversides, and the stickleback, in which they averaged forty-five per cent. They amounted to about one third the food of fishes as large and important as the red horse and the river carp, and made nearly one-fourth that of fifty-one buffalo fishes. They appear further in considerable quantity in the food of a number of the minnow family (Notropis, Pimephales, etc.), which habitually frequent the swift water of stony streams, but were curiously deficient in the small collection of miller's thumbs (Cottidæ) which hunt for food in similar situations. The sunfishes eat but few of this important group, the average of the family being only six per cent.

Larvæ of aquatic beetles, notwithstanding the abundance of some of the forms, occurred in only insignificant ratios, but were taken by fifty-six specimens, belonging to nineteen of the species,—more frequently by the sunfishes than by any other group. The kinds most commonly captured were larvæ of Gyrimidæ and Hydrophilidæ: whereas the adult surface beetles themselves (Gyrinus, Dineutes, etc.)—whose zigzag-darting swarms no one can have failed to notice—were not once encountered in my studies.

The almost equally well-known slender water-skippers (Hygretrechus) seem also completely protected by their habits and activity from capture by fishes, only a single specimen occurring in the food of all my specimens. Indeed, the true water bugs (Hemiptera) were generally rare, with the exception of the small soft-bodied genus, Corisa, which was taken by one hundred and ten specimens, belonging to twenty-seven species,—most abundantly by the sunfishes and top minnows.

From the order Neuroptera, fishes draw a larger part of their food than from any other single group. In fact, nearly a fifth of the entire amount of food consumed by all the adult fishes examined by me consisted of aquatic larvæ of this order, the greater part of them larvæ of day flies (Ephemeridæ), principally of the genus Hexagenia.* These neuropterous larvæ were eaten especially by the miller's thumb, the sheepshead, the white and striped bass, the common perch, thirteen species of the darters, both the black bass, seven of the sunfishes, the rock bass and the croppies, the pirate perch, the brook silversides, the sticklebacks, the mud minnow, the top minnows, the gizzard shad, the toothed herring, twelve species each of the true minnow family and of the suckers and buffalo, five catfishes, the dog-fish, and the shovel fish.—seventy species out of the eighty-seven which I have studied.

Among the above, I found them the most important food of the white bass, the toothed herring, the shovel fish (fifty-one per cent.), and the croppies; while they made a fourth or more of the alimentary contents of this sheepshead (forty-six per cent.), the darters, the pirate perch, the common sunfishes (Lepomis and Chanobytus), the rock bass, the little pickerel, and the common sucker (thirty-six per cent.).

Ephemerid larvæ were eaten by two hundred and thirteen specimens of forty-eight species—not counting young. The larvæ of Hexagenia, one of the commonest of the "river flies," was by far the most important insect of this group, this alone amounting to about half of all the Neuroptera eaten. They made nearly one half of the food of the shovel fish, more than one tenth that of the sunfishes, and the principal food resource of half-grown sheepshead; but were rarely taken by the sucker family, and made only five per cent. of the food of the catfish group.

The various larvæ of the dragon flies, on the other hand, were much less frequently encountered. They seemed to be most abundant in the food of the grass pickerel, (twenty-five per cent.), and next to that, in the croppie, the pirate perch, and the common perch (ten to thirteen per cent.).

* The winged adults of this and related genera are often called "river flies" in Illinois.

Case-worms (Phryganeidae) were somewhat rarely found, rising to fifteen per cent. in the rock bass and twelve per cent. in the minnows of the *Hybopsis* group, but otherwise averaging from one to six per cent. in less than half of the species.

THE CRUSTACEAN ELEMENT.

Of the four principal classes of the animal food of fishes: viz., fishes, mollusks, insects, and Crustacea, the latter stand third in importance according to my observations, mollusks alone being inferior to them. That insect larvæ should be more abundant in the food of fresh-water fishes than are crustaceans, is a somewhat unexpected fact, but while the former made about twenty-five per cent. of the food of our entire collection, the crustaceans amounted to only fourteen per cent. These divide conveniently into crayfishes, the medium-sized sessile-eyed crustaceans (Isopoda and Amphipoda), and Entomostraca. The so-called fresh-water shrimps (*Palaemon* and *Palamonetes*) appeared so rarely in the food that they need scarcely be taken into the account.

Crayfishes made about a sixth of the food of the burbot; about a tenth that of the common perch, a fourth that of half a dozen gars, not far from a third that of the black bass,* the dog-fish, and our four rock bass. Young crayfishes appeared quite frequently in some of the larger minnows (*Semotilus* and *Hybopsis*), and also in catfishes, especially the pond and river bull-heads, averaging nearly fifteen per cent. of the entire food of the two most abundant species.

The small, sessile-eyed crustaceans eaten by fishes were nearly all of four species: viz., *Allorchestes dentata*,—excessively abundant in the northern part of the State,—a species of *Gammarus* not uncommon in running streams, and two representatives of the isopod genera *Asellus* and *Mancasellus*. To fishes at large, this group is of little importance; but the perch of northern Illinois finds about one third of its food among them, and the common sunfishes (*Lepomis*) eat a considerable ratio (eleven per cent.). The miller's thumb of southern Illinois seems also to search for them among the stones.

The little *Allorchestes* mentioned above I found in a single white bass, in eleven of the common perch, in one of the largest darters, in five young black bass, in seventeen sunfishes of various species, in the rock bass, the pirate perch, a single grass pickerel and six top minnows, in only two of the true minnow family, in two only of the sucker tribe, in seventeen catfishes,—mostly young or of the smallest species,—in a single dog-fish, and in a single spoon-bill¹. The common *Asellus*, or water wood louse, was less generally eaten: by only two of the miller's thumb, a single sheep-head, a white bass, four perch, two young black bass, eight sunfishes (*Lepomis*), two pirate perch, a grass pickerel, three small catfishes, and a dog-fish.

The minute crustaceans commonly grouped as Entomostraca are a much more important element. Among full-grown fishes, I find them especially important in the shovel fish,—where they made one third the food of the specimens studied,—in the common lake herring², in the brook silversides (forty per cent.), in the stickleback (thirty per cent.), in the darter family (eleven per cent.), and in the mud minnows (ten per cent.). The perch had taken scarcely a trace of them. Among the sunfishes at large they were present in only insignificant ratio; but two genera (*Pomoxys* and *Centrarchus*), distinguished by long and numerous rakers on the anterior gill, had derived about one-tenth of their food from these minute crustaceans. In the early spring especially, when the backwaters of the streams are filled with Entomostraca, the stomachs of these fishes are often distended with the commonest forms of Cladocera.

* Our specimens—especially of the small-mouthed black bass—were too few in number to make this average reliable.

¹ *Polyodon*.

² *Coregonus artedii*.

Notemigonus and *Notropis* among the minnows, represented in my collections by one hundred and twenty-five and one hundred specimens respectively, had obtained about a sixth of their food from Entomostraca.

Ten per cent. of the food of the sucker family consisted of them, mostly taken by the deep-bodied species *Carpiodes* and *Ictiobus*, in which they made a fourth or a fifth of the entire food. This fact is explained, it will be remembered, by the relatively long, slender, and numerous gill-rakers of these fishes. Large river-buffalo were occasionally crammed with the smallest of these Entomostraca,—the minute *Canthocamptus*, only a twenty-fifth of an inch in length.

I have several times remarked the peculiar importance of Entomostraca to the shovel fish,—one of the largest of our fresh-water animals,—a fact accounted for by the remarkable branchial strainer of this species, probably the most efficient apparatus of its kind known to the ichthyologist. Here, again, the smallest forms were the most abundant. Generally, however, the Cladocera were more common than the other orders, the bivalve *Cypris* (most frequent in the mud, being much less abundant in the food, I have shown elsewhere,* at length, that Entomostraca compose by far the greater part of the food of young fishes of all descriptions,—with the partial exception of the sucker family, the young of which feed largely on still more minute organic forms,—and present an abstract of these facts in this article under another head.†

Particulars concerning the use of this abundant and varied group as food for fishes, are so numerous as to make them difficult to summarize, and the interested reader is again referred to the detailed list accompanying this paper.

VERMES AS FOOD FOR FISHES.

Probably to those accustomed to the abundance of true worms (Vermes) in marine situations, no feature of the poverty of fresh-water life will be more striking than the small number of this sub-kingdom occurring in the course of miscellaneous aquatic collections in the interior. Similarly we notice that in the food of fishes the occurrence of Vermes is so rarely noticed that they might be left out of account entirely without appreciably affecting any of the important ratios.

The minnows (cyprinoids) had eaten more of them than any other family,—three per cent. of the food of twenty-two specimens of *Semotilus* being credited to them, and one per cent. of that of thirteen specimens of *Pimephales*, besides a trace in the food of *Notropis*. More precisely analyzed, we find that a single *Nais*, a *Lumbriculus*, two examples of *Gordius* (doubtless taken as insect parasites) and several minute rotifers (wheel-animalcules) are the forms upon which this estimate is based.

A trace of Vermes likewise appears in the food of suckers,—mostly a polyzoan species (*Plumatella*) and minute rotifers sucked up with the mud.

Catfishes alone seem purposely to eat leeches, these occurring in nine specimens of three different species of this family, and also in one common sucker and in a single shovel fish. This leech last mentioned and a small quantity of *Plumatella* were the only Vermes eaten by the shovel fishes which I examined.

A planarian worm occurred in one small stone cat, while rotifers were recognized in a common minnow, eight young red-horse, six young chub-suckers¹, five of the common sucker², a single *Carpiodes* young, and seven young buffalo. Polyzoa were noted, in addition to the instances above mentioned, in four common sunfishes, the croppie, and seven buffalo.

* Bull. Ill. St. Lab. Nat. Hist., Vol. I., No. 3, pp. 75, 76.

† See pp. 495 and 496.

1 *Erimyzon sucetta*. 2 *Catostomus teres*.

SPONGES AND PROTOZOA.

One of the fresh water sponges (*Spongilla*) had been eaten in considerable quantities by two examples of the spotted cat taken in September, but this element was not encountered elsewhere in my studies.

That the minutest and simplest of all the animal forms, far too small for the eye of a fish to see without a microscope, should have been recognized in the food of seventeen species of fishes is, of course, to be explained only as an incident of the feeding habit. It is possible, however, that these Protozoa, where especially abundant, may be recognized in the mass by the delicate sensory structures of the fish; and they seem in most cases to have been taken with mud and slime rich in organic substances. As most of them are extremely perishable, and can scarcely leave a trace a few seconds after immersion in the gastric juices of the fish, it is probable that they contribute much more generally than our observations indicate to the food of some fishes, especially to those which feed upon the bottom.

Young suckers under six inches in length clearly take them purposely, substituting them in great part for the Entomostraca taken by other fishes of their size and age.

I detected Protozoa in the food of several genera of Cyprinidae, in the young of buffalo, the river carp, the chub sucker, the red horse, the stone roller¹, in the common sucker, in a single gizzard shad, in a stone cat, and in a top minnow. The commonest forms, as would be supposed, were those protected by permanent shells: viz., *Difflugia*, *Centropyxis*, *Arcella*, and the like; but occasionally specimens of *Actinosphaerium*, *Euglena*, and *Dinobryon* were present and recognized.

SCAVENGERS.

The only scavenger fishes of our collection were three species of the common catfishes: the spotted cat, the yellow cat, and the marbled cat, — all of which had eaten dead animal matter, including pieces of fish, ham, mice, kittens, and the like. A single large-mouthed black bass had likewise eaten food of this description.

VEGETABLE FEEDERS.

Considering the wealth of vegetation accessible to aquatic animals, and the fact that few other strictly aquatic kinds have the vegetarian habit, it is indeed remarkable that the plant food of fishes is an unimportant part of their diet. Taking our nine hundred specimens together, the vegetation eaten by them certainly would have amounted to less than ten per cent. of their entire food, and excluding vegetable objects apparently taken by chance, it probably would not reach five per cent.

The greatest vegetarians are among the minnow family, largely in the genera *Hybopsis*, *Notemigonus*, and *Semotilus*, thirteen specimens of the first and twenty-five of the second having taken about half their food from vegetable objects. One hundred and twelve *Notropis*, twenty-two *Semotilus*, eighteen *Hybognathus*, and nine *Campostoma*, had found in the vegetable kingdom a fourth or fifth of their food. Counting each genus as a unit, I find that the family as a whole obtained from plants about twenty-three per cent. of its food. The little *Phenacobius*, already reported as strictly insectivorous, was the only one studied in which vegetation can scarcely be said to occur.

The mud minnows (*Umbridae*) are also largely vegetarian (forty-one per cent.); and likewise the cyprinodonts, the vegetable average in the food of thirty-three specimens being seventeen per cent. Plant structures made about one-fourth the food of seven sticklebacks.

¹ *Hypentelium*.

Certain of the sunfishes evidently take plant food purposely, on occasion, this making, for example, nearly a tenth of the food of forty-seven specimens of *Lepomis*. Among the larger fishes, the principal vegetarian is the gizzard shad, in which this element was reckoned at about a third,—taken, however, not separately, but with quantities of mud. A considerable part of it was distillery slops obtained near towns.

The buffalo fishes are likewise largely vegetarian, more than a fourth of their food coming from plants,—about a third of this in our specimens, refuse from distilleries. Vegetation made a tenth of the food of the larger genera of catfishes (*Amiurus* and *Ictalurus*),—some of it distillery refuse,—and nearly as large a ratio of that of the great *Polyodon*.

Not infrequently, terrestrial vegetable rubbish—seeds of grasses, leaves of plants, and similar matter—was taken in quantity to make it certain that its appropriation was not accidental.

Besides a great variety of Algae, both filamentous and unicellular, including considerable quantities of diatoms, the principal plant forms found in the food of fishes were the duck-weeds *Lemna* and *Wolffia*. The deep-bodied suckers, especially, occasionally take quantities of these little plants during the autumnal months.

MUD.

The principal mud-eating fishes are the gizzard shad, the common shiner, and the genera of minnows belonging to the groups with elongate intestines and cultrate pharyngeal teeth: viz., *Pimephales*, *Hybognathus*, *Chrosomus*, and *Campostoma*. Much mud was taken also by the cylindrical members of the sucker family, but apparently as an incident to their search for mollusks.

SUMMARY OF THE FOOD OF THE YOUNG.*

By an examination of three hundred and seven specimens, representing twenty-seven species, twenty-six genera, and twelve families of Illinois fishes, I learn that the food of many species differs greatly according to age, and that, in fact, the life of most of our fishes divides into at least two periods, and that of many into three, with respect to the kinds of food chiefly taken.

In the first of these periods a remarkable similarity of food was noticed among species whose later feeding habits are widely different. The full grown black bass, for example, feeds principally on fishes and crayfishes, the sheephead on mollusks, and the gizzard shad on mud and Algae, while the catfishes are nearly omnivorous; yet all these agree so closely in food when very small, that one could not possibly tell from the contents of the stomachs which group he was dealing with.

I will now summarize the facts concerning the earliest food of the principal species, taken *seriatim*:

The food of six common perch (*Perca lutea*) from an inch to an inch and a quarter long, consisted wholly of Entomostraca (ninety-two per cent.) and minute larvæ of Chironomus. No very small white bass (Labracidae) were found, the youngest being an inch and a quarter long. Half the food of this consisted of Entomostraca, and the other half of minute gizzard shad. Forty-three sunfishes (Centrarchidae) from five-eighths of an inch to

* For detailed treatment of this topic see Bull. Ill. St. Lab. Nat. Hist., Vol. I., No. 3, p. 66, and No. 6, p. 95.

two inches long, had made ninety-six per cent. of their food of Entomostraca and the small larvæ of gnats (*Chironomus*) already mentioned, seventy per cent. of the first and twenty-six of the second. This group comprised five specimens of black bass under three-quarters of an inch in length, two rock bass of similar size, two of the large-mouthed sunfish (*Chenobryttus*) from seven-eighths of an inch to an inch long, nineteen of the commoner sunfishes (*Lepomis*) ranging in length from an inch to two inches, five of the genus *Centrarchus*, one inch and under, four croupies (*Pomoxys*) from three-quarters of an inch to an inch and a half, and six indeterminable specimens, probably *Lepomis*, from seven-sixteenths to five-eighths of an inch long. A single sheephead an inch and an eighth in length had eaten *Chironomus* larvæ (seventy-five per cent.) and larvæ of the "river fly" (*Hexagenia*). A single grass pickerel about an inch and a quarter long had taken about sixty per cent. of its food from Entomostraca and young Amphipoda, the remainder consisting of little fishes.

The first food of the common white-fish was determined experimentally, the breeding habits of this species making direct observation impossible. Three hundred and forty very young fry fed with fragments of the brook shrimp, *Gammarus*, in a hatching house, were examined in January, 1881, and thirty-five of them, which had apparently taken food, were dissected. Minute fragments of *Gammarus* were found in but eighteen of these, while five contained minute insect larvæ, four, Entomostraca, and eight, small particles of vegetation,—objects accidentally conveyed to them in the water of the hatching house. In two hundred and forty-two others, confined in spring water, only eight were found to have eaten anything, and these had taken only Algae and vegetable fragments. In February of the same year, fourteen specimens, confined in a small aquarium and supplied with living objects, plant and animal, from stagnant pools, were proven to feed freely upon the smallest Entomostraca presented to them,—chiefly *Cyclops* and *Canthocamptus*, ten of the fourteen eating *Cyclops*, three *Canthocamptus*, and one a specimen of each.

A little later, a more extensive experiment was conducted by means of a large aquarium, in which there were placed several hundred fry, kept constantly supplied with all the living objects which a fine gauze net would separate from the waters of Lake Michigan. Of one hundred and six of these, dissected within the following fortnight, sixty-three had taken food consisting almost wholly of the smallest Entomostraca occurring in the lake (a minute *Cyclops* and a slender *Diaptomus*). The other objects encountered were rotifers, and diatoms and other unicellular Algae, appearing, however, in such trivial quantity as to contribute nothing of importance to the support of the fry.

A dozen specimens of small gizzard shad, ranging in length from four-fifths of an inch to nearly two inches, had eaten about ninety per cent. of Entomostraca, two per cent. of *Chironomus* larvæ, and, for the remainder, Algae.

The true minnows (*Cyprinidae*) seem to agree with the suckers in the more minute character of their early food. Six examples—three-eighths to three-fourths of an inch long—too small to determine, but apparently belonging to the genera *Minnilus*, had eaten Entomostraca, *Chironomus* larvæ, many Protozoa, and unicellular Algae, a few filamentous Algae and minute fungi and fungus spores, a water mite, and a few accidental insects. In several specimens of the common chub minnow (*Semotilus*), from five-eighths of an inch to an inch in length, seven per cent. of the food was Entomostraca, and the remainder consisted of filamentous Algae. It should be noted, however, that twenty per cent. of that of the smallest specimen, which was five-eighths of an inch long, was *Cyclops*, and it may be that *Semotilus* lives wholly on Entomostraca at first, merely changing its habit earlier than most of its allies. Two other minnows of the genus *Notropis*, an inch and a half in length, had eaten nothing but Entomostraca. The *Cyprinidae*, like the sucker family, are toothless when young.

Thirty young suckers were studied, representing five genera of their family. The very smallest were found feeding on Entomostraca only, and it is possible that these usually form the first food of the family; but later they resort to elements still more minute: viz., rotifers, Protozoa, and unicellular Alga, quantities of which were found in the intestines of young suckers six inches or more in length. Young stone rollers (*Hypentelium*) not more than an inch and a half long, had taken chiefly larvæ of *Chironomus* (ninety per cent.), the remaining tenth being principally Entomostraca. A single small black sucker (*Minytrema*) had eaten little but *Cyclops*. Four chub suckers (*Erimyzon*), two three-quarters of an inch, and two an inch and a quarter long, had eaten only Entomostraca and a trace of water mites. In two larger specimens, however, still minuter forms were the leading feature of the food, including rotifers, Protozoa, and unicellular Alga. Another example, three inches long, had eaten a trace of *Chironomus* larvæ, but for all the rest, one of the smallest of the Entomostraca (*Canthocamptus*). Ten young red horse (*Moxostoma*), varying in length from an inch to two and three-fourths inches, had fed largely upon Protozoa,—especially the largest of the specimens,—but the smallest of them had taken a considerable amount of Entomostraca,—notably the bivalve cyprids occurring on the bottom. Two of the commonest buffalo fish (*Ictiobus*), seven-eighths of an inch long, had eaten most freely of unicellular Alga (sixty-three per cent.), the remainder of the food consisting of rotifers and Entomostraca. Four of the river carp (*Carpoides*), seven-eighths of an inch to two inches long, had fed like the preceding, except that the Entomostraca amounted to nearly half the food, while the rotifers were comparatively few.

Young catfishes, only three-eighths of an inch in length, belonging to the genus *Amiurus*, but quite too small to be specifically determinable, were filled with various Entomostraca and *Chironomus* larvæ. Other examples of this genus, making thirteen in all, none longer than an inch and five-eighths, had fed almost wholly on Entomostraca and larvæ of *Chironomus*, the latter, however, composing seventy-four per cent. of the food of all, and the former eighteen per cent. Six small stone cats (*No-turus*), varying in length from seven-eighths of an inch to one and a half inches, had taken more *Chironomus* larvæ and scarcely any Entomostraca.

A single dogfish (*Amia*), one and three-fourths inches long, had eaten seventy per cent. of Entomostraca, a few larvæ of *Chironomus*, some small crustaceans, and aquatic insects. Others of the species, under an inch in length, had the intestine packed with Entomostraca. Of the common river gars one, an inch and a quarter long, had filled itself with minute Entomostraca, while two other specimens had eaten only the smallest fry of fishes.

To recapitulate, I find that, taking together the young of all the genera studied, considering each genus as a unit, and combining the minute dipterous larvæ with the Entomostraca as having essentially the same relation, about seventy-five per cent. of the food taken by young fishes of all descriptions, is made up of these elements.

From the above it is clear that young fishes in general depend at first on Entomostraca and certain small insect larvæ (chiefly those of two genera of gnats), beginning with the smallest of these forms, or with those especially exposed to their attack. One-celled plants and animals are also eaten freely by the young of two of the largest families.

Correlated with these facts, I find that two at least of the genera, which are toothless when adult, have minute raptorial teeth in this early stage, viz., *Coregonus* and *Dorosoma*. Otherwise young fishes have no apparatus specially adapted to the capture of their minute prey, but this is brought within their reach merely by their own small size and the corresponding minuteness of their structures of food prehension. Later, as the larger species grow, this apparatus becomes too coarse to retain objects so minute, but other food resources are made available, usually through some adaptive modification of the fishes themselves.

In other words, one-celled organisms and Entomostraca are the natural, and practically the only, food of an undifferentiated small fish; and to be at liberty to grow, the fish must either change its food (as is usually done) or must develop a special apparatus (commonly a set of fine long gill-rakers) for the separation of Entomostraca from the waters in which they swim.

Of the fishes which emerge from this earliest stage, through increase in size with failure to develop alimentary structures especially fitted to the appropriation of minute animal forms, some become mud-eaters, like *Campostoma* and the gizzard shad; a few apparently become vegetarians at once; but most pass into or through an insectivorous stage. After this a few become nearly omnivorous, like the bullheads; others learn to depend chiefly on molluscan food—the sheephead and the redhorse species—but many become essentially carnivorous. In fact, unless the gars are an exception, as they now seem to be (attacking young fishes almost as soon as they can swallow), all our specially carnivorous fishes make a progress of three steps, marked respectively, by the predominance of Entamostraca, of insects, and of fishes, in their food; and the same is true of those strictly fitted for a molluscan diet.

While small fishes of all sorts are evidently competitors for food, this competition is relieved to some extent by differences of breeding season, the species dropping in successively to the banquet, some commencing in very early spring, or even, like the whitefish, depositing their eggs in fall, that their young may be first at the board, while others delay until June or July. The most active breeding period coincides, however, with that of the greatest evolution of Entomostraca in the backwaters of our streams; that is, the early spring.

That large adult fishes, with fine and numerous rakers on the gills—like the shovelfish and the river carp—may compete directly with the young of all other species, and tend to keep their numbers down by diminishing their food supply—especially in times of scarcity—is very probable, but is not certainly true; for these larger fishes have other food resources also, and may resort to Entomostraca only when these are superabundant, thus appropriating the mere excess above what are required for the young of other groups.

ON THE DEFINITENESS AND PERMANENCY OF THE FOOD HABITS OF FISHES.

It is always possible that the seemingly specific differences of food exhibited by data derived from miscellaneous collections not strictly comparable as to dates and localities, are really due to differences of circumstance affecting the representatives of the species, and not to differences in the food habits or the regimen of the species in general. Date, locality, and other circumstantial conditions, may have more to do with the distinctions of food detected than structure and specific habit. It is true that the probability of such errors of inference is reduced to a minimum where alimentary peculiarities can be clearly correlated with peculiarities of structure, as has usually been done in my discussions; but to test still further the distinctness of species and genera with respect to food habits and preferences, I have assorted my observations according to dates and localities of the collections on which they were made, and have compared species with species as occurring under the same general conditions and at the same time. If perch and catfishes caught in the same haul of the seine show more marked differences in food between the two groups than those exhibited by the individuals of each group among themselves, the probability is considerable that the differences are specific instead of accidental; and such probability becomes greater the greater the number of species found to present corresponding differences under corresponding circumstances. Although it was rarely the case that examples enough of

two or more species comparable as to size and range had been taken at the same time and place to afford a tolerable average of the food under local conditions, yet a sufficient number of such cases was found to give a considerable amount of evidence on this point.

Thus three specimens of the marbled cat, *Ameiurus marmoratus*, taken at Peoria, Nov. 1, 1878, had derived nine-tenths of their food from *Hexagenia* larvæ, the remainder consisting of leeches and a few spiders: while eight specimens of the large-mouthed black bass, *Micropterus salmoides*, taken at the same time and place, had eaten nothing but the young gizzard shad (*Dorosoma*).

Comparing the food of four examples of the channel cat *Ictalurus punctatus* with seven croppies (*Pomoxys*), both taken at Peoria, April 10, 1878, I found that aquatic insects made ninety-eight per cent. of the food of the latter, seventy per cent. being *Hexagenia* larvæ, while only sixty-two per cent. of the food of the catfishes consisted of insects (ephemerid larvæ twenty-eight per cent.), the remainder consisting of vegetation and scraps of dead fishes.

A contrast equally decided is shown by three specimens of the gizzard shad (*Dorosoma*) and four of the rock bass (*Ambloplites rupestris*), all obtained at Ottawa, July 8, 1879. The former had swallowed large quantities of fine mud containing about twenty per cent. of minutely divided vegetable *débris*, while the latter had fed wholly upon insects, fishes, and crayfishes—the first chiefly aquatic larvæ.

Even in the shallow muddy pools left behind in the retreating overflow of the Mississippi in southern Illinois, fishes of the same size but differing widely in alimentary structures exhibit corresponding differences in the selections made from the meager food resources of their localities. Two of the common blunt-jawed minnows (*Hypognathus nuchalis*) had fed here almost wholly upon mud mixed with Algae and miscellaneous vegetation: while three of the little pirate perch (*Aphredoderus*) had eaten little but *Chironomus* larvæ, half the food of one of the specimens being wholly small fishes, and insignificant quantities of Entomostraca occurring in the stomachs of the others.

A small collection, made from the Little Fox river, in White county, in southern Illinois, Oct. 5, 1882, of four specimens each of *Labidesthes* and *Zygonoetes notatus* enables us to bring into comparison the food of two extremely different species taken together from the same pools in a running stream. The *Labidesthes*, although predaceous in habit and feeding most commonly upon Entomostraca, was here giving its attention wholly to terrestrial insects—more than two-thirds of them winged *Chironomus*: while the *Zygonoetes* had eaten in addition to thirty-seven per cent. of terrestrial insects (scarcely any of them *Chironomus* imagos), about thirty per cent. of aquatic vegetation, nine per cent. of Entomostraca, eleven per cent. of aquatic insects, and fourteen per cent. of mollusks. These differences in food have no apparent relation to the essential structural differences of the species, but must be considered an illustration of the various effect of like conditions when applied to different species.

On the other hand, three bull-heads (*Ameiurus nebulosus*) and six common perch (*Perca*) taken from Fox river, at McHenry, May 9, 1880, did not differ remarkably in food, both groups having eaten crayfishes, mollusks, aquatic insects and vegetation. One of the catfishes had taken another fish and one had eaten leeches. It is to be noted, however, that these species are both bottom feeders, and that both lots of these specimens had taken about the average food of their kind.*

The above are examples of the food relations of fishes widely separated from each other in the classification, and decidedly different in alimentary structures and in feeding habits. Illustrations of the differences in food apparent in species allied in classification but differing with respect to the structures concerned in the appropriation of food are given by the following examples.

*See Bull. Ill. St. Lab. Nat. Hist., Vol. I., No. 3, p. 35.

Two species of minnows, *Chrosomus erythrogaster* and *Semotilus atromaculatus*—the first represented by fourteen specimens and the second by six, all collected from a small tributary of the Fox, near Plano, Sept. 8, 1882—were brought into comparison with reference to their food, with the result that the characteristic differences of the species, as shown in the general discussion of the group published in our Bulletin 6, Vol. I., were clearly manifested by this small number. In the former lot seventy-five per cent. of the food was mud, the remainder being indiscriminate vegetable *débris*; while in the latter the entire mass consisted of insects (chiefly terrestrial) except a single insect parasite (*Gordius*).

From one of the permanent ponds or so-called lakes of southern Illinois, covered in September with a film of *Wolffia* and other vegetation, three specimens of *Gambusia patruelis* and five of *Umbrina limi* were examined. The former had eaten little but *Wolffia*, which amounted to more than ninety per cent. of the food, the remainder consisting of Entomostraca, mollusks and aquatic insect larvæ, while the *Umbrina* made less than sixty per cent. of the food of the *Umbrina*—about one-fourth consisting of Entomostraca and the remainder of unrecognized insects.

Two minnows of similar range (*Phenacobius mirabilis* and *Notropis whipplei*) agree essentially in gill structure and pharyngeal teeth, and differ but little in the relative length of intestine, and they have consequently been placed by me in the same alimentary group.* They are unlike, however, in the form of the mouth and in their haunts and feeding habits. This difference is reflected in the food of a small collection made in the Galena river, in April, 1880, three specimens of *Phenacobius* having eaten only aquatic larvæ and pupæ (nearly all chironomid), while the food of the *Notropis*, represented by six specimens, was of a varied character, containing few aquatic larvæ (only one per cent. of *Chironomus*), but consisting chiefly of miscellaneous collections of terrestrial insects, seeds and anthers of terrestrial plants, and other accidental rubbish.

From a collection made at Henry, Illinois, Nov. 1, 1887, four specimens of croppie (*Pomoxys nigromaculatus*) are comparable with five sunfishes (*Lepomis pallidus*), and three large-mouthed black bass (*Micropterus salmoides*) may be compared with three striped bass (*Morone chrysops*). Eighty-four per cent. of the food of the *Pomoxys* consisted of *Hexagenia* larvæ, an additional six per cent. being other aquatic larvæ, and the remaining ten per cent. consisting of fishes; while the *Lepomis* had eaten but twelve per cent. of *Hexagenia* larvæ, eight per cent. of other aquatic insects, and no fishes at all—the remaining elements being terrestrial insects (about one-fourth), worms (*Nais* and *Lumbriculus*, fifteen per cent.) and mollusks (thirty-seven per cent.).

The black bass had eaten chiefly fishes and a mouse, together with a few aquatic insects, while the food of the striped bass was nearly all ephemeropterid larvæ with only a trace of fishes.

A collection of small fishes, made from Mackinaw creek, in Woodford county, August 20, 1879, affords an interesting opportunity to compare the food of a number of the smaller species (cyprinoids, darters, etc.). About half that of four specimens of *Notropis megalops* collected there consisted of insects, the remainder being terrestrial and aquatic vegetation, and substantially the same statement may be made with respect to six specimens of *Notropis whipplei*—these two species belonging respectively to the third and fourth groups of my paper on the "Food of the Smaller Fresh Water Fishes."*

Two specimens of *Hypobrycon biguttatus*, on the other hand, had eaten only aquatic vegetation, and two examples of *Phenacobius*—a species extremely darter-like in its haunts and habits—had taken only *Chironomus* larvæ.

The darters were represented by four examples of *Boleosoma* and six of *Hadropterus*, the former and smaller species having eaten mostly Chirono-

*Bull. Ill. St. Lab. Nat. Hist., Vol. I., No. 6, p. 76.

mus larvæ and Entomostraca—eighty-nine per cent. and eleven per cent. respectively—while the larger had taken only aquatic larvæ—nearly all ephemeroids.

Finally, eight of the slender, active and wholly predaceous little brook silversides (*Labidesthes sicculus*) had eaten a single fish, fourteen per cent. of Entomostraca, and about eighty per cent. of insects—somewhat more than half of aquatic origin. In brief, the structures of *Labidesthes*, the habits of *Phenacobius* and the darters, and the differences in size of the species of *Boleosoma* and *Hadropterus* were all reflected in the food of this little group.

The obverse fact of the unifying effect of similarity of alimentary structures is apparently shown by a small collection of minnows, all belonging to the first two groups of the paper cited above,* made from an extremely muddy little creek in Jersey county, which contained no visible vegetation and few, if any, Entomostraca. Twelve of these fishes, representing the genera *Campostoma*, *Pimephales*, *Hyborhynchus*, *Hybognathus* and *Notemigonus*, agreed in food almost precisely, all having swallowed the fine mud of the creek bottom, with a slightly varying admixture of unicellular *Algæ* and vegetable *débris*.

As an example of a contrast between two species agreeing in alimentary structures, but differing in size and somewhat, also, in habitual range, we may take three examples of *Notropis heterodon* and three of *Notropis megalops*, captured at McHenry, May 8, 1880. More than half the food of the latter group consisted of vegetation, and of the former only ten per cent. The remaining ninety per cent. of the food of *heterodon* was Entomostraca; but these were not represented at all in the *megalops*, the remaining food of these specimens consisting of insects and amphipod Crustacea.

Sensible and even conspicuous differences in food often appear between groups which are neither widely separate in classification nor yet distinguished by marked differences in alimentary structures, as between species of the same genus. Sometimes these are apparently due to differences in habit with respect to the search for food, but sometimes seem dependent upon distinction of habit or preferences even more obscure.

Six specimens of the channel cat (*Ictalurus punctatus*, taken at Peoria, October 6, 1887, had eaten insects, mollusks and vegetation at the rate of forty-one, nineteen and forty per cent., respectively, the vegetation being nearly all *Cladophora* and *Potamogeton*, while the same number of bull-heads (*Ameiurus nebulosus*) had derived thirty-seven per cent. of their food from insects and sixty-three per cent. from mollusks. The difference here was substantially a larger ratio of mollusks for *Ameiurus*, replacing the vegetable food of the *Ictalurus* group. By a comparison of these differences with those detected between the species at large, as explained on pages 456-461, it will be seen that the former do not represent the specific differences in food, but simply give evidence that the two species may be differently affected by the same conditions.

Other specific differences in the same genus are shown by the collections made Oct. 27, 1875, from Peoria lake. Eight examples of the wall-eyed pike (*Stizostedion vitreum*) had eaten only soft-finned fishes,—excepting one small sunfish,—while four of ten specimens of the related species *S. canadense*, had eaten spiny-finned fishes, and in only three were the fishes recognizable as belonging to the soft-finned species. Three specimens of *Micropetrus* taken with the above had eaten cray-fishes and fishes (including a catfish).

Among my specimens of the sucker family (Catostomatidae), a lot obtained at Quincy, Aug. 25, 1887, are comparable for the present purpose. Four examples each of *Ictalurus urus* and *I. cyprinella* presented a decided contrast with respect to the elements of their food, that of *I. urus* consisting almost wholly of Chironomid larvæ, with large quantities of dirt, while three of the specimens of *I. cyprinella* had eaten scarcely anything but Al-

*See the preceding page.

gae, ninety per cent. of the food of the fourth being *Chironomus* larvæ, and the remainder, larvæ of Neuroptera,—*Hexagenia* and *Corydalis*.

On the other hand, two small collections of the same species made at Peoria, Oct. 9, 1878—four of *L. urus* and five of *L. cyprinellus*—exhibit similar food, composed chiefly of Entomostraca, *Chironomus* larvæ, distillery waste (meal, etc.), and aquatic vegetation. The *urus* group alone had eaten Entomostraca, these being replaced in the other by a larger quantity of meal.

The facts above recited are evidence that fishes are not mere animated eating-machines, taking indiscriminately and indifferently whatever their structures fit them to capture, to strain from the waters, or to separate from the mud, but that psychological preferences as well as physical capabilities have something to do with their choice of food.

THE STRUCTURES OF ALIMENTATION.

A brief review of the principal facts respecting the structures of alimentation in fishes will be necessary to exhibit clearly the relation of habit and organization in this particular.

These structures may be conveniently divided into those of *search*, of *prehension*, of *mastication*, and of *digestion*. Means of defence and escape may also properly be mentioned, as belonging to the obverse side of the food relation.

Structural peculiarities relating to the methods and situation of the search for food are illustrated by the barbels of the catfishes and the sturgeons, the shovel of *Polyodon*, the square head of the stone roller, the flat heads of the top minnows, and the pointed snouts of the darters,—which fit them for prying about between and under stones in running water. Similarly related, are the bare breasts of many darters and the large pectoral fins of the stone roller and *Phenacobius*.

The structures of food prehension are the lips, the jaws, the teeth, and the gill-rakers, with which should be considered, perhaps, the gill slit or branchial opening. The sucking lips of the *Catostomatidae*, organs of touch as well as of prehension, are of course related to the mud-searching habit of these fishes, the protractile jaws aiding in their use. The stout wide jaws of the catfishes, with their wide bands of minute, pointed teeth, are probably to be understood as an apparatus for seizing, holding, and pulling about relatively large objects, whether hard or soft, and are perhaps most useful in feeding upon mollusks. The very large but weak jaw of the shovel fish is explained by the minute character of its food, which offers no resistance, but necessitates the passage of large quantities of water through the mouth; while the long and slender jaws of the long nosed gar (*Lepidosteus*) armed with several rows of acute raptatorial teeth, are the best apparatus in our waters for the destruction of a relatively small but active living prey.

The teeth of our fresh-water fishes are always pointed and acute, there being no examples of pavement teeth or cutting incisors among them, such as are found in several marine forms, nor are there any instances of either jaw being toothed and the other not. The evanescent teeth of the young of several species which become toothless when mature, are sometimes to be understood as rudiments, as in the shovel fish, and sometimes as related to the early food, as in the white-fish and the gizzard shad.

The gill-rakers of fishes vary widely in number, length, and usefulness, but are as important and significant as any other part of the feeding apparatus. As they oppose the only obstacle to the escape through the gill slit, of objects which enter the mouth with the water of respiration, they set the minimum of size for objects of the fishes food, the only exception to this rule being afforded by the few fishes which swallow mud with little or no discrimination.

They are usually arranged in two rows on each gill arch, with frequently one also on the pharyngeal, behind the last gill slit. Occasionally only one row is developed on each gill plate "herring", and commonly the second row, if present, is less prominent than the first. The shovel fishes are, however, an exception to this latter statement, for in them both rows are equally and remarkably developed. As the anterior rakers guard the relatively large passage-way between the foremost gill and the opercle, while the other rows merely prevent the escape of objects between the several pairs of gills, the anterior row is almost invariably longer than the remaining series. The shovel fish and the gizzard shad are exceptions. The rakers of this row are commonly longest in the middle of the arch, shortening toward each end; but the particulars of this disposition depend on the length and shape of the arch and the concavity of the inner surface of the opercle. In the gizzard shad, however, the short but very numerous and fine gill-rakers project in a nearly horizontal direction.

The gill-rakers, when short and ineffective, are often armed with minute denticles, variously arranged, but are never branched or pinnate. In several of the sucker family, the rakers of the lower horizontal arm of the arch are represented by a thick, broad pad, transversely ridged (the ridges representing the separate rakers) so that when approximated these structures form a continuous floor for the sides of the buccal cavity. The rakers may vary in number in different species from ten or twelve in a series, as in some sunfishes, to more than five hundred, as in the shovel fish; and in length from mere tubercles, to two or three times the length of the corresponding filaments of the gill. Rarely they are completely wanting, as in the pike. The anterior row is commonly so set upon the arch as to be obliquely divaricated by the separation of the branchial structures being thus automatically adapted to the respiratory movements.

They are little developed in young fishes, the small branchial arches and the narrow slits between them serving to separate from the water the minute objects of their earliest food. Their development with the growth of the fish simply enables it to retain as elements of its dietary, objects which the coarseness of its branchial structures would otherwise compel it to forego.

Concerning their relation to food prehension, we may say in general that if numerous, long, and fine, they indicate the importance of Entomostraca to the fish. If less numerous, but moderately long and stout, in a fish of medium size, we may presume that insects form a considerable ratio of the food. If wanting, or rather short and strong, the presumption is (except for the smaller fishes) that the species is either piscivorous or feeds largely upon mollusks, the dental and pharyngeal apparatus easily showing which.

The pike-perch (*Stostedion*) is somewhat remarkable in the fact that although strictly piscivorous when adult, it has long and strong gill-rakers, much longer in fact than in the less piscivorous related species, the common perch. In this case the rakers seem to have been retained, and even further developed, as a basis of attachment for several rather large recurved teeth borne on their inner surfaces, useful in preventing the escape of a living prey.

The masticatory apparatus of fishes (sometimes wanting) comprises always a pair of pharyngeal bones—the lower pharyngeal jaws, a pair of modified branchial arches. These are commonly opposed by superior pharyngeals, which most frequently consist of osseous and cuticular thickenings of the upper ends of the gill arches—sometimes of only one or two, as in the catfish family, sometimes of all, as in the sunfishes. In the cyprinoids, the upper pharyngeal is a quadrate or triangular pad, rarely, if ever, toothed, borne upon an oblique, expanded process of the basioccipital. In the sucker family the sickle-shaped lower pharyngeals act against a more or less indurated palatal arch supported by the same cranial process, the firmness and width of this hardened band vary with the development of the lower arches of the apparatus. In most of the Acanthopteri and in the catfish family the lower pharyngeals have a fusiform outline, varying

in width according to the food, the upper service set with minute denticles sharp-pointed in the insectivorous species, more or less blunt and conical in those which take a considerable per centage of molluscan food. The immense development of these structures in the sheephead (*Aplodinotus*) as a crushing apparatus for mollusca, is too well known to require description. In the *Catostomidae* the number of teeth may vary from thirty or less to two hundred or more, reduction in number going with increase in size (especially in the lower part of the arch), both being related to an increased importance of molluscan food.

In the cyprinoids or minnow family this is practically an insectivorous apparatus, except in some of the species with very long intestine and the limphagous habit, where it seems useful chiefly as a means of grinding up the mud ingested.

In the piscivorous species and in those with highly developed gill-rakers, the lower pharyngeals are commonly slight and insignificant, but in the former group the upper pharyngeals may be preserved and enlarged as a basis for the insertion of hooked teeth, to aid in the retention of their struggling prey.

Concerning the digestive structures, I will only remark that the fishes with the longest intestine are mud-feeders, as a rule, and that in one of them—the gizzard shad, a mud lover, *par excellence*—the pharyngeal jaws (which in the mud-eating cyprinoids are evidently used to grind the food) are functionally replaced by a bulbous, muscular stomach, the pharyngeals themselves being reduced to thin and delicate plates, scarcely better than rudiments.

In this connection the adult size of the fish ought always to be mentioned since this has, perhaps, at least as much to do with the food as any structural endowment, and frequently in fact has had a determining influence on the latter. Many fishes can enjoy the advantages of large size only on condition that they acquire some new capacity of food prehension adapting them to new food relations. Simple and symmetrical growth of a small fish would render it incapable of straining out Entomostraca without fitting it for the appropriation of any other food except, perhaps, the larger Crustacea and some aquatic insects; and beyond this insectivorous stage nothing is possible without new adaptations.

CORRELATIONS OF ALIMENTARY ORGANS.

Correlations of structure may be either mediate or immediate, in the latter case modification of one organ being directly dependent on modification of another, and in the former both parties to the correlation being modified by a common cause. The immediate class of correlations are relatively few and simple in the alimentary structures of fishes, while several of the mediate class are less obvious and more suggestive. That a fish with canine teeth has a strong jaw is a less interesting fact than the weakness of the jaw in one with long and numerous gill-rakers, or the incompatibility of canine teeth and heavy lower pharyngeals. The first is an immediate adaptive adjustment which a child might foresee, while the others are to be understood only when the peculiarities of the food are known to which both owe their character. The weak jaw of the shovel fish and the slight lower pharyngeals of the pike-perch illustrate the law of disuse (especially when we take into account the teeth of the young in the former and the large pharyngeals of the common perch), and the branchial apparatus of the shovel fish and canine teeth of the pike-perch are examples of special adaptation to particular kinds of food.

Some mediate correlations are inverse, others coincident, the related structures varying oppositely or in the same direction. An interesting inverse correlation is exhibited by the gill-rakers and the pharyngeals in the suckers; as the former lengthen and multiply, the latter become weaker and bear smaller and more numerous teeth. The cause of this correlation is seen in the food, the species with heavy pharyngeals, few and large pharyngeal teeth, and few and short gill-rakers being mollusk

feeders, and the other group depending largely on insects and crustaceans and using mollusks sparingly, and then only the small and thin-shelled sorts. A similar inverse relation is seen between the large mouths and the weak pharyngeals of many piscivorous fishes: between the weak pharyngeals and the muscular stomach of the gizzard shad, and between the long gill-rakers and the rudimentary pharyngeals of the shovel fish. Such correlations are often evidence of a specialization and corresponding limitation of the feeding habit—the increased efficiency of one structure corresponding to the increased importance to the fish of the related kind of food, and the defective development of the correlated structure indicating an abandonment of the food for whose appropriation it was especially fitted. On the other hand, the absence of these inverse correlations marks an omnivorous habit—as in the catfishes, whose jaws, teeth, gill-rakers and pharyngeals are all moderately developed, while the food is correspondingly indiscriminate.

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