July 1943

Fishes of the Middle West

Rachel L. Carson
US Fish & Wildlife Service

FOOD FROM HOME WATERS

Fishes

OF THE

Middle West

U. S. DEPARTMENT OF THE INTERIOR

FISH AND WILDLIFE SERVICE

Conservation Bulletin 34

The waters of the Mississippi River and the Great Lakes are a potential source of several hundred million pounds of food in the form of tasty lake and river fishes. This rich resource of the inland waters is important to a nation at war. Because of the growing meat shortage, people will eat more fish than in pre-war years. In the interior of the country, people will eat more fresh-water fish than before, because fish are good and nutritious and because, in the coming months, the shipments of rosefish, halibut, shrimp, and other seafoods that come to them from the Atlantic, Pacific, and Gulf coasts may be curtailed.

Among the scores of fishes native to the Mississippi and the Great Lakes are many excellent food fishes, some of them little known even in the States that produce them in greatest quantity. These fishes, if known and properly used, will add variety to wartime meals and health-giving proteins, minerals, and vitamins to the diet. This publication has been written to acquaint the people of the Middle West with their native food fishes as individual species differing in their food qualities, their adaptability to various methods of preparation, and their seasons of availability.

FOOD FROM HOME WATERS

Conservation Bulletin 34

Fishes

OF THE

Middle West

BY

RACHEL L. CARSON

Aquatic Biologist

Fish and Wildlife Service

UNITED STATES DEPARTMENT OF THE INTERIOR

Harold L. Ickes, Secretary

FISH AND WILDLIFE SERVICE

Ira N. Gabrielson, Director

CONTENTS

UNITED STATES GOVERNMENT PRINTING OFFICE • WASHINGTON • 1943

For sale by the Superintendent of Documents, Washington, D. C. - - - Price 15 cents

FOOD FROM HOME WATERS

The Middle West takes its native fishes from a vast system of waterways—the 2,500 miles of the Mississippi from its headwaters in northern Minnesota to its mouth in the Gulf, the tens of thousands of miles of tributary streams that find their way to the Mississippi, the five Great Lakes, and the thousands of lesser waters ranging from the borderline lakes of Minnesota to the smallest farm ponds of the South. More than thirty kinds of food fishes are found in these waters. They are a rich and varied aquatic bill of fare: delicious whitefish from Huron and Superior, tasty smelt from the lakes or from cold Michigan streams, the richly flavored channel catfish from the swift rushes of the Mississippi, delicate panfish like the perches, crappies, and sunfishes, as well as a score or more of other fishes, many of them familiar but others almost unknown even to the people of the regions that produce them.

Many of the fishes native to the Mississippi Valley and the lake region enjoy a Nation-wide reputation among those who appreciate good food. Wherever it appears, on the menus of famous restaurants or in private dining rooms, the whitefish is rated one of the most delicious of fishes. Smelt taken from beneath the ice of Lake Michigan are rushed eastward to the people of New York, Boston, and other eastern cities. Also widely known and highly regarded are broiled lake trout and smoked herring. Less familiar except in scattered communities are the excellence of certain recipes for creating a savory dish from the catfish, the tastiness of a carp taken from clear, cold waters and properly prepared, or the fish chowders which rank as epicurean dishes.

The fishery resources of the Middle West yield more than 140 million pounds of food a year. This figure represents only the commercial catch. To it must be added the large but unknown poundage taken by the sportsman and by the hook-and-line fisherman who brings in a string of perch or crappie for his family's dinner. Another unmeasured but substantial crop comes from the private ponds where farmers raise sunfish, bass, and other fish as a sideline to their corn, hogs, wheat, and cattle.

Being widely distributed throughout the region, this food crop of midwestern waters makes only modest demands on our transportation

system, for almost every community has a fish supply of some sort within the range of a short truck haul. This is an excellent reason for eating locally produced fish.

As beef, pork, and lamb grow scarce in domestic markets, fish become more and more important as nutritious and highly acceptable alternates. This wider use of fish should be a pleasant and healthful change in the diet of American households. Real satisfaction in the use of fish will not be attained, however, until the great variety and the distinctive qualities of the individual species are understood. Some fish are fat, some lean; some are adapted to the preparation of the substantial main dish of the meal, others to the creation of salads and appetizers. By varying the method of cooking in accordance with these characteristics, the natural flavors and textures are preserved. It is to provide an understanding of the individual qualities of the fishes of the Middle West that this paper is written.[1]

FISH HAVE A HIGH NUTRITIVE VALUE

Most people eat fish because they enjoy their varied flavors and their adaptability to many different methods of preparation. There are further benefits from eating aquatic food, however, for fish are good natural sources of calcium, phosphorus, iron, and copper, and provide protein of unexcelled quality. Some species also furnish vitamins in appreciable quantities and sea fish are rich in iodine.

Fish are an important source of proteins, a type of food which must be included in the diet to provide the elements needed to grow and repair worn-out body tissues. Some proteins are complete in that they supply all of the elements needed; others are incomplete and must be supplemented with other protein foods if the body is to remain in normal health. Fish proteins, like those in beef, pork, and other meats, are complete in themselves and proteins of this type should supply about one-third of the daily protein requirement.

Fish are an excellent source of most of the minerals which the body needs to develop properly and perform its functions. Calcium and phosphorus (without which proper development of bones and teeth is impossible) occur in fish fillets in about the same quantities as in beef round. Marine fishes are especially rich sources of iodine, containing 50 to 200 times as much of this essential element as any other food. Oysters, shrimp, and crabmeat, compared with milk, provide half as much calcium, five times as much magnesium, and slightly more phosphorus. Iron and copper, which build up the hemoglobin

[1] Several photographs reproduced in this bulletin were made available through the courtesy of the Detroit News, the Detroit Free Press, the Michigan Department of Conservation, and the Wisconsin Department of Conservation.

content of the blood and prevent or remedy nutritional anemia, are easily obtained by eating most fish. Oysters and shrimp are the best known sources of these two minerals.

12,624

Figure 1.—"Main Street" in a Great Lakes fishing village.

Although fish-liver oils have long been recognized as first-class sources of vitamins A and D, it is less widely known that the flesh of fish is also a source of several vitamins. On the average, daily

vitamin requirements could be obtained from ordinary serving portions of fish to the following extent: vitamin A, 10 percent; vitamin D, more than adequate amounts; thiamin (vitamin B_1), 15 percent; riboflavin (vitamin B_2) and nicotinic acid (another element of the vitamin B complex), 70 percent.

GENERAL GUIDES FOR SELECTING AND PREPARING FISH

How to buy.—Insist upon freshness. A fresh fish may be recognized by the following: firm and elastic flesh, scales that cling to the skin in most species, reddish gills free from disagreeable odor, eyes bright and full, not sunken. In selecting shellfish like clams and oysters, be sure that the shells are tightly shut, indicating that the animals are alive, unless you prefer to buy the meat separately as shucked shellfish. Crabs and lobsters should be bought alive or as cooked meat. However, uncooked shrimp may be bought in the shell provided it feels firm to the touch. Cooked shrimp is sold either with or without the shell, with the heads already removed.

When to buy.—In general, the fish of any species are of highest food quality when most abundant, for at these periods fishermen are making their catches in the shortest time and shipping them promptly. Usually, but not always, fish are cheapest when most abundant. (See pages 6 to 9 for information on seasonal changes in the market supplies of some midwestern fishes.)

Common market forms.—Fresh (refrigerated) fish and completely frozen fish should be equally good if the freezing is done by the modern methods now well known to the industry. Both are marketed in a variety of convenient forms, as follows:

Whole or round fish are those marketed in the form in which they come from the water, and are of three kinds: fish that keep as well or better without dressing, small fishes, or the small sizes of larger species. Before cooking, whole or round fish are eviscerated, and in all but the very small sizes, the heads, scales, and sometimes the fins are removed.

Drawn fish are those marketed with only the entrails removed. To prepare these fish for cooking, the heads, scales, and (if desired) the fins are removed, and the fish may be split or cut into serving portions if too large to be cooked whole.

Dressed fish have had the head and entrails removed and the tail and fins may be cut off. If dressed fish are large, they may be cut into pieces in preparation for cooking. Very large dressed fish are sometimes marketed in pieces.

Steaks are slices (usually about half an inch thick) cut across a large dressed fish.

Fillets are meaty slices cut lengthwise from the sides of the fish. Fillets contain no bones or other waste. Their weight varies with the size of the fish from which they are cut.

Sticks are crosswise or lengthwise cuts of fillets.

12,82

Figure 2.—Pound nets take large quantities of whitefish, lake trout, herring, suckers, and pike perches.

Canned fish.—Besides the universally familiar canned salmon, tuna, and sardines, many kinds of fish are canned for use in main dishes, salads, and appetizers. For the duration of the war, however, the amount of canned fish available for civilians will be considerably less than normal.

Salt or smoked fish.—Tasty variations in the menu are provided by salt or smoked fish. Salt fish ordinarily requires one-half to several hours' soaking before further preparation; while smoked fish usually is ready to eat as it is, or may be heated.

Fat content of fish.—For best results in preparing a fresh fish, it is always desirable to know whether it is fat or lean. Fat fish are especially suitable for baking, and may also be broiled, while lean fish are best adapted to steaming, boiling, and frying. Medium-fat fish are prepared like the lean, or may be dressed with strips of salt pork or bacon and baked. Most cook books classify fish as follows:

Fat fish are those containing more than 5 percent fat. Examples are catfish, herring, and lake trout.

Medium-fat fish are those containing from 2 to 5 percent fat. Examples are smelt and perch.

530548°—43——2

Lean fish are those containing less than 2 percent fat. Examples are sheepshead, pike, and carp.

Sauces and garnishes.—The attractiveness of almost any dish consisting of fish will be increased greatly by the use of sauces that subtly enhance or complement the flavor. Any good cook book contains excellent suggestions as to the choice and preparation of such sauces. Fresh and colorful garnishes also do much to create a dish as pleasing to the eye as to the palate, thereby whetting the appetite and helping to make the serving of fish a pleasurable and often repeated experience.

AVAILABLE SUPPLIES OF FISH IN MIDWESTERN WATERS

Of the total fish supply from the Mississippi River and the Lakes, the only part that can be measured with any degree of accuracy is the commercial catch. While the poundage taken by commercial fishermen is presumably the major part of the available supply, it is supplemented by the catch of anglers and by the production of farm fish ponds. Total yields from the last two sources can only be estimated at present. Neither are our figures for the commercial catch entirely satisfactory, for no complete canvass has been made of the fisheries of the Mississippi River during the past decade. On the Great Lakes, the most recent complete figures were collected in 1940. The information presented in table 1, which records the catch in the Lakes in 1940 and the Mississippi River catch in 1931, is, therefore, only an approximate indication of the amount of food that may be derived from the fisheries of this region. Probably it errs on the side of conservatism, for the intensity of the river fisheries may have increased appreciably during the past decade.

SEASONAL VARIATIONS IN THE MARKET SUPPLY

Fish of a large number of species, either fresh or in the equally good frozen form, are available at any season. Each species, however, has a particular period—of one to several months—during which it is especially abundant in the markets. Ordinarily it is during this seasonal peak that fish reach the market in best condition. This is true either because fishermen seek fish when they are in their prime (fattest, or of best flavor), or for the simple reason that when fish are plentiful fishermen make their catches quickly and send them to the markets in the shortest possible time. In buying fish, therefore, it is helpful to know something of these changes in the market supplies.

Our only source of complete information on the month-to-month supply of fishes in markets of the Middle West is contained in the

reports of the Fishery Market News office of the Fish and Wildlife Service in Chicago. The following information is based on these reports. Although applicable in all details only to the Chicago area, it will give a general picture of the seasonal shifts in the availability of the various species.

Table 1.—Production of edible fish and shellfish in the Great Lakes and the Mississippi River and its tributaries [1]

[Expressed in thousands of pounds and thousands of dollars; that is, 000 omitted]

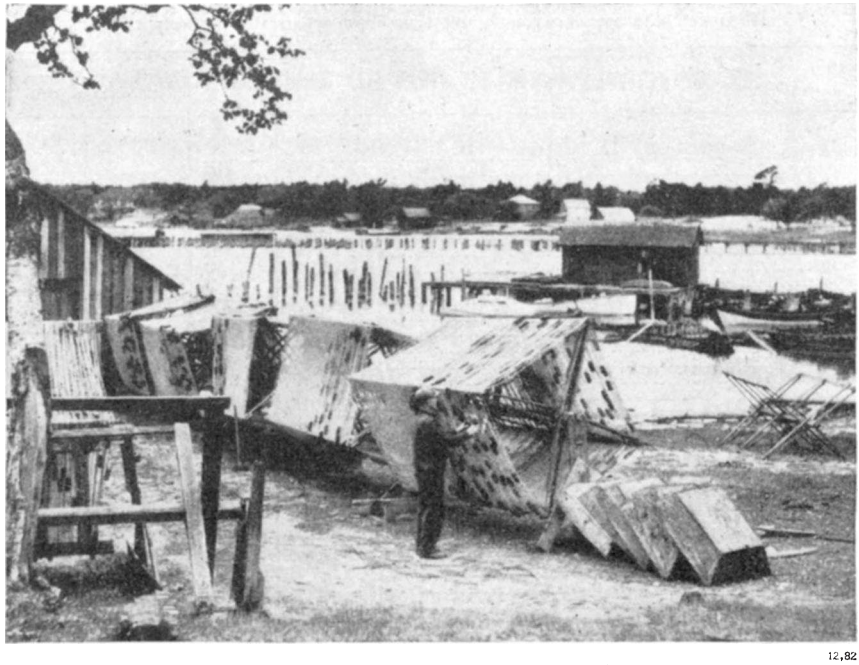
Species	Lakes, 1940		Mississippi River and tributaries, 1931	
FISH	*Quantity*	*Value*	*Quantity*	*Value*
Black bass			14	$2
Blue pike	5,073	$404		
Bowfin	6	(2)	428	9
Buffalofish			15,772	687
Burbot	488	6		
Carp	5,998	148	11,892	455
Catfish and bullheads	1,053	90	10,267	878
Chubs	2,411	375		
Cisco	157	19		
Crappie	(2)	(2)	41	3
Eels	32	1	7	1
Gars			73	1
Goldfish	217	7		
Lake herring	22,480	486		
Lake trout	9,859	1,608		
Mooneye	15	1	3	(2)
Paddlefish			952	43
Pike or pickerel	220	8	5	(2)
Quillback			268	11
Rock bass	20	1		
Sauger	696	60	2	1
Sheepshead	2,995	61	3,905	143
Smelt	4,209	126		
Sturgeon	23	11		
Sturgeon, shovelnose			87	8
Suckers	4,399	122	315	13
Sunfish	34	1	22	1
Tullibees	1,227	52		
White bass	470	28	3	(2)
Whitefish:				
Common	4,618	735		
Menominee	101	7		
Yellow perch	6,216	533		
Yellow pike	6,067	731	5	1
Total	79,084	5,621	44,061	2,257
SHELLFISH, ETC.				
Crawfish	3	(2)	29	(2)
Shrimp			49	4
Terrapin			19	(2)
Turtles			94	3
Frogs			875	131
Total	3	(2)	1,066	138
Grand total	79,087	5,621	45,127	2,395

[1] Data from Fish and Wildlife Service's Current Fishery Statistics No. 27.
[2] Less than 500 pounds or dollars.

The winter months are the best time to buy carp and chubs. Of these species it seems to be true that the colder the water, the better the fish. In Chicago, December was the peak month for chubs (in 1941), January for carp. In January, too, the big lake fisheries for

smelt are under way and these fish are at their best for freezing. Saugers from the Canadian lakes reach their highest abundance just after the first of the year and continue plentiful through February and March.

March brings in an abundance of frozen fish from more distant waters, especially halibut, sablefish, and salmon from the Pacific. This month big shipments of buffalofish reach the markets, continuing



12,82

Figure 3.—Gill nets drying on reels are familiar sights in inland fishing towns.

through April. Carp is still abundant and of good flavor, so one may interchange these two somewhat similar species.

April is the month for catfish, pickerel, lake trout, and suckers; smelt from the streams of Michigan and Wisconsin; yellow pike perch and perch. The fresh-water fishes in general are near the peak of their abundance on the market; the ocean fishes at a relatively low ebb. Lobster meat is fairly plentiful, and this is the last month to enjoy any but frozen oysters until the opening of the fall season.

May is the best month to buy the delicious blue pike perch. Sheepshead are also coming into the markets in great abundance, although any month from March through June finds good numbers of this fish available. Catfish are still abundant, and continue so throughout the summer. Lake trout and yellow perch should be plentiful this month.

More whitefish are on the market during June than any other month, although they are available throughout the year and numerous from May or June through September. (Most of the whitefish consumed in the United States come from Canada.) Many catfish, chubs, lake trout, sheepshead, and suckers are seen in the markets this month.

In July and August yellow perch, whitefish, suckers, chubs, and catfish are good fishes to buy. Fresh-water fishes are less abundant during the summer months than at other seasons of the year, whereas the frozen fillets of marine species like haddock, pollock, and rosefish are sold in greatest quantity at this season.

In September, catfish, chubs, lake trout, pickerel, sauger, whitefish, and yellow pike all are above their average market abundance.

Eels, taken in largest numbers during their fall migration down the rivers to the ocean, are most numerous in the markets during October, but continue abundant until the end of the year. Bullheads, pickerel, sauger, suckers, and whitefish are also good October fish.

Fisheries for lake trout and lake herring are most active in November, and large quantities of these excellent fish are shipped to market. Except for whitefish, most other fishes are somewhat under their average market abundance.

In December, heavy fishing for chubs is in progress, taking quantities of these small, fat members of the whitefish family from icy lakes to be smoked and marketed. Herring, lake trout, whitefish, and yellow perch are all good fish to buy in December.

BIOGRAPHIES OF MIDWESTERN FISHES

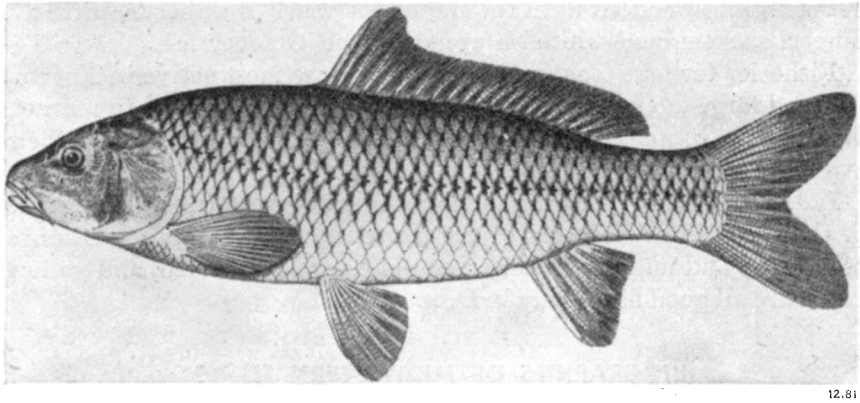
Carp (*Cyprinus carpio*)

Carp are regularly taken for market in at least 35 States and, along with buffalofish and catfish, rank as the most important commercial species of the Mississippi River and its tributaries. Because most of the carp of the Middle West have been shipped to specialized markets in such eastern cities as New York, Boston, and Philadelphia, many people, even in the chief carp-producing States such as Illinois and Minnesota, are totally unfamiliar with its possibilities as a food fish.

Properly prepared, carp is not merely palatable but a real delicacy—lean-meated rather than fat—firm-fleshed and of good flavor. The average size of market carp ranges from 2 to 7 pounds. In certain cities, especially in St. Louis, the practice of filleting carp makes it unnecessary for the housewife to buy a larger fish than her family can eat at one meal. While some people may prefer the convenient and easy-to-prepare fillets, others will use the whole carp baked and stuffed as an appetizing family dinner, available at low cost. A split or

filleted carp may be broiled or fried. Some people put carp left-overs through the meat grinder and prepare fish cakes, using the carp much as they use flaked or shredded codfish. Carp also lends itself to the preparation of savory stews, and in smoked form is a product worth trying, although only small quantities are available.

Carp may be caught at any season of the year, but since their flavor is better when taken from cold waters, there is little fishing for this species during the summer. In many sections of the Middle West, carp taken in off seasons are placed in holding ponds and later shipped to market. In winter, the carp fishermen of Minnesota, Wisconsin, and Illinois set their long nets under the ice and haul them by machinery. Smaller quantities of carp are taken in hoop nets which are set in shallow water.



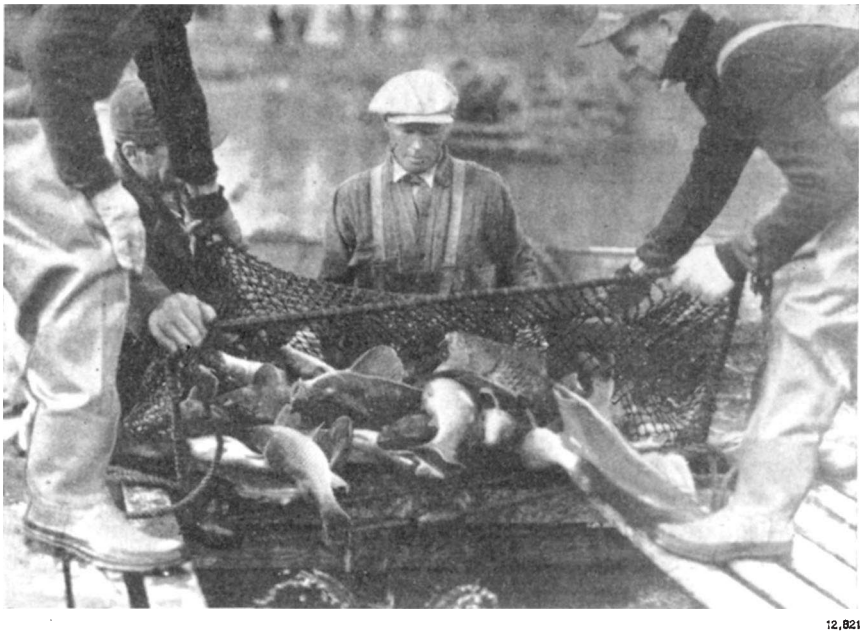
12.81

Figure 4.—The carp fisheries can provide millions of pounds of good food.

In the Chicago markets, January is the biggest carp month, although large quantities are sold also in December, March, April, and May. The catch of carp in the Mississippi usually is several times as great as that in the Great Lakes. The carp fisheries of the Great Lakes are principally in Lakes Michigan, Huron, and Erie, where the largest catches are made west of Sandusky. Such large impoundments as the TVA lakes recently have become known for the abundance of their carp.

The story of the carp is interesting as the tale of an immigrant fish that has adapted itself with surprising ease to conditions found in a new country. As recently as the Civil War period there were no carp in the Middle West nor anywhere else in the United States. Not until 1876 were carp brought to this country from Germany, thus completing another step in the series of involuntary migrations that brought this fish from China, its native land, to Europe in 1227, to England at the beginning of the sixteenth century, and

finally to America. Here its closest relatives, the numerous and varied minnows, were native members of the fish fauna. The introduced carp were put into fish ponds in Washington, D. C., and in 1879 the species was distributed in the waters of 25 States and Territories. Quickly establishing itself, the carp has multiplied so rapidly that in some areas it is accused of crowding out other species. In any event, it is now so abundant and so widely distributed as to provide a valuable source of protein food for hundreds of scattered communities.



12,821

Figure 5.—A netful of carp.

Under domestication in ponds, three races of the original carp have arisen. The common uniformly scaled type is most like the ancestral Asiatic fish; the so-called mirror carp have very large scales placed in irregular rows with intervening patches of uncovered skin; the third variety, the leather carp, has no scales (or at the most, very few) and its skin is soft and velvety to the touch. Occasionally, the carp hybridizes with the goldfish, another Asiatic importation to which it is related. Many such hybrids are now found in Lake Erie.

Largely vegetarian in their diet, carp also eat shellfish, insect larvae, and shrimp-like water animals. They prefer moderately warm water, but can withstand extreme cold. May and June are the spawning months in northern United States. Carp are only mod-

erately prolific, and deposit five or six hundred eggs at a time, and about four to five thousand a season. Young carp are 4 to 6 inches long at the end of their first summer and weigh about a pound when they are a year old. Although the average market weight of United States carp is 2 to 7 pounds, some specimens weigh as much as 30 pounds.

The carp is especially well adapted to pond cultivation. Studies by Illinois biologists indicate waters that can support 300 pounds of crappies, sunfishes, and the like, per acre, will yield as much as 1,000 pounds of carp per acre. This is largely because carp live chiefly on vegetation and so are not dependent on the establishment of complex food chains of aquatic animals, each living at the expense of smaller creatures until microscopic forms are reached.

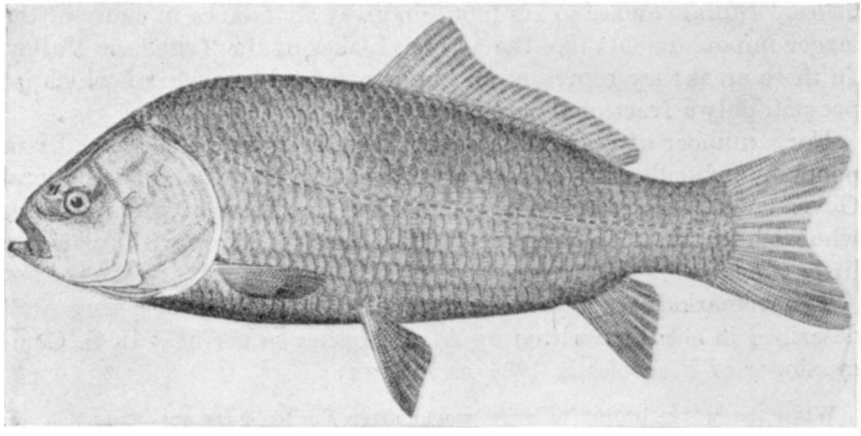
At present, the carp yield is probably about 15 to 20 million pounds a year, but this catch could be greatly increased. In a number of States, carp have the equivalent of a protected status because commercial fishing is prohibited in certain waters in an attempt to safeguard the game fishes. Far from accomplishing this purpose, such exclusion of the commercial fishermen's nets actually allows carp, buffalo, and similar fishes to multiply excessively and crowd out the game fish. This situation exists throughout much of the Tennessee Valley. If controlled commercial fishing were permitted in such waters, not only would many thousands of pounds of fish be made available but the game fish would actually benefit.

Where carp are now subject to commercial fishing, only a fraction of the available crop is harvested. Increased market demands and more adequate financial returns to fishermen will accelerate the upward trend already evident and encourage much larger catches. Already a brisk demand for carp in certain cities of the Middle West exceeds the catch, and sales of carp in Chicago during 1942 were more than a fourth larger than in 1941. Wartime stress may therefore transform the carp from a neglected and underestimated food to probably the most important and productive fishery resource of the entire Mississippi Valley.

Buffalofishes

As food, the buffalofishes are very much like the carp, being lean-meated, firm-fleshed, and well adapted to the preparation of substantial dishes. Some people consider them superior to carp, with less troublesome bones. They may be baked, boiled, or fried; or they may be flaked and used in many appetizing variations of creamed or scalloped fish. Chowders and tasty stews also may be prepared from the flesh of the buffalofishes. Information already given on market forms and methods of preparing carp applies also to these fishes. Smoked buffalofish is used in the East more extensively than smoked carp.

The buffalofish of midwestern markets may be any one of at least three species of fishes, all found throughout the Mississippi Valley but seldom taken in the Great Lakes. The common buffalofish, *Ictiobus cyprinella*, which also goes by such picturesque names as redmouth, bigmouth, and gourdhead buffalo, prefers bays, sloughs, and lakes rather than the swift currents of rivers. Ordinarily it is the largest of the group, the giants of the species reaching a weight of 75 pounds. The round buffalo, *Ictiobus niger*, (called also the bugler, the rooter, and the prairie buffalo) is most abundant in the southern part of the Mississippi Valley, usually weighs less than 20 pounds but may weigh as much as 70 pounds, and is very similar to the common buffalo in its



12,814

Figure 6.—The smallmouth buffalo and its close relatives are the most abundant food fishes of the Mississippi River.

qualities as a food fish and in its general habits. Third and last of the common market species is the smallmouth buffalo, *Ictiobus bubalis*, known in some localities as the suckermouth or channel buffalo, and in the southern Mississippi Valley as the razorback. This is a fish of the rivers, at home in deep channels and turbulent currents, with a more lithe and slender body fitting it for an active existence. The smallmouth buffalo may reach a weight of 45 pounds and a length of 3 feet. It is usually considered superior in flavor to the other species.

All of the buffalofishes belong to the sucker family, which has numerous representatives scattered throughout the United States. The family is closely related to the carps and minnows and like them is thought to have originated in Asia. The suckers, however, unlike the carps, made their own way to America. The two groups are easily distinguished by noticing the conspicuous, whiskerlike barbels on the upper jaw of the carp, and the heavy, serrated dorsal spine. These features are lacking in the buffalofishes.

530548°—43——3

Although carp outrank buffalo in volume of production if the Great Lakes and Mississippi catches are combined, the buffalofishes are produced more abundantly than any other fish in the Mississippi and its tributaries. For many years the annual catch has amounted to about 15 million pounds, most of which comes from the State of Louisiana. Fyke nets in the Atchafalaya and Red Rivers take the greater part of the Louisiana catch.

Like the carp, the buffalofishes eat quantities of vegetation and also feed on numerous minute aquatic animals, chiefly those found on the bottom. Their simpler food habits have much to do with the fact that they are able to live in waters where conditions are unsuitable for fish like bass and crappies, which exist largely on a diet of smaller fishes. Buffalo and carp are found in great abundance in many of the larger impoundments like the artificial lakes of the Tennessee Valley. In these areas they represent an important food resource of which, at present, only a fractional part is harvested.

For a number of years buffalofishes have been reared successfully in ponds by fish-culturists of several Midwestern States and the Federal Government. They are to be commended to owners of private ponds who wish to produce a substantial, nutritious food crop with relatively little effort.

The remarkable spawning habits of the buffalofishes were well described in a letter written by A. A. Mosher to the first U. S. Commissioner of Fisheries in 1885, as follows:

> When the water begins to grow warm after the ice goes out these fish are around the shores in immense quantities: they are in bunches of from 3 to 7 or 8; the female is in the center, and when she sinks to the bottom to deposit her eggs the males crowd around and under her, pushing her to the top of the water, until their tails and fins are out; then they make a tremendous rush, causing the water to foam, and, with a noise that can be heard on a still evening a mile, they go ahead for a few rods, then sink, and the same performance is done over. The people call it "tumbling"; in fact, it is a sight which once seen will never be forgotten.

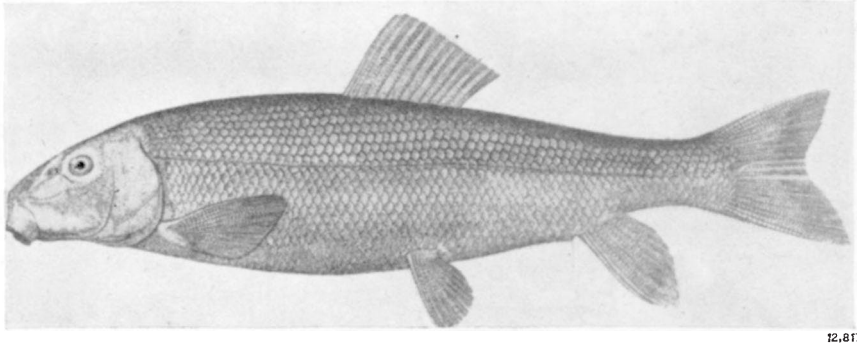
It is believed that the eggs are expelled and fertilized during the splashing. The parent fish do not prepare a nest and give no care to the fertilized eggs and resulting young. The eggs adhere for the most part to submerged or floating grasses, brush, or debris. Under favorable temperatures the young hatch in 9 or 10 days and immediately come to the surface.

Although there has been a regular fishery for the buffalofishes for many years, apparently they are as abundant as ever in the Mississippi Valley as a whole. Probably there is a reserve supply—especially in the large artificial lakes—adequate to meet the already increasing demand. Certainly any fishes as abundant and as long

and widely known as the buffalofishes will play an important part in relieving the shortage of protein foods.

Suckers (Genera *Catostomus* and *Moxostoma*)

Almost every boy who ever fished a country stream has caught a sucker, for these are among the most abundant and widely distributed of all our fishes. About 60 species inhabit the waters of the United States, some living in small streams, others in the Great Lakes. One kind of sucker when it is full grown may be no longer than a man's hand; related species may attain a length of 3 feet. Out of this bewildering number and variety of suckers, two groups are of outstanding importance as food: the fine-scaled suckers of the genus *Catostomus* and the red-horse suckers of the genus *Moxostoma*.



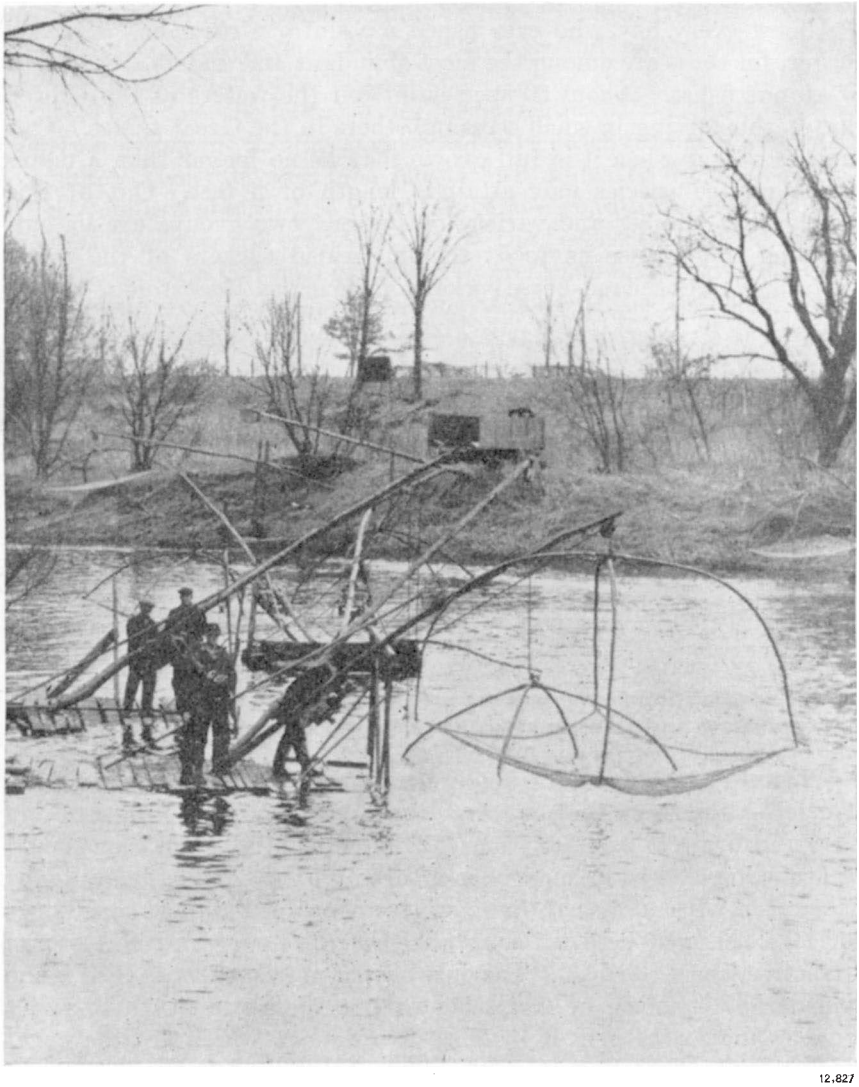
12,817

Figure 7.—Suckers, abundant in many rivers and lakes, are good food fishes. The common sucker shown here is a native of the Great Lakes and the upper Mississippi Valley.

When they come from the deep waters of lakes or from clear running streams—as most of the commercially important species do—suckers have a firm, sweet, and flaky meat. Being definitely lean they should be broiled or stewed or may be used in any of the recipes calling for flaked fish. Use of any of the sauces recommended in good cook books for lean fish will help to bring out the full flavor and add to the attractiveness of the dish. The only objection to suckers as food is the considerable number of small bones; but these are not necessarily troublesome in the fish of three to five pounds which are the usual market sizes. Small numbers of suckers are smoked, but most are sold fresh.

The quantities of suckers taken by commercial fishermen ordinarily have run to 5 or 6 million pounds, about two-thirds of which come from Lakes Huron and Michigan. Suckers rank about seventh among all fishes of the Great Lakes in the volume of production. Shipments into Chicago in 1942 increased by more than 50 percent over those in

1941, suggesting that the fishery as a whole perhaps may be increasing in intensity, and certainly that the demands in some markets are greater than formerly.



12.827

Figure 8.—With crude dip nets, fishermen take suckers from the streams.

Some suckers are caught throughout the year, but the largest catches are made during the spring months. This is the spawning season, when suckers of all species run up into small streams to deposit their eggs. The suckers begin to run as soon as the ice is out of the streams, often fighting swift currents and rough waters. At this time it is easy

to distinguish the males by the gay coloring of black or red that appears on the body, especially on the fins. The males also develop rough, wart-like protuberances, called pearl organs, on head, fins, and tail. These spawning runs, when large numbers of fish crowd into narrow headwater streams, have long been familiar to farmers and others who have had an opportunity to observe them.

Suckers, often known as fresh-water mullet, get their more frequently used common name from their method of obtaining food. Using their rounded, protruding lips almost like a vacuum cleaner, they suck food from the stream or lake bed into their mouths. Suckers have no teeth on their jaws, but the bones in the throat region are equipped with teeth which in certain species are heavy enough to crush the shells of fresh-water mussels or snails. Such shellfish, along with the larvae of aquatic insects, are the principal foods of the larger species of suckers which form the bulk of the commercial supply.

Most important of the fine-scaled suckers is the white or common sucker, *Catostomus commersonii*, a fish of the Great Lakes and also of smaller rivers and streams of the upper Mississippi Valley. This is one of the most abundant suckers, especially common in Lakes Huron and Michigan. It is taken in seines, traps, and gill nets, and often accepts a baited hook. It may attain a length of 22 inches and a weight of 5 pounds but the average fish is somewhat smaller. This is an olive-colored—almost golden—fish, and in the spring the males develop rosy bands along their flanks.

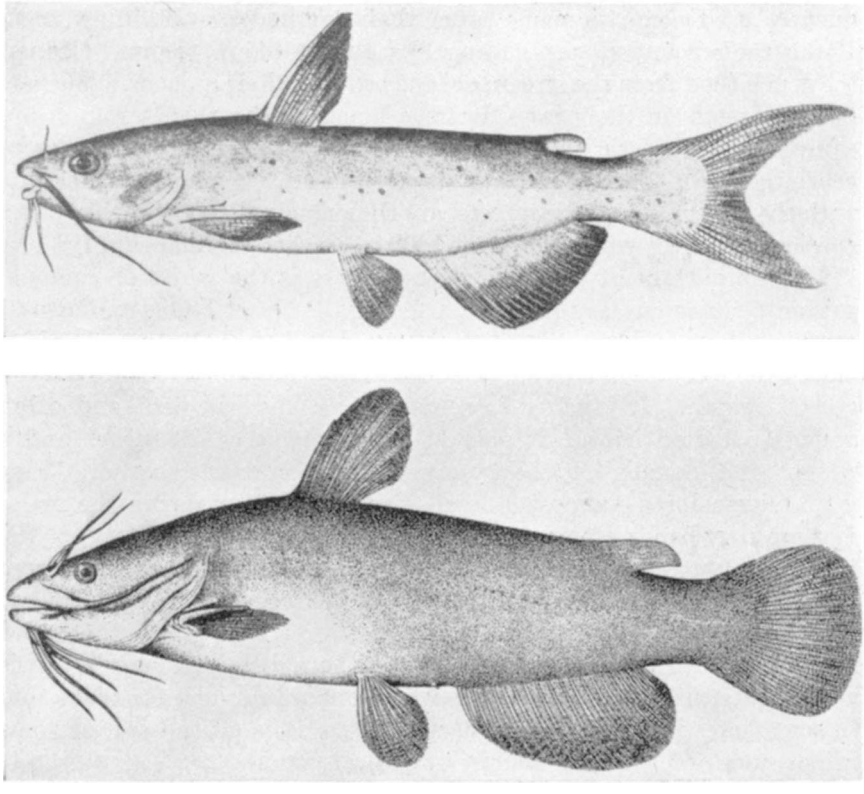
The long-nosed sucker, *Catostomus catostomus*, is abundant from the Great Lakes northward, although scarce in the Mississippi Valley. This species is also called the northern sucker and (from the broad rosy band worn by the males in spring) the red-striped sucker. It is a cold-water fish found in streams where one would look for trout, and in some lakes it is taken from deep water. It is a food fish of some importance and attains a weight of several pounds.

The red-horse suckers, also called redfin, are named from the color assumed by the lower fins of the males during the spawning season. The common redhorse, *Moxostoma aureolum*, may weigh as much as 5 or 6 pounds. Its range includes the Great Lakes region to the watershed of the Missouri and extends southward to the latitude of Arkansas. It prefers swift-flowing streams and its flesh is of good flavor.

Catfishes and Bullheads

Throughout the whole of the Mississippi Basin, the catfishes are among the most important of food fishes. Annual commercial production is more than 10 million pounds, and in addition, a large, but unknown number are caught by hook-and-line fishermen for home use. More than half of the total commercial yield, or some 6,662,987

pounds, comes from the State of Louisiana, where the river Atchafalaya is the center of the fishery. Another million pounds comes from the waters of Arkansas, the other States of the Valley sharing about equally in the production of the remaining 3 million pounds. Although ranking third in volume, the catfishes and bullheads are the most valuable fishery product of the Mississippi River.



12,811; 12,812

Figure 9.—The channel catfishes have forked tails, while the bullheads carry a broom-shaped tail. Both are excellent food fishes, although the channel catfishes are generally preferred.

Fishery statistics group all catfishes and bullheads together, although the total figures include at least four major species: the blue channel catfish, the spotted or fiddler catfish, the yellow catfish, and the bullhead or horned pout. The first three are generally classed as channel-cats in allusion to their general preference for clear streams and deep, swift channels. The catfishes have deeply notched tails, whereas bullheads have square or shallowly notched tails.

Largest of the Mississippi catfishes is the channel-cat or blue channel-cat, *Ictalurus furcatus*, found throughout the Valley and in the

Gulf States, and most abundant in the southern part of its range. It frequents the deeper waters of river channels, but in spring follows the flood waters as they overflow into shallow backwaters and swamps, and bites well on the trot lines set by fishermen in these regions. Average size blue catfish probably run from 15 to 20 pounds, and enormous specimens as large as 150 pounds have been recorded. This species ranks with the paddlefish and the lake sturgeon as one of the three largest North American fresh-water food fishes, although no American catfish competes with the 400-pound wels or European catfish. The flesh of the blue channel-cat is of excellent quality, being firm and flaky, highly nutritious, and delicately flavored.

Most widely distributed and perhaps most generally esteemed of all catfishes native to the Mississippi Valley is the smaller spotted or fiddler cat, *Ictalurus punctatus*. It ranges from Florida and northern Mexico to the Great Lakes region, and has been successfully acclimatized in regions where it is not native. Much smaller than the blue channel cat, it commonly weighs about 5 pounds, although larger specimens have been taken. It is trimmer and more gamy than the other catfishes or bullheads, and is accordingly esteemed by anglers as well as by commercial fishermen. As a food fish, many people give it first rank among the catfishes. The flesh is firm, flaky, and deliciously flavored. Because of its thinner skin there is less waste in preparing it for the table.

The yellow catfish or goujon, *Leptops olivaris*, is another large species, frequently weighing as much as 50 or 75 pounds, and sometimes more than 100 pounds. Strong, active, and predacious in habit, it roams the channels and the more sluggish waters alike. It is highly esteemed as a food fish because of the fine texture and excellent flavor of its flesh. With the blue catfish, it forms the principal support of the fisheries of the Atchafalaya River.

The bullhead or horned pout, *Ameiurus nebulosus*, is better adapted to cultivation in private ponds than any of the catfishes. Abundant in all ponds, lakes, and sluggish streams of eastern United States and the Mississippi Valley region, it has adapted itself to widely varying conditions and may be cultivated with less difficulty than the channel catfishes, which do not thrive in still water. Although not generally considered a sport fish, the bullhead bites on almost any bait, hence is well known even to amateur anglers. The unusual breeding habits of the bullhead are of particular interest. After preparing the nest, both parents care for the eggs, keeping the water agitated with their fins. From time to time the parent takes the eggs into the mouth and blows them out forcibly. Both of these actions are continued even after the eggs hatch and until the fry are ably to swim freely. The maximum size of this species is

about a foot and a half with the average size considerably smaller. Like that of the catfishes, the flesh, properly prepared, is firm, flaky, and delicious.

In addition to those described, many other species of catfishes and bullheads are native to the United States but are unimportant as food fish. The salt-water species include interesting forms in which the males carry the eggs in the mouth during the entire period of incubation. Another unusual species is the electric catfish of the Nile which is capable of inflicting a strong electric shock. Undoubtedly derived from scaled ancestors, during later development the catfishes have become naked skinned. As a group they are hardy, prolific, and able to survive many unfavorable conditions. It is rather surprising that no species of catfish is native to United States waters west of the Rocky Mountains, although several have now been introduced successfully.

Because of their good quality and widespread occurrence, the catfishes form a valuable food resource that presents no difficult problems of distribution. Most of the catch is consumed locally, shipments even to such a large midwestern city as Chicago amounting to only about 300,000 pounds a year. The months from April to September are the height of the catfish season.

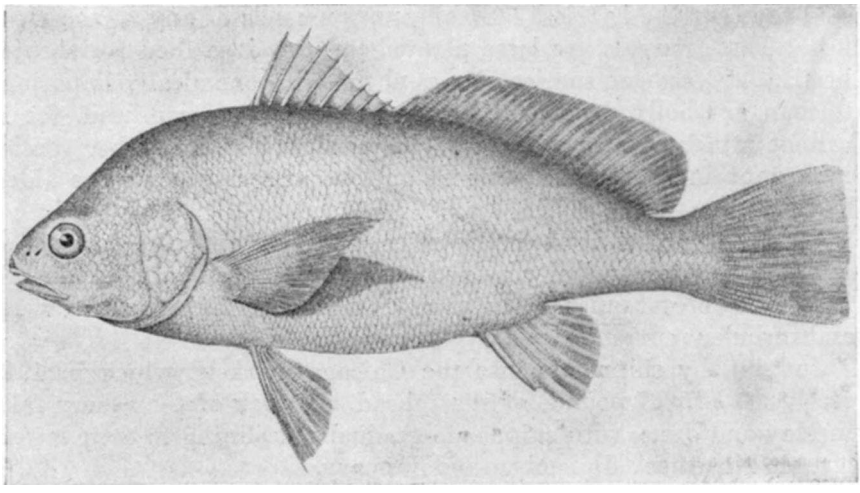
Sheepshead (*Aplodinotus grunniens*)

The only fresh-water relative of the well-known marine croakers and red and black drums is the sheepshead. This single species of fish, known by at least half a dozen different common names, is to be found in almost all the lakes and larger streams from the Great Lakes to Texas, and between the Appalachian Mountains and the Great Plains.

Pre-war fisheries for the sheepshead brought in annual yields amounting to about six or seven million pounds, taken chiefly in the Mississippi and its tributaries. It is safe to say that future yields will be much larger as market demands continue to increase. Recent changes in the Chicago market indicate a definite trend toward wider use of the sheepshead. In 1942, Chicago dealers handled nearly twice as great a poundage of this species as in 1941, a considerably greater increase than was registered by carp, buffalo, or catfish.

The sheepshead is one of the largest river fishes in America, weighing as much as 50 or 60 pounds. The larger specimens are of interest from the natural history standpoint, but are of no value for the market. The smaller individuals, on the other hand, (three-quarters of a pound to three pounds) are tender-meated and of excellent flavor. The meat of these choice sheepshead is lean and white and, like that of all other fishes, easily digested and rich in nutritious elements.

It would seem logical that in any locality sheepshead, ranging all the way from newly-hatched fry to the patriarchal 60-pounders, might be found. This is not true, however, a fact which is still mystifying the naturalists. One lake or section of a river may be noted for 30-to 40-pound fish; in another the catch may consist almost invariably of 2- or 3-pound fish; and in still another place sheepshead between 4 and 15 pounds may be extremely rare, even though the larger and smaller sizes are abundant. In general, sheepshead of the Mississippi River itself are moderate-sized fish, suitable for the market.



12,695

Figure 10.—The sheepshead is a fresh-water relative of the marine drums and like them produces sounds audible above the water.

Throughout much of its range, people commonly call the sheepshead the fresh-water drum because of its ability to produce a noise easily heard through several feet of water. Where sheepshead are particularly abundant, this strange reverberation is one of the characteristic evening sounds of the river. Like its salt-water relatives, the croakers and drums, the sheepshead possesses specialized muscles which may be vibrated against the large airbladder to produce the drumming noise. Probably the sound serves to call the schools of fish together. Other names referring to the same habit are croaker and thunder-pumper. Less appropriate is the name white perch by which the sheepshead, unfortunately, is called in some parts of the Mississippi Valley. In Louisiana there is still heard the name "gaspergou," applied by the early French inhabitants in recollection of some Old World fish of fancied similarity. This old name is now generally shortened to goo and is so listed on bills of shipments.

The sheepshead limits its diet almost exclusively to fresh-water mussels, and has the further distinction of being the only known fish whose activities result in the cultivation of a food crop which it later harvests. Young mussels must pass the early or larval stages of life attached as parasites to the gills of a fish. During this period they absorb nourishment from the blood of the fish, later drop off and develop into adult mussels on the bed of the river. Only certain fishes can serve as hosts to certain species of mussels because of chemical differences in the composition of the blood. The sheepshead picks up enormous numbers of larvae as it feeds on mussel beds and is said to carry the heaviest load of young mussels of any of the river fish. These mussels are later planted to grow into food for sheepshead. At least one species of mussel that is economically important to man is wholly dependent for its existence on sheepshead, for it cannot attach to any other fish. In addition, several other species important in the manufacture of buttons and ornaments are aided by this fish.

Chiefly a market fish taken in seines and fyke nets, the sheepshead is also caught occasionally by anglers using crayfish bait. Although it seems to prefer quiet water, at times it is taken from areas of swift and turbulent currents.

Judging by shipments into the Chicago markets, which in 1942 received 1,807,667 pounds of sheepshead, the peak of the fishery falls in May and June, with shipments gradually declining to their lowest level in November, December, and January.

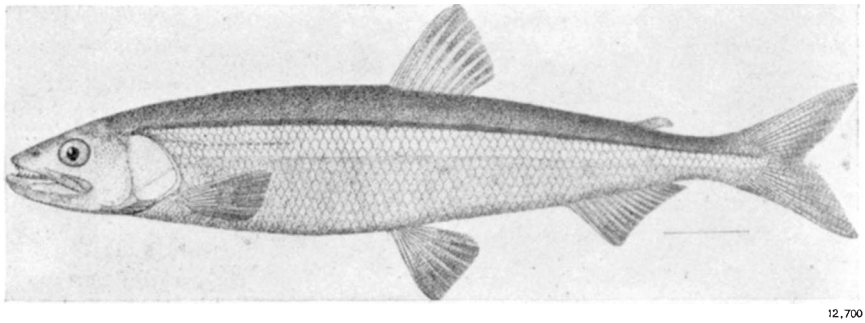
Smelt (*Osmerus mordax*)

The smelt was introduced into Great Lakes waters to provide food for fish, but has now become a valued food for man. Easily caught not only by commercial fishermen but by any amateur with even a felt hat as a dipnet, the small fish at the time of the spawning runs provide a welcome and delicious local food in Michigan and Wisconsin and are shipped to points as far distant as New York and Boston. In less than 40 years' time, the smelt has become so abundant that the total catch by all classes of fishermen outranks any regular commercial fishery of Lake Michigan, and on the Great Lakes as a whole is exceeded only by that of three or four fisheries.

The slender, green and silvery smelt takes its name from the ancient Anglo-Saxon word "smoelt," meaning smooth or shining. Local names that suggest its color are ice fish and frost fish. In appearance much like a small and slender member of the salmon family to which it is related, the smelt was brought to the Great Lakes area from its native New England in 1906. The purpose of the introduction was to provide food for the landlocked salmon which were being planted

simultaneously in Michigan. The introduction of the salmon failed; that of the smelt succeeded beyond the wildest expectations of those who carried out the project. First smelt plantings in Michigan went into the St. Mary's River, but the only successful introductions were those in Crystal, Howe, and Trout Lakes. In fact, it is believed that all the smelt now found in Lakes Superior, Michigan, Huron, and Erie came from some sixteen million eggs taken from Green Lake, Maine, and planted in Crystal Lake. The smelt is now caught in all the Great Lakes, but nevertheless is most abundant in Lake Michigan, and of all Lake Michigan waters, appears to prefer Green Bay.

Smelt fisheries, which fall into three classes, collectively take perhaps 20 million pounds of fish. The commercial fishery is prosecuted on the Great Lakes during the winter, when most of the fish must be



12,700

Figure 11.—The smelt was introduced into the Great Lakes from New England, and now is considered an important source of food.

taken under the ice. Because of the ease of shipping these winter-caught fish long distances, smelt fishermen get best prices at this season, obtaining as much as 15 cents a pound for their catches. The winter fishery in Lake Michigan alone yields from a million to a million and a half pounds. In addition to the regular commercial operators, occasional hook-and-line fishermen catch a few hundred thousand pounds in the smaller lakes. By far the greatest part of the smelt production, however, takes place during the spawning runs, at which time professionals and amateurs—old and young—men and women—join in the occupation of smelt dipping. Smelt jamborees and smelt festivals are annual events in which literally tens of thousands of people take part, to their own enjoyment and the profit of hotels, restaurants, and merchants in the areas of the heavy smelt runs.

Like their relatives that live in the ocean and ascend rivers and streams to spawn, the smelt of the Great Lakes area leave the large lakes and throng into the tributary streams as soon as the ice breaks up in the spring. Coming up the rivers in unbelievable numbers, their glittering bodies darken the water and form easy prey for the hundreds

of people who line the banks waiting to scoop them up. The dipping continues throughout the night, with bonfires on the river banks illuminating the scene. The spawning runs in the Great Lakes area may begin as early as March 17 or as late as April 28. The peak of the runs seldom lasts more than a week, and because of the enormous number of fish caught in so short a time many are wasted. The spring

12,820

Figure 12.—These silvery smelt were taken in a Michigan pound net.

production in Green Bay, center of smelt dipnetting, is about 6 million pounds; and in the Menominee River about the same quantity is taken by dipnetters.

Smelt are sold both fresh and frozen. Fresh smelt are packed in 25-pound boxes, iced, and shipped by express, often in carload lots, to New York, Boston, Cleveland, Detroit, Chicago, and other cities. With wider utilization of frozen smelt, much of the waste of the spring-caught fish might be avoided.

According to the average size of the fish caught (7 or 8 inches),

it takes ten or eleven smelt to make a pound. In Lake Michigan they may reach a length of 14 inches and a weight of half a pound, but these larger specimens are few. The spawning runs are made up largely of fish 7 to 9 inches long, which are 2 to 3 years old.

The flesh of the smelt is lean and sweet, with a particularly delicate flavor, earning this fish the reputation of being one of the choicest of panfishes. Van Oosten [2] tells how to prepare it:

Smelt are usually eaten fried. They are most palatable when rolled in flour, corn meal, or cracker meal and fried in plenty of fat. Some prefer to mix a small quantity of brown sugar with the corn meal. Butter or a mixture of ¼ butter and ¾ vegetable shortening or bacon grease imparts an excellent flavor The fish should be fried until golden brown. A gourmet has his smelt fried crisp and eats bones and all.

Smelt may also be baked. Two methods are recommended. The first method consists of rolling the smelt in flour and placing them in a shallow pan. The fish are covered with slices of bacon, seasoned with salt and pepper, and baked in a moderately hot oven until brown. The second method consists of placing slices of bacon, tomatoes (canned tomatoes should be drained), chopped green peppers, and minced onions between layers of smelt in a deep baking dish or casserole. The top should be sprinkled with cracker crumbs and dotted with butter. After the mixture has been baked thoroughly it should be browned in a very hot oven and served immediately.

Burbot (*Lota maculosa*)

The only member of the cod family that lives in fresh water is the burbot. This long and rather slender fish, with elongated fins running in a low and almost continuous flange around the posterior half of the body, looks more like the New England cusk than the cod, and is, in fact, called the fresh-water cusk. It is easily distinguished from other fishes found in the same waters by this unusual form of body and also by the presence of three whisker-like barbels, two by the nostrils and one on the middle of the chin.

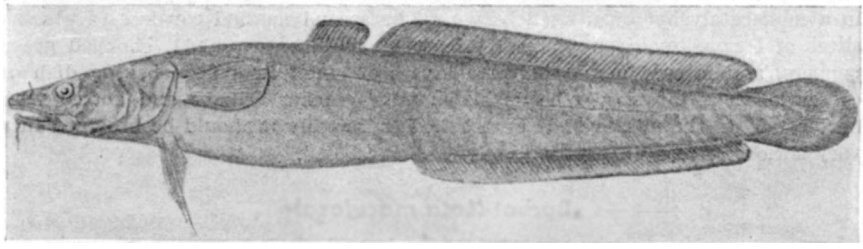
The burbot is found in the Great Lakes and in smaller lakes and some rivers all the way from the latitude of Maine and New York and the upper Missouri and Columbia Rivers to the Arctic Circle. Like other cods, it prefers cold water. Usually it remains in the deeper parts of the ponds and lakes it inhabits, and has been taken at depths as great as 700 feet. It is generally a nocturnal feeder, and in some places comes into the shallows at night.

The burbot was once described (Adams and Hankinson, 1928) as "a fish of the future," awaiting only some circumstance which would bring it to public attention to gain for it recognition as a desirable food fish. Wartime meat shortages, plus scarcity of more familiar

[2] Van Oosten, John. The smelt, *Osmerus mordax* (Mitchill). February 14, 1940. (Mimeographed publication of the Michigan Conservation Commission.)

fishes, already are making the public burbot-conscious. In Chicago, only 1,800 pounds of burbot were marketed in 1941, but 34,000 pounds found their way to this city in 1942. Frozen fillets of burbot made up more than two-thirds of these greatly increased shipments.

The flesh of the burbot somewhat resembles that of its popular New England relatives, the cod and haddock. Salt burbot is said to be almost indistinguishable from salt codfish, although this product is not prepared on a commercial scale. In Europe it has long been esteemed as a great delicacy, both for its white and delicate flesh and for its liver. When taken from cold northern waters the burbot is at its best as a food fish. It should be prepared for the table like any other lean-meated fish, and most of the well-known recipes for cod and haddock may be used. It may be dipped in egg and cracker crumbs, seasoned, and fried; or it may be boiled and combined with



12.696

Figure 13.—The burbot is a fresh-water cod.

spaghetti, tomato sauce, or cheese. Baking is also recommended. Flaked burbot may be used to make a fish loaf or pie, or in salads or sandwich fillings.

The burbot is also an excellent source of medicinal oils, for its liver is very oily and yields a product richer in vitamin A than the well-known cod-liver oil.

Before the war began to make it familiar to housewives of other regions, the greatest demand for burbot was in Maine, New Hampshire, and Montana. In the latter State it is sometimes marketed as northern catfish, perhaps on account of its whisker-like facial appendages. As has been pointed out, the burbot is a cod, with no close relatives among the catfish clan.

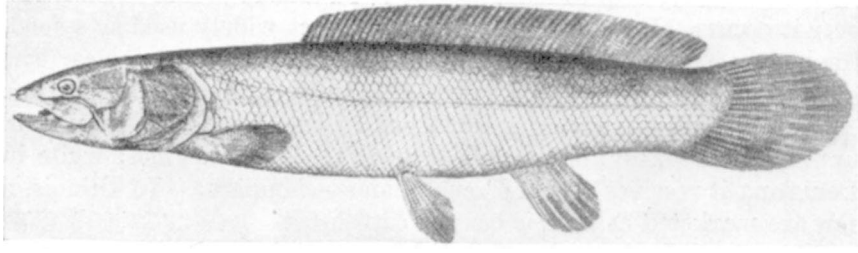
The burbot itself is a fish eater, its diet consisting almost entirely of other fishes and crayfish. By reputation, it is one of the greatest gourmands among fishes, eating until it is unable to cram another particle of food into its distensible stomach.

Anglers are not much interested in the burbot, although it takes a trout hook readily enough. Sometimes it is taken through the ice, and occasionally is captured by tip-up fishermen seeking pike perch. Most of the commercial catch is taken in trap nets.

Bowfin (*Amia calva*)

If you like your fish tangy, and full of the rich flavor of green hickory smoke, try smoked bowfin as a local substitute for smoked salmon and herring or finnan haddie. The chances are that you will agree with Gowanloch, Louisiana biologist and gourmet, who 10 years ago pronounced the bowfin "one of the best of all smoked fishes."

Unfortunately, with characteristic slowness to fit the recipe to the fish, most of us who have departed from culinary routine enough to try the bowfin have eaten it fresh, with disappointing results. It takes an expert to make anything out of a bowfin in the fresh state, whereas the smoked product may be prepared with appetizing results by almost any of the tried and tested recipes for other smoked fish. Some people like smoked bowfin cold, served with the garnish of their



12.816

Figure 14.—The bowfin makes an excellent smoked fish; usually is less palatable eaten fresh.

choice. If you insist upon trying it fresh, Gowanloch (1933) passes on the recommendation that the fish be skinned, deprived of its backbone, cut into halves and then into slices which are fried in deep fat, like doughtnuts.

Throughout much of the region from the Great Lakes to the Gulf, the bowfin is such an abundant fish in the lakes, the sluggish rivers, and the swampy backwaters of the Mississippi that hundreds of communities will have their own local supply. This fact makes it possible for farmers and others who have suitable facilities to smoke their own bowfin, just as they smoke their own hams and bacon. Although often eaten in southern Illinois and further south, the bowfin is an under-exploited resource, awaiting only intelligent utilization to make it a valuable contributor to our food supply.

While the general public has largely neglected the bowfin, for many years naturalists have considered it one of the most interesting fishes in American fresh waters. Combining characteristics of fishes that are extinct as truly as the dinosaur or the dodo with other qualities appropriate to a thriving twentieth-century fish, the bowfin is a strange blend of contradictions. Unlike most other fishes, it sometimes breathes air as land animals do. This arrangement goes back

to the ancient Devonian period, when vast droughts made life difficult for all fishes. The ancestors of the modern bowfin were able to survive the Devonian droughts by swallowing air into the sac known as the air bladder, which thus functioned as a primitive sort of lung. Now, when the receding flood waters of the Mississippi leave vast backwater areas of swampy mud, the bowfin suffers no inconvenience, for, like its long-dead ancestors, on such occasions it breathes the oxygen of the air instead of the oxygen of the water. It is claimed that after the Louisiana fields have dried out enough for cultivation to begin, live bowfin are sometimes turned up by the plow.

No doubt this surprising tenacity of life has something to do with the fact that the bowfin figures in much local folklore of a sensational and highly imaginative character. Its general physical toughness, plus the fact that people have seldom troubled to exploit it commercially, help to make it a thriving and abundant form wherever it occurs. Despite the fact that it is not widely used as a food, the bowfin is a well-known fish bearing a variety of local names: Virginians give it the dignified name of John A. Grindle, which in the central Mississippi Valley is shortened to Grindle; Great Lakes and upper Mississippi Valley people are apt to call it dogfish; while in Louisiana it receives an old French name—choupique. In Illinois, a few are marketed as prairie bass or catfish.

Of interest also is the bowfin's habit of building nests and guarding its eggs, much as sunfishes do. The male fish prepares the nest by clearing away vegetation and hollowing out a circular area on the bottom, into which it brushes fine gravel and plant debris. The nest is about 2½ feet across. The male guards his property with great aggressiveness and, after the hatching of the young, accompanies the fry as they swim about in a compact school. This parental care is not relaxed until the young are about 4 inches long.

In the most recent year for which complete figures are available, about half a million pounds of bowfin were marketed, chiefly from the Mississippi. Undoubtedly a much larger quantity can be caught in response to increased demand.

Gars or Gar Pikes (Family Lepisosteidae)

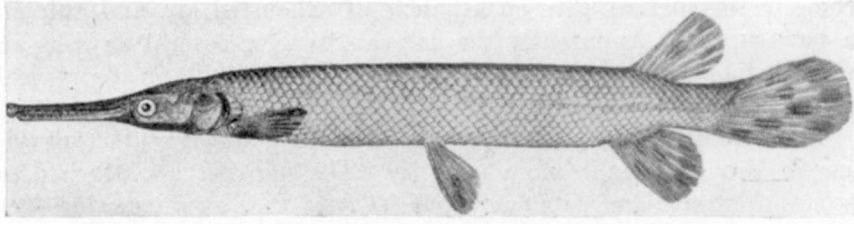
The gars are exclusively American fishes, being found only in Northern and Central America, although fossils of their ancestors have been discovered in Europe. They are abundant fish of the Mississippi and Great Lakes drainages, inhabiting the larger streams and more sluggish waters.

The modern gar-pike family includes at least three species in North America, all of which are abundant enough to be important as a fishery resource. These are the large alligator gar of the lower Mis-

sissippi, a 12-foot fish that is equally at home in salt and fresh water; the long-nosed gar, measuring up to 4 feet and found all the way from the Great Lakes to the Gulf and on the Atlantic coast; and the short-nosed gar, which is confined to the Mississippi and attains a slightly larger size than the preceding species.

Being abundant and widely distributed, the gars offer definite possibilities as a food resource. The meat is white and wholesome, and is at its best smoked. Louisiana fishermen often dig large pits in the ground, fill them with oak logs and smoke the gars over the hot ashes. The resulting product is a half-smoked, half-barbecued fish said to be very palatable. Steaks cut from smoked gars are broiled, or the meat may be used in the preparation of fish cakes.

The eggs or roe of the gar are sometimes toxic and should not be eaten.



12 810

Figure 15.—Like the bowfin, the gar is at its best smoked.

Past neglect of the gar as a food fish has probably been due in part to the former abundance of better known species, in part to the prejudice of fishermen against the gar as a notorious enemy of other fishes. The destructiveness of the gar is obviously no argument against its exploitation by man, for the development of an extensive commercial fishery would reduce its abundance and, to a corresponding degree, its depredations against more valuable fishes.

As predators, the gars are formidable enemies of the smaller or less active fishes of the rivers, approaching their prey stealthily and seizing it by a sudden swift attack. Even very small gars display both the cunning and the greediness of their elders. A long-nosed gar only an inch and a quarter long was found by Forbes and Richardson (1908) to have captured and eaten a minute fish, while a 2-inch gar examined by them had eaten 16 young minnows!

The presence of gars is not altogether harmful to the fauna of the rivers, however, for these fish, like the sheepshead, serve as hosts to the larval stages of certain fresh-water mussels. The most valuable of all river mussels, the yellow sand shell, whose shell approaches in luster and beauty true mother-of-pearl, apparently is entirely dependent for its existence on the gar. Because of chemical differences in the

blood, no other fish is a suitable host for these young mussels during the stage at which they must attach themselves to the gills of a fish and draw nourishment from its blood. Therefore, many of our most beautiful pearl buttons, knife handles, and other ornaments are the indirect result of the presence of gars in our mussel-bearing rivers.

In a more direct way the gars have contributed to our stock of useful and ornamental objects. Like the primitive Ganoid fishes from which they are descended, the gars wear an armor of heavy bony scales. Smith (1907) passes along the story that before the days of steel plows farmers sometimes covered their wooden plowshares with the skin of gars, and Gowanloch (1933) cites evidence that the Indians used the scales as arrow heads. In recent times pins and other ornaments have been made from the beautifully white and lustrous scales.

Like the bowfin, the gars are able to breathe air, and frequently come to the surface, give off a bubble of exhausted air, and gulp in a new supply. Apparently the gar can live for several days as an air breather without recourse to breathing by the gills in the typical fishlike manner.

The gars usually deposit their eggs in shallow, weedy water, spawning in May or June in most localities. The eggs become attached to stones or weeds, and hatch in about 8 days. It is an interesting fact that very soon after hatching the young display the solitary habits of the adults. They float near the surface in the sun or may even suspend themselves (so tiny are they) from the surface film. Forbes and Richardson (1920) describe them as "extremely interesting and even beautiful little animals, each marked with a broad black lateral band."

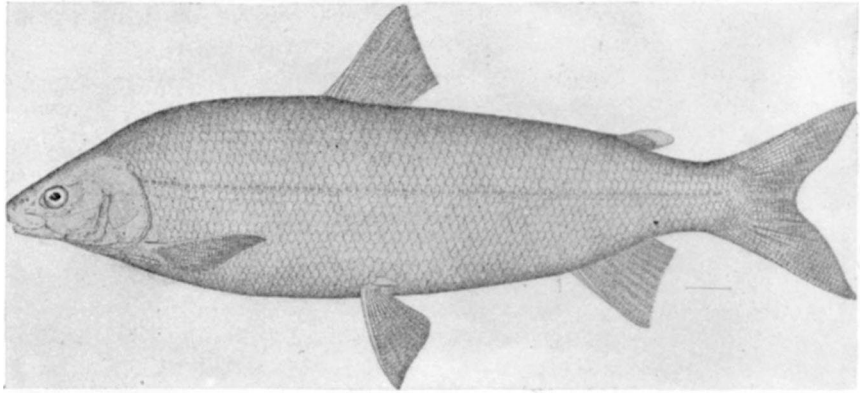
Development of the commercial fishery for gars should be encouraged by public willingness to try this little-known food. The addition of quantities of nutritious food to our diet is not the only benefit to be expected, for a fishery that would remove gars on the same scale on which catfish, buffalo, sheepshead, and other commercial species are now caught would restore a more natural balance to the life of the rivers.

Whitefish (*Coregonus clupeaformis*)

The whitefish is generally recognized as the king of fresh-water fishes, known all over the country for its delicious flesh. Its popularity has proved disastrous, however, for this fish is now greatly reduced in numbers and in some waters once famed for the quality and quantity of their whitefish has become almost extinct. Throughout the Great Lakes country from Lake Champlain to Lake Su-

perior whitefish were once abundant. Now the total yield for the United States waters of the Great Lakes and the borderline lakes of Minnesota amounts to only about 4½ million pounds a year.

Most of the catch of whitefish is marketed fresh. Probably the favorite method of preparation is baking, but delicious dishes are also achieved by pan frying or broiling. The flesh is white and flaky and the flavor delicate. The epicure considers smoked whitefish one of the greatest contributions of the Great Lakes country to his table. There is no problem of creating a demand for smoked whitefish; the problem is to satisfy the existing demand. The production of smoked whitefish in 1939 was 2,759,000 pounds, with a value to the producer of $865,500. Whitefish roe, as a byproduct of the fishery, is made into caviar as a substitute for the roe of the vanishing sturgeon. The average weight of the individual fish in the commercial catch is four pounds.



12.677

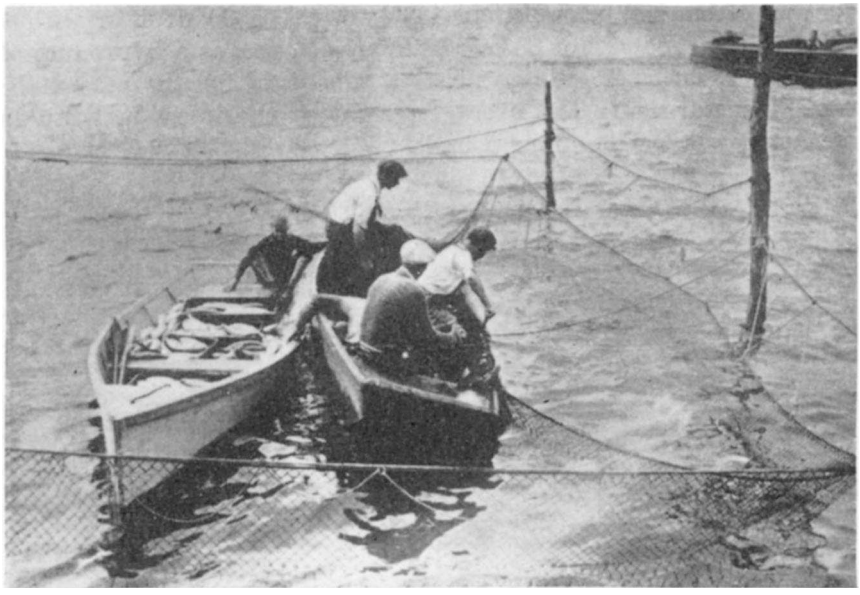
Figure 16.—One of the most prized of all fresh-water fishes, the whitefish is less abundant now than formerly.

The whitefish is a member of the family Coregonidae, which includes the lake herring, chubs, ciscoes, and menominees, and is closely related to the trouts. An easily observed mark of this relationship is the short, fleshy adipose fin on the back near the tail fin. Members of the whitefish family are mainly lake fishes, although a few inhabit rivers of the far Northwest. As a group, they are the most valuable of all fishes of the Great Lakes.

Whitefish live in the moderately deep waters of the lakes, feeding on shellfish and insects, and come into the shallows only at spawning time. They are known to spawn in the fall on rocky reefs and shoals from 4 to 20 feet deep. The female deposits from 10,000 to 75,000 eggs, depending on her size. About 5 months are required for the

eggs to hatch, and during this time they are preyed upon by various fishes and by mud-puppies (called lizards or water dogs in some localities).

Schools of young whitefish 2 to 4 weeks old may sometimes be seen in shallow water near shore in the spring. Whitefish fry hatched in the New York Aquarium were carried through the critical period of infancy on a diet of mosquito larvae. Later, they were fed chopped fresh meat on which they grew and thrived for more than 10 years. These specimens are apparently the only whitefish ever brought to



12,822

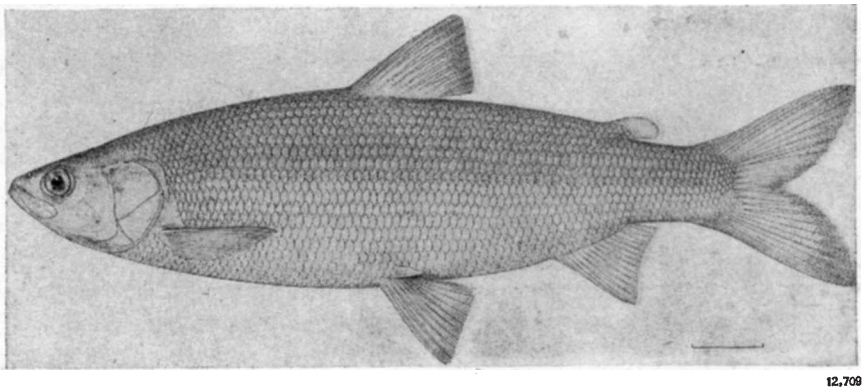
Figure 17.—Two tons of whitefish were removed from this net.

maturity in captivity. The greatest age recorded for the whitefish is 26 years, a figure determined by examining the markings on the scales.

Commercial fishing operations are adjusted to the extensive seasonal migrations of the whitefish. In Lake Erie, for example, where the whitefish is confined to deep water at the eastern end of the lake for the greater part of the year, a spring and fall movement shoreward and toward the western end occurs each year. These migrations greatly increase the area of distribution during a limited period and give rise to special gill- and pound-net fisheries. The spring movement takes place during late April and May, while the fall migration, which is much heavier and more widespread, takes the fish to spawning grounds at a considerable distance from their native habitat.

Lake Herring (*Leucichthys artedi*)

The herring of the Great Lakes is related, not to the universally known sea herring, but to the whitefish, being another member of the family Coregonidae. Although the lake herring is found in all of the Great Lakes, as well as in many of the smaller deep lakes of the vicinity, it varies greatly from lake to lake in its characteristics as a food fish. Those from western Lake Ontario and from Lake Erie (where they are called ciscoes) are richer in oil than those from Huron and Michigan. These fat herring are in great demand as fresh fish, being somewhat similar to the whitefish. Erie herring competed strongly with chubs for the smoked-fish trade until excessive fishing brought about a collapse of the cisco fishery of this lake in 1925. Only a fraction of the former catch of ciscoes is now being made in Lake



12,709

Figure 18.—The lake herring is eaten both fresh and smoked.

Erie. Most of the Lake Superior herring are salted, although some are frozen. A small amount of herring is sold in filleted form. Commercial size herring usually run three or four to the pound.

Where herring are abundant they wander about in large and easily observed schools. They avoid inshore areas in mid-winter, when the water is rough, and in mid-summer when it is warm. At these seasons the herring seek the deep and cool waters of the open lakes. During the spawning season of the whitefish the lake herring is said to work considerable mischief by eating the eggs of its larger relative. In the spring the herring shoals feed inshore and in the fall they come in again to spawn. They not infrequently accept a baited hook.

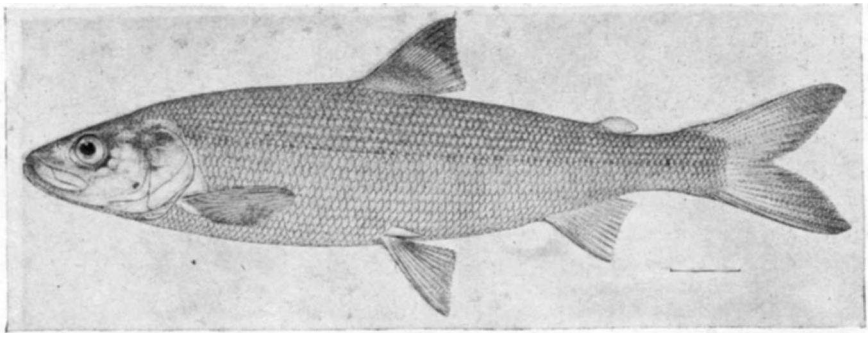
Studies of the scales of the lake herring show that it may attain an age of at least 12 years. Because of the intensity of the fishery, however, few have an opportunity to live longer than 3 to 5 years.

Present catches of lake herring (in all lakes combined) amount

to about 22 million pounds, the largest yield of any single species of Great Lakes fish. Since this, like the whitefish and lake trout, is another resource that is being fished almost to the limit of its productivity, only a small increase in the catch can be expected in response to current demands.

Chubs (Species of *Leucichthys*)

The claim of the chubs to gastronomic fame rests on their excellence as smoked fish. Every one of the seven kinds of chubs found in the Great Lakes lends itself to smoking, but only one—the blackfin—is used extensively as a fresh fish. The latter species enjoys a reputation as a pan fish of superior flavor, but is now so reduced in numbers that Lake Superior is about the only source of commercial quantities.



12.708

Figure 19.—The chubs, related to the whitefish, are found in the deeper waters of the Great Lakes.

The chubs are members of the whitefish family that inhabit the deeper waters of the Great Lakes. There are seven closely related species,[3] all of which reach a size suitable for use as food. Lake Michigan is the only lake that contains all seven species of chubs, while shallow-watered Lake Erie has no chubs at all.

Intensive fishing has brought about changes in the chub populations, resulting in the virtual disappearance of the largest chubs in many areas. Although the early chub fishery was based almost entirely on the larger species, the present-day fishery is maintained by fish of smaller size. All species of chubs are seriously reduced in numbers throughout their range, and this depletion has been carried to the point of extinction as a commercial fish in the case of the bluefin of Lake Superior, the blackfin in Lake Michigan, and the

[3] The species of chubs found in the Great Lakes are *Leucichthys zenithicus, L. reighardi; L. alpenae,* the longjaw; *L. johannae, L. nigripinnis,* the blackfin; *L. kiyi;* and *L. hoyi,* the bloater.

bloater in Lake Ontario. The total catch of all species of chubs in United States waters in 1940 was 2,410,500 pounds, whereas even as recently as 1934 it had been more than 7 million pounds. With proper regulation of the fishery, a sustained yield of 5 or 6 million pounds is believed to be attainable.

The chubs may be distinguished from the whitefish by their more slender body, smaller size, and the greater number of gill-rakers on the first arch. The young are often confused with the Great Lakes shiner (one of the true minnows), but may be identified easily by the presence of a short fleshy fin (the adipose fin) on the top of the tail base. It is extremely difficult to distinguish one species of chub from another, because the species are very similar and there is, besides, a considerable amount of individual variation.

During most of the year the chubs native to a particular lake intermingle very freely, feeding together and being caught together in fishermen's nets. As the spawning season for each species approaches, however, its individuals detach themselves from the mingled chub population, and seek the customary spawning grounds of that particular species. Some chubs spawn in water as shallow as 50 or 60 feet, others at 300 to 350 feet.

Chubs are slow-growing fish. The Lake Superior longjaw of average commercial size is 7 years old and weighs only 6 ounces. In Lake Michigan, the kiyi attains an average weight of 6 ounces in 5 years. The greatest ages recorded for three species whose scales have been examined are 11 years for the longjaw, 8 years for the kiyi, and 13 years for the blackfin.

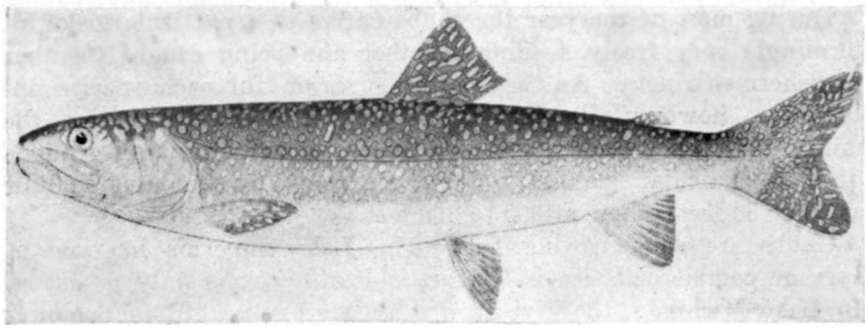
Lake Trout (*Cristivomer namaycush*)

The largest trout in North America is the lake trout, a giant member of the family that includes the familiar brook and rainbow trouts as well as the renowned salmon of both Atlantic and Pacific coasts. The lake trout inhabits all five of the Great Lakes and most other large lakes from New Brunswick and Maine westward to Vancouver Island and north to Alaska, Hudson Bay, and Labrador. In the days of its great natural abundance it commonly reached a weight of 60 to 100 pounds, but nowadays fishing has so reduced its numbers that few have an opportunity to grow to the full stature of the race. The maximum size of the trout now taken is probably about 60 pounds; while the average weight of spawning trout in Lake Michigan is 4½ pounds, and in Lake Superior, 7 pounds.

The lake trout ranks second among all Great Lakes fishes in the poundage it contributes to the commercial fisheries. In 1940, some 10 million pounds of this excellent food fish were taken from United States waters. The flesh is of very delicate flavor and is particularly

rich in protein and oil. Baked lake trout is considered an especial delicacy. These trout may be purchased whole or in convenient filleted form, and sometimes are available smoked.

Lake trout usually spawn on the reefs of honeycomb rock which lie 10 to 15 miles offshore at depths of 6 to 120 feet. The spawning season occurs during the ordinarily cold and stormy weeks of late October to late November in Lakes Huron and Michigan. Unlike those of other members of the salmon family, the spawning habits of the lake trout cannot be observed, but it is supposed that the eggs are allowed to settle into indentations in the rocks, there to develop somewhat as the eggs of other salmonids undergo incubation among the gravels of a stream bed.



12,707

Figure 20.—The prized lake trout supports one of the principal Great Lakes fisheries.

The lake trout is an omnivorous feeder, preying largely upon other fishes. It was once thought that young whitefish formed its principal food, and for that reason fishermen opposed its artificial propagation. This belief is probably unfounded, however, for lake trout return to deep water immediately after spawning, while the young whitefish remain in the shallows. Alewives, yellow perch, whitefish, chubs, and herrings are their principal items of food.

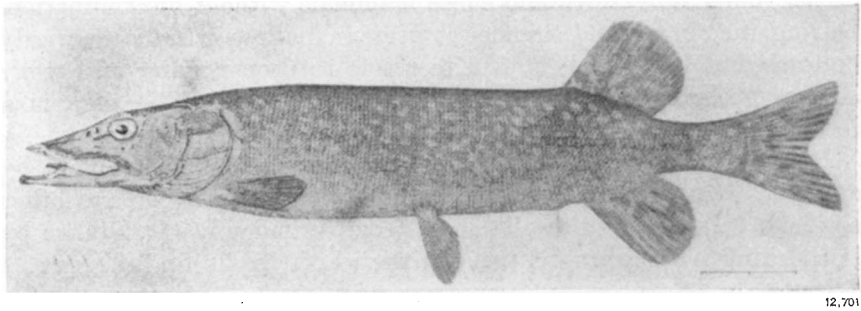
A deep-water variant of the lake trout, called the siscowet, is commonly found in deep water in Lake Superior, and occurs also in Lake Michigan and possibly Huron.

Lakes Superior, Michigan, and Huron furnish by far the greater part of the commercial catch. Gill nets, operated from steam, gasoline, or oil-burning tugs that set 5 to 7 miles of nets in a day, are the principal gear of the fishery. During recent years, sport fishermen have developed a keen interest in the lake trout as a powerful and gamy antagonist. Definite figures are not available, but it is believed that the catch by sportsmen may amount to tens of thousands of pounds. Since most or all the lake trout so caught are eaten, this sport fishery represents no waste of food resource. The combined

sport and commercial catches are so heavy, however, that no appreciable increase in the yield of this species can be brought about without endangering future supplies.

The Pikes (Genus *Esox*)

The common pike, *Esox lucius;* the muskellunge, *E. masquinongy;* and the pickerels, *E. reticulatus* and *E. vermiculatus*, are all pikes in the language of the scientist, although the sportsman and fisherman know them best by their individual common names. All have long, broad, and flattened snouts, large mouths, broad bands of movable teeth on both jaws, and dorsal and anal fins placed far back on the body near the tail. They may be separated by noticing the



12,701

Figure 21.—Most pike are taken in cold northern waters.

arrangement of scales on the side of the head. In the pickerels, the cheeks and gill covers are completely scaled; in the pike, the cheeks are scaled but the lower half of the gill cover is bare; in the muskellunge the cheeks, as well as the lower half of the gill cover, are bare.

The pikes are better known as sport fish than as commercial species. The yield taken for the market is small (only about 200,000 pounds), but the amount of food derived from this source could probably be increased somewhat, especially by full utilization of the sportsmen's catch. The flesh of all the pikes is white, firm, and flaky. It is marketed whole or filleted, both fresh and frozen.

The common pike is the only species of the genus that occurs outside of North America. This is a fish of wide distribution, inhabiting rivers that empty into the Sea of Okhotsk, and the Arctic Ocean, as well as into the Caspian Sea, the Sea of Azov, and the basin of the Danube. In North America its range extends from the States bordering the Great Lakes to Alaska and the Arctic Circle. Like all other widely distributed fishes, the pike has acquired a number of common names which tend to confuse it with its relatives. It is sometimes called the lake pickerel, and it is the grass pike of Lake Erie and the jack pike of Canada. Great northern pike or simply northern pike

are other common designations. This species is the most abundant of the four here described and makes up most of the commercial catch listed as "pike, pickerel, or jacks." Pike weighing from 25 to 30 pounds have been taken in the United States waters of the Great Lakes, but the average size is considerably smaller.

In the Great Lakes region most of the catch comes, not from the large lakes, but from Lake of the Woods, Rainy Lake, and Namakan Lake, the three lakes on the boundary of Minnesota and Canada. Most of the catch is taken in gill nets and pound nets. In addition to the domestic yield, about 65,000 pounds are imported.

The pike has earned a reputation as the most voracious of fresh-water fishes, habitually lying in wait in dense beds of grass or rushes and darting out on its victims with lightning speed. It devours other fishes, young waterfowl, and small mammals without discrimination. During the spring and summer it prefers shallow inlets with weedy bottoms, but in autumn is said to resort to deeper water and stony shores, probably following shoals of other fishes. The pike is a solitary hunter, never seen with its fellows except at spawning time.

Being a strong and persistent fighter, the pike is much sought by anglers. It is usually taken by trolling with spoon hooks and other artificial baits, or with small fish or frogs. Sometimes it is taken by still-fishing in deep waters through the ice, or by tip-up fishermen.

Yellow Perch (*Perca flavescens*)

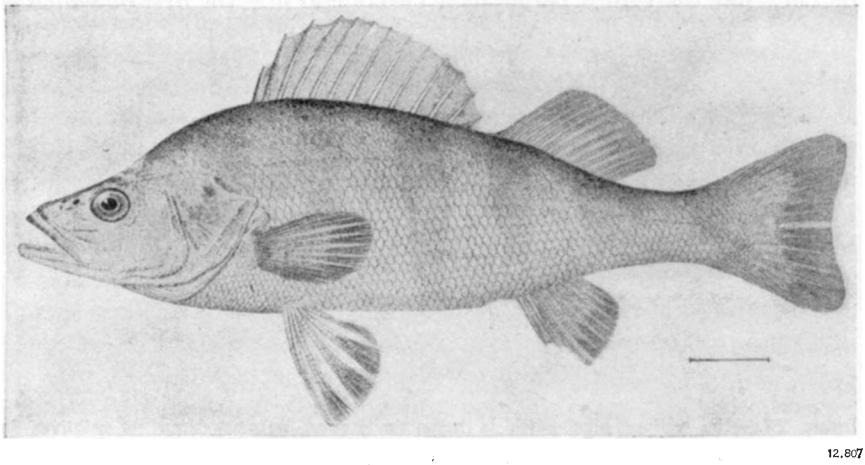
Generally voted one of the best flavored of all fresh-water fishes, the yellow perch is so well known that it needs no introduction. Almost every angler has at some time taken from his hook this greenish-golden fish, banded with bars of dusky color. The relatively large commercial catch (6 million pounds in 1940) makes it a familiar market fish in many towns and cities of the Middle West. It is an excellent pan fish, seldom exceeding 12 inches in length or 1 pound in weight. It may be had whole or in fillets, and is available in good quantity throughout the year.

Along with its close relatives, the blue and yellow pike perches and the sauger (p. 40), the yellow perch belongs to one of the most important families of fishes in the Great Lakes. The combined yield of all these members of the perch family was about 18 million pounds in 1940, and exceeded that of any other group except the whitefish family.

Chief production centers for the yellow perch of the commercial fisheries in the Great Lakes are western Lake Erie, Green Bay in northern Lake Michigan, and Saginaw Bay in Lake Huron. Added to the 6 million pounds of this excellent food fish which are derived chiefly from these centers are the unrecorded thousands of perch taken by anglers for their own tables from lakes, ponds, and larger rivers all

over northeastern United States, from the Great Lakes to the upper Mississippi Valley. Transplantings have considerably extended the natural range of the yellow perch, so that it now inhabits lakes in such western States as Washington and California and is also to be found in the Ohio River.

Although it is primarily a lake fish, the yellow perch avoids the greater depths of the lakes and seldom lives deeper than 100 feet. Apparently it prefers shallows and weedy bars, and in the younger stages may be found in water less than 5 feet deep. It is a sociable fish, moving about in schools and congregating in thickets of pond weeds.



12.807

Figure 22.—Everyone knows the yellow perch, an appetizing pan fish quick to take the hook.

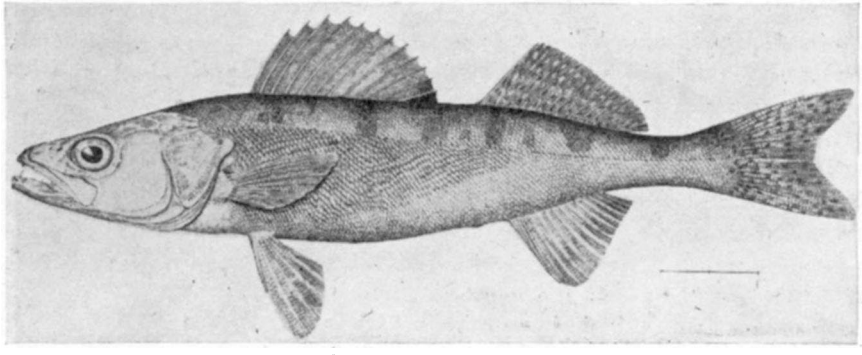
Perch apparently have large appetites and are equipped to capture practically any kind of small water animals. Their gills are so constructed that they can strain microscopic food organisms from the water, or they can pick water insects from plants or stones or snatch crayfish from rocky hiding places. If they have an opportunity to capture larger prey, the backward slant of their teeth aids in holding the struggling victim. Insects and crustaceans make up the bulk of their diet.

The remarkable egg masses of the yellow perch are familiar to many people who have frequent opportunities to observe the life of the waters. In April, May, or June, depending on the locality, the adult fish move into shallow waters where there are weeds, submerged timber, or other objects to provide anchorage for the eggs. These are extruded in a peculiar, gelatinous mass which gives the appearance of being accordion pleated. These egg masses swell on exposure to the water and frequently become ribbons several feet long. The eggs extruded by a single female perch may number as many as 90,000.

The young hatch in about 27 days. They spend their first year in very shallow water, usually remaining in the shelter of weed beds. Later they move into deeper parts of the lake or river. According to studies of Lake Erie perch, they are about 6 inches long at the end of the second year of life, and attain the most desirable market size (about 9 inches) at the end of the fourth year.

Pike Perches (Species of *Stizostedion*)

The three pike perches are members of the perch family, quite unrelated to the pikes in spite of their common name. A glance at the back fins will immediately make this relationship clear, for the pike perches, like the yellow perch, have two dorsal fins, the first of which is



12.817

Figure 23.—The yellow pike perch is taken in greater quantity than its relatives in United States waters.

spiny, the second soft. The pikes, on the other hand, have a single dorsal fin, which is soft and is located well back on the body, near the tail.

Blue pike perch, yellow pike perch, and sauger—known collectively as the pike perches—are the largest members of the perch family in American waters. They are of considerable importance commercially. In 1940 the domestic catch of the blue pike perch, *Stizostedion glaucum*, was 5,073,000 pounds; the catch of the yellow pike perch, *S. vitreum*, was 6,067,000 pounds; and the catch of saugers, *S. canadense*, was 696,000 pounds. Imports of these species—especially of saugers—are considerably in excess of the United States catch. In 1940, we imported from Canada 8,169,000 pounds of yellow pike perch, 1,487,000 pounds of blue pike perch, and 12,683,000 pounds of saugers.

All three are considered excellent food fishes, although the yellow and blue pike perches are usually thought to be superior to the sauger. The flesh is firm, white, and of good flavor, even in the warmest

weather, and the fish stand shipment, holding, or freezing well. The smaller specimens are suitable for frying or broiling, while the larger ones are excellent when baked. The bones, although numerous, are large and easily separated, and little loss occurs in dressing because of the small size of the abdominal cavity. The greater part of the catch of blue pike perch and sauger is filleted.

Most of the commercial catch in Lake Erie consists of fish 11 to 13 inches long, which are 3 to 5 years old. The pike perches often live to a much greater age, however, for readings of the scales have revealed ages as great as 11, 13, and 17 years for the blue pike perch, sauger, and yellow pike perch, respectively.

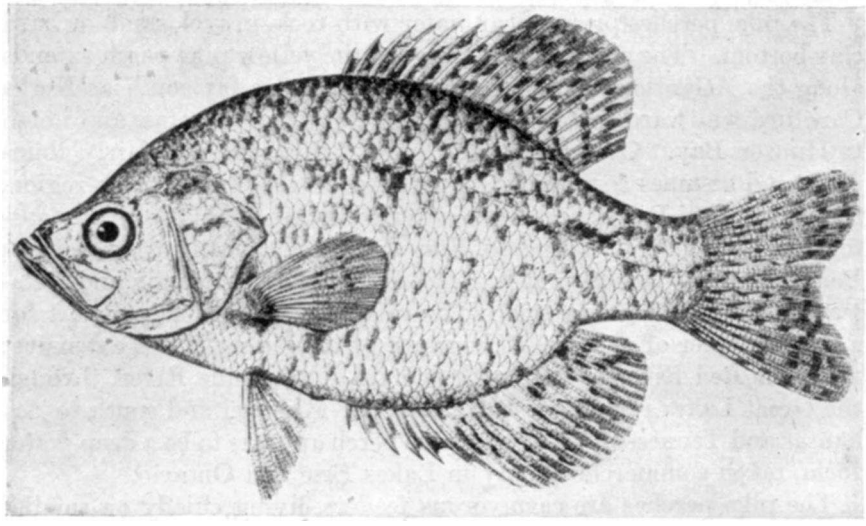
The pike perches prefer clear water with rock, gravel, sand, or hard clay bottom. The geographical range of the yellow pike perch extends along the Atlantic seaboard from Connecticut as far south as North Carolina, westward to Kansas, Nebraska, and the Dakotas, and north to Hudson Bay. Over the greater part of this area it is fairly abundant, and assumes commercial importance in the Great Lakes region, the Mississippi Basin, and the southern part of the Hudson Bay system. Although not native to New Jersey, Connecticut, or eastern Pennsylvania, it has become acclimated in the Susquehanna and Delaware Rivers and in many small lakes in Michigan, furnishing sport for a large number of anglers. The range of the sauger is less extensive: from the Red River of the north and the Assiniboine River, through the Great Lakes region, west to the upper Missouri and south to Arkansas and Tennessee. The blue pike perch appears to be a deep-water form, taken commercially only in Lakes Erie and Ontario.

The pike perches are carnivorous feeders, living chiefly on smaller fish, crayfish, and insects. Apparently they destroy fewer of the species valued by man than do most predatory fishes. As a source of quantities of excellent food and as highly regarded game fishes, they are one of our more valuable fishery resources.

Crappies (*Pomoxis annularis* and *Pomoxis sparoides*)

The crappies are included in this account of the fishery resources of the Middle West because they are highly suitable for pond culture, and may be reared successfully in the thousands of fish ponds which have been built on farms throughout this area. They are among the best of the pan fishes, seldom weighing more than a pound or measuring more than 12 inches in length. The meat is white, tender, and of excellent flavor. Pond cultivation of the crappies for home use makes it possible to take the fish from the water immediately before they are to be placed in the frying pan, and under such conditions they become a truly delicious food.

In most States, commercial fishing for crappies is prohibited by law with a view to reserving these species for the angler. Some biologists hold that this restriction defeats its purpose, for the crappies are extremely prolific, reproducing at such a rate that a small lake quickly becomes crowded with stunted fish that offer little sport. These biologists believe that a regulated commercial fishery for crappies and certain other species would not only make available to the public a considerable quantity of excellent food, but would improve sport fishing by eliminating overcrowding and giving the fish a chance to grow to good size.



12,809

Figure 24.—Crappies can be reared in farm ponds to supplement the family diet.

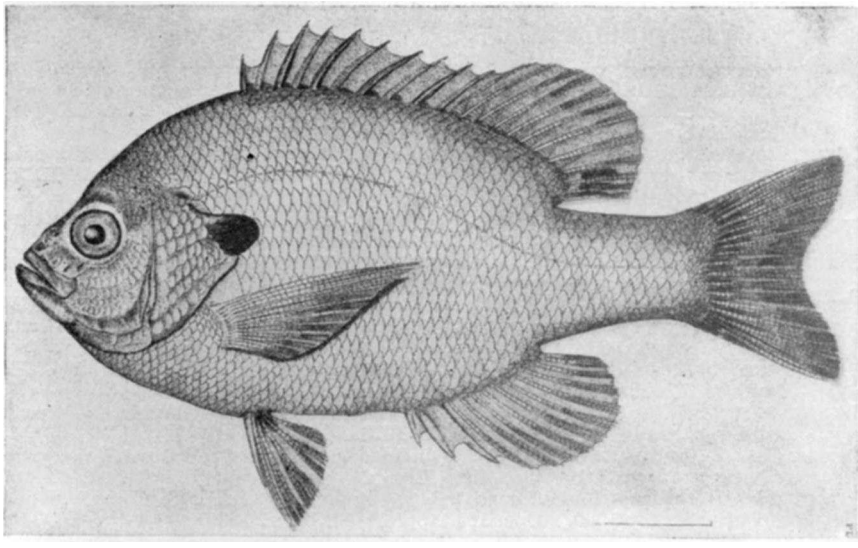
The white crappie, *Pomoxis annularis*, is found in ponds, lakes, creeks, and rivers from New York and Vermont westward through the Great Lakes region and the Mississippi Valley to the Dakotas and south to Texas. It seems to prefer more or less muddy water and in the southern part of its range grows to a length of about a foot. Other common names for this species are bachelor, sac-a-lait, chinquapin, and white perch. It takes the hook well, especially in the spring and fall.

The black crappie, *Pomoxis sparoides*, is also known as the strawberry bass. It is abundant in the Great Lakes region and the Mississippi Valley, and the extremes of its range lie in New Jersey and Texas. It is a hardier fish than the white crappie and is even better adapted to pond culture. The two species may be distinguished easily by the fact that the white crappie has five or six spines in the dorsal fin whereas the black has seven or eight.

Bluegill Sunfish (*Lepomis incisor*)

The bluegill sunfish is considered the finest of all pondfishes available for private culture, and is to be recommended above any other sunfish for artificial propagation. It thrives under a wide variety of conditions, is highly prolific, and is a food fish of high quality. Its flesh is firm, flaky, and of delicious flavor, and it may attain a weight of about a pound.

Like the crappies (page 41), the sunfishes are reserved by most States as game fishes, although similar arguments might be advanced for opening up a controlled commercial fishery in some localities.



12,813

Figure 25.—The sunfishes are well adapted to pond culture and are among the most delicious food fishes.

The bluegill sunfish is found abundantly in quiet streams, ponds, and lakes of the Mississippi Valley and the Great Lakes region. In the latter area, the many small lakes of glacial origin seem to provide ideal homes for it, but it is also at home in warm and sluggish streams or in weedy ponds. It is considered an excellent sport fish, being game for its size and taking almost any kind of bait. It is propagated extensively and has been widely distributed through artificial means.

Like other sunfishes, the bluegill scoops out a nest, which may measure about 2 feet across, on the bottom of its pond or stream. The bluegills are of more sociable habit than some of their relatives, however, for colonies of as many as 15 nests have been observed. The round, shallow nests are usually attached to roots and may be grouped about

the base of a tree of semiaquatic habit, like the willow. Perhaps the fish are attracted by the shade, as well as by the shelter which the roots afford. After the eggs are deposited, the male fish drives the female away and mounts guard over the nest. His vigilant care continues until the eggs hatch, after which he soon leaves the young to shift for themselves. Most bluegills begin to spawn at the age of 1 year, and raise several broods during a season.

Bluegill sunfish are often planted in combination with black bass, for which their numerous young form an abundant supply of food. Because there is no opportunity for the sunfish population to outstrip its food supply in such ponds, the bluegills then grow to a size that makes them very desirable for sport or food purposes.

BIBLIOGRAPHY

ADAMS, CHARLES C., and T. L. HANKINSON. The ecology and economics of Oneida Lake fish. Roosevelt Wildlife Annals. Vol. 1, Nos. 3 and 4, pp. 235–548, illus., 1928.

COKER, ROBERT E. Studies of common fishes of the Mississippi River at Keokuk. Document No. 1072. Bulletin, U. S. Bureau of Fisheries, Vol. XLV, pp. 141–225, illus., 1930.

——— The bowfin: An old-fashioned fish with a new-found use. Economic Circular No. 26, U. S. Bureau of Fisheries, 4 pp., illus., 1917.

EVERMANN, BARTON W., and H. W. CLARK. Lake Maxinkuckee: A physical and biological survey. Dept. of Conservation, Indiana. Vol I, 660 pp., 1920.

FORBES, STEPHEN A., and R. E. RICHARDSON. The fishes of Illinois. Natural History Survey of Illinois. Vol. 3 (Ichthyology) i–cxxxvi+357 pp., illus., 1920.

GOWANLOCH, JAMES NELSON. Fishes and fishing in Louisiana. Bull. No. 23, Dept. of Conservation, State of Louisiana, 638 pp., illus., 1933.

HANKINSON, T. L., and C. L. HUBBS. The establishment of smelt in the Great Lakes waters. Copeia, 109: 57–59, 1922.

HUBBS, CARL L., and KARL F. LAGLER. Guide to the fishes of the Great Lakes and tributary waters. 100 pp., illus., 1941.

JAMES, M. C. Propagation of pond fishes. Report of the U. S. Commissioner of Fisheries for 1929. Doc. 1056, pp. 19–50, illus., 1930.

KENDALL, WILLIAM C. American catfishes: Habits, culture, and commercial importance. Report of the U. S. Commissioner of Fisheries for 1908: 39 pp., illus., 1910.

——— The pikes: Their geographic distribution, habits, culture, and commercial importance. Appendix 5, Report of the U. S. Commissioner of Fisheries for 1917: 45 pp., illus., 1919.

——— The smelts. Bulletin, U. S. Bureau of Fisheries, Vol. XLII: p. 217–375, 1927.

LEACH, GLEN C. Artificial propagation of pike perch, yellow perch, and pikes. Appendix 1, Report of the U. S. Commissioner of Fisheries for 1927: 27 pp., illus., 1928.

MOORE, H. F. The burbot: A fresh-water cousin to the cod. Economic Circular No. 25, U. S. Bureau of Fisheries: 4 pp., illus., 1917.

SCHNEBERGER, EDWARD. The biological and economic importance of the smelt in Green Bay. Transactions of the American Fisheries Society, 1936: pp. 139–142, 1937.

SCHRENKEISEN, RAY. Field book of fresh-water fishes of North America north of Mexico: i–xii+312 pp., illus., 1938.

SMITH, HUGH M. Fishes of North Carolina. North Carolina Geological and Economic Survey, Vol. II: 453 pp., illus., 1907.

TAYLOR, H. F. The carp: A valuable food resource. Economic Circular No. 31, U. S. Bureau of Fisheries. 7 pp., illus., 1917.

WHITEMAN, ELIZABETH. Wartime fish cookery. Department of the Interior. Conservation Bulletin No. 27, 24 pp., illus., 1943.

○