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FISHING INDUSTRY OF THE GREAT LAKES

By WALTER KOELZ

DEPARTMENT OF COMMERCE

Bureau of Fisheries Document No. 1091

DEPARTMENT OF COMMERCE
BUREAU OF FISHERIES
HENRY O'MALLEY, Commissioner

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APPENDIX XI TO THE REPORT OF THE U. S. COMMISSIONER
OF FISHERIES FOR 1925

Bureau of Fisheries Document No. 1001

PRICE 20 CENTS

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Washington, D. C.

WASHINGTON
GOVERNMENT PRINTING OFFICE
1926

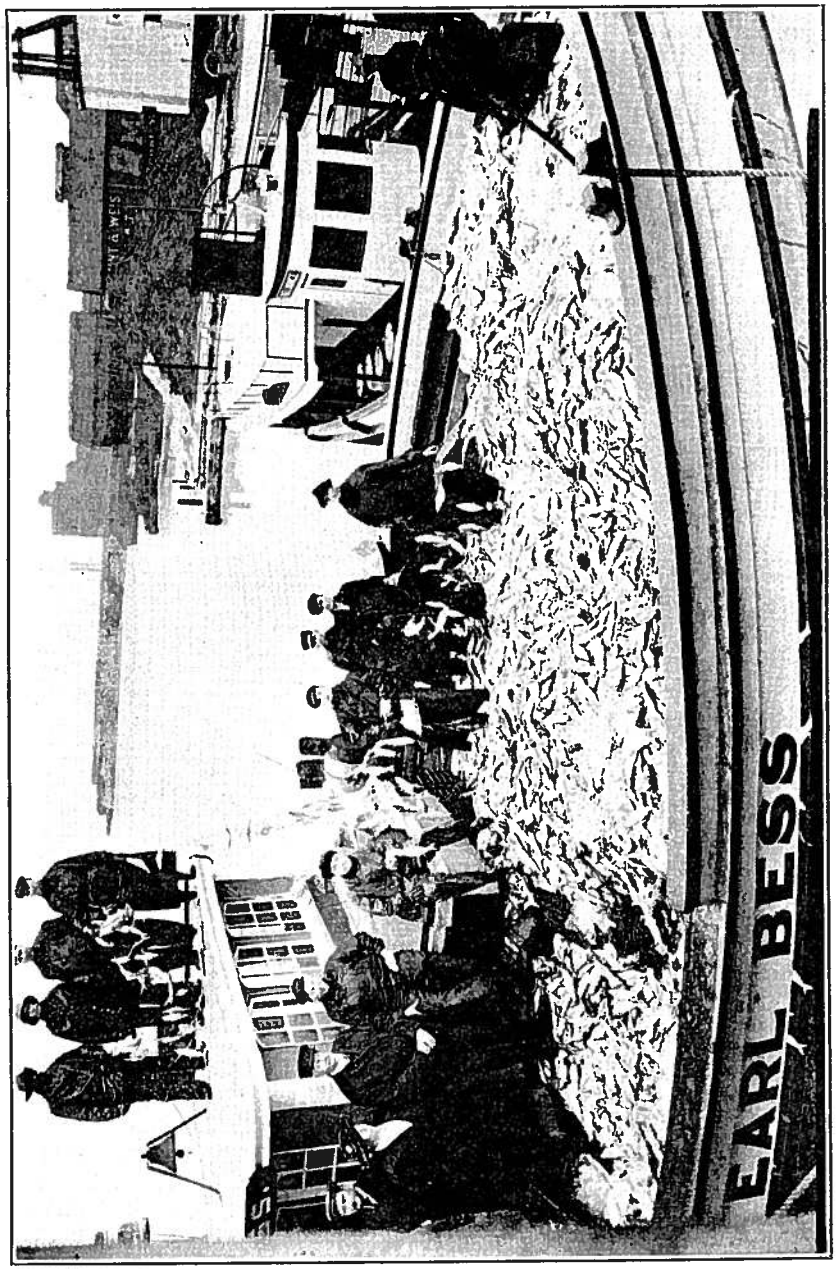

FIG. 1.—A catch of Lake Erie herring in spawning time (November, 1918). Part of a 30-ton catch. The lift was so heavy that the gill nets were not cleared of fish when they were lifted, as is usually done

FISHING INDUSTRY OF THE GREAT LAKES [1]

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[1] Appendix XI to the Report of the U. S. Commissioner of Fisheries for 1925. B. F. Doc. 1001.

INTRODUCTION

In the preparation of this account of fishing conditions on the Great Lakes, the reports of the Department of Marine and Fisheries of Canada and the Game and Fisheries Department of Ontario, which give statistics of the Canadian fisheries, and the statistical bulletins of the United States Bureau of Fisheries were drawn upon. I am indebted for certain dates relative to the commencement of fishing operations on the various lakes to the very excellent report of Richard Rathbun and William Wakeham with regard to the preservation of the fisheries in waters contiguous to the United States and Canada.[2] The sections dealing with fisheries regulations were prepared from the latest issues of the fish and game laws of the various Governments and were supplemented in certain cases by special rulings and license stipulations. Other material was, in the main, collected by me while studying the systematic relationships and natural history of the whitefishes and lake herrings of the Great Lakes since 1919, and present conditions as herein reported are such as obtained at some time subsequent to that date.[3] The systematic and ecological account of the commercial species has been reserved for another publication. The aim of this paper has been to picture, with a historical background, the condition of the fisheries of the Great Lakes as they are to-day and to call attention to the need of intelligent action to preserve those fisheries.

The statements of annual production appearing in the statistical publications, and which have been abstracted in the various tables herein presented,[4] do not, for one reason or another, lend themselves to statistical treatment. Many more data than are included in these publications are needed for statistical analysis; for example, the total yardage of gill netting or the number of gill nets in use is given, but it is not stated what percentage of these nets were of the various meshes employed in the fisheries.

The method of collecting statistics is also open to much objection, and I am aware that in several cases serious discrepancies occur between the actual and reported catches. The tables giving the total catch in pounds and which indicate the relative abundance of the species are therefore intended to show only how the production of the various lakes has changed in character. If the catch of those species that were sought in the beginning of the fisheries has declined, it may be assumed that those species are now rarer, and if new species appear in the tables, their appearance may be accounted for by the assumption that they have grown in favor rather than in abundance. The tables thus also show, although only roughly, the present abundance of the various commercial species.

The five Great Lakes occupy a group of valleys which apparently were changed into lakes by events associated with the glacial epoch, and are therefore, geologically speaking, of relatively recent date.

[2] Preservation of the Fisheries in Waters Contiguous to the United States and Canada. Message from the President of the United States relating to the report of the joint commissioners. (H. Doc. No. 315, 54th Cong., 2d sess., Feb. 24, 1897; Washington.)

[3] This report was submitted to the bureau, virtually in its present form, in March, 1924, but publication has been unavoidably delayed. It has been revised since then only to include the latest statistical figures for American waters, so that changes in the fishing laws and such scientific publications as have appeared subsequent to that date have not been made use of.

[4] The quantity of salt fish is often given in barrels in the Canadian returns, and these have been converted into pounds at the rate of 200 pounds to the barrel.

They have a combined area of over 95,000 square miles, and all of them, excepting Lake Erie, have depths of 600 feet or more. A depth of over 1,000 feet is known to exist in Lake Superior. From a limnological point of view the lakes are very primitive; that is, they have little except algal vegetation, although, of course, larger plants grow in the bays and river mouths, in which semipond conditions obtain. The lakes are very cold, also, and in most of them the bottom waters beyond a depth of 350 feet are never warmer than 4° C. (39.2° F.).[5] The wind stirs up the water sufficiently so that oxygen is distributed throughout, and some sort of life occurs even at the maximum depths.

The conditions present in the lakes are favorable to the development of fish life, and before their commercial exploitation fish were extremely abundant in them. Records of the abundance of fish are found in the relations of the Jesuit Fathers as early as the beginning of the seventeenth century, and these accounts do not fail to mention the excellent quality of these fish. Even within the memory of the present generation the fish supply exceeded any limits now known to us. For the last 50 years the annual production has averaged over 100,000,000 pounds, and the output in 1922 totaled over 140,000,000 pounds, valued at more than $9,000,000. The capital invested in fishing runs into millions of dollars, and over 12,000 persons are directly engaged in the industry.

FISHING INDUSTRY

HISTORICAL

The original fisheries were prosecuted by means of seines, which were drawn along the shores during the spring and fall when the fish came into shallow water. At first enough fish were taken by this method to supply the limited demands, but as the fish became fewer (as a result of intensive and wasteful methods) and the demand increased, pound nets and gill nets were employed. All netting was originally made by hand, and there are fishermen still plying their trade who once spent their winter evenings weaving the webbing for their summer's use. The first pound nets were not radically different from those now in use, but the gill nets were much more crude. Instead of lead weights, stones, fastened by strings, sunk the nets and hand-whittled cedar splinters 6 to 10 inches long, split at one end and pinched onto the float line after the manner of a clothespin, served as floats. Both weights and floats were removed every time the nets were brought ashore, a procedure so laborious that only a few thousand feet of netting could be used. This equipment was carried by rowboats or sailboats to its place in the lake, which was always within sight of shore.

BOATS

The fishing industry has long outgrown such methods. Rowboats are no longer used except in conjunction with mechanically propelled craft, and sailboats have been abandoned since the early part of the present century. They were last in general use on the Canadian

[5] Lake Superior lies 2 to 3 degrees of latitude farther north, and the temperature readings, so far known, indicate that this temperature probably is seldom exceeded below 200 feet.

shore of Lake Ontario. The fishing vessels are now driven by steam and gasoline. The gasoline boats as a rule are only small launches 25 to 50 feet long, and they are engaged chiefly near shore in the pound and trap-net fisheries (in which case they tow a rowboat) or where gill nets are set in the shallow waters near the harbor. However, there are a few large tugs that have installed modern, oil-burning engines. Most of the steam tugs are less than 65 feet in length, since this is the maximum length of a craft that may be operated with an unlicensed pilot and engineer, and some expense in salary for the pilot and engineer is thereby saved by the operators of smaller tugs. Most of the pilots, however, own their boats, and many of them are licensed. One of the largest tugs on the lakes, in use out of Alpena on Lake Huron, is 97 feet long with 80 gross tons displacement. Most of the boats are specially constructed for use in fishing and the largest ones have a cruising radius of more than 100 miles. Gill nets are the chief apparatus employed by tugs.

Until about 1891 gill nets were lifted by hand over a roller, but since about 1900 the tugs have been equipped with automatic lifters. There are two types of lifter, but the one most widely used is the revolving drum bearing along its circumference two rows of rubber-tipped teeth, which bite together and separate again as the drum revolves. The cork and lead lines of the gill net are caught by several teeth on one side of the drum and are carried along. As each pair of teeth releases the lines after bearing them about half a revolution, another pair closes over a new stretch of lines and in this manner the nets are hauled aboard. The speed of revolution can be controlled and the nets may therefore be lifted according to requirements.

APPARATUS

Hooks.—Large numbers of hooks are employed in certain fisheries, but their most important use is in the capture of lake trout. For trout fishing the hooks are tied to a fine line about 4 feet long, and these lines are fastened at definite intervals along a heavy cord. The length of the cord depends upon the number of hooks used and may be several miles. Ordinarily 2,500 to 3,000 hooks are set in a hook gang. Small bloaters (*Leucichthys hoyi*)—so-called because they bloat from the expansion of gas in the air bladder when brought to the surface—serve as bait, and when the main cord is set on the bottom these air-filled fish float the hooks off the bottom. The entire gang may also be floated at any desired depth level by the use of air cans.

Seines.—Seines have long since become unprofitable for general use and are now employed only in special fisheries. A seine is made of heavy cotton netting, and as generally used in commercial fisheries consists of a bag and wings. The wings are strips of netting not more than 20 feet wide and of any desired length. They are fastened on each side of the bag, which is only a pocket in which the fish are collected. In operation a section of the shore waters is surrounded by the extended wings, which are then drawn ashore, reducing the area of inclosure and forcing the fish into the bag.

Pound nets.—A pound net is constructed of coarse cotton netting and is maintained in position by a series of stakes driven into the bottom. The stakes are so arranged and the netting so employed

that there are three parts to a pound—the lead, the heart, and the pot or crib. The lead is simply a fence of netting which extends from the bottom to the surface and runs in a straight line, usually from shore, until it enters the base of the heart. A lead may be 60 or 70 rods long. The heart is likewise a fence of netting, but the stakes are so driven that the netting on them roughly outlines a heart. The figure is not complete, however, since its halves do not join at the base. At its apex the heart is modified into the tunnel, a completely inclosed passageway that leads into the pot. The pot is a basket of netting open at the top and with sides extending above the surface.

In principle the net works as follows: The fish, in swimming along the shore, meet the lead, which for whitefish and trout is composed of netting with meshes 2½ to 3½ inches square [6] (5 to 7 inches stretched mesh), and find their way barred. They turn, then, toward deeper water, follow the lead, and enter the heart through the opening at its base. Once in the heart escape is not easy, and the fish eventually pass through the tunnel at the apex into the pot. To prevent the fish from becoming gilled in the netting its mesh in the heart is reduced to 5 inches and in the pot to 4 inches and 3 inches—3 inches on the outer side or back of the pot, which becomes the bottom in lifting, and 4 inches on the bottom and other three sides.[7] These nets are set on soft bottom, into which the stakes can be driven, and the pot is located at depths of 25 to about 80 feet. It is impossible to set pound nets at greater depths, as there is a limit to the length of stakes that can be obtained. The nets are usually lifted daily, and the fish are alive when taken.

Trap nets.—The trap net is a modification of the pound net, in which the lead is maintained in position by leads and corks instead of by stakes, and the heart and pot by anchors, and in which the pot and heart are entirely closed like a covered basket. The net may therefore be submerged, and for this reason the fishermen often call it the "submarine."

Crib nets.—A net called the crib net is widely used on Lake Erie and Saginaw Bay, which has features of both the pound net and trap net. There are, however, two pots connected by a tunnel and two hearts. The pots are covered, as in a trap net, but the hearts are open, as in a pound.

Fyke nets.—The fyke net is also a sort of trap net, but there is no lead or heart. Two wings of variable length, held in position by stakes, converge into a tunnel which leads into the pot. The pot is cylindrical and is supported by hoops. There may be several compartments in the cylinder, each connected with the other by a tunnel, by which arrangement the escape of the fish is much complicated.

Gill nets.—A gill net consists of two heavy cotton lines—the cork and lead lines—and the netting. The first line bears aluminum or wooden floats and the latter is strung with leads, both at intervals of 6 to 10 feet, according to the option of the fishermen. The netting proper is made of fine linen or sea-island cotton thread, the size of

[6] The mesh of nets may be described as square or stretched. By square mesh is meant the length of one side of a quadrangular opening; by stretched mesh is meant the sum of the length of two sides of such an opening. The latter measurement is obtained by stretching the mesh until the opening is obliterated. Dimensions given elsewhere in this paper refer to stretched mesh.

[7] The figures given for size of the meshes are relative and are intended to show only that the size of the mesh changes in each part of the pound. The size of meshes used varies widely according to the laws or according to the species of fish sought.

the thread varying with the mesh of the netting, and is purchased according to order by the fishermen. It is then seamed onto the lead and cork lines, so that one diagonal of the quadrangular openings of the netting is perpendicular to these lines. Three sorts of gill nets are in use by the Great Lakes fishermen—(1) nets for whitefish and trout, which are regularly of 4 to 4¾ inch mesh, depending on the regulations of the various Governments, though nets up to 7 inches are used on the spawning grounds; (2) small-meshed nets, which are of 2⅛ to 3 inch mesh and are used for herring, chubs, perch, etc.; (3) nets of 1⅜ to 2 inch mesh, which are used to catch bait for the trout hooks in American waters only. In Canadian waters 2⅛ to 2¼ inch nets are permitted for this purpose. All three sorts of gill nets are set chiefly in the deeper waters of the Lakes to depths of 600 feet, though at certain seasons the first two are employed to advantage on the shoals. The nets are from 50 to 90 leads long and are handled in boxes, 3 or 4 nets to a box. In use they are united, end to end, to form gangs, one of which may reach 4 to 8 miles.

In setting a gang a buoy is thrown overboard, to which a line, somewhat longer than the depth of the water at that point, has been attached. A few rods from the lower end of this line an anchor is fastened, and the end of the line is made fast to the joined lead and cork lines of one end of the gang. The anchor is then thrown overboard and the net paid out from the moving steamer. When the end of the gang has been reached a second rope and anchor are attached to it. To the second rope a line with attached buoy is made fast and the net is allowed to sink to the bottom, where it stands upright like a tennis net. The fish swimming along the bottom run into the net and become entangled in the meshes. Since the fine threads of the net usually are caught under the gill covers of the fish they are said to be "gilled." The fish are often dead when taken.

The boats use either large-meshed gill nets exclusively and catch whitefish and trout, or use small-meshed nets exclusively; or they may, at certain seasons at least, have gangs of both. The gangs are lifted at intervals of one to six days, depending on the temperature of the water. The nets used to catch bait for the boats' "fishing hooks" are lifted daily or on every second day. The hook tugs use no other nets.

By the methods of fishing in general use on the Great Lakes (excepting Lake Erie) fish are captured from the surface to the bottom only in the shallower shore waters having a maximum depth of about 80 feet. In the deeper water they are taken by gill nets within about 5 feet of the bottom only. The fish are therefore free from capture in these deeper waters from the surface to within 5 feet of the bottom, except that trout may be taken by floated hooks.

In Lake Erie, however, nets have commonly been floated off the bottom since the beginning of the present century. From the practice of floating nets, Clarence Jackway, of Westfield, N. Y., is credited with having evolved the "bull net" about 1905, which is merely a very deep gill net. Where the ordinary gill net would take fish only within 5 feet from the bottom, the bull net, if set on the bottom, would catch fish to four or five times that height. Experience taught, however, that the currents along the bottom were frequently so strong that a bull net would be brushed flat, and for that

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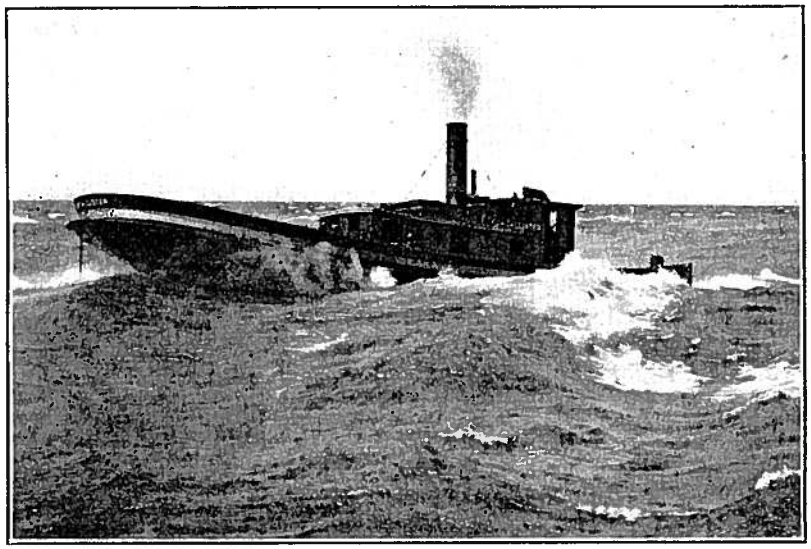

FIG. 2.—A rough day on Lake Michigan. Nets are not lifted if the lake is much rougher than this

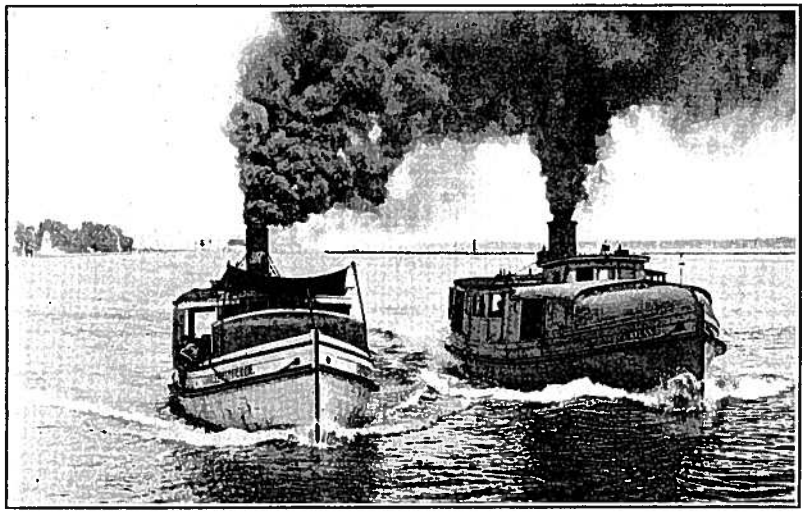

FIG. 3.—Returning to harbor with the day's catch of Lake Erie's fish. Note that these tugs are housed fore, while that in Figure 2 has an open deck. Both types are in use on the lakes

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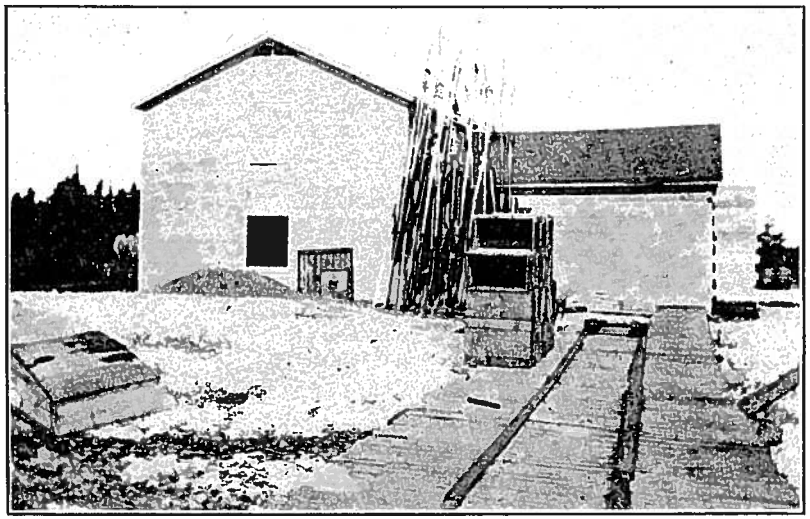

FIG. 4.—Typical fish-packing house. The tracks lead from the docks to the packing shed. At the left is the ice house. The buoys are those used for marking the location of the net gangs in the lake, and the boxes along the track are "lake boxes," in which the fish are brought ashore

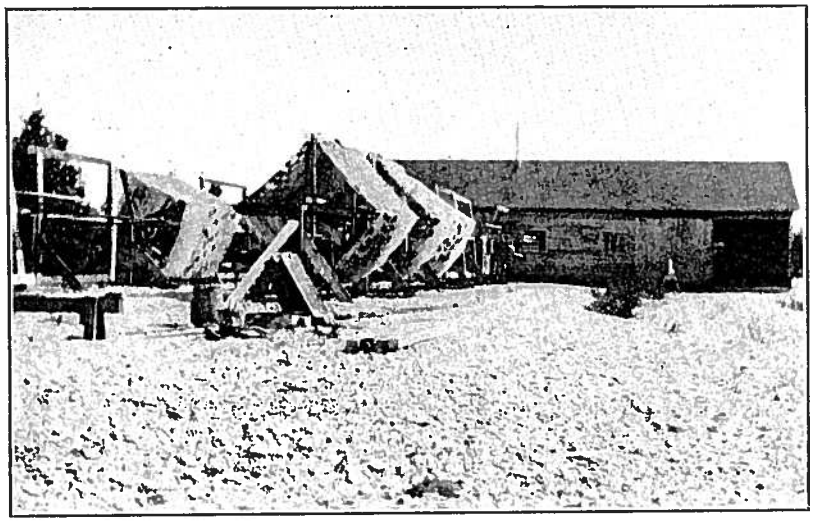

FIG. 5.—Typical net shed and reels. The nets are always reeled when brought ashore, and when mended are stored in such buildings as those shown here

reason this type of net is usually floated above the bottom. The vertical position of the gill-net gangs in Lake Erie varies from day to day—at times they are high, then on the bottom, according as the fish rise or drop. Relatively few of the bull nets are of larger mesh than 3 inches.

The practice of floating nets has been followed by European fishermen for many years, and the method was employed in the taking of herring, presumably by immigrants from Europe, on the western end of Lake Superior and also at certain points on the Canadian shore of Lake Erie long before 1900. The herring fisheries here, however, had not attained much importance, and the method was therefore little advertised, so that it remained for the American fishermen on Lake Erie to invent it anew. It is said that a fisherman at the eastern end of the lake by accident rearrived at the idea of floating nets about 1902, when a part of his gang, which had become entangled in the buoy line and was therefore suspended between the surface and the bottom, made a good catch of fish. At present the idea, on account of its usefulness in Lake Erie, has spread to other lakes, and even trap nets are floated in certain localities at certain seasons.

ORGANIZATION

Only two men are required to operate pound and trap nets, and the labor of lifting such nets is soon performed.

The personnel in the gill-net industry is differentiated into two classes—the "lake hands" and the "shore hands." The larger boats carry six or seven men—a licensed pilot, a licensed engineer, a fireman, and a crew of three or four men, who must be trained in the fishing industry. When fishing is heavy an additional man may be added to the crew. The pilot determines where the nets are to be set and is responsible for the boat in general; the engineer and fireman run the engine; and the crew lift and set the nets, remove the fish from the netting, dress them, and when the nets are brought ashore put them on the reels to dry. The engineer and fireman are exempt from duties other than those pertaining to their machinery, except that the fireman often is expected to help with the reeling.

The boats leave port at any time from 2 to 6 a. m., and usually return (depending on the length of the cruise) in the afternoon, but sometimes not until late at night. In any case, the nets must be spread on the reels before the men's work is ended. When the weather interferes with lifting the nets the boat crew has a holiday, but if there have been two such holidays in a week the following Sunday usually is reckoned a working day. The lake hands are laid off when the fishing season is over.

The nets are mended and put in readiness to set again by the shore hands, who, unlike the boat workers, have regular working hours. In the winter, when the boats do not fish, these men are kept employed in making new nets or more carefully repairing the old ones. The shore hands may properly be called skilled labor, and experience gives them an amazing dexterity in handling netting.

The laborer usually is given a definite wage, except on Lake Erie, where the boats often fish "on shares." Where such an arrangement exists no wages are paid to the lake hands, but the catch of a boat is sold to the company owning it and the proceeds are divided. The

owner gets about one-third and the remainder is prorated among the employees.

Excepting on the American shore of Lake Erie, and sometimes in the larger ports elsewhere, labor is not organized. On the American shore of Lake Erie the labor organizations are so powerful that in a measure they fix the minimum price per pound for their catches. Everywhere it is becoming increasingly difficult to obtain help. No new recruits are being added to replace those who die and the fluctuating supply of unskilled labor can not be used.

PRODUCTS

Most of the fish are sold fresh, when they are shipped in wooden boxes containing 100 to 150 pounds of fish well packed in ice. The express companies require adequate ice packing and charge one-fourth the weight of the fish extra for the ice, however much or little it may weigh. The fish are sorted and packed by one or two men who do nothing else, and are shipped according to the instructions of the manager.

Some of the fish companies have a retail trade (which, however, never assumes the proportions which the furnishing of fresh fish at cheap prices should), but most of the products are sold to distributors. Large producers or wholesalers on the Lakes maintain freezers, in which their catches are frozen and kept until market conditions are favorable. Except for the chubs and some Lake Erie herring, which are smoked, and sometimes the herring from other lakes, which are often salted, the bulk of the fish is put on the market in a fresh state. All of the fish are dressed as soon as caught, excepting those intended for the Jewish trade in the New York markets. Whitefish, wall-eyed pike, carp, and suckers are the chief support of this trade and are mainly taken in pound and trap nets. The salted and smoked fish are prepared chiefly for the consumption of the foreign-born population, but the latter product is also widely esteemed by the native population where its qualities are known. Unlike the ocean herring, these lake fish are salted lightly and are smoked over a fire which cooks them at the same time. Thus prepared the product is perishable and must be disposed of within a week or two.

A small quantity of oil is rendered from the fish offal at a few of the ports, but for the most part the offal, though abundant and rich in oil, is destroyed because there are so many difficulties in the way of converting it into a marketable product. Latterly the practice of making caviar out of whitefish and herring roe to take the place of sturgeon caviar, which is becoming rare, has spread to various ports, but the production has not yet become significant.

The principal species in the Great Lakes, as given by the Bureau of Fisheries' census for American waters for the year 1922, given in order of magnitude of the catch, are ciscoes (herring and chubs), blue pike, lake trout, carp, sauger suckers, yellow perch, whitefish, yellow pike, and sheepshead. Species of minor importance include catfish and bullheads, lawyer, eel, white bass, Menominee whitefish, pike, bowfin, rock bass, sturgeon, and sunfish. The Canadian statistics for 1922 do not separate the species in so much detail. The principal species listed in order of abundance on the Canadian shore are herring, trout, blue pike, whitefish, "coarse fish" (including every species not enumerated), yellow perch, yellow pike, pike, and carp. Species of minor importance are sturgeon, eel, catfish, and chubs. The relative importance of the species varies from census to census, and the production of the Lakes is by no means equal, nor is the proportion of the species the same for each lake.

In the succeeding sections are given a historical résumé and a statement of present conditions for each of the Great Lakes.

LAKE MICHIGAN

DESCRIPTION

Lake Michigan is the only one of the Great Lakes that lies wholly within American jurisdiction. On the north and east its waters are controlled by the State of Michigan, on the west by Wisconsin and Illinois, and at the extreme south by Indiana. The lake is about 325 miles long, with an average width of 65 miles and an area of about 22,000 square miles. In the lake bottom are two basins—one at each end—separated in the center by an uneven stretch about 60 miles in length, which bears several well-defined though uncharted reefs. From the south the bottom slopes very gradually (at the rate of 1 or 2 fathoms to a mile) into a basin with a maximum recorded depth of 97 fathoms. In this depression a somewhat circular area, about 40 miles in diameter, is inclosed by the 60-fathom contour. The rise to the elevation in the center is rather abrupt and begins about 100 miles from the southern shore. The most extensive depression extends for about 100 miles in the northern half of the lake and is overlaid by 90 to 144 fathoms of water. The 90-fathom contour roughly outlines a triangle, with the apex pointing north. For about 50 miles the figure has an average width of 30 miles and then tapers rapidly. So far as is known this area is virtually a desert. The rest of the northern sector is dotted with islands and reefs, with conspicuous depressions between. Green Bay, with an approximate area of 1,700 square miles and a maximum depth of about 20 fathoms, and Grand Traverse Bay, with an area of about 300 square miles and a maximum depth of more than 100 fathoms, are the only extensive bays, and both lie near the north end. The bottom along the shore is largely sand, but there are stretches of clay and, in the north, of rock. The deeper waters overlie clay for the most part.

FISHING INDUSTRY

HISTORY

The exact date when fishing operations began on Lake Michigan is not known, but it was without doubt coincident with the founding of settlements along its shores. On account of the proximity of good markets the fisheries resources have been exploited to the limit from the earliest times, and the lake has been exceeded only by Lake Erie in productiveness and amount of capital invested. The industry was originally prosecuted with seines and later with gill nets. Pounds were not used much before 1860, and they have never been used very extensively except in the bays and around the islands in the northern sector of the lake. The principal fishing at first was for the whitefish, but trout became increasingly important after 1880, and even before 1870 other species (principally herring in Green Bay) were significant in the fisheries. The sturgeon was originally discarded, but by 1880 it had found a market and had risen to second place in abundance

The whitefish and sturgeon, although extremely abundant at first, soon decreased because of wasteful fishing methods and the pollution of shores by sawdust, fish offal, etc., and the gill-net fisheries were carried into deeper water, where chiefly trout were caught. A few boats also fished with hooks for trout on the west shore as early as 1870, but the method decreased in effectiveness as the trout supply fell off, and not until about 1900, with the perfection of a new technique, did hook fishing begin to assume an important rôle in fishing methods.

The predilection for smoked fish of the Teutonic peoples who settled abundantly along the shores soon gave rise to another industry. About 1880, out of Milwaukee, a fisherman began bringing ashore the deep-water herring that became snarled in abundance in his trout nets, and finding them suitable for smoking on account of their rich flesh, he began to fish nets of 3-inch mesh for them. During the nineties this method of fishing spread to almost all the ports on the lake where gill nets were used, and the maximum annual output probably approached 10,000,000 pounds. These fish have decreased decidedly in abundance, and where previously boats fished for nothing else, now all boats use small-meshed nets only when it is most profitable. With the decrease of the whitefish and sturgeon from the shores the pound nets depended chiefly on suckers, perch, and other "rough fish," and latterly pounds have given place, as elsewhere, to the less expensive trap net as a means of taking such fish.

The quality of the production has varied with the change in apparatus, but since these changes did not affect the entire lake at the same time, but rather were instituted in different sections as conditions demanded them, statistics, unless they be very detailed, can not be expected to reflect their effects. The nine censuses made by the Federal Government do not give the required details, but they show in a very general way what the trend has been. In Table 1 is given the relative abundance of the principal commercial species for the nine years when censuses were taken. The interesting features of the table are the decline of the sturgeon to insignificance after 1890, the increase in importance of the trout after 1880, and the immense increase in the importance of the chub fisheries and the improvement in whitefish production between 1899 and 1922.

TABLE 1.—*Relative abundance as shown by the weight, in pounds, of the annual catch of the principal commercial species of fish of Lake Michigan, as shown by various censuses*

Species	1880	1885	1890	1893	1899	1903	1908	1917	1922
Whitefish	12,030,000	8,682,000	5,455,000	2,330,000	1,510,000	1,972,000	2,490,000	3,047,000	1,547,000
Sturgeon	3,839,000	1,406,000	946,000	311,000	108,000	56,000	70,000	[1] 10,000	9,000
Herring and chubs [2]	3,050,000	3,312,000	6,082,000	13,279,000	22,072,000	14,684,000	21,842,000	18,259,000	6,810,000
Trout	2,659,000	6,431,000	8,364,000	8,216,000	5,488,000	9,049,000	7,892,000	8,650,000	8,735,000
Perch (including some white bass)	([3])	([3])	1,943,000	3,451,000	3,077,000	3,313,000	3,256,000	2,362,000	1,244,000
Suckers	([3])	([3])	1,800,000	1,690,000	1,043,000	2,917,000	2,510,000	2,118,000	1,519,000

[1] Closed season on sturgeon in Wisconsin.
[2] After 1885 the catches are in large part chubs.
[3] Not itemized.

PRESENT STATUS, METHODS, AND APPARATUS

There were engaged in the fishing industry on Lake Michigan, according to the census of 1922, 87 steam tugs, with a total tonnage of 1,709, and 269 other vessels, with a tonnage of 2,442, equipped with 35,930 gill nets. There were, in addition, rowboats and small power boats which used 704 pound and trap nets and 10,453 gill nets besides fyke nets and seines. The number of vessels and boats was reported to have been greater only in 1893, but the amount of apparatus employed was the least on record since 1890, and the total production was the smallest on record.

Most of the boats are engaged in gill netting for trout, whitefish, and chubs, though in late years the markets for chubs have become so unstable on account of the increased use of Lake Erie herring for smoking, and the supply so uncertain, that few boats fish for chubs exclusively but many have gangs of both kinds of nets.

Many vessels, particularly on the Wisconsin shore, fish hooks for trout only. The effectiveness of this method, when properly employed, and the relatively small cost of operation have maintained its popularity. In 1917 a number of the hook tugs migrated to the waters of Lakes Huron and Superior for part of the season, a practice which has become more common as the trout supply in Lake Michigan has fallen below that of the other lakes. Those tugs that can make their way through the ice frequently fish all winter.

Pound nets and trap nets are scattered here and there all along the shores, but they are used most in the northern end of the lake, in Green Bay and Grand Traverse Bay and in the sector north of those regions. The catches are principally "rough fish," but many herring and whitefish are taken also in certain localities. Trap nets are now far more numerous than pound nets.

FISHING DISTRICTS

The principal gill-net centers are on the Michigan shore at Manistique, Charlevoix, Northport, St. James, Frankfort, Ludington, Grand Haven, and St. Joseph; on the Indiana shore at Michigan City; on the Illinois shore at Waukegan; and on the Wisconsin shore at Racine, Milwaukee, Port Washington, Sheboygan, Manitowoc, Kewaunee, Sturgeon Bay, Washington Harbor, and Marinette. Practically all the pound and trap nets licensed on the lake are employed in the north from Green Bay to Grand Traverse Bay. The boats engaged in this fishery are for the most part small launches, and as these can find shelter in any of the bays and harbors they are not assembled at any particular point, as is the case with large gill-net boats.

PRINCIPAL SPECIES

The Federal census of 1922 indicates that, listed in the order of magnitude of the catch, lake trout, chubs and herring, whitefish, sucker, and yellow perch constitute the principal species taken in the lake. The total number of pounds of each of these species caught in 1922 is shown in Table 1.

LAKE TROUT

Since 1885 Lake Michigan has produced more trout than all the other Great Lakes together. Trout support the fisheries with large-meshed gill nets and are still caught out of almost all ports, but the principal catches are made in the northern end of the lake around the islands and on the reefs, on the reefs off the Wisconsin shore, and in the southern basin. The southern trout, which are taken chiefly by Milwaukee, Racine, and Grand Haven tugs, live and spawn on clay at depths of 40 to 60 fathoms. The northern trout are shoal forms and spawn off the shores on rock bottom. There are no deep-water trout known in the north. The principal mode of capture is by means of gill nets, though hooks are used out of almost every port, but most commonly on the Wisconsin shore.

Trout were little esteemed as long as whitefish were plentiful, and relatively few were caught. In 1890, however, the catch of trout was greater than that of any other species, but since then it has been exceeded in abundance by herring and chubs in every census except that of 1922. The species is apparently maintaining itself and is in no danger of extermination, though it is by no means as abundant as formerly. It is only nominally protected by a closed season, since both Wisconsin and Michigan, within the jurisdiction of which States the spawning grounds lie, permit fishing if the spawn be saved. Trout are extensively propagated by both the Federal and State Governments.

CHUBS

In all Federal statistics the "chubs" have been grouped with the lake herring—a fish by no means equal to them in value or importance except in Lake Erie—under the name "cisco," and since little has been published pertaining to these fish, a short general account may be of service to those who may wish to understand the general scope of the fisheries.

There are in Lake Michigan seven species of deep-water herring, three of them until recently unknown to science, which are known to the trade and to the majority of the Lake Michigan fishermen as "chubs." The fishermen also call them "longjaws," "bluefins" (abbreviated to "jaws" and "fins"), "mooneyes," and "kiyis". All these names are used locally in varying senses and are not applied to the same fish by fishermen in different parts of the lake, but wherever any of these colloquial names are current any one of them may be used to designate a catch containing the seven species. All seven are fat, herringlike fish. They differ from one another in their choice of habitat, but all inhabit the deeper waters of the lake. Each ranges during the year over a rather broad, vertical zone, and the habitat zones of all the species overlap more or less at all times, so that in most large catches of chubs, at least, a few individuals of all seven species are taken, except when the nets are set on the spawning grounds of any one of the species, and in that case only the spawning species is taken. Usually, however, one or two species constitute the bulk of any large catch. The proportion of the various species varies at the different ports and also with the season at the same port.

Chubs are caught almost solely in gill nets, which in the waters of the State of Michigan are of 2¾-inch mesh and in the waters of other States are of 2½-inch mesh. The chub nets are fished on the bottom

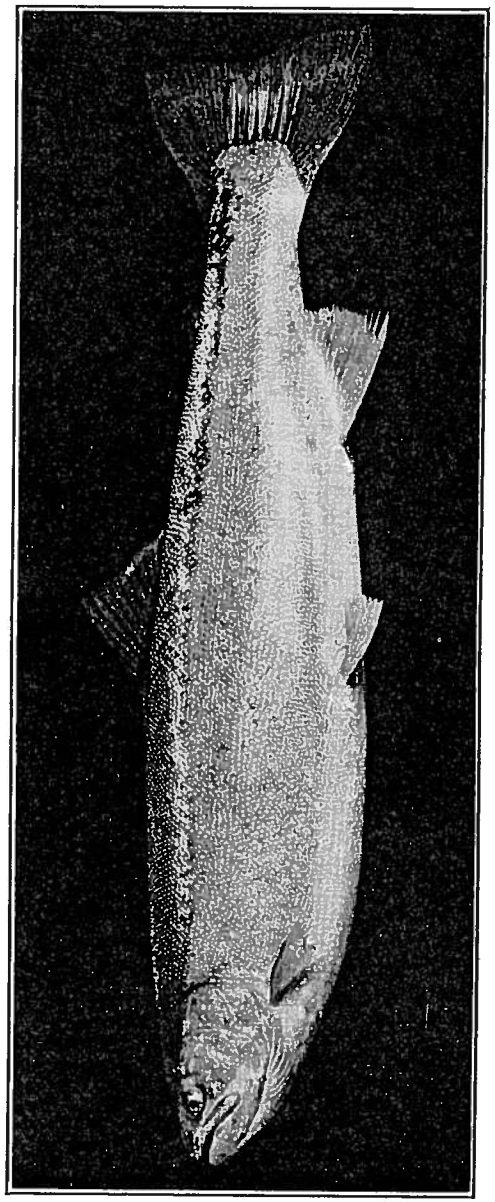

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FIG. 6.—Steelhead trout taken in Lake Michigan in June, 1909. Weight, 17 pounds. Steelheads have been introduced into the Great Lakes and are common in sections of Lake Michigan

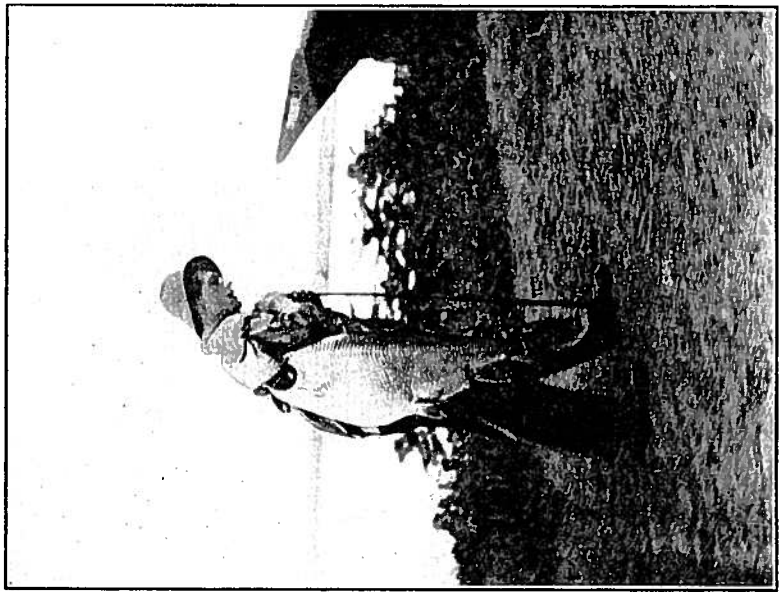

FIG. 8.—Lake trout. The specimen shown weighed 56 pounds and was taken in Lake Michigan in the catch of a gang of trout hooks. Trout of this size are no longer common in the Great Lakes

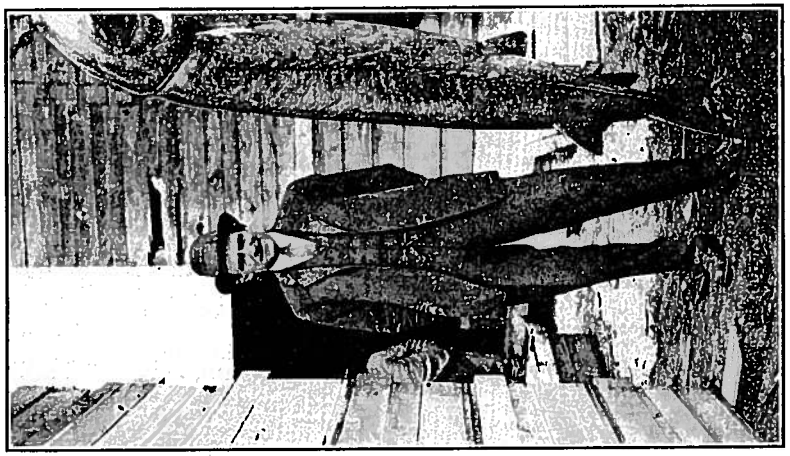

FIG. 7.—Sturgeon. This huge specimen of an almost exterminated species was captured in Lake Superior on June 29, 1922, and weighed 310 pounds. Its length may be judged from comparison with a 6-foot man. Specimens of such size have seldom been taken in the Great Lakes

as a rule between 35 and 70 fathoms, the depth usually depending on the behavior of the species which is predominant in the catches.

As each species exhibits peculiarities in the selection of a habitat, so each has a definite spawning behavior, and no two species are known to spawn on the same grounds. The spawning grounds for one species may be in water as shallow as 50 to 60 feet, and for another as deep as 300 to 350 feet, and as for the time of spawning, the eggs of one species or another are deposited during some part of every month in the year except June and July. Some spawning grounds of each of the species are known, and the fish are taken abundantly while they are spawning.

At present the greatest quantity of chubs is taken along the Wisconsin shore, especially from Manitowoc southward. This productive area extends around the lake as far north as Grand Haven on the east shore. Some chubs are caught all along the shores of the lake except in Green Bay, where the water is too shallow, but northward from Manitowoc and Grand Haven the ledge along the shore becomes narrower and the species of chubs fewer, until in the northern end of the lake the industry is supported solely by one or two species, compared with five or six in the more hospitable southern end.

As far as can be learned, chubs were first taken about 1869 in Grand Traverse Bay out of Northport. These fish were caught only in November, when they were spawning along the shores, and 3¾-inch nets were used. They were salted and sold to wholesale grocers along with whitefish and other species. About 1883 chubs were taken out of Racine in 3-inch and 2⅞-inch nets and about 1885 they were caught out of Milwaukee in nets with a 3-inch mesh. By 1885 they were also being produced out of other ports on the west and east shores of the lake, but only at certain seasons and in limited quantities to meet the demand for salt fish and cheap fresh fish.

The market for such products at that time was not large, and not until they came into demand for smoking were chubs extensively caught. Trout and whitefish had long been prepared smoked, but C. H. Fischer, of Milwaukee, is credited with having first introduced smoked chubs. About 1885 the smoked product had become so popular that it was shipped to various large cities of the middle west and many of the fishermen took to chub fishing. By 1891 chubs were being caught regularly from Sheboygan to St. Joseph, and the supply for a time exceeded the demand. During the nineties, however, there was a sharp decline in the abundance of these fish at ports where they had been taken for several years, and nets of 2¾ inches were substituted for larger mesh. Since in general the larger fish were in better demand, persons who had begun late to fish for chubs used the largest possible mesh at first.

By 1900 chub fishing had become an industry at most of the ports on the lake, but by 1910 chubs had so declined in numbers that the Wisconsin boats reduced the mesh of the chub nets to 2½ inches. Their example was followed later by vessels from Illinois and Indiana, but Michigan fisherman have never been allowed to use a net of smaller mesh than 2¾ inches. In these small-meshed nets there were now taken in abundance three species of smaller chubs, of which only the largest individuals were ever gilled in the 2¾-inch nets

previously in use, and the chub-fishing industry for a time flourished as never before.

Chubs have latterly again become scarce, and in the summer of 1920 chub fishing had to be discontinued out of many ports. Since then the catches have been larger, but any increase can be only temporary. One of the species—the blackfin—has already become commercially extinct, and the longjaw, which is the principal species off Charlevoix, is conceded to be much reduced in numbers. None of the species has ever been protected anywhere and no serious effort to propagate them has ever been made.

Trout fishermen in general are opposed to chub fishing because small trout are caught in the chub nets. The percentage of small trout taken is often high, it is true, but it has not yet been ascertained that small trout are present throughout the area frequented by the various species of chubs, and it seems not improbable that when the behavior of the former is better known the use of chub nets may be so regulated that the capture of undersized trout will be reduced to a minimum.

HERRING

The most important herring fisheries are located in Green Bay, where they are taken by means of gill nets and pounds chiefly in the fall, when they come ashore to spawn. Some are also taken in the deepest waters of the bay by gill nets in summer and are known then as bluefins. In fall they are either salted or sold fresh. Some are taken for market at points along the lake shore, but the quantity is relatively insignificant. The price paid is so low (in the past not more than 1 to 3 cents per pound) that unless the fish can be taken abundantly and easily it is not worth the effort to fish for them. They are nowhere protected by a closed season, and none are propagated.

WHITEFISH

From first place in the fisheries of Lake Michigan in 1880, the whitefish now ranks third in quantity and is produced from areas that were least exploited in 1880. Practically the entire yield is taken in pound nets and gill nets around the islands of Michigan at the north end of the lake. Over most of the lake where this fish was once abundant it is now scarce. The causes of depletion have been pointed out by every investigator and are those factors which will eventually eliminate the species elsewhere—wasteful and extravagant modes of fishing and pollution. As in the case of the trout, there is no effective closed season, but the species is extensively propagated.

YELLOW PERCH

The yellow perch is taken chiefly by the gill nets and trap nets of the shore fishermen. Most of the catch now comes from the Green Bay region, though some of it is produced out of almost every other port. Formerly they were much more abundant, according to the fishermen, and in many localities they have become commercially unimportant. Except in Wisconsin, where they are protected from April 15 to May 20, there is no closed season for perch. Some are propagated.

SUCKERS

Suckers ranked fourth in quantity among the fish of this lake in 1922, and though they have maintained their relative position in the fishery, as shown by previous censuses, the fishermen generally concede that they are less abundant than formerly. They are caught chiefly in traps, but also to some extent in gill nets. The white sucker is the principal species marketed, though the sturgeon-nose is sold to a greater extent here than in any of the other upper-lake regions. A few suckers are taken everywhere, but the bulk of the catch originates in Green Bay, with the next largest quantity from Grand Traverse Bay. Most of the catch is now sold fresh, but in 1885 it was chiefly salted. There is no closed season for suckers and none are propagated.

STURGEON

The sturgeon is now practically exterminated and claims mention only because of the important position it once held in the fisheries. Prior to about 1875 these fish were either drawn onto the beaches or else fatally wounded and released in the lake when taken in the pound nets, and immense numbers are said to have been destroyed in this way. By 1880 sturgeon had a market value, and the catch of this species on the lake in that year amounted to nearly 4,000,000 pounds. In 1890 the output had fallen to less than 1,000,000 pounds, and thereafter the decline was rapid. Except in Wisconsin, where there has been a closed season since 1915, sturgeon may still be taken at any time, and in certain waters there are not even size limits to protect the immature. No sturgeon are propagated.

OTHER INDIGENOUS SPECIES

All the species of fish native to the basin occur in Lake Michigan and are marketed. In 1922 there were taken more than 1,000,000 pounds of fish other than those mentioned above, most of which were produced in Green Bay.

INTRODUCED SPECIES

CARP

The carp has gained a foothold in Lake Michigan and is to be found almost everywhere. It is important in the fisheries only in Green Bay, where 742,000 pounds were marketed in 1922.

STEELHEAD TROUT

The steelhead is likewise established in the lake and spawns abundantly in several of the larger streams emptying into it, and probably also on the beaches. It is important in the commercial fisheries along the Indiana shore only, but there are ports on other shores where it could be taken in commercial quantities if the law permitted.

SMELT

The smelt has been planted several times in inland lakes of Michigan, notably Torch and Crystal Lakes in the lower peninsula and in Trout and Howe Lakes in Marquette County in the upper peninsula. It is now known to be well established in all of these lakes except Torch. It has also escaped into Lake Michigan and is apparently spreading there at a rapid rate. In what numbers it occurs is not known, but specimens have been taken off Frankfort and in Grand Traverse Bay off Northport and even across the lake in Big Bay de Noc and at Manistique.

The introduction of the smelt into the Great Lakes must be deplored since its presence there can not serve any useful purpose and there is some reason to believe that it is a menace to native species now commercially important. It has been argued that the smelt is itself a valuable food fish and that it serves as food for trout. In reply it may be said that there is difficulty at present in finding a market for species quite or almost as delectable as the smelt, and that if the lake originally supported a trout population many times the size of the present one it is probably capable of taking care of the few remaining individuals, especially since none of those now taken show any evidence of undernourishment. Furthermore, even if the species should become marketable, the nets required to capture fish as small as the smelt would most probably be destructive to the young of the native species. On the other hand, Carl L. Hubbs and J. Metzelaar, of the University of Michigan, who recently completed an analysis of the stomach contents of smelt collected in Crystal Lake during August and September, 1923, found that the present food of the smelt consists almost exclusively of the pelagic minnow *Notropis atherinoides*. If in Lake Michigan the smelt preys upon the small whitefish and trout that are at first pelagic, its introduction must have important consequences. We have already accumulated so much experience from the introduction of foreign species of vertebrates that it would seem unnecessary to caution against a continuation of the practice, and it is to be hoped that no organization will in the future assume the responsibility of the importation of any uncontrollable non-indigenous animal.

FISHING REGULATIONS

APPARATUS

Gill nets.—The States of Michigan and Illinois do not permit the use of nets with a mesh smaller than 4½ inches for taking trout and whitefish. Wisconsin and Indiana allow a 4-inch mesh. For the capture of chubs the State of Michigan allows nothing less than 2¾-inch mesh. Other States allow a 2½-inch minimum, and the law of Wisconsin provides that nothing larger than 2¾-inch may be used. Formerly a 3½-inch net was allowed for bluefins but was employed largely to take young trout. Fish other than chubs may be taken in Indiana with nets having a minimum mesh of 2¼ inches; in Wisconsin and Illinois 2½ inches in the minimum size; in Michigan they may be taken only with 2¾-inch nets, except that 2½-inch mesh may be used for herring from November 1 to December 15, or at any time if set not more than 2 fathoms below the surface in waters of not less than 10 fathoms depth. Wisconsin has special laws for Green Bay, effective since January 1, 1925, which differ from those in force on Lake Michigan in that the minimum mesh for general use shall be 2⅜ inches, but that 2⅛-inch nets may be used to catch herring from December 1 until the ice goes out. In Wisconsin nets used for catching bait for the trout hooks are of 1⅜-inch mesh, and in Indiana and Michigan they measure 1½ to 2 inches.

Seines.—In Wisconsin seines may have a mesh of not less than 3 inches, in Illinois not less than 5 inches, and in Michigan not less than 4 inches in the wings and 2¼ inches in the bag. The length of seines is restricted to 1,000 yards in Illinois, and their use is prohibited from April 15 to July 31, inclusive. Michigan laws prohibit the seining of whitefish and trout, but Indiana has no laws regulating seining in Lake Michigan.

Pounds and traps.—A pound or trap in Wisconsin may not have a pot of mesh larger than 2 inches; in Illinois the pot mesh may not measure less than 4½ inches for trout and whitefish or less than 2½ inches for other species; in Indiana the mesh of the back may not be smaller than 2 inches, as manufactured, and of the rest of the pot not smaller than 2½ inches. In Michigan pound-net pots for whitefish and trout may not have a back of net measuring more than 2 inches, as manufactured, for at least 15 feet below the surface of the water, and not less than 3½ inches on the bottom and sides, as used; or, if the mesh of the pot does not measure less than 4 inches, as fished, the net need not have a small-meshed back. For use in taking other fish Michigan laws further provide for a pound with a pot having a back made of mesh no larger than 2 inches and sides and bottom not less than 2¼ inches. For the taking of herring alone between the dates of October 1 and June 15, a pound, the pot of which is constructed of netting with a mesh of not less than 2 inches thoughout, as manufactured, may be used where such nets do not take immature whitefish and trout as well.

SIZE LIMITS

Indiana does not limit the size of any Great Lakes species taken except wall-eyed pike, which may not be less than 12 inches long. Wisconsin has established the minimum legal size of trout as 12 inches; of whitefish, 13 inches; suckers, 12 inches; perch, 7 inches; wall-eyed pike, 16 inches; catfish, 20 inches; buffalofish, 18 inches; and all others, 8 inches. In Illinois a minimum weight of 1¼ pounds, dressed, obtains for trout and whitefish; a minimum length of 15 inches for buffalofish; 8 inches for bullheads; 10 inches for white bass; 7 inches for perch; and 13 inches for catfish. Pike and wall-eyed pike may not be taken in nets in the Illinois waters of Lake Michigan. The minima provided by Michigan laws are as follows: Trout, 1½ pounds round or 1¼ pounds dressed; whitefish, 2 pounds round or 1 pound 10 ounces dressed; sturgeon, 20 pounds round; suckers, 1 pound round; wall-eyed pike, 1¼ pounds round; catfish and pike, 2 pounds round; bullheads, 8 ounces; perch, 9 inches.

CLOSED SEASONS

Indiana has no closed season for the Great Lakes. Wisconsin provides a closed season for trout from October 15 to November 21; for whitefish from October 15 to December 1; pike and wall-eyed

pike, March 10 to May 1; and all others, except trout, whitefish, suckers, carp, and herring, from April 15 to May 20, inclusive. There is a closed season on sturgeon at all times in Wisconsin. Illinois prohibits fishing for trout and whitefish from November 1 to December 1, inclusive, while Michigan provides a closed season for trout from October 10 to November 4, inclusive, and for whitefish from November 20 to December 15, inclusive. Wisconsin and Michigan permit net fishing during a closed season if the spawn be saved, impregnated, and delivered to the proper authorities.

LAKE SUPERIOR

DESCRIPTION

Lake Superior lies at the head of the Great Lakes and is the largest, deepest, and coldest of the chain. It receives the waters of Lake Nipigon to the northward and drains through St. Marys River into the North Channel. The lake is broadly crescentic in shape, with a length of about 355 miles and a width on the western half of about 70 miles and on the eastern half of 90 to 110 miles. Its area is about 32,000 square miles. The main body of the lake is more than 100 fathoms in depth, and a sounding of 196 fathoms has been recorded. The shore on the outer curve of the crescent is precipitous, and at many points a 100-fathom depth can be reached within 2 miles of land. The bottom slopes more gradually from the southern shore, and the 50-fathom contour is on the average about 5 or 6 miles out. There are several bays and a number of large islands in the lake, in and around which conditions are more tempered than in the lake itself. These areas, however, are relatively insignificant, and the only important stretches of shallow water lie in the Apostle Islands region, Whitefish Bay, and in the bay region on the north shore. The shores are rocky for the most part, except on the south, where there are broad stretches of sand, gravel, and clay. Most of the bottom in the deeper parts is clay.

FISHING INDUSTRY

HISTORY

The fishery resources of Lake Superior were the last to be tapped, though the earliest explorers had some idea as to their wealth. As the other lakes began to show signs of depletion, these remoter areas were investigated in order to meet the demand for fish. The opening of the interior lakes of Canada is but another and the last step in this movement.

As elsewhere, the whitefish was the principal species sought and a pound-net fishery to take them was established at the head of Whitefish Bay at Whitefish Point about 1860. From thence the fisheries spread westward, and less than 10 years later fishing operations were begun on the Canadian side. The Canadian fishing grounds have never been so extensively exploited, and when about 1890 production fell off on the American shore much American capital

was transferred to the other side. A considerable percentage of the money invested in the Canadian fisheries at present is American.

Seines were largely used on the southern shore in the earliest fisheries, but to a less extent elsewhere because the bottom does not favor their use over most of the Minnesota and Canadian shores. Pound nets were never so important in the fisheries of Superior as in those of the southern lakes because of unfavorable bottom conditions, and such as were used were located chiefly in the bays and around the islands. Latterly their use has markedly declined on the American shore, to be replaced sixfold by the less expensive and more conveniently operated traps. There are a great many more pound nets in use now than there were in the nineties, and most of them are employed on the Canadian shore.

The principal fishing gear in use everywhere has been the gill net. The first gill nets were set along shore for whitefish and trout, and except on the Canadian shore the size of the mesh was not very effectively regulated until after 1913. After 1890 the use of nets for trout was supplemented on the west shore by hooks, which were baited with pieces of fish. In recent years the whole-bait method has been most commonly employed, having received impetus from the success achieved with it in Lake Michigan. Lake Michigan fishermen have during recent years migrated to Lake Superior as far west as Marquette to fish hooks, but their operations have been much hampered by the difficulty of finding bait in Lake Superior with the 1½-inch nets. When the shore species became less abundant the nets were shifted deeper and the deep-water trout or ciscowets for a while supported the industry. The large-meshed nets are at present fished chiefly inside 60 fathoms.

About 1899, with the growing demand for fish by the smoked-fish trade, a fishery for bluefins at depths of 60 to 100 fathoms arose and was prosecuted with exceptional vigor out of Grand Marais, Marquette, Ontonagon, and Bayfield on the south shore and to less extent in a few other places, chiefly on the American side of the lake. The nets used were of 3 to 3½ inch mesh. After about six years the supply declined sharply. Fishing with the small-meshed nets was continued more or less actively out of some of the ports along the southern shore until about 1915, but the bluefins became rarer and rarer and only the inclusion of large quantities of small ciscowets in these nets made their use profitable. At present none are employed anywhere.

Chub fishing has been carried on at intervals and for short periods only at several ports, chiefly American, and though these fish are abundant they find no favor in the Chicago markets and most of those caught are consumed locally.

The catching of herring in November has become an increasingly important industry since 1900, and at present these fish are extensively taken around the Apostle Islands and in Thunder Bay. A few are also taken along the Minnesota shore, at Isle Royale, and at Marquette.

The history of production has been about the same on both sides of the boundary. In Tables 2 and 3 are given itemized accounts of the catches of the principal species over a period of years.

TABLE 2.—*Relative abundance of the principal species, as shown by the weight, in pounds, of the annual catch of the principal species in the American waters of Lake Superior, as shown by nine censuses*

Species	1880	1885	1890	1893	1899	1903	1908	1917	1922
Whitefish	2,257,000	4,571,000	3,213,000	2,732,000	693,000	794,000	910,000	302,000	380,000
Trout	1,464,000	3,488,000	2,613,000	4,342,000	3,118,000	4,954,000	2,752,000	2,588,000	2,833,000
Herring	34,000	324,000	199,000	660,000	1,125,000	4,742,000	5,360,000	12,258,000	7,394,000
Sturgeon		182,000	47,000	62,000	4,000	13,000	67,000		
Suckers				118,000	11,000	183,000	290,000	342,000	206,000
Bluefins, including chubs				36,000	435,000	2,385,000	227,000		
All other species	60,000	258,000	42,000	144,000	41,000	131,000	[1] 587,000	56,000	83,000

[1] Probably includes fish from inland waters.

TABLE 3.—*Relative abundance of the principal species, as shown by the weight, in pounds, of the annual catch, and the amount of apparatus employed in the Canadian waters of Lake Superior, as shown by 10 censuses. (From 1895 on the catches of a few inland lakes are included, but the statistics of Lake Nipigon have been subtracted wherever they appeared)*

Species	1880	1885	1890	1895	1900
Whitefish	354,000	606,000	978,000	930,000	461,000
Trout	312,000	911,000	691,000	1,391,000	1,331,000
Herring			4,000	23,000	89,000
Wall-eyed pike	31,000	83,000	90,000	33,000	40,000
Coarsefish			45,000		
Sturgeon			97,000	33,000	13,000
Pound nets—number	2	5	15	49	37
Gill nets—yards	42,000	315,000	189,000	399,000	439,000

Species	1905	1910	1915	1920	1922
Whitefish	523,000	281,000	979,000	301,000	300,000
Trout	1,983,000	3,987,000	3,624,000	1,108,000	1,495,000
Herring	191,000	801,000	3,223,000	1,903,000	604,000
Wall-eyed pike	19,000	177,000	179,000	83,000	101,000
Coarsefish	14,000	7,000	157,000	114,000	113,000
Sturgeon		7,000	16,000	9,000	9,000
Pound nets—number	35	37	57	45	53
Gill nets—yards	448,000	909,000	916,000	641,000	613,000

In considering these statistics it must be borne in mind that the production has varied from year to year in different sections of the lake, and that the figures given for the entire lake do not reflect this variation. In the Canadian waters of the lake these local fluctuations have been especially great, since the fishing districts have never been as crowded as on the American side, and when old grounds were exhausted the gear was simply moved to new ones. The abolition by Canada of the closed season, since the war, which has made possible the capture of trout and whitefish over a longer period each year, has also helped to increase the catch in recent years.

Up to 1890 whitefish constituted the most important element in the catches in American waters and usually the most important in Canadian waters, but after that date trout occupied first position and the catches of whitefish dwindled. On the American side herring grew in favor from about 1900, and since 1908 have exceeded the output of trout. They did not become significant in the Canadian yield until 1910, and then for several years crowded the trout out of first place in abundance.

Sturgeon and other shore species have never been abundant anywhere. Of these shore forms the wall-eyed pike has always been in demand, and since 1903 on the American side and about 1913 on the Canadian side the production of suckers has increased. The amount of apparatus used on the Canadian shore has declined since 1915, while the statistics for 1922 showed an increase over previous censuses in the number of traps and pounds used on the American side but a decrease in the number of gill nets employed.

PRESENT STATUS, METHODS, AND APPARATUS

There are at present less than a dozen tugs engaged in fishing on the American side of Lake Superior, but there are a number of smaller vessels at various ports. Usually one or two hook tugs from Lake Michigan operate out of ports as far west as Marquette during the spring months. A few local boats also fish hooks, but none of them do so throughout the season, as is the case on Lakes Michigan and Huron, for the reason probably that the small fish needed for bait are scarce and can not always be had.

Most of the boats fish gill nets, and trout is the principal species sought. The nets are usually set in less than 60 fathoms, and at present few ciscowets or fat trout are taken. Small-meshed nets are used in November for herring where these occur in commercial quantities, and at certain ports this fishery is very important. The chubs spawn at about the same time, and a few lifts of these may also be taken.

In addition to these larger craft there are a considerable number of smaller ones that fish gill nets near the shores and operate trap nets and pound nets. The catches of most of these consist principally of rough fish, but they also take whitefish and trout and supply the local demand for herring and chubs.

There are still fewer large boats engaged in fishing on the Canadian shore, though there are several that transport fish or combine fishing with transporting. Gill nets are the chief apparatus employed, and trout are mainly caught. The best ciscowet grounds in the lake lie off the eastern shore, and ciscowets are an important item in the fisheries out of Port Coldwell.

All trout spawn in the early fall in Lake Superior, and the fishing season is over by November, but all the gill-net boats that conveniently can fish herring in Thunder Bay during that month. In recent years the use of pound nets in the bays of the north and east shores has increased, and in 1922 there were 53 such nets. They produce most of the whitefish and rough fish taken on that shore.

Hook fishing is insignificant in the Canadian waters, and in winter practically all fishing operations are suspended on both sides of the boundary.

FISHING DISTRICTS

The most important fishing centers on Lake Superior are Sault Ste. Marie, Grand Marais, Munising, Marquette, Houghton, Ontonagon, Bayfield, and Duluth on the American shore, and Fort William, Port Arthur, Rossport, Port Coldwell, and Michipicoten Island on the Canadian side. There are also individual fishermen located in camps among the Apostle Islands, in villages on Isle Royale, and

along the Minnesota shore, whose fish are transported (in the case of the former) to Bayfield and (in case of the others) to Duluth. Across the boundary there are numerous fishing camps among the islands between Fort William and Rossport, from which the fish are collected by Fort William and Port Arthur boats; and several fishing settlements lie between Michipicoten River and Gros Cap, from whence the fish are carried to Sault Ste. Marie. The fish from these small fisheries form the greater part of the total production from the ports that receive them for distribution.

PRINCIPAL SPECIES

In 1922 the principal species in the American waters, judged by weight of catch, were herring, trout, whitefish, and suckers; in Canadian waters the census of 1922 showed that trout, herring, whitefish, and wall-eyed pike were most important. Detailed statements of the catches of these species at the time of the various censuses are given in Tables 2 and 3 (p. 572).

LAKE TROUT

The shoal trout is the most important species of Lake Superior. It supports the gill-net fishery out of every port and is the principal species taken in most of the pounds. A small percentage of the catch on the American side of the lake is taken by hooks.

There are several races of trout in the lake, not including the ciscowet, and some of them grow to large size, especially among the islands along the north shore. The ciscowet, which is a deep-water race, so fat that it may be called inedible, is now common only at points along the Minnesota shore of Lake Superior and the eastern shore of Ontario in depths of 60 fathoms or more. It supports a fishery during most of the season at Port Coldwell.

Trout are now less abundant than formerly, according to the testimony of the fishermen and as indicated by the census returns. On the American shore, census figures show that there has been a marked decrease since 1903. Though the registered amount of apparatus has been about the same during the period, the production given for each of the last three census years has been only a little over half of that recorded for 1903. In Canadian waters the fact that the amount of apparatus used is decreasing in the face of higher prices is a good indication of a decrease in abundance. There is no closed season on trout in Canadian waters and virtually none in Michigan and Wisconsin, since all fishermen are permitted to fish for spawn during that period. Minnesota has a closed season in November, but the fish usually spawn in October and the closed season has therefore no protective effect on the spawning fish. Trout are extensively propagated artificially.

WHITEFISH

The whitefish is virtually extinct along the American shore from a commercial point of view and is present in appreciable numbers only around the Apostle Islands and in the vicinity of Whitefish Bay. The census of 1922 showed a catch of only 380,000 pounds, and this with about the greatest amount of equipment and highest prices in the

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FIG. 9.—Fishing through the ice on Lake Superior. The nets are set through a series of holes chopped in the ice. Note that the catch is chiefly wall-eyed pike and whitefish

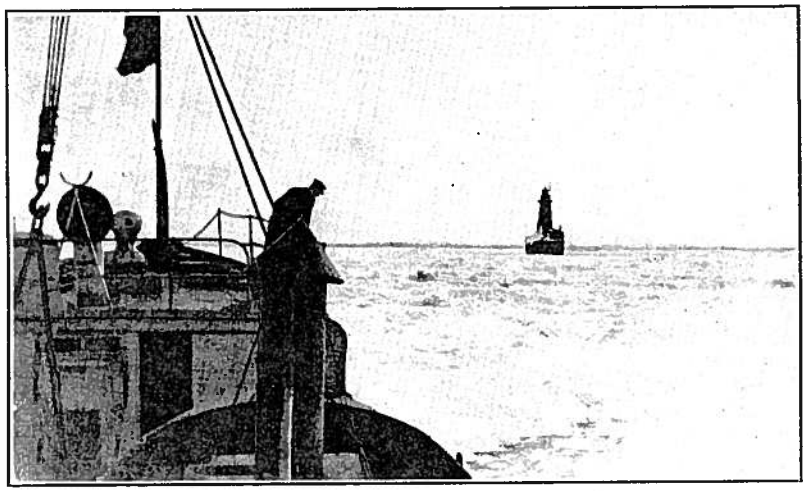

FIG. 10.—Lake Superior on May 7, 1923, still jammed with ice. Stannard Rock Light, on the right, is one of the most interesting lighthouses on the Lakes, inasmuch as it is built on a submerged rock, 28 miles from land, and is surrounded by depths of 400 or 500 feet

history of the fishery. The catch of 1885 was over 4,500,000 pounds. This fish has disappeared to an alarming degree along the Canadian shore also, though the shifting of fishing apparatus, chiefly pound nets, to new districts has helped to maintain the output in the last 10 years. From about 1,000,000 in 1895, the catch has fallen to 300,000 pounds in 1922. Most of the whitefish now produced on the Canadian shore are from Black Bay, Nipigon Bay, and along the east shore of the lake, and they are taken in pound nets. The closed season is the same for whitefish as for trout. The laws of Minnesota with respect to closed seasons need not to be considered, as the State has no productive whitefish areas within its jurisdiction.

HERRING

Until 1899 herring were taken chiefly for local consumption, but thereafter herring fishing became increasingly important. The war gave a decided impetus to production, particularly on the Canadian shore. The chief catches are made during the spawning season in November, and the most favorable spawning grounds are on the west end of the lake from the Apostle Islands to Thunder Bay. These two extremes have been the most productive areas. Fishermen with small equipment also fish for herring to some extent in summer with floated nets off the Minnesota shore and off Isle Royale.

The species never has been and is not now protected or propagated, and in one center of abundance—namely, around the Apostle Islands—it is generally conceded to be considerably less abundant now than formerly. In Thunder Bay herring have not been taken in sufficient quantities long enough to show any marked decrease, but the dumping of wheat screening on their spawning grounds is said to have affected the abundance in the last few years.

BLUEFIN AND CHUBS

Bluefins were first caught in numbers about 1897, chiefly out of Ontonagon, but the industry did not become important until 1900. Nets of 3 to 3½-inch mesh were used, and the average size of the fish taken was 1½ pounds. These fish were caught throughout the season on the bottom at depths of 60 to 100 fathoms, and were so abundant that for several years some boats fished for nothing else and lifts of 3 tons were not uncommon. The principal catches were made out of Ontonagon, Marquette, and Grand Marais on the Michigan shore, but they were also fished out of Bayfield, Wis., and Grand Marais, Minn., and to some extent along the Canadian shore, chiefly on Michipicoten Island. About 1907 the catch fell off sharply and bluefin fishing was gradually discontinued, until at present no one fishes for them anywhere and it is not known that they occur any longer in commercial quantities. At no time were any but the largest individuals taken, and it is therefore not clear as to how intensive fishing could have so abruptly reduced the supply. This species has disappeared in the same fashion in Lakes Michigan and Ontario, but still occurs abundantly in parts of Lake Huron.

Chubs are everywhere numerous but are not in demand. A few are caught every year somewhere along the American shore, chiefly for local use. Since there is only one generally distributed species of chub in the lake, and since the area suited to it is quite restricted,

OTHER INDIGENOUS SPECIES

Lake Superior contains few localities in which it is possible for the shore species to thrive, and except for the bays of the north shore, Whitefish Bay, and around the northern islands and the Apostle Islands there are no sheltered places. Consequently sturgeon were never abundant and the wall-eyed pike is confined to the areas mentioned. The sturgeon is almost extinct and the wall-eyed pike is of minor importance, particularly on the American shore. Suckers are also relatively scarce. They have been marketed on the American side for more than 30 years, but only in the last 10 years have they been brought to market from Canadian waters.

FISHING REGULATIONS

Jurisdiction over Lake Superior is divided between Ontario, Minnesota, Wisconsin, and Michigan; Wisconsin controlling a geographically small, but very important section.

APPARATUS

Gill nets.—Except for Wisconsin, which permits the use of a 4-inch gill net for taking whitefish and trout, the other governments allow nothing smaller than 4½-inch mesh. With respect to the capture of herring the laws vary. Minnesota permits 2⅜-inch netting to be used until such time as Wisconsin may declare a minimum of 2½-inches. Wisconsin allows a 2⅜-inch mesh in November and December; Michigan 2½-inch from November 1 to December 15, or at any time if set not more than 2 fathoms below the surface in waters of not less than 10 fathoms; and Ontario 2½-inch, or 2¼-inch if fished in less than 8 fathoms. Michigan permits 1½ to 2-inch nets, and Wisconsin 1⅜-inch nets for the purpose of taking bait for hooks.

Seines.—Seines in Wisconsin may be of not less than 3-inch mesh, and in Michigan of not less than 4 inches in the wings and 2¼ inches in the bag. No whitefish or trout may be taken with seines in Michigan waters. Ontario and Minnesota do not regulate the mesh of seines.

Traps and pounds.—For traps or pounds Minnesota has no regulations, since none are employed on that shore. Ontario prohibits traps but does not regulate the mesh of pound nets. Wisconsin states that the mesh of pound-net pots may not be larger than 2 inches. The Michigan pound-net law has been devised with more care, and the mesh of pound-net pots may not be smaller than 3½ inches, as fished, with a back made of net no larger than 2 inches, as manufactured, for at least 15 feet below the surface of the water. The back may be constructed of any size mesh if 4-inch netting is used elsewhere in the pot.

For the taking of herring, where not more than 10 per cent of the year's catch is of mature whitefish and trout, not less than 2¼-inch mesh may be used in the pot and not larger than 2-inch mesh in the back. For the taking of herring alone, between the dates of October 1 and June 15, a pound with the pot of netting not smaller than 2 inches throughout, as manufactured, may be used where such nets do not take immature whitefish and trout.

SIZE LIMITS

Wisconsin has no size limit for any species. Minnesota prohibits the taking of whitefish or trout less than 16 inches in length and wall-eyed pike smaller than 14 inches. The provincial law of Ontario prohibits the taking of whitefish under 2 pounds in the round, trout under 2 pounds in the round, herring under 6 ounces in the round, wall-eyed pike under 15 inches, perch under 9 inches, and sturgeon under 42 inches. The minima provided by Michigan laws are as follows: Trout, 1½ pounds round or 1¼ pounds dressed; whitefish, 2 pounds round or 1 pound 10 ounces dressed; sturgeon 20 pounds round; sucker 1 pound round; wall-eyed pike 1½ pounds round; pike 2 pounds round; bullheads 8 ounces; and perch, 9 inches.

CLOSED SEASONS

Minnesota prohibits the taking of trout during November. Wisconsin prohibits the capture of trout and whitefish during October. Michigan protects trout from October 10 to November 4 and whitefish from November 20 to December 15, but issues permits to fish for spawn. Ontario has no closed season.

The protective legislation is so variable that somewhere and at some time it must miss its purpose. There is no protection for herring, though Minnesota has signified a willingness to prohibit the capture of herring during November, when the species spawns, if Wisconsin will enact a similar law. The taking of chubs is prohibited only in Minnesota, where they are protected when spawning in November.

LAKE HURON

DESCRIPTION

Lake Huron is situated in the center of the Great Lakes chain and its waters lie about equally within the jurisdiction of the Province of Ontario on the east and the State of Michigan on the west. It receives the waters of Lake Superior through St. Marys River, and those of Lake Michigan through the Straits of Mackinaw. It drains southward through the St. Clair River, Lake St. Clair, and the Detroit River into Lake Erie. Its greatest length, from the head of the St. Clair River to the Straits of Mackinaw, is about 250 miles, and the greatest width (near the middle) about 100 miles. Excluding Georgian Bay and the North Channel, the lake has an area of approximately 17,500 square miles.

Lake Huron is divided into two approximately equal areas by the Big Reef, which extends continuously from Point Clark, Ont., to North Point, Mich. North of the reef lie the deepest waters of the lake. The 30-fathom contour is rarely more than 10 miles from shore, and a considerable portion of the area lies within the 60-fathom curve. The maximum depth of 125 fathoms known in the lake is found here. The southern portion is shallower. Here depths of 30 fathoms and less are more extensive and the maximum depth known is only 54 fathoms. The bottom alongshore is variable in character, consisting of rocks, bowlders, gravel, sand, clay, and mud, irregularly distributed. The deeper waters overlie chiefly clay and mud.

Separated from the main body of the lake and wholly within Canadian territory are the divisions known as the North Channel and Georgian Bay. Their water surfaces are approximately 1,500 and 5,000 square miles. From the junction of the North Channel with the St. Marys River to the foot of Georgian Bay at Collingwood is a distance of about 240 miles, while the greatest width of the district, from the mouth of the French River to the junction of Georgian Bay with Lake Huron, is about 60 miles. The North Channel and the northern and eastern shores of the bay are dotted with numerous islands and reefs, and the best fishing grounds are in these sections. The water in the North Channel deepens from north to south, with the maximum depth of 29 fathoms off the Manitoulin Island, which forms its southern shore. The average depth is about 20 fathoms. The floor of Georgian Bay is also tilted, but from east to west, so that the deepest waters lie hard off the Bruce Peninsula. From the east the slope is gradual and the 40-fathom contour approximately bisects the bay from north to south. The descent into depths of 60 to 90 fathoms is rapid. The shores are for the most part rocky, but stretches of sand, gravel, and clay are not uncommon. In the deep water the bottom is clay.

FISHING INDUSTRY

HISTORY

The fishing industry was established on Lake Huron later than on Michigan or the lower lakes. Seines and pound nets were not used as extensively from the beginning as on the lower lakes, and until 1880 it appears that gill nets were the main apparatus employed.

Gill netting was begun in Lake Huron, around Alpena, about 1835, and at about the same time in Georgian Bay. Whitefish were the chief species sought, and the nets were therefore set in shallow water. When the supply of whitefish was exhausted the nets were shifted into deeper waters for trout. In 1902 chub fishing, which had for many years been a considerable industry on Lake Michigan, was begun on Lake Huron out of Alpena, and by 1911 boats were fishing chubs out of about 10 ports on the lake, using 2¾-inch gill nets on the American side and 3-inch nets on the Canadian side. In Georgian Bay chub fishing began about 1912. Chubs have fallen off in the last five years so that few boats now fish them exclusively, and the gill-net industry has since been supported by trout and whitefish.

Hook fishing, introduced on the lake by Lake Michigan fishermen about 1916, has grown in favor on both sides of the boundary, but its development has been hampered somewhat on the Canadian shore by the restrictions against bait catching.

Pound nets are said to have been introduced on the American shore as early as 1854, but they were not fished in very considerable numbers till after 1885. The number increased during the nineties, but with the increase in value of "rough fish" they have in recent years given place largely to trap nets and are now employed extensively only in Saginaw Bay and the Thunder Bay region. On the Canadian shore pounds were first fished about 1882. Most of the pounds have been licensed in the North Channel and at the lower end of Lake Huron. The number has fluctuated considerably and their use has at times been prohibited, particularly in parts of Georgian Bay, but in the last few years the quantity of such nets has increased.

Seines were never very widely used, probably because the bottom in many areas is too rough to permit drawing the nets, and only in Saginaw Bay and at the lower end of the lake as far north as Goderich does seine fishing appear to have attained any importance. By 1880 the more profitable method of fishing with pound nets became so general in Saginaw Bay that there was no longer room or inducement to haul the seines, and in 1894 the Canadian Government substituted pound-net licenses for seine licenses. In the last 10 years, with the increase of carp, seines have again come into growing use in these areas.

The production of the lake has varied, both in quantity and quality, from year to year. These changes are too complicated to be treated in detail, but in Tables 4, 5, and 6 is shown the general trend of production in American and Canadian waters.

TABLE 4.—*Relative abundance as shown by the total weight, in pounds, of the annual catch of the principal species in the American waters of Lake Huron, as shown by nine censuses*

Species	1880	1885	1890	1893	1899	1903	1908	1917	1922
Herring, including chubs	246,000	1,265,000	2,514,000	2,758,000	3,699,000	4,715,000	4,791,000	5,381,000	5,496,000
Whitefish	2,700,000	1,425,000	1,004,000	1,178,000	592,000	692,000	719,000	996,000	1,300,000
Trout	2,084,000	2,539,000	1,505,000	3,439,000	1,887,000	2,108,000	1,358,000	2,079,000	2,108,000
Wall-eyed pike		940,000	[1] 1,483,000	[1] 827,000	1,110,000	1,598,000	829,000	994,000	1,260,000
Sturgeon	204,000	215,000	365,000	79,000	30,000	34,000	9,000	4,000	2,000
Suckers		[2]	1,110,000	1,824,000	1,107,000	2,690,000	2,575,000	1,776,000	1,889,000
Perch		[2]	1,817,000	1,758,000	2,740,000	1,911,000	1,805,000	844,000	633,000
Catfish		808,000	172,000	109,000	574,000	155,000	174,000	33,000	64,000
Carp					6,000	37,000	407,000	1,145,000	1,065,000

[1] Including pike. [2] Not itemized.

TABLE 5.—*Relative abundance as shown by the total weight, in pounds, of the annual catch of the principal species in the Canadian waters of Lake Huron, as shown by 11 censuses*

Species	1875	1880	1885	1890	1895	1900
Whitefish	1,166,000	762,000	1,233,000	442,000	58,000	27,000
Trout	375,000	469,000	610,000	1,410,000	1,450,000	1,027,000
Herring	1,049,000	183,000	1,382,000	1,346,000	741,000	261,000
Wall-eyed pike	165,000	22,000	246,000	182,000	285,000	281,000
Sturgeon		5,000	347,000	223,000	517,000	147,000
Mixed and rough fish				39,000	105,000	27,000
Perch					102,000	17,000

Species	1905	1910	1915	1920	1922
Whitefish	78,000	92,000	56,000	83,000	47,000
Trout	968,000	893,000	985,000	847,000	884,000
Herring	403,000	365,000	302,000	180,000	173,000
Wall-eyed pike	408,000	169,000	167,000	141,000	171,000
Sturgeon	17,000	14,000	12,000	9,000	10,000
Mixed and rough fish	146,000	92,000	80,000	99,000	104,000
Perch	13,000	92,000	161,000	129,000	126,000
Chubs			269,000	206,000	130,000

TABLE 6.—*Relative abundance as shown by the total weight, in pounds, of the annual catch of the principal species in the waters of North Channel and Georgian Bay, as shown by 11 censuses*

Species	1875	1880	1885	1890	1895	1900
Whitefish	2,346,000	1,042,000	1,421,000	5,498,000	1,355,000	1,530,000
Trout	826,000	1,001,000	3,369,000	3,497,000	3,062,000	2,913,000
Herring	53,000	12,000	187,000	78,000	600,000	161,000
Sturgeon			478,000	127,000	79,000	176,000
Wall-eyed pike		10,000	353,000	635,000	592,000	690,000
Mixed and rough fish	23,000	21,000	39,000	48,000	136,000	38,000
Pike			17,000	38,000	270,000	100,000

Species	1905	1910	1915	1920	1922
Whitefish	1,018,000	1,072,000	1,335,000	1,303,000	1,306,000
Trout	2,346,000	2,795,000	3,881,000	1,965,000	2,816,000
Herring	160,000	343,000	258,000	52,000	70,000
Sturgeon	44,000	[1] 18,000	33,000	15,000	14,000
Wall-eyed pike	594,000	247,000	417,000	301,000	273,000
Mixed and rough fish	84,000	144,000	471,000	431,000	441,000
Pike	100,000	94,000	177,000	100,000	195,000

[1] After 1909 the catches of other species not previously itemized were greater than of sturgeon.

The Canadian waters are divided roughly into three districts—Lake Huron proper, Georgian Bay, and the North Channel. The statistics published by the Ontario government do not separate accurately the catch of these three regions, fish taken in Lake Huron being included with those of the other two districts and some taken in Georgain Bay being credited to the North Channel. However, except off the Duck Islands and off Tobermory, few fishing boats penetrate far into the waters of Lake Huron proper north of Cape Hurd, and for convenience the North Channel and Georgain Bay are treated as a unit. Lake Huron proper really includes, then, only the ports from Southampton to the American boundary.

The most interesting features of Table 4 are the decline, in American waters, of the whitefish from first place in 1880 to sixth place in 1890, which position it has held practically ever since. The sturgeon is gone as an important element in the fisheries and the perch and catfish are declining. Suckers, on the other hand, are coming to the fore, and the introduced carp has captured a prominent place.

As shown in Table 5, for the Canadian side of Lake Huron proper, the whitefish has become relatively insignificant since 1890 and the sturgeon since 1900. Chubs and perch, which of late years have increased in importance in the catch, have become more marketable rather than more abundant. Trout have maintained first place since 1885 with the decrease of the whitefish, and herring have kept a relatively high position though the weight of the catches has steadily declined. Table 6, for the North Channel and Georgian Bay, shows that trout have definitely replaced the whitefish in relative abundance since 1895. The table may be taken to indicate that wall-eyed pike have become less abundant and that pike and rough fish have come into greater demand rather than increased in numbers. Sturgeon have passed out as a commercially valuable species.

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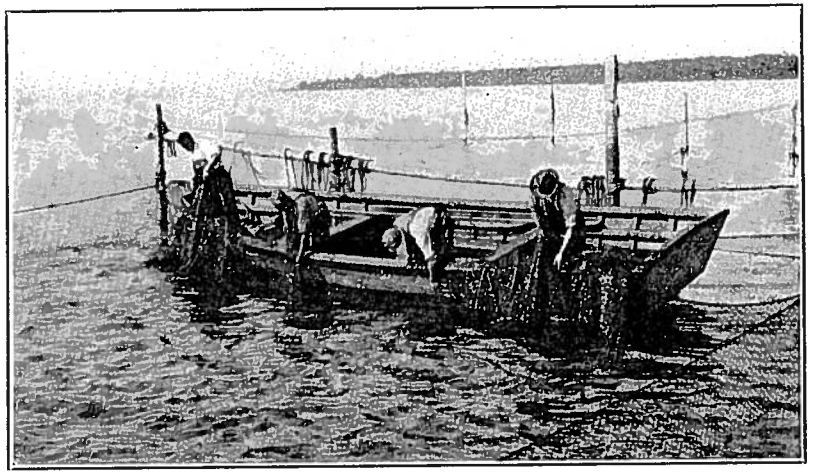

FIG. 11.—Lifting a pound net. The punt is inside the pot and the lifting has just begun. The stakes of the heart are visible in the background. This pound is on Lake Huron

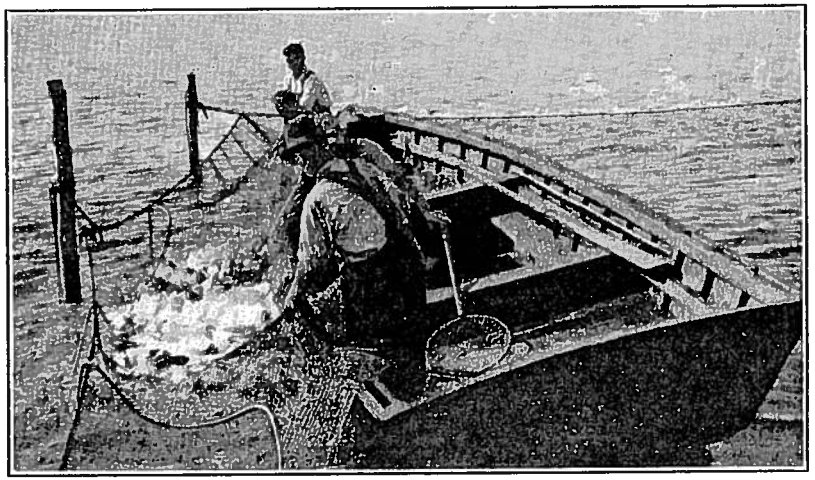

FIG. 12.—The pound net lifted. The fish have been driven into the opposite end of the pot and may now be scooped up

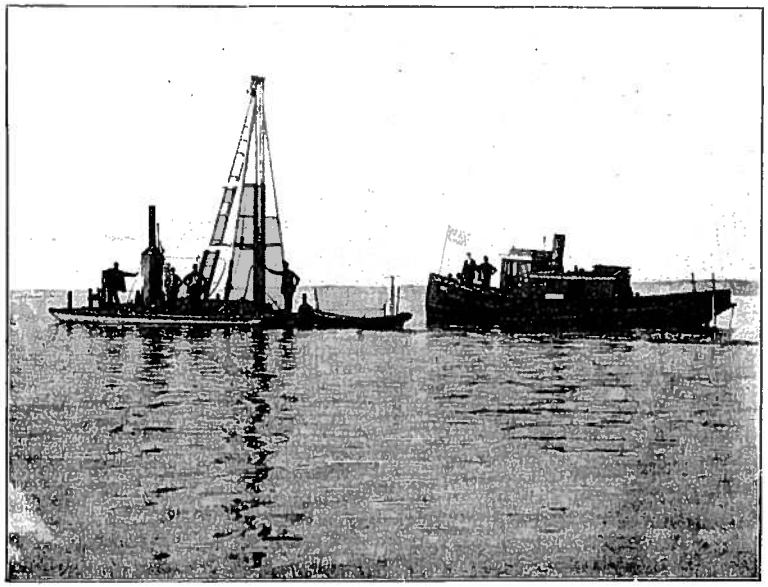

FIG. 13.—Tug and stake driver used to drive the pound-net stakes into the bottom

FIG. 14.—Herring pound net with fish gilled in the netting

PRESENT STATUS, METHODS, AND APPARATUS

The principal fisheries on the American side of Lake Huron are at present conducted by means of gill nets and the chief product taken by them is trout, but at certain seasons whitefish are also an important element in the catch. Latterly no boats have fished for chubs exclusively, but in the spring of 1923, when for a time Lake Huron chubs brought 15 cents per pound (the first time in history that such fish brought a higher price than trout), all the boats owning suitable nets took to chub fishing, and in a few weeks the price fell to 5 cents and the nets were pulled out. Alpena is now the only important chub-fishing port. Small-meshed nets are also used to a considerable extent to take herring, Menominees, and perch, but except that the large tugs frequently make a few lifts of the two last-mentioned species in fall and sometimes again in spring, these nets are used only by the shore fishermen.

Hook fishing for trout is carried on out of several ports, but the practice has not spread very rapidly in the last few years.

The chief pound-net district in American waters is in Saginaw Bay, and large numbers of traps and fykes are also employed in this region. Elsewhere traps have largely replaced pounds. The increasing value of "rough fish" has been responsible for the rise of an important trap-net fishery at the north end of the lake, which vies in production with the established fisheries in Saginaw Bay.

On the Canadian shore a large portion of the production is yielded by pound nets, most of which are located in the North Channel district, on the north and east shores of Georgian Bay and on the shores at the foot of the lake. In 1922, 288 pound nets were licensed in the Canadian waters, and these produced most of the whitefish, wall-eyed pike, pike, and rough fish, and a significant percentage of the trout taken in that year. Most of the gill nets are in use in Georgian Bay and in the main lake, and their catches are chiefly trout, though some whitefish and chubs are also taken. Hooks are also rather commonly employed in these sections to take trout. No trap nets are allowed, and there are few fishermen who use small-meshed nets for herring and rough fish along the shores.

FISHING DISTRICTS

Gill netting is carried on chiefly out of Cheboygan, Alpena, and Harbor Beach on the American side, and to a lesser extent out of Detour, Rogers, and Oscoda. Southampton, on Lake Huron, is the largest tug center on the Canadian shore, but there are numerous other hamlets and stations out of which are operated small boats having a considerable equipment of gill nets. In Georgian Bay the fishing ports are for the most part towns, and those most worthy of mention are Tobermory, Meaford, Owen Sound, Collingwood, and Parry Sound. In the North Channel and around the islands that inclose it are many sheltered harbors, and the fishing boats are therefore widely scattered in this section.

Most of the pound nets and trap nets in use on the American shore are employed in Saginaw Bay, though many are also fished in the straits, around islands at the north end of the lake, and in the vicinity of Thunder Bay. The chief pound-net areas on the Canadian shore

are around the islands in and inclosing the North Channel and off the north and east shores of Georgian Bay and on the shores at the southern end of Lake Huron.

PRINCIPAL SPECIES

On the American shore, according to the census of 1922, chubs and herring, which are grouped together in the statistics, were first in abundance. The other important species, in order of their abundance, were trout, suckers, whitefish, wall-eyed pike, carp, and yellow perch. On the Canadian shore in 1922 the lake trout was by far the principal species, with herring, wall-eyed pike, chubs, and perch ranking next. In the North Channel and Georgian Bay trout and whitefish comprise the bulk of the take, with wall-eyed pike and pike also important in the catches. The relative and absolute abundance of these species over a period of years are given in Tables 4, 5, and 6.

LAKE TROUT

Trout occur throughout the lake and in its bays (excepting Saginaw Bay), and also on the reefs in the center of the lake. For the last 40 years this species has been the chief element in the gill-net fisheries, and in some areas, particularly on the Canadian shore, it has entirely replaced the whitefish.

There are several races and they all live in relatively shallow water. These races may differ in behavior, especially in the matter of time of spawning, the black trout on the Big Reef, for example, spawning as late as December. There are no longer any important fisheries for trout in 60 fathoms and deeper, and chub nets set at these depths take relatively few small individuals. Trout are taken largely in gill nets, though in 1917 about one-third and in 1922 about one-fourth the entire catch on the American shore was on set lines by hook fishermen. Until recent years large quantities were also caught for the market on trolling lines in early summer when the trout rise off the bottom. Some are still caught in this manner but the number is now insignificant. The pound nets in certain localities, especially in the North Channel, are also effective in the capture of trout. There is at present virtually no closed season on trout, but quantities of fry are planted yearly.

WHITEFISH

Half the lake's annual production of whitefish at present comes from North Channel and Georgian Bay. The most productive areas are from Parry Sound northward in Georgian Bay and around Manitoulin Island. The catch in Lake Huron is made chiefly from Harbor Beach northward. Gill nets and pounds are the principal apparatus of capture.

The whitefish was originally the most abundant species taken in the commercial catches. It appears to have maintained itself best in North Channel and Georgian Bay, where it still holds second place, but in the lake as a whole it has fallen to fourth place on the American shore and to seventh on the Canadian shore. Though there are now no areas in Lake Huron and a very few elsewhere in which a gill-net fisherman could operate if he had to depend on whitefish alone, there appears to have been no serious depletion in this fishery since 1900 and in several localities the fishermen even report increases. It is not possible to establish statistically the question of abundance during this period, since the statistical bulletins do not furnish the kind of data that are needed. In some areas of greater abundance the increase has been attributed to the effects of propagation, but in others, particularly in North Channel and Georgian Bay, where no plants were made previous to the reported increase, some other explanation must be sought. The increased catches of 1917 and 1922 in American waters, on which to a greater or less degree the opinions of increase are based, were at least in part due to the higher value of rough fish, which are taken in the shoal waters along with the whitefish. Thus, while the opening of the interior lakes of Canada has kept the price of whitefish down to a point where in many areas it would be unprofitable to prosecute fisheries dependent on this species alone, with the rise in value of species taken incidentally, the shore fisheries have been stimulated and the catch of whitefish, even though the species may not actually be more abundant, has increased.

HERRING

The bulk of the catch of lake herring or blueback is taken in the pound nets of Saginaw Bay. Herring are taken also on the American shore in the fall by gill nets out of Oscoda, Alpena, and along the northern shores of the lake. The Canadian fishermen take few herring, relatively and absolutely, and the bulk of the catch is produced along the Bruce peninsula and at the south end of Lake Huron. There has never been a closed season on herring, and few have ever been planted, but the fishermen at Bay City are of the opinion that the supply has not diminished significantly.

Each locality has its own race of herring, and these races are often characterized by size differences, considerations that have induced the Michigan legislators to permit a 2½-inch mesh for the taking of these fish. One of the largest races occurs in Thunder Bay and northward to Middle Island, where it is the object of a considerable fishery when it spawns in November.

Originally the herring was but little esteemed and was taken, as in other lakes, only if it could be sold at all. Latterly, with the falling off of other available species, it has been caught regularly at localities where it could be taken in quantities. Most of these fish are salted, though increasingly large quantities find their way to the markets in the fresh state.

CHUBS

Fishing for chubs began later in Lake Huron than in any of the other lakes. What factors were responsible for the delay is not exactly clear, inasmuch as their presence was discovered many years previously when the deep-water trout nets took them, but it is probable that trout were sufficiently abundant and prices satisactory enough to afford no stimulus for experimenting with a new industry, particularly when it involved the purchase of an entirely different equipment of netting. In 1902 chubs were fished for in 60 fathoms off Alpena with 2¾-inch nets, and a few years later they were taken

off the Duck Islands with 3¼-inch nets, which were later reduced to 3 inch. From 1911 to 1918 was the period of greatest production, and at some time during this period boats were fishing chubs out of Cheboygan, Rogers, Alpena, Harbor Beach, Goderich, Kincardine, Southampton, Tobermory, Lion's Head, Cabot's Head, and Wiarton.

There are four species of commercial chubs in Lake Huron, all but one apparently of general distribution throughout the deeper waters of the lake and of Georgian Bay. They are taken only in gill nets, which are of 2¾-inch mesh in American waters and 3-inch mesh in Canadian waters. The chub nets usually are set in depths of 60 fathoms or more, except where such depths are not attainable, as at the northern and southern ends of the lake, and then 30 fathoms usually is the lower limit. The spawning season for the four species ranges between the middle of August and January, and some of the spawning areas of two of the species are known. At this time they are taken as abundantly as possible. Chubs have never been protected by a closed season, nor are they propagated.

It is generally believed by American fishermen that chubs have decreased in Lake Huron. At any rate, it is now necessary to increase the equipment in order to maintain the catch, and off Cheboygan, where one species is caught on its spawning grounds in September and October, the lifts are no longer as heavy as formerly. On the Canadian shores the decrease is more marked. With 3-inch nets the Canadian fishermen have always had a considerably smaller percentage of the chub population to draw from, and they were early forced to discontinue fishing where they met the American 2¾-inch nets, as off the Duck Islands. Off Southampton the catches on the chub grounds west-northwest of the city fell off after about three years, and the boats have been unable to find new grounds. In Georgian Bay chubs have been fished since 1912, but since about 1916 the numbers taken have been much reduced. The fishermen say that the lawyer is now a conspicuous element here in the chub nets set at 60 fathoms. Whether the lawyer has appropriated the area vacated by the chubs or is directly responsible for their decrease is not known.

WALL-EYED PIKE

Only the yellow race of the wall-eyed pike is commercially important in Lake Huron, and the principal catches on the American side are made in the pounds and traps of Saginaw Bay and in Canadian waters chiefly in the pounds around the islands of the North Channel, on the east coast of Georgian Bay, and around Sarnia on the St. Clair River. The wall-eyed pike has always been esteemed as a food fish and has been intensively fished for. Latterly the demand has increased and the price of the fish has risen enormously at certain seasons (40 cents per pound has been paid by the New York markets), and production everywhere has fallen off. The fish is nowhere protected by a closed season but is extensively propagated.

YELLOW PERCH

In American waters the yellow perch is taken in abundance only in Saginaw Bay, while on the Canadian shore the bulk of the catch is made off Huron County at the lower end of the lake. Pounds and traps are the principal mode of capture. Perch were an important element in the fisheries on the American shore as early as 1885, and during the late nineties and between 1900 and 1908 production was greatest. There has been a decrease from the maximum recorded catch of 2,740,669 pounds in American waters in 1899 to 633,188 pounds in 1922. On the Canadian shore perch have been much less important, and until 1894 were not reported in the statistics of the fisheries. The maximum catch recorded was only 321,680 pounds taken in 1907, which was never approached before nor has it been since. There is no closed season for perch. The species is propagated to some extent, but only in American waters.

SUCKERS

The white sucker is the principal one of this species marketed, and most of the production is sold fresh in the round to the New York markets. At present the chief catches are made in trap nets in American waters north of Cheboygan, in traps and pounds in Saginaw Bay, and with pound nets in the North Channel. Up to 1890 practically the entire catch of suckers on the American shore came from Saginaw Bay and Saginaw River, but since about 1905 an increasingly large percentage has come from the northern waters and the abundance of suckers in Saginaw Bay has diminished, so that in 1917 a little more than one-third of the total catch, which was roughly 60 per cent more than it was in 1890, originated in Saginaw Bay. In 1922, however, the northern sucker fisheries declined and those in Saginaw Bay improved so that the bulk of the catch again originated in Saginaw Bay. Fishermen hold that the pollution of Saginaw River has seriously affected the abundance of the sucker in that area.

On the Canadian shore suckers have become increasingly important since 1910.

There is no closed season for suckers, and none are propagated.

STURGEON

The sturgeon has never been extremely abundant in Lake Huron, but in the earliest fisheries of the lake it was commonly hauled ashore from the pounds and seines as a nuisance. By 1880 it was marketable on the American side of the lake, and by 1885 it was generally taken for sale in Canadian waters. At present it is the most expensive and rarest fish in the lake. The principal production is now credited to North Channel and the St. Clair River mouth, but no more than 30,000 pounds are now produced annually. There is no closed season for the species and none are propagated.

OTHER INDIGENOUS SPECIES

The only other native species of importance in the fisheries are the pike in the North Channel and Georgian Bay and the Menominee in the northern American waters.

INTRODUCED SPECIES

CARP

The carp is the only abundant nonindigenous species in the lake. The catch is taken almost exclusively in Saginaw Bay, and seines are the chief apparatus of capture. In the census of 1903 it was

insignificant (37,491 pounds) in the American fisheries, and in 1917 ranked fourth with 1,145,250 pounds. The catch in 1922 was slightly less in quantity and relatively less important.

GIZZARD SHAD

The gizzard shad or sawbelly is a small commercially unimportant fish that is said to have found its way into Lakes Erie and Michigan from the Mississippi drainage through certain connecting canals and is now working its way northward. In November, 1919, a fisherman brought me specimens which he selected from the swarms present in his pound nets in Colpoy Bay (a small indention in Georgian Bay), and it is said that in 1920 they were extremely abundant in Saginaw Bay. The presence of the gizzard shad here has no ecological significance so far as is known.

FISHING REGULATIONS

Regulations similar to those promulgated by the governments of Michigan and Ontario for Lake Superior are in force. (See p. 576.)

LAKE ERIE

DESCRIPTION

Lake Erie has an area of approximately 10,000 square miles, exceeding in size only Lake Ontario. Its length is about 250 miles and the average width is about 45 miles. It is bounded on the north by the Province of Ontario, on the west by the State of Michigan, on the south by Ohio and Pennsylvania, and on the east by New York. Lake Erie receives the waters of the upper Great Lakes through the Detroit River, and drains through the Niagara River. The deepest water occurs in the eastern sector, in that part which is bordered by Pennsylvania, New York, and the portion of the Canadian shore lying eastward of Long Point. The maximum depth recorded is 35 fathoms off Long Point. The stretch for 100 miles between Long Point and Point Pelee is a nearly flat plain covered by no more than 14 fathoms of water. East of Point Pelee is a shelf with numerous islands and reefs, having a maximum depth of 7 fathoms.

FISHING INDUSTRY

HISTORY

Lake Erie offers most favorable conditions for the growth of fish, and in practically every census, in spite of its small size, it has led all the lakes in quantity of production. On account of its shallowness, warmth, and diversified conditions many species of fish occur in its waters, and no less than 15 species have at one time or another been important in the commercial catches.

Every device known to the fishermen of the Great Lakes is employed on Lake Erie. In a general way the kind of apparatus used depends upon the species to be taken, and since in the past the important species have varied from year to year, and since the devices of capture have gradually been improved, the history of the fisheries of this lake is extremely complicated. For that reason in the historical treatment emphasis will be laid on the changes in production rather than on the modes of production.

Fishing is said to have been begun on Lake Erie as early as 1815. Seines were used, chiefly in the rivers and bays, until about 1850, when pound nets were introduced at the west end and gill nets at the east end in the American waters. The first species sought to be taken with the new apparatus was the whitefish, but soon small-meshed nets were used for other species. Commercial fishing appears to have been in full swing by 1870, and has grown in intensity since then. Gill nets, pound nets, trap nets, fyke nets, seines, and set lines were the chief apparatus employed on the American shore, similar apparatus being used in Canadian waters except that no trap nets were allowed.

On no other lake has the use of pounds and traps assumed such proportions as on Lake Erie. The shore fisheries—that is, the fisheries conducted with pound nets, trap nets, and gill nets by small boats along the shores—have been extremely important on both sides of the boundary, and the output has exceeded that of the large boats fishing gill nets only. In late years, on the American shore, the pound net has been almost entirely replaced by the crib net, which has a much lower original cost and can be moved at will. The gill-net fisheries have increased in importance with the introduction, about 1899, of the steam lifter, an improvement which made it possible for every boat to handle a great many more nets, and latterly with the practice of floating gill nets. Nets have been extensively floated since about 1903, and bull nets have become more and more widely used since about 1906, chiefly in American waters (see description on page 558), practices that have made it possible for fish to be caught while swimming off the bottom and which have increased the catch of the fish considerably.

In 1879 most of the gill netting on the American shore was carried on east of Ashtabula and practically all pound netting west of that place. Thereafter the use of gill nets in conjunction with the pound nets was begun, until in 1899 most of the gill nets as well as pound nets were owned in the west. By 1903 the pendulum had started to swing back, and in 1922 the gill nets were again owned chiefly in the east. In 1890 gill nets took most of the blue pike, sturgeon, whitefish, and trout, while the majority of herring, yellow perch, saugers, wall-eyed pike, catfish, and practically all other fish were taken in other nets. (While the pounds took the larger quantity of herring, the fish were smaller and brought less return to the fishermen.) In 1903 gill nets took most of the herring, blue pike, whitefish, and yellow perch, and excepting the seines, which took all the carp, the rest of the species were taken in greatest abundance in other gear. In 1922 the gill nets took only herring in greatest abundance, and again excepting the seines for carp, all other species were taken most abundantly with traps and pounds.

West of Port Stanley, on the Canadian shore, pound netting has been the principal industry. Gill netting was carried on chiefly from Port Dover eastward until about 1905, when Port Stanley became the principal gill-net center on the lake and has remained so since, but the east has owned the bulk of the remaining gill nets. The Canadian statistics do not separate the production according to apparatus em-

ployed, so that it is not possible to state how the constitution of the catches of the various kinds of apparatus has changed from year to year.

The fisheries have always been of more importance on the American shore, though the relative importance has changed decidedly in recent years. Where in 1885, with a catch of 51,456,000 pounds in American waters, the ratio between American and Canadian production stood 6.7 to 1 in favor of the United States, in 1899, with a catch of 58,393,000 pounds, the ratio was 5.7 to 1, and in 1922, with a catch of 55,079,000 pounds on the American shore, it had dropped to 3.1 to 1 in favor of the United States. Production on both sides of the lake has varied considerably from year to year in the last few decades, and this variation has not always been correlated with variations in the amount of apparatus employed. In the two succeeding paragraphs sufficient data are given to show what the relation of apparatus and production has been, and a discussion of the changes in the quality of the production follows.

According to the latest statistics issued by the Bureau of Fisheries, in 1922 there were engaged in the fisheries in American waters 1,041 vessels and boats, which operated 42,404 gill nets, 3,931 trap and pound nets, and 213 seines. In Table 7 are given the statistics of the last three censuses made of the fisheries on the American side of Lake Erie, showing the relation between apparatus and catch. The figures for traps, pounds, and seines are the highest on record, and only in 1890 were more gill nets reported. The number of vessels and boats employed (608 in 1903; 1,133 in 1917; and 1,063 in 1922) is the highest since 1893.

TABLE 7.—*Relation between gear employed and production of fish in the American waters of Lake Erie since 1903, as shown by censuses taken from 1903 to 1922*

	Number	Total yield	Yield per net
1903:			
Gill nets—		*Pounds*	*Pounds.*
Vessels	28,755	12,421,089	432
Boats	6,396	937,733	147
Pound nets and traps	1,469	5,837,420	3,974
Seines	110	2,633,267	23,939
Total		21,829,509	
1917:			
Gill nets—			
Vessels	38,007	17,151,247	451
Boats	9,571	1,853,294	194
Pound nets and traps	5,011	13,319,548	2,658
Seines	285	5,505,997	19,319
Total		37,830,086	
1922:			
Gill nets—			
Vessels	36,555	24,297,307	665
Boats	5,849	1,636,282	280
Pound nets and traps	3,931	22,118,403	5,627
Seines	213	5,618,210	26,377
Total		53,670,202	

The entire 1917 production was over 3,000,000 pounds less than that of 1908, which was 41,906,000 pounds; but the catch for 1908 was almost double that shown by the census of 1903. The catch in 1922 was nearly 12,000,000 pounds greater than that of 1908 and almost 15,000,000 pounds greater than the 1917 catch. The increase since 1903 has been chiefly in the production of rough fish by the shore fisheries and in the catch of herring.

The statistics of the Province of Ontario, for the Canadian shore of Lake Erie, show that in 1922 there were 39 tugs, 158 launches, and 204 sail and row boats, employing 1,362,748 yards of gill net and 655 pound nets, which yielded a total of 17,686,240 pounds of fish products. In Table 8 are given the statistics of 14 censuses, showing the relation between apparatus and catch.

TABLE 8.—*Relation between gear (except seines) and production in the Canadian waters of Lake Erie, as shown by various censuses*

Year	Pound nets	Gill nets	Yield	Year	Pound nets	Gill nets	Yield
	Number	*Yards*	*Pounds*		*Number*	*Yards*	*Pounds*
1875	16	5,665	959,000	1910	295	506,600	14,421,000
1880	54	330	2,008,000	1912	297	569,753	22,007,000
1885	132	33,520	7,654,000	1914	499	681,672	17,020,000
1890	197	49,200	8,423,000	1916	638	1,546,005	10,088,000
1895	204	111,700	8,706,000	1918	689	1,587,740	19,496,000
1900	258	301,590	10,495,000	1920	637	1,402,600	16,812,000
1905	275	395,400	7,318,000	1922	655	1,362,748	17,686,000

The table shows an immense increase in the development of the Canadian fisheries since 1910. The upward movement began with a great increase in quantity of the apparatus for taking herring around Port Stanley, and the catches of this species increased thereafter so that in the next year herring made up about two-thirds the output of fish on the entire lake. After that apparatus increased everywhere, until the peak was reached in 1918, but production has not kept pace with the increase in apparatus employed.

Table 8 shows that the increase of apparatus has been greater than the increase in production on the Canadian side. From 1916 to 1922 the number of yards of gill netting in use increased ten times and the number of pound nets three times over the figures for 1895, while production only doubled. Table 7, for the American shore, though only three censuses are given, shows with each census not only an increase in total production but in general, also an increase in the productivity of the gear, facts that point to an improvement in the fisheries.

Conditions do not warrant the unquestioned acceptance of the conclusions that might be drawn from the data in Table 7. Depletion is generally considered to be less serious in the Canadian waters of Lake Erie, and for that reason, in part, the duty on Canadian fish was asked by American fishing interests. The figures may be interpreted to show the opposite.

Production in American waters in the season of 1925 and also in the winter of 1925–26 is reported to have been unusually low, a situation one would not expect from the census of 1922. Furthermore, in 1922, in the face of 50 per cent and greater increases in the productivity of gear, the amount employed was less than in 1917. This is not the usual economic reaction to prosperous conditions. It may also be argued that between 1917 and 1922, for which period statistics are lacking, production may have declined and gear have

been reduced on that account. In such a case, the increased production of 1922 may be quite as well explained by assuming possible fluctuations in the five variables mentioned in the following paragraph, as by assuming that fish have become more numerous. Finally, it is not entirely probable that fish can increase under conditions of pollution, virtually unrestricted and most intensive fishing, and little propagation.

It has been stated elsewhere in this paper that the available statistics of the Great Lakes fisheries can not be statistically treated and in these two tables the reason can be shown.

1. None of the figures show the mesh of the gear employed. The size of the mesh determines not only the kind of species that will be taken but also the abundance of the species in the catch. The data given on page 611 indicate that a fishery for deep-water Leucichthys in Lake Ontario, which might soon fail with a 2¾-inch minimum mesh, would flourish if the mesh were reduced ¼ inch. Of course, in Lake Erie the size of meshes used has not varied greatly in the last few years, but there have always been two classes of gill nets, one chiefly for whitefish and one for smaller species. Thus, the increased catch may be due chiefly to the catch of smaller fish by nets with smaller mesh.

2. The length of the gill nets is given in Canadian waters, but not the depth, which is an extremely important factor. For American waters no dimensions whatever are given. The effectiveness of such apparatus depends also to a very great degree on its state of repair, the material of which it is spun, the fineness of its threads, etc.

3. The method of employing the apparatus is nowhere reflected in the statistics. On other pages it has been stated that the floating of nets has greatly increased the catches.

4. It is not known whether market conditions favored the capture of all species throughout the season of each year for which statistics are recorded. In 1920 thousands of pounds of blue pike and herring could not be sold because the markets were glutted, and the fisheries reacted accordingly. Such conditions have obtained at other times and their effects, of course, determine production.

5. Even if gear, market conditions, etc., were stabilized and the number of fish in the lake remained unchanged, the yield would certainly vary from year to year as a result of other conditions, especially those influenced by the weather. Being taken at about 5-year intervals, the American statistics do not permit evaluation of this annual fluctuation, even if the data were given in sufficient detail.

If, then, fish are not more abundant now than formerly, the increase in or the maintenance of the general level of production must be determined by some other factor, and the only other factor likely to influence production is increased demand, which is reflected in higher prices.

Since there are no cities on the Canadian shore of Lake Erie, and since the populaton of the Province of Ontario may obtain its fish supply from other lakes that are nearer, the Canadian fishermen are chiefly dependent on American markets. Therefore the following table of comparative prices for American waters will apply to the Canadian side also. There are statements of value for each year in the Ontario statistical bulletins, but the values given were constant over long periods, and hence must have been fixed arbitrarily.

TABLE 9.—*Average price per pound, in cents, and index number of prices of the principal commercial fishes of the American waters of Lake Erie, as shown by the various censuses taken*

[Base of index numbers: Average price in 1899=100]

Species	1890, average price	1893, average price	1899		1903		1908		1917		1922	
			Average price	Index No.	Average price	Index No.	Average price	Index No.	Average price	Index price	Average price	Index No.
Whitefish	4.95	6.09	7.36	100	7.59	103	8.17	111	13.26	180	18.80	255
Trout	4.27	4.02	5.41	100	5.29	98	4.84	89	10.45	193	8.86	164
Herring	1.03	1.24	1.29	100	3.80	294	2.70	209	6.10	473	4.98	386
Yellow pike	4.30	2.50	4.98	100	5.44	109	4.15	83	11.55	232	14.84	297
Blue pike	1.98		3.07	100	3.83	125	3.01	98	6.57	214	4.96	162
Sauger	1.24		2.49	100	2.46	99	3.05	122	6.11	245	4.92	198
Sturgeon	3.55	3.96	6.76	100	7.34	109	14.40	213	21.36	316	27.74	410
Black bass	5.44	3.80	7.38		8.02							
Perch	1.06	1.37	1.59	100	3.27	206	3.69	232	7.26	457	5.98	376
Suckers		1.09	1.15	100	1.21	105	1.47	128	3.51	305	3.10	269
Carp		2.59	1.42	100	1.67	118	1.81	127	4.54	320	4.12	290
Catfish	2.38	3.04	3.04	100	4.11	135	4.49	148	6.24	205	7.24	238
Sheepshead			.67	100	.70	105	.90	134	2.43	363	2.41	360
Lawyer		1.20			.72		1.02		1.23		1.72	
Bowfin					.56				1.34			
White bass			1.92	100	3.40	177	4.75	247	6.02	314	4.11	214
All commodities				100		115		120		236		199

This table discloses a great increase in price for every species since 1899. This increase is particularly noticeable between 1908 and 1917. Between 1917 and 1922 the prices of whitefish, yellow pike, sturgeon, catfish, and lawyer continued to increase. All of the other species decreased in price. It must be remembered that 1917 was a year of inflated values in general, and prices in 1922, while not inflated as much as in 1917, were far above those of the earliest years given in this table. Although the values given in the table indicate that prices of certain fishes have doubled, trebled, and, in some cases, quadrupled, since the earliest years, it is not evident whether the greatly increased prices in 1922 may be explained entirely by the generally inflated values of recent years, or whether they indicate the relatively increased demand for fish.

In order to examine this feature, index numbers of the prices of fish with the year 1899 as a base, as compared with the index numbers of all commodities,[8] based on the same year, have been graphically shown in Figure 15. The curve for all commodities, as shown by the heavy line, indicates that in general wholesale prices were nearly two and one-half times as high in 1917 as they were in 1899, and fully twice as high in 1922 as in 1899. If the demand for the various species of fish had remained relatively the same as in 1899, it would be expected that the prices would have very closely followed the heavy line curve; but that is not the case. It is evident from the graph that the great majority of species now cost relatively much more than in 1899, even when inflated values are taken into consideration. Trout and blue pike alone have fallen below the general level of prices. Saugers have followed general prices very closely. All other

[8] From Wholesale Prices, 1890 to 1922, Bulletin, U. S. Bureau of Labor Statistics, No. 335, 1923. Washington.

principal species have increased in value out of proportion to general prices.

It may be concluded from this that the demand has outstripped the supply of all species except sauger, trout, and blue pike since 1899, and that the supplies of sturgeon, herring, perch, and sheepshead are so far below the demand that the prices are relatively twice as great now as they were in 1899.

Along with price advances and the change in the quantity of production, there has also been a change in the quality of the production. According to the Federal statistics of 1922, the principal species taken in American waters, in order of size of catch, were herring, blue pike, sauger, carp, perch, sheepshead, yellow pike, and suckers. The relative abundance of the various species, as published in the censuses, is shown in Table 10.

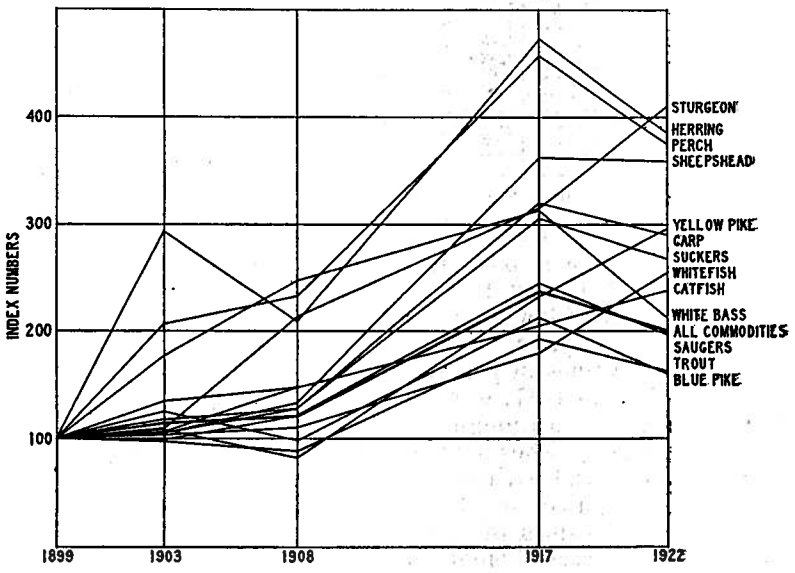

FIG. 15

TABLE 10.—*Relative abundance of the most important species as shown by the total weight, in pounds, of the annual catch of the principal species in the American waters of Lake Erie, as shown by nine censuses*

Species	1880	1885	1890	1893	1899	1903	1908	1917	1922
Whitefish	3,333,000	3,531,000	2,341,000	1,292,000	2,066,000	302,000	1,503,000	1,755,000	922,000
Herring	11,774,000	19,354,000	38,868,000	20,931,000	33,427,000	8,788,000	10,599,000	17,160,000	16,158,000
Trout	26,000	106,000	121,000	203,000	32,000	15,000	6,000	1,000	1,000
Yellow pike		2,694,000	2,105,000		1,735,000	908,000	3,506,000	1,291,000	1,813,000
Blue pike		7,899,000	7,488,000	12,529,000	4,544,000	4,915,000	9,072,000	2,057,000	14,542,000
Sauger		5,466,000	4,179,000		3,026,000	1,940,000	2,417,000	3,929,000	6,002,000
Perch		1,601,000	2,870,000	2,594,000	3,315,000	830,000	1,742,000	959,000	2,969,000
Sturgeon	1,970,000	4,727,000	2,078,000	793,000	789,000	294,000	63,000	28,000	15,000
Suckers		2,373,000	(1)	1,360,000	1,568,000	721,000	1,719,000	1,035,000	1,598,000
Sheepshead					1,147,000	642,000	1,394,000	2,855,000	2,362,000
Carp				635,000	3,633,000	3,546,000	8,893,000	6,044,000	5,899,000
Catfish		2,802,000	1,926,000	776,000	1,002,000	181,000	579,000	628,000	1,337,000
White bass					1,596,000	27,000	217,000	286,000	1,022,000

[1] Very few sheepshead were marketed before the late nineties.

It appears from this table that until 1890 the order of abundance was as follows: Herring, blue pike, sauger, sturgeon, whitefish, catfish, yellow pike, and suckers. The yellow perch changed places with the sturgeon in 1890, but in 1899 the sturgeon and catfish fell permanently below eighth place and the list was disturbed by the appearance of the carp and white bass. In the census of 1903 the white bass and whitefish dropped out of the series and the sheepshead and sucker came in. (The sucker, being a cheap fish, has fluctuated in importance from year to year according to the tone of the markets.) In 1908 the whitefish recovered eighth place from the sheepshead, and in 1917 displaced the perch from sixth.

The main features of the 1922 statistics are the great rise in importance of the blue pike and perch, occasioned by an enormous increase in production, and the decline in importance of the carp and whitefish. The latter again dropped out of the series in this census. Thus, of the eight species that were most important in the fisheries before 1890, five still maintained that distinction in 1922.

The principal species on the Canadian shore in 1922 were, in order of abundance, blue pike, herring, perch, "coarse fish" (including suckers, sauger, and white bass), whitefish, wall-eyed pike, carp, and pike. The relative abundance of the various species as shown by the annual catches at five-year intervals over a period of years is given in Table 11.

TABLE 11.—*Relative abundance as shown by total weight, in pounds, of the annual catch of the principal species taken in the Canadian waters of Lake Erie, as shown by 11 censuses*

Species	1875	1880	1885	1890	1895	1900
Herring	316,000	854,000	5,935,000	5,393,000	5,139,000	6,526,000
Whitefish	125,000	205,000	186,000	204,000	148,000	401,000
Yellow pike	193,000	143,000	685,000	961,000	1,642,000	1,218,000
Pike	13,000	19,000	17,000	62,000	30,000	821,000
Sturgeon		213,000	459,000	580,000	319,000	169,000
Perch					396,000	694,000
Coarse and mixed fish	268,000	169,000	208,000	552,000	977,000	559,000
Bass	39,000	69,000	110,000	134,000	45,000	37,000

Species	1905	1910	1915	1920	1922
Herring	3,015,000	6,959,000	5,594,000	9,651,000	6,306,000
Whitefish	304,000	1,383,000	1,832,000	838,000	751,000
Yellow pike	1,692,000	923,000	607,000	166,000	505,000
Blue pike			4,882,000	3,354,000	6,312,000
Pike	935,000	[1] 2,516,000	630,000	115,000	143,000
Sturgeon	74,000	61,000	56,000		36,000
Perch	552,000	674,000	1,042,000	1,272,000	2,109,000
Coarse and mixed fish	703,000	883,000	948,000	900,000	1,227,000
Carp		979,000	904,000	431,000	233,000

[1] These fish were certainly not all pike, but probably included blue pike.

The interesting features of the table are the rise in production and the corresponding change in relative abundance since 1910, at about which time the increased demand for certain species raised the prices paid by American markets. The statistics have not been treated in a way to permit detailed analysis, but nevertheless certain tendencies are indicated by them. The sturgeon has declined to insignificance, and blue pike, perch, and "coarse fish" have steadily risen in importance since 1910. The whitefish, which also rose to prominence at that

time, fell off to an alarming degree by 1920. The once important carp has steadily declined. Bass and other game fish have for many years been placed on the protected list everywhere in Lake Erie and also in others of the Great Lakes.

PRESENT STATUS, METHODS, AND APPARATUS

The amount of apparatus in use on Lake Erie, as stated in Table 8, has latterly been reduced on the Canadian shore and production has fallen off. Statistics for American waters also show a decline in the quantity of apparatus employed. As in the past, the fisheries on the western flat are at present mostly shore fisheries, conducted by means of traps on the American side and by pounds across the boundary. Their products are rough fish, though at certain seasons a few whitefish are also taken. Gill nets, chiefly of 3-inch mesh, are also abundantly employed by the shore fishermen to take the same species, and at certain seasons seines are used, principally for the capture of carp in the marshes.

The tugs operating with gill nets alone are owned almost entirely on the eastern half of the lake. They use principally 3-inch herring nets, which at certain seasons they also set for blue pike and perch. All boats are now equipped with bull nets, and every boat has the necessary apparatus for floating nets. At certain seasons 4½ to 4¾ inch whitefish nets are employed, but only for short periods, but most boats have a few gangs of such nets.

The fishing seasons vary in different sections of the lake, and it is now common practice for the tugs to migrate to other ports or even into the waters of other States and to return home again when fish appear near their own ports. There are no such migrations across the boundary line; though the Canadian authorities have had difficulty with American tugs that set nets in Canadian waters, and a patrol is maintained and such nets as are found are seized.

Considering the immense quantity of netting employed in so small an area as Lake Erie, it is surprising that any fish are left. At times, however, the fish seem to avoid all netting, and floated or sunken nets are alike useless. At such times fishing is discontinued or the efforts of the fishermen are directed toward less elusive species.

FISHING DISTRICTS

On the American shore the principal gill-net ports, in geographical order, are Cleveland, Ashtabula, Erie, and Dunkirk, while on the Canadian shore Port Maitland, Port Dover, Port Burwell, Port Stanley, and Rondeau are most important. There are very important shore fisheries scattered all along the lake, particularly at the western end, but since the small boats engaged in these fisheries can find shelter almost anywhere along the shore they are not collected into harbors as is the case with the gill-net tugs. Cleveland, Loraine, Vermilion, Huron, Sandusky, and Toledo are the important centers handling the shore production on the American side of the lake, and on the Canadian shore most of such fish are shipped from Kingsville, Leamington, Rondeau, and Port Stanley.

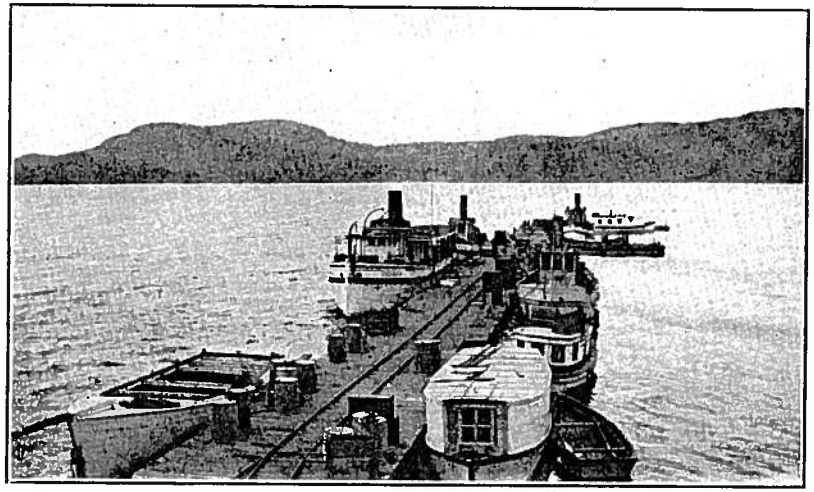

FIG. 16.—Boats comprising the fishing fleet operating on Lake Nipigon lying at anchor off the little fishing station of Macdiarmid

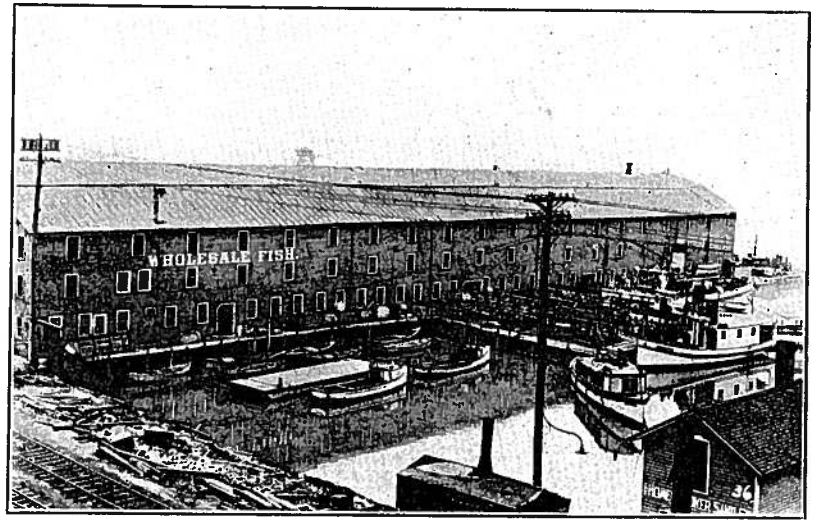

FIG. 17.—A typical Lake Erie wholesale fish house, located at Sandusky. The small launches are used in the shore fisheries, and the larger boats collect the production of the fishermen among near-by islands

FIG. 18.—Clearing the gill nets. One man is arranging the net in the box as it is delivered by the lifter (the drum in the center); the other is removing the fish (herring) from the netting. At the right are the cleared fish in "lake boxes." Above these are the "net boxes," in which the netting is handled

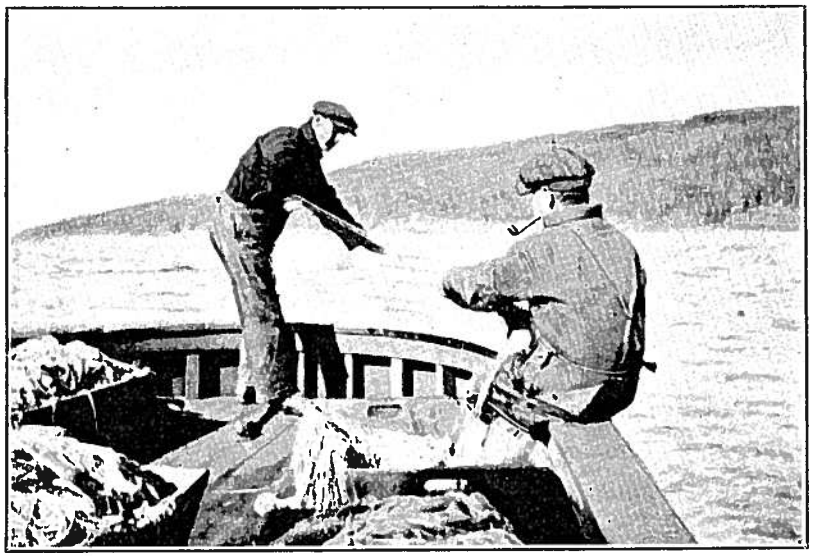

FIG. 19.—Setting gill nets from the stern of a moving tug. The nets have just been lifted, so that the snarls have to be gotten out as the nets are let into the lake

PRINCIPAL SPECIES

Unlike any other of the Great Lakes the chief production of Lake Erie is "rough fish"; that is, species other than whitefish, herring, and trout. The species taken most abundantly in 1922 in American waters were, in order of abundance, herring, blue pike, sauger, carp, perch, sheepshead, yellow pike, and suckers. In 1922 the principal species on the Canadian side were blue pike, herring, perch, whitefish, and yellow pike. The relative abundance of these and other species as shown by the annual catches made on both sides of the international boundary at various censuses are given in Tables 10 and 11 (pp. 592 and 593).

WHITEFISH

Whitefish formerly were produced principally on the flat at the western end of the lake, where they spawned, but now most of them are taken at other places on the lake, especially out of Erie, Dunkirk, and Port Maitland. Trap nets and pounds are chiefly used to take them in the west, while gill nets are employed in the east. In American waters the total catch showed decided improvement between 1903 and 1917. It is stated by the fishermen that the pollution of the Detroit River has driven the fish from many of their spawning grounds at the western end of the lake, and since 1920 the catches on these grounds are said to have been almost insignificant. The Canadian whitefish supply was not exploited to the limit until about 1908, and the catches in the last three years have fallen off considerably in spite of increased apparatus. The species is nowhere protected by a closed season, but spawn is collected to the capacity of the various State and Federal hatcheries.

HERRING

The herring were for many years the mainstay of the fisheries, but with the rise in value of "rough fish" they no longer occupy so important a position. They occur throughout the lake except on the western flat, where they have been practically exterminated; but there are several races, and the schools do not migrate from one end of the lake to the other, as many of the fishermen suppose. They are taken chiefly in special gill nets, which may be 25 feet deep and are often floated off the bottom. The pound nets on the north shore are also an important apparatus of capture. It is interesting that at certain seasons the fishermen find it impossible to take them with netting of any sort.

Originally herring were so abundant that the fishermen were content if they could dispose of a fraction of what they were able to catch, but in late years their numbers have become very much reduced, and were it not for the fact that the price asked for them by the organized producers has risen to such an extent that the demand is thereby curtailed, the species must by now have been more seriously depleted. As it is, it is certain that the herring fishery could not have been maintained at its present level without the use of floated nets. The nets often take too many fish to suit the dealers, and it is not uncommon to limit the weight of the lift that a boat may bring ashore, or even to cease fishing operations entirely if the

supply exceeds the demand. Large quantities are stored in freezers and are later sold frozen or smoked. On account of their rich flesh and large size they have lately competed strongly with the chubs, which are superior in quality but much smaller in size and consequently are taken in nets of ½-inch smaller mesh.

No States protect the herring with a closed season, but in recent years space in hatcheries not filled by whitefish eggs has been given over to the rearing of herring fry.

WALL-EYED PIKE

There are in Lake Erie two races of wall-eyed pike—the yellow and the blue. Intermediates, called "grays," are also sometimes recognized.

The status of the blue pike has so far never been established. Various scientists have expressed the opinion that the "blues" are different from the "yellows," but except for rate of growth and color no differences have been fixed. The yellows occur chiefly on the flat at the western end of the lake; the blues occur there, too, but are most common in other sections. The laws of practically all the States differentiate between the two as between two species, and the size limit for the blue race is lower in every State. The gill-net tugs frequently fish for the blues, but both kinds are commonly taken in the pounds and traps, the blues often in such abundance that they can not be sold.

The yellows have decreased in abundance, and in 1917, in American waters, the blues showed a decrease, but since then they have again increased, particularly at the eastern end of the lake. In Canadian waters they have been taken abundantly for only 10 years, and their production appears not yet to have passed it zenith.

There is no closed season to protect either race, but the yellow pike is protected in New York and has everywhere been extensively propagated. Recently attempts to propagate blue pike met with some success. It is interesting to note that of the two species the blues are holding their own better.

SAUGER

The sauger is a close relative of the wall-eyed pike and is often combined with it in the statistics. The chief catches are made in the waters of western Ohio. It is caught in the same apparatus with blue pike, and is not protected or propagated. Apparently it is maintaining itself as well as are its relatives.

YELLOW PERCH

The bulk of the perch catch is taken on the western flat, though some are found all along the lake's shores. Pounds and traps are the chief apparatus of capture, though many perch are also taken by gill nets.

The yellow perch has long been a favorite in the American markets, and even before 1890 it occupied a prominent place in the catches of Lake Erie. The supply fell off sharply before 1917, and about 1910 the production on the Canadian shore began to increase. From 1890 to 1899 the perch held fourth place in the production on the American side, but in 1917 it had fallen to ninth place. However, the price obtained rose from 1.5 cents in 1899 to 7.2 cents in 1917. In 1922 it ranked fifth, with an average price of 5.98 cents. On the Canadian side in 1910, at the beginning of the great spurt in production, the perch ranked about seventh, but by 1920 it had risen to third place, being exceeded in abundance only by the blue pike and herring.

STURGEON

Sturgeon were first made use of on Lake Erie, where they were marketable, as early as 1860. The catch of this species in 1885 amounted to nearly 5,000,000 pounds, but after 1890 production fell rapidly, and in 1922 only 15,000 pounds were reported. Practically the only sturgeon now produced are taken at the eastern and western ends of the lake on the Canadian shore and in New York waters. In Canada the apparatus of capture includes pounds, night lines, and gill nets, and excepting pounds the same gear is used in New York. The quantity caught decreases from year to year and the extermination of the species seems certain.

As yet no protection is granted the sturgeon by any State except Ohio, but all have a size limit. None are propagated. Ohio has a permanent closed season on all sturgeon, and Pennsylvania, New York, and Ontario individually enacted laws for a closed season, but suspended their operation because their neighbors had not at that time enacted similar legislation.

SHEEPSHEAD

The sheepshead is taken chiefly on the western flat, and until 10 years ago was considered hardly worth bringing ashore. The demand has now increased, however, and in 1922 this fish brought an average price of 2.4 cents, as compared with 0.9 cent recorded in the census of 1908. In 1923 as high as 6 cents was paid to the fishermen. The catches are made almost entirely with trap nets, and in the past three years have declined considerably. The species is not protected by a closed season and is not propagated.

SUCKERS

Suckers occur all along the shores, but most of the catch is now made on the western flat in trap nets, though other devices are used also. Suckers have long been in demand as a cheap fish, and the supply shows a general decrease. There is no closed season and no propagation.

OTHER INDIGENOUS SPECIES

Every fish taken in Lake Erie now has a market value. Most of the less important species are relatively rare and the price of some of them is low. As a general thing these are taken only incidentally in the catches of more valuable and abundant species. Among these miscellaneous fish may be mentioned the catfish, bullheads, white bass, pike, mooneye, sunfish, rock bass, bowfin, lawyer, and trout.

All of them except the trout and possibly the lawyer thrive best on the western flat and are taken chiefly in traps.

The trout frequents the deeper waters at the eastern end of the lake, and is caught in gill nets. Catfish, bullheads, and white bass at one time or another held an important place in the fisheries, but though they still bring good prices their numbers have been much reduced. The trout is one of the most valuable species in the lake and also one of the rarest. It was never as abundant in Lake Erie as in the other Great Lakes, and in late years has become so rare that almost no effort is made to take it. None of the species mentioned are protected by a closed season and none of them are propagated.

INTRODUCED SPECIES

CARP

The carp is now one of the most abundant species on the American shore of Lake Erie and has become quite popular with the fish dealers. The principal catches are made west of Sandusky, where they are taken in the marshes at certain seasons by means of seines. They are often kept alive in ponds and sold during the winter when fish are scarce and prices are higher. New York City is the most important market for carp. These fish were not originally planted in Lake Erie but are said to have escaped into the lake from private ponds about 1883. They increased rapidly, and 10 years later were abundant enough to be mentioned in the census. In the last 5 years carp have decreased significantly everywhere in the lake.

GOLDFISH

Goldfish are reported to be very abundant in Maumee Bay, where they are taken in traps in the spring. It has been estimated that from 10 to 15 tons are taken annually in the bay, but they have no market value and are therefore liberated. Carl L. Hubbs, of the Museum of Zoology, University of Michigan, informed me that individuals of the species are not uncommonly caught in the nets at Monroe, and fishermen report occasional specimens on the north shore.

GIZZARD SHAD

The gizzard shad, or sawbelly, is one of the commercially insignificant species of the lake. It is said to have entered the lake through canals from the southward, and has now spread even into Lake Huron.

FISHING REGULATIONS

Fishing laws on Lake Erie are administered by the States of New York, Pennsylvania, Ohio, and Michigan, and the Province of Ontario. These laws are compared in the following sections.

APPARATUS

Gill nets.—Michigan and Ontario do not permit the use of gill nets of smaller mesh than 4½ inches for taking whitefish, and in New York nothing smaller than 4¾-inch netting may be used. Ohio and Pennsylvania do not regulate the size of the mesh for taking whitefish but prohibit the taking of fish smaller than 1¾ pounds in the round.

The laws regarding trout nets are the same as for whitefish, except that Pennsylvania requires that the mesh be not smaller than 5½ inches. For all other species excepting sturgeon no net of smaller mesh than 3 inches may be employed, except in Michigan where the minimum mesh is virtually 2¾ inches.

The laws provide for the use of 2½-inch nets for taking blue-backed herring from November 1 to December 15, but few such fish occur in Michigan waters at that season. Until 1923 2¾-inch nets were allowed in the eastern end of the lake in Canadian waters.

For the capture of sturgeon the State of New York requires 10-inch nets. Michigan, Pennsylvania, and Ontario have no regulations with respect to nets for catching sturgeon but limit the size of the fish that that may be taken, while Ohio entirely prohibits their capture.

Ontario and Pennsylvania have enacted laws to prohibit the use of bull nets. In Ontario waters no gill net may be deeper than 36 meshes, while in Pennsylvania 30 meshes is the maximum depth allowed. The Ontario law has been in force since January 1, 1923, but in Pennsylvania the law will not become effective until Ohio and New York have provided similar restrictions.

Seines.—In Michigan the mesh of seine wings may not be smaller than 4 inches and that of the bag not less than 2¼ inches, while in New York no seine with smaller meshes than 3 inches is licensed. Ohio places no restriction on the use of seines in the open lake, but permits nothing less than 4-inch mesh in the marshes. In Ontario and Pennsylvania there are no regulations governing seines.

Pound nets.—In Michigan pound nets for taking whitefish and trout may have the mesh of the bottom, sides, and front of the pot not less than 3½ inches in size, as used, and that of the back not more than 2 inches, as manufactured, for at least 15 feet below the surface of the water. If the mesh of the bottom, sides, and front of the pot is not less than 4 inches, as used, the size of mesh necessary in the back is not specified. Pound nets with the front, sides, and bottom of the pot of mesh not smaller than 2¼ inches and the back with meshes of not more than 2 inches may be used for other fish if they do not catch more than 10 per cent of mature whitefish and trout in a season. The size of mesh in the lead and heart is also specified throughout, and provision is made for the use, from October 1 to June 15, of a pound with a pot made of mesh not smaller than 2 inches throughout, as manufactured, for the purpose of taking blue-backed herring.

There are no regulations governing the mesh of pound nets in Ontario, but the size of the fish that may be taken is regulated. In Ohio one-third the back of the pot of pounds must be constructed of mesh not less than 2⅞ inches in size, as fished, and the back shall hang squarely. In Pennsylvania no pound-net pot may have a mesh of less than 2½ inches, as fished. New York does not license pound nets.

Trap nets and fyke nets.—In Michigan, Ohio, and Pennsylvania the laws governing trap nets and fykes are practically the same as for pounds. In Ontario no traps are licensed and the mesh of fykes may be not less than 2½ inches. In New York no trap net or fyke may have meshes smaller than 3 inches.

SIZE LIMITS

The regulations governing legal size of fish are given in Table 12.

TABLE 12.—*Minimum size limits of fish that may be taken in Lake Erie, as decreed by the laws of the various States*

Species	New York	Ontario	Pennsylvania	Ohio	Michigan
Whitefish	1¼ pounds, round.	2 pounds, round.	1¼ pounds, round.	1¼ pounds, round.	2 pounds, round.
Herring		8 ounces	6 ounces, round.	11 inches	
Blue pike		11 inches	11 inches	do	
Yellow pike	12 inches	15 inches	13 inches	13 inches	1½ pounds, round.
Sauger			11 inches	11 inches	
Catfish				15 inches	2 pounds, round.
Perch		9 inches		9 inches	9 inches.
White bass		do		do	
Bullhead				do	8 ounces, round.
Sheepshead		12 inches		11 inches	
Carp		3 pounds, round		15 inches	
Sturgeon	42 inches	42 inches	48 inches	(Closed season)	20 pounds, round.
Trout	15 inches	2 pounds, round			1½ pounds, round.
Sucker					1 pound, round.
Pike					2 pounds, round.

Ontario specifies that the length of a fish shall be measured from the tip of the nose to the center of the tail. Other States do not define length.

CLOSED SEASONS

There is a winter closed season along the lake in Pennsylvania from December 16 to March 1, both dates inclusive, during which all fishing is prohibited. In Ontario the closed season extends from December 15 to March 15 west of longitude 80° 30′ west, and in Ohio it covers the period from December 15 to March 14. New York has no winter closed season but will probably enact one for the sake of uniformity.

Whitefish and trout are protected nowhere except in Michigan, where a closed season operates during the spawning period. However, Ohio prohibits using nets on the reefs except with the permission of the Secretary of Agriculture. Since whitefish spawn on the reefs, the taking of spawn is in this way controlled. Michigan has never had trout in its waters and at present has but few whitefish, but the State has declared a closed season on whitefish from November 20 to December 15. Fishing is permitted during the spawning season if the spawn is saved. New York provides in its fishing licenses that the spawn of these species must be saved.

Yellow pike are protected in New York waters from March 2 to May 9, both dates inclusive. The blue pike, which are by far the more numerous, are not included in this protection.

No sturgeon may be taken in the State of Ohio. New York, Pennsylvania, and Ontario have tried for a number of years to come to an agreement to protect the sturgeon, but so far have met with no success, and fish larger than the minimum size provided by the various State laws may still be taken. It is deplorable that laws can not be enacted to save the sturgeon.

There are no closed seasons in any State for the protection of any species except those mentioned.

The laws are in no respect so seriously at variance with one another as in the matter of trap and pound nets. The smallest mesh that may be used in New York is 3 inches, in Pennsylvania 2½ inches, and in Ohio 2⅞ inches. In Michigan the mesh of the back of the pot may not be larger than 2 inches unless the mesh of the rest of the pot be at least 4 inches in size. Ontario has no regulations at all governing the size of mesh. Furthermore, some of the States do not distinguish between meshes *as manufactured* and *as fished*. Before the netting is used it is tarred, and this treatment increases the diameter of the twine and the water later shrinks it; all of which reduces the size of the mesh. The Ohio law alone specifies that the mesh shall *hang squarely* so that small fish may be able to escape. If the netting is not properly strung, the openings of the mesh are reduced and the escape of small fish is restricted. Many conservationists believe that up to a certain point the meshes of trap nets can not be made too small, since when they are small fewer fish gill themselves in the twine when the net is lifted. This might be true if the fishermen could be persuaded to take time to lift their nets so slowly that it would be possible to sort out the marketable fish and release the rest without injuring them; but such procedure is not always practicable, and the young are too frequently injured or even destroyed in the lifting. There are, furthermore, provisions in the laws of most of the States permitting the possession of from 3 to 10 per cent of undersized fish.

Many States fail to provide size limits for certain species. However, except for the sucker and the pike the other undesignated species are not sufficiently important in the various States, where the laws now make no provision for them, to become the objects of particular legislation.

LAKE ONTARIO

DESCRIPTION

Lake Ontario is the smallest and the farthest east of the Great Lakes and is bounded on the north and west by the Province of Ontario and on the south and east by the State of New York. It has a length of 185 miles and an average width of 40 miles, and, with its bays, a total area of about 7,300 square miles. There are no islands or shoals except near the outlet, where it discharges into the St. Lawrence River. The shores everywhere slope rapidly into deep water, but most rapidly on the south, and the deep trough runs nearer this shore. The 30-fathom contour on an average runs less than 3 miles from land on the southern shore, while on the north it is about 5 to 10 miles distant. The trough broadens toward the east and is overlaid by depths of 70 to 90 fathoms in the western half and by 90 to 123 fathoms in the eastern half. The bottom over most of the lake is clay, with narrow stretches of sand and rock along the shores, particularly among the islands at the eastern end.

FISHING INDUSTRY

HISTORY

The fisheries of Lake Ontario began with the settling of its shores, and the first species sought were the whitefish and trout. These were taken with seines, which gear, it is said, was used as early as 1807. Fishing by this method was conducted principally on the northeastern and eastern shores, but seines were also drawn wherever the bottom was suitable. According to all accounts large numbers of sturgeon and herring were included with the whitefish and trout, but these were not desired and were destroyed as nuisances along with the smaller whitefish. The catch was salted, and this practice was continued until about 1860, when the fish became rare in the shore waters. Gill nets were then employed, since thereby the deeper waters could be reached. Pound nets were never widely used on Lake Ontario, and in recent years none have been licensed. With the general decline in abundance of whitefish and trout gill nets of smaller mesh were set for herring and the sturgeon was marketed.

The catch of trout and whitefish in American waters dropped off to insignificance as early as 1885, and by that year the chief production on the Canadian shore was herring and ciscoes. The latter were discovered in the western waters about 1860, and played an important rôle in the fisheries of that section for many years. The best fishing grounds on the Canadian side are at the east end of the lake, and at first fishing was most intense there. With the exhaustion of the original whitefish and trout grounds here and the increase in the demand for herring the center of fishing activities swung to the west end of the lake westward from Toronto. By 1910 the economic forces that stimulated fish production on the Canadian side of Lake Erie and in other Canadian waters at about the same time were felt on Lake Ontario, and fishing apparatus increased enormously, resulting in a more intensive and extensive exploitation of the fishery resources, particularly of the salmonids. Since this date over two-thirds of all the netting on the lake has been employed in a small sector to the eastward from Brighton.

Only a narrow shelf along the American shore is suited for shore fishing, and since this area was thoroughly exploited from the beginning the American fishermen had no other place in which to look for whitefish or trout and turned their attention to other species.

About 1875, out of Oswego, a large deep-water herring was discovered in 60 fathoms and deeper, which supported the fishing industry out of that port for about 12 years. These fish were known as "bloaters" and were caught with 3½ to 4 inch nets. Bloater fishing spread along the shore, and by 1890 was established at Wilson. By 1895 the bloater was everywhere so rare that no one fished in deep water, and since then the little fishing done on the American shore has been carried on chiefly by means of trap nets, which had been in growing use since 1885.

The trend of the fisheries on the American shore may be clearly expressed by a digest of the statistics over a period of years, itemized in Table 13.

TABLE 13.—*Weight, in pounds, of the annual catch of the principal species of fish taken in the American waters of Lake Ontario, as shown by eight censuses*

Species	1880	1885	1890	1893	1899	1903	1908	1917	1922
Whitefish	1,064,000	90,000	148,000	45,000	161,000	25,000	56,000	88,000	54,000
Trout	569,000	20,000	41,000	6,000	15,000	4,000	14,000	23,000	46,000
Herring (including bloaters)	611,000	403,000	598,000	164,000	86,000	121,000	35,000	424,000	187,000
Sturgeon	545,000	386,000	541,000	125,000	189,000	110,000	37,000	10,000	34,000
Wall-eyed pike	(1)	[2] 269,000	331,000	[2] 216,000	197,000	68,000	154,000	35,000	141,000
Perch	(1)	(1)	358,000	131,000	407,000	122,000	35,000	31,000	30,000
Catfish and bullheads	(1)	442,000	471,000	69,000	518,000	349,000	122,000	45,000	107,000
Suckers	(1)	(1)	279,000	47,000	278,000	773,000	128,000	71,000	77,000
Pike	(1)		129,000		100,000	31,000	87,000	15,000	19,000
Carp					1,000	4,000	4,000	25,000	138,000
Eels	(1)	61,000	257,000	(1)	123,000	73,000	44,000	41,000	45,000
Lawyer								61,000	15,000

[1] Not itemized. [2] Including pike.

In 1880 whitefish, trout, herring, and sturgeon made up over 75 per cent of the total production of 3,640,000 pounds; the greatest year on record. In the six censuses taken between 1885 and 1908 the catch of these species, combined, was less than half that of "rough fish"—principally wall-eyed pike, perch, eels, suckers, and such other species as frequent the shores. The high point in the production of rough fish was reached in 1890, and the catch has declined since, so that in 1917, even with the stimulant of war prices, the total yield of these species fell below that of any previous census and was exceeded by the 424,000-pound catch of herring in that year. In 1921 the New York law was amended to permit fishing to within ½ mile of shore, instead of 1 mile, and it is possible that the slightly increased catch of 1922 was partly due to the enlarging of the available fishing grounds.

The history of Canadian fisheries has been more cheerful, due to better fishing grounds on that side of the lake and also to the greater care taken of them. After the whitefish and trout fell off (in about 1885) the chief fisheries were for ciscoes, herring, and rough fish, and not until 1905, when netting was more commonly used in the eastern waters, which have always produced most of the whitefish and trout, did these species rise to prominence again. They are now the mainstay of the Canadian fisheries, though significant quantities of herring and rough fish are also produced. Ciscoes have for many years been commercially extinct. Herring were caught chiefly west of Toronto until 1918, but since then they have become rarer in these waters and the catches in the east have increased so that now the east side of the lake exceeds the west side in the output of these fish. Rough fish have always been most abundant in the east.

PRESENT STATUS, METHODS, AND APPARATUS

On the American shore only small launches are now used in the fisheries and trap nets and fyke nets are their chief equipment. Occasionally, however, a larger boat, usually from Lake Erie, equipped with abundant up-to-date apparatus, has been lured to Lake Ontario by the prospect of great fish wealth present in the deeper waters, into which the frail craft of the native fishermen do not venture, but the prospectors soon become disillusioned and return whence they come. There are still a few gill-net fishermen, mainly

at the eastern end of the lake, who fish during the summer for whitefish and herring, and some fishermen still use gill nets at certain seasons for taking sturgeon. Hooks are also used for taking sturgeon, as well as for eels. No pound nets are licensed.

Many of the fishermen now ply their trade only when runs of certain species may be expected, and at other times they withdraw their netting. The schools of herring that come ashore at certain places in the fall receive especial attention.

The best fishing obtains off the Canadian shore, and the majority of fishermen on the lake are Canadians. Here, also, the fishing boats are small launches and rowboats, but gill nets are the chief apparatus. These are lifted by hand. Trout and whitefish are the principal species taken with large-meshed gill nets and herring with the small-meshed nets. Pound and trap nets are not licensed. Fykes may be fished but are used only at the eastern end, where their catch consists chiefly of rough fish. Hooks are also employed in this region for taking eels and catfish, and a few seines are operated here and elsewhere. The amount of apparatus engaged in the fisheries is increasing.

FISHING DISTRICTS

Since only small boats are employed in the fisheries, these can find shelter almost anywhere along the shore, and the principal fishing districts may be most conveniently designated by the larger political subdivisions. On the New York shore these are Jefferson and Oswego Counties, and on the Ontario shore Lincoln and Halton Counties on the west and Durham, Northumberland, and Prince Edward Counties, including the Bay of Quinte, on the east are the important districts.

PRINCIPAL SPECIES

The principal species on the American shore in 1922, the last census year, was the herring, of which about 187,000 pounds were taken. Wall-eyed pike ranked second, with 141,000 pounds, while carp and bullheads came third and fourth, respectively, with 138,000 and 107,000 pounds.

On the Canadian shore in 1922 whitefish ranked first, with a production of 2,098,000 pounds, while trout were second with 721,000 pounds. Coarse fish—chiefly suckers, pike, catfish, eels, wall-eyed pike, carp, and perch—ranked next in order of abundance. The production in 1917 and 1922 is more fully shown in Tables 13 and 14.

TABLE 14.—*Weight, in pounds, of the annual catch of each of the important species and amount of gill netting used in the Canadian waters of Lake Ontario, as shown by 10 censuses*

Species	1880	1885	1890	1895	1900
Whitefish	729,000	360,000	404,000	126,000	129,000
Trout	249,000	307,000	106,000	109,000	60,000
Herring, including ciscoes	233,000	1,503,000	2,484,000	1,407,000	1,095,000
Sturgeon	16,000	55,000	41,000	39,000	18,000
Pickerel	139,000	229,000	135,000	245,000	34,000
Pike	80,000	255,000	213,000	445,000	232,000
Eels	(1)	18,000	29,000	37,000	40,000
Perch	(1)	(1)	(1)	249,000	283,000
Catfish	(1)	(1)	(1)	(1)	267,000
Carp			(1)	(1)	(1)
Mixed and coarse fish	978,000	936,000	780,000	714,000	722,000
Gill nets, yards	399,000	236,000	305,000	346,000	462,000

[1] Not separated from "mixed and coarse fish."

TABLE 14.—*Weight, in pounds, of the annual catch of each of the important species and amount of gill netting used in the Canadian waters of Lake Ontario, as shown by 10 censuses*—Continued

Species	1905	1910	1915	1920	1922
Whitefish	472,000	694,000	817,000	2,027,000	2,098,000
Trout	75,000	413,000	555,000	462,000	721,000
Herring, including ciscoes	1,390,000	997,000	1,801,000	1,291,000	345,000
Sturgeon	14,000		1,000		1,000
Pickerel	48,000	60,000	85,000	46,000	144,000
Pike	203,000	378,000	366,000	311,000	250,000
Eels	19,000	104,000	219,000	91,000	146,000
Perch	179,000	128,000	119,000	107,000	74,000
Catfish	135,000	269,000	267,000	170,000	177,000
Carp	(1)	140,000	112,000	65,000	121,000
Mixed and coarse fish	257,000	367,000	438,000	413,000	448,000
Gill nets, yards	499,000	1,075,000	887,000	1,057,000	1,600,000

[1] Not separated from "mixed and coarse fish."

WHITEFISH

The whitefish originally ranked first in the fisheries on the American shore, but few are now taken and these are produced for the most part in Jefferson and Oswego Counties. At other points along the American shore they are taken only occasionally. The whitefish is now first in abundance on the Canadian side of the lake and still supports a fishery out of many ports, but by far the most productive whitefish area lies eastward from Brighton. The best spawning grounds are also in this region. Gill nets are the principal apparatus of capture. There have been times when in many sections the species was rarer than at present and the fishermen ascribe the increase to planting and to the unusually low mortality among the alewives in recent years. There is no closed season for whitefish on the lake, but the species is extensively propagated.

LAKE TROUT

The lake trout is now an insignificant element in the American waters and such few as are taken come from the eastern end of the lake. On the Canadian shore the trout is next in importance to the whitefish, and its geographical distribution is similar to that of the whitefish, being most abundant at the eastern end. The fish is taken chiefly in gill nets, though there was a time prior to 1900 when set lines were employed to some extent. There is no closed season on trout and the species has not been very extensively propagated.

HERRING

On the American shore of Lake Ontario herring are taken principally in the area from Sodus Bay eastward to the St. Lawrence River. Most of them are caught in the fall in trap nets and gill nets when they come ashore to spawn, but a few fishermen, particularly in Oswego County, fish for them with gill nets during the summer and take them abundantly in water as deep as 200 feet.

On the Canadian shore most of the herring are taken in shallow water at the west end of the lake and in the Bay of Quinte region. Herring are also found at the west end in deep water, and until 1923

it was permissible to use a mesh of 2½ inches to take them in this area. These deep-water herring are fatter than those taken along the shores or from other sections of the lake, and are sometimes smoked. The use of 2½-inch nets dates back to the "cisco" fishing of 1860 and thereafter, but the fishermen are unanimous in their opinion that these herring have succeeded the "ciscoes."

Herring are not protected by a closed season, but are sometimes propagated. They have fluctuated in abundance from year to year in certain areas of the lake, now appearing on certain spawning grounds in immense schools and then forsaking them for a period of years, often to return again in apparently undiminished abundance.

BLOATERS AND CISCOES

The bloater is a deep-water herring that attained a weight of about 1½ pounds, which was taken principally along the American shore, though for three or four years, in the nineties, it was also taken out of the Canadian ports at the west end of the lake. Nowhere else does a depth of 60 fathoms (which is the depth at which the bloater lived) occur within sight of shore, and the sailboats, which were chiefly in use at that time, could not set nets and expect to find them again unless it was possible to take range of their location from points along the shore.

The first fishery for bloaters was carried on out of Oswego about 1875. A fisherman operating out of that port found a few individuals in the outer ends of his whitefish gangs and conceived the idea that it might be profitable to fish them. The fish were sold fresh and were so much in demand that at one time there were several boats engaged exclusively in bloater fishing out of that port. The industry gradually spread to the westward, and by 1890 bloaters were being taken out of Wilson. At first they were extremely abundant and it was never necessary in American waters to use a net of smaller mesh than 3 inches, and usually the mesh employed was 3½ inches, but before 1900 the bloater was commercially exterminated, and efforts to revive the industry since then have met with absolute failure. Repeated efforts to locate these fish, made by me in the summers of 1921 and 1923, failed, and not a single specimen was found, so that it appears likely that the species is extinct. No cause for its extermination suggests itself. At no time were any but the largest examples of the species taken, and so far as known it had no important vertebrate enemies. The case has close parallels in the related blackfin of Lake Michigan and the bluefin in Lake Superior, which suddenly became commercially insignificant, though not extinct, under identical conditions.

The "ciscoes" were also deep-water fish, which were discovered off Burlington Beach about 1860. Until about 1895 they were taken in 2½-inch nets at a depth of 35 fathoms and more, chiefly in late fall when they spawned. In the nineties, from all accounts, the bloaters appeared off the shore, because the Canadian fishermen found it necessary to use nets of 3¼ inches to take them. These nets were used for three or four years. Since 1900 there have been no more "ciscoes," according to the fishermen.

What the "ciscoes" were can not be positively stated, but it is likely that they were *Leucichthys hoyi*, which is known to occur more of less abundantly in other parts of the lake, though none are taken

because nets of small enough mesh are not permitted. Two other species of deep-water herring occur with *hoyi* in depths of 50 to 70 fathoms, but these are also small and can not be taken in the minimum 3-inch net which is now allowed. The nets of 2½ inch and 2¾-inch mesh set by me in the summer of 1921 showed that these three species occur off Wilson, Rochester, and Sodus Point. Since about half the entire area of Lake Ontario is frequented by no other fish than these three species and the lawyer, it would be a distinct economic gain if they might be taken commercially.

OTHER INDIGENOUS SPECIES

The "rough fish" are found only in the shallowest water, and such areas have been pretty well protected on Lake Ontario. The New York law allowed no nets within 1 mile of shore from about 1890 until 1921, and the Canadians licensed practically no traps or pounds. The chief species are sturgeon, eels, pike, wall-eyed pike, suckers, catfish, bullheads, perch, and lawyer. The Atlantic salmon, which was at one time abundant in the streams emptying into Lake Ontario, is now probably extinct.

The sturgeon, once valueless, is now the most valuable of all the species in the lake, and though almost exterminated it is still abundant enough on the American shore so that several fishermen make particular efforts during the summer to capture it. Gill nets and set lines are used, and the output is a few hundred fish yearly.

The eel, which obtains access to the lake from the St. Lawrence River, is taken chiefly on night lines, and all the other species are taken in fykes, traps, or gill nets. The greatest amount of each species, except the sturgeon and lawyer, is taken on the Canadian side, where the most sheltered situations occur.

The lawyers are abundant enough everywhere, but the Canadians have no market for them and the Americans have just begun to utilize them. The campaign of the United States Bureau of Fisheries to acquaint people with the food qualities of this species is no doubt largely responsible for the increased demand.

None of the species mentioned in this section are protected by a closed season except the wall-eyed pike, which in New York may not be taken from March 2 to May 9, both dates inclusive. However, most of the wall-eyed pike in American waters are of the blue race, and these are not protected in any manner whatever.

INTRODUCED SPECIES

ALEWIFE

An account of the Ontario fisheries is not complete without mention of the alewife, which was present in abundance in the lake as early as 1873, according to a letter found in the files of Fisheries Inspector John W. Kerr, of Hamilton, dated June 10, 1873. It is supposed to have been introduced, and is at present very abundant along the shores but is not taken for market. Its chief interest lies in the heavy mortality among adults in the spring, when they are said to occur frequently in windrows on the beaches. To the decay of these carcasses the fishermen attribute in large part the decrease of the whitefish, and from personal observations I believe that it is not

improbable that this may have been a factor. On August 24, 1923, while witnessing the lifting of a 3-inch gill net set for lake herring in 30 fathoms off Sandy Pond, from three to nine dead and decayed fish were brought up between each two corks (about 8 feet), wrapped about the threads of the net. The nets had been out for two nights and a stiff breeze had induced the currents, which swept the fish along the bottom and entangled some of them in the nets.

CARP

Another important nonindigenous species is the carp, which is thriving in Lake Ontario, where conditions are suited to it. They are caught for market at several points on both the American and the Canadian shore, chiefly at the eastern and western ends. They are taken for the most part in seines and traps on the American side and by seines on the Canadian shore.

SHAD

Shad were introduced into Lake Ontario many years ago and for a time were occasionally taken. Specimens are still reported at rare intervals.

FISHING REGULATIONS

APPARATUS

Gill nets.—The New York law allows no gill net of a mesh less than 4¾ inches to take whitefish or trout in Lake Ontario, and the Ontario law allows none smaller than 4½ inches. For sturgeon New York requires a gill net of not less than 10-inch mesh, while Ontario has no requirements but regulates the length of the sturgeon that may be possessed. For all other species gill nets of not less than 3-inch mesh are legal. In addition, the New York law specifies that no net may be set within ½ mile of land or within 1 mile of the mouth of the Niagara River, except that nets may be set for herring from October 15 to December 15 outside of an area 500 feet from shore and outside a radius of 1,000 feet from the mouth of any river, bay, inlet, or outlet. There are exceptions to this law in the case of some of the larger bays.

No Canadian fisherman may use a gill net of greater depth than 36 meshes, and certain restrictions are placed on fishing in the Bay of Quinte.

Seines.—No seine of less than 3-inch mesh may be used in New York waters. Ontario does not specify the size of mesh that may be used.

Trap nets.—Pound nets are not licensed on Lake Ontario. Trap nets are prohibited in the Ontario waters of the lake, but fyke nets are allowed and may be of a mesh not smaller than 2½ inches. Both traps and fykes are allowed in New York but may not be of mesh smaller than 3 inches.

SIZE LIMITS

New York State prohibits the taking of whitefish of less than 1¾ pounds in the round, trout less than 15 inches in length, wall-eyed pike (yellow only) less than 12 inches, or sturgeon less than 42 inches.

The Ontario law prohibits the taking of whitefish or trout under 2 pounds in the round, herring under 8 ounces, carp under 3 pounds, sturgeon under 42 inches, wall-eyed pike (blue) under 11 inches, wall-eyed pike (yellow) under 15 inches, perch under 9 inches, sheepshead under 12 inches, and white bass under 9 inches.

CLOSED SEASONS

There is no closed season on any species except that wall-eyed pike (yellow) may not be taken in New York waters from March 2 to May 9, both dates inclusive.

CONSERVATION OF THE GREAT LAKES FISHERIES

DEPLETION AND ITS CAUSES

The preservation of the fisheries has been discussed often during the past 50 years, and more excellent suggestions have been made than have been followed. In the meantime the fish supply has continued to decrease. No argument is necessary to prove that fish are now less abundant than they were 50 years ago, but it is of interest to express, if possible, the relationship between present and past abundance. The complete statistics for American waters gathered in 1917 disclose a 100 per cent inflation in the value of fisheries products, which stimulated a production hardly equal to that of a preceding survey in 1908 and below the level reached in 1890 and 1899. Fifty per cent more gill nets and about 90 per cent more traps were needed to attain this level. The 1922 data show the amount of apparatus to have declined somewhat, and the catch to have increased slightly, but the quantity of apparatus is still greater than that reported at any census previous to 1917, and the catch of what were "rough fish" in 1880 is by far the highest on record. On the Canadian shore fishing has not been prosecuted so intensively or extensively as on the American shore until within the last 10 years, but the Canadian statistics show the same unequal relationship between the increase in apparatus and the increase in production. The statistics do not show what part of the total yield is made up of previously undesirable species, nor do they reflect the effectiveness of the superior apparatus now generally employed.

If we turn from incomplete statistics to a consideration of the testimony of the fishermen we are forced to the same conclusion. While in certain localities the pursuit of the remnants of certain species has so fallen off as to allow them to maintain their numbers or even to increase somewhat, in general, the situation can not be viewed with any satisfaction. We are faced with the extermination of the sturgeon in all the lakes, of the bluefin in Lake Superior, the blackfin in Lake Michigan, and the bloater in Lake Ontario, and with the reduction of the whitefish from first place in abundance in 1880 to fourth place in 1922, with that place contested closely by the sucker, which was in 1880 not considered worth the catching.

POLLUTION

The pollution of the streams and shores that serve as feeding and spawning grounds for the fish is believed to have contributed in no small degree to the reduction of the fish supply. In the days of lum-

bering, sawdust, bark, and logs were thrown into the water, and often streams were blocked with this refuse. The bottoms of the lakes are still strewn with this debris, and in stormy weather the nets in shallow water are in danger of destruction from the logs and bark, which have been preserved in the cold water for the last five decades and are washed hither and thither by the waves. These substances have probably long since ceased to be chemically active, but their mechanical effect in smothering the bottom can not be negligible.

In later years the pollution of rivers and bays by modern industrial plants has made barren some of the most productive fishing grounds, and the continuation of the evil is not only preventing the recovery of these grounds but is spreading its effects. The dumping of ashes into the lakes by steamboats must also have an effect, even on waters so extensive in area as those of the Great Lakes, especially when one considers that the tonnage of shipping that annually passes through the Soo locks alone is greater than that through the Panama Canal. The total weight of such waste must every year run into thousands of tons, and so generally is it distributed that it is not uncommon to pick up clinkers in the gill nets in deep water.

The practice of dumping fish offal into the lake, even where gulls are at hand to feed on it, is also to be deplored. The gulls are not always hungry enough to consume even such particles as float and those that sink lie on the bottom for months, decomposing but slowly because the water is of such low temperature. There are laws prohibiting the dumping of fish refuse, but it is not surprising that such laws are not strictly adhered to when their violators are constantly and in every way reminded of pollution from more noxious sources.

The effects of this pollution are mechanical or chemical, or both. No one can defend the introduction into the lakes of substances that smother the bottom, but it is possible to argue in favor of certain forms of chemical pollution. The argument must be drawn from analogy of the effects of such chemicals in small lakes, but since the conditions in shallow lakes are so radically different from those in bodies of water like the Great Lakes that they even maintain an entirely different fauna it must be admitted that a strict analogy is not possible. The fact that pure water will not maintain aquatic life is generally known, and it is a conspicuous feature of the waters of the Great Lakes that they are relatively so very pure. The quality of the water, within certain limits, of course, affects fish only indirectly by influencing their food. In the case of the Great Lakes we know that prior to human interference in their economy the animals that comprised the food of the typical Great Lakes' species were sufficiently abundant to support a fish population vastly denser than that of to-day, and it must follow that to introduce into the water foreign substances of unknown effect may be deleterious to this food supply.

WASTEFUL FISHING METHODS

Even though the fishermen may be justified in their complaints against others for spoiling the waters for fish, they have no one but themselves to blame for the wasteful fishing methods that have been one of the main factors in the decline of the fisheries. It has often been recorded how sturgeon, herring, and other fish, and immature whitefish and trout were originally destroyed because they

were a nuisance in the seines and pounds, and how, after fish became rarer, nets were even set with the special object of taking the immature individuals, often of a size too small to be marketable. Such fish must have been diminutive indeed. The failure of the responsible Governments to check such wanton destruction can not be too severely censured, but in view of the fact that other natural resources have been and still are being squandered in the same way it is not surprising that wealth apparently so unlimited as that of the Great Lakes should not have been conserved.

More interest has been shown in conservation on the Canadian side of the boundary than on the American side, and the Canadian laws regulating fishing not only antedate most of those on the American side by many years but have been throughout much more conservative.

REMEDIAL MEASURES

LEGISLATION

At present there are laws everywhere regulating the taking of fish, which are more or less effectively enforced. It has already been shown how these laws often vary in character on the same lake, due to diversity of opinion among the legislators responsible for their framing, and it has also been shown how the enactment of protective legislation lags behind the need for protection. The necessity for protecting the fish can be understood by anyone, but few persons other than fishermen can appreciate the significance of the variations in the stipulations of the laws, particularly of those governing the size of the mesh of the netting.

By way of illustrating the importance of apparently insignificant differences in the provisions of these regulations, data relative to the difference in effectiveness of nets which differ in size of mesh to the amount of ¼ inch are given. The netting used for the experiments was linen gill netting of 2½ and 2¾ inch mesh set in Lake Ontario in 1921 at depths of more than 60 fathoms. The two kinds of nets were equal as regards quality and fineness of thread, manner of hanging, and length of pieces, and the fish caught were of two species only, both practically equal in the matter of absolute size attained. On July 4, off Braddock Point Light, three pieces of 2¾-inch net took 22, 20, and 19 fish, and one piece of 2½-inch net took 59 fish. On July 16, off Wilson, three pieces of 2¾-inch net took 49, 48, and 51 fish, while one piece of 2½ took 106 fish. Thus, a difference of ¼ inch in these two cases more than doubled the catch. From these results it may be conjectured what bearing the inequality of the provisions of the various laws regulating the size of netting has on the conservation of the fisheries. Variations in the type of apparatus allowed is a subject too complicated to discuss in all its phases within the limited scope of this paper, however, and I will therefore pass on to a consideration of the quantity of apparatus used, a subject which has been recommended to conservationists for attention before but which so far has received but little.

There are no laws limiting the number of nets that may be set or the quantity of fish that may be taken in the Great Lakes. The Canadian authorities have placed definite limits on the amount of fish that may be caught annually in the important inland lakes but

have not applied such restrictions to the Great Lakes, most probably because they are so large. It is this immensity in size that sustains the general belief in the inexhaustibility of their resources. Most people believe that water is all that any fish requires and that any and all fish can survive and thrive if only there is water, but the fisherman knows that the maintenance of the fish supply is dependent on other things as well. Certain species occur only within certain depth limits, and within these limits only where certain bottom conditions obtain. Thus in Lake Superior, for example, with its area of some 32,000 square miles, there are hundreds of miles of shore line where whitefish are practically unknown, and in over one-fourth its area there occurs no marketable species of fish. Yet, in spite of this, Governments on both sides of the international boundary expend money every year planting fish in virgin waters, in which, if the fish could find suitable conditions, they most probably would have flourished from the beginning.

Even if the Great Lakes were suited throughout their extent for all kinds of fish and were they ever so much larger than they are, the supply must nevertheless just as certainly be in danger of exhaustion if at any time the bulk of the species came within human control. In the Great Lakes this dangerous control may be exerted in the case of most species during the spawning season. The individuals of the more important species congregate to spawn near the shores where bottom conditions are favorable, usually within limits which, in comparison with the normal range of the fish, are extremely restricted. During the excitement of the mating act they not only approach the bottom, and thus come within the range of influence of the nets, but they appear also to lose there awareness of the netting,[9] a faculty which protects them to some extent from capture at other times, and they are taken in an abundance unknown at other seasons.

For the benefit of those, if any such there be, who believe that the practice of commercial fishing must necessarily, in itself, deplete any body of water, I present an abstract of an article written by Dr. J. Heuscher,[10] in which he gives the history of Lake Sempach, a Swiss lake of approximately 5½ square miles area, which, under judicious control, maintained a commercial fishery on a large scale for over 400 years and which was depleted only when fishing operations were allowed to go on uncontrolled.

The lake has a maximum depth of about 47 fathoms over an area of nearly 2 miles, and limnological conditions in this lake approximate those in the Great Lakes. At one time this body of water supported immense numbers of a whitefish, related to those in our lakes. Fishing rights in Lake Sempach were legally established as early as the tenth century. In 1394 these rights came into the possession of the city of Lucerne, which disposed of them in various ways at various times, mainly in the form of leases stipulating the cession to the city of a certain percentage of the fish caught. The city's documents record the number of fish thus taken annually from 1418 to 1853. The catches varied from year to year, chiefly between 100,000 and 600,000 fish.

[9] It can not be doubted that the fish are aware of gill netting in the shallower waters. The principle of the pound net and all trap nets is based on the ability of the fish to perceive the lead, which is of a mesh large enough to permit them to swim through it uninjured. To reason further in the same strain, if they are aware of their food in deeper water they must likewise retain the capacity of sensing the presence of the netting.

[10] Swiss Fishery Journal, Vol. III, 1895.

There are still extant fishing regulations drafted in 1421 in which closed seasons, reserve zones, minimum mesh, and maximum equipment are fixed. Control over the waters relaxed, however, in 1798, and various abuses crept in. In 1825 improved apparatus supplanted the primitive gear, and in 1853, when the fishing leases were sold outright, the production was so enormous that fish were fed to the pigs. The last good year was 1856, and thereafter the supply dwindled. Drastic regulations were drafted to protect the fish, and fry were planted annually, but until about 1918 it had not been possible to restore the productivity of the lake. From 1918 to 1920, according to a letter from Dr. G. Surbeck, Swiss fish inspector at Berne, dated February 18, 1924, the production of whitefish in Lake Sempach increased considerably, and it is estimated that 35,000 to 45,000 pounds were taken annually during this period—a total probably about equal to the average annual yield of the nineteenth century. Doctor Surbeck and other investigators are of the opinion, however, that the whitefish now caught is not of the same species as that which originally inhabited the lake, but of a species which has replaced the original form. Latterly the catches have again declined markedly.

The history of the Sempach fish has more than a philosophical interest and teaches another lesson besides the obvious one. Our experience with the bluefin of Lake Superior, which has been undisturbed for from 10 to 20 years, and of the bloater of Lake Ontario, which has not been fished for in 25 years, both of which have apparently continued to decrease in abundance, closely parallels the case of this Swiss whitefish and emphasizes the danger of reducing a gregarious species below certain limits.

If, then, there is danger of exhausting the fish supply by overfishing, the production should be regulated in some manner. It is generally recognized that the taking of game must be controlled both by bag limits and closed seasons, and similar restrictions are considered necessary to preserve the game fishes. It can not, therefore, appear illogical to urge the application of the same kind of legislation to the commercial fisheries. What form such legislation should take the writer can not say. Over an area so extensive as that of the Great Lakes, which is influenced by such diverse climatic as well as physiographic conditions, no one may expect to apply a simple or uniform remedy; but, faced by the need of action, the dictates of common sense will point out a way, and these directions must not be ignored, even if they entail sacrifice on the part of some.

PROPAGATION

The work of hatching eggs of the important commercial species has been carried on more vigorously than ever in recent years. The output of species originally propagated has increased, and operations have been extended to include species previously ignored. In the stocking of streams and small lakes notable success has been achieved, and through making observations on conditions in such relatively limited areas positive evidence of the benefit of introducing fry and fingerlings has been gathered. Unfortunately there are no criteria by which we may judge the effect of propagation in the Great Lakes. There areas are so extensive and the migrations and

interrelations of the species so little known that though fish increase, or appear to increase, after extensive plants it can not be positively stated that such increase is due to planting. Enemies of the species may have decreased or the increase may have been due to natural multiplication. The fact that there are areas where whitefish are said to have increased in recent years without the aid of artificial propagation, and the fact that the sucker, perch, sauger, blue pike, chubs, and herring, in spite of the persecution they have sustained, do not make a worse showing in the statistics than the carefully fostered whitefish and trout, at least justify an attitude of skepticism toward the enthusiastic claims of some of the propagationists.

At this point it is only fair to state that the leading fish-culturists now regard artificial propagation rather as a supplement to than an improved substitute for nature, but the rank and file of the conservationists of the Great Lakes area are still influenced by the exuberant optimism of the pioneer fish-culturists, who, inspired by the novel achievement of being able to hatch countless fry, entertained rosy visions of the possibilities of the new-found art. This optimism, first and last, arises out of the natural propensity of the human mind to be impressed by figures of inconceivable magnitude. If the hatching of a billion fish eggs is reported in a hatchery bulletin, certainly, one argues, that immense number can not fail to affect the fish supply advantageously; but no statistical bulletins can show what an insignificant fraction of nature's production of fish eggs this huge figure represents, after all, and nowhere is advertised nature's amazing prodigality in dealing with these eggs, though her stupendous carelessness in this particular can be demonstrated by anyone who is familiar with mathematical progressions.

Whatever the results of fish hatching on the Great Lakes may be, confidence in the effectiveness of propagation has had most important consequences, and the methods of propagation and the effects of this confidence ought to be carefully considered. In a vast section of the Great Lakes there is no closed season on any species of fish, and for some, commercial fishing is allowed as soon as 40 per cent of the fish, as shown by test nets, are ripe. The case of the whitefish will serve to illustrate the situation.

In the year 1919 one boat which set test nets on the "north grounds" at Alpena took 5,000 pounds of whitefish, practically all males, indicating that spawning had not yet begun, since the first run on the spawning grounds consists of males. These males are often so reduced in number by uncontrolled fishing that later on it is not possible to secure enough milt to fertilize the eggs that are collected. Let us assume, however, that half of these Alpena fish were females. Then there should have been produced by this boat, in one day, 2,500 × 10,000 (the average number of eggs estimated by fish-culturists to be produced by each pound of fish), or 25,000,000 eggs. The production of whitefish on the spawning grounds at Alpena in that year was over 50,000 pounds, or a potential 250,000,000 eggs, and the "north ground" off Alpena is only one of the many places in Lake Huron where whitefish spawn. On Lake Huron alone, then, the production of whitefish eggs might have far exceeded the entire collections by all the hatcheries on both sides of the boundary. It is not necessary to state that no such quantity of eggs was collected on Lake Huron.

Most of the eggs were wasted, nor could this destruction, under the circumstances, have been avoided.

No fisherman would assert that it is possible to save more than a fraction of the spawn, since many of the fish are green or dead when taken. If the nets are caught in a blow, and blows are the rule in the fall, most of the fish taken are dead. Even under favorable conditions the fishermen, where the collection of eggs is left entirely in their hands, give first attention to handling the fish and care for the spawn afterward. Many of them know well enough that the collection of a few hundred thousand eggs a trip is quite likely to satisfy the hatchery official to whom the spawn must be surrendered, and they act accordingly.

Since the taking of whitefish from the spawning grounds was permitted everywhere on all five of the Great Lakes, but since the entire collection of eggs was equal at most to the quantity which Lake Huron would have produced if the eggs of all the fish taken could have been saved, it may be assumed then that conservationists consider that the effectiveness of the output of one lake, handled by the hatcheries, equal to that of the other lakes left to natural conditions. Furthermore, since whitefish are liberated as fry, the practice of hatching must be based on the assumption that very few eggs hatch under natural conditions. Either they are not fertilized in nature or they are destroyed after fertilization by enemies or natural forces, or both. There are no other possibilities. It can not be stated too positively that any statements made with regard to the history of the whitefish egg, or of the egg of any other Great Lakes fish, for that matter, are purely theoretical. There is not a particle of evidence to show that the eggs are not fertilized in nature, notwithstanding assertions to the contrary, and all experience with fish breeding in nature indicates that they are fertilized. As for enemies, it must be remembered that the eggs of the whitefish are deposited at a time when other fish are least active and take the minimum of food or cease feeding entirely. The scale theory, which is now well established, is based on this assumption. Besides, the eggs are laid on rough bottom, so that many must fall into crevices where they would be comparatively safe.

While it is very desirable that as many eggs as possible should hatch, it can not be conceded that with the hatching of the egg the most dangerous stage in the development of the individual has passed. We have not yet the necessary knowledge of the life history of any Great Lakes fish to enable us to state which are the critical periods in the life history. It is apparent, however, to all field workers, and to fish-culturists in particular, that an immense percentage of the young fish die before they become an inch long and many more perish before they attain double that length, else the stocking of waters with fish would be a simple matter indeed. For this reason it is essential that the question of whether fry planted by the hatcheries have as much chance of surviving as those which are hatched naturally, or whether they have any chance at all, be given consideration.

Although there is no doubt that the distribution of fry in the Great Lakes has been carried out with the best of intentions, it is nevertheless true that no one is qualified to say what are the most favorable conditions for the planting of fry, and for safety's sake they should be planted on the natural spawning grounds. In many cases this has

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been done. However, there have come to my attention too many instances of careless distribution, when fry were dumped at random into waters of any depth or even into polluted rivers. Since the hatcheries frequently are forced to rely for distribution of their products on the charity of well-intentioned but often incompetent people, perhaps better results can not be expected, but the damage done by such an irresponsible procedure can not be mended nor can the practice be condoned by any excuse, however valid.

It is also a singular fact that many people who have distributed fry never knew, or had forgotten, that a sudden change of temperature is fatal even to an adult fish, and therefore made no provision for acclimatizing the fry to their new surroundings. In the case of whitefish and trout the water in the lakes at the time of planting is probably nearly at zero, and if the fry were iced in the cans they would be subjected to no great change in temperature, but when plants are made at other times abrupt changes of temperature should be most carefully guarded against.

A further consideration, which has been neglected, concerns the proper time for making plants. It is not practicable to feed the fry, but they can be retained without food without heavy mortality for some time after hatching, though it is not known what the consequences of such retention are. In some young animals feeding instincts atrophy if they are not exercised within a certain period, and it is not inconceivable that the withholding of food from fish fry for even a day at the critical time may be fatal.

To recapitulate, the practice of propagating whitefish or other Great Lakes species is not in itself condemned, but an effort has been made to show that the present system of permitting fishing during the spawning season is vastly wasteful. No one may safely affirm that the relatively few eggs that are artificially hatched—few in comparison with the numbers destroyed in the effort to collect them—can compensate for the benefits that might be derived if all the fish were allowed to spawn naturally. Particular force is lent to this argument by the fact that we now know absolutely nothing about the percentage of eggs hatched under natural conditions and nothing about the proper attention fry should receive after they have been hatched. It follows, then, that nature should not be interfered with blindly, lest more harm than good be done, a maxim the soundness of which, as applied to certain species, fish-culturists have already subscribed to. The closed season during spawning time should be restored at once, and studies into the effectiveness of propagation should be begun without delay. The collection of such spawn as is thereafter deemed necessary should be under the supervision of State and Federal authorities.

RECOMMENDATIONS

1. The needs of the Great Lakes fisheries should be studied, and in the light of the knowledge gained regulations having for their object the conserving of the fisheries should be created. We already have data to show that no single law can be devised to meet the varying conditions presented by one lake, to say nothing of applying one law to several of the lakes. The application of any laws found advisable must be independent of political boundaries. The present division of authority over the fisheries among several States impedes the enactment and complicates the administration of any legislative provisions, and it is therefore urgently recommended that some definite and responsible organization, international in character, be provided through which a coordinated control of the fisheries may be secured.

2. The closed season to protect spawning fish should be restored wherever practicable, and no spawn should be collected if investigations and experiments fail to establish the desirability and effectiveness of propagation.

3. Investigations to determine the life histories of the important species already begun should be continued, and statistics reflecting the condition of the fisheries should be collected from year to year to supplement these studies. Only by means of such statistics, interpreted in the light of life-history facts, can the fishing industry be intelligently controlled.

SCIENTIFIC NAMES OF FISHES

The following are the scientific names of the species of fish mentioned in the text:

Alewife	*Pomolobus pseudoharengus.*
Black bass (largemouth)	*Micropterus salmoides.*
Black bass (smallmouth)	*Micropterus dolomieu.*
Bloater (of Lake Ontario only), Bluefin (of Lake Superior only), Blackfin (of Lakes Michigan and Huron)	*Leucichthys nigripinnis.*
Bowfin	*Amia calva.*
Buffalofish	Ictiobus (species).
Carp, German	*Cyprinus carpio.*
Catfish, including bullheads	Ameiurus (species). / *Ictalurus punctatus.*
Chubs	Leucichthys (species).
Eel	*Anguilla rostrata.*
Gizzard shad	*Dorosoma cepedianum.*
Goldfish	*Carassius auratus.*
Herring, lake	*Leucichthys artedi.*
Longjaw	*Leucichthys alpenæ.*
Lawyer	*Lota maculosa.*
Menominee	*Prosopium quadrilaterale.*
Mooneye	*Hiodon tergisus.*
Pike	*Esox lucius.*
Rock bass	*Ambloplites rupestris.*
Salmon, Atlantic	*Salmo salar.*
Sauger	*Stizostedion canadense griseum.*
Shad	*Alosa sapidissima.*
Sheepshead	*Aplodinotus grunniens.*
Smelt	*Osmerus mordax.*
Sturgeon	*Acipenser fulvescens.*
Sucker, sturgeon-nosed	*Catostomus catostomus.*
Sucker, white	*Catostomus commersonii.*
Sunfishes	Centrarchidæ (species).
Trout, lake (ciscowet, fat trout)	*Cristivomer namaycush.*
Trout, steelhead	*Salmo irideus.*
Wall-eyed pike (blue pike, yellow pike)	*Stizostedion vitreum.*
White bass	*Roccus chrysops.*
Whitefish	*Coregonus clupeaformis.*
Yellow perch	*Perca flavescens.*

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