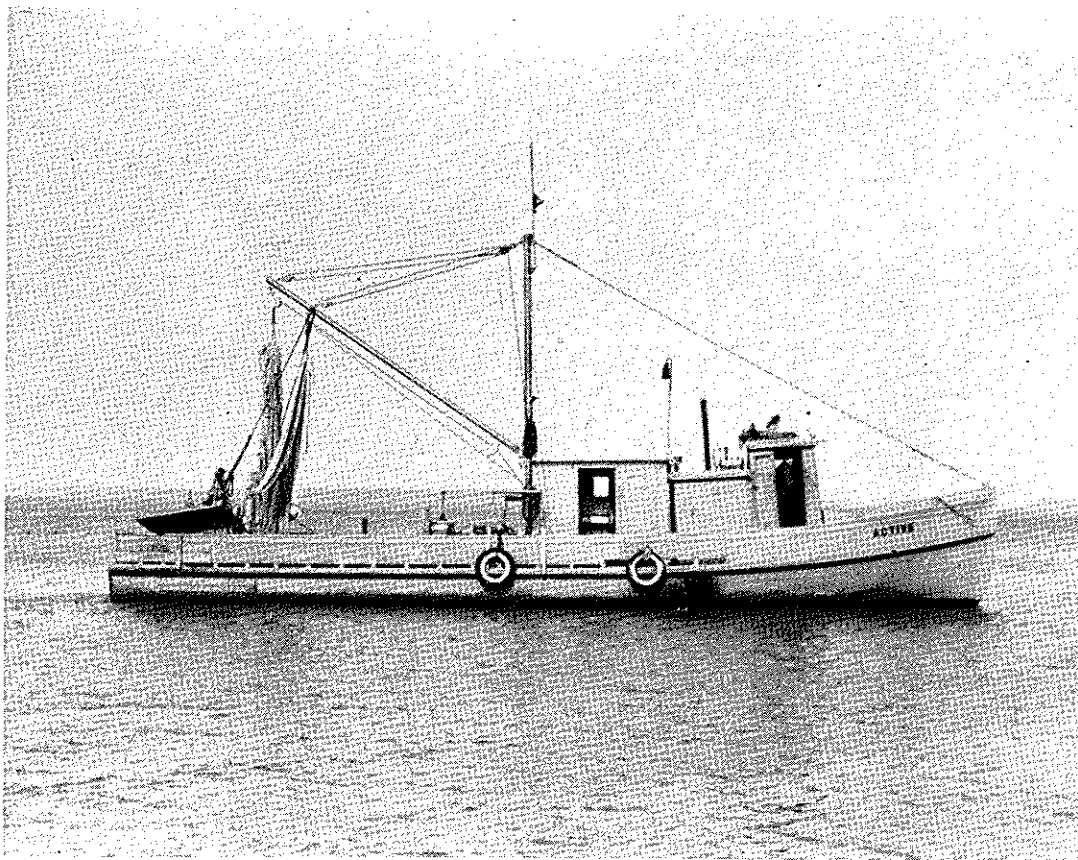


NOT FOR CIRCULATION

→ **DISCARDED** MAY 21 1968

**ECONOMIC REVIEW of the
GREAT LAKES COMMERCIAL
FISHERIES, 1940-59**



**UNITED STATES DEPARTMENT OF THE INTERIOR
Fish and Wildlife Service
Bureau of Commercial Fisheries**

CIRCULAR 141

Cover: U. S. Fish and Wildlife Service exploratory vessel *Active* on Lake Erie.

UNITED STATES DEPARTMENT OF THE INTERIOR, Stewart L. Udall, *Secretary*
FISH AND WILDLIFE SERVICE, Clarence F. Pautzke, *Commissioner*
BUREAU OF COMMERCIAL FISHERIES, Donald L. McKernan, *Director*

ECONOMIC REVIEW OF THE GREAT LAKES COMMERCIAL FISHERIES

1940-59

by

Keith D. Brouillard
Commodity Industry Economist
Bureau of Commercial Fisheries
U.S. Fish and Wildlife Service
Ann Arbor, Michigan



United States Fish and Wildlife Service
Circular 141

Washington, D. C.
1963



Catch of Lake Michigan chubs by a converted gill net tug. *Courtesy of Vern Arendt.*

CONTENTS

	Page
Introduction.....	1
Production	1
Production by gill nets	2
Production by trap nets	3
Production by pound nets	4
Species substitution in production.....	4
Production trends for selected species.....	6
Imports of fresh-water fish.....	8
Operating units and costs.....	9
Marketing:	
Markets.....	12
Prices.....	14
Wholesale	14
Retail.....	17
New developments:	
Processing.....	17
Production methods	18
Biological research	18
Conclusions and recommendations.....	19
Acknowledgment.....	19
Selected references	20

FIGURES

	Page
1. Monthly landings of smelt in Michigan as percent of total, 1956-57.....	4
2. Production of blue pike, Ohio waters, Lake Erie, 1944-58.....	5
3. Production of walleye, Ohio waters, Lake Erie, 1944-58.....	5
4. Annual catch by groups of species, 1940-59.....	6
5. United States Great Lakes smelt production and prices, 1930-59.....	6
6. United States Great Lakes production of chubs and lake trout, 1940-59.....	7
7. Annual production of blue pike and walleye combined, compared with yellow perch, 1940-59	7
8. Total supply, domestic production, and U.S. ex-vessel price for lake trout, 1940-59....	8
9. Total supply, domestic production, and U.S. ex-vessel price for whitefish, 1940-59....	8
10. Index of prices paid by fishermen in the Great Lakes area for items used in production and family maintenance, 1940-58; 1942 100	10
11. Parity ratio for lake trout and whitefish, 1940-58; 1942 100	11
12. Parity ratio for yellow perch and chubs, 1940-58; 1942 100.....	11
13. Chicago wholesale market receipts of fresh-water fish, salt-water fish, and shrimp, 1940-59	13
14. Price range for Canadian and domestic walleye at Chicago wholesale market, 1947-59.	16
15. Price ranges for Canadian and domestic lake trout at Chicago wholesale market, 1947-59	16
16. Price range for Canadian and domestic whitefish at Chicago wholesale market, 1947-59	17
17. Average annual retail price for walleye and whitefish, 1950-57.....	18
18. Shaded area shows location of one-third of the ranch mink of the United States, 1957...	18

ABSTRACT

Economic developments in the Great Lakes commercial fisheries since 1940 are examined, and catch, principal types of gear, marketing, and recent developments in the fishery are reviewed.

In a section on recommendations, the necessity for expanded research in fishing methods and marketing of the presently underutilized species is pointed out, consideration of fishermen's cooperatives is suggested, use of available species in new products is discussed, and cooperation among all research agencies is indicated to be a requirement if the fishing industry is to expand and strengthen its economic position.

ECONOMIC REVIEW OF THE GREAT LAKES COMMERCIAL FISHERIES, 1940-59

by Keith D. Brouillard

INTRODUCTION

Historically the Great Lakes fisheries have been a principal source of commercial fresh-water fish for the United States. In recent years the species composition of the catch has changed, and the financial position of the fishery has declined.

A research program to obtain basic data on the economic condition of the fisheries was started by the Bureau of Commercial Fisheries. Elementary research on the production, imports, and marketing of fresh-water fish was necessary as a first step in the development of the program. The present report is the result of this review of the Great Lakes fisheries. Much of the information found can be used as a basis for future studies.

The physical limits of time, personnel, and funds restricted the study to the primary economic factors of the fishery, so detailed information on each commercial species of fish or on all types of commercial gear is not presented.

PRODUCTION

The catch in the commercial fisheries of the Great Lakes was quite stable from 1940 until relatively recent years. The fluctuations that have occurred were to be expected in an enterprise such as commercial fishing.

After 1957 the volume of production indicated that some permanent changes in the commercial fishery might be developing. Compared with 1956, the landings decreased by 5.1 million pounds in 1957, by 8.1 million pounds in 1958, and by 14.8 million pounds in 1959.

An additional picture of the trends in the fishery is indicated by the average price per pound for landings (table 1). Beginning in 1942 the average value of a pound of fish produced increased because of shortages of meat products during World War II. In this respect the Great Lakes fisheries followed the trends of the

salt-water fisheries. The total value of the production and the average price per pound remained at a rather high level during the following decade. In 1953 the value of the production fell below \$10 million, and the price per pound was under 13.0 cents. At the average price of 10.8 cents per pound received for the 1959 catch, it would be necessary for the Great Lakes production to reach a volume of over 90 million pounds to produce a return of \$10 million.

A decline in the price per pound for the total catch could mean either that the species composition of the catch has changed or that the value of the individual species has dropped. Studies of catch and price by species indicate that a change in the species composition is the cause of the decline.

Table 1.--Quantity, value, and average price, U.S. Great Lakes fisheries, 1940-59

Year	Quantity	Value	Average price
	<i>Million pounds</i>	<i>Million dollars</i>	<i>Cents per pound</i>
1940	79.1	5.6	7.1
1941	78.1	6.5	8.3
1942	75.2	8.6	11.4
1943	78.2	12.3	15.7
1944	75.7	10.9	14.4
1945	78.6	13.8	17.6
1946	78.3	11.7	14.9
1947	69.8	10.7	15.3
1948	84.0	12.7	15.1
1949	85.7	11.5	13.4
1950	70.9	10.8	15.3
1951	70.1	10.7	15.2
1952	81.8	11.5	14.0
1953	77.3	9.6	12.4
1954	81.2	10.0	12.3
1955	76.8	9.7	12.6
1956	80.6	10.2	12.6
1957	75.5	9.6	12.7
1958	71.7	8.7	12.1
1959	65.8	7.1	10.8

Table 2.--U.S. Great Lakes catch of specified species, 1940-59

Year	Blue pike	Chubs	Herring	Lake trout	Carp	White-fish	Yellow perch	Walleye
	<i>Thousand pounds</i>	<i>Thousand pounds</i>	<i>Thousand pounds</i>	<i>Thousand pounds</i>	<i>Thousand pounds</i>	<i>Thousand pounds</i>	<i>Thousand pounds</i>	<i>Thousand pounds</i>
1940	5,073	2,411	22,480	9,859	5,998	4,678	6,451	6,072
1941	3,384	2,283	22,820	10,534	5,376	4,693	6,716	5,181
1942	6,261	2,337	18,777	10,174	5,000	4,184	5,223	5,589
1943	11,273	2,776	17,920	10,376	5,053	3,315	5,416	5,352
1944	14,989	3,197	16,899	10,604	4,317	3,248	5,703	5,139
1945	7,849	4,666	22,290	8,980	6,460	3,529	3,273	6,604
1946	3,141	4,621	26,809	7,457	4,838	4,892	4,554	7,851
1947	3,328	5,362	18,930	5,402	4,130	11,631	3,540	5,128
1948	9,122	6,298	24,634	4,155	4,178	12,250	4,919	5,248
1949	14,085	7,732	22,068	3,309	4,568	8,837	4,595	7,116
1950	6,236	9,413	17,454	3,255	4,209	5,270	4,851	7,856
1951	2,402	10,529	20,333	2,928	5,054	2,761	4,355	6,704
1952	7,239	11,252	23,505	2,843	5,759	3,782	4,559	6,386
1953	8,103	11,343	18,581	2,423	5,467	2,992	6,140	7,164
1954	6,361	10,999	20,777	2,257	6,543	2,830	8,293	6,908
1955	7,679	11,367	16,589	2,101	6,547	1,999	7,066	7,205
1956	6,867	11,430	16,330	1,813	6,504	1,716	11,181	8,004
1957	3,993	11,318	14,810	1,191	7,128	1,413	12,293	6,346
1958	580	12,108	12,293	1,061	8,344	695	10,935	4,482
1959	35	11,212	12,512	868	7,274	629	11,731	2,190

The nature of the change is indicated by the landings of the eight species of fish shown in table 2. Since the 1940's, blue pike, lake trout, walleye (yellow pike), and whitefish have been considered the most valuable species. Of these four species, only landings of walleye have been maintained near the production levels of the 1940's. The factors that have caused the decline in the catch of the other species will be discussed in the following pages.

Production by Gill Nets

Since 1940 the Great Lakes fisheries have relied on three major types of gear--gill net, trap net, and pound net--depending on the location of the fishery and the species being exploited.

The gill net has been the most important single type of gear in operation on the Great Lakes (table 3). Formerly this gear was used in the capture of lake trout and whitefish in Lakes Huron, Michigan, and Superior. When the populations of these fish declined, the fishermen changed to taking chubs and, to some extent, yellow perch.

Of the types of gear operated on the Great Lakes the gill net is probably the most inefficient. No mechanical method is used in the

Table 3.--Quantity, value, and price of fish caught by U.S. gill nets in the Great Lakes, 1940-59

Year	Quantity	Value	Average price
	<i>Pounds</i>	<i>Dollars</i>	<i>Cents per pound</i>
1940	37,230,600	2,829,472	7.6
1941	39,272,500	3,501,468	8.9
1942	36,061,900	4,471,816	12.4
1943	37,881,200	6,433,362	17.0
1944	38,195,900	6,287,939	16.5
1945	39,291,400	7,848,588	20.0
1946	37,653,100	5,641,776	15.0
1947	31,800,600	4,881,645	15.4
1948	39,917,500	6,031,689	15.1
1949	33,148,600	5,738,172	17.3
1950	35,179,300	5,502,294	15.6
1951	37,797,900	5,372,722	14.2
1952	43,524,500	6,182,300	14.2
1953	36,778,500	4,958,202	13.5
1954	39,728,400	5,167,029	13.0
1955	39,316,500	5,262,510	13.4
1956	38,891,400	5,548,072	14.3
1957	36,337,700	5,450,883	15.0
1958	35,310,200	5,210,062	14.8
1959	30,738,500	4,275,969	13.9

Table 4.--Quantity of gill net of various mesh size used in the Great Lakes by U.S. fishermen during specified years from 1940 to 1959

Year	Small mesh 1 1/4 to 3 7/8 inches	Large mesh 4 to 7 inches	Extra large mesh 7 1/8 to 14 inches
	<i>Square yards</i>	<i>Square yards</i>	<i>Square yards</i>
1940	9,855,000	18,722,000	12,000
1950	12,842,000	17,222,000	339,000
1954	11,966,000	14,319,000	93,000
1955	8,764,000	8,469,000	70,000
1956	8,122,000	8,093,000	174,000
1957	7,390,000	6,843,000	155,000
1958	7,635,000	5,742,000	184,000
1959	8,346,700	5,465,800	203,100

Great Lakes for separating a gilled fish from the net, and this entire operation is performed manually. Obviously, the price received for fish caught by this method must be high and the size of individual fish large if a profit is to be obtained. The number of fish that must be handled now is much greater than before. In the fishery on Lake Michigan, large volumes of small chubs (bloaters¹) become entangled in the nets. The market price for these small chubs has been about 2 5 cents per pound; and since it takes approximately six to make a pound, there is little or no profit in the operation. Therefore, these fish are not usually landed. The apparent substantial increase in the bloater population in Lake Michigan has reduced the margin of profit in gill net operations.

In addition, many fishermen have reported that during certain seasons of the year, alewives become entangled in the gill nets in such numbers that operations are stopped until this species has left the grounds. The alewife is particularly difficult to remove from gill nets because of its "saw-belly." Recent prices for alewives, if they can be sold at all, have failed to cover the cost of removal from the nets.

The smelt, which become entangled in the gill net by their teeth, is the third species that causes difficulty in gill net operations. Generally the price for smelt during the seasons when they disrupt gill net operations is too low to cover the cost of removal.

Production by Trap Nets

The trap net is the second most important gear in the commercial fisheries of the Great Lakes. It has been most used on Lake Erie and has also been used extensively in certain

other shallow-water areas, such as Saginaw Bay and northern Green Bay.

The return per pound of fish in the trap net fishery has been reasonably good. In 1959, however, the average price dropped to less than 10 cents per pound (table 5). The Lake Erie fishery has been hampered by a decline in the populations of walleye and blue pike, and, in substituting for these species, fishermen have on occasion glutted the market with perch. At times, owing to low prices, fishermen would lose money by operating and so were forced to discontinue until the market improved. These interruptions decrease the gross profits.

Table 5.--U.S. catch of fish in trap nets in the Great Lakes, 1940-59

Year	Quantity	Value	Average price
	<i>Pounds</i>	<i>Dollars</i>	<i>Cents per pound</i>
1940	20,667,300	1,557,000	7.5
1941	21,013,100	1,727,800	8.2
1942	22,683,000	2,597,900	11.5
1943	23,941,100	3,612,600	15.1
1944	24,434,400	2,912,700	11.9
1945	21,229,600	3,364,900	15.9
1946	21,579,700	3,558,900	16.5
1947	20,297,900	3,685,800	18.2
1948	26,324,900	4,248,900	16.1
1949	28,199,500	3,732,900	13.2
1950	21,489,700	3,705,000	17.2
1951	18,980,500	3,818,100	20.1
1952	22,831,800	3,777,200	16.5
1953	24,556,500	3,330,000	13.6
1954	23,293,300	3,407,000	14.6
1955	20,458,500	3,162,900	15.5
1956	23,727,200	3,438,400	14.5
1957	20,904,900	3,073,100	14.7
1958	15,011,200	2,336,100	15.6
1959	14,633,400	1,423,922	9.7

¹"Bloater" is the name fishermen commonly give to all small chubs (*Coregonus* sp.). The true bloater is *Coregonus hoyi* (Gill).

The change in fish populations has resulted in a deterioration of the trap net fishery. It is possible that the abundance of walleyes will increase in Lake Erie, resulting in greater gross income to the trap net fishery there.

Production by Pound Nets

The pound net fishery is made up of several fisheries that generally employ these nets for a specific species of fish. Data are not available for each of these fisheries, so they must be taken as a unit.

The volume of fish caught with pound nets has increased in recent years. The statistics presented in table 6 indicate a decrease in the price per pound and in the total value. The increased volume of, and lower price for, the pound net fish are the result of the production of smelt in Green Bay. The smelt fishery, however, is extremely seasonal (fig. 1) and smelt are not available to this gear during a large part of the year. It is therefore doubtful that a profit can be maintained from year-round operations.

Table 6.--U.S. catch of fish by pound nets in the Great Lakes, 1940-59

Year	Quantity	Value	Average price
	Pounds	Dollars	Cents per pound
1940	7,715,300	432,800	5.6
1941	6,412,600	490,700	7.7
1942	5,303,600	591,800	11.2
1943	4,948,900	878,800	17.8
1944	3,133,500	705,600	22.5
1945	5,190,300	1,076,400	20.7
1946	7,868,300	1,163,400	14.8
1947	8,804,300	1,182,500	13.4
1948	9,903,300	1,569,600	15.8
1949	8,320,300	1,239,300	14.9
1950	7,809,400	1,004,500	12.9
1951	5,807,500	673,200	11.6
1952	7,949,200	820,800	10.3
1953	8,211,100	662,300	8.1
1954	9,159,900	721,500	7.9
1955	8,035,900	551,200	6.9
1956	9,322,600	567,300	6.1
1957	7,796,200	356,200	4.6
1958	11,114,000	407,800	3.7
1959	7,886,100	357,441	4.5

The pound net fishery can be expected to continue operating with a very narrow margin of profit. Improvement of its financial position depends upon the type and extent of changes in the fish populations of the Great Lakes. An increase of whitefish would permit production over a longer period of time and a higher re-

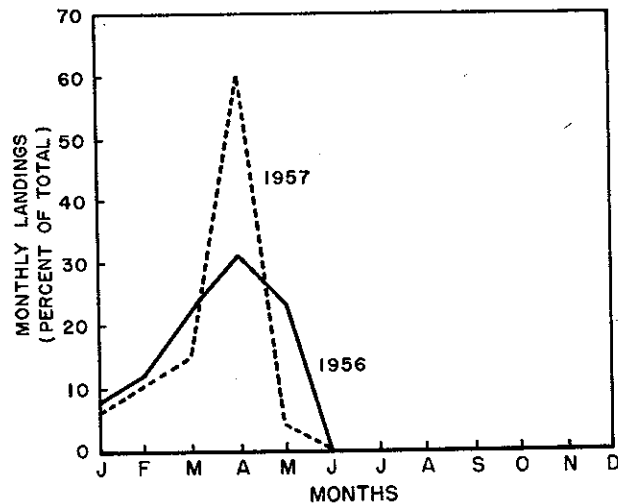


Figure 1.--Monthly landings of smelt in Michigan as percent of total, 1956-57.

Source: Michigan Department of Conservation, Biennial Report 1958.

turn per pound of fish for the entire fishery. As was stated earlier this operation would not be the same type as in the smelt fishery and would require different gear located in different areas.

Species Substitution in Production

The sea lamprey has largely destroyed the fishery for lake trout in Lakes Huron and Michigan and is rapidly depleting the stocks in Lake Superior. In addition, the fluctuations occurring in the population of whitefish because of lamprey attacks and other causes have resulted in a decline in the landings of whitefish.

Blue pike and walleyes are commercial fish of front-rank importance. Both species are subject to fluctuations in abundance from year to year. The fluctuations in blue pike abundance have been much greater than those for walleyes. For example, figure 2 indicates the extreme variations in blue pike catches. Assuming that fishing effort is about equal for each year, this catch variation is the result of year-class strength. Figure 3 indicates similar fluctuations in walleye spawning success. Preliminary biological studies confirm these variations.

In an effort to continue fishing operations in the Great Lakes, the fishermen have increased exploitation of the lower priced species, to some extent, as substitutes for the preferred species. The most important species now being harvested are chubs, carp, smelt, and yellow perch. These fishes are plentiful, but some are

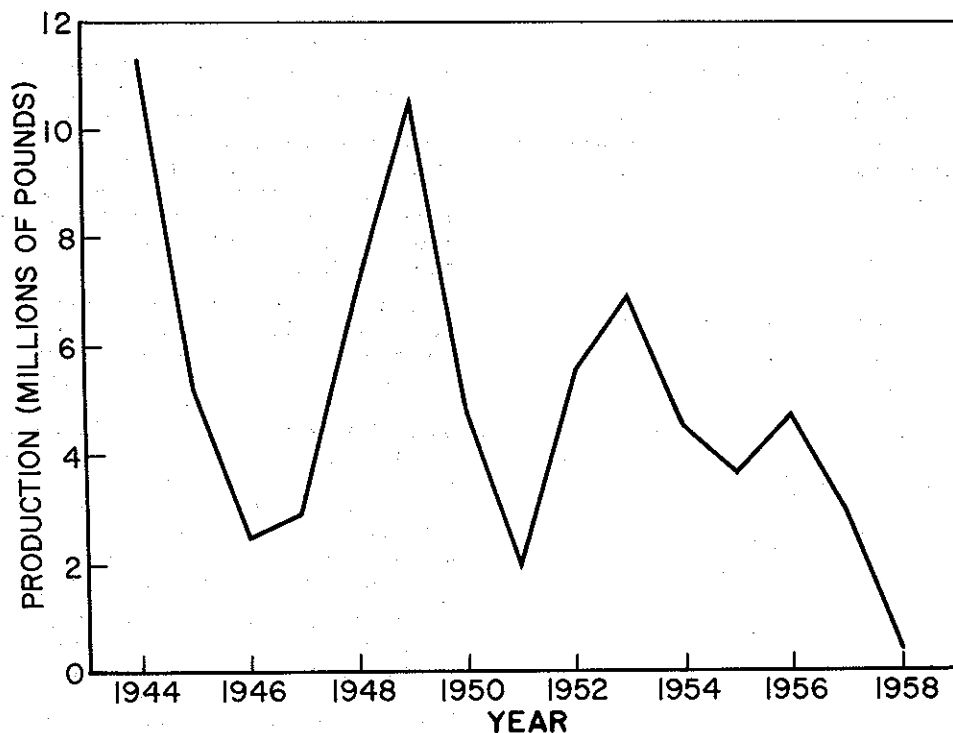


Figure 2.--Production of blue pike, Ohio waters, Lake Erie, 1944-58.

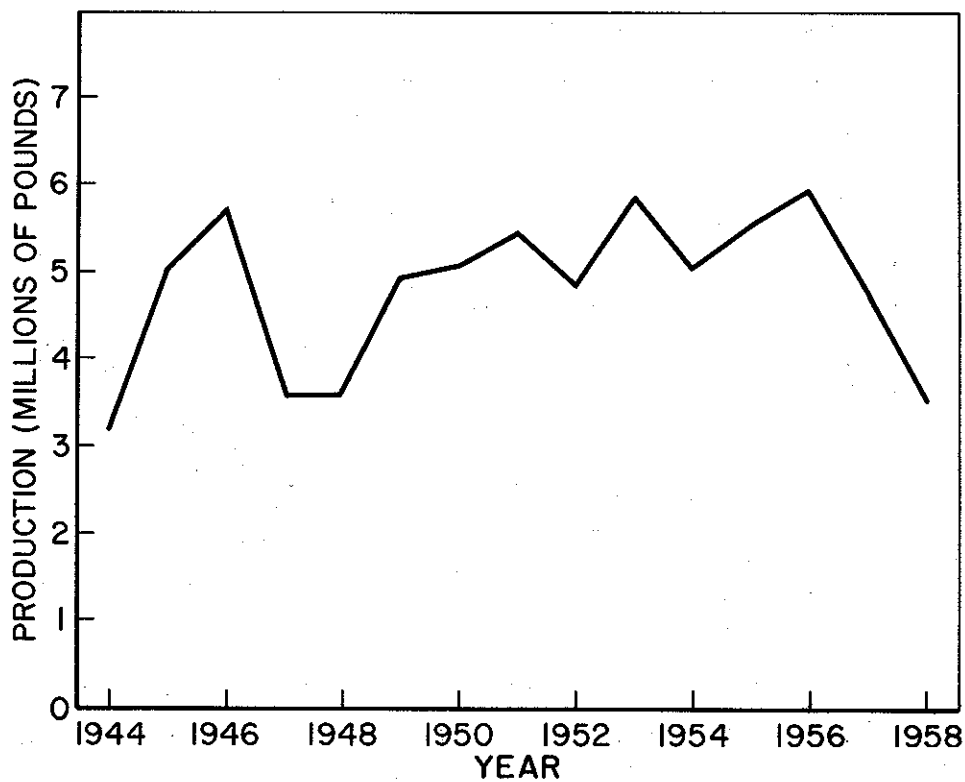


Figure 3.--Production of walleye, Ohio waters, Lake Erie, 1944-58.

small, difficult to handle, or low priced. The change in the volume of the catch by groups of species is shown in figure 4. The fishes comprising these two groups have been selected in order to compare the quantity of preferred species caught with the catch of the lower priced species.

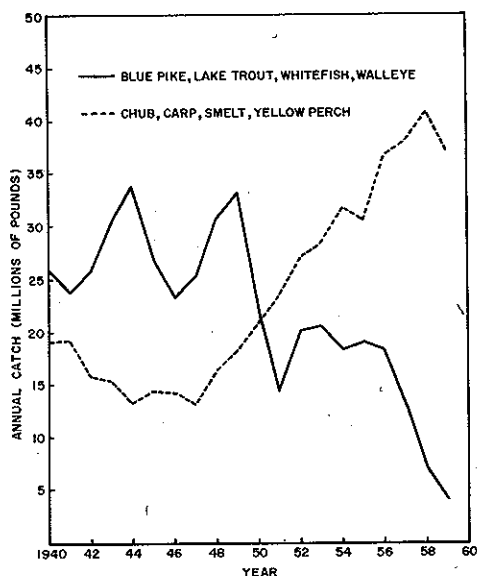


Figure 4.--Annual catch by groups of species, 1940-59.

The increase in chub landings in Lakes Huron and Michigan has been attributed to the disappearance of lake trout. Formerly, laketrout utilized chubs as source of food. As the lake trout was eliminated by the sea lamprey, populations of chub increased. Unfortunately, the sea lamprey appears also to have attacked the larger chubs (Hile and Buettner, 1955), thereby reducing the profits in the gill net fishery for this species.

Landings of carp have increased in recent years probably as a result of the efforts of commercial fishermen to remain in operation. Generally the market for carp is unable to absorb all of the possible catch of this species. The Mississippi River and many inland lakes yield large quantities of carp, which catch competes with that of the Great Lakes. To some extent the Great Lakes catch of carp is utilized by the mink ranchers in the Midwest, but this market pays a low price and the fishermen have difficulty in making a profit.

The large catch of smelt (fig. 5) is undoubtedly the result of a tremendous increase in the population of this species and the decrease of certain others. Although the price has declined as the production has increased, it can be assumed that many fishermen are depending upon the income from the catch of smelt as a substitute for earnings from several of the preferred species.

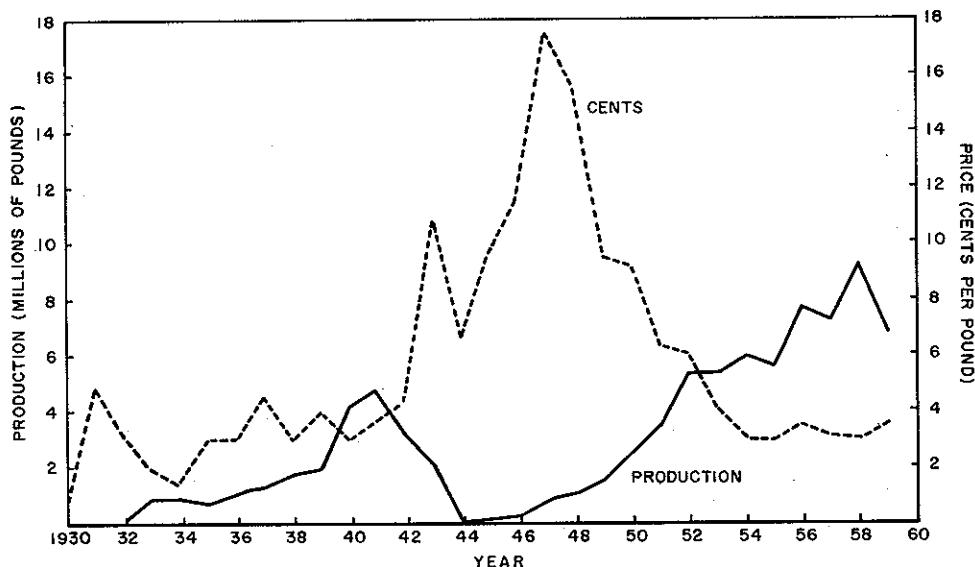


Figure 5.--U. S. Great Lakes smelt production and prices, 1930-59.

Yellow perch have been landed in increasing quantities because of their availability, and, in Lake Erie especially, because of the decline in blue pike and walleyes. In recent years yellow perch have become an important source of income to fishermen.

Production Trends for Selected Species

The apparent leveling off of the chub production, beginning with 1952, is probably the result of marketing problems and the decrease in availability of market-size chubs. The

lowered abundance of the large chubs can be attributed in part to sea lamprey depredation. Another factor in the decreasing size is increased commercial exploitation of the larger chubs (Hile and Buettner, 1955).

Fishermen are now landing smaller chubs, but the total volume of production is at a high level (fig. 6). Labor costs in the handling of smaller fish, at both the fishermen's level and the smokers' level, result in lower profits from these operations.

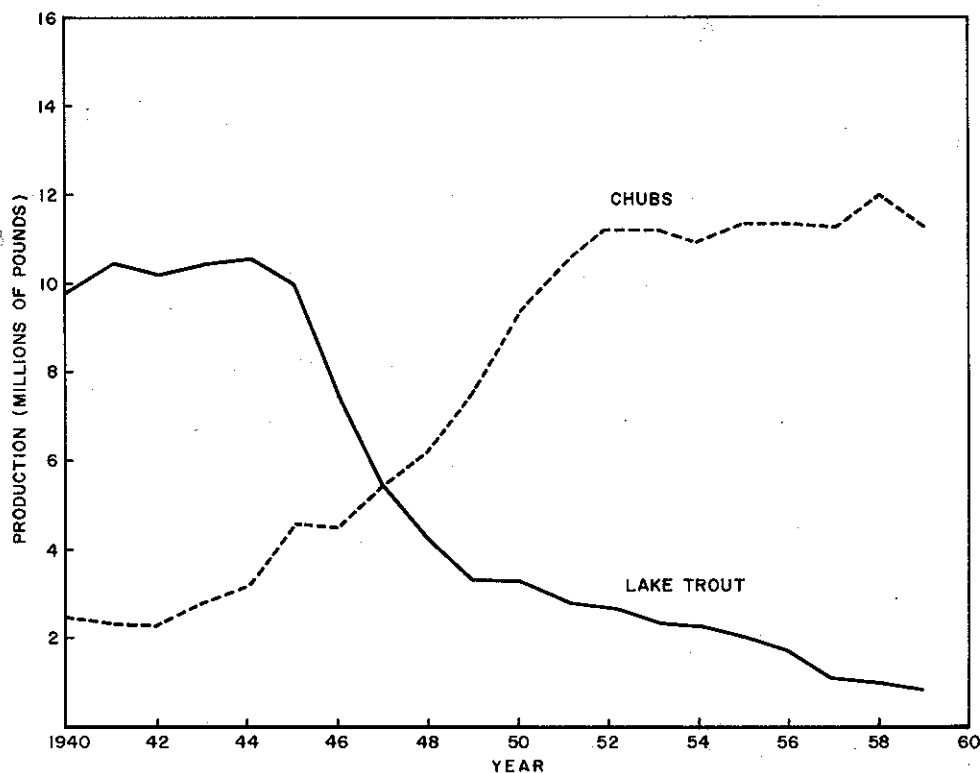


Figure 6.--U.S. Great Lakes production of chubs and lake trout, 1940-59.

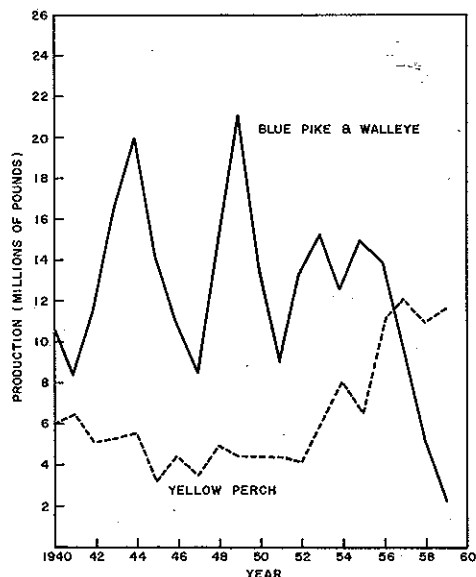


Figure 7.--Annual production of blue pike and walleye combined, compared with yellow perch, 1940-59.

A comparison of the production of blue pike and walleye with that of yellow perch (fig. 7) indicates the role of the latter as a substitute fish. In recent years, yellow perch landings have increased, while the landings of the other two species have declined.

The landings of yellow perch may not be a true indication of the population because many fishermen do not take this species when prices are low. Records of the fishing effort reveal that in the Saginaw Bay area, perch are not fully exploited (Hile and Buettner, 1959). It is believed that this situation is true for the entire yellow perch fishery.

The prices received by fishermen in the Great Lakes commercial fisheries have tended to increase with the decrease in domestic production. This inverse relationship between the price and quantity produced is clearly indicated in figures 8 and 9. In these figures the production and price curves, as well as the curve for total supply (imports plus domestic production), for lake trout and whitefish demonstrate that, in general, the prices for these

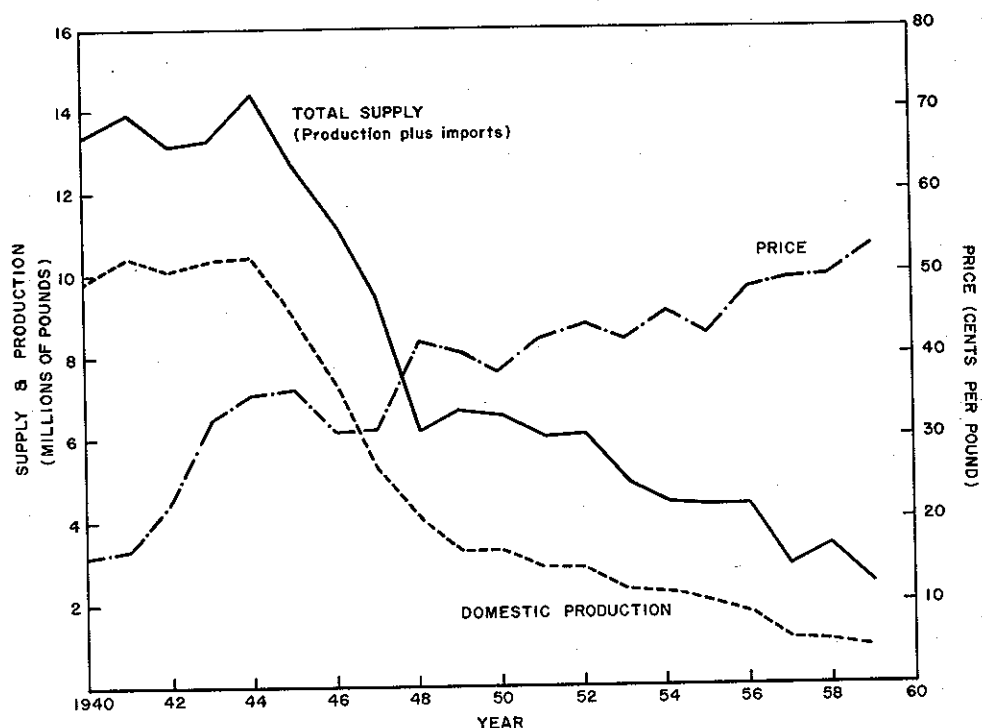


Figure 8.--Total supply, domestic production, and U.S. ex-vessel prices for lake trout, 1940-59.

species have increased when domestic production decreased. The price trends in recent years for lake trout, however, cannot be explained entirely on the basis of supply and demand. Almost the entire production of this species is now purchased by public eating establishments. As a result of this specialized demand, the product is not readily available to the general public in retail outlets such as supermarkets and fish specialty stores. Under these conditions the price curve would not follow the same pattern as that for some other fishes.

Imports of Fresh-Water Fish

Figures 8 and 9 bring out the importance of imports of lake trout and whitefish. Imports of these two species now supply a greater part of the United States market than does the domestic production. The implications of this situation have been discussed earlier (Brouillard, 1960). In general, because of the low domestic production, it can be assumed that imports of both lake trout and whitefish are not now inimical to our domestic fishermen's long-term interests. If the present program of lamprey control reaches the point at which lake trout and whitefish are able to repopulate the Great Lakes, many problems relating to imports can be expected to develop.

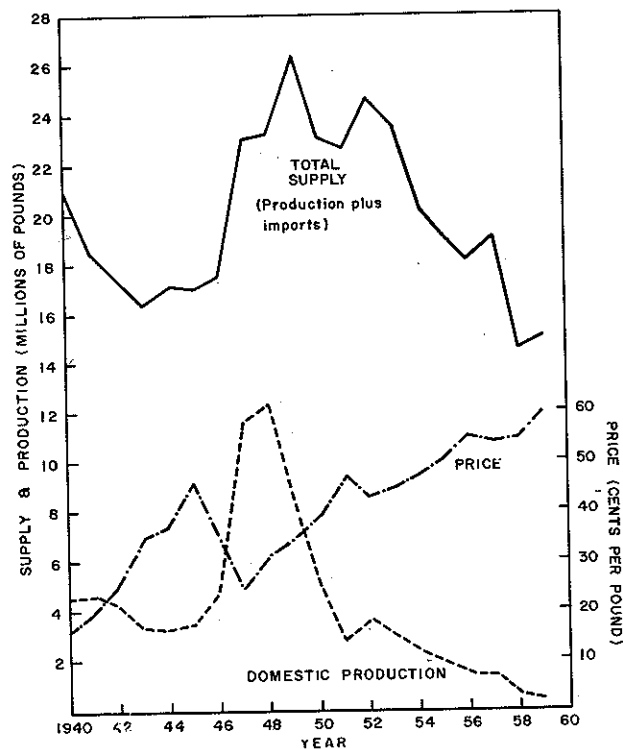


Figure 9.--Total supply, domestic production, and U.S. ex-vessel price for white fish, 1940-59.

Table 7.--Imports of selected species of fresh-water fish, 1940-59

Year	Blue pike	Chubs	Lake herring	Lake trout	White-fish	Sauger	Yellow Perch	Walleye
	<i>Thousand pounds</i>	<i>Thousand pounds</i>	<i>Thousand pounds</i>	<i>Thousand pounds</i>	<i>Thousand pounds</i>	<i>Thousand pounds</i>	<i>Thousand pounds</i>	<i>Thousand pounds</i>
1940	1,487	1,450	1,732	3,656	16,020	12,683	3,274	8,169
1941	1,227	1,820	1,192	3,490	13,741	12,642	3,615	8,225
1942	2,765	1,132	1,053	3,033	13,104	11,513	2,502	9,230
1943	6,672	966	1,191	3,016	13,015	7,226	2,176	11,048
1944	5,224	887	1,243	3,890	13,882	5,889	2,221	12,056
1945	3,725	796	6,872	3,781	13,362	6,137	2,629	11,842
1946	1,284	172	10,370	3,866	12,654	5,383	3,124	11,487
1947	1,158	345	4,698	3,960	11,371	3,895	3,217	10,848
1948	763	509	1,991	2,903	10,998	1,932	817	8,782
1949	1,284	485	728	3,495	13,738	2,723	809	7,977
1950	796	288	718	3,464	13,525	4,539	711	7,826
1951	581	318	413	3,184	14,940	3,522	726	9,351
1952	444	160	400	3,392	14,794	2,382	965	8,566
1953	226	212	377	2,607	14,876	1,629	1,169	6,712
1954	3	¹ 348	(¹)	2,213	10,386	720	203	4,070
1955	47	¹ 351	(¹)	2,298	10,161	1,065	352	3,387
1956	29	¹ 262	(¹)	2,537	10,761	1,150	207	3,845
1957	23	¹ 260	(¹)	1,748	12,066	2,051	84	3,452
1958	30	¹ 720	(¹)	2,298	13,968	2,575	189	5,624
1959	20	¹ 1,142	(¹)	1,628	14,365	2,108	379	5,652

¹ Herring and ciscoes included with chubs.

Imports of several species of fresh-water fish other than lake trout and whitefish (table 7) are competing with the domestic production in the Great Lakes area. An important development has been the trend toward imports of processed products. The volume of imported fillets from fresh-water species has increased greatly in recent years.

Table 8.--Imports of fresh-water fish fillets from Canada, 1949-59

Year	Quantity
	<i>Million pounds</i>
1949	7.8
1950	7.8
1951	7.8
1952	9.1
1953	11.1
1954	13.1
1955	14.1
1956	16.4
1957	17.0
1958	14.3
1959	15.6

Because of the extensive commercial fisheries for these same species in the many inland lakes of Canada, it is possible for Canadians

to export fresh-water fish even when production in the Great Lakes is low. The largest single fishery of this type is on Great Slave Lake, which yields about 9 million pounds annually. In addition, other larger and several thousand smaller lakes in Canada are being exploited. Since the Canadian inland fishery appears to be well managed, a substantial harvest can be expected indefinitely. Exports to the United States could continue and would be a factor in the price trends for domestic products.

Operating Units and Costs

The general decline of the Great Lakes fisheries is reflected in the decrease in operating units and employment. The reduction in the number of vessels and boats in the Great Lakes fisheries, compared to 1950, is shown in table 9. Reduced landings, age of vessels, and increased cost of gear cause an inevitable reduction in operating units. Few vessels have been replaced since 1950. A sample of 40 gill net vessels operating in the chub fishery in the Michigan waters of Lake Michigan revealed that only 6 of them had been built since 1950. Twelve of the vessels were constructed prior to 1930. If this sample is indicative of the entire fishery, it is obvious that many of the vessels may not be in efficient operating condition and some may even be dangerous to continue in operation.

Table 9.--United States Great Lakes operating units, specified years

Unit	1940	1950	1954	1955	1956	1957	1958	1959
Number of vessels	¹ 499	661	654	596	577	521	555	511
Vessel net tonnage	¹ 6,073	7,864	7,822	7,111	6,657	6,251	6,768	6,390
Number of boats								
Motor	1,186	1,437	1,164	1,083	887	968	1,059	1,013
Other	599	373	371	296	272	247	255	173
Accessory		191	211	182	166	151	146	137
Total number of boats	1,785	2,001	1,746	1,561	1,315	1,366	1,460	1,323

¹ Includes 30 steam vessels totaling 646 net tons.

Employment in the fishery has also declined since 1950 (table 10). This decline has been partly the result of efforts on the part of vessel owners to reduce costs. When lake trout and whitefish were plentiful, for example, gill net operators commonly used five men in the operation; the usual number is four.

Another factor in the reduction of the number of fishermen is the decline in "weekend" commercial fishermen. In former years, many people purchased commercial licenses to operate small amounts of gear on weekends only. As the fishery has become less profitable, the number of this type of fisherman has declined.

Table 10.--Fishermen employed in the U.S. Great Lakes fishery, specified years

Year	On vessels	On boats and shore	Total
	<i>Number</i>	<i>Number</i>	<i>Number</i>
1940	1,694	3,448	5,142
1950	1,988	2,853	4,841
1954	1,949	2,503	4,452
1955	1,658	2,230	3,888
1956	1,589	2,097	3,686
1957	1,503	2,006	3,509
1958	1,583	2,125	3,708
1959	1,497	2,254	3,851

The capital value of the fishery also is declining (table 11). The data in the table were based on producers' estimates of the value of their equipment and should not be taken as the market prices. The data, nevertheless, serve to indicate the trends over a period of years. Since the estimated value of equipment has been declining, it is believed that replacement of gear has been limited. The ages of the

vessels and operating units leave little doubt that most owners are unwilling or unable to invest in modern equipment to replace that still in use.

The pessimism that prevails in the Great Lakes fisheries is easily understood in view of increasing costs and declining purchasing power obtained from the return from sale of the catch. There has been a steady rise in the cost of items used in fishing operations and in the cost of living for the fisherman and his family (fig. 10). These costs have increased almost 90 percent since 1942.

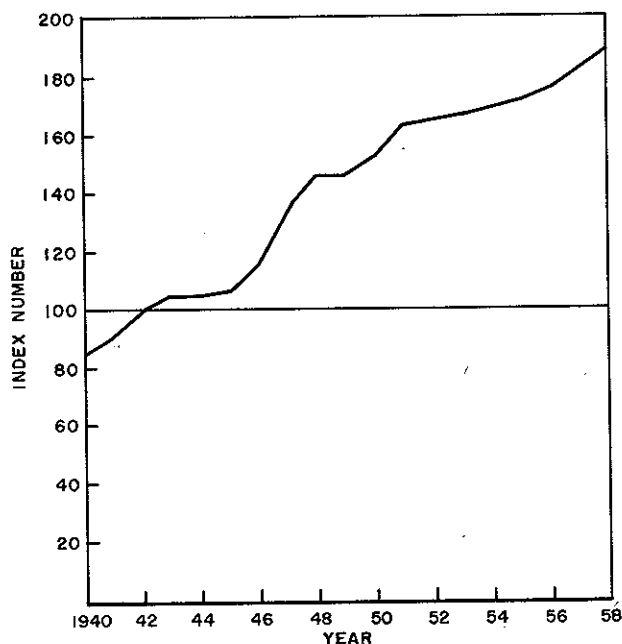


Figure 10.--Index of prices paid by fishermen in the Great Lakes area for items used in production and family maintenance, 1940-58; 1942 = 100.

Table 11.--Estimated value of nets, boats, and vessels in the U.S. Great Lakes fisheries, specified years

Year	Boats and vessels	Gill nets		Pound nets	Trap nets	Other gear	Total
		Large mesh	Small mesh				
	<i>Thousand dollars</i>	<i>Thousand dollars</i>	<i>Thousand dollars</i>	<i>Thousand dollars</i>	<i>Thousand dollars</i>	<i>Thousand dollars</i>	<i>Thousand dollars</i>
1940	2,147	1,049	769	465	1,209	194	5,833
1950	5,138	2,353	2,003	1,004	2,796	519	13,813
1954	3,689	1,729	1,615	725	2,809	447	11,014
1955	3,544	1,307	1,534	761	3,369	319	10,834
1956	2,808	1,480	1,738	630	2,906	331	9,893
1957	2,362	1,330	1,611	748	3,547	309	9,907

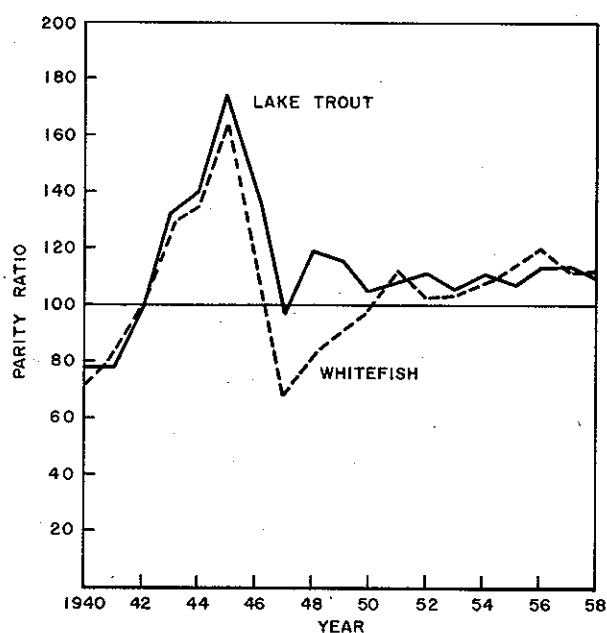


Figure 11.--Parity ratio for lake trout and whitefish, 1940-58; 1942 = 100.

Prices received by fishermen in recent years for lake trout and whitefish have more than kept pace with costs. The parity ratio, which is the relationship between prices received and prices paid, is over 100 (fig. 11). In other words, the purchasing power obtained from 1 pound of either species is greater today than in 1942. A review of figures 8 and 9, however, will show that only limited amounts of these species are landed by the Great Lakes fishermen.

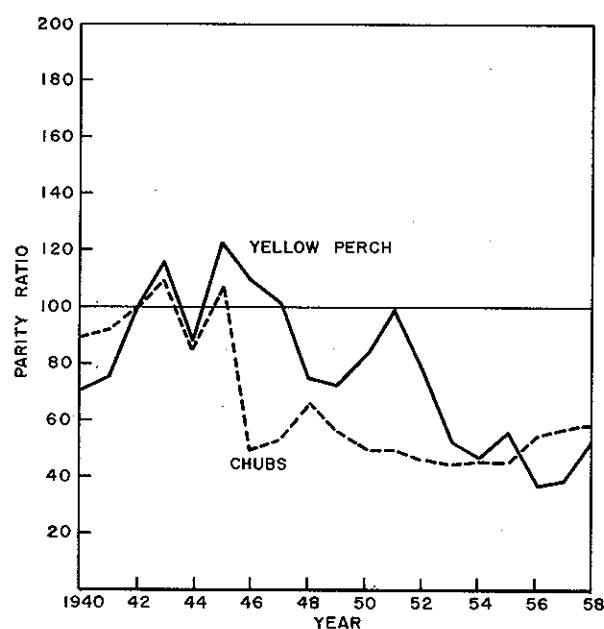


Figure 12.--Parity ratio for yellow perch and chubs, 1940-58; 1942 = 100.

The parity ratio for chubs and yellow perch is at a very unfavorable level (fig. 12). These two species made up over 30 percent of the Great Lakes catch in 1957 and 1958, and hence are quite important in determining the economic status of the commercial fishermen. In 1958 a fisherman had to land approximately 2 pounds of chubs or yellow perch to purchase the same amount of goods that income from 1 pound would have bought in 1942.

MARKETING

Markets

Technological advances in freezing, bread-ing, and packaging have made it possible to transport and market fishery products in every section of the country. The consumers in inland areas, such as the Great Lakes States, have now accepted salt-water fishery products. Many housewives in the Midwest, for example, now purchase such products as breaded shrimp, fried haddock, fish sticks, and ocean perch fillets, which were unknown or rare a few years ago.

The development of these products and their acceptance by the consumer have brought about the establishment of more wholesale firms to distribute them. The expansion in this field and the increased employment in wholesaling and manufacturing firms dealing in fishery products (table 12) have taken place without the benefit of an increase in domestic catches of fresh-water fish.

Table 12.--Establishments and employees engaged in wholesaling and manufacturing fishery products in the Great Lakes area, specified years

Year	Firms	Average annual employment
	<i>Number</i>	<i>Number</i>
1940	221	2,144
1950	312	2,540
1954	366	2,533
1955	388	2,673
1956	382	2,664
1957	382	2,482
1958	444	2,889
1959	401	2,619

Table 13.--Wholesale and manufacturing establishments by State, specified years

Year	New York	Pennsyl- vania	Ohio	Mich- igan	Indiana and Illinois	Wiscon- sin	Minne- sota
	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>
1940	18	6	47	50	49	39	12
1950	32	8	52	74	81	51	14
1954	39	9	67	96	82	57	16
1955	44	9	70	100	82	68	15
1956	37	11	68	102	89	62	14
1957	38	10	67	119	67	69	12
1958	47	9	71	129	64	105	19
1959	36	5	64	115	60	101	20

Formerly, in the Great Lakes area, Chicago was the most important wholesale market for fishery products. In recent years, however, there has been considerable expansion in wholesaling (table 13). As a result, Michigan and Wisconsin now have the greatest number of wholesale establishments in the Great Lakes area. Such cities as Detroit and Milwaukee are supplementing and competing with Chicago as important centers for distributing fishery products.

Despite the growing number of wholesale firms elsewhere, Chicago is still a major center of distribution. A large volume of fresh-water and salt-water fish and shellfish is handled there each year (table 14). The substantial increase in the volume of shellfish, especially shrimp (fig. 13), is an indication of changing trends in the habits of the consumer in the Great Lakes area.

Imports account for approximately one-third of the receipts of fresh-water fish in Chicago (table 15). The record of receipts of lake trout and whitefish and their origin shows that whitefish imports from Canada have increased since 1940 (table 16) and have served to maintain a nearly uniform supply on the wholesale market. Under the present conditions in the domestic fishery, these imports are necessary to maintain adequate supplies for the United States market.

The relative importance of Chicago as a distribution point for certain fresh-water species can be seen by referring to table 17. On the basis of the percentage of the total United States supply--that is, domestic production plus imports--Chicago is an important outlet for chubs, lake trout, sauger, walleye, whitefish, and, to some extent, yellow perch. The percentage of sauger distributed through Chicago is high, but the total supply of this species is not large and cannot be considered as important as the total supply of the other species.

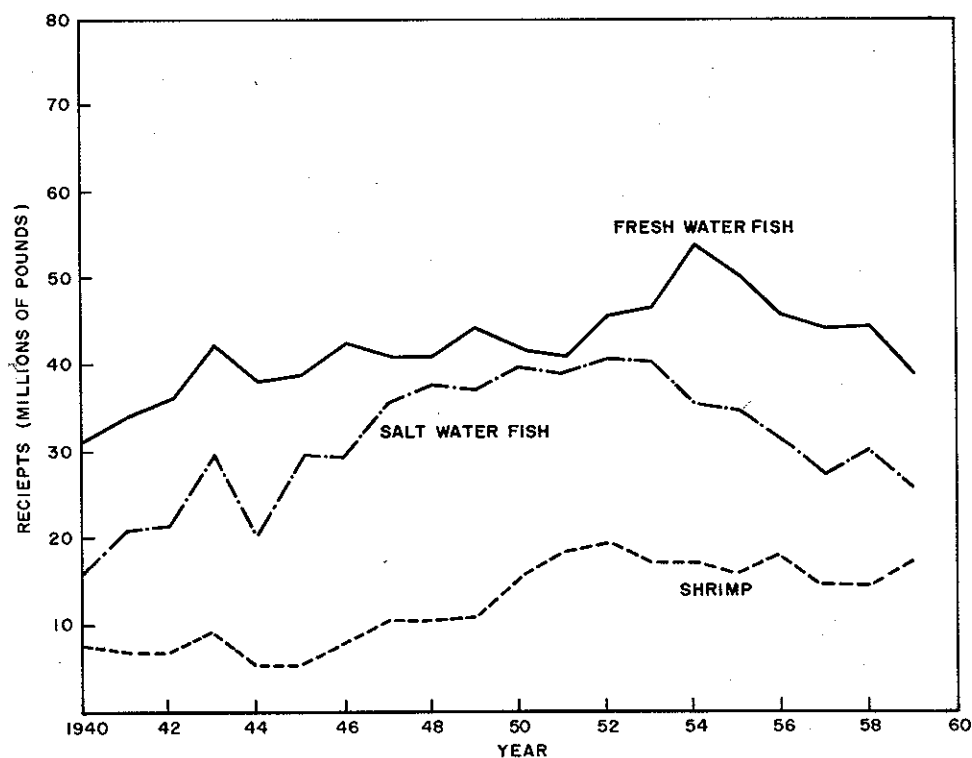


Figure 13.--Chicago wholesale market receipts of fresh-water fish, salt-water fish, and shrimp, 1940-59.

Table 14.--Chicago wholesale market receipts of fresh-water fish, salt-water fish, and shellfish, 1940-59

Year	Fresh-water fish	Salt-water fish	Shellfish	Total
	<i>Thousand pounds</i>	<i>Thousand pounds</i>	<i>Thousand pounds</i>	<i>Thousand pounds</i>
1940	31,747	16,198	11,487	59,432
1941	33,399	21,564	10,606	65,569
1942	35,913	21,913	10,342	68,168
1943	42,508	29,820	11,706	84,034
1944	38,133	20,439	8,089	66,661
1945	38,763	29,783	9,122	77,668
1946	42,601	29,353	12,406	84,360
1947	41,652	35,820	17,178	94,650
1948	41,654	37,512	18,145	97,311
1949	44,191	37,091	19,949	101,231
1950	42,055	39,702	24,988	106,745
1951	41,632	38,360	27,184	107,176
1952	46,362	48,857	29,655	124,874
1953	46,592	40,352	26,879	113,823
1954	53,698	35,417	27,498	116,613
1955	50,171	34,656	26,990	111,817
1956	46,232	32,006	28,128	106,366
1957	39,107	27,774	24,346	91,227
1958	39,554	30,105	22,662	92,321
1959	39,307	26,080	27,106	92,493

Table 15.--Chicago wholesale market receipts of fresh-water fish by origin, 1940-59

Year	Domestic	Imported
	<i>Thousand pounds</i>	<i>Thousand pounds</i>
1940	23,191	8,556
1941	22,888	10,511
1942	26,195	9,718
1943	29,888	12,620
1944	25,986	12,147
1945	27,881	10,882
1946	30,371	12,230
1947	31,263	10,389
1948	31,294	10,357
1949	29,810	14,381
1950	28,095	13,960
1951	26,088	15,544
1952	31,394	14,968
1953	34,019	12,573
1954	38,636	15,062
1955	34,728	15,443
1956	32,801	13,431
1957	25,812	13,295
1958	25,524	14,030
1959	26,295	13,012

Whitefish ranks first in volume of the more important species marketed in Chicago (table 18). The volume of lake trout has been declining in recent years, reflecting the decline in production in the Great Lakes. The large quantity of walleye handled is an indication of an increased demand for this species. On the other hand, the volume of chubs marketed through Chicago has increased because of the greater availability.

Prices

Wholesale-- Wholesale prices are subject to wide fluctuations during some seasons of the year. Periods of oversupply and shortage develop principally because of legal restrictions on fishing seasons, weather conditions, and availability of fish. In the spring, large supplies of fresh-water fish are available, but during the winter, when the fishing season is closed in most States, few fish are marketed.

Frequently imports supplement the domestic production during periods of short supply, but sometimes large quantities of imported fish are available at the same time that domestic supplies are plentiful. During such periods the wholesale prices for the domestic products are depressed.

Table 16.--Chicago wholesale market receipts of lake trout and whitefish by origin, 1940-59

Year	Lake trout		Whitefish	
	Domestic	Canadian	Domestic	Canadian
	<i>Thousand pounds</i>	<i>Thousand pounds</i>	<i>Thousand pounds</i>	<i>Thousand pounds</i>
1940	4,927	1,108	1,883	2,124
1941	4,949	1,161	1,914	1,767
1942	5,583	834	1,569	1,842
1943	5,951	1,050	1,401	3,270
1944	5,847	1,462	1,355	4,538
1945	5,208	1,556	1,560	3,640
1946	4,702	1,652	2,503	4,084
1947	4,160	1,958	4,560	3,168
1948	3,668	1,498	5,478	3,217
1949	3,037	2,587	4,370	5,562
1950	2,280	1,792	3,572	5,828
1951	2,108	1,946	2,834	6,940
1952	2,332	1,689	3,563	6,616
1953	1,897	1,682	3,335	5,679
1954	1,785	2,542	2,816	6,894
1955	1,150	2,429	1,852	6,968
1956	864	2,069	1,774	5,938
1957	483	1,935	1,130	6,939
1958	629	1,684	1,246	7,654
1959	636	1,290	1,154	7,092

The price ranges for walleye, lake trout, and whitefish are shown in figures 14 to 16. There is a tendency for the price of the domestic walleye to have a greater range than that of the imported product. This condition is probably the result of fluctuations in the supply, due to closed seasons in some areas during some parts of the year.

The price ranges for lake trout show an increase in the price for domestic fish in recent years (fig. 15). This trend can be attributed to the decline in the availability of this species. The highest price reached by the domestic trout has been \$1 per pound. Since this level was reached in three different years, it would seem to represent the highest price at which sales can be made. The prices for Canadian trout are gradually increasing, reflecting the demand for lake trout and an increasing acceptance of imported trout as a replacement for the diminished domestic production.

The wholesale price ranges are wider for drawn whitefish than for the other species for which data are presented (fig. 16). During the years covered, the price ranges for Canadian whitefish have been at the lower level of the range for the domestic product.

Table 17.--Percentage of the total supply of selected species received in the Chicago wholesale market, 1940-59

Year	Chubs	Lake herring	Lake trout	Sauger	Walleye	White-fish	Yellow perch
	<i>Percent</i>	<i>Percent</i>	<i>Percent</i>	<i>Percent</i>	<i>Percent</i>	<i>Percent</i>	<i>Percent</i>
1940	23.4	14.9	44.5	26.3	13.1	19.5	30.4
1941	22.3	13.2	43.6	36.4	13.7	20.0	33.0
1942	36.3	18.0	48.6	31.4	15.5	19.7	30.4
1943	37.1	21.5	52.2	30.3	22.8	28.4	27.4
1944	35.2	17.0	50.4	29.8	20.0	32.5	23.9
1945	36.8	12.4	52.8	16.0	15.2	30.8	29.4
1946	53.2	9.8	56.2	25.8	21.6	37.6	35.9
1947	48.8	10.6	65.1	32.6	30.0	33.6	40.1
1948	44.4	8.5	83.3	47.1	28.6	37.5	44.9
1949	38.8	9.9	82.7	42.3	29.7	37.8	45.7
1950	34.8	13.6	60.8	40.0	26.9	40.7	36.1
1951	31.8	13.9	66.5	48.6	27.2	43.1	37.6
1952	36.8	12.9	64.9	60.4	30.6	41.2	38.7
1953	31.7	17.7	71.6	59.6	38.0	38.0	39.6
1954	(¹)	(¹)	96.1	92.3	52.0	47.6	41.8
1955	(¹)	(¹)	81.3	70.2	59.5	45.9	43.5
1956	(¹)	(¹)	66.7	73.1	57.6	42.6	25.4
1957	(¹)	(¹)	83.8	33.8	51.1	42.5	21.8
1958	(¹)	(¹)	68.0	31.0	40.9	60.5	24.2
1959	(¹)	(¹)	77.1	31.5	50.0	55.0	26.2

¹ Data not available.

Table 18.--Chicago wholesale market receipts of selected species, 1940-59

Year	Chubs	Lake trout	White-fish	Yellow perch	Walleye
	<i>Thousand pounds</i>	<i>Thousand pounds</i>	<i>Thousand pounds</i>	<i>Thousand pounds</i>	<i>Thousand pounds</i>
1940	903	6,008	4,007	2,953	1,860
1941	912	6,110	3,682	3,410	1,830
1942	1,258	6,417	3,411	2,336	2,297
1943	1,390	7,002	4,671	2,079	3,733
1944	1,438	7,311	5,893	1,896	3,443
1945	2,010	6,764	5,201	1,735	2,808
1946	2,552	6,353	6,588	2,760	4,167
1947	2,785	6,118	7,728	2,722	4,791
1948	3,030	5,166	8,694	2,603	4,010
1949	3,189	5,624	9,931	2,531	4,479
1950	3,378	4,072	9,400	2,015	4,222
1951	3,452	4,054	9,774	1,928	4,375
1952	4,196	4,021	10,179	2,139	4,569
1953	3,662	3,580	9,014	2,905	5,268
1954	4,393	4,326	9,710	3,748	5,751
1955	4,209	3,579	8,820	3,232	6,304
1956	4,437	2,934	7,722	2,897	6,826
1957	4,030	2,428	8,069	2,698	5,006
1958	4,719	2,313	8,900	2,769	4,388
1959	3,669	1,925	8,246	3,175	3,921

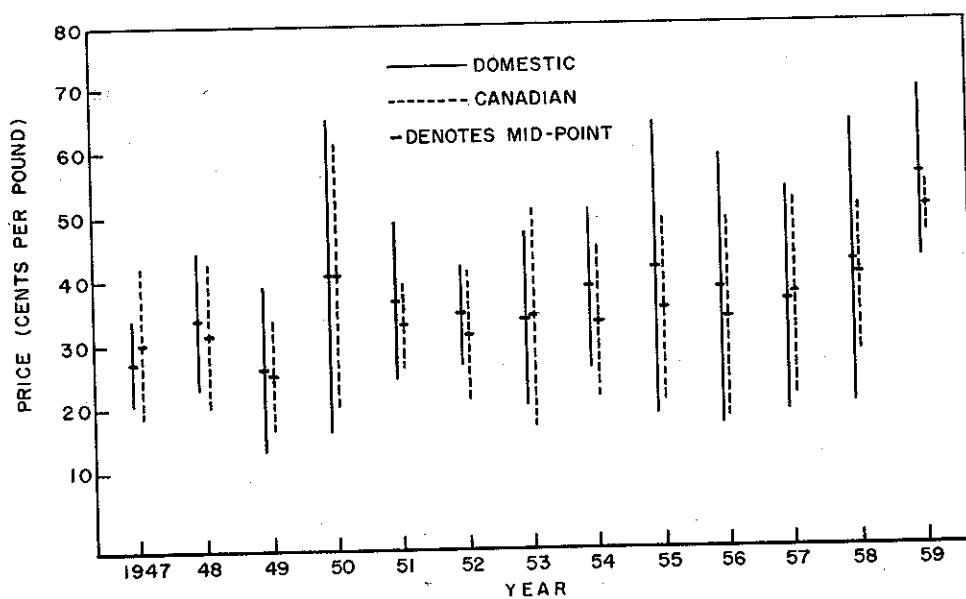


Figure 14.--Price range for Canadian and domestic walleye at Chicago wholesale market, 1947-59.

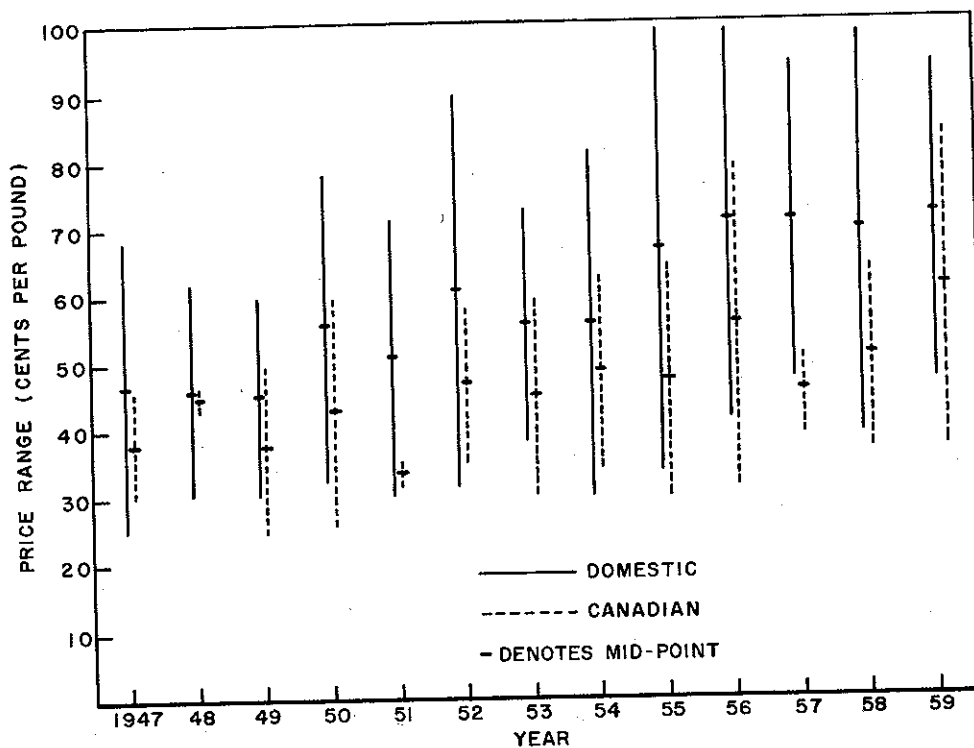


Figure 15.--Price range for Canadian and domestic lake trout at Chicago wholesale market, 1947-59.

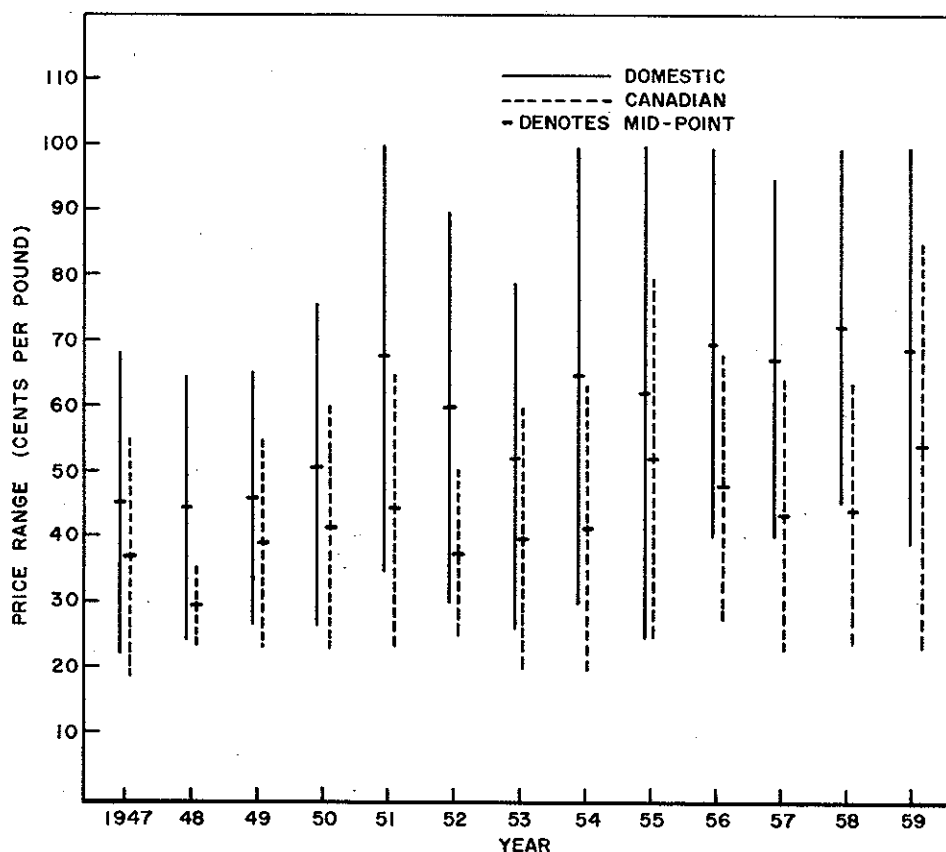


Figure 16.--Price range for Canadian and domestic whitefish at Chicago wholesale market, 1947-59.

Retail--Only limited data are available on retail prices. The average prices for walleye and whitefish are shown in figure 17. As can be seen, the retail price has increased in recent years. The relatively high prices can be expected to prevail until such time as the production of these species increases. Since the volume of production is low and a large part of the supply is purchased by the institutional trade, it has been possible to retail these species at a high price. It may not be possible, however, to sell large quantities on the retail market and still maintain the price level prevailing for whitefish.

NEW DEVELOPMENTS

Processing

Changes in the fish populations of the Great Lakes have forced members of the fishing industry to try new methods of production and processing. Many of the innovations now being tried there have been in operation for several years in the marine fisheries.

Until recently, filleting was not important in the marketing of fresh-water fish; but as

the nearby markets for filleted salt-water species expanded, some of the fishermen and wholesalers in the Great Lakes area found it profitable to fillet the local fish.

The filleting operation, however, was done by hand--a method that requires skilled labor and is expensive. In an effort to improve efficiency, some processors have attempted to use filleting machines. Experiments with various types of machines were conducted to determine the feasibility of filleting fresh-water fish. Good results have been obtained from Lake Erie yellow perch and lake herring from Lake Superior.

Preliminary findings indicated that machine filleting of yellow perch resulted in a yield of over 50 percent of the round weight. The high rate of return and the speed of the machine--1,000 pounds of fillets per hour--indicate that the machine should be practical for filleting this species. If the full potential of the machine is to be realized, it will be necessary for the processors to expand their freezing facilities for the storage of fillets during periods of glut production for more orderly marketing over a period of several months.

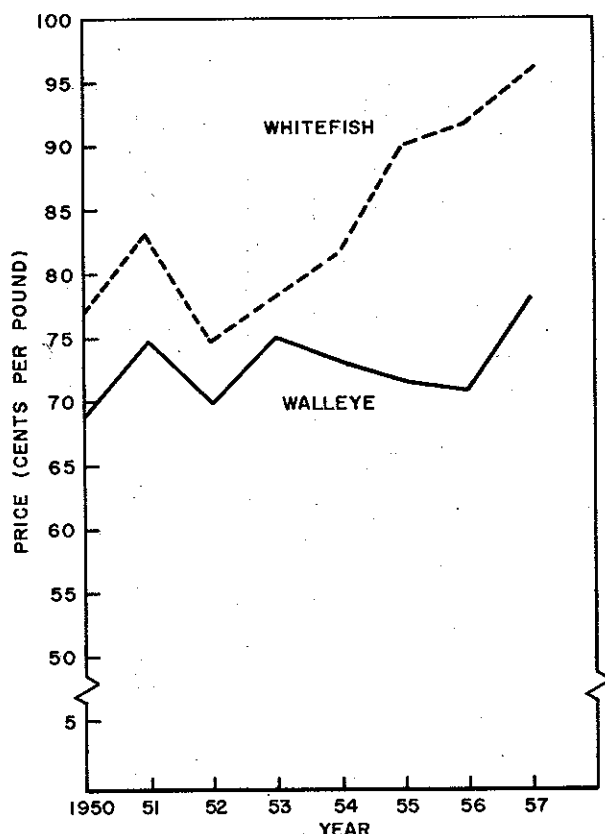


Figure 17.--Average annual retail price for walleye and whitefish, 1950-57.

Production Methods

In the past the fishermen of the Great Lakes have relied on high-priced fish to obtain a profit with their relatively inefficient gear. The decline of lake trout and whitefish, as well as other high-priced species, has eliminated many producers.

Some members of the industry have started experimenting with otter trawls in areas where this gear is legal. These fishermen have converted their gill net and trap net vessels to trawlers. Others have attempted to improve the efficiency of the trawling operations by purchasing shrimp trawlers and sailing them up the Mississippi River to the Great Lakes. This innovation may be an important step in the rehabilitation of the industry. Fishing operations with trawlers have been successful with respect to increased catch rate, and the production of fish for industrial purposes has proven feasible. It seems reasonable to expect a large expansion in capital invested in the fishing and allied industries of the Great Lakes if the States that now permit experimental trawling will allow an expansion of this type of fishery.

The limited number of vessels suitable for conversion to trawling is an obstacle in the development of this type of fishery. Also, without adequate knowledge concerning the size of the resource and the area suitable for trawling, sound conclusions on the future of this new type of fishing method cannot be drawn.

Trawl fishermen, however, should not encounter difficulty in selling their catch. The Great Lakes States contain many mink farms. One-third of the ranch mink produced in the United States comes from this section (see shaded area in fig. 18). A survey conducted by the Bureau of Commercial Fisheries indicated that the mink ranchers in this area fed their animals about 70 million pounds of fish during 1957. Approximately half of this amount was made up of salt-water species shipped from the coastal areas of the United States. It is believed that a large volume of fresh-water fish would be used by the mink ranchers if the prices were competitive with the salt-water species. The use of fish by mink ranchers might be expanded even further through a program of education.

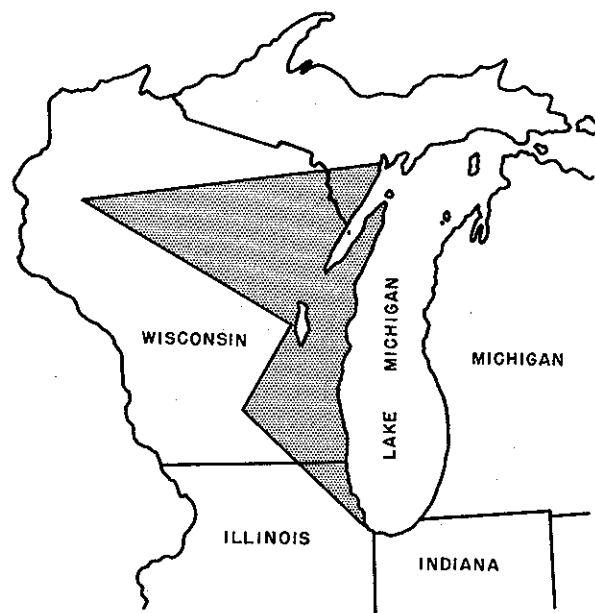


Figure 18.--Shaded area shows location of one-third of the ranch mink of the United States, 1957.

Biological Research

The future of the lake trout and whitefish fisheries is dependent upon the success of the program to control the sea lamprey in the Great Lakes area. The development of an effective selective toxicant for the treatment of streams containing immature sea lampreys

gives cause for optimism for the ultimate success of the program. It will be some time before complete success of this method of attack is proven in the field and a commercial fishery for lake trout can be re-established in Lakes Huron, Michigan, and Superior.

CONCLUSIONS AND RECOMMENDATIONS

The fishing industry of the Great Lakes has declined because of the decrease in abundance of the higher priced species. Methods that were once effective for the capture of these fishes are inefficient and excessively expensive for harvesting those now present. For profitable exploitation of many of the existing stocks, more efficient gear is necessary.

The development of a trawl fishery appears to be the most practical method for economical harvesting of most species that are now available. At present, trawling is limited to the capture of smelt, chubs, and alewives. From this limited trawling, however, it appears that large populations of these species exist in some areas. Since trawling is the only economical method available for catching these industrial fishes, increased use of this type of gear appears to be necessary for the expansion of the commercial fishery in the Great Lakes area. A continuous review by biologists would prevent depletion of the fish populations by this method and would result in sound management of the resource.

There should be a uniform system of laws designed to foster continued harvest of the resource at the maximum yield, taking into account economic factors in each body of water under commercial exploitation.

Fishermen may wish to consider the value of forming cooperatives in the Great Lakes area, especially if they expand their trawling operations. With cooperative endeavor, the fishermen in the area may find it easier to make effective gains with any type of gear. The traditional methods of landing fish at many small ports proved to be unprofitable in the industrial fishery of this area.

Additional research in fishing methods is necessary. At present the otter trawl is being employed on an experimental basis. Earlier attempts to use the midwater trawl and lampara seine did not prove to be profitable. These types of gear, however, may be practical under certain conditions. The usefulness of seining gear for the capture of alewives has not been tested as yet. In this same area of research is the modification of the existing gear in the fishery. It may be possible to improve catching operations in a manner which will result in a lowering of raw material production costs.

New ways of marketing must be tried. Formerly most of the production has been sold as fresh fish. At the present time the most

practical method of marketing food fish in the United States is in the form of frozen fillets. This method probably could be used in the Lake Erie yellow perch fishery. During some periods perch are in short supply, and at other times the supply is excessive. Through filleting and freezing, marketing can be made much more orderly, with the expectation of a better overall profit picture for the industry.

One area of processing not yet fully exploited is the filleting, breeding, cooking, and freezing of fresh-water fish. Yellow perch seem to be the species most easily adapted to this type of product, and smelt may be satisfactory for the same operation. The rapid expansion of the markets for the breaded salt-water species is indicative of consumer preference. There seems to be no reason why fresh-water products cannot be distributed in the same form, but there remains the need for thorough test-marketing of such products to establish this hypothesis as a fact.

An expansion of the research programs on the Great Lakes will be necessary for the development of satisfactory procedures for the management of the fisheries. At present, the possible yield is unknown. In some of the Great Lakes there is little or no information on the composition of the species or the density of the populations. It is known that the chub population in Lake Michigan has increased since the decline of the lake trout, and that a large population of alewives has developed in some of the Great Lakes; but biological repercussions of these changes are not known. An accelerated program of research therefore is necessary to obtain adequate information for the evaluation of these changes in relation to the future of the industry.

A valuable adjunct to the above-mentioned research programs would include increased knowledge concerning the economic aspects of these fisheries. As an example, information on the position of the Great Lakes fishing industry with respect to competition for the consumers' dollars coming from other fishery products and other food products would be useful. An expanded knowledge concerning the possibilities of improving marketing conditions for these species would be particularly helpful for those segments of the industry concerned with problems of over supply.

ACKNOWLEDGEMENTS

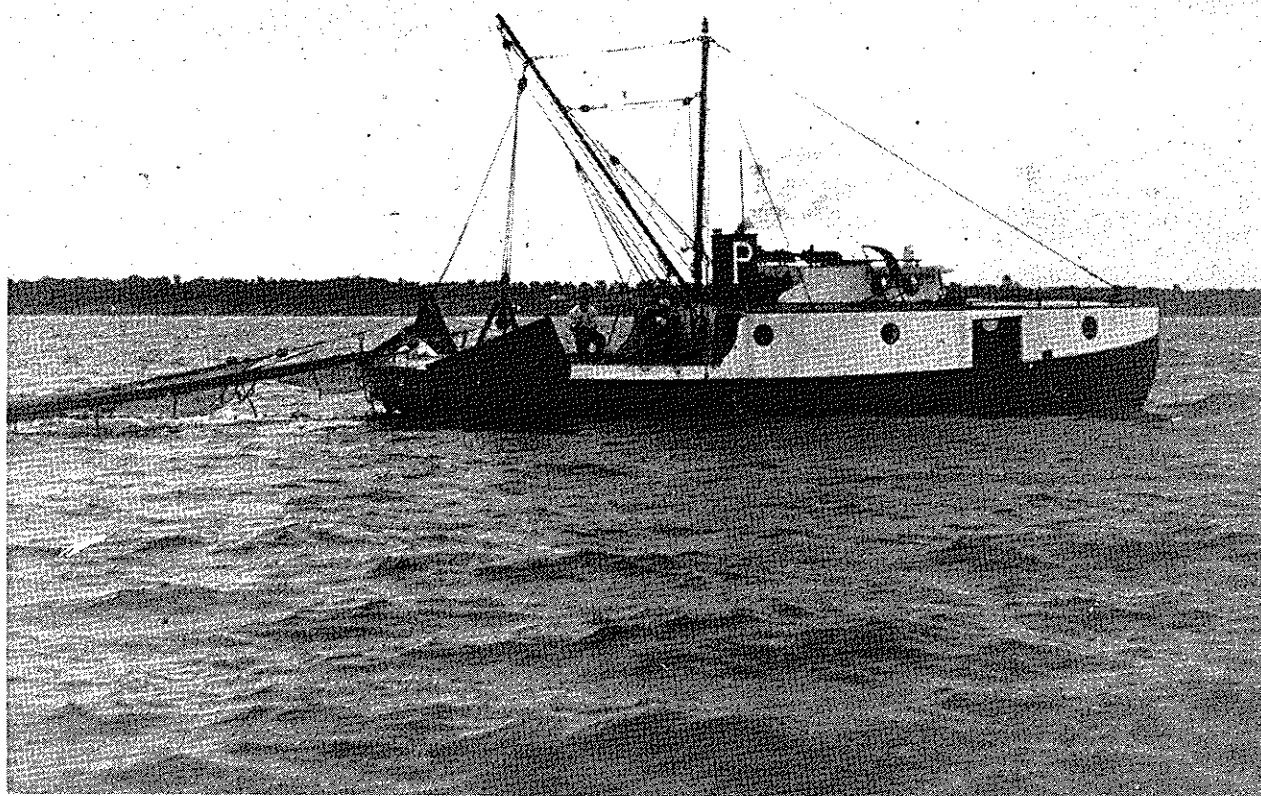
The assistance of the staff of the Bureau of Commercial Fisheries in Ann Arbor, Michigan, was invaluable in the preparation of this study. Robert Balkovic and Walter Jones of the Branch of Marketing supplied much of the information contained in the chapter on marketing. William Gordon of the Branch of Exploratory Fishing gave advice on the parts of the text relating to fishing gear.

SELECTED REFERENCES

- Albano, G[aspard] A[ndre].
1959. Lake trout and whitefish markets at Chicago. U. S. Fish and Wildlife Service, Commercial Fisheries Review, vol. 21, no. 12 (January), p. 31-32.
- Brouillard, Keith D.
1960. Complex problem faces Great Lakes. Fishing Gazette Publishing Corp., New York 1, New York.
- Hile, Ralph.
1952. Fishing regulations. The Fisherman, vol. 20, no. 3, p. 5. The Marine Publishing Co., Grand Haven, Michigan.
- Hile, Ralph, and Howard J. Buettner.
1955. Commercial fishery for chubs (ciscoes) in Lake Michigan through 1953. U.S. Fish and Wildlife Service, Special Scientific Report--Fisheries No. 163, 49 p.
1959. Fluctuations in the commercial fisheries of Saginaw Bay, 1885-1956. U.S. Fish and Wildlife Service, Research Report 51, 38 p.
- Jones, Walter G.
1959. Sources of lake fish for pet foods. Petfood Industry, vol. 1, no. 3 (March), p. 21 and 25. Garden State Publishing Co., Sea Isle City, New Jersey.
1959. Potential production of "rough fish" in the Great Lakes area. Petfood Industry, vol. 1, no. 4 (April), p. 33-34 and 38. Garden State Publishing Co., Sea Isle City, New Jersey.
- Moffett, James William.
1957. Recent changes in the deep-water fish populations of Lake Michigan. Transactions of the American Fisheries Society, vol. 86 (for the year 1956), p. 393-408.
- Rawson, D. S.
1947. Great Slave Lake. Fisheries Research Board of Canada, Bulletin No. 72, p. 45-68, Ottawa.
- United States Fish and Wildlife Service.
1959. Survey of the United States shrimp industry, vol. II. Special Scientific Report--Fisheries No. 308, 163 p.
1959. Western Lake Erie biological research continued. Commercial Fisheries Review, vol. 21, no. 10 (October), p. 29.
1960. Experimental trawling for smelt in Lake Erie yields commercial quantities. Commercial Fisheries Review, vol. 21, no. 10 (January), p. 36.
- van Oosten, John
1947. Mortality of smelt, *Osmerus mordax* (Mitchill), in Lakes Huron and Michigan during the fall and winter of 1942-43. Transactions of the American Fisheries Society, vol. 74 (for the year 1944), p. 310-337.
- Widerstrom, Frans L., Jr.
1959. An economic and financial study of the fluke otter-trawl fishery of New Jersey. U.S. Fish and Wildlife Service, Commercial Fisheries Review, vol. 21, no. 12 (December), p. 17-26.

MS #1109

GPO 927613



Converted gill net tug on Lake Michigan, lifting trawl.

Created in 1849, the Department of the Interior—America's Department of Natural Resources—is concerned with the management, conservation, and development of the Nation's water, fish, wildlife, mineral, forest, and park and recreational resources. It also has major responsibilities for Indian and Territorial affairs.

As the Nation's principal conservation agency, the Department works to assure that nonrenewable resources are developed and used wisely, that park and recreational resources are conserved for the future, and that renewable resources make their full contribution to the progress, prosperity, and security of the United States—now and in the future.