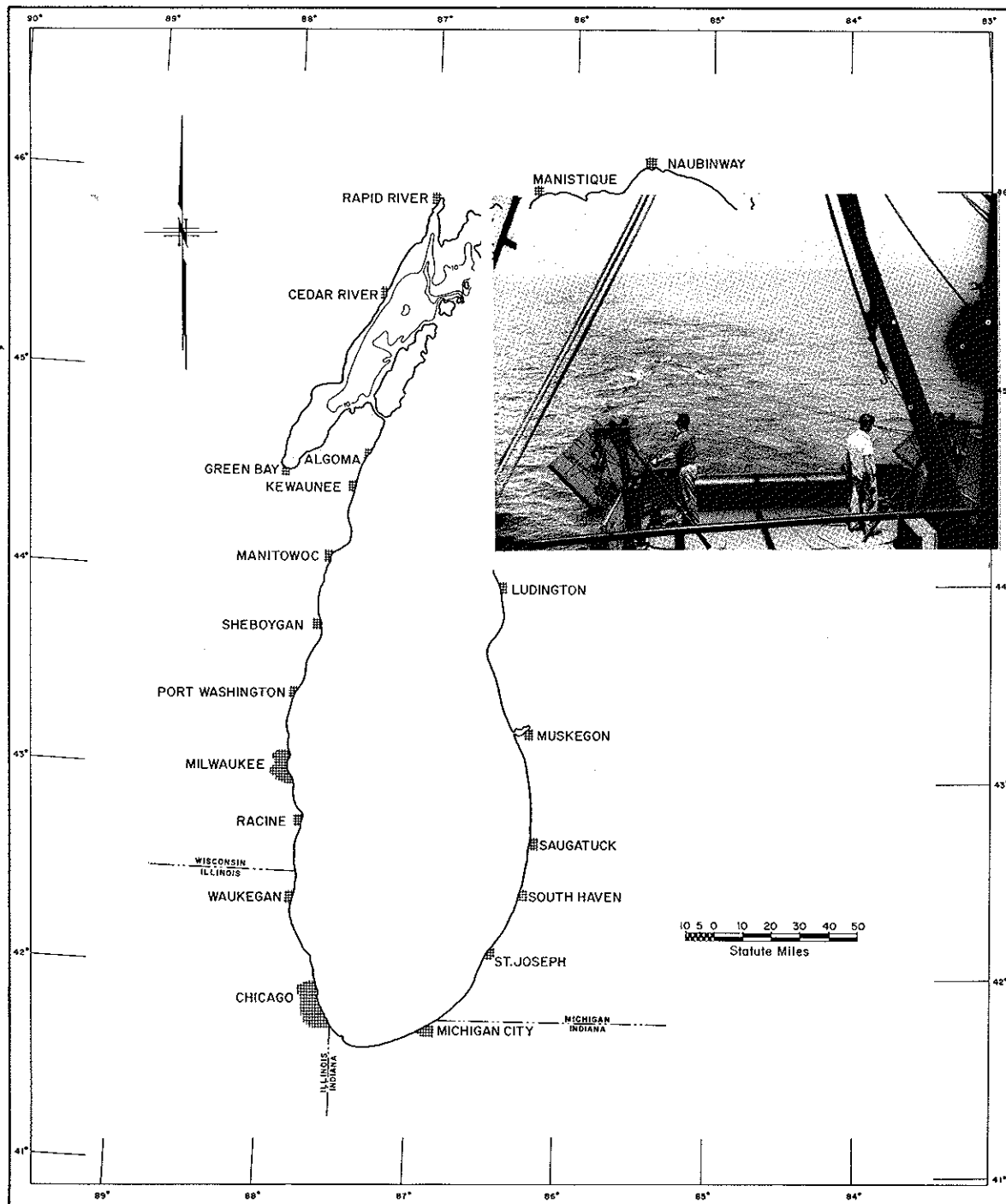


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Bottom Trawl Explorations in Southern Lake Michigan, 1962-65



**UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE**

BUREAU OF COMMERCIAL FISHERIES

Circular 301

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By

NORMAN J. REIGLE, JR.

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By

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ABSTRACT

For 4 years the Bureau of Commercial Fisheries Exploratory Fishing and Gear Research Base at Ann Arbor, Mich., surveyed the abundance, seasonal availability, and depth distribution of various fish stocks.

The alewife (*Alosa pseudoharengus*) and chubs (*Leucichthys* spp.) were taken readily with the bottom trawl. Alewives composed 51.4 percent and chubs 44.0 percent of the trawl catch. Two other commercial species, yellow perch (*Perca flavescens*) and smelt (*Osmerus mordax*), were taken occasionally in commercial amounts.

The alewife stocks have increased tremendously in recent years. The poundage of alewives in the trawl catch increased each year from 17 percent in 1962 to 74 percent in 1965. Alewives exhibited pronounced seasonal movements and generally were available to bottom trawls only at specific depths. The trawls caught alewives at depths of less than 5 fathoms to over 50 fathoms. Alewives appeared to be distributed universally in the study area during most of the year but were found only in some sections in winter. Alewives were more difficult to catch between July and the end of December than during January through June.

Chubs were abundant all year throughout southern Lake Michigan. Chubs were caught over a wide depth range throughout the year, although bottom trawling indicated some horizontal dispersal shoreward in summer and back to deeper water in fall.

INTRODUCTION

The fish population of Lake Michigan has changed dramatically since the sea lamprey (*Petromyzon marinus*) became plentiful, and the valuable food species subsequently declined (Hile, Eschmeyer, and Lunge, 1951; Hile and Buettner, 1955; Moffett, 1957; and Smith, 1964). The commercial fishery in the southern portion of the lake was based originally on lake trout (*Salvelinus namaycush*), whitefish (*Coregonus clupeaformis*), and some chubs (*Leucichthys* spp.), particularly the larger species such as black fin cisco (*L. nigripinnis*) and deepwater cisco (*L. johanna*). With the decline or disappearance of these choice species, emphasis shifted to an almost exclusive chub fishery based on the medium-sized species: longjaw (*L. alpenae*), shortjaw (*L. zenithicus*), shortnose (*L. reighardi*), and kiyi (*L. kiyi*). These species have now either disappeared or are found only in small numbers. The chub population is now dominated by the bloater (*L. hoyi*), which is

the smallest and slowest growing of the chub species. The recent explosive invasion of the alewife (fig. 1) has had additional effects on the fauna. Today the struggling gill net fishery is based on the few remaining larger chubs and a sporadic yellow perch population. Thus, to survive, fishermen must now turn to the abundant low-value species such as alewives and bloaters. A limited trawl fishery has become established in southern Lake Michigan--three vessels now are operating in Michigan waters, and eight vessels in Wisconsin waters. In 1965 these vessels landed over 12 million pounds of fish, primarily alewives and chubs.

The Bureau of Commercial Fisheries began bottom trawl explorations in Lake Michigan in August 1960 (Gordon, 1963). After the construction of the R. V. Kaho in 1961 for exploratory fishing and gear research, explorations have continued since 1962. This paper summarizes explorations from 1962 to 1965 in southern Lake Michigan.



Figure 1.--Trawl catch of 3,800 pounds of alewife and 300 pounds of chubs being landed aboard the R. V. Kaho. The catch was made in a 15-minute drag in 40 fathoms off Manitowoc, Wis., May 3, 1964.

The purpose of the exploratory fishing cruises during this study was to provide information regarding the seasonal depth and geographic distribution of certain abundant and unutilized species such as alewives and chubs in relation to their availability to a new and growing trawl fishery. This information was distributed to the fishing industry in the form of cruise reports at the end of each cruise. The operations were intended to determine the feasibility of trawling at widely separated areas at particular times.

Southern Lake Michigan is here defined as that portion of Lake Michigan south of a line between Manitowoc, Wis., on the west shore and Ludington, Mich., on the east shore (fig. 2). A few drags made a few miles north of this line are included here. A fishing log of all trawl drags is given in the appendix.

VESSELS, GEAR AND METHODS

All the fishing explorations in this study, with the exception of cruise 30, were made with the 65-foot research vessel Kaho. The research vessel Cisco made 14 trawl drags in southern Lake Michigan on cruise 30.

Most trawling was with a 52-foot (headrope) Gulf of Mexico type fishing trawl (Gordon and Browillard, 1960). During phase II of cruise 3, 33 drags were made with a 62-foot (headrope) modified western type bottom trawl. Both nets were rigged with a 1-inch mesh (stretched measure) cotton liner in the cod end to sample young fish and small species. All drags were recorded with a high-resolution echo sounder with fish-discriminating features.

Most trawl drags were for 1/2-hour duration although 38 drags were extended for longer periods (up to 2 hours) to determine rates that commercial fishermen might expect and 65 were ended purposely before 30 minutes for one of the following reasons: encountered snags, avoided set fishing gear, i.e. gill nets in the area, limited catch of alewives to a size that could be handled conveniently, avoided rough bottom, or ran out of time. Gear was damaged severely on 19 occasions and moderately on 30 drags.

During most cruises trawl drags were made at regular depth intervals at preselected locations. These depth series were generally made along the contour at 5-fathom intervals from the shallowest depth possible to fish, which depended on bottom conditions, to 50 fathoms and at 10-fathom intervals thereafter to 70 or 80 fathoms (88 fathoms on one occasion). Not all depth series, however, covered all depths and fishing effort varied from year to year and port to port (see fishing effort). Reasons for incomplete depth series other than bottom conditions were generally gear limitations in

1962 or lack of time. Series out to 70 fathoms were usually made only during cross-lake transects. During this study, 84 depth series were made, 38 of which covered a range of 40 fathoms or more.

Bottom irregularities and currents at times caused variations of several fathoms in actual fishing depths. To simplify analyses, actual fishing depths are rounded off to the nearest 5- or 10-fathom midpoint as follows:

Depth range Fathoms	Designated depth Fathoms	Depth range Fathoms	Designated depth Fathoms
3-7	= 5	38-42	= 40
8-12	= 10	43-47	= 45
13-17	= 15	48-55	= 50
18-22	= 20	56-65	= 60
23-27	= 25	66-75	= 70
28-32	= 30	76-85	= 80
33-37	= 35	86-95	= 90

In making some depth analyses, I considered three depth zones as follows:

1. Shallow water - 3 to 17 fathoms (5- to 15-fathom intervals)
2. Intermediate depth - 18 to 55 fathoms (20- to 50-fathom intervals)
3. Deepwater - 56 fathoms and deeper (60- to 90-fathom intervals)

During 1962, drags were made in random directions or in opposite directions on alternate drags; however, in 1963, biologists noted that current apparently affected the size of catches. Thereafter on each series, two drags were made initially in opposite directions at the same depth. If a drag made in one direction had a substantially greater catch, all remaining drags in the series were made in the direction producing the larger catch.

Evaluations of fishing results are based here on two methods of calculation: (1) Catch rate - which is pounds produced per unit effort for all drags in a particular evaluation and (2) average catch for effective effort - which is pounds per unit effort for only those drags that contained the species being evaluated. Effective fishing effort has been discussed by Hile (1962). All analyses of catch rates and average catch for effective effort are based on 1/2-hour dragging time unless specified. For most evaluations, total dragging time was divided into 1/2-hour periods.

To define more accurately the seasonal availability of alewives to bottom trawls in southern Lake Michigan, the seasonal fishing depths of three commercial trawlers from Saugatuck, Mich., were evaluated. Since 1961 these commercial trawlers have provided the Bureau of Commercial Fisheries with records

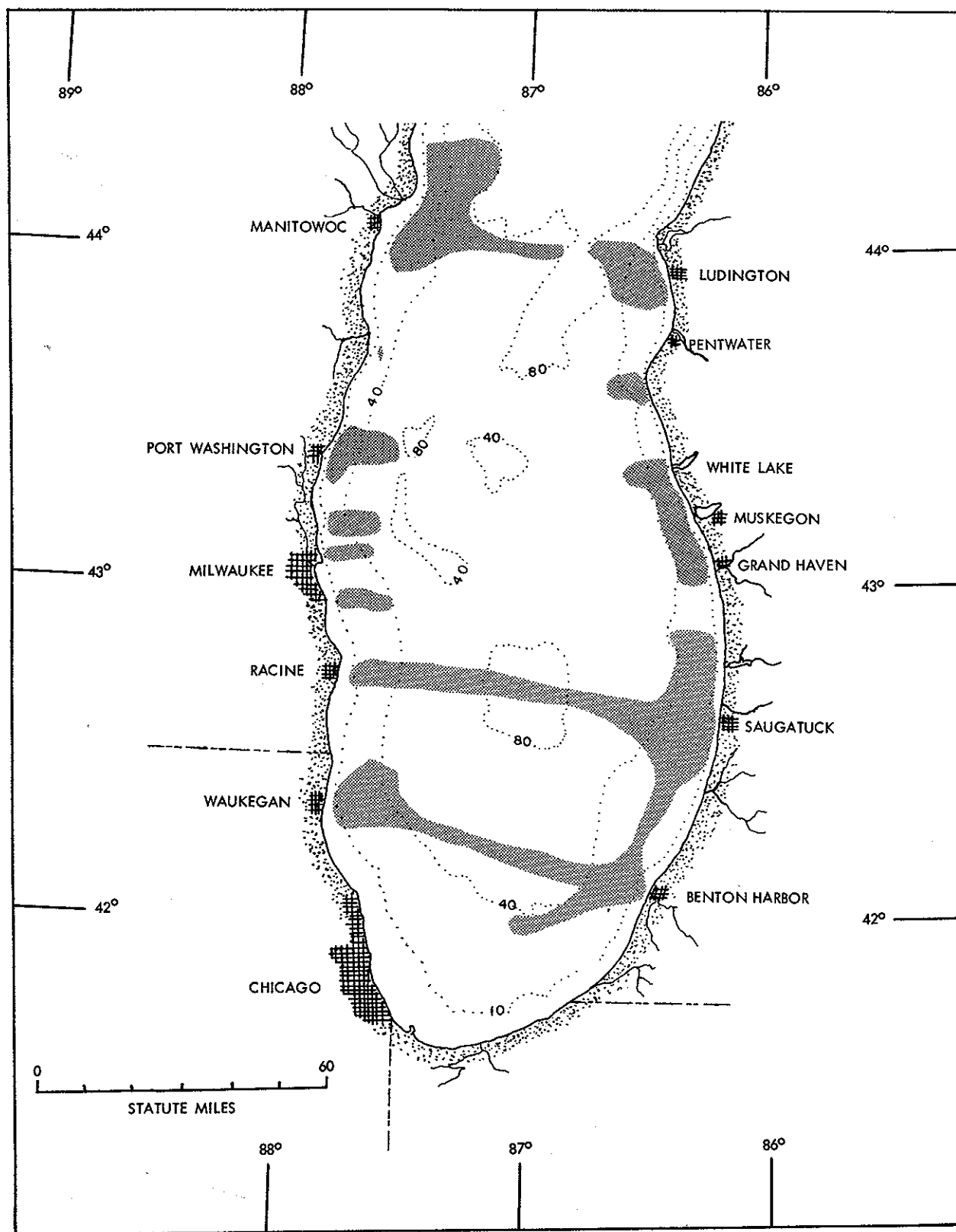


Figure 2.--Map of southern Lake Michigan showing grounds trawled during this study.

of the results of each drag. The catch records have been coded and recorded on punchcards. The following criteria were used for this analysis of seasonal availability of alewives:

1. Drags that had a fishing depth range of more than 4 fathoms were eliminated because these were searching efforts and cross contour drags.
2. Drags that did not contain at least 500 pounds of alewives were eliminated, thus sorting out effort that was likely directed at other species. Early operations by these trawlers were directed mainly at catching chubs.
3. Drags were sorted by month and year, and each month was further subdivided into three periods, i.e., the 1st to the 10th, the 11th to the 20th, and the 21st to the end of the month inclusive.
4. Drags meeting the above criteria were tabulated by 1/3-month periods, and a mean fishing depth was calculated.
5. The mean depths were graphed if at least five drags made during the period had a catch rate of at least 500 pounds per hour. Many of the drags that fulfilled criterion 2 were for more than 1 hour.

Data from all three vessels were combined. The results are presented in the alewife discussion.

A catch is considered here to be commercially significant when its exvessel value is \$7.50 or more per one-half hour. Under current conditions a significant catch would be 500 pounds of alewives per one-half hour, based on a value that lies between prices paid by manufacturers of pet food and prices paid by fish meal producers. Because chubs are commonly used for pet food and most catches have some chubs large enough for human consumption, 250 pounds per one-half hour was considered a commercially significant catch of chubs. Seventy-five pounds of yellow perch in a $\frac{1}{2}$ -hour drag is significant.

FISHING EFFORT

From 1962 to 1965, 14 exploratory cruises were entirely or partially devoted to fishing explorations in southern Lake Michigan. These cruises totaled 193 operating days and averaged 14 days per cruise. During the survey, 798 trawl drags were completed in 388 hours (table 1). Exploratory fishing cruises are numbered consecutively regardless of operation; therefore, cruise numbers in this paper are not consecutive.

In 1962 three entire cruises were spent in southern Lake Michigan. Owing to gear limitations, fishing was restricted to depths between 8 and 45 fathoms. Most of the drags were

between 10 and 40 fathoms. Cruise 1 was a Kaho shakedown cruise in which two trial drags were made off Saugatuck in February and eight drags off Saugatuck and two drags off Ludington in March. The main portion of cruise 1 was made in April and covered the east shore from Benton Harbor, Mich., to Ludington and the west shore from Milwaukee, Wis., to Manitowoc. Cruise 3 was divided in three phases--(I) June, (II) July, and (III) August. Southern Lake Michigan was explored during each phase. Cruise 6 was made in November and December, and trawls were dragged at stations on both sides of the lake. During 1962 the Kaho fished in southern Lake Michigan at least 1 day a month for 8 months.

The fishing effort in southern Lake Michigan during 1963 was about half that of the previous year. Depth coverage was from 5 to 88 fathoms, and the scope of operations were extended to Green Bay and northern Lake Michigan. Of five cruises in Lake Michigan in 1963, four explored the southern portion of the lake. Cruise 9 included operations off Manitowoc, Ludington, Port Washington, Wis., and White Lake, Mich. On cruise 13 three cross-lake transects were made in southern Lake Michigan as follows: Manitowoc to Ludington; Racine, Wis., to Saugatuck; and Waukegan, Ill., to Benton Harbor. During cruise 14 a cross-lake transect was made from Ludington to Manitowoc. Five drags made off Saugatuck in December are a part of cruise 15. In 1963 the Kaho was active in southern Lake Michigan during 5 months.

In 1964 the fishing effort in southern Lake Michigan was about the same as in 1962. Drags were made at depths of 5 to 80 fathoms. The remainder of cruise 15 included a series of drags off Saugatuck in late January and early February and a transect between Saugatuck and Racine in March. Cruise 16 consisted of two cross-lake transects, Manitowoc to Ludington and Waukegan to Benton Harbor. Cruises 17 and 21 each consisted of three cross-lake transects as follows: Manitowoc to Ludington, Port Washington to White Lake, and Waukegan to Benton Harbor. On cruise 19, random stations were fished on both sides of southern Lake Michigan and one transect was made from Manitowoc to Ludington. In 1964 the Kaho fished in southern Lake Michigan for 7 months.

Operations in Lake Michigan during 1965 were concerned primarily with explorations in Green Bay and northern Lake Michigan; however, three transects were made between Manitowoc and Ludington during cruises 24 (April), 28 (August), and 30 (December). A depth series was also made off Port Washington during cruise 24.

Owing to rough bottom conditions close to shore in southern Lake Michigan, very few

Table 1.--Exploratory fishing effort in southern Lake Michigan by cruise and year, 1962-65

Cruise No.	Dates in southern Lake Michigan	Total drags	Gear damage		Total fishing time
			Minor	Major	
	<u>1962</u>	<u>Number</u>	<u>Number</u>	<u>Number</u>	<u>Minutes</u>
1	February 23 to April 17	54	3	-	1,595
3 Phase I	June 12 to 24	65	2	1	2,291
Phase II	July 10 to August 1	56	3	-	2,321
Phase III	August 18 to 27	61	8	3	1,987
6	November 14 to December 19	47	1	4	1,389
	Total	283	17	8	9,583
	<u>1963</u>				
9	April 10 to 24	43	3	4	1,211
13	August 25 to September 17	75	5	2	2,163
14	October 24 to 28	23	-	-	690
15 (Part)	December 17	5	-	-	150
	Total	146	8	6	4,214
	<u>1964</u>				
15 (Part)	January 30 to March 11	56	-	1	1,650
16	April 1 to 9	34	1	-	1,050
17	April 28 to May 6	66	-	1	1,865
19	July 15 to 23	65	2	-	1,727
21	September 14 to 29	71	1	1	2,052
	Total	292	4	3	8,344
	<u>1965</u>				
24	April 4 to 23	38	-	-	1,074
28	August 11 to 15	25	1	1	726
30	December 5 to 18	14	-	1	405
	Total	77	1	2	2,205
	Grand total	798	30	19	24,346

drags were made at the 5-fathom interval. Only 19 drags, or less than 2 percent of the total fishing effort, were in 7 fathoms or less. At depths from 10 to 70 fathoms the coverage was more complete (table 2).

The fishing effort by port was unequal, and not all ports were visited on each cruise. Muskegon, Mich., and Grand Haven, Mich., were visited only at the beginning of the study. Milwaukee was visited only in June 1962 and July 1964. Racine was also visited infrequently because it is near Waukegan. The ports near the areas covered intensively were Ludington, White Lake, Saugatuck, and Benton Harbor on the east shore and Wauke-

gan, Port Washington, and Manitowoc on the west shore. The total effort was 444 drags off the east shore and 354 drags off the west shore. The large number of drags off Ludington and Manitowoc was because of the inclusion of this cross-lake transect in operations that were concerned primarily with explorations of northern Lake Michigan and Green Bay. A large number of drags were also made off Saugatuck, which is the home port of the Kaho. (table 3).

Because of storms very little fishing was possible during January and February (table 4). During the remaining 10 months at least two depth series were made each month.

Table 2.--Summary of exploratory fishing effort in southern Lake Michigan by depth, 1962-65

Depth range	Drags made in:				Total
	1962	1963	1964	1965	
Fathoms	Number	Number	Number	Number	Number
5	0	4	12	3	19
10	23	7	20	4	54
15	46	15	27	7	95
20	50	14	40	9	113
25	45	17	32	8	102
30	44	13	31	8	96
35	38	14	28	6	86
40	33	12	28	7	80
45	4	14	23	7	48
50	0	13	24	6	43
60	0	10	13	5	28
70	0	8	12	5	25
80	0	4	2	2	8
90	0	1	0	0	1
Total	283	146	292	77	798

Table 3.--Summary of exploratory fishing effort in southern Lake Michigan by port, 1962-65

Port	Drags made in:				Total
	1962	1963	1964	1965	
	Number	Number	Number	Number	Number
Lugington	30	44	41	36	151
White Lake	12	8	28	0	48
Muskegon	15	0	0	0	15
Grand Haven	27	0	0	0	27
Saugatuck	50	21	43	0	114
Benton Harbor	46	12	31	0	89
Waukegan	42	11	39	0	92
Racine	0	11	18	0	29
Milwaukee	7	0	15	0	22
Port Washington	36	7	34	11	88
Manitowoc	18	32	43	30	123
Total	283	146	292	77	798

Table 4.--Summary of exploratory fishing effort in southern Lake Michigan by month, 1962-65

Month	Drags made in:				Total
	1962	1963	1964	1965	
	Number	Number	Number	Number	Number
January	0	0	13	0	13
February	2	0	3	0	5
March	10	0	39	0	49
April	42	43	54	38	177
May	0	0	47	0	47
June	65	0	0	0	65
July	51	0	65	0	116
August	66	5	0	25	96
September	0	70	71	0	141
October	0	23	0	0	23
November	30	0	0	0	30
December	17	5	0	14	36
Total	283	146	292	77	798

TRAWLING GROUNDS

Gordon (1963) described the relation of bottom conditions to trawling in southern Lake Michigan. Grounds trawled during this study are shown in figure 2.

In general the bottom was more suitable for trawling along the east shore than along the west shore. Gear was damaged most frequently while fishing the rough bottom along the west shore inside the 20-fathom contour at all stations from Manitowoc to Milwaukee. Other areas with frequent snags were off Waukegan in 20 to 25 fathoms, off Manitowoc in 35 to 40 fathoms, and near shore due west of the piers at Ludington. Better bottom for trawling was found off Ludington just south of the piers out to 35 fathoms. Gear was seldom damaged along the east shore south of Pentwater, Mich.

SPECIES COMPOSITION OF THE CATCH

The combined catch of alewives and chubs constituted over 95 percent of the total catch by weight (table 5). Alewives dominated the catch (51.4 percent) followed by chubs (44.0 percent), yellow perch (1.9 percent), sculpins (1.5 percent), and smelt (0.8 percent). Ten additional species composed less than 0.5 percent of the catch by weight.

The species composition of the trawl catch changed annually during the survey (fig. 3 and table 6). Each year the percentage of alewives in the catch increased while the percentage of chubs decreased. In 1964 alewives surpassed chubs in the catch by 38 percent. Noticeable

Table 5.--Species composition of 798 exploratory trawl catches in southern Lake Michigan, 1962-65

Species	Total catch		Occurrences in total drags		Catch rate per 1/2-hr. effort	Average catch for effective 1/2-hr. effort
	Pounds	Per-cent ¹	Number	Per-cent ¹	Pounds ¹	Pounds
Alewife (<i>Alosa pseudoharengus</i>).....	130,540	51.4	506	63	168.3	265
Chubs (<i>Leucichthys</i> spp.).....	111,723	44.0	709	89	144.0	154
Yellow perch (<i>Perca flavescens</i>).....	4,798	1.9	148	19	6.2	31
Sculpins (<i>Cottidae</i>).....	3,720	1.5	297	37	4.8	13
Smelt (<i>Osmerus mordax</i>).....	2,087	.8	251	31	2.7	8
Lake herring (<i>Leucichthys artedii</i>).....	565	.2	98	12	.7	6
Carp (<i>Cyprinus carpio</i>).....	193	.1	4	T	.2	46
Common whitefish (<i>Coregonus clupeaformis</i>)..	168	.1	37	5	.2	5
Trout-perch (<i>Percopsis omiscomaycus</i>).....	124	T	69	9	.2	2
Spottail shiner (<i>Notropis hudsonius</i>).....	96	T	44	6	.1	2
White sucker (<i>Catostomus commersoni</i>).....	40	T	10	1	T	3
Lake trout (<i>Salvelinus namaycush</i>).....	10	T	9	1	T	1
Lake sturgeon (<i>Acipenser fulvescens</i>).....	5	T	1	T	T	5
Ninespine stickleback (<i>Pungitius pungitius</i>)	4	T	4	T	T	1
Burbot (<i>Lota lota</i>).....	1	T	1	T	T	1
Total	254,074	100.0			327.5	328

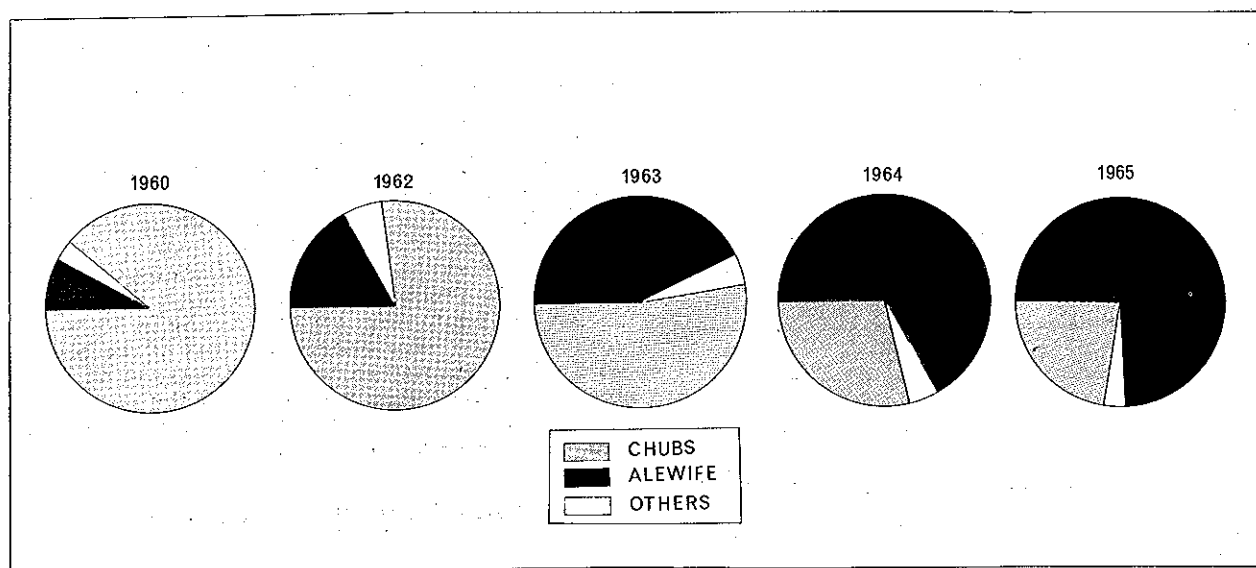
¹ T = Trace, less than 0.5 or 0.05.

Figure 3.--Species composition of exploratory trawl catches by year in southern Lake Michigan. The 1960 data are from Gordon (1963).

percentage differences occurred in 1962 for smelt and in 1965 for sculpins. These changes, however, do not necessarily represent any biological change. The high percentage of smelt in 1962 was likely the result of two factors: (1) two unusually good catches of 340 and 450 pounds and (2) a 65 percent greater fishing effort in the depths of 15 to 25 fathoms where two-thirds of the total poundage of

smelt were taken during this study. The catch rate of smelt at 15 to 25 fathoms was similar for all years. The high percentage of sculpins in 1965 was a result of greater trawling effort in water deeper than 45 fathoms.

Because of the pronounced seasonal movements of alewives and some movement by chubs, the species composition by depth zones differed for each quarter of the year (table 7).

Table 6.--Species composition of exploratory trawl catches by year in southern Lake Michigan, 1962-65

Species	1962		1963		1964		1965	
	Pounds	Percent	Pounds	Per-cent ¹	Pounds	Per-cent ¹	Pounds	Per-cent ¹
Alewife.....	10,162	17.2	20,891	43.0	84,217	67.0	15,270	73.8
Chubs.....	45,290	76.8	25,563	52.5	36,158	28.7	4,712	22.8
Yellow perch...	1,753	3.0	675	1.4	2,366	1.9	4	t
Sculpins.....	109	0.2	901	1.9	2,137	1.7	573	2.8
Smelt.....	1,303	2.2	321	0.7	376	0.3	87	0.2
Lake herring...	228	0.4	55	0.1	257	0.2	25	0.1
Whitefish.....	62	0.1	13	t	88	t	5	t
Others.....	88	0.1	183	0.4	197	0.2	5	t
Total	58,995	100.0	48,602	100.0	125,796	100.0	20,681	99.7

¹ t = trace, less than 0.05.

Table 7.--Percentage species composition of exploratory trawl catches by depth zones and one-quarter year in southern Lake Michigan, 1962-65

Depth zone	Alewife	Chubs	Yellow perch	Smelt	Sculpins	Total catch	1/2-hr. catch rate
Fathoms	Percent	Percent	Percent ¹	Percent	Percent	Pounds	Pounds
<u>January-March</u>							
5-15	0.1	0.3	76.6	0.2	0.1	1,328	78
20-50	72.7	25.1	0.1	0.3	0.5	21,820	492
60-90	75.4	18.6	t	t	5.9	2,190	438
<u>April-June</u>							
5-15	75.6	20.9	1.1	0.5	0.1	15,008	189
20-50	58.0	39.3	t	1.5	0.9	77,322	378
60-90	35.0	31.1	t	t	33.3	3,667	143
<u>July-September</u>							
5-15	62.8	26.9	6.5	0.5	t	34,023	439
20-50	22.4	76.6	0.1	0.2	0.6	58,295	218
60-90	t	44.7	t	t	55.3	1,775	71
<u>October-December</u>							
5-15	84.6	4.6	9.2	1.1	t	7,334	286
20-50	46.5	49.7	1.5	1.4	0.7	30,500	510
60-90	1.2	60.1	t	1.0	39.7	511	85
<u>January-December</u>							
5-15	69.5	21.4	7.4	0.5	t	55,018	313
20-50	46.7	51.1	0.4	0.9	0.6	190,913	332
60-90	36.1	32.6	t	t	31.2	8,143	132

¹ t = trace, less than 0.05.

January to March the yellow perch dominated the shallow-water zone and alewives the intermediate and deepwater zones. During the April to June period alewives were found at times in all depth zones and dominated the zone when present. Chubs were also common in all three zones during this period. From July through September alewives were taken most abundantly in shallow water, chubs in intermediate depths, and sculpins (mainly the deepwater sculpin, *Myoxocephalus thompsoni*) in deep water. The percentage of alewives from catches in shallow water and intermediate depth increased from October to December because the chubs moved into deeper water. Late in this period alewives moved into the intermediate and deepwater zones.

Species composition varied by area in southern Lake Michigan. Smelt, which were only 0.8 percent of the total catch, made up 2 percent of the catch in drags from Port Washington to Manitowoc. The percentages of lake herring and whitefish in the lake were higher on the east side than on the west side.

DISCUSSION BY SPECIES

The following sections describe fishing results for each of the important commercial species taken during the study. The order of

discussion is based on total poundage for the 14 cruises. Carp is considered a miscellaneous species even though it exceeded whitefish in total landings (193 pounds to 168 pounds). Although these species are taken infrequently, whitefish is important to commercial trawlers in southern Lake Michigan because it commands a high price whereas carp brings a low price.

Alewife

The alewife had the highest catch rate and highest average catch for effective effort of the species taken. The catch rate for alewives was 168 pounds, and alewives occurred in 63 percent of all drags for an average catch for effective effort of 265 pounds. Catch records of alewives by cruise and year are summarized in table 8. Catch rates varied by cruise but were generally higher on cruises made during the spring spawning run or in winter when alewives were concentrated in deep water. The highest catch rates per cruise were obtained on cruise 17 (581 pounds) and cruise 30 (580 pounds). Three of the cruises (15, 17, and 30) had average catches for effective effort of over 500 pounds. Commercially significant catches (500 pounds or more per

Table 8.--Summary of catch records of alewives in southern Lake Michigan by cruise and year, 1962-65

Year	Cruise No.	Total drags	Significant catches	Total catch	Catch rate per 1/2-hour effort	Average 1/2-hour catch for effective effort
		Number	Number	Pounds	Pounds	Pounds
1962	1	54	0	85	2	3
	3	182	1	2,744	13	38
	6	47	3	7,333	158	169
	Total or average	283	4	10,162	32	68
1963	9	43	8	10,118	251	303
	13	75	3	4,824	67	118
	14	23	4	4,069	177	271
	15	5	1	1,880	376	376
	Total or average	146	16	20,891	149	217
1964	15	56	11	17,520	319	501
	16	34	1	3,613	120	151
	17	66	22	36,135	581	651
	19	65	18	12,700	221	364
	21	71	11	14,249	208	297
	Total or average	292	63	84,217	303	421
1965	24	38	5	6,849	191	221
	28	25	0	594	24	106
	30	14	7	7,827	580	580
	Total or average	77	12	15,270	208	305

1/2-hour drag) were taken on all but two cruises, 1 and 28. Cruise 1, a shakedown cruise, apparently missed the right fishing depth. Cruise 28 fished only off Ludington and Manitowoc at a time when alewives were dispersed vertically. Of the 84 depth series, 33 or nearly 40 percent had commercially significant catches of alewives; however, in the 38 depth series covering a range of 40 fathoms or more, 22 or nearly 60 percent had commercially significant amounts of alewives. Ninety-five or 12 percent of the total drags had a catch rate of 500 pounds or more of alewives per one-half hour. The largest catch of alewives during the study was 3,800 pounds taken in 15 minutes off Manitowoc on cruise 17 (table 9). The best catch rate for an individual drag was 1,500 pounds in a 5-minute drag off Port Washington also on cruise 17.

Similar to other anadromous fishes, the alewife exhibited very pronounced seasonal movements in southern Lake Michigan. The trend of these seasonal movements is disclosed by records of fishing depths by commercial trawlers (fig. 4) and catch rates of the Kaho during selected periods (fig. 5). In general the seasonal depth availability to bottom trawls appears to follow the same pattern throughout southern Lake Michigan and can be identified in six phases as follows:

1. From the first of the year to about the second week in April, alewives concentrate on the bottom in water 35 fathoms

and deeper. Throughout February the highest catches are taken in 45 fathoms or deeper, and alewives appear to form isolated schools because they are only taken in certain areas. Late in the period few alewives are taken at less than 30 fathoms, although at the beginning of the period some are taken at shallower depths.

2. About the second week in April, alewives begin a massive spawning migration that continues through mid-May. During this period large quantities of alewives can be taken easily on the bottom over a wide depth range. The start of the spawning run is not uniform throughout the southern portion of the lake and may lag for several weeks or more. The shoreward movement begins first in the extreme southern portion of the lake and continues at successive locations northward. The inshore move appears to happen sooner on the west shore than at the same latitude on the east shore.
3. In southern Lake Michigan most of the spawning occurs from mid-May through June; however, some spawning apparently takes place into August. During mid-May to June, alewives are taken in large quantities in rivers and along the beaches in 5 fathoms or less, and very few alewives are on the bottom in water deeper than 5 fathoms.

Table 9.--Largest catch of alewives for each cruise in southern Lake Michigan, 1962-65

Cruise No.	Date	Nearest port	Depth	Time fished	Alewife catch
			Fathoms	Minutes	Pounds
¹ 1	-		25-40	30	10
3	8/17/62	Ludington	10	30	520
6	11/15/62	Waukegan	35	30	1,000
	12/14/62	Muskegon	25	30	1,000
9	4/20/63	Port Washington	25	30	2,290
13	9/10/63	Manitowoc	15	30	820
14	10/27/63	Manitowoc	14	30	990
15	2/3/64	Saugatuck	35	30	3,400
16	4/2/64	Waukegan	50	30	950
17	5/2/64	Port Washington	10	5	1,500
	5/3/64	Manitowoc	40	30	3,800
19	7/16/64	Milwaukee	20	30	1,000
	7/17/64	Racine	20	30	1,000
21	9/17/64	Waukegan	15	30	1,100
24	4/22/65	Port Washington	30	30	1,700
28	8/11/65	Ludington	10	30	310
30	12/12/65	Ludington	20	30	1,300

¹ Five 1/2-hour drags caught 10 pounds each at scattered locations between 25 and 40 fathoms.

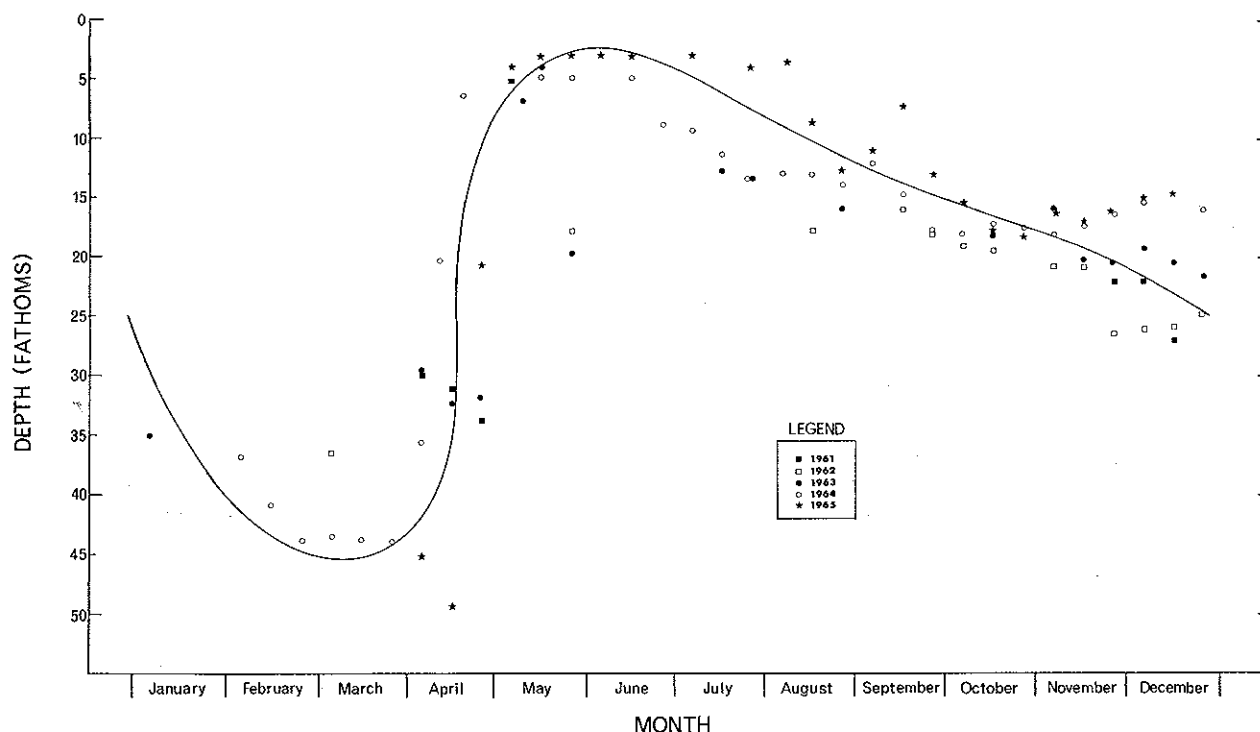


Figure 4.--The pattern of seasonal movements of alewives in southern Lake Michigan based on bottom trawl catches by commercial trawlers out of Saugatuck, Mich. When sufficient data were available, tabulations were made for three periods each month, the 1st to the 10th, the 11th to the 20th, and the 21st to the end of the month.

4. From the beginning of July to about mid-September the lake is stratified by temperature, and the depth distribution of alewives appears to be controlled by temperature. Catch rates and bottom temperatures taken from July 15 to July 23, 1964, indicate that catch rates decrease generally with temperature and few alewives are taken in trawl catches in areas where the bottom temperature is colder than 50 F. The availability of alewives from July to mid-September can also be related to depth since most of the alewives are caught in 15 fathoms or less and few are taken deeper than 25 fathoms. Catch rates begin to drop off during July and through this period.
5. From mid-September through most of November the fish are scattered and taken in trawls from shore to about 35 fathoms. The largest concentrations are taken generally between 15 and 20 fathoms. Catch rates are low during this period.
6. From the end of November to the end of the year the fish remain scattered, the best catches vary from day to day at depths from 15 to 30 fathoms, and fish concentrations must be searched for daily. The movement to deep water is

apparently rapid but has not been documented yet. This deepwater movement apparently takes place sometime in late December or early January. Catch rates during this period are also low and sporadic.

Alewives were taken in commercially significant amounts by the Kaho in every month except January and June. Only 13 drags were made in January, and none was deeper than 30 fathoms. Catches of 3,000 and 3,400 pounds in 1/2-hour drags taken on February 3, and catches of 750 and 1,000 pounds per one-half hour made on December 17 indicated that alewives might be available in commercial amounts in January. The 65 drags in June 1962 were made in 10 fathoms or deeper when spawning alewives were in water shallower than 10 fathoms. Commercial trawlers have made large significant catches during January and June.

Catch rates varied during the year. Catch rates were highest during the inshore spawning migration and spawning and were high when schools were in deep water in winter. After major spawning (about July 1) to the end of the year, catch rates were lower, because alewives dispersed and were not concentrated on the bottom.

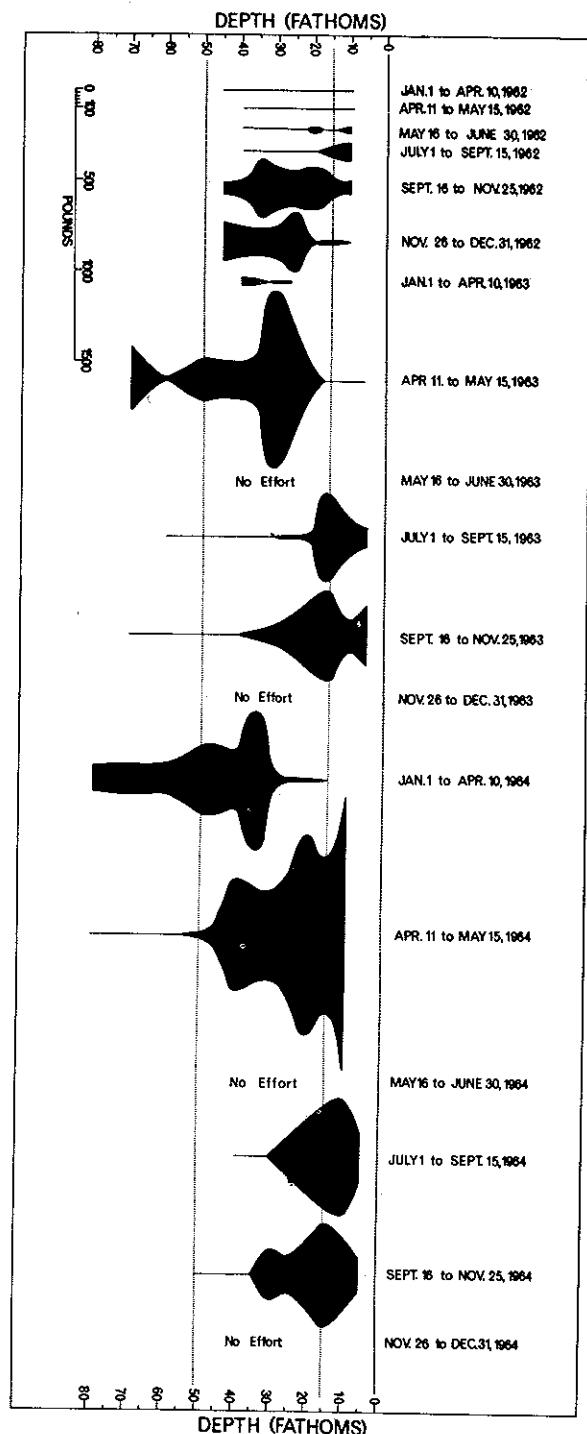


Figure 5.--Availability of alewives to bottom trawls in southern Lake Michigan by depth and selected time periods from 1962 through 1964. The expanding alewife population in Lake Michigan can be seen by comparing relative abundance during the same time period in different years. The illustration figures represent the 1/2-hour catch rate of alewives at 5-fathom intervals. In 1962 fishing was confined to 10 to 45 fathoms.

Alewives were taken in commercially significant amounts at least once off 10 of the 11 ports. A lack of fishing effort at appropriate depths during the four visits off Grand Haven in 1962 apparently accounted for the failure to take significant amounts off that port.

Catches varied from port to port during cruises, but these variations did not appear to have any uniform pattern. Catch variations were possibly caused by vertical dispersal of the schools, which was likely to be an effect of daily environmental conditions.

There is some evidence that alewives concentrate only in the southern portion of the study area during January through March. Commercial trawlers have failed to find alewives at that time off Milwaukee and Manitowoc, while trawlers from Saugatuck and the Kaho have made good catches in the southernmost portion of the lake. The Kaho did not trawl in the northern portion of the study area during these months; however, it took good catches off Manitowoc and Ludington in December 1965.

Chubs

Chubs were second in total pounds landed and composed 44 percent of the total catch. Chubs occurred most frequently, however, in the trawl catches (89 percent of all catches). The overall catch rate for chubs was 144 pounds per 1/2-hour drag, and the average catch for effective effort was 154 pounds per drag. Chub catches by cruise and year are summarized in table 10. About 3 to 5 percent of the chubs in a usual trawl catch were of a size suitable for human consumption as smoked fish. Significant amounts of chubs (250 pounds per one-half hour) were taken on 143 occasions, or 18 percent of all drags, and in 51 of the 84 depth series.

The best chub catches for each cruise are summarized in table 11. The best catch was 1,195 pounds in a 1/2-hour drag off Port Washington during cruise 3.

The seasonal movements of chubs in southern Lake Michigan are not as pronounced as those of alewives (fig. 6). Jobs (1949) described the seasonal movements and depth distribution of bloater chubs based on gill net studies. No previous attempts have described the depth distribution of chubs in Lake Michigan in relation to bottom trawling. Availability of chubs to bottom trawls is described by 3-month periods.

January through March.--Very few if any chubs were found in less than 20 fathoms. The best catches were taken at 30 to 35 fathoms or at 45 to 50 fathoms. Some chubs were in water deeper than 50 fathoms, and more were taken between 60 to 80 fathoms in this period than during the rest of the year.

Table 10.--Summary of catch records of chubs in southern Lake Michigan by cruise and year, 1962-65

Year	Cruise No.	Total drags	Signi- ficant catches	Total catch	Catch rate per 1/2-hour effort	Average 1/2-hour catch per effective effort
		<u>Number</u>	<u>Number</u>	<u>Pounds</u>	<u>Pounds</u>	<u>Pounds</u>
1962	1	54	5	4,413	83	113
	3	182	35	32,379	147	150
	6	47	15	8,498	183	188
Total or average		283	55	45,290	142	160
1963	9	43	13	7,070	175	206
	13	75	17	12,574	174	184
	14	23	11	5,842	254	278
	15	5	0	77	15	19
Total or average		146	41	25,563	185	209
1964	15	56	6	5,574	101	124
	16	34	6	5,388	154	157
	17	66	13	9,198	148	171
	19	65	8	8,115	141	150
	21	71	10	7,883	115	129
Total or average		292	43	36,158	130	146
1965	24	38	0	1,751	49	70
	28	25	0	1,583	65	75
	30	14	4	1,378	102	120
Total or average		77	4	4,712	64	82

Table 11.--Largest catch of chubs for each cruise in southern Lake Michigan, 1962-65

Cruise No.	Date	Nearest port	Depth	Time fished	Chub catch
			<u>Fathoms</u>	<u>Minutes</u>	<u>Pounds</u>
1	4/17/62	Port Washington	30	30	455
3	8/19/62	Port Washington	20	30	1,195
6	11/15/62	Waukegan	40	30	905
9	4/19/63	Port Washington	35	30	920
13	8/25/63	Ludington	25	30	669
14	10/24/63	Ludington	30	30	1,029
15	3/7/64	Racine	35	30	425
16	4/2/64	Waukegan	35	30	420
17	4/30/64	Waukegan	30	30	1,145
19	7/21/64	Manitowoc	15	30	500
21	9/18/64	Port Washington	20	30	400
24	4/18/65	Manitowoc	35	30	180
28	8/15/65	Manitowoc	35	30	180
30	12/12/65	Ludington	30	25	300
	12/17/65	Manitowoc	35	30	300
	12/18/65	Manitowoc	45	30	300

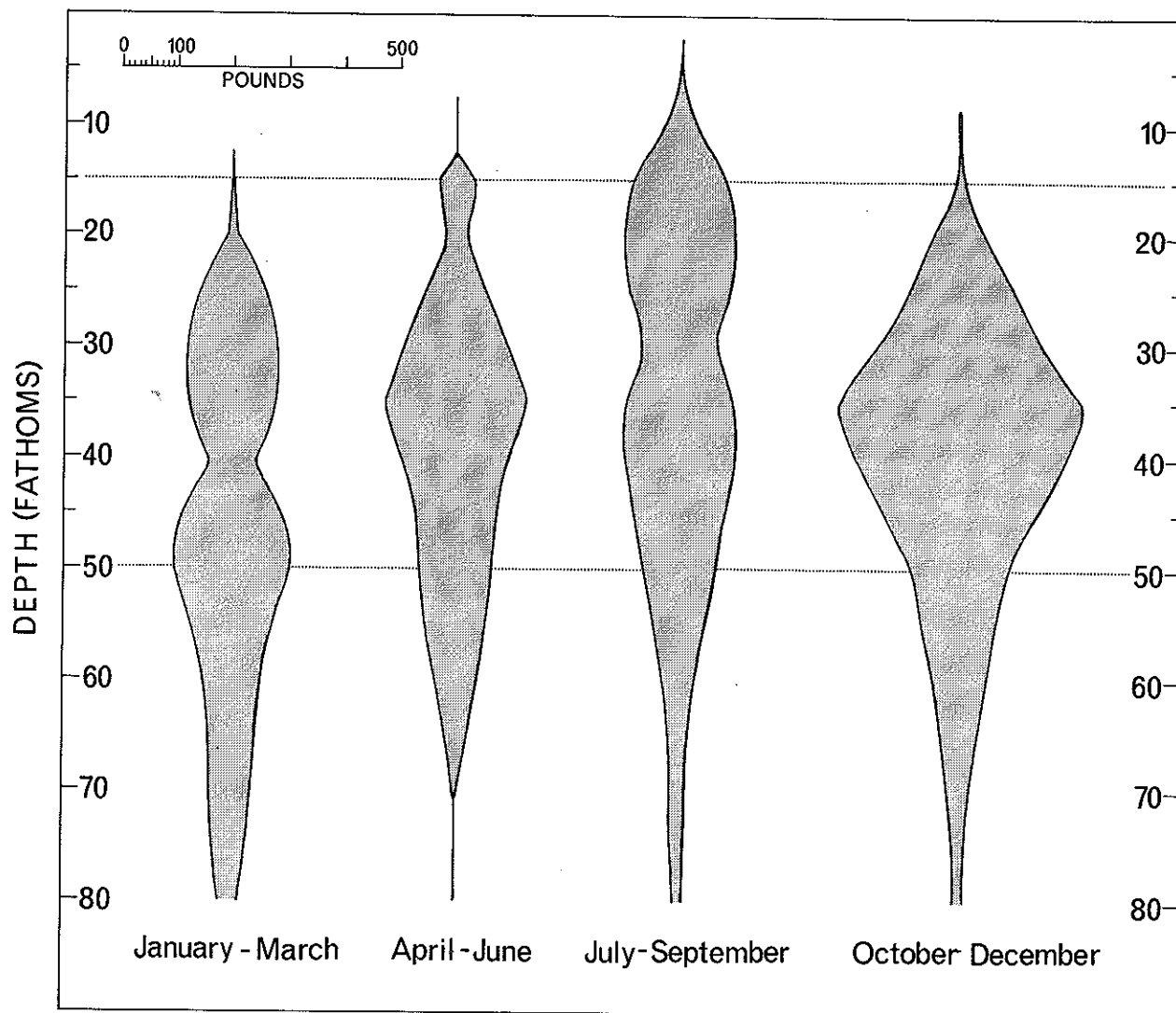


Figure 6.--Availability of chubs (primarily *Leucichthys hoyi*) to bottom trawls in southern Lake Michigan by depth and 3-month periods. The illustration figures represent catch rates of chubs at 5-fathom intervals.

April through June.--During most of this period very few chubs were taken in less than 20 fathoms; however, toward the end of the period some bloaters moved into shallower water and could be taken at that depth or shallower. The heaviest concentrations were generally in 30 to 45 fathoms. In 50 fathoms and deeper, chub catches dropped off sharply; below 70 fathoms, few chubs were taken.

July through September.--In summer, chubs were taken at all depths from 5 to 80 fathoms. At nearly all stations visited during this period, chub concentrations could be found at two distinct depths. Usually one group was concentrated somewhere between 15 and 25 fathoms and a second group somewhere between 35 and 45 fathoms.

A comparison of chub catch rates to bottom temperature was made during cruise 19. Although some chubs were taken where water temperatures were 39° and 63° F., most were found between 41° and 59° F. Jobes (1949) found the extremes of water temperature to be 34.7° to 52.5° F., and the greater abundance of chubs were in water between 38.8° and 44.6° F.

October through December.--At this time few bloaters were found in less than 20 fathoms and the largest catches were made between 30 and 40 fathoms. Catch rates tapered off beyond 40 fathoms.

During this study, chubs were taken from 5 fathoms (the shallowest depth fished) to 80 fathoms. The only drag that was made deeper

than 80 fathoms (88 fathoms) did not contain chubs. Commercially significant catches were taken only between 10 and 55 fathoms.

The occurrence of chubs in 89 percent of all drags demonstrates the universal geographic distribution and wide range of depth distribution of chubs in southern Lake Michigan. The 84 drags that lacked chubs can be described as follows: 10 drags failed to take fish owing to damaged gear, 55 drags were in 15 fathoms or shallower, 5 drags in 70 fathoms or deeper, and the remaining 14 drags between 20 and 60 fathoms. Of these 14, 12 were made at 20 to 25 fathoms in April and May.

The suggestion by Jobes (1949) that chubs tend to concentrate simultaneously in two depths of water at certain times was also borne out by this investigation. The two-depth concentration was most pronounced and commonly encountered during July, August, and September; however, indications of this pattern were also observed in May, June, and November. This pattern is demonstrated best in a study of the appendix tables.

Chubs can be harvested consistently throughout the year with a bottom trawl. Commercially significant amounts were taken in every month except February during the study. This failure is attributed to a lack of fishing effort that month (only 5 drags), because significant catches were made on January 31 and March 7 and commercial trawlers have made significant catches in February. Significant catches of chubs were taken off every port visited, thus indicating that chubs can be fished effectively from any location in southern Lake Michigan.

Yellow perch

Yellow perch were taken in 148 trawl drags and were third in total poundage landed (4,798 pounds). Owing to the dominance of alewives and chubs, yellow perch constituted less than 2 percent of the total catch. Over 90 percent of the perch were taken off Saugatuck and Waukegan, and no significant concentration was found elsewhere in southern Lake Michigan. Perch were taken in 86 drags off other ports, but the average catch for effective effort off these ports was only 5 pounds. November through March, perch were most abundant in 15 fathoms, and April through October, they were most abundant in 5 to 10 fathoms. Throughout the study 88 percent of the perch were caught in 15 fathoms or less.

Yellow perch can be trawled for selectively or avoided successfully if so desired. Alewives and yellow perch are in nearly the same depth only from early May through mid-August, but at other times alewives are in deeper water than yellow perch. When alewives and perch are in nearly the same depth, no difficulty is

encountered in selectively catching one species or the other. May through June, alewives can be fished for effectively in harbors and close to the bench and perch are taken a little deeper. July through mid-August, alewives are taken in slightly deeper water. Few perch are taken with spawning populations of alewives, as indicated by only two yellow perch in 23,000 pounds of alewives caught during a cruise in 1966 to locate spawning alewives. Yellow perch concentrations were always in shallower water than were chub concentrations.

Sculpins

Nearly 40 percent of the trawl drags in southern Lake Michigan had sculpins in amounts from several individuals to 160 pounds in a 1/2-hour drag. Although sculpins were taken at all depths, the largest catches of sculpins were made at depths over 45 fathoms. During the study 3,720 pounds of sculpins were landed at a catch rate of 4.8 pounds per drag and an average catch for effective effort of 13 pounds.

Smelt

Although smelt were in nearly one-third of all the drags in southern Lake Michigan, catches generally were small and totaled only 2,087 pounds. Smelt were taken during every month of the year, but most during the spring. Smelt were found throughout southern Lake Michigan; however, catches were extremely light along the east shore when the average catch for effective effort on smelt was just over 2 pounds and the best catch was only 33 pounds. Along the west shore the average catch for effective effort for smelt was 16 pounds. The best area for smelt was between Manitowoc and Port Washington, where two-thirds of the total catch was landed. The best catches, both made in April 1962, were 450 pounds taken in 20 fathoms off Port Washington and 340 pounds taken in 30 fathoms off Manitowoc.

Lake herring

Lake herring contributed very little to the total catch in southern Lake Michigan. In the 4-year period, lake herring were taken in only 98 drags and amounted to 565 pounds. The best catch was 100 pounds taken in April 1962 at 15 fathoms off Grand Haven. Lake herring were taken at least once at every port; however, they were 4-1/2 times more abundant on the east side of the lake and were most vulnerable to the bottom trawl during early

spring. Over 75 percent of the total catch was taken during March and April. On a year around basis, nearly 85 percent of the lake herring were taken at depths from 15 to 25 fathoms.

Whitefish

Whitefish occurred in only 37 trawl drags, and the total catch was 168 pounds. The average catch for effective effort was 4.6 pounds. The best catch was 43 pounds taken in 15 fathoms off Saugatuck in July 1964. The east shore from Ludington to Saugatuck produced 90 percent of the catch. Seventy-five percent of the whitefish were taken in 10 to 15 fathoms.

Miscellaneous species

The following species, in order of poundage, were taken in the trawl catch in southern Lake Michigan: carp, (*Cyprinus carpio*); spottail shiner, (*Notropis hudsonius*); trout-perch, (*Percopsis omiscomaycus*); white sucker, (*Catostomus commersoni*); lake trout; sturgeon, (*Acipenser fulvescens*); stickleback, (*Pungitius pungitius*) and burbot, (*Lota lota*). The occurrences, total pounds landed, catch rate, and average catch for effective effort of these species are given in table 5.

None of the miscellaneous species were taken frequently enough or in amounts large enough to indicate a potential for commercial harvesting with the bottom trawl in the near future. Carp were taken in only four drags, all in depths 10 fathoms or shallower. All but 3 pounds of the carp catch were taken off Saugatuck. The best catch was 90 pounds. Spottail shiners and trout-perch were commonly taken in small amounts in the same trawl catch. Up to 10 pounds of spottail shiners per drag were taken in 5 to 30 fathoms. Trout-perch were taken up to 3 pounds per drag in 5 to 25 fathoms. Lake trout were encountered very infrequently before the last cruise (30) when nine recently stocked trout were recovered off Manitowoc and Ludington (table 12). A single 5-pound sturgeon was taken in January 1964 in 15 fathoms off Saugatuck. Sticklebacks, suckers, and burbot were taken in very small amounts on infrequent occasions.

Adult sea lampreys were occasionally found in the trawl catches (table 13). Twelve lampreys were taken in 1962, two in 1963, four in 1964, and none in 1965. Most were taken in 20 to 25 fathoms, and 15 of 18 were taken along the west shore.

Table 12.--Occurrence of lake trout in exploratory trawl catches in southern Lake Michigan, 1962-65

Drag No.	Nearest port	Depth	Date	Lake Trout
		Fathoms		Number
73	Milwaukee	15	June 17, 1962	1
223	Saugatuck	10	August 27, 1962	1
239	Benton Harbor	20	November 14, 1962	2
331	Port Washington	20	April 20, 1963	2
584	Saugatuck	15	January 30, 1964	1
1250	Ludington	20	December 12, 1965	1
1263	Manitowoc	20	December 17, 1965	6
1266	Manitowoc	35	December 17, 1965	1
1267	Manitowoc	40	December 17, 1965	1

Table 13.--Occurrence of adult sea lampreys in exploratory trawl catches in southern Lake Michigan, 1962-65

Nearest port	Depth	Month and year	Sea Lampreys
	Fathoms		Number
Saugatuck	24	March 1962	1
Manitowoc	22	June 1962	1
Manitowoc	25	June 1962	3
Waukegan	26	July 1962	1
Waukegan	25	July 1962	1
Waukegan	20	July 1962	1
Waukegan	25	November 1962	1
Port Washington	25	July 1962	1
Port Washington	20	July 1962	1
Port Washington	30	August 1962	1
Ludington	15	September 1963	1
Ludington	14	October 1963	1
Waukegan	25	April 1964	1
Port Washington	15	July 1964	2
Manitowoc	20	July 1964	1

CONCLUSIONS

The Bureau of Commercial Fisheries Branch of Exploratory Fishing made a trawling survey of southern Lake Michigan over a 4-year period. The aims of the study were (1) to learn about the seasonal and depth distribution of the fish so that more effective and efficient fishing methods could be used to harvest the existing fish resources and (2) to give the fishing industry timely information on occurrence of fish.

Alewives (51.4 percent) and chubs (44.0 percent) dominated the total trawl catch. The percentage species composition in the trawl catch shifted from 17 percent alewives and 77 percent chubs in 1962 to 74 percent alewives and 23 percent chubs in 1965. In southern Lake Michigan large underutilized populations of these two species constitute the basis of a growing trawl fishery.

Alewives were taken in commercially significant amounts throughout the year; however, catch rates dropped from early July to December because alewives dispersed after spawning. Alewives exhibited pronounced seasonal movements and were found only at specific depths most of the year. Owing to this pronounced vertical migration, the species composition in different depth zones changed from season to season.

Chubs were taken in commercially significant amounts in all seasons throughout the study area. The seasonal movements of chubs consisted mainly of a horizontal dispersal inshore in the summer and back to deep water in the fall. Chubs were found over a wide depth range throughout the year.

Two other species, yellow perch and smelt, were taken occasionally in commercially significant quantities. Commercially significant catches of yellow perch were taken only off of Waukegan, Ill., and Saugatuck, Mich. Smelt

was most abundant along the west shore from Port Washington, Wis., to Manitowoc, Wis.

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APPENDIX

The fishing log, for 798 exploratory trawl drags in southern Lake Michigan from 1962 to 1965, is divided into 11 tables. Each table lists trawl drags off 1 of the 11 fishing ports in a clockwise direction from Ludington, Mich., to Manitowoc, Wis. Drags are listed to the nearest of these ports. The R. V. Kaho made all the drags except six drags off Ludington and eight off Manitowoc made by the R. V. Cisco during cruise 30. Table entries are primarily arranged chronologically by cruise and station if the station was visited more than once during a cruise. Entries are further arranged by descending fishing depths. All but 33 of the drags were made with a 52-foot (headrope) Gulf of Mexico type fish trawl. The remaining 33 drags (all during phase II of cruise 3) were made with a 62-foot (headrope) modified Western type box trawl and are footnoted.

Appendix table 1.--R/V Kaho Fishing Log - Lake Michigan trawl stations
off Ludington, Mich., 1962-65

Cruise No.	Depth	Date	Drag No.	Position		Course	Time of day	Fished	Limiting factor 1/	Catch						Others 2/	Total
				Lat. N.	Long. W.					Alewife	Chubs	Yellow perch	Sculpins	Smelt			
	Fath.	1962						Min.									
1	8	3-21	11	43°47'	86°38'	S.	1050	30	5	-	-	-	-	-	1	1	
	10	4-12	38	43°34'	86°32'	N.	0830	30	5	-	-	-	-	-	-	-	
	14	3-21	12	43°49'	86°28'	S.	1230	30	7	-	-	-	-	-	-	-	
	14	4-12	39	43°35'	86°33'	N.	0910	30	5	-	-	-	-	-	-	-	
	20	4-12	40	43°36'	86°35'	S.	1000	30	5	-	1	-	-	1	-	2	
	24	4-12	41	43°35'	86°34'	N.	1040	30	5	5	34	-	-	1	10	50	
	30	4-12	42	43°36'	86°36'	S.	1150	30	0	1	236	-	1	1	1	240	
	35	4-12	43	43°35'	86°36'	N.	1240	30	0	10	106	-	1	1	2	120	
	40	4-12	13	43°49'	86°29'	N.	1550	27	1	1	88	-	1	-	-	90	
40	4-12	44	43°36'	86°36'	S.	1340	30	0	1	98	-	-	1	-	100		
3 Phase I	10	6-12	101	43°37'	86°34'	N.	0950	30	8	80	3	1	-	1	-	85	
	15	6-12	102	43°39'	86°34'	SW.	1050	30	0	3	80	-	-	2	-	85	
	20	6-12	103	43°39'	86°34'	NW.	1140	30	0	-	115	-	-	5	-	120	
	25	6-12	104	43°39'	86°35'	S.	1230	30	0	1	58	-	-	1	-	60	
	29	6-12	105	43°37'	86°35'	N.	1320	30	7	1	39	-	-	-	-	40	
	35	6-12	106	43°39'	86°37'	S.	1410	30	2	-	-	-	1	-	-	1	
3 Phase III	10	8-17	199	43°37'	86°33'	N.	1000	30	3	520	133	15	1	1	-	670	
	15	8-17	198	43°39'	86°34'	S.	0910	30	0	200	600	-	-	-	-	800	
	20	8-17	197	43°37'	86°34'	N.	0830	30	0	1	528	-	-	1	-	530	
	25	8-16	196	43°37'	86°34'	N.	1540	30	0	1	219	-	-	-	-	220	
	30	8-16	195	43°39'	86°35'	S.	1450	30	0	1	148	-	-	-	1	150	
	35	8-16	194	43°37'	86°36'	N.	1340	30	2	-	149	-	-	-	1	150	
6	10	11-18	259	43°37'	86°33'	N.	1720	30	0	60	4	-	-	1	-	65	
	13	11-18	258	43°39'	86°34'	S.	1630	30	0	65	13	-	-	1	21	100	
	20	11-18	257	43°37'	86°34'	N.	1540	30	0	270	455	1	-	32	1	759	
	25	11-18	256	43°39'	86°35'	S.	1450	30	0	170	305	-	-	2	3	480	
	30	11-18	255	43°37'	86°35'	N.	1400	30	0	360	259	-	-	1	-	620	
	35	11-18	254	43°39'	86°31'	S.	1200	30	4	55	352	-	2	1	-	410	
	40	11-18	253	43°37'	86°38'	N.	1100	30	0	45	324	-	1	-	-	370	
	45	11-18	252	43°39'	86°40'	S.	1000	30	0	5	43	-	2	-	-	50	
	9	10	4-10	284	43°58'	86°32'	N.	0650	30	0	-	-	-	-	-	-	-
15		4-10	285	43°59'	86°34'	S.	0750	30	0	-	-	-	-	-	-	-	
20		4-10	286	43°58'	86°35'	N.	0850	30	4	-	-	1	-	1	-	2	
20		4-17	316	44°06'	86°28'	N.	1340	30	3	1	1	-	1	1	-	4	
25		4-10	290	44°00'	86°36'	S.	1320	5	8	1	3	-	-	1	-	5	
25		4-17	315	44°08'	86°29'	S.	1250	30	8	120	123	1	-	1	15	260	
25		4-24	337	44°06'	86°29'	N.	1010	30	8	-	300	-	-	1	19	320	
30		4-10	289	43°58'	86°36'	N.	1220	30	0	5	530	-	-	1	4	540	
35		4-10	288	44°00'	86°37'	S.	1120	30	0	20	527	-	-	1	2	550	
35		4-24	338	44°00'	86°37'	S.	1210	30	0	200	449	-	-	-	1	650	
40		4-10	287	43°58'	86°37'	N.	1020	30	0	50	378	-	-	1	1	430	
45		4-11	291	43°59'	86°38'	S.	0740	35	2	9	-	-	1	-	-	10	
45		4-11	292	44°01'	86°38'	N.	1830	30	0	810	30	-	-	-	-	840	
50		4-11	293	43°59'	86°40'	N.	0930	30	0	460	18	-	1	1	-	480	
65		4-11	294	44°01'	86°42'	S.	1050	30	2	17	32	-	1	-	-	50	
68		4-11	296	44°02'	86°57'	N.	1430	30	8	600	9	-	1	-	-	610	
75		4-11	295	44°00'	86°46'	N.	1210	30	0	100	15	-	5	-	-	120	
13 (in part)	25	8-25	434	44°00'	86°36'	N.	1120	30	0	1	669	-	-	-	-	670	
	30	8-25	433	44°01'	86°37'	S.	1030	30	3	1	64	-	-	-	-	65	
	35	8-25	432	43°59'	86°37'	N.	0930	30	0	1	198	-	1	-	-	200	
	40	8-25	431	44°01'	86°38'	S.	0840	30	0	1	318	-	1	-	-	320	
	45	8-25	430	43°59'	86°38'	N.	0730	30	0	1	259	-	-	-	-	260	
13 (in part)	7	9-13	479	43°57'	86°29'	SE.	1710	30	0	200	29	7	-	5	9	250	
	15	9-13	470	43°58'	86°34'	SE.	0720	30	0	800	167	-	-	-	3	970	
	19	9-13	471	43°57'	86°36'	N.	0820	30	4	10	275	-	3	2	-	290	
	30	9-13	472	43°59'	86°37'	S.	0940	15	8	1	238	-	1	-	-	240	
	35	9-13	473	43°57'	86°38'	N.	1020	30	0	1	408	-	1	-	-	410	
	40	9-13	474	43°59'	86°39'	S.	1120	30	0	1	279	-	-	-	-	280	
	45	9-13	475	43°59'	86°39'	S.	1220	30	0	2	213	-	5	-	-	220	
	50	9-13	476	43°57'	86°40'	N.	1310	30	0	1	223	-	5	1	-	230	
	60	9-13	477	43°59'	86°42'	S.	1420	30	0	1	74	-	10	-	-	85	
	70	9-13	478	43°57'	86°43'	N.	1520	30	0	-	90	-	40	-	-	130	

See footnotes at end of table.

Appendix table 1.--R/V Kaho Fishing Log - Lake Michigan trawl stations
off Ludington, Mich., 1962-65--Continued

Cruise No.	Depth	Date	Drag No.	Position		Course	Time of day	Fished	Limiting factor 1/	Catch						
				Lat. N.	Long. W.					Alewife	Chubs	Yellow perch	Sculpins	Smelt	Others 2/	Total
	Fath.	1963						Min.								
14	10	10-24	505	43°56'	86°30'	S.	0730	30	0	40	-	1	-	2	-	43
	14	10-24	506	43°54'	86°31'	S.	0820	30	0	280	16	10	-	2	2	310
	20	10-24	507	43°53'	86°32'	N.	0900	30	0	650	268	1	-	10	1	930
	24	10-24	508	43°54'	86°34'	S.	1000	30	0	250	629	-	1	10	-	890
	30	10-24	509	43°53'	86°35'	N.	1050	30	0	100	1,029	-	-	1	-	1,130
	35	10-24	510	43°54'	86°37'	N.	1150	30	0	50	558	-	1	1	-	610
	40	10-24	511	43°54'	86°39'	S.	1240	30	7	-	380	-	-	-	-	380
	45	10-24	512	43°56'	86°39'	S.	1330	30	7	-	378	-	2	-	-	380
	50	10-24	513	43°56'	86°39'	S.	1430	30	7	-	276	-	34	-	-	310
	60	10-26	514	43°58'	86°39'	S.	0820	30	0	1	104	-	45	-	-	150
	70	10-26	515	43°57'	86°43'	N.	0930	30	0	-	31	-	15	-	-	46
	80	10-26	516	43°59'	86°44'	S.	1050	30	0	-	20	-	15	-	-	35
1964																
16	20	4-7	666	43°59'	86°36'	S.	1230	30	0	3	2	-	-	-	-	5
	25	4-7	665	43°57'	86°36'	S.	1130	30	0	170	208	-	2	-	-	380
	30	4-7	664	43°59'	86°37'	S.	1040	30	0	15	262	-	3	-	-	280
	35	4-7	663	43°59'	86°37'	S.	0930	30	0	25	343	-	2	-	-	370
	40	4-7	662	43°59'	86°38'	S.	0840	30	0	470	220	-	-	-	-	690
	45	4-7	661	43°59'	86°38'	SW.	0730	30	0	120	176	-	4	-	-	300
	50	4-6	660	43°59'	86°39'	S.	1520	30	0	10	140	-	160	-	-	310
	60	4-6	659	44°00'	86°41'	S.	1410	30	0	5	15	-	140	-	-	160
	70	4-6	658	44°00'	86°43'	S.	1300	30	0	2	8	-	75	-	-	85
1964																
17	10	5-6	730	43°59'	86°31'	S.	0730	30	5	250	-	-	-	-	-	250
	15	5-6	731	43°59'	86°34'	S.	0820	30	5	140	6	-	2	-	2	150
	20	5-6	732	43°59'	86°36'	S.	0920	30	5	100	55	-	5	-	-	160
	25	5-6	733	43°59'	86°35'	S.	1000	30	5	5	100	-	-	-	-	105
	30	5-5	728	43°57'	86°36'	N.	1450	30	0	2	198	-	-	-	-	200
	30	5-5	729	43°59'	86°36'	S.	1540	30	5	35	65	-	-	-	-	100
	35	5-5	727	43°59'	86°37'	S.	1400	30	5	1	239	-	-	-	-	240
	40	5-5	726	43°59'	86°37'	S.	1320	30	5	5	190	-	5	-	-	200
	45	5-5	725	43°59'	86°38'	S.	1230	30	5	10	35	-	5	-	-	50
	50	5-5	724	43°59'	86°39'	S.	1140	30	5	15	135	-	30	-	-	180
	60	5-5	723	44°00'	86°41'	S.	1030	30	5	5	10	-	105	-	-	120
	70	5-5	722	44°00'	86°43'	S.	0920	30	5	-	15	-	100	-	-	115
	80	5-5	721	44°00'	86°47'	S.	0750	30	0	-	2	-	10	-	-	12
1964																
19	8	7-22	894	43°56'	86°29'	N.	0650	30	8	650	-	5	-	-	5	660
	10	7-22	895	43°56'	86°30'	S.	0730	30	0	550	5	5	-	-	-	560
	15	7-22	896	43°54'	86°31'	SE.	0820	30	0	700	200	-	-	10	-	910
	20	7-22	897	43°54'	86°31'	SE.	0920	30	0	770	189	-	-	1	-	960
	25	7-22	898	43°54'	86°34'	S.	1020	30	0	210	220	-	-	-	-	430
	30	7-22	899	43°54'	86°36'	SE.	1120	30	0	10	230	-	-	-	-	240
1964																
21	6	9-20	1009	43°56'	86°29'	N.	1730	30	0	20	-	-	-	-	-	20
	10	9-21	1010	43°57'	86°30'	S.	0700	30	0	40	-	-	-	-	-	40
	15	9-21	1011	43°54'	86°31'	S.	0800	30	0	900	10	-	-	-	10	920
	15	9-21	1012	43°53'	86°30'	N.	0840	30	0	600	-	-	-	-	-	600
	20	9-21	1013	43°54'	86°33'	S.	0950	30	7	20	130	-	-	-	-	150
	25	9-22	1014	43°55'	86°34'	SE.	0730	30	8	1	20	-	-	-	-	21
	30	9-22	1015	43°55'	86°36'	SE.	0820	30	0	-	60	-	-	-	-	60
	35	9-22	1016	43°55'	86°37'	S.	0920	30	0	2	78	-	-	-	-	80
	40	9-22	1017	43°56'	86°35'	S.	1020	30	0	-	150	-	-	-	-	150
	45	9-22	1018	43°56'	86°38'	S.	1120	30	0	-	120	-	-	-	-	120
	50	9-22	1019	43°56'	86°39'	S.	1210	30	0	-	338	-	2	-	-	340
	70	9-20	1007	44°00'	86°57'	E.	1350	30	0	-	-	-	5	-	-	5
	70	9-20	1008	43°59'	86°45'	E.	1530	30	0	-	15	-	40	-	-	55

See footnotes at end of table.

Appendix table 1.--R/V Kaho Fishing Log - Lake Michigan trawl stations
off Ludington, Mich., 1962-65--Continued

Cruise No.	Depth	Date	Drag No.	Position		Course	Time of day	Fished	Limiting factor 1/	Catch							Total
				Lat. N.	Long. W.					Alewife	Chubs	Yellow perch	Sculpins	Smelt	Others 2/		
	Fath.	1965						Min.				Pounds					
24	5	4-14	1076	43°56'	86°29'	N.	0920	17	2	-	-	-	-	-	-	-	
	10	4-14	1077	43°56'	86°30'	S.	1000	30	0	-	-	-	-	1	-	1	
	15	4-14	1078	43°53'	86°30'	N.	1050	30	0	1	-	1	-	1	-	3	
	20	4-14	1079	43°55'	86°32'	SE.	1150	30	0	2	-	-	-	-	-	2	
	25	4-14	1080	43°53'	86°33'	N.	1230	30	0	2	60	-	-	-	3	65	
	30	4-14	1081	43°55'	86°36'	S.	1320	30	0	10	110	-	-	-	-	120	
	30	4-14	1082	43°53'	86°36'	N.	1410	30	0	4	96	-	-	-	-	100	
	35	4-14	1083	43°56'	86°37'	S.	1500	30	0	2	126	-	2	-	-	130	
	40	4-14	1084	43°56'	86°38'	S.	1550	30	0	-	14	-	-	-	-	14	
	40	4-17	1085	43°58'	86°38'	S.	0710	30	0	7	150	-	3	-	-	160	
	45	4-17	1086	43°58'	86°38'	S.	0800	30	0	5	80	-	-	-	-	85	
	50	4-17	1087	43°58'	86°39'	S.	0850	30	0	-	65	-	-	-	-	65	
	60	4-17	1088	43°59'	86°42'	S.	0940	30	0	18	37	-	-	-	-	55	
	70	4-17	1089	43°59'	86°43'	S.	1040	30	8	20	-	-	60	-	-	80	
	80	4-17	1090	43°59'	86°45'	S.	1140	30	7	5	-	-	35	-	-	40	
28	5	8-11	1167	43°58'	86°29'	S.	0650	30	0	5	-	1	-	-	-	6	
	10	8-11	1168	43°56'	86°30'	S.	0740	30	0	310	27	-	-	-	3	340	
	10	8-11	1169	43°54'	86°30'	N.	0820	30	3	150	10	-	-	-	-	160	
	15	8-11	1170	43°54'	86°31'	S.	0940	30	2	-	-	-	-	-	-	-	
	15	8-13	1171	43°54'	86°31'	SE.	0800	30	0	120	80	-	-	-	-	200	
	20	8-13	1172	43°52'	86°32'	NW.	0910	30	0	-	160	-	-	-	-	160	
	25	8-13	1173	43°54'	86°34'	S.	1010	30	0	-	150	-	-	-	-	150	
	30	8-13	1174	43°52'	86°36'	NW.	1110	30	0	-	125	-	5	-	-	130	
	35	8-13	1175	43°54'	86°37'	N.	1210	23	4	-	110	-	-	-	-	110	
	40	8-13	1176	43°56'	86°38'	S.	1310	30	0	-	-	-	-	-	-	-	
	45	8-13	1177	43°45'	86°39'	N.	1410	30	0	-	160	-	10	-	-	170	
	50	8-13	1178	43°56'	86°39'	S.	1510	30	0	-	12	-	10	-	-	22	
	60	8-13	1179	43°54'	86°40'	N.	1610	30	0	-	20	-	110	-	-	130	
	70	8-13	1180	43°56'	86°42'	S.	1710	30	0	-	10	-	90	-	-	100	
	80	8-14	1181	43°57'	86°45'	NW.	0800	30	0	-	10	-	70	-	-	80	
30	5	12-5	1247	43°57'	86°29'	S.	0900	30	0	50	-	-	-	-	-	50	
	10	12-12	1248	43°58'	86°32'	S.	0840	30	7	1,000	1	1	-	-	-	1,002	
	15	12-12	1249	43°58'	86°34'	S.	1000	30	7	1,100	4	1	1	5	1	1,112	
	20	12-12	1250	43°56'	86°36'	N.	1100	30	7	1,300	40	-	-	10	2	1,352	
	25	12-12	1251	43°57'	86°37'	N.	1210	30	7	750	100	-	10	10	-	870	
	30	12-12	1252	43°57'	86°37'	N.	1320	25	4	500	300	-	5	10	-	815	

1/ 0 - clear drag, 1 - snag encountered (no gear damage), 2 - gear malfunction, 3 - minor gear damage, 4 - major gear damage (including loss of net), 5 - wind over 20 m.p.h., 6 - strong current, 7 - adverse weather conditions (including ice, fog, high seas), 8 - rough bottom, 9 - set fishing gear in area.

2/ Include lake herring, carp, common whitefish, trout-perch, spottail shiner, white sucker, lake trout, lake sturgeon, stickleback, and burbot.

Appendix table 2.--R/V Kaho Fishing Log - Lake Michigan trawl stations
off White Lake, Mich., 1962-64

Cruise No.	Depth	Date	Drag No.	Position		Course	Time of day	Fished	Limiting factor 1/	Catch							Total
				Lat. N.	Long. W.					Alewife	Chubs	Yellow perch	Sculpins	Smelt	Others 2/		
												Pounds					
1962																	
Fath.																	
Min.																	
3 Phase II	10	7-22	139	43°19'	86°26'	NE.	1130	30	8	-	341	4	-	1	4	350	
	14	7-22	140	43°17'	86°27'	S.	1230	30	8	-	146	-	-	1	3	150	
	19	7-22	141	43°19'	86°29'	N.	1320	30	0	-	270	1	-	1	8	280	
	25	7-22	142	43°17'	86°30'	S.	1420	30	0	-	149	1	-	-	-	150	
	30	7-22	143	43°19'	86°30'	N.	1510	30	0	-	159	-	1	-	-	160	
	35	7-22	144	43°17'	86°31'	S.	1600	30	3	-	140	-	-	-	-	140	
1962																	
3 Phase III	10	8-16	188	43°19'	86°26'	SE.	0650	30	0	-	49	1	-	-	-	50	
	15	8-16	189	43°18'	86°27'	N.	0730	30	4	150	299	1	-	-	-	450	
	20	8-16	190	43°19'	86°29'	S.	0830	25	0	1	99	-	-	-	-	100	
	25	8-16	191	43°18'	86°30'	N.	0910	30	0	-	26	-	-	-	-	26	
	30	8-16	192	43°19'	86°30'	S.	1010	30	0	1	269	-	-	-	-	270	
	35	8-16	193	43°18'	86°31'	N.	1050	30	0	-	288	2	-	-	-	290	
1963																	
9	20	4-18	323	43°16'	86°28'	N.	1600	30	0	1	5	1	1	1	-	9	
	25	4-18	322	43°18'	86°30'	S.	1510	20	0	-	107	1	-	2	-	110	
	29	4-18	321	43°16'	86°31'	N.	1410	30	0	1	526	1	1	1	-	530	
	35	4-18	320	43°18'	86°31'	S.	1310	30	0	1	698	1	-	-	-	700	
	40	4-18	319	43°15'	86°32'	N.	1220	30	0	10	419	-	1	-	-	430	
	45	4-18	318	43°18'	86°34'	S.	1130	30	0	5	253	1	-	-	1	260	
	55	4-18	317	43°25'	86°37'	N.	1010	5	1	-	32	-	3	-	-	35	
	65	4-19	324	43°23'	86°41'	N.	0740	30	4	5	1	-	35	-	-	41	
1964																	
17	10	5-4	709	43°23'	86°27'	N.	0710	30	0	1,340	9	1	-	-	-	1,350	
	15	5-4	710	43°23'	86°28'	N.	0800	30	0	320	190	-	-	-	-	510	
	20	5-4	711	43°25'	86°29'	S.	0840	30	0	160	120	-	-	-	-	280	
	20	5-4	712	43°23'	86°29'	N.	0930	30	0	150	120	-	-	-	-	270	
	25	5-4	713	43°23'	86°30'	N.	1020	30	0	35	55	-	-	-	-	90	
	30	5-4	714	43°23'	86°31'	N.	1110	30	0	30	50	-	-	-	-	80	
	35	5-4	715	43°23'	86°32'	N.	1200	30	0	4	85	-	2	-	-	91	
	40	5-4	716	43°23'	86°33'	N.	1250	30	0	1	83	-	1	-	-	85	
	45	5-4	717	43°23'	86°34'	N.	1340	30	0	-	34	-	1	-	-	35	
	50	5-4	718	43°23'	86°35'	N.	1430	30	0	-	95	-	25	-	-	120	
	60	5-4	719	43°23'	86°39'	N.	1340	30	0	1	14	-	50	-	-	65	
	70	5-4	720	43°25'	86°46'	N.	1650	30	0	1	9	-	80	-	-	90	
1964																	
19	5	7-22	900	43°22'	86°27'	N.	1510	15	0	230	-	8	-	-	2	240	
	10	7-22	901	43°23'	86°28'	S.	1540	13	9	400	1	9	-	-	-	410	
	15	7-22	902	43°23'	86°29'	N.	1620	15	0	330	191	1	-	5	3	530	
	20	7-22	903	43°23'	86°29'	S.	1640	15	0	50	175	-	-	5	-	230	
	25	7-22	904	43°22'	86°30'	N.	1710	15	0	-	100	-	-	-	-	100	
1964																	
21	5	9-29	1030	43°21'	86°25'	N.	1520	15	0	2	-	-	-	-	-	2	
	10	9-29	1029	43°21'	86°27'	N.	1440	30	0	115	-	-	-	-	-	115	
	15	9-29	1020	43°22'	86°28'	N.	0640	30	0	520	20	-	-	-	-	540	
	15	9-29	1021	43°24'	86°28'	S.	0720	30	0	450	20	-	-	-	-	470	
	20	9-29	1022	43°22'	86°29'	N.	0800	30	0	120	10	-	-	-	-	130	
	25	9-29	1023	43°22'	86°30'	N.	0840	30	0	650	30	-	-	-	-	680	
	30	9-29	1024	43°22'	86°31'	N.	0920	30	0	330	140	-	-	-	-	470	
	35	9-29	1025	43°22'	86°32'	N.	1000	30	0	1	9	-	-	-	-	10	
	40	9-29	1026	43°22'	86°33'	W.	1040	30	0	6	10	-	-	-	-	16	
	45	9-29	1027	43°22'	86°34'	N.	1130	30	0	-	85	-	-	-	-	85	
	50	9-29	1028	43°22'	86°35'	N.	1220	30	0	-	44	-	15	-	1	60	

1/ 0 - clear drag, 1 - snag encountered (no gear damage), 2 - gear malfunction, 3 - minor gear damage, 4 - major gear damage (including loss of net), 5 - wind over 20 m.p.h., 6 - strong current, 7 - adverse weather conditions (including ice, fog, high seas), 8 - rough bottom, 9 - set fishing gear in area.

2/ Include lake herring, carp, common whitefish, trout-perch, spottail shiner, white sucker, lake trout, lake sturgeon, stickleback, and burbot.

Appendix table 3.--R/V Kaho Fishing Log - Lake Michigan trawl stations
off Muskegon, Mich., 1962

Cruise No.	Depth	Date	Drag No.	Position		Course	Time of day	Fished	Limiting factor 1/	Catch						Total
				Lat. N.	Long. W.					Alewife	Chubs	Yellow perch	Sculpins	Smelt	Others 2/	
	Fath.	1962					Min.									
1	10	4-11	35	43°18'	86°26'	N.	1540	30	8	-	-	-	-	-	-	-
	15	4-11	36	43°19'	86°28'	S.	1630	30	7	1	-	1	-	1	1	4
	19	4-11	37	43°18'	86°29'	N.	1720	30	7	-	18	-	-	1	6	25
1962																
6 (in part)	10	11-19	260	43°09'	86°19'	S.	0820	30	0	150	48	1	-	1	-	200
	14	11-19	261	43°07'	86°21'	S.	0910	30	0	160	58	1	-	1	-	220
	19	11-19	262	43°09'	86°22'	N.	1000	30	0	200	49	-	-	1	-	250
	24	11-19	263	43°07'	86°23'	S.	1100	30	7	300	138	-	-	1	1	440
	29	11-19	264	43°07'	86°25'	S.	1150	10	7	120	89	-	-	1	-	210
	35	11-19	265	43°07'	86°25'	S.	1240	30	7	120	357	-	1	1	1	480
	40	11-19	266	43°09'	86°27'	N.	1330	30	7	120	250	-	-	-	-	370
1962																
6 (in part)	10	12-14	267	43°07'	86°18'	N.	1250	30	0	-	-	-	-	-	-	-
	15	12-14	268	43°09'	86°20'	NW.	1340	30	0	45	2	-	-	1	1	49
	20	12-14	269	43°07'	86°21'	N.	1430	30	0	30	1	-	-	1	1	33
	25	12-14	270	43°09'	86°22'	N.	1520	30	0	1,000	150	-	3	4	3	1,160
	30	12-14	271	43°07'	86°24'	N.	1620	30	0	500	200	-	3	4	3	710

1/ 0 - clear drag, 1 - snag encountered (no gear damage), 2 - gear malfunction, 3 - minor gear damage, 4 - major gear damage (including loss of net), 5 - wind over 20 m.p.h., 6 - strong current, 7 - adverse weather conditions (including ice, fog, high seas), 8 - rough bottom, 9 - set fishing gear in area.

2/ Include lake herring, carp, common whitefish, trout-perch, spottail shiner, white sucker, lake trout, lake sturgeon, stickleback, and burbot.

Appendix table 4.--R/V Kaho Fishing Log - Lake Michigan trawl stations
off Grand Haven, Mich., 1962

Cruise No.	Depth	Date	Drag No.	Position		Course	Time of day	Fished	Limiting factor 1/	Catch						Total
				Lat. N.	Long. W.					Alewife	Chubs	Yellow perch	Sculpins	Smelt	Others 2/	
	Fath.	1962					Min.									
1	11	4-11	30	43°04'	86°18'	N.	0750	30	0	1	-	1	-	1	10	13
	15	4-10	28	43°01'	86°18'	S.	1550	30	7	1	-	-	-	1	2	4
	19	4-10	29	42°59'	86°18'	N.	1640	30	7	7	100	1	-	1	103	212
	24	4-11	31	43°05'	86°21'	S.	0850	30	0	1	104	1	1	1	2	110
	28	4-11	32	43°04'	86°22'	N.	0950	30	0	1	195	1	1	1	1	200
	34	4-11	33	43°05'	86°23'	S.	1050	30	0	10	167	-	1	1	1	180
	39	4-11	34	43°04'	86°24'	N.	1140	30	0	10	129	-	-	1	-	140
1962																
3 Phase I	10	6-13	88	43°09'	86°19'	S.	0720	30	0	24	1	-	-	-	-	25
	15	6-13	89	43°07'	86°20'	NW.	0810	30	0	1	24	-	-	-	-	25
	20	6-13	90	43°09'	86°23'	S.	0850	30	0	1	59	-	-	-	-	60
	25	6-13	91	43°07'	86°23'	N.	0950	30	0	-	70	-	-	-	-	70
	30	6-13	92	43°09'	86°25'	SE.	1040	30	0	-	75	-	-	-	-	75
	35	6-13	93	43°07'	86°25'	N.	1130	30	0	-	119	1	-	-	-	120
	40	6-13	94	43°09'	86°28'	S.	1230	30	0	-	80	-	-	-	-	80
1962																
3 Phase II	12	7-23	150	43°07'	86°20'	N.	1240	30	0	10	310	-	-	-	-	320
	20	7-23	149	43°09'	86°23'	S.	1200	30	0	-	280	-	-	-	-	280
	25	7-23	148	43°07'	86°23'	N.	1100	30	0	-	228	1	1	-	-	230
	30	7-23	147	43°09'	86°25'	S.	1010	30	0	-	248	1	1	-	-	250
	35	7-23	146	43°07'	86°25'	N.	0920	30	0	-	148	1	1	-	-	150
	40	7-23	145	43°09'	86°28'	S.	0820	30	0	-	139	1	-	-	-	140
1962																
3 Phase III	10	8-15	181	43°04'	86°08'	N.	1130	30	0	1	118	40	-	1	-	160
	15	8-15	182	43°06'	86°19'	S.	1220	30	0	1	575	3	-	1	-	580
	20	8-15	183	43°04'	86°20'	N.	1310	30	0	1	319	-	-	-	-	320
	25	8-15	184	43°06'	86°21'	S.	1410	30	0	-	230	-	-	-	-	230
	30	8-15	185	43°04'	86°22'	N.	1510	30	2	-	-	-	-	-	-	-
	35	8-15	186	43°06'	86°25'	S.	1550	30	0	1	146	1	1	1	-	150
	40	8-15	187	43°04'	86°24'	N.	1650	30	0	-	198	1	1	-	-	200

1/ 0 - clear drag, 1 - snag encountered (no gear damage), 2 - gear malfunction, 3 - minor gear damage, 4 - major gear damage (including loss of net), 5 - wind over 20 m.p.h., 6 - strong current, 7 - adverse weather conditions (including ice, fog, high seas), 8 - rough bottom, 9 - set fishing gear in area.

2/ Include lake herring, carp, common whitefish, trout-perch, spottail shiner, white sucker, lake trout, lake sturgeon, stickleback, and burbot.

Appendix table 5.--R/V Kaho Fishing Log - Lake Michigan trawl stations
off Saugatuck, Mich., 1962-64

Cruise No.	Depth	Date	Drag No.	Position		Course	Time of day	Fished	Limiting factor	Catch							Total
				Lat. N.	Long. W.					Alewife	Chubs	Yellow perch	Sculpins	Smelt	Others 2/		
	Fath.	1962						Min.									
1 (in part)	9	3-20	3	42°48'	86°14'	N.	1000	30	8	-	-	6	-	1	7	14	
	14	3-20	4	42°52'	86°16'	S.	1120	30	0	-	1	5	1	1	13	21	
	18	3-20	5	42°52'	86°18'	SE.	1230	30	0	1	20	1	-	-	8	30	
	19	2-23	2	42°41'	86°19'	N.	1620	15	5	-	6	150	-	1	3	160	
	24	3-20	6	42°52'	86°19'	S.	1420	30	0	-	18	12	-	1	4	35	
	28	3-20	7	42°48'	86°20'	N.	1530	13	2	1	15	1	-	1	1	19	
	29	3-20	8	42°50'	86°20'	N.	1620	30	0	1	27	1	-	1	1	31	
	33	3-20	9	42°51'	86°22'	N.	1740	40	0	1	115	1	1	1	1	120	
	36	2-23	1	42°41'	86°22'	N.	1410	30	5	-	110	-	10	-	-	120	
	39	3-20	10	42°51'	86°26'	NW.	1920	30	0	10	35	3	2	-	10	60	
1962																	
1 (in part)	15	4-3	14	42°38'	86°17'	N.	0830	30	0	4	-	-	-	-	-	4	
	20	4-3	15	42°39'	86°18'	S.	0920	30	0	1	1	2	-	1	8	13	
	24	4-3	16	42°37'	86°20'	N.	1010	30	0	1	160	-	-	1	28	190	
	29	4-3	17	42°39'	86°22'	S.	1110	30	0	1	93	1	-	1	14	110	
	35	4-3	18	42°38'	86°23'	N.	1210	30	0	-	3	-	-	1	1	5	
	40	4-3	19	42°39'	86°25'	S.	1310	30	0	-	3	-	-	1	-	4	
	44	4-3	20	42°38'	86°35'	N.	1410	30	0	1	3	-	-	-	-	4	
1962																	
3 Phase I	10	6-24	119	42°41'	86°15'	S.	1040	30	0	75	1	4	-	-	-	80	
	14	6-14	95	42°30'	86°18'	S.	1050	30	0	-	5	-	-	-	-	5	
	15	6-23	107	42°41'	86°17'	N.	0040	70	0	-	31	-	1	-	-	32	
	15	6-23	110	42°42'	86°17'	S.	0550	81	0	-	268	-	1	-	-	270	
	15	6-23	111	42°40'	86°17'	S.	0730	60	0	-	279	1	-	-	-	280	
	15	6-23	112	42°38'	86°17'	N.	0850	60	0	-	338	-	-	1	1	340	
	15	6-23	113	42°40'	86°17'	S.	2020	60	0	-	129	1	-	-	-	130	
	15	6-23	114	42°38'	86°17'	N.	2130	60	0	-	74	-	1	-	-	75	
	15	6-24	115	42°40'	86°17'	S.	0530	60	0	-	128	1	1	-	-	130	
	15	6-24	116	42°38'	86°17'	N.	0650	60	0	-	229	1	-	-	-	230	
	15	6-24	117	42°40'	86°17'	S.	0750	60	0	1	189	-	-	-	-	190	
	15	6-24	118	42°38'	86°17'	N.	0920	60	0	-	297	2	-	1	-	300	
	16	6-23	108	42°43'	86°17'	S.	0130	30	0	-	58	-	1	1	-	60	
	16	6-23	109	42°40'	86°17'	N.	0440	60	0	-	149	-	1	-	-	150	
	20	6-14	96	42°31'	86°20'	N.	1150	30	0	-	1	-	-	-	-	1	
	24	6-14	97	42°31'	86°22'	S.	1240	30	0	-	1	-	-	-	-	1	
	30	6-14	98	42°31'	86°24'	N.	1330	30	0	-	1	-	-	-	-	1	
	35	6-14	99	42°31'	86°27'	S.	1430	30	0	-	18	-	-	-	-	18	
	38	6-14	100	42°31'	86°31'	NE.	1530	30	0	-	8	-	-	-	-	8	
1962																	
3 Phase III	10	8-27	223	42°48'	86°15'	N.	1210	15	0	9	-	130	-	-	1	140	
	15	8-24	231	42°20'	86°16'	S.	1240	60	3	-	600	-	-	-	-	600	
	15	8-24	232	42°16'	86°16'	N.	1400	60	0	1	635	3	-	-	1	640	
	15	8-25	233	42°28'	86°16'	S.	1950	60	3	-	140	-	-	-	-	140	
	15	8-25	234	42°24'	86°16'	S.	2120	60	0	-	100	-	-	-	-	100	
	15	8-25	235	42°20'	86°16'	S.	2230	60	0	-	100	-	-	-	-	100	
	15	8-25	236	42°16'	86°16'	N.	2350	120	0	-	100	-	-	-	-	100	
	18	8-27	224	42°39'	86°18'	S.	1230	15	0	-	100	-	-	-	-	100	
	18	8-27	225	42°42'	86°18'	N.	1140	15	0	-	120	-	-	-	-	120	
	20	8-27	226	42°41'	86°19'	N.	1310	15	0	-	110	-	-	-	-	110	
	20	8-24	229	42°28'	86°16'	S.	0930	60	0	-	120	-	-	-	-	120	
	20	8-24	230	42°24'	86°16'	S.	1130	60	0	-	560	-	-	-	-	560	
	22	8-27	227	42°40'	86°19'	S.	1350	30	0	-	100	-	-	-	-	100	
	25	8-27	228	42°40'	86°20'	N.	1450	45	0	-	199	1	-	-	-	200	
1963																	
13	5	9-6	435	42°45'	86°13'	N.	0930	30	0	25	-	420	-	-	105	550	
	10	9-6	436	42°43'	86°14'	N.	1030	30	0	200	166	2	-	1	71	440	
	15	9-6	437	42°45'	86°17'	N.	1120	30	0	1	239	-	-	-	-	240	
	19	9-6	438	42°43'	86°18'	N.	1220	30	0	5	275	-	-	-	-	280	
	23	9-15	481	42°25'	86°24'	SW.	1340	30	0	3	196	-	-	-	1	200	
	24	9-15	480	42°33'	86°21'	SW.	1210	30	0	3	186	-	-	-	1	190	
	25	9-6	439	42°45'	86°19'	S.	1310	30	0	-	198	1	1	-	-	200	
	30	9-6	440	42°43'	86°21'	N.	1400	30	0	-	150	-	-	-	-	150	
	35	9-7	441	42°43'	86°22'	N.	0820	30	0	-	45	-	-	-	-	45	
	40	9-7	442	42°43'	86°24'	S.	0930	30	0	-	228	1	1	-	-	230	
	45	9-7	443	42°41'	86°30'	N.	1050	30	0	-	113	-	7	-	-	120	
	50	9-7	444	42°43'	86°36'	S.	1220	30	0	1	208	-	1	-	-	210	
	60	9-7	445	42°41'	86°44'	N.	1350	30	0	-	30	-	5	-	-	35	
	71	9-7	446	42°43'	86°47'	S.	1510	30	7	-	50	-	30	-	-	80	
	80	9-8	447	42°41'	86°51'	N.	1010	30	0	-	32	-	13	-	-	45	
	88	9-8	448	42°43'	86°55'	N.	1150	30	0	-	-	-	1	-	-	1	

See footnotes at end of table.

Appendix table 5.--R/V Kaho Fishing Log - Lake Michigan trawl stations
off Saugatuck, Mich., 1962-64--Continued

Cruise No.	Depth	Date	Drag No.	Position		Course	Time of day	Fished	Limiting factor	Catch							Total
				Lat. N.	Long. W.					Alewife	Chubs	Yellow perch	Sculpins	Smelt	Others ^{2/}		
	Fath.	1963						Min.									
15 (in part)	17	12-17	573	42°41'	86°17'	S.	9810	30	7	860	34	22	-	4	-	920	
	17	12-17	574	42°39'	86°17'	N.	0900	30	7	120	20	5	-	-	5	150	
	17	12-17	575	42°41'	86°17'	S.	0950	30	7	450	14	11	-	-	5	480	
	17	12-17	576	42°39'	86°17'	N.	1040	30	7	150	9	1	-	-	-	160	
	17	12-17	577	42°41'	86°17'	S.	1210	30	7	300	-	-	-	-	-	300	
15 (in part)	5	1-30	579	42°42'	86°13'	N.	0830	30	0	-	-	20	-	-	10	30	
	5	1-30	580	42°42'	86°13'	S.	0910	30	0	-	-	45	2	3	15	65	
	10	1-30	581	42°41'	86°15'	N.	1000	30	0	-	-	85	1	-	19	105	
	10	1-30	582	42°42'	86°15'	S.	1040	30	0	-	-	110	2	-	8	120	
	15	1-28	578	42°42'	86°17'	S.	1410	30	0	-	-	30	-	-	10	40	
	15	1-30	583	42°41'	86°17'	N.	1130	30	0	-	-	230	1	-	19	250	
	15	1-30	584	42°42'	86°17'	S.	1210	30	0	-	-	320	2	-	18	340	
	20	1-30	585	42°41'	86°17'	N.	1300	30	0	-	16	3	6	1	14	40	
	20	1-30	586	42°42'	86°17'	S.	1340	30	0	-	14	1	6	2	12	35	
	25	1-30	587	42°41'	86°19'	N.	1430	30	0	1	127	-	2	-	-	130	
	25	1-30	588	42°42'	86°19'	S.	1530	30	0	-	203	-	5	-	2	210	
	30	1-31	589	42°41'	86°21'	N.	0910	30	7	20	254	-	1	5	-	280	
	30	1-31	590	42°42'	86°21'	SW.	1000	30	7	45	215	-	-	-	-	260	
	35	2-3	591	42°41'	86°23'	N.	0830	30	0	3,000	30	-	-	-	-	3,030	
	35	2-3	592	42°42'	86°25'	S.	0940	30	0	3,400	30	-	-	-	-	3,430	
	40	2-3	593	42°41'	86°25'	N.	1050	30	0	2,400	60	-	-	-	-	2,460	
15 (in part)	10	3-10	628	42°41'	86°15'	N.	0810	30	7	-	-	40	1	1	13	55	
	10	3-10	629	42°42'	86°15'	S.	0850	30	7	-	-	32	1	1	8	42	
	15	3-10	630	42°41'	86°16'	N.	0940	30	7	10	2	30	1	5	37	85	
	15	3-10	631	42°42'	86°16'	S.	1030	30	7	5	-	48	2	5	20	80	
	20	3-3	594	42°41'	86°17'	N.	0950	30	0	1	20	1	1	5	7	35	
	20	3-3	595	42°42'	86°17'	S.	1040	30	0	1	20	1	1	1	11	35	
	25	3-3	596	42°41'	86°19'	N.	1130	30	0	1	186	-	1	5	27	220	
	25	3-3	597	42°42'	86°19'	S.	1220	30	0	1	145	-	1	2	11	160	
	30	3-3	598	42°41'	86°20'	N.	1310	30	0	5	200	-	2	5	8	220	
	30	3-3	599	42°42'	86°21'	S.	1400	30	0	2	80	-	1	1	1	85	
	35	3-3	600	42°41'	86°22'	N.	1450	30	0	650	115	-	3	2	-	770	
	35	3-3	601	42°42'	86°22'	S.	1540	30	0	500	85	-	1	1	3	590	
	40	3-3	602	42°41'	86°25'	N.	1650	30	0	400	85	-	2	1	2	490	
	40	3-3	603	42°42'	86°25'	S.	1740	30	0	80	55	-	2	3	-	140	
	45	3-4	604	42°41'	86°31'	N.	0850	30	4	1,900	100	-	-	-	-	2,000	
	45	3-4	605	42°42'	86°31'	S.	1000	30	0	1,000	114	1	5	-	-	1,120	
50	3-4	606	42°41'	86°35'	N.	1130	30	0	1,300	100	-	-	-	-	1,400		
50	3-4	607	42°42'	86°35'	S.	1250	30	0	1,100	100	-	-	-	-	1,200		
60	3-4	608	42°41'	86°44'	N.	1420	30	0	300	100	-	-	-	-	400		
60	3-4	609	42°42'	86°44'	S.	1520	30	0	700	115	-	5	-	-	820		
70	3-6	610	42°41'	86°47'	N.	1120	30	7	510	80	-	10	-	-	600		
80	3-11	632	42°41'	86°50'	N.	1010	30	0	140	34	-	95	-	-	-	259	
16	35	4-9	667	42°43'	86°25'	S.	1030	30	0	300	119	-	1	-	-	420	
19	5	7-23	905	42°40'	86°13'	N.	0920	36	0	200	-	400	-	-	40	640	
	10	7-23	906	42°42'	86°15'	S.	1020	20	0	850	-	150	-	-	-	1,000	
	15	7-23	907	42°40'	86°16'	N.	1120	30	0	910	13	30	-	-	47	1,000	
	20	7-23	908	42°42'	86°17'	N.	1220	30	0	10	170	-	-	-	-	180	

1/ 0 - clear drag, 1 - snag encountered (no gear damage), 2 - gear malfunction, 3 - minor gear damage, 4 - major gear damage (including loss of net), 5 - wind over 20 m.p.h., 6 - strong current, 7 - adverse weather conditions (including ice, fog, high seas), 8 - rough bottom, 9 - set fishing gear in area.

2/ Include lake herring, carp, common whitefish, trout-perch, spottail shiner, white sucker, lake trout, lake sturgeon, stickleback, and burbot.

Appendix table 6.--R/V Kaho Fishing Log -- Lake Michigan trawl stations
off Benton Harbor, Mich., 1962-64

Cruise No.	Depth	Date	Drag No.	Position		Course	Time of day	Fished	Limiting factor 1/	Catch							Total
				Lat. N.	Long. W.					Alewife	Chubs	Yellow perch	Sculpins	Smelt	Others 2/		
	Fath.	1962						Min.						Pounds			
1	9	4-4	21	42°02'	86°35'	S.	0830	30	0	-	-	5	-	-	-	5	
	15	4-4	22	42°02'	86°39'	S.	0940	30	0	-	-	-	-	-	-	-	
	20	4-4	20	42°03'	86°40'	S.	1030	30	0	-	1	-	1	1	4	7	
	25	4-4	24	42°03'	86°42'	N.	1120	30	0	1	80	1	-	1	12	95	
	30	4-4	25	42°03'	86°45'	S.	1210	30	0	1	65	-	1	12	11	90	
	35	4-4	26	42°05'	86°45'	N.	1310	30	2	1	155	1	-	1	2	160	
	40	4-4	27	42°04'	86°49'	S.	1410	30	0	-	185	1	1	1	2	190	
3 Phase I	10	6-15	55	42°00'	86°35'	S.	0740	30	0	3	1	-	-	-	-	4	
	14	6-15	56	42°01'	86°39'	NE.	0850	30	2	1	-	-	-	-	-	1	
	18	6-15	57	42°03'	86°39'	S.	0940	30	0	-	1	-	-	-	-	1	
	23	6-15	58	42°03'	86°42'	NE.	1050	30	0	-	190	-	-	-	-	190	
	29	6-15	59	42°04'	86°42'	S.	1210	30	0	-	90	-	-	-	-	90	
	34	6-15	60	42°04'	86°44'	NE.	1250	30	0	-	110	-	-	-	-	110	
	38	6-15	61	42°06'	86°46'	S.	1350	30	0	-	85	-	-	-	-	85	
3 Phase II	10	7-24	157	42°00'	86°35'	S.	1820	30	0	90	8	70	-	-	2	170	
	15	7-24	156	42°02'	86°39'	NE.	1720	30	0	200	55	3	-	1	1	260	
	18	7-10	122 3/4	42°02'	86°40'	NE.	1440	40	0	-	30	-	-	-	-	30	
	20	7-24	155	42°03'	86°39'	S.	1630	30	0	1	178	-	-	1	-	180	
	25	7-10	123 3/4	42°04'	86°40'	S.	1550	60	0	-	75	-	-	-	-	75	
	25	7-24	154	42°03'	86°42'	N.	1530	30	0	-	179	1	-	-	-	180	
	28	7-10	124 3/4	42°00'	86°43'	SW.	1720	60	0	-	139	1	-	-	-	140	
	28	7-10	126 3/4	41°57'	86°49'	E.	1950	60	0	-	174	-	1	-	5	180	
	28	7-11	129 3/4	41°57'	86°04'	W.	0210	120	0	-	395	-	5	-	-	400	
	30	7-10	125 3/4	41°58'	86°47'	SW.	1840	60	0	-	178	1	-	-	1	180	
	30	7-10	127 3/4	41°56'	86°53'	W.	2120	120	0	-	198	1	1	-	-	200	
	30	7-24	153	42°04'	86°42'	N.	1440	30	0	-	98	1	1	-	-	100	
	31	7-10	128 3/4	41°56'	86°58'	W.	2350	120	0	-	328	-	2	-	-	330	
	35	7-10	121 3/4	42°04'	86°44'	NE.	1310	30	0	-	60	-	-	-	-	60	
	35	7-24	152	42°04'	86°44'	N.	1350	30	0	-	88	1	1	-	-	90	
	40	7-10	120 3/4	42°04'	86°47'	S.	1210	30	0	-	64	-	1	-	-	65	
	40	7-24	151	42°07'	86°20'	SW.	1300	30	0	-	108	1	1	-	-	110	
3 Phase III	10	8-23	222	42°04'	86°36'	S.	1020	30	0	180	4	6	-	-	-	190	
	15	8-23	221	42°02'	86°39'	N.	0920	30	0	200	210	-	-	-	-	410	
	20	8-23	220	42°04'	86°40'	S.	0840	30	0	-	98	1	-	1	-	100	
	25	8-23	219	42°02'	86°41'	N.	0740	30	0	-	95	-	-	-	-	95	
	30	8-23	218	42°04'	86°42'	S.	0650	30	0	-	110	-	-	-	-	110	
	35	8-22	217	42°07'	86°44'	S.	1440	30	2	-	13	-	-	-	-	13	
	40	8-22	216	42°07'	86°47'	N.	1350	30	0	-	120	-	-	-	-	120	
6	10	11-14	238	42°01'	86°35'	S.	0810	30	0	1	1	-	-	-	-	2	
	15	11-14	237	42°01'	86°39'	N.	0910	30	0	70	5	-	-	-	-	75	
	20	11-14	239	42°03'	86°40'	S.	1020	30	0	300	22	18	-	1	9	350	
	25	11-14	240	42°04'	86°42'	NE.	1110	30	0	19	1	1	-	-	2	23	
	25	11-14	241	42°04'	86°41'	SW.	1150	30	0	270	56	1	-	2	1	330	
	30	11-14	242	42°03'	86°44'	NE.	1250	30	0	32	11	-	-	-	1	44	
	35	11-14	243	42°05'	86°44'	S.	1350	30	7	170	84	-	3	3	-	260	
	40	11-14	244	42°05'	86°48'	NE.	1450	30	7	65	240	-	5	-	-	310	
13	10	9-16	483	42°06'	86°33'	N.	0640	30	0	6	1	2	-	-	1	10	
	15	9-16	484	42°08'	86°36'	N.	0740	30	0	380	30	-	-	-	-	410	
	20	9-16	485	42°10'	86°38'	S.	0830	30	0	14	25	-	-	1	-	40	
	24	9-15	482	42°17'	86°36'	SW.	1520	30	0	4	166	-	-	-	-	170	
	25	9-16	486	42°09'	86°39'	N.	0920	30	0	10	230	-	-	-	-	240	
	30	9-16	487	42°11'	86°41'	S.	1020	30	0	1	239	-	-	-	-	240	
	34	9-16	488	42°08'	86°43'	S.	1120	30	0	1	189	-	-	-	-	190	
	39	9-16	489	42°07'	86°45'	N.	1220	30	0	-	125	-	5	-	-	130	
	44	9-16	490	42°09'	86°47'	NE.	1330	30	0	-	124	1	5	-	-	130	
	49	9-16	491	42°11'	86°48'	NE.	1430	30	0	-	100	-	20	-	-	120	
	57	9-16	493	42°15'	86°58'	N.	1710	30	0	-	85	-	55	-	-	140	
	61	9-16	492	42°14'	86°54'	S.	1600	30	0	-	85	-	25	-	-	110	

See footnotes at end of table.

Appendix table 6.--R/V Kaho Fishing Log - Lake Michigan trawl stations
off Benton Harbor, Mich., 1962-64--Continued

Cruise No.	Depth	Date	Drag No.	Position		Course	Time of day	Fished	Limiting factor 1/	Catch						
				Lat. N.	Long. W.					Alewife	Chubs	Yellow perch	Sculpins	Smelt	Others 2/	Total
	Fath.	1964						Min.				Pounds				
16	20	4-1	633	42°08'	86°38'	N.	0710	30	7	50	1	1	1	1	1	55
	25	4-1	634	42°08'	86°39'	N.	0800	30	7	110	16	-	-	-	4	130
	30	4-1	635	42°09'	86°40'	N.	0900	30	7	300	30	-	-	-	-	330
	35	4-1	636	42°09'	86°42'	N.	0950	30	7	450	49	-	1	-	-	500
	40	4-1	637	42°10'	86°44'	N.	1050	30	7	40	328	-	2	-	-	370
	45	4-1	638	42°10'	86°46'	N.	1200	30	7	60	357	-	3	-	-	420
	50	4-1	639	42°10'	86°47'	N.	1300	30	7	20	192	-	8	-	-	220
	60	4-1	640	42°14'	86°50'	N.	1410	30	7	5	195	-	-	-	-	200
	60	4-2	641	42°15'	86°59'	N.	0900	30	0	160	173	-	17	-	-	350
17	10	4-28	671	42°09'	86°32'	S.	1640	30	0	1,860	-	60	-	-	-	1,920
	15	4-28	670	42°10'	86°36'	S.	1540	30	0	1,520	-	20	-	-	-	1,540
	20	4-28	668	42°10'	86°38'	S.	1350	30	0	1,230	-	-	5	-	5	1,240
	20	4-28	669	42°08'	86°38'	N.	1440	30	0	700	-	-	-	-	-	700
	25	4-29	672	42°16'	86°34'	S.	0810	30	0	1,230	9	-	-	-	1	1,240
	30	4-29	673	42°11'	86°40'	S.	0900	30	0	1,250	8	-	-	-	2	1,260
	35	4-29	674	42°11'	86°42'	S.	1000	30	0	671	49	-	-	-	1	721
	40	4-29	675	42°12'	86°44'	S.	1100	30	0	150	308	-	12	-	-	470
	45	4-29	676	42°12'	86°46'	S.	1200	30	0	90	170	-	40	-	-	300
	50	4-29	677	42°12'	86°47'	S.	1310	30	0	60	134	-	46	-	-	240
21	5	9-15	971	42°09'	86°27'	S.	1730	30	7	150	-	40	-	-	10	200
	7	9-14	960	42°08'	86°29'	NE.	1520	30	0	100	34	-	-	-	6	140
	10	9-14	961	42°09'	86°32'	S.	1610	30	5	340	20	7	-	-	3	370
	15	9-15	962	42°08'	86°36'	N.	0740	30	7	450	30	-	-	-	-	480
	20	9-15	963	42°08'	86°38'	N.	0830	30	7	450	80	-	-	-	-	530
	20	9-15	964	42°10'	86°38'	S.	0920	30	7	400	60	-	-	-	-	460
	25	9-15	965	42°08'	86°39'	N.	1010	30	7	400	90	-	-	-	-	490
	30	9-15	966	42°09'	86°40'	N.	1110	30	7	100	180	-	-	-	-	280
	35	9-15	967	42°09'	86°42'	N.	1200	30	7	90	340	-	-	-	-	430
	40	9-15	968	42°10'	86°44'	N.	1300	30	7	20	320	-	-	-	-	340
	45	9-15	969	42°10'	86°46'	N.	1400	30	7	-	220	-	-	10	-	230
	50	9-15	970	42°11'	86°48'	N.	1500	30	7	-	210	-	-	10	-	220

1/ 0 - clear drag, 1 - snag encountered (no gear damage), 2 - gear malfunction, 3 - minor gear damage, 4 - major gear damage (including loss of net), 5 - wind over 20 m.p.h., 6 - strong current, 7 - adverse weather conditions (including ice, fog, high seas), 8 - rough bottom, 9 - set fishing gear in area.

2/ Include lake herring, carp, common whitefish, trout-perch, spottail shiner, white sucker, lake trout, lake sturgeon, stickleback, and burbot.

3/ Drag made with 62-foot (headrope) modified western type box trawl.

Appendix table 7.--R/V Kaho Fishing Log - Lake Michigan trawl stations
off Waukegan, Ill., 1962-64

Cruise No.	Depth	Date	Drag No.	Position		Course	Time of day	Fished	Limiting factor 1/	Catch						
				Lat. N.	Long. W.					Alewife	Chubs	Yellow perch	Sculpins	Smelt	Others 2/	Total
				Fath.	1962					Min.	Pounds					
3 Phase I	14	6-16	67	42°24'	87°43'	SW.	1330	30	0	55	360	-	-	1	4	420
	19	6-16	66	42°24'	87°40'	N.	1240	30	0	130	140	-	-	-	-	270
	25	6-16	65	42°24'	87°40'	S.	1140	30	0	9	401	-	-	-	-	410
	29	6-16	64	42°24'	87°35'	N.	1040	30	0	19	371	-	-	-	-	390
	34	6-16	63	42°24'	87°37'	S.	0940	30	0	5	225	-	-	-	-	230
	40	6-16	62	42°24'	87°35'	N.	0820	30	0	5	125	-	-	-	-	130
1962																
3 Phase II	15	7-26	164 3/4	42°25'	87°44'	S.	0850	30	0	400	20	145	-	50	5	620
	20	7-11	131 3/4	42°25'	87°41'	NW.	1500	30	0	-	69	-	-	1	-	70
	20	7-26	162 3/4	42°25'	87°41'	N.	0650	15	2	-	11	-	-	-	-	11
	20	7-26	163 3/4	42°24'	87°41'	N.	0750	30	0	1	586	1	-	1	1	590
	22	7-12	138 3/4	42°26'	87°42'	N.	1110	30	0	1	207	1	-	1	-	210
	23	7-12	136 3/4	42°25'	87°40'	S.	0850	90	0	1	498	-	-	1	-	500
	24	7-11	134 3/4	42°26'	87°39'	S.	1850	90	0	-	340	-	-	-	-	340
	25	7-11	132 3/4	42°27'	87°40'	S.	1610	40	0	-	149	-	-	1	-	150
	25	7-12	135 3/4	42°24'	87°40'	N.	0650	90	0	1	297	-	-	1	1	300
	25	7-12	137 3/4	42°27'	87°40'	W.	1040	4	1	-	20	-	-	-	-	20
	25	7-25	161	42°25'	87°40'	S.	1530	10	3	-	80	-	-	-	-	80
	26	7-11	133 3/4	42°24'	87°40'	NW.	1700	90	0	-	469	-	-	-	1	470
	29	7-11	130 3/4	42°25'	87°38'	NW.	0430	92	0	-	418	1	1	-	-	420
	30	7-25	160	42°25'	87°39'	S.	1430	30	0	-	319	1	-	-	-	320
	35	7-25	159	42°25'	87°37'	N.	1340	30	0	-	129	-	1	-	-	130
	40	7-25	158	42°24'	87°35'	S.	1240	30	0	-	149	-	1	-	-	150
1962																
3 Phase III	15	8-22	215	42°26'	87°44'	S.	0730	30	0	-	150	-	-	-	-	150
	20	8-22	214	42°24'	87°44'	N.	0650	30	0	1	107	-	-	1	1	110
	25	8-21	213	42°25'	87°40'	N.	1400	30	0	-	350	-	-	-	-	350
	28	8-21	212	42°24'	87°38'	S.	1310	27	1	-	140	-	-	-	-	140
	35	8-21	211	42°26'	87°38'	N.	1200	30	0	-	280	-	-	-	-	280
	40	8-21	210	42°26'	87°34'	S.	1110	30	0	-	150	-	-	-	-	150
1962																
6 (in part)	15	11-15	245	42°24'	87°44'	N.	0820	30	0	85	45	620	-	38	2	790
	20	11-15	246	42°26'	87°42'	S.	0910	30	0	230	205	180	-	60	5	680
	25	11-15	247	42°24'	87°40'	N.	1020	30	0	200	238	270	-	20	2	730
	30	11-15	248	42°26'	87°38'	S.	1130	30	3	200	77	-	5	8	-	290
	35	11-15	249	42°25'	87°37'	N.	1330	30	0	1,000	847	-	1	2	-	1,850
	40	11-15	250	42°26'	87°34'	S.	1440	30	0	190	905	-	3	2	-	1,100
	45	11-15	251	42°24'	87°32'	N.	1550	30	0	135	130	-	5	-	-	270
1962																
6 (in part)	15	12-19	279	42°24'	87°44'	N.	1050	30	0	-	3	1	1	10	3	18
	20	12-19	280	42°26'	87°42'	S.	1150	30	0	1	38	-	1	32	3	75
	25	12-19	281	42°24'	87°40'	N.	1250	29	7	55	418	-	1	45	1	520
	30	12-19	282	42°26'	87°35'	S.	1350	30	7	9	488	-	1	1	1	500
	35	12-19	283	42°24'	87°37'	N.	1500	30	7	1	407	-	1	1	-	410
	40	12-16	278	42°24'	87°35'	N.	1120	30	0	300	608	-	1	1	-	910
	45	12-16	277	42°26'	87°31'	S.	1010	30	0	200	254	-	5	1	-	460
1963																
13	5	9-17	494	42°22'	87°47'	NE.	0630	20	3	230	-	7	-	-	3	240
	10	9-17	495	42°23'	87°46'	S.	0720	25	8	630	5	60	-	5	-	700
	15	9-17	496	42°21'	87°44'	N.	0820	30	0	500	43	85	1	1	-	630
	20	9-17	497	42°23'	87°42'	S.	0910	30	0	320	27	31	1	1	-	380
	24	9-17	498	42°20'	87°39'	W.	1030	10	3	35	111	-	1	3	-	150
	29	9-17	499	42°22'	87°37'	SE.	1100	30	0	8	230	-	1	1	-	240
	35	9-17	500	42°20'	87°34'	N.	1150	30	0	-	590	-	-	-	-	590
	40	9-17	501	42°21'	87°32'	S.	1250	30	0	-	339	-	1	-	-	340
	45	9-17	502	42°18'	87°25'	E.	1410	30	0	-	105	-	65	-	-	170
	49	9-17	504	42°15'	87°09'	E.	1650	30	0	-	150	-	25	-	5	180
	50	9-17	503	42°16'	87°17'	E.	1540	30	2	-	1	-	1	-	-	2
1964																
16	20	4-4	647	42°20'	87°42'	N.	0710	30	7	2	44	-	-	2	7	55
	25	4-4	648	42°20'	87°38'	N.	0810	30	7	5	142	-	-	-	3	150
	30	4-2	646	42°20'	87°36'	N.	1530	30	3	-	203	-	-	-	17	220
	35	4-2	645	42°19'	87°34'	N.	1430	30	0	-	420	-	-	-	-	420
	40	4-2	644	42°19'	87°32'	N.	1330	30	0	20	318	-	2	-	-	340
	45	4-2	643	42°17'	87°24'	N.	1220	30	0	320	222	-	8	-	-	550
	50	4-2	642	42°15'	87°10'	N.	1100	30	0	950	110	-	-	-	-	1,060

See footnotes at end of table

Appendix table 7.--R/V Kaho Fishing Log - Lake Michigan trawl stations
off Waukegan, Ill., 1962-64--Continued

Cruise No.	Depth	Date	Drag	Position		Course	Time of day	Fished	Limiting factor 1/	Catch							Total
				Lat. N.	Long. W.					Alewife	Chubs	Yellow perch	Sculpins	Smelt	Others 2/		
	Fath.	1964						Min.					Pounds				
17	10	4-30	679	42°23'	87°46'	S.	0640	30	0	1,320	-	60	-	-	-	-	1,380
	15	4-30	680	42°23'	87°43'	S.	0730	30	0	2,490	8	-	-	-	-	2	2,500
	20	4-30	681	42°22'	87°42'	S.	0920	30	0	1,420	10	-	-	-	-	-	1,430
	25	4-30	682	42°22'	87°38'	S.	1020	30	0	510	370	-	-	-	-	-	880
	30	4-30	683	42°22'	87°36'	S.	1120	30	1	220	1,145	-	-	-	-	5	1,370
	35	4-30	684	42°21'	87°35'	S.	1210	30	0	200	880	-	-	-	-	-	1,080
	40	4-30	685	42°21'	87°32'	S.	1310	30	0	160	670	-	-	-	-	-	830
	45	4-30	686	42°19'	87°25'	S.	1410	30	0	160	362	-	18	-	-	-	540
50	4-29	678	42°16'	87°10'	S.	1610	30	0	45	150	-	35	-	-	-	230	
19	10	7-18	870	42°23'	87°46'	S.	1400	30	0	460	31	2	-	5	2	-	500
	15	7-18	869	42°23'	87°44'	S.	1300	30	0	400	160	-	-	10	-	-	570
	20	7-17	865	42°26'	87°42'	S.	1650	10	3	29	198	-	1	2	-	-	230
	20	7-18	868	42°23'	87°42'	S.	1140	30	0	300	160	-	-	5	-	-	465
	25	7-18	866	42°22'	87°39'	SE.	0950	17	8	-	180	-	-	-	-	-	180
	25	7-18	867	42°22'	87°41'	S.	1030	30	0	-	310	-	-	-	-	-	310
	30	7-17	864	42°26'	87°38'	S.	1550	30	0	1	188	-	1	-	-	-	190
	35	7-17	863	42°26'	87°37'	S.	1450	30	0	1	229	-	-	-	-	-	230
	40	7-17	862	42°26'	87°35'	S.	1340	30	0	1	108	-	1	-	-	-	110
	45	7-17	861	42°26'	87°31'	S.	1230	30	0	-	139	-	1	-	-	-	140
	50	7-17	860	42°26'	87°27'	S.	1110	30	2	1	125	-	4	-	-	-	130
21	5	9-17	983	42°27'	87°46'	N.	1240	22	8	340	10	50	-	-	-	-	400
	10	9-17	982	42°26'	87°46'	N.	1140	30	0	280	66	490	-	-	-	14	850
	15	9-17	981	42°26'	87°44'	N.	1030	30	0	1,100	49	1	-	-	-	-	1,150
	20	9-17	980	42°26'	87°42'	N.	0940	30	0	200	40	-	-	-	-	-	240
	25	9-17	979	42°26'	87°40'	N.	0850	30	0	30	300	-	-	-	-	-	330
	30	9-17	978	42°24'	87°38'	N.	0800	30	0	10	230	-	-	-	-	-	240
	35	9-16	977	42°19'	87°35'	N.	1500	30	0	5	195	-	-	-	-	-	200
	40	9-16	975	42°19'	87°32'	N.	1320	30	3	-	275	-	-	-	-	5	280
	40	9-16	976	42°21'	87°32'	S.	1410	30	0	-	237	-	-	-	-	3	240
	45	9-16	974	42°17'	87°25'	W.	1220	30	0	-	310	-	-	-	-	-	310
	50	9-16	972	42°14'	87°09'	N.	0950	30	0	-	72	-	3	-	-	-	75
50	9-16	973	42°17'	87°21'	N.	1110	30	0	-	95	-	5	-	-	-	100	

1/ 0 - clear drag, 1 - snag encountered (no gear damage), 2 - gear malfunction, 3 - minor gear damage, 4 - major gear damage (including loss of net), 5 - wind over 20 m.p.h., 6 - strong current, 7 - adverse weather conditions (including ice, fog, high seas), 8 - rough bottom, 9 - set fishing gear in area.

2/ Include lake herring, carp, common whitefish, trout-perch, spottail shiner, white sucker, lake trout, lake sturgeon, stickleback, and burbot.

3/ Drag made with 62-foot (headrope) modified western type box trawl.

Appendix table 8.--R/V Kaho Fishing Log - Lake Michigan trawl stations
off Racine, Wis., 1963-64

Cruise No	Depth	Date	Drag No.	Position		Course	Time of day	Fished	Limiting factor 1/	Catch						Others 2/	Total
				Lat. N.	Long. W.					Alewife	Chubs	Yellow perch	Sculpins	Smelt			
															Pounds		
Fath.		1963															
13	15	9- 9	459	42°43'	87°40'	S.	1610	30	5	300	639	-	-	10	1	950	
	19	9- 9	458	42°41'	87°38'	N.	1530	30	5	40	79	-	-	1	-	120	
	25	9- 9	457	42°43'	87°38'	S.	1430	30	5	1	217	-	1	1	-	220	
	30	9- 9	456	42°41'	87°36'	N.	1340	30	0	1	277	-	1	1	-	280	
	35	9- 9	455	42°43'	87°35'	S.	1240	30	0	1	377	-	1	1	-	380	
	40	9- 9	454	42°41'	87°34'	N.	1140	30	0	1	378	-	1	-	-	380	
	45	9- 9	453	42°43'	87°31'	N.	1040	30	0	-	269	-	1	-	-	270	
	50	9- 9	452	42°43'	87°29'	S.	0840	30	0	-	241	-	9	-	-	250	
	58	9- 8	451	42°41'	87°25'	N.	1730	30	0	-	70	-	40	-	-	110	
	70	9- 8	450	42°43'	87°18'	N.	1610	30	0	-	45	-	40	-	-	85	
	80	9- 8	449	42°41'	87°09'	S.	1440	30	0	-	30	-	15	-	-	45	
1964																	
15	15	3- 7	611	42°42'	87°40'	N.	0850	30	0	-	10	10	1	5	4	30	
	15	3- 7	612	42°41'	87°40'	N.	0940	30	0	-	5	5	1	5	4	20	
	20	3- 7	613	42°42'	87°40'	S.	1020	30	0	-	7	2	2	5	4	20	
	20	3- 7	614	42°41'	87°41'	N.	1120	30	0	-	12	-	1	5	2	20	
	25	3- 7	615	42°42'	87°38'	S.	1150	30	0	2	80	-	1	10	2	95	
	25	3- 7	616	42°41'	87°38'	N.	1240	30	0	-	50	-	3	5	2	60	
	30	3- 7	617	42°42'	87°36'	S.	1340	30	0	-	205	-	1	2	2	210	
	30	3- 7	618	42°41'	87°36'	N.	1420	30	0	-	195	-	2	3	-	200	
	35	3- 7	619	42°42'	87°35'	S.	1520	30	0	-	425	-	2	3	-	430	
	35	3- 7	620	42°41'	87°35'	N.	1610	30	0	3	395	-	2	-	-	400	
	40	3- 7	621	42°42'	87°33'	S.	1710	30	0	1	188	-	1	-	-	190	
	40	3- 7	622	42°41'	87°33'	N.	1800	30	0	1	108	-	1	-	-	110	
	45	3- 8	623	42°42'	87°30'	S.	0840	30	0	5	310	-	5	-	-	320	
	45	3- 8	624	42°41'	87°30'	N.	0930	30	7	5	170	-	5	-	-	180	
	50	3- 8	625	42°42'	87°28'	S.	1040	30	7	10	400	-	10	-	-	420	
	50	3- 8	626	42°41'	87°28'	N.	1140	30	7	20	250	-	10	-	-	280	
	60	3- 9	627	42°41'	87°25'	N.	1010	30	7	1	79	-	20	-	-	100	
1964																	
19	20	7-17	859	42°43	87°39'	S.	0830	30	0	1,000	160	-	-	10	-	1,170	

1/ 0 - clear drag, 1 - snag encountered (no gear damage), 2 - gear malfunction, 3 - minor gear damage, 4 - major gear damage (including loss of net), 5 - wind over 20 m.p.h., 6 - strong current, 7 - adverse weather conditions (including ice, fog, high seas), 8 - rough bottom, 9 - set fishing gear in area.

2/ Include lake herring, carp, common whitefish, trout-perch, spottail shiner, white sucker, lake trout, lake sturgeon, stickleback, and burbot.

Appendix table 9.--R/V Kaho Fishing Log - Lake Michigan trawl stations
off Milwaukee, Wis., 1962 and 1964

Cruise No.	Depth	Date	Drag No.	Position		Course	Time of day	Fished	Limiting factor 1/	Catch							Total	
				Lat. N.	Long. W.					Alewife	Chubs	Yellow perch	Sculpins	Smelt	Others 2/			
	Fath.	1962						Min.			Pounds							
3 Phase I	10	6-17	74	43°12'	87°52'	N.	1400	10	4	5	11	-	-	-	-	-	16	
	15	6-17	73	43°12'	87°52'	S.	1310	30	0	65	103	1	-	-	-	1	170	
	20	6-17	72	43°12'	87°51'	N.	1220	30	0	20	200	-	-	-	-	-	220	
	25	6-17	71	43°12'	87°50'	S.	1120	30	0	50	350	-	-	-	-	-	400	
	30	6-17	70	43°12'	87°49'	N.	1030	30	0	26	144	-	-	-	-	-	170	
	34	6-17	69	43°12'	87°48'	S.	0940	30	0	20	110	-	-	-	-	-	130	
	40	6-17	68	43°12'	87°47'	N.	0850	30	0	1	109	-	-	-	-	-	110	
1964																		
19	5	7-15	850	43°01'	87°53'	N.	1540	6	1	130	-	-	-	-	-	-	130	
	15	7-16	852	43°11'	87°51'	N.	0940	11	8	400	1	8	-	-	-	1	410	
	20	7-15	844	43°00'	87°46'	S.	0700	7	1	200	2	1	-	-	7	-	210	
	20	7-16	853	43°11'	87°50'	N.	1010	30	0	1,000	150	-	-	10	-	-	1,160	
	20	7-16	854	43°13'	87°51'	S.	1110	30	0	900	330	-	-	10	-	-	1,240	
	25	7-15	845	42°59'	87°44'	S.	0730	30	0	800	135	-	-	5	-	-	940	
	25	7-15	846	42°58'	87°42'	N.	0830	6	1	110	5	-	-	-	-	-	115	
	25	7-15	851	42°59'	87°43'	S.	2140	30	0	400	62	-	2	5	1	-	470	
	25	7-16	855	43°11'	87°50'	N.	1210	30	0	85	315	-	-	10	-	-	410	
	30	7-15	847	42°59'	87°41'	S.	0910	19	1	-	103	-	1	1	-	-	105	
	30	7-16	856	43°11'	87°49'	N.	1310	30	0	-	189	-	1	-	-	-	190	
	35	7-15	848	42°59'	87°38'	S.	0950	30	0	-	229	-	1	-	-	-	230	
	35	7-16	857	43°11'	87°48'	N.	1410	30	0	-	123	-	2	-	-	-	125	
	40	7-15	849	42°59'	87°36'	S.	1310	30	0	-	185	-	5	-	-	-	190	
	40	7-16	858	43°11'	87°45'	N.	1510	30	0	-	190	-	-	-	-	-	190	

1/ 0 - clear drag, 1 - snag encountered (no gear damage), 2 - gear malfunction, 3 - minor gear damage, 4 - major gear damage (including loss of net), 5 - wind over 20 m.p.h., 6 - strong current, 7 - adverse weather conditions (including ice, fog, high seas), 8 - rough bottom, 9 - set fishing gear in area.

2/ Include lake herring, carp, common whitefish, trout-perch, spottail shiner, white sucker, lake trout, lake sturgeon, stickleback, and burbot.

Appendix table 10.--R/V Kaho Fishing Log - Lake Michigan trawl stations
off Port Washington, Wis., 1962-65

Cruise No.	Depth	Date	Drag No.	Position		Course	Time of day	Fished	Limiting factor 1/	Catch							Total
				Lat. N.	Long. W.					Alewife	Chubs	Yellow perch	Sculpins	Smelt	Others 2/		
																Fath.	
1	20	4-17	54	43°28'	87°47'	S.	1530	30	0	1	7	1	-	450	1	460	
	25	4-17	53	43°27'	87°46'	N.	1440	30	0	10	167	-	1	30	2	210	
	30	4-17	52	43°28'	87°45'	N.	1340	30	0	2	455	1	-	1	1	460	
	35	4-17	51	43°26'	87°44'	N.	1230	30	3	1	328	-	-	1	-	330	
	37	4-17	50	43°28'	87°42'	S.	1140	30	0	1	438	-	1	-	-	440	
3 Phase I	20	6-18	79	43°27'	87°46'	N.	1320	30	0	15	284	-	-	1	-	300	
	25	6-18	78	43°27'	87°45'	S.	1230	30	0	10	120	-	-	-	-	130	
	30	6-18	77	43°27'	87°44'	N.	1140	30	0	1	89	-	-	-	-	90	
	35	6-18	76	43°27'	87°44'	S.	1050	30	0	-	100	-	-	-	-	100	
	40	6-18	75	43°27'	87°42'	NE.	0950	30	0	1	139	-	-	-	-	140	
3 Phase II	15	7-26	166 3/4	43°13'	87°50'	S.	1610	20	8	34	72	3	1	10	-	120	
	18	7-26	165 3/4	43°12'	87°51'	N.	1510	30	0	-	114	-	1	15	-	130	
	20	8-1	175 3/4	43°28'	87°46'	N.	1030	30	0	1	327	-	-	1	1	330	
	25	7-27	167 3/4	43°13'	87°50'	S.	0840	30	0	-	184	-	1	4	1	190	
	25	8-1	174 3/4	43°26'	87°43'	S.	0940	30	0	-	149	-	-	1	-	150	
	30	7-27	168 3/4	43°13'	87°49'	N.	0930	30	0	-	198	-	1	1	-	200	
	30	8-1	173 3/4	43°28'	87°44'	N.	0900	30	0	-	189	-	-	1	-	190	
	35	7-27	169 3/4	43°13'	87°47'	S.	1030	30	0	-	199	-	-	1	-	200	
	35	8-1	172 3/4	43°28'	87°44'	SW.	0810	30	0	-	219	-	-	1	-	220	
	40	7-27	170 3/4	43°13'	87°47'	S.	1120	30	0	-	179	-	1	-	-	180	
	40	8-1	171 3/4	43°28'	87°42'	N.	0720	30	0	-	260	-	-	-	-	260	
3 Phase III	20	8-19	204	43°28'	87°46'	S.	1630	30	0	2	1,195	-	-	3	-	1,200	
	20	8-20	209	43°14'	87°51'	S.	1240	30	0	-	450	-	-	-	-	450	
	25	8-19	203	43°26'	87°46'	N.	1540	30	0	-	499	-	-	1	-	500	
	25	8-20	208	43°12'	87°50'	N.	1130	30	0	-	300	-	-	-	-	300	
	30	8-19	202	43°28'	87°43'	S.	1450	30	0	-	220	-	-	-	-	220	
	30	8-20	207	43°14'	87°49'	S.	1030	30	4	-	109	-	-	-	1	110	
	35	8-19	201	43°26'	87°43'	N.	1220	30	4	-	330	-	-	-	-	330	
	35	8-20	206	43°12'	87°48'	N.	0800	30	0	-	600	-	-	-	-	600	
	40	8-19	200	43°28'	87°42'	S.	1130	30	0	-	200	-	-	-	-	200	
40	8-20	205	43°14'	87°41'	S.	0710	30	0	-	400	-	-	-	-	400		
6	20	12-15	272	43°26'	87°46'	N.	1020	30	5	1	4	-	-	6	1	12	
	25	12-15	273	43°28'	87°46'	N.	1110	30	0	-	1	-	-	-	-	1	
	30	12-15	274	43°26'	87°45'	N.	1200	30	2	2	185	-	-	3	-	190	
	35	12-15	275	43°28'	87°43'	S.	1250	30	2	1	41	-	-	1	-	43	
	38	12-15	276	43°26'	87°42'	N.	1350	30	2	1	117	-	-	2	-	120	
9	20	4-20	331	43°25'	87°48'	S.	1420	30	0	600	-	-	-	75	5	680	
	25	4-20	330	43°23'	87°47'	S.	1310	30	0	2,290	9	-	-	1	-	2,300	
	30	4-20	329	43°25'	87°46'	S.	1150	30	0	1,930	219	-	-	1	-	2,150	
	35	4-19	327	43°25'	87°44'	S.	1540	30	7	50	920	-	-	-	-	970	
	40	4-19	326	43°23'	87°44'	N.	1440	30	0	75	305	-	-	-	-	380	
	45	4-19	325	43°25'	87°43'	S.	1340	30	0	5	245	-	-	-	-	250	
	55	4-20	328	43°23'	87°41'	N.	1030	30	0	10	275	-	15	-	-	300	
17	10	5-2	693	43°21'	87°51'	N.	0700	5	8	1,500	-	-	-	-	-	1,500	
	15	5-2	694	43°21'	87°50'	N.	0730	30	4	-	-	-	-	-	-	-	
	20	5-2	698	43°23'	87°48'	N.	1140	30	0	940	120	-	-	-	-	1,060	
	25	5-2	697	43°23'	87°47'	N.	1050	30	0	640	300	-	-	-	-	940	
	30	5-2	696	43°23'	87°45'	N.	0950	30	0	90	210	-	-	-	-	300	
	35	5-2	695	43°23'	87°44'	N.	0900	30	0	60	370	-	-	-	-	430	
	40	5-1	691	43°25'	87°43'	S.	1450	30	0	4	266	-	-	-	-	270	
	40	5-1	692	43°23'	87°43'	N.	1540	30	0	20	270	-	-	-	-	290	
	45	5-1	690	43°23'	87°43'	N.	1400	30	0	15	246	-	9	-	-	270	
	50	5-1	689	43°23'	87°42'	N.	1300	30	0	25	266	-	9	-	-	300	
	60	5-1	688	43°23'	87°40'	N.	1200	30	0	2	87	-	41	-	-	130	
	70	5-1	687	43°23'	87°37'	N.	1100	30	0	1	9	-	45	-	-	55	

See footnotes at end of table.

Appendix table 10.--R/V Kaho Fishing Log - Lake Michigan trawl stations
off Port Washington, Wis., 1962-65--Continued

Cruise No.	Depth	Date	Drag No.	Position		Course	Time of day	Fished	Limiting factor 1/	Catch						Total
				Lat. N.	Long. W.					Alewife	Chubs	Yellow perch	Sculpins	Smelt	Others 2/	
	Fath.	1964						Min.								
19	15	7-20	881	43°26'	87°48'	N.	1310	30	0	600	240	-	-	7	3	850
	20	7-20	880	43°23'	87°49'	N.	1150	30	0	1	37	-	-	1	1	40
	25	7-20	879	43°23'	87°47'	N.	1050	30	0	1	43	-	-	-	1	45
	30	7-19	871	43°23'	87°46'	N.	0930	30	0	-	150	-	-	-	-	150
	30	7-19	872	43°25'	87°46'	S.	1020	30	0	2	97	-	-	1	-	100
	35	7-19	873	43°23'	87°44'	N.	1100	30	0	-	229	1	-	-	-	230
	40	7-19	874	43°23'	87°43'	N.	1200	30	0	-	124	-	1	-	-	125
	45	7-19	875	43°23'	87°43'	N.	1300	30	0	-	139	-	1	-	-	140
	50	7-19	876	43°23'	87°42'	N.	1410	30	0	-	70	-	5	-	-	75
	60	7-19	877	43°23'	87°40'	N.	1520	30	0	-	8	-	14	-	-	22
	70	7-19	878	43°23'	87°37'	N.	1630	30	0	-	2	-	1	-	-	3
			1964													
21	6	9-19	994	43°29'	87°46'	N.	0740	15	0	200	-	-	-	-	-	200
	10	9-19	993	43°24'	87°49'	N.	0650	25	9	950	20	-	-	-	-	970
	15	9-18	992	43°26'	87°48'	N.	1600	30	7	330	280	-	-	-	-	610
	20	9-18	991	43°23'	87°48'	N.	1510	30	7	280	390	-	-	-	-	670
	25	9-18	990	43°23'	87°47'	N.	1430	30	7	25	375	-	-	-	-	400
	30	9-18	984	43°25'	87°45'	N.	0850	30	7	720	90	-	-	-	-	810
	30	9-18	985	43°25'	87°45'	S.	0930	30	7	580	80	-	-	-	-	660
	35	9-18	986	43°23'	87°44'	N.	1020	30	7	75	185	-	-	-	-	260
	40	9-18	987	43°23'	87°44'	N.	1110	30	7	60	250	-	-	-	-	310
	45	9-18	988	43°23'	87°43'	N.	1210	30	7	10	150	-	-	-	-	160
	50	9-18	989	43°23'	87°41'	N.	1300	30	7	5	105	-	-	-	-	110
			1965													
24	15	4-22	1103	43°26'	87°47'	N.	0700	14	1	30	-	-	-	3	4	37
	20	4-22	1104	43°23'	87°48'	N.	0750	30	0	1,050	4	-	-	6	-	1,060
	20	4-22	1105	43°25'	87°48'	S.	0910	30	0	350	-	-	-	5	5	360
	25	4-22	1106	43°23'	87°47'	N.	1650	30	0	1,600	-	-	-	-	-	1,600
	30	4-22	1107	43°23'	87°45'	N.	1750	30	0	1,700	-	-	-	-	-	1,700
	35	4-23	1113	43°23'	87°44'	N.	1210	30	7	540	70	-	-	-	-	610
	40	4-23	1112	43°23'	87°43'	N.	1110	30	7	400	80	-	-	-	-	480
	45	4-23	1111	43°23'	87°42'	N.	1020	30	7	600	60	-	-	-	-	660
	50	4-23	1110	43°23'	87°41'	N.	0920	30	7	20	24	-	2	-	-	46
	60	4-23	1109	43°23'	87°40'	N.	0820	30	7	7	63	-	20	-	-	90
	70	4-23	1108	43°23'	87°37'	N.	0720	30	0	10	2	-	2	-	-	14

^{1/} 0 - clear drag, 1 - snag encountered (no gear damage), 2 - gear malfunction, 3 - minor gear damage, 4 - major gear damage (including loss of net), 5 - wind over 20 m.p.h., 6 - strong current, 7 - adverse weather conditions (including ice, fog, high seas), 8 - rough bottom, 9 - set fishing gear in area.

^{2/} Include lake herring, carp, common whitefish, trout-perch, spottail shiner, white sucker, lake trout, lake sturgeon, stickleback, and burbot.

^{3/} Drag made with 62-foot (headrope) modified western type box trawl.

Appendix table 11.--R/V Kaho Fishing Log - Lake Michigan trawl stations
off Manitowoc, Wis., 1962-65

Cruise No.	Depth	Date	Drag No.	Position		Course	Time of day	Fished	Limiting factor 1/	Catch						
				Lat. N.	Long. W.					Alewife	Chubs	Yellow perch	Sculpins	Smelt	Others 2/	Total
	Fath.	1962						Min.								
1	20	4-16	45	44°07'	87°29'	S.	1250	30	0	-	-	-	-	1	-	1
	25	4-16	46	44°08'	87°29'	N.	1350	30	0	1	-	-	-	8	-	9
	30	4-16	47	44°09'	87°26'	N.	1430	30	0	3	4	-	-	340	3	350
	34	4-16	48	44°11'	87°24'	S.	1530	30	0	-	310	-	-	-	-	310
	40	4-16	49	44°09'	87°24'	S.	1620	30	0	1	367	-	-	1	1	370
3 Phase I	20	6-19	80	44°01'	87°34'	NE.	0640	30	0	1	5	-	-	-	-	6
	20	6-19	87	44°06'	87°28'	S.	1430	30	0	15	44	-	-	1	10	70
	22	6-19	81	44°01'	87°30'	S.	0730	30	0	20	53	-	-	1	1	75
	25	6-19	86	44°08'	87°27'	S.	1350	30	0	3	76	-	-	-	1	80
	30	6-19	85	44°09'	87°26'	S.	1200	30	0	9	70	-	-	1	-	80
	35	6-19	84	44°10'	87°24'	NE.	1110	30	0	1	86	1	1	1	-	90
	40	6-19	82	44°01'	87°26'	NE.	0850	30	0	2	87	-	-	1	-	90
	40	6-19	83	44°09'	87°24'	N.	1020	30	0	1	69	-	-	-	-	70
	3 Phase III	20	8-18	180	44°08'	87°29'	N.	1630	30	0	60	385	-	-	5	-
25		8-18	179	44°10'	87°29'	S.	1540	30	0	-	297	-	1	1	1	300
30		8-18	178	44°12'	87°25'	S.	1450	30	2	-	-	-	-	-	-	-
35		8-18	177	44°10'	87°25'	N.	1350	30	0	1	138	-	-	1	-	140
40		8-18	176	44°08'	87°25'	N.	1310	30	0	1	298	-	-	1	-	300
9	5	4-13	307	44°12'	87°31'	N.	1330	4	4	-	-	-	-	-	-	-
	10	4-13	305	44°03'	87°36'	N.	1030	30	4	-	-	-	-	-	-	-
	15	4-13	304	44°04'	87°34'	N.	0940	30	0	-	-	-	-	-	-	-
	18	4-13	306	44°10'	87°27'	N.	1220	30	8	20	3	-	-	2	-	25
	20	4-13	303	44°01'	87°32'	N.	0850	32	0	3	2	-	-	1	-	6
	25	4-13	302	44°03'	87°31'	S.	0750	30	0	250	39	-	-	1	-	290
	30	4-13	301	44°03'	87°30'	S.	1530	30	0	980	20	-	-	-	-	1,000
	35	4-12	300	44°00'	87°29'	N.	1430	30	0	850	30	-	-	-	-	880
	39	4-12	299	44°02'	87°26'	S.	1330	30	0	500	99	-	1	-	-	600
	45	4-12	298	43°59'	87°23'	N.	1220	30	0	110	98	-	1	1	-	210
	49	4-12	297	43°59'	87°22'	S.	1110	30	0	29	350	-	1	-	-	380
13	15	9-10	460	44°04'	87°34'	S.	1330	30	0	820	134	-	-	10	6	970
	19	9-10	461	44°02'	87°32'	N.	1420	30	0	170	100	-	-	1	29	300
	25	9-10	462	44°04'	87°32'	S.	1510	30	0	70	208	-	-	1	1	280
	30	9-10	463	44°01'	87°30'	N.	1600	20	0	20	189	-	1	-	-	210
	34	9-11	464	44°11'	87°24'	N.	0840	30	4	-	-	-	-	-	-	-
	40	9-11	465	44°13'	87°25'	S.	0940	3	2	-	11	-	1	-	-	12
	43	9-11	466	44°12'	87°23'	N.	1010	30	5	1	188	-	1	-	-	190
	50	9-11	467	44°14'	87°23'	S.	1110	30	7	-	179	-	1	-	-	180
	60	9-11	468	44°12'	87°20'	N.	1210	30	7	-	70	-	5	-	-	75
	68	9-11	469	44°13'	87°18'	S.	1320	30	7	-	10	-	70	-	-	80
14	10	10-27	517	44°15'	87°28'	N.	1030	30	0	-	-	-	-	-	-	-
	14	10-27	518	44°17'	87°26'	S.	1120	30	0	990	9	-	1	10	-	1,010
	19	10-27	519	44°15'	87°26'	N.	1210	30	0	700	21	-	-	29	-	750
	25	10-27	520	44°17'	87°25'	S.	1300	30	0	500	270	-	-	50	-	820
	30	10-27	521	44°15'	87°24'	N.	1400	30	0	400	284	-	75	-	1	760
	34	10-27	522	44°15'	87°24'	S.	1600	30	0	100	960	-	-	50	-	1,110
	45	10-27	523	44°17'	87°23'	N.	1720	30	0	2	305	-	3	-	-	310
	50	10-28	524	44°22'	87°22'	S.	0810	30	0	1	152	-	2	5	-	160
	60	10-28	525	44°22'	87°20'	N.	0910	30	0	-	102	-	18	-	-	120
	69	10-28	526	44°22'	87°18'	S.	1030	30	0	-	40	-	80	-	-	120
78	10-28	527	44°20'	87°13'	N.	1250	30	0	5	10	-	20	5	-	40	
16	20	4-5	649	44°06'	87°30'	S.	0720	30	7	1	-	-	-	13	6	20
	25	4-5	650	44°06'	87°29'	S.	0820	30	7	-	8	-	-	105	47	160
	30	4-5	651	44°06'	87°28'	S.	0910	30	7	-	158	-	-	2	-	160
	35	4-5	652	44°05'	87°27'	S.	1020	30	7	-	237	-	3	-	-	240
	40	4-5	653	44°05'	87°27'	S.	1120	30	7	-	189	-	1	-	-	190
	45	4-5	654	44°05'	87°25'	S.	1220	30	7	-	228	-	2	-	-	230
	50	4-5	655	44°05'	87°20'	S.	1340	30	7	-	145	-	15	-	-	160
	60	4-6	656	44°04'	87°18'	S.	0800	30	7	-	30	-	90	-	-	120
	70	4-6	657	44°04'	87°16'	S.	0930	30	7	-	10	-	120	-	-	130

See footnotes at end of table.

Appendix table 11.--R/V Kaho Fishing Log - Lake Michigan trawl stations
off Manitowoc, Wis., 1962-65--Continued

Cruise No.	Depth	Date	Drag No.	Position		Course	Time of day	Fished	Limiting factor	Catch							Total
				Lat. N.	Long. W.					Alewife	Chubs	Yellow perch	Sculpins	Smelt	Others 2/		
	Fath.	1964						Min.				Pounds					
17	20	5- 2	699	44°04'	87°30'	N.	1600	20	9	2,250	-	-	-	6	4	2,260	
	20	5- 2	700	44°06'	87°30'	S.	1640	20	0	2,280	-	-	-	-	-	2,280	
	25	5- 3	701	44°06'	87°29'	S.	0800	30	0	2,200	53	-	-	15	2	2,270	
	30	5- 3	702	44°06'	87°28'	N.	0900	15	0	1,500	30	-	-	-	-	1,530	
	35	5- 3	703	44°06'	87°28'	S.	0940	15	0	2,070	240	-	-	-	-	2,310	
	40	5- 3	704	44°06'	87°27'	S.	1020	15	0	3,800	300	-	-	-	-	4,100	
	45	5- 3	705	44°06'	87°25'	S.	1140	15	0	800	100	-	-	-	-	900	
	50	5- 3	706	44°05'	87°20'	S.	1240	30	0	45	165	-	10	-	-	220	
	60	5- 3	707	44°04'	87°18'	S.	1400	30	0	-	60	-	90	-	-	150	
70	5- 3	708	44°04'	87°16'	S.	1520	30	0	1	9	-	90	-	-	100		
19	15	7-21	884	44°01'	87°36'	NE.	0700	30	0	4	500	-	-	15	1	520	
	20	7-20	882	44°04'	87°30'	S.	1730	26	9	1	36	-	1	1	1	40	
	20	7-20	883	44°04'	87°30'	N.	1810	26	0	1	36	-	-	1	2	40	
	20	7-21	885	44°01'	87°35'	NE.	0800	30	0	1	97	-	-	2	-	100	
	25	7-21	886	44°01'	87°34'	NE.	0900	30	0	1	52	-	1	1	-	55	
	30	7-21	887	44°01'	87°31'	N.	1000	30	0	-	169	-	1	-	-	170	
	35	7-21	888	44°01'	87°30'	N.	1100	30	0	-	180	-	-	-	-	180	
	40	7-21	889	44°01'	87°26'	N.	1200	30	0	-	169	-	1	-	-	170	
	45	7-21	890	44°01'	87°24'	N.	1310	30	0	-	119	-	1	-	-	120	
	50	7-21	891	44°01'	87°21'	N.	1430	30	0	-	93	-	7	-	-	100	
	60	7-21	892	44°01'	87°18'	N.	1540	30	0	-	22	-	53	-	-	75	
	70	7-21	893	44°02'	87°16'	N.	1650	30	0	-	2	-	118	-	-	120	
21	5	9-19	1001	44°00'	87°39'	N.	1610	15	4	-	-	-	-	-	-	-	
	10	9-19	1000	44°01'	87°38'	N.	1530	10	3	480	38	2	-	-	-	520	
	15	9-19	999	44°01'	87°36'	N.	1440	30	0	280	230	-	-	10	-	520	
	20	9-19	995	44°01'	87°34'	N.	1110	30	0	860	130	-	-	-	-	990	
	20	9-19	996	44°03'	87°33'	S.	1150	30	0	670	190	-	-	-	-	860	
	25	9-19	997	44°01'	87°34'	N.	1250	30	0	470	200	-	-	-	-	670	
	30	9-19	998	44°01'	87°30'	N.	1350	30	0	10	90	-	-	-	-	100	
	35	9-20	1002	44°01'	87°30'	N.	0730	30	0	-	65	-	-	-	-	65	
	40	9-20	1003	44°01'	87°26'	N.	0830	30	0	-	120	-	-	-	-	120	
	45	9-20	1004	44°01'	87°24'	N.	0930	30	0	-	90	-	-	-	-	90	
	50	9-20	1005	44°01'	87°21'	N.	1040	30	0	-	43	-	-	-	-	43	
	70	9-20	1006	44°01'	87°10'	E.	1220	30	0	-	10	-	60	-	-	70	
24	15	4-18	1102	44°02'	87°35'	S.	1540	30	0	-	-	-	-	-	-	-	
	20	4-18	1101	44°02'	87°33'	S.	1450	30	0	2	3	-	-	2	3	10	
	25	4-18	1099	44°02'	87°32'	S.	1300	6	9	-	-	-	-	-	-	-	
	25	4-18	1100	44°22'	87°32'	S.	1330	30	2	25	100	-	-	5	10	140	
	30	4-18	1098	44°02'	87°29'	S.	1150	30	0	13	87	-	-	-	-	100	
	35	4-18	1097	44°02'	87°28'	S.	1100	30	0	20	180	-	-	-	-	200	
	40	4-18	1096	44°02'	87°26'	S.	1010	30	0	80	150	-	-	-	-	230	
	45	4-18	1094	44°00'	87°24'	N.	0830	30	0	4	56	-	-	-	-	60	
	45	4-18	1095	44°02'	87°24'	S.	0910	30	0	7	63	-	-	-	-	70	
	50	4-18	1093	44°02'	87°21'	S.	0730	30	0	5	41	-	-	-	-	46	
	60	4-17	1092	44°05'	87°17'	S.	1540	30	0	220	30	-	-	-	-	250	
	70	4-17	1091	44°02'	87°16'	N.	1500	17	9	90	-	-	10	-	-	100	
28	20	8-15	1190	44°04'	87°29'	N.	1030	30	0	-	100	-	-	-	10	110	
	20	8-15	1191	44°06'	87°30'	S.	1120	18	1	7	40	-	-	2	-	49	
	25	8-15	1189	44°06'	87°29'	S.	0940	30	0	-	80	-	-	-	-	80	
	30	8-15	1188	44°04'	87°28'	N.	0900	30	0	2	110	-	8	-	-	120	
	35	8-15	1187	44°06'	87°27'	S.	0800	30	0	-	180	-	-	-	-	180	
	40	8-14	1186	44°03'	87°27'	N.	1720	25	9	-	110	-	-	-	-	110	
	45	8-14	1185	44°05'	87°26'	S.	1620	30	0	-	40	-	5	-	-	45	
	50	8-14	1184	44°03'	87°21'	N.	1500	30	0	-	25	-	30	-	-	55	
	60	8-14	1183	44°04'	87°18'	S.	1320	30	0	-	14	-	25	-	-	39	
70	8-14	1182	44°04'	87°16'	N.	1210	30	0	-	10	-	45	-	-	55		
30	15	12-17	1262	44°04'	87°30'	N.	0920	30	7	27	-	-	-	1	-	28	
	20	12-17	1263	44°04'	87°30'	NE.	1030	30	7	250	3	-	-	2	2	257	
	25	12-17	1264	44°04'	87°29'	NE.	1130	30	7	1,000	15	-	1	4	-	1,020	
	30	12-17	1265	44°04'	87°28'	NE.	1240	30	7	750	40	-	2	8	-	800	
	35	12-17	1266	44°04'	87°28'	N.	1400	30	7	150	300	-	3	2	1	456	
	40	12-17	1267	44°04'	87°27'	N.	1500	30	7	300	250	-	20	10	1	581	
	45	12-18	1268	44°05'	87°25'	N.	1010	30	0	400	300	-	3	-	-	703	
	50	12-18	1269	44°08'	87°24'	S.	1120	20	0	250	25	-	10	-	-	285	

1/ 0 - clear drag, 1 - snag encountered (no gear damage), 2 - gear malfunction, 3 - minor gear damage, 4 - major gear damage (including loss of net), 5 - wind over 20 m.p.h., 6 - strong current, 7 - adverse weather conditions (including ice, fog, high seas), 8 - rough bottom, 9 - set fishing gear in area.

2/ Include lake herring, carp, common whitefish, trout-perch, spottail shiner, white sucker, lake trout, lake sturgeon, stickleback, and burbot.

MS. #1820

GPO 863-444

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