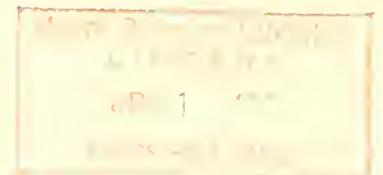


# Bottom Trawl Explorations in Lake Superior, 1963-65



**UNITED STATES DEPARTMENT OF THE INTERIOR**  
**FISH AND WILDLIFE SERVICE**  
**BUREAU OF COMMERCIAL FISHERIES**

Circular 294





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By

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# Bottom Trawl Explorations in Lake Superior, 1963-65

By

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## ABSTRACT

Six exploratory fishing cruises, totaling 122 operating days, were made by the research vessel Kaho from November 1963 to October 1965. Most of the exploratory operations were in the central and eastern portions of the lake; however, limited surveys were made in the western area during 1965. This study is the first attempt to assess the potential for commercial bottom trawling in Lake Superior.

Suitable bottom for trawling was found along about 65 percent of the south shore. Over 74 percent of the total catch by the Kaho were chubs (Leucichthys spp.) followed by American smelt (Osmerus mordax), 10 percent; suckers (Catostomus spp.), 6.5 percent; and lake trout (Salvelinus namaycush), 3 percent. Commercially significant catches, 250 pounds per one-half hour, of chubs were taken on every cruise and these fish, even if used mainly for animal food products, could apparently support a limited trawl fishery. Smelt, suckers, and common whitefish (Coregonus clupeaformis) were caught occasionally in commercially significant quantities and could greatly supplement production efforts. Most lake trout were caught in specific geographic areas and appeared to be segregated by size in specific depth zones. Abundant concentrations of small trout could easily be avoided after being located by fishing certain depths. With proper care, most trout were returned to the water alive. The alewife (Alosa pseudoharengus), which is now the basis of a growing trawl fishery in Lake Michigan, and lake herring (Leucichthys artedi) were not taken in significant amounts during the study.

## INTRODUCTION

The commercial fishery of Lake Superior has been declining since the mid-1950's. The decline is attributed primarily to the sea lamprey, which almost destroyed the populations of lake trout and whitefish.

Fishing gear and methods that were satisfactory for catching large and valuable fish are not satisfactory for taking the small and low-valued fish that are available today. Some species, such as American smelt, cannot be profitably taken by traditional methods (pound nets) except during their spawning season. Other abundant species, such as bloater chubs (Leucichthys hoyi), which are now used for animal food, cannot be caught efficiently enough by traditional methods (gill nets) for profitable operations.

To investigate current problems and provide advisory services to the commercial fishery sector of the Lake Superior economy, a technical assistance project was established under the Area Redevelopment Administration (now the Economic Development Administra-

tion). A basic study phase of the project was in effect from April 1964 to September 1965. One part of this study was to determine the seasonal abundance and distribution patterns of important species as related to their availability to effective and economical fishing methods. This report summarizes four exploratory cruises that were made under this project and two additional cruises that were made in support of the investigation.

Bottom trawling was chosen as the primary fishing method because of its proven ability in the Great Lakes and elsewhere to sample fish that spend all or most of their time in bottom waters. Trawling has long been a common method for surveying fishery resources and for catching a wide variety of species.

The Bureau of Commercial Fisheries research vessel Kaho operated 122 days on Lake Superior during six cruises. Bottom trawl explorations began in the Whitefish Bay area during November 1963. In 1964 three additional cruises were made: (1) in late May through early June, (2) August, and (3) November through early December. During

these cruises, fishing was extended westward to the Keweenaw Peninsula. In 1965 two cruises were made: (1) from mid-May through mid-June and (2) from early September through early October. In 1965 operations were extended westward to Duluth.

### VESSEL, GEAR, AND METHODS

The R/V Kaho (fig. 1), of West Coast purse seiner design, was built in 1961 and is of welded steel and riveted aluminum construction. The overall length is 64.75 feet; beam, 17.75 feet; and loaded draft, 8.0 feet. Propulsion is by two 150-horsepower diesel engines that provide a cruising speed of 9.3 knots. It has accommodations for six men. Storage space for fuel, water, and galley supplies enables the vessel to operate continuously for about 14 days.

The fishing equipment is typical of a small stern trawler. Deck gear, besides the usual boom-mast arrangement, includes a hydraulic net reel and two hydraulic winches each with

a capacity for 2,500 feet of 3/8-inch diameter cable. A metal roller, 18 inches in diameter and 8.25 feet long, is installed in the stern bulwark to facilitate net handling and retrieval. As on most vessels of this design, trawl nets are set and towed from the stern. The net and catch are retrieved directly over the stern roller (fig. 2). Electronic equipment includes radar, high-resolution echo sounder with fish-discriminating features (fig. 3), radio-telephone, intercommunications system, and automatic magnetic-electronic pilot and helm unit.

Three types of trawls were used. All but 14 of the 340 trawl drags were made with a 52-foot (headrope) Gulf of Mexico type fish trawl (Gordon and Brouillard, 1960); 2 drags were made with a 40-foot midwater trawl; and the remaining 12, with a 72-foot (headrope) two-seam wing trawl. All nets had a 1-inch mesh (stretch measure) cotton liner in the cod end to catch young fish and small species.

Most drags were one-half hour long, although eight were extended to 1 hour to determine the size of catches under possible commercial



Figure 1.--The research vessel Kaho of the Bureau of Commercial Fisheries Branch of Exploratory Fishing and Gear Research.



Figure 2.--Lifting catch of Lake Superior chubs aboard R/V Kaho.

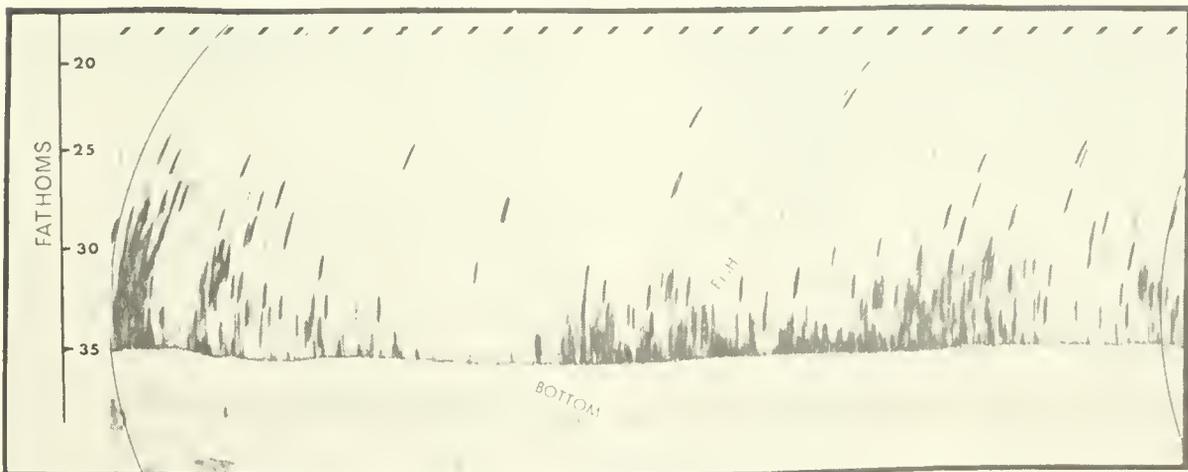


Figure 3.--Echogram made off Ontonagon on June 3, 1965, showing good bottom concentration of chubs. A 1/2-hour trawl drag over this area caught 450 pounds of chubs.

trawling. During cruise 18, 20 of the drags were 15 minutes long to delineate unknown trawling grounds. On other occasions, 48 drags were ended early to prevent fouling fishing gear set by commercial fishermen, i.e., gill

nets, or to reduce the number of trout caught in areas known to have large concentrations, or because snags were encountered. The gear was severely damaged on 17 drags and had minor tears on 39 drags.

When possible, drags were made along depth contours at 5-fathom intervals, i.e., 5, 10, 15, . . . , and 50 fathoms, and at the 60- and 70-fathom contours. Bottom irregularities and water currents often caused the actual fishing

Depth range	Designated depth	
	Fathoms	
3-7	=	5
8-12	=	10
13-17	=	15
18-22	=	20
23-27	=	25
28-32	=	30

In this study, evaluations of fishing results are based on two methods of calculations: (1) catch rate, which is pounds per unit effort for all drags in a particular evaluation, and (2) average catch for effective fishing effort, which is pounds per unit effort for only those drags that contained the particular species being evaluated. Hile (1962) has discussed effective fishing effort. All analyses of catch rate and average catch for effective fishing effort are based on 1/2-hour fishing time. Total fishing time was divided into 1/2-hour periods, thus drags that snagged are included in the evaluations. Analysis on a 1/2-hour basis is judged to be realistic for it appears that most commercial trawl drags in Lake Superior would be limited to about one-half to 1 hour because of bottom conditions and the need to save incidentally caught lake trout.

A catch is considered here to be commercially significant when its ex-vessel value is \$7.50 per 1/2-hour drag. For the four species that are considered to be available for commercial bottom trawling the individual commercially significant 1/2-hour catches would be as follows: chubs - 250 pounds, smelt - 150

depths to sometimes vary by several fathoms. To simplify discussion, I have rounded off the fishing depths to the nearest 5- or 10-fathom midpoint as follows:

Depth range	Designated depth	
	Fathoms	
33-37	=	35
38-42	=	40
43-47	=	45
48-55	=	50
56-65	=	60
66-75	=	70

pounds, suckers - 200 pounds, and common whitefish - 15 pounds.

### FISHING EFFORT

During the study period, the R/V Kaho completed six exploratory cruises in Lake Superior (table 1). Smith, Buettner, and Hile (1961) have defined fishery statistical districts, which are used to report annual commercial production for the Great Lakes. The information compiled during this study is described and analyzed in reference to these districts. Only the south shore was explored, and trawls were dragged in seven statistical districts. To simplify discussions the seven districts are renumbered consecutively from east to west. The district boundaries are outlined in figure 4 and defined simply below:

- District I - (MS-6)<sup>1</sup>/Michigan waters from Sault Ste. Marie to the Crisp Point Light.
- District II - (MS-5) Michigan waters from Crisp Point Light to the outlet of Beaver Lake.

<sup>1</sup>Designations in parentheses are those used by Smith et al. (1961).

Table 1.--R/V Kaho fishing effort in Lake Superior by cruise, 1963-65

Cruise No.	Districts fished	Dates	Days <sup>1</sup>	Drags	Trawl damage		Time fished	1/2-hr. periods
					Minor	Major		
					<u>Number</u>	<u>Number</u>	<u>Minutes</u>	<u>Number</u>
14	I, II	Nov. 16-20, 1963	5	15	0	0	414	13.8
18	III, IV	May 26-June 8, 1964	14	42	4	3	815	27.2
20	I, II, III, IV	Aug. 7-22, 1964	16	54	3	4	1,552	51.7
23	I, II, III, IV	Nov. 8-Dec. 8, 1964	31	61	10	2	1,725	57.5
25	III, IV, V, VI, VII	May 15-June 11, 1965	28	79	2	3	2,398	79.9
29	I, II, III, IV, V, VI, VII	Sept. 9-Oct. 6, 1965	28	89	20	5	2,500	83.3
Total			122	340	39	17	9,404	313.4

<sup>1</sup> Travel and storm-bound days excluded.

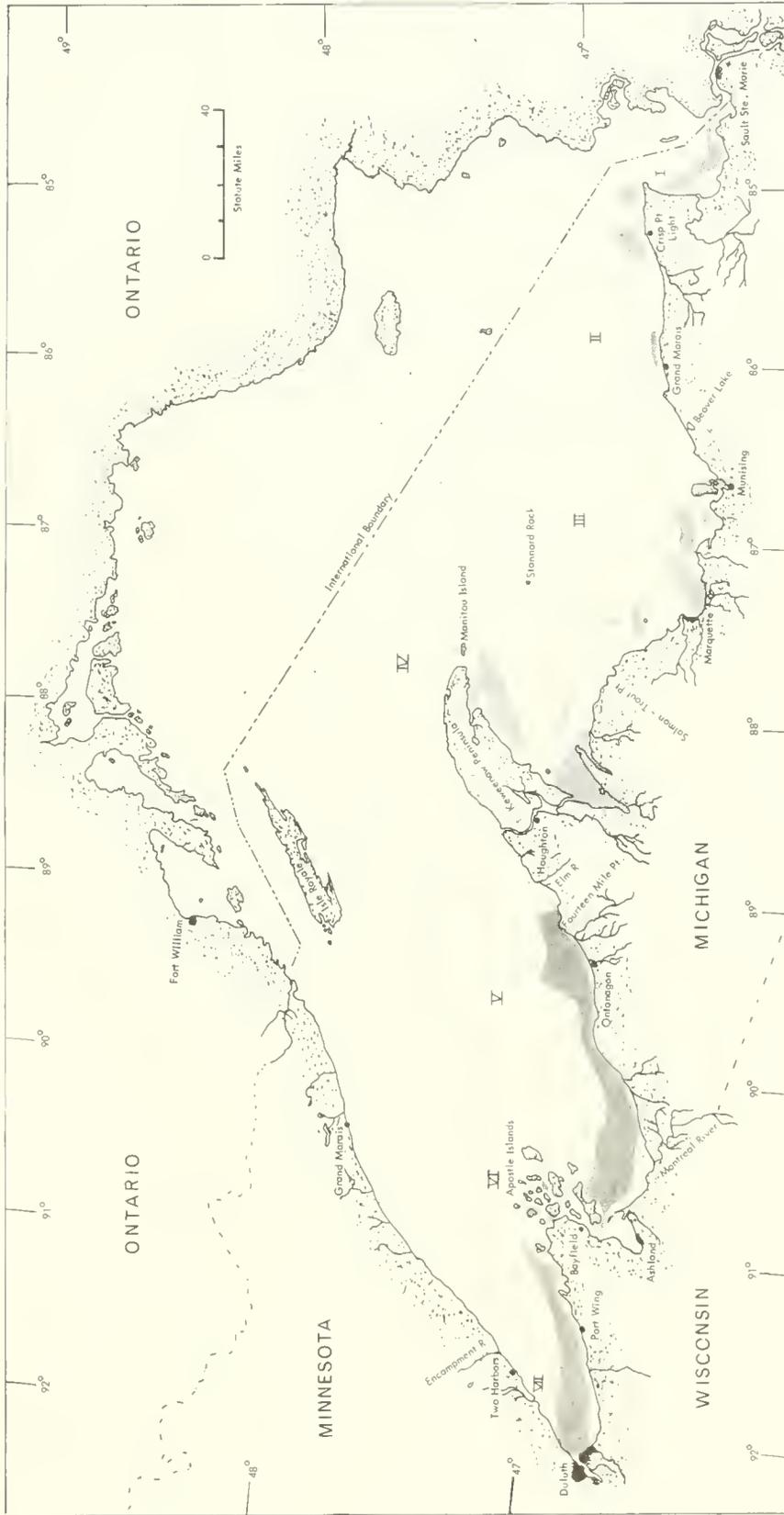


Figure 4.--Lake Superior showing the location of trawling grounds along the south shore and discussion districts, which correspond to State and Federal fishery statistics reporting districts. Localized snags were encountered in some of the grounds shown, but favorable trawling bottom exists over most of the shaded areas.

- District III - (MS-4) Michigan waters from outlet of Beaver Lake to Salmon-Trout Point.
- District IV - (MS-3) Michigan waters from Salmon-Trout Point to the Elm River.
- District V - (MS-2) Michigan waters from the Elm River to the Montreal River.
- District VI - (Wisc.) Wisconsin waters.
- District VII - (M-1) Minnesota waters from Duluth to the Encampment River.

Trawlable grounds were located in all seven districts (fig. 4). All districts were not visited during each cruise (table 1), nor was any district completely covered during the investigation. Thus, it is possible that additional trawlable grounds will be located in the future.

Exploratory fishing cruises are numbered consecutively regardless of area of operation. Thus, in this paper on trawling in Lake Superior cruise numbers are not consecutive.

Cruises were planned to explore progressively westward along the south shore. The first cruise (cruise 14) was a brief trip to the extreme eastern portion of the lake in the fall

of 1963 to obtain preliminary data regarding fish distribution and bottom conditions needed for survey planning purposes. Cruise 18 was devoted to initial explorations along the central portion of the south shore and Keweenaw Bay. On cruises 20 and 23, seasonal assessments were made in areas previously visited. Cruise 25 was concerned primarily with the seasonal assessments from Munising to Manitou island and the potential of fish production in District IV, but was extended to include initial explorations west of the Keweenaw Peninsula to Duluth. During cruise 29, seasonal explorations were made along the entire south shore in all seven districts.

Three hundred and forty exploratory trawl drags, which amounted to 157 hours of fishing time, were made in Lake Superior during this study. The effort by district was unequal owing to extent of trawlable grounds, more favorable location for production studies, and sequence of initial explorations. The effort (number of drags in each district) was distributed as follows:

- District I - 39 drags
- District II - 14 drags
- District III - 49 drags
- District IV - 167 drags
- District V - 27 drags
- District VI - 34 drags
- District VII - 10 drags

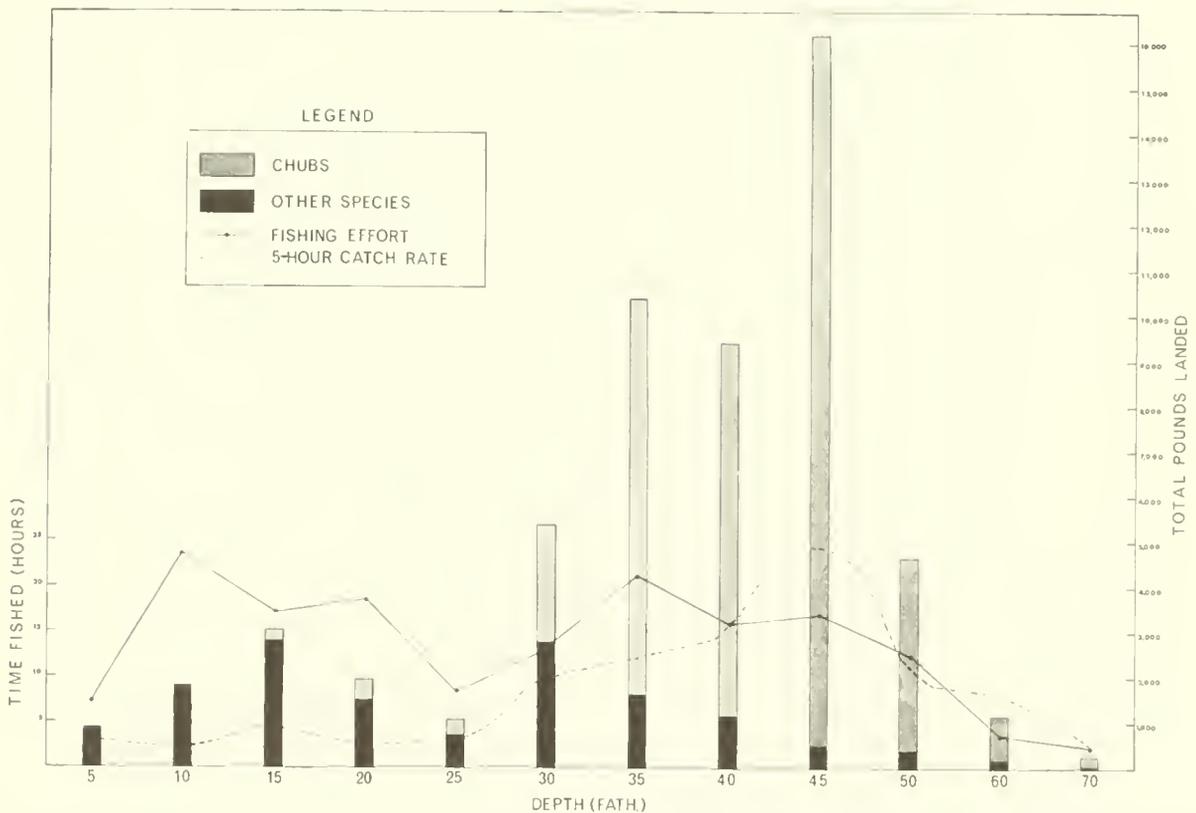


Figure 5.--Fishing effort, total pounds landed, and catch rate by depth for 340 trawl drags in Lake Superior. Note that fishing effort was fairly well distributed by depth; however, catch rate and total pounds landed were higher in water deeper than 30 fathoms and reached a peak at 45 fathoms because chubs were concentrated at these depths. On this figure the 1/2-hour catch rate has been multiplied by 10 to comply with the scale.

## SPECIES COMPOSITION OF THE TRAWL CATCH

Species composition and catch rate varied with fishing depth primarily because of the increasing abundance of chubs at depths greater than 30 fathoms. Of the 157 hours of total fishing time, 86 hours (55 percent) were spent in 30 fathoms or less. These drags, however, produced only 25 percent of the total catch (fig. 5).

Figure 6 shows the total species composition as well as the species composition for drags at two depth ranges--up to 30 fathoms and 35 to 70 fathoms. Shallow water drags caught a variety of species with one-third of the catch composed of smelt; whereas, chubs accounted for 25 percent; suckers, 22 percent; and lake trout, 8 percent. In deeper water, the catch was nearly homogeneous, with 90 percent chubs and only 2-1/2 percent smelt, 2 percent suckers, and 1-1/2 percent lake trout. The total species

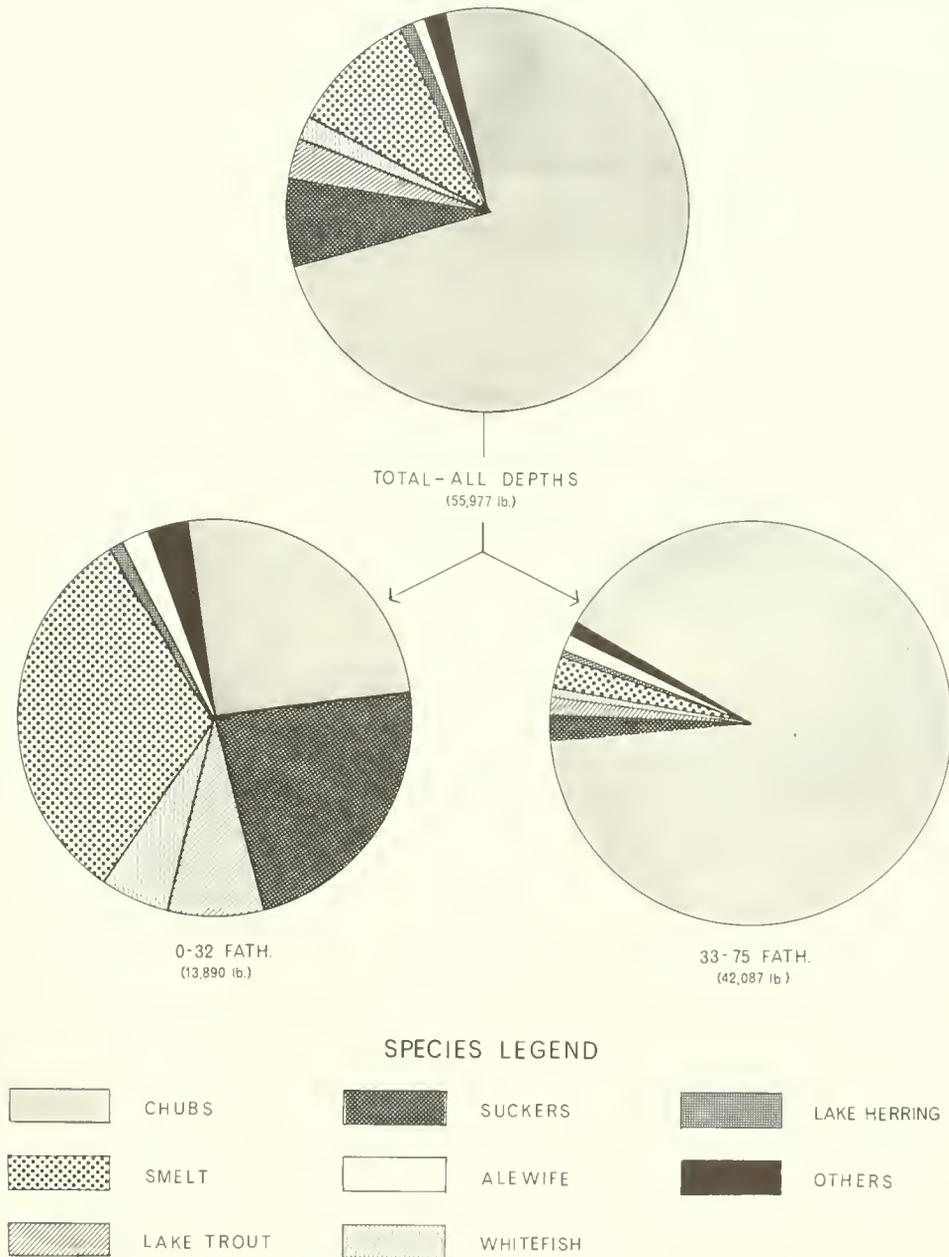


Figure 6.--Species composition of catch taken by Kaho trawl drags in Lake Superior. Top circle is total catch for all drags. Lower circles represent species composition of catch taken in the 0- to 30-fathom and 35- to 75-fathom depths.

Table 2.--Species composition of 340 trawl catches by R/V Kaho in Lake Superior, 1963-65

Species	Total catch		Occurrences in total drags		Catch rate per 1/2-hr. effort	Average catch for effective 1/2-hr. effort
	Pounds	Percent <sup>1</sup>	Number	Percent <sup>1</sup>	Pounds <sup>1</sup>	Pounds
Chubs ( <u>Leucichthys</u> spp.).....	41,534	74.2	174	51	132.5	240
American smelt ( <u>Osmerus mordax</u> ).....	5,608	10.0	189	56	17.9	32
Longnose sucker ( <u>Catostomus catostomus</u> ).....	1,899	3.4	21	6	6.1	92
Lake trout ( <u>Salvelinus namaycush</u> ).....	1,735	3.1	200	59	5.5	9
White sucker ( <u>Catostomus commersoni</u> ).....	1,676	3.0	42	12	5.3	40
Common whitefish ( <u>Coregonus clupeaformis</u> ).....	1,080	1.9	41	12	3.4	28
Alewife ( <u>Alosa pseudoharengus</u> ).....	736	1.3	62	18	2.3	12
Burbot ( <u>Lota lota</u> ).....	497	.9	70	21	1.6	8
Lake herring ( <u>Leucichthys artedii</u> ).....	446	.8	79	23	1.4	6
Sculpins ( <u>Cottidae</u> ).....	230	.4	47	14	.7	5
Ninespine stickleback ( <u>Pungitius pungitius</u> ).....	149	.3	56	16	.5	3
Menominee whitefish ( <u>Prosopium cylindraceum</u> ).....	134	.2	34	10	.5	5
Trout-perch ( <u>Percopsis omiscomaycus</u> ).....	92	.2	21	6	.3	5
Pigmy whitefish ( <u>Prosopium coulteri</u> ).....	75	.1	36	11	.2	2
Yellow perch ( <u>Perca flavescens</u> ).....	23	T	9	3	.1	3
Spottail shiner ( <u>Notropis hudsonius</u> ).....	18	T	7	2	.1	3
Rainbow trout ( <u>Salmo gairdneri</u> ).....	13	T	5	1	T	3
Yellow pike or Walleye ( <u>Stizostedion vitreum vitreum</u> )..	13	T	2	T	T	7
Lake sturgeon ( <u>Acipenser fulvescens</u> ).....	7	T	1	T	T	7
Brown trout ( <u>Salmo trutta</u> ).....	6	T	2	T	T	3
Redhorse ( <u>Moxostoma</u> spp.).....	6	T	2	T	T	3
TOTAL	55,977	99.8			178.4	

<sup>1</sup> T=Trace, less than 0.5 or 0.05

composition is summarized in table 2. The most abundant fish taken were chubs, followed by smelt, suckers, lake trout, common whitefish, alewife, burbot (Lota lota), and lake herring in that order. Other species accounted for less than one-half percent each.

#### DISCUSSION BY DISTRICT

The following discussion describes the bottom trawling areas and fishing results in each of the seven fishing statistical districts along the south shore. Districts are discussed consecutively from east to west.

##### District I - Michigan Waters from Sault Ste. Marie to Crisp Point Light

In general, much of the Whitefish Bay area and the deeper waters north of Whitefish Point are favorable for trawling. No major snags were encountered or nets damaged during the four cruises in the district.

Fishing in shoal water was very poor during each cruise--the catch rate was only 7 pounds

of fish per one-half hour (24 1/2-hour periods) for all drags at depths of 30 fathoms or less.

In deeper water (35 to 50 fathoms), the catch rate was 180 pounds per one-half hour of which 136 pounds were chubs. The only area consistently good for chubs was the 35-fathom station, 6 miles north of Whitefish Point. The largest chub catches in District I were taken from this station on every cruise on which the station was sampled. The best catch was 770 pounds during cruise 23.

Catches of other species were light in District I. Over half the drags had smelt, but the catch rate was only 10 pounds per drag. The best smelt landing was 200 pounds taken during cruise 23 at 40 fathoms in the southern portion of Whitefish Bay. Over half of the total poundage of alewives landed by the Kaho was taken in District I, although only 11 percent of the total fishing effort was devoted to this district. The largest catch (200 pounds) of alewives landed in Lake Superior was taken early in the survey at 35 fathoms in the southern portion of the bay during cruise 14. The percentage of trout in the trawl drags (2 percent of the total

poundage) was less than the lakewide average. Only small amounts of lake herring, whitefish, and suckers were taken.

#### District II - Michigan Waters from Crisp Point Light to the Outlet of Beaver Lake

Few drags were attempted in this district because of poor harbor facilities, unfavorable weather during the visits, and extensive stretches of irregular bottom. Fourteen drags in District II caught a total of only 52 pounds of fish, and none of the drags was of commercial significance.

#### District III - Michigan Waters from the Outlet of Beaver Lake to Salmon - Trout Point

A large number of snags were encountered in this district, and bottom trawling is feasible only in rather restricted areas in the deeper water. From Marquette Bay to Granite Island, 50 percent of the drags hit snags.

Catches of chubs were generally fair in this district. Fifteen drags with the 52-foot trawl in 35 fathoms and deeper produced a catch rate of 207 pounds of chubs per 1/2-hour drag. The best catches, both taken off Shelter Bay, were 580 pounds at 50 fathoms during cruise 23 and 950 pounds at 40 fathoms during cruise 29.

Trout were taken in only 18 of the 49 drags, making up 1.7 percent of the total catch by weight and yielding 1-1/2 pounds per 1/2-hour drag.

Excellent catches of common whitefish were taken in Munising Bay. Six drags here caught three-quarters of all whitefish taken in Lake Superior by the Kaho. The best individual catch in Munising Bay was 235 pounds, and the average catch for effective effort was 135 pounds. Whitefish were also taken in Marquette Bay, but the best catch was only 41 pounds.

Catches of other species were small. The best smelt catch (110 pounds) was taken in 50 fathoms off Shelter Bay during cruise 23. The best alewife catches (30 and 60 pounds) were taken west of Granite Island in Marquette Bay. Lake herring and suckers were taken occasionally only in small amounts.

#### District IV - Michigan Waters from Salmon-Trout Point to the Elm River

Explorations were made only from Salmon-Trout Point to Manitou Island, thus waters of this district adjacent to the west side of the peninsula were not trawled. A large amount of localized trawling grounds is available in the area explored, and few snags (mostly submerged logs) were encountered on these grounds.

The most successful and consistent production rates for chubs in Lake Superior have been obtained in this district especially along the east shore of the Keweenaw Peninsula

and in Keweenaw Bay. Consistently good catches of chubs were taken in 35 to 50 fathoms in the following areas: off Portage Entry, along the east shore and south central portion of Keweenaw Bay, and along the east shore of the Keweenaw Peninsula from Grand Traverse Bay to Bete Grise Bay (fig. 7). The best chub catch rates in District IV were obtained at 45 fathoms on all but the last cruise. The 1/2-hour catch rates at 45 fathoms for cruises 18 through 25 were as follows: 440, 425, 520, and 650 pounds. On cruise 29 the best catch rate (250 pounds) was obtained at the 40-fathom depth. At the above depths where chub production was the best, very few lake trout were taken in the trawl as indicated by catch rates by cruise of only 2, 0, 1, 7, and 2 pounds, respectively. The best individual 1/2-hour chub catches in this district for each of the five cruises (18 to 29) were 840, 1,210, 620, 1,650 and 430 pounds. Figure 8 illustrates the catch rates of chubs and trout by depth in this district for each cruise.

A potential harvest for smelt and suckers also appears to exist in this district. The best individual catches of smelt taken in District IV on each cruise (18 to 29) were 320, 240, 150, 25, and 1,200 pounds. All of the above landings were in Huron Bay or the southern half of Keweenaw Bay. Good catches (140 to 255 pounds) of suckers were taken during cruises 20, 23, and 29 in 10 to 15 fathoms in Huron Bay and at the mouth of Huron Bay. Lesser amounts of suckers (up to 120 pounds) were caught in Keweenaw Bay. Alewives were taken sporadically, and the best catch was 75 pounds in 30 fathoms in Keweenaw Bay during cruise 23. Catches of both common and round whitefish were small--the best catch was less than 50 pounds.

#### District V - Michigan Waters from the Elm River to the Montreal River

Good trawling bottom was found continuously from Fourteen Mile Point, east of Ontonagon, to the Montreal River. Depths from 5 to 75 fathoms were trawlable, and the only snags encountered were submerged logs.

Most drags in District V during cruise 25 were aimed at taking chubs; therefore, most effort was made at 35 fathoms where the largest chub concentrations in the district were located at that time. At the 35-fathom depth range on cruise 25, the catch rate was 204 pounds, and the best catch of 450 pounds was taken off Ontonagon. During cruise 29, significant catches of chubs--250 and 350 pounds--were taken at 30 and 40 fathoms, respectively.

Species other than chubs totaled 48 percent of the district landings. Suckers were the most abundant of the other species followed by smelt and lake trout. Sucker concentrations were not found on cruise 25; however, during cruise 29, suckers were taken in 11 of the 15 drags

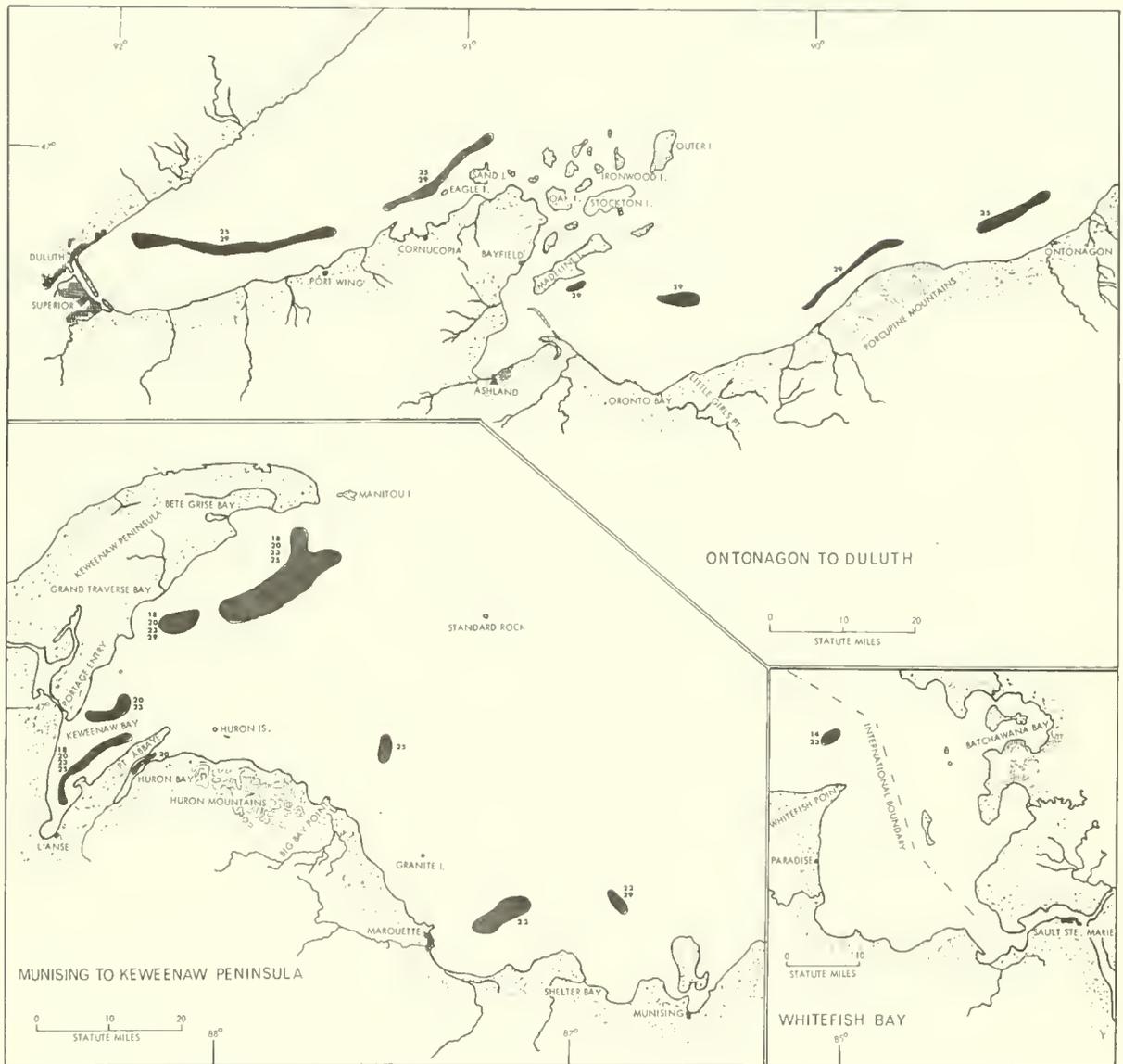


Figure 7.--Geographic locations of commercially significant chub catches (250 pounds or more per 1/2-hour drag). All commercially significant catches of chubs in Lake Superior during the study period were made within the dark areas. (Numbers refer to cruises during which the concentrations were located.)

and were the most abundant species landed in the district during the cruise. The largest sucker catches of 900 and 320 pounds were taken off the Porcupine Mountains in 30 and 40 fathoms, respectively. Smelt occurred in 40 percent of all the district drags, and the best catch of 75 pounds was taken off Little Girls Point on cruise 29. Lake trout were taken in 15 of the 27 drags in the district and made up 3 percent of the total catch. The catch rate of lake trout was 5 pounds per drag.

#### District VI - Wisconsin Waters

In the eastern portion of the district, trawlable grounds were found from the Montreal River to Madeline Island. In the Apostle Islands area, much of the bottom is unsuitable and trawling grounds are limited. Trawling by the Kaho has been limited thus far to the following Apostle Islands locations: In Big Bay of Madeline Island, the south channel off Madeline Island, between Stockton and Ironwood Islands,

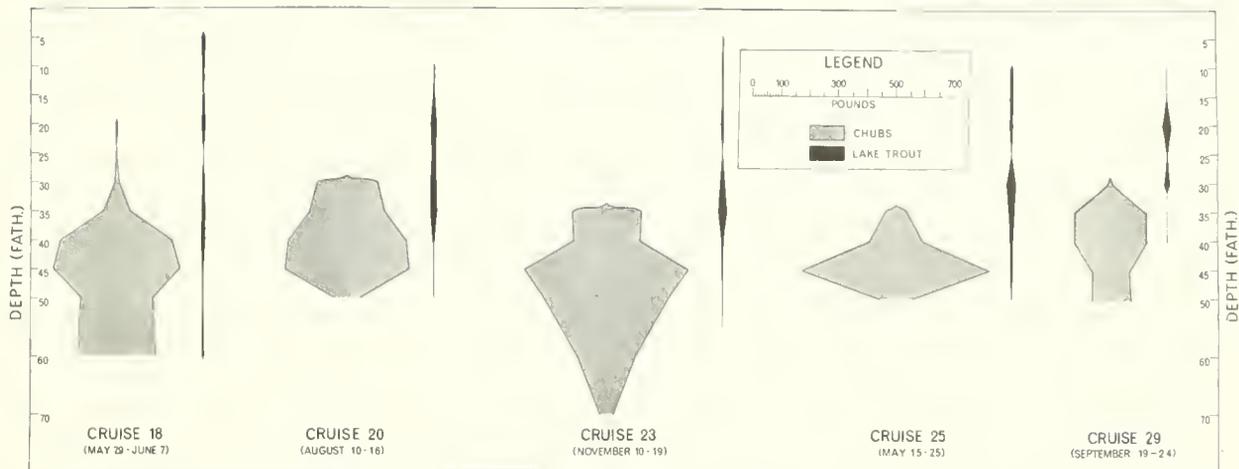


Figure 8.--Bathymetric distribution of chubs and lake trout in District IV by cruise. Distribution is based on catch rate per 1/2-hour effort at each depth range. Fishing at 35 fathoms (dotted line) or deeper would produce the highest catch rate of chubs and take few trout.

and between Oak Island and the mainland. Very favorable trawling bottom was found from north of Sand Island continuously to Superior at depths of 4 to 50 fathoms. Snags were encountered only at 25 fathoms off the Brule River and in shallow water off Superior where clay banks make trawling difficult.

Chubs were 87 percent of the total catch in District VI and were taken in all but five drags. The most productive grounds were located along the 35-fathom contour running from directly north of Sand Island to 3 miles past the Eagle Island shoals. Four drags here had catch rates of 656 pounds of chubs and 17 pounds of lake trout. In the same area, but along the 30-fathom contour, four drags had catch rates of only 278 pounds of chubs and 40 pounds of lake trout. The best individual catches in the above area by cruise were 1,500 pounds during cruise 25 and 525 pounds during cruise 29. During cruise 29, smaller but significant chub catches were taken along the 30- and 35-fathom contours at stations from Eagle Island to Duluth and from the Montreal River to Madeline Island. All drags deeper than 33 fathoms had a catch rate of 263 pounds of chubs.

Lake trout were caught in 23 of the 34 drags in this district and composed 4 percent of the total catch. Heavy concentrations, however, were located only in 28 to 33 fathoms from Sand Island to Eagle Island shoals and in 22 fathoms south of Madeline Island. Five drags in these two areas and at the depths indicated took 75 percent of the lake trout catch in the district. West of Cornucopia, only 9 pounds of lake trout were caught in 13 drags.

During cruise 29, in the Apostle Islands area one 15-minute drag took 50 pounds of smelt, and another similar drag caught 175 pounds of suckers.

### District VII - Minnesota Waters from Duluth to the Encampment River

This district is trawlable from 2 fathoms off Duluth eastward to 40 fathoms. Towards the north shore, however, the bottom becomes rougher and suitable trawling grounds are scarce.

Although only 10 drags were made in the district, maximum catches of chubs, smelt, and suckers were 350, 225, and 124 pounds, respectively. A total of 10 pounds of lake trout were taken in three drags. On cruise 29, over 200 young-of-the-year yellow pike or walleye (*Stizostedion vitreum vitreum*) were caught in 4 fathoms off Duluth.

### DISCUSSION BY SPECIES

The following discussion describes fishing results, by species, for each of the important commercial species taken during this study. The discussion order is based on total landings for the six cruises. Two species of suckers [longnose (*Catostomus catostomus*) and white (*C. commersoni*)] are discussed together as are two species of whitefish [common (*Coregonus clupeaformis*) and menominee (*Prosopium cylindraceum*)]. Burbot is considered as a miscellaneous species even though it exceeded lake herring (497 pounds to 446 pounds) in total landings. In Lake Superior burbot has never been an important commercial species whereas lake herring has long dominated the commercial landings.

#### Chubs

Chubs were caught most frequently in commercially significant quantities during the

fishing explorations, and their abundance and availability are apparently sufficient to support limited trawling on Lake Superior. Chubs appear to average larger in Lake Superior than on the other Great Lakes, and about 10 percent of the trawl-caught chubs were of acceptable size for human food as a smoked or fresh product. The catch records of chubs by cruise is summarized in table 3, and the best 1/2-hour chub catches during each cruise are summarized in table 4. Of the 174 exploratory drags catching chubs, 59 were of commercial significance (a catch rate of 250 pounds or more per one-half hour of trawling). The average catch for effective effort was 240 pounds.

Commercially significant catches of chubs were taken in all but one district and at more than one location on every cruise. Commercially significant concentrations of chubs were found all along the south shore but in specific geographic locations (fig. 7). Few significant chub catches have been made in waters shallower than 35 fathoms, and none deeper than 55 fathoms. Three-quarters of all the significant catches were made in the 35- to 45-fathom range.

Almost half of the total fishing effort was expended in District IV where consistently

good chub catches were found. An analysis of the depth distribution of chubs during each of the five cruises in this district is shown in figure 8. Only small amounts were caught shallower than 30 fathoms during cruises 18, 20, and 29, and none was taken shallower than this depth during cruises 23 and 25. The best catch rates throughout the area were obtained at the 45-fathom depth during all but the last cruise when the highest catch rate was at the 40-fathom interval. The best individual catches were also made at the 45-fathom interval on cruises 23 and 25; however, on cruises 18, 20, and 29, the best individual catches were made at the 40-fathom interval.

A study of commercial production potential was made between Grand Traverse Bay and Bete Grise Bay on cruise 25 (fig. 9). Twelve drags to test production potential, totaling 8-2/3 hours of fishing effort, caught 12,230 pounds of chubs, 40 pounds of smelt, 129 pounds of lake trout, 96 pounds of lake herring, and 25 pounds of miscellaneous species. These drags averaged 1,475 pounds of fish per hour of which 1,410 pounds were chubs. Ninety-four percent of the chubs measured in these catches were over 9 inches long and averaged 3.8 fish in the round to the pound. Nearly all the lake trout caught in this study were returned to the water alive and successfully re-entered subsurface levels.

During the production trials, six drags with a 72-foot headrope, two-seam wing trawl were compared with six drags made with the 52-foot standard assessment trawl. The highest individual catch rate was obtained eventually with the bigger trawl (2,200 pounds in 40 minutes), but the 52-foot trawl outfished the larger one by an average hourly rate of 1,575 pounds to 1,270 pounds. I believe that increased experience with the larger net would lead to an improvement in its effectiveness.

## Smelt

In total poundage caught, smelt was the second most abundant species taken during the fishing explorations. Smelt were in over half of all drags and composed 10 percent of the total catch, but only 18 drags netted over 100 pounds per 1/2-hour drag, and the average catch for effective effort for all cruises was only 32 pounds. The overall catch rate was only 17 pounds per 1/2-hour effort. Smelt were found most consistently in Huron and Keweenaw Bays and off Duluth.

Commercially significant catches of smelt were taken on four cruises; however, very poor catches were made on cruises 14 and 25. During cruise 14 in Whitefish Bay, not more than 15 pounds per drag were taken. On Cruise 18 in the central portion of the lake, good catches of 300 and 320 pounds were taken in Huron Bay at 25 and 30 fathoms, whereas in Keweenaw and Grand Traverse Bays, the smelt

Table 3.--Summary of catch records of chubs in Lake Superior by cruise, 1963-65

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
14	15	1	403	29	81
18	42	5	1,580	58	141
20	54	6	5,393	104	220
23	61	12	6,591	115	246
25	79	23	20,103	252	391
29	89	12	7,464	90	141

Table 4.--Summary of largest chub catch for each cruise

Cruise No.	Drag No.	Depth	Location	Chubs per 1/2-hour drag
				Pounds
14	3	35	North of Whitefish Point	305
18	37	38	Off Grand Traverse Bay	880
20	98	40	Keweenaw Bay	1,210
23	169	35	North of Whitefish Point	770
25	222	43	Off Bete Grise Bay	1,650
29	279	40	Off Shelter Bay	950



Figure 9.--Trawl catch taken off Grand Traverse Bay during cruise 25. Drag lasted 1 hour, and the catch was 2,600 pounds of chubs, 20 pounds of lake trout, and 10 pounds of smelt.

were more scattered and the best catches of 100, 110, and 180 pounds were taken at 10 and 15 fathoms. During cruise 20, smelt were also scattered; however, good catches of 100 to 240 pounds were taken at 10 to 15 fathoms in Huron and Keweenaw Bays. On cruise 23, fair concentrations of smelt were in deeper water (30 to 50 fathoms), and catches were taken as follows: 200 pounds at 40 fathoms in Whitefish Bay, 110 pounds at 50 fathoms off Shelter Bay, and 100 to 150 pounds at 30 to 40 fathoms in Keweenaw Bay. During cruise 25, smelt were extremely dispersed and were taken at all depths from 5 to 52 fathoms, and the best catch was only 45 pounds taken off Duluth in 12 fathoms. On cruise 29, smelt were concentrated mostly in 15 and 20 fathoms, where the catch rate was 100 pounds per drag. The largest catch of smelt taken during the study was 1,200 pounds in Huron Bay during the last cruise. Other significant catches during cruise 29 were made in Keweenaw Bay and off Duluth.

#### Suckers

The trawl catches contained longnose and white suckers. The composite total of both species made suckers the third most abundant

fish taken during the study, composing 6.5 percent of the total catch. White suckers were taken more frequently east of the Keweenaw Peninsula whereas longnose suckers were more common west of the peninsula. West of Keweenaw Peninsula, where only 20 percent of the total fishing effort was devoted, over 75 percent of the total poundage of suckers was taken. Over 80 percent of the total poundage of suckers during the study was caught on cruise 29.

The two most outstanding catches of 900 and 320 pounds were taken off the Porcupine Mountains at 30 and 40 fathoms. Other areas west of the Keweenaw Peninsula that produced catches over 100 pounds include Ontonagon, Apostle Islands area, and Duluth. East of the Keweenaw Peninsula, only Keweenaw and Huron Bays, particularly the latter, produced catches of over 100 pounds. The best catch east of the Keweenaw Peninsula was 225 pounds during cruise 23.

#### Lake Trout

Results of the Kaho's explorations helped substantiate the success of lake trout rehabilitation in Lake Superior. Lake trout were in 59 percent of the Kaho's 340 drags. The

catches of lake trout were usually small, and, of the total drags, trout were caught at a catch rate of only 5-1/2 pounds per 1/2-hour drag for all depths. Lake trout are an ecological associate of chubs, and of the 251 drags that contained either chubs or trout, one-half contained a combination of both species, one-third contained only trout, and one-sixth contained only chubs. Because adult lake trout, except for spawning, do not gather in large schools, they would not be a primary target species for trawling. Moreover, during trawling, most immature lake trout can be effectively avoided by fishing at selective depths.

Catch rates, number of trout per drag, and average weight of trawl-caught lake trout varied with depth. An analysis of three depth zones showed the following:

4 to 12 fathoms--In this zone the catch rate and number of trout taken were very small (2.2 pounds of lake trout and 1.7 trout per 1/2-hour drag). The average weight of trout was 1.3 pounds.

13 to 27 fathoms--In this zone the catch rate and number of trout increased to 5.7 pounds and 7.3 trout per 1/2-hour drag, whereas the average weight of trout decreased to 0.78 pounds. Within the zone, the catch rate was highest at 20 fathoms.

28 fathoms and deeper--This zone took primarily very small trout with an average weight of 0.41 pounds per trout. The catch rate and number of trout taken were very high at 30 fathoms (16.4 pounds and 38.3 trout per 1/2-hour drag) and decreased sharply with depth. At 50 fathoms, the catch rate was 1.5 pounds and 2.9 trout per drag. No trout was taken deeper than 55 fathoms.

Figure 10 shows the average individual weights, number of trout per drag, and catch rates by 5-fathom depth intervals for all lake trout captured during the study.

Maximum concentration of small trout varied several fathoms from cruise to cruise and in different geographical areas; however, few concentrations (15 pounds or more per drag) were taken deeper than 35 fathoms. Once a concentration was located, an adjustment of fishing depth of several fathoms effectively avoided the concentration. This avoidance was demonstrated north of Cornucopia when the Kaho made a comparison drag side by side with the experimental commercial trawler Nichevo using the same size net, vessel speed, towing direction, and drag duration. The Nichevo fishing in 33 fathoms caught only 12 trout, and the Kaho fishing in 28 fathoms caught 150 trout. Both vessels caught commercially significant amounts of chubs in 20 minutes, but the Nichevo's catch was 34 percent greater.

Concentrations of trout (catch rates over 15 pounds per one-half hour) were located only

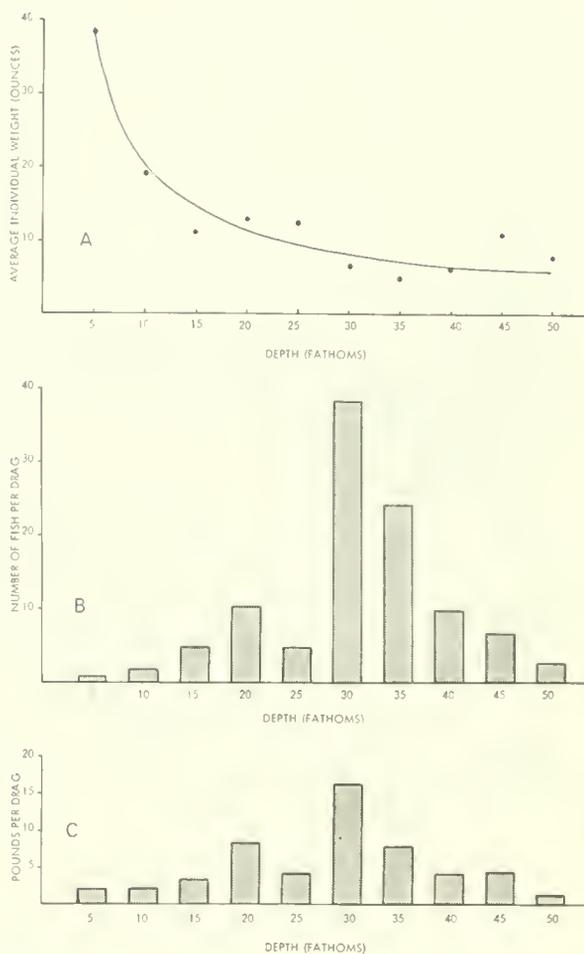


Figure 10.--Distribution of trawl-caught lake trout by depth in Lake Superior. A. Average individual weight of lake trout by depth. B. Number of lake trout captured per 1/2-hour drag at each depth interval. C. Catch rates of lake trout (pounds per 1/2-hour drag) at each depth interval. The data above are for all drags during the study.

in the following areas: southern Keweenaw Bay, the east shore of Keweenaw Bay off Pt. Abbaye, Keweenaw Bay off Portage Entry, several localities between Grand Traverse Bay and Bete Grise Bay, off Ontonagon, off the Porcupine Mountains, in the south channel off Madeline Island, and north of Cornucopia. Thirty-six drags in these areas took nearly 60 percent of the total pounds of trout caught by the Kaho in Lake Superior. It is noteworthy, that of the 36 drags, 21 were in 28 to 37 fathoms, 7 in 20 to 22 fathoms, only 3 deeper than 38 fathoms, and 5 at other depths.

The total catch of lake trout was insignificant. During the study, the Kaho made exploratory drags at preselected areas and depths and used a smaller size mesh (1-inch stretched measure) in the cod end than would be used by a commercial trawler. Although

little effort was made to avoid catching trout, only 3.1 percent of the total catch by weight were lake trout. A commercial operation could expect to catch fewer trout. Forty-four drags of the Kaho made in 35 fathoms or deeper had commercially significant quantities of chubs. The total catch of these 44 drags was 29,187 pounds, of which only 323 pounds or 1.1 percent were lake trout.

Lake trout taken by a trawl can usually be returned alive to the water. Successful survival depends upon the following factors: (1) amount of crowding in the code end, (2) availability of recovery tank with running water, (3) suitable water temperatures on the lake surface and in the recovery tank, (4) deflation of the swim bladder if necessary, (5) sufficient time in the recovery tank, and (6) protection from predation by sea gulls. Survival rates can be increased in proportion to application of the above factors.

I doubt that trawling would conflict with commercial and sport fishing for trout. In addition to selective depth fishing, the trawler can reduce the catches of small trout by increasing the cod end mesh size and by avoiding areas where trout are concentrated.

A practical method to conserve small, planted lake trout and at the same time effectively harvest chubs and smelt would be to regulate trawling in depths from 28 to 37 fathoms. Commercial trawl drags in these depths should be preceded by short (10- to 15-minute) exploratory drags to determine if small trout are present. Commercial quantities of smelt were found most frequently at depths shallower than 28 fathoms, and commercially significant amounts of chubs were located most frequently in waters deeper than 37 fathoms.

### Whitefish

Common whitefish were caught consistently in commercially significant amounts (15 pounds per one-half hour) only in Munising Bay. Here catches of 60, 140, 150, 180, and 230 pounds were taken, but most of the fish were small. Edsall (1960) reported that the whitefish population in Munising Bay is unharvested and slow growing. Only five other drags took 25 to 50 pounds.

Catches of menominee whitefish were small; the largest catch was 16 pounds, and the average catch for effective effort was 5 pounds.

### Alewife

Alewives were not found in commercially significant amounts in Lake Superior. The best catches of 110 and 200 pounds were landed in Whitefish Bay during the first cruise. These catches accounted for 42 percent of the total alewife catch. The only other catches over 35 pounds were 60 pounds taken in 5 fathoms in Marquette Bay during cruise 20 and 75 pounds

Table 5.--Largest alewife catches taken by otter trawl in Lake Superior by district and year

Year	District						
	I	II	III	IV	V	VI	VII
	.....Pounds.....						
1963	200	0	-	-	-	-	-
1964	10	1	60	75	-	-	-
1965	8	1	0	2	4	1	2

taken from 30 fathoms in Keweenaw Bay on cruise 23. The largest alewife catches taken in each district by year are given in table 5.

### Lake Herring

Thus far, efforts to catch lake herring by the Kaho with a bottom trawl in Lake Superior have been unsuccessful. A heavy bottom concentration of this species has not been found. Echo tracings indicated that lake herring may comprise some midwater schools of fish not taken by bottom trawls (fig. 11).

Lake herring appeared in one-quarter of the trawl catches, but the average catch for effective effort was only 6 pounds and less than 1 percent of the total catch was composed of this species. The best catch was only 45 pounds; however, a 7-minute drag caught 22 pounds--a catch rate of 94 pounds per one-half hour. Both catches were in late spring.

### Miscellaneous Species

The trawl took small amounts of twelve other species [burbot, sculpin (Cottidae), stickleback (Pungitius pungitius), trout-perch (Perocopsis omiscomaycus), pigmy whitefish (Prosopium coulteri), yellow perch (Perca flavescens), spottail shiner (Notropis Hudsonius), rainbow trout (Salmo gairdneri), yellow pike or walleye (Stizostedion vitreum vitreum), lake sturgeon (Acipenser fulvescens), brown trout (Salmo trutta), and redhorse (Moxostoma spp.).] None were caught frequently enough or in sufficient quantities to be commercially significant. The total poundage of the 12 species was only 2.0 percent of the total catch, and none was more than 0.9 percent individually (see table 2). Of the miscellaneous species, burbot was caught most frequently--70 times at an average catch for effective effort of 8 pounds. Burbot was taken in greater quantities west of the Keweenaw Peninsula. Although only 21 percent of the fishing effort was expended west of the Keweenaw Peninsula, 75 percent of the burbot catch was taken there. During cruise 29 at 35 fathoms, trawls took only two adult sea lampries (Petromyzon marinus)--one in Whitefish Bay and the other off Eagle Island.



Figure 11.--Example of echogram from a high-resolution echo sounder showing midwater concentrations of fish believed to be lake herring. Echogram was made in Huron Bay on June 6, 1964. Distance traveled is 2 miles.

### CONCLUSIONS

The research vessel *Kaho* made a six-cruise, exploratory trawling survey of the south shore of Lake Superior. The aim of the study was to obtain the basic biological information necessary to establish more effective and efficient fishing methods to harvest the existing fish resources.

The explorations successfully delineated fishing grounds along about 65 percent of the south shore and demonstrated that limited trawl fishing is practical for harvesting stocks of commercial fish that are now virtually ignored by the industry. Commercially significant catches of chubs were taken on every cruise. Good catches of smelt were made during those seasons when fresh smelt are not normally available. Occasionally, sizeable quantities of suckers and common whitefish were taken in certain areas. The most strategic locations for trawlers would be: (1) Houghton or Hancock, Mich., to fish the east shore of the Keweenaw Peninsula to Huron Bay; (2) Ontonagon, Mich., (3) Apostle Islands area (between Bayfield, Wis., and Port Wing, Wis.); and (4) Duluth, Minn., or Superior, Wis.

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### APPENDIX

The following seven tables summarize the fishing logs for 340 exploratory trawl drags in Lake Superior by the R/V *Kaho* between November 1963 and October 1965. Each table represents a summary of trawl drags in each of the seven statistical districts defined along the south shore by Smith et al. (1961). Table entries are primarily arranged by descending depth stations and chronologically by cruise. All but 14 drags were made with a 52-foot (headrope) Gulf of Mexico type fish trawl. Two drags made with a 40-foot midwater trawl (table 3) are footnoted, as are the 12 drags made with a 72-foot (headrope) two-seam wing trawl (table 4).

Appendix table 1.--R/V Kaha Fishing Log - Lake Superior trawl stations in District 1 (MS-6)  
(Michigan waters from Sault Ste. Marie to Crisp Point Light)

Cruise No.	Depth	Date	Drag No.	Position		Course	Time of day	Fished	Limiting factor 1/	Catch							Total	
				Lat. N.	Long. W.					Chubs	Smelt	Suckers 2/	Lake trout	White-fish 3/	Ale-wife	Lake herring		Others 4/
	Fath.	1963					Min.											
14	8	11-16	1	46°47'	85°02'	E.	1210	30	5	-	-	-	-	-	-	-	-	-
	10	11-19	10	46°36'	84°59'	N.	1020	4	1	-	-	-	-	-	-	-	-	-
	12	11-20	15	46°27'	84°47'	W.	0930	20	1	-	-	-	-	-	-	-	-	-
	13	11-19	12	46°34'	84°52'	SE.	1230	30	0	-	-	-	-	-	-	-	-	-
	15	11-19	11	46°39'	84°58'	S.	1030	30	0	-	1	-	-	-	-	-	-	1
	18	11-19	14	46°30'	84°38'	NW.	1540	30	0	1	15	-	1	-	10	-	-	7
	20	11-20	16	46°28'	84°48'	E.	1010	30	0	-	1	-	5	6	-	1	-	13
	22	11-16	2	46°47'	85°02'	SE.	1320	30	5	-	1	-	-	1	-	-	-	2
	33	11-20	17	46°31'	84°49'	S.	1120	30	0	1	1	-	1	5	110	1	1	120
	35	11-16	3	46°52'	85°01'	S.	1550	30	5	305	10	-	-	-	11	1	3	330
	35	11-19	13	46°34'	84°50'	NW.	1340	30	0	60	10	-	6	-	200	4	-	280
	35	11-19	9	46°46'	84°56'	N.	0830	30	2	36	10	-	-	-	12	4	2	64
	1964																	
	20	10	8-20	105	46°47'	85°02'	W.	1220	30	0	-	-	-	-	-	-	-	1
15		8-22	113	46°39'	84°58'	S.	0850	30	0	-	17	-	-	2	-	-	2	21
16		8-21	111	46°35'	84°53'	S.	1100	30	7	-	-	-	-	-	-	-	-	-
20		8-22	115	46°28'	84°48'	NE.	1130	15	0	-	1	-	2	5	-	-	-	8
23		8-20	106	46°49'	85°03'	N.	1400	30	0	-	-	-	5	-	-	-	-	5
32		8-21	110	46°34'	84°50'	NW.	1010	30	5	-	1	-	1	-	-	-	-	2
33		8-22	114	46°31'	84°49'	S.	1030	30	0	20	10	-	8	-	5	4	-	47
35		8-22	112	46°43'	84°56'	S.	0740	30	0	1	2	-	2	-	10	1	-	16
35		8-20	107	46°52'	85°01'	S.	1450	30	0	120	-	-	-	-	-	10	-	130
1964																		
23	10	12-6	171	46°47'	85°02'	SE.	1540	30	0	-	-	-	-	1	-	-	-	1
	15	12-7	176	46°37'	84°58'	NW.	1400	30	0	1	-	-	-	1	-	-	-	2
	15	12-7	174	46°33'	84°53'	N.	1150	30	0	-	-	-	-	-	-	-	-	-
	20	12-7	172	46°28'	84°48'	E.	0920	30	3	-	-	-	-	-	-	-	2	2
	25	12-6	170	46°49'	85°02'	SE.	1500	30	3	-	-	-	-	1	-	2	-	3
	35	12-6	169	46°52'	85°01'	S.	1400	30	0	770	18	-	1	-	1	10	-	800
	38	12-7	173	46°30'	84°49'	N.	1040	30	0	150	16	-	4	-	10	-	-	180
	40	12-7	175	46°35'	84°52'	SE.	1240	30	0	100	200	-	2	-	6	-	2	310
1965																		
29	7	9-14	267	46°47'	85°00'	N.	0700	30	2	3	1	-	-	-	-	-	-	4
	10	9-13	261	46°38'	85°00'	S.	0940	30	0	-	1	2	-	-	1	-	-	4
	15	9-13	260	46°39'	84°59'	S.	0840	30	0	-	40	-	1	-	8	-	3	52
	15	9-13	262	46°34'	84°52'	S.	1040	30	0	-	2	-	-	-	-	-	3	5
	20	9-15	269	46°48'	85°01'	NW.	0730	11	8	-	-	-	-	-	-	-	2	2
	25	9-13	265	46°29'	84°49'	E.	1350	30	0	-	4	-	-	-	-	-	1	5
	30	9-13	264	46°31'	84°49'	S.	1250	30	0	35	-	-	10	-	-	12	2	59
	35	9-13	259	46°43'	84°56'	S.	0740	30	0	5	2	-	5	-	-	3	-	15
	40	9-13	263	46°34'	84°50'	NW.	1140	30	0	12	10	-	6	-	3	-	3	34
	50	9-13	266	46°37'	84°51'	NW.	1600	30	0	17	1	-	-	-	-	-	15	33

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 high seas, fog, and ice), 8 - rough bottom, 9 - set fishing gear in area.

2/ Include longnose and white suckers.

3/ Include common and menominee whitefish.

4/ Include burbot, sculpin, stickleback, trout-perch, pigmy whitefish, yellow perch, spottail shiner, rainbow trout, walleye, lake sturgeon, brown trout, and redear.

Appendix table 2.--R/V Kaho Fishing Log - Lake Superior trawl stations in District II (MS-5)  
(Michigan waters from Crisp Point Light to Beaver Lake outlet)

Cruise No.	Depth Fath.	Date	Drag No.	Position		Course	Time of day	Fished Min.	Limiting factor <sup>1/</sup>	Catch									
				Lat. N.	Long. W.					Chubs	Smelt	Suckers <sup>2/</sup>	Lake trout Pounds	White fish <sup>3/</sup>	Ale-wife	Lake herring	Others <sup>4/</sup>	total	
14	10	11-17	4	46°45'	85°25'	E.	1020	30	0	-	-	-	-	-	-	-	-	-	
	25	11-17	5	46°47'	85°20'	W.	1140	30	0	-	1	-	-	1	-	-	-	2	
	30	11-17	6	46°50'	85°17'	SW.	1250	30	0	-	1	-	-	-	-	1	1	3	
20	1964																		
	17	8-20	102	46°45'	85°25'	NE.	0840	30	0	-	-	-	-	-	-	-	-	1	1
	25	8-20	103	46°47'	85°22'	E.	0930	25	3	-	-	-	-	-	-	-	-	-	
23	1964																		
	18	12- 6	166	46°45'	85°24'	W.	0950	30	0	-	-	-	-	2	-	1	-	-	3
	28	12- 6	167	46°47'	85°20'	W.	1040	30	3	-	-	-	1	-	-	1	-	2	
29	1965																		
	11	9-16	275	46°39'	86°16'	NE.	1310	30	4	-	-	-	-	5	-	-	-	5	10
	12	9-16	274	46°43'	85°50'	E.	1010	30	0	-	-	-	-	-	-	-	-	10	10
20	15	9-15	270	46°45'	85°23'	W.	0850	30	2	-	-	-	-	-	-	-	-	3	3
	20	9-15	272	46°52'	85°15'	E.	1050	30	4	-	5	-	-	1	1	-	-	-	7
	25	9-15	271	46°48'	85°22'	E.	0940	30	0	-	2	-	-	-	-	-	-	1	3

<sup>1/</sup> See footnote 1, app. table 1.

<sup>2/</sup> See footnote 2, app. table 1.

<sup>3/</sup> See footnote 3, app. table 1.

<sup>4/</sup> See footnote 4, app. table 1.

Appendix table 3.--R/V Kaho Fishing Log - Lake Superior trawl stations in District III (MS-4)  
(Michigan waters from Beaver Lake outlet to Solmon-Trout Point)

Cruise No.	Depth Fath.	Date 1964	Drag No.	Position		Course	Time of day	Fished Min.	Limiting factor <sup>1/</sup>	Catch									
				Lat. N.	Long. W.					Chubs	Smelt	Suckers <sup>2/</sup>	Lake trout	White-fish <sup>3/</sup>	Ale-wife	Lake herring	Others <sup>4/</sup>	Total	
18	5	5-26	20	46°30'	87°16'	E.	1550	30	5	-	1	1	-	41	-	-	-	7	50
	10	6-8	59	46°26'	86°50'	NE.	1330	30	0	-	10	-	-	1	1	-	-	-	12
	10	5-27	21	46°30'	87°16'	E.	0650	30	3	-	1	-	-	1	1	-	-	2	5
	19	5-27	22	46°32'	87°11'	NE.	0830	30	8	-	4	-	1	1	-	-	-	2	8
	20	5-26	18	46°38'	86°48'	SE.	0850	30	4	-	-	-	1	-	-	-	-	1	2
	20	5-26	19	46°34'	86°57'	NE.	1250	22	0	-	-	-	-	-	-	-	-	-	-
	24	5-27	23	46°33'	87°11'	NE.	0930	24	4	-	1	-	-	-	1	-	-	4	6
	24	6-5	45	46°45'	87°30'	SE.	0950	30	0	-	1	-	-	-	30	-	-	1	32
	30	5-27	24	46°33'	87°15'	E.	1210	30	3	-	4	-	3	-	1	-	-	-	8
	30	6-5	46	46°45'	87°30'	NE.	1040	7	4	-	-	-	1	-	-	22	-	-	23
	42	6-5	44	46°47'	87°24'	NW.	0800	10	8	15	-	-	-	-	1	1	-	2	19
	20	5	8-7	63	46°30'	87°13'	NW.	1340	30	7	-	1	-	-	1	60	-	-	3
10		8-7	61	46°26'	86°50'	N.	1020	30	0	-	1	-	-	-	-	-	-	-	1
10		8-7	64	46°30'	87°15'	NW.	1420	30	0	-	-	-	-	-	2	-	-	-	2
15		8-7	60	46°25'	86°39'	N.	0720	30	0	-	23	-	7	140	-	-	-	-	170
20		8-7	62	46°34'	86°57'	E.	1140	30	7	-	-	-	-	-	-	-	-	-	-
20		8-9	65	46°32'	87°12'	NE.	0700	30	4	-	-	-	2	-	-	-	-	-	2
20		8-9	68	46°45'	87°30'	SE.	1320	7	2	-	-	-	-	-	-	-	-	-	-
40		8-9	66	46°47'	87°25'	NE.	0950	30	4	15	-	-	-	-	-	-	-	-	15
70		8-9	67	46°54'	87°21'	SE.	1120	30	0	28	-	-	-	-	-	-	-	1	29
23		5	11-8	119	46°30'	87°14'	W.	1300	30	0	-	-	-	-	-	-	-	-	-
	8	11-8	117	46°26'	86°50'	N.	0940	30	0	-	-	-	-	1	-	-	-	-	1
	10	11-8	120	46°30'	87°16'	E.	1340	18	0	-	-	-	-	-	-	-	-	-	-
	12	11-8	116	46°25'	86°39'	NE.	0730	30	8	-	-	-	-	39	-	-	-	1	40
	20	11-8	118	46°34'	86°57'	W.	1150	30	0	-	-	-	-	-	-	-	-	-	-
	20	11-9	121	46°45'	87°30'	SE.	1000	7	3	-	-	-	-	-	-	-	-	-	-
	46	11-22	161	46°35'	87°15'	SW.	0840	30	0	210	8	-	1	-	5	-	-	6	230
	48	11-22	162	46°34'	87°16'	NE.	0932	30	0	150	8	-	1	-	1	-	-	-	160
	50	11-22	163	46°32'	86°53'	NW.	1230	30	5	580	110	-	-	-	25	10	-	5	730
	70	11-9	122	46°44'	87°16'	NW.	1150	30	0	70	-	-	-	-	-	-	-	15	85
	38	11-22	164 <sup>5/</sup>	46°28'	86°37'	SW.	1840	20	0	3	1	-	1	10	-	-	-	2	17
38	11-22	165 <sup>5/</sup>	46°26'	86°38'	NE.	1940	20	0	2	1	-	1	5	-	-	-	-	9	
25	5	5-15	185	46°29'	87°13'	W.	1310	30	0	-	-	-	-	-	-	-	-	2	2
	10	5-15	180	46°25'	86°39'	SE.	0610	30	0	-	2	-	5	153	-	-	-	1	161
	10	5-15	182	46°26'	86°50'	N.	0920	30	0	-	-	-	-	-	-	-	-	-	-
	10	5-15	186	46°30'	87°15'	E.	1350	30	0	-	-	-	-	-	-	-	-	2	2
	20	5-15	184	46°34'	86°57'	NW.	1140	17	4	-	-	-	-	-	-	-	-	-	-
	35	5-15	181	46°27'	86°37'	SE.	0710	30	0	19	3	-	3	235	-	-	-	-	260
	45	5-16	187	46°50'	87°29'	E.	1040	30	0	300	-	-	2	-	-	8	-	-	310
50	5-15	183	46°32'	86°52'	NW.	1040	30	0	180	-	-	10	-	-	-	-	-	190	
29	5	9-17	280	46°29'	87°13'	W.	1420	8	1	-	3	-	-	1	-	-	-	-	4
	10	9-17	281	46°30'	87°15'	E.	1450	30	3	-	3	-	-	-	-	-	-	-	3
	10	9-17	277	46°25'	86°39'	N.	0820	30	0	-	30	-	6	60	-	-	-	10	106
	15	9-17	278	46°26'	86°50'	NW.	1030	30	0	-	-	4	3	1	-	-	-	-	8
	35	9-18	276	46°26'	86°50'	W.	1610	30	8	70	5	-	15	180	-	-	-	-	270
	40	9-17	279	46°32'	86°53'	NW.	1210	30	0	950	20	-	14	-	-	-	-	-	984
	45	9-19	284	46°52'	87°29'	S.	0910	30	7	120	1	-	-	-	-	-	-	2	123
	60	9-18	282	46°45'	87°17'	SE.	1420	30	0	65	-	-	-	-	-	5	-	20	90
	70	9-18	283	46°54'	87°21'	SE.	1630	30	0	30	-	-	-	-	-	-	-	2	32

1/ See footnote 1, app. table 1.  
2/ See footnote 2, app. table 1.  
3/ See footnote 3, app. table 1.  
4/ See footnote 4, app. table 1.  
5/ Drag made with 40-ft. midwater trawl.

Appendix table 4.--R/V Kaho Fishing Log - Lake Superior trawl stations in District IV (MS-3)  
(Michigan waters from Salmon-Troul Point to Elm River)

Cruise No.	Depth	Date	Drag No.	Position		Course	Time of day	Fished	Limiting factor 1/	Catch								
				Lat. N.	Long. W.					Chubs	Smelt	Suckers 2/	Lake trout	White-fish 3/	Alewife	Lake herring	Others 4/	Total
	Fath.	1964					Min.											
18	5	5-30	29	47°23'	87°57'	E.	1050	4	1	-	-	-	-	-	-	-	-	-
	6	6-1	39	46°54'	88°28'	N.	0950	15	0	-	1	-	4	-	-	-	-	2
	7	6-1	42	46°52'	88°27'	N.	1330	30	0	-	55	2	20	9	7	2	5	100
	8	6-1	38	46°52'	88°27'	N.	0910	15	0	-	90	-	11	5	-	-	-	4
	8	6-1	43	46°52'	88°27'	N.	1420	15	0	-	2	-	7	1	-	-	-	10
	10	6-1	40	46°54'	88°27'	S.	1030	15	0	-	2	-	2	-	-	-	-	4
	10	5-30	30	47°23'	87°56'	E.	1150	15	0	-	1	-	-	3	-	-	-	5
	12	6-6	48	46°56'	88°01'	NE.	1020	13	3	-	1	-	-	-	-	-	-	1
	12	6-6	49	46°52'	88°14'	NE.	1150	15	0	-	32	1	1	8	35	1	2	80
	13	6-6	51	46°56'	88°29'	NE.	1640	15	0	-	2	-	3	1	-	-	-	6
	14	6-1	41	46°53'	88°26'	N.	1100	15	5	-	47	-	1	1	-	-	1	50
	14	5-30	31	47°22'	87°52'	W.	1240	15	0	-	55	-	4	-	-	-	1	60
	20	6-5	47	46°55'	87°43'	W.	1230	5	3	-	-	-	-	1	-	-	-	1
	20	6-6	52	46°49'	88°24'	NE.	1800	15	0	5	10	-	15	-	-	1	1	32
	20	6-7	56	46°58'	88°10'	NE.	0950	15	0	-	2	-	2	-	1	0	1	6
	23	6-7	57	46°55'	88°09'	E.	1200	30	0	2	300	-	2	15	20	-	1	340
	23	5-29	27	47°02'	88°20'	S.	1650	30	8	4	25	-	1	-	-	-	-	30
	24	6-7	58	46°57'	87°52'	N.	1520	15	0	-	-	-	-	-	2	-	-	2
	28	6-6	50	46°56'	88°06'	SW.	1300	30	0	6	320	-	3	6	13	-	2	350
	29	5-29	28	47°00'	88°22'	SW.	1920	30	0	23	42	-	8	-	4	-	3	80
	35	5-29	26	46°57'	88°22'	N.	1610	30	8	62	45	-	12	-	2	2	2	125
	35	6-7	53	46°54'	88°21'	W.	0720	15	0	130	1	-	15	-	-	2	2	159
	37	5-29	25	46°57'	87°22'	NE.	1410	30	8	42	21	-	2	-	3	2	5	75
	38	5-30	32	47°17'	87°48'	W.	1620	15	0	46	-	-	1	1	-	2	5	55
	38	5-31	37	47°11'	88°09'	E.	1550	15	0	420	-	-	19	-	1	8	2	450
	41	6-7	54	46°53'	88°21'	NE.	0800	15	0	115	-	-	2	-	-	3	-	120
	45	5-31	35	47°14'	87°50'	W.	1120	15	0	220	-	-	1	-	-	8	1	230
	50	5-31	34	47°14'	87°52'	W.	1000	15	0	175	-	-	-	-	-	-	5	180
	50	6-7	55	46°54'	88°21'	NE.	0840	10	0	40	-	-	1	-	-	-	1	42
	54	5-31	36	47°12'	88°03'	E.	1410	15	0	165	-	-	4	-	-	-	11	180
	60	5-31	33	47°13'	87°55'	W.	0840	15	0	110	-	-	-	-	-	1	39	150
		1964																
20	5	8-14	87	46°53'	88°28'	S.	0700	30	0	-	-	-	-	-	-	-	-	-
	8	8-14	88	46°52'	88°27'	N.	0740	30	0	-	240	-	-	-	-	-	10	250
	10	8-11	71	47°23'	87°53'	W.	0920	30	0	-	-	-	-	-	-	-	-	-
	10	8-14	89	46°53'	88°27'	S.	0820	30	0	-	100	-	5	-	-	-	5	110
	10	8-14	92	46°45'	88°29'	N.	1220	30	3	1	4	2	5	-	-	-	-	12
	12	8-13	82	46°56'	88°00'	W.	1000	30	0	-	7	140	-	3	-	-	-	150
	15	8-13	85	46°52'	88°14'	N.	1340	30	0	230	180	-	10	5	-	35	-	460
	15	8-13	83	46°55'	88°05'	W.	1100	30	3	-	-	-	2	-	-	-	-	2
	15	8-16	101	46°56'	87°54'	SW.	1240	10	4	-	-	-	-	1	-	-	-	1
	15	8-14	90	46°52'	88°26'	N.	0910	30	0	-	4	-	7	3	-	-	-	14
	15	8-11	72	47°22'	87°55'	E.	1010	30	0	-	-	-	-	-	-	-	-	-
	20	8-13	81	46°58'	87°52'	W.	0840	30	0	-	-	-	1	-	-	-	-	1
	20	8-13	86	46°58'	88°10'	W.	1530	30	0	-	1	26	13	-	-	-	-	40
	20	8-12	84	46°54'	88°06'	W.	1230	10	9	-	-	-	2	-	-	-	-	2
	23	8-16	99	46°49'	88°24'	N.	0830	30	0	-	4	-	36	48	1	1	-	90
	25	8-15	94	47°00'	88°21'	N.	1030	30	0	-	45	-	15	-	-	-	-	60
	30	8-15	93	46°58'	88°22'	NE.	0920	30	0	210	30	-	20	-	5	5	-	270
	35	8-15	96	46°57'	88°22'	N.	1250	30	0	240	20	-	23	-	5	2	-	290
	35	8-16	100	45°53'	88°22'	NE.	0940	15	0	160	9	-	20	-	1	-	-	190
	35	8-10	70	47°10'	88°09'	NE.	1630	30	0	230	-	-	1	-	-	-	9	240
	40	8-15	95	46°48'	88°22'	S.	1150	30	0	100	9	-	7	-	-	-	4	120
	40	8-11	73	47°18'	87°50'	NW.	1130	30	0	50	-	-	-	-	-	-	-	50
	40	8-11	74	47°16'	87°49'	SE.	1240	30	5	510	-	-	-	-	-	-	-	510
	40	8-12	80	47°18'	87°50'	SE.	1100	60	7	880	-	-	-	-	-	-	-	880
	40	8-10	69	47°08'	88°05'	SE.	1500	30	0	120	-	-	6	-	-	-	4	130
	40	8-15	98	46°53'	88°22'	NE.	1510	30	0	1,210	-	-	15	-	-	-	5	1,230
	45	8-11	75	47°15'	87°50'	SW.	1340	30	7	520	-	-	-	-	-	-	-	520
	45	8-11	77	47°10'	88°09'	SE.	1640	30	7	330	-	-	-	-	-	-	-	330
	50	8-15	97	46°55'	88°19'	SW.	1410	30	0	140	-	-	1	-	8	-	1	150
	50	8-11	76	47°14'	87°53'	SW.	1430	30	7	18	-	-	-	-	-	-	-	18
	50	8-12	79	47°13'	87°56'	NE.	0930	30	7	140	-	-	-	-	-	-	-	140
	55	8-14	91	46°50'	88°26'	N.	1030	30	0	60	-	-	5	-	-	-	-	65
	55	8-12	78	47°12'	88°02'	NE.	0810	30	7	60	-	-	-	-	-	-	5	65

See footnotes at end of table.

Appendix table 4 (continued).--R/V Kaho Fishing Log - Lake Superior trawl stations in District IV (MS-3)  
(Michigan waters from Salmon-Trout Point to Elm River)

Cruise No.	Depth	Date	Drag No.	Position		Course	Time of day	Fished	Limiting factor 1/	Catch								
				Lat. N.	Long. W.					Chubs	Smelt	Suckers 2/	Lake trout	White-fish 3/	Ale-wife	Lake herring	Others 4/	Total
	Fath.	1964					Min.											
23	5	11-11	130	46°52'	88°28'	N.	1310	25	3	-	2	6	2	-	10	-	-	20
10	11-17	155	46°56'	88°05'	NE.	0940	30	4	4	-	-	-	-	-	-	-	-	
10	11-17	156	46°52'	88°14'	NE.	1410	30	0	-	2	255	-	-	38	-	5	10	310
10	11-11	131	46°54'	88°27'	S.	1400	30	0	-	-	-	8	26	1	-	-	-	35
10	11-12	138	46°54'	88°20'	NE.	1210	30	3	-	-	-	2	-	-	-	-	1	3
12	11-15	146	47°22'	87°56'	E.	1230	15	3	-	-	-	1	-	-	-	-	-	1
12	11-11	126	46°46'	88°29'	NE.	0920	30	0	-	-	4	13	1	-	1	-	1	20
14	11-10	124	46°52'	88°15'	NE.	1400	30	0	-	5	200	8	14	-	-	-	43	270
14	11-15	147	47°23'	87°56'	NE.	1320	15	0	-	1	-	1	-	-	-	-	-	2
15	11-11	132	46°52'	88°27'	N.	1450	30	0	-	1	-	7	-	1	-	-	1	10
15	11-16	154	46°59'	88°18'	NE.	1520	30	4	-	-	-	-	-	-	-	-	-	-
20	11-10	125	46°55'	88°09'	E.	1510	30	0	-	4	45	5	5	-	3	-	8	70
20	11-11	127	46°49'	88°24'	NE.	1010	30	0	-	2	4	12	6	-	1	-	5	30
20	11-11	133	46°54'	88°26'	S.	1540	30	0	-	1	-	15	-	1	1	-	-	18
20	11-12	137	46°55'	88°20'	SW.	1130	30	0	-	1	-	5	-	1	-	-	-	7
20	11-12	139	46°58'	88°12'	NE.	1330	30	0	-	-	-	2	-	-	-	-	-	2
20	11-13	143	46°59'	88°22'	N.	1210	30	0	-	-	-	-	-	-	-	-	3	3
25	11-12	123	46°58'	87°54'	E.	1130	30	0	-	-	-	-	5	-	1	-	1	7
30	11-13	141	46°58'	88°23'	S.	1010	30	8	-	20	-	12	-	3	-	-	-	35
30	11-12	136	46°54'	88°21'	NE.	1040	30	0	-	100	-	35	-	75	-	-	-	210
30	11-12	140	46°59'	88°12'	SW.	1420	30	8	-	2	-	8	-	1	1	-	-	12
35	11-13	142	46°51'	88°23'	N.	1110	30	8	240	50	-	35	-	3	-	-	2	330
38	11-16	149	47°18'	87°50'	SE.	0830	30	0	120	10	-	3	-	-	-	-	7	140
40	11-16	150	47°25'	87°50'	W.	0930	30	5	320	10	-	5	-	-	-	-	5	340
40	11-11	129	46°52'	88°27'	S.	1210	30	0	300	150	2	15	-	-	1	-	2	470
40	11-12	135	46°55'	88°21'	SW.	0950	30	0	110	15	20	5	-	-	-	-	-	150
42	11-13	144	47°07'	88°04'	NW.	1420	30	3	310	15	-	4	-	-	-	-	1	330
45	11-19	159	46°55'	88°21'	SE.	1452	30	0	620	9	75	3	-	-	-	-	3	710
45	11-13	145	47°08'	88°07'	SE.	1510	30	8	410	10	-	-	-	-	-	-	-	420
48	11-11	128	46°50'	88°26'	N.	1100	30	0	300	1	17	3	-	1	1	-	17	340
50	11-12	134	46°54'	88°21'	NE.	0900	30	0	600	-	17	-	-	-	-	-	3	620
50	11-16	151	47°14'	87°53'	W.	1030	30	5	390	-	-	-	-	-	4	-	6	400
55	11-16	152	47°13'	87°54'	W.	1130	30	7	260	-	-	-	-	-	4	-	6	270
65	11-16	153	47°12'	88°00'	W.	1240	30	7	150	-	-	-	-	-	-	-	40	190
70	11-15	148	47°22'	87°36'	N.	1530	15	0	50	-	-	-	-	-	1	-	4	55
40	11-19	157	5/ 46°55'	88°21'	SE.	1150	30	0	23	1	-	-	-	-	1	-	-	25
40	11-19	158	5/ 46°55'	88°21'	SE.	1320	30	0	41	1	2	-	-	-	-	-	2	46
40	11-19	160	5/ 46°55'	88°21'	SE.	1620	30	0	310	10	5	2	-	1	2	-	-	330
		1965																
25	5	5-18	192	46°54'	88°28'	S.	0650	30	0	-	1	-	-	-	-	-	-	1
8	5-18	198	46°46'	88°29'	NE.	1420	30	0	-	-	-	15	12	-	1	-	-	28
10	5-25	226	46°52'	88°28'	N.	1330	30	5	-	2	-	1	-	-	-	-	1	4
10	5-25	227	46°54'	88°28'	S.	2040	30	0	-	10	1	12	18	-	-	-	-	41
10	5-18	193	46°52'	88°27'	N.	0730	30	0	-	-	-	8	10	-	-	-	-	18
12	5-19	204	46°53'	88°20'	NE.	1320	30	0	-	2	-	3	-	-	-	-	-	5
12	5-19	201	46°52'	88°14'	NW.	0910	30	0	-	11	-	4	20	-	45	-	-	80
15	5-18	194	46°54'	88°26'	S.	0820	30	0	-	1	-	35	-	-	-	-	-	36
15	5-18	200	46°51'	88°24'	SW.	1560	30	5	-	5	-	1	-	-	-	-	-	6
20	5-19	202	46°59'	88°10'	W.	1100	30	0	-	5	-	-	-	-	-	-	-	5
20	5-19	205	46°55'	88°18'	SW.	1410	30	0	-	20	-	12	-	-	-	-	-	32
20	5-18	195	46°52'	88°26'	N.	0910	30	0	-	-	-	29	-	-	-	-	-	29
20	5-18	199	46°49'	88°25'	N.	1510	30	0	-	-	-	40	-	-	-	-	-	40
20	5-25	228	46°52'	88°26'	N.	2130	5	4	-	5	-	-	-	-	1	-	2	8
20	5-25	224	46°52'	88°26'	N.	1200	30	0	-	-	-	15	-	-	-	-	1	16
25	5-17	188	46°57'	87°52'	NW.	1210	13	8	-	-	-	-	1	-	-	-	-	1
30	5-19	203	46°59'	88°12'	N.	1140	30	0	-	-	-	10	-	-	-	-	-	10
30	5-19	206	46°53'	88°21'	NE.	1450	30	0	-	4	-	35	-	-	-	-	-	39
30	5-25	225	46°54'	88°26'	S.	1240	30	0	-	10	-	61	-	-	-	-	-	71
33	5-17	190	47°00'	88°20'	SW.	1550	30	0	80	5	-	25	-	-	-	-	-	110
37	5-17	191	46°58'	88°22'	E.	1640	7	9	20	5	-	-	-	-	-	-	-	25
40	5-18	196	46°52'	88°26'	S.	1150	30	0	80	10	-	5	-	-	-	-	-	95
40	5-19	207	46°55'	88°21'	W.	1540	20	0	230	2	-	8	-	-	-	-	-	240
43	5-21	211	47°15'	87°45'	SW.	1300	30	7	450	-	-	2	-	-	-	-	1	453
43	5-21	212	47°14'	87°45'	NE.	1350	60	7	750	-	-	1	-	-	-	-	1	752
44	5-24	218	47°11'	88°05'	SW.	0830	30	0	850	-	-	14	-	1	10	-	-	875
45	5-23	216	47°12'	88°04'	SW.	0740	30	0	1,100	20	-	18	-	2	-	-	-	1,140
45	5-23	217	47°12'	88°04'	NE.	1530	60	0	2,600	10	-	20	-	-	-	-	-	2,630
46	5-24	219	47°10'	88°04'	NE.	0920	30	0	550	-	-	10	-	-	10	-	-	570
47	5-20	210	47°05'	88°08'	SE.	1100	30	0	130	7	-	10	-	-	3	-	-	150

See footnotes at end of table.

Appendix table 4 (continued).--R/V Koho Fishing Log - Lake Superior trawl stations in District IV (MS-3)  
(Michigan waters from Solman-Trout Point to Elm River)

Cruise No.	Depth	Date	Drag No.	Position		Course	Time of day	Fished	Limiting factor <sup>1/</sup>	Catch									
				Lat. N.	Long W.					Chubs	Smelt	Suckers <sup>2/</sup>	Lake trout	White-fish <sup>3/</sup>	Ale-wife	Lake herring	Others <sup>4/</sup>	Total	
	Fath.	1965					Min.						Pounds						
25	50	5-18	197	46°52'	88°26'	S.	1300	30	0	15	4	-	2	-	-	-	-	5	26
	50	5-19	208	46°53'	88°21'	NE.	1620	30	0	50	-	-	-	-	-	-	-	-	50
	52	5-20	209	46°52'	88°25'	S.	0710	30	0	260	4	-	-	-	-	-	-	6	270
	52	5-17	189	47°01'	87°57'	SE.	1310	30	0	180	5	-	5	-	-	-	-	-	190
	20	5-25	229	5/ 46°54'	88°26'	S.	2200	30	1	1	25	-	4	-	-	-	2	-	32
	43	5-24	222	5/ 47°18'	87°52'	SW.	1320	40	0	2,200	-	-	25	-	-	-	-	-	2,225
	43	5-25	223	5/ 46°51'	88°26'	N.	0920	30	3	210	13	-	1	-	-	-	-	1	225
	43	5-21	213	5/ 47°16'	87°42'	SW.	1540	60	7	800	-	-	10	-	1	-	-	1	812
	45	5-22	214	5/ 47°14'	87°47'	NW.	0740	60	0	1,000	-	-	5	-	-	30	-	1	1,036
	45	5-22	215	5/ 47°16'	87°42'	SW.	1050	60	0	750	-	-	8	-	-	20	-	2	780
	46	5-24	220	5/ 47°11'	88°05'	SW.	1050	30	0	750	-	-	11	-	-	20	-	-	781
	46	5-24	221	5/ 47°10'	88°04'	NE.	1120	30	0	430	10	-	3	-	-	-	7	-	450
	48	5-25	230	5/ 46°50'	88°26'	S.	2300	30	0	75	-	-	-	-	-	-	-	16	92
	29	10	1965																
10		9-22	299	46°54'	88°27'	S.	0910	30	4	-	5	-	3	-	-	-	-	-	8
12		9-23	303	46°45'	88°29'	NE.	1040	15	3	-	60	2	-	-	-	-	-	-	62
15		9-24	305	46°51'	88°25'	S.	0800	30	4	-	30	2	6	-	-	-	-	3	41
15		9-24	306	46°49'	88°24'	N.	1010	30	3	-	5	4	-	-	-	-	-	-	9
15		9-22	298	46°52'	88°26'	N.	0810	24	9	-	5	-	1	-	-	-	-	4	10
15		9-19	287	46°52'	88°15'	NE.	1500	30	0	15	1,200	230	7	6	-	4	1	1,463	
15		9-21	294	46°58'	88°10'	SW.	1140	30	0	-	2	-	-	-	-	-	-	-	2
16		9-21	296	46°53'	88°19'	NE.	1430	30	0	-	10	2	5	-	-	-	-	-	17
20		9-21	297	46°54'	88°19'	SW.	1520	30	0	-	130	120	50	-	-	-	-	-	300
20		9-22	300	46°52'	88°26'	N.	1010	25	4	-	-	-	-	-	-	-	-	-	-
25		9-19	285	46°57'	87°52'	W.	1210	10	1	-	7	-	2	-	-	-	-	-	9
25		9-22	301	46°54'	88°21'	NE.	1130	30	4	-	30	2	8	-	-	-	-	-	40
30		9-21	295	46°57'	88°12'	NE.	1230	30	0	-	5	10	15	-	-	18	-	-	48
30		9-23	302	46°54'	88°21'	NE.	0810	30	3	5	210	50	20	2	-	10	5	302	
35		9-20	292	47°10'	88°09'	NE.	1640	30	0	245	2	-	4	-	-	-	-	-	251
40		9-20	291	47°12'	88°05'	SW.	1540	30	0	430	-	-	2	-	-	-	-	-	432
40		9-20	288	47°15'	87°47'	NW.	1040	30	0	70	-	-	2	-	-	-	-	2	74
45		9-21	293	47°05'	88°07'	E.	0820	30	3	130	-	-	-	-	-	-	-	1	131
50		9-20	289	47°14'	87°46'	NE.	1200	20	9	120	-	-	2	-	-	2	3	127	
50		9-19	286	47°00'	87°54'	NW.	1250	28	8	65	-	-	-	-	-	-	-	2	67
52	9-20	290	47°13'	87°54'	W.	1400	30	0	150	-	-	-	-	-	-	10	160		
52	9-23	304	46°51'	88°26'	S.	1150	15	0	90	5	-	-	-	-	-	-	15	110	

1/ See footnote 1, app. table 1.

2/ See footnote 2, app. table 1.

3/ See footnote 3, app. table 1.

4/ See footnote 4, app. table 1.

5/ Drag made with 72 ft. (headrope) two seam wing trawl.

Appendix table 5.--R/V Kaho Fishing Log - Lake Superior trawl stations in District V (MS-2)  
(Michigan waters from Elm River to the Montreal River)

Cruise No.	Depth Fath.	Date	Drag No.	Position		Course	Time of day	Fished Min.	Limiting factor 1/	Catch							Total			
				Lat. N.	Long. W.					Chubs	Smelt	Suckers 2/	Lake trout Pounds	White fish 3/	Alewife	Lake herring		Others 4/		
25	5	6-4	234	47°00'	89°04'	W.	0810	30	0	-	-	15	-	1	-	-	-	-	16	
	8	6-4	238	46°55'	89°17'	SW.	1540	12	1	-	3	12	-	-	-	-	-	1	16	
	15	6-4	237	46°57'	89°15'	W.	1440	30	0	-	8	-	-	-	1	-	1	8	18	
	25	6-4	235	46°04'	89°03'	SW.	0930	30	0	1	1	-	8	-	-	1	-	-	11	
	35	6-3	231	47°04'	89°05'	NE.	0910	30	7	100	-	-	4	-	-	-	-	-	104	
	35	6-3	232	46°58'	89°20'	NE.	1250	30	0	450	-	-	17	-	1	2	-	-	472	
	35	6-3	233	46°54'	89°34'	E.	1450	30	0	270	-	-	15	-	-	-	-	-	285	
	35	6-5	240	46°50'	89°47'	E.	0910	30	0	120	-	-	-	-	-	-	-	2	122	
	35	6-5	241	46°46'	89°58'	W.	1100	30	0	170	-	-	3	-	-	-	-	-	173	
	35	6-5	242	46°41'	90°11'	SW.	1230	30	0	115	-	-	1	-	-	-	-	-	116	
	40	6-5	239	46°50'	89°45'	W.	0800	30	0	1	-	-	-	-	-	-	-	-	1	
	75	6-4	236	47°08'	89°20'	NE.	1220	30	2	-	-	-	-	-	-	-	-	10	10	
			1965																	
	29	7	9-26	307	47°00'	89°04'	W.	1100	30	7	-	10	40	-	1	-	-	-	12	63
10		9-26	313	46°54'	89°22'	E.	1730	30	0	-	5	5	-	-	-	-	-	20	30	
15		9-26	312	46°56'	89°20'	W.	1640	30	3	-	2	3	1	-	-	-	-	16	22	
20		9-26	311	46°56'	89°21'	W.	1550	30	7	-	15	3	2	-	-	-	-	9	29	
22		10-1	326	46°38'	90°21'	W.	0930	30	7	1	75	4	11	-	-	-	-	7	98	
25		9-26	310	46°56'	89°21'	W.	1440	30	7	-	15	25	-	-	-	-	-	-	40	
30		9-27	320	46°46'	89°58'	W.	1410	30	0	250	35	900	45	-	4	10	10	1,254		
30		9-26	309	46°56'	89°24'	E.	1340	30	7	120	-	190	2	-	-	-	-	-	312	
35		9-26	308	46°57'	89°22'	W.	1240	30	7	80	-	4	11	-	-	-	-	9	104	
35		9-27	319	46°51'	89°45'	W.	1230	30	3	5	20	10	8	-	-	-	-	12	55	
40		9-27	314	46°58'	89°23'	W.	0650	30	3	100	-	-	1	-	-	-	-	-	101	
40		9-27	318	46°51'	89°45'	W.	1120	30	3	350	-	320	-	-	-	5	10	685		
45		9-27	315	46°58'	89°23'	W.	0740	30	0	20	-	-	1	-	-	-	-	6	27	
50		9-27	316	46°59'	89°24'	W.	0840	30	0	24	-	-	-	-	-	-	-	3	27	
60	9-27	317	47°00'	89°25'	W.	0940	30	0	40	-	-	-	-	-	-	-	40	80		

1/ See footnote 1, app. table 1.

2/ See footnote 2, app. table 1.

3/ See footnote 3, app. table 1.

4/ See footnote 4, app. table 1.

Appendix table 6.--R/V Koko Fishing Log - Lake Superior trawl stations in District VI (Wisc.).  
(Wisconsin waters)

Cruise No.	Depth	Date	Drog No.	Position		Course	Time of day	Fished	Limiting factor <sup>1/</sup>	Catch						Total		
				Lat. N.	Long. W.					Chubs	Smelt	Suckers <sup>2/</sup>	Lake trout	White-fish <sup>3/</sup>	Alewife		Lake herring	Others <sup>4/</sup>
	Fath.	1965					Min.											
25	12	6-8	249	46°41'	91°58'	NW.	1610	19	4	-	-	30	-	3	-	-	4	37
	12	6-6	244	46°49'	90°40'	S.	1150	10	0	-	-	-	7	-	-	-	-	7
	28	6-11	257	46°57'	91°03'	S.	1100	20	0	320	10	-	50	-	-	-	10	390
	32	6-10	255	47°02'	90°57'	SW.	1340	30	0	330	5	-	50	-	-	-	-	385
	32	6-11	256	46°56'	91°05'	SE.	0910	30	0	180	-	-	24	-	-	-	10	214
	33	6-11	258	47°02'	90°57'	SW.	1320	30	0	1,500	-	-	45	-	-	-	-	1,545
	35	6-7	245	46°58'	91°02'	N.	1000	15	0	300	5	-	15	1	1	-	3	325
	35	6-7	246	46°52'	91°15'	E.	1150	30	0	375	2	-	3	-	-	2	-	382
	35	6-7	247	46°49'	91°37'	E.	1430	30	0	400	-	-	1	-	-	-	-	401
	35	6-9	250	46°49'	91°35'	W.	1050	60	0	200	-	-	2	-	-	-	-	202
	35	6-10	253	46°51'	91°24'	E.	1000	30	0	190	-	-	-	-	-	-	-	190
	35	6-10	254	46°57'	91°06'	SW.	1150	30	0	300	2	-	7	-	-	-	1	310
	35	6-5	243	40°45'	90°25'	NE.	1420	30	1	-	-	-	4	-	-	-	-	4
	29	9	9-28	321	46°48'	90°40'	NE.	1320	30	3	-	-	-	-	3	-	-	-
20		10-2	332	46°45'	90°49'	N.	0740	15	0	-	50	-	5	10	-	-	2	67
20		10-2	333	46°57'	90°47'	SE.	0920	15	3	50	40	175	2	-	-	-	11	278
22		9-28	322	46°46'	90°41'	W.	1430	30	0	300	25	-	60	-	-	-	2	387
25		10-6	347	46°48'	91°36'	E.	1000	9	3	1	1	10	-	-	-	-	7	19
30		9-29	324	46°59'	91°02'	S.	1240	15	7	50	1	-	3	-	-	-	44	98
30		10-4	339	46°48'	91°34'	SW.	1420	30	0	280	3	10	-	-	-	-	20	313
30		10-1	327	46°43'	90°23'	E.	1040	30	7	125	25	-	11	-	-	-	11	172
32		10-2	334	46°59'	90°35'	SW.	1120	30	0	120	1	5	1	1	1	-	7	136
35		10-1	328	46°44'	90°21'	W.	1130	30	7	150	10	-	8	-	-	10	5	183
35		10-4	338	46°49'	91°34'	SW.	1330	30	0	225	-	5	1	-	-	-	16	247
35		9-29	325	46°59'	91°03'	S.	1310	30	7	525	5	-	1	-	-	-	12	543
36		10-4	335	46°53'	91°14'	SW.	1000	28	8	115	-	10	1	-	-	-	20	146
36		10-4	336	46°51'	91°22'	SW.	1110	30	0	250	1	15	-	-	-	-	21	287
40		10-4	337	46°50'	91°34'	SW.	1240	30	0	180	-	1	-	-	-	-	16	197
40		10-1	329	46°46'	90°21'	W.	1240	30	7	325	-	-	9	-	-	10	-	344
45		10-1	330	46°46'	90°23'	E.	1340	30	3	175	-	-	-	-	-	5	-	180
45		10-6	348	46°51'	91°34'	W.	1100	30	0	15	-	-	-	-	-	-	4	19
48	9-29	323	47°00'	91°02'	W.	1130	30	7	40	-	-	-	-	-	-	2	42	
50	10-6	349	46°52'	91°36'	E.	1200	30	0	30	-	-	-	-	-	-	12	42	
50	10-1	331	46°47'	90°21'	W.	1430	30	0	100	-	-	1	-	-	-	-	101	

1/ See footnote 1, opp. table 1.

2/ See footnote 2, opp. table 1.

3/ See footnote 3, opp. table 1.

4/ See footnote 4, opp. table 1.

Appendix table 7.--R/V Kaho Fishing Log - Lake Superior trawl stations in District VII (M-1)  
(Minnesota waters from Duluth to Encampment River)

Cruise No.	Depth	Date	Drag No.	Position		Course	Time of day	Fished	Limiting factor <sup>1/</sup>	Catch								
				Lat. N.	Long. W.					Chubs	Smelt	Suckers <sup>2/</sup>	Lake trout	White-fish <sup>3/</sup>	Ale-wife	Lake herring	Others <sup>4/</sup>	Total
Fath.		1965											Pounds					
25	12	6- 9	251	46°45'	92°01'	NW.	1250	30	0	-	45	90	-	-	-	-	-	135
	13	6- 8	248	46°45'	92°01'	NW.	1120	30	0	-	35	100	-	-	-	-	-	135
	28	6-10	252	46°47'	91°52'	E.	0720	30	0	180	-	-	3	-	-	-	-	183
		1965																
29	4	10- 5	340	46°47'	92°05'	SE.	0830	30	0	-	150	124	-	-	1	1	18	294
	10	10- 5	341	46°45'	92°01'	NW.	0920	27	3	-	25	105	-	1	-	2	57	190
	15	10- 5	342	46°48'	91°56'	S.	1030	30	0	1	40	25	3	-	2	1	7	79
	20	10- 5	343	46°48'	91°56'	NW	1150	30	0	90	225	40	4	-	-	-	-	359
	25	10- 5	344	46°50'	91°55'	SE.	1240	30	0	250	10	40	-	-	-	-	-	305
	32	10- 5	345	46°51'	91°51'	SE.	1350	30	0	350	25	-	-	-	-	-	10	385
	40	10- 5	346	46°51'	91°45'	NE.	1500	30	0	100	5	-	-	-	-	-	-	110

<sup>1/</sup> See footnote 1, app. table 1.

<sup>2/</sup> See footnote 2, app. table 1.

<sup>3/</sup> See footnote 3, app. table 1.

<sup>4/</sup> See footnote 4, app. table 1.

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