NOAA Data Report ERL GLERL-1-1

ICE THICKNESS AND STRATIGRAPHY AT NEARSHORE LOCATIONS ON THE GREAT LAKES (ENGLISH UNITS)

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Ann Arbor, Michigan
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NATIONAL OCEANIC AND
ATMOSPHERIC ADMINISTRATION
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FOREWORD

The publication of this report marks the first time that the entire ice-thickness and stratigraphy data base has been edited. During the process of editing, a number of systematic errors were discovered and the incorrect data were recoded from the original field reports. All versions of these data released prior to July 1978 are superseded by this report.

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FIGURES

TABLES

ICE THICKNESS AND STRATIGRAPHY AT NEARSHORE LOCATIONS ON THE GREAT LAKES[1]

Frederick E. Sleator

Ice-thickness and stratigraphic data have been collected under a program instituted by the U.S. Lake Survey during winter 1965-66. The program is continuing under the Great Lakes Environmental Research Laboratory. The data collection network is documented and the data collection and editing procedures are described. Edited data are presented in Standard (English) units. A version of this report using metric units is available.[2]

1. INTRODUCTION

A program designed to collect Great Lakes ice information was implemented by the U.S. Lake Survey during winter 1965-66. The intent of the program was to document and develop an understanding of regional ice characteristics on the Great Lakes. The information to be collected included the dates of first ice formation and ice breakup, significant events affecting the ice and the dates of their occurrence, rates of ice growth and decay, and the type, thickness, and stratigraphic structure of the ice.

It was expected that this information would be useful for winter navigation, shoreline structure engineering, studies on the effect of thermal effluents from power plants, and various other applications.

2. DATA COLLECTION NETWORK

The ice sampling sites or stations were selected primarily on the basis of climate and secondarily on the basis of geographic location and the availability of an observer. Sites were selected on inland lakes and waterways, as well as on the Great Lakes. It was assumed that the inland lakes would be relatively unaffected by wind and wave action and would freeze over completely, unlike the Great Lakes. They were intended to provide a basis for comparing ice formed on the Great Lakes with undistrubed ice formed under the same meteorological conditions.

Stations were established in all five Great Lake basins. A disproportionately large number of these stations, 45 out of 95, were in

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[1] GLERL Contribution No. 168.

[2] NOAA Data Report ERL GLERL-1-2

the Lake Superior Basin. There were several reasons for this: Lake Superior has more ice for a longer period of time than the other lakes, making it better suited for studying ice; less was known about the ice on Lake Superior than about the ice on the other lakes; and some of the stations were established in conjunction with another project.

During the 1969-70 season the number of stations was reduced from over 90 to around 30 to cut the cost of operating the program and to eliminate some stations that were not providing useful or representative data. Most of the fluctuation in the number of stations after the 1969-70 season was due to the temporary unavailability of observers.

Each station was assigned a three digit number. The first digit indicates the lake basin in which the station was located:

100 - 199	Lake Superior
200 - 299	Lake Michigan
300 - 399	Lake Huron
400 - 499	Lake Erie
500 - 599	Lake Ontario.

Within each basin there is no particular order to the numbers. As new stations are added, they are assigned the next available number. If a station is dropped, the number is "retired" and not reused for another stations. Table 1 lists the stations (arranged by station number), their locations, and the period of record for each station. Figures 1 through 6 show the approximate location of each station. (The map scales are very small and the station symbols are large enough that pinpointing the locations is not possible.)

3. DATA COLLECTION METHODS

Once the general location for a station was chosed, the observer was instructed to select a site that normally had stable ice throughout the season. The site was to be at least 50 m off shore, preferably in deep water, and free from obstructions that might cause unusual snow drifts. Docks, mouths of rivers and streams, industrial discharge areas, and other areas likely to have unusual ice conditions were to be avoided. Once the site was selected, all of the weekly measurements were made on undisturbed ice as close to the original measurement site as possible.

To take measurements, the observer bored a hole in the ice with a hand auger and hooked a folding rule with a special "foot" attachment under the bottom of the ice. The distance from the bottom of the ice to the top of each layer of ice, slush, water, or snow was recorded. If the ice was unsafe, the observer estimated its thickness and stratigraphic structure, based either on past experience or, if possible, on nearby ice conditions. Measurements were originally made to the nearest whole inch,

Table 1. Ice measurement stations, locations, and periods of record.

STATION + NUMBER	LOCATION	65 66	66 67	67 68	68 69	69 70	70 71	71 72	72 73	73 74	74 75	75 76	76 77
108 MOSQUITO BAY	N46-28/W084-28				+	+	+	+	+	+	+	+	+
109 GROS CAP LIGHT	N46-31/W084-36			+	+	+	+	+	+	+	+	+	+
110 MONOCLE LAKE	N46-28/W084-39			+	+	+							
111 PENDILLS LAKE	N46-26/W084-46			+	+	+							
112 WAISKA BAY	N46-25/W084-35			+									
113 LAKE HULBERT	N46-19/W085-10			+	+								
114 TAHQUAMENON BAY	N46-32/W085-01			+	+	+	+	+	+	+	+		
115 WARNERS LAKE	N46-42/W085-02	+	+	+	+	+							
116 BODI LAKE	N46-42/W085-19			+	+								
117 LITTLE LAKE	N46-43/W085-22			+	+								
118 MUSKALLONGE LAKE	N46-40/W085-39			+	+								
119 GRAND MARAIS HARBOR MI	N46-40/W085-59			+									
120 SOUTH BAY-MUNISING	N46-25/W086-39			+	+		+	+	+	+	+	+	+
121 MARQUETTE HARBOR	N46-32/W087-22			+	+								
122 PINE LAKE	N46-52/W087-52			+	+								
123 LANSE BAY-KEWEENAW BAY	N46-46/W088-28			+	+	+	+		+	+	+	+	+
124 LAKE FANNY HOOE	N47-28/W087-52			+	+								
125 COPPER HARBOR	N47-28/W087-52			+	+								
126 BEAR LAKE	N47-14/W088-36			+	+								
127 PORTAGE LAKE-KEWEENAW WATERWAY	N47-02/W088-31		+	+	+		+	+	+	+	+	+	+
128 LAKE GOGEBIC	N46-36/W089-35			+	+	+							
129 CHEQUAMEGON BAY-ASHLAND WI	N46-35/W090-55		+	+	+		+	+	+	+	+	+	+
130 BAYFIELD HARBOR	N46-50/W090-49		+	+									
131 MADELINE ISLAND-APOSTLE IS.	N46-56/W090-47			+	+								
132 DULUTH HARBOR	N46-46/W092-06		+	+	+	+	+	+	+	+	+	+	+
133 LAKE SHAGAWA	N47-55/W091-50			+	+	+							
134 AGATE BAY-TWO HARBORS MN	N47-01/W091-40			+	+								
135 LAX LAKE	N47-21/W091-18			+	+								
136 DEVIL TRACK LAKE	N47-50/W090-27			+	+								
137 GRAND MARAIS HARBOR MN	N47-45/W090-20		+	+									
138 GRAND PORTAGE BAY	N47-57/W089-39			+	+		+	+	+	+	+	+	+
139 TEAL LAKE	N47-59/W089-39		+	+	+								
140 ISLE ROYALE-WASHINGTON HARBOR	N47-55/W089-10			+	+	+	+	+	+	+	+	+	+
152 POINT IROQUOIS	N46-30/W084-37			+	+			+	+	+	+	+	+
153 BIG BAY	N46-50/W087-42			+									
154 LAKE INDEPENDENCE	N46-49/W087-42			+									
156 RICE LAKE	N46-52/W092-10			+									
157 SISKIWIT BAY WI	N46-52/W091-06			+									
164 CEDAR POINT	N46-27/W084-30							+	+	+	+		
165 LAKE SHAGAWA-FWPCA	N47-55/W091-50					+							
166 TWO HARBORS-=1 DOCK	N47-01/W091-40				+								
167 TWO HARBORS-=1 DOCK-NEW SITE	N47-01/W091-40				+								
168 BAY MILLS POINT-WHITEFISH BAY	N46-26/W084-34			+									
169 WHITEFISH POINT HARBOR	N46-46/W084-58			+									
170 TWO HARBORS-INNER HARBOR	N47-01/W091-40			+									
200 GREEN BAY WI	N44-34/W087-55			+	+	+	+		+	+	+	+	+
201 STURGEON BAY	N44-48/W087-23			+	+								

Table 1. (Continued)

STATION #	NUMBER	LOCATION	65 66	66 67	67 68	68 69	69 70	70 71	71 72	72 73	73 74	74 75	75 76	76 77
202	HEDGEHOG HARBOR	N45-18/W087-02			•	•								
203	EUROPE LAKE	N45-16/W086-59			•	•								
204	GIBSON LAKE	N46-10/W088-10			•	•	•							
205	LAKE MICHIGAMME	N46-32/W088-05			•	•	•							
206	LAKE ANTOINE	N45-45/W087-57			•	•	•							
207	LONG LAKE	N45-52/W088-46			•									
209	ESCANABA-LITTLE BAY DE NOC	N45-45/W087-03			•	•		•	•	•	•			•
210	PIG ISLAND LAKE	N46-11/W086-30			•	•								
211	INDIAN LAKE	N46-00/W086-20			•	•								
212	NAUBINWAY HARBOR	N46-05/W085-26			•	•								
213	BEAVER ISLAND-LAKE BARNEY	N45-43/W085-34	•	•	•	•								
214	LITTLE TRAVERSE BAY-PETOSKEY	N45-23/W085-00			•	•			•	•	•	•	•	•
215	LAKE CHARLEVOIX	N45-18/W085-14			•	•	•							
216	S. MANITOU IS.-LAKE FLORENCE	N45-01/W086-07	•	•	•	•								
217	CRYSTAL LAKE	N44-42/W086-14			•	•	•							
218	MUSKEGON LAKE-SNUG HARBOR	N43-15/W086-20			•	•	•	•	•	•				
219	GRAND TRAVERSE BAY-WEST ARM	N44-47/W085-37								•	•			•
220	MENOMINEE MI	N45-06/W087-36							•	•	•	•	•	•
301	LAKE GEORGE	N46-26/W084-07			•	•								
302	LAKE MUNUSCONG	N46-13/W084-10			•	•	•		•	•	•	•	•	•
303	RABER BAY	N46-06/W084-03		•	•	•	•	•	•	•	•	•	•	•
304	ST. MARTIN BAY	N46-01/W084-41			•	•			•	•	•	•	•	•
305	CHAIN LAKE	N45-52/W084-45			•	•								
306	MACKINAW CITY	N45-46/W084-43			•	•	•	•	•	•	•	•	•	•
307	CHEBOYGAN-DUNCAN BAY	N45-39/W084-26			•	•								
308	THUNDER BAY-ALPENA	N45-03/W083-26			•	•	•	•	•	•	•	•	•	•
309	POINT LOOKOUT-SAGINAW BAY	N44-02/W083-36			•	•	•	•	•	•	•	•	•	•
310	WIGWAM BAY-SAGINAW BAY	N43-59/W083-49							•	•	•	•	•	•
312	CARIBOU LAKE	N46-00/W084-00				•								
313	BOIS BLANC ISLAND-TWIN LAKE	N45-45/W084-28				•	•							
314	DETOUR-ST. MARYS RIVER	N46-00/W083-54							•	•	•	•	•	•
400	MARINE LAKE-ERIE HARBOR	N42-08/W080-08			•	•		•	•	•	•	•	•	•
401	MARBLEHEAD-EAST HARBOR	N41-32/W082-48			•	•								
402	BREST BAY	N41-55/W083-19			•	•		•	•	•	•		•	•
406	BUFFALO HARBOR	N42-45/W078-53				•		•	•	•	•	•	•	
407	DELAWARE LAKE-BUFFALO	N42-55/W078-50				•								
408	MARBLEHEAD-CATAWBA ISLAND	N41-33/W082-52						•	•	•	•	•	•	•
410	LAKE ST. CLAIR-NEW BALTIMORE	N42-40/W082-43			•	•	•	•	•	•	•	•	•	•
411	LAKE ST. CLAIR-SELFRIDGE AFB	N42-37/W082-48						•	•	•				
500	IRONDEQUOIT BAY-ROCHESTER	N43-12/W077-31			•	•	•	•	•	•	•	•	•	•
501	LITTLE SODUS BAY	N43-19/W076-43			•	•								
502	NORTH POND	N43-39/W076-11			•	•		•	•	•	•	•	•	•
503	HENDERSON HARBOR	N43-52/W076-13			•	•		•	•	•	•			
504	WILSON BAY	N44-05/W076-21			•	•		•	•	•	•	•	•	•
505	GALLOO ISLAND-GILL HARBOR	N43-55/W076-23				•	•							
506	LAKE OF THE ISLES-WELLESLEY I.	N44-20/W076-00			•									
507	CAPE VINCENT-ST. LAWRENCE R.	N44-03/W076-20					,		•	•	•	•		

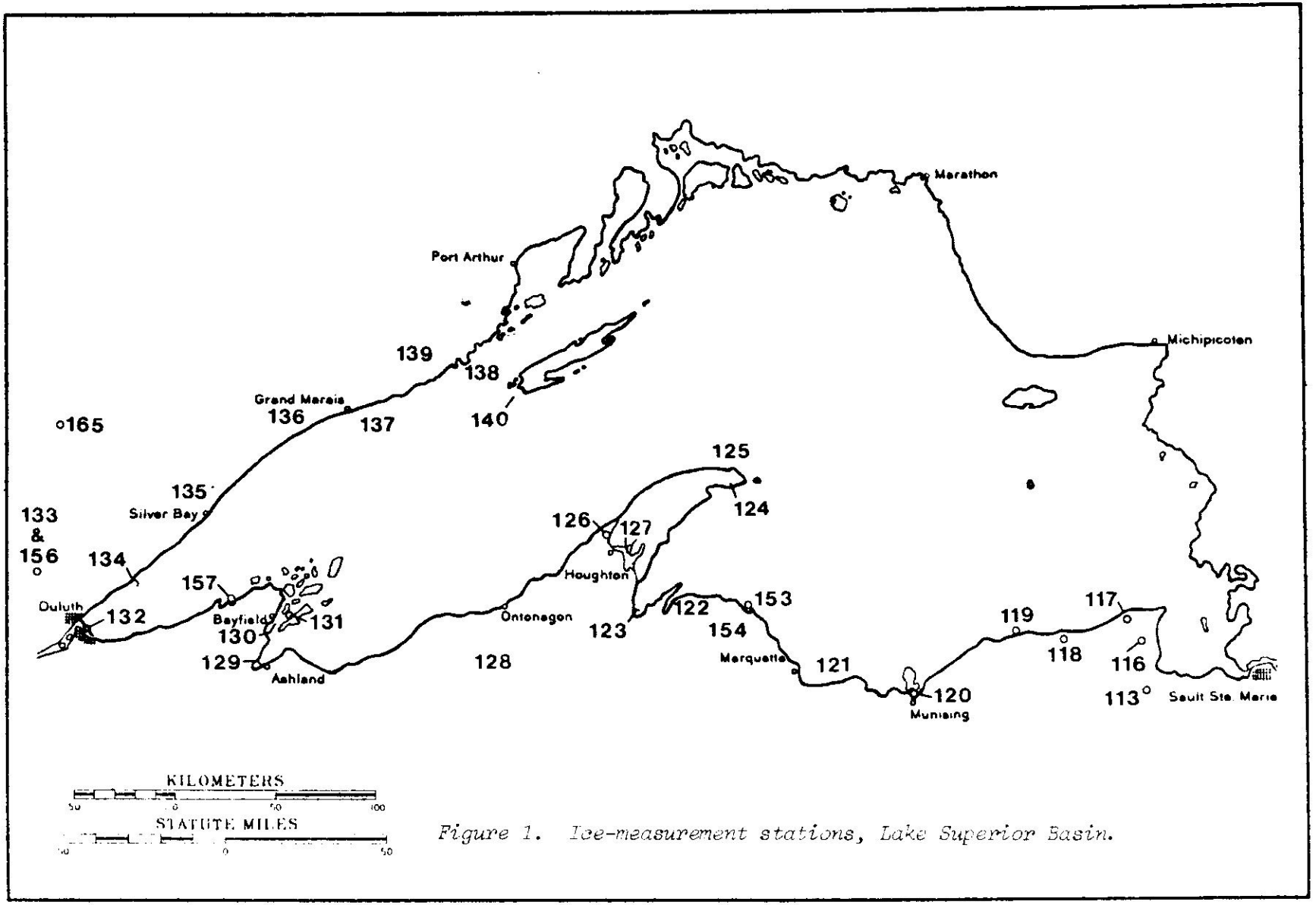


Figure 1. Ice-measurement stations, Lake Superior Basin.

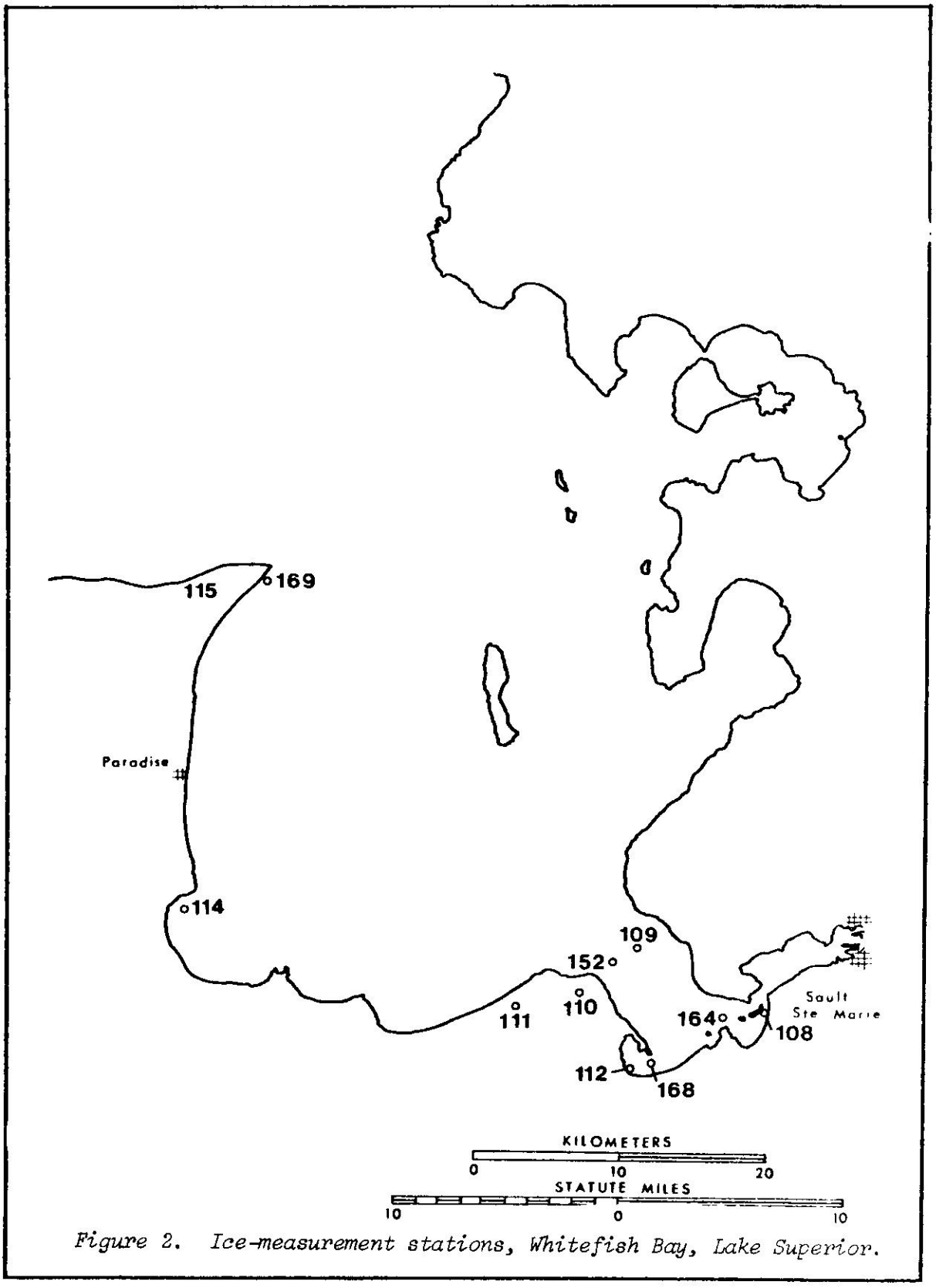


Figure 2. Ice-measurement stations, Whitefish Bay, Lake Superior.

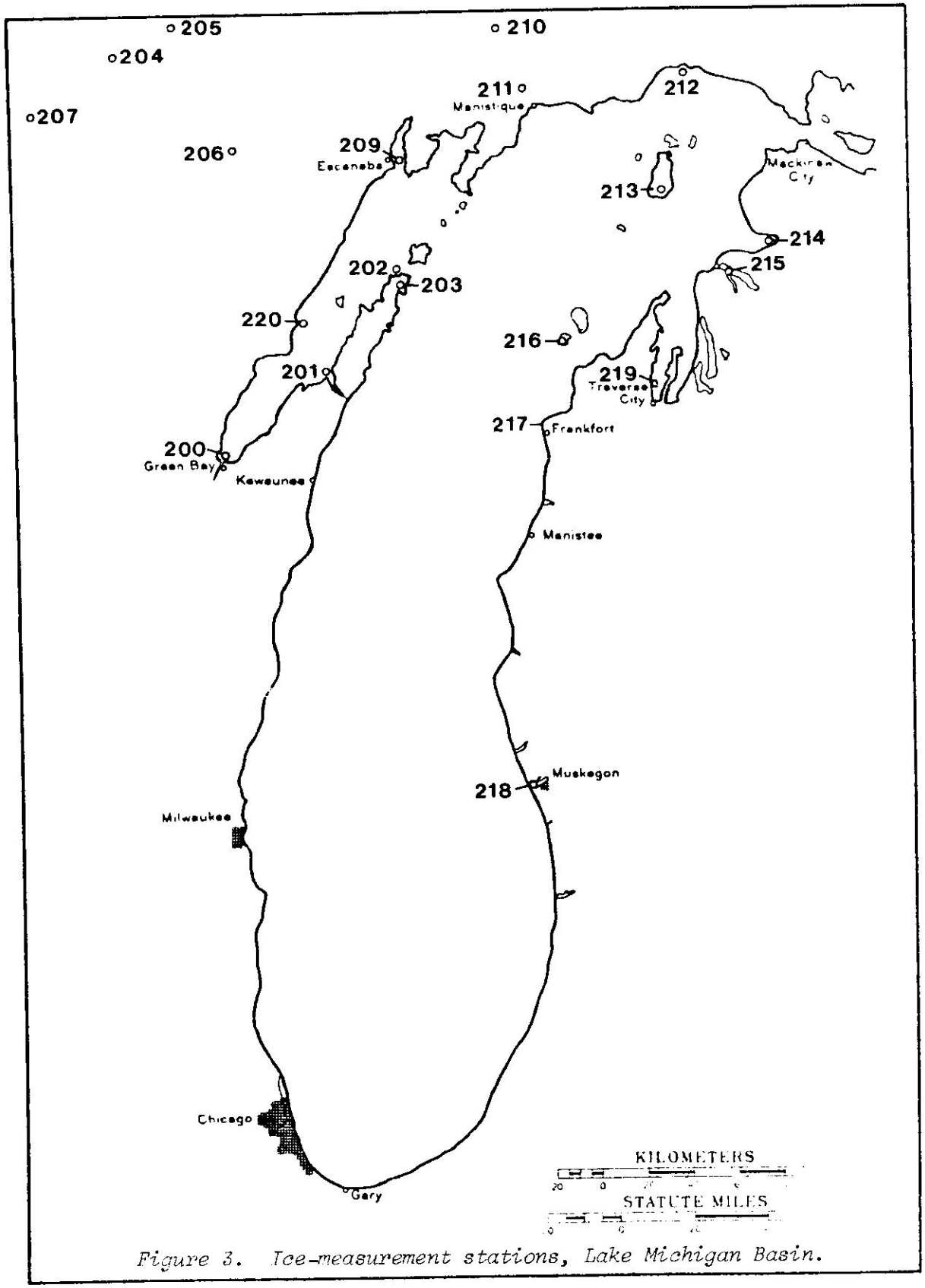


Figure 3. Ice-measurement stations, Lake Michigan Basin.

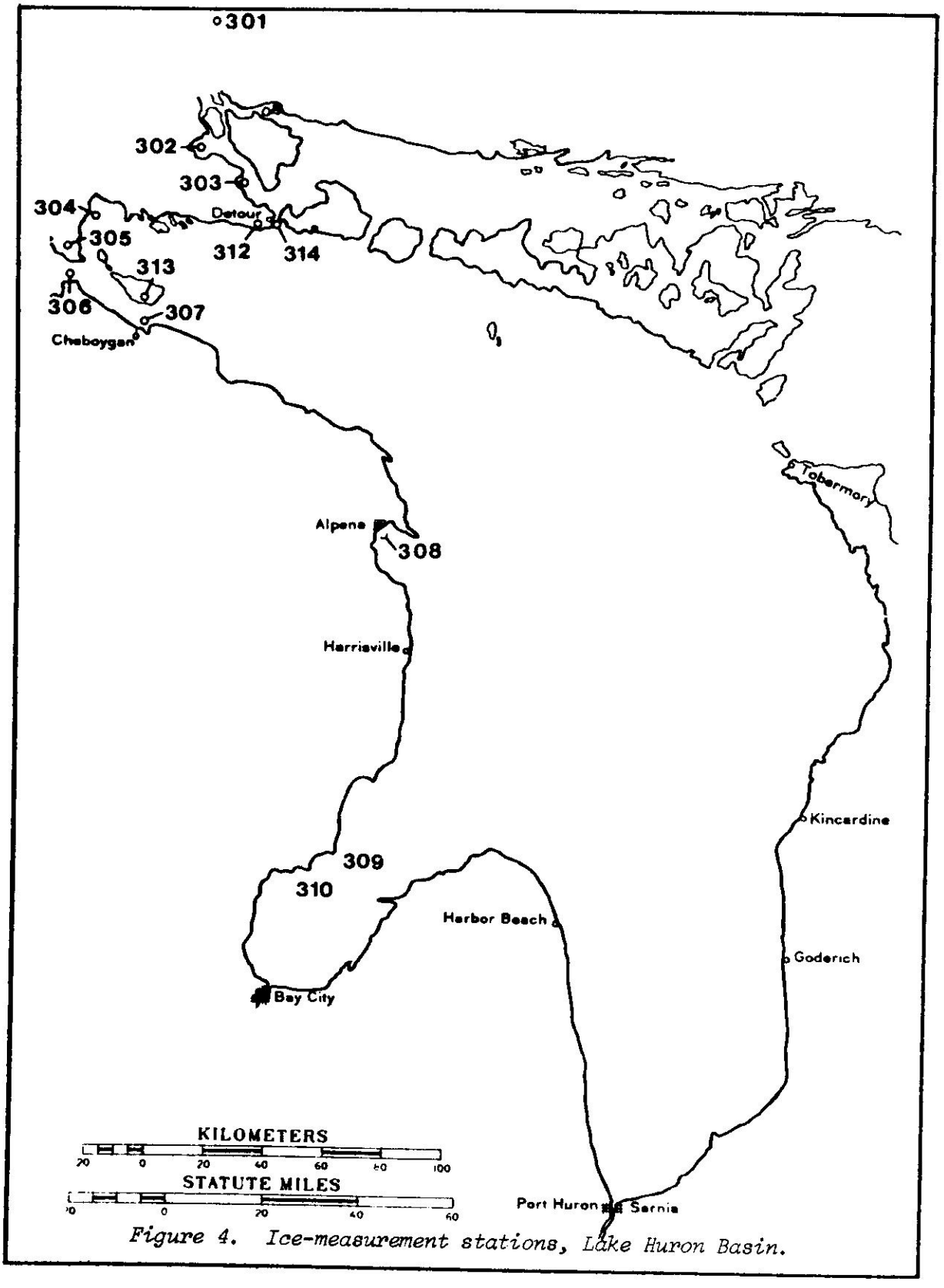


Figure 4. Ice-measurement stations, Lake Huron Basin.

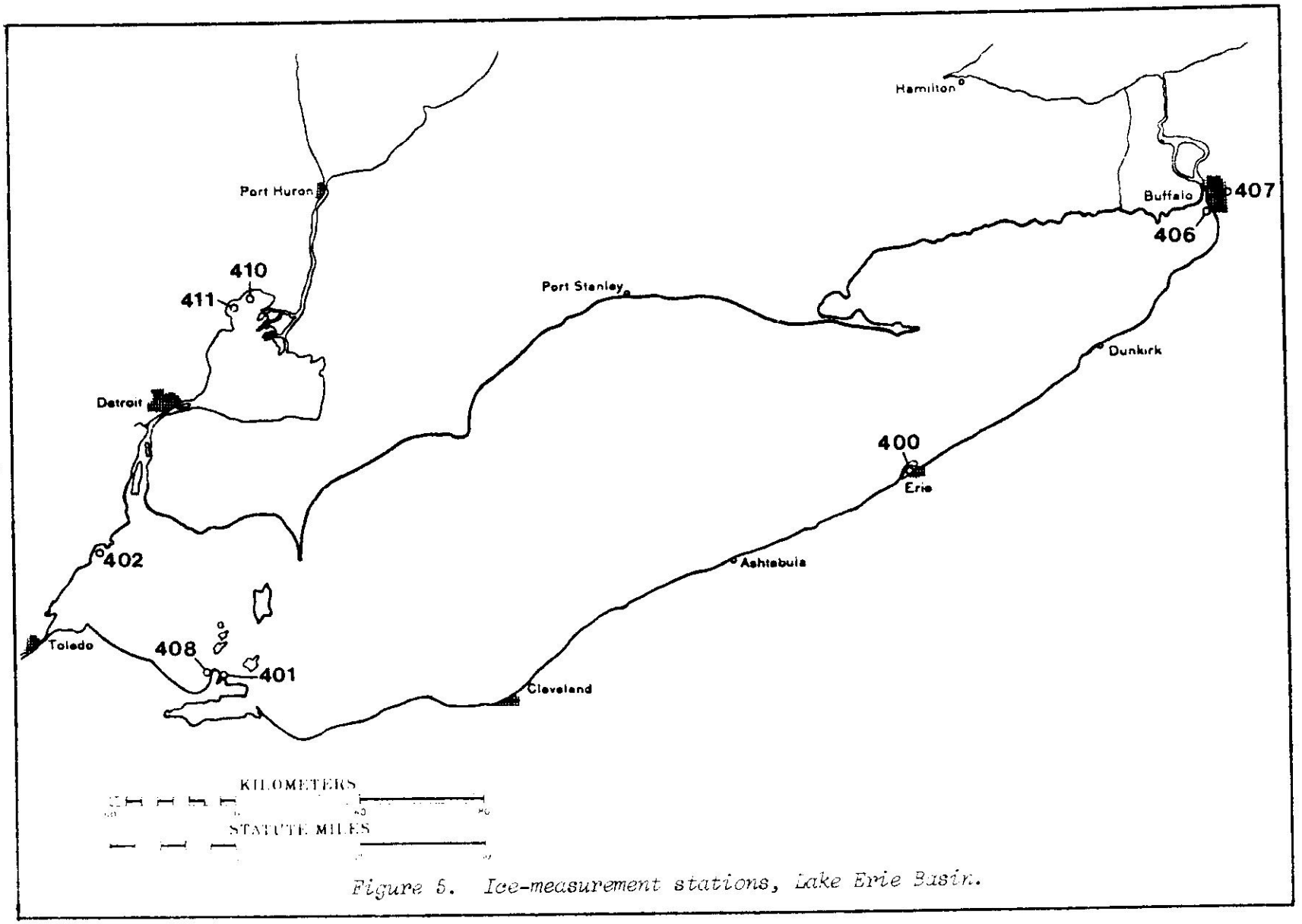


Figure 5. Ice-measurement stations, Lake Erie Basin.

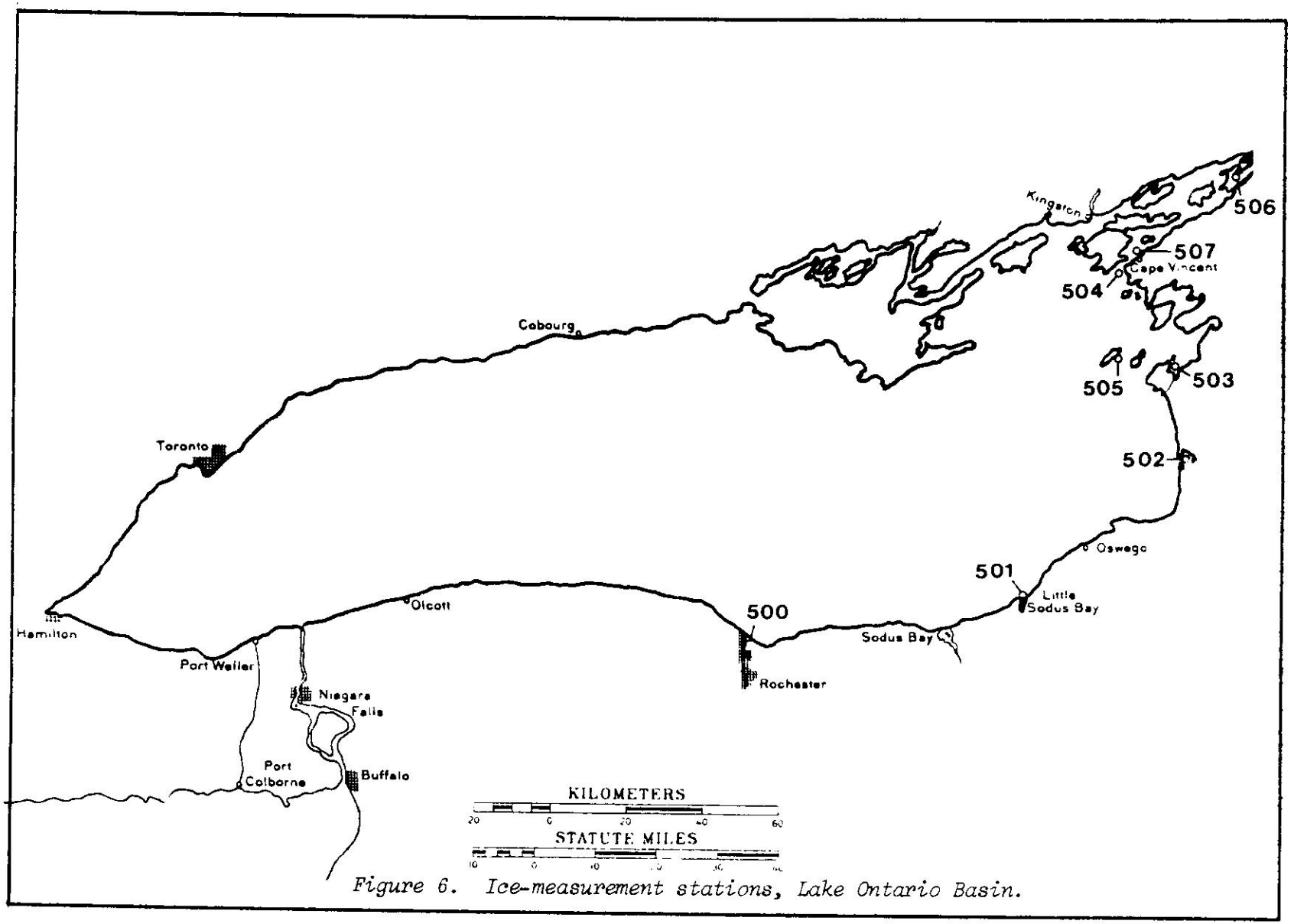


Figure 6. Ice-measurement stations, Lake Ontario Basin.

but starting with the 1977-78 season, measurements were made to the nearest whole centimeter. All measurements and observations were recorded on a standard form and returned to the Great Lakes Environmental Research Laboratory.

4. REPORT FORMS

Several different report forms have been used. An example of the earliest report form, used through the 1967-68 ice season, is shown in Figure 7. This form was adequate for recording the thickness of the ice, but observers often did not include other useful information. Figure 8 shows the report form that was used from the 1968-69 through the 1973-74 ice seasons. This form requested more information about conditions that might affect the ice than the previous form, but had the apparent disadvantage of having to be interpreted and coded before the data could be keypunched and placed in a computer file. The form shown in Figure 9 was used from the 1974-75 through the 1976-77 ice seasons. It was designed to make the interpretation and coding unnecessary, but it was ambiguous. There were a variety of problems encountered by the observers in filling out the form, usually due to misinterpretation of the form itself or of the instructions. Other problems with this form were lack of compatibility with the previous forms (different codes used to indicate the same condition or event) and the use of letters rather than numbers for the visual observation codes; these had to be changed for efficient computer processing. Finally, the fact that these forms could be keypunched without being coded usually meant that these reports were edited poorly, if at all. This combination of factors resulted in a large number of improperly coded reports being placed in the computer file.

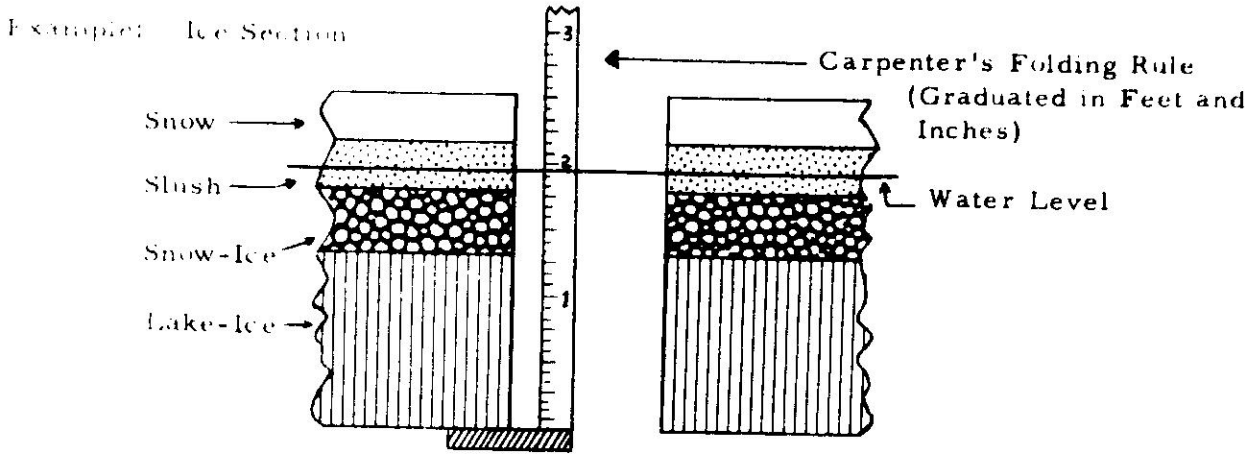
In an attempt to eliminate these problems, a new form was developed (Figure 10) combining the best characteristics of the previous forms. In addition, a precise editing and coding procedure was developed. These changes are expected to improve the reliability of the data and to reduce the amount of time between collection and processing.

5. EDITING PROCEDURES

At the end of each season the ice-thickness reports were coded and keypunched, one report per computer card. At the start of the editing procedure, the reports were placed on file in the computer, but several problems were immediately apparent: The data were not in order; data from different seasons were formatted differently; and the data from the 1973-74 through 1976-77 seasons were coded differently than the previous data.

Several procedures were developed to correct these problems. A computer program was developed to sort the data. The station and date codes were reformatted into a 10-digit integer (station number,

RECORDING PROCEDURE



OBSERVATIONS ON ICE THICKNESS AND STRUCTURE

Name of Lake _____ Date of Obser. _____
Approx. Time _____

	Inches
Top of Lake Ice	_____
Top of Snow Ice	_____
Top of Slush	_____
Top of Snow	_____
Water Level	_____

Remarks:

NCL HO 21 (Rev 27 Nov 67) (1000)

Figure 7. Ice Report Form No. 1.

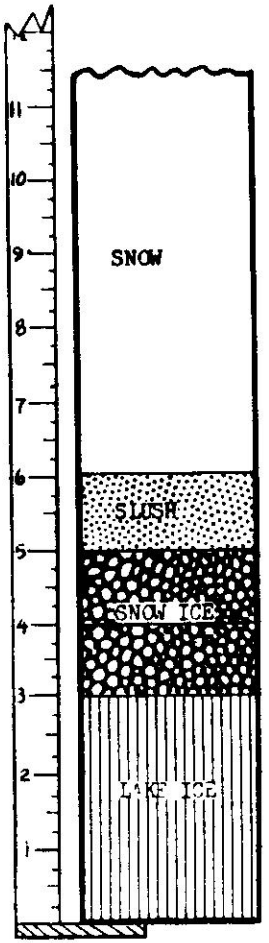
ICE REPORT

STATION CODE _____

OBSERVATION DATE

DAY ___ MONTH ___ YEAR ___

PROCEDURE: MEASURE THE DISTANCE (TO THE NEAREST WHOLE INCH) FROM THE BOTTOM OF THE ICE SHEET TO THE TOP OF EACH SNOW OR ICE LAYER.



Top of Snow ☐

CIRCLE NUMBER DESCRIBING SNOW

WET - - - - - - - - - 1
DRY - - - - - - - - - 2
PACKED - - - - - - - 3
MELTING - - - - - - - 4
FLUFFY - - - - - - - 5
CRUST ON TOP - - - 6

Top of Slush ☐

Top of Snow Ice ☐

Water Level ☐

Top of Lake Ice ☐

CIRCLE NUMBER DESCRIBING LAKE ICE

SOLID - - - - - - - - 7
MELTING - - - - - - - 8
CANDLED - - - - - - - 9

NOTE: IF YOUR SITE HAS ADDITIONAL SLUSH AND ICE LAYERS, OTHER THAN THE LAYERS INDICATED IN THE DIAGRAM, DRAW A SKETCH IN THE REMARKS SECTION GIVING THE TYPE, POSITION, AND THICKNESS OF THE ADDITIONAL LAYERS.

over

NOL HO 21 (Rev 17 Oct 68) (6000)

Figure 8. Ice Report Form No. 2.

SECTION 1 SIGNIFICANT PERIODS OF ICE DEVELOPMENT

FREEZE - OVER PERIOD	DAY	MONTH	YEAR
FIRST SKIM ICE FORMATION			
COMPLETE FREEZE-OVER			

MID - WINTER AND SPRING THAW PERIODS	DAY	MONTH	YEAR
STARTING DATE OF THAW			
ENDING DATE OF THAW			
ICE FLOODED WITH WATER			
WATER PUDDLES ON ICE			
ICE SHEET BREAK-UP INTO ICE FLOES			
ICE FLOES BLOW OUT OF AREA			
ICE FLOES BLOW INTO AREA			
ICE FLOES PILE UP ON SHORE			
ONLY SHORE ICE LEFT IN AREA			
ALL ICE COMPLETELY GONE FROM AREA			

SECTION 2 REMARKS

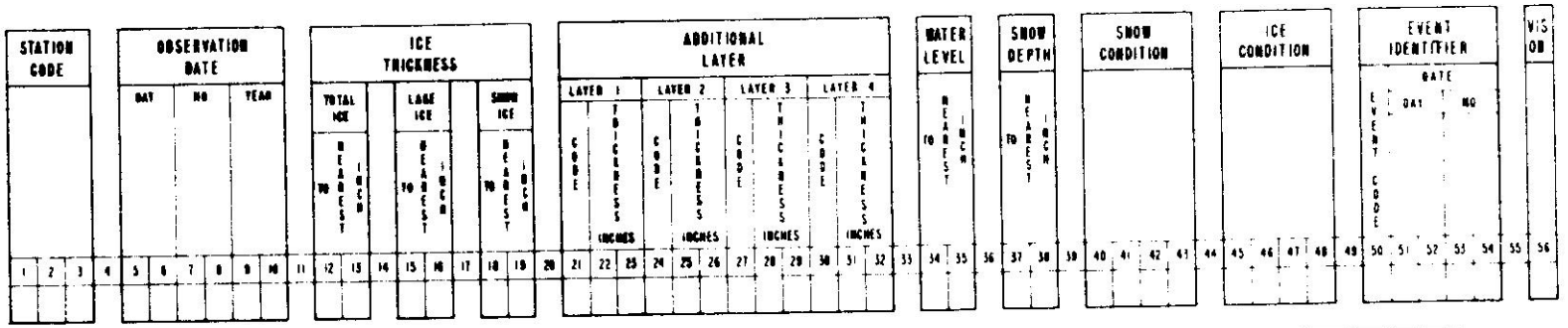
SIGNIFICANT WEATHER DURING ANY PERIOD	DAY	MONTH	YEAR
HEAVY SNOW FALL - 4 INCHES OR MORE			
HIGH WIND AND/OR HIGH WAVES			
COLD TEMPERATURES (AROUND OR BELOW 0°F)			
RAIN AND/OR SLEET			

Figure 8. (continued)

ICE THICKNESS REPORT

NOAA FORM 86-517
(5/74)

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Great Lakes Environmental Research Laboratory



ADDITIONAL LAYER CODES

1. SNOW
2. SLUSH
3. SNOW ICE
4. LAKE ICE
5. WATER
6. FROZEN RAIN

SNOW CONDITION CODES

1. DRY
2. FLUFFY
3. WET
4. PACKED
5. MELTING
6. CRUSTED
7. DRIFTED

ICE CONDITION CODES

1. THAW HOLES
2. WINDROWED
3. PUDDLE
4. FLOODED
5. CRACKED
6. DRY
7. SOLID
8. MELTING
9. CANDLED
10. PILED ON SHORE
11. BROKEN

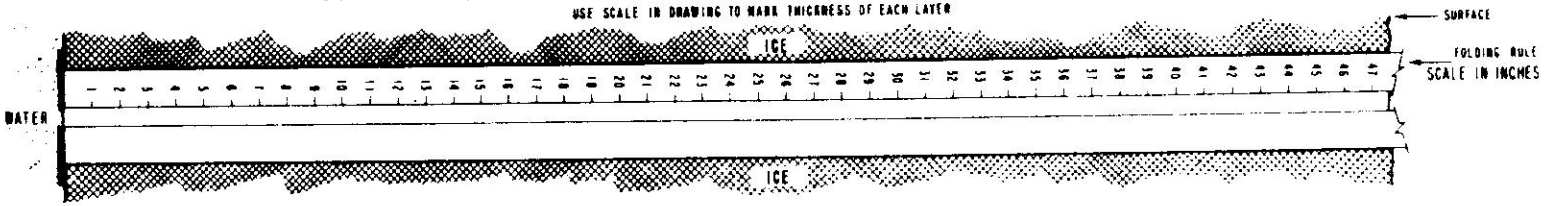
EVENT IDENTIFIER CODE

1. SOLID ICE (AT MEASUREMENT LOCATION)
2. FREEZE OVER (AT MEASUREMENT LOCATION)
3. SHORE BOAT
4. BREAKUP
5. UNNATURAL BREAKUP (I.E., ICEBREAKER)
6. ICE FREE
7. MEASUREMENT SITE MOVED TO NEW LOCATION

VISUAL OBSERVATION CODES

A. OPEN WATER
B. SOLID ICE
C. HONEYCOMBED ICE
D. WINDROWED ICE
E. SLUSH ICE
F. DRIFTING ICE
G. ICE GORGE

SKETCH IN LAKE ICE, SNOW ICE, ANY ADDITIONAL LAYERS, SNOW COVER AND WATER LEVEL IN AUGERED HOLE JUST AS YOU SEE THEM
USE SCALE IN DRAWING TO MARK THICKNESS OF EACH LAYER



MEASURE THE THICKNESS OF EACH LAYER TO THE NEAREST WHOLE INCH.

Figure 3. Ice Report Form No. 3.

Observer's Ice Report

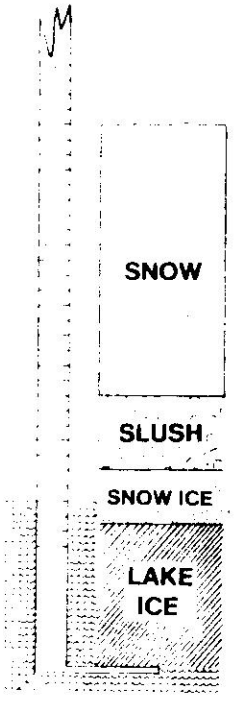
Great Lakes Environmental Research Laboratory
National Oceanic and Atmospheric Administration
2300 Washtenaw Avenue
Ann Arbor, Michigan 48104

Season	1977-78
Station Code:	
Observation Date	MONTH / DAY

Follow this procedure for determining thickness Measure the distance from the bottom of the ice to the top of each ice or snow layer. Record this measurement to the nearest whole centimeter. If your site has ice, slush, or snow layers other than the layers indicated on the diagram, draw a sketch on the back of this sheet giving the type, position, and thickness of the layers. The example on the left below is filled in correctly. Record your observations in this same manner in the spaces to the right of the example numbers.

Mark the box describing the SNOW on top of your ice

- WET [ ] 1
- DRY [ ] 2
- PACKED [ ] 3
- MELTING [ ] 4
- FLUFFY [ ] 5
- CRUST ON TOP [ ] 6



EXAMPLE	*Write in your MEASUREMENTS*	
36 cm	TOP OF SNOW	cm
18 cm	TOP OF SLUSH	cm
13 cm	TOP OF SNOW ICE	cm
11 cm	WATER LEVEL	cm
10 cm	TOP OF LAKE ICE	cm

Mark box describing your ICE

- SOLID [ ] 7
- MELTING [ ] 8
- CANDLED [ ] 9

Mid-Winter and Spring THAW PERIODS	Day & Mo.
Starting Date of Thaw	
Ending Date of Thaw	
Ice Flooded with Water	
Water Puddles on Ice	
Ice Sheet Breakup into Ice Floes	
Ice Floes Blow out of Area	
Ice Floes Blow into Area	
Ice Floes Pile up on Shore	
Only Shore Ice Left in Area	
All Ice Completely Gone from Area	

FREEZE-OVER PERIOD	Day & Mo.
First Skim Ice Formation	
Complete Freeze-Over	

SIGNIFICANT WEATHER during any period	Day & Mo.
Heavy Snow Fall (4 inches or more)	
High Winds and/or High Waves	
Cold Temperatures (around or below 0°F)	
Rain and/or Sleet	

Make additional remarks on back!

Figure 10. Ice Report Form No. 4.

followed by a zero, year, month, and day), giving each report a unique identification number and allowing the reports to be put in order by station and date simultaneously. The data were then printed out by station, with each report being represented by one line on the computer printout, and printouts were checked against the original field reports. If changes were necessary the reports were re-coded and keypunched; when the checking was completed, a computer program was used to delete the incorrect reports and to insert the correct data. Most of the errors that occurred were the result of forms being improperly coded or interpreted. A large number of keypunch errors were also found.

After the data were corrected, several computer programs were used to check for incorrect formats, unusual data values, missing data, duplication of data, and other errors that might have been overlooked during the editing procedure. Ice thickness and other measurements are presented in inches, as they were originally collected.

6. DISCUSSION

Several factors must be considered when the data presented in the following appendix are used. Their relative importance will depend on what use is made of the data, but they are, in general, constraints on the data. The most obvious of these factors is the short period of record of the data base. In no case does it exceed 11 seasons and for most of the stations it is shorter. Statistical analysis of such a brief period of record might not be meaningful.

Another significant factor is that the severity of the winters in the Great Lakes region is highly variable. Winter severity can be measured in terms of accumulated freezing degree-days (FDD's). Assel and Quinn (1977) have developed a preliminary classification of winter severity for the Great Lakes based on 30 years of FDD data. Table 2 shows the severity classification for the period of record covered by the ice-thickness and stratigraphy data base. It should be noted that the ice-thickness data for some stations may not cover the full range of winter conditions and, therefore, may not accurately represent the ice conditions that are of interest to those using this data base.

Another factor is that these data were collected in nearshore areas. Ice conditions on the Great Lakes are highly variable and the data may not be valid for nearby areas or representative of offshore conditions.

Table 2. Winter Severity Classification

Area	1965-66	1966-67	1967-68	1968-69	1969-70	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76	1976-77
Western Lake Superior							S*					
Eastern Lake Superior	M**				S	S		M				S
Northern Lake Michigan						S		M				S
Southern Lake Michigan						S						S
Lake Huron (all)					S	S		M				S
Lake Erie (all)					S							S
Lake Ontario (all)					S	S		M		M		S

*S = severe winter
**M = mild winter
No letter = normal winter

One further consideration is that the visual observation codes were changed after the 1973-74 ice season to make the reports more accurate. The visual observation code originally represented the amount of ice either recorded or implied by the observer. Prior to the 1974-75 season, this information was coded as follows:

1 = ice to limit of visibility
2 = shore ice
3 = no ice
4 = ice floes and/or ice field
5 = ice present.

These codes were changed for the 1974-75 season and remain as follows:

1 = open water
2 = solid ice
3 = honeycombed ice
4 = windrowed ice
5 = slush ice
6 = drifting ice
7 = ice gorge.

In spite of any shortcomings, the data have proven to be well suited for their intended purpose. They provide a good comparison of ice history, thickness, and stratigraphy in different areas of the Great Lakes. They are useful for site-specific shoreline engineering studies, and they have provided useful information for winter navigation projects and remote sensing studies. Additional data collection will eliminate most of the constraining factors mentioned above.

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8. REFERENCE

Assel, R. A., and F. H. Quinn (1977): A preliminary classification of Great Lakes winter severity, 1947-1976, GLERL Open File Report, 8 pp.