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U. S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Ocean Survey

Great Lakes Ice Cover Winter 1972-73

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Lake Survey Center

DETROIT, MICH.

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GREAT LAKES ICE COVER

WINTER 1972-73

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Limnology Division
Detroit, Michigan

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ABSTRACT. Visual aerial ice reconnaissance data were used to compile weekly composite ice charts of the Great Lakes from mid-December to the beginning of April. Composite charts depict generalized ice-cover distributions. In addition, more detailed ice information is provided in the form of ice charts of individual lakes and areas which supplement the composite charts.

Freezing degree-day accumulations indicate the 1972-73 winter was near normal for Lakes Superior and Huron and bordering between mild and normal for Lakes Michigan, Erie, and Ontario.

First reports of ice on the upper lakes came in the latter part of November. Below normal temperatures the first half of December resulted in early shore ice build up. By mid-December portions of western Lake Superior, St. Marys River, Green Bay, and Saginaw Bay had extensive ice cover. Milder weather the last half of December slowed ice formation. Ice covers increased the first 2 weeks of January and decreased in many areas the rest of the month. Ice formed over open-lake areas in February and reached its greatest areal extent the latter part of February. Estimated percentage ice cover during the last 2 weeks in February compares favorably with freezing degree-day accumulations and is as follows: Lake Superior, 60 percent; Lake Michigan, 20 percent; Lake Huron, 60 percent; Lake Erie, 95 percent; and Lake Ontario, 20 percent. Unusually mild weather in March caused early loss of ice cover on the northern lakes. By mid-March the ice was well into the decay period with large areas of the lakes being ice free and by April 1, almost all of the ice cover was gone. The last report of ice came from western Lake Superior during the second week of April.

INTRODUCTION

This report presents visual aerial ice reconnaissance data collected over the Great Lakes during the 1972-73 winter. Ice reconnaissance flights were made by the Lake Survey Center, United States Coast Guard, and Canadian Department of the Environment. Ice information collected on these flights was incorporated into weekly composite ice charts of the Great Lakes. Ice charts of specific lakes and areas upon which the composite charts are based are presented. A brief discussion of seasonal ice development and winter weather is also included.

The Lake Survey Center began making visual aerial ice reconnaissance flights in February 1963. The program has continued since that time. Data on the areal extent and structure of the Great Lakes ice cover are used to analyze seasonal patterns of ice formation, growth, and decay. In recent years, the U.S. Coast Guard has made visual aerial ice reconnaissance flights over the Great Lakes on a regularly scheduled basis and has made ice charts available to the Lake Survey Center. As a result, Lake Survey Center ice reconnaissance flights have been greatly reduced. During the 1972-73 winter 15 flights were made and nine of these were made in support of the Great Lakes St. Lawrence Seaway-Navigation Season Extension-Demonstration Program.

DATA COLLECTION

Fifteen Lake Survey Center ice reconnaissance flights were made between December 14, 1972 and March 22, 1973. Approximately 4,610 miles (7,376 km) and 40 hours were logged during these flights. Ten flights were made in Cessna 172 and Cessna 182 aircraft flying at altitudes up to 6,000 ft. (1,800 m). In addition, five flights were made in U.S. Coast Guard aircraft. Flight dates, flight times and areas covered are given in Table 1.

Visual aerial ice observations were recorded on worksheets using the symbols given in Table 2. Data includes observations of ice concentration, ice boundaries, surface characteristics of ice cover, and age and size of ice floes. Ice charts were drafted and sent via telecopier to the U.S. Coast Guard Ice Navigation Center in Cleveland, Ohio, immediately after each flight.

U.S. Coast Guard ice charts were received from the Ice Navigation Center in Cleveland, Ohio, from December 11, 1972 through April 11, 1973. Composite ice charts were received from the Canadian Department of the Environment, Ice Forecasting Central in Ottawa, Ont., for the period December 20, 1972 to April 6, 1973. This information was used in assessing ice conditions during the winter and in compiling the weekly composite ice charts appearing in this report.

Surface ice reports from shore-based U.S. Coast Guard and Lake Survey Center observers were received throughout the winter. Reports included visual descriptions of ice cover and measurements of ice thickness. This information was helpful in identifying areas of first ice formation, areas where ice remained the longest, and in monitoring ice conditions throughout the winter.

Average weekly air temperatures taken from the Department of Commerce publication, Weekly Weather and Crop Bulletin, were used to calculate freezing degree-day accumulations for eight sites around the perimeter of the Great Lakes: Duluth, Minn.; Sault St. Marie, Mich.; Green Bay, Wis.; Alpena, Mich.; Milwaukee, Wis.; Detroit, Mich.; Cleveland, Ohio; and Rochester, N. Y. One freezing degree-day is defined as a day with the average temperature one degree below 32°F. One thawing degree-day is a day with the average air temperature one degree above 32°F. In this report freezing degree-days were assigned a positive algebraic sign and thawing degree-days a negative algebraic sign. A cumulative sum of freezing and thawing degree-days from November through April was maintained and used to indicate winter severity and helped in scheduling ice reconnaissance flights.

Table 1. Visual aerial ice reconnaissance flights - winter 1972-73

Flight No.	Date	Time (GMT)	Area
1	Dec. 14	1515-1700	St. Marys River
2	Jan. 3	1530-1730	Lake St. Clair
3	Jan. 12	1600-1830	Lake St. Clair
4	Jan. 24	1825-2000	Lake St. Clair
5	Jan. 26	1500-1730	Whitefish Bay, St. Marys River
6	Feb. 8	2000-2130	Whitefish Bay, St. Marys River
7	Feb. 9	1600-1730	Lake St. Clair *
8	Feb. 13	1800-1930	Lake St. Clair *
9	Feb. 13	1845-2220	Lake Ontario
10	Feb. 26	1425-1640	Western Lake Erie, Lake St. Clair (CG)
11	Feb. 27	1422-1705	Southern Lake Huron (CG)
12	Feb. 28	1440-1725	Northern Lake Erie (CG)
13	Mar. 5	1342-1915	Northern Lakes Michigan, Huron (CG)
14	Mar. 5	1300-2130	Lake Superior, Whitefish Bay, St. Marys River (CG)
15	Mar. 22	1456-1728	Whitefish Bay, St. Marys River

* No ice chart produced as result of these flights.
(CG) - U.S. Coast Guard flight support.

DATA PRESENTATION

Two types of ice charts were prepared by Lake Survey Center: (1) small-scale composite charts compiled from data submitted by other agencies and (2) larger-scale charts produced from Lake Survey Center observations. Sixteen composite ice charts (figs. 1-16) portray general seasonal patterns of ice distribution on the Great Lakes. Twenty large-scale charts (figs. 17-36) include more detail, including synoptic conditions, than the composite charts.

Composite Ice Charts

The composite ice charts incorporate data collected by Lake Survey Center, United States Coast Guard, and Canadian Department of the Environment. Each composite chart represents a subjective evaluation of ice conditions on the entire Great Lakes, based on available information, for the end of each week. There may be, therefore, minor differences in ice extent and concentration as shown on the composite ice charts and those appearing in figures 17-36. The composite ice charts portray generalized ice distribution patterns and not synoptic conditions as do the individual ice charts. Charts begin for the week ending December 17, 1972 and continue each week through April 1, 1973.

Freezing degree-day accumulations are presented on each composite chart for the eight locations mentioned previously. The tabulations include freezing degree-days accumulated during the week, the total seasonal accumulation through the end of that week, and the normal seasonal accumulation, based on a 10-year mean, to the end of that week. The 10-year means were calculated at Lake Survey Center from average daily temperatures.

Freezing degree-day accumulations are also presented in graph form. Current year accumulations (1972-73), the 10-year mean, and maximum accumulations for 24 years starting in the 1947-48 winter are illustrated in figures 37-41.

Ice Charts

Twenty ice charts cover portions of Whitefish Bay, St. Marys River, and Lakes Superior, Michigan, Huron, St. Clair, Erie, and Ontario. These charts were produced from data gathered on Lake Survey Center ice reconnaissance flights and include information on ice boundaries, ice concentration, surface characteristics, and age and size of ice floes.

Thirteen of the 20 charts are of Whitefish Bay, St. Marys River, and Lake St. Clair. The emphasis on these areas was in support of the Demonstration Program to extend the navigation season on the Great Lakes and St. Lawrence Seaway. The remaining seven ice charts illustrate ice distribution patterns on individual lakes near the time of maximum freezing degree-day accumulations.

WINTER CHARACTERISTICS

Winter Classification

Based on maximum freezing degree-day accumulations at selected stations, Great Lake winters are classified as mild, normal, or severe (Rondy, 1971)[1]. Using that criteria, figures for the 1972-73 winter indicate Lakes Superior and Huron had near-normal winters; Lakes Michigan, Erie, and Ontario experienced winters ranging between mild and normal.

Winter Weather

November was a cloudy month over portions of the Great Lakes basin with several stations reporting record low amounts of sunshine. Duluth, Minn., had 32.4 hours during the month, Milwaukee, Wis., had 59.3 hours, and Chicago, Ill., had 61.7 hours total monthly sunshine. These figures represent 61-,97-, and 101-year lows respectively. Rochester, N.Y., on Lake Ontario recorded 16.9 inches (42.9 cm) of snowfall in November, the heaviest in 102 years. Average daily air temperatures were intermittently below freezing over the enire basin by mid-November although there were no extended periods of severe low temperatures.

In December, Sault Ste. Marie, Mich., recorded the third heaviest snowfall in 84 years; Alpena, Mich., the second heaviest in 99 years; and Houghton Lake, Mich., the second heaviest in 56 years. Rochester, N.Y., recorded the lowest monthly sunshine total for December of this century. Temperatures ranged from mild on the lower lakes to freezing and below on the upper lakes during the first half of December. Extremes occurred on December 3 when the high temperature at Duluth, Minn., was -2°F (-18.8°C), while the high at Cleveland, Ohio, was 48°F (8.8°C). The second half of the month was characterized by milder temperatures throughout the basin that continued into early January. Circulation from a high pressure center, located northwest of Lake Superior, on January 4 brought an end to the mild spell and initiated a period of cold weather that lasted until mid-month. In mid-January, circulation off the back side of a high, centered south of the Great Lakes, brought thawing temperatures to the region. Mild weather continued through January 27 with maximum daily temperatures frequently above freezing on the lower lakes. January 25 is noteworthy as the high temperature at Duluth that day was 47°F (8.3°C). A high pressure center northwest of Lake Superior drifted eastward over the upper lakes the last three days in January bringing severe cold weather to that region. On the lower lakes January snowfall records were set in Milwaukee, Wis., the least amount in 101 years, and Detroit, Mich., the least amount in 24 years.

1. D. R. Rondy, Great Lakes Ice Atlas, Rev. ed., Lake Survey Center, 1971.

February started out with a storm approaching the lakes region from the southwest. Air temperatures were in the high 40's and 50's on the lower lakes on February 1 and 2. Generally mild temperatures persisted in the lower lakes through February 7. Mean daily temperatures were below freezing the rest of the month with the exception of thaws on February 14, 19, 20, and 28 that were restricted primarily to portions of the lower lakes. A notable period of low temperatures occured near mid-month, February 15-18, as an intense high pressure center approached the lakes from the northwest, drifted over the region and spread southward. Cleveland received 10.6 inches (27 cm) of snow on February 15-16, the greatest daily snowfall total for February in 102 years. Minimum daily temperature records were established at Muskegon, Mich., (14°F; -10°C) and Erie, Penn., (-12°F; -24.4°C) on February 17.

Mild weather began in early March with daily mean temperature on the lower lakes and daily maximum temperature on the upper lakes above freezing.. The average temperature was above freezing at many locations in the Great Lakes Basin for the week ending March 11. Temperatures continued to fluctuate near freezing through the rest of the month, but without any sustained periods of low temperatures.

DISCUSSION

General Seasonal Patterns of Ice Distribution

Low temperatures the first half of December, and January, and during February provided periods favorable to ice formation. Based on these temperature trends and data from ice charts the following seasonal pattern of ice distribution was deduced: early December through early February (figs. 1-8) ice cover was in general restricted to shallow waters, along the perimeter of the lakes, and to protected waters of bays and harbors; during February and early March (figs. 9-12) ice cover formed over the open-water areas of the lakes and reached its maximum areal extent; in March (figs. 13-15) ice cover decreased although new ice did form on cool, calm nights when diurnal temperatures dipped below the freezing point (fig. 15). By April 1 (fig. 16) most of the ice was gone from the lakes.

Lake Superior

First reports of ice came near the end of November from western harbors and Whitefish Bay. Due to unusually low air temperatures the first half of December, shore ice was more extensive than normal for this period. In general, the ice was located in the extreme west end of the lake, the Apostle Islands area, the large bays along the north shore and along the southern shore line. The effects of low temperatures during the first half of January were minimized by milder weather during the rest of the month. This resulted in slight increases in ice concentration in some protected shore areas but little net change in the lakeward extent of the ice.

In midlake areas ice began forming during February. By mid-month ice covered the western half of the lake and eastern shore areas. Freezing degree-day accumulations at Duluth and Sault Ste. Marie were approaching maximum by month's end and the lake was estimated to be at maximum ice cover during the last ten days in February (fig. 11). On February 25 ice was estimated to cover 55 percent of the lake surface. The central portion of the eastern basin was ice free but the rest of the lake had an extensive ice cover.

A Lake Survey Center ice reconnaissance flight was made on March 5 and resulted in the production of one ice chart (fig. 17). On that date the lake in the vicinity of Duluth was completely ice-covered. Various sized floes in concentrations ranging from four-to eight-tenths were observed along the north shore from east of Duluth to Grand Marais. A long shore lead started near Duluth and extended along the southern shore to the north of Bayfield, Wis. The Apostle Island area north of Bayfield had a snow-covered ice sheet while medium-to-large floes of four-to seven-tenths concentration were observed in the central portion of the western basin. Concentrations varied from three-to six-tenths along the southwest shore between the Apostle Islands and Houghton, Mich. The midlake area of the eastern basin was ice free while ice of five-to nine-tenths concentration was observed to extend a considerable distance into the lake along portions of the south shore between Houghton and the east end of the lake. Whitefish Bay was ice-covered but a large open-water area was observed immediately north of it which extended westward.

Unusually mild weather in March brought an early reduction of the ice cover. The average temperature was above freezing at Sault Ste. Marie the week ending March 11. By April 1, the only extensive areas of ice were located in the west end of the lake, in the large bays along the north shore, and in Whitefish Bay. A ship was trapped in the ice near Duluth for approximately ten hours on March 30. Ice was last reported lakeward of Duluth and in Whitefish Bay during the second week of April.

St. Marys Waterway

Ice reconnaissance flights were made over St. Marys River and Whitefish Bay (St. Marys Waterway) and four ice charts of Whitefish Bay (figs. 18-21) and five of the St. Marys River (figs. 22-26) were produced.

Ice was first reported south of Neebish Island, in mid-November and in the upper river by the end of the month. By mid-December young ice covered the river from the vicinity of Detour to Neebish Island and east of Sugar Island (fig. 22). The river was completely ice-covered by the end of December. Shipping continued through the river with the aid of Coast Guard icebreakers until February 8 setting a new closing date record for the locks at Sault Ste. Marie.

In March, mild weather was responsible for early deterioration of the ice cover. The upper river began to open up the second week in March. On the last Lake Survey Center ice reconnaissance flight over the river on March 22, the upper river was observed to contain many pools with open water north and northwest of Sugar Island and an eight-to ten-tenths cover along the southern half of the island. The lower river was completely covered with ice made up of melted and refrozen snow with many cracks. A ship track filled with brash ice was observed running the length of the lower river and ending in an area of open water and ice rind near the river mouth.

By April 1, the upper river was free of ice with the exception of drift ice from Whitefish Bay. By the middle of April the river was virtually ice free. The first commercial ship passed through the locks at Sault Ste. Marie on March 28, 1973.

Lake Michigan

The first report of ice came from Green Bay on November 30. By mid-December Green Bay had developed an unusually extensive ice cover for so early in the season. From mid-December through early February ice cover at the northern entrance to Green Bay fluctuated in response to weather conditions. The southern portion of the bay was completely ice-covered by the end of the first week in January. By mid-January the lake in the vicinity of Mackinaw City westward to the island area at the north end of the lake were completely ice-covered and ice lined portions of the lake's southern shore. However, a thaw the second half of January brought a reduction in ice concentration and extent.

The ice cover increased in February, reaching its maximum areal extent during the second half of the month. On February 27 the ice cover was estimated to extend over 20 percent of the lake's surface. At that time the ice extended from the north shore to the islands at the north end of the lake with concentrations of four-to six-tenths northwest and north of the island and concentrations of seven-to nine-tenths east and northeast of the islands. Green Bay and the Mackinaw City vicinity of the lake were completely ice-covered and ice of seven-to nine-tenths concentration covered the large bays along the northeast shore of the lake. Maximum freezing degree-day accumulation at Green Bay occurred the week of March 4. The following ice conditions (fig. 27) were observed on a flight over the northern part of the lake on March 5. The main body of ice was in Green Bay and along the north shore from lakeward of Manistique to Mackinaw City. The north end of Green Bay was open and the ice in the rest of the bay showed signs of decay with pools and cracks. The ice along the north shore was composed of areas of brush and floes of various sizes. Ice concentrations ranged from seven-to ten-tenths. Some shore ice was present in the bays on the northeast shore.

Spring-like rains in the first half of March and above freezing temperatures produced an early reduction in ice cover. By mid-month the lake was virtually ice free except for parts of Green Bay. Ice was last reported in the northern end of Green Bay on March 24.

Lake Huron

Ice was reported in Saginaw Bay on November 30 and in the Straits of Mackinac on December 4. Ice began forming in the North Channel, Georgian Bay, Saginaw Bay, and the Straits of Mackinac during the first half of December. Saginaw Bay and North Channel were frozen over by the end of the first week in January. The Straits east to Cheboygan were frozen by mid-January. Various amounts of ice lined the perimeter of the lake from the last week in December through the second week in January. Mild weather the second half of January reduced ice cover in the Straits, Saginaw Bay, and along the shores.

More seasonable temperatures in February provided good conditions for ice formation. Ice cover in general increased throughout February and reached its maximum extent the last half of the month. On February 27, Lake Huron was estimated to be 60 percent ice-covered and near maximum ice cover. An ice reconnaissance flight was made over the southern part of the lake on February 27 and resulted in the production of one ice chart (fig. 28). On that date, the area from Port Huron to Bay City was observed to be completely ice-covered. The ice in the area of Port Huron had a light, drifted snow cover and was composed of young and winter ice while the ice in Saginaw Bay had a heavy snow cover and pools were seen in the northern end of the bay. A shore lead was observed in the vicinity of the top of the bay with an area of ice rind observed northeast of the lead. Winter ice of eight-tenths concentration composed of various sized floes was observed east of the area of ice rind. A reconnaissance flight was made over the northern part of the lake on March 5 and ice conditions observed that date are shown in figure 29. At that time the area from the Straits east to the vicinity of Cheboygan was still frozen over. Young ice and brash ice of eigh-to nine-tenths concentration covered a large area east of the solid ice edge in the Straits. The lake from Alpena south to Harrisville was relatively ice free with the exception of small areas of brash and very limited amounts of shore ice.

Ice cover decreased early in March. Maximum freezing degree-day accumulation at Alpena occurred the week of March 4. By mid-month most of the ice left was located in Georgian Bay and the North Channel. The Coast Guard icebreaker Mackinaw was called upon to assist a ship trapped in the ice in the Straits on March 26. On April 1, the North Channel was still 70-to 90-percent ice-covered but the rest of the lake was virtually ice free.

St. Clair Waterway

Lake Survey Center personnel made six ice reconnaissance flights over the St. Clair Waterway, which includes St. Clair River and Lake St. Clair. Four ice charts (figs. 30-33) were produced from data collected during those flights.

Ice was first reported on the St. Clair River on December 10, however, the river remained virtually ice free through early January. On January 12 (fig. 31) the river above Algonac was observed to contain ice floes of two-to three -tenths concentration and ice eight-tenths concentration in the St. Clair delta. Thawing air temperatures the second half of January and in early February resulted in less than normal amounts of ice on the river. On January 24 (fig. 32) the river was observed to be virtually ice free. Ice coming down the river from southern Lake Huron caused some jamming in the lower river on February 9-11. An ice bridge was reported at Port Huron the latter part of February. Mild weather in early March brought an earlier than normal deterioration of ice cover and the last ice on the river was reported March 11.

Ice was reported in Lake St. Clair on December 1. Alternate periods of cold and mild weather in December and January produced periods of generally increasing ice cover the first half of December and January and decreasing ice cover the second half of those months. Young ice was estimated to cover 60 to 80 percent of the lakes surface by mid-December and 70 to 90 percent by mid-January. Ice cover increased in February and was near its maximum the second half of that month. On an ice reconnaissance flight made February 26 (fig. 33) the lake was observed to be completely ice-covered with light drifted snow on the ice. An area of eight-tenths ice concentration was located at the south end of the lake near the head of the Detroit River. Cracks and pools were observed along the west shore of the lake, below the delta area, and extending outward from the southwest shore.

The ice cover deteriorated during the first week in March as mild weather prevailed. The last report of ice came from St. Clair Shores on March 7.

Lake Erie

Lake Survey personnel made two ice reconnaissance flights over Lake Erie from which two ice charts were produced. Ice was reported forming in western Lake Erie on December 7. Shore ice that had formed in the west end of the lake during the first half of December to a large degree, was lost the second half of the month because of mild weather. Air temperatures were below normal the first half of January providing good ice-forming potential. By mid-January the western part of the lake was 70-to 90-percent ice-covered and shore ice lined the perimeter of the lake. The shore ice was heaviest along the north shore. The last two weeks in

January and first week in February were mild which markedly reduced existing ice cover. The main body of ice in early February was located in the island area of the western basin and along the north shore of the lake.

Ice cover increased in February and was estimated to be at its maximum extent during the last half of that month. The lake was estimated to be 95 percent ice-covered on February 28. On ice reconnaissance flights made over the lake February 26 (fig. 34) and February 28 (fig. 35) the following ice conditions were observed. Open water extended southward from the mouth of the Detroit River gradually changing to two-tenths slush. The slush extended eastward along the Canadian shore to north of the islands. Ice concentration increased southward from the river and completely covered much of the west shore and southwest end of the lake. Pools were observed lakeward of the solid ice along the south shore between Toledo, Ohio, and the islands. Ice concentration varied from seven- to nine-tenths in this area of the lake. The midlake area west of the islands contained an ice field of nine-to ten-tenths concentration with pools observed in the vicinity of the islands. This ice had a light drifted snow cover. A lead was observed east of the islands orientated in a northwest-southeast direction. The north shore east of the islands had a nine-to ten-tenths concentration of ice rind and young floe ice of various sizes. There was little snow on this ice and rafting and ridging were evident in some areas.

Maximum freezing degree-day accumulation at Cleveland occurred the week of February 25. Ice cover was diminishing by early March and by the second week of March the lake was nearly ice free. Last report of ice came from the western end of the lake on March 9. The first commercial ship passed through the Welland Canal on March 28.

Lake Ontario

Ice was first reported forming in bays and harbors at the east end of the lake during the last half of November. Mild weather the latter part of December slowed ice growth. The St. Lawrence Seaway closed during the third week in December. Shore ice formed in the northeast part of the lake in the first week of January. It was confined to bays, harbors, and island areas. Ice cover decreased the second half of January due to thawing air temperatures.

Low air temperatures during February made this month a time of extensive ice formation, with ice cover approaching maximum areal extent by mid-month. The ice cover was at its maximum extent the second half of February and the lake was estimated to be about 20 percent ice-covered during that period. The following ice condtions were observed on a Lake Survey Center ice reconnaissance flight over the lake on February 13 and are illustrated in figure 36. The south shore of the lake between Rochester and Oswego, N. Y., was lined with brash, pancake, and ice rind. The east end of the lake had more extensive shore ice than the south side with the ice cover composed of young ice and ice rind of nine-tenths concentration. The bays, harbors, and shoreward side of island waters in the northeast section of the lake had winter ice with a heavy snow cover. Young ice and ice rind extended lakeward of the winter ice.

Maximum freezing degree-day accumulations at Rochester, N. Y., occurred the week ending March 4. However, after that dropped rapidly so that by mid-March the lake was virtually ice free. The last report of ice came from Cape Vincent, N. Y., on March 15, and about 2 weeks after that, on March 28, the St. Lawrence Seaway opened.

SATELLITE IMAGERY

Satellite imagery of the Great Lakes provides an additional source of ice-cover information. Currently data from several satellite systems are being studied by Lake Survey Center to develop image interpretation techniques keyed to ice cover.

The potential for satellite imagery to document ice cover is shown in figures 42 and 43. The first shows the Great Lakes on February 26. It is an image from the NOAA-2 satellite showing ice cover near the time of maximum extent. The second is an Earth Resources Technology satellite (ERTS) image of western Lake Superior taken the same date.

ACKNOWLEDGEMENTS

Lake Survey Center visual aerial ice reconnaissance activities were carried out under the general guidance of L. Bajorunas, Chief of the Limnology Division and F. H. Quinn, Chief of the Lake Hydrology Branch, and were under the supervision of C. Adams of the Lake Hydrology Branch. Ice observers included C. Adams and NOAA Corps Officers L. Smith, and M. Eisenstat.

Flight support was provided by the U.S. Coast Guard, Ninth District (U.S.C.G. Air Stations, Detroit and Traverse City, Mich.).

Climatological data used in this report was taken from the U.S. Department of Commerce publications, <u>Weekly Weather and Crop Bulletin</u> and <u>Daily Weather Map Weekly Series</u>.

Table 2. Key to ice chart symbols

Age and size of floes

Station model

$$\frac{A}{\mathrm{DOM,\ SEC}}\ \frac{C_n}{n_1 n_2 n_3} + \frac{C}{\mathrm{NEW}}$$

A - IND for C_n AGE

DOM - 10ths DOM AGE

SEC - 10th SEC AGE

AGE - Y (Yng) - Young ice
W - Winter ice
MW - Medium winter
TW - Thick winter

C_n - Total CONC of $n_1 n_2$ and n_3 in 10ths

n_1 - CONC of brash and cakes in 10ths

n_2 - CONC of small and medium floes in 10ths

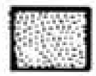
n_3 - CONC of big bloes and ice field in 10ths

C - CONC of NEW ice in 10ths
NEW - SLH - Slush
IR - Ice rind
SLG - Sludge
PCK - Pancake

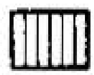
Notes are used with just one CONC or when reporting unusual observation

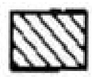
All times refer to eastern standard time.

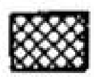
Total concentration

 Open water

 1 - 3 Tenths Coverage (very open pack)

 4 - 6 Tenths Coverage (open pack)

 7 - 9 Tenths Coverage (close pack)

 10 Tenths Coverage (consol pack)

Boundaries

Observed visually

Assumed

Undercast (limits)

Limit of observed data

Snow cover

Station model

$$\frac{S_n}{AMT, \quad COND}$$

S_n - IND for snow

AMT - 0 - No Snow
L - Light
H - Heavy

NOTE: No AMT mean MOD

COND - D - Drifted
CR - Crusted
Pd - Puddled

Topography

$$\frac{T}{COND}$$

T - Type of pressure ice

 - Rafted

 - Ridged

 - Hummocked

COND - L - Light
H - Heavy

NOTE: No COND means MOD.

Stage of melting

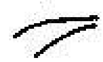
Station model

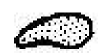
$$\frac{Pd}{n, \quad COND}$$

Pd - IND for melting
n - 10ths of area
COND - TH - Thaw hole
R - Rotten ice
RFZN - Refrozen puddles

Openings in ice

 Crack (Crk)

 Lead

 Pool or Polynya (Plya)

Abbreviations

BSH - Brash

CK - Cake

CONC - Concentration

COND - Condition

NT OBS - Not Observed

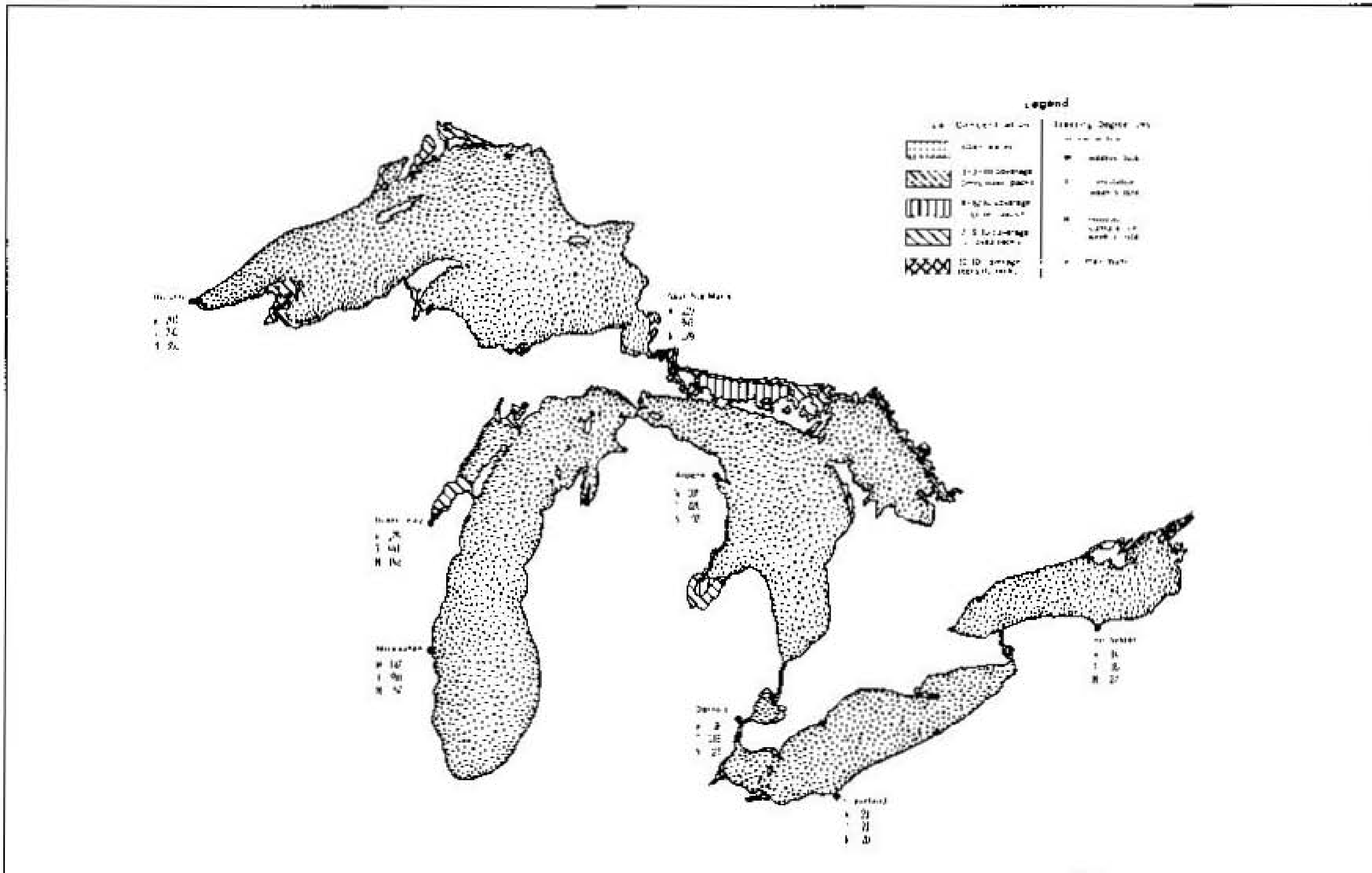


Figure 1.--Lake Survey Center composite ice chart for week ending Dec. 17, 1972.

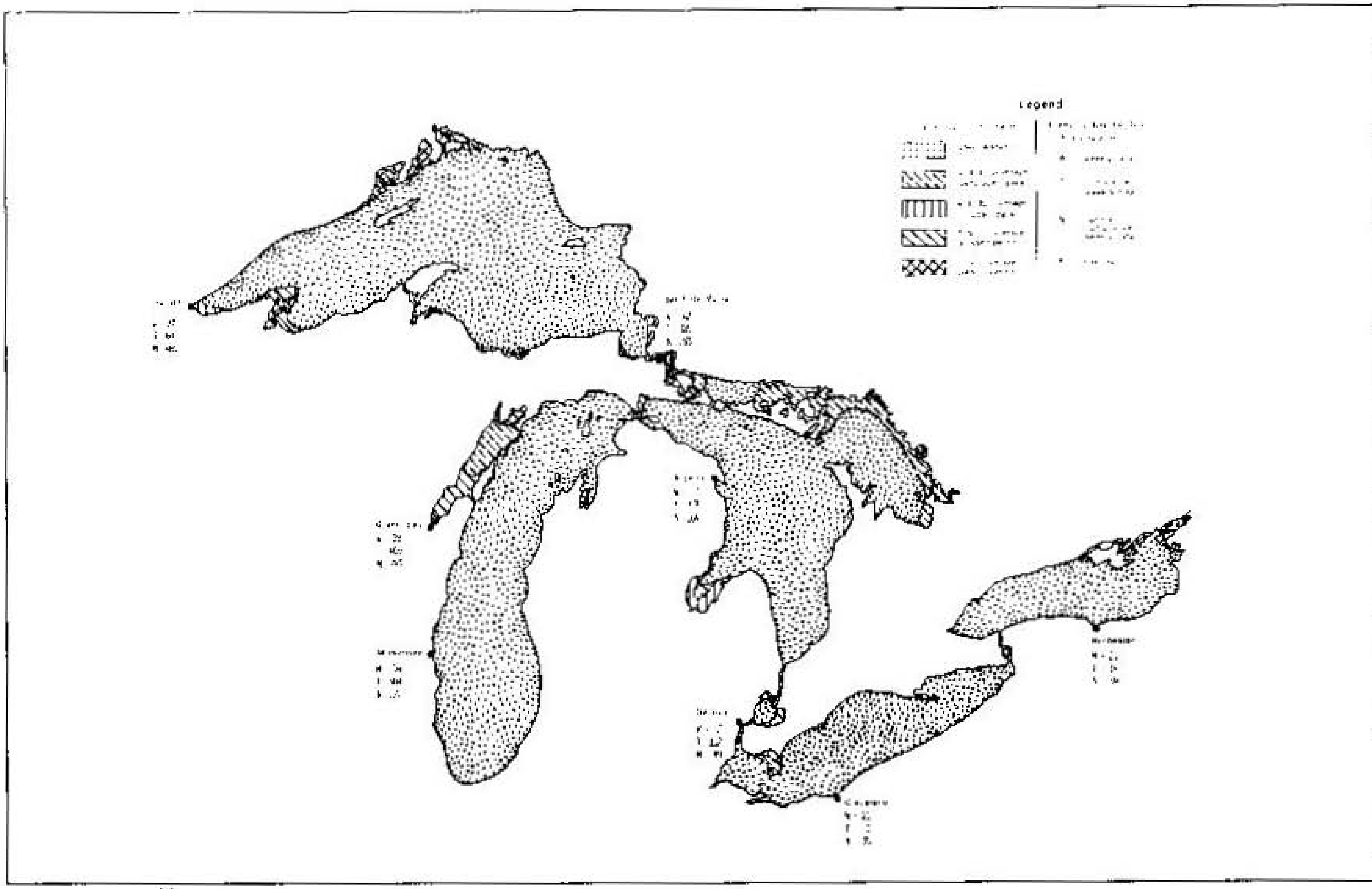


Figure 2.--Lake Survey Center composite ice chart for week ending Dec. 24, 1972.

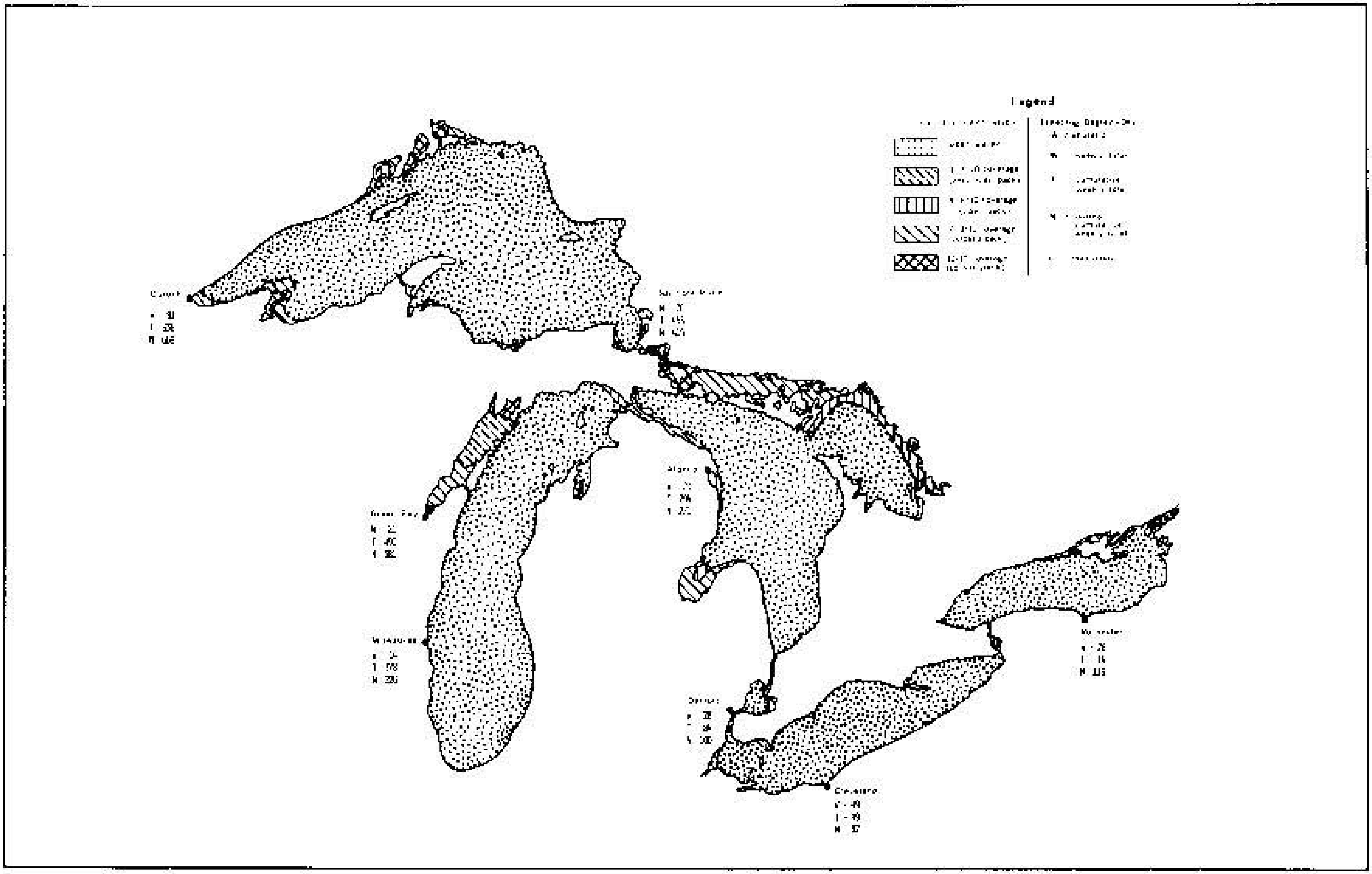


Figure 3.--Lake Survey Center composite ice chart for week ending Dec. 31, 1972.

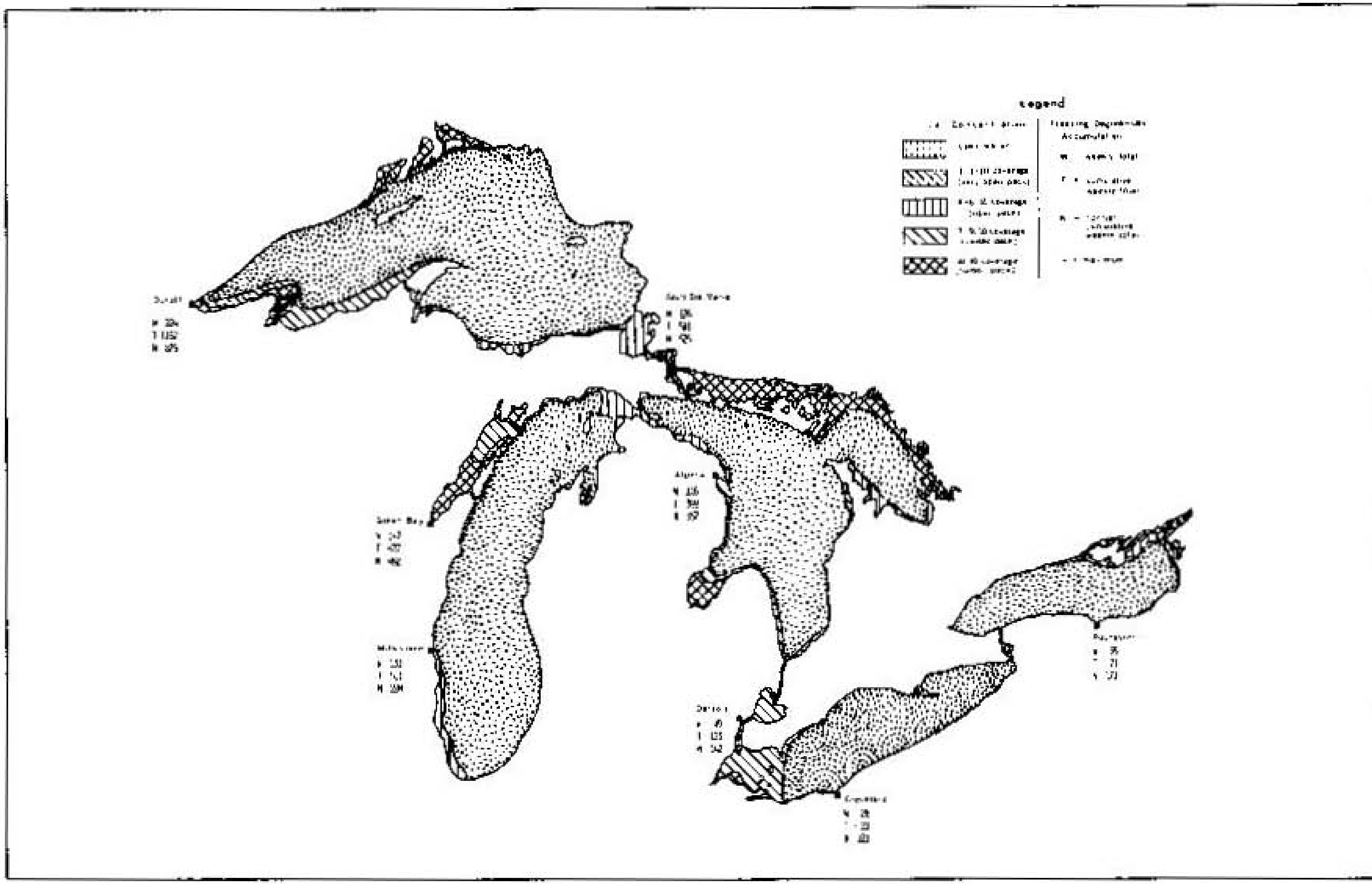


Figure 4.--Lake Survey Center composite ice chart for week ending Jan. 7, 1973.

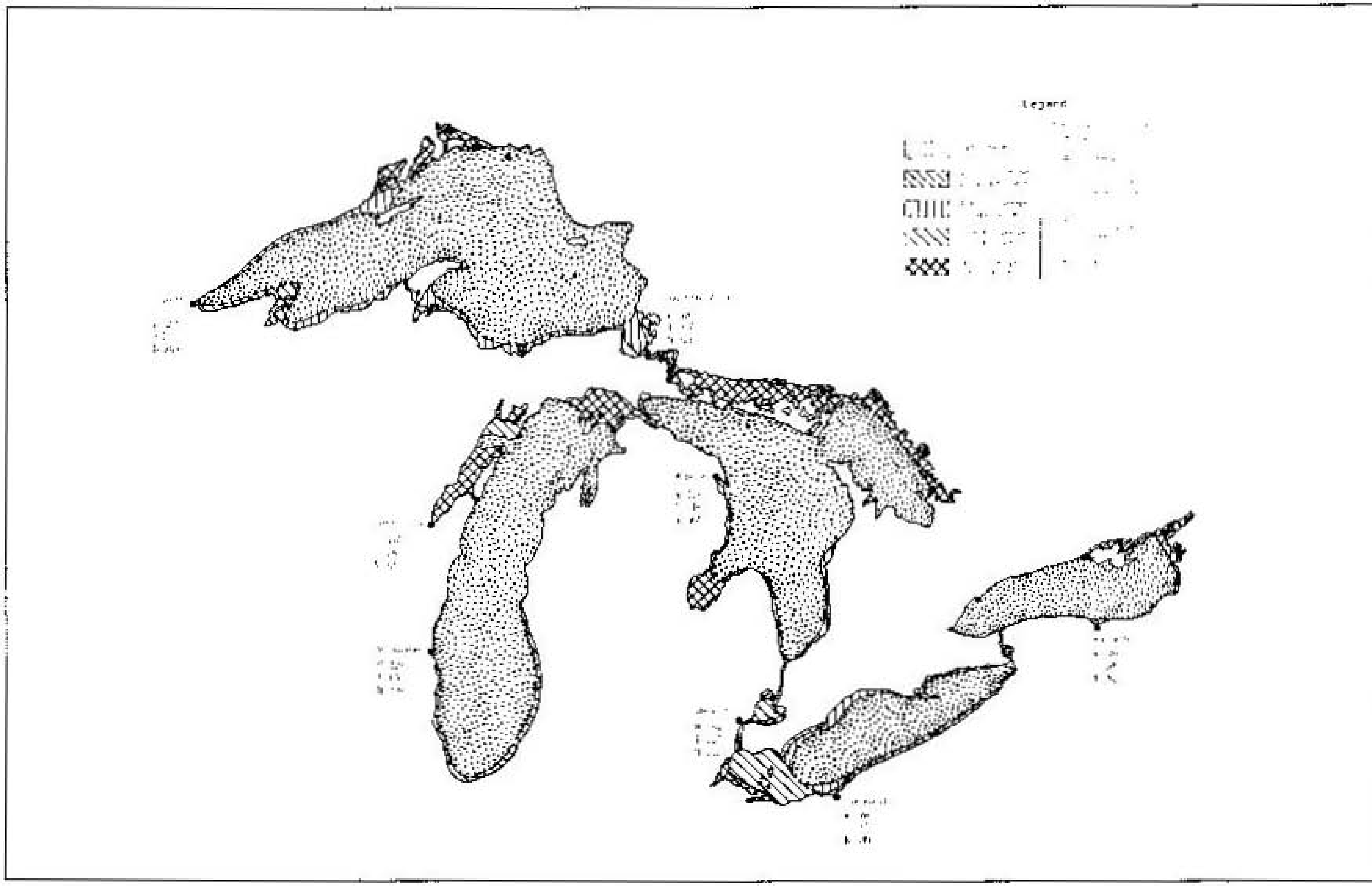


Figure 5.--Lake Survey Center composite ice chart for week ending Jan. 14, 1973.

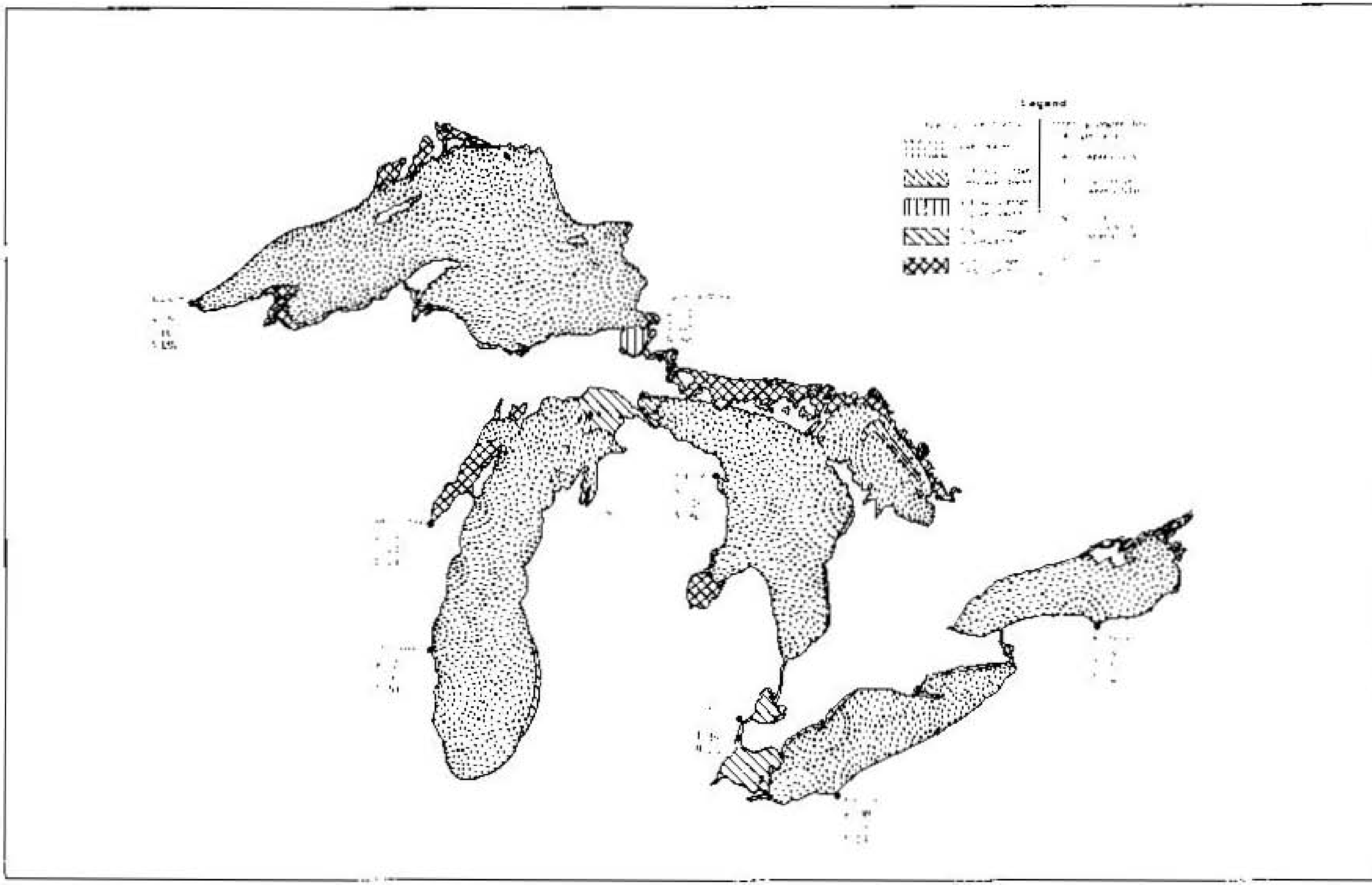


Figure 6.--Lake Survey Center composite ice chart for week ending Jan. 21, 1973.

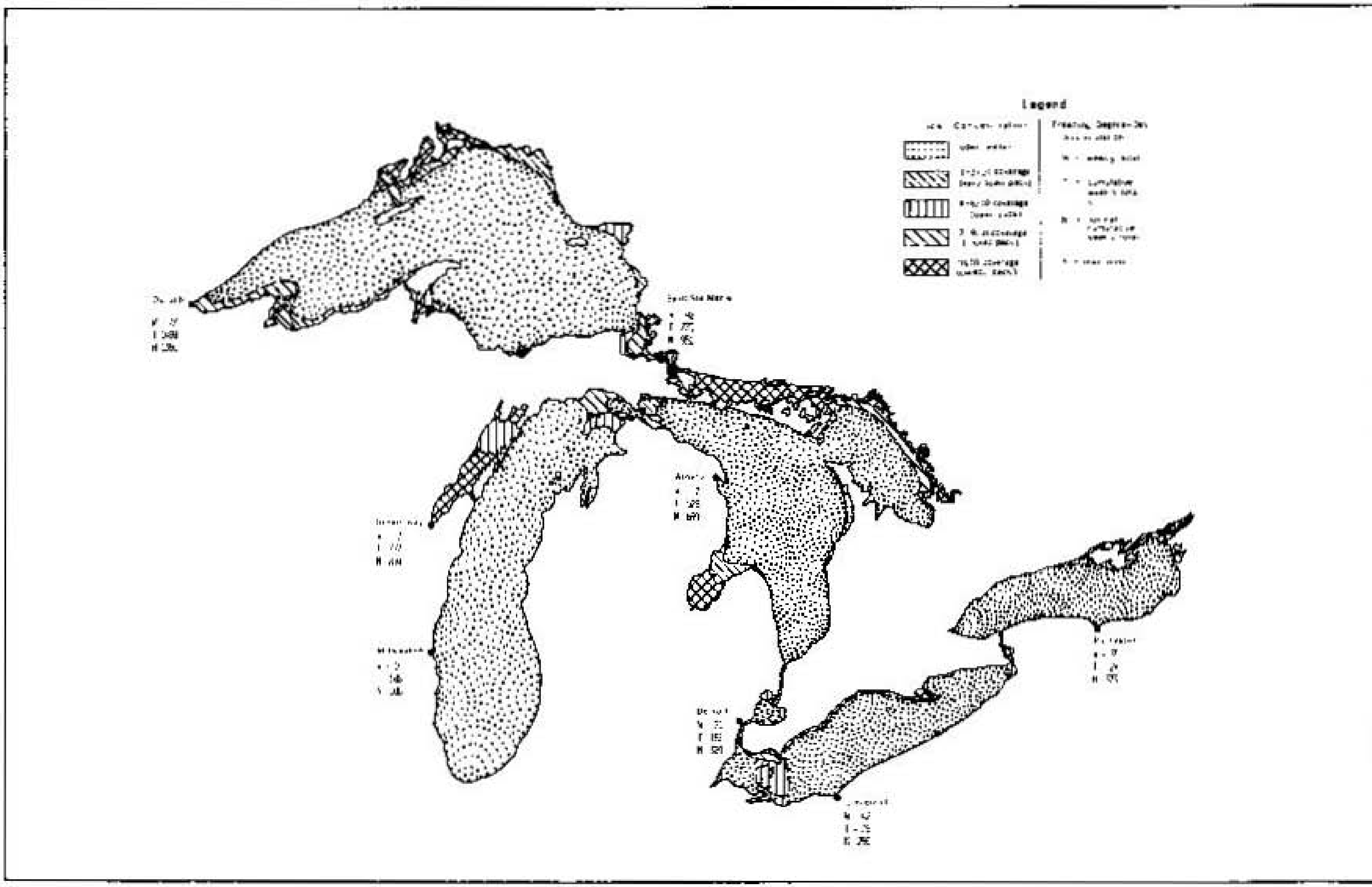


Figure 7.--Lake Survey Center composite ice chart for week ending Jan. 28, 1973.

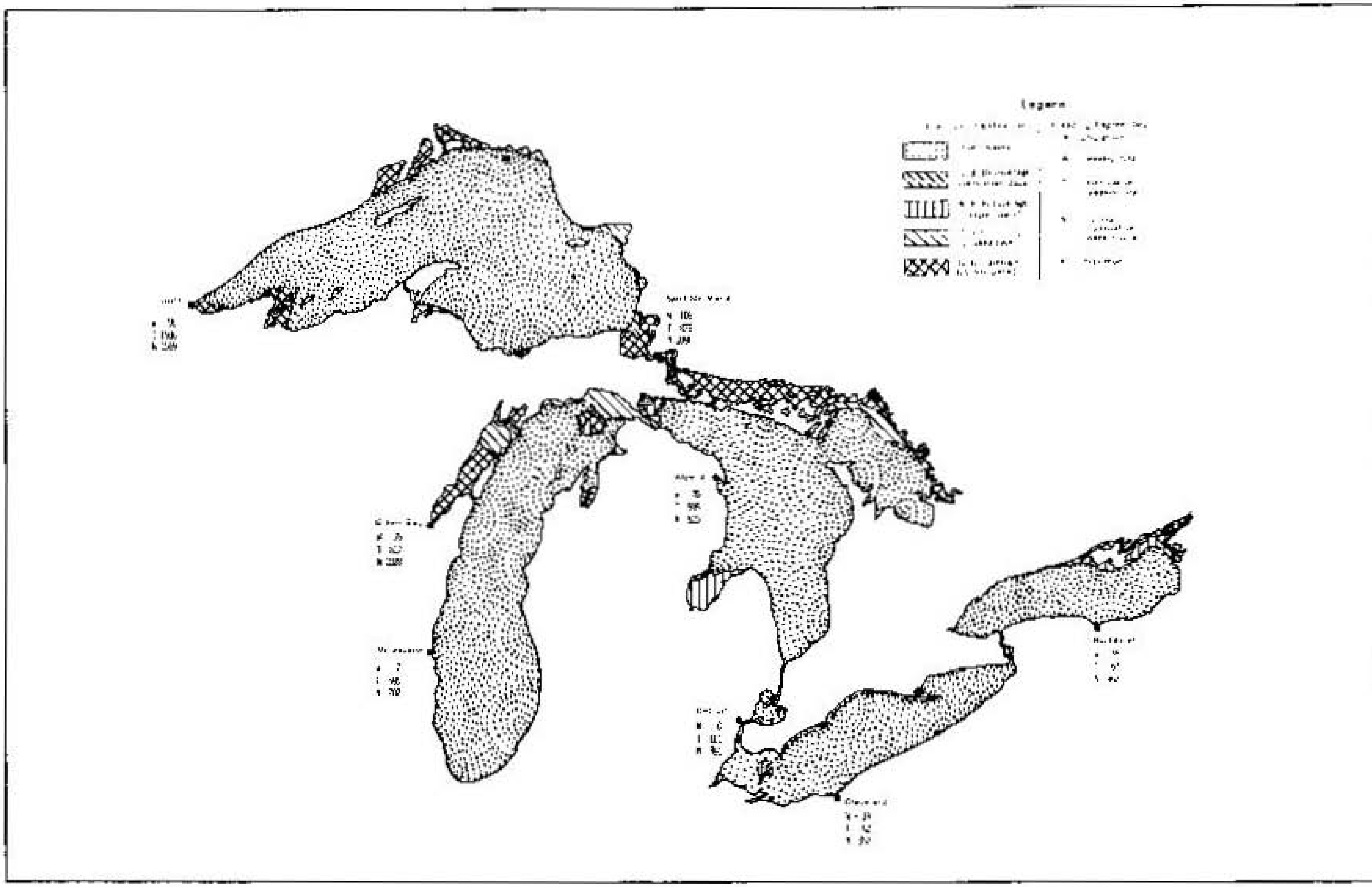


Figure 8.--Lake Survey Center composite ice chart for week ending Feb. 4, 1973.

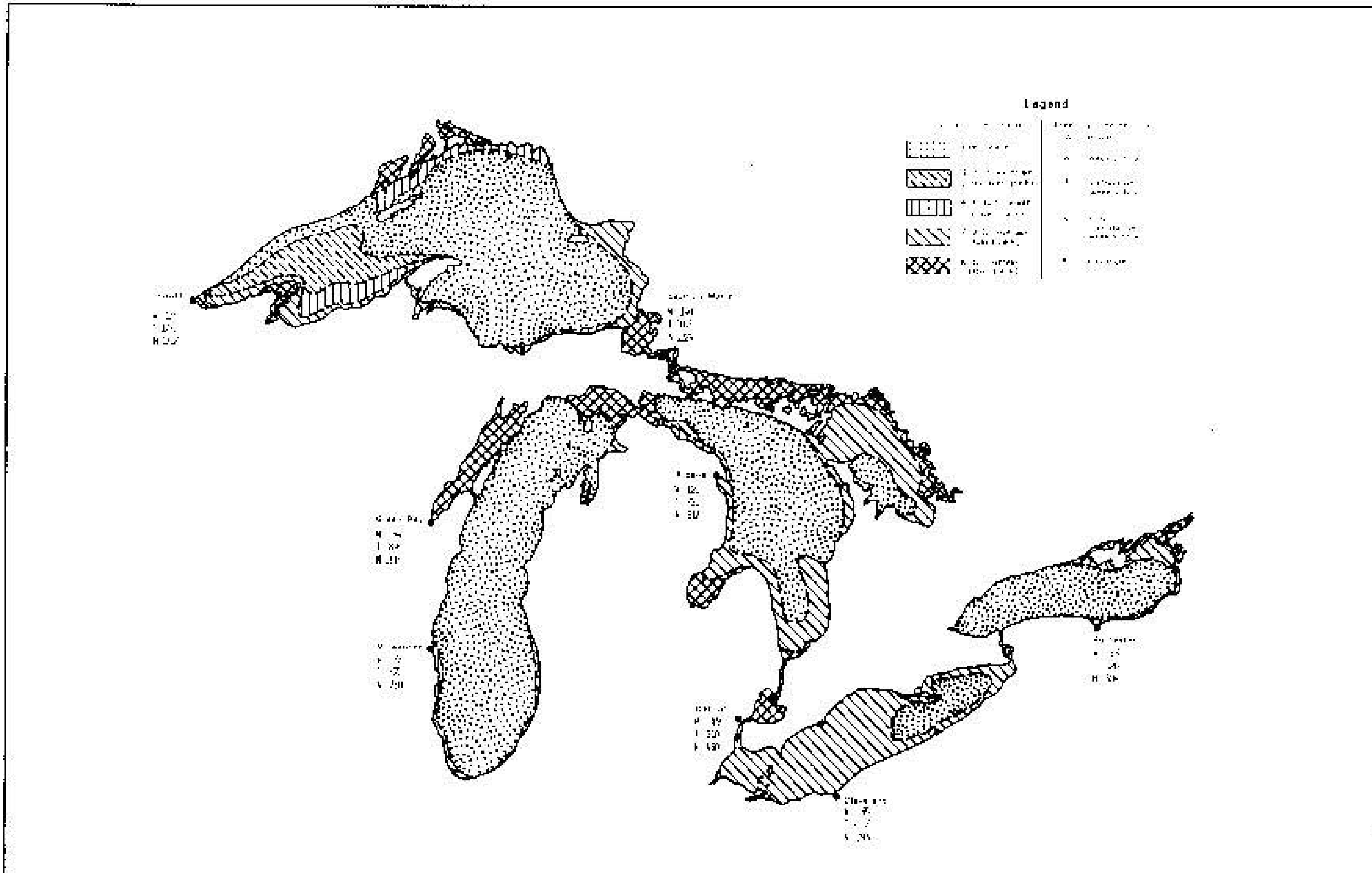


Figure 9.--Lake Survey Center composite ice chart for week ending Feb. 11, 1973.

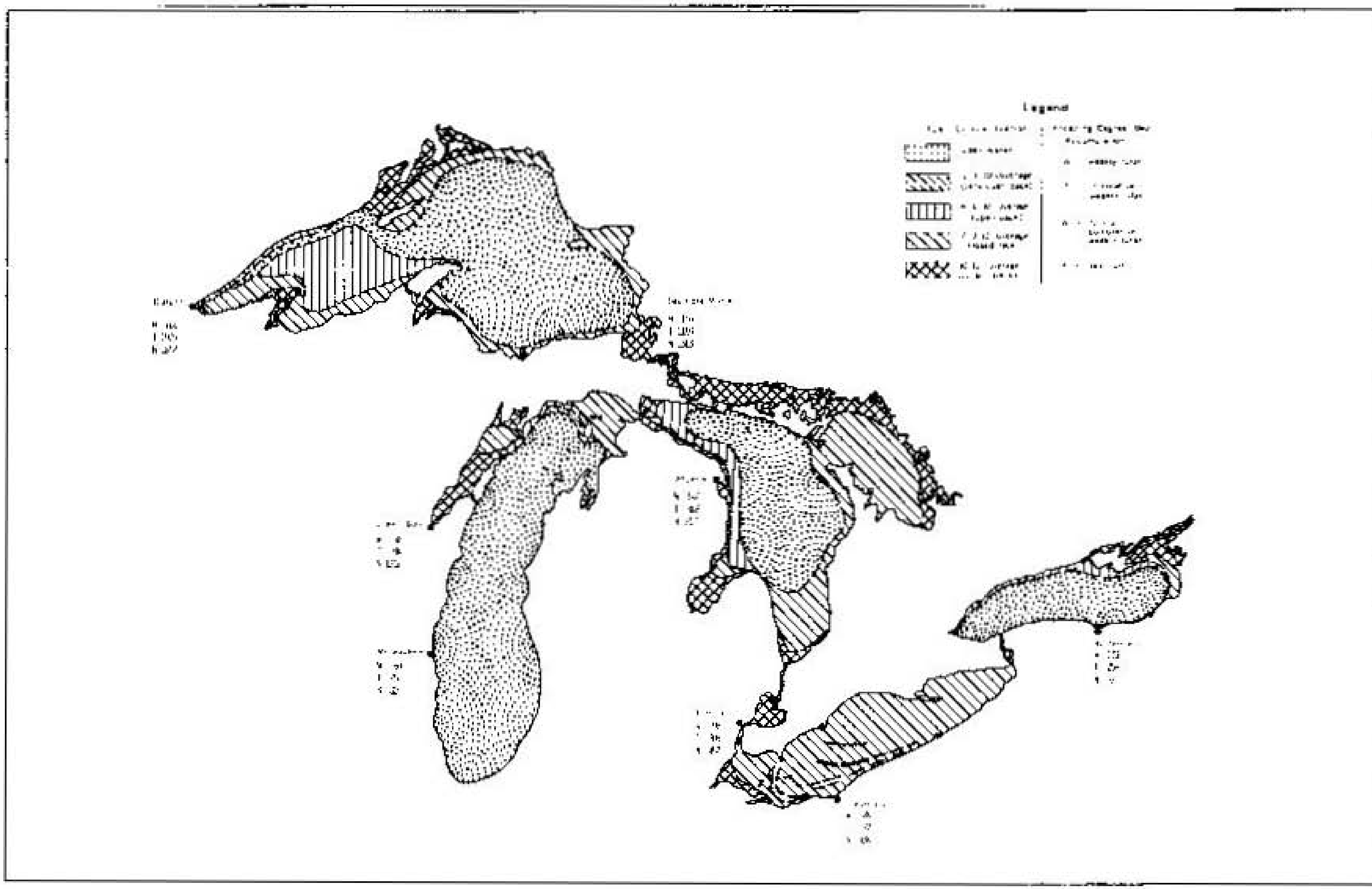


Figure 10.--Lake Survey Center composite ice chart for week ending Feb. 18, 1973.

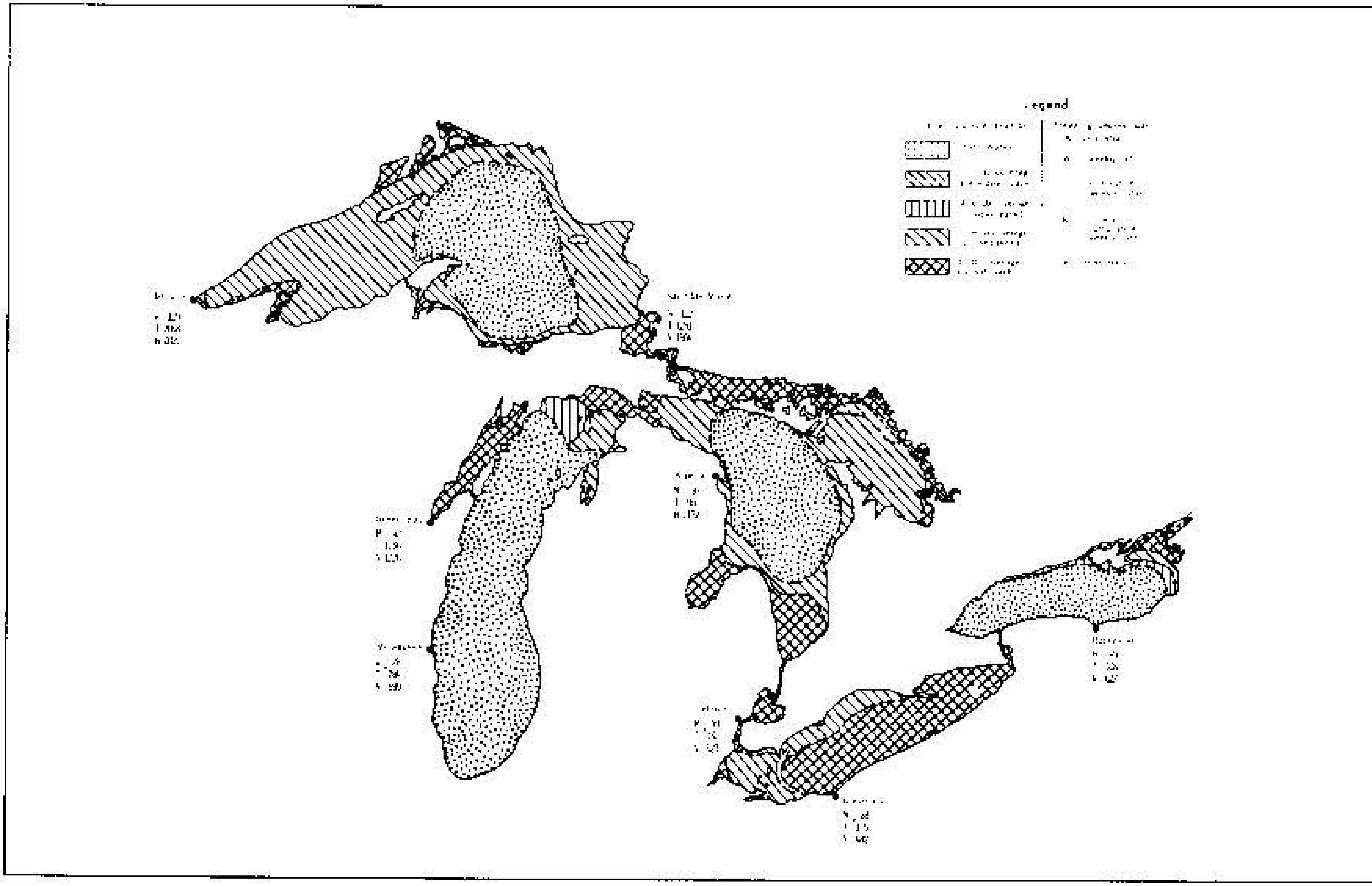


Figure 11.--Lake Survey Center composite ice chart for week ending Feb. 25, 1973.

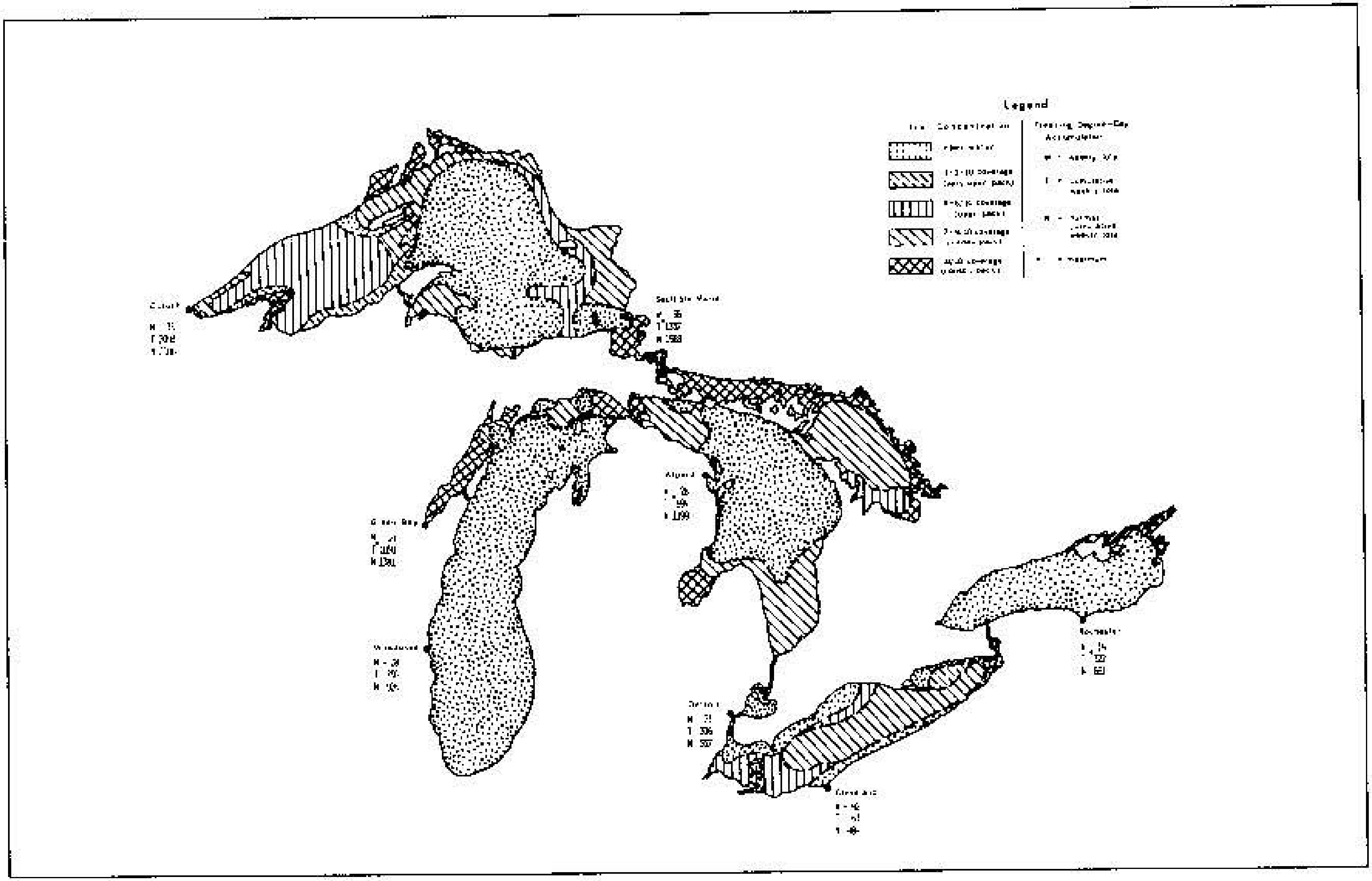


Figure 12.--Lake Survey Center composite ice chart for week ending Mar. 4, 1973.

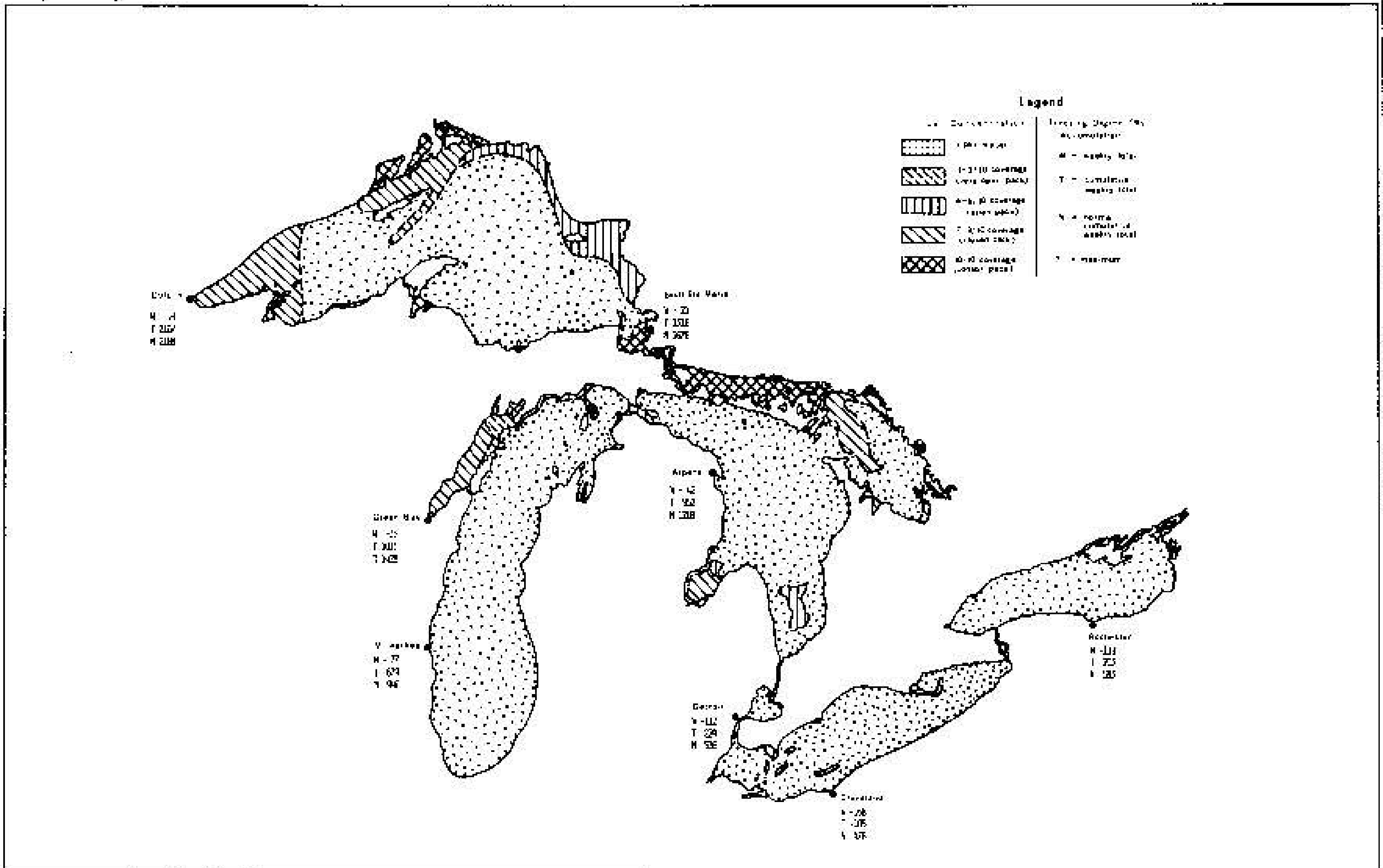


Figure 13.--Lake Survey Center composite ice chart for week ending Mar. 11, 1973.

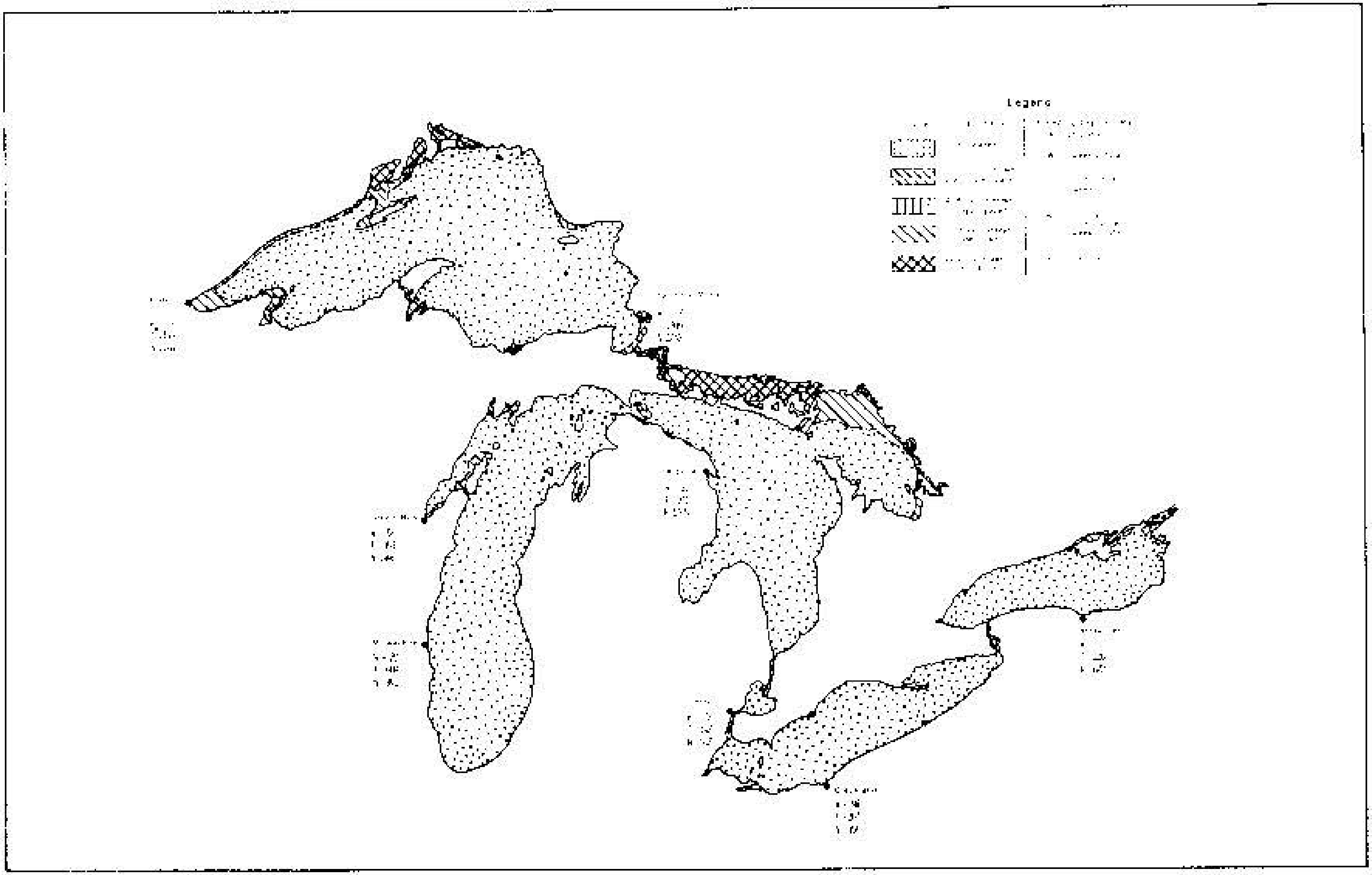


Figure 14.--Lake Survey Center composite ice chart for week ending Mar. 18, 1973.

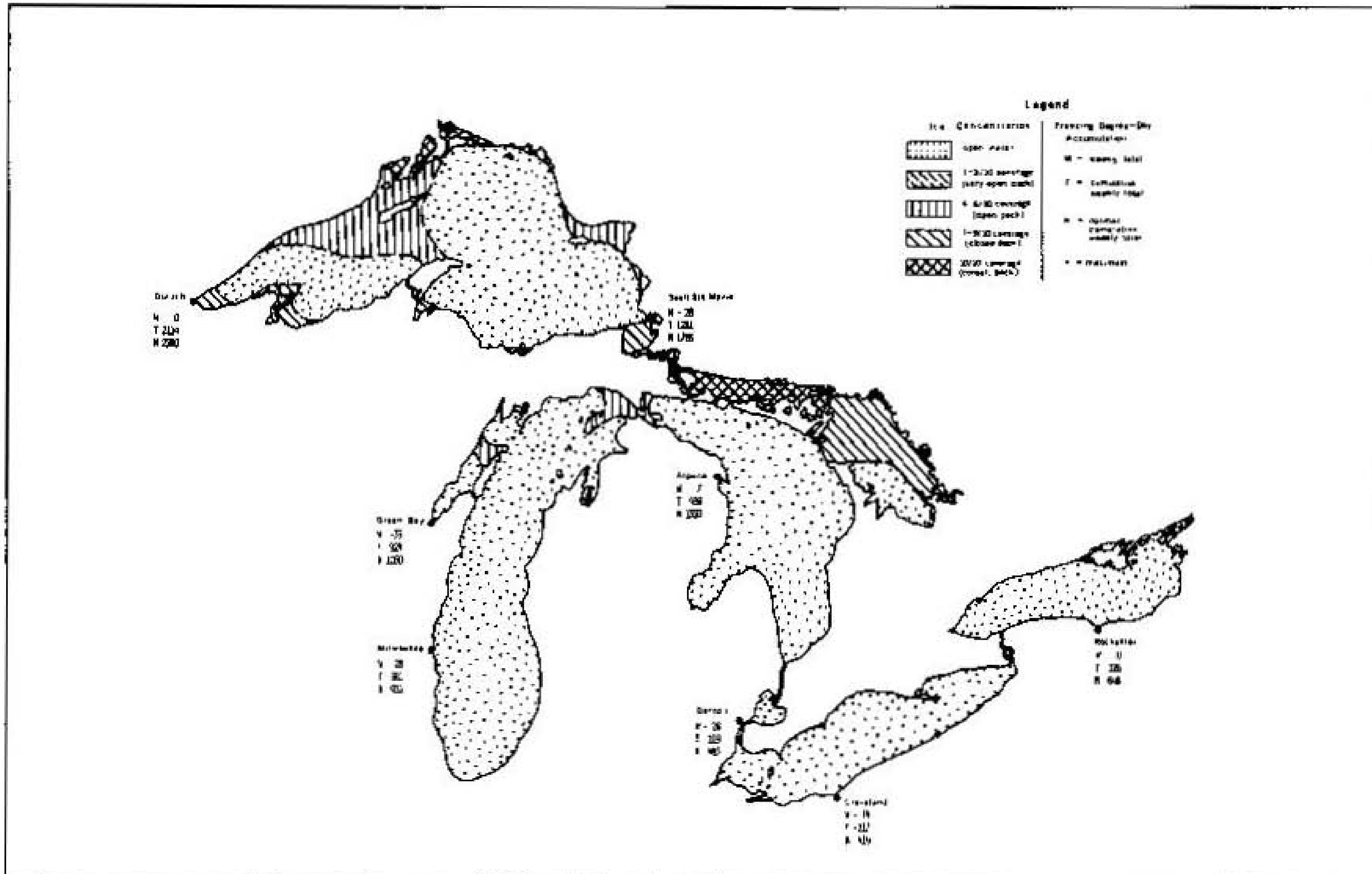


Figure 15.--Lake Survey Center composite ice chart for week ending Mar. 25, 1973.

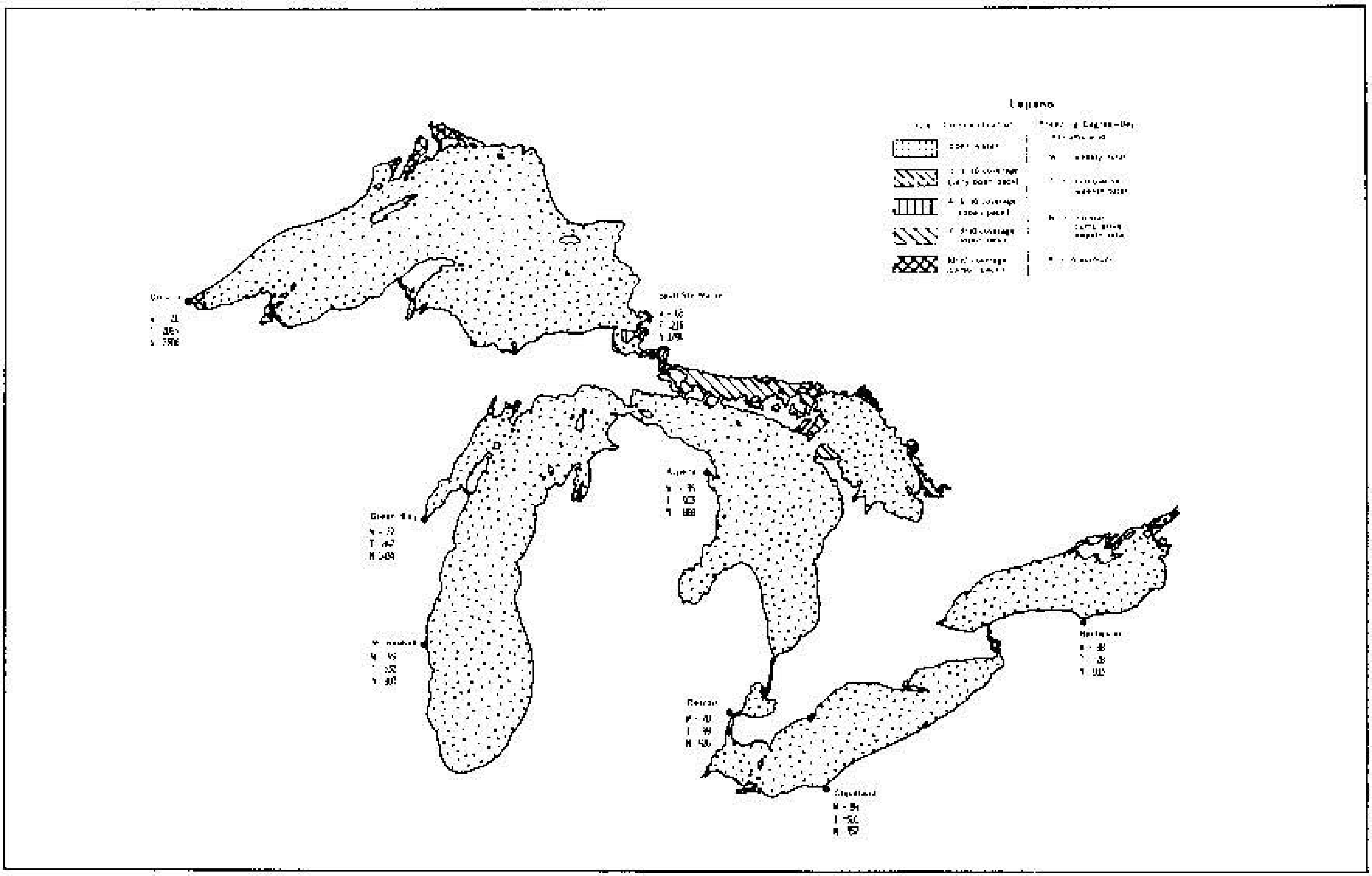


Figure 16.--Lake Survey Center composite ice chart for week ending Apr. 1, 1973.

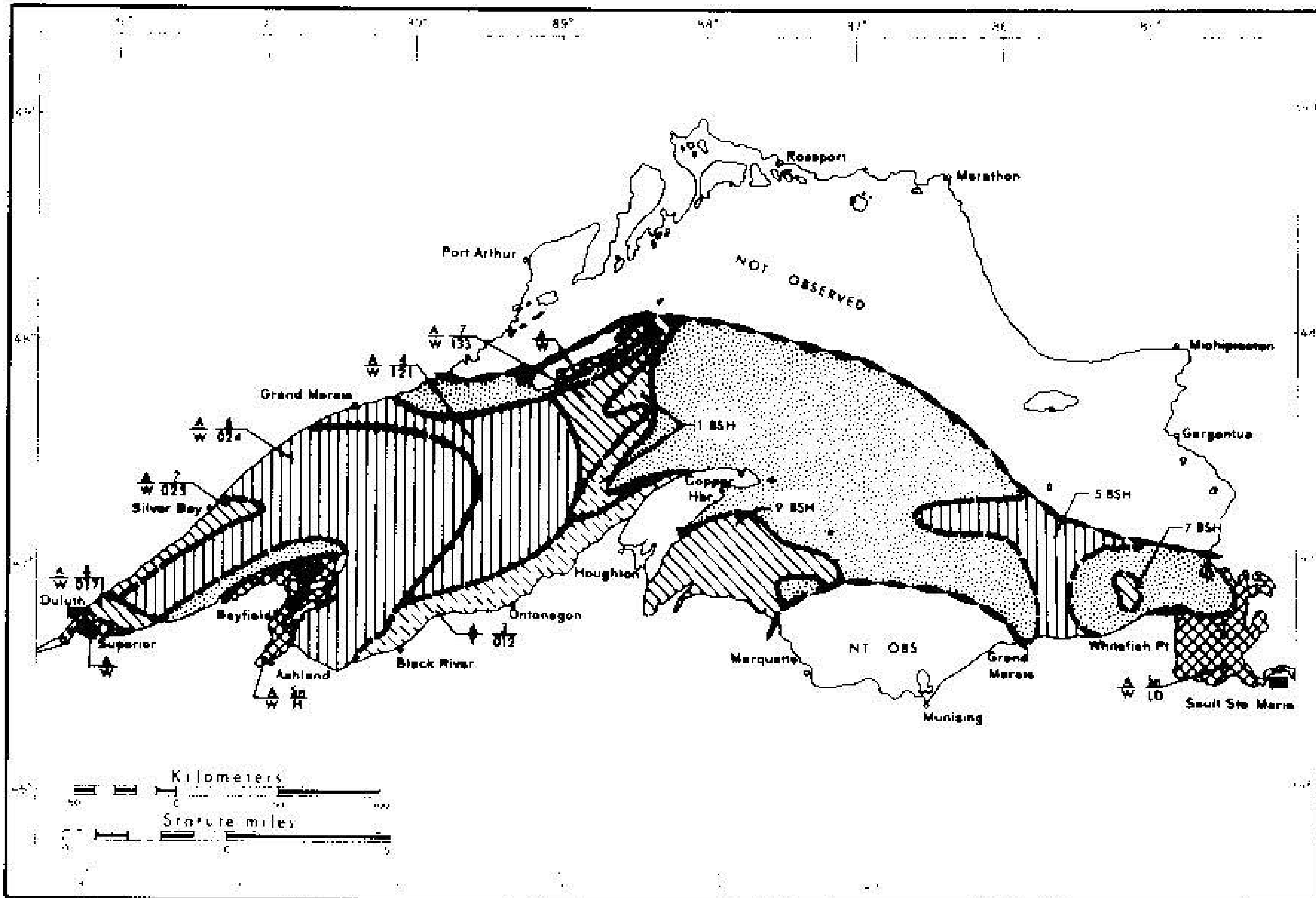


Figure 17.--Lake Superior ice chart, Mar. 5, 1973.

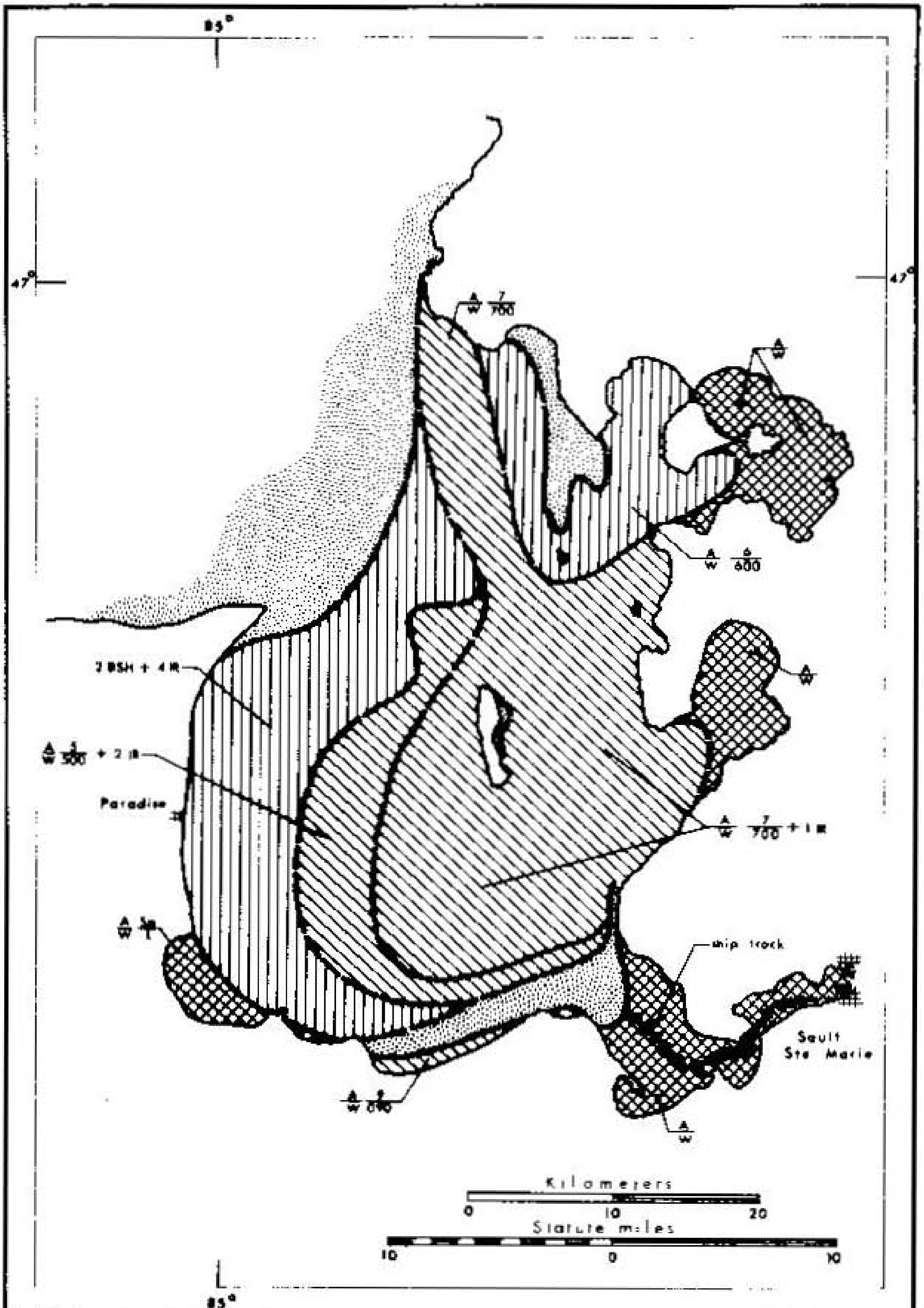


Figure 18.--Whitefish Bay ice chart Jan. 26, 1973.

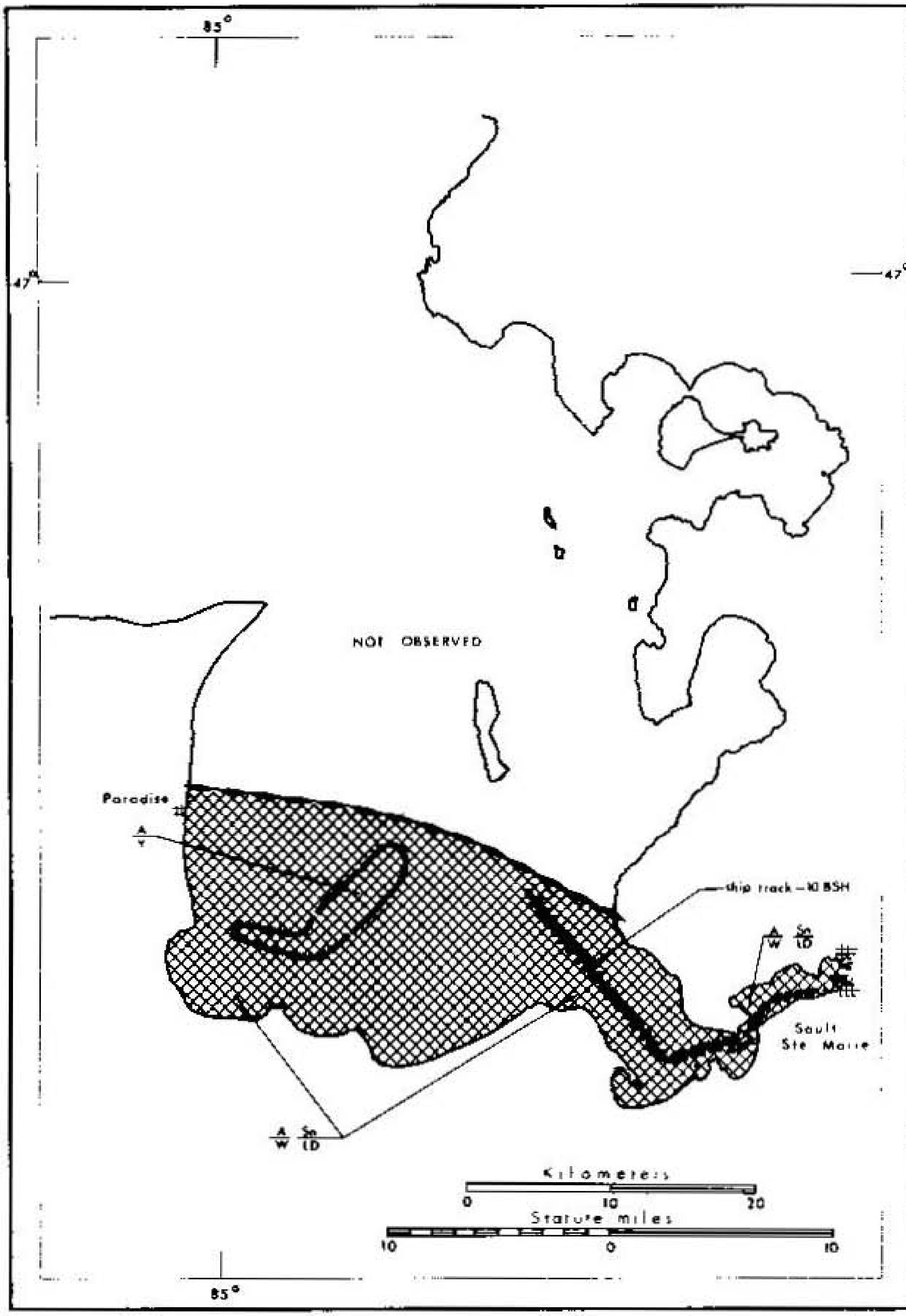


Figure 19.--Whitefish Bay ice chart Feb. 8, 1973.

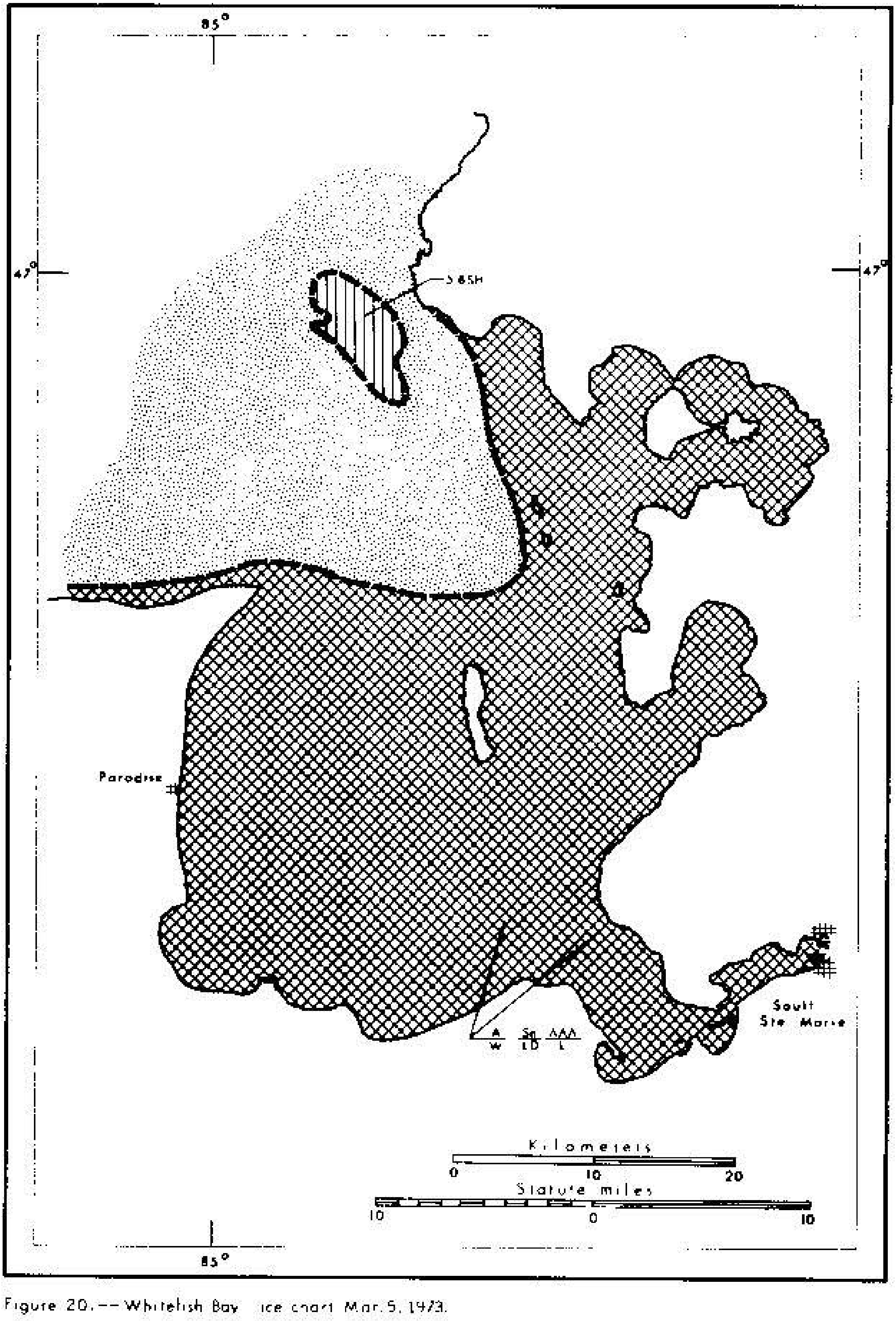


Figure 20.—Whitefish Bay ice chart Mar. 5, 1973.

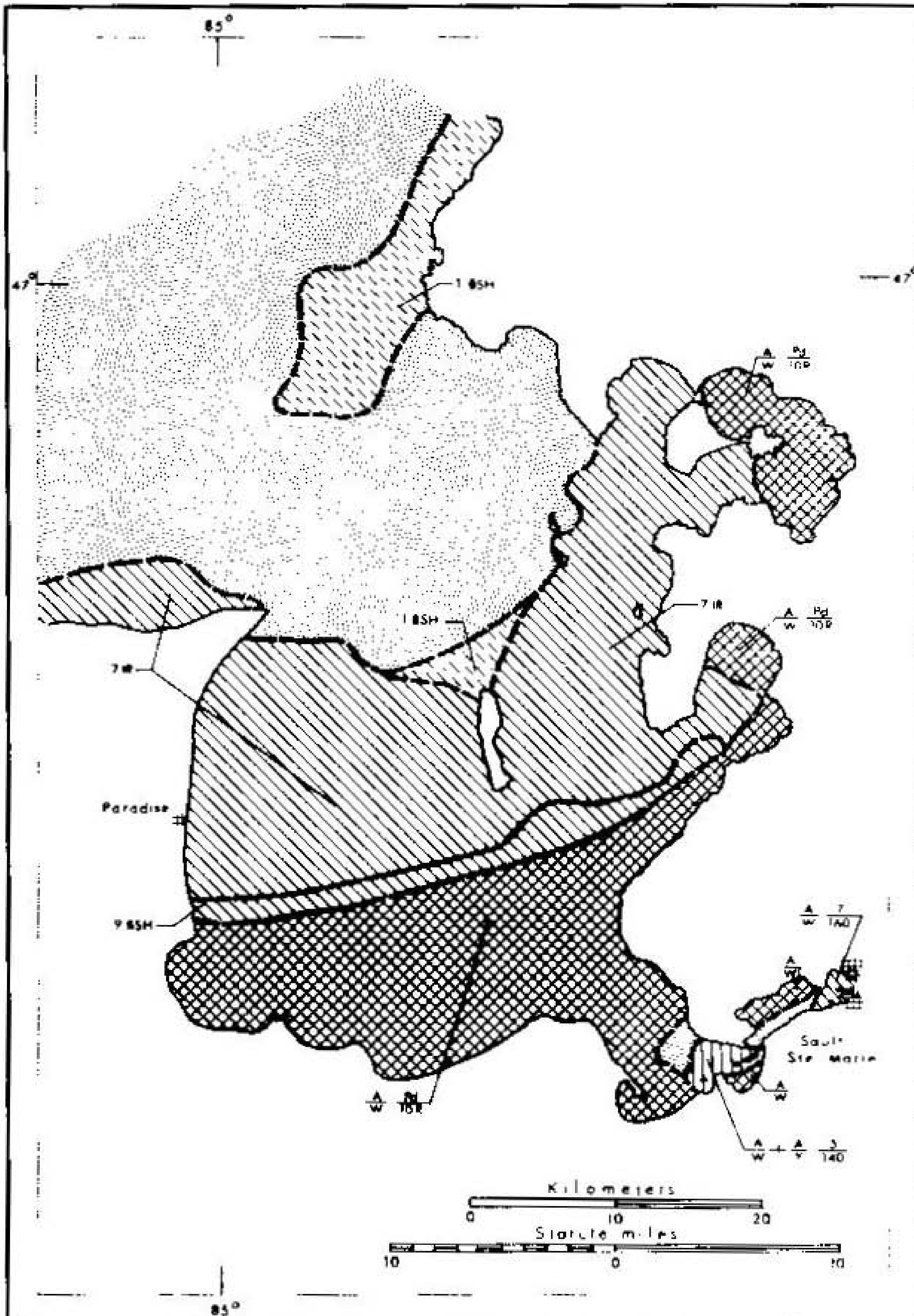


Figure 21.--Whitefish Bay ice chart Mar. 22, 1973.

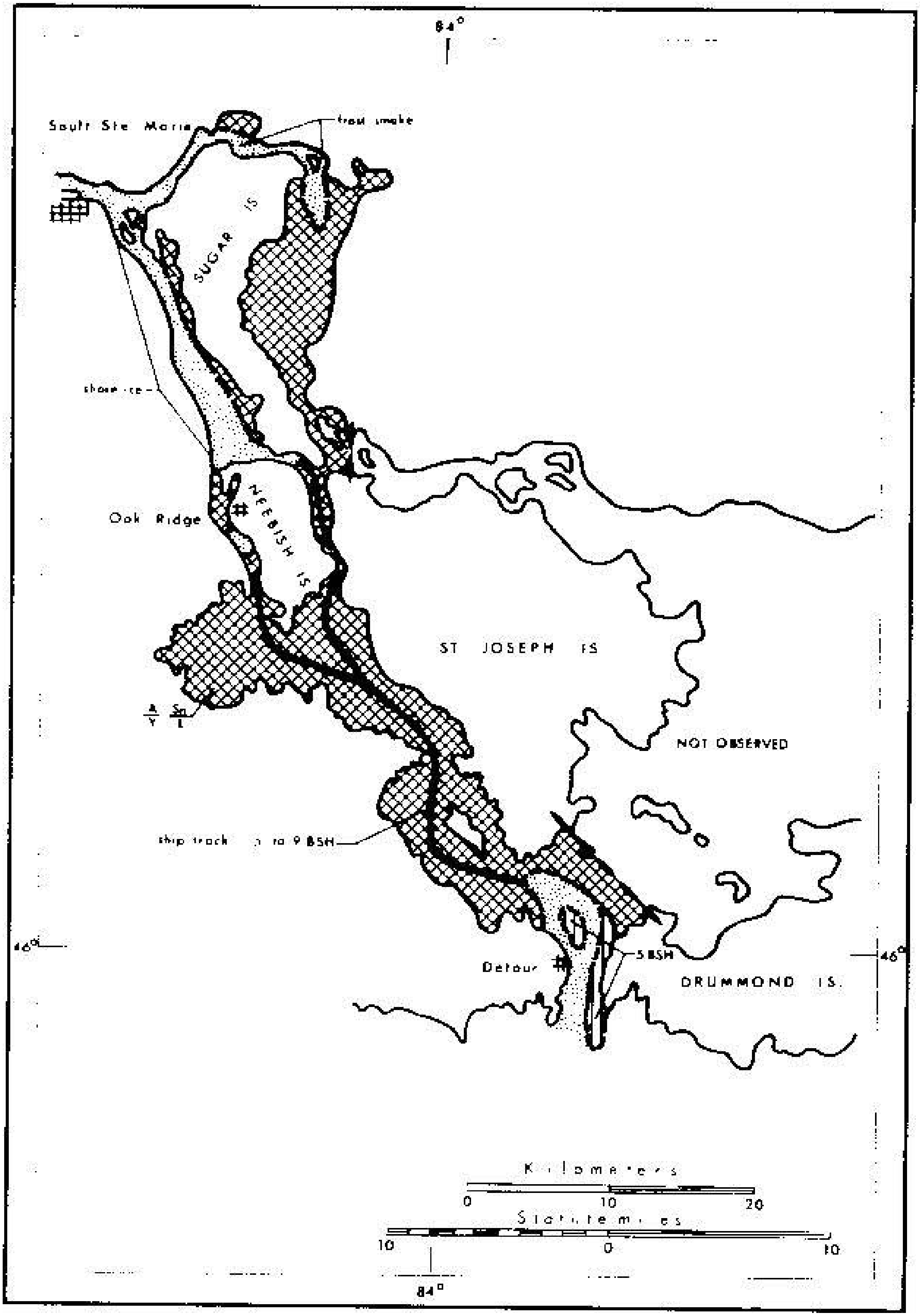


Figure 22. -- St Marys River ice chart Dec. 14, 1972.

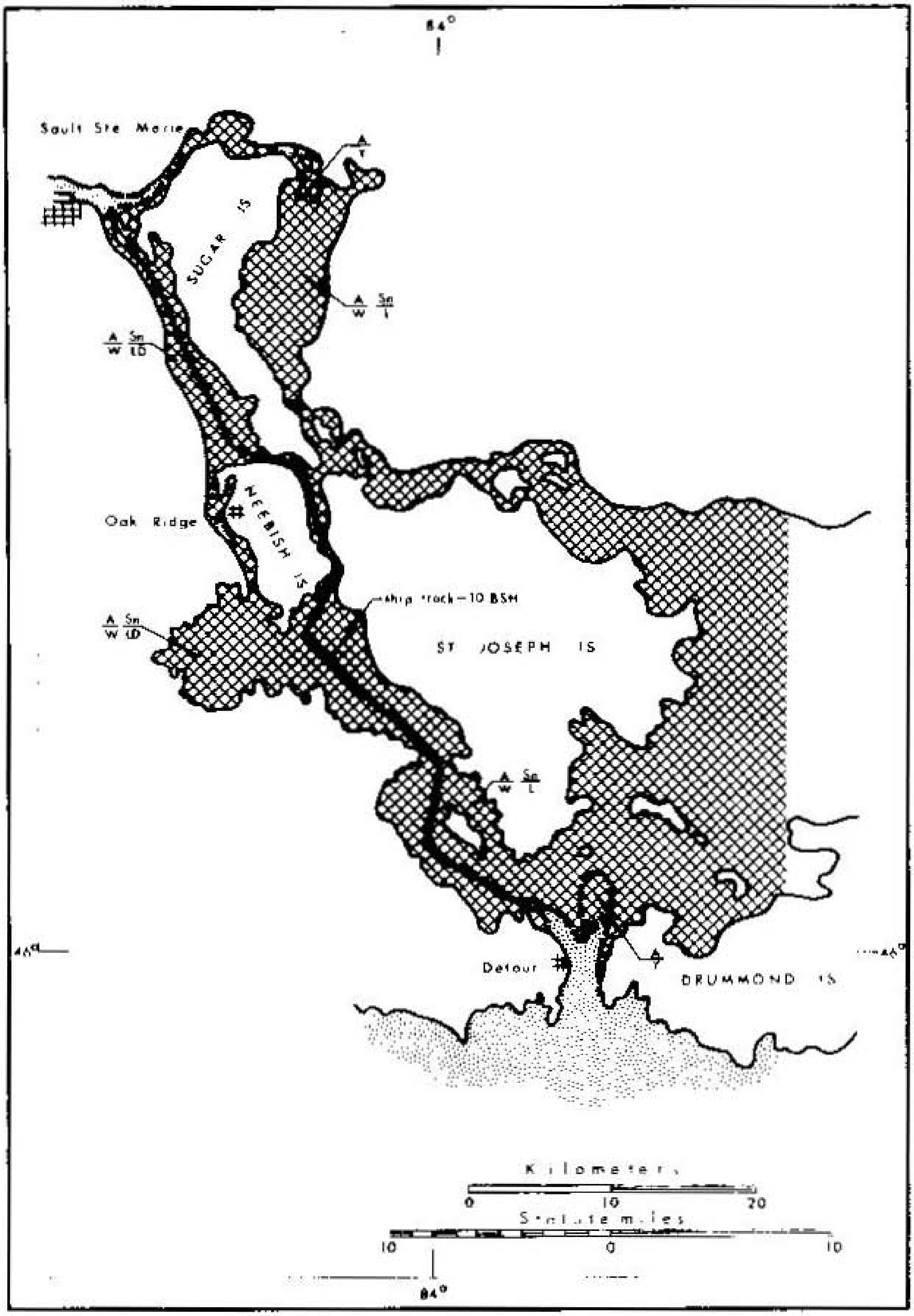


Figure 23.—St Marys River ice chart Jan. 26, 1973.

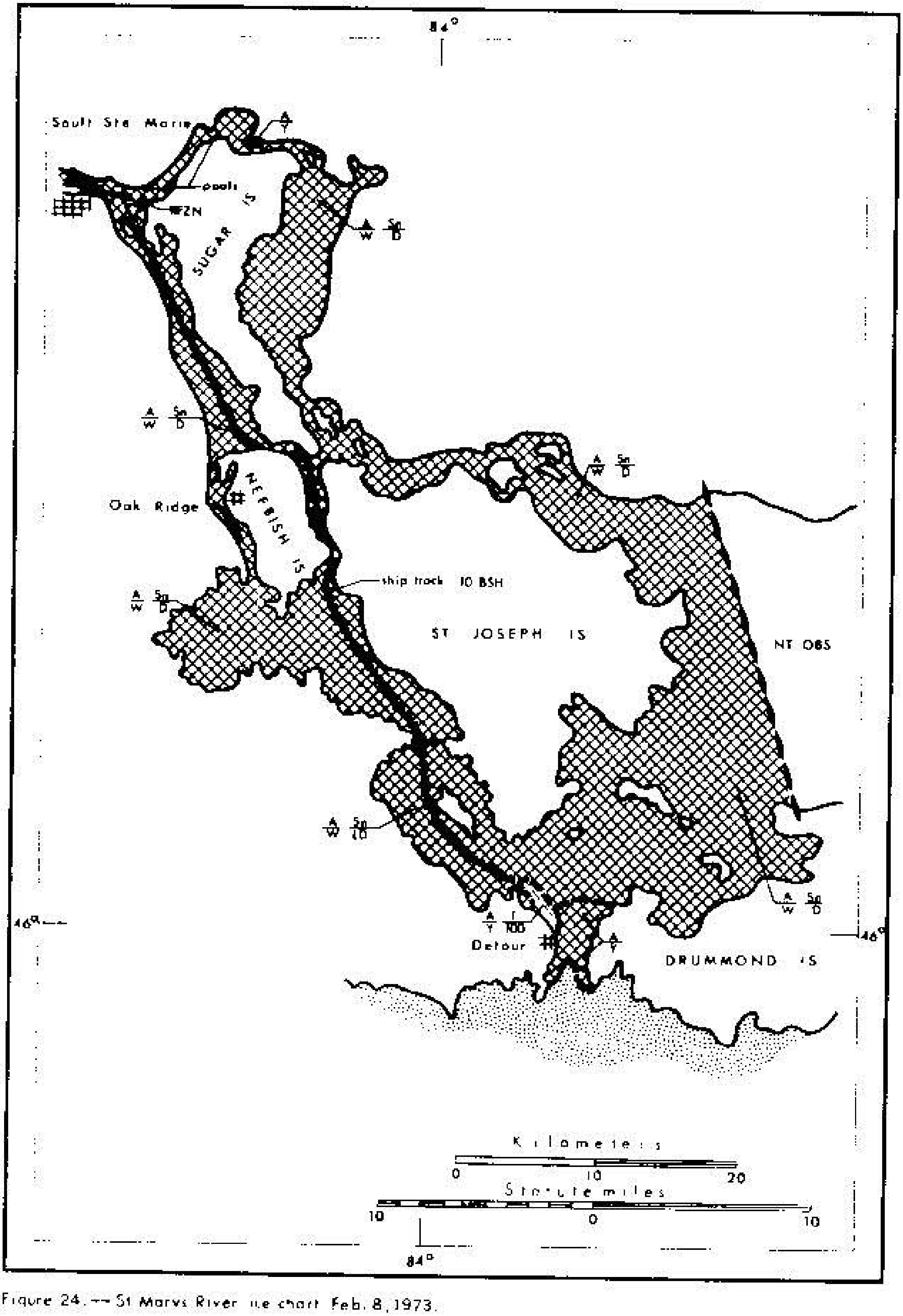


Figure 24.--St Marys River ice chart Feb. 8, 1973.

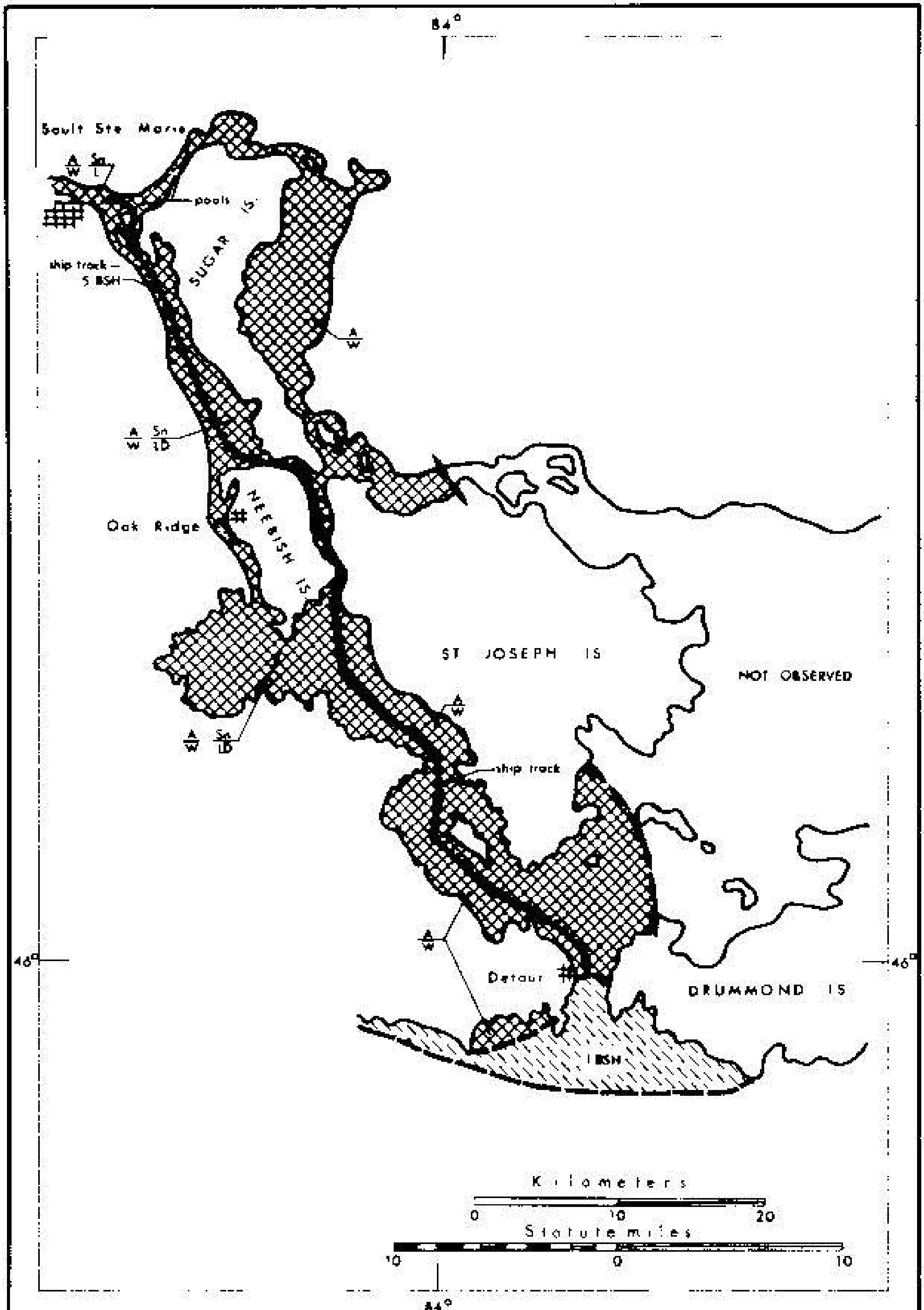


Figure 25.—St Marys River ice chart Mar. 5, 1973.

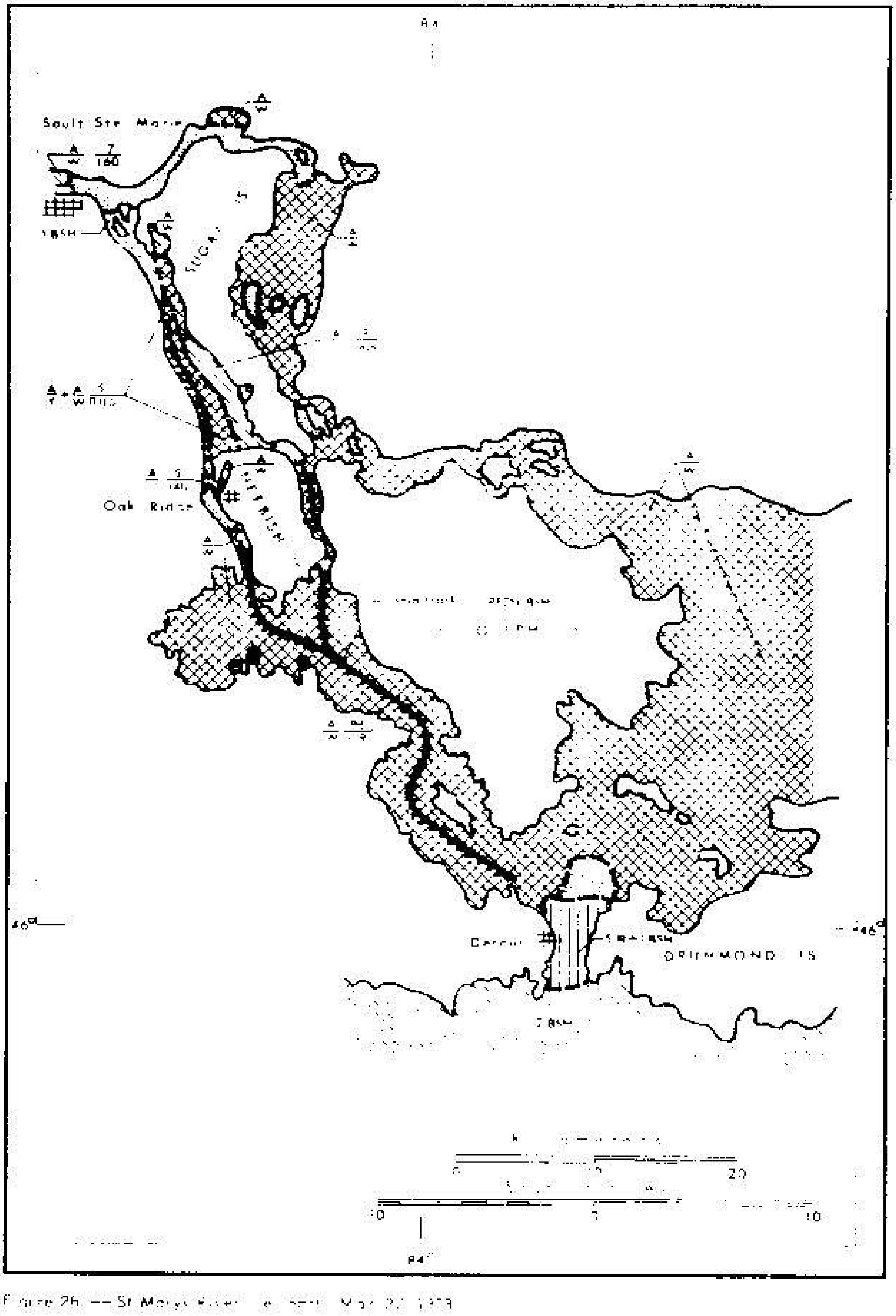


Figure 26 -- St Marys River [illegible] May [illegible] 1979

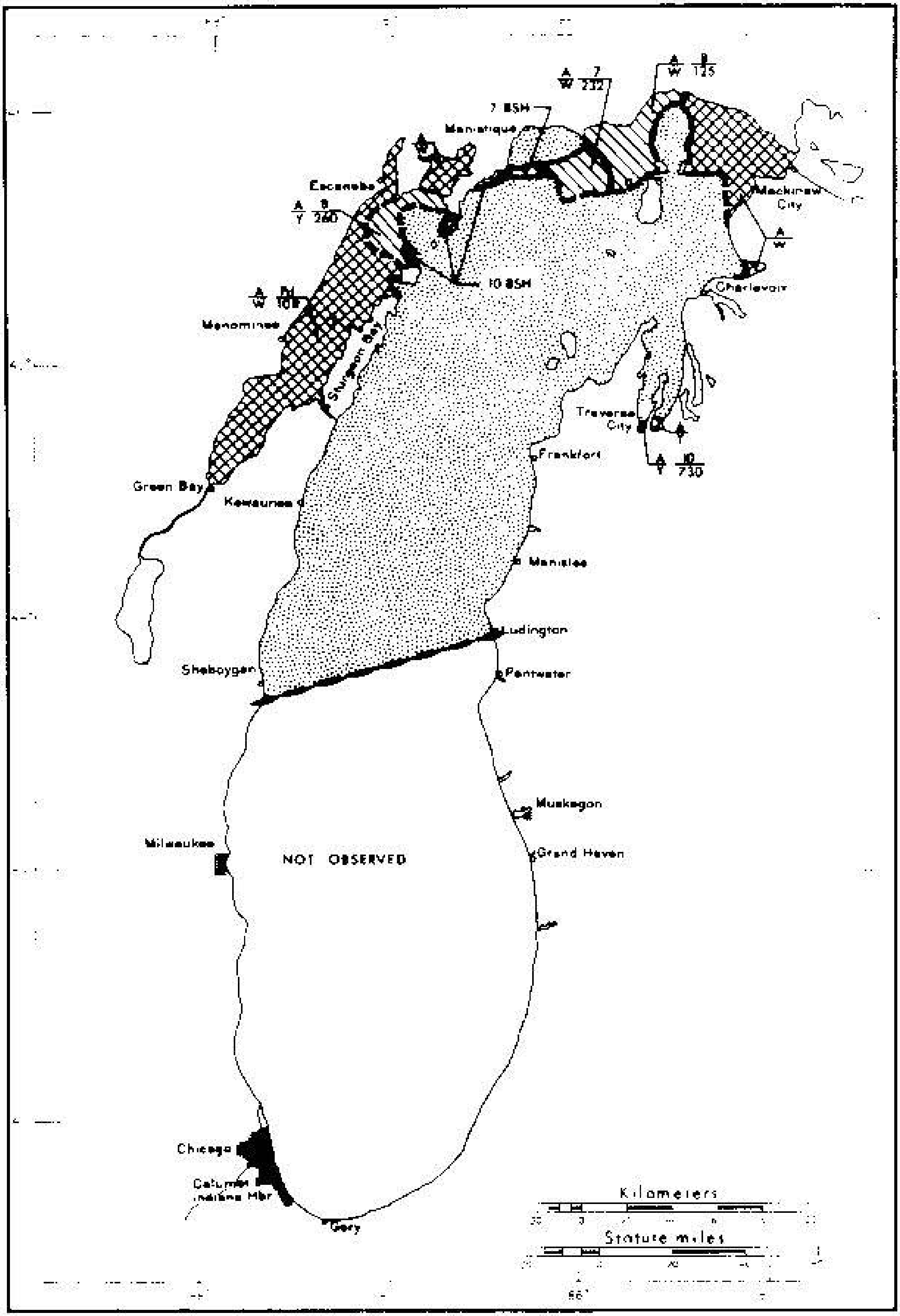


Figure 27.-- Lake Michigan ice chart Mar.5,1973.

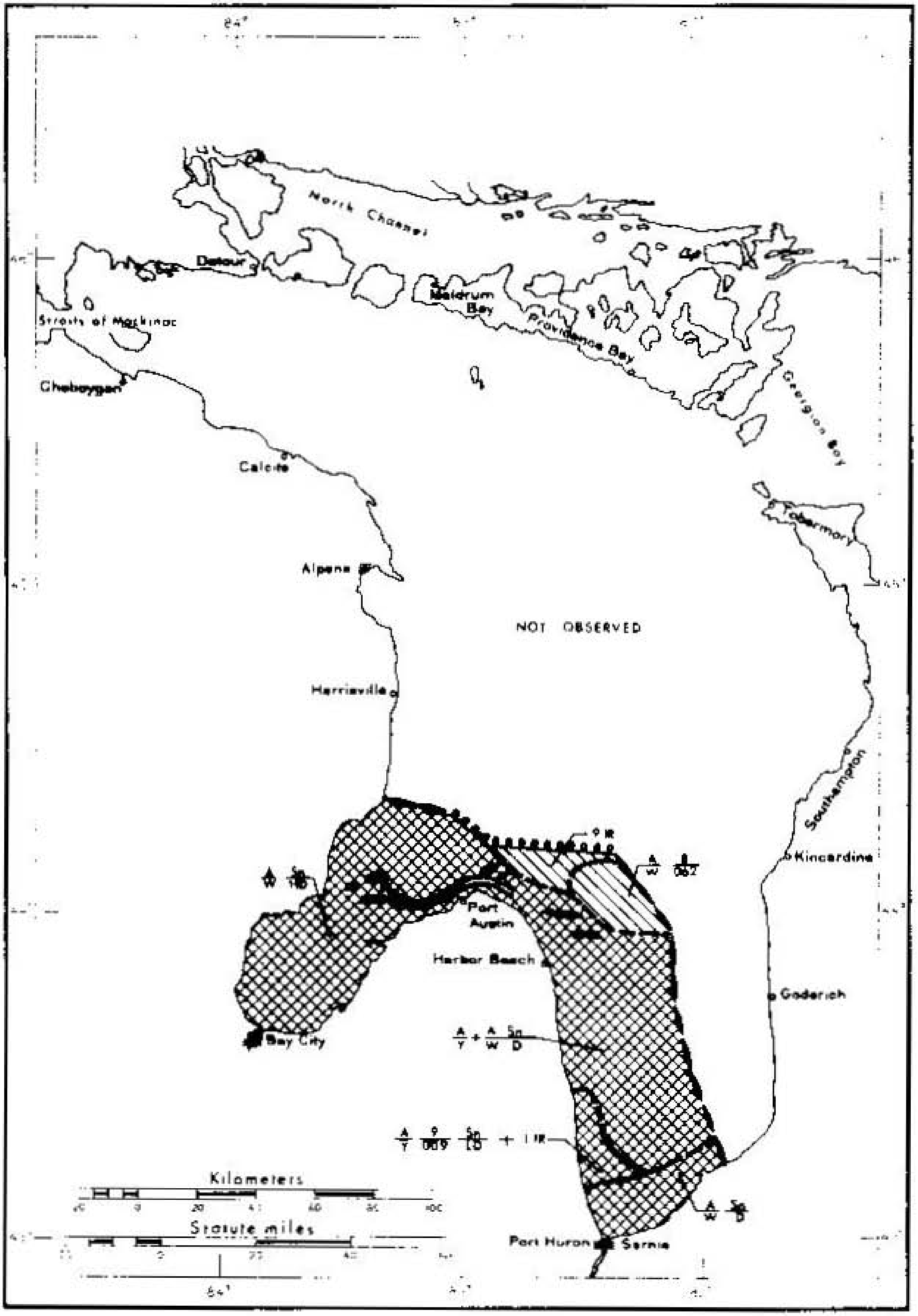


Figure 28 -- Lake Huron ice chart Feb. 27, 1973.

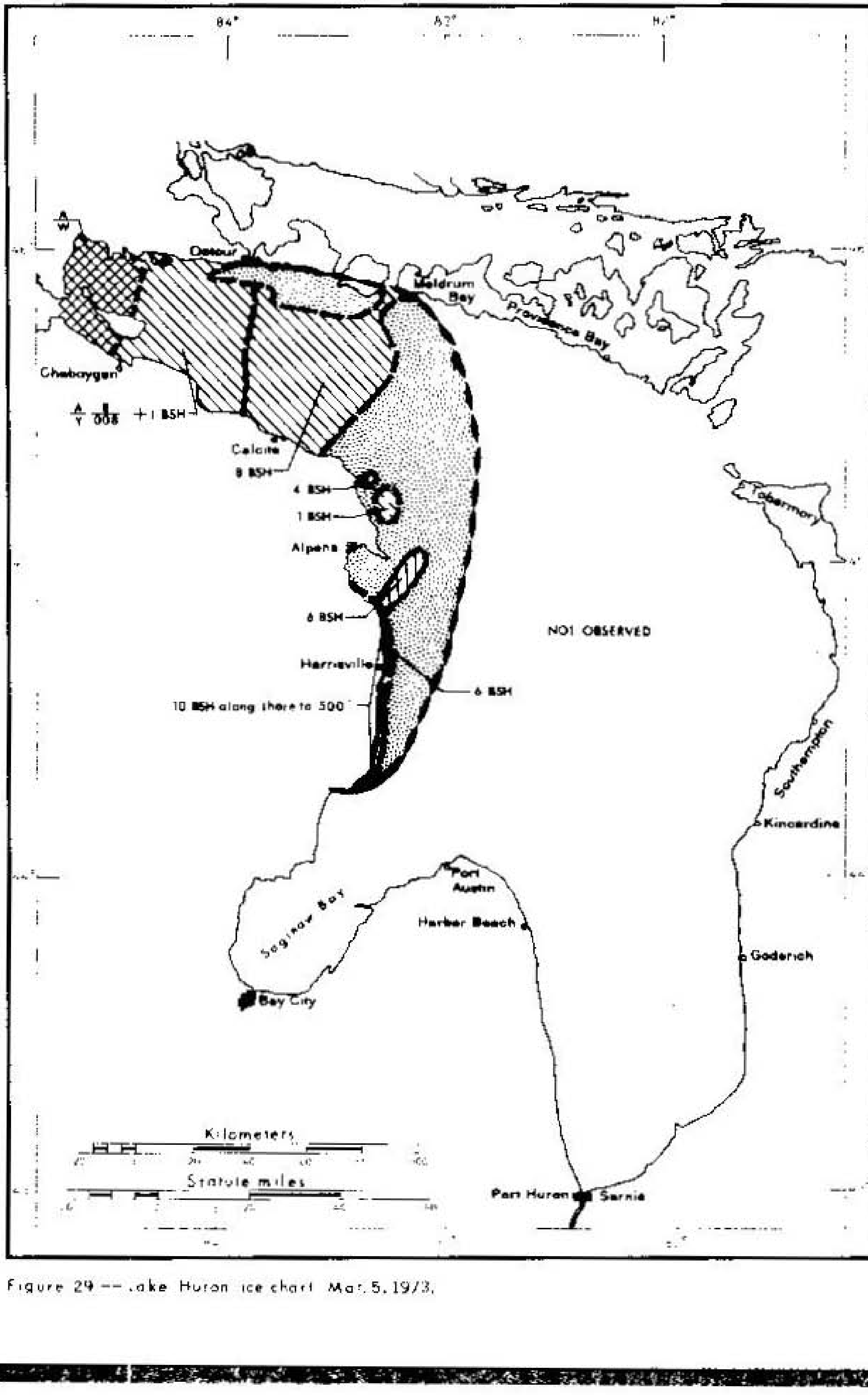


Figure 29 -- Lake Huron ice chart Mar. 5, 1973.

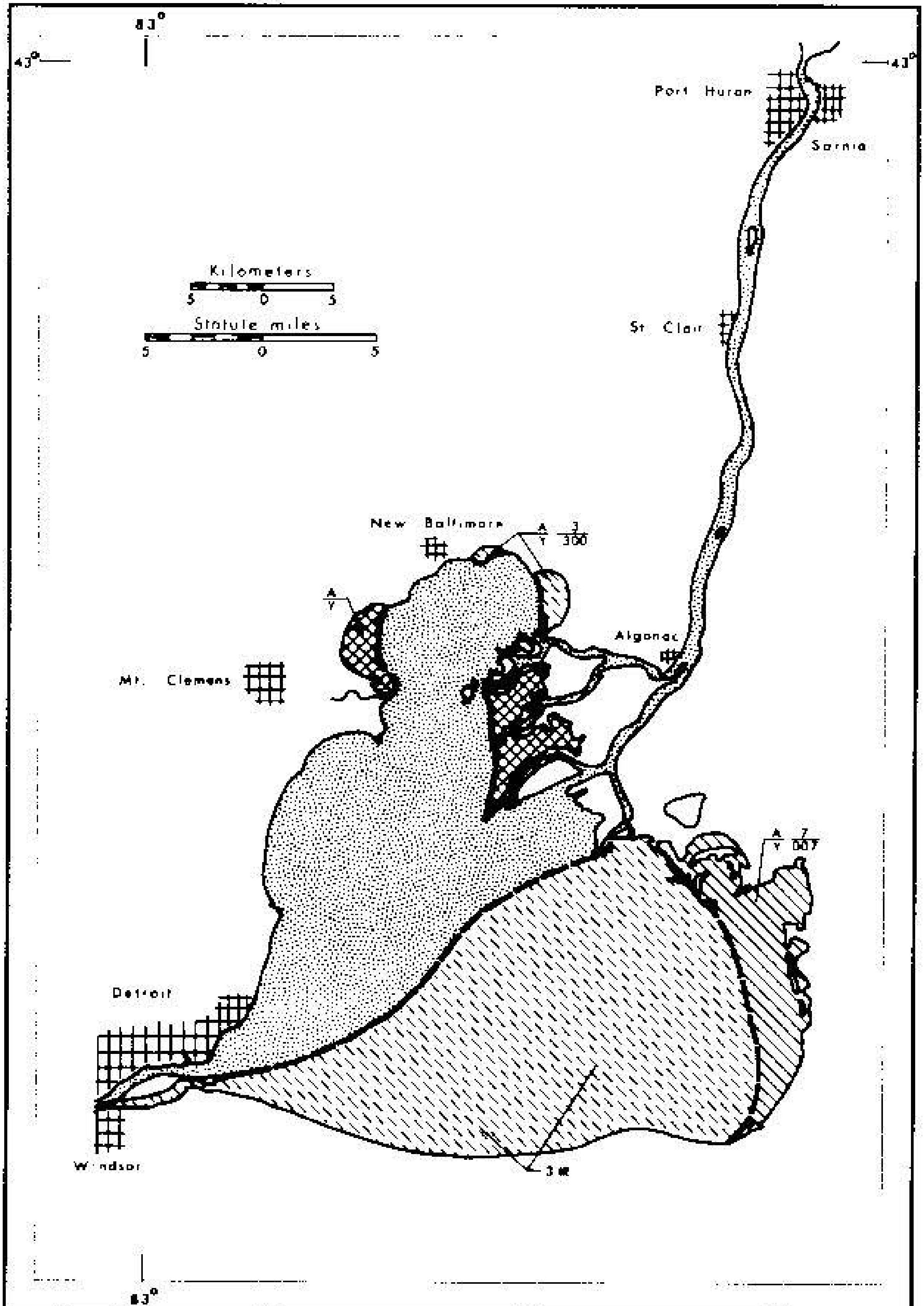


Figure 30.—Lake St. Clair ice chart, Jan. 3, 1973.

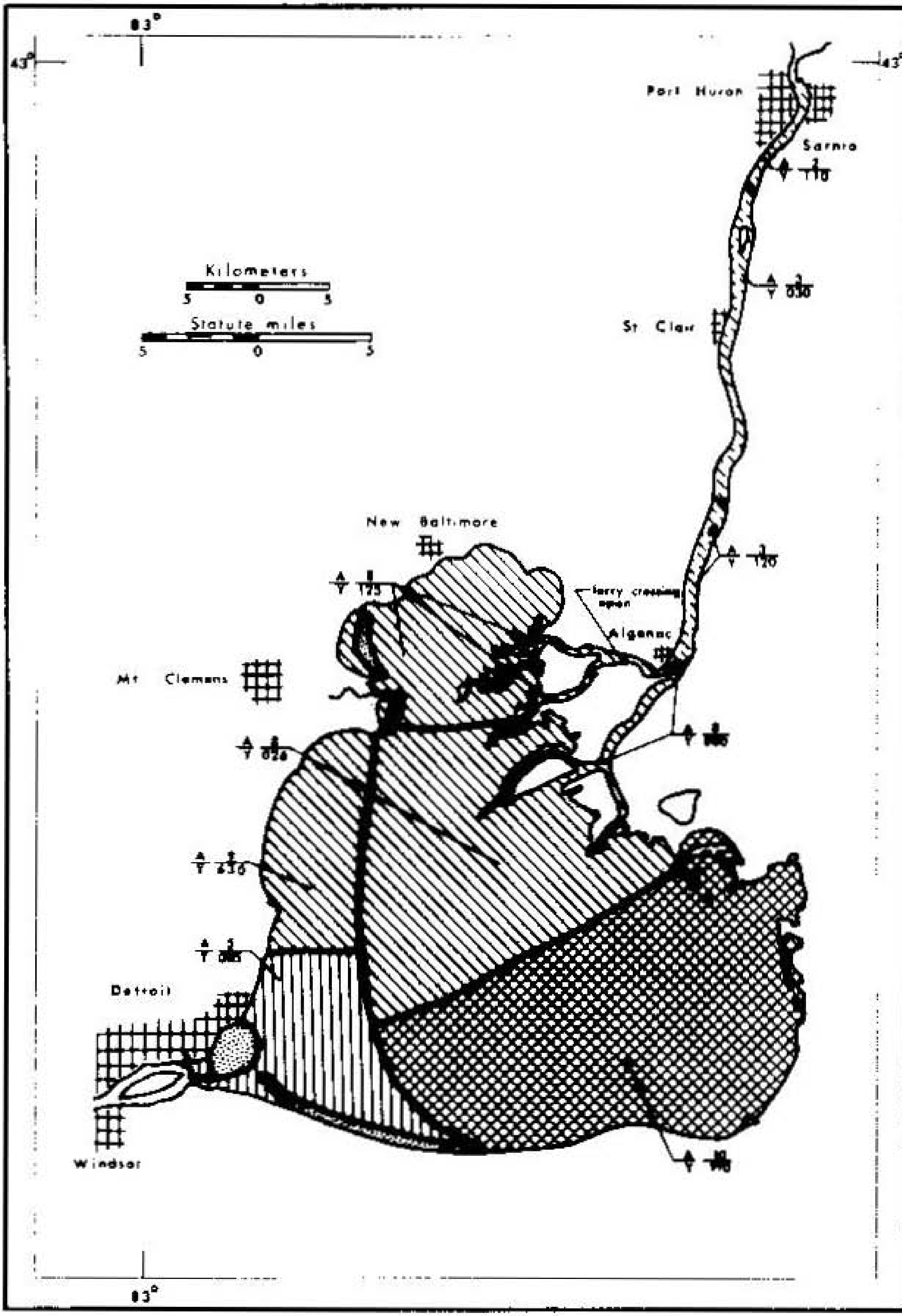


Figure 31.--Lake St Clair ice chart Jan. 12, 1973.

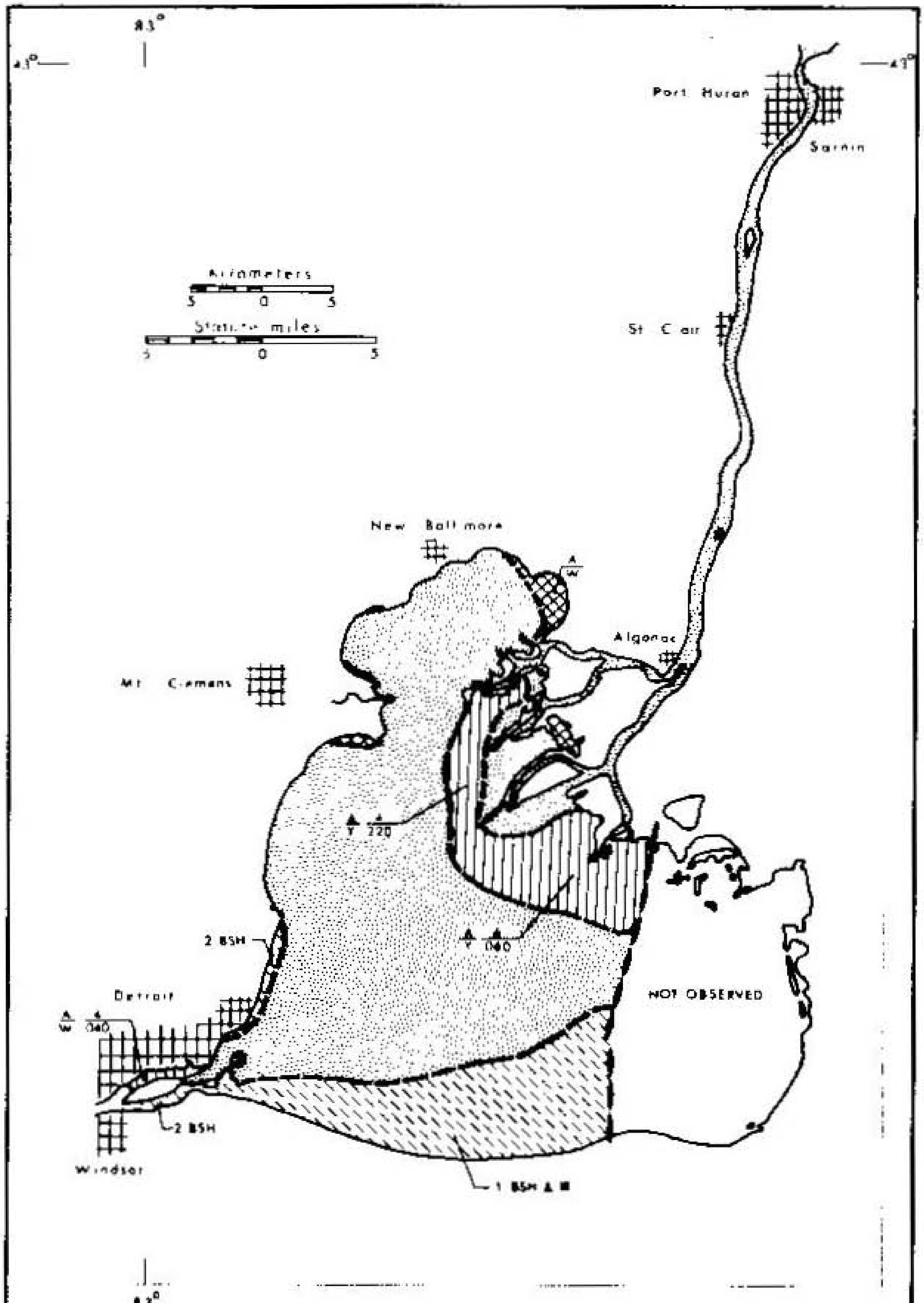


Figure 42.—Lake St Clair ice chart, Jan 24, 1973.

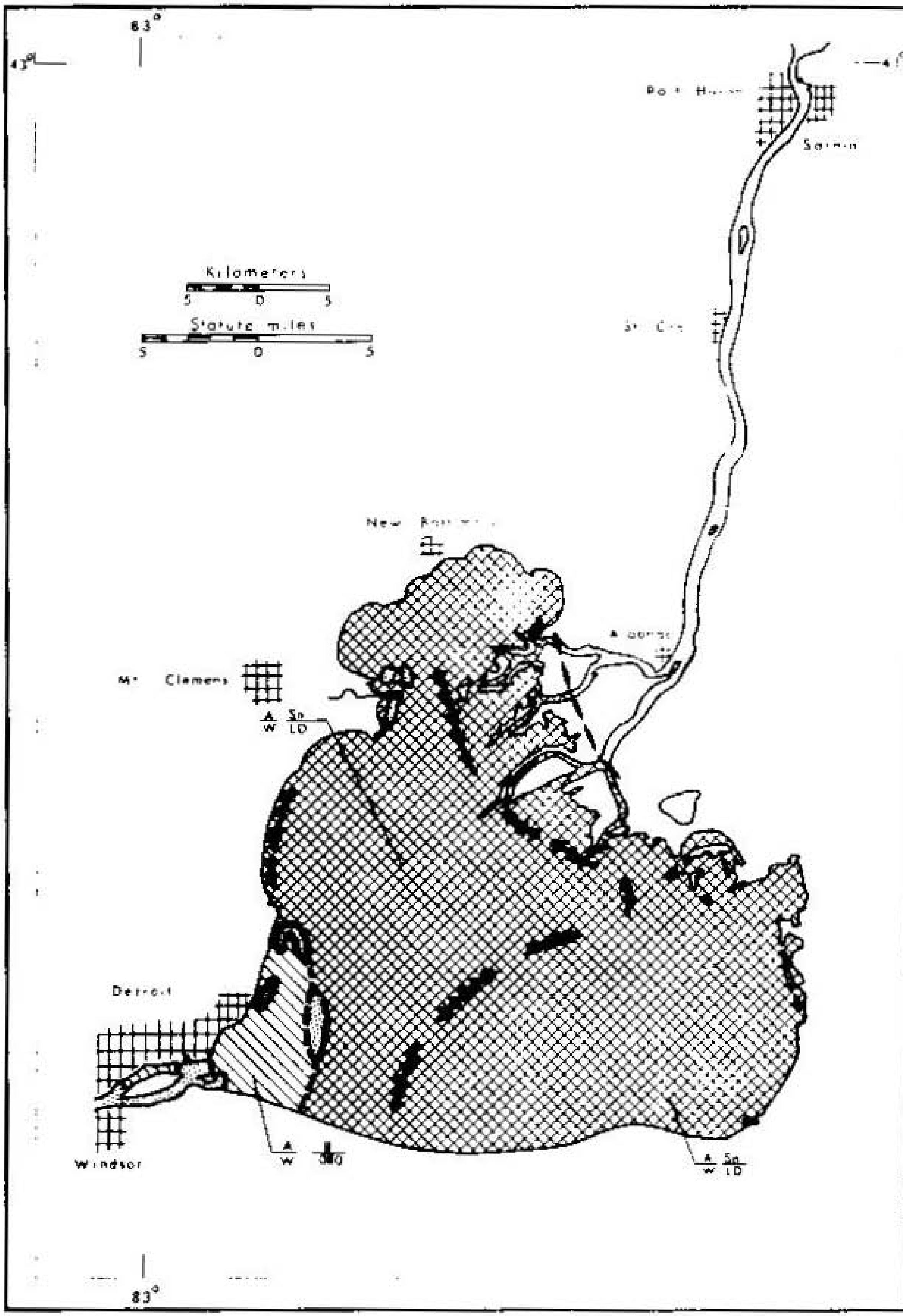


Figure 83.--Lake St Clair ice chart Feb. 26 1973

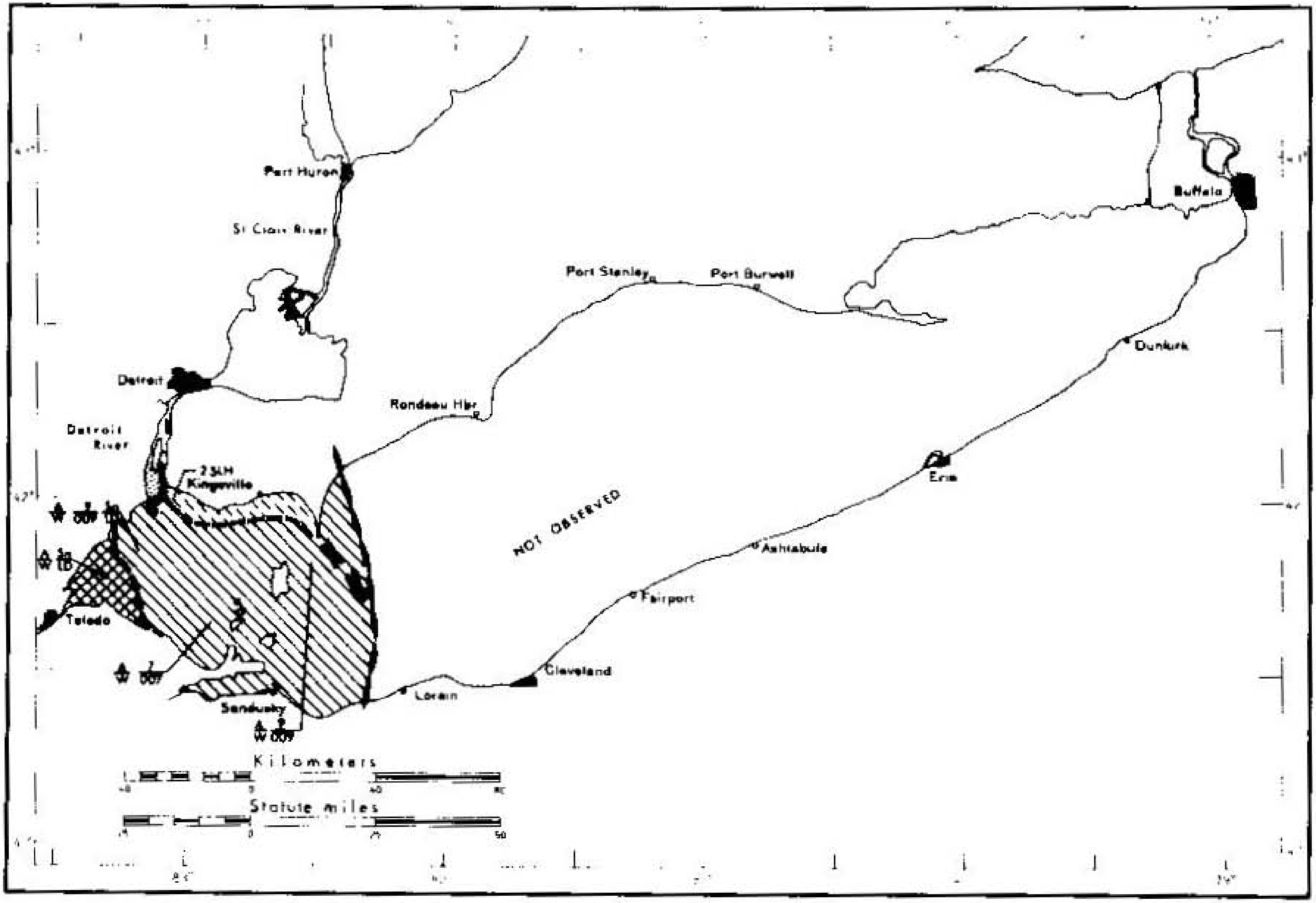


Figure 34 -- Lake Erie ice chart Feb.26,1973.

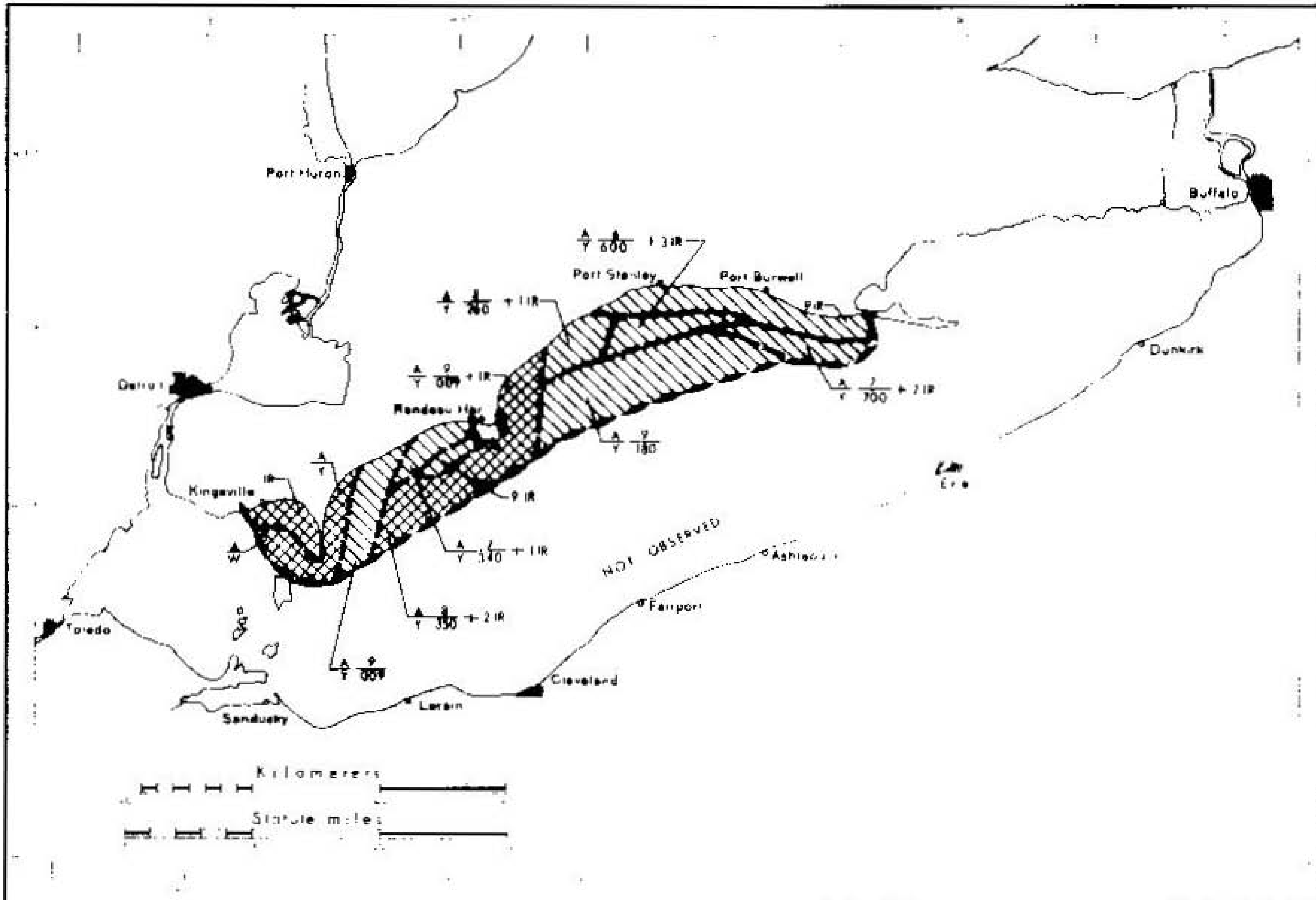


Figure — Lake Erie ice chart Feb. 28, 1973

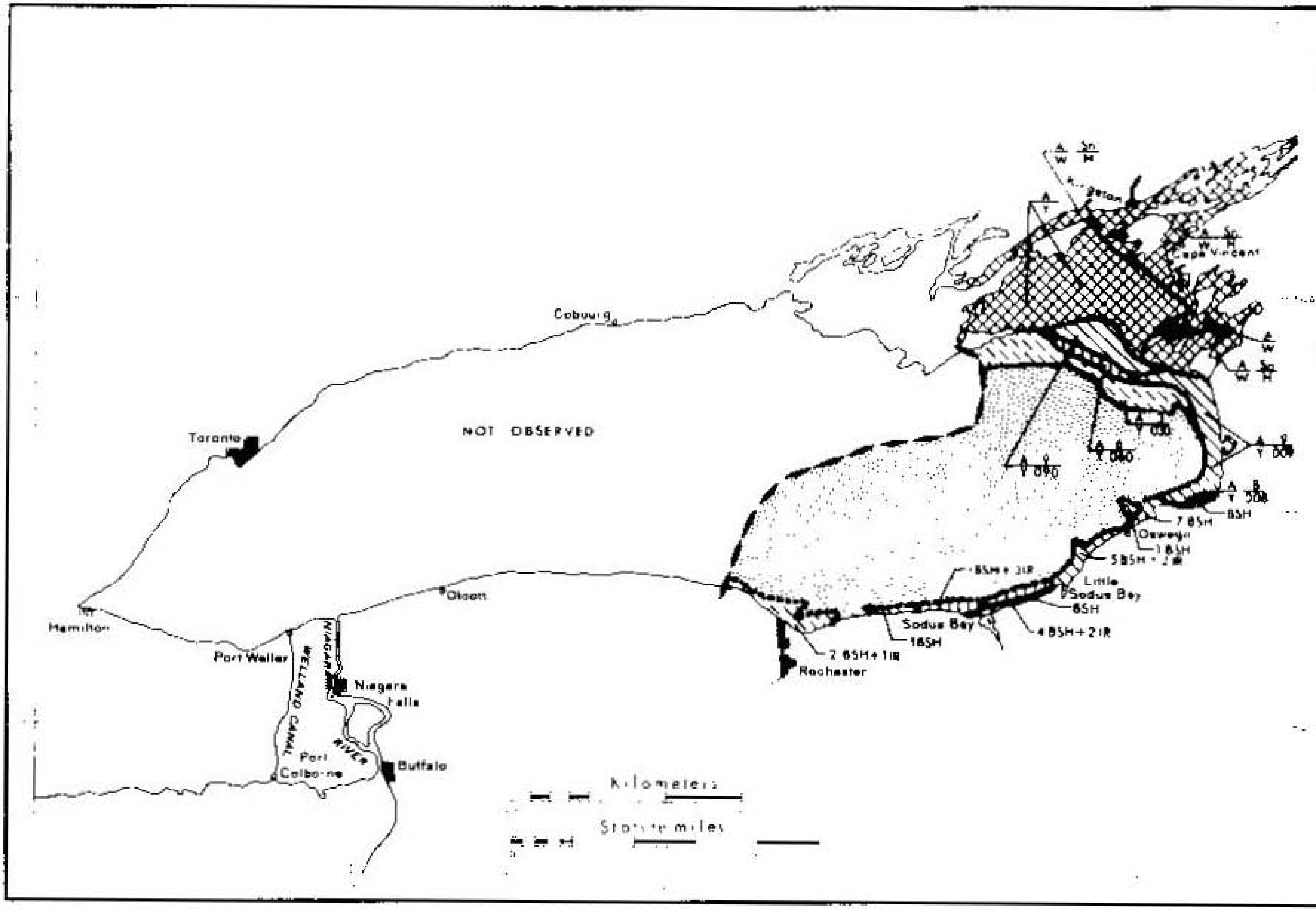


Figure 36.--Lake Ontario ice chart Feb 15, 1973

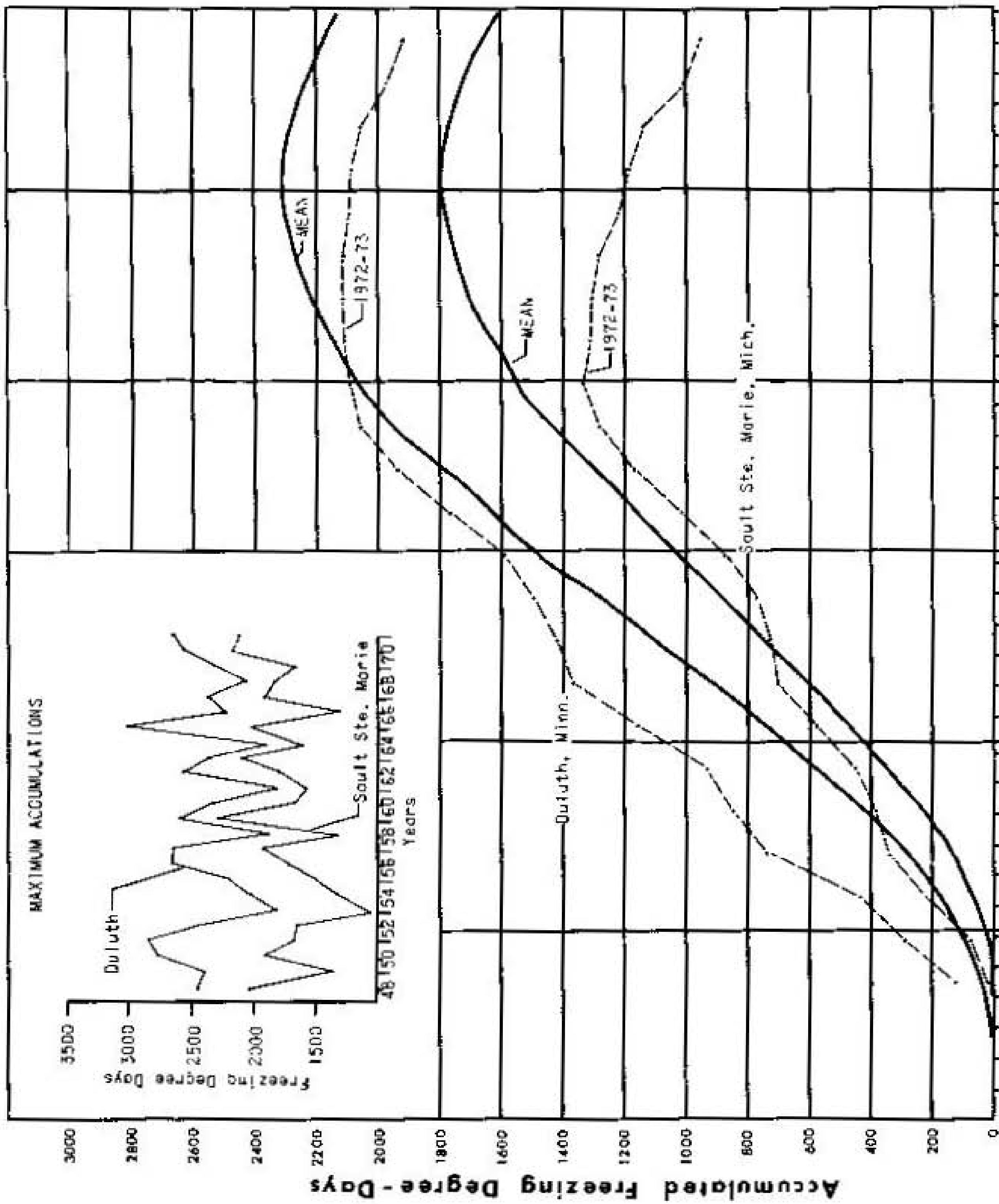


Figure 37.--Lake Superior

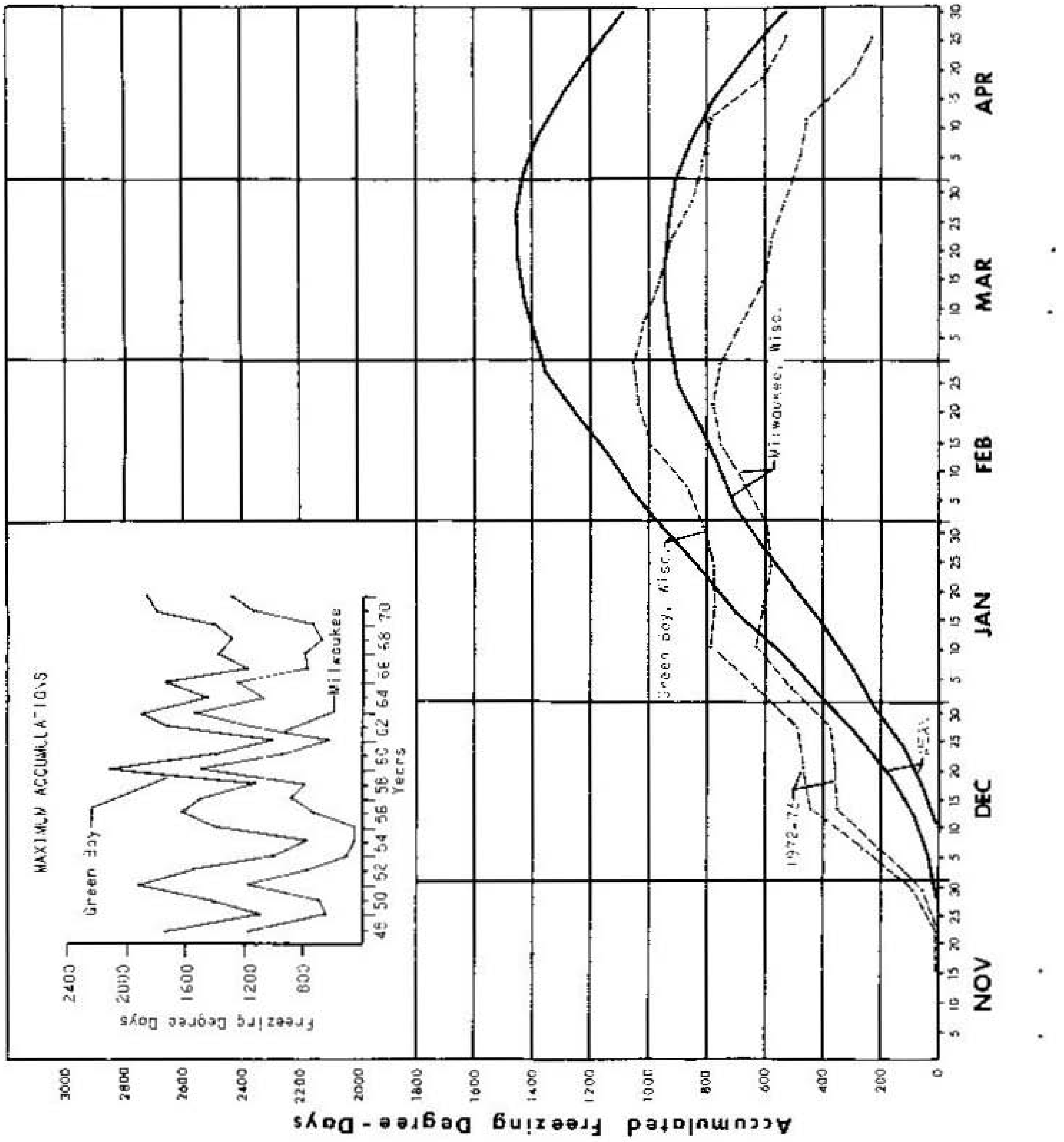


Figure 38.--Lake Michigan

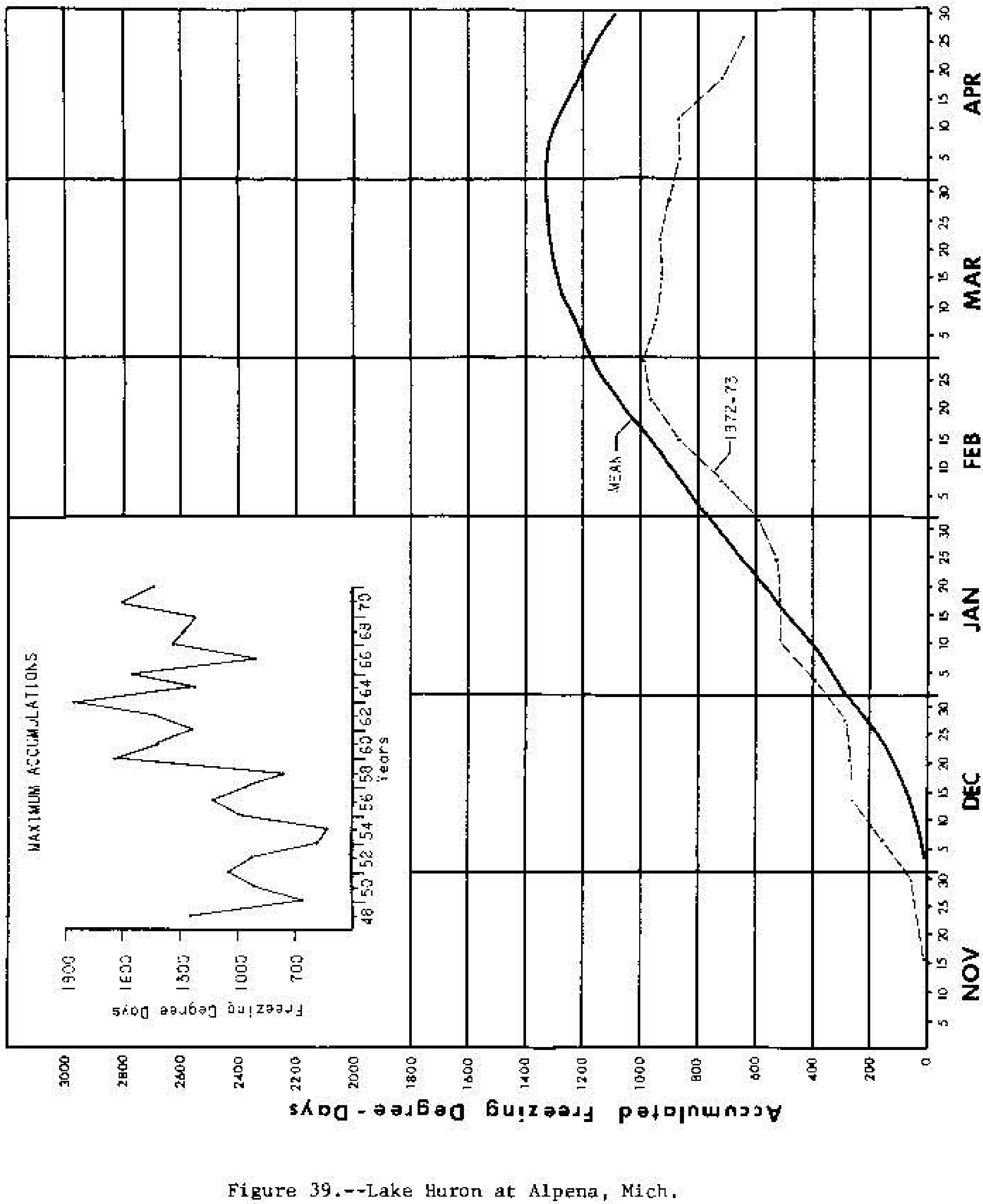


Figure 39.--Lake Huron at Alpena, Mich.

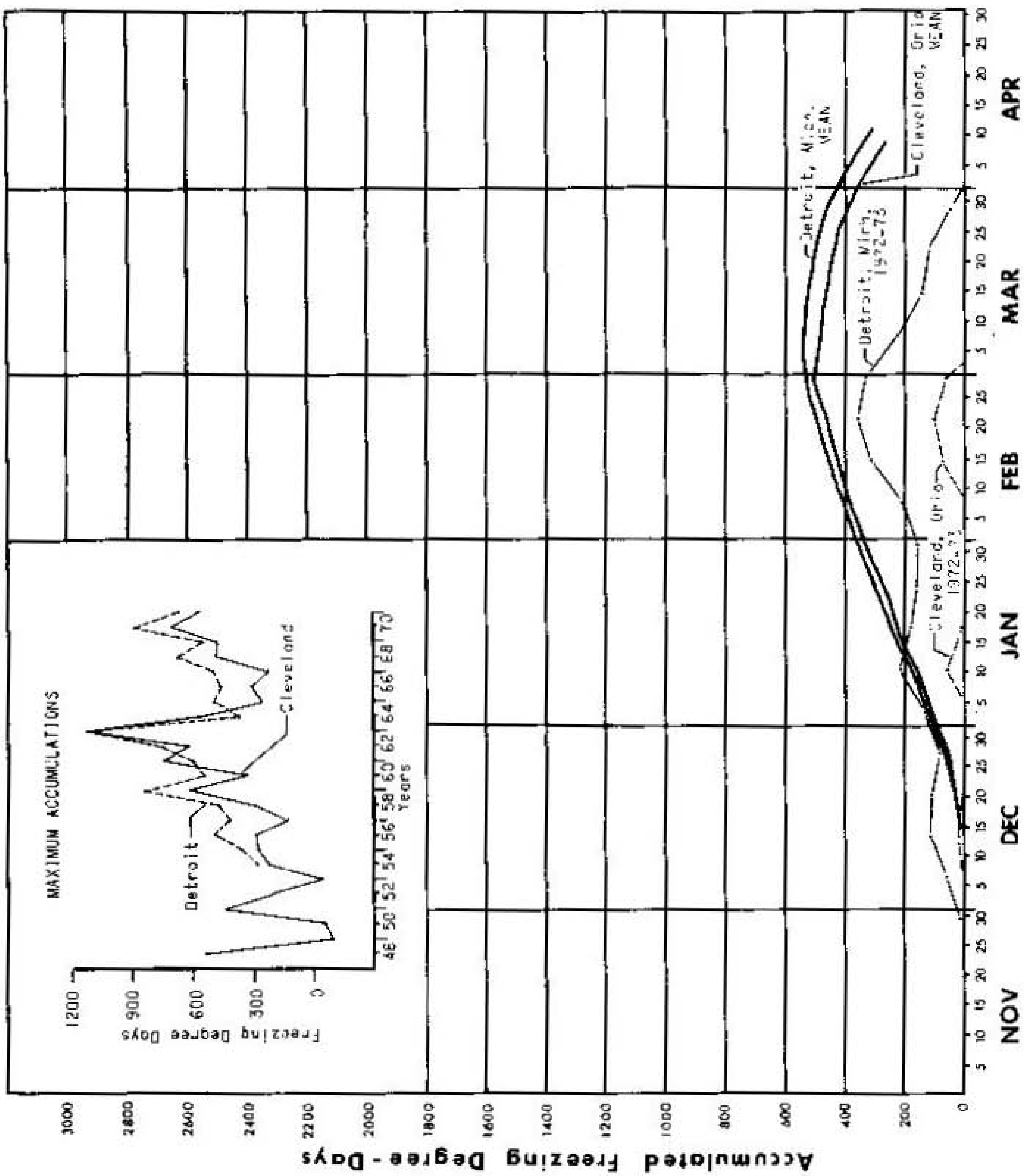


Figure 40.—Lake St. Clair at Detroit and Lake Erie at Cleveland.

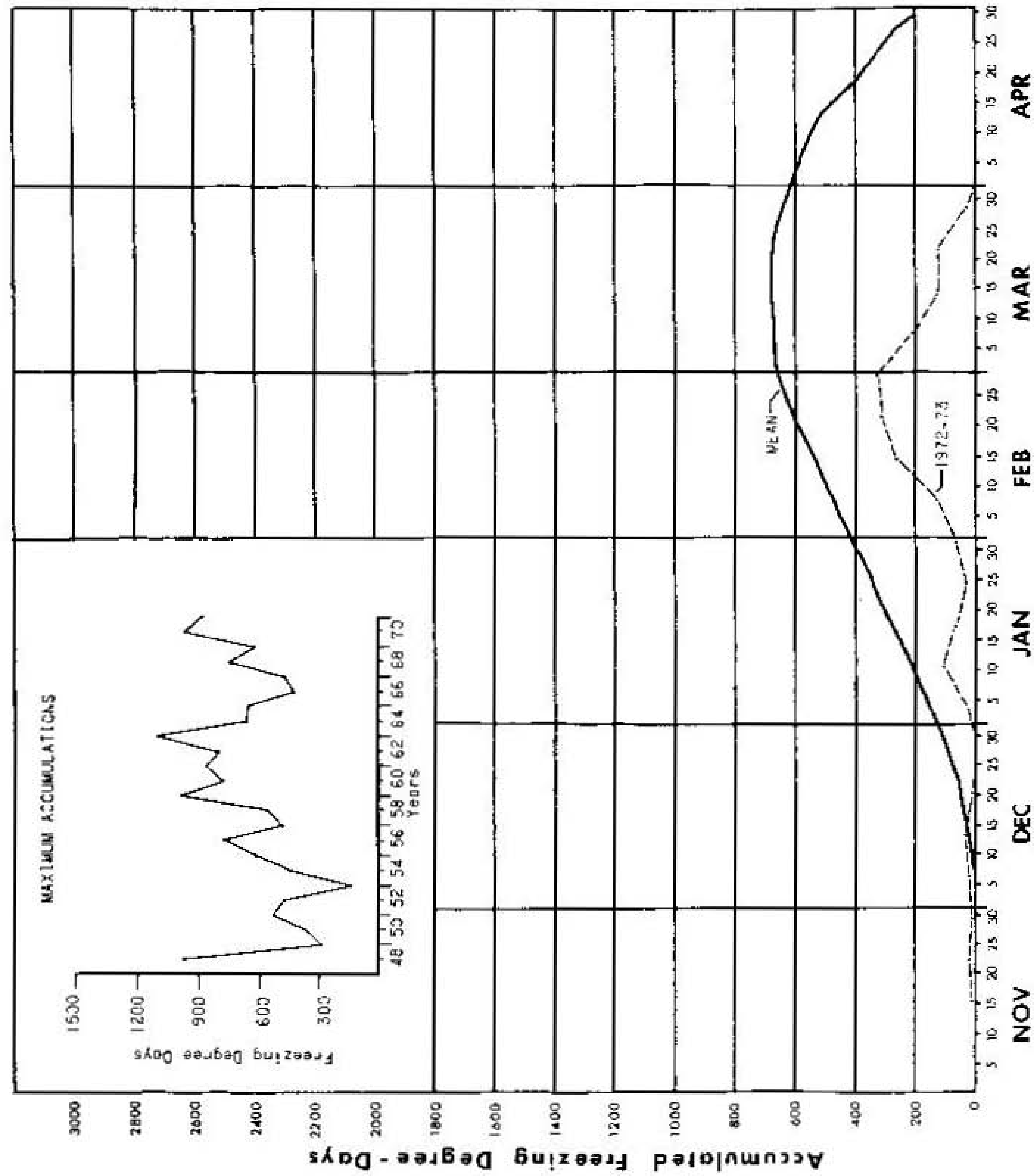


Figure 41.--Lake Ontario at Rochester, N.Y.

Figure 42.—NOAA-2 VHRR-VIS image of the Great Lakes, Feb. 26, 1973.

Figure 43.--ERTS image, band 6 - western Lake Superior, Feb. 26, 1973.