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LAKE ERIE WATER QUALITY: ASSESSMENT OF 1980 OPEN LAKE CONDITIONS AND TRENDS FOR THE PRECEDING DECADE

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EXECUTIVE SUMMARY

Ten water quality monitoring cruises were undertaken in the western and central basins of Lake Erie during the period April to December 1980. The primary objective of the study is to provide an annual assessment of priority issues in Lake Erie eutrophication. These issues include: 1) hypolimnetic oxygen depletion rates, 2) concentrations and quantities of nutrients, 3) biomass production, 4) concentration of dissolved substances and 5) trophic status of the lake.

The central basin of Lake Erie exhibited a typical thermal structure in 1980, but the period of stratification lasted about 120 days, 2-3 weeks longer than normal. Hypolimnetic oxygen depletion rates were also typical of recent years: area loss per day of 0.63 g/m^2 and volume loss per day of 0.11 mg/l. This loss resulted in an anoxic area of 4,330 km^2 (36 percent of the hypolimnion and 27 percent of the entire central basin). Anoxic regeneration of phosphorus in this basin is estimated at 2,100 metric tons. The annual mean concentrations for total phosphorus were 28.8 and 13.7 ug/l for the western and central basins, respectively. The largest single source was the Detroit River, but the Maumee River exhibited the highest concentrations. Average summer transparency was 1.6 m in the western basin and 5.9 m in the central basin. Chlorophyll a values averaged 8.4 and 3.1 ug/l in the western and central basins, respectively. These concentrations yielded a trophic classification of eutrophic for the western basin and most of the Sandusky sub-basin of the central basin. The remainder of the central basin is mesotrophic in the spring and fall, but becomes oligotrophic in its deeper portions in the summer when primary production depletes some nutrients.

An analysis of Lake Erie water quality data for the past decade, as an assessment of trends, indicates a general improvement in lake quality. Water levels in Lake Erie have been above the long-term mean since 1970, which have provided some dilution of contaminants. Thermal structure of the lake is influenced by meteorological conditions which have resulted in thin hypolimnions and severe depletion of oxygen, as in 1973, and thick hypolimnions and relatively small areas of anoxia, as in 1975. In the past decade the oxygen demand rate in the central basin has been relatively constant after increasing dramatically from 1930 to 1970. The oxygen demand rate of the eastern basin may still be increasing slightly.

Concentrations of total phosphorus in the western and central basins were relatively constant during the period 1970 to 1977; however, in the past three years (1978-1980) significant declines in the concentrations and quantities in these basins have been observed. This improvement coincides with the approximate 800-metric-ton-per-year

reduction in total phosphorus loaded to the lake during the period 1970-1979. Eastern basin data also indicates a progressive decline in phosphorus since the mid-1970's. Transparency shows no discernable trends, but in 1980 the central basin had the highest average summer transparency during the period of record, 1973-1980. Chlorophyll a concentrations in 1980 were also the lowest average annual values on record (1970-1980). for the western and central basins. Dissolved substances, as measured by conductivity and chloride, also show a significant decline in the past 15 years.

Many of these trends are preliminary interpretations and must stand the test of further scientific scrutiny. However, the evidence is continuing to mount that Lake Erie is no longer degrading and that future improvements are eminent.

INTRODUCTION

Background

Lake Erie, as one of the Great Lakes of North America, represents a significant source of fresh surface water for the people of Canada and the United States. In recognition of the importance of this resource and the need to restore and maintain its water quality, the Canadian and United States governments entered into the Great Lakes Water Quality Agreement in 1972. The agreement was reaffirmed in 1978 by further actions to enhance water quality in the Great Lakes Basin ecosystem.

The International Joint Commission has been mandated to assist in the implementation of these agreements. Within that mandate, the Commission is to collect, analyze and disseminate information relating to Great Lakes water quality. Recognizing the need for a uniform surveillance effort by both parties of the agreements and the cooperating state and provincial jurisdictions, the Commission directed the Water Quality Board to develop an international surveillance plan. Work groups were established for each lake, with the responsibility for developing detailed plans.

The Lake Erie Work Group prepared a nine-year surveillance plan in 1977, which was designed to provide an understanding of the overall, long-range responses of the lake to pollution abatement efforts. The main lake portion of the plan called for intensive investigations in 1978 and 1979 and annual assessments at a less intensive level for the period 1980-1986. With the support of the United States Environmental Protection Agency and Environment Canada, the majority-recommended plan was implimented on schedule. The results of the 1980 annual main lake surveillance cruises, as well as an assessment of Lake Erie water quality trends for the preceding decade, are presented in this report.

Objective

The primary objective of the main lake component of the surveillance plan is to provide an annual assessment of the priority issues in Lake Erie eutrophication, utilizing key trophic-related parameters. Monitoring cruises were undertaken during the ice-free period of 1980 in the western and central basins to determine:

1. oxygen depletion rates in the hypolimnion of central Lake Erie, areas of anoxia and the duration of anoxia;

2. concentrations and amount of nutrients (phosphorus, nitrogen and silicon) in the lake and the quantity regenerated during anoxia;

3. response of the lake, via primary productivity, to to the availability of nutrients as measured by the concentration and quantity of chlorophyll and related lake characteristics such as light penetration and suspended particles;

4. trends in dissolved substances in the lake as indicated by measurements of conductivity, alkalinity and pH;

5. trophic status of various regions of the lake for spring, summer and autumn.

The broader objective of the main lake component is to provide, on an annual basis, open water data necessary to determine long-term changes in water quality and biota. These changes are generally very slow and subtle and cannot be accurately assessed without repetitive annual surveys. The annual state-of-the-lake assessment reports are intended to provide the information analysis analysis needed to support the Great Lakes water quality management process, including establishment of goals, planning future strategies and recommending remedial programs.

METHODS

Shipboard Methods

Ten water quality monitoring cruises were undertaken in Lake Erie during the period 1 April to 4 December 1980 (Table 1). A total of 37 stations were visited in the western and central basins (Figure 1). All stations were sampled on cruises 4, 5 and 6 to determine oxygen depletion rates, while 19 stations were monitored on the other cruises. The geographic coordinates of the stations are listed in Table 2. Three additional stations were monitored in the eastern basin by the Canada Centre for Inland Waters (Figure 1). Information for these stations is not available at this time, but will be incorporated in a later report.

The 68-foot research vessel Hydra was utilized to conduct the cruises in the western and central basins. Twelve water quality parameters were measured shipboard:

1. temperature
2. dissolved oxygen (DO)
3. soluble reactive phosphorus (SRP)
4. nitrate + nitrite ($NO_2 + NO_3$)
5. dissolved reactive silica (DRS)
6. turbidity
7. transparency
8. light extinction
9. transmissability
10. specific conductance
11. pH
12. total alkalinity

Water samples were also obtained for five additional parameters to be analyzed in a land-based laboratory:

1. total phosphorus (TP)
2. total dissolved phosphorus (TDP)
3. total suspended solids (TSS)
4. volatile solids (VS)
5. Chlorophyll a, corrected (Chl)

Analytical methods for each parameter are summarized in Table 3.

Water samples or in situ probe readings were taken one meter below the surface and one meter above the bottom in the western basin. In the central basins, during unstratified periods (cruises 1, 2, 8, 9 and 10), samples or probe readings were taken at the same two horizons plus one at a mid-water depth . During periods of stratification (cruises 3-7), four horizons were utilized: 1) one meter below the surface, 2) one meter above the upper knee of the thermocline, 3) one meter below the lower knee of the thermocline and 4) one meter above the bottom. A continuous profile of temperature versus depth was obtained at each monitoring station.

Laboratory Methods

Whole water samples were taken for total phosphorus (TP), total alkalinity and turbidity analyses. Water to be analyzed for total dissolved phosphorus (TDP), soluble reactive phosphorus (SRP), nitrate + nitrite ($NO_3 + NO_2$) and dissolved reactive silica (DRS) were filtered through Sartorious 0.45 u membrane filters. The filter pads were specially ordered without separator papers to avoid possible contamination. Water samples for total suspended solids (TSS), volatile solids (VS) and chlorophyll *a* were filtered through Whatman GF/C 0.45 u filters. Samples for SRP, $NO_3 + NO_2$ and SRS were held at 4°C until analyzed with a shipboard Technicon AutoAnalyzer II, generally within four hours of collection. Analytical methods for laboratory determinations of the above parameters are listed in Table 3.

Quality control samples were collected at a frequency of approximately one to every ten environmental samples. A duplicate cast was made while on each QC station so that two surface and two bottom samples were collected. Each duplicate sample was split just prior to analysis and each portion was run according to normal procedure. The differences between splits was calculated and a standard deviation for each parameter, by basin, was calculated. For AutoAnalyzer parameters, filtered and unfiltered blanks and spikes were prepared daily.

Data Analysis Procedures

Water quality data for all parameters was entered in the central computer system at The Ohio State University in preparation for transmittal to the STORET data system. Cruise means, by basin, for each parameter were calculated for each sampling horizon. An area/volume weighting program developed by the Canada Centre for Inland Waters (Survey 8) was utilized to analyze data for temperature, dissolved oxygen, selected nutrient parameters and chlorophyll *a*. The techniques employed by Rockwell et al. (1980) for Lake Michigan were used to describe the trophic status of various regions of the lake.

WATER QUALITY FINDINGS FOR 1980

The results of the ten water quality cruises for 1980 are presented in this section. The data have been organized into topics covering: 1) temperature and thermal structure, 2) oxygen concentrations and hypolimnetic depletion rates, 3) nutrient concentrations and quantities, 4) suspended particles and light penetration, 5) chlorophyll concentrations and quantities and 6) dissolved substances concentrations and distribution. Tables 4 and 5 contain listings of the mean concentrations of each parameter monitored, by cruise, for the western and central basins, respectively. Distribution maps for most of the parameters for cruises 4-6 (complete station coverage cruises) are presented in a Lake Erie Water Quality Atlas (Appendix A, Maps 1-64).

Temperature and Thermal Structure

Western Basin. This basin showed no evidence of stratification in 1980. The mean cruise temperatures ranged from a low of 3.3°C in late November to a high of 25.3°C in late August. The maximum difference of 2°C between surface and bottom temperatures was found during late spring and late summer.

Central Basin. In 1980, this basin exhibited the typical thermal structure described by Zapotosky (1980). The minimum cruise mean temperature of 2°C was observed during April, and the maximum temperatures occurred in the epilimnion in early September. The basin was stratified for approximately 120 days from late May through late September. A maximum epilimnion to hypolimnion gradient of 10°C existed in late August.

The maximum epilimnion temperature for a typical central basin station was observed during early August (Figure 2). Cooling and rewarming of the epilimnion waters were observed for late August and early September, respectively. The fluctuations in epilimnion temperature can be explained by the "sloshing" between epilimnion and hypolimnion waters. The thermocline remained approximately at the 15-meter level (± 1.0 meter) throughout the stratified period.

There was a small portion of the central basin that was stratified during late September. There was no hypolimnion, and the mesolimnion was on the lake bottom and one-meter thick.

Classically, Hutchinson (1957) has shown that for destratification to occur the epilimnion waters cool down to near hypolimnion temperatures. This was not the case for the central basin 1980 destratification. A 5°C decrease from early to late September in the epilimnion waters was a significant enough cooling to destratify the central basin. This morphometric orientation of the central basin in the direction of the dominant wind increases the importance of wind and wave action and their affect on the thermal structure and its stability.

Oxygen Concentrations and Hypolimnetic Depletion Rates

Western Basin. Cruise mean concentrations of dissolved oxygen (DO) ranged from over 12 mg/l in April to 7 mg/l in August to over 11 mg/l in November. The IJC objective for DO was exceeded in July (cruise 5) when the mean bottom concentration, at 5.49 mg/l, was slightly below the objective limit of 6.0 mg/l. The mean DO saturation for bottom waters during this cruise was 64 percent. Surface waters exceeded 107 percent saturation during this cruise due to high algal productivity.

Central Basin. Cruise mean concentrations of DO ranged from nearly 14 mg/l in April to 5.6 mg/l in early September to over 11 mg/l in December. Hypolimnion concentrations (cruise mean) were less than the IJC objective (6.0 mg/l) for the August and September cruises, with a minimum hypolimnion mean of 2.9 mg/l in early September (31 percent saturation). Calculations of 1980 net oxygen depletion rates are presented in Tables 6 and 7 and comparisons are made with the rates for 1978 and 1979:

Mean Hypolimnetic Oxygen Depletion Rates
for Central Lake Erie

Year	Area Rate Loss/Day (g/m^2)	Volume Rate Loss/Day (mg/l)
1978	0.51 ± 0.36	0.09 ± 0.07
1979	0.41 ± 0.26	0.09 ± 0.04
1980	0.63 ± 0.02	0.11 ± 0.01

Nutrient Concentrations and Quantities

Western Basin. Mean concentrations of total phosphorus (TP), soluble reactive phosphorus (SRP), Nitrate plus Nitrite ($NO_3 + NO_2$) and dissolved reactive silica (DRS) for surface and bottom water for each cruise are presented in Table 4, and metric tons of TP and SRP for each cruise are listed in Appendix C. Cruise mean concentrations of nutrients are given below by season:

Seasonal Mean Nutrient Concentrations
(ug/l) in Western Lake Erie

Season	TP	SRP	$NO_3 + NO_2$	DRS
Spring	71.1 ± 32.2	19.9 ± 7.7	1821 ± 292	1889 ± 725
Summer	67.8 ± 15.3	16.3 ± 3.0	949 ± 368	1886 ± 334
Fall	71.0 ± 24.4	3.7 ± 0.8	307 ± 78	978 ± 188

The summer and fall decline in soluble nutrients is reflected in an increase in chlorophyll a during the time period.

The influence of extremely high concentrations of phosphorus entering western Lake Erie at the mouth of the Maumee River is illustrated on Maps 19-22 of Appendix A. The relatively low concentrations in mid-channel Detroit River water are also well-shown as water masses which extend well into the center of the basin.

Central Basin. Mean concentrations of TP, SRP, $NO_3 + NO_2$ and DRS for each thermal strata of the basin, by cruise, are presented in Table 5, and metric tons for each cruise are listed in Appendix D. Cruise mean concentrations of nutrients are given below by season:

Seasonal Mean Nutrient Concentrations (ug/l) in Central Lake Erie

Season	TP	SRP	$NO_3 + NO_2$	DRS
Spring	13.1 ± 9.5	1.5 ± 0.2	324 ± 30	184 ± 81
Summer	9.2 ± 3.1	1.8 ± 0.4	164 ± 25	761 ± 229
Fall	25.1 ± 2.3	3.7 ± 1.2	112 ± 20	372 ± 203

Mean surface concentrations of SRP remain above 1.0 ug/l throughout the year; therefore, it is unlikely that algal production was significantly limited by the scarcity of this nutrient in the central basin.

Anoxic regeneration of soluble phosphorus is illustrated on Map 28 of Appendix A. East of Kelleys Island the bottom concentration of SRP in August reached levels 10 times greater than concentrations in July due to this process. The TP quantity in the central basin increased from a total of 1,729 metric tons in early August to 3,889 metric tons in early September. A significant amount of this 2,160-metric-ton increase can be attributed to anoxic regeneration.

Suspended Particles and Light Penetration

Total suspended solids (TSS), volatile solids (VS) and turbidity determinations were made in the western and central basins as a measure of suspended particles. Transparency (secchi disk) and the depth to extinction of surface light to one percent were determined as indicators of light penetration. The mean seasonal results of these are presented below:

Suspended Solids Measurements

Season	TSS (mg/l)	VS (mg/l)	Turbidity (NTU)
		Western Basin	
Spring	33.2 ± 20.3	5.0 ± 2.3	34.5 ± 29.8
Summer	19.8 ± 2.2	4.7 ± 1.1	22.9 ± 6.3
Fall	20.9 ± 8.6	3.6 ± 1.3	22.2 ± 6.4
		Central Basin	
Spring	5.8 ± 4.2	1.5 ± 0.6	4.5 ± 4.1
Summer	2.0 ± 0.3	1.0 ± 0.2	1.5 ± 0.3
Fall	6.2 ± 2.3	1.6 ± 0.6	5.0 ± 1.1

Light Penetration Measurements

Season	Transparency (m)	Light Extinction Depth to 1% of Surface (m)
	Western Basin	
Spring	0.7 ± 0.3	2.7 ± 1.6
Summer	1.4 ± 0.2	4.0 ± 0.6
Fall	0.9 ± 0.1	2.4
	Central Basin	
Spring	2.2 ± 1.0	9.2 ± 5.6
Summer	5.0 ± 1.3	12.5 ± 1.9
Fall	1.6 ± 0.4	4.0 ± 0.5

Chlorophyll Concentrations and Quantities

Chlorophyll a (corrected) concentrations for each cruise are presented in Tables 4 and 5, and quantities in metric tons are given in Appendices C and D for the western and central basin, respectively. A comparison of seasonal concentrations for the two basins are presented below:

Chlorophyll Concentrations in Western and Central Lake Erie

Season	Western Basin (ug/l)	Central Basin (ug/l)
Spring	6.4 ± 3.4	3.0 ± 1.2
Summer	10.7 ± 4.9	2.8 ± 0.9
Fall	12.1 ± 5.5	5.5 ± 0.6

Dissolved Substances Concentrations and Distribution

Specific conductance (conductivity) and hydrogen-ion concentrations (pH) were measured as indicators of dissolved substances. Distribution patterns for conductivity (Maps 63 and 64, Appendix A) show a gradual increase in the dissolved solids from west to east. A seasonal comparison of conductivity and pH values for the western and central basins are given below:

Specific Conductance and pH Measurements in Western and Central Lake Erie

	WESTERN BASIN		CENTRAL BASIN	
Season	Conductivity (umhos/cm)	pH (units)	Conductivity (umhos/cm)	pH (units)
Spring	226 ± 52	8.1 ± 0.4	268 ± 7	8.4 ± 0.2
Summer	275 ± 6	8.2 ± 0.2	278 ± 3	8.1 ± 0.1
Fall	196 ± 34	8.2 ± 0.3	291 ± 6	8.0 ± 0.1

Trophic Status

Trophic status maps of Lake Erie were prepared for the three, ice-free seasons of 1978, 1979 and 1980, using the computational techniques of Rockwell et al. (1980). These maps (Figures 4-12) classify the regions of the lake in terms of classical trophic subdivision: oligotrophic, mesotrophic and eutrophic. The consensus of the three systems used to develop these maps shows the western basin to be primarily eutrophic during May, July and November cruises for all three years. The central and eastern basins were primarily mesotrophic in May, July and November of 1978 and 1979. No data is available for the eastern basin in 1980, but the central basin was again mesotrophic. In all three years the Sandusky sub-basin of the central basin was mostly eutrophic. In July for all three years, deeper portions of the central basin were classified as oligotrophic. No changes or trends in the trophic status of the lake can be seen during this limited time span.

WATER QUALITY TRENDS: 1970-1980

Prior to 1970, water quality investigations of Lake Erie were conducted at sporadic intervals with a wide variety of field procedures and analytical techniques. For these reasons it is difficult to document long-term trends to any degree of accuracy. Starting with Project Hypo in 1970 (a joint Canadian-United States project to investigate the eutrophication of Lake Erie), consistent shipboard and laboratory procedures have been utilized by the several research groups monitoring the status of the open waters of Lake Erie. Cruises have been undertaken each year in the three basins of the lake by the following organizations: 1) Canada Centre for Inland Waters (CCIW), 2) Center for Lake Erie Area Research (CLEAR), 3) Great Lakes Laboratory (GLL) and 4) Great Lakes National Program Office (USEPA). The schedules for these cruises are presented in Appendix B, and essential water quality findings are listed in Appendices C, D and E for the western, central and eastern basins, respectively. Appendices F, G and H contain information on the stratification characteristics of these basins for each cruise.

Water quality trends for the period 1970-1980 are discussed in this section. Data has been analyzed for the following characteristics: 1) water level, 2) thermal structure, 3) dissolved oxygen, 4) nutrients, 5) transparency, 6) chlorophyll and 7) dissolved substances. An assessment of the significance of these trends in terms of loading and trophic status is also presented.

Water Level

During the past decade (1970-1980) the mean annual water level in Lake Erie has been well above the 1900-1980 mean level of the lake (Figure 13). In 1973 the lake attained the maximum recorded level, nearly one meter above the long-term mean. In the last decade, the lowest lake levels were recorded in 1970 and 1977 when the lake stood only slightly above the long-term mean.

Water level changes of these magnitudes can have a significant influence on the volume of water in the lake (Appendix D). A comparison of maximum volume of water held in the central basin for 1970 and 1973 is given below:

Volume of Water in Lake Erie

Year	Central Basin	Percent Difference
1970	274.5 km^3	12%
1973	312.2 km^3	

Periods of low water level, such as 1970 and 1977, appear to be associated with periods of high turbidity in the western basin and high concentrations of total phosphorus in the western and central basins (Figure 16), but these associations are not strong or statistically significant. However, the loading of total phosphorus to Lake Erie (Figure 14) does show a more positive correlation with water levels. High water represents periods of high flow from the Detroit River and other tributaries, which enhances the delivery of phosphorus to Lake Erie.

Thermal Structure

The western basin of Lake Erie is essentially isothermal throughout the year. This basin was determined to be unstratified during all 64 cruises undertaken during the period 1970-1980 (Appendix F). However, periods of temporary stratification in isolated areas of the western basin have been reported by Britt (1955), Carr et al. (1965) and Zapotosky and Herdendorf (1980). Such stratification is usually transitory in nature but can result in severe oxygen depletion conditions due to high oxygen demand of the sediments.

The central basin of Lake Erie typically stratifies in early June and turns over in early September (Table 8 and Appendix G). The mean thicknesses of the epilimnion, mesolimnion and hypolimnion during the period 1973-1980 are presented below:

Central Lake Erie Thermal Strata

Strata	Thickness (m)
epilimnion	12.4 ± 2.3
mesolimnion	2.3 ± 1.4
hypolimnion	5.0 ± 1.6

In general, the hypolimnion decreases in thickness and increases in temperature throughout the stratified period. Table 8 shows the mean thicknesses and temperatures as follows for the period 1973-1980:

Hypolimnion Thicknesses and Temperatures

Period	Thickness (m)	Temperature (°C)
June	6.6 ± 0.8	8.9 ± 1.5
July	5.5 ± 1.1	11.4 ± 2.0
August	4.7 ± 1.4	12.3 ± 1.3
September	3.7 ± 1.3	13.8 ± 2.8

The thickness of the hypolimnion appears to be related to the extent of anoxic conditions in the central basin. Herdendorf (1980) found that in 1975 the thickness of the hypolimnion was considerably thicker than earlier years of the decade and that the areal extent of anoxia was greatly reduced (Table 10). The average hypolimnion thicknesses and temperatures for the central basin, 1973-1980, are listed below:

Average Hypolimnion Characteristics

Year	Thickness (m)	Temperature (°C)
1973	4.1 ± 1.0	12.0 ± 1.8
1974	5.0 ± 1.0	11.5 ± 2.5
1975	7.1 ± 0.6	8.1 ± 1.9
1976	4.8 ± 2.6	11.6 ± 3.0
1977	4.1 ± 2.1	11.1 ± 0.6
1978	5.6 ± 1.2	11.6 ± 1.7
1979	4.2 ± 1.5	14.1 ± 4.6
1980	5.7 ± 0.5	12.8 ± 0.3

The eastern basin of Lake Erie is normally stratified from June through October or early November (Appendix H). The mean thicknesses of the epilimnion, mesolimnion and hypolimnion during 1978 are presented below:

Eastern Lake Erie Thermal Strata

Strata	Thickness (m)
epilimnion	13.1 ± 6.0
mesolimnion	8.5 ± 4.0
hypolimnion	12.5 ± 1.0

Generally the hypolimnion in the eastern basin is of sufficient thickness that severe oxygen depletion problems do not develop.

The thermal structure of Lake Erie is highly dependent on wind and other meteorological conditions. Calm weather in the western basin can be effective in forming transitory stratification during the summer months. In the central and eastern basins, calm weather during the late spring can result in a shallow thermocline and a correspondingly thick hypolimnion. This situation occurred in 1975 with a dramatic impact on the oxygen levels in the central basin hypolimnion and is well-documented by Herdendorf (1980).

Dissolved Oxygen

Low concentrations of dissolved oxygen, particularly in the central basin hypolimnion, is one of the most important environmental problems plaguing Lake Erie. Small areas of anoxic water in the central basin were observed as early as 1930 (Fish, 1960). The size of the late summer anoxic portion of the lake continued to grow for the next several decades until 1973, when approximately 94 percent of the hypolimnion had oxygen concentrations below 0.5 mg/l (Herdendorf, 1980). More recent surveys have shown wide fluctuations in the size of the anoxic area in the central basin, primarily due to the meteorological conditions discussed earlier, but the area and the percent of the hypolimnion experiencing anoxia have declined significantly in the period 1975 to 1980:

Central Lake Erie Anoxic Area Trends

Period	Anoxic Area (km^2)	Percent Hypolimnion	Total Basin
1970-1974	9,000 ± 2,100	78 ± 15	56 ± 13
1975-1980	3,800 ± 2,500	40 ± 28	26 ± 18

The estimated areas of anoxic hypolimnion of central Lake Erie for the period 1930 to 1980 are presented in Table 9.

Another method for determining trends in the oxygen concentrations in hypolimnetic waters of the central and eastern basins involves determining the loss of oxygen in the interval between two cruises. Table 10 lists the net oxygen demand for 1930 to 1980 based on daily losses per unit area and per unit volume. Rates of loss for major blocks of years are compared below:

Net Oxygen Loss Per Day

	CENTRAL BASIN		EASTERN BASIN	
Period	Area (g/m^2)	Volume (mg/l)	Area (g/m^2)	Volume (mg/l)
1930-1970	0.25 ± .13	0.079 ± .022		
1970-1975	0.55 ± .12	0.115 ± .013	0.57 ± .24	0.034 ± .017
1976-1980	0.57 ± .13	0.111 ± .016	0.59 ± .01	0.048 ± .013

From these data it can be seen that the central basin hypolimnion has experienced a significant increase in the rate of oxygen loss for the period 1930-1970, but since 1970 the net oxygen demand has been relatively stable. The stability of the oxygen depletion rate from 1970 to 1980 in central Lake Erie, particularly during the month of August, is illustrated in Figure 14. Early data is not available for the eastern basin, but a slight increase is indicated from the first half to the second half of the past decade.

Nutrients

Phosphorus has been identified as a limiting nutrient for algal productivity in Lake Erie (Hartley and Potos, 1971). Cruise mean concentrations and quantities of total and soluble reactive phosphorus for the period 1970-1980 are presented in Appendices C, D and E for the western, central and eastern basins of Lake Erie, respectively. Annual mean concentrations for this period for the three basins are presented below:

Total Phosphorus Concentrations in Lake Erie (ug/l)

Year	BASIN Western	Central	Eastern
1970 (CCIW)	44.6 ± 9.6	20.5 ± 7.8	17.5 ± 7.0
1973 (CLEAR/GLL)	34.7 ± 11.9	18.5 ± 6.2	31.1 ± 22.6
1974 (CLEAR/GLL)	35.1 ± 8.8	16.8 ± 2.7	20.8 ± 6.9
1975 (CLEAR/GLL)	42.3 ± 8.6	20.3 ± 6.8	27.6 ± 9.2
1976 (CLEAR)	44.9 ± 15.0	22.5 ± 5.2	
1977 (CLEAR)	40.7 ± 10.9	24.1 ± 8.1	18.3 ± 4.1
1978 (CCIW)		14.2 ± 1.2	13.0 ± 2.5
1979 (GLNPO)	33.9 ± 24.8	13.4 ± 2.7	10.8 ± 5.4
1980 (CLEAR)	28.8 ± 6.6	13.7 ± 6.9	
1970-1975	39.2 ± 5.0	19.0 ± 1.7	24.3 ± 6.2
1976-1980	37.1 ± 7.4	17.6 ± 5.3	14.0 ± 3.9
1978-1980	31.4 ± 3.6	13.8 ± 0.4	11.9 ± 1.6

When concentrations for the first half of the decade are compared to those of the second half, very little difference can be seen between the western and central basins; however, data for 1978-1980 does show a significant decline. The eastern basin data shows a consistent reduction in total phosphorus from 1975 to 1979.

The loading of total phosphorus to the lake has declined at an average rate of 814 metric tons per year for the period 1970-1979 (Figure 15). The 1970 loading to the entire lake from all sources, except shoreline erosion, was 23,724 metric tons; in 1979 the total loading is estimated at 13,809 metric tons. Figure 15 illustrates the quantity

of total phosphorus in the central basin during the period 1970-1980. A progressive decline in the quantity of phosphorus in the lake, similar to that shown in the loading diagram (Figure 15) is not apparent. This can be partially explained by phosphorus releases from sediment through wave resuspension and anoxic regeneration. Several investigations have demonstrated that approximately 80 percent of the phosphorus loading to Lake Erie becomes incorporated into the bottom sediments (Burns, 1976 and Herdendorf, 1980).

Figure 17 shows both total and soluble reactive phosphorus increasing in minimum summer quantities in the central basin for the period 1970 to 1976. Cruise data for 1978-1980, however, begins to show a response to decreasing phosphorus loading with lower summer minima and annual quantities.

Transparency

An analysis of Lake Erie transparency was performed for the period 1973-1980 by area-weighting secchi disk results from 35 cruises in the western basin, 41 in the central basin and 5 in the eastern basin (Table 11). No significant trends or improvements were demonstrated by the data. The mean summer values for each basin are presented below:

Secchi Disk Transparency

Year	Western	Central	Eastern
1973	1.94 ± 0.17 m	5.45 ± 1.01 m	
1974	1.72 ± 0.50 m	5.69 ± 0.81 m	
1975	1.21 ± 0.39 m	5.51 ± 2.24 m	
1976	1.82 ± 1.36 m	4.41 ± 0.02 m	
1977	1.09 ± 0.00 m	5.55 ± 0.94 m	5.60 ± 1.78 m
1978	2.14 ± 0.30 m	5.52 ± 1.45 m	5.74 ± 1.27 m
1979	2.19 ± 0.68 m	5.02 ± 1.33 m	5.27 ± 1.98 m
1980	1.58 ± 0.13 m	5.88 ± 1.18 m	

The year with the poorest water clarity in the western basin (1977) coincides with the year of the lowest lake level (Figure 13). This suggests that wave resuspension of bottom sediments may be more effective during low water periods. Transparency in the central basin was relatively constant throughout the period with the exception of 1976 when the mean decreased more than one meter from adjacent years. This may be the result of an early fall turnover (Table 4). From the limited data for the eastern basin, it appears that mean transparencies in the eastern and central basins are very similar. In general, the central basin transparency exceeds that of the western basin by a factor of 3.5.

Chlorophyll

Chlorophyll serves as a useful indicator of algal productivity in Lake Erie. Concentrations and quantities of corrected chlorophyll a for 1970-1980 cruises are given in Appendices C, D and E for the western, central and eastern basins, respectively. Annual mean concentrations for the three basins are listed below:

Chlorophyll a, Corrected, Concentrations in Lake Erie (ug/l)

Year	BASIN Western	Central	Eastern
1970 (CCIW)	8.6 ± 4.6	4.5 ± 2.1	3.3 ± 1.4
1973 (CLEAR/GLL)	10.7 ± 2.1	4.6 ± 2.9	5.1 ± 1.8
1974 (CLEAR/GLL)	13.4 ± 3.4	4.2 ± 2.6	5.1 ± 1.6
1975 (CLEAR/GLL)	13.7 ± 5.9	5.9 ± 2.8	3.6 ± 1.3
1976 (CLEAR)	12.4 ± 4.6	5.2 ± 2.4	
1977 (CLEAR)	10.8 ± 6.1	4.0 ± 1.4	3.0 ± 1.1
1978 (GLNPO)	12.5 ± 4.3	5.2 ± 2.1	3.2 ± 1.3
1979 (GLNPO)	11.5 ± 4.5	5.1 ± 1.7	2.7 ± 0.9
1980 (CLEAR)	8.4 ± 3.1	3.1 ± 1.0	
1970-1975	11.6 ± 2.4	4.8 ± 0.8	4.3 ± 1.0
1976-1980	11.1 ± 1.7	4.5 ± 0.9	3.0 ± 0.3
1979-1980	10.0 ± 2.2	4.1 ± 1.4	2.7 ± 0.9

A comparison of the first half of the past decade to the last half shows very small differences and no discernable trends for the western and central basins. However, in likely response to reduced phosphorus concentrations, the 1980 chlorophyll levels indicate a possible decline in algal biomass. Figure 18 also demonstrates this trend with a marked lowering in the quantity of central basin chlorophyll a in 1980. Similar trends for surface water chlorophyll a concentrations in all three basins are illustrated in Figures 19-21, with decreased minima, maxima and means compared with most years of the preceding decade.

Dissolved Substances

Trends in dissolved substances in Lake Erie water can be inferred from Lake Erie conductivity measurements and determination of major conservative ions, such as sulfate and chloride. STORET data files for the period 1966 to 1980 were used for a trend analysis, based on central basin cruise data supplied by Canada Centre for Inland Waters (CCIW), Ontario Ministry of Environment (MOE), USEPA, Great Lakes National Program Office (GLNPO) and Ohio State University, Center for Lake Erie Area Research (CLEAR). Ontario Ministry of Environment data was obtained from stations 1-7 km offshore, while data from the other three groups were from open

lake stations, generally five or more km offshore. Data points on Figures 22-24 represent cruise mean values for periods of isothermal lake conditions (March-May and October-December). Annual mean values for conductivity, chloride and sulfate are listed below:

Dissolved Substances Trends in Central Lake Erie

Year	Conductivity (umhos/cm)	Chloride (mg/l)	Sulfate (mg/l)
1966	311	25.0	
1967	319 ± 0.6	24.4 ± 0.4	
1968	314 ± 3.4	24.4 ± 1.4	26.4 ± 1.1
1969	308 ± 8.6	23.7 ± 0.9	23.4
1970	312 ± 7.2	22.5 ± 1.0	23.1 ± 1.7
1971	318 ± 9.5	24.3 ± 1.2	24.0 ± 0.8
1972	303 ± 8.3	22.2 ± 1.5	
1973	289 ± 3.1	21.2 ± 2.6	22.4 ± 0.9
1974	282 ± 24.9	19.4 ± 2.8	21.7 ± 3.5
1975	282 ± 20.0	19.9 ± 1.6	22.5 ± 3.4
1976	283 ± 23.3	19.4 ± 4.2	
1977	272	19.5 ± 1.7	
1978	289 ± 8.4	19.6 ± 1.4	21.6 ± 5.2
1979	288 ± 2.9	18.4 ± 1.3	23.4 ± 1.1
1980	287 ± 10.7		
1966-1970	313 ± 4.1	24.0 ± 1.0	24.3 ± 1.8
1970-1975	298 ± 15.6	21.6 ± 1.8	22.7 ± 0.8
1975-1980	284 ± 6.3	19.4 ± 0.6	22.5 ± 0.9

Conductivity (Figure 22) indicates a rather slow decline for mean levels for the period of record. The mean value for 1975-1980 (284 umhos/cm) is approximately nine percent lower than the mean 1966-1970 value (313 umhos/cm). Trends in central basin chloride (Figure 23) shows a more noticeable decline from a mean concentration of 24.0 mg/l for 1966-1970 to 19.4 mg/l for 1975-1979. Sulfate concentrations showed a weaker but discernable trend (Figure 24), falling from a mean concentration of 24.8 mg/l for 1968-1970 to 22.5 mg/l for 1975-1979.

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TABLES

TABLE 1. DATES FOR 1980 LAKE ERIE WATER QUALITY CRUISES

Cruise Number	Calendar Date	Julian Date	Julian Mid-point
1	April 1 - April 4	092 - 095	094
2	April 28 - May 2 plus May 13	119 - 123 + 134	121
3	May 27 - June 2	148 - 154	151
4	June 29 - July 6	181 - 188	185
5	July 28 - August 8	210 - 221	216
6	August 18 - August 23	231 - 236	234
7	August 28 - September 6	241 - 250	246
8	September 27 - October 1	271 - 275	273
9	October 27 - November 5	301 - 310	306
10	November 23 - December 4	328 - 339	334

TABLE 2. GEOGRAPHIC COORDINATES OF 1980 LAKE ERIE WATER QUALITY MONITORING STATIONS

Station Number	Latitude (N)	Longitude (W)	Water Depth (m)	Basin	Water Quality Grid No.
24	42°05'54"	80°29'00"	19.5	central	19
25	42°14'54"	80°33'36"	21.5	central	20
26	42°24'00"	80°38'12"	19.8	central	20
27	42°32'54"	80°45'30"	16.0	central	21
29	42°36'18"	80°17'54"	12.3	central	22
30	42°25'48"	80°12'18"	20.5	central	23
31	42°15'12"	81°06'24"	21.3	central	24
32	42°04'54"	81°00'42"	21.5	central	25
33	41°55'54"	80°55'00"	17.7	central	26
35	41°45'48"	81°23'00"	12.6	central	27
36	41°56'06"	81°28'42"	22.9	central	28
37	42°06'36"	81°34'30"	23.9	central	29
38	42°16'54"	81°40'18"	21.6	central	30
39	42°21'30"	81°42'24"	18.7	central	31
40	42°11'30"	81°55'18"	16.8	central	32
41	42°08'06"	82°08'24"	20.4	central	32
42	41°57'54"	80°02'30"	22.2	central	33
43	41°47'18"	81°56'42"	22.6	central	34
44	41°31'48"	81°42'30"	12.3	central	36
45	41°36'24"	81°53'48"	17.5	central	35
46	41°40'54"	82°05'12"	19.5	central	37
47	41°50'18"	82°12'48"	18.9	central	38
48	42°02'48"	82°21'54"	17.0	central	39
50	41°48'48"	82°30'06"	11.0	central	40
51	41°38'30"	82°24'12"	13.5	central	41
53	41°25'12"	82°30'12"	10.8	central	42

(continued)

TABLE 2 (continued)

Station Number	Latitude (N)	Longitude (W)	Water Depth (m)	Basin	Water Quality Grid No.
54	41°34'00"	82°38'06"	11.9	central	43
55	41°44'18"	82°44'00"	10.3	western	44
57	41°49'54"	83°01'06"	9.9	western	48
59	41°43'36"	83°09'00"	8.2	western	47
61	41°56'48"	83°02'42"	8.8	western	61
66	41°58'00"	82°41'00"	10.7	western	45
75	41°54'00"	83°18'00"	6.1	western	49
76	41°36'30"	83°04'00"	4.0	western	46
84	41°46'00"	83°20'00"	9.7	western	49
M-1 (202)	41°41'48"	83°28'00"	9.6	western	N
D-1 (401)	42°03'00"	83°08'30"	10.4	western	N

TABLE 3. ANALYTICAL METHODS SUMMARY FOR 1980 LAKE ERIE WATER QUALITY DETERMINATION

Parameter	Storet Number	Unit	Method or Procedure	Accuracy (+) or Detection Limit
Temperature	00010	°C	InterOcean *in situ* probe, profile	± 0.05
Dissolved Oxygen	00300	mg/l	Azide modified winkler	± 0.1
Phosphorus, Total	00665	ug/l	Technicon AAII stannous chloride	0.5
Total Dissolved	00666	ug/l	Technicon AAII stannous chloride	0.5
Soluble Reactive	00671	ug/l	Technicon AAII stannous chloride	0.5
Nitrate plus Nitrite	00630	ug/l	Technicon AAII cadmium reduction	5
Dissolved Reactive Silica	00955	ug/l	Technicon AAII molybdosilicate-ascorbic-oxalic acid	30
Solids, Total Suspended (residue, filterable)	00530	mg/l	Glass filter pads, drying and ignition	0.2
Solids, Volatile (residue, filter, volatile)	00520	mg/l	Glass filter pads, drying and ignition	0.2

(continued)

TABLE 3 (continued)

Parameter	Storet Number	Unit	Method or Procedure	Accuracy (+) or Detection Limit
Turbidity	00076	NTU	Hach nephelometer	0.1
Transparency	00078	meters	Secchi disk	0.1
Light Extinction (1%)	NA	meters	Protomatic *in situ* cell	0.1
Transmissibility	NA	%	Martek *in situ* probe	1
Chlorophyll *a*, Corrected	32211	ug/l	Spectrophotometric, acetone extraction	0.3
Conductance, Specific at 25°C	00095	umhos/cm	InterOcean *in situ* probe	± 2
pH	00400	units	InterOcean *in situ* probe	± 0.02
Alkalinity	00410	mg/l as $CaCO_3$	pH end point titration	0.5

TABLE 4. LAKE ERIE WATER QUALITY MEASUREMENTS--1980
WESTERN BASIN CRUISE MEAN CONCENTRATIONS

Cruise Number	Date	Limnion	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (%)	Total Phosphorus (ug/l)
1	4/1 -4/2	Surface	3.90	12.13	95.62	99.40
		Bottom	4.10	11.92	94.20	116.95
		Mean	4.00	12.03	94.91	108.18
2	4/28-4/30	Surface	9.83	10.71	93.26	52.36
		Bottom	9.54	10.51	91.17	54.94
		Mean	9.69	10.61	92.22	53.65
3	5/27-5/29	Surface	18.31	9.76	100.4	44.61
		Bottom	16.79	8.71	87.1	57.97
		Mean	17.55	9.24	93.7	51.29
4	6/29-6/30	Surface	21.49	7.84	87.13	58.20
		Bottom	21.03	7.53	82.77	63.43
		Mean	21.26	7.69	84.95	60.81
5	7/28	Surface	24.40	7.37	87.79	53.96
		Bottom	23.91	6.74	79.49	60.57
		Mean	24.16	7.06	83.64	57.27
7	8/28-8/29	Surface	25.33	8.77	107.19	78.91
		Bottom	23.53	5.49	64.23	91.70
		Mean	24.43	7.13	85.71	85.31
8	7/27-7/28	Surface	18.09	8.16	83.87	83.87
		Bottom	17.84	8.44	86.51	84.41
		Mean	17.97	8.30	85.19	84.14
9	11/5	Surface	7.74	10.93	92.00	76.49
		Bottom	7.73	10.87	91.49	85.69
		Mean	7.74	10.90	91.74	81.09
10	11/23	Surface	3.33	11.67	91.17	36.61
		Bottom	3.34	11.63	90.84	48.87
		Mean	3.34	11.65	91.01	42.74

(continued)

TABLE 4 (continued)

Cruise Number/ Limnion*	Soluble Reactive Phosphorus (ug/l)	Nitrate + Nitrite (ug/l)	Dissolved Reactive Silica (ug/l)	Total Suspended Solids (mg/l)	Volatile Suspended Solids (mg/l)	Turbidity (NTU)
1 S	28.25	2045	2393	49.67	6.81	37.18
B	28.67	2175	2547	62.79	8.42	74.02
M	28.46	2110	2470	56.23	7.61	55.60
2 S	14.14	1520	2104	24.34	3.63	12.73
B	13.47	1532	2136	26.68	4.34	14.17
M	13.81	1526	2120	25.51	3.98	13.45
3 S	17.89	1938	1113	14.96	3.62	N.A.
B	16.66	1716	1039	20.75	3.12	N.A.
M	17.27	1827	1076	17.86	3.38	N.A.
4 S	14.09	1438	1587	18.94	5.67	17.91
B	11.69	1153	1414	25.70	6.12	23.96
M	12.89	1296	1501	22.32	5.89	20.93
5 S	16.83	994	2452	10.15	4.13	27.62
B	18.00	983	1754	27.33	3.37	32.20
M	17.42	989	2103	18.74	3.75	29.91
7 S	15.51	558	1721	13.92	3.43	13.90
B	21.34	569	2386	23.01	5.46	21.86
M	18.43	563	2054	18.46	4.44	17.88
8 S	N.A.	442	1301	19.06	3.87	19.00
B	N.A.	351	1084	22.90	4.22	23.59
M	N.A.	397	1193	20.98	4.04	21.29
9 S	3.76	258	896	22.27	3.91	26.73
B	4.69	273	900	36.74	5.30	31.23
M	4.22	266	898	29.51	4.61	28.98
10 S	2.99	256	840	17.70	2.73	15.51
B	3.27	257	845	6.76	1.73	17.27
M	3.13	257	843	12.23	2.22	16.39

(continued)

TABLE 4 (continued)

Cruise Number/ Limnion*	Transparency (m)	Light Extinction Depth, 1% Surface (m)	Corrected Chlorophyll a (ug/l)	Conductivity (umhos/cm)	pH (units)
1 S	0.4	1.03	2.20	180	8.20
B			3.77	196	8.24
M			2.99	188	8.22
2 S	0.7	3.0	6.67	192	8.40
B			6.39	218	8.35
M			6.53	205	8.38
3 S	1.0	4.2	11.27	301	7.62
B			8.16	270	7.55
M			9.72	286	7.59
4 S	1.3	3.6	6.22	275	8.11
B			4.19	260	8.16
M			5.21	268	8.14
5 S	1.4	4.4	12.76	279	8.26
B			11.81	279	7.77
M			12.29	279	8.01
7 S	1.6	N.A.	16.40	285	8.65
B			12.97	274	8.14
M			14.69	279	8.40
8 S	0.8	2.41	15.73	240	8.45
B			16.76	230	8.46
M			16.25	235	8.46
9 S	0.9	N.A.	13.34	181	8.10
B			14.68	182	8.11
M			14.01	182	8.11
10 S	0.9	N.A.	6.13	170	7.95
B			5.65	173	7.97
M			5.89	172	7.96

*S = surface, B = bottom, M = mean.

TABLE 5. LAKE ERIE WATER QUALITY MEASUREMENTS--1980
CENTRAL BASIN CRUISE MEAN CONCENTRATIONS

Cruise Number	Date	Limnion	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (%)	Total Phosphorus (ug/l)
1	4/3 - 4/4	Surface	2.14	13.8	104.9	23.06
		Mid-water	2.14	13.8	105.0	23.19
		Bottom	2.14	13.8	105.0	23.14
		Mean	2.14	13.8	105.0	23.13
2	5/1 - 5/13	Surface	7.97	12.25	103.4	8.69
		Mid-water	7.12	11.94	99.4	11.99
		Bottom	6.50	11.55	95.1	16.17
		Mean	7.20	11.91	99.3	12.28
3	5/31- 6/2	Epi	13.53	10.71	99.9	3.79
		Meso	12.05	10.24	93.6	3.63
		Hypo	9.64	9.34	81.4	5.13
		Mean	11.74	10.10	91.6	4.02
4	7/2 - 7/6	Epi	18.48	9.36	99.0	6.54
		Meso	14.36	8.36	87.6	8.23
		Hypo	12.71	7.79	70.7	10.67
		Mean	16.64	8.87	85.8	7.76
5	8/4 - 8/8	Epi	23.46	8.49	101.1	4.20
		Meso	17.40	6.18	76.4	6.98
		Hypo	13.05	4.46	45.1	8.84
		Mean	20.33	7.28	74.2	5.61
6	8/18- 8/23	Epi	22.63	8.07	93.5	12.04
		Meso	16.82	5.20	65.9	12.66
		Hypo	12.48	2.98	31.0	12.95
		Mean	20.14	6.83	63.5	12.27
7	9/3 - 9/6	Epi	23.57	8.09	96.9	11.98
		Meso	19.39	5.67	62.2	9.99
		Hypo	15.41	2.92	30.5	10.41
		Mean	19.46	5.56	63.2	11.27

(continued)

TABLE 5 (continued)

Cruise Number	Date	Limnion	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (%)	Total Phosphorus (ug/l)
8	9/29-10/1	Surface	18.66	8.78	91.9	22.20
		Mid-water	18.25	8.29	86.2	21.75
		Bottom	17.19	5.47	56.9	32.16
		Mean	18.03	7.51	78.3	25.37
9	10/28-10/29	Surface	10.33	9.91	87.7	26.33
		Mid-water	10.32	9.89	87.5	26.84
		Bottom	10.32	9.91	87.7	28.72
		Mean	10.32	9.90	87.6	27.30
10	12/1 -12/4	Surface	4.33	11.51	91.4	20.61
		Mid-water	4.33	11.31	89.8	22.81
		Bottom	4.33	11.34	90.0	24.68
		Mean	4.33	11.39	90.4	22.70

(continued)

TABLE 5 (continued)

Cruise Number/ Limnion*	Soluble Reactive Phosphorus (ug/l)	Nitrate + Nitrite (ug/l)	Dissolved Reactive Silica (ug/l)	Total Suspended Solids (mg/l)	Volatile Suspended Solids (mg/l)	Turbidity (NTU)
1 S	2.06	350	273	10.18	2.02	8.77
MW	1.81	353	272	10.45	2.17	9.10
B	0.89	355	276	10.43	2.29	9.30
M	1.59	353	274	10.35	2.16	9.06
2 S	1.94	304	101	3.48	1.16	2.46
MW	1.55	329	109	3.65	1.24	1.78
B	1.48	344	137	7.44	1.85	4.49
M	1.66	327	116	4.86	1.42	2.91
3 EL	1.29	288	67	1.79	0.98	1.17
ML	1.27	312	138	1.87	1.00	1.25
HL	1.65	279	277	2.93	1.14	1.79
M	1.35	293	161	2.20	1.04	1.40
4 EL	2.11	186	293	1.27	0.80	0.98
ML	2.43	192	451	1.99	0.65	1.47
HL	3.21	208	724	3.16	0.94	2.40
M	2.43	195	489	2.14	0.80	1.62
5 EL	1.32	142	219	1.34	0.97	0.84
ML	1.35	170	586	1.63	1.01	1.10
HL	2.37	192	1242	2.34	1.00	1.88
M	1.57	168	682	1.77	0.99	1.27
6 EL	1.39	126	293	1.63	1.07	0.94
ML	1.56	155	722	1.76	1.01	1.14
HL	2.19	203	1524	2.28	0.98	1.59
M	1.57	161	846	1.89	1.02	1.22
7 EL	1.52	77	430	2.34	1.61	1.57
ML	1.56	132	962	1.97	1.25	1.55
HL	1.97	191	1689	2.70	1.07	2.15
M	1.62	133	1027	2.34	1.31	1.76

(continued)

TABLE 5 (continued)

Cruise Number/ Limnion*	Soluble Reactive Phosphorus (ug/l)	Nitrate + Nitrite (ug/l)	Dissolved Reactive Silica (ug/l)	Total Suspended Solids (mg/l)	Volatile Suspended Solids (mg/l)	Turbidity (NTU)
8 S	1.59	89	419	3.07	1.28	2.95
MW	1.37	84	432	3.30	0.67	3.22
B	5.44	93	1229	4.69	1.09	5.04
M	2.80	89	560	3.69	1.02	3.74
9 S	4.97	121	398	6.27	1.54	5.74
MW	4.66	120	399	6.61	1.49	5.75
B	5.37	121	404	6.88	1.56	6.02
M	5.00	121	400	6.59	1.53	5.84
10 S	3.32	124	167	7.36	2.81	5.19
MW	3.32	128	150	6.32	1.63	5.29
B	2.88	123	151	10.90	2.00	5.91
M	3.17	125	156	8.19	2.14	5.46

(continued)

TABLE 5 (continued)

Cruise Number/ Limnion*	Transparency (m)	Light Extinction Depth, 1% Surface (m)	Light Transparency (%)	Corrected Chlorophyll a (ug/l)
1 S	1.1	3.9	N.A.	3.55
MW				3.07
B				3.11
M				3.24
2 S	2.7	8.7	N.A.	3.67
MW				3.75
B				4.88
M				4.10
3 S	2.9	15.0	N.A.	1.78
MW				1.64
B				1.64
M				1.75
4 EL	6.7	14.3	88.7	1.61
ML			87.4	1.37
HL			81.8	1.32
M			86.1	1.52
5 EL	5.4	12.7	41.0	2.79
ML			37.1	2.69
HL			28.4	2.49
M			34.5	2.71
6 EL	4.2	N.A.	33.1	4.16
ML			30.8	3.37
HL			25.6	2.13
M			29.8	3.61
7 EL	3.7	10.5	N.A.	3.85
ML				2.86
HL				1.49
M				3.25

(continued)

TABLE 5 (continued)

Cruise Number/ Limnion*	Transparency (m)	Light Extinction Depth, 1% Surface (m)	Light Transparency (%)	Corrected Chlorophyll a (ug/l)
8 S	2.0	3.7	N.A.	7.15
MW				6.12
B				5.09
M				6.12
9 S	1.5	3.7	N.A.	4.99
MW				4.79
B				5.34
M				5.04
10 S	1.3	4.6	N.A.	5.11
MW				4.96
B				5.65
M				5.24

(continued)

TABLE 5 (continued)

Cruise Number/ Limnion*	Conductivity Corrected to 25°C (umhos/cm)	pH (units)	Total Alkalinity (mg/l)
1 S	261	8.32	N.A.
MW	260	8.41	
B	259	8.45	
M	260	8.39	
2 S	271	8.70	N.A.
MW	271	8.51	
B	274	8.34	
M	272	8.52	
3 EL	268	8.42	N.A.
ML	271	8.19	
HL	277	7.82	
M	272	8.14	
4 EL	277	8.23	93.13
ML	278	7.99	93.48
HL	280	7.57	93.58
M	278	7.93	93.40
5 EL	266	8.48	91.30
ML	273	8.08	92.77
HL	282	7.58	94.41
M	274	8.05	92.83
6 EL	272	8.54	92.73
ML	282	8.12	94.17
HL	292	7.60	96.40
M	282	8.09	94.43
7 EL	266	8.64	N.A.
ML	279	8.22	
HL	288	7.70	
M	278	8.19	

(continued)

TABLE 5 (continued)

Cruise Number/ Limnion*	Conductivity Corrected to 25°C (umhos/cm)	pH (units)	Total Alkalinity (mg/l)
8 S	281	8.21	N.A.
MW	284	8.14	
B	290	7.81	
M	285	8.05	
9 S	293	8.10	N.A.
MW	291	8.11	
B	295	8.11	
M	293	8.11	
10 S	298	7.99	N.A.
MW	293	7.94	
B	296	7.95	
M	296	7.96	

*S = surface, MW = mid-water, B = Bottom, M = mean, EL = epilimnion, ML = mesolimnion, HL = hypolimnion.

TABLE 6. SUMMARY OF 1978-1980 HYPOLIMNETIC SURVEYS OF LAKE ERIE

CRUISE BASIN	DATE	AREA (km^2)	VOLUME (km^3)	AVG. THICKNESS (m)	TOTAL HEAT ($kcal \times 10^{12}$)	AVG. TEMP. (°C)	TOTAL O_2 ($kg\ O_2 \times 10^6$)	MEAN O_2 (mg/l)	AVG. T-GRAD* ($°C\ m^{-1}$)	AVG. O_2 GRAD* ($g\ O_2\ m^{-4}$)
Central	1978									
4	6/22-7/2	14,164	79.8	5.6	739.75	9.27	879.40	11.02	1.26	0.053
5	7/19-7/29	14,188	100.3	7.0	1,252.75	12.49	754.26	7.52	1.66	0.22
6	8/8-8/20	12,752	69.8	5.5	804.79	11.53	379.01	5.43	2.27	0.70
7	8/29-9/6	11,960	51.7	4.3	678.30	13.12	155.10	3.00	2.48	1.45
Central	1979									
3	5/15-5/26	13,976	78.2	5.6	765.58	9.79	943.09	12.06	0.60	0.23
5	7/10-7/19	11,320	49.4	4.4	693.23	14.09	354.73	7.21	2.44	1.00
8	9/11-9/21	8,704	23.5	2.7	434.05	18.47	147.58	6.28	1.06	1.29
Central	1980									
4	7/2-7/6	13,168	81.4	6.2	1,034.81	12.71	633.95	7.79	3.39	0.92
5	8/4-8/8	12,488	72.9	5.8	951.38	13.05	324.81	4.46	4.00	1.55
6	8/18-8/23	12,528	65.1	5.2	812.56	12.48	193.97	2.98	6.34	3.18

TABLE 6 (continued)

CRUISE BASIN	DATE	AREA (km^2)	VOLUME (km^3)	AVG. THICKNESS (m)	TOTAL HEAT ($kcal \times 10^{12}$)	AVG. TEMP. (°C)	TOTAL O_2 ($kg\ O_2 \times 10^6$)	MEAN O_2 (mg/l)	AVG. T-GRAD.* ($°C\ m^{-1}$)	AVG. O_2 GRAD* ($g\ O_2\ m^{-4}$)
Eastern	1978									
4	6/22-7/2	3,944	68.5	17.4	505.53	7.38	790.49	11.54	1.20	0.12
5	7/19-7/29	3,984	53.8	13.5	395.43	7.35	519.71	9.66	1.68	0.09
6	8/8-8/20	3,176	44.2	13.9	380.12	8.60	398.24	9.01	1.96	0.06
7	8/29-9/6	3,280	47.6	14.5	409.36	8.60	407.93	8.57	2.20	0.03
Eastern	1979									
3	5/15-5/26	2,744	24.8	9.0	165.42	6.67	312.23	12.59	0.60	0.05
5	7/10-7/19	3,656	48.6	13.3	424.76	8.74	521.96	10.74	2.03	0.22
8	9/11-9/21	2,856	32.1	11.2	316.19	9.85	249.42	7.77	1.67	0.16
9	10/2-10/11	2,076	17.2	8.2	159.27	9.26	130.03	7.56	1.14	0.32
Eastern	1980									

*Average gradient across the mesolimnion.

TABLE 7. LAKE ERIE HYPOLIMNETIC OXYGEN DEPLETION RATES FOR 1978-1980

Cruise Number	Date			MODEL CALCULATION (BURNS, 1976) RATE: Areal*	Volumetric**
		1978		Central Basin	
4-5	6/22-7/2	to	7/19- 7/29	0.09	0.014
5-6	7/19-7/29	to	8/8 - 8/20	0.66	0.105
6-7	8/8 -8/20	to	8/29- 9/6	0.77	0.157
5-7	7/19-7/29	to	8/29- 9/6	0.71	0.137
Mean (4-7)	6/22-7/2	to	8/29- 9/6	0.51 ± 0.36	0.092 ± 0.072
		1979		Central Basin	
3-5	5/15-5/26	to	7/10- 7/19	0.59	0.12
5-8	7/10-7/19	to	9/11- 9/21	0.22	0.06
Mean (3-8)	5/15-5/26	to	9/11- 9/21	0.405 ± 0.26	0.09 ± .04
		1980		Central Basin	
4-5	7/2 -7/6	to	8/4 - 8/8	0.61	0.101
5-6	8/4 -8/8	to	8/18- 8/23	0.64	0.116
Mean (4-6)	2/3 -7/6	to	8/18- 8/23	0.625 ± 0.02	0.1085 ± 0.011

(continued)

TABLE 7 (continued)

Cruise Number	Date	RATE:	MODEL CALCULATION (BURNS, 1976) Areal*	Volumetric**
			Eastern Basin	
	1978			
4-5	6/22-7/2 to 7/19- 7/29		1.00	0.065
5-6	7/19-7/29 to 8/18- 8/20		0.44	0.032
6-7	8/8 -8/20 to 8/29- 9/6		0.31	0.022
5-7	7/19-7/29 to 8/29- 9/6		0.38	0.027
Mean (4-7)	6/22-7/2 to 8/29- 9/6		0.058 ± 0.37	0.048 ± 0.023
			Eastern Basin	
	1979			
3-5	5/15-5/26 to 7/10- 7/19		0.55	0.048
5-8	7/10-7/19 to 9/11- 9/21		0.61	0.049
8-9	9/11-9/21 to 10/2 -10/11		0.51	0.005
Mean (3-8)	5/15-5/26 to 9/11- 9/21		0.58 ± 0.04	0.0485 ± 0.0007
			Eastern Basin	
	1980			

*Areal rate: g O_2 m^{-2} day^{-1}.

**Volumetric rate: mg O_2 l^{-1} day^{-1}.

TABLE 8. COMPARISON OF 1970-1980 CHARACTERISTICS OF HYPOLIMNION IN CENTRAL LAKE ERIE

	1970 (Project Hypo)	1973	1974	1975	1976	1977	1978	1979	1980
MAY									
Thick (m)	-	-	-	-	-	-	-	5.6	-
DO (mg/l)	-	-	-	-	-	-	-	12.0	-
Temp. (°C)	-	-	-	-	-	-	-	9.8	-
JUNE									
Thick (m)	-	-	6.2	7.7	6.6	6.8	5.6	N.A.	-
DO (mg/l)	-	-	9.9	10.0	9.6	8.3	11.0	N.A.	-
Temp. (°C)	-	-	8.8	6.5	9.4	10.4	9.3	N.A.	-
JULY									
Thick (m)	-	5.0	4.6	6.7	-	4.6	7.1	4.4	6.2
DO (mg/l)	-	4.9	5.2	7.8	-	5.1	7.5	7.2	7.8
Temp. (°C)	-	10.3	11.8	7.7	-	11.0	12.5	14.0	12.7
EARLY AUGUST									
Thick (m)	-	4.4	4.3	6.8	3.0	3.0	5.5	N.A.	5.8
DO (mg/l)	-	1.6	2.1	3.3	0.7	2.1	5.4	N.A.	4.5
Temp. (°C)	-	11.9	13.5	10.2	13.7	11.9	11.5	N.A.	13.1
SEPTEMBER									
Thick (m)	-	3.0	-	-	-	2.1	4.3	2.7	5.2
DO (mg/l)	-	1.1	-	-	-	0.5	3.0	6.3	3.0
Temp. (°C)	-	13.8	-	-	-	11.2	13.1	18.5	12.5
NET OXYGEN DEMAND (loss/day)									
Volume rate ($mg\ O_2/l$)	0.11	0.12	0.13	0.10	0.13	0.13	0.09	0.09	0.11
Area rate ($g\ O_2/m^2$)	0.38	0.53	0.60	0.67	0.75	0.58	0.51	0.41	0.63

Data sources: 1970--CCIW; 1973 to 1977, 1980--OSU/CLEAR; 1978 and 1979--USEPA/GLNPO.

TABLE 9. ESTIMATED AREA OF THE ANOXIC HYPOLIMNION OF THE CENTRAL BASIN OF LAKE ERIE 1930-1980

YEAR	AREA (km^2)	PERCENT OF CENTRAL BASIN	
		Hypolimnion	Total Basin
1930	300	3.0	1.9
1959	3,600	33.0	22.3
1960	1,660	15.0	10.3
1961	3,640	33.0	22.5
1964	5,870	53.0	36.3
1970	6,600	60.0	40.4
1972	7,970	72.5	49.3
1973	11,270	93.7	69.8
1974	10,250	87.0	63.4
1975	400	4.1	2.5
1976	7,300	63.0	53.0
1977	2,870	24.8	20.8
1978	3,980	71.7	24.6
1979	N.A.	N.A.	N.A.
1980	4,330	35.9	26.8

Data Sources:
1930--Fish (1960)
1959-1961--Thomas (1963)
1964--FWPCA (1968)
1970--CCIW (Burns and Ross, 1972)
1972-1977, 1980--OSU/CLEAR
1978--ANL (Zapotosky and Sedgefield, 1980)

TABLE 10. TRENDS IN NET OXYGEN DEMAND OF THE CENTRAL AND EASTERN BASIN HYPOLIMNIONS OF LAKE ERIE 1930-1980

DATA SOURCE*	YEAR	NET OXYGEN DEMAND			
		Rate Per Unit Area ($g\ O_2\ m^{-2}\ day^{-1}$)		Rate Per Unit Volume ($mg\ O_2\ l^{-1}\ day^{-1}$)	
		Central Basin	Eastern Basin	Central Basin	Eastern Basin
1	1930	0.08	-	0.054	-
1	1940	0.15	-	0.067	-
1	1950	0.25	-	0.070	-
1	1960	0.37	-	0.093	-
2	1970	0.38	0.70	0.110	0.055
3,4	1973	0.53	0.23	0.120	0.016
3,4	1974	0.60	0.57	0.130	0.026
3,4	1975	0.67	0.76	0.100	0.040
3,4	1976	0.75	-	0.130	0.032
3	1977	0.58	0.68	0.130	0.060
2	1977	0.48	0.51	0.120	0.065
5	1978	0.51	0.58	0.092	0.048
2	1978	0.54	0.61	0.111	0.047
5	1979	0.41	0.58	0.090	0.049
3	1980	0.63	-	0.109	-

*Data sources: 1) Dobson and Gilbertson, 1971; 2) CCIW--Noel Burns, personal communication; 3) OSU/CLEAR--Central Basin, 1973-1977; Eastern Basin, 1977; 4) SUNY/GLL--Eastern Basin, 1973-1976; 5) USEPA/GLNPO--rate calculation OSU/CLEAR.

TABLE 11. LAKE ERIE TRANSPARENCY MEASUREMENTS 1973-1980

Date	Year	Cruise No.	Area-Weighted Transparency, Secchi Disk (m) Western	Central	Eastern
6/28- 7/12	1973	1	1.92	4.31	N.A.
7/17- 7/23		2	N.A.	6.72	N.A.
7/25- 8/2		3	1.78	5.86	N.A.
8/7 - 8/11		4	N.A.	5.85	N.A.
8/29- 9/4		5	2.12	4.53	N.A.
9/19- 9/29		6	1.14	3.77	N.A.
10/14-10/24		7	0.87	3.35	N.A.
11/7 -11/15		8	1.01	2.26	N.A.
12/4		9	1.30	1.75	N.A.
4/7 - 4/17	1974	1	0.56	1.62	N.A.
4/25- 5/4		2	0.60	3.03	N.A.
5/14- 5/24		3	1.05	3.34	N.A.
6/1 - 6/10		4	2.35	4.38	N.A.
6/28- 7/7		5	1.31	6.28	N.A.
7/26- 8/4		6	2.16	5.93	N.A.
8/12- 8/19		7	1.54	6.36	N.A.
8/26- 9/7		8	1.25	5.51	N.A.
9/24- 9/27		9	1.08	N.A.	N.A.
10/21-11/1		10	1.96	3.31	N.A.
12/11-12/14		12	0.56	0.76	N.A.
3/19- 3/31	1975	1A	0.64	0.90	N.A.
4/21- 4/25		1B	0.45	1.65	N.A.
6/9 - 6/19		2	1.28	4.92	N.A.
7/13- 7/21		3	1.56	7.99	N.A.
8/30- 9/7		4	0.79	3.63	N.A.
9/27-10/6		5	0.94	2.70	N.A.
12/2 -12/10		6	0.44	1.03	N.A.
3/22- 3/30	1976	1	0.81	2.27	N.A.
6/2 - 6/10		2	2.78	4.39	N.A.
8/21- 8/29		3	N.A.	4.42	N.A.
9/8 - 9/17		4	0.85	3.12	N.A.
10/18-10/30		5	1.01	2.08	N.A.
3/20- 3/31	1977	1	1.75	4.90	N.A.
4/29- 5/8		2	N.A.	4.56	4.98
6/20- 6/30		3	N.A.	5.41	3.69
7/12- 7/22		4	N.A.	6.55	7.21
8/11- 8/21		5	N.A.	4.69	5.91
9/11-10/8		6	1.09	4.01	4.50
11/7 -11/20		7	1.36	2.22	2.88

(continued)

TABLE 11 (continued)

Date	Year	Cruise No.	Area-Weighted Transparency, Secchi Disk (m) Western	Central	Eastern
	1978	1	N.A.	N.A.	N.A.
5/18- 5/27		2	2.50	3.87	3.96
6/5 - 6/15		3	2.02	4.31	4.22
6/23- 7/1		4	2.00	4.22	6.87
7/19- 7/29		5	2.06	6.93	5.95
8/8 - 8/16		6	2.68	6.60	7.03
8/29- 9/6		7	1.94	5.16	4.65
10/3 -10/12		8	1.58	4.31	3.20
10/24-11/1		9	2.08	2.93	3.63
11/10-11/19		10	0.65	3.42	3.16
	1979	1	N.A.	N.A.	N.A.
4/17- 4/20		2	0.67	1.28	N.A.
5/15- 5/26		3	1.81	2.82	3.16
6/12- 6/21		4	1.44	3.49	3.07
7/11- 7/19		5	3.03	5.80	6.91
7/31- 8/4		6	2.38	5.78	N.A.
8/23- 9/4		7	1.91	N.A.	N.A.
9/11- 9/21		8	1.29	3.92	5.82
10/2 -10/14		9	1.59	3.50	4.26
11/7 -11/16		10	0.96	5.03	3.67
6/29- 7/6	1980	4	1.51	7.02	N.A.
7/28- 8/8		5	1.73	5.95	N.A.
8/18- 8/23		6	1.50	4.66	N.A.

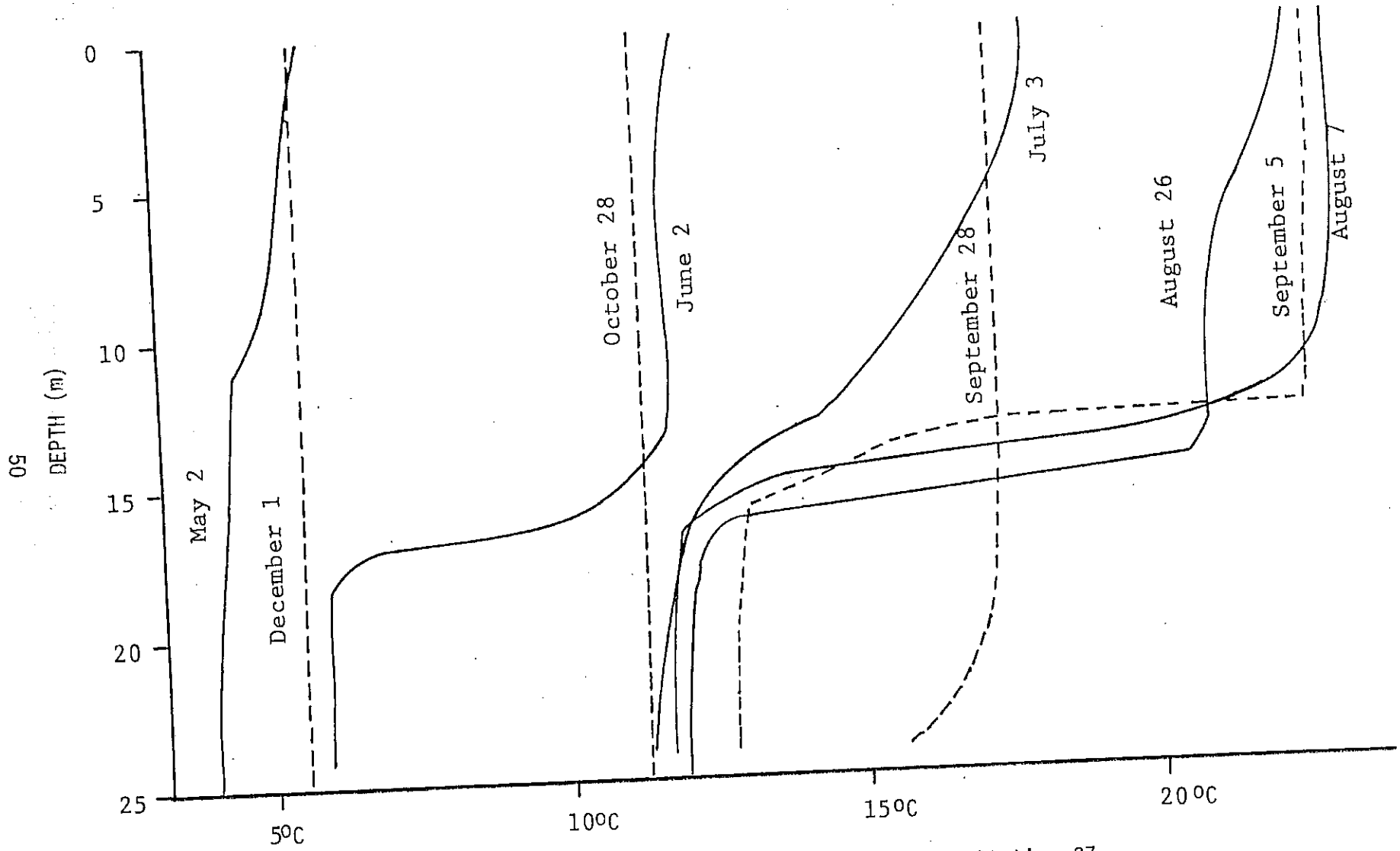


Figure 2. Thermal structure of central Lake Erie at Station 37, May to December 1980.

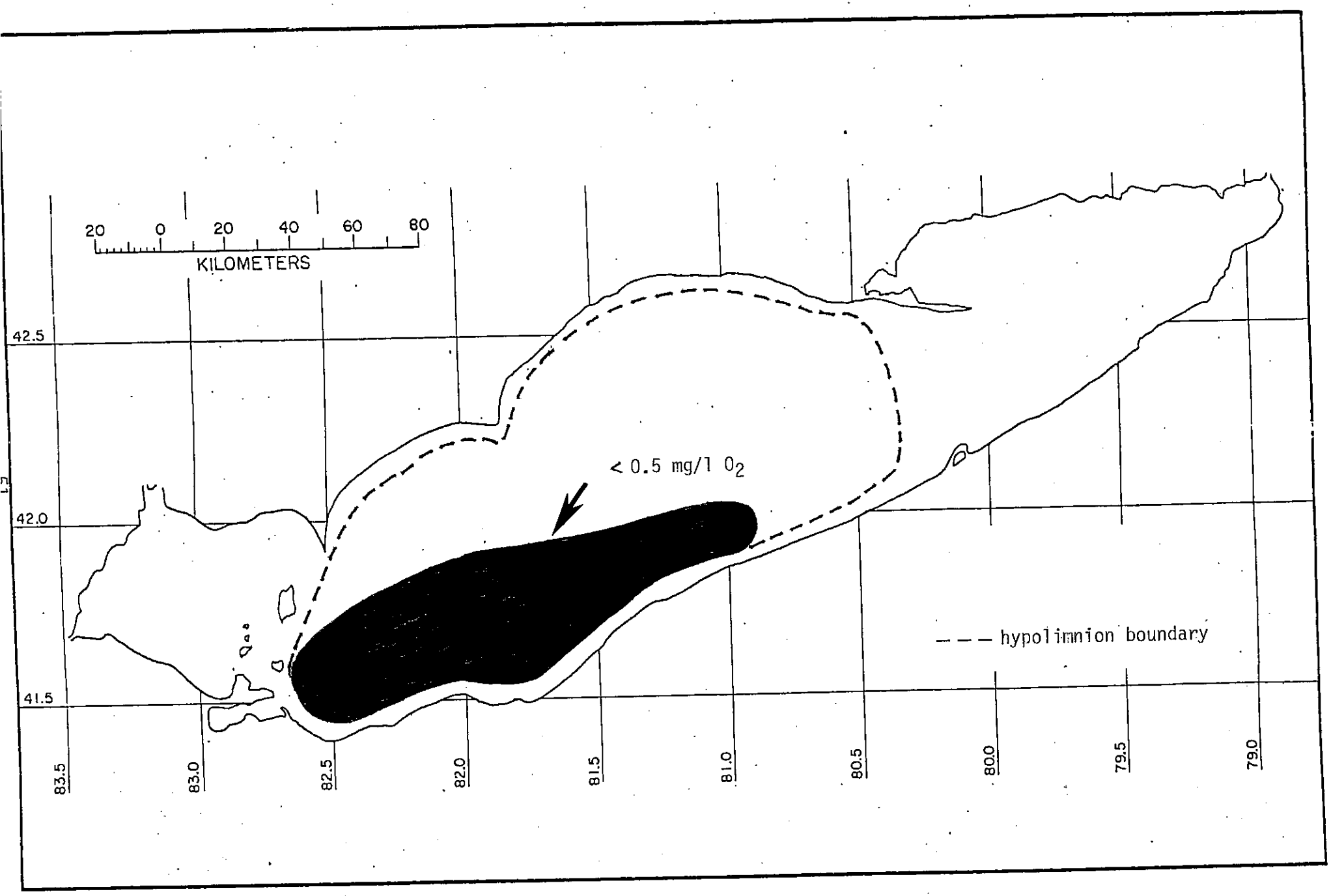


Figure 3. Area of maximum anoxic hypolimnion in central Lake Erie in 1980.

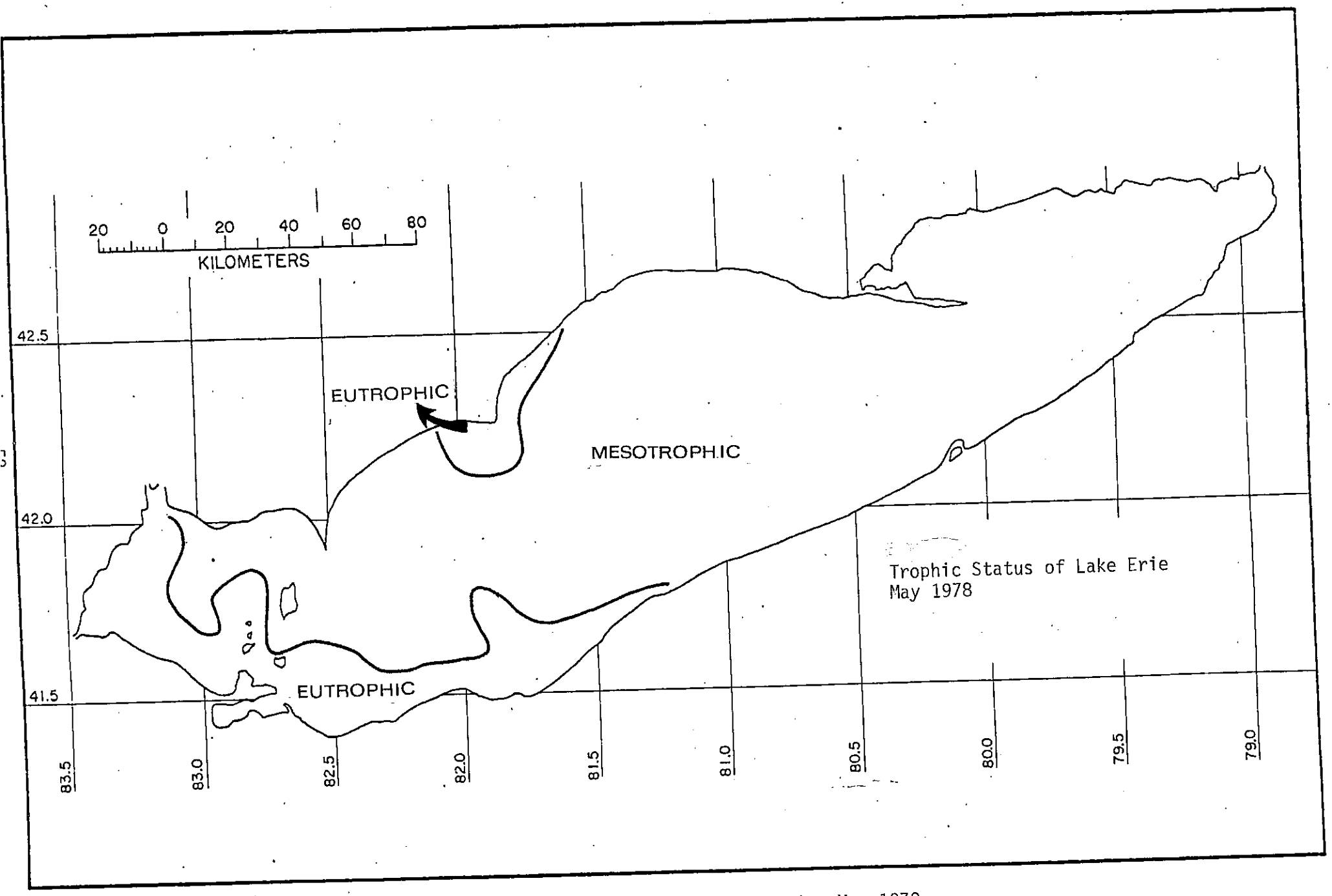


Figure 4. Trophic status of Lake Erie--May 1978.

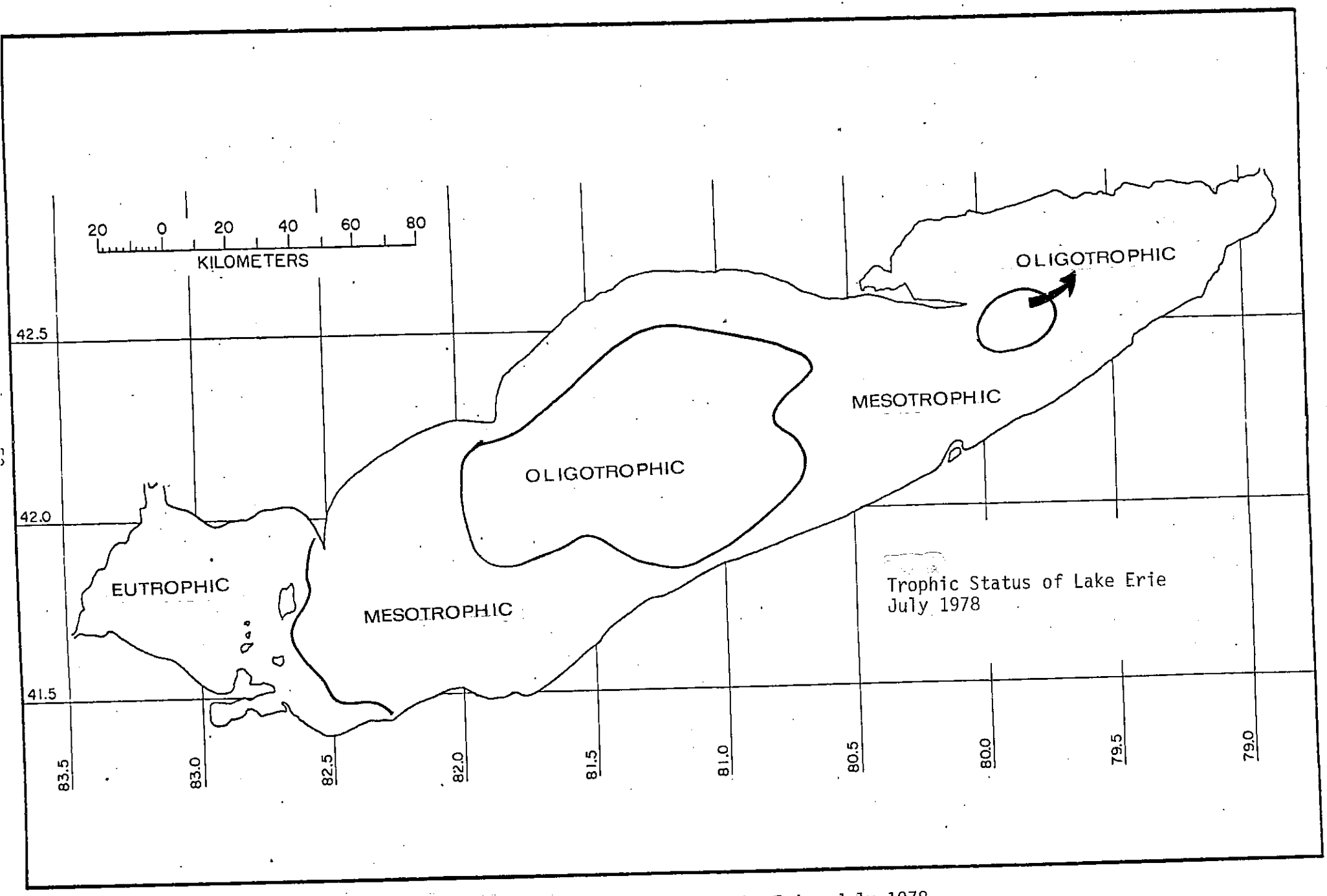


Figure 5. Trophic status of Lake Erie--July 1978.

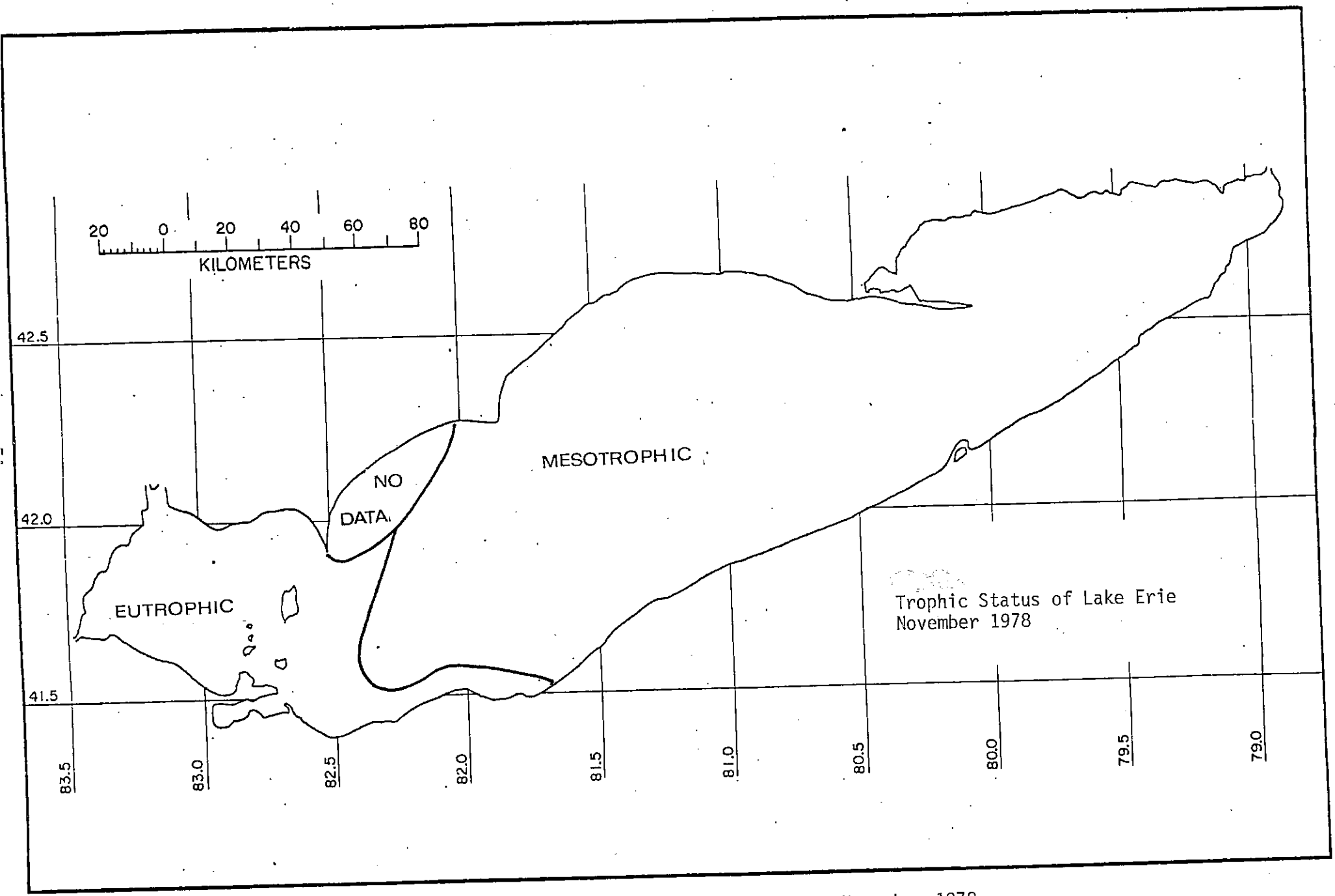


Figure 6. Trophic status of Lake Erie--November 1978.

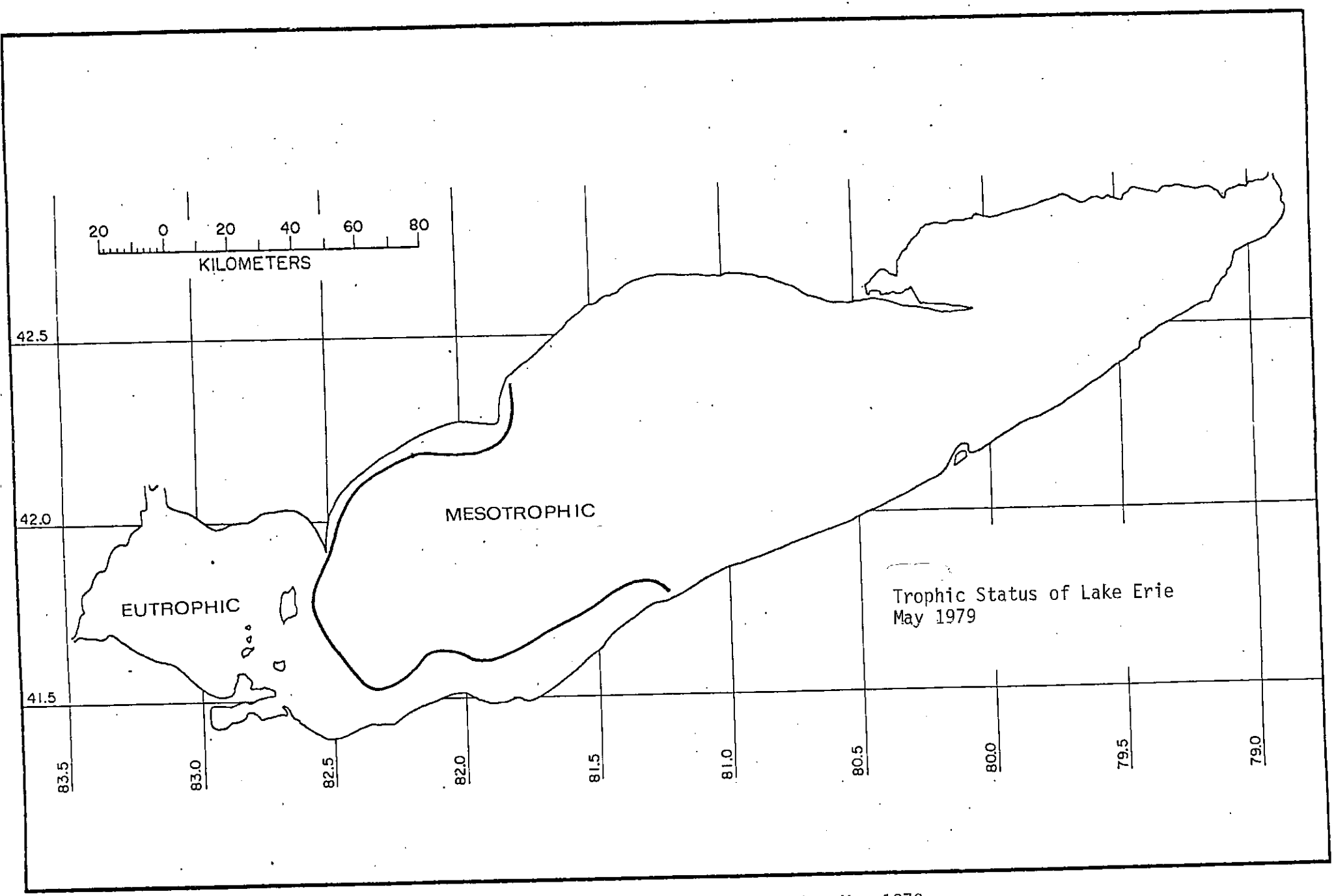


Figure 7. Trophic status of Lake Erie--May 1979.

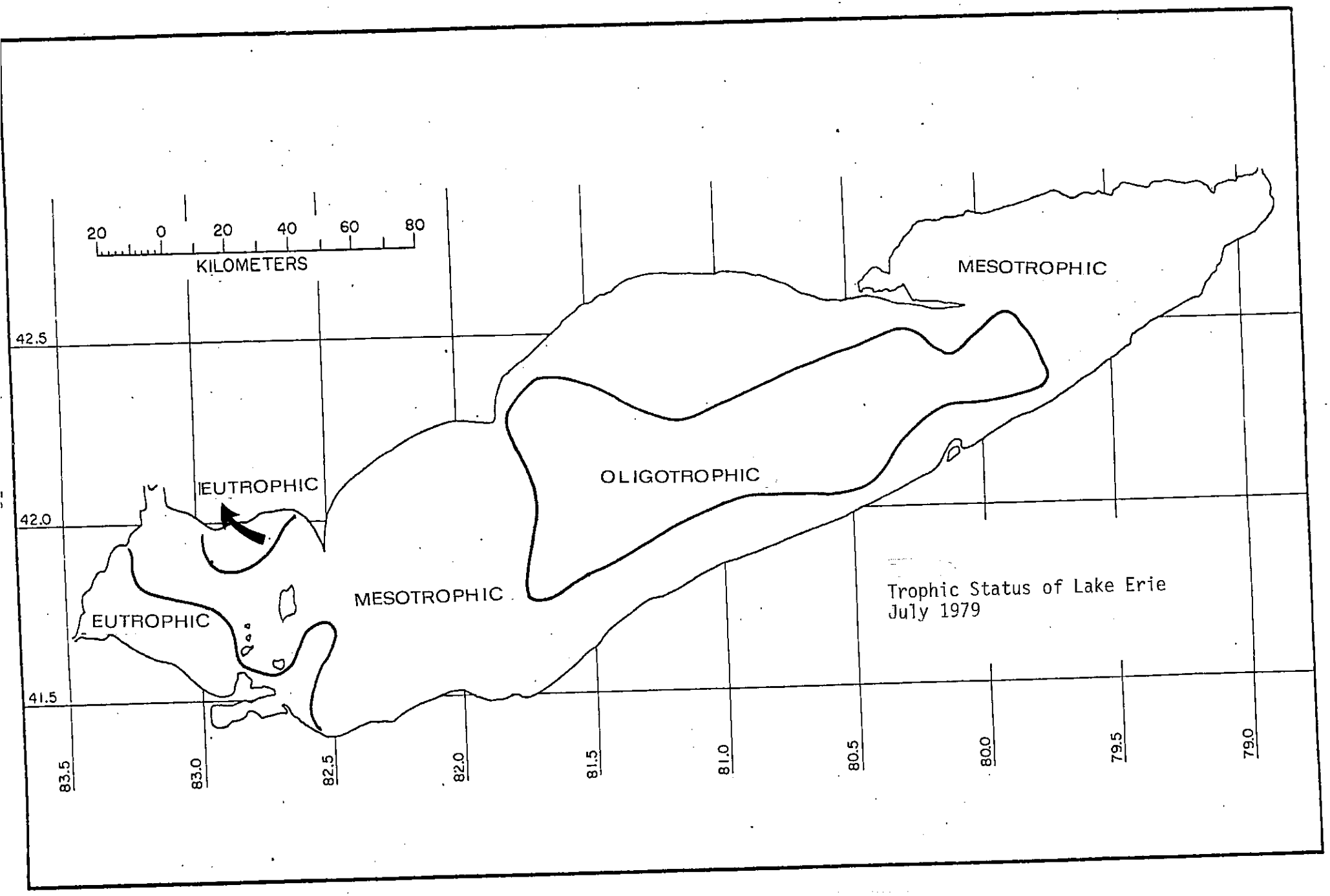


Figure 8. Trophic status of Lake Erie--July 1979.

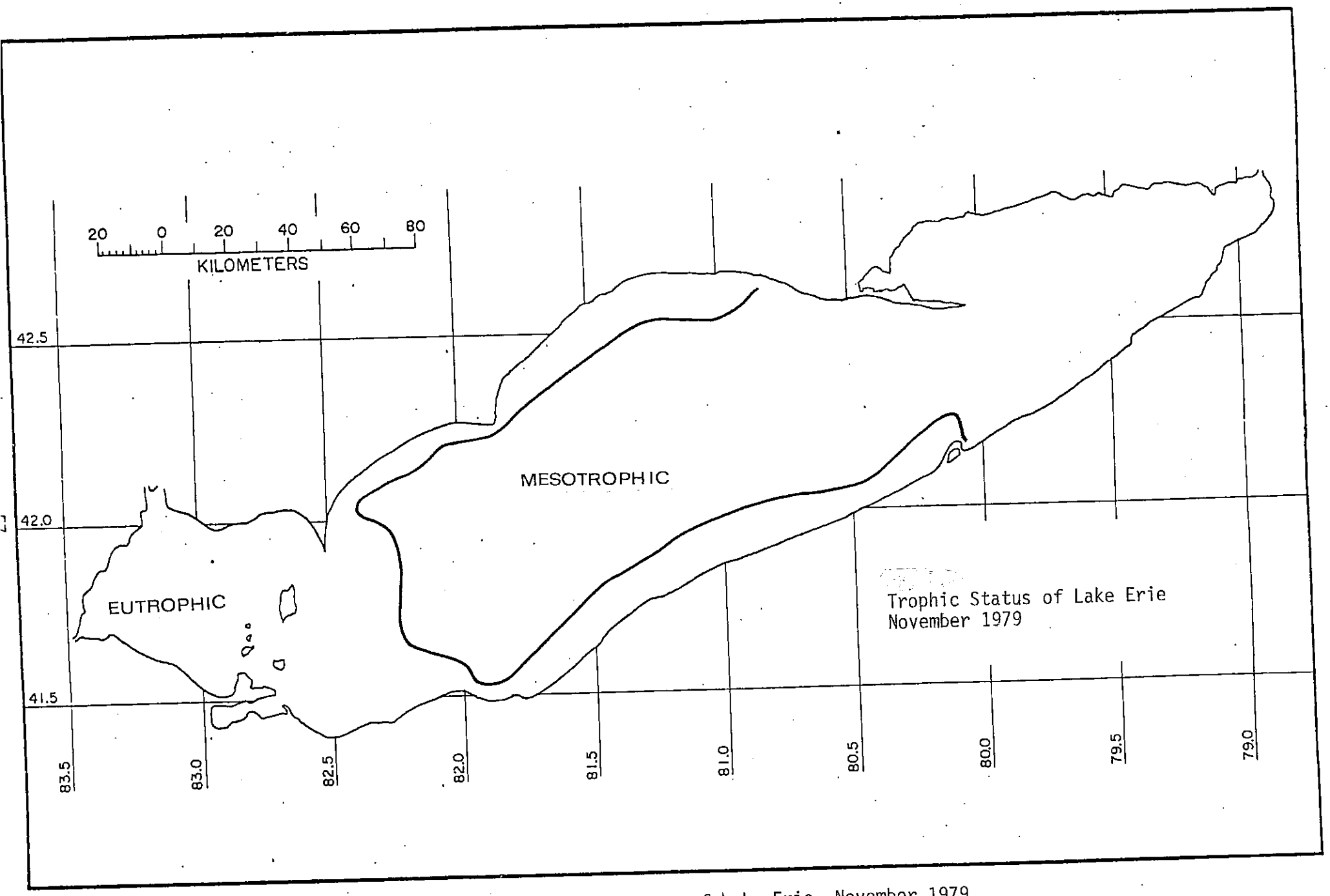


Figure 9. Trophic status of Lake Erie--November 1979.

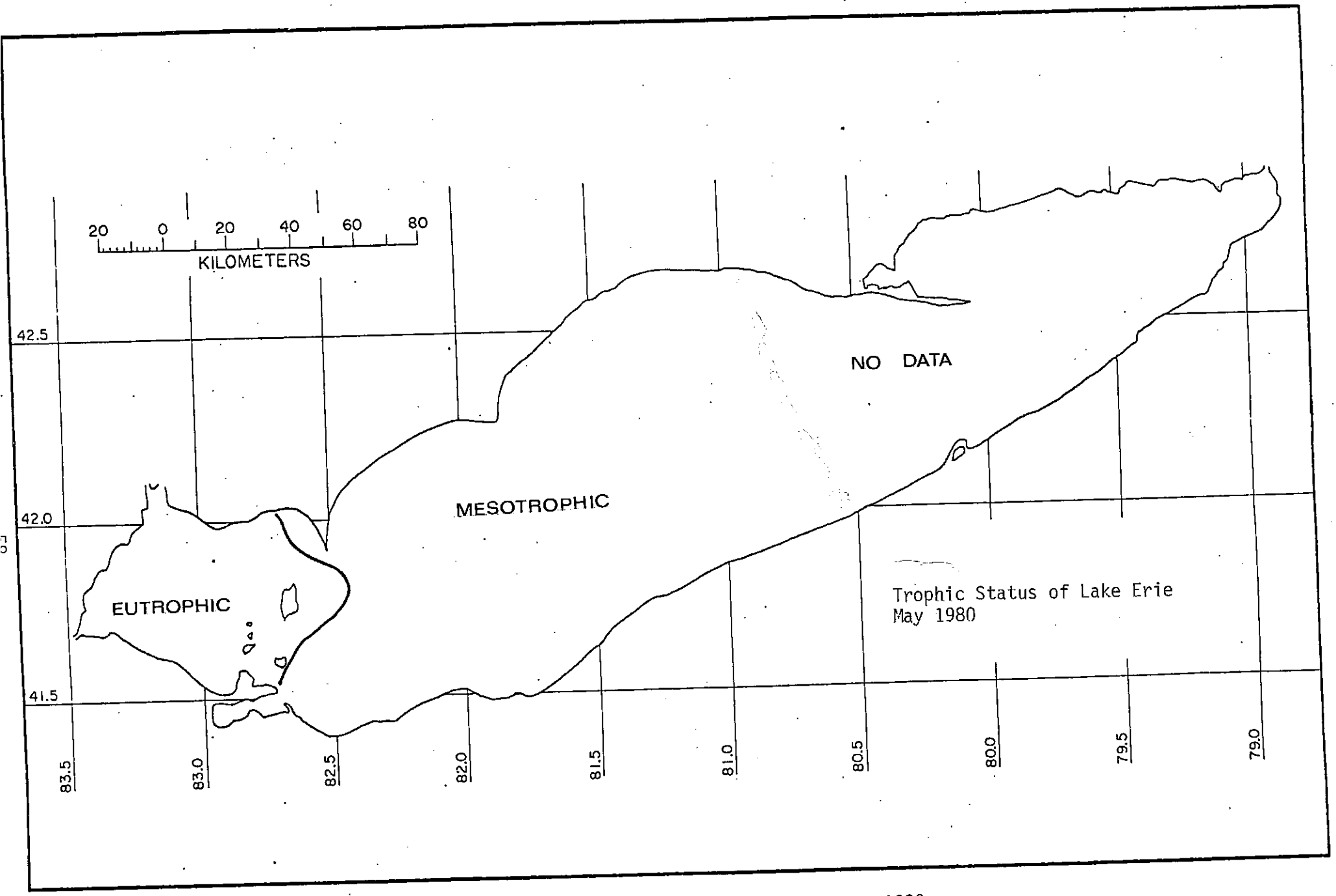


Figure 10. Trophic status of Lake Erie--May 1980.

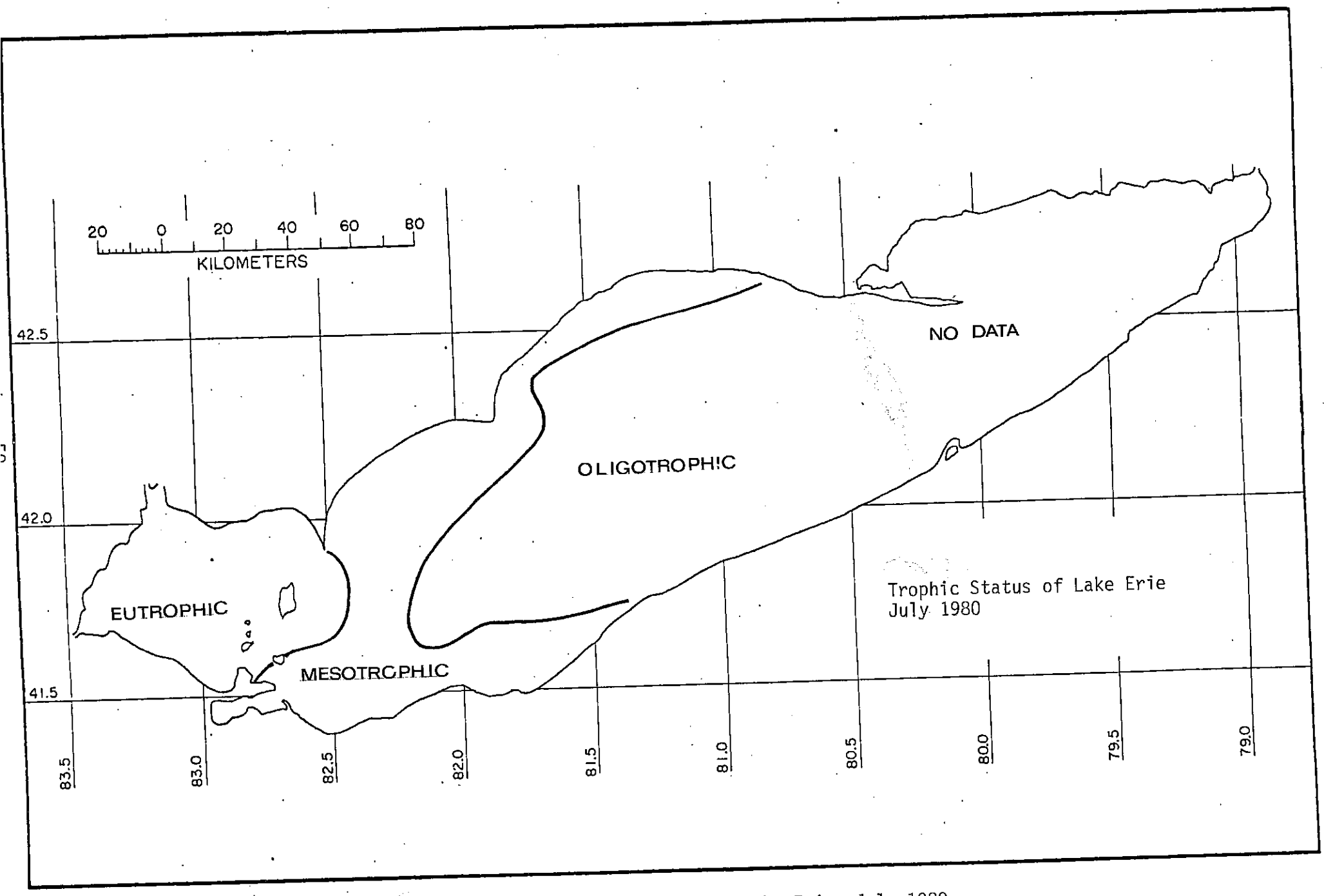


Figure 11. Trophic status of Lake Erie--July 1980.

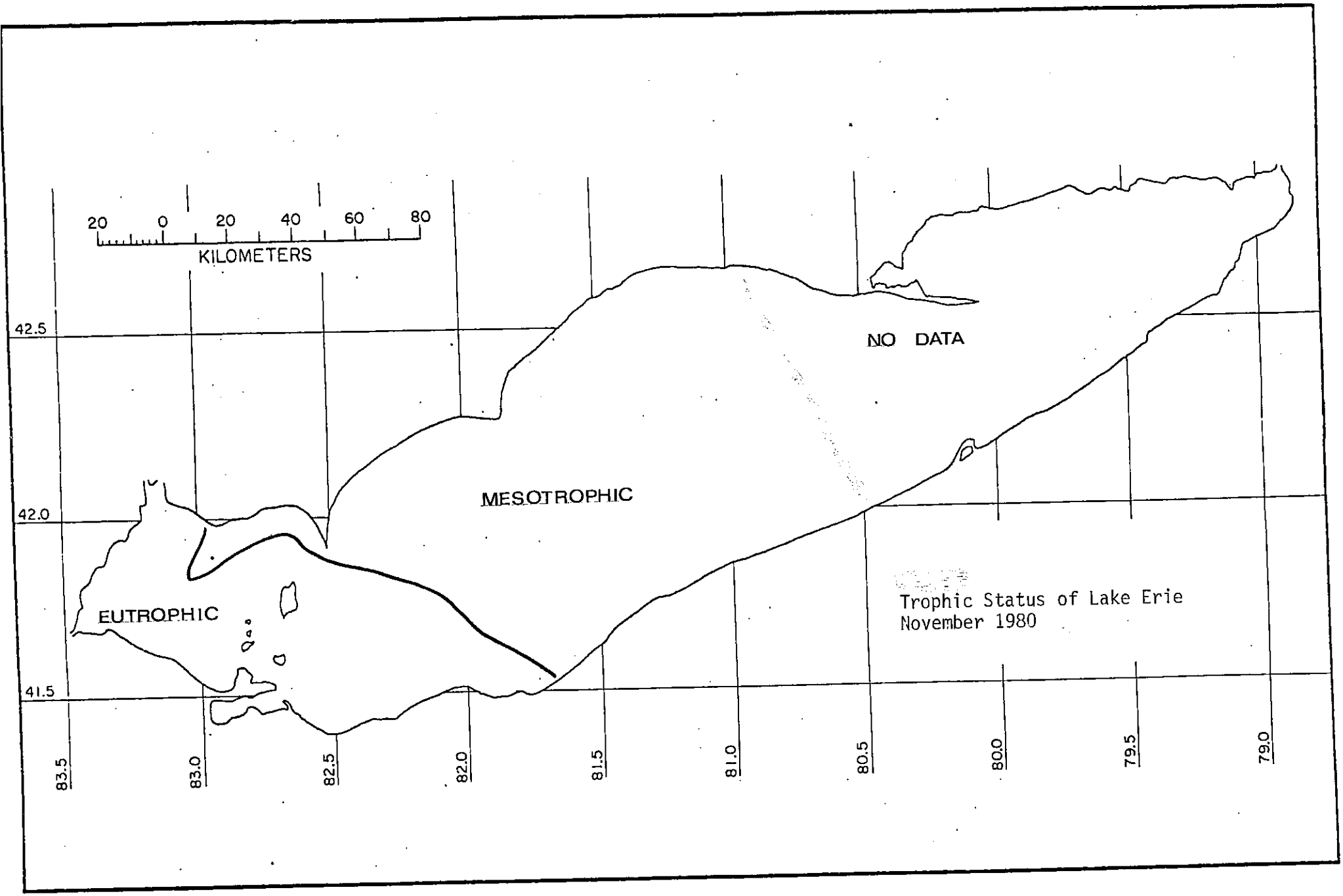


Figure 12. Trophic status of Lake Erie--November 1980.

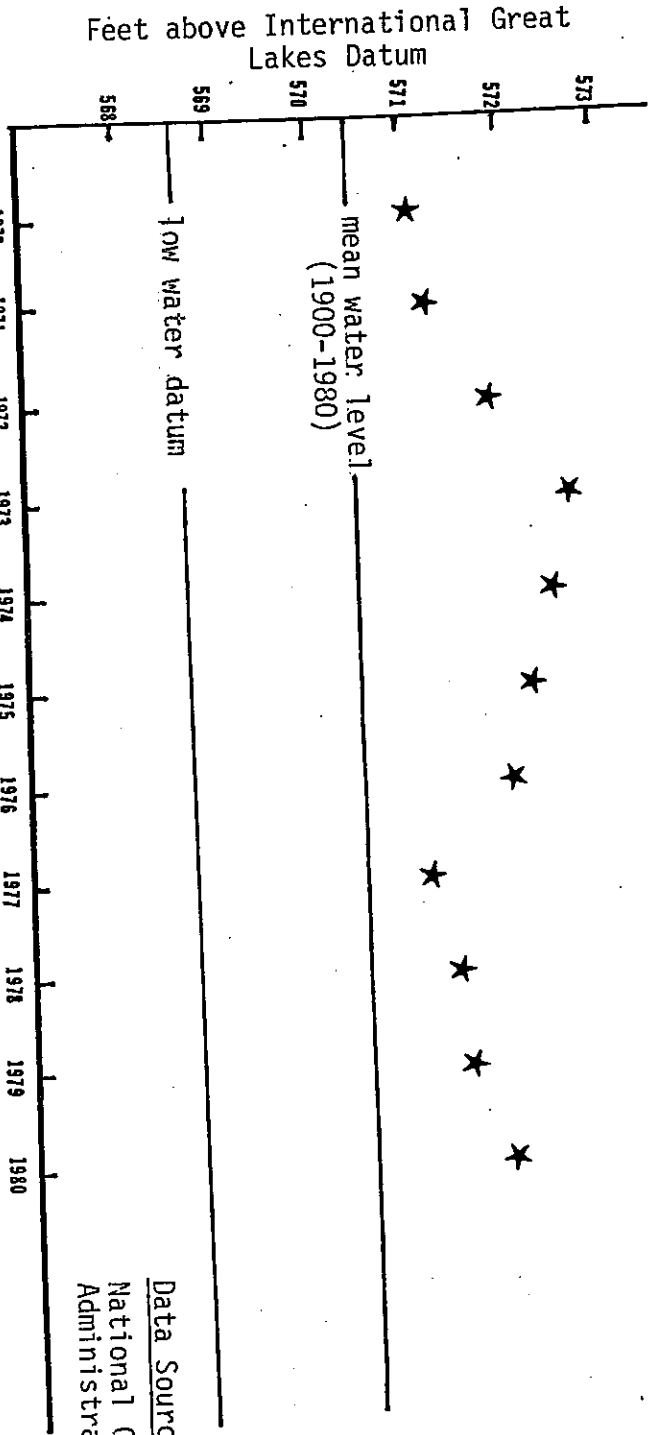


Figure 13. Average annual water levels for Lake Erie 1970-1980.

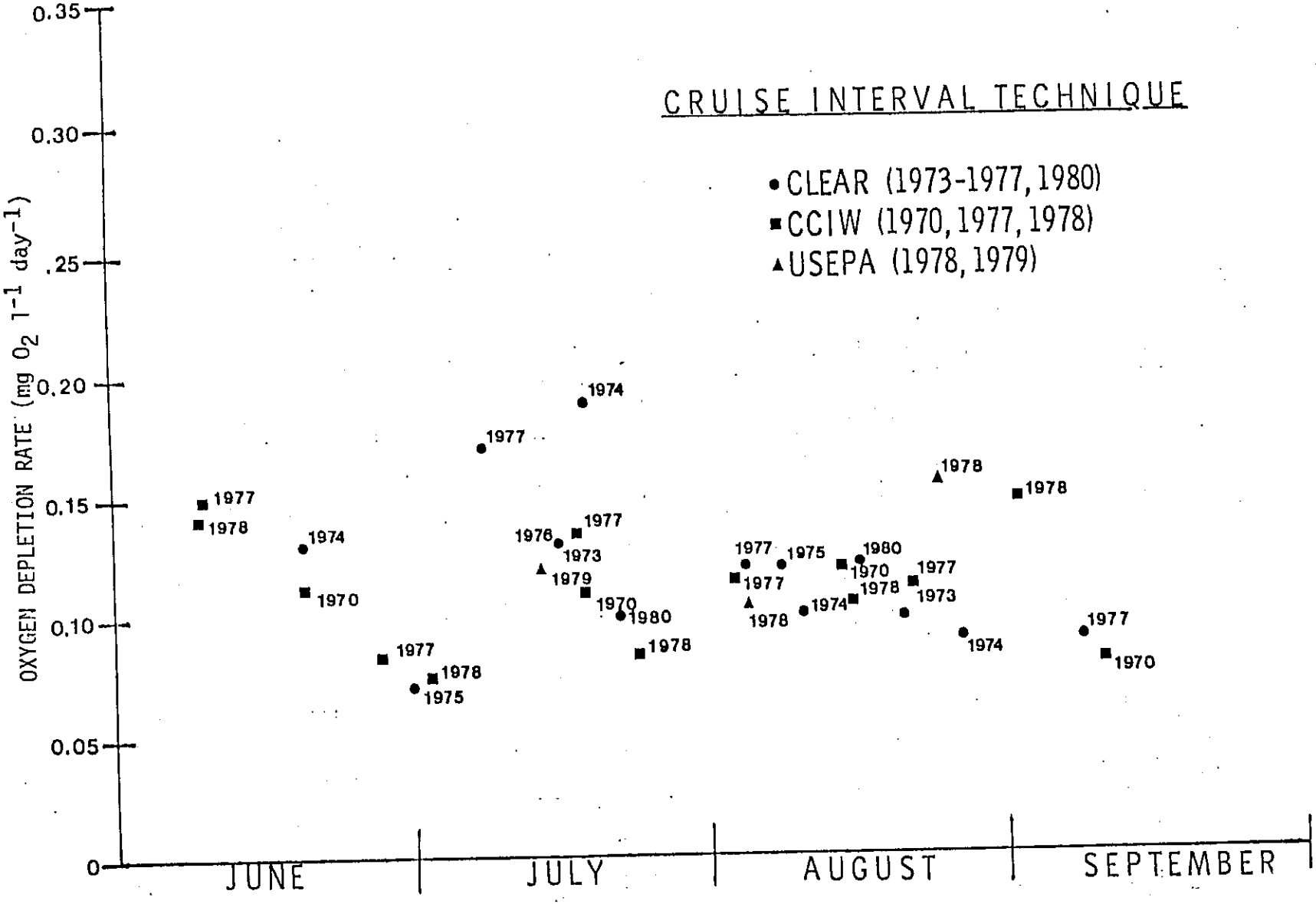


Figure 14. Hypolimnetic oxygen depletion rates for central Lake Erie 1970-1980.

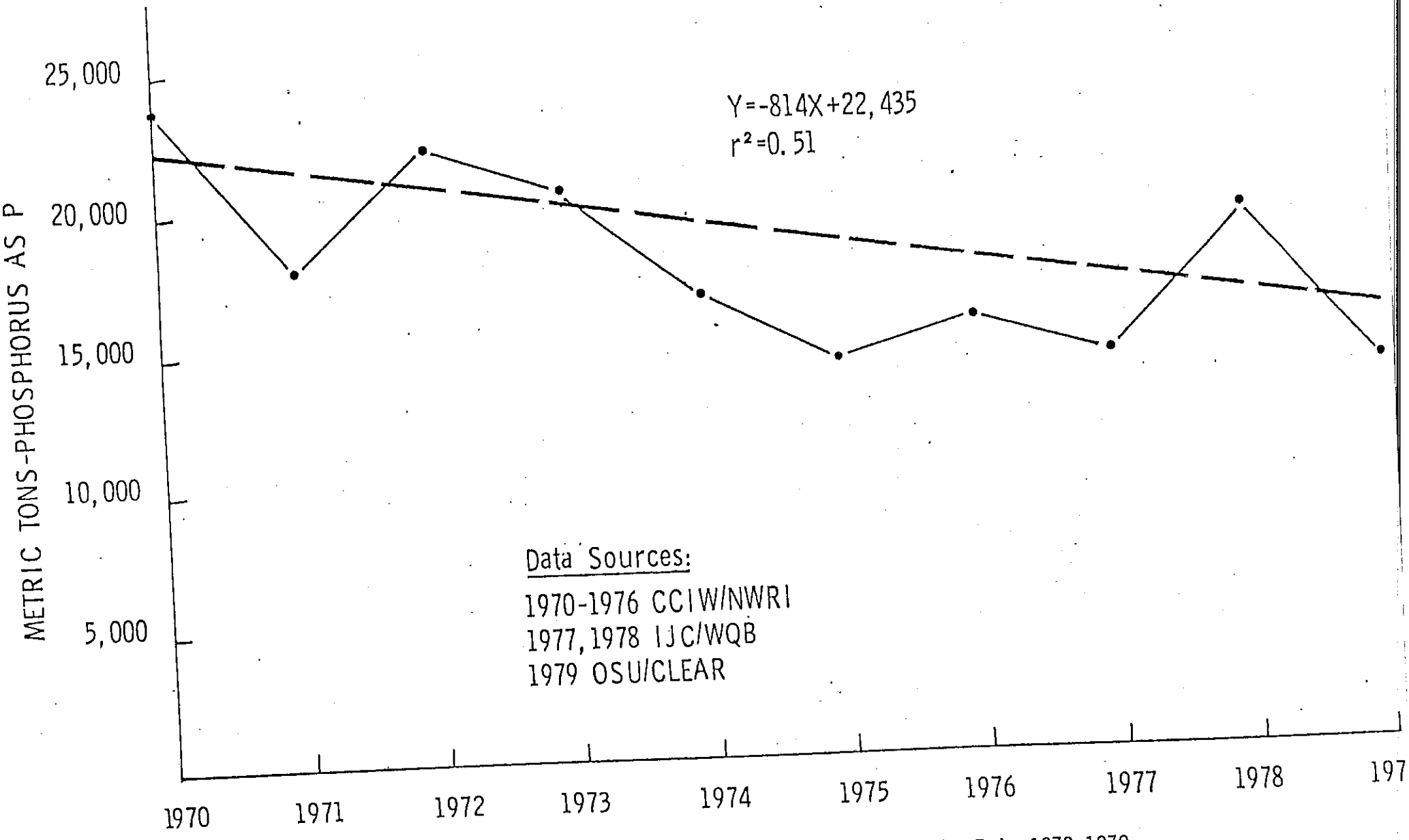


Figure 15. Loading of total phosphorus to Lake Erie 1970-1979.

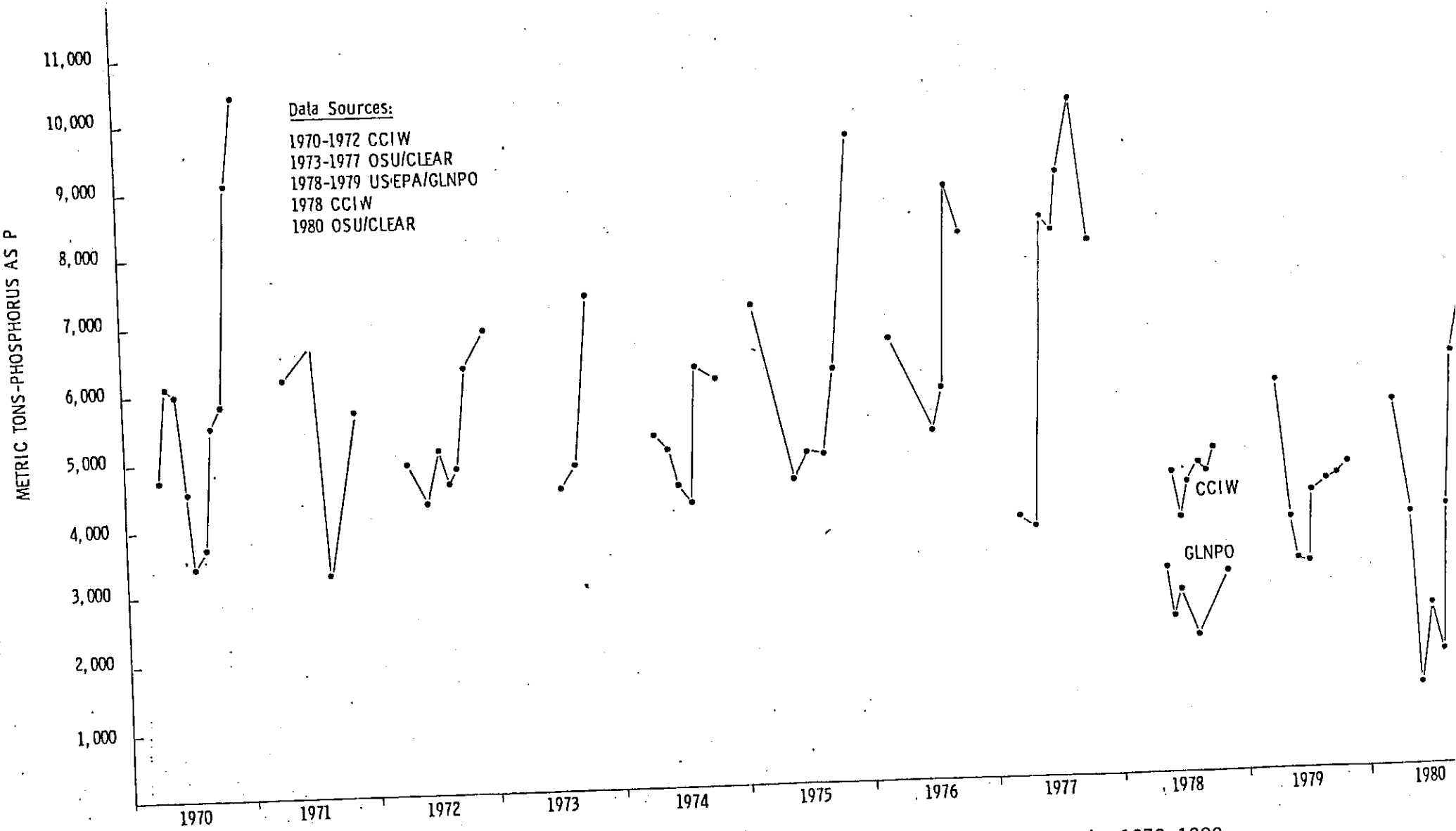


Figure 16. Total Phosphorus quantities in the central basin of Lake Erie 1970-1980.

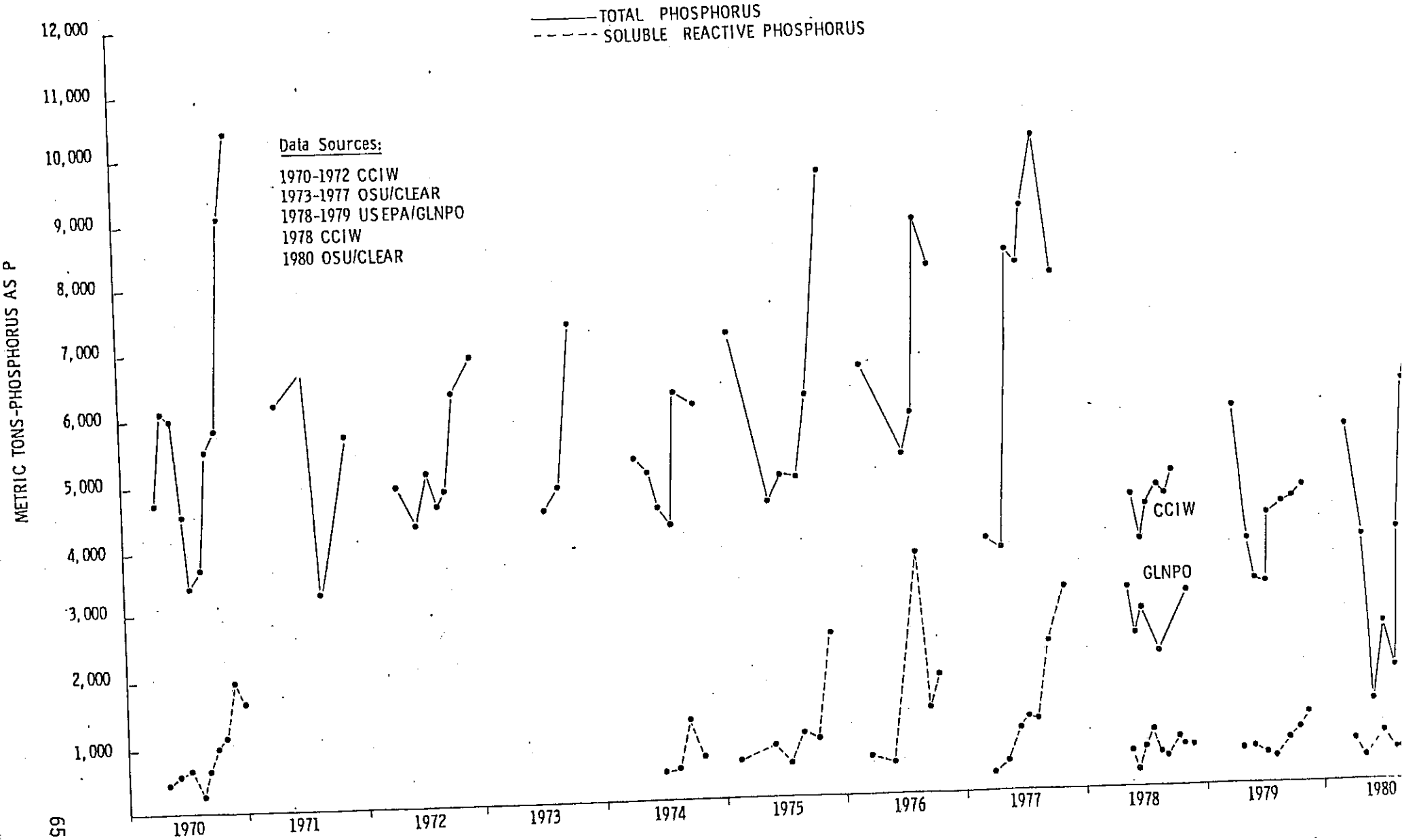


Figure 17. Total and soluble reactive phosphorus quantities in the central basin of Lake Erie 1970-1980.

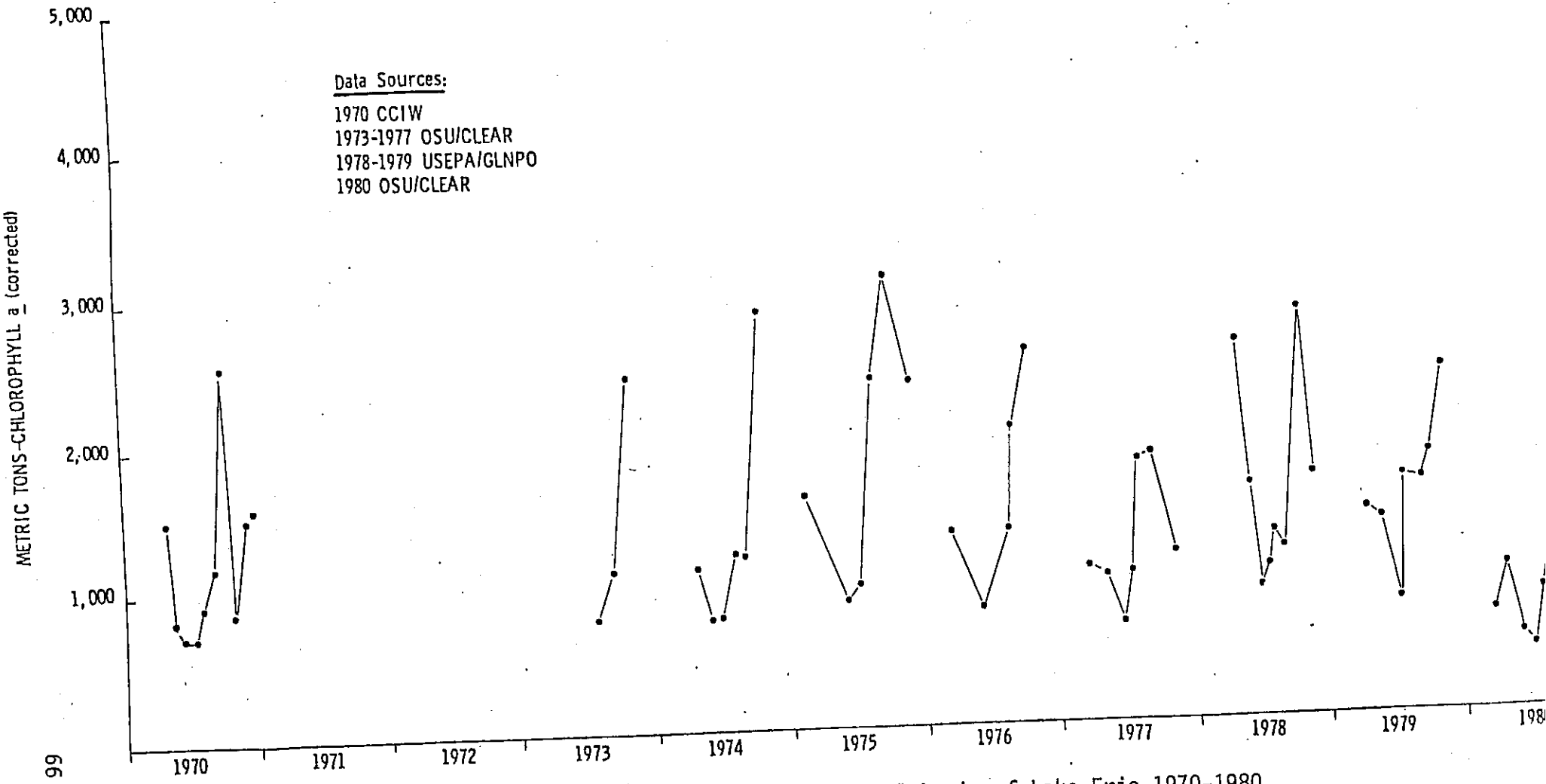


Figure 18. Chlorophyll a quantities in the central basin of Lake Erie 1970-1980.

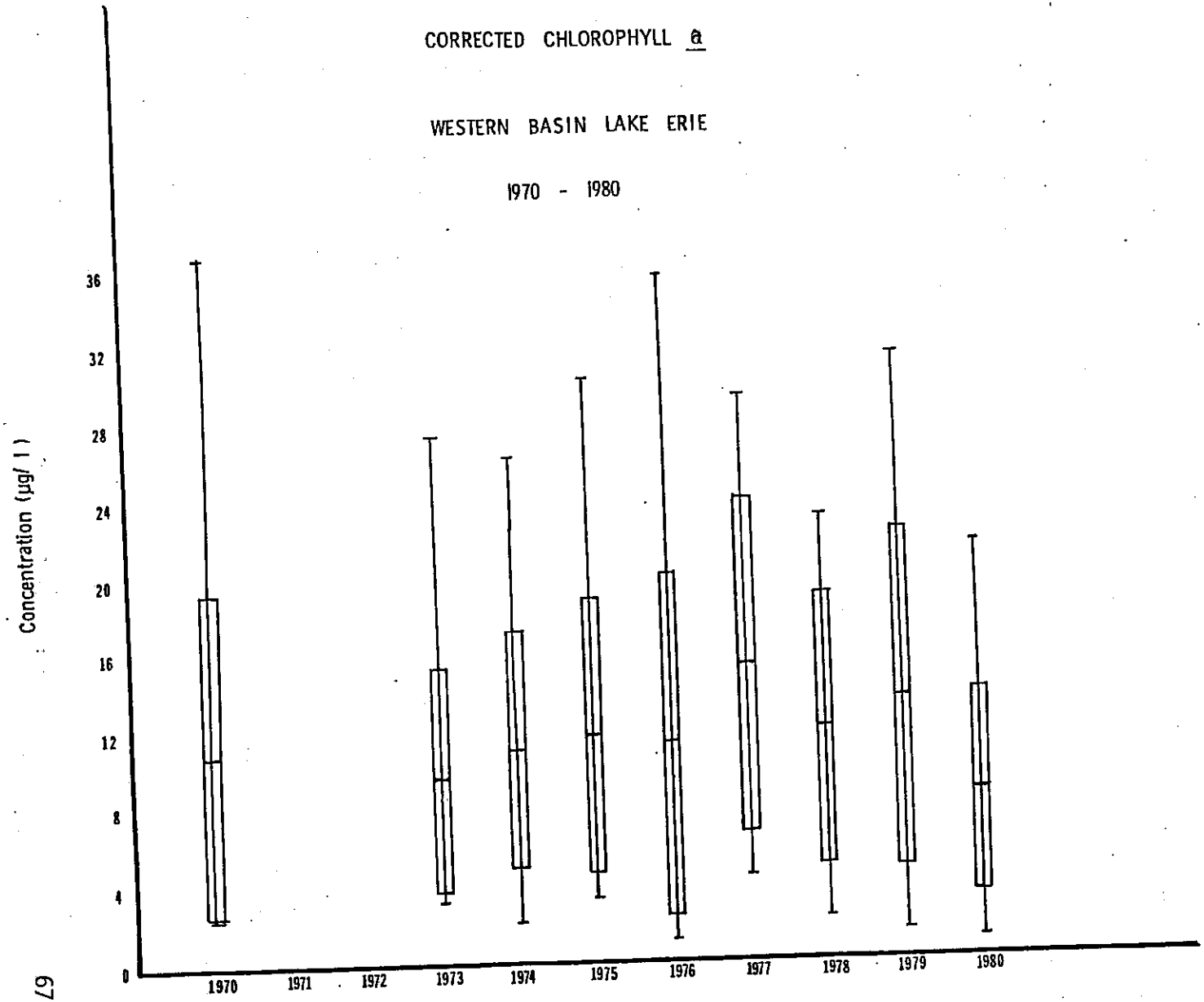


Figure 19. Chlorophyll a concentrations in surface waters of western Lake Erie 1970-1980.

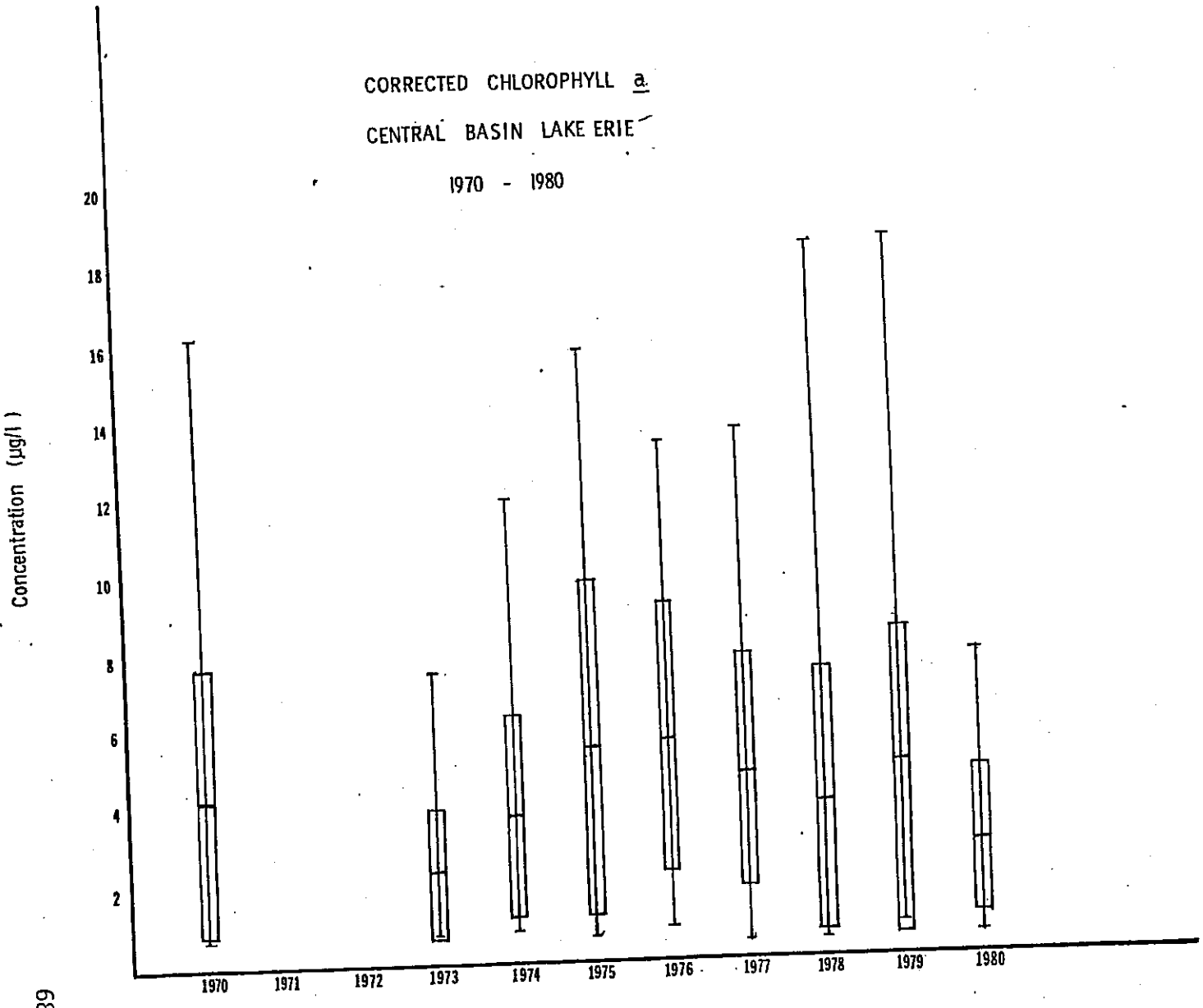


Figure 20. Chlorophyll a concentrations in surface waters of central Lake Erie 1970-1980.

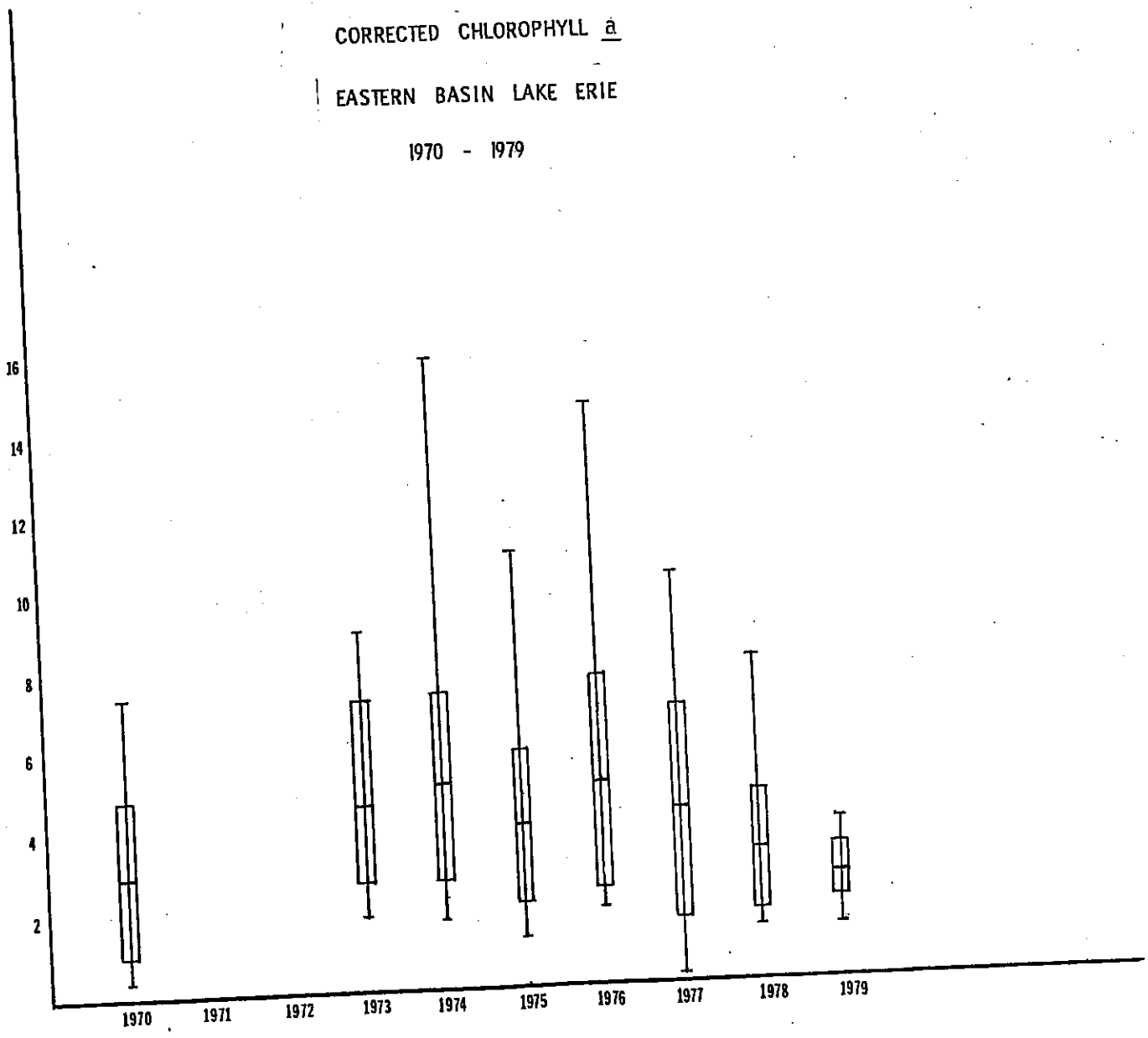


Figure 21. Chlorophyll a concentrations in surface waters of eastern Lake Erie 1970-1980.

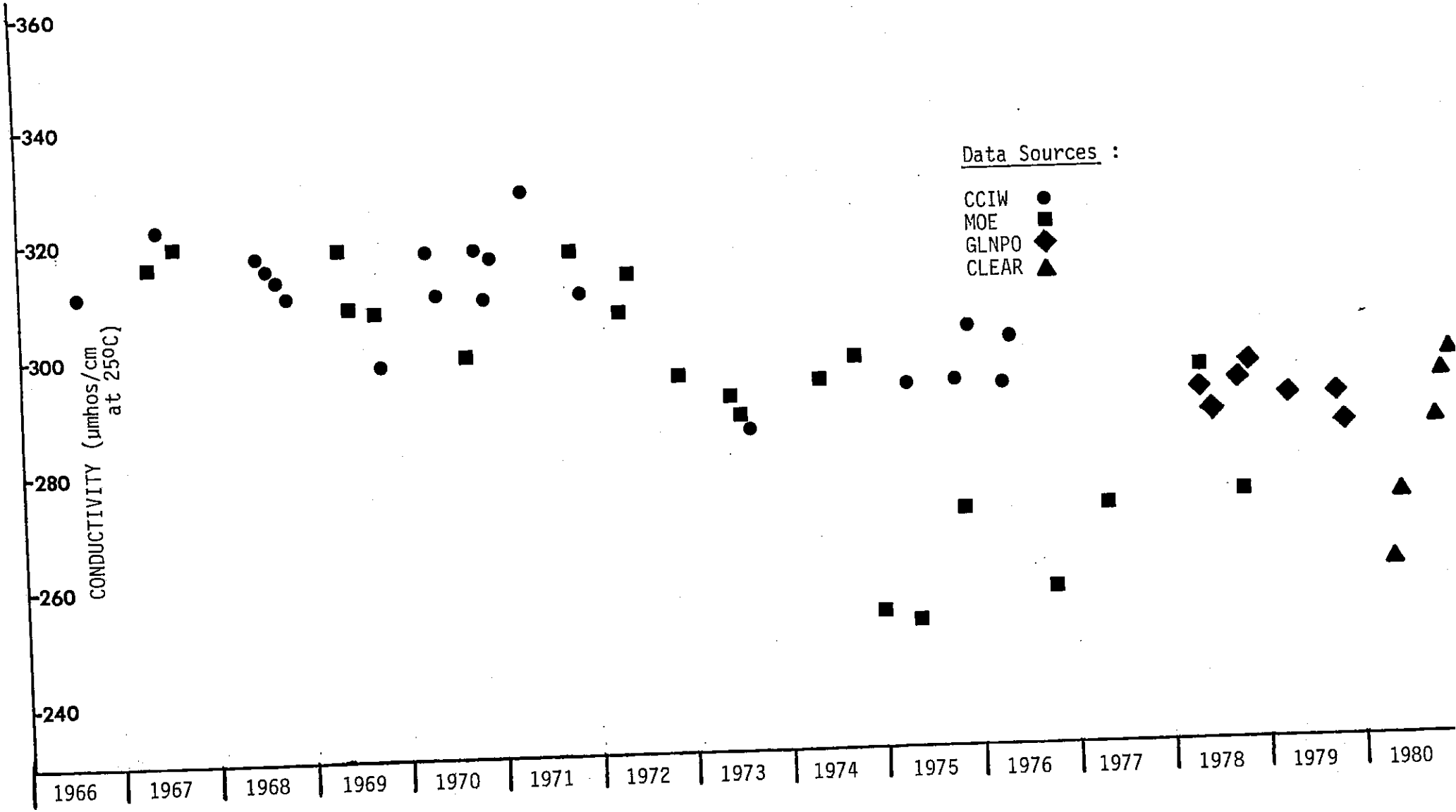


Figure 22. Specific conductance of central Lake Erie 1966-1980.

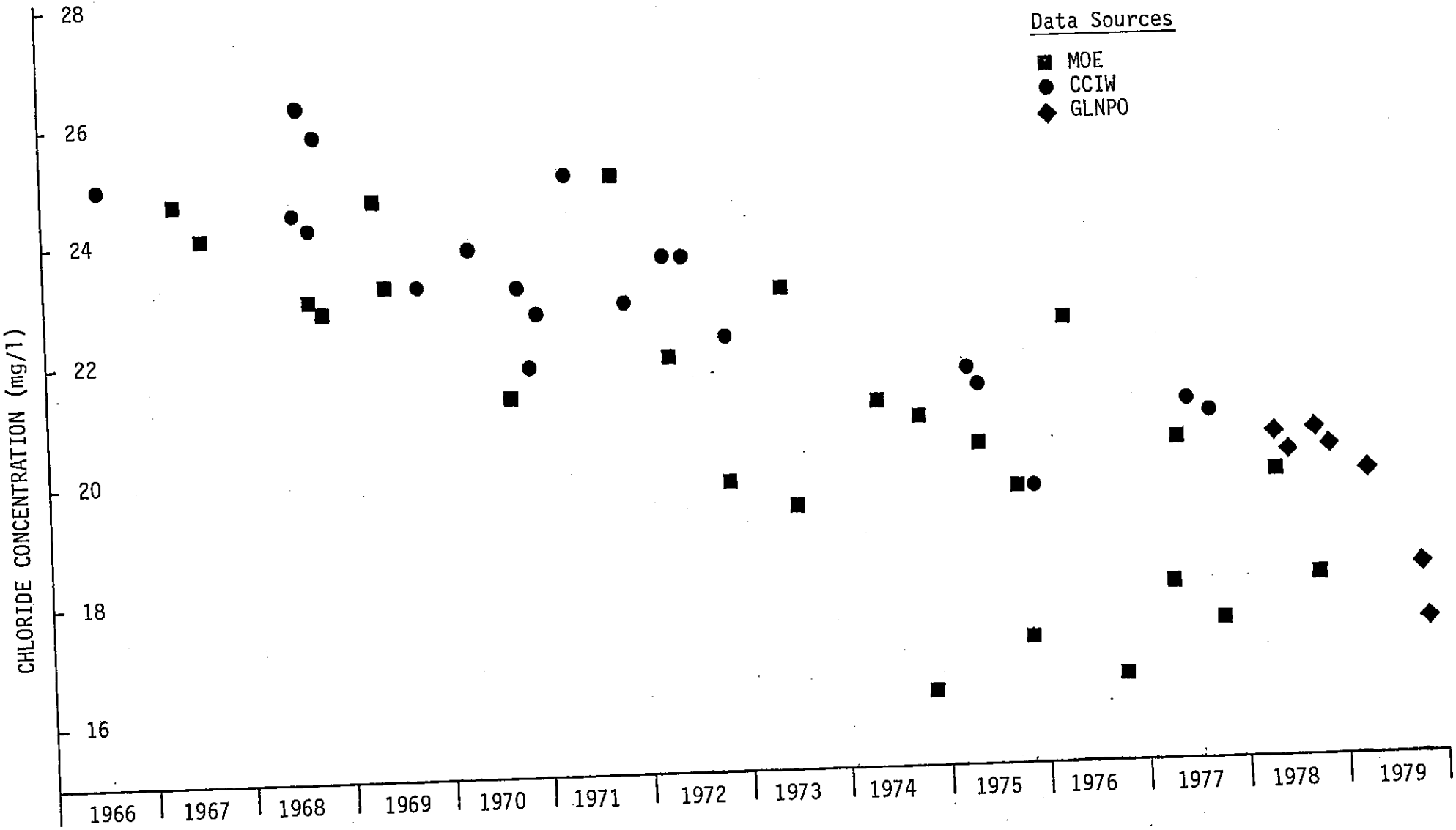


Figure 23. Chloride concentrations in central Lake Erie 1966-1979.

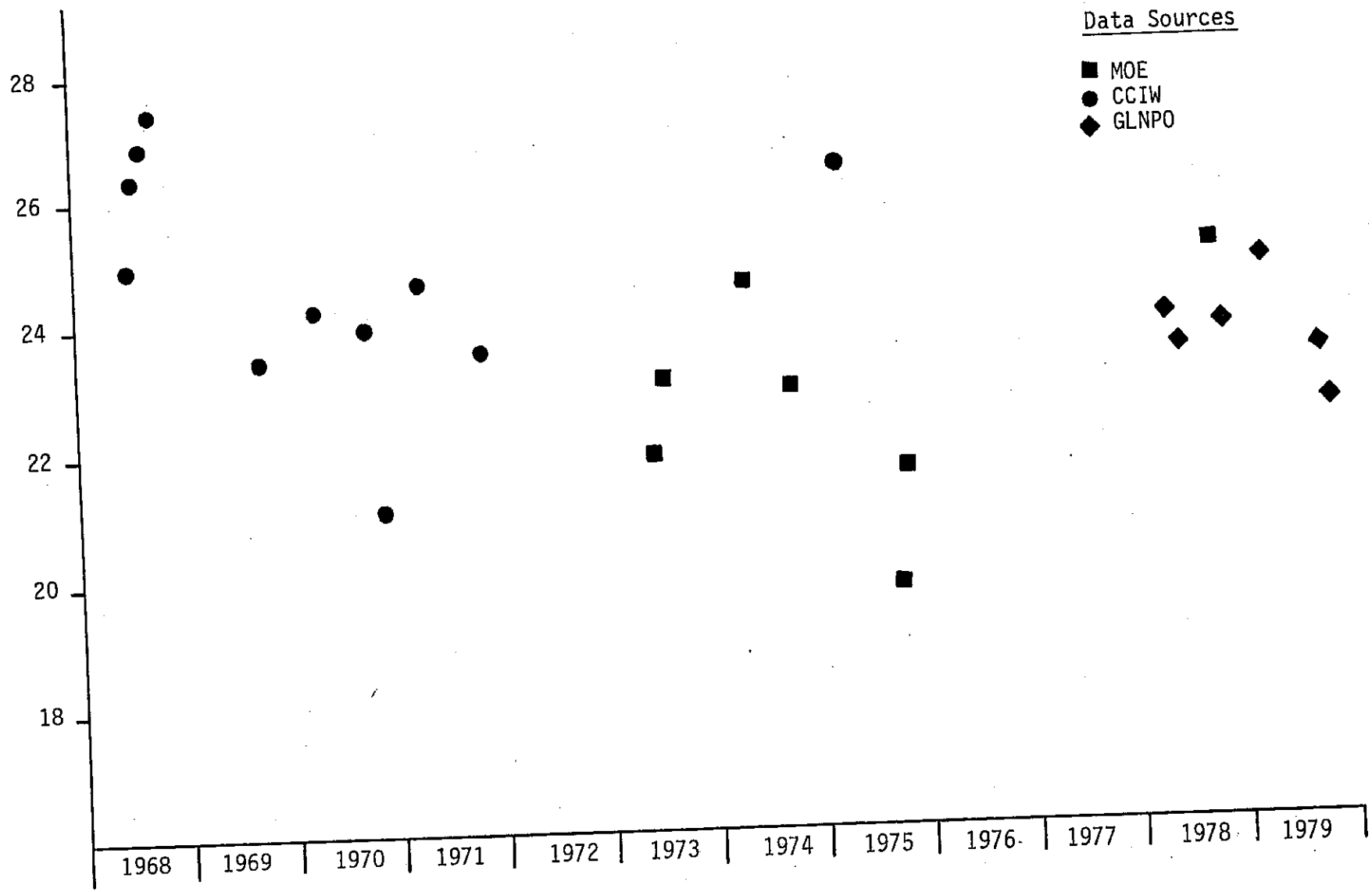


Figure 24. Sulfate concentrations in central Lake Erie 1968-1979.

APPENDIX

APPENDIX A

LAKE ERIE WATER QUALITY ATLAS FOR 1980

Temperature and Thermal Structure

Map 1 Surface Temperature (Cruise No. 4)
Map 2 Bottom Temperature (Cruise No. 4)
Map 3 Surface Temperature (Cruise No. 5)
Map 4 Bottom Temperature (Cruise No. 5)
Map 5 Surface Temperature (Cruise No. 6)
Map 6 Bottom Temperature (Cruise No. 6)

Map 7 Hypolimnion Thickness (Cruise No. 4)
Map 8 Hypolimnion Thickness (Cruise No. 5)
Map 9 Hypolimnion Thickness (Cruise No. 6)
Map 10 Hypolimnion Thickness (Cruise No. 7)

Oxygen

Map 11 Bottom Dissolved Oxygen (Cruise No. 4)
Map 12 Bottom Dissolved Oxygen (Cruise No. 5)
Map 13 Bottom Dissolved Oxygen (Cruise No. 6)
Map 14 Bottom Dissolved Oxygen (Cruise No. 7)

Map 15 Bottom Saturation (Cruise No. 4)
Map 16 Bottom Saturation (Cruise No. 5)
Map 17 Bottom Saturation (Cruise No. 6)
Map 18 Bottom Saturation (Cruise No. 7)

Nutrients

Map 19 Surface Total Phosphorus (Cruise No. 4)
Map 20 Bottom Total Phosphorus (Cruise No. 4)
Map 21 Surface Total Phosphorus (Cruise No. 5)
Map 22 Bottom Total Phosphorus (Cruise No. 5)
Map 23 Surface Total Phosphorus (Cruise No. 6)
Map 24 Bottom Total Phosphorus (Cruise No. 6)

Map 25 Surface Soluble Reactive Phosphorus (Cruise No. 4)
Map 26 Bottom Soluble Reactive Phosphorus (Cruise No. 4)
Map 27 Surface Soluble Reactive Phosphorus (Cruise No. 5)
Map 28 Bottom Soluble Reactive Phosphorus (Cruise No. 5)
Map 29 Surface Soluble Reactive Phosphorus (Cruise No. 6)
Map 30 Bottom Soluble Reactive Phosphorus (Cruise No. 6)
Map 31 Surface Soluble Reactive Phosphorus (Cruise No. 7)
Map 32 Bottom Soluble Reactive Phosphorus (Cruise No. 7)

Map 33 Surface Nitrate plus Nitrite (Cruise No. 4)
Map 34 Bottom Nitrate plus Nitrite (Cruise No. 4)
Map 35 Surface Nitrate plus Nitrite (Cruise No. 5)
Map 36 Bottom Nitrate plus Nitrite (Cruise No. 5)
Map 37 Surface Nitrate plus Nitrite (Cruise No. 6)
Map 38 Bottom Nitrate plus Nitrite (Cruise No. 6)

Map 39 Surface Dissolved Reactive Silica (Cruise No. 4)
Map 40 Bottom Dissolved Reactive Silica (Cruise No. 4)
Map 41 Surface Dissolved Reactive Silica (Cruise No. 5)
Map 42 Bottom Dissolved Reactive Silica (Cruise No. 5)
Map 43 Surface Dissolved Reactive Silica (Cruise No. 6)
Map 44 Bottom Dissolved Reactive Silica (Cruise No. 6)

Suspended Particles and Light Penetration

Map 45 Surface Turbidity (Cruise No. 4)
Map 46 Bottom Turbidity (Cruise No. 4)
Map 47 Surface Turbidity (Cruise No. 5)
Map 48 Bottom Turbidity (Cruise No. 5)
Map 49 Surface Turbidity (Cruise No. 6)
Map 50 Bottom Turbidity (Cruise No. 6)

Map 51 Transparency (Cruise No. 4)
Map 52 Transparency (Cruise No. 5)
Map 53 Transparency (Cruise No. 6)

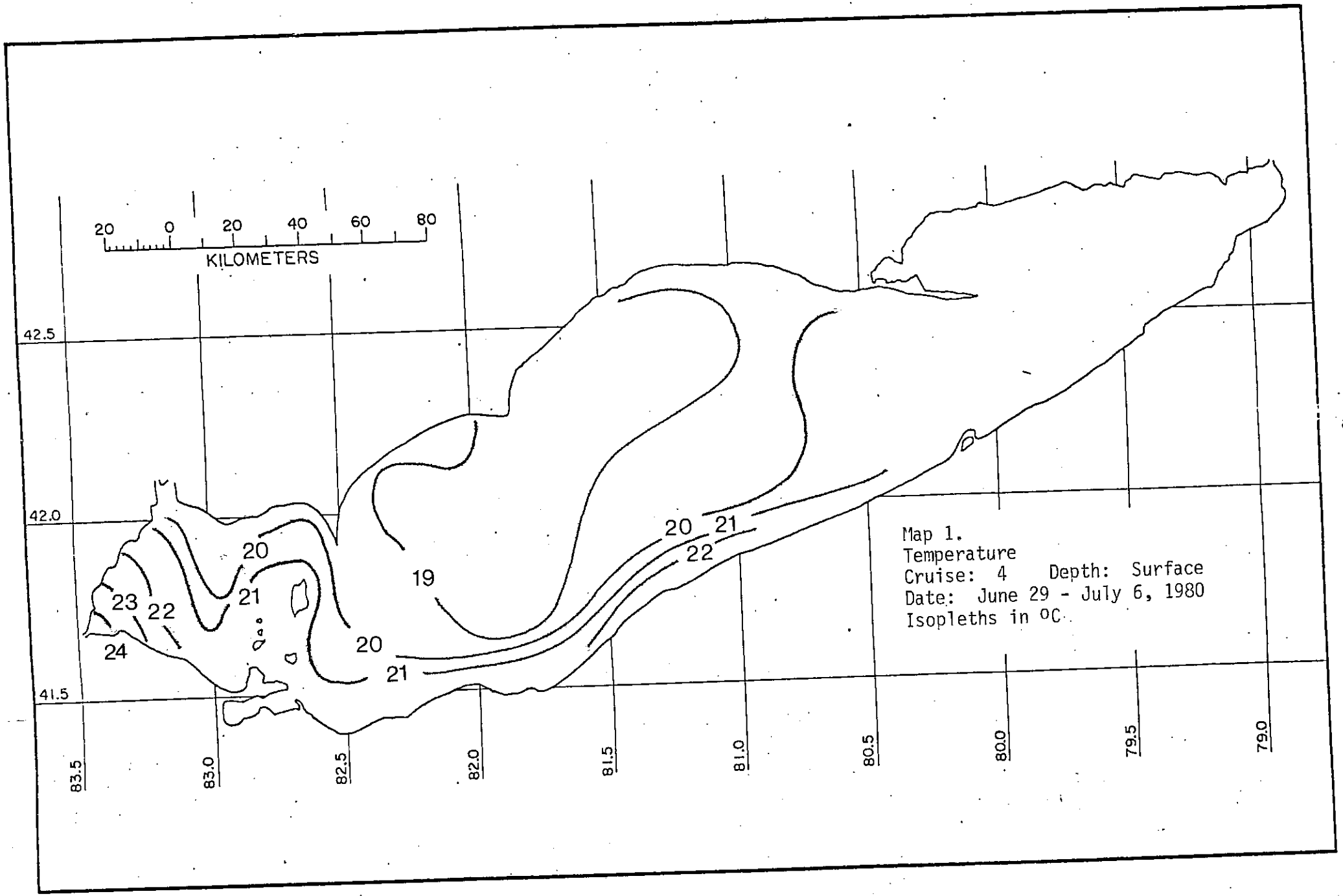
Map 54 Extinction Depth (Cruise No. 4)
Map 55 Extinction Depth (Cruise No. 5)
Map 56 Extinction Depth (Cruise No. 6)

Chlorophyll

Map 57 Surface Chlorophyll a (Cruise No. 4)
Map 58 Bottom Chlorophyll a (Cruise No. 4)
Map 59 Surface Chlorophyll a (Cruise No. 5)
Map 60 Bottom Chlorophyll a (Cruise No. 5)
Map 61 Surface Chlorophyll a (Cruise No. 6)
Map 62 Bottom Chlorophyll a (Cruise No. 6)

Dissolved Substances

Map 63 Surface Conductivity (Cruise No. 5)
Map 64 Bottom Conductivity (Cruise No. 5)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81.5
81.0
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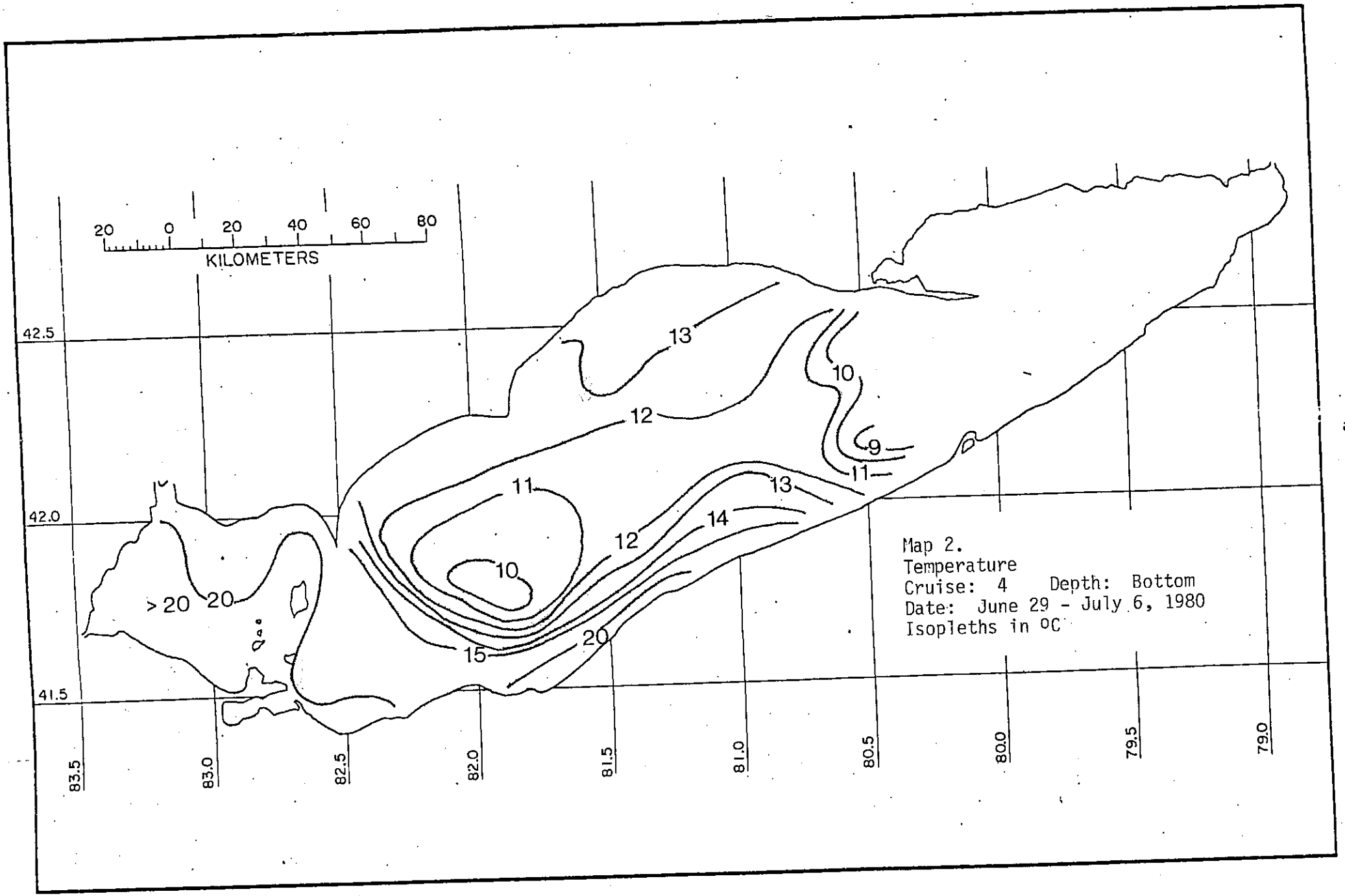
80.0
79.5
79.0
19
20
21
22
23
24
Map 1.
Temperature
Cruise: 4 Depth: Surface
Date: June 29 - July 6, 1980
Isopleths in °C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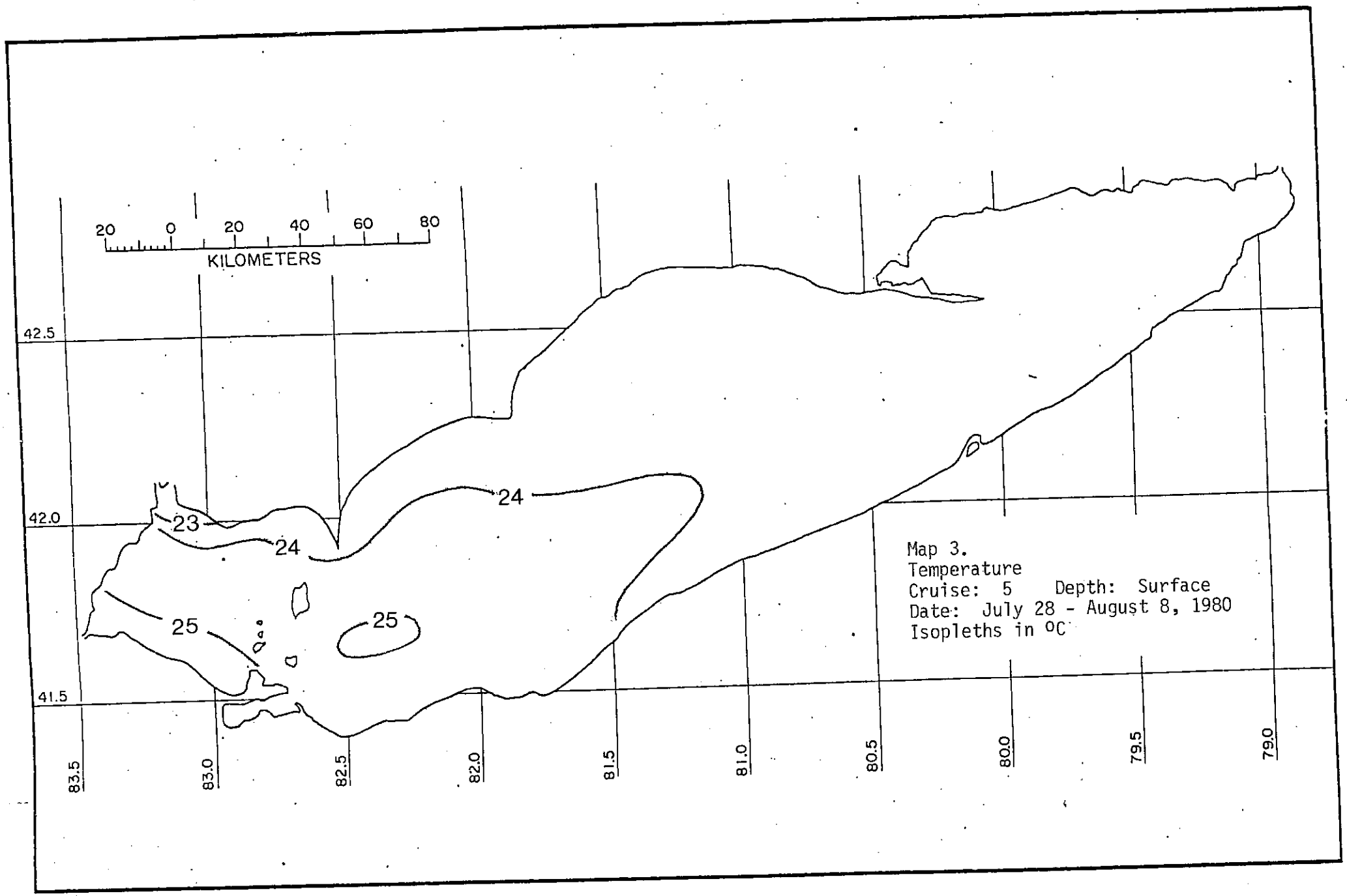
10
12
9
11
11
13
14
12
10
> 20
20
15
20
Map 2.
Temperature
Cruise: 4 Depth: Bottom
Date: June 29 - July 6, 1980
Isopleths in °C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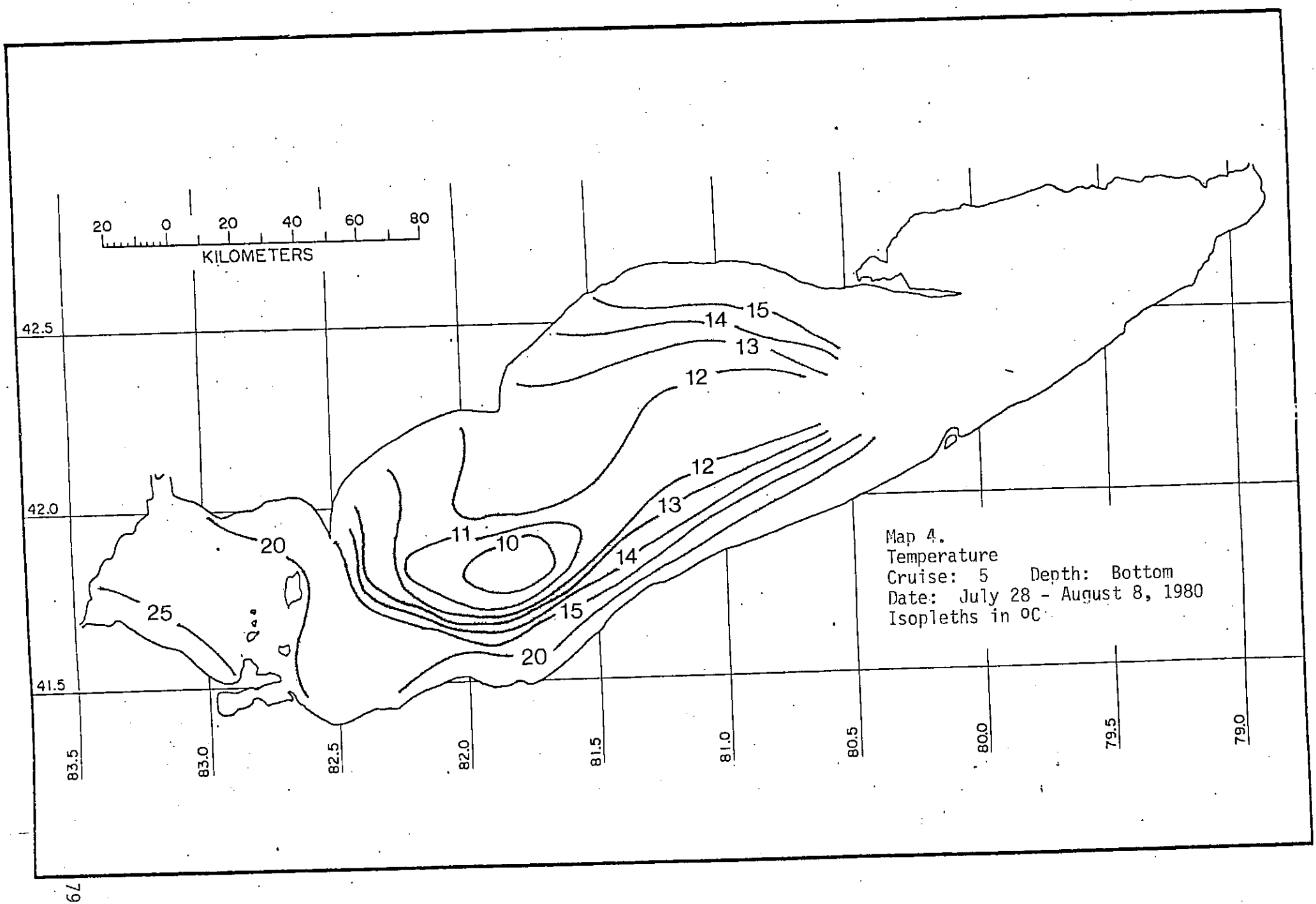
Map 3.
Temperature
Cruise: 5 Depth: Surface
Date: July 28 - August 8, 1980
Isopleths in °C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12
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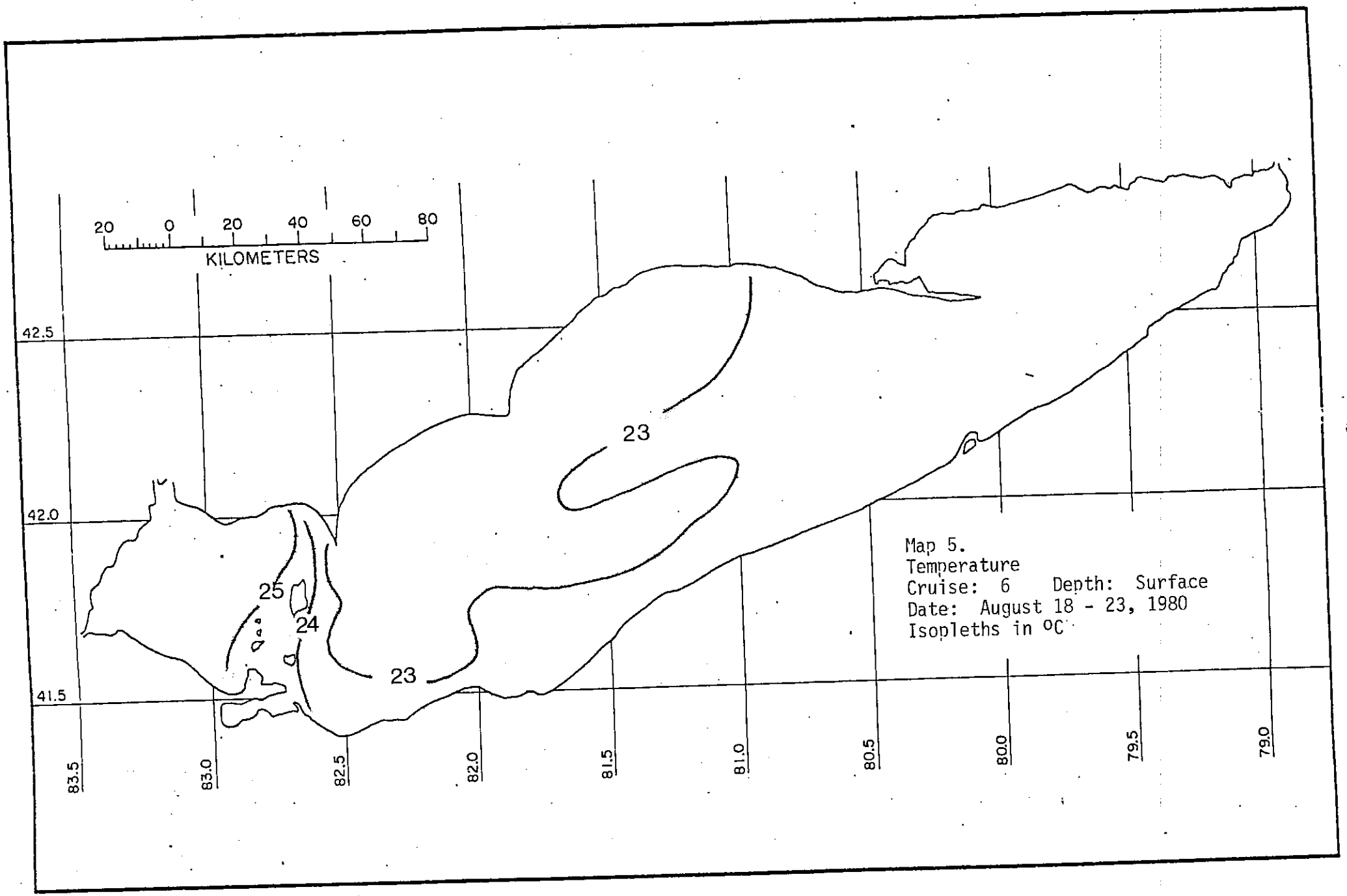
11
10
20
25
Map 4.
Temperature
Cruise: 5 Depth: Bottom
Date: July 28 - August 8, 1980
Isopleths in °C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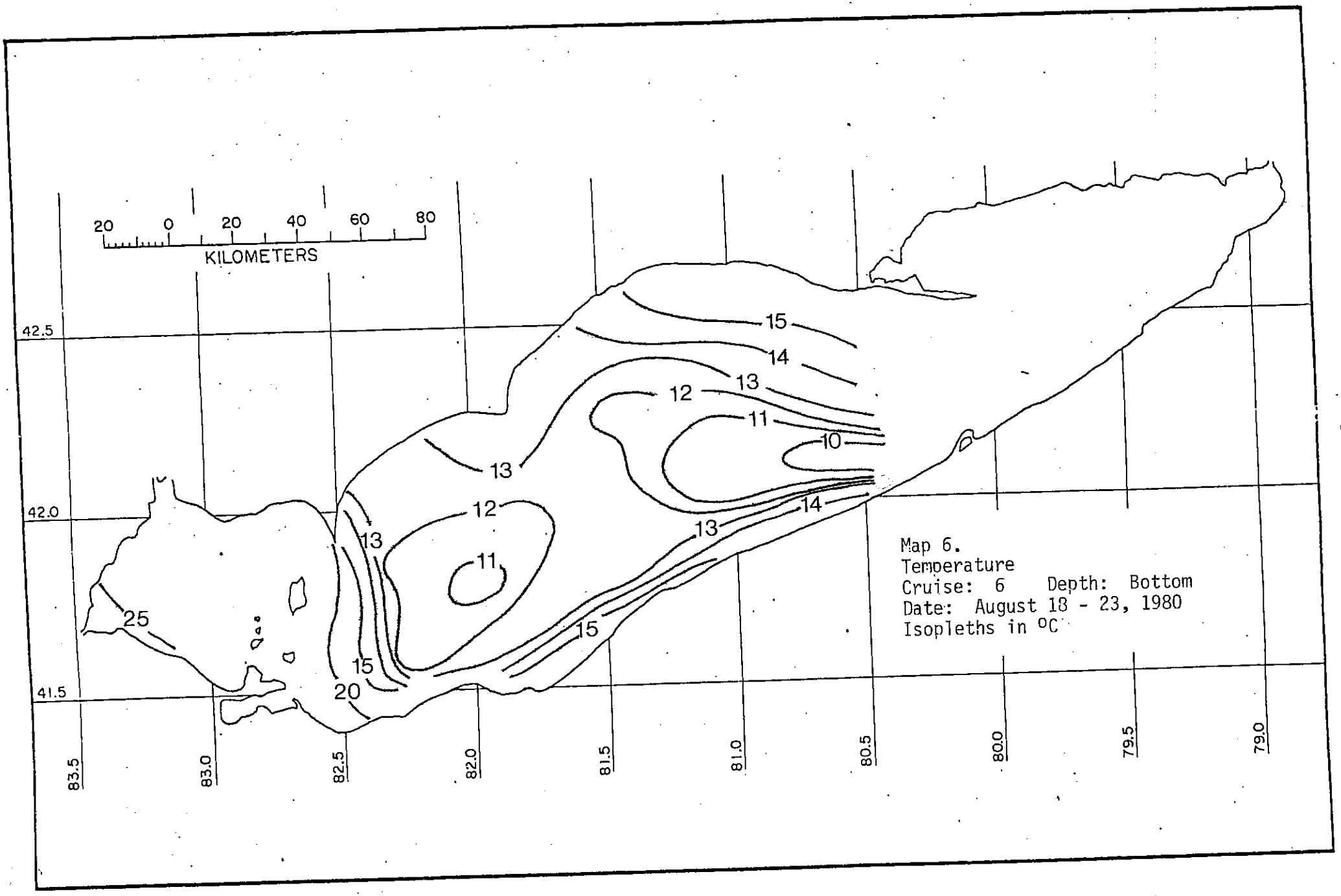
23
25
24
23
Map 5.
Temperature
Cruise: 6 Depth: Surface
Date: August 18 - 23, 1980
Isopleths in °C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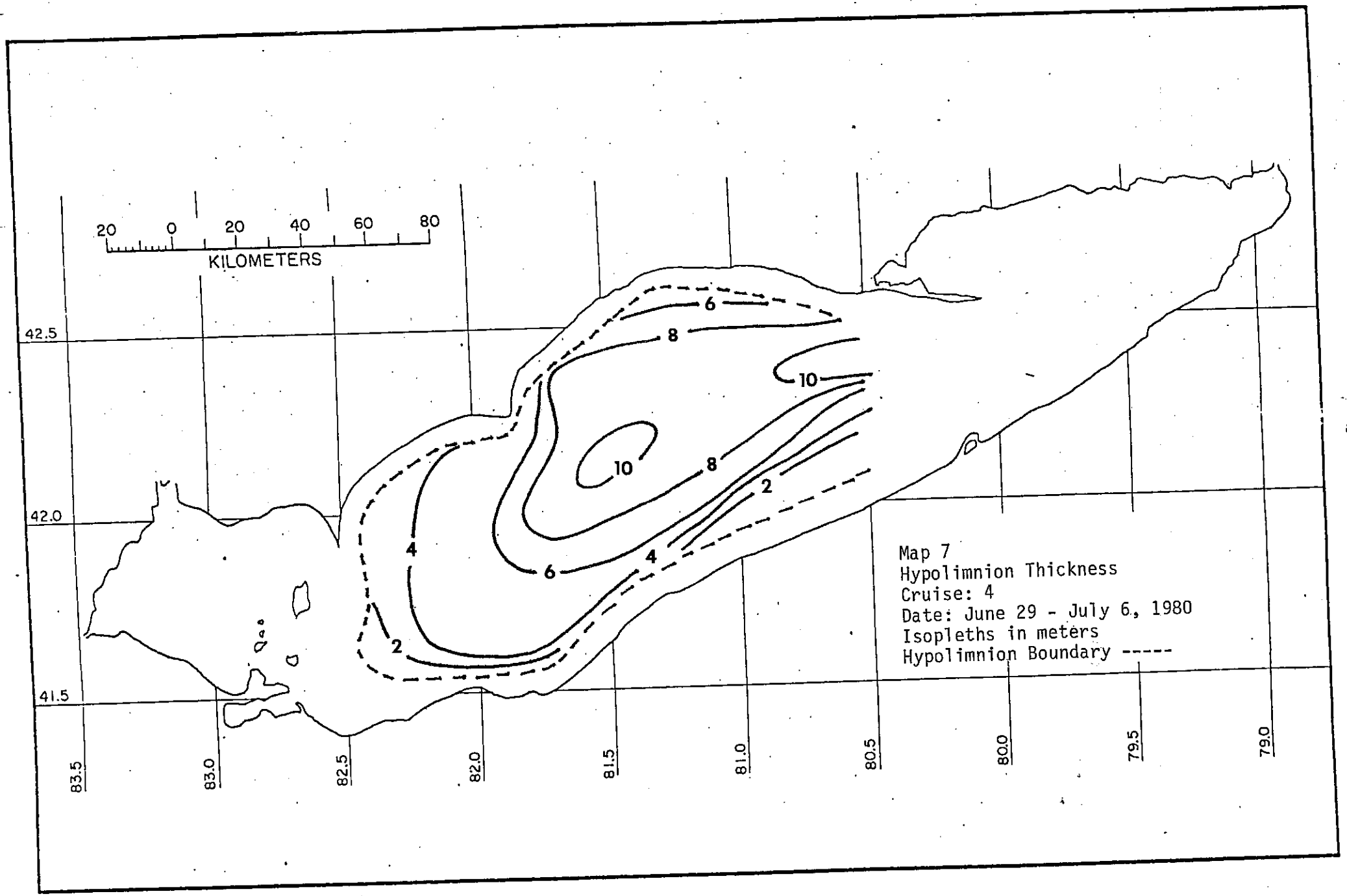
Map 6.
Temperature
Cruise: 6 Depth: Bottom
Date: August 18 - 23, 1980
Isopleths in °C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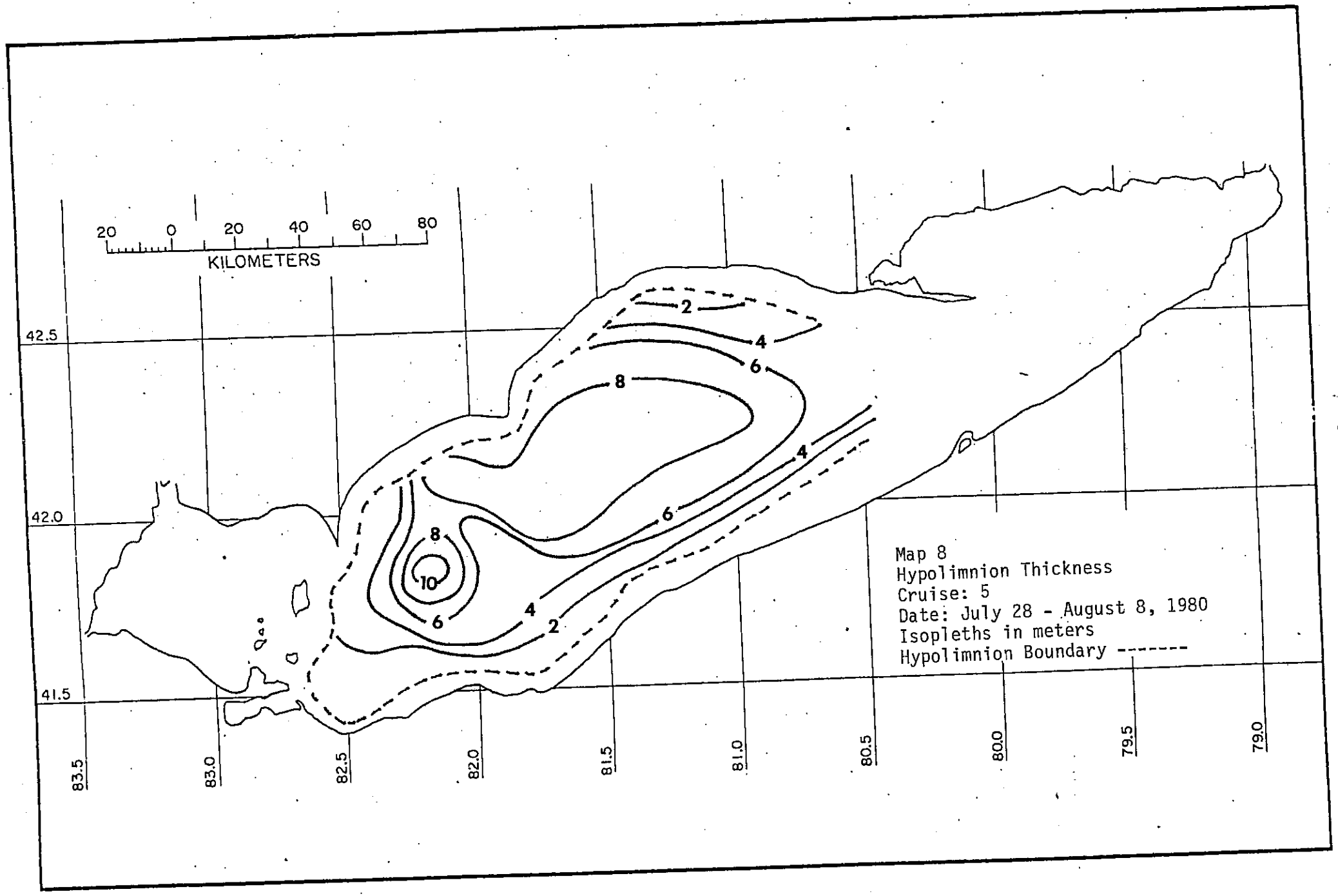
4
6
8
10
Map 7
Hypolimnion Thickness
Cruise: 4
Date: June 29 - July 6, 1980
Isopleths in meters
Hypolimnion Boundary -----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4
6
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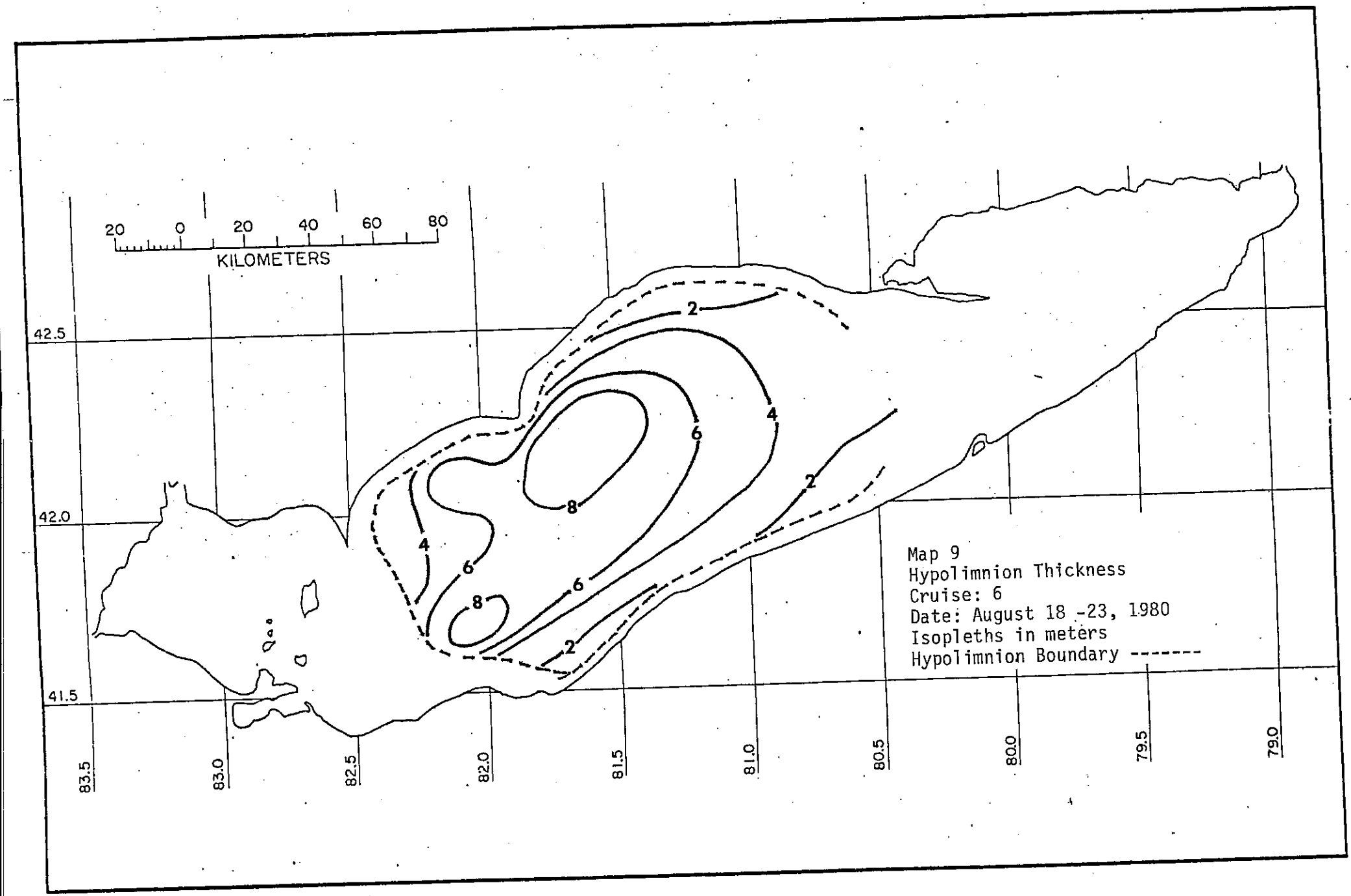
Map 8
Hypolimnion Thickness
Cruise: 5
Date: July 28 - August 8, 1980
Isopleths in meters
Hypolimnion Boundary -------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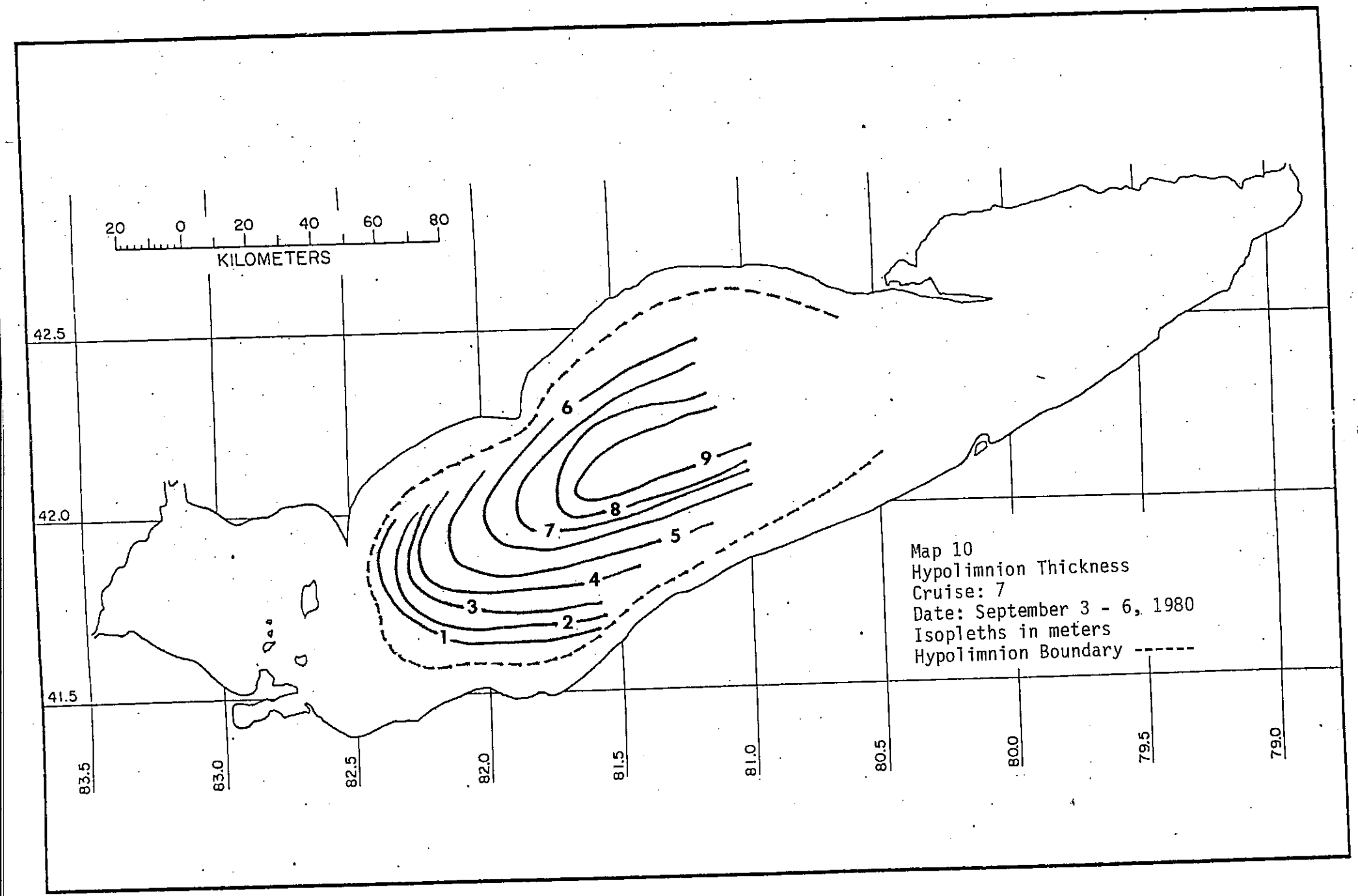
79.5
79.0
2
4
6
8
Map 9
Hypolimnion Thickness
Cruise: 6
Date: August 18 -23, 1980
Isopleths in meters
Hypolimnion Boundary -------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1
2
3
4
5
6
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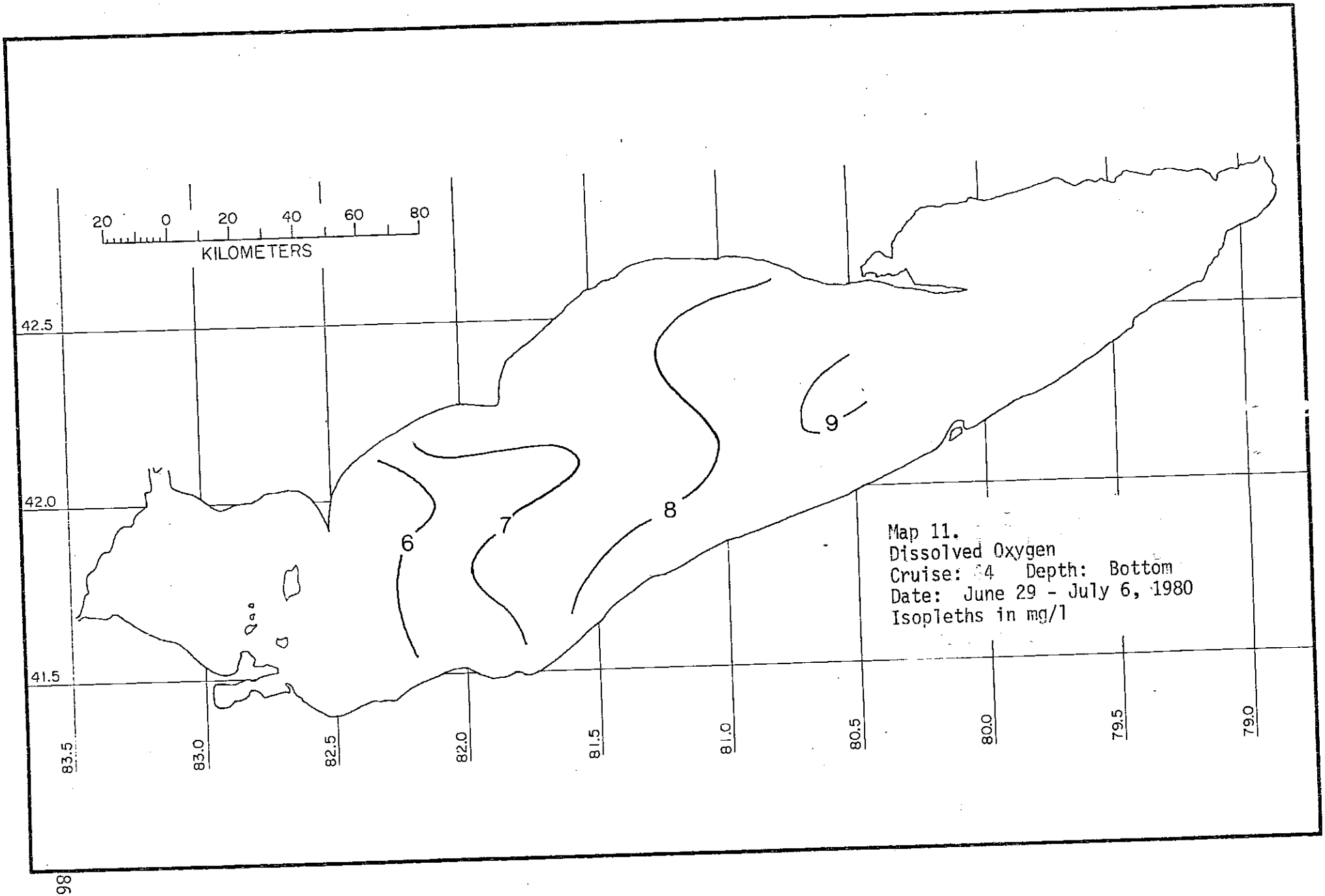
8
9
Map 10
Hypolimnion Thickness
Cruise: 7
Date: September 3 - 6, 1980
Isopleths in meters
Hypolimnion Boundary ------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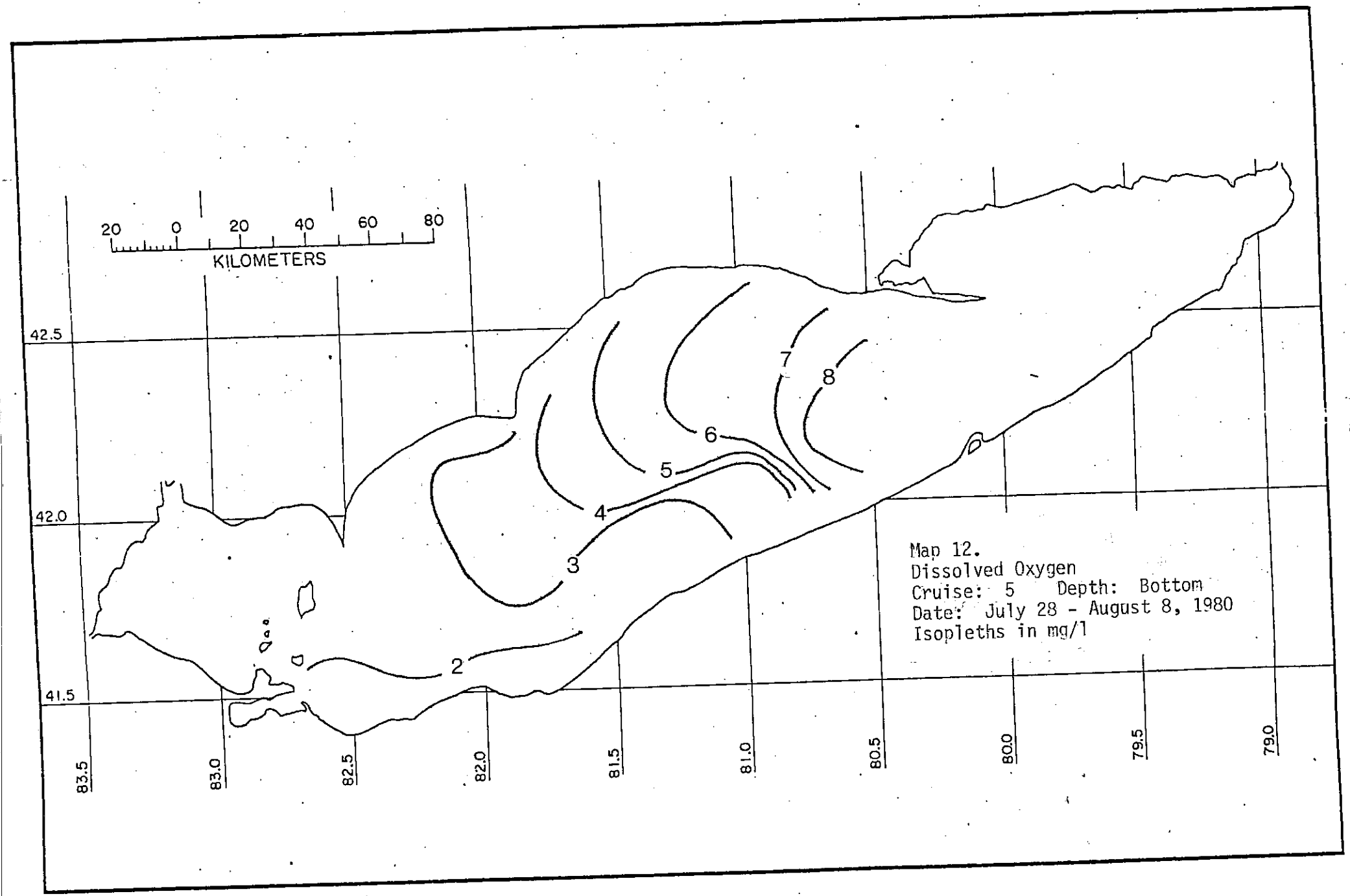
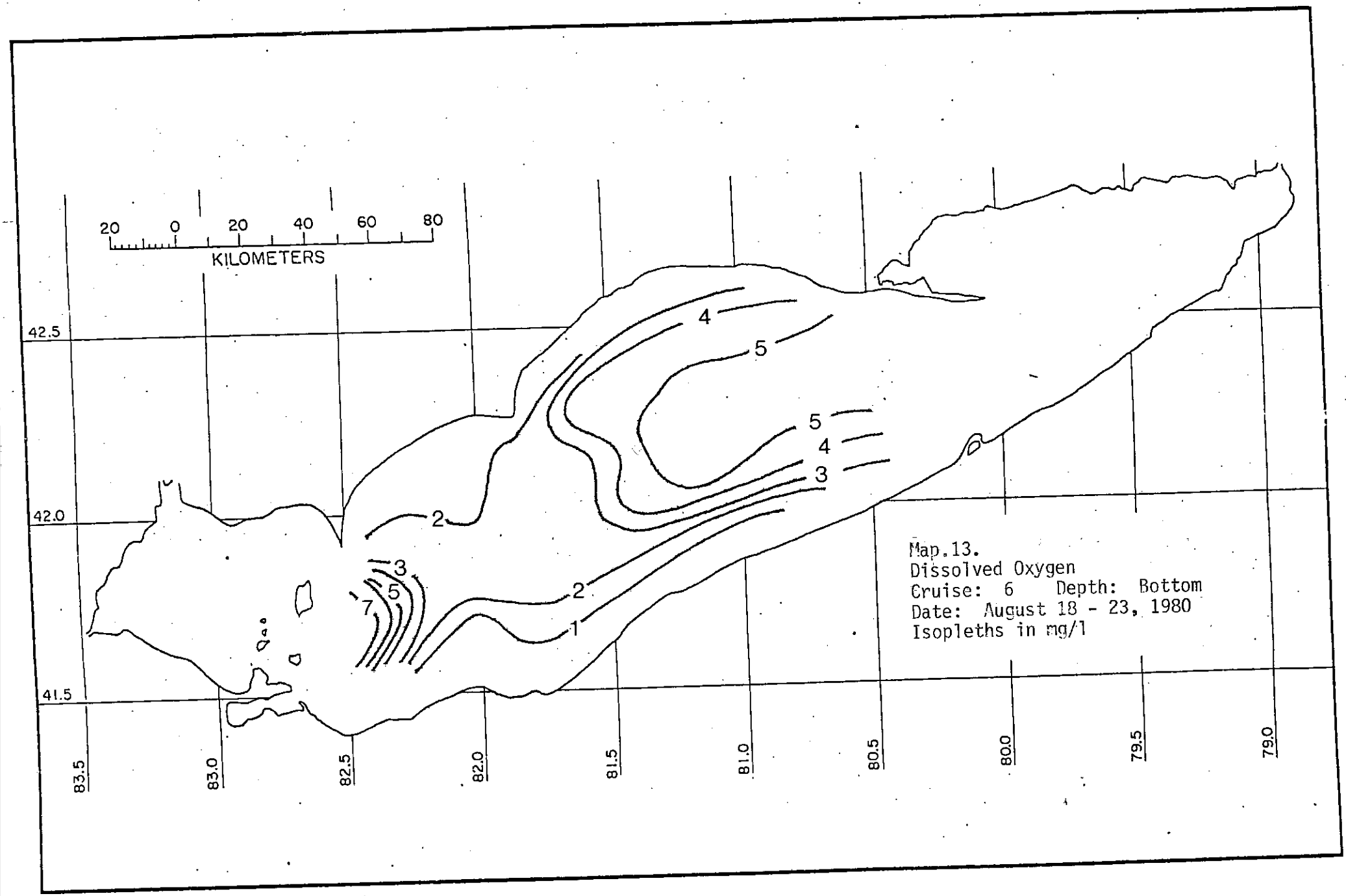
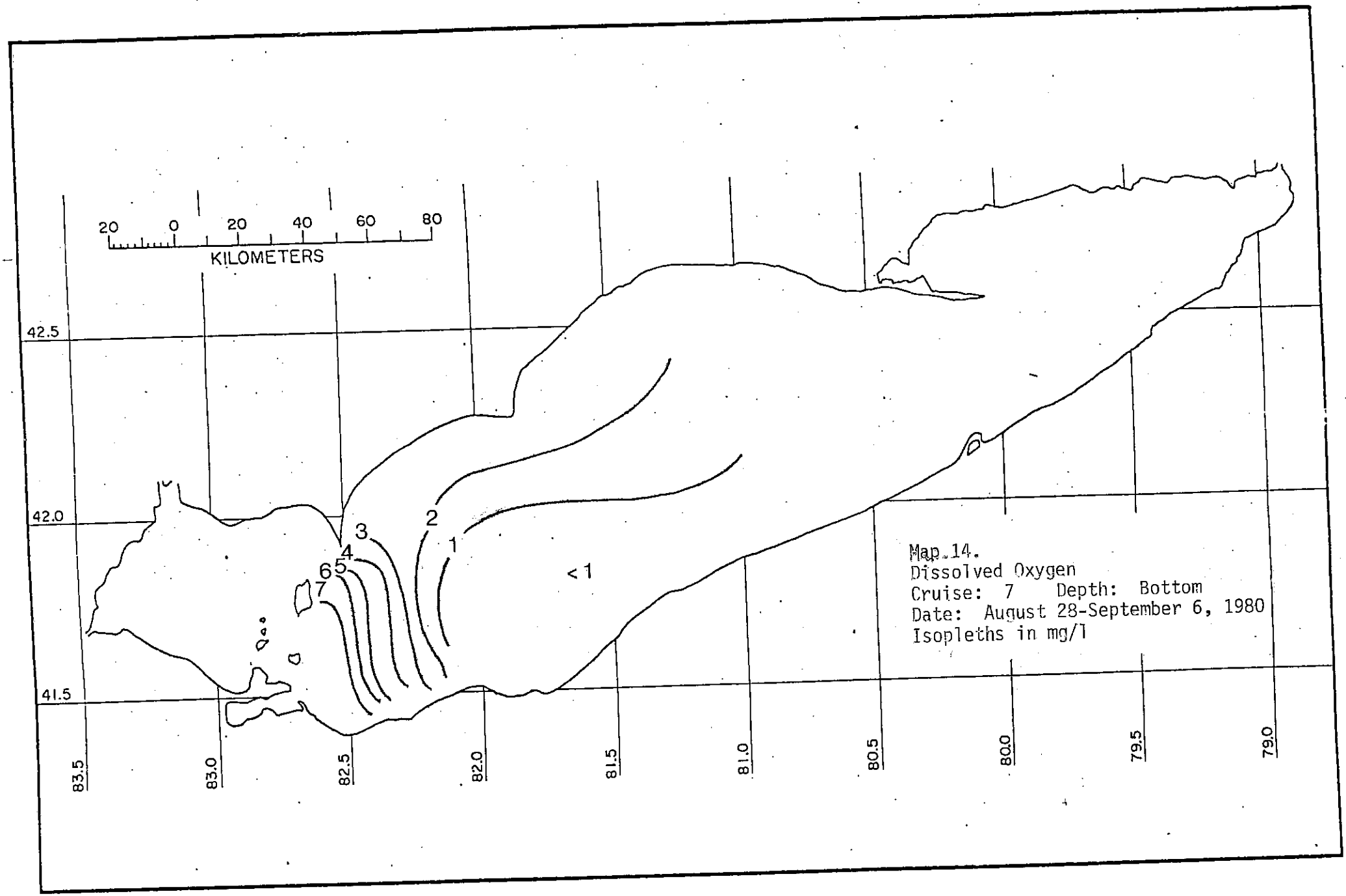
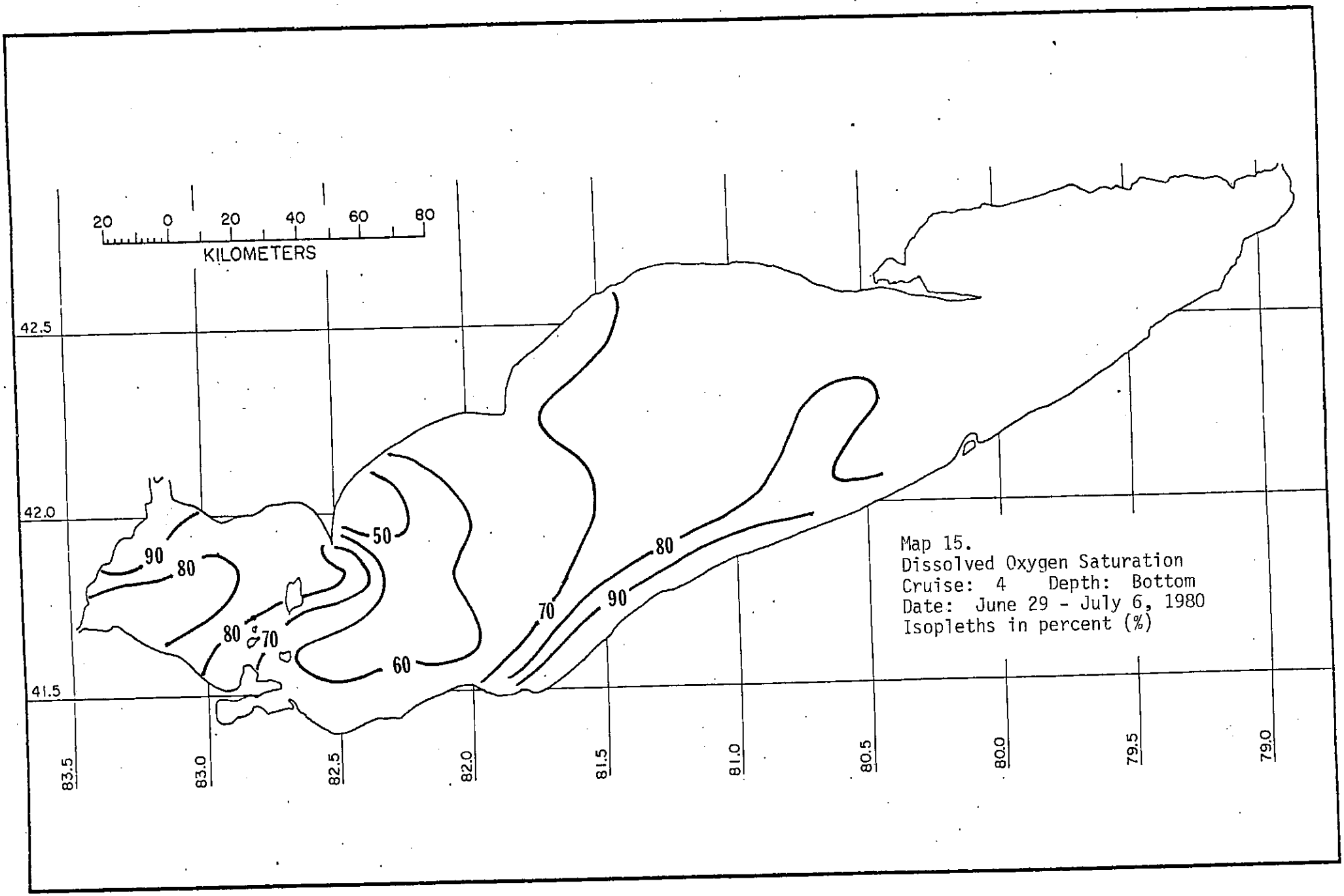
Map 11.
Dissolved Oxygen
Cruise: 4 Depth: Bottom
Date: June 29 - July 6, 1980
Isopleths in mg/l

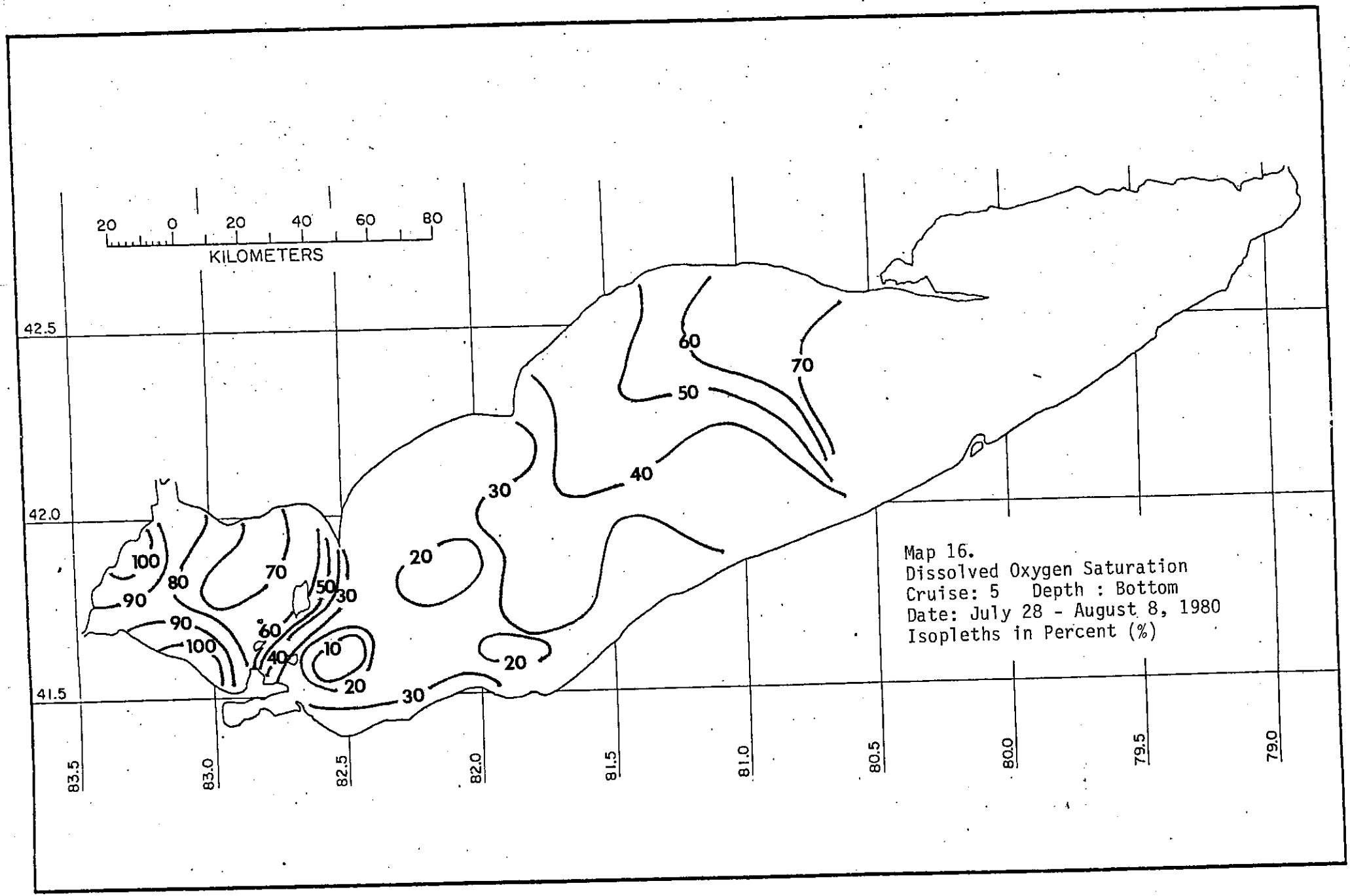

20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
2
3
4
5
6
7
8
Map 12.
Dissolved Oxygen
Cruise: 5 Depth: Bottom
Date: July 28 - August 8, 1980
Isopleths in mg/l

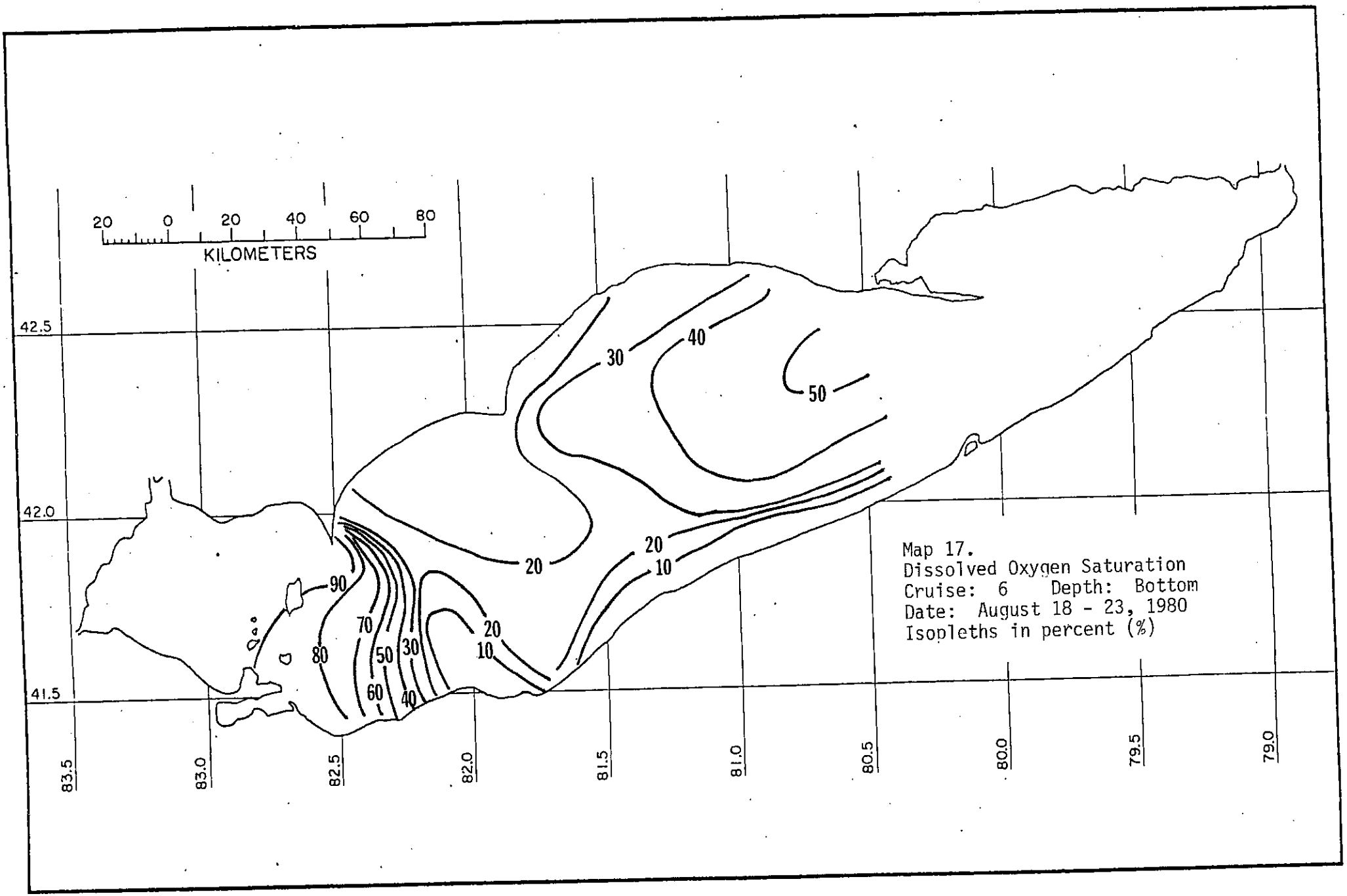

20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
4
5
5
4
3
2
3
5
7
2
1
Map.13.
Dissolved Oxygen
Cruise: 6 Depth: Bottom
Date: August 18 - 23, 1980
Isopleths in mg/l


20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
1
2
3
4
5
6
7
< 1
Map 14.
Dissolved Oxygen
Cruise: 7 Depth: Bottom
Date: August 28-September 6, 1980
Isopleths in mg/l

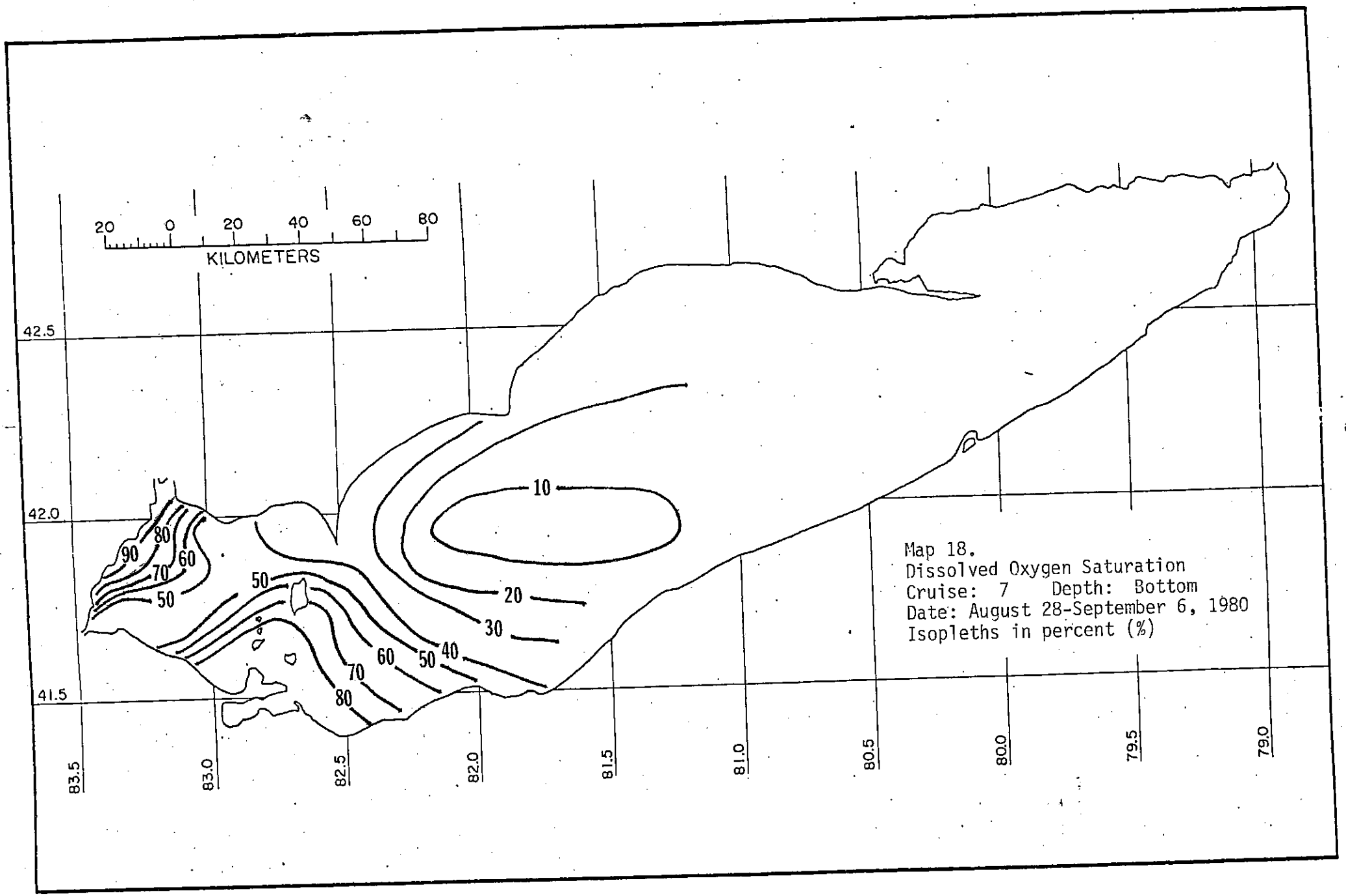


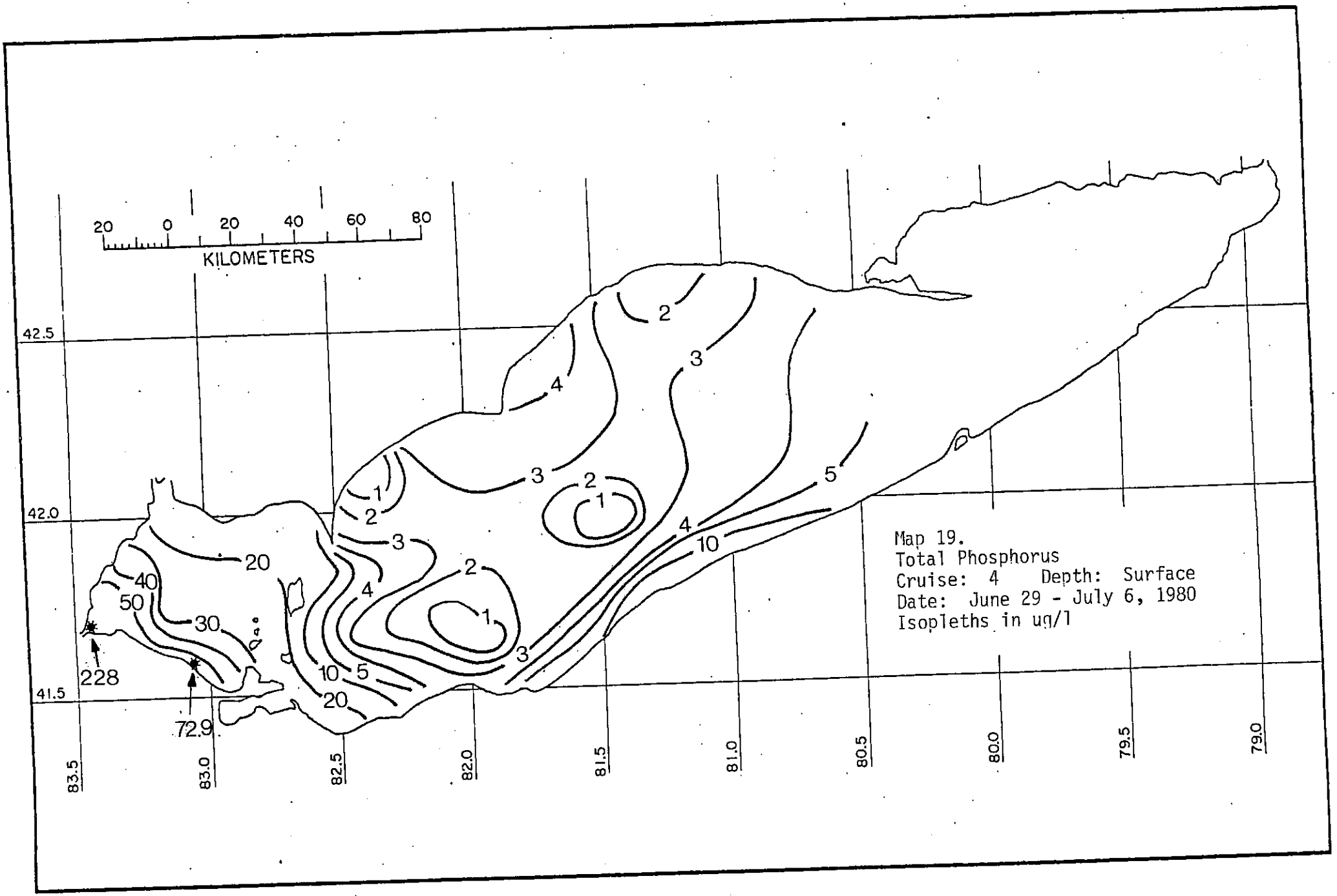
Map 15.
Dissolved Oxygen Saturation
Cruise: 4 Depth: Bottom
Date: June 29 - July 6, 1980
Isopleths in percent (%)

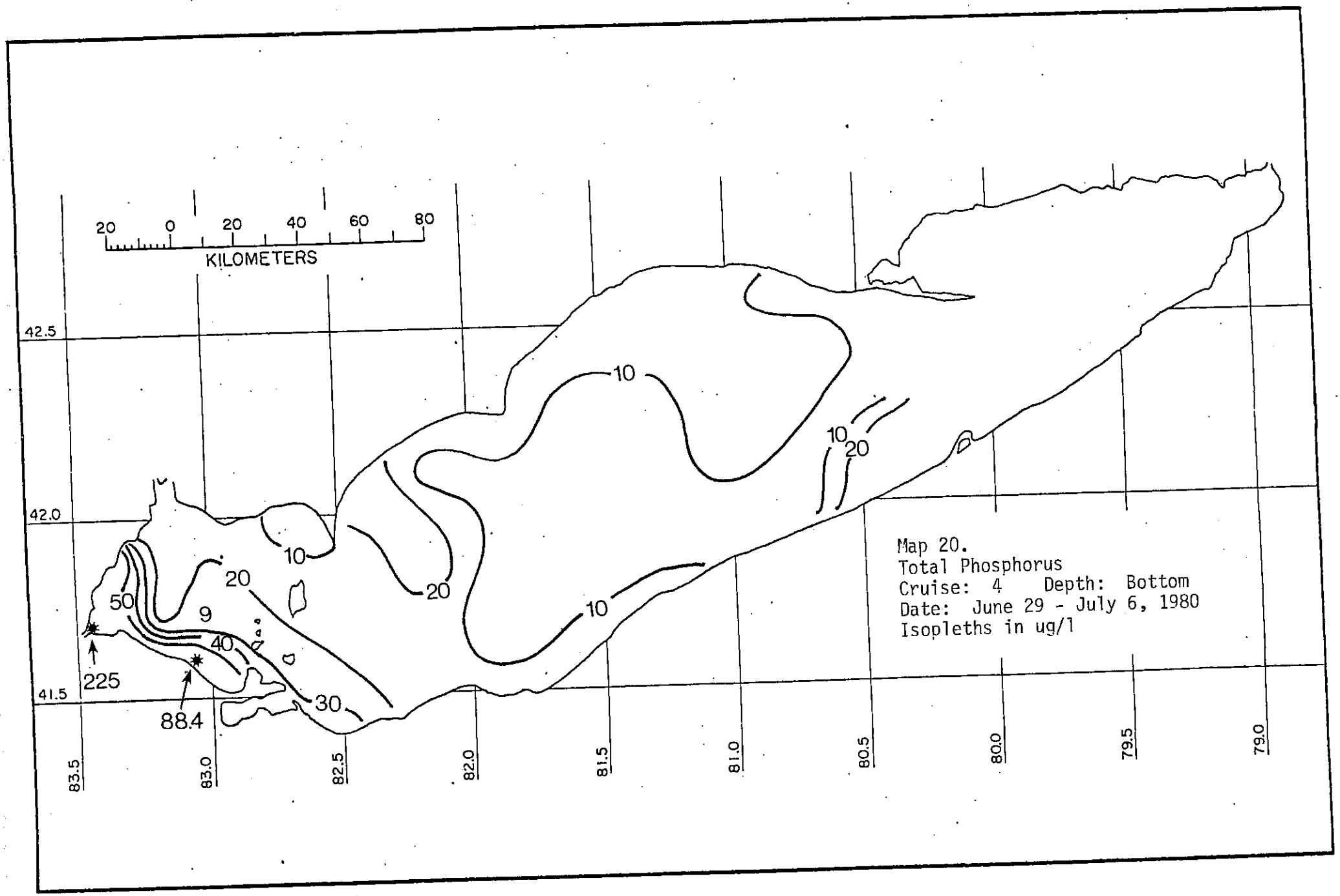

20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
100
90
80
70
60
50
40
30
20
10
Map 16.
Dissolved Oxygen Saturation
Cruise: 5 Depth : Bottom
Date: July 28 - August 8, 1980
Isopleths in Percent (%)

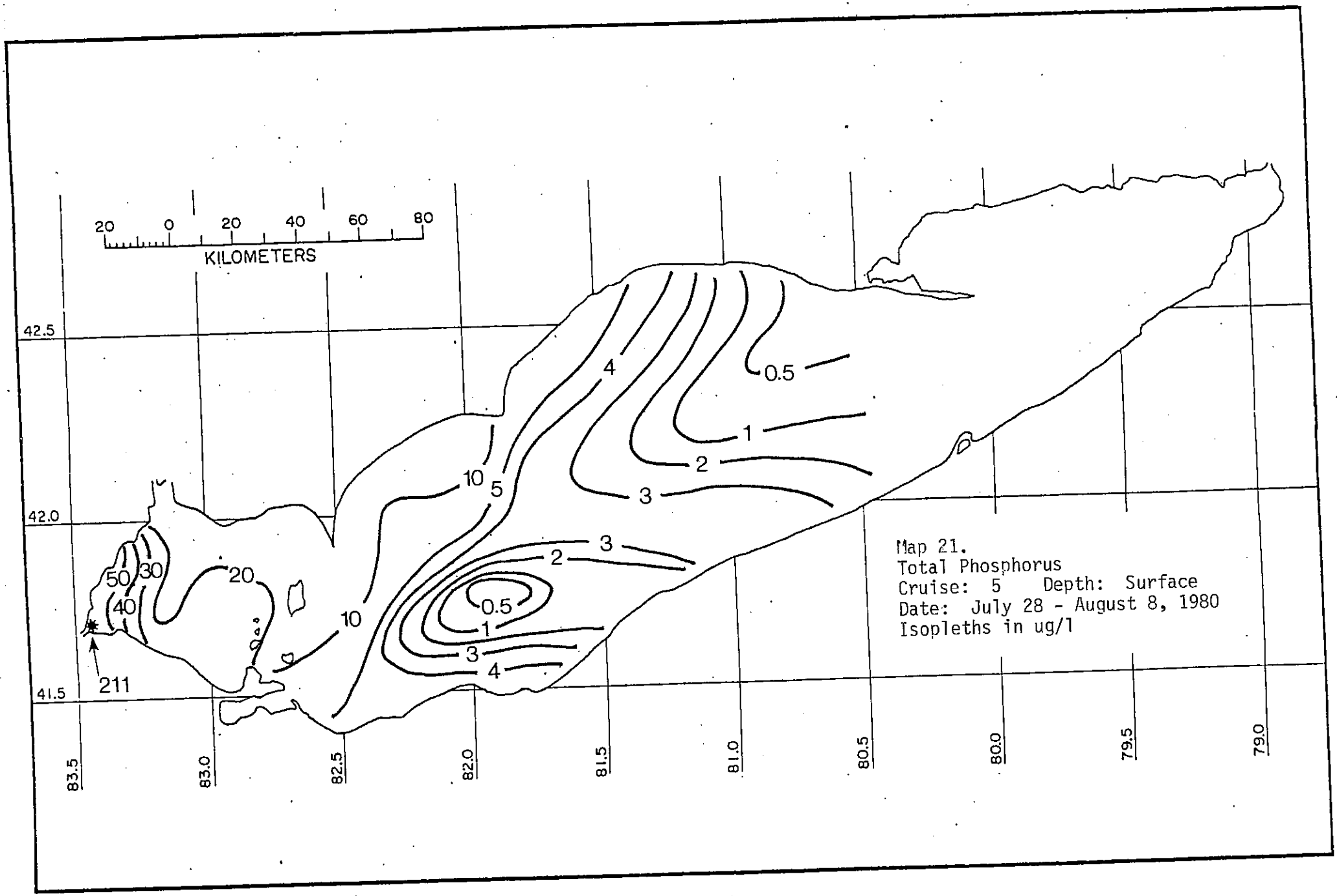


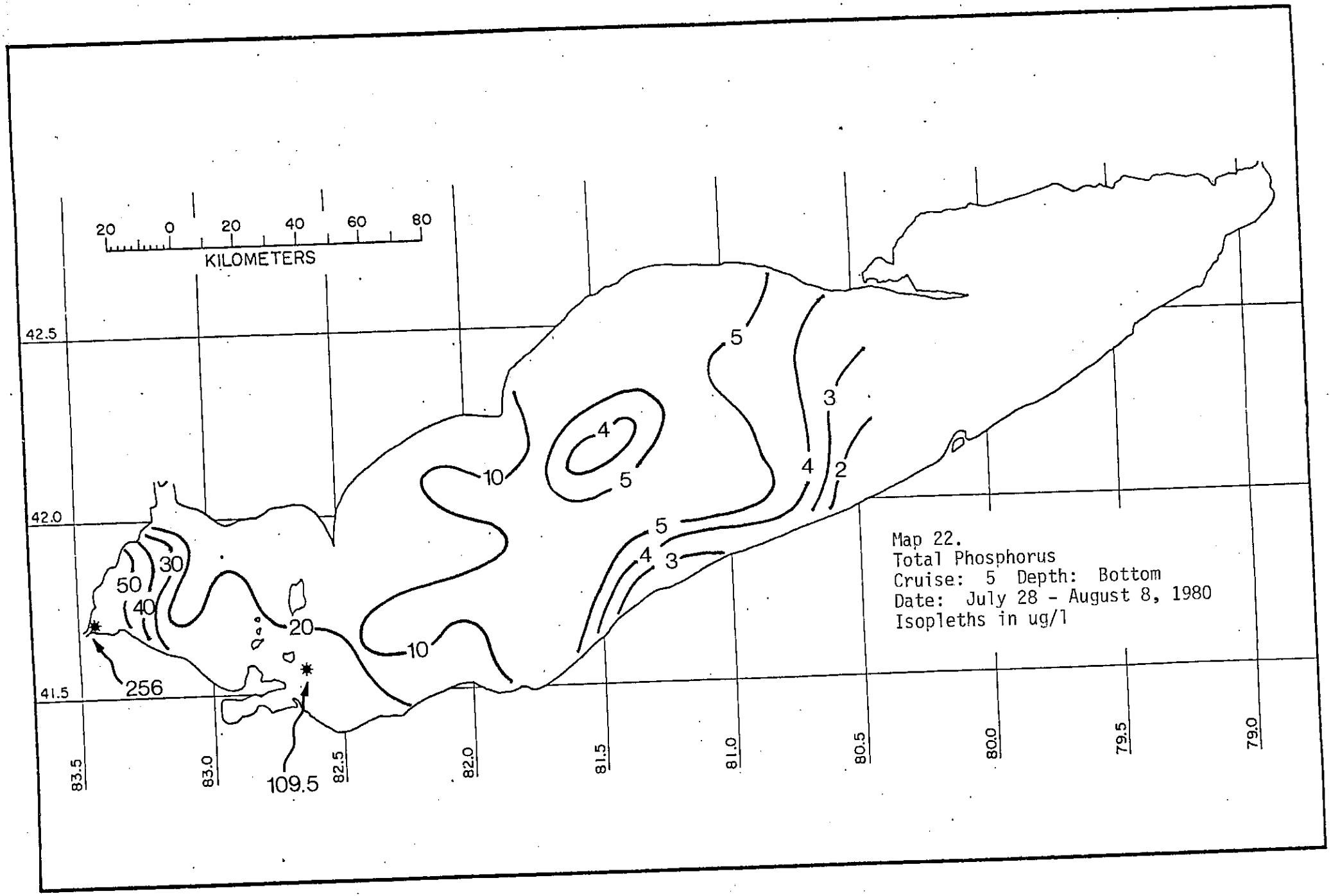
Map 17.
Dissolved Oxygen Saturation
Cruise: 6 Depth: Bottom
Date: August 18 - 23, 1980
Isopleths in percent (%)

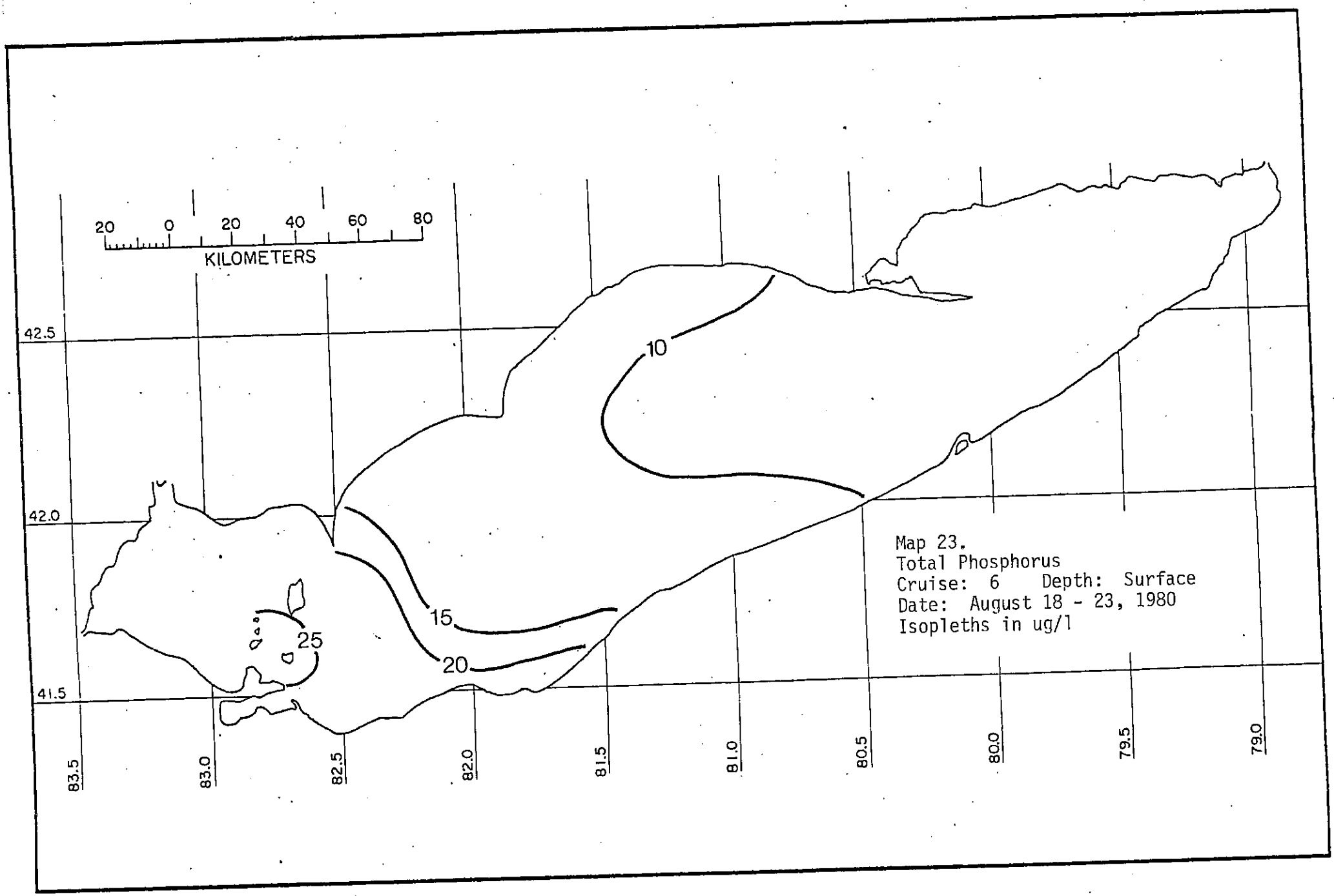

20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
10
20
30
40
50
60
70
80
90
Map 18.
Dissolved Oxygen Saturation
Cruise: 7 Depth: Bottom
Date: August 28-September 6, 1980
Isopleths in percent (%)

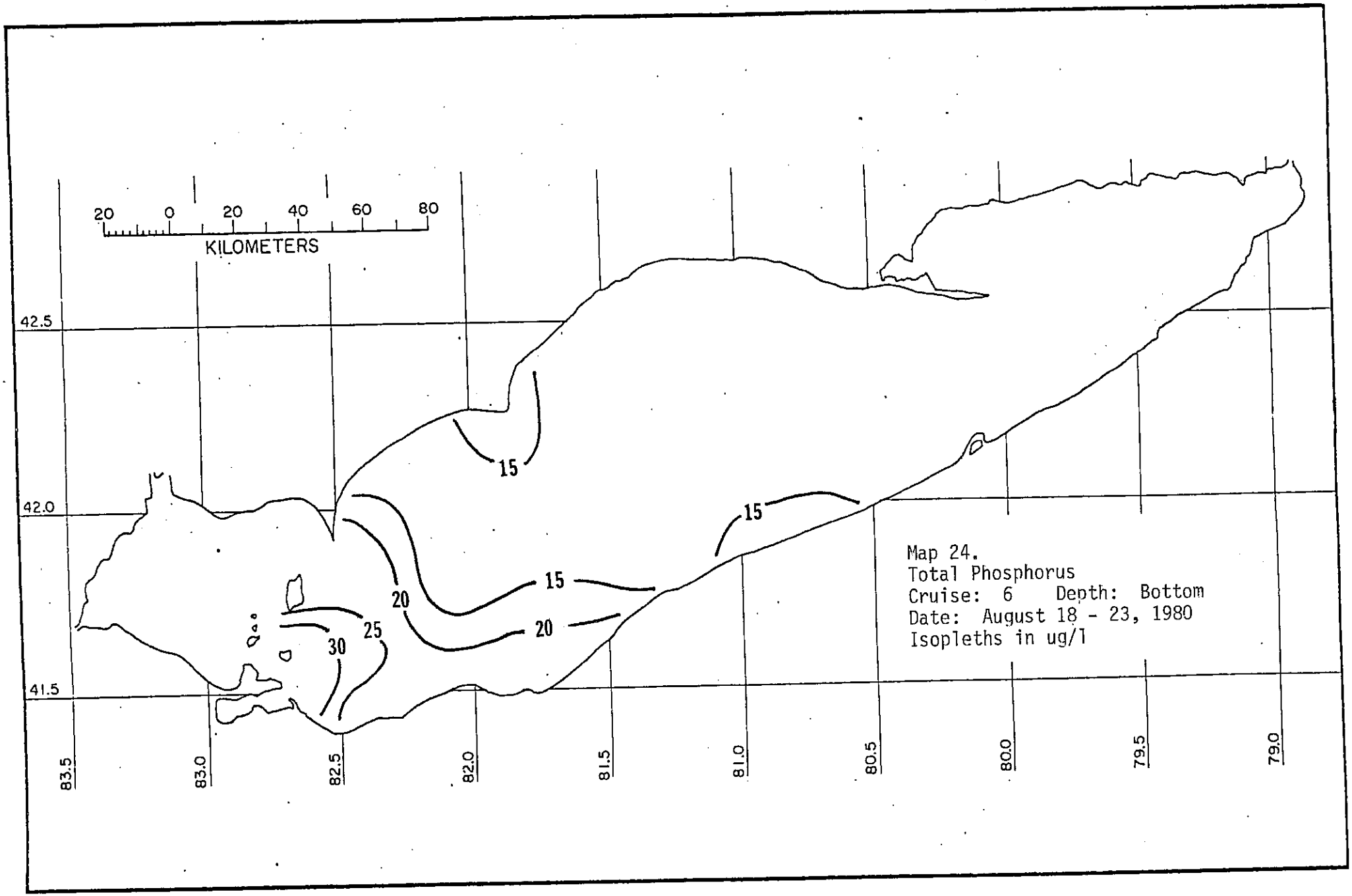

20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
228
72.9
Map 19.
Total Phosphorus
Cruise: 4 Depth: Surface
Date: June 29 - July 6, 1980
Isopleths in ug/l

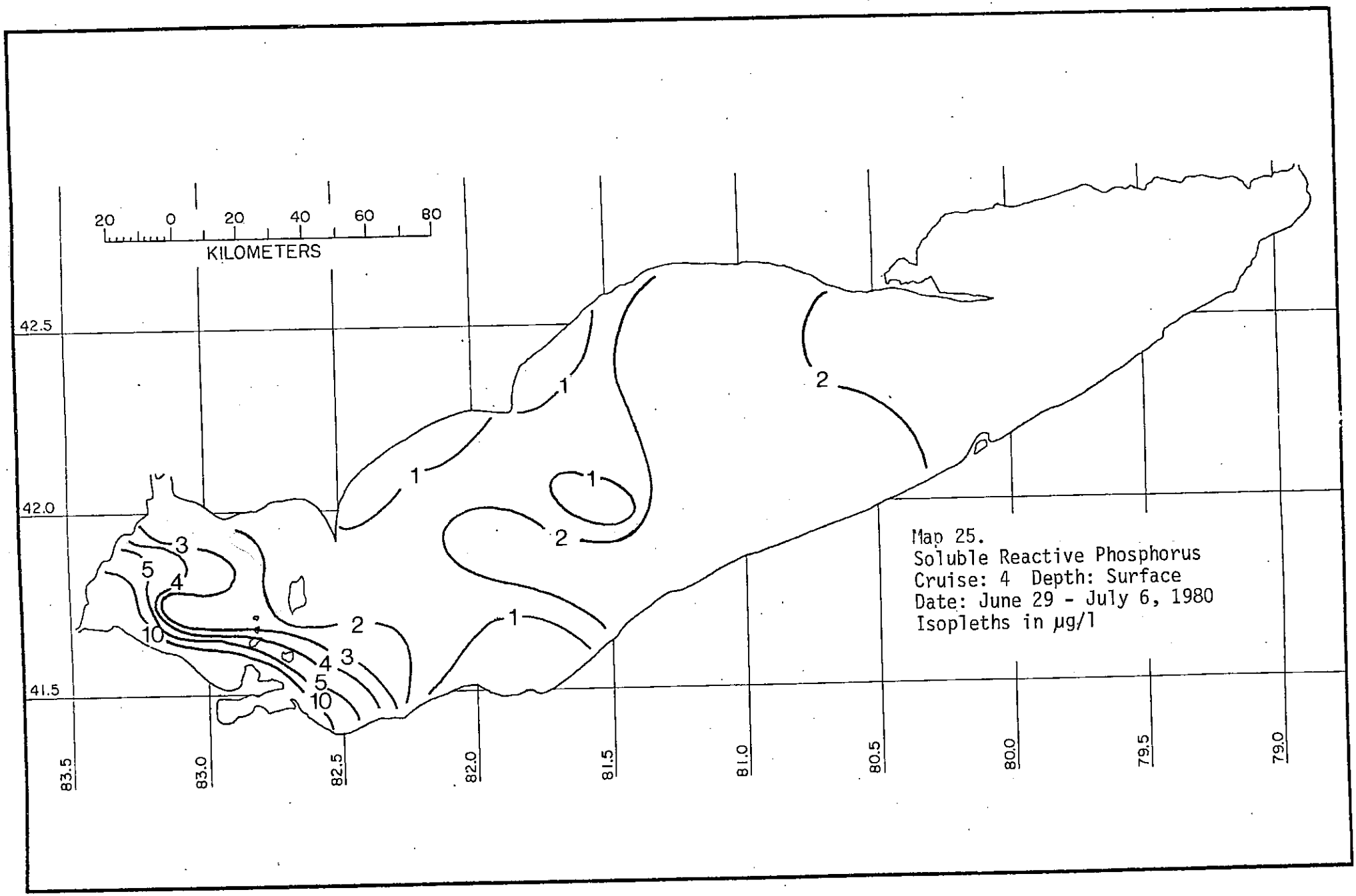

20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
10
20
10
20
10
10
50
9
40
20
30
225
88.4
Map 20.
Total Phosphorus
Cruise: 4 Depth: Bottom
Date: June 29 - July 6, 1980
Isopleths in ug/l

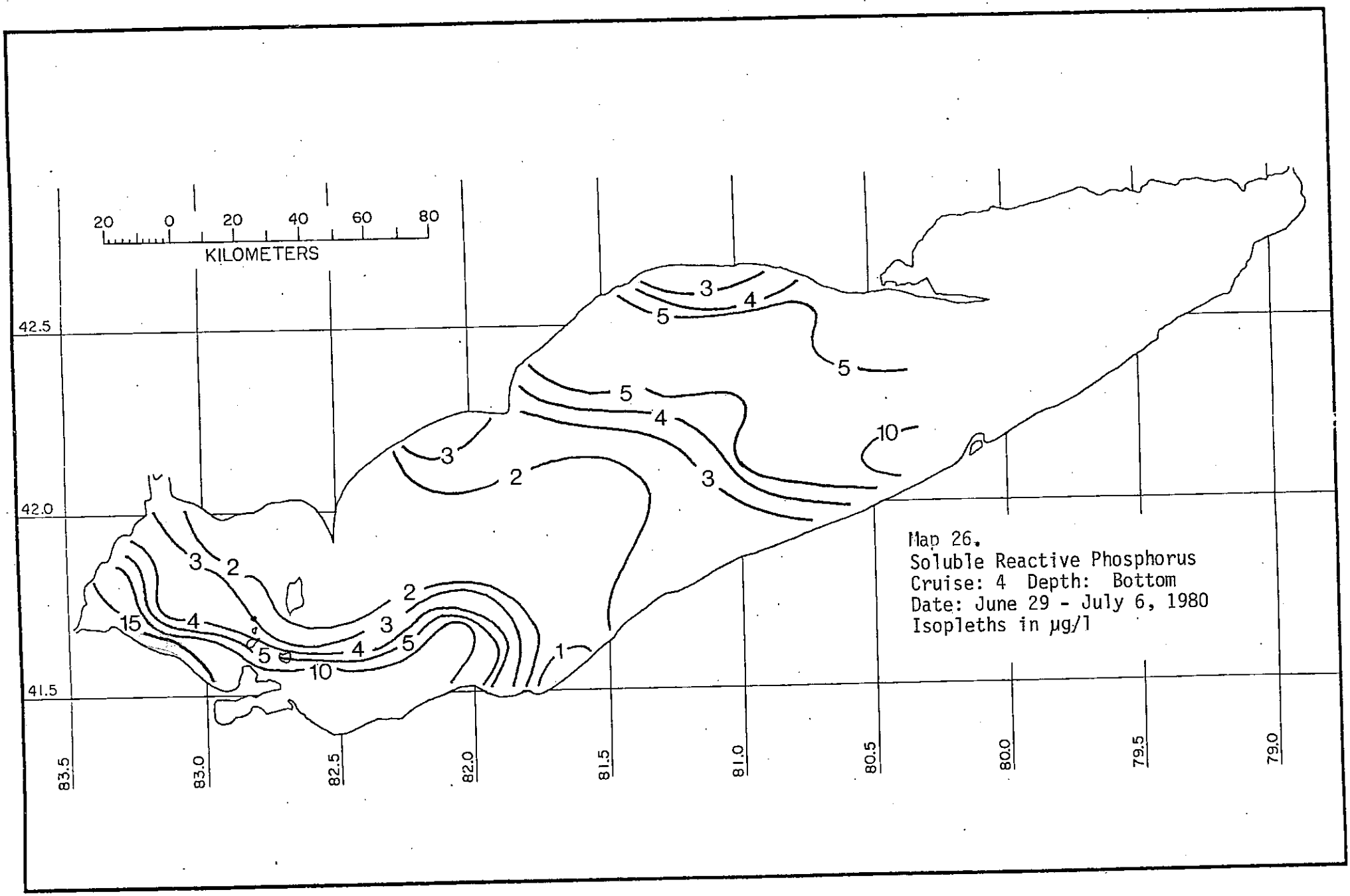

20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
0.5
1
2
3
4
5
10
20
30
40
50
211
Map 21.
Total Phosphorus
Cruise: 5 Depth: Surface
Date: July 28 - August 8, 1980
Isopleths in ug/l

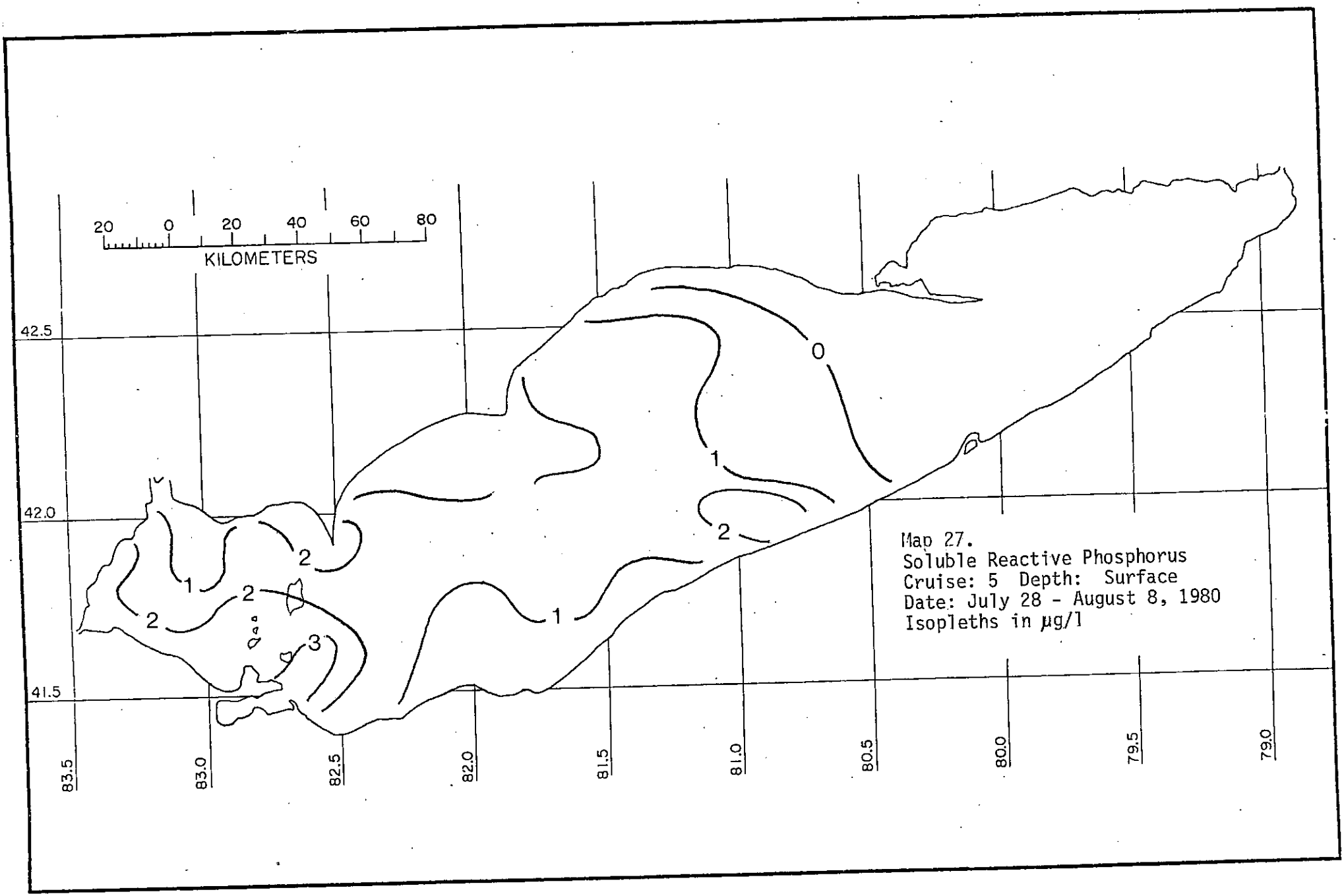

20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
5
3
4
2
10
4
5
5
4
3
50
30
40
20
10
256
109.5
Map 22.
Total Phosphorus
Cruise: 5 Depth: Bottom
Date: July 28 - August 8, 1980
Isopleths in ug/l


20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
10
15
20
25
Map 23.
Total Phosphorus
Cruise: 6 Depth: Surface
Date: August 18 - 23, 1980
Isopleths in ug/l

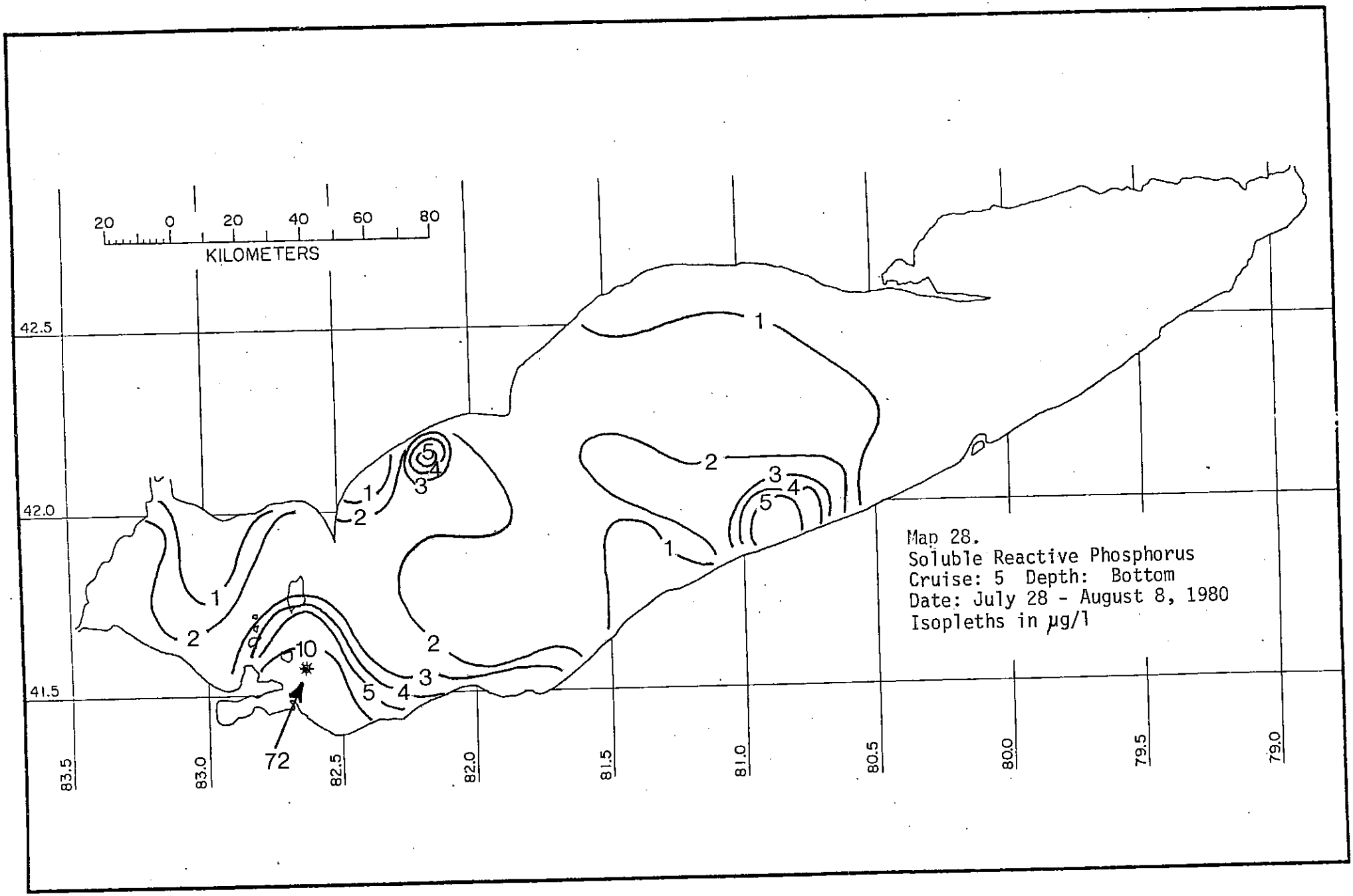

20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
15
15
15
20
20
25
30
Map 24.
Total Phosphorus
Cruise: 6 Depth: Bottom
Date: August 18 - 23, 1980
Isopleths in ug/l

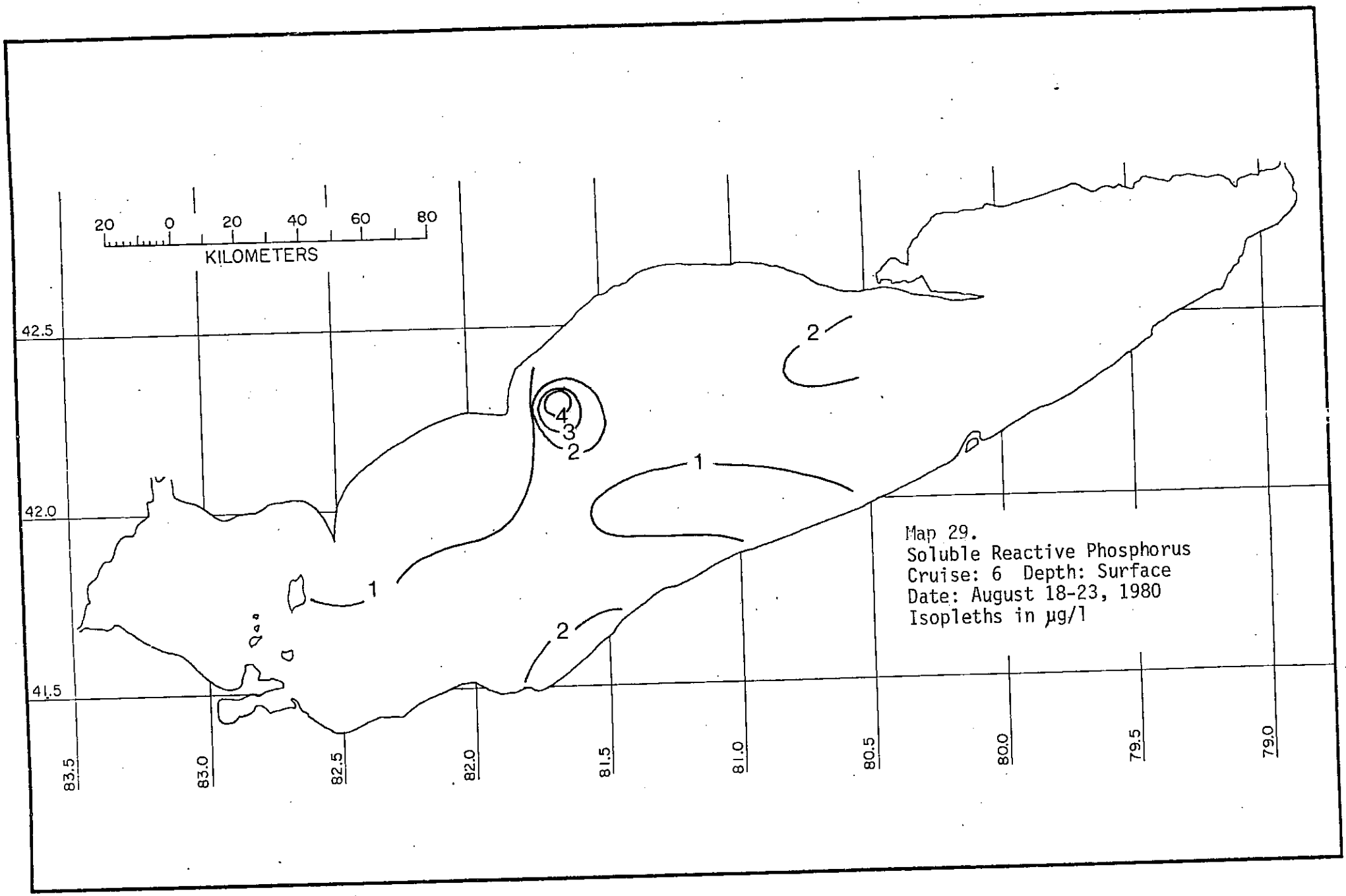

20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
1
2
3
4
5
10
Map 25.
Soluble Reactive Phosphorus
Cruise: 4 Depth: Surface
Date: June 29 - July 6, 1980
Isopleths in µg/l

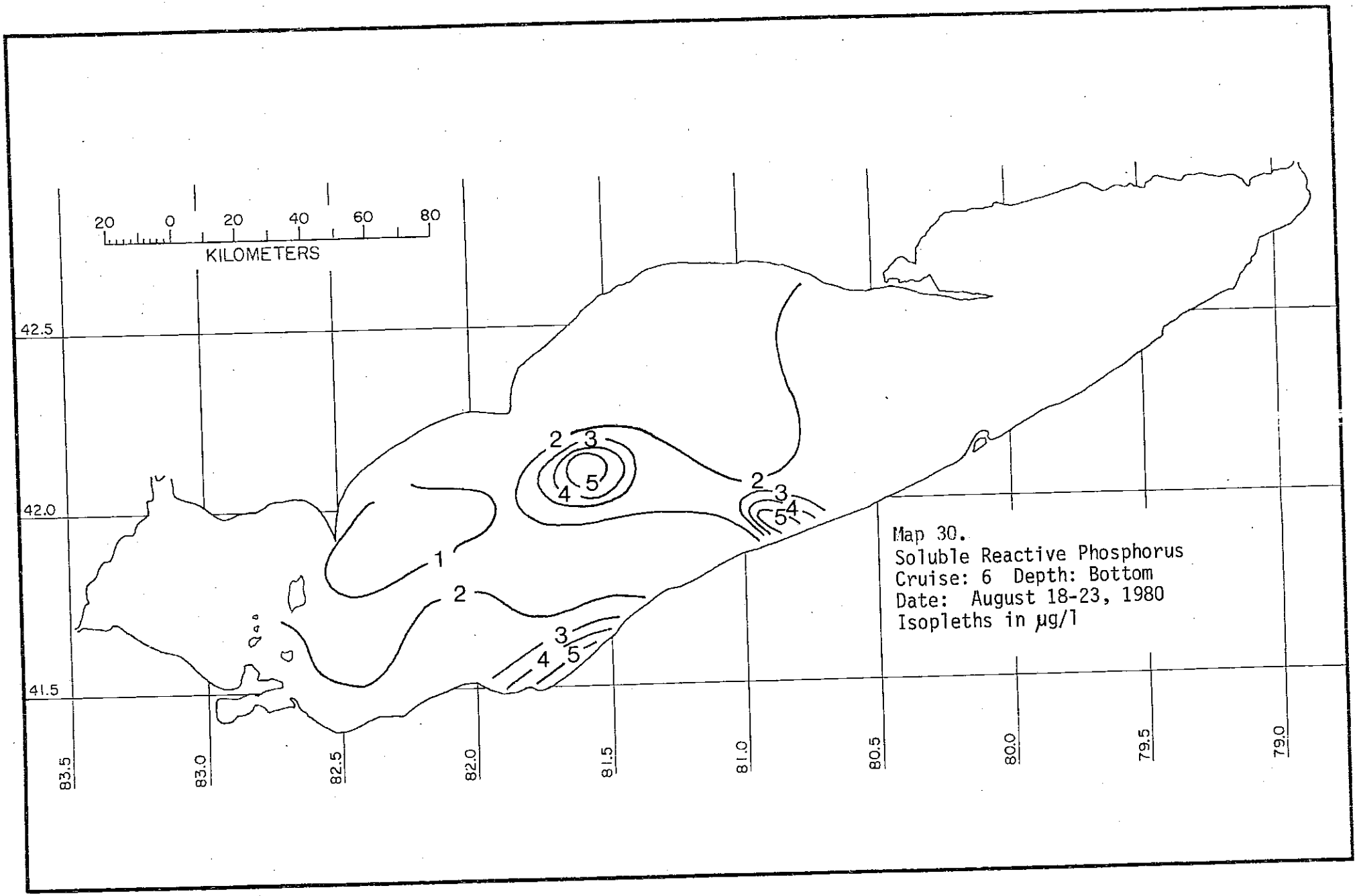

20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
3
4
5
5
5
4
10
3
2
3
2
2
3
4
5
15
4
5
10
1
Map 26.
Soluble Reactive Phosphorus
Cruise: 4 Depth: Bottom
Date: June 29 - July 6, 1980
Isopleths in µg/l

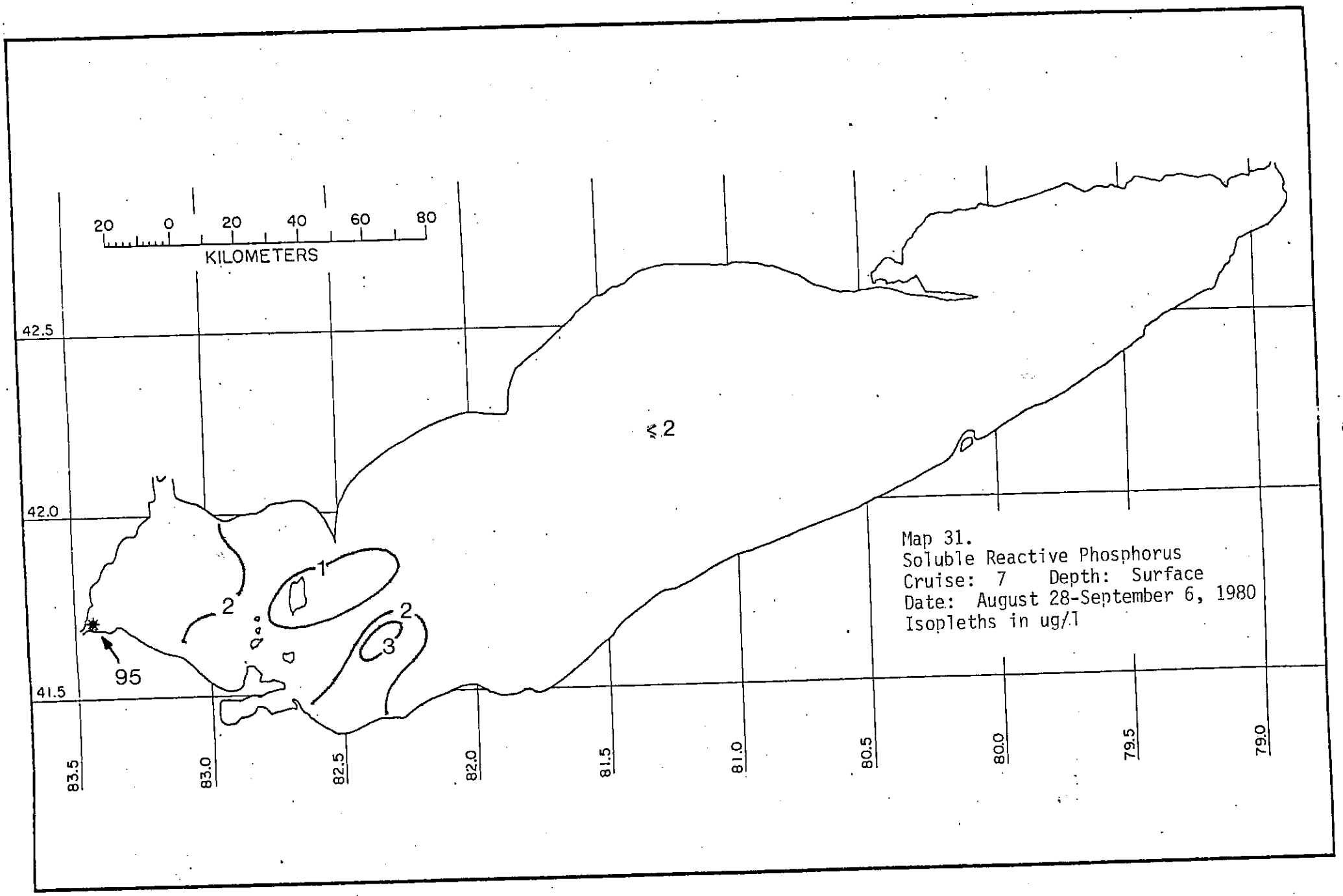


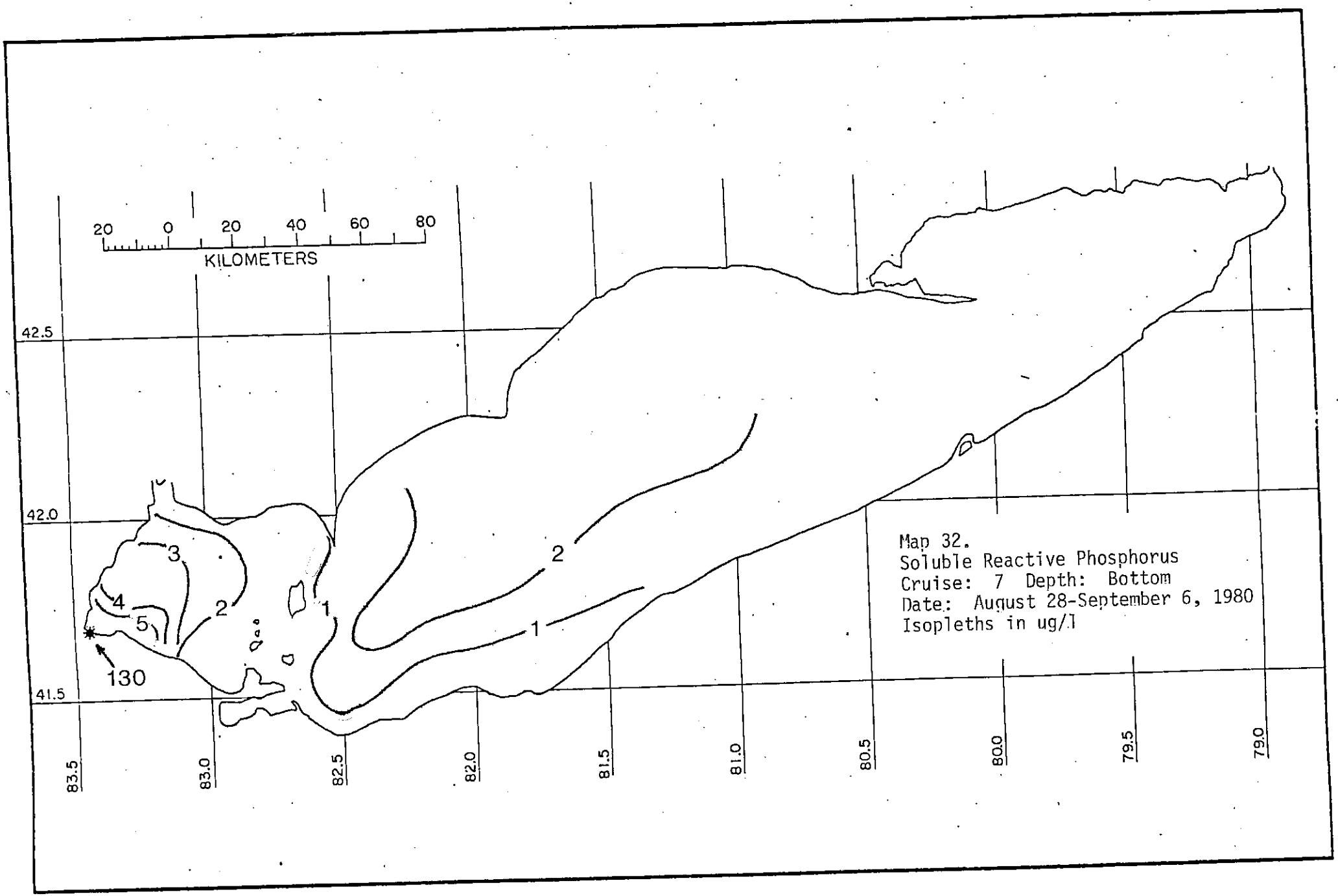
Map 27.
Soluble Reactive Phosphorus
Cruise: 5 Depth: Surface
Date: July 28 - August 8, 1980
Isopleths in µg/l

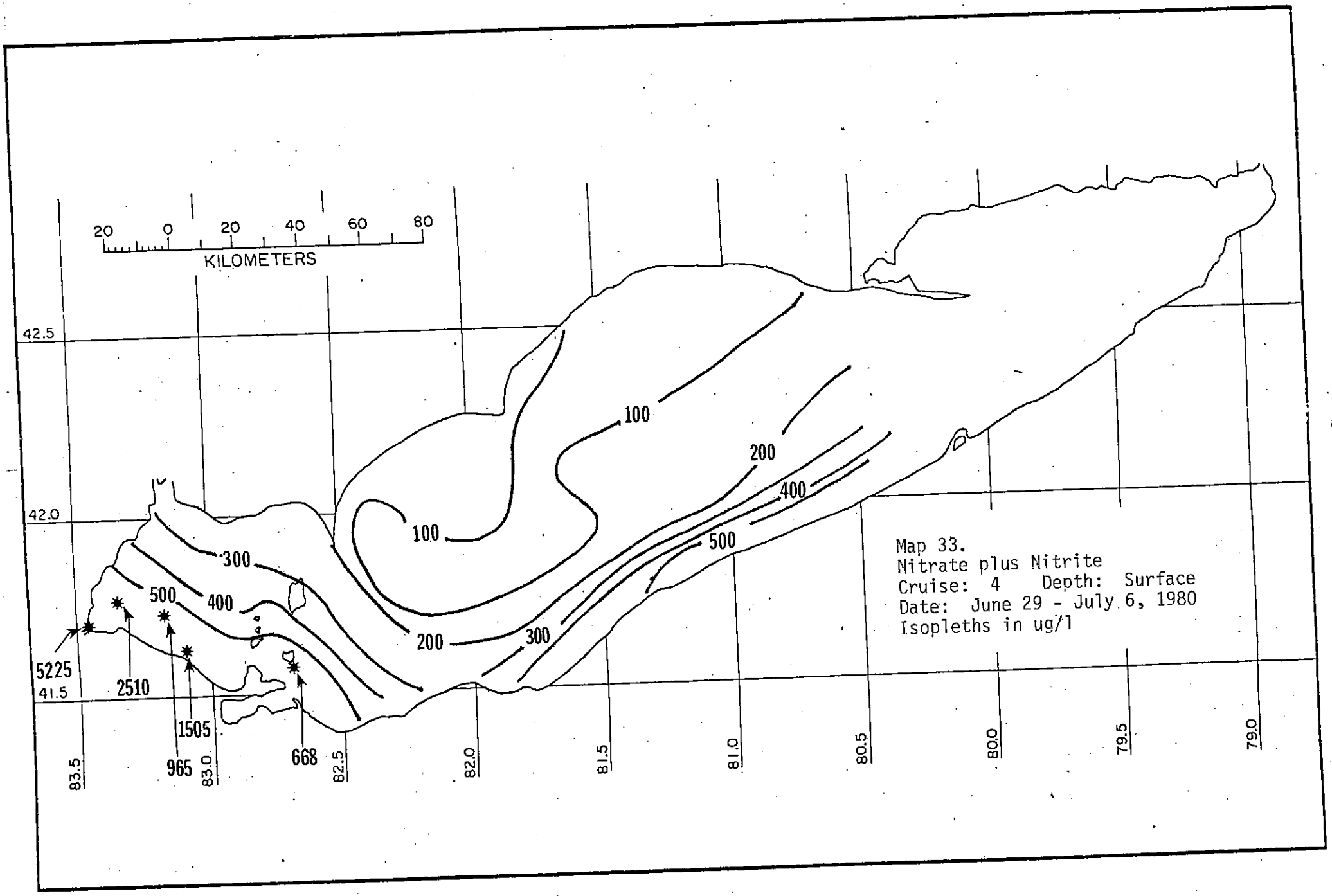

20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
72
Map 28.
Soluble Reactive Phosphorus
Cruise: 5 Depth: Bottom
Date: July 28 - August 8, 1980
Isopleths in µg/l

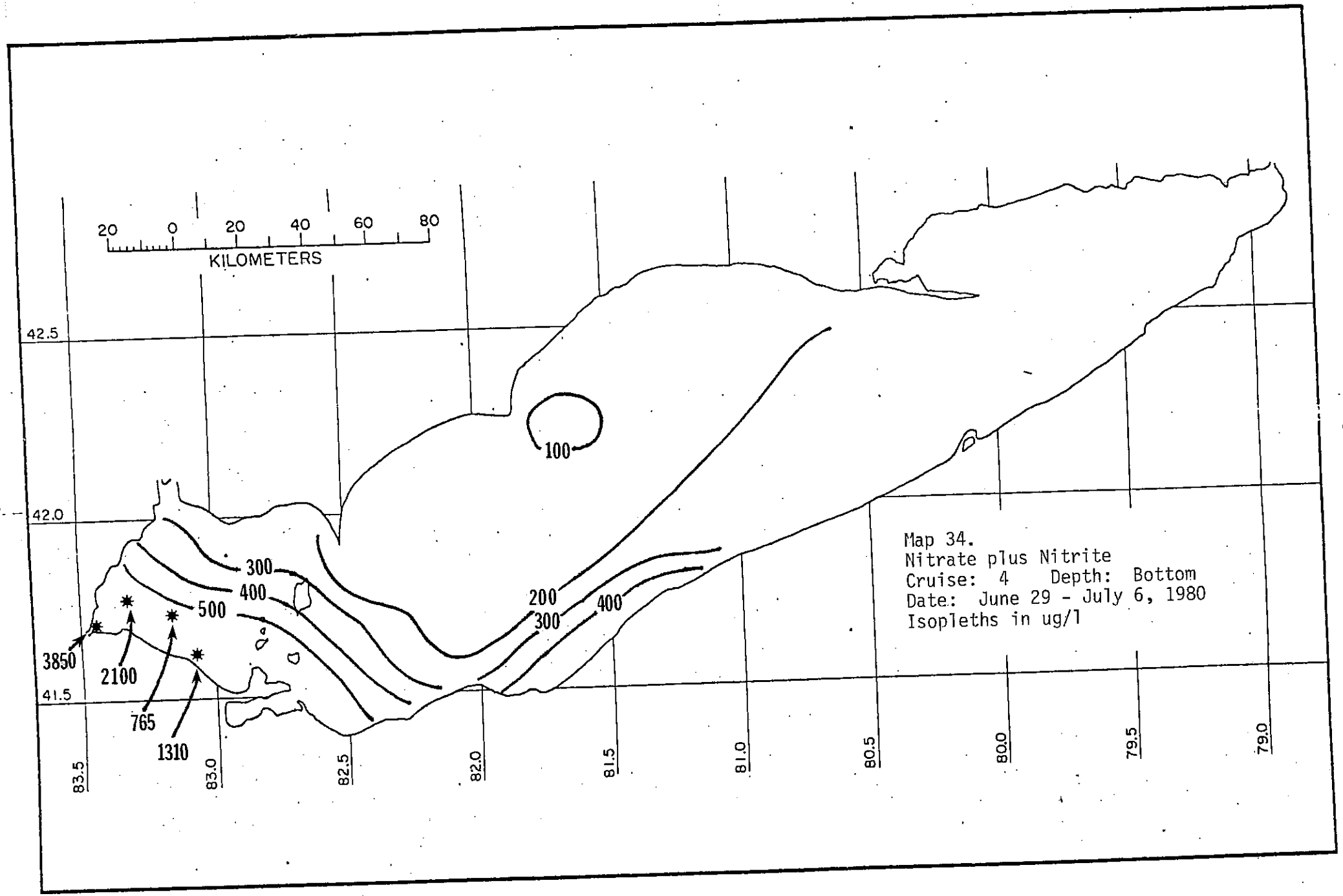

20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
1
2
3
4
Map 29.
Soluble Reactive Phosphorus
Cruise: 6 Depth: Surface
Date: August 18-23, 1980
Isopleths in µg/l


20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
1
2
3
4
5
Map 30.
Soluble Reactive Phosphorus
Cruise: 6 Depth: Bottom
Date: August 18-23, 1980
Isopleths in µg/l

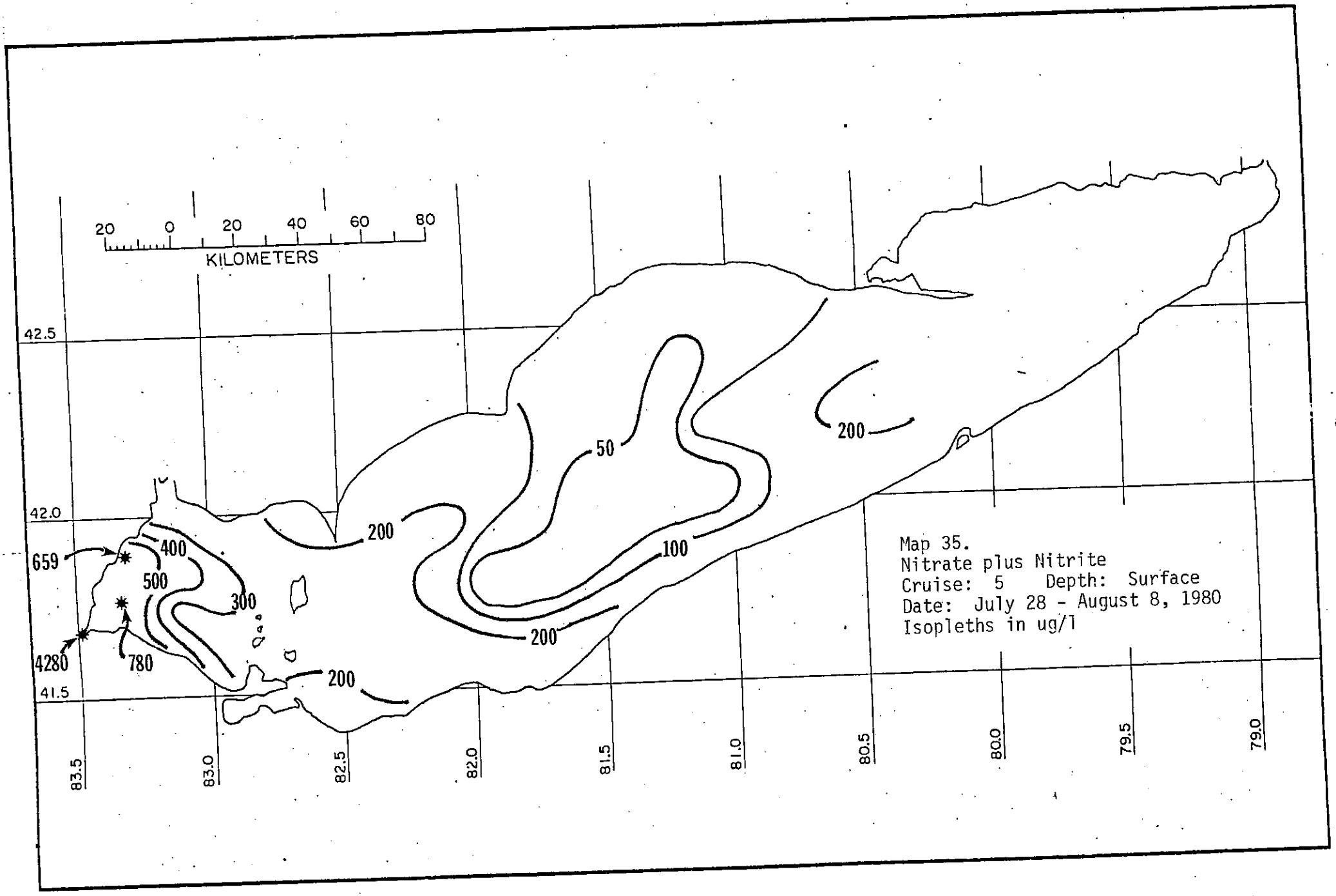

20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
2
1
2
2
3
95
Map 31.
Soluble Reactive Phosphorus
Cruise: 7 Depth: Surface
Date: August 28-September 6, 1980
Isopleths in ug/l

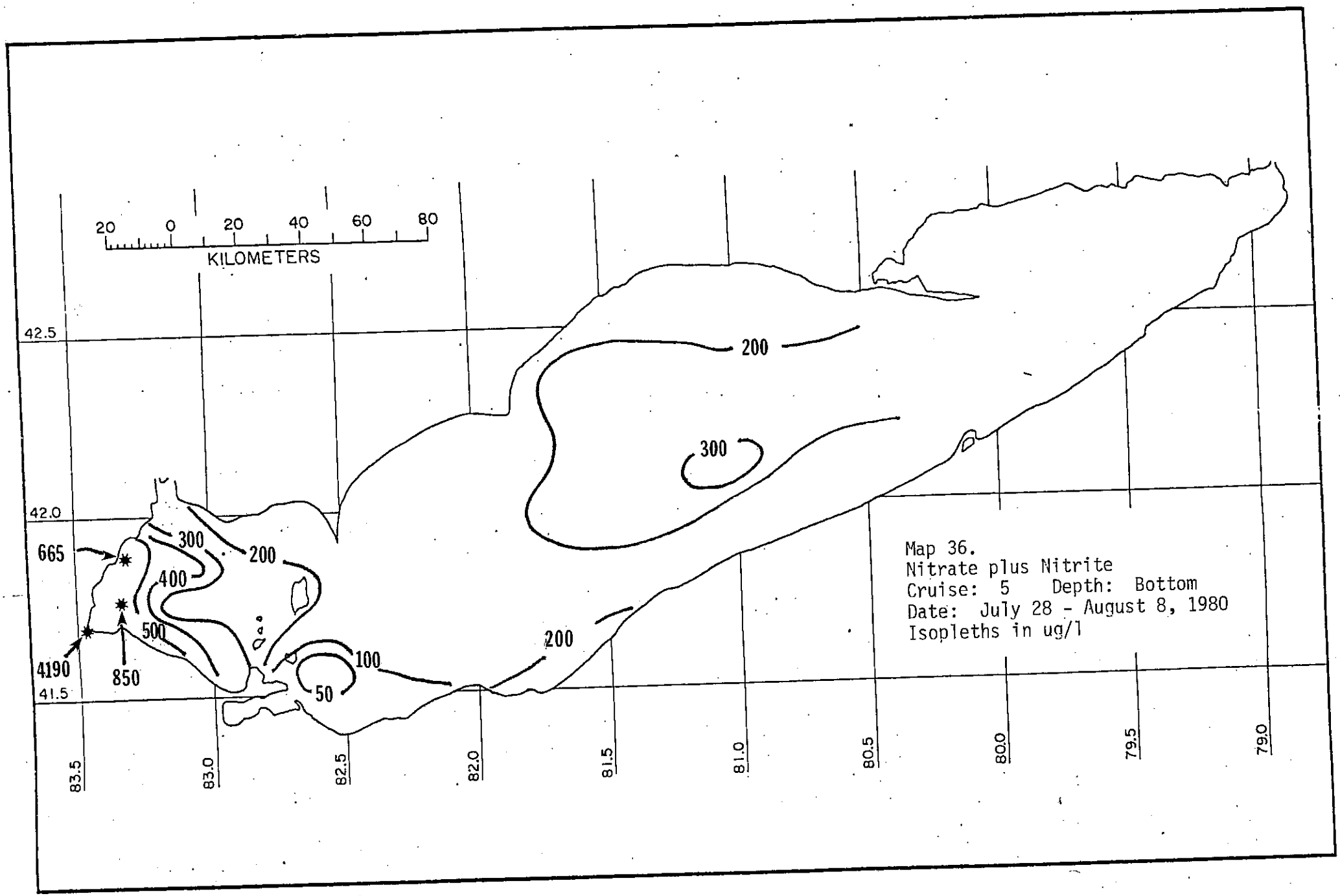

20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
3
4
5
2
1
2
1
130
Map 32.
Soluble Reactive Phosphorus
Cruise: 7 Depth: Bottom
Date: August 28-September 6, 1980
Isopleths in ug/l

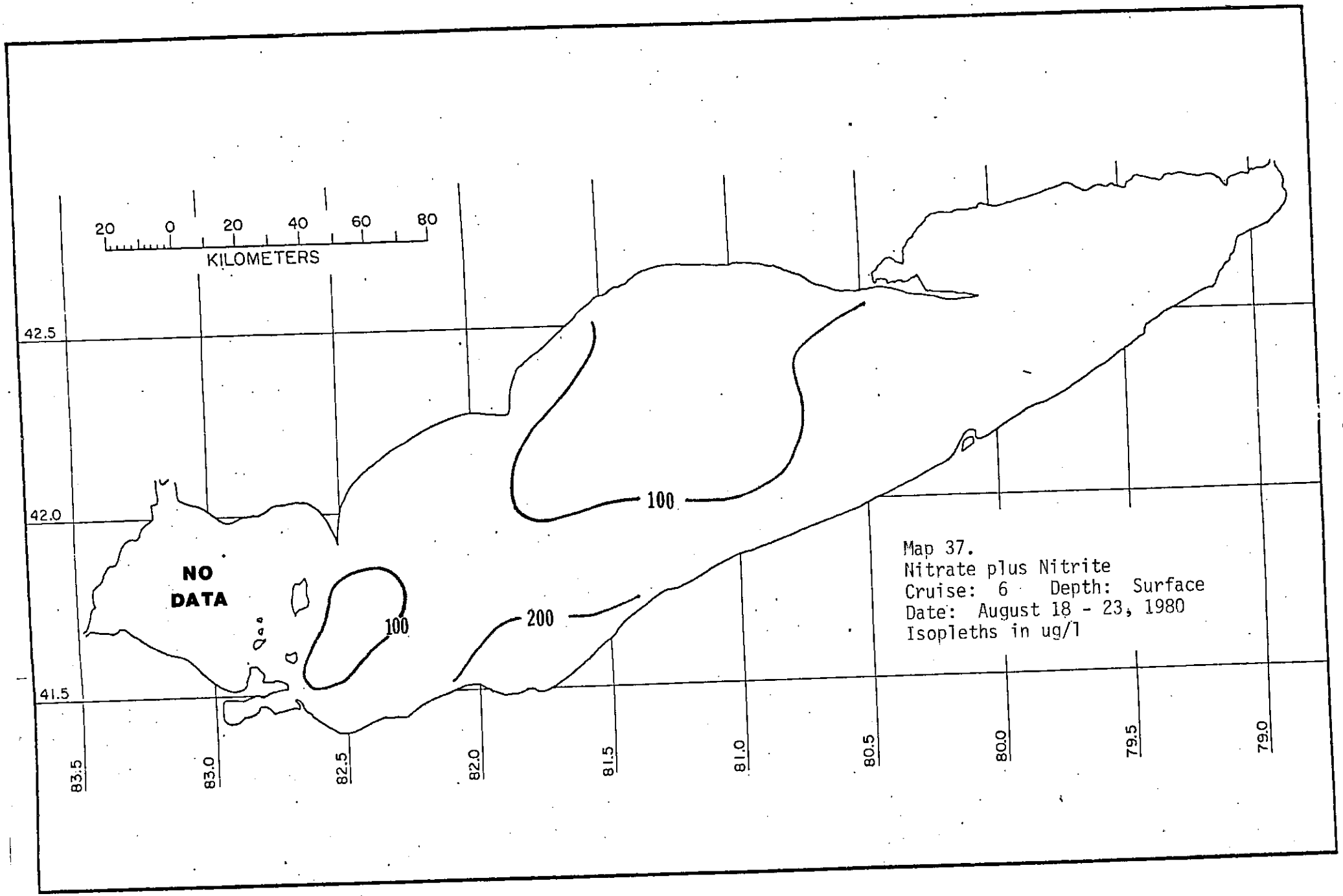

20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
100
100
200
300
400
500
200
300
400
500
5225
2510
1505
965
668
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
Map 33.
Nitrate plus Nitrite
Cruise: 4 Depth: Surface
Date: June 29 - July 6, 1980
Isopleths in ug/l



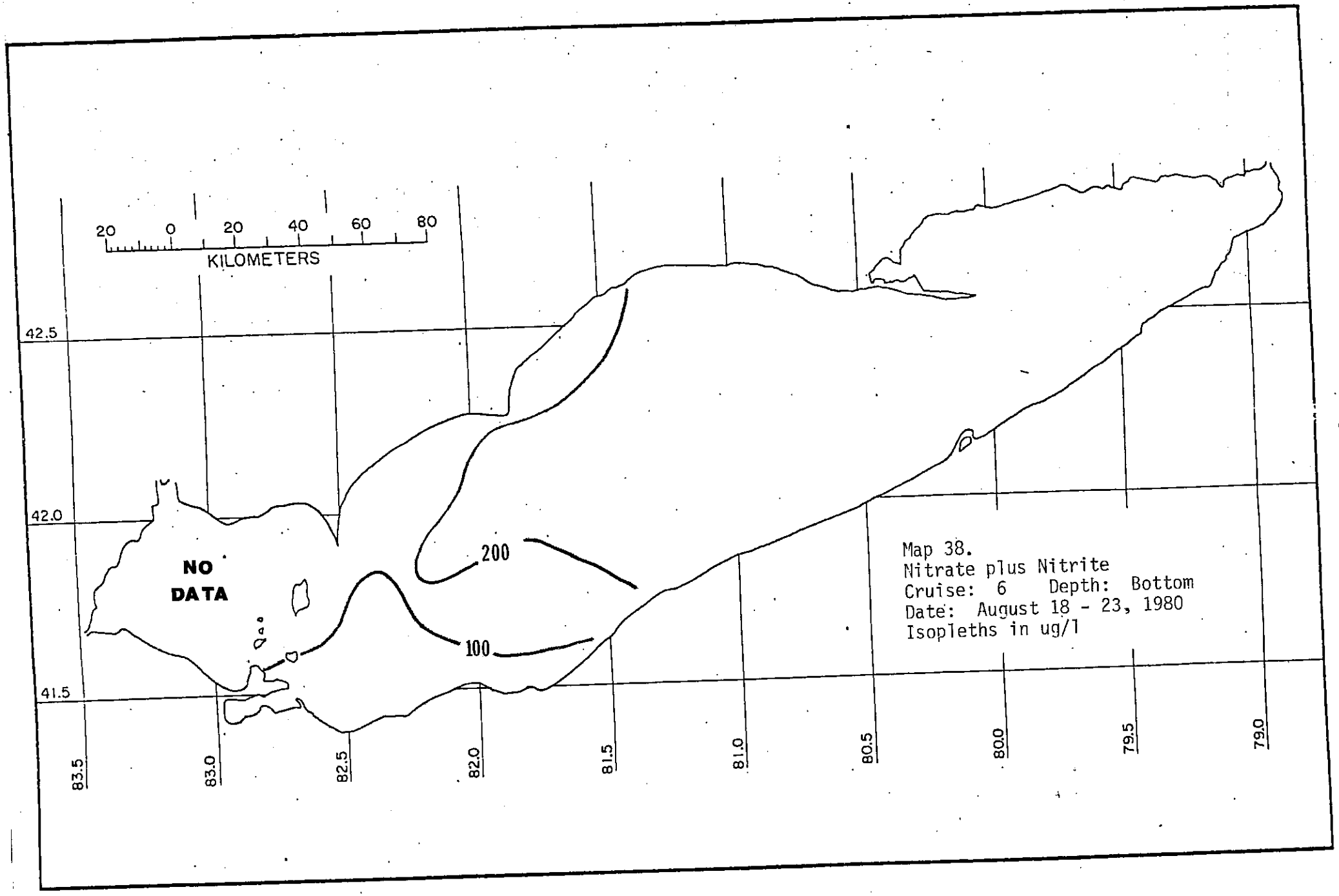
Map 34.
Nitrate plus Nitrite
Cruise: 4 Depth: Bottom
Date: June 29 - July 6, 1980
Isopleths in ug/l

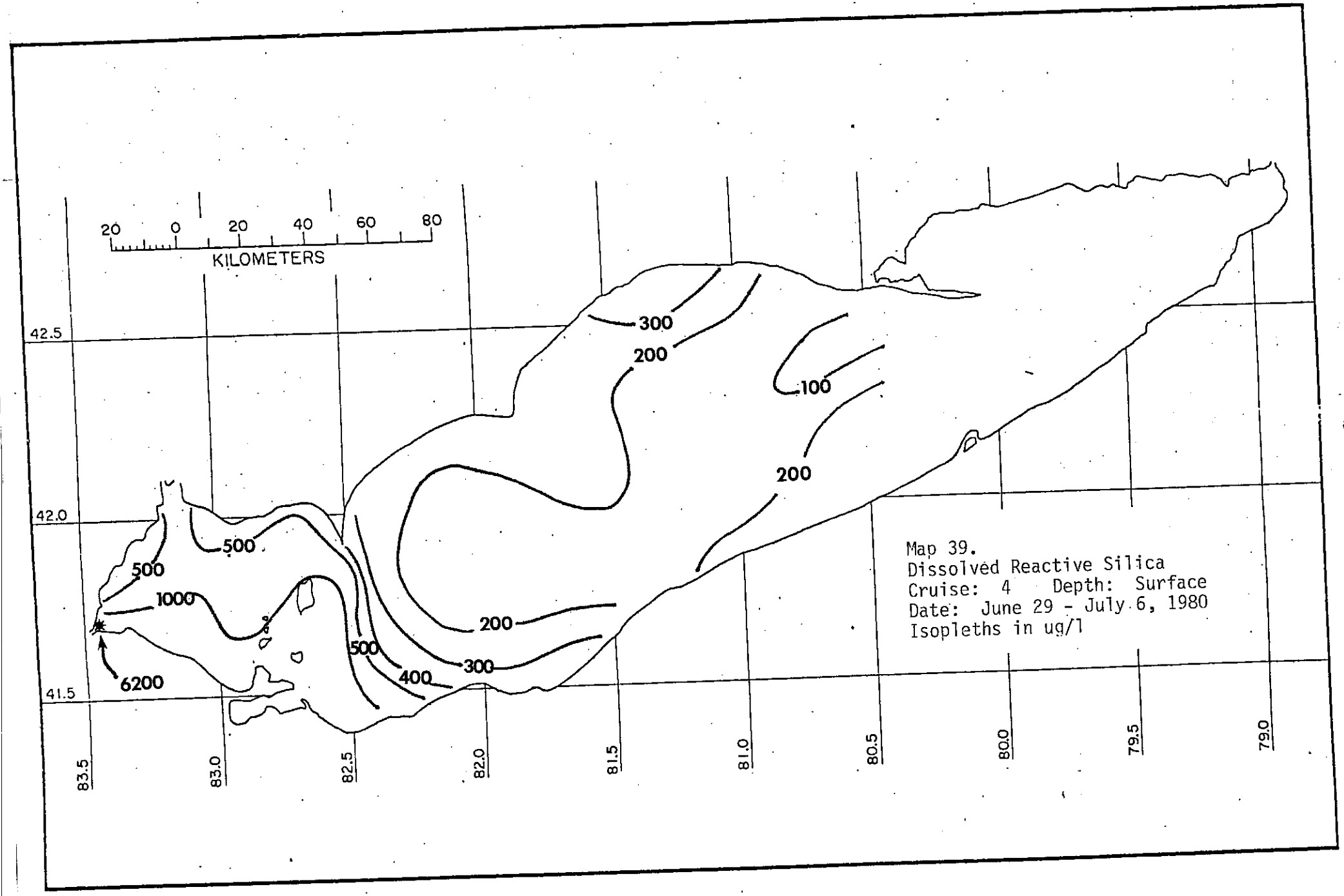

20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
659
400
500
300
4280
780
200
50
200
100
200
200
Map 35.
Nitrate plus Nitrite
Cruise: 5 Depth: Surface
Date: July 28 - August 8, 1980
Isopleths in ug/l

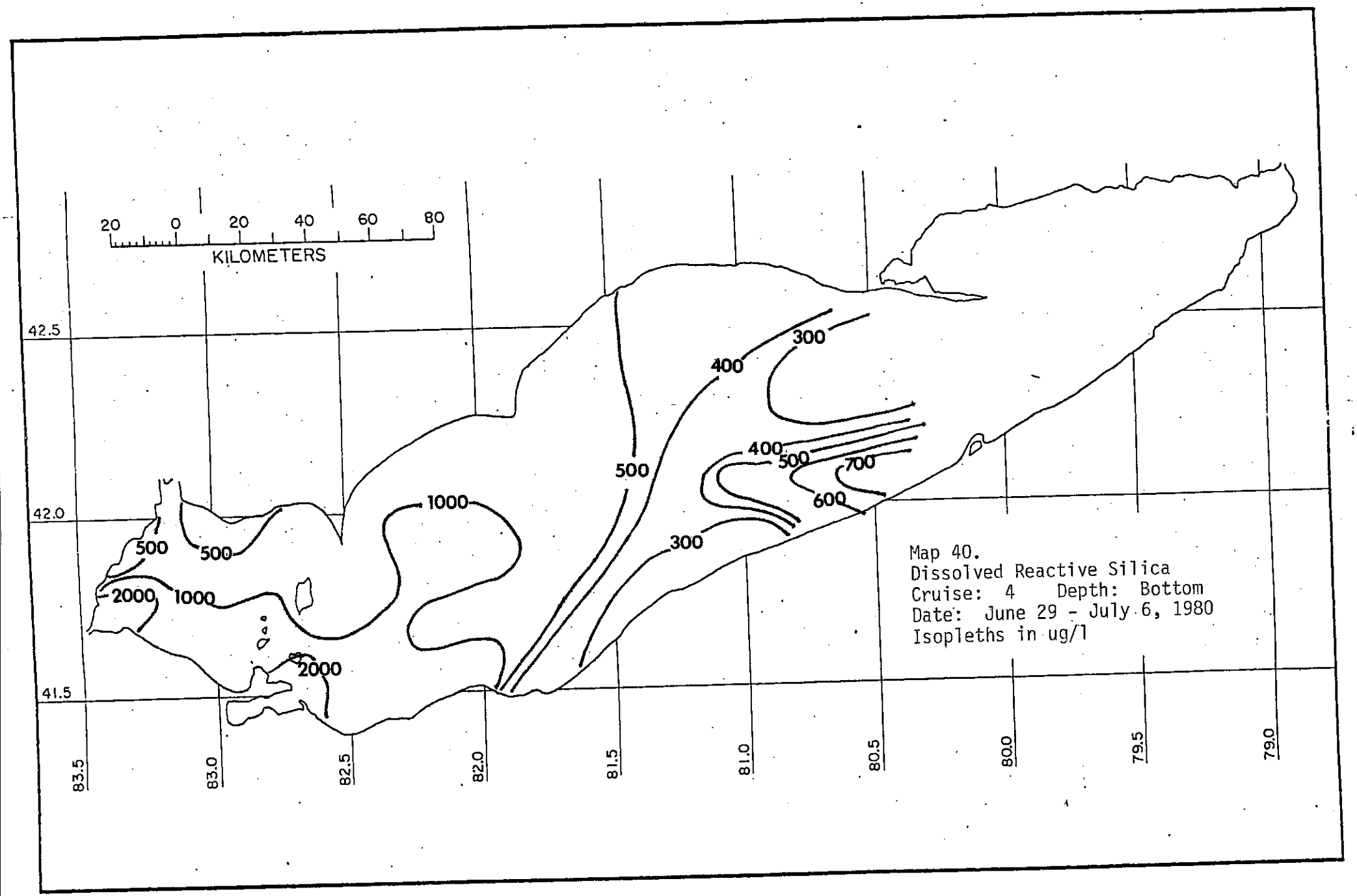

20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
200
300
665
300
200
400
500
4190
850
100
50
200
Map 36.
Nitrate plus Nitrite
Cruise: 5 Depth: Bottom
Date: July 28 - August 8, 1980
Isopleths in ug/l

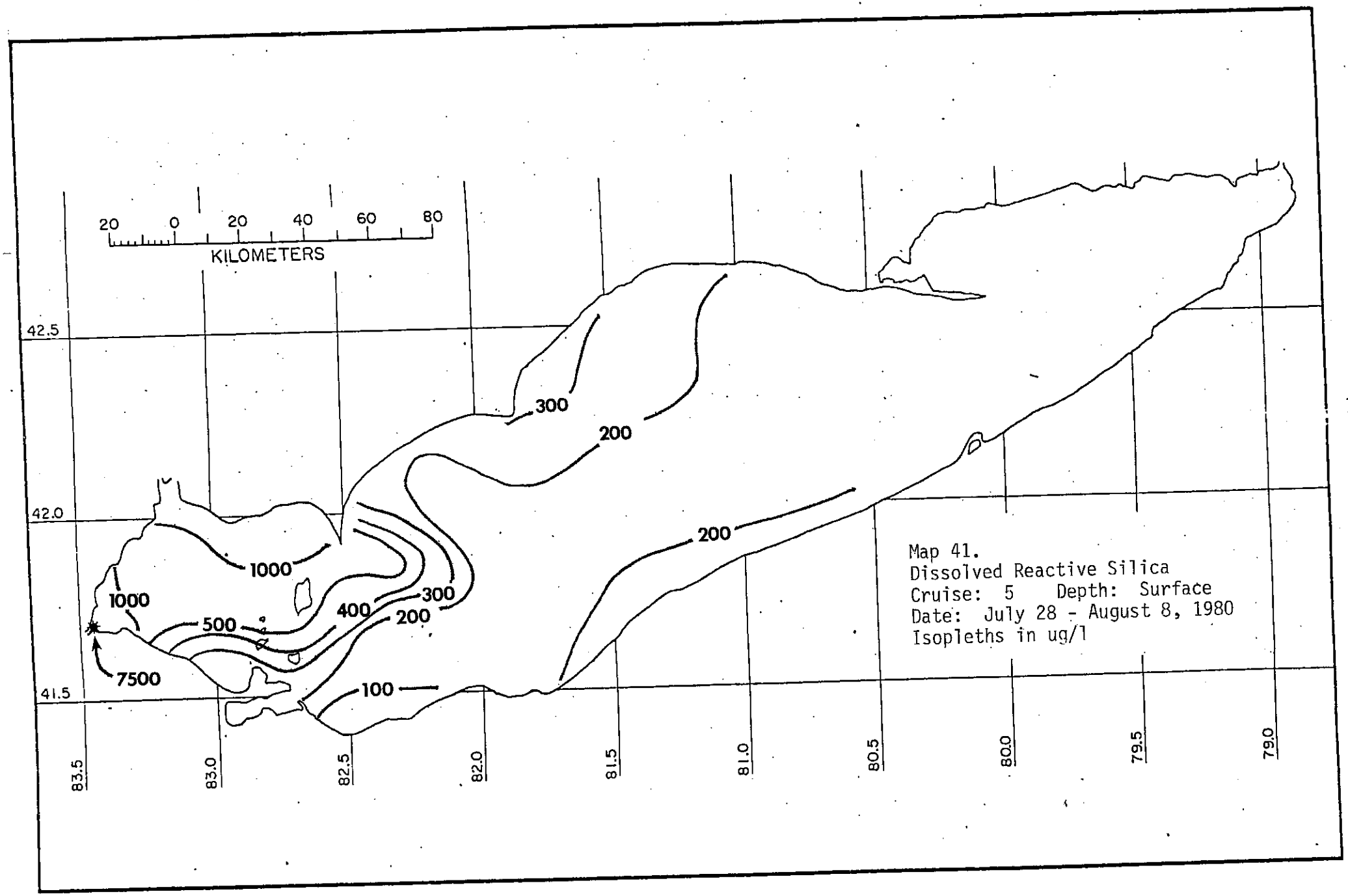


Map 37.
Nitrate plus Nitrite
Cruise: 6 Depth: Surface
Date: August 18 - 23, 1980
Isopleths in ug/l

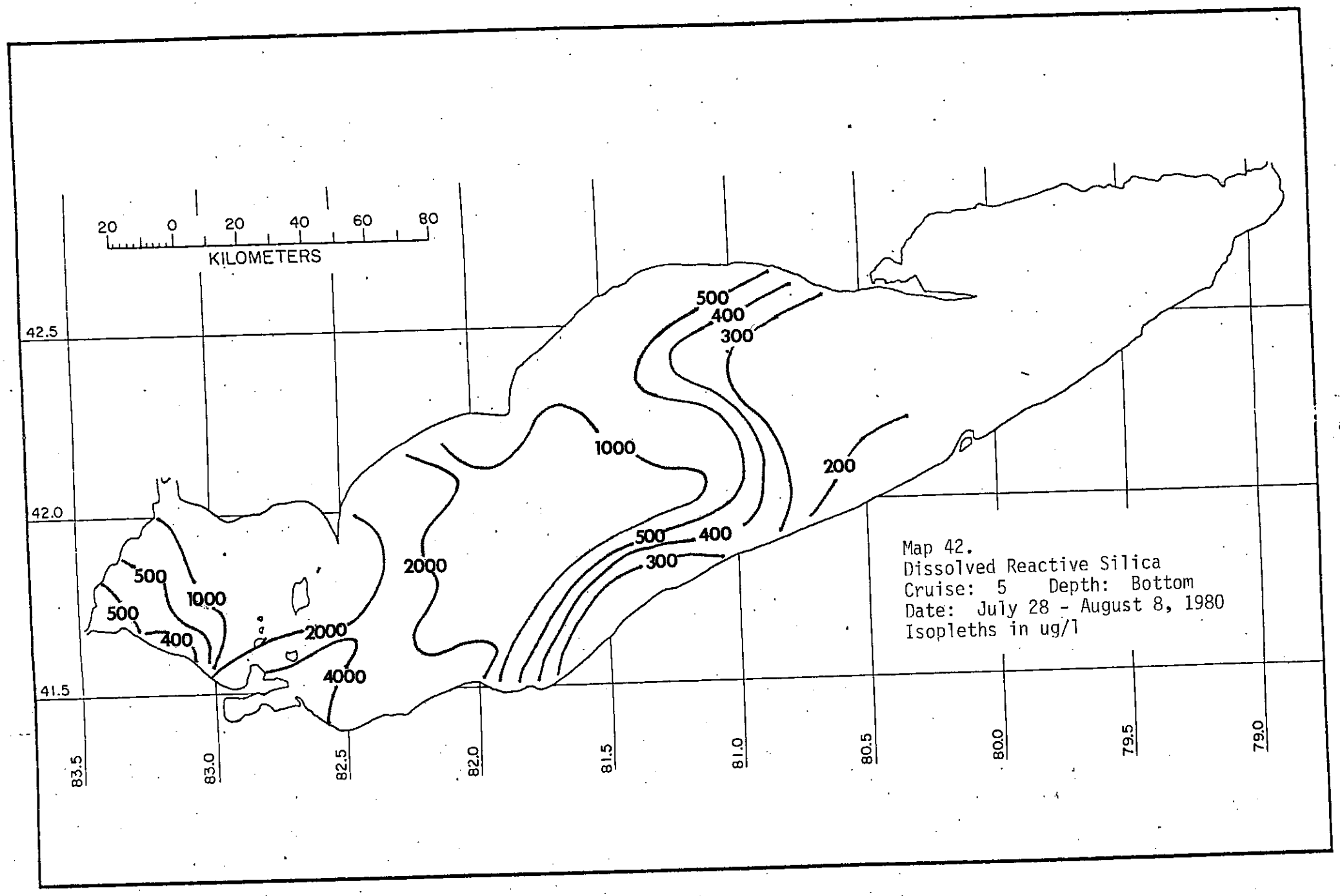

20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
NO DATA
200
100
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
Map 38.
Nitrate plus Nitrite
Cruise: 6 Depth: Bottom
Date: August 18 - 23, 1980
Isopleths in ug/l


20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
300
200
100
200
500
500
1000
200
500
400
300
6200
Map 39.
Dissolved Reactive Silica
Cruise: 4 Depth: Surface
Date: June 29 - July 6, 1980
Isopleths in ug/l

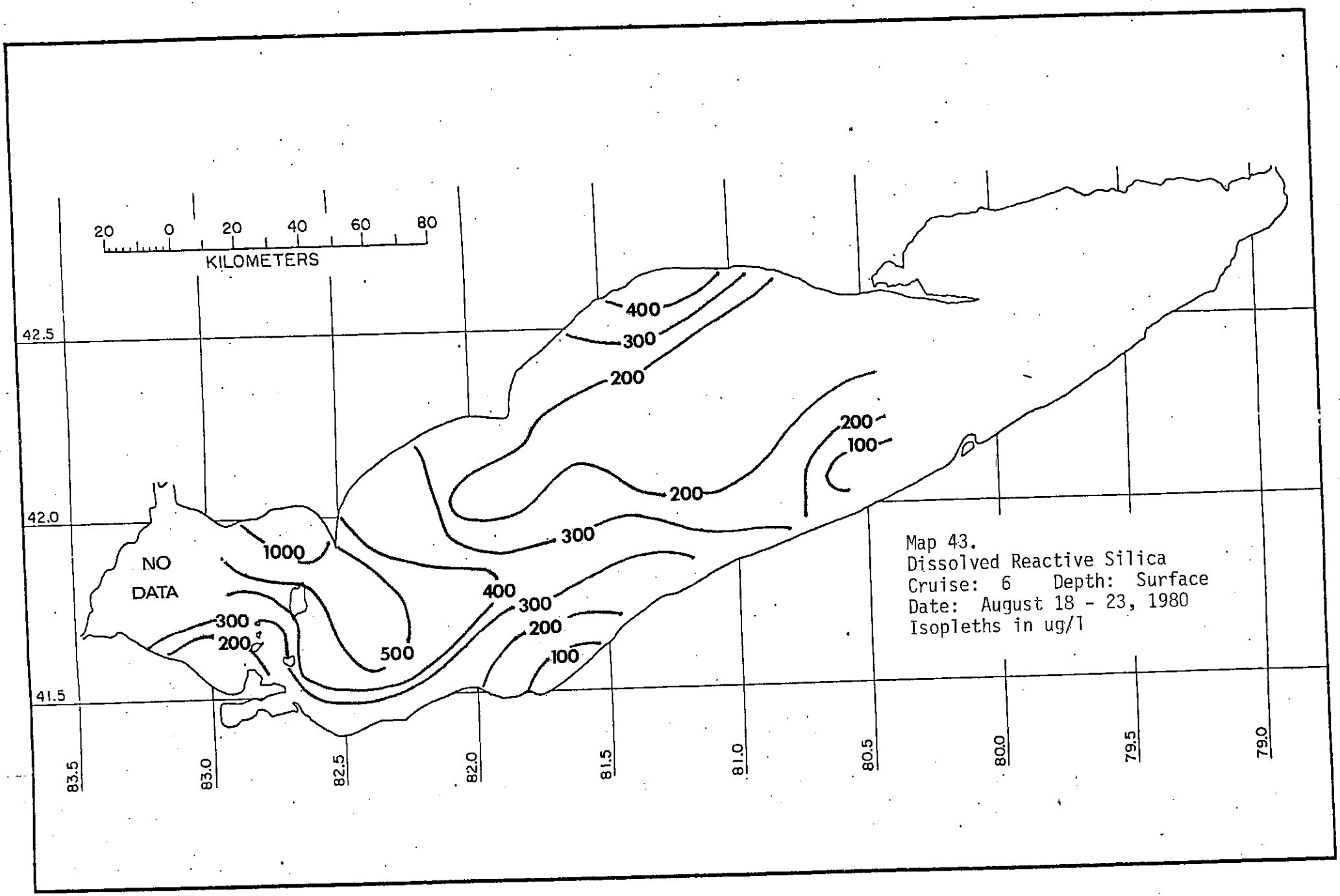

20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
300
400
500
1000
500
500
2000
1000
2000
400
500
700
600
300
Map 40.
Dissolved Reactive Silica
Cruise: 4 Depth: Bottom
Date: June 29 - July 6, 1980
Isopleths in ug/l

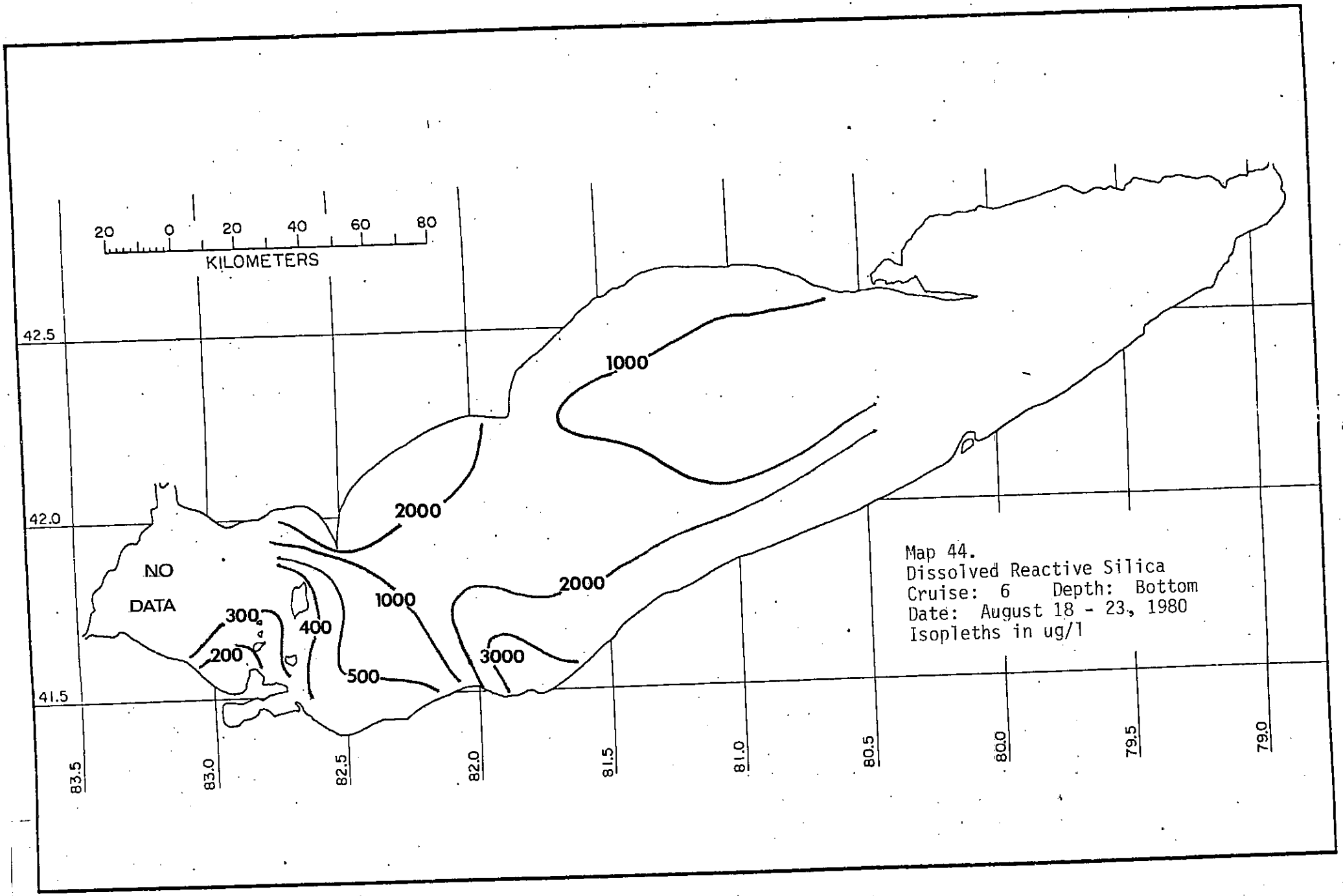


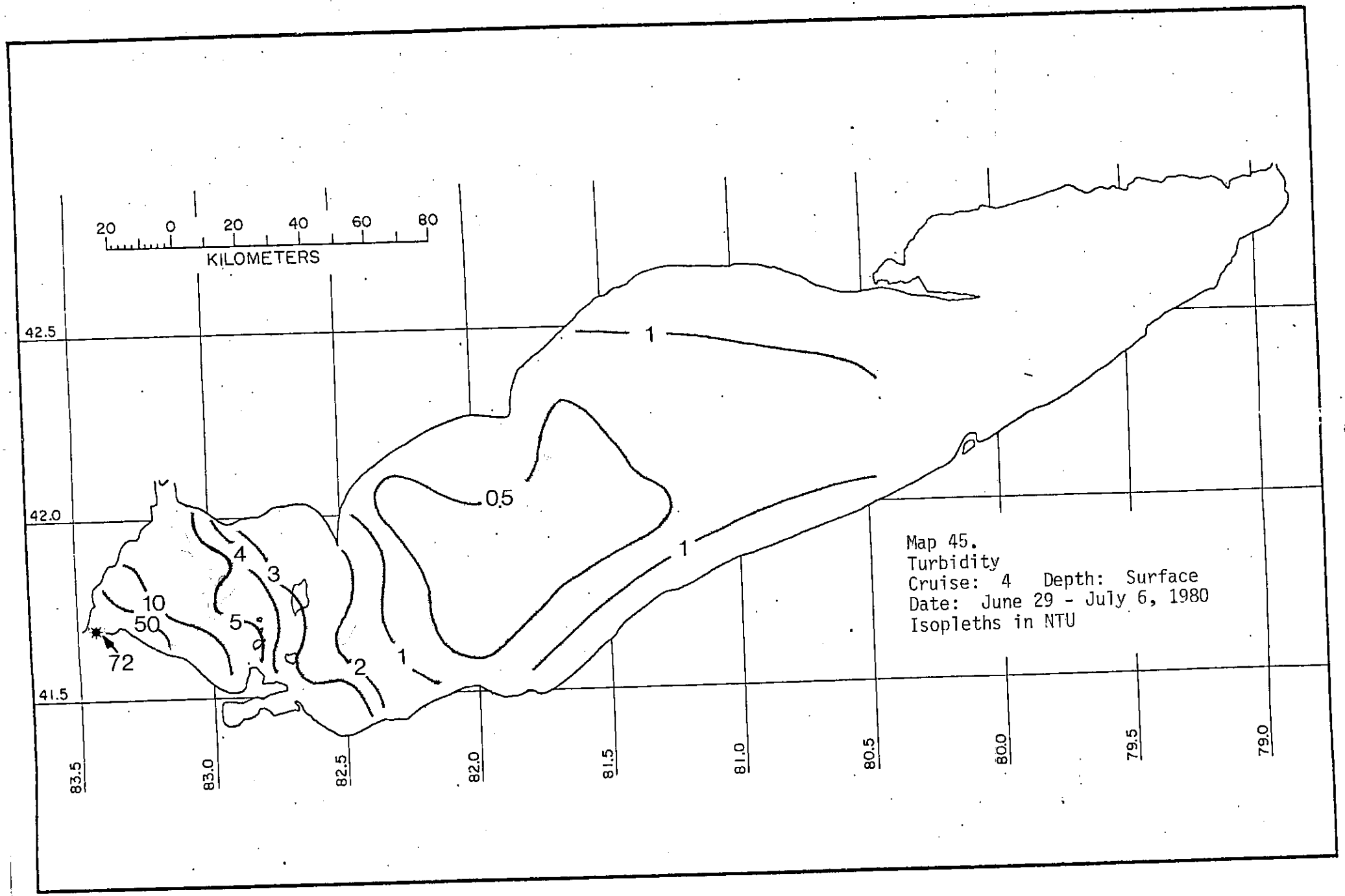
Map 41.
Dissolved Reactive Silica
Cruise: 5 Depth: Surface
Date: July 28 - August 8, 1980
Isopleths in ug/l

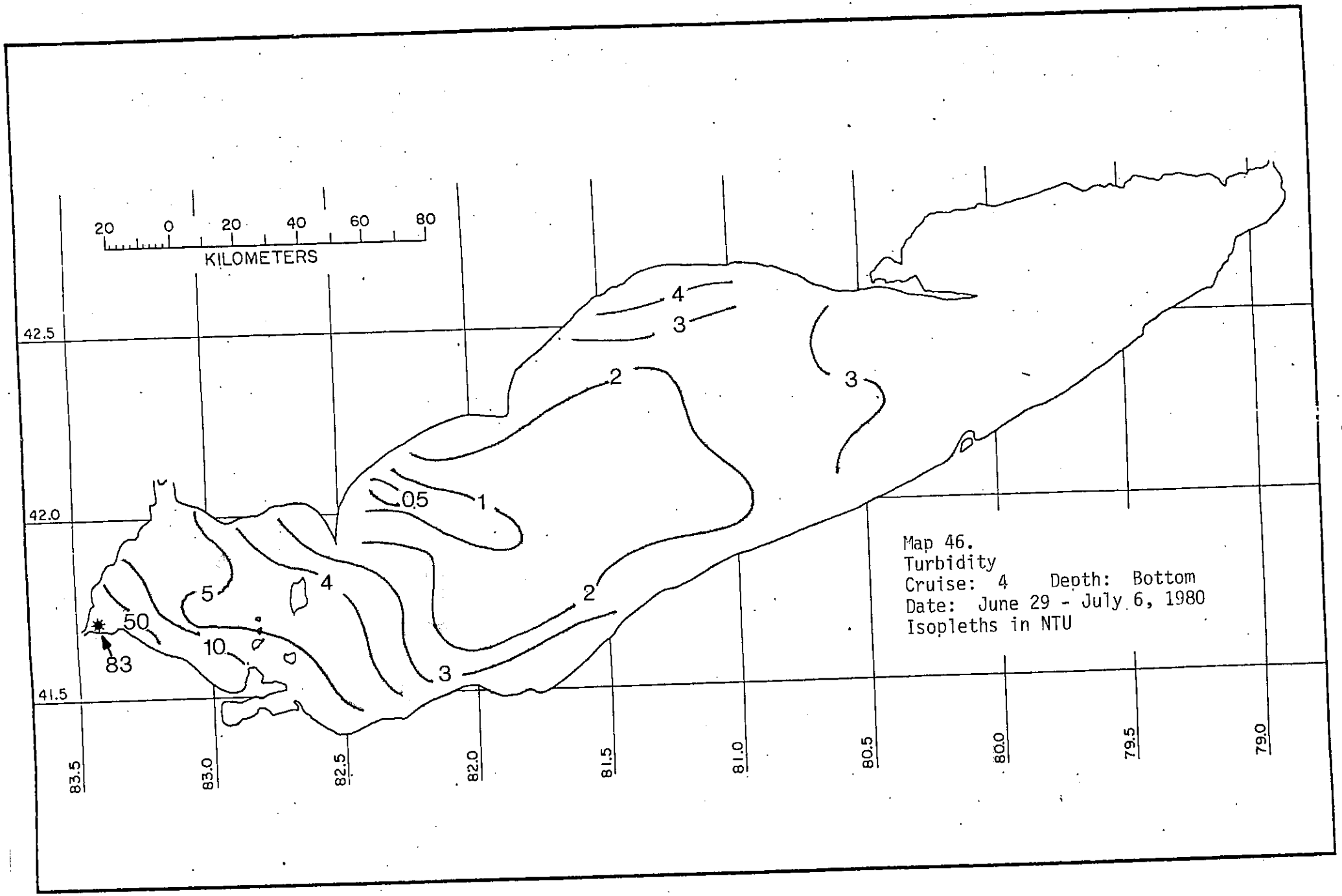


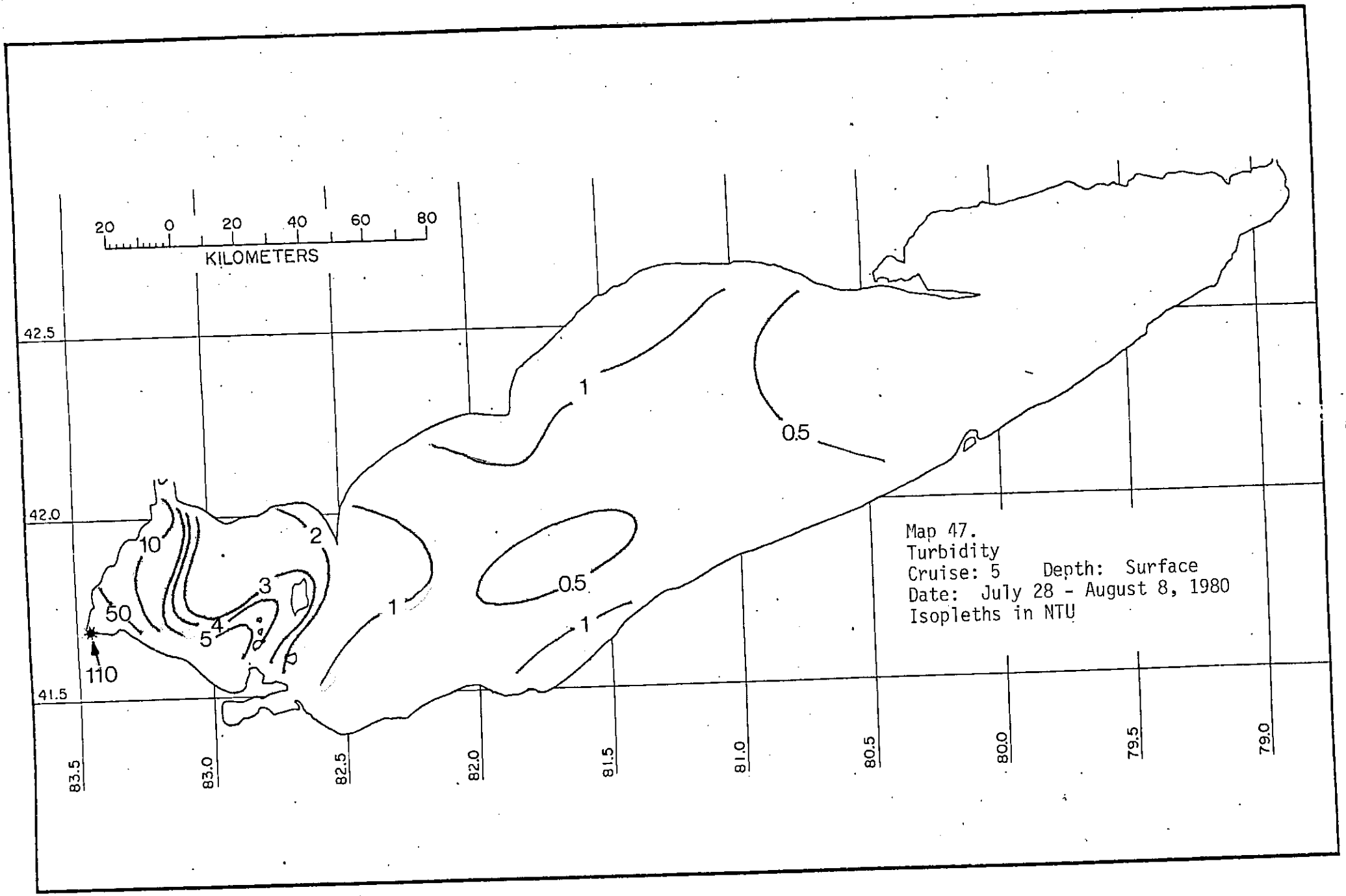
Map 42.
Dissolved Reactive Silica
Cruise: 5 Depth: Bottom
Date: July 28 - August 8, 1980
Isopleths in ug/l

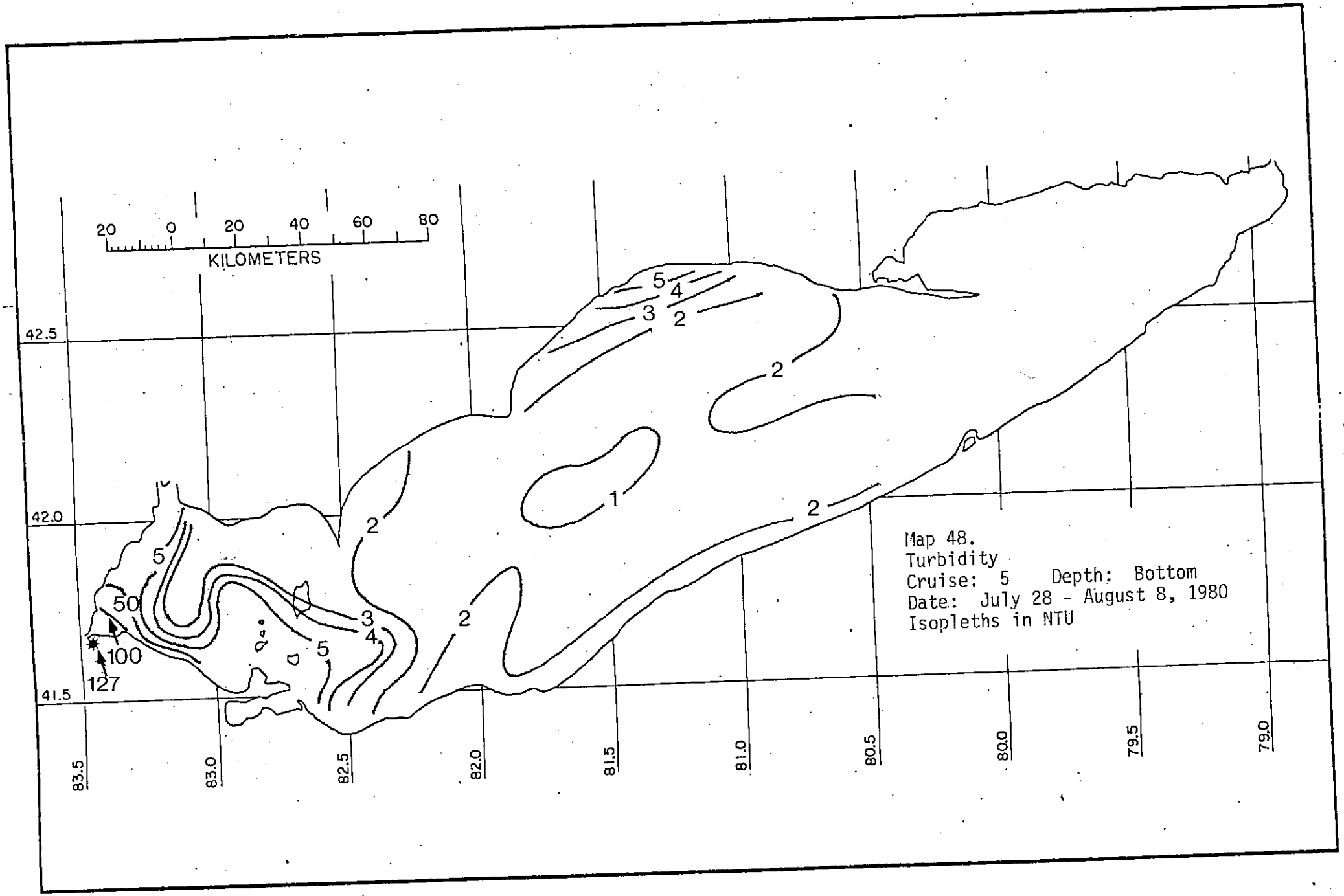

20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
400
300
200
200
100
200
300
1000
NO
DATA
400
300
200
100
300
200
500
Map 43.
Dissolved Reactive Silica
Cruise: 6 Depth: Surface
Date: August 18 - 23, 1980
Isopleths in ug/l

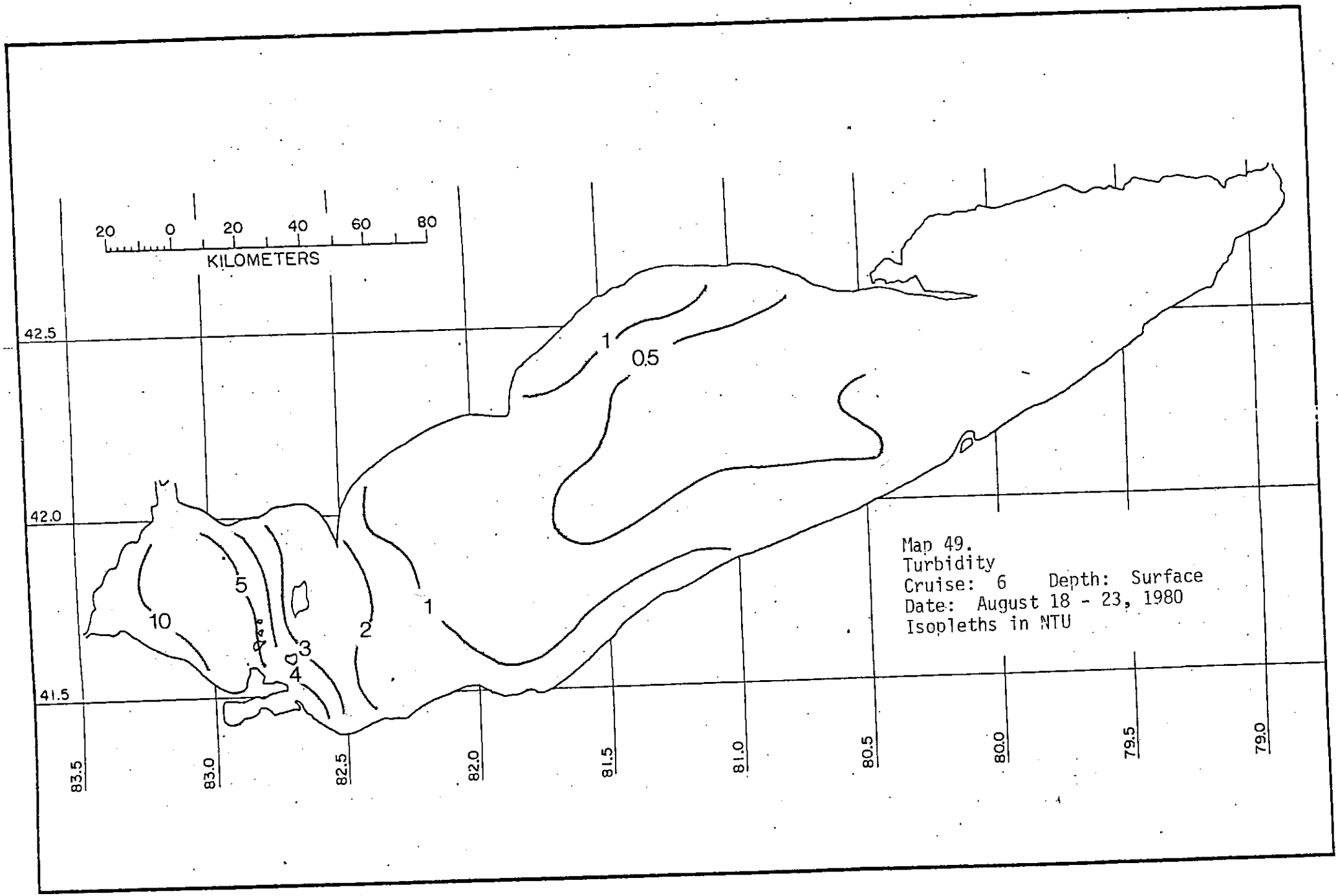

20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
NO
DATA
300
200
400
500
1000
2000
1000
2000
3000
Map 44.
Dissolved Reactive Silica
Cruise: 6 Depth: Bottom
Date: August 18 - 23, 1980
Isopleths in ug/l

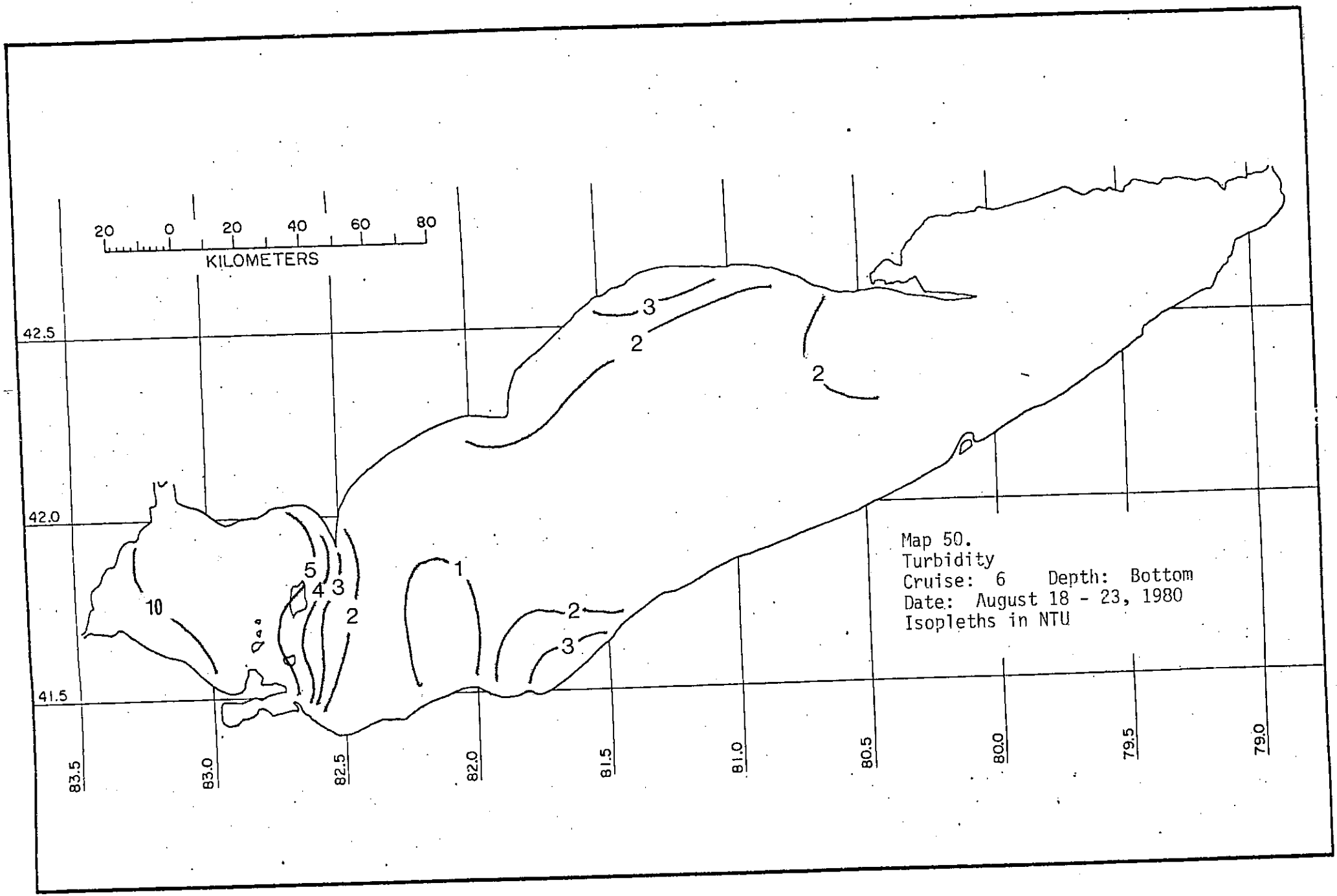

20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
1
0.5
1
4
3
10
50
5
72
2
1
Map 45.
Turbidity
Cruise: 4 Depth: Surface
Date: June 29 - July 6, 1980
Isopleths in NTU

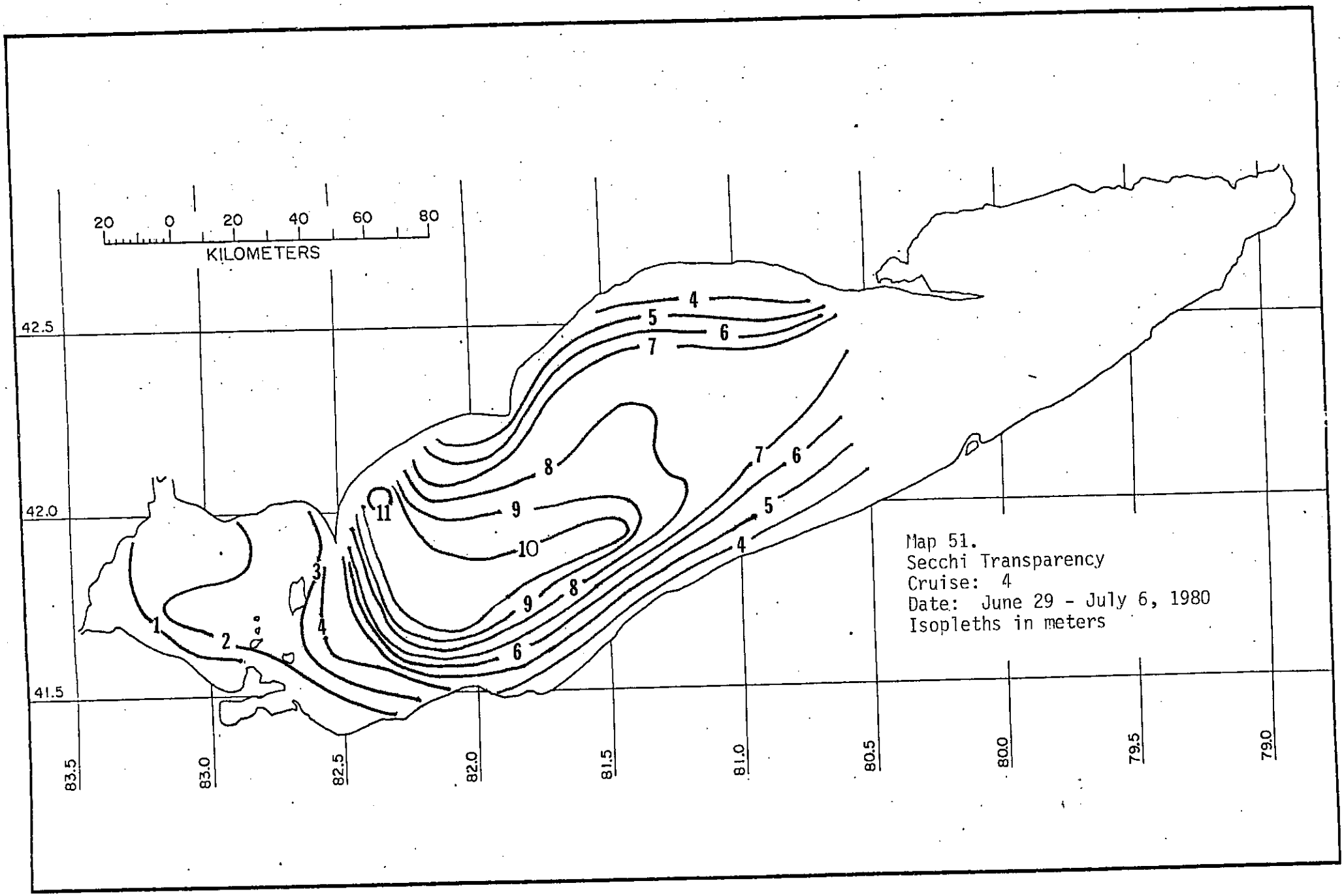

20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
4
3
2
3
.05
1
5
4
2
50
10
83
3
Map 46.
Turbidity
Cruise: 4 Depth: Bottom
Date: June 29 - July 6, 1980
Isopleths in NTU

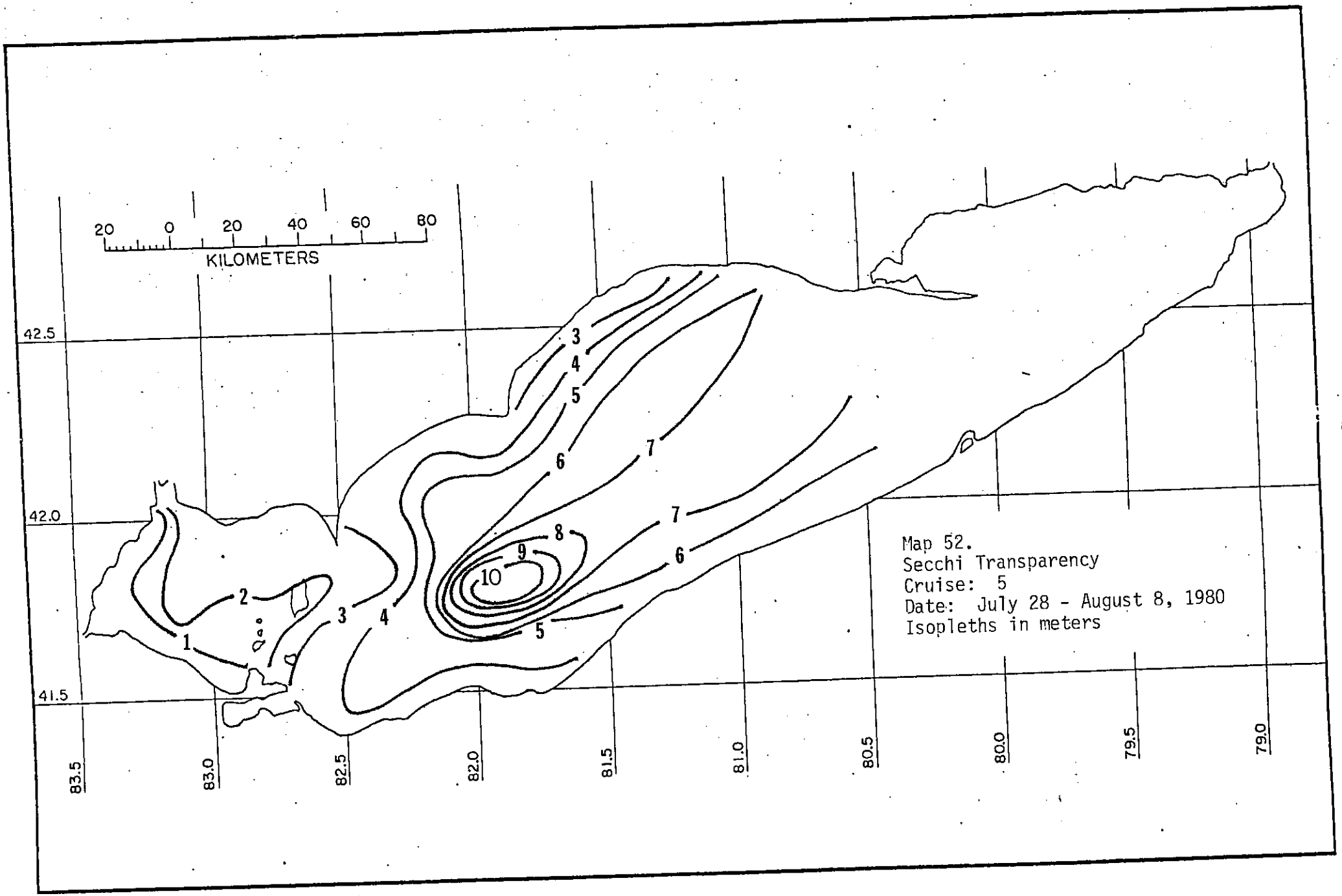

20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
1
0.5
0.5
1
1
2
3
4
5
10
50
110
Map 47.
Turbidity
Cruise: 5 Depth: Surface
Date: July 28 - August 8, 1980
Isopleths in NTU

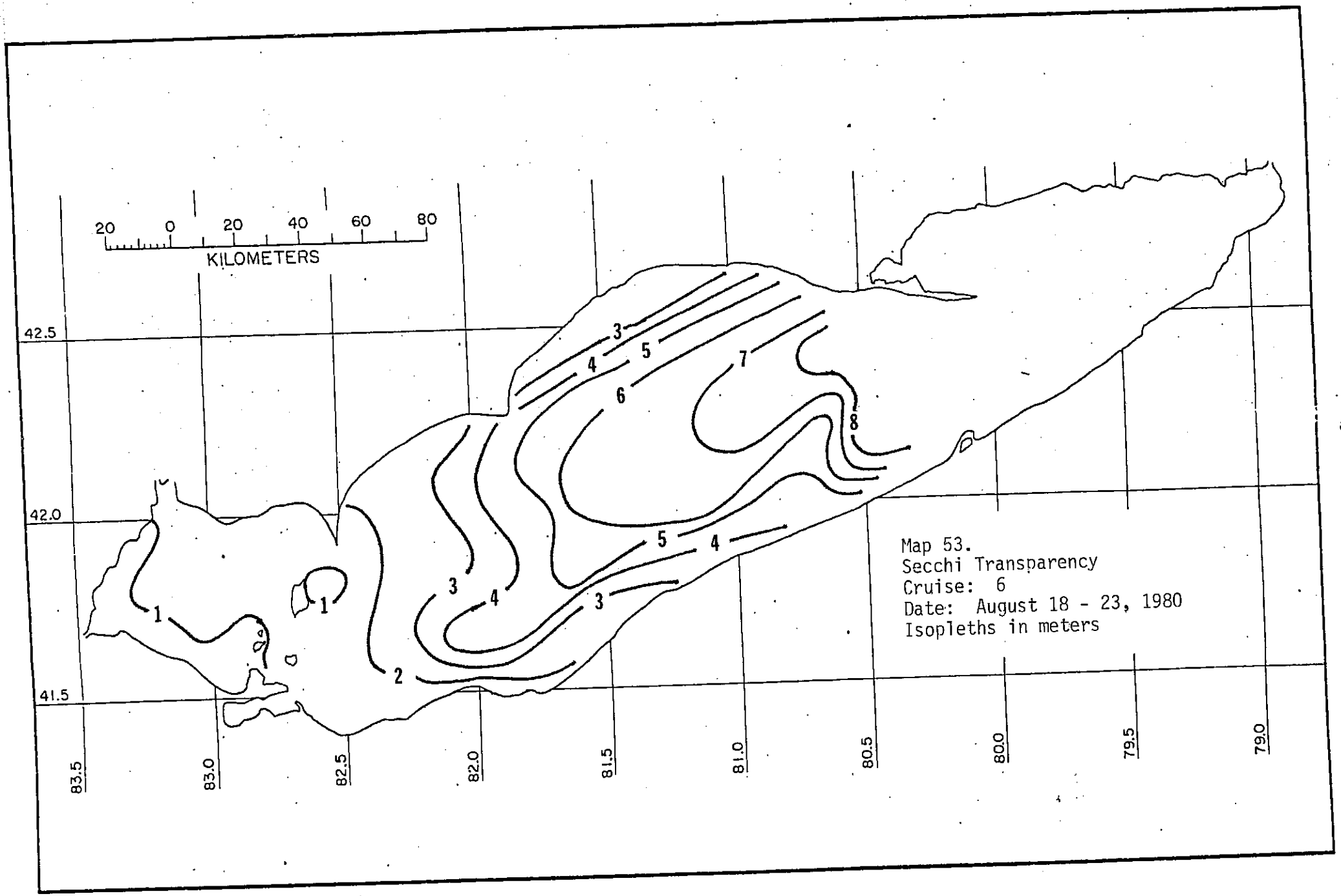

20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
5
4
3
2
2
2
1
2
5
50
100
127
3
4
2
5
Map 48.
Turbidity
Cruise: 5 Depth: Bottom
Date: July 28 - August 8, 1980
Isopleths in NTU

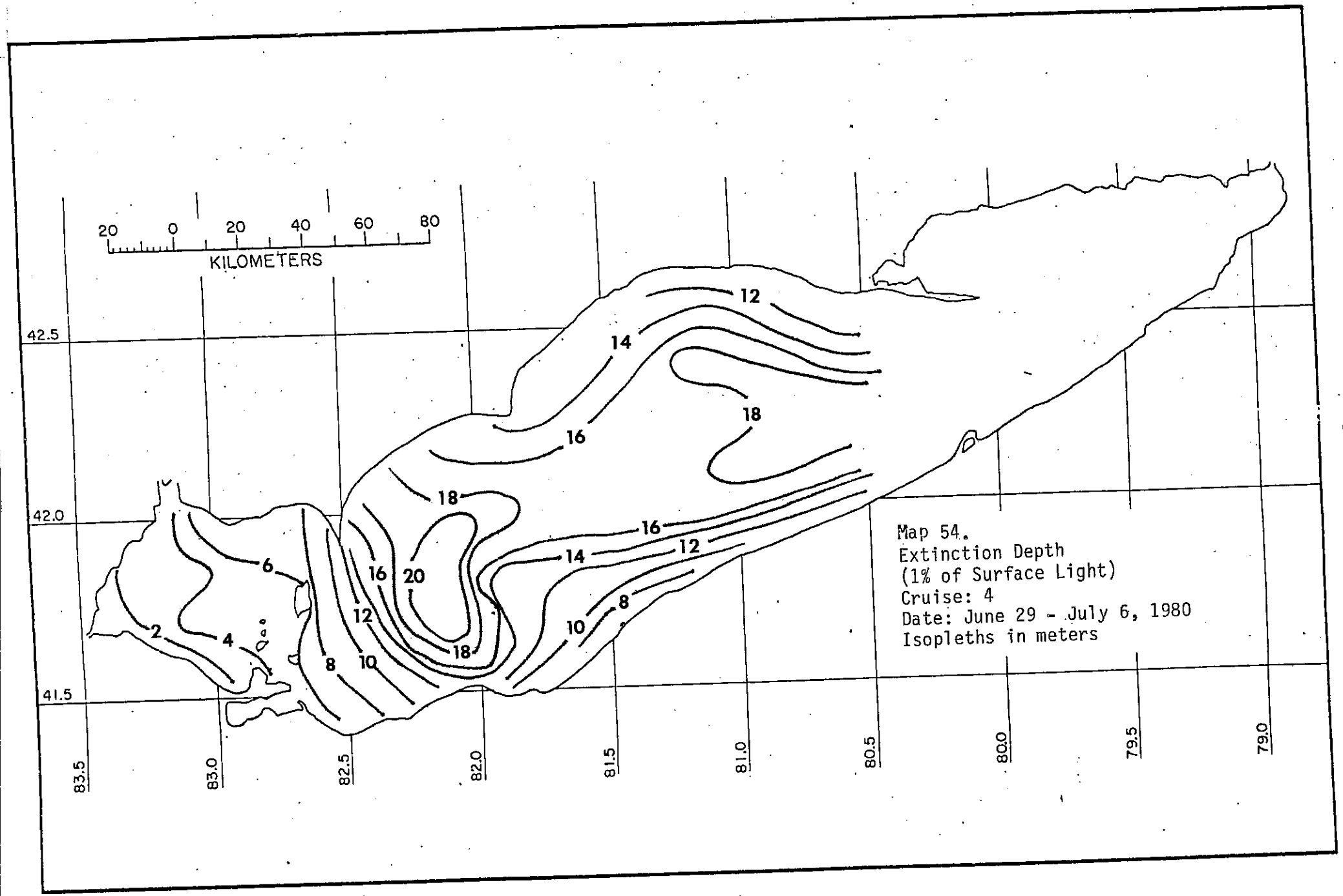

20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
0.5
1
2
3
4
5
10
Map 49.
Turbidity
Cruise: 6 Depth: Surface
Date: August 18 - 23, 1980
Isopleths in NTU

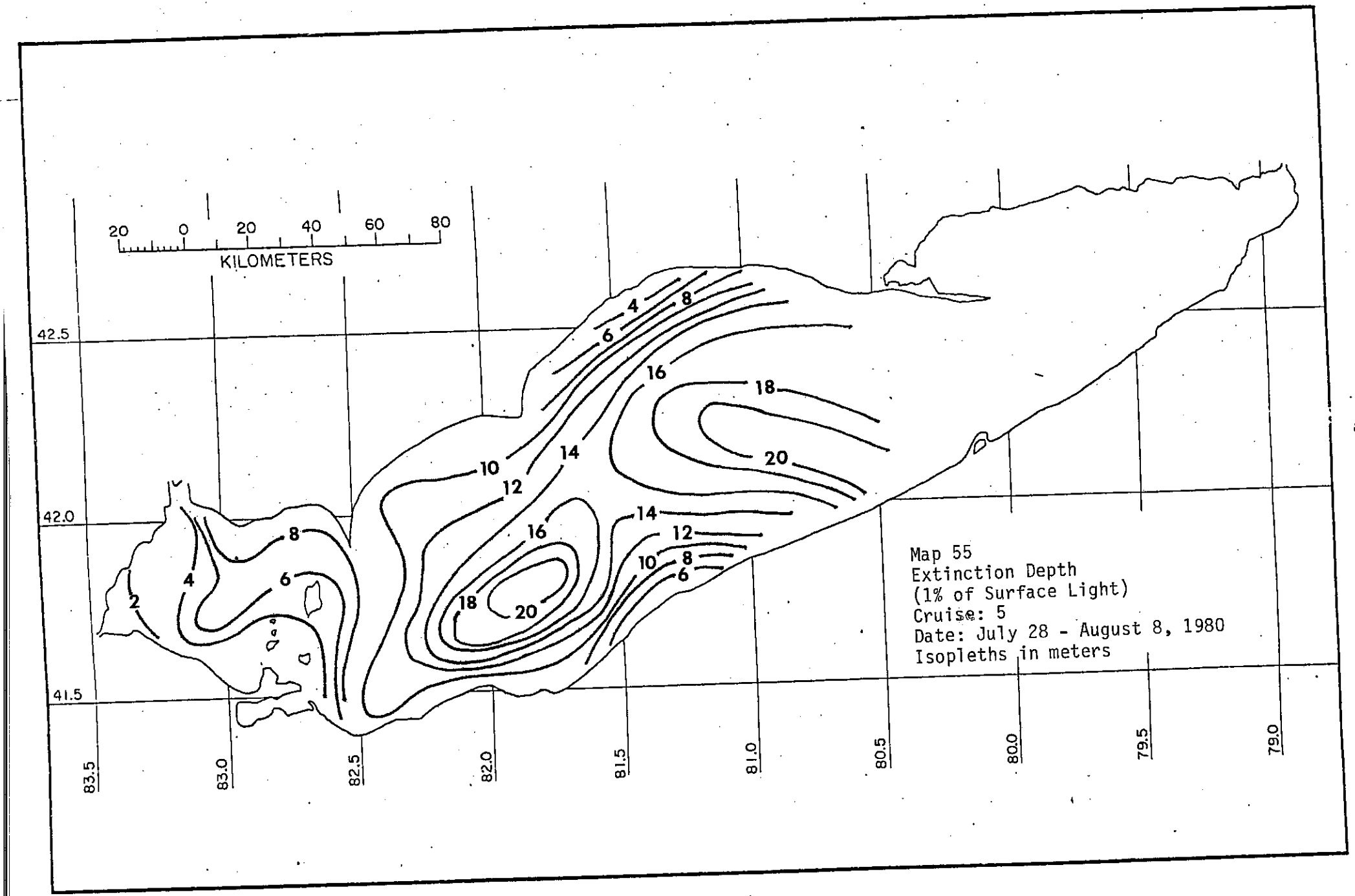

20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
10
5
4
3
2
1
2
3
2
3
2
Map 50.
Turbidity
Cruise: 6 Depth: Bottom
Date: August 18 - 23, 1980
Isopleths in NTU

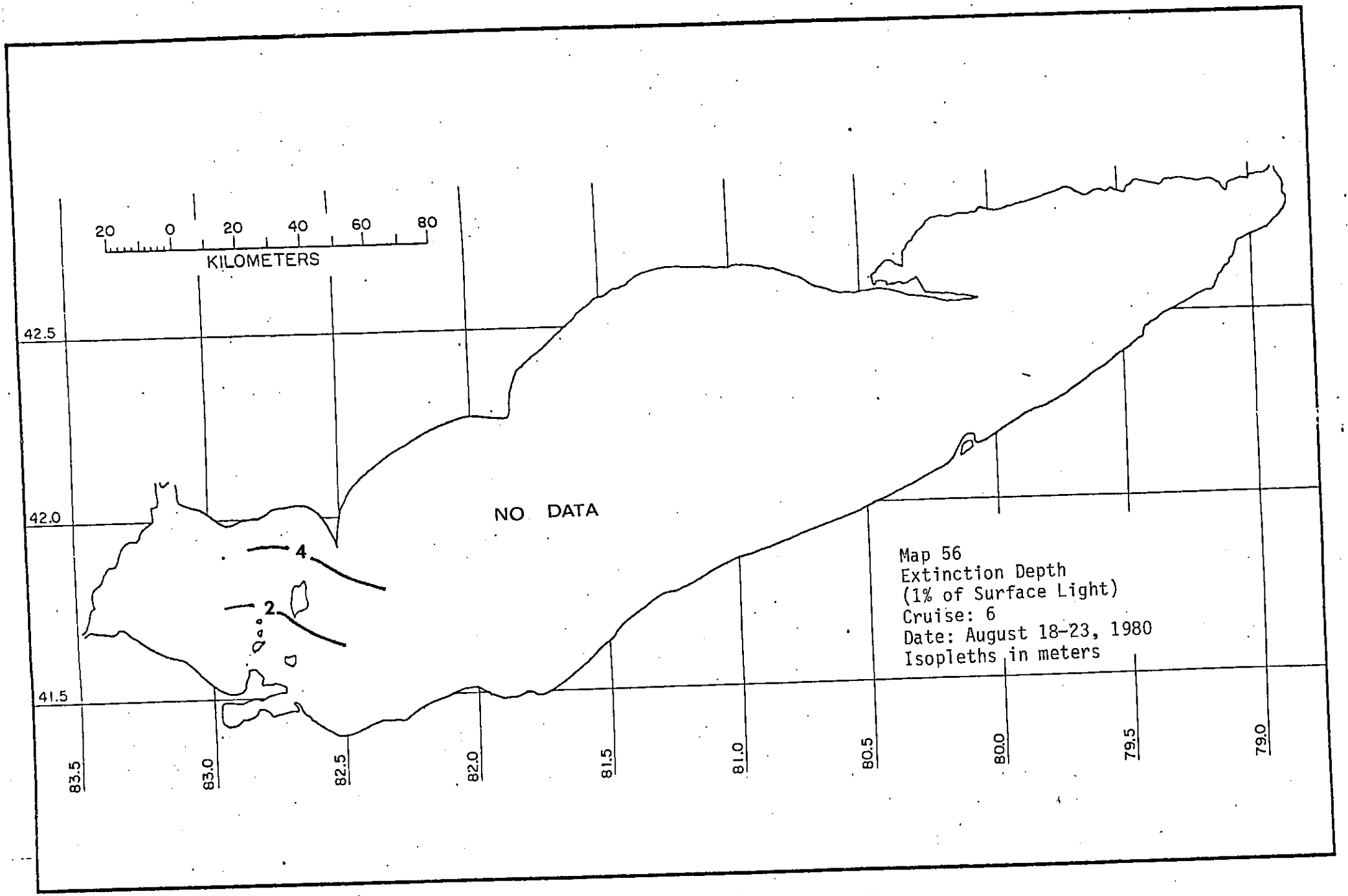

20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
1
2
3
4
5
6
7
8
9
10
11
Map 51.
Secchi Transparency
Cruise: 4
Date: June 29 - July 6, 1980
Isopleths in meters

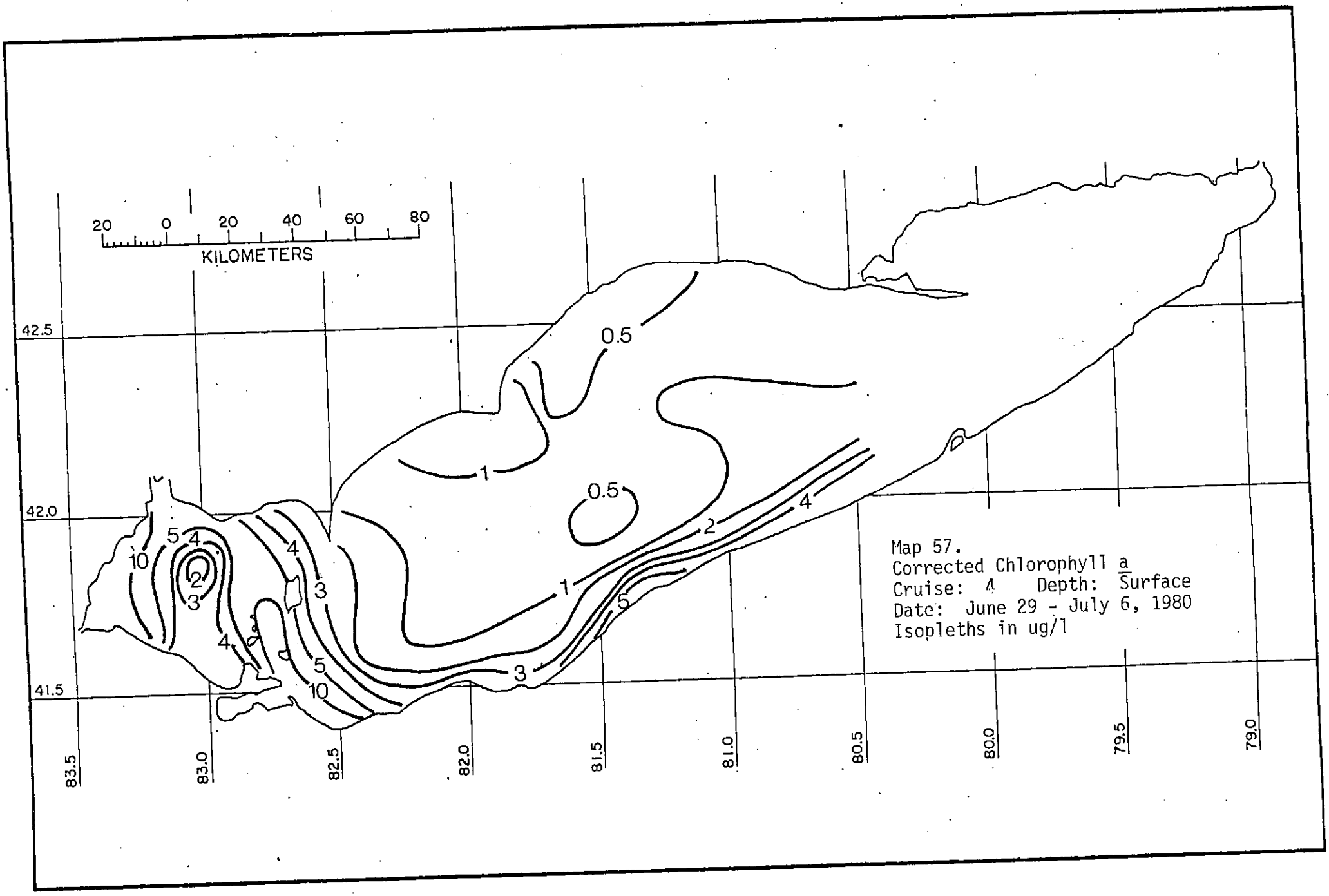

20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
1
2
3
4
5
6
7
8
9
10
Map 52.
Secchi Transparency
Cruise: 5
Date: July 28 - August 8, 1980
Isopleths in meters

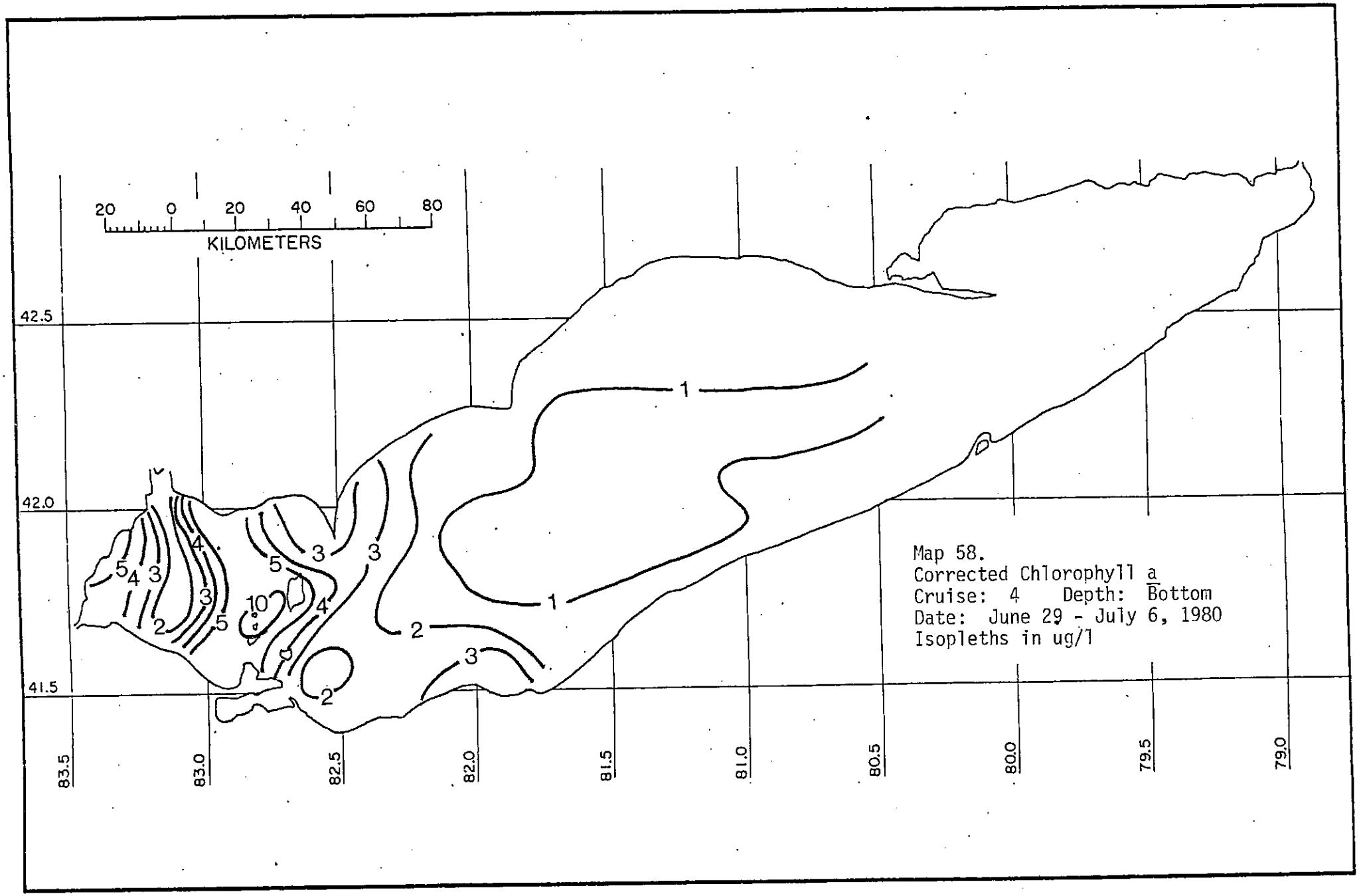

20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
1
2
3
4
5
6
7
8
Map 53.
Secchi Transparency
Cruise: 6
Date: August 18 - 23, 1980
Isopleths in meters

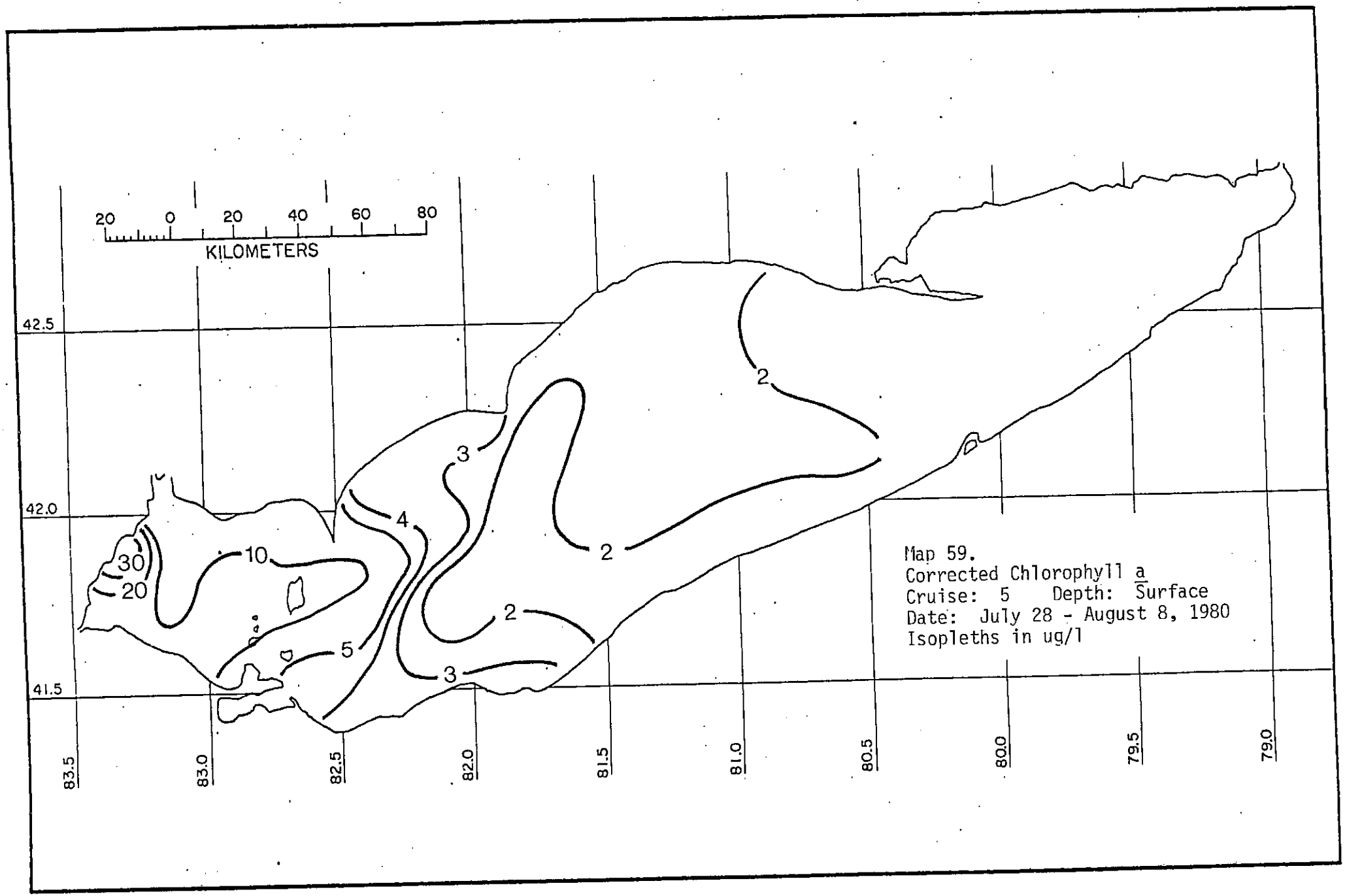

20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
2
4
6
8
10
12
14
16
18
20
Map 54.
Extinction Depth
(1% of Surface Light)
Cruise: 4
Date: June 29 - July 6, 1980
Isopleths in meters

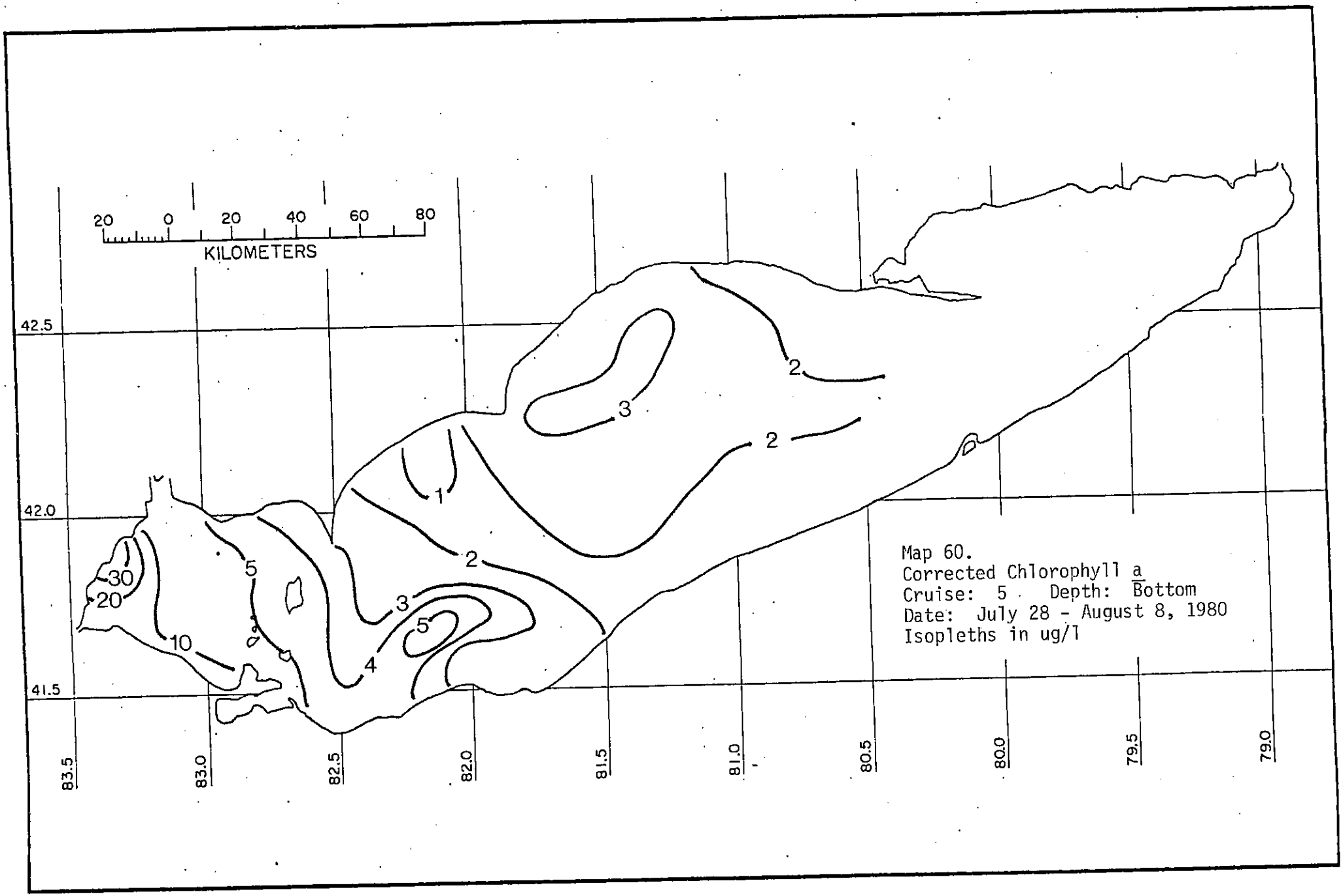

20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
2
4
6
8
10
12
14
16
18
20
Map 55
Extinction Depth
(1% of Surface Light)
Cruise: 5
Date: July 28 - August 8, 1980
Isopleths in meters

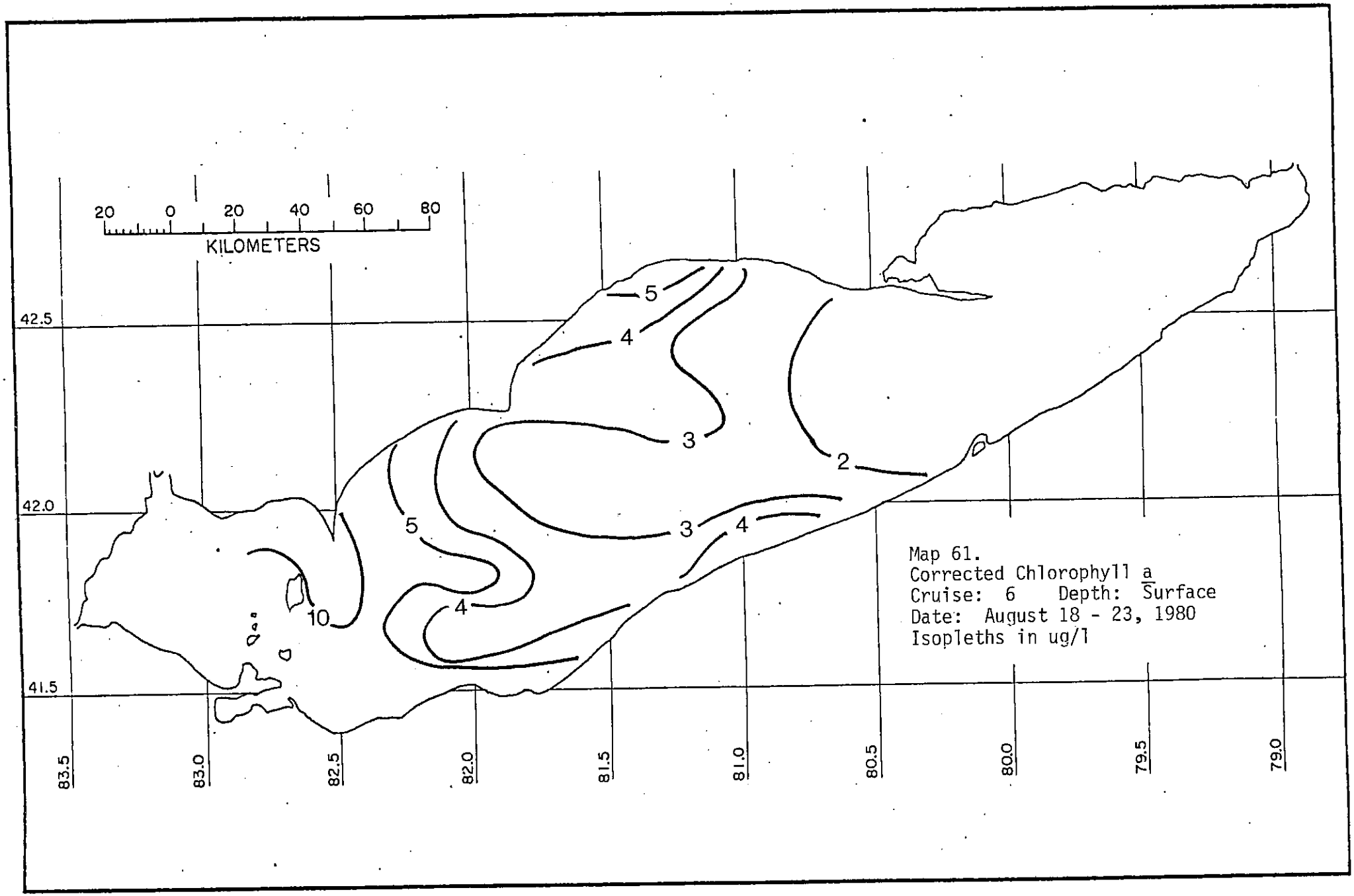

20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
NO DATA
4
2
Map 56
Extinction Depth
(1% of Surface Light)
Cruise: 6
Date: August 18-23, 1980
Isopleths in meters
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0

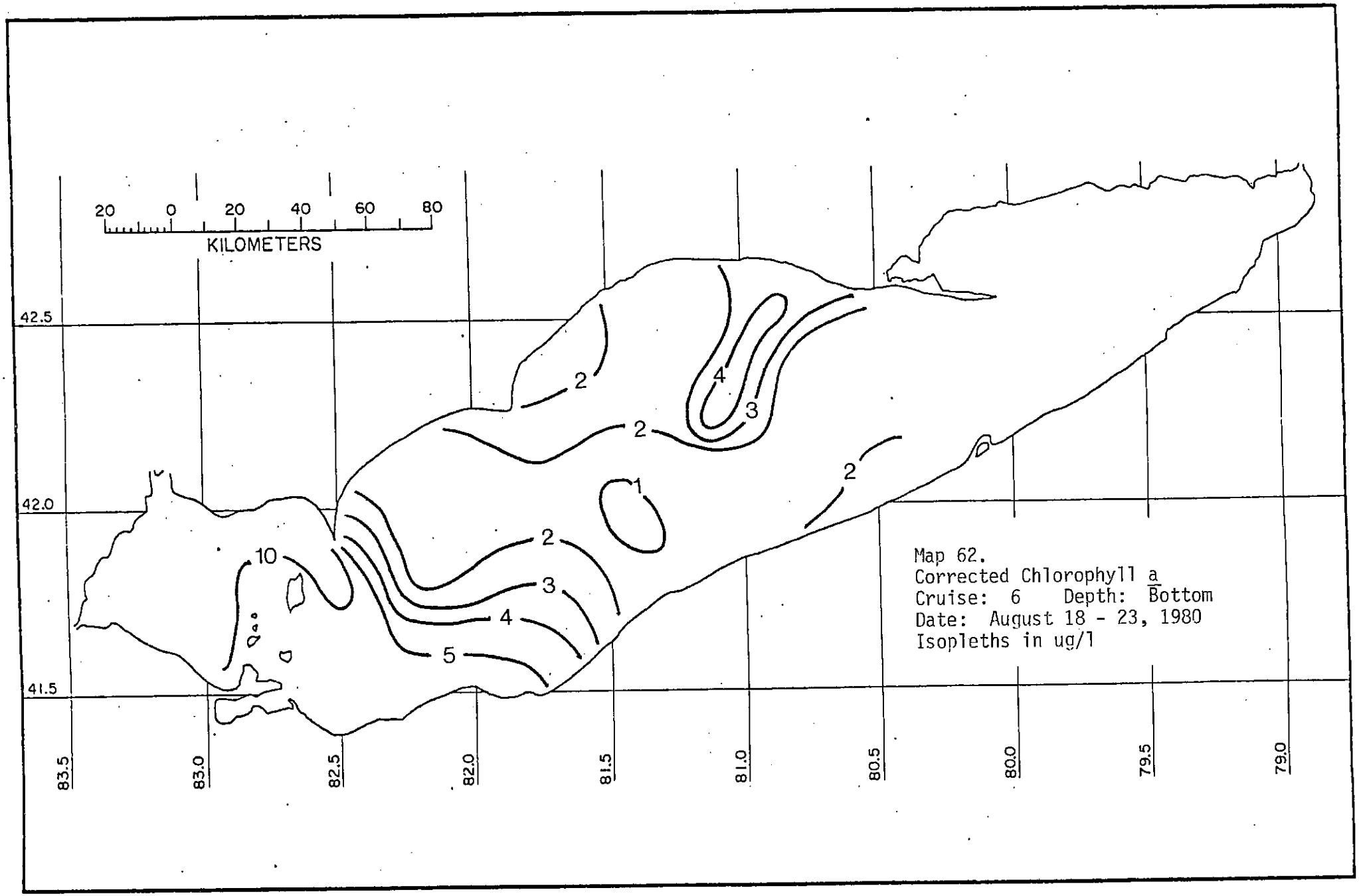

20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
0.5
1
0.5
2
4
1
5
3
10
5
4
4
3
2
3
4
5
10
Map 57.
Corrected Chlorophyll a
Cruise: 4 Depth: Surface
Date: June 29 - July 6, 1980
Isopleths in ug/l

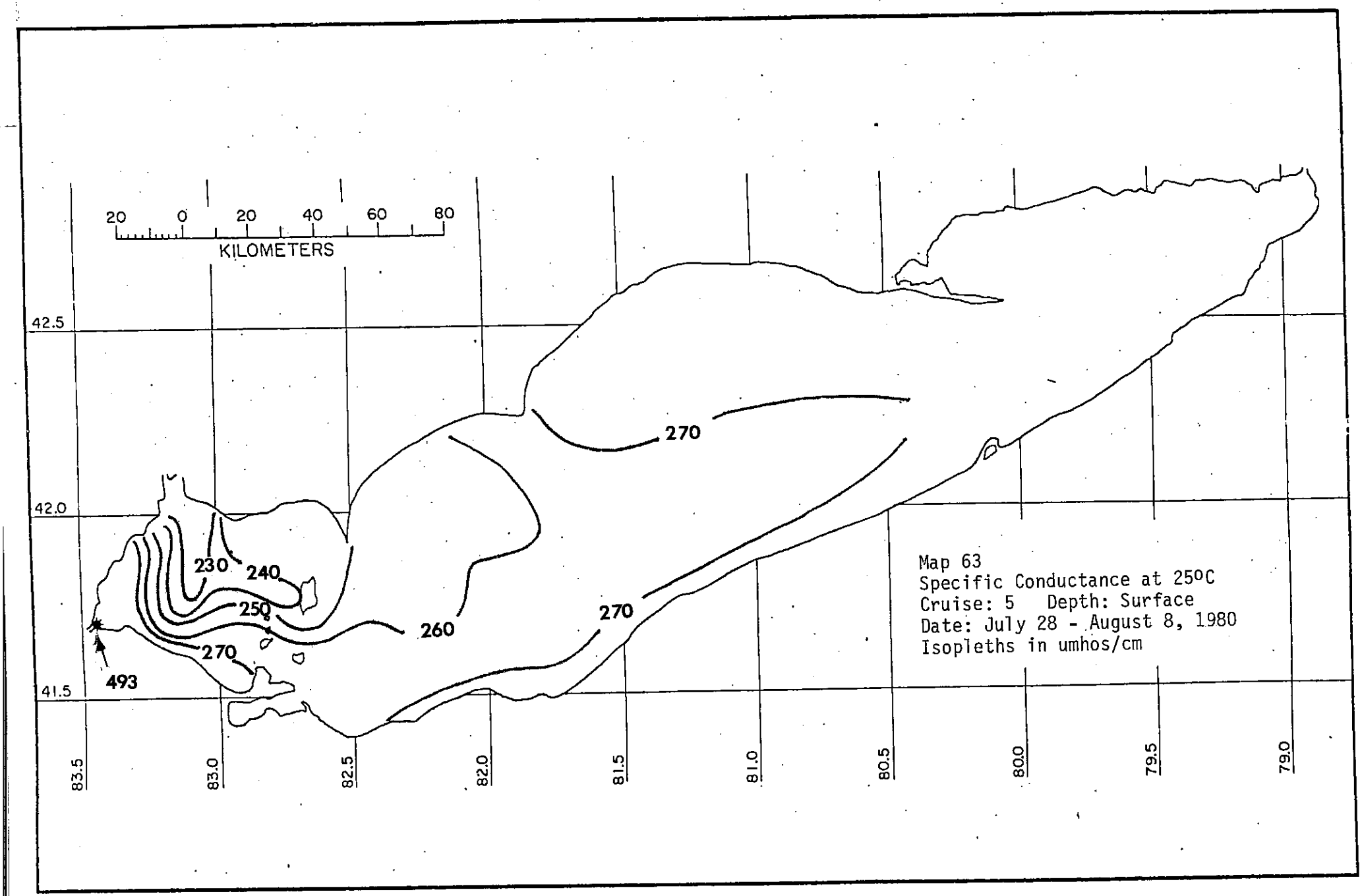

20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
Map 58.
Corrected Chlorophyll a
Cruise: 4 Depth: Bottom
Date: June 29 - July 6, 1980
Isopleths in ug/l

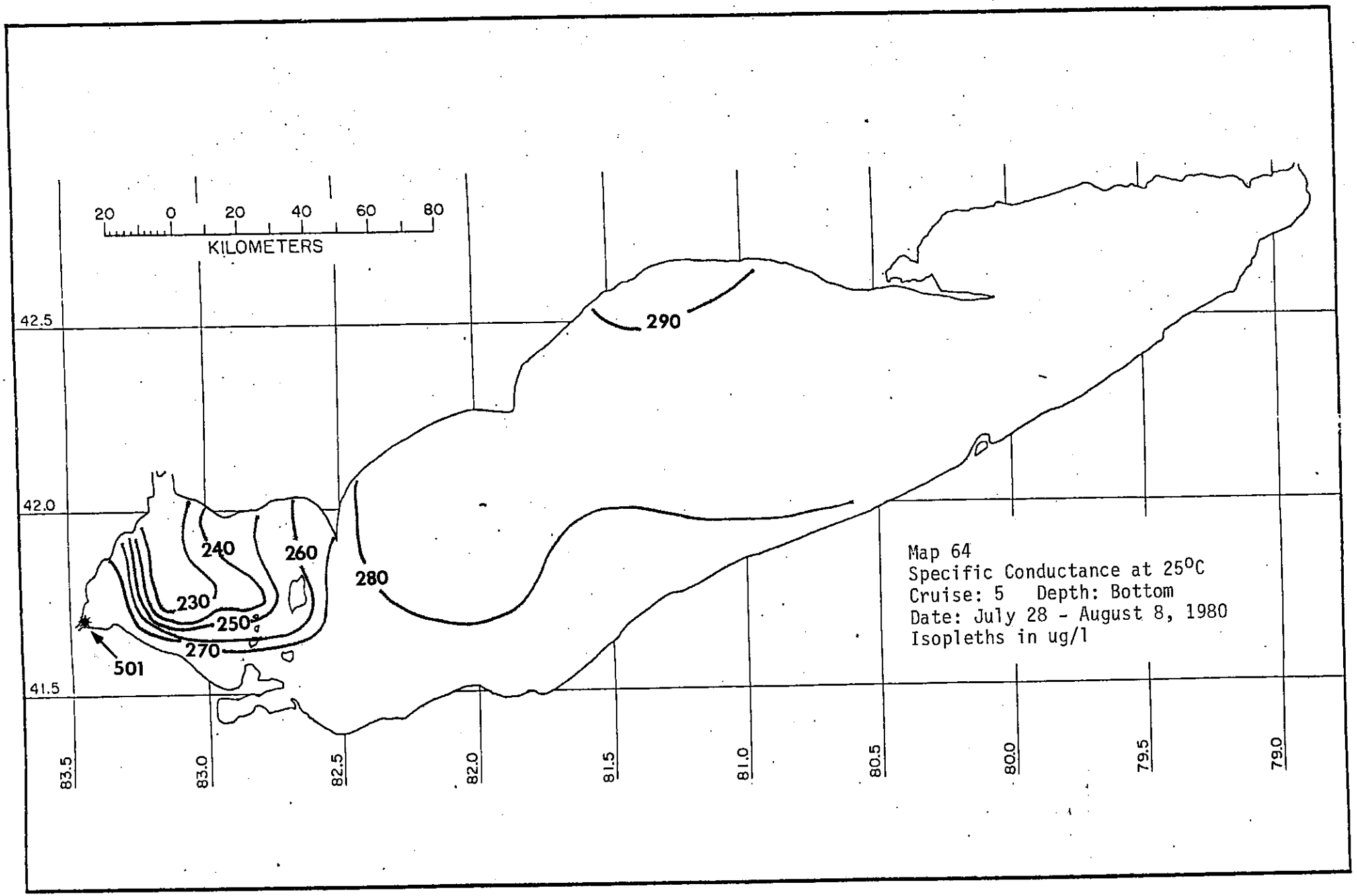

20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
30
20
10
5
4
3
3
2
2
2
Map 59.
Corrected Chlorophyll a
Cruise: 5 Depth: Surface
Date: July 28 - August 8, 1980
Isopleths in ug/l


20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
30
20
10
5
4
3
2
1
Map 60.
Corrected Chlorophyll a
Cruise: 5 Depth: Bottom
Date: July 28 - August 8, 1980
Isopleths in ug/l


20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
5
4
3
2
3
4
5
10
4
Map 61.
Corrected Chlorophyll a
Cruise: 6 Depth: Surface
Date: August 18 - 23, 1980
Isopleths in ug/l


20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
2
2
4
3
2
1
2
10
2
3
4
5
Map 62.
Corrected Chlorophyll a
Cruise: 6 Depth: Bottom
Date: August 18 - 23, 1980
Isopleths in ug/l


20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
230
240
250
260
270
270
270
493
Map 63
Specific Conductance at 25°C
Cruise: 5 Depth: Surface
Date: July 28 - August 8, 1980
Isopleths in umhos/cm


20 0 20 40 60 80
KILOMETERS
42.5
42.0
41.5
83.5
83.0
82.5
82.0
81.5
81.0
80.5
80.0
79.5
79.0
290
280
260
240
230
250
270
501
Map 64
Specific Conductance at 25°C
Cruise: 5 Depth: Bottom
Date: July 28 - August 8, 1980
Isopleths in ug/l

APPENDIX B

LAKE ERIE CRUISE SCHEDULES 1970-1980

Basin*	Year	Cruise	Date	Julian Date	Julian Mid Point
WB, CB, EB	1970 (CCIW)	1	April 7 - April 11	097 - 101	099
		2	May 6 - May 10	126 - 130	128
		3	June 2 - June 6	153 - 157	155
		4	July 3 - July 7	184 - 188	186
		5	July 28 - August 2	209 - 214	212
		6	August 25 - August 30	237 - 242	239
		7	September 23 - September 27	266 - 270	268
		8	October 21 - October 26	294 - 299	297
		9	November 25 - November 30	329 - 334	332
		10	December 14 - December 18	348 - 352	350
WB, CB	1973 (CLEAR)	1	June 28 - July 12	179 - 193	186
		2	July 17 - July 23	198 - 204	201
		3	July 25 - August 2	206 - 214	210
		4	August 7 - August 11	219 - 223	221
		5	August 29 - September 4	241 - 247	244
		6	September 19 - September 29	262 - 272	267
		7	October 14 - October 24	287 - 297	292
		8	November 7 - November 15	311 - 319	315
		9	December 4	338	338
EB	1973 (GLL)	1	June 11 - June 27	162 - 178	170
		2	July 4 - July 11	185 - 191	188
		3	July 11 - July 16	191 - 197	194
		4	July 31 - August 6	212 - 218	215
		5	August 15 - August 20	227 - 232	230
		6	September 11 - September 15	254 - 258	256
		7	October 1 - October 4	274 - 277	276
		8	October 8 - October 11	281 - 284	283
		9	October 22 - October 26	295 - 299	297
		10	December 8 - December 12	342 - 346	344
WB, CB	1974 (CLEAR)	1	April 7 - April 17	097 - 107	102
		2	April 25 - May 4	115 - 124	120
		3	May 14 - May 24	134 - 144	139
		4	June 1 - June 10	152 - 161	157
		5	June 28 - July 7	179 - 188	184
		6	July 26 - August 4	207 - 216	212
		7	August 12 - August 19	224 - 231	228
		8	August 26 - September 7	238 - 250	244
		9	September 24 - September 27	267 - 270	269
		10	October 21 - November 1	294 - 305	300
		11	December 11 - December 14	345 - 348	347

Basin*	Year	Cruise	Date	Julian Date	Julian Mid Point
EB	1974 (GLL)	1-3	Mechanical Failure		
		4	May 21 - June 1	141 - 152	147
		5	June 4 - June 7	155 - 158	157
		6	June 18 - June 22	169 - 173	171
		7	July 8 - July 11	189 - 192	191
		8	July 26 - July 30	207 - 211	209
		9	August 6 - August 9	218 - 221	220
		10	August 12 - August 16	224 - 228	226
		11	September 6 - September 9	249 - 252	251
		12	September 16 - September 21	259 - 264	262
		13	October 1 - October 9	274 - 282	278
		14	October 23 - October 27	296 - 300	298
		15	November 5 - November 11	309 - 315	312
		16	November 19 - December 5	323 - 339	331
WB, CB	1975 (CLEAR)	1	a. March 19 - March 31	078 - 090	084 > 099
		1	b. April 21 - April 25	111 - 115	113
		2	June 9 - June 19	160 - 170	165
		3	July 13 - July 21	194 - 202	198
		4	August 30 - September 7	243 - 250	247
		5	September 27 - October 6	270 - 279	274
		6	December 2 - December 10	336 - 344	340
EB	1975 (GLL)	1	April 9 - April 12	099 - 103	101
		2	June 2 - June 5	153 - 156	155
		3	July 25 - July 29	206 - 210	208
		4	September 15 - September 18	258 - 261	260
		5	December 1 - December 5	335 - 339	337
WB, CB	1976 (CLEAR)	1	March 22 - March 30	083 - 090	087
		2	June 2 - June 10	154 - 162	158
		3	August 21 - August 29	234 - 242	238
		4	September 8 - September 17	252 - 261	256
		5	October 18 - October 30	292 - 304	298
EB	1976 (GLL)	1	April 30 - May 2	121 - 123	122
		2	July 14 - July 21	196 - 203	200
		3	August 2 - August 6	215 - 219	217
		4	September 27 - October 2	271 - 276	273

Basin*	Year	Cruise	Date	Julian Date	Julian Mid Point
WB, CB, EB	1977 (CLEAR)	1	March 20 - March 31	080 - 093	086
		2	April 29 - May 8	119 - 128	124
		3	June 20 - June 30	171 - 181	176
		4	July 12 - July 22	193 - 203	198
		5	August 11 - August 21	223 - 233	228
		6	September 11 - October 8	254 - 281	267
		7	November 7 - November 20	311 - 324	317
WB, CB, EB	1978 (USEPA)	1	cancelled		
		2	May 18 - May 27	138 - 147	143
		3	June 5 - June 15	156 - 166	161
		4	June 23 - July 1	174 - 182	178
		5	July 19 - July 29	200 - 210	205
		6	August 8 - August 16	220 - 228	224
		7	August 29 - September 6	241 - 249	245
		8	October 3 - October 12	276 - 285	281
		9	October 24 - November 1	297 - 305	301
		10	November 10 - November 19	314 - 323	318
WB, CB, EB	1978 (CCIW)	103	May 29 - June 2	149 - 157	153
		104	June 19 - June 24	170 - 175	173
		106	July 13 - July 18	194 - 199	197
		110	August 19 - August 23	231 - 235	233
		111	September 13 - September 19	256 - 262	259
		114	September 30 - October 4	273 - 277	275
WB, CB, EB	1979 (USEPA)	W1	January 16 - January 18	016 - 018	017
		W2	February 27 - March 1	058 - 060	059
		W3	March 27 - March 29	086 - 088	087
		2	April 17 - April 20 (WB & WCB only)	107 - 110	109
		3	May 15 - May 26	135 - 146	141
		4	June 12 - June 21	163 - 172	167
		5	July 11 - July 19	192 - 200	196
		6	July 31 - August 4 (WB & WCB only)	212 - 216	214
		7	August 23 - September 4	235 - 247	241
		8	September 11 - September 21	254 - 264	259
		9	October 2 - October 14	275 - 287	281
		10	November 7 - November 16	311 - 320	316

Basin*	Year	Cruise	Date	Julian Date	Julian Mid Point
WB, CB	1980 (CLEAR)	1	April 1 - April 4	092 - 095	094
		2	April 28 - May 2 plus May 13	119 - 123 + 134	121
		3	May 27 - June 2	148 - 154	151
		4	June 29 - July 6	181 - 188	185
		5	July 28 - August 8	210 - 221	216
(CB only)		6	August 18 - August 23	231 - 236	234
WB, CB		7	August 28 - September 6	241 - 250	246
		8	September 27 - October 1	271 - 275	273
		9	October 27 - November 5	301 - 310	306
		10	November 23 - December 4	328 - 339	334

*WB--western basin; CB--central basin; EB--eastern basin.

APPENDIX C

LAKE ERIE WATER QUALITY--WESTERN BASIN 1970-1980

DATE	YEAR	CRUISE NO.	STRATIFICATION	LIMNION	VOLUME (km^3)	TOTAL PHOSPHORUS		SOLUBLE REACTIVE PHOSPHORUS		CORRECTED CHLOROPHYLL a	
						METRIC TONS	CONC. (µg/l)	METRIC TONS	CONC. (µg/l)	METRIC TONS	CONC. (µg/l)
4/7-4/11	1970	1	Unstratified	total	28.2	1678.0	59.48	453.7	16.09	166.4	5.9
5/6-5/11	(CCIW)	2	Unstratified	total	28.2	941.0	33.36	74.3	2.64	124.1	4.4
6/2-6/6		3	Unstratified	total	28.2	1048.0	37.16	292.9	10.39	166.4	5.9
7/3-7/7		4	Unstratified	total	28.2	1068.0	37.88	144.3	5.12	335.5	11.9
7/28-8/2		5	Unstratified	total	25.9	891.0	34.38	81.3	2.88	254.0	9.8
8/25-8/30		6	Unstratified	total	28.2	1352.0	47.96	23.6	0.84	544.1	19.3
9/23-9/27		7	Unstratified	total	28.2	1199.0	42.53	194.9	6.91	287.6	10.2
10/21-10/26		8	Unstratified	total	28.2	1218.0	43.18	226.4	8.03	220.0	7.8
11/25-11/30		9	Unstratified	total	28.2	1691.0	59.95	352.3	12.49	214.4	7.6
12/14-12/18		10	Unstratified	total	28.2	1422.0	50.44	243.9	8.65	93.0	3.3
7/17-7/23	1973	2	Unstratified	total	23.90	648.0	27.1	ND	ND	199.3	8.34
8/29-9/4	(CLEAR)	5	Unstratified	total	23.65	677.0	28.6	ND	ND	277.6	11.74
10/14-10/24		7	Unstratified	total	22.54	1091.0	48.4	ND	ND	269.4	11.99
4/25-5/4	1974	2	Unstratified	total	24.00	1056.0	44.0	ND	ND	210.0	8.75
6/1-6/10	(CLEAR)	4	Unstratified	total	24.11	746.0	31.0	ND	ND	241.7	10.03
6/28-7/7		5	Unstratified	total	23.95	734.0	30.6	166.0	6.90	395.1	16.50
8/12-8/19		7	Unstratified	total	23.53	855.0	36.3	79.4	3.40	403.2	17.14
8/26-9/7		8	Unstratified	total	23.45	1075.0	45.9	250.0	10.70	316.1	13.48
10/21-11/1		10	Unstratified	total	22.62	517.0	22.9	23.2	1.00	331.4	14.65
3/19-3/31	1975	1	Unstratified	total	23.64	1338.0	56.61	215.0	9.10	244.5	10.34
4/21-4/25	(CLEAR)	2	Unstratified	total	23.50	760.0	32.40	147.0	6.20	495.1	21.07
6/9-6/19		3	Unstratified	total	23.35	1085.0	46.50	293.0	12.60	410.8	17.59
7/13-7/21		4	Unstratified	total	23.35	893.0	38.20	109.0	4.70	380.9	16.31
8/30-9/7		5	Unstratified	total	23.07	997.0	43.20	248.0	10.80	284.6	12.34
9/27-10/6		6	Unstratified	total	22.54	835.0	37.00	181.0	8.00	105.0	4.66
3/22-3/30	1976	1	Unstratified	total	23.62	1582.0	66.99	243.6	10.31	207.0	8.75
6/2-6/10	(CLEAR)	2	Unstratified	total	23.62	696.0	29.48	84.6	3.58	152.0	6.44
8/21-8/29		3	Unstratified	total	23.30	886.0	38.01	82.4	3.54	365.0	15.66
9/8-9/17		4	Unstratified	total	23.01	1212.0	52.70	118.2	5.14	389.0	16.90
10/18-10/30		5	Unstratified	total	22.43	832.0	37.08	97.5	4.35	323.0	14.40
3/21-4/3	1977	1	Unstratified	total	22.16	773.0	34.89	142.0	6.39	144.7	6.53
4/28-5/8	(CLEAR)	2	Unstratified	total	ND	ND	ND	ND	ND	ND	ND
6/20-6/30		3	Unstratified	total	ND	ND	ND	ND	ND	ND	ND
7/12-7/31		4	Unstratified	total	ND	ND	ND	ND	ND	ND	ND
8/11-8/21		5	Unstratified	total	ND	ND	ND	ND	ND	ND	ND
9/10-10/9		6	Unstratified	total	22.57	1204.0	53.32	189.0	8.35		
11/7-11/20		7	Unstratified	total	22.48	762.0	33.91	130.0	5.77	339.4	15.10
5/18-5/27	1978	2	Unstratified	total	25.09	335.5	13.19	36.4	1.45	243.4	9.57
6/5-6/15	(USEPA)	3	Unstratified	total	25.07	433.3	17.27	75.5	3.01	129.6	5.16
6/23-7/1		4	Unstratified	total	25.10	654.3	26.06	96.6	3.85	326.2	13.06
7/19-7/29		5	Unstratified	total	24.40	ND	ND	176.6	7.24	422.0	17.29
8/8-8/16		6	Unstratified	total	24.33	ND	ND	38.6	1.59	434.6	17.76
8/29-9/6		7	Unstratified	total	24.14	ND	ND	43.9	1.82	369.1	15.26
10/3-10/12		8	Unstratified	total	23.85	ND	ND	145.8	6.11	ND	ND
10/24-11/1		9	Unstratified	total	23.80	ND	ND	38.4	1.61	302.3	12.65
11/10-11/19		10	Unstratified	total	23.89	532.6	22.29	66.1	2.77	219.7	9.21
4/17-4/20	1979	2	Unstratified	total	24.80	2427.9	98.02	149.5	6.03	113.3	4.58
5/15-5/26	(USEPA)	3	Unstratified	total	24.99	476.3	19.06	61.3	2.45	245.1	9.84
6/12-6/21		4	Unstratified	total	24.76	480.1	19.39	ND	ND	ND	ND
7/11-7/19		5	Unstratified	total	25.02	463.7	18.48	70.3	2.81	197.5	7.89
7/31-8/4		6	Unstratified	total	25.07	671.4	26.73	53.6	2.13	392.3	15.65
8/23-9/4		7	Unstratified	total	25.11	779.4	31.03	39.8	1.59	ND	ND
9/11-9/21		8	Unstratified	total	24.75	871.6	35.15	65.6	2.66	432.9	17.49
10/2-10/14		9	Unstratified	total	24.42	594.2	24.32	41.0	1.68	274.4	11.24
11/7-11/16		10	Unstratified	total	24.19	790.4	32.67	51.6	2.13	330.9	13.68
4/1-4/2	1980	1	Unstratified	total	25.4	959.1	37.72	180.8	7.11	107.0	4.21
4/28-4/30	(CLEAR)	2	Unstratified	total	25.4	711.3	27.98	93.4	3.67	204.1	8.03
5/27-5/29		3	Unstratified	total	25.4	449.9	17.69	59.9	2.36	156.3	6.15
6/29-6/30		4	Unstratified	total	25.4	753.5	29.65	118.4	4.66	144.4	5.68
7/28		5	Unstratified	total	25.41	565.9	22.27	70.8	2.81	271.5	10.75
ND		6	ND	ND	ND	ND	ND	ND	ND	ND	ND
8/28-8/29		7	Unstratified	total	24.9	756.1	30.29	56.1	2.11	310.6	12.44
9/27-9/28		8	Unstratified	total	25.1	952.1	37.91	51.8	2.08	320.9	12.78
11/5		9	Unstratified	total	24.2	726.1	30.01	62.9	2.59	220.7	9.12
11/23		10	Unstratified	total	24.2	611.3	25.27	43.3	1.79	143.1	5.92

APPENDIX D

LAKE ERIE WATER QUALITY--CENTRAL BASIN 1970-1980

DATE	YEAR	CRUISE NO.	STRATIFICATION	LIMNION	VOLUME (km^3)	TOTAL PHOSPHORUS		SOLUBLE REACTIVE PHOSPHORUS		CORRECTED CHLOROPHYLL	
						METRIC TONS	CONC. (µg/l)	METRIC TONS	CONC. (µg/l)	METRIC TONS	CONC. (µg/l)
4/7-4/11	1970 CCIW	1	Unstratified	total	274.4	4611.0	16.80	655.0	2.39	1459.9*	5.3
5/6-5/11		2	Unstratified	total	274.4	5852.0	21.33	442.3	1.61	793.4	2.9
6/2-6/6		3	Stratified	epi	229.0	4714.0	20.58	440.1	1.92		
				meso	19.5	351.0	17.98	33.3	1.71		
				hypo	25.9	463.0	17.86	59.4	2.29		
				total	274.4	5528.0	20.15	532.8	1.95	697.8	2.7
7/3-7/7		4	Stratified	epi	213.8	3188.0	14.91	424.2	1.98		
				meso	19.9	270.0	13.55	38.3	1.92		
				hypo	40.8	726.0	17.79	142.9	3.50		
				total	274.5	4184.0	15.24	605.4	2.23	688.6	2.5
7/28-8/2		5	Stratified	epi	220.4	2542.0	11.53	191.3	0.87		
				meso	23.6	271.0	11.47	17.6	0.74		
				hypo	30.5	357.0	11.69	38.9	1.27		
				total	274.5	3170.0	11.55	247.8	0.90	879.9	3.7
8/25-8/30		6	Stratified	epi	222.0	2560.0	11.53	240.9	1.09		
				meso	20.0	306.0	15.28	71.9	3.60		
				hypo	32.5	844.0	25.98	281.1	8.65		
				total	274.5	3710.0	13.52	593.9	2.23	1141.1	4.1
9/23-9/27		7	Stratified	epi	260.0	4151.0	15.97	443.3	1.71		
				meso	7.6	321.0	42.16	106.7	14.04		
				hypo	6.9	761.0	110.30	407.3	59.02		
				total	274.5	5233.0	19.06	957.3	3.41	2545.9	9.2
10/21-10/26		8	Unstratified	total	274.4	5351.0	19.50	1063.3	3.88	822.0	3.0
11/25-11/30		9	Unstratified	total	274.4	8719.0	31.78	1922.5	7.00	1474.6	5.4
12/14-12/18		10	Unstratified	total	274.4	9876.0	35.99	1607.7	5.86	1563.1	5.7
7/17-7/23	1973 CLEAR	2	Stratified	epi	228.63	3221.4	14.09	-	-	535.2	2.34
				meso	22.22	349.8	15.62	-	-	64.0	2.86
				hypo	61.31	894.4	14.57	-	-	152.2	2.48
				total	312.16	4465.6	14.31	-	-	751.4	2.41
8/29-9/4		5	Stratified	epi	238.20	3484.6	14.63	-	-	885.0	3.72
				meso	24.86	342.3	13.77	-	-	75.9	3.05
				hypo	47.07	1003.0	21.31	-	-	129.4	2.75
				total	310.13	4829.9	15.57	-	-	1090.3	3.52
10/14-10/24		7	Unstratified	total	306.09	7839.9	25.61	-	-	2409.1	7.87
4/25-5/4	1974 CLEAR	2	Unstratified	total	311.94	5247.2	16.82	-	-	1082.7	3.50
6/1-6/10		4	Stratified	epi	195.82	2635.5	13.46	-	-	458.1	2.34
				meso	22.74	431.6	18.98	-	-	58.3	2.56
				hypo	93.67	1962.4	20.95	-	-	233.2	2.49
				total	312.23	5029.5	16.11	-	-	749.6	2.40
6/28-7/7		5	Stratified	epi	249.10	3362.9	13.50	269.0	1.10	641.8	2.58
				meso	12.52	203.9	16.29	27.8	2.20	18.3	1.46
				hypo	50.12	961.3	19.18	140.2	2.79	92.2	1.84
				total	311.74	4528.1	14.53	437.0	1.40	752.3	2.41
8/12-8/19		7	Stratified	epi	235.35	3058.2	12.99	247.5	1.05	985.2	4.19
				meso	23.83	282.4	11.85	41.7	1.75	72.8	3.05
				hypo	50.63	864.2	17.07	170.7	3.37	127.0	2.51
				total	309.81	4204.8	13.57	459.9	1.48	1185.0	3.82
8/26-9/7		8	Stratified	epi	243.01	4534.9	18.66	395.2	1.63	1036.0	4.26
				meso	17.45	296.4	16.98	109.1	6.25	41.6	2.38
				hypo	48.38	1378.2	28.49	743.1	15.36	85.2	1.76
				total	308.84	6209.5	20.11	1247.4	4.04	1162.8	3.76
10/21-11/1		10	Unstratified	total	303.97	6046.2	19.89	629.0	2.07	2871.4	9.40

DATE	YEAR	CRUISE NO.	STRATIFICATION	LIMNION	VOLUME (km^3)	TOTAL PHOSPHORUS		SOLUBLE REACTIVE PHOSPHORUS		CORRECTED CHLOROPHYLL	
						METRIC TONS	CONC. (µg/l)	METRIC TONS	CONC. (µg/l)	METRIC TONS	CONC. (µg/l)
3/19-3/31	1975 CLEAR	1	Unstratified	total	308.69	7100.9	23.00	568.0	1.80	1571.0	5.10
4/21-4/25				epi	174.03	2421.4	13.91	457.2	2.63	395.1	2.27
6/9-6/19		2	Stratified	meso	30.76	469.3	15.26	70.9	2.31	81.5	2.65
				hypo	104.70	1638.3	15.65	242.0	2.31	362.8	3.47
				total	309.49	4529.0	14.63	770.1	2.49	839.4	2.71
				epi	182.64	2357.0	12.91	288.9	1.58	482.7	2.64
7/13-7/21		3	Stratified	meso	35.56	637.7	17.94	66.3	1.86	121.3	3.41
				hypo	90.49	1919.8	21.22	209.0	2.31	351.8	3.89
				total	308.69	4914.5	15.92	564.2	1.83	955.8	3.10
				epi	227.39	3488.5	15.34	632.1	2.78	1894.4	8.33
8/30-9/7		4	Stratified	meso	15.23	215.9	14.17	40.1	2.63	109.0	7.16
				hypo	66.07	1183.6	17.91	273.0	4.13	381.0	5.77
				total	308.69	4888.0	15.83	945.2	3.06	2384.4	7.72
9/27-10/6		5	Unstratified	total	307.06	6134.2	19.98	812.4	2.65	3086.3	10.05
12/2-12/10		6	Unstratified	total	303.96	9623.0	31.66	2480.6	8.16	2103.3	6.92
3/22-3/30	1976 CLEAR	1	Unstratified	total	309.83	6644.8	21.45	561.8	1.81	1311.5	4.23
6/2-6/10		2	Stratified	epi	216.92	3590.8	16.55	356.2	1.64	501.5	2.31
				meso	13.19	206.3	15.64	17.4	1.32	36.3	2.75
				hypo	80.07	1311.4	16.38	115.9	1.45	250.2	3.12
				total	310.18	5108.5	16.47	489.5	1.58	788.0	2.54
				epi	249.94	3807.6	15.23	1956.6	7.83	1115.4	4.46
8/21-8/29		3	Stratified	meso	23.81	516.9	21.71	256.3	10.77	98.1	4.12
				hypo	34.57	1521.0	44.00	1505.4	43.55	110.7	3.20
				total	308.32	5845.5	18.96	3718.3	12.06	1324.2	4.29
				epi	291.19	8267.9	28.39	1094.2	3.76	1996.9	6.86
9/8-9/17		4	Stratified	meso	8.72	202.2	23.19	37.2	4.26	43.3	4.96
				hypo	6.85	373.4	54.51	140.3	20.49	12.0	1.76
				total	306.76	8843.5	28.83	1271.7	4.15	2052.2	6.69
10/18-10/30		5	Unstratified	total	303.34	8108.0	26.73	1780.4	5.87	2590.1	8.54
3/20-3/31	1977 CLEAR	1	Unstratified	total	302.20	3988.1	13.20	294.6	0.97	1045.0	3.46
4/29-5/8		2	Unstratified	total	306.08	3747.7	12.24	450.0	1.47	986.8	3.22
6/20-6/30		3	Stratified	epi	178.79	5090.5	28.47	564.4	3.16	463.8	2.59
				meso	35.24	805.2	22.85	84.3	2.39	73.6	2.09
				hypo	89.91	2433.1	27.06	272.2	3.03	155.8	1.73
				total	303.94	8328.8	27.40	920.9	3.03	693.2	2.28
				epi	219.21	5759.0	26.27	825.9	3.77	762.3	3.48
7/12-7/22		4	Stratified	meso	25.45	591.7	23.25	86.4	3.39	82.2	3.29
				hypo	59.82	1792.9	29.97	196.8	3.29	156.0	2.61
				total	304.48	8143.6	26.75	1109.1	3.64	1000.4	3.28
				epi	256.94	7361.7	28.65	741.4	2.89	1544.0	6.01
8/11-8/21		5	Stratified	meso	11.59	423.2	36.52	55.4	4.78	71.5	6.17
				hypo	35.44	1182.0	33.35	314.3	8.87	168.5	4.75
				total	303.97	8966.9	29.50	1111.1	3.66	1784.0	5.87
				epi	298.34	9509.8	31.88	2069.6	6.94	1787.5	5.99
9/11-10/8		6	Stratified	meso	2.25	184.4	81.94	53.4	23.73	19.6	8.7
				hypo	3.89	388.7	99.91	134.5	34.58	20.5	5.3
				total	304.48	10082.9	33.12	2257.5	7.41	1828.6	6.0
11/7-11/20		7	Unstratified	total	300.45	7912.2	26.33	3094.9	10.30	1131.8	3.77

DATE	YEAR	CRUISE NO.	STRATIFICATION	LIMNION	VOLUME (km^3)	TOTAL PHOSPHORUS		SOLUBLE REACTIVE PHOSPHORUS		CORRECTED CHLOROPHYLL	
						METRIC TONS	CONC. (µg/l)	METRIC TONS	CONC. (µg/l)	METRIC TONS	CONC. (µg/l)
5/18-5/27	1978 USEPA	2	Unstratified	total	315.93	3040.0	9.60	524.8	1.66	2590.7	8.17
6/5-6/15		3	Stratified	total	305.47	2314.9	7.54	255.4	0.83	1630.4	5.32
6/23-7/1		4	Stratified	epi	129.97	975.5	7.51	277.5	2.13	215.3	1.65
				meso	105.30	969.8	9.19	182.5	1.73	295.8	2.80
				hypo	79.76	789.6	9.91	140.0	1.75	385.2	4.83
				total	315.03	2734.9	8.68	600.0	1.90	896.3	2.85
7/19-7/29		5	Stratified	epi	118.54	ND	ND	294.9	2.49	444.2	3.75
				meso	93.14	ND	ND	419.2	4.50	242.2	2.60
				hypo	100.30	ND	ND	171.6	1.71	342.4	3.41
				total	311.98	ND	ND	885.7	2.84	1028.8	3.30
8/8-8/16		6	Stratified	epi	172.07	912.2	5.31	300.7	1.75	582.3	3.38
				meso	69.66	384.8	5.52	112.3	1.61	387.8	5.55
				hypo	69.66	720.1	10.35	113.1	1.62	298.0	4.27
				total	311.39	2017.0	6.48	526.1	1.69	1268.1	4.07
8/29-9/6		7	Stratified	epi	201.96	ND	ND	347.9	1.72	706.8	3.49
				meso	56.71	ND	ND	79.7	1.41	197.3	3.48
				hypo	51.62	ND	ND	54.2	1.05	269.8	5.22
				total	310.29	ND	ND	481.8	1.55	1173.9	3.78
10/3-10/12		8	Unstratified	total	308.81	ND	ND	731.4	2.37	ND	ND
10/24-11/1		9	Unstratified	total	308.81	ND	ND	620.1	2.01	2562.9	8.29
11/10-11/19		10	Unstratified	total	299.54	2968.4	9.88	617.5	2.06	1649.1	5.49
5/29-6/2	1978 CCIW	103	Stratified	epi	93.8	1245.2	13.3				
				meso	101.2	1479.6	14.6				
				hypo	121.9	1754.5	14.4				
				total	316.9	4479.3	14.1				
6/19-6/24		104	Stratified	epi	179.5	1975.9	11.0				
				meso	69.9	913.5	13.0				
				hypo	65.9	904.4	13.7				
				total	315.3	3793.8	12.0				
7/13-7/18		106	Stratified	epi	191.6	2281.8	11.9				
				meso	59.4	915.3	15.3				
				hypo	61.0	1146.1	18.8				
				total	312.0	4343.2	13.9				
8/19-8/23		110	Stratified	epi	220.7	2847.5	12.8				
				meso	37.5	686.9	18.3				
				hypo	53.8	1095.6	20.3				
				total	312.0	4630.0	14.8				
9/13-9/19		111	Stratified	epi	266.9	3752.2	14.2				
				meso	18.2	304.6	16.7				
				hypo	24.7	412.6	16.6				
				total	309.8	4469.4	14.4				
9/30-10/4		114	Stratified	epi	280.3	4254.5	15.1				
				meso	16.4	331.9	20.2				
				hypo	12.1	257.7	21.3				
				total	308.8	4844.1	15.7				
4/17-4/20	1979 USEPA	2	Unstratified	total	313.30	5758.2	18.36	508.5	1.62	1410.2	4.49
5/15-5/26		3	Stratified	epi	193.68	2192.1	11.32	321.9	1.66	852.3	4.40
				meso	43.27	515.9	11.91	63.3	1.46	171.6	3.96
				hypo	78.15	1038.4	13.27	135.8	1.73	336.5	4.31
				total	315.10	3746.4	11.89	521.0	1.65	1360.4	4.32
6/12-6/21		4	Stratified	epi	253.2	2652.8	10.48				
				meso	24.1	245.6	10.17				
				hypo	37.9	480.7	12.68	ND	ND	ND	ND
				total	315.20	3379.1	10.72				
7/11-7/19		5	Stratified	epi	232.92	2445.5	10.46	311.9	1.34	613.9	2.63
				meso	32.04	259.8	8.09	48.9	1.53	68.8	2.15
				hypo	49.23	424.6	8.59	110.8	2.25	105.1	2.13
				total	314.19	3129.9	9.96	471.6	1.50	787.8	2.51

DATE	YEAR	CRUISE NO.	STRATIFICATION	LIMNION	VOLUME (km^3)	TOTAL PHOSPHORUS		SOLUBLE REACTIVE PHOSPHORUS		CORRECTED CHLOROPHYLL	
						METRIC TONS	CONC. (ug/l)	METRIC TONS	CONC. (ug/l)	METRIC TONS	CONC. (ug/l)
7/31-8/4	1979 USEPA	6	Stratified	epi	219.16	3085.5	14.07	249.1	1.14	1253.5	5.72
				meso	30.32	327.4	10.79	49.2	1.62	124.7	4.11
				hypo	65.55	720.4	10.97	144.1	2.19	254.9	3.89
				total	315.03	4133.3	13.12	442.4	1.40	1633.1	5.18
8/23-9/4		7	Stratified	epi	ND	ND	ND	ND	ND	ND	ND
				meso							
				hypo							
				total							
9/11-9/21		8	Stratified	epi	272.91	3610.3	13.22	468.2	1.72	1464.7	5.37
				meso	16.87	209.2	12.38	50.7	2.99	56.7	3.36
				hypo	23.46	488.2	20.75	159.4	6.78	67.0	2.86
				total	313.24	4307.7	13.75	678.3	2.17	1588.4	5.07
10/2-10/14		9	Unstratified	total	303.29	4394.8	14.49	821.4	2.71	1794.7	5.92
11/7-11/16		10	Unstratified	total	301.63	4546.7	15.06	1064.4	3.53	2387.8	7.92
4/3-4/4	1980 CLEAR	1	Unstratified	total	308.3	5462.8	17.72	621.4	2.01	716.4	2.32
5/1-5/13		2	Unstratified	total	308.3	3798.6	12.32	368.5	1.19	1009.9	3.28
5/31-6/2		3	Stratified	epi	233.9	886.2	3.79	301.0	1.29	416.6	1.78
				meso	18.8	68.2	3.63	23.9	1.27	30.8	1.64
				hypo	55.5	285.0	5.13	91.5	1.65	91.0	1.64
				total	308.2	1239.4	4.02	416.4	1.35	538.4	1.75
7/2-7/6		4	Stratified	epi	203.4	1330.7	6.54	429.0	2.11	328.1	1.61
				meso	23.5	193.4	8.23	57.2	2.43	32.2	1.37
				hypo	81.4	868.7	10.67	261.5	3.21	107.2	1.32
				total	308.3	2392.8	7.76	747.7	2.43	467.5	1.52
8/4-8/8		5	Stratified	epi	201.4	846.6	4.20	266.1	1.32	561.7	2.79
				meso	34.0	237.3	6.98	45.9	1.35	91.7	2.69
				hypo	72.9	644.8	8.84	172.6	2.37	181.6	2.49
				total	308.3	1728.7	5.61	484.6	1.57	835.0	2.71
8/18-8/23		6	Stratified	epi	229.7	2765.1	12.04	319.7	1.39	955.6	4.16
				meso	22.1	280.3	12.66	34.6	1.56	74.5	3.37
				hypo	65.1	843.4	12.95	142.6	2.19	113.8	2.13
				total	316.9	3888.8	12.27	496.9	1.57	1143.9	3.61
9/3-9/6		7	Stratified	epi	215.9	2585.5		327.5	1.52	832.3	3.85
				meso	22.5	231.0	9.99	35.1	1.56	64.2	2.86
				hypo	68.3	735.9	10.41	134.3	1.97	101.6	1.49
				total	306.7	3522.4	11.27	496.9	1.62	998.1	3.25
9/29-10/1		8	Unstratified	total	306.7	6168.3	20.10	839.5	2.74	1202.4	3.92
10/27-10/29		9	Unstratified	total	301.9	6990.8	23.15	1081.4	3.58	1257.1	4.16
12/1-12/4		10	Unstratified	total	301.9	6859.2	22.72	1047.3	3.47	1387.1	4.59

*1970 Chlorophyll a quantities estimated by multiplying concentration x total volume.

LAKE ERIE WATER QUALITY--EASTERN BASIN 1970-1980

DATE	YEAR	CRUISE NO.	STRATIFICATION	LIMNION	VOLUME (km^3)	TOTAL PHOSPHORUS		SOLUBLE REACTIVE PHOSPHORUS		CORRECTED CHLOROPHYLL a	
						METRIC TONS	CONC. (µg/l)	METRIC TONS	CONC. (µg/l)	METRIC TONS	CONC. (µg/l)
4/7-4/11	1970	1	Unstratified	total	166.4	5143.0	30.90	629.3	3.78	682.4	4.1
5/6-5/11	(CCIW)	2	Unstratified	total	166.4	2770.0	16.65	438.5	2.64	582.4	3.5
6/2-6/6		3	Stratified	epi	50.8	1296.0	25.51	70.9	1.40		
				meso	32.0	658.0	20.55	47.6	1.49		
				hypo	83.5	1142.0	13.61	108.7	1.30		
				total	166.3	3096.0	18.62	227.2	1.37	898.0	5.4
7/3-7/7		4	Stratified	epi	90.9	1344.0	14.79	208.5	2.29		
				meso	21.2	279.0	13.14	58.5	2.76		
				hypo	54.2	729.0	13.45	247.0	4.56		
				total	166.3	2352.0	14.14	514.0	3.09	249.5	1.5
7/28-8/2		5	Stratified	epi	89.5	1243.0	13.89	105.4	1.18		
				meso	42.2	455.0	10.79	126.9	3.01		
				hypo	34.6	430.0	12.43	154.5	4.46		
				total	166.3	2128.0	12.80	386.8	2.33	731.7	4.4
8/25-8/30		6	Stratified	epi	98.9	923.0	9.33	82.8	0.84		
				meso	30.7	232.0	7.56	40.9	1.33		
				hypo	36.8	308.0	8.37	100.4	2.73		
				total	166.4	1463.0	8.79	224.1	1.35	449.3	2.7
9/23-9/27		7	Stratified	epi	131.6	1452.0	11.04	212.1	1.61		
				meso	6.2	61.0	9.86	21.1	3.41		
				hypo	28.5	348.0	12.21	155.5	5.46		
				total	166.3	1861.0	11.19	388.7	2.34	781.6	4.7
10/21-10/26		8	Stratified	epi	149.6	1999.0	13.36	607.5	4.06		
				meso	6.1	67.0	10.97	25.9	4.25		
				hypo	10.6	126.0	11.90	63.1	5.95		
				total	166.3	2192.0	13.18	696.5	4.19	232.8	1.4
11/25-11/30		9	Unstratified	total	166.3	3784.0	22.75	995.0	5.98	449.0	2.7
12/14-12/18		10	Unstratified	total	166.3	4279.0	25.73	1165.1	7.01	432.4	2.6
Summer	1973			total			47.0		ND		ND
7/4-7/11	(GLL)	2									2.75
7/31-8/6		4		total			15.1		ND		ND
Fall											6.59
10/1-10/4		7									6.40
10/8-10/11		8		total			30.6		ND		4.90
Annual											
Spring	1974			total			21.5		ND		7.11
5/21-6/1	(GLL)	4		total			27.3		ND		ND
Summer											4.97
6/18-6/22		6									3.33
7/26-7/30		8		total			13.6		ND		ND
Fall											4.25
9/6-9/9		11									7.14
10/23-10/27		14									3.91
11/19-12/5		16									
Annual	1974			total			22.3		ND		5.11
	(GLL)										
Spring	1975	1		total			38.1		ND		3.24
4/9-4/12	(GLL)			total			23.8		ND		ND
Summer											2.46
6/2-6/5		2									2.98
7/25-7/29		3		total			20.9		ND		ND
Fall											5.88
9/15-9/18		4									3.63
12/7-12/21		5		total			25.2		ND		3.66
Annual											
3/21-4/3	1977	1	Unstratified	total	ND	ND	ND	ND	ND	ND	ND
	(CLEAR)										
4/28-5/8		2	Unstratified	total	169.16	2192.8	12.96	295.9	1.75	362.5	2.14
6/20-6/30		3	Stratified	epi	99.57	1888.3	18.96	232.5	2.34	246.3	2.47
				meso	14.33	246.7	17.22	27.0	1.89	28.2	1.97
				hypo	54.76	950.4	17.36	149.8	2.73	73.4	1.34
				total	168.66	3085.4	18.29	409.3	2.43	347.9	2.06
7/12-7/31		4	Stratified	epi	84.50	ND	ND	ND	ND	227.79	2.70
				meso	35.67					60.26	1.56
				hypo	48.02					53.07	1.11
				total	168.19					341.12	2.00
8/11-8/21		5	Stratified	epi	114.20	ND	ND	ND	ND	561.37	4.92
				meso	18.25					67.75	3.71
				hypo	36.40					61.84	1.70
				total	168.85					690.96	4.09

DATE	YEAR	CRUISE NO.	STRATIFICATION	LIMNION	VOLUME (km^3)	TOTAL PHOSPHORUS		SOLUBLE REACTIVE PHOSPHORUS		CORRECTED CHLOROPHYLL a	
						METRIC TONS	CONC. (µg/l)	METRIC TONS	CONC. (µg/l)	METRIC TONS	CONC. (µg/l)
9/10-10/9	1977	6	Stratified	epi	142.97	2719.0	19.02	661.7	4.63	700.97	4.90
				meso	2.43	48.6	19.98	13.4	5.53	5.92	2.44
				hypo	23.29	456.9	19.62	194.0	8.33	35.87	1.54
				total	168.69	3224.5	19.11	869.11	5.15	742.76	4.40
11/7-11/20		7	Unstratified	total	167.68	3844.7	22.93	873.8	5.21	548.5	3.27
5/18-5/27	1978 (USEPA)	2	Unstratified	total	160.28	1701.7	10.57	746.0	4.65	860.7	5.35
6/5-6/15		3	Stratified	total	159.07	1330.2	8.29	253.6	1.59	660.7	4.12
6/23-7/1		4	Stratified	epi	48.50	399.8	8.23	83.7	1.73	102.2	2.10
				meso	43.15	384.0	8.89	70.1	1.62	152.5	3.54
				hypo	68.51	634.6	9.26	164.9	2.40	146.9	2.14
				total	160.16	1418.4	8.86	318.7	1.99	401.6	2.51
7/19-7/29		5	Stratified	epi	63.62	ND	ND	79.9	1.25	210.6	3.30
				meso	41.64			59.6	1.43	71.8	1.72
				hypo	53.81			70.5	1.31	116.3	2.16
				total	159.07			210.0	1.32	398.7	2.51
8/8-8/16		6	Stratified	epi	85.35	821.2	9.58	93.1	1.09	178.3	2.08
				meso	28.65	242.6	8.54	31.6	1.10	52.9	1.81
				hypo	44.15	575.6	13.21	44.8	1.01	44.5	1.01
				total	158.15	1639.4	10.37	169.5	1.07	275.7	1.74
8/29-9/6		7	Stratified	epi	84.57	ND	ND	74.4	0.88	197.0	2.32
				meso	25.92			34.6	1.33	49.9	1.92
				hypo	47.49			51.7	1.09	38.3	0.81
				total	157.98			160.7	1.02	285.2	1.81
10/3-10/12		8	Unstratified	total	157.92	ND	ND	196.9	1.24	ND	ND
10/24-11/1		9	Unstratified	total	158.05	ND	ND	245.6	1.55	580.8	3.67
11/10-11/19		10	Unstratified	total	157.58	603.4	3.81	242.1	1.54	592.8	3.75
5/29-6/2	1978 (CCIW)	103	Stratified	epi	15.6	234.4	15.1				
				meso	92.6	1578.2	17.0				
				hypo	52.8	840.5	15.9				
				total	161.0	2653.1	16.5				
6/19-6/24		104	Stratified	epi	67.6	998.4	14.7				
				meso	42.0	571.6	13.6				
				hypo	50.7	726.3	14.3				
				total	160.3	2296.3	14.3				
7/13-7/18		106	Stratified	epi	68.7	863.5	12.5				
				meso	44.6	635.9	14.2				
				hypo	45.9	744.7	16.2				
				total	159.2	2244.1	14.1				
8/19-8/23		110	Stratified	epi	94.6	1177.5	12.4				
				meso	29.1	384.3	13.2				
				hypo	35.6	527.9	14.8				
				total	159.3	2089.7	13.1				
9/13-9/19		111	Stratified	epi	105.8	1110.0	10.5				
				meso	16.8	166.7	9.9				
				hypo	34.1	347.7	10.2				
				total	156.7	1624.4	10.4				
9/30-10/4		114	Stratified	epi	109.4	1103.7	10.1				
				meso	17.6	159.6	9.0				
				hypo	31.2	302.1	9.7				
				total	158.2	1565.4	9.9				
	1979 (USEPA)	2	Unstratified	total	ND	ND	ND	ND	ND	ND	ND
5/15-5/26		3	Stratified	epi	126.61	2340.2	18.47	323.2	2.55	408.0	3.22
				meso	8.91	147.2	16.47	19.7	2.21	34.8	3.89
				hypo	24.68	490.6	19.80	35.6	1.44	64.5	2.60
				total	160.20	2978.0	18.59	378.5	2.36	507.3	3.17
6/12-6/21		4	Stratified	epi							
				meso							
				hypo							
				total	160.4						
7/11-7/19		5	Stratified	epi	87.94	799.7	9.09	205.4	2.33	167.0	1.92
				meso	23.61	193.7	8.21	60.5	2.56	20.2	0.86
				hypo	48.62	457.9	9.42	162.8	3.35	38.2	0.79
				total	160.17	1451.3	9.06	428.7	2.68	225.4	1.41
7/31-8/4		6	Stratified	epi	ND	ND	ND	ND	ND	ND	ND
				meso							
				hypo							
				total							
8/23-9/4		7	Stratified	epi	ND	ND	ND	ND	ND	ND	ND
				meso							
				hypo							
				total							

APPENDIX E (continued)

DATE	YEAR	CRUISE NO.	STRATIFICATION	LIMNION	VOLUME (km^3)	TOTAL PHOSPHORUS		SOLUBLE REACTIVE PHOSPHORUS		CORRECTED CHLOROPHYLL a	
						METRIC TONS	CONC. (µg/l)	METRIC TONS	CONC. (µg/l)	METRIC TONS	CONC. (µg/l)
9/11-9/21	1979	8	Stratified	epi	109.09	610.6	5.61	108.3	1.00	312.0	2.86
				meso	18.38	77.1	4.16	29.2	1.59	46.5	2.53
				hypo	32.19	142.7	4.52	83.3	2.61	43.1	1.34
				total	159.66	830.4	5.20	220.8	1.38	401.6	2.52
10/2-10/14		9	Stratified	epi	129.03	957.4	7.42	226.5	1.75	333.6	2.59
				meso	12.99	79.0	5.94	27.3	2.10	26.1	2.01
				hypo	17.15	117.9	7.19	34.1	1.99	22.0	1.28
				total	159.17	1154.3	7.25	287.9	1.81	381.7	2.40
11/7-11/16		10	Stratified	total	158.64	2203.4	13.89	524.0	3.30	621.4	3.92

APPENDIX F

LAKE ERIE STRATIFICATION CHARACTERISTICS--WESTERN BASIN 1970-1980

DATE	YEAR	CRUISE	STRATIF.	LIMNION	VOL. km^3	AREA km^2	THICKNESS m
4/7-4/11	1970	1	unstratified	total	28.2	2840	9.93
5/6-5/11	(CCIW)	2	unstratified	total	28.2	2840	9.93
6/2-6/6		3	unstratified	total	28.2	2840	9.93
7/3-7/7		4	unstratified	total	28.2	2840	9.93
7/28-8/2		5	unstratified	total	25.9	2840	9.12
8/25-8/30		6	unstratified	total	28.2	2840	9.93
9/23-9/27		7	unstratified	total	28.2	2840	9.93
10/21-10/26		8	unstratified	total	28.2	2840	9.93
11/25-11/30		9	unstratified	total	28.2	2840	9.93
12/14-12/18		10	unstratified	total	28.2	2840	9.93
7/17-7/23	1973	2	unstratified	total	23.90	2840	8.42
8/29-9/4	(CLEAR)	5	unstratified	total	23.65	2840	8.33
10/14-10/24		7	unstratified	total	22.54	2840	7.94
4/25-5/4	1974	2	unstratified	total	24.00	2840	8.45
6/1-6/10	(CLEAR)	4	unstratified	total	24.11	2840	8.49
6/28-7/7		5	unstratified	total	23.95	2840	8.43
8/12-8/19		7	unstratified	total	23.53	2840	8.29
8/26-9/7		8	unstratified	total	23.45	2840	8.26
10/21-11/1		10	unstratified	total	22.62	2840	7.96
3/19-3/31							
4-21-4/25	1975	1	unstratified	total	23.64	2840	8.32
6/9-6/19	(CLEAR)	2	unstratified	total	23.50	2840	8.27
7/13-7/21		3	unstratified	total	23.35	2840	8.22
8/30-9/7		4	unstratified	total	23.35	2840	8.22
9/27-10/6		5	unstratified	total	23.07	2840	8.12
12/2-12/10		6	unstratified	total	22.54	2840	7.94
3/22-3/30	1976	1	unstratified	total	23.62	2840	8.32
6/2-6/10	(CLEAR)	2	unstratified	total	23.62	2840	8.32
8/21-8/29		3	unstratified	total	23.30	2840	8.20
9/8-9/17		4	unstratified	total	23.01	2840	8.10
10/18-10/30		5	unstratified	total	22.43	2840	7.90
3/21-4/3	1977	1	unstratified	total	22.16	2840	7.80
4/28-5/8	(CLEAR)	2	unstratified	total	ND	2840	ND
6/20-6/30		3	unstratified	total	ND	2840	ND
7/12-7/31		4	unstratified	total	ND	2840	ND
8/11-8/21		5	unstratified	total	ND	2840	ND
9/10-10/9		6	unstratified	total	22.57	2840	7.95
11/7-11/20		7	unstratified	total	22.48	2840	7.92

APPENDIX F (continued)

DATE	YEAR	CRUISE	STRATIF.	LIMNION	VOL. km^3	AREA km^2	THICKNESS m
5/18-5/27	1978	2	unstratified	total	25.09	2840	8.83
6/5-6/15	(USEPA)	3	unstratified	total	25.07	2840	8.83
6/23-7/1		4	unstratified	total	25.10	2840	8.84
7/19-7/29		5	unstratified	total	24.40	2840	8.59
8/8-8/16		6	unstratified	total	24.33	2840	8.57
8/29-9/6		7	unstratified	total	24.14	2840	8.50
10/3-10/12		8	unstratified	total	23.85	2840	8.40
10/24-11/1		9	unstratified	total	23.80	2840	8.38
11/10-11/19		10	unstratified	total	23.89	2840	8.41
4/17-4/20	1979	2	unstratified	total	24.80	2840	8.73
5/15-5/26	(USEPA)	3	unstratified	total	24.99	2840	8.80
6/12-6/21		4	unstratified	total	24.76	2840	8.72
7/11-7/19		5	unstratified	total	25.02	2840	8.81
7/31-8/4		6	unstratified	total	25.07	2840	8.83
8/23-9/4		7	unstratified	total	25.11	2840	8.84
9/11-9/21		8	unstratified	total	24.75	2840	8.71
10/2-10/14		9	unstratified	total	24.42	2840	8.60
11/7-11/16		10	unstratified	total	24.19	2840	8.52
4/1-4/2	1980	1	unstratified	total	25.4	2840	8.94
4/28-4/30	(CLEAR)	2	unstratified	total	25.4	2840	8.94
5/27-5/29		3	unstratified	total	25.4	2840	8.94
6/29-6/30		4	unstratified	total	25.4	2840	8.94
7/28		5	unstratified	total	25.4	2840	8.94
ND		6	ND	ND	ND	2840	ND
8/28-8/29		7	unstratified	total	24.9	2840	8.77
9/27-9/28		8	unstratified	total	25.1	2840	8.84
11/5		9	unstratified	total	24.2	2840	8.52
11/23		10	unstratified	total	24.2	2840	8.52

APPENDIX G

LAKE ERIE STRATIFICATION CHARACTERISTICS--CENTRAL BASIN 1973-1980

DATE	YEAR	CRUISE	STRATIF.	LIMNION	VOL. km^3	AREA km^2	THICKNESS m
7/17-7/23	1973 (CLEAR)	2	stratified	epi	228.6		12.5
				meso	22.2		1.7
				hypo	61.3	12,883	4.8
				total	312.1	16,426	19.0
8/7-8/11		4	stratified	epi	224.5		12.3
				meso	25.8		2.0
				hypo	60.8	12,962	4.7
				total	311.1	16,374	19.0
8/29-9/14		5	stratified	epi	238.2		13.0
				meso	24.9		2.0
				hypo	47.1	11,829	4.0
				total	310.2	16,326	19.0
9/19-9/29		6	stratified	epi	NA		14.4
				meso	NA		1.5
				hypo	11.3	3,660	3.1
				total	307.4	16,179	19.0
10/14-10/24		7	unstratified	total	306.1	16,111	19.0
6/1-6/10	1974 (CLEAR)	4	stratified	epi	195.8		11.2
				meso	22.7		1.6
				hypo	93.7	14,819	6.2
				total	312.2	16,432	19.0
6/28-7/7		5	stratified	epi	249.1		13.8
				meso	12.5		1.1
				hypo	50.1	11,860	4.1
				total	311.7	16,405	19.0
8/12-8/19		7	stratified	epi	235.4		12.6
				meso	23.8		1.4
				hypo	50.6	11,698	5.0
				total	309.8	16,305	19.0
8/26-9/7		8	stratified	epi	243.0		12.6
				meso	17.5		1.8
				hypo	48.4	10,556	4.6
				total	308.9	16,258	19.0
10/21-11/1		10	unstratified	total	304.0	16,000	19.0
3/19-3/31							
4/21-4/25	1975	1	unstratified	total	308.7	16,247	19.0
6/9-6/19	(CLEAR)	2	stratified	epi	174.0		9.2
				meso	30.8		2.1
				hypo	104.7	13,678	7.7
				total	309.5	16,290	19.0

APPENDIX G (continued)

DATE	YEAR	CRUISE	STRATIF.	LIMNION	VOL. km^3	AREA km^2	THICKNESS m
7/13-7/21	1975	3	stratified	epi	182.6		9.8
				meso	35.6		2.4
				hypo	90.5	13,385	6.8
				total	308.7	16,250	19.0
8/30-9/7		4	stratified	epi	227.4		10.5
				meso	15.2		1.6
				hypo	66.1	9,599	6.9
				total	308.7	16,250	19.0
9/27-10/6		5	unstratified	total	307.1	16,160	19.0
12/2-12/10		6	unstratified	total	304.0	16,000	19.0
3/22-3/30	1976	1	unstratified	total	309.8	16,310	19.0
6/2-6/10	(CLEAR)	2	stratified	epi	216.9		11.2
				meso	13.2		1.2
				hypo	80.1	12,105	6.6
				total	310.2	16,330	19.0
8/21-8/29		3	stratified	epi	249.9		14.0
				meso	23.8		2.0
				hypo	34.6	11,550	3.0
				total	308.3	16,230	19.0
9/8-9/17		4	stratified	epi	291.2		14.4
				meso	8.7		2.6
				hypo	6.9	3,380	2.0
				total	306.8	16,150	19.0
10/18-10/30		5	unstratified	total	303.3	15,960	19.0
3/20-3/31	1977	1	unstratified	total	302.2	15,910	19.0
4/29-5/8	(CLEAR)	2	unstratified	total	306.1	16,110	19.0
6/20-6/30		3	stratified	epi	178.8		9.5
				meso	35.2		2.7
				hypo	89.9	13,245	6.8
				total	303.9	15,999	19.0
7/12-7/22		4	stratified	epi	219.2		12.4
				meso	25.5		2.0
				hypo	59.8	12,876	4.6
				total	304.5	16,030	19.0
8/11-8/21		5	stratified	epi	256.9		15.0
				meso	11.6		1.0
				hypo	35.4	11,705	3.0
				total	303.9	15,990	19.0

APPENDIX G (continued)

DATE	YEAR	CRUISE	STRATIF.	LIMNION	VOL. km^3	AREA km^2	THICKNESS m
9/11-10/8	1977	6	stratified	epi	298.3		15.7
				meso	2.2		1.2
				hypo	3.9	1,891	2.1
				total	304.4	16,030	19.0
11/7-11/20		7	unstratified	total	300.5	15,820	19.0
5/18-5/27	1978	2	unstratified	total	315.9	16,280	19.4
6/5-6/15	(USEPA)	3	stratified	total	305.5	15,910	19.2
6/23-7/1		4	stratified	epi	130.0		7.9
				meso	105.3		6.8
				hypo	79.8	14,250	5.6
				total	315.1	15,520	20.3
7/19-7/29		5	stratified	epi	118.5		7.2
				meso	93.1		6.0
				hypo	100.3	14,130	7.1
				total	311.9	15,360	20.3
8/8-8/16		6	stratified	epi	172.1		10.5
				meso	69.7		4.7
				hypo	69.7	12,670	5.5
				total	311.5	15,050	20.7
8/29-9/6		7	stratified	epi	202.0		12.4
				meso	56.7		3.8
				hypo	51.6	12,000	4.3
				total	310.3	15,140	20.5
10/3-10/12		8	unstratified	total	308.8	16,340	18.9
10/24-11/1		9	unstratified	total	308.8	16,340	18.9
11/10-11/19		10	unstratified	total	299.5	15,850	18.9
5/29-6/2	1978 (CCIW)	103	stratified	epi	93.8	-	5.7
				meso	101.2		6.5
				hypo	121.9		8.6
				total	316.9		22.4
6/19-6/24		104	stratified	epi	179.5		10.9
				meso	69.9		4.5
				hypo	65.9		4.7
				total	315.3		19.3
7/13-7/18		106	stratified	epi	191.6		11.7
				meso	59.4		4.0
				hypo	61.0		4.8
				total	312.0		19.1

APPENDIX G (continued)

DATE	YEAR	CRUISE	STRATIF.	LIMNION	VOL. km^3	AREA km^2	THICKNESS m
8/19-8/23	1978	110	stratified	epi	220.7		13.5
				meso	37.5		2.6
				hypo	53.8		4.1
				total	312.0		19.1
9/13-9/19		111	stratified	epi	266.9		16.3
				meso	18.2		1.8
				hypo	24.7		3.4
				total	309.8		18.9
9/30-10/4		114	stratified	epi	280.3		17.1
				meso	16.4		1.8
				hypo	12.1		2.7
				total	308.8		18.9
4/17-4/20	1979	2	unstratified	total	313.3		
5/15-5/26	(USEPA)	3	stratified	epi	193.7		
				meso	43.3		
				hypo	78.2		
				total	315.2		
6/12-6/21		4	stratified	epi	253.2		
				meso	24.1		
				hypo	37.9		
				total	315.2		
7/11-7/19		5	stratified	epi	232.9		
				meso	32.0		
				hypo	49.2		
				total	314.1		
7/31-8/4		6	stratified	epi	219.2		
				meso	30.3		
				hypo	65.6		
				total	315.1		
8/23-9/4		7	stratified	epi			
				meso			
				hypo			
				total			
9/11-9/21		8	stratified	epi	272.9		16.7
				meso	16.9		1.5
				hypo	23.5	8,700	2.7
				total	313.3	14,990	20.9
10/2-10/14		9	unstratified	total	303.3	15,960	19.0
11/7-11/16		10	unstratified	total	301.6	15,960	18.9

APPENDIX G (continued)

DATE	YEAR	CRUISE	STRATIF.	LIMNION	VOL. km^3	AREA km^2	THICKNESS m
4/3-4/4	1980	1	unstratified	total	308.3	15,970	19.3
5/1-5/13	(CLEAR)	2	unstratified	total	308.3	15,970	19.3
5/31-6/2		3	stratified	epi	233.9		14.7
				meso	18.8		1.6
				hypo	55.5	11,330	4.9
				total	308.2	14,540	21.2
7/2-7/6		4	stratified	epi	203.4		12.7
				meso	23.5		1.7
				hypo	81.4	13,130	6.2
				total	308.3	14,970	20.6
8/4-8/8		5	stratified	epi	201.4		12.6
				meso	34.0		2.6
				hypo	72.9	12,570	5.8
				total	308.3	14,680	21.0
8/18-8/23		6	stratified	epi	229.7		14.0
				meso	22.1		1.5
				hypo	65.1	12,520	5.2
				total	316.9	15,310	20.7
9/3-9/6		7	stratified	epi	215.9		13.5
				meso	22.5		1.6
				hypo	68.3	12,890	5.3
				total	306.7	15,030	20.4
9/29-10/1		8	unstratified	total	306.7	15,970	19.2
10/27-10/29		9	unstratified	total	301.9	15,970	18.9
12/1-12/4		10	unstratified	total	301.9	15,970	18.9

APPENDIX H

LAKE ERIE STRATIFICATION CHARACTERISTICS--EASTERN BASIN 1970-1980

DATE	YEAR	CRUISE	STRATIF.	LIMNION	VOL. km^3	AREA km^2	THICKNESS m
4/7-4/11	1970	1	unstratified	total	166.4	6423	25.9
5/6-5/11	(CCIW)	2	unstratified	total	166.4	6423	25.9
6/2-6/6		3	stratified	epi	50.8		
				meso	32.0		
				hypo	83.5		
				total	166.3	6423	25.9
7/3-7/7		4	stratified	epi	90.9		
				meso	21.2		
				hypo	54.2		
				total	166.3	6423	25.9
7/28-8/2		5	stratified	epi	89.5		
				meso	42.2		
				hypo	34.6		
				total	166.3	6423	25.9
8/25-8/30		6	stratified	epi	98.9		
				meso	30.7		
				hypo	36.8		
				total	166.4	6423	25.9
9/23-9/27		7	stratified	epi	131.6		
				meso	6.2		
				hypo	28.5		
				total	166.3	6423	25.9
10/21-10/26		8	stratified	epi	149.6		
				meso	6.1		
				hypo	10.6		
				total	166.3	6423	25.9
11/25-11/30		9	unstratified	total	166.3	6423	25.9
12/14-12/18		10	unstratified	total	166.3	6423	25.9
3/21-4/3	1977	1	unstratified	total	ND	ND	ND
4/28-5/8	(CLEAR)	2	unstratified	total	169.1	6423	26.3
6/20-6/30		3	stratified	epi	99.5		
				meso	14.3		
				hypo	54.7		
				total	168.6	6423	26.3
7/12-7/31		4	stratified	epi	84.5		
				meso	35.6		
				hypo	48.0		
				total	168.1	6423	26.2

APPENDIX H (continued)

DATE	YEAR	CRUISE	STRATIF.	LIMNION	VOL. km^3	AREA km^2	THICKNESS m
8/11-8/21	1977	5	stratified	epi	114.2		
				meso	18.2		
				hypo	36.4		
				total	168.8	6423	26.3
9/10-10/9		6	stratified	epi	142.9		
				meso	2.4		
				hypo	23.2		
				total	168.6	6423	26.3
11/7-11/20		7	unstratified	total	167.6	6423	26.1
5/18-5/27	1978	2	unstratified	total	160.2	6423	25.0
6/5-6/15	(USEPA)	3	stratified	total	159.0	6423	24.8
6/23-7/1		4	stratified	epi	48.5		
				meso	43.1		
				hypo	68.5		
				total	160.1	6423	24.9
7/19-7/29		5	stratified	epi	63.6		
				meso	41.6		
				hypo	53.8		
				total	159.0	6423	24.8
8/8-8/16		6	stratified	epi	85.3		
				meso	28.6		
				hypo	44.1		
				total	158.1	6423	24.6
8/29-9/6		7	stratified	epi	84.5		
				meso	25.9		
				hypo	47.4		
				total	157.9	6423	24.6
10/3-10/12		8	unstratified	total	157.9	6423	24.6
10/24-11/1		9	unstratified	total	158.0	6423	24.6
11/10-11/19		10	unstratified	total	157.5	6423	24.5
5/29-6/2	1978 (CCIW)	103	stratified	epi	15.6		2.6
				meso	92.6		15.8
				hypo	52.8		13.3
				total	161.0	6423	25.0
6/19-6/24		104	stratified	epi	67.6		11.5
				meso	42.0		8.7
				hypo	50.7		14.0
				total	160.3	6423	25.0

APPENDIX H (continued)

DATE	YEAR	CRUISE	STRATIF.	LIMNION	VOL. km^3	AREA km^2	THICKNESS m
7/13-7/18	1978	106	stratified	epi	68.7		11.6
				meso	44.6		9.1
				hypo	45.9		12.1
				total	159.2	6423	24.8
8/19-8/23		110	stratified	epi	94.6		16.0
				meso	29.1		7.2
				hypo	35.6		11.3
				total	159.3	6423	24.8
9/13-9/19		111	stratified	epi	105.8		18.1
				meso	16.8		4.8
				hypo	34.1		12.1
				total	156.7	6423	24.4
9/30-10/4		114	stratified	epi	109.4		18.5
				meso	17.6		5.4
				hypo	31.2		12.4
				total	158.2	6423	24.6
	1979	2	unstratified	total	ND	6423	ND
5/15-5/26	(USEPA)	3	stratified	epi	126.6		
				meso	8.9		
				hypo	24.6		
				total	160.2	6423	24.9
6/12-6/21		4	stratified	epi			
				meso			
				hypo			
				total	160.4	6423	25.0
7/11-7/19		5	stratified	epi	87.9		
				meso	23.6		
				hypo	48.6		
				total	160.1	6423	24.9
7/31-8/4		6	stratified	epi	ND		
				meso			
				hypo			
				total	ND	6423	ND
8/23-9/4		7	stratified	epi	ND		
				meso			
				hypo			
				total	ND	6423	ND
9/11-9/21		8	stratified	epi	109.0		
				meso	18.3		
				hypo	32.1		
				total	159.6	6423	24.9

APPENDIX H (continued)

DATE	YEAR	CRUISE	STRATIF.	LIMNION	VOL. km^3	AREA km^2	THICKNESS m
10/2-10/14	1979	9	stratified	epi	129.0		
				meso	12.9		
				hypo	17.1		
				total	159.1	6423	24.8
11/7-11/16		10	stratified	total	158.6	6423	24.7

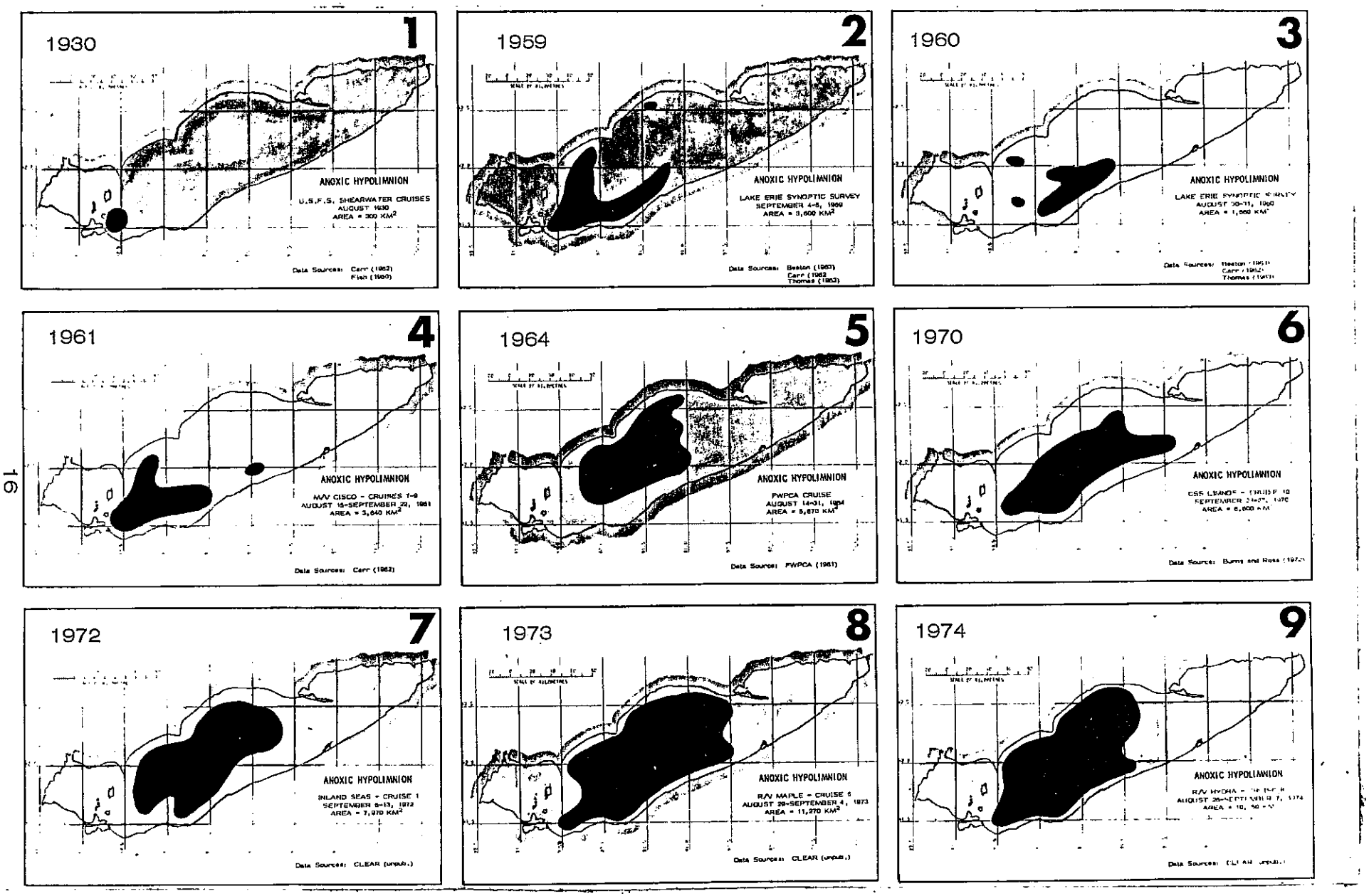


Figure 4. Trends in anoxic hypolimnion of Lake Erie 1930-1974.

ERRATA
TECHNICAL REPORT #219

Text Corrections

1. The word "prepared" in the 1st line of the Trophic Status section (page 11) was deleted.

2. Figure 13 was mistakenly referred to in the 3rd line of water level section (page 12) as Figure 12.

3. Figure 16 was mistakenly referred to in the 3rd line from the top of page 13 as Figure 15.

4. Typographical error page 19, line 1, should say "offshore."

Figure Corrections

1. In Figures 23 and 24 there was some confusion in regards to the symbols used. CCIW data was actually represented by squares and MOE data by circles. To make these two figures uniform with Figure 21, they will be redrawn.

2. On Map 50, the most extreme western basin contour mistakenly read 1 when it should have been 10 ntu's.

78-80 Hydrolo. nalic survey SLE

CRUISE BASIN	DATE	AREA (km^2)	VOLUME (km^3)	AVG. THICKNESS (m)	TOTAL HEAT ($kcal \times 10^{12}$)	AVG. TEMP. (°C)	TOTAL O_2 ($kg\ O_2 \times 10^6$)	MEAN O_2 (mg/l)	AVG. T-GRAD$_1$ ($°C\ m^{-1}$)	AVG. O_2 GRAD ($g\ O_2\ m^{-4}$)
Central	1978									
4	6/22-7/2	14,164	79.8	5.6	739.75	9.27	879.40	11.02	1.26	0.053
5	7/19-7/29	14,188	100.3	7.0	1,252.75	12.49	754.26	7.52	1.66	0.22
6	8/8-8/20	12,752	69.8	5.5	804.79	11.53	379.01	5.43	2.27	0.70
7	8/29-9/6	11,960	51.7	4.3	678.30	13.12	155.10	3.00	2.48	1.45
Central	1979									
3	5/15-5/26	13,976	78.2	5.6	765.58	9.79	943.09	12.06	0.60	0.23
5	7/10-7/19	11,320	49.4	4.4	693.23	14.09	354.73	7.21	2.44	1.00
8	9/11-9/21	8,704	23.5	2.7	434.05	18.47	147.58	6.28	1.06	1.29
Central	1980									
4	7/2-7/6	13,168	81.4	6.2	1,034.81	12.71	633.95	7.79	3.39	0.92
5	8/4-8/8	12,488	72.9	5.8	951.38	13.05	324.81	4.46	4.00	1.55
6	8/18-8/23	12,528	65.1	5.2	812.56	12.48	193.97	2.98	6.34	3.18

CRUISE BASIN	DATE	AREA (km^2)	VOLUME (km^3)	AVG. THICKNESS (m)	TOTAL HEAT ($kcal \times 10^{12}$)	AVG. TEMP. (°C)	TOTAL O_2 ($kg\ O_2 \times 10^6$)	MEAN O_2 (mg/l)	AVG. T-GRAD ($°C\ m^{-1}$)	AVG. O_2 GRAD ($g\ O_2\ m^{-4}$)
Central	1978									
4	6/22-7/2	14,164	79.8	5.6	739.75	9.27	879.40	11.02	1.26	0.053
5	7/19-7/29	14,188	100.3	7.0	1,252.75	12.49	754.26	7.52	1.66	0.22
6	8/8-8/20	12,752	69.8	5.5	804.79	11.53	379.01	5.43	2.27	0.70
7	8/29-9/6	11,960	51.7	4.3	678.30	13.12	155.10	3.00	2.48	1.45
Central	1979									
3	5/15-5/26	13,976	78.2	5.6	765.58	9.79	943.09	12.06	0.60	0.23
5	7/10-7/19	11,320	49.4	4.4	693.23	14.09	354.73	7.21	2.44	1.00
8	9/11-9/21	8,704	23.5	2.7	434.05	18.47	147.58	6.28	1.06	1.29
Central	1980									
4	7/2-7/6	13,168	81.4	6.2	1,034.81	12.71	633.95	7.79	3.39	0.92
5	8/4-8/8	12,488	72.9	5.8	951.38	13.05	324.81	4.46	4.00	1.55
6	8/18-8/23	12,528	65.1	5.2	812.56	12.48	193.97	2.98	6.34	3.18

Tab 2 cont

CRUISE BASIN	DATE	AREA (km^2)	VOLUME (km^3)	AVG. THICKNESS (m)	TOTAL HEAT ($kcal x 10^{12}$)	AVG. TEMP. (°C)	TOTAL O_2 ($kg\ O_2 x 10^6$)	MEAN O_2 (mg/l)	AVG. T-GRAD. ($°C\ m^{-1}$)	AVG. O_2 GRAD. ($g\ O_2\ m^{-4}$)
Eastern	1978									
4	6/22-7/2	3,944	68.5	17.4	505.53	7.38	790.49	11.54	1.20	0.12
5	7/19-7/29	3,984	53.8	13.5	395.43	7.35	519.71	9.66	1.68	0.09
6	8/8-8/20	3,176	44.2	13.9	380.12	8.60	398.24	9.01	1.96	0.06
7	8/29-9/6	3,280	47.6	14.5	409.36	8.60	407.93	8.57	2.20	0.03
Eastern	1979									
3	5/15-5/26	2,744	24.8	9.0	165.42	6.67	312.23	12.59	0.60	0.05
5	7/10-7/19	3,656	48.6	13.3	424.76	8.74	521.96	10.74	2.03	0.22
8	9/11-9/21	2,856	32.1	11.2	316.19	9.85	249.42	7.77	1.67	0.16
9	10/2-10/11	2,076	17.2	8.2	159.27	9.26	130.03	7.56	1.14	0.32
Eastern	1980									
4										
5										
6										

Tab. 2 cont

CRUISE BASIN	DATE	AREA (km^2)	VOLUME (km^3)	AVG. THICKNESS (m)	TOTAL HEAT ($kcal \times 10^{12}$)	AVG. TEMP. (°C)	TOTAL O_2 ($kg\ O_2 \times 10^6$)	MEAN O_2 ($mg\ l^{-1}$)	AVG. T-GRAD ($°C\ m^{-1}$)	AVG. O_2 GRAD ($g\ O_2\ m^{-4}$)
Eastern	1978									
4	6/22-7/2	3,944	68.5	17.4	505.53	7.38	790.49	11.54	1.20	0.12
5	7/19-7/29	3,984	53.8	13.5	395.43	7.35	519.71	9.66	1.68	0.09
6	8/8-8/20	3,176	44.2	13.9	380.12	8.60	398.24	9.01	1.96	0.06
7	8/29-9/6	3,280	47.6	14.5	409.36	8.60	407.93	8.57	2.20	0.03
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3	5/15-5/26	2,744	24.8	9.0	165.42	6.67	312.23	12.59	0.60	0.05
5	7/10-7/19	3,656	48.6	13.3	424.76	8.74	521.96	10.74	2.03	0.22
8	9/11-9/21	2,856	32.1	11.2	316.19	9.85	249.42	7.77	1.67	0.16
9	10/2-10/11	2,076	17.2	8.2	159.27	9.26	130.03	7.56	1.14	0.32
Eastern	1980									
4										
5										
6										