CLEAR TECHNICAL REPORT NO. 235

(LAKE ERIE TAT CONTRIBUTION NO. 10)

LAKE ERIE INTENSIVE STUDY: SYNOPTIC MAPPING OF WATER QUALITY--WESTERN BASIN

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Great Lakes Water Quality Board
International Joint Commission
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INTRODUCTION

Background

As part of the Lake Erie Intensive Study, water quality measurements were made in western Lake Erie by three organizations in 1978 and 1979.

1. U.S. Environmental Protection Agency, Great Lakes National Program Office - main lake portion of western Lake Erie.

2. Ontario Ministry of Environment, Water Resources Branch -Canadian nearshore from the Detroit River mouth to Wheatley, Ontario on the east side of Point Pelee.

3. Ohio State University, Center for Lake Erie Area Research -United States nearshore from the Detroit River mouth to Huron, Ohio on the east side of Cedar Point.

Each organization undertook a series of cruises each year (Figures 1a and 1b) in which a total of approximately 130 stations were visited each cruise (Figures 2-4). Water quality determinations, including typical physicochemical and nutrient measurements, were made at each and the date entered in STORET system.

Objective

The availability of a data set as complete as the one described above over a period of two years is rare. It presents in excellent opportunity to obtain a synoptic view of western lake Erie water quality conditions for spring, summer and fall seasons in 1978 and 1979. The objective of this investigation is to merge the data from the three organizations into a common file and to perform various mapping and statistical operations on the data to obtain a better understanding of the distribution and seasonal variability of nutrients and other water quality parameters in western Lake Erie.

METHODS

Data from the STORET system for 1978 and 1979 were merged into a single file and entered into the computing system at the Ontario Minstry of Environment, Water Resources Branch facilities in Toronto. Appropriate segments of the data were goruped into four sets or cruises for each year. Each set was processed with a SYNMAP program to produce synoptic maps of western lake Erie for each desired parameter. This program displays the map with up to 10 value bands or contours which can be selected by the operator to any desired interval with the range of values measured for each parameter. This method provided excellent distributional patterns.

In addition, STORET programs were operated to obtain monthly mean values for the United States data, Canadian data and merged data. This was done to obtain information on seasonal variability. Also, STORET programs were operated for several other nearshore reaches of Lake Erie (Figure 5) to obtain

some perspective as to the relationship of western Lake Erie to the central and eastern portions of the lake.

RESULTS AND DISCUSSION

Synoptic Maps

Synoptic maps for the following parameters have been produced for four cruises for each year:

1. Surface Temperature (^{o}C)
2. Surface Conductivity (μmhos/cm)
3. Surface Turbidity (FTU)
4. Transparency (Secchi Disk, m)
5. Surface Total Phosphorus (μg/l)
6. Surface Inorganic Nitrogen (mg/l)
7. Surface Dissolved Reactive Silicate (μg/l)
8. Surface Chlorophyll a (corr., μg/l)

An example of the contour pattern produced by this process is shown in Figure 6, total phosphorus (TP) concentrations for April 1978. The relative high concentrations of TP contributed by the Maumee and Sandusky rivers are evident. The Detroit River flow, with lower concentrations, appears to confine the higher TP water along the Michigan and Ohio shorelines. The Ontario nearshore water, by comparison, is low in TP concentration. Maumee Bay and Sandusky Bay contain the most concentrated levels of TP within the western part of Lake Erie, while the Detroit River mouth, the center of the basin and the area near Pele Passage contains the lowest concentration levels.

Seasonal Trends

Monthly mean concentration, range, standard deviation and number of samples (1978 and 1979) for several water quality parameters are shown graphically on Figures 7-19:

	Figure No.
1. Water Temperature	
United States Nearshore	7
Canadian Nearshore	8
U.S./Canada Nearshore (combined)	9
2. Total Chloride	
United States Nearshore	10
Canada Nearshore	11
U.S./Canada Nearshore (combined)	12
3. Transparency (Secchi Disk)	
United States Nearshore	13

	Figure No.
4. Total Phosphorus	
United States Nearshore	14
Canada Nearshore	15
U.S./Canada Nearshore (combined)	16
5. Nitrate + Nitrite	
United States Nearshore	17
6. Dissolved Reactive Silicate	
United States Nearshore	18
7. Corrected Chlorophyll a	
United States Nearshore	19

Water temperature shows typical seasonal fluctuations each year with the highest temperatures in July-August (24°C) and the most rapid warming between April and June. Both years, chloride indicated a small but noticeable decline between April and October. Water transparency improved through the spring, stabilized in the summer at about 0.7 m, and declined in the fall. Total phosphorus showed very little seasonal variability in 1978 and 1979. Nitrate + nitrite and soluble reactive silicate both indicated a marked decline from spring to summer and a less pronounced decline from summer to fall. Chlorophyll a followed a seasonal trend similar to that of water temperature, except the peak concentrations occurred about a month later than the highest temperatures.

Comparison of Nearshore Reaches

In order to better assess conditions in western Lake Erie, water quality parameters for this basin were compared with other nearshore reaches throughout the lake (Figure 5). Mean monthly means of several parameters were plotted for these reaches:

	Figure No.
1. Water Temperature	
1978	20
1979	21
2. Total Chloride	
1978	22
1979	23
3. Turbidity	
1978	24
1979	25

	Figure No.
4. Total Phosphorus	
1978	26
1979	27
5. Nitrate + Nitrite	
1978	28
1979	29

Mean water temperatures were relatively uniform throughout the lake with the Canadian nearshore being slightly cooler. Chloride showed a gradual increase from the western basin to the central basin, with the United States nearshore of the central basin having the highest concentrations. The high turbidity of the southern portion of the western basin declined toward the east, but the north shore remained low and relatively uniform in turbidity from west to east. Total phosphorus concentration showed a very similar pattern with an even more dramatic decline from west to east in the United States nearshore. Nitrate + nitrite did not show as consistent pattern but some decline in an easterly direction is indicated.

FIGURES

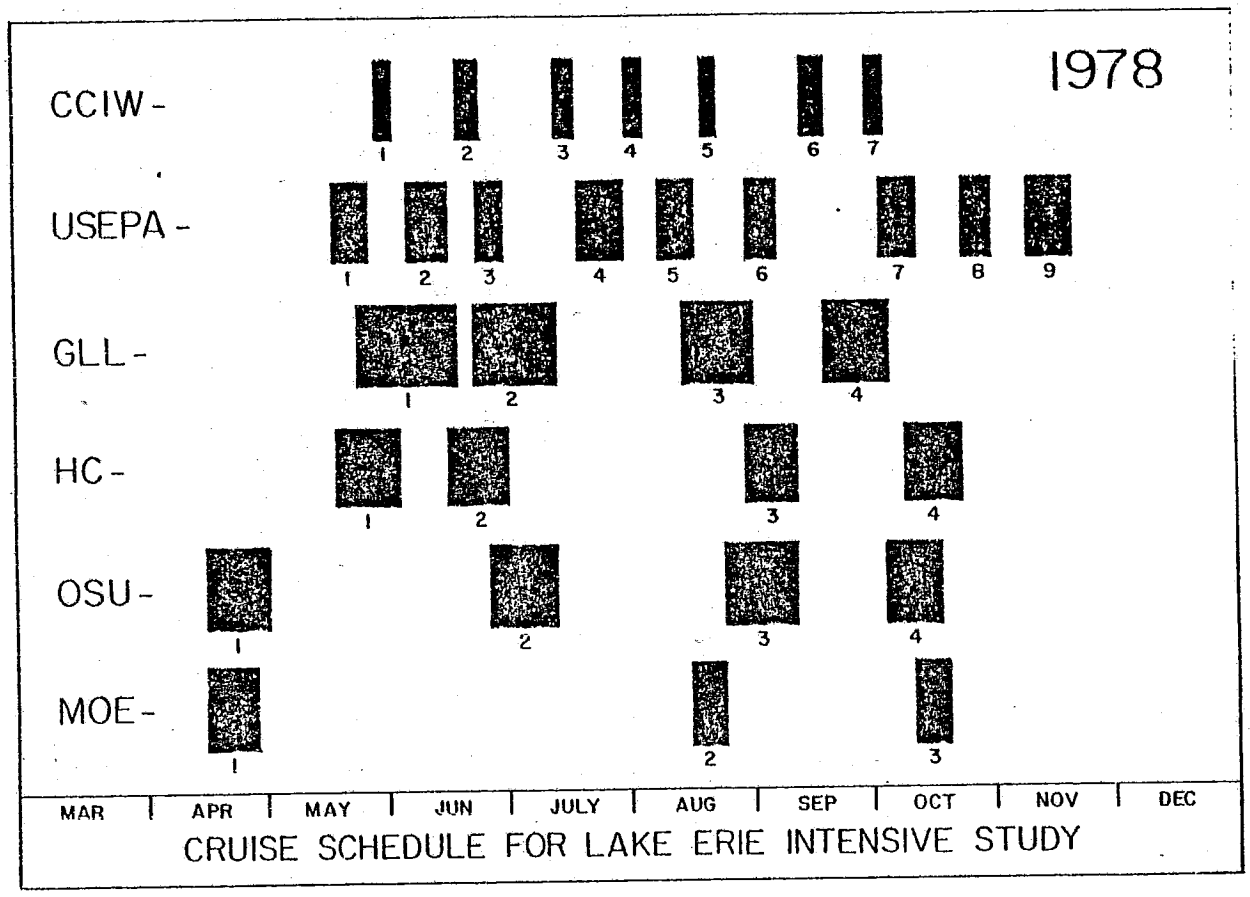

Figure 1A. Lake Erie Intensive Study Cruise Schedule for 1978.

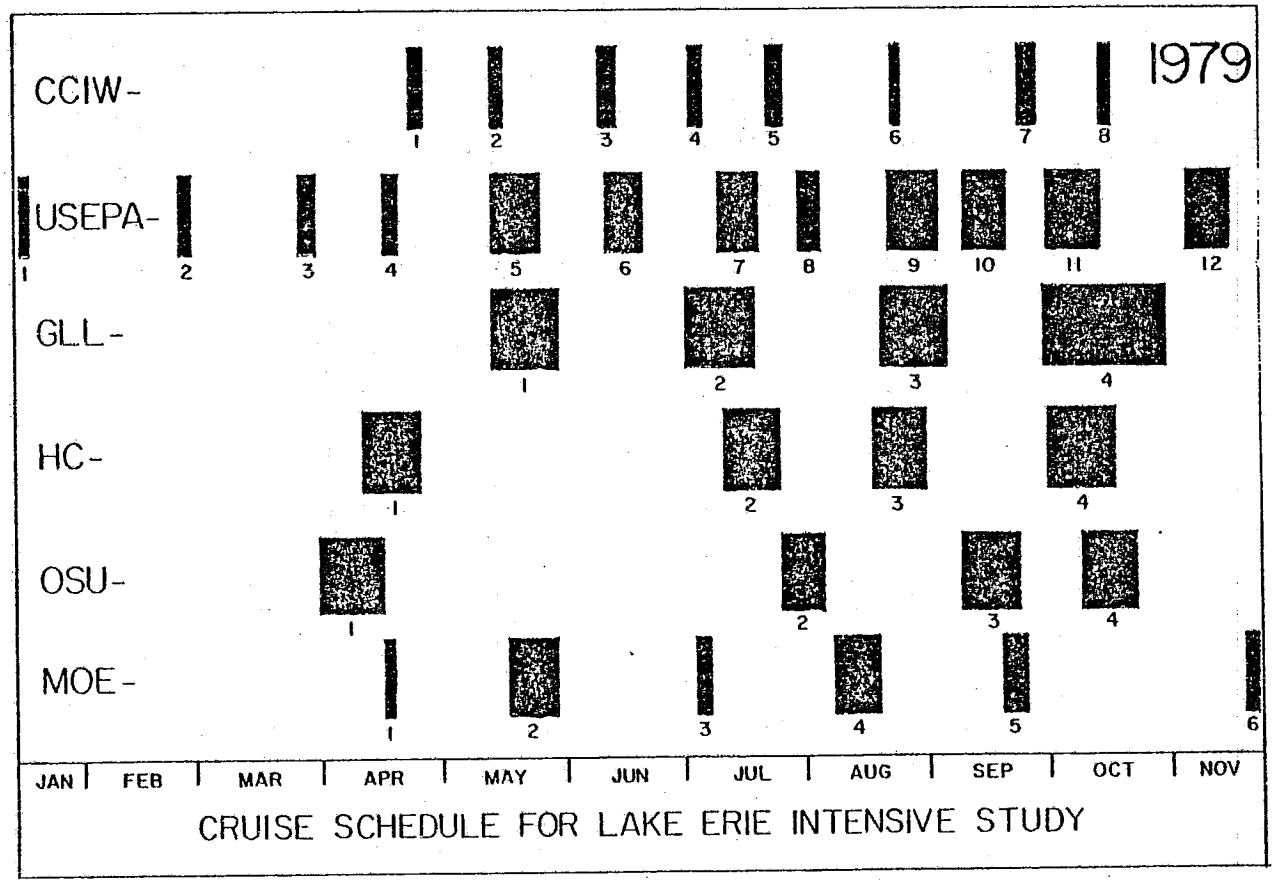

Figure 1B. Lake Erie Intensive Study Cruise Schedule for 1979.

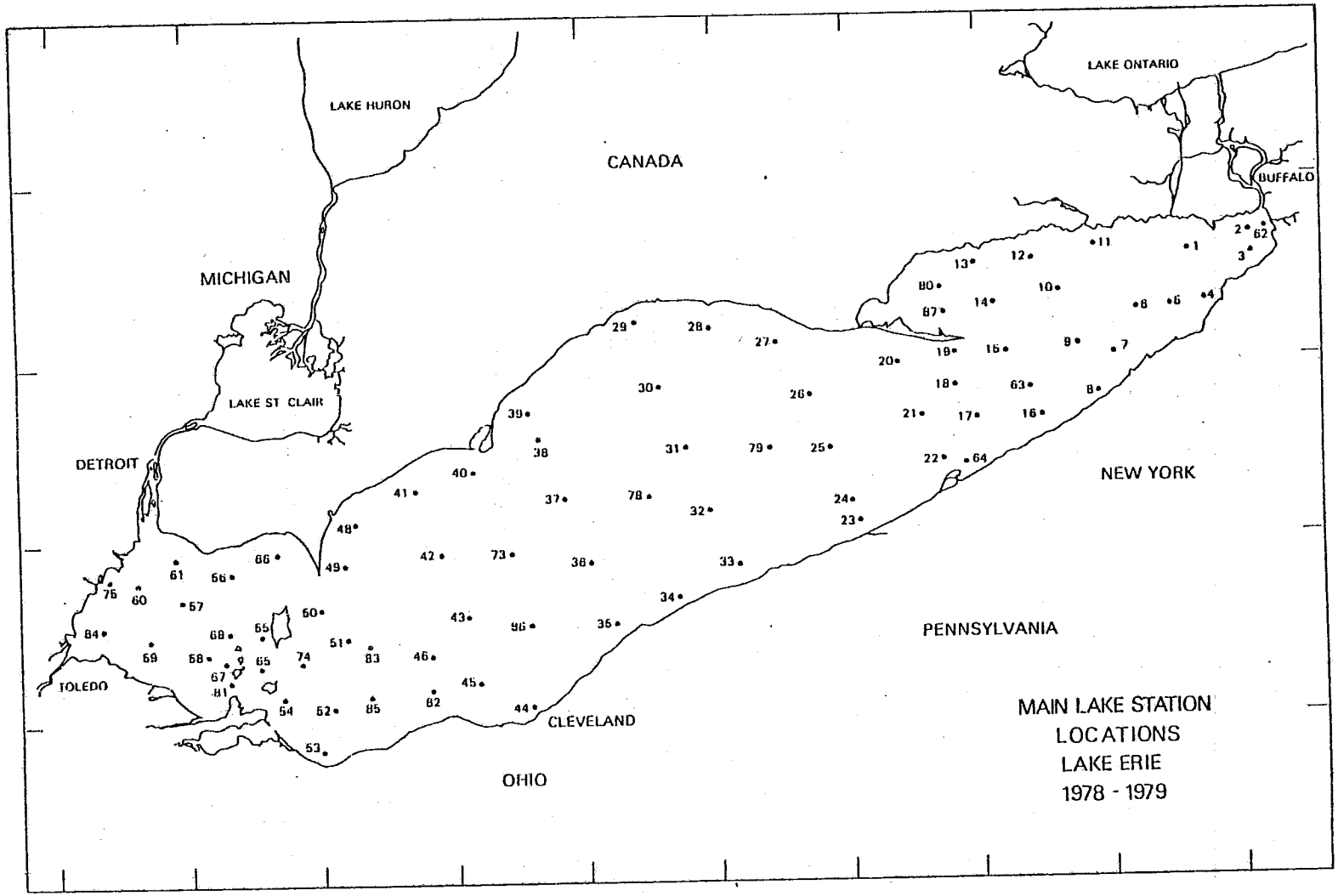

Figure 2. USEPA Surveillance Stations for 1978 and 1979.

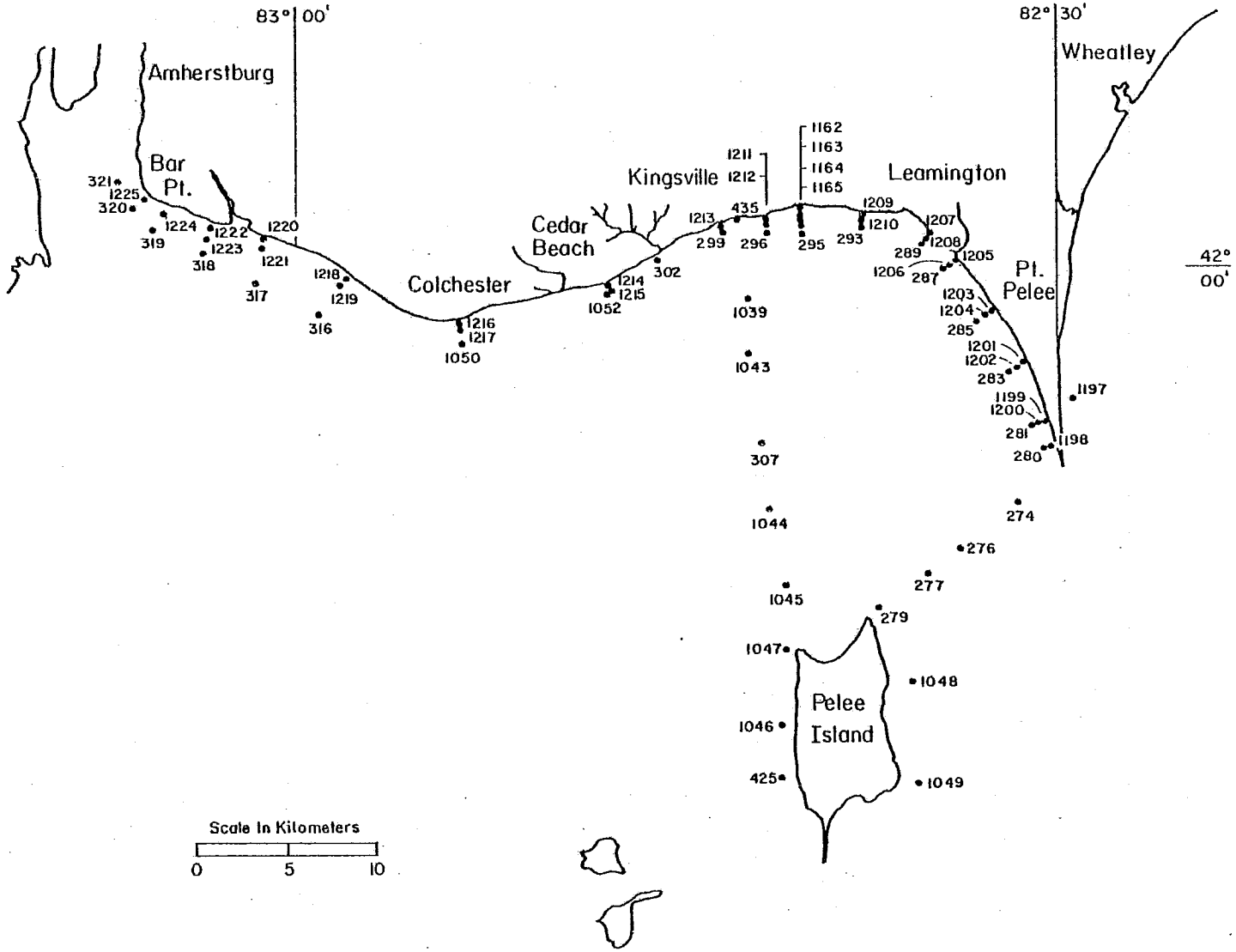

Figure 3. MOE Nearshore Surveillance Stations for 1978 and 1979.

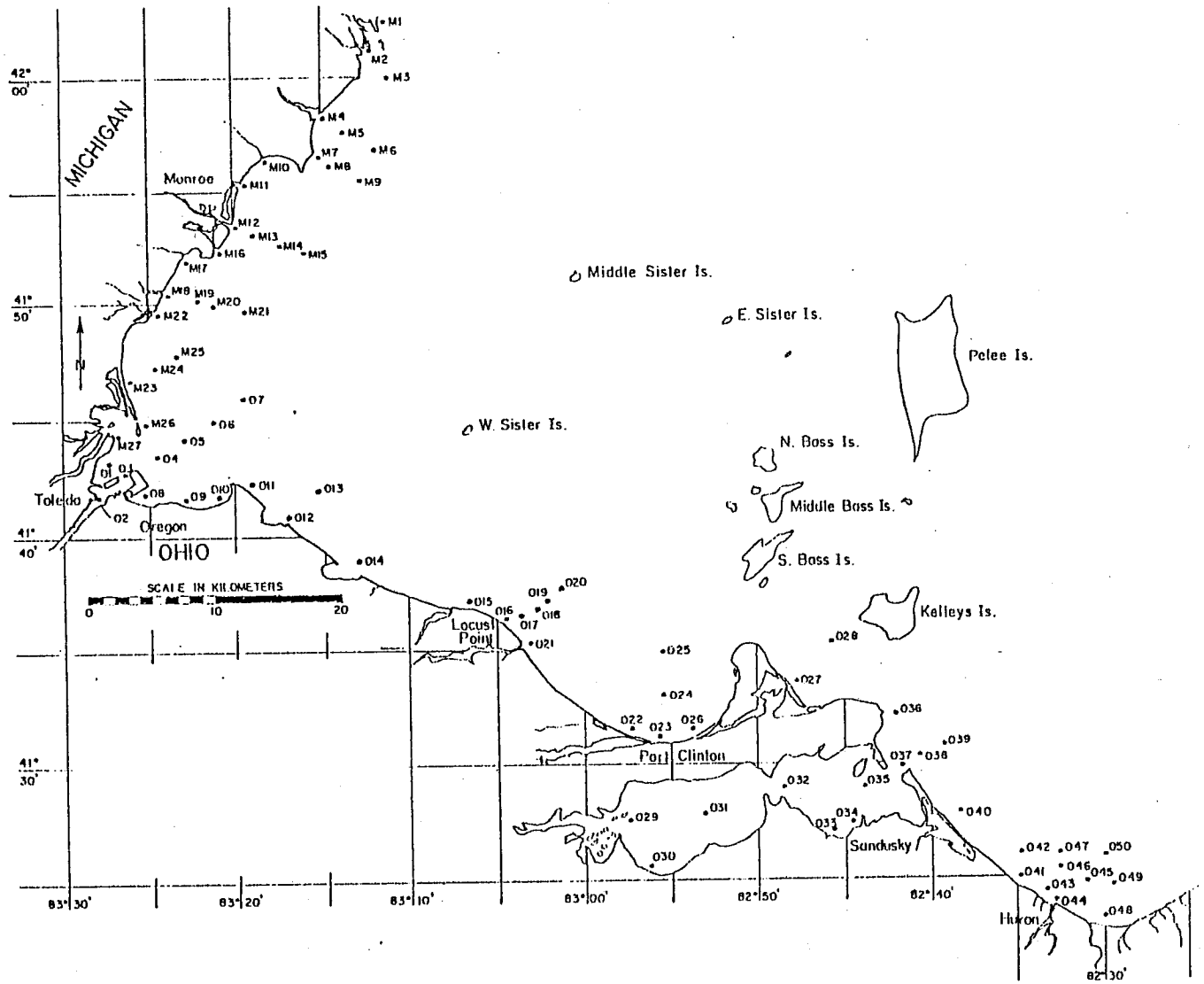

Figure 4. OSU/CLEAR Nearshore Surveillance Stations for 1978 and 1979.

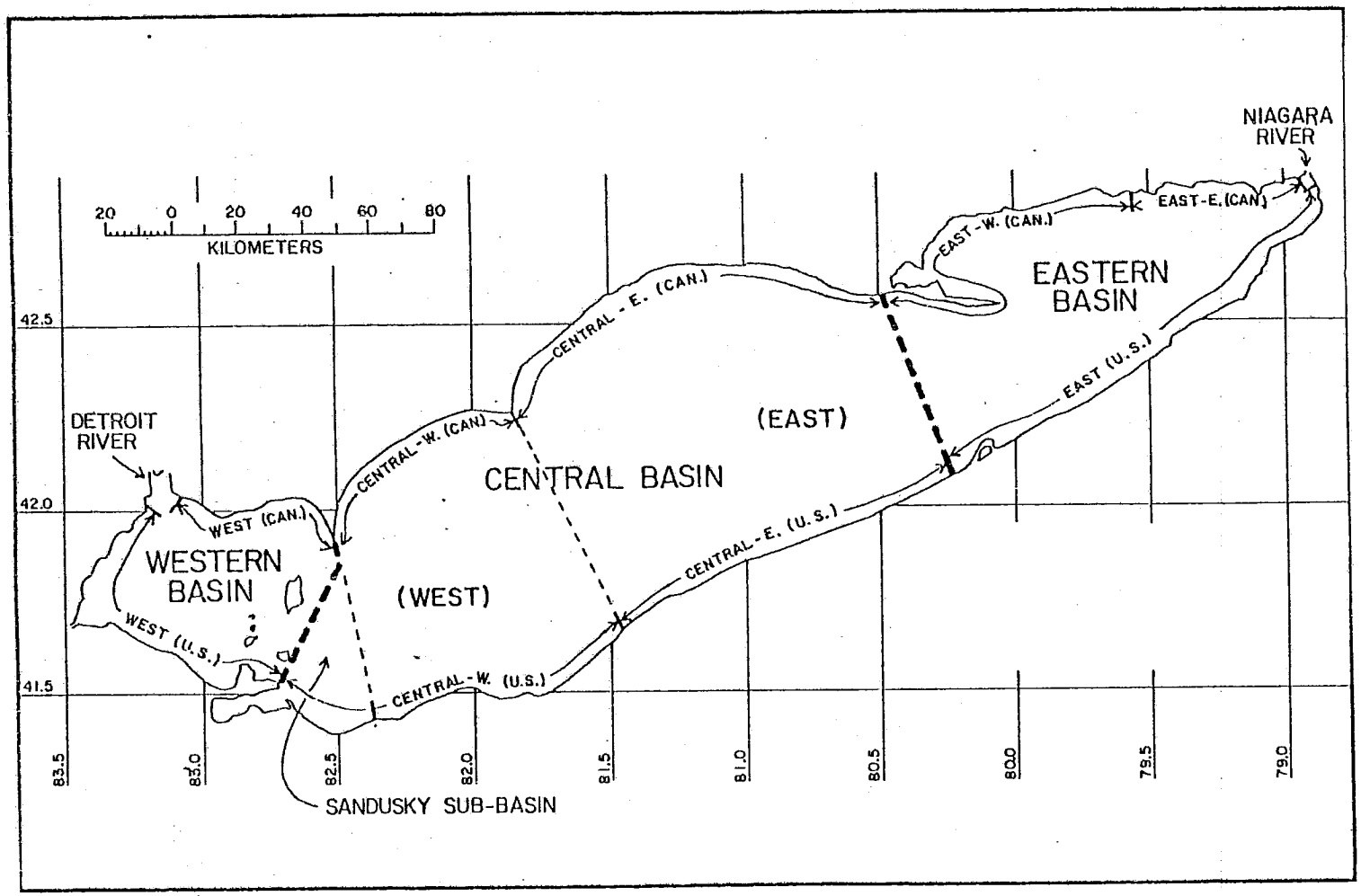

Figure 5. Major Nearshore Reaches of Lake Erie.

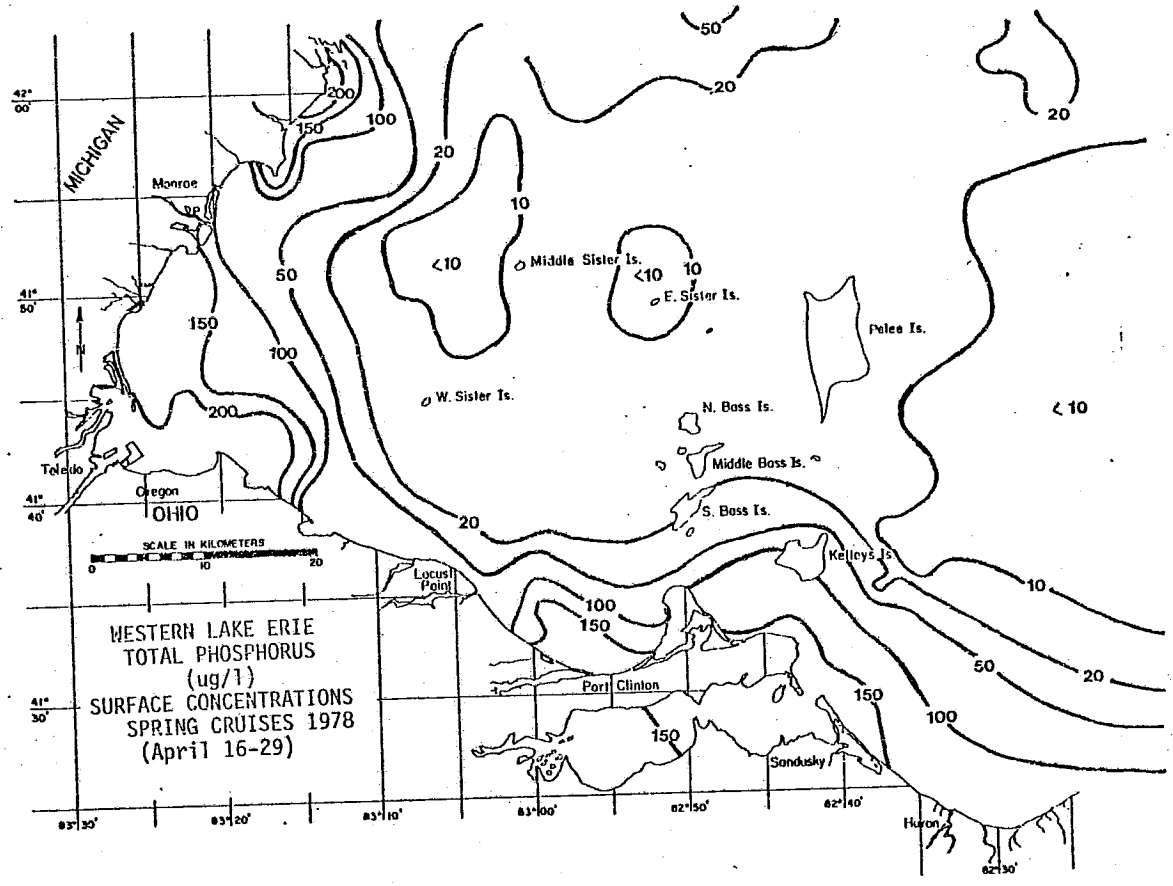

Figure 6. SYNMAP Representation of Total Phosphorous, Spring 1978.

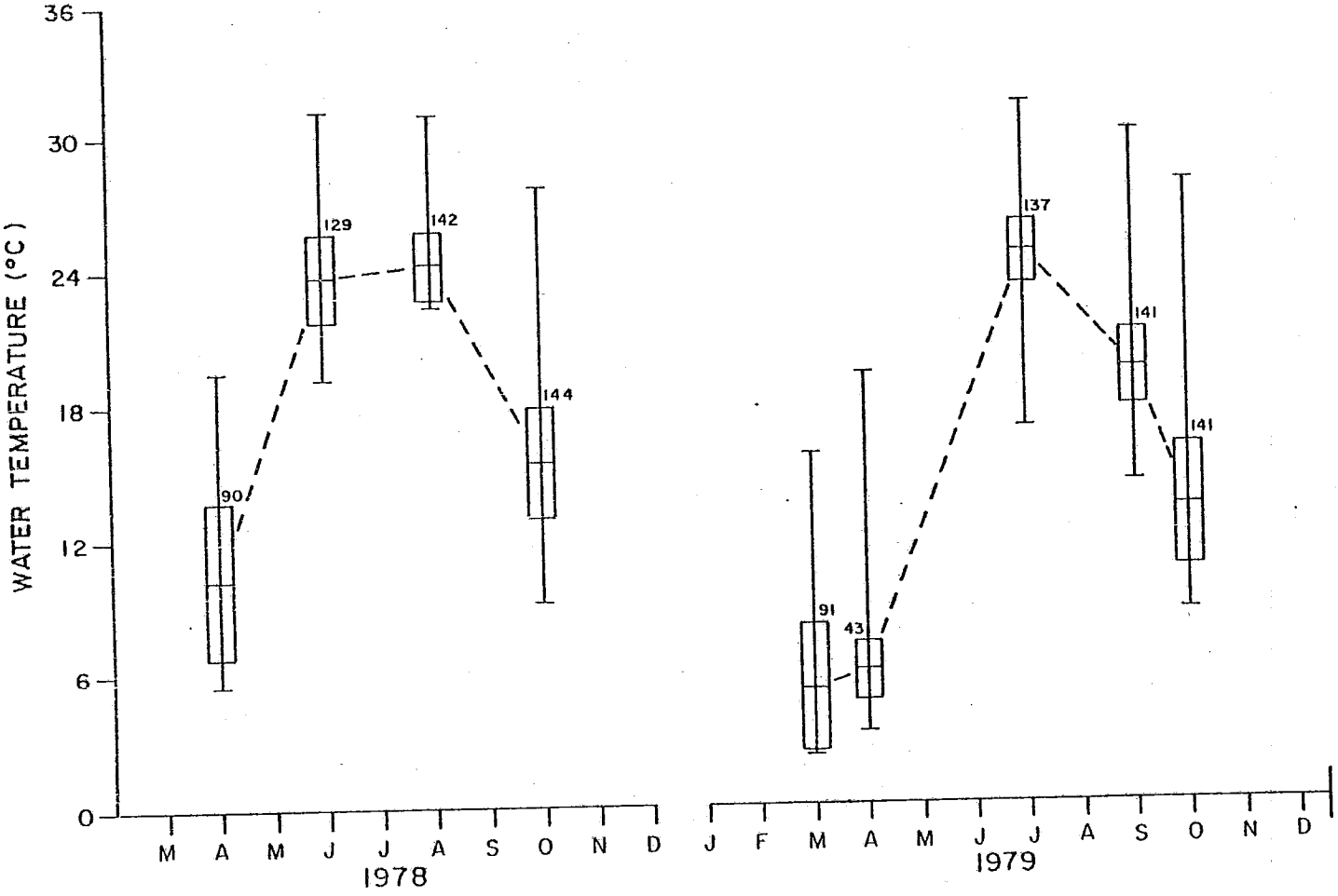

Figure 7. Nearshore Temperature - Western Lake Erie (United States), 1978-1979.

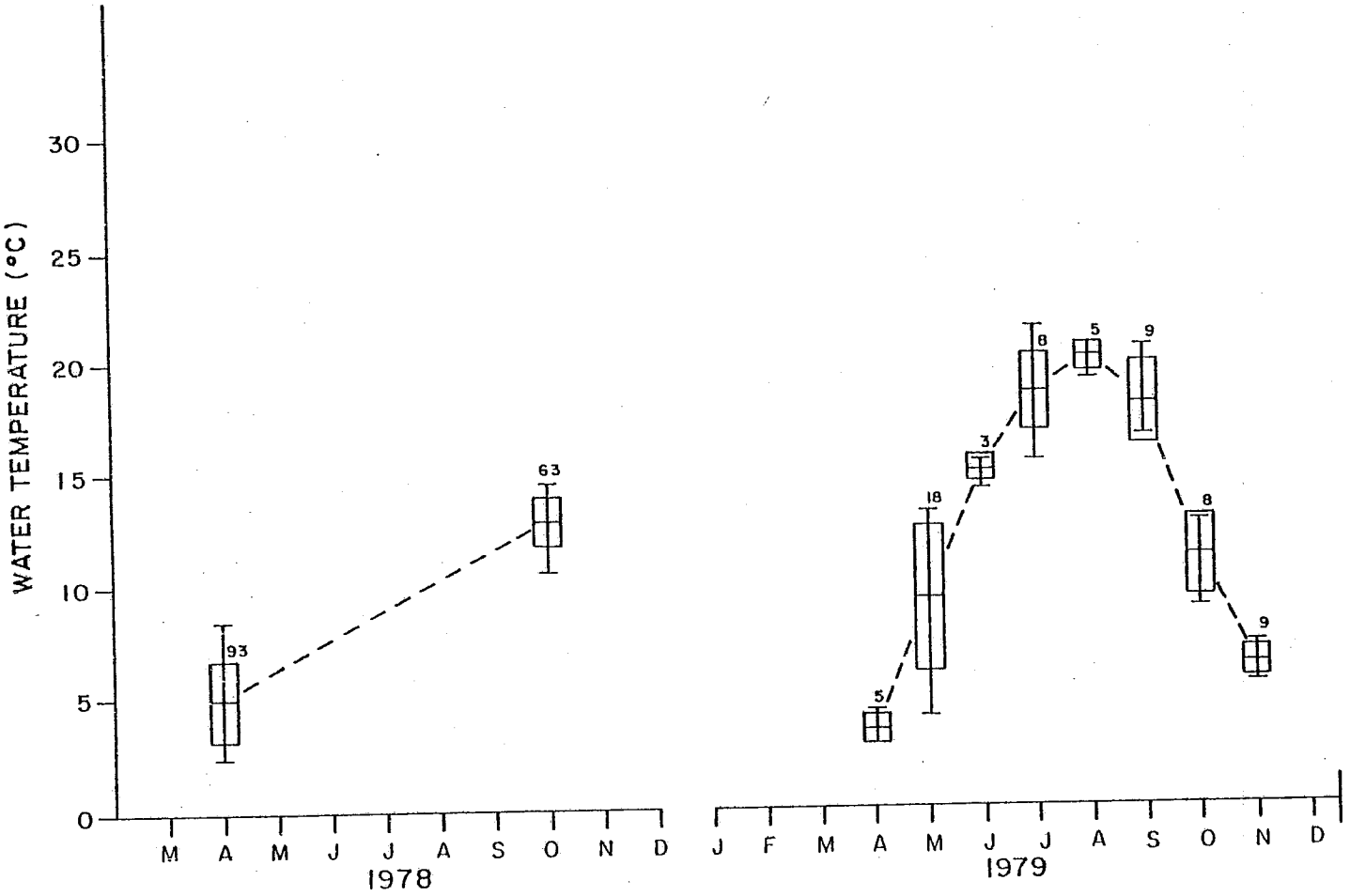

Figure 8. Nearshore Water Temperature - Western Lake Erie (Canada), 1978-1979.

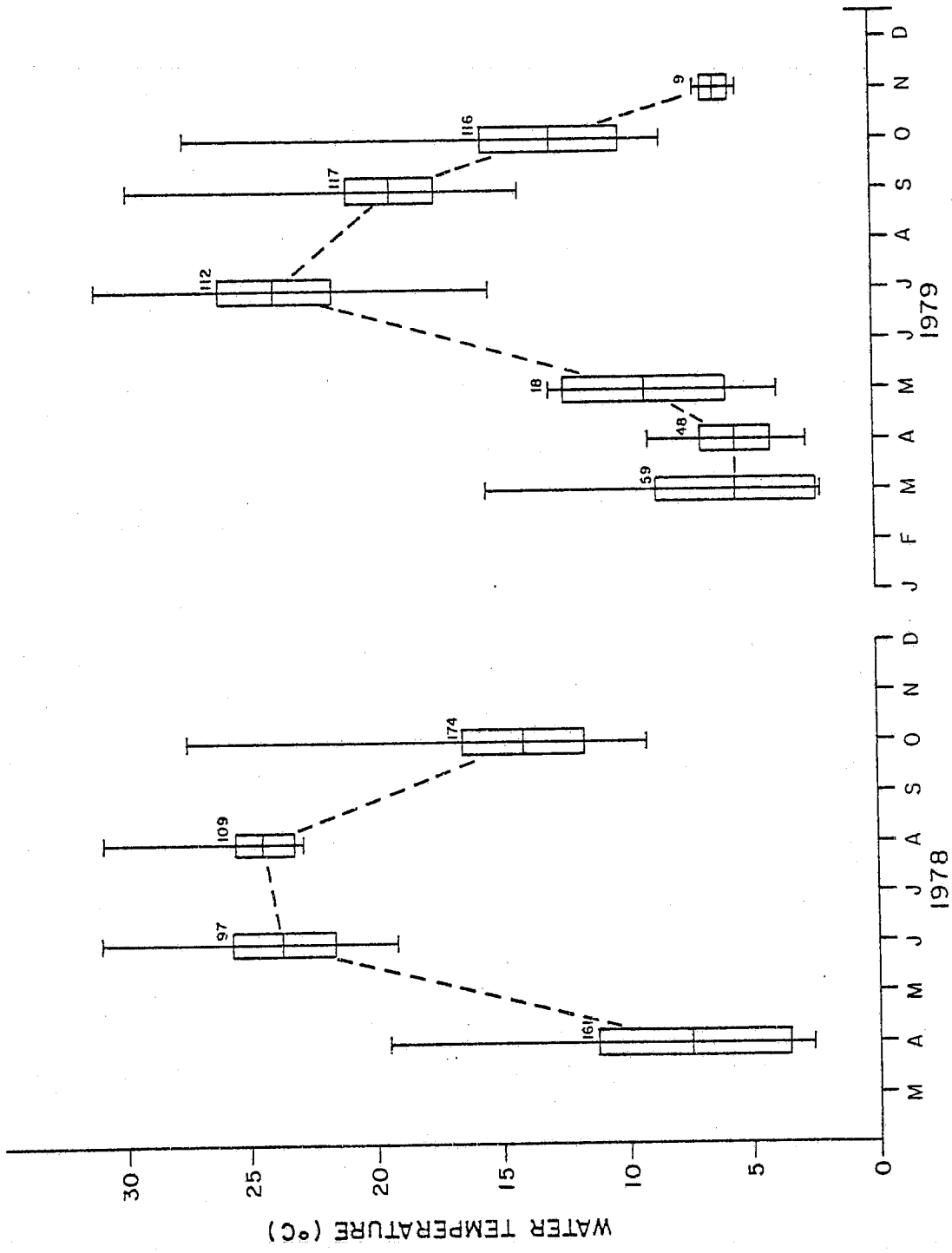

Figure 9. Nearshore Water Temperature - Western Lake Erie (Canada-United States), 1978-1979.

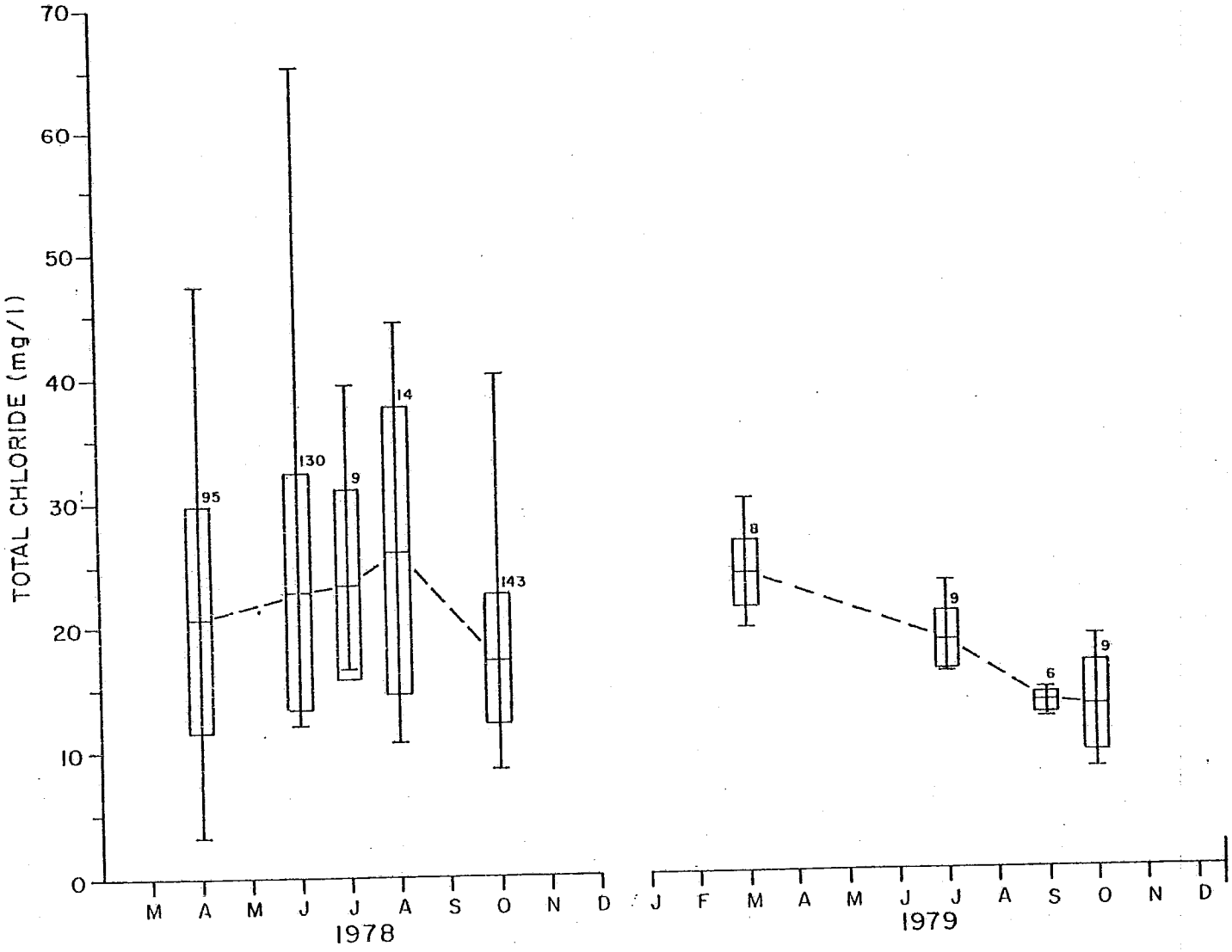

Figure 10. Nearshore Total Chloride - Western Lake Erie (United States), 1978-1979.

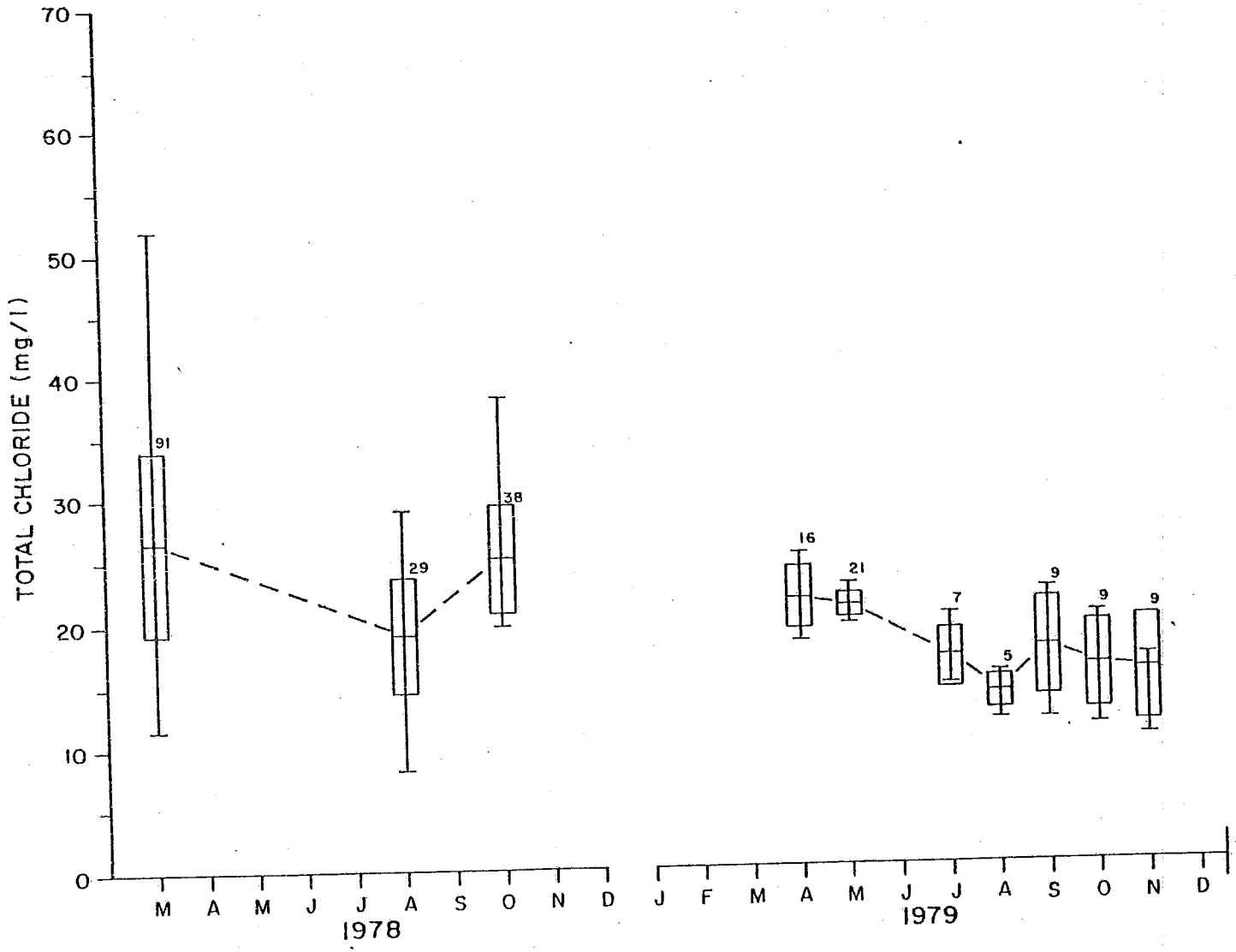

Figure 11. Nearshore Total Chloride - Western Lake Erie (Canada), 1978-1979.

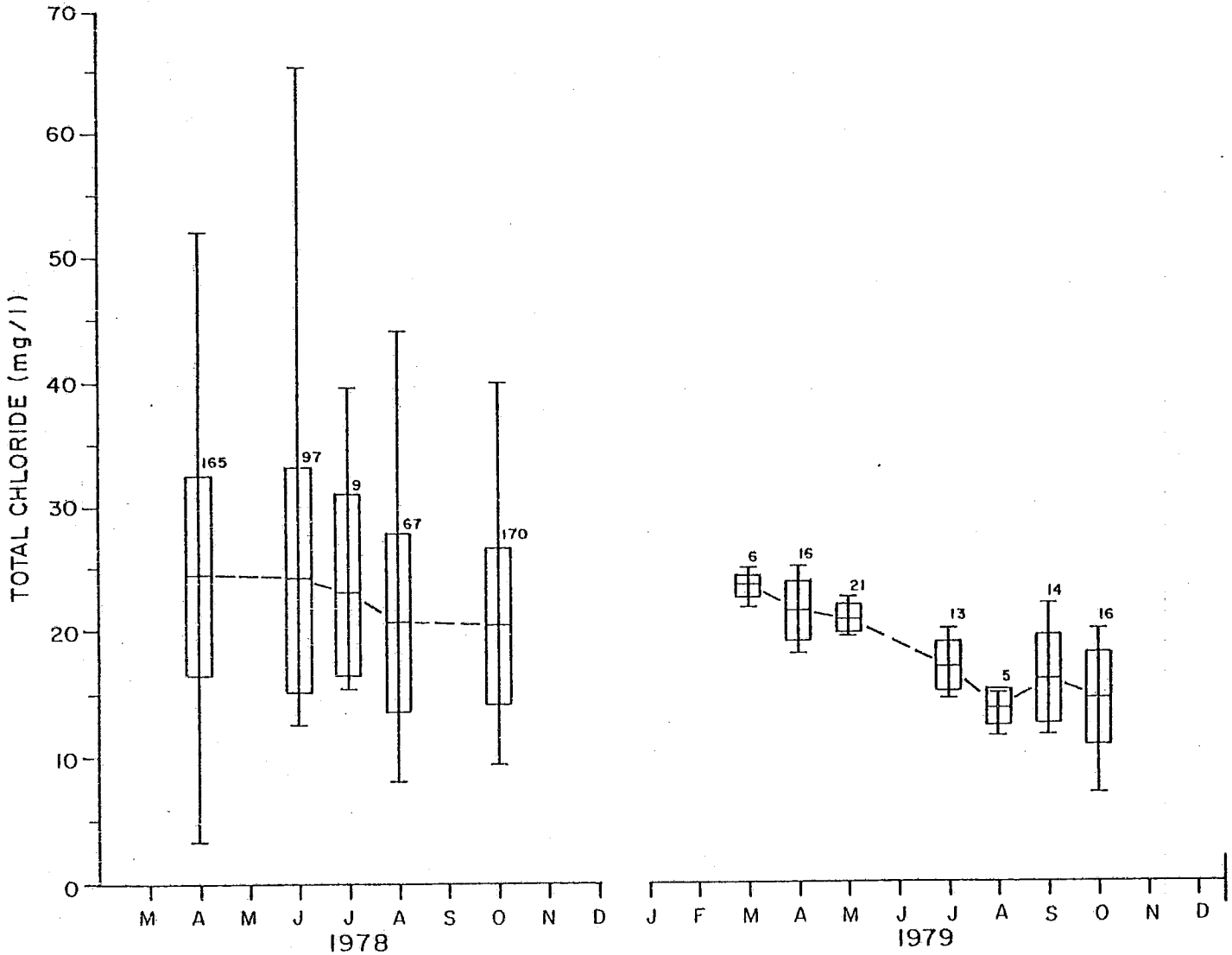

Figure 12. Nearshore Total Chloride - Western Lake Erie (Canada-United States), 1978-1979.

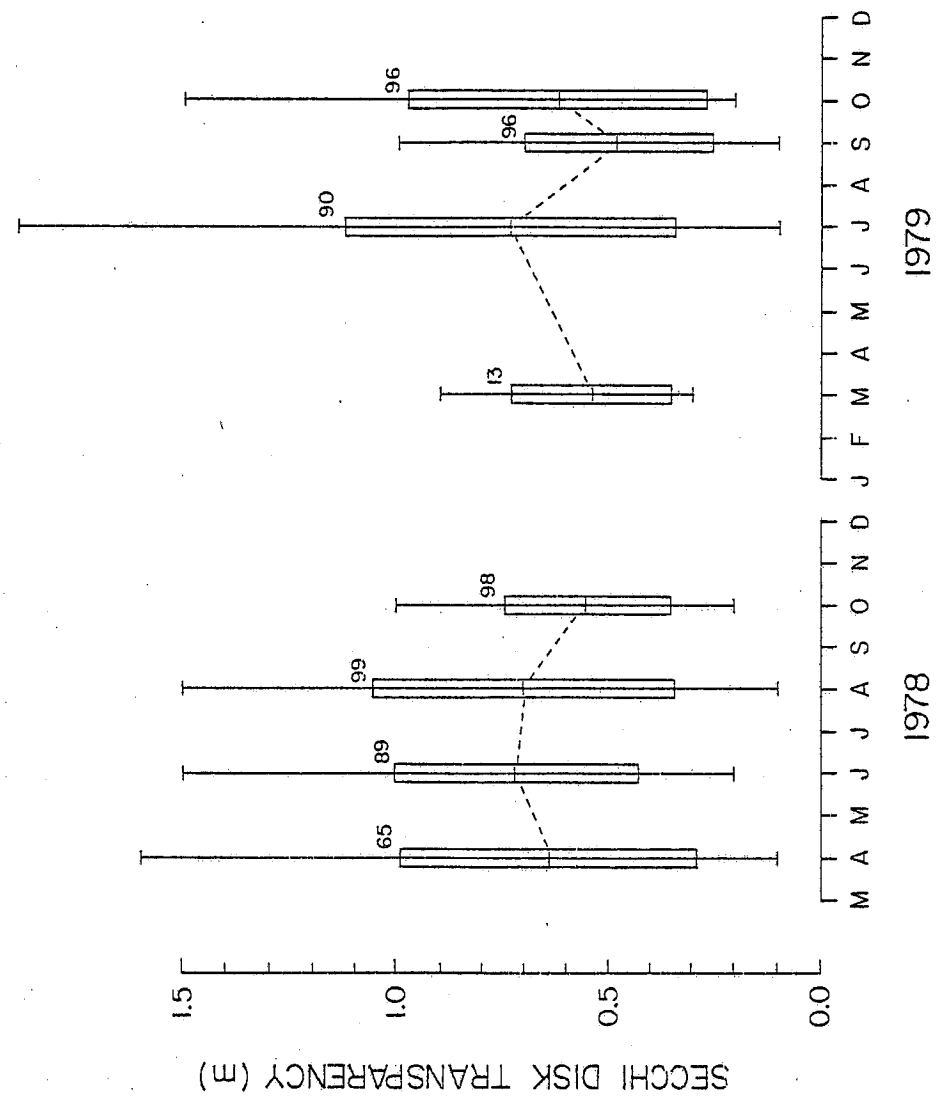

Figure 13. Nearshore Water Transparency - Western Lake Erie (United States), 1978-1979.

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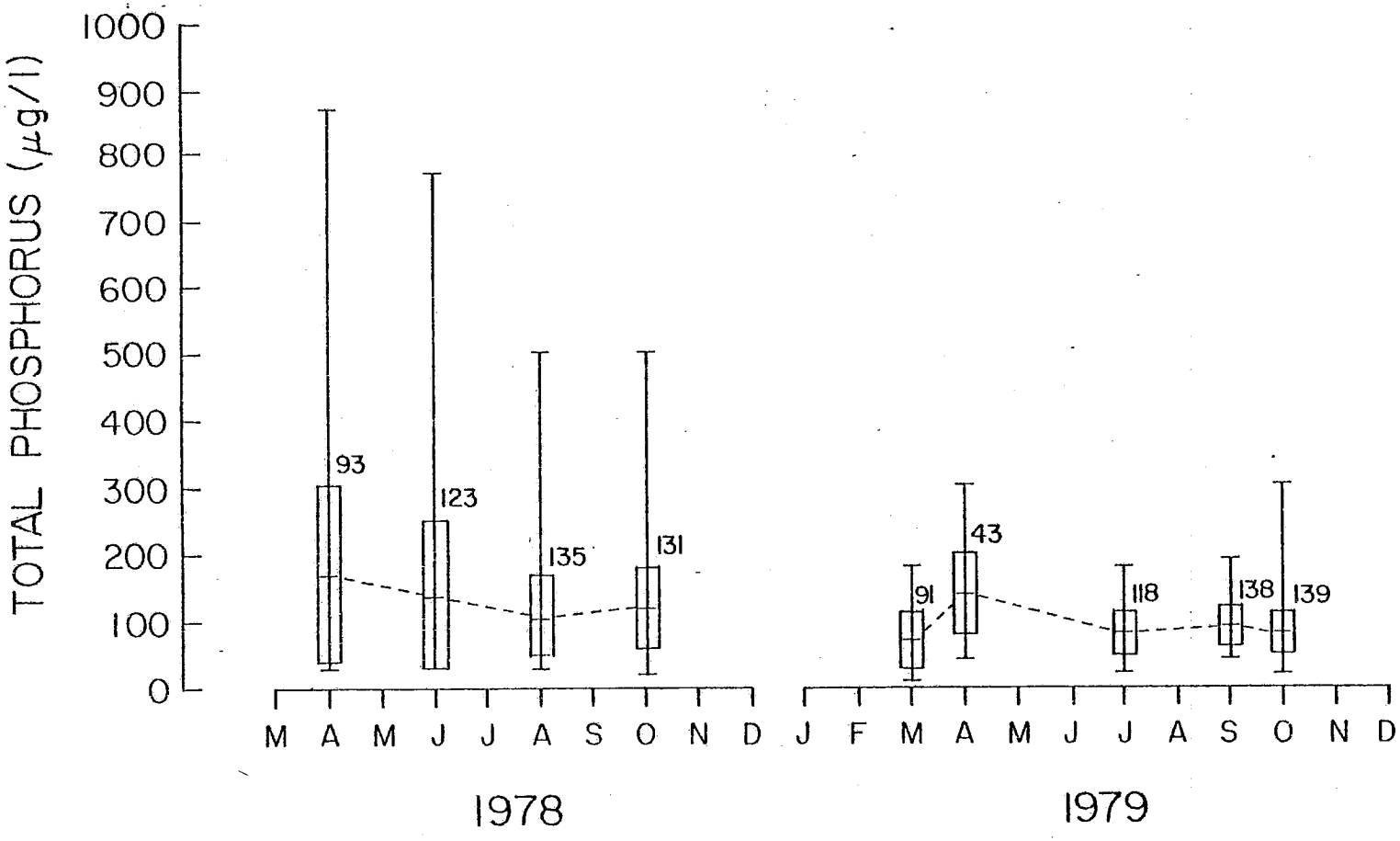

Figure 14. Nearshore Total Phosphorous - Western Lake Erie (United States), 1978-1979.

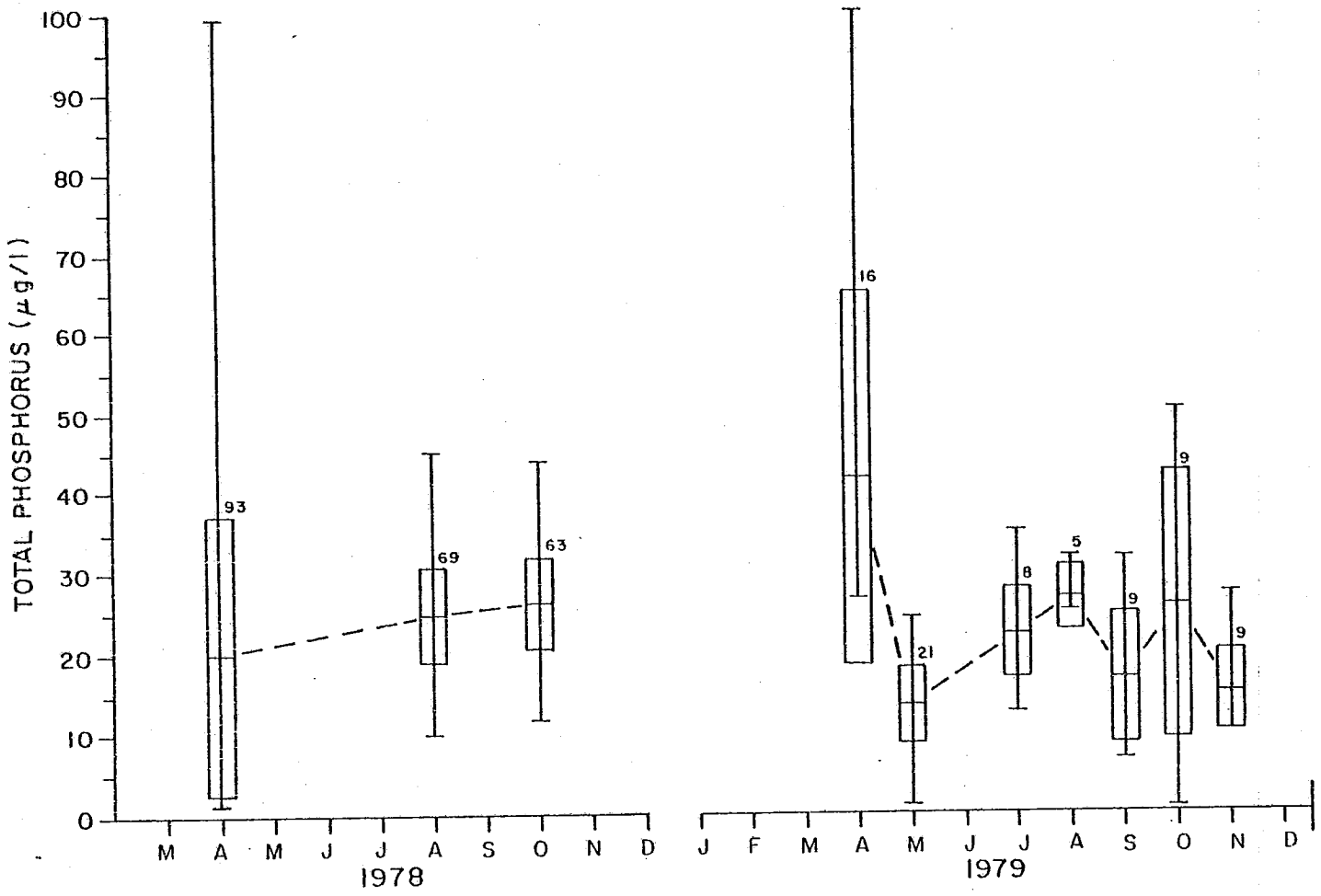

Figure 15. Nearshore Total Phosphorous - Western Lake Erie (Canada), 1978-1979.

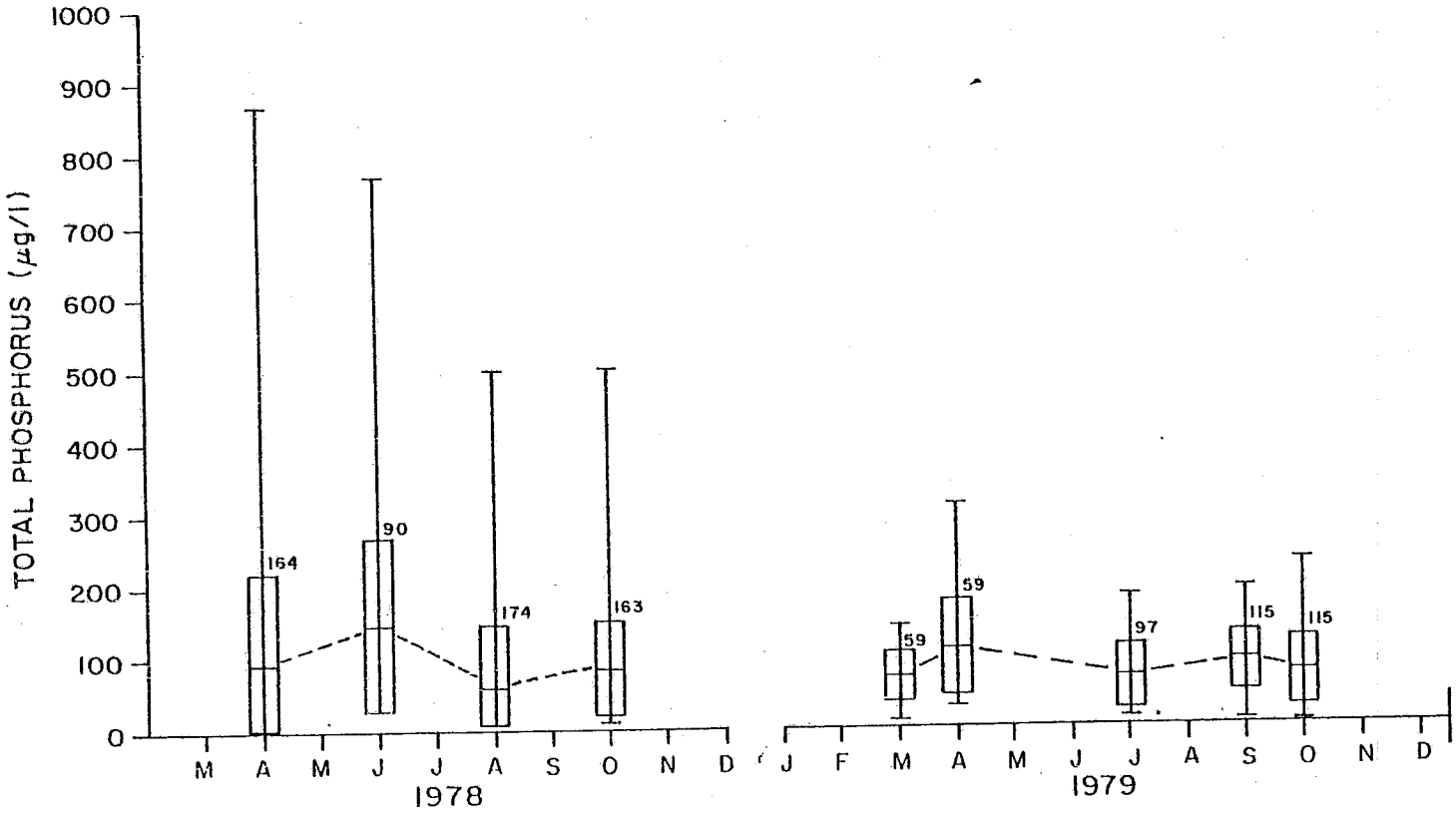

Figure 16. Nearshore Total Phosphorous - Western Lake Erie (Canada-United States), 1978-1979.

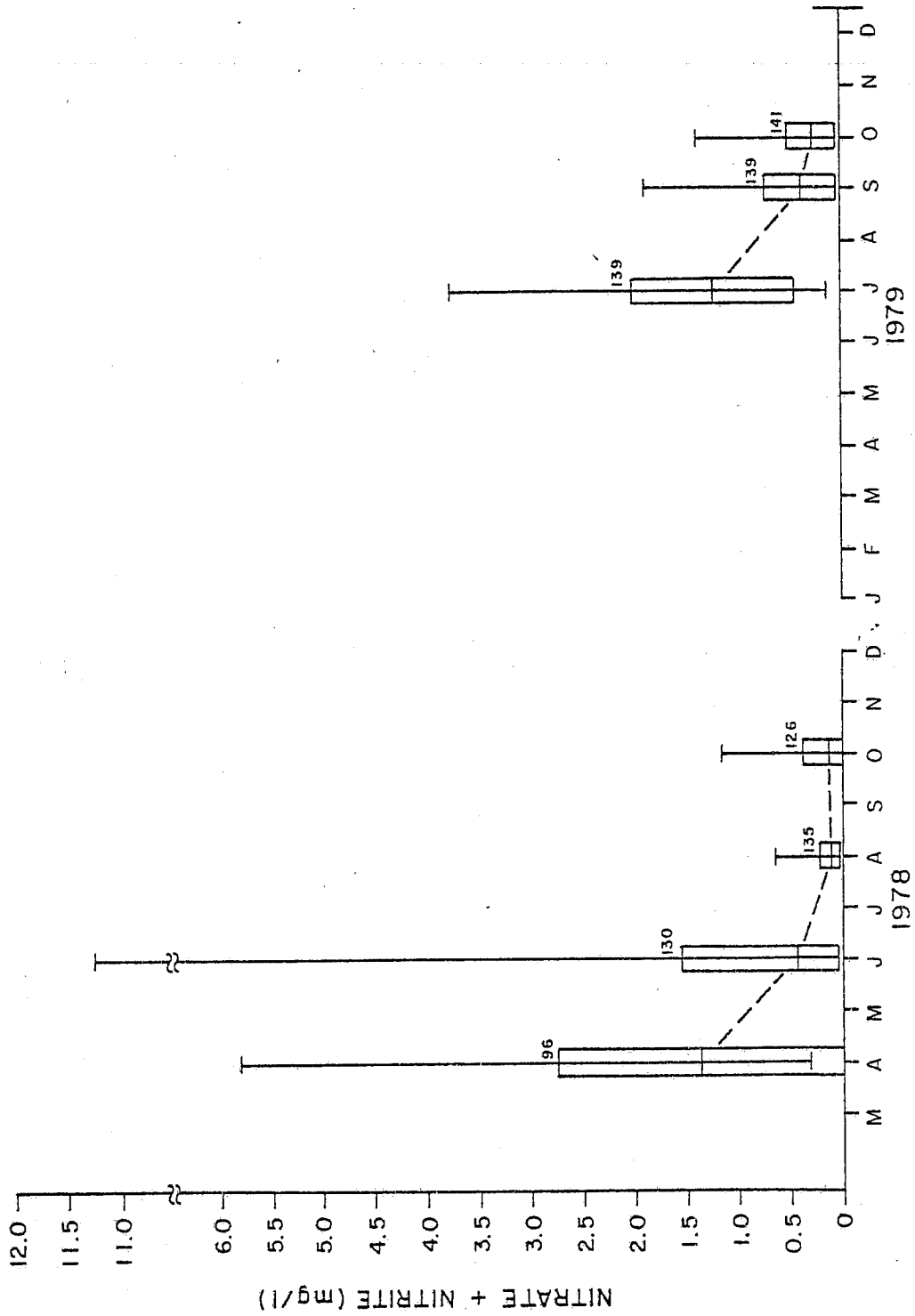

Figure 17. Nearshore Nitrate + Nitrite - Western Lake Erie (United States), 1978-1979.

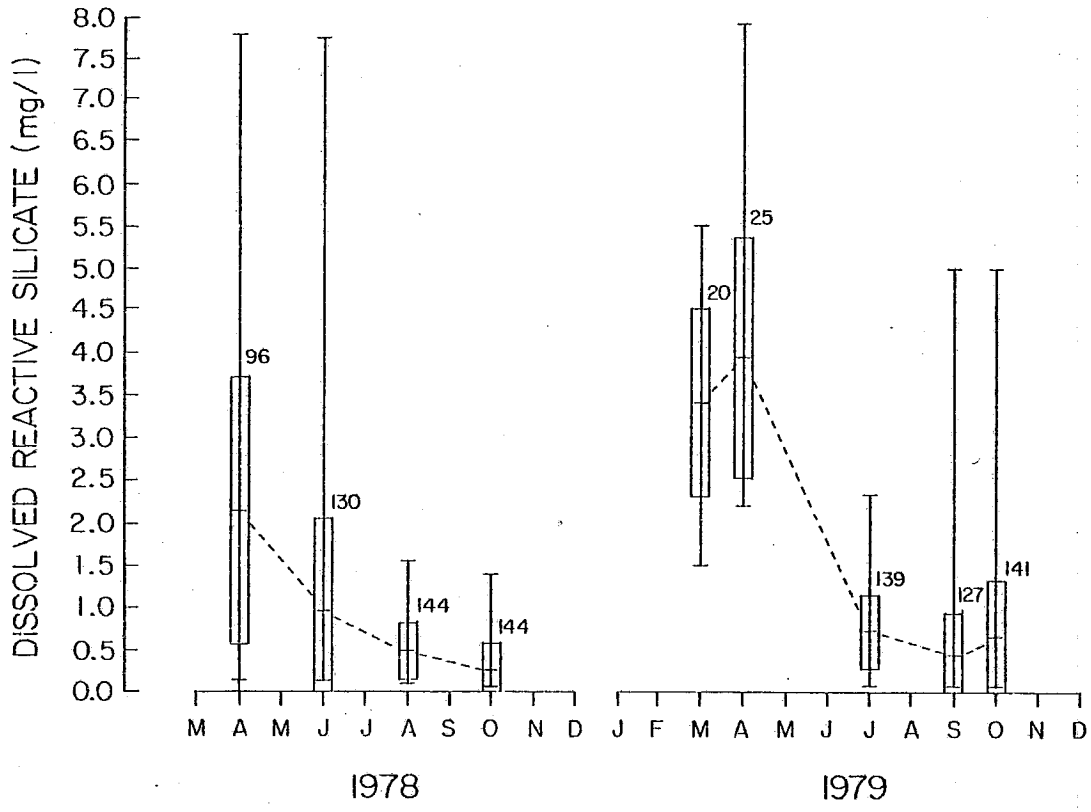

Figure 18. Nearshore Dissolved Reactive Silicate - Western Lake Erie (United States), 1978-1979.

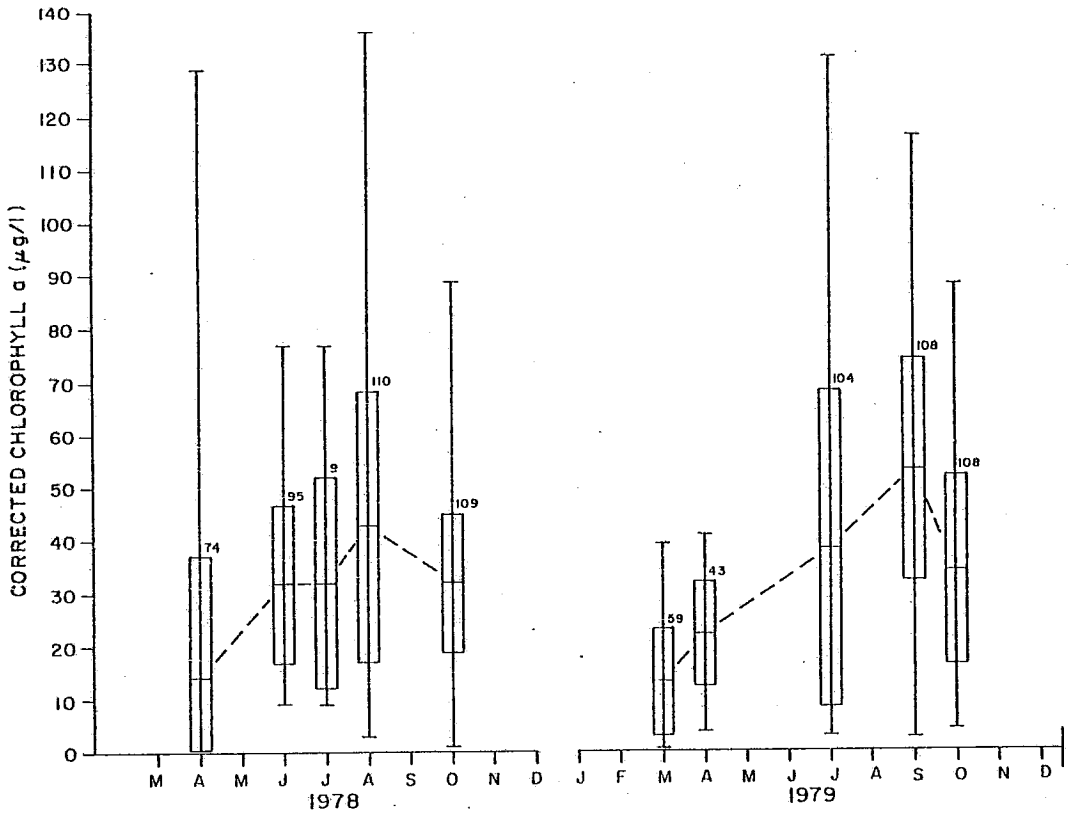

Figure 19. Nearshore Corrected Chlorophyll a - Western Lake Erie (United States), 1978-1979.

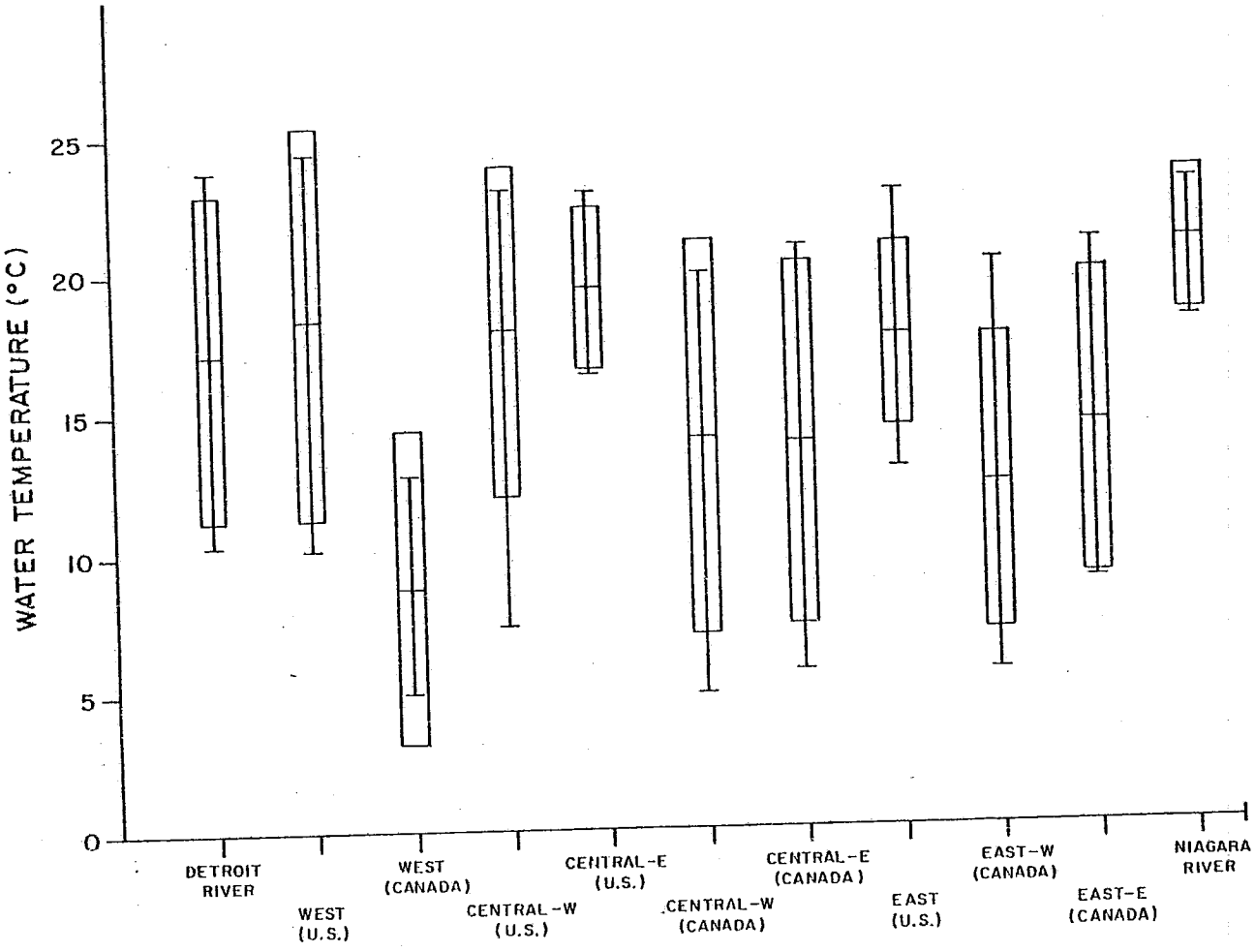

Figure 20. Mean Monthly Mean Water Temperature in Nearshore Reaches of Lake Erie, April to October 1978.

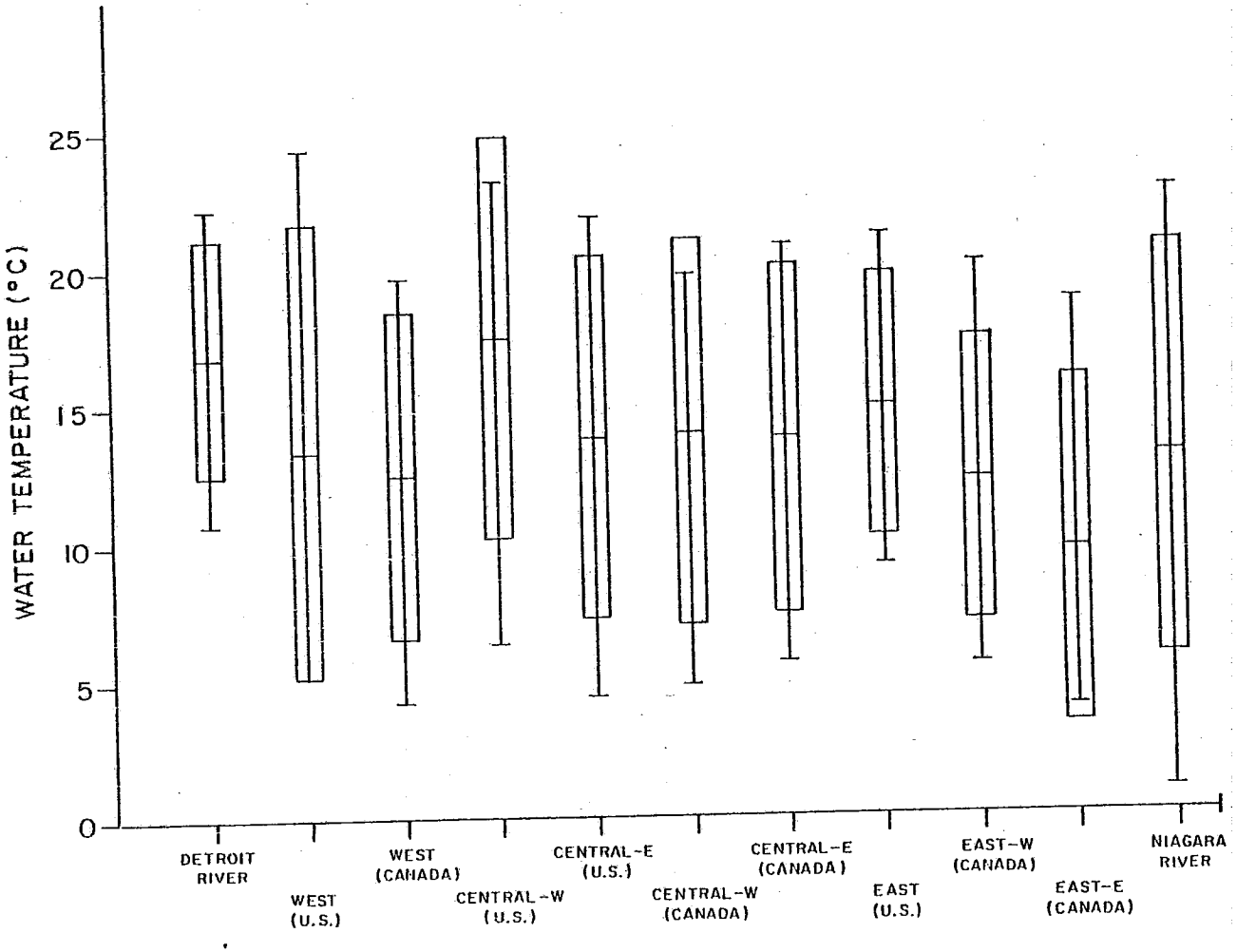

Figure 21. Mean Monthly Mean Water Temperature in Nearshore Reaches of Lake Erie, March to November 1979.

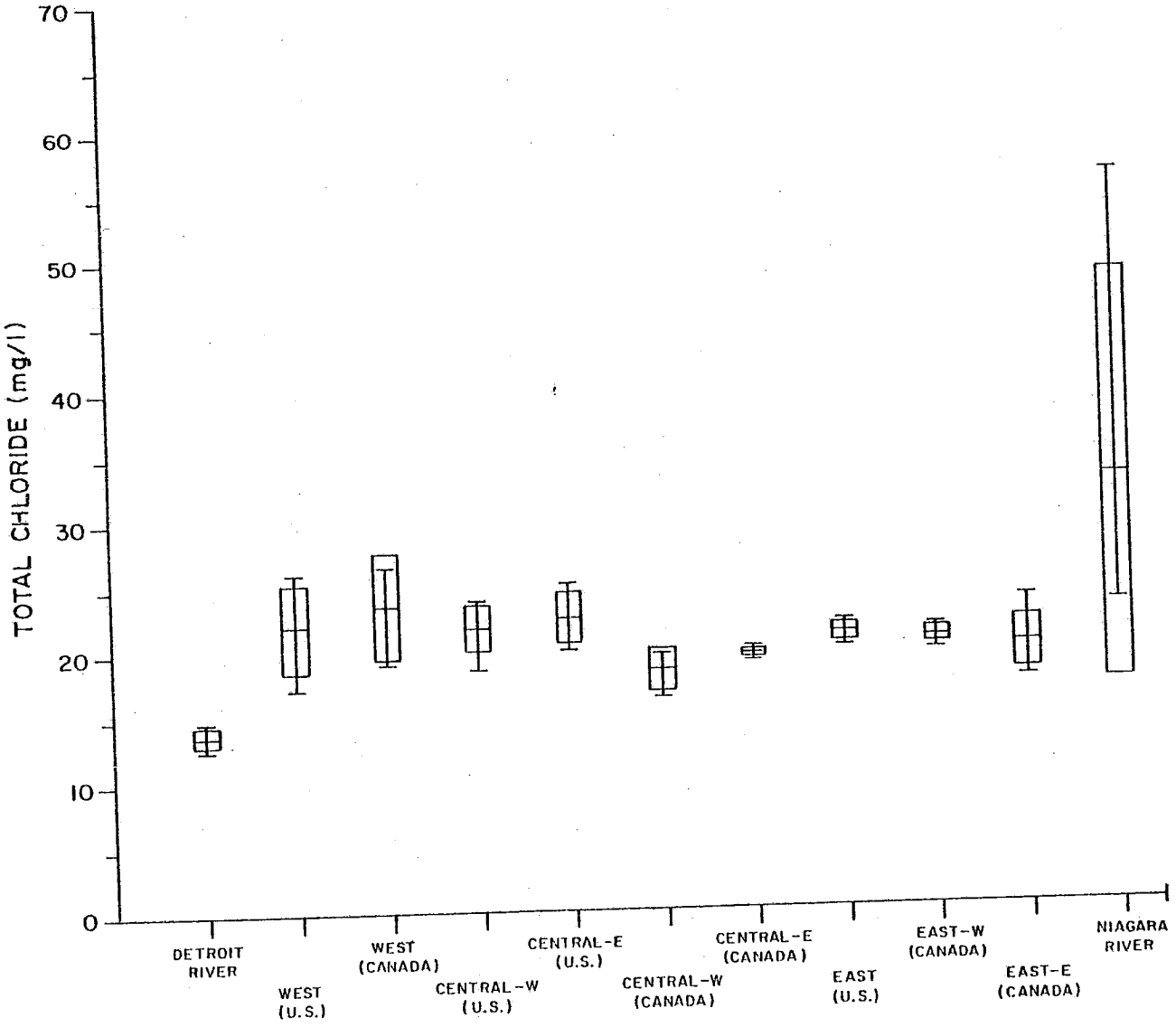

Figure 22. Mean Monthly Mean of Total Chloride in Nearshore Reaches of Lake Erie, April to October 1978.

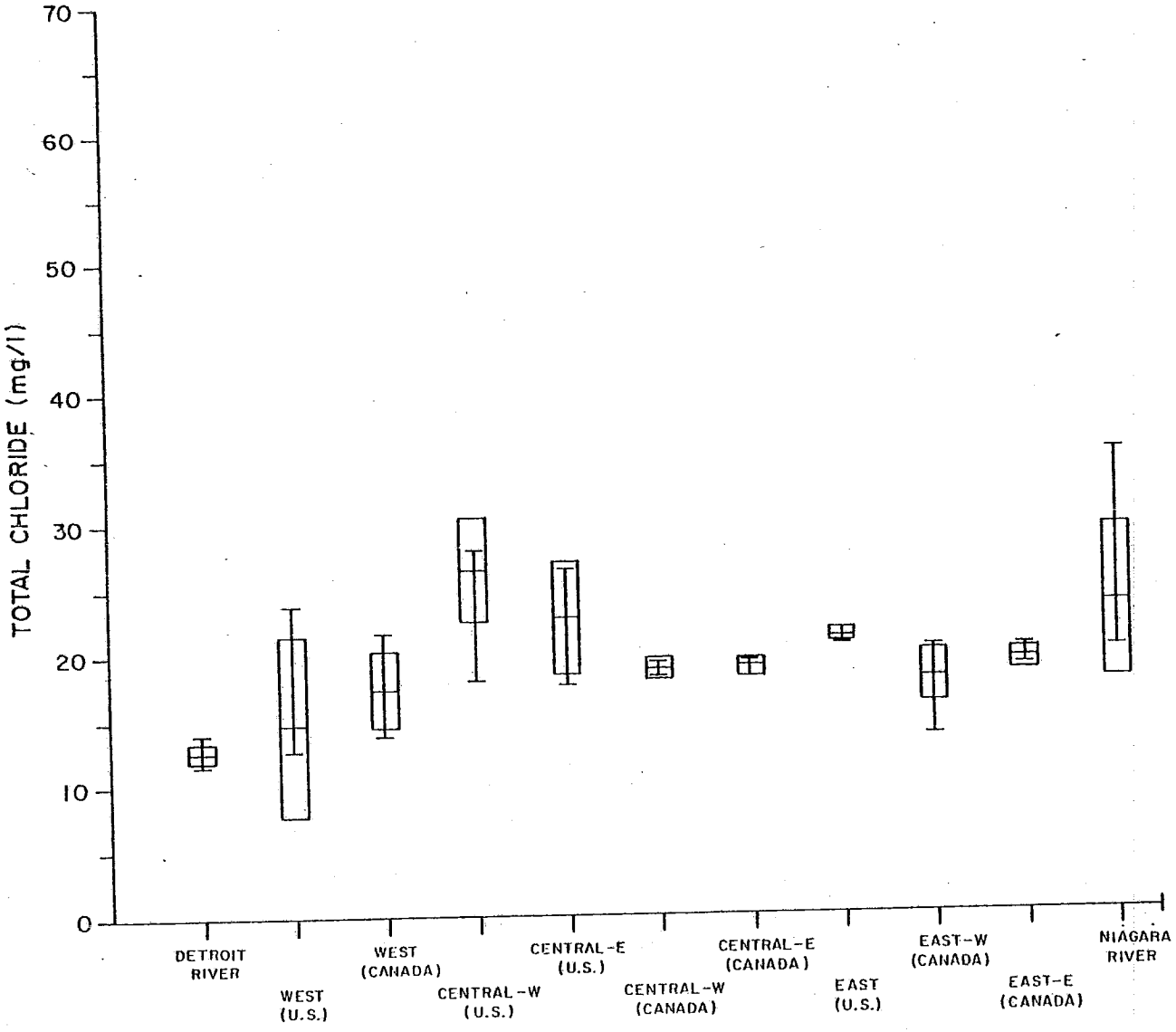

Figure 23. Mean Monthly Mean of Total Chloride in Nearshore Reaches of Lake Erie, March to November 1979.

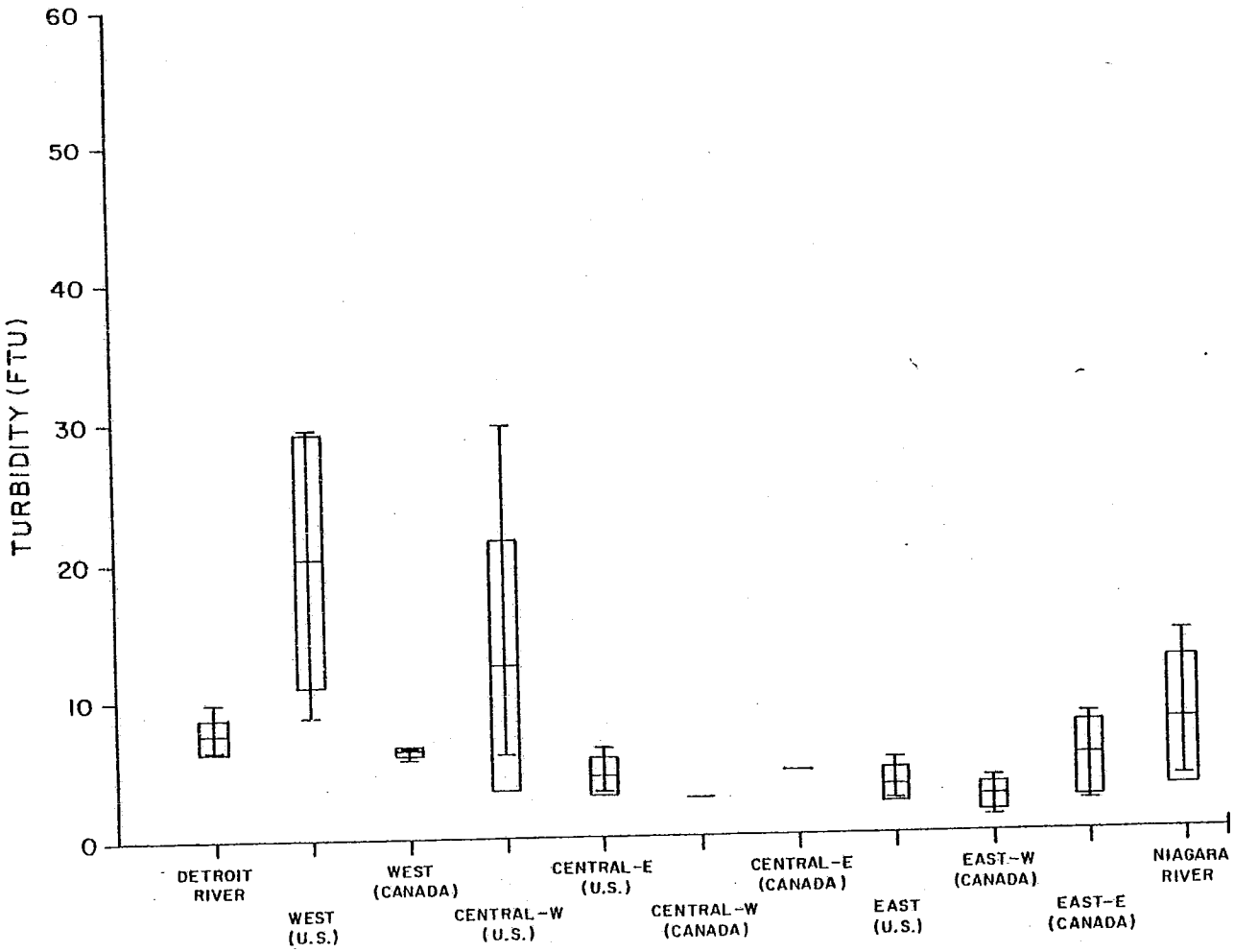

Figure 24. Mean Monthly Mean Turbidity in Nearshore Reaches of Lake Erie, April to October 1978.

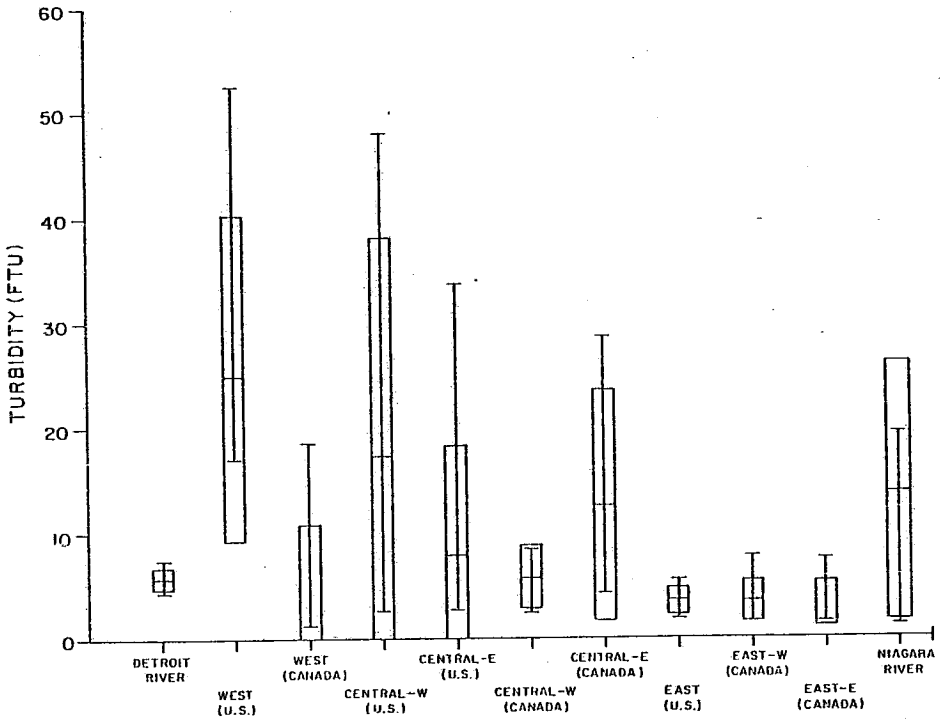

Figure 25. Mean Monthly Mean Turbidity in Nearshore Reaches of Lake Erie, March to November 1979.

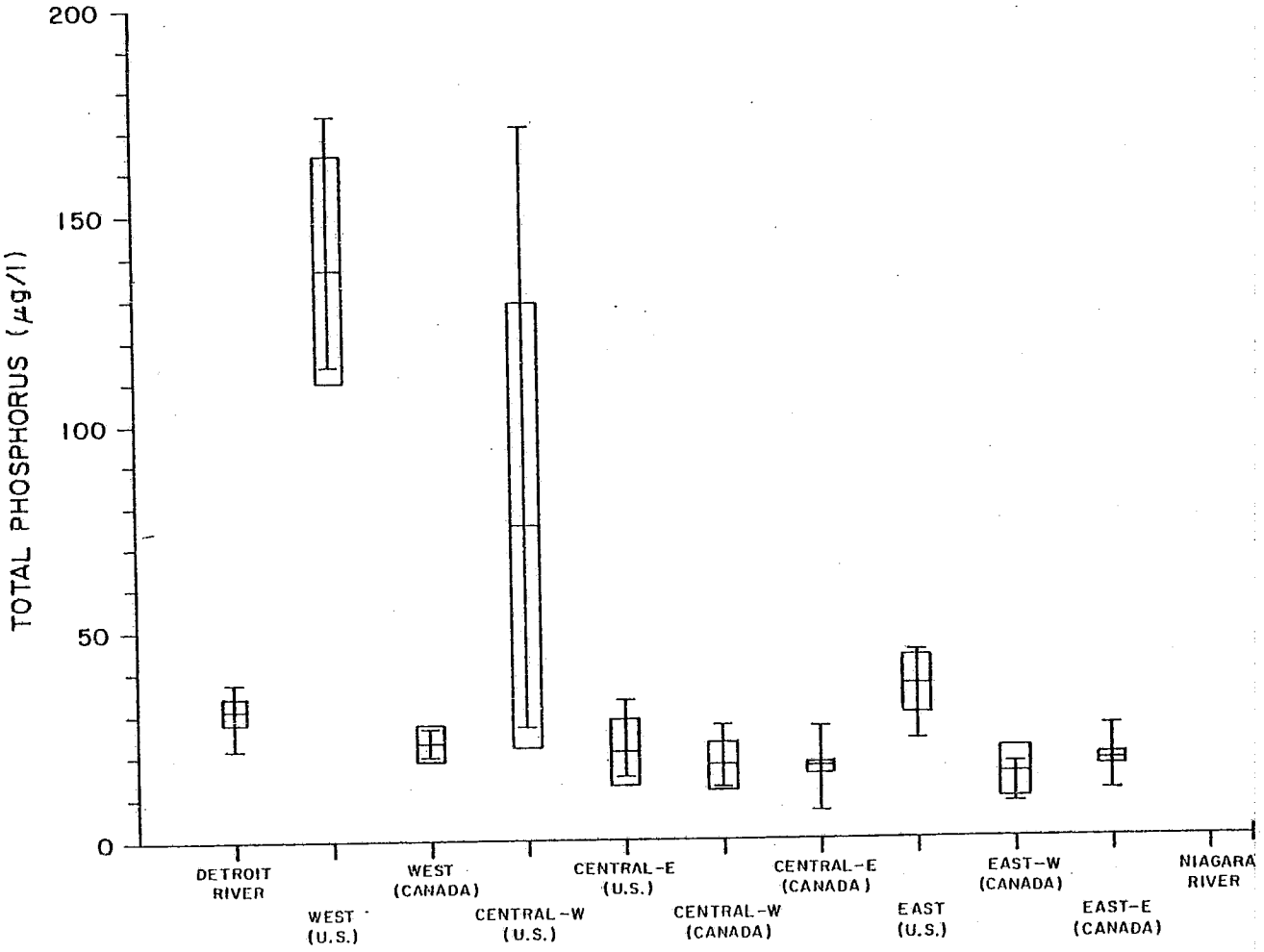

Figure 26. Mean Monthly Mean Concentrations of Total Phosphorous in Nearshore Reaches of Lake Erie, April to October 1978.

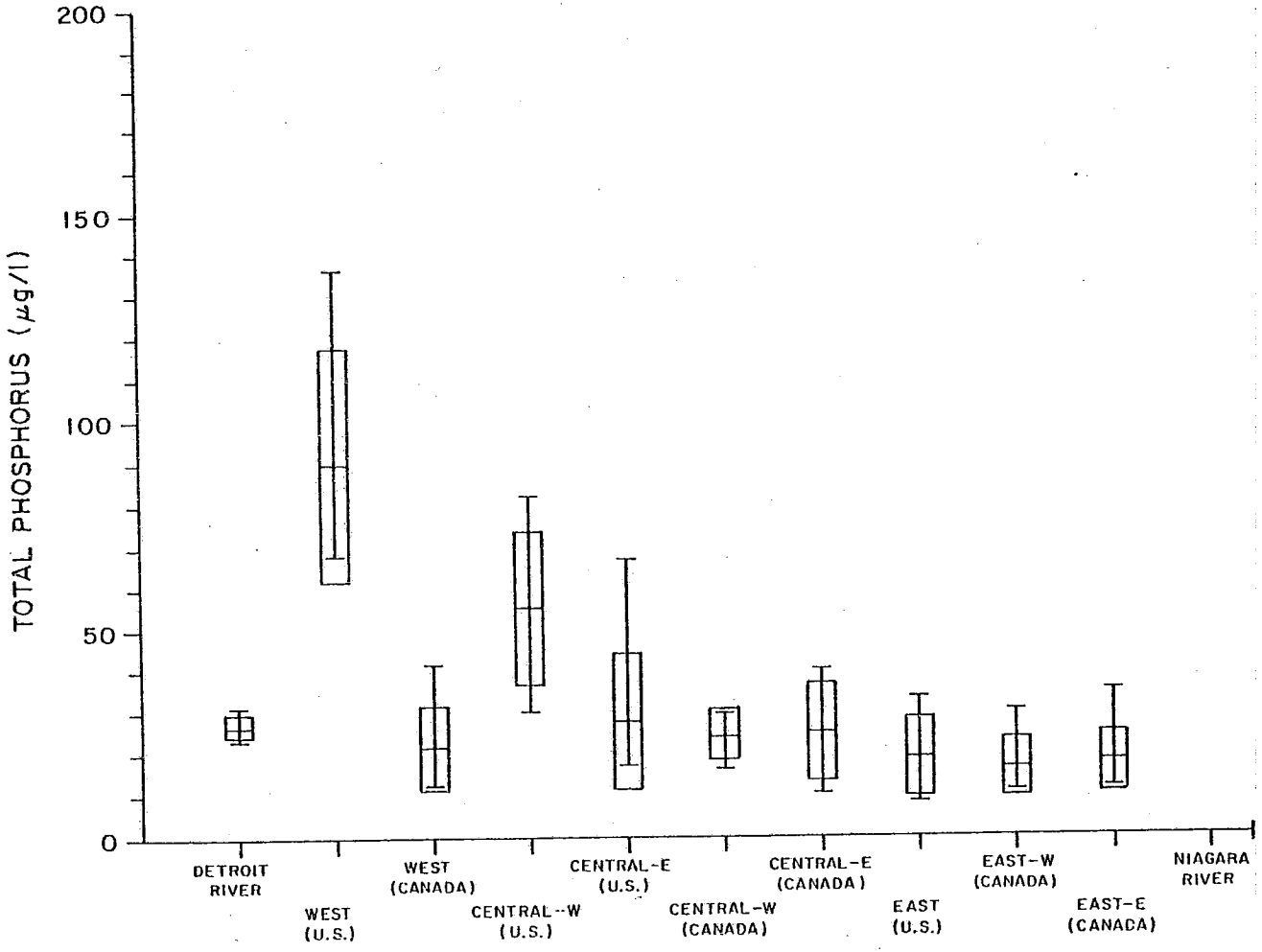

Figure 27. Mean Monthly Mean Concentrations of Total Phosphorous in Nearshore Reaches of Lake Erie, March to November 1979.

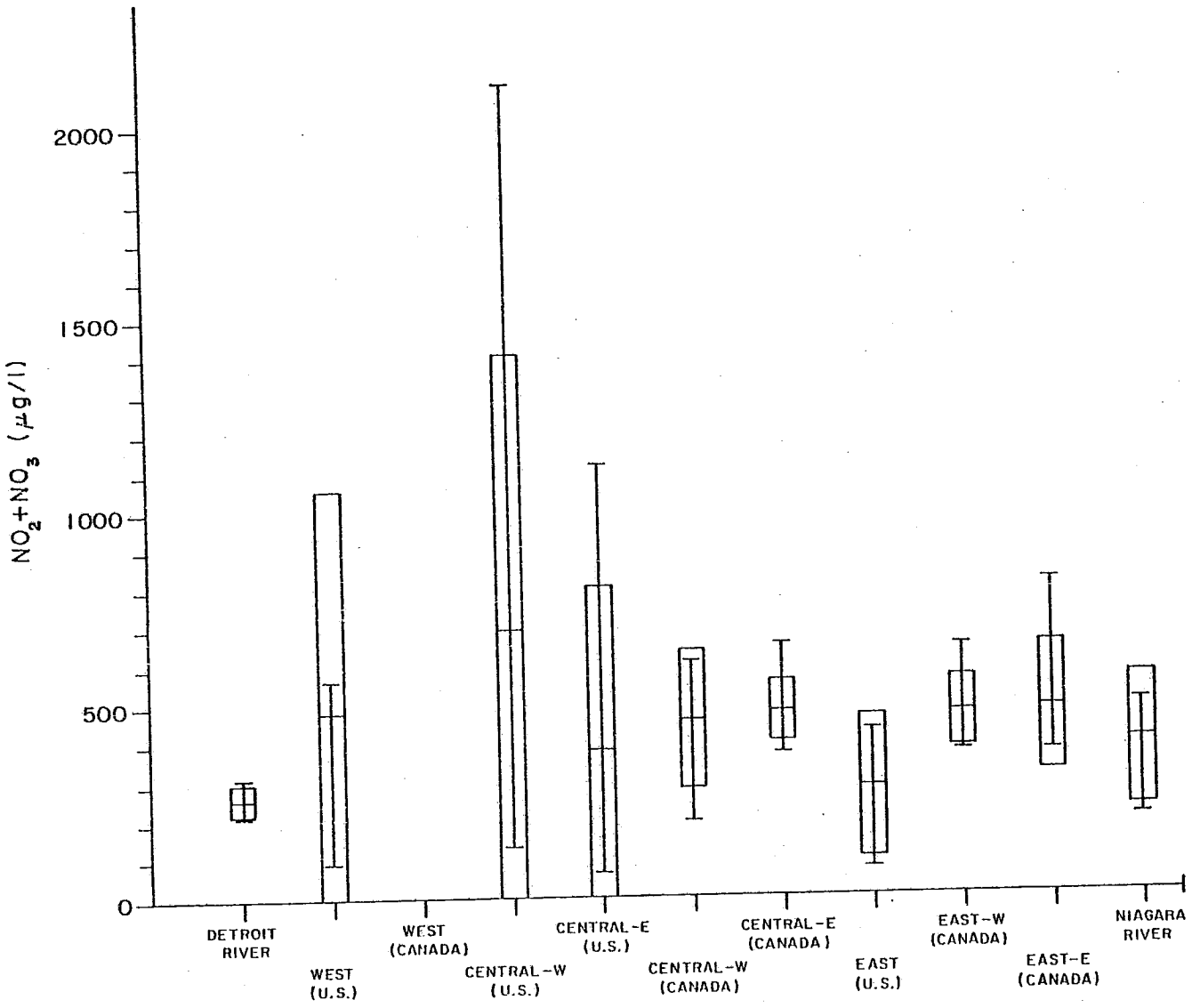

Figure 28. Mean Monthly Mean Nitrate + Nitrite in Nearshore Reaches of Lake Erie, April to October 1978.

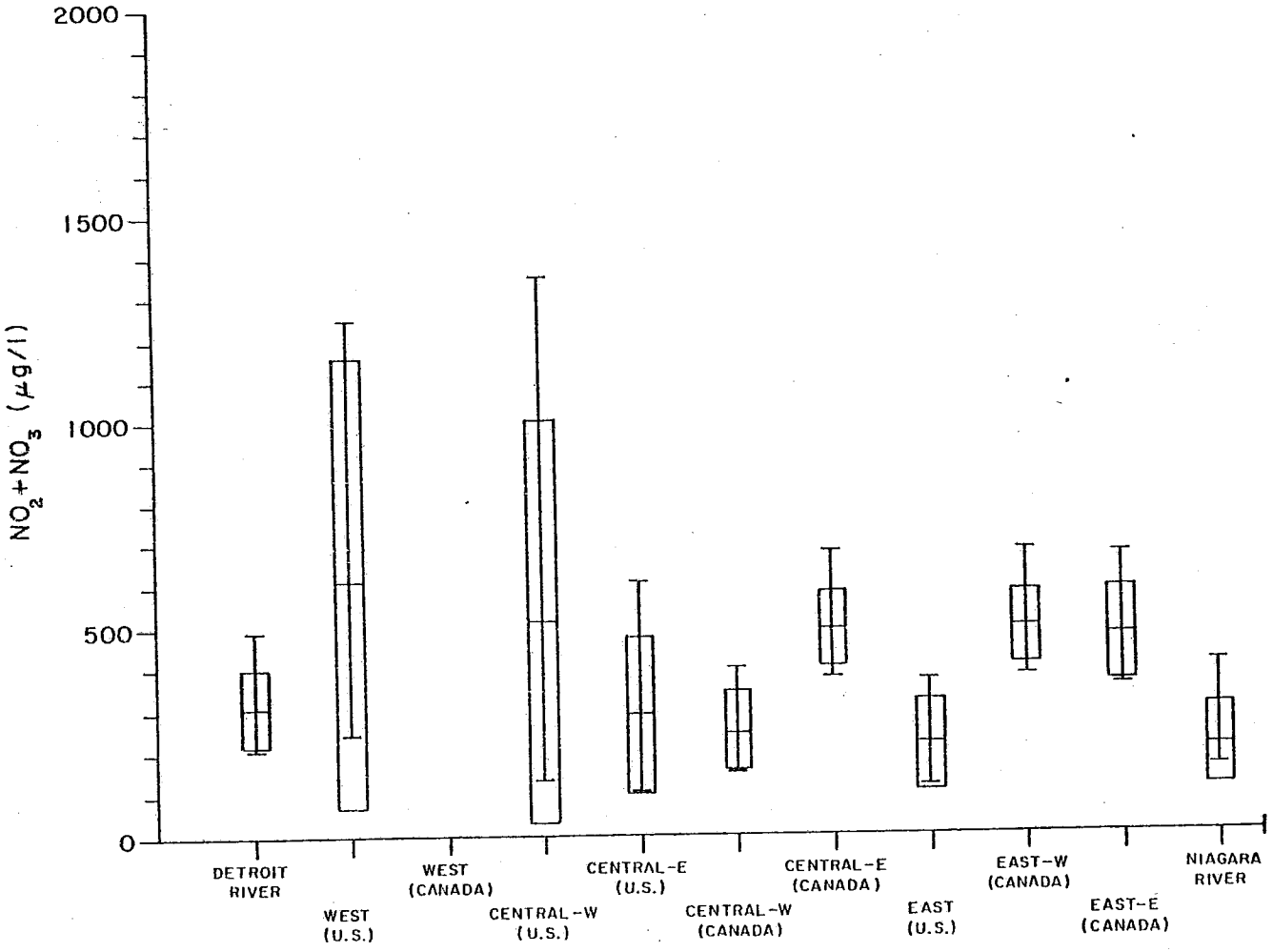

Figure 29. Mean Monthly Mean Nitrate + Nitrite in Nearshore Reaches of Lake Erie, March to November 1979.