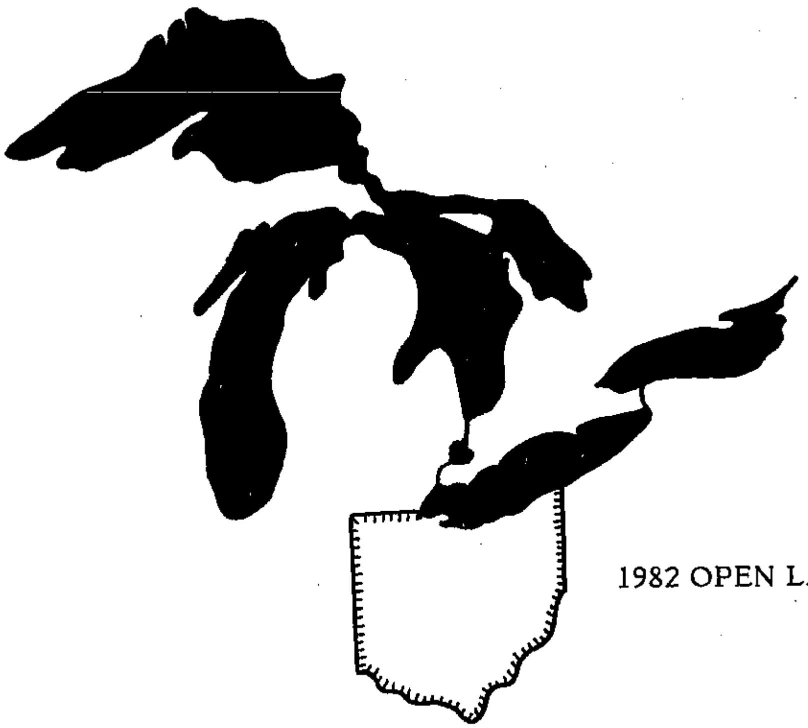

CLEAR TECHNICAL REPORT 274-F

1982 OPEN LAKE WATER QUALITY CONDITIONS FOR LAKE ERIE

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Acknowledgment

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EXECUTIVE SUMMARY

Summary 1982

Thermal stratification in the central basin was observed from May 26 through September 13, a span of 111 days, only two days longer than the observed period of 1981. The volumetric oxygen depletion rate was 0.111 mg/l/day $\pm$ .009. An increase in hypolimnion area and volume occured prior to cruise 4 which lowered the volumetric depletion rate for the cruise 3 to 4 interval to 0.102 mg/l/day.

Higher than average nutrient concentrations were found during the Spring cruise. The water in the Western basin was extremely turbid as was the Detroit River water. Also, large globs of sediment were observed frozen in chunks of ice at station 401 at the mouth of the Livingstone Channel. Some of the turbid waters in this area appeared to be coming down from the upper lakes and some may have blown back from the central basin due to the easterly storm occuring from April 5th to 7th.

The yearly average total phosphorus mean for the western basin is 46.9 ug/l. Excluding the April cruise TP mean of 139.7 ug/l, lowers the yearly mean to 31.4 ug/l.

The particulate material concentrations and relationships were very similar to those found during 1981 with the exception of the April cruise. In most cases the correlation coefficients are greater than 0.9. The exclusion of April 1982 cruise means increased the correlations for chlorophyll.

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INTRODUCTION

Objectives of the Sampling Plan

Since 1973, the objective of the open lake sampling plan has been to obtain annual data for total phosphorus, corrected chlorophyll a and dissolved oxygen. Total phosphorus and corrected chlorophyll data have been of interest for eutrophication indices and long term trends. Oxygen data is utilized to calculate the cruise interval hypolimnetic depletion rate. During the open lake cruises other limnological parameters have also been evaluated to help variations in parameter concentrations due to lake processes and for lake modelling.

Description of the Sampling Pattern

Seven open lake cruises were conducted during the 1982 field season beginning on April 5 and ending on October 26. Thermal stratification was exhibited from cruise 2 (May 26) through cruise 6 (September 13). Cruise dates, durations and midpoints are presented in Table 1. A total of 41 stations were dispersed throughout the western (n=12) and the central (n=29) basins. (Figure 1). The number of stations actually sampled and the percent of the total (n=41) is as follows:

cruise 1	28	68%
2	41	100%
3	41	100%
4	41	100%
5	40	98%
6	41	100%
7	41	100%

The eastern portion of the central basin could not be sampled on the first cruise due to large ice floes and to inclement weather. A listing of the geographic coordinates, bottom depths and basin designations are presented in Table 2

METHODS

A summary of the methods employed for the 1982 season can be seen in Table 3. A detailed description of the methods are presented in Letterhos, 1982.

QUALITY CONTROL SUMMARY

A quality control program is routinely followed for all pertinent parameters, constituting approximately ten percent of the total sampling effort. This program utilizes a series of known standards, duplicates and spikes, as suggested by the International Joint Commission, to monitor accuracy, precision and to estimate standard deviations. Standard deviations are estimated for each analytical method by summing the differences between duplicate analyses, calculating a mean and dividing by 1.128 (as suggested by the IJC). Acceptable limits for the range of differences are determined by multiplying the mean difference by predetermined factors (EPA, 1972). Standard deviations calculated for 1982 are presented in Table 4. A detailed description of the quality control program can be found in Letterhos (1982).

DATA ANALYSIS

Raw data analysis were accomplished utilizing BMDP programs that calculate limnion means and medians with the appropriate variance statistics. Analysis of data over the last few years has indicated that medians are the most relevant indicator of the actual conditions in Lake Erie. A modified version of the notched block plot (Reckhow, 1980) as explained in Figure 2 is used to present seasonal concentrations. The median point is not usually in the center of the box indicating that several high values are skewing the means upward. Tables for the western and central basins are presented with the limnion means and medians for those who find it difficult to adjust to the use of medians (Tables 5 and 6).

Volume weighted data for nutrients, chlorophyll and dissolved oxygen that are presented in later sections are derived from Survey 8 volume weighting program (Hanson et. al., 1978). Further D.O. calculations are based on the oxygen depletion model by Burns (1976). Area weighted data for secchi transparency was also made available from the Survey 8 program.

PHYSICAL DATA

Thermal Distributions

The seasonal western basin water temperature pattern mirrored the atmospheric temperature. The low temperatures (2°C) found for the first cruise reflect some of the below freezing days and nights in April. A new record low air temperature of 8 F (-13.4°C) was established for the Toledo area on April 7th. New surface ice films (1 cm) were observed to be forming in the western basin as late as April 8th. The warmest water temperatures were found in early August several weeks earlier than normal as a result of cooler air temperatures in the latter half of the month. The cruise medians for all parameters for the western basin are presented in Figure 3.

The central basin epilmnion cruise medians (Figure 4) exhibited the same unimodal cycle as found in the western basin; however, values were higher than those of the western basin for the 2 fall cruises (September and October) and lower on the first 5 cruises. The central basin hypolimnion warmed from 6 C in early June to 12.5°C in early September (Figure 5).

The spatial temperature patterns are presented for the epilimnion and hypolimnion for all cruises (Figure 6). Temperatures generally increase from east to west for the epilimnion waters while the hypolimnetic water temperatures increase from north to south, as a result of upwelling and downwelling (see cruise 3, late June).

Ephemeral stratification was observed in the western basin only during one cruise (station 331, July 26). This area has been observed to stratify frequently in the past due to movement of the central basin mesolimnion or hypolimnion water into the Pigeon Bay area of the northeast corner of the western basin (Bartish, 1983). (Table 7).

Stratification in the central basin was first observed on May 26, at station 082 (cruise 2) and lasted through September 13 (station 047, cruise 6) or an observed span of 111 days. The vertical temperature profiles acquired at every station were analyzed for epilimnion and hypolimnion depths and temperatures which were necessary for the Survey 8 volume weighting programs. A synopsis of thermal traces has been prepared to demonstrate the evolution of the thermal regime for the mid lake central basin station 42 (Figure 7) and for a station in the Sandusky sub basin, Station 82 (Figure 8). Three different patterns of stratification exist. Unstratified or isothermal conditions (one layer) were observed at station 042 on April 12th and October 22nd. The standard stratification condition or three layer system was observed at station 42 from May 30th until September 10th with a progressively subsiding hypolimnion.

The two layered stratified system was observed regularly during the season in areas where shallow depths did not allow for the establishment of the more stable 3 layer condition. The Sandusky sub basin is shallow (12-16 meters) and stratifies and destratifies several times throughout the season. This area exhibits an example of the two layer system (epilimnion and mesolimnion) (Figure 8).

The area of maximum hypolimnion thickness is equivalent to the deepest portion in the mid lake area (23-25m), east of the line from Cleveland, Ohio to Erieau, Ontario (Figure 9). Seasonally, the maximum thickness (10-12m) occurred in late May/early June and descreased until destratification occurred in mid to late September. In late July/early August (cruise 4) there was an obvious expansion in the hypolimnion area and volume. The increase in area is the result of the extension of a 0-2 m thick hypolimnion into the Sandusky sub basin and is quantified in Table 9. The increase in hypolimnion volume is the result of the area increase coupled with a slight increase in hypolimnion thickness in some areas as evident from the additional pockets of 8 m thick hypolimnion that were present on cruise 4 (Figure 9, Table 8). In late August there was a return of the hypolimnion to its position during cruise 3. Re-establishment of the hypolimnion was also accompanied by a slight increase in hypo thickness to 10 m in the center portion of the central basin. Turnover of the hypolimnion had already begun by the end of cruise 6 (September 13) resulting in two separate hypolimnion areas (Figure 9). Hypolimnion thickness, temperatures and oxygen data are presented in Table 8. It can be assumed that any stratification remaining after cruise 6 (September 13) would be short lived.

Dissolved Oxygen

Medians for western basin D.O. cruise concentrations showed small seasonal fluctuations. As expected, the spring and fall concentrations were the highest while the 5 summer cruises remained nearly constant. Cruise medians for D.O. percent saturation remained uniform with the highest values occurring in early August. The early August cruise also exhibited the widest range from 10.4 to 0.1 mg/l and D.O. percent saturations from 133.2 to 1.2% (Figures 10 and 11). The single low oxygen value was encountered in the Pigeon Bay Region as discussed in the temperature section.

D.O. cruise medians for the central basin epilimnion reached a minimum on cruise 5 in late August although lower individual values were found during cruise 6 (early September) (Figure 12). As expected, the epilimnion medians for dissolved oxygen percent saturation remained at approximately 100% (Figure 13).

The seasonal display of hypolimnion D.O. contours are presented in Figure 14a. The highest concentrations of D.O. are usually found in the more stable portion of the central basin where the water column is the deepest and the hypolimnion thicknesses are greatest. The lowest D.O. levels usually occur in the southwest corner of the central basin, including or adjacent to the Sandusky sub basin. The exception occurs during cruise 6 (early September) as the lake is destratifying at which time higher 0_2 levels are observed in the southwest fringes of the hypolimnion area.

Figure 14b is a schematic presentation of the composite area that experienced anoxia during some portion of the stratified period. The 5,470 km^2 area is approximately equivalent to 42 percent of the entire hypolimnion area (13,149 km^2) or 33 percent of the central basin surface area (16,620 km^2).

The central basin hypolimnion D.O. medians indicated a continuously decreasing rate of depletion throughout the stratified period. There appears to be two different rates of hypolimnion depletion or two different slopes (Figure 15). Cruises 2 to 4 (early June to early August) exhibit the first slope (.08 mg/l) and cruises 4 to 6 (early August to mid September) indicate a slightly steeper negative slope or greater decrease in 0_2 concentration. A similar two slope change is observed for the median hypolimnion percent saturations (Figure 16). This simple analysis of the data does not reflect the actual oxygen budget and does not account for the hypolimnion thickness changes or entrainment of mesolimnion or Eastern basin water.

The budget for the 1982 central basin hypolimnion surveys was facilitated by the Survey 8 program (Hanson et. al., 1978) and calculations were performed according to the Burns model (Burns, 1976). The mesolimnion exchange model accounts for losses in dissolved oxygen due to decreasing hypolimnion volume and area. The model also corrects for the additional oxygen when an increase in hypolimnion volume and area occur as they did prior to cruise 4 (early August) (Table 9). The results of the cruise interval calculations are as follows:

Cruise Number	Duration of Interval (days)	Volumetric Rate mg/l/day
2-3	27	.106
3-4	35	.102
4-5	24	.116
5-6	19	.121

An increase in volumetric oxygen depletion is evident after cruise 4 (early August) until turnover in mid September. The overall average for the stratified season is .111 mg 0_2/l/day $\pm$ .009. This and other available data since 1930 is presented in Table 10. Central basin volumeteric depletion rates appear to fluctuate from .08 to .130 mg 0_2/l/day and depend on seasonal weather conditions (Hartley, 1966).

NUTRIENTS

Nutrients measured during the 1982 field season included total phosphorus (TP), soluble reactive phosphorus (SRP), total filtered phosphorus (TFP), ammonia (NH_3), nitrate plus nitrate (NO_2 + NO_3) and soluble reactive silica (SRS). All parameters were analyzed using a Technicon AutoAnalyzer II with the methods described in Letterhos (1982). Samples to be analyzed for soluble nutrients were filtered immediately and determined within two to four hours of collection. Total phosphorus and TFP were digested and analyzed following each cruise.

Due to spring storms and peak runoff total phosphorus concentrations were highest in both basins in early April, averaging 130 ug/l for the western basin and 33 ug/l for the central basin (Figures 17 and 18). Western Basin concentrations decreased to a minimum of 18 ug/l by late June and then began a steady increase to 44 ug/l by mid September. Values continued to decline through October. Central basin epilimnion concentrations dropped to a minimum of 8.5 ug/l during the summer months and rose again through the fall. Hypolimnion values were slightly higher than those of the epilimnion and remained fairly stable throughout the season (Figure 19).

Soluble reactive phosphorus in the western basin reached a maximum in early April of 10.5 ug/l, however, a central basin maximum of 4.4 ug/l was not observed until late October. Both basins exhibited similar seasonal distribution patterns with higher values in the spring and fall and lower values during the summer months. Hypolimnion values were only slightly greater than epilimnion values and showed only a small rise near the end of the stratified period when hypolimnion waters became anoxic (Figures 20-22). Total filtered phosphorus concentrations closely followed the seasonal pattern of SRP, measuring approximately two to three times higher. An exception to this occurred in the western basin at the end of July when TFP concentrations four times higher were measured at most stations. Within the next cruise interval, concentrations dropped back to levels consistant with SRP and remained stable for the rest of the sampling season. Figures 23 to 25 portray the range of TFP concentrations.

Western basin NO_2 + NO_3 concentrations were more varied seasonally and spatially than were those in the central basin as seen in Figures 26 and 27. Epilimnion values followed the same pattern in both basins with maximums reached in late May decreasing through late summer and rising again into October. Western basin values dropped sharply in the cruise interval from early to late August, reaching a minimum of 22 ug/l while central basin values decreased more gradually and remained above 100 ug/l. Central basin hypolimnion concentrations showed little change throughout the stratified season averaging between 225 and 275 ug/l, with a maximum reached during August and only a slight decrease noted near the end of stratification when anoxia was most extensive (Figure 28).

Ammonia nitrogen was much less variable than NO_2 + NO_3 nitrogen, but this was expected because ammonia is generally assimilated at a fast rate. Seasonal distribution patterns (Figure 29 to 31) show little difference between western basin and central basin epilimnions once peak spring loading had receded with medians ranging between 4 and 20 ug/l. A maximum cruise median of 178 ug/l was reached in the western basin in mid-April at the same time a minimum cruise median of less than 1 ug/l was reached in the central basin. The single highest ammonia value, 332 ug/l, was recorded during early August in the western basin at station 57. A corresponding D.O. level of 1.5 mg/l was measured on the bottom, indicating that regeneration of ammonia was ocurring. Central basin hypolimnion concentrations were higher than both western and central basin epilimnion concentrations during the stratified period. Hypolimnion values increased from 12.2 ug/l at the beginning of the stratified period to 34.3 ug/l by the end of June, decreased through late August to 15.0 and then increased again to 37.0 ug/l in mid September, due to regeneration.

Soluble reactive silica exhibited considerable fluctuation in the western basin and central basin hypolimnion compared with the central basin epilimnion (Figures 32 to 34). Western basin SRS concentrations were highest in early April (2100 ug/l), dropped to a minimum (280 ug/l) by late May and alternated between 350 ug/l and 900 ug/l for the remainder of the year. The central basin epilimnion values exhibited a steadily increasing silica content from early April to the end of October. Hypolimnion concentrations increased from 240 ug/l at the beginning of the stratified period to 2240 ug/l near turnover when a number of stations were anoxic. Following fall turnover, western and central basin concentrations were similar, averaging 545 ug/l.

Both central and western basin nutrient levels tended to follow the same seasonal distribution patterns observed in Lake Erie in previous years. Although anoxia was present during cruises 5 and 6, significant regeneration was only noted for ammonia and SRS (Figure 35). Generally, nutrient concentrations decreased from west to east and south to north with more concentrated nutrients emanating mainly from rivers along the south shore and following current patterns. Isopleths describing cruise by cruise observations for TP, NO_2 + NO_3, NH_3, and SRS appear in Figures 36 to 39. A full compliment of spatial distribution maps is not included for ammonia due to the lack of concentration differences observed throughout the season. Only data from the late August and early September cruises are included to demonstrate the difference between epi and hypo concentrations during anoxia. Volume weighted concentrations and total in lake metric tonnages present were calculated by basin and appear in Tables 11 and 12.

PARTICULATES

Particulate material found in the water column is comprised of both organic and inorganic suspended material. In the spring the suspended particulate concentration has a high inorganic content generally reaching up to 80% of the total (western basin). This is the result of both internal loading, the resuspension of bottom sediments and external loading from tributaries draining agricultural lands. During the summer the central basin stratifies resulting in decreased concentration of particulate inorganic material due to decreases in both internal and external loading sources. The decrease in inorganic suspended material and the increase in plankton biomass causes the percent organic suspended material to increase from 20 to nearly 50% of the total (central basin). As Fall approaches temperatures decrease and weather again becomes a factor in increasing sediment resuspension. Generally in the early fall the particulate concentration is as high as in the spring however, initially there is a higher percent organic content. This is due to the plankton biomass as well as resuspension of organic ladden sediments following turnover. After the early fall peak the percent organic suspended material decreases as plankton biomass decreases through the later portion of the year. In contrast the percent inorganic material increases as internal and external loading again increases. It is evident that the central and western basins of Lake Erie follow a similar cycle but, particulate concentrations are generally from 2 to 5 times higher in the western basin. Surface and bottom concentrations do vary but both generally follow the same pattern.

The 1982 field season followed the previously described patterns, however there were extremely high concentrations of particulate inorganic suspended material during the first cruise in early April. This was the result of very high tributary loading.

Turbidity and Secchi

Turbidity and secchi values for the 1982 field season followed the pattern previously outlined (Figures 40 and 41). The reciprocal of secchi depth has been plotted along with mean turbidity values. The highest turbidities were observed during the early spring cruise. Turbidity levels remained uniformly low throughout the summer in both basins, rising only slightly during the fall. The relationship between Secchi and turbidity is more constant for the central basin waters. Secchi area-weighted transparency for the years 1974, 1978 and 1982 are presented in Figures 42 and 43. As seen from these graphs, 1982 values followed the same pattern as seen in previous years both in the central and western basin although the clarity of the water was slightly lower in 1982. The spatial patterns of secchi disk transparency (Figure 44) throughout the season are not unique for 1982. The lowest values occurred in April for the entire western basin (0.2 m) and the greatest secchi values occurred in late July in the central basin (9 m).

Corrected Chlorophyll a

The 1982 Corrected Chlorophyll a concentrations followed the patterns previously stated with the central basin exhibiting a bimodal pattern (spring and fall peaks) and the western basin exhibiting a unimodal pattern (fall peak) (Figures 45-47). Epilimnion contours on a cruise by cruise basis are presented in Figure 48. Yearly means of Corrected Chlorophyll a (Chlacorr) surface concentrations for the western and central basins from 1970 to 1982 are presented in Figure 49.

Suspended Solids

Total, residual and volatile suspended solids for the western and central basins also followed the pattern previously described for the 1982 field season (Figures 50 and 51). The effect of cruise 1 on concentrations of total and residual suspended solids (TSS,RSS) is clearly evident from these figures. Volatile suspended solids (VSS) are less effected in cruise 1 because over 85% of the suspended material at this time was inorganic.

Particulate Organic Carbon

Particulate organic carbon (POC) followed similar seasonal patterns as outlined for Chlacorr and VSS (Figures 52 and 53). This relationship was evident throughout the central and western basins.

Relationships of the Particulates

The 1981 Open Lake Report (Fay, 1982) provided information on a three way relationship between Chlacorr, POC and VSS. Correlation coefficients (r) were calculated from the 1982 data base and similar relationships were found as reported in 1981 (Table 13; Figures 52-55). An additional relationship that correlated well both years was turbidity and TSS (Table 13, Figures 56 and 57). Relationships between these parameters were examined for two reasons. First to establish the existence of relationships between related parameters and its robustness. Second, to develop a predicitable model where one or more parameters could be estimated by using measurements of a single related parameter. Past and future data sets need to be analyzed to determine if any predictable model is possible.

Data from cruise 1 was not used in some calculations due to the high concentrations of the various components of the particulate material. The high concentrations of inorganic material during this time did not typify the remainder of the 1982 data set.

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TABLE 1

1982 LAKE ERIE SAMPLING SCHEDULE

Cruise No.	Calendar Dates	Cruise Mid-Point	Julian Dates	Julian Mid-Point
1	April 5 - April 12	April 9	095-102	099
2	May 26 - June 1	May 29	146-152	149
3	June 21 - June 29	June 25	172-180	176
4	July 26 - August 2	July 30	207-214	211
5	August 19 - August 26	August 23	231-238	235
6	September 8 - September 13	September 11	251-256	254
7	October 18 - October 26	October 22	291-299	295

TABLE 2

GEOGRAPHIC COORDINATES OF 1982 LAKE ERIE
WATER QUALITY MONITORING STATIONS

Station Number	Latitude (N)	Longitude (W)	Water Depth (m)	Basin	Water Quality Grid No.
024	42°05'54"	80°29'00"	19.5	C	19
025	42°14'54"	80°33'36"	21.5	C	20
026	42°24'00"	80°38'12"	19.8	C	20
027	42°32'54"	80°45'30"	16.0	C	21
028	42°35'30"	80°01'00"	16.5	C	22
029	42°36'18"	80°17'54"	12.3	C	22
030	42°25'48"	80°12'18"	20.5	C	23
031	42°15'12"	81°06'24"	21.3	C	24
032	42°04'54"	81°00'42"	21.5	C	25
033	41°55'54"	80°55'00"	17.7	C	26
035	41°45'48"	80°23'00"	12.6	C	27
036	41°56'06"	81°28'42"	22.9	C	28
037	42°06'36"	81°34'30"	23.9	C	29
038	42°16'54"	81°40'18"	21.6	C	30
039	42°21'30"	81°42'24"	18.7	C	31
040	42°11'30"	81°55'18"	16.8	C	32
041	42°08'06"	82°08'24"	20.4	C	32
042	41°57'54"	80°02'30"	22.2	C	33
043	41°47'18"	81°56'42"	22.6	C	34
044	41°31'48"	81°42'30"	12.3	C	36
045	41°36'24"	81°53'48"	17.5	C	35
046	41°40'54"	82°05'12"	19.5	C	37
047	41°50'18"	82°12'48"	18.9	C	38
048	42°02'48"	82°21'54"	17.0	C	39
050	41°48'48"	82°30'06"	11.0	C	40

TABLE 2 (CONTINUED)

GEOGRAPHIC COORDINATES OF 1982 LAKE ERIE WATER QUALITY MONITORING STATIONS

Station Number	Latitude (N)	Longitude (W)	Water Depth (m)	Basin	Water Quality Grid No.
051	41°38'30"	82°24'12"	13.5	C	41
053	41°25'12"	82°30'12"	10.8	C	42
054	41°34'00"	82°38'06"	11.9	C	43
057	41°49'54"	83°01'06"	9.9	W	48
059	41°43'36"	82°09'00"	8.2	W	47
061	41°56'48"	83°02'42"	8.8	W	61
075	41°54'00"	83°18'00"	6.1	W	49
076	41°36'30"	83°04'00"	4.0	W	46
082	41°34'30"	82°10'00"	15.2	C	41
084	41°46'00"	83°20'00"	9.7	W	49
202	41°41'48"	83°28'00"	9.6	W	N
321	41°36'30"	83°04'00"	4.2	W	46
325	41°45'18"	82°54'00"	10.0	W	46
328	41°52'12"	82°46'36"	11.4	W	45
331	41°59'00"	82°39'12"	10.8	W	45
401	42°03'00"	83°08'30"	10.4	W	N

TABLE 3

SYNOPSIS OF METHODS

Parameter	Method	Range	Detection Limit
Specific Conductance	In situ probe (InterOcean, Martek) Electrode (Beckman, YSI)	0-1000 umhos/cm	.02 umhos 1%
Extinction Depth	Licor Quantum/Radiometer/Photometer Protomatic submarine photometer	NA	0.1 m 0.1 m
Suspended Solids	Gravimetric, using Whatman GF/C glass fiber filters	1-10,000 mg/l	.01 mg
Temperature	Thermistor (InterOcean, Martek) Mechanical Bathythermograph NBS Calibrated Thermometer Reversing Thermometer	0-35°C	0.2°C
Transmission	Martek, Hydro Products Transmissometer	NA	
Transparency	Secchi disk	NA	.01 m
Turbidity	Hach Turbidimeters (Model 2100A and Ratio)	0-1000 NTU (3 lower ranges are available on each meter)	.02 NTU
Alkalinity	Titrimetric (.02N HCl)	0-250 mg/l $CaCO_3$	.5 mg/l
Chloride	Ferricyanide, AAII	.5-50 mg Cl/l	.5 mg/l
Ammonia	Phenate Method, AAII	0.5-100 ug N/l 1.0-200 ug N/l 2.0-400 ug N/l	.5 ug/l 1.0 ug/l 2.0 ug/l

TABLE 3 (CONTINUED)

SYNOPSIS OF METHODS

Parameter	Method	Range	Detection Limit
Nitrate + Nitrite	Cadmium Reduction, AAII	.005-1 mg N/l	.005 mg/l
pH	Electrode (InterOcean, Martek, Orion)	0-14	0.1
Dissolved Oxygen	Electrode (InterOcean, Martek) Titrimetric (Winkler azide modification)	0-20 mg O_2/l	0.05 mg O_2/l
Soluble Reactive Phosphorus	Stannous Chloride, AAII	.5-50 ug P/l	.5 ug/l
Total Phosphorus	Persulfate Digestion, Stannous Chloride	.5-50 ug/l 1.0-100 ug	.5 ug/l 1.0 ug/l
Total Filtered Phosphorus	Persulfate Digestion, Stannous Chloride, AAII	Expanded further by Machine or Manual Dilutions	
Particulate Phosphorus	Persulfate Digestion, Stannous Chloride, AAII NaOH Extraction, Stannous Chloride, AAII CDB Extraction, Stannous Chloride, AAII H_2SO_4 Extraction, Stannous Chloride, AAII		
Dissolved Reactive Silicate	Molibdosilicate-Ascorbic Acid-Oxalic Acid, AAII	.03-5.00 mg SiO_2/l	.03 mg/l
Sulfate	Methylthymol Blue, AAII	.5-50 mg SO_4/l	.5 mg/l
Dissolved Organic Carbon	UV Digestion - Phenolphthalein, AAII	.2-10 mg C/l	.2 mg/l

TABLE 3 (CONTINUED)

SYNOPSIS OF METHODS

Parameter	Method	Range	Detection Limit
Chlorophyll a	Acetone extinction Varian Spectrophotometer	0-50 ug/l	.02 ug/l
Pheopigment	Acetone extinction Varian Spectrophotometer	0-50 ug/l	.04 ug/l
Kjeldahl Nitrogen	Continuous Helix Digestion with H_2SO_4 and Hydrogen Peroxide	10-1000 ug N/l	10 ug/l
Particulate Organic Nitrogen	Perkin-Elmer Model 240 Elemental Analyzer	0-5000 mg N	.002 mg
Particulate Organic Carbon	Perkin-Elmer Model 240 Elemental Analyzer	0-5000 mg C	.005 mg
Benthos	Optical examination (Ponar Grab)		species
Phytoplankton	Optical examination (Collected w/ Niskin Bottle, Preserve w/Lugols)	macro + nanoplankton	species
Zooplankton	Optical examination (64 u net, $CaCO_3$ formalin + sucrose)	.075 mm	species

TABLE 4

QUALITY CONTROL SUMMARY FOR 1982

	Std. Dev.*	Range Limit	Scale and/or Units	N	% of Samples Within Range Limits
Chlorophyll a Corrected	0.31	1.2	ug/1	64	95.3
Conductivity Corrected to 25°C	2.12	7.8	umhos/cm	64	96.1
Dissolved Oxygen	0.06	0.2	mg/1	58	96.6
pH	0.018	0.07	units	64	98.4
Temperature	0.06	0.2	°C	50	96.4
Transparency (Secchi)	0.12	0.4	Meters	35	91.4
Turbidity	0.39	1.4	ntu's	64	95.3
Ammonia	1.16	4.3	0-100 ug/1	127	95.3
Nitrate + Nitrite	0.0020	0.007	0-1 mg/1	130	91.5
Soluble Reactive Phosphorus	0.23	0.8	0.50 ug/1	129	95.3
Total Phosphorus	0.32	1.2	0.100 ug/1	130	96.1
Total Filtered Phosphorus	0.33	1.2	0-50 ug/1	130	96.9
Soluble Reactive Silica	0.007	0.03	0-5 mg/1	130	95.0

* Standard Deviations are calculated using the system authorized by the IJC.

TABLE 5

1982 WESTERN BASIN MEAN/MEDIAN WATER QUALITY SUMMARY

Cruise		Date	Statistics	SRP (ug/l)	TP (ug/l)	TFP (ug/l)	Ammonia (ug/l)	NO_3+NO_2 (ug/l)
1	epi	4/5 - 4/12	Mean	16.4	178.9	21.7	135.6	712
			Std. Err.	3.6	39.6	4.3	21.4	151
			Median	10.5	130.0	15.1	178.5	485
			Q1	6.8	92.6	10.5	16.2	419
			Q3	22.5	192.6	26.6	192.5	729
			N	19	19	19	19	19
2	epi	5/26 - 6/1	Mean	5.6	37.0	10.7	30.1	716
			Std. Err.	1.6	7.6	2.2	10.2	115
			Median	2.0	23.1	5.7	15.8	639
			Q1	1.5	13.1	4.0	8.0	410
			Q3	7.5	49.4	16.0	35.2	804
			N	19	19	19	19	19
3	epi	6/21 - 6/29	Mean	4.1	26.4	7.4	32.8	423
			Std. Err.	0.9	4.0	1.0	7.0	54
			Median	1.9	18.0	4.9	20.8	301
			Q1	1.3	15.0	3.9	8.8	260
			Q3	6.2	36.9	10.5	55.0	552
			N	20	20	20	20	20
4	epi	7/26 - 8/2	Mean	2.9	25.0	7.9	40.2	344
			Std. Err.	0.5	2.2	0.5	17.0	24
			Median	2.1	24.2	8.0	7.0	331
			Q1	1.7	17.3	6.4	2.3	278
			Q3	3.0	30.6	8.8	46.0	391
			N	20	20	20	20	20

TABLE 5 (CONTINUED)

1982 WESTERN BASIN MEAN/MEDIAN WATER QUALITY SUMMARY

Cruise		Date	Statistics	SRP (ug/l)	TP (ug/l)	TFP (ug/l)	Ammonia (ug/l)	NO_3+NO_2 (ug/l)
5	epi	8/19 - 8/26	Mean	2.6	41.7	6.4	4.3	79
			Std. Err.	0.2	4.5	0.6	0.6	19
			Median	2.3	43.4	6.3	3.8	22
			Q1	1.9	23.6	4.1	1.9	5
			Q3	3.0	51.0	8.4	6.6	150
			N	20	20	20	20	20
6	epi	9/8 - 9/13	Mean	5.5	46.4	8.5	12.5	101
			Std. Err.	1.5	6.8	1.6	3.4	19
			Median	3.6	44.1	6.9	4.7	87
			Q1	1.5	21.5	2.9	2.7	27
			Q3	7.3	57.6	11.5	18.6	180
			N	20	20	20	20	20
7	epi	10/18 - 10/26	Mean	5.3	38.4	7.7	23.7	182
			Std. Err.	0.6	4.2	0.9	10.0	19
			Median	5.0	33.5	8.6	10.6	194
			Q1	2.7	24.5	4.8	3.9	124
			Q3	7.6	51.5	10.8	15.9	253
			N	20	20	20	20	20

TABLE 5 (CONTINUED)

1982 WESTERN BASIN MEAN/MEDIAN WATER QUALITY SUMMARY

Cruise		Date	Statistics	SRS (ug/l)	Corr. Chla (ug/l)	Corr. Cond. (umhos/cm)	D.O. (mg/l)	% Sat.
1	epi	4/5 - 4/12	Mean	2184	3.2	269	12.7	97.6
			Std. Err.	227	0.4	8	0.1	0.7
			Median	2100	3.1	263	12.7	97.2
			Q1	1450	1.8	242	12.5	96.5
			Q3	2250	4.3	279	13.0	98.8
			N	19	19	19	18	18
2	epi	5/26 - 6/1	Mean	433	4.2	268	8.4	90.4
			Std. Err.	97	1.2	8	0.3	3.2
			Median	280	2.1	257	9.0	94.8
			Q1	180	1.5	246	7.2	77.1
			Q3	510	3.3	293	9.4	101.8
			N	19	19	19	19	19
3	epi	6/21 - 6/29	Mean	664	3.8	251	8.3	91.0
			Std. Err.	98	0.5	5	0.3	3.5
			Median	580	3.7	247	8.8	95.4
			Q1	370	1.9	238	7.4	79.6
			Q3	770	5.6	260	9.4	104.3
			N	20	20	20	20	20
4	epi	7/26 - 8/2	Mean	1131	9.1	253	7.3	89.6
			Std. Err.	332	1.7	3	0.6	8.0
			Median	500	7.2	251	8.4	103.1
			Q1	170	3.2	242	5.7	67.5
			Q3	1680	11.9	267	9.2	113.8
			N	20	20	20	20	20

TABLE 5 (CONTINUED)

1982 WESTERN BASIN MEAN/MEDIAN WATER QUALITY SUMMARY

Cruise		Date	Statistics	SRS (ug/l)	Corr. Chla (ug/l)	Corr. Cond. (umhos/cm)	D.O. (mg/l)	% Sat.
5	epi	8/19 - 8/26	Mean	924	17.1	232	8.4	98.7
			Std. Err.	88	2.4	3	0.1	1.4
			Median	913	16.9	231	8.4	99.1
			Q1	665	10.6	221	8.2	96.0
			Q3	1285	24.5	236	8.6	102.7
			N	20	20	20	20	20
6	epi	9/8 - 9/13	Mean	493	17.3	236	8.3	88.6
			Std. Err.	100	2.4	4	0.1	1.3
			Median	350	15.5	232	8.3	88.4
			Q1	165	8.9	221	8.1	86.1
			Q3	665	26.9	250	8.6	92.1
			N	20	20	20	20	20
7	epi	10/18 - 10/26	Mean	692	11.7	241	9.6	89.6
			Std. Err.	134	2.2	4	0.1	0.7
			Median	530	7.9	238	9.6	89.0
			Q1	120	2.9	225	9.4	88.3
			Q3	1350	20.7	255	9.9	90.4
			N	20	20	20	20	20

TABLE 5 (CONTINUED)

1982 WESTERN BASIN MEAN/MEDIAN WATER QUALITY SUMMARY

Cruise		Date	Statistics	Temperature (^oC)	pH (su)	Secchi (m)	Turbidity (ntu's)	TSS (mg/1)
1	epi	4/5 - 4/12	Mean	2.3	7.93	.2	143.9	71.5
			Std. Err.	0.2	0.02	.02	31.8	11.9
			Median	2.2	7.94	.2	105.0	71.9
			Q1	1.7	7.92	.2	60.0	51.0
			Q3	2.9	7.95	.2	175.0	92.1
			N	20	19	9	19	4
2	epi	5/26 - 6/1	Mean	19.7	8.20	1.9	16.1	3.4
			Std. Err.	0.4	0.05	0.40	4.6	1.2
			Median	20.3	8.29	2.1	8.1	3.3
			Q1	18.4	7.99	0.7	2.1	1.3
			Q3	20.8	8.39	2.7	16.0	5.4
			N	19	19	10	19	4
3	epi	6/21 - 6/29	Mean	20.7	8.22	1.9	8.1	3.6
			Std. Err.	0.3	0.06	0.35	2.0	0.7
			Median	20.8	8.24	1.9	6.1	3.0
			Q1	19.7	8.03	1.0	2.9	2.9
			Q3	21.9	8.40	2.2	8.9	4.3
			N	20	20	9	20	4
4	epi	7/26 - 8/2	Mean	25.0	8.40	2.1	6.6	6.5
			Std. Err.	0.3	0.11	0.26	1.0	2.1
			Median	25.2	8.61	2.3	6.6	6.2
			Q1	24.1	8.02	1.3	2.7	2.8
			Q3	25.9	8.77	2.7	8.0	10.1
			N	20	20	10	20	4

TABLE 5 (CONTINUED)

1982 WESTERN BASIN MEAN/MEDIAN WATER QUALITY SUMMARY

Cruise		Date	Statistics	Temperature (°C)	pH (su)	Secchi (m)	Turbidity (ntu's)	TSS (mg/1)
5	epi	8/19 - 8/26	Mean	23.9	8.68	1.0	11.2	13.9
			Std. Err.	0.1	0.04	0.08	1.3	2.1
			Median	24.1	8.71	1.0	10.4	15.6
			Q1	23.7	8.65	0.8	7.6	11.2
			Q3	24.2	8.80	1.1	13.7	16.5
			N	20	20	10	20	4
6	epi	9/8 - 9/13	Mean	19.7	8.55	0.9	15.4	13.6
			Std. Err.	0.1	0.04	0.10	3.3	1.7
			Median	20.0	8.53	0.9	11.9	14.3
			Q1	19.4	8.38	0.7	9.1	11.5
			Q3	20.1	8.70	1.2	14.3	15.7
			N	20	20	10	20	4
7	epi	10/18 - 10/26	Mean	13.0	8.30	0.8	14.2	11.8
			Std. Err.	0.2	0.03	0.06	1.2	1.4
			Median	12.9	8.24	0.8	13.6	11.5
			Q1	12.5	8.17	0.7	11.3	10.1
			Q3	13.9	8.43	0.9	16.9	13.5
			N	20	20	10	20	4

TABLE 6

1982 CENTRAL BASIN MEAN/MEDIAN WATER QUALITY SUMMARY

Cruise	No.	Date	Statistics	SRP (ug/1)	TP (ug/1)	TFP (ug/1)	Ammonia (ug/1)	$NO_3 + NO_2$ (ug/1)
1	epi	4/5-4/12	Mean	2.9	42.4	5.9	16.3	368
			Std. Err.	0.37	3.86	0.56	4.63	32.5
			Median	2.5	33.0	4.8	1.0	251
			Q1	1.4	30.9	3.7	1.0	197
			Q3	3.4	39.1	5.7	6.0	440
			N	48	48	48	42	48
2	epi	5/26-6/1	Mean	2.0	12.4	3.7	8.0	290
			Std. Err.	0.11	0.87	0.21	1.42	24.0
			Median	1.7	10.8	3.4	3.1	265
			Q1	1.6	8.6	2.7	1.3	108
			Q3	2.0	13.8	4.1	6.8	451
			N	66	66	66	66	66
	hypo		Mean	1.9	15.7	4.2	14.9	254
			Std. Err.	0.06	1.18	0.64	2.02	16.0
			Median	1.8	14.1	3.7	12.2	230
			Q1	1.7	12.8	3.0	7.5	190
			Q3	2.1	16.0	3.8	15.7	296
			N	33	33	33	33	33
3	epi	6/21-6/29	Mean	2.4	12.1	5.3	11.2	266
			Std. Err.	0.31	0.85	0.41	1.32	20.3
			Median	1.6	9.4	4.1	9.2	203
			Q1	1.0	7.5	3.0	5.3	142
			Q3	2.2	15.2	6.2	12.7	364
			N	66	66	66	66	66

TABLE 6 (CONTINUED)

1982 CENTRAL BASIN MEAN/MEDIAN WATER QUALITY SUMMARY

Cruise	No.	Date	Statistics	SRP (ug/1)	TP (ug/1)	TFP (ug/1)	Ammonia (ug/1)	$NO_3 + NO_2$ (ug/1)
	hypo		Mean	2.4	16.7	5.3	34.7	251
			Std. Err.	0.20	0.78	0.34	2.96	9.6
			Median	2.1	15.8	4.7	34.3	242
			Q1	1.7	14.0	4.1	24.5	215
			Q3	2.8	18.0	6.2	38.3	258
			N	33	33	33	33	33
4	epi	7/25-8/2	Mean	1.9	10.4	5.0	8.5	210
			Std. Err.	0.15	0.65	0.30	0.58	7.4
			Median	1.5	8.6	4.3	7.6	208
			Q1	1.3	7.6	3.7	5.7	163
			Q3	2.0	10.4	5.3	10.3	253
			N	60	60	60	60	60
	hypo		Mean	2.2	14.3	5.4	21.9	290
			Std. Err.	0.10	0.53	0.18	1.69	11.8
			Median	2.0	13.9	5.0	22.1	273
			Q1	1.7	11.7	4.4	10.9	229
			Q3	2.5	16.0	6.4	31.8	355
			N	47	47	47	47	47
5	epi	8/19-8/26	Mean	2.3	315.5	5.4	5.8	152
			Std. Err.	0.41	1.39	0.53	0.63	5.6
			Median	1.3	12.0	4.1	5.0	146
			Q1	1.0	9.4	3.6	2.2	125
			Q3	1.6	16.0	4.9	7.0	174
			N	61	61	61	61	61

TABLE 6 (CONTINUED)

1982 CENTRAL BASIN MEAN/MEDIAN WATER QUALITY SUMMARY

Cruise	No.	Date	Statistics	SRP (ug/1)	TP (ug/1)	TFP (ug/1)	Ammonia (ug/1)	$NO_3 + NO_2$ (ug/1)
	hypo		Mean	2.0	15.6	5.2	21.5	283
			Std. Err.	0.25	0.82	0.40	4.07	10.2
			Median	1.6	14.0	4.6	15.0	275
			Q1	1.5	12.1	4.3	7.8	242
			Q3	1.9	17.4	5.4	22.0	336
			N	34	34	34	34	34
6	epi	9/8-9/13	Mean	1.9	15.0	4.8	9.9	111
			Std. Err	0.21	1.01	0.30	1.30	5.0
			Median	1.4	11.7	4.2	5.5	109
			Q1	1.0	10.1	3.4	3.8	94
			Q3	1.9	16.8	5.5	12.5	134
			N	69	69	69	69	69
	hypo		Mean	2.9	15.5	6.0	44.0	233
			Std. Err.	0.43	1.43	0.68	7.25	16.7
			Median	2.4	14.6	5.9	37.0	241
			Q1	1.7	11.1	3.5	21.0	208
			N	14	14	14	14	14
7		10/18-10/26	Mean	4.8	22.2	8.1	10.0	130
			Std. Err.	0.30	0.61	0.34	0.62	3.8
			Median	4.4	21.7	7.4	8.6	126
			Q1	2.6	19.4	6.5	5.9	110
			Q3	6.0	23.8	9.4	14.2	146
			N	85	85	85	85	85

TABLE 6 (CONTINUED)

1982 CENTRAL BASIN MEAN/MEDIAN WATER QUALITY MEASUREMENTS

Cruise	No.	Date	Statistics	SRP (ug/1)	Corr. Chla (ug/1)	Corr. Cond. (umhos/cm)	D.O. (mg/1)	% Sat.
1	epi	4/5-4/12	Mean	443	3.9	266	13.3	100.8
			Std. Err.	76	0.15	1.3	0.04	0.34
			Median	150	3.8	267	13.4	101.2
			Q1	120	3.3	263	13.2	98.6
			Q3	575	4.8	272	13.5	102.9
			N	48	48	47	47	
2	epi	5/26-6/1	Mean	175	2.4	267	10.5	100.1
			Std. Err.	25	0.17	1.1	0.16	1.34
			Median	85	2.2	266	10.6	103.0
			Q1	40	1.4	261	10.0	97.2
			Q3	220	3.0	272	11.5	107.3
			N	66	66	66	66	66
	hypo		Mean	299	3.4	276	10.6	87.2
			Std. Err.	44	0.16	0.7	0.19	1.35
			Median	240	3.5	276	10.8	87.9
			Q1	150	2.8	273	9.9	81.3
			Q3	330	4.1	278	11.6	93.2
			N	33	33	33	33	33
3	epi	6/21-6/29	Mean	283	2.0	271	9.2	92.2
			Std. Err.	26	0.23	0.8	0.07	0.66
			Median	213	1.3	271	9.3	93.1
			Q1	120				
			Q3	390	2.4	274	9.5	95.6
			N	66	66	66	66	66

TABLE 6 (CONTINUED)

1982 CENTRAL BASIN MEAN/MEDIAN WATER QUALITY MEASUREMENTS

Cruise	No.	Date	Statistics	SRP (ug/1)	Corr. Chla (ug/1)	Corr. Cond. (umhos/cm)	D.O. (mg/1)	% Sat.
	hypo		Mean	601	1.8	281	8.1	68.3
			Std. Err.	65	0.13	1.1	0.19	1.60
			Median	510	1.5	280	8.3	69.9
			Q1	440	1.3	276	7.7	64.9
			Q3	670	2.1	285	8.8	74.1
			N	33	33	33	33	33
4	epi		Mean	312	3.1	267	8.3	96.4
			Std. Err.	26	0.23	0.8	0.06	0.80
			Median	260	2.5	267	8.4	98.0
			Q1	185	2.0	263	8.1	92.9
			Q3	365	3.6	272	8.6	100.7
			N	60	60	60	60	60
	hypo		Mean	1105	3.33	282	4.7	41.9
			Std. Err.	150	0.27	0.7	0.25	2.22
			Median	740	2.7	281	5.3	46.1
			Q1	420	1.7	278	3.9	33.5
			Q3	1490	4.6	286	6.0	52.0
			N	47	47	47	47	47
5	epi		Mean	498	6.8	268	7.9	85.8
			Std. Err.	39	0.67	1.1	.09	1.28
			Median	390	4.6	269	8.0	88.1
			Q1	235	2.9	266	7.6	84.1
			Q3	720	8.9	272	8.3	92.3
			N	61	61	61	61	61

TABLE 8

LAKE ERIE CENTRAL BASIN LIMNION, OXYGEN AND TEMPERATURE DATA, 1982*

Date	Yr/Agency	Cruise No.	Stratification	Limnion	Volume km^3	Hypo Area km^2	Thickness m	Oxygen mg/l	Temperature °C
4/5 - 4/12	1982/CLEAR	1	unstratified	total	308.3	0.0	19.3	13.3	1.2
5/26 - 6/1		2	stratified	epi	200.8		12.6	10.9	13.6
				meso	40.7		3.3	10.7	8.7
				hypo	65.2	11,439	5.7	11.0	6.4
				total	306.7				
6/21 - 6/29		3	stratified	epi	244.9		15.4	9.4	16.4
				meso	18.9		1.5	8.1	11.2
				hypo	42.8	10,974	3.9	8.3	8.2
				total	306.6				
7/26 - 8/2		4	stratified	epi	202.7		12.7	8.3	23.2
				meso	42.2		3.0	6.2	15.3
				hypo	61.8	13,149	4.7	5.2	10.8
				total	306.7				
8/19 - 8/26		5	stratified	epi	245.0		15.4	7.9	20.6
				meso	12.9		1.0	4.8	15.0
				hypo	47.1	11,775	4.0	2.7	11.4
				total	305.0				
9/8 - 9/13		6	stratified	epi	274.5		17.2	8.4	19.7
				meso	13.0		1.9	4.5	14.7
				hypo	14.4	5,538	2.6	2.2	14.0
				total	301.9				
10/18 - 10/26		7	unstratified	total	300.3				

*This data was derived from the Survey 8 volume weighting program.

TABLE 9

SUMMARY OF 1982 CENTRAL BASIN HYPOLIMNETIC SURVEYS OF LAKE ERIE

Date	Cruise No.	Area km^2	Volume km^3	Average Thickness (m)	Total Heat (kcal x 10^{12})	Average Temp. (^oC)	Total 0_2 (kg 0_2 10^6)	Mean 0_2 mg/1	Average T-Grad ($^oC\text{-}m^{-1}$)	Average 0_2 Grad ($g0_2\text{-}m^{-1}$)
5/26 - 6/1	2	11,439	65.2	5.7	417.3	6.4	717.2	11.0	2.18	0.03
6/21 - 6/29	3	10,974	42.8	3.9	351.0	8.2	355.2	8.3	5.47	0.73
7/26 - 8/2	4	13,149	61.8	4.7	667.4	10.8	321.4	5.2	4.13	1.03
8/19 - 8/26	5	11,775	47.1	4.0	536.9	11.4	127.2	2.7	9.20	5.20
9/8 - 9/13	6	5,538	14.4	2.6	201.7	14.0	31.7	2.2	3.00	3.26

TABLE 10

TRENDS IN NET OXYGEN DEMAND OF THE CENTRAL AND EASTERN BASIN HYPOLIMNIONS OF LAKE ERIE 1930 TO PRESENT

		NET OXYGEN DEMAND			
		Rate Per Unit Area ($g\ O_2\ m^{-2}\ day^{-1}$)		Rate Per unit Volume ($mg\ O_2\ l^{-1}\ day^{-1}$)	
DATA SOURCE*	YEAR	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	-
3	1981	0.47	-	0.085	-
3	1982	0.47 $\pm$ .04		0.111 $\pm$ .009	-

*Data sources: 1) Dobson and Gilbertson, 1972; 2) CCIW--Noel Burns, personal communication; 3) OSU/CLEAR--Central Basin, 1973-1977, 1980-1982; 4) SUNY/GLL--Eastern Basin, 1973-1976, 1977; 5) USEPA/GLNPO--rate calculation by OSU/CLEAR

TABLE 11

LAKE ERIE WESTERN BASIN WATER QUALITY SUMMARY, 1982

Date	Yr/Agency	Cruise No.	Stratification	Limnion	Volume km^3	Total metric tons	Phosphorus conc. ug/l	Corr. metric tons	Chl a conc. ug/l
4/5 - 4/12	1982/CLEAR	1	unstratified	total	25.4	3551.3	139.7	84.0	3.3
5/26 - 6/1		2	unstratified	total	25.0	691.7	27.6	78.6	3.1
6/21 - 6/29		3	unstratified	total	25.1	603.9	24.0	89.8	3.6
7/26 - 8/2		4	unstratified	total	25.1	581.5	23.2	180.9	7.2
8/19 - 8/26		5	unstratified	total	24.8	943.4	38.0	414.3	16.7
9/8 - 9/13		6	unstratified	total	24.2	977.1	40.4	366.0	15.1
10/18 - 10/26		7	unstratified	total	23.9	842.0	35.3	231.6	9.7

TABLE 11 (CONTINUED)

LAKE ERIE WESTERN BASIN WATER QUALITY SUMMARY, 1982

Date	Yr/Agency	Cruise No.	Stratification	Limnion	Volume km^3	Nitrate + Nitrite metric tons	Nitrate + Nitrite conc. ug/l	Ammonia metric tons	Ammonia conc. ug/l
4/5 - 4/12	1982/CLEAR	1	unstratified	total	25.4	14,939	587.6	3249	127.9
5/26 - 6/1		2	unstratified	total	25.0	15,649	625.3	603	24.1
6/21 - 6/29		3	unstratified	total	25.1	10,411	414.5	683	27.2
7/26 - 8/2		4	unstratified	total	25.1	8,163	325.0	1104	43.9
8/19 - 8/26		5	unstratified	total	24.7	2,660	107.7	108	5.6
9/8 - 9/13		6	unstratified	total	24.2	2,592	107.1	282	11.6
10/18 - 10/26		7	unstratified	total	23.9	4,394	184.0	682	28.6

TABLE 12

LAKE ERIE CENTRAL BASIN WATER QUALITY SUMMARY, 1982

Date	Yr/Agency	Cruise No.	Stratification	Limnion	Volume km^3	Total Phosphorus metric tons	Total Phosphorus conc. ug/1	Corr. Chl a metric tons	Corr. Chl a conc. ug/1
4/5 - 4/12	1982/CLEAR	1	unstratified	total	308.3	10729.6	34.8	1163.7	3.8
5/26 - 6/1		2	stratified	epi	200.8	2217.1	11.0	488.8	2.4
				meso	40.7	513.4	12.6	114.3	2.8
				hypo	65.2	921.6	14.1	206.7	3.2
				total	306.7	3652.1	11.9	809.8	2.6
6/21 - 6/29		3	stratified	epi	244.9	2395.2	9.8	349.7	1.4
				meso	18.9	227.9	12.0	34.2	1.8
				hypo	42.8	714.1	16.7	83.9	2.0
				total	306.6	3337.2	10.9	467.8	1.5
7/26 - 8/2		4	stratified	epi	202.7	1850.8	9.1	555.6	2.7
				meso	42.2	466.5	11.1	127.1	3.0
				hypo	61.8	871.8	14.1	199.2	3.2
				total	306.7	3189.1	10.4	881.9	2.9
8/19 - 8/26		5	stratified	epi	245.0	2980.7	12.2	1256.4	5.1
				meso	12.9	170.9	13.2	61.9	4.8
				hypo	47.1	714.0	15.1	204.5	4.3
				total	305.0	3865.6	12.7	1522.8	5.0
9/8 - 9/13		6	stratified	epi	274.5	3385.1	12.3	1314.2	4.8
				meso	13.0	148.9	11.5	45.7	3.5
				hypo	14.4	223.6	15.5	47.2	3.3
				total	301.9	3757.6	12.5	1407.1	4.7
10/18 - 10/26		7	unstratified	total	300.3	6311.7	21.0	1692.5	5.6

TABLE 12 (CONTINUED)

LAKE ERIE CENTRAL BASIN WATER QUALITY SUMMARY, 1982

Date	Yr/Agency	Cruise No.	Stratification	Limnion	Volume km^3	Nitrate + Nitrite metric tons	Nitrate + Nitrite conc. ug/1	Ammonia metric tons	Ammonia conc. ug/1
4/5 - 4/12	1982/CLEAR	1	unstratified	total	308.3	94,607	306.9	3963	12.9
5/26 - 6/1		2	stratified	epi	200.8	49,746	247.7	1453	7.2
				meso	40.7	10,260	251.9	409	10.1
				hypo	65.2	16,822	258.1	885	13.6
				total	306.7	76,828	250.5	2747	9.0
6/21 - 6/29		3	stratified	epi	244.9	55,002	224.6	2446	10.0
				meso	18.9	4,244	224.1	415	21.9
				hypo	42.8	11,450	267.4	1419	33.1
				total	306.6	70,696	230.6	4280	14.0
7/26 - 8/2		4	stratified	epi	202.7	38,585	190.3	1599	7.9
				meso	42.2	9,647	228.7	846	20.1
				hypo	61.8	17,675	285.9	1436	23.2
				total	306.7	65,907	214.9	3881	12.7
8/19 - 8/26		5	stratified	epi	245.0	37,867	154.5	1240	5.1
				meso	12.9	2,789	215.3	168	13.0
				hypo	47.1	13,618	288.9	761	16.1
				total	305.0	54,274	178.0	2169	7.1
9/8 - 9/13		6	stratified	epi	274.5	32,204	117.3	2624	9.6
				meso	13.0	2,071	159.4	247	19.0
				hypo	14.4	3,169	219.4	432	29.9
				total	301.9	37,444	124.0	3303	10.9
10/18 - 10/26		7	unstratified	total	300.3	39,920	132.9	2896	9.6

TABLE 12 (CONTINUED)

LAKE ERIE CENTRAL BASIN WATER QUALITY SUMMARY, 1982

Date	Yr/Agency	Cruise No.	Stratification	Limnion	Volume km^3	Silica metric tons	Silica conc. ug/1
4/5 - 4/12	1982/CLEAR	1	unstratified	total	308.3	79,761	
5/26 - 6/1		2	stratified	epi	200.8	28,289	140.9
				meso	40.7	7,897	193.9
				hypo	65.2	15,471	237.4
				total	306.7	51,657	168.4
6/21 - 6/29		3	stratified	epi	244.9	49,886	203.7
				meso	18.9	706	372.6
				hypo	42.8	23,086	539.1
				total	306.6	73,678	240.3
7/26 - 8/2		4	stratified	epi	202.7	55,284	272.7
				meso	42.2	23,429	555.5
				hypo	61.8	55,918	904.6
				total	306.7	134,631	439.0
8/19 - 8/26		5	stratified	epi	245.0	99,925	407.8
				meso	12.9	11,528	890.2
				hypo	47.1	61,250	1299.4
				total	305.0	172,703	566.2
9/8 - 9/13		6	stratified	epi	374.5	117,251	427.2
				meso	13.0	13,062	1005.2
				hypo	14.4	26,403	1827.5
				total	301.9	156,716	519.1
10/18 - 10/26		7	unstratified	total	300.3	176,263	586.8

TABLE 13

CORRELATION COEFFICIENTS (R) FOR THE CENTRAL AND WESTERN BASINS

Particulates for 1981 and 1982[1]

	Western Basin		Central Basin	
	1981	1982	1981	1982
POC - VSS	.82	.97	.86	.94
POC - Chlacorr	.95	.94	.76	.83*
Chlacorr - VSS	-	.89*	.91	.70*
Turbidity - TSS	.95	.98	.98	.99

[1]epilimnion data only

*Cruise 1 data omitted.

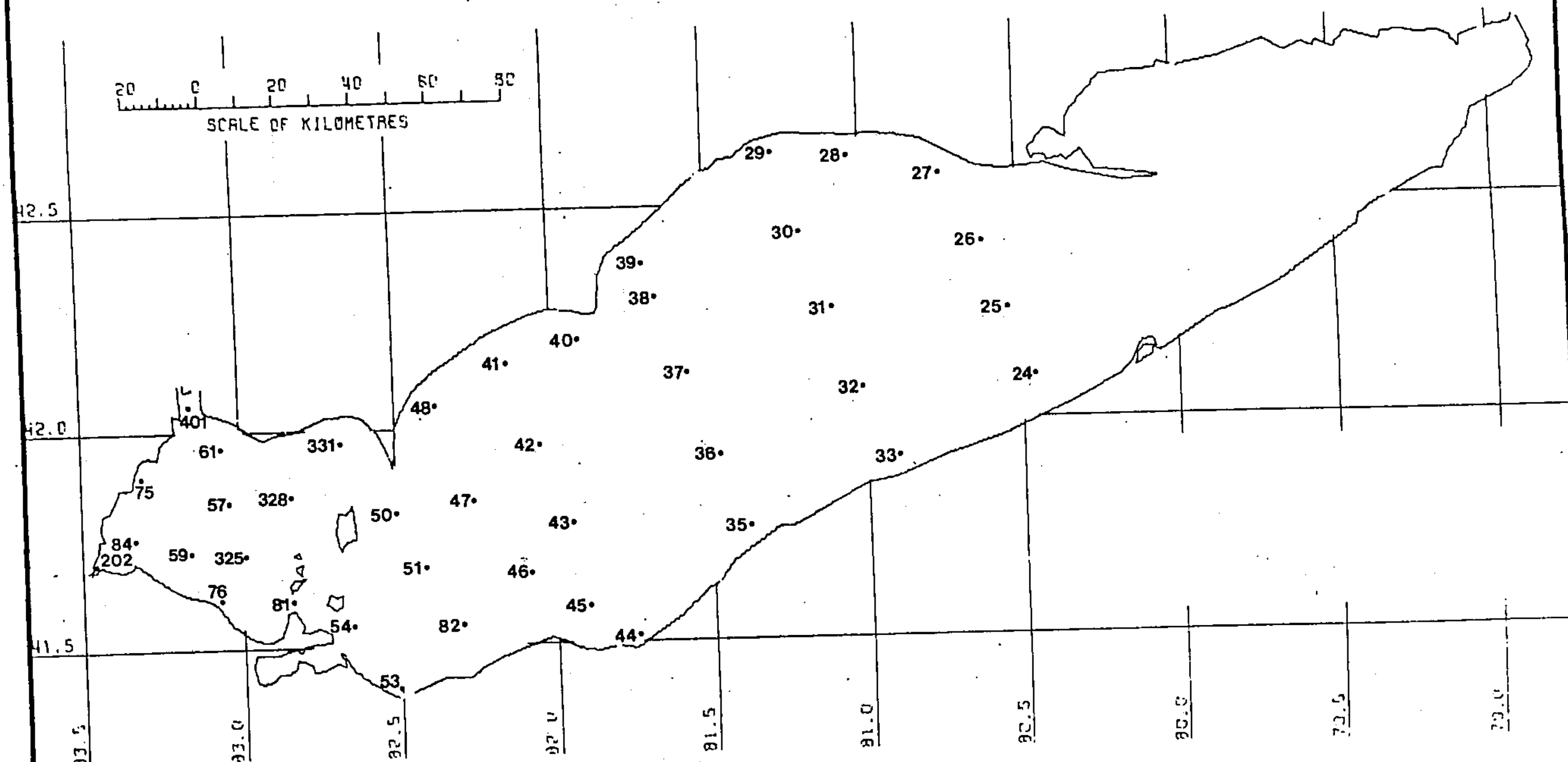
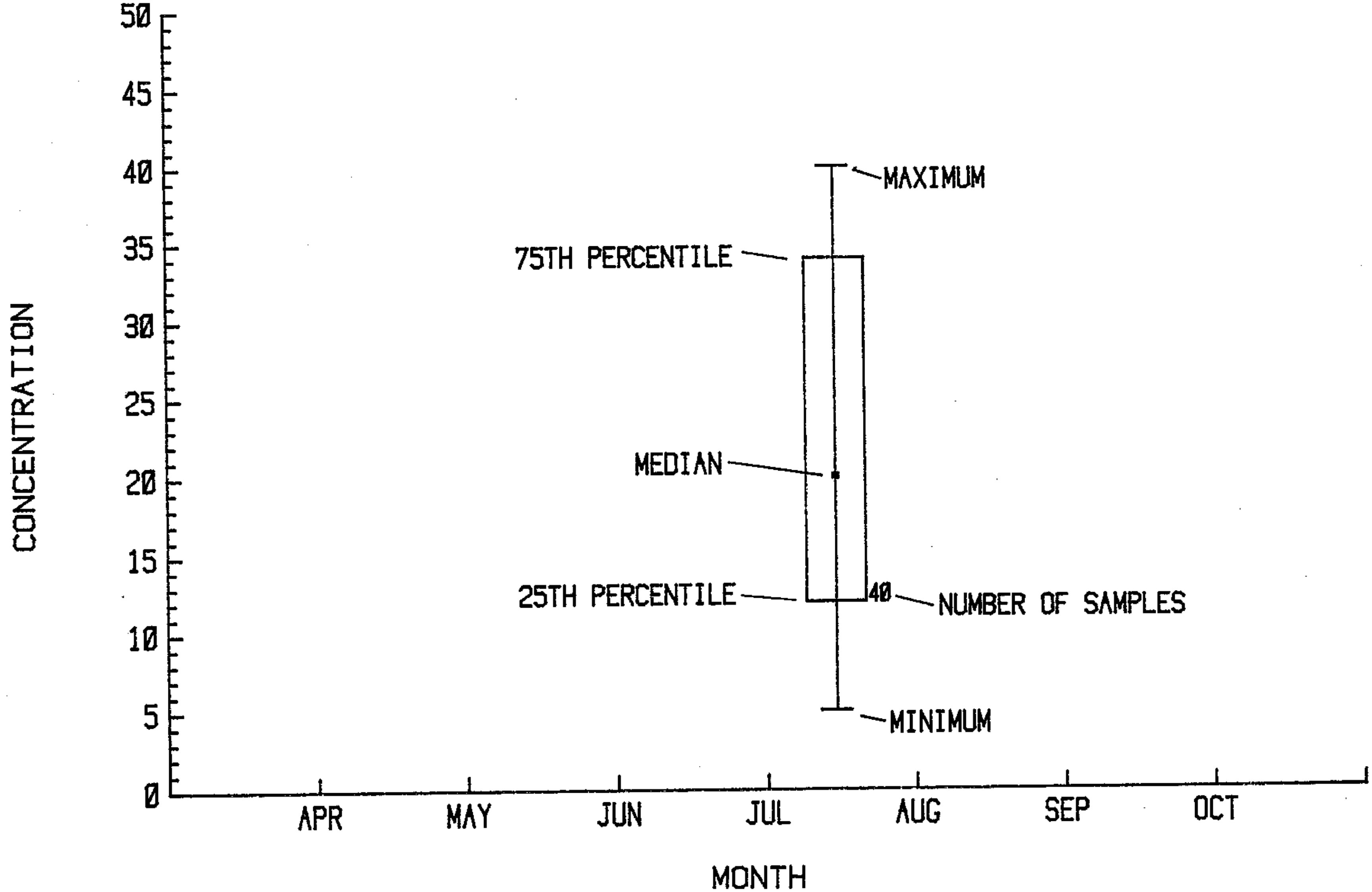


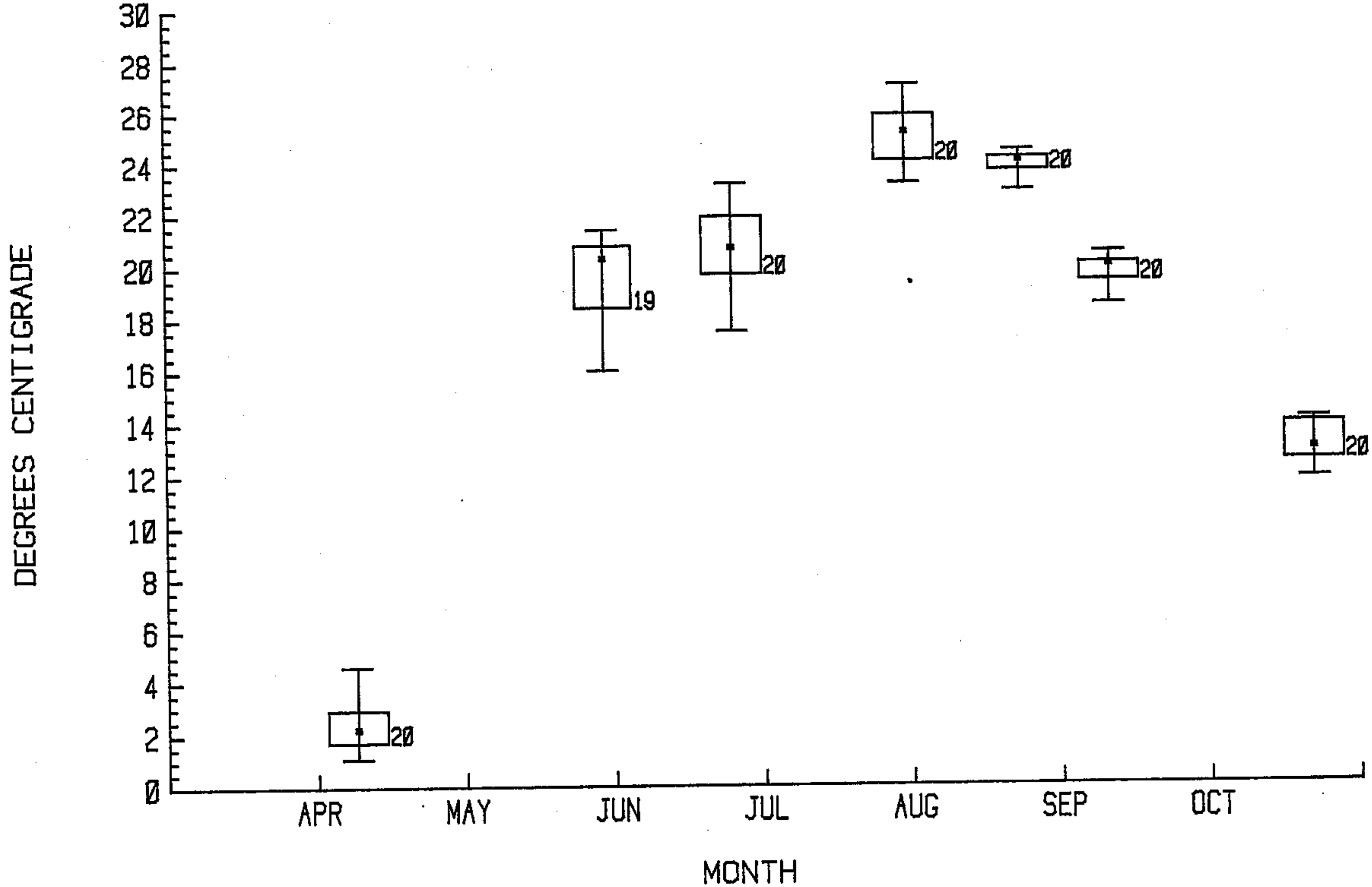
Figure 1. 1982 Open Lake Water Quality Monitoring stations (n=41)



EXPLANATION OF MEDIAN PLOTS

(After Reckhow, 1980)

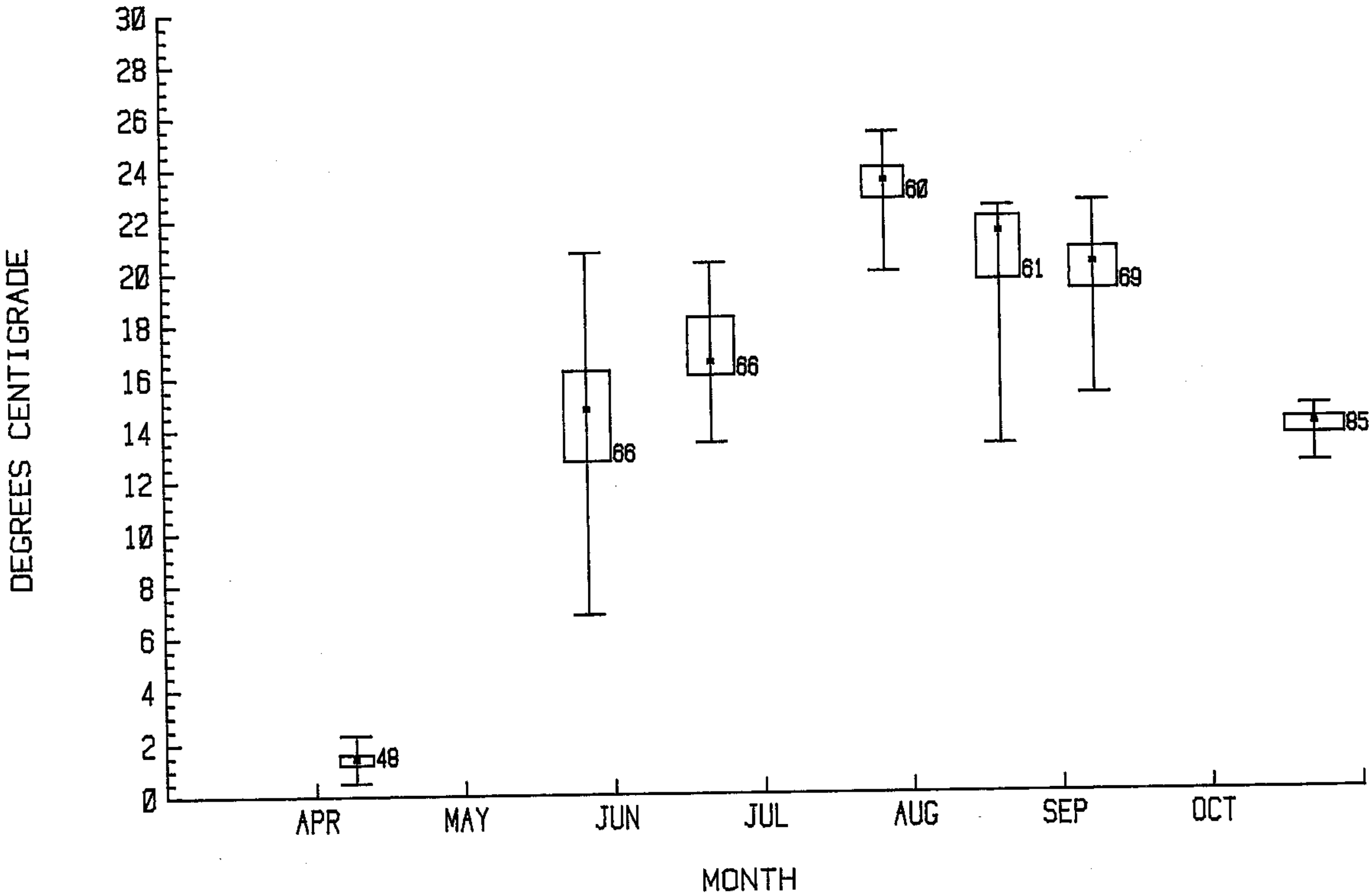
Figure 2



TEMPERATURE MEDIANS

WESTERN BASIN 1982

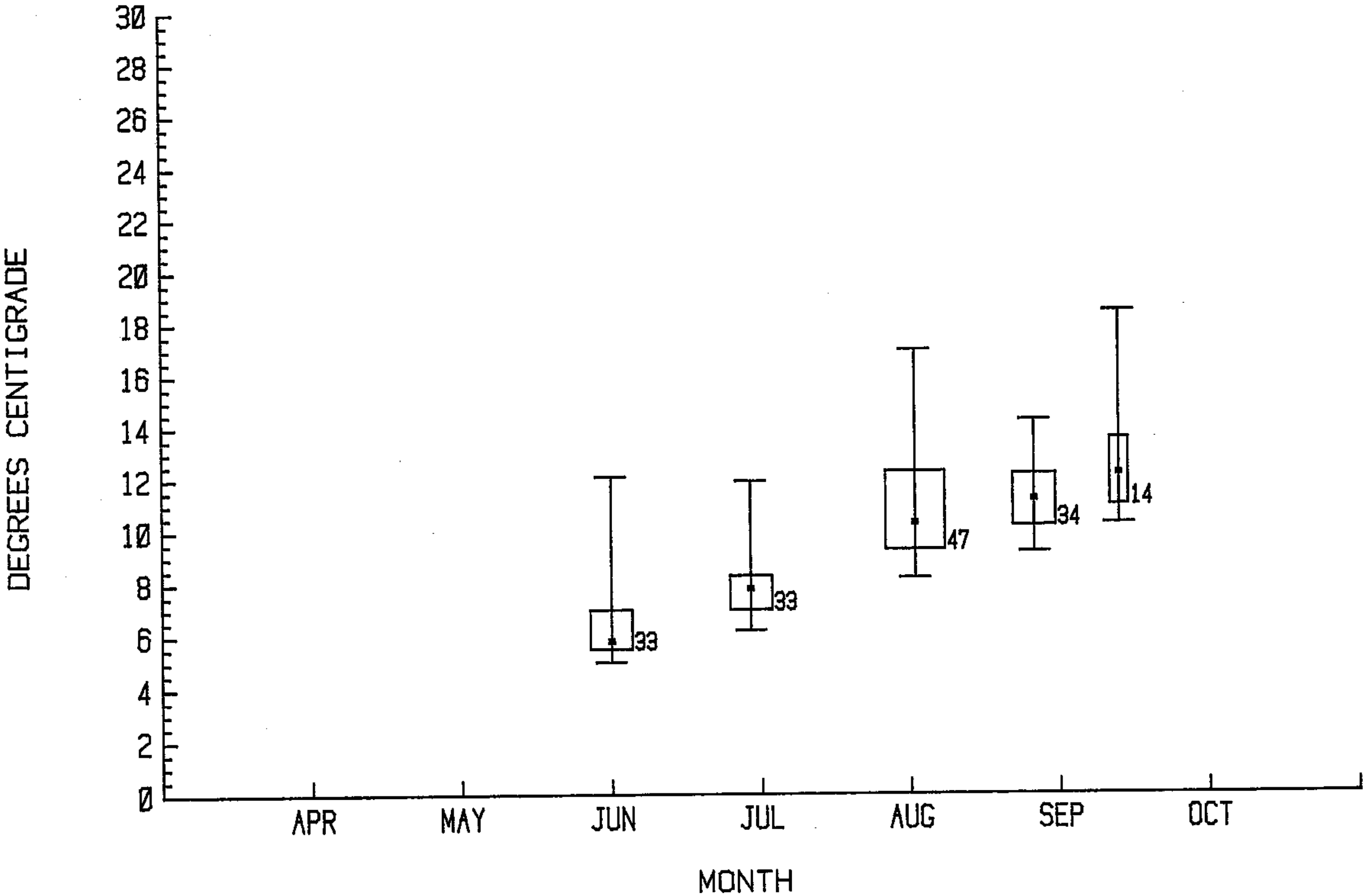
Figure 3



TEMPERATURE MEDIANS

CENTRAL BASIN EPILIMNION 1982

Figure 4



TEMPERATURE MEDIANS

CENTRAL BASIN HYPOLIMNION 1982

Figure 5

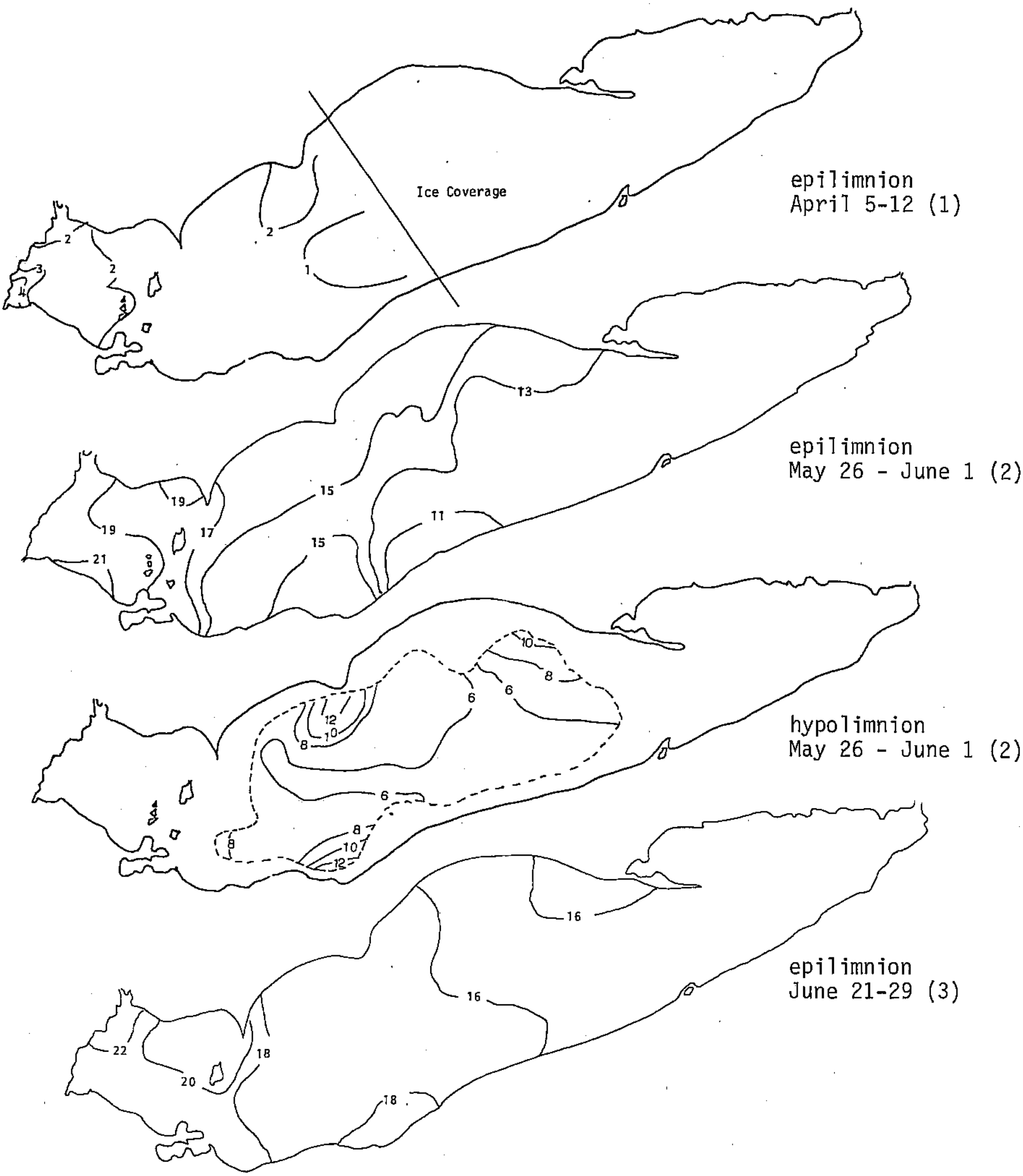


Figure 6. Limnion horizontal distribution maps for Temperature (^{0}C) 1982.

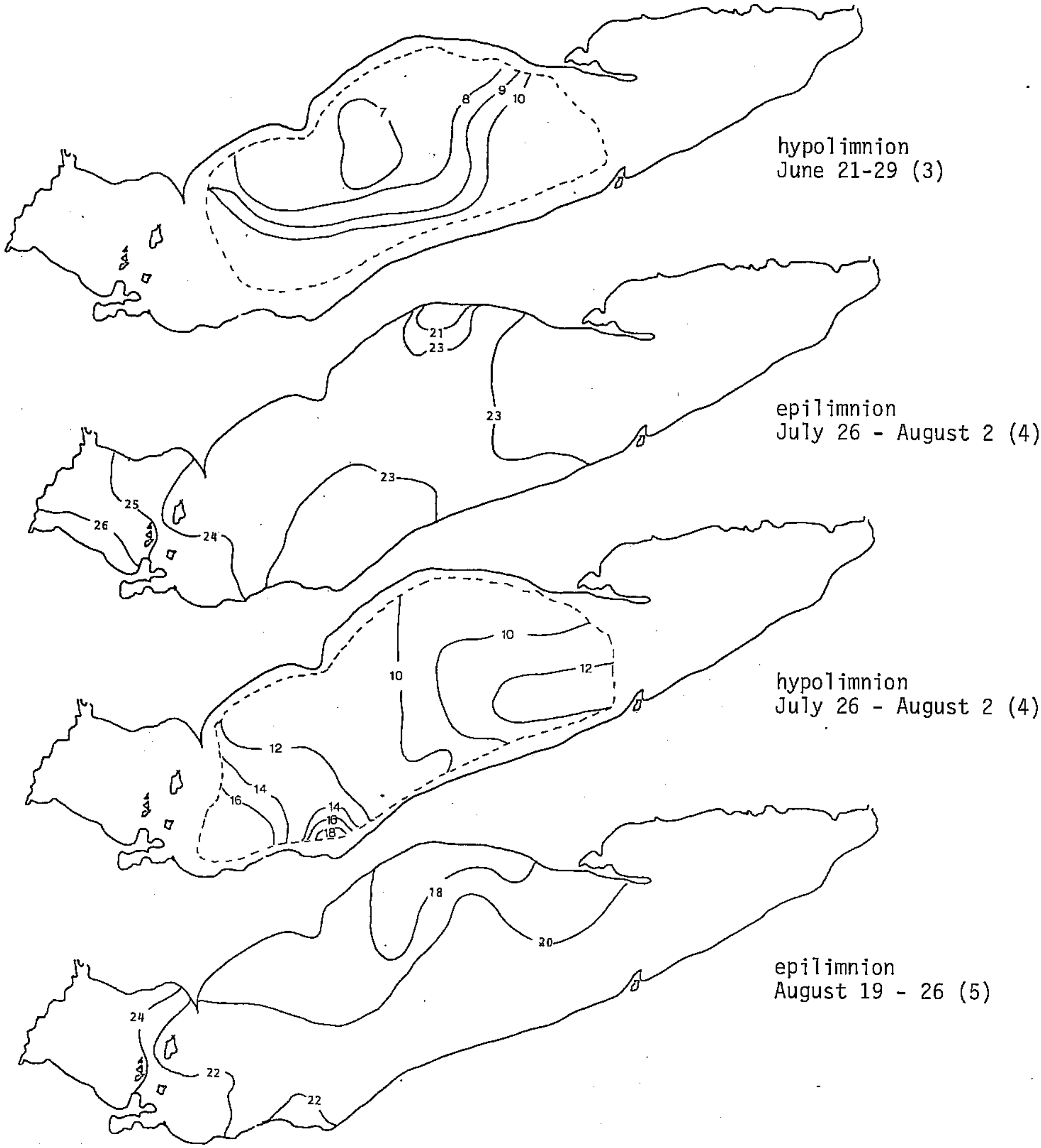
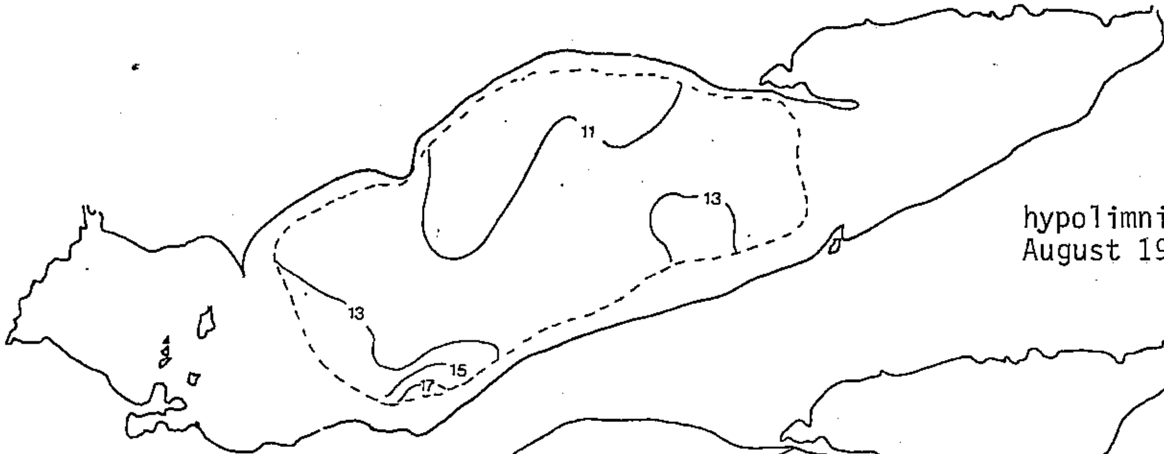
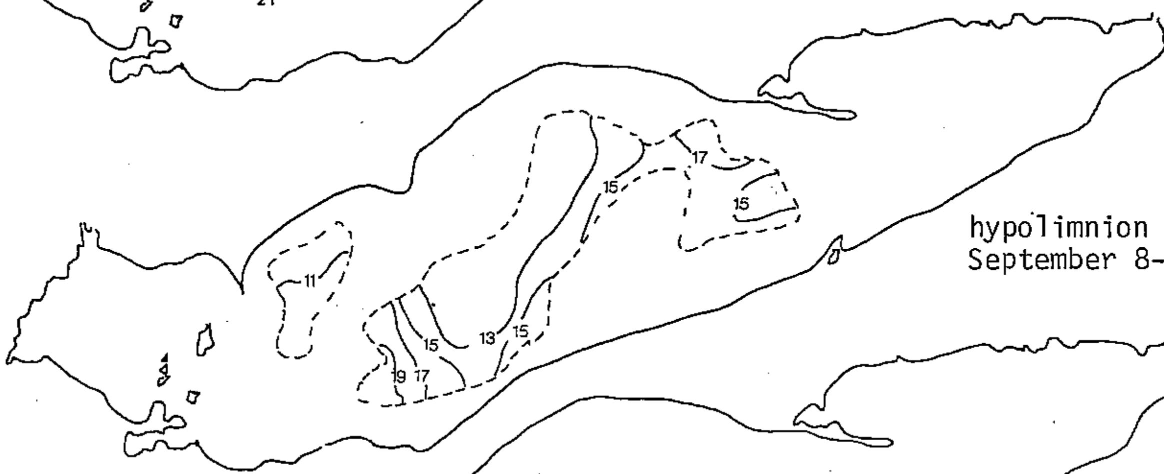


Figure 6. (continued)
Limnion horizontal distribution maps for Temperature (^{o}C) 1982.

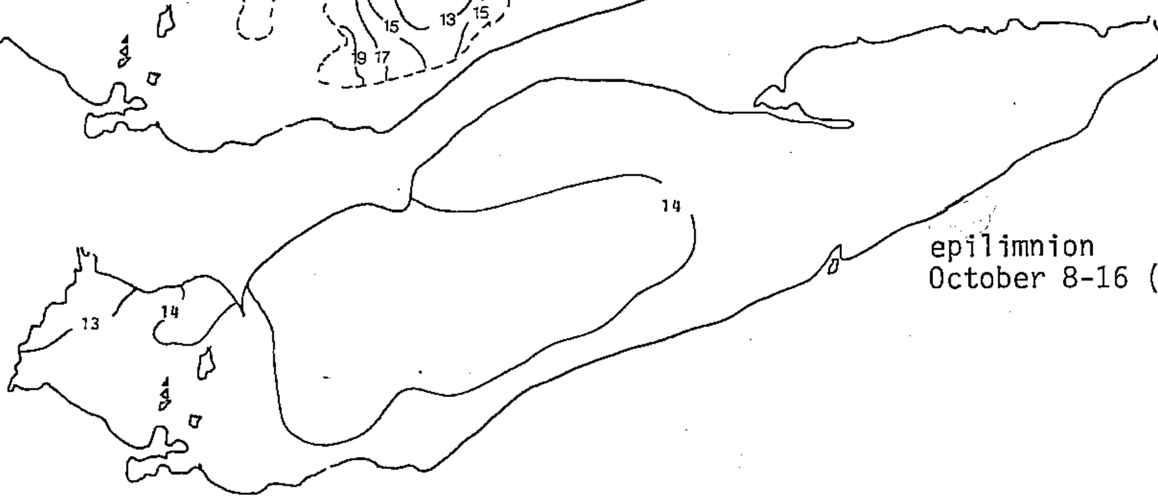


hypolimnion
August 19-26 (5)

epilimnion
September 8-13 (6)



hypolimnion
September 8-13 (6)



epilimnion
October 8-16 (7)

Figure 6: (continued)
Limnion horizontal distribution maps for Temperature (^{o}C) 1982.

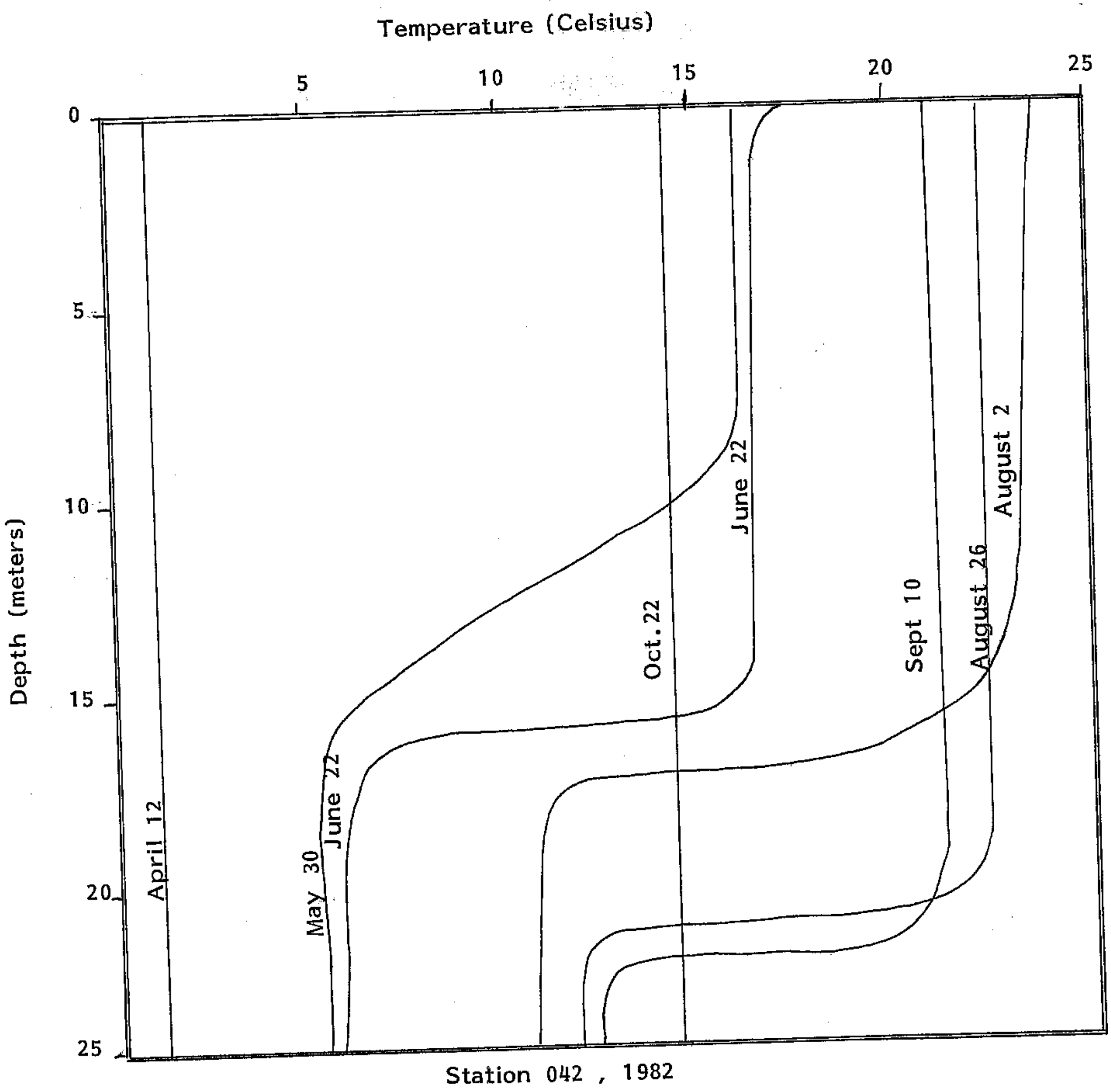
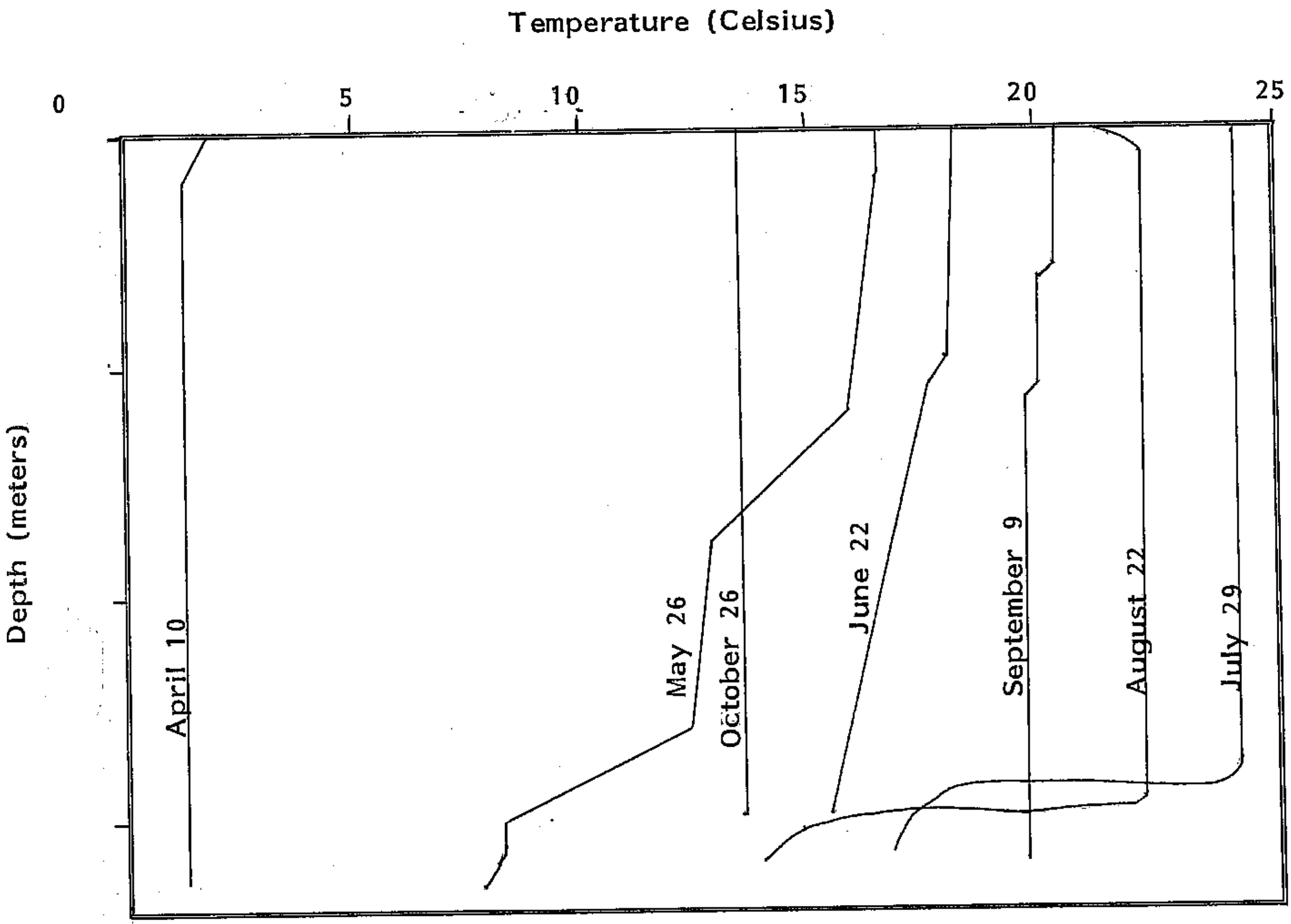


Figure 7. Thermal structure of central Lake Erie at station 042 May to October, 1982.



Station 082 , 1982
Sandusky sub basin

Figure 8. Thermal structure of the Sandusky Sub basin of Lake Erie at station 082 May to October, 1982.

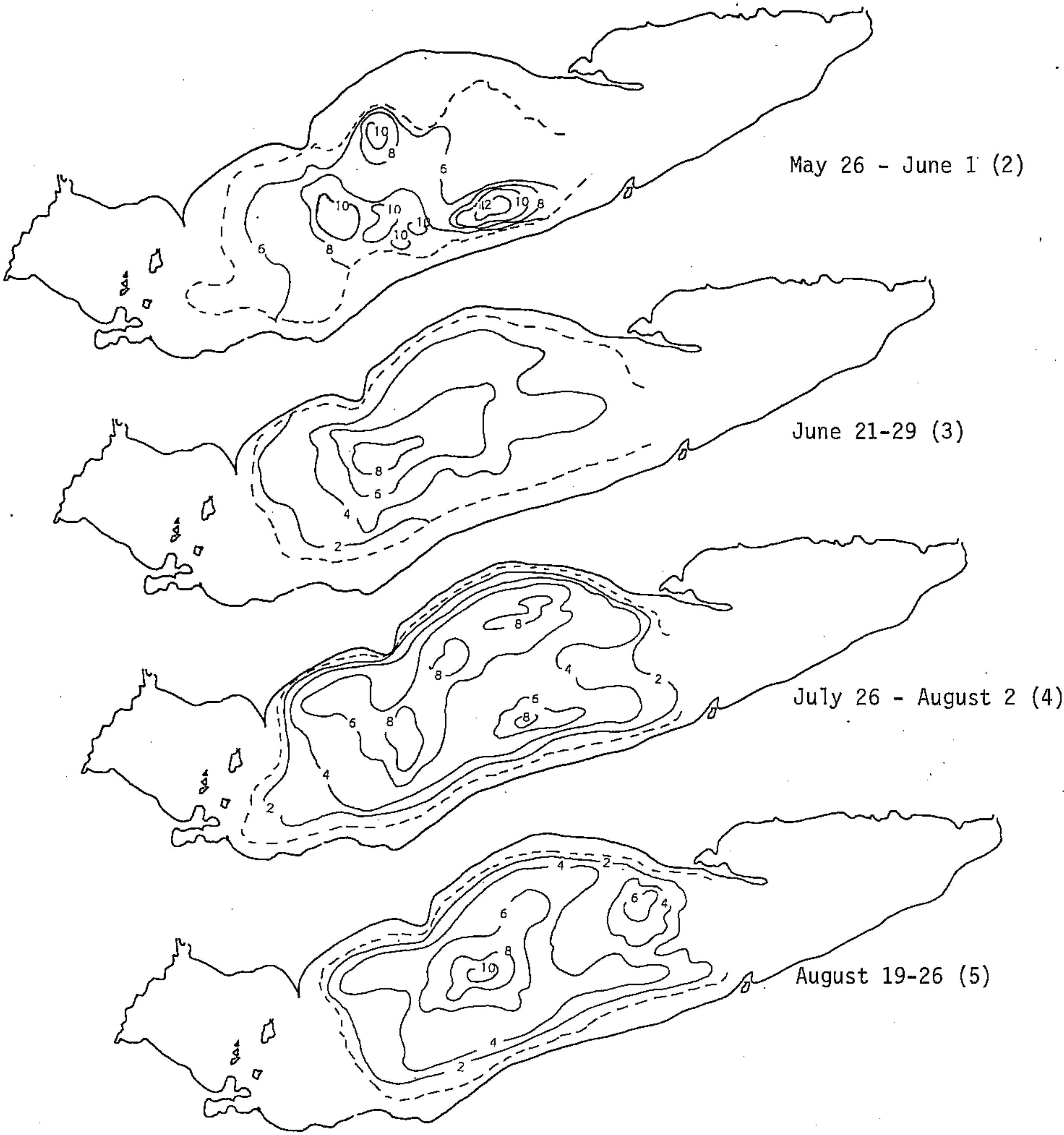
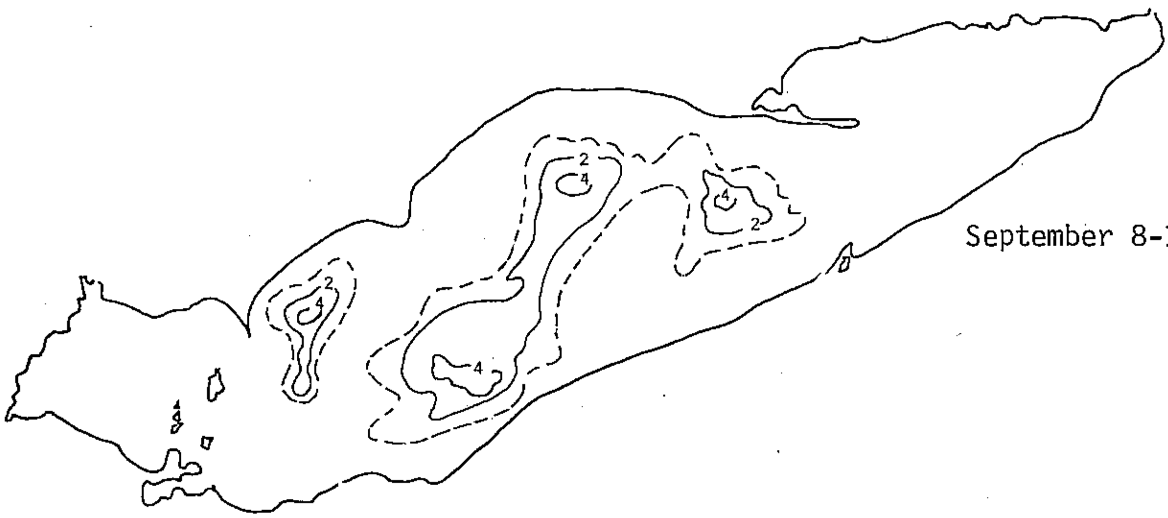
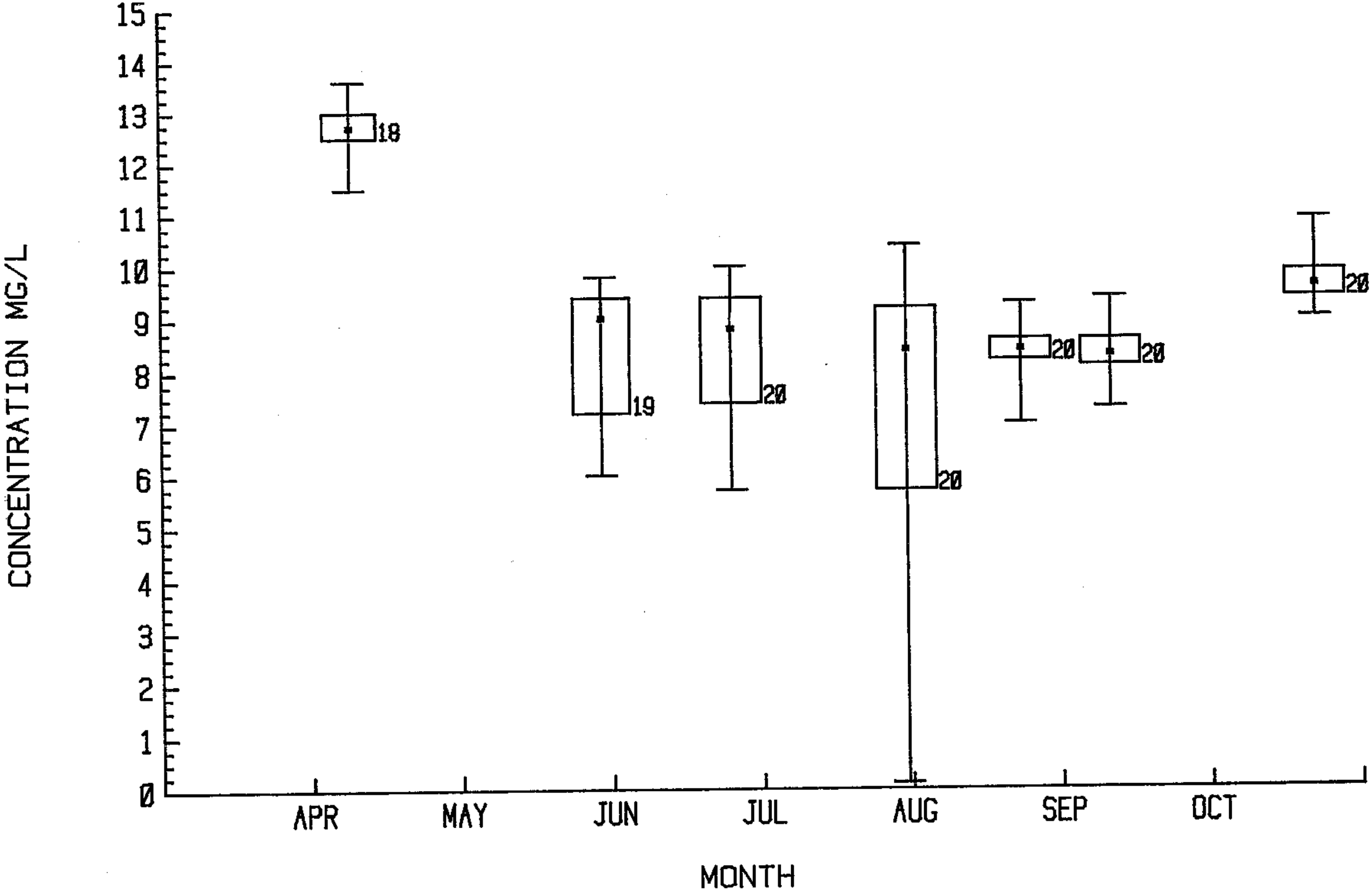


Figure 9. Hypolimnion thicknesses (m) for 1982



September 8-13 (6)

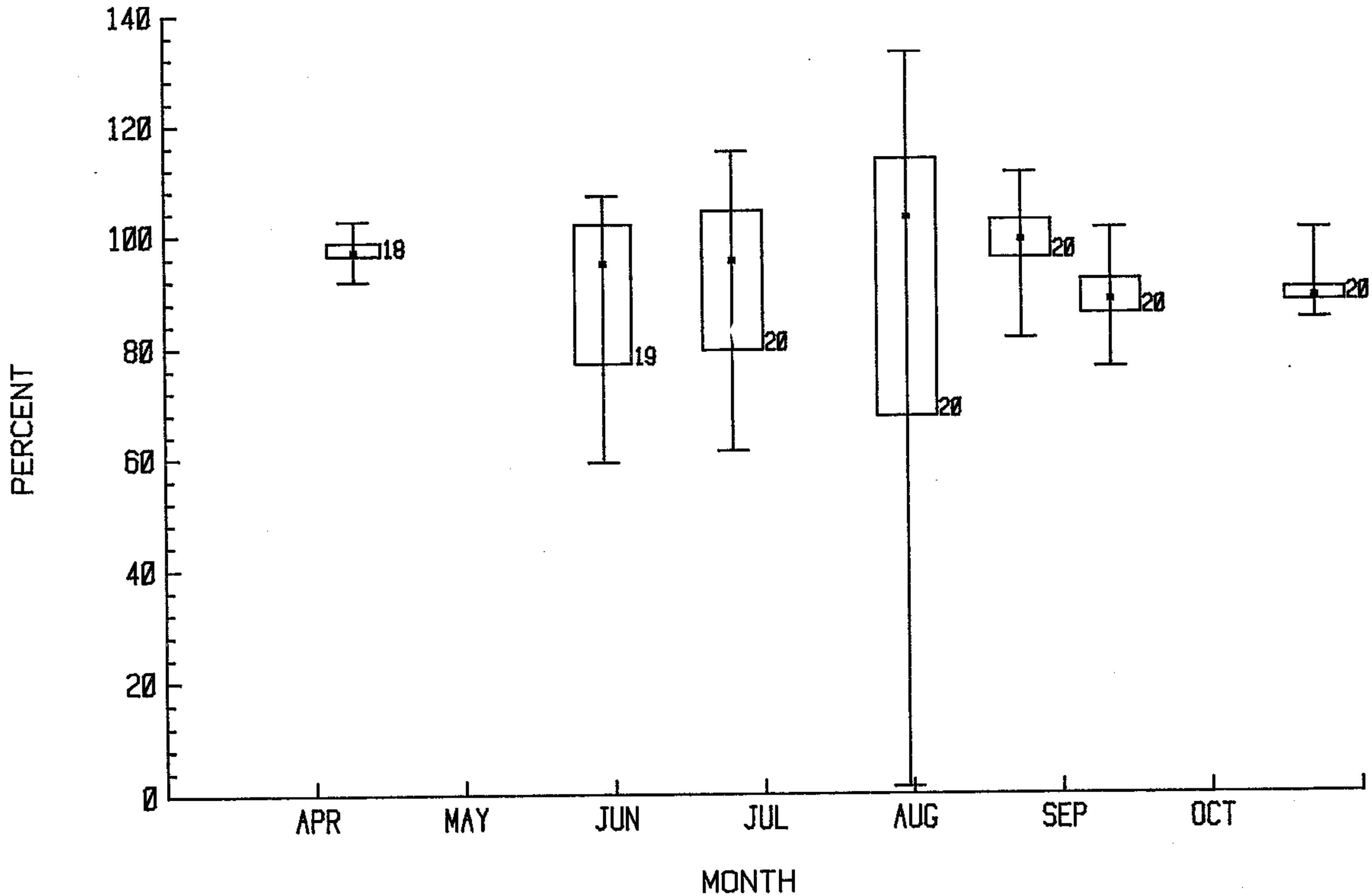
Figure 9. (continued)
Hypolimnion thicknesses (m) for 1982



DISSOLVED OXYGEN MEDIANS

WESTERN BASIN 1982

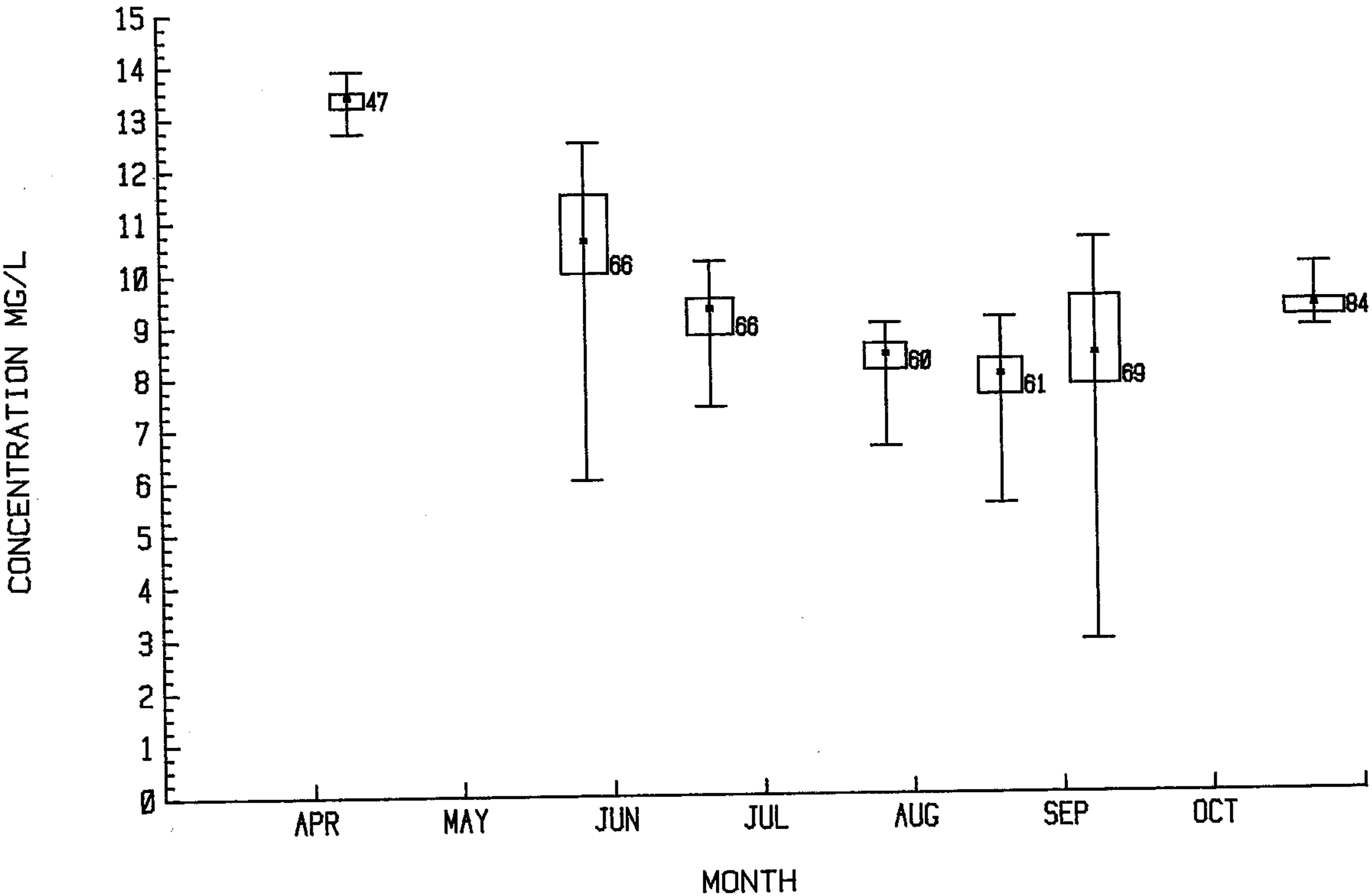
Figure 10



DISSOLVED OXYGEN % SATURATION MEDIANS

WESTERN BASIN 1982

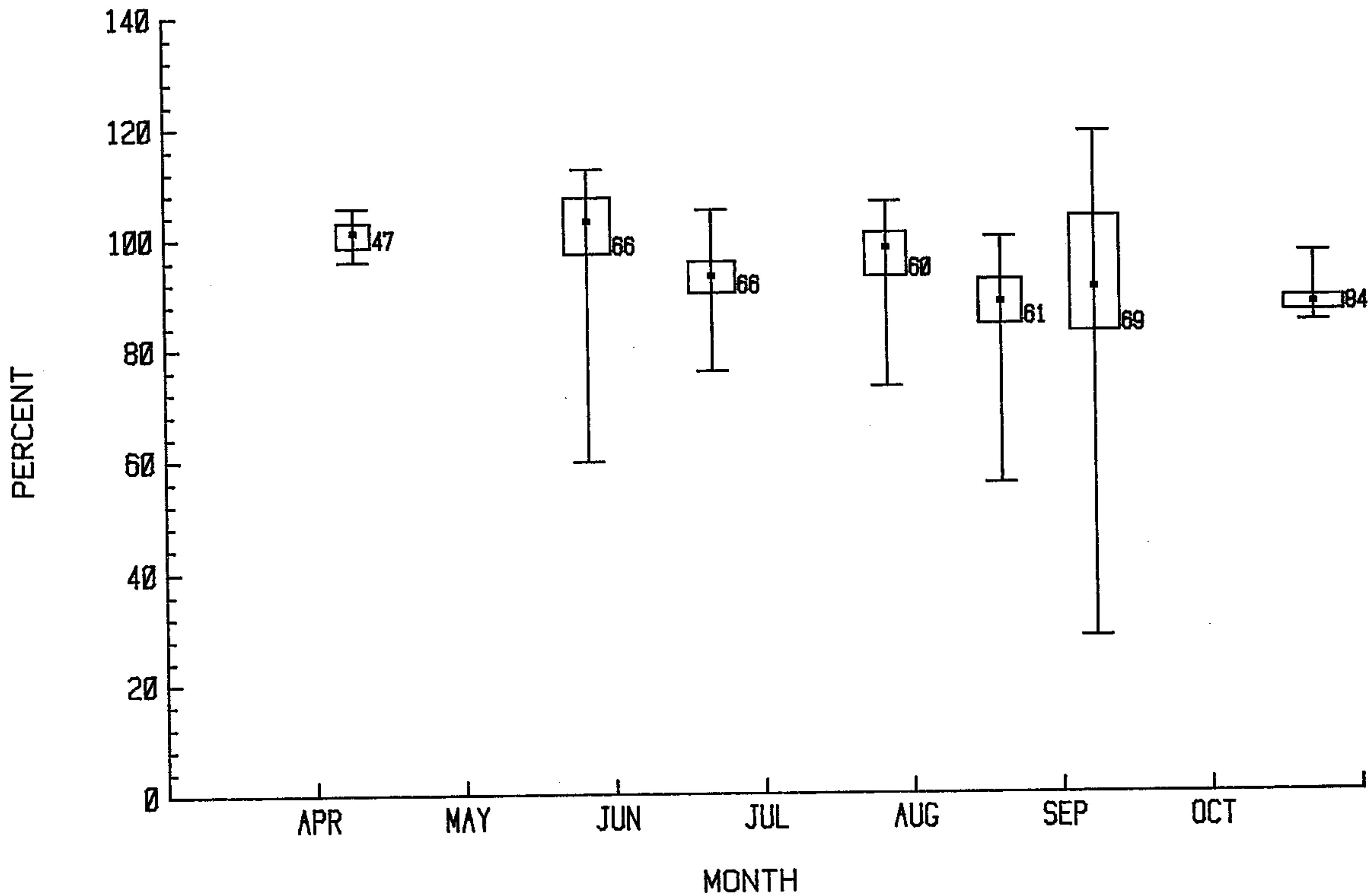
Figure 11



DISSOLVED OXYGEN MEDIANS

CENTRAL BASIN EPILIMNION 1982

Figure 12



DISSOLVED OXYGEN % SATURATION MEDIANS

CENTRAL BASIN EPILIMNION 1982

Figure 13

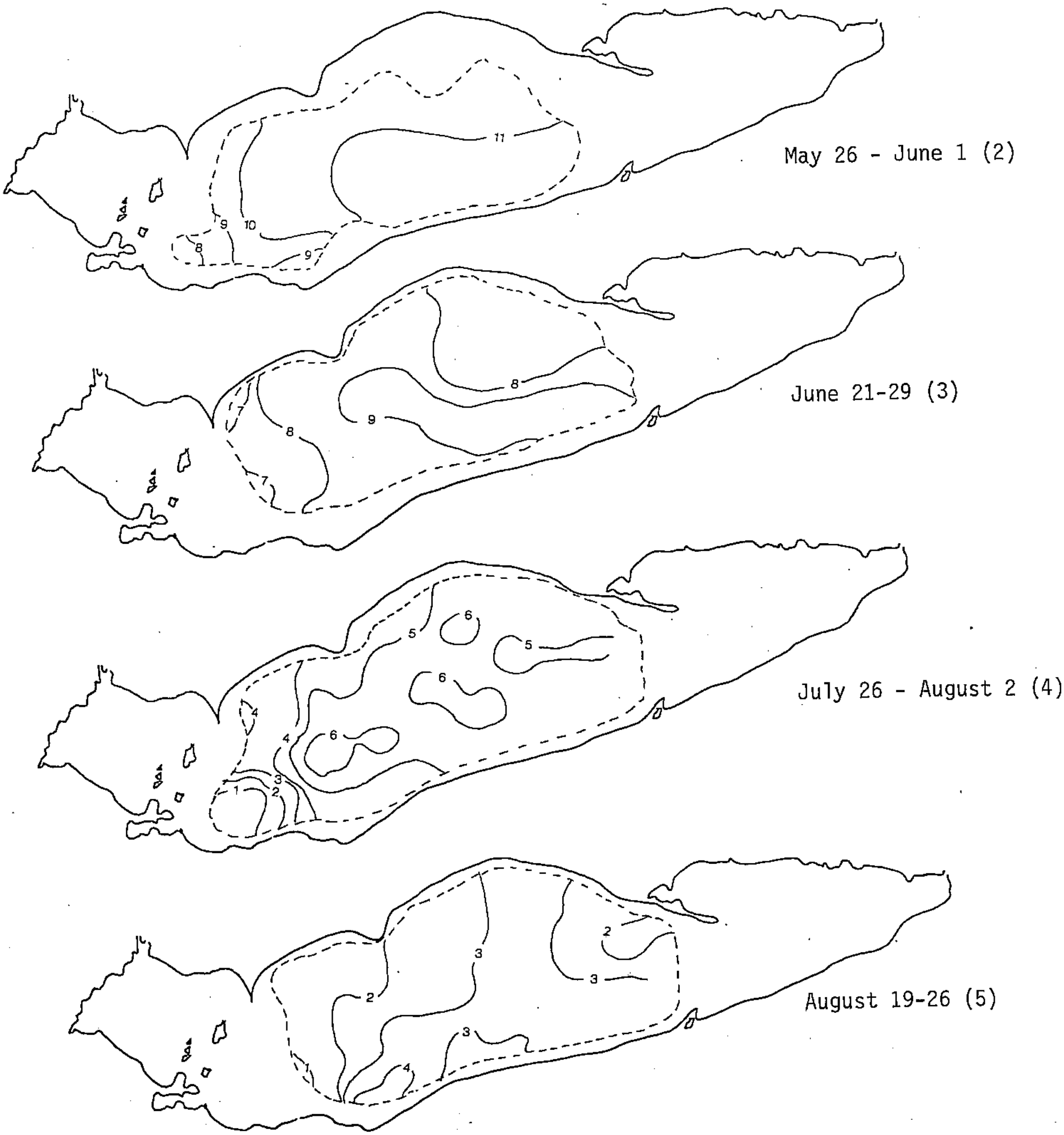
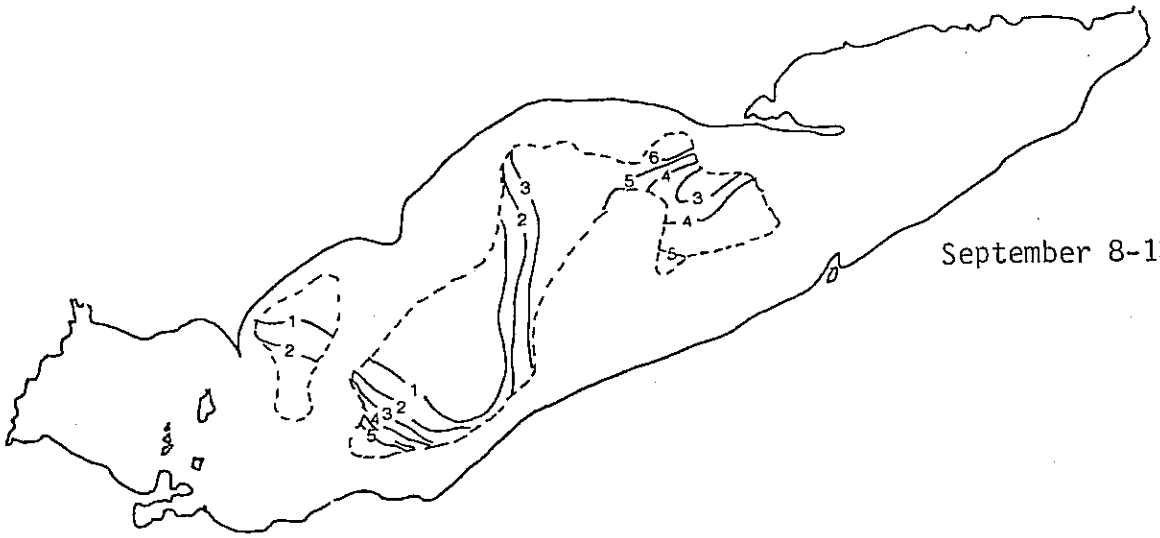


Figure 14a. Hypolimnion horizontal Distribution maps for Dissolved Oxygen (mg/ℓ), 1982.



September 8-13 (6)

Figure 14a. (continued)
Hypolimnion horizontal Distribution maps for Dissolved Oxygen (mg/ℓ), 1982.

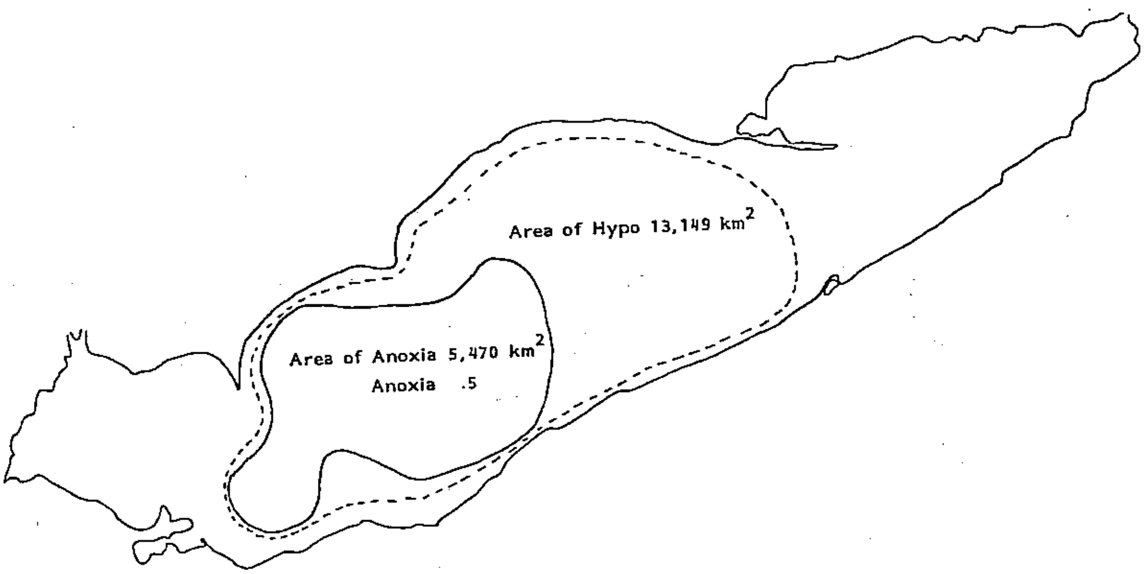
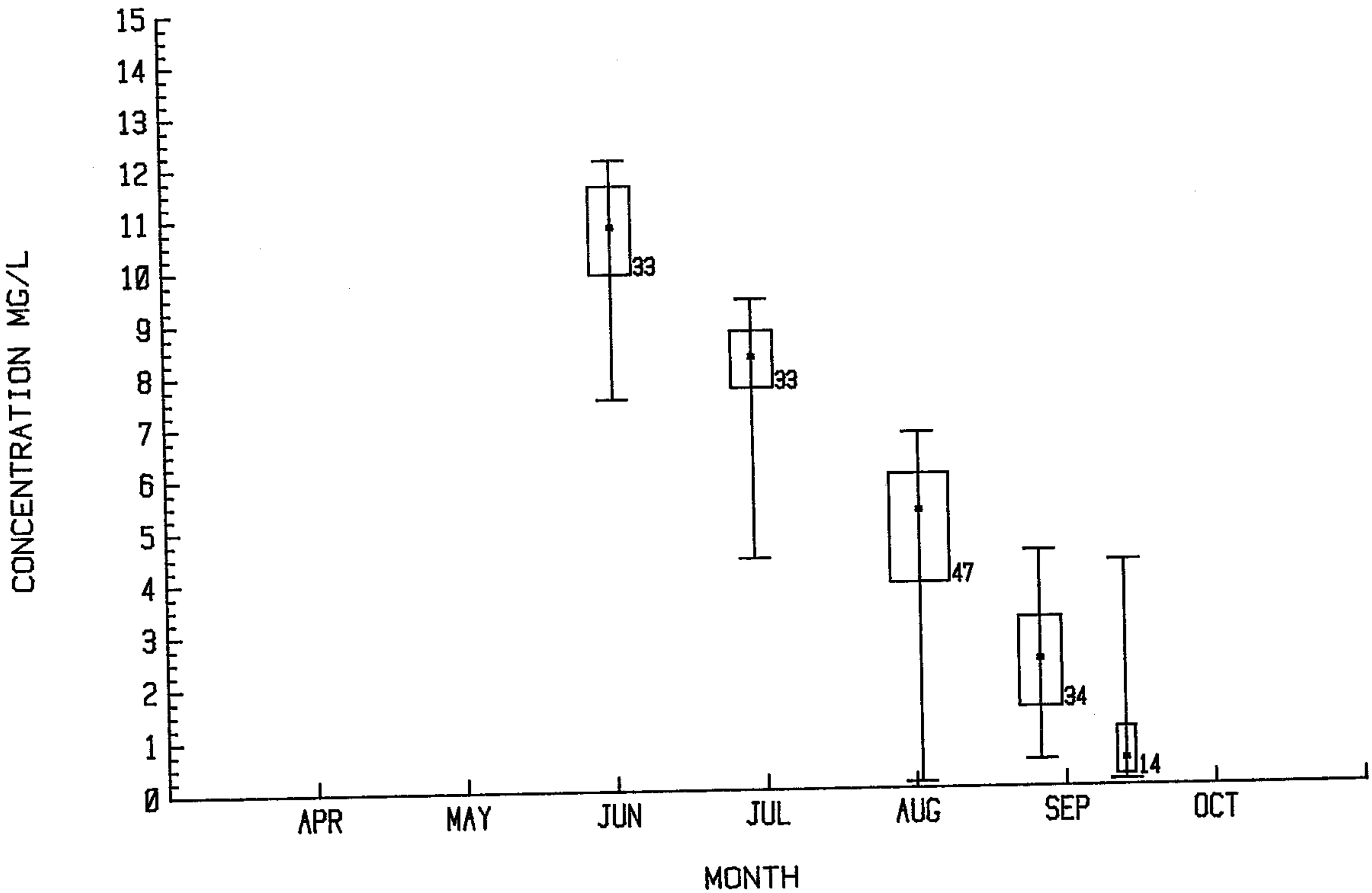


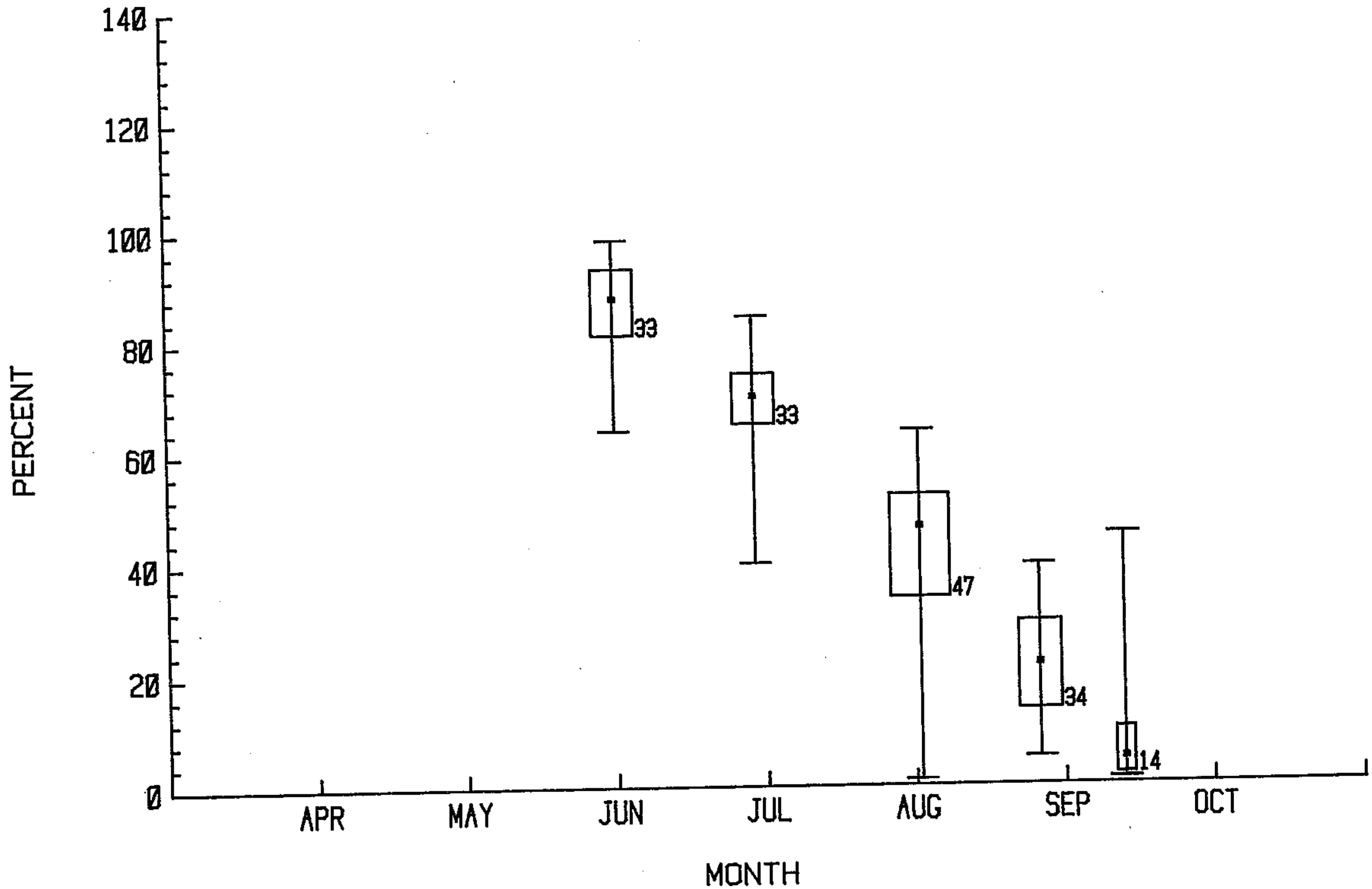
Figure 14b. Composite of Anoxic Area during Stratification of the 1982 field season.



DISSOLVED OXYGEN MEDIANS

CENTRAL BASIN HYPOLIMNION 1982

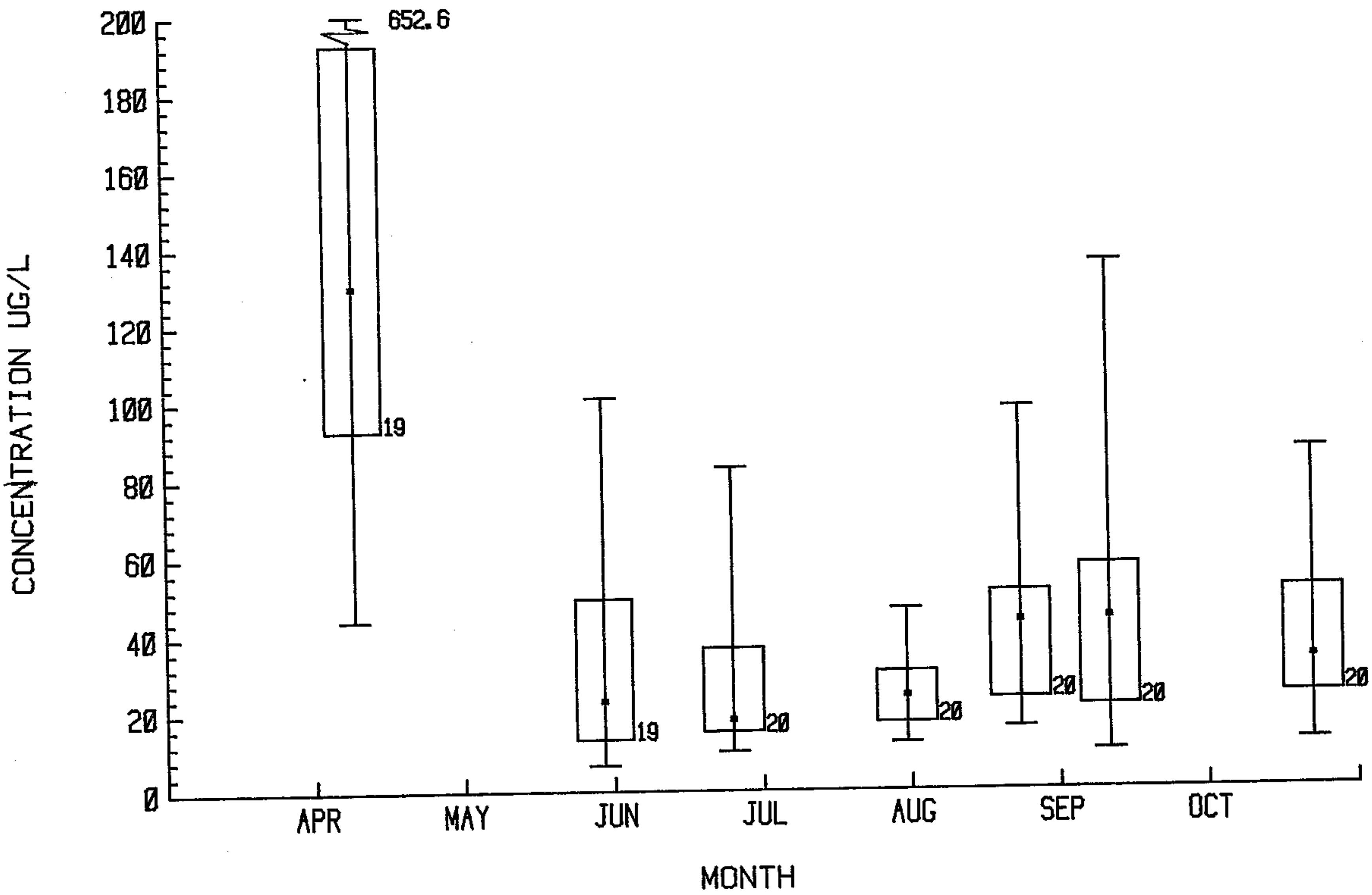
Figure 15



DISSOLVED OXYGEN % SATURATION MEDIANS

CENTRAL BASIN HYPOLIMNION 1982

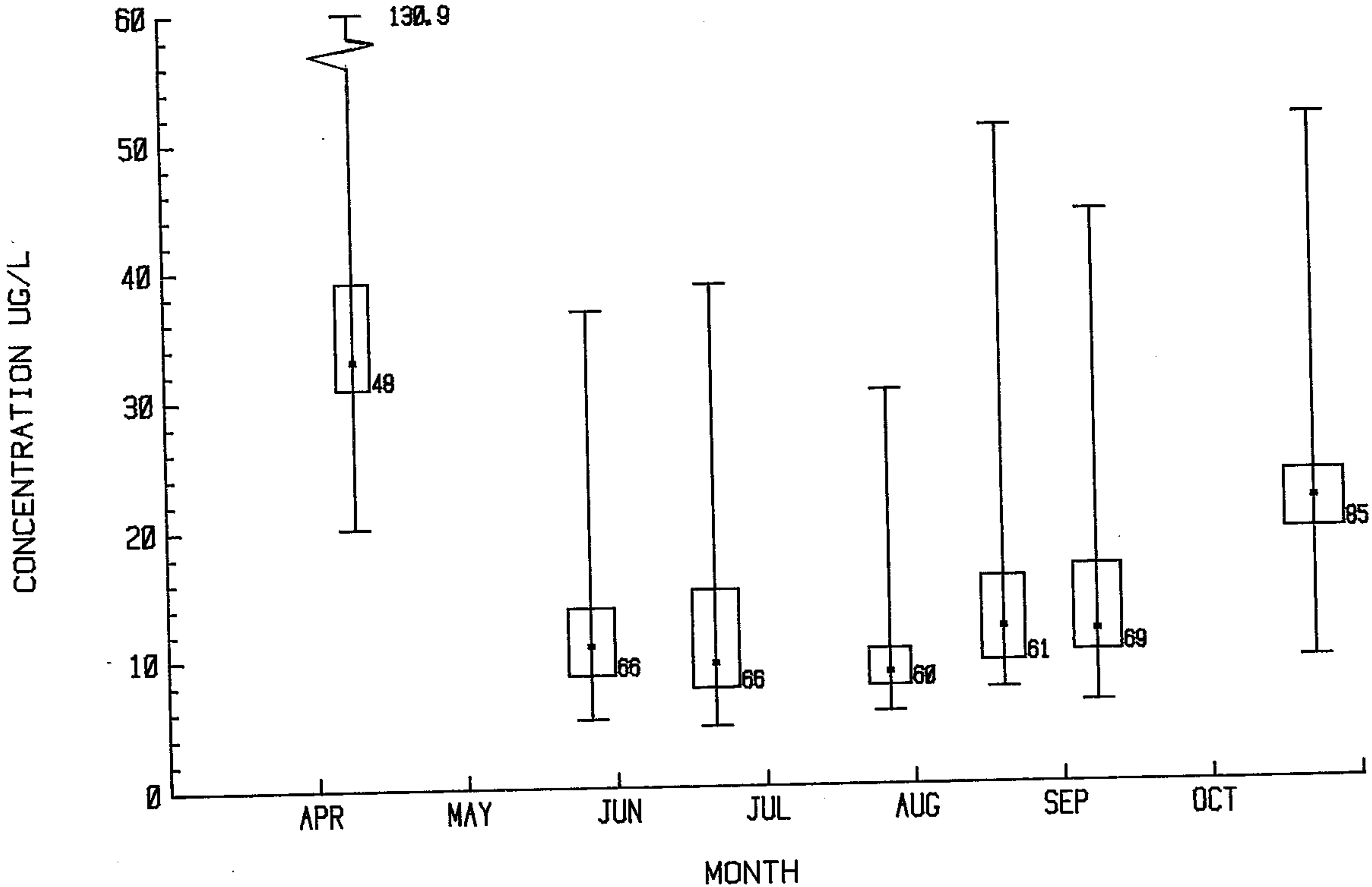
Figure 16



TOTAL PHOSPHORUS MEDIANS

WESTERN BASIN 1982

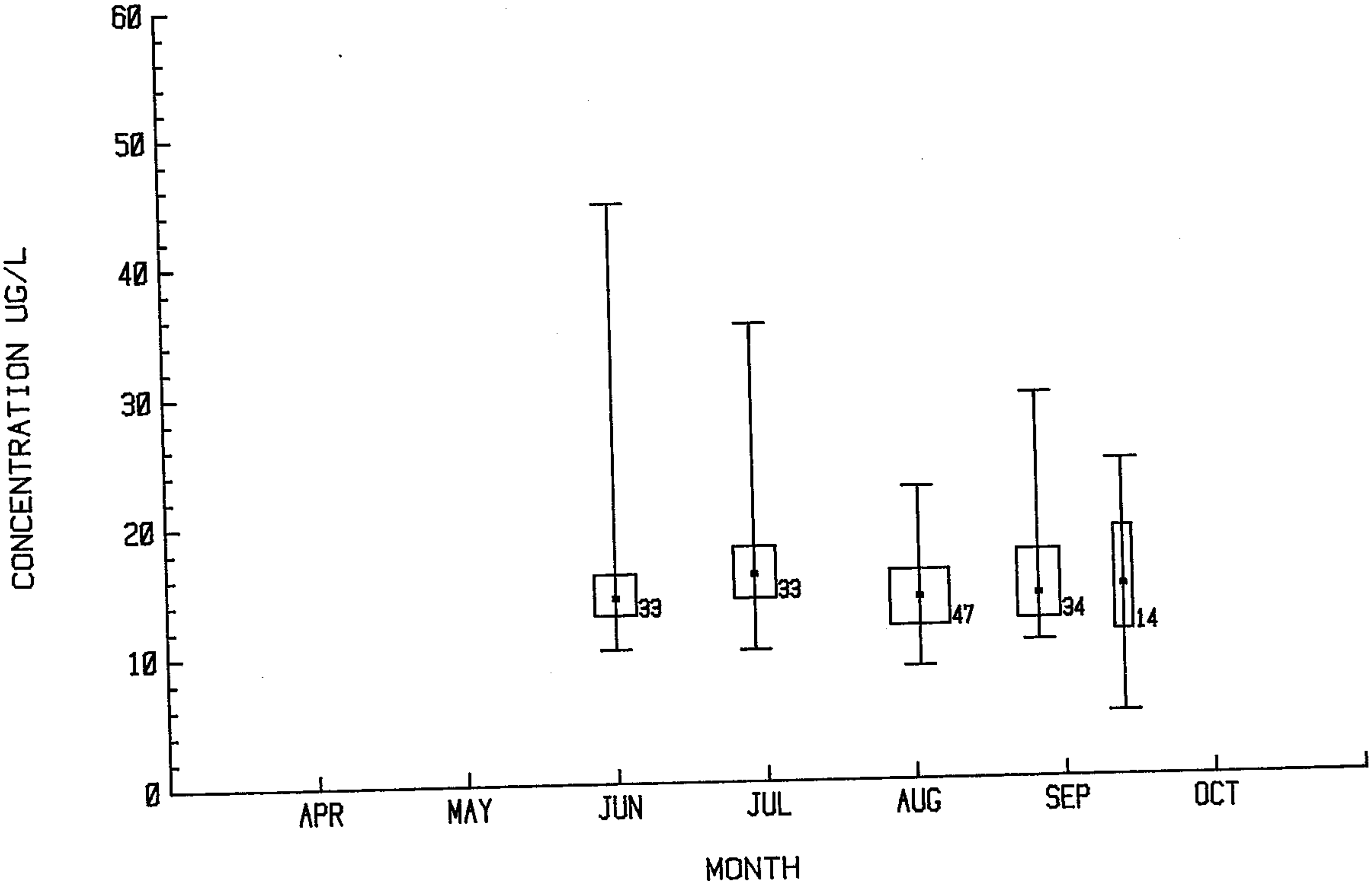
Figure 17



TOTAL PHOSPHORUS MEDIANS

CENTRAL BASIN EPILIMNION 1982

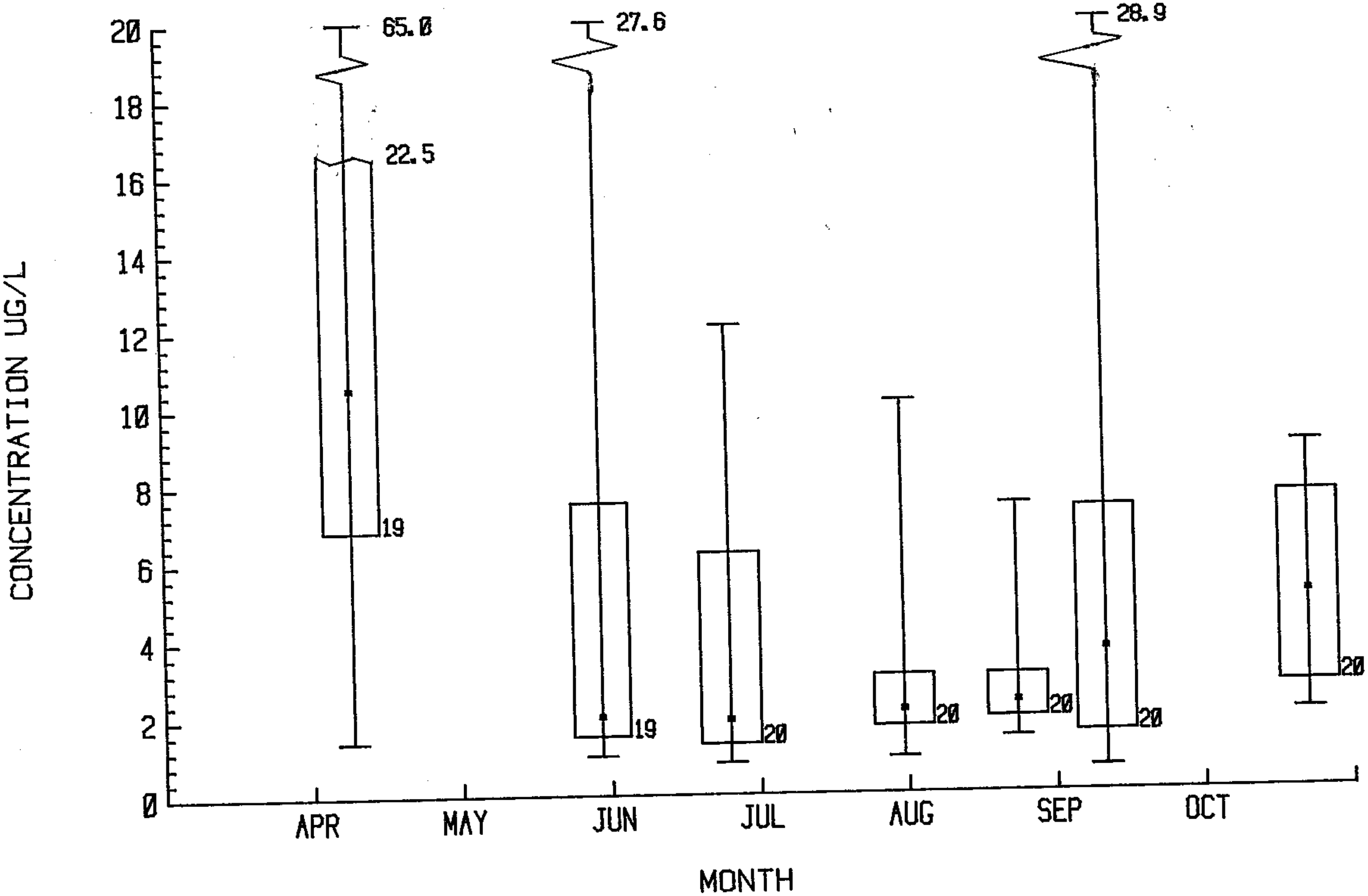
Figure 18



TOTAL PHOSPHORUS MEDIANS

CENTRAL BASIN HYPOLIMNION 1982

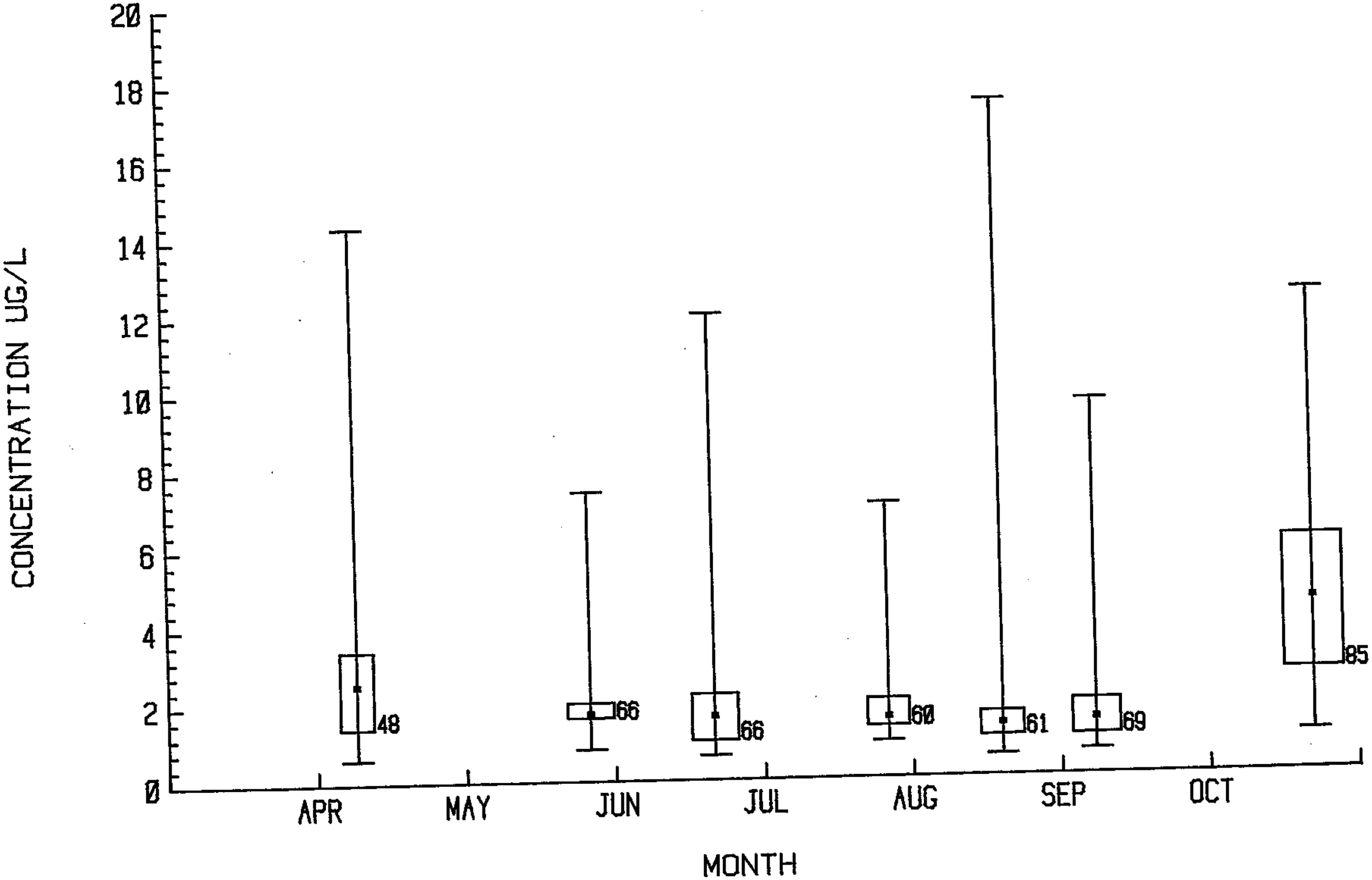
Figure 19



SOLUBLE REACTIVE PHOSPHORUS MEDIANS

WESTERN BASIN 1982

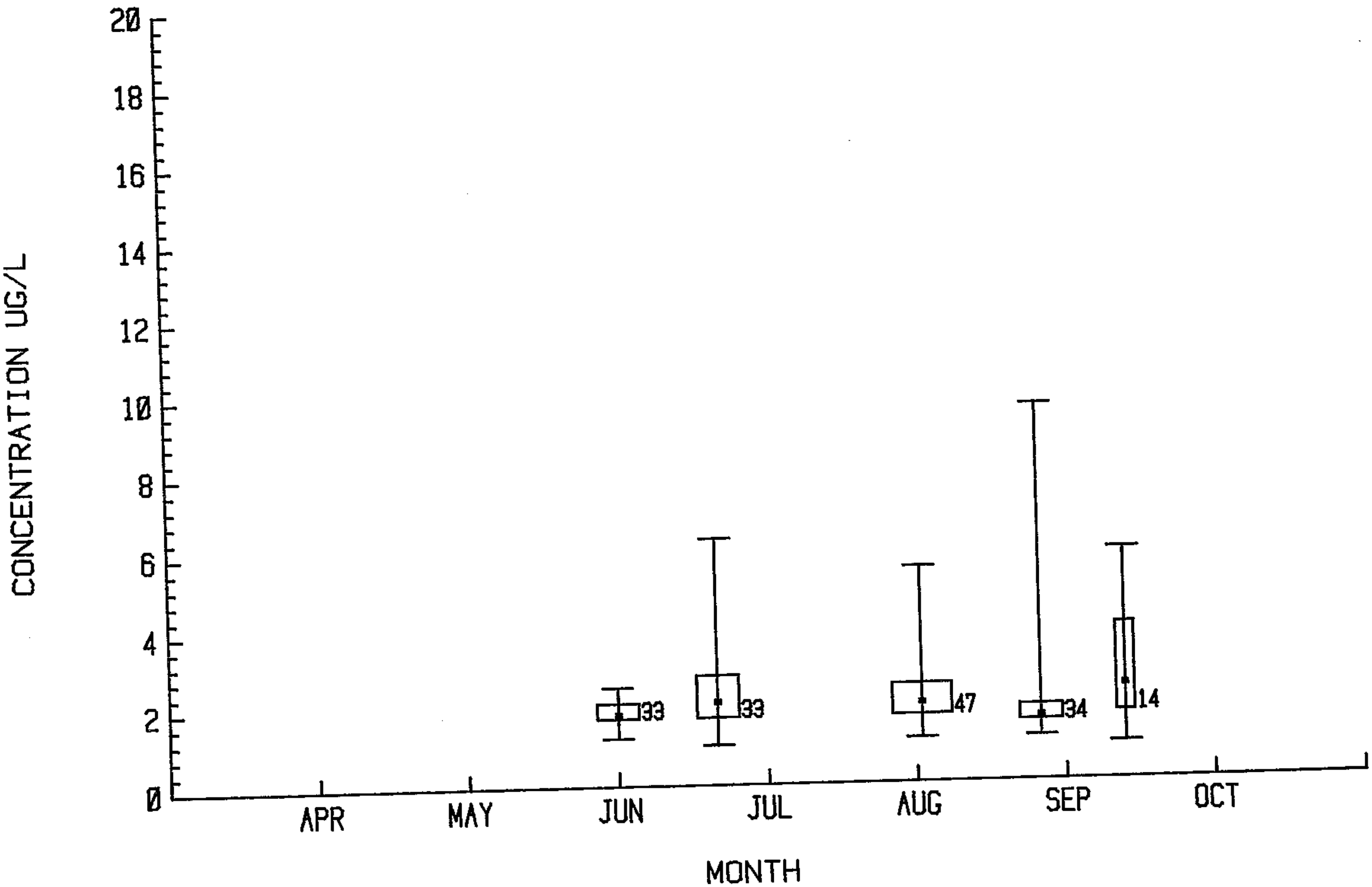
Figure 20



SOLUBLE REACTIVE PHOSPHORUS MEDIANS

CENTRAL BASIN EPILIMNION 1982

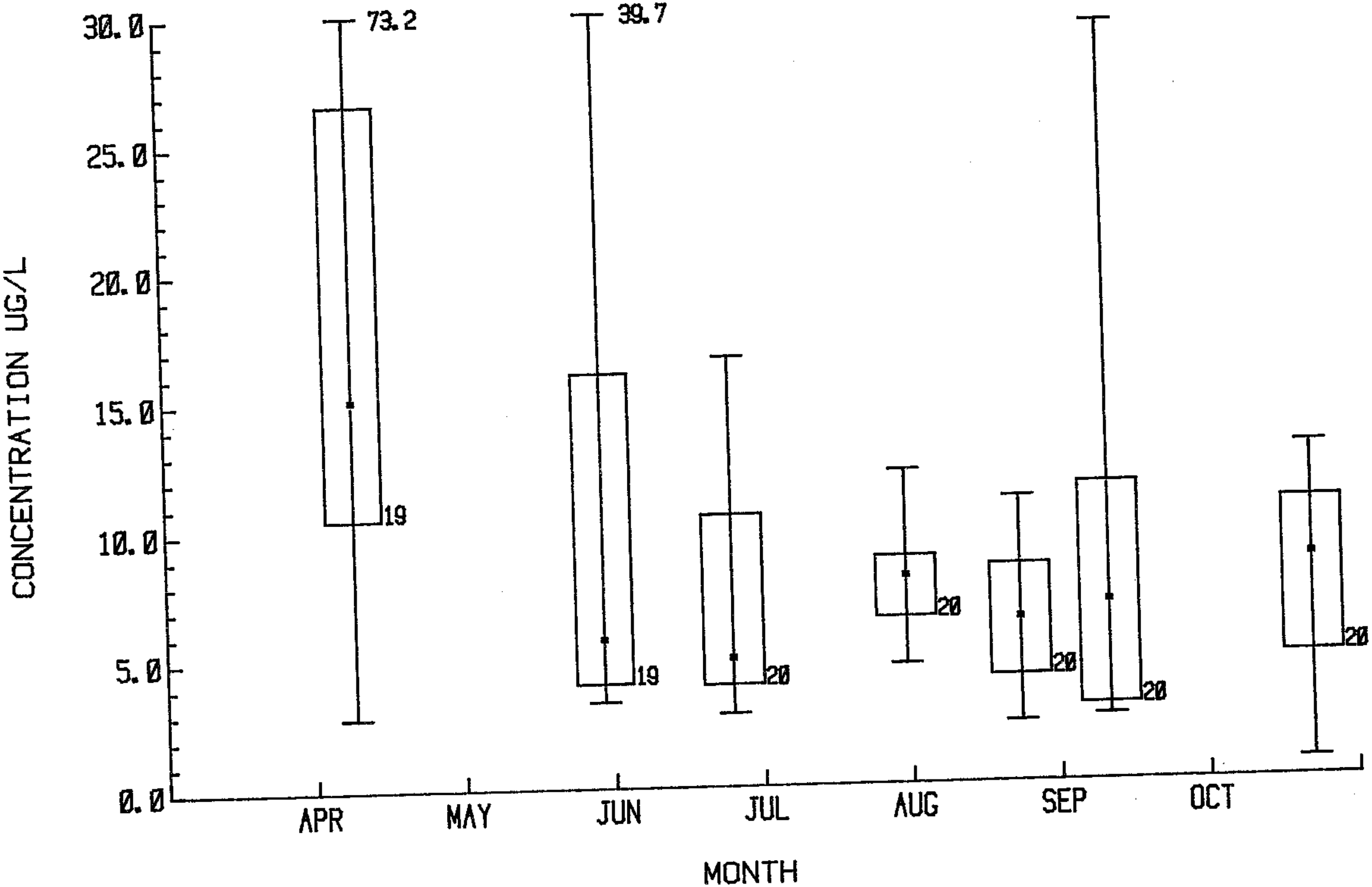
Figure 21



SOLUBLE REACTIVE PHOSPHORUS MEDIANS

CENTRAL BASIN HYPOLIMNION 1982

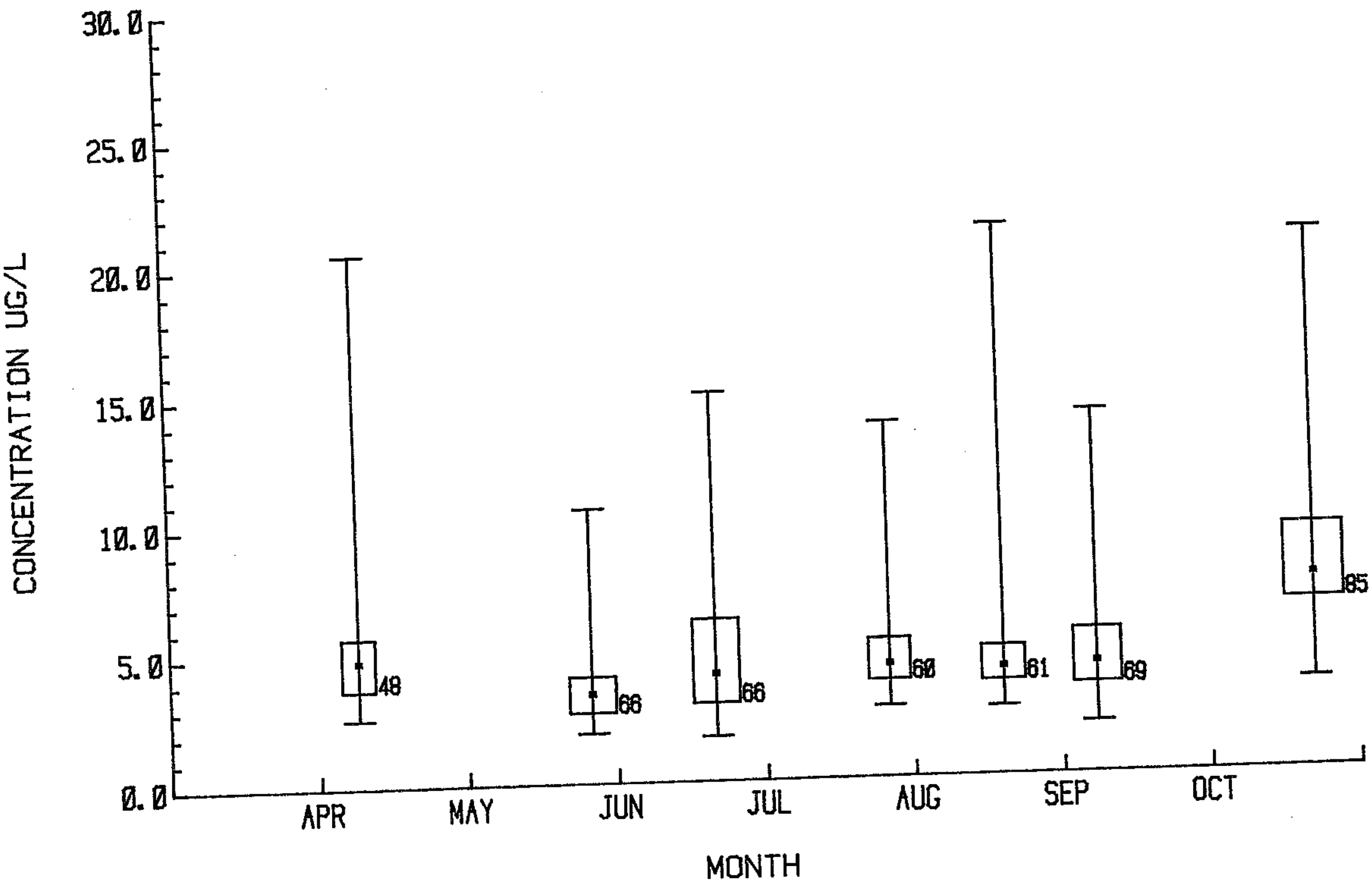
Figure 22



TOTAL FILTERED PHOSPHORUS MEDIANS

WESTERN BASIN 1982

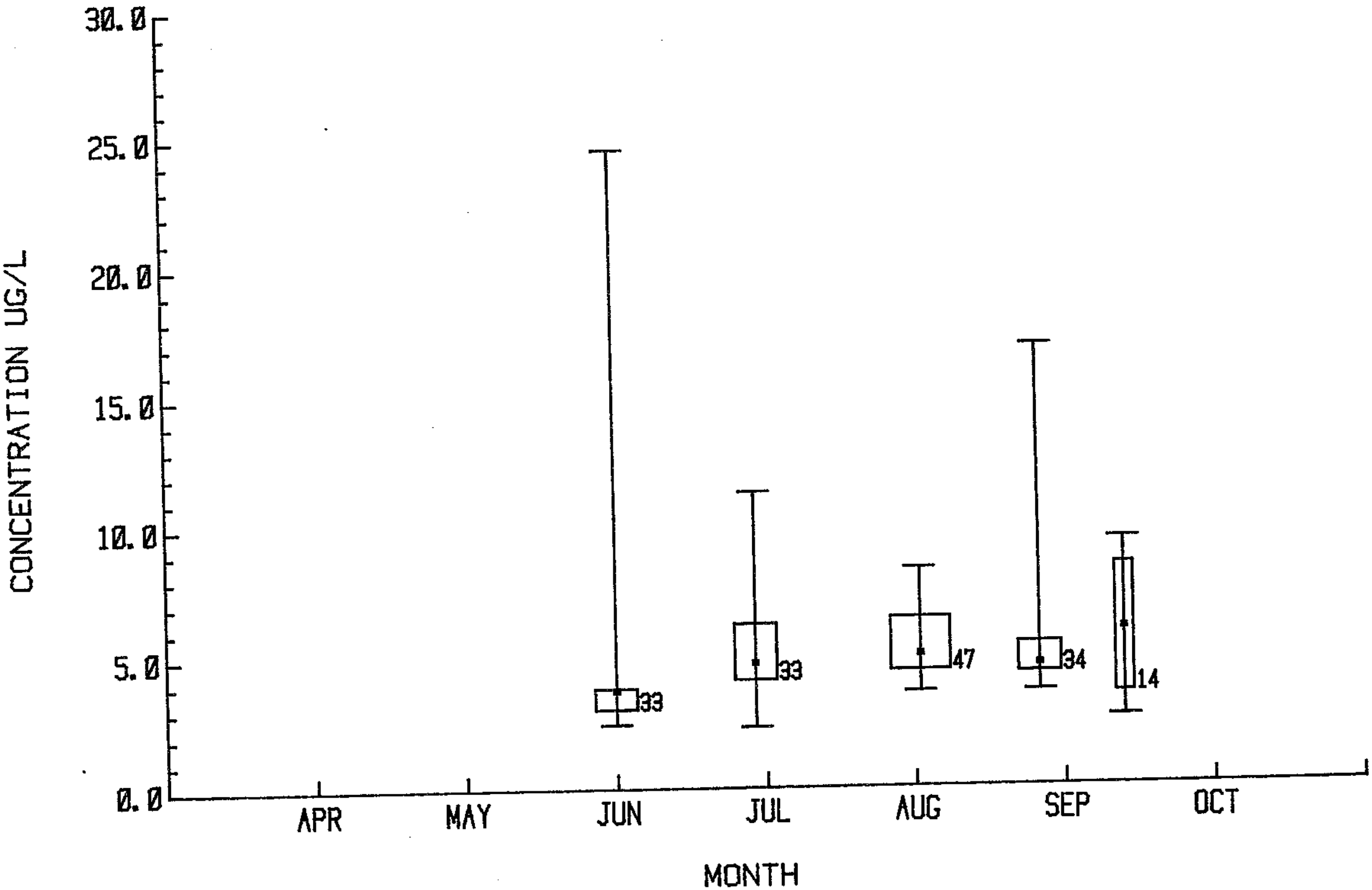
Figure 23



TOTAL FILTERED PHOSPHORUS MEDIANS

CENTRAL BASIN EPILIMNION 1982

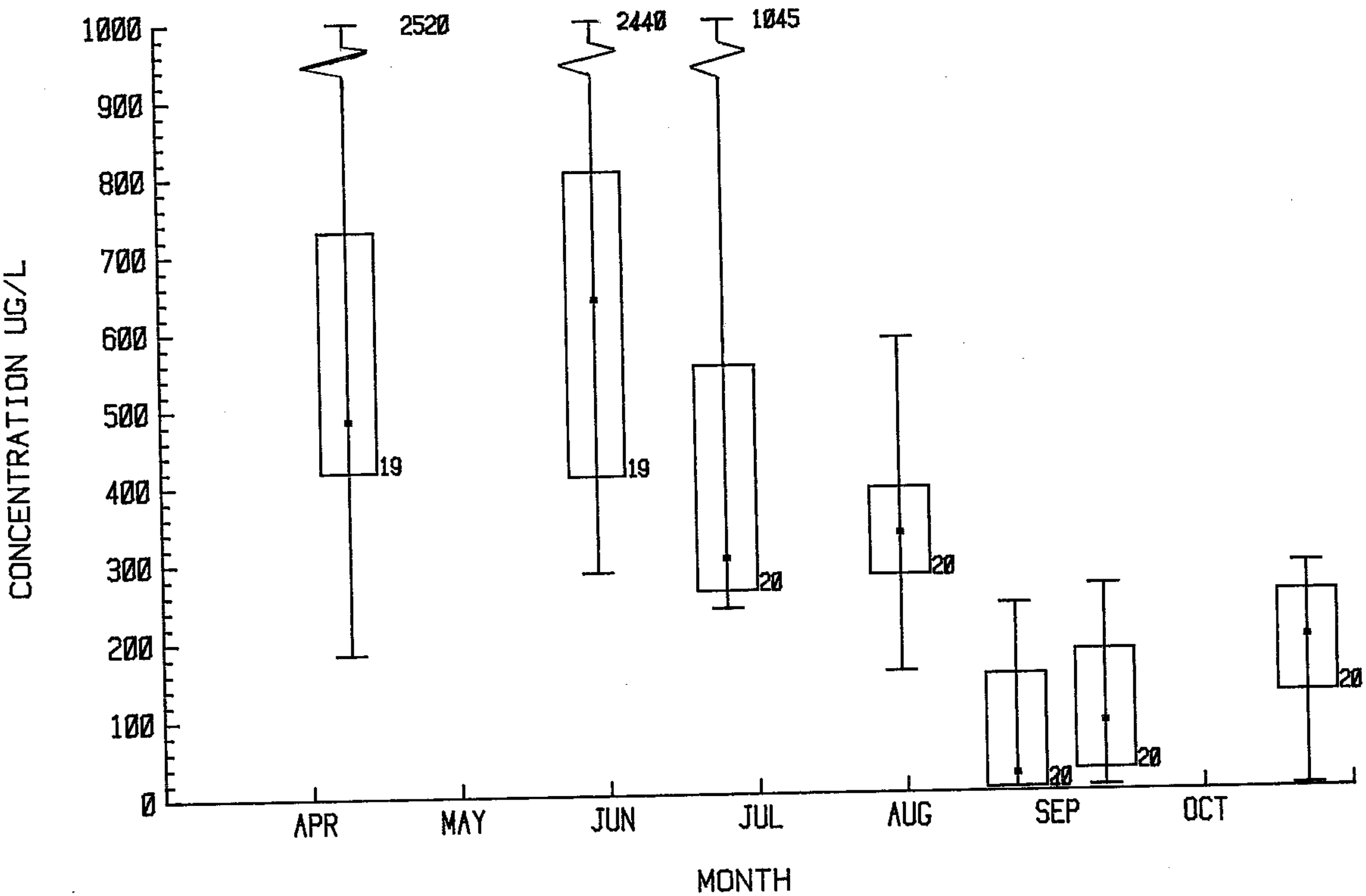
Figure 24



TOTAL FILTERED PHOSPHORUS MEDIANS

CENTRAL BASIN HYPOLIMNION 1982

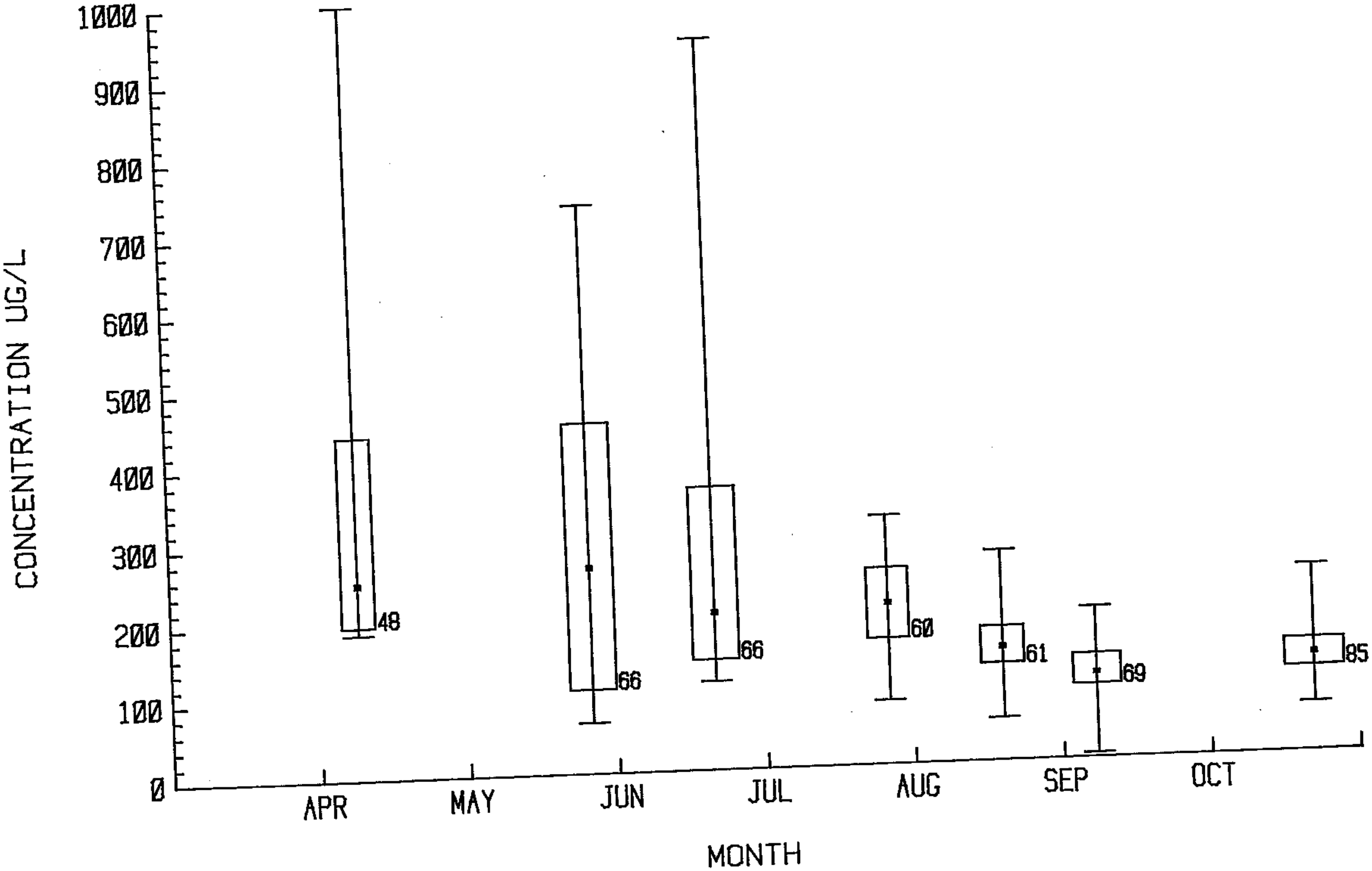
Figure 25



NITRATE + NITRITE MEDIANS

WESTERN BASIN 1982

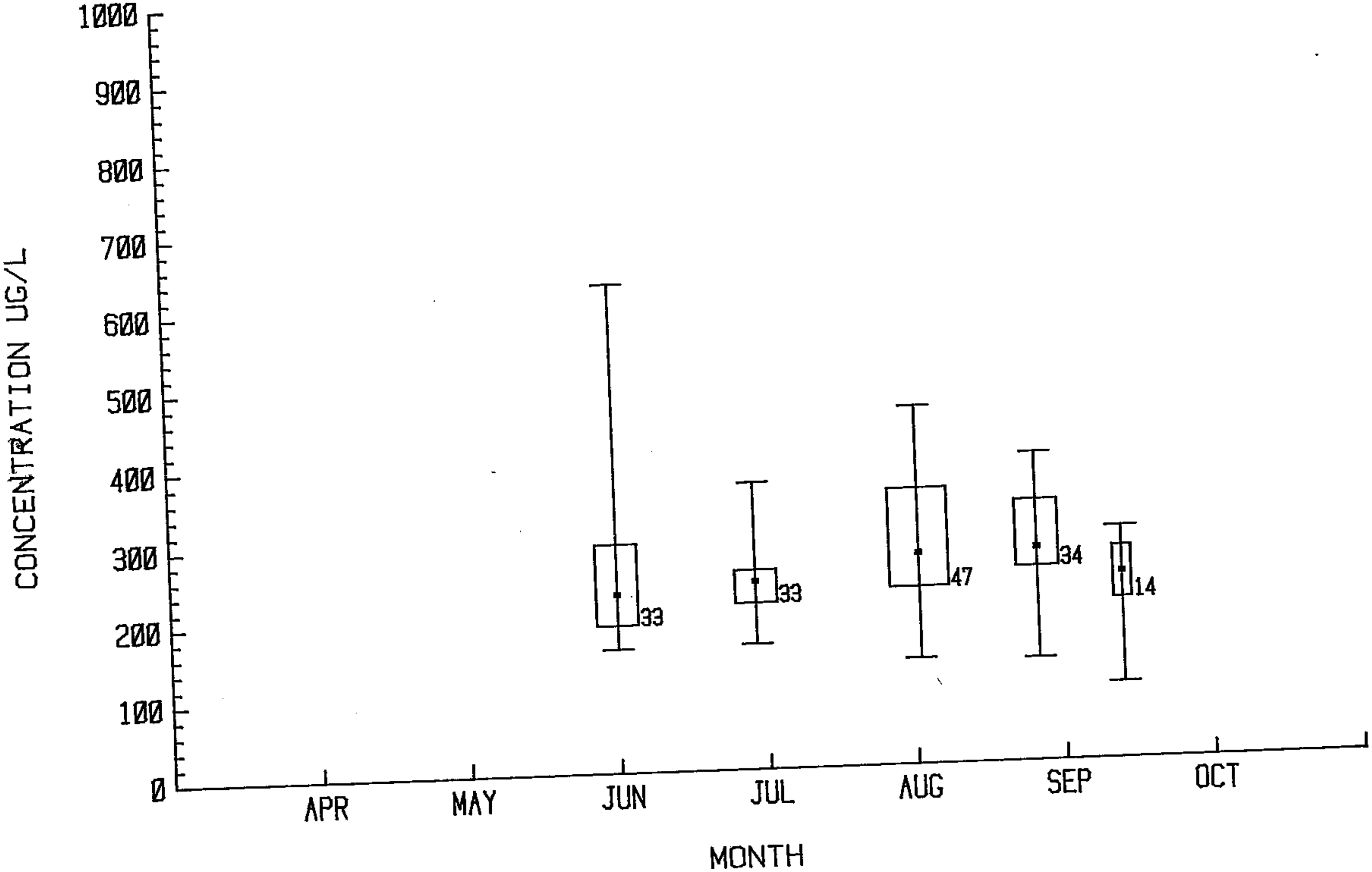
Figure 26



NITRATE + NITRITE MEDIANS

CENTRAL BASIN EPILIMNION 1982

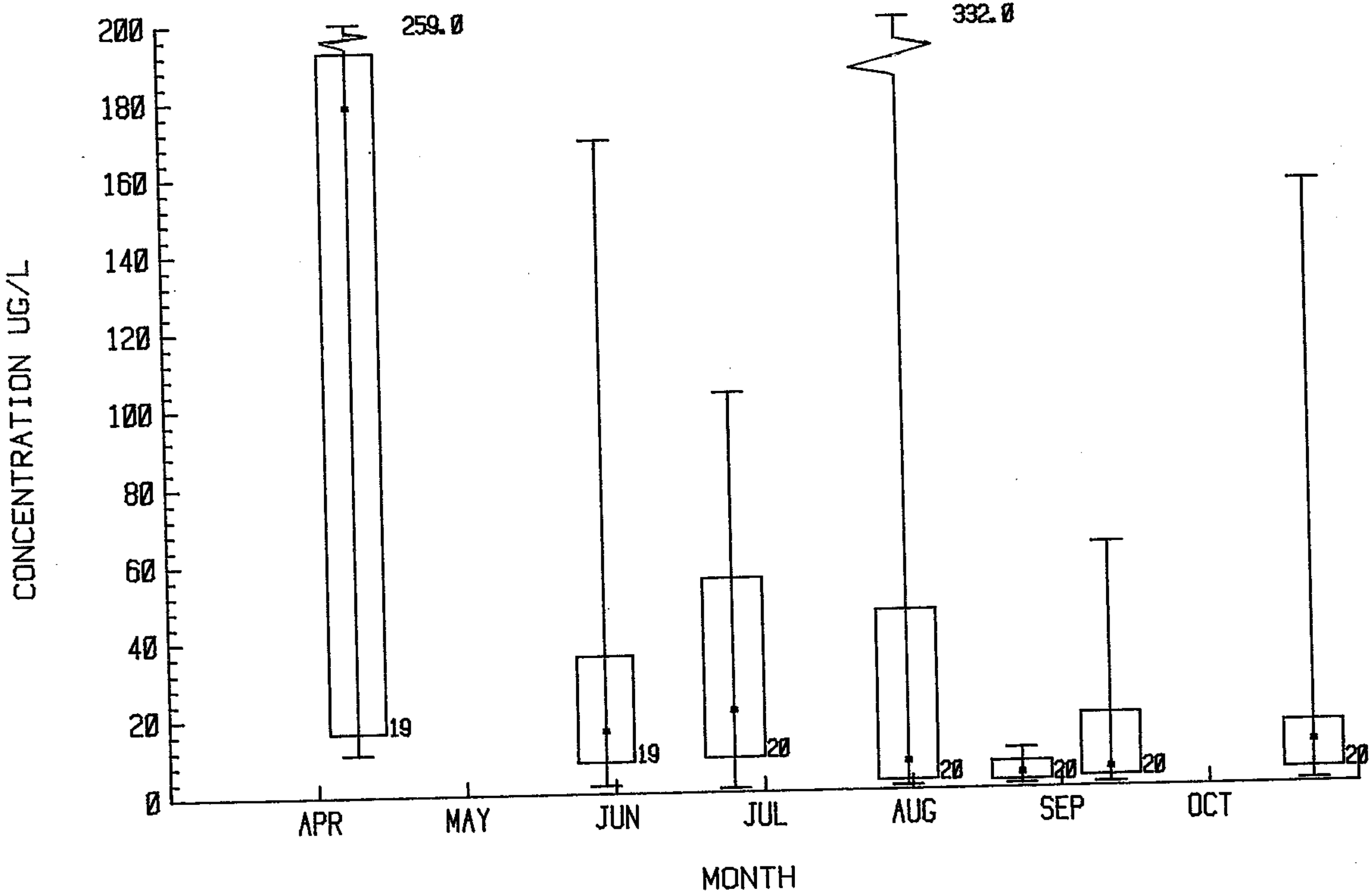
Figure 27



NITRATE + NITRITE MEDIANS

CENTRAL BASIN HYPOLIMNION 1982

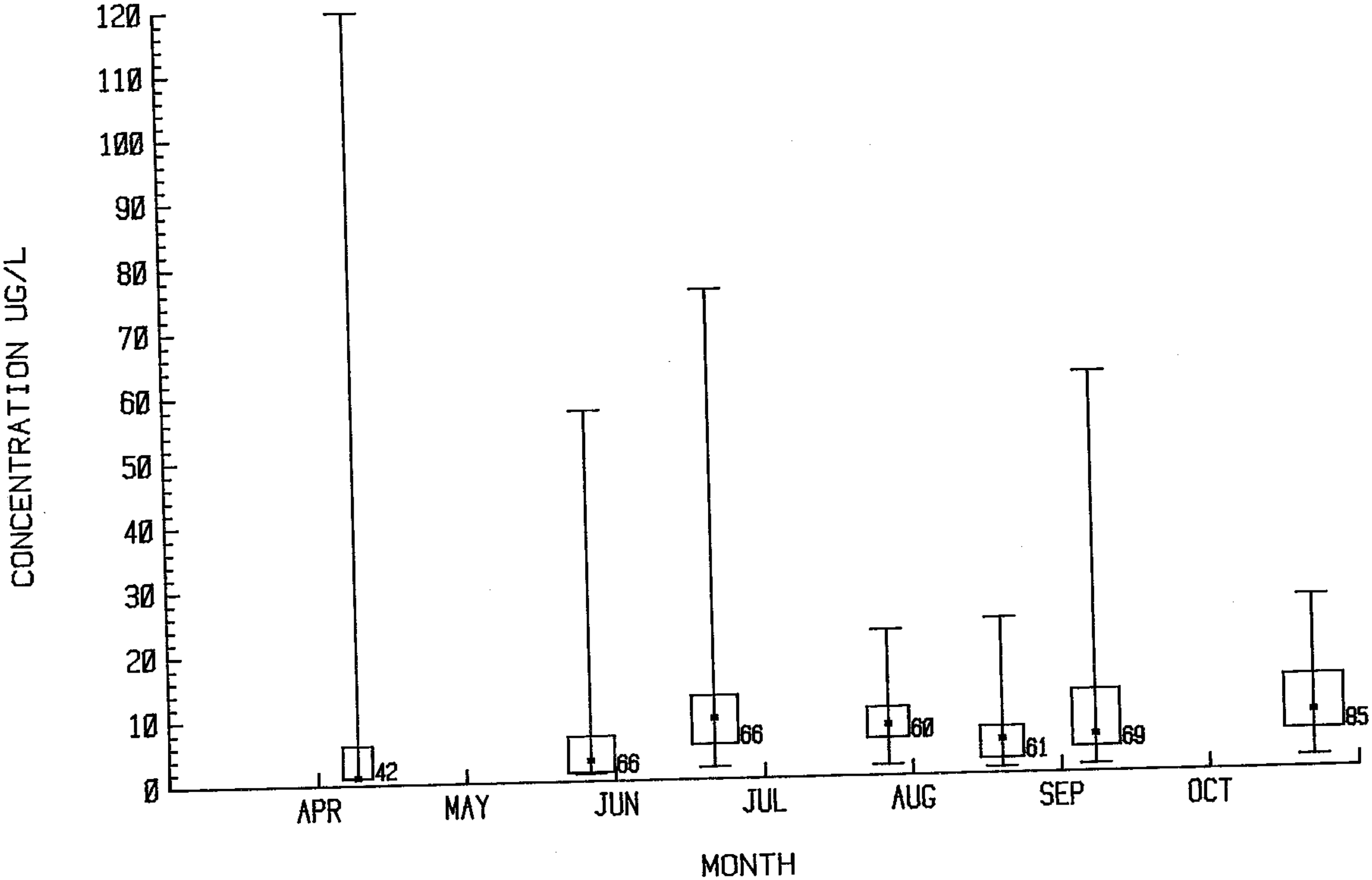
Figure 28



AMMONIA MEDIANS

WESTERN BASIN 1982

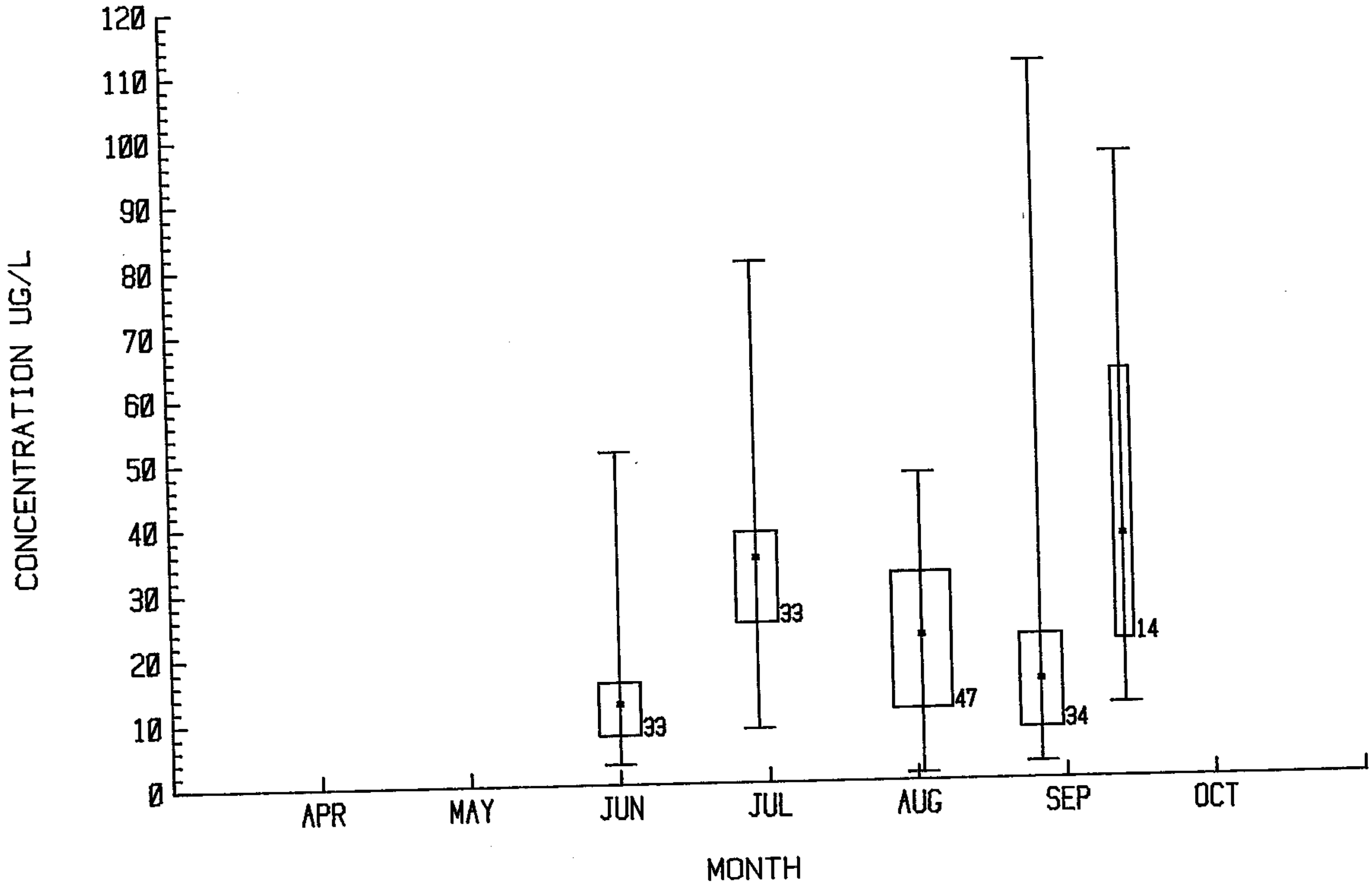
Figure 29



AMMONIA MEDIANS

CENTRAL BASIN EPILIMNION 1982

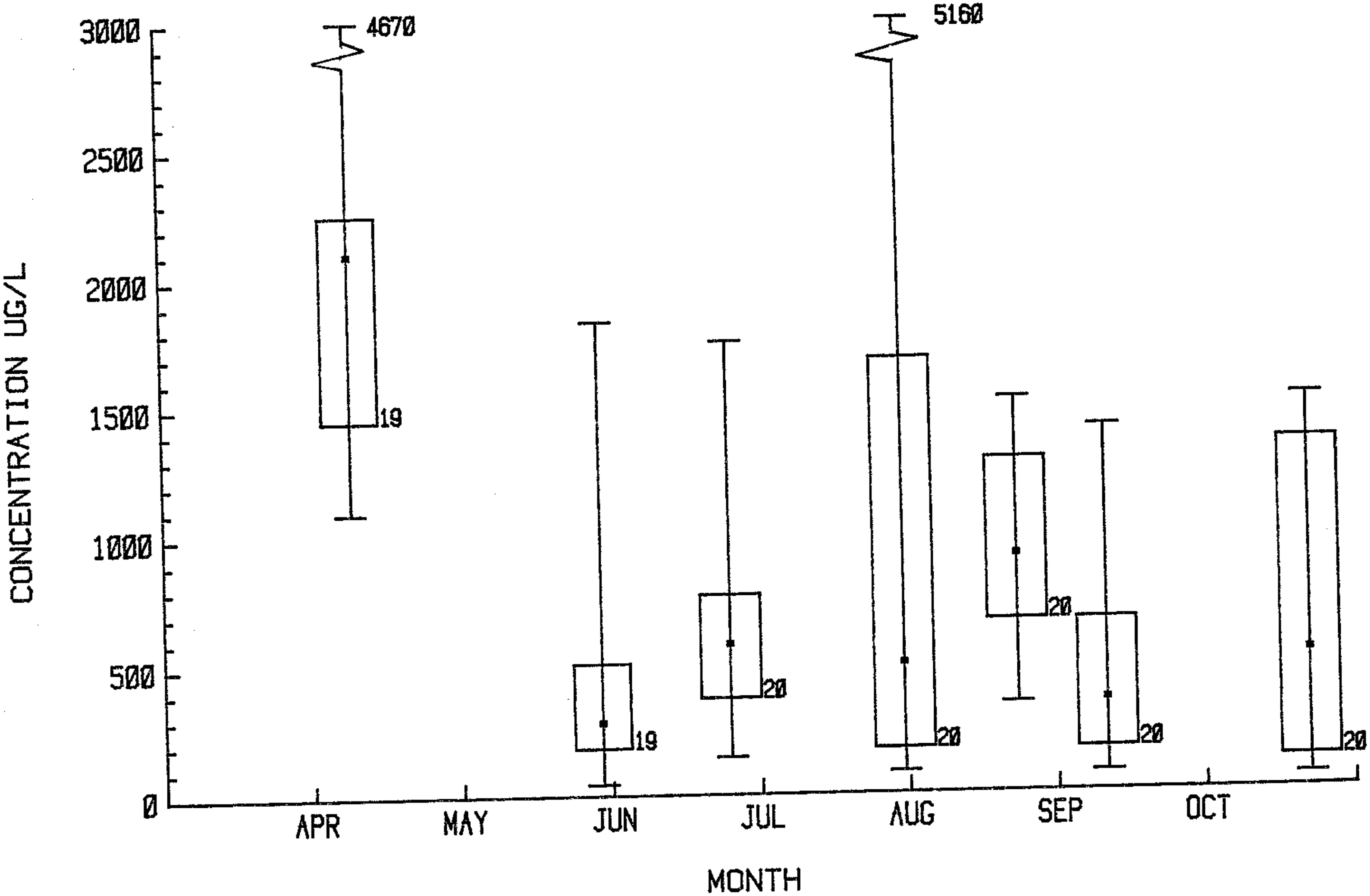
Figure 30



AMMONIA MEDIANS

CENTRAL BASIN HYPOLIMNION 1982

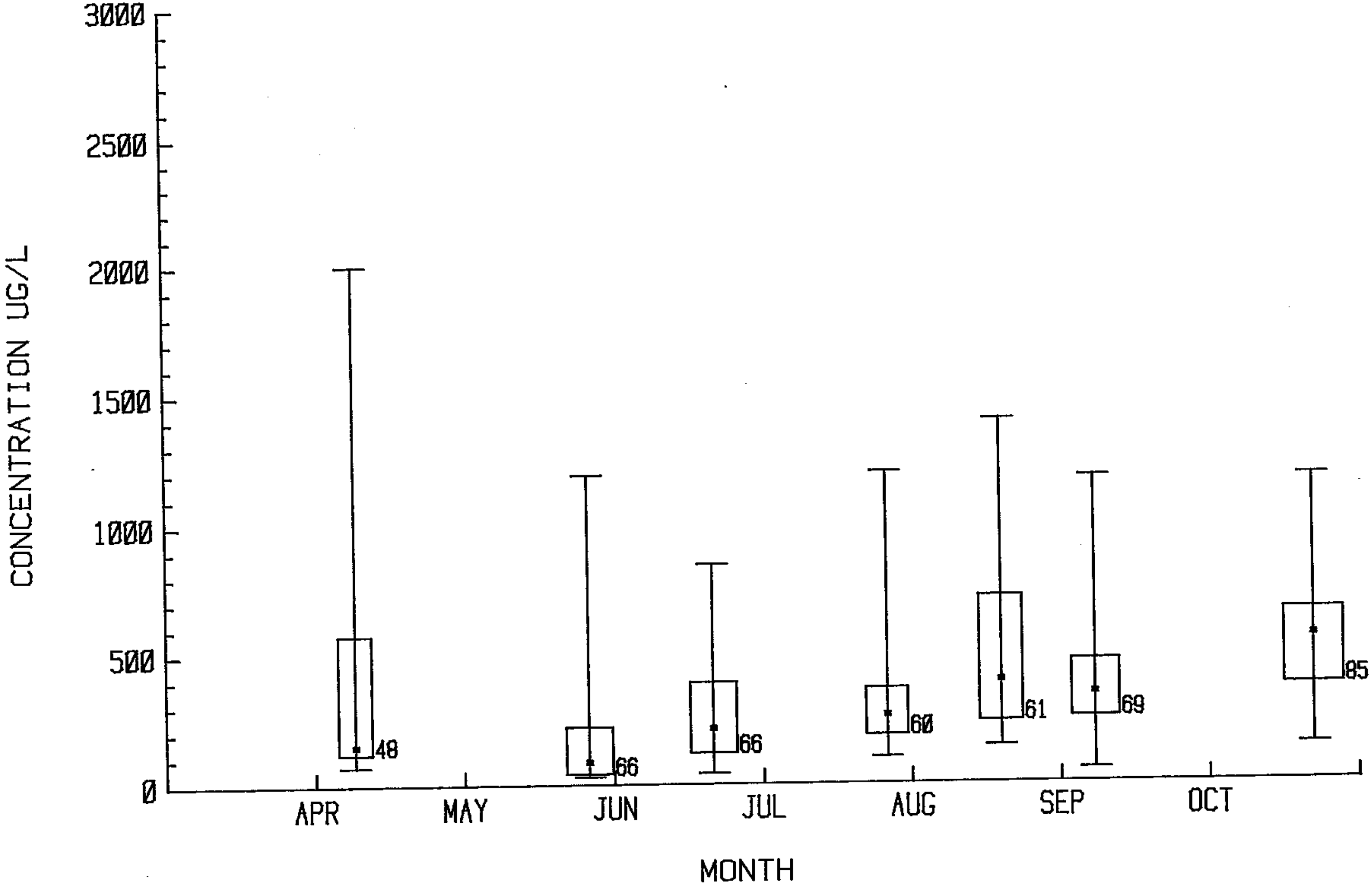
Figure 31



SOLUBLE REACTIVE SILICA MEDIANS

WESTERN BASIN 1982

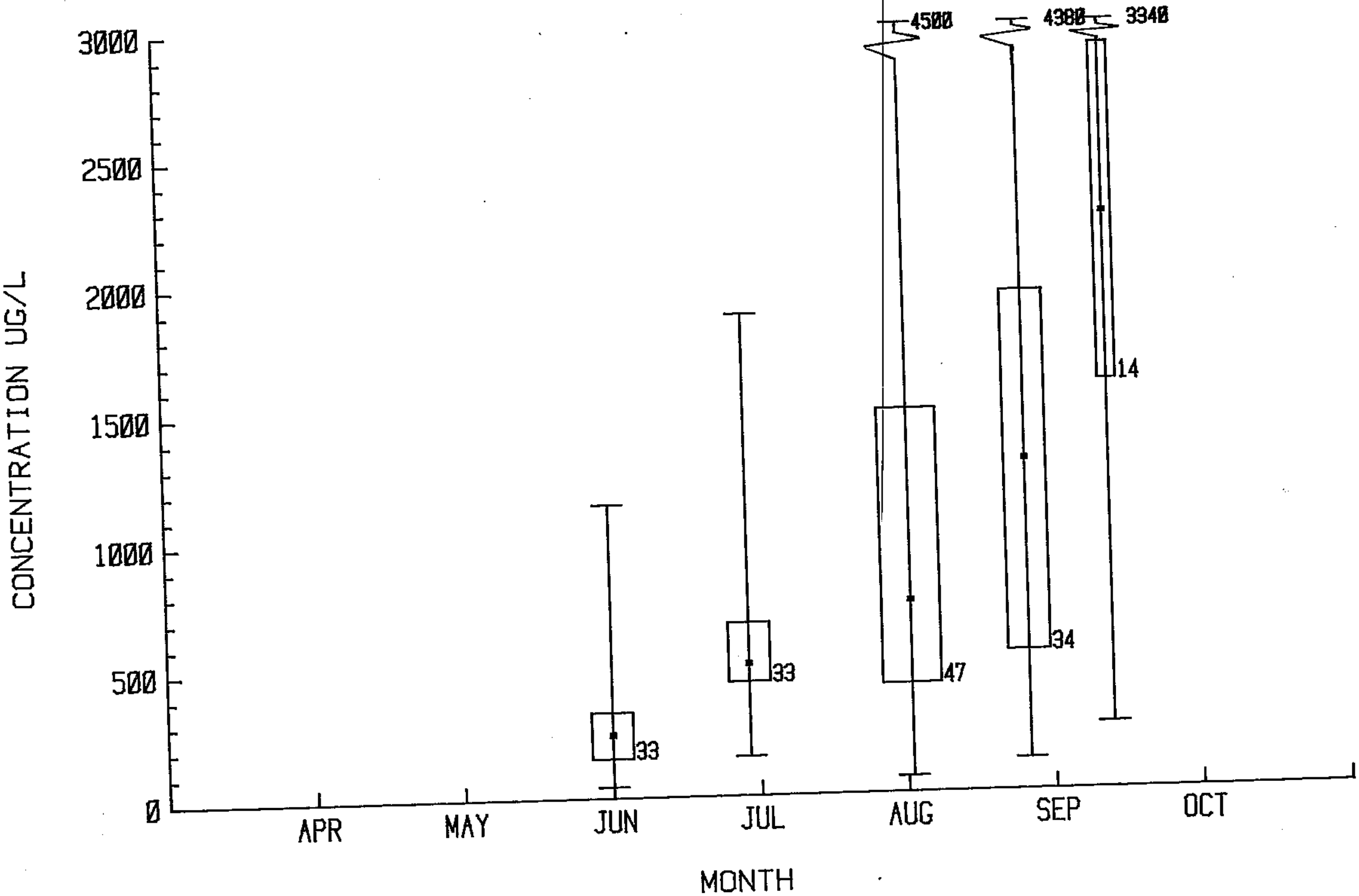
Figure 32



SOLUBLE REACTIVE SILICA MEDIANS

CENTRAL BASIN EPILIMNION 1982

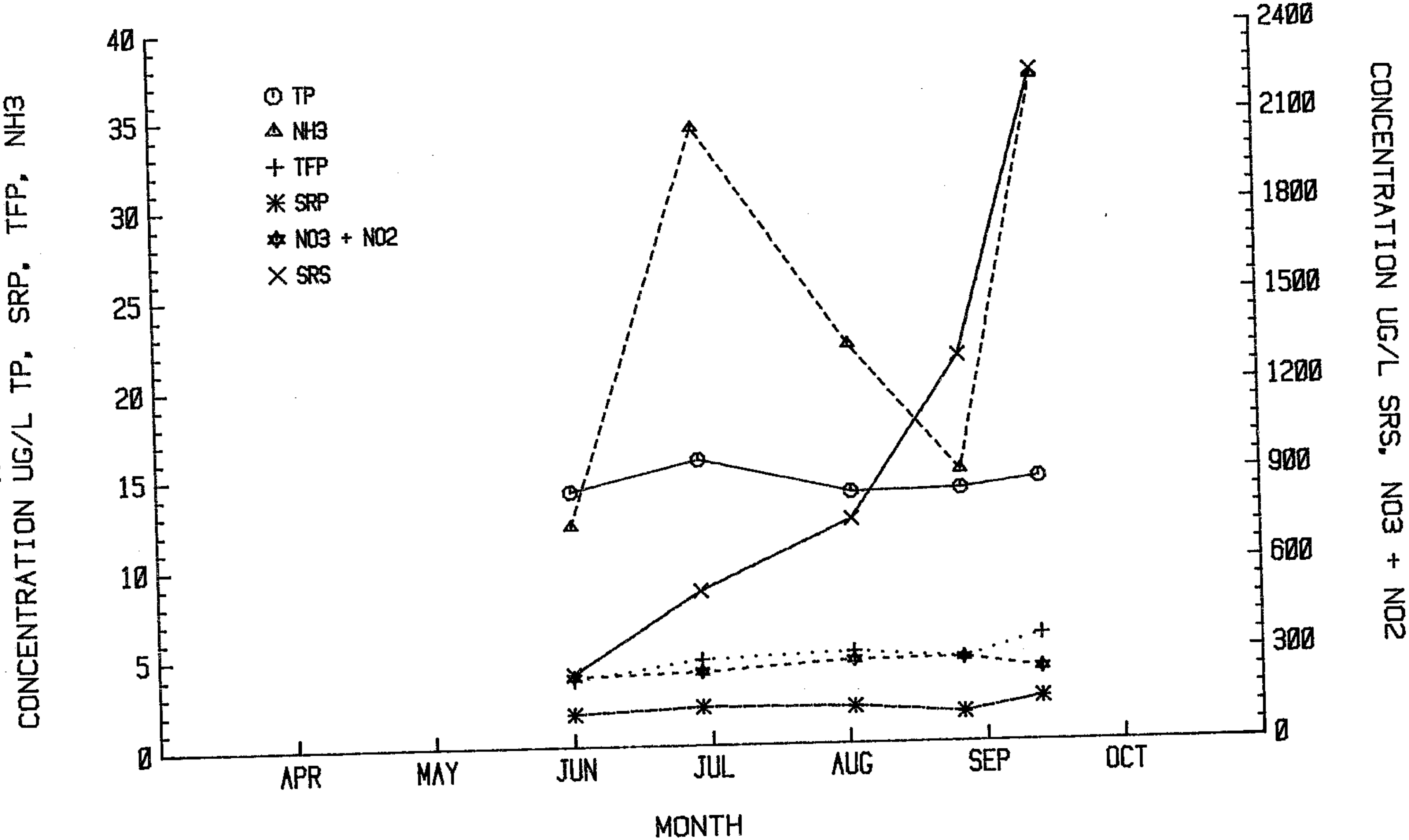
Figure 33



SOLUBLE REACTIVE SILICA MEDIANS

CENTRAL BASIN HYPOLIMNION 1982

Figure 34



HYPOLIMNION NUTRIENT CONCENTRATIONS

CENTRAL BASIN 1982

Figure 35

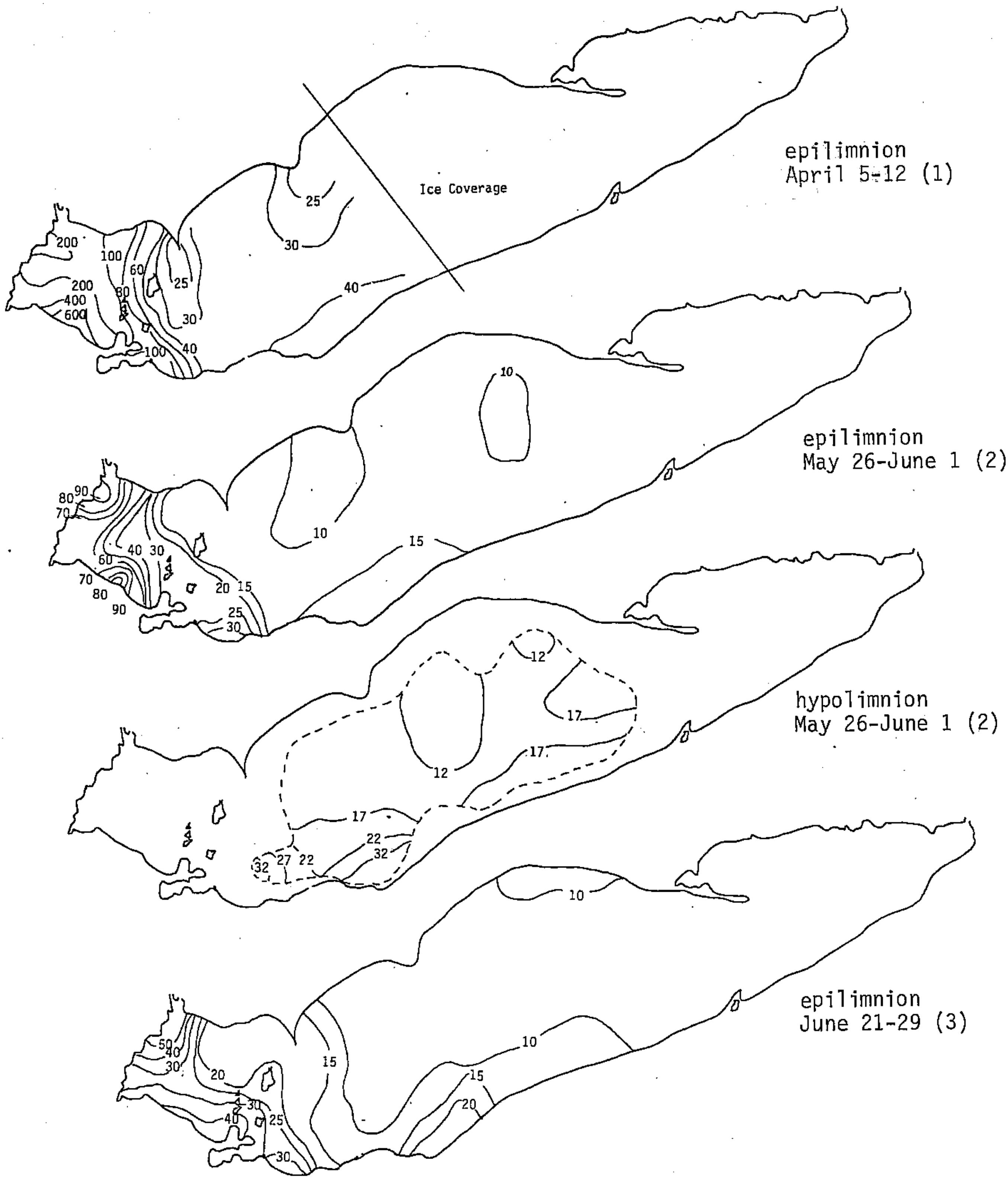


Figure 36. Limnion horizontal distribution maps for total phosphorus (μg/ℓ) 1982.

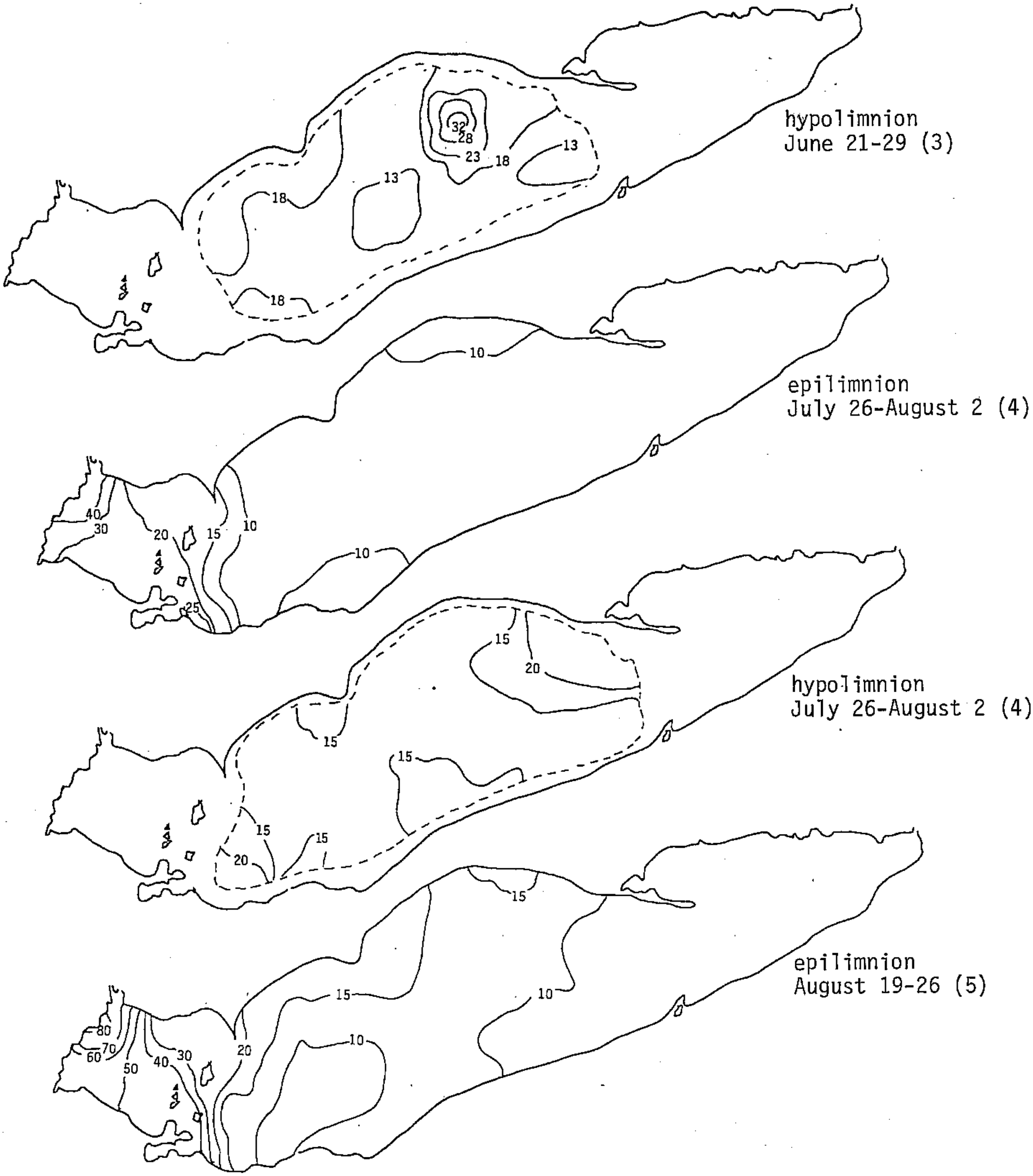


Figure 36 (continued)
Limnion horizontal distribution maps for total phosphorus (μg/ℓ) 1982.

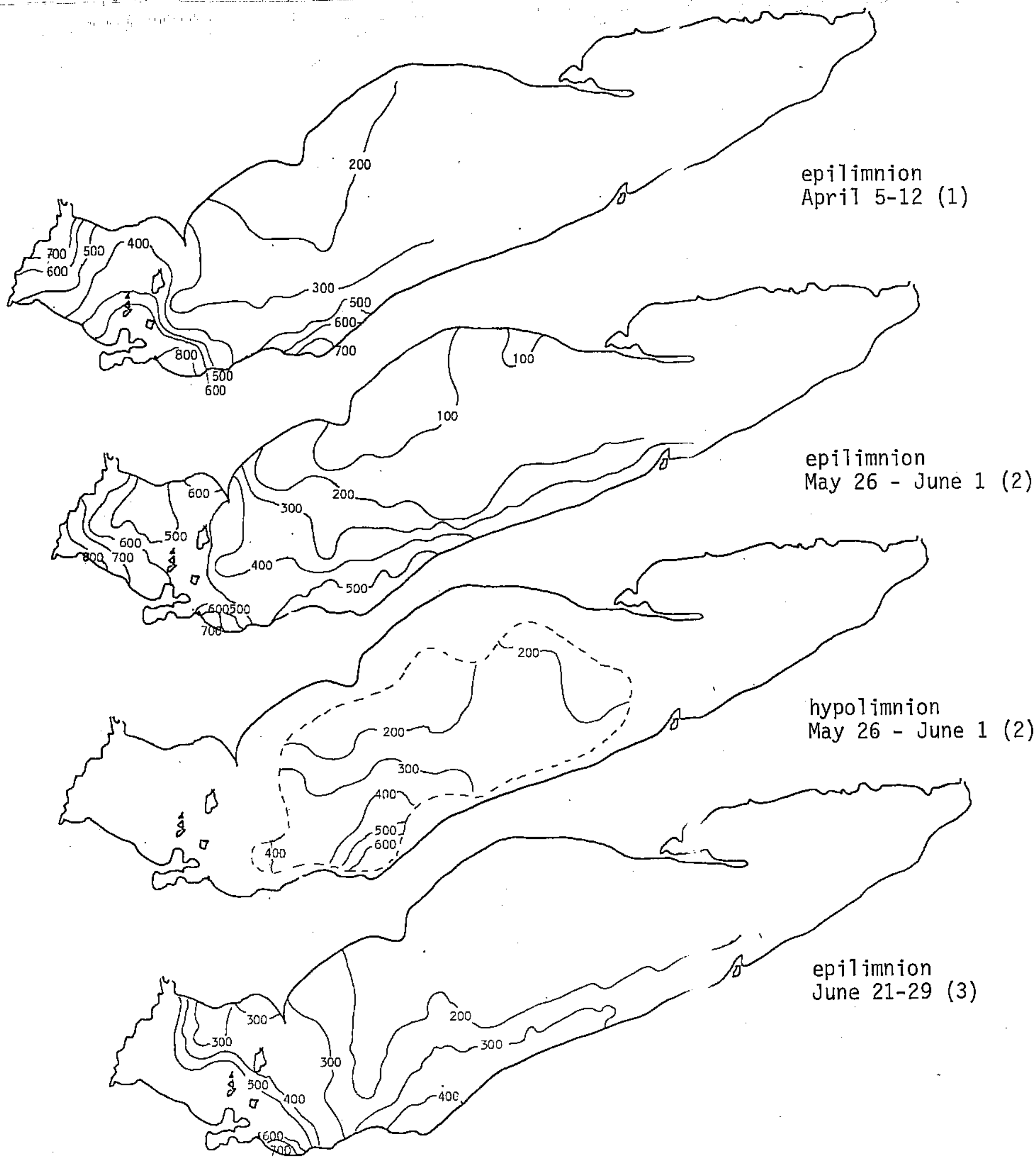


Figure 37. Limnion horizontal distribution maps for nitrate plus nitrite (μg/ℓ), 1982

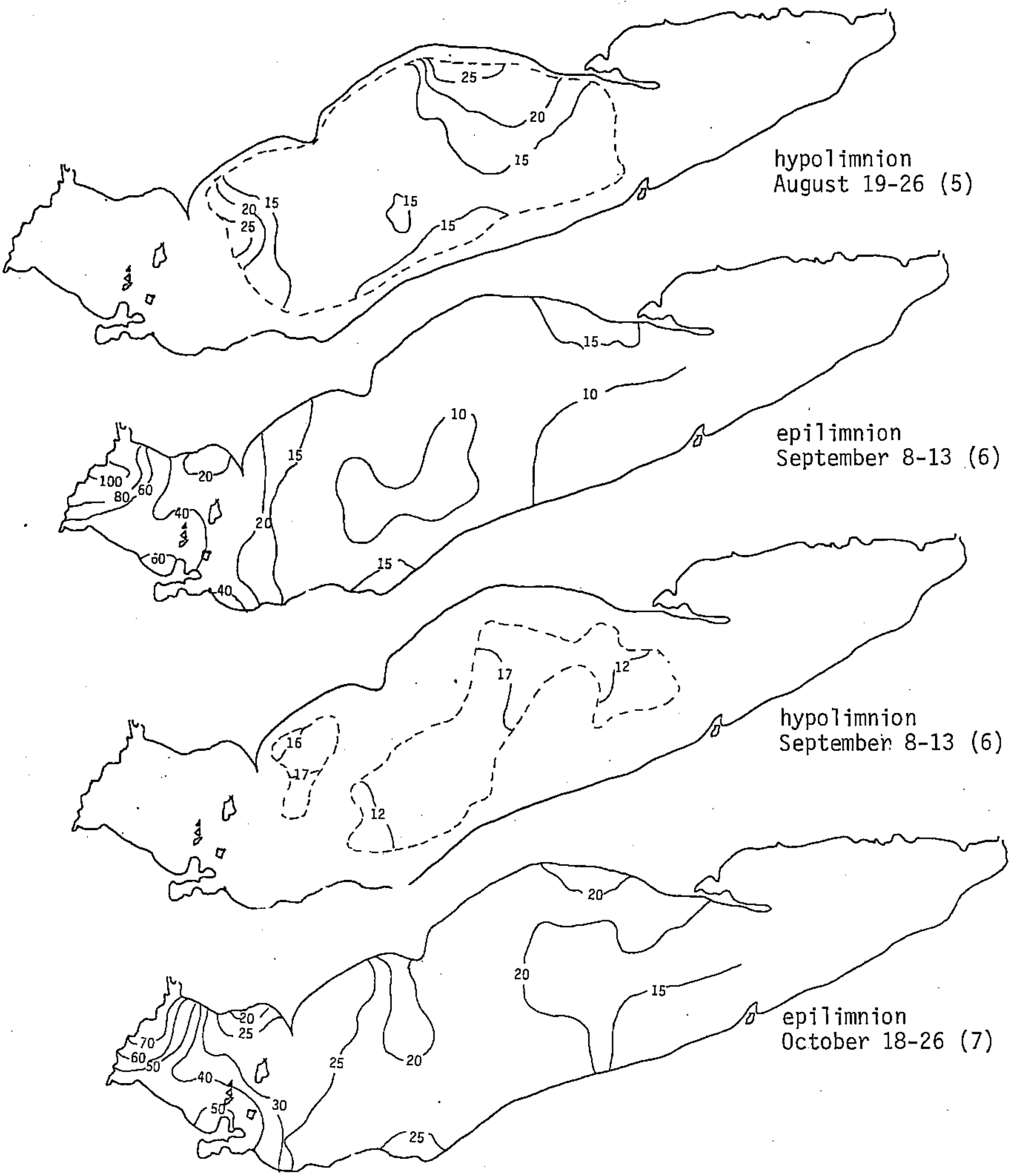


Figure 36 (continued)
Limnion horizontal distribution maps for total phosphorus ($\mu g/\ell$) 1982.

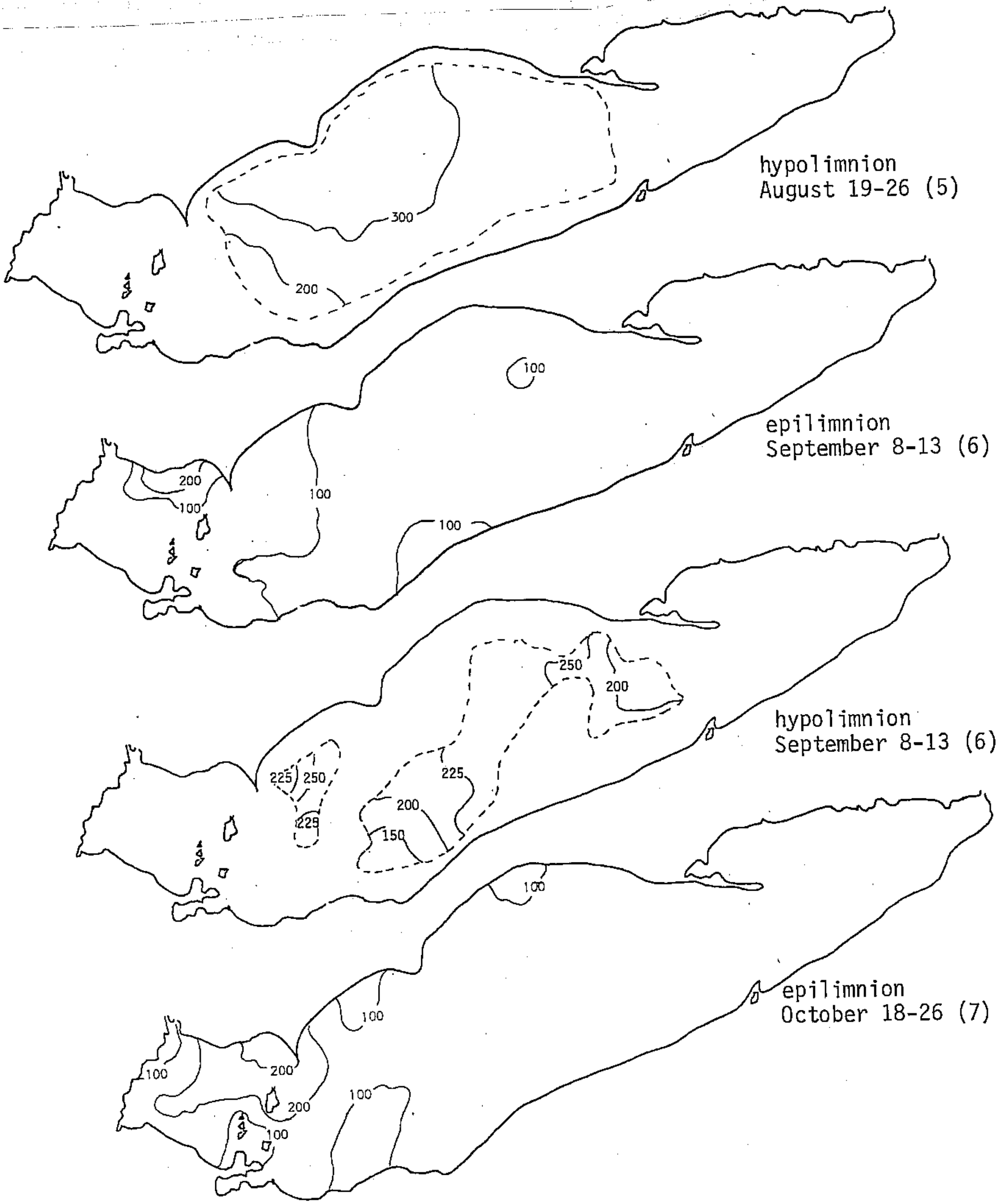


Figure 37. (continued)
Limnion horizontal distribution maps for nitrate plus nitrite ($\mu g/\ell$), 1982.

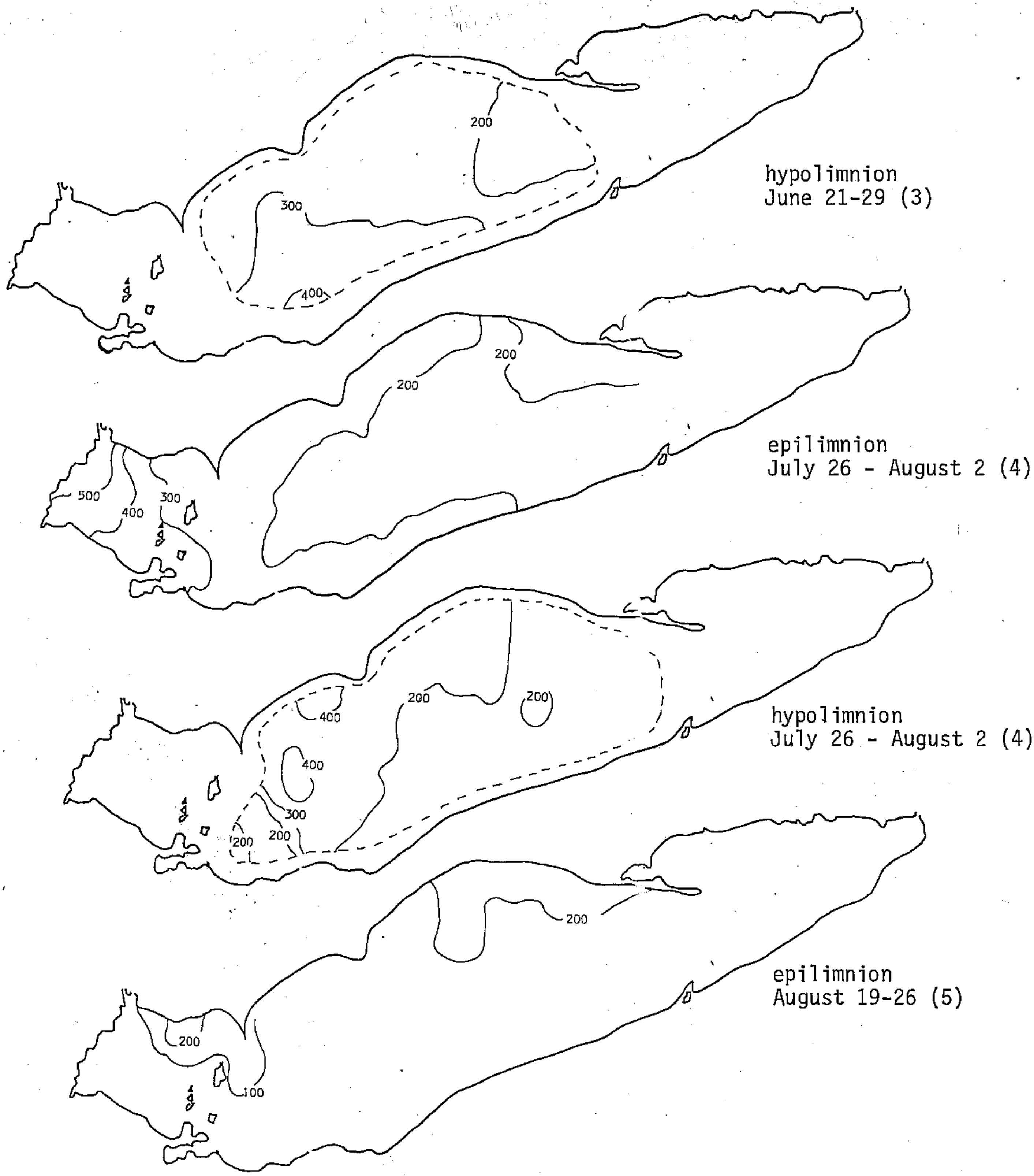


Figure 37. (continued)
Limnion horizontal distribution maps for nitrate plus nitrite ($\mu g/\ell$), 1982.

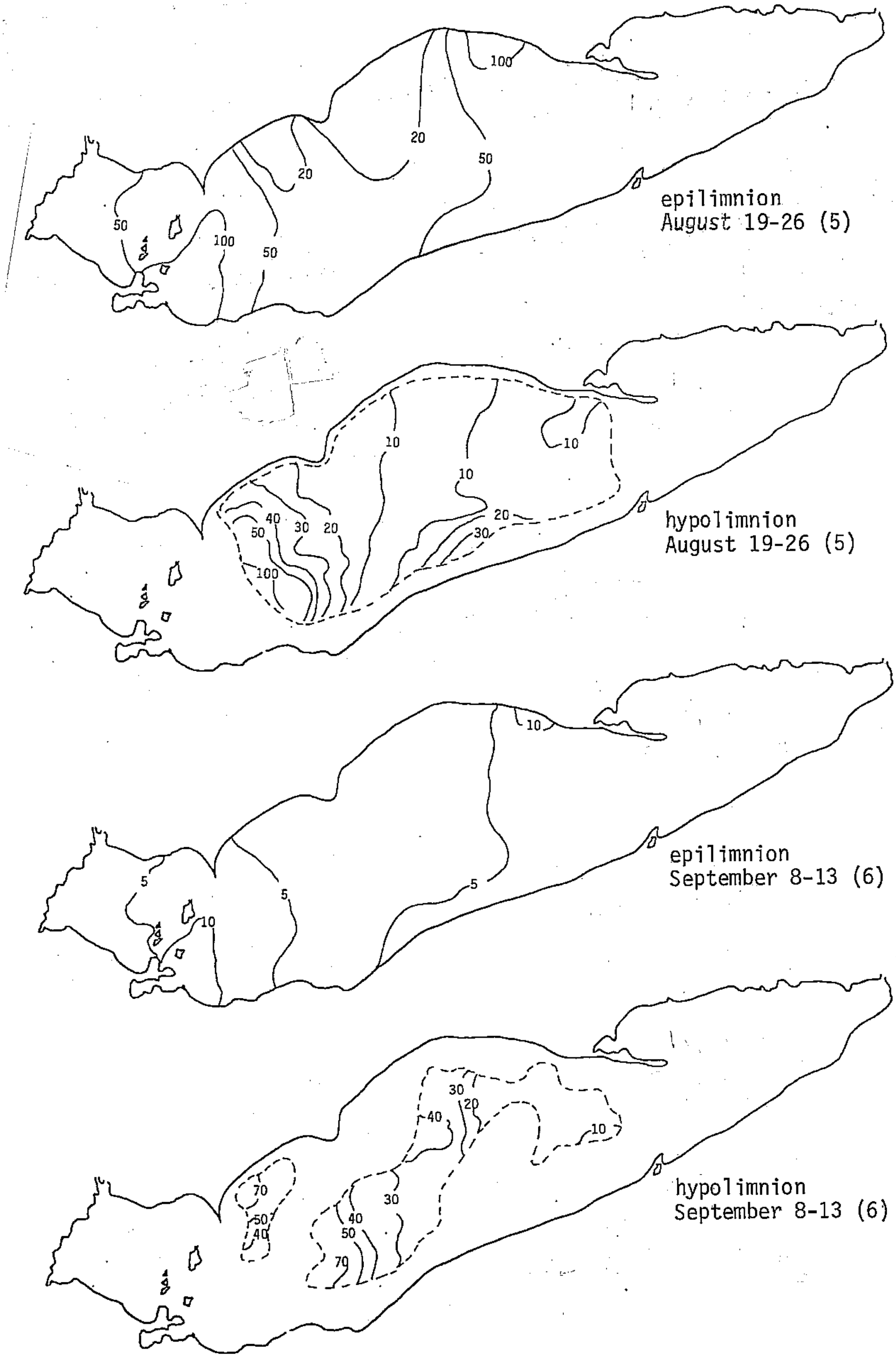


Figure 38.
Limnion horizontal distribution maps for ammonia (μg/ℓ), 1982.

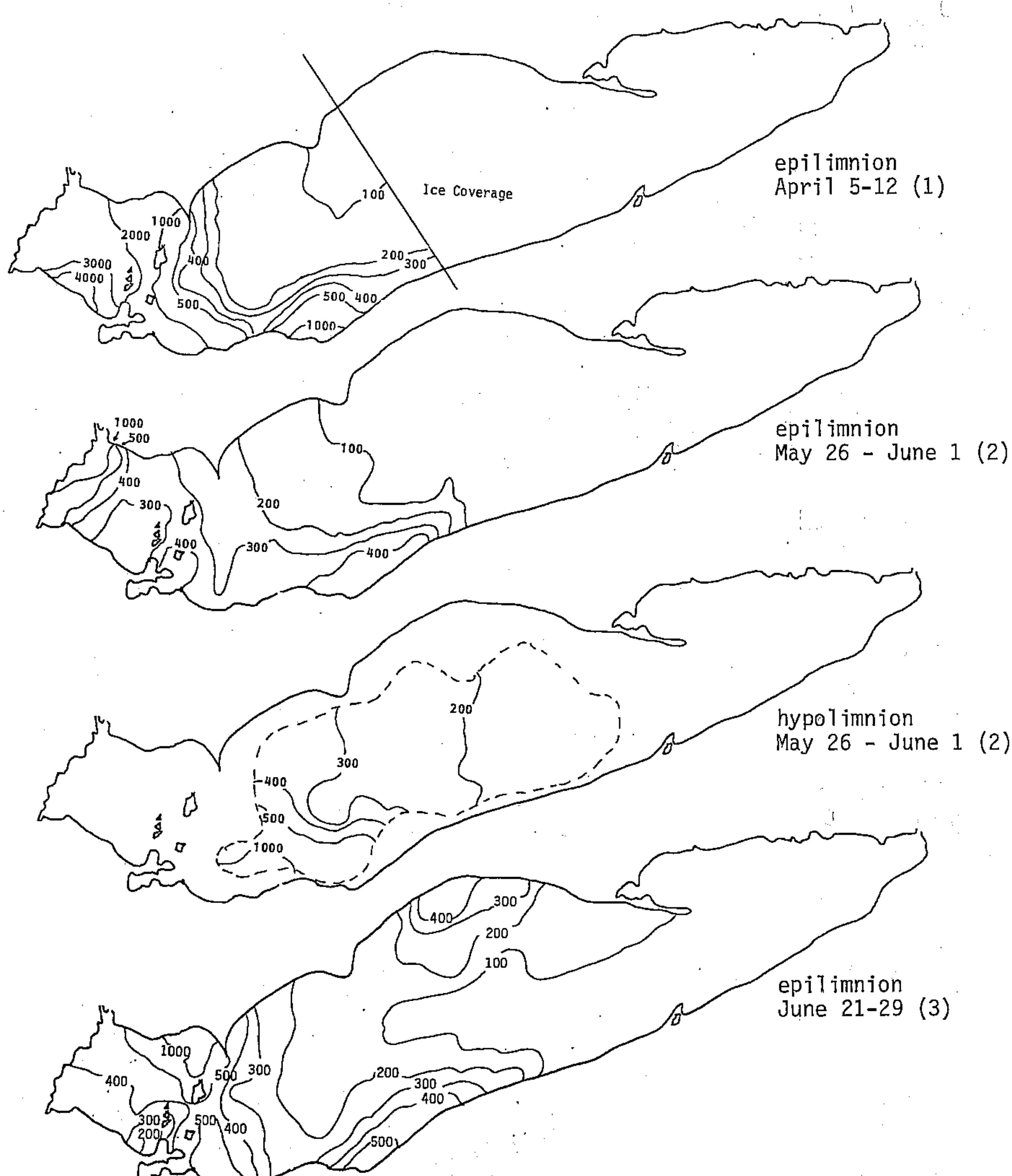
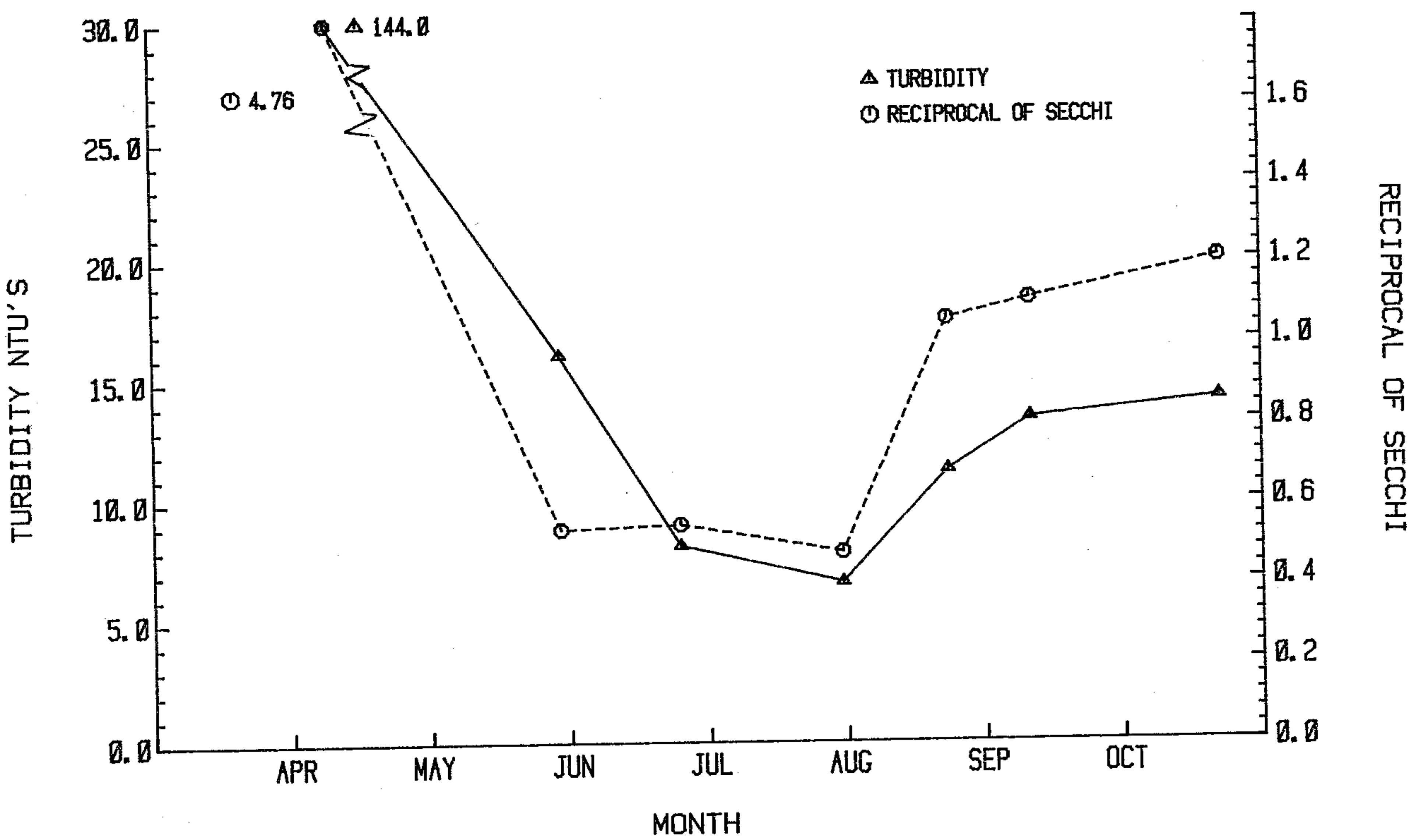


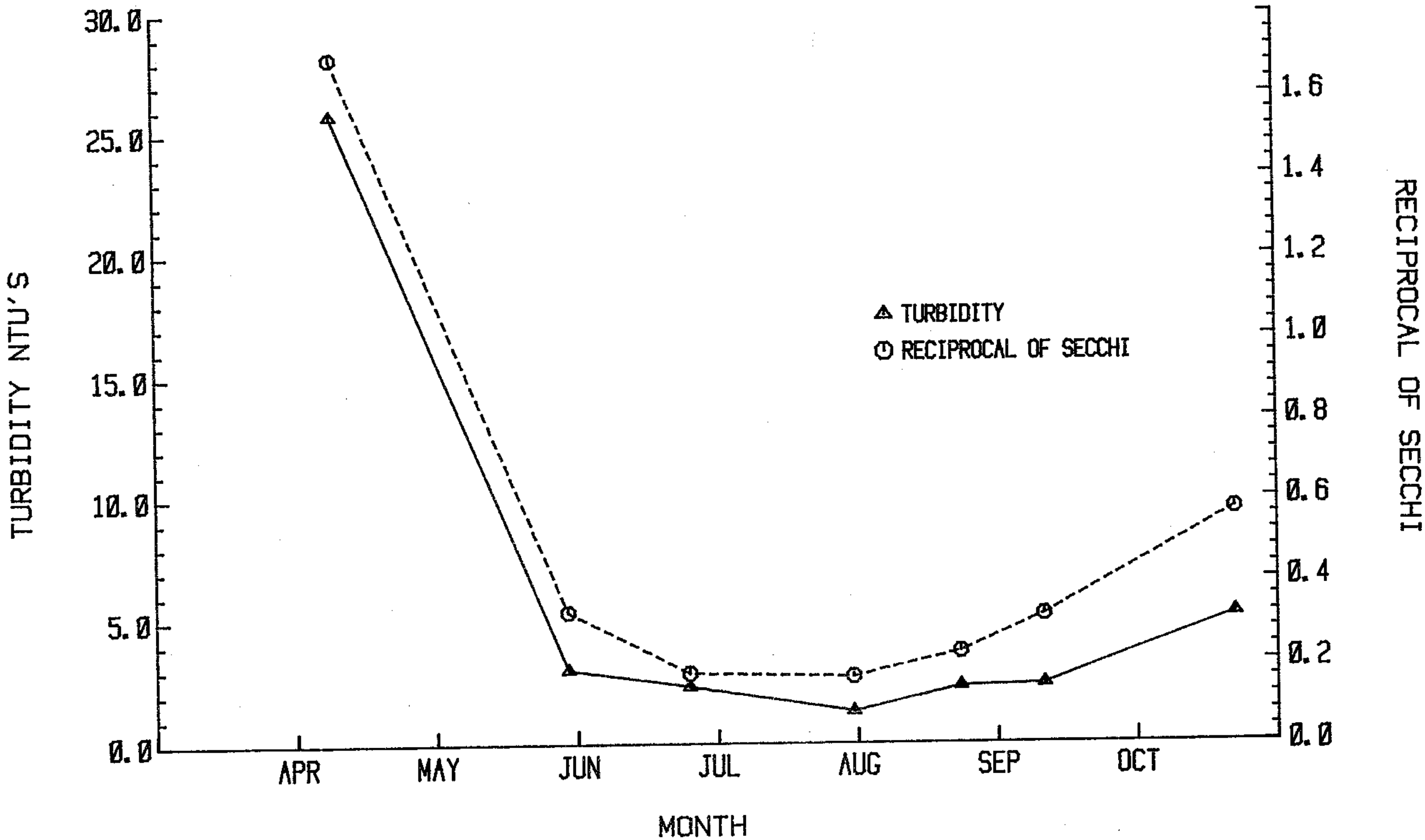
Figure 39. Limnion horizontal distribution maps for soluble reactive silica ($\mu g/\ell$), 1982.



TURBIDITY VS RECIPROCAL OF SECCHI

WESTERN BASIN 1982

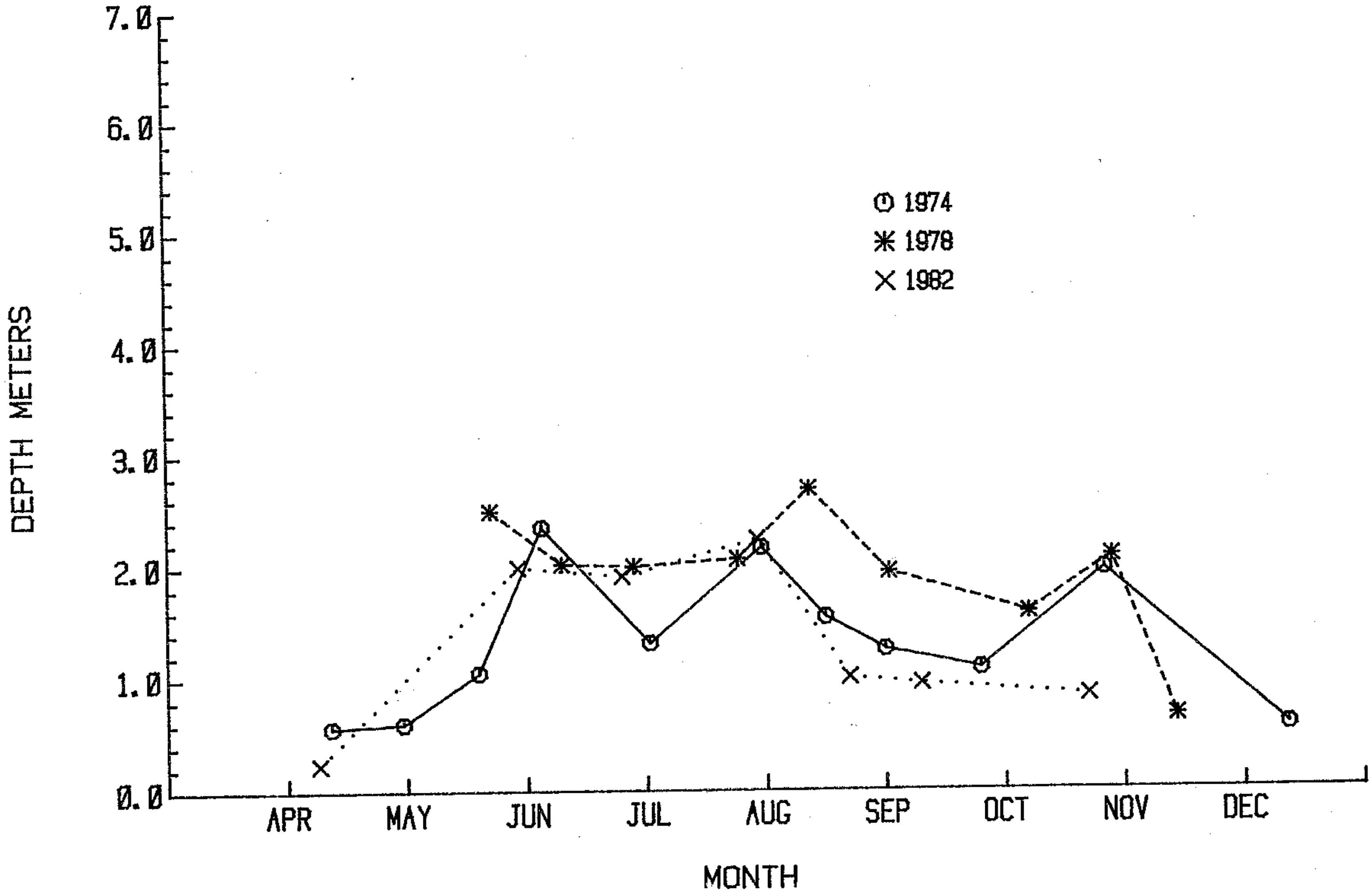
Figure 40



TURBIDITY VS RECIPROCAL OF SECCHI

CENTRAL BASIN SURFACE 1982

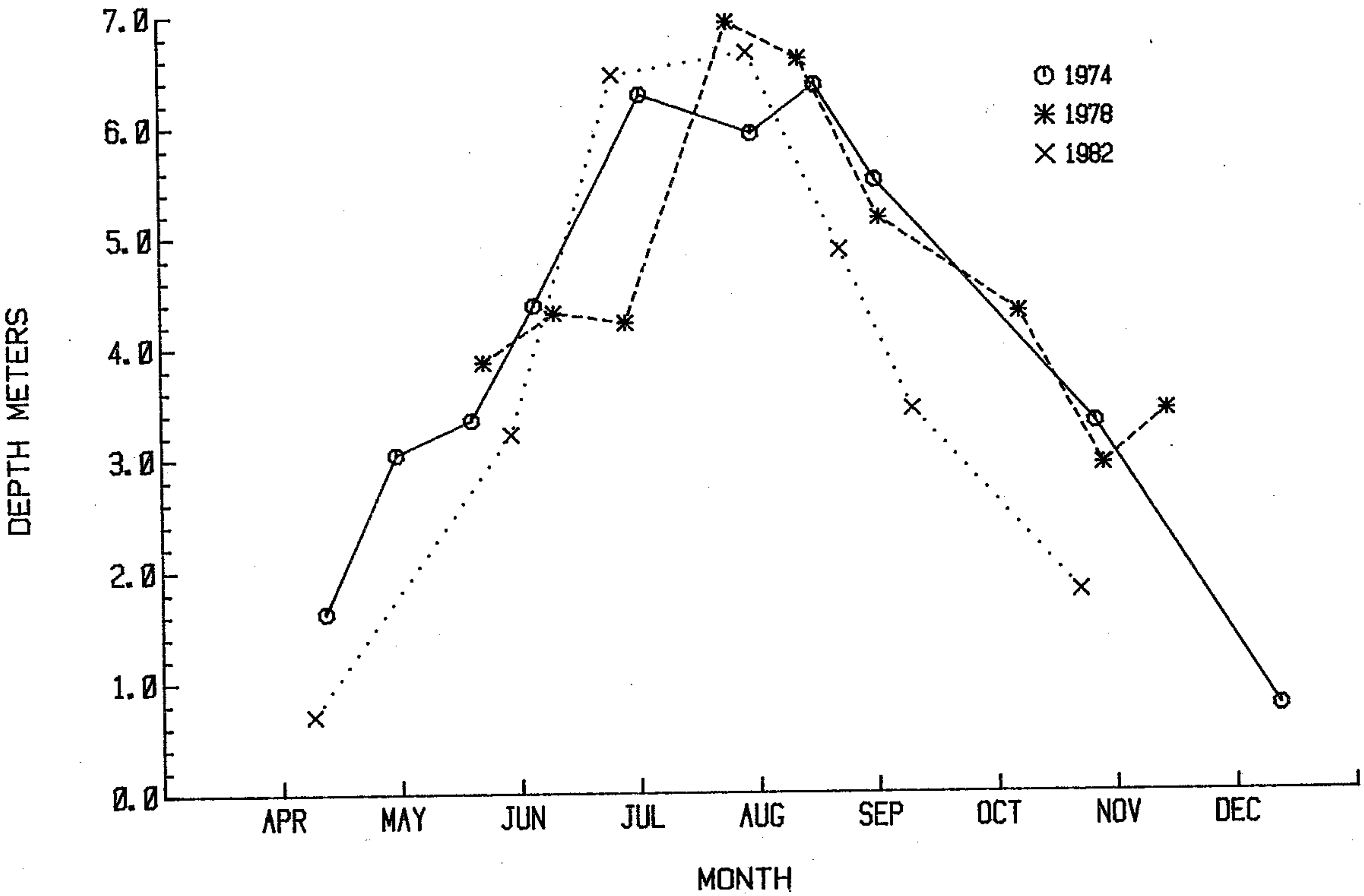
Figure 41



SECCHI AREA-WEIGHTED TRANSPARENCY

WESTERN BASIN

Figure 42



SECCHI AREA-WEIGHTED TRANSPARENCY

CENTRAL BASIN

Figure 43

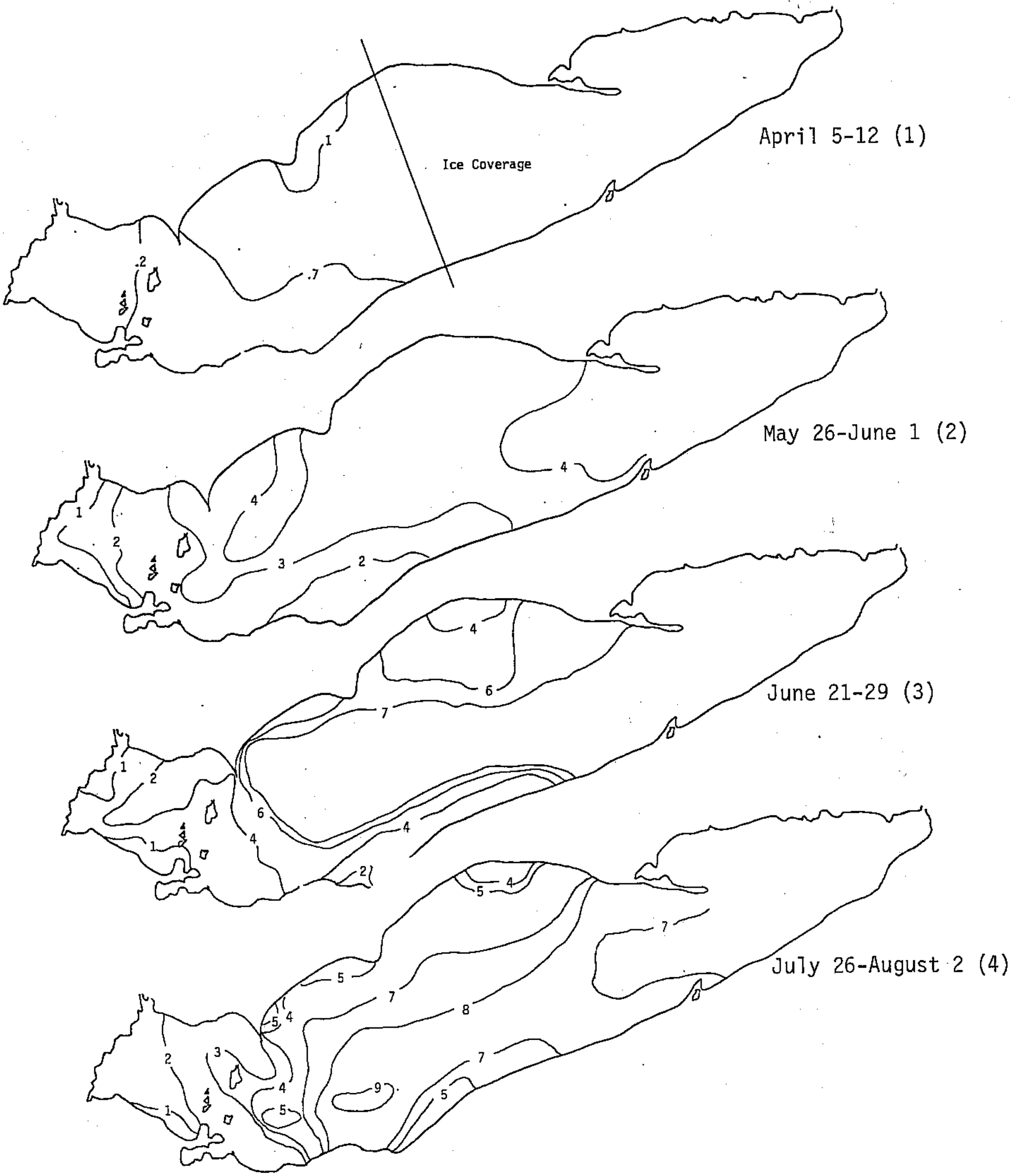


Figure 44. Horizontal Distribution maps for Secchi (m) 1982.

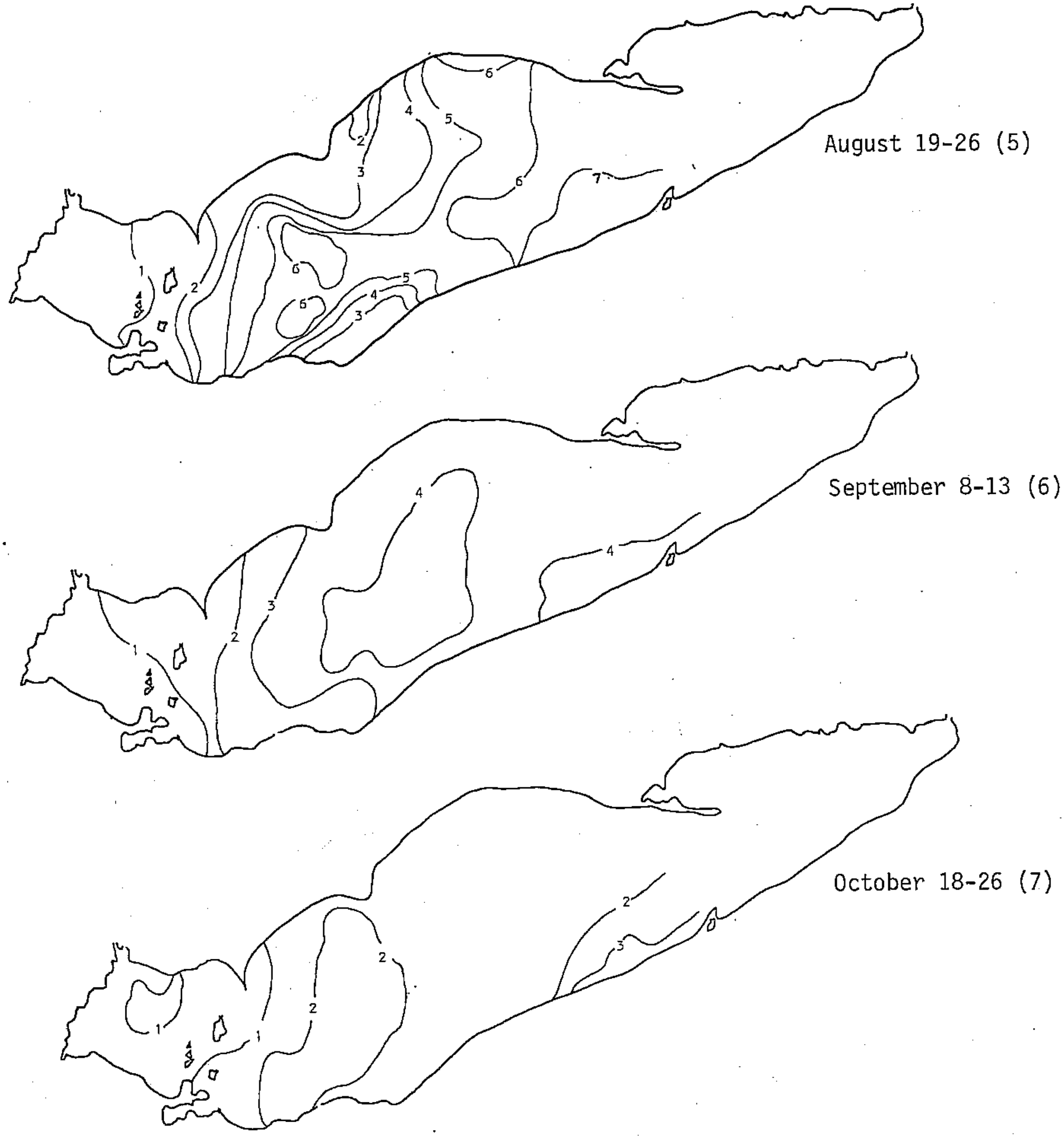
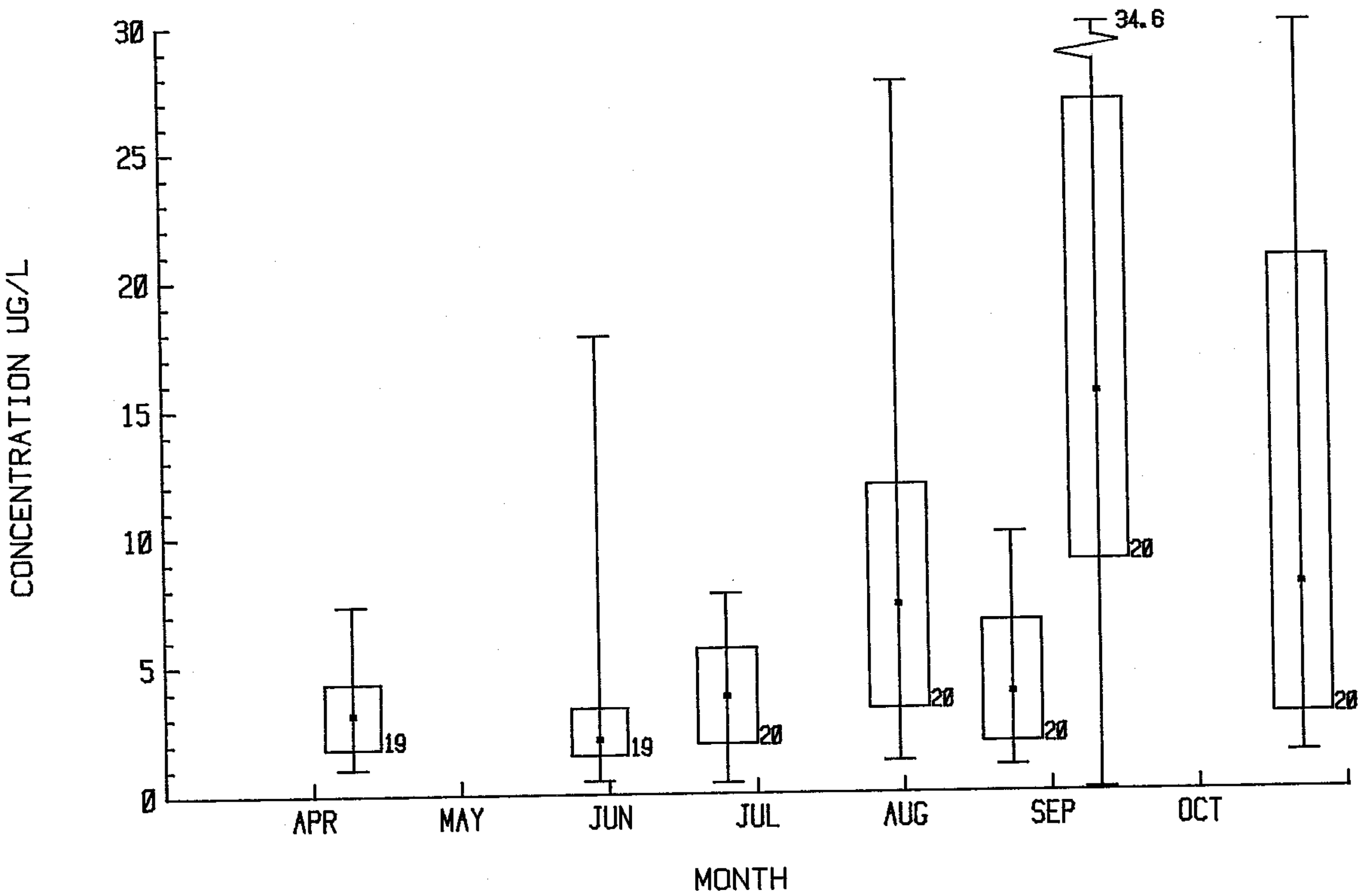


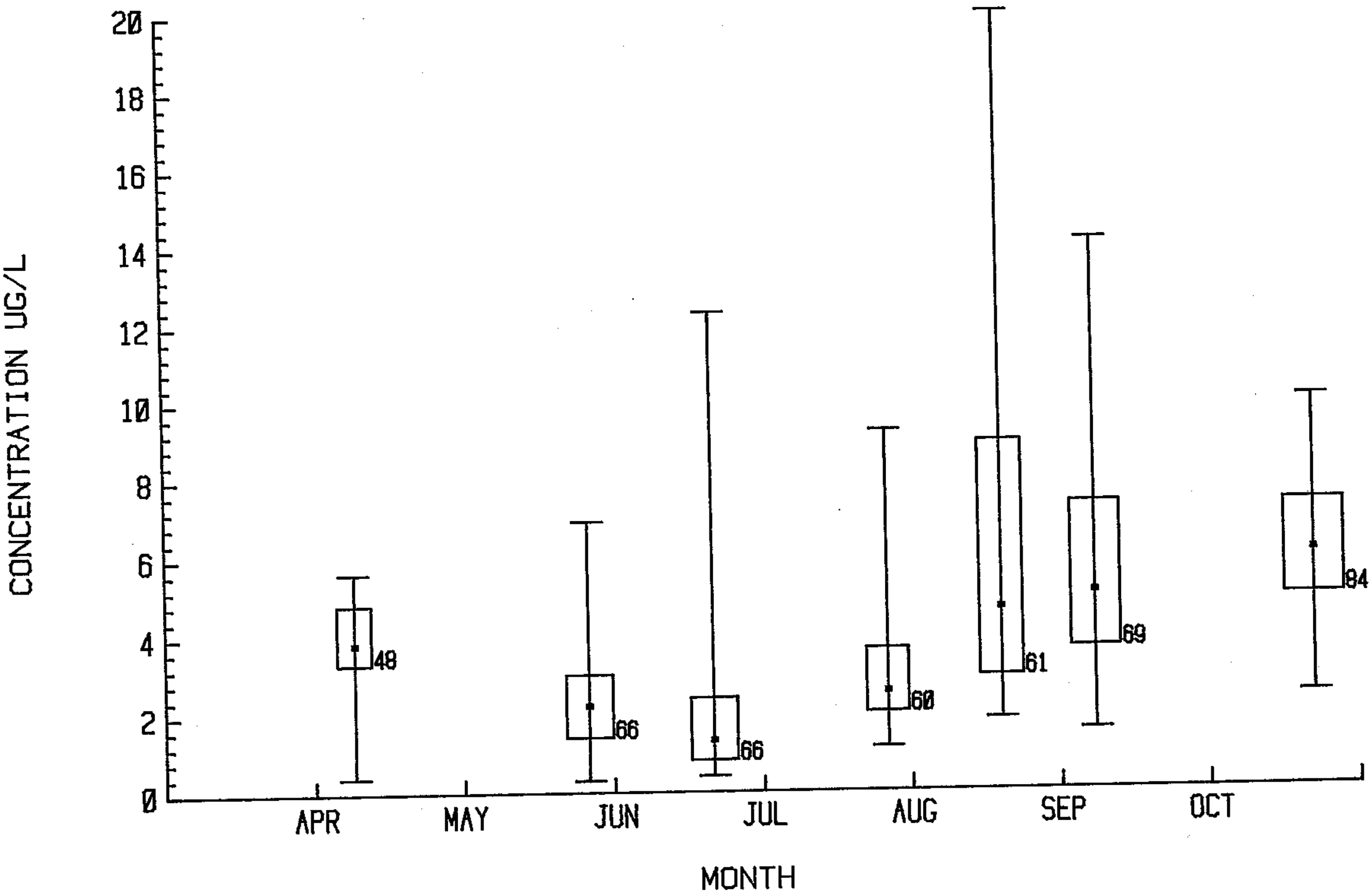
Figure 44(continued)
Horizontal Distribution maps for Secchi (m) 1982.



CORRECTED CHLOROPHYLL A MEDIANS

WESTERN BASIN 1982

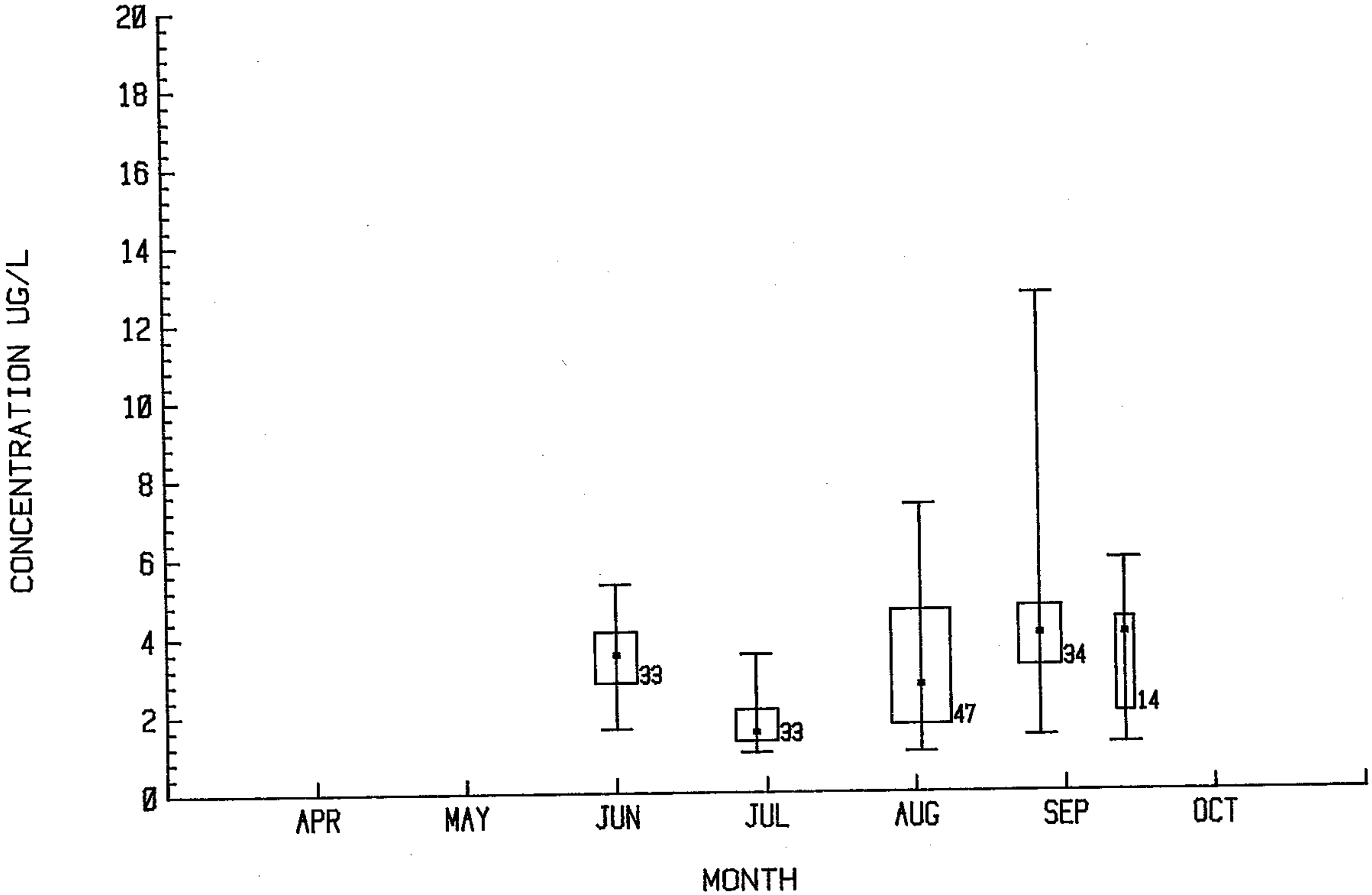
Figure 45



CORRECTED CHLOROPHYLL A MEDIANS

CENTRAL BASIN EPILIMNION 1982

Figure 46



CORRECTED CHLOROPHYLL A MEDIANS

CENTRAL BASIN HYPOLIMNION 1982

Figure 47

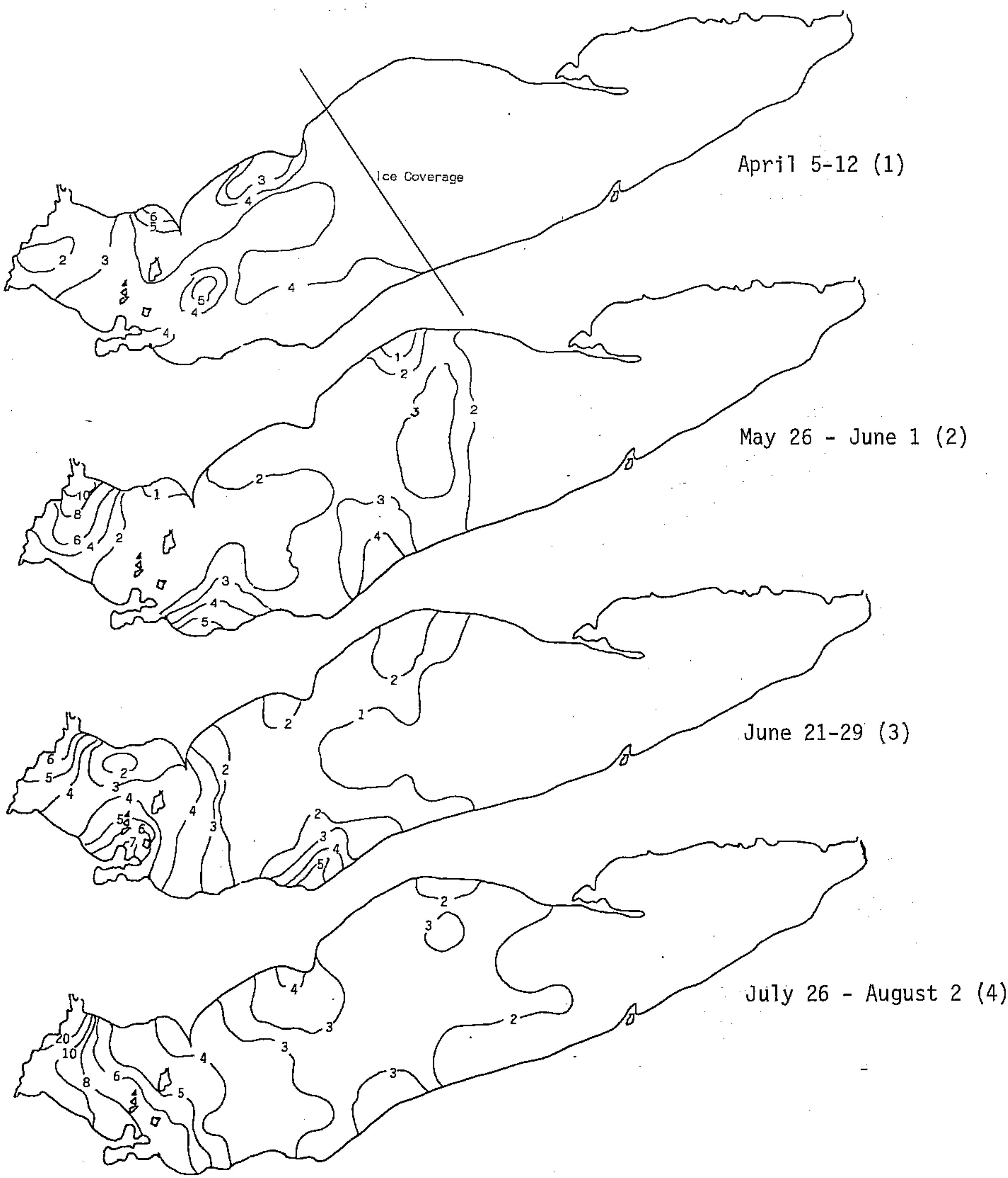


Figure 48. Epilimnion horizontal distribution maps for Corrected Chlorophyll a ($\mu g/\ell$), 1982.

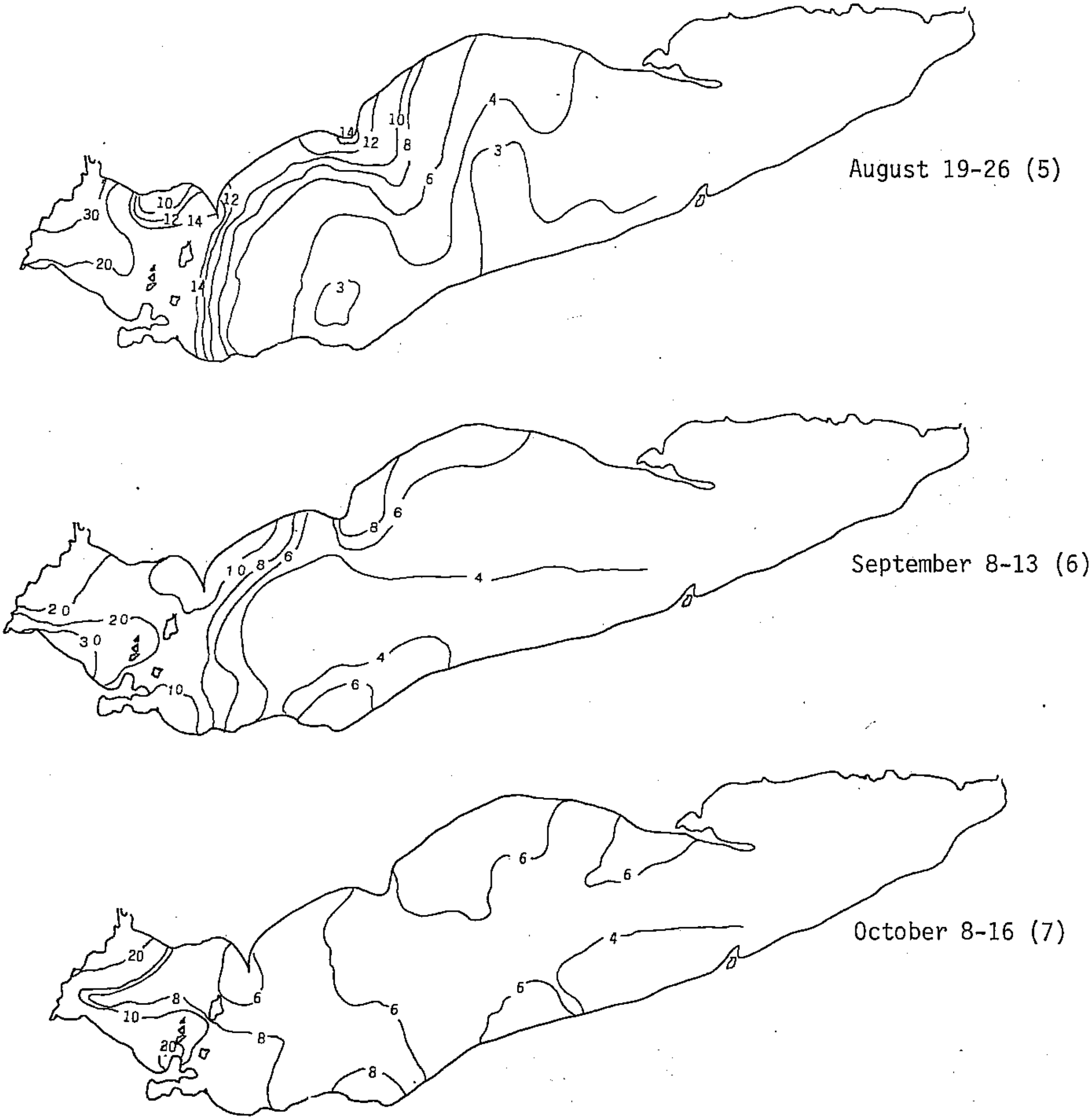


Figure 48 (continued)
Epilimnion horizontal distribution maps for Corrected Chlorophyll a (μg/ℓ), 1982.

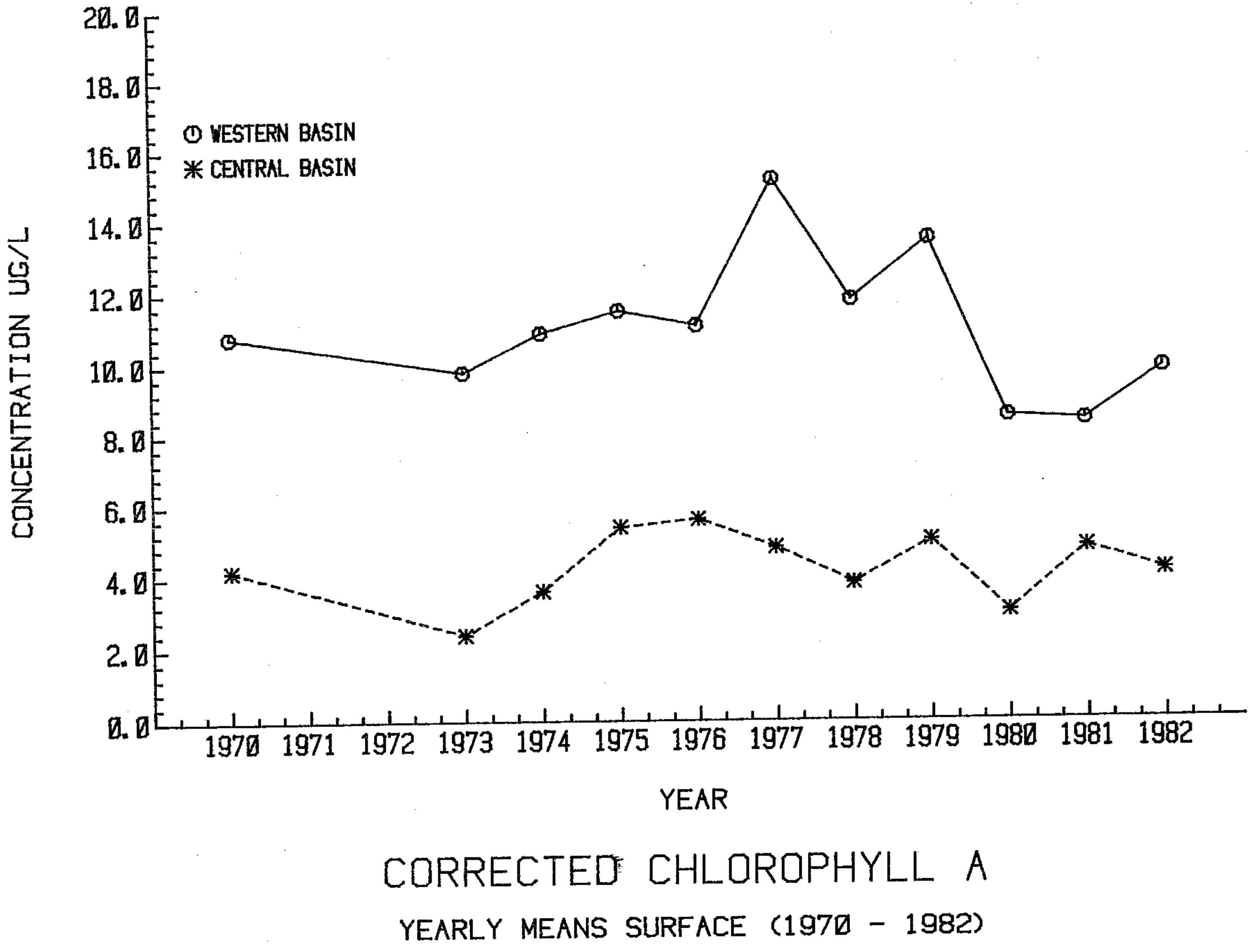
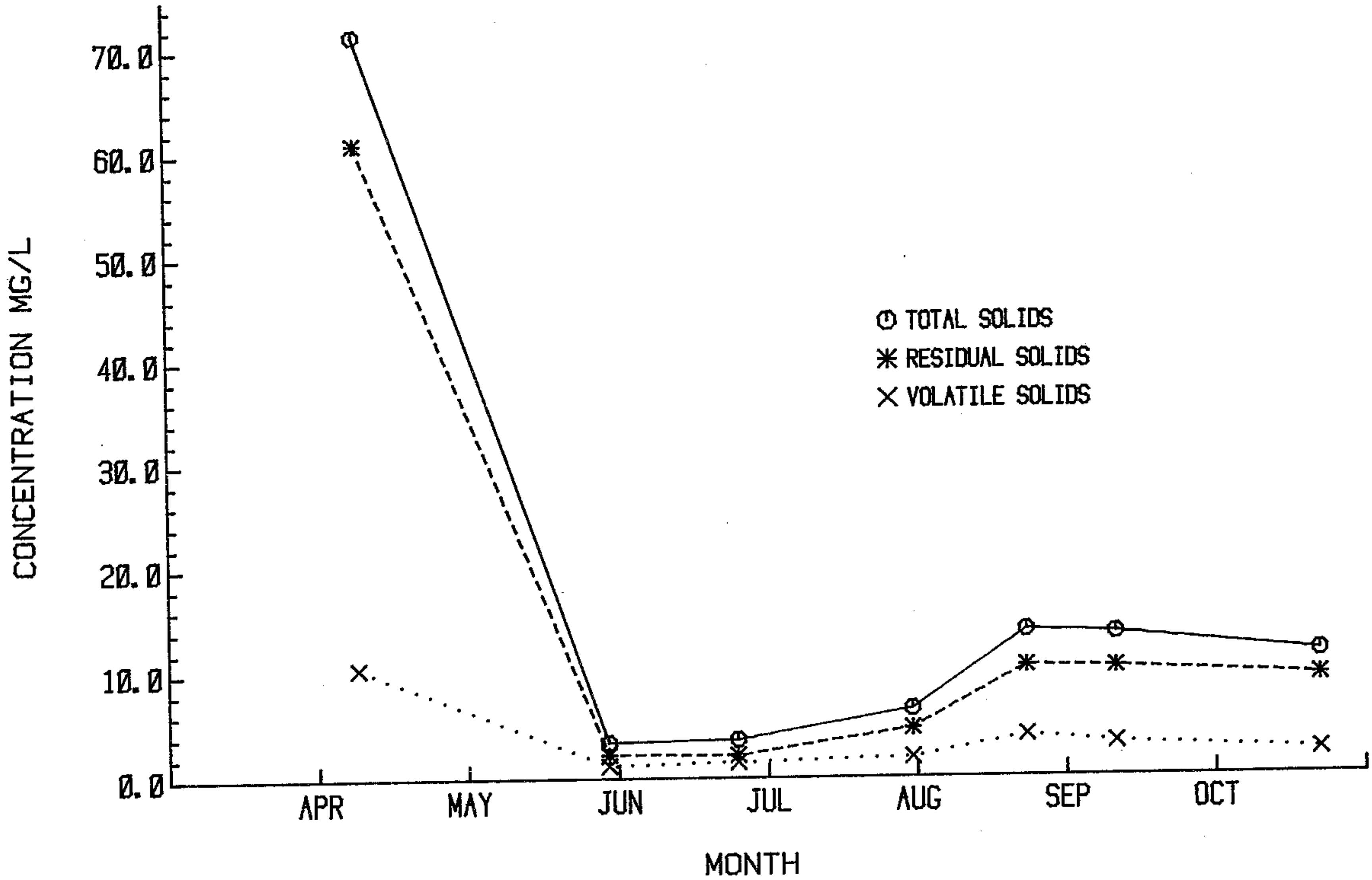

20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
CONCENTRATION UG/L
WESTERN BASIN
CENTRAL BASIN
1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982
YEAR
CORRECTED CHLOROPHYLL A
YEARLY MEANS SURFACE (1970 - 1982)

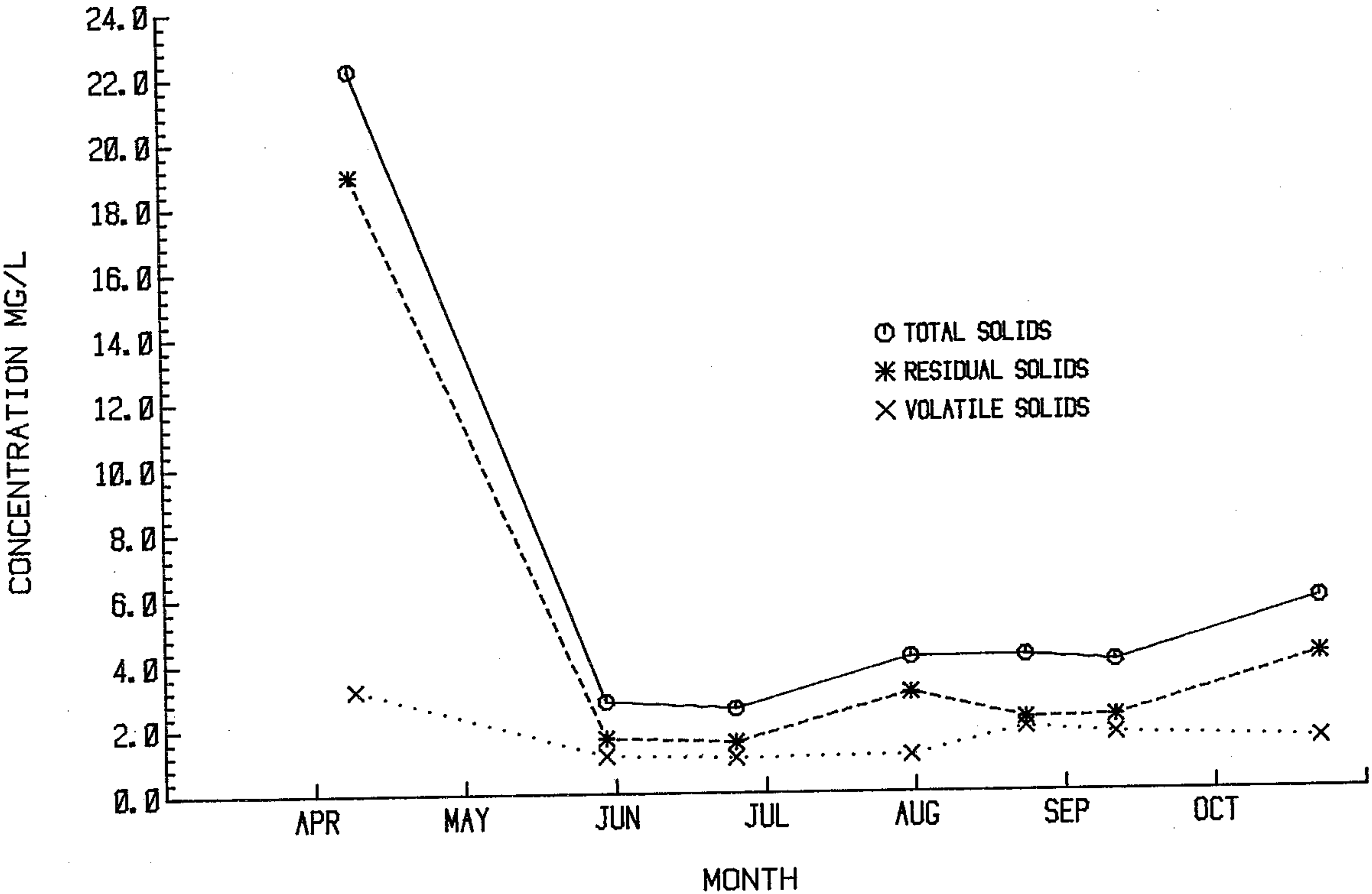
Figure 49



SUSPENDED SOLIDS MEANS

WESTERN BASIN 1982

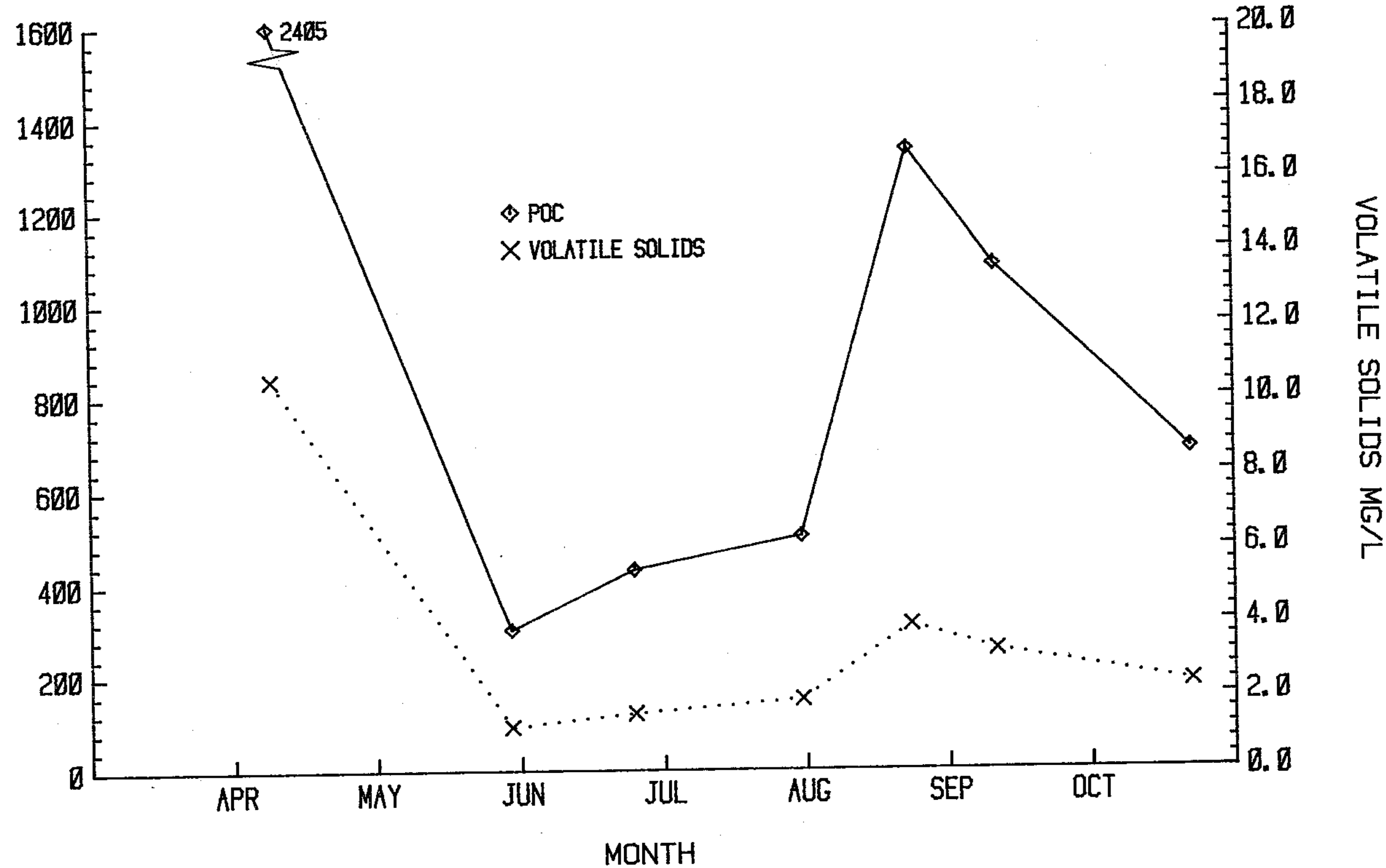
Figure 50



SUSPENDED SOLIDS MEANS

CENTRAL BASIN EPILIMNION 1982

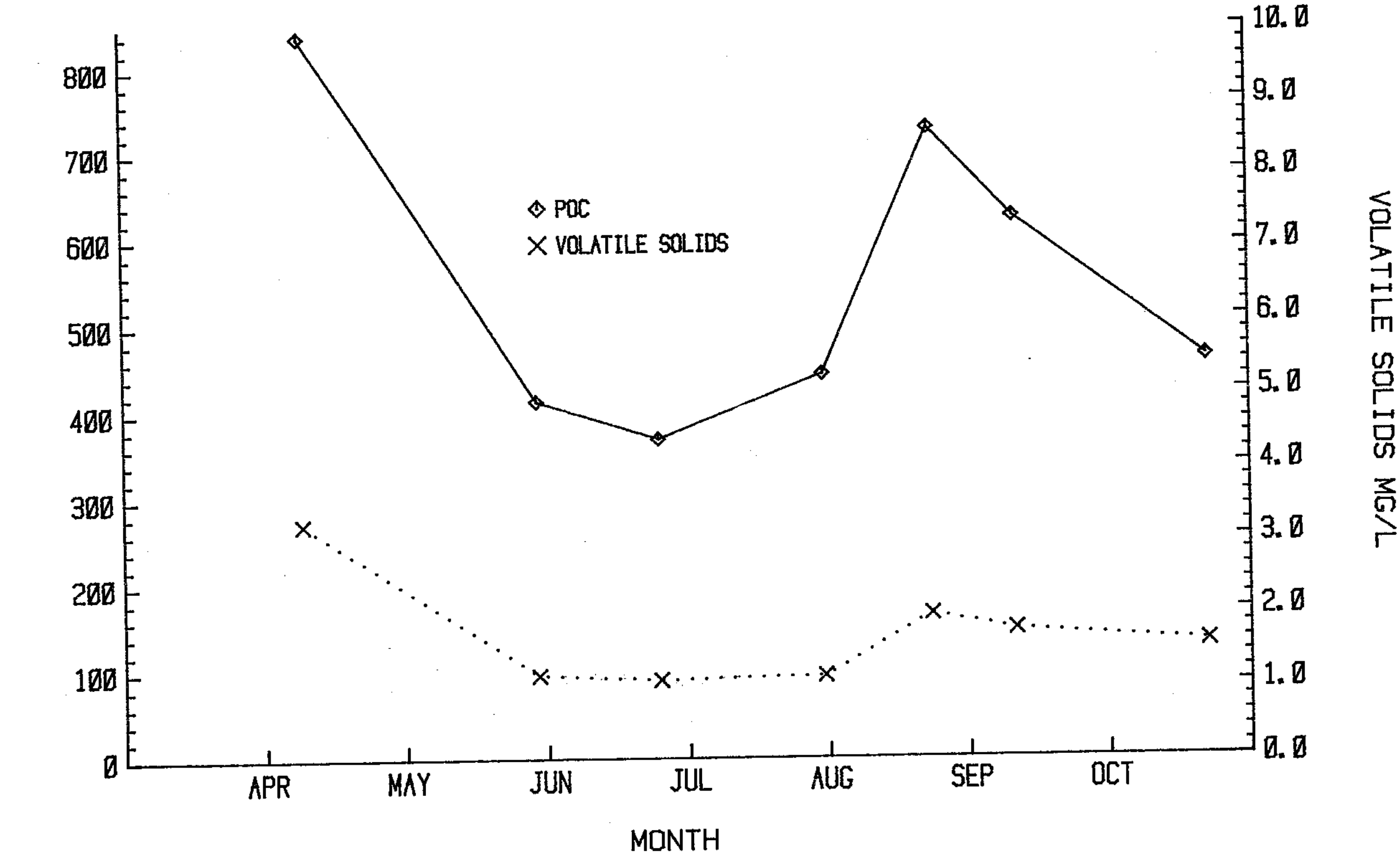
Figure 51



POC VS VOLATILE SOLIDS

WESTERN BASIN 1982

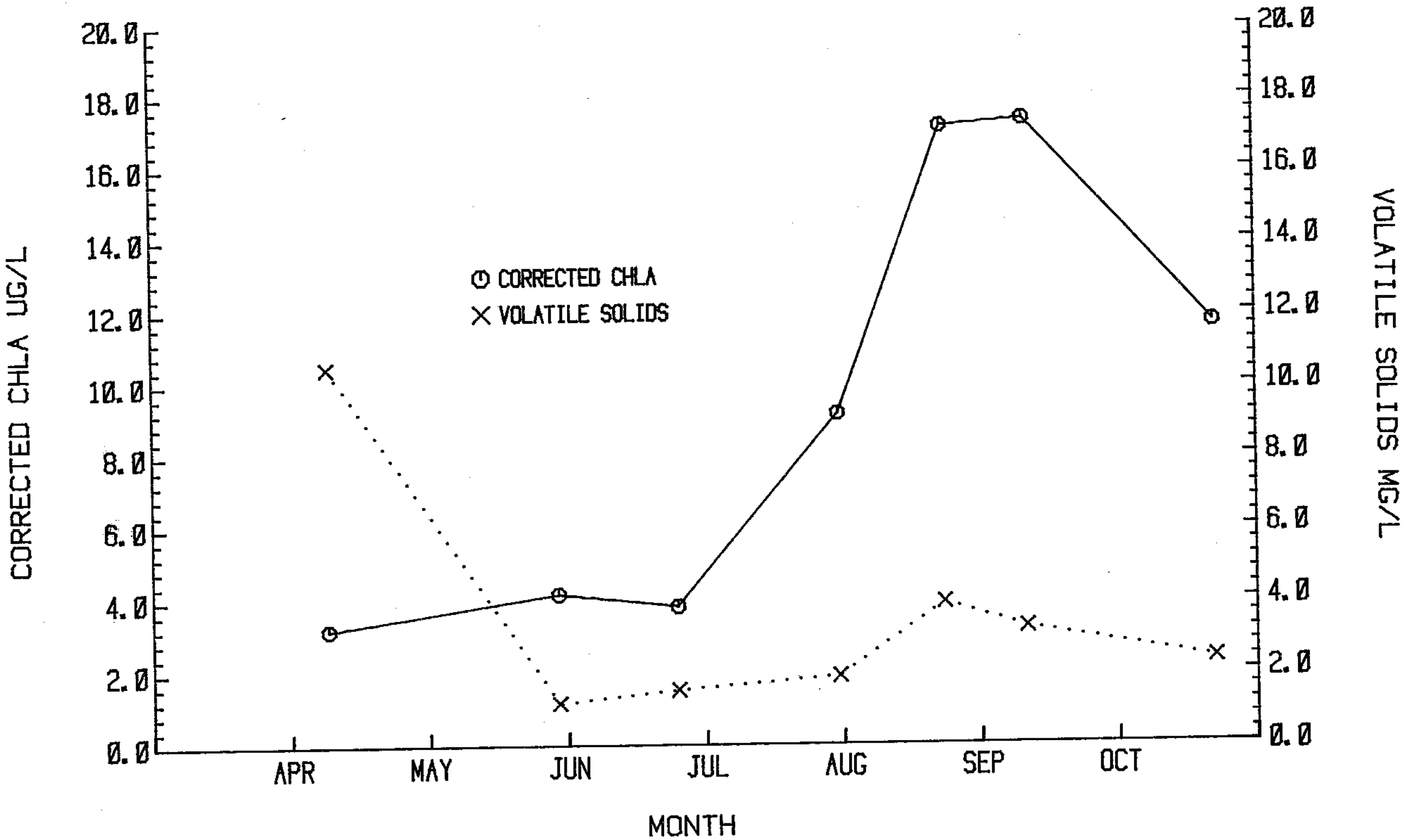
Figure 52



POC VS VOLATILE SOLIDS

CENTRAL BASIN EPILIMNION 1982

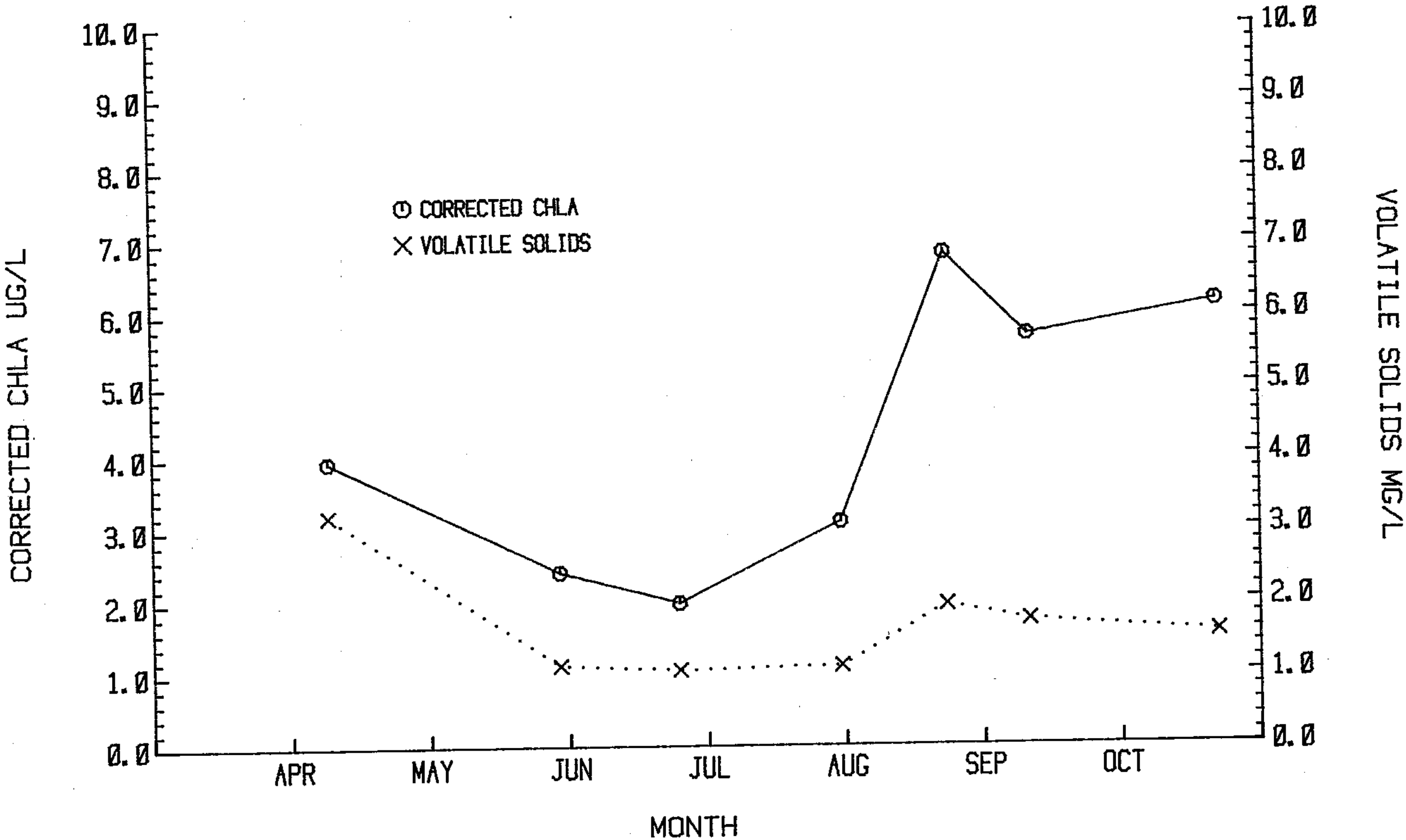
Figure 53



CORRECTED CHLA VS VOLATILE SOLIDS

WESTERN BASIN 1982

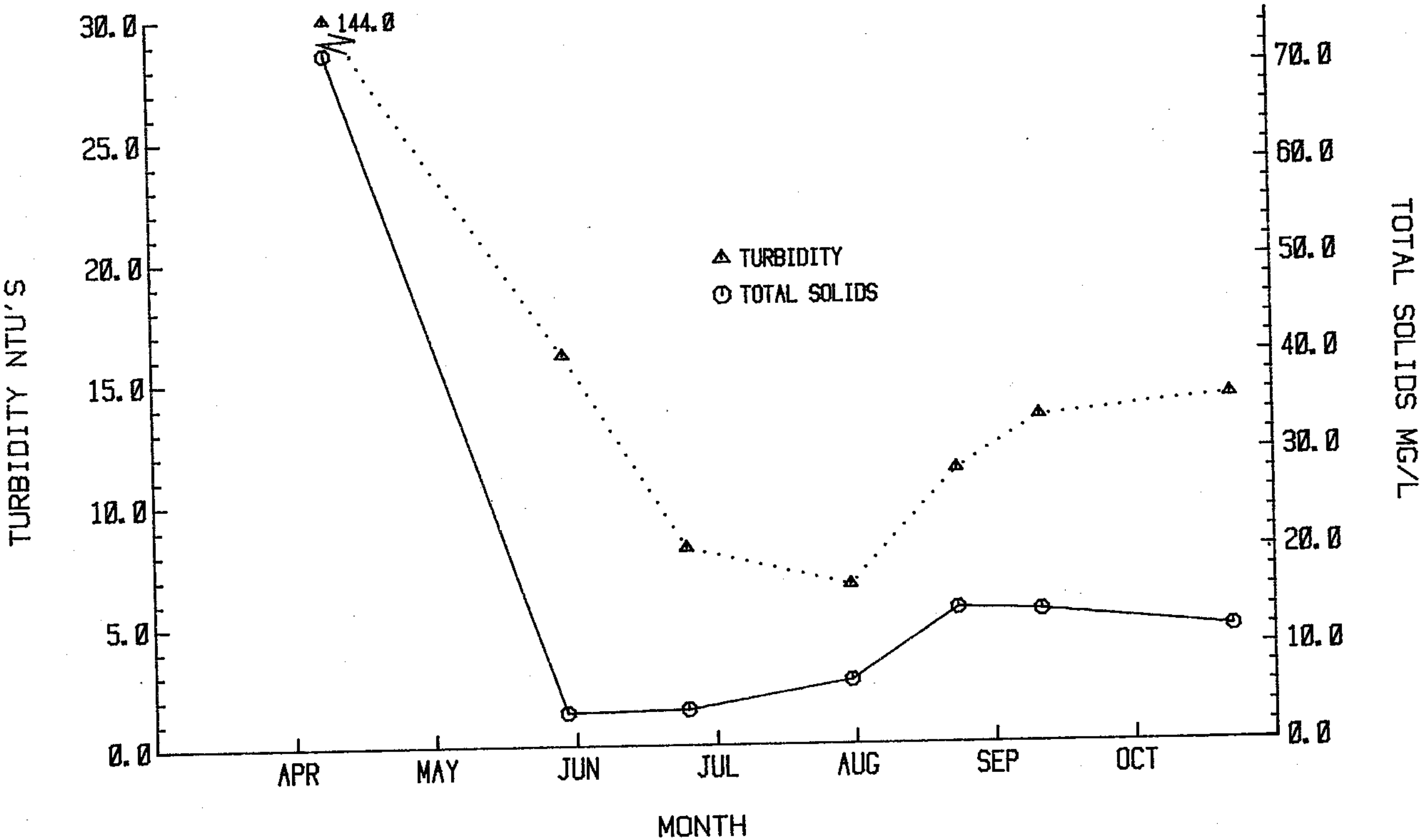
Figure 54



CORRECTED CHLA VS VOLATILE SOLIDS

CENTRAL BASIN EPILIMNION 1982

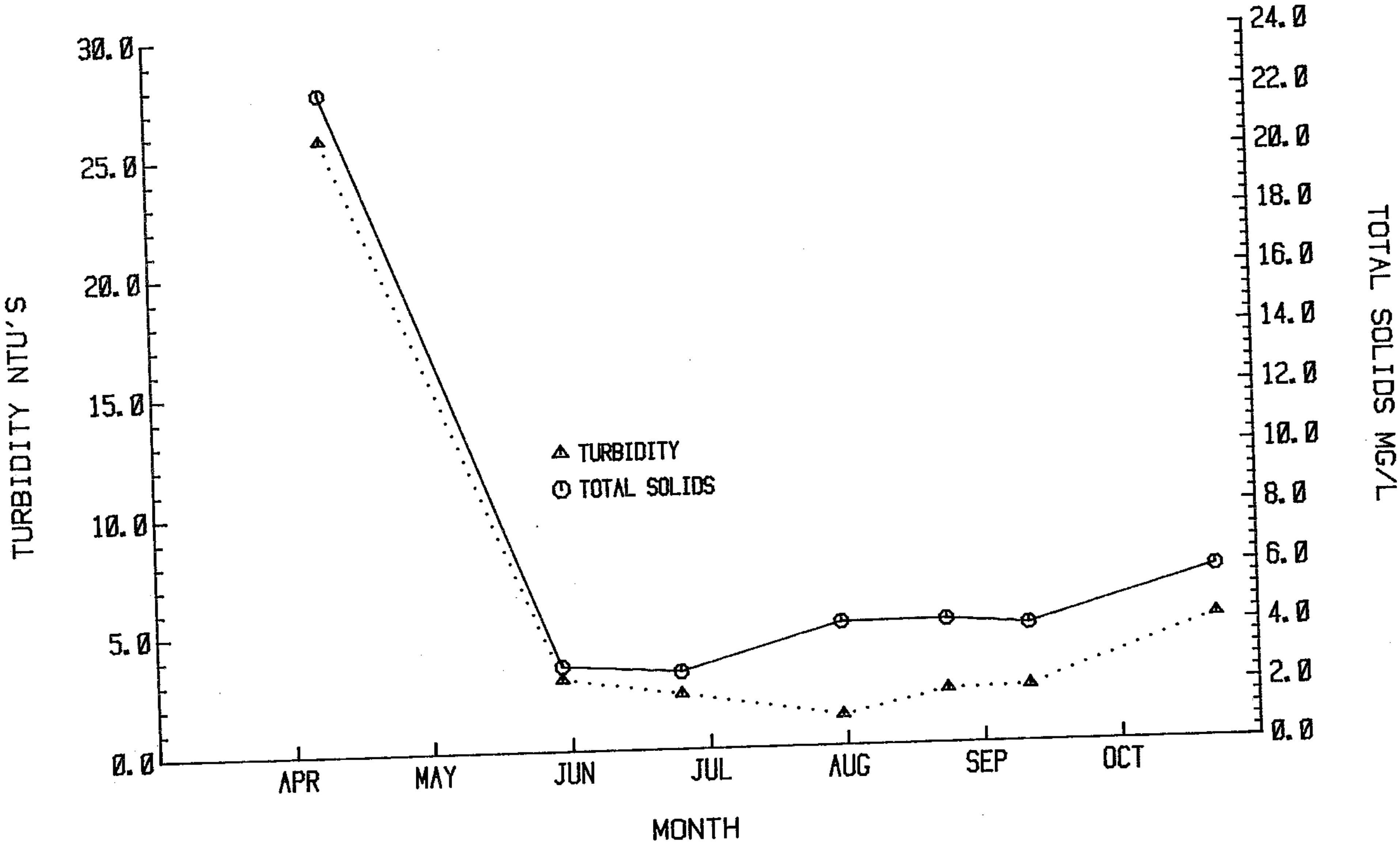
Figure 55



TURBIDITY VS TOTAL SUSPENDED SOLIDS

WESTERN BASIN 1982

Figure 56



TURBIDITY VS TOTAL SUSPENDED SOLIDS

CENTRAL BASIN EPILIMNION 1982

Figure 57

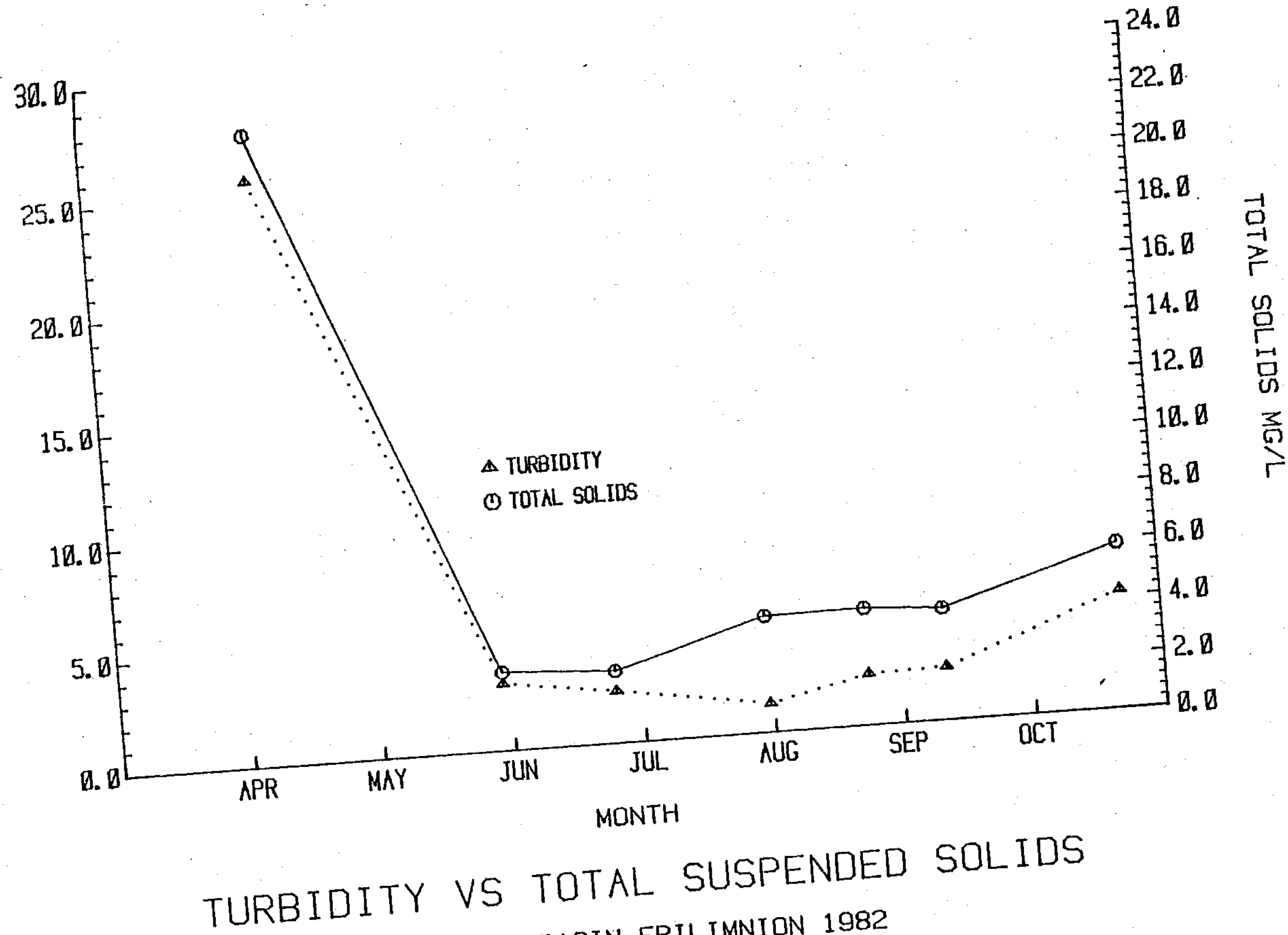

TURBIDITY NTU'S
30.0
25.0
20.0
15.0
10.0
5.0
0.0
TOTAL SOLIDS MG/L
24.0
22.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
APR
MAY
JUN
JUL
AUG
SEP
OCT
MONTH
TURBIDITY
TOTAL SOLIDS
TURBIDITY VS TOTAL SUSPENDED SOLIDS
CENTRAL BASIN EPILIMNION 1982

Figure 57