

**ORGANIC SEDIMENTATION AND RESUSPENSION IN
LAKE ERIE (1979)**

by

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ORGANIC SEDIMENTATION DYNAMICS IN LAKE ERIE

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MANAGEMENT PERSPECTIVE

The Project Hypo report of the early 1970's recommended further research into the oxygen depletion problem as a prerequisite to knowledge which would avoid management surprises. The present research was designed to clarify the effect of algal productivity on the bottom water oxygen regime. Work was done in 1979 to coincide with other projects and the GLISP intensive surveillance year.

Sediment traps developed at NWRI were used to measure the organic "fallout" from the productive warm layer into the cooler bottom layer where the oxygen depletion problem occurs. The traps indicated that the fallout was insufficient to drive the oxygen depletion process on a daily basis. This means that oxygen depletion represents a long-term integration of lake processes and the sediments must supply some of the organic matter in the summer. A consistent observation was that traps near to the lake bottom always caught more material than other traps a few metres away. This means that a layer of the bottom is continually being stirred up into the water column thereby affecting the water quality and the oxygen regime.

Although sediment processes are important to the oxygen problem they are not fully quantified now due to methodology uncertainties. The sediment effect on oxygen can lag behind response of other water quality variables to nutrient load reductions due to mixing of recent sediments with previous accumulations. This mixing causes a half equilibration time of about 30 years to a new loading and buffers the effects of rapid changes in nutrient loads on the oxygen regime. The response of oxygen in Lake Erie cannot be accurately predicted until more is known about the effect of lake physics on the sediment related portion of oxygen depletion.

DÉCANTATION ET REMISE EN SUSPENSION DES SUBSTANCES ORGANIQUES DANS LE LAC ÉRIÉ

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PROSPECTIVE-GESTION

Pour éviter aux responsables de la gestion des eaux des surprises désagréables, le rapport du projet Hypo recommandait, au début des années 1970, de faire des recherches plus poussées sur le problème de l'appauvrissement en oxygène. Cette recherche a été conçue afin d'obtenir des renseignements supplémentaires au sujet des effets de la prolifération des algues sur la teneur en oxygène des eaux de fond. En 1979, d'autres travaux ont été réalisés pour compléter des projets en cours ainsi que le programme de surveillance intensive des Grands Lacs (PSIGL).

Nous avons utilisé les pièges à sédiments mis au point par l'INRE pour mesurer les chutes de matière organique à partir des couches tièdes et productives de surface aux couches de fond plus froides, caractérisées par un appauvrissement en oxygène. Nous avons découvert que la matière recueillie dans les pièges n'était pas suffisante pour entretenir un appauvrissement quotidien en oxygène. Ceci signifie que l'appauvrissement en oxygène est sans doute causé par la combinaison à long terme de toutes les réactions qui se produisent dans le lac et que l'été, ce sont les sédiments qui fournissent une partie de la matière organique. Des observations attentives nous ont permis de constater que dans les pièges placés près du fond, on recueillait toujours plus de substances que dans ceux qui se trouvaient à quelques mètres du fond. On peut en conclure qu'une couche de fond est continuellement brassée dans la colonne d'eau et modifie ainsi la qualité de l'eau et la teneur en oxygène.

On sait que les processus de sédimentation jouent un grand rôle dans le problème d'appauvrissement en oxygène, mais à cause du manque de précision des méthodes de mesure, il n'a pas encore été possible de les évaluer complètement. Les effets de la sédimentation sur la teneur en oxygène peuvent passer au second plan si l'on considère comment réagissent d'autres paramètres de qualité de l'eau aux réductions de charges en nutriments, lesquelles sont causées par le mélange de nouveaux sédiments à des accumulations précédentes. À cause de ce mélange, il faut à une nouvelle charge environ 30 ans pour atteindre un état de demi-équilibre; de plus, les effets sur la teneur en oxygène de changements rapides dans

les charges en nutriments s'en trouvent ralenties. Il ne sera pas possible de prévoir avec précision des conditions d'oxygénation du lac Érié tant que l'on ne pourra pas préciser davantage quelles sont les réactions physiques dans le lac qui influent sur la relation entre la sédimentation et l'appauvrissement en oxygène.

ABSTRACT

Oxygen depletion in Lake Erie's Central Basin hypolimnion is sustained by the respiration rate of organisms using organic matter which is produced in, and falls from, the trophogenic zone. Although transformations involving nitrogen (nitrification and denitrification), sulphur (hydrogen sulphide production via sulphate reduction), carbon (methane oxidation and methanogenesis), iron and manganese are certainly important, they are nevertheless driven by the decomposition rates of organic carbon both in the water column and in the sediments. Rates of transport of particulate organic carbon to the hypolimnion and sediments were measured using sediment traps. Corrections for sediment resuspension were necessary even during the summer period when the lake is stratified in both Central and Eastern Basins. The particulate organic carbon concentrations were independent of short term variations in chlorophyll concentration and the net downflux of carbon to the hypolimnion was less than required to support the observed oxygen depletion. Sediment resuspension accounted for 54% of the particulate material caught by the sediment traps and is a potential source of bioavailable particulate phosphate.

RÉSUMÉ

Dans l'hypolimnion du bassin central du lac Erié, le phénomène d'appauvrissement en oxygène est entretenu par la respiration des organismes qui consomment la matière organique provenant de la couche trophogène où cette matière est produite. Les réactions de transformation de l'azote (nitrification et dénitrification), du soufre (production de sulfure d'hydrogène par réduction des sulfates), du carbone (oxydation et production de méthane), du fer, et du manganèse sont certainement importantes, mais elles dépendent néanmoins du taux de décomposition de carbone organique dans la colonne d'eau et dans les sédiments. Nous avons mesuré la vitesse de chute du carbone organique particulièrement jusqu'à l'hypolimnion et aux sédiments à l'aide de pièges à sédiments. Il a été nécessaire d'apporter les corrections qui s'imposaient à cause de la remise en suspension des particules même durant les mois d'été, période où les eaux des bassins central et de l'est du lac sont stratifiées. Nous avons découvert que les concentrations du carbone organique ne dépendaient pas des variations à court terme dans les concentrations de la chlorophylle, et que la quantité de carbone qui tombait à l'hypolimnion était inférieure à ce qui est nécessaire pour entretenir le phénomène observé d'appauvrissement en oxygène. Cinquante-quatre pour cent du matériel particulaire recueilli dans les pièges était des sédiments remis en suspension, ce qui constitue une source possible de phosphate particulaire biodisponible.

INTRODUCTION

The state and functioning of Lake Erie have been of great interest in recent years due to rehabilitation efforts under the Canada-United States Agreement on Great Lakes Water Quality. The oxygen depletion phenomenon has been a focal point and symbol of the attempt to reverse eutrophication (Burns and Ross, 1972). As a result of the intensive "Project Hypo" study in 1970, recommendations were made (Burns et al., 1976) to study the generation and fate of organic material in the lake as an aid to understanding oxygen depletion. Sediment traps were used in the following investigation to measure the rate that particulate organic carbon moves to the hypolimnion and sediments of both the Central and Eastern basins of the lake. The work was conducted in conjunction with studies of primary production and respiration (Charlton and Lean in Prep) which will be presented elsewhere.

METHODS

Sediment traps (Charlton, 1983) were installed at 15 locations in Lake Erie during April 1979 (Fig. 1). The station depth at each site was greater than 20 m. Traps were installed at 1 m off the bottom (B-1) and at a position just under the summer thermocline (top traps). In the East basin, an additional set of traps were installed at an intermediate depth. Table 1 shows the exposure intervals of the sediment traps.

Upon retrieval, the liquid in the trap was decanted twice and the particulate material frozen. Later, samples

were freeze dried and weighed. Loss on ignition (%LOI) was determined at 500°C for 4h. Water samples were collected with an integrating sampler (0-10M) and discrete samples were collected at a depth of 1 m above the bottom (B-1m) with a Rosette sampler equipped with an electronic bathythermograph (EBT). Particulate organic carbon (POC) was measured in water samples by filtering through pre-ignited GF/C filters prior to analysis using a Hewlett Packhard model 185 CHN analyzer. Chlorophyll a was determined according to Strickland and Parsons (1968). Filters for the measurement of seston weight and %LOI were prepared by first washing with 500 mL of distilled water to remove any loose fibres, dried at 60°C for 24 h, combusted as above, stored in a dessicator and weighed using a Mettler MB-30 electrobalance. Samples (500 mL) were collected by filtration and frozen. Upon analysis, filters were dried as above and reweighed. %LOI was determined after ashing at 500°C for 2 h.

RESULTS AND DISCUSSION

Seston, that fraction of living and non-living material retained during filtration, is largely decomposed within the epilimnion (Charlton unpub. data) but a portion sinks to be decomposed in the hypolimnion while the balance will form sediments. Some refractory compounds will persist for thousands of years while others are decomposed quickly (1 to 10 years). Seston concentrations in the Central Basin epilimnion were highest during spring and fall (Fig. 2A). Unexpected results showing B-1 concentrations often higher than in the epilimnion

were observed especially in mid-summer. Furthermore, hypolimnetic seston concentrations seemed to be independent of epilimnion seston concentrations. Highest values for the B-1 water samples were usually found at the shallower stations.

The organic content of the seston is particulate organic carbon (POC). Differences in POC concentration between stations were greater than that for seston weight (Fig. 2B) but similar patterns were observed. Lowest values occurred in the epilimnion during mid-summer. B-1 samples showed little seasonal variation and were maintained at levels as high as or higher than those in the epilimnion. The chlorophyll concentrations (Fig. 2C) also exhibited the same trends which at first is surprising since the 1 % light level, thought to be the lower limit of the trophogenic zone, in the summer was never deeper than 15 m.

POC concentration is not greatly influenced by chlorophyll in the hypolimnion (Fig. 3). As chlorophyll increases from 1 to 8 $\mu\text{g.L}^{-1}$ the POC concentration scarcely doubles. Using the geometric functional regression of Ricker (1973) the POC intercept was 0.17 mg.L^{-1} . This intercept is about half the mean POC concentration and illustrates that a large fraction of the hypolimnetic POC is detrital carbon not associated with the chlorophyll.

The seasonal pattern of chlorophyll for the Eastern Basin (Fig. 4) shows certain similarities to the Central Basin. The chlorophyll concentrations in the East Basin epilimnion were lower than in the Central Basin and the B-1 concentrations were usually much lower than corresponding epilimnion values during the stratified period (Fig. 4C). This indicates a less direct

interaction between the epilimnion and hypolimnion and a more complete decomposition of organic particles consistent with the greater depth of the East Basin (Charlton, 1980a).

Percent POC and %LOI values follow a reciprocal relationship. A low %LOI in the epilimnion indicates most of the particulate material is inorganic. The lowest values were observed during the unstratified period (Fig. 5). During stratification, the %LOI in the epilimnetic seston rose to 70-98%. As the mixing depth increased in September and October, the %LOI again declined. The hypolimnetic seston %LOI showed more variation among stations with %LOI values usually lower than those of in the epilimnion at the same time.

As in the Central Basin, the %LOI in the Eastern Basin epilimnion (Fig. 5) was low in the spring and fall with high values during stratification but B-1 seston %LOI was more clearly different from corresponding epilimnion values during the stratified period. This may be due to a greater depth and time over which the sedimenting organic matter from the epilimnion can decompose in the East Basin (Charlton, 1980a) or in these deeper waters the importance of sediment resuspension is not as great.

There are two possible mechanisms of the decrease in seston %LOI. The first results from the formation of calcium carbonate and the second is due to the resuspension of sediments with their consistently high ash content (>90 % - see below Fig. 7). A slight decline in calcium concentrations occurs due to precipitation when the lake warms. This is at the wrong time of year to explain the low %LOI values in the Spring and Fall. Thus,

sediment resuspension is the likely explanation for the low %LOI values.

The total dry weight of material in the traps for each of the sampling periods (Fig. 6) calculated on a per day basis shows that rates were highest in the spring and fall when sediment resuspension would be highest. During periods of thermal stratification, the catch rates were about $5 \text{ g dry weight m}^{-2} \text{ d}^{-1}$ or less which is the range found in small lakes (Charlton, 1975). Also, consistent with the notion that sediment resuspension is significant is the observation (Fig. 6) that the bottom traps caught more material than the top traps especially during the fall period. In general, catch rates were highest when the thermal barrier to deep mixing was removed and wind speeds were higher in the Spring and Fall. Catch rates near Long Point, on the north shore between the Eastern and Central Basin were often higher than corresponding rates at mid-lake locations. A trap installed at an intermediate depth at the deepest East Basin station caught material at rates between the top and bottom traps. These observations are consistent with a West to East movement of eroded shoreline material which is responsible for the Long Point formation and relatively high rates of sediment accumulation in the deeper area of the East Basin (Thomas et al., 1976).

The difference in catch rate between the top and bottom traps cannot provide an estimate of POC decomposed between the two layers. For example, using a catch rate of $2 \text{ g. m}^{-2} \text{ d}^{-1}$ and a seston concentration of 2 g. m^{-3} the mean sedimentation

velocity would be 1 m. d^{-1} . Since the exposure time was up to 30 days the material would be held in traps longer than it would take to settle the distance between the traps. While it would be desirable to answer the question of whether hypolimnetic oxygen depletion results from respiration of sedimenting material or from the sediments themselves, exposure times must be shorter. Conventional wisdom is based on the assumption that the main source of POC in the water is derived from the production of algae in the surface layers. Our observation of high catch rates in the fall occurred during unstratified conditions and high wind stresses. Such conditions are known to cause sediment resuspension (Lam and Jaquet 1976).

The unexpected result that the traps near the bottom caught more material than traps just under the thermocline even during summer stratification is inconsistent with the hypothesis that hypolimnion particles are derived from falling seston generated by the primary production of algae in the epilimnion. Instead, the main sources of particles in the hypolimnion are from the sediment resuspension even during the most quiescent period of the year. This phenomenon was observed in both basins and illustrates the need for accurate measurements of hypolimnetic current energy near the sediment water interface as a prerequisite to understanding the resuspension phenomenon.

Resuspension of bottom sediments can have a profound impact on the properties of lake water particles. They provide a source of particulate available phosphate not normally detected using conventional analysis. Furthermore, the composition of sediment particles is different from the organic particles generated by

lake productivity. The %LOI of surficial (0-2 cm) sediments at the sediment trap sites (Fig. 7) are all less than 10. Resuspension of these sediments into the water column would result in a dilution of the seston which would be expected to be in excess of 90% LOI if no dilution occurred. The mixture results in a lowering of the %LOI of the seston (Fig. 5).

The mean %LOI of the 10 sediment trap installations in the Central Basin for each exposure interval (Fig. 8) reflect the influence of sediment. The %LOI in the bottom traps never approached the %LOI of either the 0-10 or B-1 seston (Fig. 5). The %LOI in the top traps was less than 0-10 seston %LOI but similar to that for B-1 seston.

Further evidence that resuspended sediments dilutes organic carbon settling from the zone of productivity is provided by plotting the %LOI of trap contents against trap catch rates for the Central (Fig. 9) and Eastern (Fig. 10) Basins. All are similar and consistent with the view that a small downflux of organic particles is diluted with an large amount of highly inorganic particles derived from surficial sediments. The Central Basin curves are superimposable indicating that the sources of the particles are the same but the intensity of the resuspension contribution to the contents diminishes with distance from the lake bottom. This effect was also found by Bloesch (1982), Chambers and Eadie (1981), Charlton (1983), and Rosa (1985).

There are 2 important differences between the trap material from the Central and Eastern Basins. At maximum catch rates, the %LOI was lower in the Eastern than in the Central Basin possibly

reflecting the difference between the sediment source material (Fig.7). Secondly, because of their different depths, the highest catch rates were lower in the Eastern than in the Central Basin.

The oxygen depletion rate in 1979 was $0.11 \text{ mg.L.}^{-1}.\text{d}^{-1}$ (Charlton unpub. data) giving a stoichiometric value for carbon consumption of $0.04 \text{ mg C.L.}^{-1}.\text{d}^{-1}$. Assuming an average value for hypolimnetic POC (Fig. 2B) of $0.35 \text{ mg C.L.}^{-1}$ a 4 m hypolimnion would contain POC sufficient to meet the oxygen demand for only 9 days. The corresponding 16 m epilimnion would supply enough carbon for 50 days. Clearly, the standing stock of POC in the Central Basin is small relative to the 90-110 day duration of the oxygen depletion process. Thus, the supply of particles is important. The surficial sediments with an organic carbon concentration of 5 % can act as an alternative supply with a carbon content in the uppermost mm equivalent to 31 days oxygen consumption. If this zone were all resuspended at once, a POC concentration of $1.25 \text{ mg C.L.}^{-1}$ would result. Although that concentration was rarely approached, the continual resupply of POC from the sediments may help maintain oxygen depletion in the water column. Much of the sediment carbon may, however, be refractory. The ultimate source is new production but the constancy of the slope of oxygen with time each year (Charlton 1980b) argues for a stabilizing mechanism which damps out the effects of variability in productivity during the stratified season. Resuspended organic carbon derived from production of preceeding weeks, months, and years may be a stabilizing influence. Nevertheless, to add understanding of the oxygen

depletion phenomenon, accurate estimates of net carbon fluxes to the hypolimnion are needed.

By comparing the %LOI of sediment traps, seston, and bottom sediments (Charlton, 1975) the downflux due to resuspension can be approximately eliminated. This reduced the range of values from 573:1 (Fig. 6) to 12:1 . (Although much of the difference between the top and bottom traps was eliminated, downflux rates remained higher for bottom traps.) A 3-4 M hypolimnion would consume at least 0.12-0.16 gC or 0.24-0.32 g organic matter.M⁻².d⁻¹ .

Figure 11 shows that organic downfluxes into the top traps were below the amount required in June and July and slightly above in Aug.

The higher organic downfluxes in the bottom traps are caused by the resuspension or recirculation of fresh organic inputs to the hypolimnion. The resuspension correction only removes the effect of resuspended bottom sediments on the trap catches. Since the resuspended component in the top traps averaged 54% of the dry weight, even the organic downfluxes indicated by the top traps may be about twice as high as the actual inputs to the hypolimnion.

Another outcome of the resuspension calculations is that the sediments supply a significant portion of the POC present in the hypolimnion. The sediment derived POC in the traps ranged from 10-20% in the top traps to 29-44% in the bottom traps. If traps had been placed closer to the bottom, these figures would have been higher. This is consistent with the suggestion in Fig.3 that much of the hypolimnion POC is independent of the

ambient chlorophyll. Since POC is correlated with oxygen depletion (Charlton and Rao, 1983), the resuspended POC may help stabilize depletion processes relative to variations in inputs suggested by Fig. 11.

Direct measurements of oxygen consumption obtained from enclosed samples is higher than the net depletion observed in the hypolimnion over the summer. By combining sediment and water oxygen consumption measurements, Davis et. al (1981) have calculated that the Central Basin hypolimnion consumed oxygen at a rate of $1.6 \text{ g O}_2 \cdot \text{M}^{-2} \cdot \text{d}^{-1}$. This is equivalent to a consumption of $1.2 \text{ gM}^{-2} \cdot \text{d}^{-1}$ of organic matter which is far greater than the fluxes indicated by the sediment trap results in Fig. 11. Again, this indicates some stabilizing mechanism which may render the oxygen depletion pattern partially independent of short term carbon supplies.

On the other hand, decomposition in the sediment traps may have caused organic fluxes may be too low by 20% (Bloesch 1982). Also, sediment oxygen consumption measurements depend greatly on the method used (see discussions by Snodgrass and Davis this issue). The sediment oxygen consumption measurements of Davis require that there be a large, unaccounted for, source of oxygen to the hypolimnion to reduce the depletion rate to the net observed. Our measurements of water oxygen consumption (unpub. data) and those of Davis are high enough to almost account for the net depletion. The relationship between hypolimnion thickness and net oxygen depletion (Charlton 1980b) suggests that sediment processes account for about half of the consumption. This, again, implies that oxygen consumption is about twice the

net depletion observed. Clearly, the discovery of an appropriate sediment oxygen consumption method and a complete analysis of the physical aspects of reoxygenation remain fruitful avenues for research in the future.

Many pathways for organic carbon decomposition and fermentation are possible. Through the use of in situ dialysis samplers, Adams et al. (1982) have calculated that the flux of methane from Central basin sediments is equivalent to about 23% of the observed oxygen depletion. If the carbon dioxide outflux (D. Adams per. com.) is taken to represent oxygen consumed in the sediments, then the sediment portion of the oxygen depletion due to reduced chemical species may be about 35% of the total observed depletion. Sediment oxygen consumption measured by in-situ chambers was about 61% of the total hypolimnion consumption in 1979 (Davis et al. 1981). This sediment portion may respond only slowly to loading changes due to the mixing of new sedimenting material.

At a mixing depth of 60 mm and an annual accumulation of 1.4mm (Kemp et al. 1977) a sediment concentration would require about 30 years to half equilibrate to a step concentration change in depositing material. More recent work by Robbins (1982 and personal communication) suggests that the half equilibration time may be on the order of 20 years. These calculations mean that the sediment portion of oxygen depletion is probably stable in the short term and especially stable compared to the 30 years of sharply increasing nutrient loadings which began in the 1940s and which were subsequently controlled in the 1970s.

The large surface area and shallow depth of Lake Erie makes it the most susceptible of the Great Lakes for sediment resuspension resulting from wind induced currents. Resuspension, however, has been detected in both Lake Michigan (Chambers and Eadie 1981) and Lake Ontario (Charlton 1983). While the physics of water movement and bottom stresses are reviewed elsewhere it is appropriate to note that these factors have a profound effect on the function of Lake Erie. In the period of highest sediment trap catches, (Sept-Oct) there were distinct layers of sediment in the traps which must have accumulated during resuspension episodes caused by weather events. According to the work of Komar and Miller (1973) the orbital velocity of surface waves is an important mechanism for sediment movement. At a typical depth of 20 m in Lake Erie, waves with a height of only 0.5 m could disturb sediments. These orbital velocities are superimposed on mean current speeds and may enhance resuspension. Certainly the higher wind speeds which occur in the fall, winter and spring would induce an energy level of both currents and orbital movements sufficient to cause sediment resuspension. Keeping particulates in suspension would enhance the year-round decomposition of recently formed organic matter resulting in less storage of organic matter in sediments. This, plus the inputs of sediment may explain why the %LOI of Lake Erie sediments is so low compared to the 40-50% found in small lakes.

The sediment trap work has revealed that resuspension can occur in the deep areas of the lake even during the most quiescent period of the year. This is in contrast to the predictions from early models which would predict only about 50 days of

resuspension mostly during the Fall-Spring period of maximum wind speeds (Chesters and Delfino, 1978). Resuspension appears to help maintain particulate concentrations which are correlated with the oxygen depletion phenomenon. The amount of organic material falling into the hypolimnion appeared to be less than that required to support the oxygen depletion. This may be reconciled by sediment storage of organic matter in the unstratified months with subsequent stability in the sediment portion of the total oxygen consumption.

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FIGURE HEADINGS

Figure 1. Experimental stations in Lake Erie 1979.

Figure 2. Seasonal changes of (A) seston weight (mg.L^{-1}); (B) POC (mg.L^{-1}) and (C) chlorophyll (ug.L^{-1}) in Central Lake Erie. Symbols are as in Fig. 1.

Figure 3. Relationship between POC and Chlorophyll in seston (B-1) in Central Lake Erie.

Figure 4. Seasonal changes of chlorophyll (ug.L^{-1}) in Eastern Lake Erie. Symbols are as in Fig. 1.

Figure 5. Seasonal pattern of seston %LOI for the Central Basin (top) and Eastern Basin (bottom) for 0-10 (left) and B-1 (right). Symbols are as in Fig. 1.

Figure 6. Sedimentation rates ($\text{g. m}^{-2}.\text{day}^{-1}$) for all traps in both basins from first exposure interval (upper line) to last exposure interval (bottom line).

Figure 7. %LOI of surficial sediments at experimental sites.

Figure 8. Average %LOI of sediment trap contents in the Central Basin.

Figure 9. Relationship for top (left panel) and B-1 (right panel) trap catch rate and %LOI for Central Basin. Symbols are as in Fig.1.

Figure 10. Relationship between trap catch rate and %LOI of trap contents in the Eastern Basin.

Figure 11. Downflux of organic material corrected for resuspension in Top and Bottom traps in Central Basin. (Horizontal line represents stoichiometric downflux equivalent to net oxygen depletion.)

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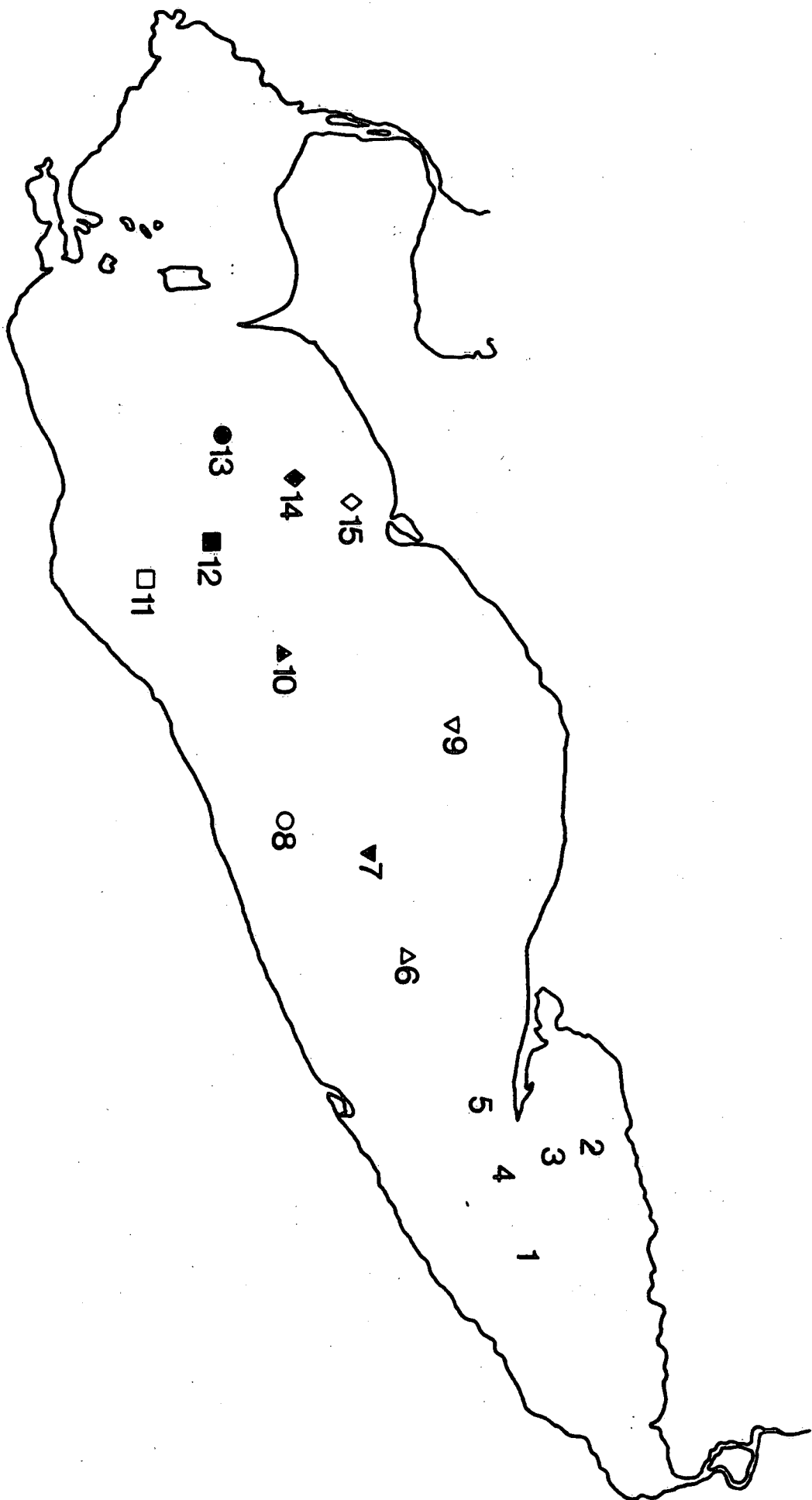
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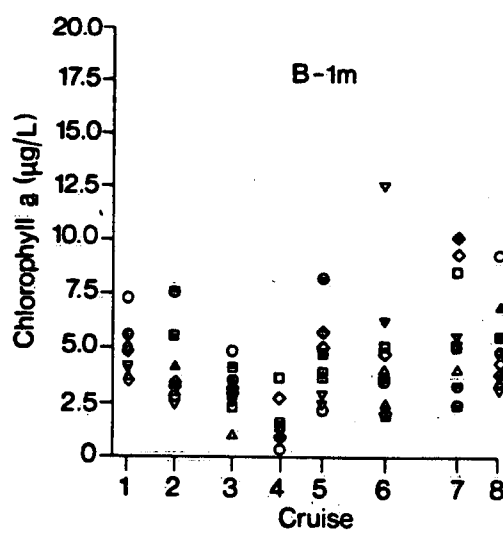
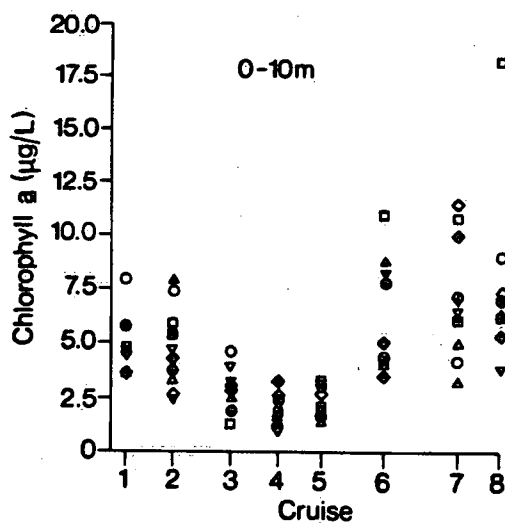
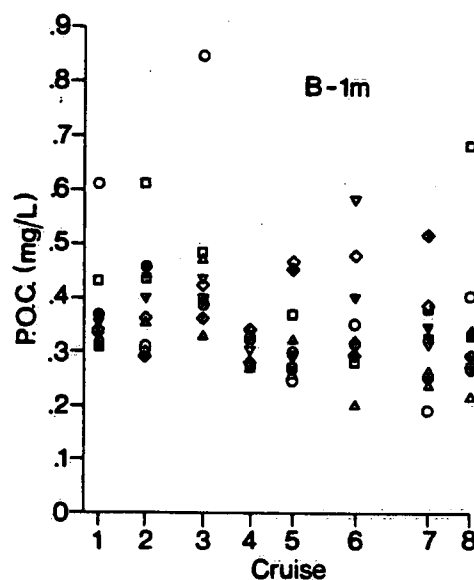
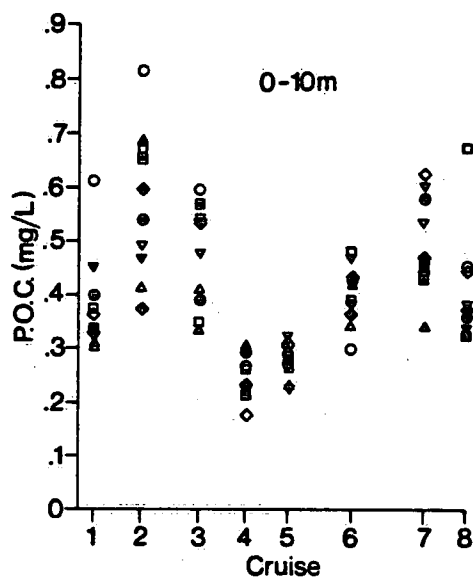
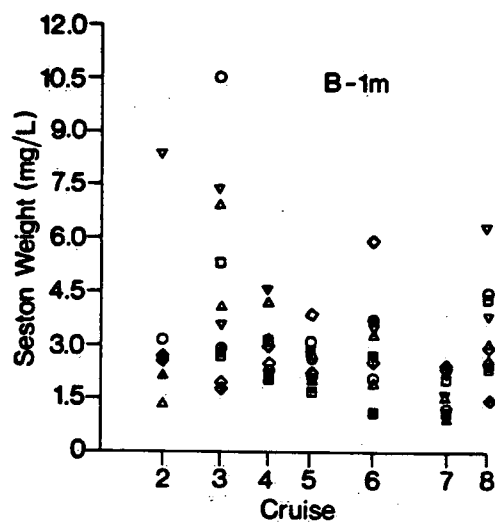
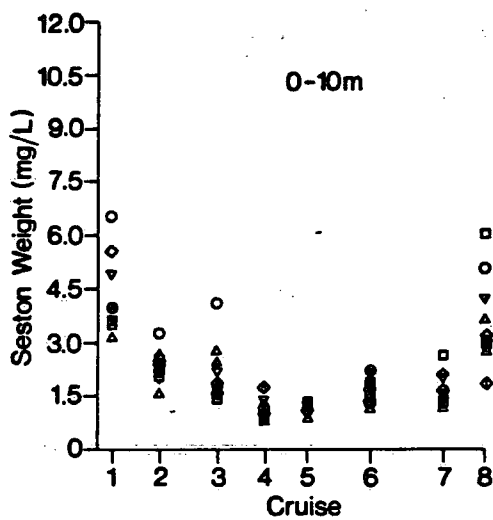
Strickland, J.D.H., and Parsons, T.R. 1968. A practical handbook of sea water analysis. Fish. Res. Board Can. Bull. 167.

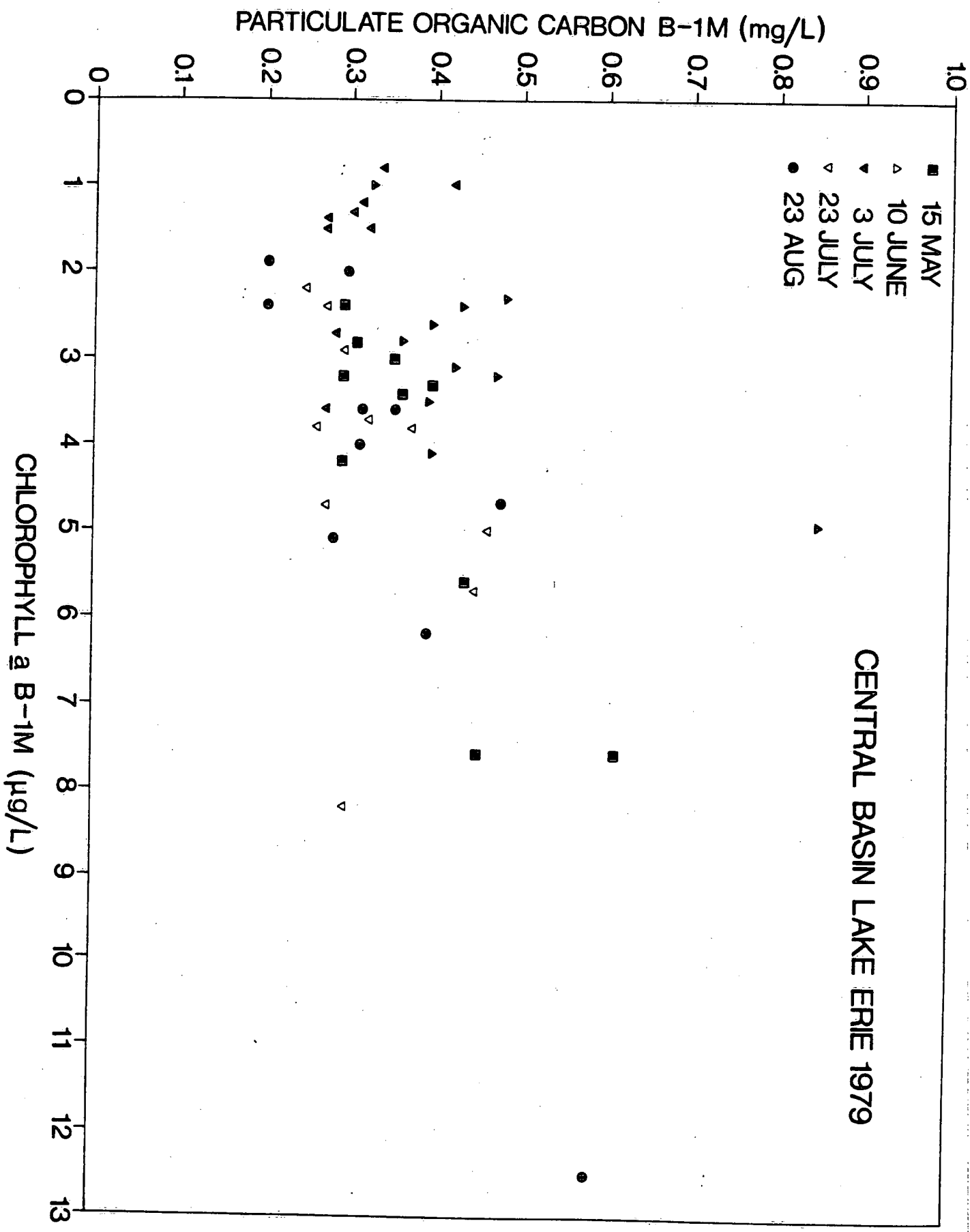
Thomas, R.L., Jaquet, J.-M., Kemp, A.L.W., and Lewis, C.F.M. 1976. Surficial sediments of Lake Erie. J. Fish. Res. Board Can. 33: 385-403.

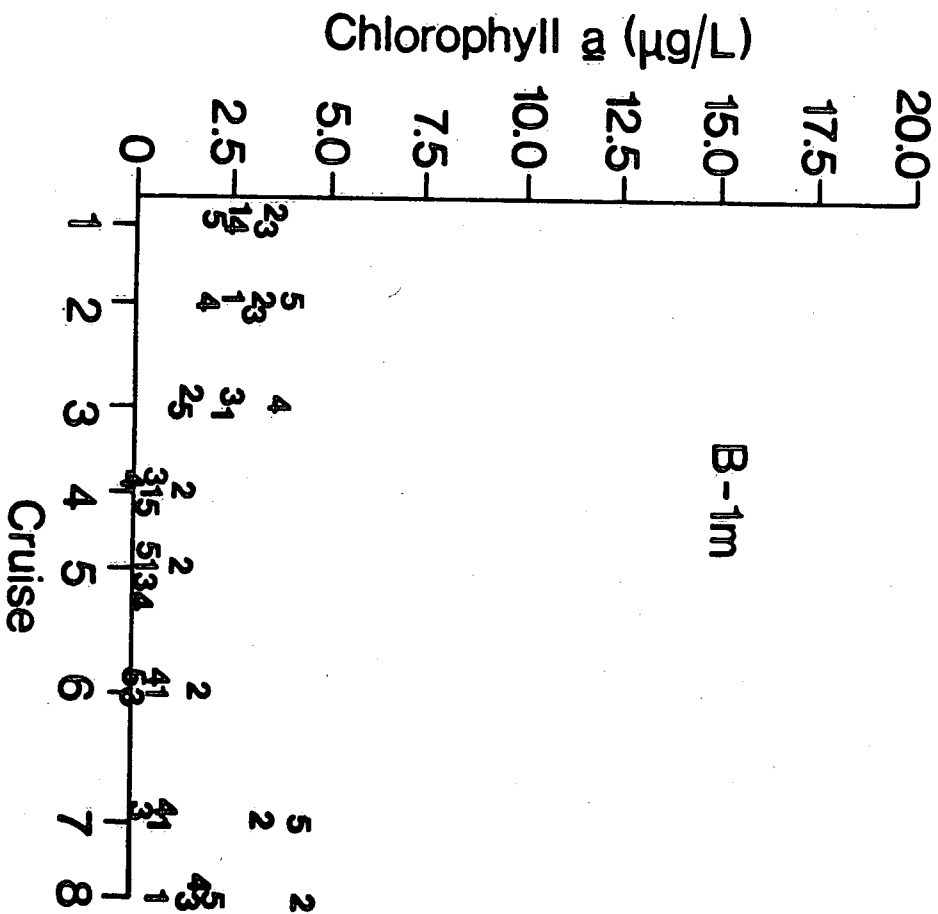
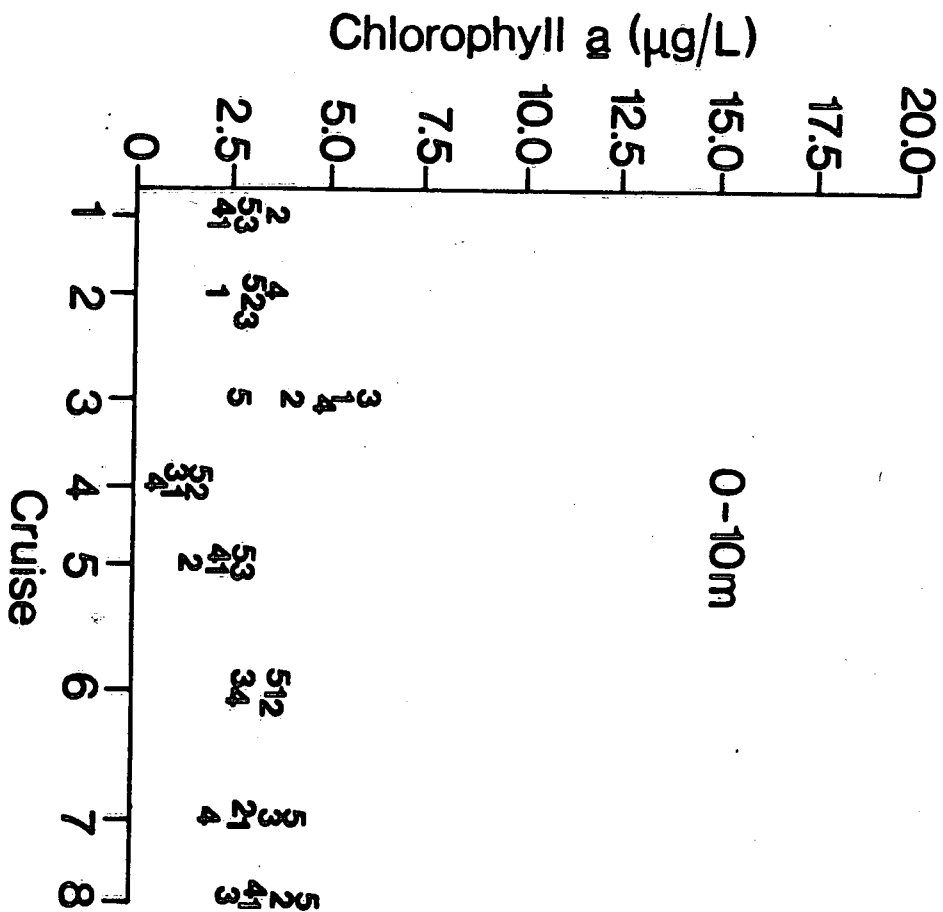
Table 1: Installation and retrieval times of sediment traps 1979.

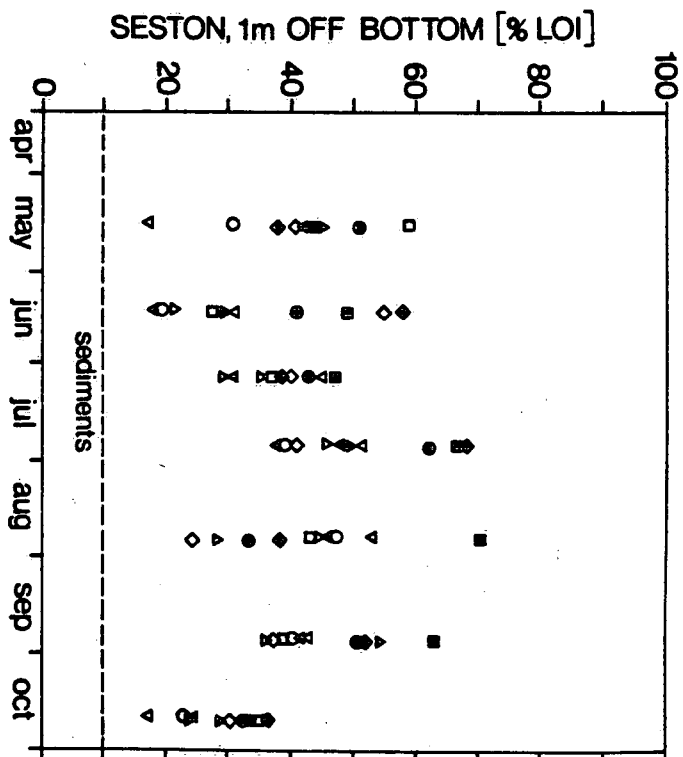
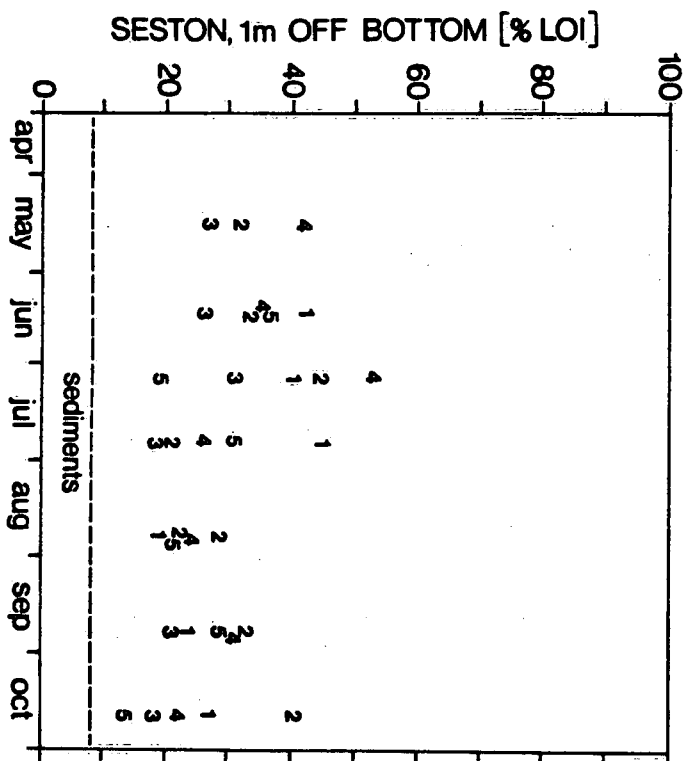
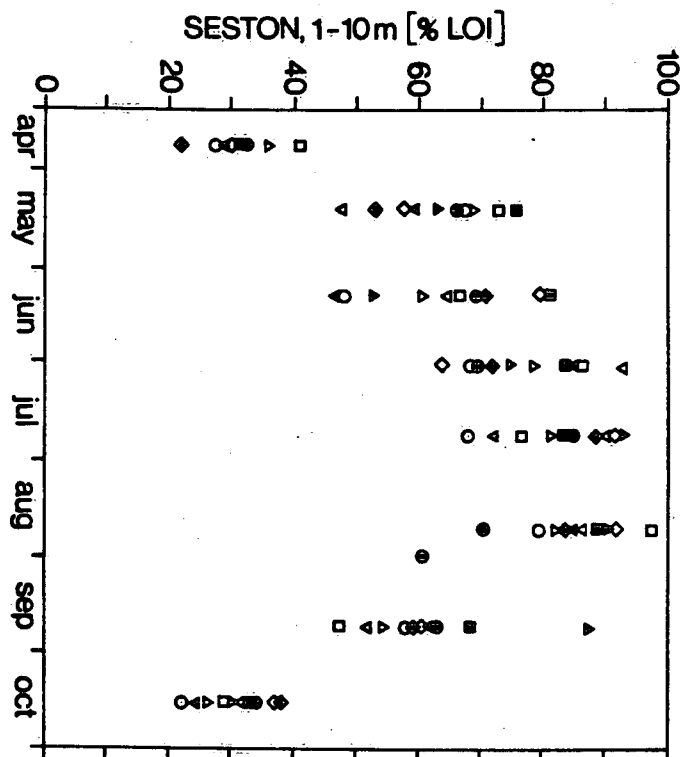
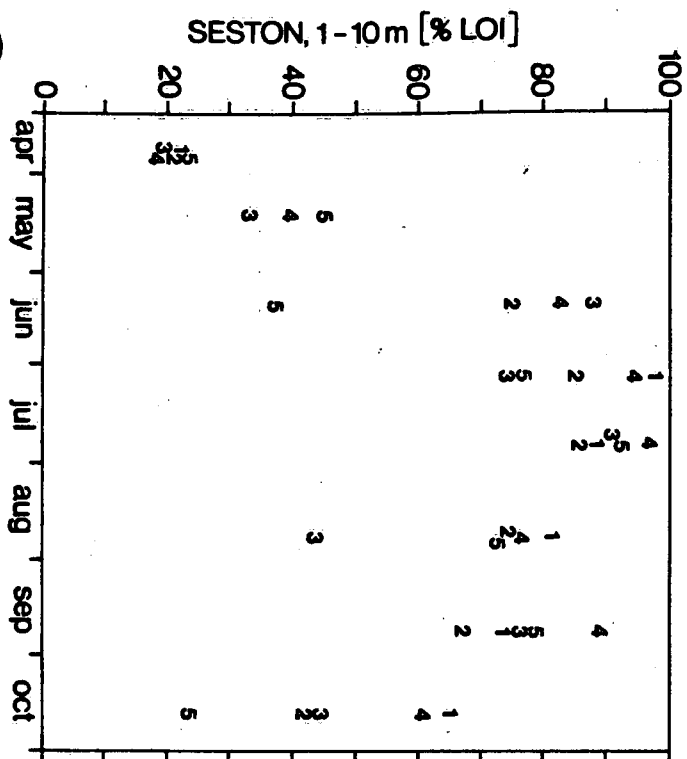
| Interval | Top | Bottom | In/Out Dates |
|----------|-----|--------|--------------|
| 1 | | - | 24/4-16/5 |
| 2 | | - | 16/5-12/6 |
| 3 | | - | 12/6-5/7 |
| 4 | - | - | 5/7-4/7 |
| 5 | - | - | 24/7-24/8 |
| 6 | - | - | 24/8-23/9 |
| 7 | - | - | 23/9-16/10 |

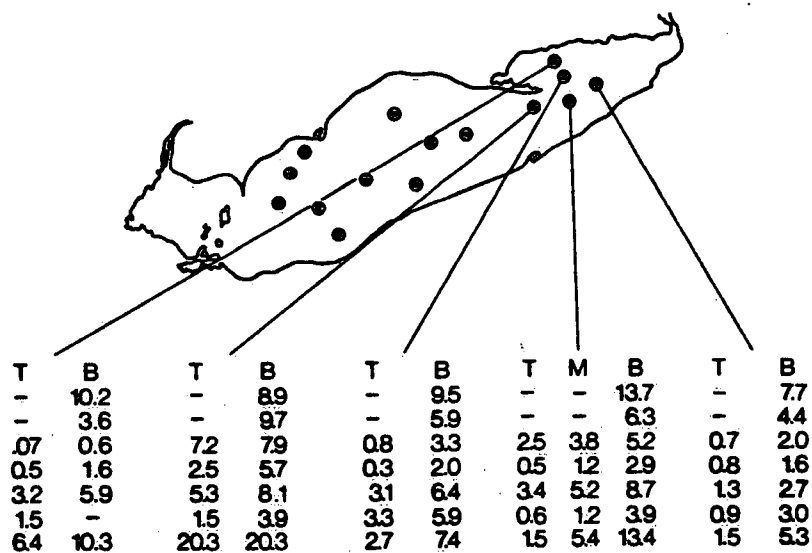
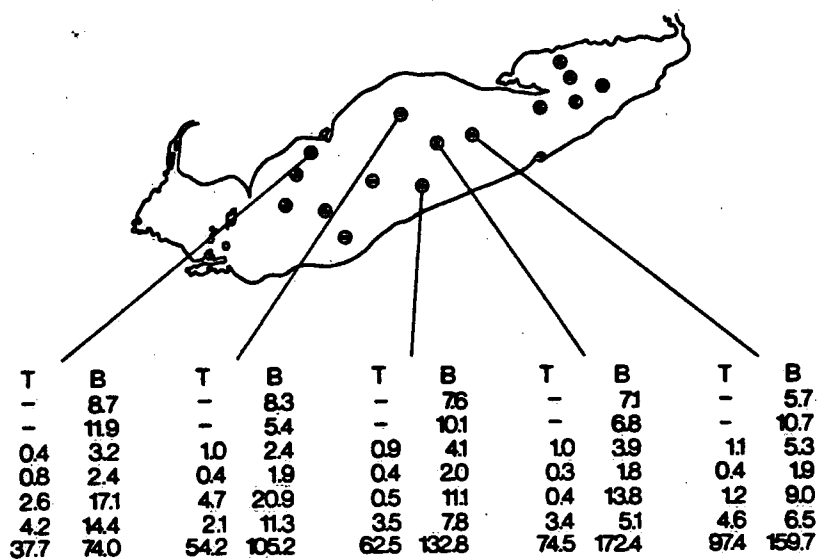
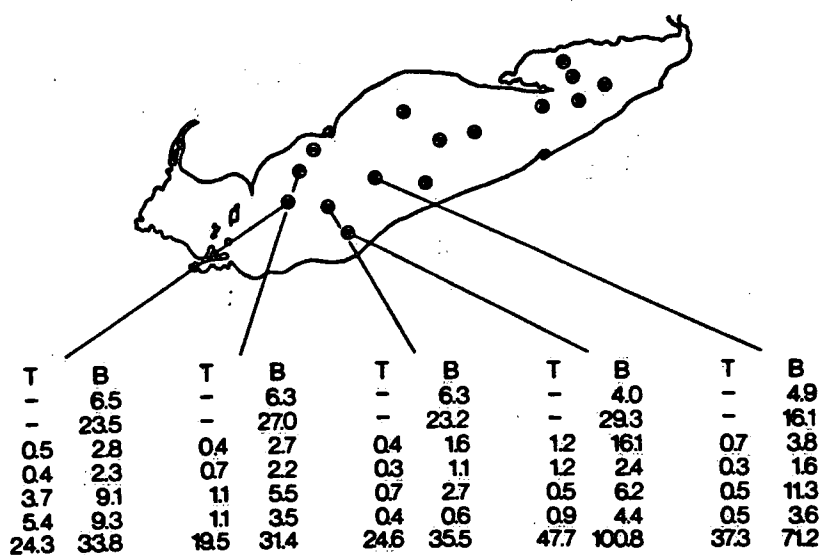












SEDIMENT TRAP DOWNFLUX (g DRY WEIGHT . m⁻² d⁻¹)

