EFFECTS OF LAKE DRAWDOWN ON SEDIMENT DYNAMICS IN THE BIG MUSKEGO LAKE COMPLEX, WISCONSIN

INTERIM REPORT 1: PREDRAWDOWN RESULTS

by

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BACKGROUND AND OBJECTIVES

Drawdown of Big Muskego Lake, for purposes of sediment consolidation, may have a strongly positive impact on rates of nutrient release from sediments (Fabre 1988), particularly if refractory sediment N and P pools are mobilized during sediment desiccation and oxidation. The outcome of enhanced rates of internal nutrient loading from these sediments could be the development of a large pulse of N and P to the water column of Big Muskego Lake, potentially exported thereafter downstream to Wind Lake. Large nutrient pulses have been observed in other systems (e.g., Lake Delavan) after lake drawdown.

The objectives of this phase of research were to examine 1) sediment physical and chemical composition, and 2) internal phosphorus (P) and nitrogen (N) loadings, and 3) aquatic macrophyte distribution and community composition in the Big Muskego/Wind Lake complex prior to drawdown of Big Muskego Lake. Reported here is information on sediment physical and chemical composition and rates of P and N release from sediment measured in laboratory incubation systems. A separate report will be provided on aquatic macrophyte distribution and community composition in Big Muskego Lake.

METHODS

Sediment composition

During September-October, 1995, sampling stations were established in Bass Bay (n=6), Big Muskego Lake (n=54), and Wind Lake (n=30) for examination of baseline sediment characteristics and sediment nutrient fractions before drawdown of Big Muskego Lake. Sampling stations in Bass Bay were arbitrarily established in the deep central basin (n=2) and along the shoreline region (n=4; Fig. 1). Sampling stations in Big Muskego and Wind Lakes were selected randomly from an array of Universal Transverse Mercator (UTM) coordinates established at 200-m intervals throughout the Big Muskego-Wind Lake complex (Figs. 1 and 2). Sampling stations in these lakes were located by a global positioning system (GPS).

Sediment samples were collected at each station with a Wildco KB sediment core sampler (Wildco Wildlife Supply Co.) for determination of the variables listed in Table 1. The upper 10 cm of sediment were immediately extruded into an airtight container to preserve the redox integrity of the sample. In the laboratory, sediments were gently homogenized under a nitrogen atmosphere prior to fractionation. Fresh sediment was dried at 105 °C to a constant weight for determination of moisture content and sediment density, then combusted at 550 °C in a muffle furnace for determination of particulate organic matter (POM). Additional sediment was centrifuged at 4 °C at 3000 RPM for ~ 2 hours for separation of sediment porewater. The porewater was carefully decanted under a nitrogen atmosphere, filtered through a 0.45 μm filter, and analyzed for soluble reactive phosphorus, ammonium-nitrogen, soluble calcium, and soluble iron using methods described in APHA (1992). Sequential fractionation of inorganic phosphorus in the sediment was conducted according to Hieltjes and Lijklema (1980) for the determination of NH_4Cl-extractable phosphorus (NH_4Cl-P; loosely-bound and $CaCO_3$-adsorbed phosphorus), NaOH-extractable phosphorus (NaOH-P; aluminum- and iron-bound phosphorus), and HCl-extractable phosphorus (HCl-P; calcium-bound phosphorus). Each extraction was filtered through a 0.45 μm filter, adjusted to pH 7, and analyzed for soluble reactive phosphorus. Analyses of total sediment nitrogen and phosphorus concentrations were performed colorimetrically using Lachet QuikChem procedures (Lachet Method 10-107-06-2-D for nitrogen and 13-115-06-1-B for phosphorus; Lachet Inst., Milwaukee, WI) following digestion with sulfuric acid, potassium sulfate, and red mercuric oxide (Plumb, 1981). Exchangeable nitrogen was determined by cation exchange according to Bremner (1965). Total inorganic P of the sediment was calculated as the sum of NH_4Cl-P, NaOH-P, and HCl-P. Total organic P of the sediment was calculated as the difference between total sediment P and inorganic P. All sediment concentrations are expressed in units of mg g^{-1} dry sediment mass.

Rates of N and P release from sediments

From a subset of sediment sampling stations, sediment cores were collected for incubation under oxic and anoxic conditions. A sediment core sampler, equipped with an acrylic core liner (6.5-cm ID and 50-cm length), was used to collect intact sediment cores from two stations in Bass Bay, 18 stations in Big Muskego Lake, and 10 stations in Wind Lake (see Appendix 1 for a listing of stations). The core liners, containing both sediment and overlying water, were sealed immediately using stoppers and stored in a protective box until analysis. Additional lake water was collected near the bottom in each lake for later incubation with the collected sediment.

In the laboratory, rates of P release from sediments under oxic and anoxic conditions and rates of ammonium-nitrogen release under anoxic conditions were evaluated in incubation systems according to the procedures described in James and Barko (1991) and James et al. (1995, 1996). Incubation systems were constructed by extruding the upper 10-cm section of sediment into a core liner (6.5-cm ID and 25-cm length), siphoning 300 ml of filtered lake water onto the sediment, and sealing the system with rubber stoppers. The redox environment in each system was controlled by bubbling the water with either air (oxic conditions) or nitrogen (anoxic conditions). For each station, one sediment system was subjected to an oxic environment while another sediment system was subjected to an anoxic environment. Sediment systems were incubated at 20 °C over a 2-3 week period. Thus, a total of 60 incubations were conducted in 1995 for sediments collected in the Big Muskego/Wind Lake complex.

N (as ammonium-nitrogen) and P (as SRP) were measured colorimetrically using standard methods (APHA 1992). Rates of N and SRP release from the sediment (mg m^{-2} d^{-1}) were calculated as the linear change in concentration in the overlying water divided by time and the area of the incubation core liner.

SUMMARY OF RESULTS

Big Muskego Lake

Summary statistics for sediment characteristics and rates of nutrient release from the sediments of Big Muskego Lake before lake drawdown are shown in Table 2. Data summaries for each station in Big Muskego Lake are provided in Appendix 1. In general, mean moisture content of the sediments was very high (> 90%) while mean sediment density was low, reflecting the fluid nature of the surface sediment. Mean organic matter of the sediments was also very high in the lake (> 40%) . With the exception of a region in the northwest corner of the lake, moisture content and organic matter (Figs. 3 and 4) were homogeneous throughout the lake.

Mean concentrations of soluble reactive phosphorus in the porewater of the sediment were very low (Table 2) and did not exhibit pronounced spatial variations in the lake (Fig. 5). Mean NH_4Cl-P and NaOH-P accounted for a relatively large fraction of the total inorganic sediment phosphorus (37% and 56%, respectively) while HCl-P accounted for only 17% of the total inorganic sediment phosphorus (Table 2). NH_4Cl-P and NaOH-P exhibited greatest concentrations near the outflow of Big Muskego Lake, with gradients of lower concentrations toward the northern shoreline region (Figs. 6 and 7). In contrast, spatial trends were not observed for HCl-P (Fig. 8).

Overall, organic fractions of sediment P accounted for a slightly greater percentage 58%) of the sediment total P than did inorganic P fractions (Table 2). Concentrations of sediment inorganic, organic, and total P were greatest near the outflow and along the southeastern shoreline of the lake, with gradients of lower concentrations toward the northern shoreline of the lake (Figs. 9-11). Mean concentrations of sediment total P, inorganic P, organic P, NaOH-P, and HCl-P in Big Muskego Lake were low, but fell within the range of concentrations for surficial sediments of lakes in eastern North America (Ostrofsky 1987). Mean NH_4Cl-P in Big Muskego Lake was greater than the mean concentration reported by Ostrofsky (1987) for lakes in eastern North America.

Laboratory rates of P release from sediments, measured at 20 °C under both oxic and anoxic conditions, were very low in Big Muskego Lake (Table 2), with no discernable spatial patterns (Figs. 12-13). In particular, rates of P release from sediments under oxic conditions were near zero for most stations in the lake (Fig. 12). Under anoxic conditions, rates of P release from the sediments were only slightly greater than rates measured under oxic conditions (Fig. 13). The greatest rate of P release from the sediments under anoxic conditions was only ~ 1.9 mg m^{-2} d^{-1} for a station located near the outflow region (Fig. 13).

Significant ($p<0.05$) correlations existed among many of the variables measured for the surface sediments of Big Muskego Lake (Table 3). NH_4Cl-P was positively correlated with NaOH-P, total inorganic and organic P, and total sediment P. NaOH-P exhibited similar strong correlations with total inorganic, organic P, and sediment total P. In contrast, HCl-P was not correlated with any other sediment variables (Table 3). Rates of P release from sediments under oxic conditions were negatively correlated with sediment organic matter concentration while rates of P release from sediments under anoxic conditions were weakly and positively correlated with NH_4Cl-P.

Mean total sediment N in Big Muskego Lake was very high (Table 2), compared to the range of values for different sediments reported in Barko and Smart (1986), and exhibited spatial variations similar to patterns in the distribution of sediment total P (Fig. 14). Mean exchangeable nitrogen, considered an important fraction in the sediment for macrophyte root uptake (Barko et al. 1988), accounted for < 1% of the total sediment N and exhibited minimal spatial variations (Fig. 15). Release of ammonium-N from the sediments was high under anoxic conditions, in comparison to rates of P release, ranging between 11 and 40 mg m^{-2} d^{-1} (Table 2 and Fig. 16).

Bass Bay

Summary statistics for sediment characteristics and rates of nutrient release from the sediments of Bass Bay are shown in Table 4. Data summaries for each station in Bass Bay are provided in Appendix 1. Like Big Muskego Lake, mean sediment moisture content was high, while sediment density was low. However, the mean percent organic matter of the sediment was much lower in Bass Bay, compared to Big Muskego Lake (14%; Table 4). Sediment moisture and organic matter content were greatest in the deep, central portion of the bay and declined slightly with decreasing depth at stations located near the shoreline (Figs. 3-4).

Mean concentrations of soluble reactive phosphorus in the porewater of the sediment were ~2.8 mg/L (Table 4), with concentrations often exceeding 4 mg/L at depths > 5 m in Bass Bay (Fig. 5). Mean NH_4Cl-P was the dominant fraction of inorganic P in the sediment (56%), followed by NaOH-P (25%) and HCl-P (19%). NH_4Cl-P and NaOH-P exhibited greatest concentrations in the deep, central portion of Bass Bay (Figs. 6 and 7). In contrast, HCl-P exhibited lowest concentrations in the deep, central portion of the bay (Fig. 8).

Organic and inorganic P in the sediments of Bass Bay were equivalent in concentration, with each accounting for ~ 50% of the sediment total P (Table 4). Sediment inorganic, organic, and total P concentrations were generally greatest in the deep, central portion of the bay (Figs. 9-11).

Laboratory rates of P release from sediments collected in the deep region of Bass Bay were high under both oxic and anoxic conditions (Table 4; Figs . 12 and 13) and similar to rates of P release measured from eutrophic lake sediments (Nürnberg et al. 1986; Nürnberg 1988). The greatest rate of P release from the sediments under anoxic conditions was 8.6 mg m^{-2} d^{-1} for a station located near deep, central region (Fig. 13).

Like Big Muskego Lake, Bass Bay exhibited high sediment total N concentrations

(Table 4 and Fig. 14). Exchangeable nitrogen (Fig. 15) and porewater ammonium (not shown) exhibited marked depth-related variations, as concentrations were greatest in the deep profundal sediments and declined with decreasing depth. Mean laboratory rates of ammonium release from the deep, profundal sediments were very high (68 mg m^{-2} d^{-1}) under anoxic conditions (Fig. 16).

Wind Lake

Spatial variations in sediment characteristics were strongly related to basin morphometry in Wind Lake. Moisture content of the sediments was greatest in the deep region of the lake and generally declined with decreasing depth (Fig. 17). These depth-related variations in moisture content were used to identify zones of sediment erosion (moisture content < 50%) and zones of sediment accumulation (moisture content > 75%; i.e., Hakanson 1977). Based on these criteria, sediment accumulation was occurring in the deep basin, while sediment erosion was occurring in shallow regions, particularly along the southern shoreline. An exception to this pattern occurred in the shallows near the inflow to Wind Lake, where moisture content was elevated compared to other shallow regions. This pattern suggested possible influences of sediment loading from Big Muskego Lake and accretion in this region. Additional sediment core results from Wind Lake, to be obtained in October, 1996, will be used to further delineate the extent of these sedimentary zones in the lake.

Organic matter content exhibited a similar pattern to that of moisture content, as concentrations were greatest in the deep region and the shallows near the inflow, and lower in other shallow regions (Fig. 18). In general, organic matter content was greater than 20% in the deep region and the shallows near the inflow, and declined to less than 5% in other shallow areas of the lake.

Porewater concentrations of soluble reactive phosphorus were very high (> 9.5 mg/L) in the deep region of Wind Lake and declined to less than 0.5 mg/L in the shallow regions (Fig. 19). NH_4Cl-P and NaOH-P followed a similar depth-related pattern (Figs. 20-21), while HCl-P was nearly homogeneous in concentration at all depths (Fig. 22). Sediment inorganic P, organic P, and total P were also greatest in the deep region, with gradients of lower concentration as a function of decreasing depth (Figs. 23-25). Secondary peaks in the concentration of these variables occurred near the mouth of the inflow to Wind Lake (Figs. 23-25).

Like sediment P variables, laboratory rates of P release from sediments under oxic and anoxic conditions (20 °C) were greatest in the deep region of Wind Lake and generally declined with decreasing depth (Figs. 26-27). In the deep region, rates of P release from sediments exceeded 6 mg m^{-2} d^{-1} under oxic conditions and 10 mg m^{-2} d^{-1} under anoxic conditions (Figs. 26-27). In contrast, rates of P release from sediments in shallow regions were negligible under oxic conditions, similar to rates of P release from sediments observed in Big Muskego Lake under the same conditions. At these same stations in the shallows located around the shoreline of the lake, however, rates of P release were greater than 1 mg m^{-2} d^{-1} under anoxic conditions. Summary statistics for sediment variables and rates of nutrient release are provided in Table 5. Data summaries for each station in Wind Lake are provided in Appendix 1.

There were significant correlations among sediment variables in Wind Lake (Table 6). In general, most sediment variables were strongly related to depth, suggesting possible links to zones of sediment erosion and accumulation. Strong correlations existed between porewater P, NH_4Cl-P, NaOH-P, HCl-P, sediment inorganic and organic P and sediment total P. Rates of P release from sediments under oxic conditions were correlated with depth, porewater P, NaOH-P, total organic P, and sediment total P suggesting possible regulatory influences as a function of iron-bound and/or organic-bound sediment P (Table 6). Rates of P release from sediments under anoxic conditions were also correlated with depth, porewater P, NaOH-P, total organic P, and sediment total P (Table 6).

Unlike Big Muskego Lake, Wind Lake exhibited concentrations of total sediment N (Table 5 and Fig. 28) that fell within the range of values reported by Barko and Smart (1986). The spatial distribution of total sediment N, exchangeable N (Fig. 29), and porewater ammonium (not shown) was strongly related to depth, as concentrations of these variables were greatest in the deep, profundal region of Wind Lake. Laboratory rates of ammonium release under anoxic conditions followed a similar depth-related pattern (Fig. 30).

CONTINUED RESEARCH EFFORTS

After approximately one year of drawdown, sediment cores will be collected from randomly-selected stations in Big Muskego Lake for assessment of changes in rates of P and N release from the sediments and changes in sediment physical and chemical characteristics, as a result of sediment desiccation and oxidation, and potential impacts, if any, to Wind Lake. Additional sediment cores will also be collected from randomly-selected stations in Wind Lake and Bass Bay to further evaluate and delineate sediment characteristics in relation to zones of sediment erosion and accumulation in these lakes. Further information on spatial variations in rates of P release from the sediments and sediment P characteristics in Wind Lake and Bass Bay will be of critical importance in the development of management scenarios to control internal P loading from the sediments via alum treatment.

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Table 1. Variable list for surface sediment characteristics.

Moisture Content, %
Sediment Density, g/mL
Organic Matter Content, %
Total Sediment Nitrogen, mg/g
Exchangeable Nitrogen, mg/g
Total Sediment Phosphorus, mg/g
NH_4Cl-Extractable Phosphorus, mg/g
NaOH-Extractable Phosphorus, mg/g
HCl-Extractable Phosphorus, mg/g
Total Inorganic Phosphorus, mg/g
Total Organic Phosphorus, mg/g
Porewater Iron, Calcium, and Phosphorus, mg/L
Oxic Phosphorus Release, mg m^{-2} d^{-1}
Anoxic Phosphorus Release, mg m^{-2} d^{-1}
Anoxic Ammonium-N Release, mg m^{-2} d^{-1}

Table 2. Summary statistics for various sediment characteristics in Big Muskego Lake for sediment samples (n=18-54) collected at all depths.

SUMMARY STATISTICS FOR BIG MUSKEGO LAKE, 1995 (All Depths)					
	VARIABLE	MEAN	1 S.E.	MIN	MAX
SEDIMENT CHARACTERISTICS	MOISTURE CONTENT, %	90.9	1.9	61.1	97.5
(n=54)	SEDIMENT DENSITY, g/mL	0.08	0.01	0.03	0.52
	PARTICULATE ORGANIC MATTER, %	44.5	1.0	5.8	58.8
POREWATER CHARACTERISTICS	PHOSPHORUS, mg/L	0.022	0.013	0.002	0.642
(n=54)	AMMONIUM-NITROGEN, mg/L	4.847	0.269	0.770	10.500
	DISSOLVED CALCIUM, mg/L	73.03	1.15	55.30	96.20
	DISSOLVED IRON, mg/L	0.029	0.008	0.006	0.418
SEDIMENT NUTRIENT FRACTIONS	NH_4Cl-BOUND PHOSPHORUS, mg/g	0.145	0.005	0.020	0.248
(n=54)	NaOH-BOUND PHOSPHORUS, mg/g	0.179	0.013	0.040	0.384
	HCl-BOUND PHOSPHORUS, mg/g	0.068	0.005	0.010	0.164
	TOTAL INORGANIC PHOSPHORUS, mg/g	0.392	0.016	0.092	0.630
	TOTAL ORGANIC PHOSPHORUS, mg/g	0.540	0.031	0.137	1.214
	TOTAL SEDIMENT PHOSPHORUS, mg/g	0.932	0.016	0.229	1.830
	EXCHANGEABLE NITROGEN, mg/g	0.136	0.009	0.031	0.365
	TOTAL SEDIMENT NITROGEN, mg/g	20.217	0.551	1.630	27.600
NUTRIENT RELEASE RATES	OXIC PHOSPHORUS RELEASE, mg m^{-2} d^{-1}	0.04	0.01	0	0.154
(n=18)	ANOXIC PHOSPHORUS RELEASE, mg m^{-2} d^{-1}	0.25	0.10	0.08	1.91
	ANOXIC NH_3-NITROGEN RELEASE, mg m^{-2} d^{-1}	20.88	1.97	11.2	40.4

Table 3. Pearson Correlation Coefficients for various sediment characteristics in Big Muskego Lake. N.S. = not significant at $p < 0.05$.

VARIABLE	B	C	D	E	F	G	H	I	J	K	L	M
A) DEPTH	N.S.	0.31	-0.38	N.S.	-0.39	-0.33	0.31	-0.30	-0.52	-0.48	N.S.	N.S.
B) MOISTURE CONTENT, %		-.033	N.S.	N.S.	N.S	N.S	N.S	N.S	0.27	N.S.	N.S.	N.S.
C) SEDIMENT DENSITY, g/mL			-0.72	N.S.	-0.63	-0.47	N.S.	-0.61	-0.55	-0.61	N.S.	N.S.
D) PARTICULATE ORGANIC MATTER, mg/g				N.S.	0.49	N.S.	N.S.	0.29	0.41	0.39	-0.61	N.S.
E) POREWATER PHOSPHORUS, mg/L					N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
F) NH_4Cl-EXTRACTABLE PHOSPHORUS, mg/g						0.62	N.S.	0.77	0.72	0.79	N.S.	0.46
G) NaOH-EXTRACTABLE PHOSPHORUS, mg/g							N.S.	0.92	0.72	0.84	N.S.	N.S.
H) HCl-EXTRACTABLE PHOSPHORUS, mg/g								N.S.	N.S.	N.S.	N.S.	N.S.
I) TOTAL INORGANIC PHOSPHORUS, mg/g									0.73	0.87	N.S.	N.S.
J) TOTAL ORGANIC PHOSPHORUS, mg/g										0.97	N.S.	N.S.
K) TOTAL PHOSPHORUS. mg/g											N.S.	N.S.
L) OXIC PHOSPHORUS RELEASE, mg m^{-2} d^{-1}												N.S.
M) ANOXIC PHOSPHORUS RELEASE, mg m^{-2} d^{-1}												

Table 4. Summary statistics for various sediment characteristics in Bass Bay for sediment samples (n=2-6) collected at all depths.

SUMMARY STATISTICS FOR BASS BAY, 1995
(All Depths)

	VARIABLE	MEAN	1 S.E.	MIN	MAX
SEDIMENT CHARACTERISTICS	MOISTURE CONTENT, %	83.8	1.6	78.0	88.4
(n=6)	SEDIMENT DENSITY, g/mL	0.18	0.02	0.12	0.26
	PARTICULATE ORGANIC MATTER, %	14.1	1.8	1.4	26.1
POREWATER CHARACTERISTICS	PHOSPHORUS, mg/L	2.771	0.894	0.021	5.157
(n=6)	AMMONIUM-NITROGEN, mg/L	21.070	4.645	5.020	32.500
	DISSOLVED CALCIUM, mg/L	98.48	4.09	83.30	111.18
	DISSOLVED IRON, mg/L	0.074	0.015	0.044	0.143
SEDIMENT NUTRIENT FRACTIONS	NH_4Cl-BOUND PHOSPHORUS, mg/g	0.266	0.033	0.166	0.356
(n=6)	NaOH-BOUND PHOSPHORUS, mg/g	0.118	0.012	0.082	0.152
	HCl-BOUND PHOSPHORUS, mg/g	0.091	0.024	0.008	0.176
	TOTAL INORGANIC PHOSPHORUS, mg/g	0.476	0.026	0.408	0.564
	TOTAL ORGANIC PHOSPHORUS, mg/g	0.482	0.082	0.273	0.855
	TOTAL SEDIMENT PHOSPHORUS, mg/g	0.957	0.092	0.701	1.343
	EXCHANGEABLE NITROGEN, mg/g	0.298	0.081	0.049	0.477
	TOTAL SEDIMENT NITROGEN, mg/g	8.800	0.719	5.915	10.537
NUTRIENT RELEASE RATES	OXIC PHOSPHORUS RELEASE, mg m^{-2} d^{-1}	4.04	0.63	3.41	4.66
(n=2)	ANOXIC PHOSPHORUS RELEASE, mg m^{-2} d^{-1}	7.34	1.26	6.08	8.60
	ANOXIC NH_3-NITROGEN RELEASE, mg m^{-2} d^{-1}	68.25	3.55	64.70	71.80

Table 5. Summary statistics for various sediment characteristics in Wind Lake for sediment samples (n=10-30) collected at all depths.

SUMMARY STATISTICS FOR WIND LAKE, 1995
(All Depths)

	VARIABLE	MEAN	1 S.E.	MIN	MAX
SEDIMENT CHARACTERISTICS	MOISTURE CONTENT, %	63.0	5.1	22.0	90.7
(n=30)	SEDIMENT DENSITY, g/mL	0.59	0.10	0.10	1.43
	PARTICULATE ORGANIC MATTER, %	14.1	1.8	1.4	26.1
POREWATER CHARACTERISTICS	PHOSPHORUS, mg/L	1.508	0.564	0.011	10.226
(n=30)	AMMONIUM-NITROGEN, mg/L	11.816	2.981	1.110	54.700
	DISSOLVED CALCIUM, mg/L	78.16	4.06	55.40	119.88
	DISSOLVED IRON, mg/L	0.26	0.17	0.01	4.00
SEDIMENT NUTRIENT FRACTIONS	NH_4Cl-BOUND PHOSPHORUS, mg/g	0.136	0.013	0.036	0.266
(n=30)	NaOH-BOUND PHOSPHORUS, mg/g	0.083	0.011	0.020	0.272
	HCl-BOUND PHOSPHORUS, mg/g	0.166	0.015	0.052	0.472
	TOTAL INORGANIC PHOSPHORUS, mg/g	0.359	0.030	0.093	0.694
	TOTAL ORGANIC PHOSPHORUS, mg/g	0.216	0.045	0	0.804
	TOTAL SEDIMENT PHOSPHORUS, mg/g	0.575	0.066	0.093	1.282
	EXCHANGEABLE NITROGEN, mg/g	0.124	0.036	0.005	0.716
	TOTAL SEDIMENT NITROGEN, mg/g	6.397	0.980	0.255	13.343
NUTRIENT RELEASE RATES	OXIC PHOSPHORUS RELEASE, mg m^{-2} d^{-1}	1.93	1.25	0.09	11.8
(n=180)	ANOXIC PHOSPHORUS RELEASE, mg m^{-2} d^{-1}	3.21	1.40	0.13	12.19
	ANOXIC NH_3-NITROGEN RELEASE, mg m^{-2} d^{-1}	29.37	8.78	3.90	96.00

Table 6. Pearson Correlation Coefficients for various sediment characteristics in Wind Lake. N.S. = not significant at $p < 0.05$.

VARIABLE	B	C	D	E	F	G	H	I	J	K	L	M
A) DEPTH	0.46	-0.41	0.54	0.92	0.71	0.65	N.S.	0.49	0.70	0.74	0.91	0.92
B) MOISTURE CONTENT, %		-0.99	0.94	0.43	0.63	0.70	N.S.	0.63	0.82	0.89	N.S.	N.S.
C) SEDIMENT DENSITY, g/mL			-0.91	-0.39	-0.60	-0.66	N.S.	-0.62	-0.78	-0.85	N.S.	N.S.
D) PARTICULATE ORGANIC MATTER, mg/g				0.50	0.64	0.74	N.S.	0.55	0.88	0.90	N.S.	N.S.
E) POREWATER PHOSPHORUS, mg/L					0.65	0.66	N.S.	0.47	0.67	0.71	0.95	0.67
F) NH_4Cl-EXTRACTABLE PHOSPHORUS, mg/g						0.71	N.S.	0.84	0.55	0.78	N.S.	N.S.
G) NaOH-EXTRACTABLE PHOSPHORUS, mg/g							N.S.	0.75	0.64	0.81	0.84	0.72
H) HCl-EXTRACTABLE PHOSPHORUS, mg/g								0.70	N.S.	N.S.	N.S.	N.S.
I) TOTAL INORGANIC PHOSPHORUS, mg/g									0.38	0.72	N.S.	N.S.
J) TOTAL ORGANIC PHOSPHORUS, mg/g										0.91	0.75	0.80
K) TOTAL PHOSPHORUS. mg/g											0.81	0.81
L) OXIC PHOSPHORUS RELEASE, mg m^{-2} d^{-1}												0.95
M) ANOXIC PHOSPHORUS RELEASE, mg m^{-2} d^{-1}												

FIGURE CAPTIONS

Fig. 1. Sediment sampling stations in Big Muskego Lake and Bass Bay in 1995.

Fig. 2. Sediment sampling stations in Wind Lake in 1995. Depth contours represent 10-ft intervals.

Fig. 3. Spatial variations in sediment moisture content in Big Muskego Lake and Bass Bay in 1995.

Fig. 4. Spatial variations in sediment organic matter content in Big Muskego Lake and Bass Bay in 1995.

Fig. 5. Spatial variations in sediment porewater soluble reactive phosphorus in Big Muskego Lake and Bass Bay in 1995.

Fig. 6. Spatial variations in sediment NH_4Cl-extractable phosphorus in Big Muskego Lake and Bass Bay in 1995.

Fig. 7. Spatial variations in sediment NaOH-extractable phosphorus in Big Muskego Lake and Bass Bay in 1995.

Fig. 8. Spatial variations in sediment HCl-extractable phosphorus in Big Muskego Lake and Bass Bay in 1995.

Fig. 9. Spatial variations in sediment total inorganic phosphorus in Big Muskego Lake and Bass Bay in 1995.

Fig. 10. Spatial variations in sediment organic phosphorus in Big Muskego Lake and Bass Bay in 1995.

Fig. 11. Spatial variations in sediment total phosphorus in Big Muskego Lake and Bass Bay in 1995.

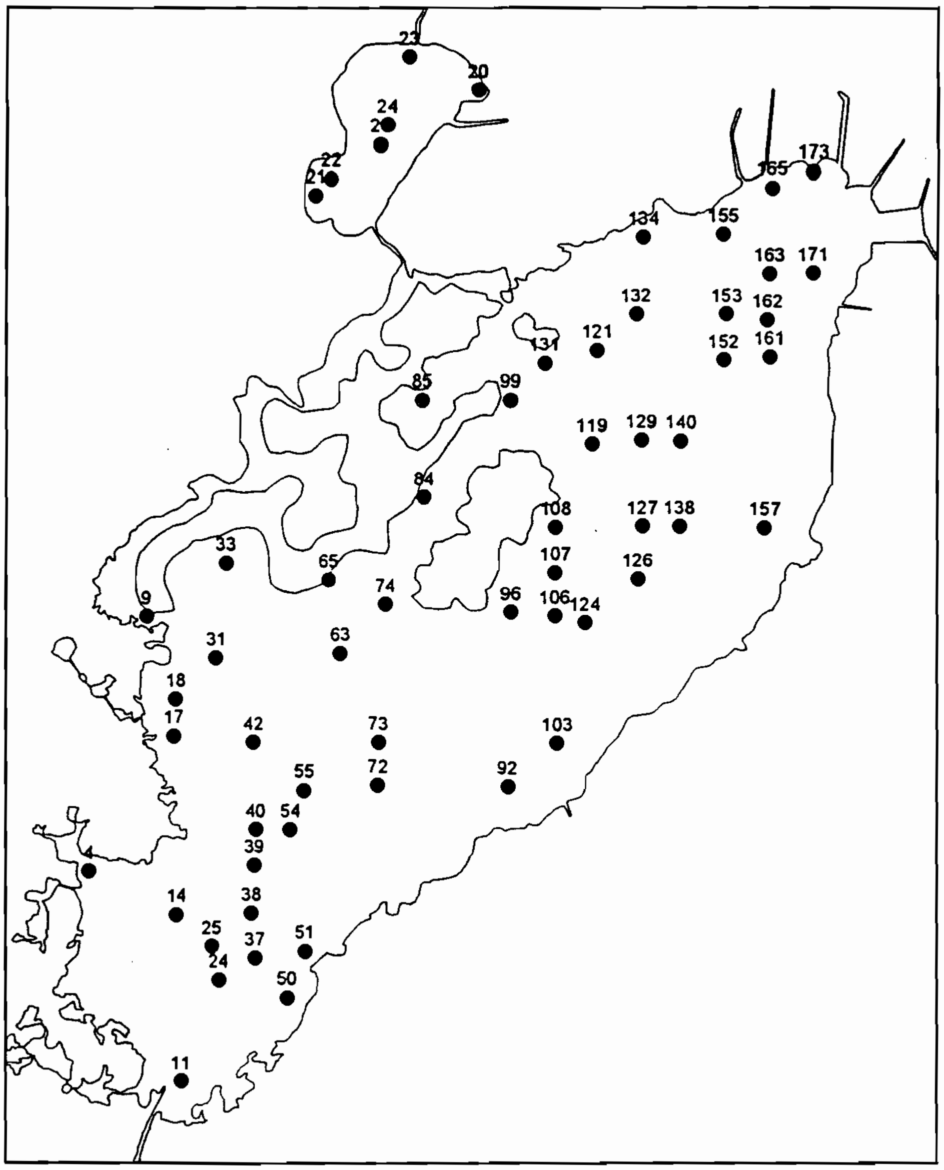
Fig. 12. Spatial variations in laboratory rates of phosphorus release from sediments under oxic conditions at 20 °C in Big Muskego Lake and Bass Bay in 1995.

Fig. 13. Spatial variations in laboratory rates of phosphorus release from sediments under anoxic conditions at 20 °C in Big Muskego Lake and Bass Bay in 1995.

Fig. 14. Spatial variations in sediment total nitrogen in Big Muskego Lake and Bass Bay in 1995.

Figure 1

BIG MUSKEGO LAKE
SEDIMENT SAMPLING STATIONS
1995



WIND LAKE
SEDIMENT SAMPLING STATIONS
1995

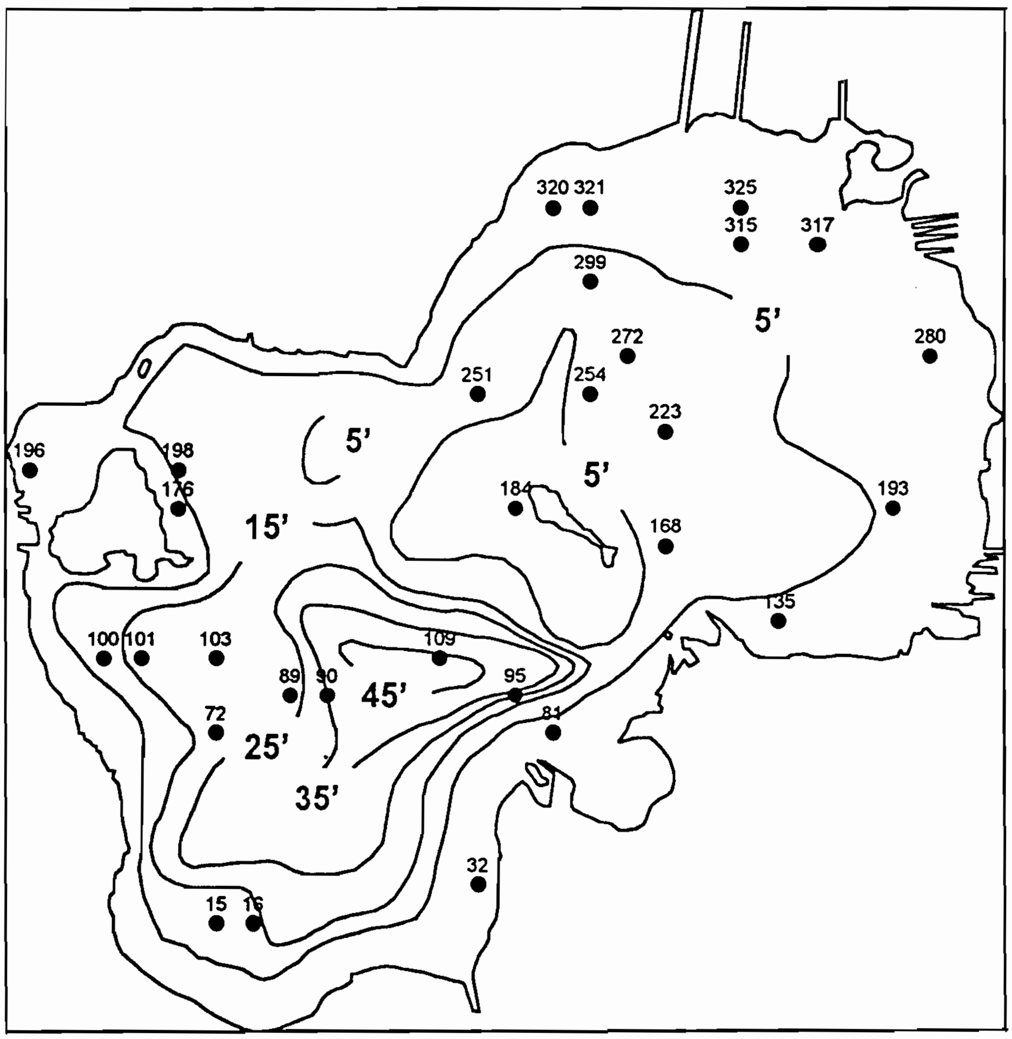


Figure 3

BIG MUSKEGO LAKE
MOISTURE CONTENT, %
1995

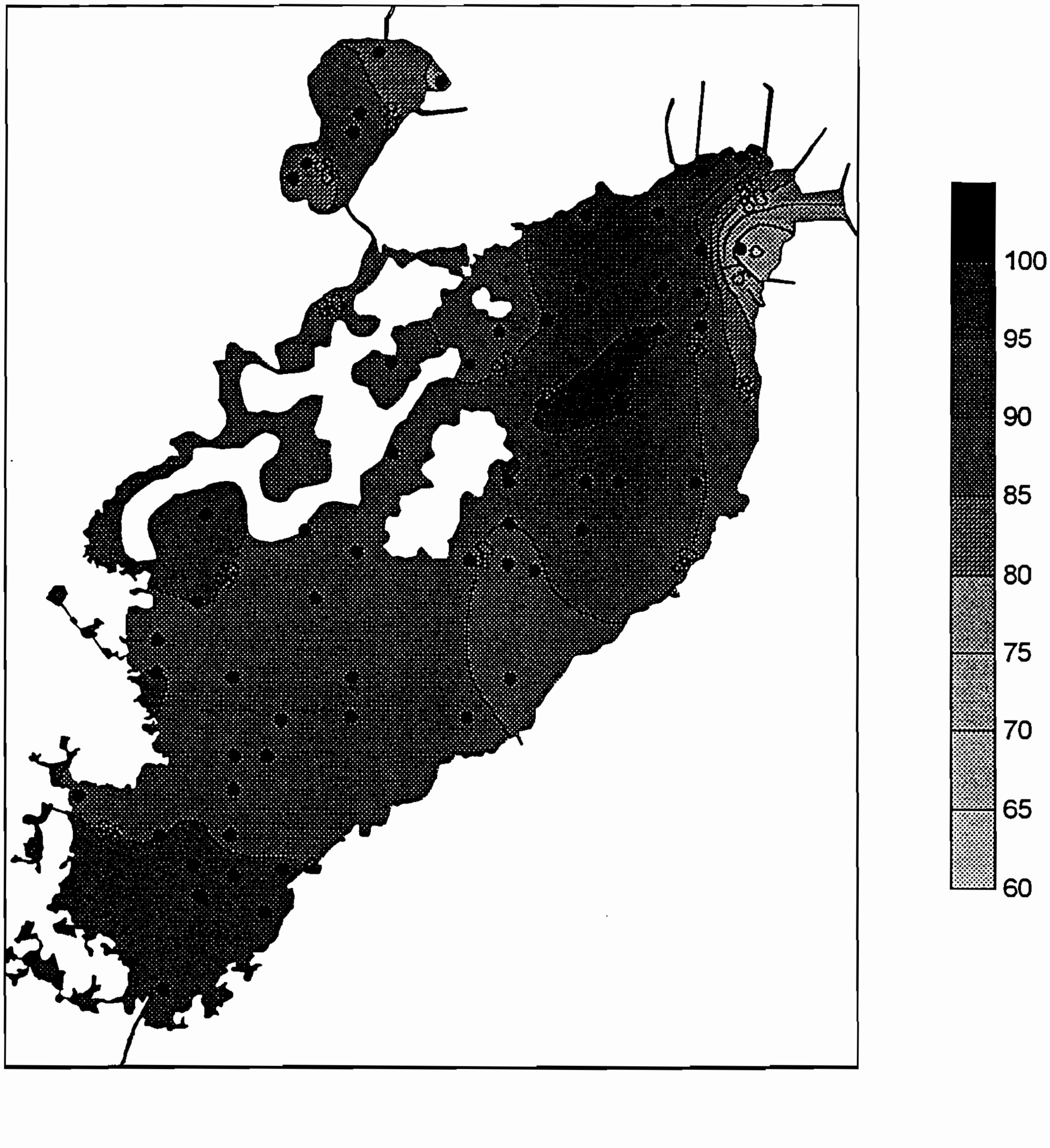


Figure 4

BIG MUSKEGO LAKE
SEDIMENT ORGANIC MATTER, %
1995

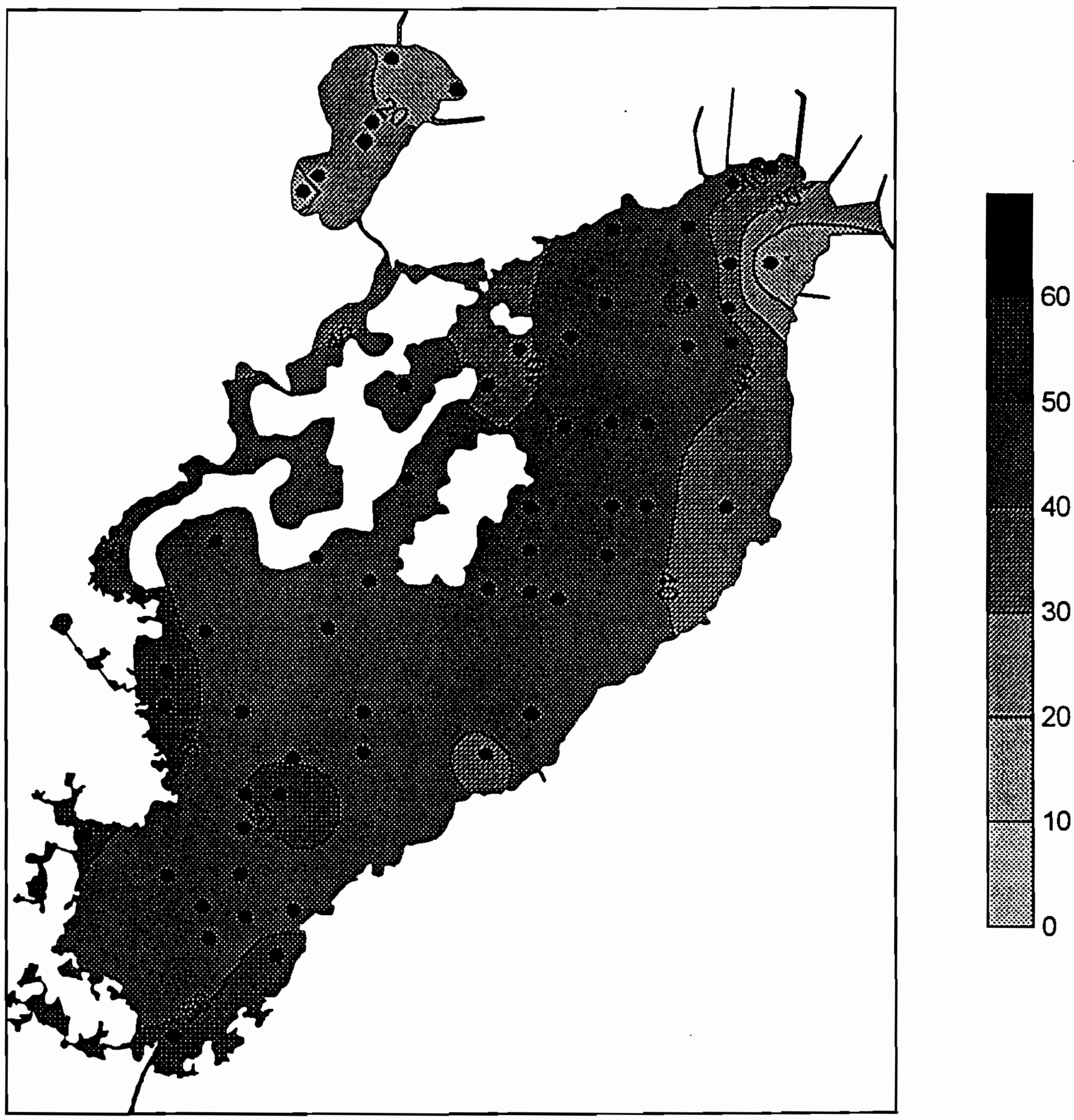


Figure 5

BIG MUSKEGO LAKE
POREWATER PHOSPHORUS, mg/L
1995

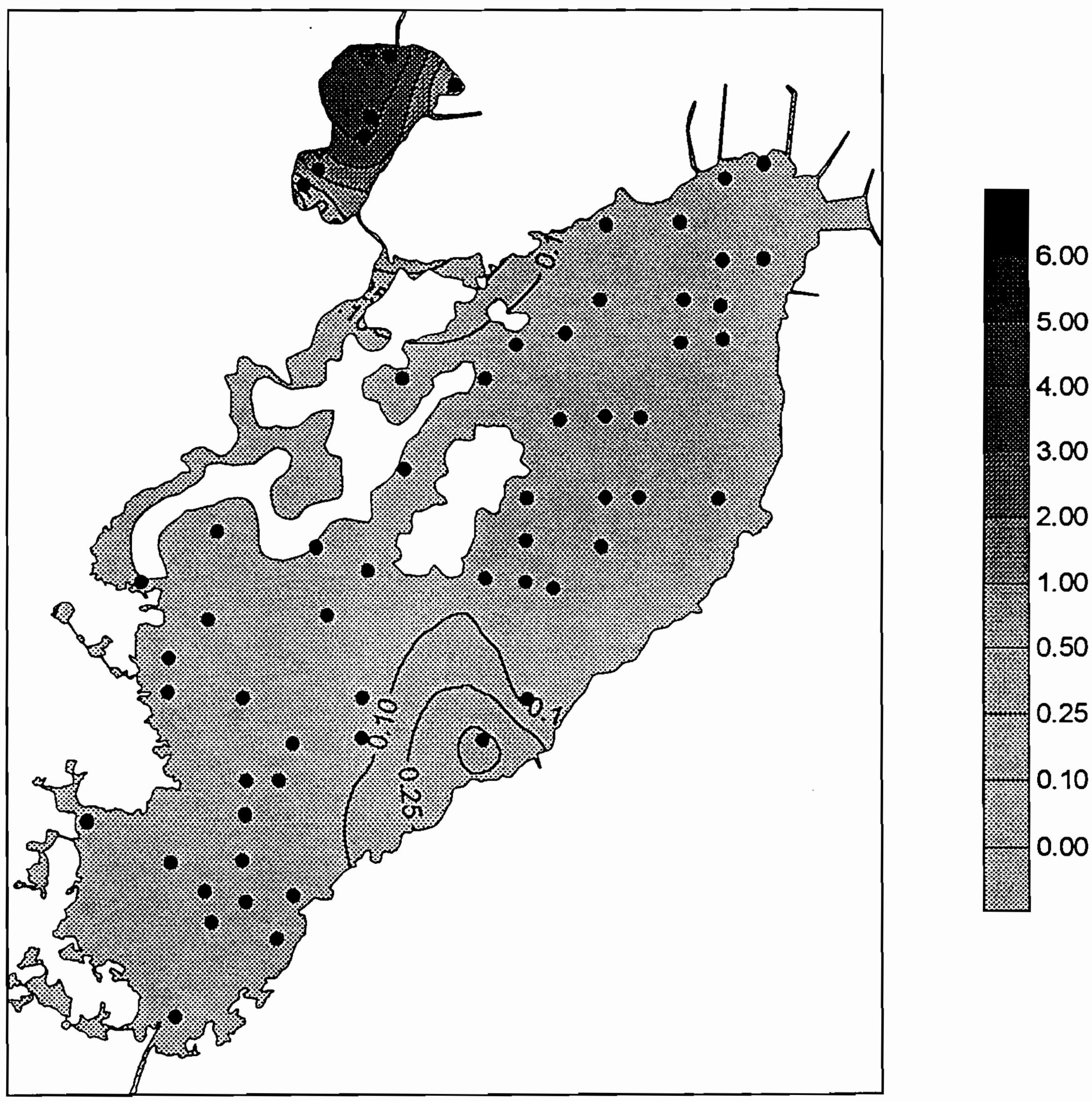


Figure 6

BIG MUSKEGO LAKE
NH4Cl-EXTRACTABLE PHOSPHORUS, mg/g
1995

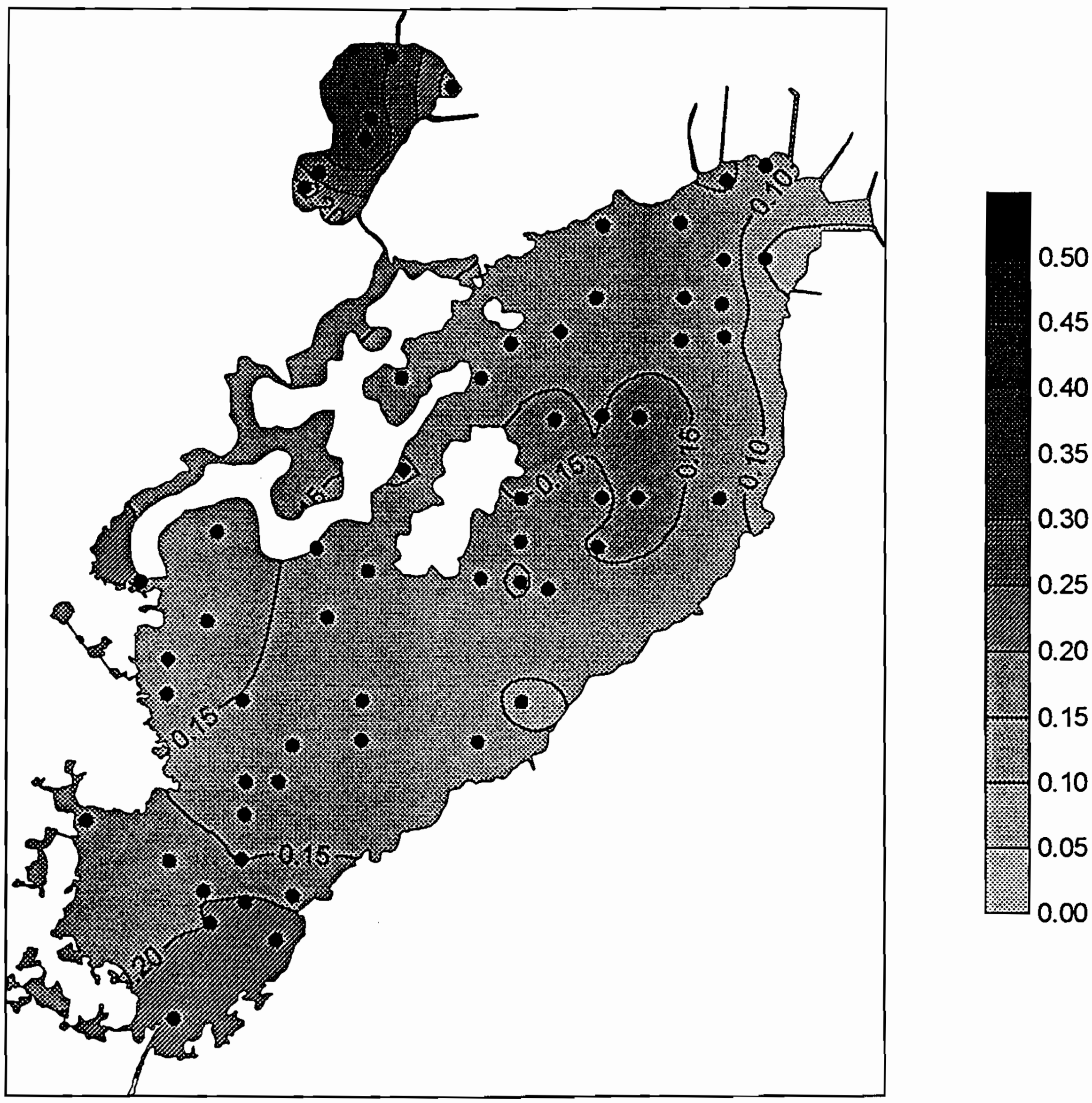
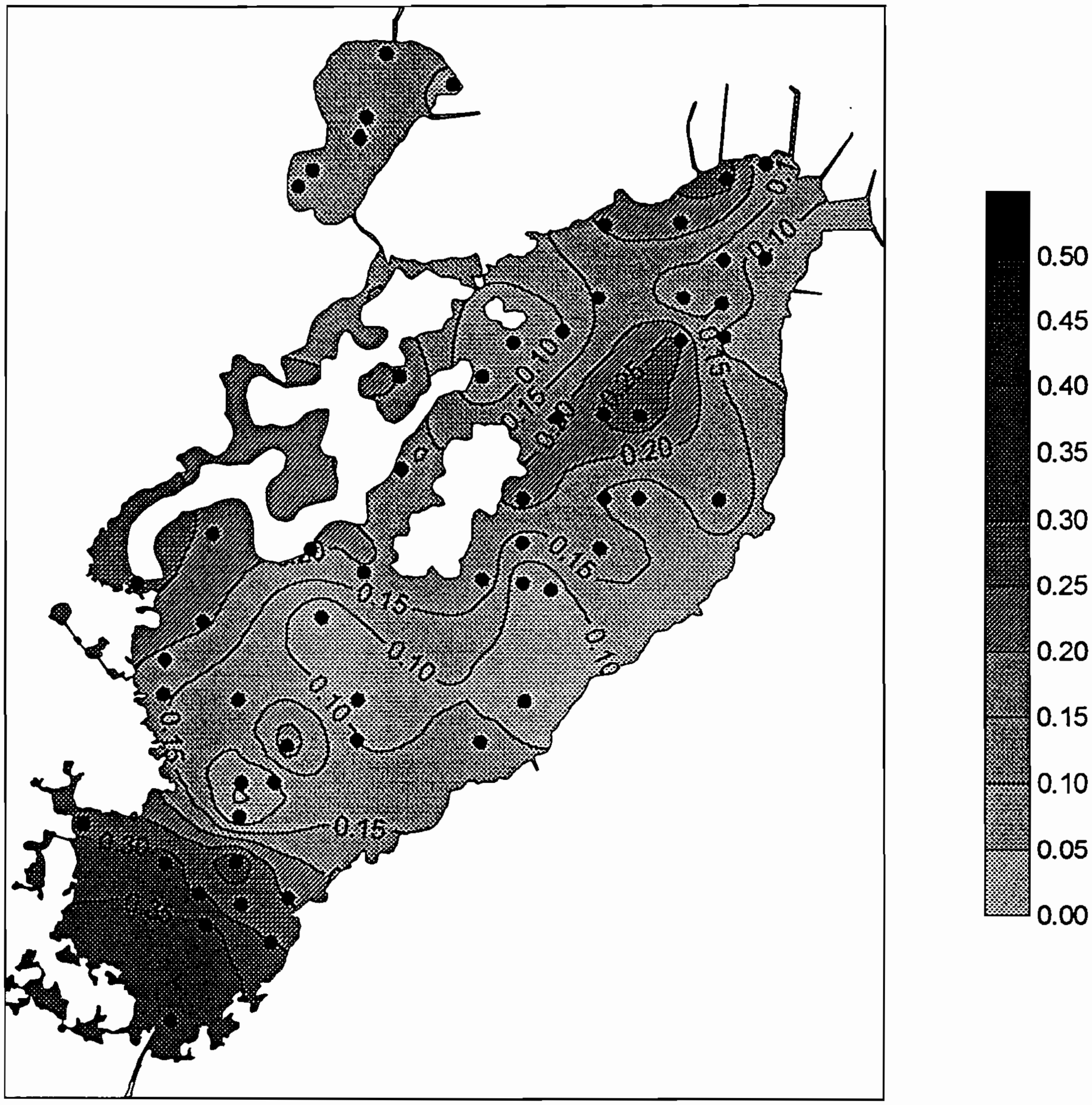


Figure 7

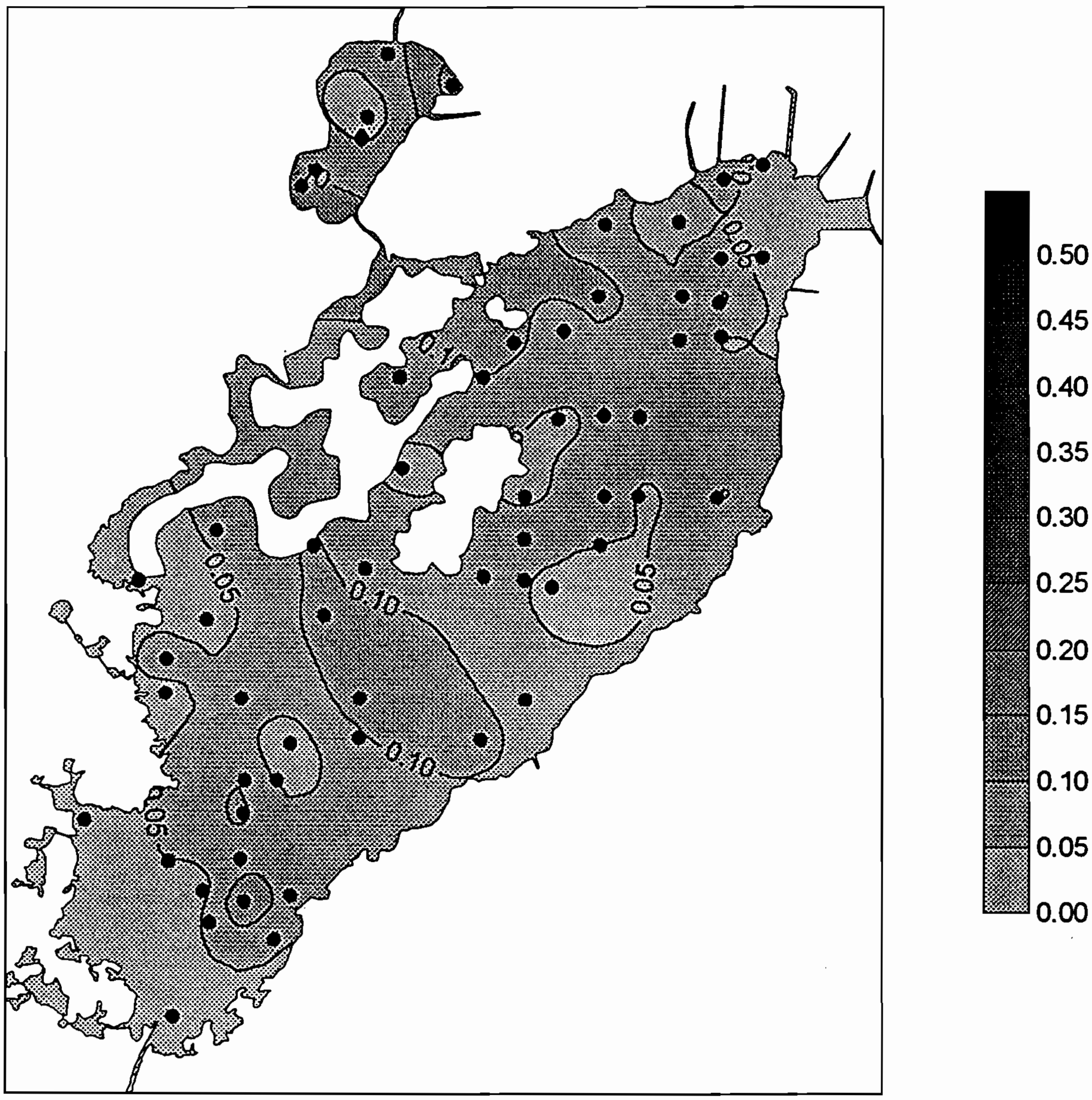
BIG MUSKEGO LAKE
NaOH-EXTRACTABLE PHOSPHORUS, mg/g
1995



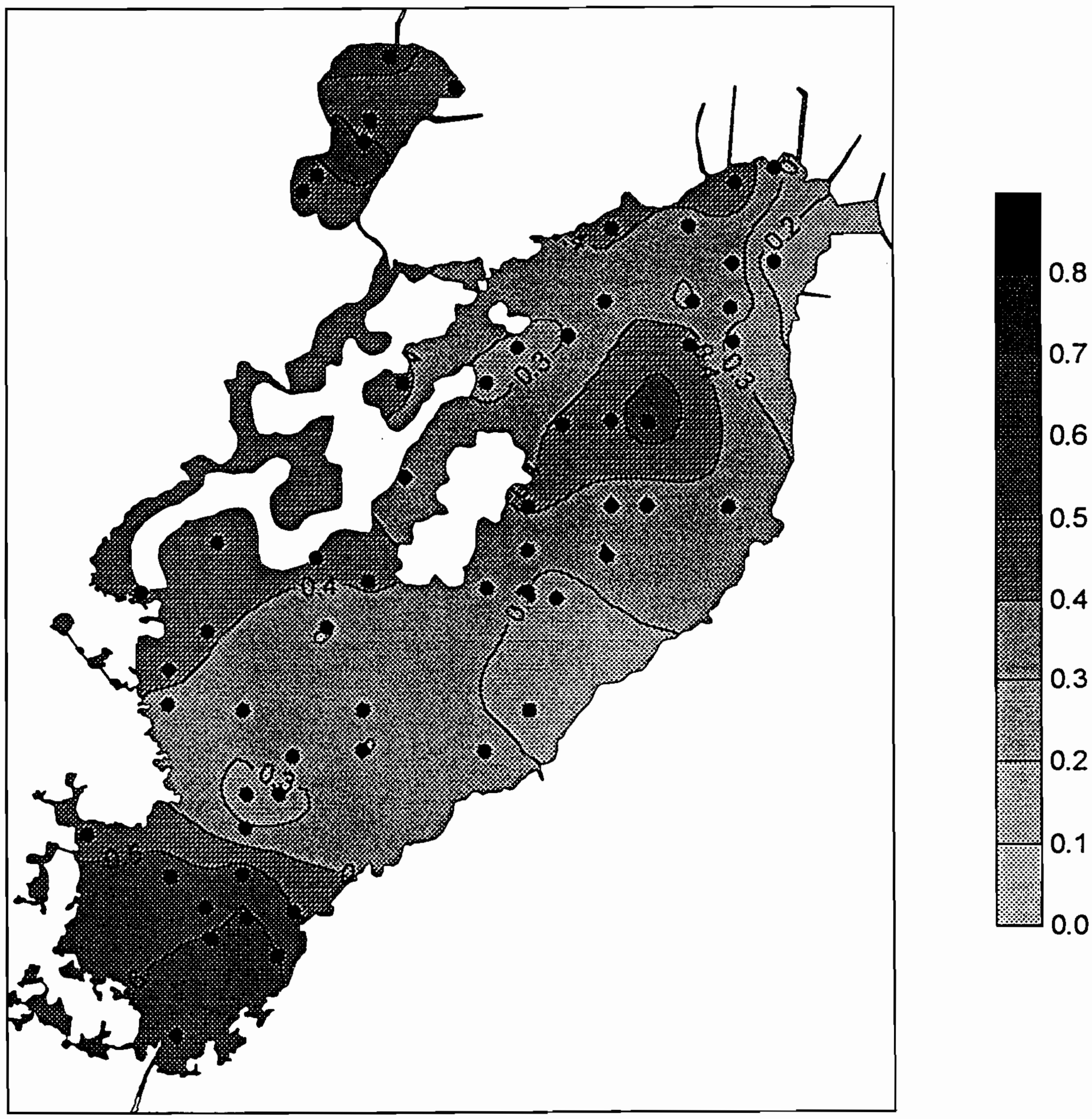
Eutrophic Lakes 0.5-0.7

Figure 8

BIG MUSKEGO LAKE
HCl-EXTRACTABLE PHOSPHORUS, mg/g
1995



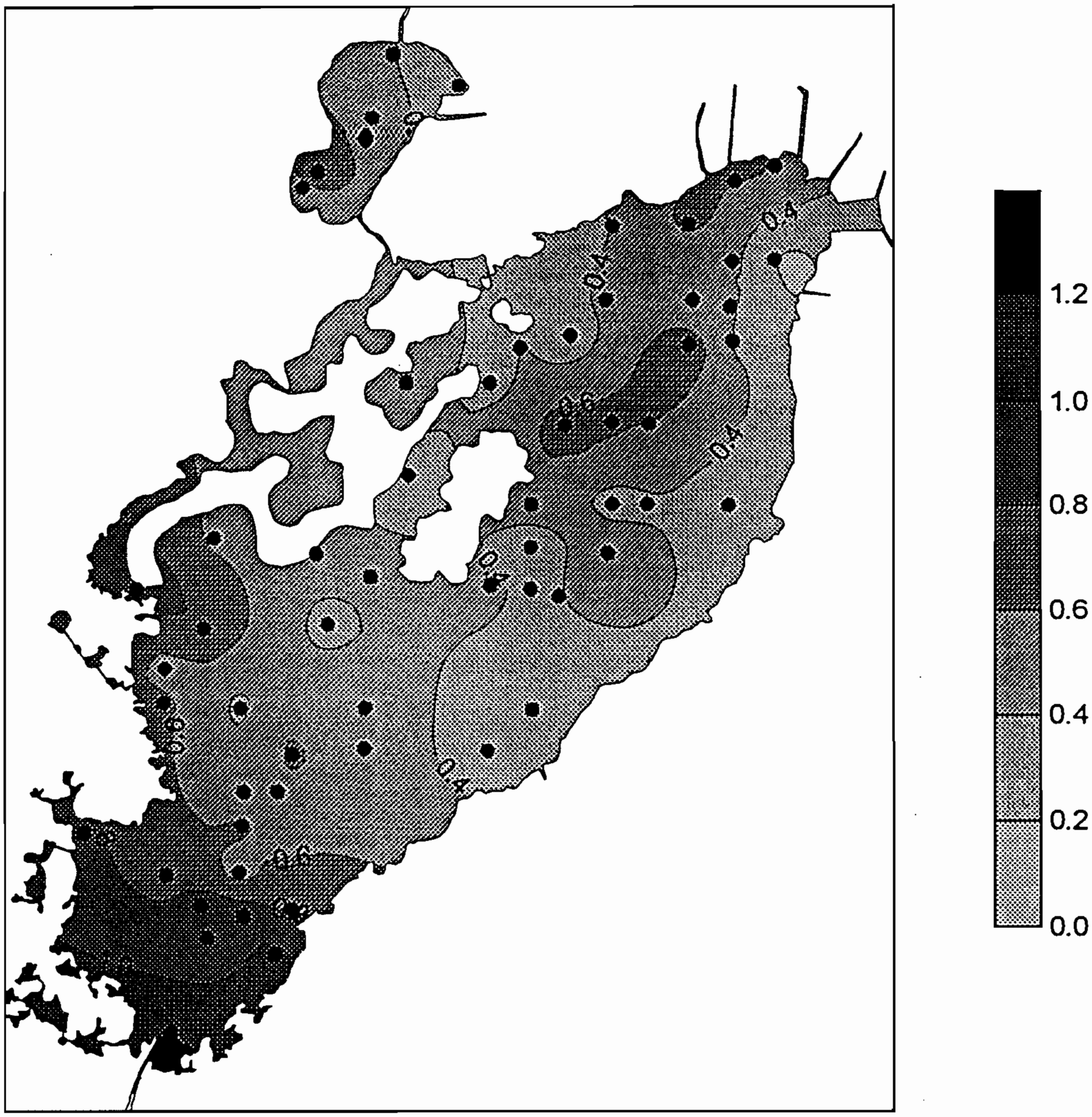
BIG MUSKEGO LAKE
INORGANIC PHOSPHORUS, mg/g
1995



low

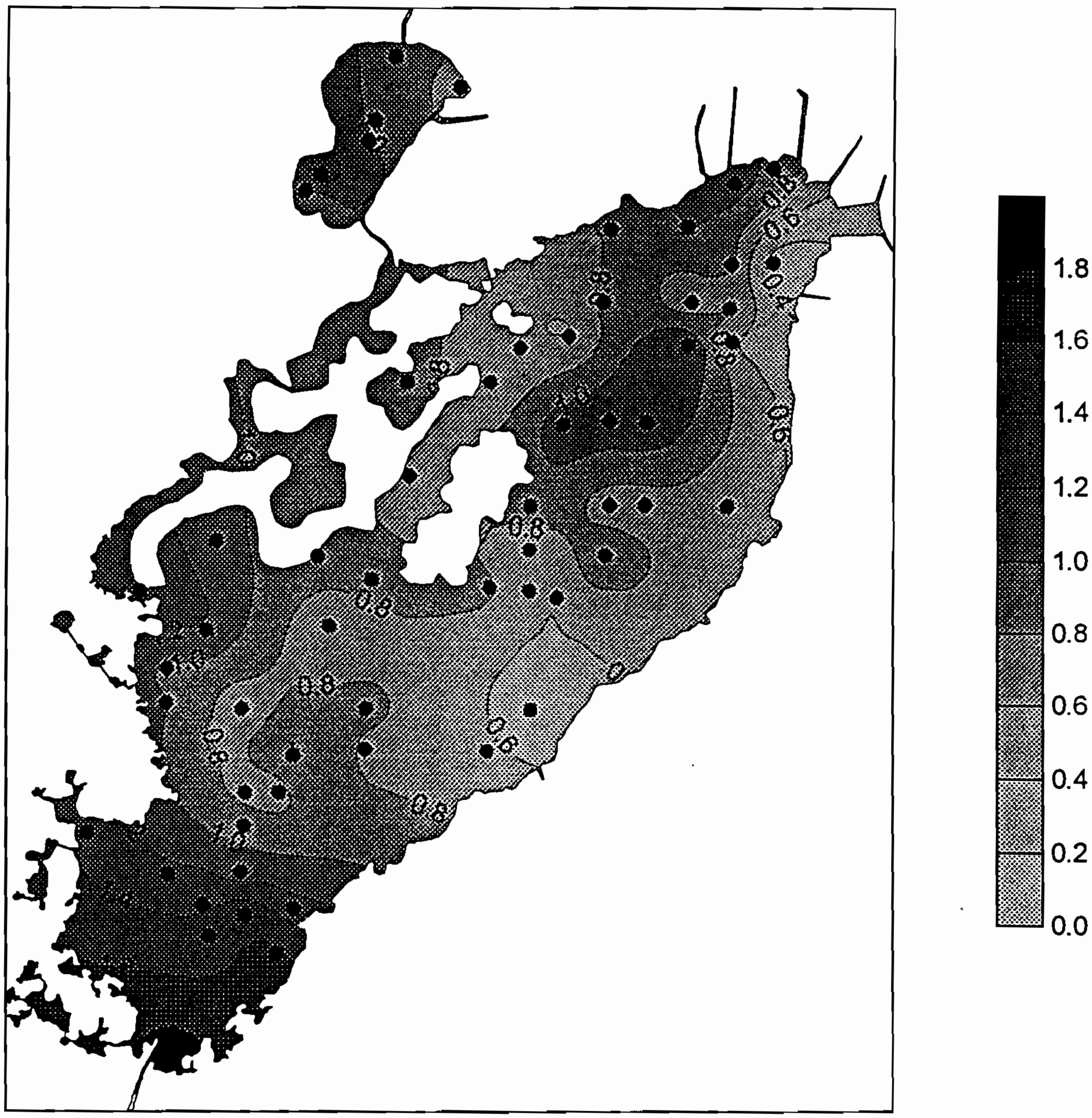
Figure 10

BIG MUSKEGO LAKE
ORGANIC PHOSPHORUS, mg/g
1995



Surprising when inorganic higher than organic lower

BIG MUSKEGO LAKE
TOTAL PHOSPHORUS, mg/g
1995



lower than lakes which are generally 1.5 or 5.0

Figure 12

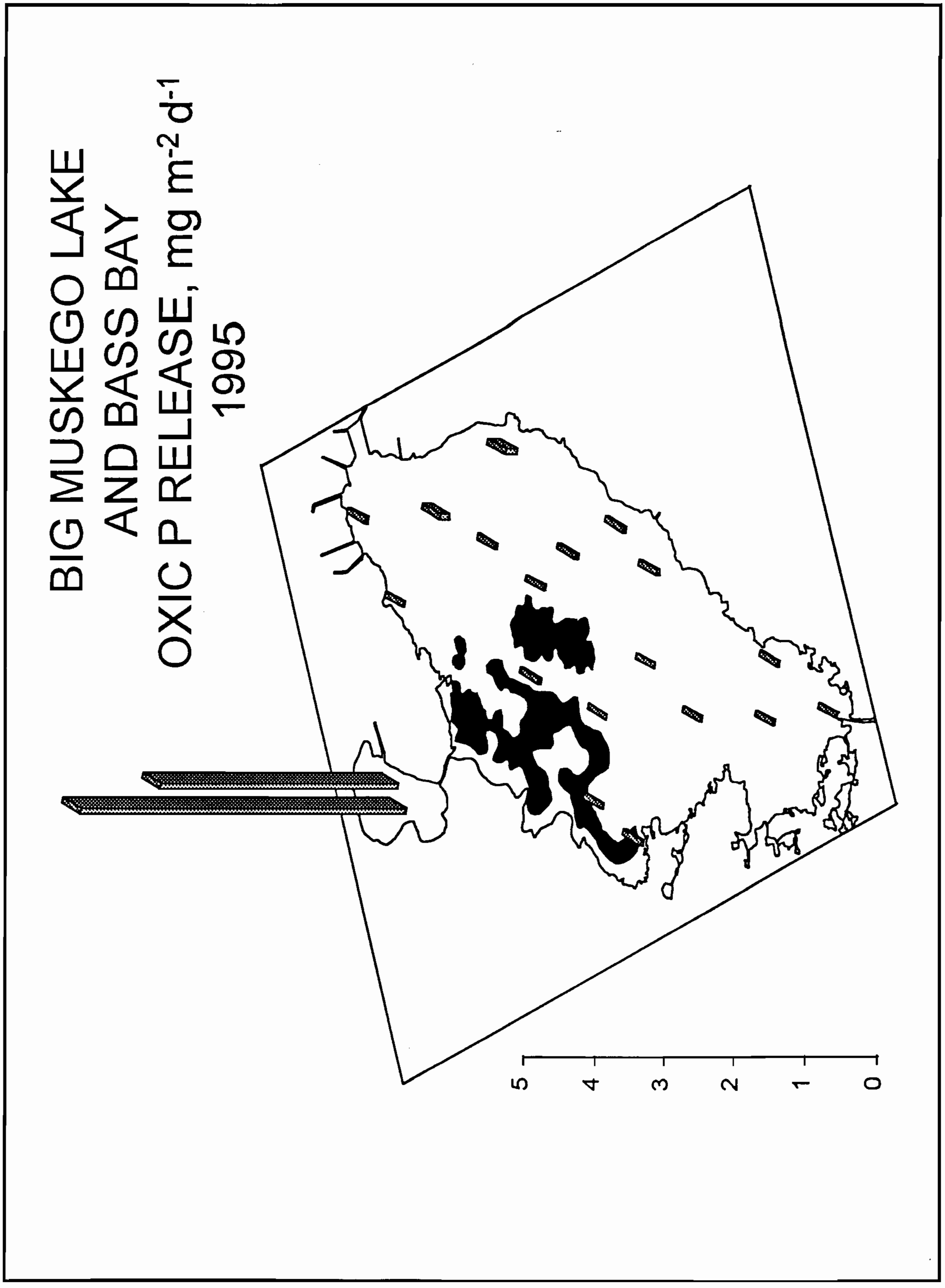

BIG MUSKEGO LAKE
AND BASS BAY
OXIC P RELEASE, mg m-2 d-1
1995
5
4
3
2
1
0

Figure 13

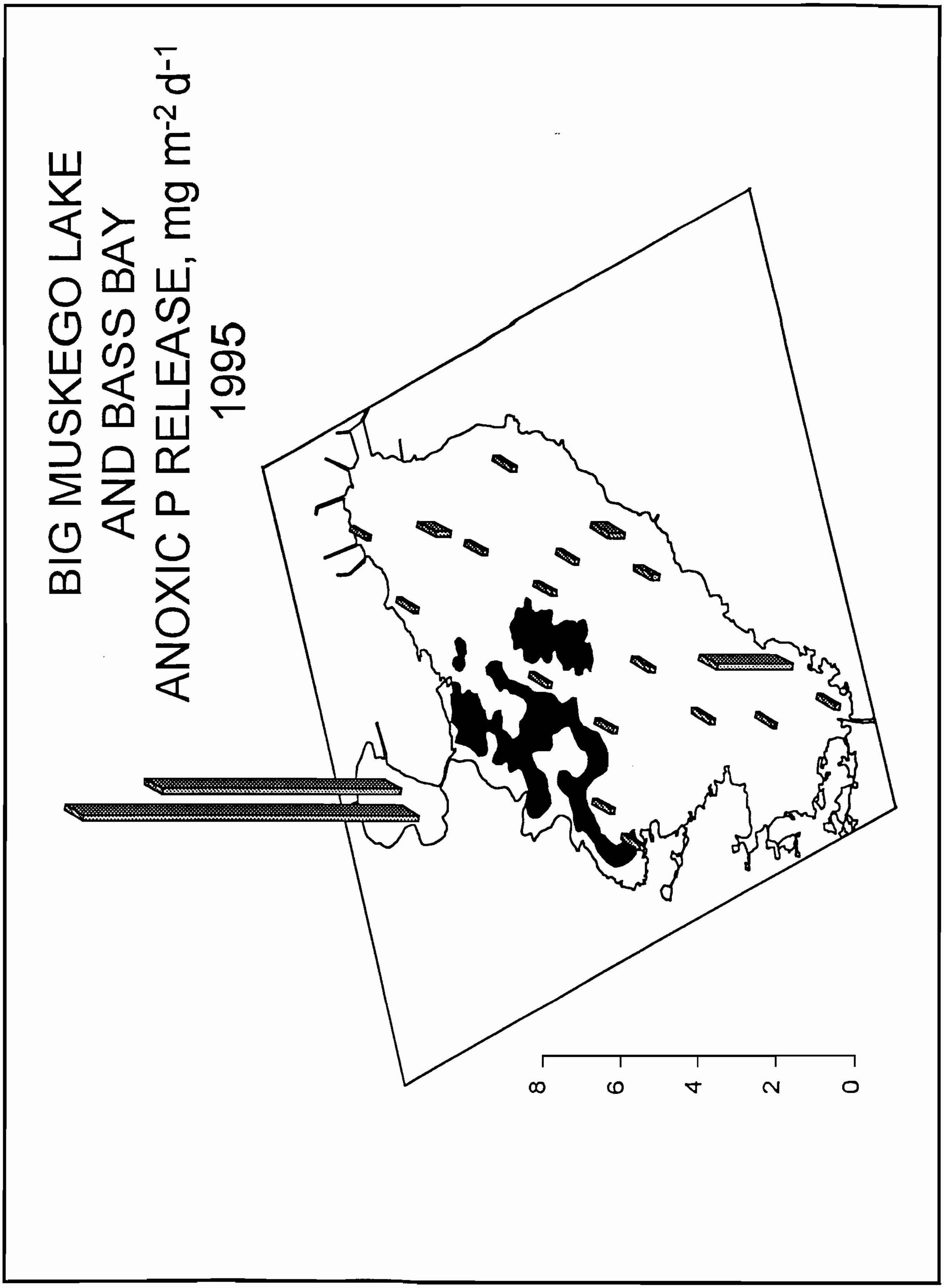
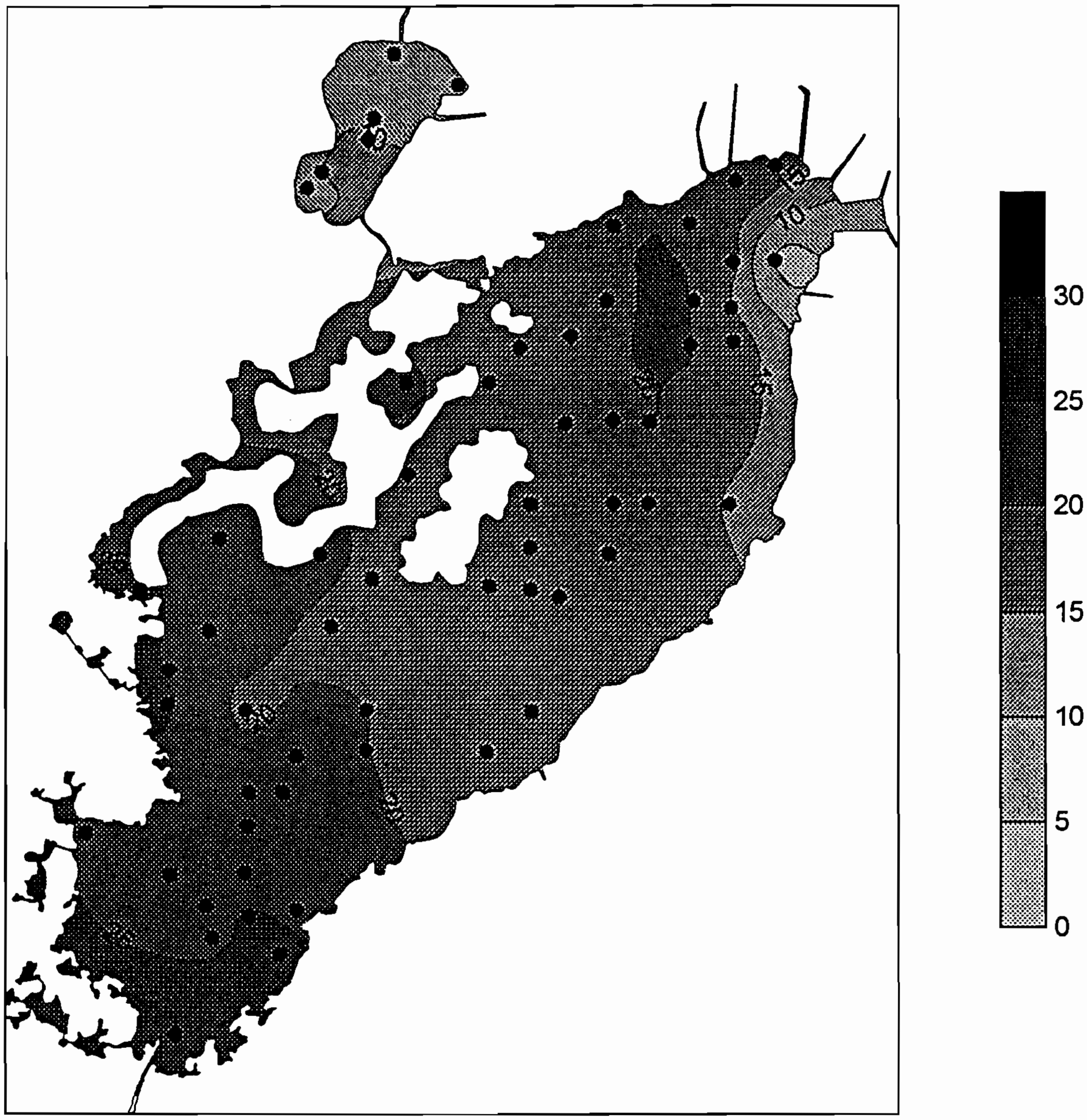

BIG MUSKEGO LAKE
AND BASS BAY
ANOXIC P RELEASE, mg m-2 d-1
1995
8
6
4
2
0

Figure 14

BIG MUSKEGO LAKE
TOTAL NITROGEN, mg/g
1995



BIG MUSKEGO LAKE
EXCHANGEABLE NITROGEN, mg/g
1995

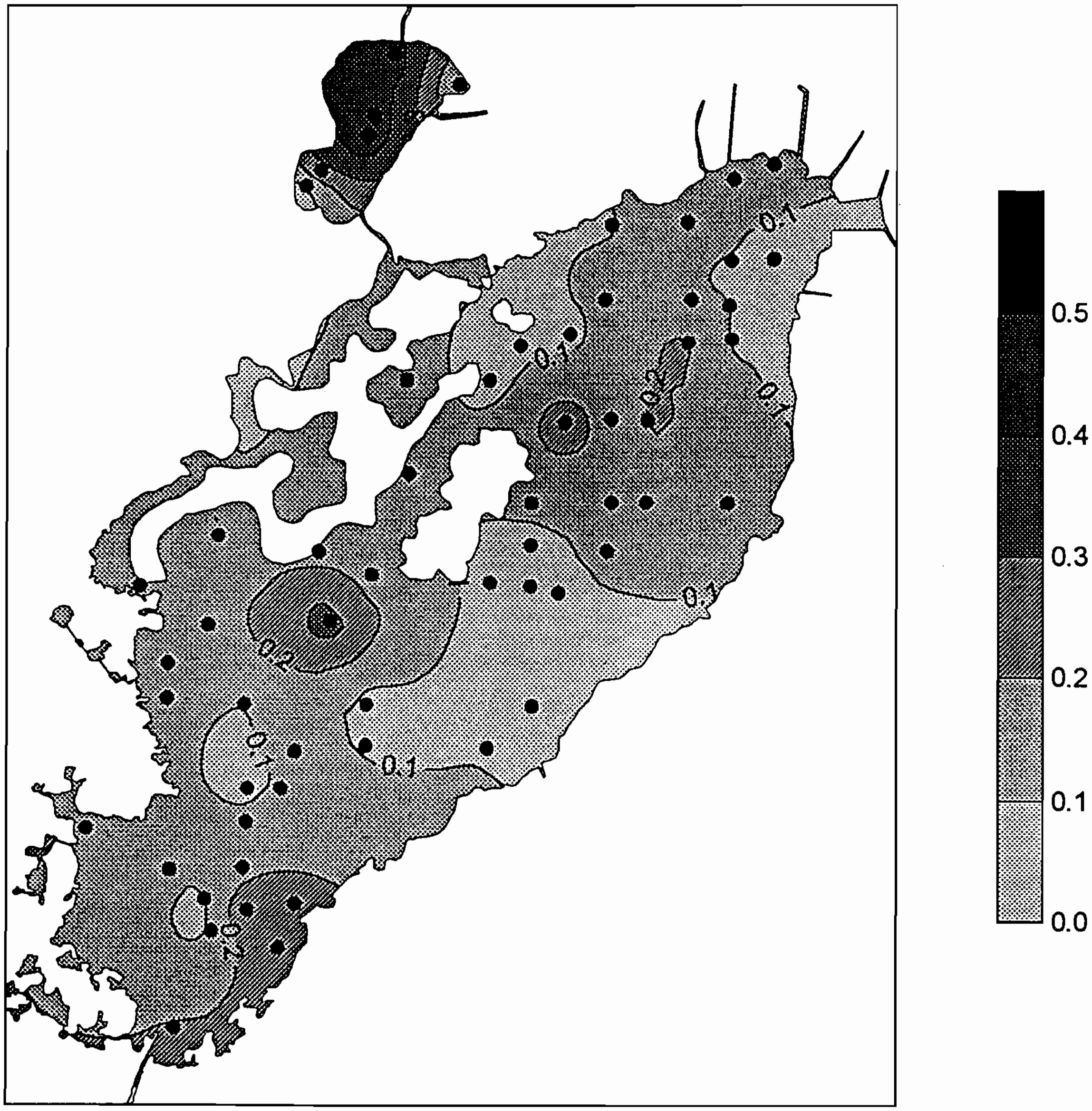


Figure 16

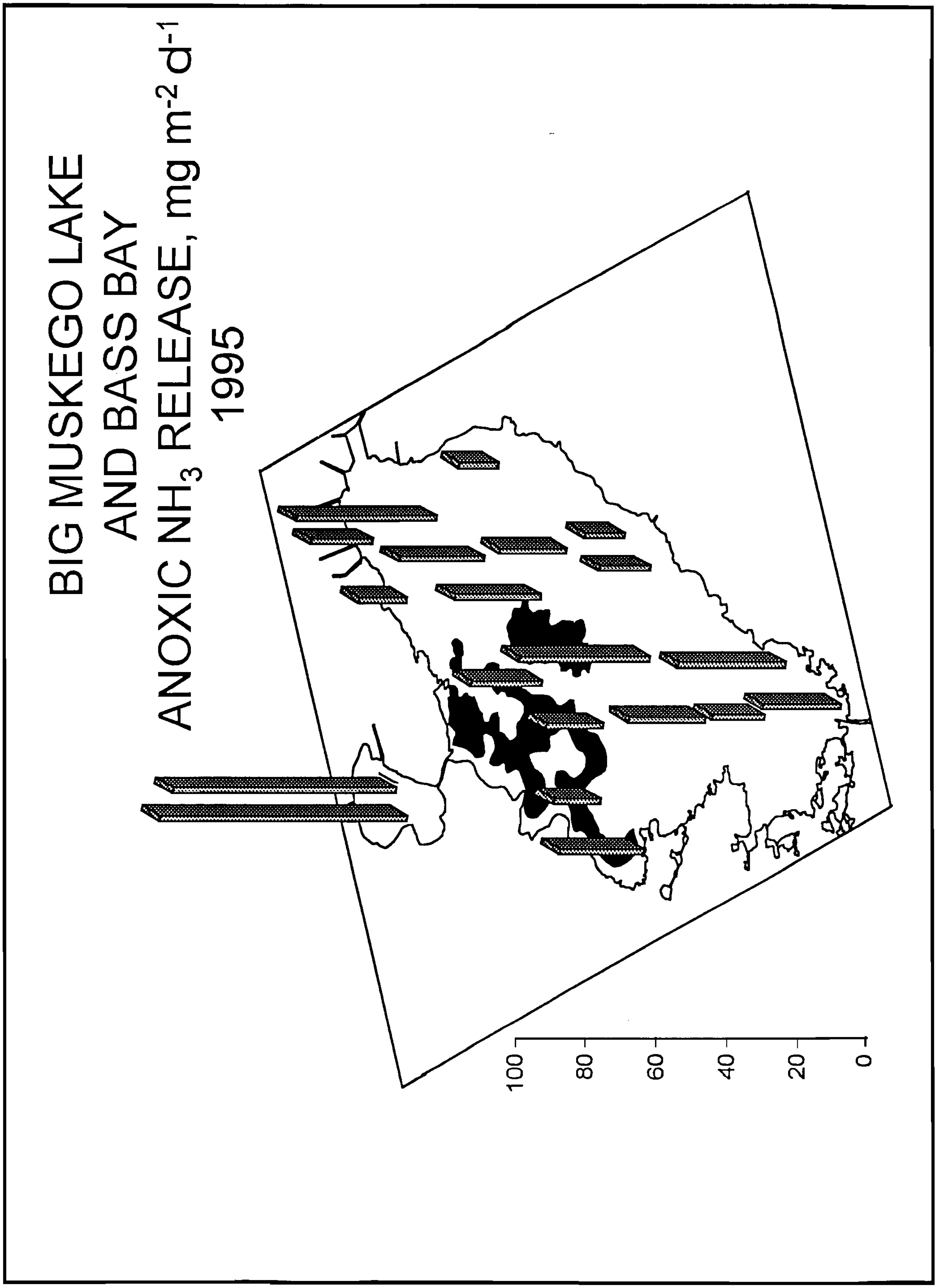

BIG MUSKEGO LAKE
AND BASS BAY
ANOXIC NH_3 RELEASE, mg m^{-2} d^{-1}
1995
100
80
60
40
20
0

Figure 17

WIND LAKE
MOISTURE CONTENT, %
1995

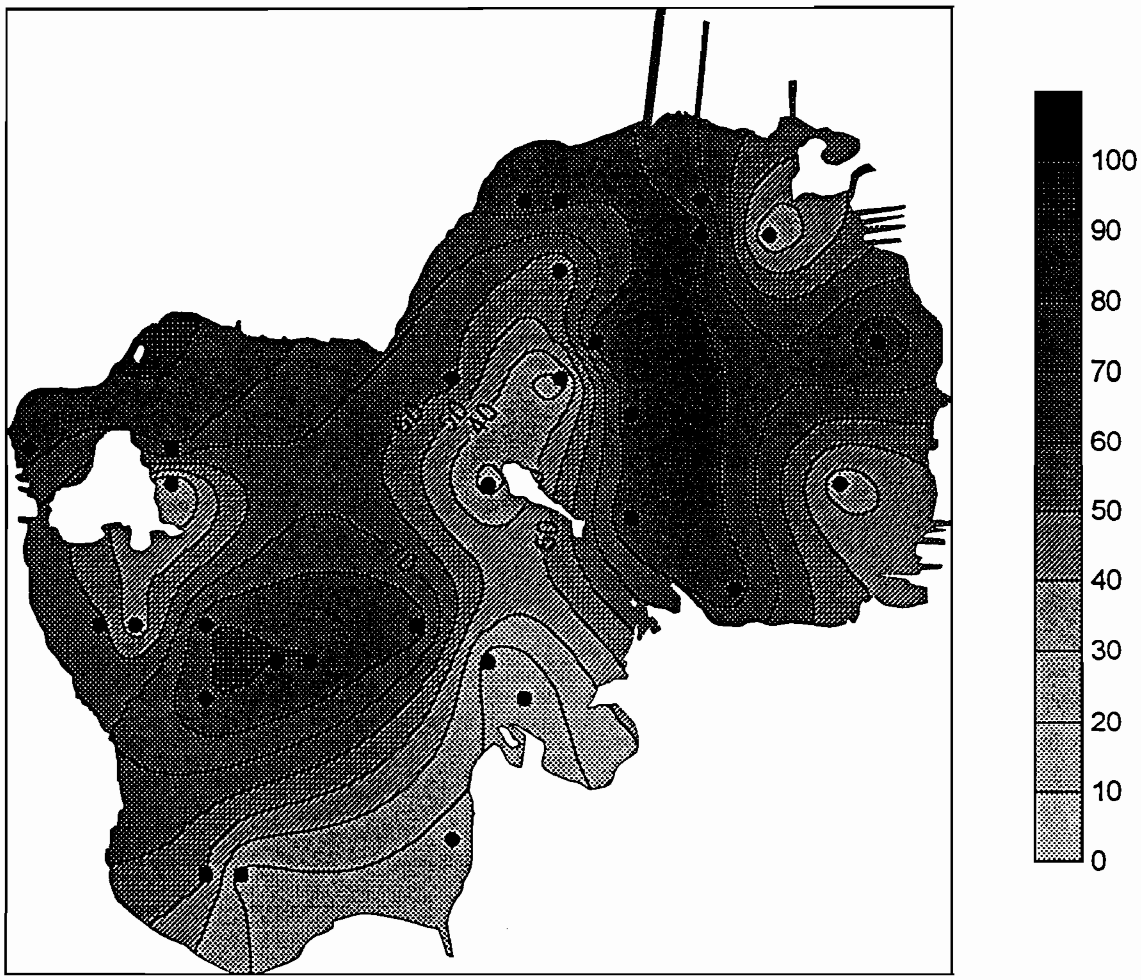


Figure 18

WIND LAKE
SEDIMENT ORGANIC MATTER, %
1995

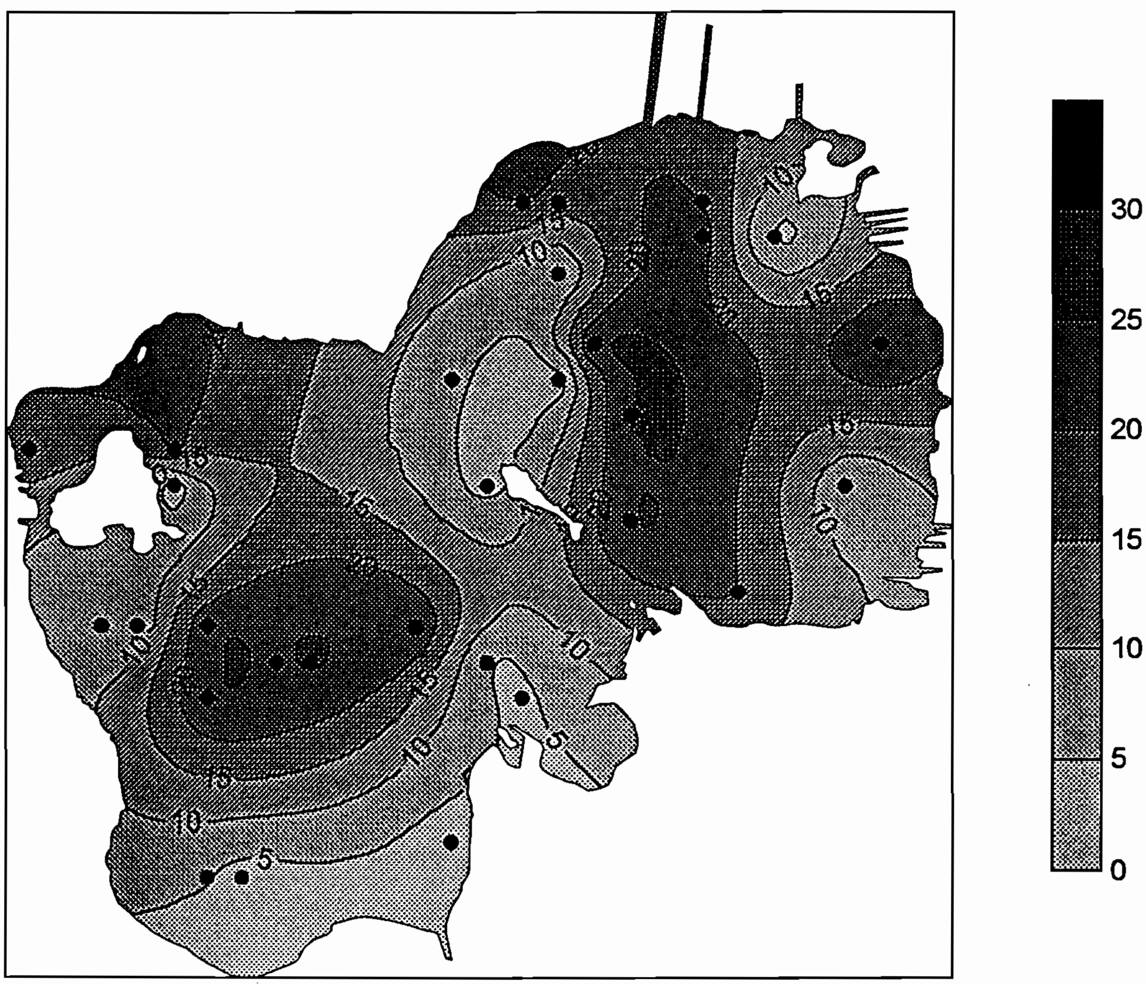


Figure 19

WIND LAKE
POREWATER PHOSPHORUS, mg/L
1995

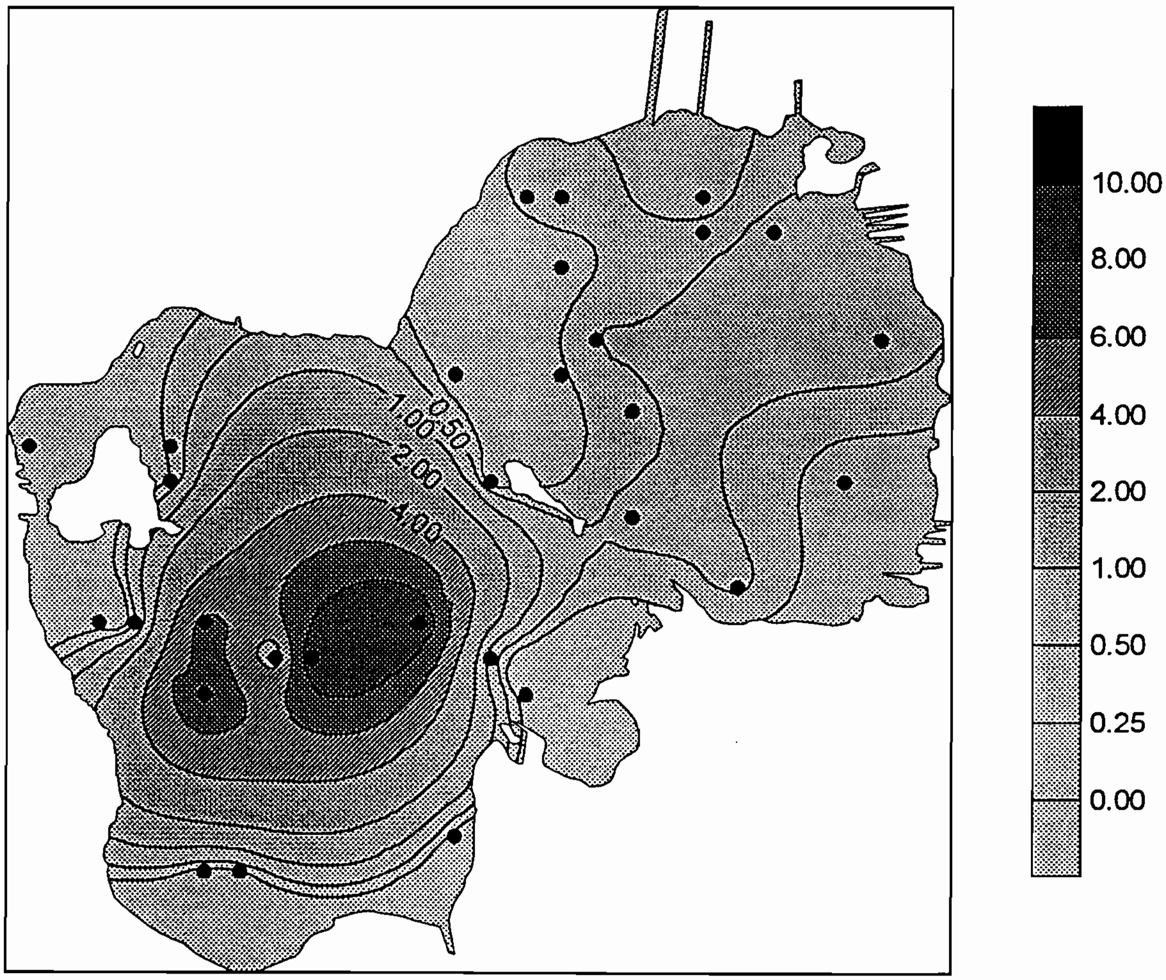


Figure 20

WIND LAKE
NH4Cl-EXTRACTABLE PHOSPHORUS, mg/g
1995

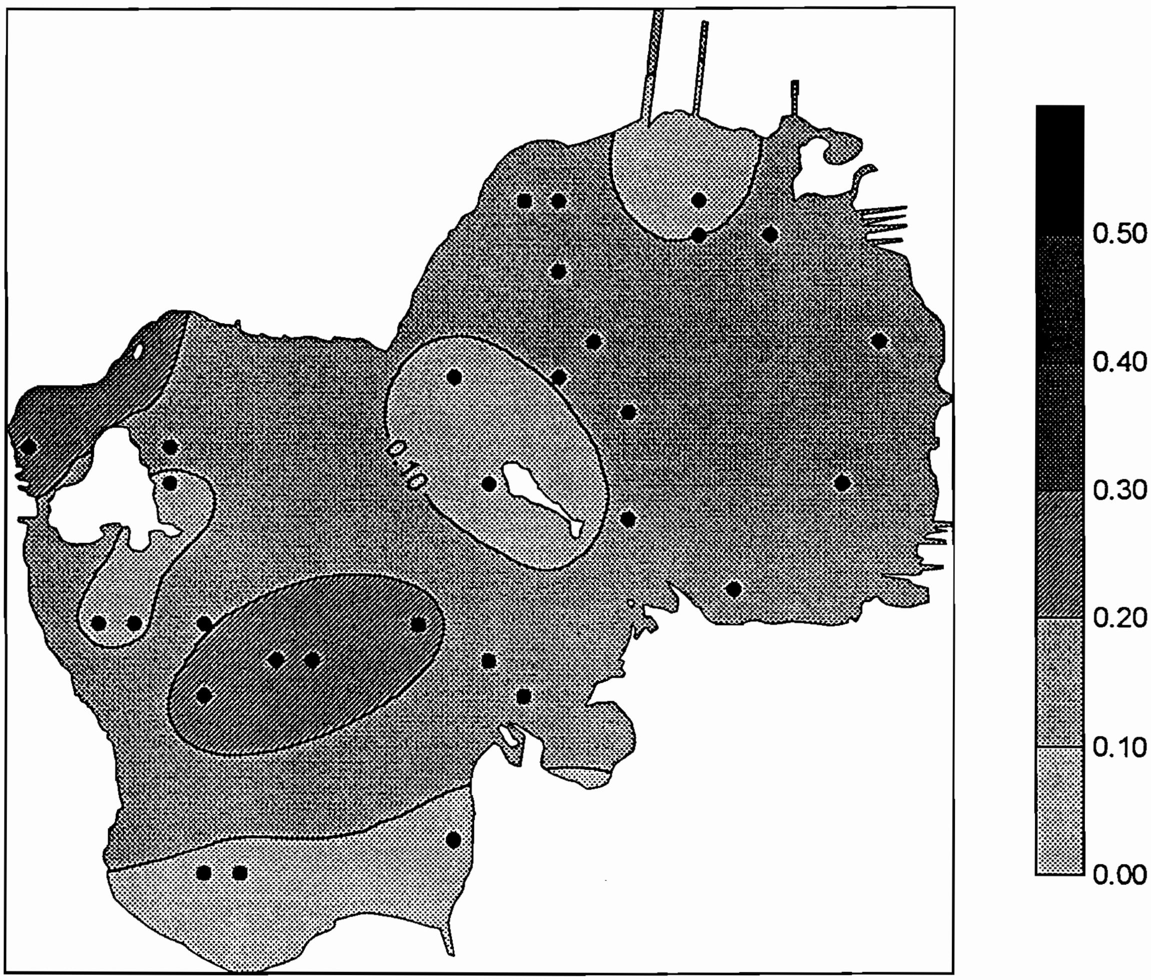


Figure 21

WIND LAKE
NaOH-EXTRACTABLE PHOSPHORUS, mg/g
1995

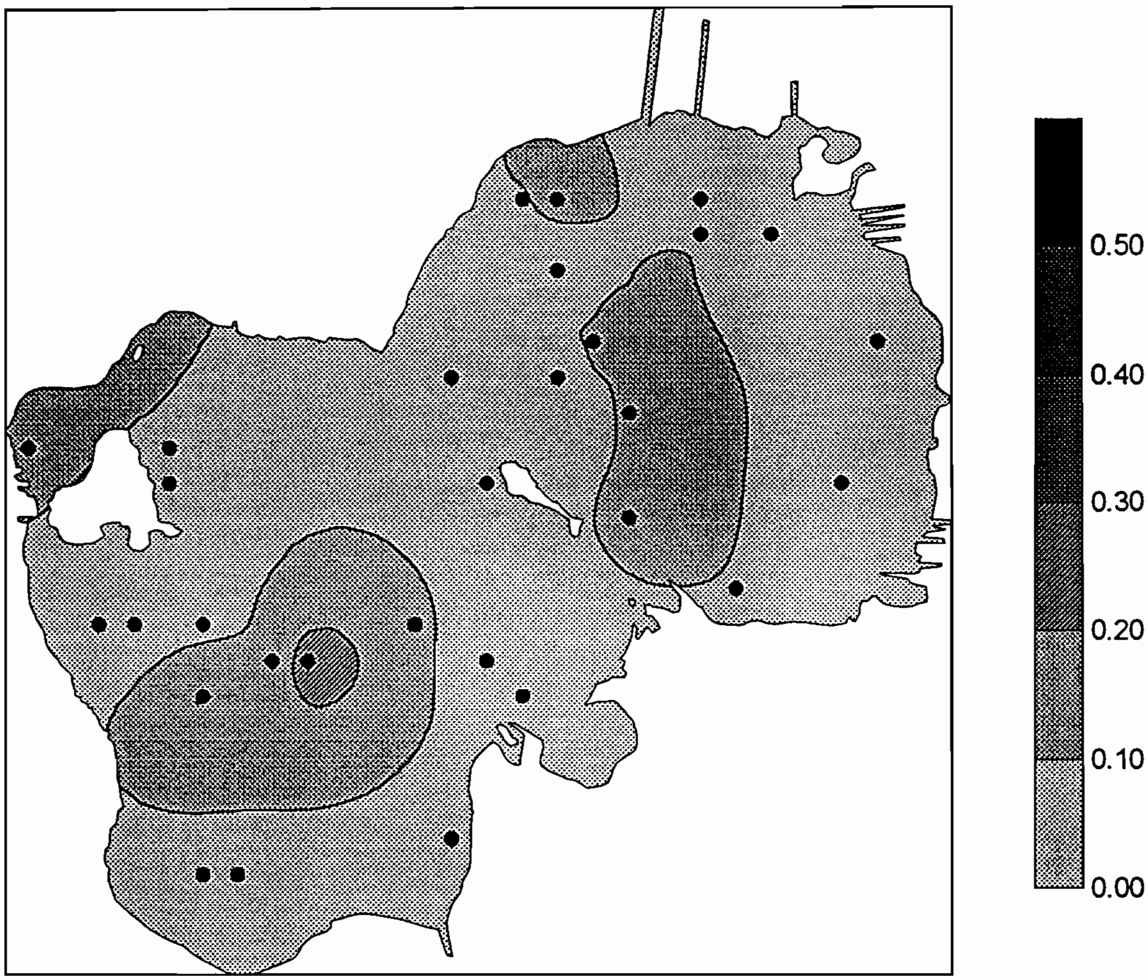


Figure 22

WIND LAKE
HCl-EXTRACTABLE PHOSPHORUS, mg/g
1995

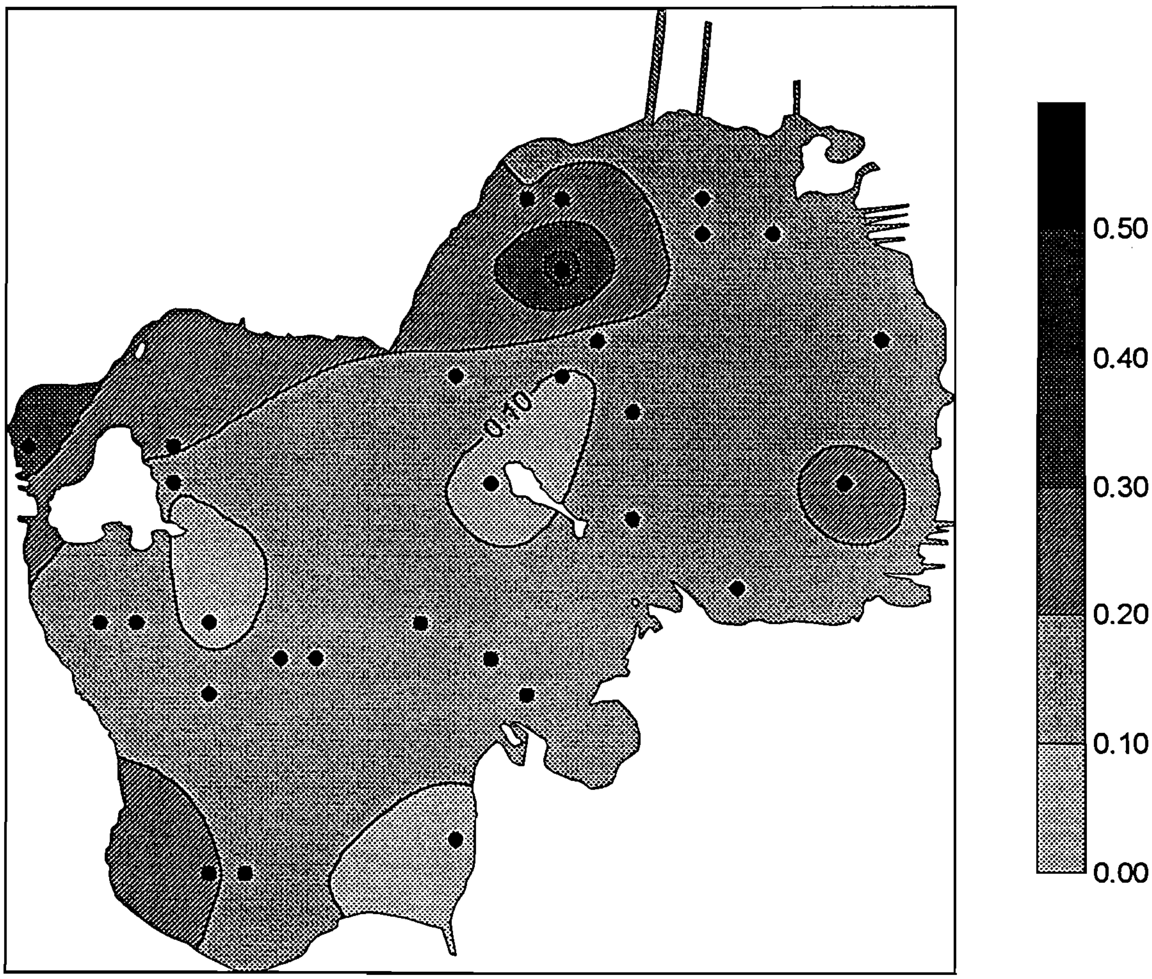


Figure 23

WIND LAKE
INORGANIC PHOSPHORUS, mg/g
1995

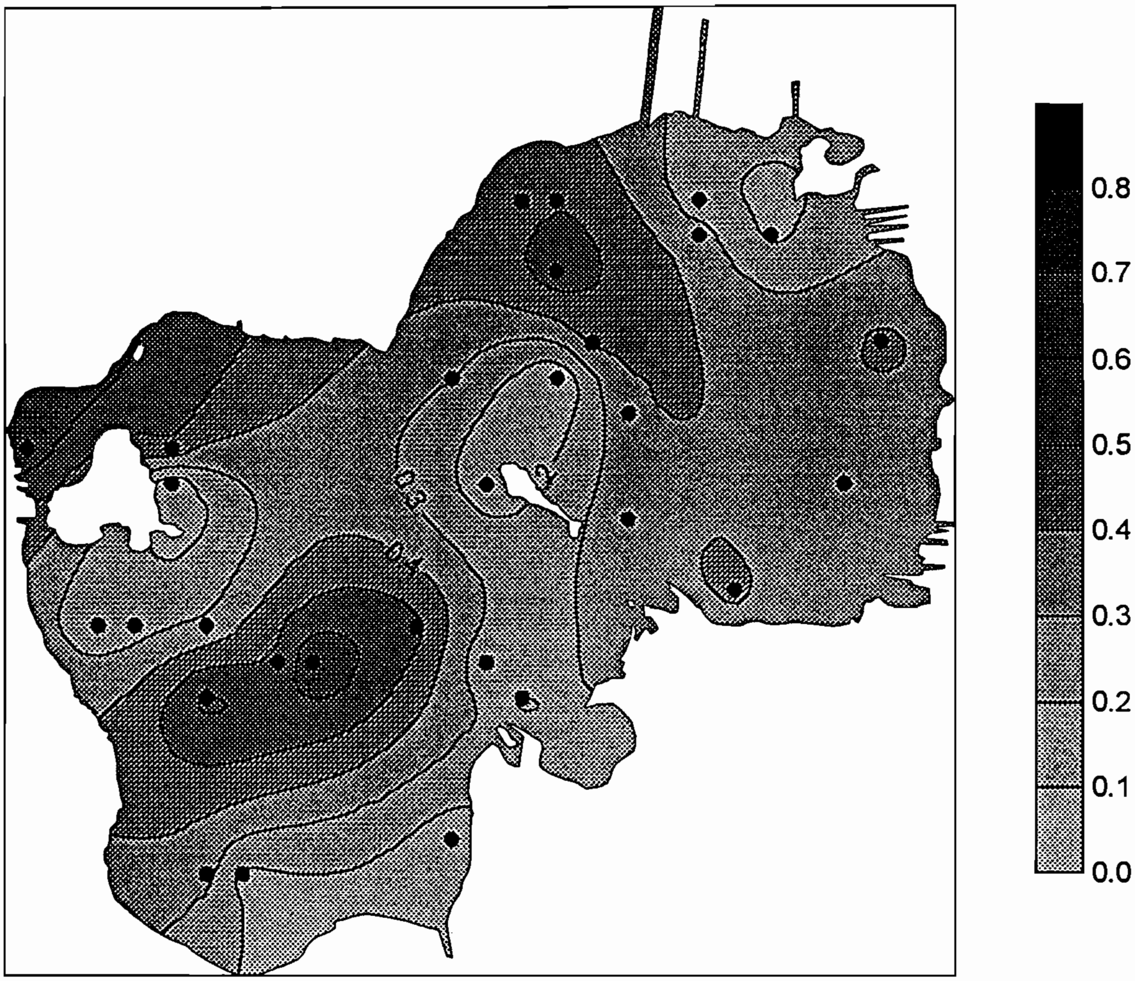


Figure 24

WIND LAKE
ORGANIC PHOSPHORUS, mg/g
1995

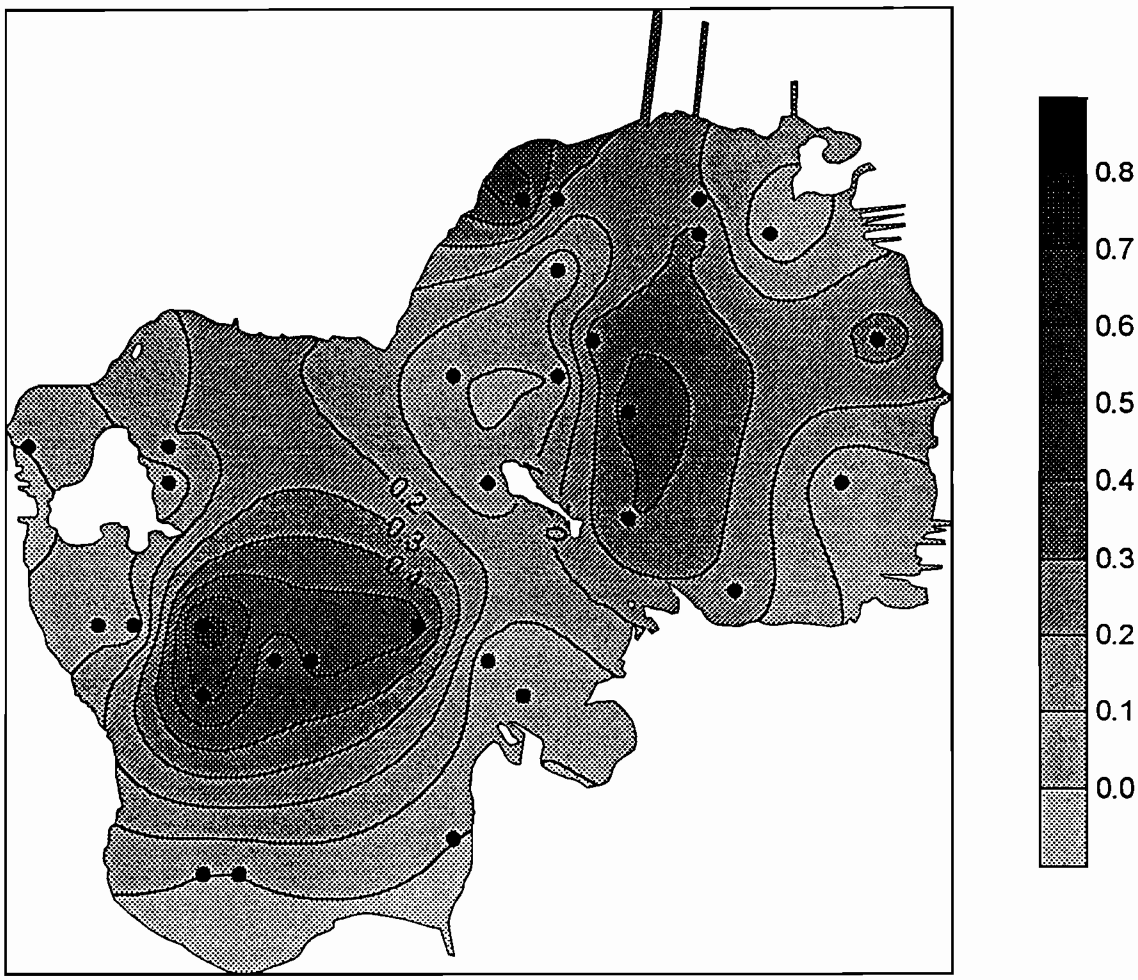


Figure 25

WIND LAKE
TOTAL PHOSPHORUS, mg/g
1995

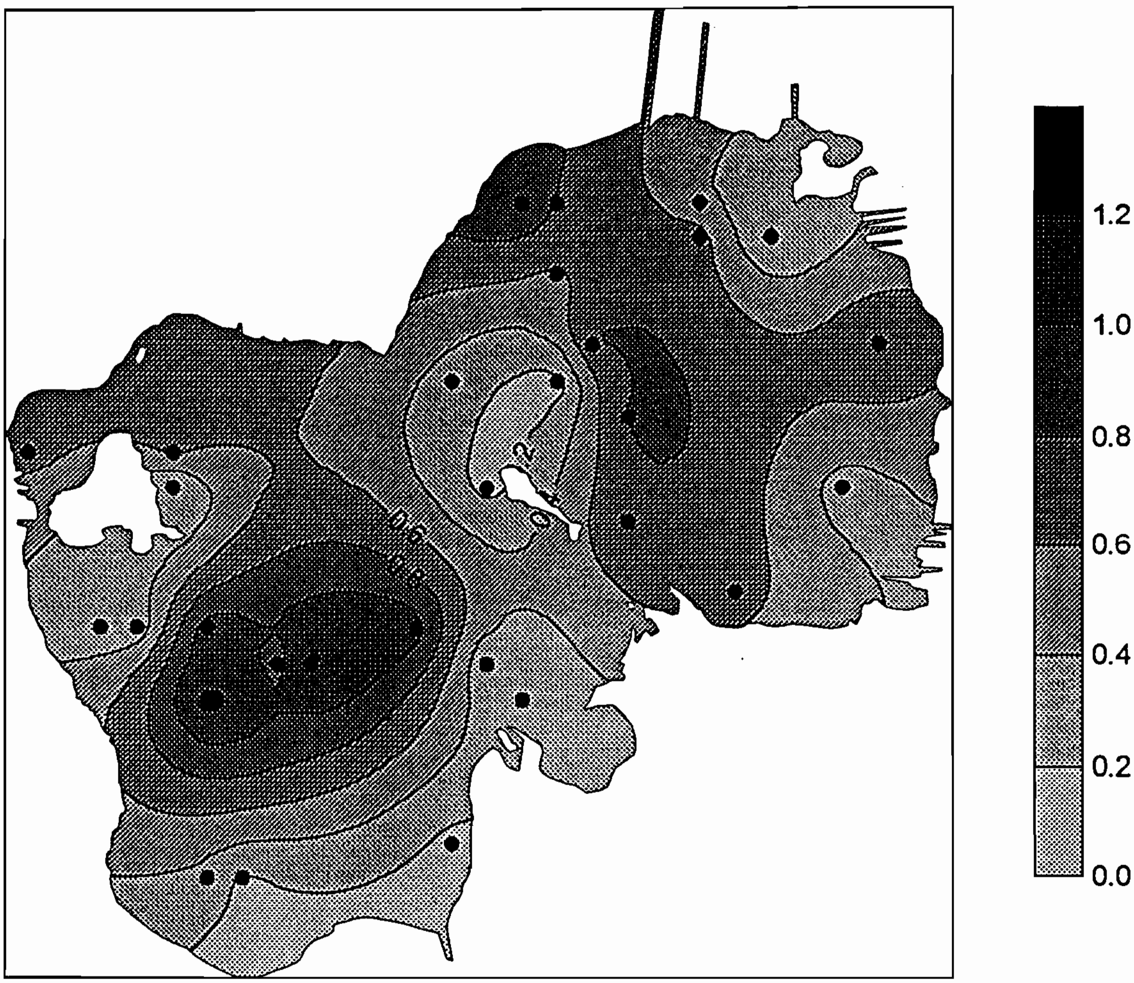


Figure 26

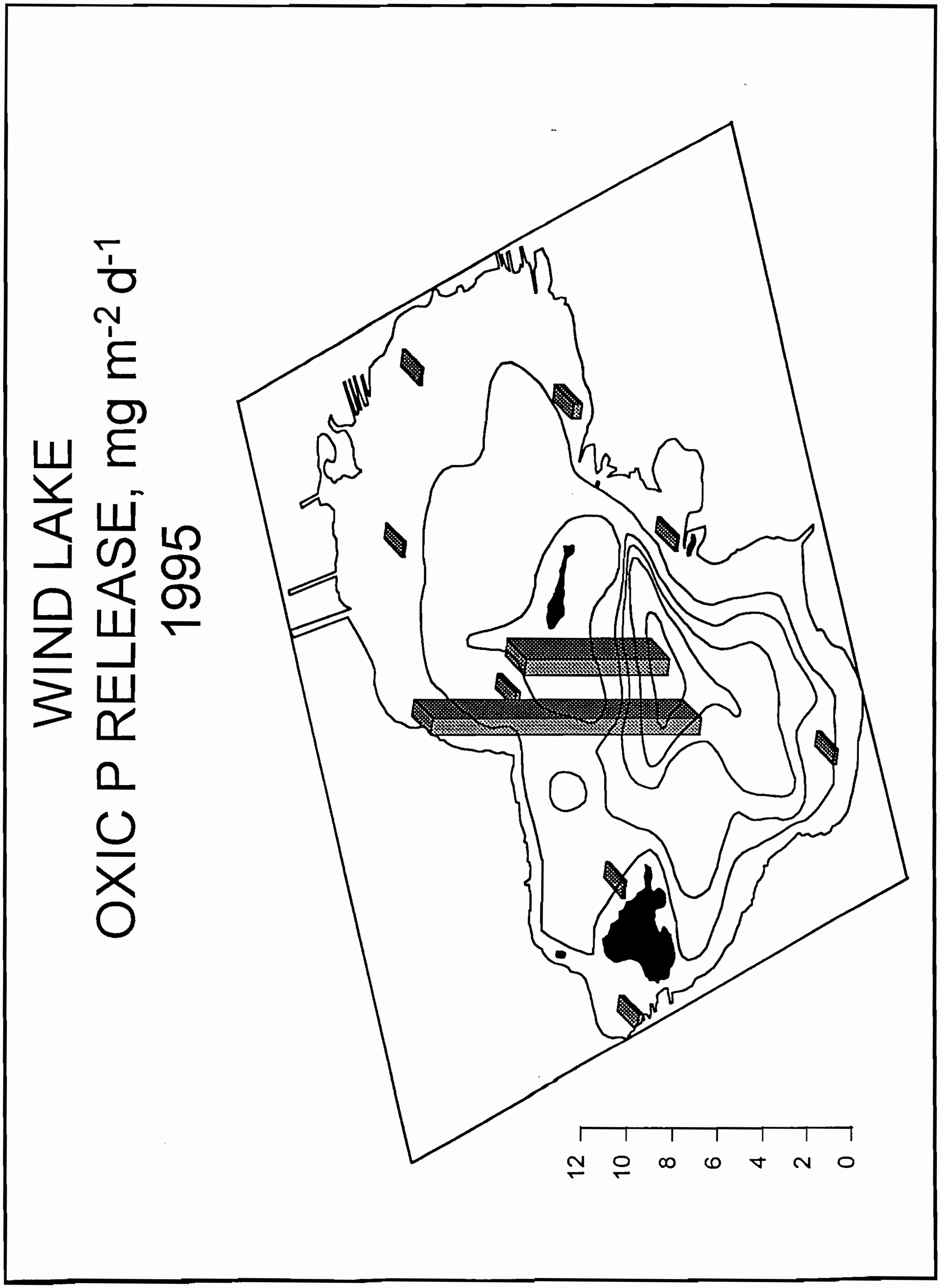


Figure 27

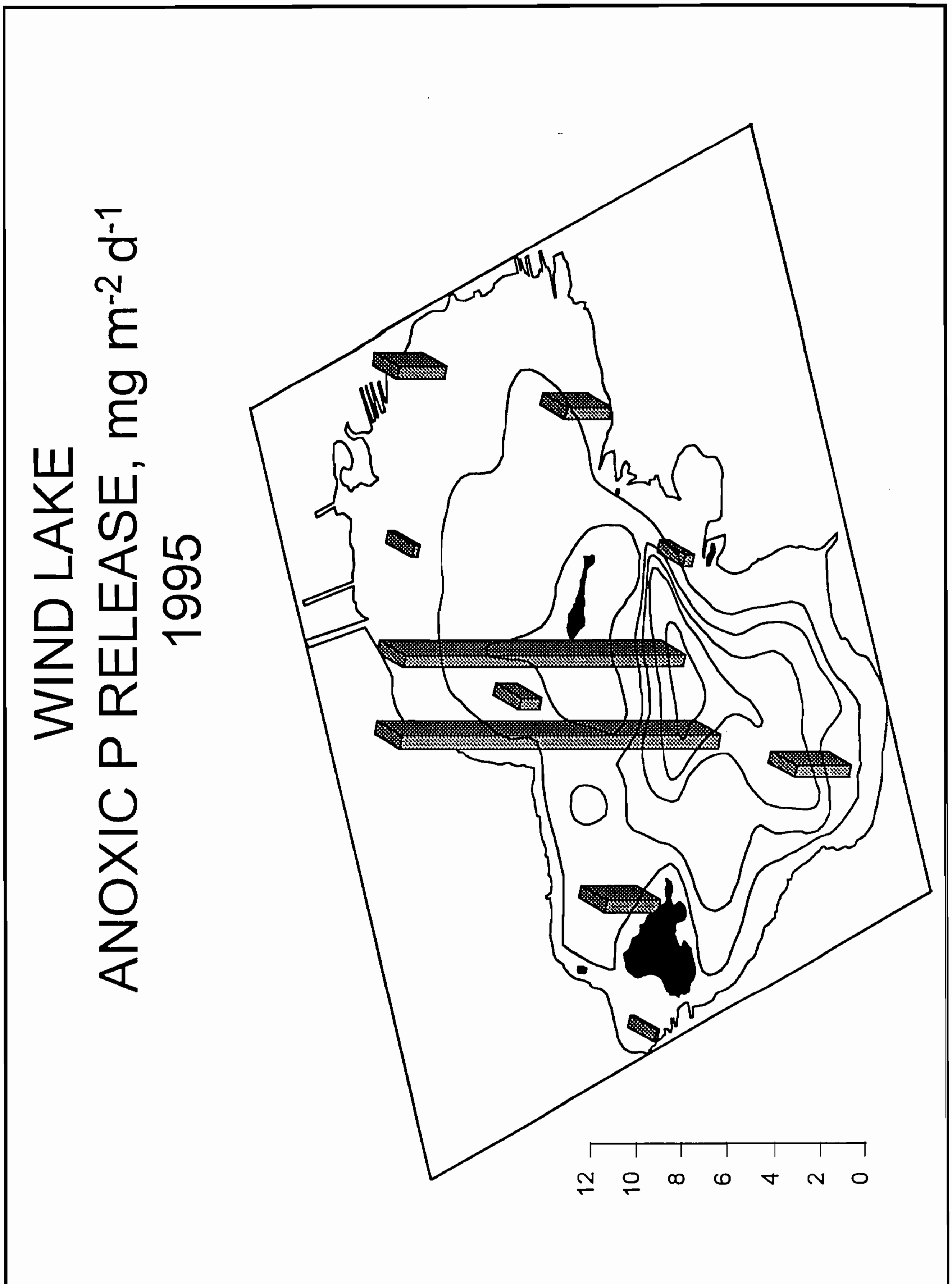
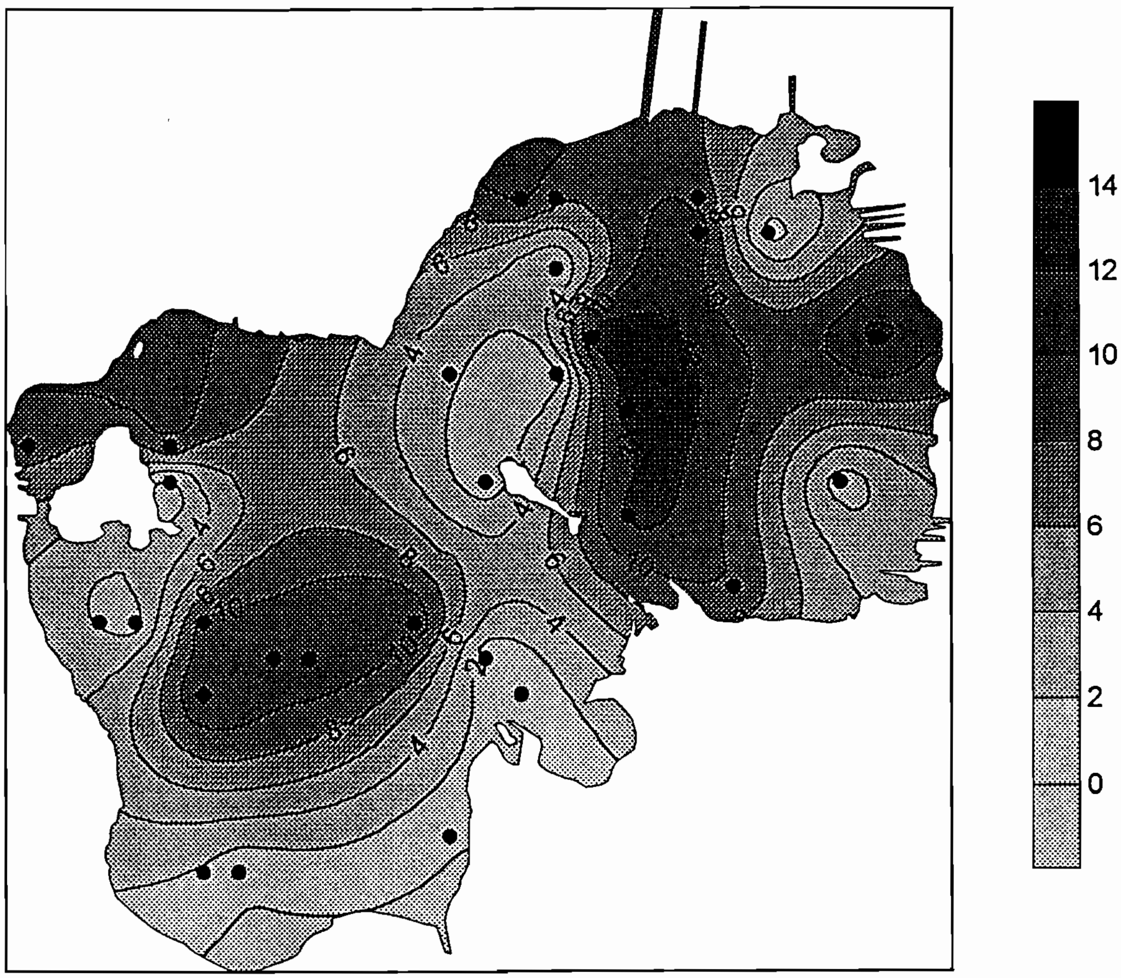


Figure 28

WIND LAKE
TOTAL NITROGEN, mg/g
1995



WIND LAKE
EXCHANGEABLE NITROGEN, mg/g
1995

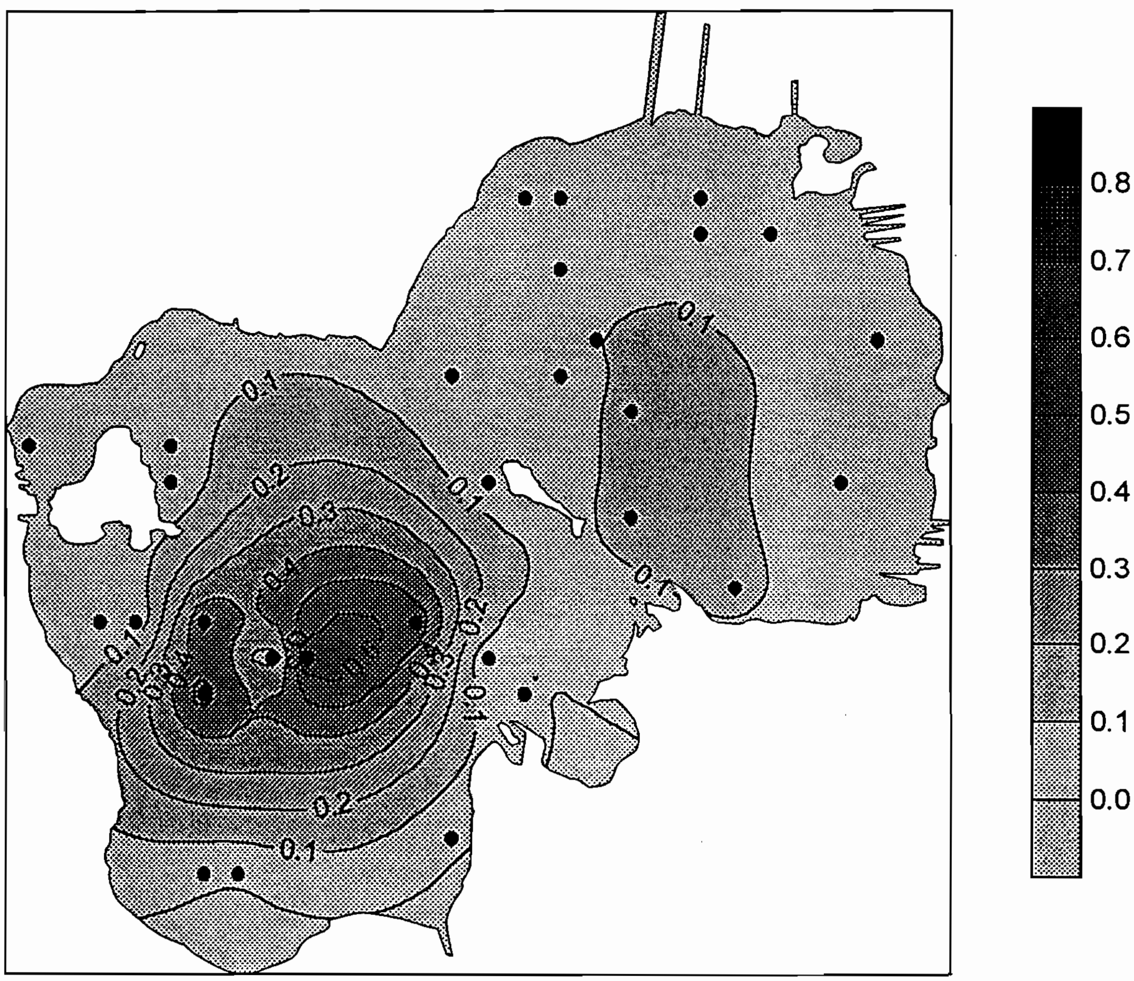
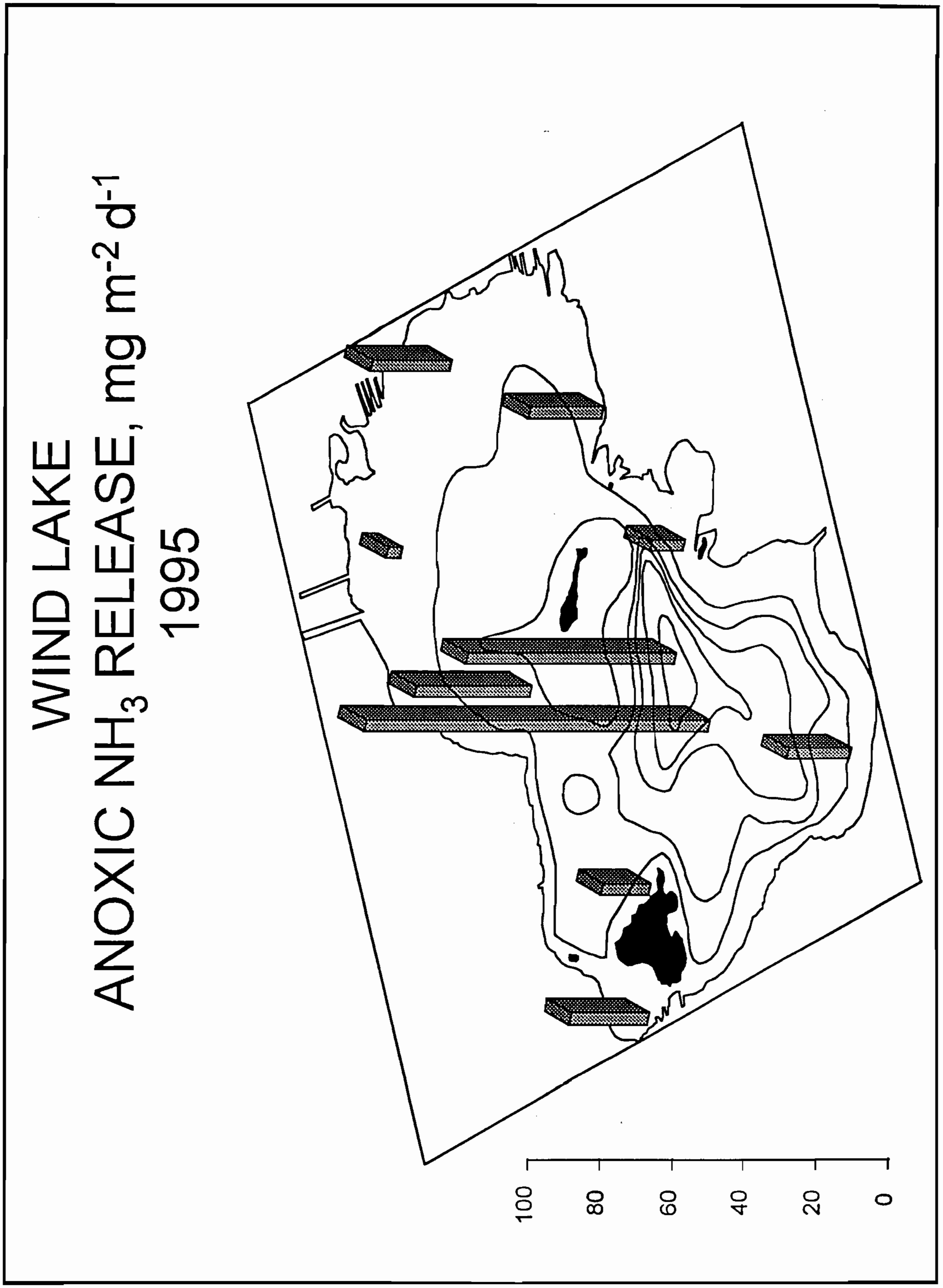


Figure 30



APPENDIX 1: Data Summaries for Big Muskego Lake, Bass Bay, and Wind Lake

Abbreviation List

Station	BM = Big Muskego Lake, BB = Bass Bay, WL = Wind Lake
P Oxic	Phosphorus release from sediments under oxic conditions
P Anoxic	Phosphorus release from sediments under anoxic conditions
N Anoxic	Ammonium-nitrogen release from sdiments under anoxic conditions
Porewater NH4	Porewater ammoniun-nitrogen
Porewater P	Porewater soluble reactive phosphorus
Porewater Ca	Porewater soluble calcium
Porewater Fe	Porewater soluble iron
POM	Sediment organic matter
B. Dens.	Sediment bulk density
Moisture	Sediment moisture content
NH4Cl-P	Sediment NH_4Cl-extractable phosphorus
NaOH-P	Sediment NaOH-extractable phosphorus
HCl-P	Sediment HCl-extractable phosphorus
Total-P	Sediment total phosphorus
Total-N	Sediment total nitrogen
EXCH-N	Sediment exchangeable nitrogen

SEDIMENT CHARACTERISTICS IN THE BIG MUSKEGO/WIND LAKE COMPLEX

STATION	DEPTH	SEDIMENT RELEASE			POREWATER				SEDIMENT								
		P OXIC	P ANOXIC	N ANOXIC	NH4	P	Ca	Fe	POM	B. DENS.	MOISTURE	NH4Cl-P	NaOH-P	HCl-P	TOTAL-P	TOTAL-N	EXCH-N
	m	$mg/m^2 d$	$mg/m^2 d$	$mg/m^2 d$	mg/L	mg/L	mg/L	mg/L	mg/g	g/ml	%	mg/g dw.	mg/g dw.	mg/g dw.	mg/g dw.	mg/g dw.	mg/g dw.
BM-4	0.6				8.11	0.007	82.56	0.025	0.518	0.0520	94.84	0.162	0.286	0.018	1.32	24.8	0.199
BM-9	0.65	0.036	0.099	23.4	5.14	0.005	68.96	0.023	0.518	0.0370	96.45	0.2	0.268	0.01	1.42	26	0.195
BM-11	0.5	0.018	0.093	22.6	4.89	0.004	74.62	0.041	0.505	0.0310	97.06	0.208	0.384	0.024	1.83	27.6	0.207
BM-14	0.85				6.58	0.011	84.12		0.437	0.0540	94.71	0.176	0.33	0.052	1.24	22.7	0.166
BM-17	0.55				3.01		65.72	0.015	0.57	0.0390	96.17	0.164	0.154	0.032	1.02	26	0.133
BM-18	0.8				6.33	0.002	72.86	0.009	0.562	0.0560	94.57	0.182	0.186	0.082	0.922	24.6	0.172
BM-24	0.9				2.21	0.002	96.2	0.026	0.454	0.0530	94.57	0.196	0.378	0.056	1.37	23.9	0.081
BM-25	1.05	0.018	0.081	14.8	0.77	0.004	61.2	0.007	0.465	0.0250	97.51	0.204	0.268	0.022	1.42	23.2	0.059
BM-31	0.8				6.41	0.002	74.96	0.018	0.465	0.0440	95.76	0.18	0.212	0.022	1.24	23.1	0.178
BM-33	1.1	0.018	0.099	13.1	2.44	0.002	59.46	0.009	0.478	0.0410	96.00	0.19	0.244	0.06	1.05	21.6	0.097
BM-37	0.8				10.5		82.24	0.017	0.452	0.0470	95.52	0.21	0.254	0.164	1.59	25.5	0.32
BM-38	0.9				5.67	0.004	78.64	0.006	0.467	0.0610	94.15	0.146	0.362	0.068	1.09	23.3	0.142
BM-39	0.9	0.027	0.118	21.8	5.44	0.005	71.98	0.009	0.452	0.0600	94.27	0.136	0.046	0.114	0.94	21.3	0.136
BM-40	0.8				2.52	0.005	63	0.037	0.487	0.0770	92.79	0.112	0.04	0.1	0.72	22.1	0.064
BM-42	1				5.32	0.023	67.88	0.012	0.411	0.0930	90.79	0.148	0.114	0.062	0.663	18.2	0.095
BM-50	0.55	0.018	1.905	30.6	6	0.005	70.36	0.012	0.547	0.0300	97.07	0.248	0.306	0.052	1.66	26.9	0.263
BM-51	0.65				8.22	0.005	88.44	0.017	0.466	0.0470	95.39	0.18	0.246	0.07	1.27	23.6	0.239
BM-54	0.7				5.82	0.056	78.78	0.009	0.588	0.0840	91.92	0.124	0.068	0.032	0.71	24.8	0.117
BM-55	0.75	0.017	0.145	37	4.58	0.012	71.32	0.034	0.48	0.0410	95.00	0.142	0.258	0.022	1.09	24.4	0.142
BM-63	1				3.66	0.005	66.44	0.026	0.42	0.1020	90.50	0.126	0.04	0.116	0.616	18.9	0.365
BM-65	0.9	0	0.118	16.1	7.06	0.007	72.72	0.023	0.463	0.0620	94.08	0.132	0.21	0.108	0.913	21.6	0.167
BM-72	0.75				3.55	0.009	73.08	0.013	0.462	0.0710	93.19	0.104	0.094	0.094	0.743	20	0.092
BM-73	0.95				2.13	0.007	81.9	0.007	0.47	0.0570	94.46	0.114	0.074	0.128	0.867	20.2	0.062
BM-74	0.85				5.79	0.007	72.3	0.015	0.435	0.0680	93.41	0.14	0.202	0.082	0.886	18.8	0.146
BM-84	0.9	0.036	0.118	20.2	4.44	0.009	65.56		0.437	0.0850	91.77	0.154	0.142	0.036	0.628	17.4	0.099
BM-85	0.8				5.5	0.011	67.26	0.023	0.5	0.0520	95.04	0.136	0.21	0.082	0.968	21.7	0.143
BM-92	0.6	0.045	0.203	14.4	4.35	0.642	74.3	0.063	0.367	0.0910	91.31	0.116	0.12	0.11	0.667	14.5	0.096
BM-96	1				8.78	0.092	70.6	0.034	0.426	0.0890	91.53	0.112	0.2	0.086	0.867	18.9	0.089
BM-99	1.15				4.06	0.012	64	0.015	0.362	0.1240	87.99	0.118	0.042	0.104	0.584	15.7	0.063
BM-103	1.05	0.027	0.404	11.2	1.94	0.009	71.14	0.027	0.479	0.1260	88.09	0.092	0.072	0.084	0.448	19	0.048
BM-106	1.1				2.83		63.06	0.017	0.431	0.1420	86.59	0.178	0.054	0.058	0.619	18.7	0.056
BM-107	0.9				2.82	0.014	65.56	0.009	0.443	0.1160	89.36	0.132	0.12	0.096	0.58	18.8	0.067
BM-108	0.8	0.018	0.118	24.5	3.19	0.009	63.2	0.022	0.419	0.0450	95.70	0.152	0.228	0.032	0.969	20.1	0.127
BM-119	0.8				8.05	0.009	80.74	0.027	0.427	0.0480	95.43	0.18	0.206	0.04	1.13	20.3	0.264
BM-121	1.1				2.14	0.009	55.3	0.038	0.447	0.1090	89.73	0.12	0.086	0.07	0.506	18.6	0.066

BM-124	0.65	0.036	0.099	18.8	4.15	0.019	88.46	0.076	0.443	0.1080	89.60	0.112	0.07	0.026	0.607	18.7	0.091
BM-126	0.77				3.31	0.007	82.6	0.027	0.429	0.0580	94.35	0.16	0.21	0.048	1	20.2	0.115
BM-127	1.3				4.9	0.009	64.64	0.007	.474	0.0910	91.10	0.12	0.14	0.1	0.667	18.7	0.129
BM-129	0.95	0.018	0.099	24.2	3.13	0.005	65.84	0.018	0.424	0.0410	96.03	0.134	0.26	0.058	1.08	18.7	0.14
BM-131	1				4.22	0.007	65.16	0.02	0.38	0.1340	87.62	0.112	0.07	0.112	0.71	16.7	0.085
BM-132	1				4.95	0.007	68.82	0.021	0.426	0.0660	93.69	0.11	0.158	0.126	0.857	19	0.148
BM-134	0.85	0.018	0.099	13.7	3	0.007	79.42	0.027	0.47	0.0670	93.48	0.142	0.21	0.066	0.811	19.7	0.093
BM-138	0.85				5.27	0.007	82.06	0.01	0.441	0.0820	92.11	0.194	0.106	0.028	0.712	18.7	0.14
BM-140	0.8				6.81	0.011	77.58	0.012	0.423	0.0460	95.43	0.192	0.284	0.102	1.19	20.2	0.218
BM-152	1.1	0.127	0.383	40.4	7.74	0.012	86.46	0.015	0.42	0.0450	95.59	0.13	0.274	0.1	1.25	20.2	0.221
BM-153	1.05				4.39	0.007	64.46	0.01	0.541	0.0990	90.82	0.102	0.088	0.044	0.597	20.2	0.098
BM-155	0.85				5.38	0.009	75.12	0.02	0.418	0.0640	93.86	0.112	0.228	0.01	1	19.3	0.134
BM-157	0.8	0.154	0.139	11.4	7.03	0.009	76.16	0.02	0.323	0.0980	90.60	0.106	0.166	0.104	0.671	14.3	0.121
BM-161	0.95				4.01	0.009	66.12	0.022	0.487	0.1160	88.88	0.108	0.062	0.042	0.59	18.3	0.083
BM-162	1.1				4.14	0.007	77.72	0.021	0.353	0.0550	94.61	0.142	0.174	0.114	0.87	15.2	0.107
BM-163	1	0.036	0.099	17.7	3.5	0.007	71.4	0.017	0.379	0.0640	93.93	0.156	0.13	0.096	0.848	17	0.096
BM-165	0.95				6.24	0.009	73.94	0.027	0.416	0.0430	95.80	0.166	0.282	0.07	1.13	19.7	0.203
BM-171	1.07				3.95	0.007	84.92	0.418	0.058	0.5170	61.09	0.02	0.062	0.01	0.229	1.63	0.031
BM-173	1				5.4	0.007	72.18	0.027	0.421	0.0630	93.96	0.118	0.164	0.034	0.929	18.5	0.158
BB-20	1.1				10.6	0.352	83.3	0.084	0.1373	0.2560	78.03	0.17	0.082	0.176	0.701	5.915	0.069
BB-21	1.15				5.02	0.021	97.88	0.143	0.1625	0.2180	80.81	0.166	0.108	0.134	0.779	7.458	0.049
BB-22	5.15				19.8	2.455	91.86	0.053	0.2231	0.1730	83.74	0.282	0.114	0.092	1.343	10.069	0.278
BB-23	6.9				32.5	5.157	111.18	0.044	0.2013	0.1670	84.52	0.304	0.152	0.08	0.94	9.388	0.459
BB-24	6	4.66	8.6	71.8	26.5	4.33	100.32	0.058	0.2094	0.1410	87.16	0.32	0.102	0.008	0.949	9.431	0.453
BB-25	6.95	3.41	6.08	64.7	32	4.312	106.34	0.059	0.2244	0.1220	88.41	0.356	0.152	0.056	1.035	10.537	0.477
WL-15	1.9	0.14	2.14	17	7.62	0.088	92.14	0.013	0.0581	0.6610	52.96	0.08	0.052	0.246	0.343	1.763	0.025
WL-16	1.1					0.139			0.0219	1.3370	25.29	0.054	0.028	0.116	0.173	0.339	0.009
WL-32	0.6					0.044			0.0249	1.3450	26.29	0.062	0.04	0.066	0.142	0.255	0.015
WL-72	11.6				38.9	8.202	104.74	0.094	0.2518	0.0950	90.68	0.262	0.214	0.16	1.282	12.383	0.558
WL-81	6.6	0.1	0.33	9.3	2.58	0.069	57.3	0.186	0.0435	1.4340	23.53	0.124	0.062	0.156	0.31	0.59	0.006
WL-89	7.6				10.5	2.235	76.3	0.025	0.2423	0.1020	89.88	0.258	0.102	0.148	0.89	10.342	0.178
WL-90	14	11.8	12.19	96	54.7	10.226	112.2	0.279	0.2562	0.1010	90.06	0.246	0.272	0.176	1.242	11.752	0.716
WL-95	6.3					0.285			0.0369	1.4320	23.82	0.116	0.032	0.112	0.219	0.45	0.005
WL-100	2.1				3.95	0.083	69.82	0.122	0.0525	0.4390	64.94	0.088	0.026	0.12	0.315	1.911	0.017
WL-101	1.4				1.11	0.011	96.82	0.083	0.0591	0.9190	40.7	0.072	0.038	0.17	0.258	0.898	0.01
WL-103	11.3				33.4	6.758	93:56	0.1	0.2459	0.1010	90.28	0.192	0.07	0.052	1.118	10.856	0.502
WL-109	12.5	6.24	10.76	57.9	48.8	9.944	119.88	0.116	0.255	0.1150	88.99	0.248	0.124	0.162	1.094	12.09	0.587
WL-135	2.7	0.36	1.67	20.2	9.37	0.588	88.8	0.053	0.2033	0.1660	84.83	0.158	0.096	0.158	0.687	9.978	0.127
WL-168	3.3				7.27	0.621	66.04	0.038	0.2565	0.1080	89.61	0.108	0.124	0.144	0.785	12.655	0.129
WL-176	1.05	0.095	2.07	13.1		0.178			0.0235	1.4300	22.75	0.048	0.026	0.094	0.112	0.336	0.009

WL-184	1				8.98	0.035			0.0293	1.3710	25.09	0.036	0.04	0.07	0.138	0.639	0.019
WL-193	0.8				2.05	0.012	101.46	4.001	0.0511	1.1470	32.75	0.104	0.064	0.222	0.316	0.774	0.016
WL-196	1.6	0.181	0.127	21.3	6.1	0.31	70.92	0.139	0.1834	0.1730	83.63	0.266	0.158	0.338	0.669	9.047	0.084
WL-198	3.5				4.09	0.306	56.98	0.034	0.2068	0.1640	85.41	0.178	0.082	0.234	0.695	10.511	0.071
WL-223	3.5				7.96	0.447	58.8	0.07	0.2586	0.1170	88.63	0.126	0.11	0.144	0.837	13.233	0.149
WL-251	1.6	0.171	0.738	32.8	6.36	0.023	67.88	0.193	0.0635	0.4860	62.79	0.072	0.058	0.174	0.315	2.444	0.028
WL-254	0.73								0.0137	1.4020	21.96	0.106	0.026	0.074	0.093	0.342	0.006
WL-272	3.4				6.26	0.539	55.4	0.048	0.2611	0.1230	88.28	0.154	0.13	0.144	0.806	13.343	0.104
WL-280	3.2	0.108	1.81	22.2	5.91	0.708	63.62	0.043	0.2562	0.1220	88.42	0.194	0.088	0.138	0.772	13.114	0.098
WL-299	2.3				2.47	0.069	59.02	0.083	0.0364	0.7230	50.42	0.146	0.026	0.472	0.559	1.193	0.009
WL-315	2.7				6.43	0.4	65	0.036	0.2286	0.1590	85.24	0.102	0.1	0.152	0.676	11.416	0.082
WL-317	1.65				7.2	0.642			0.0196	1.2260	29.08	0.156	0.02	0.154	0.177	0.676	0.008
WL-320	2.5				4.38	0.299	62.76	0.057	0.212	0.1450	86.21	0.156	0.09	0.204	1.027	10.828	0.055
WL-321	2.8				6.82	0.417	70.72	0.067	0.17	0.1830	82.81	0.13	0.138	0.23	0.752	8.328	0.074
WL-325	1.05	0.09	0.241	3.9	2.18	0.046	87.58	0.119	0.2036	0.2970	73.9	0.04	0.042	0.14	0.439	9.427	0.024

APPENDIX 1: Data Summaries for Big Muskego Lake, Bass Bay, and Wind Lake

Abbreviation List

Station	BM = Big Muskego Lake, BB = Bass Bay, WL = Wind Lake
P Oxic	Phosphorus release from sediments under oxic conditions
P Anoxic	Phosphorus release from sediments under anoxic conditions
N Anoxic	Ammonium-nitrogen release from sdiments under anoxic conditions
Porewater NH4	Porewater ammoniun-nitrogen
Porewater P	Porewater soluble reactive phosphorus
Porewater Ca	Porewater soluble calcium
Porewater Fe	Porewater soluble iron
POM	Sediment organic matter
B. Dens.	Sediment bulk density
Moisture	Sediment moisture content
NH4Cl-P	Sediment NH_4Cl-extractable phosphorus
NaOH-P	Sediment NaOH-extractable phosphorus
HCl-P	Sediment HCl-extractable phosphorus
Total-P	Sediment total phosphorus
Total-N	Sediment total nitrogen
EXCH-N	Sediment exchangeable nitrogen

SEDIMENT CHARACTERISTICS IN THE BIG MUSKEGO/WIND LAKE COMPLEX

STATION	DEPTH	SEDIMENT RELEASE P OXIC	SEDIMENT RELEASE P ANOXIC	SEDIMENT RELEASE N ANOXIC	POREWATER NH4	POREWATER P	POREWATER Ca	POREWATER Fe	SEDIMENT POM	SEDIMENT B. DENS.	SEDIMENT MOISTURE	SEDIMENT NH4Cl-P	SEDIMENT NaOH-P	SEDIMENT HCl-P	SEDIMENT TOTAL-P	SEDIMENT TOTAL-N	SEDIMENT EXCH-N
	m	$mg/m^2 d$	$mg/m^2 d$	$mg/m^2 d$	mg/L	mg/L	mg/L	mg/L	mg/g	g/ml	%	mg/g dw.	mg/g dw.	mg/g dw.	mg/g dw.	mg/g dw.	mg/g dw.
BM-4	0.6				8.11	0.007	82.56	0.025	0.518	0.0520	94.84	0.162	0.286	0.018	1.32	24.8	0.199
BM-9	0.65	0.036	0.099	23.4	5.14	0.005	68.96	0.023	0.518	0.0370	96.45	0.2	0.268	0.01	1.42	26	0.195
BM-11	0.5	0.018	0.093	22.6	4.89	0.004	74.62	0.041	0.505	0.0310	97.06	0.208	0.384	0.024	1.83	27.6	0.207
BM-14	0.85				6.58	0.011	84.12		0.437	0.0540	94.71	0.176	0.33	0.052	1.24	22.7	0.166
BM-17	0.55				3.01		65.72	0.015	0.57	0.0390	96.17	0.164	0.154	0.032	1.02	26	0.133
BM-18	0.8				6.33	0.002	72.86	0.009	0.562	0.0560	94.57	0.182	0.186	0.082	0.922	24.6	0.172
BM-24	0.9				2.21	0.002	96.2	0.026	0.454	0.0530	94.57	0.196	0.378	0.056	1.37	23.9	0.081
BM-25	1.05	0.018	0.081	14.8	0.77	0.004	61.2	0.007	0.465	0.0250	97.51	0.204	0.268	0.022	1.42	23.2	0.059
BM-31	0.8				6.41	0.002	74.96	0.018	0.465	0.0440	95.76	0.18	0.212	0.022	1.24	23.1	0.178
BM-33	1.1	0.018	0.099	13.1	2.44	0.002	59.46	0.009	0.478	0.0410	96.00	0.19	0.244	0.06	1.05	21.6	0.097
BM-37	0.8				10.5		82.24	0.017	0.452	0.0470	95.52	0.21	0.254	0.164	1.59	25.5	0.32
BM-38	0.9				5.67	0.004	78.64	0.006	0.467	0.0610	94.15	0.146	0.362	0.068	1.09	23.3	0.142
BM-39	0.9	0.027	0.118	21.8	5.44	0.005	71.98	0.009	0.452	0.0600	94.27	0.136	0.046	0.114	0.94	21.3	0.136
BM-40	0.8				2.52	0.005	63	0.037	0.487	0.0770	92.79	0.112	0.04	0.1	0.72	22.1	0.064
BM-42	1				5.32	0.023	67.88	0.012	0.411	0.0930	90.79	0.148	0.114	0.062	0.663	18.2	0.095
BM-50	0.55	0.018	1.905	30.6	6	0.005	70.36	0.012	0.547	0.0300	97.07	0.248	0.306	0.052	1.66	26.9	0.263
BM-51	0.65				8.22	0.005	88.44	0.017	0.466	0.0470	95.39	0.18	0.246	0.07	1.27	23.6	0.239
BM-54	0.7				5.82	0.056	78.78	0.009	0.588	0.0840	91.92	0.124	0.068	0.032	0.71	24.8	0.117
BM-55	0.75	0.017	0.145	37	4.58	0.012	71.32	0.034	0.48	0.0410	95.00	0.142	0.258	0.022	1.09	24.4	0.142
BM-63	1				3.66	0.005	66.44	0.026	0.42	0.1020	90.50	0.126	0.04	0.116	0.616	18.9	0.365
BM-65	0.9	0	0.118	16.1	7.06	0.007	72.72	0.023	0.463	0.0620	94.08	0.132	0.21	0.108	0.913	21.6	0.167
BM-72	0.75				3.55	0.009	73.08	0.013	0.462	0.0710	93.19	0.104	0.094	0.094	0.743	20	0.092
BM-73	0.95				2.13	0.007	81.9	0.007	0.47	0.0570	94.46	0.114	0.074	0.128	0.867	20.2	0.062
BM-74	0.85				5.79	0.007	72.3	0.015	0.435	0.0680	93.41	0.14	0.202	0.082	0.886	18.8	0.146
BM-84	0.9	0.036	0.118	20.2	4.44	0.009	65.56		0.437	0.0850	91.77	0.154	0.142	0.036	0.628	17.4	0.099
BM-85	0.8				5.5	0.011	67.26	0.023	0.5	0.0520	95.04	0.136	0.21	0.082	0.968	21.7	0.143
BM-92	0.6	0.045	0.203	14.4	4.35	0.642	74.3	0.063	0.367	0.0910	91.31	0.116	0.12	0.11	0.667	14.5	0.096
BM-96	1				8.78	0.092	70.6	0.034	0.426	0.0890	91.53	0.112	0.2	0.086	0.867	18.9	0.089
BM-99	1.15				4.06	0.012	64	0.015	0.362	0.1240	87.99	0.118	0.042	0.104	0.584	15.7	0.063
BM-103	1.05	0.027	0.404	11.2	1.94	0.009	71.14	0.027	0.479	0.1260	88.09	0.092	0.072	0.084	0.448	19	0.048
BM-106	1.1				2.83		63.06	0.017	0.431	0.1420	86.59	0.178	0.054	0.058	0.619	18.7	0.056
BM-107	0.9				2.82	0.014	65.56	0.009	0.443	0.1160	89.36	0.132	0.12	0.096	0.58	18.8	0.067
BM-108	0.8	0.018	0.118	24.5	3.19	0.009	63.2	0.022	0.419	0.0450	95.70	0.152	0.228	0.032	0.969	20.1	0.127
BM-119	0.8				8.05	0.009	80.74	0.027	0.427	0.0480	95.43	0.18	0.206	0.04	1.13	20.3	0.264
BM-121	1.1				2.14	0.009	55.3	0.038	0.447	0.1090	89.73	0.12	0.086	0.07	0.506	18.6	0.066

BM-124	0.65	0.036	0.099	18.8	4.15	0.019	88.46	0.076	0.443	0.1080	89.60	0.112	0.07	0.026	0.607	18.7	0.091
BM-126	0.77				3.31	0.007	82.6	0.027	0.429	0.0580	94.35	0.16	0.21	0.048	1	20.2	0.115
BM-127	1.3				4.9	0.009	64.64	0.007	.474	0.0910	91.10	0.12	0.14	0.1	0.667	18.7	0.129
BM-129	0.95	0.018	0.099	24.2	3.13	0.005	65.84	0.018	0.424	0.0410	96.03	0.134	0.26	0.058	1.08	18.7	0.14
BM-131	1				4.22	0.007	65.16	0.02	0.38	0.1340	87.62	0.112	0.07	0.112	0.71	16.7	0.085
BM-132	1				4.95	0.007	68.82	0.021	0.426	0.0660	93.69	0.11	0.158	0.126	0.857	19	0.148
BM-134	0.85	0.018	0.099	13.7	3	0.007	79.42	0.027	0.47	0.0670	93.48	0.142	0.21	0.066	0.811	19.7	0.093
BM-138	0.85				5.27	0.007	82.06	0.01	0.441	0.0820	92.11	0.194	0.106	0.028	0.712	18.7	0.14
BM-140	0.8				6.81	0.011	77.58	0.012	0.423	0.0460	95.43	0.192	0.284	0.102	1.19	20.2	0.218
BM-152	1.1	0.127	0.383	40.4	7.74	0.012	86.46	0.015	0.42	0.0450	95.59	0.13	0.274	0.1	1.25	20.2	0.221
BM-153	1.05				4.39	0.007	64.46	0.01	0.541	0.0990	90.82	0.102	0.088	0.044	0.597	20.2	0.098
BM-155	0.85				5.38	0.009	75.12	0.02	0.418	0.0640	93.86	0.112	0.228	0.01	1	19.3	0.134
BM-157	0.8	0.154	0.139	11.4	7.03	0.009	76.16	0.02	0.323	0.0980	90.60	0.106	0.166	0.104	0.671	14.3	0.121
BM-161	0.95				4.01	0.009	66.12	0.022	0.487	0.1160	88.88	0.108	0.062	0.042	0.59	18.3	0.083
BM-162	1.1				4.14	0.007	77.72	0.021	0.353	0.0550	94.61	0.142	0.174	0.114	0.87	15.2	0.107
BM-163	1	0.036	0.099	17.7	3.5	0.007	71.4	0.017	0.379	0.0640	93.93	0.156	0.13	0.096	0.848	17	0.096
BM-165	0.95				6.24	0.009	73.94	0.027	0.416	0.0430	95.80	0.166	0.282	0.07	1.13	19.7	0.203
BM-171	1.07				3.95	0.007	84.92	0.418	0.058	0.5170	61.09	0.02	0.062	0.01	0.229	1.63	0.031
BM-173	1				5.4	0.007	72.18	0.027	0.421	0.0630	93.96	0.118	0.164	0.034	0.929	18.5	0.158
BB-20	1.1				10.6	0.352	83.3	0.084	0.1373	0.2560	78.03	0.17	0.082	0.176	0.701	5.915	0.069
BB-21	1.15				5.02	0.021	97.88	0.143	0.1625	0.2180	80.81	0.166	0.108	0.134	0.779	7.458	0.049
BB-22	5.15				19.8	2.455	91.86	0.053	0.2231	0.1730	83.74	0.282	0.114	0.092	1.343	10.069	0.278
BB-23	6.9				32.5	5.157	111.18	0.044	0.2013	0.1670	84.52	0.304	0.152	0.08	0.94	9.388	0.459
BB-24	6	4.66	8.6	71.8	26.5	4.33	100.32	0.058	0.2094	0.1410	87.16	0.32	0.102	0.008	0.949	9.431	0.453
BB-25	6.95	3.41	6.08	64.7	32	4.312	106.34	0.059	0.2244	0.1220	88.41	0.356	0.152	0.056	1.035	10.537	0.477
WL-15	1.9	0.14	2.14	17	7.62	0.088	92.14	0.013	0.0581	0.6610	52.96	0.08	0.052	0.246	0.343	1.763	0.025
WL-16	1.1					0.139			0.0219	1.3370	25.29	0.054	0.028	0.116	0.173	0.339	0.009
WL-32	0.6					0.044			0.0249	1.3450	26.29	0.062	0.04	0.066	0.142	0.255	0.015
WL-72	11.6				38.9	8.202	104.74	0.094	0.2518	0.0950	90.68	0.262	0.214	0.16	1.282	12.383	0.558
WL-81	6.6	0.1	0.33	9.3	2.58	0.069	57.3	0.186	0.0435	1.4340	23.53	0.124	0.062	0.156	0.31	0.59	0.006
WL-89	7.6				10.5	2.235	76.3	0.025	0.2423	0.1020	89.88	0.258	0.102	0.148	0.89	10.342	0.178
WL-90	14	11.8	12.19	96	54.7	10.226	112.2	0.279	0.2562	0.1010	90.06	0.246	0.272	0.176	1.242	11.752	0.716
WL-95	6.3					0.285			0.0369	1.4320	23.82	0.116	0.032	0.112	0.219	0.45	0.005
WL-100	2.1				3.95	0.083	69.82	0.122	0.0525	0.4390	64.94	0.088	0.026	0.12	0.315	1.911	0.017
WL-101	1.4				1.11	0.011	96.82	0.083	0.0591	0.9190	40.7	0.072	0.038	0.17	0.258	0.898	0.01
WL-103	11.3				33.4	6.758	93.56	0.1	0.2459	0.1010	90.28	0.192	0.07	0.052	1.118	10.856	0.502
WL-109	12.5	6.24	10.76	57.9	48.8	9.944	119.88	0.116	0.255	0.1150	88.99	0.248	0.124	0.162	1.094	12.09	0.587
WL-135	2.7	0.36	1.67	20.2	9.37	0.588	88.8	0.053	0.2033	0.1660	84.83	0.158	0.096	0.158	0.687	9.978	0.127
WL-168	3.3				7.27	0.621	66.04	0.038	0.2565	0.1080	89.61	0.108	0.124	0.144	0.785	12.655	0.129
WL-176	1.05	0.095	2.07	13.1		0.178			0.0235	1.4300	22.75	0.048	0.026	0.094	0.112	0.336	0.009

WL-184	1				8.98	0.035			0.0293	1.3710	25.09	0.036	0.04	0.07	0.138	0.639	0.019
WL-193	0.8				2.05	0.012	101.46	4.001	0.0511	1.1470	32.75	0.104	0.064	0.222	0.316	0.774	0.016
WL-196	1.6	0.181	0.127	21.3	6.1	0.31	70.92	0.139	0.1834	0.1730	83.63	0.266	0.158	0.338	0.669	9.047	0.084
WL-198	3.5				4.09	0.306	56.98	0.034	0.2068	0.1640	85.41	0.178	0.082	0.234	0.695	10.511	0.071
WL-223	3.5				7.96	0.447	58.8	0.07	0.2586	0.1170	88.63	0.126	0.11	0.144	0.837	13.233	0.149
WL-251	1.6	0.171	0.738	32.8	6.36	0.023	67.88	0.193	0.0635	0.4860	62.79	0.072	0.058	0.174	0.315	2.444	0.028
WL-254	0.73								0.0137	1.4020	21.96	0.106	0.026	0.074	0.093	0.342	0.006
WL-272	3.4				6.26	0.539	55.4	0.048	0.2611	0.1230	88.28	0.154	0.13	0.144	0.806	13.343	0.104
WL-280	3.2	0.108	1.81	22.2	5.91	0.708	63.62	0.043	0.2562	0.1220	88.42	0.194	0.088	0.138	0.772	13.114	0.098
WL-299	2.3				2.47	0.069	59.02	0.083	0.0364	0.7230	50.42	0.146	0.026	0.472	0.559	1.193	0.009
WL-315	2.7				6.43	0.4	65	0.036	0.2286	0.1590	85.24	0.102	0.1	0.152	0.676	11.416	0.082
WL-317	1.65				7.2	0.642			0.0196	1.2260	29.08	0.156	0.02	0.154	0.177	0.676	0.008
WL-320	2.5				4.38	0.299	62.76	0.057	0.212	0.1450	86.21	0.156	0.09	0.204	1.027	10.828	0.055
WL-321	2.8				6.82	0.417	70.72	0.067	0.17	0.1830	82.81	0.13	0.138	0.23	0.752	8.328	0.074
WL-325	1.05	0.09	0.241	3.9	2.18	0.046	87.58	0.119	0.2036	0.2970	73.9	0.04	0.042	0.14	0.439	9.427	0.024