BENTHIC PHOSPHORUS STUDIES IN ATLANTIC REGION LAKES

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Abstract

Flux rates of soluble reactive phosphorus (SRP) from lake sediments were measured using *insitu* dialysis sediment porewater samplers in 24 lakes in the Atlantic region. Predicted flux rates ranged from -0.007 to 0.361 mgP/m^2/d. Two lakes had negative flux rates, nine had no measurable flux while the remainding 13 all showed positive fluxes. Flux rates were correlated with inlake and sediment porewater SRP concentrations. Sediment SRP concentrations were higher in dystrophic (colored) lakes with high dissolved organic carbon (DOC) than comparable clear water lakes with similar geology but different external phosphorus supply. Acidic lakes all showed positive pH gradients in surface sediments except for Beaverskin Lake which showed no sediment-water pH gradient. Flux rates of SRP to overlying waters could not be correlated with lake acidity.

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Introduction

Movement of materials across the sediment-water interface has been found to be an important aspect of the energetics of many lake types. Particularly important is the movement of biologically available phosphorus given its significance as a limiting nutrient and a key component in regulating lake productivity (Vollenweider and Kerekes, 1980). Phosphorus exchange across the sediment-water interface has been recognized as an important cycling pathway (Mortimer, 1941,1942) although traditional views have held that in aerobic sediments the movement of phosphorus is largely unidirectional towards the sediment (Wetzel, 1975) and that sediments are a phosphorus sink (Evans and Rigler, 1980; Doremus and Clesceri, 1982). More recently a number of studies have described significant phosphorus release rates from oxic sediments (Lee et al., 1977; Neame, 1977; Starkel, 1985; Quigley and Robbins, 1986).

The vast majority of lakes in the Atlantic provinces are shallow where aerobic sediments predominate yet very little is known about the exchange of materials across the sediment-water boundary. The primary objective of this study is to examine the significance of sediment phosphorus regeneration in lakes covering a broad range of lake types.

Several recent studies in some acidified lakes have found declines in microbial activity and sediment decomposition rates (Leivestad et al., 1976; Kelly et al., 1984). This reduction in sediment decomposition rates has been linked to increased acidification and may be the cause of long term declines in inlake total phosphorus concentration (Grahn et al., 1974) and subsequent lake oligotrophication. Any perturbation impeding nutrient cycling thereby affecting phosphorus availability will almost certainly cause declines in overall productivity of a waterbody. The second objective of this study is to examine the relationship between benthic phosphorus flux and acidity.

The Study Areas

Of the thirty lakes sampled using one or more of the sampling devices 10 are located in New Brunswick and 20 in Nova Scotia (Table 1, Fig. 1).

The lakes located in the Kejimkujik area have been described in detail by Kerekes and Schwinghamer (1973), the Cape Breton area lakes by Kerekes et al. (1978), the Halifax area lakes (Drain and Little Springfield Lakes) by Kerekes et al.(1984) and Laytons Lake by Howell and Kerekes (1984). . Lakes located in Fundy National Park, New Brunswick (Bennet, Wolf and McLaren Ponds) are described by Kerekes et al. (1975).

The other lakes sampled have not been studied previously. Loon Lake is being excluded from further analysis because it has been disturbed by urban development.

Methods

Three sampling methods were used to examine the exchange of phosphorus between sediments and overlying water.

(1) During the growing season of 1984 and in the fall of 1986 a bell jar chamber (Hargrave and Connolly, 1978) with a clock driven release mechanism was used *in situ* to collect samples of water trapped over undisturbed sediments in several lakes (Table 2). Samples collected in 1984 using this device were collected in 50 cc Plastipak (Reg TM) syringes every three hours over a 24 hour cycle. Samples were analyzed for dissolved oxygen, total phosphorus (TP), total dissolved phosphorus (TDP) and soluble reactive phosphorus (SRP). Biological activity in the syringes was halted by 1 ml of 1% $HgCL_2$ preadded to syringes. In 1984 the chambers were lowered gently into the sediments from a boat. In 1986 chambers were placed *insitu* by SCUBA divers to minimize sediment disturbance. The chambers enclosed 17.6 l of water and covered 0.145 m^2 of sediment. An electric motor was used to drive a small impeller at 20-30 rpm to avoid stagnation inside the chamber. Flux of oxygen or phosphorus was calculated as J_f according to Hargraves and Connolly (1978) where :

$$J_f = \frac{(C_o - C_t)}{A} * \frac{10^{-4}}{T} \qquad (1)$$

where V = volume of water over the sediment.
C_o and C_t = dissolved concentrations (l^{-1}) before and after time T.
A = area of sediment enclosed.

During 1986 glass syringes were substituted for plastic syringes.

(2) In 1986 clear plexiglas chambers measuring 60 cm x 31 cm x 25 cm enclosing 46.8 l of water and a sediment surface area of 0.190 m^2 were used to duplicate bell jar measured release rates except over longer periods (7 to 10 days). These chambers were placed in 5 locations (Table 3). Samples retrieved from the chambers were analyzed for TDP, SRP and dissolved oxygen (DO). Water inside these chambers was not circulated. Chambers were placed *in situ* and samples retrieved at selected intervals by SCUBA divers.

(3) *In situ* sediment porewater samplers (Hesselin, 1976; Carignan, 1984) were used to define compositional changes in sediment porewater pH, specific conductance and total dissolved (persulfate digested) and soluble reactive phosphorus. These samplers were constructed of clear plexiglas and consisted of two 17.5 x 80 cm sheets of plexiglas, one 0.3 cm thick and the other 1.3 cm thick. The two pieces were held together by metal machine screws. Seventy paired compartments 7 cm long, 0.6 cm wide and 1.0 cm deep were inscribed through the thin piece into the thick piece at 1 cm intervals over the length of the sampler. Each cell held approximately 4 mls. The sampler was prepared for use by immersing the compartmented section in a bath of distilled (Super-Q) water previously deoxygenated by bubbling with N_2 for at least two hours. A sheet of dialysis membrane (Gelman Tuffryn HT-450 polysulphone membrane 0.45u pore size) was carefully laid

over the compartments and held in place by the thin plexiglas sheet and machine screws. The sampler (peeper) was held in the bath and constantly bubbled with hipure N_2 until immediately prior to placement into lake sediments. Peepers were placed vertically into sediments by SCUBA divers leaving the upper 10 cm above the sediment water interface.

During 1985-86 peepers were placed in 27 lakes located in selected areas of New Brunswick and Nova Scotia (Table 4). Exposure times ranged from 15 to 83 days. Field trials were performed to verify the suitability of exposure time with respect to equilibration of pH, conductance and phosphorus fractions between sediment porewater and peeper cells. Tests were also conducted on the effects of exposure to aerobic conditions on pH after peeper retrieval. To do this pH was analyzed immediately upon retrieval, 15 and 30 minutes after retrieval and 2 days after retrieval.

Heterogenity of sediments was tested by placement of three duplicate pairs of peepers in three locations (3.0, 5.0 and 7.0 m) in Beaverskin Lake. Peepers were placed and retrieved simultaneously and analyzed for conductance and phosphorus fractions.

Samples for analysis of specific conductance and phosphorus fractions were placed in glass vials and analyzed within 3 days of retrieval.

After use peepers were disassembled, scrubbed mechanically and placed in a dilute acid bath (4% HCl) for a minimum of 7 days. Before reuse peepers were scrubbed again and rinsed repeatedly in distilled water and allowed to air dry. Peeper blanks were set up as for normal use except they remained in the laboratory for two weeks. Samples were collected and analyzed to check for changes in chemistry due to procedure.

Specific conductance was measured using a Radiometer Model CDM2c conductivity meter. The pH was measured <u>in situ</u> using a Fisher Model 156 pH meter and 5 probe switch box equipped with 5 combination electrodes (150 mm long x 3mm wide). Total dissolved and soluble reactive phosphorus were analyzed using the molybdenum blue method (Menzel and Corwin, 1965). Absorbance was measured at 885 nm on a LKB Ultrospec 4051 spectrophotometer. Dissolved oxygen measurements were made using the Winkler method and azide modification (APHA,1975) or a Winkler calibrated YSI Model 54 dissolved oxygen meter. Meter readings were done <u>in situ</u>, Winkler readings were done within 4 hours.

Core-

A single sediment core from Kejimkujik Lake was analyzed for percent water, organic and mineral (ash) content. Core sections were dried overnight at 100°C for determination of dry weight. Ash weight was determined by ashing the sections at 500°C for a minimum of 6 hrs.

Flux-

Phosphorus flux rates (J_s) were calculated according to Ficks first law of diffusive transport based on SRP porewater gradients in the upper 10 cm of sediment as well as physical properties of the sediments based on Berner (1980) where:

$$J_s = -\phi \frac{D}{\theta^2} \frac{dC}{dx}\bigg|_{x=0} * A \qquad (2)$$

where ϕ = sediment porosity (%).
D = diffusion coefficient of PO_4 in freshwater solution.
θ = tortuosity term that depends on size, shape and packing of sediment particles where $\theta^2=\phi F$ and $F=\phi^{-N}$ (N was assumed to be 1.3).
dC/dx = SRP gradient based on 5-6 points in the upper 10 cm of sediment.
A = proportionality constant used to convert flux units to mg PO_4-P/m^2/d.

Results

Methodology checks-

During the initial use of bell jar chambers in 1984 plastic syringes were used. Inconsistent results obtained while using plastic syringes were suspected to be caused by procedural contamination of samples. New and used syringes filled with Super Q and left standing overnight showed unacceptably high but inconsistent background phosphorus levels in all syringes. Various cleaning methods including acid washes, persulfate digestion and washing were unsuccessful at removing the problem. Glass syringes were tested and found to be acceptable and were used to replace plastic.

Peeper blanks were found to be acceptable with virtually no contamination evident in any test peepers. Exposure time to allow equilibration of constituents across the dialysis membrane tested by placing peepers insitu for periods ranging from 15 to 83 days indicated no significant differences in pH, specific conductance, TDP or SRP with increased duration. Shorter periods of placement were not tested based on published information which indicated a minimum of one to two weeks for equilibration (Hesselin, 1976; Carignan, 1984; Bottomley and Balay, 1984).

Concerns regarding changes in pH after removal of peepers from sediments and exposure to air were found to be justified. Measurements of pH from peepers removed simultaneously from Beaverskin Lake indicated rapid changes in pH with repeated measurements at 15 minute intervals continuing up to two days (Fig. 2).

Sediment Heterogenity-

Heterogenity of lake sediments at different depths with respect to conductance and phosphorus fractions showed increased conductivity, TDP and SRP with increased depth of placement. Conductivity profiles were highly scattered however phosphorus profiles showed clear trends with depth. Sediment phosphorus concentrations at the 5 m site tended to be slightly higher than those at the 3.0 meter site however this trend was not consistent over the entire profile nor, where differences occurred, was the magnitude as large as between the 5.0 and 7.0 m sites (Fig. 3).

Oxygen Uptake-

Oxygen uptake rates (Table 5) were measured in 10 lakes using benthic chambers. Uptake rates ranged from 0.070 $mgO_2/l/hr$ in

Loon Lake to 0.176 $mgO_2/l/hr$ in Grafton Lake. Respiration rates per unit surface area of sediments ranged from 1.34 $mgO_2/m^2/hr$ in Big Dam East Lake to 21.3 $mgO_2/m^2/hr$ in Grafton Lake. Respiration rates tended to be higher in colored and higher trophic lakes but the results were based on only a limited number of measurements and were not consistent.

pH-

Many of the lakes studied are either naturally or anthropogenically acidic. The most acidic lakes were Drain and Little Springfield Lakes (pH = 4.1 and 3.6 respectively) and the most alkaline was Presquile Lake (pH = 7.4). Acidic lakes generally showed an increasing pH gradient with increased sediment depth although the gradient was strongest in the upper 10 cm. In many lakes pH changed very little after the initial increase as illustrated by Kejimkujik Lake sediment pH profiles (Fig. 4). Shallow acidic lakes where sediments are disturbed by wind and wave action showed more gradual increases in pH with increasing sediment depth and usually obtained a lower maximum pH in the deepest portion of the sediment sampled. Pebbleloggitch Lake (Fig. 5), Lands and Forests control pond, Bog Exhibit Pond and to a lesser extent East and West Twin Lakes exhibited this type of profile.

Almost all of the acidic lakes had pH values approaching 6.0 to 6.5 by 70 cm sediment depth even in Drain and Little Springfield Lakes which had the highest surface water acidities. Beaverskin Lake was the only lake which had acidic overlying waters (pH ~ 5.5) and high sediment pH (~ 6.4) but no gradient in surficial sediments on any of 5 sampling occasions. In this lake the sediment-water boundary was separate and sharp (Fig. 6).

Circumneutral lakes, those with pH around 7.0, also showed no gradient as sediment and water values were similar. This type of profile was common in the southwest New Brunswick, Fundy lakes, Big Dam East and Laytons Lakes. Only two lakes sampled (McLaren Pond and Presquile Lake) showed pH values in overlying water significantly higher than in sediments. In both of these lakes the gradient in surface sediments was negative. In Presquile Lake the pH of overlying water was ~ 8.2 however by 10 cm below the interface sediment porewater pH was only 6.9 (Fig. 7).

In lakes where repeated measurements were made results were generally consistent with pH not varying by more than 0.2 pH units between samplings (eg. Fig. 4). In shallow lakes the pH of surface sediments was slightly more variable (0.9 pH units) as illustrated in Pebbleloggitch Lake (Fig. 5).

Specific Conductance-

Specific conductance was highly variable both within and amongst lakes. Conductivity of porewater generally reflected conductivities of overlying water although porewater was 2 to 3 times higher. Lakes with surface water conductivities of 20 - 40 umho/cm such as those in southwest N.B., Fundy and the Kejimkujik area , had sediment porewater conductivities of less than 100 umho/cm. Lakes with higher surface water conductivity (ie: Freshwater, 400 - 900; McLaren, 250 - 300; Laytons, 400 - 2000;

Drain, 140 - 240; Little Springfield, 150 - 600 and Presquile Lakes, 100 - 2000 umho/cm) also had much higher porewater conductivity.

Conductivity profiles usually increased in the upper 10 cm of sediment although peaks followed by declines were not uncommon (Fig. 8). Only two lakes, Drain and Little Springfield, showed consistent decreases in porewater conductivity as sediment depth increased.

In lakes where conductivity was measured on more than one occasion results were highly variable especially in lakes with low conductivity such as Beaverskin Lake.

Phosphorus-

Phosphorus flux estimates based on chamber measurments were not attempted because of technical problems such as disturbance of the sediment surface during placement and syringe comtamination problems. In most cases where the above problems were overcome, chambers were placed in locations where flux rates were found to be minimal (ie Big Dam East L.; see Table 2) and no detectable changes in chamber SRP were detected. For these reasons flux rates based on chamber data is not presented or discussed further.

Phosphorus concentrations in sediments were much greater than in overlying waters in all lakes particularly for SRP. Clear water lakes on granitic or slate bedrock had the lowest inlake and sediment porewater phosphorus concentrations followed by colored lakes on similar substrates. Sediment porewater phosphorus concentration reflected lake trophic status with mesotrophic and eutrophic lakes having progressively higher phosphorus concentrations. The lowest sediment porewater phosphorus concentrations were found in the southwest N.B. lakes such as Anthony Lake (Fig. 9) where TDP and SRP did not exceed 40 and 10 ugP/l respectively. The highest porewater TDP concentration (1100 ugP/l) was found in Laytons Lake followed by 600 ugP/l in McLaren and Presquile Lakes. Colored lakes such as Big Dam West, Kejimkujik and Pebbleloggitch Lakes had consistently higher porewater TDP and SRP concentrations than comparable clear water lakes (such as Beaverskin and Big Dam Lakes) lying on similar bedrock (Fig. 10).

The relative proportions of porewater fractions (TDP and SRP) varied between lake types. Lakes with sediments overlain by oxic water (ie Beaverskin Lake; Fig. 11) tended to have less of the TDP as SRP (~30%) compared to almost 90% in sediments overlain by anoxic water for extended periods (eg: McLaren Pond; Fig 12). The proportion of TDP and SRP appeared to be constant over the length of the profile.

Phosphorus flux (eq. 2) was estimated using regression analyses of sediment SRP porewater concentrations in the upper 10 cm of sediment. Regression data including sample size, coefficient of determination, significance, standard error, intercept and slope are given in Table 6 for individual sample dates. SRP gradients tended to be shallow in clear water oligotrophic lakes with low sediment P concentrations. Many of the lakes of this type (Canns, Mud, Anthony, Jake Lee, Newton and Adelaide) had vertical profiles which gave zero slope and as would be expected, no correlation with sediment depth. Some clear water lakes with higher sediment phosphorus concentrations such as Beaverskin and Wolfe Lakes, showed some evidence of a shallow gradient (slope < 0.002). Colored lakes with progressively higher sediment phosphorus concentrations showed stronger gradients ranging from 0.004 in East Twin Lake (color = 40 H.u.) to 0.037 in Big Dam West Lake (color = 100 H.u.). The strongest gradients (0.050) were found in the two eutrophic lakes, Laytons Lake and the artifically fertilized Lands and Forests experimental pond.

Only two lakes showed negative slopes indicating a decrease in sediment porewater SRP with increasing sediment depth. These were Anthony and Little Springfield Lakes which both had a slope of − 0.001 (Table 6). Little Springfield Lake (Fig. 13) and Anthony Lake also had the lowest SRP concentrations in porewaters of any lake sampled. Drain Lake also showed a negative slope on one occasion but the average of three measurements used to calculate flux was positive.

Average phosphorus flux rates are presented in Table 7 along with selected water chemistry variables for 24 sites were such calculations were feasible. Flux rates directly reflected concentration gradients. Anthony and Little Springfield Lakes both showed negative flux rates of −0.007 mgP/m^2/d. Clear water, oligotrophic lakes (color < 10 H.u.) showed flux rates ranging from 0 to 0.014 mgP/m^2/d. Colored lakes showed substantially higher flux rates ranging from 0.029 in Mud Lake (color 40 H.u.) to 0.267 in Big Dam West Lake (color 100 H.u.). The highest flux rates were found in Laytons Lake and the fertilized Lands and

Forests pond (0.361 mgP/m^2/d). A relatively high flux was estimated for McLaren Pond (0.106 mgP/m^2/d), the only site having completely anoxic sediments. Kejimkujik and Pebbleloggitch Lakes, both highly colored lakes but having oxic surface sediments had flux rates greater than that of eutrophic and anoxic McLaren Pond (Table 7).

Multiple regression analyses of flux rates versus dissolved organic carbon (DOC), inlake total phosphorus and hydrogen ion concentration indicates a significant relationship between only flux and phosphorus concentration (Table 8).

Sediment water, organic and mineral content-

Estimates of sediment porosity used to calculate flux rates are based on the results of analysis of only one sediment core taken from the deep station of Kejimkujik Lake. This core showed relatively consistent percent water, organic and mineral content throughout the 70 cm length of the core (Fig. 14). Water content of the core was about 90% at the surface declining to about 85% over the first few centimeters reaching and remaining at approximately 80% below 15 cm. Organic content was 9% at the sediment surface increasing gradually to about 15% by 70 cm downcore. Mineral (ash) content remained at < 5% throughout the core.

Discussion

Of the three sampling methodologies used only the peepers provided data of suitable quality to estimate flux rates of phosphorus from lake sediments. Although the plexiglas and Hargraves chambers did allow calculation of oxygen uptake rates it appears that exposure times of 24 hrs for the Hargraves chambers and up to 9 days for the Plexiglas chambers was inadequate to measure detectable changes in SRP concentration within them. Initial variations in SRP concentrations were overcome by use of glass syringes however no significant changes in chamber SRP concentrations were detected probably because of the low flux rates in the lakes sampled and the short exposure times.

Oxygen Uptake-

Oxygen consumption over lake sediments tended to increase with increasing phosphorus and organic content but results were not consistent. In lakes where repeated measurements were made there is evidence of strong seasonal variation which may account for some of the problems since measurements were made at different times in different lakes.

Sediment Heterogenity-

Results of peeper studies indicated that lake sediments are heterogeneous particularly with respect to lake depth and subsequent exposure to wind and wave action. These physical properties of different lake zones are known to result in differences in sediment grain size spectra, porosity and organic content (Wetzel, 1975). These differences are also reflected in sediment porewater characteristics, particularly in phosphorus concentrations which probably reflect differences in organic content resulting from resuspension of organic material in shallow zones and focusing of sediments in deeper areas of lakes. The sediment profiles from Beaverskin Lake (Fig. 3) indicate that lakes cannot be treated as homogeneous systems. Sediment SRP gradients measured in the three zones of this lake showed lower slopes in shallower depths meaning that flux rates are also likely to be less in these areas.

pH-

The pH gradients in lake sediments with more acidic overlying water indicate a diffusive loss of H^+ to the sediments and a loss of HCO_3^- from the sediments. Alkalinity production by sediments (or hydrogen ion neutralization) has been clearly documented in studies of sediment-water interactions in acidified lakes (Carignan, 1985). Cook et al.,(1986) found that alkalinity production occurred primarily through bacterial sulphate reduction and the exchange of hydrogen for calcium and magnesium. Schindler et al.,(1986) found similar process occurred in their acidified lakes in addition to alkalinity produced by bacterial reduction of NO_3.

The reason why Beaverskin L. shows no gradient in the upper few centimeters of sediment (Fig. 6) in any of the five sample dates is not known. This is the only lake which does not appear to exchange alkalinity across the sediment-water interface. It is evident that sediments in all of the acidic lakes except Beaverskin L., may be significant sources of alkalinity and may play an important role in lake acid neutralizing capacity.

The remainder of the lakes sampled have lakewater pH similar or greater than those found in their sediments. In high pH lakes such as Presquile L. (Fig. 7) the reverse process is implied by the negative gradient in the surface sediments of this lake.

Specific Conductance-

Conductance profiles reflected concentrations of ions in sediment porewaters. Conductivity of sediment porewaters generally reflected conductance of overlying water in relative terms. That is, lakes with low conductivity had low porewater conductivity relative to lakes with higher conductivity in their surface waters which also had higher porewater conductivity. The lakes with the highest porewater conductivities were lakes with strong marine influence (Presquile L.) or those lying on highly soluble substrates such as gypsum (Laytons L.). Lakes with low conductivity in sediment porewaters were predominantly found on insoluble substrates overlain by thin, impoverished soils such as the lakes located in southwest N.B., the Kejimkujik area, Halifax area (Drain and Little Springfield Lakes) and in the Cape Breton highlands. All of these lakes lay on either granitic, slate or combination of theses types of bedrock.

Higher conductivity in porewaters compared to that of overlying water partially reflects the breakdown of organic compounds by microbial or meiofaunal activity. Many ionic constituents are also mobile in sediments (Lerman and Brunskill, 1971; Nriagu, 1976; Hesselin, 1980) to varying degrees which may account for the variability observed in some of the profiles.

Phosphorus-

Results clearly indicate that porewater phosphorus concentration reflects lake trophic status (inlake [TP]) with one notable exception. The exception is Drain L., a recently eutrophied lake which receives domestic sewage. Sediments in this lake have phosphorus concentrations comparable to upstream Little Springfield L. which is low and reflects preeutrophication conditions.

Sediments of colored lakes show higher TDP and SRP concentrations than adjacent clear water lakes because they receive additional organic and nutrient input in the form of organic acids. The best example of this contrast are Big Dam East (color < 5 H.u.) and Big Dam West (color ~ 100 H.u.) Lakes. These lakes lie adjacent each other with the former flowing into the latter. The main difference between the two lakes is that Big Dam West has bogs within its catchment while Big Dam East has very little bog influence. As a consequence the sediment porewater in Big Dam West L. has TDP and SRP concentrations 5 to 6 times greater than in Big Dam East L. Within the group of study lakes sediment phosphorus concentrations were only weakly correlated with water color even when eutrophic, clear water lakes were removed ($p < 0.05$) indicating that other factors also affect sediment phosphorus concentration.

Flux estimates indicate that many of the lakes do release inorganic phosphorus although sediments are a net sink for phosphorus with only a small percentage of the incoming phosphorus returned to the lake system. It is not clear whether or not the sediment derived phosphorus is significant in terms of a whole lake budget for any of the lakes. Flux rates of SRP were wide ranging and included both negative (net flux into sediments) and positive flux (flux out of sediments). All of the flux rates with the exception of the three eutrophic lakes (Laytons, Presquile and L&F Fertilized) are very low (Table 7). Seven oligotrophic lakes showed no flux, two showed negative flux rates, thus of the 24 lakes studied, 9 (38%) do not appear to make any contribution to inlake phosphorus supply. All of these lakes were clear water, oligotrophic lakes with the exception of Bog Exhibit Pond which is slightly colored. The only lake studied which had an anoxic hypolimnion, McLaren Pond, had a relatively high flux rate (106 $mgP/m^2/d$) but was not as high as that estimated for Big Dam West, Kejimkujik or Pebbleloggitch Lakes. These latter three lakes were all highly colored with oxic surface sediments. The relatively low flux in McLaren Pond may be due to the fact that SRP concentration in water overlying the sediments was also very high (177 ugP/l).

Flux rates predicted for the study lakes compared favorably with values obtained from the literature for lakes in their respective trophic categories (Table 8). The only lakes in this study which have had SRP flux measured previously were

Beaverskin, Kejimkujik and Pebbleloggitch Lakes. Andrews (1980), using sediment porewater gradients obtained with different techniques , estimated a flux rate of 0.164 mgP/m²/d in Pebbleloggitch L. which approximates the flux rate of 0.115 mgP/m²/d measured in this study. Andrews (1980) attempted to measure flux in Beaverskin L. but found the slope of the porewater gradient was too shallow and did not attempt the calculation considering the flux to be too low to be of any significance, which does not seem unreasonable given the low flux rate of 0.014 mgP/m²/d estimated from porewater gradients in this study. SRP concentrations in porewater profiles measured in this study and by Andrews (1980) in both of these lakes were very similar.

As previously stated, recent studies in some acidified lakes have indicated increased accumulation rates in organic bottom sediments (Grahn et al., 1974) thought to be related to reductions in microbial activity and organic decomposition rates (Leivestad et al., 1976; Kelly et al., 1984). Rao (1982) found lower bacterial numbers and activity in both pelagic and benthic microbial communities in Beaverskin, Pebbleloggitch and Kejimkujik Lakes as well as reduced organic degredation rates of organic material in these lakes compared to less acid stressed systems. Reductions in benthic decomposition rates are suspected to be the cause of long term reductions in inlake phosphorus concentration observed in some lakes (Grahn et al., 1974). Given the importance of phosphorus supply in regulating primary production even in highly acidic lakes (Shellito and DeCosta, 1981; Dillon et al., 1979; Kerekes et al., 1984) the relationship between flux rates and acidity were examined. Multiple regression analysis of inlake DOC, TP and hydrogen ion concentration did not reveal any correlation between flux rates and hydrogen ion (Table 8). It can be seen in Fig. 15 and Table 7 that the two most acidic lakes, Drain and Little Springfield Lakes, have very low SRP flux rates with the latter having a negative flux. This cannot be directly related to acidity since both of these lakes also have among the lowest porewater SRP concentrations measured in any of the study lakes. In addition, acidic lakes such as Big Dam West, Kejimkujik and Pebbleloggitch have much higher flux rates many less acidic lakes (which also usually had much lower porewater SRP concentrations). The relationship between flux and inlake TP concentration was significant at $p < 0.05$ (Table 9) indicating that higher flux rates occured in higher trophic lakes with higher inlake and sediment phosphorus levels. Comparisons of flux rates in relation to acidity are difficult since there are no lakes which have similar sediment SRP concentrations but different acidities.

Andrews (1980) found that sediment porosity varied from 86-90% in Beaverskin L. to 81-89% in Pebbleloggitch L. More information is required on variability in percent water and organic content amongst different lakes. Additional information is also required on physical and chemical characteristics of sediments in all lakes, especially lakes with similar sediment SRP concentrations but contrasting acidities. Chemical characteristics of sediment porewaters, particularly Fe, Mn and Al concentrations are important because these constituents are known to form oxidehydroxide complexes to which phosphorus readily sorbes (Syers et al., 1973; Nur and Bates, 1979).

Several samples will also be collected for analysis of meiofaunal abundance since meiofauna are also known to enhance phosphorus flux (Starkel, 1985).

Flux estimates in this study were based on SRP concentrations made at 2 cm intervals and should be considered preliminary. Continued studies will attempt to better define SRP porewater concentrations by measuring SRP at 1cm intervals in the upper 10 cm of sediment which may result in some revisions in estimates.

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Table 1: Location and coordinates of study areas.

NO.	SITE	LATITUDE			LONGITUDE			COUNTY
		o	'	"	o	'	"	
1	ADELAIDE LAKE	45	19	00	66	38	50	CHARLOTTE N.B.
2	ANTHONY LAKE	45	16	10	66	43	60	CHARLOTTE N.B.
3	BENNET LAKE	45	38	12	65	05	51	ALBERT N.B.
4	BEAVERSKIN LAKE	44	18	30	65	20	00	QUEENS N.S.
5	BIG DAM EAST	44	27	00	65	16	00	DIGBY N.S.
6	BIG DAM WEST	44	28	00	65	17	30	DIGBY N.S.
7	BOG EXHIBIT	46	44	22	60	49	48	INVERNESS N.S.
8	CANNS LAKE	46	40	20	60	26	00	VICTORIA N.S.
9	CRANBERRY LAKE	44	41	00	63	29	00	HALIFAX N.S.
10	DRAIN LAKE	44	47	50	65	45	20	HALIFAX N.S.
11	EAST TWIN LAKE	45	18	40	66	36	50	CHARLOTTE N.B.
12	FRENCH LAKE	46	43	41	60	51	56	INVERNESS N.S.
13	FRESHWATER LAKE	46	38	40	60	23	47	VICTORIA N.S.
14	JAKE LEE POND	45	14	60	66	38	80	CHARLOTTE N.B.
15	KEJIMKUJIK LAKE	44	22	30	65	14	00	QUEENS N.S.
16	LANDS AND FORESTS C	44			65			QUEENS N.S.
17	LANDS AND FORESTS F	44			65			QUEENS N.S.
18	LAYTONS LAKE	45	47	40	64	15	20	CUMBERLAND N.S.
19	LITTLE SPRINGFIELD	44	48	00	63	44	50	HALIFAX N.S.
20	LOON LAKE	44	31	90	63	42	50	HALIFAX N.S
21	MCLAREN POND	45	36	45	64	57	57	ALBERT N.B.
22	MOUNTAIN LAKE	44	19	70	65	15	70	QUEENS N.S
23	MUD LAKE	45	21	00	66	36	50	CHARLOTTE N.B.
24	NEWTON LAKE	45	16	10	66	43	00	CHARLOTTE N.B.
25	PEBBLELOGGITCH LAKE	44	18	00	65	21	00	DIGBY N.S.
26	PETPESWICK LAKE	44	46	00	63	11	00	HALIFAX N.S.
27	PRESQUILE LAKE	46	41	25	60	57	25	INVERNESS N.S.
28	WARREN LAKE	46	42	50	60	23	40	VICTORIA N.S.
29	WEST TWIN LAKE	45	18	30	66	37	00	CHARLOTTE N.B.
30	WOLFE LAKE	45	39	45	65	08	57	ALBERT N.B.

Table 2: Location, dates of placement and retrieval and analyses using Hargraves chambers.

LOCATION	DATE IN DDMMYY	DATE OUT DDMMYY	DAYS IN	TP	TDP	SRP	OXYGEN
BIG DAM EAST	31186	41186	1	X			
CRANBERRY LAKE	70684	80684	1			X	X
GRAFTON LAKE	230584	240584	1			X	X
KEJIMKUJIK LAKE	230884	230884	1		X	X	X
KEJIMKUJIK LAKE	200884	210884	1			X	X
LOON LAKE	170584	180584	1		X	X	X
LOON LAKE	50784	60784	1	X			
LOON LAKE	120784	130784	1	X			X
LOON LAKE	310584	10684	1			X	X
LOON LAKE	221086	231086	1	X		X	
LOON LAKE	30884	40884	1			X	
LOON LAKE	150884	160884	1			X	X
LOON LAKE	10884	20884	1			X	X
LOON LAKE	281086	291086	1	X		X	
LOON LAKE	90884	100884	1			X	
LOON LAKE	21084	31084	1				X
LOON LAKE	310784	10884	1			X	X
MOUNTAIN LAKE	210884	220884	1				
MOUNTAIN LAKE	190784	200784	1			X	X
PETPESWICK LAKE	300986	11086	1	X			
PETPESWICK LAKE	130984	140984	1				
PETPESWICK LAKE	270884	280884	1		X	X	X

Table 3: Location, dates of placement and retrieval and analyses using Plexiglas chambers.

LOCATION	DATE IN DDMMYY	DATE OUT DDMMYY	DAYS IN	CHAMBER			
				TP	TDP	SRP	OXYGEN
BEAVERSKIN LAKE	270586	60686	10	X		X	X
BEAVERSKIN LAKE	250686	40786	9	X		X	X
BIG DAM EAST	240686	30786	7	X		X	X
BIG DAM WEST	240686	30786	7	X		X	X
KEJIMKUJIK LAKE	230686	30786	8	X		X	X
KEJIMKUJIK LAKE	260586	60686	10	X		X	X
LITTLE SPRINGFIELD	10686	240686	14	X		X	X
PEBBLELOGGITCH	270586	50686	9	X		X	X
PEBBLELOGGITCH	240686	30786	10	X		X	X

Table 4: Location, dates of placement and retrieval and analyses using peepers.

LOCATION	DATE IN DDMMYY	DATE OUT DDMMYY	DAYS IN	pH	COND	TDP	SRP
ADELAIDE LAKE	230786	160986	56	X	X	X	X
ANTHONY LAKE	220786	170986	58	X	X	X	X
BEAVERSKIN LAKE	50685	100785	35	XXXX	X	X	
BEAVERSKIN LAKE	270586	270686	32	X	X	X	X
BEAVERSKIN LAKE	50685	200685	16	X	X	X	
BEAVERSKIN LAKE	120885	11085	51	XXX	XXX	XXX	XXX
BEAVERSKIN LAKE	11085	261185	57		XXX	XXX	XXX
BENNETT (DEEP)	170786						
BENNETT (SHALLOW)	170786	140886	29	X	X	X	X
BIG DAM EAST	11085	251185	55	X	X	X	X
BIG DAM EAST	280586	260686	30	X	X	X	X
BIG DAM WEST	11085	251185	56	X	X	X	X
BIG DAM WEST	150585	110785	57	X		X	
BIG DAM WEST	280586	260686	30	X	X	X	X
BIG DAM WEST	150585	190685	37	X	X	X	
BOG EXHIBIT	240785	270885	35	X	X	X	X
CANNS LAKE	250785	280885	35	X	X	X	X
DRAIN LAKE	70585	290785	83	X	X	X	X
DRAIN LAKE	150486	40686	51	X	X	X	X
DRAIN LAKE	111085	201185	41	X	X	X	X
DRAIN LAKE	70585	120685	36	X	X	X	
EAST TWIN LAKE	240786	150986	54	X	X	X	X
FRENCH LAKE	240785	270885	35	X	X	X	X
FRESHWATER LAKE	230785	290885	38	X	X	X	X
JAKE LEE	230786	160986	56	X	X	X	X
KEJIMKUJIK LAKE	260586	260686	31	X	X	X	X
KEJIMKUJIK LAKE	160585	90785	54	XX	X	X	X
KEJIMKUJIK LAKE	160585	180685	34	X	XX	X	
LANDS & FOR (CONT)	141185	111285	27	X	X	X	X
LANDS & FOR (FERT)	141185	111285	27	X	X	X	X

Table 4: cont'd

LOCATION	DATE IN DDMMYY	DATE OUT DDMMYY	DAYS IN	pH	COND	TDP	SRP
LAYTONS LAKE	220586	100786	50	X	X	X	X
LITTLE SPRINGFIELD	150486	100686	56	X	X	X	X
LITTLE SPRINGFIELD	111085	201185	41	X	X	X	X
LITTLE SPRINGFIELD	60585	290785	83	X	X	X	X
LITTLE SPRINGFIELD	60585	120685	37	X	X	X	
LOON LAKE	290185	180285	20		X	XX	XX
LOON LAKE	290185	250285	27			X	X
LOON LAKE	180185	260285	27			X	X
LOON LAKE	230485	110685	45	X	X	X	
LOON LAKE	180185	80285	21	X	X	X	X
LOON LAKE	130285	280285	15			X	X
LOON LAKE	180185	130285	26		X	X	X
LOON LAKE	130285	70385	22			X	X
MCLAREN LAKE	160786	130886	29	X	X	X	X
MUD LAKE	220786	160986	57	X	X	X	X
NEWTON LAKE	220786	160986	57	X	X	X	X
PEBBLELOGGITCH	50685	200685	15	X	X	X	
PEBBLELOGGITCH	11085	261185	57		X	X	X
PEBBLELOGGITCH	50685	100785	35	X	X	X	
PEBBLELOGGITCH	120885	11085	51	XX	X	X	X
PEBBLELOGGITCH	270586	270686	32	X	X	X	X
PRESQUILE LAKE	240785	270885	35	X	X	X	X
WARREN LAKE	230785	270885	37	X	X	X	X
WEST TWIN LAKE	240786	150986	54	X	X	X	X
WOLFE (DEEP)	170786	140886	29	X	X	X	X
WOLFE (SHALLOW)	170786	140886	29	X	X	X	X

Table 5: Oxygen uptake rates measured in chambers in selected lakes. (N= no.of sampling dates)

LAKE	OXYGEN UPTAKE (mgO2/l/hr)	RESPIRATION (mgO2/m2/hr)	N
BEAVERSKIN LAKE	0.012	1.68	4
BIG DAM EAST LAKE	0.01	1.34	2
BIG DAM WEST LAKE	0.016	2.2	1
CRANBERRY LAKE	0.125	15.2	1
GRAFTON LAKE	0.176	21.3	1
KEJIMKUJIK LAKE	0.056	7.3	4
LOON LAKE	0.07	8.5	4
MOUNTAIN LAKE	0.112	13.4	2
PEBBLELOGGITCH LAKE	0.017	2.3	3
PETPESWICK LAKE	0.137	16.6	1

Table 6: Regression statistics of sediment SRP concentration in the upper 10 cm of the study lakes.

LAKE	N	R2	PROB.	STD. ERROR	INTER.	SLOPE	FLUX mgP/m2/d
ADELAIDE L.	6	0.85	0.01	0.001	0.005	0.0	0.0
ANTHONY L.	6	0.59	0.07	0.002	-0.001	-0.001	-0.007
BENNET L.	5	0.83	0.03	0.001	0.005	0.0	0.0
BEAVERSKIN SHALLOW	7	0.69	0.02	0.003	0.001	0.001	0.007
" "	6	0.05	0.68	0.002	0.005	0.0	0.0
BEAVERSKIN MID	6	0.74	0.03	0.002	-0.001	0.001	0.007
" "	6	0.49	0.12	0.002	0.001	0.0	0.0
BEAVERSKIN DEEP	6	0.98	0.001	0.001	0.0	0.003	0.022
" "	6	0.92	0.004	0.002	0.007	0.002	0.014
" "	5	0.32	0.32	0.008	0.01	0.001	0.007
BIG DAM EAST L.	5	0.53	0.16	0.005	0.003	0.001	0.007
BIG DAM WEST L.	6	0.77	0.02	0.017	0.095	0.037	0.267
" "	7	0.62	0.04	0.087	0.134	0.027	0.195
" "	6	0.74	0.03	0.07	0.1	0.036	0.260
BOG EXHIBIT	6	0.28	0.32	0.002	-0.004	0.0	0.0
CANNS LAKE	6	0.83	0.01	0.001	0.0	0.0	0.0
DRAIN LAKE	6	0.81	0.01	0.004	0.015	0.002	0.014
" "	6	0.48	0.13	0.002	0.004	0.0	0.0
" "	6	0.2	0.62	0.004	0.008	-0.001	-0.007
EAST TWIN LAKE	6	0.85	0.01	0.006	0.011	0.004	0.029
FRESHWATER L.	7	0.53	0.06	0.008	-0.002	0.002	0.014
JAKE LEE	6	0.001	0.97	0.001	0.003	0.0	0.0
KEJIMKUJIK L.	5	0.81	0.037	0.053	0.081	0.026	0.188
LANDS&FORESTS (C)	7	0.52	0.07	0.003	0.007	0.001	0.007
LANDS&FORESTS (F)	6	0.9	0.005	0.061	0.076	0.05	0.361
LAYTONS LAKE	6	0.79	0.02	0.096	0.145	0.05	0.361
LITTLE SPRINGFIELD	6	0.9	0.005	0.001	0.013	-0.001	-0.007
" "	5	0.81	0.04	0.002	0.002	0.001	0.007
" "	5	0.79	0.04	0.002	0.003	0.001	0.007
McLAREN POND	6	0.41	0.17	0.132	0.38	0.029	0.106
MUD LAKE	7	0.01	0.86	0.001	0.003	0.0	0.0
NEWTON LAKE	6	0.94	0.002	0.0	0.003	0.0	0.0
PEBBLELOGGITCH L.	6	0.94	0.003	0.021	0.026	0.022	0.159
" "	6	0.64	0.05	0.043	0.063	0.015	0.108
" "	7	0.64	0.03	0.035	0.038	0.011	0.079
PRESQUILE L.	7	0.98	0.001	0.016	-0.003	0.03	0.217
WEST TWIN L.	6	0.98	0.001	0.001	0.003	0.001	0.007
WOLFE SHALLOW	5	0.77	0.05	0.003	0.0	0.002	0.014
WOLFE DEEP	6	0.71	0.04	0.002	0.007	0.001	0.007

Table 7: Location, flux rate, pH, dissolved organic carbon, total phosphorus and hydrogen ion concentration.

LAKE	FLUX	PH	DOC	TP	H+
	(mgP/m2/d)		---------mg/l--------		
ADELAIDE	0	6.1	2.6	3.1	0.0008
ANTHONY	-0.007	6	2.1	3.6	0.001
BDE	0.007	5.9	3.6	6.7	0.0013
BDW	0.267	5.2	9.7	11.3	0.006
BENNET	0	6.63	5	7.2	0.0002
BL	0.014	5.3	3.3	5	0.005
BOG EXH	0	4.7	16.5	10.5	0.02
CANNS	0	6.3	4.4	8.5	0.0005
DRAIN	0.002	4.18	3.9	25	0.066
E.TWIN	0.029	4.9	6.2	9.5	0.013
FRESHWATE	0.014	7.1	1.8	7.9	0.0008
JAKE LEE	0	5.6	2.4	7.4	0.0025
KEJ	0.188	4.82	10.2	10	0.015
LAYTONS	0.361	7.3	3.9	25.4	0
LF (C)	0.007	5.5	6.3	4.5	0.0003
LF FERT	0.05	6.6	9.1	11.3	0.0002
LTS	-0.007	3.7	3.3	10.9	0.2
MCLAREN	0.106	6.7	3	13.7	0.0002
MUD	0	5.3	3.4	5	0.0005
NEWTON	0	5.6	3.4	5	0.0025
PL	0.115	4.37	13.6	14	0.043
PRESQUILE	0.217	7.4	3.6	10.5	0
W.TWIN	0.007	5.1	7.5	9.5	0.0079
WOLFE	0.011	6.52	3	5	0.0003

Table 8: Multiple regression analysis of flux rate vs
DOC, inlake total phosphorus and hydrogen ion.

```
FLUX              Stepwise Regression Summary Table

Step        Variable           Multiple         Increase  Number of Independent
 No.    Entered  Removed      R        RSQ       in RSQ     Variables Included
-------------------------------------------------------------------------------
  1      IV2(TP)           0.5640   0.3181     0.3181             1
  2      IV3(H+)           0.6211   0.3858     0.0676             2
  3      IV1(DOC)          0.6512   0.4241     0.0383             3


        Regression Statistics

Coefficient of multiple determination =  0.4241   ( Corrected = 0.3521 )
Coefficient of multiple correlation   =  0.6512   ( Corrected = 0.5934 )
Standard error of multiple estimate   =  0.0881   ( Corrected = 0.0935 )

F-Ratio                  =  3.6816
Degrees of freedom       =  3 & 15
Probability of chance    =  0.0357

Number of valid cases    =  19
Number of missing cases  =  0
Response percent         =  100.00 %   (Mean substitution used 0 times)


                      Regression coefficients

Constant =-0.0590

Var.         Coeff.        Beta       F-ratio       Prob.      Std. Error
---------------------------------------------------------------------------
IV1         0.0069       0.2015        0.998        0.665        0.0069
IV2         0.0099       0.5687        7.678        0.014        0.0036
IV3        -0.4149      -0.2421        1.450        0.246        0.3446
```

Table 9: Published SRP flux estimates from aerobic lake and river sediments.

LOCATION	TROPHIC STATUS	METHOD	FLUX (SRP) (mgP/m2/d)	REFERENCE
L.MENDOTA (WISCONSIN)	EUTROPHIC	CORE INCUBATION	1.0-5.0 a	HOLDREN, 1976
L.MENDOTA	EUTROPHIC	CORE INCUBATION	0.0-9.0	GALLEPP, 1979
L.MENDOTA	EUTROPHIC	CORE INCUBATION	(-1.92)-83.01	HOLDREN & ARMSTRONG, 1980
WINGRA (WISCONSIN)	EUTROPHIC	CORE INCUBATION	(-0.6)-3.4	HOLDREN & ARMSTRONG ,1980
MINOCQUA (WISCONSIN)	MESOTROPHIC	CORE INCUBATION	0.02-0.41	HOLDREN & ARMSTRONG, 1980
LITTLE JOHN (WISCONSIN)	EUTROPHIC	CORE INCUBATION	0.02-1.1	HOLDREN & ARMSTRONG, 1980
L.ESRON (DENMARK)	EUTROPHIC	CORE INCUBATION	(-8.0)-16.11	KAMP-NEILSON, 1974
L.ESRON	EUTROPHIC	CORE INCUBATION	-1.4 ± 0.7 b	KAMP-NEILSON, 1974
FURESO	EUTROPHIC	CORE INCUBATION	-2.0 ± 1.8	KAMP-NEILSON, 1974
GRANE LANGSO (DENMARK)	OLIGOTROPHIC	CORE INCUBATION	0.6 ± 0.1	KAMP-NEILSON, 1974
ST.GRIBSO (DENMARK)	DYSTROPHIC	CORE INCUBATION	0.2 ± 0.2	KAMP-NEILSON, 1974
L.WARNER (MASSACHUSETTS)	EUTROPHIC	HOMOGENIZED SEDIMENT INCUBATION	0.65	NEAME, 1977
L.WARNER	EUTROPHIC	LABORATORY	1.2	FILLOS & SWANSON, 1975
L.CONSTANCE (GERMANY)	EUTROPHIC	HOMOGENIZED SEDIMENT INCUBATION	1.2	FILLOS & SWANSON, 1975
LAKE ERIE (CENTRAL BASIN)	EUTROPHIC	MASS BALANCE CALCULATION BASED ON O2 DEPLETION/ CO2 INCREASE	3.51	BANOUB, 1975
LAKE ERIE	EUTROPHIC	IN SITU	0.68	BURNS & ROSS, 1972
L.ONTARIO (INSHORE SILTS)	MESOTROPHIC	CORE INCUBATION	0.68	BURNS & ROSS, 1975
L.ONTARIO (INSHORE SILTS)	MESOTROPHIC	PREDICTED FROM PORE WATER GRADIENT	0.8	BANNERMAN ET AL., 1974
L.MICHIGAN (SE NEAR SHORE)	MESOTROPHIC	CORE INCUBATION	0.17-0.57	QUIGLY & ROBBINS, 1986
L.MICHIGAN (SE NEAR SHORE)	MESOTROPHIC	PREDICTED FROM PORE WATER GRADIENT	1.12 ± 0.14	QUIGLY & ROBBINS, 1986
DOBOY SOUND		INTACT CORE	0.031	POMERY ET AL., 1965
MUDDY RIVER		LABORATORY	9.6	FILLOS & SWANSON, 1975
L.NORRIVIKEN		LABORATORY	5.0	AHIGREN, 1972

a = range
b = mean ± std. dev.

Table 1: Location and coordinates of study areas.

NO.	SITE	LATITUDE	LONGITUDE	COUNTY
		o ' "	o ' "	
1	ADELAIDE LAKE	45 19 00	66 38 50	CHARLOTTE N.B.
2	ANTHONY LAKE	45 16 10	66 43 60	CHARLOTTE N.B.
3	BENNET LAKE	45 38 12	65 05 51	ALBERT N.B.
4	BEAVERSKIN LAKE	44 18 30	65 20 00	QUEENS N.S.
5	BIG DAM EAST	44 27 00	65 16 00	DIGBY N.S.
6	BIG DAM WEST	44 28 00	65 17 30	DIGBY N.S.
7	BOG EXHIBIT	46 44 22	60 49 48	INVERNESS N.S.
8	CANNS LAKE	46 40 20	60 26 00	VICTORIA N.S.
9	CRANBERRY LAKE	44 41 00	63 29 00	HALIFAX N.S.
10	DRAIN LAKE	44 47 50	65 45 20	HALIFAX N.S.
11	EAST TWIN LAKE	45 18 40	66 36 50	CHARLOTTE N.B.
12	FRENCH LAKE	46 43 41	60 51 56	INVERNESS N.S.
13	FRESHWATER LAKE	46 38 40	60 23 47	VICTORIA N.S.
14	JAKE LEE POND	45 14 60	66 38 80	CHARLOTTE N.B.
15	KEJIMKUJIK LAKE	44 22 30	65 14 00	QUEENS N.S.
16	LANDS AND FORESTS C	44	65	QUEENS N.S.
17	LANDS AND FORESTS F	44	65	QUEENS N.S.
18	LAYTONS LAKE	45 47 40	64 15 20	CUMBERLAND N.S.
19	LITTLE SPRINGFIELD	44 48 00	63 44 50	HALIFAX N.S.
20	LOON LAKE	44 31 90	63 42 50	HALIFAX N.S
21	MCLAREN POND	45 36 45	64 57 57	ALBERT N.B.
22	MOUNTAIN LAKE	44 19 70	65 15 70	QUEENS N.S
23	MUD LAKE	45 21 00	66 36 50	CHARLOTTE N.B.
24	NEWTON LAKE	45 16 10	66 43 00	CHARLOTTE N.B.
25	PEBBLELOGGITCH LAKE	44 18 00	65 21 00	DIGBY N.S.
26	PETPESWICK LAKE	44 46 00	63 11 00	HALIFAX N.S.
27	PRESQUILE LAKE	46 41 25	60 57 25	INVERNESS N.S.
28	WARREN LAKE	46 42 50	60 23 40	VICTORIA N.S.
29	WEST TWIN LAKE	45 18 30	66 37 00	CHARLOTTE N.B.
30	WOLFE LAKE	45 39 45	65 08 57	ALBERT N.B.

FIGURE 1: LOCATIONS OF STUDY AREAS.

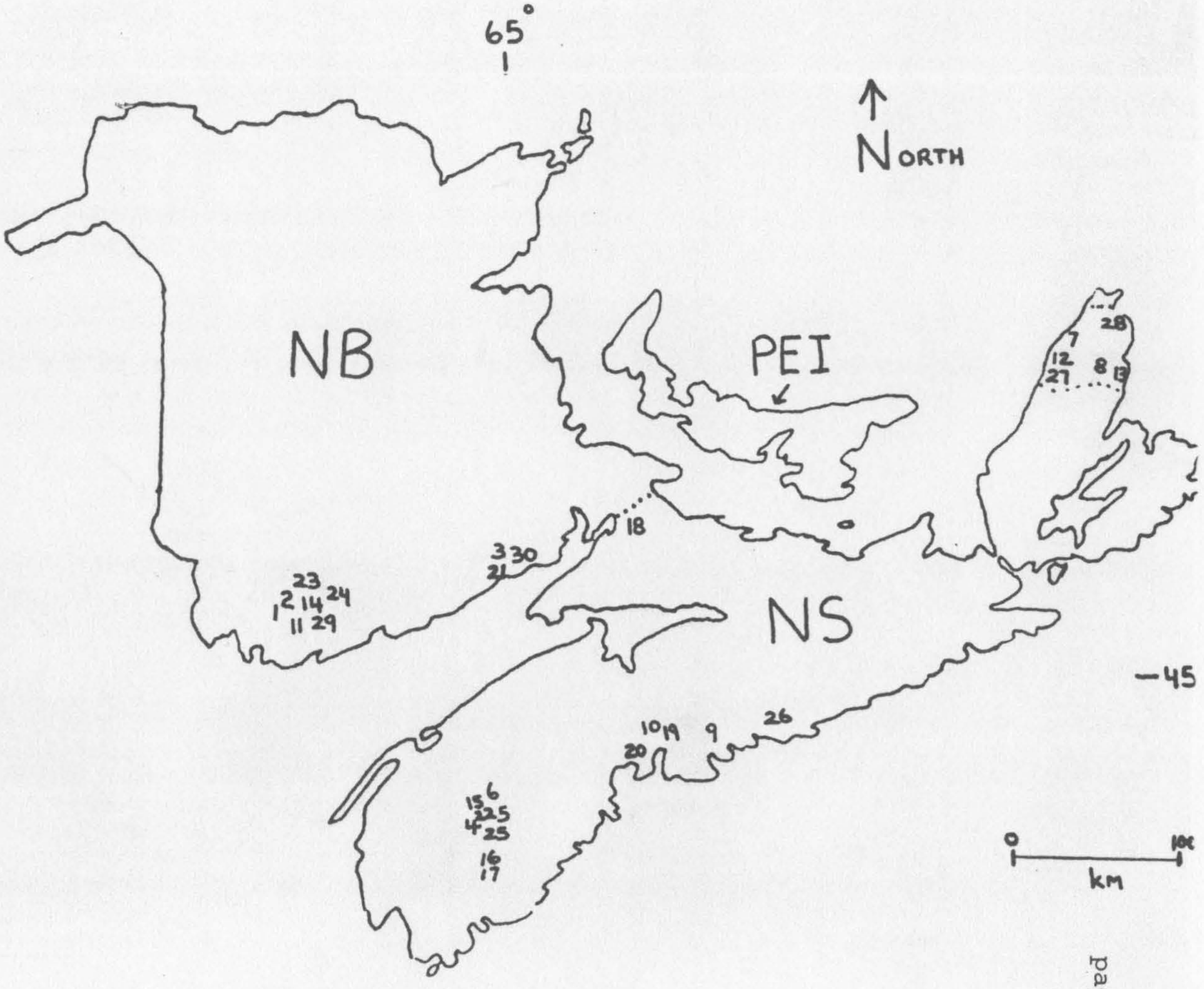

Figure 2: Changes in pH after retrieval.

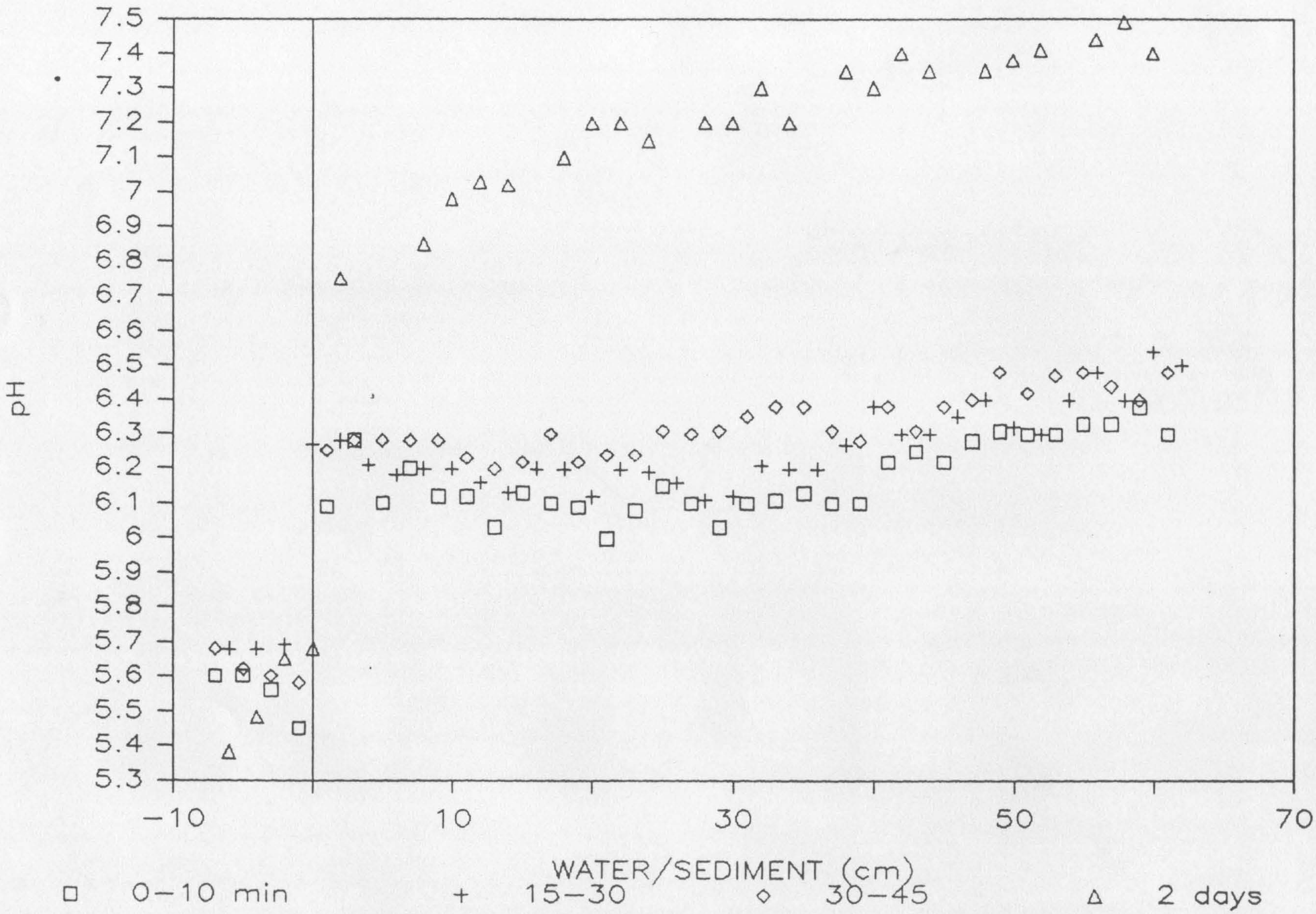

Figure 3: Comparison of sediment porewater SRP concentrations at three locations in Beaverskin Lake.

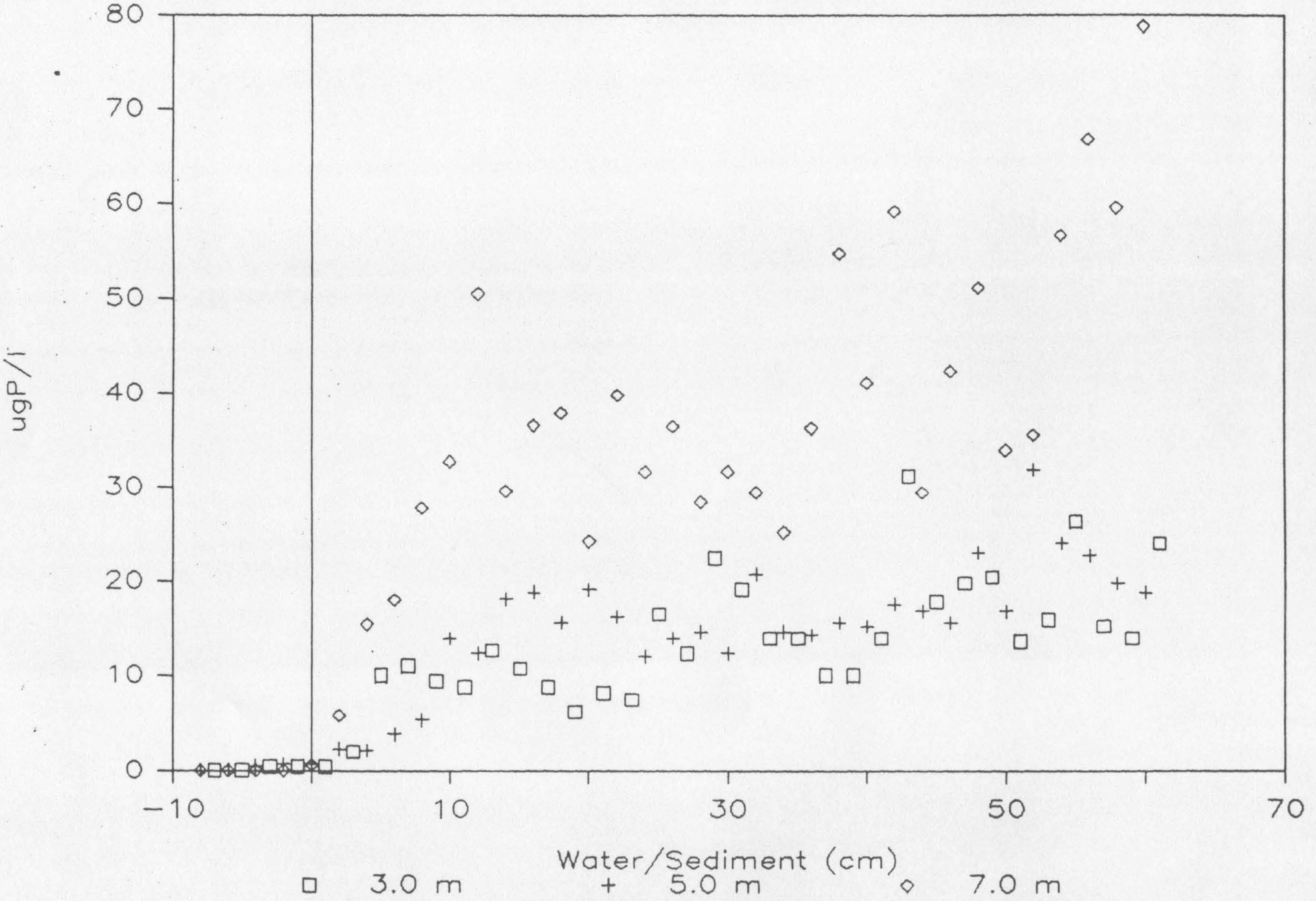

Figure 4: Sediment pH profiles in Kejimkujik Lake on four sampling dates.

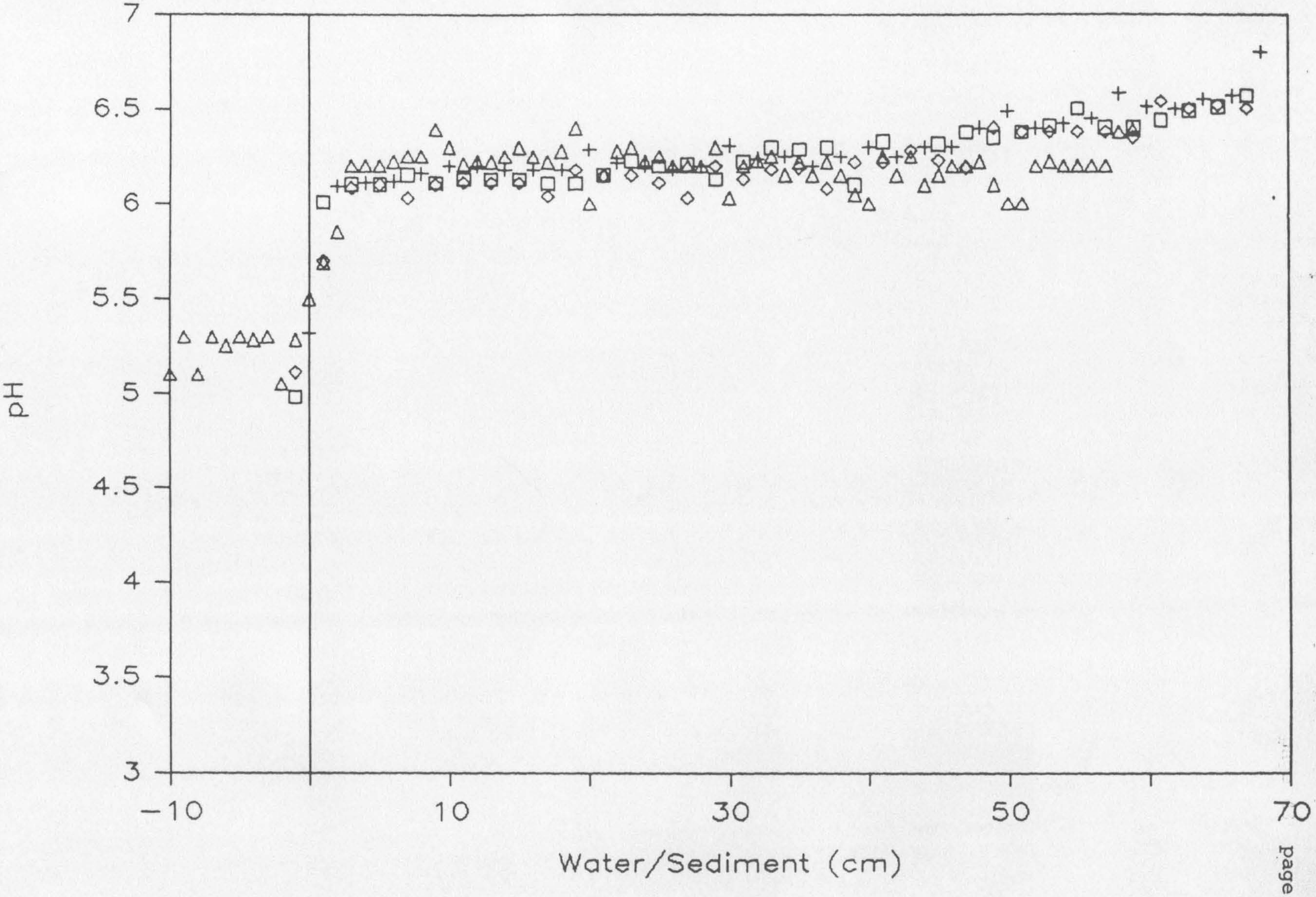

Figure 5: Sediment pH profiles in Pebbleloggitch Lake on four sampling dates.

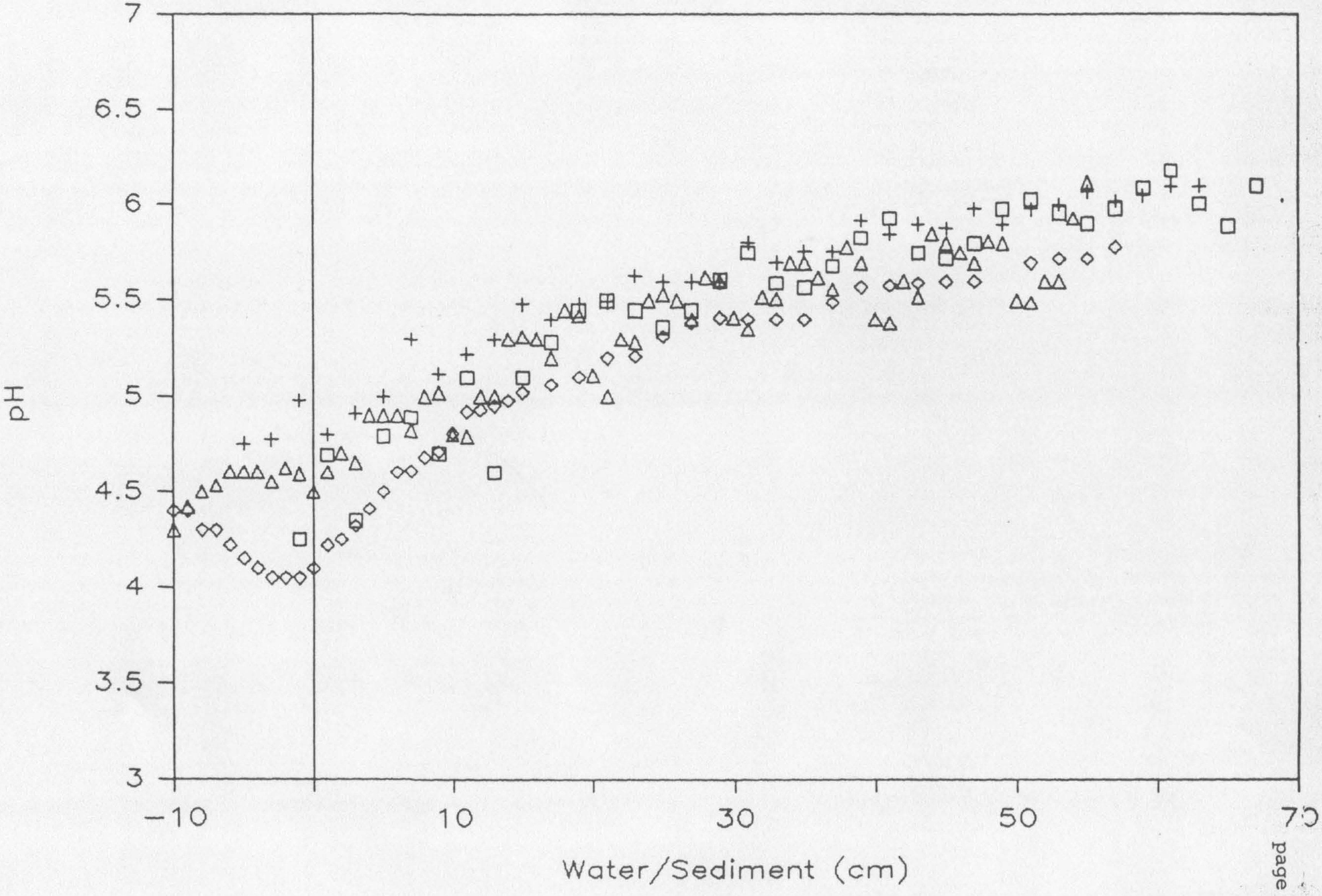

Figure 6: Sediment pH profiles in Beaverskin Lake on four sampling dates.

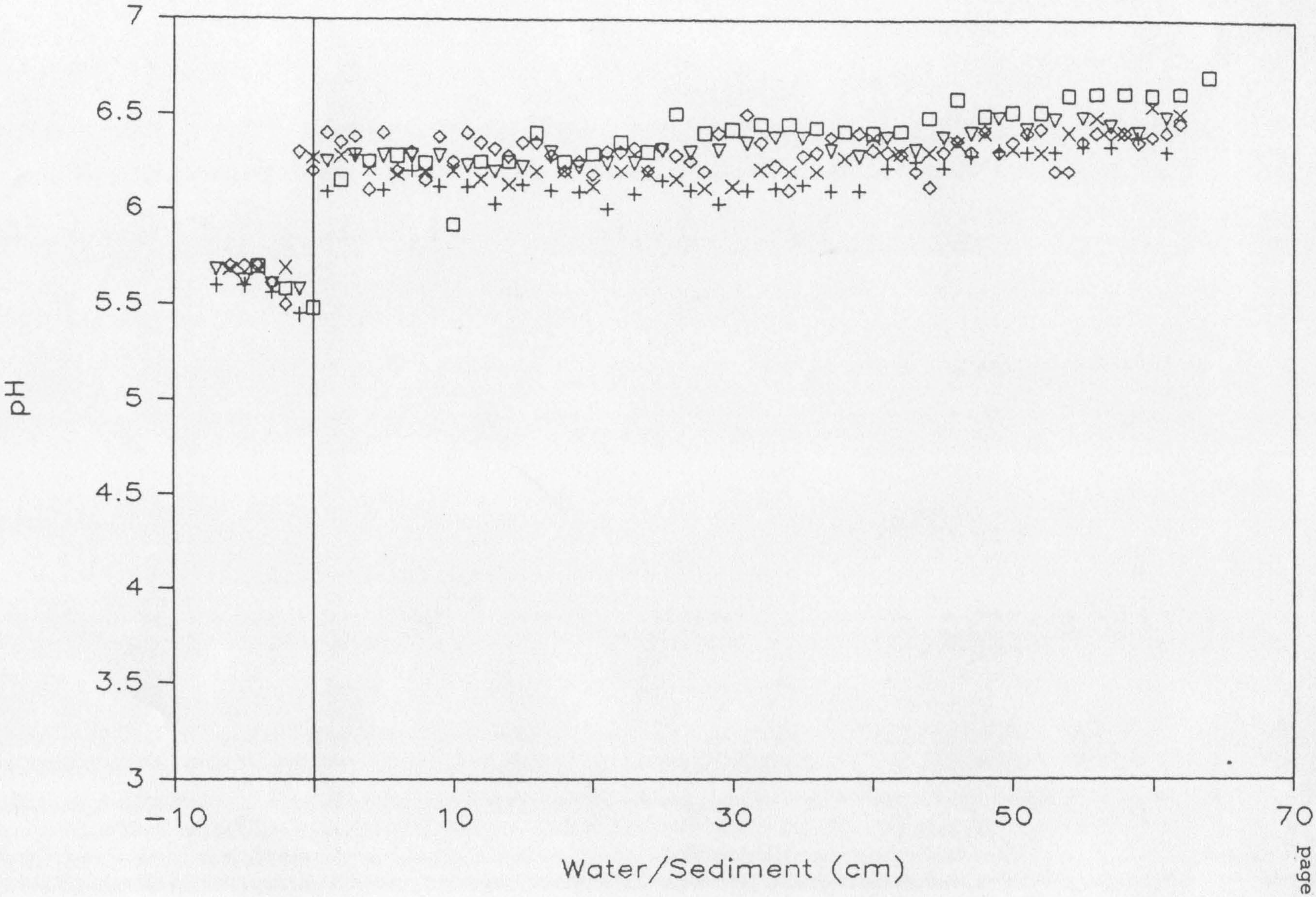

Figure 7: Sediment pH profile in Presquile Lake.

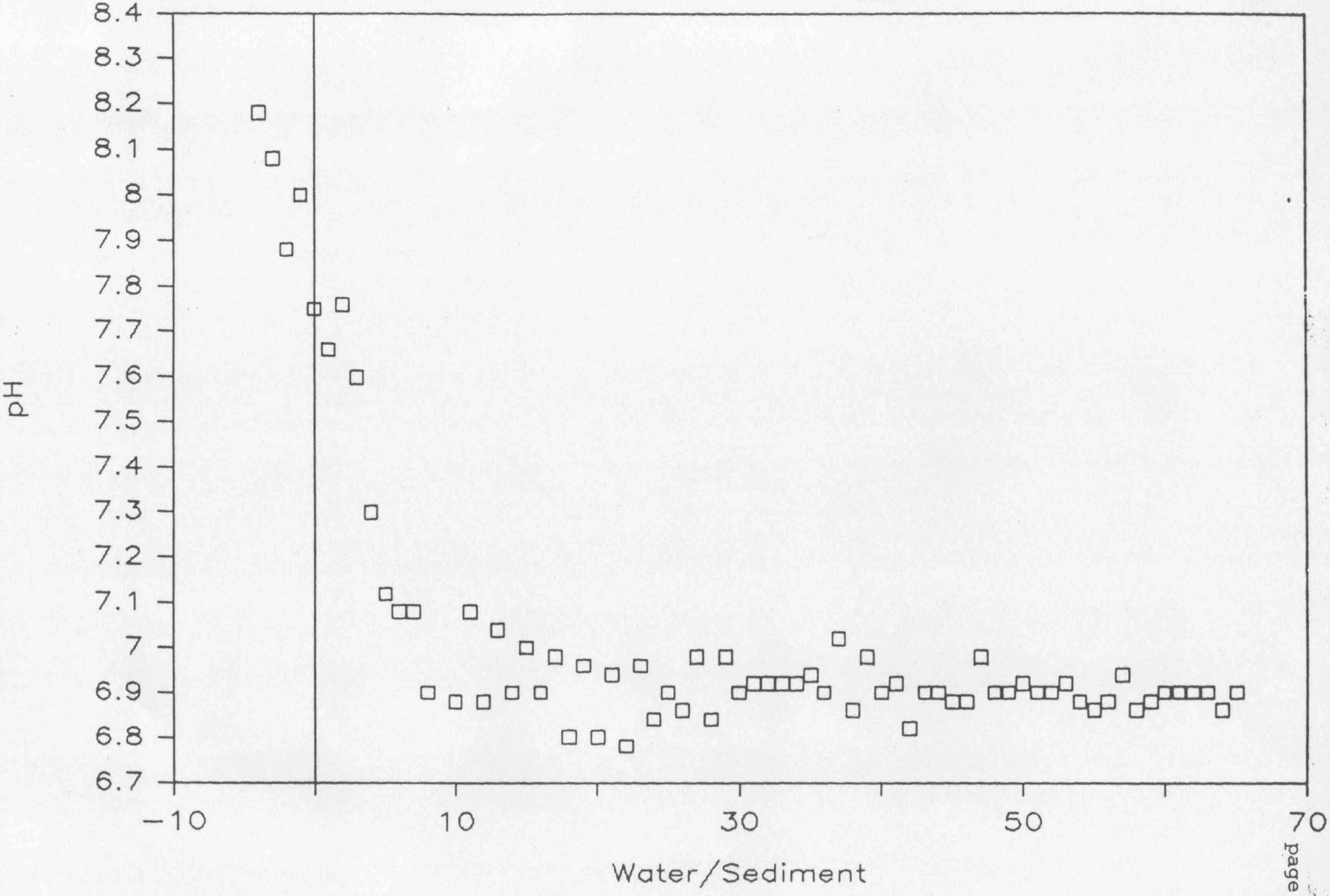

Figure 8: Specific conductance in Anthony Lake sediments.

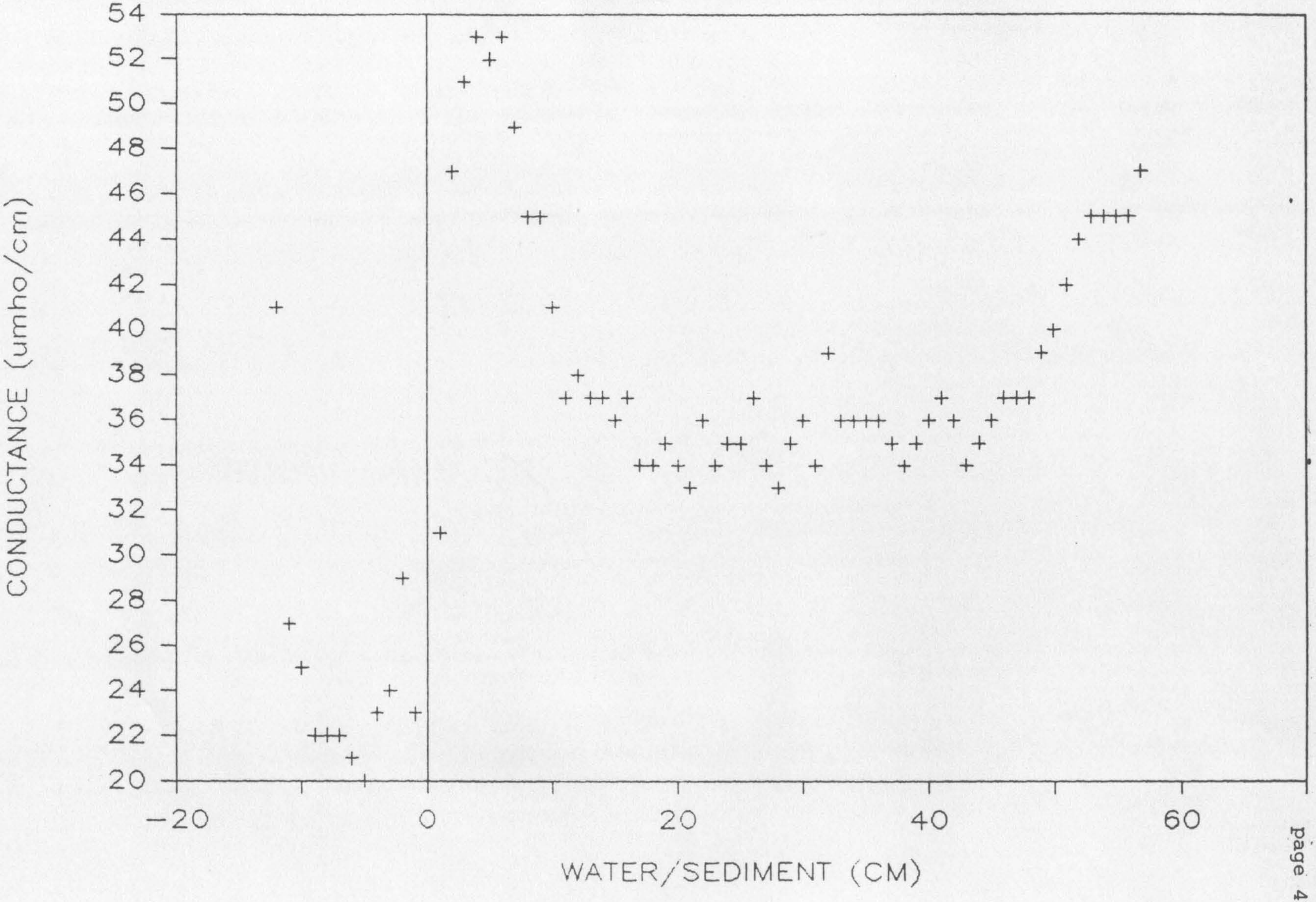

Figure 9: Total dissolved and soluble reactive phosphorus in Anthony Lake sediments.

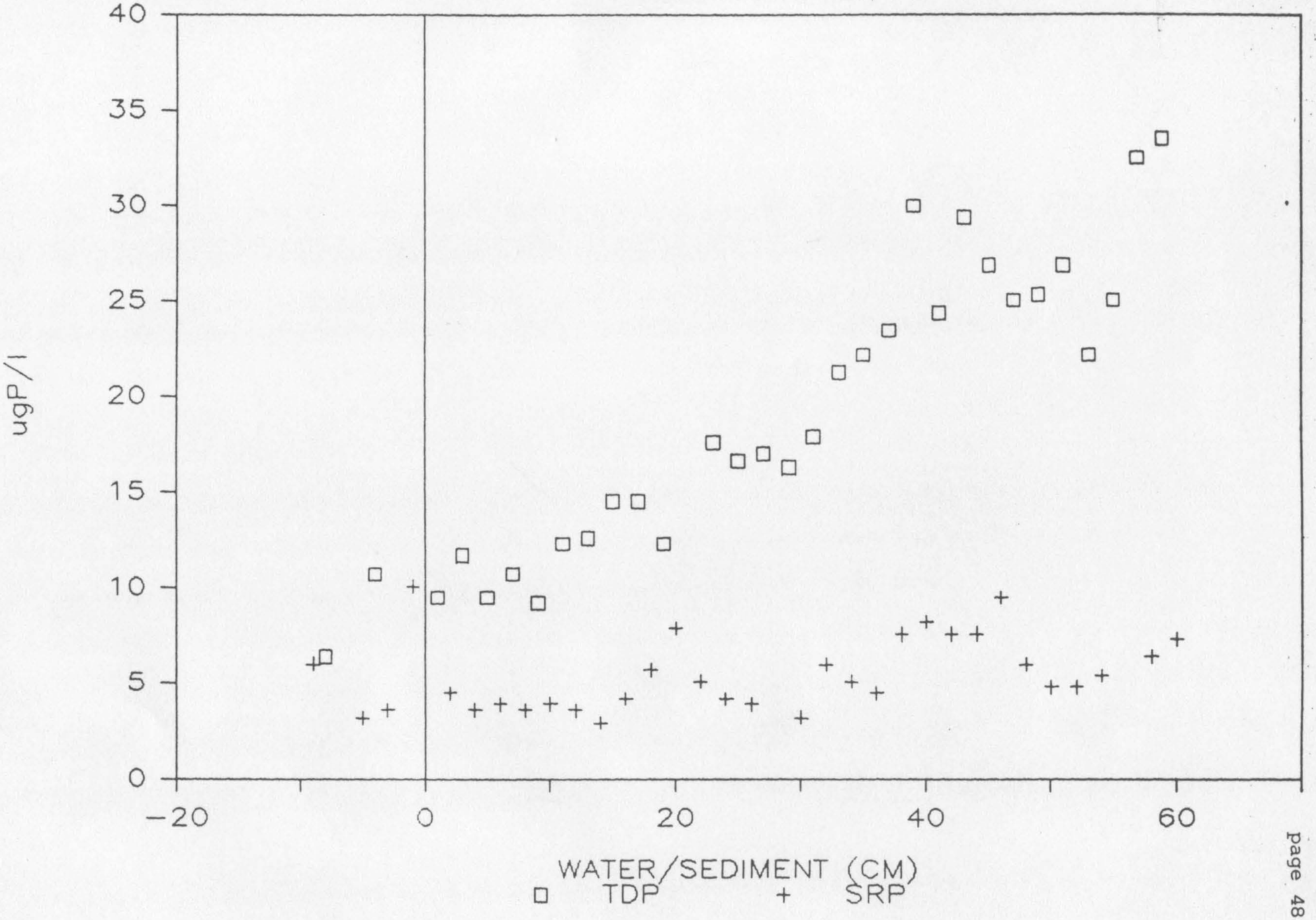

Figure 10: Soluble reactive phosphorus in sediment porewater of Big Dam East Lake (Color <5 H.u.) and Big Dam West Lake (Color ~100 H.u.).

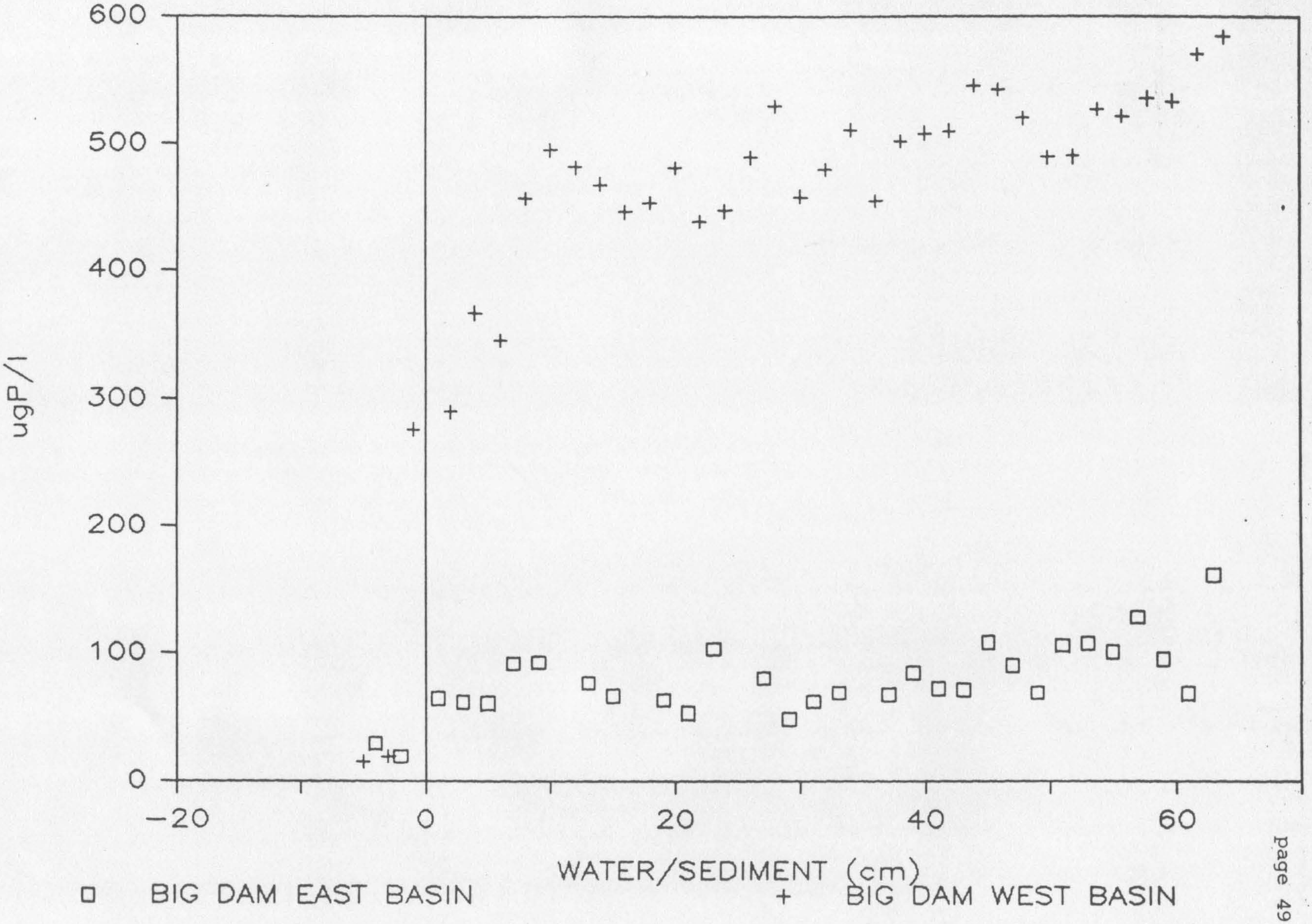

Figure 11: Total dissolved and soluble reactive phosphorus in sediments of Beaverskin Lake.

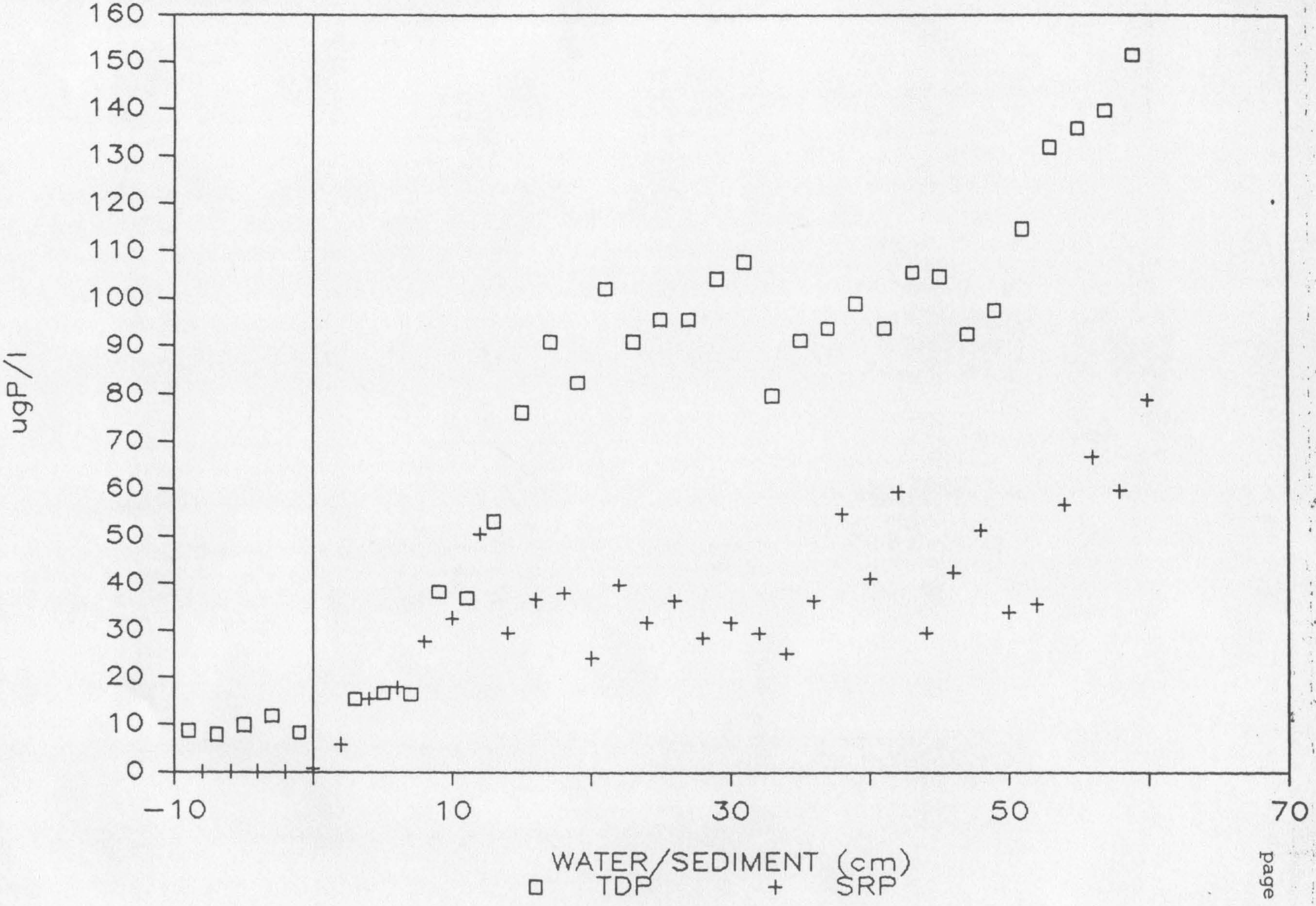

Figure 12: Total dissolved and soluble reactive phosphorus in sediments of McLaren Pond.

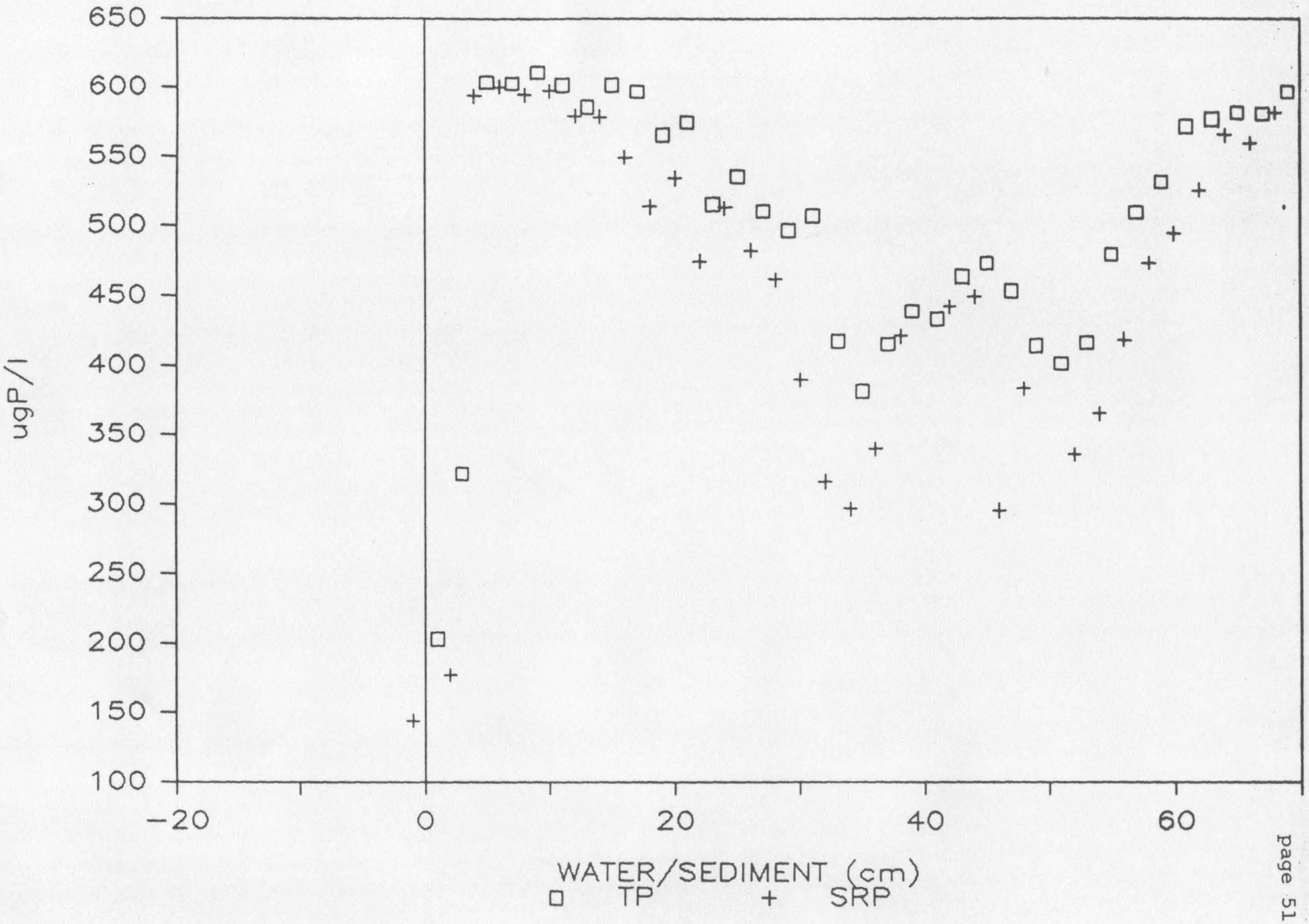

Figure 13: Soluble reactive phosphorus in sediments of Little Springfield Lake.

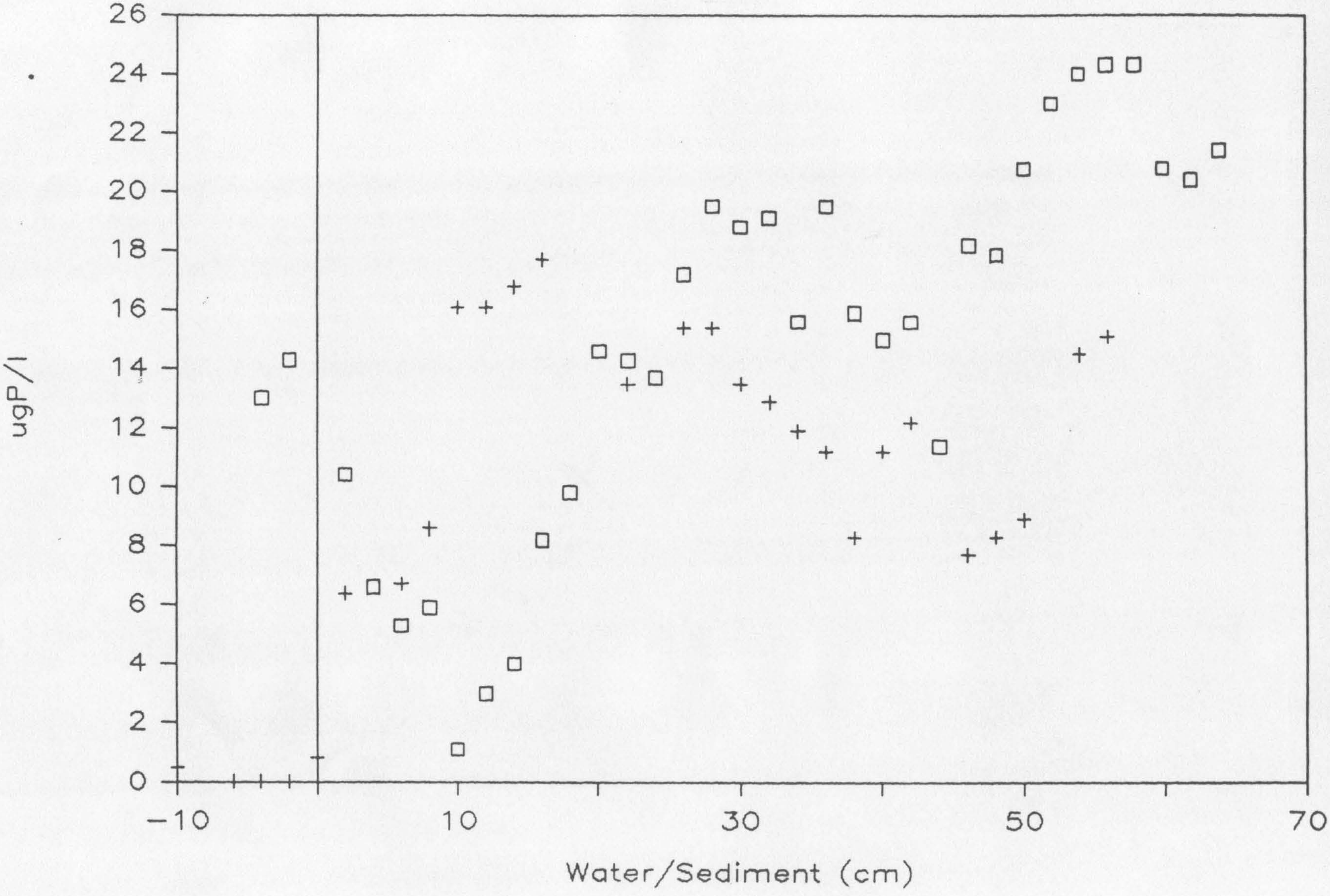

Figure 14: Percent water, organic and ash in a single core from Kejimkujik Lake.

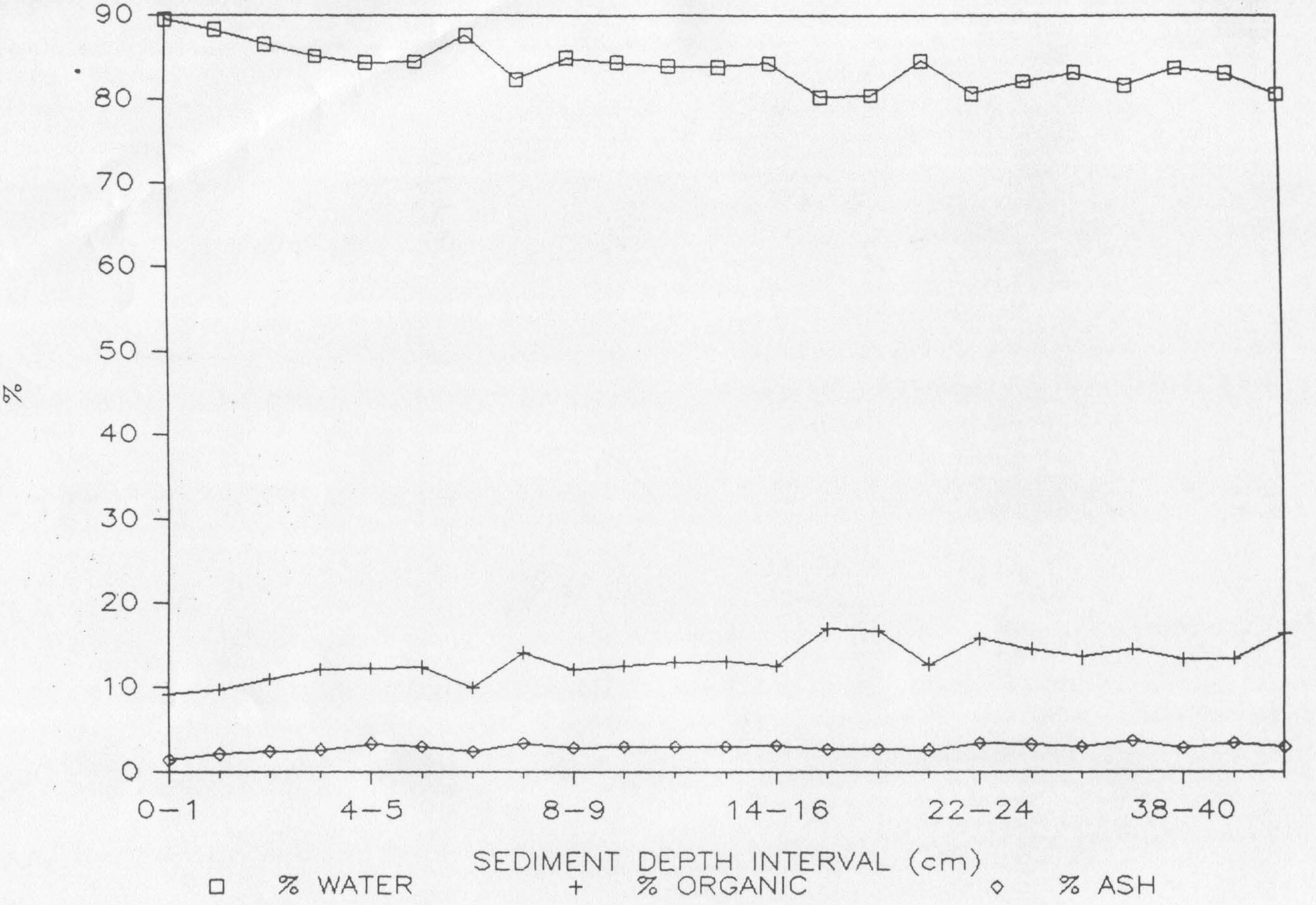

Figure 15: SRP flux versus hydrogen ion concentration in the study lakes.