A preliminary study of the ecology of Basin Head and South Lake, P. E. I.: final report of summer job corps project 16-01-009S
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A preliminary study of the ecology of Basin Head and South Lake, P.E.I.

Final report of

Summer Job Corps Project 16-01-009S

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INTRODUCTION

The Irish Moss fishery in Prince Edward Island ranks second only to lobster. The discovery of a particularly large, robust strain of *Chondrus crispus* (Irish Moss) at Basin Head in eastern P.E.I. sparked a great deal of interest both from the provincial Department of Fisheries and the National Research Council in Halifax. This hardy strain of *Chondrus* is known only to occur at Basin Head in large quantities although many similar barrachois occur along the coast-line of P.E.I. The purpose, then, of this project was to study the ecology of the Basin Head barrachois and determine the particular conditions that sustain this unique Irish Moss population. A barrachois at South Lake, about 4 km from Basin Head, was also to be studied to obtain comparative data and to determine the feasibility of transplanting this strain of *Chondrus*.

The Basin Head area is not a complete stranger to research activities. Diane Griffin (1973) researched a Masters thesis from Acadia University on the ecology of the Basin Head sand dune system. The dunes are also the subject of botany field trips from U.P.E.I. The *Chondrus* population was discovered several years ago by personnel of the P.E.I. Dept. of Fisheries while surveying for *Gracilaria*, and Jim Murchinson of that agency has done growth rate experiments with Basin Head *Chondrus* and has transplanted the plants to several locations including South Lake. Here, an acre plot was seeded this summer (1979) and the results of this experiment are yet unknown; the plants appear healthy, however.

An ecological study is a very broad topic for a 14-week project. With this in mind, a very general programme was initiated. Benthos would be studied to get an idea of species present and their density and biomass. Both phytoplankton and zooplankton would be analyzed. Nutrients are of obvious importance so weekly water analysis for various nutrients (nitrate, nitrite, phosphorous) would be undertaken. Also weekly, various physical parameters (temperature, salinity, oxygen content, pH) would be measured to provide baseline comparative data. The above variables would be studied at both Basin Head and South Lake. The Chondrus population at Basin Head would merit particular study and factors such as total biomass of the bed, growth rate and faunal relationships between the Chondrus and other biota would be examined.

If it were possible to transplant the BH strain of Chondrus to other barrachois and have a similar rapid growth rate and large, healthy plants, a kind of aquaculture could develop involving low overhead costs and relatively little manpower. This preliminary study of the ecology of Basin Head and South Lake should provide valuable baseline data for selecting appropriate sites which may support a profitable Irish Moss population.

STUDY AREA

Basin Head is a barrachois or lagoon located in eastern Kings County, P.E.I., 12 km east of Souris. The harbour proper is about 760 m long and 380 m wide with a channel, 500 m long, connecting it to the Northumberland Strait (Fig. 1). This channel is relatively deep, about 2.5 m, and was formed some 40 years ago when the former channel at the most eastern end of the system filled in. The harbour is shallow, from 1.0-1.5 m deep at high tide, with extensive eel grass beds and a very soft bottom, likely for formed when the area was the head of the system.

A long, narrow arm extends for 3.0 km east of the harbour, separating a large sand dune system from agricultural land to the north. This arm, about 100-130 m wide, is a sheltered area protected by the dunes to the south and steep banks to the north. The fields above the barrachois support a variety of crops including potatoes, clover and oats. A typical *Spartina* spp. dominated salt marsh borders the system to the south and in pockets to the north.

The Basin Head sand dunes are a very fragile ecosystem supporting five vegetational communities. The *Spartina* spp. community, as mentioned above, borders the barrachois while the *Ammophila breviligulata* community anchors the dunes and causes them to grow to great heights. The *Corema Conradii* - *Cladonia* spp. community is very fragile and easily disrupted, while *Picea mariana*, occurring in low lying positions forms a relatively stable community. This holds true also of the *Vaccinium macrocarpon* community which is found in sheltered slacks receiving nutrients from nearby higher dune areas (Griffin, 1973). These dunes, from 400 to 800 m wide, extend the length of the arm.

The Basin Head barrachois is dominated by eel grass, Zostera marina, Chondrus crispus and Ulva lactuca (sea lettuce). Zostera is ubiquitous throughout the system while large sheets of Ulva are found piled several layers deep at the head, completely covering the substrate. Chondrus is found about 800 m up the arm and continues for 1100 m, with very dense growth occurring between Transects 1 and 4 (T1 and T4) (Fig. 3). Here, Chondrus forms a thick mat over the substrate anchored only to the blue mussel Mytilus edulis. Common fish species include the eel Anguilla rostrata, mummichogs (Fundulus heteroclitus) and Pseudopleuronectes americanus (winter flounder), while major invertebrates inhabiting the system, apart from Mylitus, are the periwinkles Littorina littorea and L. saxitilis, the crab Cancer irroratus, the amphipod Gammarus oceanicus and the polychaete Nereis diversicolor. The clam Mya arenaria occurs in the sandy intertidal mud flats of the harbour and lower arm and supports a small clamming fishery.

Good tidal flushing appears to occur at Basin Head with fairly strong currents still evident about 2 or more km up the arm. The tidal amplitude is 0.7 m maximum but the tide height up the arm is rather unpredictable; sometimes high tide coincides with high tide outside the system and other times a delay of several hours seems to occur.

South Lake is another barrachois about 4 km east of Basin Head and 9 km west of East Point. It is 4.7 km long and 0.4 to 0.6 km wide and is open to the Northumberland Strait at the western end of the Lake (Fig. 2). Here, the tide flows over an extensive sand shoal and fairly strong currents occur around the mouth; water flow diminishes farther up the barrachois. At high tide about 2 m of water cover the deeper areas near the head and the mouth, while at low tide several sand bars are barely submerged, particularly 400 m up from the mouth. Tidal amplitude is similar to Basin Head, from 0.5 to 0.7 m. The barrachois is basically similar to that at Basin Head being bordered by a typical Spartina salt marsh, agricultural land and sand dunes. However, the dunes are much narrower and less complex at South Lake, being dominated solely by an Ammophila breviligulata community with an occasional Picea mariana.

The barrachois is dominated by Zostera marina although numerous species of algae also occur. A preliminary checklist of the algae at South Lake has been compiled by Jotcham (1979). Ulva lactuca occurs in dense canopies over the bottom at the head of South Lake; however Chondrus is rarely found apart from a patch of transplanted Basin Head Irish Moss (see Appendix I). Fish and invertebrate species are comparable to those at Basin Head although the fauna at South Lake appears somewhat more diverse. Substrate in the upper three-quarters is very soft, fine silt easily disturbed whereas that of Basin Head was generally more clay-like in consistency.

MATERIALS AND METHODS

Five transects at Basin Head and 4 at South Lake were established early in the summer. At Basin Head, the transects ran through the area of Chondrus growth with Transect 1 (T1) located where the first specimens of robust moss were found and Transect 5 (T5) where they eventually petered out (Fig. 3). Transects 2 and 3 (T2 and T3) ran across dense beds of Chondrus. Transects were approximately 300 m apart and were marked on either shore with wooden stakes painted flourescent orange. In addition to the transects, several sampling sites were visited at Basin Head, indicated on Fig. 3 as S1, S2, S3, S4, S5 and S6. At South Lake, one transect was established through the transplanted Chondrus (T2) and one 600 m to each side (T1 and T3). An additional transect (T4) was located near the mouth of the barrachois (Fig. 2). These transects were also marked with orange wooden stakes.

Benthos was quantitatively sampled using a 15 cm by 15 cm Eckman grab (Ward's). Three sampling stations were established along each transect, two each 1 m from the edge of the salt marsh on either side and one in the middle. Duplicate or single grabs were taken at each station and were sieved through a 850 μ mesh (Canadian Standard Sieve Series No. 20) and then a 425 μ mesh (Canadian Standard Sieve Series No. 40). This procedure prevented the coarse vegetative material from clogging the fine screen. Once washed, the contents of both sieves were put in jars containing 4% formalin. The preserved samples were sorted in the lab and stored in 70% ethanol. The organisms were identified to species and enumerated using Zeiss binocs and Olympus microscopes and weighed using a Mettler H-20 or P-1200 microbalance. Various vertebrate and invertebrate keys were used in identification including Miner (1950), Leim and Scott (1966), Gosner (1971), Bousfield (1973), Morris (1973), Brinkhurst et al (1976), Linkletter (1976) and Appy, Linkletter and Dadswell (1979).

Benthos sampling along transects at Basin Head occurred every 2 weeks from 5 June until 2 August 1979, inclusive. In addition several sites were visited twice during the summer. Sampling was less intensive at South Lake being undertaken 3 times during the summer.

The following parameters were measured on a weekly basis at Basin Head from 29 May to 10 August 1979 and on each visit to South Lake: Salinity, oxygen content, pH and temperature. Salinity was measured at each station with a Model 33 S-C-T Meter (Yellow Springs Instrument Co.) calibrated frequently with standard sea water. Oxygen was measured at the middle station of each transect with a Model 54 Oxygen Meter (Yellow Springs Instrument Co.) In addition, two BOD samples were taken and immediately preserved at each transect, and were titrated in the lab following the Windler method, after Strickland and Parsons (1972). Temperature was measured on both meters and by using a standard mercury thermometer, while pH was measured in the lab on water samples using a Fisher Accumet pH meter (Model 210).

The following nutrients were measured on a weekly basis from 21 June to 10 August 1979 at Basin Head and on 28 June and 19 July 1979 at South Lake: nitrate (NO_3^-), nitrite (NO_2^-) and reactive phosphorous (P). Two water samples were collected at each transect in plastic sample bottles, 1 ℓ for nitrate and nitrite analysis and 0.5 ℓ for phosphorous analysis. Samples were millipore filtered upon collection and immediately frozen on dry ice. Analysis of these nutrients followed Strickland and Parsons (1972) using mini-reduction columns for nitrate. Absorbance was read on a Coleman 124 double-beam spectrophotometer.

Total nitrogen content of Chondrus crispus was measured following the Kjeldahl experiment (Clark, 1943). These plants were selected randomly on various dates, dried, and ground using mortar and pestle as no ball mill was available. Also, the generation (gametophyte or tetrasporophyte) of the Basin Head Chondrus was determined by testing for kappa carrageenan (gametophyte) or lambda carrageenan (tetrasporophyte). This method is outlined in Weesh and Shadlock (1971).

Plankton tows were taken at various sites but no quantitative work was done. Both Basin Head and South Lake were sampled using a phytoplankton (#10) net and several zooplankton nets of undetermined sizes. Two plankton nets were devoured by South Lake; this unexplainable hunger limited plankton sampling. Samples obtained were sent to Acadia University to be analyzed.

Permission was obtained from Fisheries and Oceans Canada to set a Fyke net at Basin Head. It was set twice; once overnight and again for about 4 hours. The fish caught were preserved and stored in 10% formalin.

Several temporary transects were established in order to determine total biomass of Irish Moss at Basin Head. Transects were set up 50 m apart and a rope marked in metres was stretched across the width of the bed. Then a team of two "divers" equipped with mask and snorkel (and wetsuits on occasion) and two in a boat or canoe followed the rope across noting occurrance of Zostera and Chondrus. Samples were taken every 8 m in the Chondrus bed using round stainless steel 1/4 m^2 plots. The flora within the plot was gathered and taken ashore where the Chondrus was separated from Zostera and Mytilus and then weighed. Since this procedure was labour intensive and didn't begin until late summer, only 9 transects were completed and the data for 2 of these misplaced. The results of this study are presented in Table 12, but no total biomass estimate of Chondrus at Basin Head for the summer 1979 could be speculated.

On several occasions during the summer, Jim Jotcham and I undertook specific plant collecting trips of both salt marsh vascular plants and algae at Basin Head and South Lake. On these occasions, collections were made both with snorkel gear from canoe or boat and by hand from shore. Larger, more obvious specimens were also collected during regular field trips. Specimens were either mounted on herbarium sheets or preserved in vials of 4% formalin and keys used in identification were Dawson (1956), Taylor (1957) and Brunel (1962). Jotcham (1979) prepared a preliminary report on the algae collected from South Lake.

RESULTS

All species collected at Basin Head and South Lake with notes on abundance and habitat are listed in Appendix I. This includes benthic species (collected by Eckman grab), fish species (collected by Fyke net), algal and vascular plant species and other specimens collected by hand. The species list comprises only organisms inhabiting the two barrachois and plants of the immediate salt marshes. Abundance of species is given as abundant, common, occasional or rare with habitat and special relationships noted. The list of plant species is based primarily on the work of Jim Jotcham, taken from Jotcham (1979) for South Lake species, and personal communication for Basin Head flora.

Benthic species for Basin Head are listed in Tables 1 and 2 while those for South Lake are found in Table 3. Each table shows numbers per m^2 for each transect on each sampling date. At Basin Head, the major species in abundance was the polychaete *Nereis diversicolor* which was found throughout the barrachois. Other numerous polychaetes were *Polydora ligni* and *Scoloplos fragilis*. Molluscs comprised an important component of Basin Head fauna. *Littorina* spp. were found upon *Chondrus* fronds and *Ulva* plants, while *Mytilus edulis* was abundant in association with *Chondrus*, acting as a firm substrate for the holdfasts of these plants. *Gammarus oceanicus* was the most commonly collected amphipod but *Corophium* spp. were also numerous, albeit much smaller. Collected rarely in the Eckman grab was the four-spine stickleback, *Apeltes quadracus*. Although not benthic in nature it is included with the benthos as it was collected in the same samples.

Species diversity was a little higher at South Lake than at Basin Head, largely due to a greater number of polychaete species collected there. No one species was clearly dominant in numbers, but major species included *Nassarius trivittatus*, *N. obsoletus*, *Nereis diversicolor*, *Polydora ligni* and various other Spionidae, and *Corophium* spp.

Physical data (temperature, salinity, dissolved oxygen and pH) collected along the Basin Head transects throughout the summer are presented in Table 4, while Table 5 shows physical data for the South Lake transects. Temperature increased during the study period from about 16°C inearly June to about 23°C in early August, with a subsequent decline due to a cool snap. The water at the head of the system (T5) was generally warmer than that nearer the mouth. Salinity was lower at the head and higher near the mouth of the barrachois with values dependent upon tide height (i.e. amount of sea water influx) and ranging from 10 $^{o}/oo$ to 23 $^{o}/oo$. The amount of dissolved oxygen varied from day to day, dependent upon plant activity. Generally there was less oxygen at the head of the system with values from about 7 to 13 µg-at per litre, whereas values at T1 ranged from about 9 to 19 µg-at per litre. Values of pH were relatively constant, from 6.5 to 7.5, throughout the summer. At South Lake, much the same picture is drawn with salinity and oxygen values higher near the mouth. However, a narrower range of values is evident at South Lake likely due to its larger size and greater mixing potential.

Nutrient data for Basin Head and South Lake are shown in Tables 7 and 8, respectively. Nitrate, nitrite and phosphorous were chosen for analysis as these nutrients are often a limiting factor in algal growth. Other nutrients, although undoubtably important, were not analyzed because of lack of time and personnel. Values of these nutrients were generally somewhat irregular from transect to transect and from one sampling date to another, but generally higher phosphorous concentrations were evident at South Lake while concentrations of nitrite and nitrate were higher at Basin Head. Nitrate was 100 to 500 times the concentration of nitrite and phosphorous 50 to 100 times more concentrated than nitrite. Buckle (1977), working in the Minas Basin, reported higher nitrate than nitrite concentrations with generally higher values for both. As well, results in that study were similarly irregular. He did, however, correlate higher nutrient content with increased sediment load in the water column.

On three occasions during the project one site was sampled hourly to get an idea of nutrient flux and changes in physical parameters over a period of time. Because of the impetus of Irish Moss to this project, both Basin Head sites were located over dense *Chondrus* beds (T2 on 13-14 June and T3 on 11 July) while the South Lake site was over the transplanted BH *Chondrus* (T2, 6 August). The first study was 24 hours in duration; however sampling throughout the night proved arduous so 12 hours studies were henceforth conducted. Every hour, water samples (for NO_3^- , NO_2^-, P, pH), water depth, temperature, salinity and oxygen content measurements were taken. Vertical plankton hauls were taken hourly the first trip, but were abandoned in the future as depth was too shallow and zooplankton too sparse. The results of the "overnight trips" to Basin Head and South Lake are presented in Table 9 and Fig. 4 (physical data) and Table 10 and Fig. 5 (nutrient data). No overall pattern in nutrient flux is discernable from these results, however on 11 July, Basin Head, nitrate was most concentrated at low tide, as were nitrite and phosphorous on 6 August, South Lake. Buckle (1977) reported that nitrate and nitrite values were higher at low tide; this was related to increased sediment load. The Minas Basin, where Buckle researched, is very much more turbid than either study area here; this may explain the lower concentrations and irregular results. Several points are evident from the hourly physical data. On 13-14 June, Basin Head, salinity follows the tidal cycle, as could be expected, with higher values at high tide and vice-versa. Temperature was tempered by the ambient temperature, as the chilly values for early morning indicate, but also was a factor of tide height. However, on 11 July temperature increased throughout the day leveling off in the evening, whereas salinity decreased steadily. On that day, water depth was slow in increasing, reflected in a delay of incoming seawater bringing lower temperatures and higher salinities. The tide was very low, 0.1 m, during the afternoon likely contributing to the delayed high tide at the study site. Oxygen values dropped off with nightfall as one might expect with cessation of photosynthesis and increased respiration.

Overall, conditions over a period of time seemed more stable at South Lake than Basin Head with less variations in parameters. Again, high and low tide appeared delayed about 2 hours from the tides predicted for the immediate Northumberland Strait. Oxygen content dropped sharply with the setting sun, as occurred at Basin Head, again likely as a result of plant activity.

Several plankton tows were taken throughout the summer. The zooplankton is currently being analyzed at Acadia University, while some phytoplankton results are incorporated into the species list in Appendix I. Copepods were extremely abundant in early summer at South Lake, but not Basin Head.

Chondrus crispus at Basin Head appeared to be a unique strain found only in this area in large quantities. The dense *Chondrus* bed began about halfway between T1 and T2 and continued luxuriant until halfway between T3 and T4. The moss did not occur in great quantities in channels, where eel grass dominated. Generally, the population was densest and most pure in shallow flat areas; indeed some fronds of *Chondrus* were exposed on very low tides. Patches of bare mud and empty mussel shells were scattered throughout the *Chondrus* bed. These seemed to occur naturally but may also be the result of transplanting activities. The plants were generally large, robust and healthy with little evidence of grazing activity. The density of the population in spots was over 5 kg per 1/4 m^2 (20 kg / m^2) with an average of about 7.5 kg per m^2. These figures apply to the moss bed from T2 to about 100 m beyond T3 where the population is most dense. Seven transects, 50 m apart, were run across the barrachois in this area and 30 samples in total were taken along these transects in areas of dense *Chondrus* growth as well as in areas where only a few plants were found among the eel grass blades and in patchy areas. All mussels and eel grass was sorted from the *Chondrus* before weighing. In very dense areas, biomass was regularly from 10 to 14 kg per m^2. Jim Murchinson, in a study in 1977, reported the amount of *Chondrus* at Basin Head to be about 95,000 kg with an average density of 2.8 kg per m^2. His study encompassed the whole bed from T1 to T5, whereas my calculations are from the densest part of the bed. However, it seems that for the same area, the population was more dense in 1979 than in 1977.

The sediment at Basin Head is very soft black mud, an unusual substrate on which to find *Chondrus* plants. These plants, however, are found anchored by their holdfasts to the blue mussel, *Mytilus edulis*, and its abyssal fibres. Several species appear to be associated with this unusual *Chondrus* population (Table 13). *Nereis diversicolor*, an important component of the benthic fauna, is commonly found amongst these plants along with the scale worm *Harmothoe imbricata*. Smaller annelid species also found on Irish Moss plants include *Polydora ligni*, *Streblospio benedicti* and various oligochaetes. *Littorina littorea* and the smaller *L. saxitilis* creep on the *Chondrus* plants while a great quantity of amphipods, mostly *Gammarus oceanicus* but also *Corophium* spp. and the isopod *Jaera marina* cling to the *Chondrus* fronds. *Cancer irroratus* is commonly seen using the firm plants to walk upon; this crab is uncommon in soft bottom habitats, and apparently uses the Chondrus bed as a semi-firm substrate. The most noticable relationship, as mentioned before, is between Chondrus and Mytilus, with the latter comprising from about 10% to 50% of the Chondrus biomass in a given sample, whereas amphipods comprise only from 0.5% to 0.9%.

Few epiphytes grow on the Chondrus population compared to the neighbouring Zostera blades which support a variety of epiphytic forms. It may be that the amphipods, notably G. oceanicus, graze on the epiphytes keeping the population in check and the Chondrus "clean". Idotea balthica is used in Chondrus culture tanks to graze on epiphytic growths; perhaps Jaera marina performs this function, in part, in the Basin Head system although this isopod at Basin Head is very small in size but numerous. It is known that Littorina don't browse directly on Chondrus plants once they are larger than 1 or 2 cm (Dr. Hanic, pers.comm.), so perhaps these gastropods also help keep the epiphytic population in check. Littorina littorea is likely more effective in this matter than L. saxitilis as the latter is common on the heavily epiphytized Zostera blades where L. littorea would be too large and heavy to cling to the delicate blades; the more robust Chondrus easily supports large numbers of this species. The Chondrus plants showed little evidence of actual grazing on their fronds (as opposed to the epiphytes) although towards late summer some plants had irregular tips as if they had been consumed. This could have been due to amphipod or gastropod feeding activities.

The Chondrus plants were tested for carrageenan type and of 80 randomly selected plants all had kappa carrageenan; that is they were gametophytes. It could be that the population reproduces asexually and has no alternation of generation. Further tests are necessary to determine if any tetrasporophytes are present. Test done in 1977 on BH Chondrus revealed a very high carrageenan content with some plants having over 75% carrageenan (mostly kappa carrageenan) (Murchinson, pers. comm.). The total nitrogen of various plants of the Chondrus population was tested and values ranged from 2.67 to 3.12% nitrogen, somewhat higher than 2.35% nitrogen for Ulva (Table 11). These values compare well with nitrogen content of Chondrus plants in Nova Scotia (Staples, pers. comm.)

In areas of dense Chondrus growth, the substrate was generally very black and smelled strongly of hydrogen sulphide (H_2S). It could be that the dense canopy of Chondrus acted to create a partially anaerobic condition resulting in increased activity of sulphur reducing bacteria. However, the benthos from these areas was not significantly different from that in areas of sparse or no Chondrus growth. A similar condition resulted from dense Ulva growth at the head of the barrachois.

CONCLUSION

Basin Head and South Lake are two quite similar areas. Both barrachois are bordered by saltmarsh and surrounded by farmland to the north and a sand dune system to the south. Both are somewhat estuarine, connected to the waters of the Northumberland Strait by a narrow opening, yet with relatively little fresh water input. However, significant differences exist between the two areas. South Lake is larger and deeper than Basin Head and physical conditions of the water are less variable. The water at South Lake is more turbid, likely due to mixing currents created by wind action, and precluded bottom visibility except near the mouth where the water was much clearer due to the sandy bottom. Basin Head is a more sheltered area due to the wider sand dunes and steep treed banks acting as wind barriers. Also, the barrachois is much narrower. The water is basically clear despite a muddy bottom and swift currents; evidently the substrate is less easily disturbed (i.e. not as fine) as that at South Lake.

The presence of _Chondrus_ at Basin Head and not South Lake is a result of several factors. The areas seem comparable in terms of physical water conditions, nutrients, flora and fauna. The abundance of mussels at Basin Head in clear, shallow water apparently provided a suitable point of attachment and growth for Chondrus. No extensive mussel bed was found at South Lake and here the turbid water could have clogged filtering apparatus in these pelecypods and would reduce light intensity to any bottom plant. At Basin Head, the swift current flowing through a fairly narrow channel likely sustains the filter feeding mussel population but it would be interesting to know why the mussels (and subsequently *Chondrus*) grow so prolifically in the 500 m or so area between T1 and T3.

Basin Head is a unique area and further studies there would prove valuable. A detailed study of the epiphytes, both plant and animal, on *Zostera* blades would be a worthy project in itself. Some data from the Northumberland Strait would be useful in comparing physical parameters, plankton and nutrients. Whenever we had time for such an excursion this summer, the water was too rough for our small boat. A more accurate estimate of total *Chondrus* biomass at Basin Head should be calculated involving many transects and much sorting and weighing. It would be valuable to know what enters the system in terms of sediment and nutrient input from nearby farmland and what water movement is like within the system. Water flux, current and turbidity are likely key factors limiting *Chondrus* growth and future studies should measure these parameters as well as further baseline data.

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TABLES

Table 1. Numbers per m^2 of benthic invertebrate species collected along 5 transects (T1-T5) at Basin Head, P.E.I. on 23 May, 5 June, 21 June, 5 July, 20 July and 2 August, 1979.

23 May 79

Species	T1	T2	T3	T4	T5
Littorina saxitillus				89	444
L. littorea	178	44	444	44	
Nassarius obsoletus	44				44
Lacuna vincta			44		
Mytilus edulis	267	44			89
Modiolus demissus	44				
Macoma balthica	267	44			88
Gemma gemma				577	
Eteone longa			44		
E. heteropoda	44				
Nereis diversicolor	844	1422	4089	1467	1689
Scoloplos fragilis	622	356	266	178	222
Heteromastus filiformis	44				
Polydora ligni	178				
Streblospio benedicti				44	
Oligochaetes	44	133			
Jaera marina				44	
Corophium acherusicum		44	44		
Corophium sp.				44	
Gammarus oceanicus		89		44	
G. lawrencianus		178	89	756	622
G. spp.	89	1111	888	933	533
Mysis stenolepis	1289				
Crangon septemspinosa	178	44			
Apeltes quadracus			44		
Cancer irroratus	44				

Table 1 cont'd

5 June 79

Species	T1	T2	T3	T4	T5
Nematodes		44			
Littorina littorea			89	89	
L. saxitilis	44				
Hydrobia minuta			311		
Mytilus edulis	133		267	133	89
Macoma balthica	44		44	44	44
Gemma gemma			133		
Harmothoe imbricata	44			89	
Nereis diversicolor	844	1111	2800	2178	1689
Scoloplos fragilis	178	178	89	311	311
Polydora ligni	178	356	756	622	222
P. websteri	89	44	89		
Streblospio benedicti		178		89	
Pygospio elegans	44	44		266	
Scolecolepides viridis	89			89	
Oligochaetes			44		89
Jaera marina				44	
Corophium acherusicum		44	44		
Gammarus oceanicus		89		178	
G. lawrencianus	89	89	44	488	
G. spp.	311	1733	222	622	488
Mysis stenolepis	44			44	
Crangon septemspinosa			222		
Insect larvae		89		44	

Table 1 cont'd

21 June 79

Species	T1	T2	T3	T4	T5
Nematodes	44				
Littorma littorea		178			
L. saxitilis		133			
Hydrobia minuta		133		44	
Mytilus edulis		178		89	
Macoma balthica			44	89	
Gemma gemma		178		89	
Eteone flava	44	44			
Nereis diversicolor	89	3200	2667	3200	3689
Scoloplos fragilis		489	44	44	44
Polydora ligni		1378	578	1111	1600
Streblospio benedicti		356	133	133	
Scolecolepides viridis		133			
Oligochaetes					44
Jaera marina		178			
Corophum acherusicum		311			
C. insidiosum		89			
C. spp			133		44
Gammarus oceanicus		4667		44	133
G. lawrencianus				178	222
G. mucronatus		44			578
G. spp.			2222	1377	3156
Crangon septemspinosa	133				
Chironomid larvae		44			
Insect larvae		44			

Table 1 cont'd

5 July 79

Species	T1	T2	T3	T4	T5
Nematodes		44			
Littorina littorea		489	44	222	
L. saxitilis		133		89	44
Hydrobia minuta		44			
Nassarius obsoletus				44	
Mytilus edulis	489	178	89	178	444
Modiolus demissus					44
Mya arenaria		44	44		
Macoma balthica				44	
Harmothoe imbricata				89	
Nereis diversicolor	2133	1422	1956	2311	1466
Scoloplos fragilis	178	311	44	89	
Polydroa ligni	1200	311	533	622	222
P. websteri				89	
Streblospio benedicti					89
Heteromastus filiformis			44		
Gammarus oceanicus			44		

Table 1 cont'd

20 July 79

Species	T1	T2	T3	T4	T5
Littorima littorea	400	67	45	22	
L. saxitilis	67	289	422	356	244
Hydrobia minuta	244	867	1267	489	622
Nassarius obsoletus	67		22		
Mytilus edulis	511	489	67	67	22
Macoma balthica		22	22		22
M. calcarea				22	22
Mya arenaria			44		
Gemma gemma	44	44	422		89
Harmothoe imbricata	22		22		
Nereis diversicolor	4089	1867	2333	1911	1511
Scoloplos fragilis	178		89	178	200
Eteone longa		22	89		
Polydora ligni	3733	867	911	1622	667
P. websteri			22	22	
Scolecolepides viridis	133				
Streblospio benedicti	22	44	22	22	44
Oligochaetes	67	22	22	22	267
Corophium insidiosum	22				
C. spp.	1022	89	289		67
Gammarus oceanicus	44	1689			89
G. lawrencianus	44		67	44	644
G. mucronatus				67	89
G. spp.	22			89	244
Crangon septemspinosa	67	22	133	22	
Apeltes quadracus				22	

Table 1 cont'd

2 Aug. 79

Species	T1	T2	T3	T4	T5
Notoplana sp.	44			133	89
Nemertina	44				44
Littorima littorea	89	44	400	222	44
L. saxitilis	222	89	133	622	622
Hydrobia minuta	89	311	44	133	533
Nassarius obsoletus		44			
Mytilus edulis	311	222	267		1244
Mya arenaria	89			44	178
Gemma gemma		267		44	1689
Eteone longa	44	133			
Nereis diversicolor	3244	2978	933	2044	3111
Scoloplos fragilis	489	356	44	311	133
Polydora ligni	3378	1467	667	2400	3467
Streblospio benedicti	444	133	89	44	
Oligochaetes	178		178	89	133
Jaera marina			44		
Corophium spp.	133		222	178	711
Gammarus oceanicus	844	267	1333	44	889
G. lawrencianus	444		89	44	178
G. mucronatus		89	267	178	
G. spp.		44	44		44
Crangon septemspinosa	89			44	
Apeltes quadracus	44			44	

Table 2. Numbers per m^2 of benthic invertebrate species collected at certain sites at Basin Head, P.E.I. on 29 May and 5 July 1979.

29 May 1979

Species	S1	S3	S4	S5	S6
Nemertines				44	
Littorina littorea			89		
Mytilus edulis				44	
Harmothoe imbricata				44	
Nereis diversicolor		89	356		1422
Nephtys incisa			44		
Micropthalmus sczelkowii	44			44	89
Scoloplos fragilis			133	89	
Polydora ligni			267		
Pygospio elegans	44			44	445
Scolecolepides viridis	44		89	89	
Chaetozone setosa				89	
Oligochaetes				44	
Corophium acherusicum	89			89	
Gammarus lawrencianus		266			
G. spp.		44			844

Table 2 cont'd

5 July 1979

Species	S1	S3	S4	S5	S6
Littorima littorea			222	356	
Nassarius trivittatus				44	
Harmothoe imbricata			44	267	
Eteone longa		44	178	44	
Micropthalmus sczelkowii				44	
Nereis diversicolor		578	311	44	711
Scoloplos fragilis			133	89	44
Polydora ligni		1333	89		1156
Scolecolepides viridis			489	311	
Scolelepis squamata			89	89	
Chaetozone setosa			311		
Heteromastus filiformis				89	

Table 3. Numbers per m^2 of benthic invertebrate species collected along 4 transects (T1-T4) at South Lake, P.E.I. on 7 June, 28 June and 19 July 1979.

7 June 1979

Species	T1	T2	T3	T4
Nematodes			133	
Littorina saxitilis	44			
Hydrobia minuta	44			
Nassarius obsoletus	44	89		
N. trivittatus				133
Modiolus demissus	44			
Macoma balthica	44	133		
Mya arenaria	44		44	
Gemma gemma	89		133	
Harmothoe imbricata			178	
Eteone lactea			89	
E. heteropoda		133		
Exogone hebes				44
Nephtys caeca				44
Nereis diversicolor	356	178	89	178
Scoloplos fragilis	44	311	311	
Polydora ligni	133	44		578
P. quadrilobata			44	
Streblospio benedicti	267	133	44	
Pygospio elegans	44		311	267
Scolelepis squamata	44			2578
Heteromastus filiformis	178	222	178	
Oligochaetes		1156		
Harpacticoid copepods			444	
Idotea balthica			89	
Neomysis americana			44	
Corophium acherusicum			178	
C. insidiosum	44		44	
C. spp.	1777		667	
Gammarus oceanicus	311		44	
G. lawrencianus	267			44
G. spp.	12089			
Ampithoe longimana			89	
Crangon septemspinosa			44	
Pseudopleuronectes americanus	44			

Table 3 cont'd

28 June -979

Species	T1	T2	T3	T4
Crepidula fornicata		311		
Littorina littorea		44		
L. saxitilis	44	44		
Nassarius obsoletus	222	489	267	
Mytilus edulis		44		
Macoma balthica		89		
Mya arenaria	44		89	
Gemma gemma			489	44
Harmothoe imbricata		89		
Nereis diversicolor	89	800	44	89
Scoloplos fragilis		267		
Naineris quadricuspida	44			
Polydora ligni	133	578	44	533
P. quadrilobata				222
Streblospio benedicti	44			
Pygospio elegans				89
Scolecolepides viridis		133		1022
Scolelepis squamata	89			
Heteromastus filiformis	44	133		
Notomastus latericeus		133		
Capitella capitata	89			
Corophium spp.	222	133	222	222
Gammarus lawrencianus	89	44	44	266
G. mucronatus	44		44	89
G. spp.			44	
Neopanope texana		44		

Table 3 cont'd

19 July 1979

Species	T1	T2	T3	T4
Nemertines		44		
Littorina saxitilis	22			44
Hydrobia minuta			67	
Nassarius obsoletus	178	156	178	
N. trivittatus			178	156
Macoma balthica		44		
M. calcarea			89	
Mya arenaria	22	89	22	44
Gemma gemma			89	244
Harmothoe imbricata	22			
Eteone longa				22
E. heteropoda	44	89	22	
Nereis diversicolor	44	244	311	622
Scoloplos fragilis		266	289	
Polydora ligni	600	156	822	356
Streblospio benedicti	111		22	
Pygospio elegans				89
Scolecolepides viridis	44			
Scolelepis squamata				400
Heteromastus filiformis	22	67	356	
Notomastus latericeus	111			
Chaetozone setosa			22	
Oligochaetes	622			
Idotea balthica	133	22		
Corophium insidiosum	67			
C. spp.	667	89		
Gammarus oceanicus			22	
G. lawrencianus		22		
G. mucronatus	89		89	
G. spp.	44		44	
Neomysis americana		22	22	
Crangon septemspinosa				133

Table 4. Temperature, salinity, dissolved oxygen and pH data collected along 5 transects (T1-T5) at Basin Head, P.E.I., for 9 sample periods during summer 1979.

Date	Temperature (°C)					Salinity (°/oo)				
	T1	T2	T3	T4	T5	T1	T2	T3	T4	T5
5 June	15.9	16.2	16.0	16.7	16.6					
21 June	22.5	22.3	21.7	20.0	19.8	17.0	17.0	21.1	17.9	17.4
29 June	17.0	18.0	18.0	18.0	17.5	22.1	20.8	18.5	17.2	15.7
5 July	17.0	17.7	18.0	19.3	20.0	23.8	20.1	18.7	18.6	17.3
12 July	16.3	17.5	18.8	19.7	20.1	21.8	20.8	18.2	16.2	16.8
20 July	22.3	22.0	24.5	21.2	22.3	20.3	18.9	19.9	19.2	19.2
25 July	20.0	20.0	21.0	21.0	21.5	17.0	12.0	18.0	15.0	14.5
2 Aug.	25.0	23.5	23.0	23.0	22.5	10.2	10.0	9.0	10.2	10.3
10 Aug.	16.0	16.1	16.0	16.5	17.0	15.5	18.5	16.5	15.3	14.0

Table 4 cont'd

Date	Oxygen ug-atoms per litre					pH				
	T1	T2	T3	T4	T5	T1	T2	T3	T4	T5
5 June	10.59	10.28	9.40	8.87	8.88	6.90	6.82	6.99	6.77	6.65
21 June	19.39	18.09	14.97	12.98	10.88		7.46	7.15	7.38	7.40
29 June	12.18	11.51	13.72	14.94	13.45	7.43	7.55	7.28	7.05	6.99
5 July	8.39	8.20	7.83	6.94	6.81	6.89	6.53	7.01	6.98	7.06
12 July	11.95	10.60	9.07	9.42	10.02	7.18	7.18	6.99	7.28	7.31
20 July	11.31	10.46	9.25	8.62	9.10					
25 July	10.90	10.64	10.25	10.01	9.58	7.46	7.35	7.55	7.48	7.38
2 Aug.	18.74	17.47	15.59	12.65	13.52	7.32	7.35	7.40	7.22	7.41
10 Aug.	9.78	8.34	8.35	7.92	7.95	7.25	7.40	7.50	7.22	7.57

Table 5. Temperature, salinity, dissolved oxygen, and pH data collected along 4 transects (T1-T4) at South Lake, P.E.I. for 3 sample periods during summer 1979.

Date	Temperature (°C) T1	T2	T3	T4	Salinity ($^{o}/oo$) T1	T2	T3	T4
7 June	14.9	16.2	17.0	16.9	22.2	23.2	23.2	24.9
28 June	17.0	16.5	17.0	19.5	17.7	17.8	18.6	19.5
19 July	18.5	18.5	18.0	18.5	19.8	19.5	19.3	19.2

Date	Oxygen ($^{o}/oo$) T1	T2	T3	T4	pH T1	T2	T3	T4
7 June	8.83	11.24	10.19	12.06	7.30	-	6.00	-
28 June	11.54	10.21	10.83	13.29	6.50	7.02	6.60	7.03
19 July	9.71	9.86	9.57	13.03	5.74	6.88	6.80	6.75

Table 6. Temperature, salinity, dissolved oxygen, pH, nitrate and nitrite data collected at certain sites at Basin Head, P.E.I., during summer 1979.

Date & Location		Temp.	Salinity	Oxygen	pH	NO_3	NO_2
May 29	S3	12.5	24.9	7.30			
	S4	11.3	24.9	9.39			
	S5	8.7	25.8	9.48			
	S6	12.4	25.4	12.14			
July 5	S3	16.3	22.3	8.10	6.89	2.768	0.007
	S4	16.5	23.5	8.53	6.34	0.196	0.004
	S5	16.2	24.1	9.72	6.59	0.995	-
	S6	18.7	21.5	11.05	6.20	30.049	0.032

Table 7. Nitrate (NO_3^-), nitrite (NO_2^-) and phosphorous (P) in μgram-atoms per litre (μg-at/l) present along 5 transects (T1-T5) at Basin Head, P.E.I., for 7 sample periods during summer 1979.

	Nitrate (ug-at NO_3/l)					Nitrite (ug-at NO_2/l)					Reactive Phosphate (ug-at P/l)				
ate	T1	T2	T3	T4	T5	T1	T2	T3	T4	T5	T1	T2	T3	T4	T5
1 June		2.132	1.348	3.658	4.729		0.044	0.028	0.027	0.044					
9 June	1.839	1.683	1.707	1.683	1.863	0.004	0.004	0.002	0.004	0.002	0.201	0.051	0.183	0.094	0.056
5 July	2.162	2.393	1.372	2.535	2.090	0.014	0.005	0.004	0.018	0.019			0.557	0.557	0.253
2 July	0.644	1.281	2.608	2.974	2.650	0.000	0.007	0.012	0.023	0.014		0.070	0.047	0.112	0.066
5 July	1.284	1.587	2.633	2.474	1.593	0.004	0.011	0.009	0.012	0.005	0.103	0.098	0.094	0.089	0.066
2 Aug.	3.076	2.881	2.021	3.311	0.620	0.032	0.027	0.021	0.019	0.002	0.056	0.080	0.112	0.047	0.070
0 Aug.	1.128	1.816	4.494	1.372	3.027	0.004	0.004	0.035	0.004	0.014					

Table 8. Nitrate (NO_3^-), nitrite (NO_2^-) and phosphorous (P) in μgram-atoms per litre (μg-at/l) present along 4 transects (T1-T4) at South Lake, P.E.I. for 2 sample periods during summer 1979.

Date	Nitrate (μg-at NO_3^-/l)				Nitrite (μg-at NO_2^-/l)				Reactive Phosphate (μg-at/l)			
	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4
28 June	2.908	1.290	0.825	0.771	0.000	0.019	0.041	0.011	0.421	0.356	0.033	0.056
10 July	0.927	1.328	1.166	0.710	0.005	0.004	0.011	0.000	-	-	-	-

Table 9. Temperature, salinity, dissolved oxygen and pH data collected hourly on 13-14 June and 11 July 1979 at Basin Head, P.E.I., and 6 August 1979 at South Lake, P.E.I. (See also Fig. 4)

Date & Location	Time	Temp.	Salinity	Oxygen	pH
June 13-14 Basin Head	13:30	17.0	22.8	15.50	7.23
	14:30	17.5	22.6	17.01	6.75
	15:30	19.0	21.4	17.36	7.05
	16:30	16.2	19.3	16.69	7.18
	17:30	16.3	19.4	17.37	-
	18:30	16.0	19.6	16.51	-
	19:30	15.5	17.4	17.68	7.28
	20:30	15.0	16.9	16.38	7.15
	21:30	15.0	14.8	11.06	7.38
	22:30	15.0	15.0	12.19	-
	23:30	15.0	14.2		7.22
June 14	00:30	15.7	19.3		-
	01:30	10.0	25.2		7.28
	02:30	8.8	25.5		7.33
	03:30	10.4	23.2		7.01
	04:30	10.6	21.8		7.13
	05:30	11.6	20.7		6.75
	06:30	11.3	19.5		7.02
	07:30	11.5	19.1		7.07
	08:30	11.0	20.1		7.27
	09:30	11.3	20.8		-
	10:30	12.0	21.8		7.50
	11:30	13.2	23.0		7.45

Table 9 cont'd

Date & Location	Time	Temp.	Salinity	Oxygen	pH
July 11 Basin Head	10:30	17.2	30.3	13.47	7.02
	11:30	18.0	24.0	13.96	6.73
	12:30	21.5	22.0	14.42	6.69
	13:30	17.3	24.0	15.45	7.05
	14:30	21.1	21.0	15.81	7.27
	15:30	18.1	20.1	15.62	7.13
	16:30	20.1	19.8	16.46	7.34
	17:30	23.3	19.7	16.62	7.41
	18:30	23.3	16.5	17.60	7.19
	19:30	23	14.9	17.13	7.36
	20:30	22.9	14.8	15.76	7.24
	21:30	22.9	14.0	14.66	6.72
	22:30	22.0	14.0	12.32	7.20
August 8 South Lake	08:30	24.0	25.0	10.37	7.49
	09:30	24.0	21.3	10.50	7.51
	10:30	25.2	22.1	10.90	7.40
	11:30	24.0	22.5	11.33	7.45
	12:30	24.0	23.5	11.61	7.48
	13:30	24.5	24.0	11.60	7.40
	14:30	24.5	24.5	11.60	7.33
	15:30	24.5	24.1	12.02	7.39
	16:30	24.7	23.7	13.30	7.42
	17:30	24.7	24.0	13.91	7.12
	18:30	24.5	23.6	13.73	7.40
	19:30	24.5	23.5	10:50	7.42

Table 10. Nitrate (NO_3^-), nitrite (NO_2^-) and phosphorous (P) in µg-at/l collected hourly on 13-14 June and 11 July 1979 at Basin Head, P.E.I., and 6 August 1979 at South Lake, P.E.I. (See also Fig. 5)

Date & Location	Time	NO_3	NO_2
June 13-14 Basin Head	13:30	2.393	0.071
	14:30	1.709	-
	15:30	1.683	0.004
	16:30	1.617	0.004
	17:30		
	18:30		
	19:30	0.821	-
	20:30	1.598	-
	21:30	1.624	0.019
	22:30		
	23:30	1.043	-
June 14	00:30		
	01:30	1.461	0.071
	02:30	1.424	0.005
	03:30	1.169	0.007
	04:30	1.918	0.124
	05:30	1.954	-
	06:30	2.660	0.004
	07:30	2.082	0.027
	08:30	2.038	0.071
	09:30		
	10:30	4.128	0.023
	11:30	2.853	0.011

Table 10 cont'd

Date & Loaction	Time	NO_3^-	NO_2^-	P
July 11 Basin Head	10:30	1.212	0.009	0.131
	11:30	0.910	-	0.023
	12:30	1.062	0.002	0.037
	13:30	1.528	0.004	0.037
	14:30	1.996	0.002	0.033
	15:30	2.578	0.019	0.033
	16:30	2.638	0.004	0.019
	17:30	2.853	0.011	0.028
	18:30	3.474	0.011	0.042
	19:30	1.793	0.005	0.009
	20:30	2.453	0.011	0.028
	21:30	1.420	0.023	0.042
	22:30	1.345	0.009	0.037
August 6 South Lake	8:30	1.866	0.021	0.304
	9:30	0.874	0.014	0.255
	10:30	0.777	-	0.178
	11:30	0.953	0.046	0.075
	12:30	1.478	0.320	0.594
	13:30	1.110	-	0.234
	14:30	0.295	0.030	0.028
	15:30	0.333	-	0.061
	16:30	0.590	0.009	0.019
	17:30	0.617	0.005	0.103
	18:30	0.433	0.011	0.140
	19:30	0.618	0.004	0.126

Table 11. Total nitrogen content of Chondrus crispus and Ulva lactuca from Basin Head, following Kjeldahl procedure.

Date (1979)	Plant	% N	average %N
12 June	C. crispus	3.02, 3.00, 3.08, 2.93	3.01
15 June	"	2.66, 2.65, 2.69	2.67
19 June	"	3.28, 3.18, 3.08, 3.04	3.19
9 July	"	3.10, 3.12, 3.05, 3.08	3.09
20 July	"	3.15, 3.14, 3.08, 3.10	3.12
26 June	U. lactuca	2.38, 2.47, 2.27, 2.35	2.35

Table 12. Weight (g) of Chondrus per 1/4 m^2 along 7 transects at Basin Head in early August, 1979.

Transect	Chondrus (g)	Transect	Chondrus (g)
1	659	5	796
	3192		4839
	219		3755
			3735
2	81		
	3505	6	399
	3202		1019
	1142		
	320	7	1060
			1926
3	741		288
	3285		35
	2303		
	5045		
	3025		
4	3387		
	3749		
	1861		
	1480		
	129		
	43		
	140		

Table 13. Species associated with *Chondrus crispus* at Basin Head, P.E.I.

Mollusca

- *Littorina littorea*
- *L. saxitilis*
- *Mytilis edulis*

Annelida

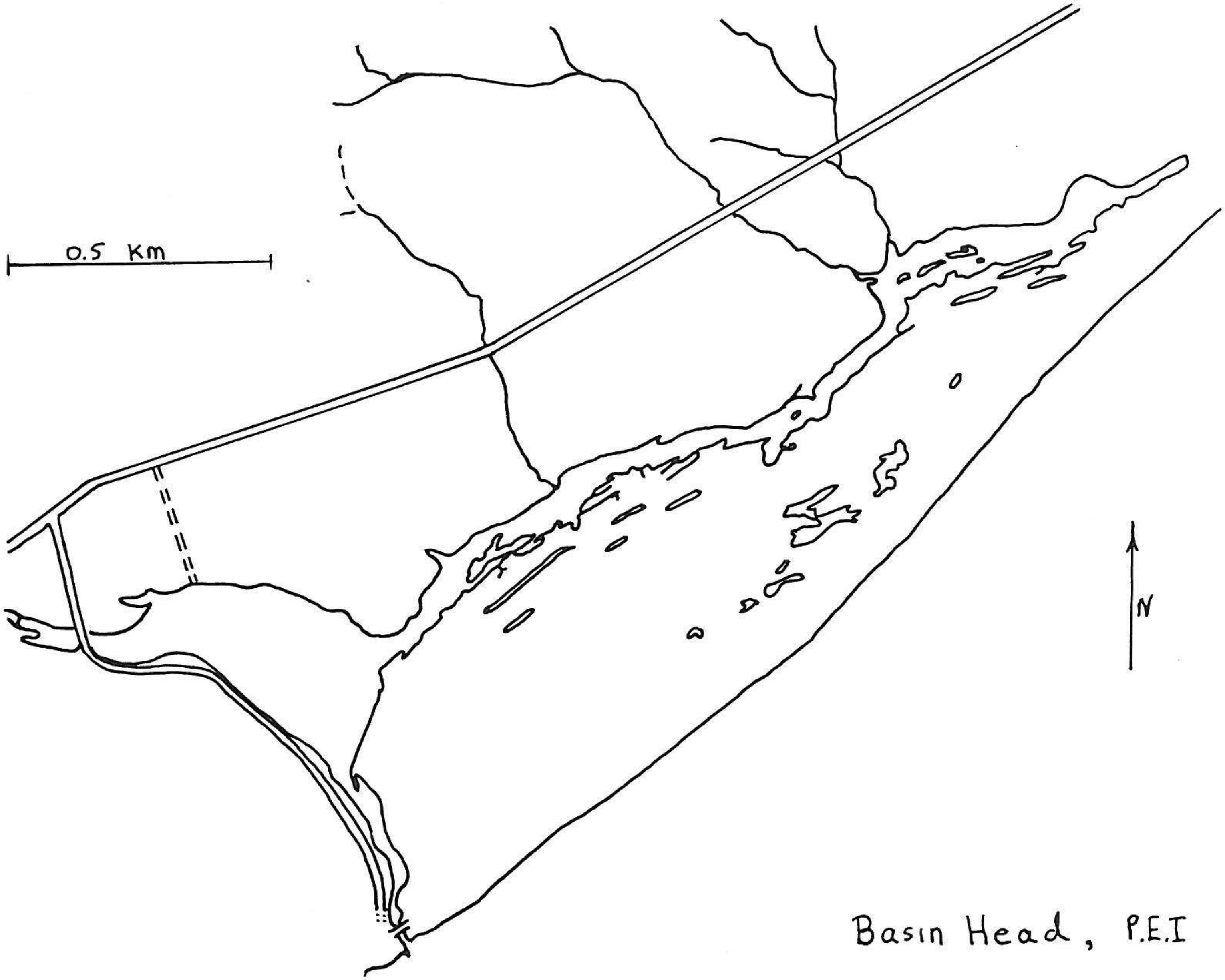
- *Harmothoe imbricata*
- *Nereis diversicolor*
- *Polydora ligni*
- *Streblospio benedicti*
- Oligochaetes

Arthropoda

- *Gammarus oceanicus*
- *Corophium* spp.
- *Jaera marina*
- *Cancer irroratus*

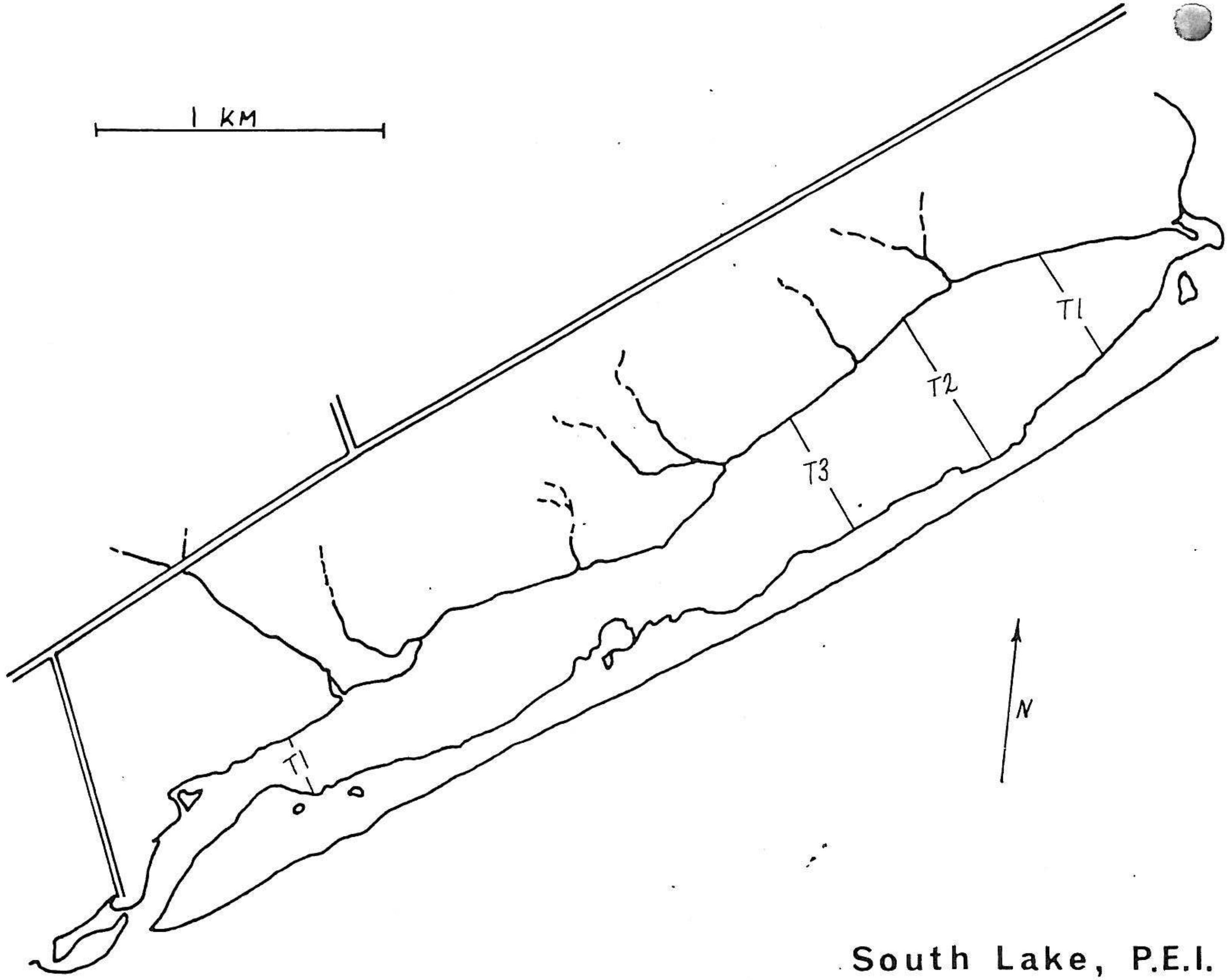
FIGURES

Figure 1. Map of Basin Head, P.E.I.



Basin Head, P.E.I

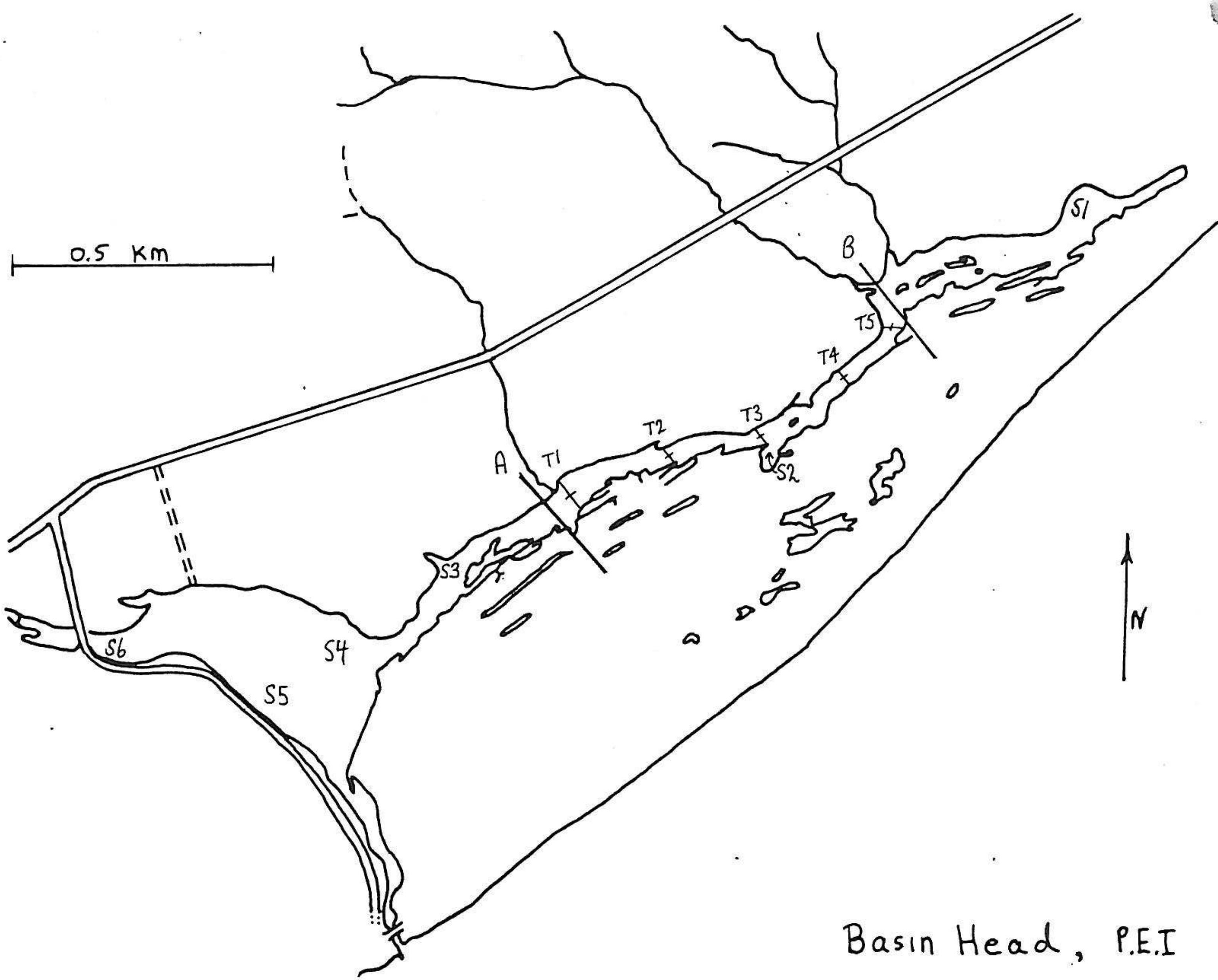
Figure 2. Map of South Lake, P.E.I., showing transects, T1 through T4



South Lake, P.E.I.

Figure 3. Map of Basin Head, P.E.I., showing transects and sampling stops.

a) overall study area
b) transect area enlarged (from A to B)



Basin Head, P.E.I

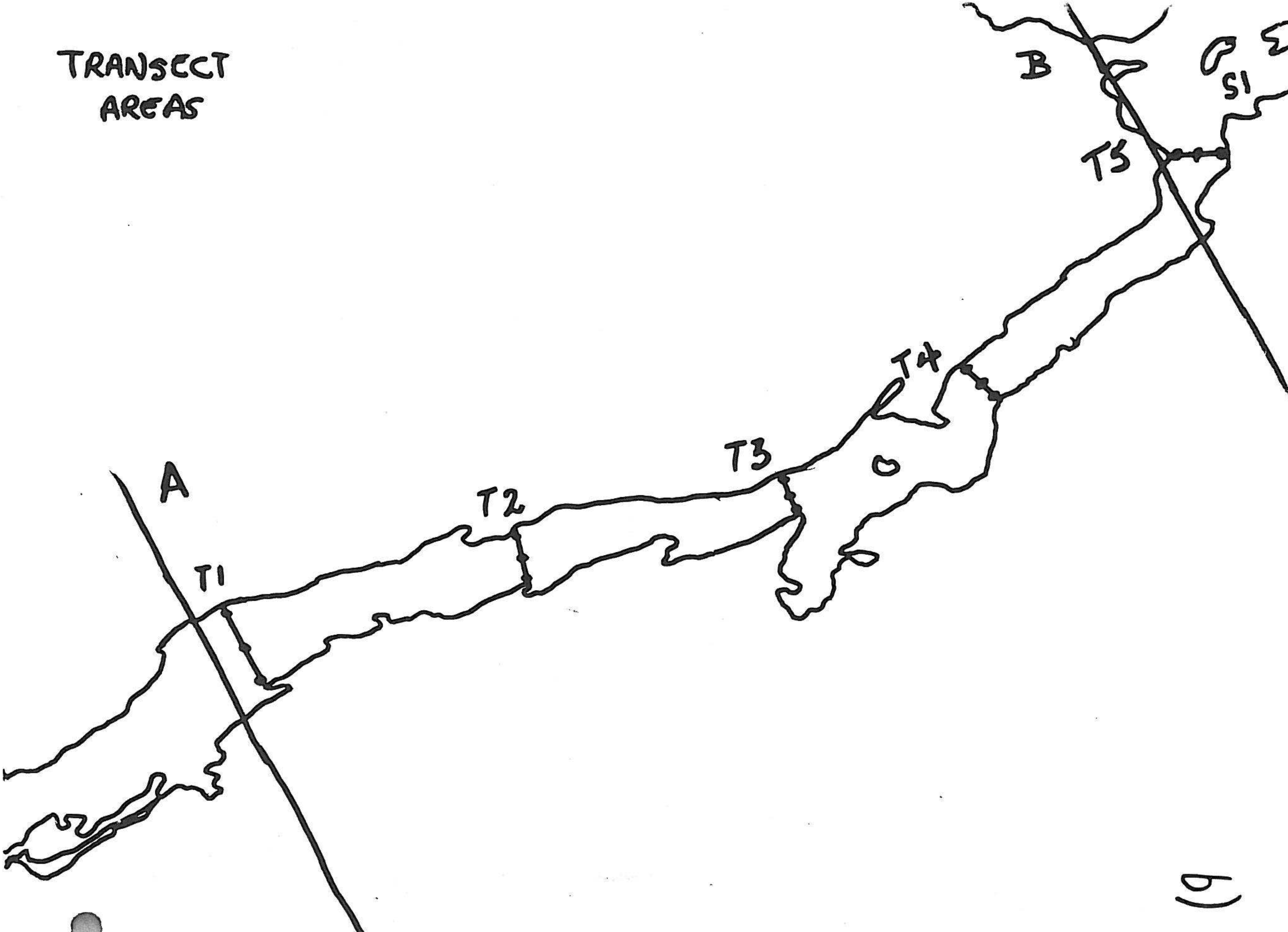
Figure 4. Physical data over hourly intervals at Basin Head and South Lake, summer 1979.

Key: S - salinity
T - temperature
O - oxygen
W.D. - water depth (in feet)

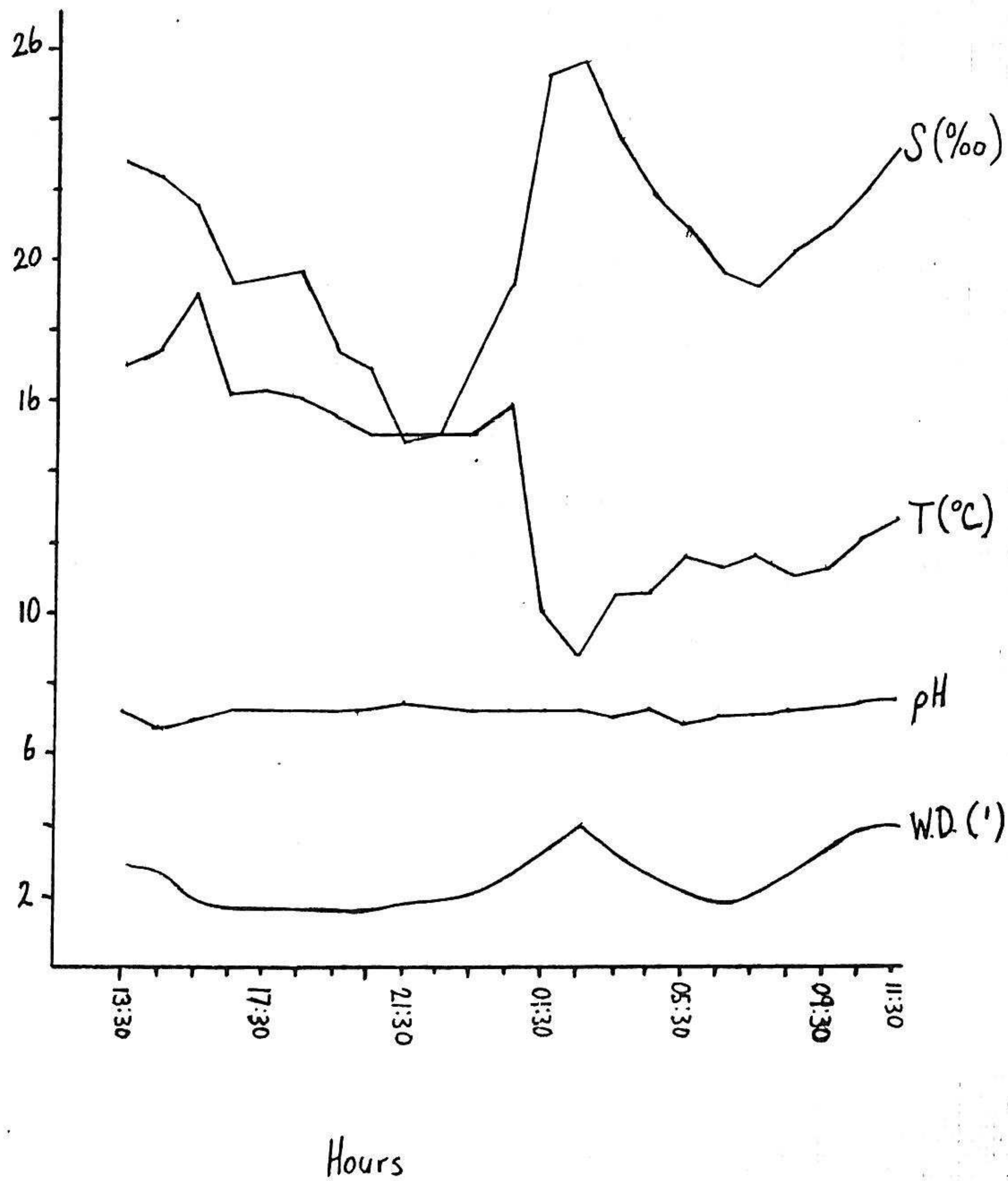
a) 13-14 June, Basin Head
b) 11 July, Basin Head
c) 6 August, South Lake

Data presented in Table 9

TRANSECT AREAS



a)



26
20
16
10
6
2
S(‰)
T(°C)
pH
W.D. (')
13:30
17:30
21:30
01:30
05:30
09:30
11:30
Hours

b)

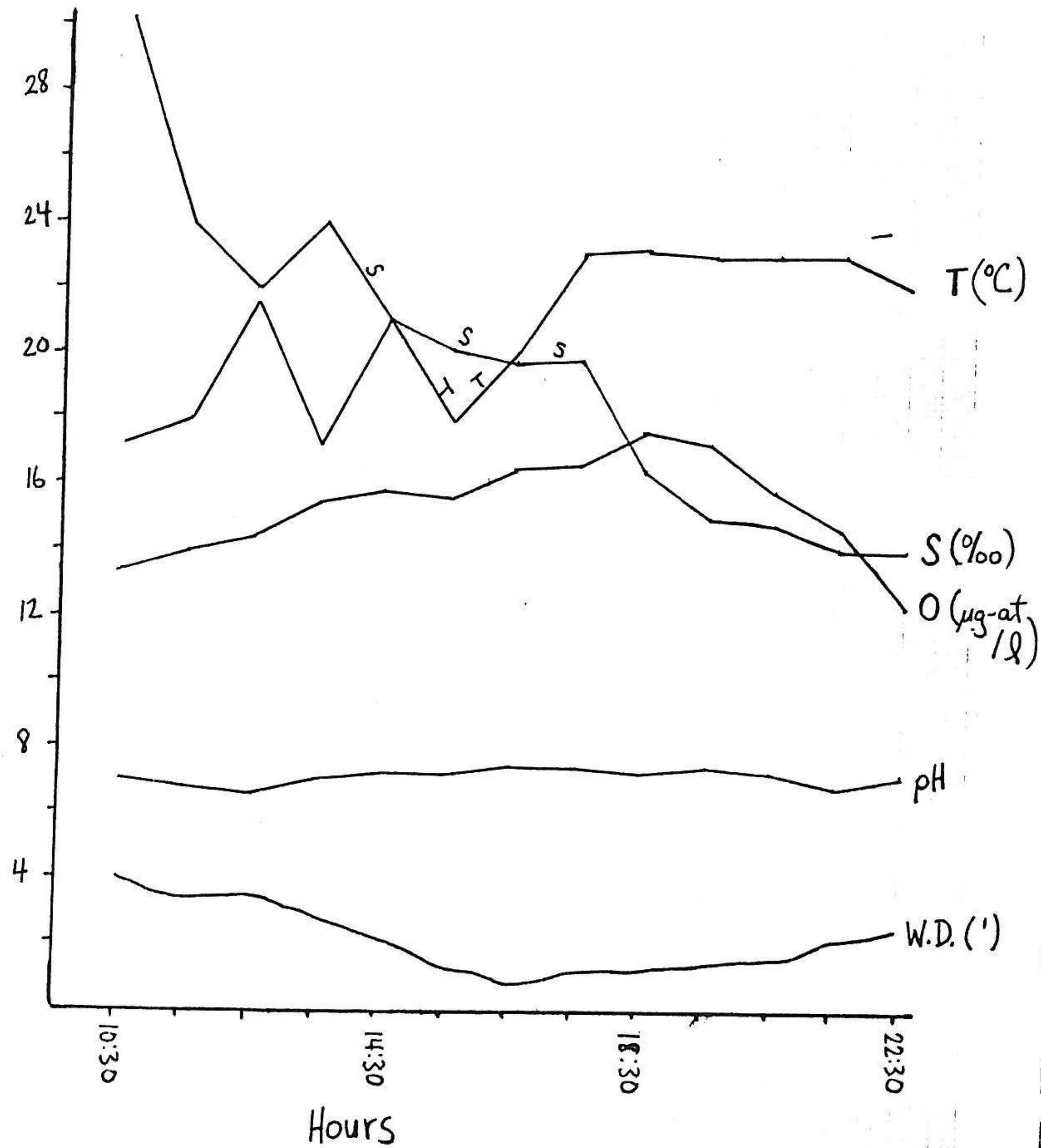


Figure 5. Nutrient concentrations (µg-at per litre) over hourly intervals at Basin Head and South Lake, summer 1979.

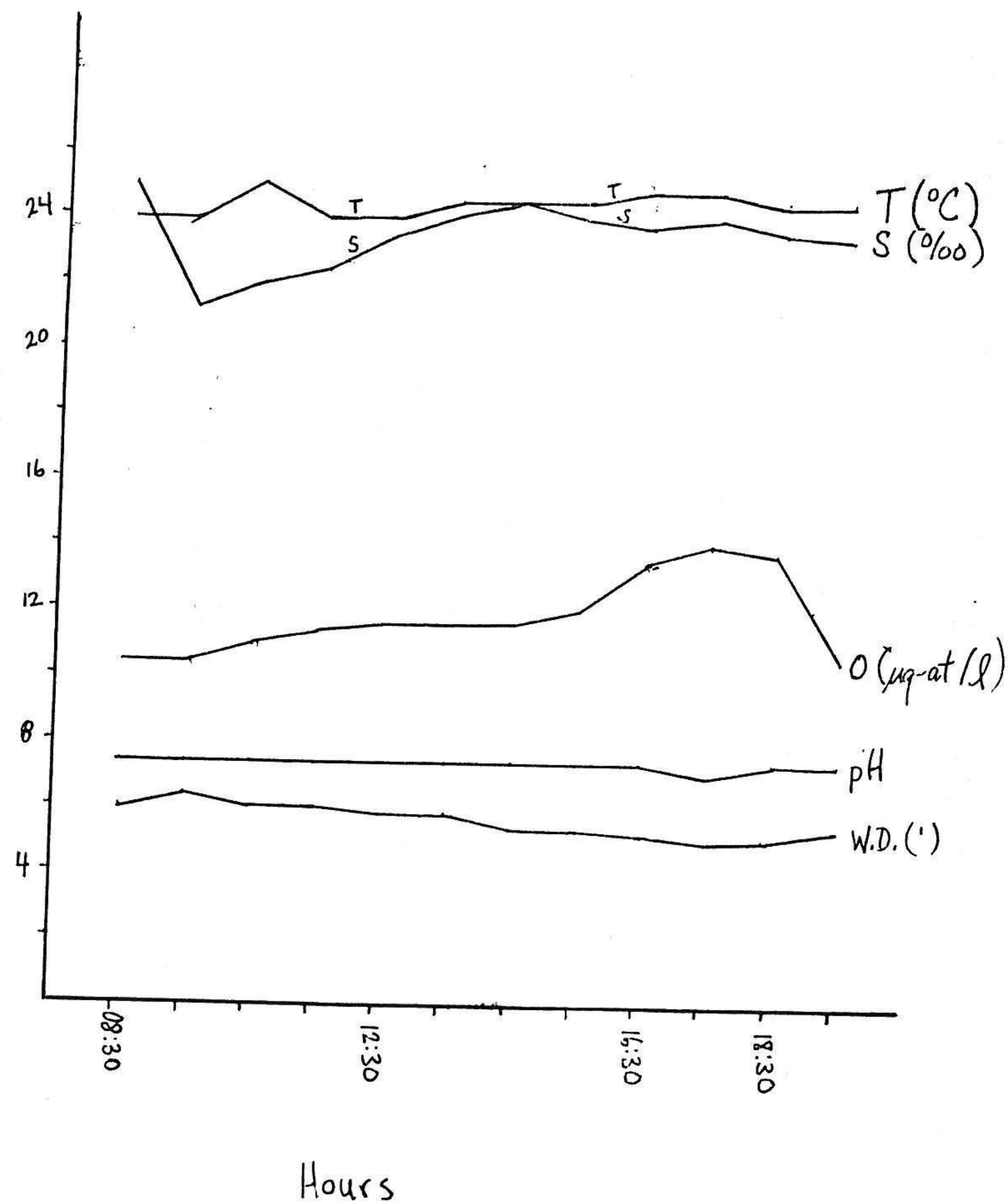
a) 13-14 June, Basin Head

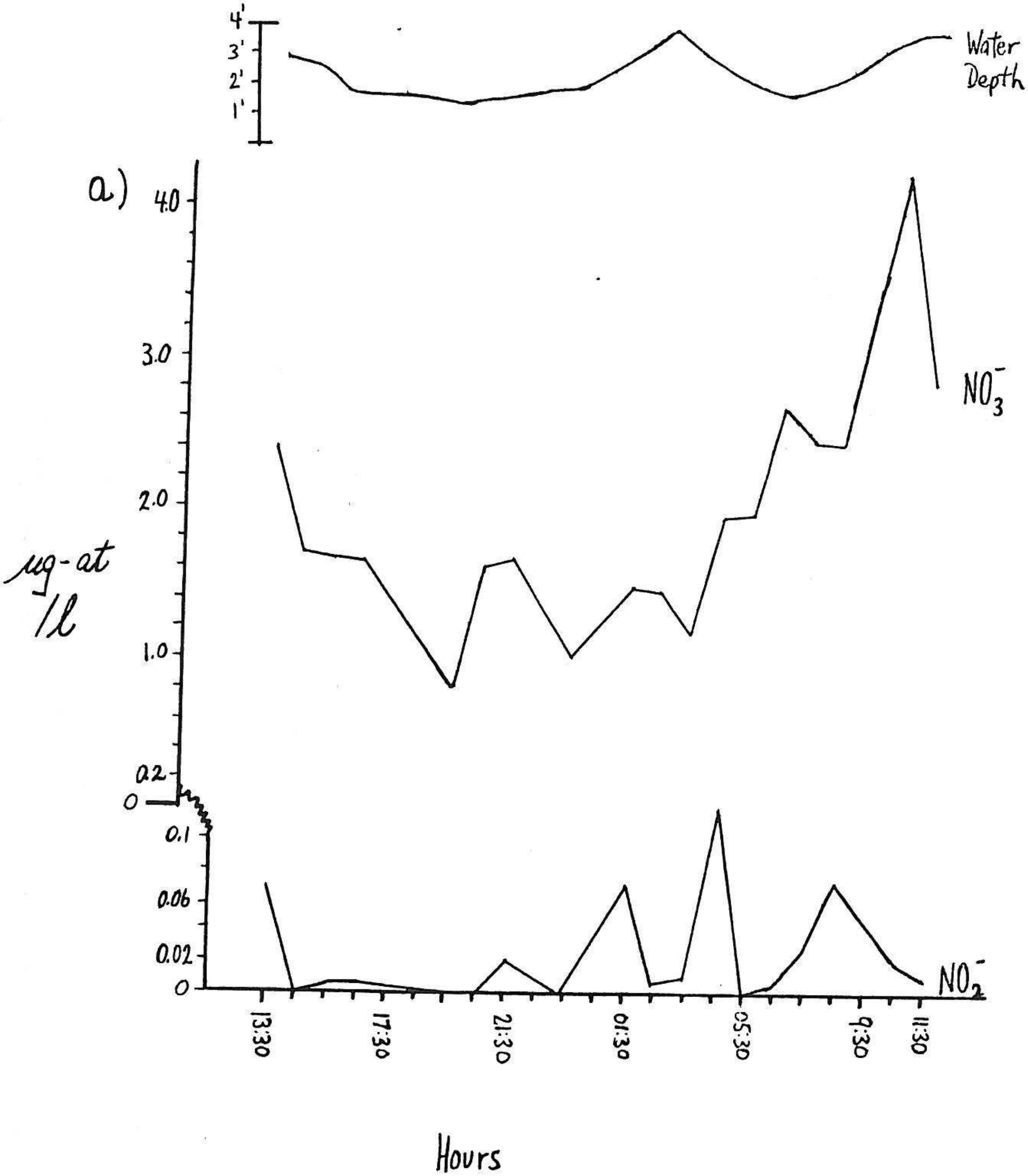
b) 11 July, Basin Head

c) 6 August, South Lake

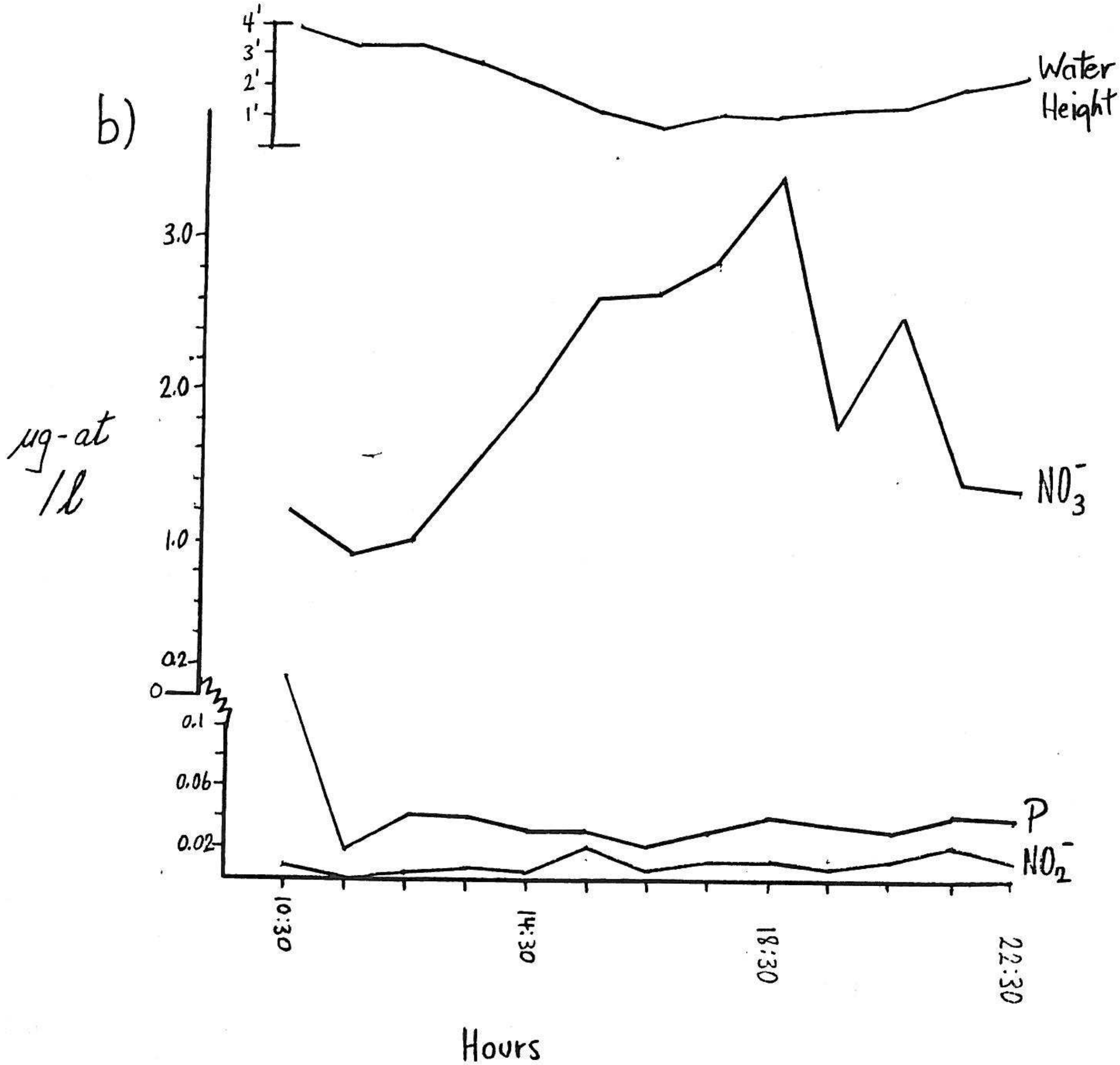
Data presented in Table 10

C)

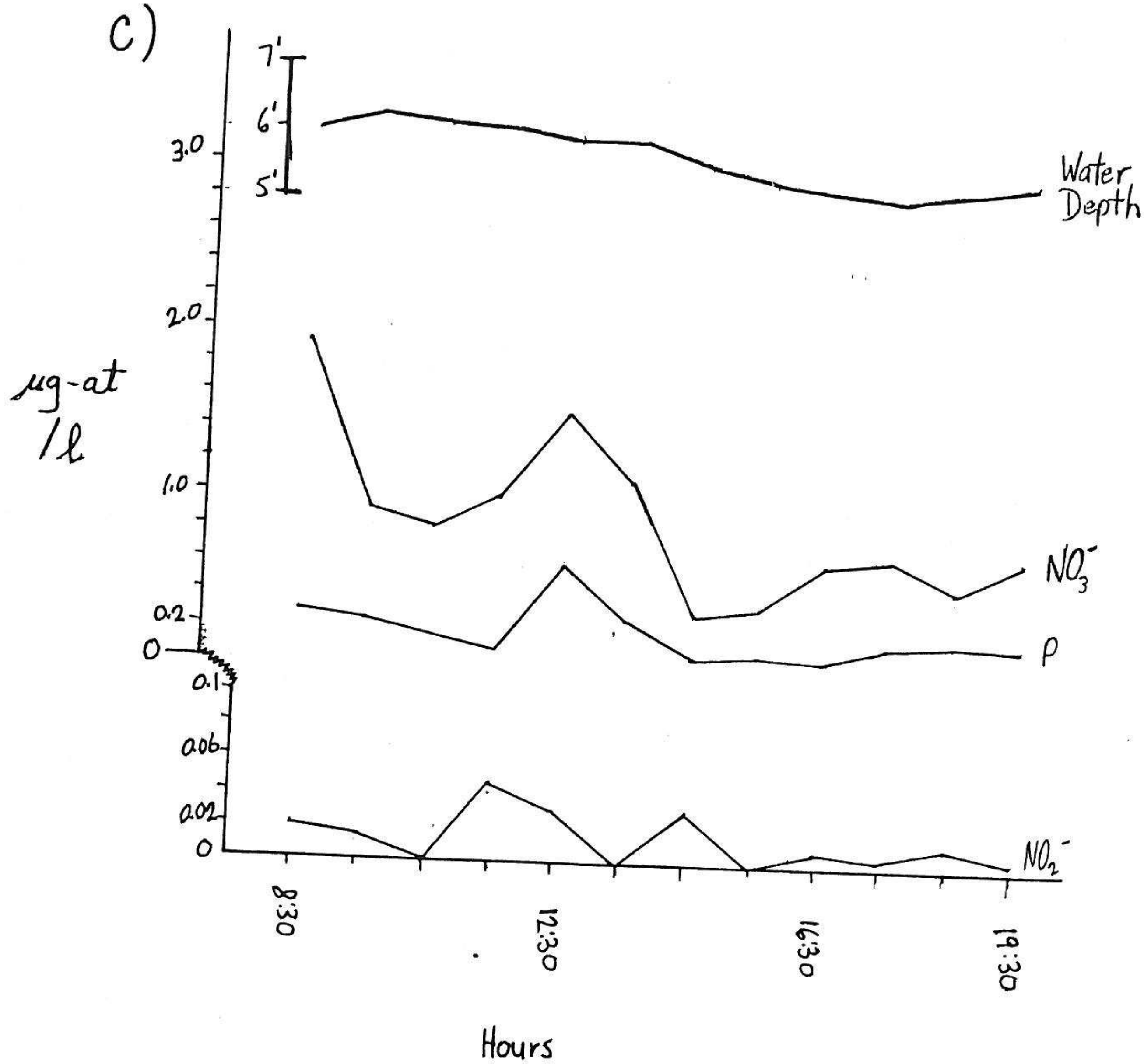




4'
3'
2'
1'
Water Depth
a)
4.0
3.0
2.0
1.0
0.2
0
0.1
0.06
0.02
0
NO_3^-
NO_2^-
μg-at /l
13:30
17:30
21:30
01:30
05:30
9:30
11:30
Hours



b)
4'
3'
2'
1'
Water Height
3.0
2.0
1.0
0.2
0
0.1
0.06
0.02
µg-at/l
NO_3^-
P
NO_2^-
10:30
14:30
18:30
22:30
Hours



C)
7'
6'
5'
3.0
2.0
1.0
0.2
0
0.1
0.06
0.02
0
μg-at /l
Water Depth
NO3-
P
NO2-
8:30
12:30
16:30
19:30
Hours

Appendix I. All species collected during the summer 1979 at Basin Head and South Lake. This list includes only marine and intertidal species, and notes on abundance and habitat are listed under BH (for Basin Head) and SL (for South Lake).

Abbreviations used:

Abundance	A	abundant
	C	common
	O	occasional
	R	rare
Habitat	Be	Benthic
	B	attached to bottom (plants)
	D	lying on bottom, possible drift
	E	epiphytic (on *Zostera*)
	F	floating, definitely drifting
	P	planktonic; mixed in with other material

If a semicolin is preceded by a number, then a corresponding footnote follows the species list. No serious attempt was made to identify microscopic algae (e.g. diatoms, bluegreens). Such specimens were fixed for later study at Acadia University. Also not included in this list are zooplankton species which are also being studied at Acadia.

	B H	S L
Platyhelminthes		
Notoplana sp.	R, Be	
Nematoda	R, Be	R, Be
Nemertina	R, Be	R, Be
Cnideria		
Tima formosa L. Agassiz	14; O, F	
Cyania capillata Eschscholtz	O, F	14; O, F
Obelia sp.	8; A, E	8; A, E
Ctenophora		
Pleurobranchia pileus Vanhoffen	14; C, F	
Mollusca		
Crepidula fornicata Say		O, Be
Littorina littorea (Linn.)	15; A, Be	O, Be
L. saxitilis (Olivi)	C, Be	O, Be
Hydrobia minuta (Totten)	C, Be	O, Be
Nassarius obsoletus (Say)	O, Be	A, Be
N. trivittatus (Say)	R, Be	C, Be
Lacuna vincta Turton	R, Be	
Mytilus edulis Linn.	15; A, Be	O, Be
Modiolus demissus (Dill.)	R, Be	R, Be
Macoma balthica (Linn.)	O, Be	O, Be
M. calcarea (Gmelin)	R. Be	R, Be
Mya arenaria Linn.	O, Be	C, Be
Gemma gemma (Totten)		
Annelida		
Harmothoe imbricata (Linne)	15; O, Be	C, Be
Eteone longa (Fabricius)	C, Be	R, Be
E. heteropoda Hartman	O, Be	C, Be
E. lactea Claparede	R, Be	O, Be
E. flava (Fabricius)	R, Be	
Nephtys caeca (Fabricius)		R, Be
N. incisa Malmgren	R, Be	
Exogone hebes (Webster & Benedict)		R, Be
Nereis diversicolor Muller	15; A, Be	A, Be
Micropthalmus sczelkowii Mecanikow	R, Be	
Capitella capitella (Fabricius)		R, Be
Heteromastus filiformis (Claparède)	R, Be	O, Be
Notomastus latericeus Sars		R, Be
Polydora ligni Webster	15; A, Be	A, Be
P. quadrilobata Jacobi	R, Be	R, Be
P. websteri Hartman	R. Be	
Streblospio benedicti Webster	15; C, Be	C, Be
Pygospio elegans Claparède	R, Be	O, Be
Scolelepis squamata (Muller)	R, Be	C, Be
Scolecolepides viridis (Verrill)	O, Be	C, Be
Scoloplos fragilis (Verrill)		
Naineris quadricuspida (Fabricius)		R, Be
Chaetozone setosa Malmgren	R, Be	R, Be
Oligochaeta	15; O, Be	O, Be

	B H	S L
Arthropoda		
Copepoda, Harpacticoids		R, Be
Idotea balthica (Pallas)		O, Be
Jaera marina (Fabricius)	15; O, Be	
Corophium acherusicum Costa	O, Be	O, Be
C. insidiosum Crawford	R, Be	O, Be
C. spp.	15; C, Be	C, Be
Gammarus oceanicus (Segerstrale)	15; A, Be	O, Be
G. lawrencianus Bousfield	O, Be	C, Be
G. mucronatus Say	R, Be	O, Be
G. spp.	C, Be	C, Be
Ampithoe longimana Smith		R, Be
Neomysis americana (S.I. Smith)		R, Be
Mysis stenolepis S.I. Smith	R, Be	
Crangon septemspinosa Say	O, Be	O, Be
Neopanope texana (Stimpson)		R, Be
Cancer irroratus Say	15; C, Be	
Chordata		
Fundulus heteroclitus (Linn.)	A	A
Menida menida (Linn.)		R
Roccus americanus (Gmelin)		O
Pseudopleuronectes americanus (Walbaum)	C	C
Gadus morhua Linn.		R
Lipposetta putnami (Gill)	O	
Gasterosteus aculeatus Linn.	O	
Apeltes quadracus (Mitchill)	C	
Anguilla rostrata (LeSueur)	A	
Bacillariophyta		
Achnanthes sp.	C, P	O, P
Licmorphora sp.	C, E	C, E
Navicula sp.	C,E; C, B	O, B
Skeletonema sp.		O, P
Striatella sp.	C, P	C, P
Surirella sp.	C, E	C, E
Pleurosigma sp.	C, P	C, P
Cyanophyta		
Lyngbya sp.	13; O, E.	C, B; C,
Oscillatoria sp.	O, B	O, B
Spirulina subsalsa Oerst ex Gomont	1; A,B; A,E	R, P
Chlorophyta		
Chaetomorpha linum (Mull.) Kutz.		2;C,B;C,
C. sp	11; C,E	
Cladophora sp.		
Enteromorpha cathrata (Roth) J. Ag.	10; A,E	10;A,E;C,
E. intestinalis (L.) Link	C,B,	C,B
E. linza (L.) J. Ag.		R,F
Rhizoclonium sp.		C,B
Ulothrix flacca (Dillw.) Thuret	C,E	C,E
Ulva lactuca L.	9; A,B;C,F	9;A,B;C,

	B H	S L
Rhodophyta		
Acrochaetium zosterae Papen.	12;	C,E
Ahnfeltia plicata (Huds.) Fries		R,D
Ceramium diaphanum (Lightf.) Roth.		D,E
C. elegans (Ducl.) C.Ag.		C,E
C. rubrum (Huds.) C.Ag.	O,F	
Chondrus crispus Stackh	A,D	3;R,D
Corallina officinalis L.		R,D
Furcellaria fastigiata (Huds.) Lamour		R,D
Gracilaria verrucosa (Huds.) Papent.		4;R,D
Polysiphonia nigra (Huds.) Batt.		C,E
P. urceolata (Lightf.) Grev.	R,D	O,F
P. sp.	O,F	C,E;C,F
Rhodymenia palmata (L.) Grev.	R,F	O,F
Trailliella intricata (J.Ag.) Batt.		O,F
Phaeophyta		
Agarum cribrosum (Mert.) Bory	R,F	
Ascophyllum nodosum (L.) Le Jol.	O,F;O,D	R,D
Chorda filum (L.) Lamour.		5; C,B
C. tomentosum Lyngb.	5;C,B	
Chordaria flagelliformis (Mull.) C.Ag.		O,F
Desmarestia aculeata (L.) Lamour.		O,F
Dictyosiphon foeniculaceus (Huds.) Grev.		O,F
Ectocarpaceae	6;A	6; A
Ectocarpus confervoides (Roth.) Le Jol.	A,E	A,E
Fucus serratus L.	7;O,D	7;C,D
F. evanescens C.Ag.	O,D	
Laminaria agardii Kjellm.		7;C,D
Anthophyta		
Atriplex patula L. var. hastata (L.) Gray	C	C
Carex paleacea Wahlenb.	C	
Glaux maritima L. var. *obtusifolia* fern	C	C
Juncus balticus Willd. var. *littoralis* Engelm.	A	A
Limonium nashii Small.	C	C
Plantago juncoides Lam.	C	C
Salicornia europaea L.	C	C
Solidago sempervirens L.	C	C
Spartina alterniflora Loisel.	A	A
S. patens (Ait.) Muhl.	A	A
Stellaria humifusa Rottb.	O	
Suaeda maritima (L.) Dumort.	C	C
Triglochin elata Nutt.	C	C
Zostera marina L. var. *stenophylla*	8;A	8; A

Footnotes

1) Spirulina is a very common green "felt" on the bottom at Basin Head. In addition, clumps were found on Chondrus and Zostera.

2) Chaetomorpha linum is common in shallow water near T4 at South Lake but not elsewhere.

3) A single clump of Chondrus crispus was found along T3 at South Lake lying on the bottom, but was shore variety rather than BH variety. A few "shore" plants of Chondrus were seen in the harbour of Basin Head.

4) Gracilaria was found along South Lake T3 (one specimen only) but is supposed to be common there according to Fisheries personnel.

5) Chorda is common at both Basin Head at South Lake at the mouth of each barrachois subject to strong tidal currents.

6) Ectocarpus could not be differentiated from Pylaiella in certain collections. In any event theEctocarpaceae is an important part of the biomass at both Basin Head and South Lake as the main epiphyte on Zostera.

7) Pockets of Ascophyllum, Fucus and Laminaria occurred in saltmarsh nooks at both areas. This likely was drift material.

8) Zostera marina, a marine anthophyte, is dominant plant in both barrachois and host of all epiphytes, including Obelia which was as common as Ectocarpaceae. All other Anthophyta are intertidal.

9) Ulva is third dominant plant at Basin Head after Zostera and Chondrus, and second at South Lake. It occurred at the head of both systems and in quiet "bays".

10) Enteromorpha cathrata is an important epiphyte on Zostera along along with the Ectocarpaceae.

11) This Chaetomorpha could not be keyed to species. Filaments generally 60-75 μ wide but not typical C. cannabina.

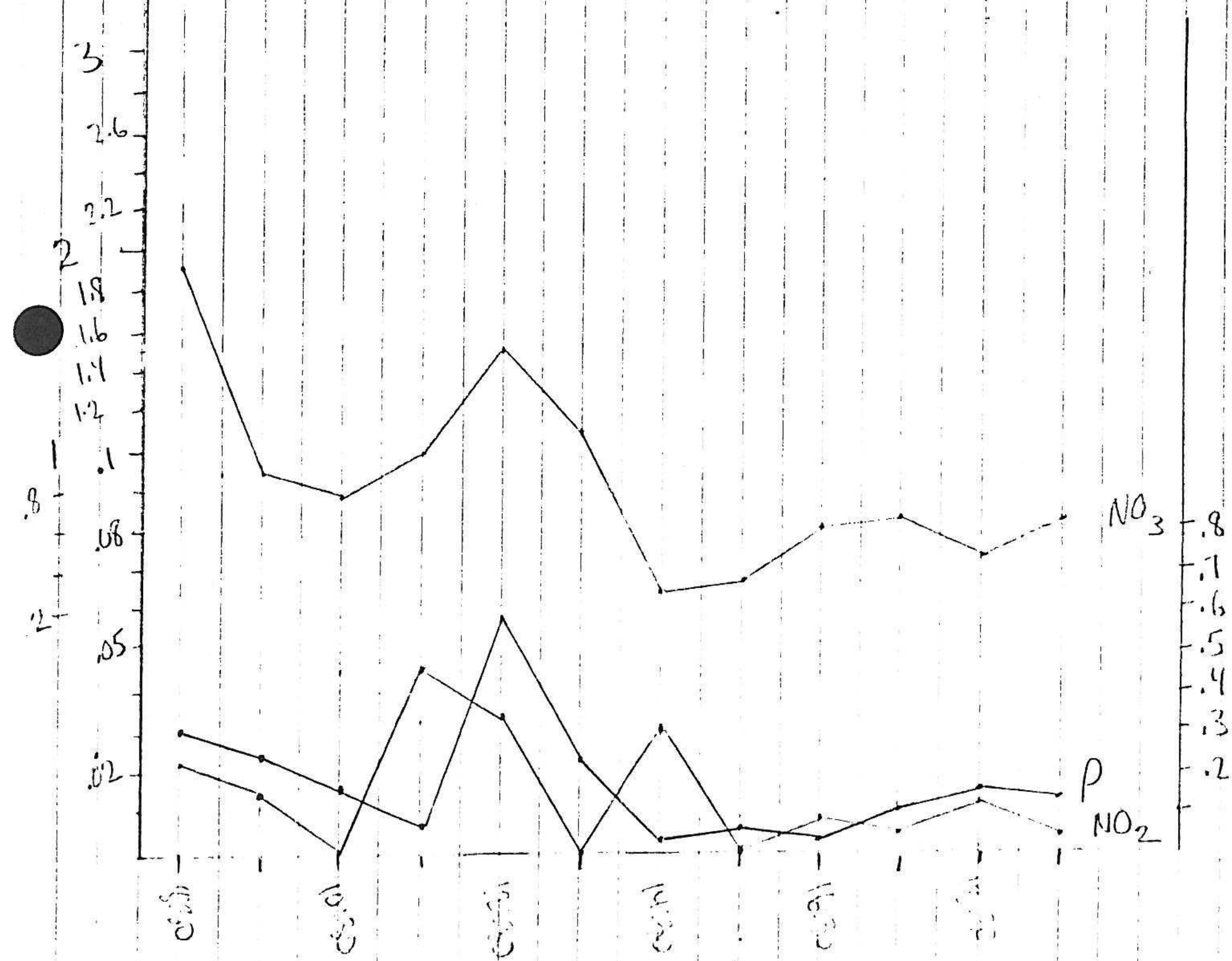
12) Acrochaetium is a common epiphyte at South Lake. Although not collected at Basin Head it likely occurs there as well.

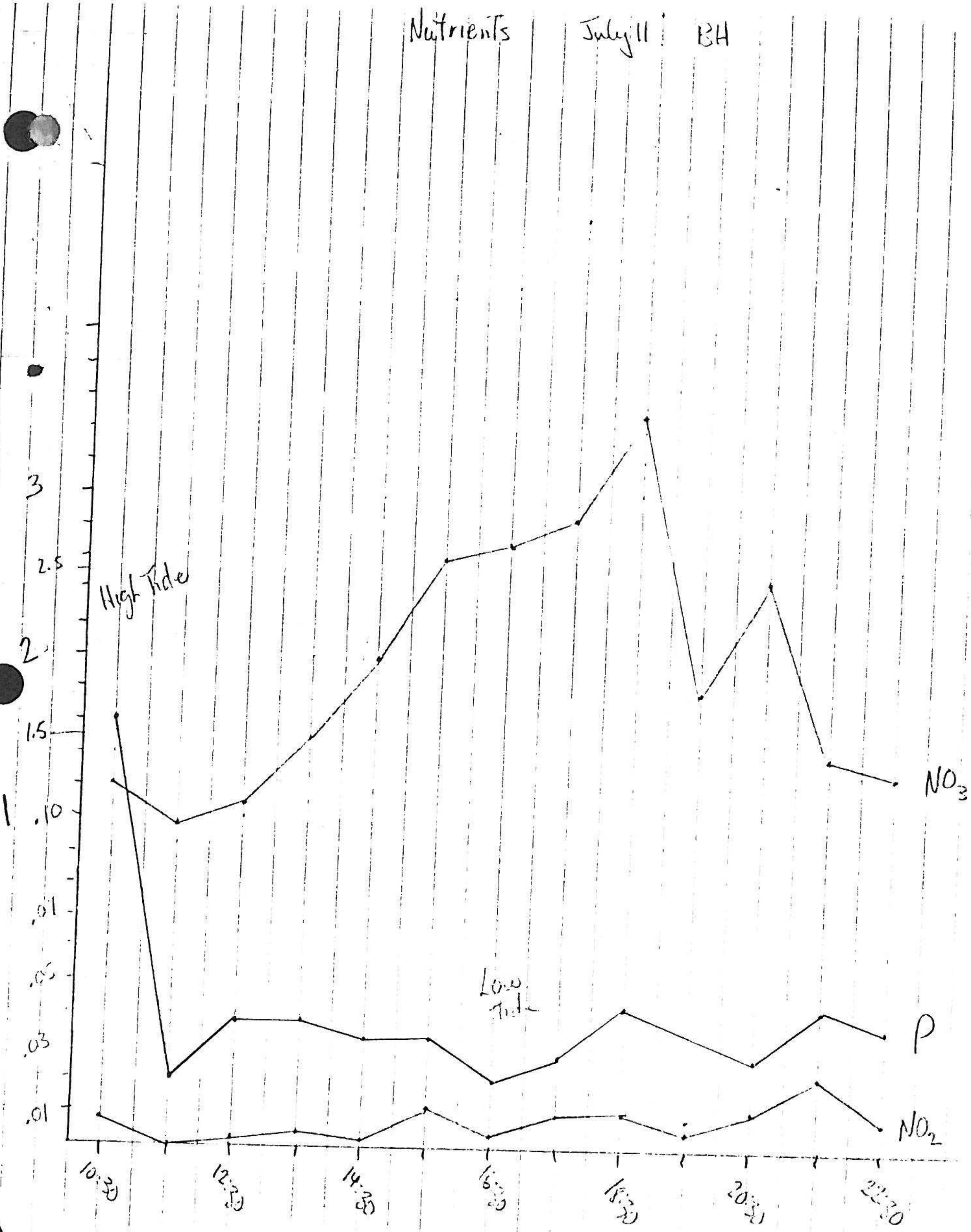
13) Lyngbya is ubiquitous throughout South Lake but is especially abundant near the mouth where it covers the sand as a black mat, uncovered at low tide.

14) Pleurobranchia and Tima were common at Basin Head in early summer. Cyanea was noted in mid summer at South Lake.

15) Species associated with the Basin Head Chondrus population.

Nutrients Aug 6 SL





Nutrients July 11 BH
High Tide
Low Tide
3
2.5
2
1.5
1
.10
.07
.05
.03
.01
10:30
12:30
14:30
16:30
18:30
20:30
22:30
NO_3
P
NO_2

ATE ↓	Nitrate (µg-at NO_3^- /l)				Nitrite (µg-at NO_2 /l)				Reactive Phosphate (µg-at /l)			
Transect →	1	2	3	4	1	2	3	4	1	2	3	4
28 June	2.908	1.290	0.825	0.771	0.000	0.019	0.041	0.011	0.421	0.356	0.033	0.056
7 July	0.927	1.328	1.166	0.710	0.005	0.004	0.011	0.000	—	—	—	—
Aug												

DATE	Nitrate (µg-at NO_3/l) 1	2	3	4	5	Nitrite (µg-at NO_2/l) 1	2	3	4	5	Reactive Phosphate (µg-at P/l) 1	2	3	4	5
21 June	~	2.132	1.348	3.658	4.729	~	0.044	0.028	0.027	0.044					
[illegible] June	1.839	1.683	1.707	1.683	1.863	0.004	0.004	0.002	0.004	0.002	0.201	0.051	0.183	0.094	0.056
5 July	2.162	2.393	1.372	2.535	2.090	0.014	0.005	0.004	0.018	0.019	~	~	0.557	0.557	0.253
12 July	0.644	1.281	2.608	2.974	2.650	0.000	0.007	0.012	0.023	0.014	~	0.070	0.047	0.112	0.066
25 July	1.284	1.587	2.633	2.474	1.593	0.004	0.011	0.009	0.012	0.005	0.103	0.098	0.094	0.089	0.066
2 Aug	3.076	2.881	2.021	3.311	0.620	0.032	0.027	0.021	0.019	0.002	0.056	0.080	0.112	0.047	0.070
10 Aug	1.128	1.816	4.494	1.372	3.027	0.004	0.004	0.035	0.004	0.014					

Basin Head Nutrients.

Physical Data → South Lake Transects

Date / Transect #	Temperature (°C) 1	2	3	4	Salinity (‰) 1	2	3	4
7 June	14.9	16.2	17.0	16.9	22.2	23.2	23.2	24.9
28 June	17.0	16.5	17.0	19.5	17.7	17.8	18.6	19.5
19 July	18.5	18.5	18.0	18.5	19.8	19.5	19.3	19.2

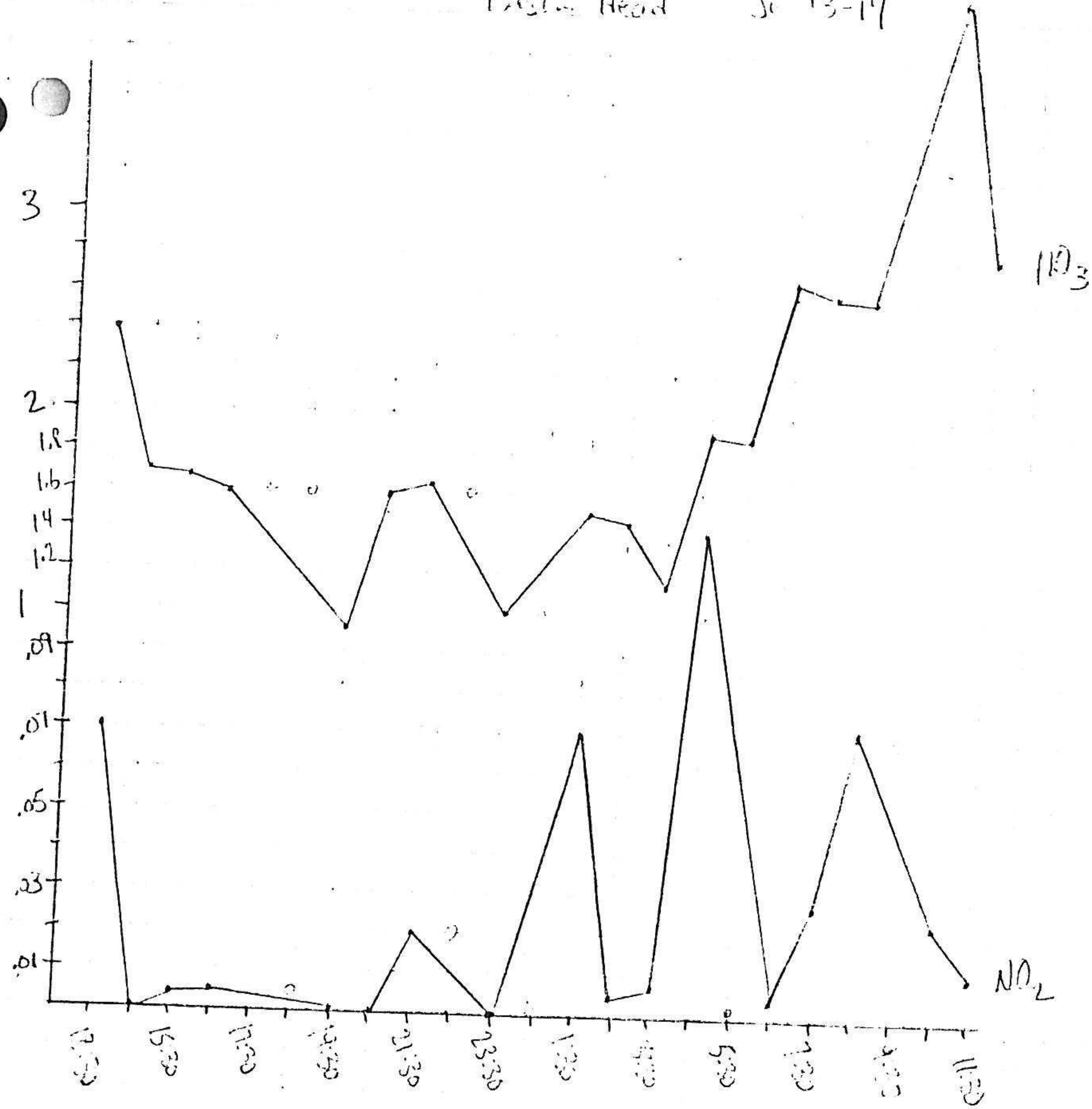
Transect #	Oxygen (‰) 1	2	3	4	pH 1	2	3	4
7 June	8.83	11.24	10.19	12.06	7.30	–	6.00	–
28 June	11.54	10.21	10.83	13.29	6.50	7.02	6.60	7.03
19 July	9.71	9.86	9.57	13.03	5.74	6.88	6.80	6.75

Date	Temperature (°C)						Salinity (‰)				
Transect #	1	2	3	4	5		1	2	3	4	5
[illegible] June	15.9	16.2	16.0	16.7	16.6						
[illegible]1 June	22.5	22.3	21.7	20.0	19.8		17.0	17.0	21.1	17.9	17.4
29 June	17.0	18.0	18.0	18.0	17.5		22.1	20.8	18.5	17.2	15.7
5 July	17.0	17.7	18.0	19.3	20.0		23.8	20.1	18.7	18.6	17.3
1[illegible] July	16.3	17.5	18.8	19.7	20.1		21.8	20.8	18.2	16.2	16.8
20 July	22.3	22.0	24.5	21.2	22.3		20.3	18.9	19.9	19.2	19.2
25 July	20.0	20.0	21.0	21.0	21.5		17.0	12.0	18.0	15.0	14.5
2 Aug	25.0	23.5	23.0	23.0	22.5		10.2	10.0	9.0	10.2	10.3
[illegible]0 Aug	16.0	16.1	16.0	16.5	17.0		15.5	18.5	16.5	15.3	14.0

NUTRIENT DATA over Time.

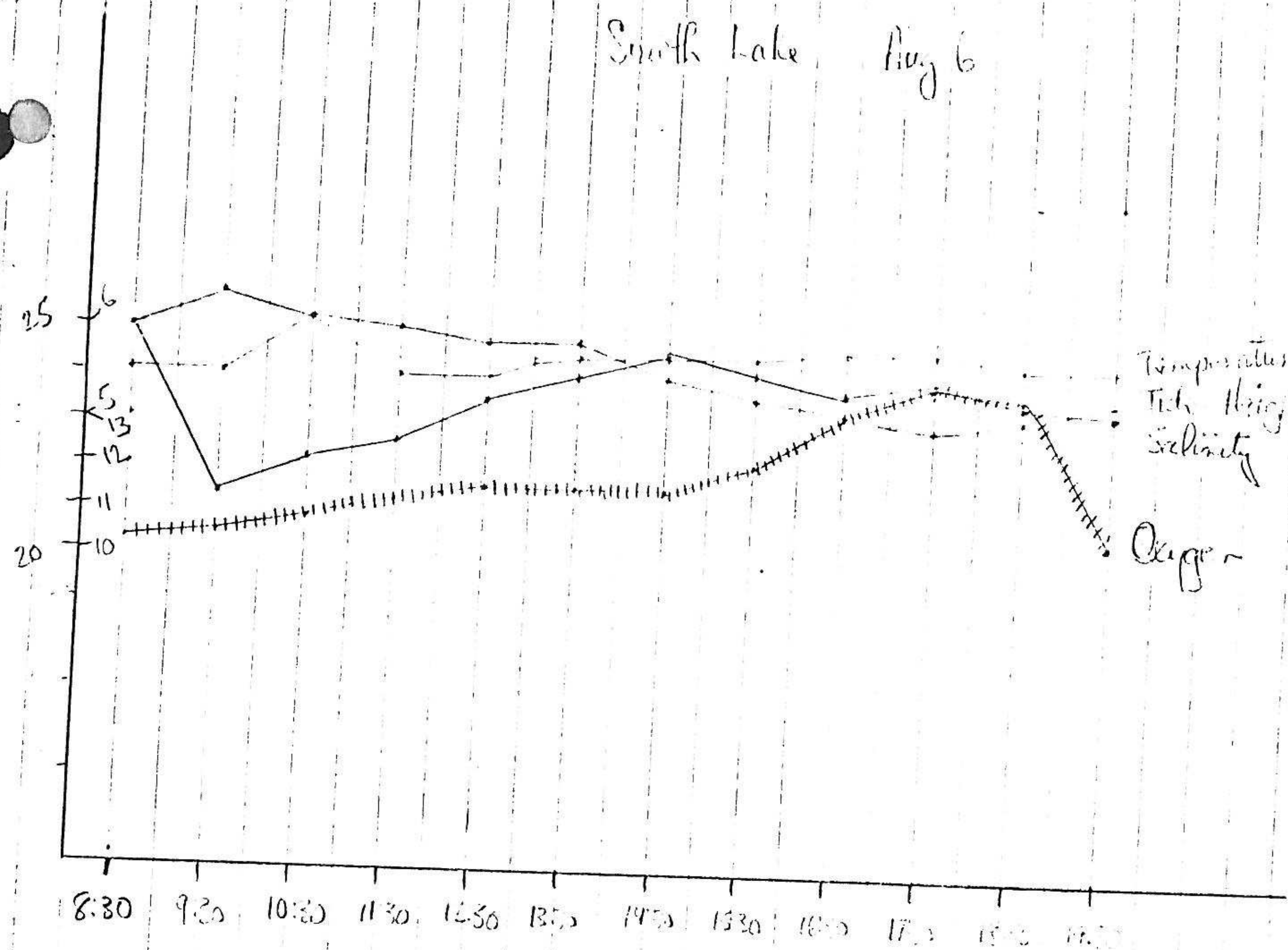
late & Location	Time	NO_3	NO_2
ıne 13 - 14	13:30	2.393	0.071
·ASIIU HEAD	14:30	1.709	—
	15:30	1.683	0.004
	16:30	1.617	0.004
	17:30	~	~
	18:30	~	~
	19:30	0.821	—
	20:30	1.598	—
	21:30	1.624	0.019
	22:30	~	~
	23:30	1.043	—
Je 14	00:30	~	~
	1:30	1.461	0.071
	2:30	1.424	0.005
	3:30	1.169	0.007
	4:30	1.918	0.124
	5:30	1.954	—
	6:30	2.660	0.004
	7:30	2.082	0.027
	8:30	2.038	0.071
	9:30	~	~
	10:30	4.128	0.023
	11:30	2.853	0.011

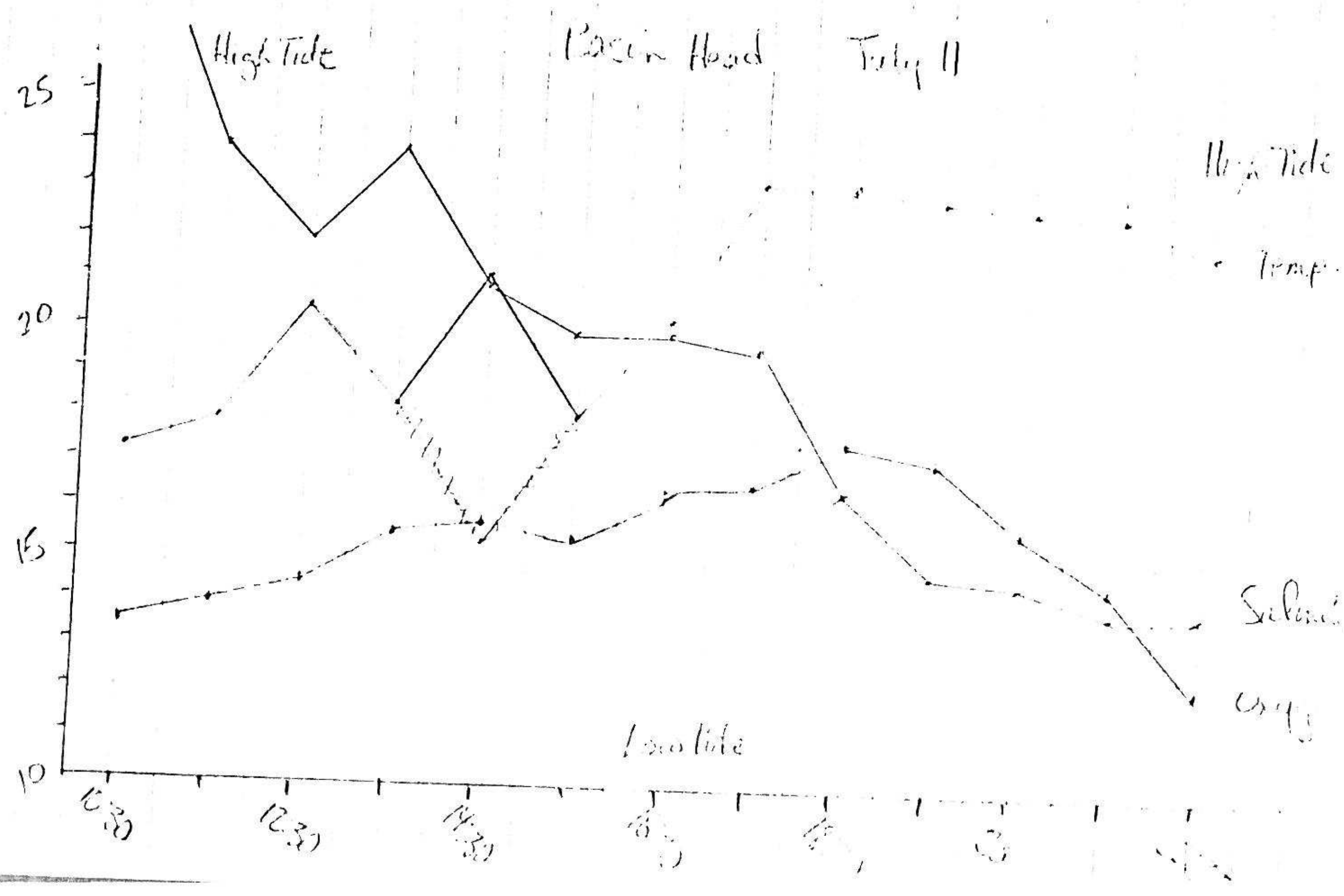
Fasin Head Jc 13-14



Physical Data over Time

e & Location	Time	Temp	Salinity	Oxygen	pH	
g 11	10:30	17.2	30.3	~~[illegible]~~ 13.47	7.02	
Basin Head	11:30	18.0	24.0	~~[illegible]~~ 13.96	6.73	
	12:30	21.5	22.0	~~[illegible]~~ 14.42	6.69	
	13:30	17.3	24.0	~~[illegible]~~ 15.45	7.05	
	14:30	21.1 ~~22.6~~ ~~15.2~~	21.0	~~[illegible]~~ 15.81	7.27	
	15:30	18.1	20.1	15.62	7.13	
	16:30	~~[illegible]~~ 20.1	19.8	16.46	7.34	
	17:30	23.3	19.7	16.62	7.41	
	18:30	23.3	16.5	17.60	7.19	
	19:30	23	14.9	17.13	7.36	
	20:30	22.9	14.8	15.76	7.24	
	21:30	22.9	14.0	14.66	6.72	
	22:30	22.0	14.0	12.32	7.20	
6	8:30	24.0	25.0	10.37	7.49	6'
South Lake	9:30	24.0	21.3	10.50	7.51	6'4"
	10:30	25.2	22.1	10.90	7.40	6,1
	11:30	24.0	22.5	11.33	7.45	6'
	12:30	24.0	23.5	11.61	7.46	5,8
	13:30	24.5	24.0	11.60	7.46	5,9
	14:30	24.5	24.5	11.60	7.33	5,5
	15:30	24.5	24.0	12.02	7.37	5,3
	16:30	24.7	23.7	13.30	7.42	5,2
	17:30	24.7	24.0	13.91	7.12	5,0
	18:30	24.5	23.6	13.73	7.40	5,1
	19:30	24.5	23.5	10.50	7.42	5,3


Smith Lake Aug 6
Temperature
Tide Height
Salinity
Oxygen
25
20
6
5
13
12
11
10
8:30
9:30
10:30
11:30
12:30


High Tide
Basin Head July 11
High Tide
Temp.
Salini
Oxyg
Low tide
25
20
15
10
10:30
12:30
14:30

Nutrient Data over Time

te & Location	Time	NO_3^-	NO_2^-	P
ly 11	10:30	1.212	0.009	0.131
ASIN HEAD	11:30	0.910	—	0.023
	12:30	1.062	0.002	0.037
	13:30	1.528	0.004	0.037
	14:30	1.996	0.002	0.033
	15:30	2.578	0.019	0.033
	16:30	2.638	0.004	0.019
	17:30	2.853	0.011	0.028
	18:30	3.474	0.011	0.042
	19:30	1.793	0.005	0.009
	20:30	2.453	0.011	0.028
	21:30	1.420	0.023	0.042
	22:30	1.345	0.009	0.037
ug 6	8:30	1.866	0.021	0.304
SOUTH LAKE	9:30	0.874	0.014	0.255
	10:30	0.777	—	0.178
	11:30	0.953	0.046	0.075
	12:30	1.478	0.320	0.594
	13:30	1.110	—	0.234
	14:30	0.295	0.030	0.028
	15:30	0.333	—	0.061
	16:30	0.590	0.009	0.019
	17:30	0.617	0.005	0.103
	18:30	0.433	0.011	0.140
	19:30	0.618	0.004	0.126

SPECIFIC GRAVITY — SALINITY