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PHYSICAL OCEANOGRAPHIC AND SEDIMENTOLOGICAL STUDIES IN THE SOUTHERN BIGHT OF MINAS BASIN

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Physical features of water in the southern bight of Minas Basin, including salinity, temperature, light penetration, and suspended sediment concentration and size distribution, were studied during the summer of 1978. Salinities decreased from 29 °/oo at the entrance of the southern bight to $<$25 °/oo at the mouth of the Cornwallis River, whereas surface suspended sediments increased from $<$ 10mg/ℓ to $>$ 100 mg/ℓ. Time-depth studies over 12 to 13 h periods were done at 3 locations in which changes in light penetration, salinity, and sediment load at meter depth intervals were recorded. Particle size frequency distributions varied according to locality and stage of tide. Some evidence of gravity settling was noted at high tide. A survey of the lower part of the Cornwallis River was also done, including an investigation of behavior of suspended sediments in the mouth over a tidal cycle. Maximum suspended sediment load in the river was 4.9 g/ℓ at 1/ km above the mouth—the farthest point of study.

Introduction

Minas Basin is an extensive, macrotidal estuary that, until recently, has been little studied. With renewed interest in tidal power development, a large scale program of study was initiated, firstly with geological studies (e.g. Amos & Joice 1977; Middleton 1977) and subsequently with faunal studies (e.g. Risk et al. 1977; Gratto 1978; Boates 1978; Pennachetti 1978). As part of this program a group was established to investigate the composition, abundance, and role in trophic pathways of the zooplankton.

It has been long recognised that zooplankton diversity is low in highly turbid localities. Jermolajev (1958) concluded from a study of zooplankton samples taken in Minas Basin and Channel that typical copepods from the Bay of Fundy fail to maintain themselves and starve when carried accidentally into Minas Basin. She did note, however, that some smaller species were extremely abundant in certain locations. With little phytoplankton to feed on, we assumed that these successful species must derive much of their trophic support from organic matter associated with suspended sediments. It was clearly necessary, therefore, to investigate in some detail the relationship between zooplankton and suspended sediments in a small portion of Minas Basin.

The present study was initiated to provide a clearer understanding of physical conditions in the southern bight region. The much more extensive study of Amos and Joice (1977) was necessarily conducted on a scale that provides insufficient information about small subunits of Minas Basin, particularly in shallow regions that are greatly influenced by river input. Furthermore, biological communities in the southern bight are quite different from those described by Risk et al. (1977) and Yeo (1978) for Cobequid Bay. They exhibit much greater diversity and regional heterogeneity than in the more easterly portions of the Basin. It is clearly desirable to discover reasons for these differences.

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This paper describes the first attempts made to quantify and categorise the suspended material in the southern bight region, to investigate the fate of these sediments as tidal waters moved in and out of the region, and to determine the degree to which light penetration is restricted. Water samples were taken at the same time that plankton was sampled so that possible correlations between the 2 might be detected. The objective of this study, therefore, was to establish in outline the postulated sediment-zooplankton interaction. Associated with this objective, the role of zooplankton in maintenance of local nekton populations is also under study, so that eventually an assessment of the significance of zooplankton in these highly turbid localities may be made. Preliminary results of zooplankton and fish studies are recorded in Pennachetti (1978), and more detailed accounts will be published elsewhere.

Methods

Water samples were collected at 1 m depth intervals using either a 2.1 *l* PVC Kemmerer bottle or a 1 *l* Knudsen bottle. Immediately upon retrieval of the sampler to the side of the boat, a 1 *l* sample was drawn off into a Nalgene bottle for analysis of suspended sediment. Surface water samples were obtained by direct filling of a sample bottle. These procedures minimized the effects of gravity settling of suspended material.

Analyses of suspended sediments were commenced within 48 h of collection for samples obtained during time-depth tidal studies, and within 4 h for survey studies. Subsamples of known volume were filtered through pre-weighed 0.4 µm Millipore or Nuclepore filters following agitation of the sample bottle to resuspend settled material. The filters were dried in a vacuum oven at 50 ± 1°C for 24 h and reweighed to provide estimates of total suspended solids (S.S.C.). Size-frequency distributions were examined using a Coulter Counter Model TA II equipped with a 280 µm aperture tube. Calibration was done using 10.01 µm polystyrene microspheres, and the electrolyte employed was Millipore-filtered sea water obtained at the site and time of collection of samples. Dilutions of samples varied according to concentration.

Temperature and salinity were recorded at the site of collection using a Y.S.I. S-C-T meter. During time-depth tidal studies, light penetration was measured at 0.5 m intervals using a Kahlsico Submarine Photometer, but during some survey studies a 20 cm Secchi Disc was employed.

Results

Survey Studies

In order to provide an account of regional and temporal variations in salinity, turbidity, temperature, and suspended sediment concentrations within the southern bight, 20 sample sites were visited at high tides between 17 May and 28 August 1978 (Fig 1). A summary of the results obtained is provided in Table I; more complete details are given in Pennachetti (1978).

Sites A-C lay either in the mouth of the Cornwallis River or in the outlet channel, and for these sites the influence of the river was predominate. Salinities were on the low side (23-27°/oo), whereas turbidity was high because of the relatively heavy load of suspended sediments (> 25 mg/*l*). Similar conditions were encountered in the mouth of the Canard River (site I) and that of Habitant Creek (L). At stations more distant from the river mouths (E-H, J, K, M) the influence of riverine water decreased and that of tidal water increased. This is most notable with regard to suspended

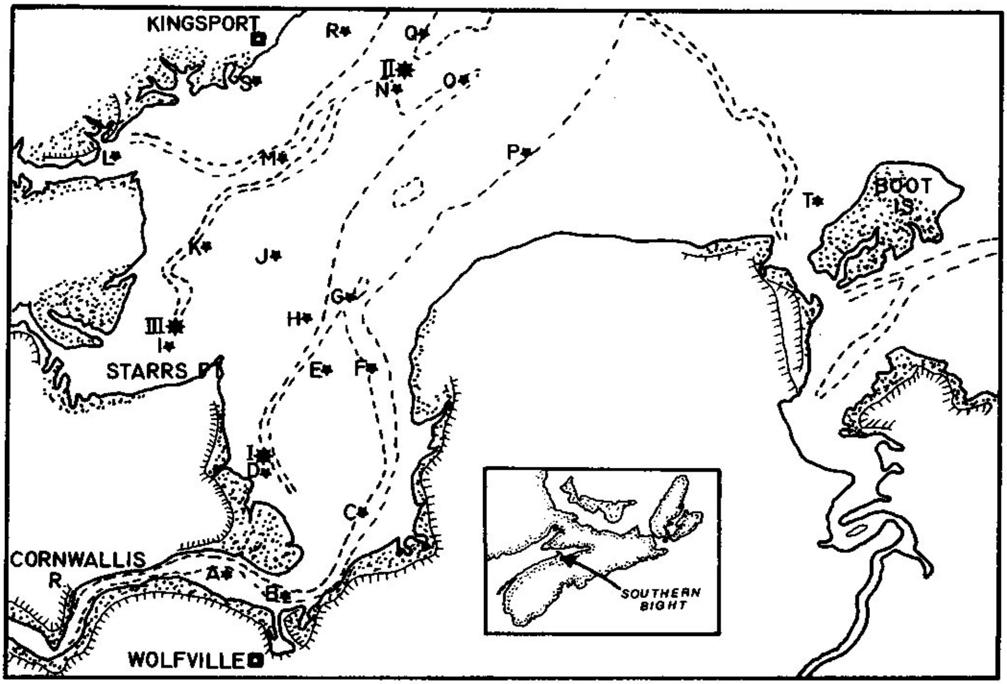

Fig 1. Southern bight of Minas Basin. A-T (small stars) Survey stations; I-III (large stars) Time-Depth anchor stations. Inset: Maritime Provinces showing study area.

sediment concentrations which were usually < 20 mg/ℓ and in Secchi Disc depths which approached 1 m. The unusually high suspended sediment value of 41.9 mg/ℓ obtained at site F probably indicates that a plume of undispersed river water had been sampled. The remaining sample sites illustrate the much greater clarity, higher salinity, and lower suspended sediment concentrations of true tidal water.

Because of time limitations, only a few sites could be visited on any single day. Six sites (A, D, E, I, L, and Q), however, were visited at regular intervals during the summer, and these results give some measure of temporal variability in these physical features. Considerable variation is evident, particularly in the amount of suspended material. On 1 occasion at each of sites B, D, I, and Q, water samples were taken at the surface, at mid-depth, and just above the bottom and the amount of suspended sediment present determined. In only 1 case (I) was there an indication that the water column was well mixed vertically, whereas at sites D and Q the deepest water carried a much greater suspended load than that at the surface. In the river channel (B), however, the greatest load was in the mid-depth sample, which is presumably correlated with a greater rate of flow.

Size frequency analysis of suspended sediments in surface water samples from different sites indicated a marked change in principal particle sizes as the mouth of the Cornwallis River was approached (Fig 2). At deeper locations primarily influenced by tidal water (e.g. R, O, J - Fig 2A) suspended sediments included particles at all sizes that could be measured with the 280 μm aperture used (<112 μm diam), with only a slight preponderance of particles 6 to 20 μm diameter. In contrast, samples from shallower stations (D, E, H, L - Fig 2B) and the river (B, F - Fig 2C) ex-

Table I. Physical features of the southern bight of Minas Basin, 1978.

Station	Date (day/mo)	H.T.* Time	Sample** Time (h)	Max. Water Depth (m)	Temp. (°C)	Sal. (° / oo)	S.S.C.*** (mg/l)	Secchi Disc Depth (m)
A	19/5	1039	-0.9	7.0	11.1	23.5	-	0.3
	24/5	1444	-1.6	9.8	10.1	25.8	-	-
	9/6	1609	-1.2	-	15.5	23.2	109.6	-
	3/8	1324	-1.4	-	20.0	25.0	-	-
B	9/6	1609	-0.9	8.5	13.5	24.8	32.4(s) 78.0(m) 25.7(b)	-
C	3/8	1324	-1.1	9.0	20.0	27.0	-	-
D	19/5	1039	-0.4	7.5	9.0	29.0	-	0.6
	24/5	1444	-1.2	7.0	9.9	26.5	-	-
	9/6	1609	-0.8	9.5	12.3	26.8	14.9(s) 15.3(m) 121.2(b)	
	7/7	1504	-1.7	-	-	-	30.5	0.6
	21/7	1409	-0.2	10.0	16.5	-	13.1	-
	3/8	1324	-0.8	9.5	21.0	26.2	-	-
E	19/5	1039	-0.2	4.5	9.5	25.5	-	0.5
	24/5	1444	-0.9	7.3	9.3	26.3	-	-
	9/6	1609	-0.2	-	13.0	25.0	4.9	-
	21/7	1409	-0.6	5.9	16.0	-	17.7	-
	3/8	1324	-0.7	9.0	18.0	28.0	-	-
F	7/7	1504	-1.3	-	-	-	41.9	0.6
	21/7	1409	-0.8	>17.0	16.5	-	15.4	-
G	3/8	1324	-0.5	12.5	20.5	26.8	-	-
H	19/5	1039	+0.3	8.0	8.6	25.5	-	1.0
	24/5	1444	-0.7	13.3	8.6	26.5	-	-
	7/7	1504	-2.1	-	-	-	22.1	0.7
	21/7	1409	-1.1	5.9	16.0	-	10.8	-
I	24/5	1444	+0.3	11.0	10.0	26.1	-	0.9
	9/6	1609	-0.7	6.7	-	-	3.5	-
	23/6	1514	-1.1	6.2	16.5	23.1	83.0	0.7
	7/7	1504	-1.6	-	-	-	17.6	-
	21/7	1409	-0.5	5.5	19.5	26.5	27.1(s) 22.2(m) 24.7(b)	0.6
	3/8	1324	-0.8	5.5	18.6	-	-	0.9
J	23/6	1514	-1.6	7.0	15.0	23.8	-	1.0
	21/7	1409	-0.7	5.5	18.0	26.7	16.1	-

Station	Date (day/mo)	H.T.* Time	Sample** Time (h)	Max. Water Depth (m)	Temp. (°C)	Sal. (° / oo)	S.S.C.*** (mg/*l*)	Secchi Disc Depth (m)
K	17/5	0859	-1.8	4.5	10.0	26.1	-	0.8
	7/7	1504	0	-	-	-	12.4	-
L	17/5	0859	-0.2	6.5	11.0	26.0	-	1.2
	24/5	1444	+0.6	8.8	9.5	26.3	-	0.6
	23/6	1514	-0.6	5.2	18.0	24.1	124.9	0.9
	7/7	1504	-1.9	-	-	-	15.2	-
	21/7	1409	-0.3	14.4	17.0	-	11.0	-
	3/8	1324	-0.6	9.0	18.9	-	-	1.2
M	17/5	0859	0	-	9.5	26.0		1.2
	3/8	1324	-0.3	7.3	17.1	-	-	1.5
N	7/7	1504	-0.8	-	-	-	7.5	-
O	17/5	0859	-	-	8.2	26.5	-	-
	21/7	1409	-0.8	14.0	17.0	26.0	9.2	1.5
P	23/6	1515	0	14.0	12.0	26.0	8.5	1.6
Q	24/5	1444	-1.2	11.0	8.0	26.5	-	1.3
	9/6	1609	+0.4	14.6	-	-	3.5	-
	23/6	1414	-0.3	15.0	12.2	21.1	21.4	1.6
	7/7	1504	-1.1	-	-	-	8.5	-
	21/7	1409	-1.3	12.0	18.2	24.9	11.1(s) 11.9(m) 16.9(b)	1.5
	3/8	1324	-1.2	11.5	17.0	-	-	-
R	9/6	1609	+0.6	-	-	-	1.8	-
	3/7	1324	-0.2	>6	17.1	-	-	1.5
S	9/6	1609	-1.2	8.3	-	-	2.5	-
T	24/5	1444	-0.7	7.0	9.5	26.3	-	0.8

* H.T. - time of high tide predicted for Walton (Canadian Tide and Current Tables 1978)

** Sample time in hours relative to predicted high tide time (e.g. -0.5 indicates samples taken 0.5h before predicted high tide).

*** S.S.C. = Suspended sediment concentration. s = surface sample; m = mid-depth sample; b = sample taken near max. depth, but above bottom. Except where indicated otherwise, all samples were taken at the surface.

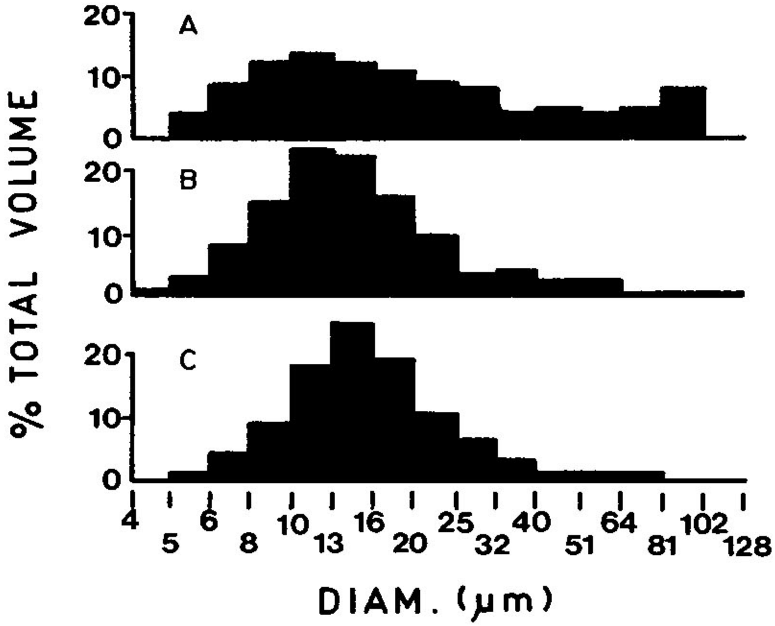

Fig 2. Typical particle size-frequency distributions in the surface waters at high tide. A - pattern at deeper water stations; B - inshore stations over mudflats; C - River mouth station.

hibited a distinct peak in the 10 to 20 μm range and a low percentage of particles >40 μm diameter. We attribute this change in percentage frequency to a combination of 2 factors: the resuspension of fine particles from the surface of the mud and the partial settling out of larger particles and floccules (Krank 1978) as velocities decreased when the water moved over the mud flat.

Time-depth Tidal Studies

Although some general trends in salinity and suspended sediment concentrations are evident from the survey sample results, it was obvious that physical conditions at any given point varied markedly according to the stage of the tide. Tide-related changes were expected to be even greater in shallower waters such as the southern bight than were recorded by Amos and Joice (1977) from their metered stations near Blomidon. For this reason 3 studies were carried out in which hourly samples at 1 m depth intervals were taken from a single point over 12 to 13 h periods. Because of the difficulties of access and the small (<14') boats employed, the time-depth tidal studies commenced at a convenient morning high tide and continued until the next high tide. Locations of the time-depth studies are indicated in Figure 1.

i) Wolfville Station (1) 29 May: On the first time-depth study, sampling began at 0830 h, just after high tide, and continued until 2000 h. Between 1200 and 1500 h the boats used were left stranded on the mud flat as the water receded further than expected. Results of this series are presented in Figure 3.

Vertical temperature and salinity data indicate clearly that in general the water column is moderately to well mixed, temperatures rarely varying by >1.5°C from top to bottom of the water column. The diel temperature fluctuation would appear

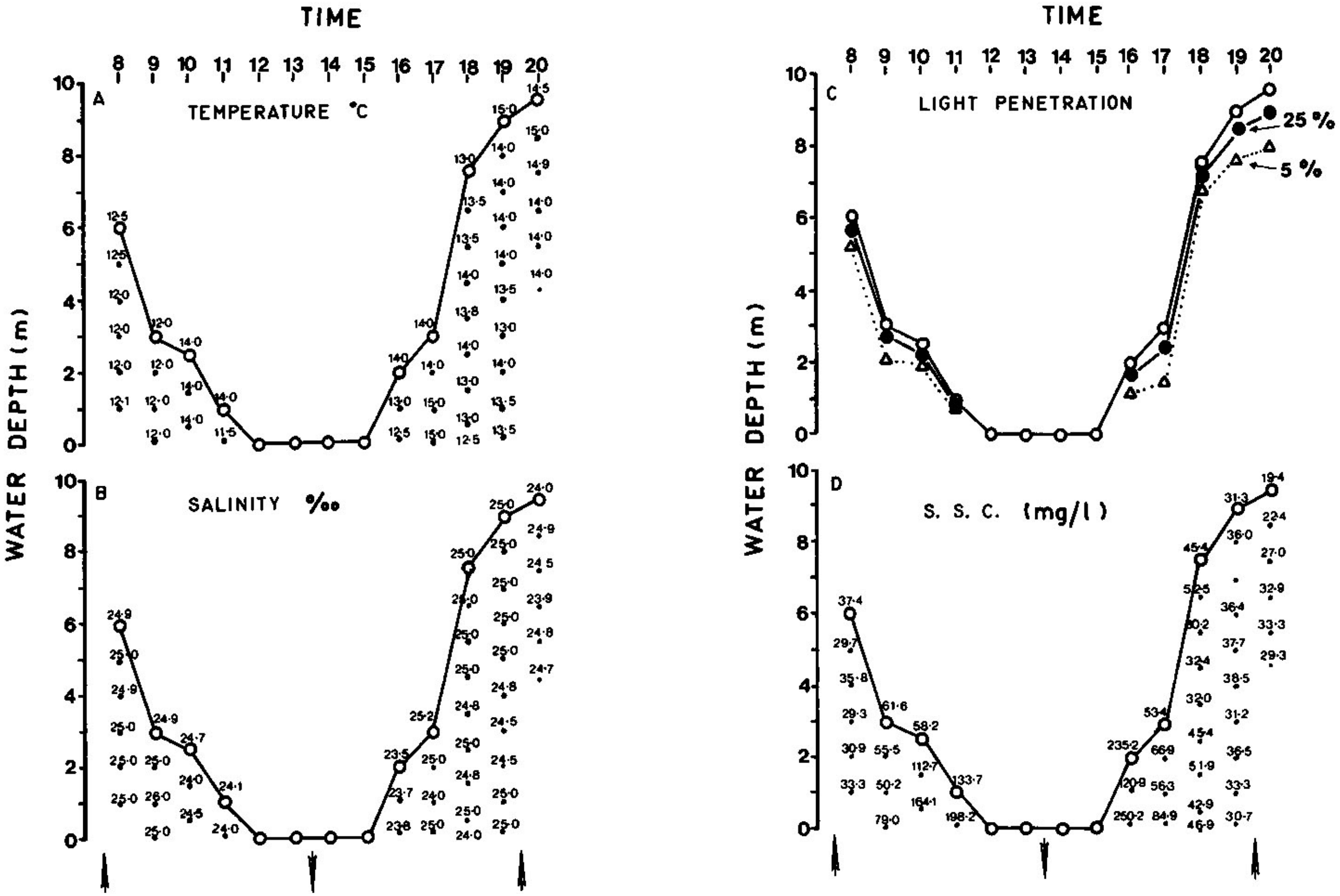

Fig 3. Time-depth patterns of Temperature (A), Salinity (B), Light penetration (C), and Suspended Sediment Concentration (D) at site 1, 29 May 1978. o—o water depth; • sample points; high tides; ↓ low tides.

to have been of greater importance than the tidal; during the morning hours while the tide was ebbing, temperatures were somewhat cooler than on the afternoon flood tide. Exposed mud flats such as these accumulate a great deal of heat when low tide occurs at midday, and this heat is transferred to returning flood water. Similarly, vertical salinity variations were also small, being not much greater than might be attributed to instrument error. Light penetration was greatly restricted as a result of the high suspended sediment load. Maximum depth at which 5% of incident surface light occurred was about 1 m at the time of high tide corresponding to a Secchi Disc reading of 0.5 m. During both ebb and flood, however, the much greater quantities of suspended sediments resulted in shallower light penetration.

Greatest vertical inhomogeneity in the water column is seen in the suspended sediments. Mean concentration in the water column rose from about 33 mg/*l* at 0800 h to 165 mg/*l* by 1100 h as the tide ebbed, whereas on the flooding tide mean concentration decreased from 202 mg/*l* to 27 mg/*l* at the next high tide. Within each column sampled, variations in concentration suggest that vertical mixing was incomplete, but it must be noted that only a single sampler was in use, so that the samples collected at any given hour were not simultaneous. The decline in concentration near high tide is largely attributable to dilution by the somewhat clearer water coming from the open part of the Basin, but might also be the result of gravity settling of larger suspended particles as current speeds diminish.

An examination of particle size frequencies in each sample taken failed to verify the occurrence of gravity settling, probably because of the incomplete data set available at 2000 h. Figure 4 presents selected size frequency distributions obtained during this study. As with previous samples (Fig 2) a wide spectrum of sizes was present in most samples, with a broad peak over the 10 to 40 μm range. In some samples from deeper water, however, the size distribution curve is even flatter because of the presence of a few large particles < 100 μm diameter (e.g. Fig 4B). Near high tide at 2000 h a marked increase in modal size occurred with depth: from 10 to 16 μm at the surface (C) to 20 to 32 μm at depths of 4 and 6 m (D, E).

ii) Longspell Point Station, 16 and 29 June. A second series of time-depth samples was commenced on 16 June at a point farther out in the Basin. Because of equipment limitations, only light penetration and partial temperature profiles were obtained on this date, and accordingly the site was revisited on 29 June to obtain a series of suspended sediment samples. Results from these two dates are given in Figure 5.

Temperatures on 16 June ranged from 13°C at the morning high tide to 21°C at low tide when water depth was < 5 m (Pennachetti 1978). The water column was essentially homothermal at all times with a maximum range of 1.5°C over a depth of 15 m. Light penetration was considerably greater than at the Wolfville site with the 5% light level being at a depth of 5 m during the morning high tide. As the tide ebbed, however, suspended sediment concentrations increased considerably (e.g. from ca. 8 mg/*l* at high tide to > 20 mg/*l* at low tide on 29 June) and correspondingly, the depth of 5% light penetration decreased to about 2 m. During the afternoon flood tide, sediment concentrations decreased once more, and on the flood tide of 16 June some increase in light penetration was noted (Fig 5). Since these data were obtained on separate occasions no further consideration is warranted.

Particle sizes in samples taken on 29 June were generally more symmetrical in distribution than those obtained over the mud flat near Wolfville. Modal size in most cases was in the 10 to 16 μm range. There was a little evidence of gravity settling at slack water (cf. Pennachetti 1978).

iii) Canard River Station, 13 July. The sample site in the mouth of the Canard River was in the middle of the main drainage channel and thus the boats remained with a small amount of channel water at low tide. As a consequence of the location, the

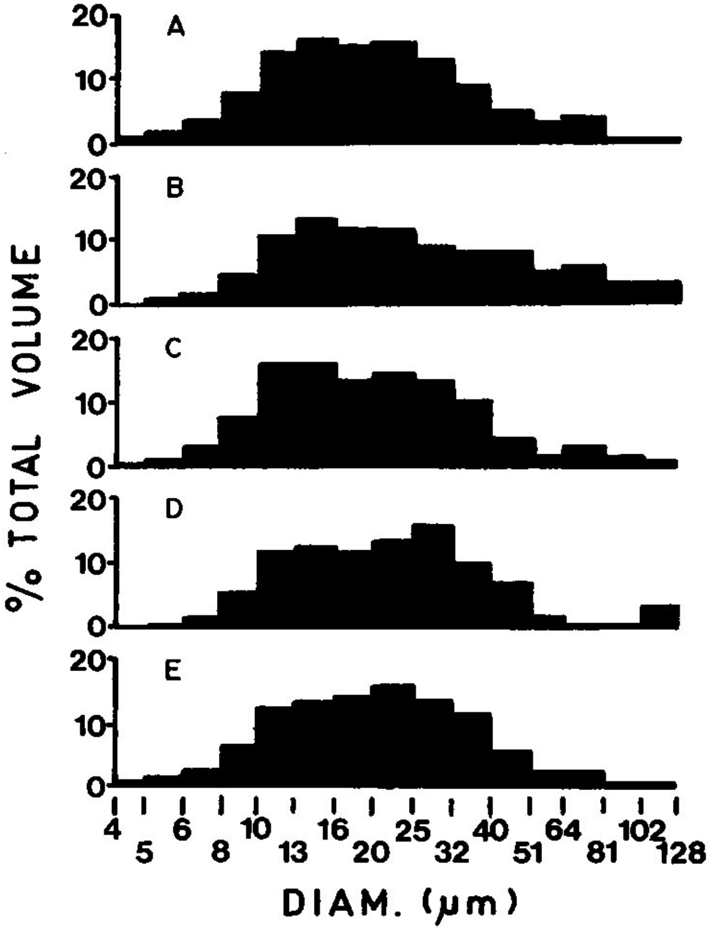

Fig 4. Particle size-frequency distributions of selected samples from 29 May 1978 time-depth study.
A - Surface sample, 1000 h; B - Bottom sample 1600 h;
C - Surface sample, 2000 h; D - 4m sample, 2000 h; E - 6 m sample, 2000 h.

pattern of the ebb and flood tide was unusual, with an anomalous increase in depth mid-way through the ebb tide and a similar decrease in depth half way through the flood (Fig 6). These events are presumably caused by frictional resistance to sheet flow over the surrounding flats which in the first instance impedes drainage into the channel, and in the second, away from the channel over the mudflats.

Temperature results reflect those obtained on earlier time-depth studies. At most sample times there was little difference in temperature from top to bottom of the water column, but near the evening high tide (1930 h) an inversion of the usual pattern occurred when cooler, more saline water appeared to be overriding warmer, less saline water. It is probable that this unstable configuration resulted from the constraining effect of the steep channel walls preventing much lighter water from riding out over the incoming tidal water.

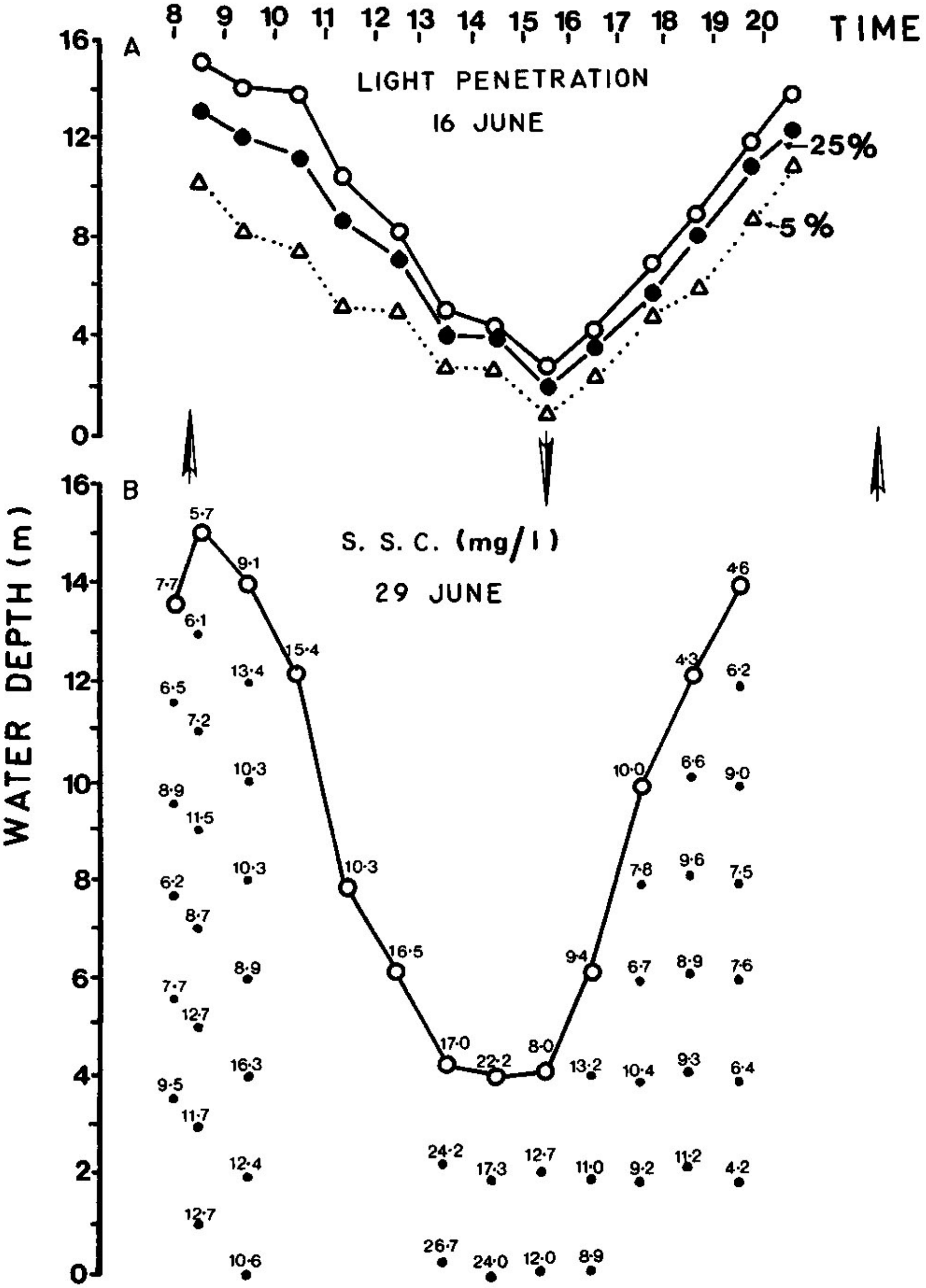

Fig 5. Light penetration (A), 16 June 1978 and Suspended Sediment Concentration (B), 29 June 1978 during time-depth studies at site II. Symbols and units as Fig 3. Note differences in vertical scale.

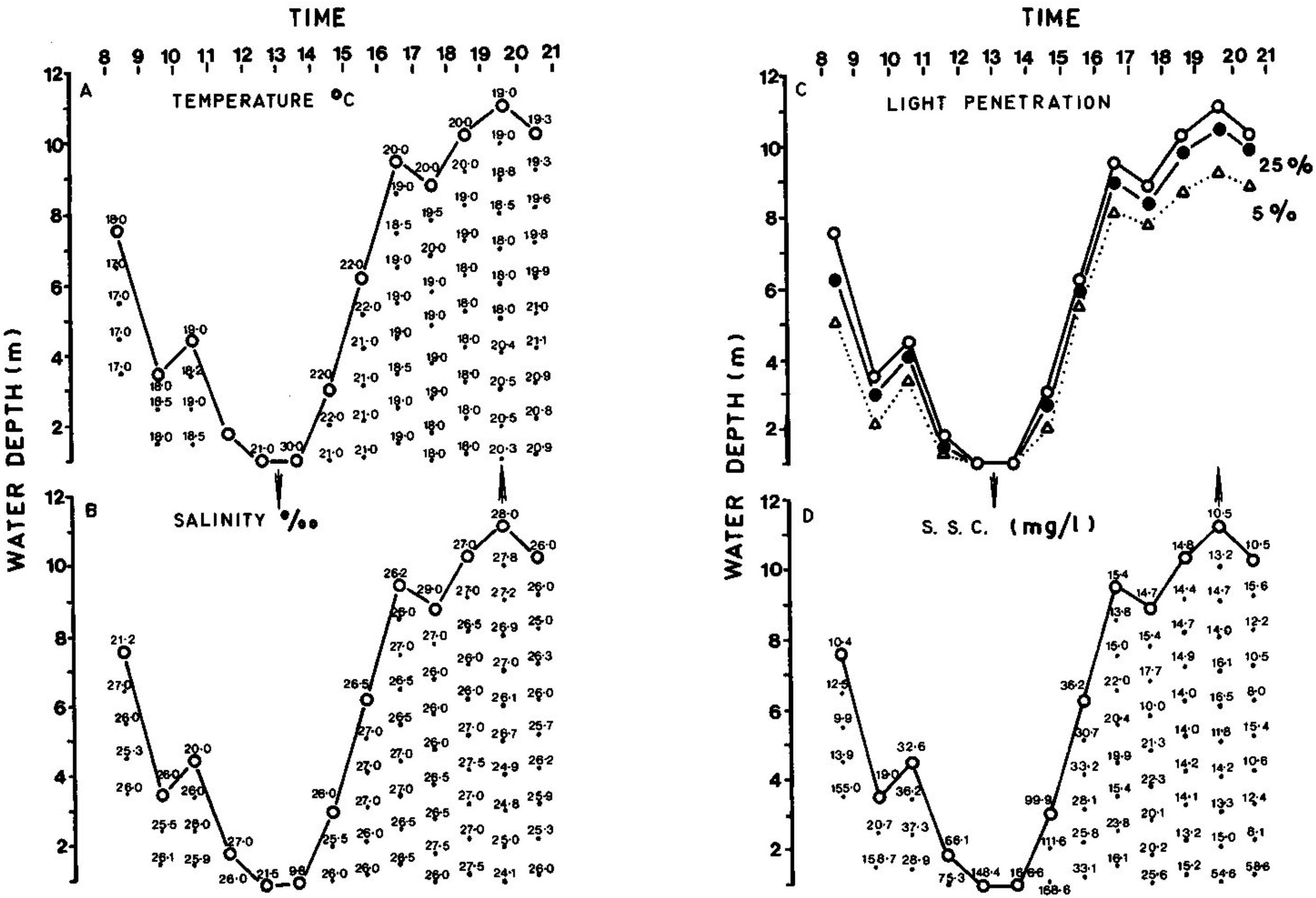

Fig 6. Time-depth patterns of Temperature (A), Salinity (B), Light Penetration (C) and Suspended Sediment Concentration (D) at site III, 13 July 1978.

Salinities ranged from as little as 9.8 °/oo at low tide when the channel contained mostly Canard River water to a maximum of 29.0 °/oo during the flooding tide. Except for the high tide condition noted above, there was little vertical inhomogeneity. Maximum light penetration occurred near the high tides, the 5% level being at 1.5 to 2.5 m, and minimum penetration at low tide when 95% of surface light was extinguished at 0.3 m depth. Correspondingly, suspended sediment concentrations were high (> 140 mg/*l*) around low tide and diminished sharply (< 17 mg/*l*) towards the high tide. It is notable that several bottom samples exhibited much greater quantities of sediment in suspension than water immediately above (e.g. 0830, 0930, 1430 etc.). This phenomenon is also undoubtedly related to channel shape, and presumably indicates an extremely turbid layer near the bottom that does not get completely mixed with the rest of the column because of the restraining channel walls.

Particle size distributions were much more variable in these samples than in previous studies. Although most samples exhibited a skewed broad spectrum with modal sizes in the 10 to 16 μm range (Fig 7A), some bottom samples showed spectra that were highly truncated at the low end (Fig 7B) as a result of the dominance of particles > 20 μm. On the evening high tide a progressive shift in mode from a 10 to 13 μm at the surface (Fig 7C) to > 20 μm (D, E) suggests a significant gravity settling effect. Because of the entraining effects of the channel at this site, however, interpretation of these results must be cautious.

Cornwallis River Study

A major source of freshwater for the southern bight region is the Cornwallis River. In order to examine the fate of particulate material carried in suspension by water in the river a series of surveys was carried out to provide a descriptive account of suspended sediments and salinity along the course of the river. One such survey is reported here; the remainder are described in Pennachetti (1978). Subsequent to these surveys, a study was conducted of the changes occurring over one tidal cycle at 2 locations in the river.

i) 21 June survey. A survey of surface waters from the mouth to > 11 km above the mouth of the Cornwallis River was carried out near high tide on 21 June. Results are given in Table II, and location of sample stations in Figure 8.

Salinities decreased from 25 °/oo at the mouth of the river to 20 °/oo at the uppermost station sampled. Although not evident in this particular survey because of wind activity, the mouth of the Cornwallis River occasionally exhibits lateral stratification with higher salinities along the southern shore where flood water more strongly and lower salinities along the northern shore where river outflow is more important. This effect is limited to the lower reaches of the river and has not been noted above station 9.

Suspended sediment concentrations increased greatly from about 50 mg/*l* at the mouth to > 4500 mg/*l* at the upper stations. Secchi Disc visibility is ≤ 1 cm for several km further upstream than examined in this survey. The size distribution of suspended particles also showed a progressive change along the course of the river. At the more upstream stations the percentage volume distribution was almost uniform over the range 8 to 100 μm (Fig 9A), but at intermediate (B) and lower stations (C) a more symmetrical pattern around a mode of 16 to 20 μm was evident. It is not certain how much influence was played by sample time in determining these frequency distributions. While all samples were obtained at the surface around high tide on the same day, sampling commenced at the upstream station (39) before high tide and proceeded downstream, the whole series taking 1.5 h. The lowest stations were sampled at slack water. If gravity settling occurred, its effect would be to remove the largest particle sizes from the surface and leave a distribution skewed to

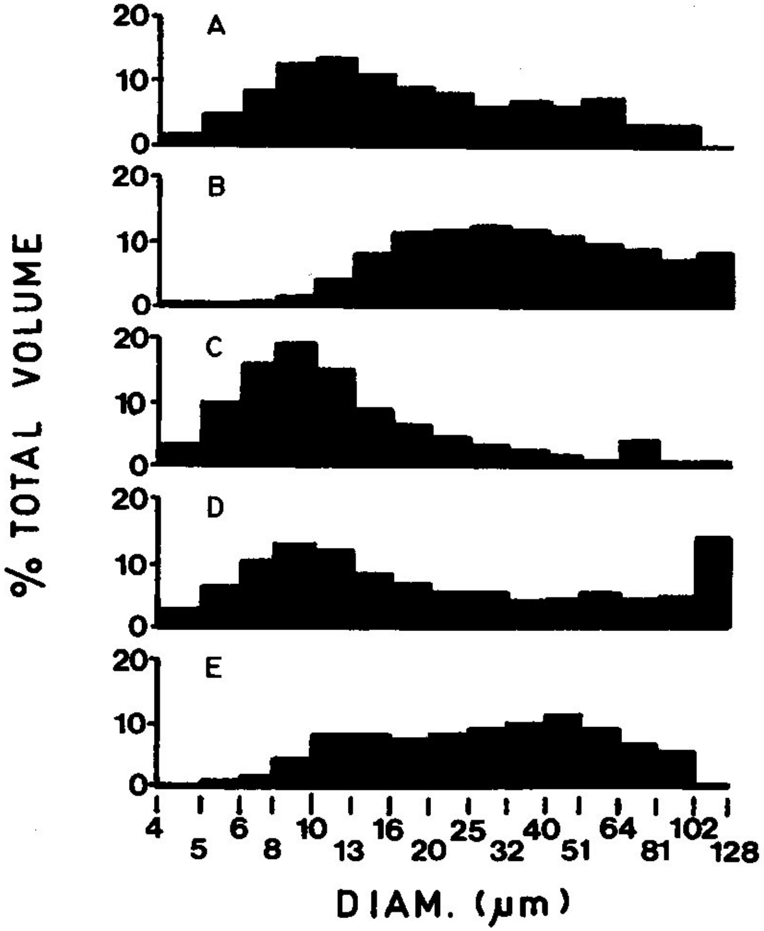

Fig 7. Particle size-frequency distributions of selected samples from 13 July 1978 time-depth study.
A - 5 m depth, 1830 h; B - 2 m depth, 0930 h; C - Surface sample 2030 h; D - 4 m depth, 2030 h; E - Bottom (9 m) sample, 2030 h.

the lower end of the spectrum. The effect would be greater at the lower stations. The symmetry observed at the lower stations, however, suggests this effect is negligible.

ii) Tidal study, 6 July. In order to investigate temporal phenomena related to tidal movements in the mouth of the river surface, water samples were taken in midstream at two points (Stations 2 and 13, Fig 8), one near Wolfville at the mouth of the river, and the other at Port Williams bridge. Results are given in Figure 10.

Extensive changes in salinity were recorded at both stations, reaching maximum values of 23.5 °/oo at the Wolfville station (2). During the ebb tide, however, salinity decreased more rapidly at the outermost station than at Port Williams, and for the last 3 hours the upstream station was, paradoxically, more saline than the lower station. Whether this is related to temporal stratification at the mouth is unknown.

Temperatures at both stations varied irregularly during the tidal cycle over a range of 1.5°C. A diurnal heating effect is presumably indicated by the fact that

TABLE II. Physical features of the Cornwallis River, 21 June 1978.

Station	Temperature (°C)	Salinity (° / oo)	S.S.C. (mg/l)
1		25.1	69
2		25.1	52
3		25.2	55
4		25.2	67
5	13.0	25.1	49
6		25.0	89
7		25.0	106
8		25.1	66
9		24.2	109
10		25.0	90
11		25.4	102
12		25.1	229
13	13.0	25.0	442
14		25.1	2248
15		24.7	160
16		25.0	306
17	13.0	24.0	1195
18		24.1	2210
19		25.0	186
20		24.9	282
21		24.6	345
22		24.3	403
23		24.2	713
24		24.9	288
25		23.8	154
26		23.7	687
27		24.1	564
28		24.0	1751
29		23.5	754
30		23.2	1435
31		23.3	924
32		23.8	1290
33		22.2	2011
34		22.4	1123
35		21.8	2772
36		22.0	4060
37	13.8	21.0	2374
38		21.1	4923
39		20.1	4656

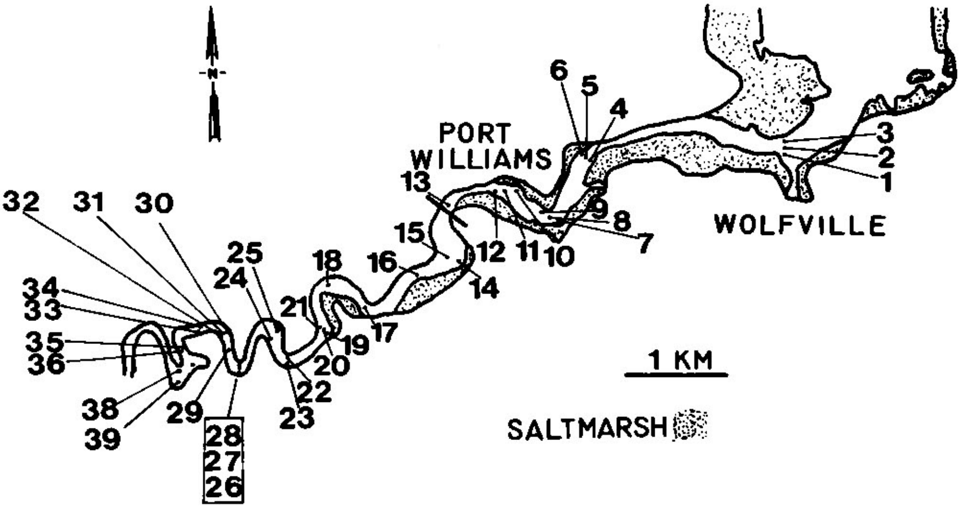

Fig 8. Cornwallis River. 1-39: sample stations, 21 June 1978.

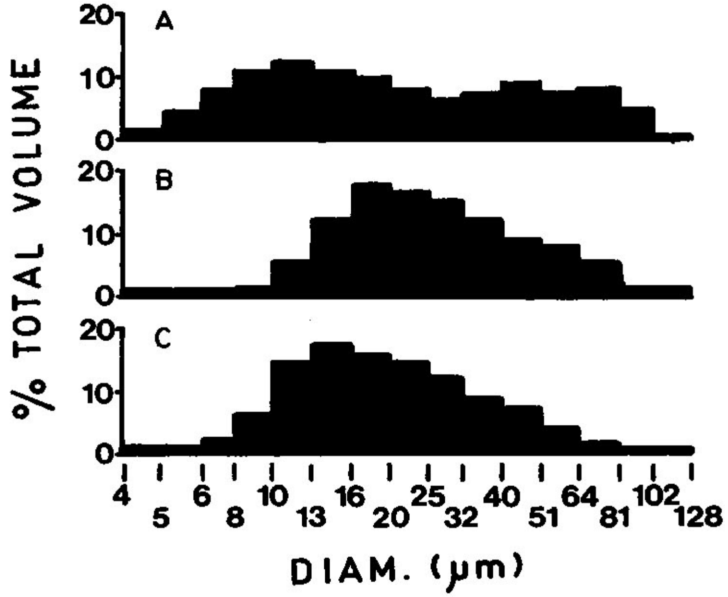

Fig 9. Particle size-frequency distributions of selected surface samples from Cornwallis River, 21 June 1978.
A: station 37; B: station 13; C: station 3.

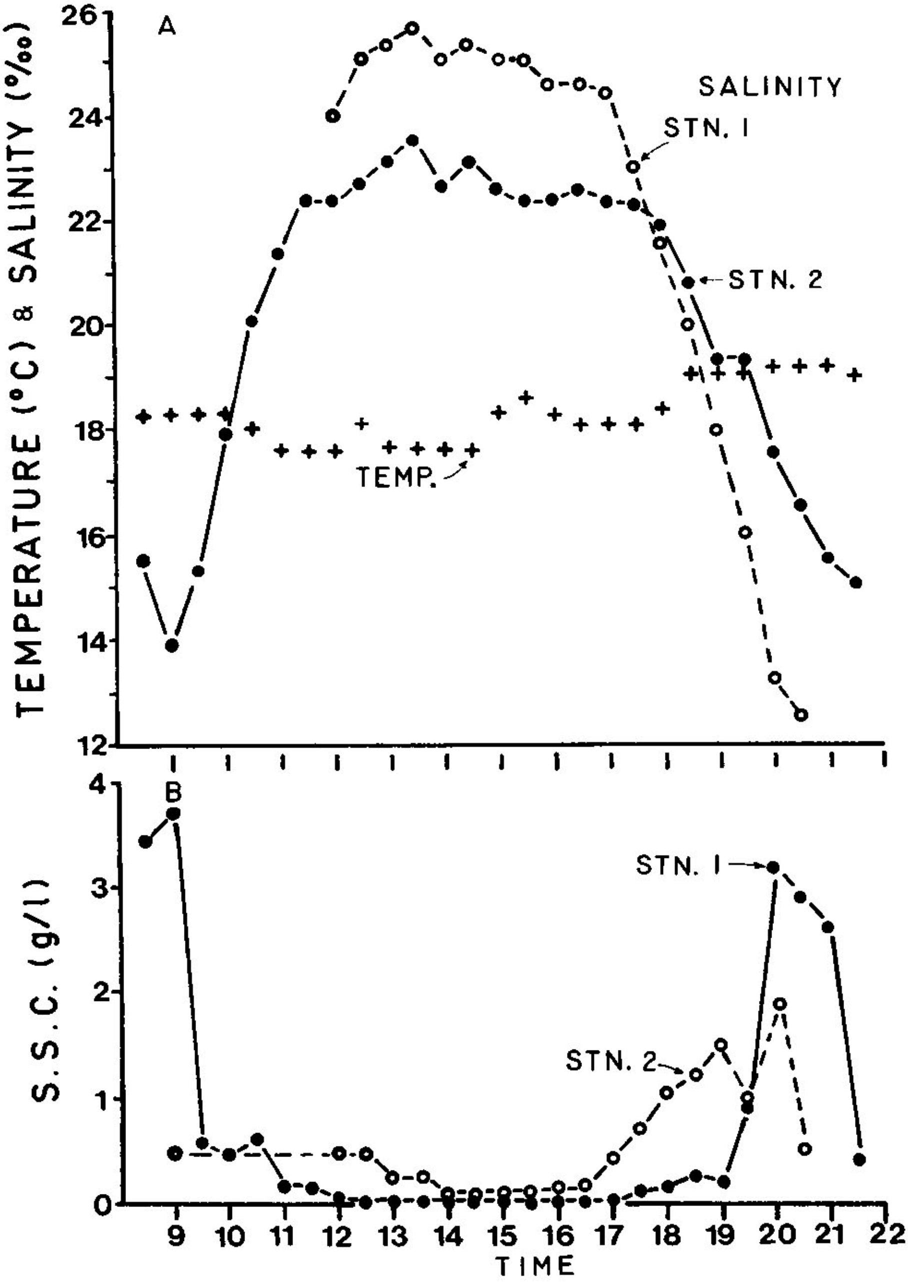

Fig 10. Temporal changes in surface waters at 2 stations on Cornwallis River, 6 July 1978.

A - Salinity changes at Port Williams (stn. 1) and Wolfville (stn. 2) and Temperature changes for both stations.

B - Changes in Suspended Sediment Concentration at Port Williams and Wolfville. Note - units in g/*l* evening low tide temperatures were about 1°C higher than at the morning low tide.

Suspended sediment concentrations were extremely high at Port Williams during low tide, and decreased sharply as the flood tide brought in Minas Basin water having much lower concentrations. Over the high tide period at these two stations the surface waters carried $<$ 200 mg/$l$of suspended sediment. Coulter counter analyses of these water samples show considerable changes in size distribution, including evidence of gravity settling at high tide (Pennachetti 1978).

Discussion

In the present study the concentrations of suspended sediments measured in surface waters at high tide correspond well to the ranges interpolated by Amos and Joice (1977) from Landsat imagery. With proximity to the mouth of the Cornwallis River, sediment levels increase substantially and continue to increase over the lower 11 km of river channel. The suspended sediments that are present in the river mouth at high tide, however, are not apparently transported out into the southern bight in any quantity on the ebb tide. At all stages of the tide the water in the southern bight is considerably less turbid than that in the river mouth. Furthermore, on calm days sharp lines of demarcation are evident at high tide between the clearer water entering the southern bight from Minas Basin, and residual water that remains in the bight but oscillates back and forth over the mud flats and into the river mouth. Finally, the mud flats of the region appear to have accumulated little in recent years, suggesting that the suspended sediments are almost in dynamic balance with fluvial supply. According to Amos and Joice (1977) the only nearby sites of active erosion are at Kingsport. Since most erosion occurs at high tide, particularly when winds blow onshore, the direction of ebb flow would tend to remove eroded material away from the southern bight and thus not cause further accretion at inner regions of the bight.

Our conclusion is, therefore, that the evidence obtained indicates little loss of suspended material from the southern bight occurring as a consequence of tidal movements alone. It should be noted, however, that all our studies were conducted on calm days. Thus, we were only examining the simple effects of tidal oscillations. Yet, as Yeo and Risk (1979) have demonstrated, the major causes of erosion and translocation of deposited sediments in Minas Basin are storms or other strong wind activity. By maintaining turbulence at high tide, strong winds could certainly cause material resuspended on the flooding tide to travel well beyond its probable point of deposition on the ebbing tide. Clearly our studies provide no insight into the fate of suspended sediments under more typical Nova Scotia conditions.

In a series of time-depth studies the vertical distribution of suspended material was examined closely in order to detect the occurrence of gravity settling. Unequivocal evidence of this was not obtained, for a variety of reasons. Nonetheless, there is sufficient indication that a pattern of resuspension and deposition does occur.

Particle size frequency distributions varied considerably, primarily in relation to location in the southern bight, but also in relation to stage of tide. Broad, almost flat percentage volume distributions over the range of 10 to 128 μm were typical of offshore locations, whereas distributions were peaked around 10 to 20 μm at high tide over mud flats. The nature of the sedimentary material was examined in a series of S.E.M. photographs of suspended sediment filtered onto 0.45 μum Nuclepore filters (Pennachetti 1978). The samples were taken during the 29 May time-depth study near Wolfville. Examination of these photographs suggests that many particles $>$ 20 μm were flocculated, but few of these floccules were $>$ 80 μThere was no evidence of nannoplankton. Samples exhibiting significant quantities of material > 80 μm diameter occurred both onshore at a river mouth, or offshore at the entrance to the southern bight. In the latter location, diatoms (viz. species of *Rhizosolenia, Coscinodiscus,* and *Biddulphia*) were fairly common and were major components of the $>$ 80 μm classes. Diatoms were generally absent or infrequent in the river mouths, and the more regular percentage volume frequency distribution undoubtedly reflects the presence of sand grains and detritus.

These changes in particle type are probably correlated with changes in zooplankton distribution. At the entrance to the southern bight region, the summer zooplankton is a moderately heterogenous assemblage of copepods, with a few coelenterates, chaetognaths, and larval stages of benthic animals. The most abundant species is usually *Eurytemora herdmani.* In the more turbid regions closer to the river mouths, however, *Eurytemora* becomes even more dominant (see Daborn & Pennachetti 1979). This species is well known to be associated with highly turbid waters and maintains itself well on particulate material < 60 μ diameter even when this is predominantly non-living detritus (Heinle et al. 1977). Other copepods, however, may not be able to maintain themselves on non-living material, and thus would be unable to reside in inner portions of the bight.

The studies reported herein provide a valuable background to the physical conditions occurring in the water column during summer months in the southern bight. Much needs to be learned, however, before the essential features of this correlation may be described. We know very little, for example, about the organic composition of sedimentary material, and the role played by the relatively extensive salt marshes that surround the southern bight. It seems probable that organic content in the more turbid regions of the southern bight is higher than in comparable sections of Cobequid Bay, which may explain some of the apparent biological differences between the two regions. There is certainly need for much more study of the biological significance of suspended material before we can make predictions about the effects of dam construction in the region.

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