An Analysis of Factors Responsible for Anoxic Conditions at Troy Pond, Cape Breton, Nova Scotia

Prepared For

The Nova Scotia Department of Natural Resources

Contract # 4103083826

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November 2004

Publication No. 77 of the Acadia Center for Estuarine Research

SUMMARY

Troy Pond, a small coastal embayment located along the south-western coast of Cape Breton, has developed into a system characterized by strong odours of hydrogen sulfide that appears to the result of anaerobic decomposition of seaweed wrack that has accumulated within its innermost subtidal zone. In order to confirm that this is due to the anaerobic decomposition of seaweed wrack, and to better understand the conditions that exist in the pond, a study was carried out to monitor the temporal variations in dissolved oxygen level and a number of other water quality parameters within the pond. In addition, a survey was carried out to determine if other coastal ponds exhibiting similar characteristics are present along the south-western coastline of Cape Breton.

The results of the study indicate that Troy Pond does become anoxic for long periods of time, particularly within its innermost subtidal area which contains large masses of partially decomposed seaweeds. The outer portion of the pond, which is shallower, also undergoes periods of anoxic conditions, but to a much lesser extent than does the inner pond. An analysis of the variation in dissolved oxygen concentration indicated that it is controlled largely by the extent of tidal flushing of the pond, which in turn is a function of tidal amplitude and the velocity and direction of winds.

An aerial and ground survey indicted that the situation that exists within Troy Pond is not widespread. Although there was some evidence of seaweed wrack accumulation and very localized development of odours associated with hydrogen sulphide at two sites located very close to Troy Pond, there was no indication of the presence of other sites along the coastline having the severity of characteristics present at Troy Pond.

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1. Introduction

Troy Pond, a small coastal embayment located along the south-western coast of Cape Breton, has over the last several years developed into a system characterized by low levels of dissolved oxygen and high concentrations of anaerobic decomposition products, especially hydrogen sulfide, which imparts a strong obnoxious odour to the surrounding area. This has created serious problems for a cabin rental business located approximately 100 meters above its shoreline. This situation has arisen largely as a result of the accumulation, and subsequent anaerobic decomposition, of seaweed wrack, mainly rockweeds, within the inner subtidal portion of the embayment.

In order to remediate this situation, it is being proposed that the embayment be in-filled with rock to eliminate its subtidal area. This would reduce the potential for seaweed to become entrained in subtidal water where the development of anoxic conditions is greatest. It would also increase the intertidal area of the embayment where decomposition of seaweed wrack would be less susceptible to the development of anoxic conditions as a result of being exposed to the air during periods of low tide.

The major objectives of this study were to (1) confirm that the water contained in the subtidal portion of the embayment does become anoxic, and that this is the major cause of the strong obnoxious odours present; and (2) determine if streams discharging into the embayment contain excessive amounts of nutrients that would hasten the decomposition of the entrained seaweed wrack and development of anoxic conditions. An additional objective of this study was to survey similar nearby coastal embayments to determine how typical this problem is along this coastline.

2. Site Description

Troy Pond is a small tidal embayment open to tidal exchange with St. Georges Bay (Fig. 2.1). It consists of an outer shallow portion and an inner deeper portion. The outer and inner portions are connected by a narrow sill which separates the two areas at extreme low tides. The maximum depth of the inner pond ranges between about 2 and 3 meters depending on the stage of the tidal cycle. The maximum depth of the outer pond is shallower, ranging between about 1 and 2 meters (Fig. 2.2). Tides in this area are mixed semi-diurnal and characterized by two high and two low tides per day in which successive tides differ substantially in their amplitude (see Appendix I for tide times and heights during the period of this study).

Fig. 2.1. Aerial overview of Troy Pond.

Water within the inner pond is characterized by a milky green color, and a thick, light brown mat of sulphate reducing bacteria covers much of the bottom of the pond (Fig 2.3). The greenish colour of the water is probably due to the presence of anoxygenic phototrophic bacteria, a group of photosynthetic bacteria that can carry out photosynthesis only under anoxic conditions and which do not evolve oxygen. Water within the outer pond, in contrast, is relatively clear and a bacterial mat is not present on the bottom.

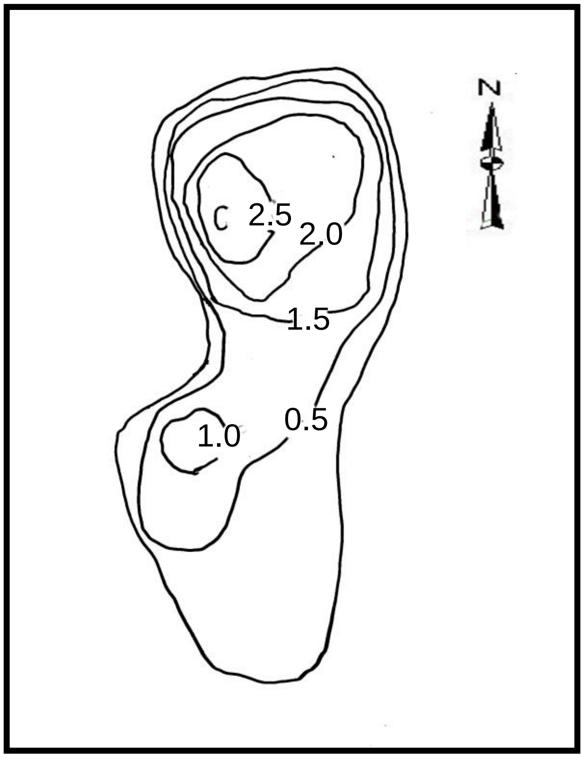

Fig. 2.2. Bathymetric map of Troy Pond.

Fig. 2.3. Bacterial mat covering bottom of Troy Pond.

Two small streams enter the pond (Figure 2.4). To the north, a persistent spring-fed stream discharges into the inner portion of the embayment. To the south, a larger stream discharges into the outer portion of the embayment. This stream receives effluent from a sewage treatment plant that services a trailer park containing about 50 mobile homes.

Fig. 2.4. Overview of area surrounding Troy Pond.

A survey of the area was carried out in the spring of 2004 by Nova Scotia Department of Natural Resources (NSDNR) personnel (Powers 2004). The immediate upland area consists of a shrub swamp wetland approximately three hectares in area. A historical analysis of the area using aerial photographs taken between 1969 and 1998 indicated that, with the exception of the railway line, the shrub swamp was relatively undisturbed in 1969. By 1975, however, portions of the shrub swamp had begun to be in-filled and by 1998 progressive infilling had considerably altered the original wetland. A field survey of the area, carried out by NSDNR, indicated that the pond is used by sandpipers and other migratory birds as a feeding site, and provides habitat for a diversity of other avian wildlife.

3. History of Problem

The following account is based largely on an interview with Ms Katherine Bunyan, owner and operator of Paul Bunyan Cabins, and other local residents familiar with the historical changes that have occurred to the pond.

In the past, Troy Pond was a relatively pristine environment. At one time it was isolated from the sea and was largely freshwater. Up until the early 1990s it was a popular swimming area for local residents. In the spring of 1996, when the cabins were built, and during 1997, there was some odour of hydrogen sulfide emanating from the pond, but it was not particularly strong or persistent. In 1998, the odour became much stronger and more persistent. In an attempt to remedy this, the inner portion of the pond was dredged to remove seaweed wrack that had accumulated below the low tide level. During this process a substantial amount of subtidal sediment was also removed. The dredge spoils can still be seen along the northern shoreline of the pond (Fig 3.1).

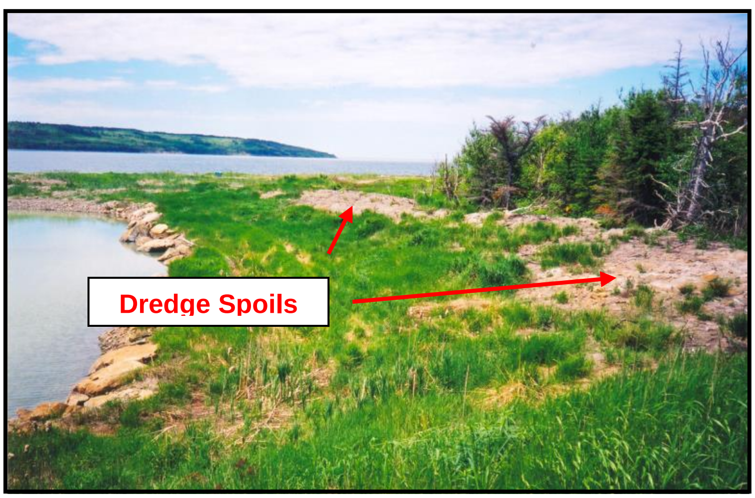

Fig. 3.1. Dredge spoils along northern shore of Troy Pond.

Deepening the inner portion of the pond, however, resulted in the accumulation of even more seaweed wrack and additional dredging was carried out during June 2000. Although both dredgings improved the situation for a short while, it had the effect of increasing the accommodation area for deposition and accumulation of even more seaweed wrack. In 2001, a major storm deposited a large amount of wrack within the inner pond and along the intertidal shoreline of the outer pond. Much of the seaweed deposited within the latter was later moved by excavator to the upper intertidal area where it currently exists as a layer that is in some areas over one meter thick (Fig. 3.2). This upper intertidal layer of wrack is slowly decomposing anaerobically and contributes to what is now an almost unbearable odour, especially when winds are blowing onshore.

Fig. 3.2. Seaweed wrack in the upper intertidal zone of Troy Pond.

The dredging that occurred undoubtedly worsened the problem by increasing the volume of the subtidal portion of the embayment and creating conditions for even greater amounts of seaweed wrack to become entrained, and also by decreasing the pond's flushing rate.

4. Approach and Methodology

Monitoring of the existing situation was carried out using a Yellow Springs Instrument (YSI) Model 9600 multi-probe sonde, programmed to record water depth, water temperature, salinity, and dissolved oxygen concentration at a frequency of every 15 minutes. The monitoring was done over a period of at least 14 days within both the inner and outer portion of the embayment to determine the influence of spring-neap tidal cycle hydrodynamics on variations in water temperature and dissolved oxygen concentrations. The inner pond was monitored from 19 May to 1 June, and the outer pond was monitored from 2 June to 17 June. The locations of the sonde deployments are shown in Fig. 4.1.

Fig. 4.1. Location of sonde deployments.

In order to assess the potential input of nutrients to the pond, excessive amounts of which could exacerbate the development of anoxic conditions as a result of stimulating the growth of phytoplankton within the pond and/or by enhancing the rate at which the accumulated seaweeds are broken down, nitrate concentrations were monitored on a weekly basis between 18 May and 17 August at each of the two stream inflows to the pond.[1] The nitrate samples were collected by personnel of the Nova Scotia Department of Environment and Labour (NSDEL) and transported on the same day to Environmental Services Laboratory Incorporated (ESLI) in Sydney, N.S. for analysis. Additional measurements of nitrate were made by personnel of the Acadia Centre for Estuarine Research during the month of June at the inflows of the North and South Brook as well as at a site located approximately 250 m upstream of where the South Brook enters the pond. These samples were analyzed for nitrate using the HACH high range cadmium reduction method (HACH 2002).

Samples for fecal coliform bacteria levels were also collected by NSDEL personnel at the same sites and times as were nitrate samples and these were also sent to ESLI for analysis. Fig. 4.2 illustrates the location of each site at which nitrate and coliform bacteria samples were collected.

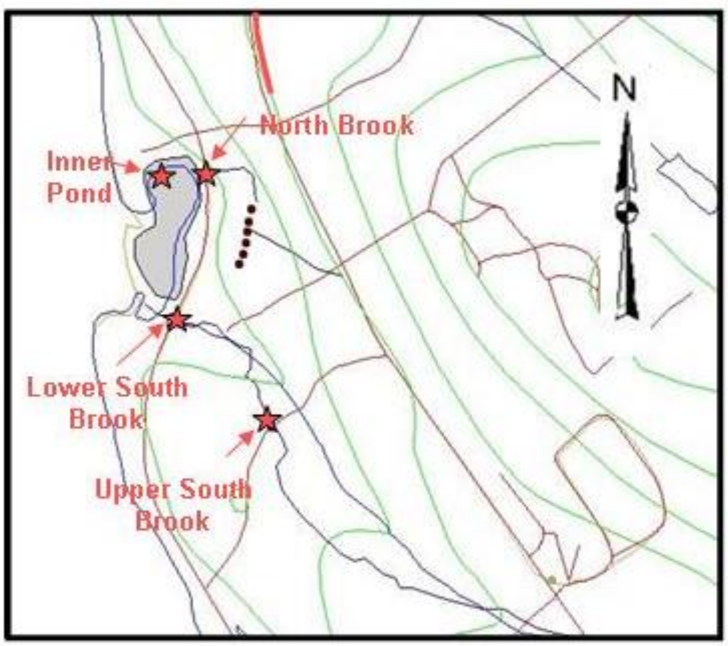

Fig. 4.2. Location of nitrate and coliform bacteria sample sites.

[1] Samples for nitrate analysis were also collected from the inner pond. However, the technique that was employed for nitrate analysis is not valid for seawater samples because of interference by high chloride levels present in sea water. As a result, those measurements are not included in this report.

Vertical profiles of temperature, salinity and dissolved oxygen concentration were made at the locations of the sonde deployments at the times when the sonde was initially deployed and when it was recovered. The vertical profile measurements were made using a YSI Model 30 Salinity-Temperature-Conductivity meter and a YSI Model 95 Dissolved Oxygen meter.

5. Results

5.1. Time Series Data

5.1.1. Inner Pond

Time series data collected within the inner pond between 19 May and 1 June is shown in Fig. 5.1. This deployment covered a period of 14 days and captured salinity, temperature, water depth and dissolved oxygen concentration over a complete spring-neap tidal cycle. Water depths at the location of the sonde ranged from 1.18 m to 1.67 m. The tidal amplitude varied considerably as can be seen from Fig. 5.1a.

Water temperature and salinity varied little during the earlier part of the deployment (Fig. 5.1 b and c), but on the last three days (between 30 May and June 1) it appears that a significant amount of cold water entered the pond. This corresponded with a period of spring tides (see Appendix I for predicted tide heights) and represents increased seawater flushing of the pond during this period.

At most times, dissolved oxygen levels were always low and very near zero (Fig. 5.1d), except for short periods of time on four different occasions when the levels increased and decreased rapidly. On the first two and the last occasion, dissolved oxygen levels increased to about 4 mg/L when there was an obvious influx of seawater during the period when high tide water levels were highest. On the third occasion, which occurred on 26 May, dissolved oxygen levels increased to about 8 mg/L over a period of about 7 hours and then decreased to near zero over the following seven hours. This event did not appear to be associated with a period of high water levels and its occurrence is difficult to explain based on the data available.

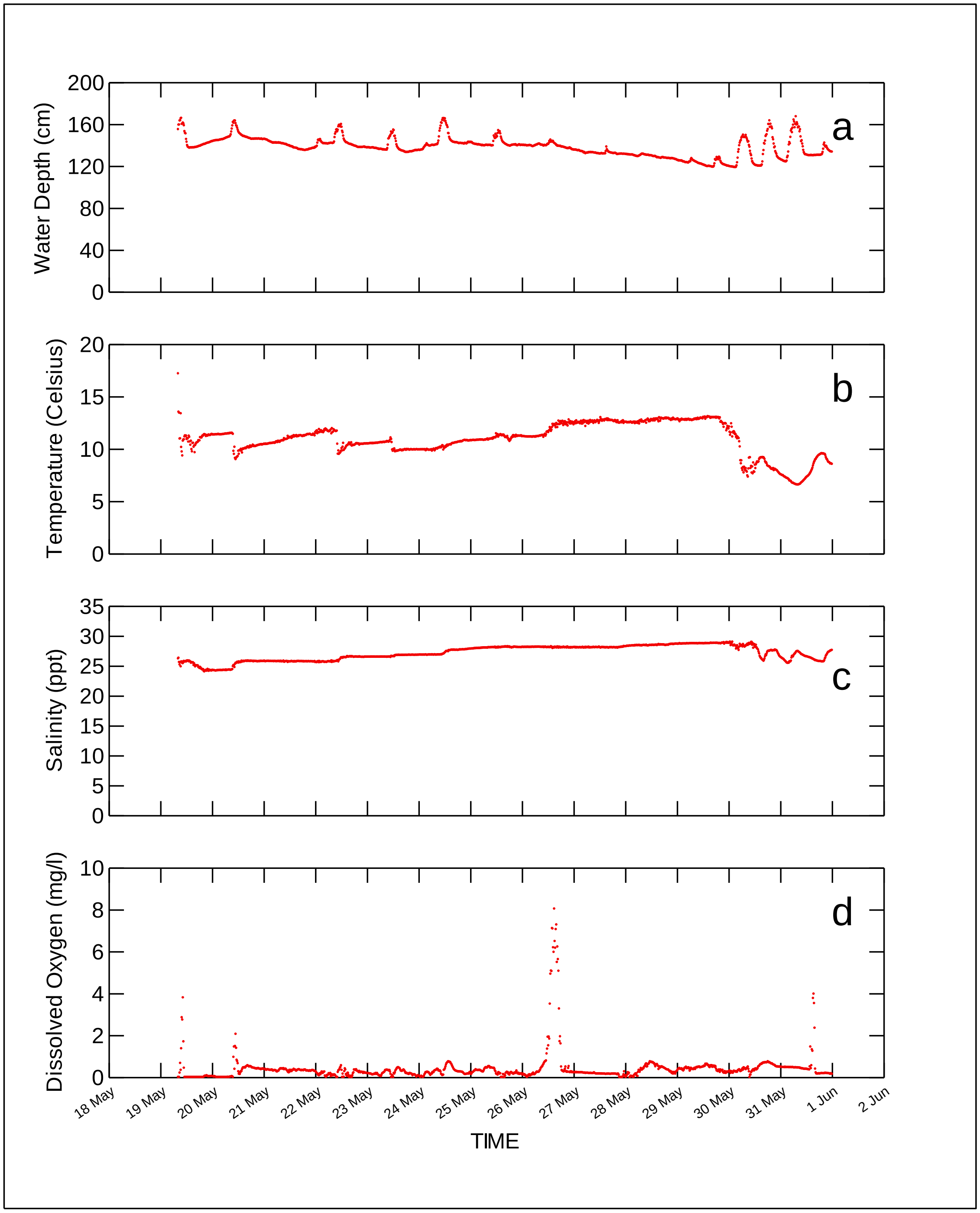

Fig. 5.1. Time series data collected at inner Troy Pond.

The incidences of increased levels of dissolved oxygen indicate that under certain conditions the inner portion of the pond does become oxygenated for short periods of time. Most of the time, however, water within the inner pond is anoxic.

5.1.2 Outer Pond

Time series data was collected at the outer pond between 2 June and 17 June (Fig. 5.3). The outer pond experienced large fluctuations in dissolved oxygen concentrations. Values ranged from a low of 0 mg/L to a high of 11.5 mg/L. The outer pond is much shallower than the inner pond and is flushed much more completely during each tide cycle. Spring tides were in effect during the earlier stages of the deployment and this is reflected by the relatively consistently higher dissolved oxygen concentrations during this period. The latter period of the deployment was dominated by neap tides. At this time the outer pond was less completely flushed and experienced periods of low dissolved oxygen concentrations during each tidal cycle. Figure 5.2 illustrates the relationship between tide height and dissolved oxygen concentration and clearly shows the dependency of the dissolved oxygen concentration on the tidal flushing cycle.

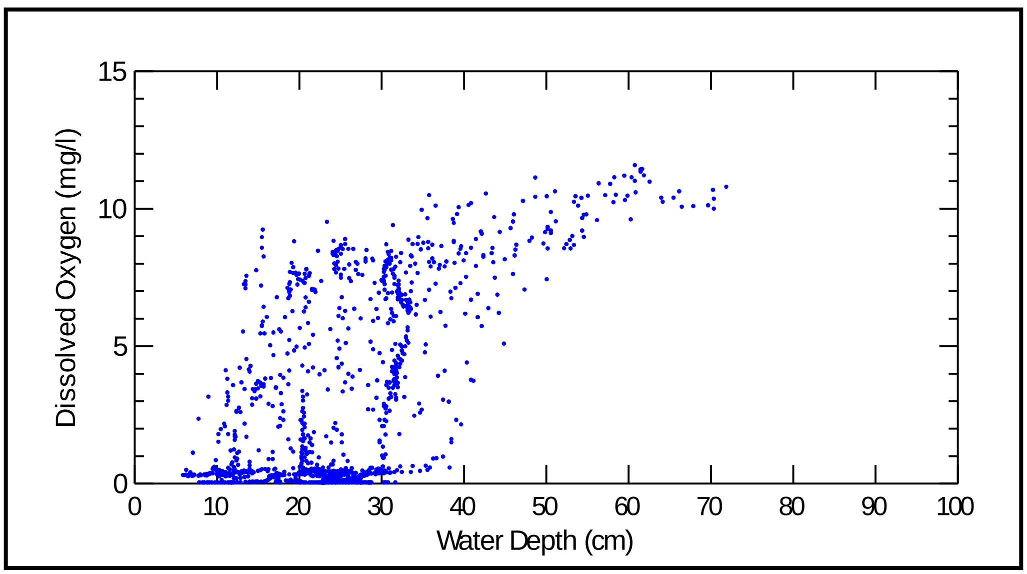

Fig. 5.2. Relationship between dissolved oxygen concentration and water depth at the inner pond.

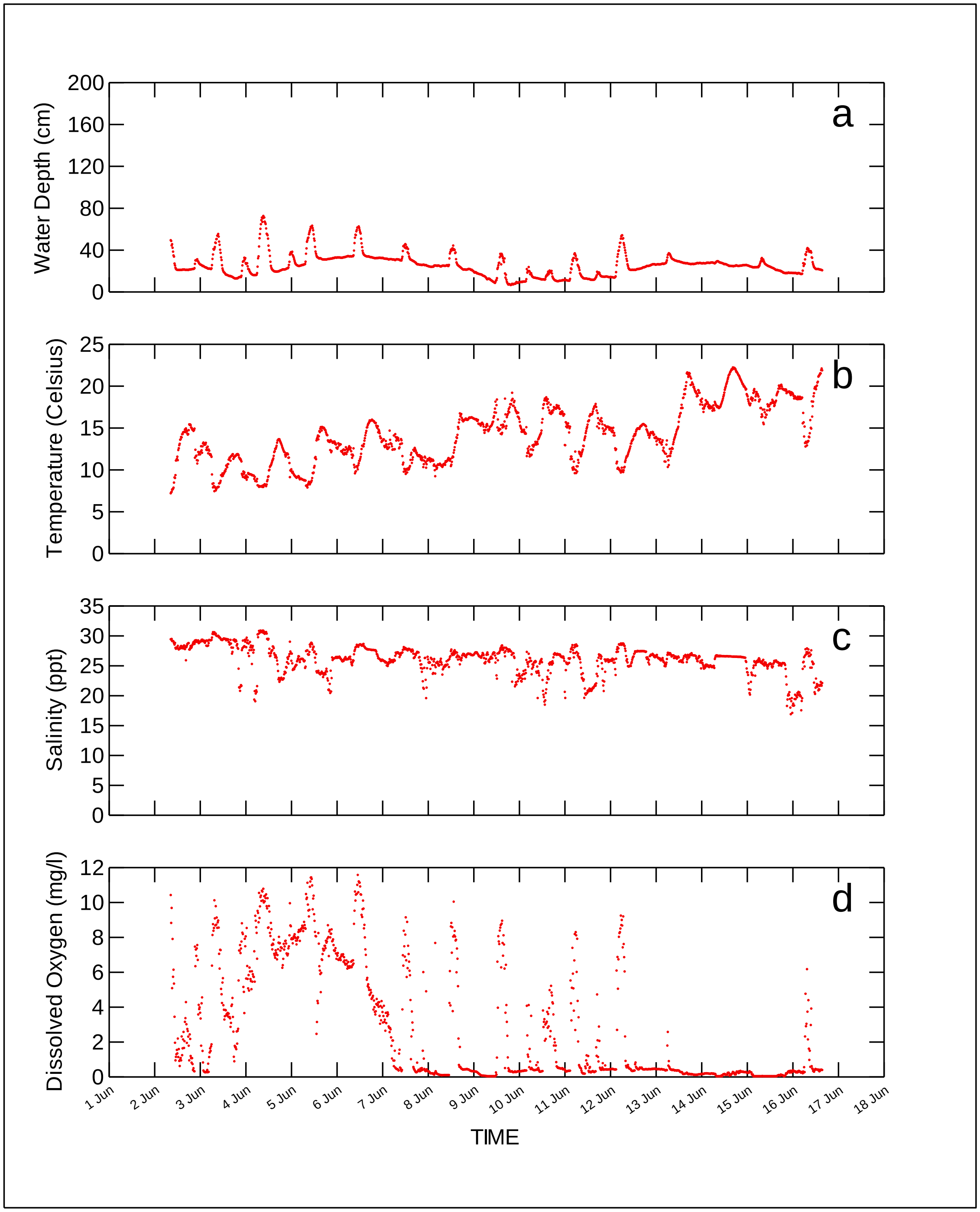

Fig. 5.3. Time series data collected at outer Troy Pond.

5.1.3. Vertical Water Column Profiles

Vertical water column profiles of temperature, salinity and dissolved oxygen, at both the inner and outer pond, were collected during times when the sonde was deployed and recovered. Both ponds showed considerable variation in all of these parameters (Fig. 5.4). At the time of the sonde deployment, the inner pond contained an upper layer of low salinity, cool, oxygenated water overlying a layer of warmer, high salinity, anoxic water. The upper layer most probably represents fresh water from the north, spring fed brook that overlies sea water. This profile was collected very close to high tide. During the time of the sonde recovery, temperature and salinity were much lower and most of the water in the pond was very low in dissolved oxygen. This profile was collected at low tide. The differences in the profiles illustrate that, despite what appears to be considerable exchange of sea water during tidal cycles, there is little increase in dissolved oxygen within the bottom water of the pond. Any dissolved oxygen brought into the pond by either sea water or the North Brook is very quickly utilized in biological decomposition.

The profiles (and time series data) collected in the outer pond suggest that it is much more variable in terms of its dissolved oxygen concentrations. Flood tides transport well oxygenated sea water into the pond, but ebb tides transport low oxygen water from the inner pond to the outer pond. The profile collected at the time of deployment of the sonde coincided with high tide and indicated the presence of cold, high salinity water just below warmer fresher water. The upper warmer layer probably represented water being flushed out of the inner pond. Dissolved oxygen levels were low in the surface water and high in the bottom waters. During recovery of the sonde, the tide was at mid-flood and the outer pond contained warm, anoxic water having a salinity lower than that of the sea water entering the pond. At this time, water within the outer pond was most likely in the process of assuming the characteristics present at high tide during the time of deployment.

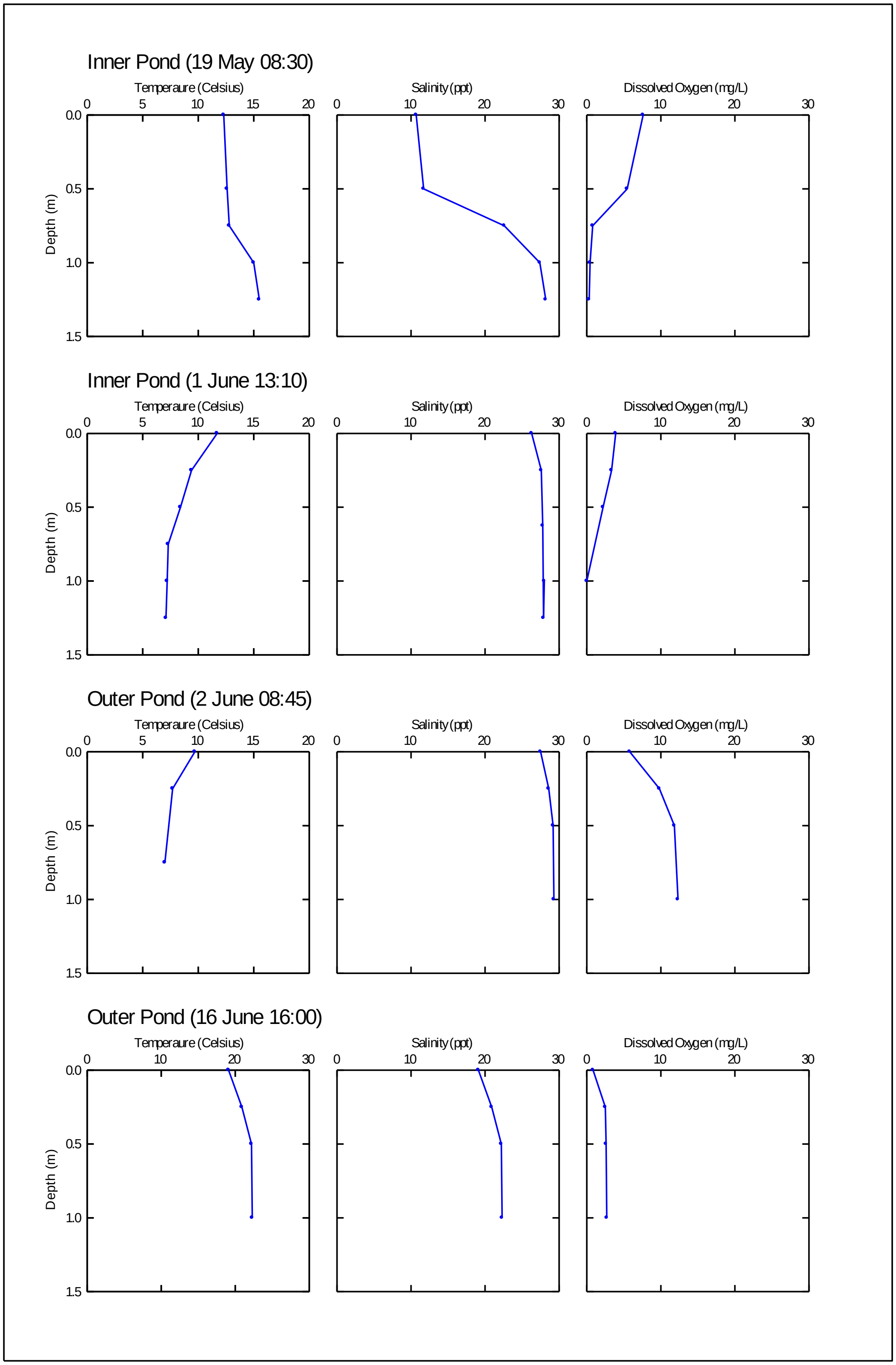

Fig. 5.4. Vertical water column profiles collected at inner and outer Troy Pond during periods of sonde deployment and recovery.

5.1.4. Influence of Wind Direction and Velocity on Tidal Flushing

In an attempt to determine the role of wind direction and velocity on the exchange of sea water and aeration of water within the inner pond, hourly wind direction and velocity data for the period during which time series data was collected at the outer pond was obtained for Tracadie, N.S from Environment Canada's climate data website. Fig 5.5 illustrates the differences in wind direction and velocity during times when dissolved oxygen concentrations were high (>50% saturation) and low (<50 % saturation). Dissolved oxygen levels tended to be highest when the strongest winds were from the northwest and lowest when the strongest winds came from the southwest. This is most likely the result of storm surge activity. The higher dissolved oxygen concentrations would result from the movement of well oxygenated offshore water into the pond by the onshore northwesterly winds. In contrast, the southwesterly offshore winds would tend to lessen the amount of offshore water entering the pond.

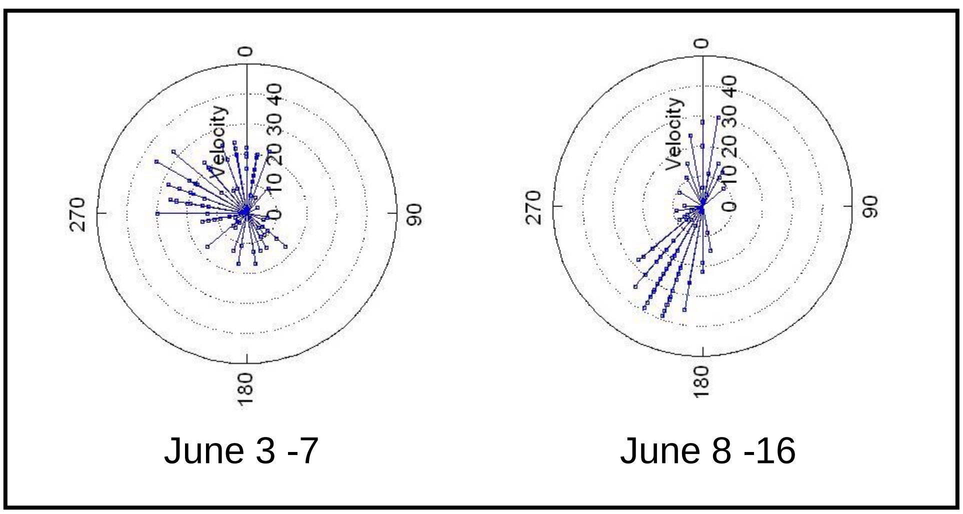

Fig. 5.5. Wind velocity and direction during times when dissolved oxygen levels were high (June 3-7) and low (June 8-16) within the outer pond.

5.32. Nitrate

The results of the nitrate measurements are summarized in (Appendix II) and Fig. 5.6. When measured concurrently, nitrate concentrations were relatively low (<0.5 mg/L) in the North Brook and high (>1.0 mg/L) in the South Brook.

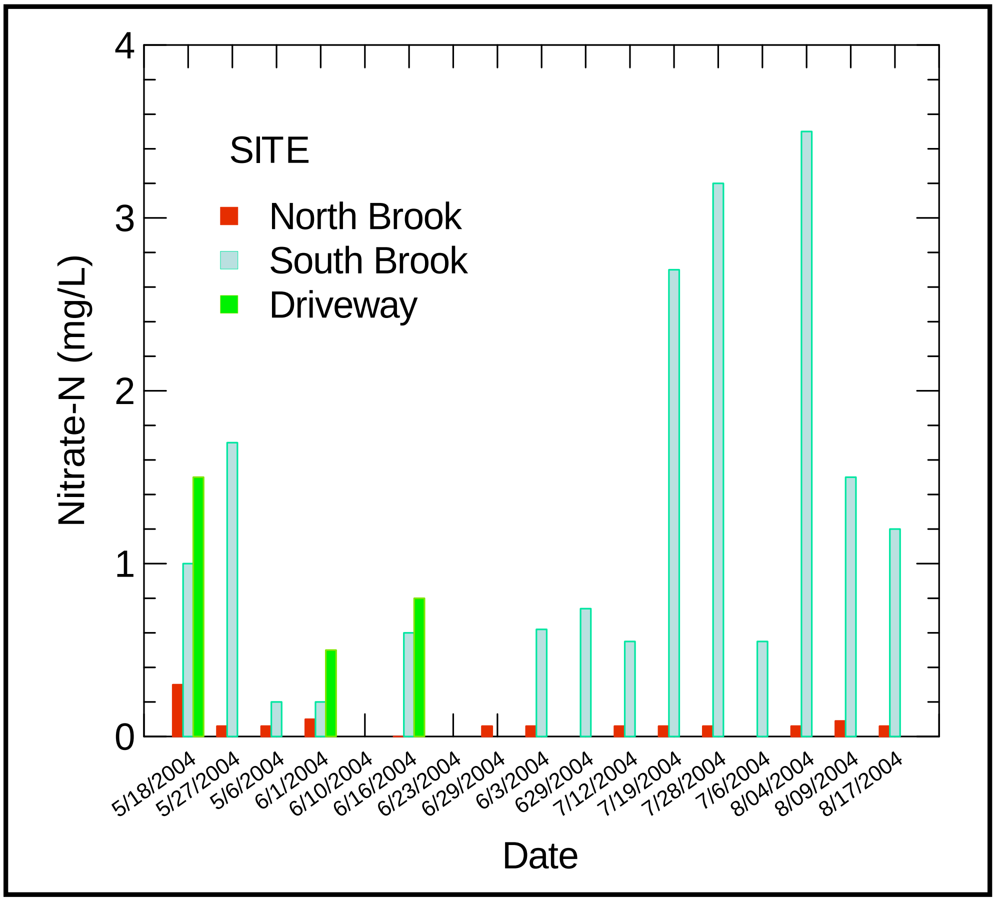

Fig. 5.6. Temporal variation in nitrate-N concentrations at the three brook sites.

On those occasions when nitrate was measured at both the Lower and Upper South Brook (Driveway) site, nitrate concentrations were always greater at the Upper South Brook site. The source of this nitrate is undoubtedly the sewage treatment plant servicing the mobile trailer park. The lower values at the Lower South Brook site indicate that the South Brook does have the capacity to assimilate some of the nitrate discharged from the sewage treatment plant before it enters the outer pond.

5.3. Fecal Coliform Bacteria

The results of fecal coliform numbers (Fig. 5.7) generally followed the same tend as nitrate concentrations at the two book sites. They were lowest in the North Brook and highest in the South Brook. Within the inner pond, coliform bacteria numbers were generally the lowest of all sites except on two occasions when coliform numbers were very high at all sites. The latter is difficult to explain based on available data.

These results indicate that waste materials from the sewage treatment plant discharging into the South Brook do enter the pond.

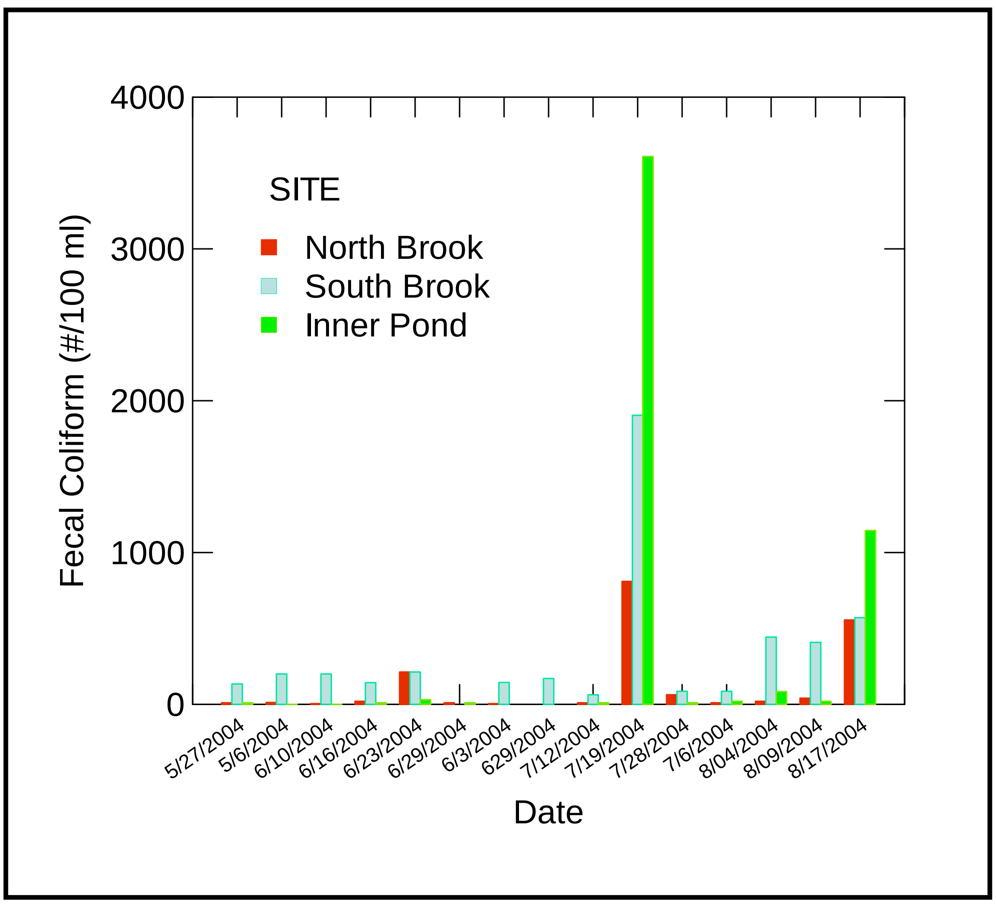

Fig. 5.7. Temporal variation in fecal coliform numbers at the two brook sites and the inner pond.

6. Aerial and Ground Surveys

A helicopter aerial survey to determine if conditions similar to those existing at Troy Pond occur in other coastal ponds along the south-western shoreline of Cape Breton and the south-eastern shoreline of the Northumberland Straight was carried out on 3 August 2004. The area surveyed extended from Merigomish to Belle Cote at the mouth of the Margaree River.

With the exception of two coastal inlets located immediately north and south of Troy Pond, there was little evidence of other coastal inlets that exhibit the conditions observed at Troy Pond. This was further confirmed by conducting a ground survey of the area between Troy Pond and Belle Cote on 17 and 18 August 2004. Most of the ponds along the coastlines surveyed have morphologies quite different from that of Troy Pond in that they are either much more open to tidal exchange, or if they do have a constricted opening, they typically have a breakwater adjacent to the opening designed to prevent the littoral long-shore drift of sediments from entering and obstructing the channel. These breakwaters would also serve to avert the drift of seaweeds into the inlets. Interviews with local fisherman and boat owners at a number of sites[2] that might be considered to be susceptible to the accumulation of seaweed wrack indicated that this seldom occurred and, if at all, was usually associated with dredging activities designed to clear sediment obstructing the channel. In these cases it did not last for much more than a few days at most.

The two coastal inlets directly north and south of Troy Pond had a slight odour of hydrogen sulfide and seaweed wrack was visible along the shoreline. Measurements of water column dissolved oxygen concentrations, however, indicated that the water within these embayments was not significantly depleted of dissolved oxygen.

[2] These included the harbours located at Port Hood, Inverness, McIssac Pond and McDonald Glen.

7. Discussion

The reason for the anaerobic conditions observed at Troy Pond are undoubtedly a result of the decomposition of masses of seaweed wrack, mainly rockweeds, that have accumulated within both the subtidal and intertidal portions of the embayment. The inflow of nutrient enriched waters via the South Brook probably also contributes to this by providing inorganic nutrients for the microoganisms involved in the decomposition process.

The fact that the inner pond remained almost entirely anoxic during the 14 day period in which the sonde was deployed indicates that tidal exchange with offshore waters is poor, most likely because of its depth and the presence of a sill that separates its deeper water from that of the outer pond and offshore water. What little dissolved oxygen that is brought into the pond by tidal exchange is quickly consumed by microoganisms decomposing the accumulated seaweed wrack. The outer pond, in contrast, is shallower and exhibits more tidal exchange. It does, however, undergo large variations in dissolved oxygen levels which appear to be controlled by wind induced storm surges and the variation in tidal exchange associated with the spring and neap tide cycle.

The situation that exists at Troy Pond appears to be relatively unique. Its combination of an inner pond that is separated form the outer sea by a sill that prevents it from draining at low tide is somewhat like a coastal fjord in that the deeper water within the pond is not easily replaced or flushed out by the tide. This results in a bottom layer of relatively stagnant water. When this situation is combined with a large input of organic matter, in this case seaweed wrack, it is subject to developing anaerobic conditions very quickly that, because of the limited flushing, may persist for a long period. The early dredging activities designed to alleviate this problem, although helpful in the short term, undoubtedly worsened the situation by creating an enlarged accommodation area for seaweeds to collect.

Observations made during the aerial and ground surveys conducted along the shorelines to the north and east of Troy Pond suggest that Troy Pond is relatively unique in its morphology. The surveys also revealed that the shorelines did not contain significant amount of seaweed wrack along the higher intertidal areas. This suggests that they do not normally accumulate in these areas, unless there is an indentation in the coastline that creates an accommodation zone like that at the inner pond at Troy Pond. It is also possible that they break down within the intertidal.

The source of the seaweed wrack is uncertain. Conversations with residents in the area have suggested the occurrence of an unusual number of severe storms over the past several years, one of which dislodged large pieces of the armour bouldering that protects the Canso Causeway. It is likely that these storm events lead to an extraordinary amount of rockweeds being torn from their substrate and eventually transported to the intertidal zone.

A major lesson to be learned from this study is that the removal of subtidal sediments, either for the purpose of dredging to aid navigation, or to remove accumulated organic matter, should not be permitted unless it is certain that it will not result in creating an increased accommodation area in which seaweeds or other forms of organic matter can accumulate.

8. Acknowledgements

This project was funded through the efforts of Bill English of the Nova Scotia Department of Natural Resources. John Gills, also of the Nova Scotia Department of Natural Resources, carried out the bathymetric survey of Troy Pond and provided the maps and aerial photographs used in this report. Dean Hart of the Nova Scotia Department of Environment and Labour collected the water samples used for determination of nitrate concentrations and coliform bacteria numbers. Helicopter time for the aerial surveys, with Mason Watt as the pilot, was kindly provided by the Nova Scotia Department of Natural Resources.

9. References

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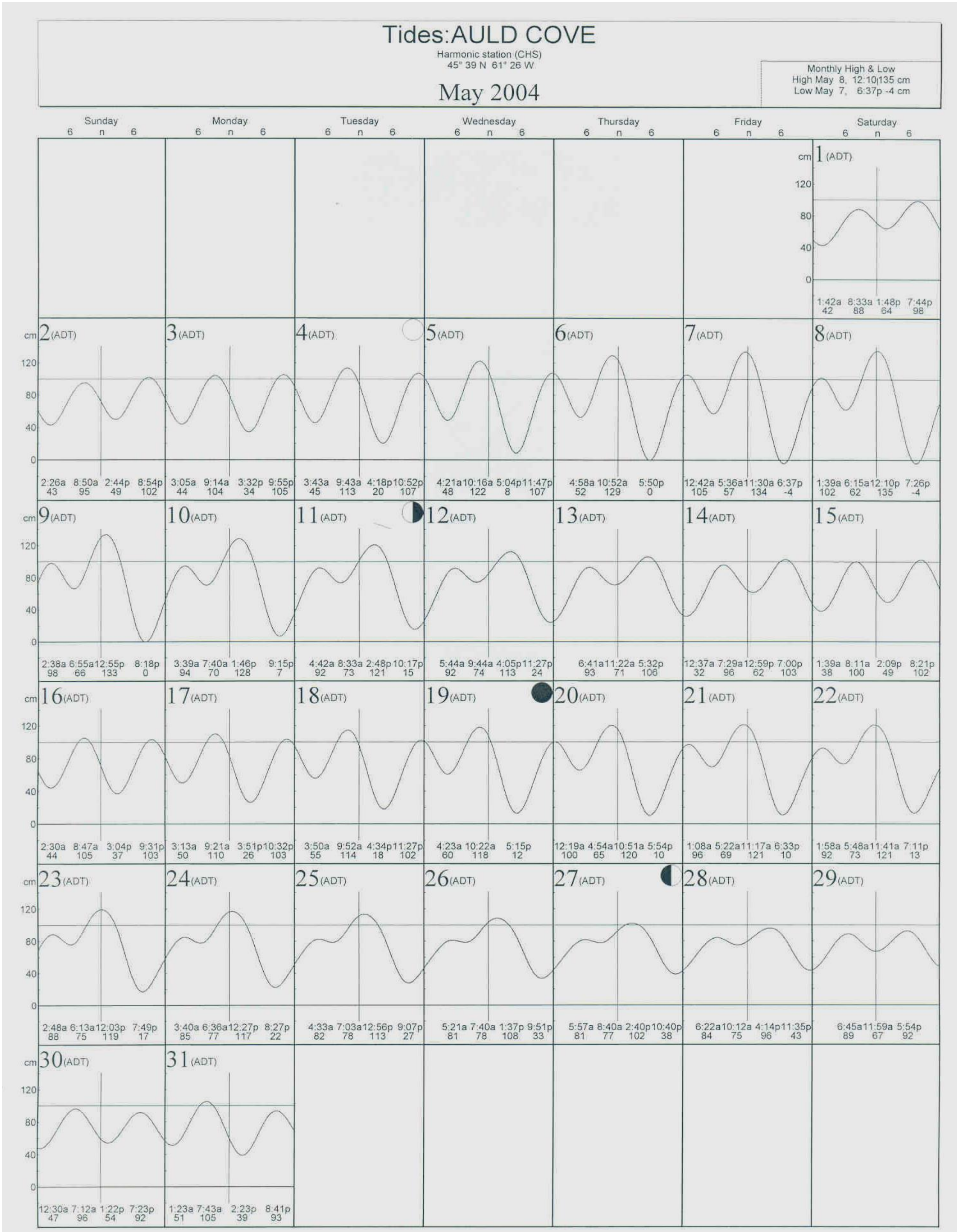
Appendix I

Auld Cove Tide Times and Heights



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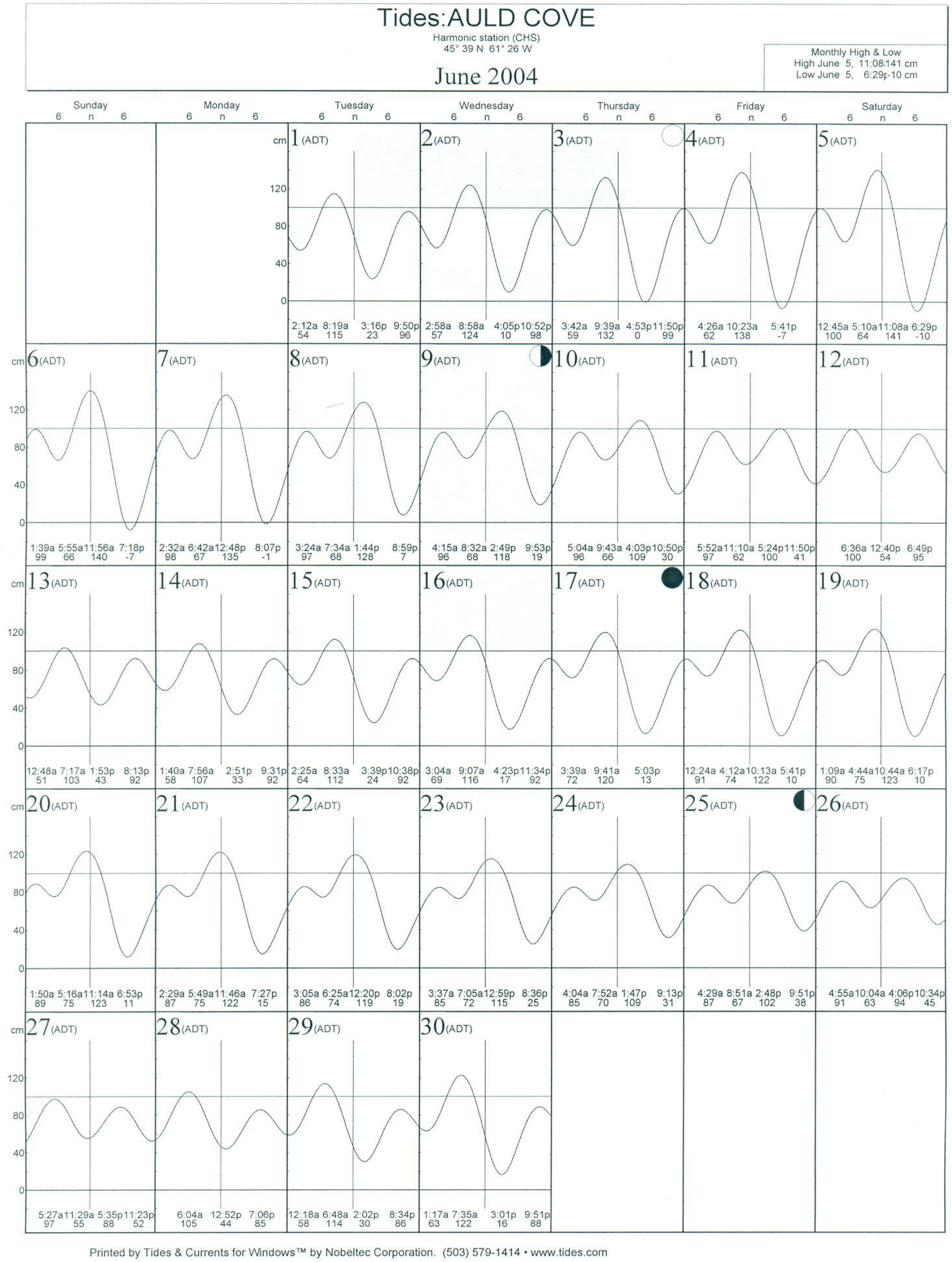
Tides:AULD COVE
Harmonic station (CHS)
45° 39 N 61° 26 W
June 2004
Monthly High & Low
High June 5, 11:08 141 cm
Low June 5, 6:29p -10 cm
Sunday Monday Tuesday Wednesday Thursday Friday Saturday
1 (ADT) 2:12a 8:19a 3:16p 9:50p 54 115 23 96
2 (ADT) 2:58a 8:58a 4:05p 10:52p 57 124 10 98
3 (ADT) 3:42a 9:39a 4:53p 11:50p 59 132 0 99
4 (ADT) 4:26a 10:23a 5:41p 62 138 -7
5 (ADT) 12:45a 5:10a 11:08a 6:29p 100 64 141 -10
6 (ADT) 1:39a 5:55a 11:56a 7:18p 99 66 140 -7
7 (ADT) 2:32a 6:42a 12:48p 8:07p 98 67 135 -1
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30 (ADT) 1:17a 7:35a 3:01p 9:51p 63 122 16 88
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Appendix II

Nitrate and Fecal Coliform Data

Appendix. II. Nitrate and coliform data**.**

SITE	Sample Collected By	Date	Time	Nitrate-N (mg/L)	Total Coliforms (#/100ml)	Fecal Coliforms (#/100 ml)
North Brook	ACER	5/18/2004	14:45	0.6		
South Brook	ACER	5/18/2004	15:00	2.0		
Driveway	ACER	5/18/2004	15:15	3.0		
North Brook	ACER	6/1/2004	13:35	0.1		
South Brook	ACER	6/1/2004	13:50	0.2		
Driveway	ACER	6/1/2004	14:10	0.4		
Inner Pond	ACER	6/1/2004	13:00			
Outer Pond	ACER	6/2/2004	08:40			
North Brook	ACER	6/16/2004	15:35	0		
South Brook	ACER	6/16/2004	15:50	1.6		
Driveway	ACER	6/16/2004	15:15	1.6		
Inner Pond	ACER	6/16/2004	15:00			
North Brook	DOE	5/6/2004	11:00	<0.06	200	12
South Brook	DOE	5/6/2004	11:00	0.20	>200	>200
Inner Pond	DOE	5/6/2004	11:00	<3.0	2	0
North Brook	DOE	5/27/2004	07:30	0.06	1333	<10
South Brook	DOE	5/27/2004	07:30	1.7	3076	134
Inner Pond	DOE	5/27/2004	07:30	<0.06	1376	<10
North Brook	DOE	6/3/2004	14:00	<0.06	>200	5
South Brook	DOE	6/3/2004	14:00	0.62	>200	144
Inner Pond	DOE	6/3/2004	14:00	3	Lost	Lost
North Brook	DOE	6/10/2004	12:00		>200	5
South Brook	DOE	6/10/2004	12:00		>200	>200
Inner Pond	DOE	6/10/2004	12:00		>200	0
North Brook	DOE	6/16/2004	15:30		1515	20
South Brook	DOE	6/16/2004	15:30		6131	143
Inner Pond	DOE	6/16/2004	15:30		8664	<10
North Brook	DOE	6/23/2004	11:30		14136	213
South Brook	DOE	6/23/2004	11:30		12996	213
Inner Pond	DOE	6/23/2004	11:30		>24192	30
North Brook	DOE	6/29/2004		<0.06	2000	10
South Brook	DOE	629/2004		0.74	>2000	170
Inner Pond	DOE	6/29/2004		<3.0	>2000	10
North Brook	DOE	7/6/2004		<0.06	4106	10
South Brook	DOE	7/6/2004		0.55	11198	86
Inner Pond	DOE	7/6/2004		<3.0	>24192	20
North Brook	DOE	7/12/2004		<0.06	1565	10
South Brook	DOE	7/12/2004		0.55	15531	63
Inner Pond	DOE	7/12/2004		<3	24192	<10
North Brook	DOE	7/19/2004		<0.06	>24192	810
South Brook	DOE	7/19/2004		2.7	>24192	1904
Inner Pond	DOE	7/19/2004		<3.0	>24192	3609
North Brook	DOE	7/28/2004	15:35	<0.06	7260	63
South Brook	DOE	7/28/2004	15:35	3.2	>24192	86
Inner Pond	DOE	7/28/2004	15:35	<1.5	>24192	<10
North Brook	DOE	8/04/2004	15:45	<0.06	4360	20
South Brook	DOE	8/04/2004	15:45	3.5	>24192	443
Inner Pond	DOE	8/04/2004	15:45	<3	>24192	84
North Brook	DOE	8/09/2004	09:50	0.09	5172	41
South Brook	DOE	8/09/2004	09:50	1.5	>24192	408
Inner Pond	DOE	8/09/2004	09:50	<1.5	>24192	20
North Brook	DOE	8/17/2004	08:00	<0.06	>24192	556
South Brook	DOE	8/17/2004	08:00	1.2	14136	571
Inner Pond	DOE	8/17/2004	08:00	<3.0	>24192	1145