Investigation of Nutrient Sources to Point Pelee Marsh*

T. Mayer, R.A Bourbonniere, L. Zanini and S. Telford
National Water Research Institute, 867 Lakeshore Rd., Burlington, Ont.

Abstract

Eutrophic conditions were observed in some of the open-water ponds along the western margin of Point Pelee Marsh, located within the boundaries of the Point Pelee National Park (McCrea, 1993). The western margin of the park is the area of main human activity; hence input from anthropogenic activities was suspected. A multidisciplinary study was initiated to identify nutrient sources to the marsh.

Sedimentary records were investigated from two locations along the western margin of the Park. One location, with the highest nutrient concentrations in the marsh was the Sanctuary Pond, where spatial and stratigraphic differences in porewater chemistry and sediment composition were investigated. No differences were found between the porewater chemistry or sediment composition among the investigated sites at the Sanctuary Pond, suggesting an absence of external nutrient sources. The results indicate that at the Sanctuary Pond sediments, rather than external sources, are responsible for excessive nutrient inputs.

The second area investigated is situated in the proximity of the Blue Heron picnic area, where public washrooms serviced by the septic system are located. Here, nearshore-offshore differences in sediment phosphorus (P) concentrations and spatial differences in the sewage specific indicator coprostanol suggest that sewage-derived input, possibly from the park septic system, may contribute nutrients to the marsh.

Introduction

Poor water quality, resulting from elevated nutrient concentrations, was observed in some of the open-water ponds at Point Pelee Marsh, located within the boundaries of Point Pelee National Park (McCrea, 1993). Ponds along the western margin of the park were particularly affected. The western margin of the park is the main area of human activity; hence input from anthropogenic activities was suspected. A study was initiated to identify nutrient sources to the marsh.

Study Area and Methods

Sedimentary records from two locations along the western margin of the park were investigated. One location, with the highest nutrient concentrations in the marsh, was the Sanctuary Pond. Two sites were selected for the investigation at the Sanctuary Pond (Figure 1). Site #1- Middle was located in the middle of the pond, while Site #2 - Corner was located in the vicinity of once suspect sources. Sediment cores were collected at each site and they were sectioned immediately

* This paper arises from a poster paper at the 1998 Annual Meeting of the Parks Research Forum of Ontario.

after retrieval into 1cm intervals. Sediments were freeze-dried and analyzed for various forms of phosphorus and for the organic content. Composition of sediment porewater was determined by deployment of *in situ* acrylic samplers, also known as peepers. The samplers were left in sediments for passive equilibration for two weeks. Porewater samples were withdrawn from individual cells, transferred to pre-acidified plastic tubes and analyzed by standard methods for PO_4-P, NH_3-N and major ions (Ca, Mg, Fe, Na, K, Mn, Al, Sr, Ba).

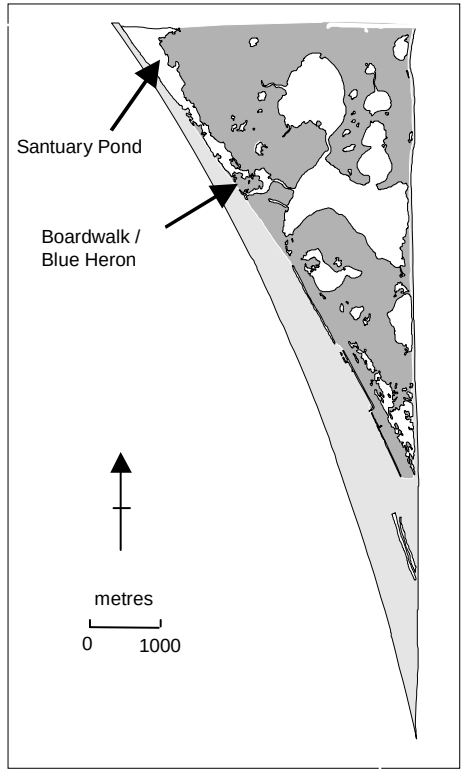

Figure 1: Point Pelee Study Areas (A) Boardwalk/Blue Heron; (B) Sanctuary Pond

Boardwalk / Blue Heron site was the second area investigated (Figure 1). This site is situated in the proximity of the Blue Heron picnic area, where public washrooms, serviced by the septic system, are located. Several inactive tile beds are also present in this area. Sediment cores were collected here from the nearshore (BH1, BW1) and offshore (BH2, BW2) areas. Similarly as for the Sanctuary Pond, the sediments were sectioned into 1 cm intervals and subsequently freeze-dried in the laboratory. Dry sediments were analyzed for total phosphorus, organic C, and for the sewage-specific molecular marker, coprostanol. Coprostanol was determined by liquid/liquid extraction, followed by high-resolution gas chromatography (GC). A detailed description of the study area and analytical procedures is provided in Mayer et al. (1997, 1998).

Results

Sanctuary Pond

The water quality data reveal a high turbidity (51 NTU) and nutrient concentrations (0.23 mg/L TP, 5.40 mg/L TKN) in the water column. At both sites, elevated concentrations (0.13 mg/L) of the NH_3-N were measured in the water column. High chlorophyll levels (~78 μg/L) suggest that primary productivity, in addition to silt, contributes to decreased water clarity. However, resuspension of benthic sediments by feeding and spawning carp and gas ebullition in the sediments are largely responsible for the high turbidity in the water column of the Sanctuary Pond.

The porewater profiles (Figure 2), as well as the levels of dissolved nutrients, were similar for both investigated sites at the Sanctuary Pond, suggesting little spatial difference in porewater nutrient chemistry. The levels of porewater PO_4-P and NH_3-N (Figure 2) were high and they were comparable with values reported for sediments of hyper-eutrophic lakes or wetlands receiving hyper-eutrophic lake water. High concentrations of PO_4-P and NH_3-N in porewater result likely from anaerobic decomposition of organic matter, which produces high concentrations of these constituents in interstitial water.

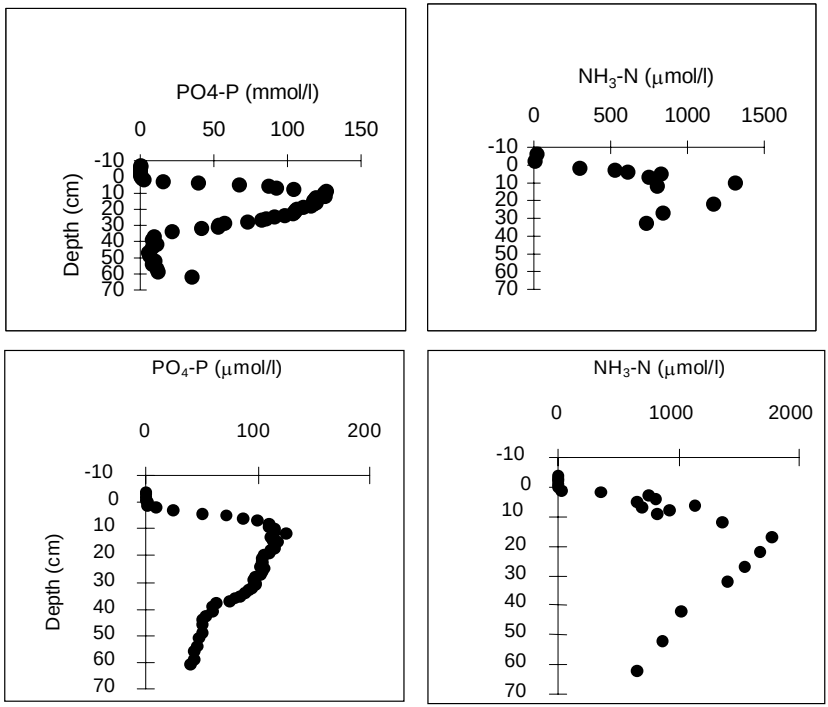

Figure 2: Concentrations of PO_4-P and NH_3-N in porewater (Upper) Site #1-Middle (Lower) Site #2-Corner

Like the porewater nutrient profiles, the benthic sediment P profiles (Figure 3), were comparable at both investigated sites. There were no differences in total

phosphorus (TP) concentrations between the nearshore site (Site #2 - Corner) and the offshore site (Site #1 - Middle) at the Sanctuary Pond. At both sites, there was a marginal decline in total phosphorus concentrations from sediment-water interface downward, mainly due to decreasing concentrations of the organic phosphorus. The lack of spatial differences in porewater and sediment nutrient concentrations suggests that sediments are the main nutrient source to the Sanctuary Pond.

Boardwalk / Blue Heron

The sediment phosphorus profiles reveal substantial spatial and stratigraphic differences between the nearshore and offshore sediments at Boardwalk and Blue Heron (Figure 3). The total phosphorus (TP) concentrations of nearshore sediments at Boardwalk and Blue Heron are substantially higher than those offshore. The differences between the nearshore and offshore data set are statistically significant at 95% confidence level. In all cores, the TP concentrations decline gradually from the sediment-water interface downward, however the differences between the nearshore and offshore sediments remain detectable.

To substantiate the assumption that the increased nearshore sediment P concentrations are attributable to sewage derived input, the distribution of a sewage specific molecular marker coprostanol was examined. Coprostanol (5β-cholestan-3β-ol) is one of the major fecal sterols excreted by man and higher mammals. It is produced primarily in the intestines by the microbial reduction of cholesterol. Because of the uniqueness of this process, coprostanol has been widely used for tracing sewage pollution in marine sedimentary environments.

Concentrations of sedimentary coprostanol range from 0.35 to 12.1 mg kg^{-1}. The data (Table 1) exhibit a definite trend, revealing the differences in coprostanol concentrations between the nearshore and offshore sediments. The nearshore sediments have higher coprostanol concentrations than the offshore sediments. The highest coprostanol concentrations (10-12 mg kg^{-1}, Table 1) were measured at the marsh edge (BH-W, Figure 1) and in the upper sediments close to the shore (BW1, BH1).

Sample/Core Depth(cm)	Coprostanol (mg kg^{-1})	Coprostanol (mg kg^{-1})
BW	nearshore	offshore
4	10.08	7.19
5	12.13	3.17
9	6.16	3.07
BH		
4	10.57	
5	11.67	
9	4.53	0.46
BH-W	11.50	

Table 1: Coprostanol concentrations in sediments from Point Pelee

At the Boardwalk/Blue Heron area, the distribution of coprostanol is consistent with the distribution of P in sediments and supports the premise that the higher P concentrations in nearshore sediments may be a result of sewage derived input to the marsh.

Conclusions

At the Sanctuary Pond, the lack of spatial differences in porewater and sediment nutrient concentrations suggests that the sediments in this pond act as a nutrient source. However, the spatial differences in phosphorus and coprostanol concentrations at the Boardwalk/Blue Heron area, suggest that sewage-derived nutrients may contribute to natural nutrient loading to the marsh.

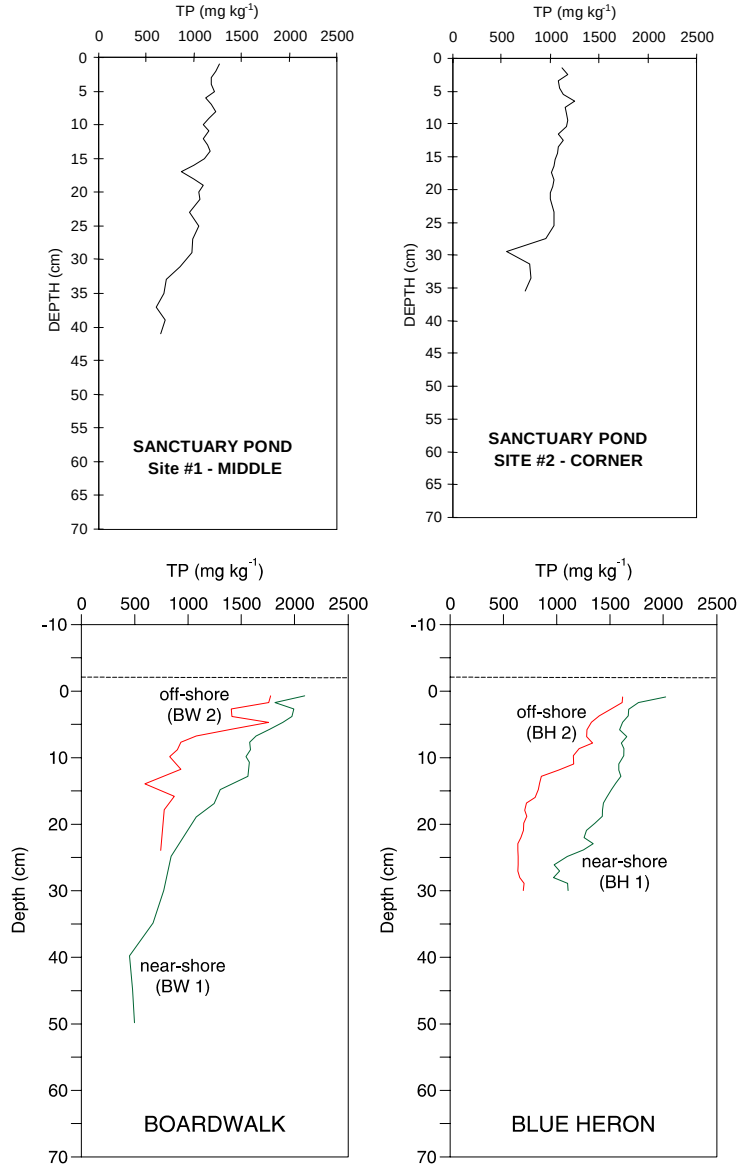

Figure 3: Concentrations of TP in sediments (Upper) Sanctuary Pond; (Lower) Boardwalk/Blue Heron.

Acknowledgements

We are grateful to L. Ziolkowski, L. Durham and J. Lee for capable assistance with laboratory analyses. We also thank C. Talbot and J. Vohralek for the field assistance, and A. Crowe, C. Ptacek and G. Mouland for valuable support throughout the study. Special thanks are due to R. McCrea, for introducing the problem for this study. This study was made possible by financial support from Parks Canada and Environment Canada Great Lakes 2000 Program.

References

McCrea, R. 1993. An assessment of the trophic status of the Point Pelee Marsh. Report to Parks Canada. Water Quality Branch, Environment Canada, Burlington, Ontario.

Mayer, T., Bourbonniere, R.A. and Crowe, A. 1998. Assessment of potential septic system-derived phopshorus input to the Point Pelee Marsh. NWRI Contribution No. 98-012.

Mayer, T., Ptacek, C. and Zanini, L. 1997. The role of sediments in nutrient dynamics in hyper-eutrophic marshes of Point Pelee, Ontario, Canada. NWRI Contribution No. 97-212.