

# The Paleoenvironmental Reconstruction of Rondeau Provincial Park: Implications for Conservation

Sarah Finkelstein and Tony Davis  
Department of Geography, University of Toronto

## Abstract

*Paleoenvironmental reconstruction is a useful tool for conservation efforts since it provides a measure of the amount of natural variability inherent in ecological systems prior to human disturbance. Rondeau Park is a sand spit characterized by a series of wooded ridges and wet sloughs. It provides an opportunity to examine the development of its different ecosystems over the 3500 years that the sand spit has been in existence. A series of sediment cores along two transects have been collected and the most preliminary findings from these cores are presented here. One core from a forested slough has been examined for pollen at 10-cm intervals and a low-count pollen diagram has been generated indicating significant ecological changes beginning at the Ambrosia rise which likely coincides with European land clearance. When analyzed in more detail, changes in the spectra of pollen taxa present can indicate a variety of pre-European environmental changes such as shifts in lake level, wetland productivity and composition of the surrounding vegetation. Ground penetrating radar will also be used to investigate the nature of the substrate to a depth of about 10 m. This geomorphological information will complement the paleoenvironmental story that emerges from this site. Future work on this project will involve geochemical analyses of the sediments, radiocarbon dating and analysis for siliceous microfossils including diatoms, chrysophyte cysts and rhizopods.*

## Introduction to paleoenvironmental reconstruction

There are a variety of techniques that can be used to describe the development and variability of ecosystems over the course of thousands of years. This information can be useful to land managers addressing conservation or remediation issues as it can inform target levels based on pre-anthropogenic environmental change. Paleoenvironmental data can be obtained by sediment coring in areas where conditions allow for the preservation of proxy ecological indicators.

Two paleoenvironmental techniques will be described here. Palynology can be used to document changes in vegetation over time. It involves physical and chemical processing of sediment to concentrate pollen grains and spores followed by microscopy to identify and count the taxa present. Although the pollen record is biased in favour of taxa that produce abundant and resistant pollen grains, it has been one of the most successful and widely used techniques for paleoenvironmental reconstruction (see Berglund & Ralska-Jasiewiczowa, 1986).

The second technique is ground penetrating radar (GPR). GPR works by transmitting radio waves into the ground; these radio waves are then reflected back to the surface at boundaries between materials with different electrical properties. The time taken for the signal to return to the receiver is recorded and plotted. A wiggle trace plot is generated that can show the depth corresponding to each reflector at each point along a horizontal survey line. Ground-truthing can show what each reflector signifies – a change in substrate materials, moisture content, bulk density or grain size. This information can indicate geomorphic changes through time (see Conyers & Goodman, 1997).

### Site description

Rondeau Provincial Park is situated in southwestern Ontario on one of the three major sand spits along the north shore of Lake Erie. Coakley (1989) dates the formation of the oldest Rondeau ridges to 3.5 ka BP. The high water phase following the Nipissing flood event increased the supply of sediment eroding from the Erie shoreline. This sediment accumulated on top of the Late Glacial Erieau moraine, situated just south of the Rondeau sand spit (see Figure 1). Subsequently, younger beach ridges formed following storm events.

The Park covers 3,254 ha but is highly diverse. The forest vegetation contains Carolinian species of which there are few Canadian examples and remnants of oak savanna. One of the principal wetland plants is wild rice (*Zizania aquatica*), a plant which may be of considerable paleoecological and archaeological importance. While little archaeological work has been done within the park, preliminary studies (Dr Dave Smith, pers. comm.) have shown that there have been people in the Rondeau area since at least the late Archaic period (3 ka BP).

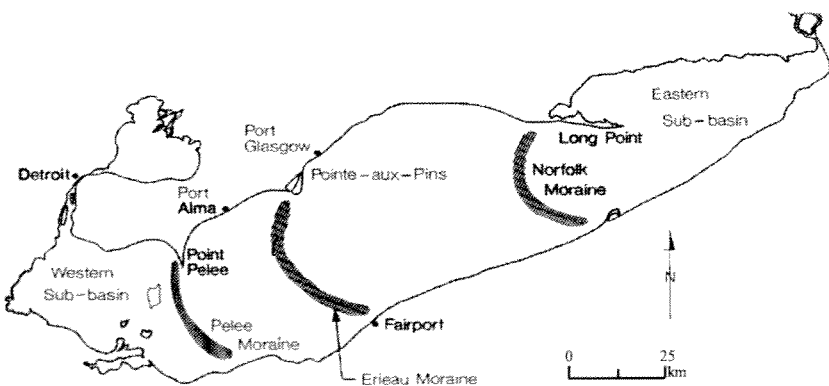


Figure 1: The Lake Erie basin showing the locations of three late glacial end moraines. Rondeau Park is located on the Pointe-aux-Pins peninsula (after Coakley, 1989).

## Methods

We have sampled the sediments at 28 locations in the wetlands and the forested sloughs within the Park using a Livingston piston corer. These cores were on average 60 cm in length. The sandy sediment prevented deeper coring with this equipment. The cores were transported back to the laboratory and stored in cool conditions. Samples of sediment were taken for analysis at 10-cm intervals in one of the cores (site R22 – see Figure 2) for palynological analysis.

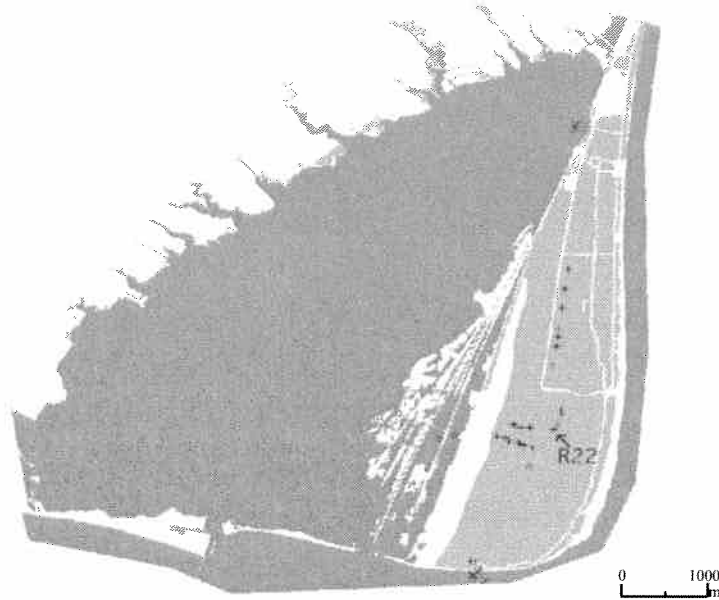


Figure 2: Rondeau Park and Bay. Darkest grey indicates lake, medium grey indicates forested area, light grey indicates wetland and white spaces are roads, buildings or areas without digital data.

? : coring site (August 2000)

+ : coring site (February 2001)

X : GPR survey transects (February 2001)

The digital data were provided by the Aylmer MNR office.

Pollen processing involved spiking 1-mL sediment samples from each level with a known number of exotic *Lycopodium* spores, followed by treatment with HCl, hot KOH and acetolysis solution. The sediment was also sieved through coarse (150  $\mu\text{m}$ ) and fine sieves (10  $\mu\text{m}$ ). Finally, the sediment was stained with safranin and mounted on microscope slides in glycerine. For this preliminary analysis, at least 150 pollen grains were counted at each level under x400 magnification. The numbers of pollen grains that were unidentifiable due to corrosion were recorded as well. Pollen counts were plotted using CANPLOT (Campbell and McAndrews, 1992).

The GPR survey was conducted in February 2001 over ice cover on the Rondeau Bay and in the wetland sloughs using a pulse EKKO IV system, manufactured by Sensors & Software of Mississauga, Ontario.

## Preliminary Results

These cores contained an organic layer of varying length overlying sand. The degree of humification in the organic section varied from core to core with some cores showing extremely coarse, peaty deposits while others were characterized by fine, highly humified sediment.

The core analyzed for pollen, R22, was 53 cm long. The top 16 cm was a fibrous, peaty deposit; the degree of humification increased downcore to 50 cm. The bottom 3 cm were sandy. The pollen diagram (Figure 3) and Table 1 below give a preliminary view of the changing vegetation through time.

Table 1: Results of preliminary pollen counts, core R22.

Level (cm)	Pollen concentration (grains/mL)	% corroded	% arboreal pollen	% <i>Ambrosia</i>
5	28,100	15	39	37
15	29,400	24	39	18
25	44,200	34	85	less than 2
35	31,900	24	78	less than 2
45	17,900	6	71	less than 2

The pollen counts done here are too low to draw many conclusions. However, the data suggest some interesting points.

- The high degree of corrosion in some places and the presence of peaty deposits with limited humification suggests an important role for hydrological change in the preservation of materials. These hydrological changes are likely to also be important controls on ecological changes at this site.
- The *Ambrosia* rise is accompanied by a suite of vegetational changes such as decreases in arboreal pollen types and increases in wetland taxa.

Two GPR profiles are shown below (Figure 4). The Rondeau Bay profile suggests the presence of a former channel beneath the bay sediments. Without ground-truthing using a motorized coring device, the possibilities for interpreting the profiles are extremely limited. However, these profiles suggest that the sediment is suitable for GPR analysis.

## Conclusions

These results suggest that Rondeau Park has a suitably well preserved paleoecological record for further analysis. The next stage in this research project is a palynological analysis of cores from the marshland habitat on the spit and to consider other paleoecological indicators. Diatoms and siliceous microfossils of other aquatic organisms are likely to complement the pollen record as they can track changes in water level, quality and aquatic vegetation.

Rondeau Park, Ontario

rondeau01.pdf, Apr. 2001

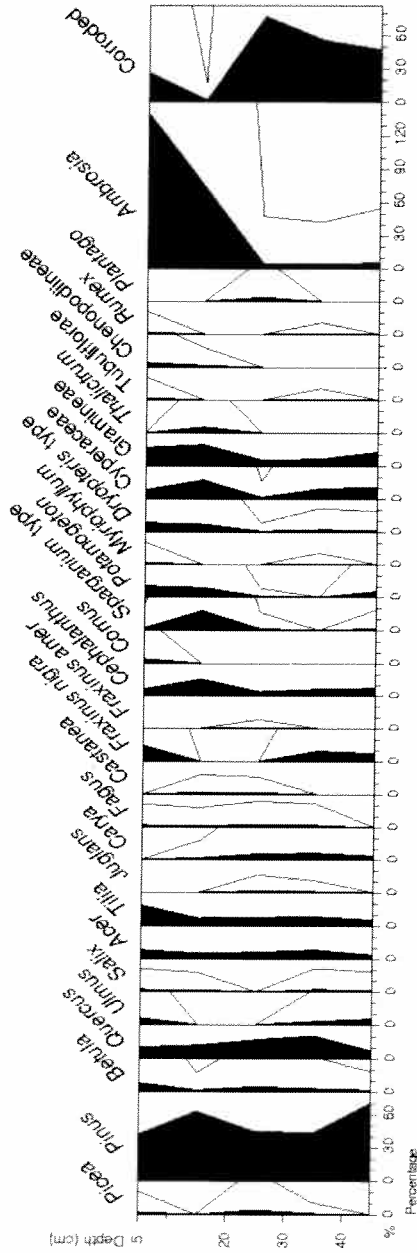


Figure 3: Skeleton pollen diagram for site R22. The vertical axis shows the depth in cm downcore. The horizontal axis indicates the percentages of each taxon at each level. The pollen sum used included all upland arboreal taxa.

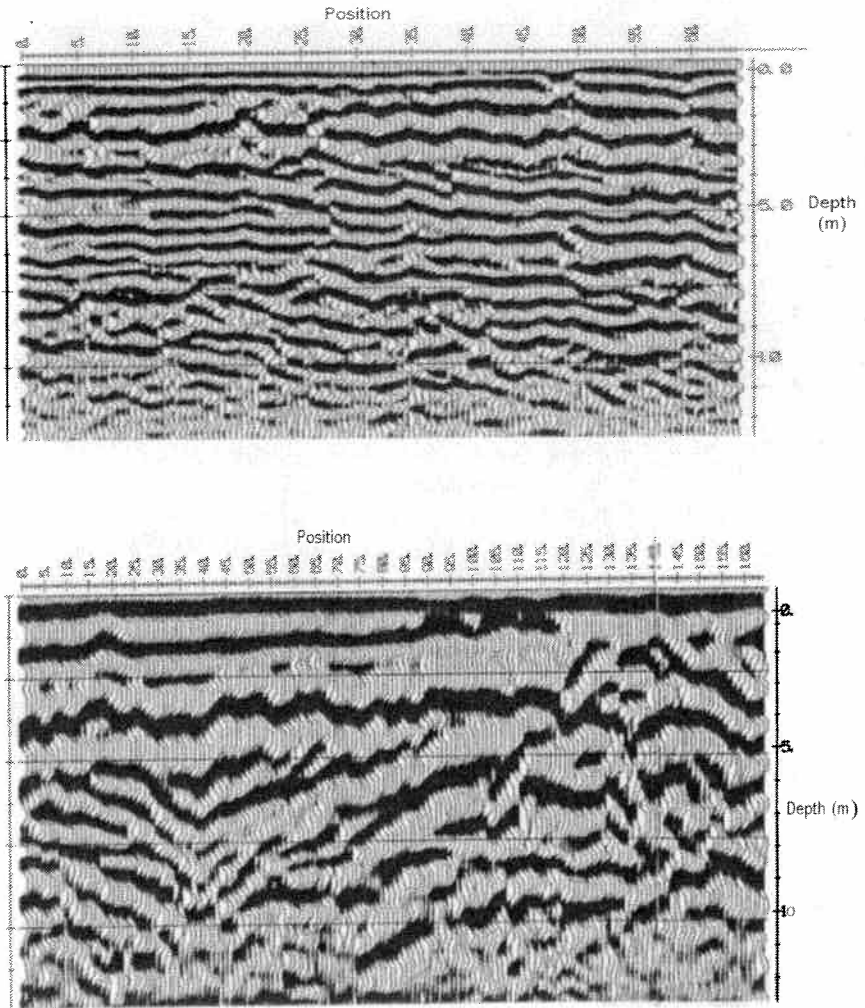


Figure 4. GPR profiles for a 164 m near-shore transect along the ice-covered surface of Rondeau Bay (bottom) and for a 64.5 m transect along an ice-covered wetland (top). The horizontal axis indicates the position of the reading and the left vertical axis indicates the two-way travel time of the signals arriving at the receiver (scale not shown). This has been converted into a depth axis on the right hand side, by assuming uniform velocity of the radio waves throughout the substrate. The Bay transect was taken using 50 MHz antennae separated by 2.0 m. The traces were 1.0 m apart. The wetland transect was taken using 100 MHz antennae separated by 1.0 m. The traces were 0.5 m apart. In both cases, the data shown have been processed using an automatic gain control, between-trace smoothing and within-trace smoothing.

The overall objective of this project is to provide a clear picture of long-term environmental change in the different Rondeau ecosystems, which will include an estimation of the degrees of ecological change associated with different types of environmental changes, including hydrological, climatic or anthropogenic changes. In order to achieve and even to define ecological integrity, managers of parks and other natural areas need to have some idea of the natural variability inherent in key ecological variables such as species diversity, productivity, nutrient availability and the stability of ecosystems in the face of disturbance. Paleocology has the potential to provide information about the rates and degrees of change in these variables in Ontario Parks on the scale of thousands of years. Although the methods used by paleoecologists have significant weaknesses such as a biased fossil record and the possibility of poorly preserved materials, paleocology is an important approach to consider when evaluating plans for the conservation, management or remediation of parks and natural areas.

### Acknowledgements

The authors would like to thank the Park staff at Rondeau for their co-operation and assistance. This research was funded by the Department of Geography, University of Toronto and by an OGS scholarship to S.F. We also thank our University of Toronto field crew who assisted in coring and conducting the GPR survey: R. Dirszowsky, K. Hodder, M. Peros, J. Ross and A. Stewart. Digital data for Fig. 2 shown here and for other analyses were collected by the MNR and supplied by Dean Kebbel, the GIS officer at the Aylmer MNR office

### References

- Berglund, B.E. & Ralska-Jasiewiczowa, M. 1986. Pollen analysis and pollen diagrams. In *Handbook of Holocene Paleocology and Paleohydrology*. Berglund, B.E. & Ralska-Jasiewiczowa, M., eds. John Wiley, Chichester, UK.
- Campbell, I.D. & McAndrews, J.H. 1992. CANPLOT: A Fortran-77 program for plotting stratigraphic data on a postscript device. *Computers and Geosciences*. 18:309-335.
- Coakley, J.P. 1989. The origin and evolution of a complex cusped foreland: Pointeaux-Pins, Lake Erie, Ontario. *Geographie physique et Quaternaire*. 43(1):65-76.
- Conyers, L.B. & Goodman, D. 1997. *Ground Penetrating Radar: an Introduction for Archaeologists*. Altamira, Walnut Creek, California, USA.