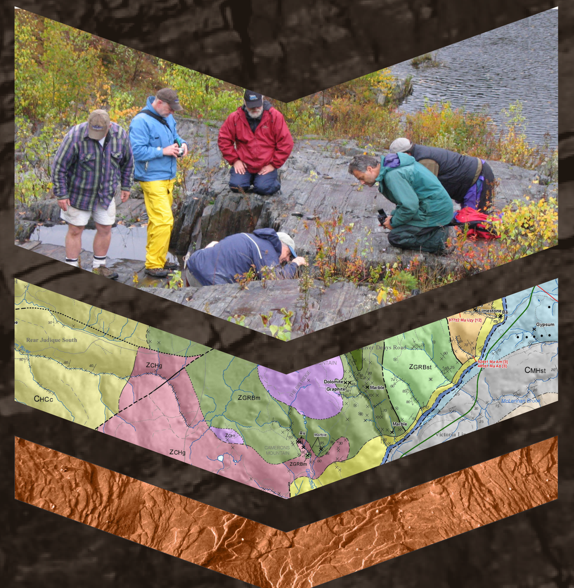
Natural Resources

Geology Matters 2013

Experts
on the ground



Opportunities
on the ground

Mineral Resources Branch

NOVA SCOTIA

Open File Illustration ME 2013-011

Environmental Geology

Chantel Nixon nixonfc@gov.ns.ca

Geohazard Assessment and Coastal Process Studies

pwfinck@gov.ns.ca Philip Finck

Coastal evolution under past, present and future sea-level rise

BRAS D'OR LAKES BARACHOIS

12% of the shoreline of the Bras d'Or Lakes (Fig. 1) consists of coastal ponds and lagoons, locally known as 'barachois'.

The barachois are separated from the open sea by a barrier beach.

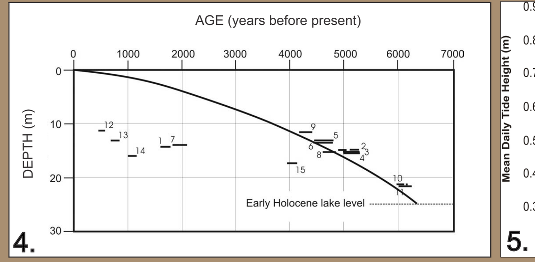
Under present and future (predicted) rates of sea-level rise, the barrier beaches will migrate landward and/or drown. Increased effort and expense will be necessary to maintain coastal defenses and other structures, particularly those developed on barrier beaches.

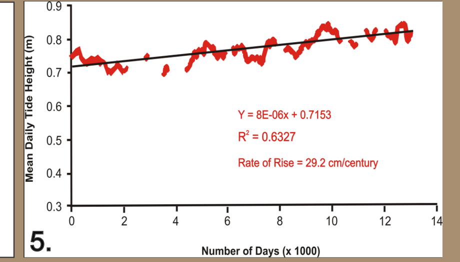
This study aims to develop a basic understanding of the age of the barachois, the nature of the sediments underlying them, and the geodynamics of the barriers (i.e., how quickly they evolve from growing or stable phases, to landward-migrating or submerging phases).

A. Irish Vale Pond (Fig. 2) is actually a lagoon, as it is open to the sea. The barrier here is partially submerged due to ongoing sea-level rise and inadequate sediment supply. Photo courtesy of F. Baechler.

B. Campbell Pond (Fig. 3) is an example of a cuspate barrier, which is unique to the Bras d'Or Lakes. The intact barrier keeps salinity levels low. Photo courtesy of F. Baechler.

RELATIVE SEA-LEVEL RISE IN THE BRAS D'OR REGION





Past sea-level rise: Figure 4. Relative sea-level curve since 6350 years before present (BP) for Bras d'Or Lakes. Samples are from the St. Patrick's Channel area. Figure from Shaw et al., 2006.

Prior to ~6350 years BP the lake was fresh. Once relative sea level rose above -25 m (depth of the sill at Great Bras d'Or Channel), the Bras d'Or Lakes were flooded with sea water.

Present sea-level rise: Figure 5. Modern sea-level rise (past ~40 years) recorded by the Sydney tidal gauge: 29.2 cm/century. Raw data from Canadian Hydrographic Services.

Future sea-level rise: 0.7-1.4 m over the next 100 years

METHODS AND PRELIMINARY RESULTS

Twenty-five kilometers of sidescan and high resolution (low penetration) echosounder profiler data were collected across the three barachois study sites in the Bras d'Or Lakes, Cape Breton (Oct. 5-6, 2013).

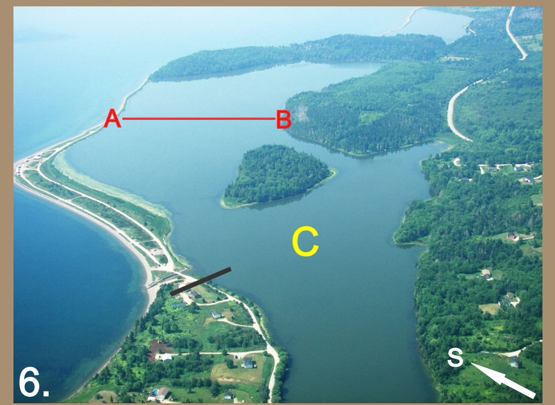
The three barachois, which are fully or partially separated from the sea by a beach barrier, include: Irish Vale, Campbell and Amaguadees ponds (sites A, B, C on Figure 1 above, respectively).

Results to date indicate that all of the ponds have organic mud fill in their centres, and sand- gravelly margins (e.g., Figure 7).

The seismic (Fig. 7) and sidescan (Fig. 8) data will be used to locate the best sites for sediment coring, planned for Winter 2014.

Once sediment cores are retrieved from the barachois, sedimentological and microfossil analyses will be conducted with the aim of identifying paleoenvironmental change in the pond (i.e., initial barachois development, barrier breaching during large storms, break-down of the barrier, etc.).

Radiocarbon dating of organic matter in the sediment cores will provide a chronological framework for these events.



C. Amaguadees Pond (Fig. 6) is closed to the sea except for an artificial channel on the north end of the barrier (black line, above). Roads, a playground, a bridge, and other structures have been built on the barrier. Photo courtesy of F. Baechler.

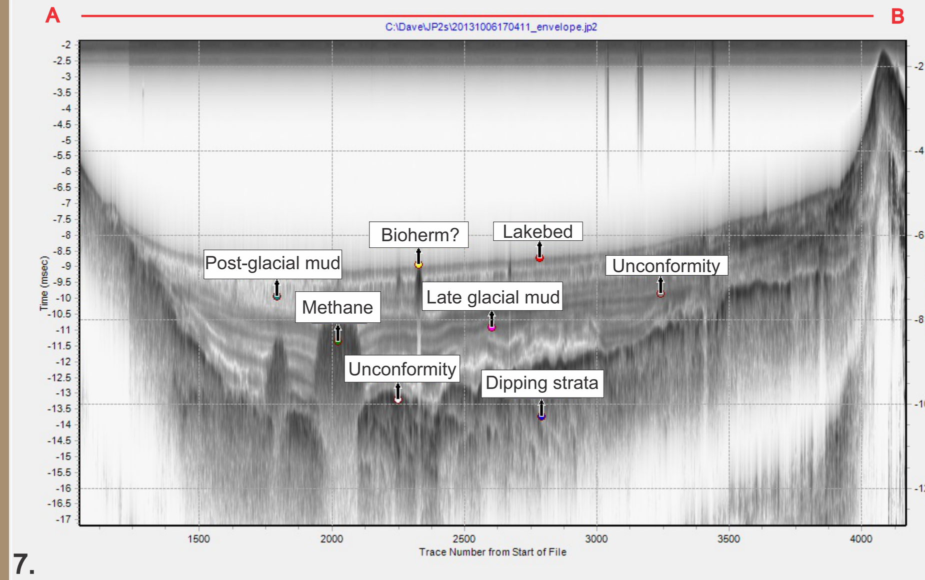


Figure 7. Initial interpretation of seismic data from Amaguadees Pond (line A-B on Fig. 6).

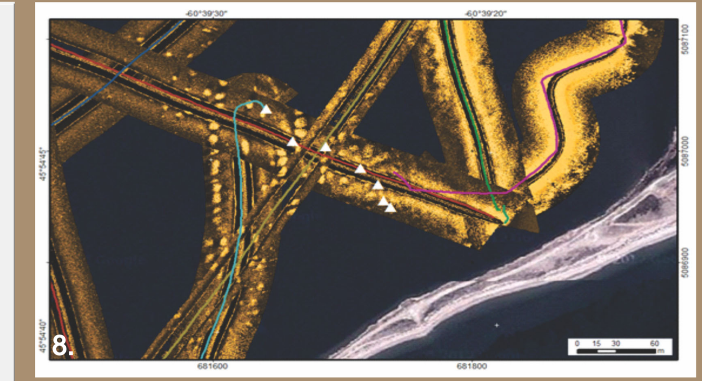


Figure 8. Some of the sidescan sonar from Amaguadees Pond showing what are thought to be oyster bioherms. Their unusual linear pattern in places may indicate anthropogenic influence. White triangles indicate grab sample locations.

PROJECT PARTNERS: Bras d'Or Lakes are golden Collaborative Environmental Protection Initiative; UNAMA'KI INSTITUTE OF NATURAL RESOURCES; CAPE BRETON UNIVERSITY; Volunteers Edward King and Gordon Cameron from the Geological Survey of Canada

Reference

Shaw, J., Taylor, R.B., Patton, E., Potter, D.P., Parkes, G.S., and Hayward, S. 2006: Sensitivity of the coasts of the Bras d'Or Lakes to sea-level rise; Geological Survey of Canada, Open File 5397, 99 p.

Past climate variability in Nova Scotia

Paleoclimate studies provide a long-term view of past climate variability in Nova Scotia.

At Little Dyke, west of Truro ('x' on **Fig. 1** above left), a large, *in situ* White Pine tree stump and its roots were exposed during trenching in 2010 (**Fig. 2**, above right).

The tree stump is overlain by ~2 m of marine clay.

Residents of this area have often noticed buried organic matter uncovered by machine operators during local excavations.

A detailed study of this site, including the acquisition of radiocarbon dates on organic matter and documentation of changes in sediments, flora and fauna, would provide valuable information on past natural climate variability. Such information is critical in understanding, predicting, and planning for future climate change.

Figure 3. View looking east toward the eroded flat-topped remnant of a cobble-gravel outwash plain (background). The flat foreground is a former marine clay plain reclaimed by Acadian diking.

Figure 4. Radiocarbon dates on tree stumps and other organic matter in and below the clay range from the Early Middle Ages (~600 AD), to the Medieval Warm Period circa (~1000 AD), to the onset of the Little Ice Age circa (~1400 AD). A study of floral and faunal changes coincident with these widespread and well-documented fluctuations in climate over the past ~2000 years will help us understand how the local environment responds to climate change.

Figure 5. Other examples of organic matter preserved in the shallow subsurface include a soil horizon underlying extensive sand dunes at Sand Hills Provincial Park, SW Nova Scotia (photo at left, outlined in red). Shells preserved under other dunes at similar sites date from 1300 to 1400 AD.

Radiocarbon dating, palynology (pollen) and other microfossil and sedimentological studies at more of these sites would help reconstruct Nova Scotia's paleo-environment during this time period.

Coastal geohazard assessement in Nova Scotia

Figure 1. Inadequate understanding of coastal processes and a lack of knowledge of the underlying bedrock geology has resulted in the rapid collapse of this engineered structure.

Figure 2. Construction of the Ben Eoin Marina. The Geological Services Branch provides coastal process expertise and a knowledge of how built infrastructure impacts natural shorelines. This information is used for Integrated Resource Management Planning, permitting activities of other Natural Resources Divisions, other government departments, and protection of the natural and built environment.

Figure 3. Gabarus Seawall, Cape Breton County. Activities include detailed hazard assessments relating to coastal protection systems that aid the local community, government decision processes and emergency preparedness.

Figures 4 and 5. Tank Pond and Catalone Gut, Cape Breton Island. Inadequate drainage, blockages of drainage channels due to migrating beaches, and other issues relating to eroding and transgressing beaches are common problems causing damage to property.

Figure 6. Dominion Beach Provincial Park, Cape Breton County. Our knowledge of coastal processes, sea-level rise, storm events, etc., has contributed to the development of more sustainable infrastructure at Dominion Beach Provincial Park.

Coastal geohazard assessment in Nova Scotia requires informed, scientific analyses of sea-level rise, storminess, susceptibility to erosion, and other impacts from the changing climate (e.g., diminishing sea ice).

Geological Services Branch staff are able to offer sound advice with respect to sustainable coastal protection.