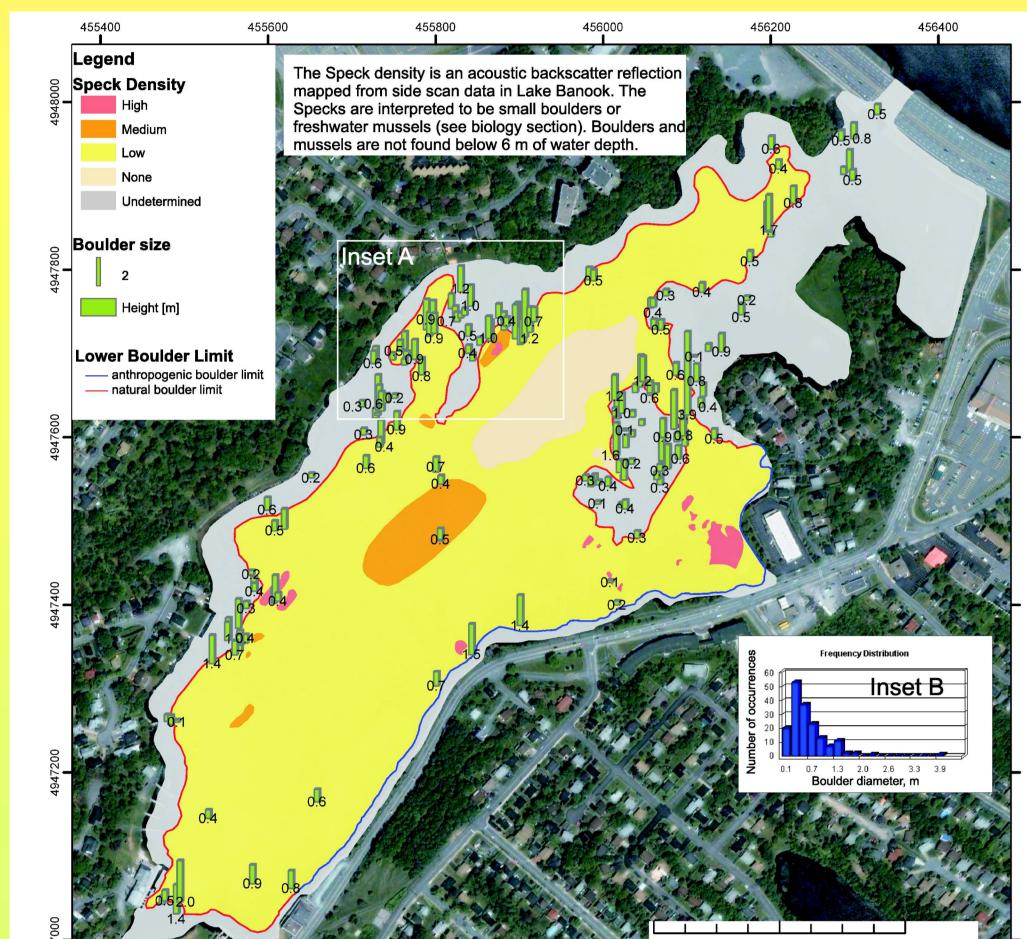
Introduction

Lake Banook in Dartmouth, Nova Scotia is in an 11.5 meter deep glacially carved basin, created during the Wisconsin glaciation, located within a regional meltwater corridor of the Scotian Ice Sheet. Geophysical data, including multibeam bathymetry, sidescan sonar, high resolution seismic (10 kHz) and underwater video data, were collected from a small research platform during summer and fall of 2007. Various seismo-stratigraphic facies were differentiated spatially and temporally within the lake basin. Sub-bottom transects show acoustic basement interpreted as basal till, correlated to onshore drumlins and tills. This is overlain by up to 10 m of well-stratified sediments, that mimic the underlying topography. The till is conformably overlain by rhythmically stratified muds up to 8 m thick, probably of glacial origin and possibly varves. This is followed by a ponded, weakly stratified unit up to 4 m thick comprising gyttja. Two low-stands are represented. A local unconformity at the top of the well stratified glacial sediments is related to a low-stand of uncertain timing. A higher lake-stand is anthropogenic. Sub-basins in the lake show facies and thickness variations apparently related to local ice sheet fluctuations. The uppermost, ponded unit correlates seismically to a nearby Penhorn Lake section displaying a climate evolution based on published microfossil studies.

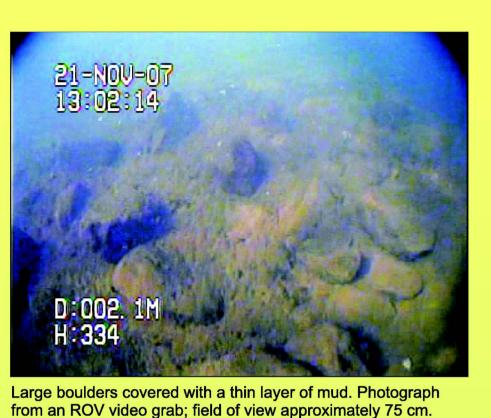
Glacial boulders washed from the till are common at the low-stands. Other significant features include shallow gas in sub-basins, drumlins, fluvial paleo-channels, glacially over-deepened basins and slump deposits. Freshwater mussels, microbacterial mats, and abundant water plants are commonly found in shallow areas less than 3 m deep. Deforestation, construction of the Shubenacadie Canal, urbanization and dredging have likely impacted Lake Banook's sedimentary record. Recent dredging provides a baseline for very recent sedimentation and biological recovery rates.

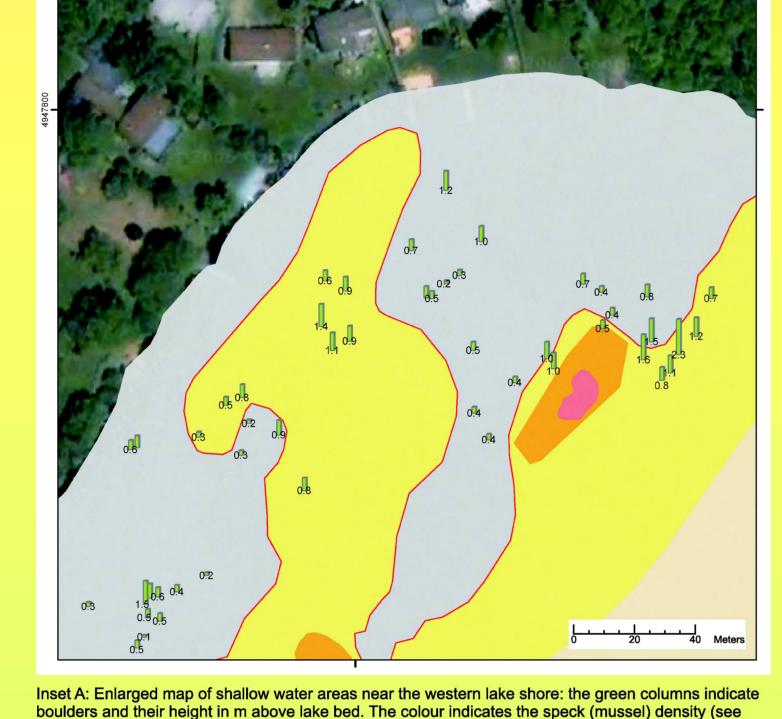
The initial objective for the Lake Banook survey was to perform a field test on the new Imagenex multibeam transducer and its integration with the motion sensor. The second objective was to establish small craft capability, especially configuration and duration of power supply. The site was chosen because it is an ideal venue for public education and public relations primarily because it contributes to the present initiative under the Sullivan's Pond and Lake Banook Master Plan by the Halifax Regional Municipality, including the Trans Canada Trail. The lake will be the site of a large international sporting event, the world sprint canoeing competition in 2009. The third objective was to provide information to be used for a natural history and appreciation display for the trail and the numerous boating clubs. http://www.halifax.ca/RealPropertyPlanning/SPLBMP/index.html

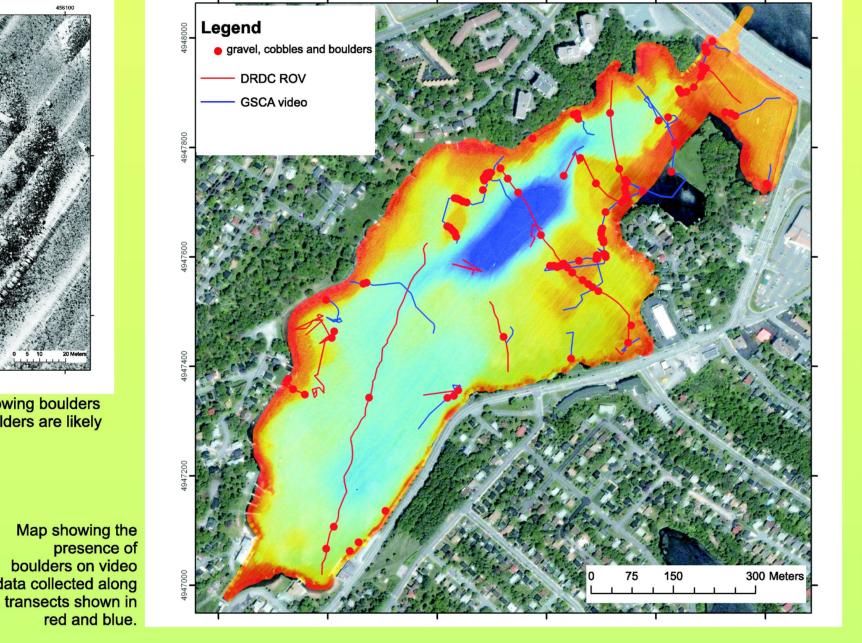
The survey was successful from a technical operations standpoint and the initial small-craft capability was extended to a modified operation from a sea kayak. The investigations indicated the presence of a Holocene mud record, as expected, but also a thick late glacial section with a variety of facies. Investigations in other lakes within the deglacial drainage system confirm a similar stratigraphy, unlike smaller, isolated lakes in the area. A February 2008 coring program from the frozen lake surface yielded six short cores from the glacial and post-glacial section. Within an honours B.Sc. project, these and the geophysical data will further be analyzed for detailed stratigraphic and facies mapping towards a synthesis of sedimentary processes,



from tens of cm to several meters, typically 0.5 m (see inset B). The lower boulder limit defines a former lake shoreline, below which the frequency of boulders diminishes rapidly. Below this limit, occurrences may have been displaced by slumping or dredging. On a local high in Paddlers Cove, some of these boulders outline the former shoreline, possibly as ice push







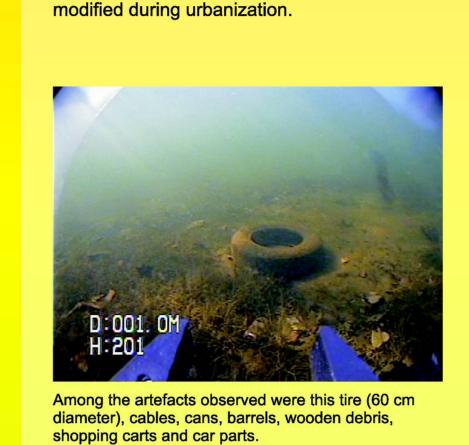
¹Huppertz, T.J., ²King, E.L., ¹Peters, N.M., and ²Cameron, G.D.M.

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¹Dalhousie University, ² Geological Survey of Canada

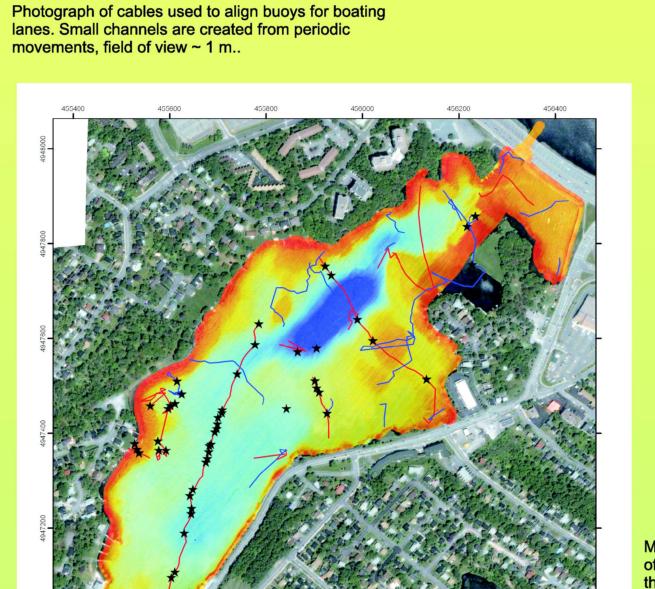
Bathymetry and dredging

displays the water depth: blue colours indicate the deepest areas of up to 11 m depth. The pale yellow highlighted zones are dredged areas. The lake surface area has changed through time, creating terraces in the lake, which are interpreted as former lake lowstands. The timing of these lower lake levels remain uncertain but may be related to deglaciation or flooding of the area during the construction of the Shubenacadie canal system. These terraces are characterized by in bathymetry along their limits. Several paleochannels were recognized in shallow water (less than 5 m) and were created by small rivers during lower lake levels. The drainage systems of these rivers are still observed in the

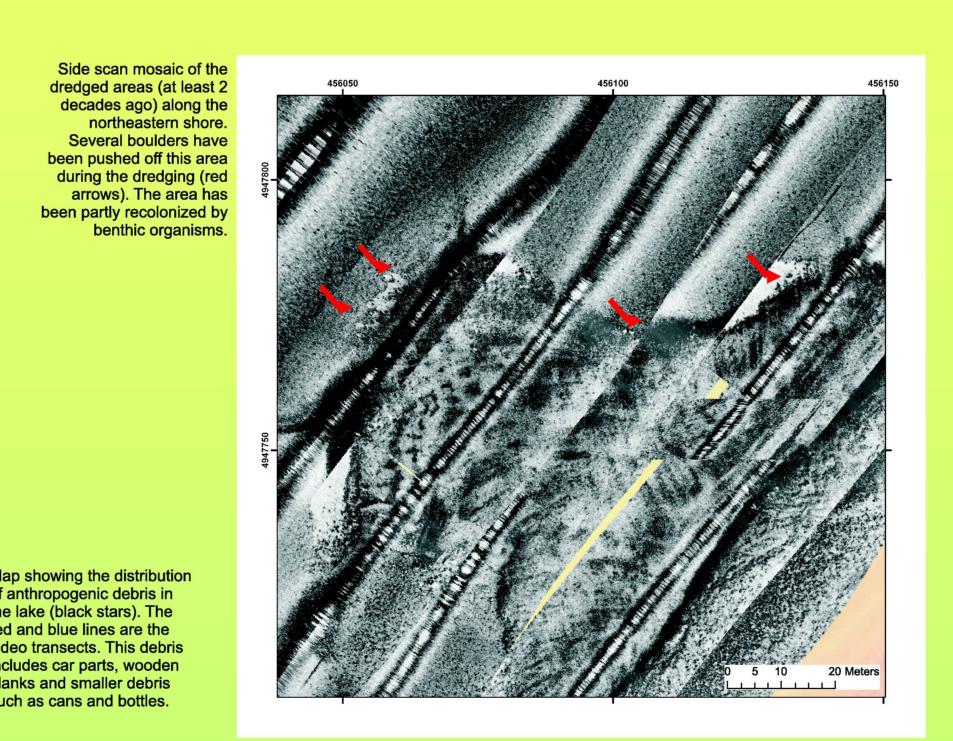


topography around the lake, but have been





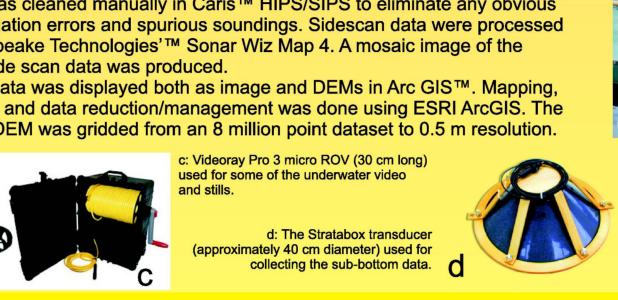
Three seismic transects in Lake Banook showing the seismic stratigraphy and overall geology in the lake.

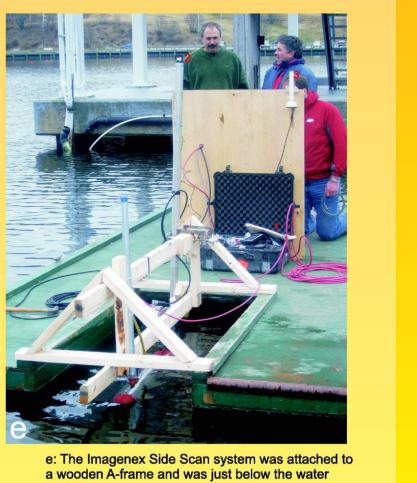


Map showing the bathymetry and dredged areas in Lake Banook; during dredging at least 15 000 m³ have been either removed from the lake bed or been redeposit-

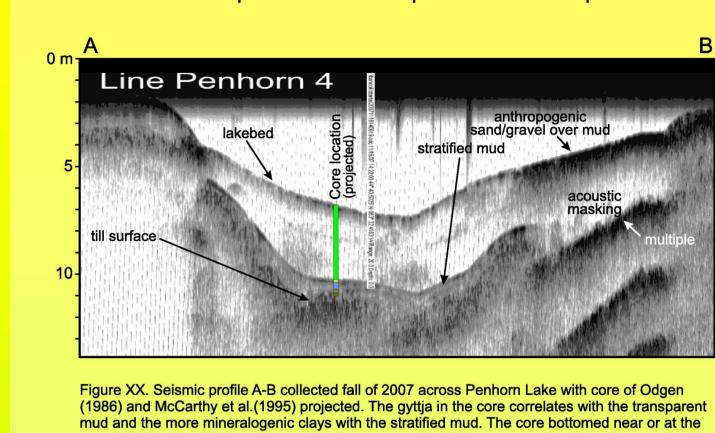
platform. The geophysical equipment consisted of Imagenex™ Sportscan side scan with a operating depth of 2 to 11 m at a frequency of 330 kHz, the Imagenex™ 837 DeltaT MBES 260 kHz 120 beam multibeam bathymetric system with a GSCA developed system for measuring pitch and roll of the craft, and the 10 kHz Oceandata Stratabox™ with more than 15 m penetration. All the devices were mounted on metal poles attached to a wooden A-frame. Two laptops were used to differential GPS, was used for positioning of the barge. A Lowrance™ navigation system or a GPS real-time system connected to an ESRI ArcMap GIS™ display was used for line running. Two car batteries (12V) and 115V inverters supplied power for Videoray™ Pro 3 ROV supplied by Defence Research and Development Canada. Navigation was cleaned manually in Caris™ HIPS/SIPS to eliminate any obvious GPS or navigation errors and spurious soundings. Sidescan data were processed using Chesapeake Technologies'™ Sonar Wiz Map 4. A mosaic image of the Bathymetry data was displayed both as image and DEMs in Arc GIS™. Mapping,







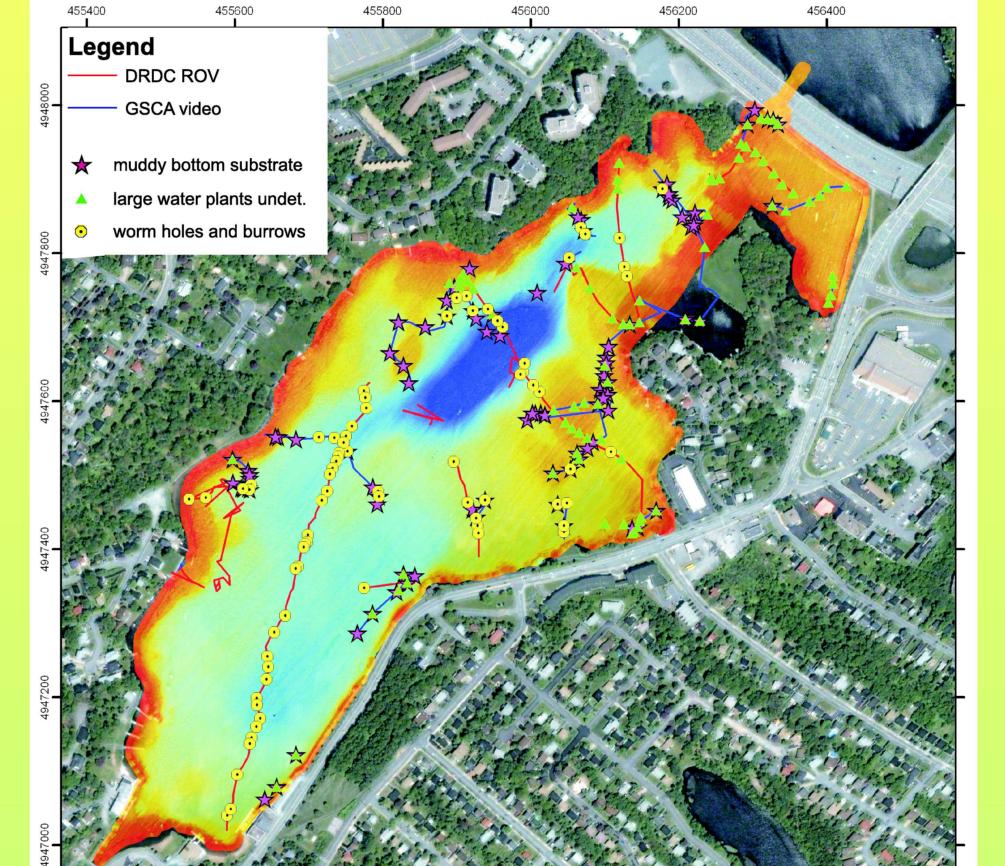
Correlation of post-glacial history with nearby Penhorn Lake

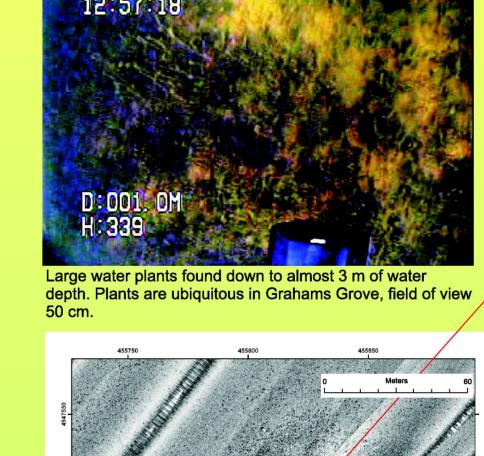


The Penhorn Lake core penetrated to the base of the muds nearly or into the till surface as shown from the adjacent figure. A gyttja (green) dominates the Holocene record but more mineralogenic sediments at the base record early post-glacial conditions. Selected pollen (A) and thecamoebian (B) analyses and interpretation by Odgen (1987) and McCarthy et al. (1995) elucidated the local climate and forest evolution. C-14 dates (Odgen) confirm early post-glacial lake sedimentation over the till. Thecamoebian assemblages (A to E) were defined through cluster analysis (McCarthy). A less organic clay topped with sandy clay at 3.5 m depth has a dominant aculeata fauna represents the Younger Dryas cooling period (McCarthy). Sedges, grasses and spruce forest gave way to birch and then pine, followed by a pine and hemlock maximum representing the Holocene hypsithermal. This was followed by a birch and spruce increase at the expense of pine and hemlock, representing a cooling of about 1° to the present.

top of till. The 4 m thick transparent mud represents the Holocene record and can be correlated McCarthy, F.M.G., Collins, E.S., McAndrews, J.H., Kerr, H.A., Scott, D.B., & Medioli, F.S. 1995. A Comparison of Postglacial Arcellacean ("Thecamoebian") and Pollen Succession in Atlantic Canada, Illustrating the Potential of Arcellaceans for Paleoclimatic Reconstruction. Journal of Paleontology. 69, 5, 980-993. directly with the seismic unit 6 in Lake Banook, while the stratified mud is a unit 3 equivalent at Banook, only 1 km to the west. Accordingly, the adjacent core and climate findings can be applied Ogden, J. G. III. 1987. Vegetational and climatic history of Nova Scotia. I. Radiocarbon-dated pollen profiles from Halifax, Nova Scotia. Canadian Journal of Botany. 65, 1482- 1490.

The biological observations are largely based on the video transects and to a lesser extent on side scan data. The biological observations include macro-flora and fauna and evidence for microbiological processes. The macrofauna consists mainly of fish and fresh-water mussels. The mussels are distributed from the shore to about 6 m water depth, beyond which abundances decrease, reaching nil below 8 m. They occur as patches in the mud and are registered on the side scan data as dark "specks". Large-scale fresh water plants are as yet unclassified. Most occur in the 0 to 3 m water depth range. Small scale organisms include green algal patches, microbiological mats and aggregates, usually associated with worm burrows. Holes, generally smaller that 5 cm in diameter and 2-3 cm deep are found throughout the deeper areas of the lake below 6 m water depth. They are associated with bioturbation, but their origin remains unclear: they may be related to fish feeding processes. Fungae are widely distibuted in these deep lake areas and are mostly occurring in small 3-4 cm large patches on the lake bed.





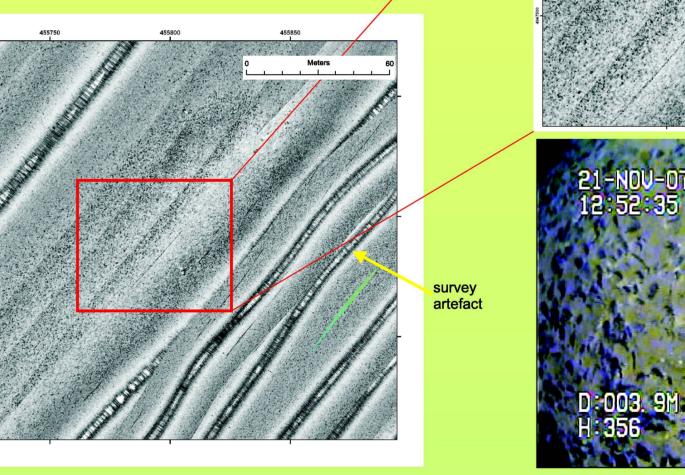
These arise from strong backscatter associated with patchy colonies of freshwater mussels.

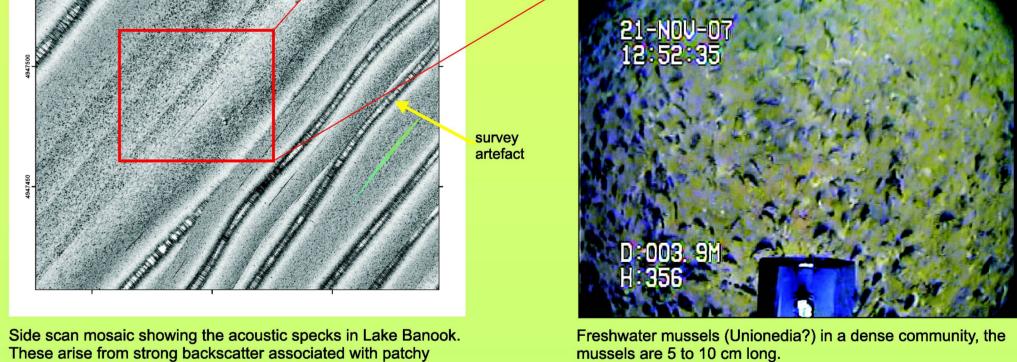
Bioturbation, probably from polychaetes whose tubes are

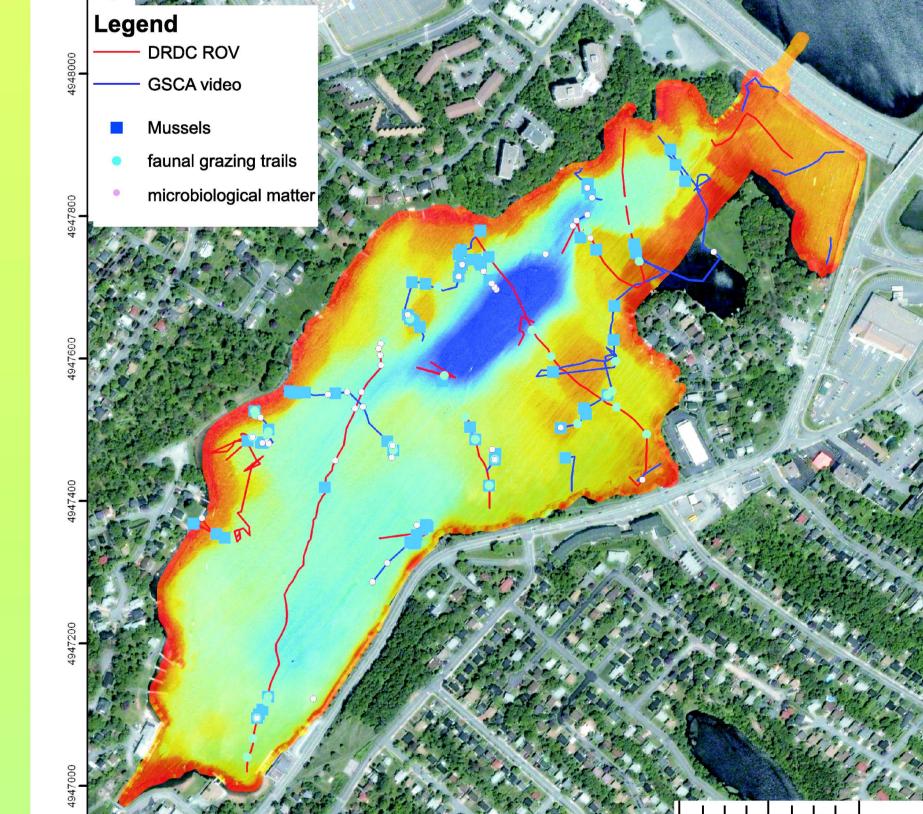
commonly visible, but the larger holes (10 cm diameter) with

erosional edges may originate from larger fauna (fish?). The

map indicates a distribution across the entire soft mud area.

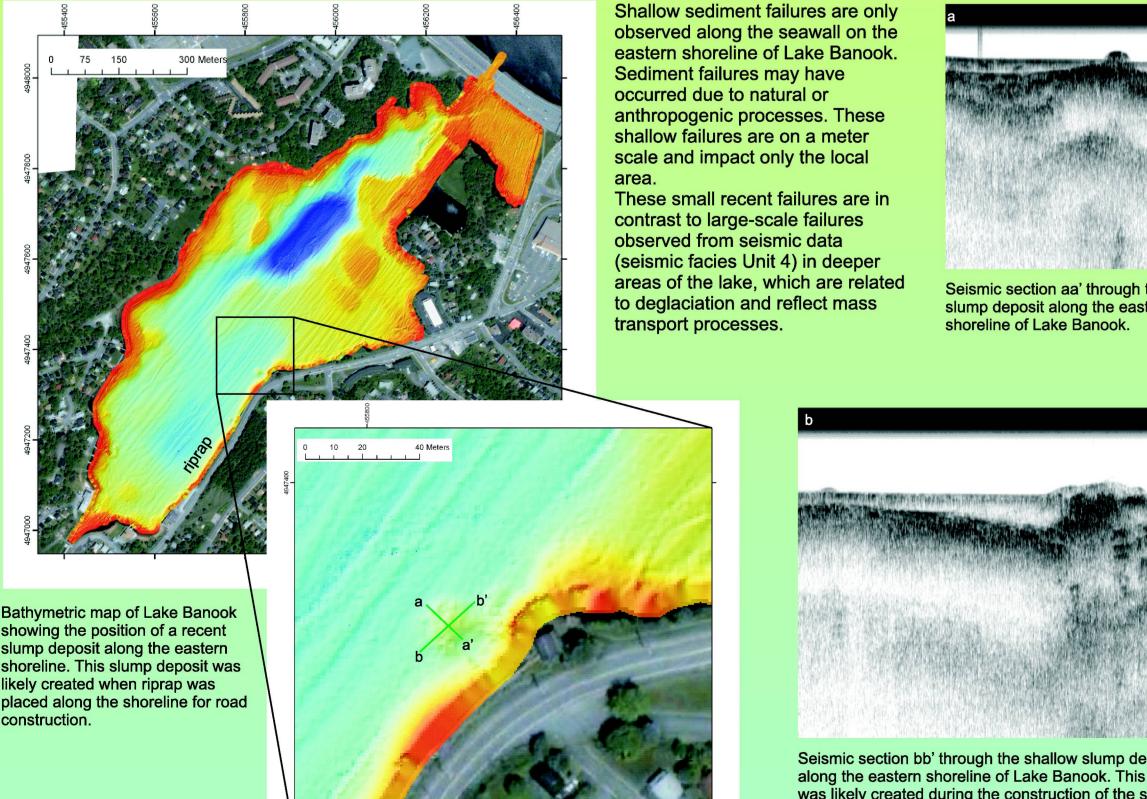






lap showing the distribution of freshwater mussels, grazing trails and microbiological matter including microbiological mats along the video transects in the lake. distribution, these patches give rise to the specks on the side

Sediment failures

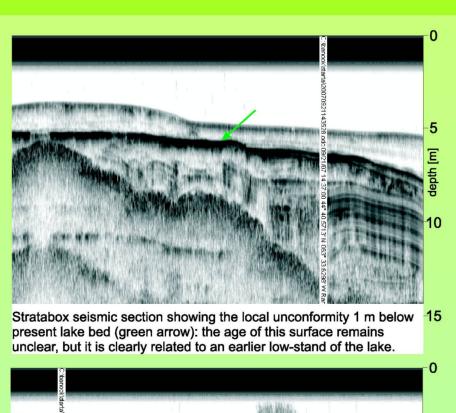


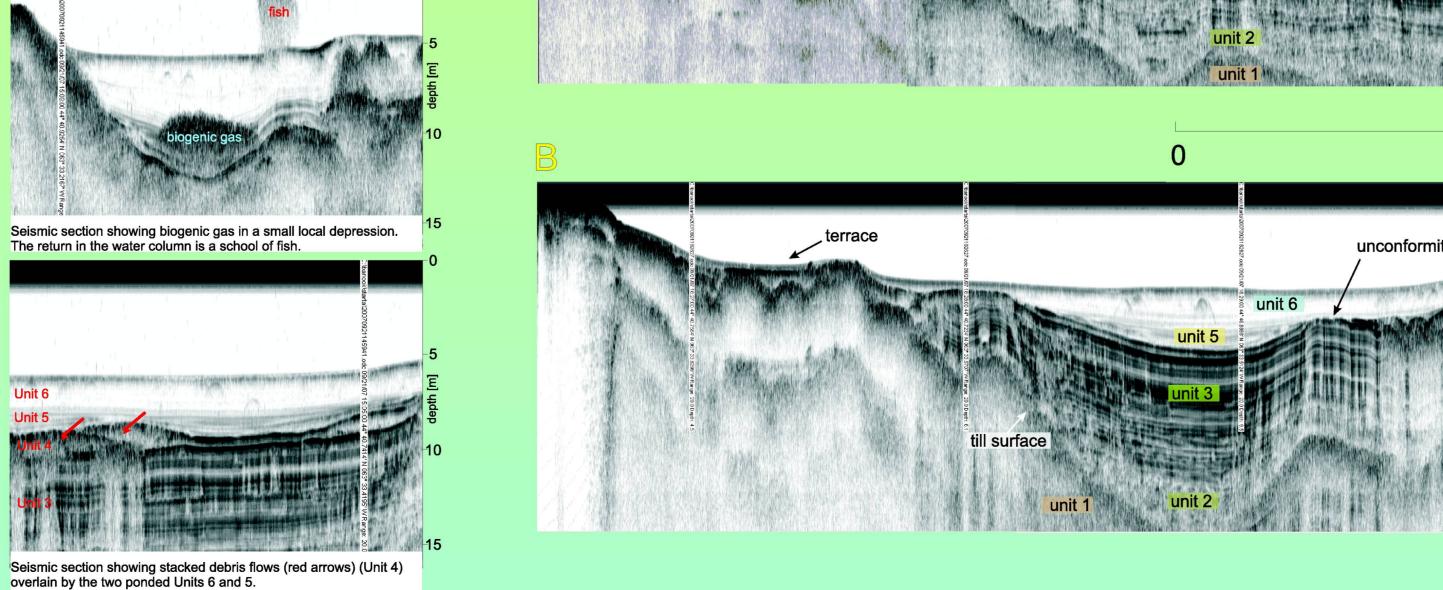
Boulders on the till a

exposed above the recent mudline, in an area with strong acoustic reflectivity

seismic character of the Penhorn Lake sequence, units 5 and 6 ir ake Banook may correlate to Late Glacial and Holocene ages the basal tills remains uncertain and further sampling will improve the understanding of deposition of the units in Lake Banook.

understanding of deposition of the units in Lake Barlook.		
stratigraphic unit	seismic character	interpretation
Unit 6	non stratified sequence	post-glacial gyttja mud?
Unit 5	weakly stratified, ponded	late glacial sediments?
Unit 4	local unconformity acoustically incoherent, local occurrence, lobate, erosional base	mass transport deposits? glacial or peri-glacial
Unit 3	strong coherent and rhythmic stratification, mimics till surface	glacio-lacustrine? sediments, possibly varves
Unit 2	poorly stratified, mimics till surface	Late glacial lacustrine or marine sediments
Unit 1	poorly stratified incoherent sequences reflecting acoustic basement	regional tills





Horizontal and vertical scales are identical on all profiles (see BB').



0 50 100 200 Meters

Huppertz, T. J., King, E. L., Peters, N. M. and Cameron, G. D. M. 2008: Geological Setting of Lake Banook - sedimentation and habitat in an urban lake, Geological Survey of Canada, Open File 5877. Land-photography from Google Maps.

Disclaimer: Open files are products that have not gone through the GSC formal publication process.

Much of the surveying, processing, interpretation, and presentation done for this project was, and will continue to be done on a volunteer basis, both on the part of the authors and those listed below. We

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