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Shoreline Stability: Impacts of Natural Processes and Human Activities, East Prince Edward Island

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Abstract

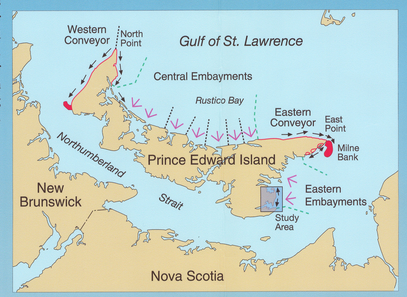
Dramatic coastal change may be triggered and produced by storms, but the change is often in response to longer term cumulative impacts of a variety of factors including: human activities, sediment abundance and changing environmental conditions. Such was the case along the Gaspereaux Shore of East PEI where commercial sediment extraction activities, and the construction of a jetty had immediate impacts on the stability of adjacent shores and longer term negative impacts on the stability of shores farther away. Wave attack on these weakened shores during recent storms has accelerated shoreline response such as landward migration and large scale adjustments in their plan form, e.g. breaking apart of Poverty Beach.

Study Area

Aerial view of the Gaspereaux Shore, East PEI. Poverty Beach has broken apart since 1955 because of natural processes and changes in human activities along shores farther north (Photo by Airscapes, Charlottetown , PEI).

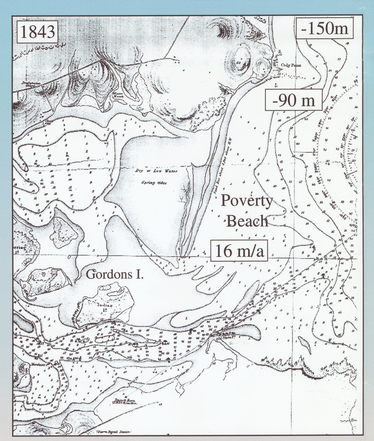
Natural Sediment Supply and Recycling

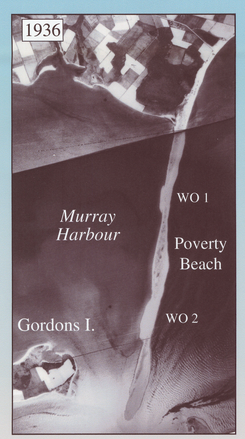
Sediment is necessary to build beaches and enable them to maintain their position against rising sea levels and changing environmental conditions. Temporary reserves of sediment for shorelines include: nearshore, beach and backshore deposits including dunes, and flood tidal deposits.



Although sediment can be supplied by recycling from other locations, e.g. offshore *"new"* sediment is only supplied if there is continued or accelerated erosion of bedrock and glacial deposits

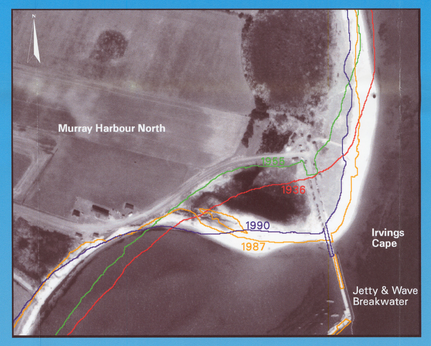
Location of study area (box) and coastline of PEI divided into natural sediment pathways (after Forbes and Manson, 2002). Along coastal conveyors sediment is transported alongshore (black arrows) to major deposition sites (red areas). Within embayments there is more of an onshore-transport of sediment (red arrows).





Natural processes re-cycle coastal sediment. At Poverty Beach shown in 1843 (Bayfield map, Courtesy of PEI Archives) and 1936 (air photo A5346-7,9) sediment was transported from shores farther north and offshore to supply sediment for the southward growth of Poverty Beach. Shoreline retreat of 90 to 150 m in the north produced 16m/a of growth in the south. Despite wave overwash (WO) at two locations on Poverty Beach in 1936, sediment supply was sufficient for natural beach recovery by the 1950s.

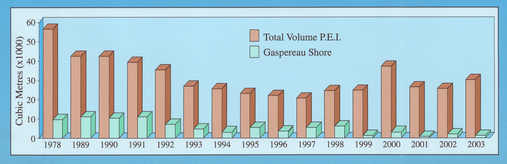
Sediment Diversion-Human Interference with Sediment Transport



Construction of structures in the coastal zone can upset the natural transport of sediment or redirect wave attack and cause changes to shores farther away.

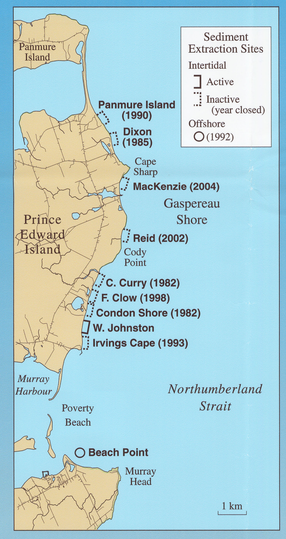
Shoreline positions (using hightide) from 1936, 1955, 1987 and 1990 are plotted on April 1968 air photo. Irvings Cape was naturally eroding between 1936 and 1955. Construction of a jetty and breakwater in 1954-55 and its extension in 1962 caused sediment accumulation on its northeast side where the shoreline migrated 130 m seaward. Shoreline retreat was observed farther south until the 1980s when the shoreline began to rebuild. The wharf was not used after early 1970s and partly removed in 1987 allowing the transfer of some sediment farther south.

Sediment Loss- Human Depletion of Sand Reserves

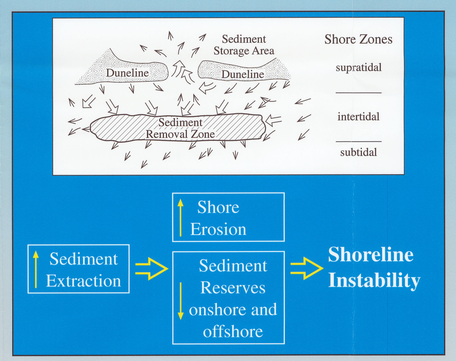


Sediment excavation was allowed (under permit) at select shores on Prince Edward Island because of a scarcity of aggregate on PEI for concrete manufacturing. Total volumes of sediment extracted each year are shown for PEI and the Gaspereaux Shore, East PEI. Volumes are derived from records kept by the PEI Department of Technology and Environment and Woodward-Clyde Consultants (1980).

Sediment is permanently removed from the coastal zone by excavation operations.

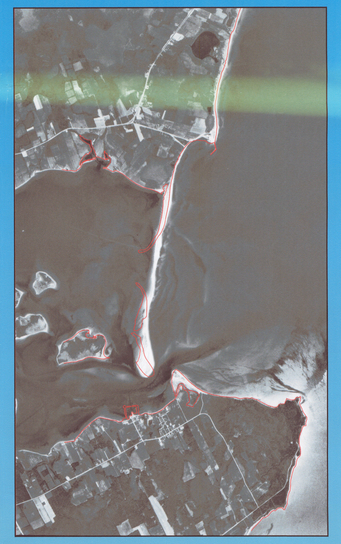


The number of commercial sediment extraction sites along the Gaspereaux Shore has varied since the 1980s. Removal of sediment accelerates natural shoreline adjustments and increases shoreline sensitivity to storms.

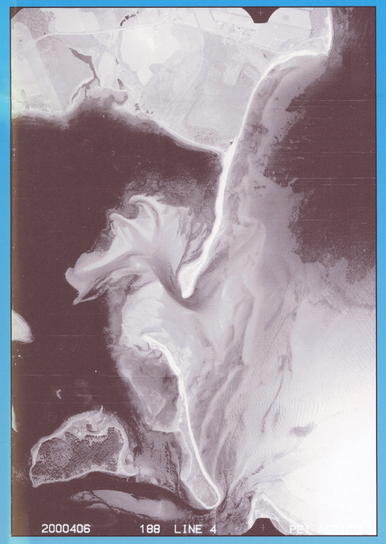


Sketch of the shore zones, showing the duneline where sediment is naturally stored and the beach where sediment is removed. Arrows (size relative to amount of sediment moved) show the redistribution of sediment. During storms, waves erode sediment from the upper beach and dunes; some is carried landward through gaps in the duneline, some alongshore, and the rest is moved downslope into the removal area and farther offshore. As the total volume of sediment extracted increases, sediment reserves onshore (dunes) and offshore (bars) become more depleted as they replenish the extracted material. The net result is increased shoreline instability.

Shoreline Response -To Changing Human Activities and Environmental Conditions



Rectified 1964 aerial photograph and digital 1985 shoreline (red line) showing physical changes to Poverty Beach and the shifting positions of inlets during the period when the jetty at Irvings Cape existed and beach sediment excavation was active north of Irvings Cape.



By 2000 much more sediment was being transported into the tidal inlet forming an extensive flood tide deposit which can become the foundation for a future beach. Some of the sediment was derived from Poverty Beach which left it vulnerable to future storms.

Aerial oblique photos of Poverty Beach taken June 14, 2001 showing further breaking apart (arrow) of its northern end in response to a decrease in sediment supply and impacts from storms in 2000 and 2001. Box shows the location of ground photo shown below.

Ground photo taken in July 1993 of a submerged tree stump illustrating the amount of shoreline retreat since the 1950s. A continued rise in sea level and possible future reduction in the protective role of sea ice in winter, will increase pressures on shorelines to respond and maintain their present position.

Conclusions

Shoreline changes can be the consequence of natural and human factors occurring both locally and farther away. Given predictions of an accelerated rise in sea level and possible future reduction in the protective role of sea ice in winter, vigilance of human activities will become more critical because of increased natural pressures on shorelines to respond and maintain their present position.

References

Forbes D.L. and Manson, G.K., 2002. Coastal Geology and Shore-zone Processes. In: Coastal Impacts of Climate Change and Sea-Level Rise on Prince Edward Island (Forbes, D.L. and Shaw, R.W. (editors) Geological Survey of Canada Open File 4261, Supporting Document 9, 85p (on CD- ROM).

Taylor, R.B. 2000. A reexamination of Beach Mining along the Gaspereaux Shore, Prince Edward Island; Report prepared for the Prince Edward Island Department of Technology and Environment, Geological Survey of Canada Open File Report 3864, 103p.

Woodward -Clyde Consultants 1980. Coastal Sand Resources, South and East Prince Edward Island; Unpub. Contract Report prepared for PEI Department of Environment, 189p.

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