

Application of the paleolimnological method in the environmental assessment of estuarine sediments in a pulp effluent receiving pond: an example from northern Nova Scotia, Canada

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Paleolimnological research at an effluent receiving pond in Pictou County, NS has focussed on understanding the spatiotemporal distribution of metals within pre- and post-disturbance sediments. The site was dammed in 1972, effectively converting an estuary into a shallow receiving pond (140 ha, 4 m max. depth). The sediment in the receiving pond reflects both estuarine and fresh water environments and can be broadly characterised as grey marine silt (~ 50% water content) which is sharply overlain by black, organic-rich sediment (~ 90% water content) that has been impacted by the effluent. To determine if contaminant overprinting has occurred, 18 cores of the grey sediment were analysed both at and below the contact for the distribution of As, Cd, Cr, Cu, Pb, Ti, Zn, Mo, and Ni. Total C, total N, $\delta^{13}\text{C}$, and $\delta^{15}\text{N}$ analyses provided clarity on organic matter composition. The samples were collected using a gravity corer, were analysed for metal concentrations using pXRF and ICP-MS techniques, and data was evaluated using R and plotted using QGIS.

Total C, N, and isotope analyses indicate a brackish to marine origin for the grey sediment. Concentrations of As, Cr, Cu, Zn, and Pb in the sediment at the receiving pond are similar to or slightly higher than at reference sites; at both sites concentrations meet or exceed Interim Sediment Quality Guidelines. There is little stratigraphic variability at each core site, indicating that overprinting of contaminants from the effluent-influenced sediment is unlikely. Considerable variation is evident spatially for all elements, though no distinct patterns were observed. These data demonstrate a geogenic source for many of the elements that have been attributed to the effluent. Our study shows that geogenic contributions must be accounted for when establishing remediation baseline conditions and assessing the effectiveness of site remediation.