A paleolimnological approach to understanding metal mobility and retention associated with salt-water inundation at Laytons Lake, Nova Scotia, Canada

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Sediments in wetlands and lakes have the potential to retain metals that have been mobilized by natural and anthropogenic disturbance. The role of variable water column chemistry and nutrient load on metal retention and mobility in wetland and lake sediments is not well understood. Laytons Lake is a coastal freshwater lake located in the Amherst Point Migratory Bird Sanctuary, a National Wildlife Conservation Area in Nova Scotia, and experienced a series of marine inundations from the Bay of Fundy in the 1940s. In the late 1970s, researchers identified that the lake was density stratified and incompletely mixed (meromictic) resulting in a strong chemocline, and elevated conductivity levels within 3 m of lake bottom sediments. Thus, a detailed paleolimnological assessment was undertaken in 2017 to investigate the geochemical impact of lake bottom sediment geochemistry on meromixis, and the rate of transition from a meromictic to an intermixing state. A geochemical analysis of lake bottom sediments was accomplished using pXRF to measure elemental proxies, and to measure total C, N and stable isotopes ($\delta^{15}N$, and $\delta^{13}C$). A total Pb curve was used to temporally date the sediment core.

Our results indicate a considerable but short-lived (~10 year) response in lake bottom sediment geochemistry to marine inundation events, and that the lake is no longer saline and mixes. Proxies of environmental stability (Ti, K) decreased likely as a result of an increase in autochthonous productivity associated with the marine inundation and a subsequent die-off of freshwater species; a sharp decline in As may be associated with this process. Cu values remained static suggesting that this marine toxicant may not be strongly influenced by changing salinity. Redox sensitive proxies (Fe, Mn) indicate that strongly reducing conditions were established after inundation and recovered slowly to baseline levels prior to the marine inundations until ~1990. The geochemical record indicates that there has been significant variability in the geochemistry of bottom sediments at Laytons Lake from 1990 to present. Collectively our data provides a framework for predicting the impacts of marine inundation on freshwater wetlands, a process that may result when creating freshwater wetlands on coastal farmland, or from marine inundation associated with rising sea levels.

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