Contaminant export through estuaries: Mercury behaviour in Hudson Bay

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➤ A broad survey of total mercury (HgT) in rivers, seawater and sediments provided information to construct a mass balance of mercury fluxes in Hudson Bay and to model chronologies of mercury deposition to the marine sediments.

➤ HgT was measured in 9 rivers and 6 estuaries of Hudson Bay during short surveys conducted between 2005 and 2007 (Figure 1). These rivers drained watersheds that represent all terrestrial ecozones of the Hudson Bay coast and account for ~26% of the freshwater delivered to Hudson Bay by rivers annually.

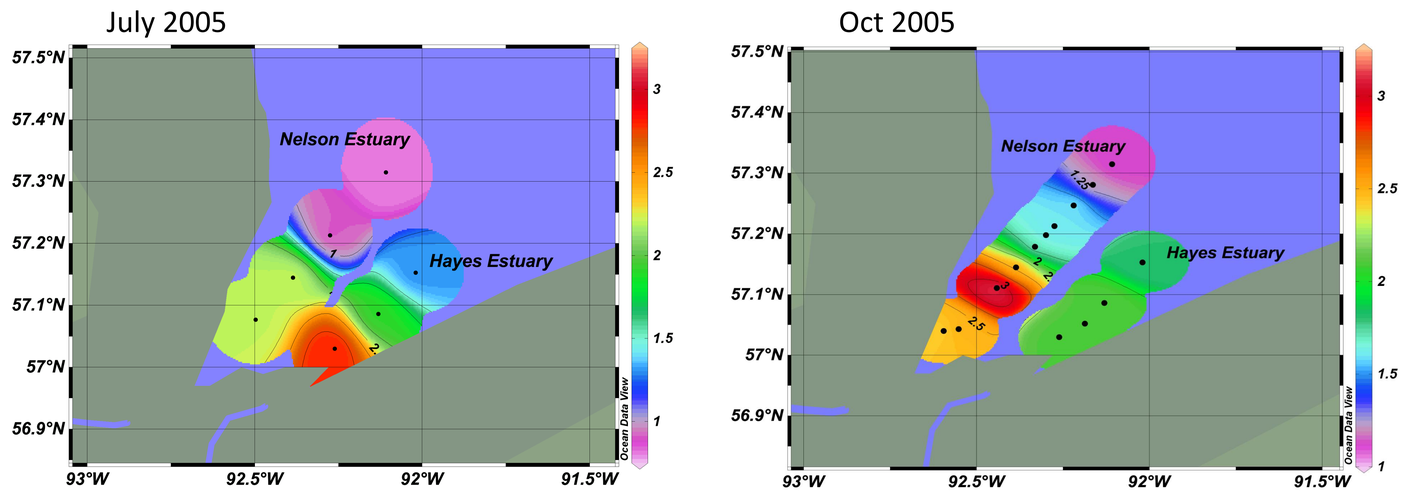


Figure 1. Example of estuary surveys performed in Hudson Bay, 2005 to 2007: Surface water HgT concentrations (ng/L) in the Nelson and Hayes River estuaries. Samples were collected at 0.5 m depth and processed as outlined by Hare et al. (2008).

➤ A limited assessment of HgT concentrations during transport through the estuaries suggests that estuarine sediments are not currently a significant source of HgT to the offshore waters of Hudson Bay, nor is sedimentation in the estuaries a significant removal process of HgT (Figures 2 and 3). Rather, riverine HgT concentrations are conservatively diluted by seawater and exported to the interior waters of the bay.

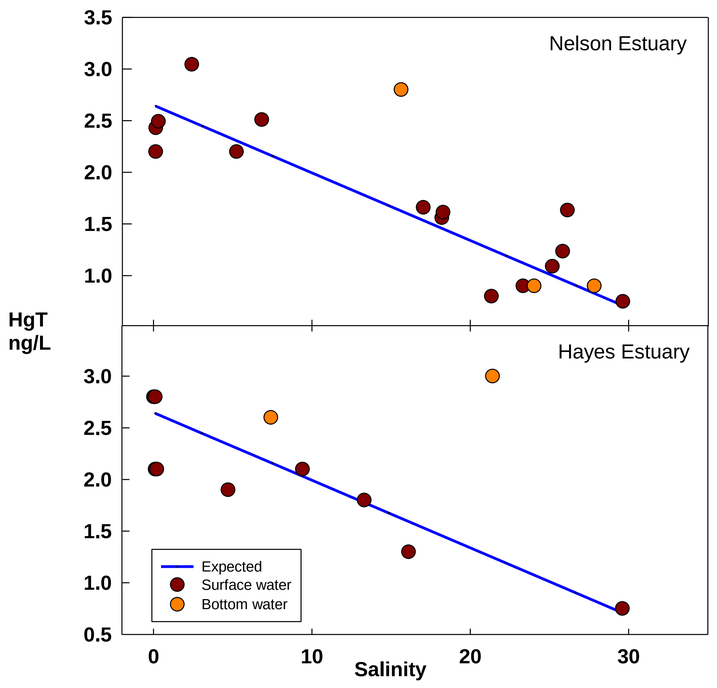


Figure 2. HgT concentrations relative to salinity in surface and bottom water of the Nelson and Hayes River estuaries. Multiple sampling surveys are grouped together for each estuary. The blue line represents conservative mixing relative to salinity. For each point, n = 2 or more replicates.

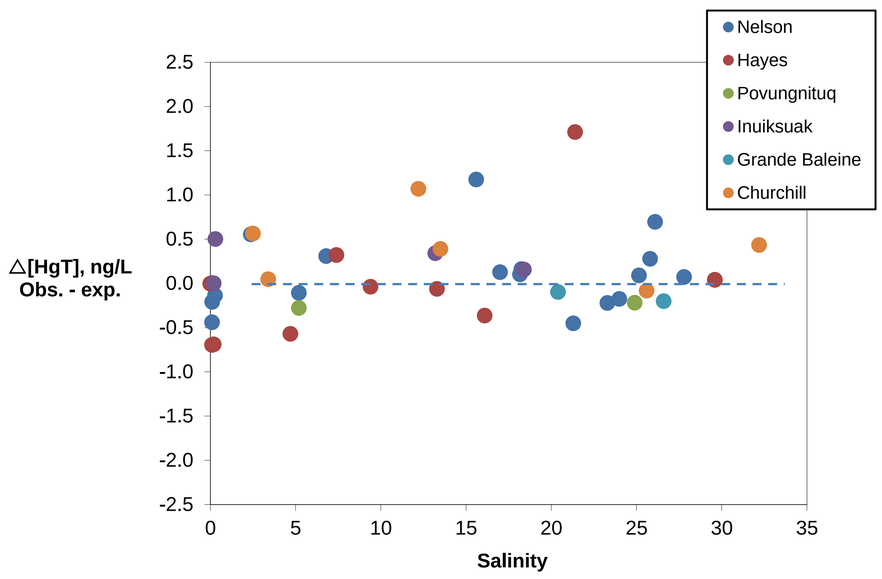


Figure 3. Difference between observed and expected HgT concentrations in all river estuaries sampled between 2005 and 2007 in Hudson Bay. Expected HgT concentrations for all rivers are based on separate expected conservative dilution lines for each location using river and ocean end-member HgT concentrations from Hare et al. 2008.

➤ Cumulatively, rivers deliver 1.9 tonnes per year of mercury to Hudson Bay water, assuming estuaries in Hudson Bay do not modify river fluxes (Figure 4). This amount is similar to that delivered by the atmosphere (1.5 t/yr) and resuspended from coastal sediments (1.7 t/yr) (Hare et al. 2008).

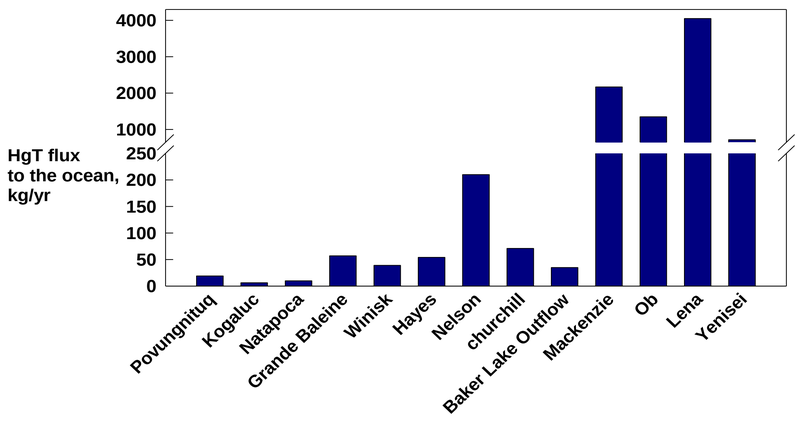


Figure 4. Total annual HgT flux from selected Arctic and Sub-Arctic rivers. Data from Hare et al. 2008, Leitch et al. 2007, and Coquery et al. 2005.

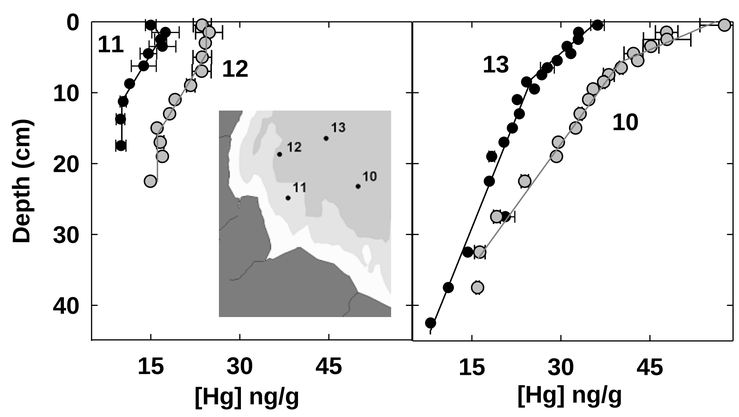
➤ Examination of offshore sediments suggests that higher contemporary river fluxes of mercury contribute to surface enrichments in sediment mercury concentrations relative to the pre-industrial era in several locations, particularly in the nearshore regions of the bay [note that river fluxes include atmospheric inputs to their watersheds] (Figure 5). In the offshore region, surface enrichments do not appear as strongly influenced by higher contemporary river fluxes (Hare et al. 2010).

➤ **Key questions remaining:**

1) Why are the Hudson Bay estuaries not acting as sinks for riverine Hg?

2) How do estuaries affect the production and removal of methylmercury, the most relevant chemical species of mercury in biological studies, in the bay?

3) How do changes in river discharge affect the amount of Hg and MeHg released into Hudson Bay?



Core	Modeled year of increasing [HgT]	Modeled year of stabilized or decreasing [HgT]
11	-	1990
12	1900	1975
10	Centuries ago	-
13	Centuries ago	-

Figure 5. Modeled, observed, and chronological HgT deposition in Hudson Bay sediments. Top panels: Modeled (lines) and observed (circles) HgT in selected sediment cores from Hudson Bay. Inset panel: Location of the sediment cores is indicated by the corresponding number on the map. The largest notch in the coastline is the Nelson estuary. Bottom panel: Modeled chronologies of HgT deposition in Hudson Bay. See Hare et al. (2010) for full details.

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Coquery et al. (1995) Water Air soil Pollut, 80:653-664