Mercury bioaccumulation in estuarine food webs with different nitrogen loads

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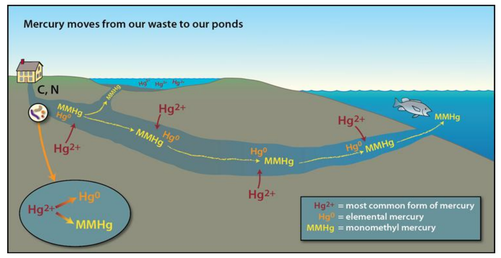
Background

- Coastal eutrophication common in estuaries worldwide
- Hg contamination in aquatic food webs also a concern
- Hg measurements in Cape Cod groundwater suggest septic-derived eutrophication increases bioavailability of Hg in groundwater



Source: (Illustration by Jack Cook, Woods Hole Oceanographic Institution) http://www.whoi.edu/news-release/wastewater-mercury

Hypothesis

- Observed increase in bioavailable Hg in groundwater with N-loading will translate to increased Hg in estuarine food webs

Approach

- Sample sentinel species in 4 adjacent estuaries with different N-loads
- Measure total Hg + $\delta^{13}C$ and $\delta^{15}N$ stable isotope values

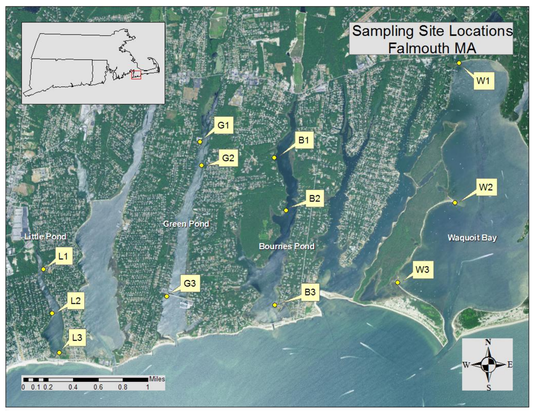
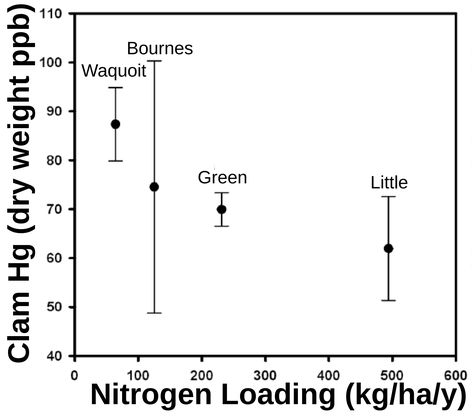
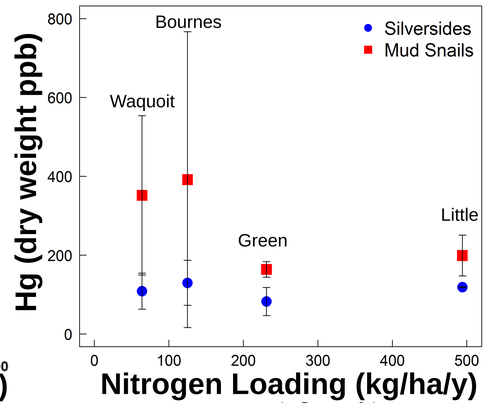


Table 1. Annual nitrogen (N) and wastewater (WW) loads, normalized by watershed area, and the resulting percent contribution of wastewater to total estimated N load. Wastewater values include inputs from septic systems and wastewater treatment facilities (Stearns & Wheler 2007).

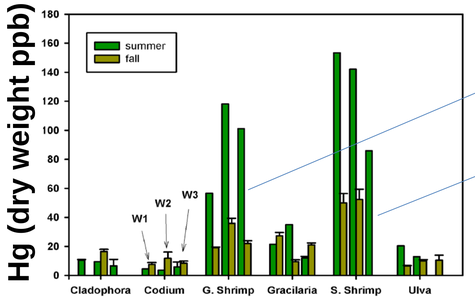
Estuary	Watershed area (ha)	N (kg/ha/yr)	WW (kg/ha/yr)	WW (%)
Waquoit Bay	374	64	37	57
Bournes Pond	60	125	93	75
Green Pond	52	231	173	75
Little Pond	18	494	406	82

Preliminary Results

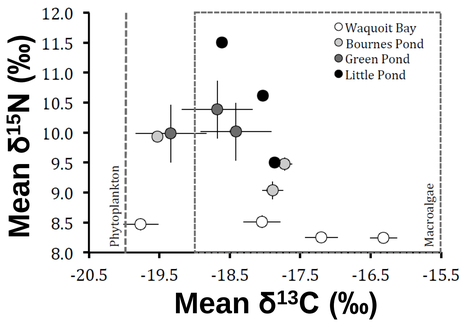




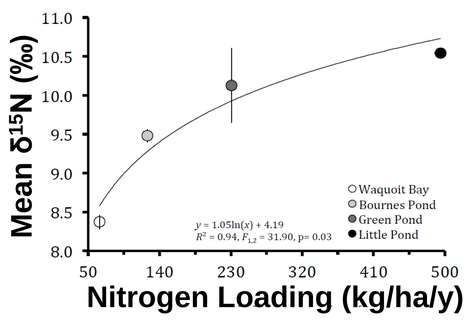
- Quahog muscle Hg actually lower in estuaries with higher N-loads
- Mud snail Hg also lower in more eutrophic systems
- Silverside (pelagic sentinel species) Hg consistent among sites
- Mud snail (presumed benthic) Hg > silverside (presumed pelagic)



Repeated fall sampling in Waquoit Bay showed shrimp Hg seasonal decline



- Clam shell $\delta^{13}C$ values vary within and among sites and show macroalgal influence at each site regardless of Hg or N load



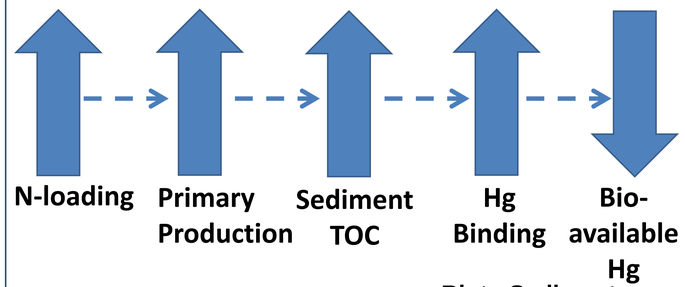
- Clam shell $\delta^{15}N$ values, indicative of higher WW contribution, were higher at higher N load sites, where Hg was lower

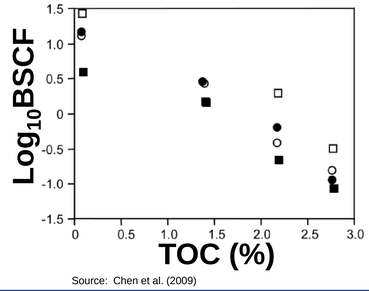
Discussion

- Higher Hg observed in benthic sentinel species from estuaries with lower N-loading counters our hypothesized relationship between Hg and N

Alternative Hypothesis

- N-loading reduces bioavailable Hg (Driscoll et al. 2012)





Source: Chen et al. (2009)

- Biota-Sediment Concentration Factor ($Hg_{Biota}/Hg_{Sediment}$) decreased with increasing sediment total organic carbon (TOC) in other northeast estuaries (Chen et al. 2009)

Potential trophic factors need further analysis:

- Clam Isotopic Variability
- Mud Snail Individual Hg Variability
- Shrimp Seasonal Hg Shifts

Next Steps

- Complete Hg analyses of sentinel species
- Measure $\delta^{13}C$ and $\delta^{15}N$ to relate sentinel Hg to TP, energy source (benthic vs pelagic)
- Measure shell Hg for comparison with shell $\delta^{15}N$

References

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Acknowledgements

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