**Response of Mercury Species to Long-term Fertilization in a NE Salt Marsh**

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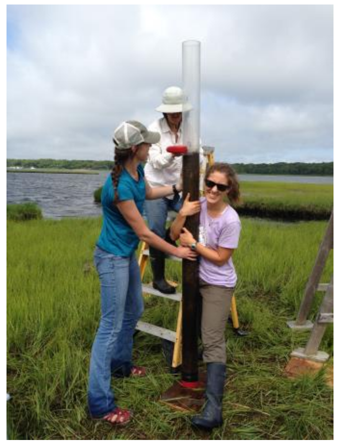

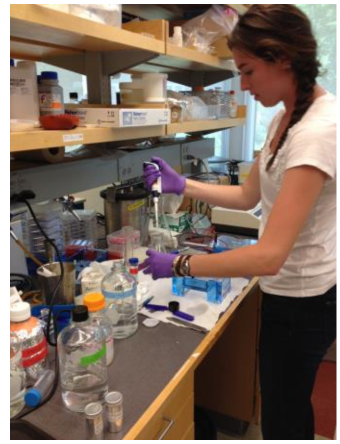

Coastal marine ecosystems are under a variety of threats. Diking, dredging, damming and invasive species are easily recognized and now well documented in the U.S. and around the world. But there are threats that are more subtle while no less concerning to the long-term health and sustainability of coastal habitats. Two of these are eutrophication and mercury. Eutrophication, the release of too many fertilizing nutrients to water bodies, can alter the delicate network of microbes, plants and animals that occurs naturally by stimulating the growth of some members of the network at the expense of others. This disruption of normal ecological connections can lead to many unfortunate consequences such as the loss of seagrass from coastal embayments, displacement of important commercial shellfishing beds, blooms of noxious algae and erosion of salt marshes, to name just a few.

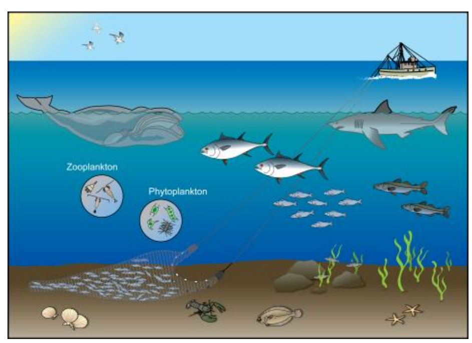


Figure 1: Illustrating the food chain beginning with phytoplankton and ending with top consumers such as tuna and whales. Mercury can biomagnify in these systems an ultimately become a threat to humans consuming certain seafood products.

On Cape Cod and elsewhere, the source of nutrients that drives the eutrophication is often human waste that escapes the relatively ineffective treatment offered by backyard septic systems. Our earlier work suggested that during the journey of this waste through groundwater to the ocean, an alarming amount of mercury, a toxic metal, can also be liberated from sandy soils. Once in the ocean, the mercury can be transformed into other chemical forms by bacteria, such as monomethylmercury, which are prone to accumulate initially in plankton but then ultimately in fish (Figure 1). With each step in the coastal food chain, the concentration of mercury in fish then increases exponentially until reaching levels that pose a health threat to pregnant women and children as well as potentially to the fish themselves and wildlife that depend on them. Thus, through the release of wastewater into watersheds, we have linked two alarming threats to the health and sustainability of the coastal environment: nutrients and mercury.

The precise nature of this linkage is unknown, but has been theorized to have suppressive effect on the danger associated with mercury; it is possible that while more mercury now enters coastal systems with nutrients, it is not as readily transformed into the most worrisome monomethylmercury form (Figure 2). We are fortunate to have in our "backyard" an ideal natural laboratory to examine the effect of releasing increased amounts of both nutrients and mercury to the coastal environment at the same time in the form of a long-term fertilization experiment being conducted in Great Sippewissett Marsh. Experimental plots in Great Sippewissett Marsh have been undergoing fertilization through the application of commercially available, sewage sludge-based fertilizer for over forty years. This material, while delivering nutrients like nitrogen to the marsh, supplies elevated amounts of mercury and other metals as well. This experiment provides a unique opportunity to test hypotheses regarding the mercury-related response of coastal marine ecosystems to eutrophication as well as assess the efficacy of salt marshes to act as sinks for increased loadings of mercury to the coastal zone. Our current work, supported by the Rinehart Coastal Research Fund, has found mercury inventories in the salt marsh sediments that were essentially equivalent to, or greater than, the inadvertent loadings from fertilizer in the treatment plots and from the atmosphere in the control plots. However, the distribution of mercury in the fertilized plots appears to be shifted relative to our reconstructed history of loadings, implying some level of mercury mobility. The abundance of monomethylmercury within the plots varied dramatically with the amount of fertilizer applied as well as sediment total sulfur, with higher percentages of mercury as monomethylmercury and amounts of sulfur in the control plots, and lowest percent methylmercury and sulfur in the most fertilized plots. Thus, from our observations, it would appear that New England salt marshes possess a strong ability to retain increased mercury loadings and that this ability is resistant to degradation by low- to moderate-level eutrophication. Finally, the prediction that eutrophication leads indirectly to less methylmercury production appears borne out in this particular ecosystem.

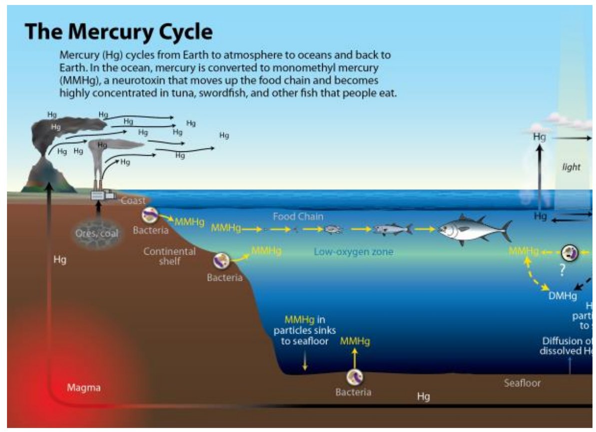

Figure 2: Illustrating the mercury cycle.

In a second, still on-going component of our research, we are examining the microbiological changes that have occurred in the experimental plots of Great

Sippewissett Marsh in an effort to understand why, exactly, eutrophication resulted in less methylmercury production. There known microbial genes, *merA* and *hgcAB* that are involved in the transformations of mercury from one form to another, including into methylated mercury, and we are examining the sediments from the plots for the abundance and diversity of these genes. Preliminary results have confirmed that dramatic changes occur in the sediment with respect to gene abundance as well as the members of the microbial community that possess those genes with increasing amounts of fertilizer. At this stage, it is not yet possible to determine whether these changes are co-incident with, or responsible for the diminished production of monomethylmercury in the fertilized marsh plots, but our work continues.

As a result of this work, we are cautiously optimistic about the resiliency of New England salt marshes to the threat posed by increased mercury loadings accompanied by increased eutrophication. But these results urge caution for the future, for if our well intended efforts to lower nutrient impacts on the coastal zone move forward, there may be a time when salt marshes and other coastal ecosystems become better at methylating the mercury load they have received from wastewater than they currently do. Thus, during the process of oligotrophication, or the rolling back of human impacts, we must be prepared for a period of potential increases in the amount of mercury in fish before systems return to a hoped for overall lower level of burden of this toxic metal. This finding underscores conventional wisdom that salt marshes are important ecosystems to preserve and restore.