

Final Report Summary

Since the Clean Water Act was passed in the 1970s, billions of dollars have been spent to decrease the input of toxic contaminants to coastal waters. In spite of this enormous effort, recent research has shown that levels of toxic trace metals in the coastal ocean have not always decreased. In major urban estuaries such as the Long Island Sound (LIS), the effect of these toxic metals may have significant impacts on the ecological and economic health of the system. For example, preliminary evidence suggests that diseased lobster in the LIS may be suffering to some degree from copper toxicity. Because of this, it is absolutely imperative that research efforts be directed toward understanding of how biogeochemical cycles are regulating toxic metal presence and mobility in coastal waters. Furthermore, it is well established that simply knowing the total amount of dissolved metals in the water is not sufficient to understand how toxic the metal may be to organisms. Instead, it is necessary to separate the individual total dissolved metal pools into different forms, or "species". Because of the evidence of its toxicity in LIS lobsters, we focused our study on dissolved copper. During two research cruises in spring and summer 2005, we measured the levels of total dissolved copper throughout surface and bottom water of the Sound. We also isolated the labile, presumably toxic, copper fraction from the total dissolved pool. In addition, we examined the non-toxic copper species which are complexed with dissolved organic matter.

Our results showed significant amounts of labile copper throughout the Long Island Sound, with the highest levels in the western Sound near New York City. This was the same pattern we found for total dissolved copper. During the spring season, "toxic" copper was higher in surface waters and was probably delivered during these high-flow conditions by river runoff and sewage. In both seasons, there was evidence that microscopic algae in the surface waters were producing organic compounds to complex the dissolved copper, thereby making it less toxic. In the summer, bottom waters of the western LIS were characterized by poor water quality, very warm and depleted of oxygen. In these deep waters, "toxic" copper was greatly elevated relative to the spring season and other places within the LIS. The data showed that poor water quality resulted in increased levels of toxic copper species. The greatest influencing factor was temperature; as water temperature reached a threshold greater than about 20°C, "toxic" (labile) copper concentrations increased very rapidly. Analyses of other chemical constituents suggested that the source of this "toxic" copper was the sediments.

Most toxic metals tend to attach strongly to the surfaces of particles, which then sink and are accumulated in the sediments. Because these sediments accumulate slowly, a century or more of metal pollution in coastal waters can be preserved in very shallow sediment deposits. Decreasing oxygen and increasing temperature can release these metals back to the water column. We believe our data indicate that these metals are released in a potentially toxic form, making this process very important for biological organisms. In the Long Island Sound, bottom water temperatures are increasing each year; this means that the influence of toxic trace metals in the Sound will probably become more important in the future. There is an urgent need for future research to examine this phenomenon in greater detail; if we can understand how it happens, we may have hope of mitigating it in the future. Certainly, for industries such as the lobster fishery in the LIS, the socioeconomic consequences of such research are enormous.