Mercury in South River Surface Coatings (Periphyton)

Michael C Newman
College of William and Mary
Virginia Institute of Marine Science
Gloucester Point, VA

Overview

Two surveys were completed of surface coatings in order to define the spatial distribution of mercury concentration in this key ecosystem component. Surface coatings include periphyton, a major component of the trophic web of many rivers such as South River. Sediment fines and metal oxides can be major components of these surface coatings: both fines and oxides are avid concentrators of mercury. Peripyton can also facilitate conversion of inorganic mercury to the more readily available methylmercury. Scrapers and grazers can then take in mercury from these materials, establishing a major pathway for mercury into the benthos-dependent food web.

Intent

Despite the potential for substantial accumulation and trophic transfer of mercury via surface coatings, there is very little information about the concentrations and spatial distribution of mercury in these materials in the vicinity of the historical mercury source. This survey defines the mercury and methylmercury concentrations in surface coatings of this region, and explores covariates that influence mercury concentrations in surface coatings. Because mercury in surface coatings at least partially determines mercury concentrations in the trophic web at any river region, information was also collected to begin to quantify the trophic transfer of mercury in the river near the historical release.

Surveys

A survey of natural surface coatings was done in June 2005 to define the spatial distribution of mercury in the river, and to assess the correlations between these mercury concentrations and covariates (distance from historical source, organic carbon content, iron concentration, and manganese concentration). Samples were also taken for $\ast\ ^{15}N$ in anticipation of using this metric of trophic position to build quantitative models of mercury biomagnification by invertebrates, fish, and birds in the region. Preliminary samples were taken of scrapers for mercury and $\ast\ ^{15}N$ analysis. Materials were collected for SEM/EDAX analysis to generally visualize and characterize the materials making up the coatings.

A second survey was requested for July 2005 to assess the concentrations of methylmercury in these surface coatings. Triplicate samples were taken at five locations within the region surveyed in June 2005. Total mercury, methylmercury, iron, manganese, organic carbon, and $\ast\ ^{15}N$ were quantified in these samples. To facilitate possible flux modeling in the future, samples were taken in such a manner during this survey that amounts of mercury could also be expressed in units of surface area of hard substrate.

Preliminary Results

More than 40 samples were taken between North Oak Lane and Dooms Crossing Rd. during the June 2005 survey. SEM/EDAX confirmed that these materials were a complex and variable mixture of sediment fines and microflora. Total mercury concentrations varied from an average of 0.057 :g/g dry wt above the historical source to an average of 7.85 :g/g dry wt at the river stretch just upstream of Dooms Crossing Rd. The 15 samples taken in July 2005 also varied in this general range but concentrations at Dooms Crossing Rd were higher (average 23.40 :g/g dry wt). River km was the dominant factor determining mercury concentration. Concentrations at all regions sampled below the historical source were higher than those from the reference region above the historical source. Relative to river km, organic carbon content, iron concentration, and manganese concentration appeared to have modest influence on mercury concentrations.

Average methylmercury concentrations ranged from approximately 1 ng/g dry wt above the historical source to a high of approximately 50 ng/g dry wt at Dooms Crossing Rd. Methylmercury was correlated strongly with river km and total mercury, and moderately with $\delta^{15}N$ and organic carbon content.

Samples of scrapers (snails) were taken for preliminary mercury and $\delta^{15}N$ analyses. More invertebrate species will be collected and analyzed in preparation for studies of trophic transfer of mercury next year. Fish samples from the most recent extensive survey will also be used next year. Discussions with Dan Cristol suggest that birds and their prey species should also be included.

Future Studies

The original study outlined three stages. The mercury concentrations, mercury spatial distribution, and covariates affecting mercury in surface coatings were defined in the first year. The nature of the materials was also to be examined by SEM/EDAX. Preliminary numbers for mercury concentrations and trophic position ($\delta^{15}N$) were to be generated in preparation for the next year/stage. Although scheduled for year 2, methylmercury was also determined in surface coatings during the first year.

During the second year/stage, work will expand upward into the trophic web with the intent of building models of mercury biomagnification. Samples of invertebrates, specific fish species, and birds will be used to build quantitative models of mercury concentration based on trophic position ($\delta^{15}N$). This will allow general description and prediction of biomagnification within selected regions below the historical source. In so doing, target concentrations in sources such as surface coatings can be set based on desired/acceptable fish tissue concentrations. Fish samples from the latest survey will be analyzed for $\delta^{15}N$ and these $\delta^{15}N$ values used with measured mercury concentrations in each sampled fish to generate a trophic transfer model. Invertebrate samples will be collected and used similarly to connect mercury concentrations at lower trophic positions with those of the fishes. Optimally, the same would be done for birds collected in the current avian project of D. Cristol.