Mercury Cycling in Stream Ecosystems

Three related U.S. Geological Survey (USGS) articles on mercury transport, biogeochemical processes, and bioaccumulation in stream ecosystems have been published in Environmental Science & Technology (ES&T). The papers were published electronically on the March 11, 2009 in the "Just Published (ASAP)" web version of ES&T, and will be published in final form in the April 15, 2009 print issue.

An ES&T news story (http://pubs.acs.org/doi/full/10.1021/es9005916) highlights selected findings from these papers.

The USGS studied eight streams in Oregon, Wisconsin, and Florida during 2002-2006. Streams in urban areas (near Portland, Oregon; Milwaukee, Wisconsin; and Orlando, Florida), and streams in relatively undeveloped areas in these states were included in the study. The streams span a range of environmental settings and watershed characteristics that can affect biogeochemistry and bioaccumulation of mercury in streams, including precipitation, mercury deposition rates, degree of urbanization, and wetland abundance. Findings from these studies can help decision makers to better anticipate concentrations of mercury and methylmercury in unstudied streams in comparable environmental settings.

Although all eight streams receive mercury predominantly via atmospheric deposition, watershed characteristics primarily determine mercury transport and bioaccumulation in these streams. Key factors include (1) the abundance of wetlands, which influence how much of the atmospherically deposited mercury is converted to methylmercury (the most toxic, bioaccumulative form of mercury); and (2) runoff of dissolved organic carbon and suspended sediment, which control how much mercury and methylmercury is delivered to the streams.

Findings show that the relative amount of methylmercury in streams is strongly correlated with streamflow and the production of methylmercury in the watersheds (particularly in wetland areas), which is subsequently transported in runoff to streams. An unexpected finding was that methylmercury production in channel sediments appears to be relatively unimportant for governing within-stream methylmercury levels.

Large differences in total mercury and methylmercury were observed in the eight streams, varying by as much as 9-fold. Nationally, atmospheric inputs (or "mass per unit area" of watershed) of mercury vary only about 4-fold. Findings show, therefore, that some stream ecosystems are more sensitive to atmospheric deposition of mercury than others.

Once methylmercury enters streams, it is available for uptake at the base of the food web (algae and periphyton). Concentrations of methylmercury in invertebrates and fish (forage and predator) were strongly and positively correlated with concentrations of filtered total mercury and methylmercury in stream water, as well as concentrations of dissolved organic carbon and the extent of wetlands within a watershed.

Methylmercury concentrations increase with each trophic level in the food chain. Findings suggest that mercury contamination in top predator fish in the studied streams likely is dominated by the amount of methylmercury available for uptake at the base of the food web, rather than by differences in the trophic position of top predator fish. Increases within the food chain appear to be similar in magnitude among areas and sites.

Publications and data from this study can be accessed electronically at http://water.usgs.gov/nawqa/mercury/pubs/. For questions on individual papers, please contact the authors: Mark Brigham (mbrigham@usgs.gov, 763-783-3274), Mark Marvin-DiPasquale (mmarvin@usgs.gov, 650-329-4442), and Lia Chasar (lchasar@usgs.gov, 850-553-3649).