Mercury in water and biota from Great Salt Lake: Reconnaissance-phase results

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Despite the ecologic and economic significance of Great Salt Lake (GSL), little is known about the concentration and biogeochemical cycling of mercury (Hg). Previous work (Tayler and others, 1980) suggests that GSL is a "*natural disposal system*" with respect to anthropogenic trace-element inputs. Although Hg has been a known environmental pollutant for several decades, its presence in freshwater and marine environments continues to generate concerns related to biological exposure (King and others, 2000). Like many environmental contaminants, Hg bioaccumulates in organisms. The lipophilic or "fat loving" nature of methylmercury (CH_3Hg) makes it much more toxic to organisms than inorganic forms of Hg.

The chemical and physical conditions present in GSL may be ideal for high rates of Hg methylation. Previous work has shown that marine sediments rich in organic matter and dissolved sulfide have rapid CH_3Hg production rates in conjunction with rapid rates of sulfate reduction (King and others, 2000). Sulfate reduction rates measured in water from GSL were higher than 6,000 nanomoles per cubic centimeter per day, one of the highest rates reported in a natural environment (Ingvorsen and Brandt, 2002). In laboratory

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experiments, King and others (2000) determined that sulfate reducing bacteria capable of acetate utilization in their metabolic pathways will methylate Hg the most efficiently. Acetate-utilizing bacteria (*Desulfobacter halotolerans* and *Desulfocella halophila*) capable of high Hg methylation rates have been isolated from sediments in the south arm of GSL (Ingvorsen and Brandt, 2002).

Atmospheric deposition is one of the major sources of Hg to aquatic environments (Krabbenhoft and Rickert, 1995). On the basis of statistics published in 1997, numerous local point sources for atmospheric Hg deposition to GSL exist. The large surface area (about 4,400 square kilometers) to depth (0 to 9 meters) ratio of GSL, coupled with high rates of sulfate reduction, no outflow, extensive boundary wetlands (162,000 hectares), and a location adjacent to numerous Hg sources, may make this ecosystem more susceptible to retention of Hg inputs and Hg methylation than other aquatic systems.

As part of an ongoing research program on GSL, the U.S. Geological Survey (USGS), Utah Science Center, initiated a reconnaissance survey in 2003 to determine Hg concentrations in water samples collected from the lake. During August 2003, eight unfiltered water samples were collected from the south part of GSL and Farmington Bay. Samples were analyzed for total Hg and CH_3Hg concentrations by the USGS Mercury Research Laboratory in Middleton, Wisconsin. Initial results indicate high levels of total Hg (exceeding 45 nanograms per liter (ng/L)) and CH_3Hg (exceeding 25 ng/L) in selected anoxic regions of the lake where high rates of bacterially mediated sulfate reduction have been documented. The concentration of CH_3Hg measured in GSL is

among the highest ever measured in surface water by the USGS Mercury Laboratory. For comparison, CH_3Hg in whole water samples collected from Maryland reservoirs ranged from 0.007 to 0.493 ng/L (Mason and Sveinsdottir, 2003).

In addition to the water sampling, the U.S. Fish and Wildlife Service (USFWS) conducted a series of reconnaissance-phase assessments of potential contaminants, including Hg, to biota in GSL. The dry weight (dw) Hg concentration in both brine shrimp and eared grebe (*Podiceps nigricollis*) liver samples was determined intermittently from 1994 through 2000 in the south arm of GSL.

The migration and molting habits of eared grebes make them an ideal population for the reconnaissance evaluation of Hg bioaccumulation. A large population of eared grebes (1.5 million in 1997) from throughout North America use GSL during the molt migration beginning in August and continuing through December and January (Aldrich and Paul, 2002). A small population of eared grebes also breeds and nests in the GSL system; subsequently, there is a grebe population in all seasons except mid-winter. During the molt migration, grebes feed almost exclusively on brine shrimp; therefore, seasonal changes in the Hg concentration in brine shrimp and eared grebe livers from GSL were monitored to evaluate Hg bioaccumulation pathways.

The seasonal changes in Hg concentration in eared grebe livers indicate bioaccumulation during the fall molting period when the grebes feed exclusively on brine shrimp. The Hg concentration in 28 brine shrimp samples collected during the spring is less than the

analytical reporting limit of 0.2 parts per million (ppm, dw). Brine shrimp samples collected during the summer and fall have a higher Hg concentration (median concentration = 0.34 ppm dw), with 51 of 52 samples exceeding the average Hg concentration in shrimp of 0.16 ppm dw (U.S. Environmental Protection Agency, 1997; converted from wet-weight data using 25-percent moisture). The median Hg concentration in eared grebe livers increases from 6.4 ppm dw in samples collected during the September early molt period, to more than 17 ppm dw in samples collected during December near the end of the molting period.

In summary, the initial water and biota samples collected from GSL indicate elevated levels of total Hg and CH_3Hg. Many questions remain to be answered regarding Hg cycling in the complex biogeochemical environment of GSL. A limited number of water and brine shrimp samples will be collected and analyzed for Hg during the upcoming 2005 field season. Additional information on the results of this study are available on the following website:

http://www.eq.state.ut.us/issues/GSL_WQSC/docs/related_fact_sheets/ASLO-Hg-poster-JAN05.pdf

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