Spatial and temporal variations in fish mercury concentrations in Grand Lake, Oklahoma, USA

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Abstract

Exposure to methylmercury (MeHg) through fish consumption is a public health concern, with thousands of fish consumption advisories in the U.S. Coal-fired power plants are the primary anthropogenic sources of atmospheric mercury (Hg) emissions and freshwater bodies near these plants may contain elevated Hg in sediments and biota. This study is based at Grand Lake, northeastern Oklahoma, a reservoir located within 100 km of six coal-fired power plants. As part of a community-based participatory research project to evaluate MeHg exposure among residents who consume local fish, we measured Hg concentrations in commonly-consumed fish throughout the watershed, evaluated food web dynamics using $\delta^{13}C$ and $\delta^{15}N$ and tested for spatial and temporal variations in Hg concentrations in prey fish and plankton. This project addresses community concerns about Hg exposure through consumption of local fish and involved local agencies and recreational fishermen in the collection of fish.

Total Hg concentrations were measured in 700 filet samples representing 23 types of commonly-consumed fish. In general, Hg concentrations were below the U.S. EPA tissue residue criterion of 0.3 $\mu g\ g^{-1}$ MeHg, with the exception of several flathead catfish, drum and largemouth bass. While Hg concentrations were generally higher as $\delta^{15}N$ increased, elevated Hg in some flathead catfish could not be explained by $\delta^{15}N$, suggesting they derive their dietary Hg from a different food web. Hg concentrations were correlated with fish length for some types of fish, but showed no length dependence in other types.

While differences in Hg concentrations were not observed in higher trophic level fish among different parts of the watershed, fish at lower trophic levels may more closely reflect spatial and temporal variations in MeHg production. Samples of prey fish (minnow, brook silverside), young mid- and high-level consumers (largemouth bass, sunfish) and plankton (53μm, 163 μm, 363 μm) were collected monthly throughout spring and summer from two locations in Grand Lake (an upstream location with primarily riverine conditions and a downstream location with primarily lacustrine conditions) and from one location in Lake Hudson, another reservoir immediately downstream of Grand Lake. Samples were analyzed for total Hg, $\delta^{13}C$ and $\delta^{15}N$, and a subset was also tested for MeHg. The results of these analyses provide insight into the extent that Hg concentrations in fish reflect localized variations in MeHg production.