Spatial Controls on Total and Methyl Hg in the Upper Hudson River basin, New York, USA

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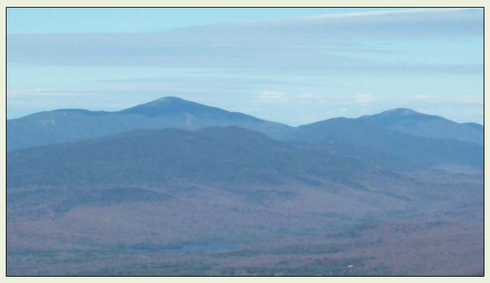
Introduction

•Mercury (Hg) contamination of aquatic ecosystems is widespread. Adirondack region of New York deemed a "hot spot" for Hg bioaccumulation.

•Atmospheric deposition is primary Hg source to most aquatic ecosystems, yet variation in deposition of Hg explains little of the variation in surface water Hg concentrations.

•Factors such as percent wetland area, extent of forest cover, land use, and others greatly affect Hg concentrations in watersheds, especially methylmercury (MeHg), the form that bioaccumulates and biomagnifies in aquatic ecosystems.

•This study explored the application of landscape metrics derived from readily available GIS coverages to explain the variation in total Hg and MeHg at 27 stream sites in Upper Hudson River, a 493 Km^2 basin in the Adirondack Mountains of New York.



Study Site and Methods

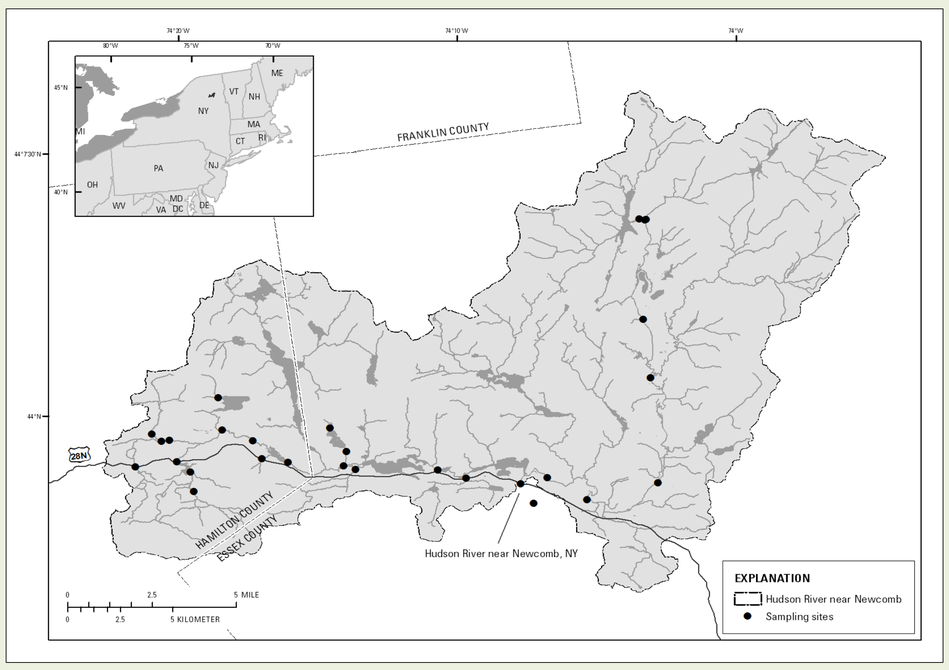
•Basin forms the headwaters of the Hudson River and is mountainous (mean slope 15.9%) with rocky slopes covered by coarse glacial till. Valley bottoms are mainly flat with coarse alluvium or outwash deposits and riparian wetlands. Bedrock is metamorphic of middle Proterozoic age.

•Basin is 92% forested with mixed northern hardwoods and spruce-fir, 6.7% wetland area and 3.6% open water. Sub-basins that were sampled ranged from steep headwaters with no wetland or open water and drainage areas of 0 – 10 km^2 to larger sub-basins with extensive riparian floodplains/wetlands and numerous ponds and lakes.

•Stream sites sampled in spring and summer of 2006 and 2008 and grouped into seasons for purposes of data analysis. Clean methods used to collect samples for Hg analysis. Samples analyzed for total Hg, MeHg, and related chemical constituents.

•Multivariate regression used to derive "best" models for predicting Hg concentrations based on a variety of landscape metrics likely to affect Hg source and transport.

•Models based on landscape metrics were compared to those derived from chemical metrics. Hybrid models that employed both types of metrics were also developed.



Map of Upper Hudson River basin, New York State with sampling sites marked.

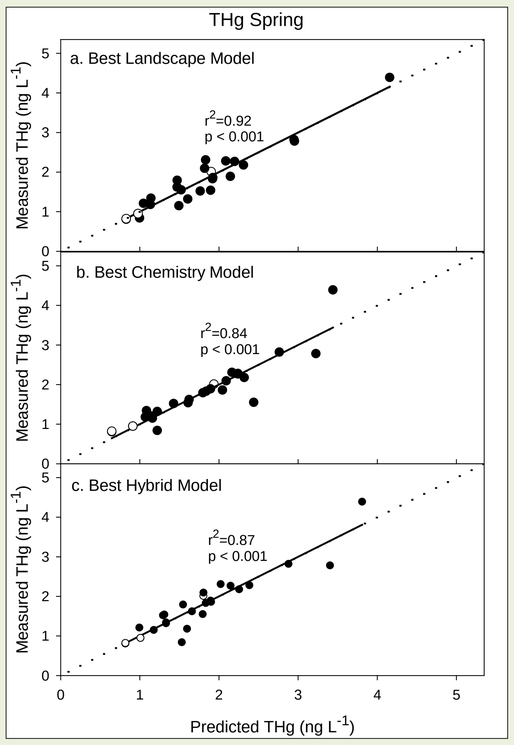
Results

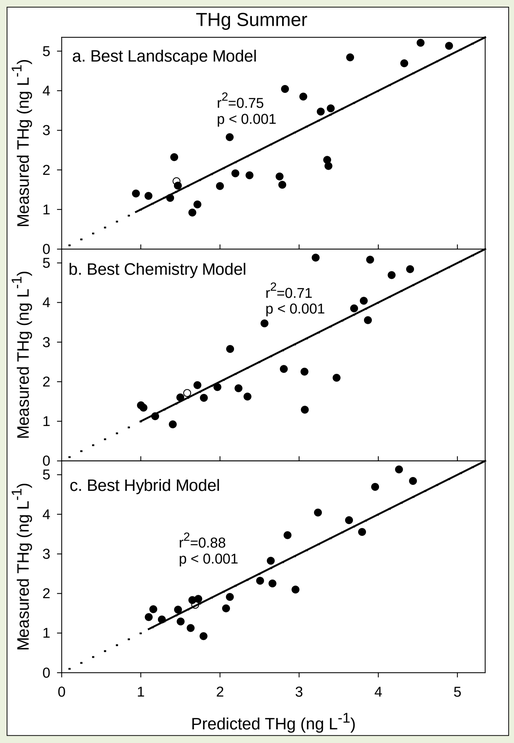
•Measures often strongly related to Hg concentrations were only weak predictors in this study. In summer, percent wetland area explained only 37% of variation in THg concentrations and 38% of variation in MeHg concentrations. Similarly, DOC concentrations explained only 35% and 29%, respectively of total Hg and MeHg concentrations in summer.

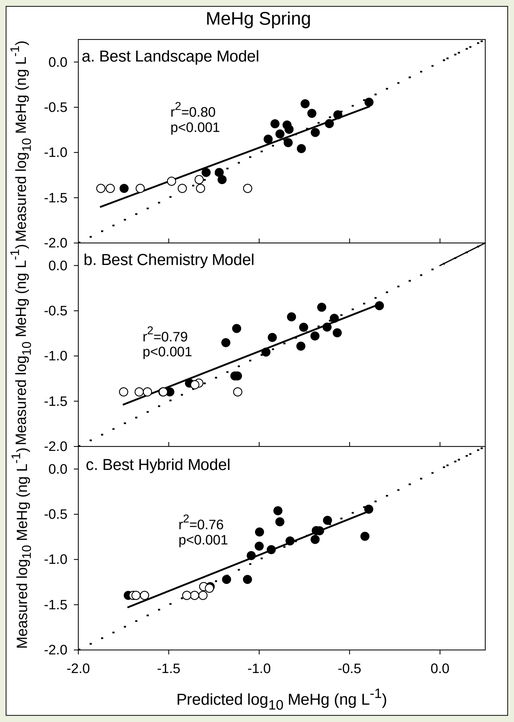
•Other metrics such as mean slope, percent riparian area, and inverse distance weighted wetland area proved stronger predictors than percent wetland area in multivariate landscape models.

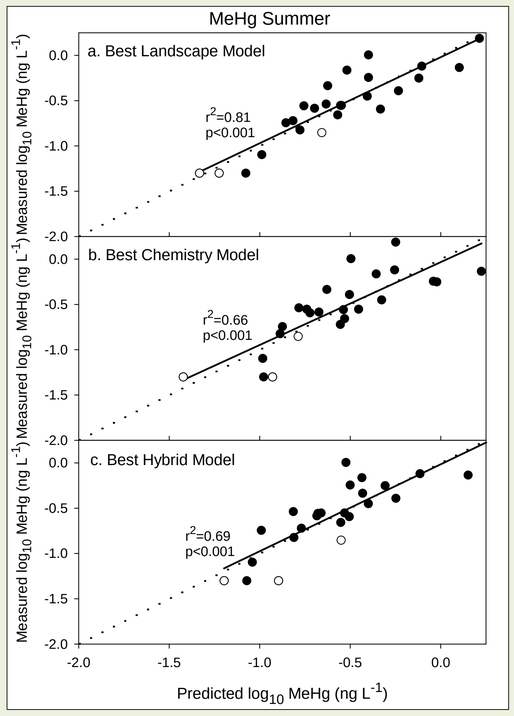
•One or more metrics based on open water area were significant in all landscape models and inversely related to Hg species concentrations. Several biogeochemical processes that act to decrease Hg concentrations such as photoreduction, demethylation, and biological uptake are known to occur in open waters.

•Models based on landscape metrics were generally as good, or better at predicting Hg species concentrations than those based on chemical metrics or hybrid models that employed both types of metrics.









Summary

Landscape measures based on GIS data can be used as a screening tool to develop models of relative risk of Hg contamination in riverine ecosystems similar to this Adirondack basin. A related investigation has found that Hg concentrations in aquatic biota are strongly related to those of MeHg concentrations in resident surface waters suggesting that multivariate models such as those developed here would also be applicable to identifying risk in aquatic biota.