

## Session D6: Transformation and Fate of Mercury in River and Streams

Room C120-122

8:00 – 9:30 am

0023

D6-1

### Willamette Basin Mercury Trends and Analysis

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The Oregon Department of Environmental Quality (ODEQ) has been monitoring mercury in the Willamette Basin since 2002. The ODEQ is integrating mercury and methyl mercury monitoring in multi-medias to develop the Willamette Basin Mercury Total Maximum Daily Load (TMDL). The ODEQ is using a phased approach to develop the TMDL. The first Phase of the TMDL was submitted to EPA in September 2006. This talk will provide an overview of ODEQ's multi-media monitoring, analytical methods, data trends, and identify possible sources for reduction.

Fish consumption advisories are currently in place for the Willamette River mainstem. The river is also identified on the ODEQ 2004 / 2006 303(d) list of mercury impaired water bodies. In order to restore the beneficial use of fish consumption (fishing) in these water bodies and meet water quality criteria, Phase 1 of a TMDL and a mercury minimization plan were developed to reduce mercury loading from point and non-point sources in 2006. ODEQ has since developed a multi-media database of sediment, water column, multi-trophic fish tissue, and air deposition data to develop the Phase 2 analysis. In 2011 ODEQ, EPA and USGS began collaborating on a new monitoring effort to assess the methyl mercury bioaccumulation and cycling in off-channel and backwater habitats. This new project targets the production and bioaccumulation of methyl mercury in Willamette River fishes and biota as a way of understanding the factors driving mercury risk in the system and informing efforts to reduce such risk.

0072

D6-2

### Characterizing Mercury Concentrations and Flux Dynamics in a Coastal Plain Watershed Using Multiple Models

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Mercury-related fish-consumption advisories are widespread in the coastal plain of the southeastern U.S., where atmospherically deposited mercury interacts with an abundance of wetlands and high-dissolved organic carbon (DOC), acidic waters. Recent trends in decision-making processes require knowledge of mercury cycling at a variety of spatial scales (*e.g.*, mesoscale watersheds, regions) and within diverse land cover types to better understand and manage the effects of this challenging water quality issue. Watershed models are primary tools for advancing questions related to such ecological exposure research. Spatially-explicit process-based watershed models can (1) improve spatial and temporal linkages between controls on environmental processes and subsequent water quality when observational studies are limited and (2) predict future changes in surface waters by using mathematical formulations. However, the science of spatially-explicit watershed scale mercury modeling is just beginning to emerge and most approaches have not been applied in mixed land cover, coastal plain watersheds. In response to this gap in current knowledge, we quantify total mercury (Hg<sub>T</sub>) concentrations and fluxes from McTier Creek Watershed, South Carolina, USA, using three novel independently developed watershed mercury models (a grid based watershed mercury model (GBMM), the VELMA-Hg model, and the TOPMODEL-Hg model) and measured in-stream Hg<sub>T</sub> concentrations and fluxes. The study watershed is located in an upper coastal plain landscape, an area with more diverse land cover, a larger drainage area, and a different geophysical setting than many previous sites of mercury research in North America, *i.e.*, small forested headwater boreal or northern forested catchments. Therefore, we aim to improve the characterization of mercury cycling in coastal plain watersheds, identify important watershed processes influencing total mercury loadings to surface waters on daily and seasonal time scales, and advance the developing science of watershed-scale mercury modeling. Based upon our understanding of the diverse mercury dynamics represented within each model, simulated Hg<sub>T</sub> fluxes at the watershed outlet using these models, and observed Hg<sub>T</sub> data, this study moves toward our goals.

0105  
D6-3

### Hydrologic Controls on Methylmercury Availability in Coastal Plain Rivers

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Methylmercury (MeHg) in streams is often attributed to methylation in up-gradient wetland areas, with episodic flood events maximizing wetland-stream hydrologic connectivity and dominating MeHg supply to the stream habitat. A number of studies have demonstrated that Coastal Plain streams in the southeastern United States are particularly vulnerable to high MeHg bioaccumulation and have attributed this vulnerability to wetland abundance and strong hydrologic connectivity between wetland areas and adjacent stream aquatic habitat. Because characteristically coarse-grained Coastal Plain sediments favor vertical infiltration with little surface runoff, flood events attributable to Coastal Plain precipitation are driven by rising groundwater, promoting efficient transport of MeHg from wetland/floodplain source areas to the stream habitat and increasing in-stream availability.

Several observations at McTier Creek, South Carolina, however, suggest that good hydrologic connectivity and efficient MeHg transport in Coastal Plain systems are not limited to flood conditions. Close correspondence between stream and shallow-groundwater water levels at McTier indicate good hydrologic connectivity exists prior to flood conditions. Dissolved MeHg concentrations do not increase under flood conditions. Thus, we assessed the flux of water and dissolved mercury (Hg) species (FMeHg and total Hg (FTHg)) from surface water and groundwater sources in a short reach at McTier Creek during separate events in April and July 2009, to determine the importance of shallow groundwater Hg transport from floodplain areas to the stream under non-flood conditions. Mass balance assessments indicated that, under non-flood conditions, the primary supply of water, FMeHg, and FTHg within the reach (excluding upstream surface-water influx) was groundwater discharge, rather than tributary transport from wetlands, in-stream MeHg production, or atmospheric deposition. The results indicate efficient transport of MeHg from out-of-channel (wetland and riparian floodplain) areas to the stream aquatic habitat in Coastal Plain streams of the southeastern United States, even under non-flood conditions.

0226  
D6-4

### Applying Measures of Watershed Geomorphology and Organic Carbon to Identify Relative Risk of Mercury Contamination in Regional Landscapes: Example from the Adirondack Mountains of New York

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Mercury (Hg) is a neurotoxin that accumulates and biomagnifies in food webs, primarily as methylmercury (MeHg). Mercury contamination of aquatic food webs is widespread across the US, and all 50 states have issued fish consumption advisories. Most Hg contamination originates from low levels of atmospheric deposition, which is later transformed to MeHg in the environment (exceptions include mined lands, industrial contamination, and wastewater discharges). Identifying water bodies at high risk for Hg contamination is an important objective of land managers and environmental regulators; however, this risk is not readily predicted based solely on levels of atmospheric Hg deposition. Other factors are critical in regional risk assessment including the transport of Hg in surface waters, the conversion of Hg to its methyl form, and uptake of MeHg into food webs and subsequent biomagnification of Hg concentrations during transfer to top predators such as fish. Mercury concentrations in surface waters of many regions are often strongly positively correlated with dissolved organic carbon (DOC) concentrations and percent basin area as wetlands. DOC concentrations and wetland area can, therefore, serve as surrogates for identifying the relative risk of finding high levels of Hg in surface waters. We sampled 27 sites for Hg and related constituents seasonally in the Upper Hudson River basin in the Adirondack Mountains of New York during 2006-09. Results indicate that while DOC concentrations and wetland area were often well correlated with Hg concentrations, far better predictions were achieved by multivariate regression models based on additional landscape and chemical variables. Measures such as basin slope, open water area, and specific ultra-violet absorbance (absorbance at a wavelength of 254 nm per unit of DOC) were key variables in these models, which accounted for about 70% to 90% of the variation in total Hg and MeHg concentrations across these sites. We propose that measures which reflect watershed geomorphology and the characteristics of aquatic organic matter can improve our ability to identify Hg risk in forested, mountainous regions such as the Adirondacks, and can form the basis of improved predictive Hg models.