Session E6: Predicting Mercury Levels in Fish and Wildlife

Room C120-122
10:30 am – 12:00 pm

0026
E6-1

A Dynamic Model Using Monitoring Data and Watershed Characteristics to Project Fish Tissue Mercury Concentrations

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This report examines the second step of a two-part dynamic model designed to examine mercury exposure in humans by linking mercury in streams through transformation and bioaccumulation to biomarkers of exposure in susceptible populations from fish consumption. The first step, projection of biomarkers of exposure for susceptible populations has been completed (DOI: 10.1002/ieam.214). This step simulates the movement of mercury from the water column through bioaccumulation in the food web to the point of human exposure: the consumption of fish. While studies have examined the correlations between various environmental factors and elevated fish tissue mercury, the relationships between these factors and how these relationships impact bioaccumulation is poorly understood.

Water quality and basin characteristics were inputs into the model, with fish tissue concentrations of generic trophic level 3, 3.5, and 4 fish were the output. Regulatory and monitoring data were used to calibrate and evaluate the model. For calibration, seven basins from Kentucky were chosen based on the availability of both water quality and fish tissue data. Seven evaluation sites outside of Kentucky were chosen based on similarities in climate, basin size, and wetlands coverage to the calibration sites. Mean average prediction error for Kentucky sites was 26%, while mean error for evaluation sites was 51%. Variability within natural systems can be substantial. The USGS National Fish Database was analyzed to quantify the natural variability found in fish tissue mercury. The mean standard deviation of fish tissue mercury was determined for sites with six or more samples of the same species of similar size and from the same year. This mean was applied to calibration and evaluation sites to produce a 95% confidence interval. The model projection was within the 95% CI for 91% of site-trophic level combinations. Analysis of model output indicated that the factors driving mercury bioaccumulation vary between basins.

0163
E6-2

MERGANSER – An Empirical Model to Predict Fish and Loon Mercury in New England Lakes

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Mercury contamination in fish is a widespread concern for human and wildlife health in New England. The region receives moderately high Hg deposition and its forested, glaciated landscape dotted with lakes and wetlands provides favorable conditions for Hg methylation and bioaccumulation. New England states have issued blanket fish consumption advisories based on measurements in a small fraction of lakes. MERGANSER is an empirical multiple regression model that “fills in the gaps” by predicting the Hg contamination risk on any New England lake larger than 8 ha (4404 total lakes). MERGANSER uses spatial data on mercury wet and dry deposition and landscape features to predict lake-specific fish Hg concentrations for user-specified species and length, as well as standardized Hg concentrations in the fish-eating common loon; a species of considerable conservation need. MERGANSER returns either an expected Hg concentration or a probability that Hg concentration exceeds the EPA recommended criterion (fish) or the severe-risk threshold for diminished reproductive success (loon). MERGANSER enables resource managers to pinpoint and quantify Hg contamination risk at multiple spatial scales. MERGANSER can project the response of fish and loon Hg concentrations or risk probability to future climate, deposition, and land use change scenarios.

0216
E6-3

Mercury and Methylmercury in Reservoirs in Indiana

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Data for mercury (Hg) and methylmercury (MeHg) in water samples, 2002–2006, and Hg in fish-tissue samples, 1996–2007, from flood-control reservoirs in the Ohio River Basin in Indiana were compiled and interpreted. The purpose was to investigate the factors affecting Hg and MeHg in these reservoirs using information from three sets of monitoring data.

As part of a statewide monitoring program for Hg and MeHg in Indiana streams, water samples were collected from "tailwaters" downstream near four reservoir dams on a quarterly schedule for 5 years. Particulate-bound Hg concentrations were significantly lower in tailwaters than in free-flowing streams while the ratio of MeHg to Hg concentrations was significantly higher. The ratio of MeHg to Hg in tailwaters was significantly higher in summer and was not related to the depth or discharge of outflow from the reservoirs. These findings indicated conditions in some reservoir summer pools could increase the rate of MeHg formation.

To evaluate the conditions that affected MeHg formation, summer pools of three reservoirs were investigated. Water temperature and dissolved oxygen were measured from the water surface to the lake bottom at numerous transects across each reservoir to identify depths separating three temperature-oxygen layers. Depth-specific water samples were collected from these layers throughout each reservoir. The investigation found that the relatively deep, cold, low-oxygen layer of water in some reservoirs had water chemistry that indicated sulfate reduction associated with the highest dissolved MeHg to Hg concentration ratios.

Hg concentrations in tissue samples of sport fish from eight reservoirs were highest in the reservoirs with the highest mean MeHg to Hg concentration ratios measured in water samples. As a group, Hg concentrations in fish-tissue samples from reservoirs had a greater percentage that exceeded the 0.3 milligram per kilogram human health criterion than samples from all water bodies in Indiana combined.

High levels of Hg and MeHg in water and fish from some reservoirs in Indiana can be attributed to factors that include: moderate to high atmospheric Hg wet and dry deposition to watersheds with heavily forested landscapes, steep terrain and near surface bedrock; and conditions promoting sulfate reduction and MeHg formation during summer thermal stratification in reservoirs with lengthy summer pools and inflow-to-outflow retention times.

0390
E6-4

Landscape-Level Patterns of Mercury Contamination of Fish in the South Central United States

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Mercury (Hg) is a toxic metal that is found in aquatic food webs and is hazardous to humans. An emerging conceptual model predicts that areas of the landscape that have the potential to contain food webs with elevated concentrations of Hg receive high amounts of Hg and sulfate deposition, and have high coverage of forests and wetlands and low coverage of agriculture. The objective of this study was to test this conceptual model using concentrations of Hg in fish. We compiled a database with 40,564 fish samples representing a variety of species from 893 water bodies in 14 ecoregions located in Oklahoma, Texas, Arkansas, Louisiana, Mississippi, and western Tennessee. All mercury values were converted to 35.5-cm total length largemouth bass equivalents using the National Descriptive Model of Mercury in Fish. The highest levels of Hg contamination in fish were in four ecoregions: the Southern Coastal Plains (648 ng/g), South Central Plains (614 ng/g), Ouachita Mountains (569 ng/g), and Southeastern Plains (544 ng/g). These ecoregions receive high levels of Hg and sulfate deposition and contain extensive coniferous forest habitat but little agriculture. Coverage by coniferous forests explained 73 percent of the variance of average Hg concentrations in largemouth bass in the 14 ecoregions. Over 70 percent of the water bodies in ecoregions with coniferous forest coverage of 20 percent or greater have Hg concentrations in largemouth bass above the EPA criterion level of 300 ng/g for fish advisories. Coniferous forests in states in the southern ecoregions may constitute a significant hazard to human health through increased exposure to Hg from fish. Neither the

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