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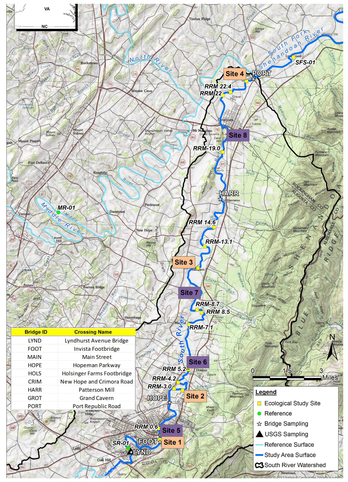
Site-Specific Application of the Bioaccumulation and Aquatic System Simulator (BASS) for Mercury Bioaccumulation in the South River, Virginia

B. Reese (AECOM, Conshohocken, PA) | R.G. Stahl Jr. and R. Landis (E. I. DuPont de Nemours & Co, Wilmington, DE) | C. Mancini and S. Thakali (AECOM, Conshohocken, PA)

BACKGROUND

Mercury (Hg) was used in the manufacturing process at a facility in Waynesboro, Virginia between 1929 and 1950. In the course of the process, Hg was released and subsequently migrated into surface water, sediments, soils, and biota of the South River. The Bioaccumulation and Aquatic System Simulator (BASS) model was used to better understand methylmercury (MeHg) trophic transfer through the river's aquatic food web to inform remedial decision-making. The model simulates the bioaccumulation dynamics of hydrophobic organic pollutants and metals, such as Hg. Bioaccumulation dynamics are described using algorithms that account for species-specific concentration trends affecting the uptake and elimination of MeHg, such as dietary composition and growth dilution.

PURPOSE AND OBJECTIVES



- Primary Objective
  - Simulate MeHg bioaccumulation dynamics of smallmouth bass (*Micropterus dolomieu*), redbreast sunfish (*Lepomis auritus*), and common shiners (*Luxilus cornutus*) across a surface water MeHg concentration gradient in the South River (Figure 1)
- Secondary Objectives
  - Evaluate fisheries management options
  - Simulate food web responses to changes in post-remediation biotic and abiotic MeHg concentrations

Figure 1. BASS Model locations

PRIMARY OBJECTIVE

Methods

Simulation, Chemical, and Fish Control Parameters:

- Site-specific data (Figure 2)
  - length/weight regressions, seasonal dietary preferences, biotic and abiotic MeHg data, etc.
- Literature-based-BASS Model Data Supplement v2.2 (Barber, 2006)

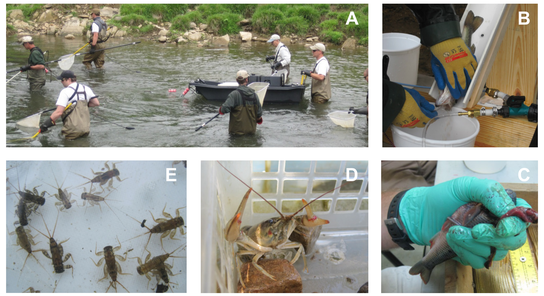
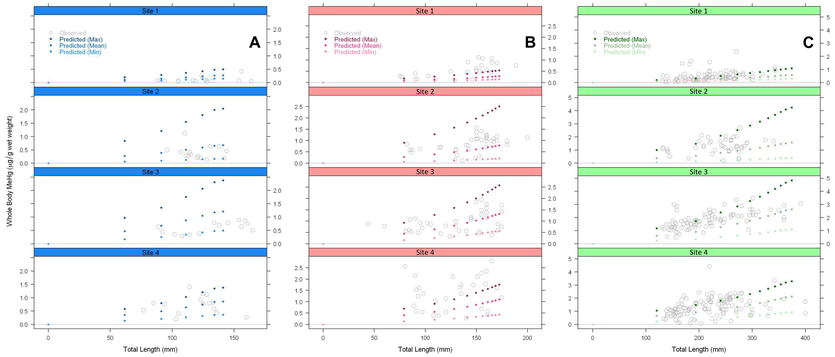


Figure 2. Site-Specific Data: A) Electrofishing for target fish; B) Smallmouth bass gut content sampling; C) Common shiner gut content sampling; D) Crayfish tissue Hg analysis; E) Mayfly Tissue Hg analysis

Results

- BASS model-predicted MeHg concentrations in common shiner, redbreast sunfish and smallmouth bass were generally comparable to empirical data (Figure 3)
- Deviations from model predictions may be accounted for by intra-site mobility, documented in mark-recapture studies
- Dietary uptake accounted for 91%-95% of the bioaccumulated MeHg in modelled fish

Figure 3. BASS Model Results: A) Common shiner; B) Redbreast sunfish; C) Smallmouth bass



SECONDARY OBJECTIVES

Fisheries Management Options

- ***Rainbow trout:*** 12-inch fish stocked on two different dates at four different sites (Figure 4)
- ***Channel catfish:*** 16-inch fish stocked on three different dates at one site
- Determined length of time until modelled fish exceed consumption advisory-level filet MeHg concentration of 0.3 µg/g

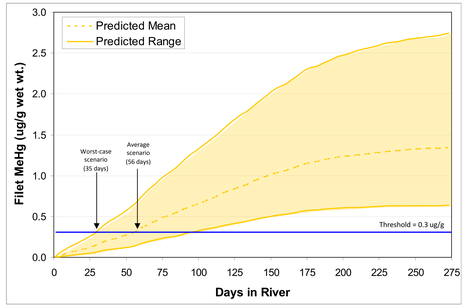


Figure 4. Rainbow Trout - Site 7 - Stocked on April 1

Figure 5. Bank Stabilization

Remedial Action Integration

- Well-calibrated bioaccumulation model developed for the South River
- Valuable tool to simulate food web responses to changes in South River abiotic and biotic MeHg concentrations for future conditions related to remediation, such as bank stabilization (Figure 5)

CONCLUSIONS

- BASS model was used to accurately simulate MeHg bioaccumulation dynamics of resident fish in the South River
- Confirmed understanding of factors controlling MeHg uptake by high trophic level aquatic organisms (i.e., importance of dietary pathway)
- Calibrated BASS model can now be used for:
  - Assessment of fisheries management options
  - Evaluation of post-remediation MeHg bioaccumulation dynamics

The work described in this poster has been performed in conjunction with the South River Science Team (SRST), a multi-stakeholder group including representatives from local, state and federal governments, academia, environmental groups and DuPont. The SRST is a collaborative team created to provide input into the watershed-level, risk-based assessment framework to address mercury in the system.
www.southriversciencteam.org

REFERENCE

Barber, M.C. 2006. Bioaccumulation and Aquatic System Simulator (BASS) Data Supplement Version 2.2. U.S. Environmental Protection Agency, Washington, D.C. EPA/600/R-06/XXX.