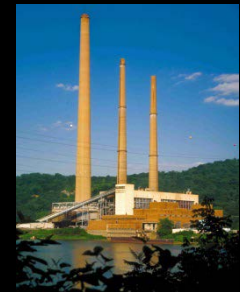
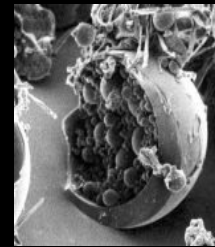


# Mercury Modeling of the Ohio River Using D-MCM: Final Results



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EPRI – Water Quality and Watershed Protection  
24 February 2014





# *Acknowledgements*

- ➔ John Goodrich-Mahoney
- ➔ Reed Harris Environmental Ltd.
- ➔ Brooks Rand Labs (MeHg analysis).
- ➔ AEP Dolan Chemical Laboratory



# ***EPRI Technical Report***

➔ ***Application of the Dynamic Mercury Cycling Model (D-MCM) to the Robert C. Byrd Navigation Pool of the Ohio River***

**2013 Technical Report 2001216**



# *Regulatory Landscape*

- ➔ ORSANCO WQS: existing requirement that mixing zones for BCCs will be eliminated in 2015, new sources can't have a mixing zone, and "no net increase" for existing sources.
- ➔ Each year, ORSANCO conducts fish tissue and THg/MeHg water sampling in various navigation pools.
- ➔ Results used to assess fish consumption use...non-attainment means TMDL is required, which may result in effluent limits more stringent than WQ criteria.



# *Hg in the Ohio River: what are the uncertainties?*

- ➔ Relative importance of sources (air, watershed, point-source). Regulator concerns of “new” Hg from FGD waste streams.
- ➔ To what extent does net methylation occur? Where does it occur?
- ➔ Are fish tissue levels increasing? If so, what factors are associated with this?



# *Available Hg Models*

- ➔ ***EPRI Report 2001198 – “Review of Bioaccumulation Models for Mercury and PCBs in Aquatic Systems”***

BASS v2.2 (EPA Athens Lab) – online

D-MCM v4.0 – EPRI only for now

WARMF v6.1 (EPRI) available online

Trim.Fate v3.3 (USEPA) – available online

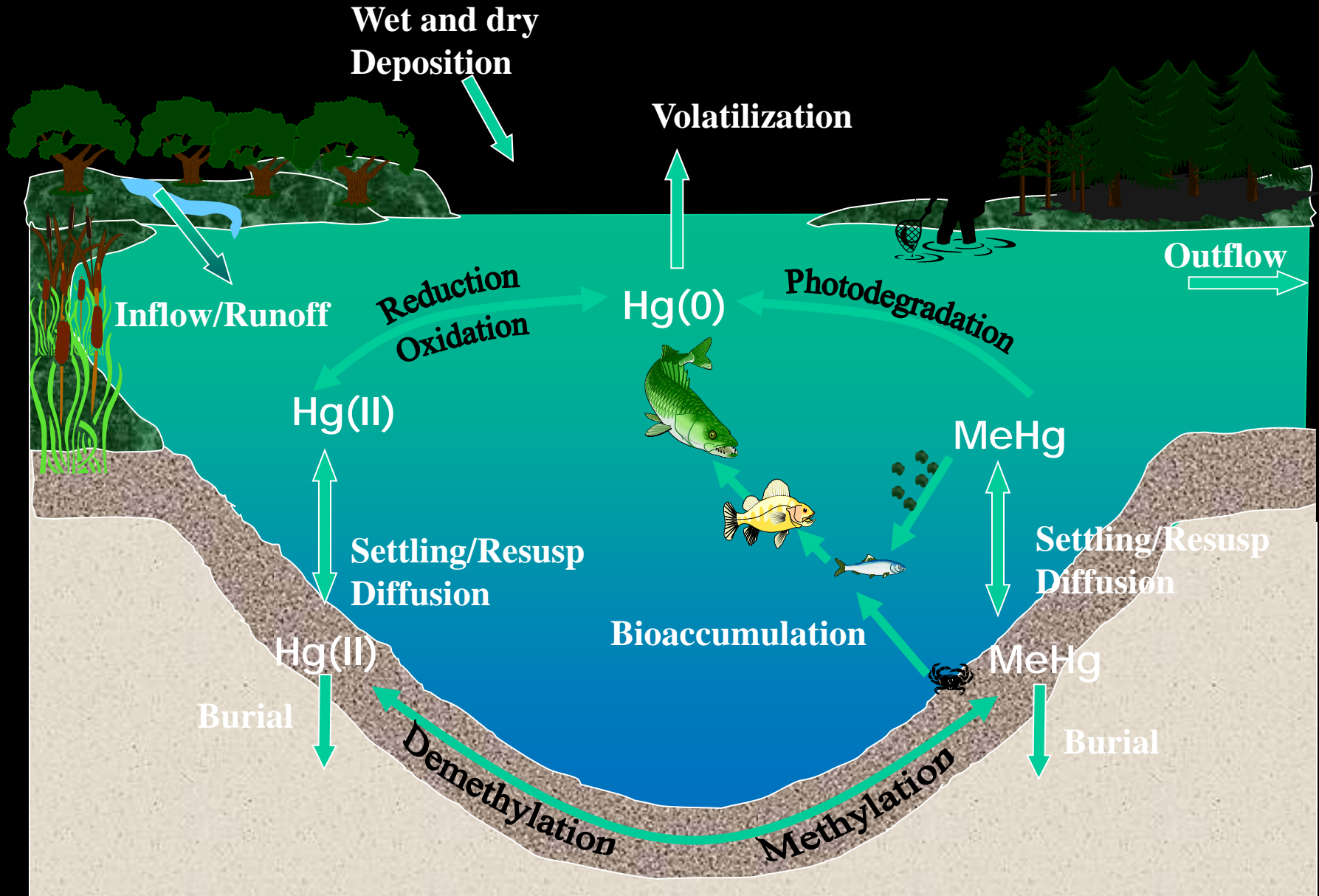
MMBM – document only



# Ohio River application of D-MCM

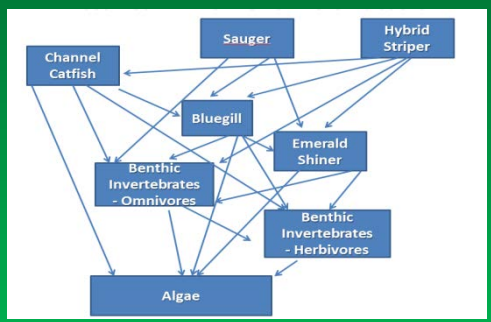
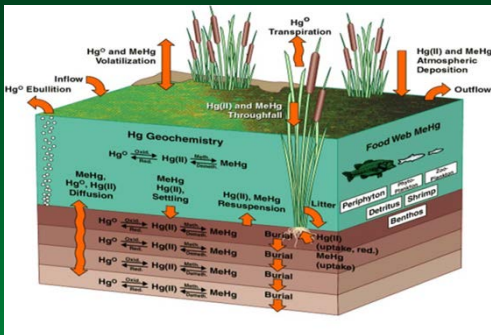
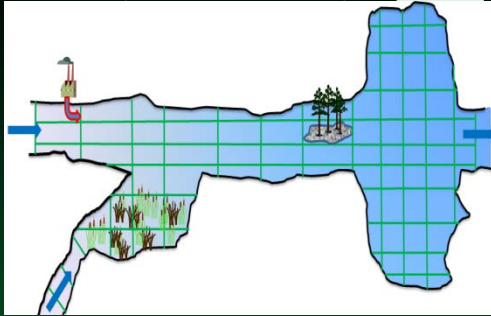
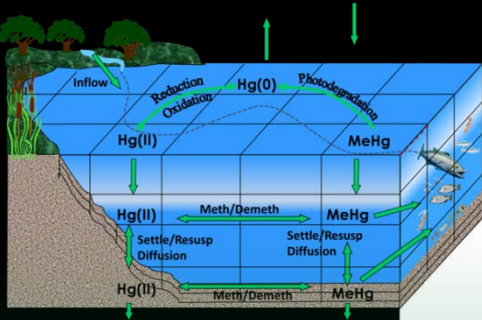
- Identify the primary sources of inorganic Hg and methylmercury to the Ohio River, and their relative importance, focusing on a single navigation pool (Robert C. Byrd Pool).
- Demonstrate the sensitivity of predicted biota mercury concentrations to various factors, including Hg loading.

# Mercury Cycling in D-MCM





# What does D-MCM do?

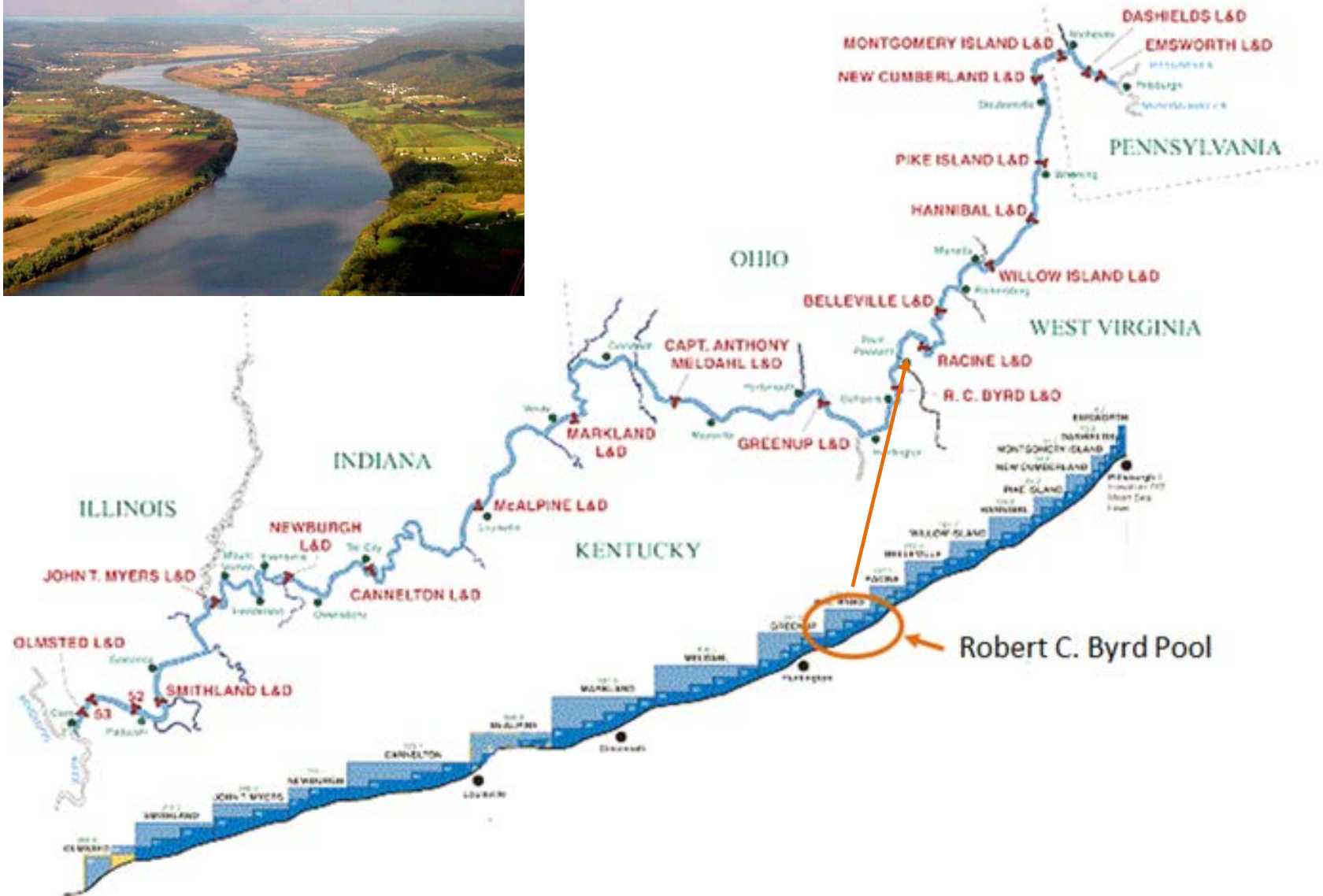


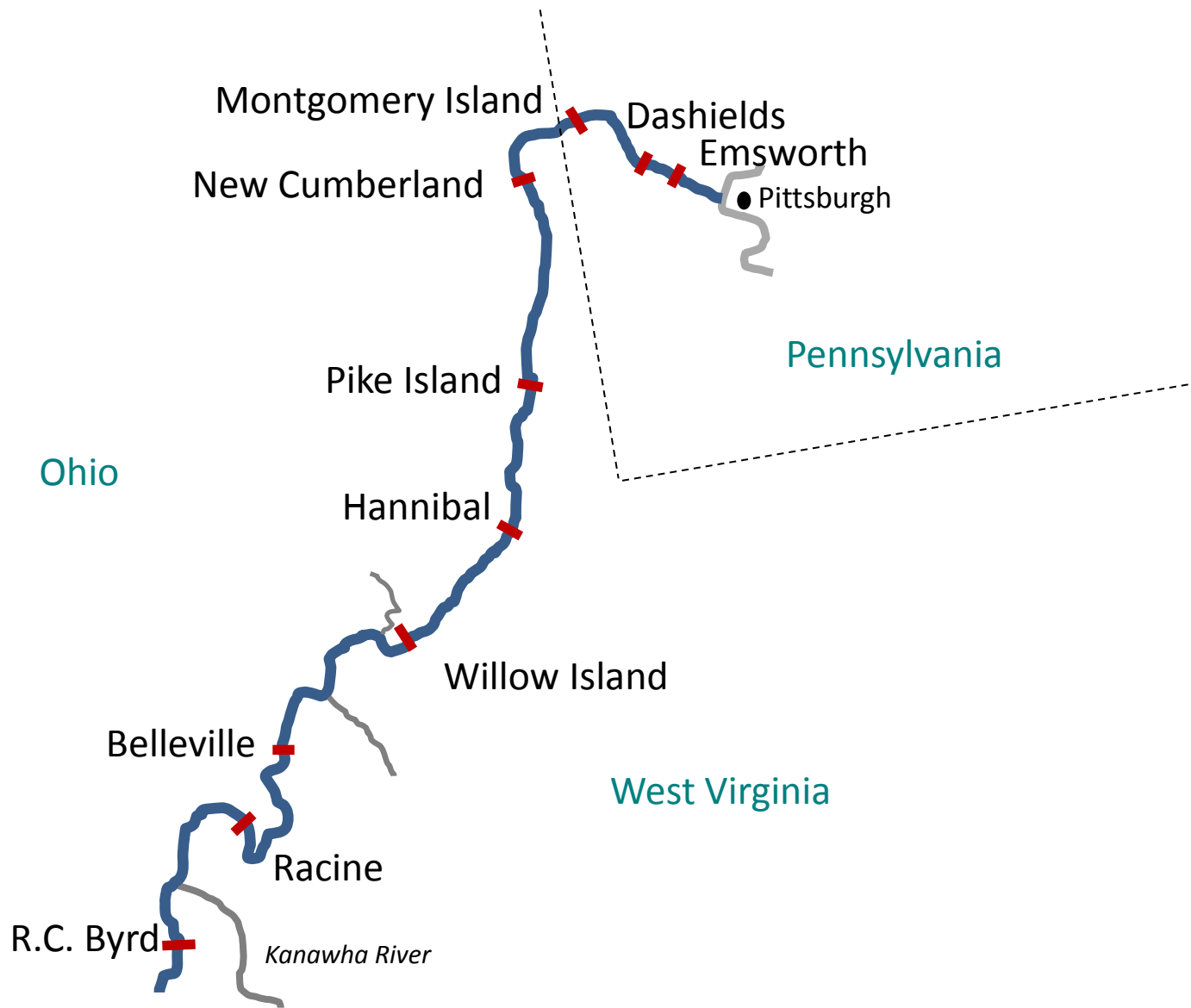
- Predicts Hg cycling & bioaccumulation in aquatic systems (lakes, rivers, wetlands, marine systems)
- Predicts response to changes in..
  - Hg loading
  - Environmental conditions (e.g. climate, pH)
  - Trophic structure
- Focuses on Hg: does not model environmental conditions that are inputs (e.g. pH, temperature).

# What's new in Version 4

- 1D to 3D capability for rivers, lakes, estuaries, wetlands and marine systems
- Expanded food web: up to 30 lower food web items, unlimited fish species
- Updated Hg cycling, including options for methylation in intermediate depth waters in oceans
- Probabilistic capability for uncertainty analysis and confidence limits









# *Model inputs and flow scenarios*

- ➔ ORSANCO L&D water quality and clean metals data; also fish tissue.
- ➔ Air deposition: data from Athens, OH MDN site.
- ➔ AEP: MeHg in water and sediments, forage fish Hg, omnivore/piscivore Hg.
- ➔ Four flow scenarios modeled: 1) annual mean flow; 2) harmonic mean flow; 3) constant 7Q10 flow; and 4) one month only 7Q10 (September).





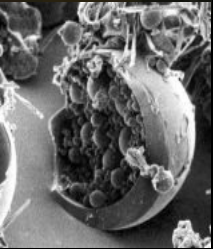
## *Model domains*

- ➔ R.C. Byrd pool only → cell upstream and downstream of Kanawha River.
- ➔ Entire Ohio River from RM 0 (Pittsburgh) to RM 279 (Byrd L&D).
- ➔ Point-source loadings from 42 facilities (large domain); 8 facilities in Byrd Pool (4 coal-fired power plants and 4 POTWs).

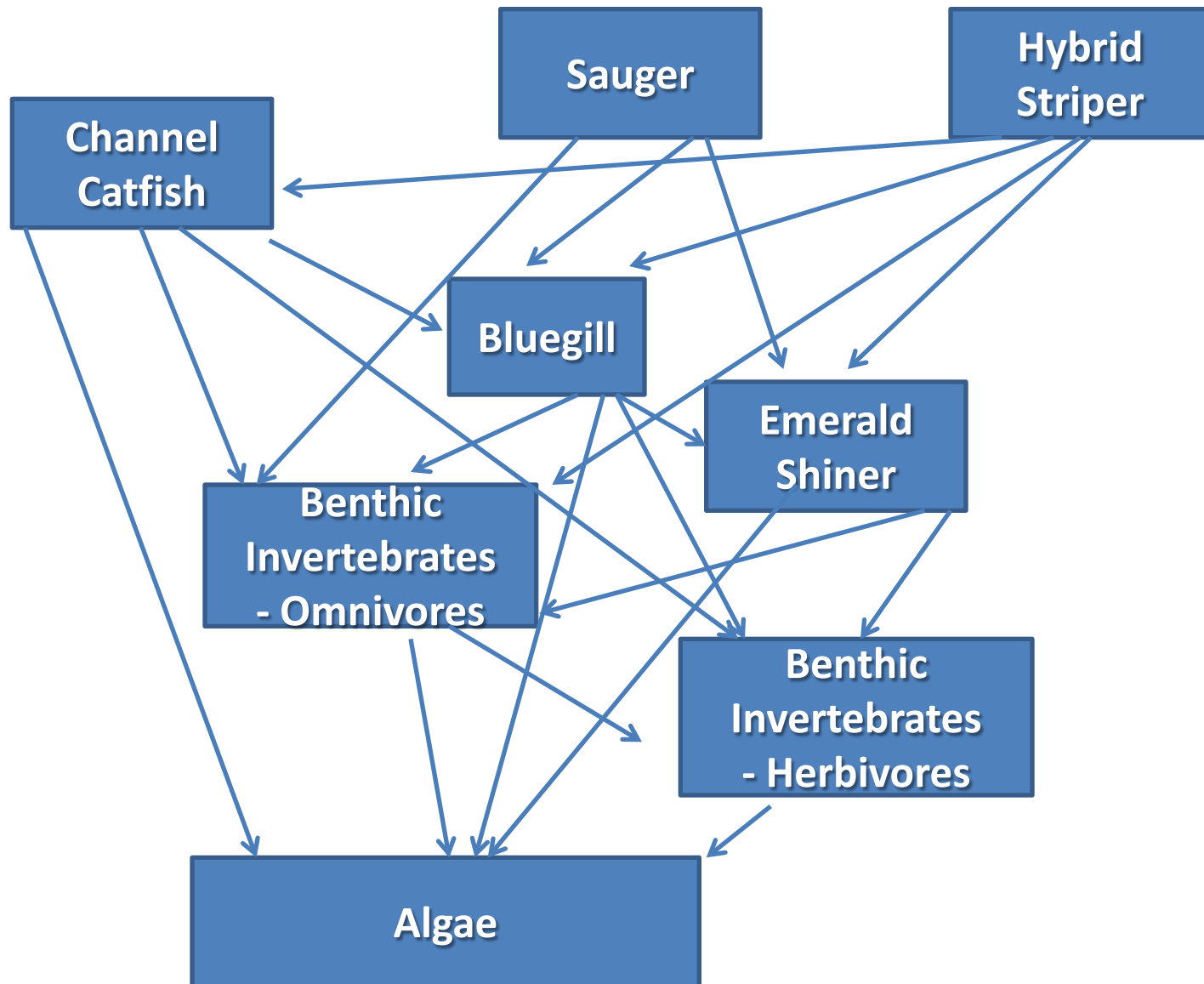


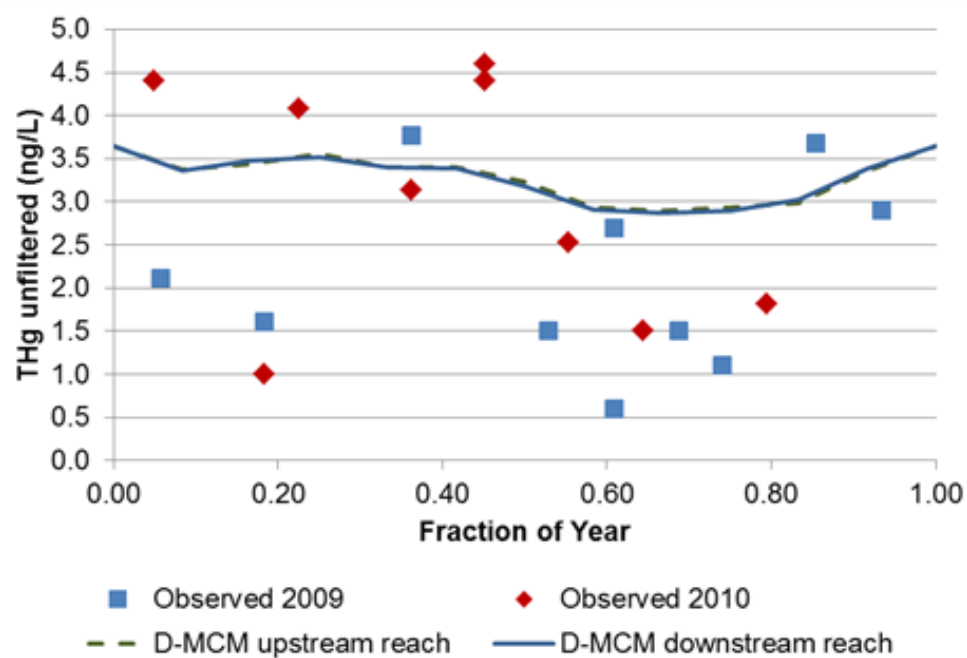
# *How was model run?*

- ➔ Model run simulated for 100-year period (allows for steady-state equilibrium).
- ➔ Results for year 101 evaluated.
- ➔ Sensitivity analysis (influence of a single variable) and probabilistic analysis (influence of aggregate variables on response variable uncertainty) performed.

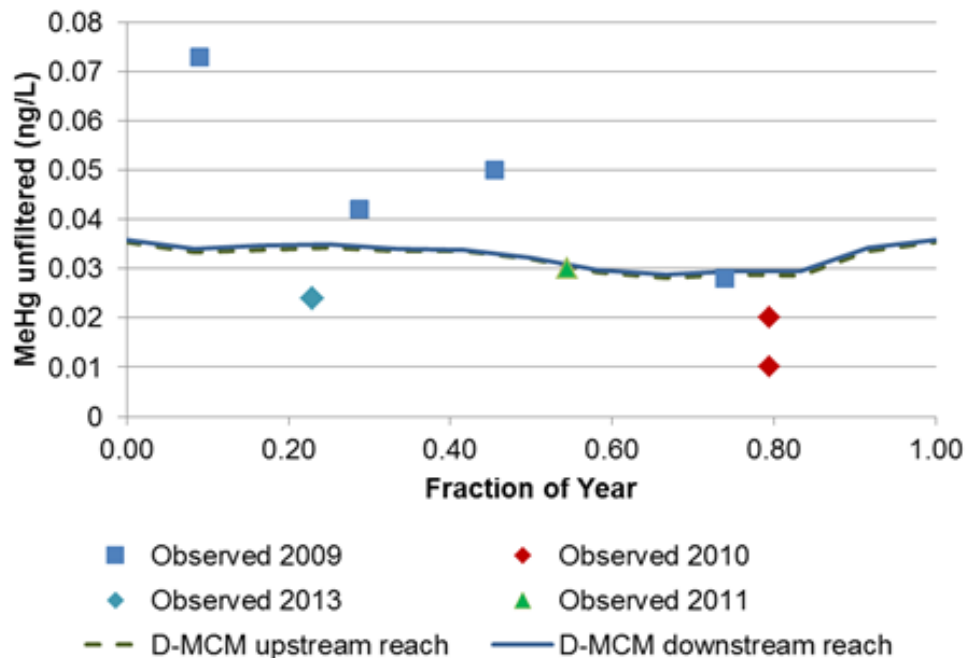


# Food web in D-MCM Ohio River simulations





**Predicted and observed concentrations of total mercury and methylmercury in Robert C. Byrd Pool**





# *Results – Hg and MeHg in water*

➔ In Byrd Pool, sources of water THg:

- 80% from upstream
- 19% from Kanawha River
- < 1% for both air deposition and point-sources

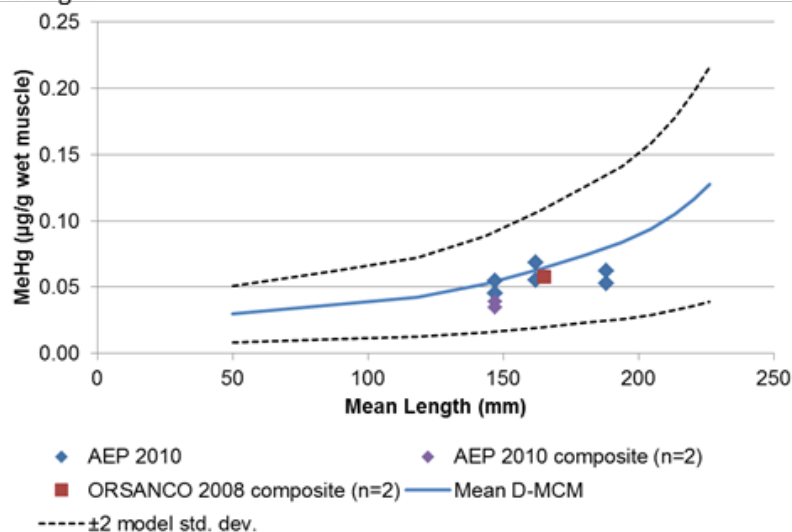
➔ 95% of total MeHg from upstream

- water column methylation < 1% of total MeHg
- sediment methylation negligible

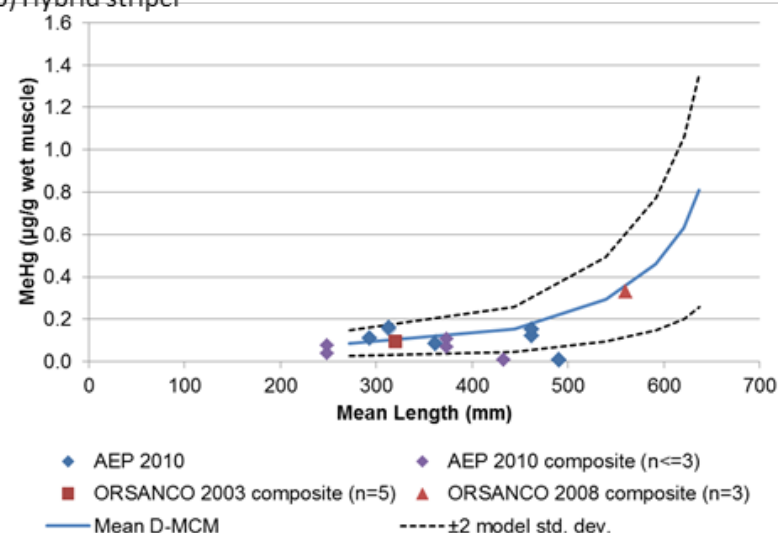
☀ ***Methylation potential in Ohio River is LOW.***

# Predicted and Observed MeHg in Fish in Robert C. Byrd Pool

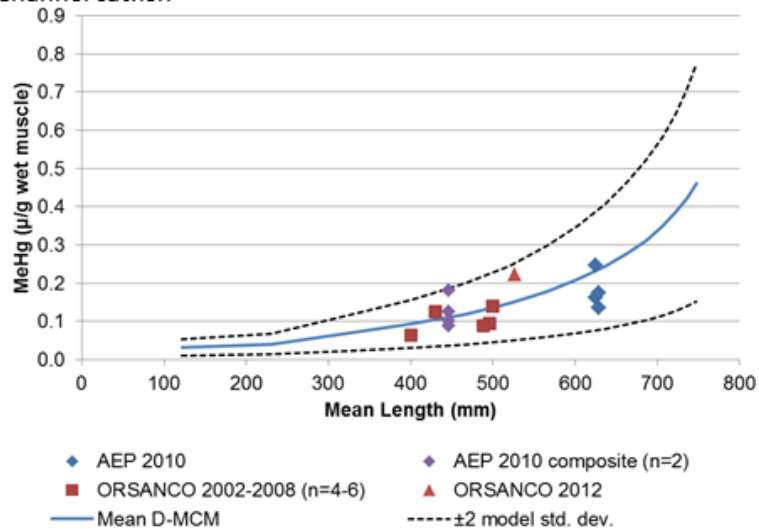
a) Bluegill



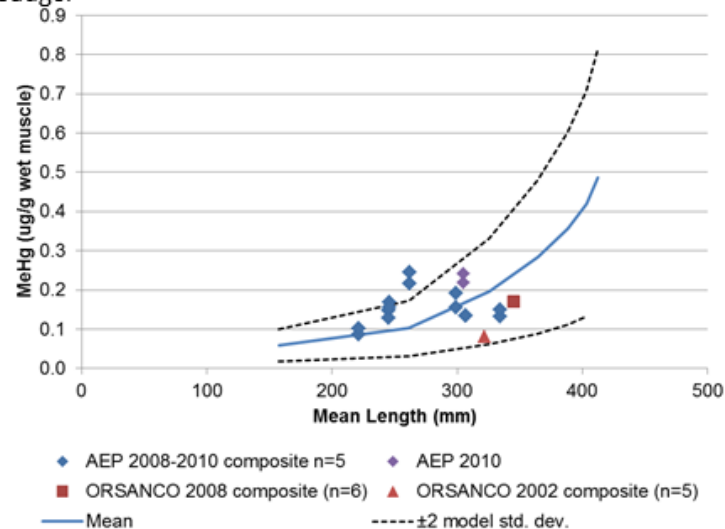
b) Hybrid striped



c) Channel catfish

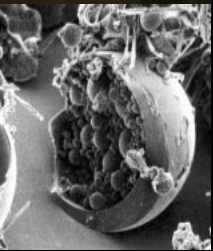


d) Sauger



# *Sensitivity analysis results*

- ➔ For response variables of THg and MeHg concentrations in water, these levels were most sensitive to upstream levels/loads.
- ➔ For MeHg in age 4 or 5 sauger, three variables were most important:
  - phytoplankton MeHg BAF
  - fish activity coefficient
  - upstream MeHg loads





# Project Summary

- Fish Hg levels in the Ohio River are low to moderate. MeHg levels in water column are low.
- The model predicted negligible water column and sediment methylation. This is consistent with the fluvial and sediment erosional characteristics of the Ohio River.
- Most of the THg and MeHg load to the Robert C. Byrd pool is from upstream. Point-source discharges in the Byrd pool (4 power plants), and air deposition, did not measurably affect water and fish tissue Hg.
- The modeled sources of Hg to the Ohio River has potential policy implications.

# Questions, Rants, or Raves?

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***Certified Fisheries Professional***

***AEP – Environmental Services***

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