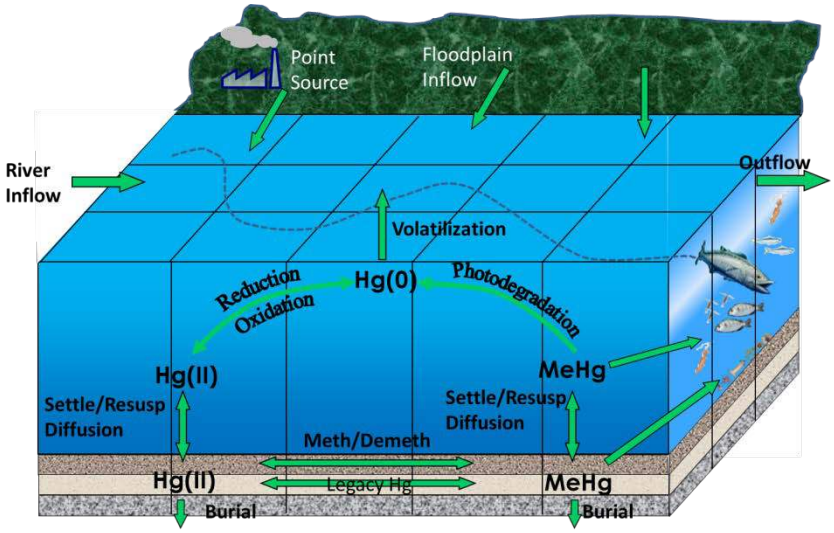
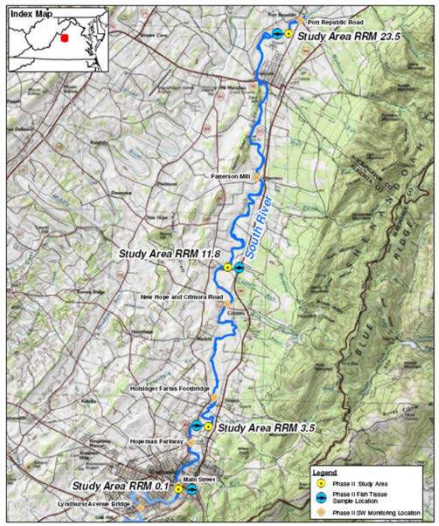
Mechanistic Mercury Modeling in the South River -Update





Presented by
Reed Harris
RHE Ltd.

May 13, 2015

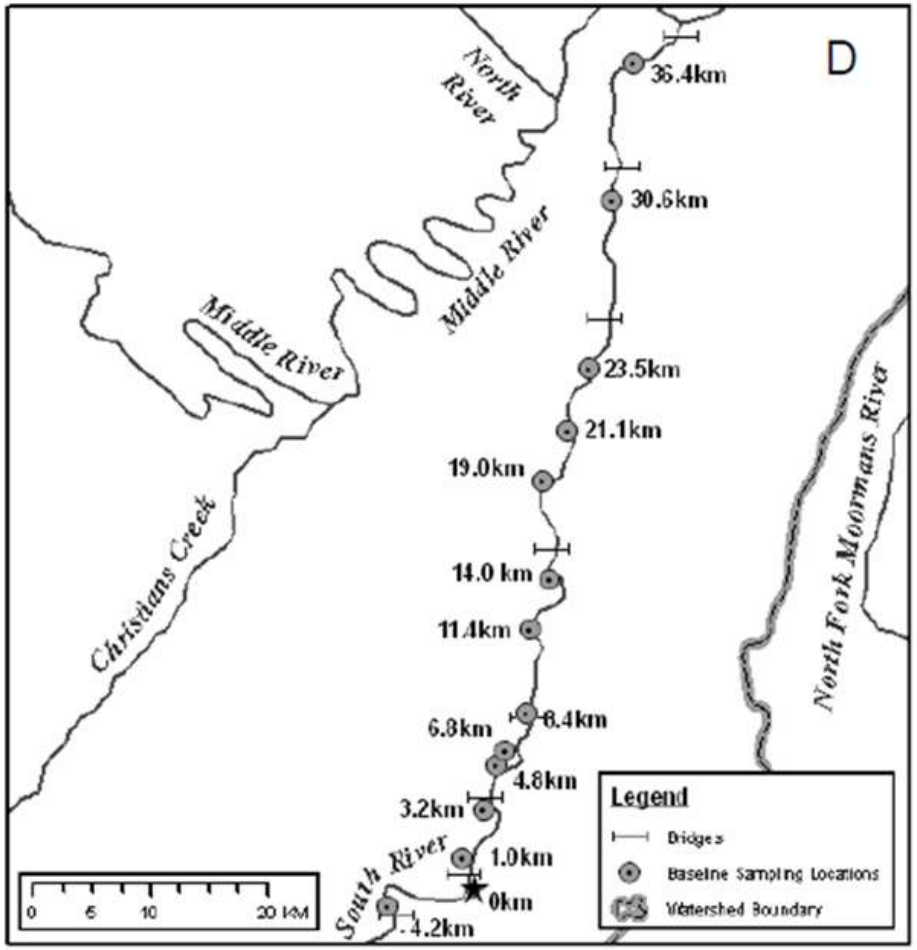
Objectives

- Help predict and assess the benefits of bank stabilization.
- Help interpret monitoring data.
- Help integrate multi-disciplinary studies carried out on the South River. Do the pieces fit together?
- Help address uncertainty
- Provide another line of support for decisions.

Key question to help address with a model:

What will happen to fish mercury levels after bank stabilization?

- Magnitude
- Timing
- Effects at different locations



Observed Hg concentrations along the South River (Source: VDEQ, 2008)

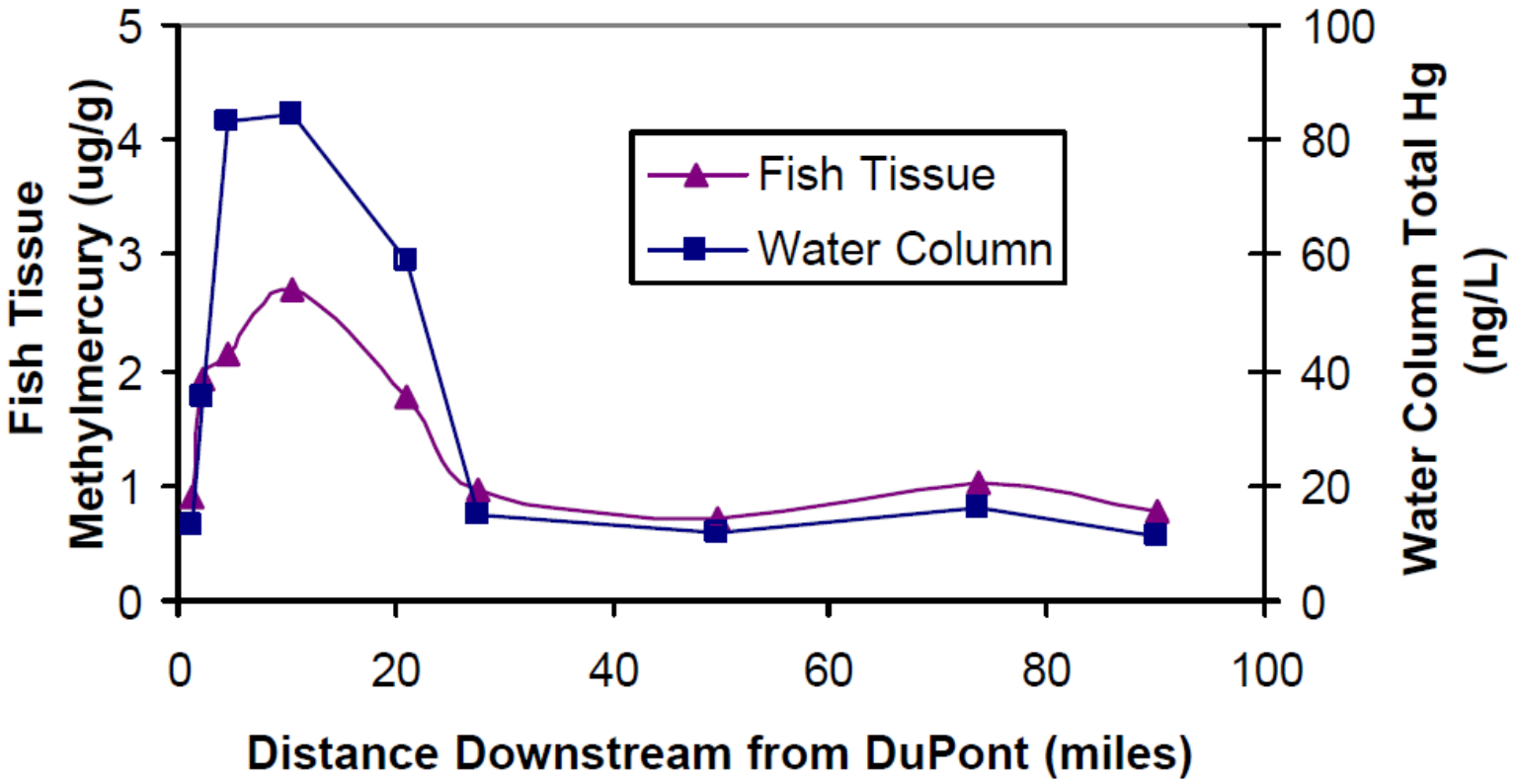
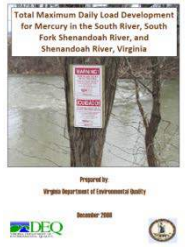
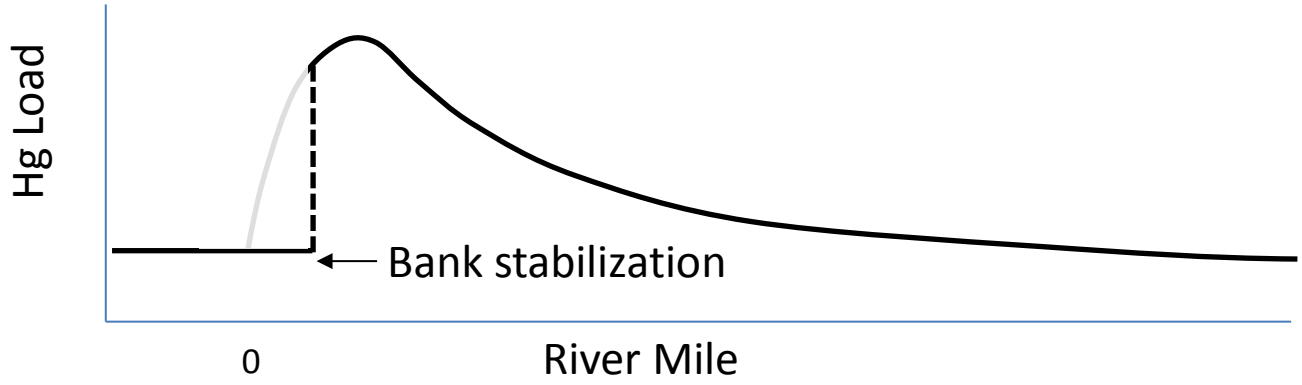
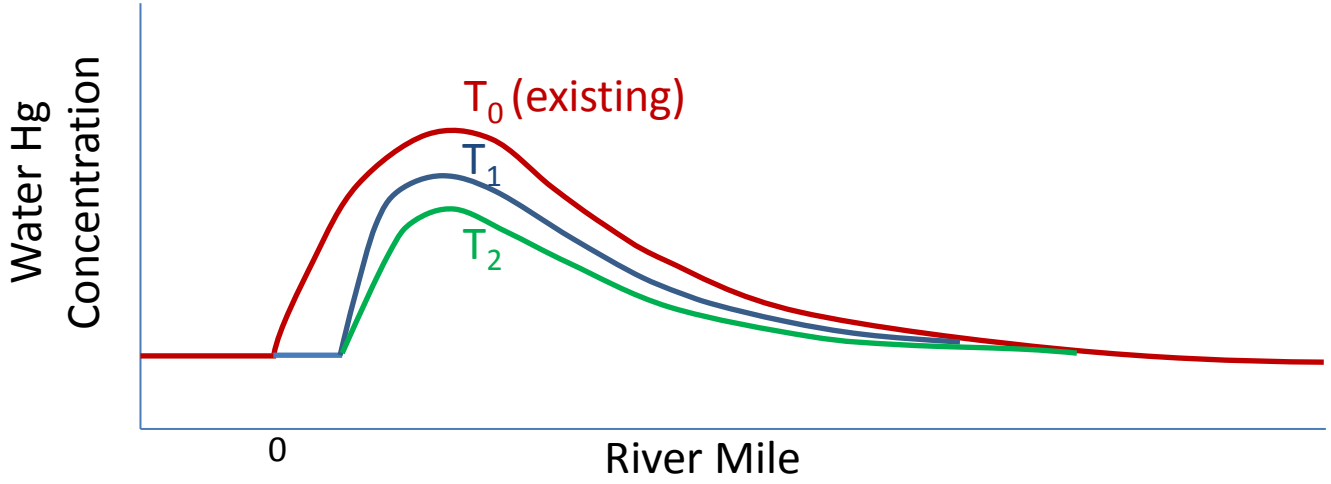
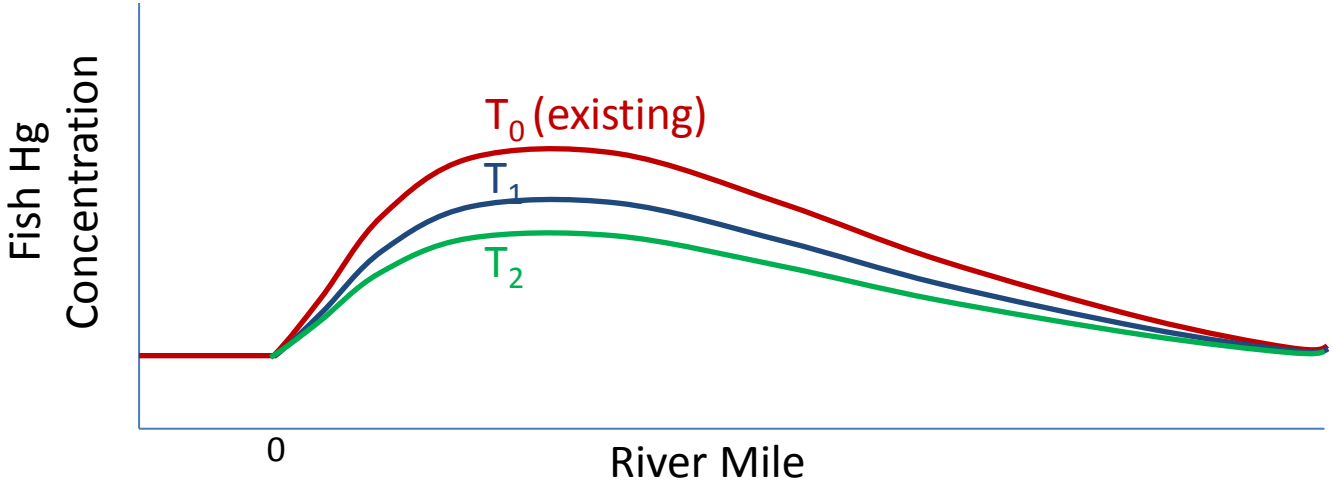


Figure 2-8. Size-normalized Fish Tissue Methylmercury and Water Column Mercury in the South River and South Fork Shenandoah River Downstream from DuPont in Waynesboro, VA.





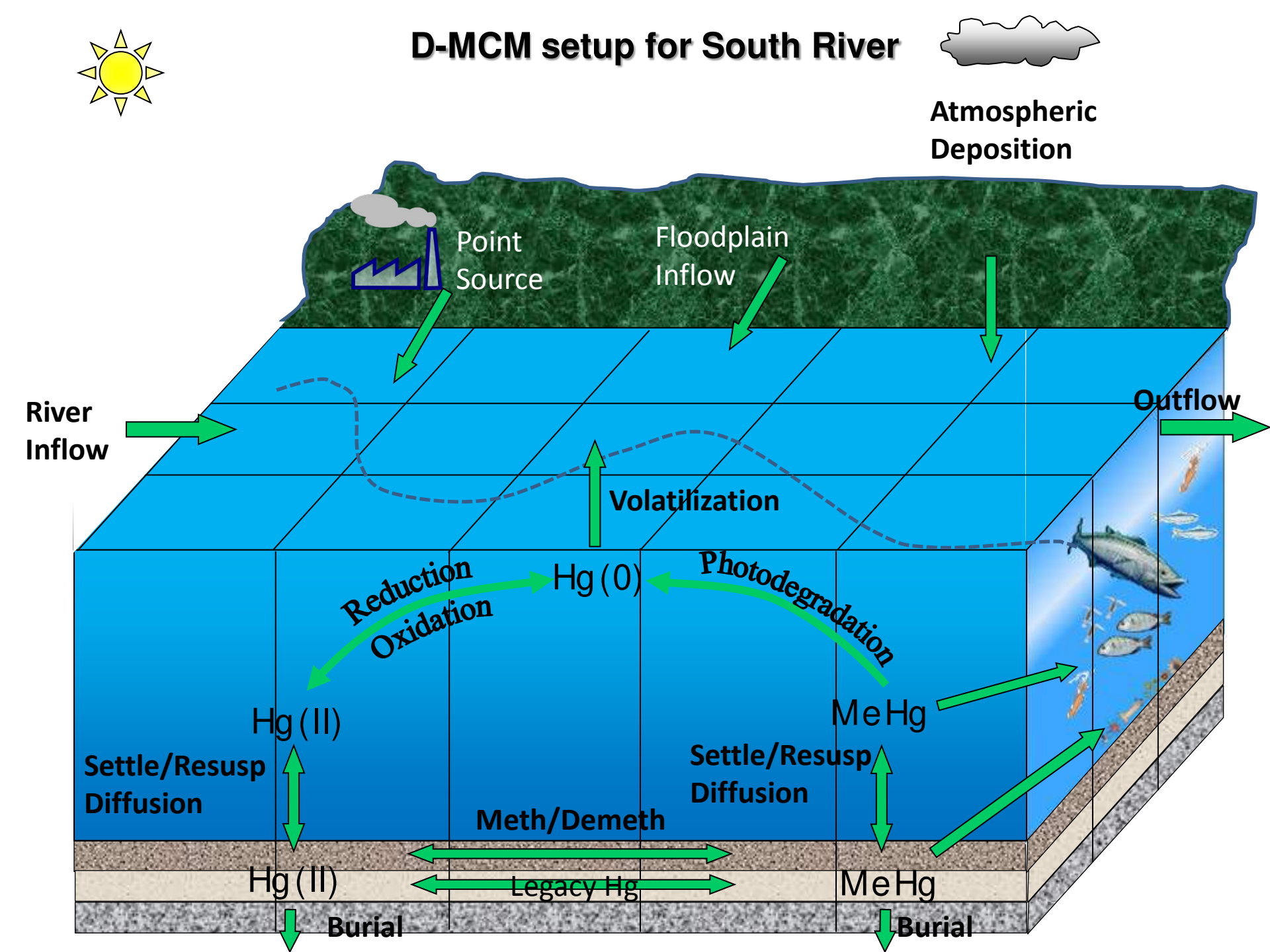




Predict response as a function of location and time

Other questions that could be examined with modeling:

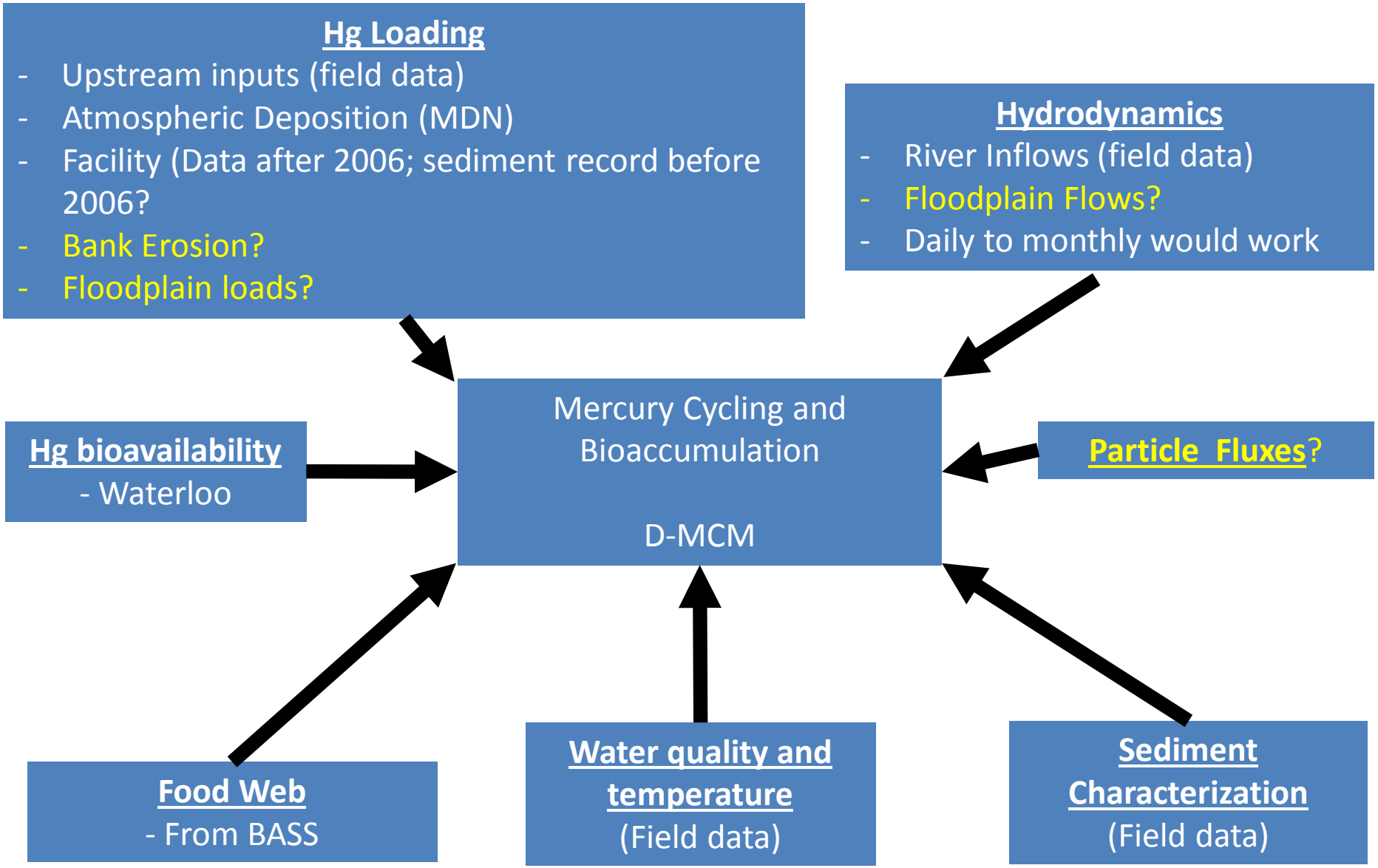
- Where does mercury in fish originate?
- What processes control the natural recovery of the system?
- What processes can be altered to accelerate recovery?
- What do the monitoring data tell us?
- Confounding factors: e.g. effects of climate change?


D-MCM setup for South River
Atmospheric Deposition
Point Source
Floodplain Inflow
River Inflow
Outflow
Volatilization
Reduction
Oxidation
Hg (0)
Photodegradation
Hg (II)
MeHg
Settle/Resusp
Diffusion
Settle/Resusp
Diffusion
Meth/Demeth
Hg (II)
Legacy Hg
MeHg
Burial
Burial

D-MCM Input Summary

- **Physical**
  - ✓ Bathymetry, water temperature.
- **Biological**
  - ✓ Key fish species, fish growth, fish diets, trophic structure relevant to MeHg supply to fish.
- **Surface water and porewater chemistry**
  - ✓ DOC, pH, O_2, Cl, SO_4, TSS, Sulfide (if relevant).
- **Hydrology**
  - ✓ Inflow and outflow rates (surface and groundwater as applicable), water levels. Tributary flows. Flows among grid cells.
- **Sediment characteristics**
  - ✓ Bulk density, porosity, organic C content, grain size distribution, mass sedimentation and resuspension rates.
- **Mercury loads**
  - ✓ Erosion, Atmospheric deposition, Inflow THg and MeHg concentrations, Point sources.
- **In-situ mercury concentrations or fluxes help to calibrate model**
  - ✓ THg and MeHg in water (filtered, particulate), sediments (solids, porewater) and biota; field estimates of Hg sedimentation or evasion are useful

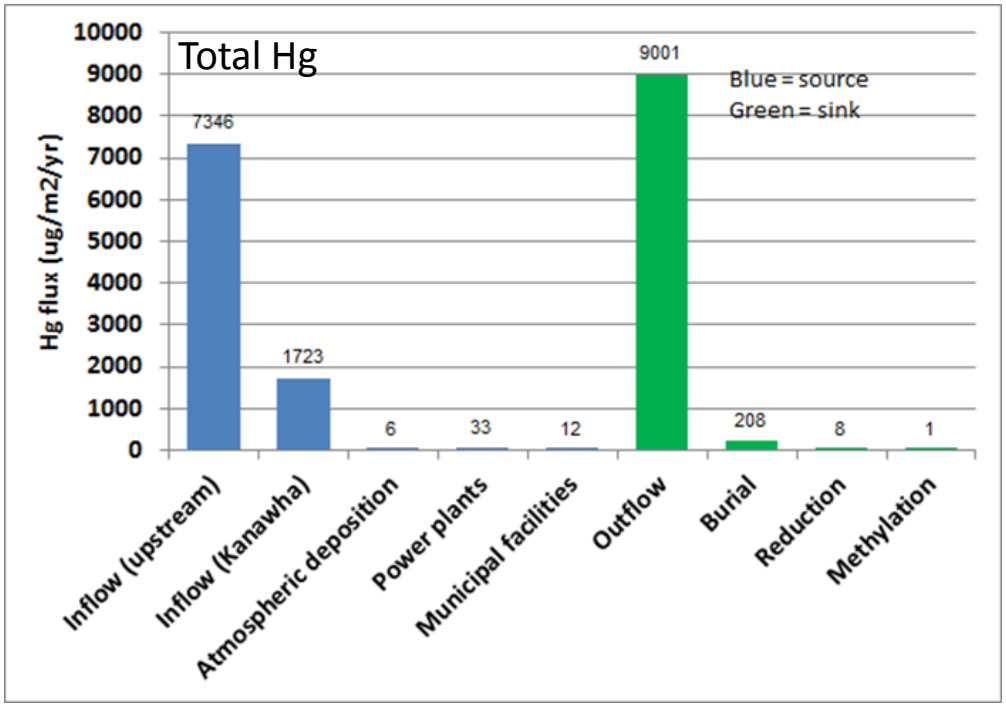
Building Blocks for Mercury Simulations

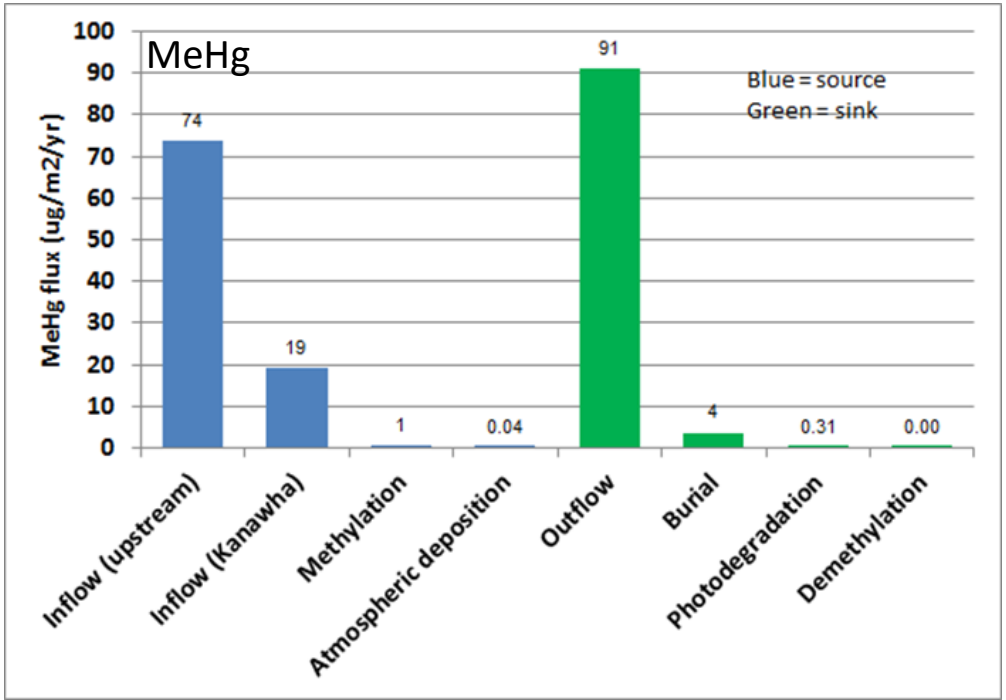


Data Sources

e.g.

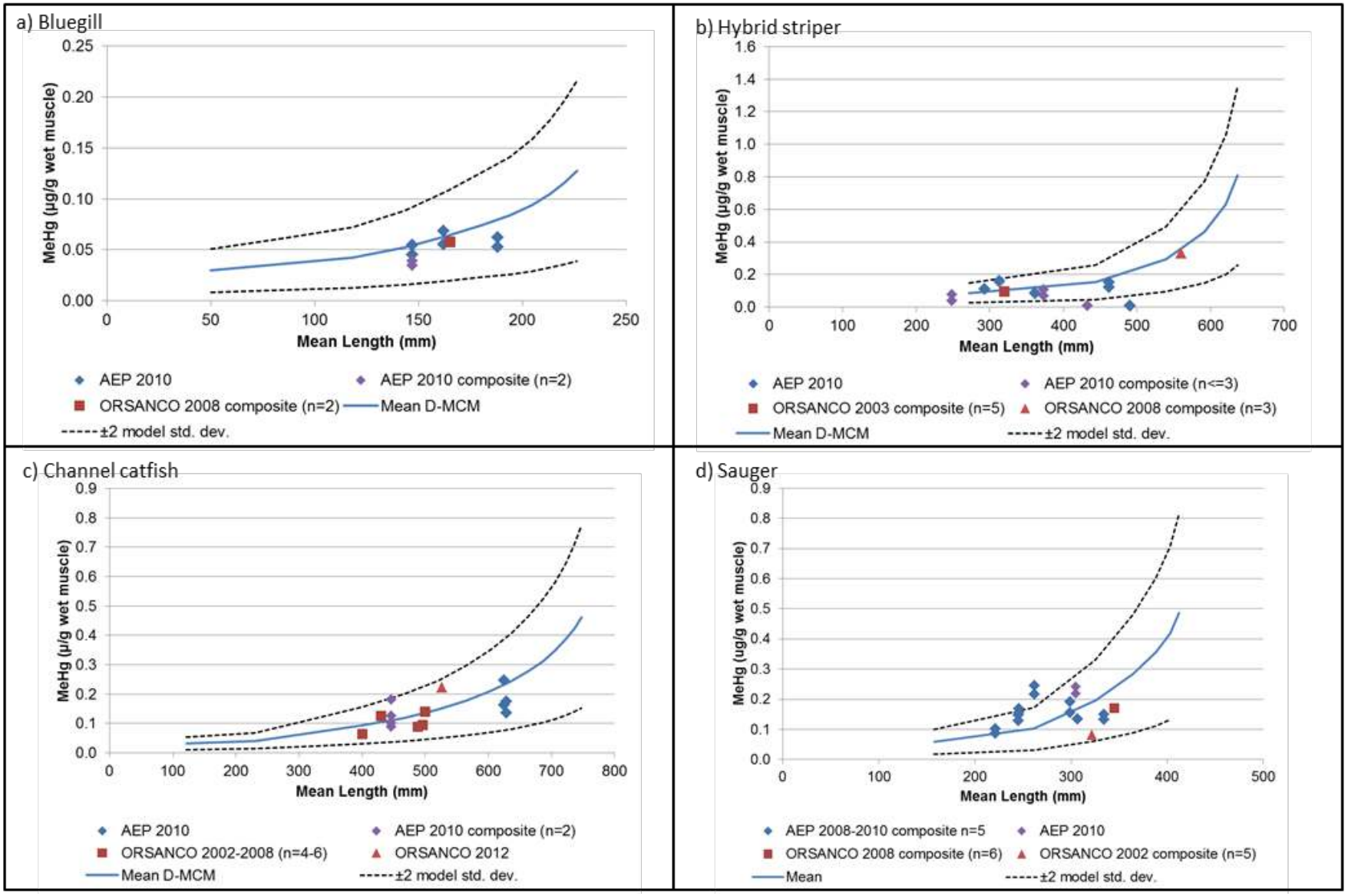
- URS (2012) Ecostudy report
- USGS (2009) South River Hg TMDL
- Hydroqual (2008) Conceptual Site Model for Hg in South River
- Dyer et al. conceptual model Hg flux estimates.
- Blum et al. Hg isotope data
- Landis et al. Benthic flux chamber data
- Ptacek et al. Bank studies
- Pizzuto et al. publications on particle dynamics
- URS food web studies
- Newman et al. trophic studies
- VDEQ fish Hg data

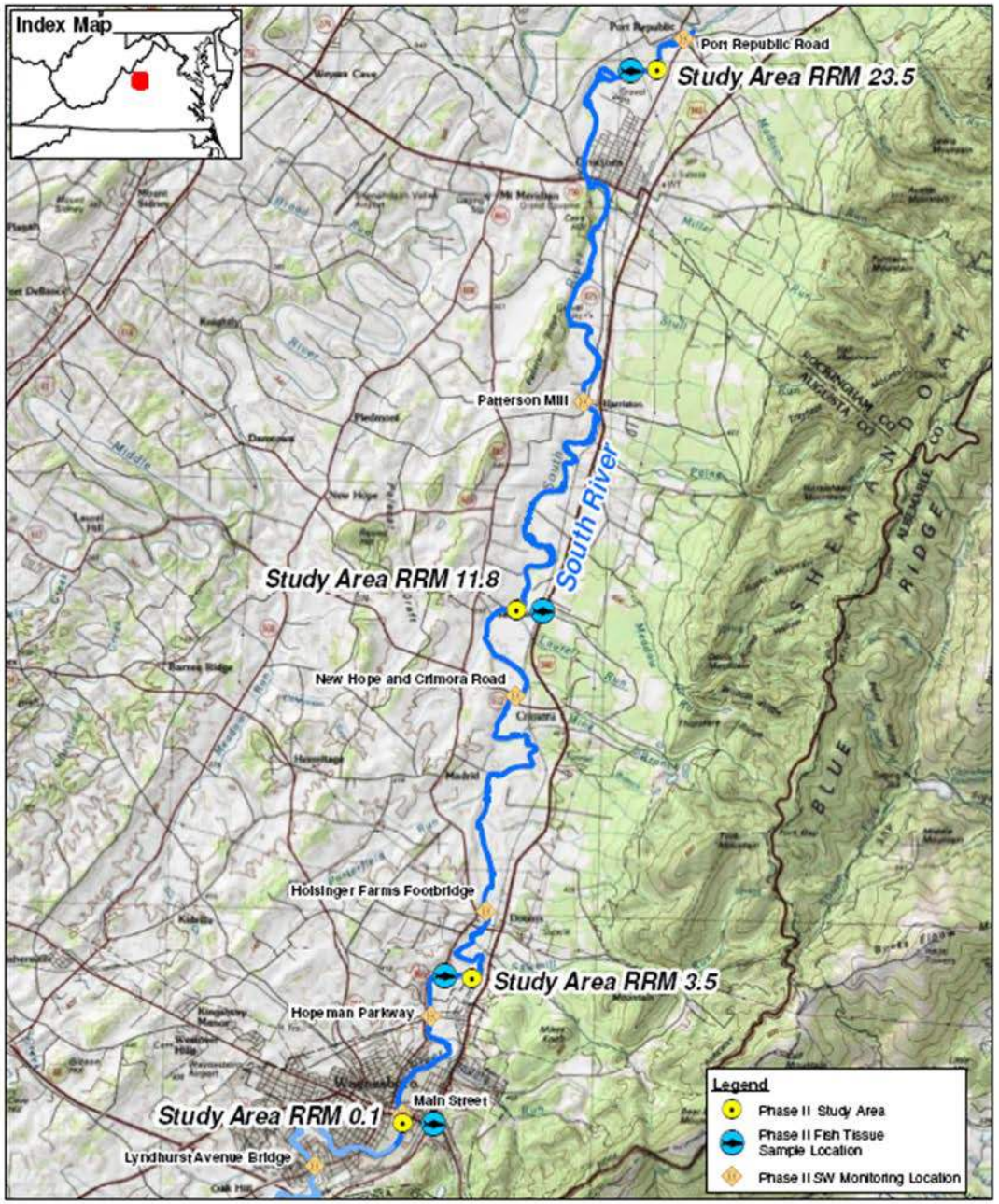


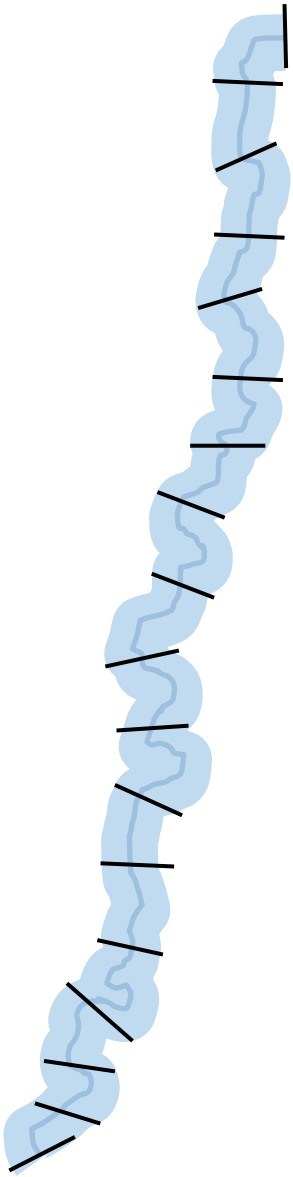


Predicted fluxes of total mercury and methylmercury in Robert C. Byrd Pool, Ohio River

Predicted and Observed MeHg in Fish in Robert C. Byrd Pool Ohio River







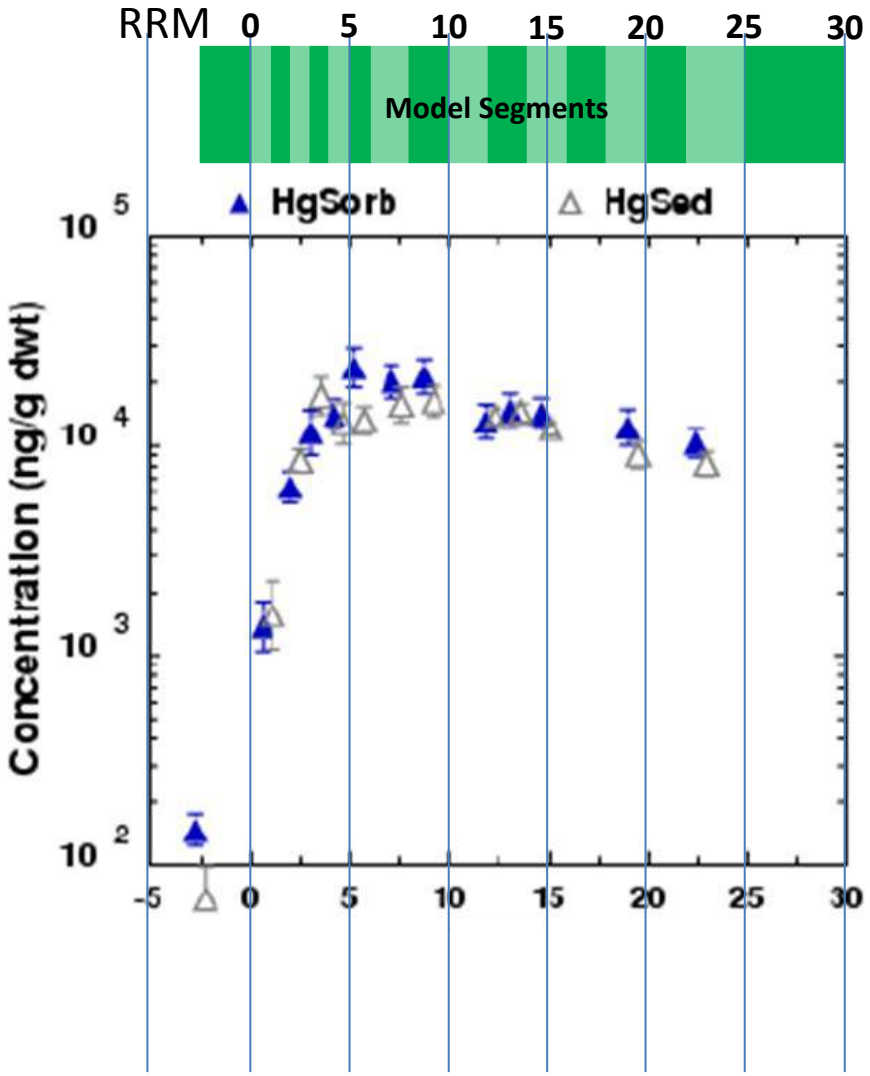
GRID DEVELOPMENT

Represent river as a set of connected cells

RM 0-30 ?

Floodplain is a boundary, not modeled with D-MCM

More model segments where conditions change faster….



Multiple factors to consider when developing grid:

e.g.

- **River conditions**
- **Hg loading**
- **Sampling locations**

How long should Hg simulations be?

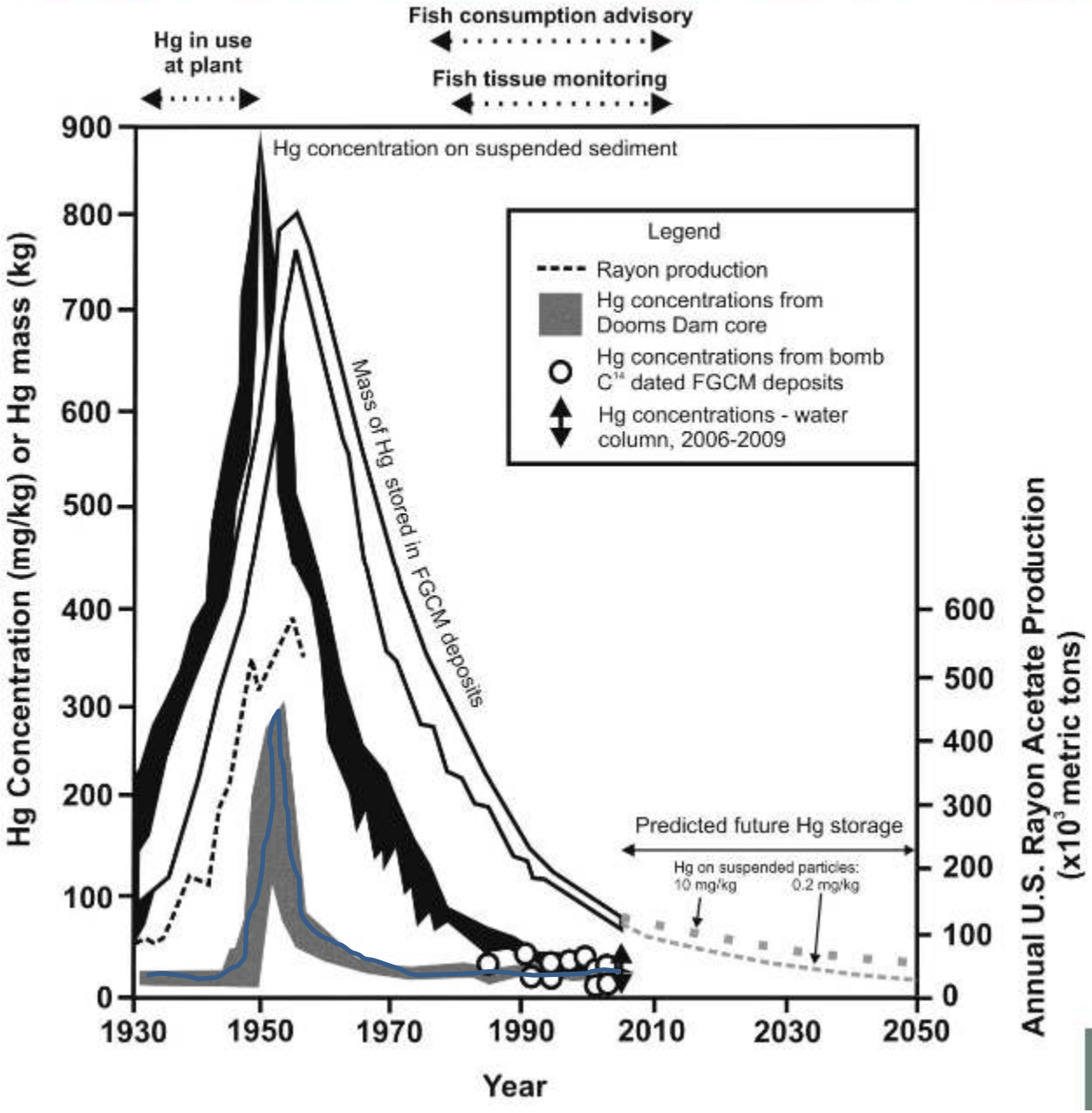
Option A: (2006-present)

- Model simulation starts with initial conditions in 2006, based on field data.
- Model is calibrated as needed to fit the data from 2006-present.
- No consideration of pre-2006 conditions.

Option B: ~1900 - present

- Hg loads before 2006 reconstructed from sediment record.
- Hg loads after 2006 based on field data (same as option A)
- Model is calibrated to match:
  - Sediment Hg history
  - Water-sediment-biota data from 2006-present.

Preliminary reconstruction of the history of Hg contamination in the South River (from Skalak and Pizzuto, i



Schedule

- Modeling completed Fall 2015
- Report completed end of 2015

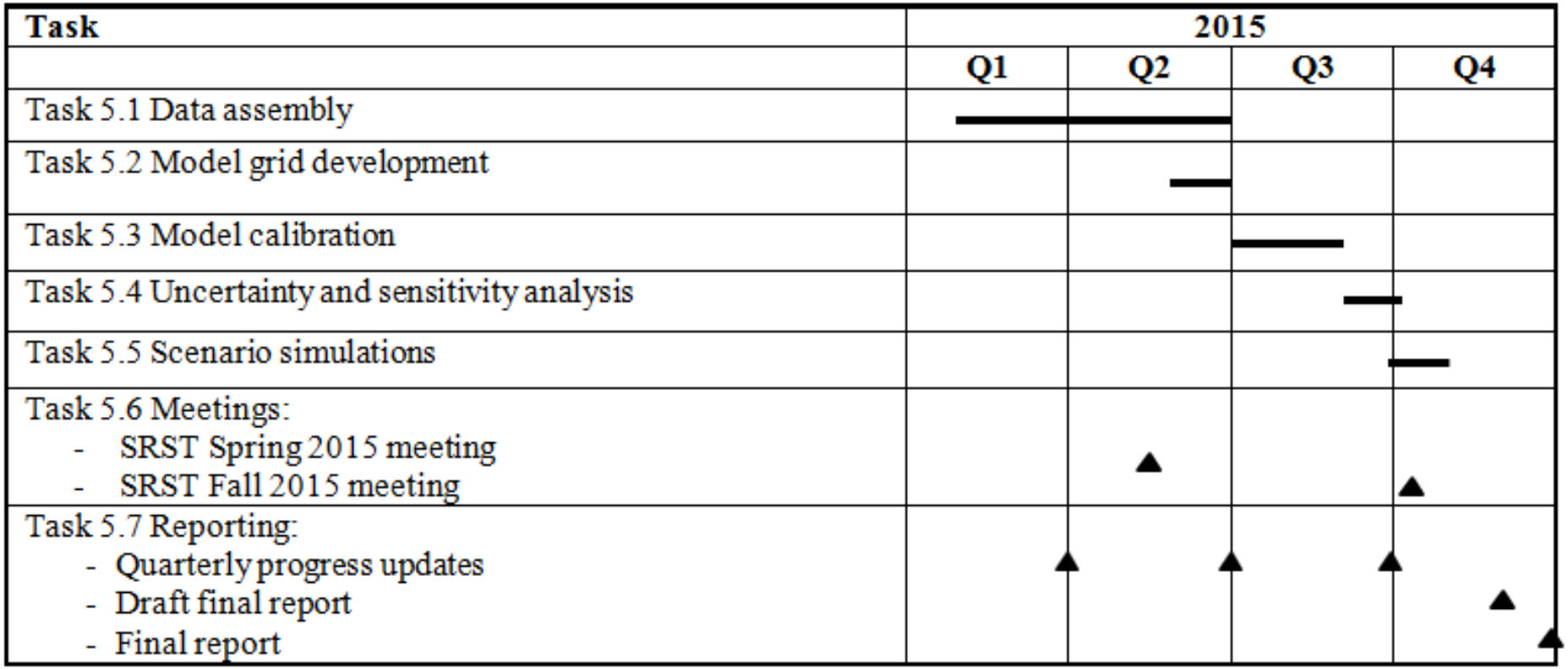


Figure 8. South River Dynamic Mercury Cycling Model study schedule

Next Steps

- Grid development
- Duration of simulation?
- How to handle storms?
- How to estimate particle fluxes.
- Data assembly