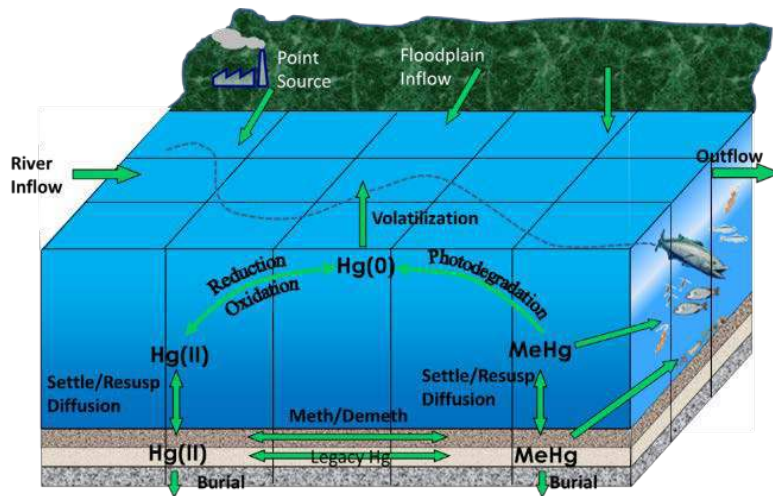
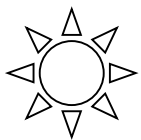


Mechanistic Mercury Modeling in the South River Project Update



Reed Harris and David Hutchinson
RHE Ltd.

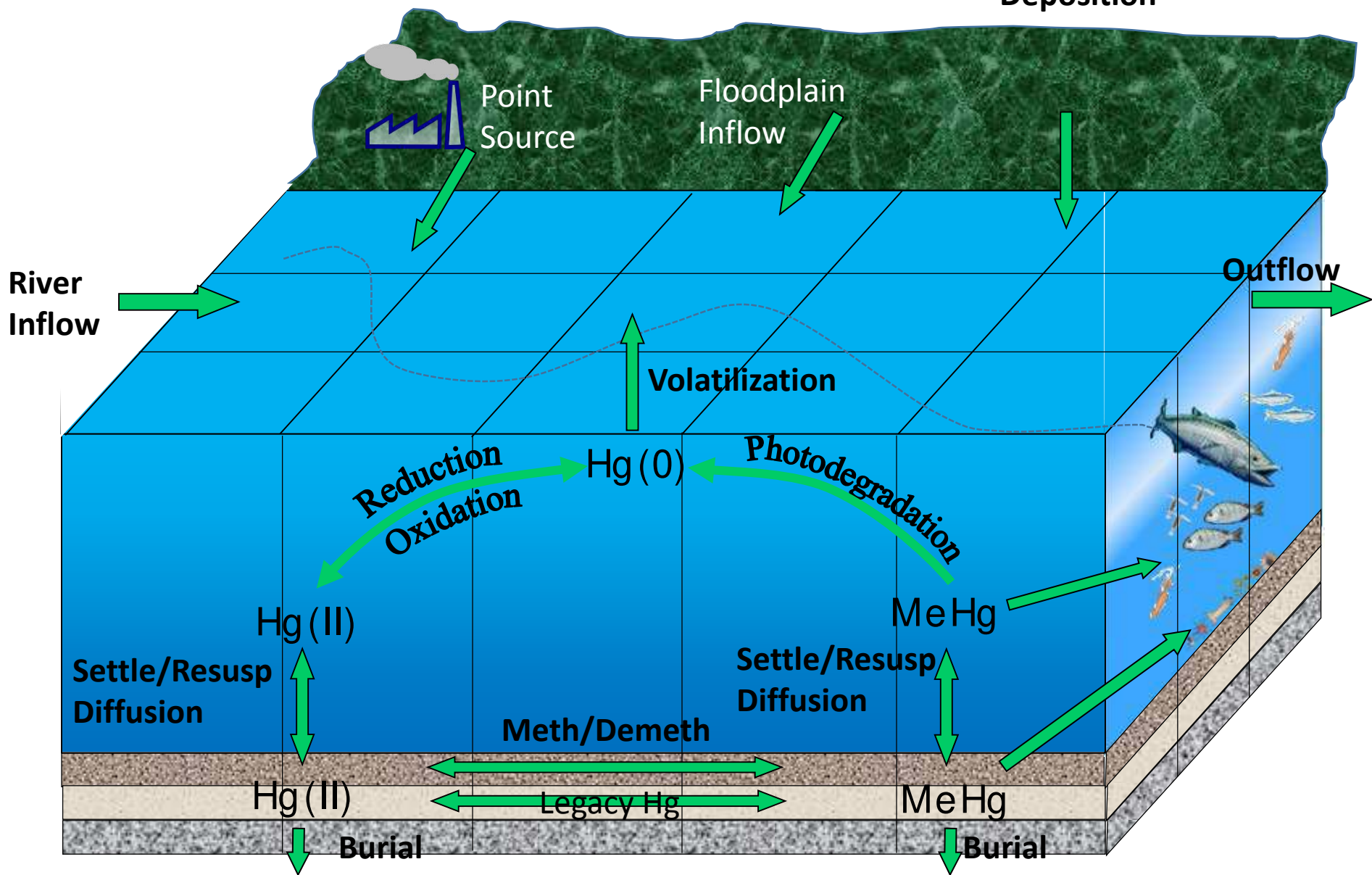
July 26, 2016



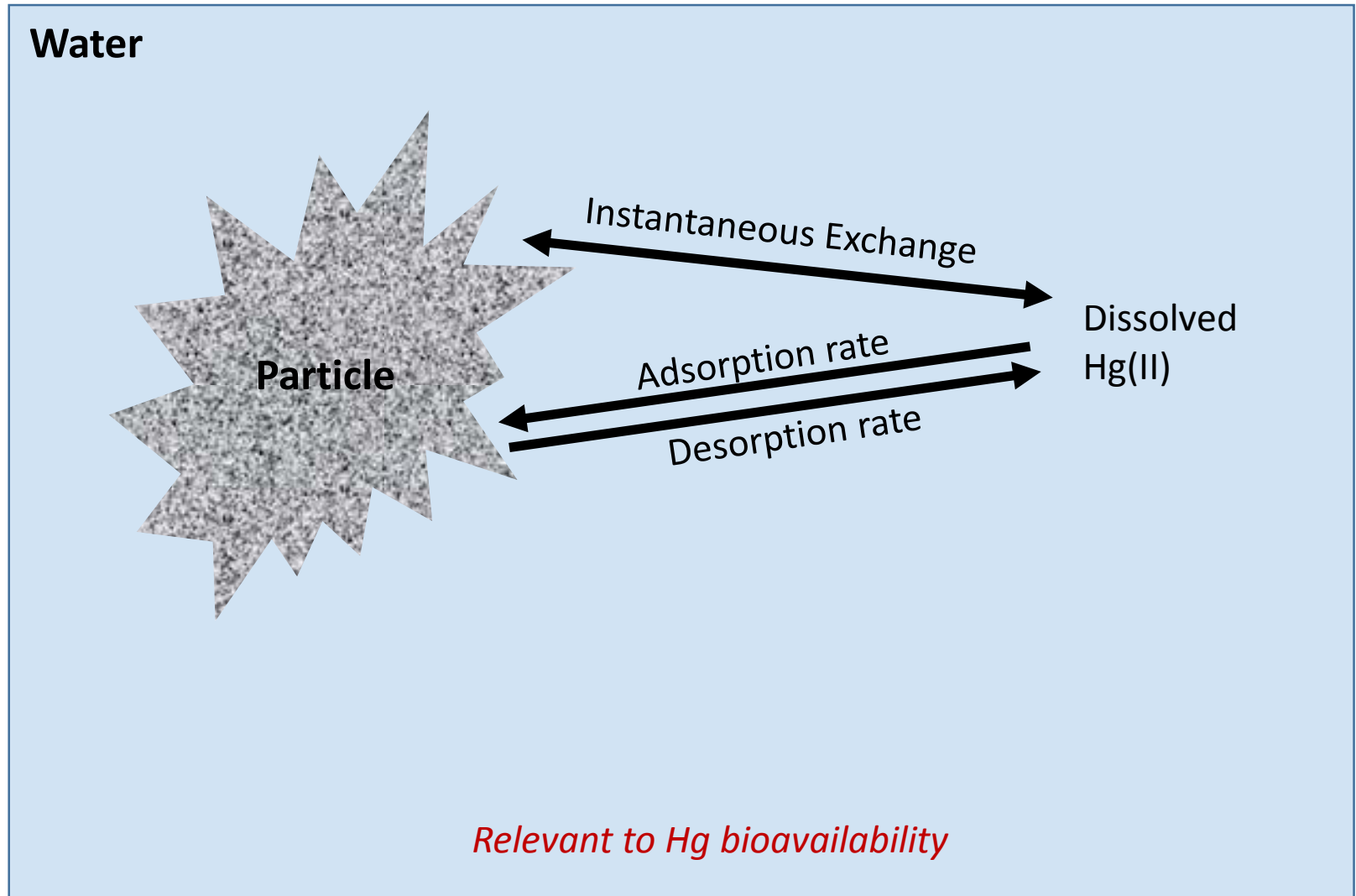
D-MCM setup for South River

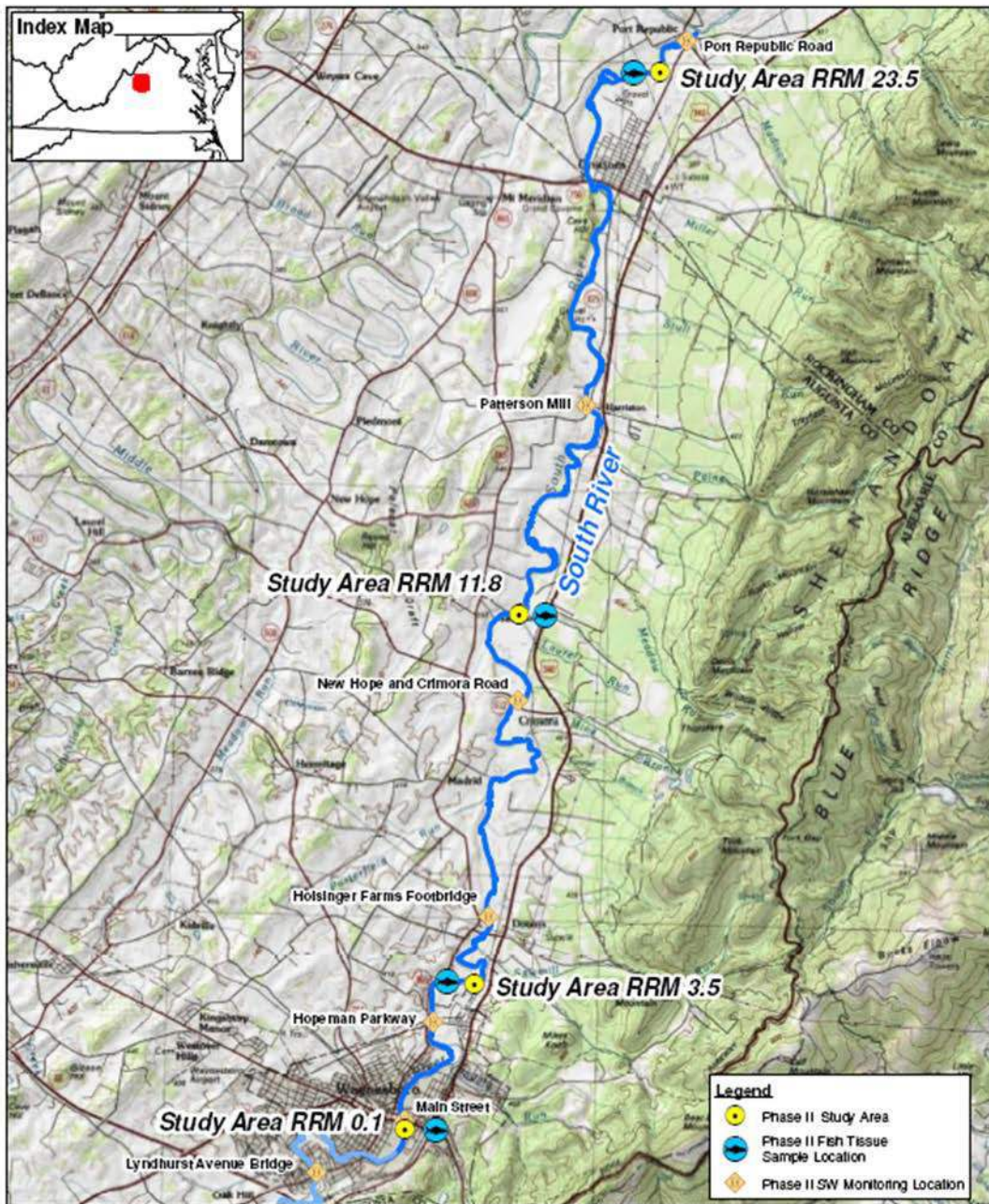


Atmospheric
Deposition



Slow and Fast Hg exchange on particles in D-MCM



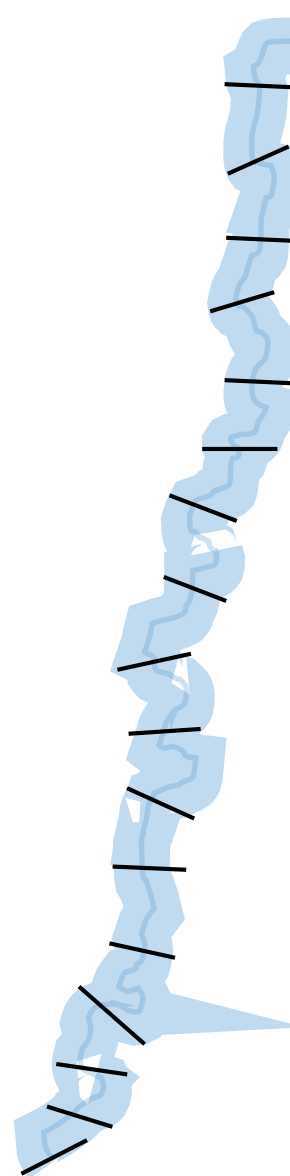


GRID DEVELOPMENT

Represent river as a set of connected cells

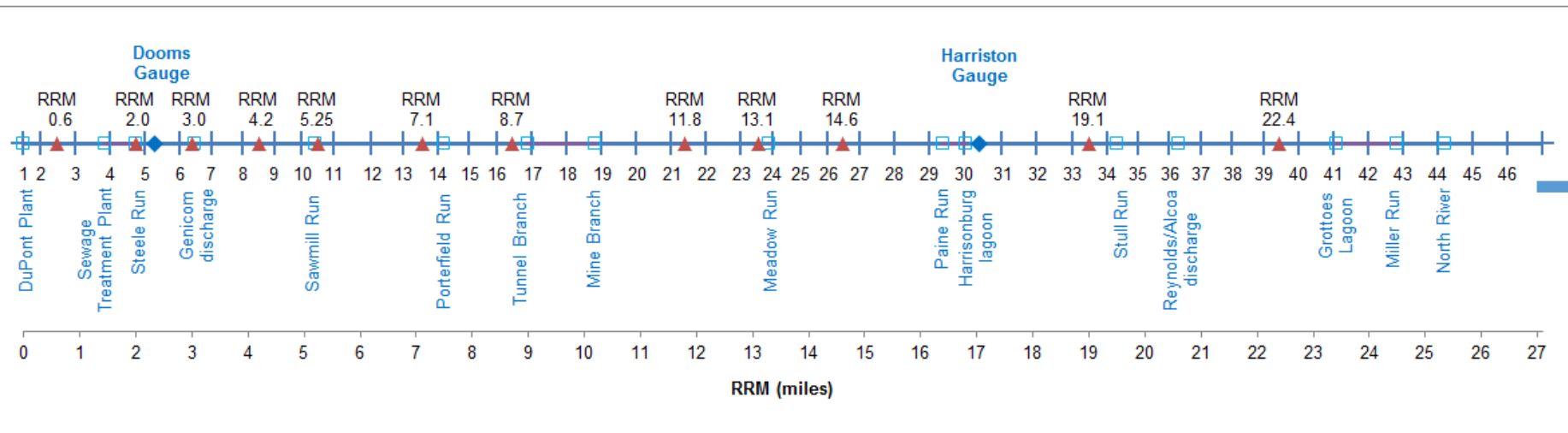
RM 0-27

Floodplain is a boundary, not modeled with D-MCM



Model Grid

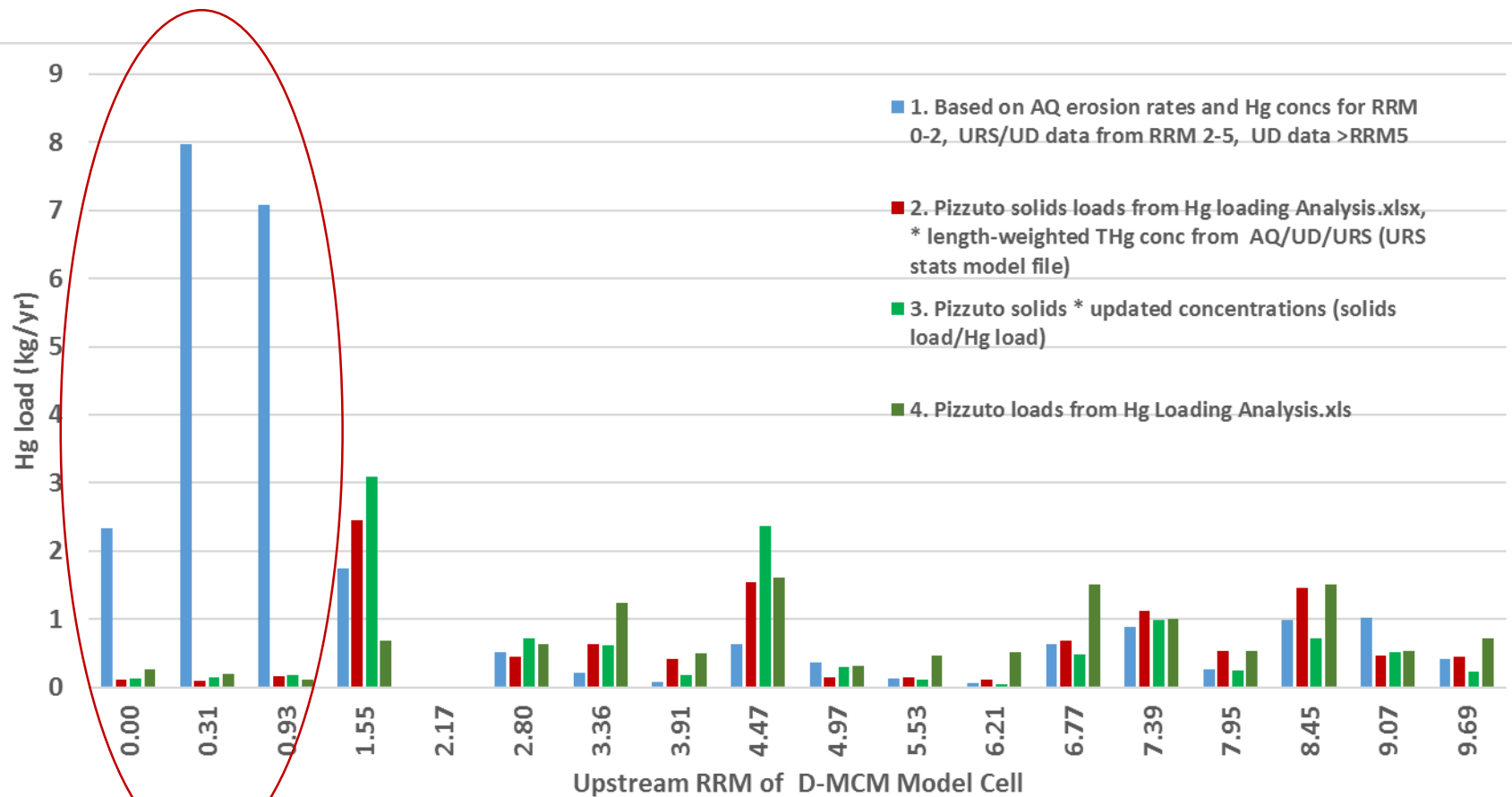
- 46 cells, each roughly 1 km long
- Simulation spans RRM 0 to ~RRM 27
- Water inputs increase flow along river



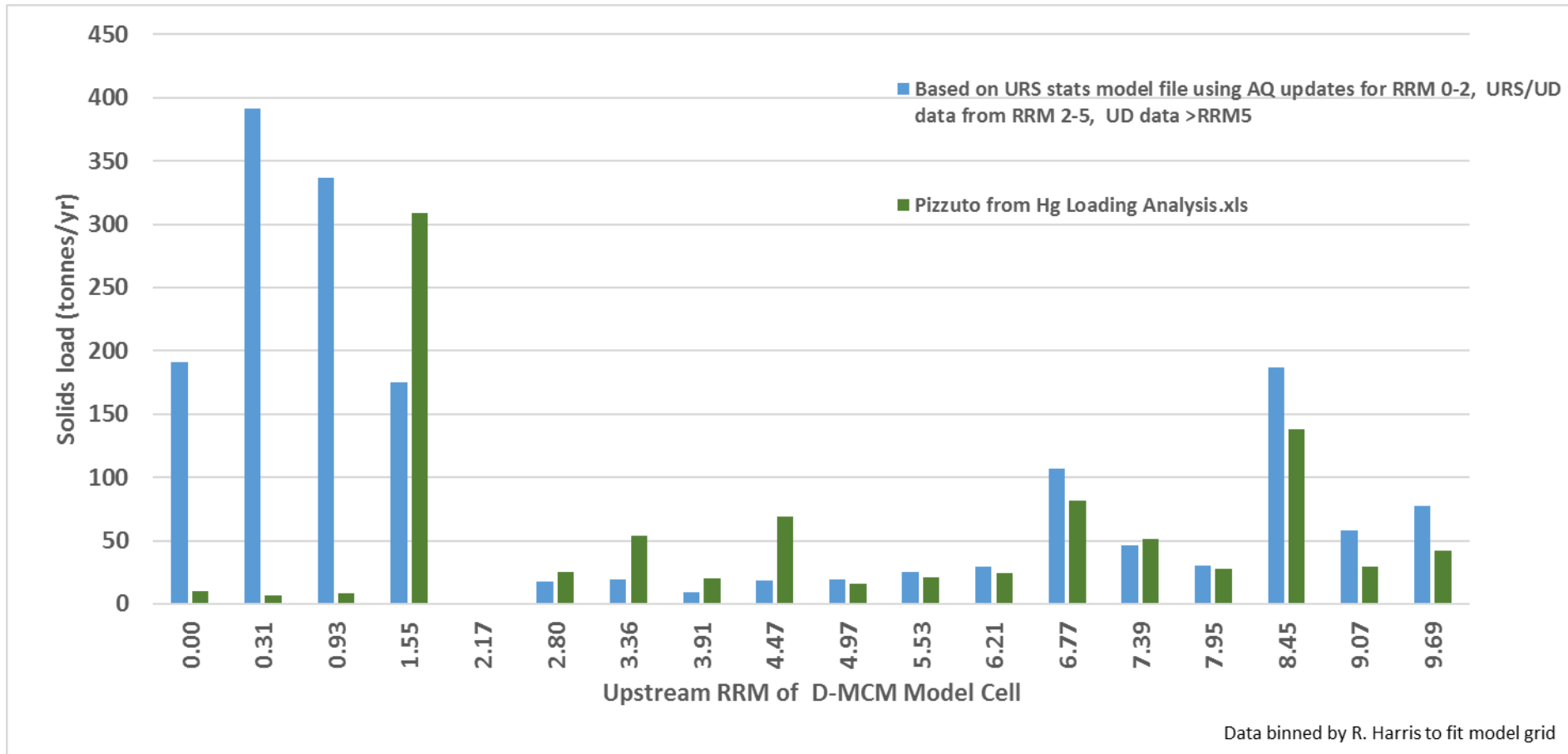
Solids and Hg loads from River Banks

Estimated Hg bank erosion loads using different combinations of solids loads and Hg concentrations....

- Wide range for first few miles....

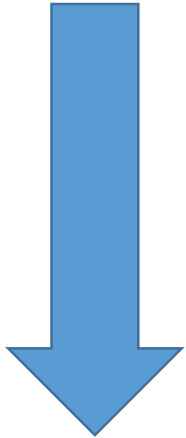


Key factor is the amount of solids eroding...

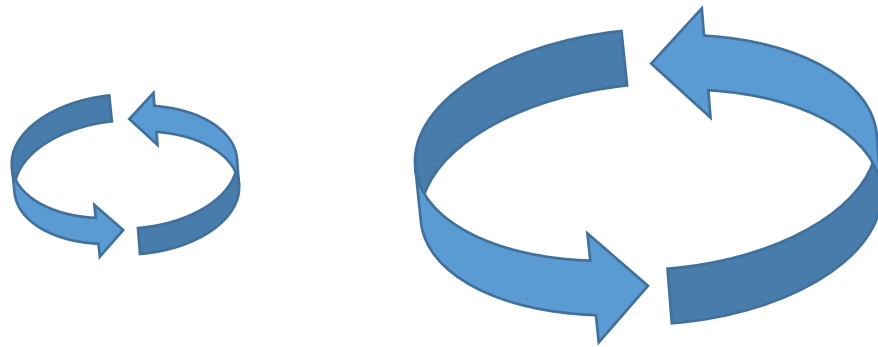


Model results are sensitive to gross and net rates of particle fluxes....

Net
sedimentation



Can achieve same net sedimentation with different combinations of settling and resuspension.

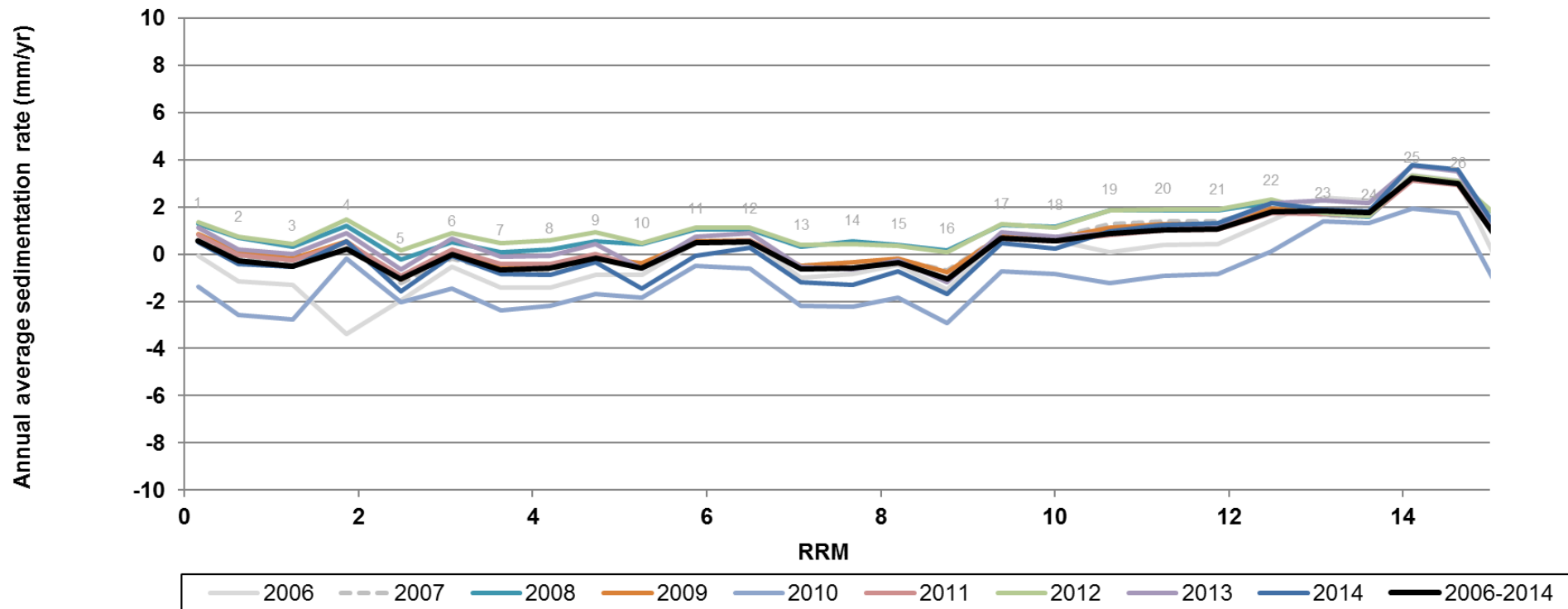


Faster resuspension and settling tend to make water column TSS Hg concentrations more like sediment concentrations.

System recovery is potentially faster if wheels spin faster... (and the ongoing Hg loading stops)

Tuned the model to try to achieve no net accumulation or erosion of solids in sediments along the river...

Is that reasonable?

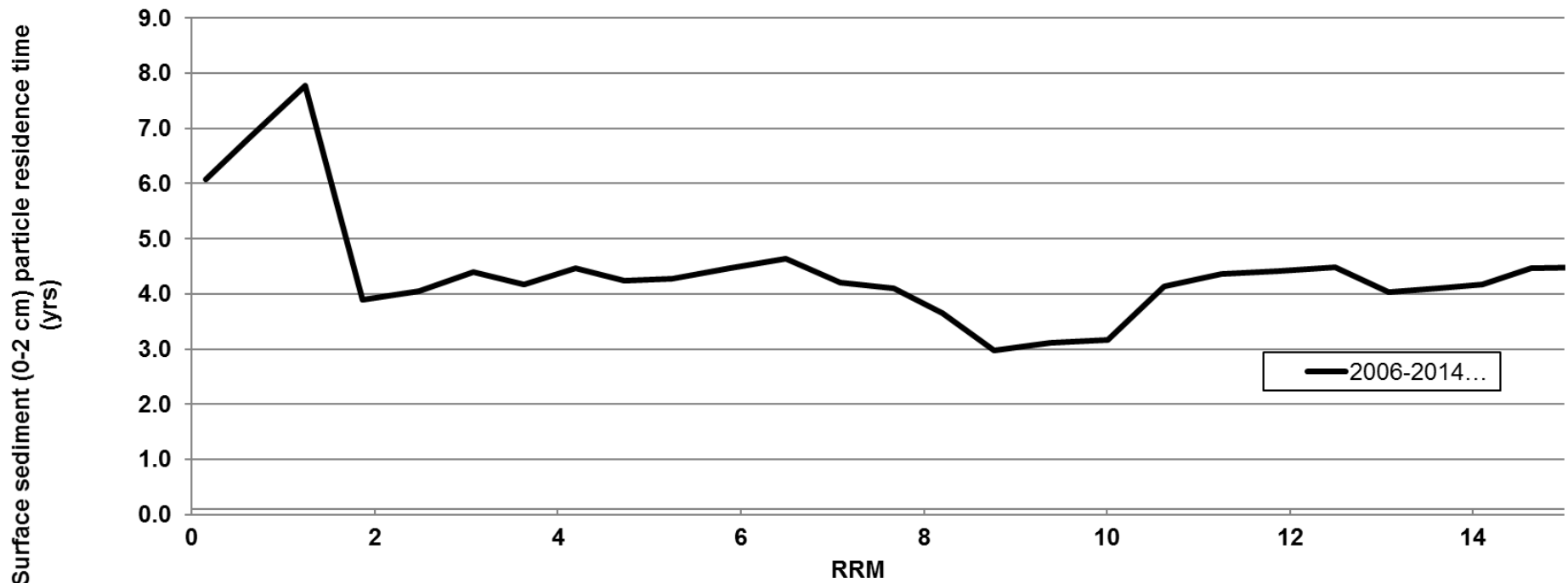


Surface layer of sediments (0-2 cm) currently have particle residence time of about 3-7 years.

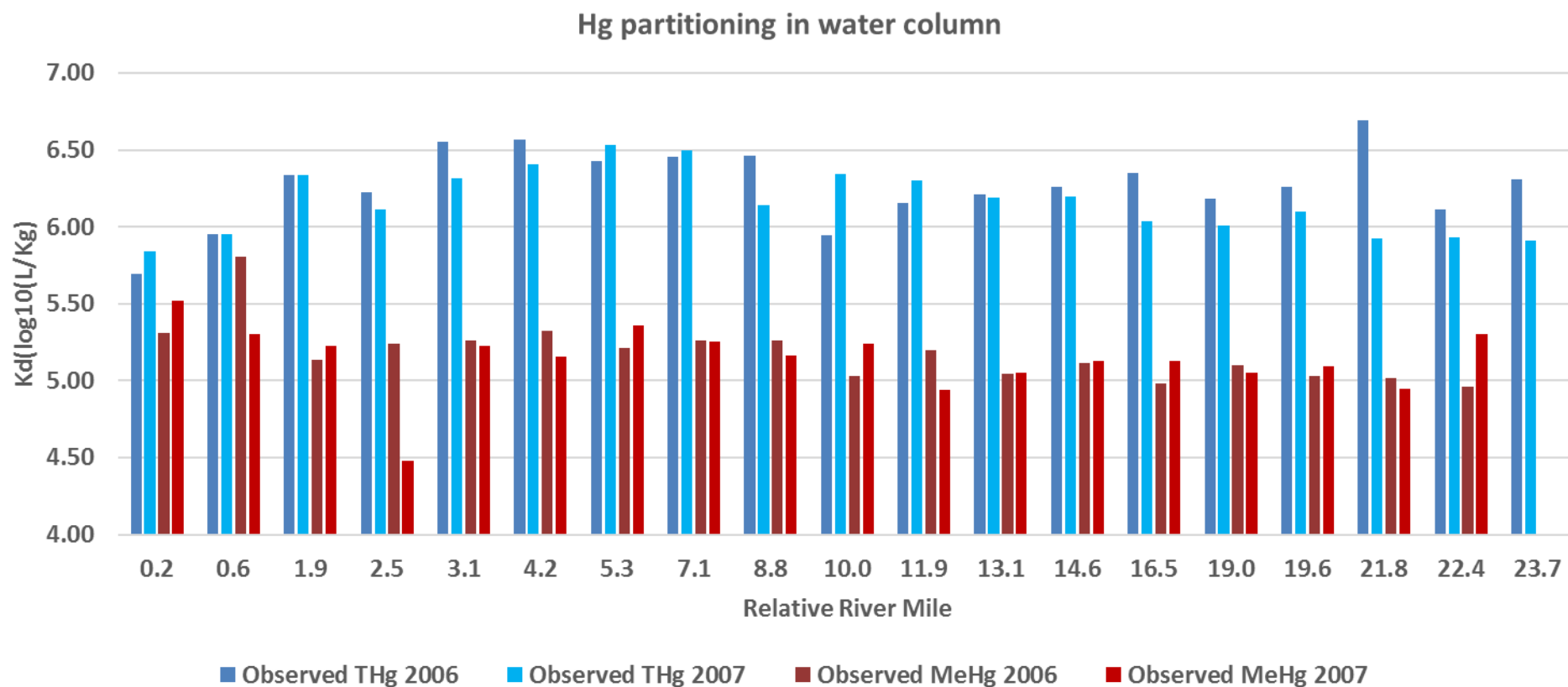
In a well mixed box it take about 3-4 residence times (10-30 years) to purge contamination, if ongoing loading stopped..

Some resuspended particles settle back into the sediments... not gone...

Are these rates reasonable?



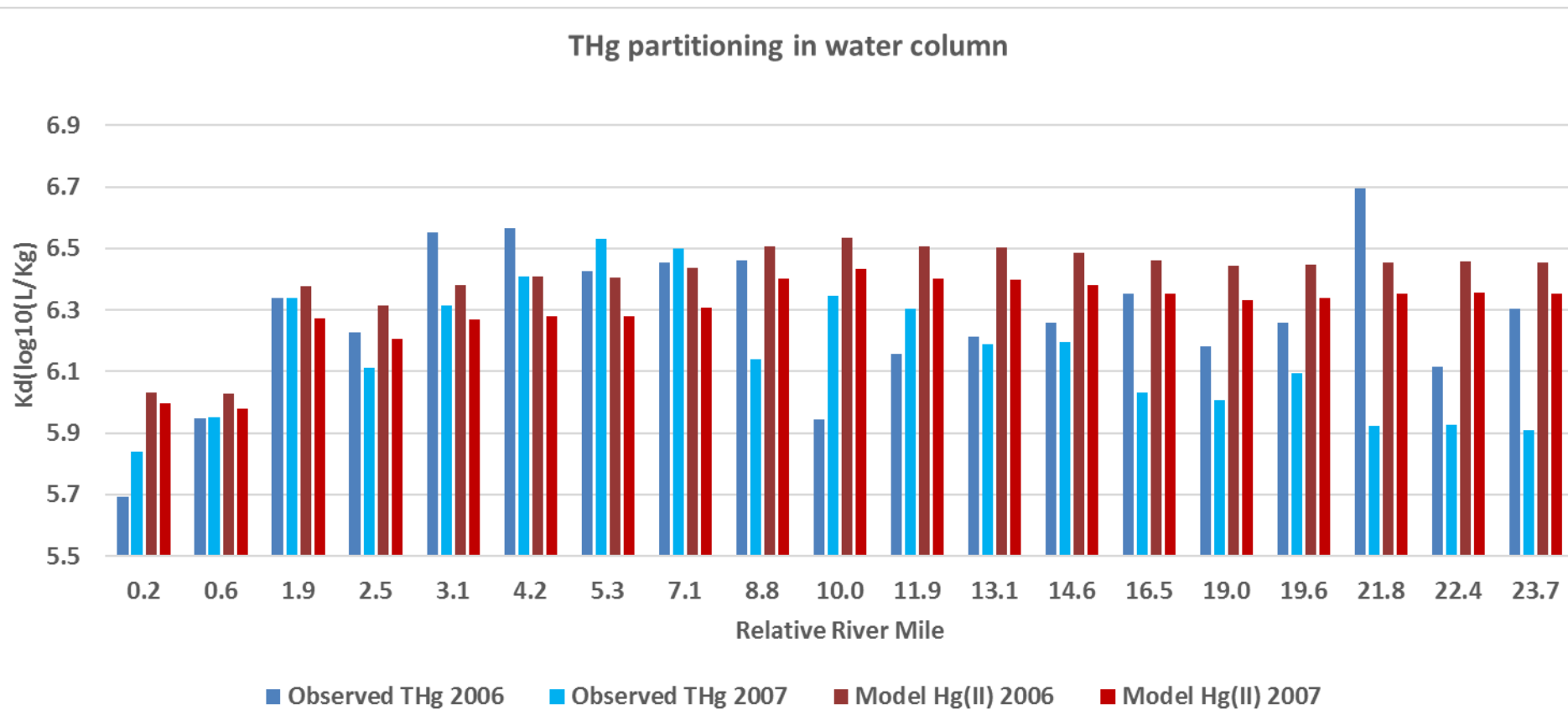
Mercury partitioning



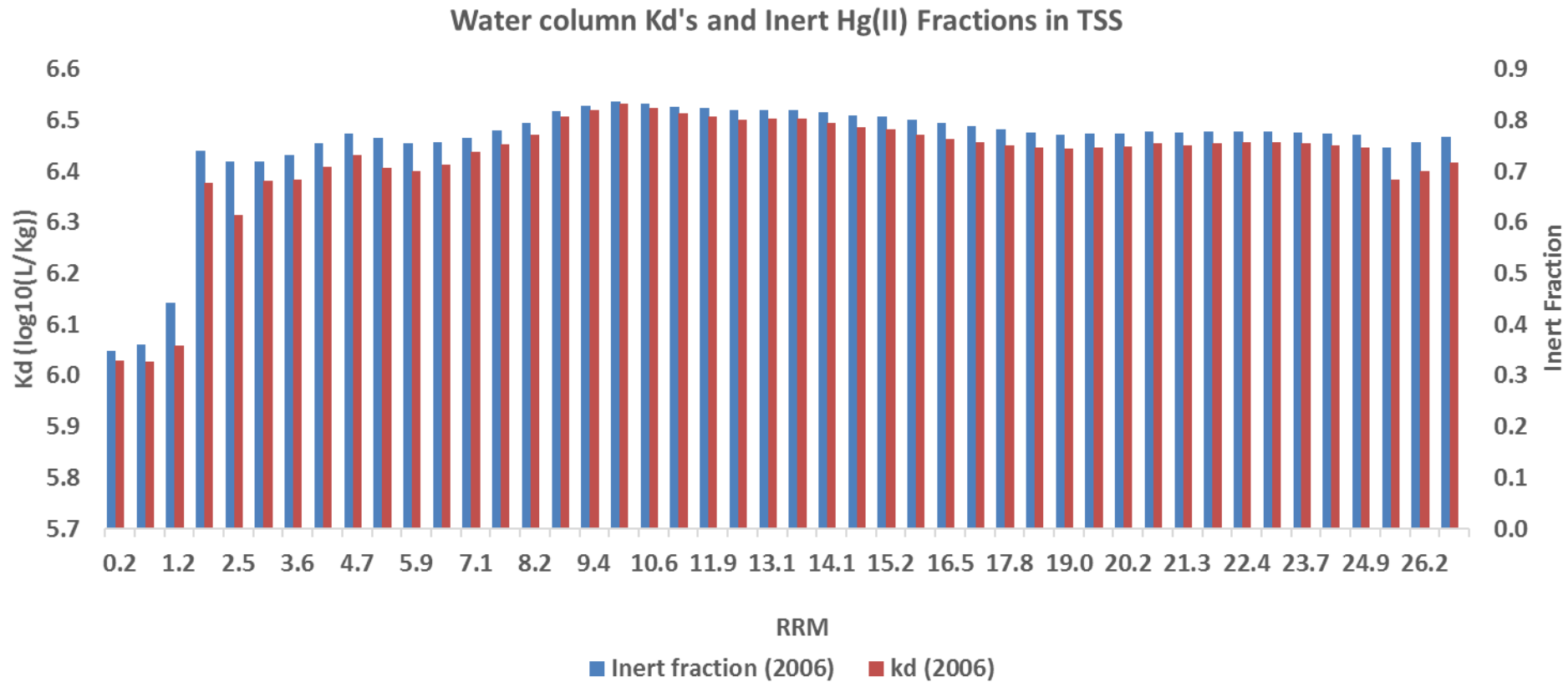
These numbers are based on average annual particle and filtered concentrations at different locations...

.....would be better to use paired samples...

Model captures increase in “Kd” for first few miles, but not the decline farther downstream...

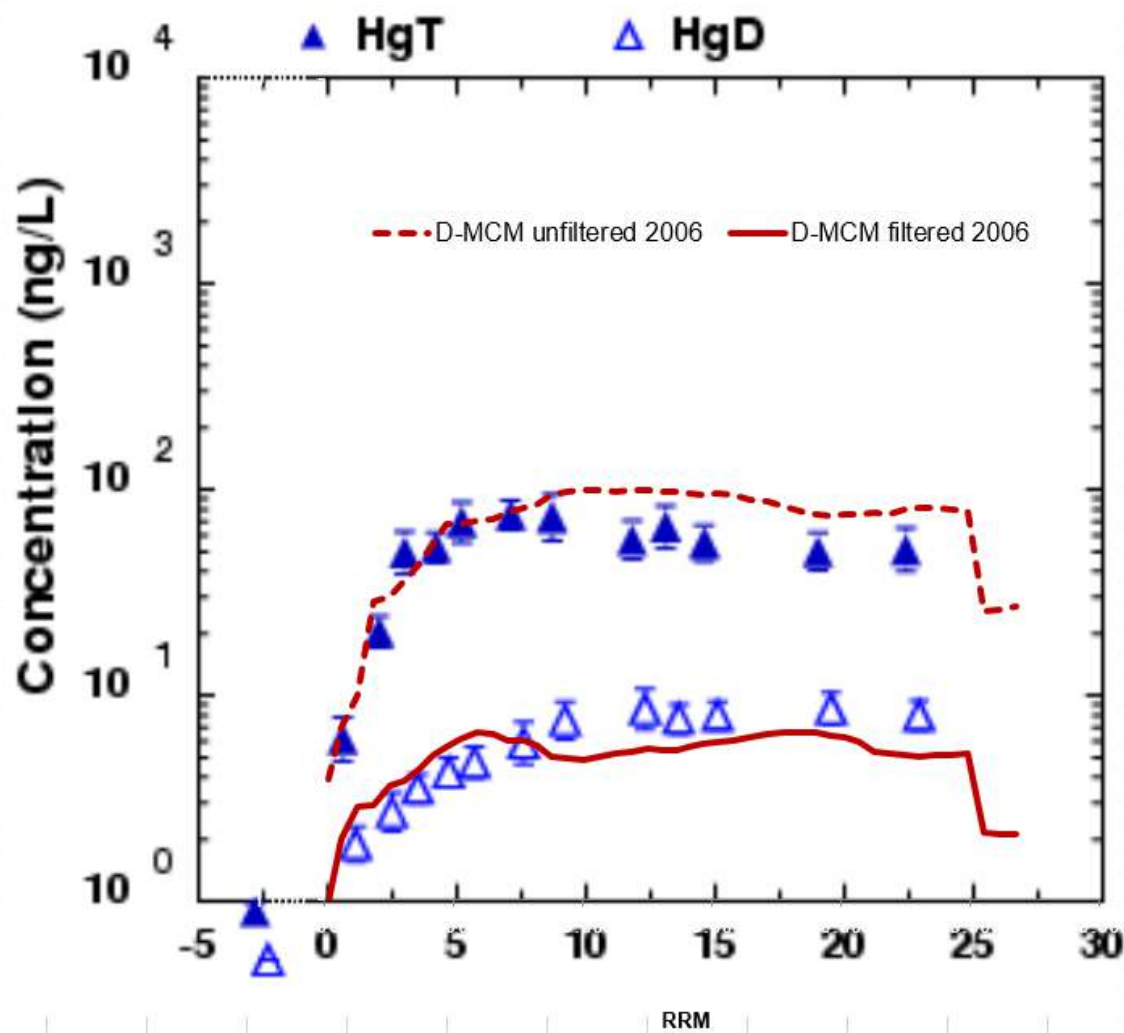


Mercury partitioning depends on the blend of freely exchangeable and strongly bound Hg in the model.....

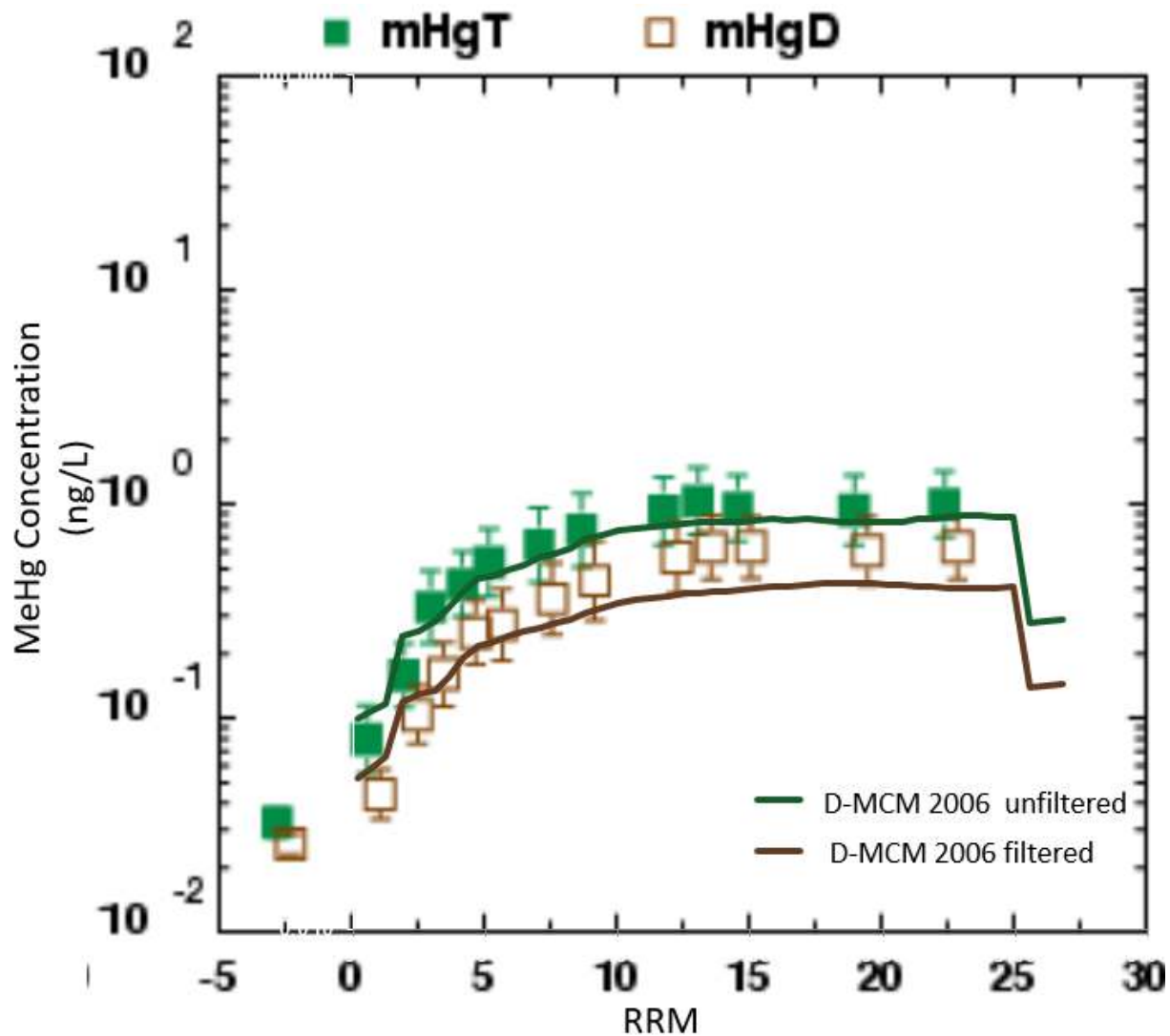


Current Calibration Results

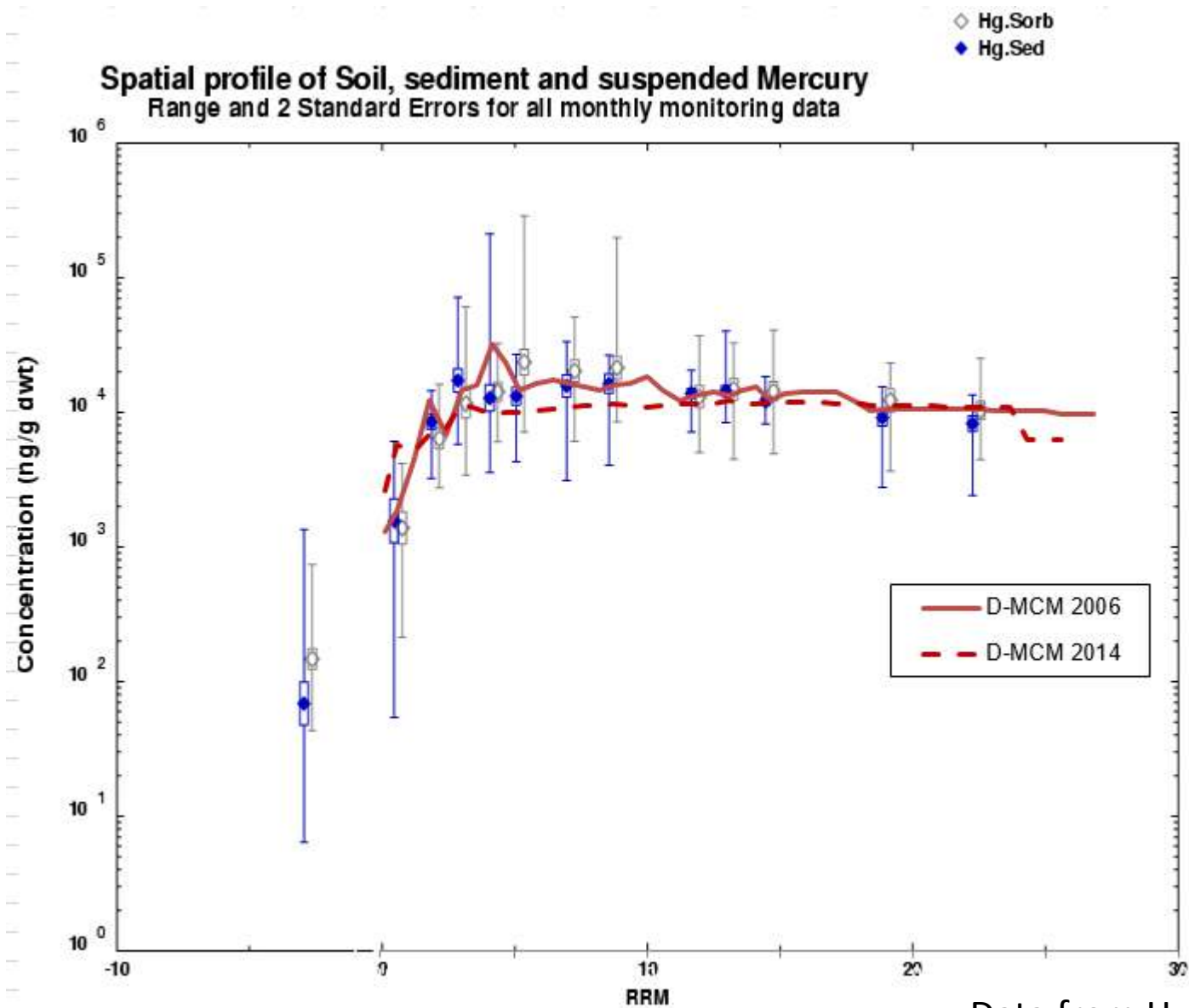
Observed and predicted THg concentrations in the water column in 2006



Observed and predicted MeHg concentrations in the water column in 2006

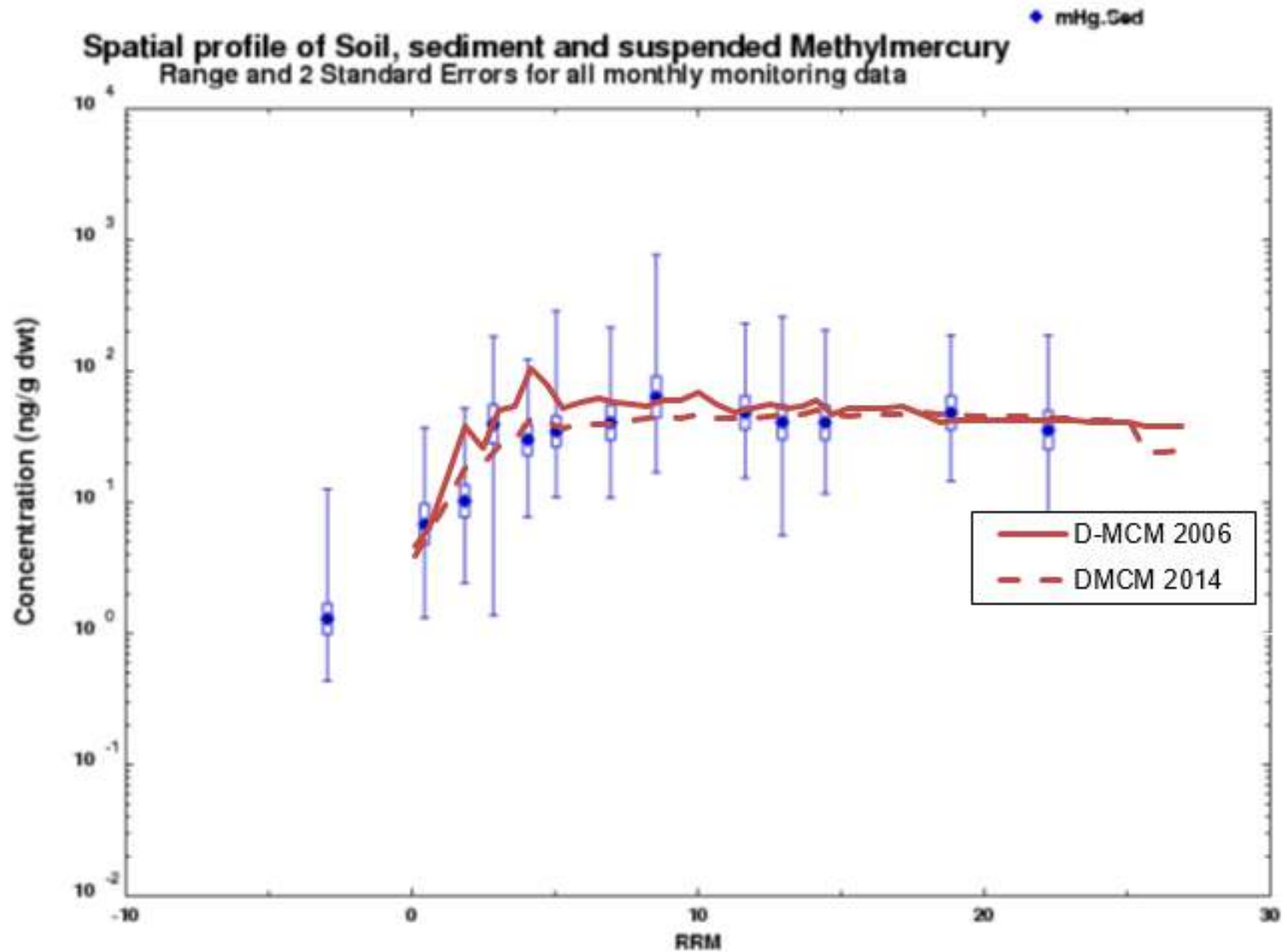


Observed and predicted THg concentrations in the surface sediments in 2006



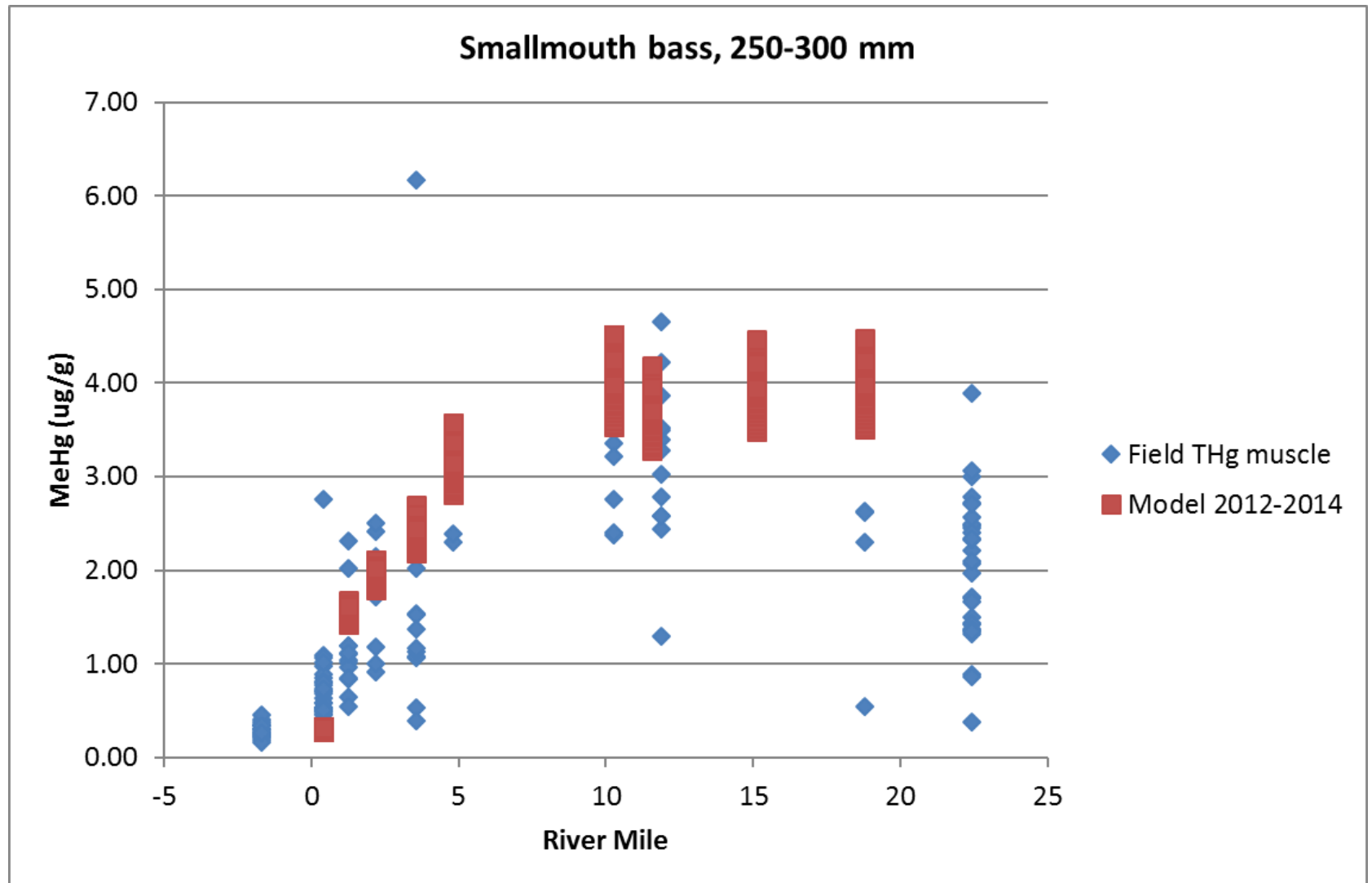
Data from HydroQual (2008)

Observed and predicted MeHg concentrations in the water column in 2006



Data from HydroQual (2008)

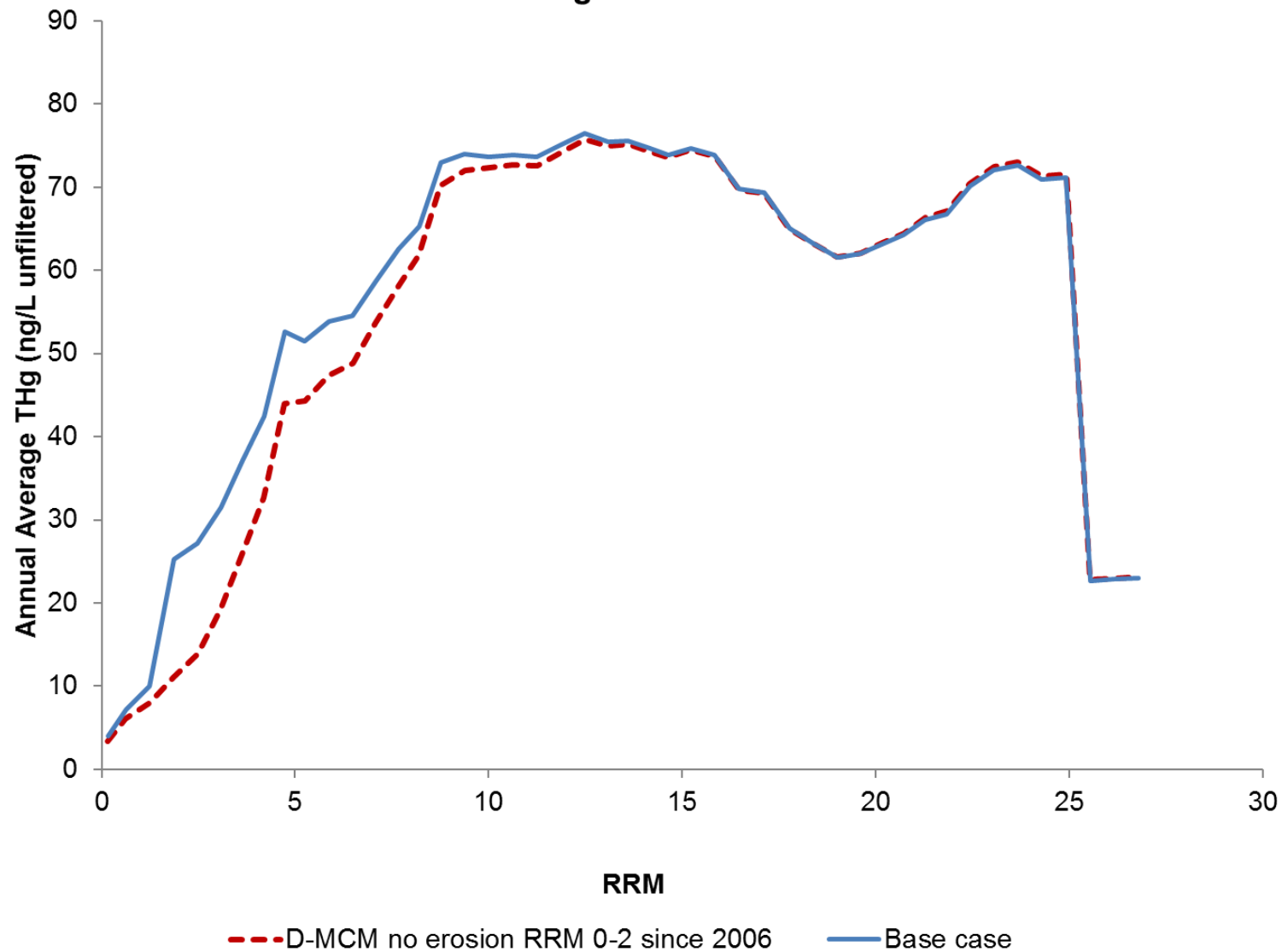
Observed and predicted MeHg concentrations in Biota



Bank Stabilization Scenario

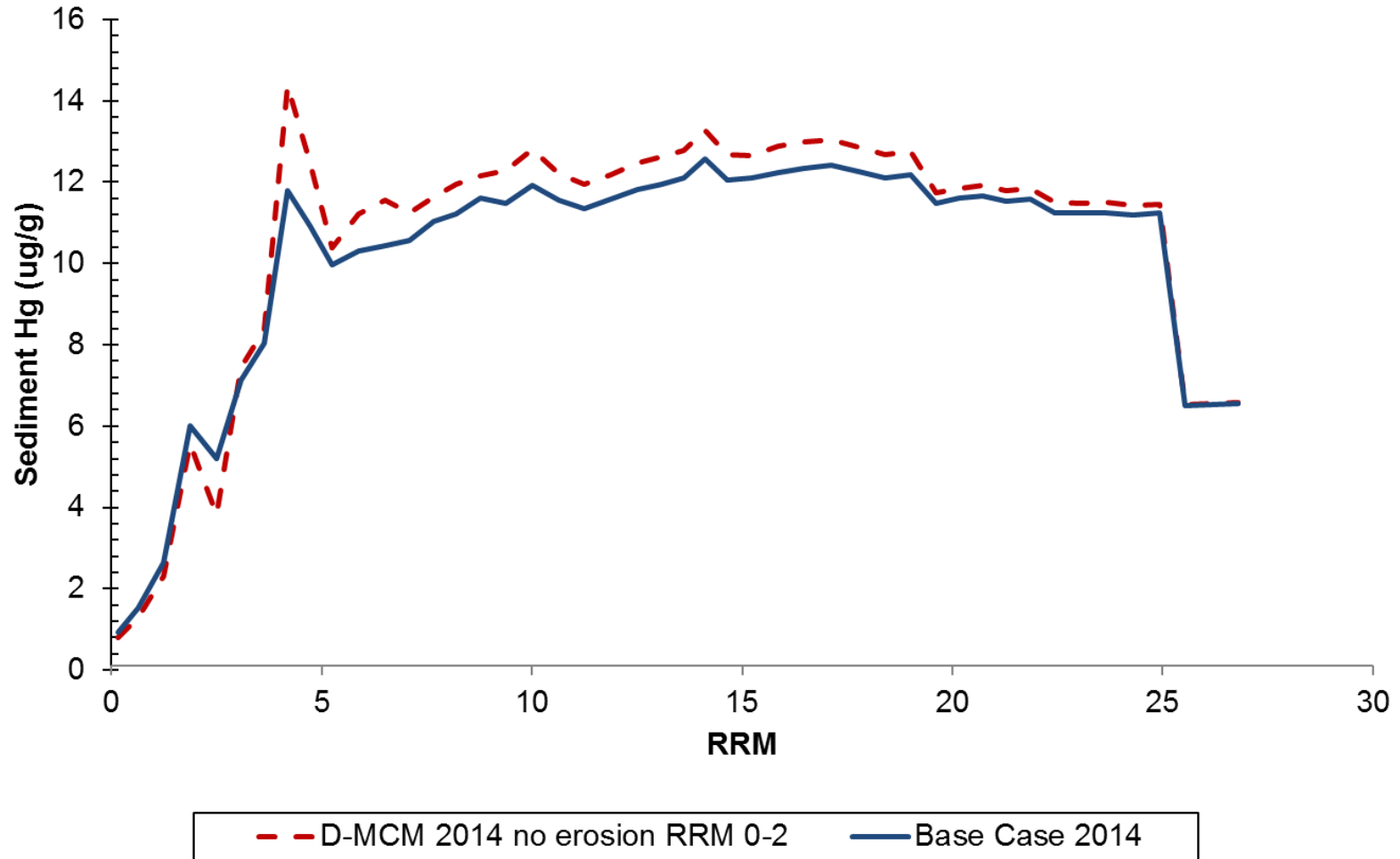
Eliminate Erosion for RRM 0-2

Predicted River THg concentrations in 2014



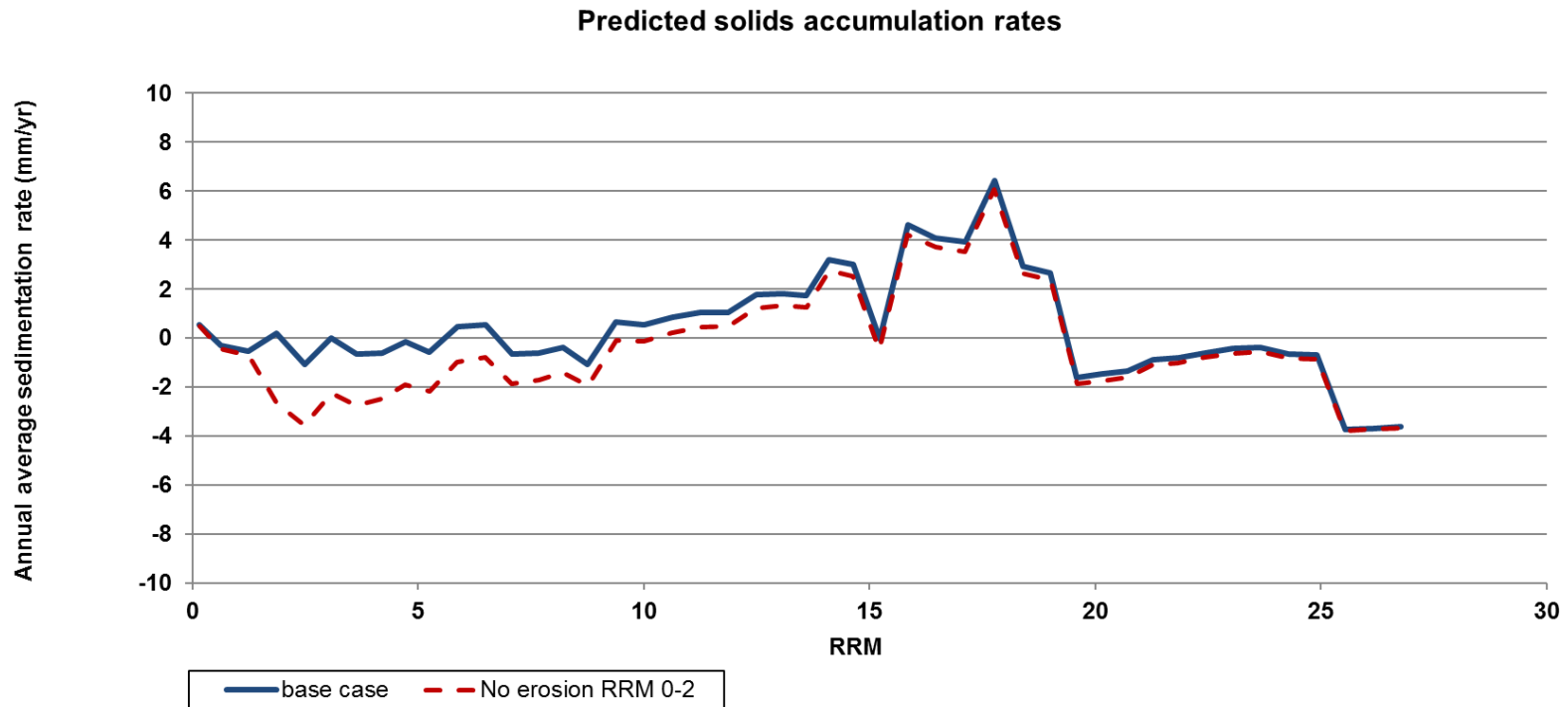
Increasing Sediment THg downstream of stabilized reaches??

- *Could easily be model artifact...*



Likely explanation in the model is that less bank erosion results in erosion in sediment bed...

Would this really happen? D-MCM treatment of particle dynamics is very simplified...



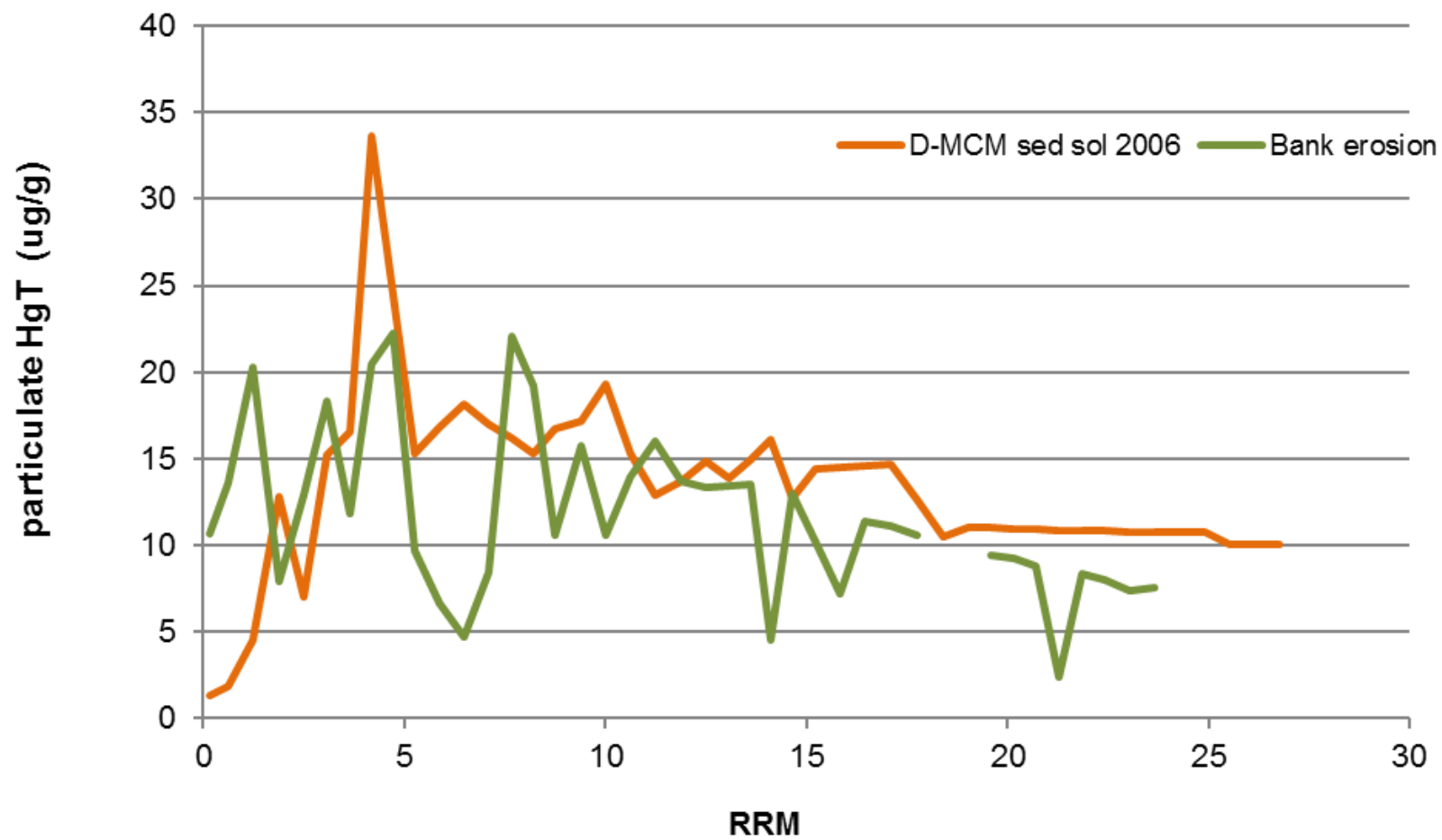
Summary

- Model reasonably simulating several, but not all, key trends
- Particle dynamics very important (gross and net fluxes)
- What will bank stabilization do to particle dynamics in river bed? Current model results probably need adjustment.

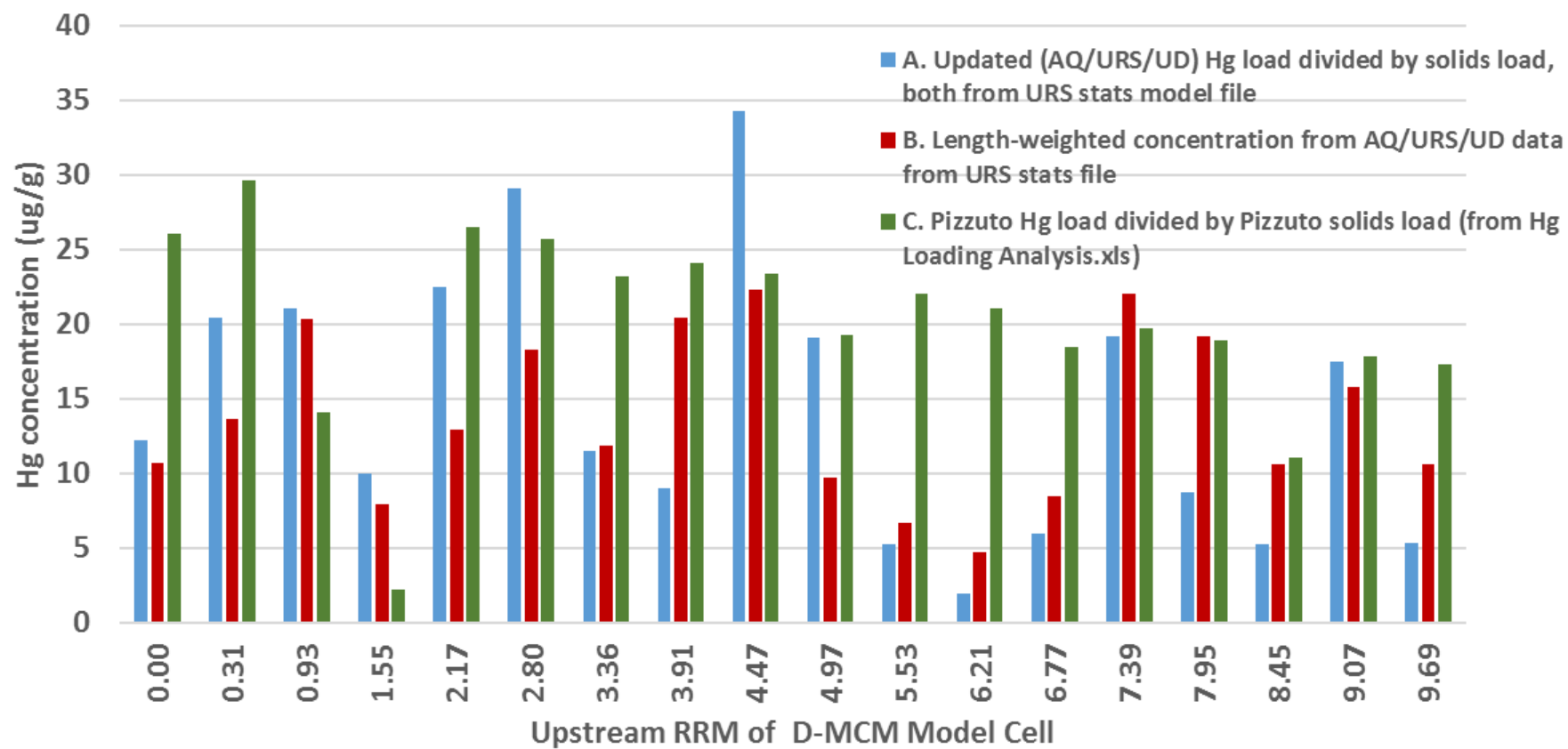
Next steps

- Resolve issue of “hump” too far downstream in model.
- Further examine model results for downstream erosion after bank stabilization... likely needs adjustments...
- Test sensitivity to strongly bound vs freely exchangeable Hg on solids.
- Scenarios with elimination of different sources
 - Bank erosion RRM 0-2
 - Bank erosion RRM 0-5
 - Bank leaching
 - Invista site loads.

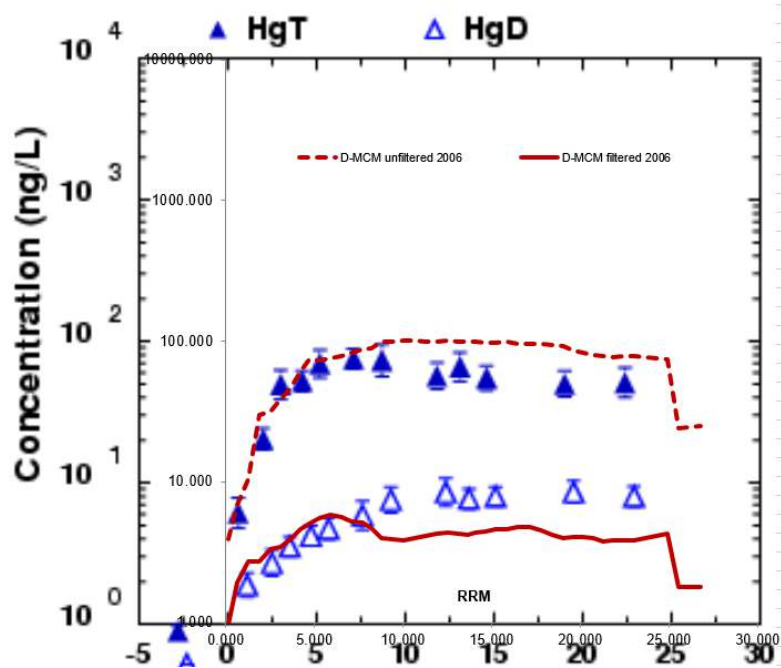
Extra slides..



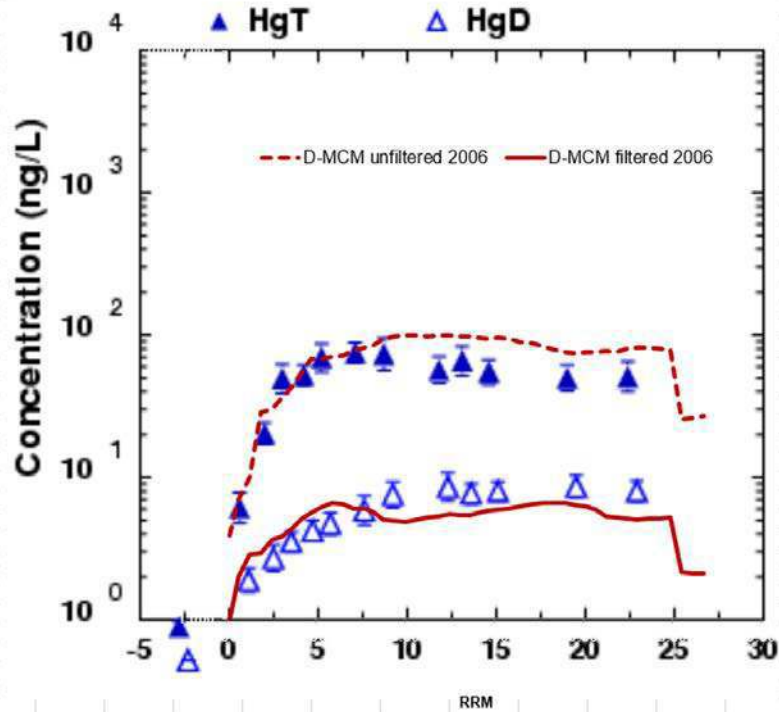
Estimated THg concentrations in D-MCM model reaches



Data binned by R. Harris to fit model grid



$V_{\text{settle}}(3) = 3 \text{ m/day}$



$V_{\text{settle}}(3) = 1.5 \text{ m/day}$