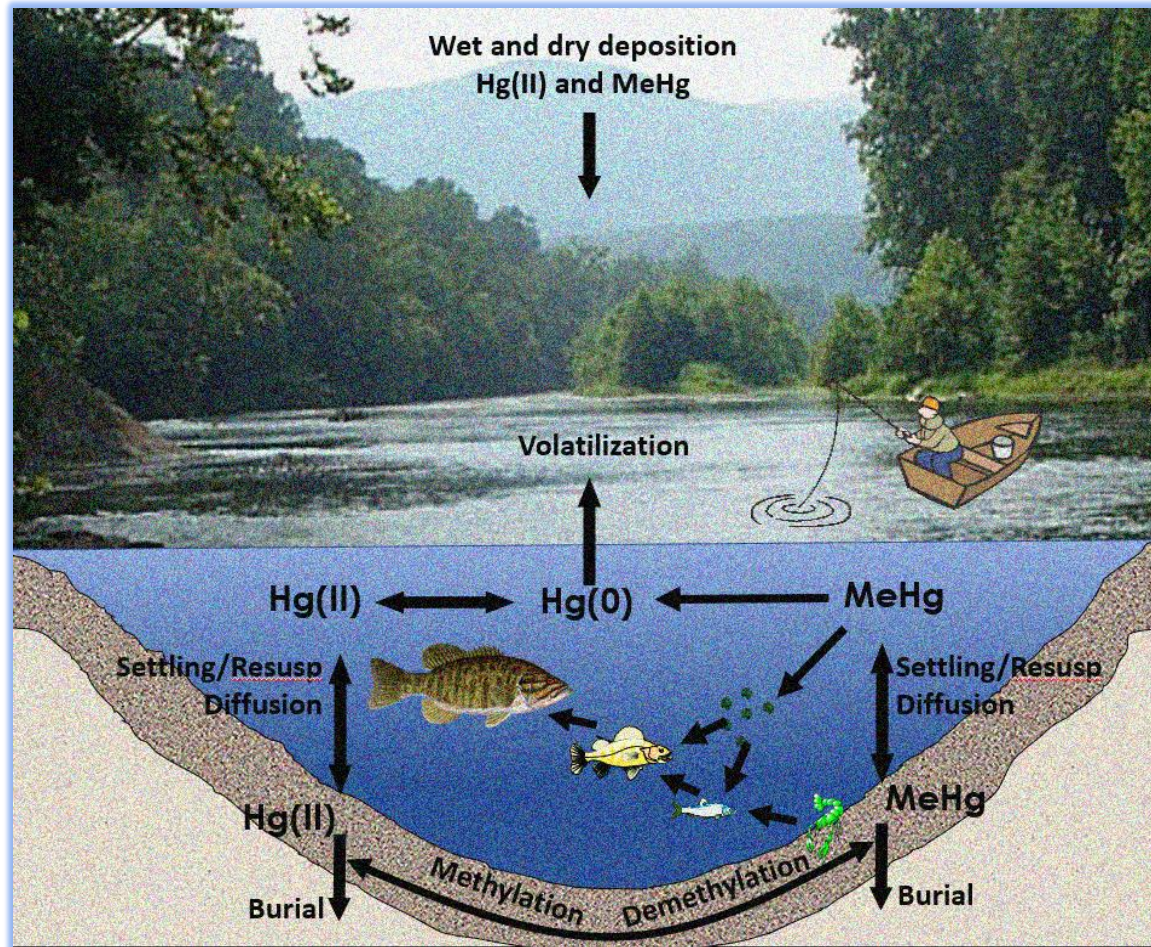


Application of a Mechanistic Mercury Model to the South River: Update



Reed Harris
RHE Ltd.

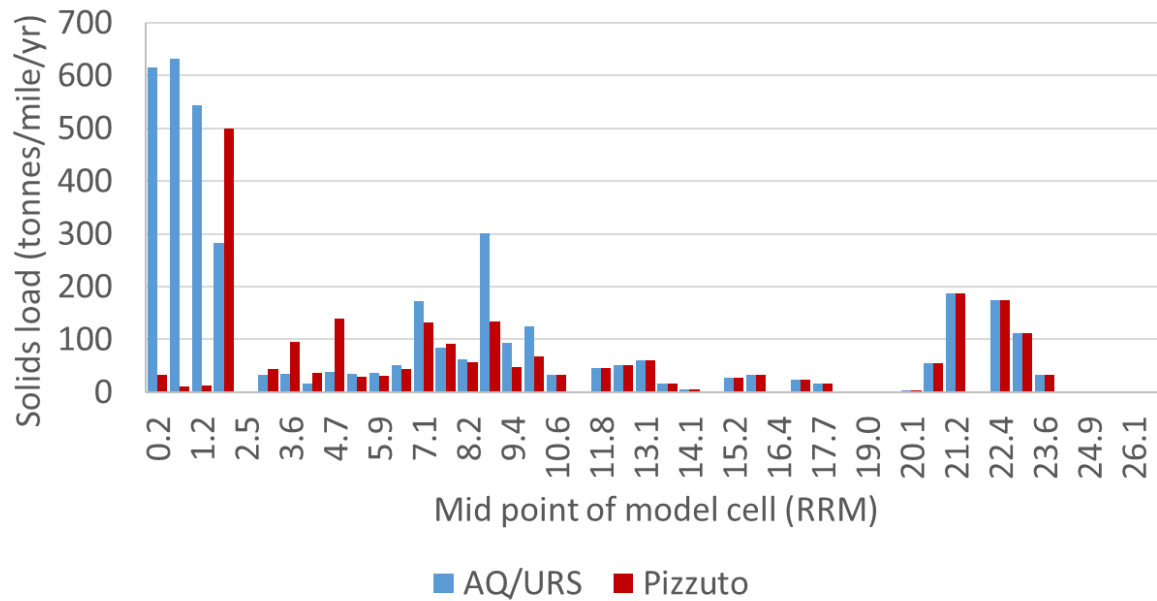
September 26, 2017

Outline

- Discussion of solids and mercury loads
- Summary of model calibration
- Scenario results
- The importance of solids...
- Status/Next steps

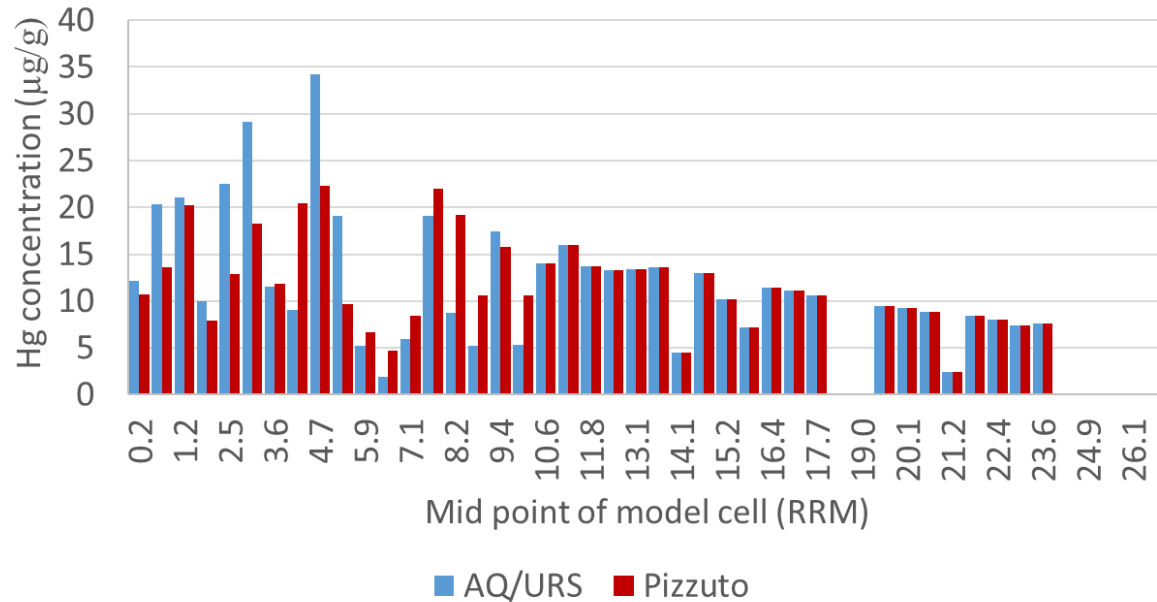
Solids and Hg loads from River Banks

Solids Loading estimates to model cells from RRM 0-27

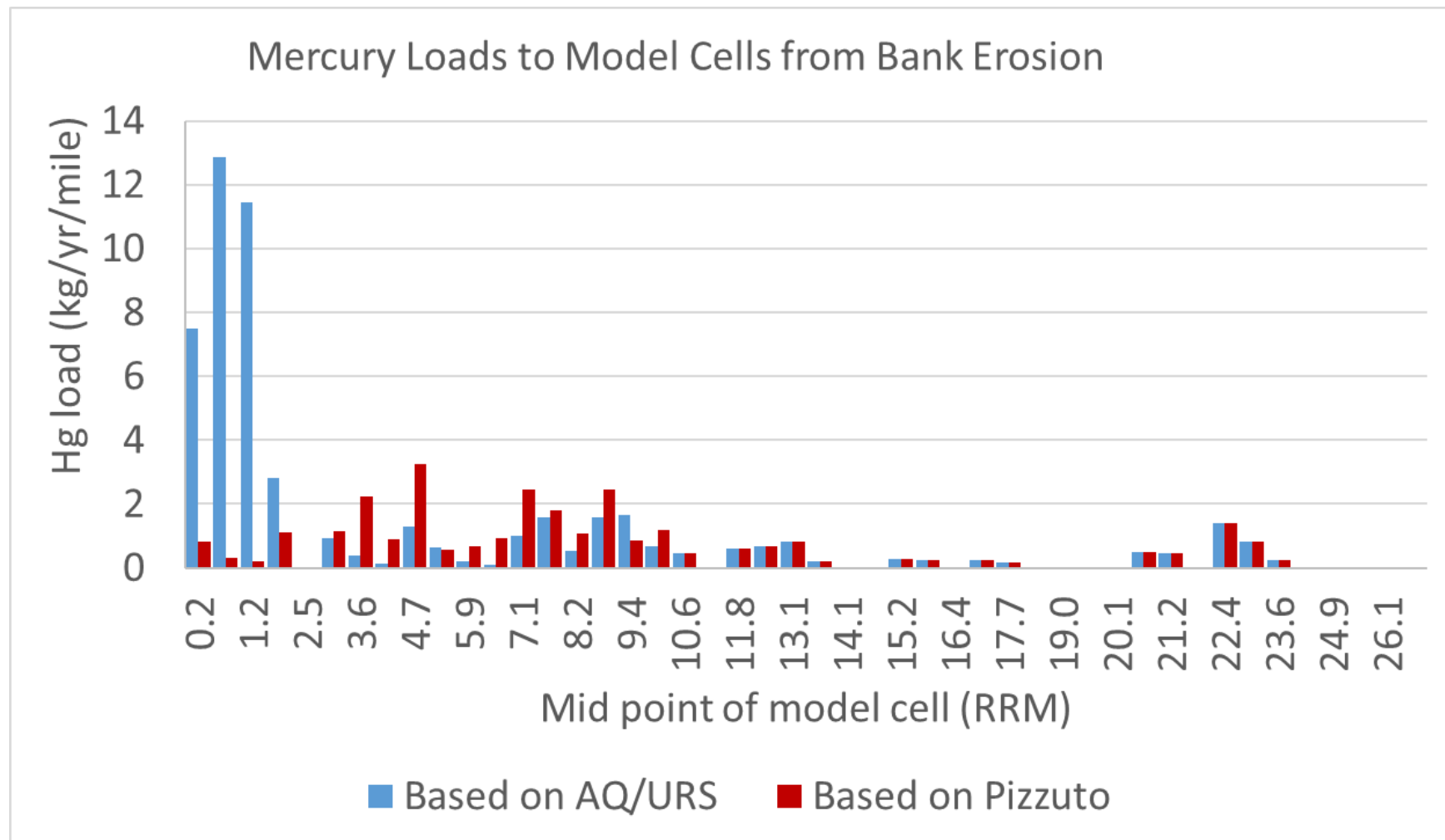


Wide range of estimates of solids loads and Hg concentrations for RRM 0-10.

Mercury concentrations in eroding river banks from RRM 0-25



Resulting range of bank erosion Hg load estimate....

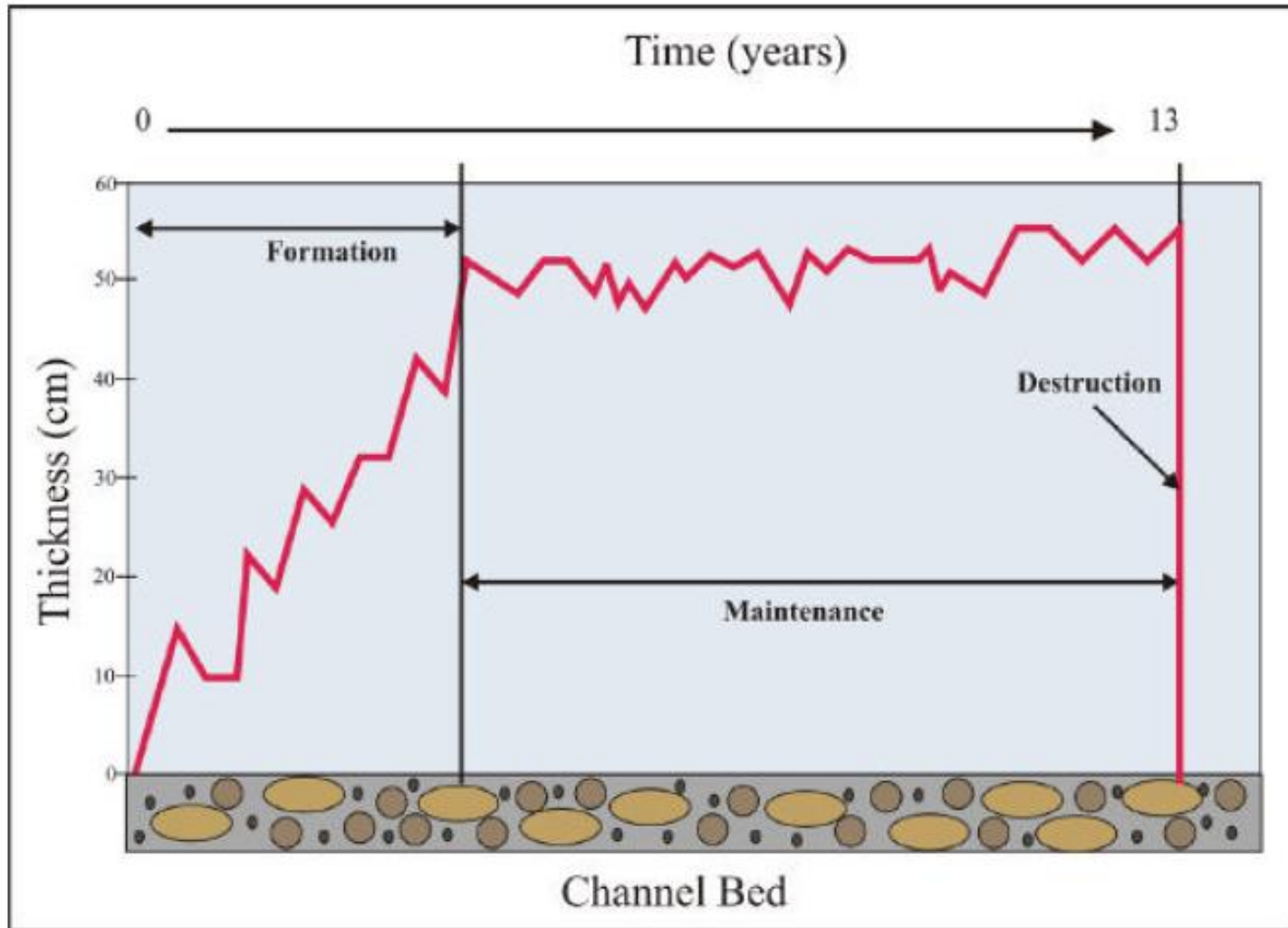


Was the river eroding, accumulating or non-depositional for:

- 2006-2014 (modeled period)
- long term (decades...)

This affects the rate of natural recovery and whether legacy mercury is ultimately buried or sent downstream.....

What stage of solids conceptual model was the river in for the period simulated (2006-2014)?

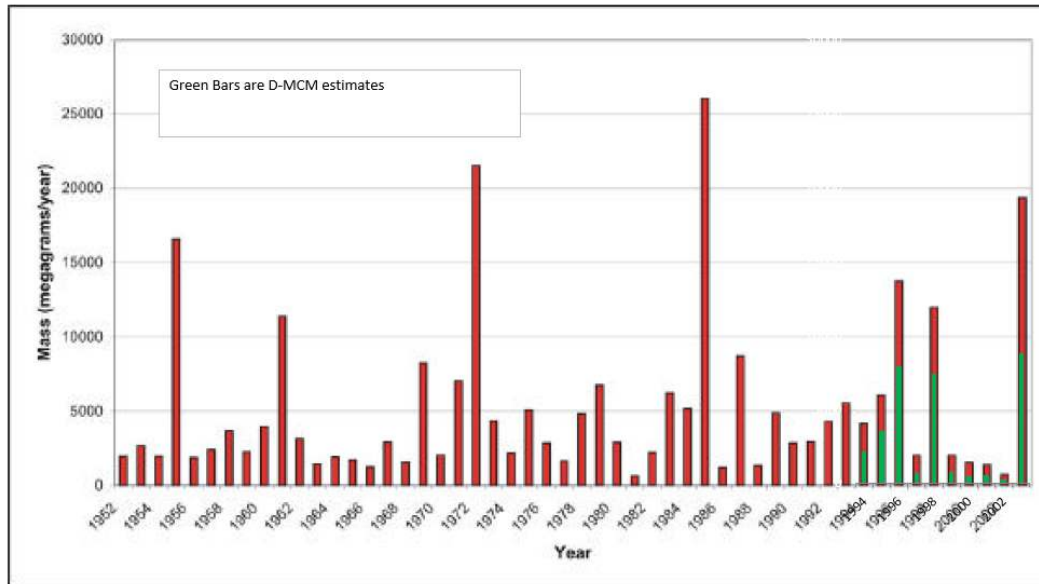


Pizzuto
conceptual
model for
particles in South
River

Figure 5.33. Idealized conceptual model for the temporal evolution of a FGCM deposit through time

Suspended solids fluxes estimated at Waynesboro for 1952-2014

From Pizzuto et al (2008)



Estimated for modeling study

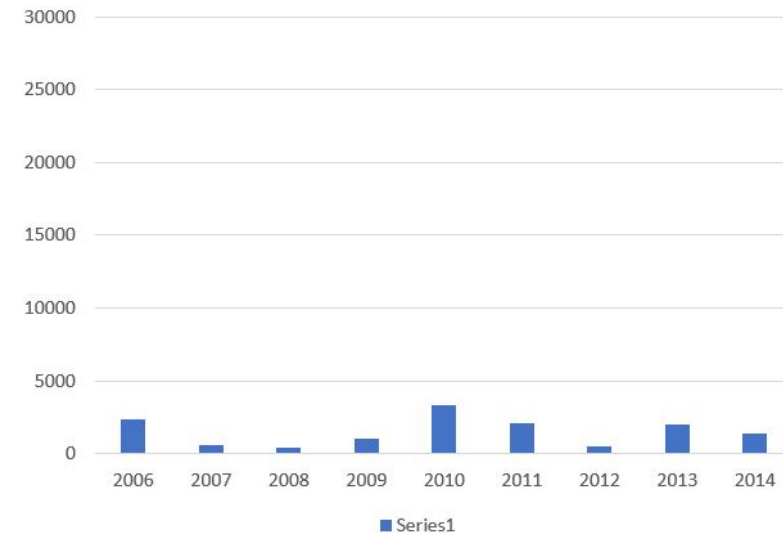


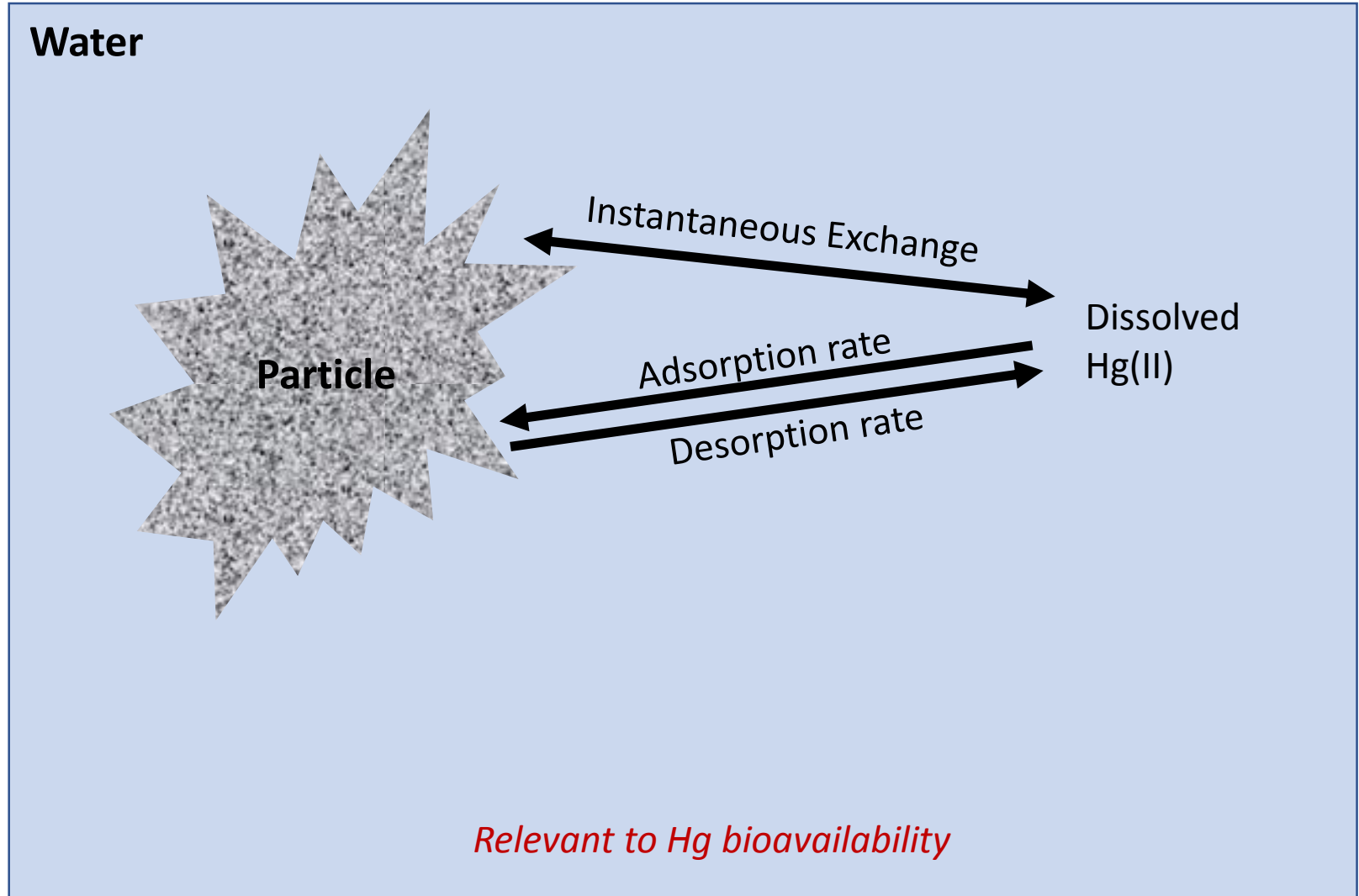
Figure 11.12. Total mass of suspended sediment for each year of discharge data on South River at Waynesboro

Model calibration status

..Have been developing two calibrations because it is not clear which one is more realistic

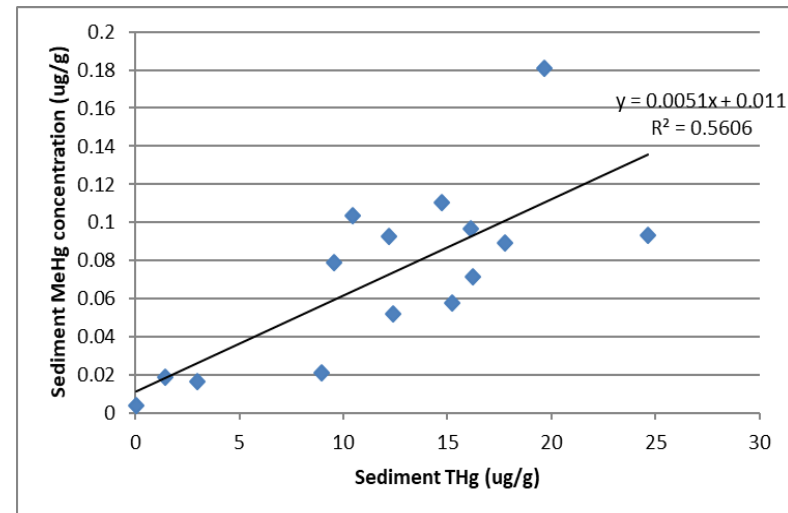
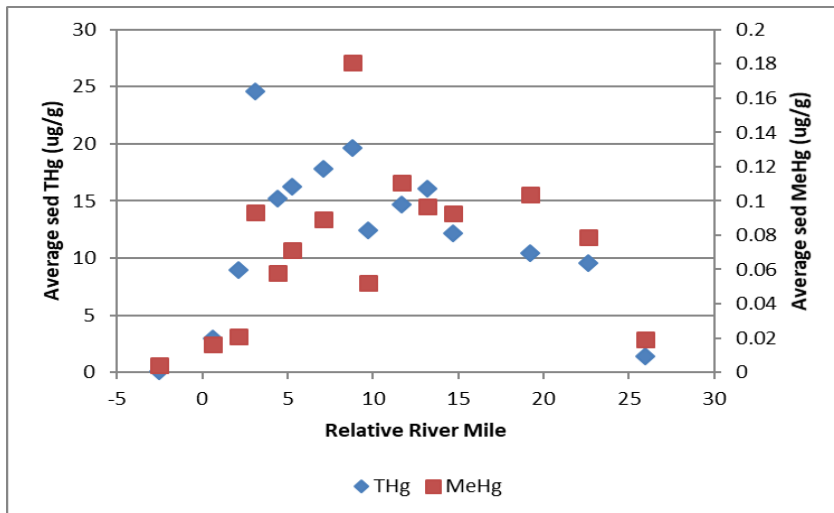
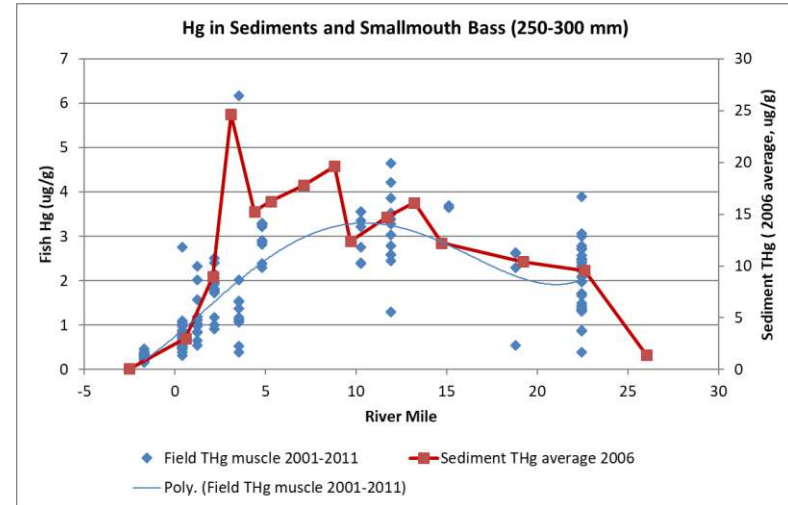
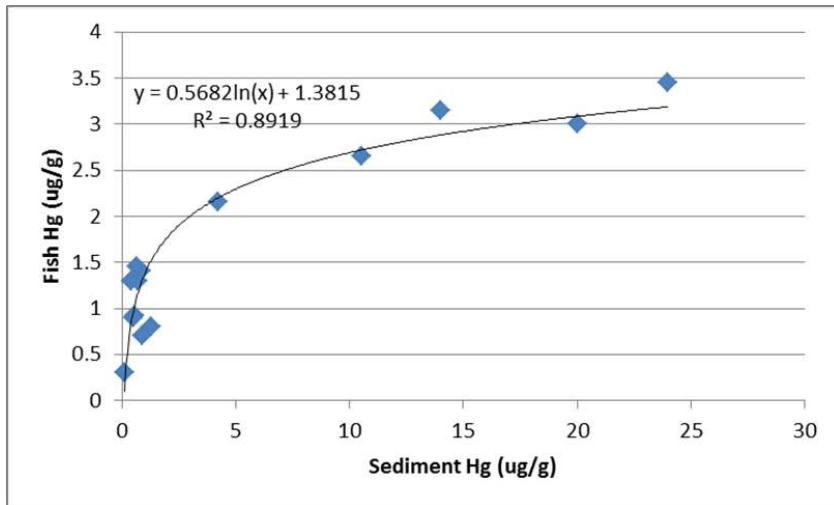
- One with all mercury fully exchangeable (methylation is proportional to inorganic Hg(II))
- One with some mercury strongly bound and unavailable for methylation (non linear)

Slow and Fast Hg exchange on particles in D-MCM

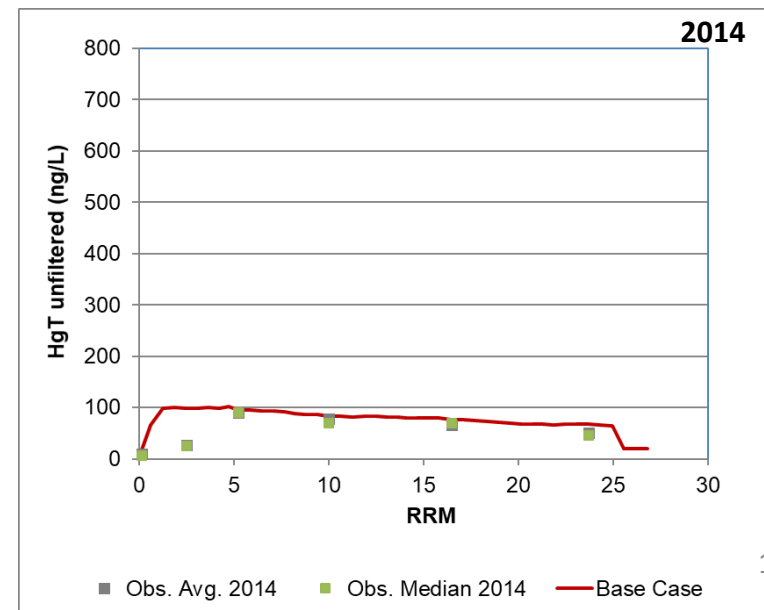
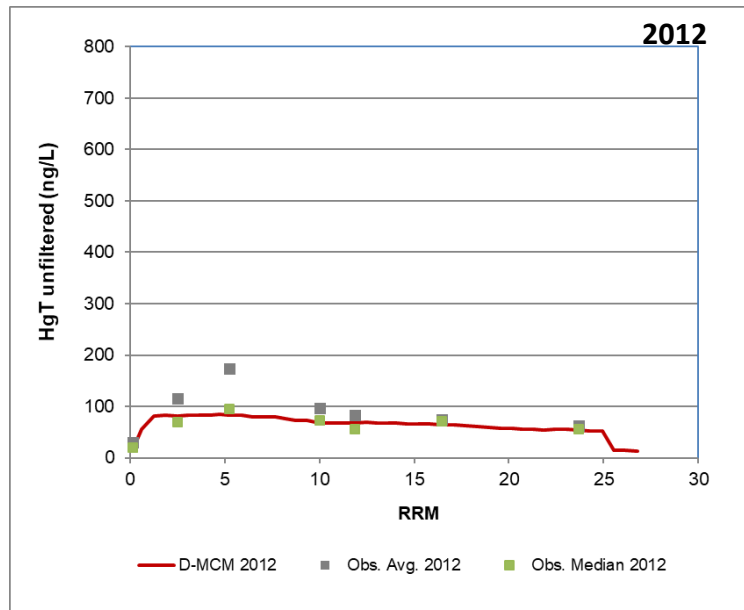
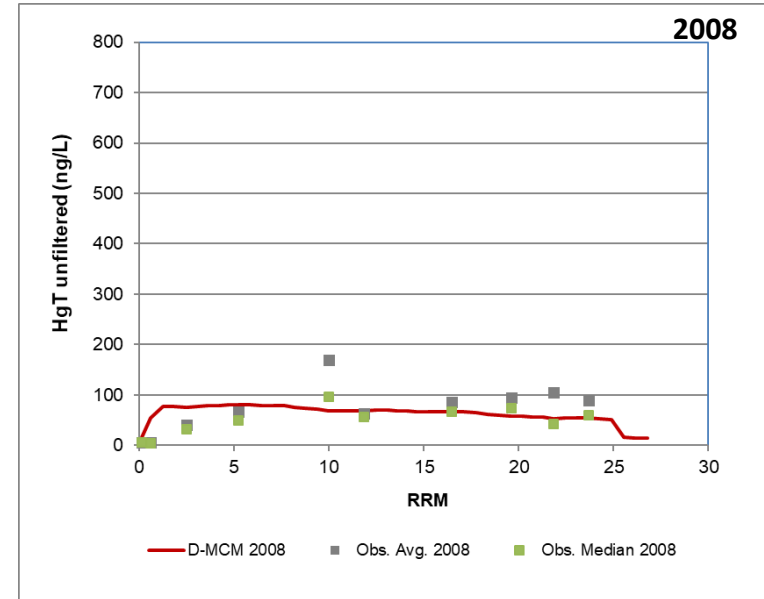
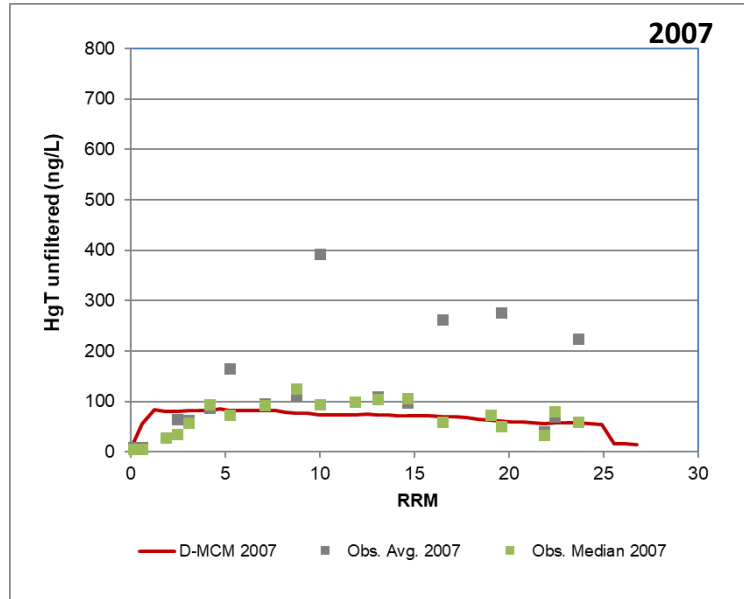


Fish MeHg – sediment THg relationship is non linear...

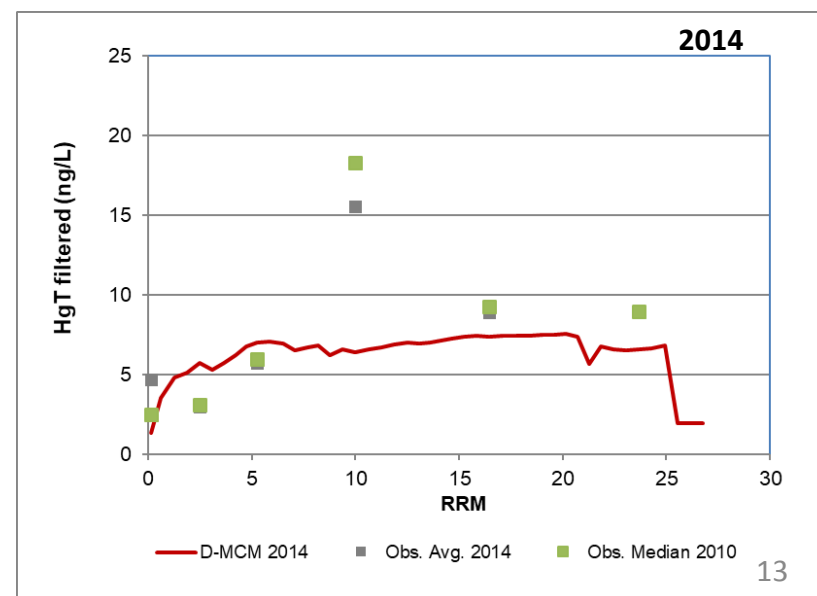
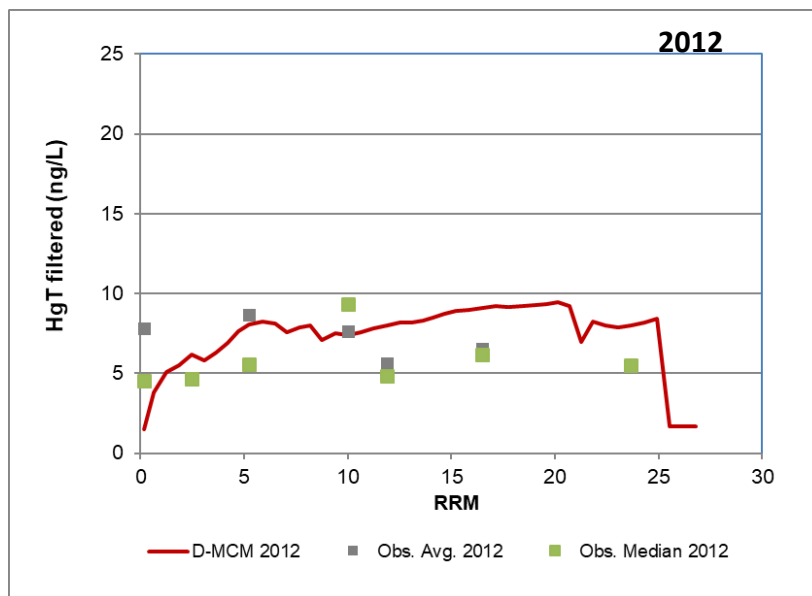
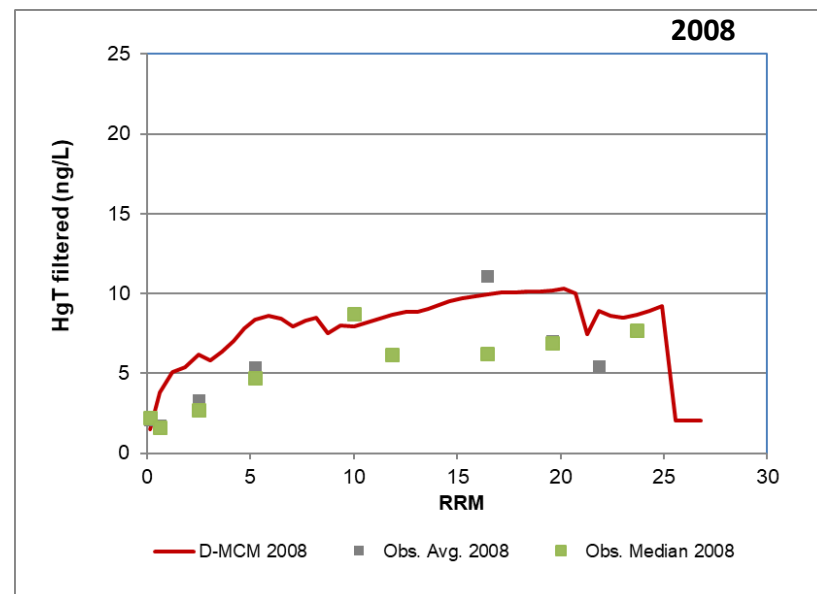
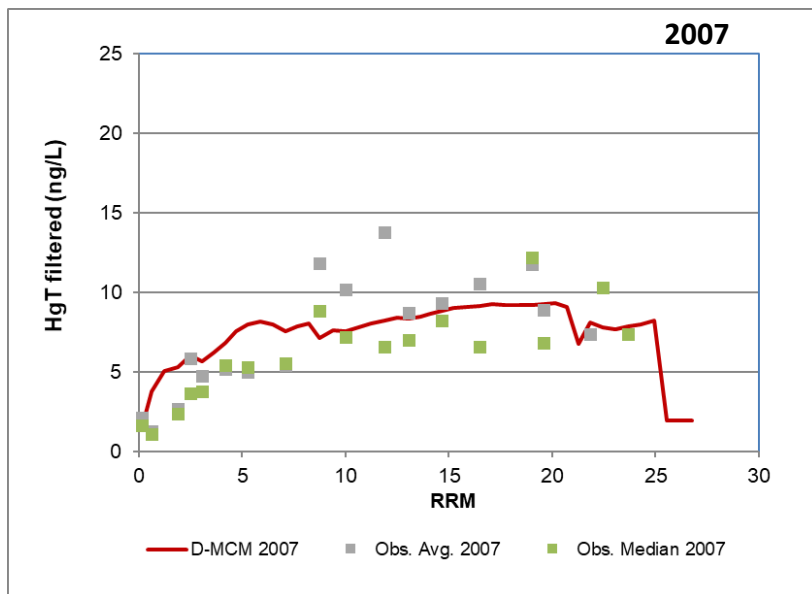
...Where does MeHg/inorganic Hg non-linearity first appear?



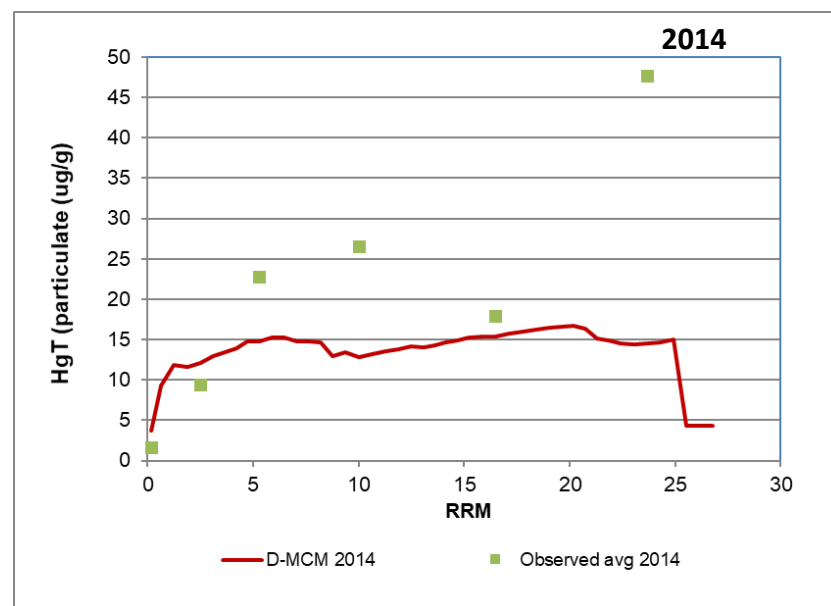
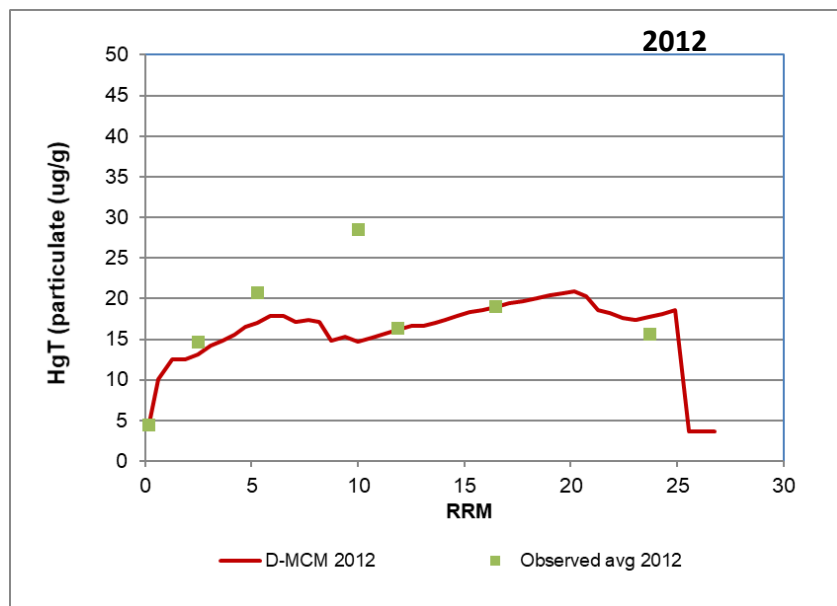
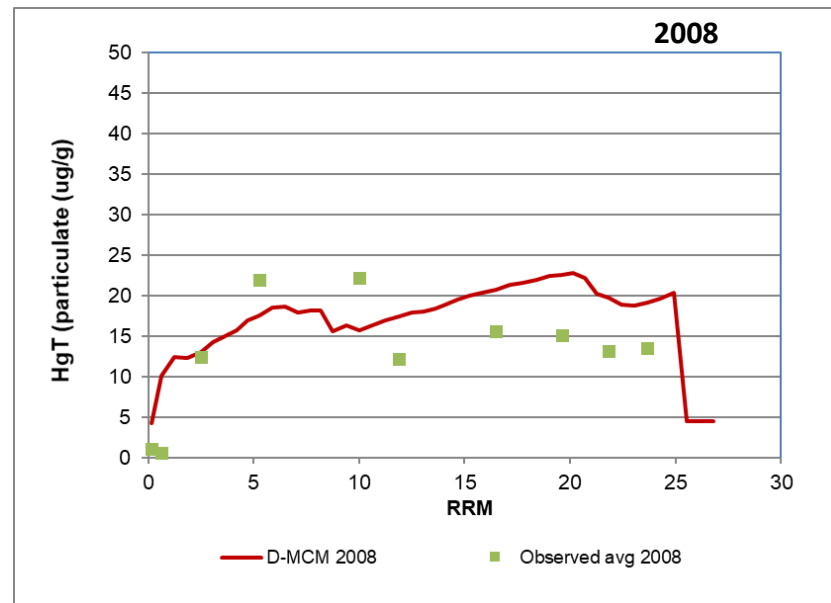
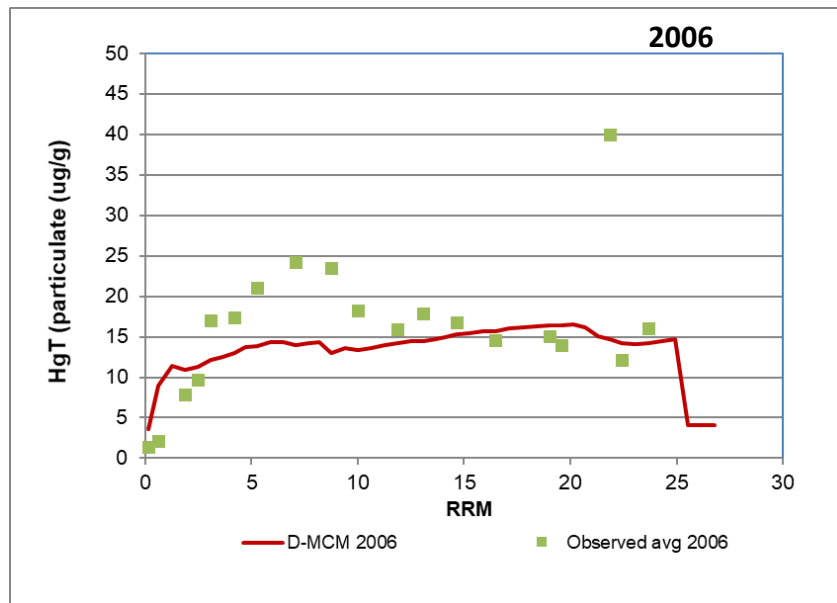
Model Calibration – Bulk Total Mercury in water (ng/L unfiltered)



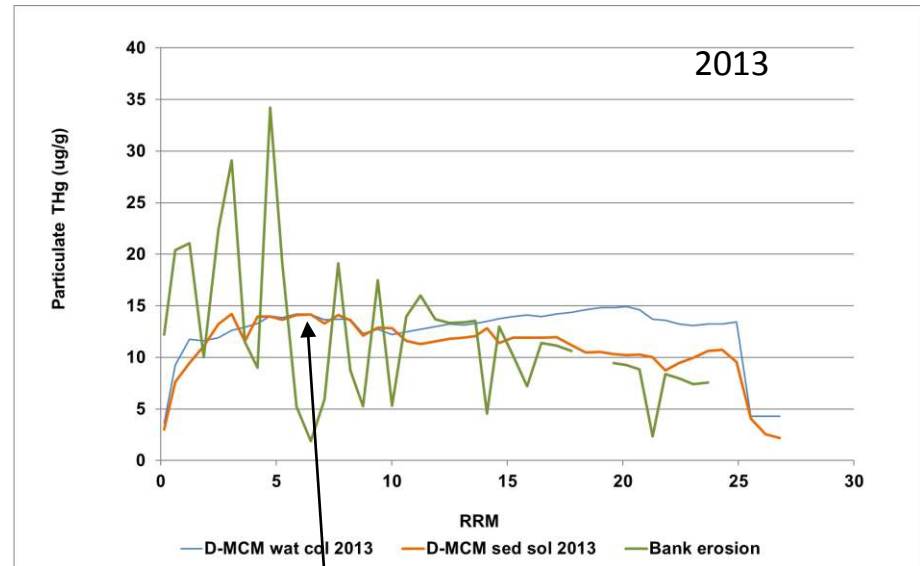
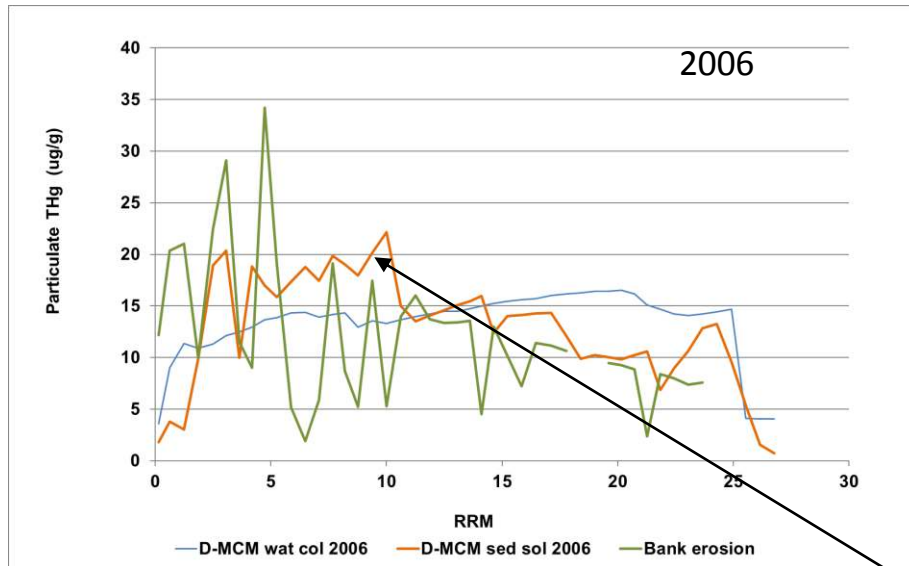
Model Calibration – Filtered Total Mercury in water (ng/L unfiltered)



Model Calibration –Total Mercury in Suspended Solids ($\mu\text{g/g}$)



Comparison of modeled Hg concentrations in eroding banks, sediments and TSS..



Predicted Sediment THg is declining with time to be more like its supply (TSS).

Solids residence time in surface sediments is an indicator of how fast the system can replace contaminated particles with low-Hg solids...

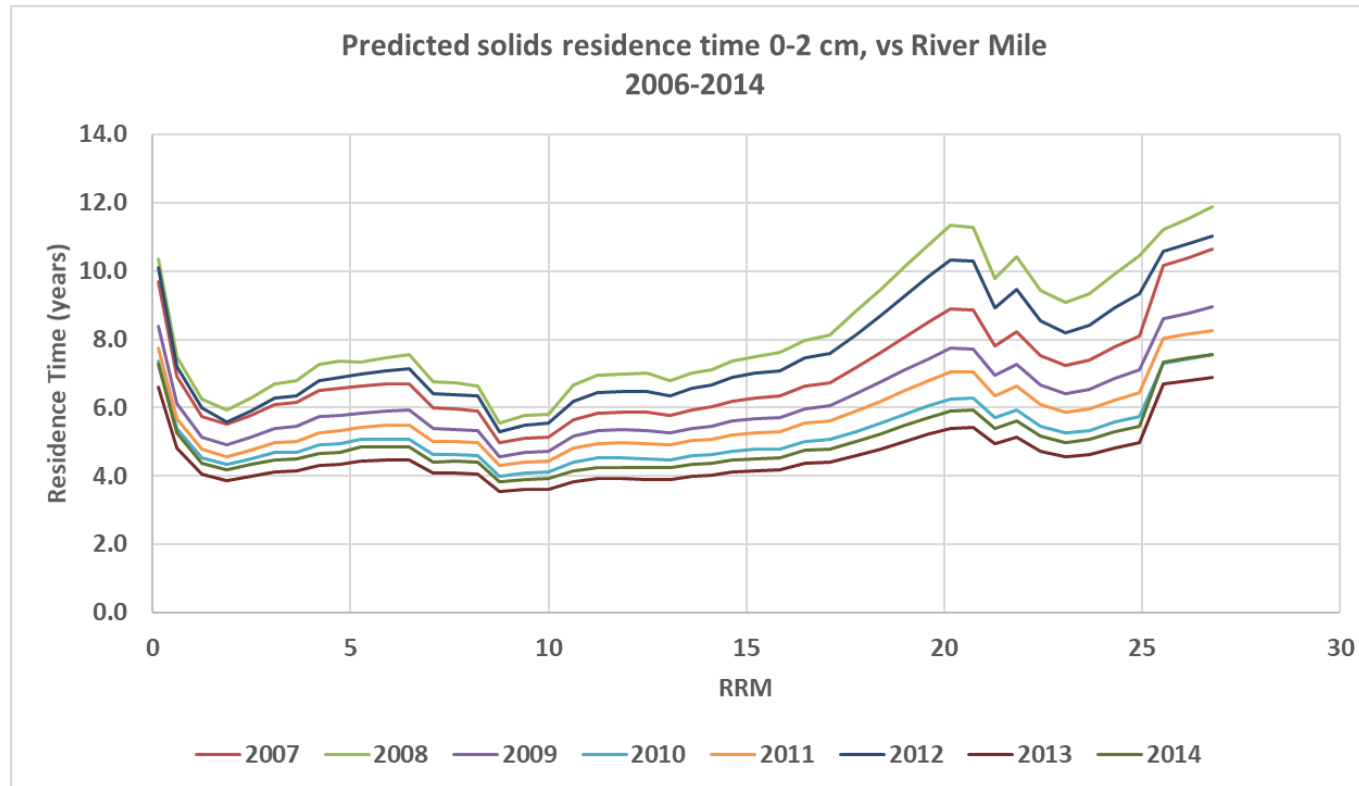


Table 5.8. Maximum age of FGCM deposits cored and dated using ^{14}C .

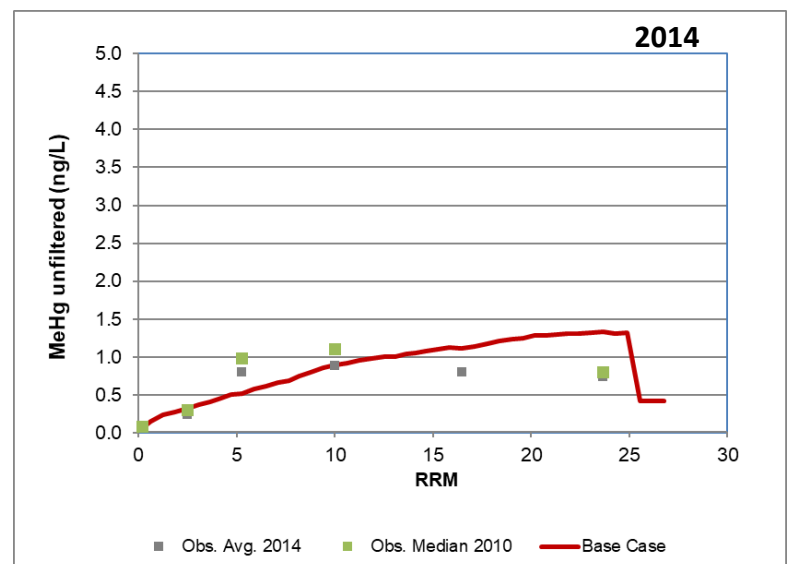
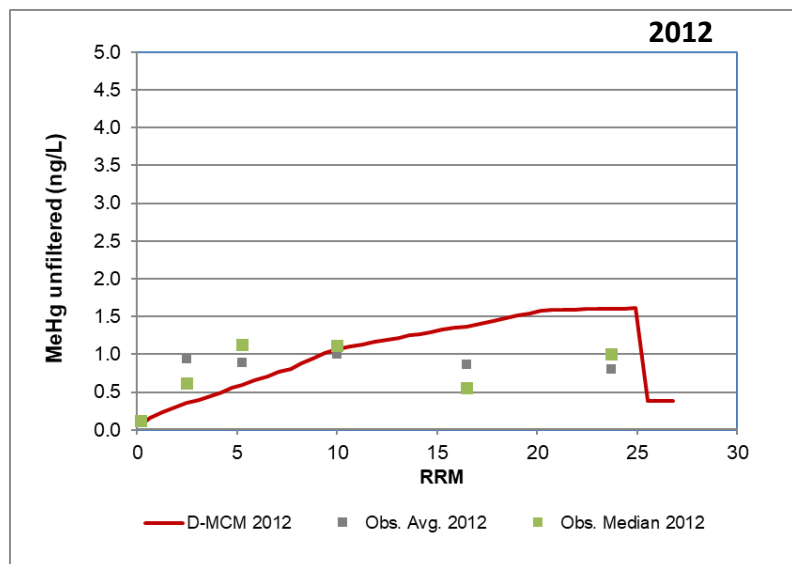
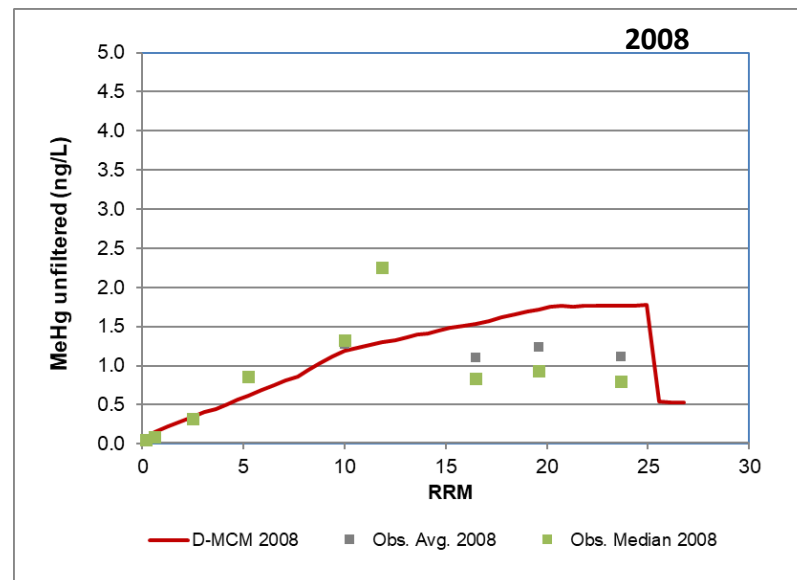
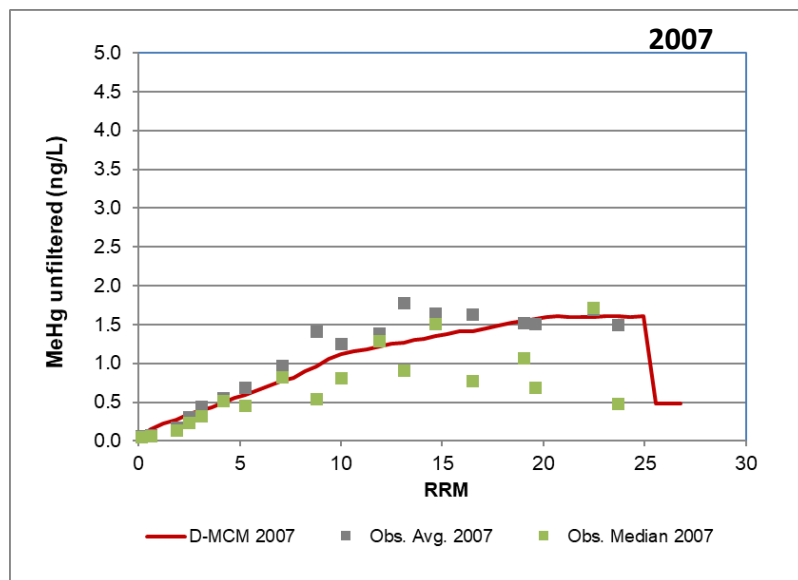
Core	Age at Base (years)
Core 1	> 55
H1A	19
H2A	14
H2C	13
D5A	10
D7A	11



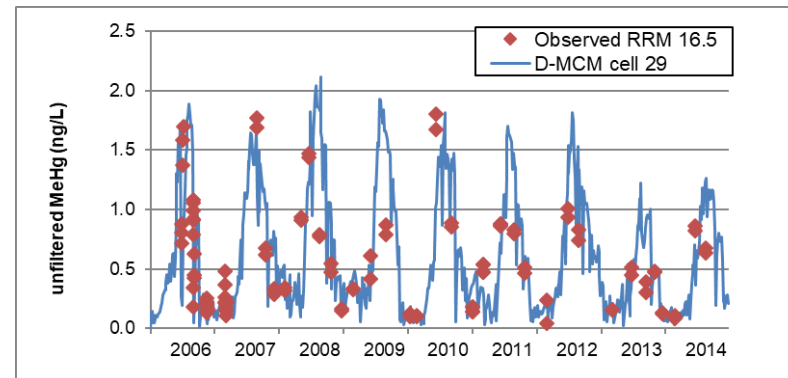
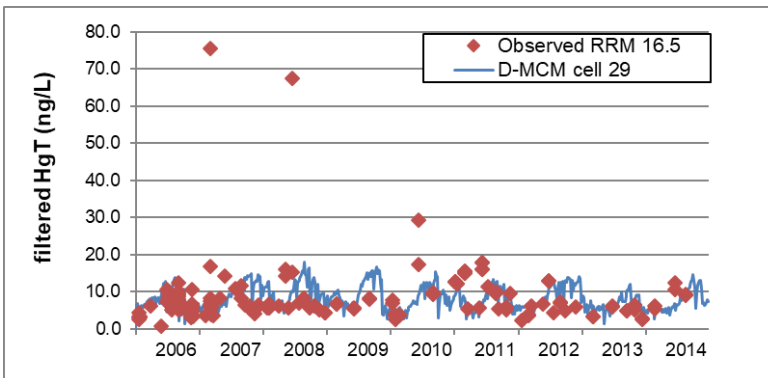
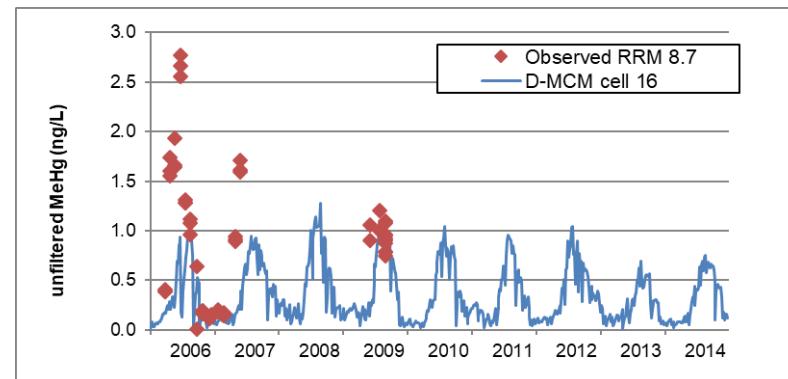
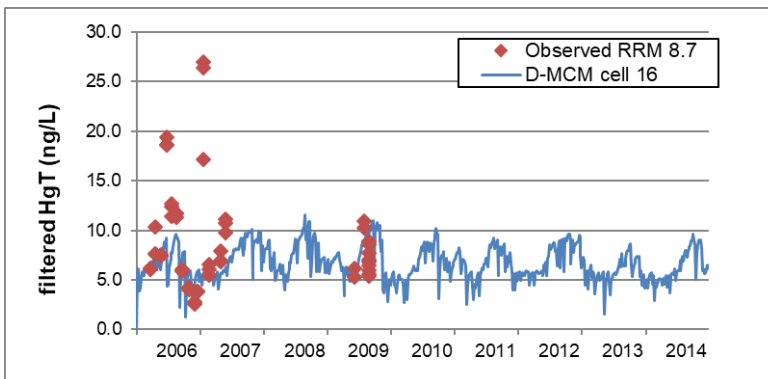
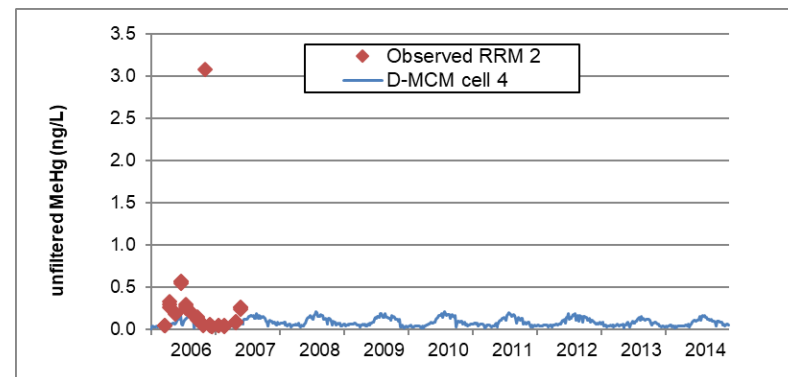
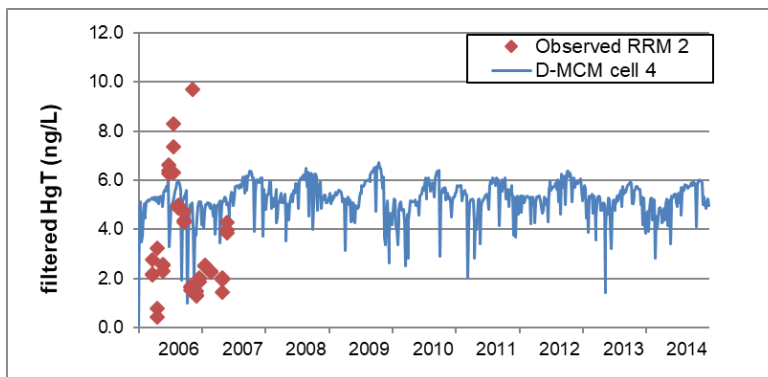
From Pizzuto et al (2008)

- Average age at base of core was 13 years
- Average age for overall sample likely less.

Model Calibration – Bulk Methylmercury in water (ng/L unfiltered)

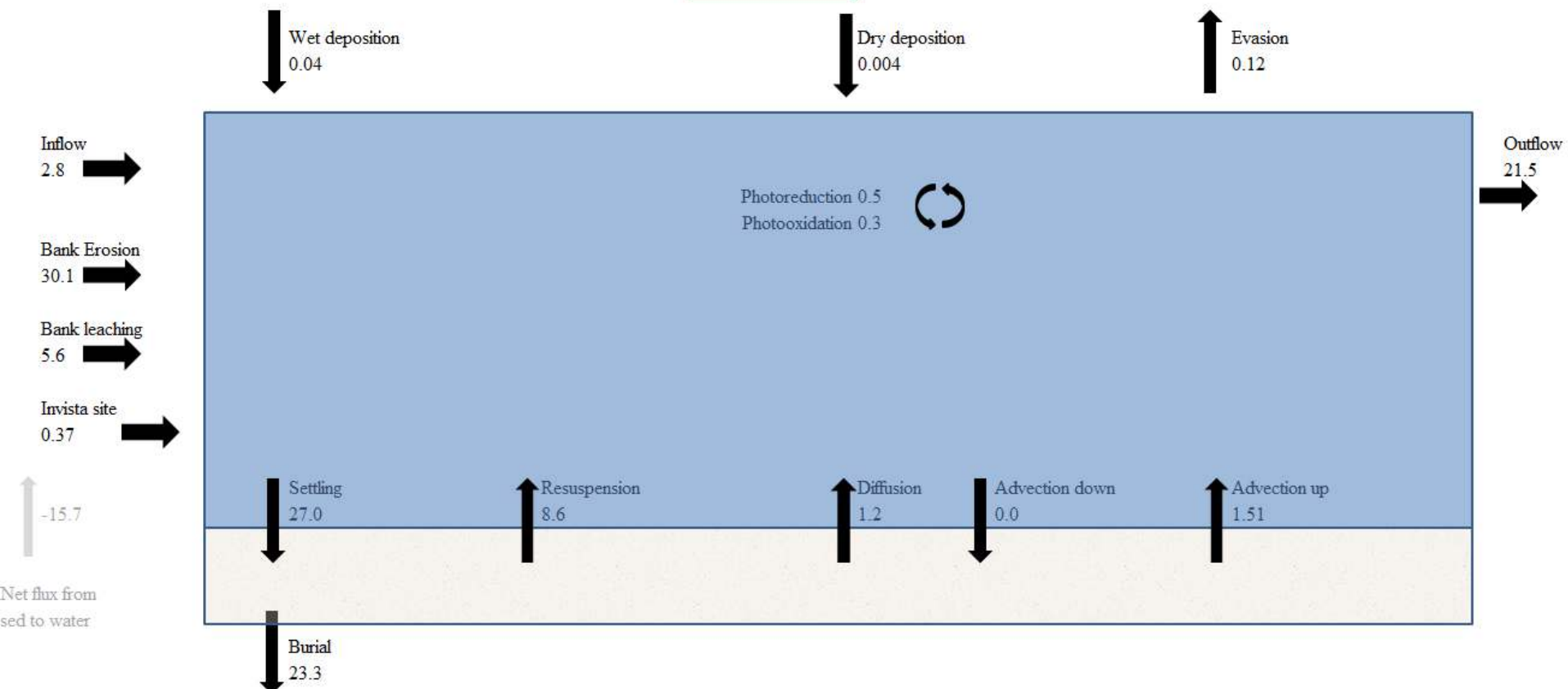


Model Calibration - Filtered THg and MeHg vs Time at Different Locations



Budgets for THg and MeHg

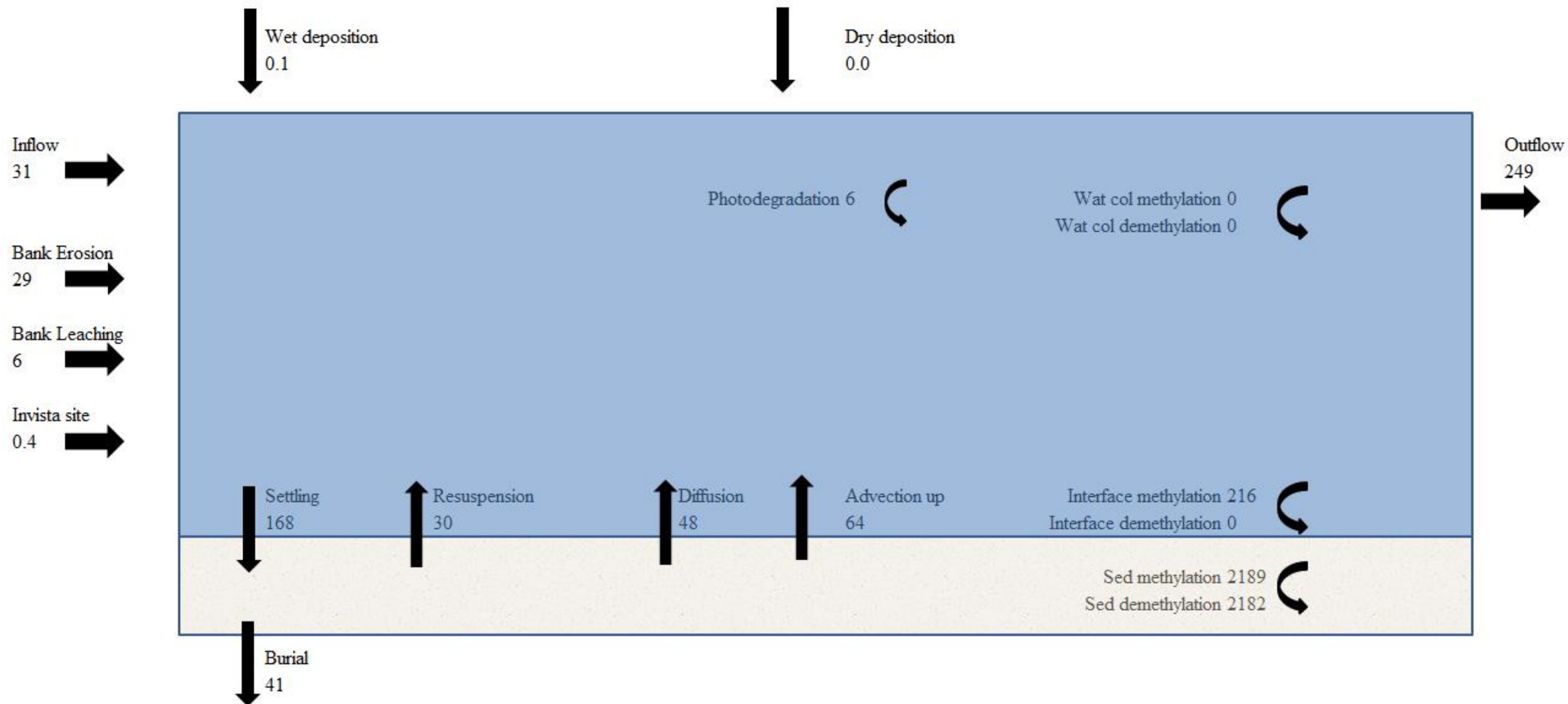
South River Mass Balance for Hg(II) from RRM 0-27 for January 1, 2006 to December 30, 2014 (average, kg Hg/yr)



Predicted Inorganic Hg sources to South River Water
column for RRM 0-27 for 2006-2014

	kg/yr	% of total load
Inflow	2.8	5.6
Bank Erosion	30.1	59.6
Bank leaching	5.6	11.1
Invista site	0.4	0.7
Wet deposition	0.04	0.1
Dry deposition	0.004	0.0
Photooxidation	0.3	0.6
Resuspension	8.6	17.0
Diffusion	1.2	2.3
Advection up	1.5	3.0
Total in	50.5	100.0

South River Mass Balance for MeHg for RRM 0-27 from January 1, 2006 to December 30, 2014 (average, g/yr)



MeHg loads from erosion, bank leaching and Invista site assumed to be 0.1% of total load

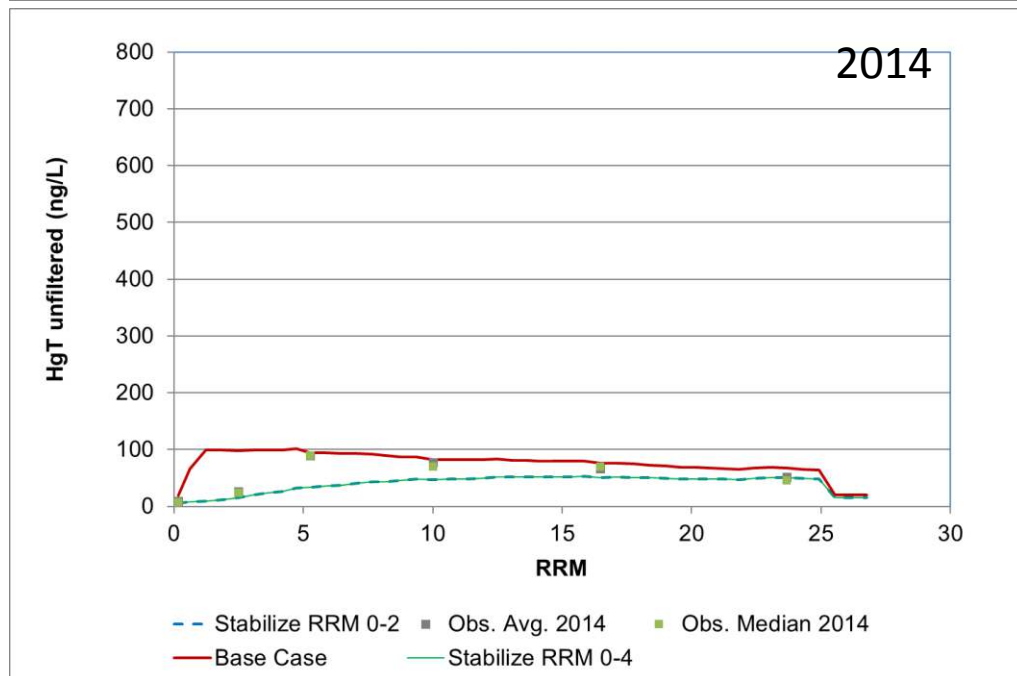
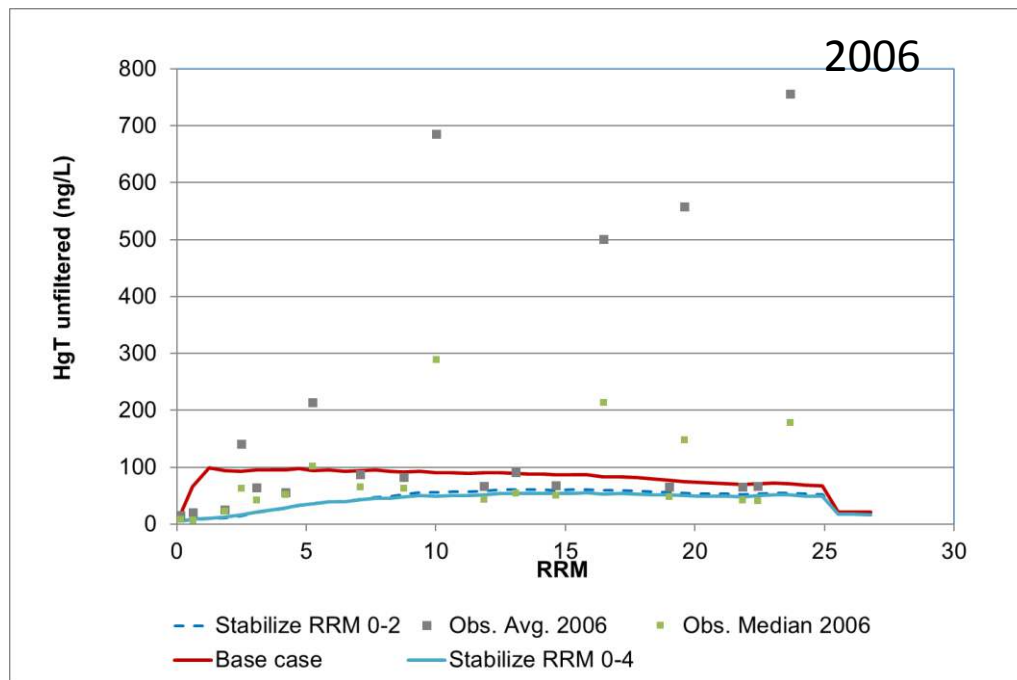
Predicted Methylmercury Sources to South River Water column for RRM 0-27 for 2006-2014

	g/yr	% of total load
Inflow	31	7.3
Bank Erosion	29	6.9
Bank Leaching	6	1.4
Invista site	0.4	0.1
Wet deposition	0.1	0.0
Dry deposition	0.0	0.0
Water methylation	0	0.0
Resuspension	30	7.0
Advection up	64	15.1
Diffusion	48	11.3
Interface methylation	216	50.9
Total in	425	100.0

*MeHg loads from erosion, bank leaching and Invista site assumed to be 0.1% of total load
Interface methylation assumed as possible source to provide "missing" MeHg..
MeHg budget still being developed!*

Bank Stabilization Scenario

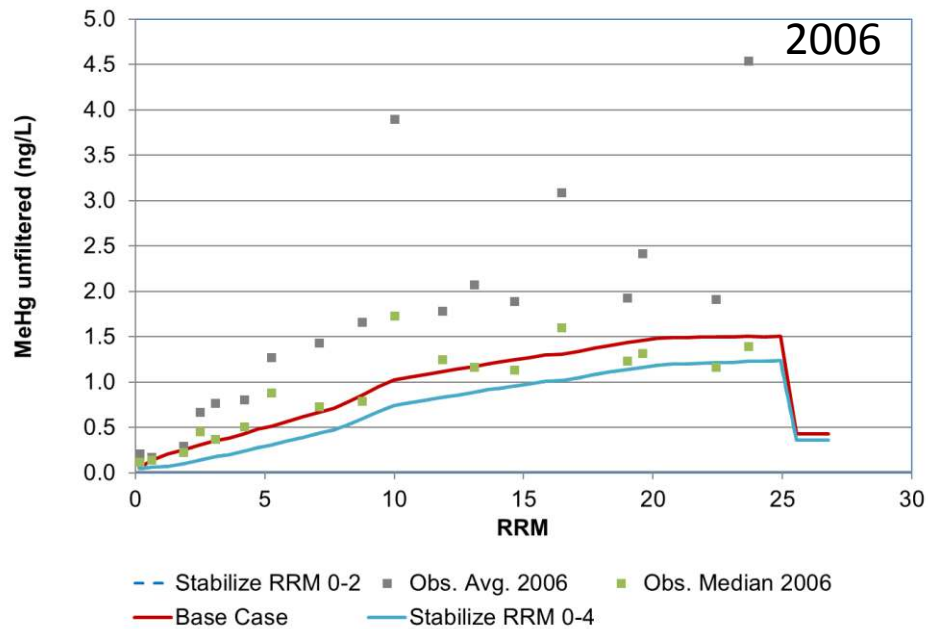
Eliminate Erosion for RRM 0-2



Predicted benefits of stabilizing 100% of banks for RRM 0-2 and 0-4

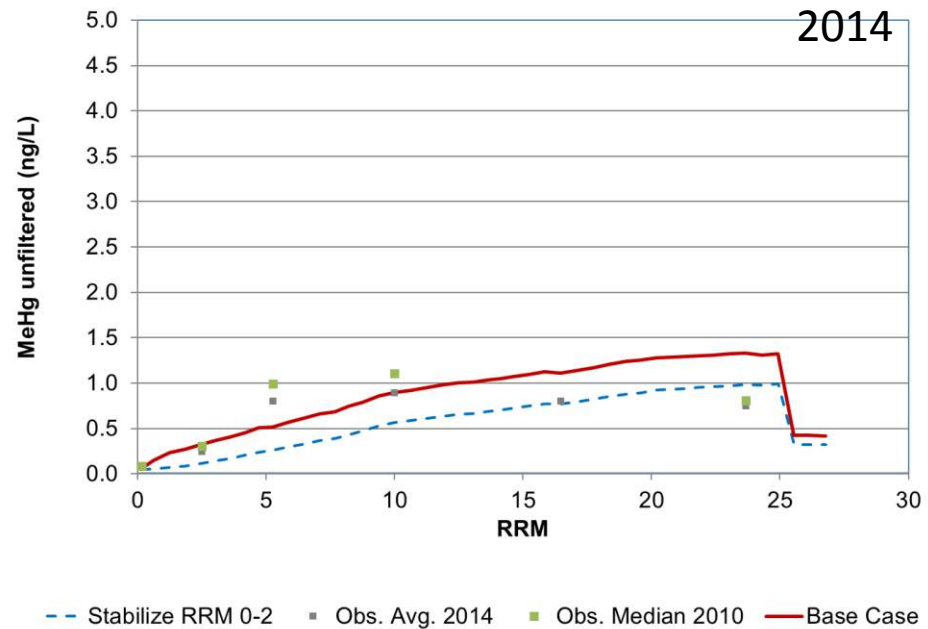
Sensitive to:

- How much of the bank Hg load is in the first 2-4 miles.
- How much mercury is supplied from sediment bed to water
- How long that takes to recover after bank stabilization.



Predicted benefits of stabilizing
100% of banks for RRM 0-2 and 0-4:

MeHg in water



Summary

- Completing two calibrations with different assumptions about linear response of system.. Does this affect predicted benefits of bank stabilization?
- Running scenarios for reducing bank erosion, bank leaching, Invista site load.
- Results are sensitive to particle dynamics (magnitude and timing).
- How much or little MeHg is loaded from banks?