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LABORATORY SIMULATION OF CAPPING/IN-SITU TREATMENT IN THE SOUTH RIVER

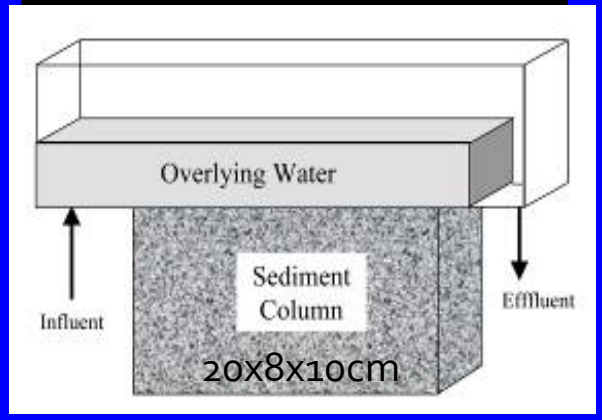
Objective

- Evaluate the ability to reduce mercury and methyl mercury impacts through management of small portions of the river, namely fine grained deposits, intermixed gravel and bank sediments.
  - Evaluate relative methylation potential of these areas
  - Evaluate ability of DGTs to measure that potential and provide an indicator of benthic response
  - Evaluate capping and in-situ treatment effectiveness

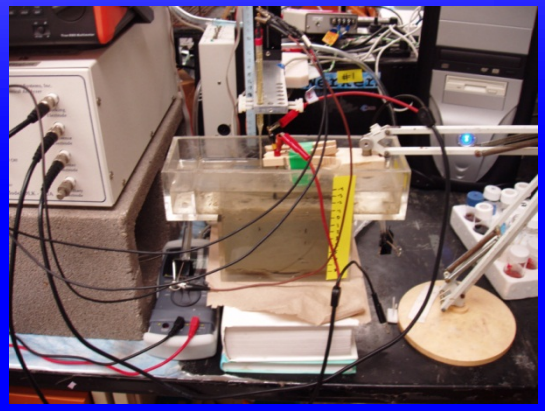
Sediment mesocosms – Overflow cells

Porewater Measurements ~ Biological Structure

Geochemical observations-
Voltammetry:
Redox profile, pH



DGT- porewater analysis:
MeHg and THg



- Periodic, non-destructive measurements made with microelectrodes at mm-scale depth resolution
- Byproducts of microbial metabolism (Fe^{2+}, Mn^{2+}, HS^-) measured in sediment porewater

- DGT-depth profiler (Diffusive gradient in thin films)
- Practical method quantification limits of 10 ng/L for THg,
  0.1 ng/L for MeHg

Baseline Studies with benthic exposure

Organisms – tubificids , active burrowing deposit feeders
Analysis by voltammetry, DGT, post-experiment coring

Just completed – data analysis underway

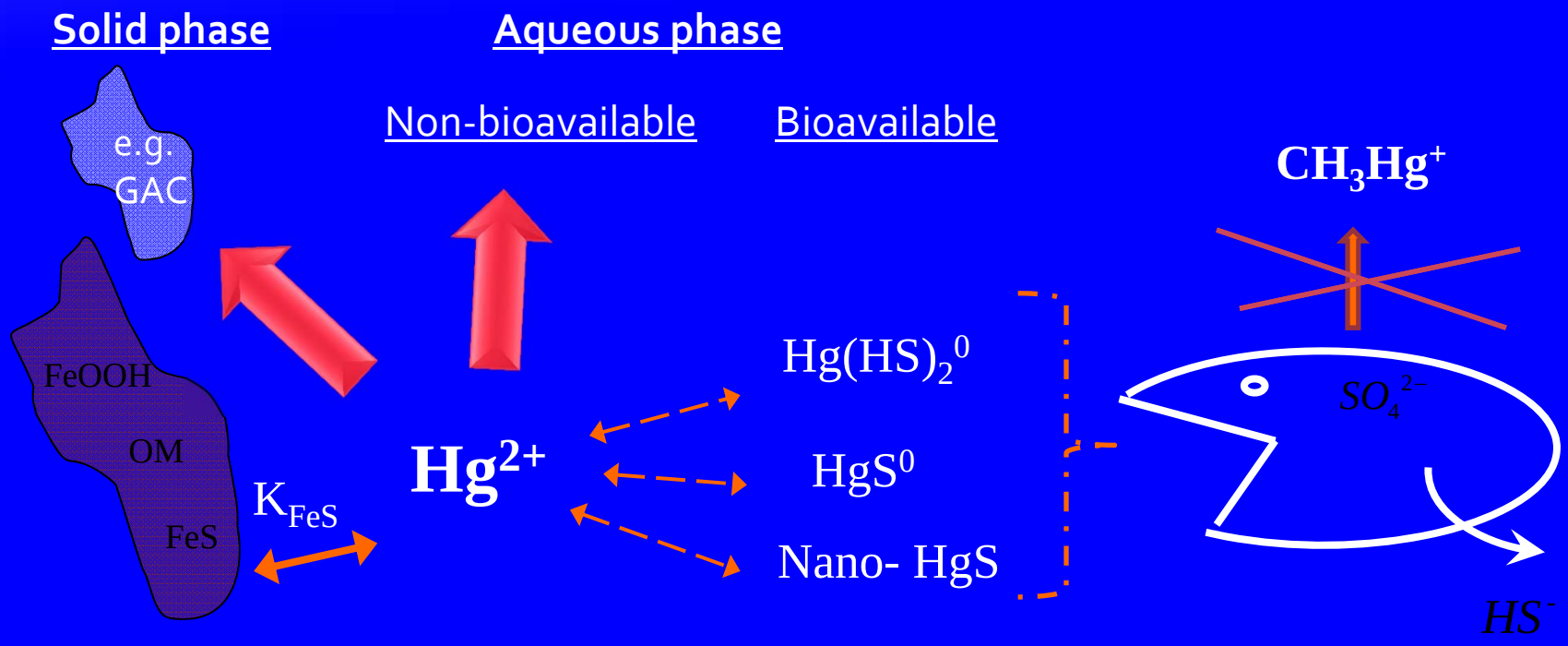
Sample	Treatments
11.8 Bank	Control (no organisms) and populated mesocosms
11.8 FGCMD	Control, autoclave control and duplicated populated mesocosms
11.8 Gravel	Control, control with potting soil, populated with potting soil
3.5 Bank	Control with triplicate populated mesocosms
3.5 Gravel	Control with populated mesocosm

Qualitative Assessment

- Total Hg in porewater
  - Consistent levels with field conditions (e.g. 11.8, 500-1000 ng/L
  - Profile assessment/variations and MeHg by treatment incomplete
- Redox conditions
  - Oxygen depleted within 1-2 cm
    - No significant difference between treatments although fine-grained sediments often deeper due to greater bioturbation activity
  - Strong manganese release and minimal iron/sulfide
    - Moderate reduction in upper 10 cm
    - Expected deeper oxic conditions in the field
- Post-experiment sampling
  - Coring – analysis underway
  - Organism recovery (good except in 11.8 gravel treatment)
    - Body burden and lipid analysis undeway

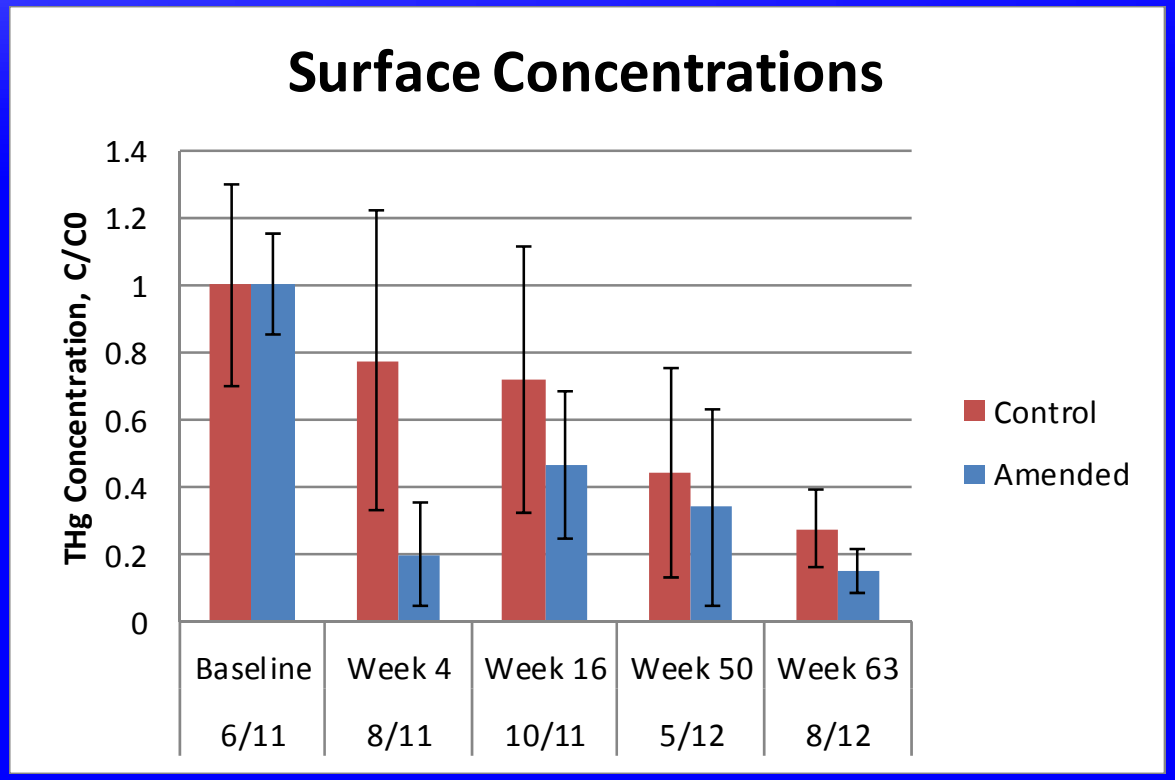
Amendment- Conceptual Model

- To reduce methylation, control aqueous speciation (e.g. bioavailable HgS) or solid phase sorption of THg (sorbing amendments)



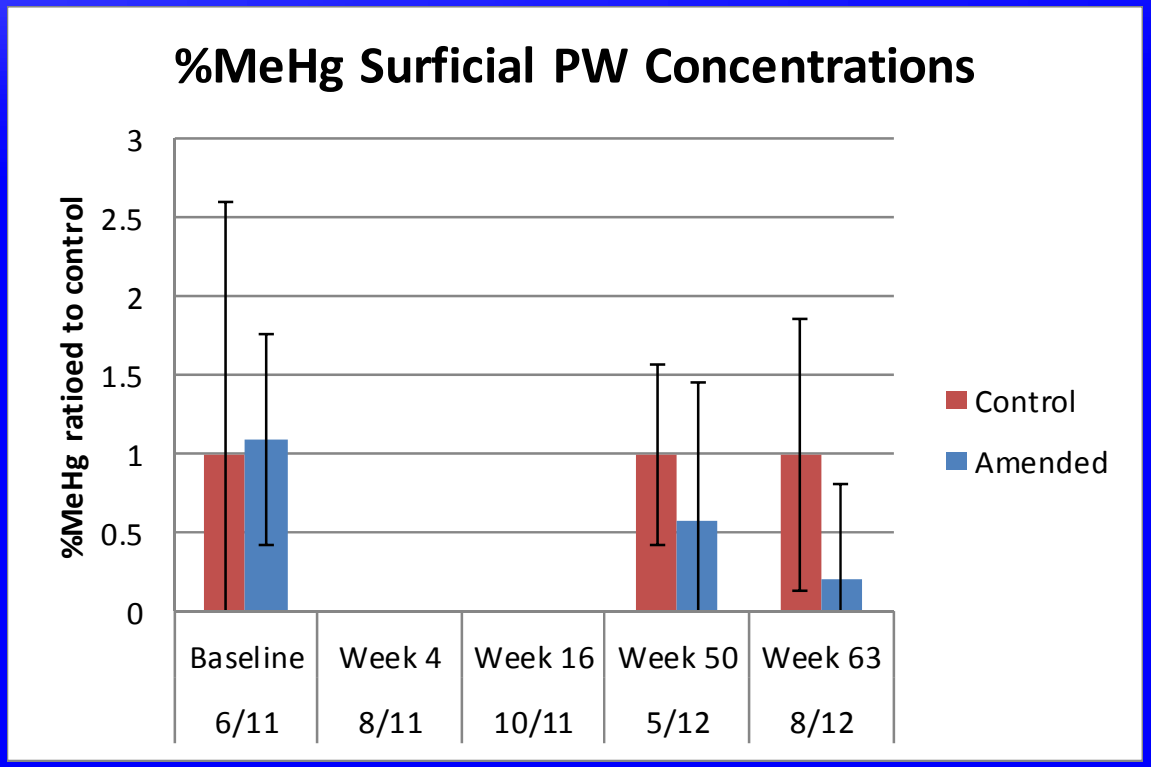
Surficial THg Porewater

- Substantial THg reductions
  - ~50%
- Reductions in both control and amended with time
  - Deposition of clean sediment?



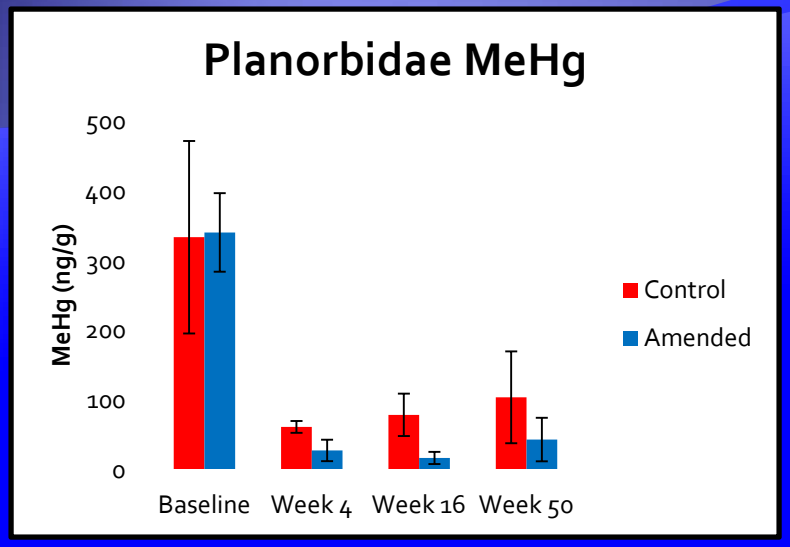
Surficial %MeHg in Porewater

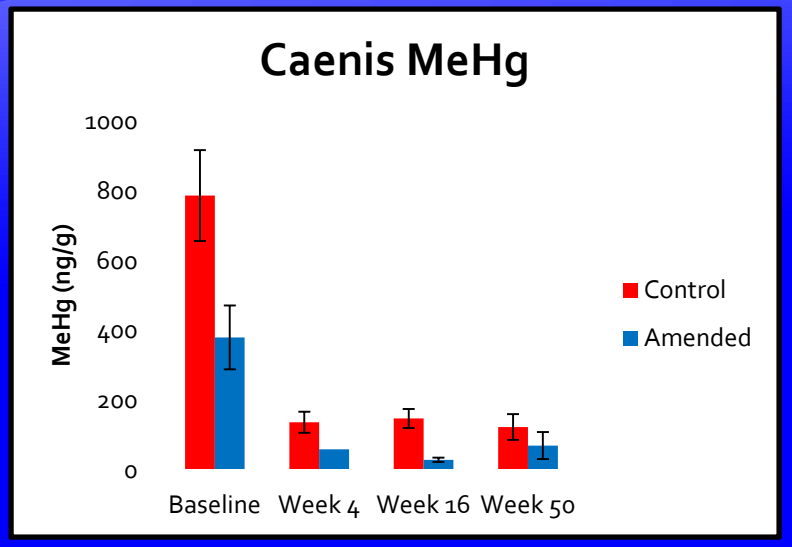
- Substantial %MeHg reductions
  - ~50%
- In addition to THg reductions
- Total Reductions in MeHg
  - Factor of ~4

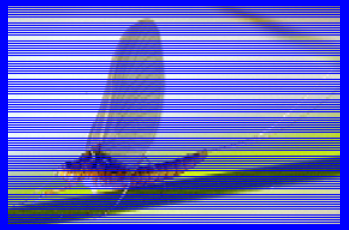


MeHg not detected weeks 4/16 – Cooler temperatures?

Benthic MeHg Data







This could also be normalized to control concentration each sample event
This does not include Chironimid data

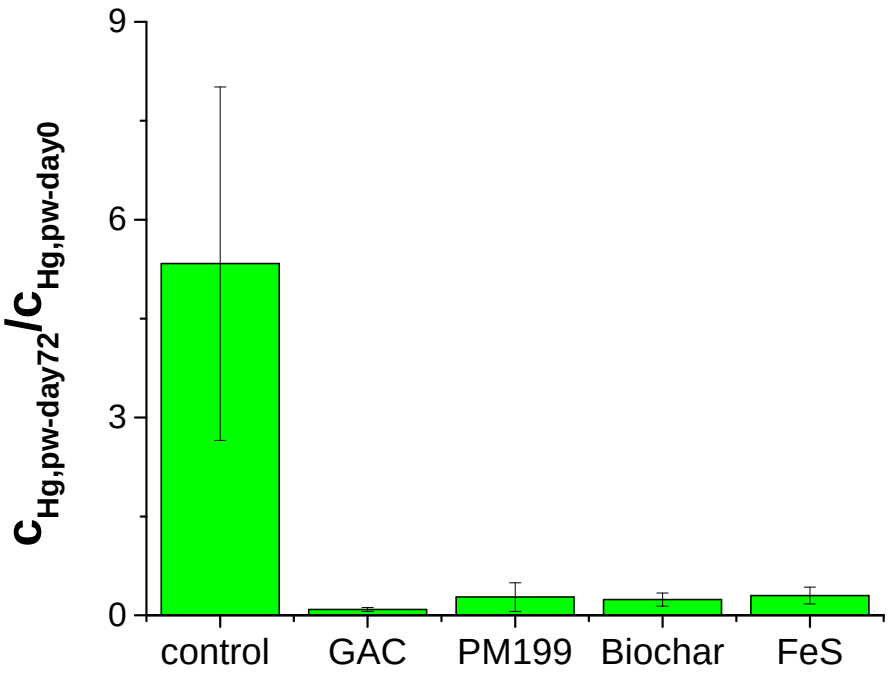
Screening of potential amendment materials - Sorption study (THg)

		artificial seawater
	sorbent	$K_{d,seawater}$ [l/kg]
Carbon based material	GAC	~ 20000*
	Sulfur impregnated AC	7250
	Mersorb (thiol) AC	5320
	Biochar-wood	600
	Biochar-Rice Husk	830
Organophilic clay based materials	PM199	9510
	MRM PM199	9520
Natural materials	Kaolinite	50
	Sand	2

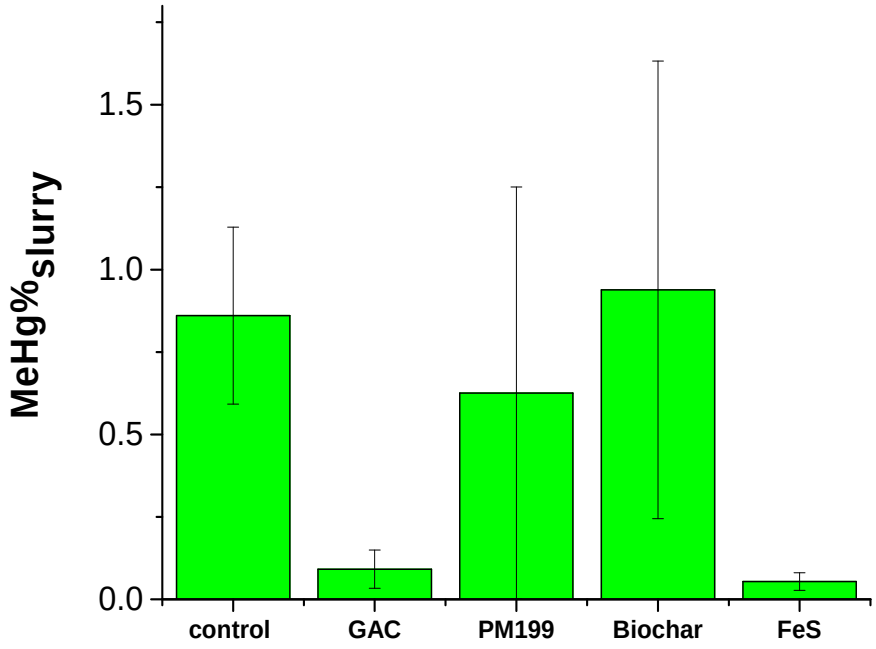
*non linear isotherm, $c_{Hg,w}$=20 µg/L

Example effects of sorbing amendments

THg, porewater



MeHg% slurry



- Amendments reduced porewater concentrations of THg

Directions

- Baseline studies
  - Further input into site conceptual model
  - Test hypothesis that porewater measurements relate to organism uptake
- Baseline plus amendments
  - Assess potential ability to manage Hg release and methylation
  - Test hypothesis that management of small areas can give significant reductions in availability/mobility of Hg
- Placement and retention
  - Applicability to the South River?
  - Coupled with field measurements on concentration/flux
  - Assessment of current status of Wertman Pond demonstration