CAN YOU TREAT THE WATER COLUMN?

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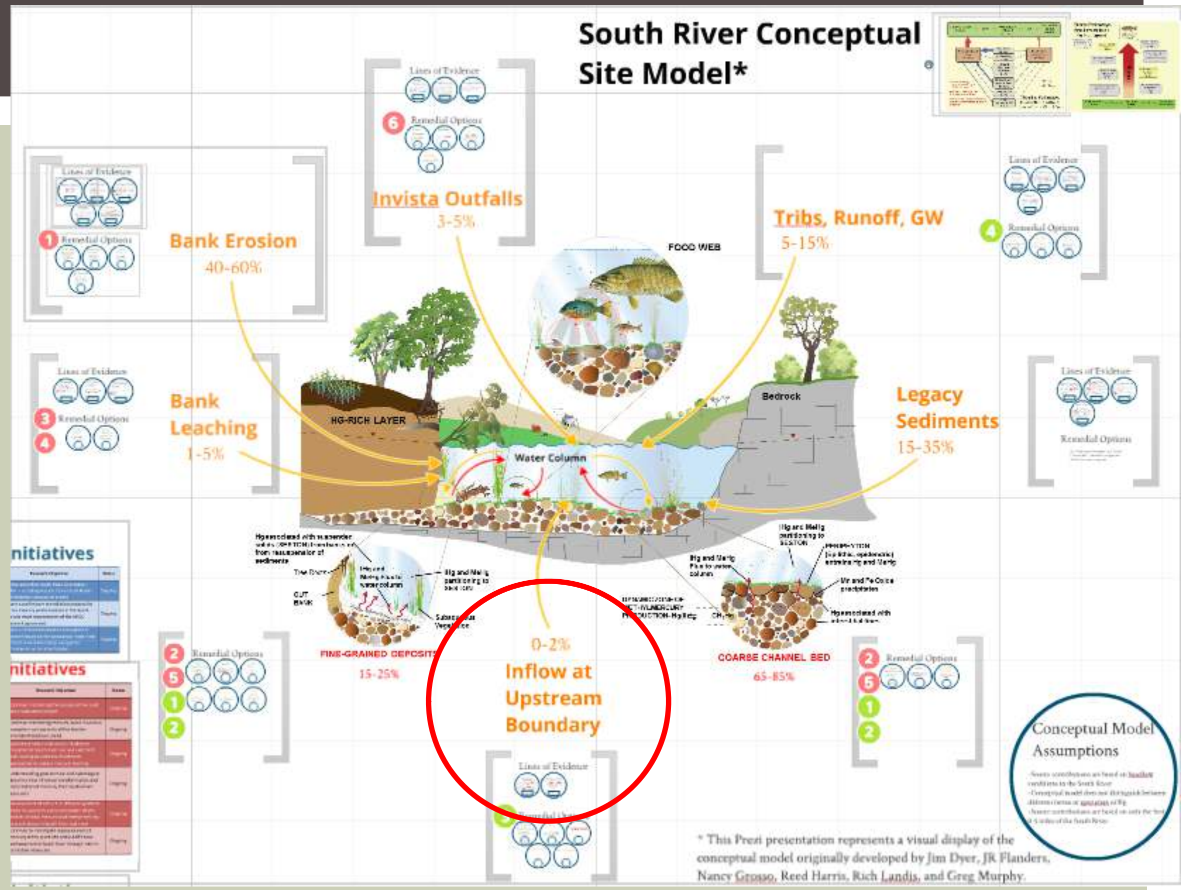
WHY THE WATER COLUMN?

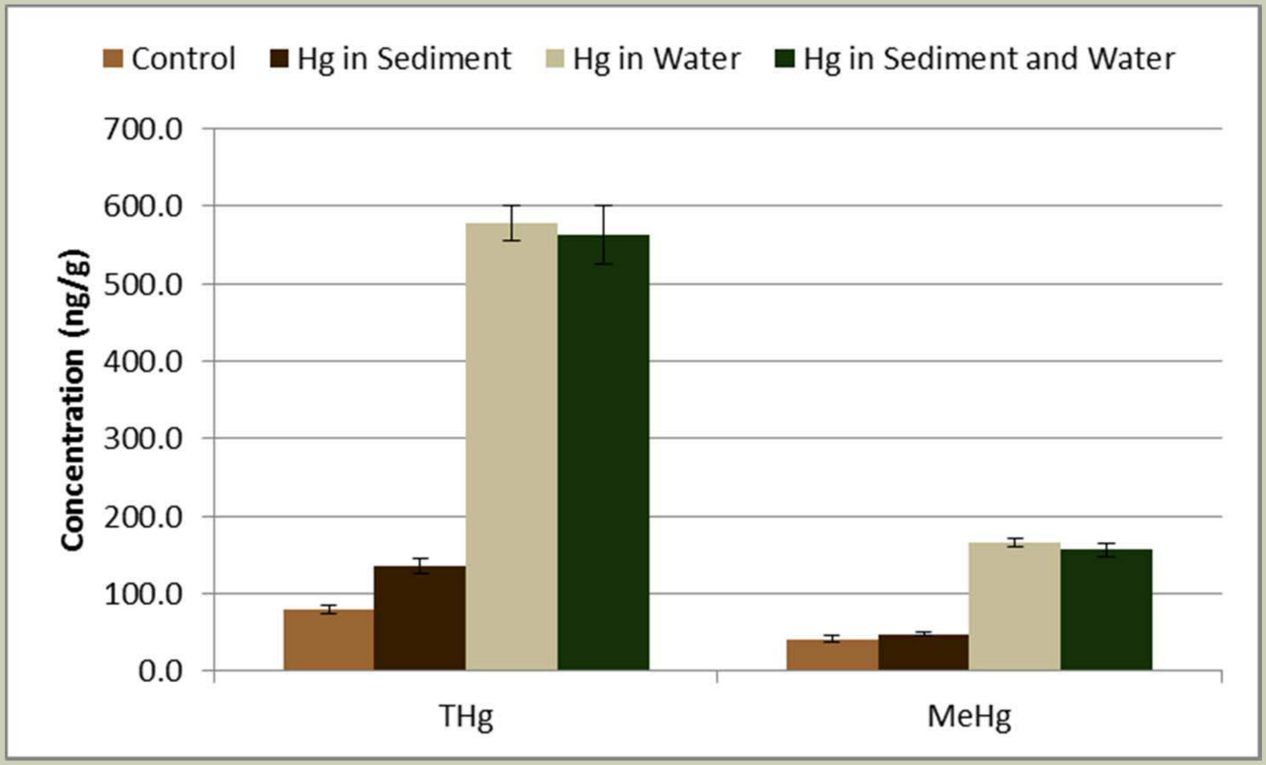
1. One of the sources identified in the conceptual model that has not received a lot of attention



2. In RM 0-5 it represents only 0-2% of mercury loading, but in many downstream reaches for the remaining 120 miles of impairment, it may represent up to 100% of the loading

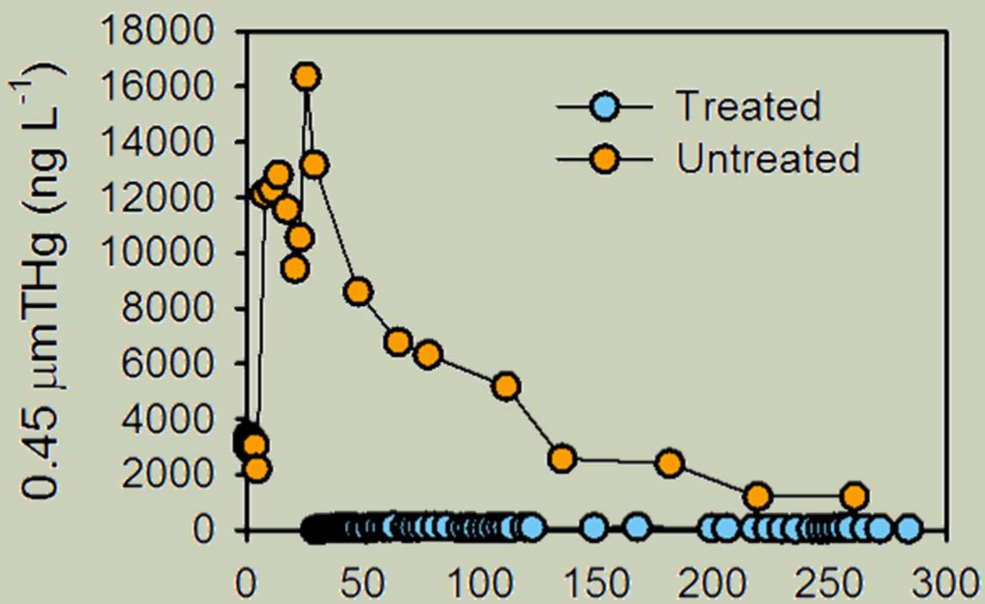
WHY THE WATER COLUMN?

3. Previous studies have shown that at the local scale, water column mercury is important in controlling uptake at the base of the food chain (Brent, 2010)



WHY THE WATER COLUMN?

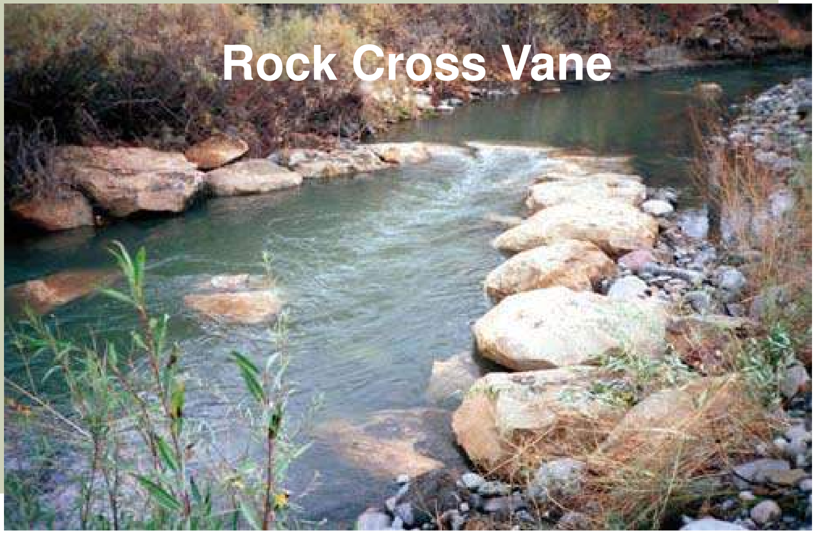
4. Previous studies have shown that biochar is effective at removing mercury from the water column (Ptacek and Blowes, 2012)



EXPERIMENTAL QUESTIONS

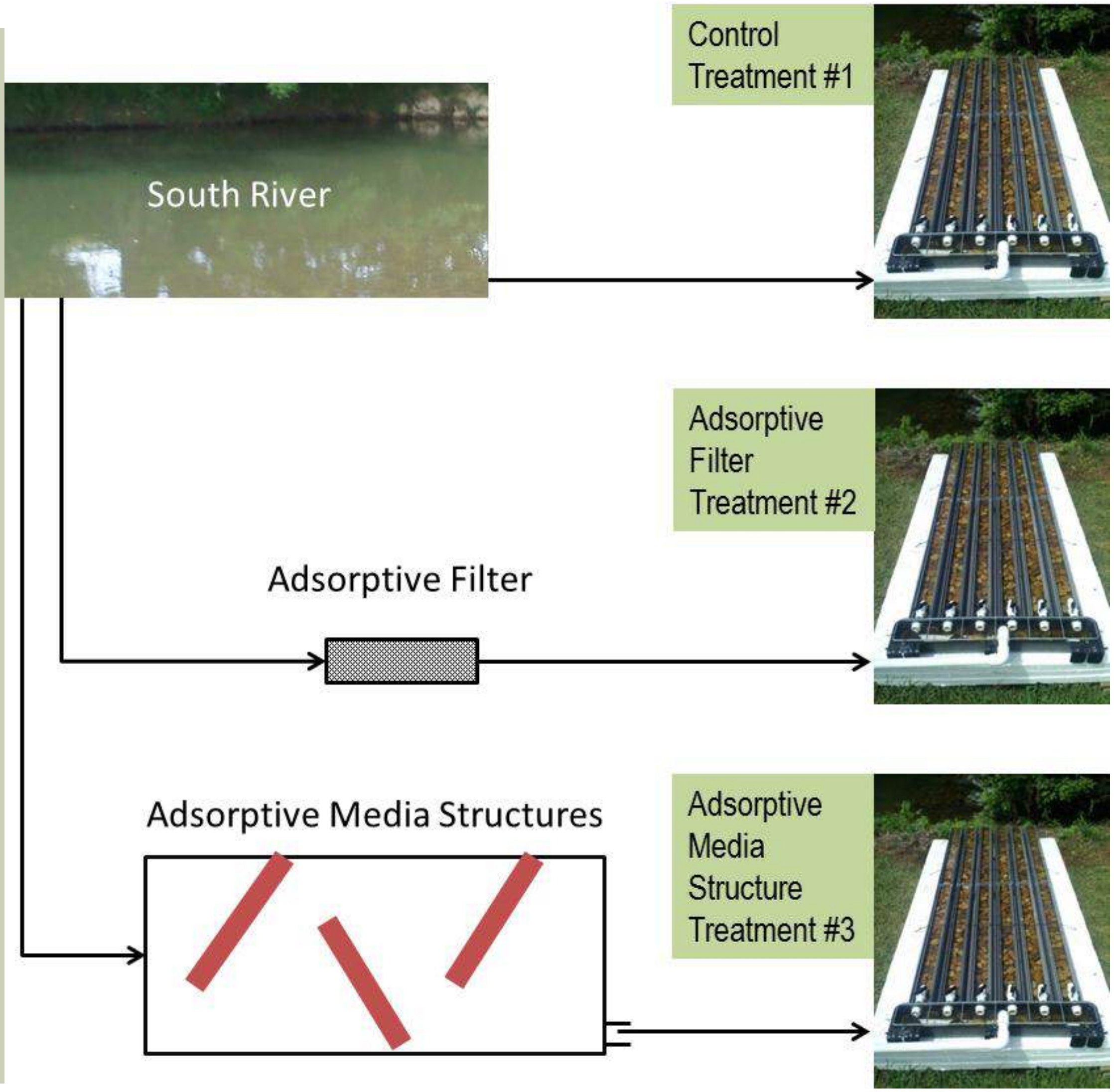
1. Can biochar be used to treat mercury in the water column?
   - In a field setting
   - Using biological endpoints (mercury accumulation in periphyton)

2. Can it be implemented in a passive treatment system using adsorptive media structures?
   - Structures that are a part of natural channel design restoration methodologies
   - Additional Benefits:
     - Improve stream habitat & ecological condition
     - Reduce erosion
     - Stabilize adsorptive media
     - Stakeholder acceptance



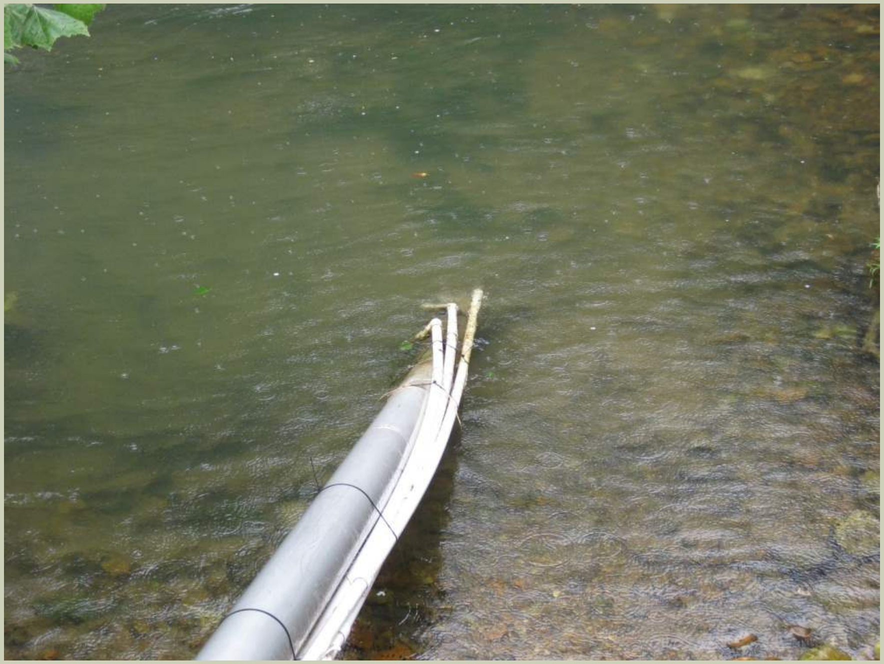
EXPERIMENTAL DESIGN

- SR water subjected to 3 treatments
- Directed through 3 mesocosms
- Mercury uptake was measured in periphyton after 6 weeks of colonization



EXPERIMENTAL SETUP

- At the Augusta Forestry Center, South River water is drawn from the river by 1 HP pumps and directed to 3 treatments



CONTROL TREATMENT

- Untreated river water was directed to mesocosm channels containing:
  - 8 kg sand/gravel from SR
  - 2 kg depositional sediment from SR (13,700 ng/g THg)
  - 80 clean rock substrates from Sawmill Run

FILTER TREATMENT

- River water was directed to one of two biochar filters containing:
  - Geotextile sediment trap
  - 8 inches of 0.5 - 2mm sieved biochar
  - Geotextile to contain biochar
  - Rock base

- Then to mesocosm channels

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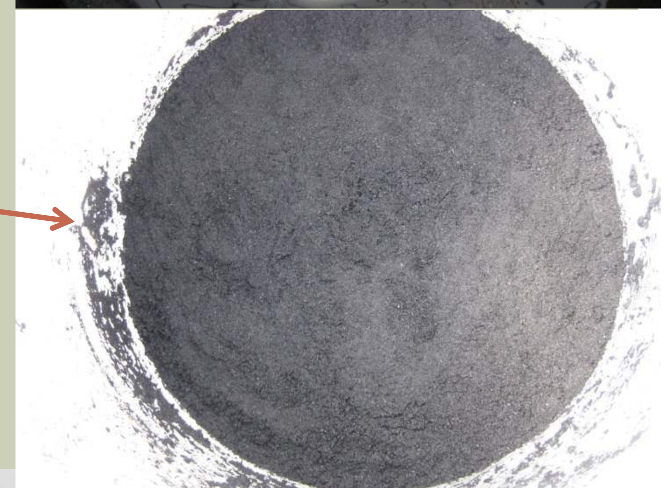
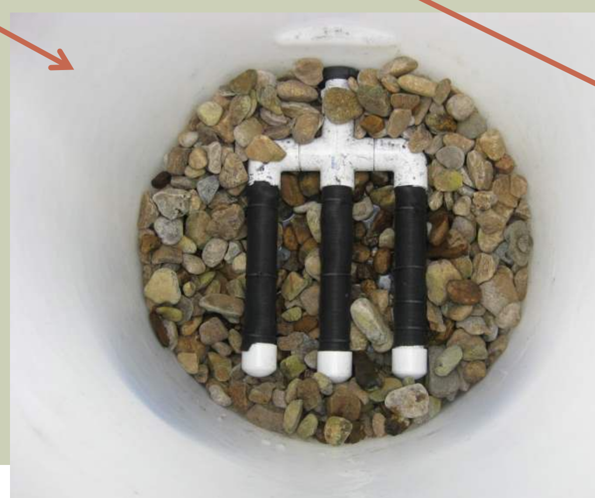




- Then to mesocosm channels

ADSORPTIVE STRUCTURE TREATMENT

- River water was directed through three channels designed with adsorptive media structures:
  - Rock drop structure
  - Log habitat structure
  - Glide structure

- Then to mesocosm channels

ADSORPTIVE STRUCTURE TREATMENT

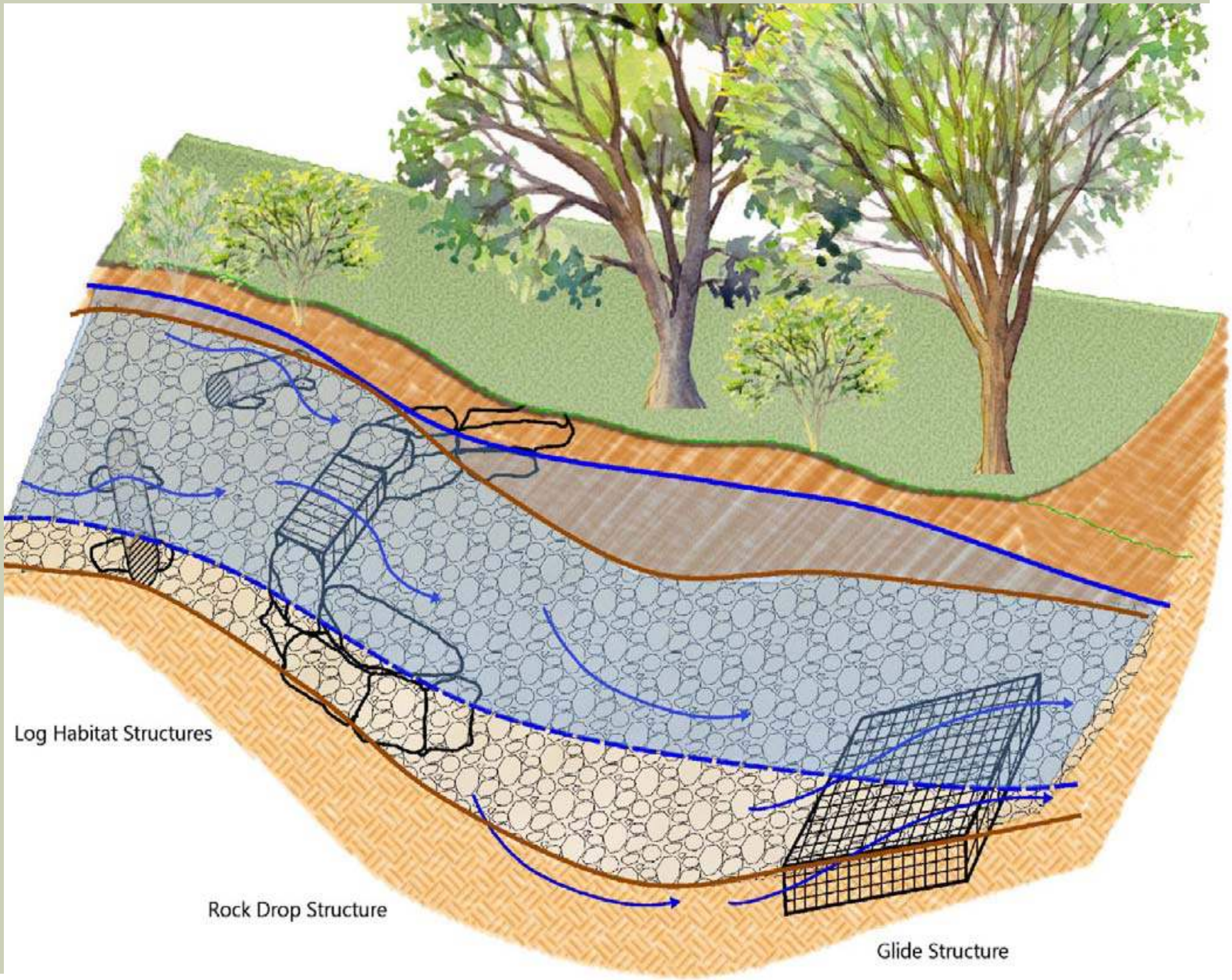
ROCK DROP STRUCTURE

LOG HABITAT STRUCTURE

GLIDE STRUCTURE

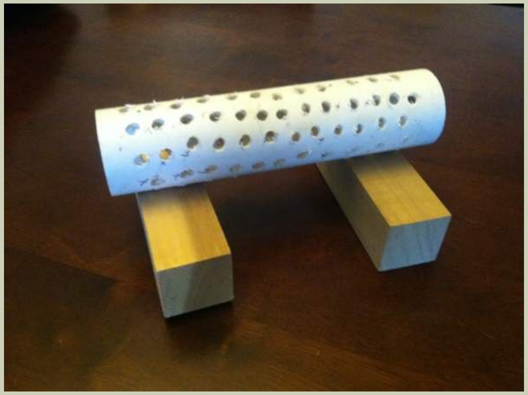
CONCEPTUAL DESIGN

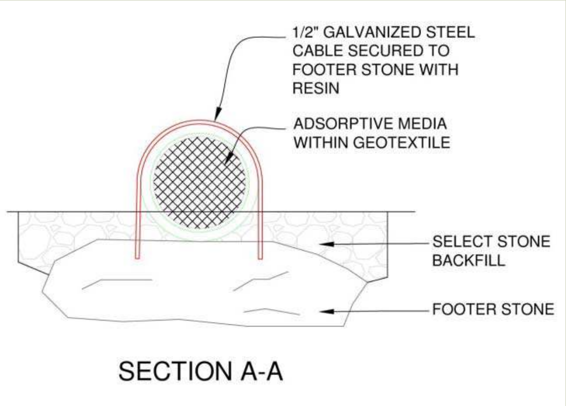
- 3 different structures designed for placement within various river settings
  - Log habitat structure
    - Riffle or run
  - Rock Drop Structure
    - Head of a pool
  - Glide Structure
    - Exit of a pool
- Placement also designed for
  - Erosion control
  - Specific habitat needs

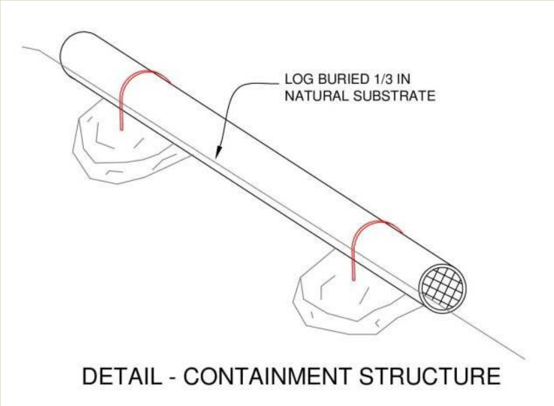


LOG HABITAT STRUCTURE

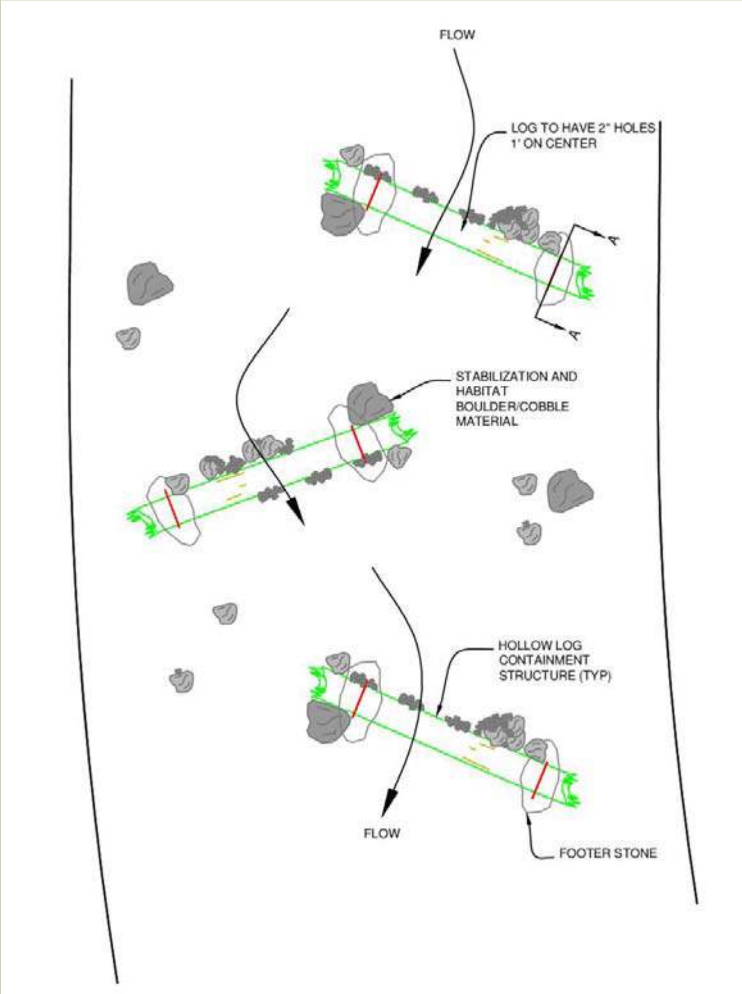
- Design characteristics
  - River Context: Riffle or run
  - Ecological Benefit:
    - Flow diversity
    - Organic carbon source
    - Habitat/refugia
  - Installation:
    - Minor excavation
    - Bedrock compatible





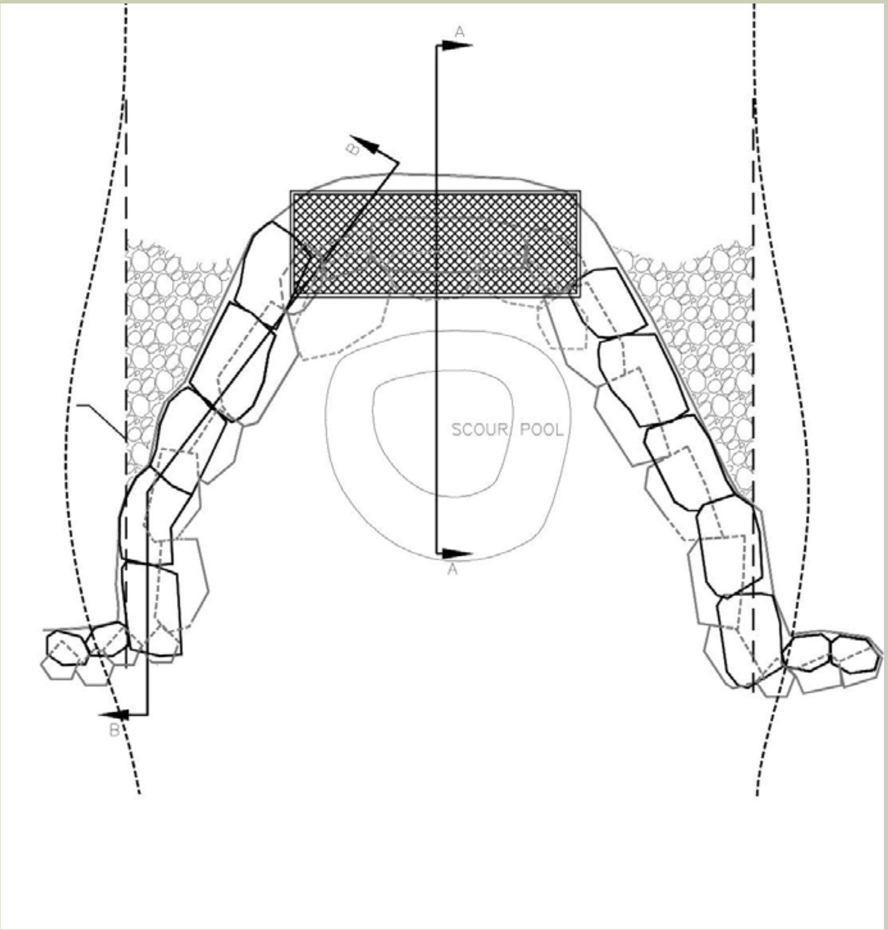


LOG HABITAT STRUCTURE



ROCK DROP STRUCTURE

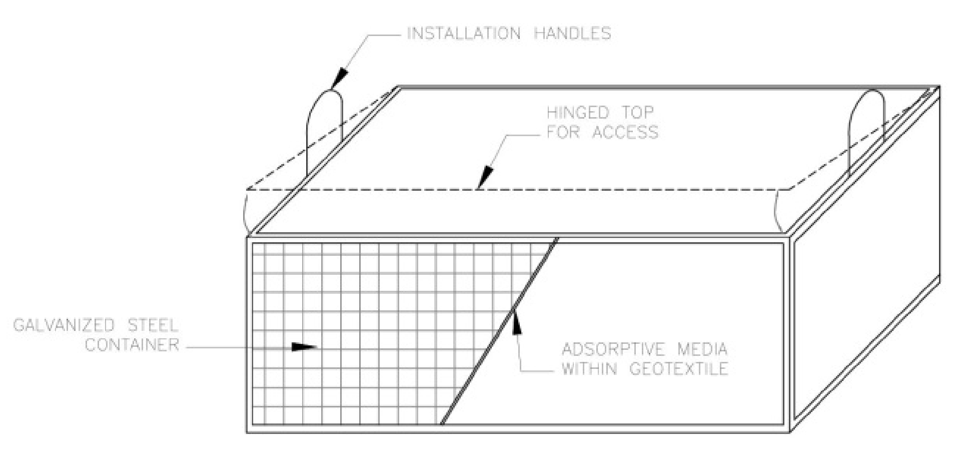
- Design characteristics
  - River Context: Log/Rock cross vane, J-hook or other grade control structure
  - Ecological Benefit:
    - Flow diversity
    - Bed form diversity
    - Habitat/refugia
    - Reduce bank erosion
  - Installation:
    - Temporary flow diversion
    - River restoration context



ROCK DROP STRUCTURE

GLIDE STRUCTURE

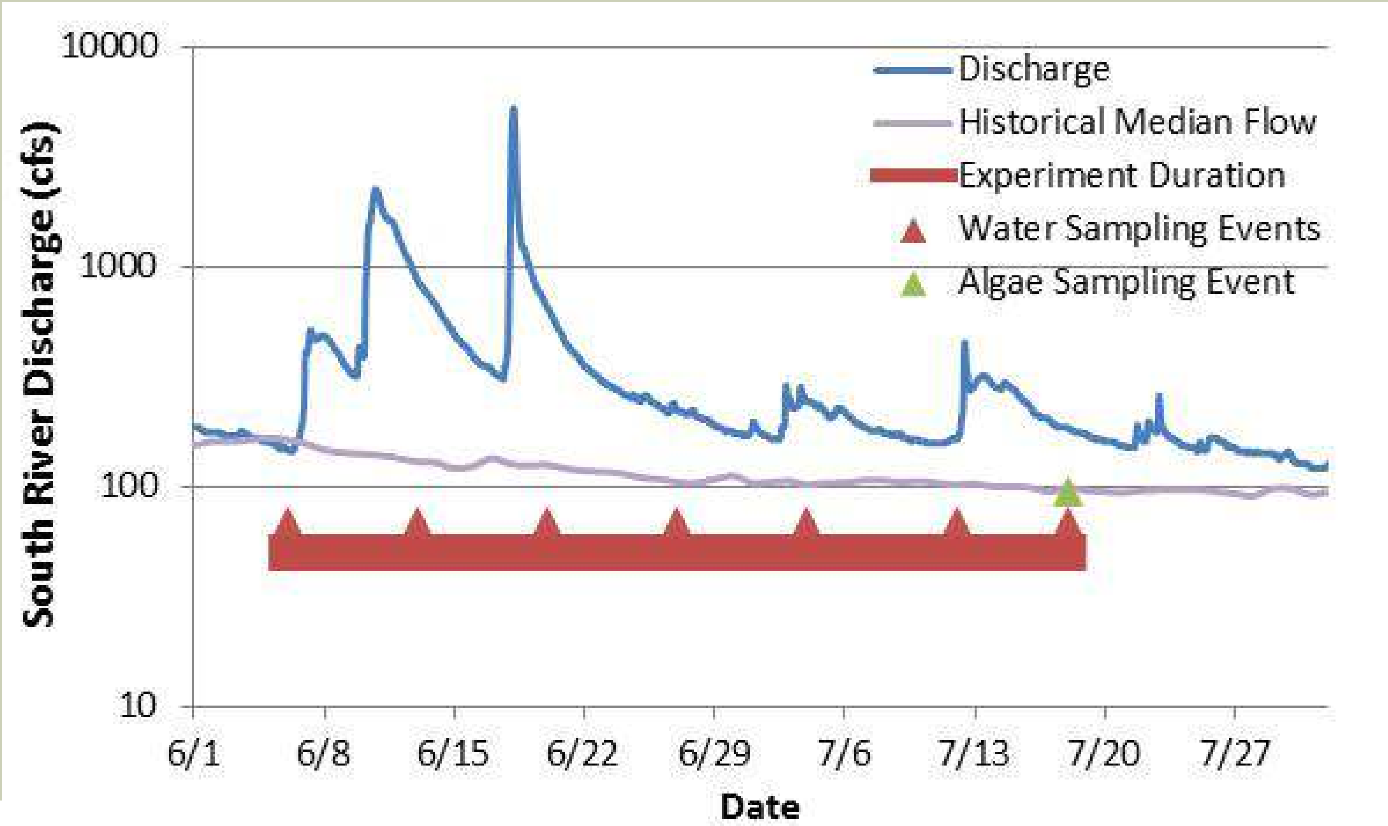
- Design characteristics
  - River Context: Glide
  - Ecological Benefit:
    - Bed form diversity
    - Hyporheic flow intersection
  - Installation:
    - Temporary flow diversion
    - River restoration context



DETAIL-CONTAINMENT STRUCTURE

RESULTS

- Experiment conducted June/July
- Several large storms
- Flow in general much higher than typical for June/July



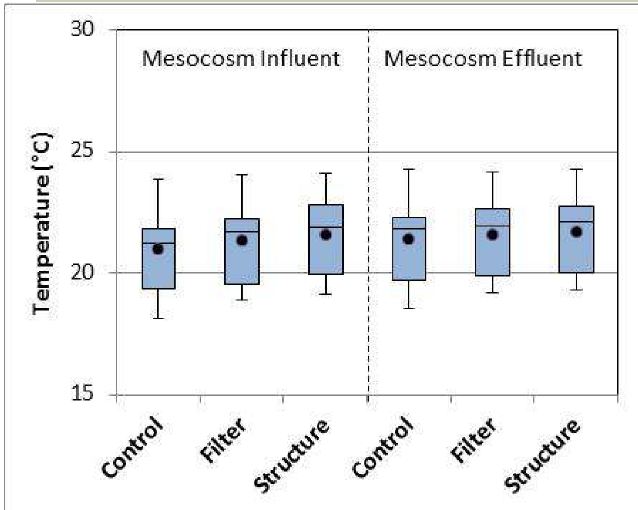
ANCILLARY WATER CHEMISTRY

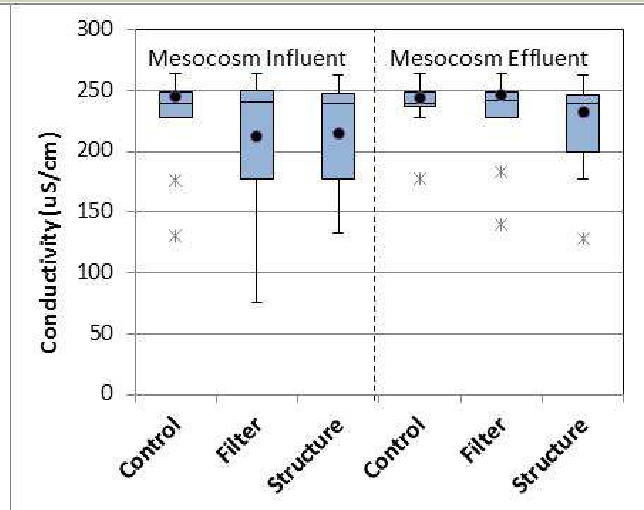
- No real differences in:
  - Temperature
  - Conductivity
  - DOC
  - Chloride
  - Nitrate
  - Sulfate
  - Phosphorus
- Filter treatment appeared lower in
  - Turbidity
  - TSS

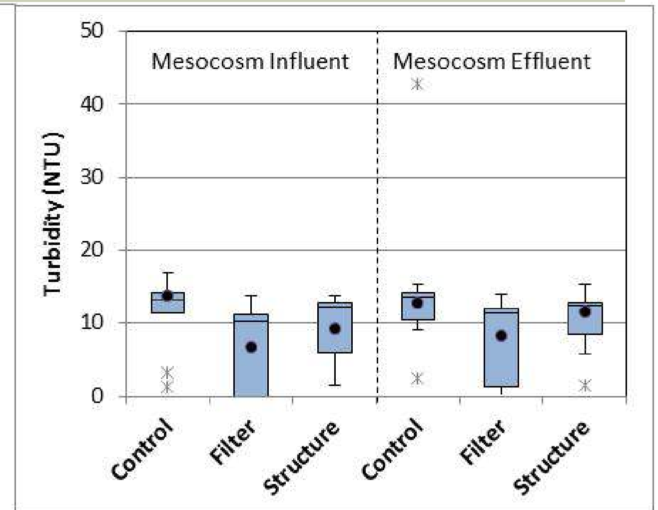
  (Not statistically significant at alpha = 0.05)
- Structure treatment and all mesocosm effluents higher in
  - DO
  - pH

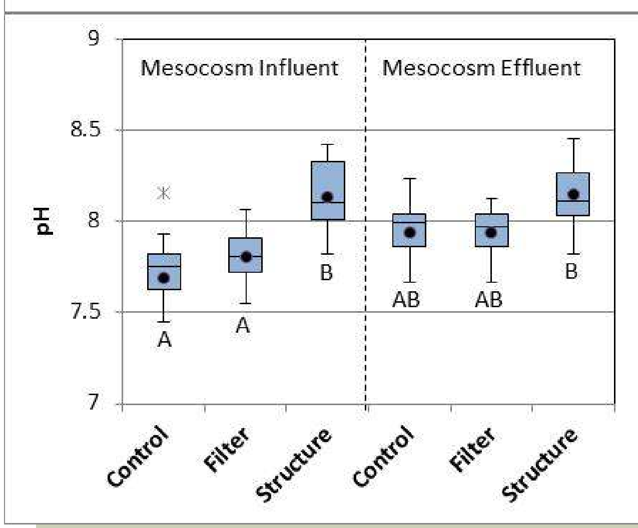
  (Statistically significant at alpha = 0.05)

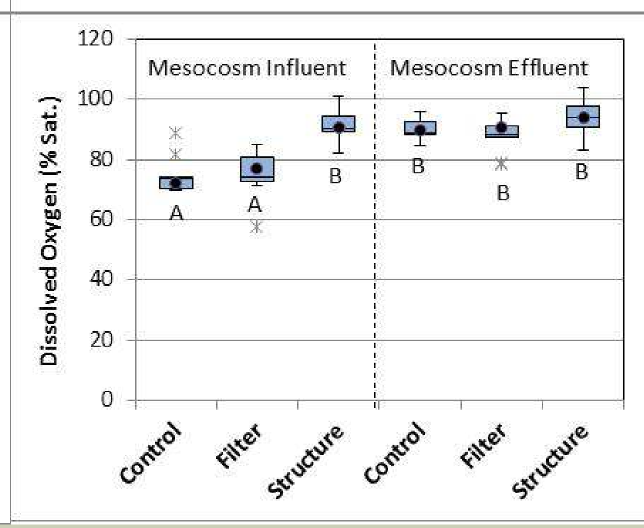
ANCILLARY WATER CHEMISTRY

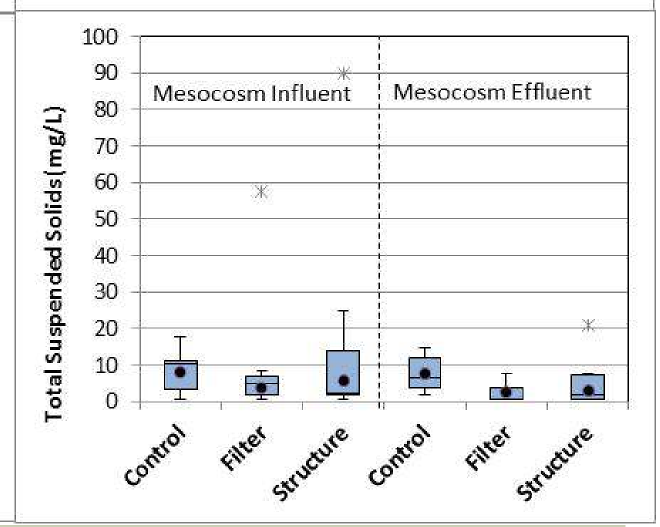












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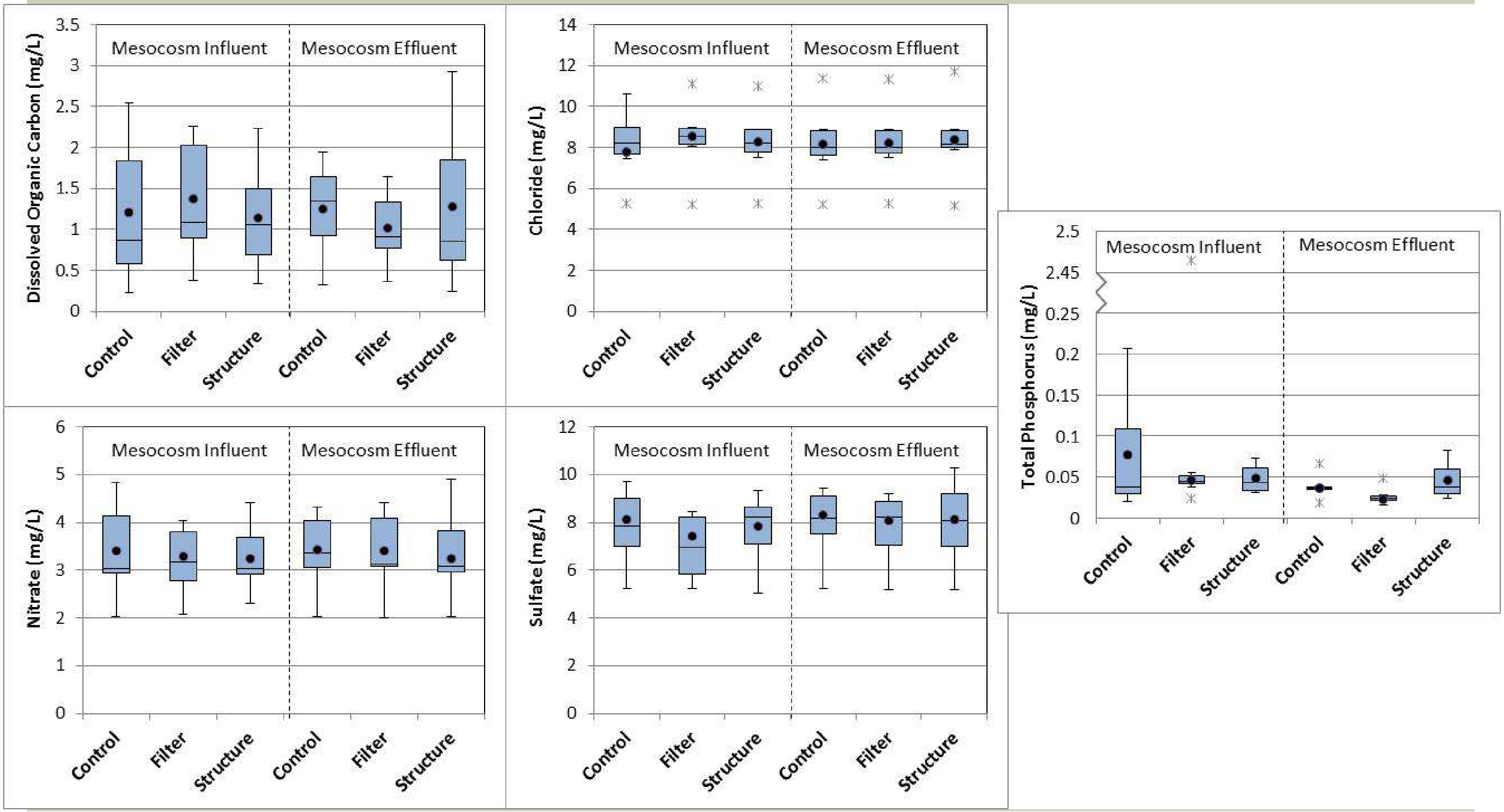
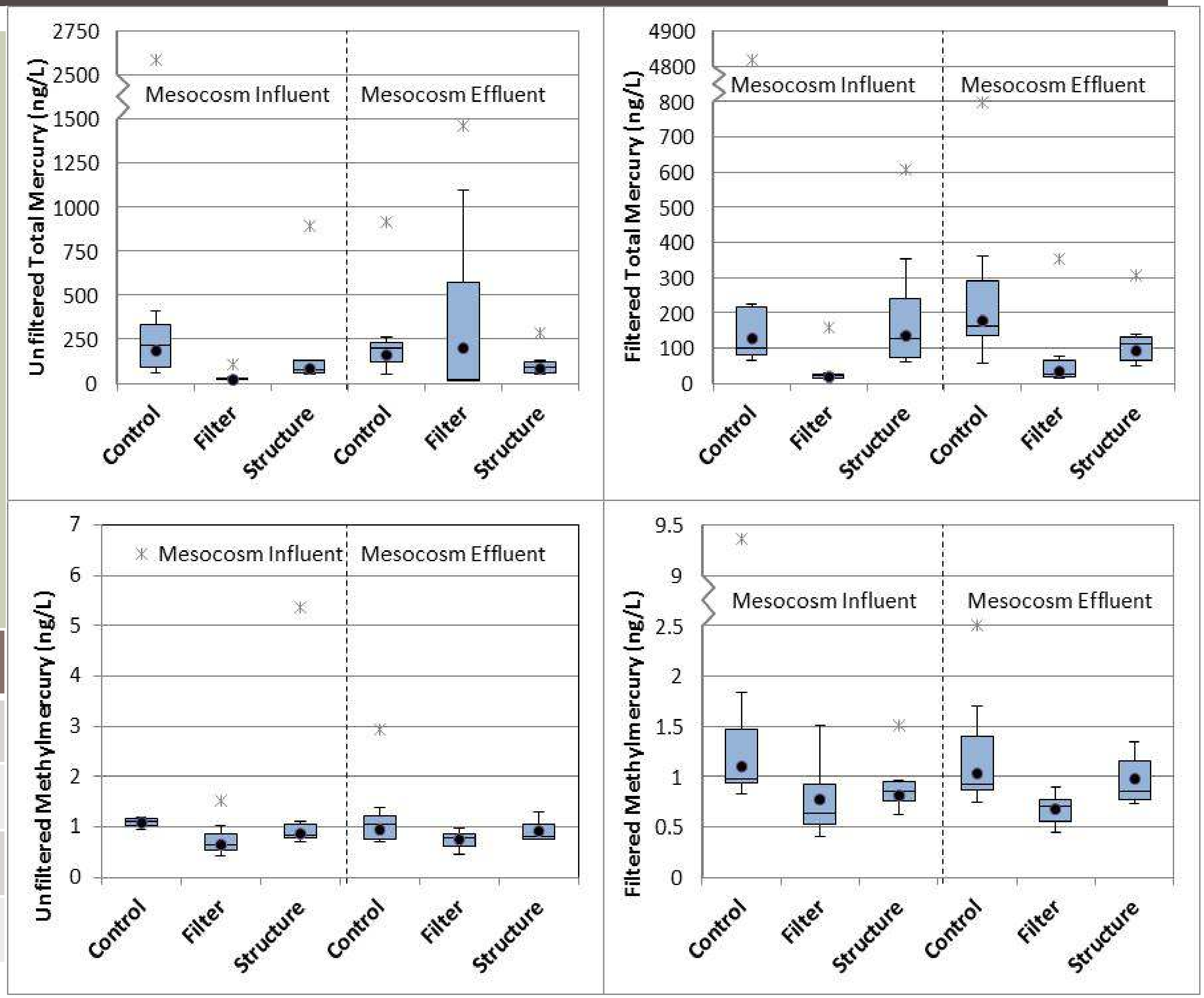


MERCURY IN WATER COLUMN

- Median mercury levels decreased 34-90% in filter treatment
- Variable in structure treatment

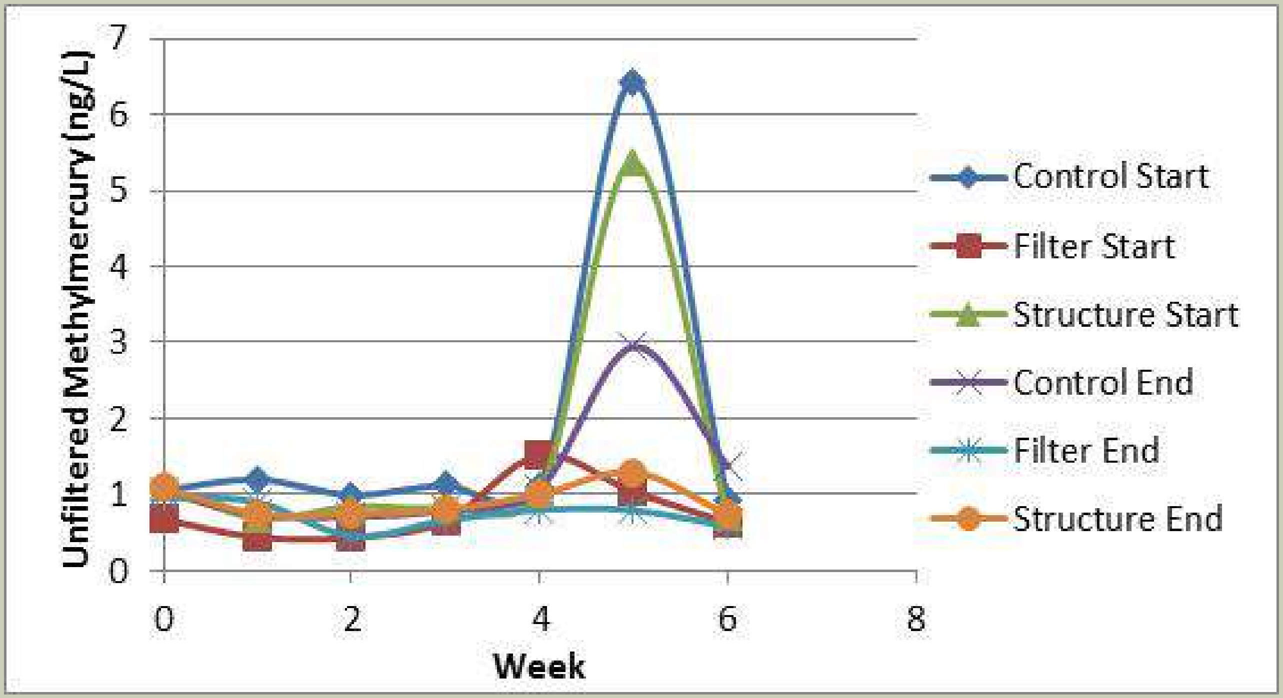
Mercury Reductions

	Filter	Structure
UTHg	↓ 90%	↓ 64%
FTHg	↓ 78%	↑ 28%
UMeHg	↓ 41%	↓ 25%
FMeHg	↓ 34%	↓ 12%



VARIABILITY IN WATER COLUMN MERCURY

- Variability associated with storm events



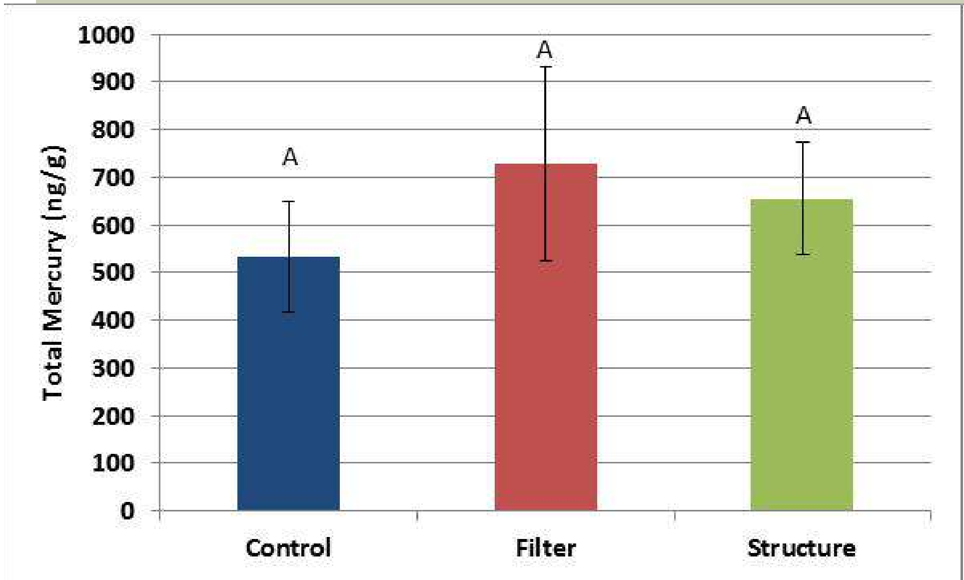
PERIPHYTON (THE REAL MEASURE)

- After 6 weeks colonization in mesocosms
- 4 replicate samples collected from each of 3 replicate channels for each treatment
- Analyzed for total and methymercury

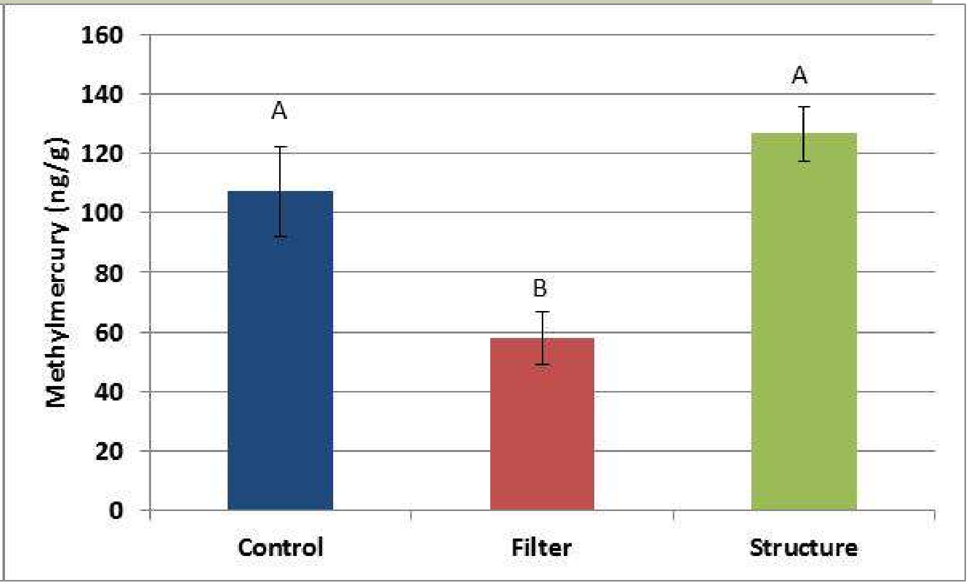
PERIPHYTON RESULTS

- No difference in Total Mercury accumulation by periphyton in various treatments
- Statistically significant 46% reduction in methylmercury accumulation by periphyton in filter treatment

Total Mercury



Methylmercury



CONCLUSIONS

- Biochar can be effectively used to treat the water column and reduce methylmercury accumulation at the base of the food chain
- Initial adsorptive structure designs did not allow sufficient contact with biochar to effectively reduce methylmercury accumulation