Exponent®

Battelle
Conference on the Remediation and Management of Contaminated Sediments

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Effects of Activated-Carbon-Based Amendments on the Bioavailability of Methylmercury from Marsh Sediments to Aquatic Invertebrates

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Introduction

- Berry's Creek Study Area (BCSA) consists of 6.5 mi of tidal waterways surrounded by 3.1 km^2 (756 acres) of common reed (*Phragmites australis*) marshes.
- Efficacy of activated carbon (AC) amendments in reducing bioavailability of PCBs and Hg in marsh sediments previously examined in BCSA field studies.

Objectives – Demonstration of Long Term Protectiveness

To evaluate the effect of fresh and aged AC amendments on:

- MeHg concentrations and partitioning in marsh sediments and porewater
- MeHg concentrations in tissue

Companion poster: ***Adaptation of Leptocheirus plumulosus bioassay to measure bioavailability and bioaccumulation of methylmercury in an oligohaline estuarine environment***

Companion presentation: ***Development and Testing of a Novel Passive Sampler for Methylmercury in Sediment and Soil Porewaters***

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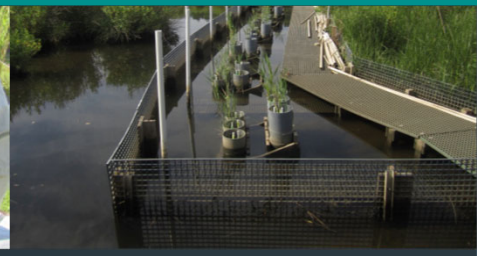
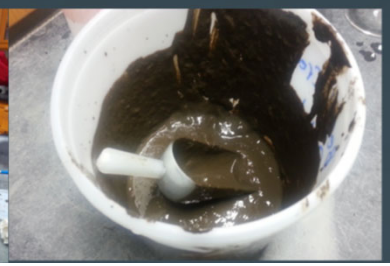
Sediment Preparation for Bioaccumulation Study



- Unamended Control and Aged AC-treated sediments (5% AC per gdw, regenerated powdered AC) collected at the end of a 20-month marsh mesocosm study (~20 ppm THg)
- Sediments were homogenized with a blender, sieved (0.5 mm), and mixed (4 min) with a motorized paddle
- Fresh AC (5% AC per gdw) added to subsample of Unamended Control sediment, mixed with a motorized paddle



Sediment Preparation for Bioaccumulation Study

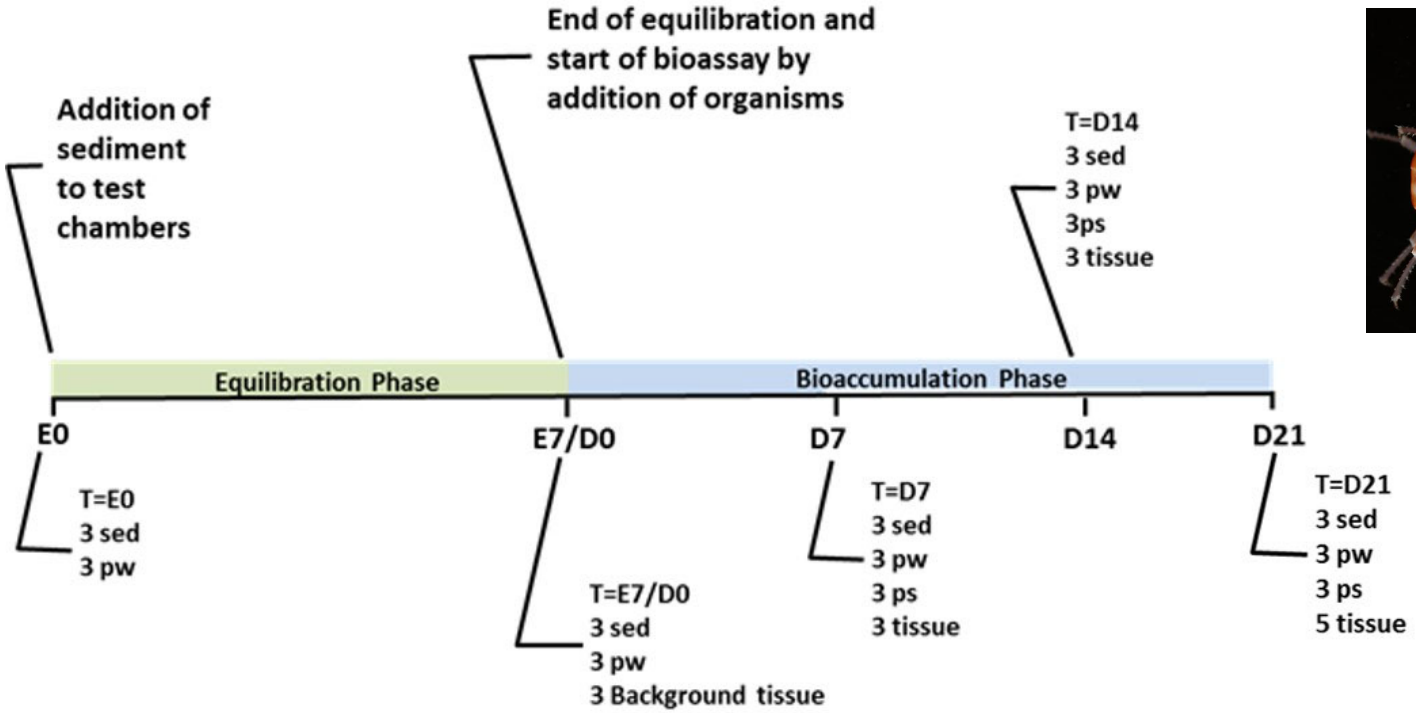
- Three Treatments:
  - Unamended Control
  - Aged AC-amended sediment (Aged AC)
  - Fresh AC-amended sediment (Fresh AC)
- Sediments held at 4°C for five weeks before bioaccumulation test

Test Methods

- 400 mL of sediment and 500 mL synthetic seawater in 1-L beakers
- Two types of passive samplers added to beakers*
- Sediment, porewater (via centrifugation), and tissue analyzed for THg and MeHg
- Redox conditions in sediment assessed using redox probes and geochemical markers (e.g., Fe, Mn, S)

* See abstract #50

Leptocheirus plumulosus Bioaccumulation Test



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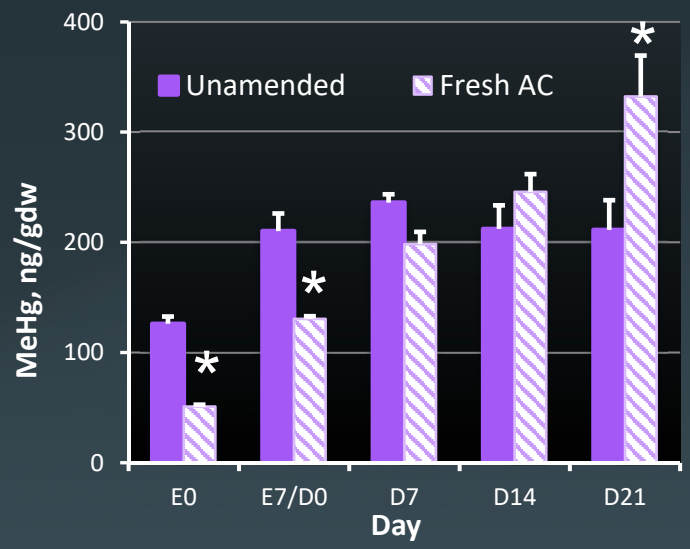
MeHg in Sediment Increased Over Time in Fresh AC Treatment



MeHg in Fresh AC sediment increased over time
MeHg in Fresh AC 1–2x higher vs. Control on Day 21

* Significant difference in Treatment vs. Control

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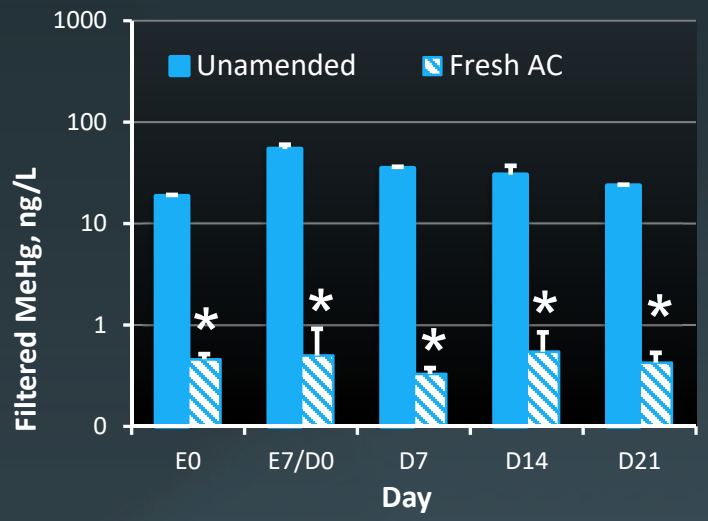
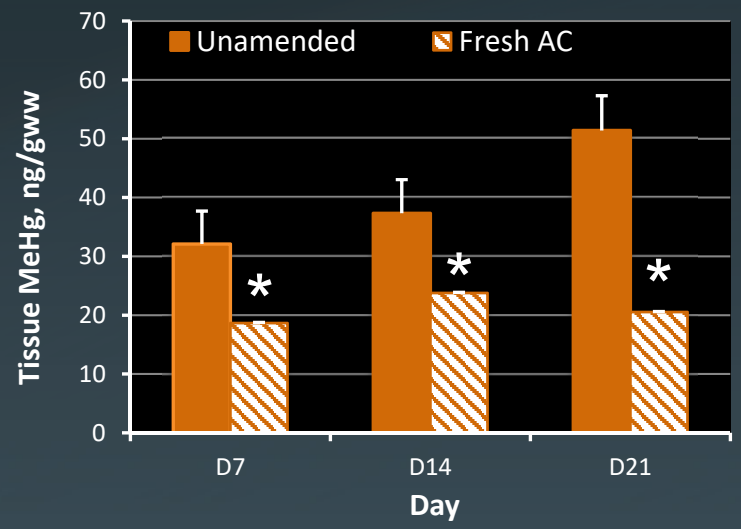
Fresh AC Decreased MeHg in Porewater and Tissue

Porewater



MeHg in Fresh AC ~50x lower vs. Control

Tissue



MeHg in Fresh AC ~2–3x lower vs. Control

* Significant difference in Treatment vs. Control

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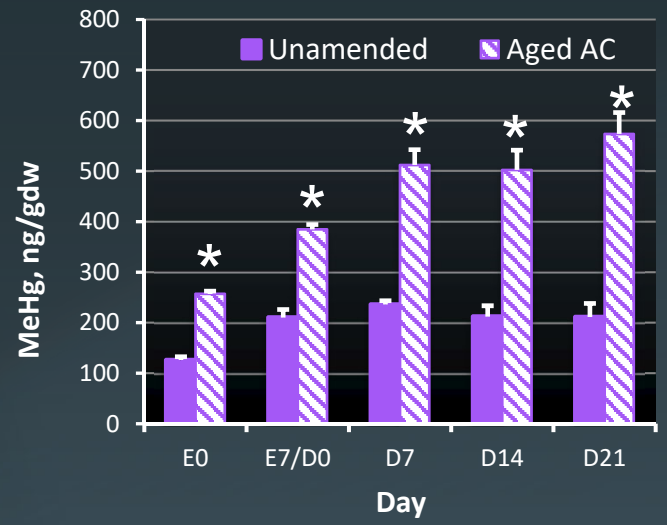
MeHg in Sediment Increased Over Time in Aged AC Treatment

Sediment



MeHg in Aged AC sediment increased over time
MeHg in Aged AC 2–3x higher vs. Control on D21

* Significant difference in Treatment vs. Control

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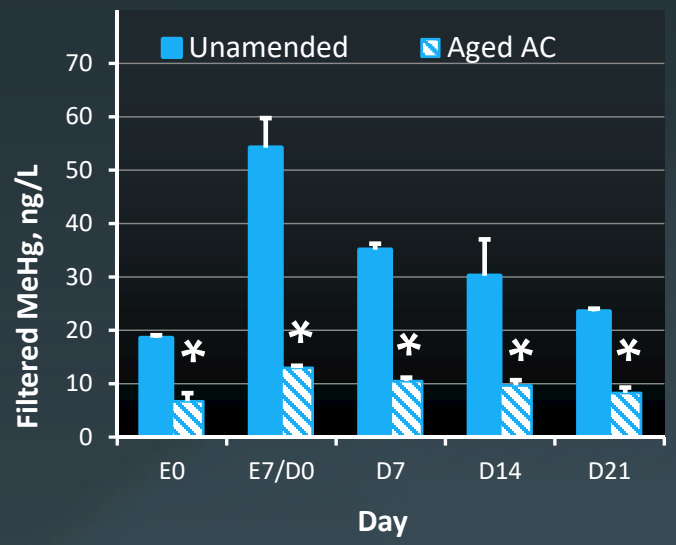
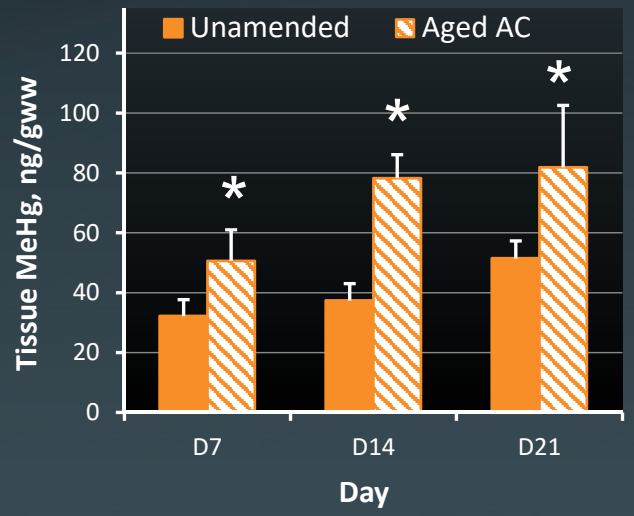
Aged AC Decreased MeHg in Porewater but Tissue Concentrations Followed Increasing Trend Over Time

Porewater



MeHg in Aged AC ~3–4x lower vs. Control

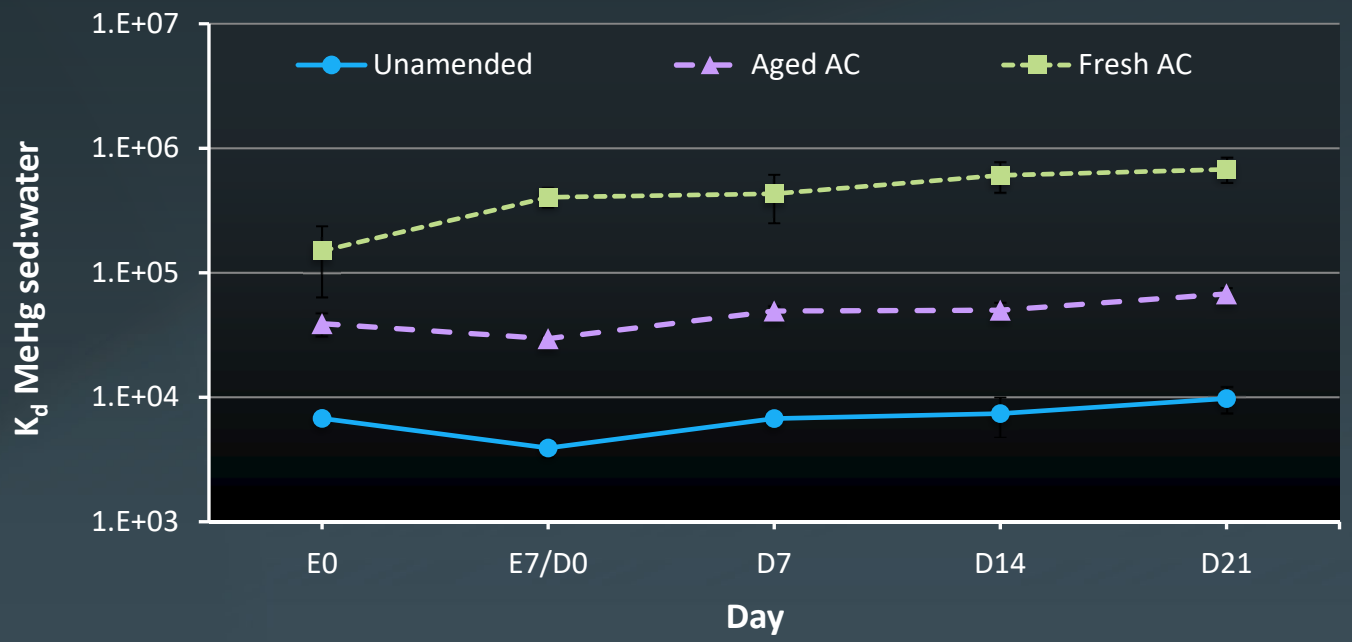
Tissue



MeHg in Aged AC ~1–2x higher vs. Control

* Significant difference in Treatment vs. Control

Sediment-porewater Partition Coefficient (K_d) Highest for Fresh AC



Tissue-Sediment-Ratio (TSR)

Normalization of tissue concentrations to sediment concentrations accounts for differences in sediment concentrations among treatments

- $TSR = \frac{\text{Tissue concentration (ng/gww)}}{\text{Sediment concentration (ng/gdw)}}$

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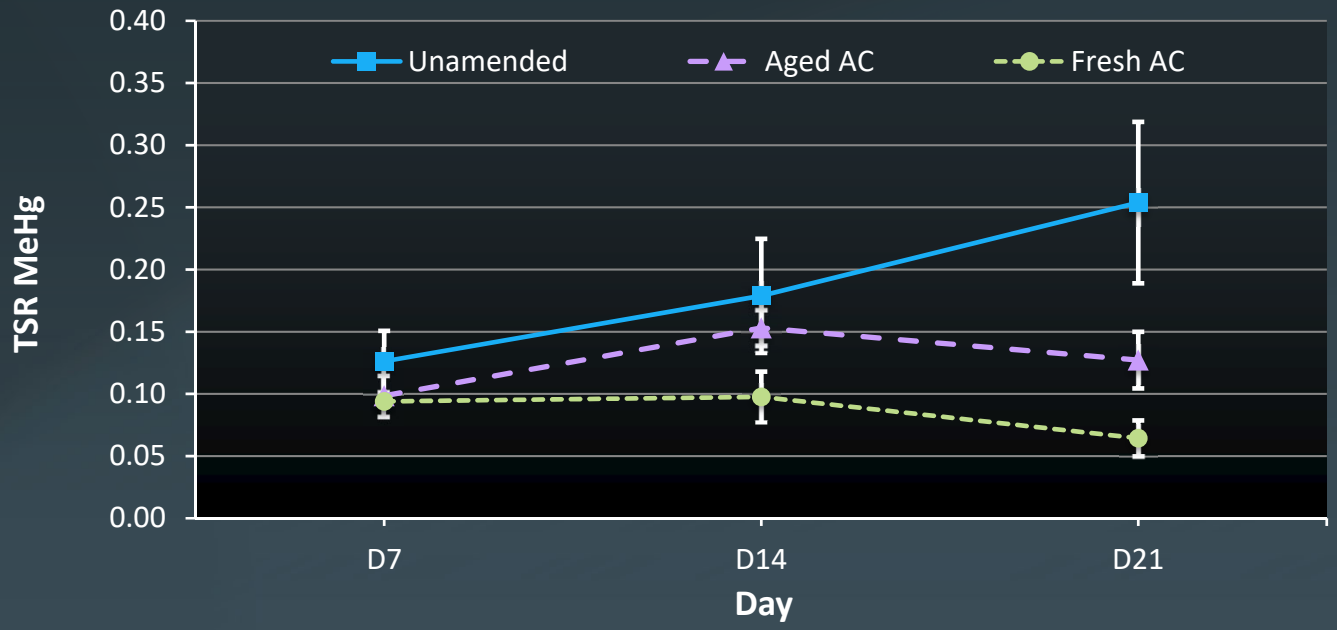
Tissue to Sediment Ratio (TSR) for MeHg Lowest for Fresh AC, Indicating Greatest Reduction in Bioavailability



Summary

- Concentrations of MeHg in porewater were significantly lower in both AC-treatments vs. Control
  - MeHg porewater were 50x lower in the Fresh AC treatment vs. Control
- MeHg in tissue were ~2–3x lower in Fresh AC treatment vs. Control
- MeHg associated with sediment tended to increase over time in both AC-treatments, but not in Control

Summary

- Normalization of tissue concentrations to sediment concentrations indicated decreased bioavailability of MeHg in both AC-treatments
- Fresh AC had the clearest effect:
  - Lowest porewater concentrations
  - Lowest tissue concentrations
  - Highest sediment-to-porewater partitioning (K_d)
  - Lowest Tissue-to-Sediment Ratio
- Aged AC also showed effects:
  - Lower sediment-to-porewater partitioning (K_d) vs. Control
  - Lower Tissue-to-Sediment Ratio vs. Control

Acknowledgments

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    - The Dow Chemical Company

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