Passive Sampling for Measuring Organic Contaminants in Sediment Porewater and Overlying Water

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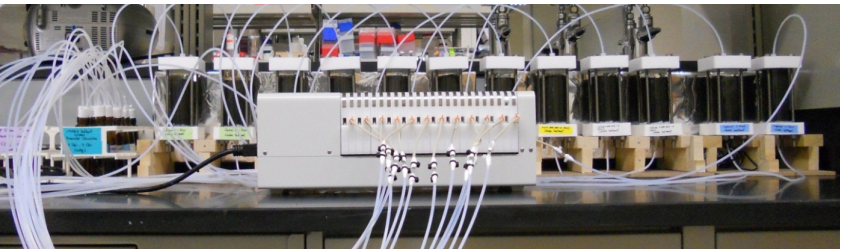
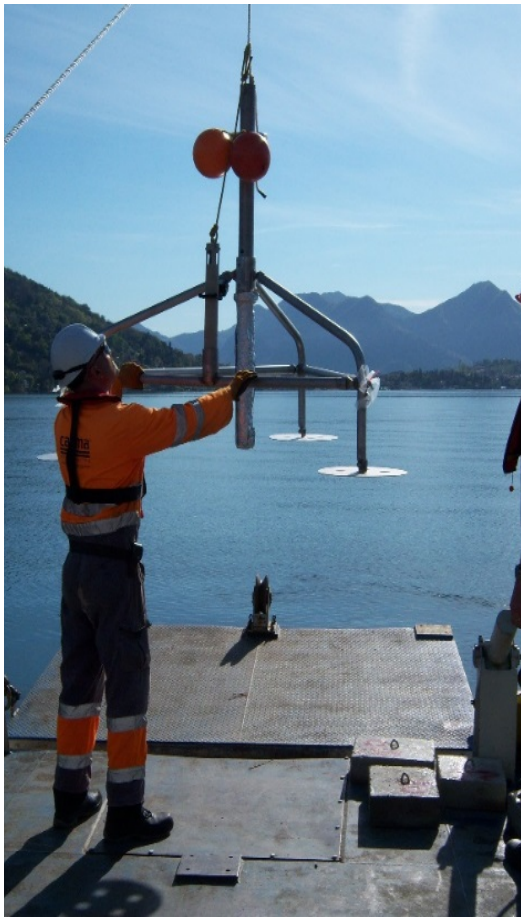
January 25, 2017

Passive sampling methods for determining $C_{porewater}$





Column tests in laboratory
Slurry tests in laboratory

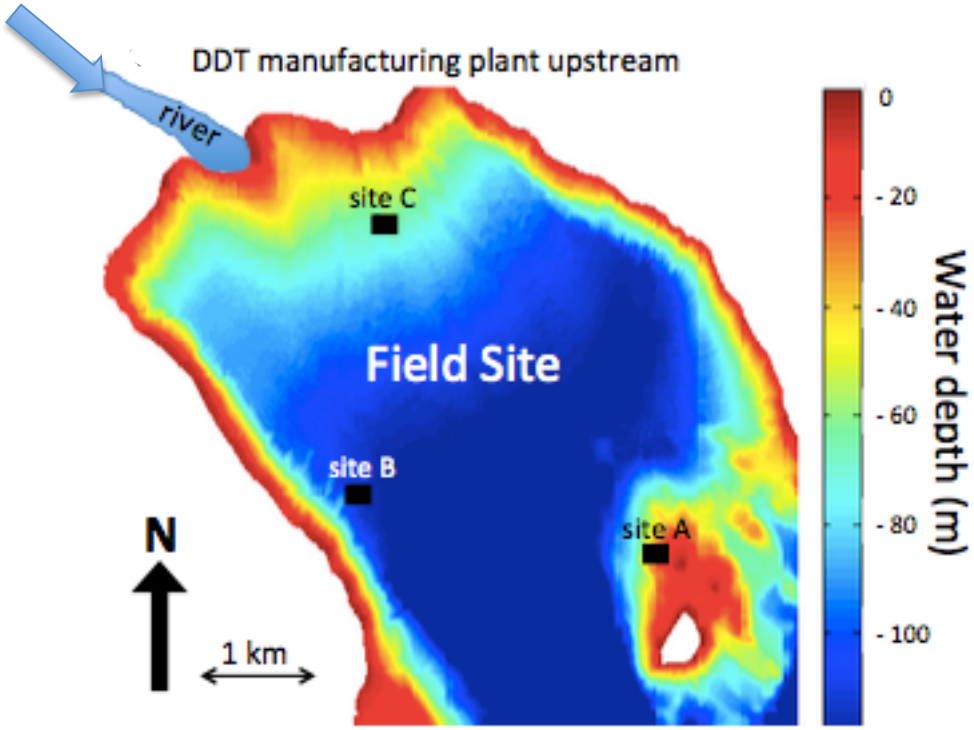
Deployment in mudflats
Deployment in tidal creek

Deployment in deep water

Lake Maggiore, Italy

Natural attenuation of sediment in a deep water lake

- Are incoming deposits clean?
- Is recovery happening quickly enough?
- Is the sediment a source of DDT?



Porewater probe – development and application

Novel Probe for in Situ Measurement of Freely Dissolved Aqueous Concentration Profiles of Hydrophobic Organic Contaminants at the Sediment–Water Interface

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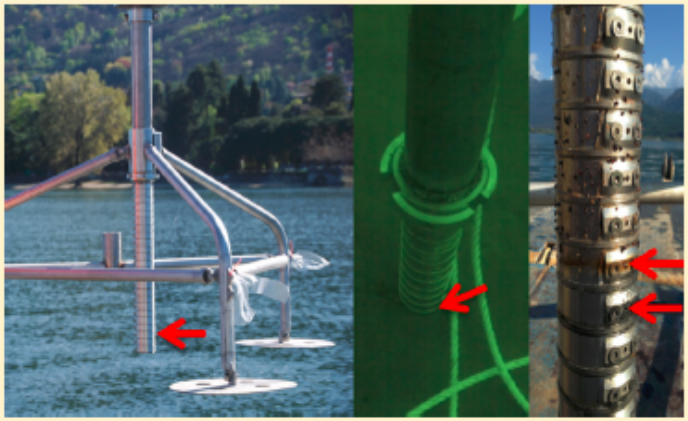
Supporting Information

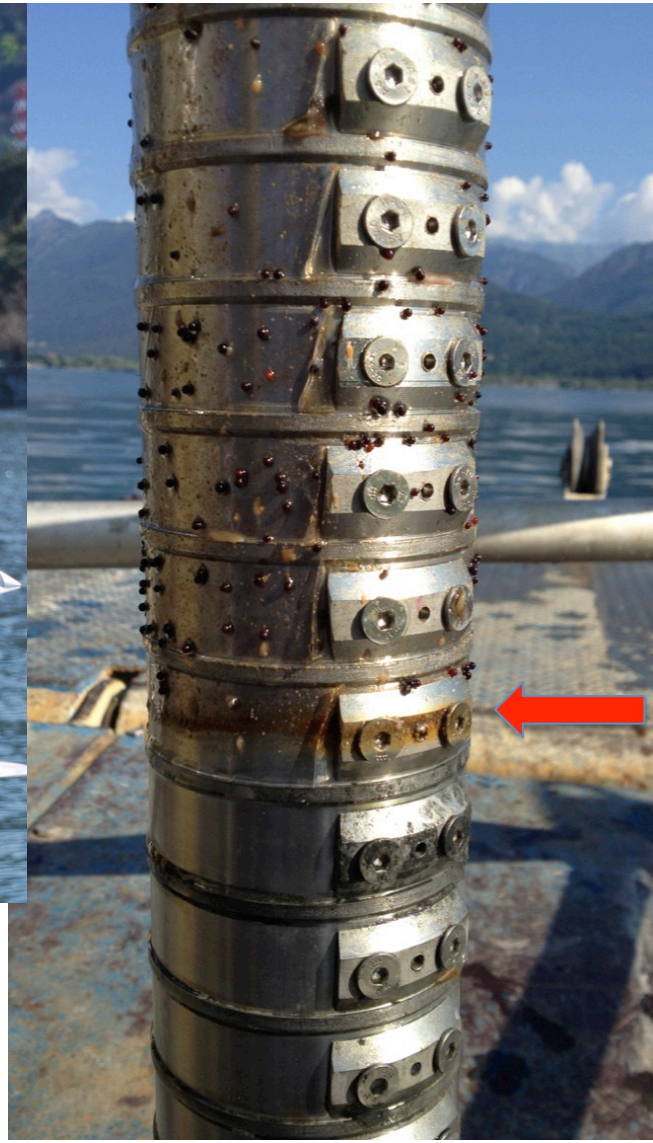
ABSTRACT: A novel pore water probe equipped with polyethylene passive samplers was used to measure the freely dissolved aqueous concentration profiles and diffusive flux profiles of DDT (dichlorodiphenyltrichloroethane) metabolites from 30 cm above to 30 cm below the sediment surface at 2.5 cm resolution intervals in a DDT-impacted lake. The probe was designed to be easily deployed in deep water without the need for divers, provide reliable indications of penetration depths, and minimize disturbance to water movement in the overlying water. The measured aqueous concentration profile allowed us to identify the peak in DDT concentration buried 15 cm below the sediment surface as a source for both upward and downward contaminant flux and to calculate the diffusive



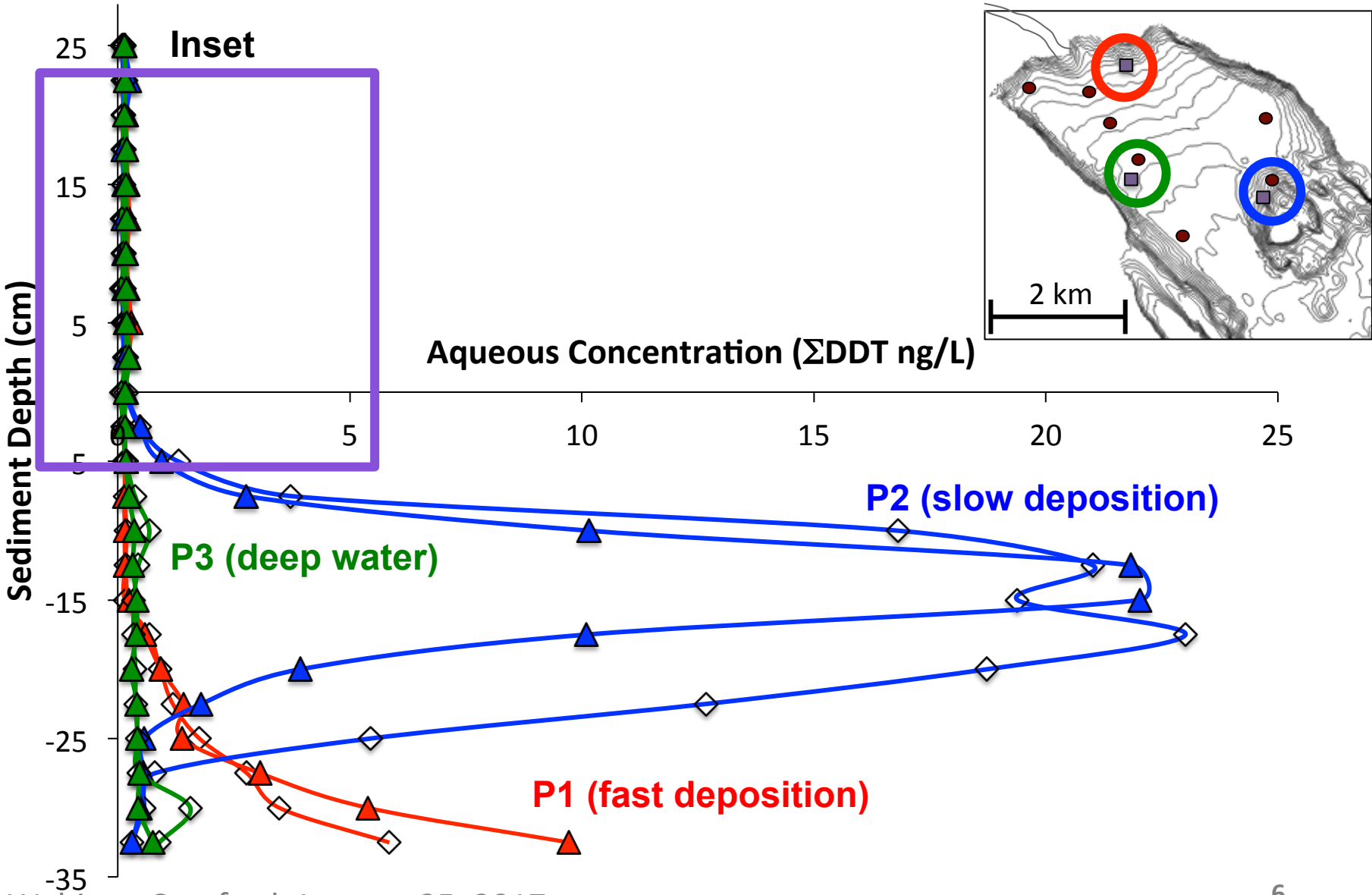
ES&T Letters 2015: 2, 320

Porewater probe measured conc. profile

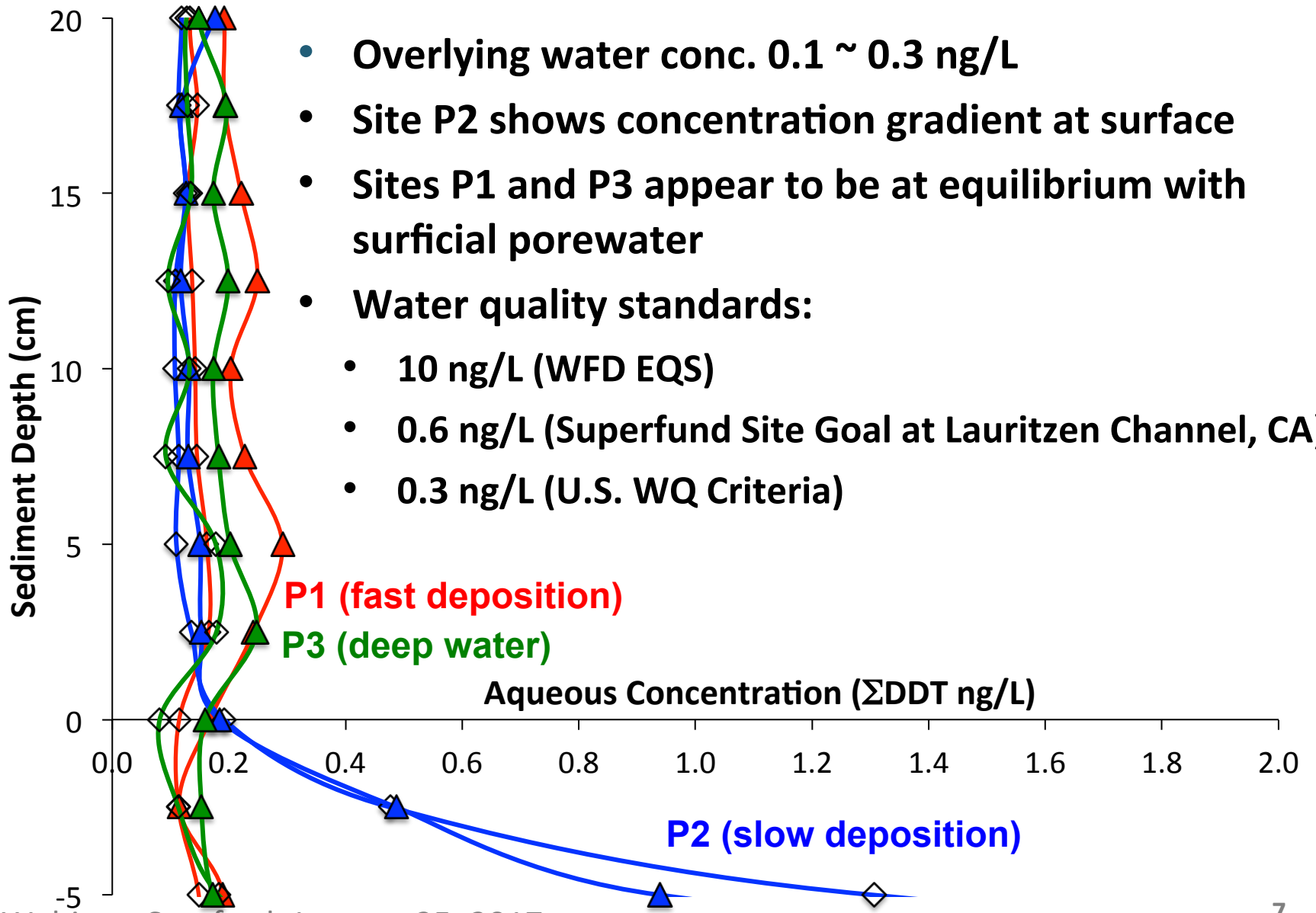
PE strips at intervals



Aqueous conc. profile at sediment surface

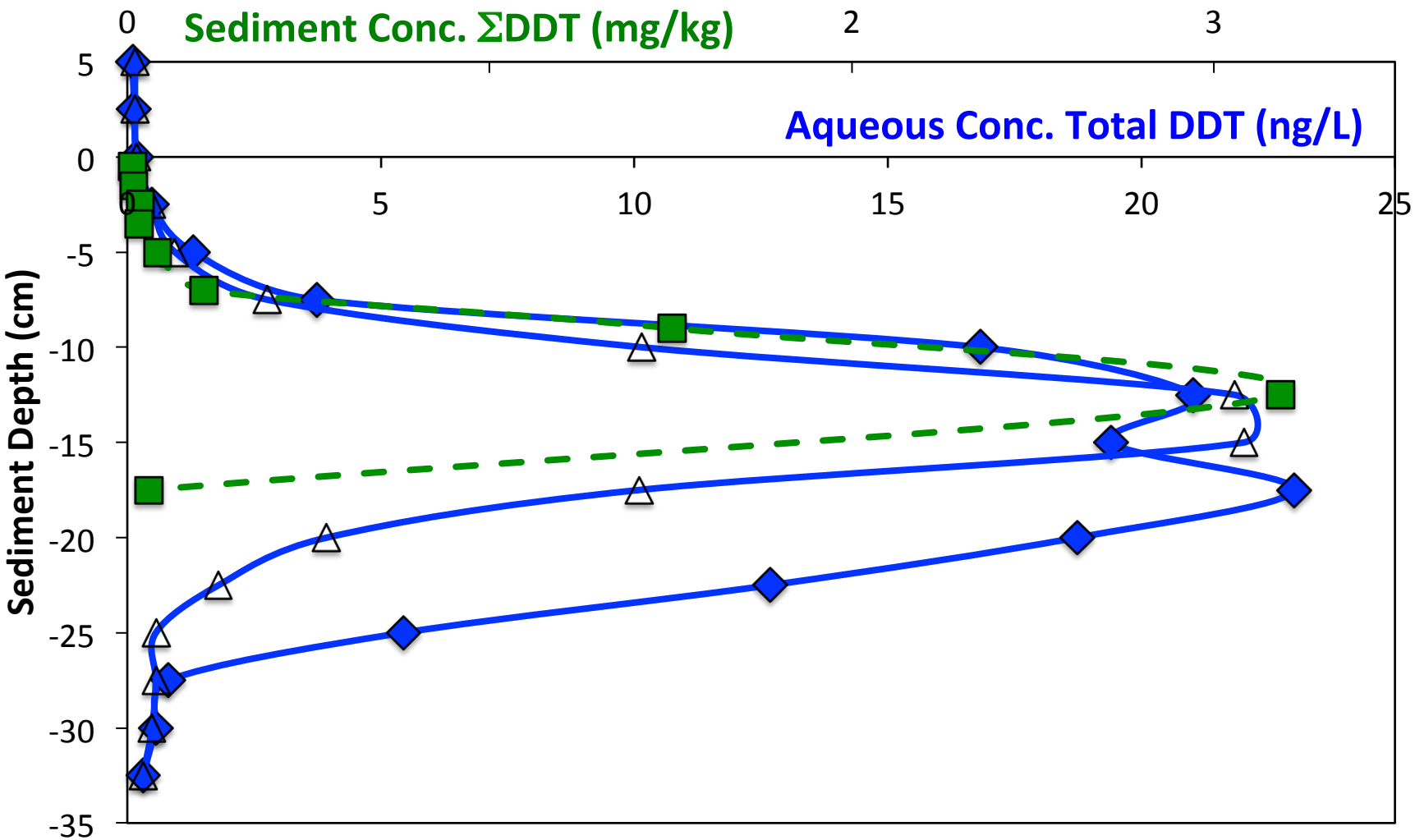


Aqueous conc. profile at sediment surface



- Overlying water conc. 0.1 ~ 0.3 ng/L
- Site P2 shows concentration gradient at surface
- Sites P1 and P3 appear to be at equilibrium with surficial porewater
- Water quality standards:
  - 10 ng/L (WFD EQS)
  - 0.6 ng/L (Superfund Site Goal at Lauritzen Channel, CA)
  - 0.3 ng/L (U.S. WQ Criteria)

Porewater profile matches sediment core at P2



Lake Maggiore, Italy

Natural attenuation of sediment in a deep water lake

- Incoming deposits are clean
- Recovery on the southern portion of the bay, more slowly on north side of the bay
- Diffusion of DDT from sediment at site P2 until ≈ 10 cm more deposition

In-situ treatment of pesticides in tidal creek

Environmental Science & Technology

Article

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Measuring and Modeling Organochlorine Pesticide Response to Activated Carbon Amendment in Tidal Sediment Mesocosms

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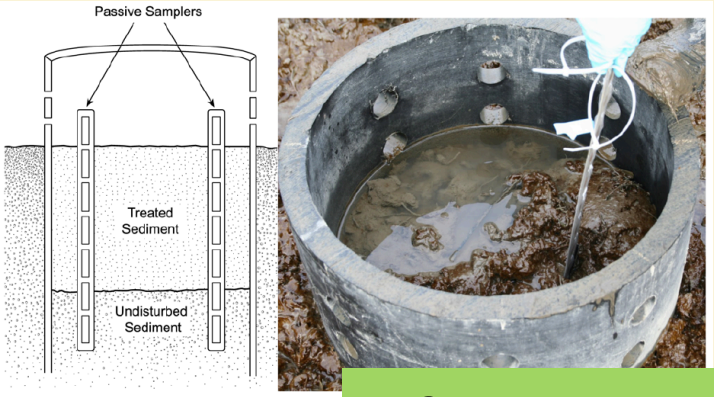
Supporting Information

ABSTRACT: Activated carbon (AC) sediment amendment for hydrophobic organic contaminants (HOCs) is attracting increasing regulatory and industrial interest. However, mechanistic and well-vetted models are needed. Here, we conduct an 18 month field mesocosm trial at a site containing dichlorodiphenyltrichloroethane (DDT) and chlordane. Different AC applications were applied and, for the first time, a recently published mass transfer model was field tested under varying experimental conditions. AC treatment was effective in reducing DDT and chlordane concentration in polyethylene (PE) samplers, and contaminant extractability by *Arenicola brasiliensis* digestive fluids. A substantial AC particle size effect



ES&T 2016: 50, 4769

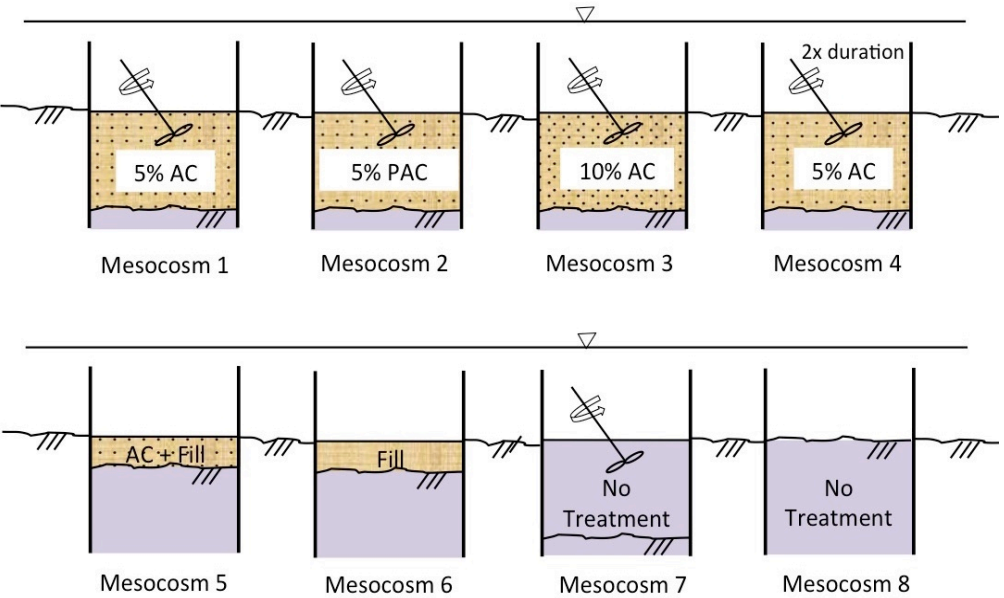
Research questions

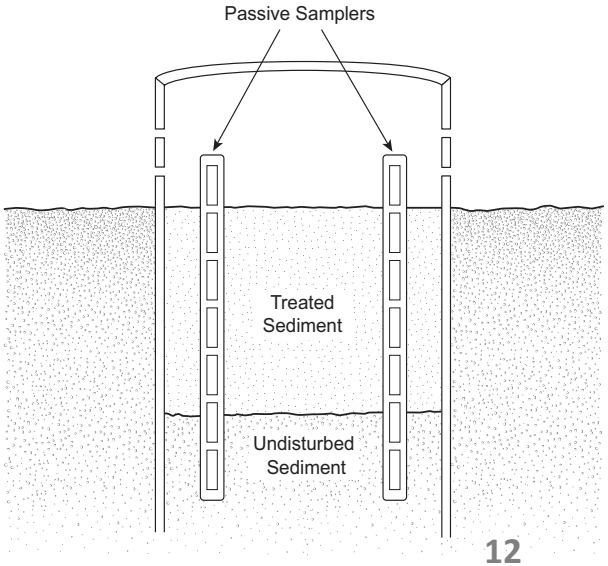
Engineered remediation of sediment in tidal creek & marsh

- **Will AC sorbent reduce porewater conc. of chlordane & DDT?**
- **How fast does porewater concentration change?**
- **What is the long-term prediction?**

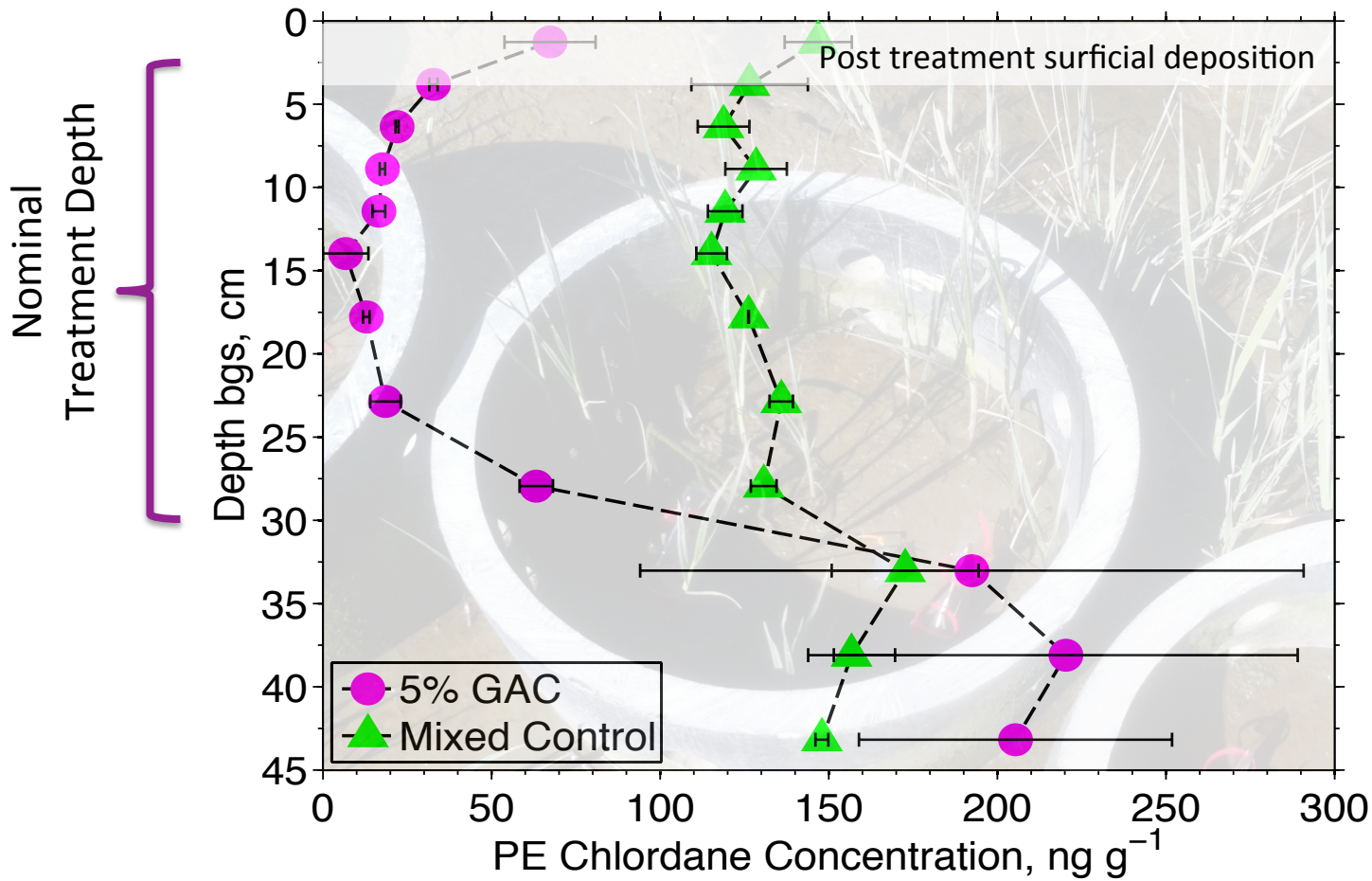
Experimental Design

- Six treatment conditions + controls
- Passive samplers (PE) and cores are used to assess treatment
- Sampling at 6 & 18 months



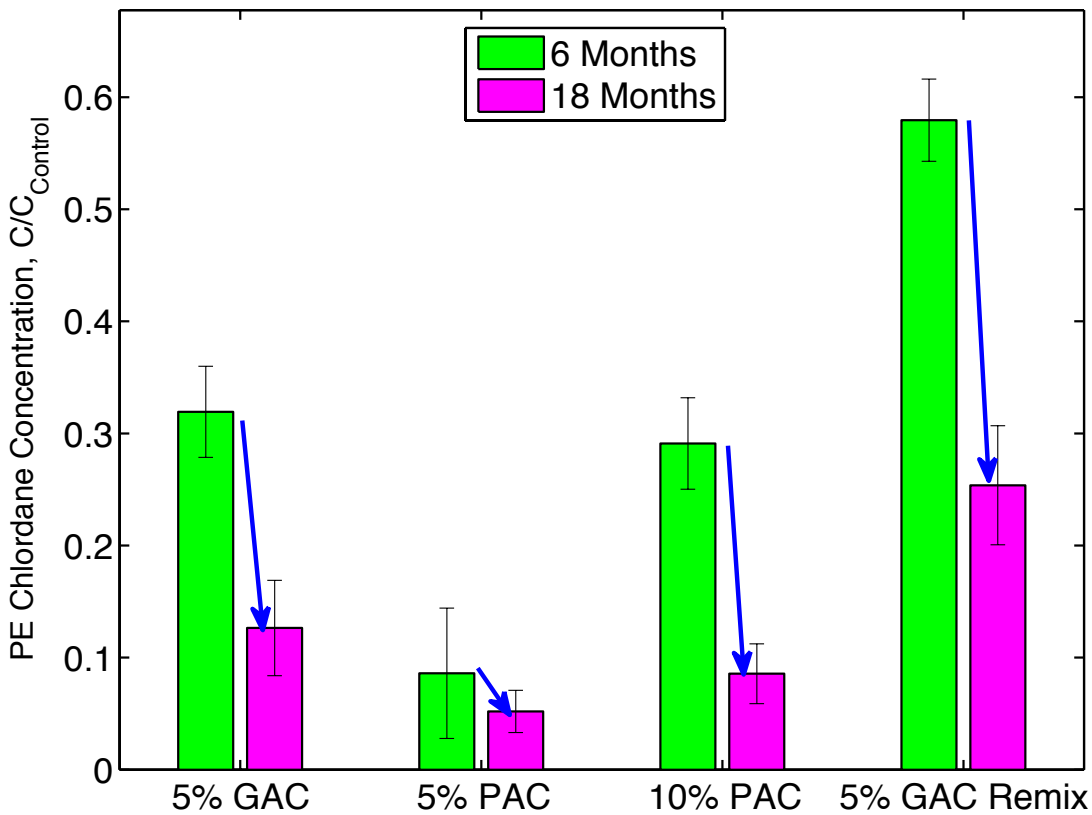


Pilot-Scale AC Amendment Test: 18 mo. Post Treatment



- **Up to 95%** reduction in Chlordane concentration 18 months post-deployment.

Pilot-Scale AC Amendment Test: Temporal Trends



- Effectiveness improves with time: it does get better
- Larger carbon particles "catching up" with PAC over time
- Confirms trends from lab tests and kinetic models

Research questions

- **AC is effective in reducing chlordane and DDT availability: up to 95% reduction after 18 months**
- **Reductions in porewater are sensitive to AC particle size**
- **Mass transfer model can accurately describe field performance**

Deduce equilibration

PE Samplers for Managing Persistent & Bioaccumulative Contaminants

- Time series
- Dosing with performance reference compounds (PRCs)
- Concentration gradient dosing of PRCs
- Multiple thicknesses

Approx. three-month deployment for significant reduction of PRCs; correction by PRCs may be required to estimate aqueous equilibrium conc.

Additional information

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Measurement and Modeling of Activated Carbon Performance for the Sequestration of Parent- and Alkylated-Polycyclic Aromatic Hydrocarbons in Petroleum-Impacted Sediments

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In Situ Sequestration of Hydrophobic Organic Contaminants in Sediments under Stagnant Contact with Activated Carbon. 1. Column Studies

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Polyethylene–Water Partitioning Coefficients for Parent- and Alkylated-Polycyclic Aromatic Hydrocarbons and Polychlorinated Biphenyls

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In Situ Sequestration of Hydrophobic Organic Contaminants in Sediments under Stagnant Contact with Activated Carbon. 2. Mass Transfer Modeling

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