



Northeastern

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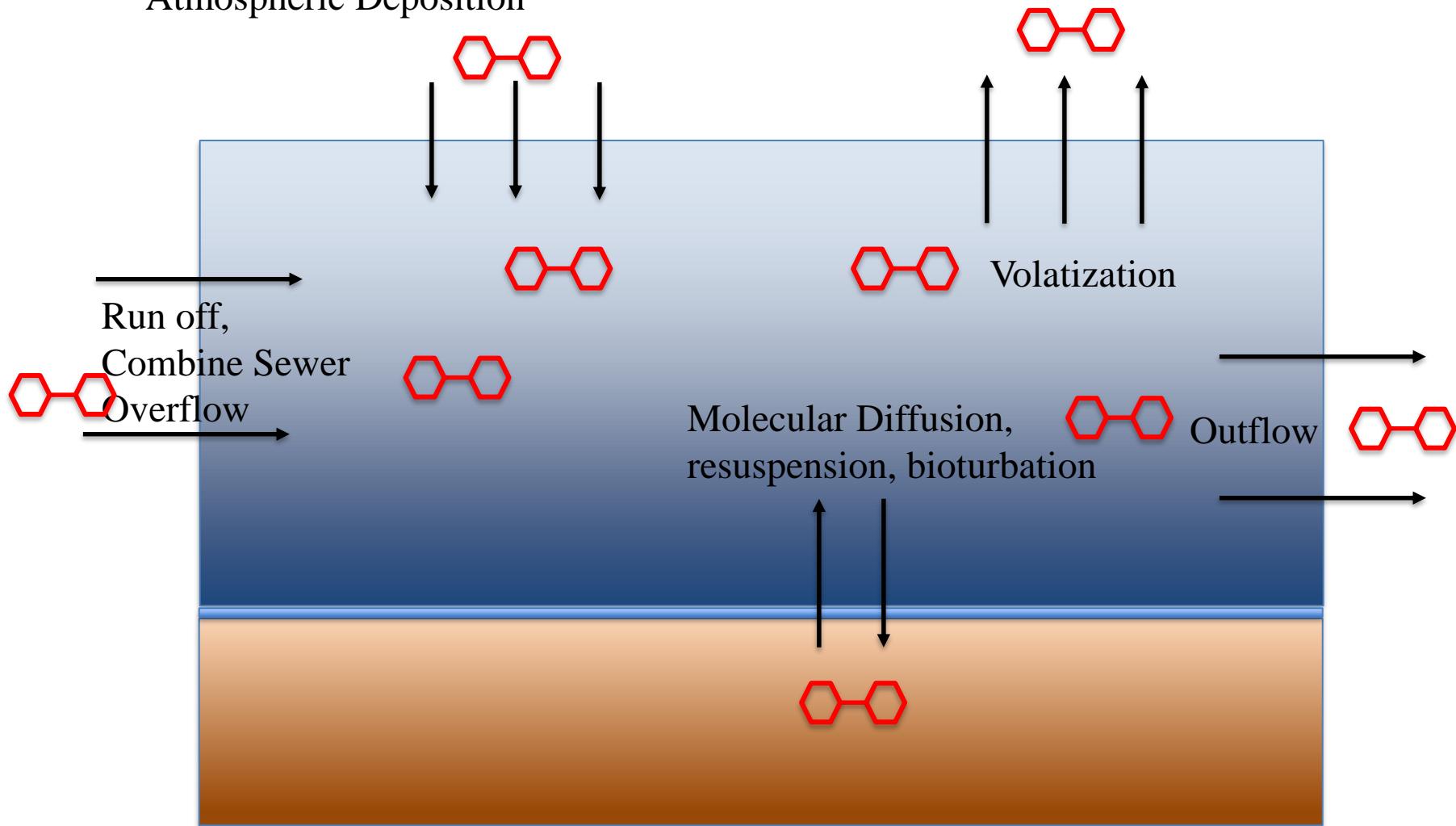
**INVESTIGATING THE EFFECTIVENESS OF
DIFFERENT CONTAMINATED SEDIMENT REMEDIES
TO CONTROL SEDIMENT-WATER EXCHANGE**

Contaminated Sediment and Remediation



Mass Transfer

Atmospheric Deposition



Objectives

- Cross-validate equilibrium and non-equilibrium passive sampling methods by comparing freely-dissolved PCB concentrations in sediment beds determined using the two sampling methods
- Assess the effectiveness of four remediation strategies (AC amendment, thin sand cap, capping with sand and AC, and the periodic addition of AC to sediment surface) in controlling the transport of native bed PCB congeners.

Sediment

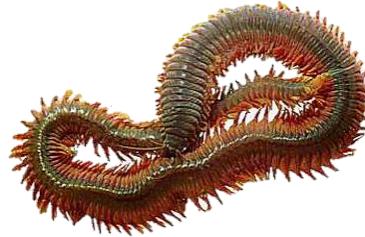


Organisms

- Reduction in bioaccumulation and bioavailability of PCBs investigated in three organisms in contaminated sediment from NBH
- Organisms were selected based on diversity in phyla, commonly used in ecotoxicological and environmental risk assessment.



Cyprinodon variegatus
Phyla: Chordate
“Fish”



Alitta virens
Phyla: Annelid
“Worm”



Mercenaria mercenaria
Phyla: Mollusk
“Clam”

Experimental Overview

Exp. 1



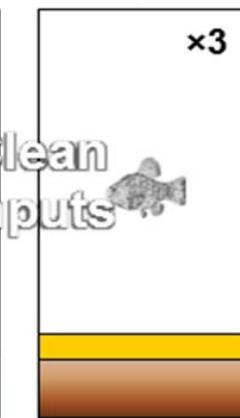
Exp. 2



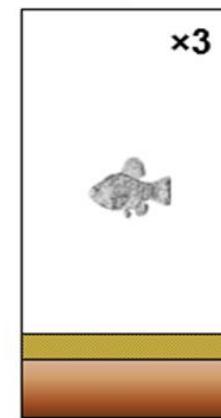
Exp. 3



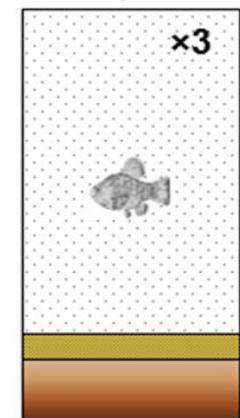
Exp. 4



Exp. 5



Exp. 6



x3



x3



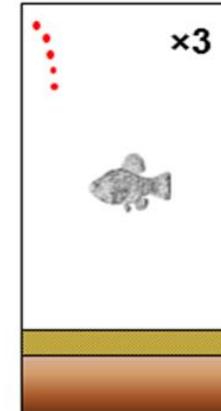
x3



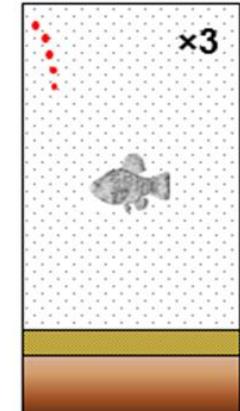
x3



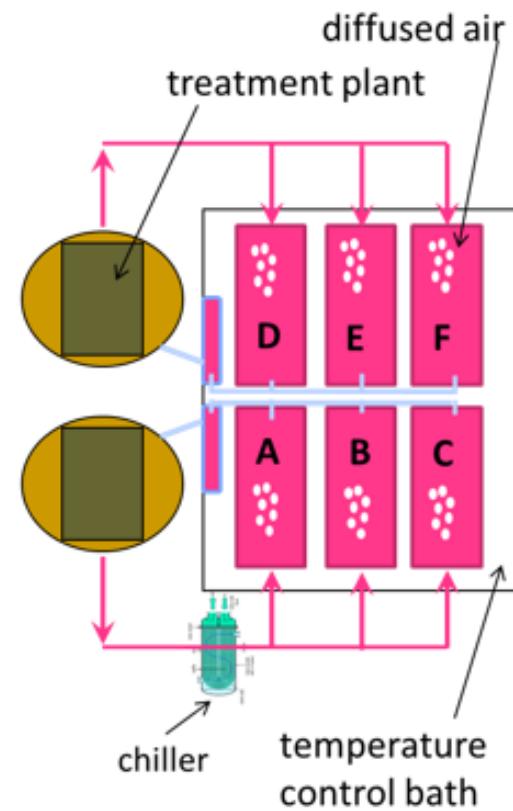
x3



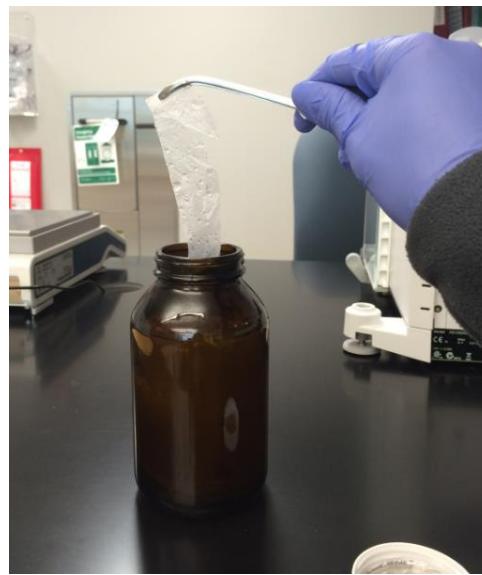
x3



Experimental Set-up



LDPE Non-Equilibrium Passive Sampler Preparation



LDPE and PDMS Passive Sampler Deployment



LDPE Non-Equilibrium Passive Sampler Extraction



Passive Sampling in Sediment and Water

Equilibrium Sampling C_{PW}

$$C_{free} = \frac{C_{silicone}}{K_{silicone, Water}}$$

Non-equilibrium Sampling C_{PW}

$$f_{eq, PRC} = \frac{C_{PE,t=0,PRC} - C_{PE,t,PRC}}{C_{PE,t=0,PRC}}$$

$f_{eq, target}$ calculated using feq, PRC for three compounds and a model of Fickian Diffusion between two media (Gschwend et al. 2014)

$$C_{PE, eq} = \frac{C_{PE,t,target}}{f_{eq,target}}$$

$$C_{free} = \frac{C_{PE, eq}}{K_{PE-Water}}$$

Non-equilibrium Sampling C_w

$$f_{eq, PRC} = \frac{C_{PE,t=0,PRC} - C_{PE,t,PRC}}{C_{PE,t=0,PRC}}$$

$$R_{s, PRC} = -\frac{\ln(1 - f_{eq, PRC})}{t} \times K_{LDPE:water} \times m_{LDPE}$$

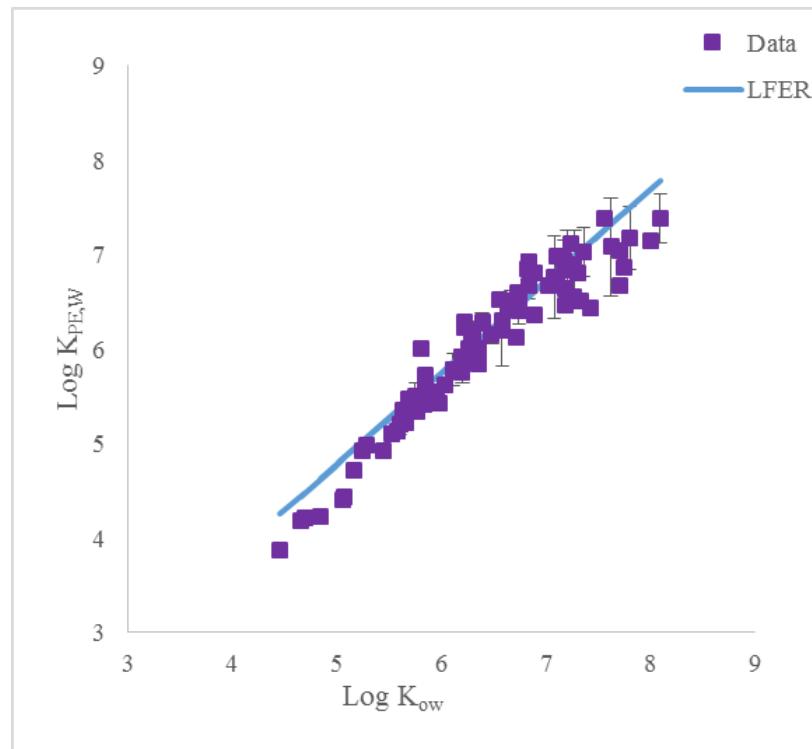
$$f_{eq, target} = 1 - e^{-\frac{R_{s, mean} \times t}{K_{LDPE:water} \times m_{LDPE}}}$$

$$C_{PE, eq} = \frac{C_{PE,t,target}}{f_{eq,target}}$$

$$C_{free} = \frac{C_{PE, eq}}{K_{PE-Water}}$$

$K_{PE,W}$ LFER

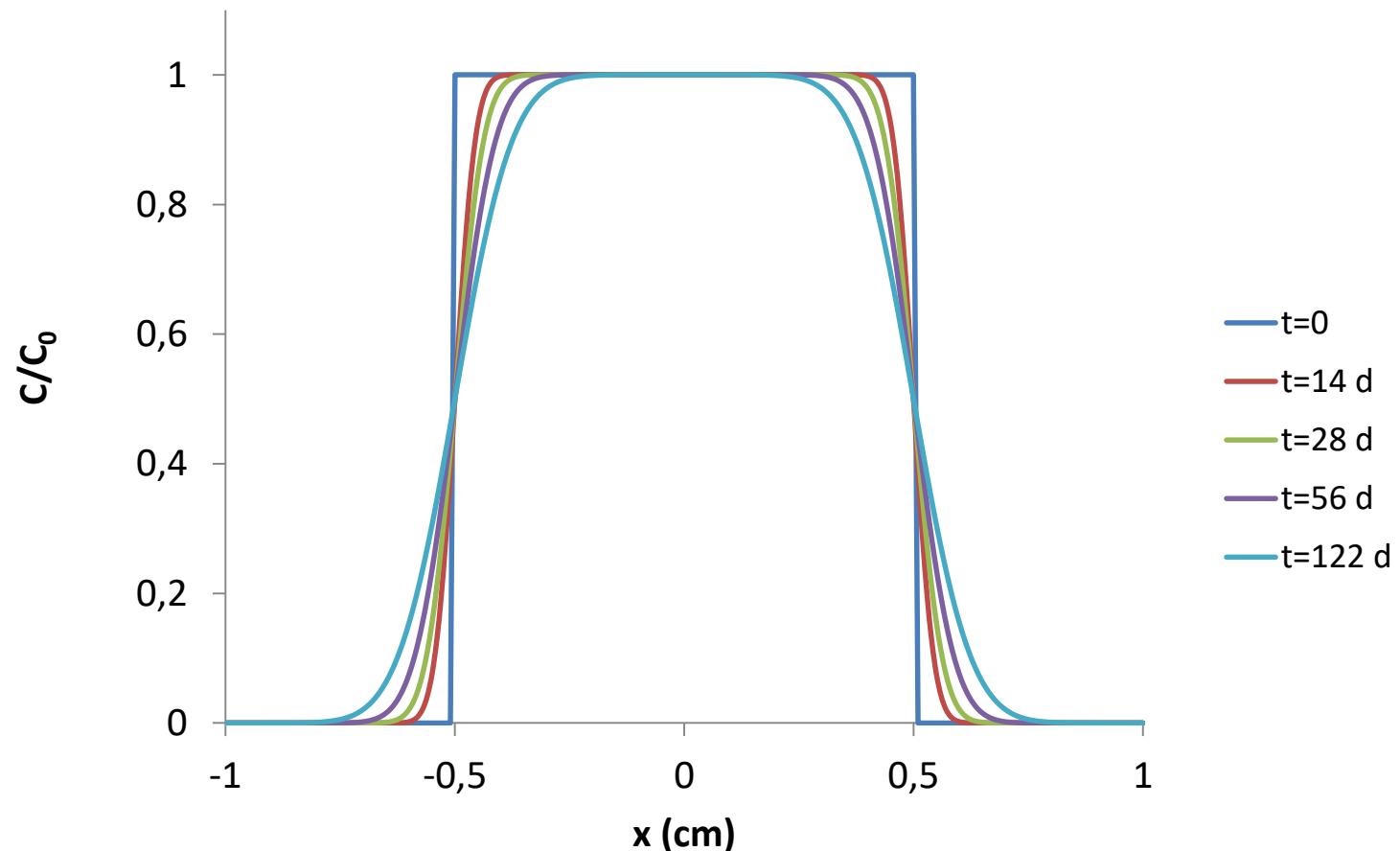
$$\log K_{PEW} = 0.97 (\pm 0.03) \log K_{ow} - 0.07 (\pm 0.17) (r^2 = 0.89)$$



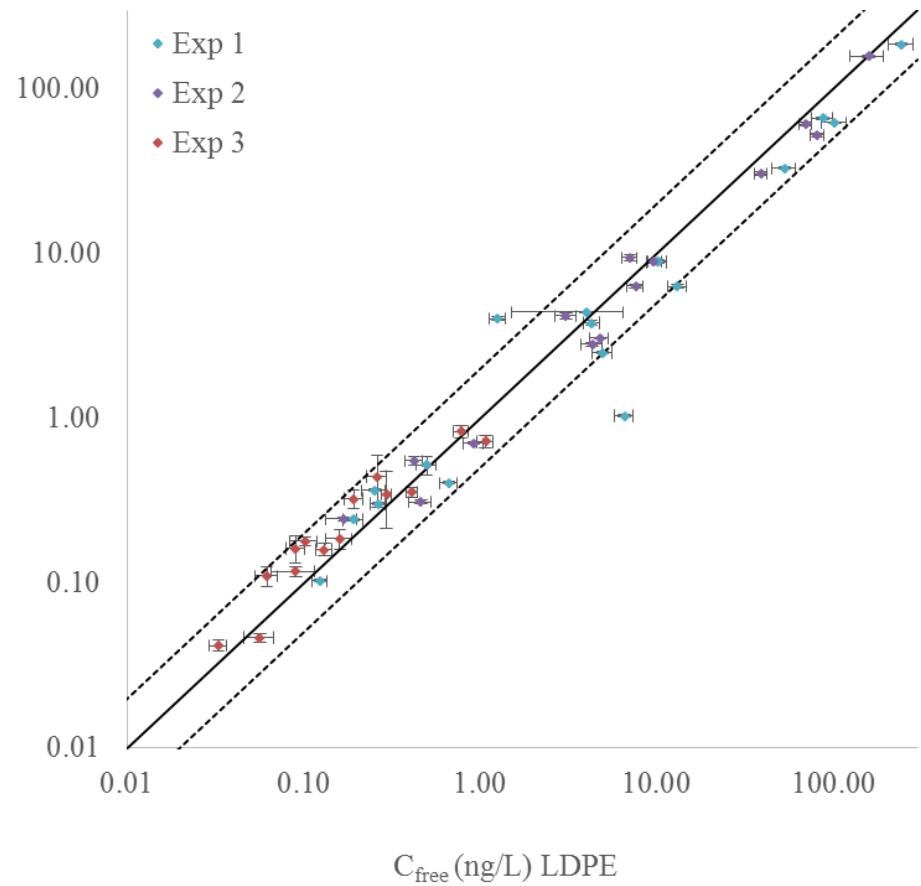
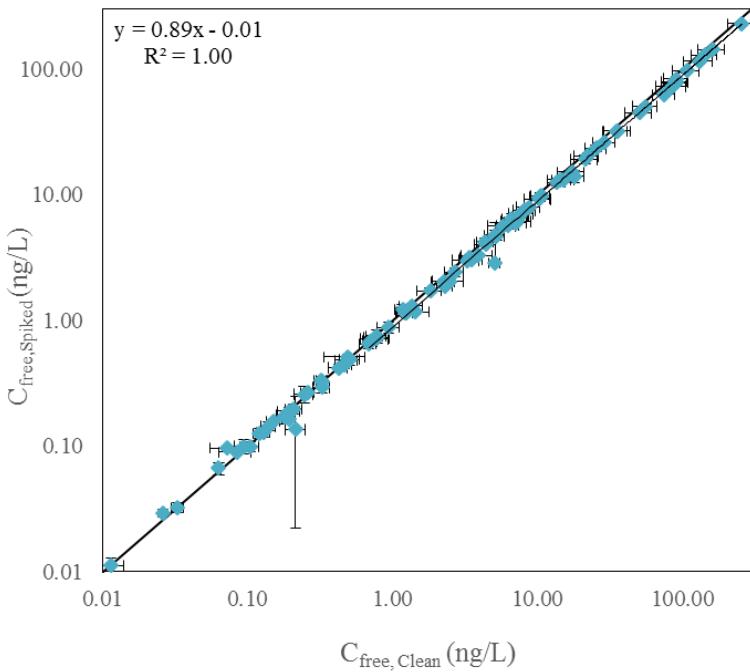
Modeled Diffusion Along LDPE Strip

DDE

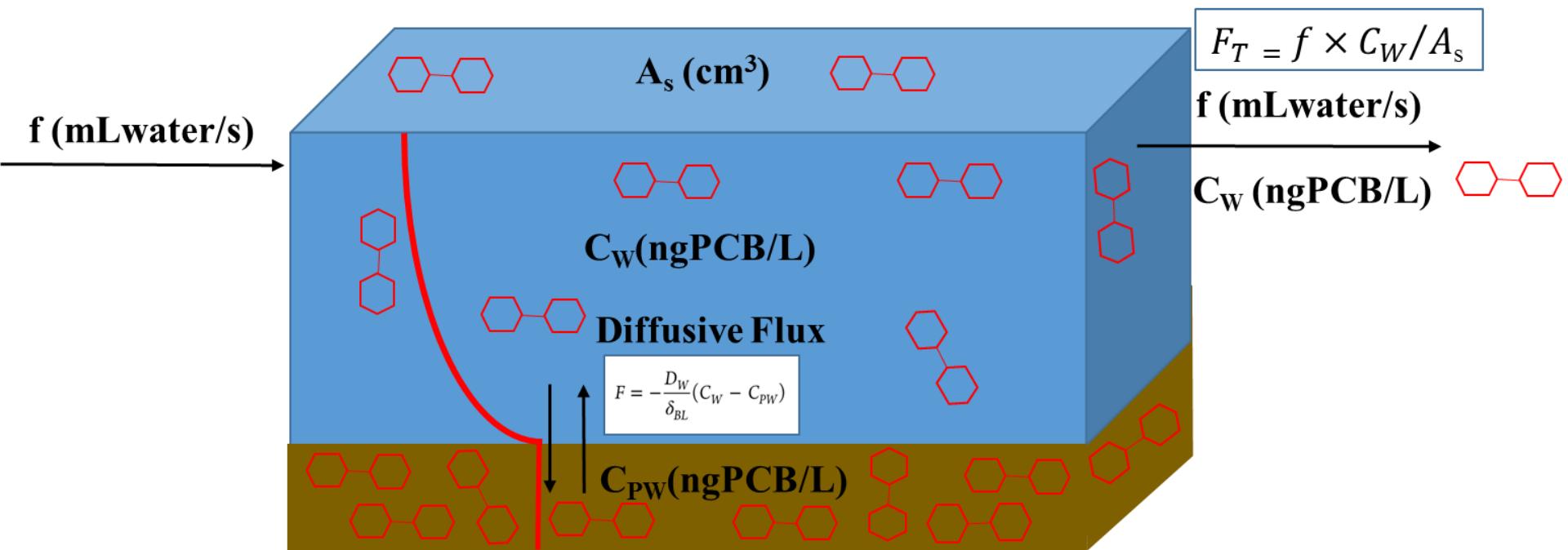
using $D_{DDE,PE} = 5 \times 10^{-10} \text{ cm}^2/\text{s}$



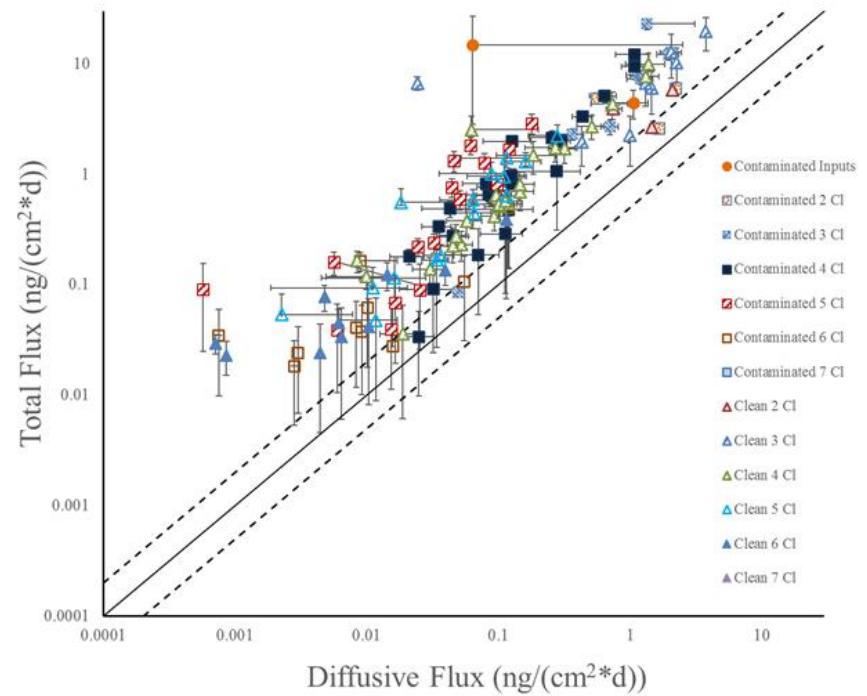
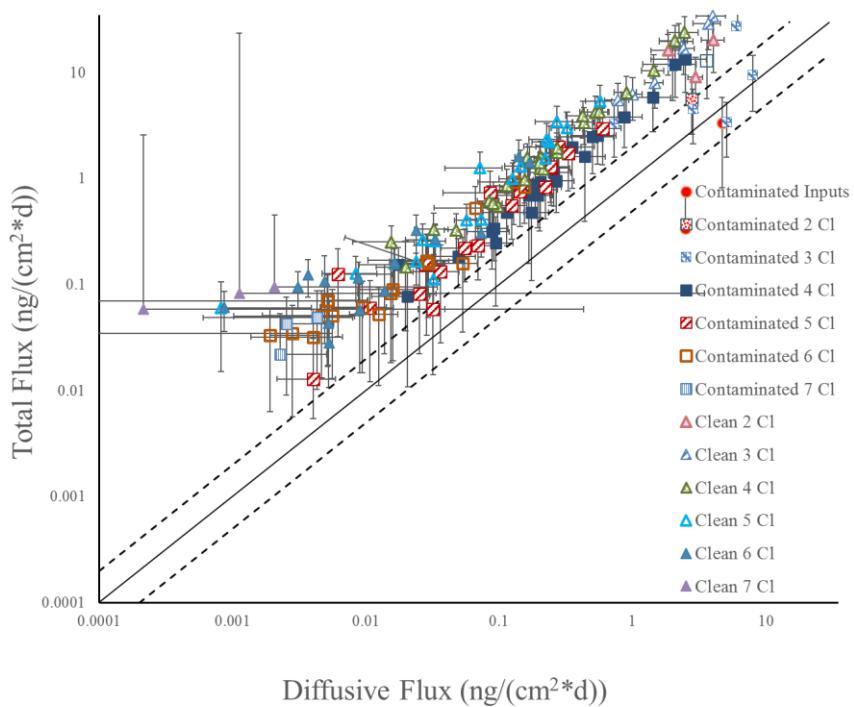
Results and Conclusions – Cross Validation of Sampling Methods



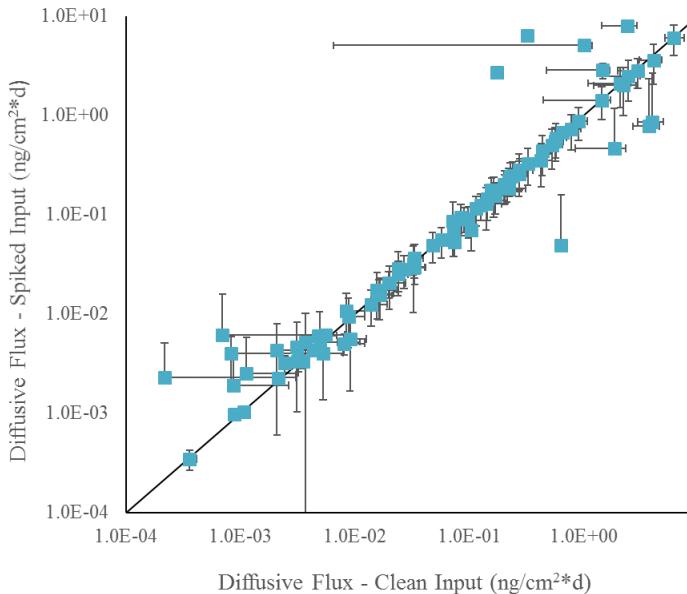
Cross-validation: Diffusive Flux and Total Flux



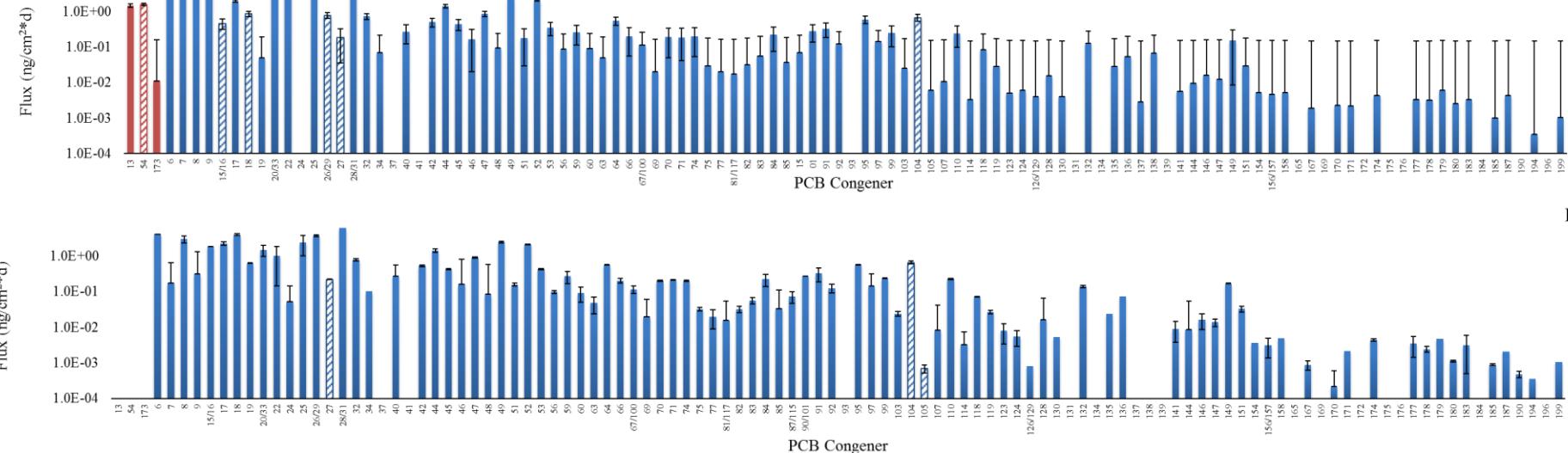
Results: Cross-Validation



Results

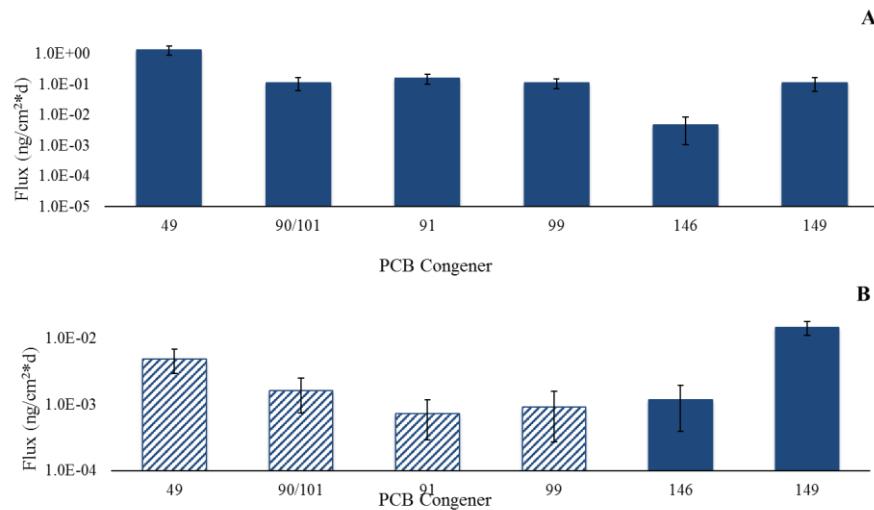


Diffusive Flux Input Congeners		
Congener	μ (ng/(cm ² *d))	σ (ng/(cm ² *d))
13	1.47	0.43
54	-1.59	3.48
173	0.0112	0.0323

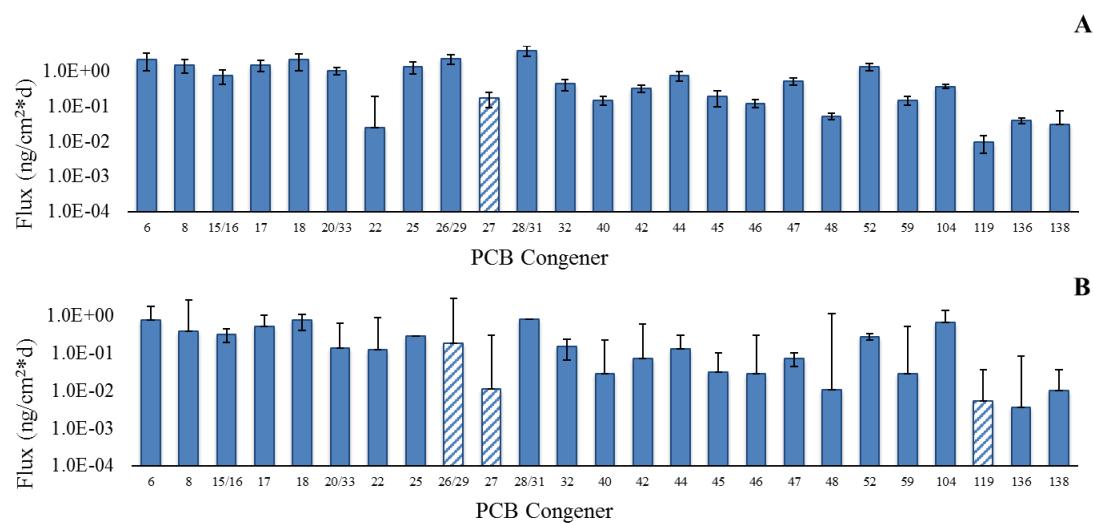


Results

Experiment 2 (no remedy) and Experiment 3 (AC)

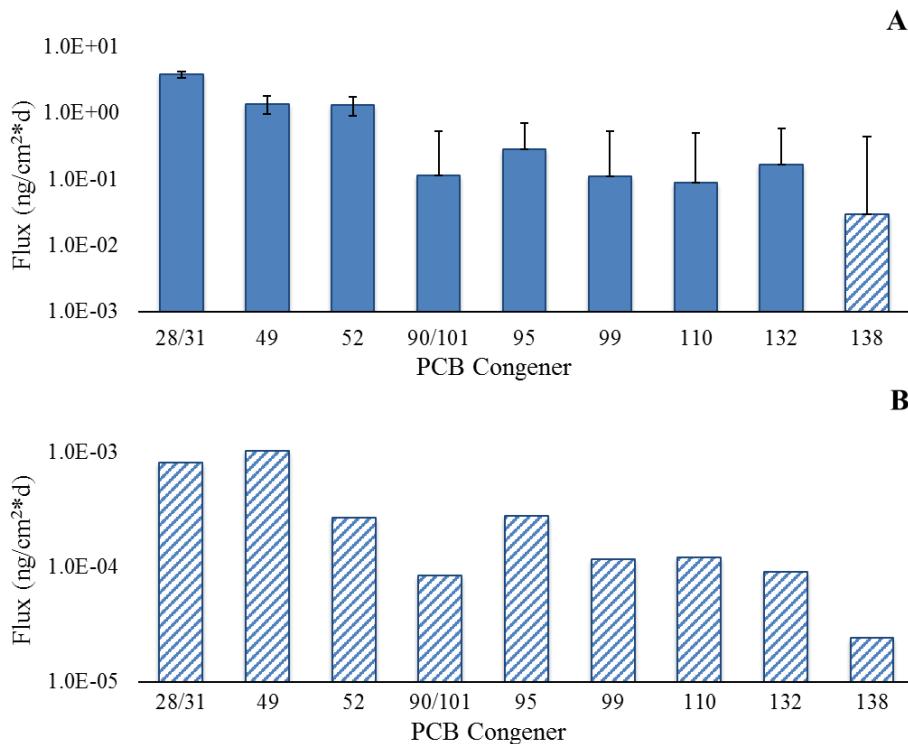


Experiment 2 (no remedy) and Experiment 4 (sand cap)

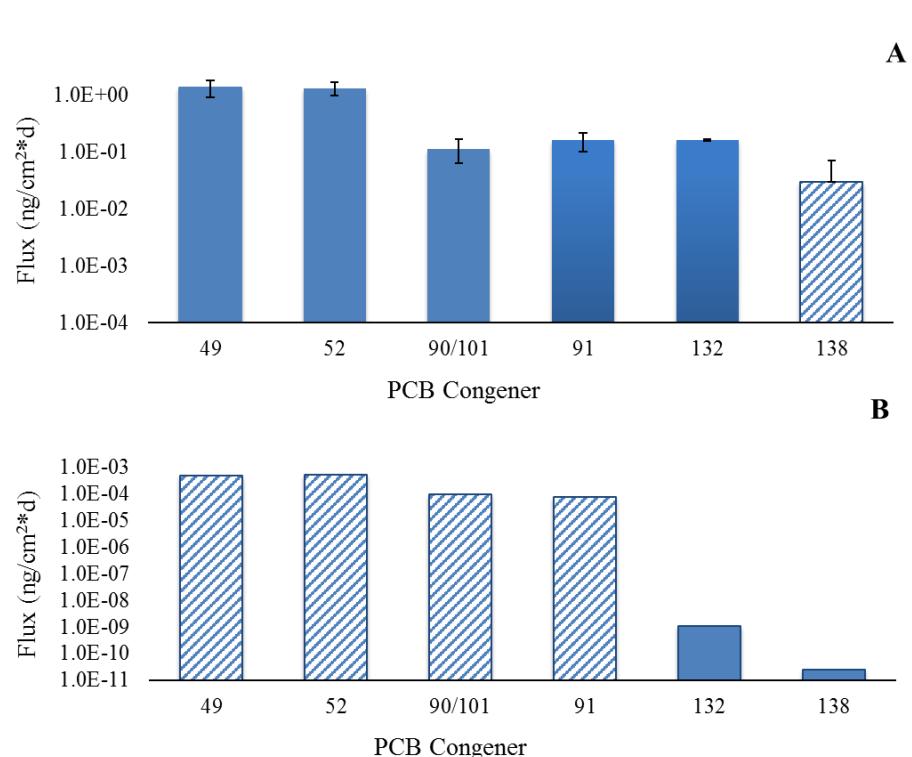


Results

Experiment 2 (no remedy) and Experiment 5 (mixed sand and AC)



Experiment 2 (no remedy) and Experiment 6 (mixed sand and AC with AC additions)



Conclusions, Future Work, Field Implications

- Conclusions
 - Sampling method
 - Contaminated inputs effect statistical validity of results
 - Greater uncertainty in mixed cap experiments
- Field Implications
 - Short term 90 day laboratory experiments
 - Seasonal variations
 - Spatial heterogeneity in Sediment

Questions?

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