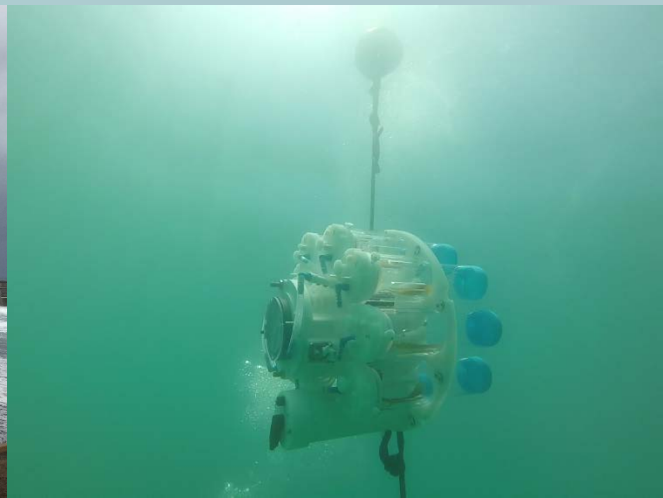
Passive Samplers and in Situ Toxicity Testing using the SEA Ring

San Diego Regional Water Board
Modern Monitoring Trade Show

April 12, 2017

Chris Stransky, Amec Foster Wheeler



Monitoring Challenges

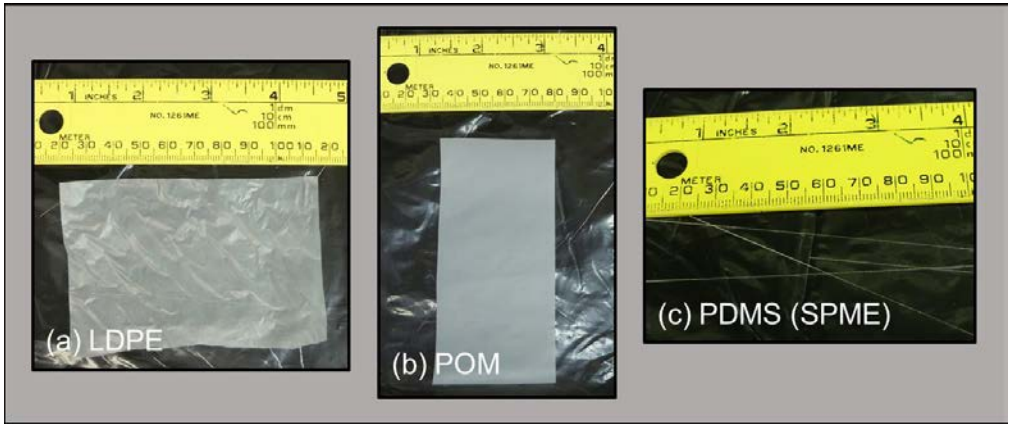
- Variability – dynamic environments
- Achieving sample representativeness
- Predicting ecological effects based on limited analyses or indicator metrics
- Analytical detection limits
- Cost/ efficiency

Environmental Variability

Passive Samplers

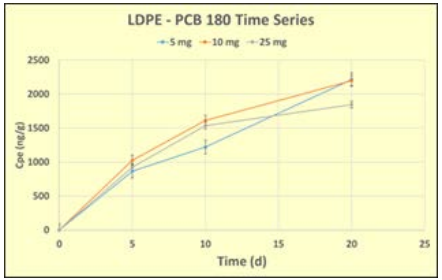
Thin Polymers:

a) Low density polyethylene (LDPE)
b) Polyoxymethylene (POM)
c) Polydimethylsiloxane (PDMS or "silicone") aka SPME (solid-phase microextraction)

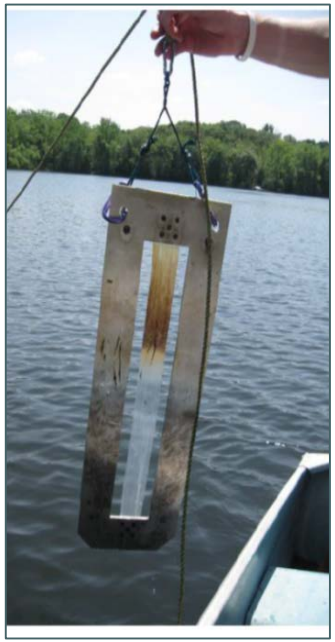


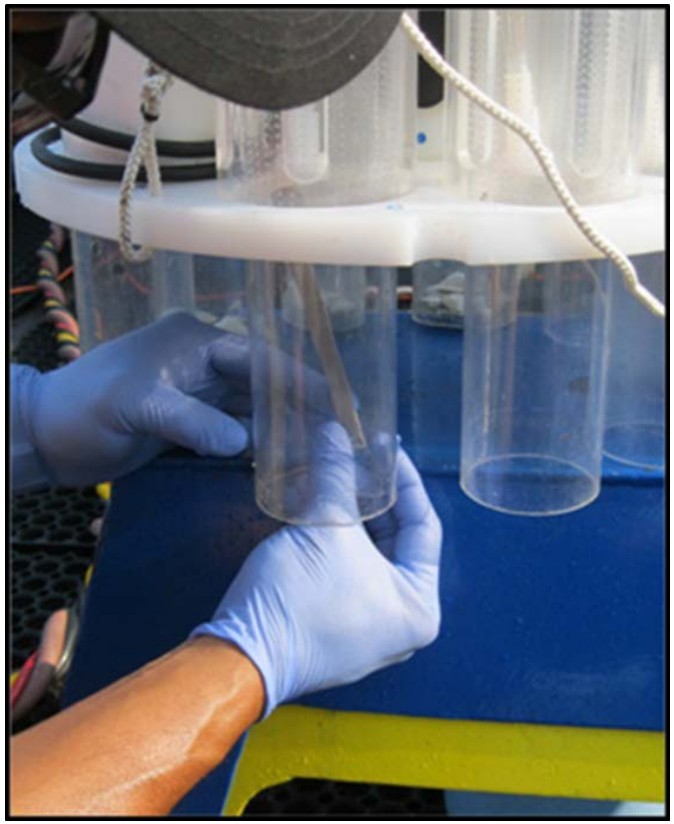
Resin Polymers:

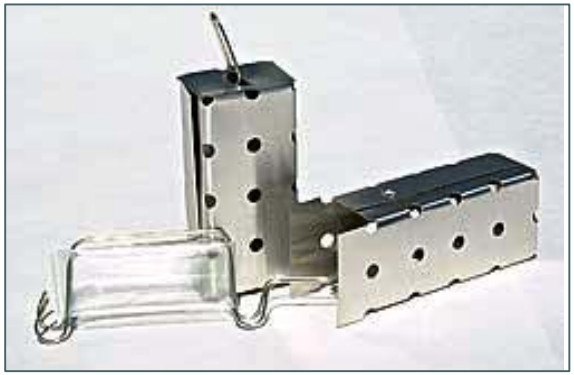
a) Polar Organic Chemical Integrative Sampler (POCIS) – (e.g. Ambersorb, Oasis HLB)
b) Diffusive Gradients in Thin Film (DGT) – Chelex resin for trace metals

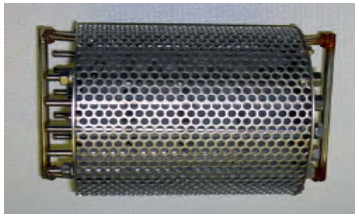


Passive Sampler Deployment





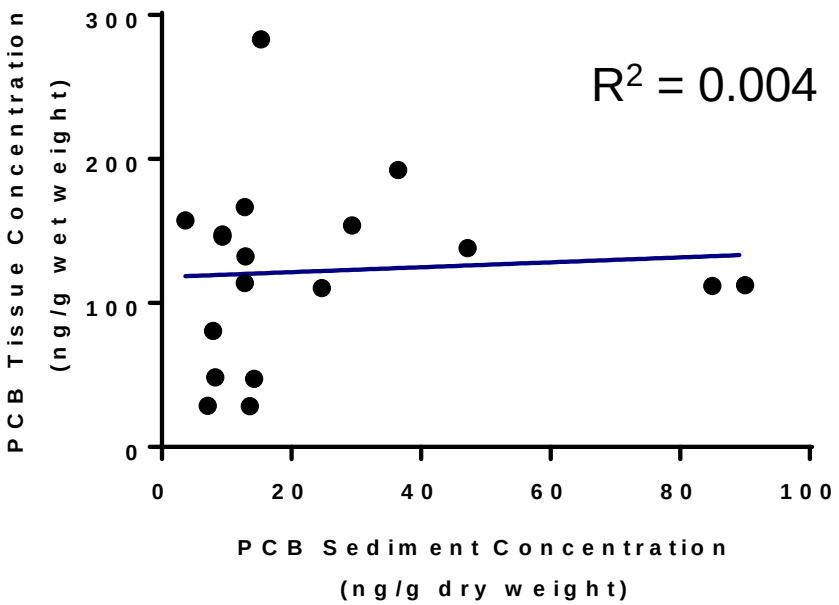




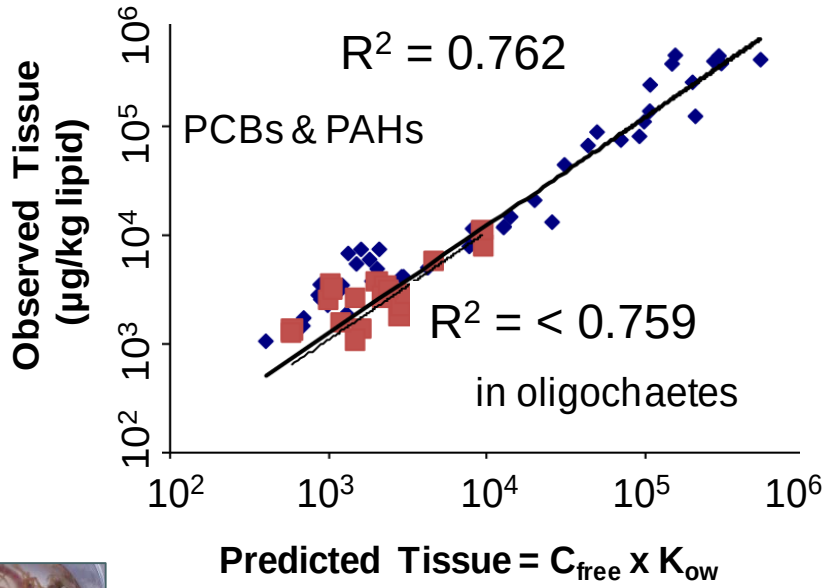
Why Passive Samplers?

- Integrative chemical measure - continuous time-weighted average concentrations – days to months deployment
- Passive samplers measure the freely dissolved concentration (Cfree) which can better represent exposure
- Greater environmental realism
- Lower detection limits
- No need for large volumes of sediment or water for extractions
- Bioaccumulation surrogate
- Cost effective

Passive Samplers - Bioaccumulation Prediction



San Diego Bay 2013-2014



Anacostia River, D.C.

Courtesy of Dr. Gi Beum Kim
SCCWRP

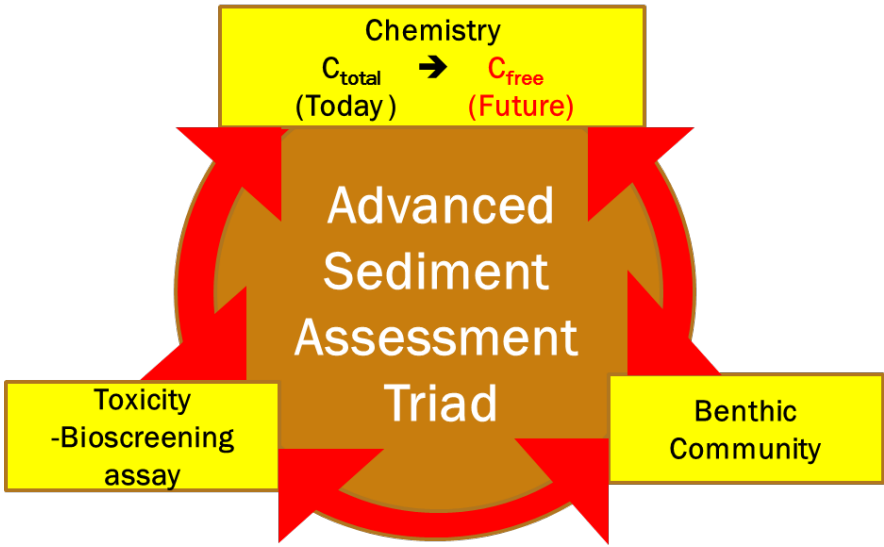
➔ C_{free} is better correlated with bioaccumulation and toxicity than total conc.

Passive Samplers
Implementation Considerations

- Logistical restraints/ consideration of deployment
- Long duration times to reach equilibrium
- Potential interference from biofouling, particulates, and UV
- Unable to quantify short-term peak concentrations that might be of ecological relevance
- Complexity of bioaccumulation among different organisms
- Need for Performance Reference Compounds (PRCs) and sufficient QA/QC samples to accurately quantify chemical concentrations

Passive Samplers - Next Steps

- Compare lab and field based C_{free} measurements for sediments
- Identify sources and direction of transport of CECs
- Calibrate food-web bioaccumulation models
- Couple passive samplers to directly measurements of toxicity /benthic community index in sediment assessment triad



Courtesy of Dr. Gi Beum Kim
SCCWRP
(Visiting Scientist from South Korea)

USGS
science for a changing world

Guidelines for the Use of the Semipermeable Membrane Device (SPMD) and the Polar Organic Chemical Integrative Sampler (POCIS) in Environmental Monitoring Studies

Chapter 4 of
Section D, Water Quality
Book 1, Collection of Water Data by Direct Measurement

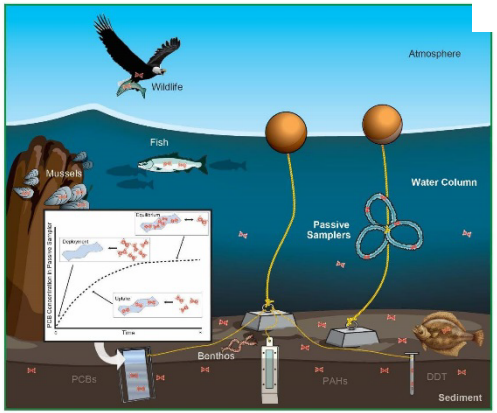
Techniques and Methods

U.S. Department of the Interior
U.S. Geological Survey

EPA/600/R-16/3

EPA United States Environmental Protection Agency | SERDP DOD • EPA • DOE | ESTCP

Laboratory, Field, and Analytical Procedures for Using Passive Sampling in the Evaluation of Contaminated Sediments: User's Manual



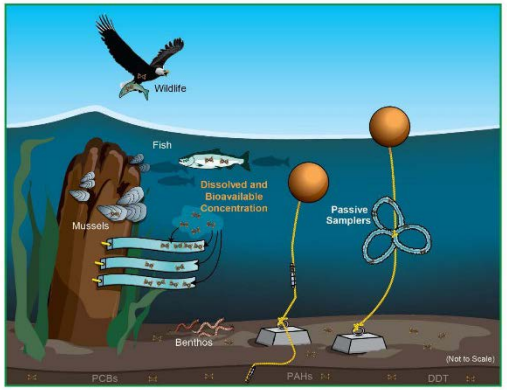
February 2017 Final Web Version (1.0)

EPA United States Environmental Protection Agency

Office of Superfund Remediation and Technology Innovation
and
Office of Research and Development

Sediment Assessment and Monitoring Sheet (SAMS) # 3

Guidelines for Using Passive Samplers to Monitor Organic Contaminants at Superfund Sediment Sites



December 2012

OSWER Directive 9200.1-110 FS

INAP
International Network for Acid Prevention

Diffusive Gradients in Thin-films (DGT)

A Technique for Determining Bioavailable Metal Concentrations

March 2002

RPM Guide

Integrating Passive Sampling Methods into Management of Contaminated Sediment Sites:
A Guide for Department of Defense Remedial Project Managers

ESTCP Project ER-201216

APRIL 2016

Charles Menzie
Susan Kane Driscoll
Exponent, Inc.

Tim Thompson
SEE, LLC.

Distribution Statement A
This document has been cleared for public release

ESTCP

In Situ Toxicity Testing Using the SEA Ring

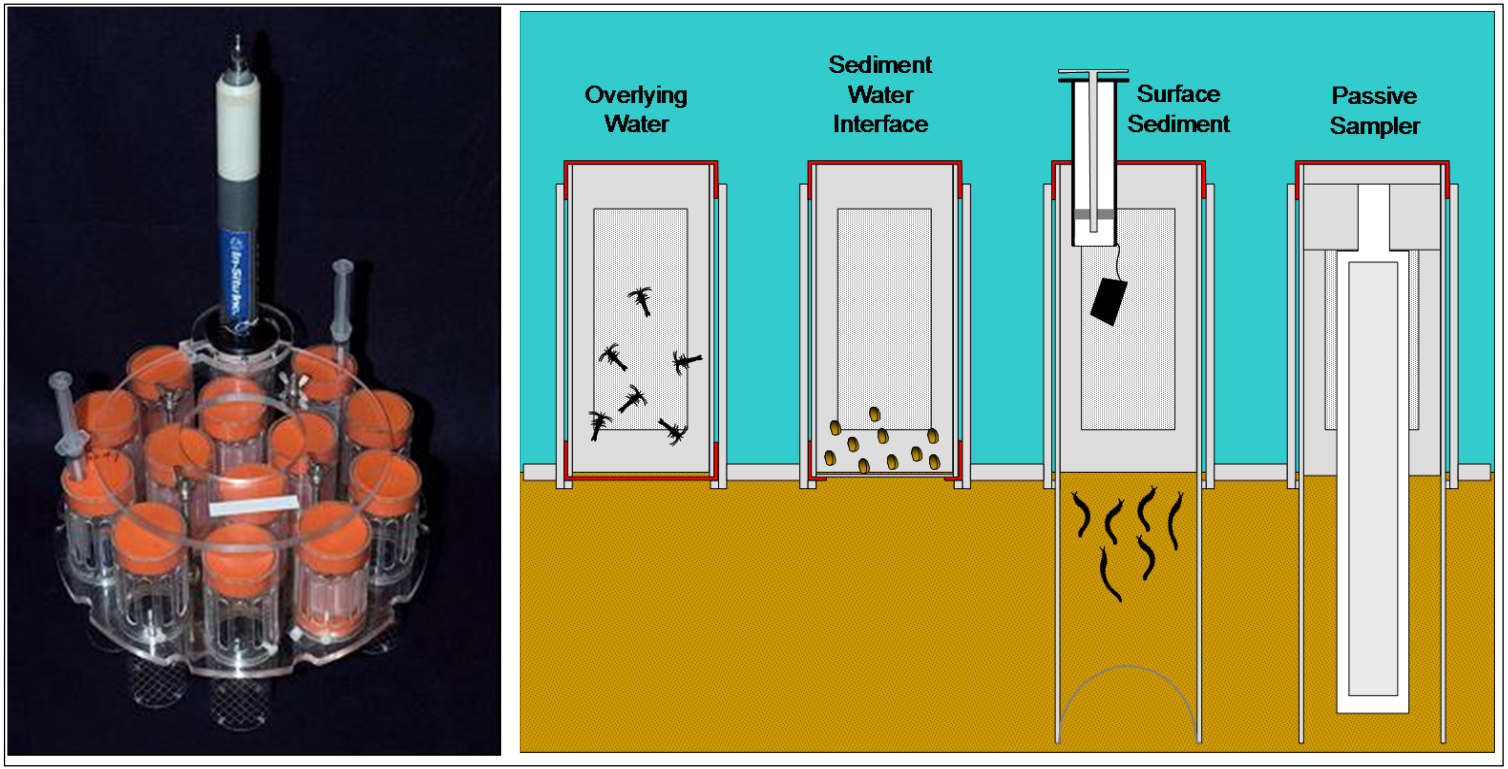
In Situ Toxicity Testing – Advantages

- Greater realism - Exposure to natural site conditions - Incorporates time varying stressors that are impossible to mimic in a lab
- Preserves sample integrity, redox gradients, and vertical distribution of contaminants
- No sample storage effects

Applications

- Ground-water/surface water interactions
- Sediment remedy effectiveness (pre/post remediation)
- Stormwater quality assessment
- Re-suspension effects of contaminated sediments
- Underwater unexploded ordnance
- Ambient overlying water conditions

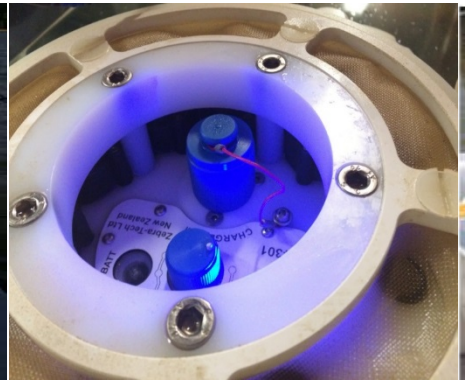
Introducing the SEA Ring - Research Prototype

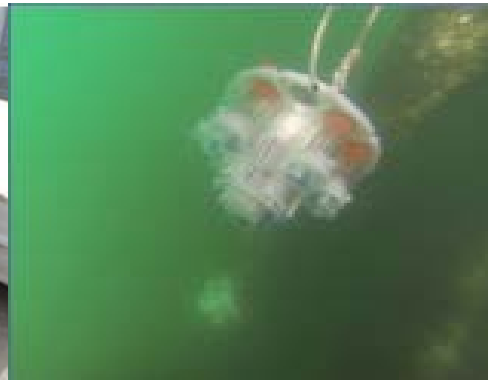


Sediment Ecotoxicity Assessment (SEA) Ring

SEA Ring Upgrade Development

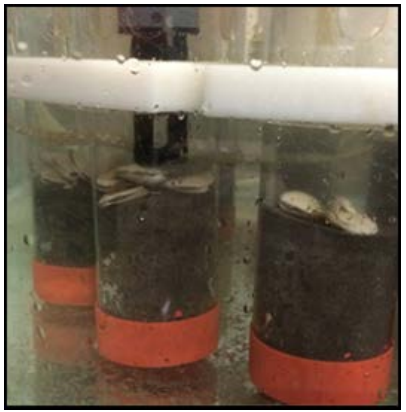
- Developed and validated with funding through SERDP, ESTCP, and NESDI. Lead - SPAWAR
- Demonstrate the performance of the SEA Ring in different sediment remedy and surface water quality assessment applications
- Promote regulatory acceptance of the technology
- Transition the technology to the commercial sector

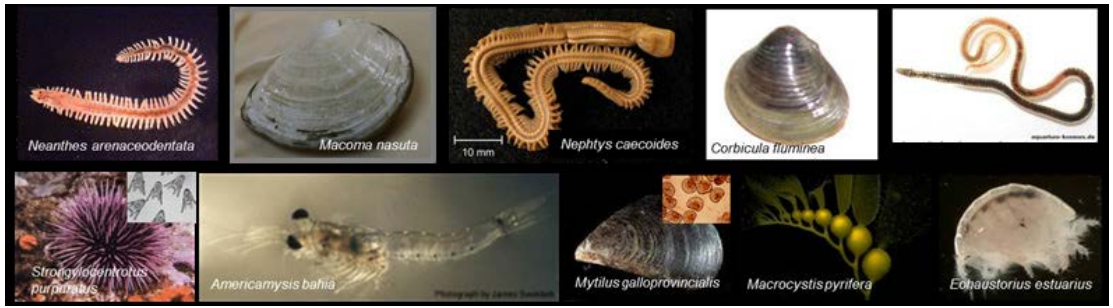





Performance Objectives

- Water Quality Maintenance
- Pumping Rate
- Organism and Sample Recovery
- Control Performance
- Integration of Passive Samplers
- Diverless Deployment/ Recovery
- Easy of Operator Use
- Cost Benefit





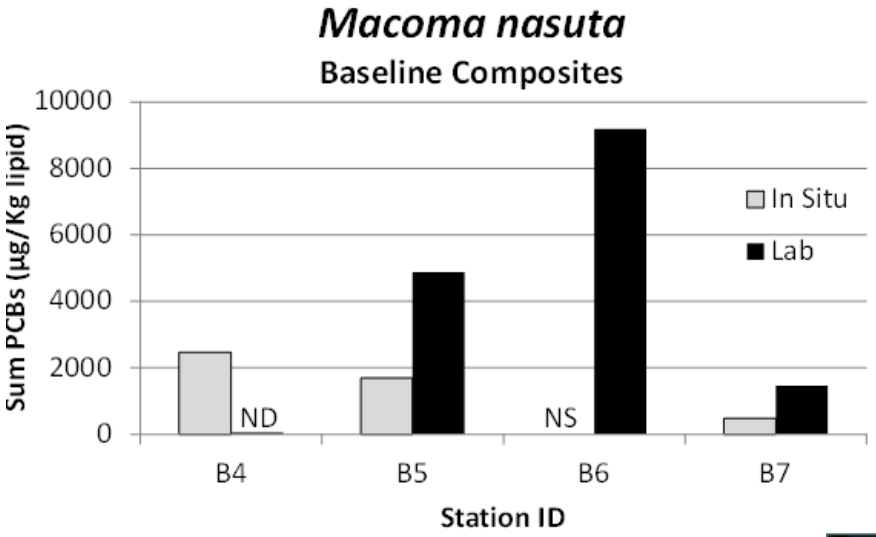
Reactive Amendment Performance

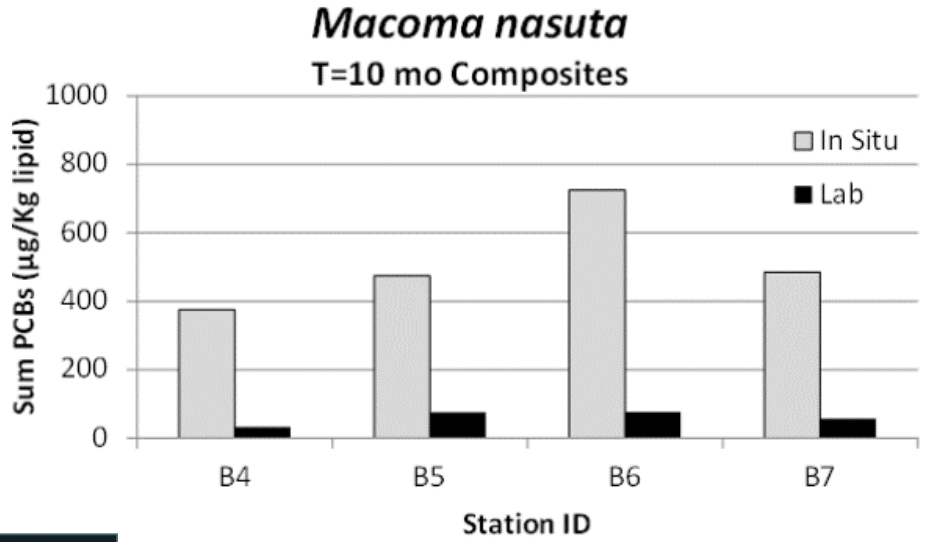
Puget Sound Naval Shipyard

- AquaGate™ – Particulate Activated Carbon
- Pre- and Post- Remedy Assessment
- PCB & Hg bioaccumulation

Reactive Amendment Performance

Puget Sound Naval Shipyard



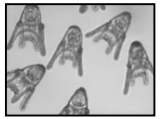


Baseline Pre-Remedy:
Jul-Aug 2012

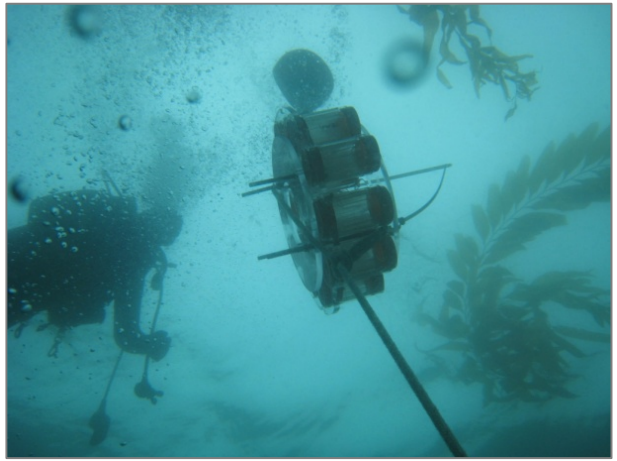
Post-Remedy*: Jul-Aug 2013
*10-month post remedy placement

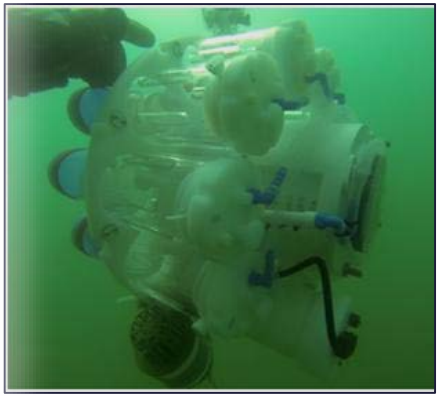
Receiving Water Assessment
Scripps Institution of Oceanography





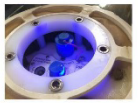




In Situ Toxicity Testing
Implementation Considerations

- Proven technology and commercially available
- As with passive samplers considerations regarding site access, safety need to be addressed
- Reduced control of natural non-treatment factors (e.g. varying water quality, temperature, and currents)
- Physical disturbance
- Species-specific needs/ considerations
- Transportation and acclimation
- Predation/ competition

Demonstration and Commercialization of the Sediment Ecosystem Assessment Protocol (ER-201130)



Environmental Restoration Project

July 25, 2016

Gunther Rosen, Bart Chadwick, Molly Colvin, SSC Pacific
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Allen Burton, University of Michigan
John Radford, Zebra-Tech, Ltd
Howard Bailey, Adrienne Cibor, Nautilus Environmental
Melissa Grover, Geosyntec Consultants, Inc.
Marc Greenberg, USEPA

Battelle
The Business of Innovation

Environmental Technology Verification Program
Advanced Monitoring Systems Center

Quality Assurance Project Plan for Verification of Sediment Ecotoxicity Assessment Ring (SEA Ring)

Acknowledgements

- Keith Maruya - SCCWRP
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- Adrienne Cibor - Nautilus
- Ruth Kolb - City of San Diego
- Kelly Tait - Port of San Diego
- Jamie Aderhold - Aqualytical

Providing support for these slides, demonstration projects, method development, and show and tell equipment. Many others as well…… Thank You!!

QUESTIONS?

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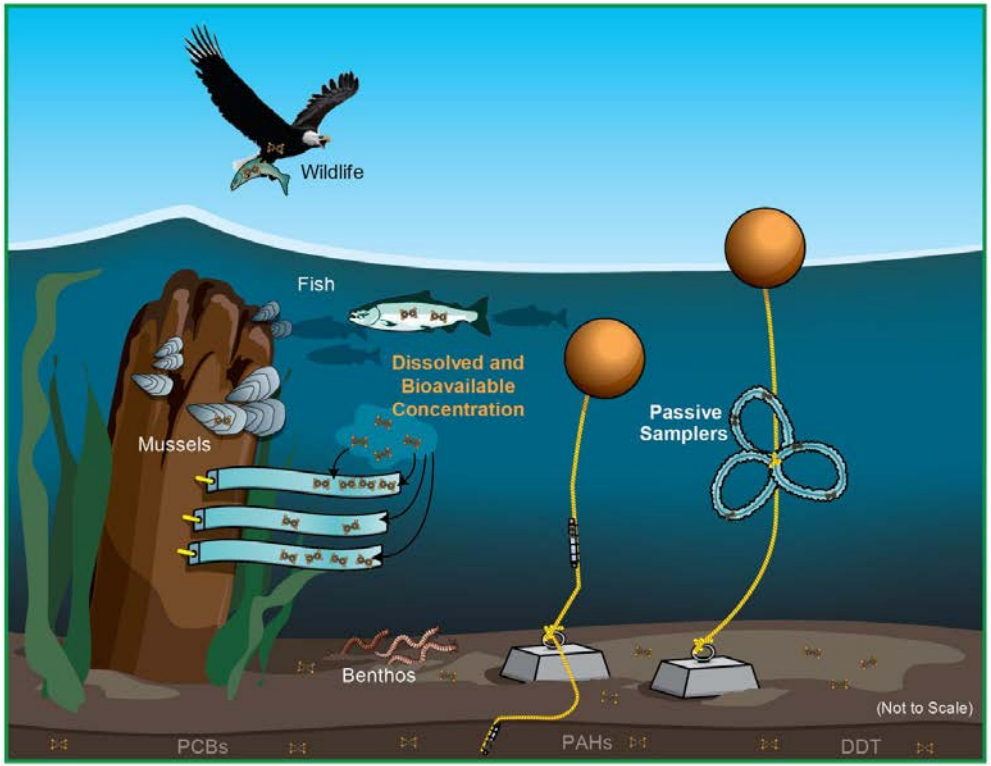
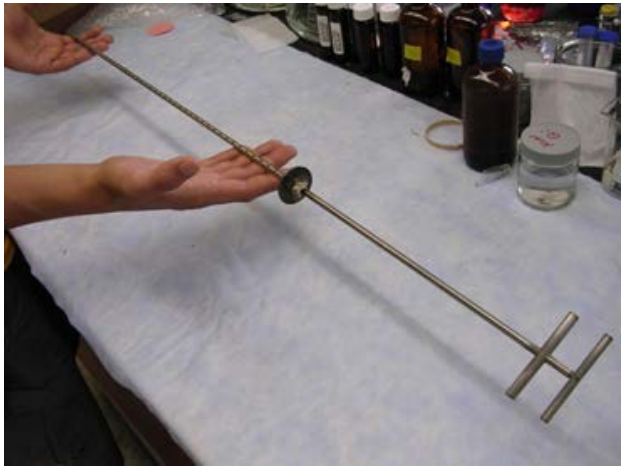
Backup Slides

Passive Sampler Deployment



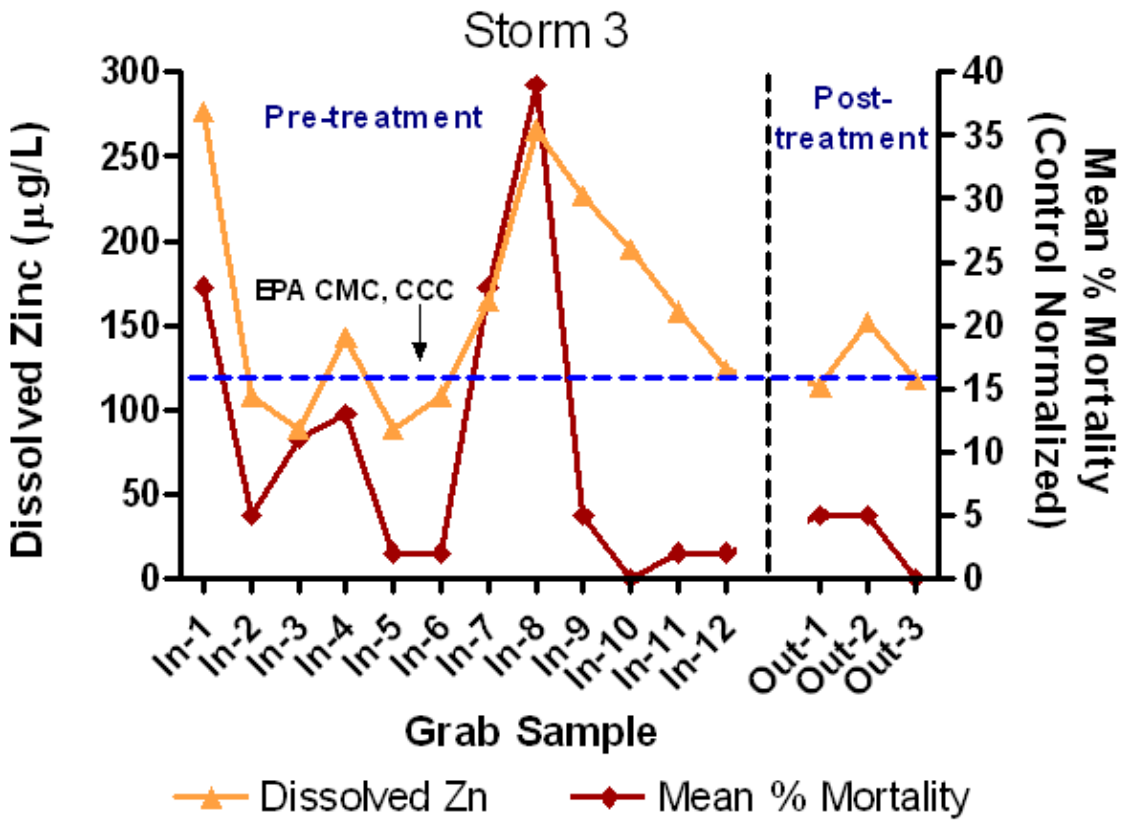
December 2012

OSWER Directive 9200.1-110 FS



Environmental Variability – Stormwater

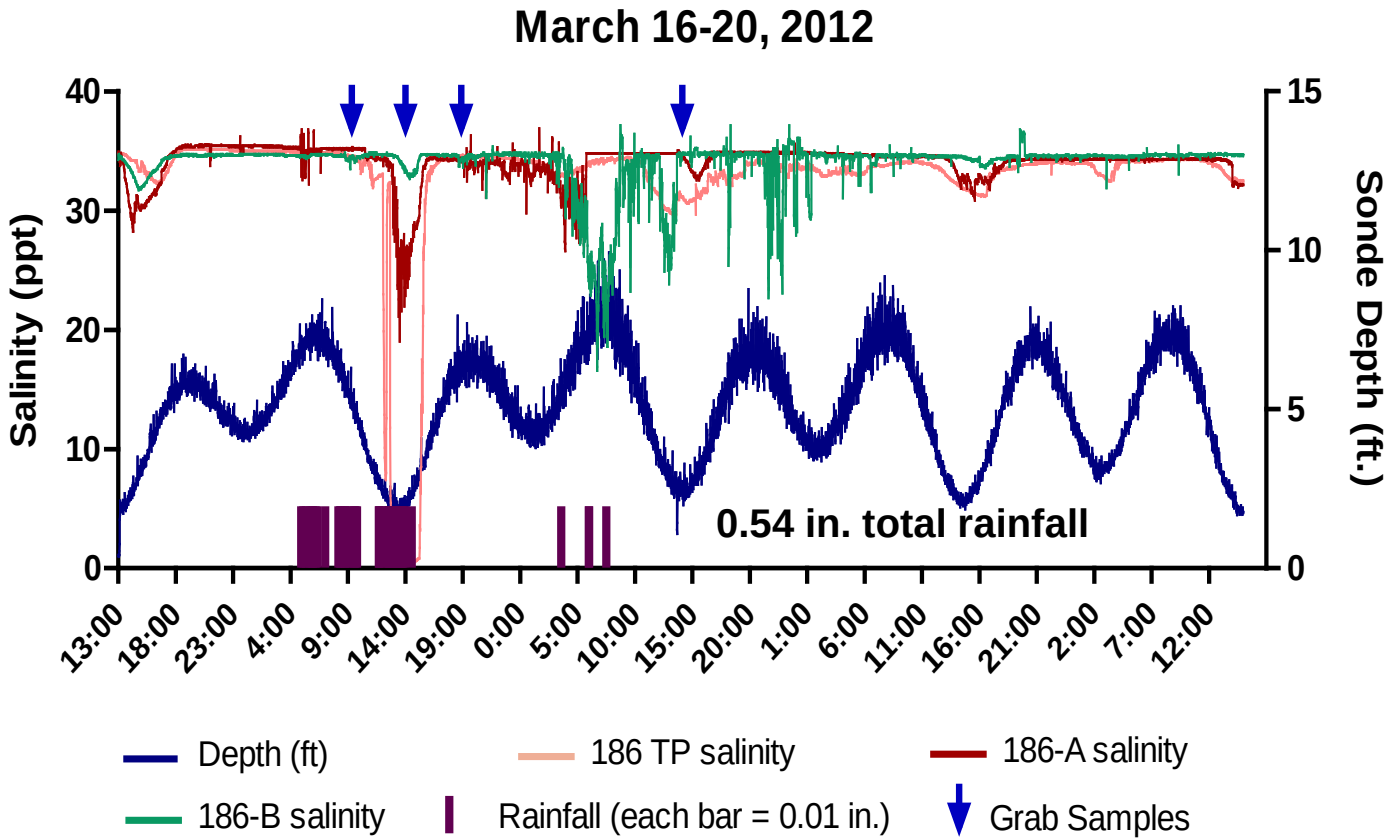
Outfall Pollutograph Sampling – Toxicity and Zinc



Environmental Variability – Sediments

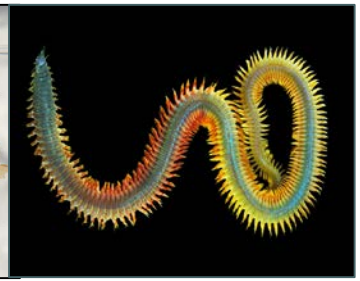
Environmental Variability – Marine Receiving Waters

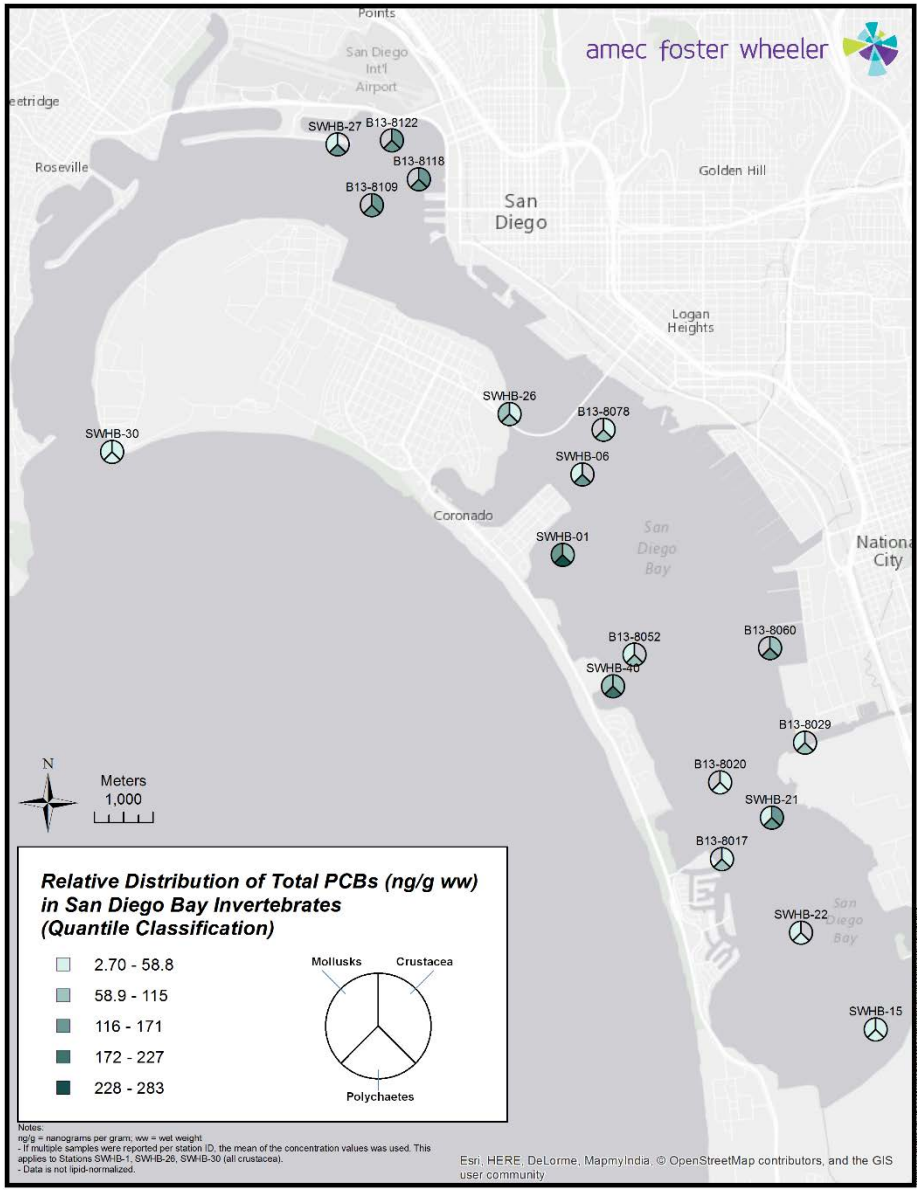
Salinity/Tide Profiles – Devil's Slide La Jolla ASBS



Environmental Variability – Tissues

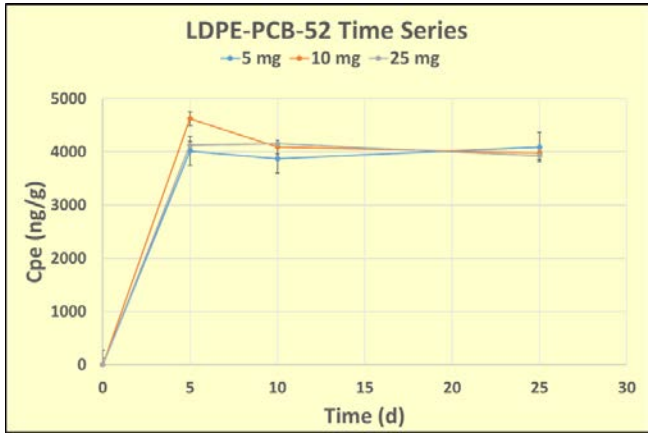
- 2013-2014 Tissue Sampling – San Diego Bay
- Complex bioaccumulation patterns that don't always match sediment chemistry
- Source?

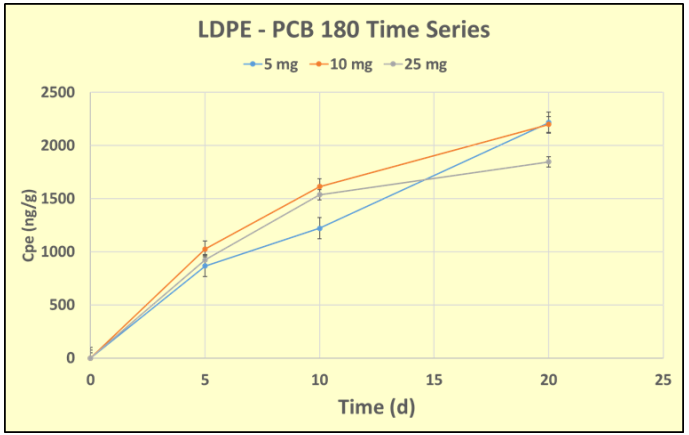




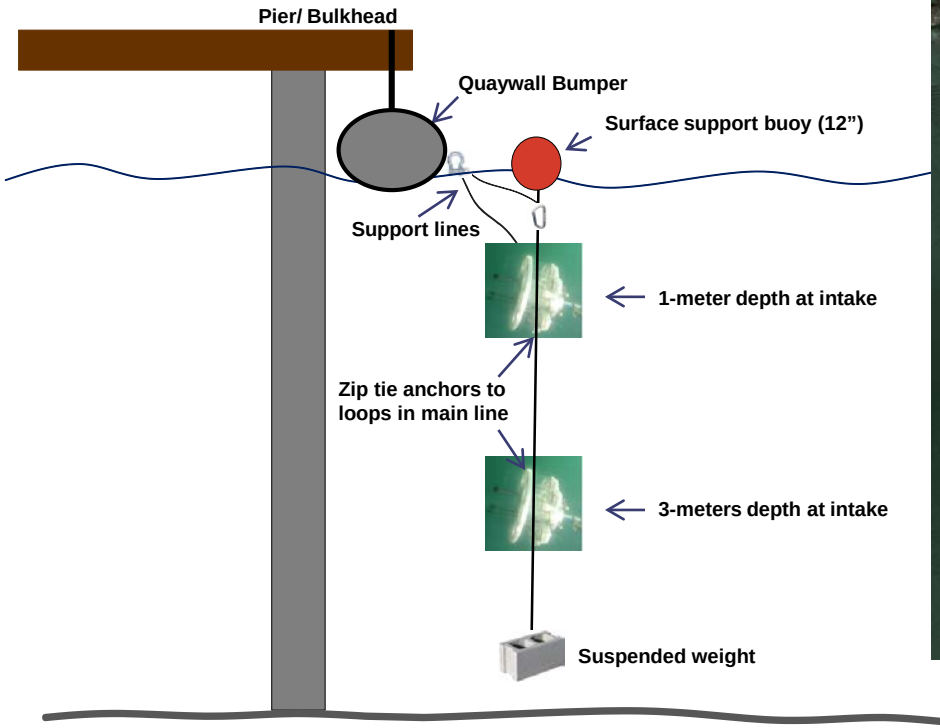
Passive Samplers –
Quantitative Analysis Requirements

- Kinetic uptake rate and equilibrium time
  - Depends on exposure time, passive sampler material, thickness, dimensions, and target compound physiochemical properties/ partitioning coefficients
- Flow across samplers
- Performance reference compounds (PRCs)

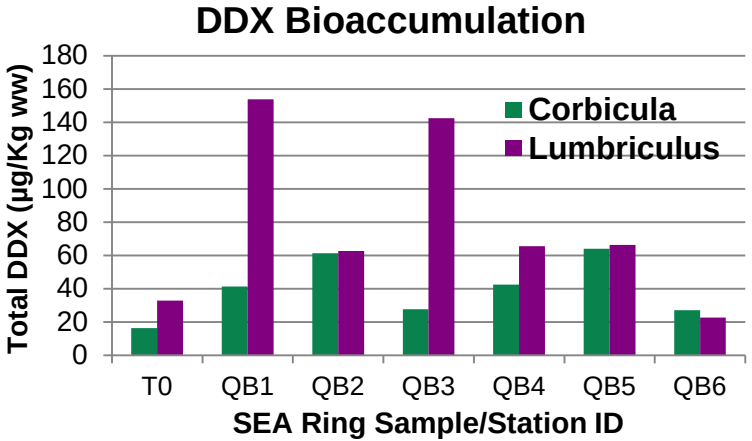




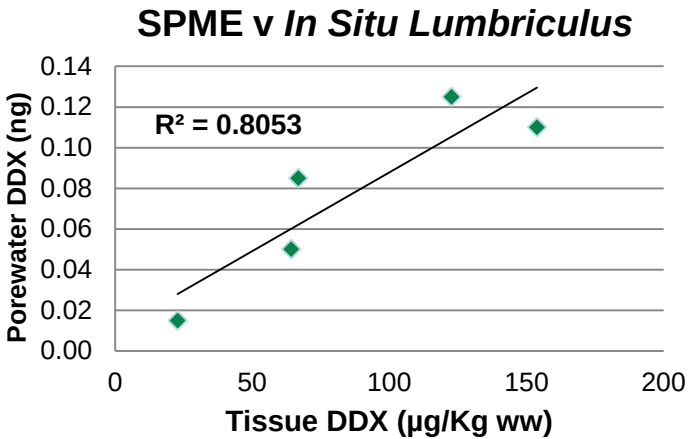
Stormwater Quality Assessment
Naval Base San Diego



Thin Layer Cap Performance
Marine Corps Base Quantico



- Filter feeding clam (*C. fluminea*) and deposit feeding oligochaete (*L. variegatus*)



- Comparison of oligochaete bioaccumulation and porewater concentration after 14 day *in situ* exposure

Enhanced Monitored Natural Recovery (EMNR) Assessment - Freshwater

Sediment Resuspension Effects

Naval Base Pearl Harbor