Surrogate Devices for Assessment of the Bioavailability of Organic Compounds in Dredged Material

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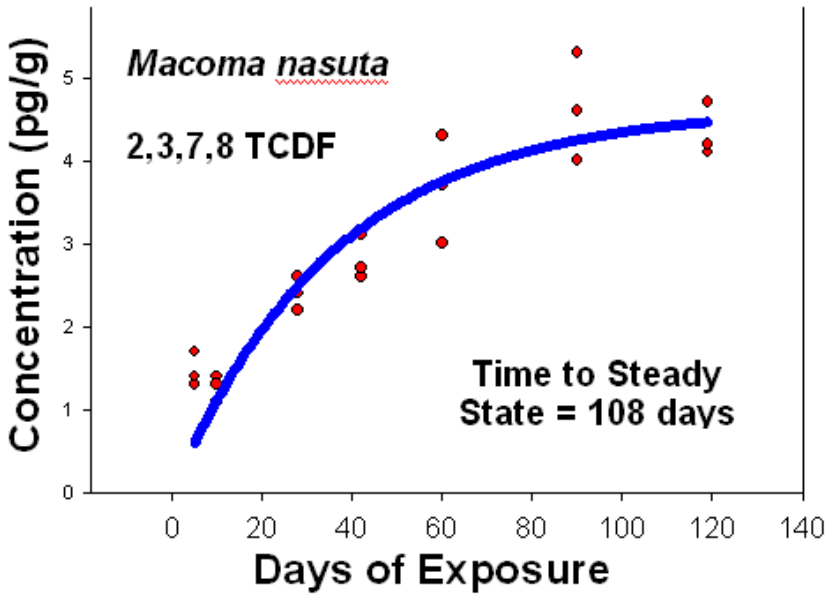
Bioavailability/Bioaccumulation Assessment

Problem:

- Traditional approaches use lengthy and costly bioaccumulation laboratory exposures.
- Confounding factors (e.g., time to steady-state, routes of uptake, metabolism, accessibility and health of test organisms) preclude the derivation of accurate bioaccumulation data.



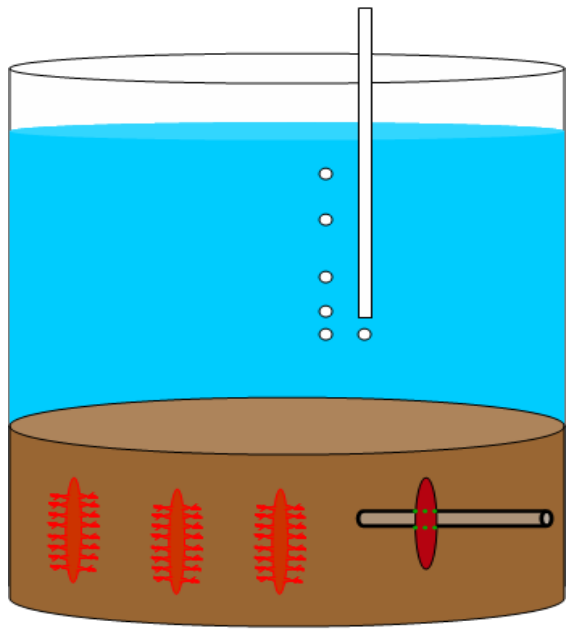
Solution:

Investigate new approaches leading to decreased cost and increased accuracy of bioavailability/bioaccumulation potential assessment of dredged materials.

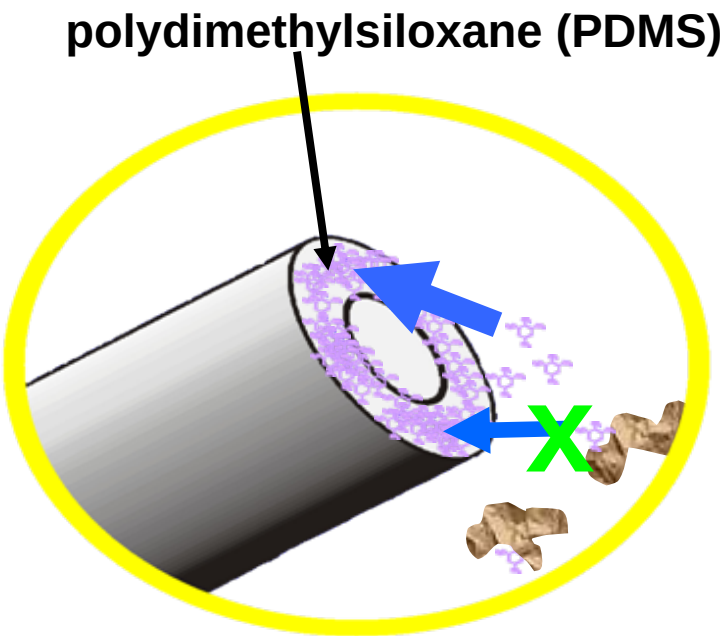
Bioavailability/Bioaccumulation Assessment

Project Objectives:

1. Evaluate the use of solid-phase microextraction (SPME) fibers as surrogate devices for measuring bioavailability in laboratory sediment exposures.
2. Evaluate the correlation between sorption to SPME and steady-state bioaccumulation of hydrophobic organic compounds.
3. Assess the feasibility of using SPME for routine bioaccumulation potential of dredged materials as accurate and cost-saving evaluation of potential bioaccumulation impacts.

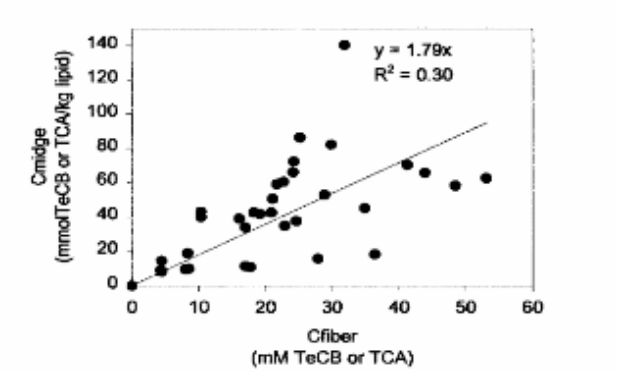


SPME



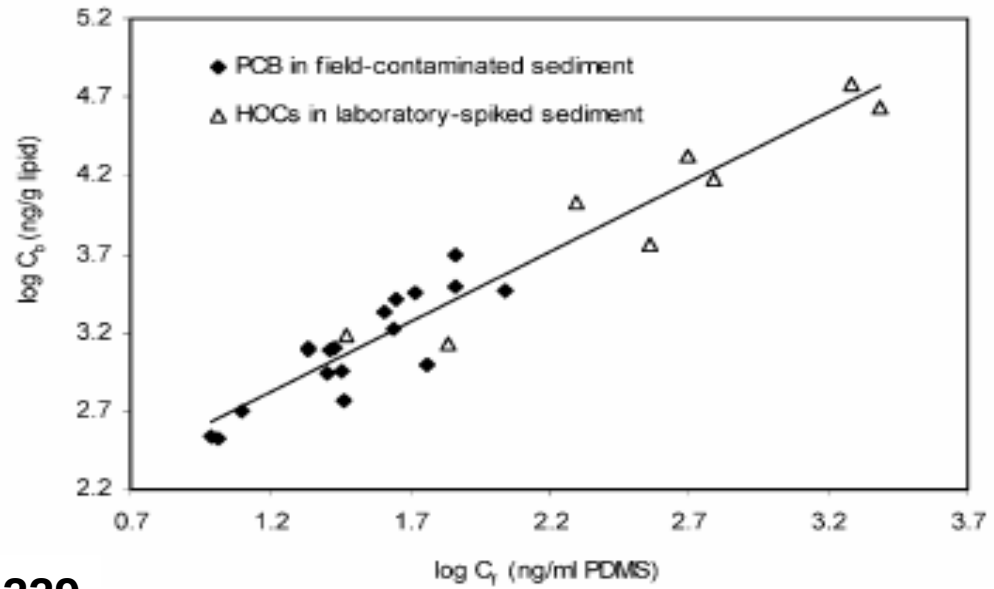
- Cost and time savings.
- Low volume, rapid response can indicate potential availability as opposed to long time to steady-state (> 28 days) bioaccumulation in macrobenthos.
- High resolution possible compared to alternative approaches (e.g. semi-permeable membrane devices).
- Responds directly to dissolved phase concentration, no interference of colloidally-bound contaminants.
- Technology for field deployment under development - Ideal for vertical profiling of bioavailability in remediation projects (e.g., capping).

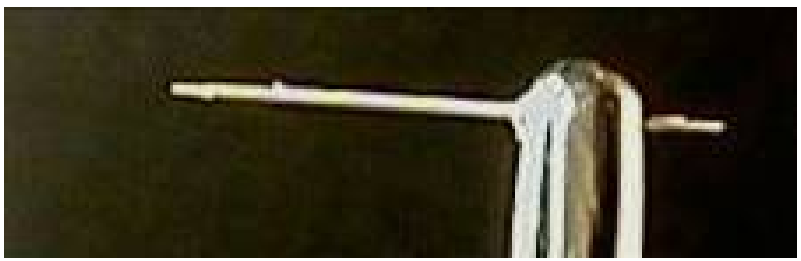
Previous Studies Comparing SPME Concentrations to Body Burdens



SPME concentrations were predictive of tissue concentrations of chlorinated hydrocarbons in aqueous exposures with midges.

Leslie et al. 2002, Environ. Tox. Chem. 21:229

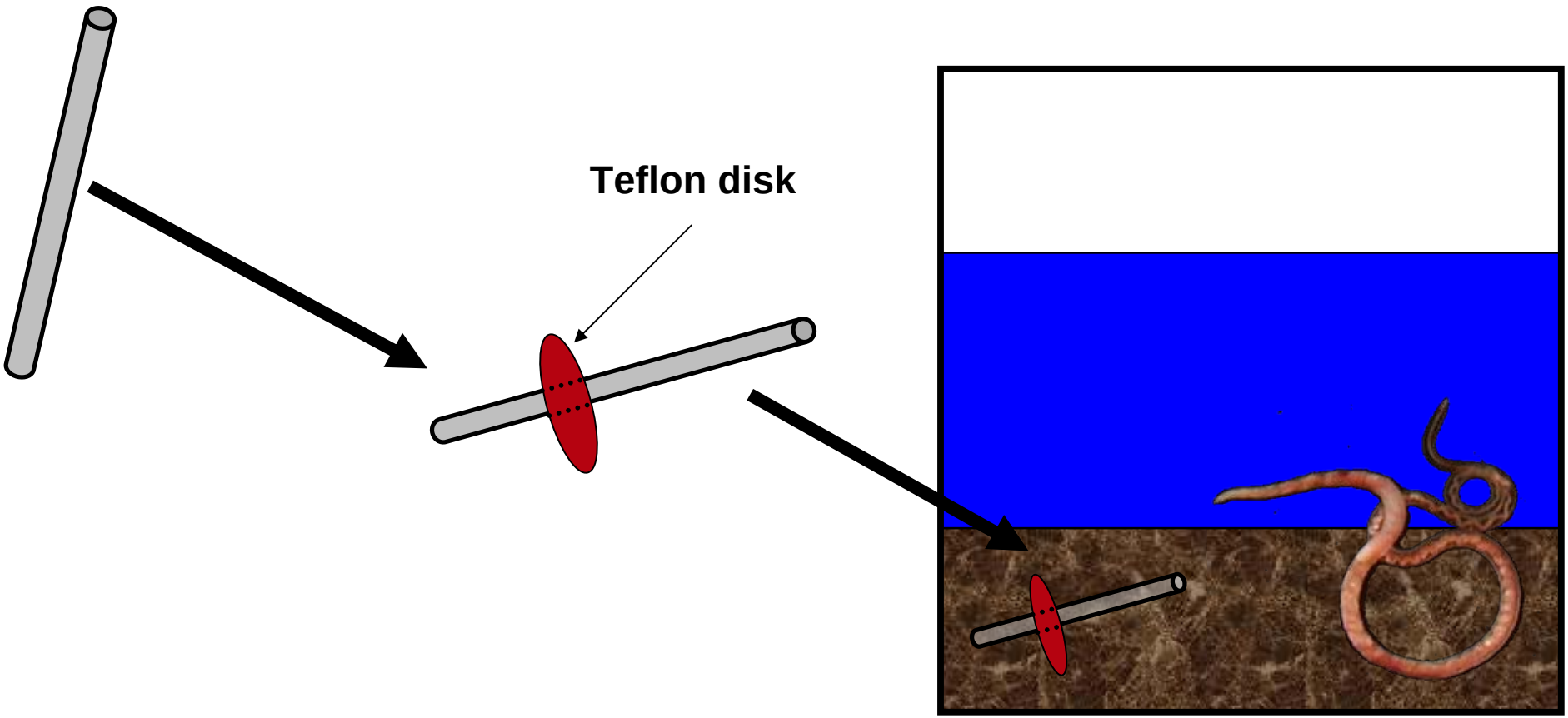




SPME concentrations were predictive of tissue concentrations of PCBs in field-contaminated sediments and chlorinated hydrocarbons laboratory-spiked sediments in *Lumbriculus variegatus*

You et al. 2006, Environ. Sci. Technol. 40: 6348

Objective 1.
SPME Deployment in Sediment for PDMS and Tissue Concentration Comparison



Conder and La Point (2004): *Env. Tox. Chem. 23*:141

Sediments Evaluated

- **Hunters Point – Navy ship yard, San Francisco Bay**
  15 mg/kg total PCBs

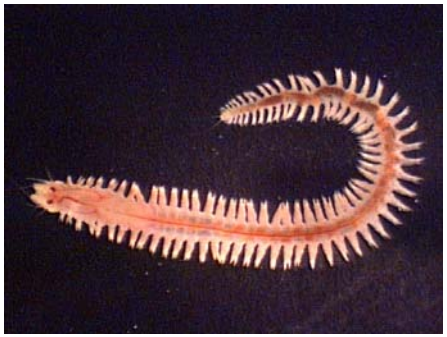
- **Anacostia River – Washington, DC**
  20 mg/kg total PAHs

- **New Bedford Harbor – New Bedford, MA**
  124 mg/kg total PCBs, 27 mg/kg total PAHs
  Diluted with reference sediments:
  - **Sequim Bay, WA (25, 12, 6, and 3% NBH by dry weight)**
  - **Browns Lake, MS (25, 12, 6, and 3% NBH by dry weight)**

  Storage at 23 °C for 8 weeks

Experimental Organisms

Leptocheirus plumulosus



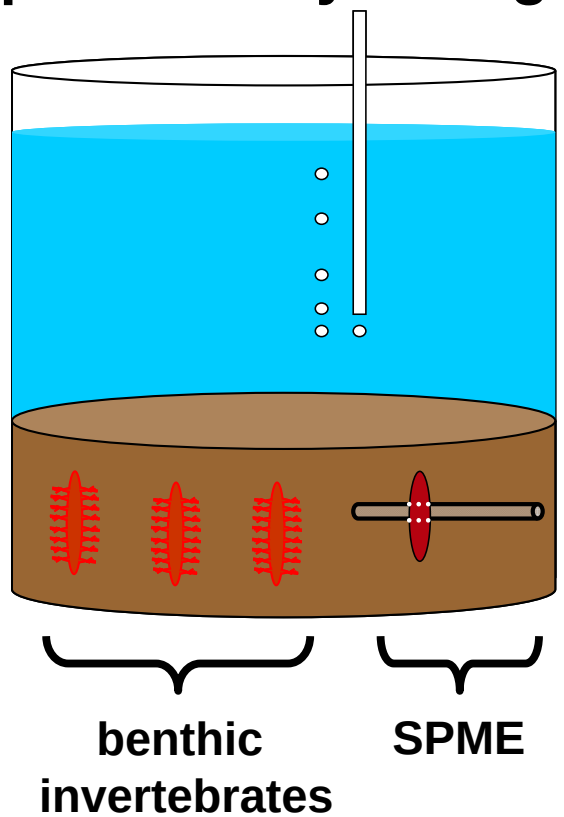
Neanthes arenaceodentata

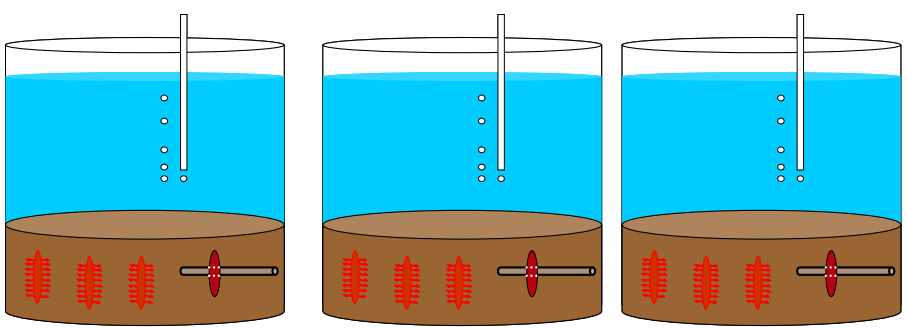
Lumbriculus variegatus

Sediment Exposure

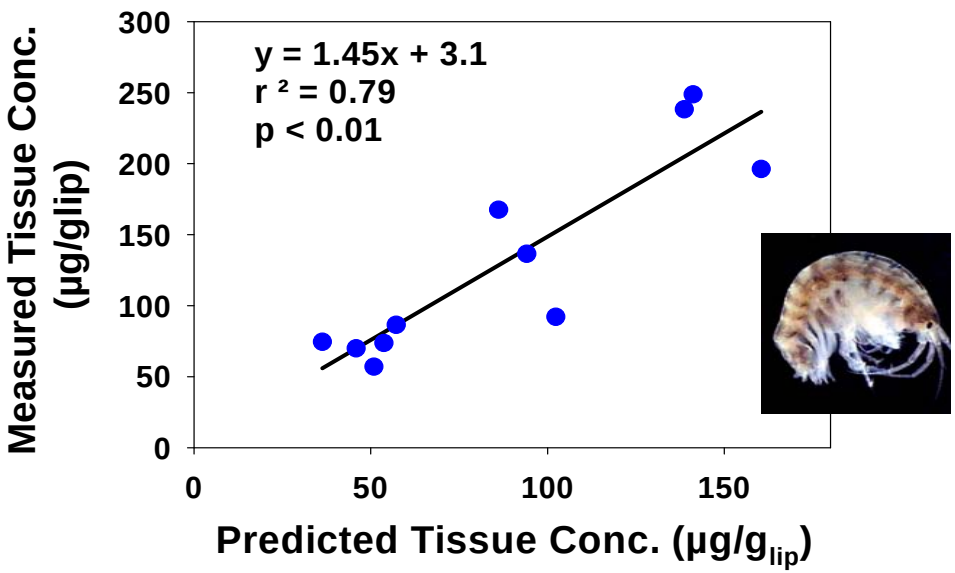
Exposure design

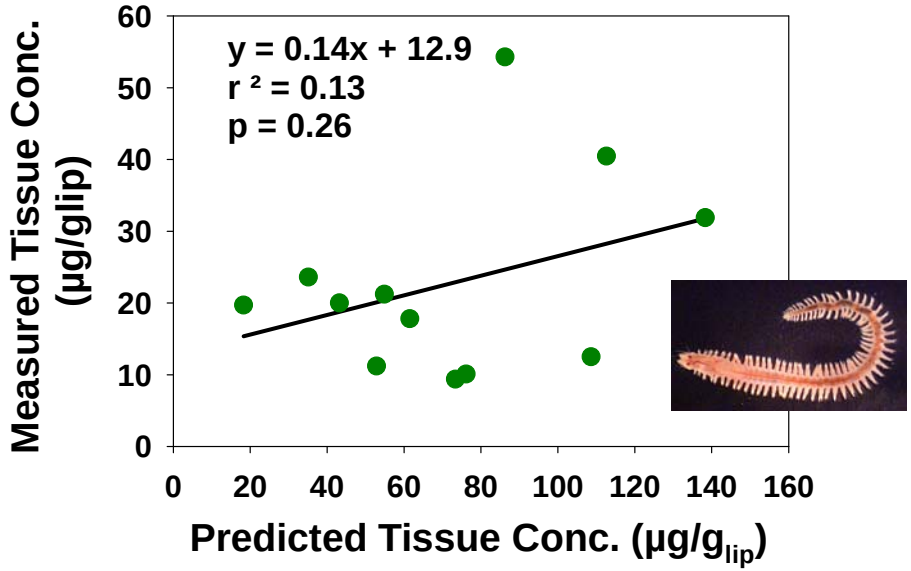
- Mass of exposure organism per replicate approximately 50 mg
- Ratio OC to biomass > 50:1
- Five replicates per treatment
- 21-day exposure duration
- No feeding
- Gentle aeration
- Overlying water exchanged 2x weekly

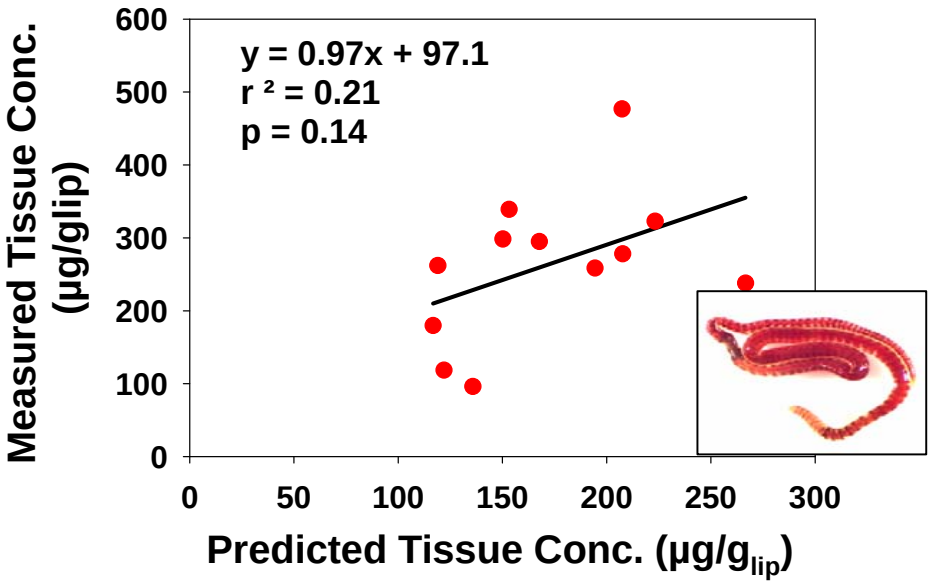




SPME-predicted vs Measured Tissue Conc.: SumPCBs







Major species-specific differences.

- Great correlation for *Leptocheirus.*
- Good correlation for *Lumbriculus* when all congener data was used (not shown).
- Poor correlations for *Neanthes*

Related Project - Field Deployment Study

Demonstration and evaluation project
ESTCP-funded (06-08)
D. Reible, PI
G. Lotufo, Co PI

Hunters Point, San Francisco
Former shipyard

Summary/Conclusions

- Concentration of PCBs in SPMEs predictive of whole body concentration in *Leptocheirus* and *Lumbriculus*. Poor relationship obtained for *Neanthes*. It is speculated that tube building and decreased feeding resulted in low bioaccumulation.
- Relationship between SPME and tissue concentration not established for PAHs because concentrations in fiber extracts below laboratory detection limit despite high concentration in sediments.

On-going and Future Research

- Establish relationship between SPME and body burden for PAHs and chlorinated pesticides.
- Establish relationship between SPME and body burden in *Macoma*, a bivalve typically used in bioaccumulation evaluation of dredged materials.
- Exposures of SPME and benthic invertebrates using other harbor sediments (e.g., Los Angeles).