The pros and cons of field vs. lab applications of passive sampling

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RMP Webinar: Passive and Alternative Sampling Methods
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SCCWRP
Established 1969

Comparing lab vs. field

- Lab-based assessment ("*ex situ*")
  - modifies/modulates geochemical conditions
  - accelerates approach to equilibrium, resulting in worse-case estimate of C_{free}
  - excellent measurement precision is possible

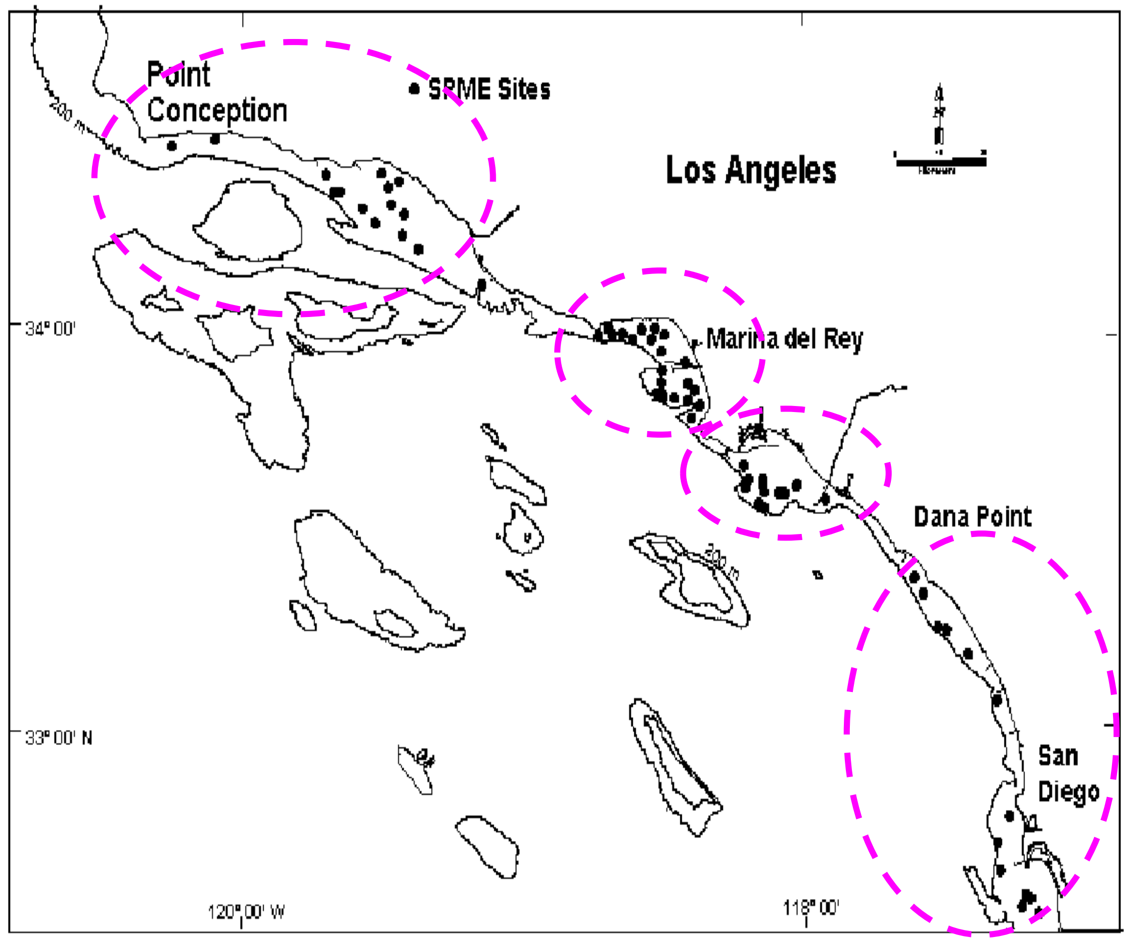
- Field-based assessment ("*in situ*")
  - preserves biogeochemical environment (higher relevance)
  - Limited mass transfer = longer deployments to approach equilibrium
  - higher variability expected (how much is real?)

- *Ex situ* assumed to be faster and cheaper, ***BUT***
- *In situ* assumed to be a more accurate/relevant, ***BUT***

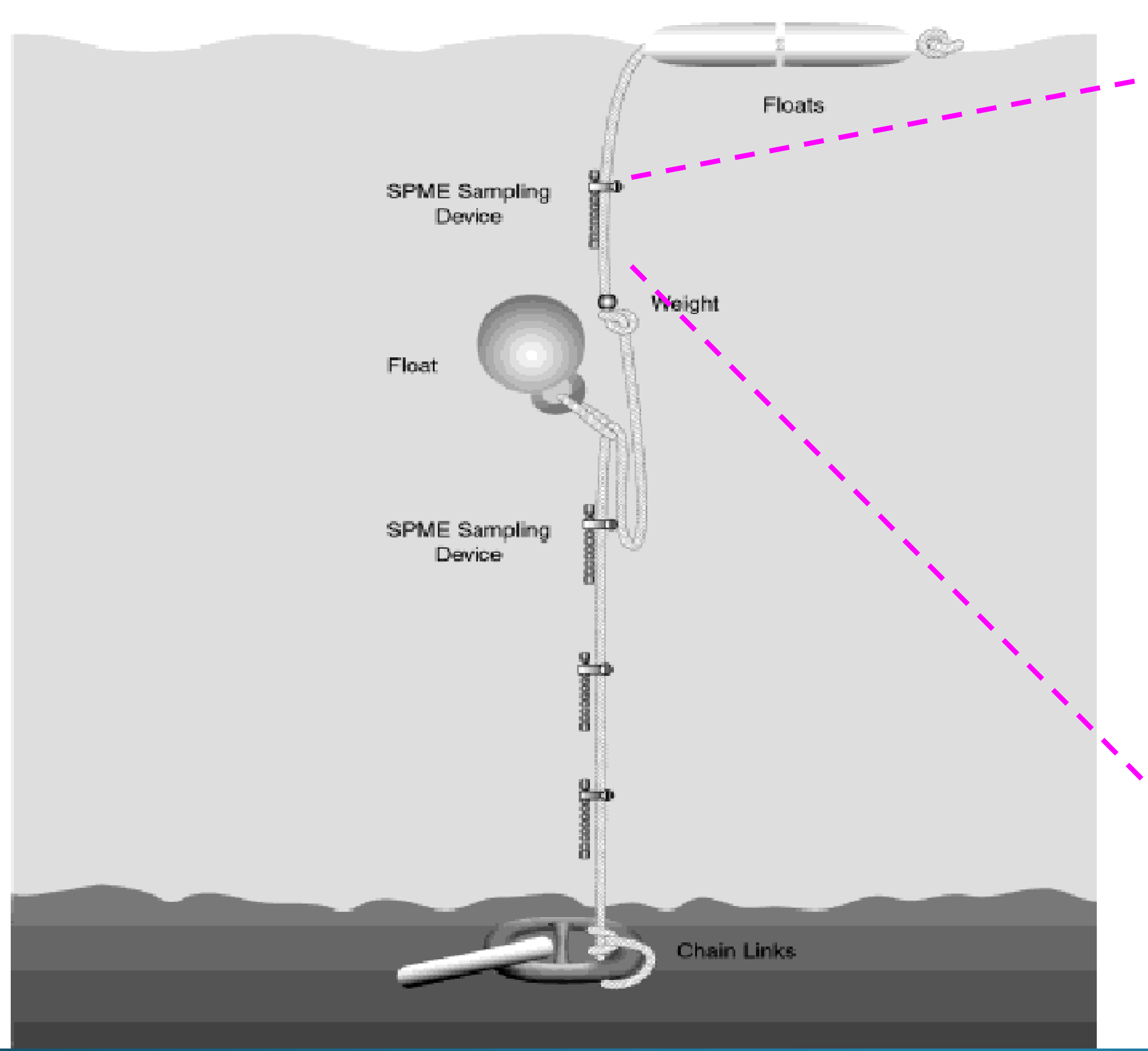
Which approach is most useful for your needs?

Bight 2003

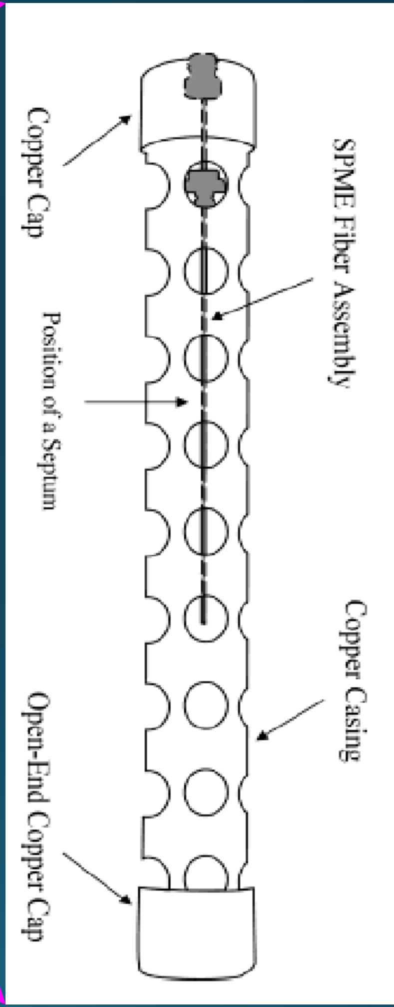
- Stratified random design
- SPME, 100 um PDMS (N~200)
- 4 depths, 1 month deployment



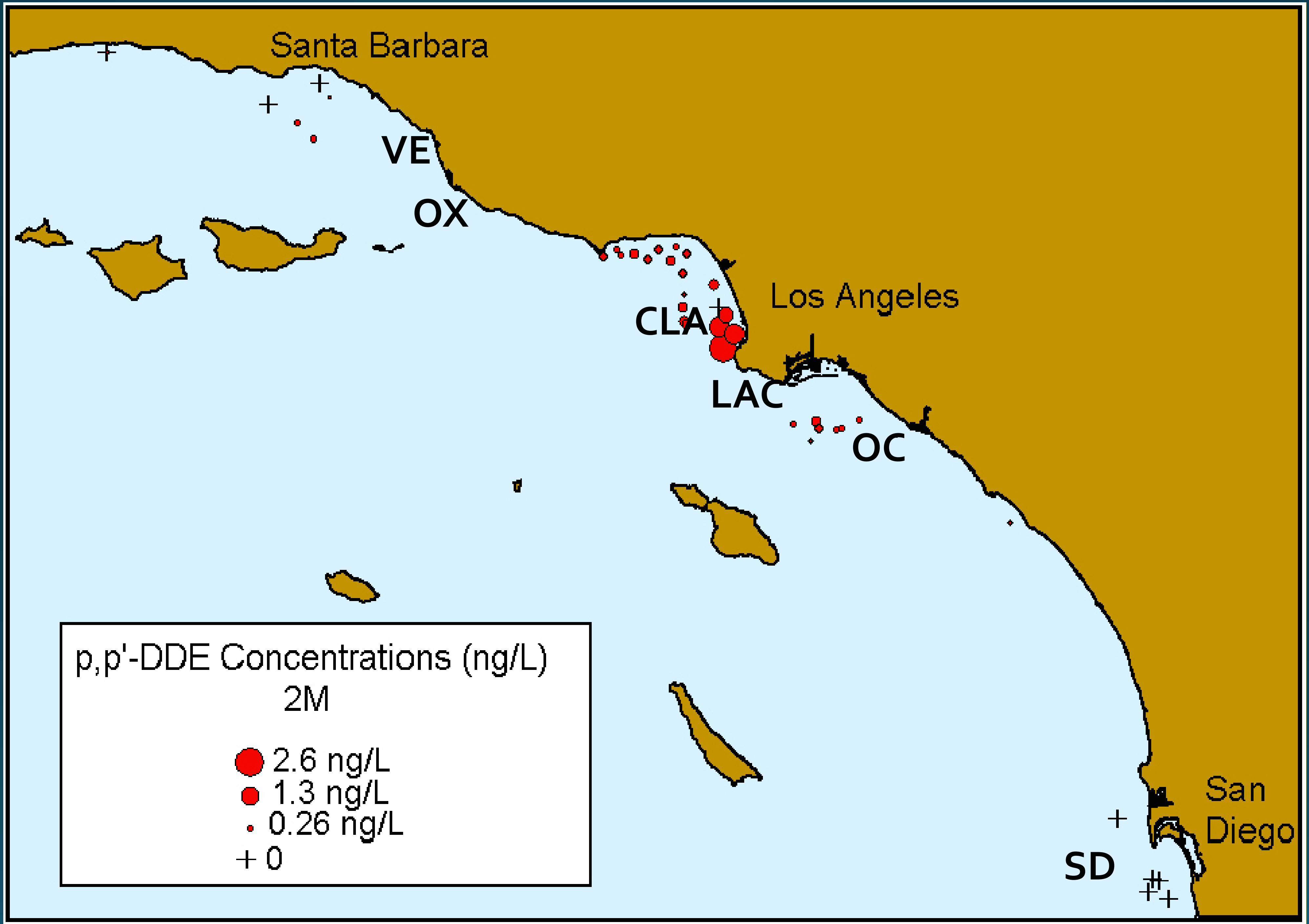
Zeng et al. 2005. *Environ Sci Technol* 39:8170-8176



SPME Device



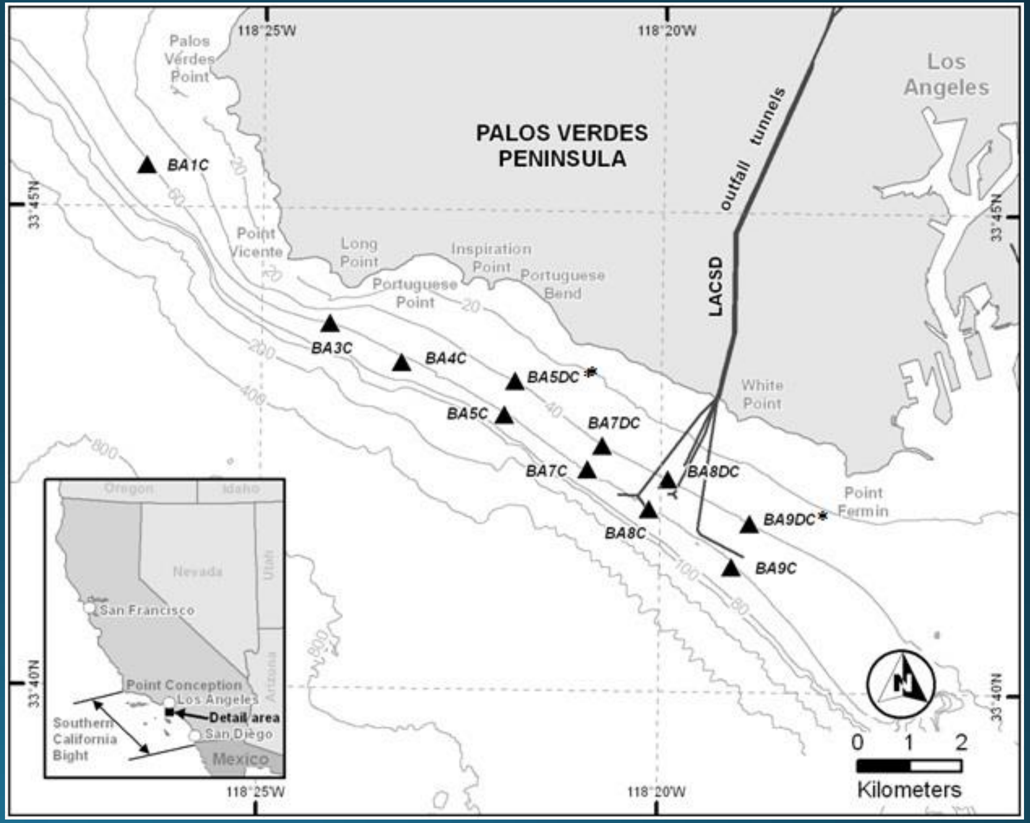
Zeng et al. (2004), *ES&T* **38,** *5737*



Santa Barbara
VE
OX
Los Angeles
CLA
LAC
OC
San Diego
SD
p,p'-DDE Concentrations (ng/L)
2M
2.6 ng/L
1.3 ng/L
0.26 ng/L
0

Palos Verdes Shelf (marine)

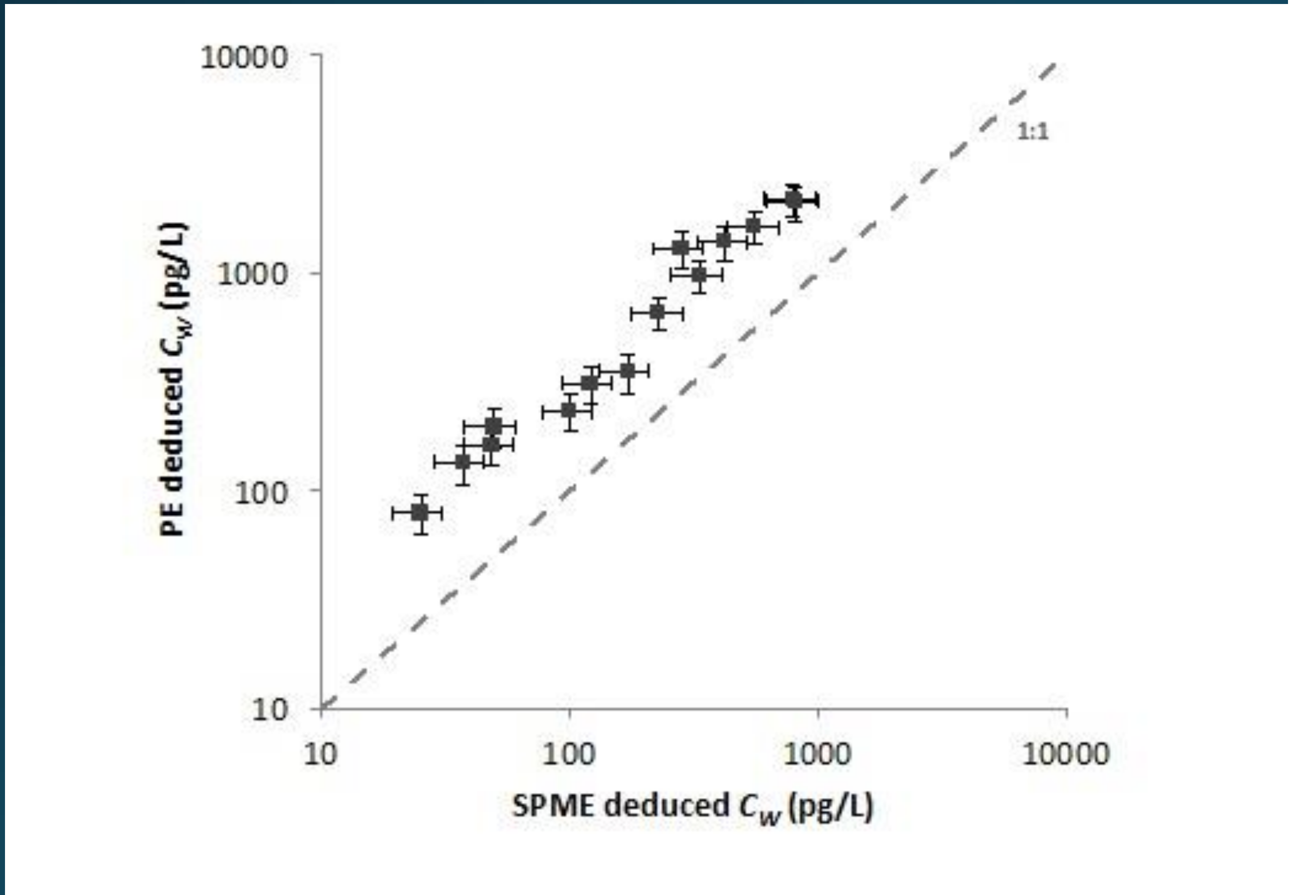
- DDTs and PCBs in sediment, aquatic life
- Gradient from WWTP outfall
- Surface, bottom (45/60 m) & mid-depth
- LDPE (n=3) & SPME-PDMS (n=4)
  - LDPE pre-loaded with PRCs
- Deployed for 32 days in Sep 2010
- Repeated in 2013 adding 100m isobath

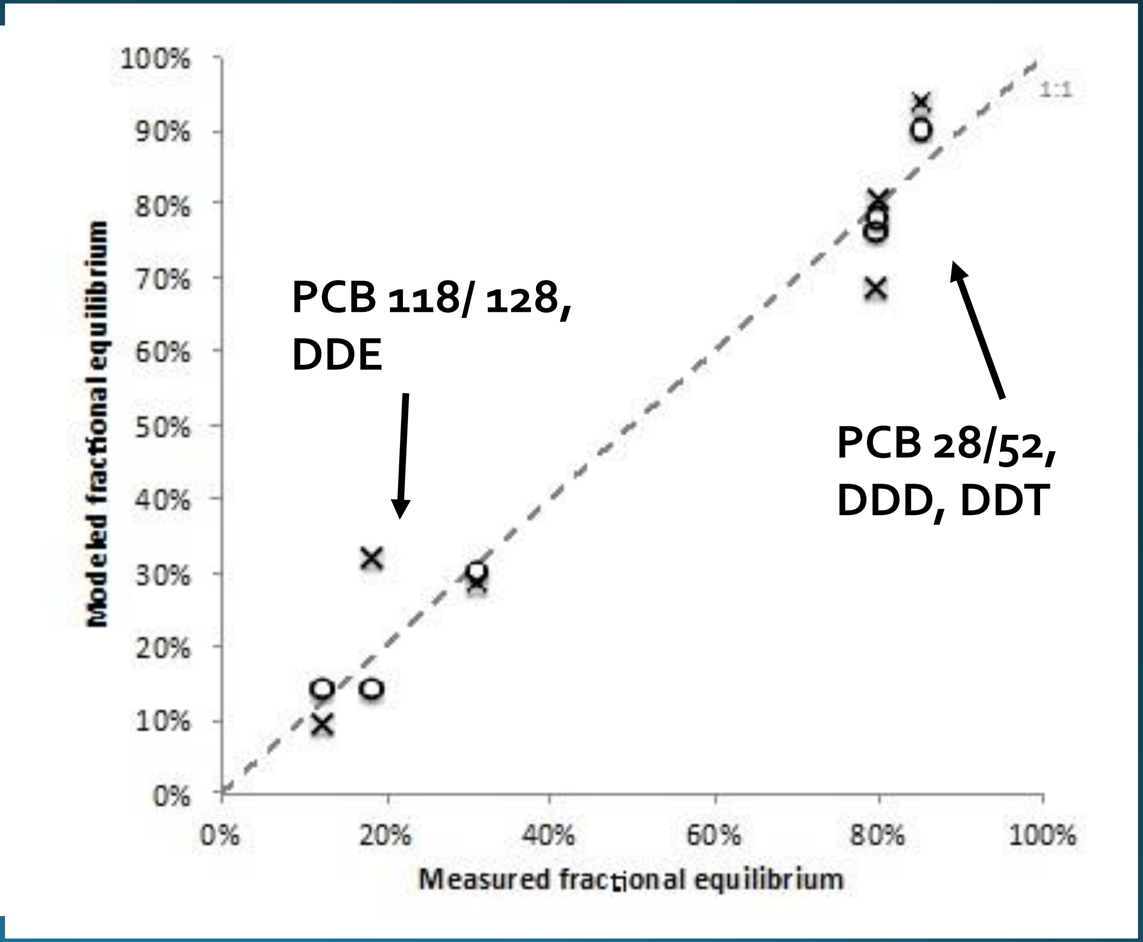


Fernandez et al. 2012. *Environ Sci Technol* 46:11397-11947

Correcting for non-equilibrium

C-13 labeled PCBs 28, 52, 118, 128; *p,p'*-DDD/E/T





Advancing the use of passive sampling in risk assessment and management of contaminated sediments: Results of an international passive sampling ring test

Michiel T.O. Jonker[1], Stephan van der Heijden[1], Yongju Choi[2], Yanwen Wu[3], Loretta Fernandez[4], Robert M. Burgess[5], Upal Ghosh[6], Mehregan Jalalizadeh[6], Jennifer Apell[7], Phil Gschwend[7], Rainer Lohmann[8], Mohammed Khairy[8], Dave Adelman[8], Michael Lydy[9], Samuel Nutile[9], Amanda Harwood[9], Keith Maruya[10], Wenjian Lao[10], Amy Oen[11], Sarah Hale[11], Danny Reible[12], Magdalena Rakowska[12], Foppe Smedes[13,14], and Mark Lampi[15]

Presented at SETAC Europe, Nantes, France, 22-26 May 2016

Participants, Methods

- 11 labs participating in ring test; 1 coordinating lab (UU)
- 14 passive sampling formats
- 3 different sediments
- 25 target compounds

Target Analytes

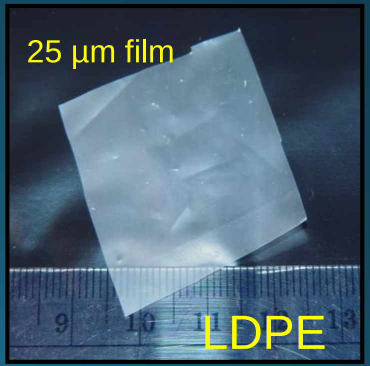
- 13 PAHs (3-6 rings) and 12 PCBs (tri- to heptachlorinated)
- Range in hydrophobicity, partitioning behavior, freely dissolved concs

Test Sediments

1. Spiked sediment (**SP**): high concentrations spiked, low background, sandy
2. Field contaminated sediment (Dutch; Biesbosch area; **BB**): homogeneous, low concentrations PAHs and PCBs
3. Field contaminated sediment composite (**FD**):
   - sandy sediment, low-high PCB levels (no PAHs)
   - clayey sediment, moderate PAH levels (no PCBs); NAPLs (diesel) present

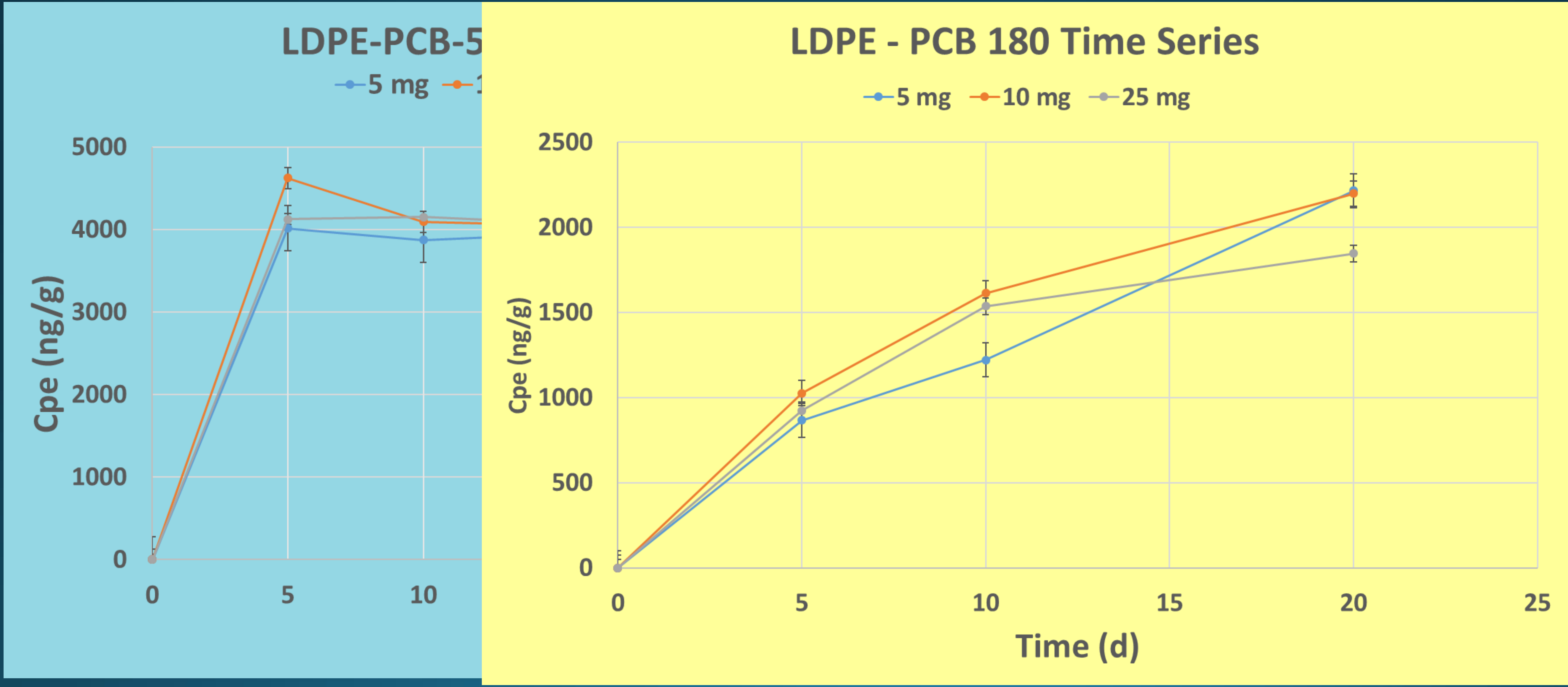
Standardizing ex situ method - LDPE

- *Goals: 1. detectability 2. minimize depletion 3. practicality*
- Spike marine sediment (f_{oc} = 0.7%) with 6 HOCs ($4 < \log K_{ow} < 7$)
- Pre-clean and weigh LDPE film pieces (5, 10 and 25 mg)
- Agitate 60 g (~50 mL) spiked sediment with LDPE
- Sample jars (4 replicates) after 5, 10 and 20 days
- Sonicate LDPE in DCM and analyze by GC-MS-SIM
- Plot C_{pe} vs. time; estimate C_{free} using $K_{pw} = C_{pe} / C_{free}$



3-yr project funded by San Diego Regional Water Board (15-044-190)

Time series results



Summary

- *In situ* well suited for water column studies
    - *Difficult to simulate or bracket dynamic conditions in the lab*
- *Ex situ* well suited for sediment studies
    - *Provides conservative ("worst case") C_{free}*
    - *Method standardization (and thus high precision) can be achieved*
- Next steps
    - Compare C_{free} in sediments determined ex situ and in situ
    - Measurement accuracy - can interlab studies give us consensus values?
    - New analytes and materials

Additional Resources

- keithm@sccwrp.org; www.sccwrp.org

- 2012 SETAC Technical Workshop on Passive Sampling for Contaminated Sediments

  Special series in *Integ Environ Assess Manag* (2014) Volume 10
  - Building consensus (Parkerton & Maruya 2014)
  - State of the science (Lydy et al. 2014)
  - Theoretical basis (Mayer et al. 2014)
  - Practical guidance: selection, calibration and application (Ghosh et al. 2014)
  - Using C_{free} for management decision making (Greenberg et al. 2014)

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- M. Jonker, T. Parkerton, G. Witt, B. Chadwick, T. Thompson
- J. Chan, S. McClain