



Passive Samplers: Considerations to Help Make Your Study a Success

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Passive samplers – What are they?

Abiotic device used to monitor for a chemical(s) in an environmental medium

- Has little or no moving parts
- Doesn't require power to operate
- Samples over prolonged durations (hours to days to months)

Selectively samples residues from the dissolved (readily bioavailable) phase – mimicking an organism's exposure.

Benefits of Passive Samplers

Allows concentration of trace, yet toxicologically relevant, contaminant mixtures over extended periods of time by sampling large volumes of water (10s to 100s L).

Primarily used for surface water applications, however, air and groundwater use is growing.

Applicable to nearly all environmental conditions, regardless of water quality.

Benefits of Passive Samplers

Detect episodic changes in environmental contaminant concentrations which are often missed with grab samples.

Provide time-weighted average concentrations which are a fundamental part of ecological risk assessment processes for chemical stressors.

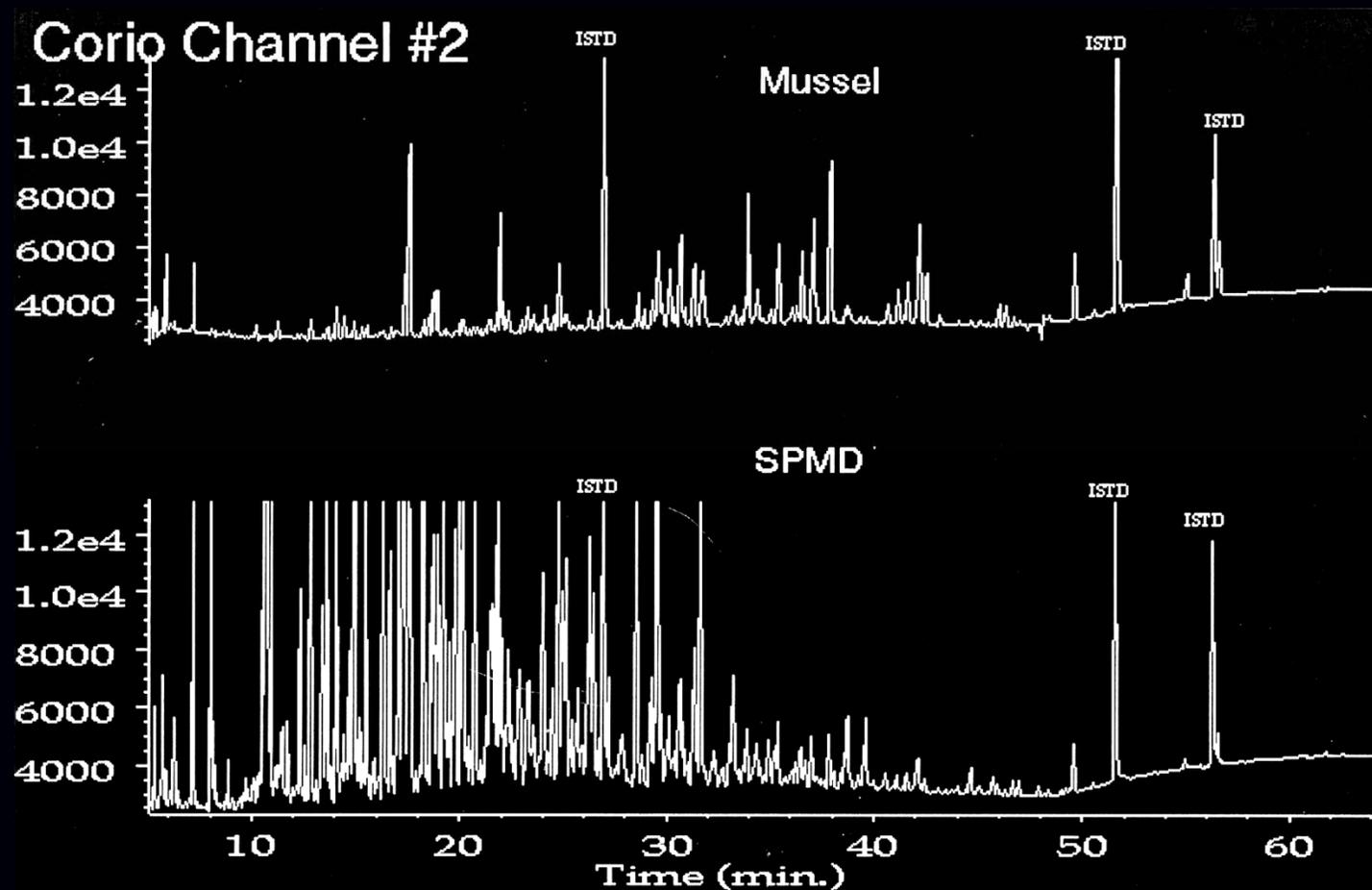
Comparison to Fish Sampling

Passive samplers don't move.

Metabolism/excretion of sampled chemicals is not an issue.

No need to analyze multiple tissues to obtain the full picture of exposure.

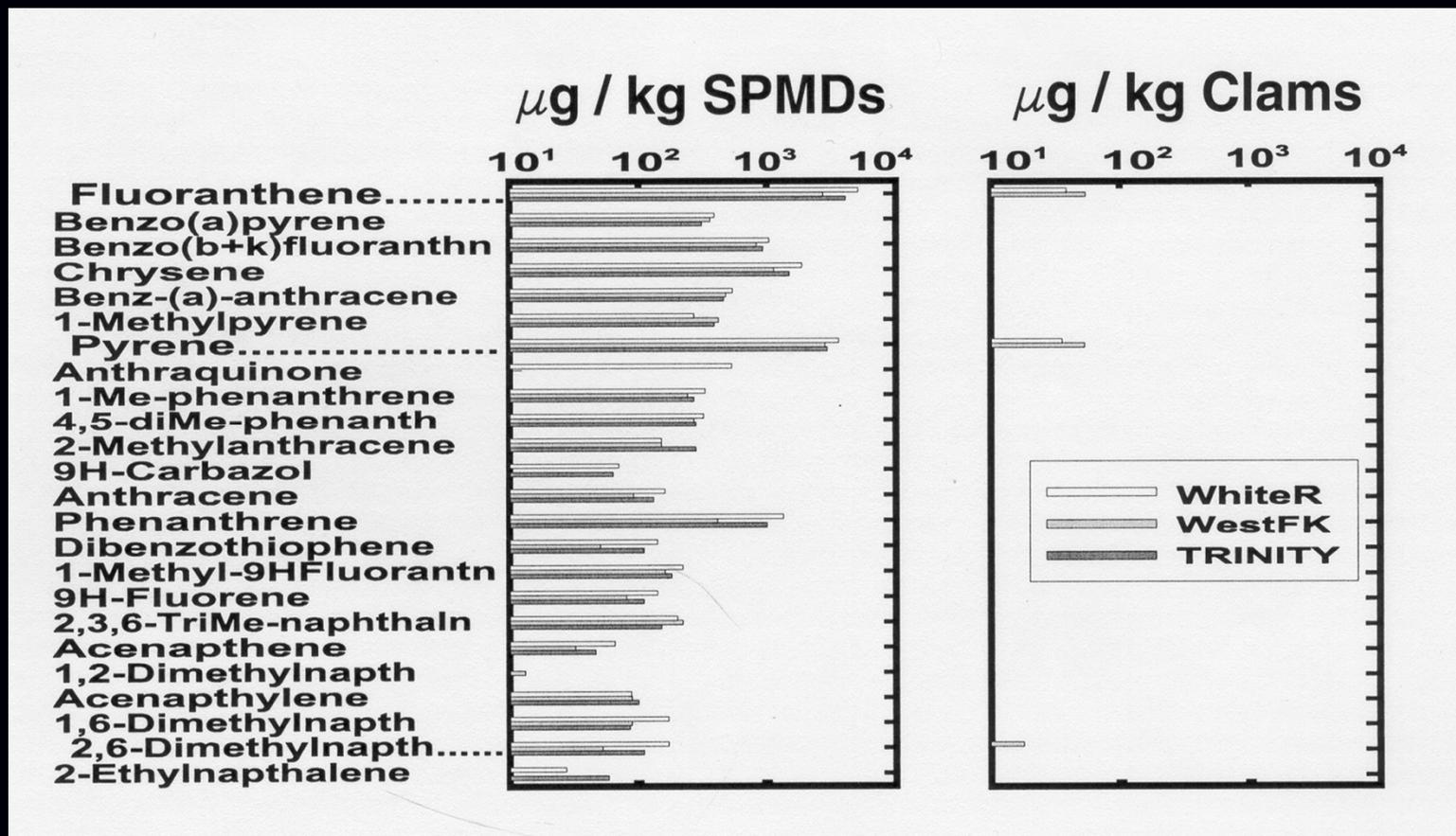
Passive Sampler and Biota Comparison



Sampling of chlorinated organics



Passive Sampler and Biota Comparison

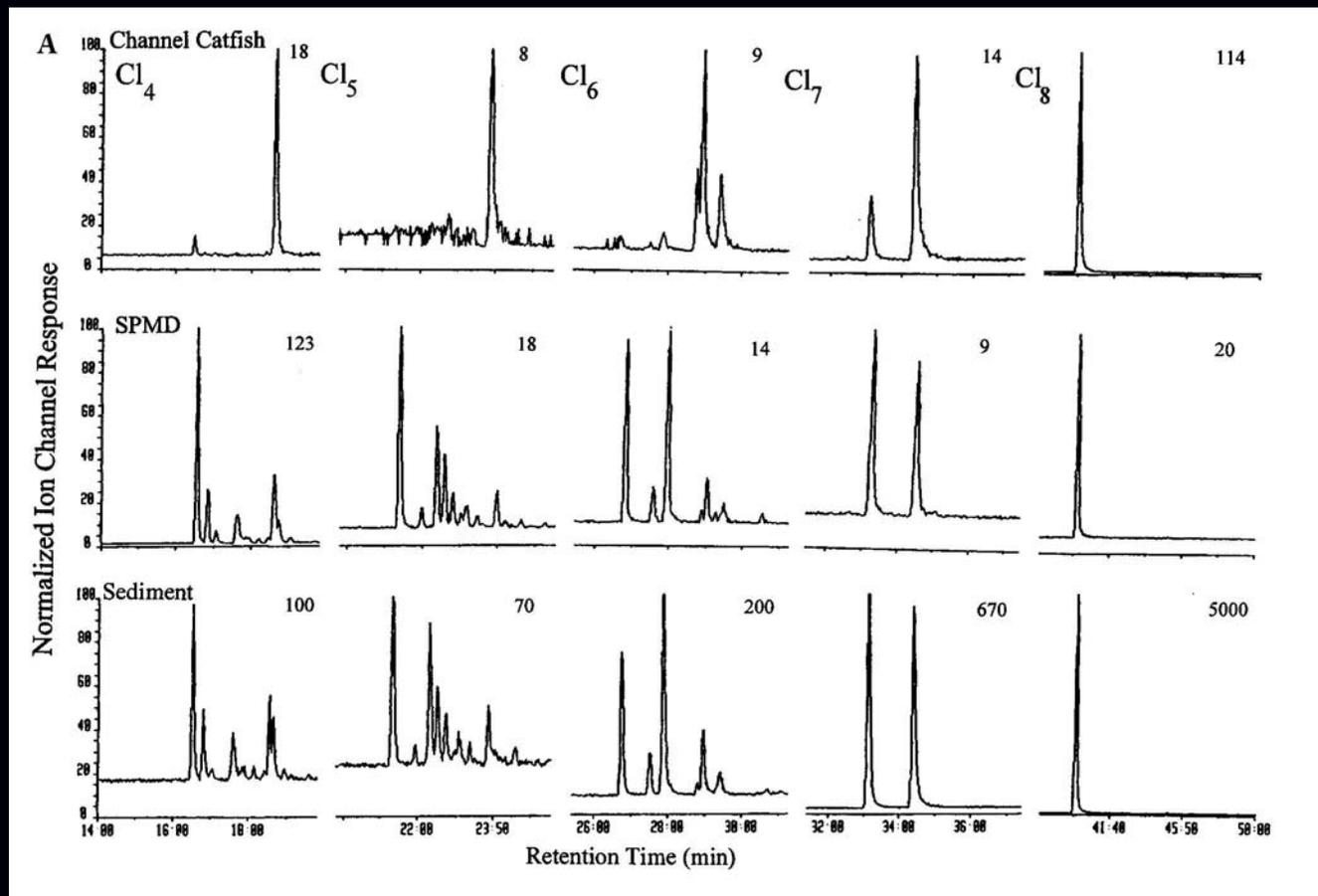


Sampling of PAHs

Depuration of PAHs: mammals > fishes > crustaceans > bivalves



Passive Sampler and Fish Comparison

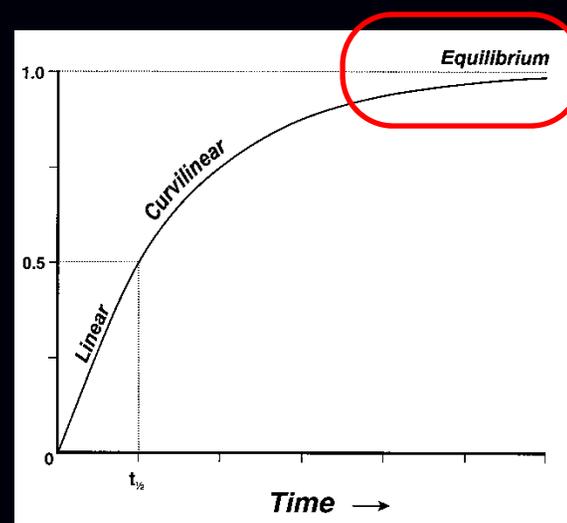


Sampling of dioxins – fish metabolizes many PCDD and PCDF congeners

General Types of Passive Samplers

Equilibrium samplers –

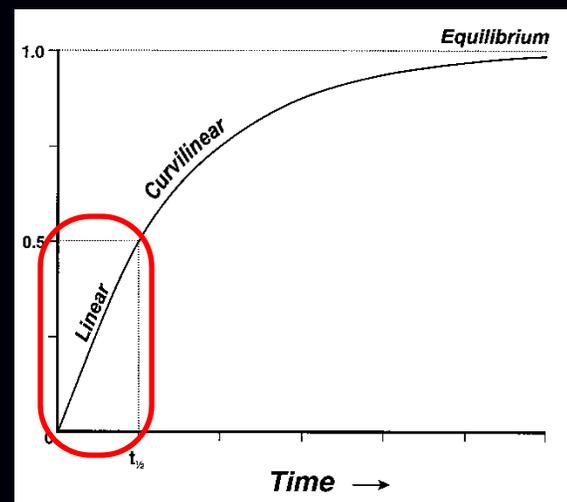
- short exposure times (days to weeks)
- low capacity
- data most representative of the latter stages of the deployment
- groundwater, sediment pore water, air, some surface water
- SPME, polymers on glass, diffusion samplers



General Types of Passive Samplers

Integrative samplers –

- long exposure times (weeks to months) – generally 1-2 months
 - Short deployments = smaller volumes sampled
 - Long deployments = risk of reduction of sampling due to biofilm buildup and change from integrative to equilibrium sampler
- Can act as Integrative and Equilibrium sampler at same time
- high capacity
- provides Time-Weighted Average concentrations over whole deployment
- surface water, air
- SPMD, POCIS, Chemcatcher, PE or Silicone strips



Passive samplers used for monitoring organic chemicals

- Semipermeable Membrane Device (SPMD)

- Lipid soluble chemicals ($\log K_{ow} > 3$)
- Triolein (lipid) filled PE tube
- Useful for both water and air sampling



SPMD

- Polar Organic Chemical Integrative Sampler (POCIS)

- Water soluble chemicals ($\log K_{ow} < 3$)
- Solid phase sorbents held between PES membranes
- Sorbents and membranes can be changed for specific applications



POCIS

Chemicals commonly sampled by SPMDs/POCIS

- Legacy / regulated contaminants

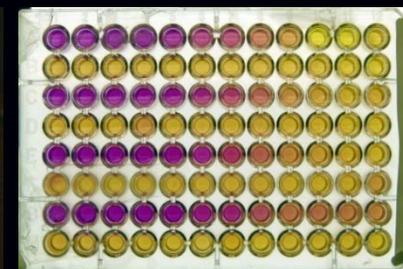
- Polycyclic aromatic hydrocarbons (PAHs)
- Polychlorinated biphenyls (PCBs)
- Polybrominated diphenyl ethers (PBDEs)
- Chlorinated pesticides (DDT, chlordanes, etc)
- Dioxins and Furans

- Emerging Contaminants

- Fragrances
- Hormones
- Pharmaceuticals / Illicit Drugs
- Current-use pesticides
- Antimicrobials (triclosan)

- Bioindicator Tests

- In vivo and in vitro assays



Study Design

- 1) Are passive samplers the best option to meet study goals?
- 2) Does the analytical lab have experience with passive samplers?
- 3) What methods/instrumentation will be used and are they compatible with the passive samplers and PRCs used?
- 4) How low do you need to measure?
- 5) What Quality Control (QC) is required?

Performance Reference Compounds (PRCs)

PRCs are added to passive samplers during construction to account for the effect of environmental conditions on sampling

- Non-interfering (analytically)
- Not present in the environment
- Cover a range of fugacities (ability to leave the SPMD)
- Preferably compatible with the target analytical method

Common to use multiple PRCs in ensure at least one has usable data

Quality Control

Blanks –

Some samplers can readily sample air therefore *Field* and *Laboratory* Blanks are essential.

Analyte Recovery Samples (Spikes) –

Samplers spiked with target chemicals should accompany every study set

- especially important for volatile chemicals and non-standard chemicals

Field Considerations

- 1) Must remain submerged at all times
- 2) Keep from getting buried in sediment
- 3) If **photosensitive** chemicals are targeted, protect from light
(add a **photolysis marker** as part of PRC mix)
- 4) Be prepared for flooding and/or floating debris
- 5) Beware of other people - **#1 cause of failed field work**

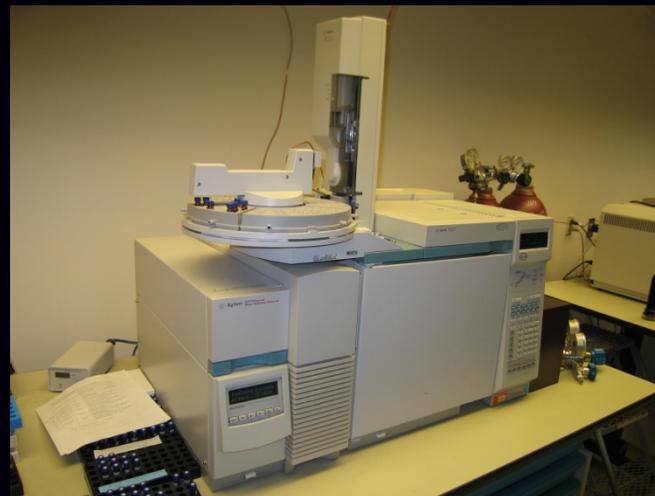
Considerations when choosing a laboratory

Many laboratories do not have experience working with passive samplers, therefore initial contact is important.

Issues to be discussed:

- What internal standards / surrogates do they use (may be same as PRCs added to samplers)?
- Can they analyze the PRCs as part of their methods and at what concentrations?
- How will the data be reported?

ng/sample needed for calculations.



Data interpretation

Results represent the average water concentration of a chemical over the deployment period.

Data is limited to the select list of chemicals in the analytical method and the capabilities of the passive sampler.

Quality control data (blank concentrations and spike recoveries) can be treated in many ways. The QC guidelines of the study/organization should be followed when interpreting this data.

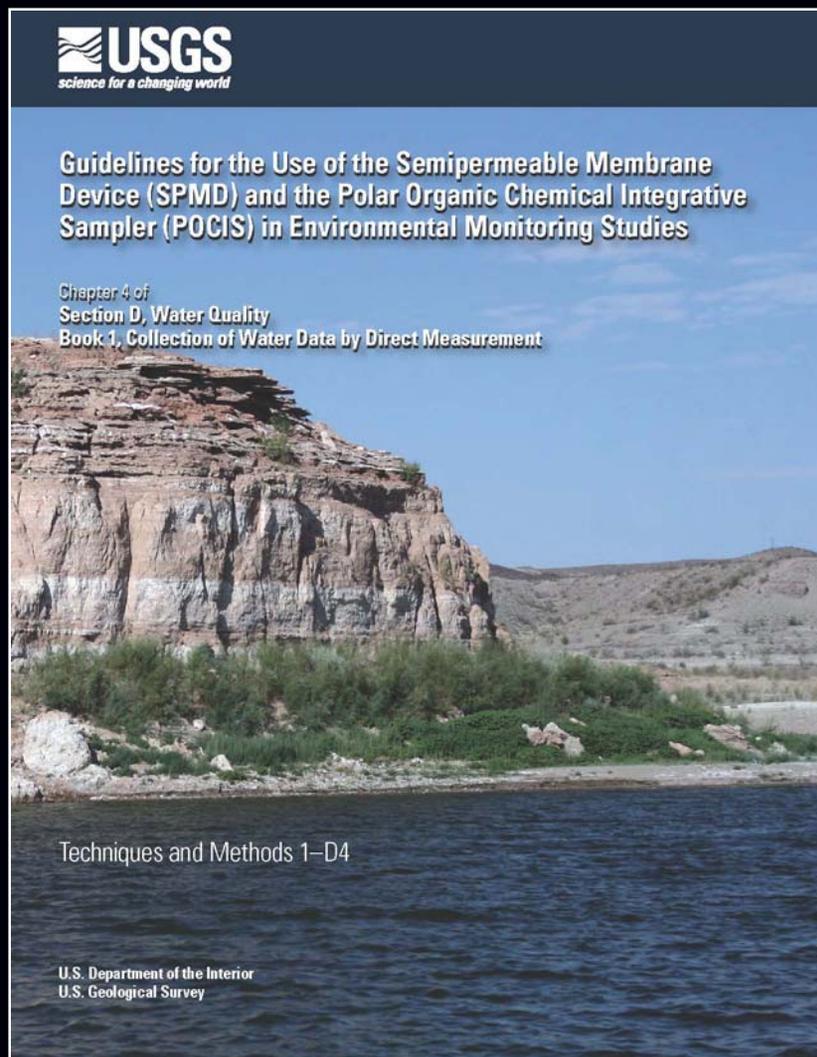
Regulatory acceptance

Samplers as personal dosimeters (human health) for determining occupational exposure is widely accepted.

Use as an environmental monitoring tool is rapidly gaining acceptance.

- in US - often viewed as a research tool by federal agencies
- a few States are using passive samplers in TMDL and reconnaissance studies
- EU is conducting studies to determine the viability for regulatory use

More information



- David Alvarez
 - dalvarez@usgs.gov
 - 573-441-2970
- SPMD/POCIS “How-To” Guide
 - Techniques and Methods Book 1, Section D, Chapter 4
 - <http://pubs.usgs.gov/tm/tm1d4/>
 - Covers topics of
 - Before heading to the field
 - In the field
 - Back at the lab
 - I have data, now what?