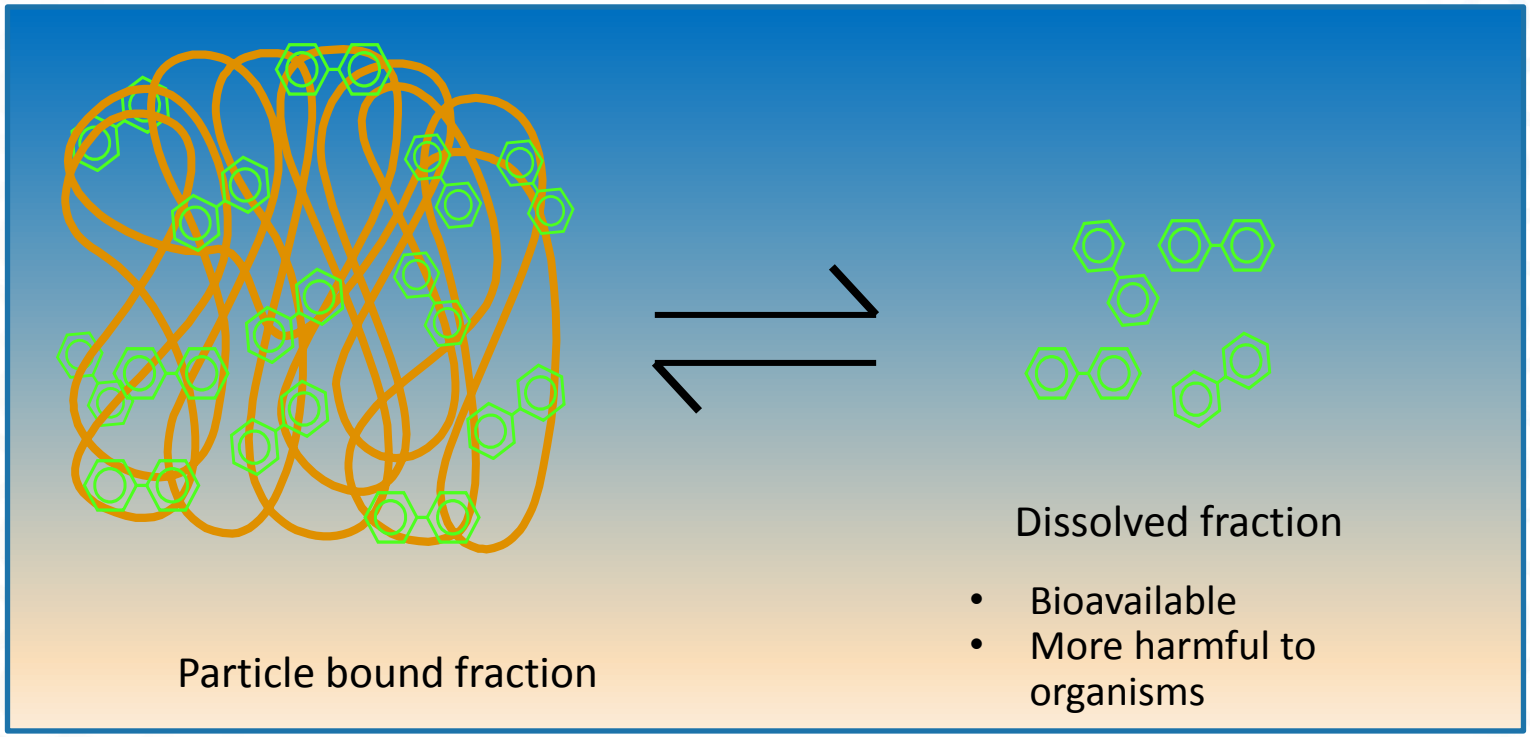
Experience with passive sampling and estimation of pollutant concentrations in water and biota

Nordic WFD Conference 2019
Heidi Ahkola
SYKE
22.5.2019

SYKE

Harmful chemicals in water



Modified from Mayer, P., 2009.

SYKE

Monitoring techniques

Grab water sampling

- Both particle bound and dissolved fraction of the chemical
- Describes the concentration at certain time
- Depends on the timing of sampling
- Low concentrations require high sampling volume
  - Cypermethrin: 0.008 ng/L; AA-EQS
  - PFOS: 0.065 ng/L; AA-EQS

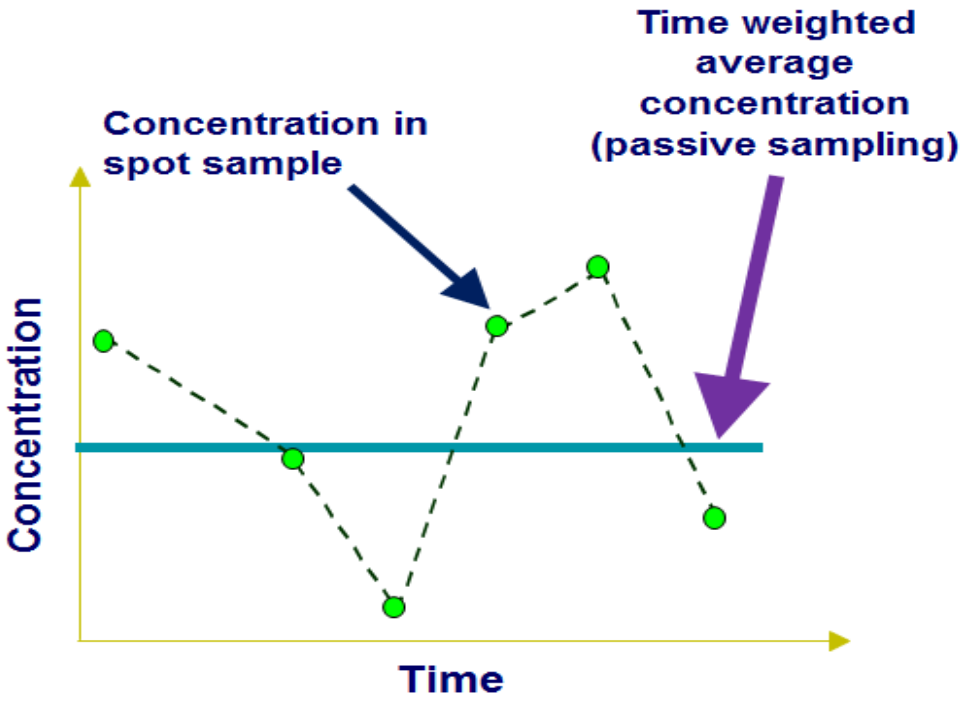
Passive sampling

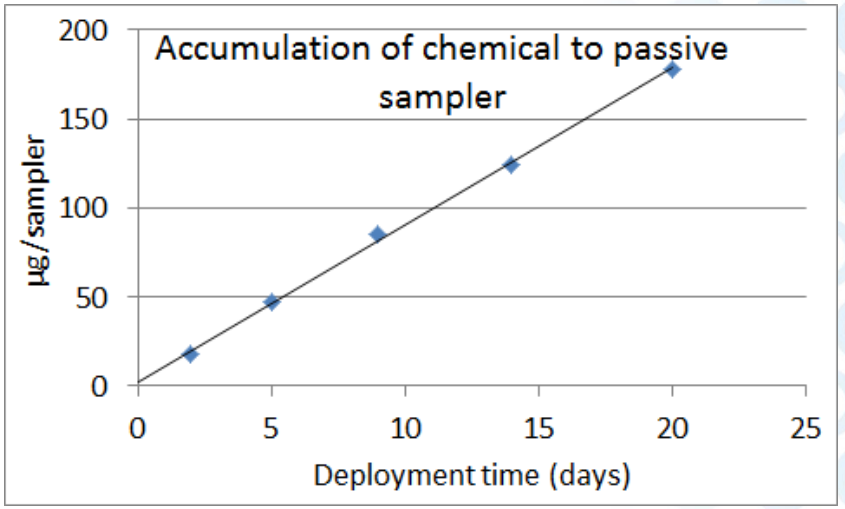
- Dissolved fraction of the chemical
- Average concentration during the deployment time
- Concentrates trace concentrations to measurable level
- Can be shipped to sampling sites via mail

→ Different techniques, differend information

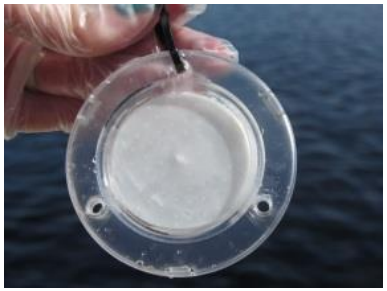
SYKE

Monitoring techniques





Vrana et al. STAMPS meeting, Brussels, 2005

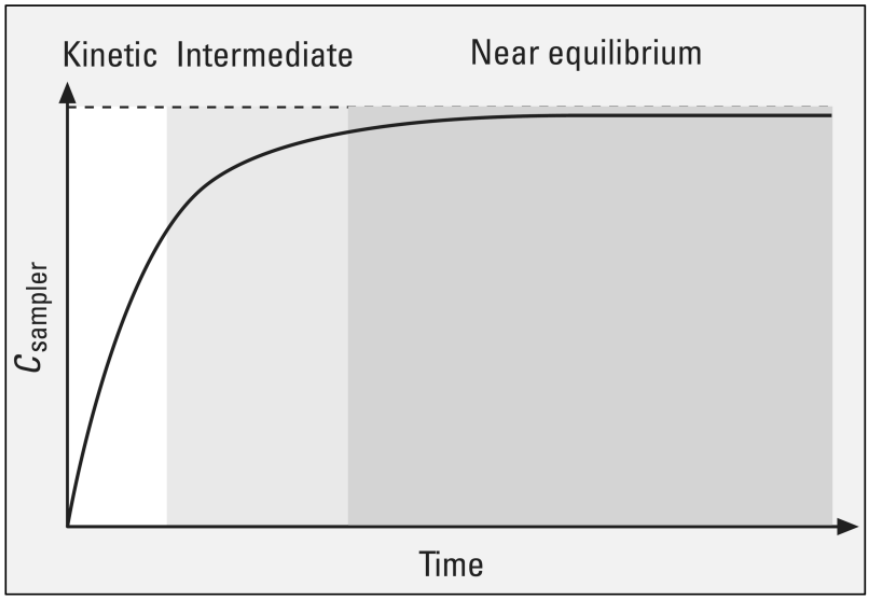


SYKE

Tyoes of passive samplers

- Integrative (kinetic) sampling
  - Measures the time weighted average (TWA) contaminant concentrations over extended time
  - Needs calibration (determination of sampling rate)
    - Sampling rates can be found from the literature

- Equilibrium sampling
  - Sampling period needs to be sufficiently long to establish thermodynamic equilibrium between the water and the sorbent phase of the sampler
  - Sampler-water distribution coefficient enables the calculation of the analyte concentration in the sampled medium



Mayer, P., Tolls, J., Hermens, J.L.M., and Mackay, D., *Environ. Sci. Technol.*, 37(9): 184A–191A (2003).

SYKE

Some passive samplers

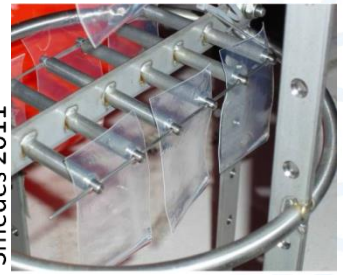
- Polar Organic Chemical Integrative Sampler (POCIS)
- SorbiCell
- Diffusive gradients in thin films (DGT)
- Chemcatcher
- Semipermeable Membrane Devices (SPMD)
  - LDPE, cellulose
  - triolein, hexane
- Silicone sheet (PDMS)
- EVA (ethylene vinyl acetate)


http://www.sorbisense.com/


http://www.est-lab.com/


https://www.dgtresearch.com/


http://www.est-lab.com/


Smedes 2011


Leppänen et al. 2011


Leppänen et al. 2010

SYKE

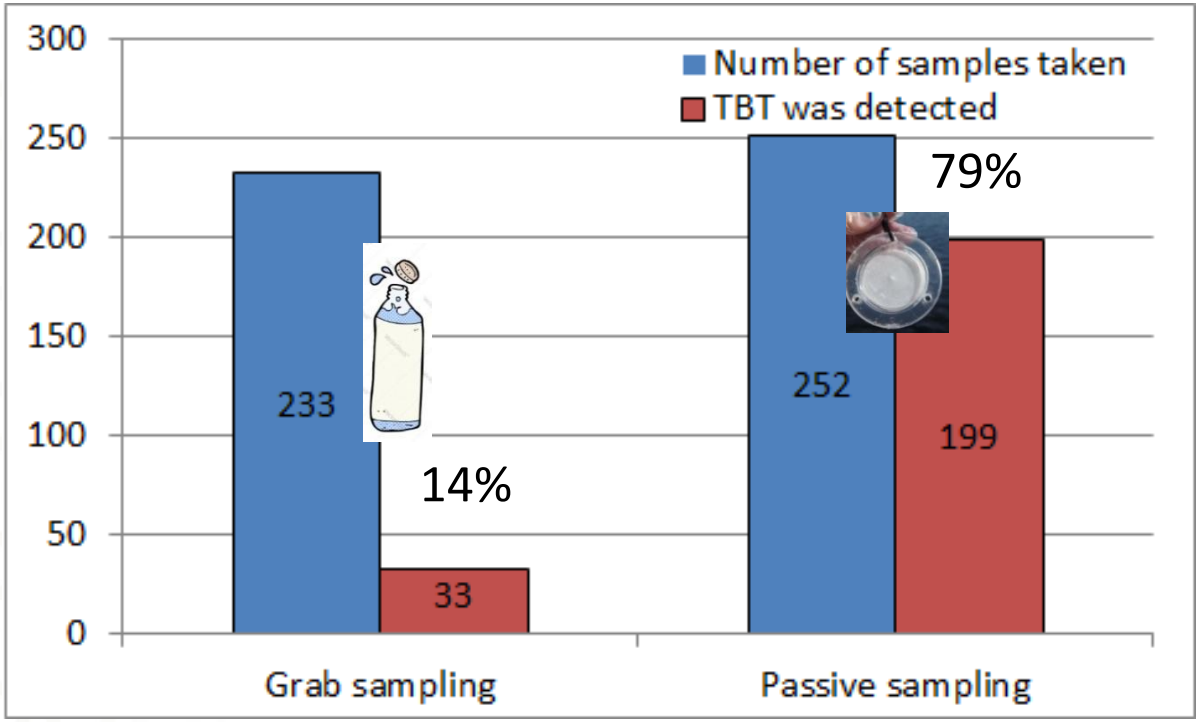
Passive sampling in SYKE

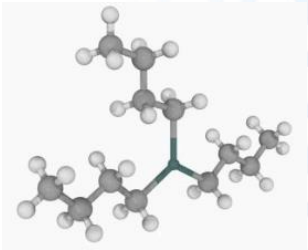
Compound	Sampler	Matrix
Metals	Chemcatcher	Surface water
Organotin compounds	Chemcatcher, PDMS	Surface and waste water
PAHs	PDMS	Surface water
Pesticides	Chemcatcher	Surface water
Pharmaceuticals	Chemcatcher	Surface water
Poly- and perfluorinated compounds (PFAS)	POCIS	Surface water
VOCs	iFlux, SorbiCell	Groundwater

SYKE

Comparison of sampling techniques

- Tributyltin (TBT) was studied in Lake Päijänne with
  - Passive sampling
  - Grab water sampling

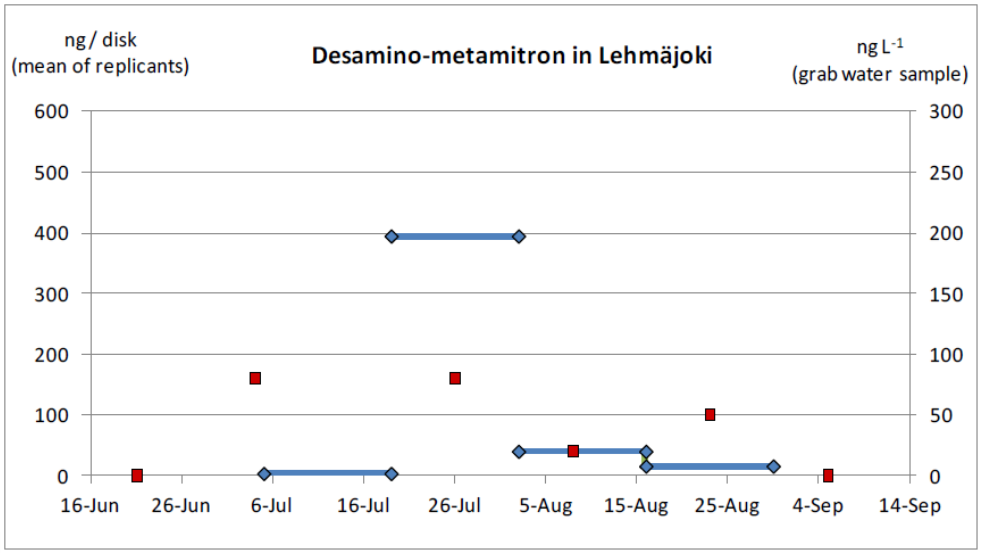


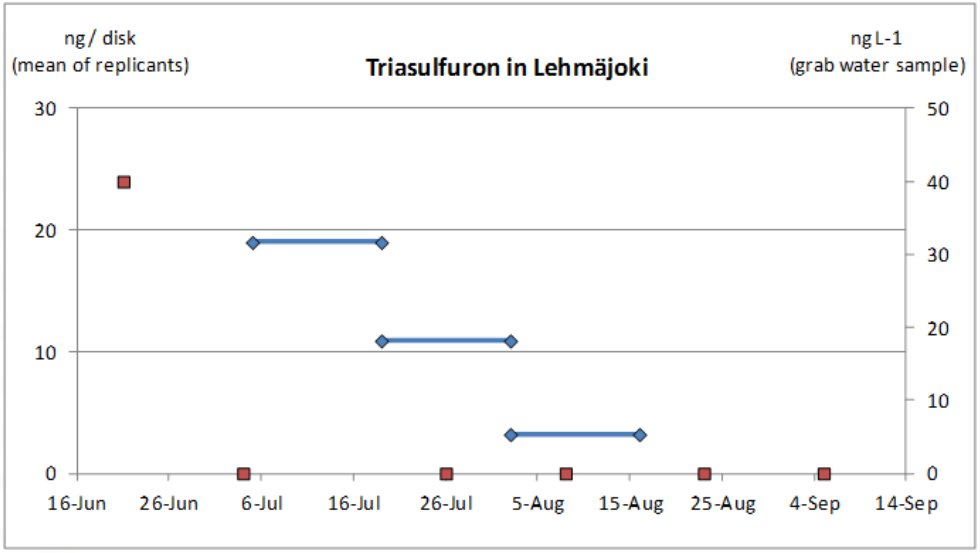


- The prescence of TBT cannot be ensured with grab samples

SYKE

Passive sampling vs. grab sampling





SYKE

Biota and passive sampling

- Biological sampling, difficulties to get e.g. fish samples
- Passive sampling can mimic accumulation to biota
- WFD pollutants studied from biota (fish) in Finland

Substance	Example of the suitable passive sampler
Dioxins	SPMD
Hg	DGT, SorbiCell
PAH	PDMS, SorbiCell
PBDE, HBCD	PDMS, SPMD
PCB and OCP	SorbiCell
PFOS	POCIS, SorbiCell
TBT	PDMS

SYKE

Remarks

- Low concentrations can be enriched to measurable level
- Concentration peak increases the average concentration

- Combining passive sampling and biotesting
- Freely dissolved chemical fraction collected with samplers
  - Biotesting with grab samples can overestimate the toxicity

- EC 2009: Guidance on the surface water chemical monitoring under the water framework directive. Guidance document No. 19.
- EC 2013: Directive 2013/39/EU
- EC: Working Group Chemicals

SYKE

Thank you

More information:

Heidi Ahkola
Finnish Environment Institute
email. Heidi.Ahkola@ymparisto.fi
p. +358 29 5251 053

Matti Leppänen
Finnish Environment Institute
email. Matti.T.Leppanen@ymparisto.fi
p. +358 295 251 368

SYKE