Passive sampling for contaminant monitoring

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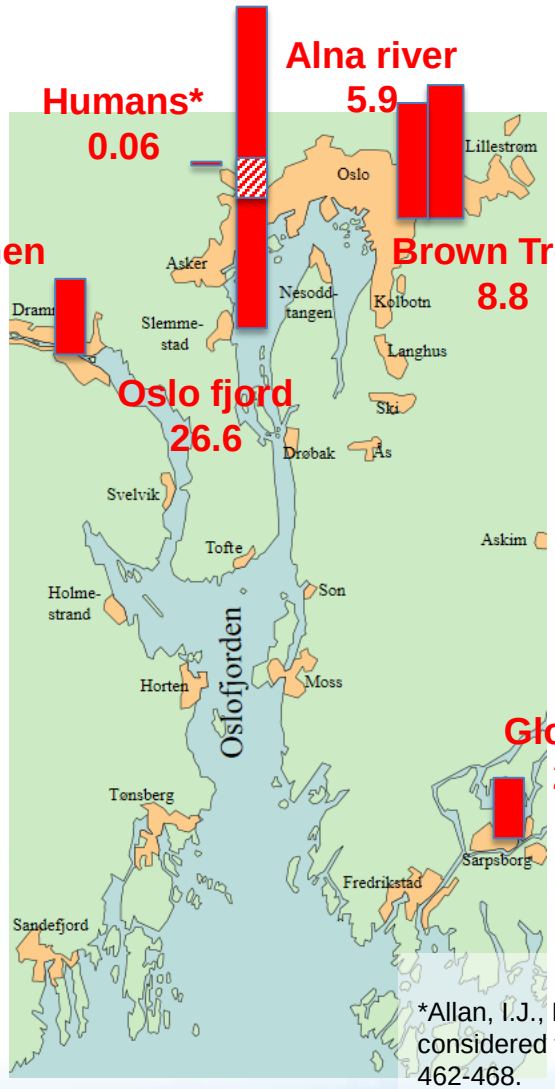
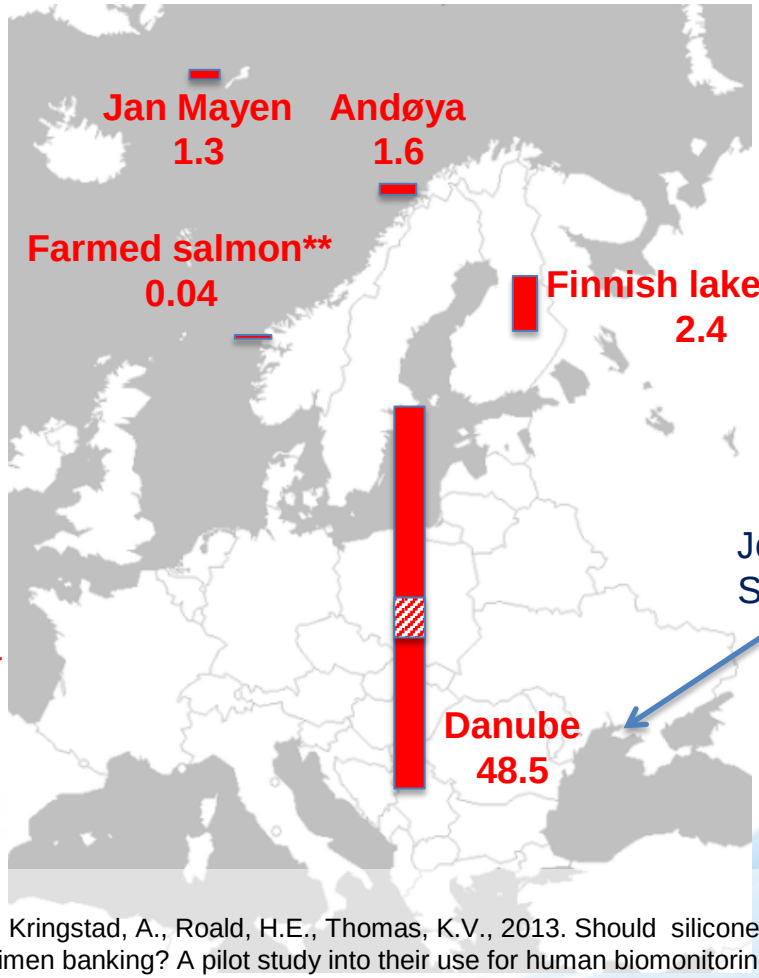
Passive sampling

- For integrative and/or equilibrium sampling
- Applicable to sampling in air, biota, sediments and water
- Data can be expressed as:
  - C_{free} (ng L^{-1})
  - $C_{pol,equil}$ (i.e. ng g^{-1} silicone rubber)
  - $C_{lip,equiv}$ (i.e. ng g^{-1} lipid)
- At equilibrium, concentrations measured in the polymer are proportional to the activity/fugacity of the chemical in the medium being sampled
- Use of performance reference compounds (PRCs) to estimate contaminant exchange kinetics between the sampler and medium being sampled

$C_{pol,equil}$ for CB28 (ng g^{-1} sil rubber)





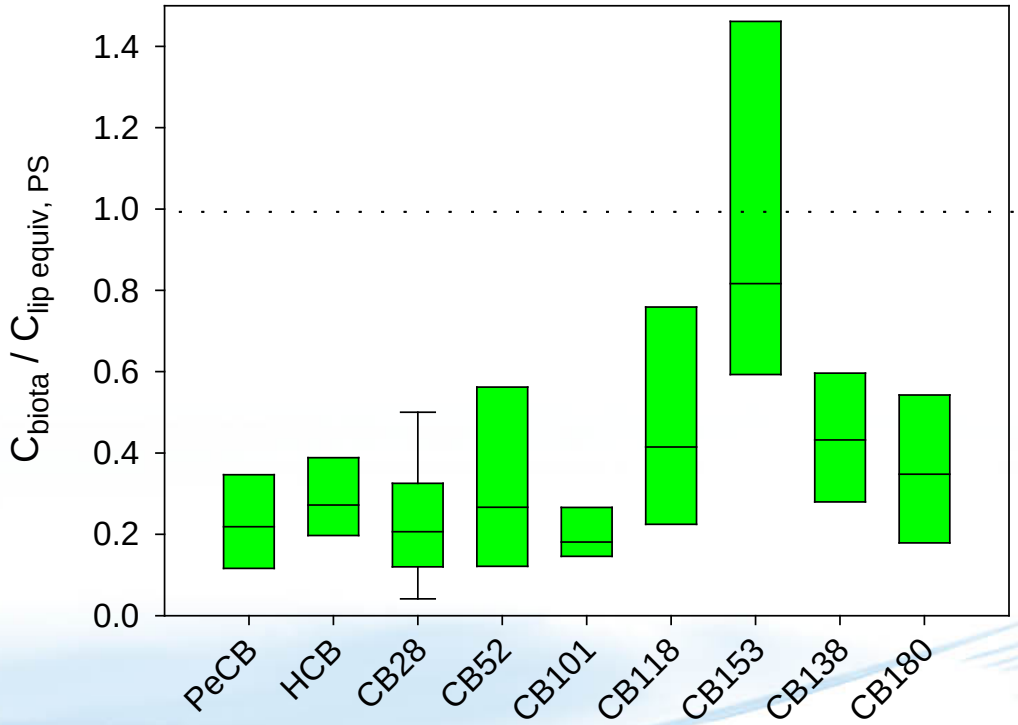
*Allan, I.J., Bæk, K., Kringstad, A., Roald, H.E., Thomas, K.V., 2013. Should silicone prostheses be considered for specimen banking? A pilot study into their use for human biomonitoring. Env Int vol 59, 462-468.

**Jahnke, A., Mayer, P., Adolfsson-Erici, M., McLachlan, M.S., 2011. Equilibrium sampling of environmental pollutants in fish: Comparison with lipid-normalized concentrations and homogenization effects on chemical activityET&C Vol 30, 1515-1521.
(corrected to an AlteSil silicone basis)

Can passive sampling help to understand bioaccumulation?

- Paired PS-cod data (Milkys/TFP)
- Multiple sites and years (from Oslofjord to Jan Mayen)
- $C_{biota}/C_{lip\text{-}equiv}$ ratios < 1 in most cases

$$C_{lip,equiv,PS} = C_{Free} \times K_{sil-w} \times K_{lip-sil}$$



Calibration for emerging contaminants

- 33 chemicals of emerging concern (CECs)
- Focus on using single phase samplers (silicone rubber and LDPE)
- Polymer calibration*:
  - Polymer diffusion coefficients, D_p with a film stack experiment
  - Polymer-water partition coefficients, K_{pw} measurement with validation using a co-solvent method

*Pintado-Herrera, Lara-Martín, González-Mazo, and Allan. Determination of silicone rubber and low density polyethylene diffusion and polymer-water partition coefficients for emerging contaminants. *In press in ET&C*, 2015

Calibration data for 33 CECs

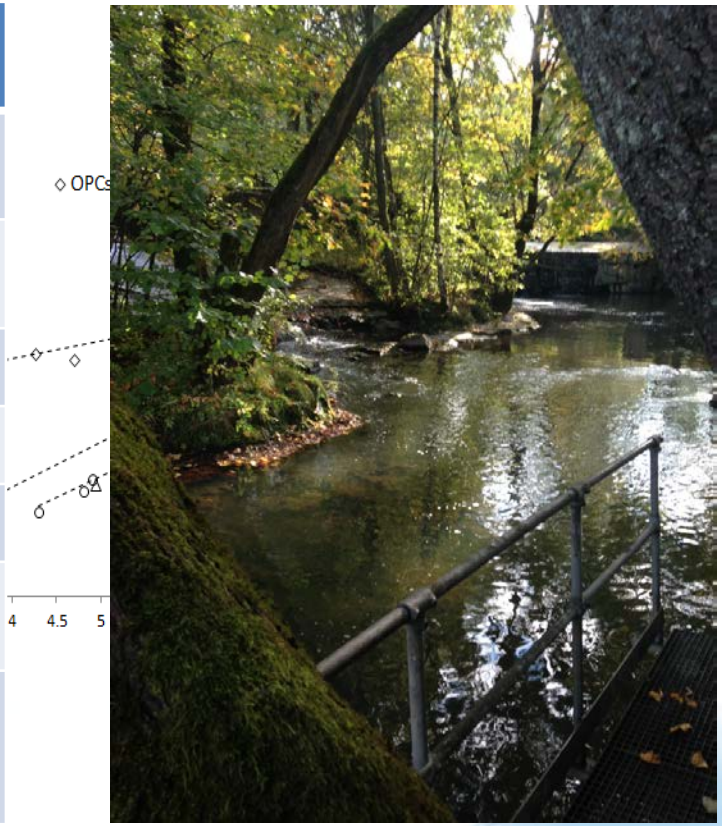
Example of measurement in the River Alna

$\log D_p$

A

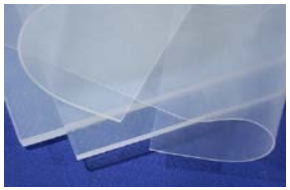
Silicone rubber

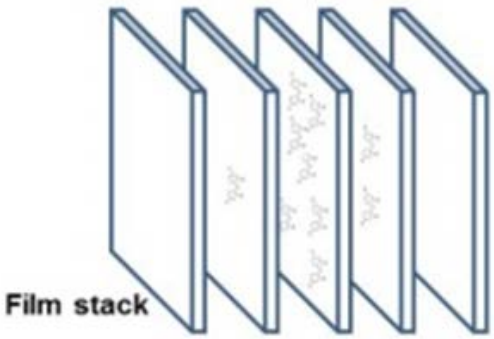
Chemical		C_{free} (ng L^{-1})
Galaxolide	Synthetic musk	1600
Tonalide	Synthetic musk	51
Oxybenzone	UV filter	108
Octocrylene	UV filter	448
Triclosan	Antibacterial	9
2-ethylhexyl-4-methoxycinnamate	UV filter	4
Triphenylphosphate	Flame retardant/plasticiser	170

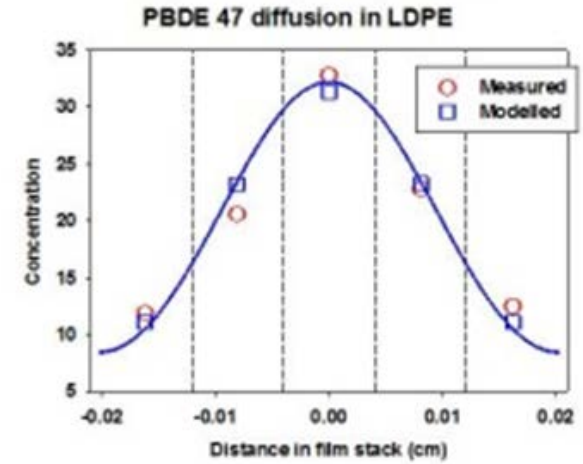


▲ Endocrine disruptor compounds
● UV filters
◆ Fragrances
■ OPCs
▫ UV filters out-of-range
○ OC pesticides (Hale et al. 2010)
+ OPCs lower detection limits

Polymer selection for passive sampling*



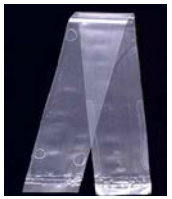




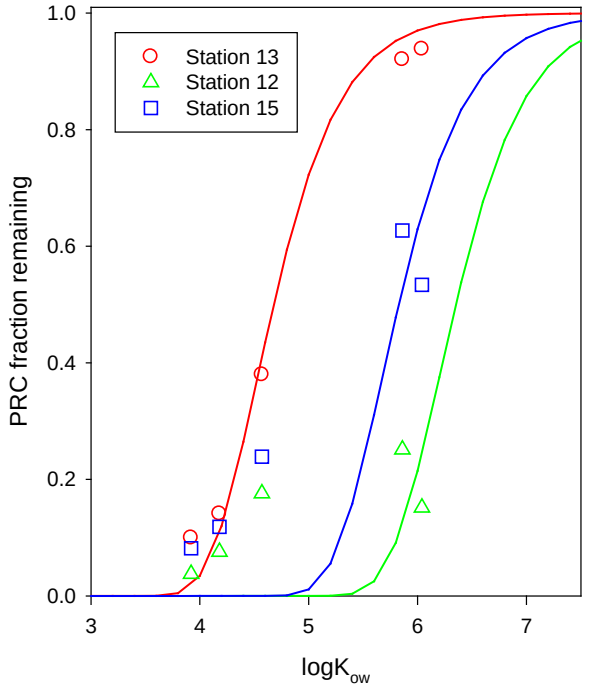
- PBDE diffusivities highest in silicone rubber
  - Simplest modelling and estimation of sampling rates
- Low to very low diffusion coefficients in LDPE
  - Relevance of taking into account transport of chemical additives within **microplastic particles** when assessing the risk these pose to aquatic organisms

*Narváez Valderrama, Baek, Molina, Allan. Implications of observed PBDE diffusion coefficients in low density polyethylene and silicone rubber. *In press in ESPI*, 2016

Effect of environmental conditions: Photodegradation in SPMDs



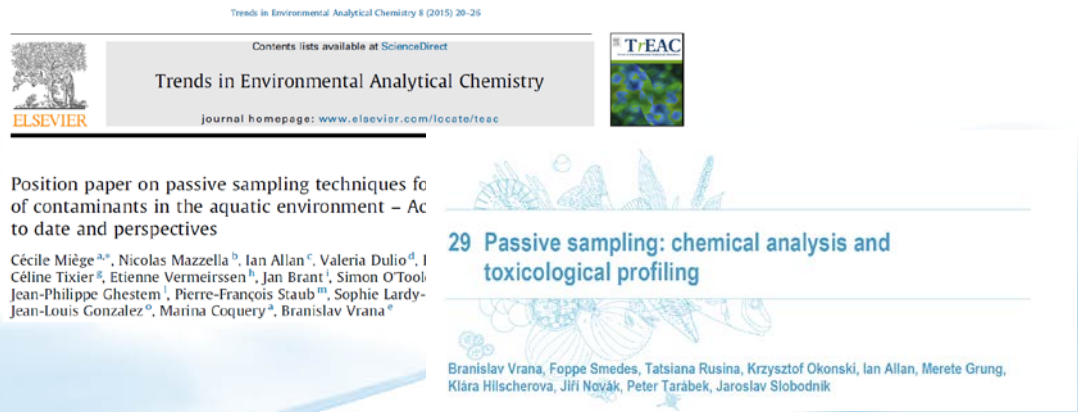
- SPMDs deployed for 36 days in the sea around Harstad in May-June
- Unconventional losses of PRCs (deuterated PAH)
- Related to depth
- Can impact masses absorbed in samplers for photosensitive substances



Allan, Christensen, Bæk and Evenset. Photodegradation of PAHs in passive water samplers, *in press in MPB*, 2016

Passive sampling activity of the NORMAN association

- NIVA lead of PS activity (2015-)
- Report of the Joint Danube Survey 3 (2013-2015)
  - Active-passive sampling along the entire Danube river
- Position paper: outcome of workshop in Lyon (Fr)
- Proposed activity for 2016
  - Development of a module to input PS data into the NORMAN database



Way forward

- Need for further developments for PS of polar and ionised substances
- Continued development of robust PS calibration data (K_{sw}, D_p, $K_{lip\text{-}sil}$)
- Further understand factors that affect contaminant uptake into aquatic organisms
  - Develop long-term paired PS-biota datasets
- Use for screening for new/unknown contaminants