

A novel active-passive sampling approach for monitoring a broad range of pollutants in water

Elvio Amato, Raewyn Town, Adrian Covaci,
Ronny Blust



Sphere

Systemic Physiological & Ecotoxicological Research
University of Antwerp

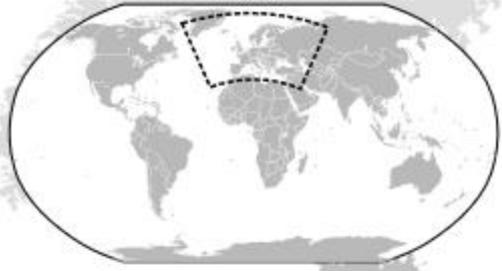


Toxicological Centre

University of Antwerp



University
of Antwerp



WIKIPEDIA
The Free Encyclopedia

- [Main page](#)
- [Contents](#)
- [Featured content](#)
- [Current events](#)
- [Random article](#)
- [Donate to Wikipedia](#)
- [Wikipedia store](#)

- Interaction
- [Help](#)
- [About Wikipedia](#)
- [Community portal](#)



Article [Talk](#)

[Read](#) [Edit](#)

Flanders

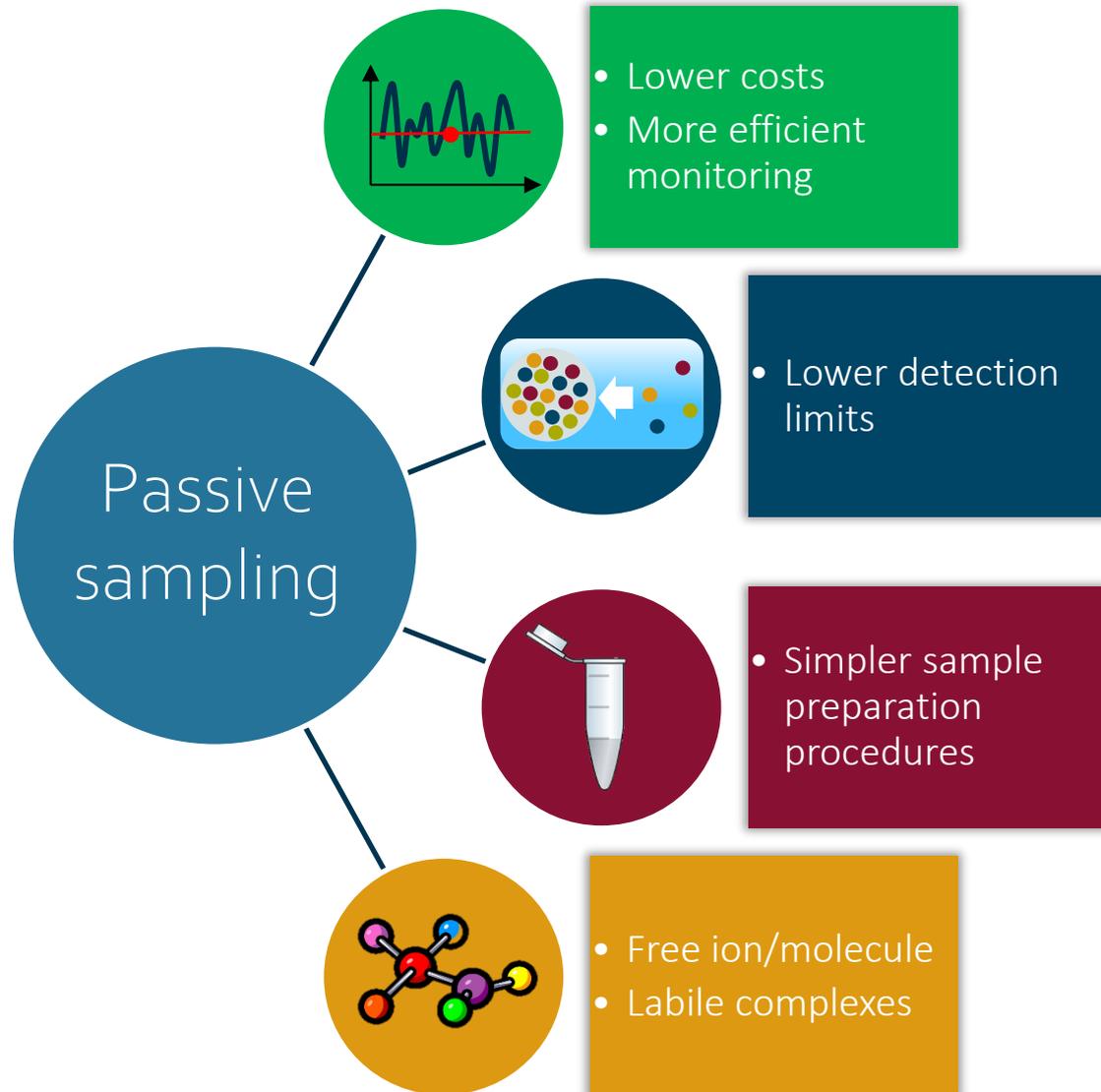
From Wikipedia, the free encyclopedia

"Flandre" and "Flandern" redirect here. For the ship Flandre, see SS Flandre. For

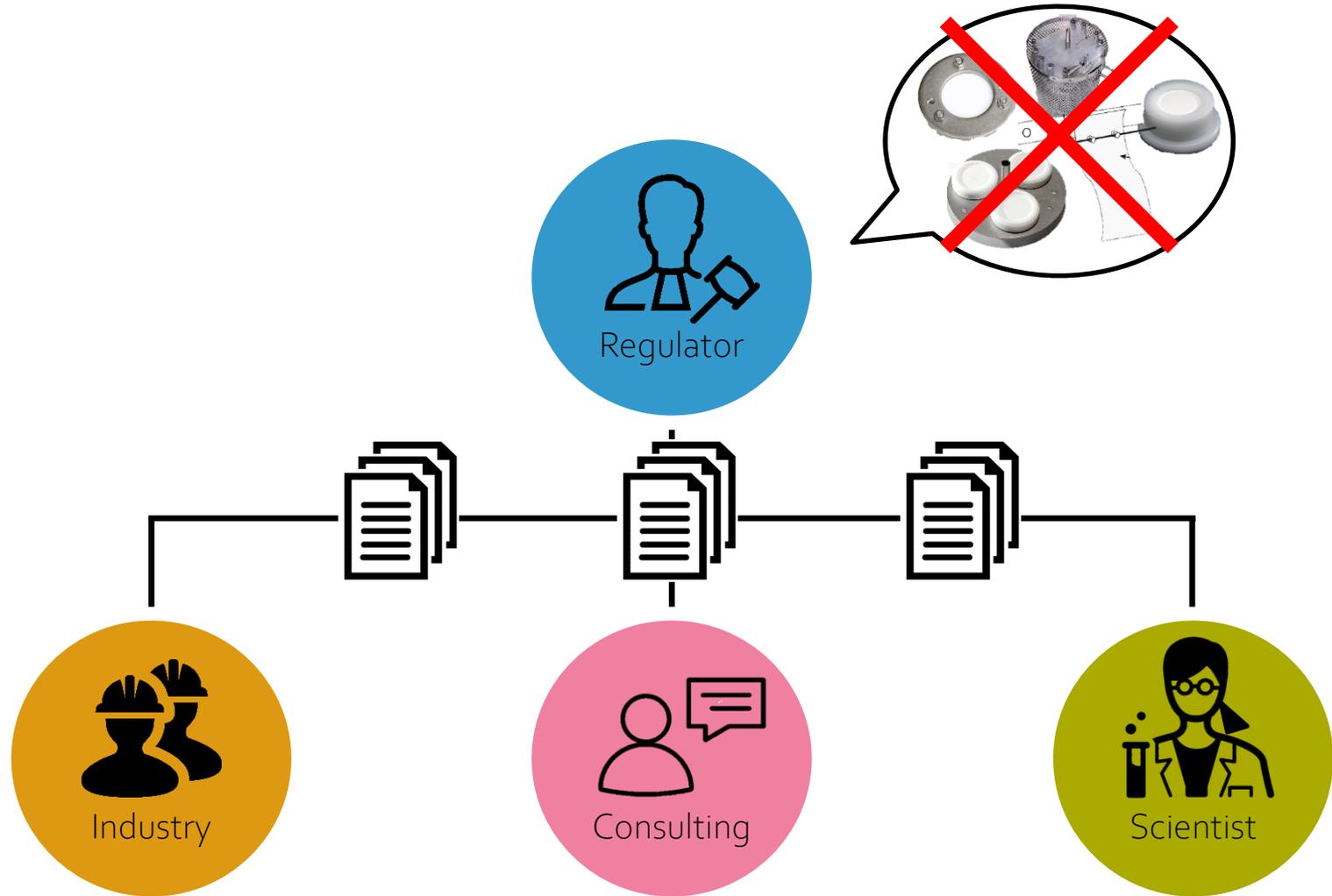
Flanders (UK: /ˈflɑːndərz/, US: /ˈflæn-/; Dutch: *Vlaanderen* [ˈvlaːndərə(n)] [ⓘ] [ⓘ] listen); French: *Flandre* [flɑ̃drɛ]; German: *Flandern* [ˈflandɛn] [ⓘ] [ⓘ] listen) is the Dutch-speaking northern portion of Belgium and one of the communities, regions and language areas of Belgium. However, there are several overlapping definitions, including ones related to culture, language, politics and history, and sometimes involving neighbouring countries. The demonym associated with Flanders is Fleming, while the corresponding adjective is Flemish. The official capital of Flanders is Brussels,^[1] although the Brussels Capital Region has an independent regional government, and the government of Flanders only oversees the



Passive sampling advantages



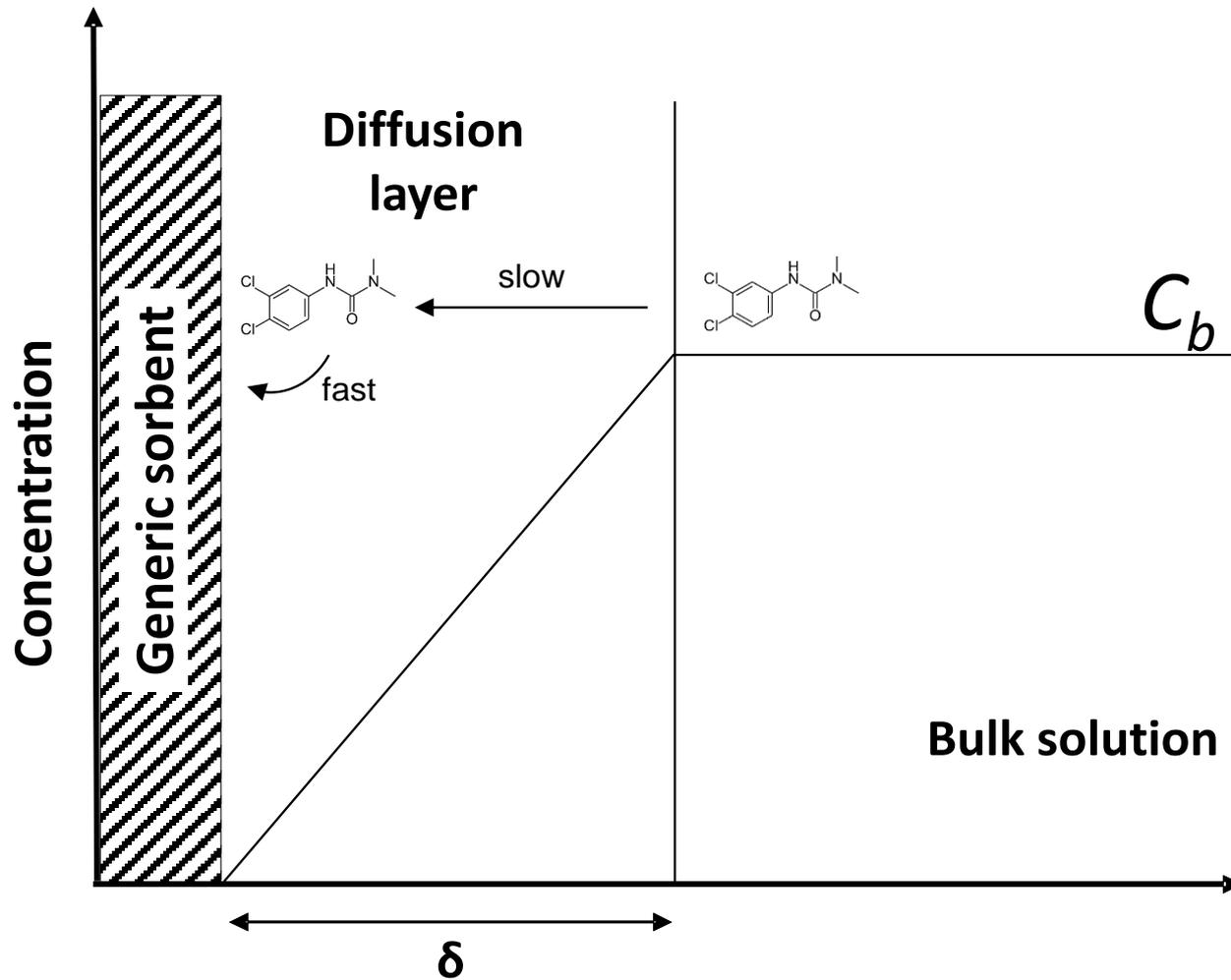
Passive sampling - potential applications



Passive sampling – areas of improvement

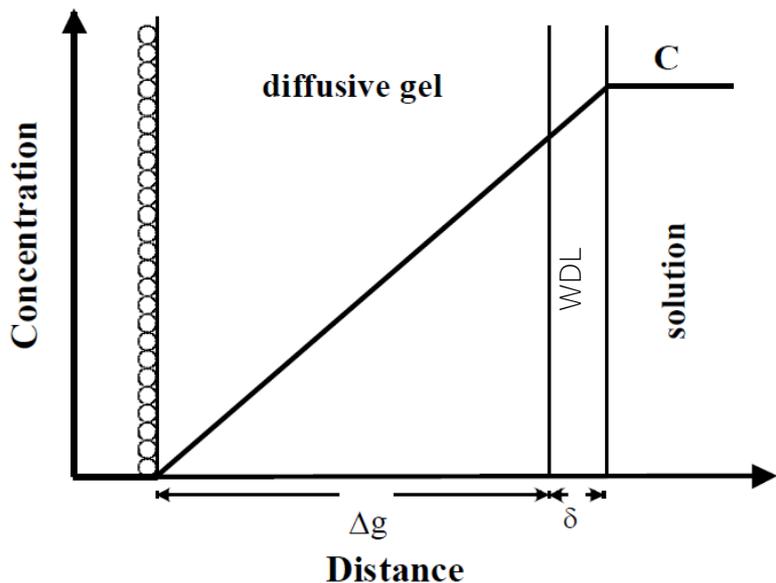
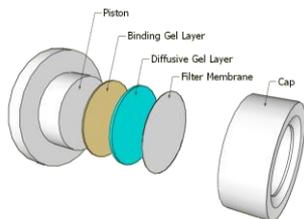
- Quantitative interpretation of passive sampling data
Impact of hydrodynamic conditions on samplers uptake
- Standardization of passive sampling methodologies
Use by commercial laboratories
- Toxicological assessment
Lack of mechanistic links between uptake by passive sampling and aquatic organisms
- QA/QC
Legal aspects

Passive sampling – uptake mechanism



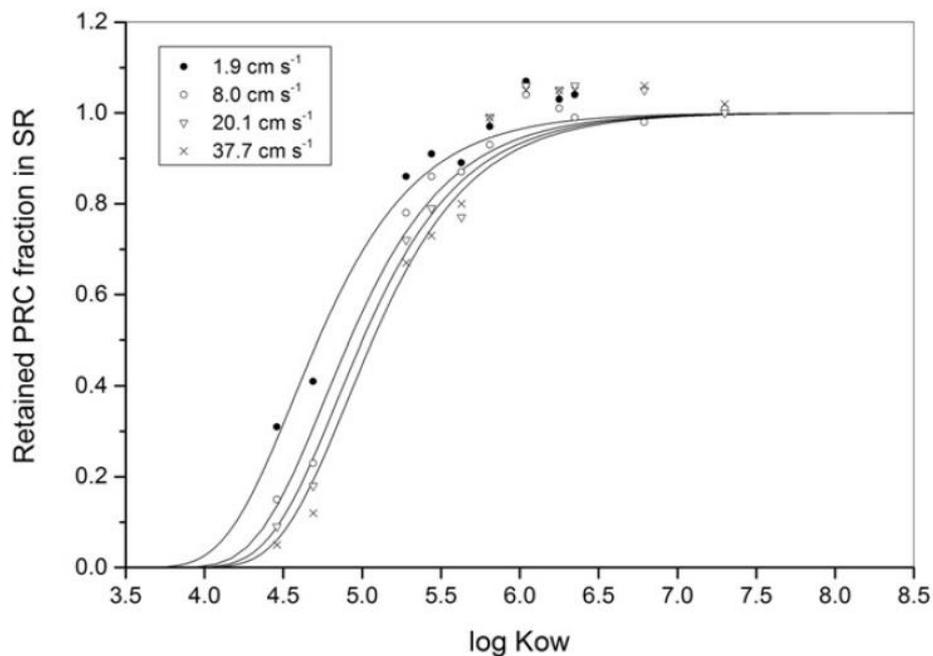
Passive sampling – uptake mechanism

Diffusive gels



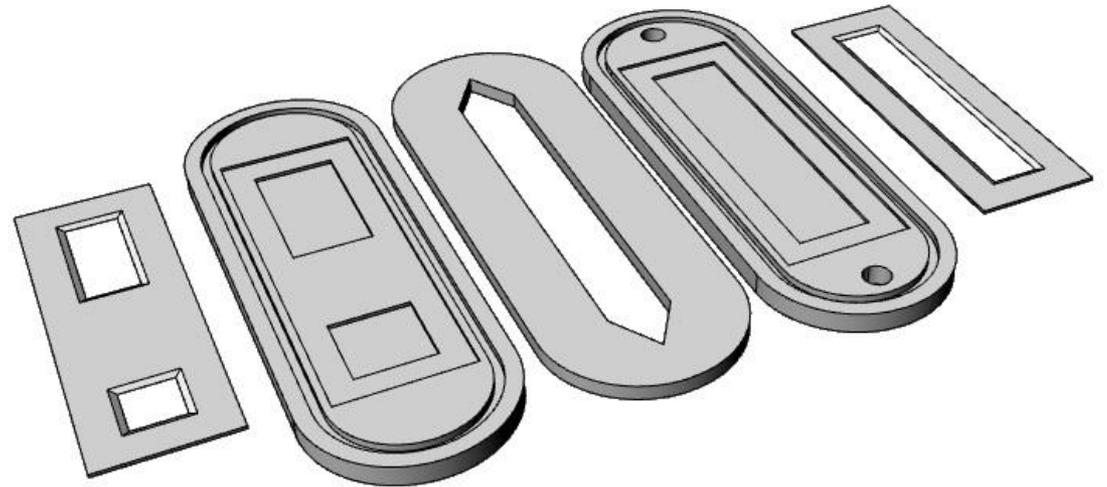
- Not reliable at low flow rates
- Metals/polar organics only

PRC

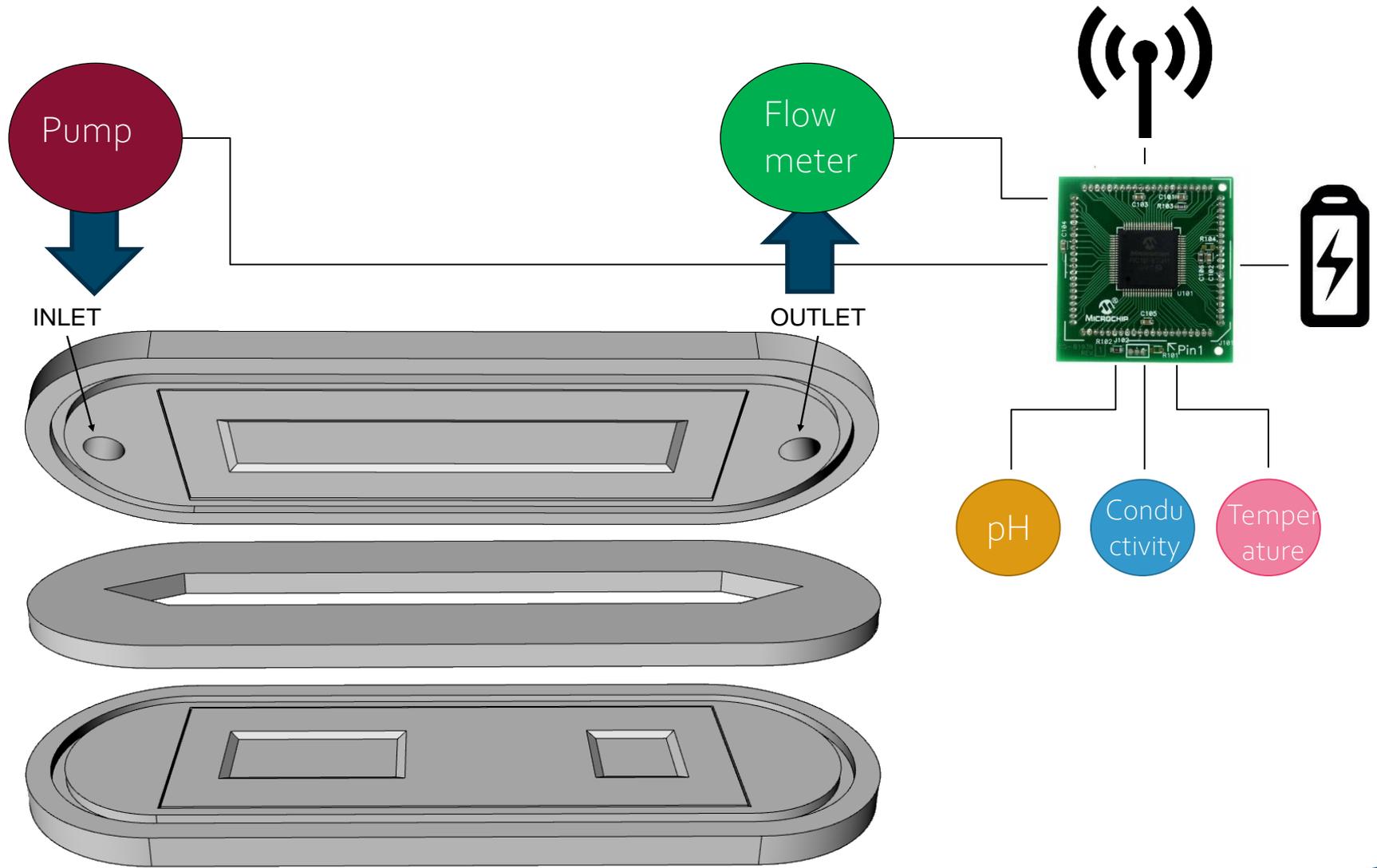


- Non-polar organics only

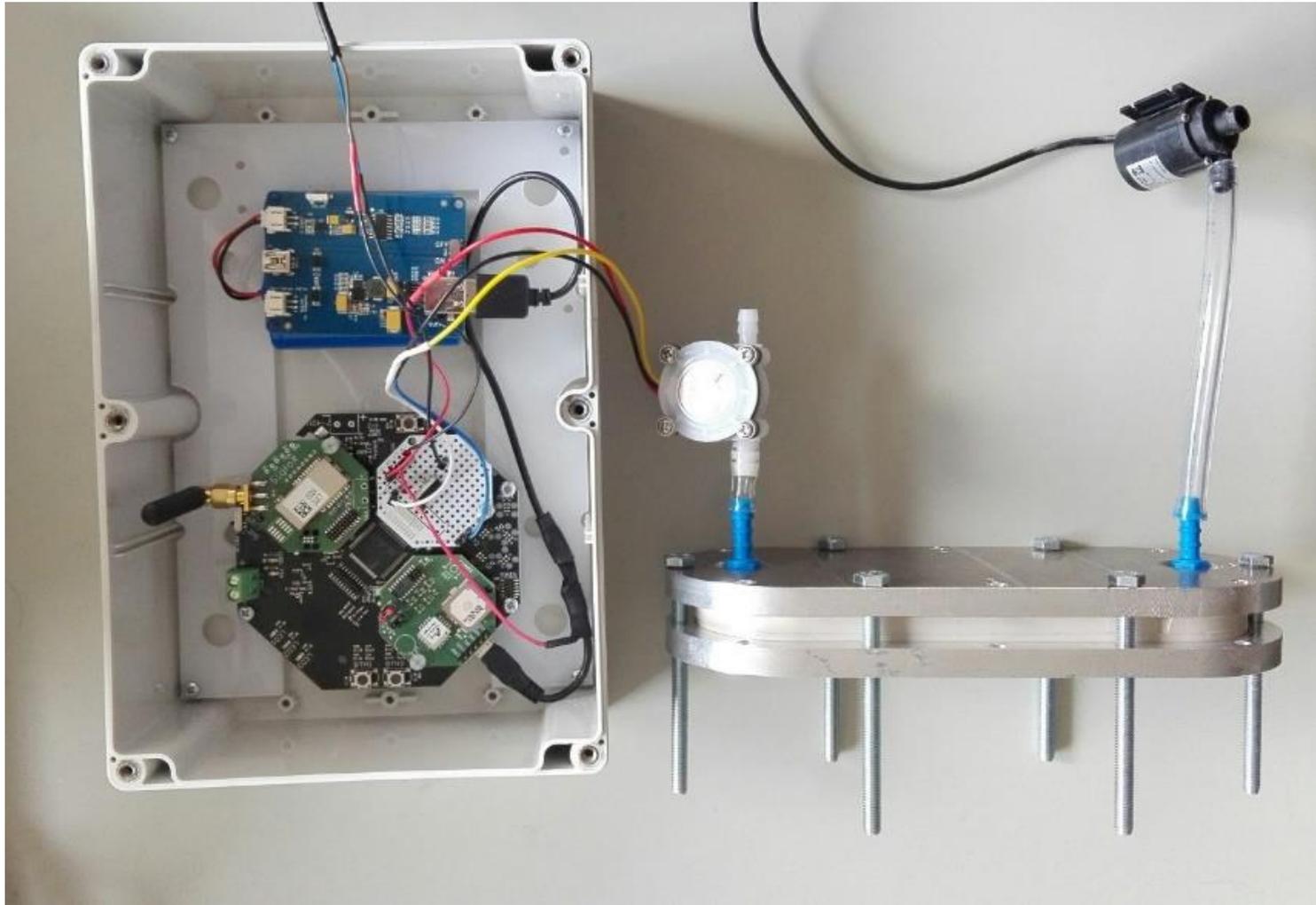
Active-passive sampling (APS) approach



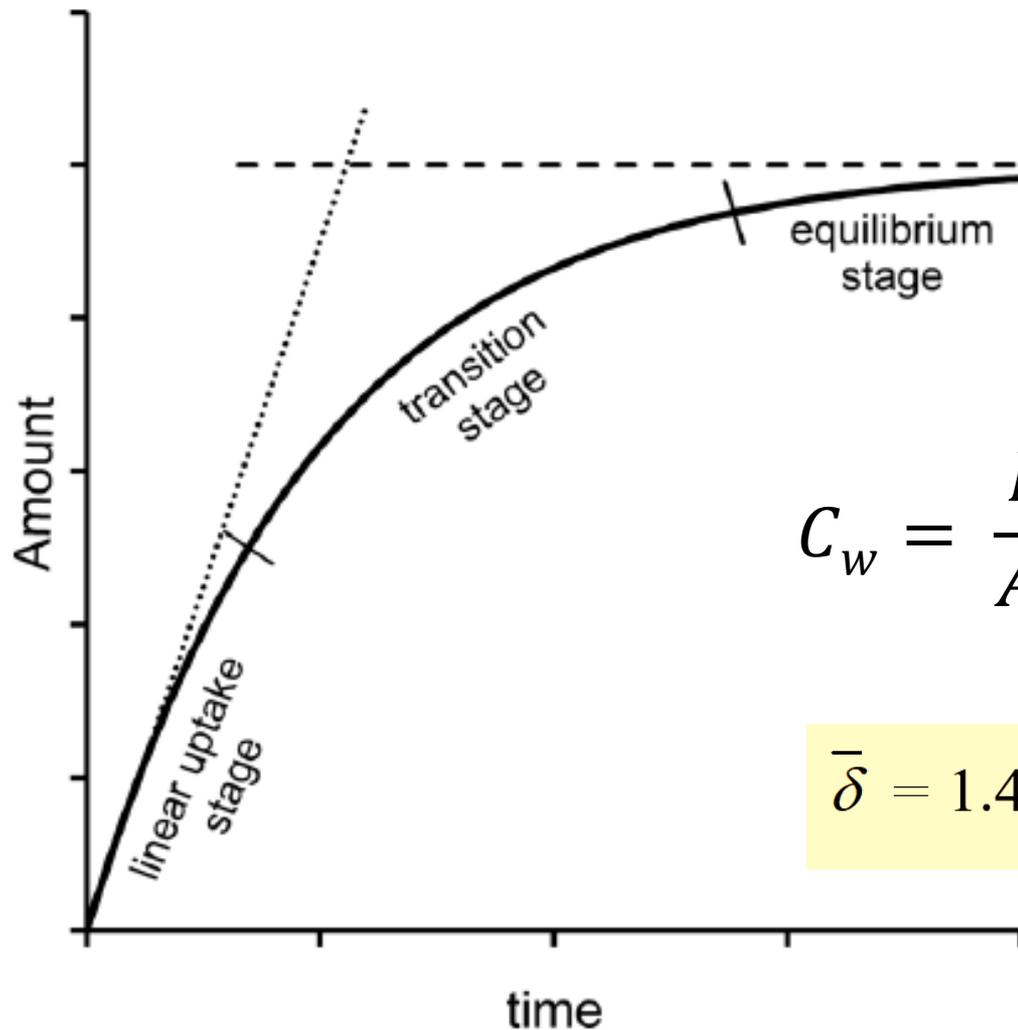
Active-passive sampling (APS) approach



Active-passive sampling (APS) approach



Active-passive sampling (APS) approach



$$C_w = \frac{M\delta}{ADt}$$

C_w = water concentration (ng/L)

M = mass (ng)

δ = water diffusion layer (m)

A = surface area (m²)

D = diffusion coefficient (m²/s)

t = time (day)

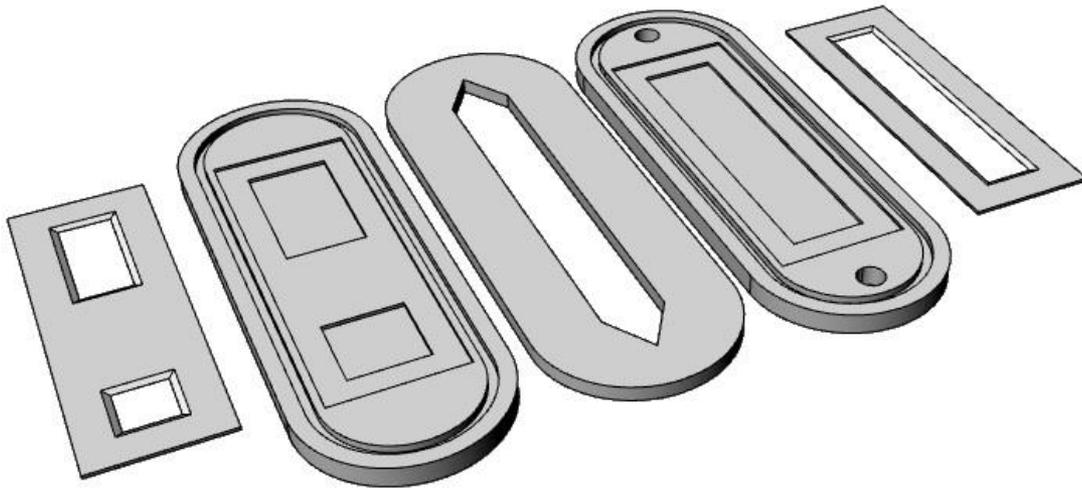
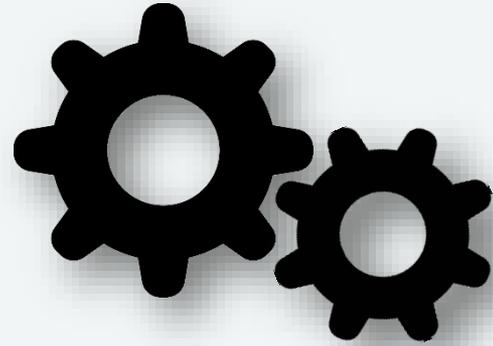
$$\bar{\delta} = 1.4327 (D)^{1/3} d^{1/3} h^{2/3} L^{1/3} \left(\frac{1}{V_f}\right)^{1/3}$$

Laure Tomaszewski and Jacques Buffle, Anal. Chem. 2003

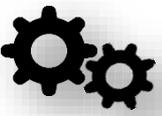
Objectives

1. Characterize δ within the diffusion cell under varying flow conditions
2. Evaluate the performance of the APS device by comparison with discrete water sampling measurements

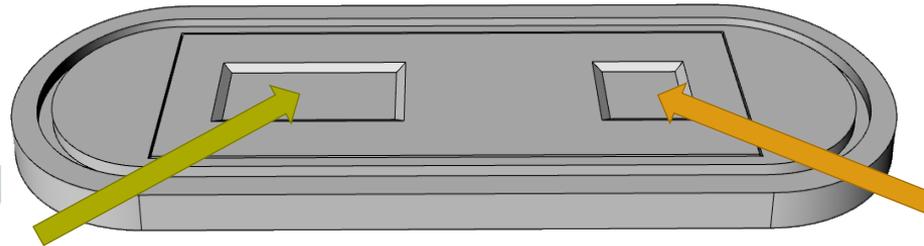
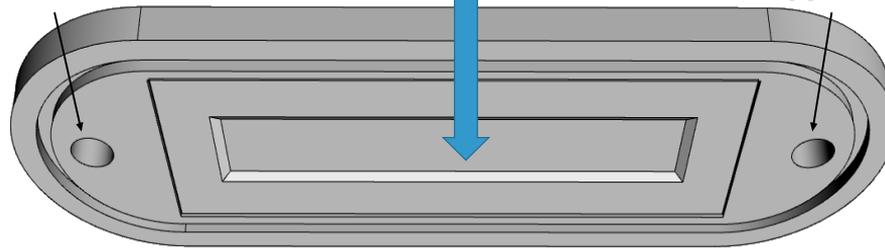
Methodology



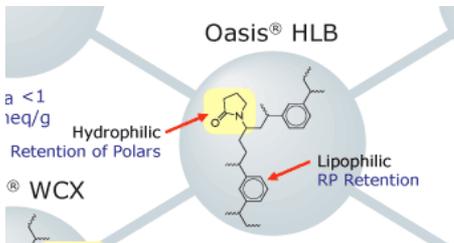
Methodology



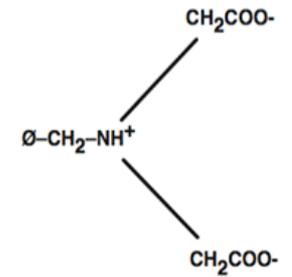
Silicon rubber

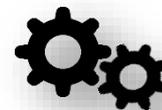


HLB



Chelex



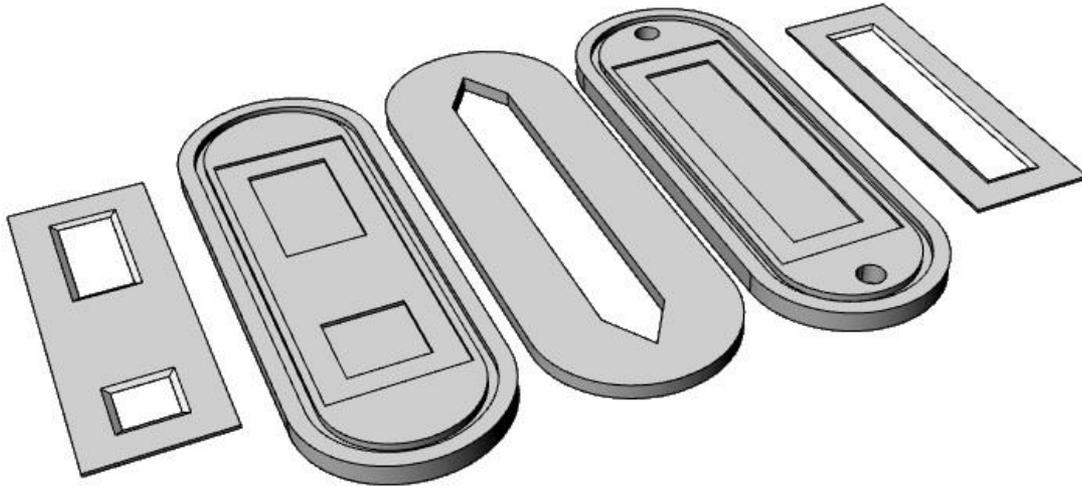


- Exposure medium: medium-hard artificial fresh water
- APS deployment time: 48h ($n = 3$)
- Discrete water samples (DWS) ($n = 7$)
- Flow rates (mL/s): F1 = 4.7; F2 = 6.9; F3 = 9.2; F4 = 4.6; F5 = 5.6; F6 = 7.7; F7 = 8.4
- Different bulk concentrations

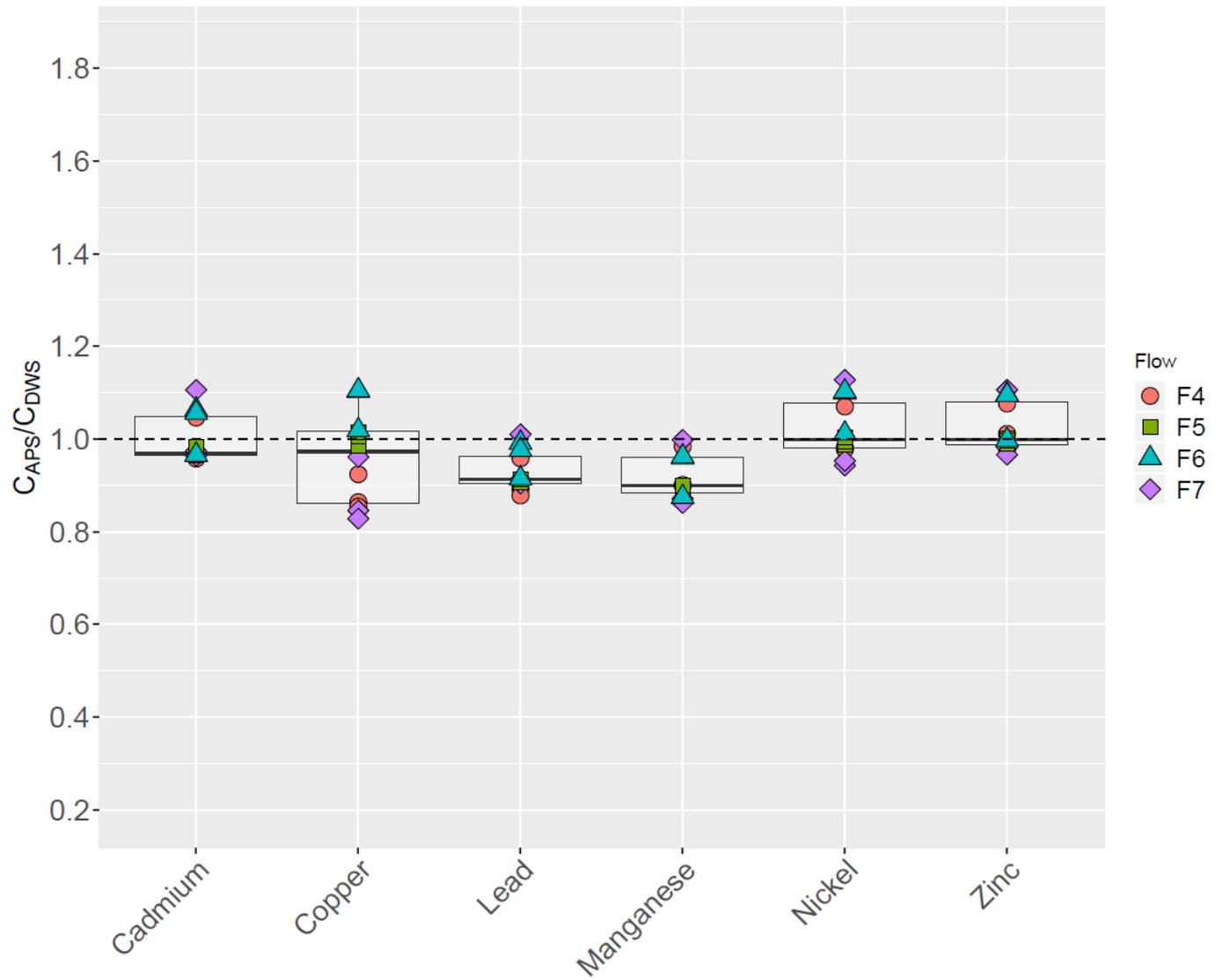
Metals	Concentration ($\mu\text{g/L}$)
Cd, Cu, Mn, Ni, Pb, Zn	5, 15
Polar organics	Concentration (ng/L)
Carbamazepine, diuron, isoproturon	100, 300
Non-polar organics	Concentration (ng/L)
Fluoranthene, heptachlor, hexachlorobenzene, trifluralin, PBCs (CB28, CB52, CB101)	1.8 – 24.0



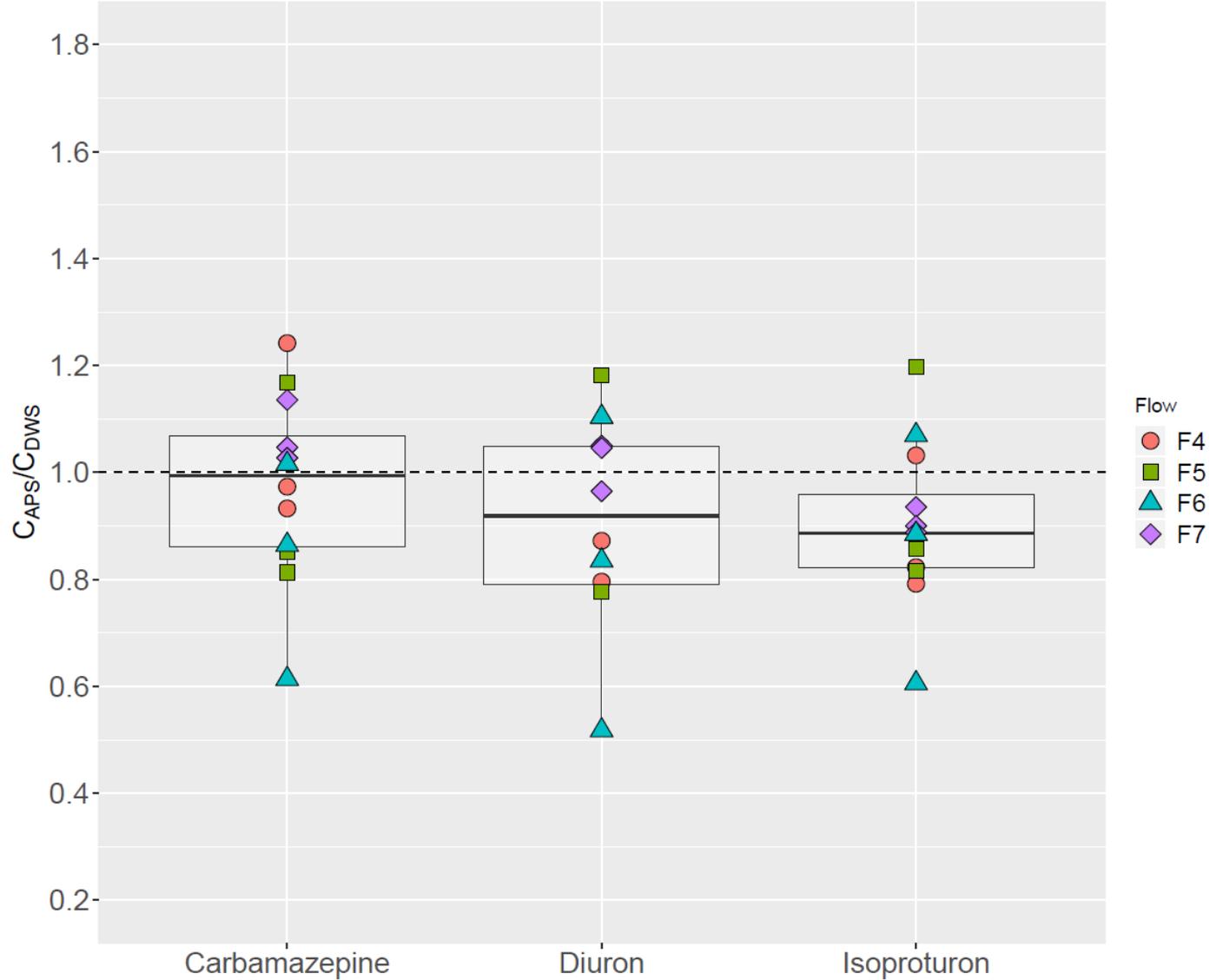
Results



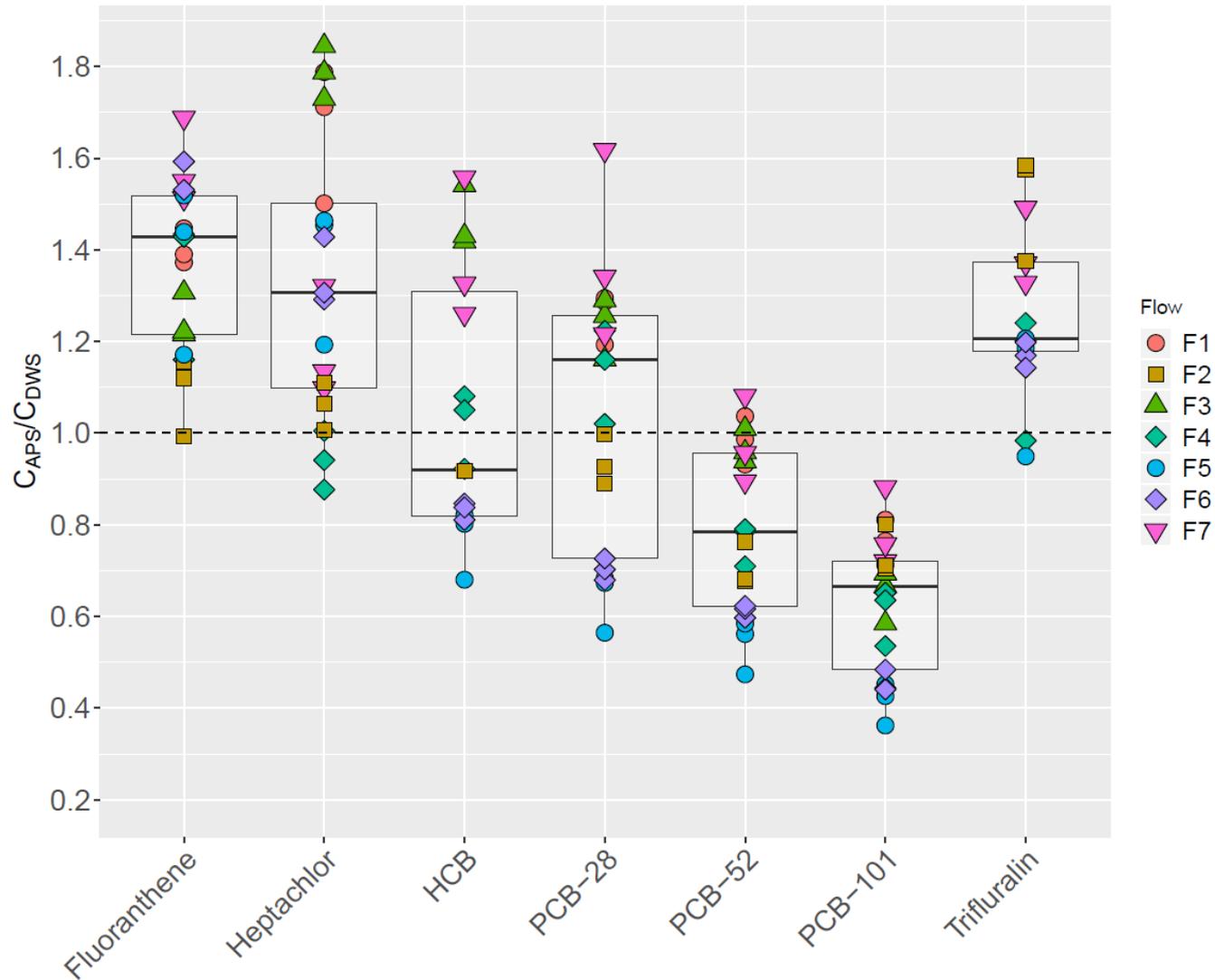
APS vs DWS – metals



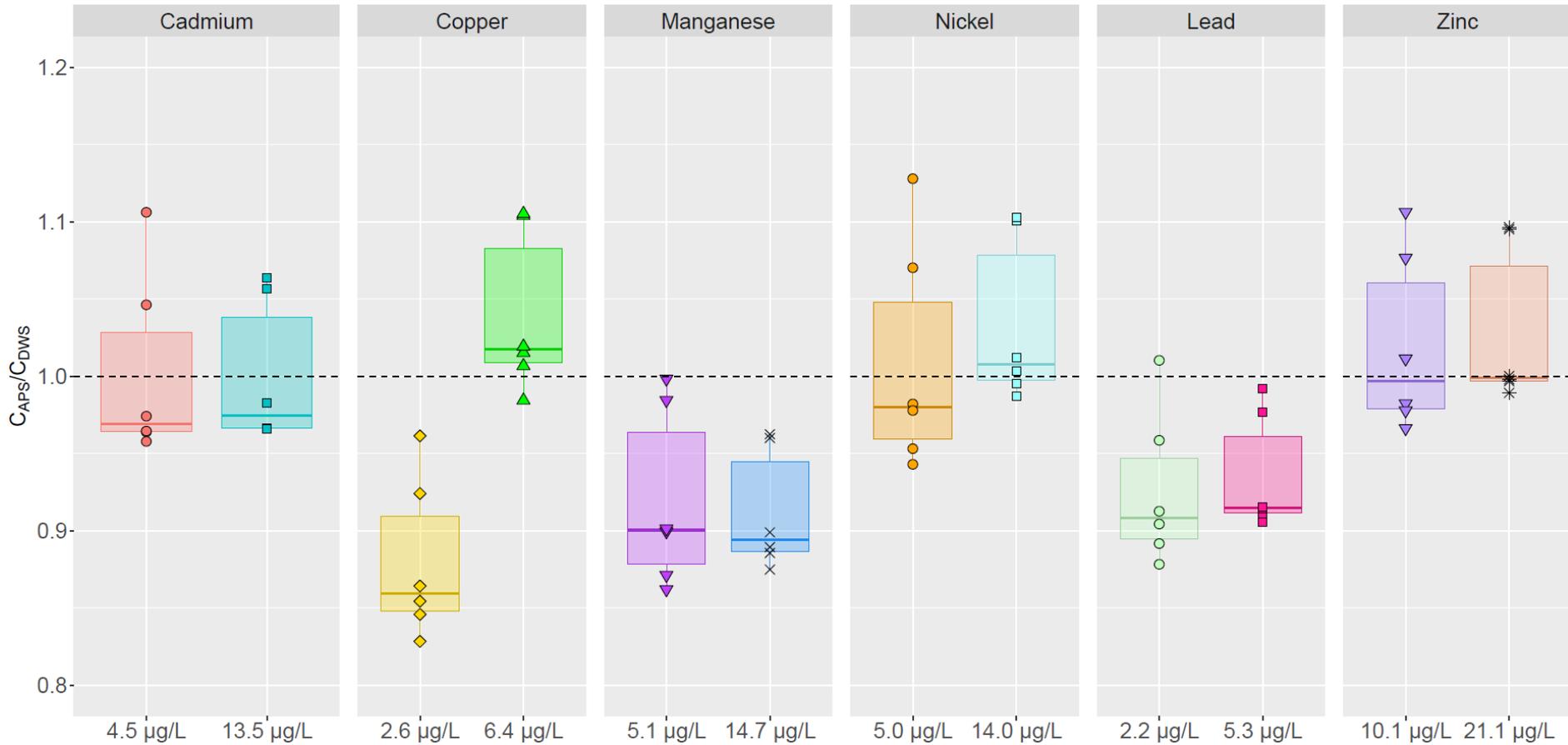
APS vs DWS – polar organics



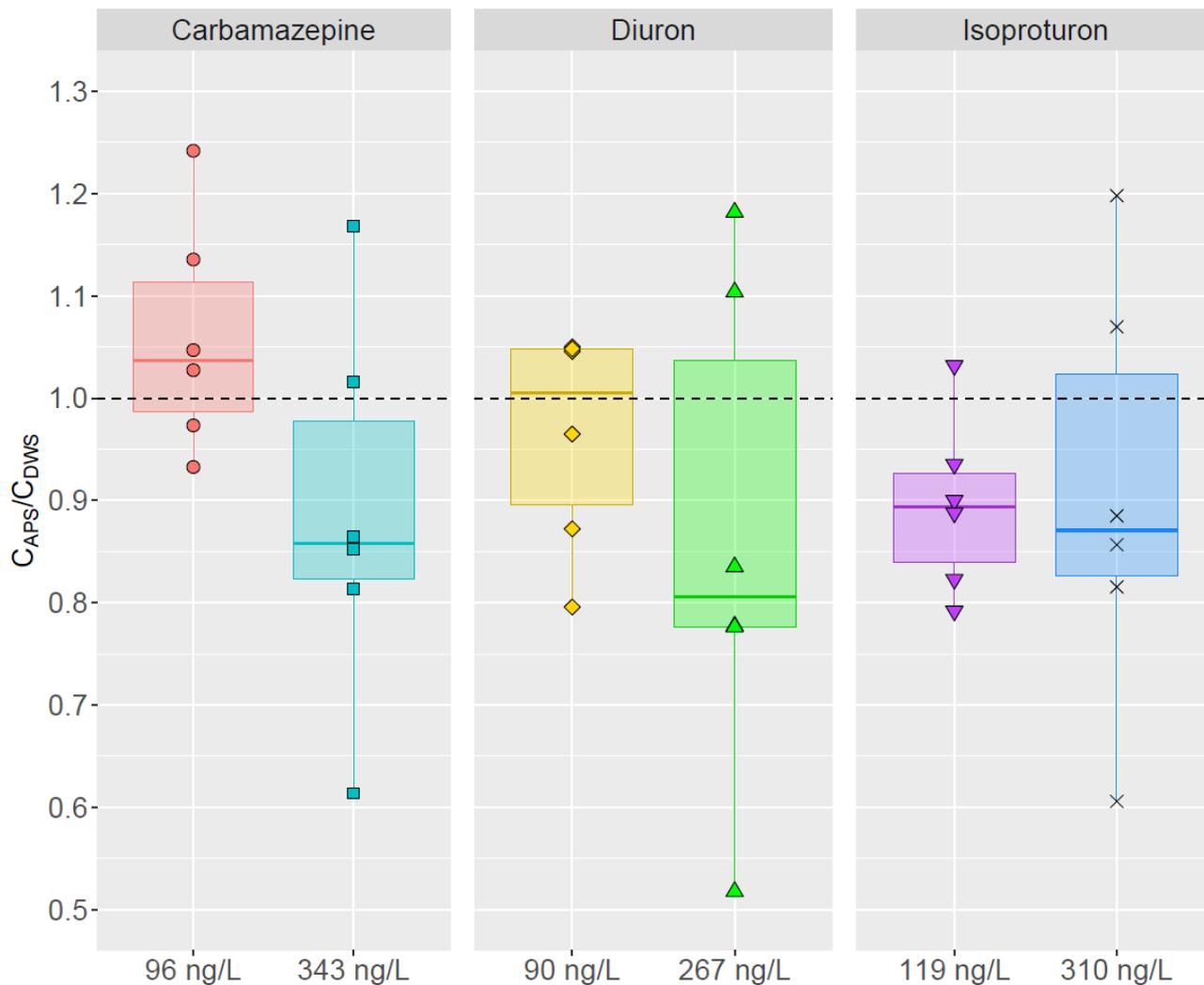
APS vs DWS – non-polar organics



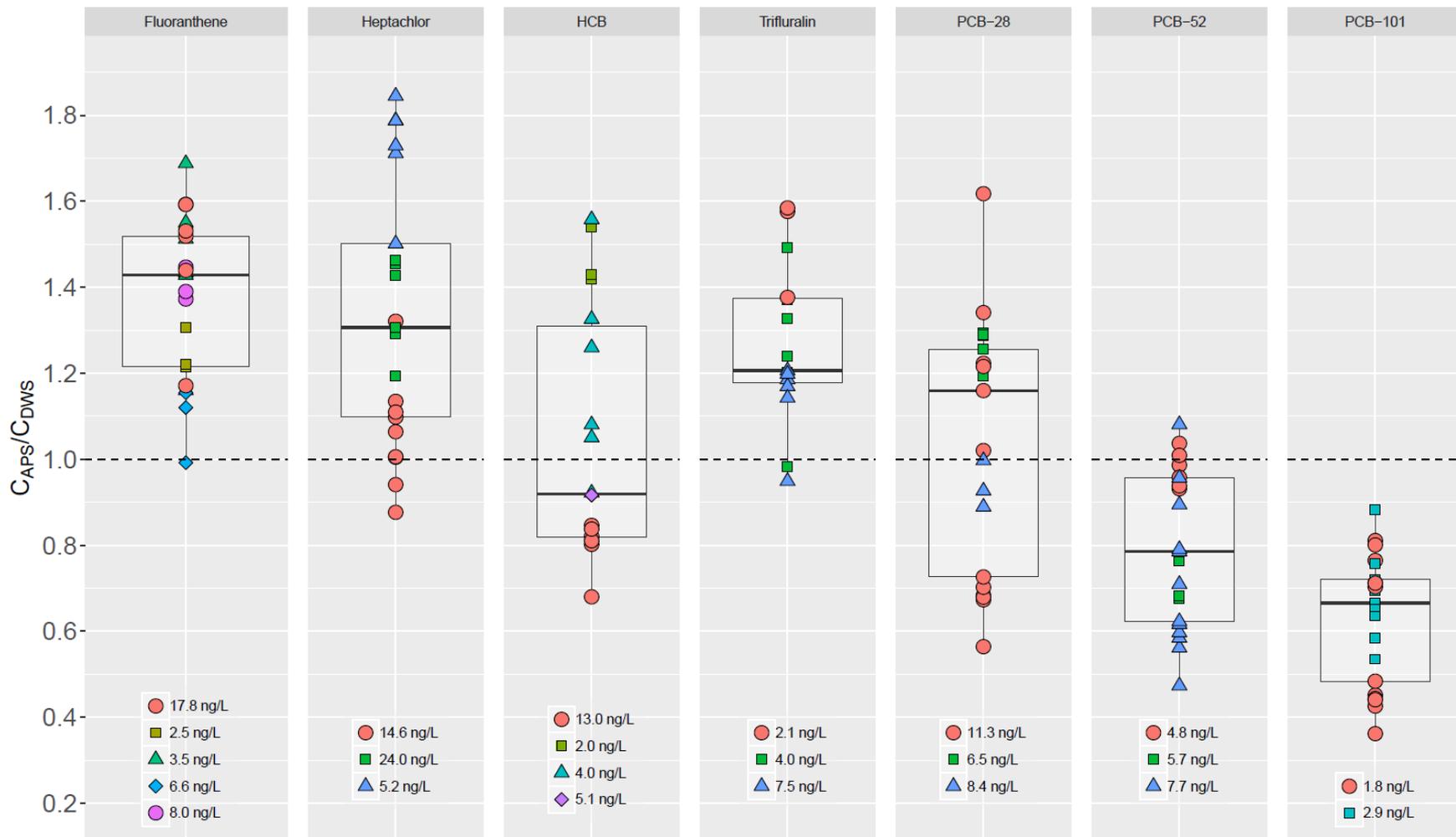
Measurements at different bulk concentrations – metals



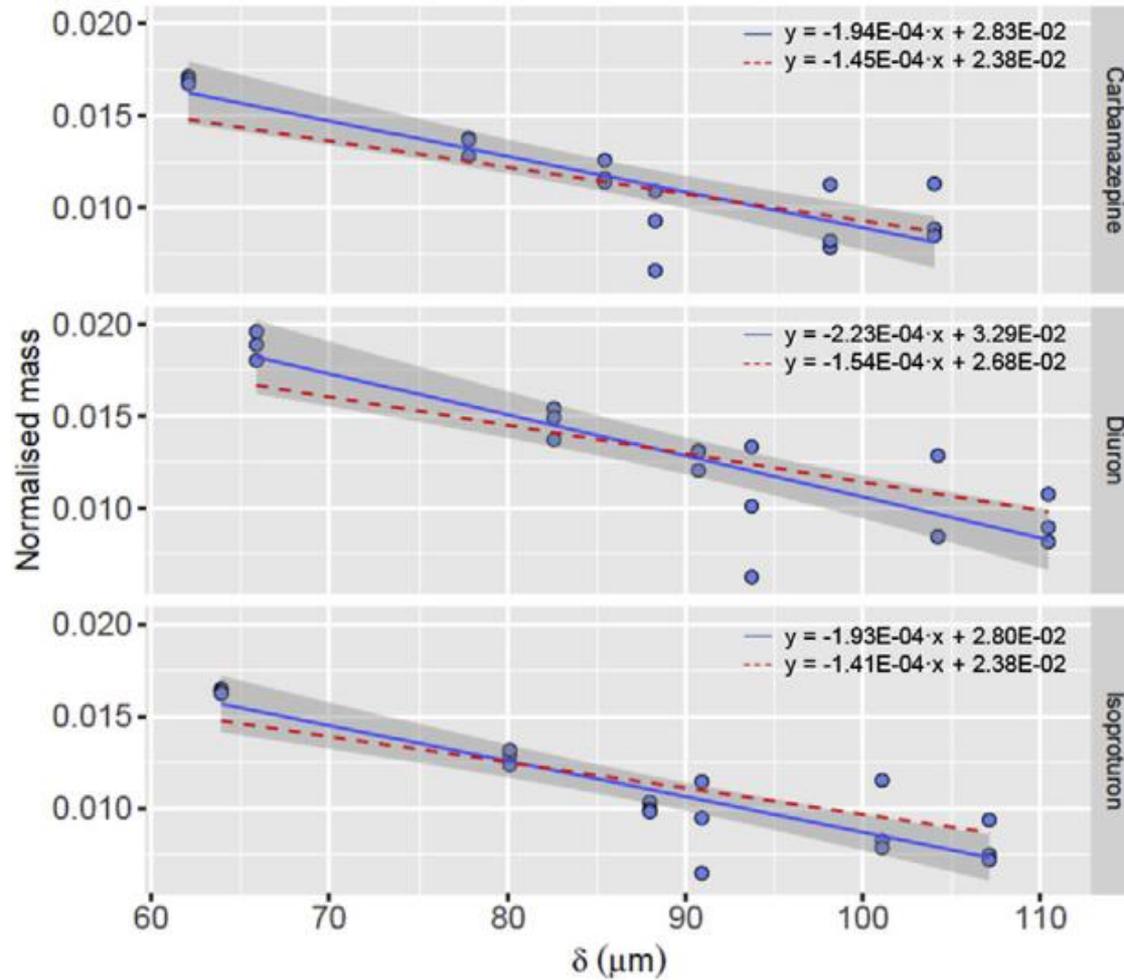
Measurements at different bulk concentrations – polar organic compounds



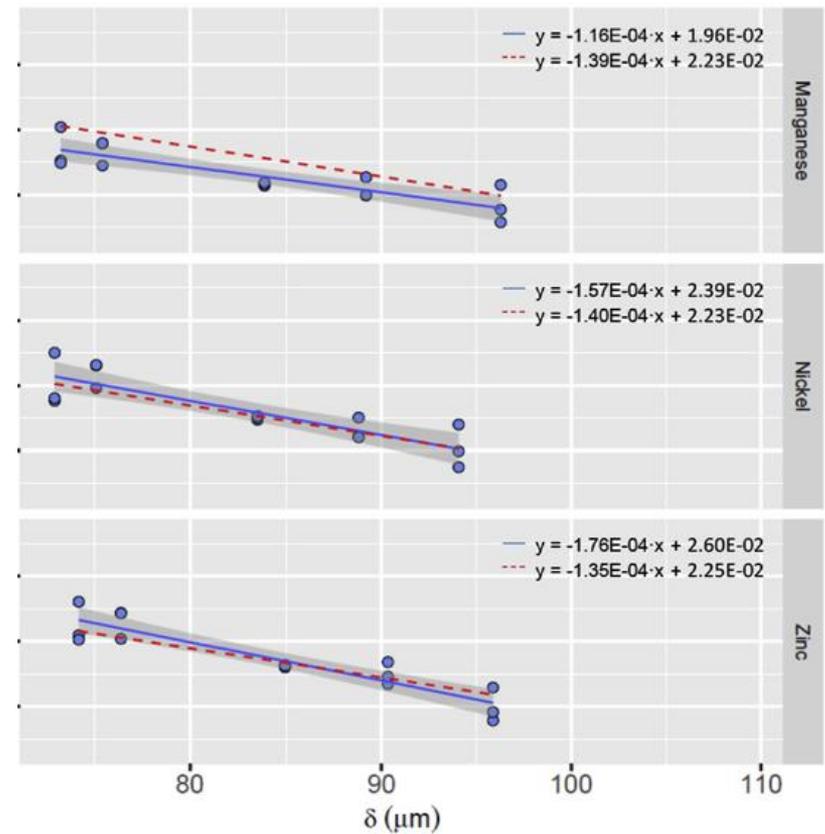
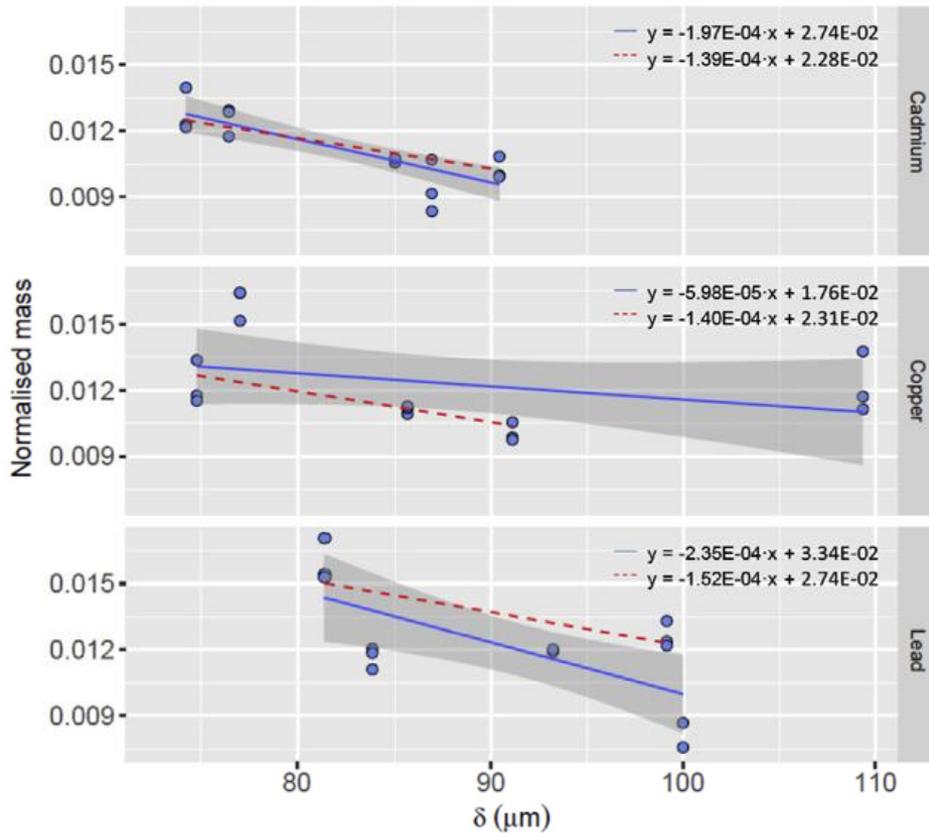
Measurements at different bulk concentrations – non-polar organic compounds



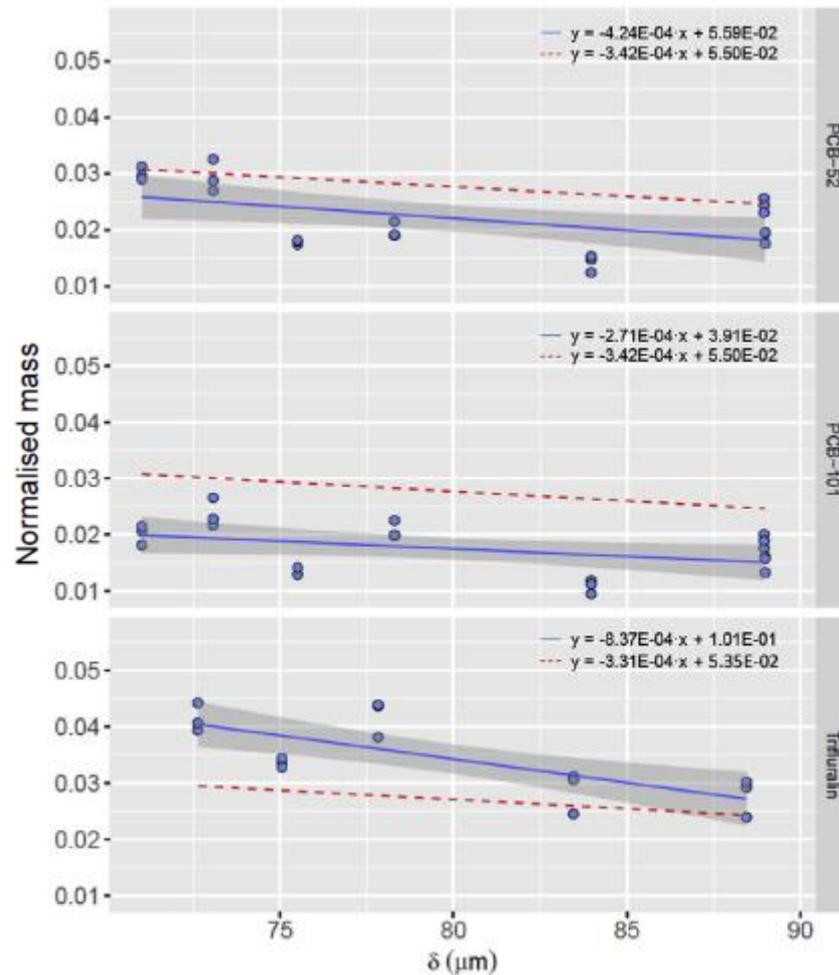
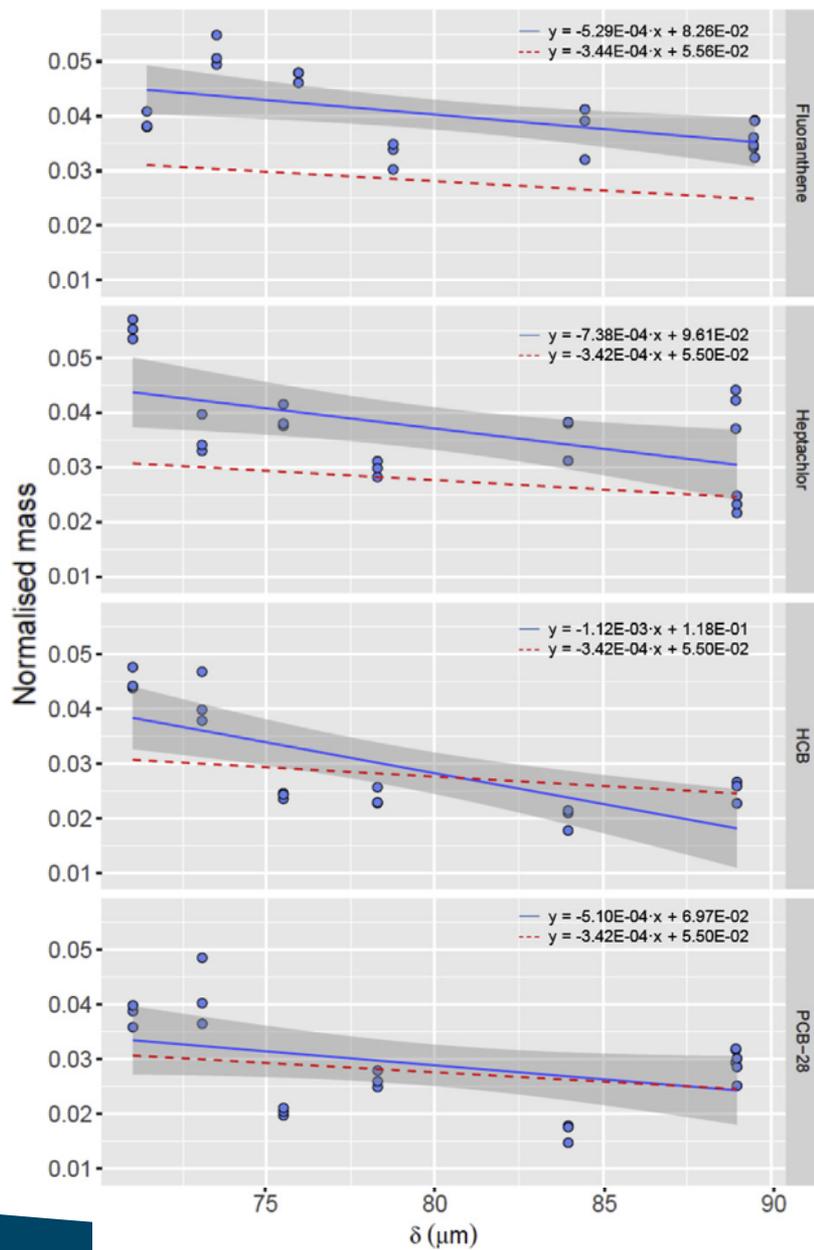
Accumulated mass vs δ



Accumulated mass vs δ



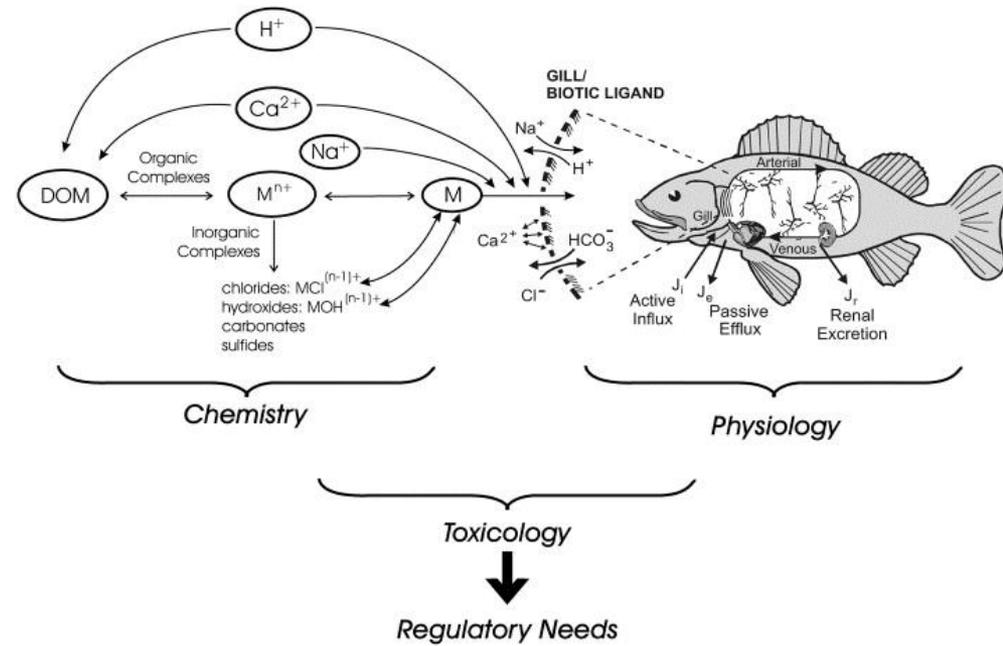
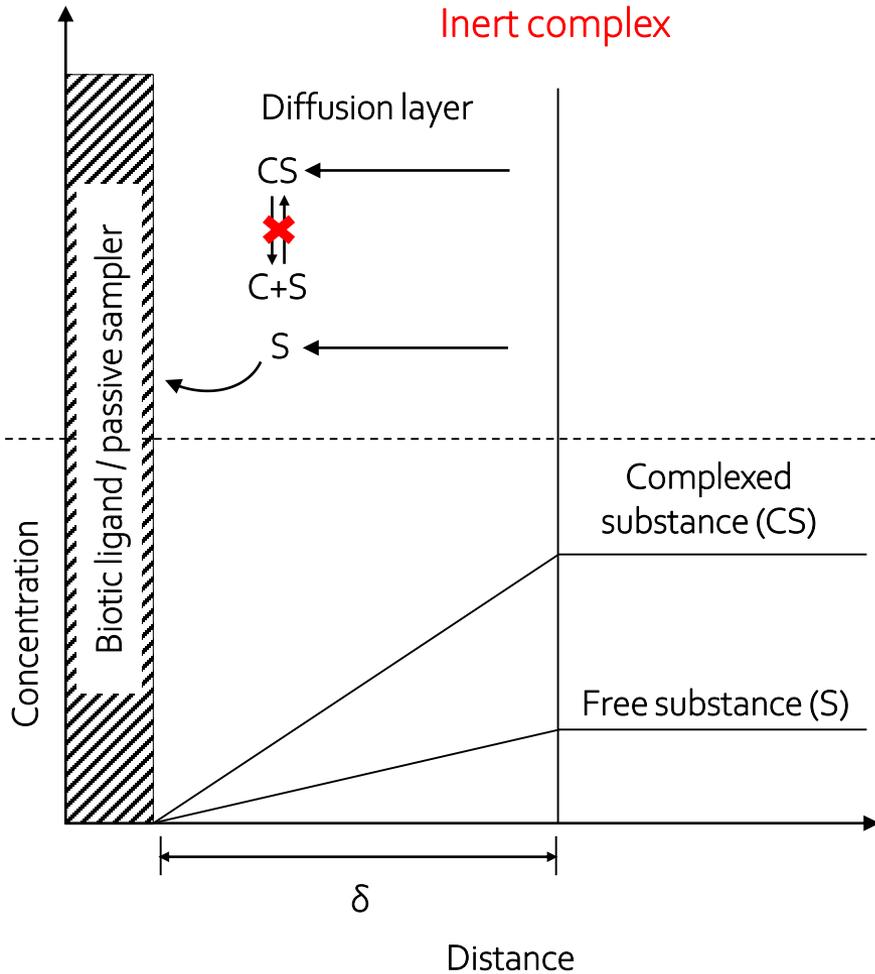
Accumulated mass vs δ



Conclusions

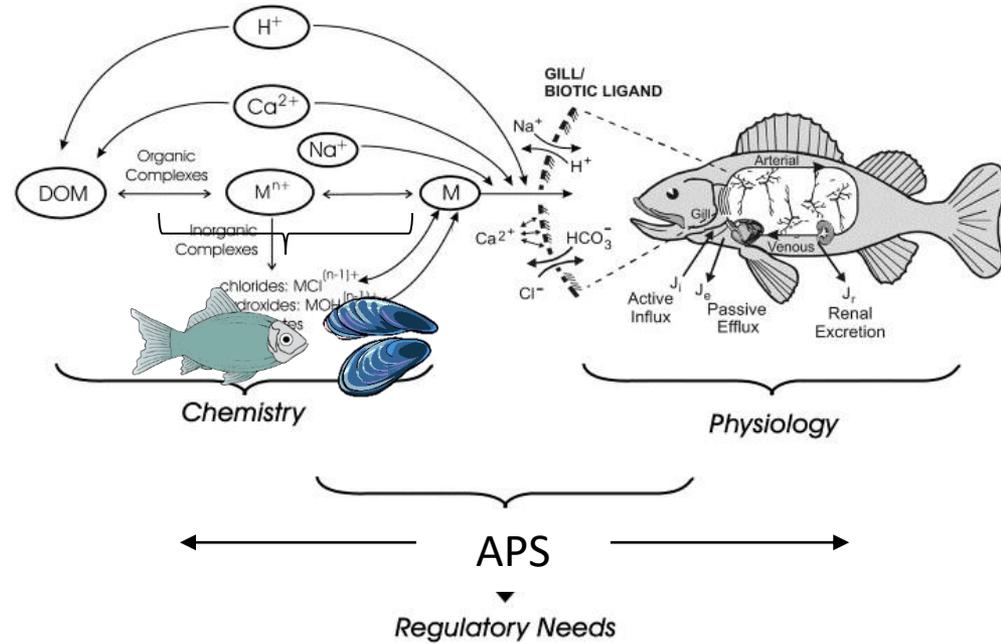
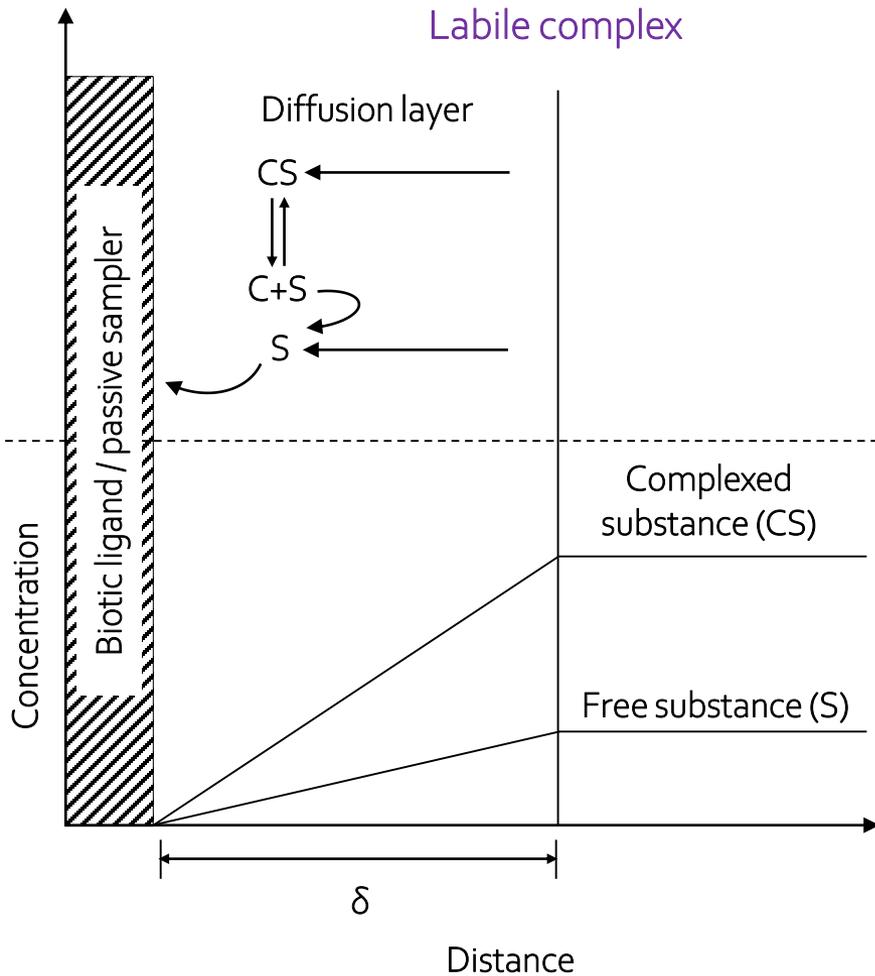
- Control the flow rate → control δ
- Measurements that are fully independent from hydrodynamic conditions
- Enables measurements of a wide range of contaminants with different chemical properties simultaneously
- Accuracies were 98 ± 17 , 106 ± 35 , and 98 ± 7 % for polar compounds, non-polar compounds and metals, respectively (mean \pm SD)

Bioavailability assessment



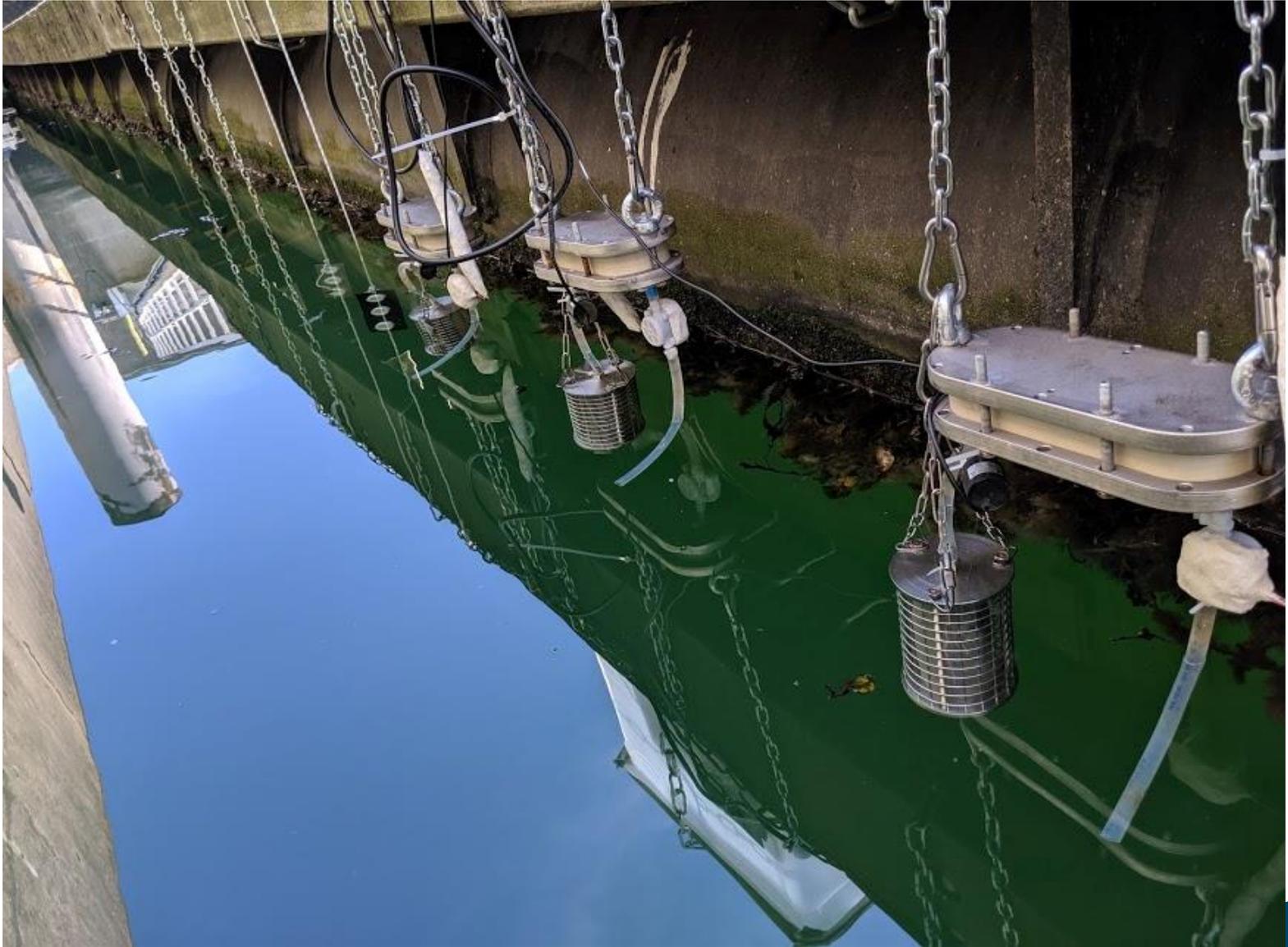
Paquin et al. *Comparative Biochemistry and Physiology Part C: Toxicology & Pharmacology* 2002

Bioavailability assessment



Paquin et al. *Comparative Biochemistry and Physiology Part C: Toxicology & Pharmacology* 2002

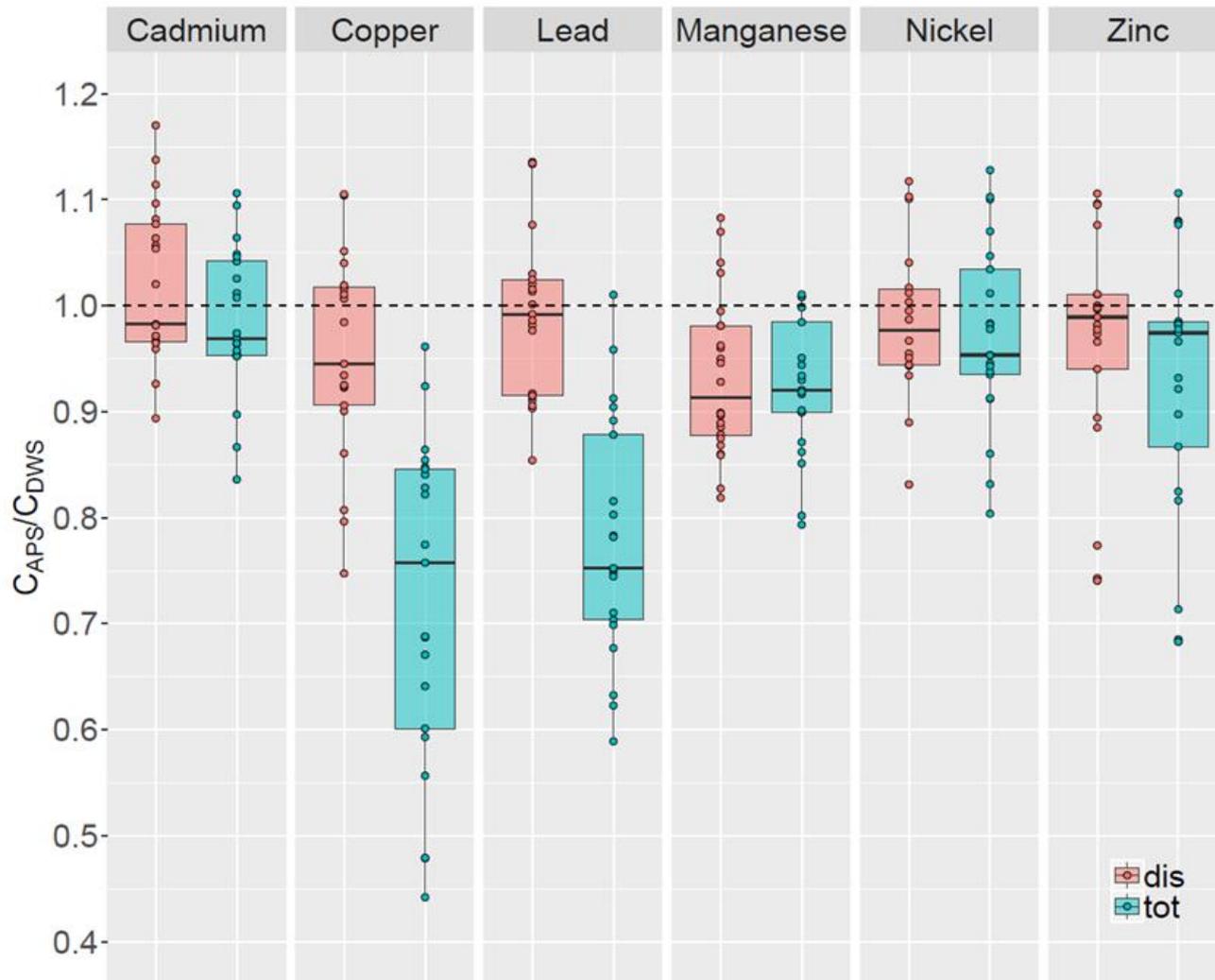
Field test



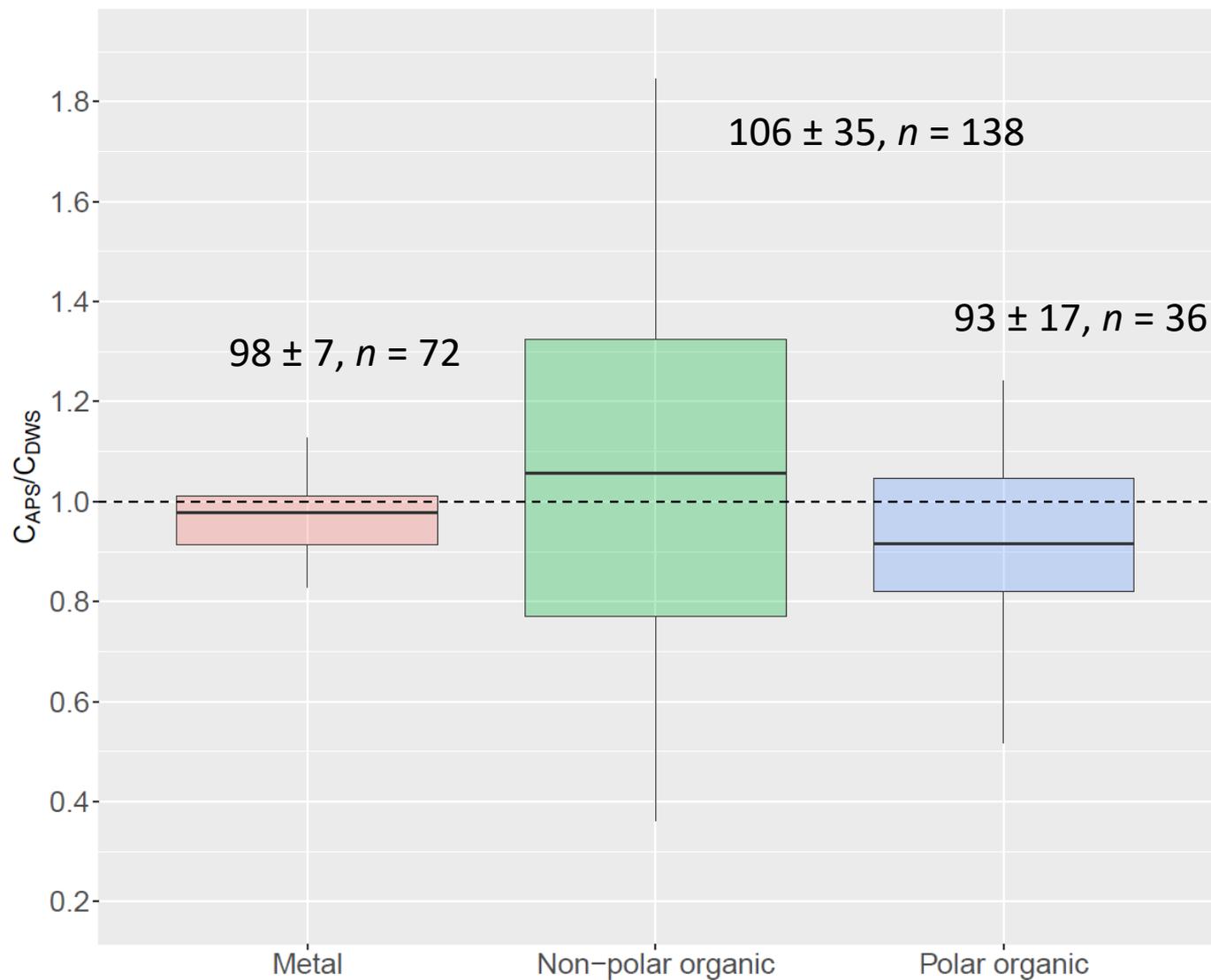


Thank you!

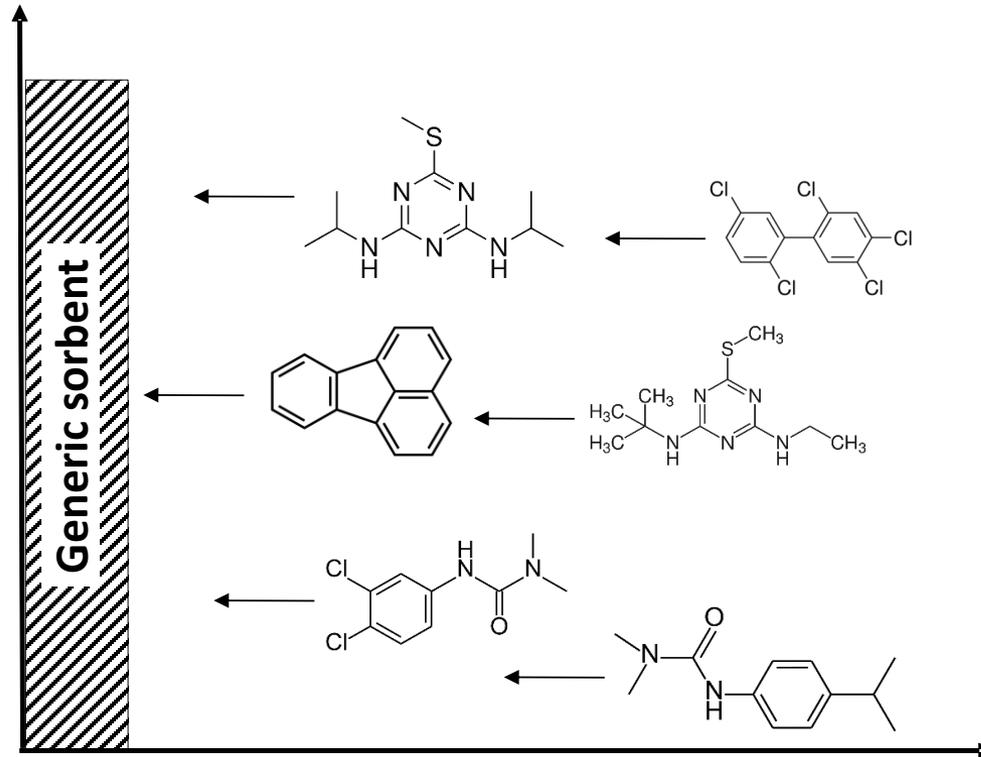
Active-passive sampling measurements vs total and dissolved concentrations – *metals*



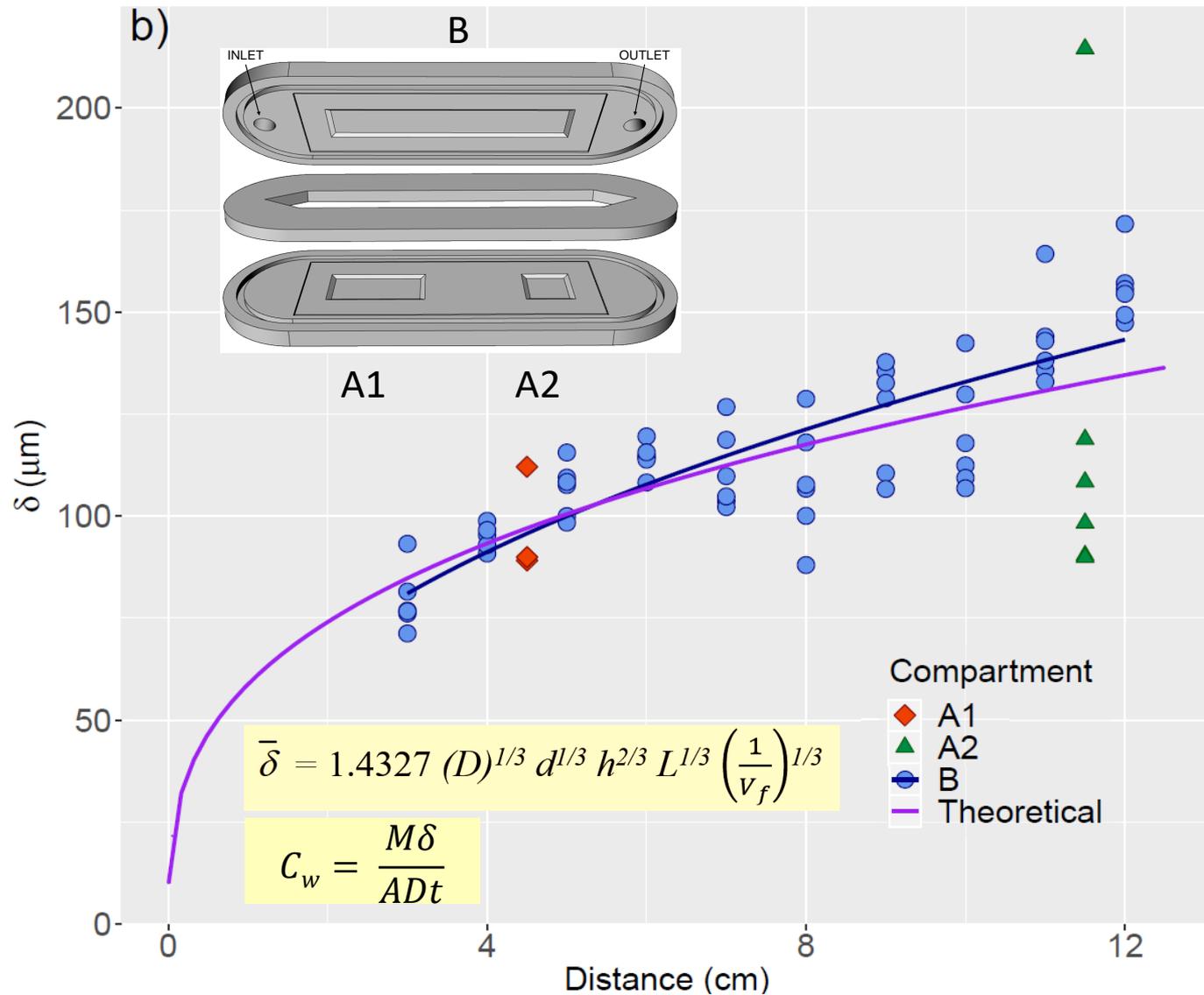
Accuracy summary



Principles of passive sampling – uptake mechanism



Influence of flow rate and flow direction – *metals*

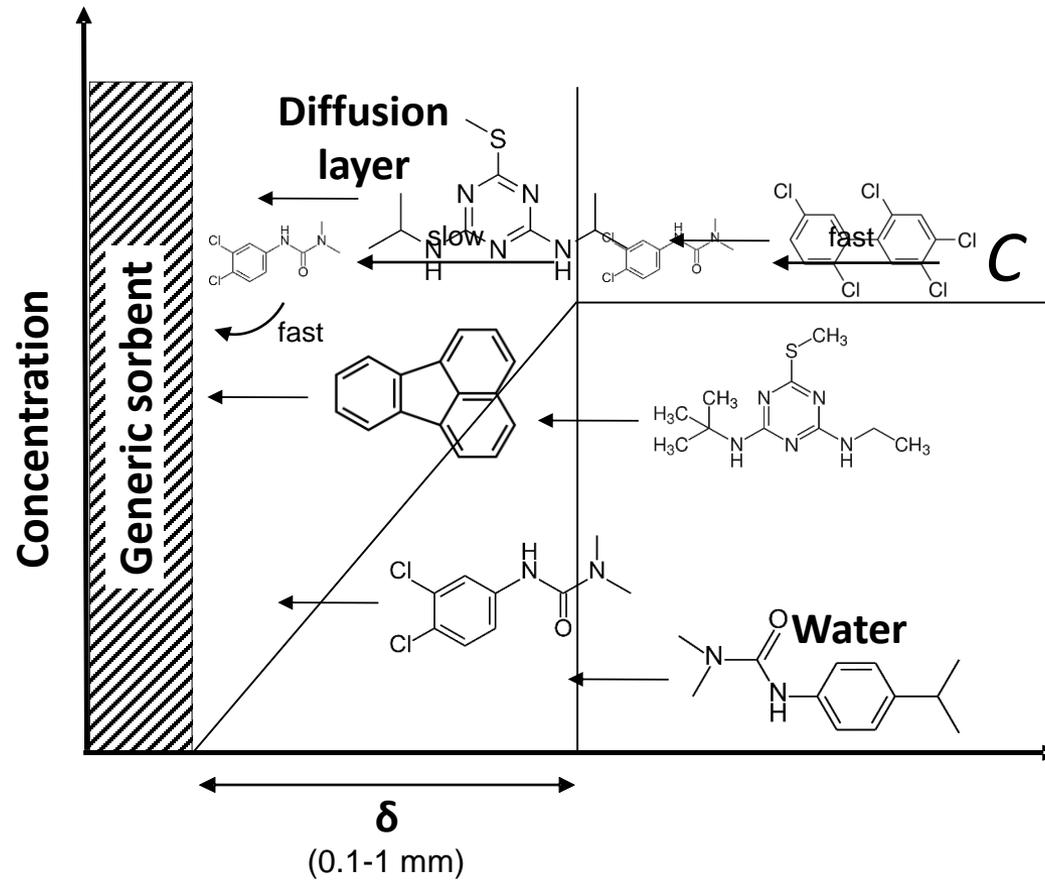


Medium physico-chemical properties

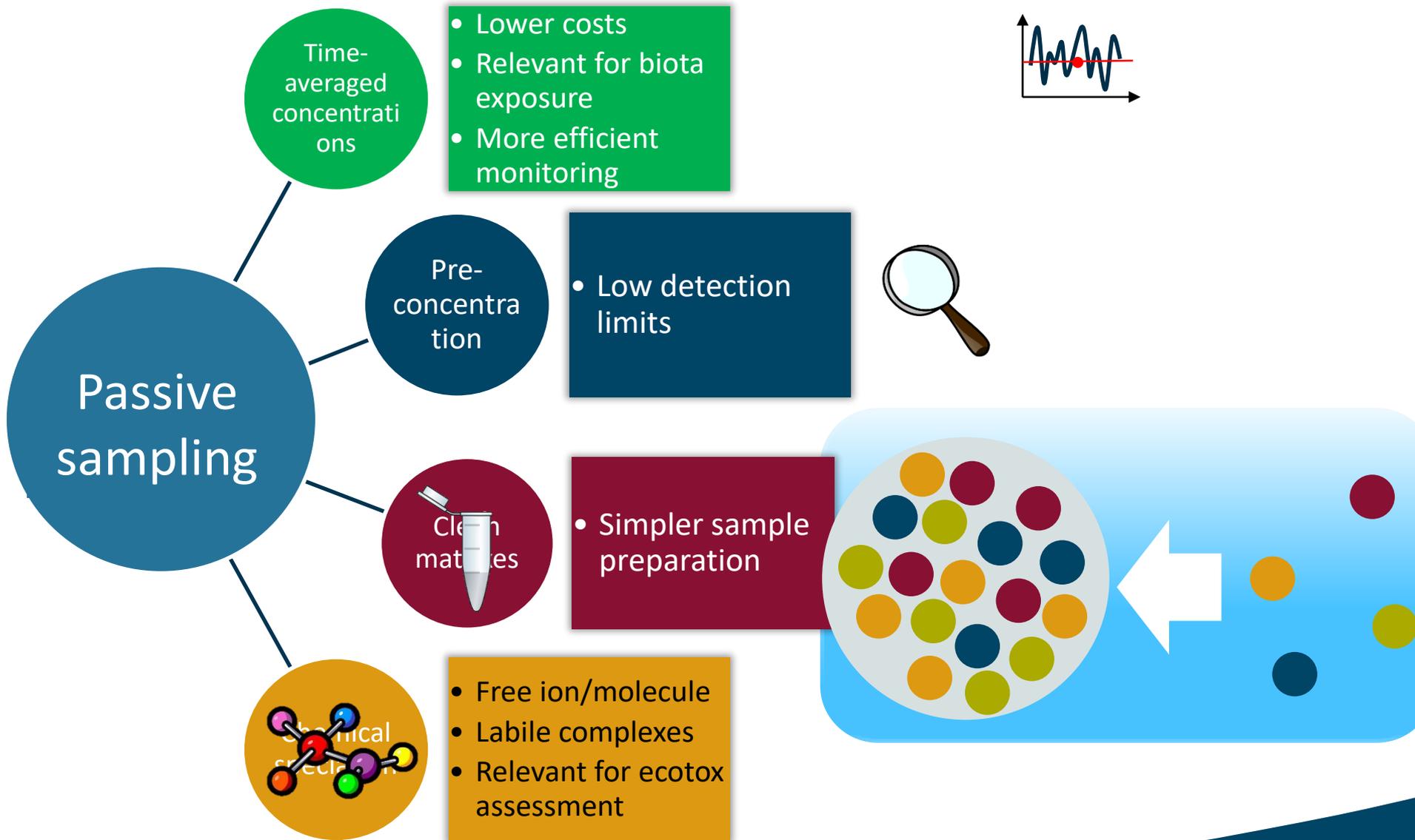


Flow	pH	T (°C)	Conductivity (μs/cm)	Oxygen (%)
F1	8.1 ± 0.0	15.2 ± 0.1	293 ± 1	101 ± 0
F2	8.0 ± 0.1	15.3 ± 0.1	301 ± 2	102 ± 1
F3	8.0 ± 0.0	15.1 ± 0.1	303 ± 1	97 ± 0
F4/F7	7.9 ± 0.1	14.9 ± 0.1	303 ± 1	96 ± 1
F5/F6	7.7 ± 0.1	14.5 ± 0.1	302 ± 1	95 ± 0

Principles of passive sampling – uptake mechanism



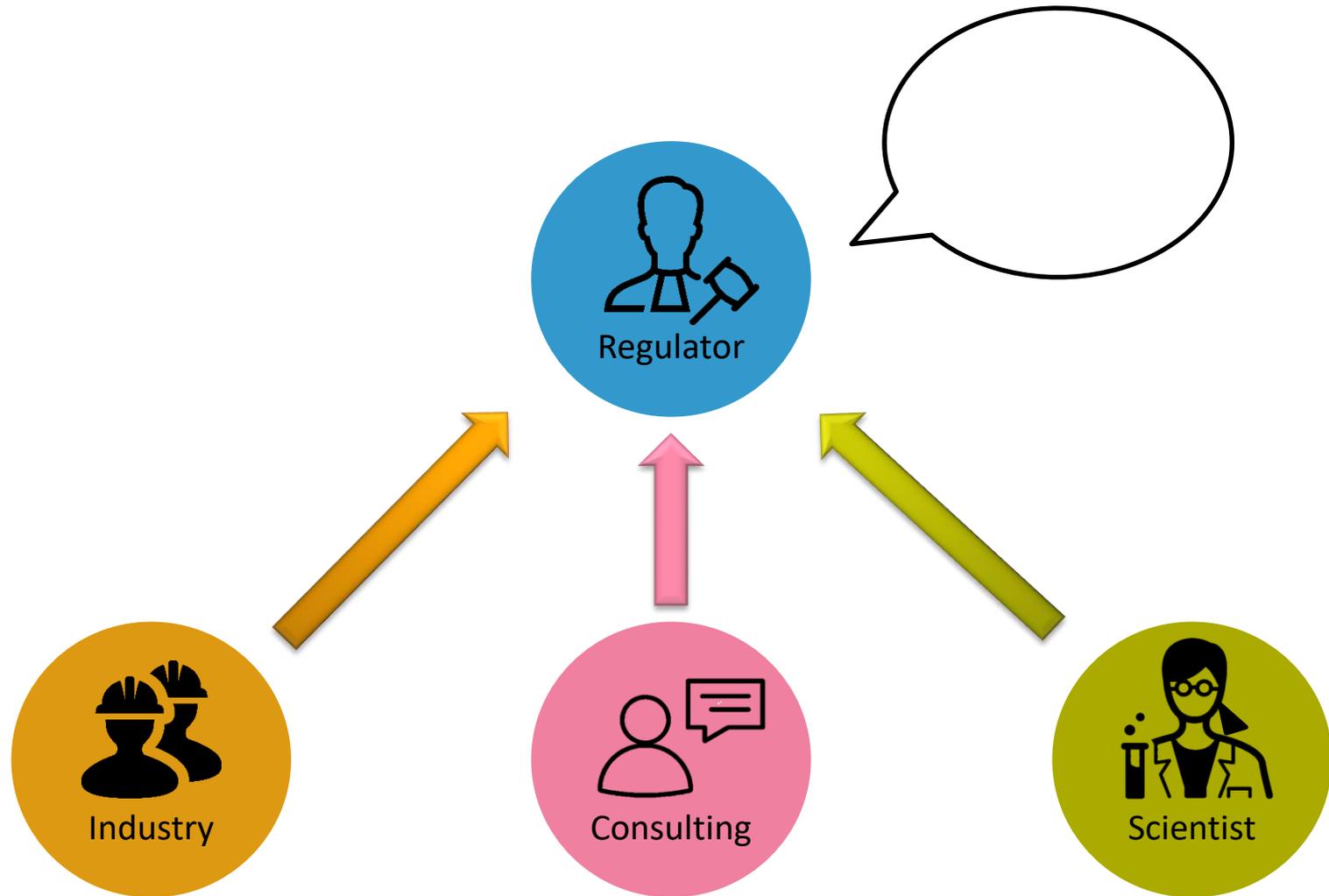
Passive sampling – how can we improve it?



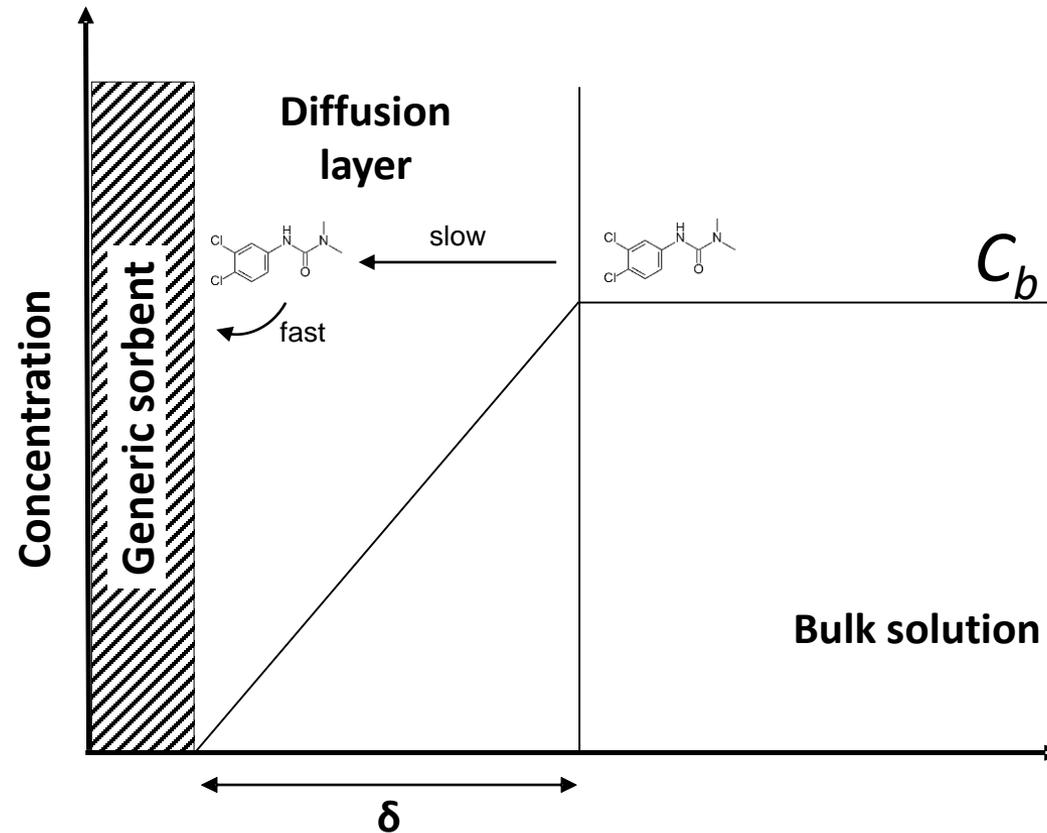
Passive sampling – applications



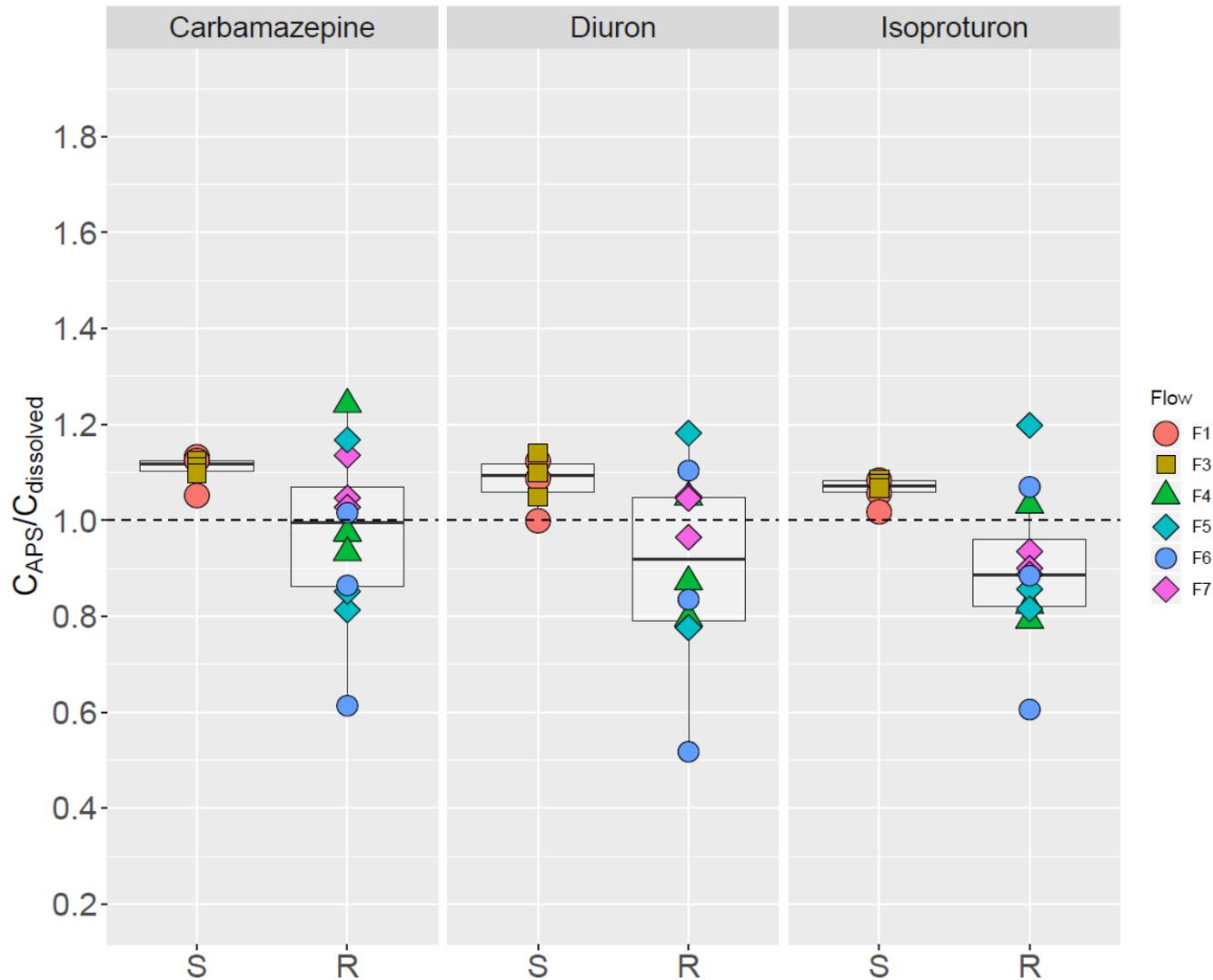
Passive sampling – limited use



Passive sampling – uptake mechanism



Influence of flow rate – polar organics



Influence of flow rate – non-polar organics

