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Environmental monitoring of priority substances in biota and passive sampling in Flanders water bodies

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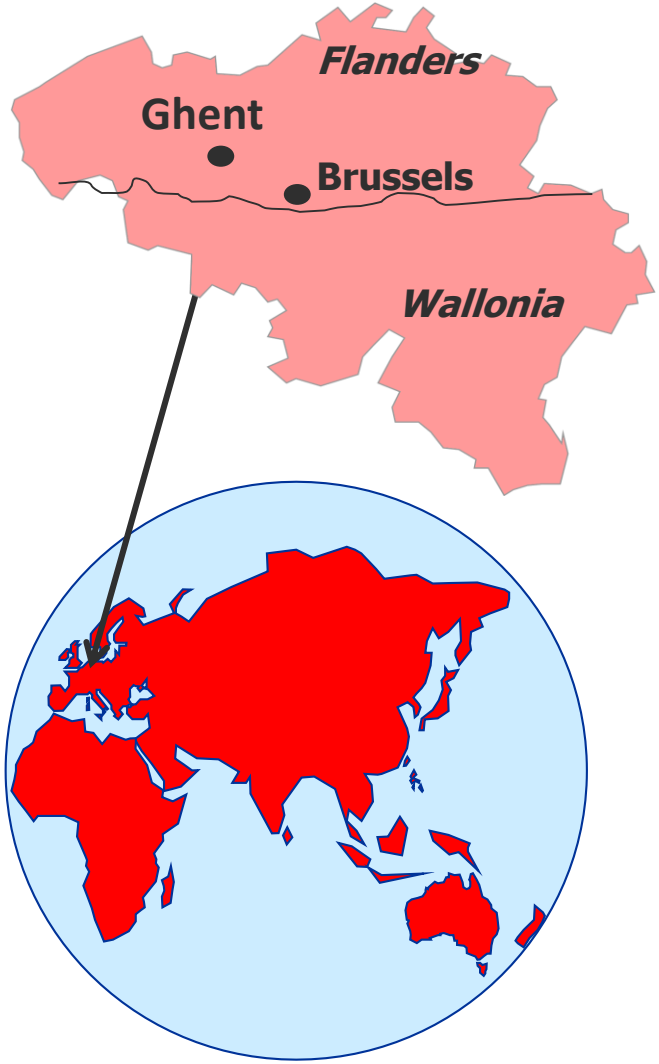
FEA: Introduction



- Flemish government agency
- Established in 1990
- Head office in Aalst, local offices in each province in Flanders
- Lab in Ghent
- ±1000 employees
- Work for a better environment
- Cover 3 main areas: water, air and the environment in general

Mission of the FEA

- contribute to the realisation of the environmental policy objectives by
  - reporting on the state of the environment
  - Preventing, limiting and reversing harmful impacts on water systems and pollution of the atmospheric
- contribute to the realisation of the integrated water policy objectives

Passive sampling story

- **2012:**
  - → The Netherlands (RWS, Deltares) had developed a method for passive sampling with AlteSil silicon sheets
  - → FEA borrowed one cage and a method for measuring and calculating
  - → Preliminary test on small scale to learn

- **2013: first passive sampling project with 6 cages**
  - → Campaign 1: 6 weeks in summer 2013
  - → Campaign 2: 6 weeks in autumn 2013, 4 places in common
  - → Campaign 3: same 4 places in autumn 2015

Locations

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Kanaal Gent-Terneuzen
Zelzate (Industry)

Kleine Nete
Retie (Background)

Bovenschelde
Pecq

Demer
Aarschot

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Before and after sampling

Kanaal Gent-Terneuzen, summer

Kanaal Gent-Terneuzen, autumn

Difference in biofouling according to location and season

Before and after sampling

Bovenschelde, summer

Bovenschelde, autumn

Kleine Nete, summer

Kleine Nete, autumn

- Less biofouling
- Plant material in summer, no influence on uptake (floating)

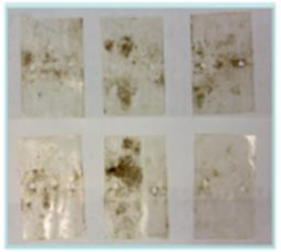
Cleaning and storage

Sheets were cleaned
at the sampling place

Sheets were stored in the
freezer untill analysis

Analysis

1. Sample



6 silicone sheets

2. Soxhlet extraction with hexane/acetone

Extract was concentrated

3. Instrumental analysis: GCMS (PAH) or GC-HRMS

4. Results

Results

- **Substances:**
  - → PAH
  - → PCB
  - → Hexachlorobenzene
  - → PBDE
- **Concentration measured in sampler (ng/sampler or µg/kg sheet) and calculated in water (ng/L or pg/L) through use of PRC**

- **Results:**
  - → Same places, different season
  - → Same places, same season, different year

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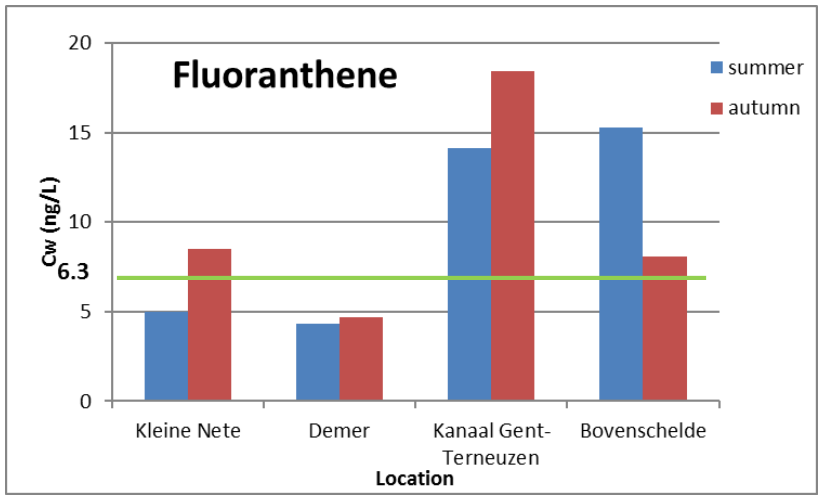
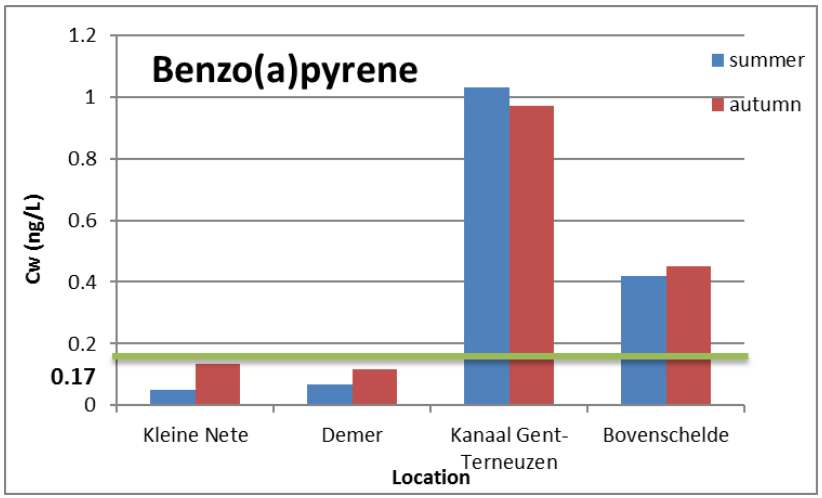
Results PAH: same place, different season

Dissolved concentrations in the water





- Little difference between summer and autumn
- Large difference between locations
- WFD standard for whole water body while results are dissolved concentrations
- Nevertheless:
  - fluoranthene concentration exceeds standard on every location except Demer
  - benzo(a)pyrene concentration exceeds standard on 2 of 4 locations

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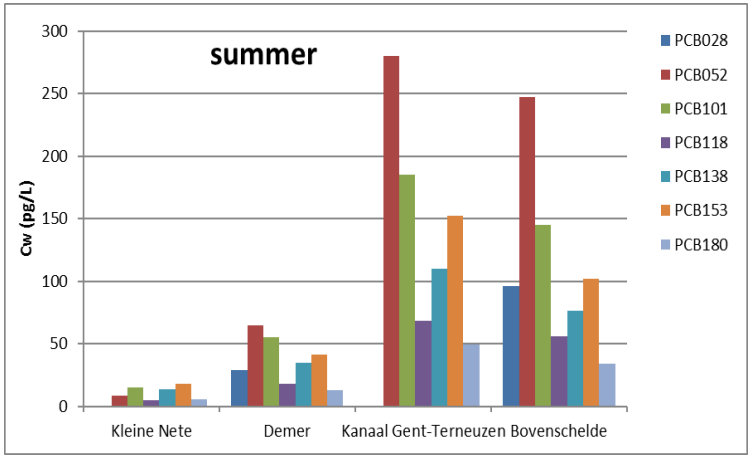
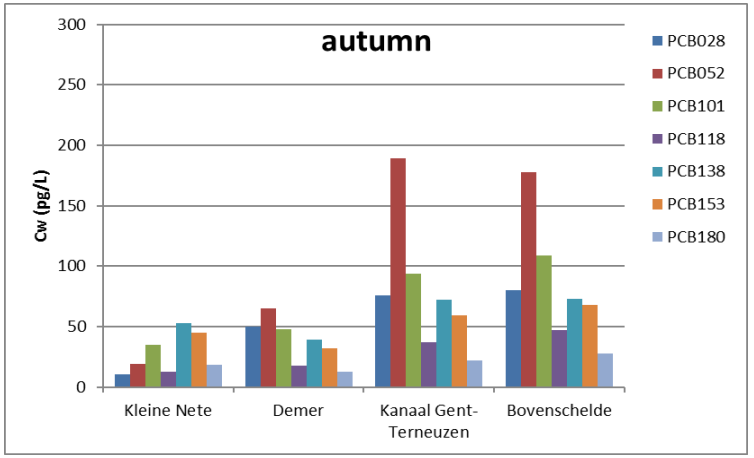
Results PCB: same place, different season





- Water concentration: pg range
- Same pattern in summer and autumn
- No WFD standard

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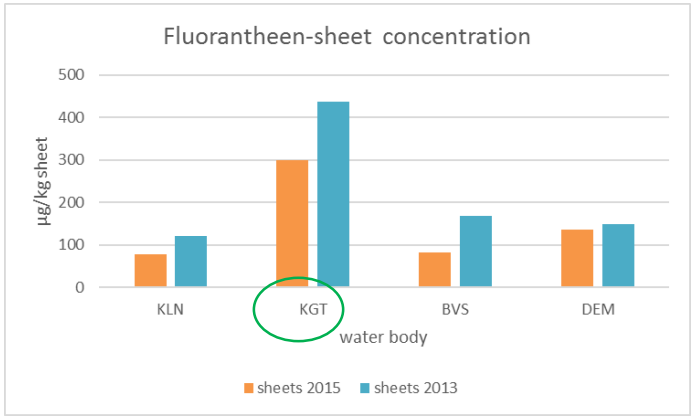
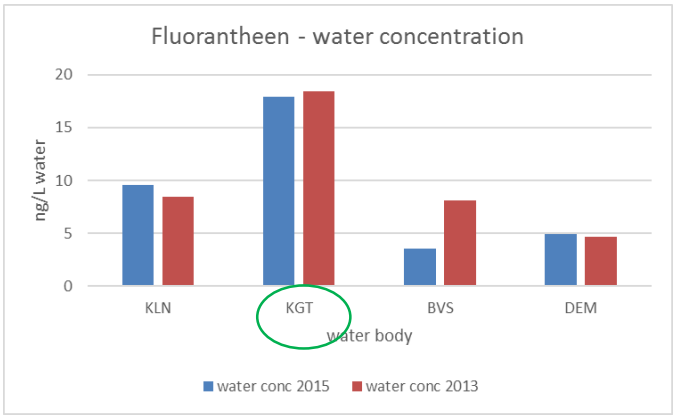
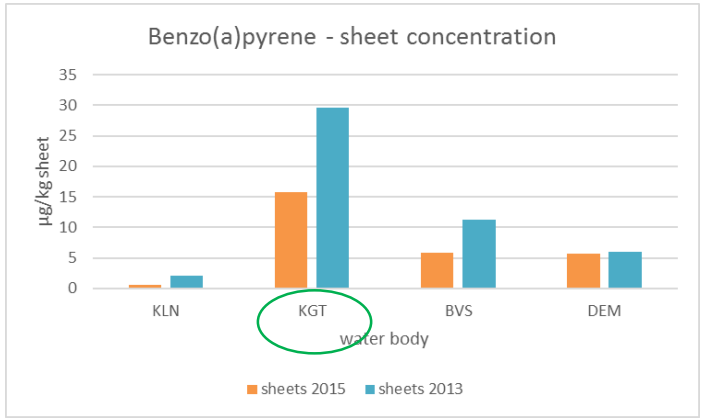
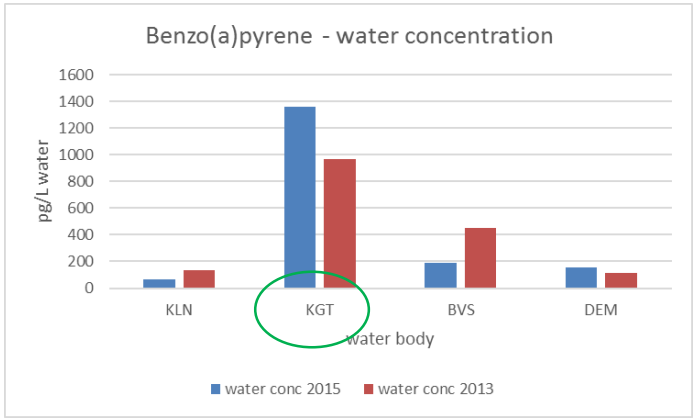
Results PAH: same season, different year



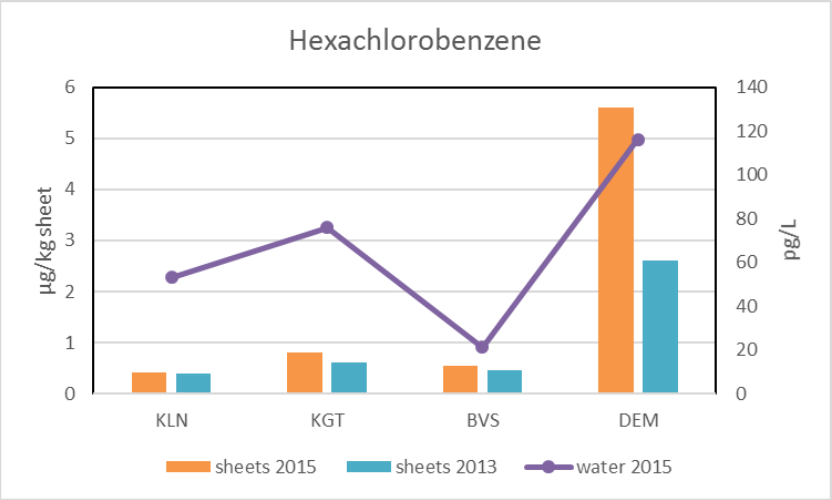






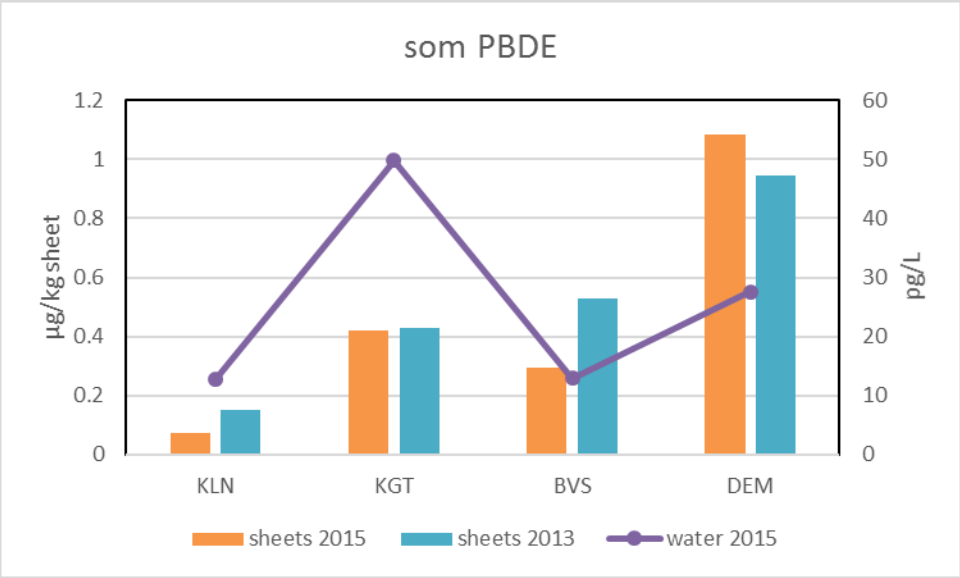
- No significant difference between 2013 and 2015 results on the same location
- Largest concentrations of PAH in Kanaal Gent-Terneuzen (industry related)

Result hexachlorobenzene



- Largest concentrations in sheets and in water in the Demer
- WFD water: HCBz: 10 ng/L
- Dissolved concentration does not exceed the WFD standard

Result ∑PBDE



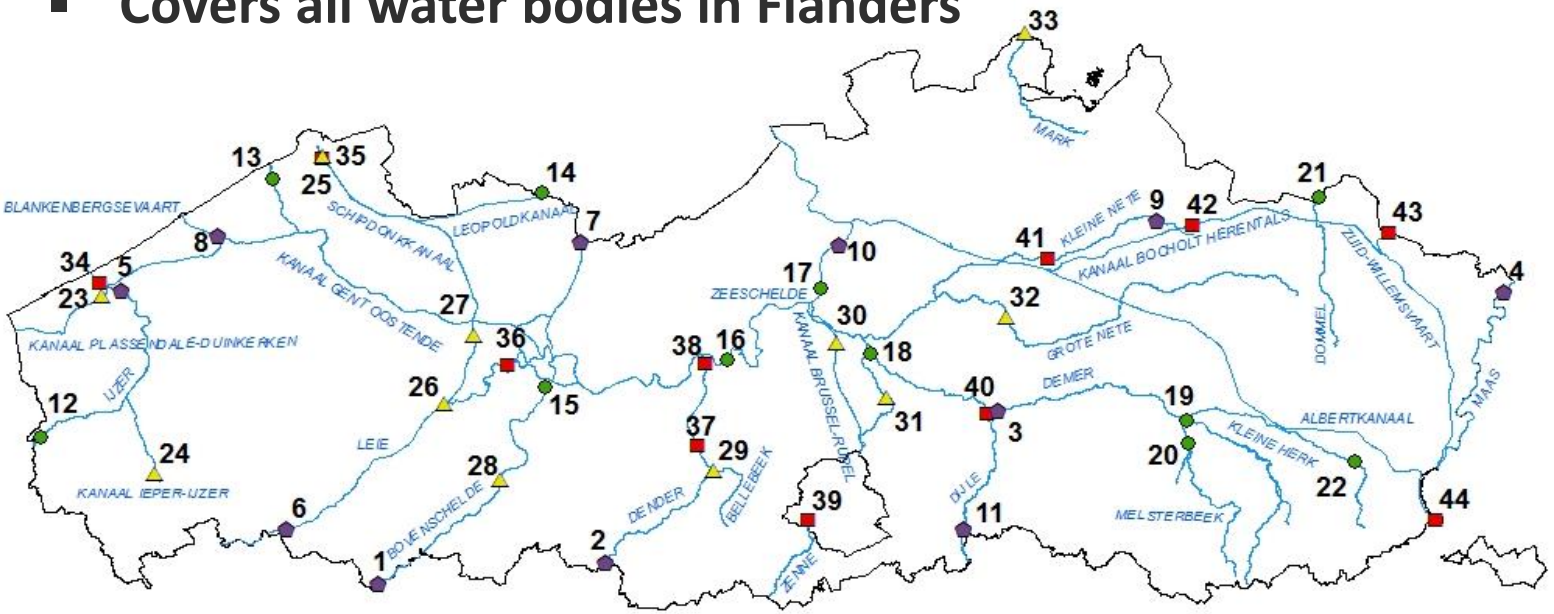
- Highest concentration in the sheets: Demer
- Highest concentration in the water: Kanaal Gent-Terneuzen
- PBDE: very high log K_{ow}
- Is balance reached after 6 weeks?

Use of passive sampling in environmental monitoring

- Routine method for passive sampling, very standardised
- WFD: monitoring in water and/or biota
- Monitoring water: core business
- Monitoring biota: no experience, lack of standardisation (which fish, age, sex,…)
- Can passive sampling (partially) replace monitoring in biota by using the silicone sheets as an artificial fish?
- Introduce passive sampling in biota monitoring network!

Biota and passive sampling measuring network 2015-2018

- Monitoring 44 places in 4 years
- 11 per year
- Covers all water bodies in Flanders

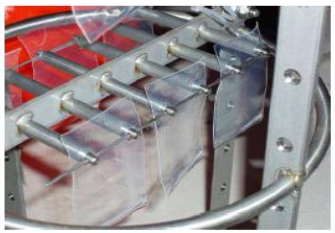


Measuring network biota 2015-2018

- Perch and eel


- Dreissena (PAHs)


- Passive sampling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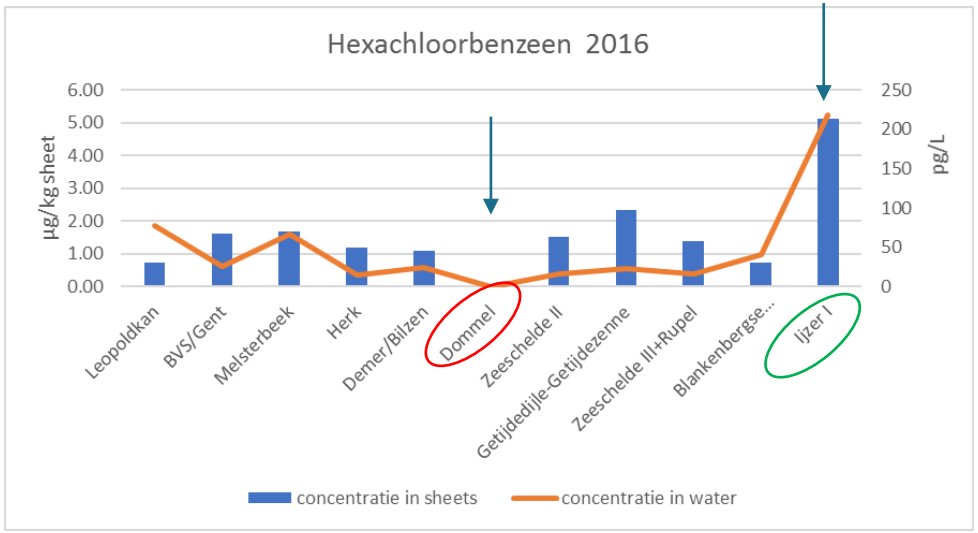
Sampling

- Catching fish: electrical fishing or fyke

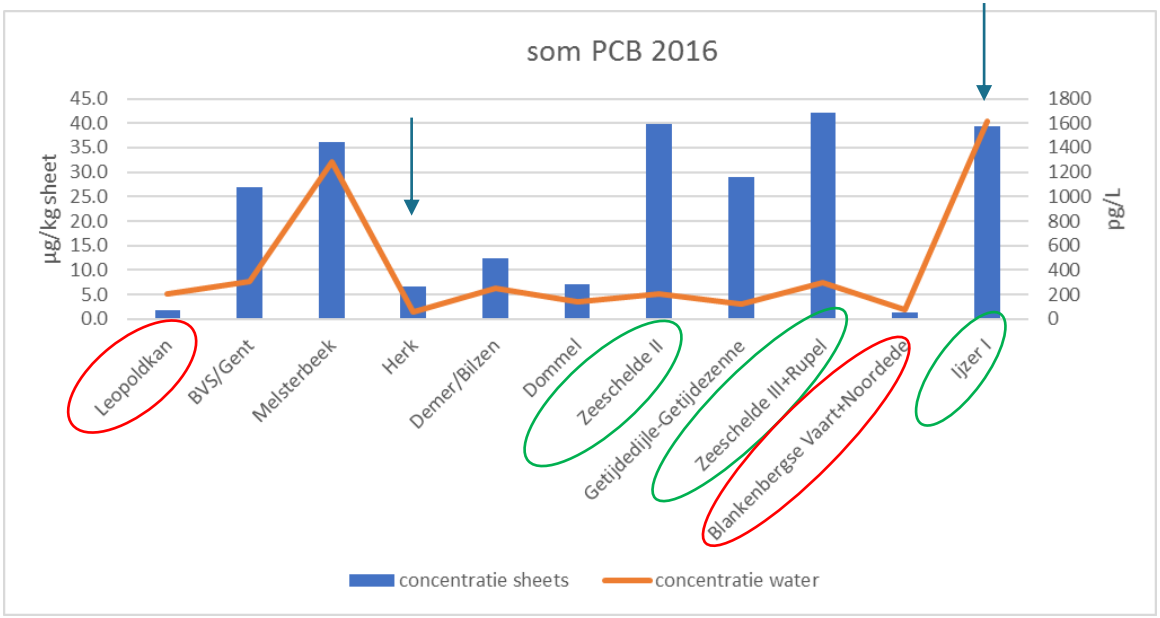
- Catching Dreissena: collecting, rinsing and placing in cages, together with passive sampling cages (same time, same place)

Results hexachlorobenzene



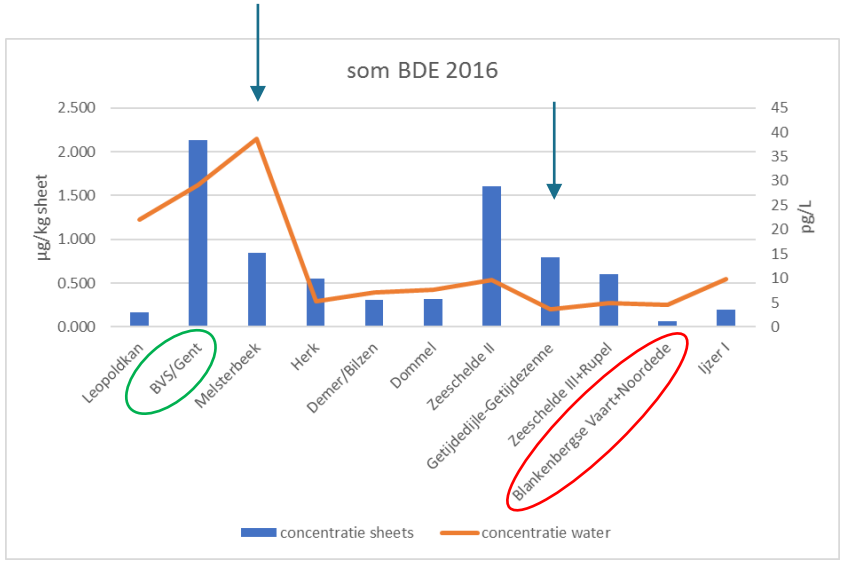
- Concentration of HCBz in the sheets ranges from lower than DL in the Dommel to 5 µg/kg sheet in the Ijzer
- Water concentrations range from lower than DL (Dommel) to 218 pg/L (Ijzer)

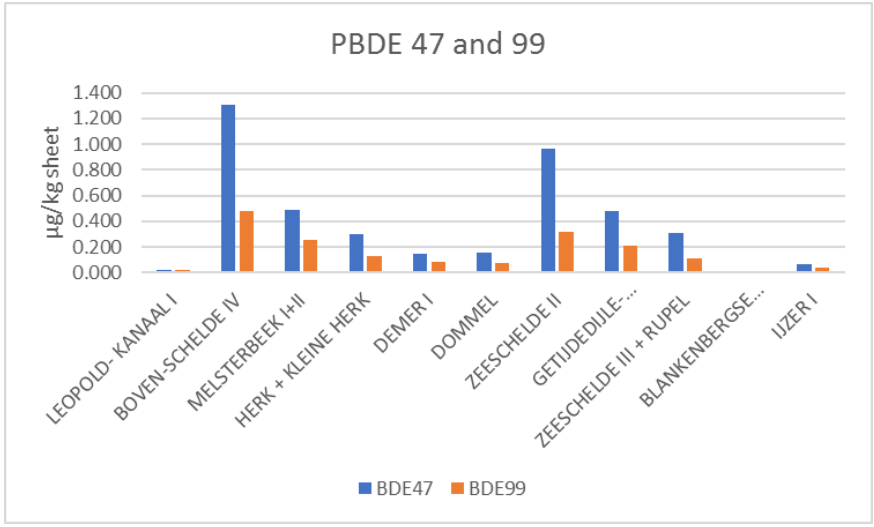
Results PCB



- ∑PCB in sheets ranges from 2 to 42 µg/kg sheet with highest concentrations in Zeeschelde and Ijzer and lowest concentration in Leopoldkanaal and Blankenbergse Vaart
- Water concentrations for PCB range from 55 pg/L (Herk) to 1600 pg/L (Ijzer)
- Highest concentration in sheet ≠ highest concentration in the water

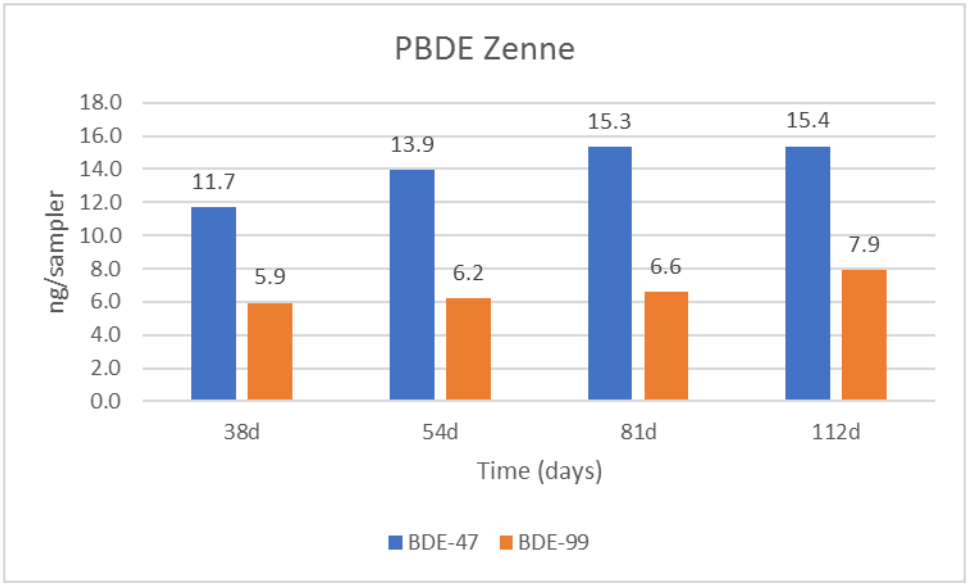
Results PBDE





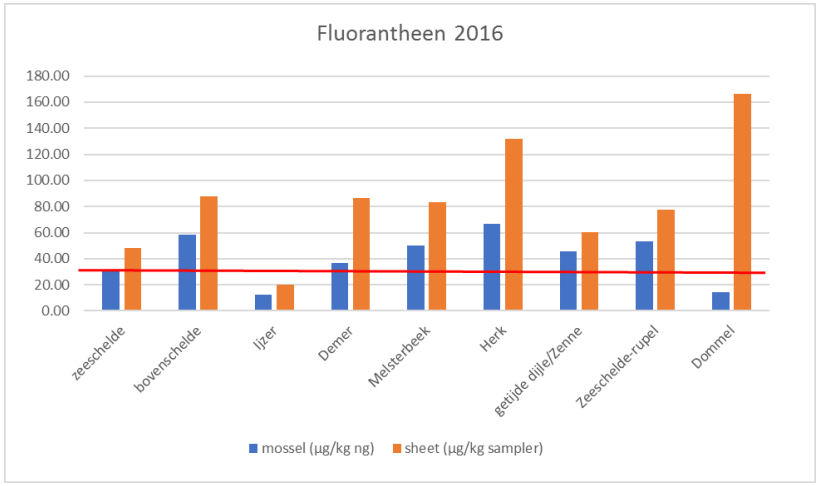
- Most abundant are PBDE 47 and 99
- ∑PBDE in sheets range from 70 ng/kg sheet (Blankenbergse Vaart) to 2100 ng/kg sheet (Bovenschelde)
- Water concentrations range from 4 pg/L (Getijdedijle) to 39 pg/L (Melsterbeek)

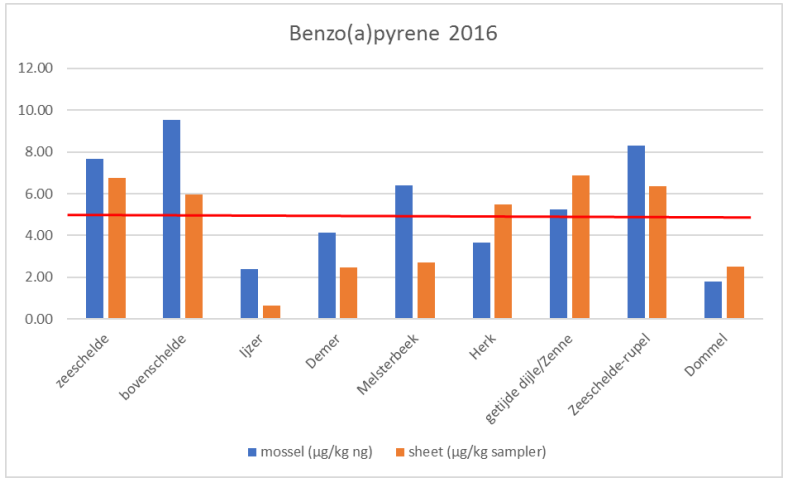
Results PBDE



- Extra test in 2017
- 4 samplers on the same location
- Analysis after 38, 54, 81 and 112 days
- When balance reached? BDE 47: after 81d, BDE99 ?
- More research needed

Results PAH in passive sampler and mussel tissue





- Exceedance of WFD biota standard on several places (Flu: 30 µg/kg ww, BaP: 5 µg/kg ww)
- Most case: mussel > WFD, PS > WFD
- Significant difference between PS and mussel for Flu, not for BaP (paired t-test)
- Correlation for Flu but not for BaP
- Indication that passive sampling can predict concentrations in mussel?

Conclusion

- Work in progress, monitoring still going on
- No real conclusions yet
- First data are promising
- At the end of the project (next year): large dataset for statistical analysis
- Correlation between passive sampling and mussel?
- Correlation between passive sampling and fish? Challenge!
- Answer to question: Can future monitoring of biota be complemented or replaced by monitoring with passive samplers?

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Thank you for your attention!

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