Innovative Scenario's for immobilization of Hydrophobic Organic Compounds (HOC) in sediment by Activated Carbon

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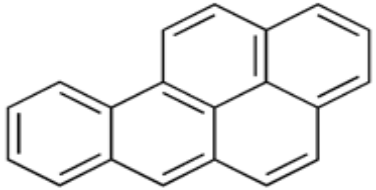
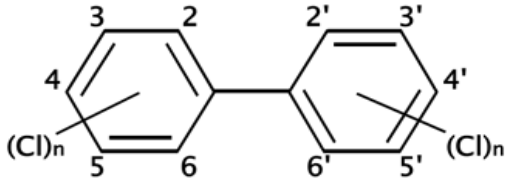
Hydrophobic Organic Compounds (HOC): bind to organic and mineral constituents of heterogeneous sediment matrix

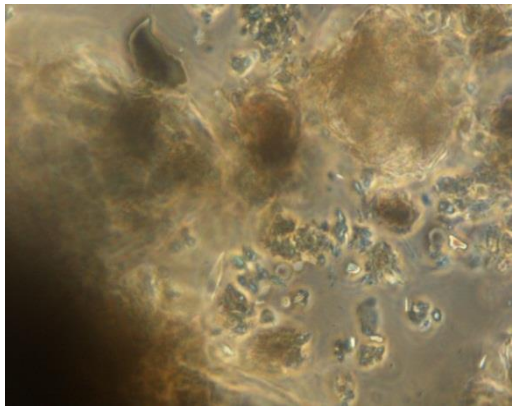
Non-polar
Persistent
Toxic
Low H_20
soluble

PAH 

PCB 

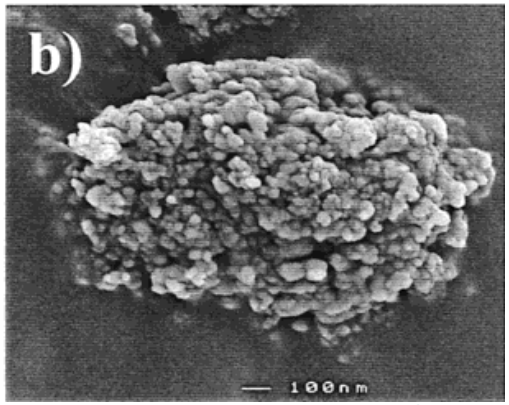
Amorphous Organic Carbon
(soil organic matter)
- relatively low affinity for HOC

Fast release



Condensed Organic Carbon
(soot, char, black carbon)
- high affinity for HOC

Slow release



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Jonker & Koelmans *2002*

Problem definition

Immobilization of HOC in sediment by Activated Carbon?

→Dose

→Particle size

→Mixing regime

→Contact time

AC should result in:

- Reduction dissolved HOC concentrations in pore water (C_{pw})
  - laboratory
  - field test
- Reduced bioaccumulation and toxicity of HOCs in benthic invertebrates

Pilot test at Field scale with AC application

Sediment:

- Biesbosch
- ΣPAH: 11 mg/kg dm
- ΣPCB: 0,7 mg/kg dm
- 44 ton

Ditches:

- Length: 15 m
- Width: 1.5 to 2.5 m
- Depths: 1.5 m

Start: December 2011, End: September 2012

Treatment scenarios

D1

Control

No treatment

3 h mixing

D2

PAC (Powder Activated Carbon)

4% nominal

PAC mixed/raked into sediment top

D3

GAC (Granular Activated Carbon)

3~4%

GAC mixed for 3h

D4

Stripped (GAC addition and removal)

3~4%

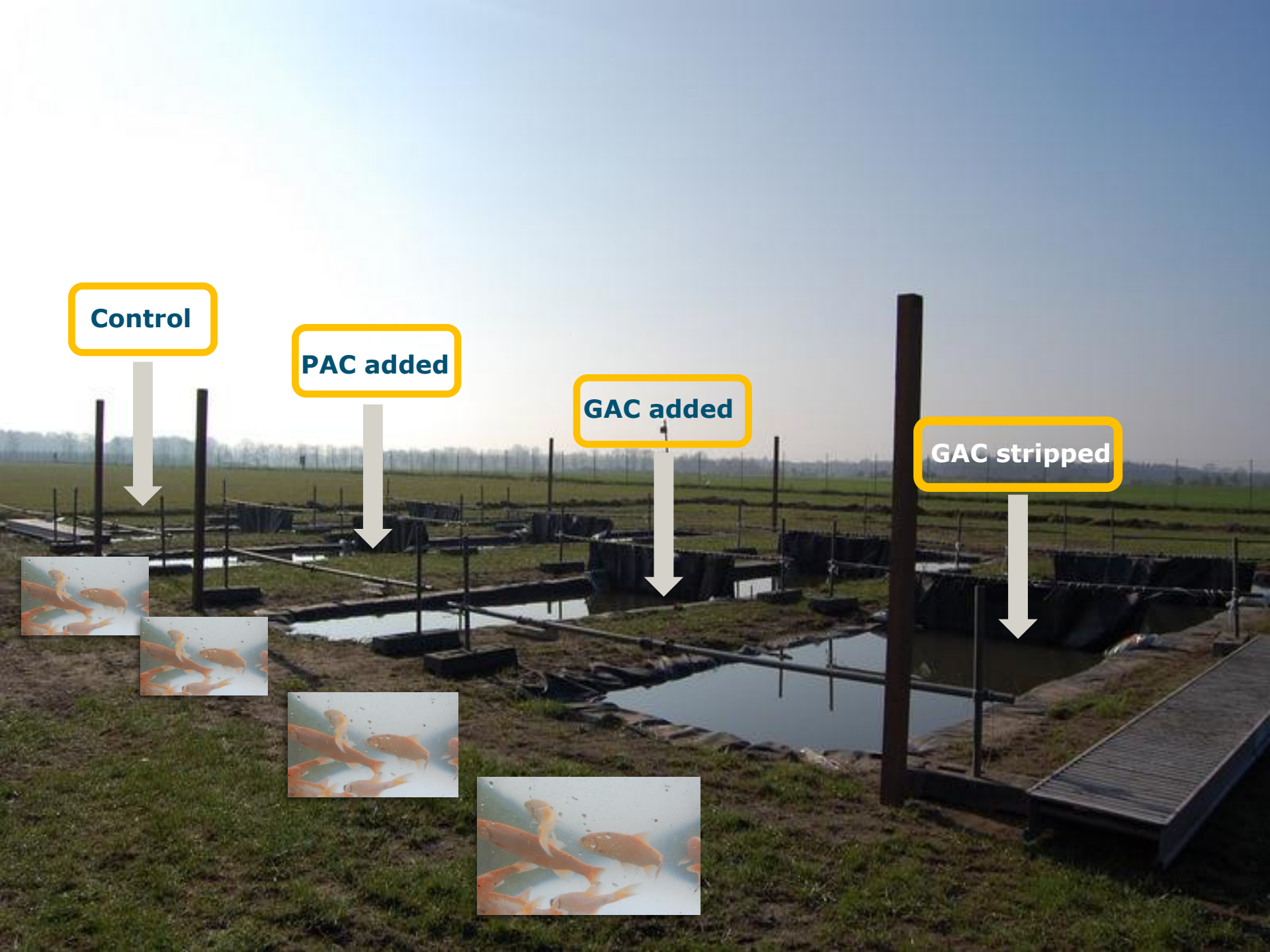
GAC mixed for 48h➔ sieved at 1 mm

Delivery sediment to 4 Ditches

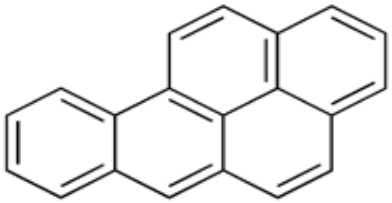
Sediment mixing before AC addition

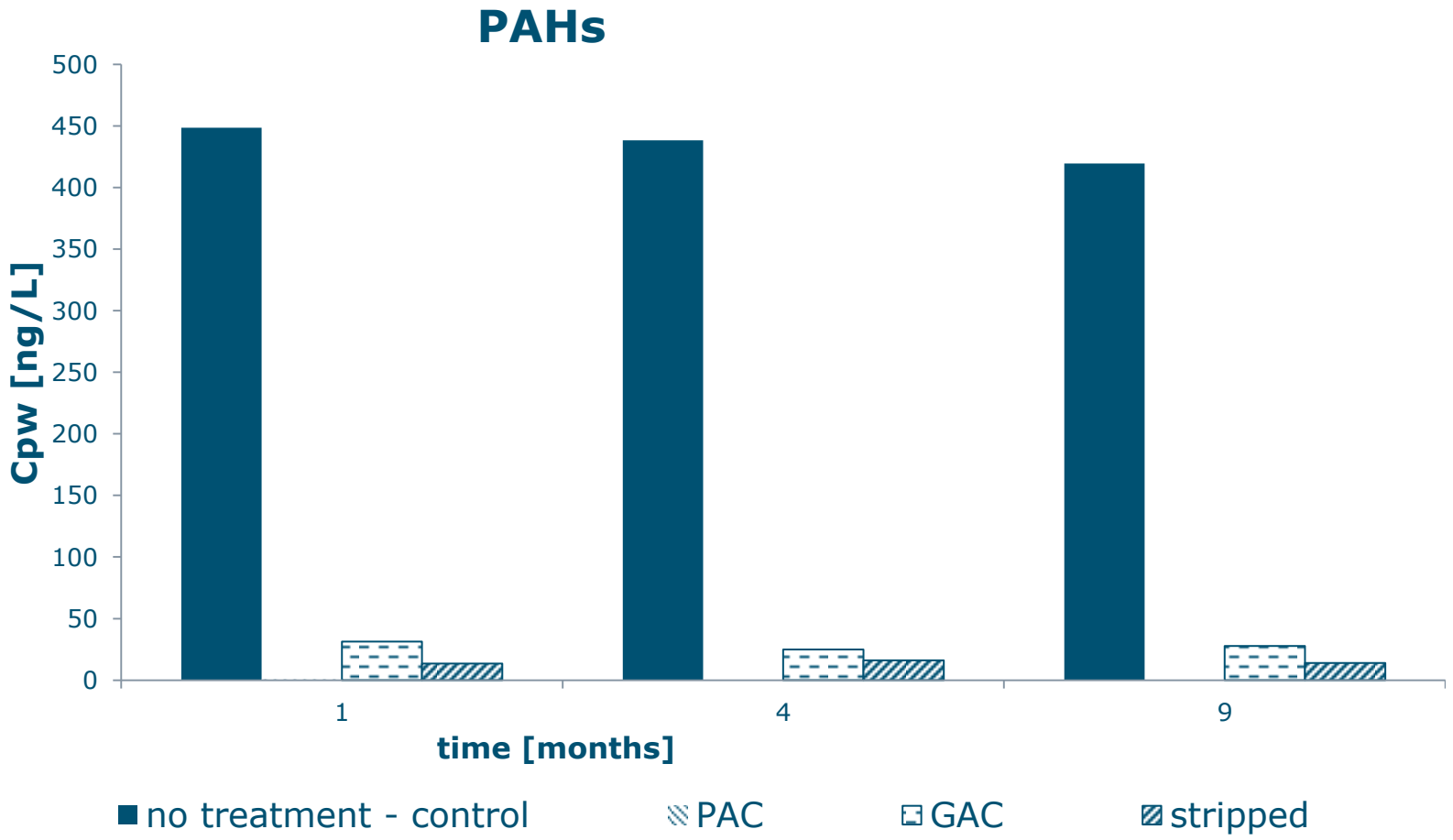
GAC Mixing

GAC Sieving 1 mm


Control
PAC added
GAC added
GAC stripped

Pore water concentration (Cpw) (method: POM-SPE)





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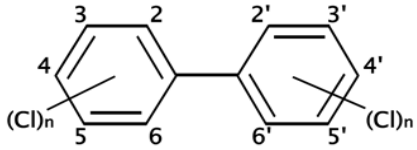
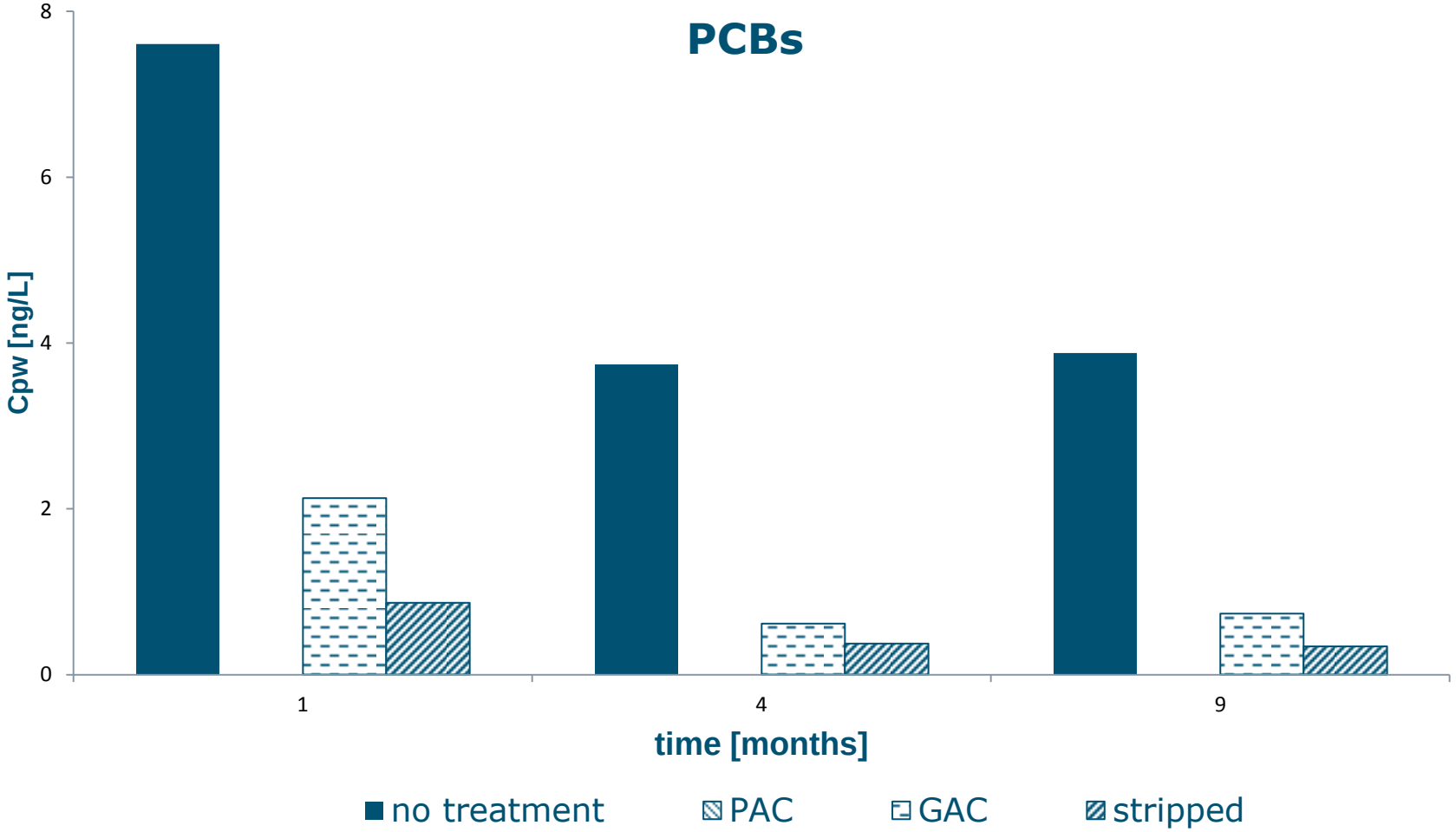
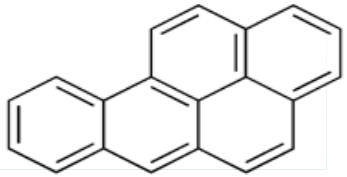
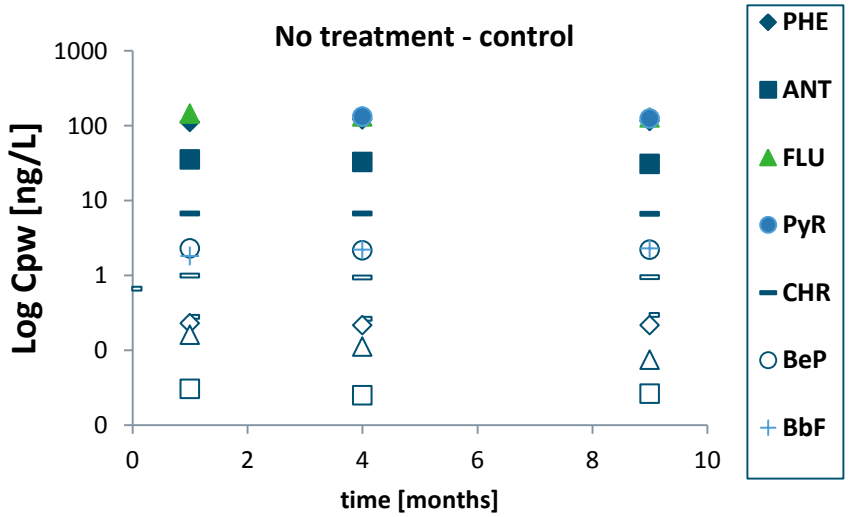
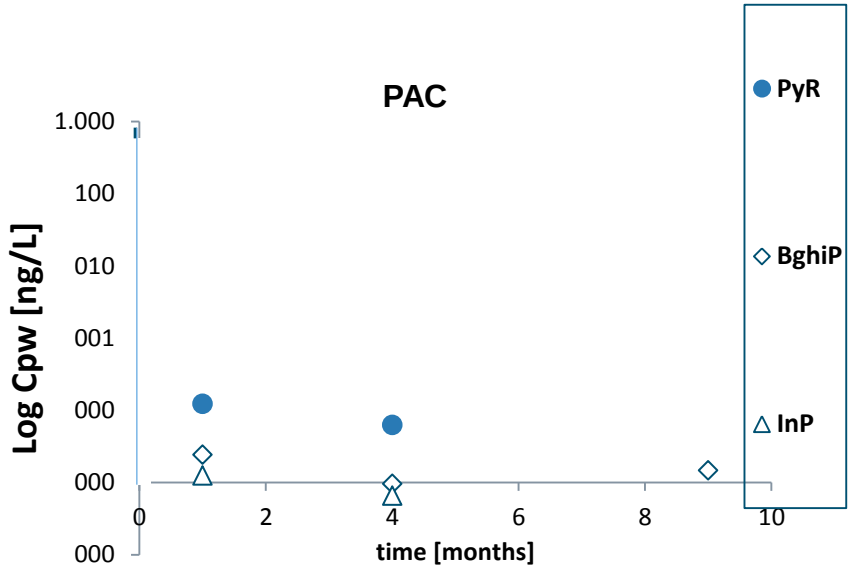


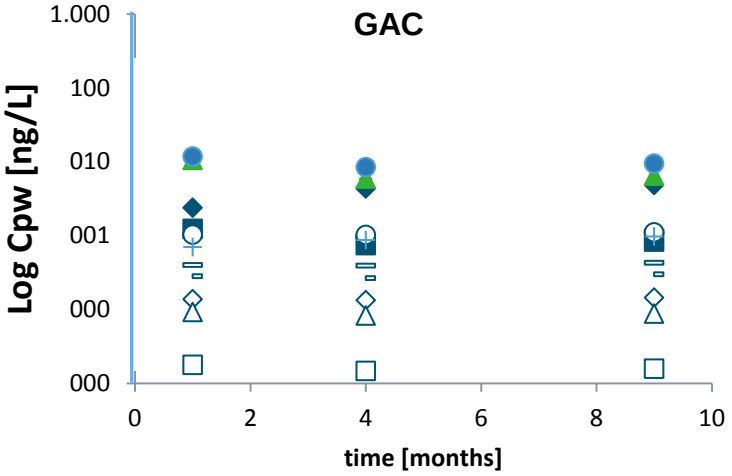


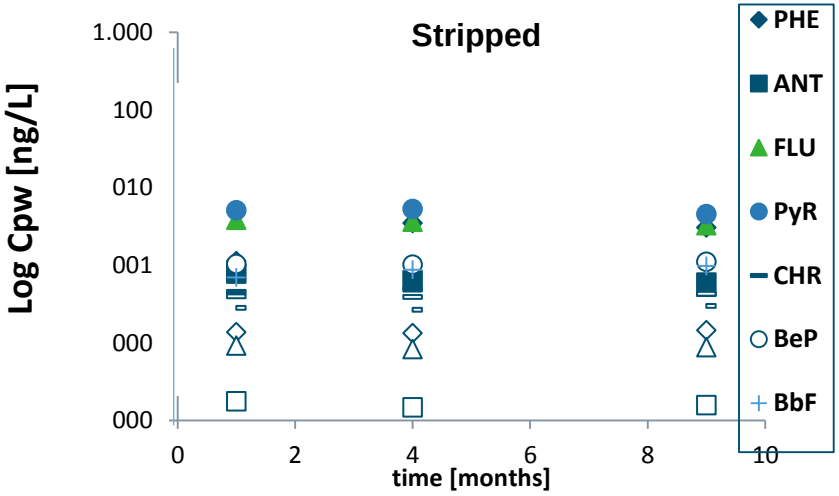
Individual PAH C_{pw}











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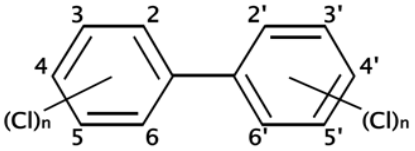
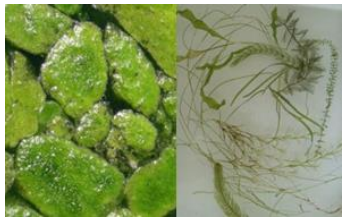
Effect on bioaccumulation PCBs



Zooplankton

Macro invertebrates



Conclusions Field test:

- AC effect on reducing HOC pore water and fluxes decrease in the order PAC>stripped>GAC

  (factor 100 to 10)

- PAC reduces PCB bioaccumulation in zooplankton, macroinvertabrates, plants and fish

- Sorption to PAC is faster than GAC

Outlook for AC immobilization concepts

AC immobilization concepts

- Powder Activated Carbon (PAC):
  - Wetland: PAC capping
  - Deep ponds: PAC encapsulation
- Granular Activated Carbon (GAC):
  - Harbors: GAC mixed in sediment
  - Reuse sediment: GAC extraction/separation

Nieuwe technologie
mogelijk maken

Norit

leading in purification

Boskalis

Deltares

Enabling Delta Life

rivm

de Vries
& van de Wiel

Milieu, GWW- & baggerwerken

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Publications

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