Developing Bivalves as Biomonitors of PFAS in Coastal Ecosystems

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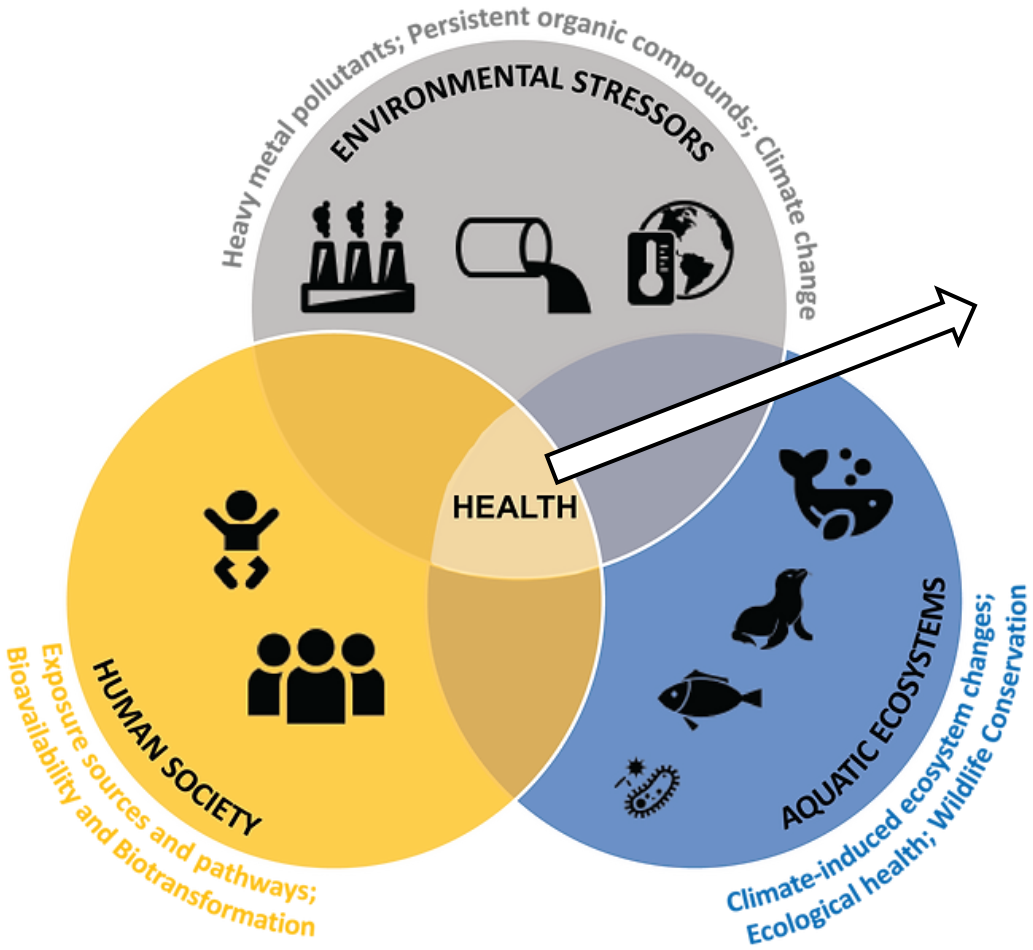
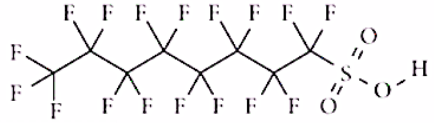


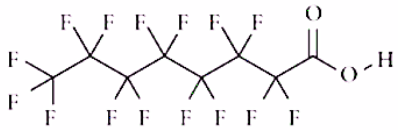
We study connection between contaminants in seafood and public health

Coastal Ecosystems Are Affected By PFAS

- Coastal ecosystems are economically and ecologically important.
- Water mobilizes and transports PFAS into coastal ecosystems.
  - Potential impact on humans and wildlife.
- Few environmental monitoring programs have incorporated PFAS into monitoring coastal waters on a national or regional level.



PFOS

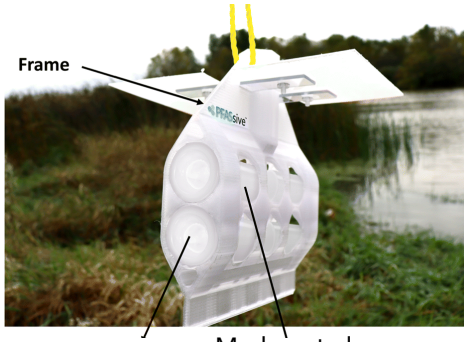


PFOA

Image from Woods Hole Oceanography Institute

Common Environmental Monitoring Approaches

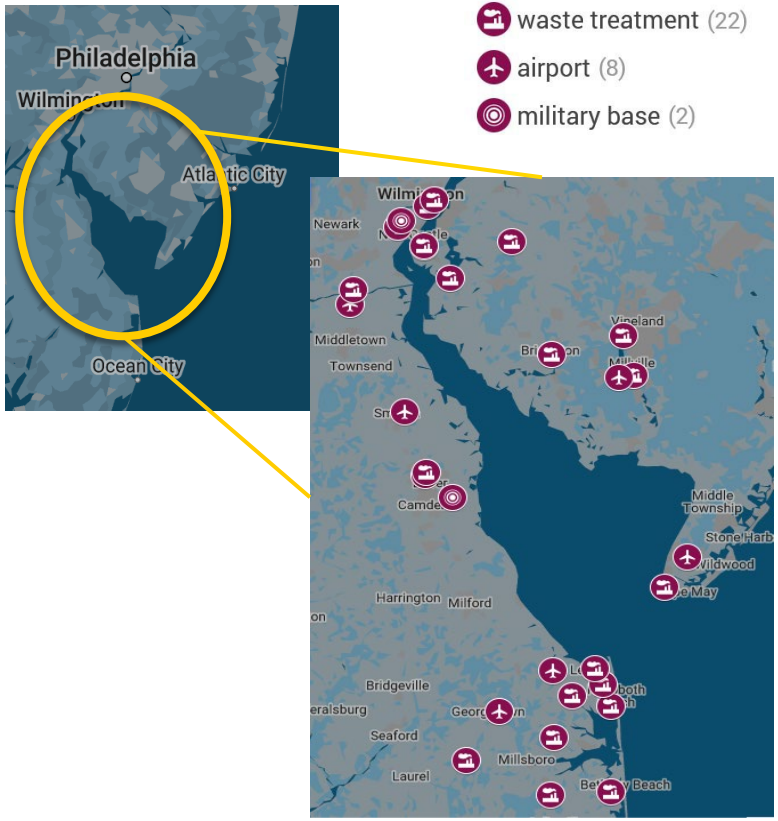
- Grab sampling
- Passive samplers
- Wildlife as biomonitors
  - Bivalves
    - Filter feeders
    - Simple exposure route
    - Sessile, site-specific, multi-year
    - Time- and ecosystem-integrated: bioavailable fraction of pollutant



Medon et al. 2023

Study Site: Delaware Bay

- Historical and current PFAS point-sources
  - Industry and manufacturing
  - Wastewater treatment plants
  - Superfund sites
  - Military bases
  - Airports
  - Cities



Study organisms

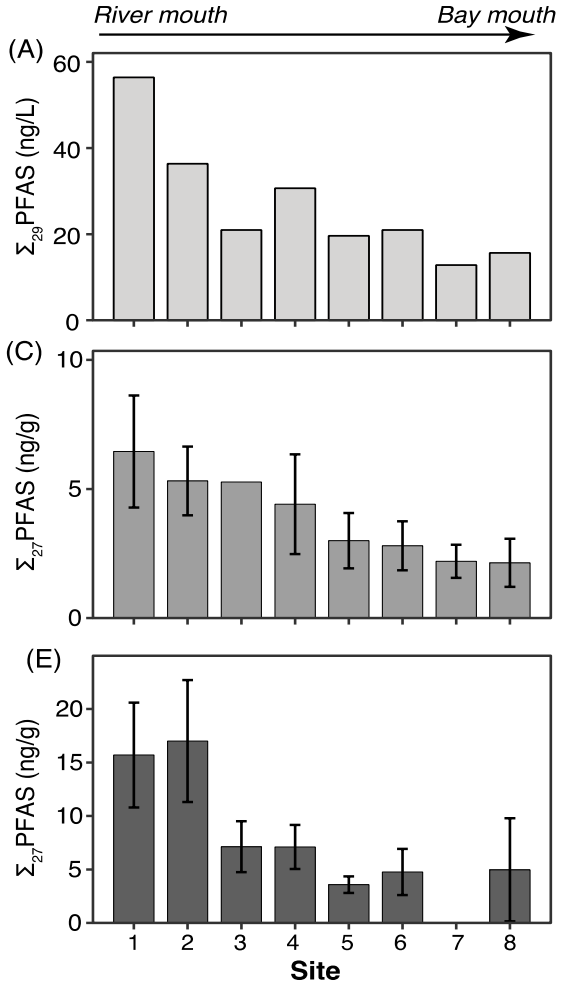
- Two bivalves are plentiful in Delaware Bay:
  - Eastern oyster (*Crassostrea virginica*)
  - Ribbed mussel (*Geukensia demissa*)
- Grow together in reef-like structures
- Large environmental tolerance range

Eastern Oyster

Ribbed Mussel

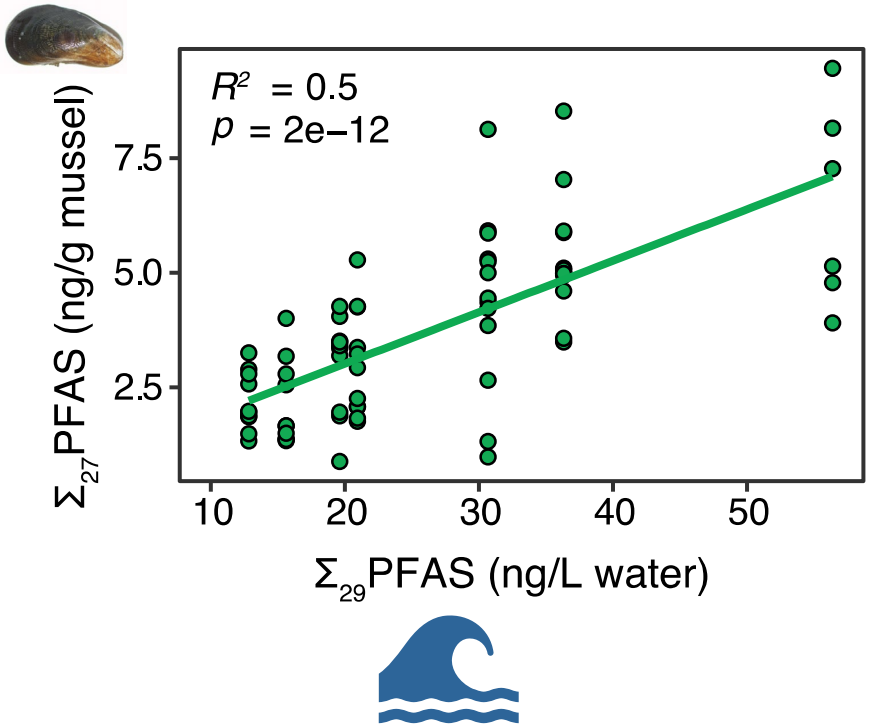
Methods

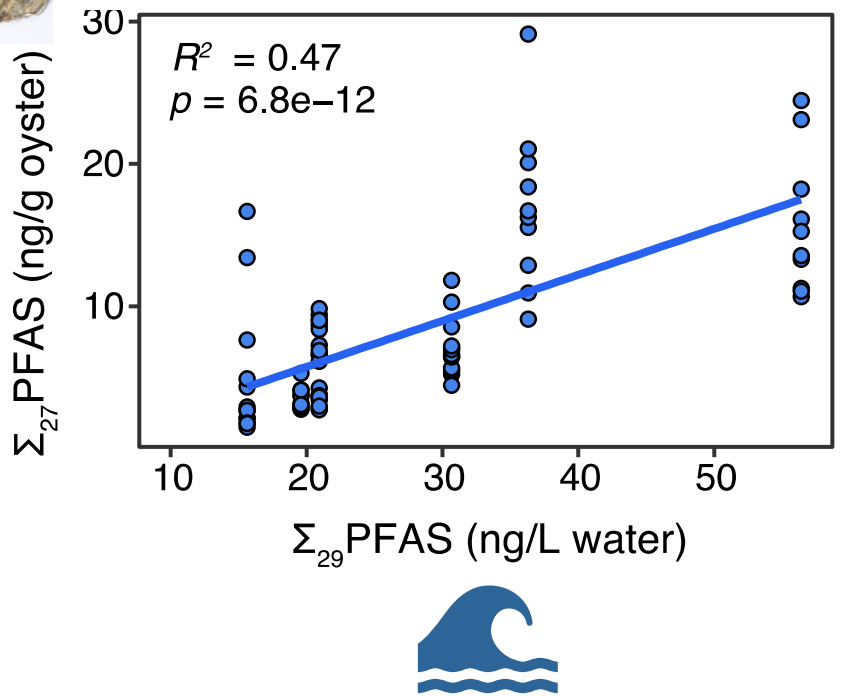
- Collect bivalves and water from 8 study sites from river to bay mouth about 10 organisms / species / site
- Extract PFAS from samples
- UPLC-MS/MS targeted analysis of 30 PFAS

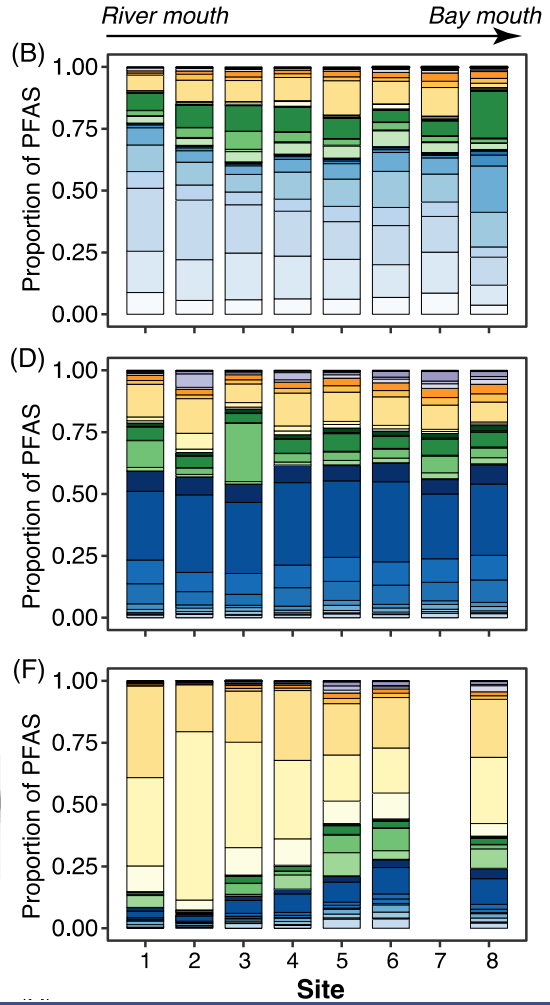


- Decreasing trend in water and bivalves from river to bay mouth.
- Oysters have much higher concentrations than mussels.

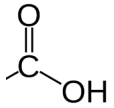
Bivalves' overall PFAS burden correlate with water, but not for individual PFAS



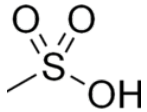




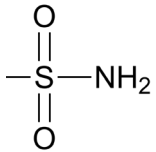
PFBA
PFPeA
PFHxA
PFHpA
PFOA
PFNA
PFDA
PFUnDA
PFDoDA
PFTriDA
PFTreDA
PFCA



PFBS
PFPeS
PFHxS
PFHpS
PFOS
PFNS
PFDS
PFSA

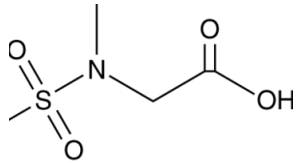


FBSA
FHxA
FOSA
NMeFOSAA
NEtFOSAA
FASA(A)



GenX
ADONA
4–2 FTS
8–2 FTS
9ClPF3ONS
11ClPF3OUdS
Other

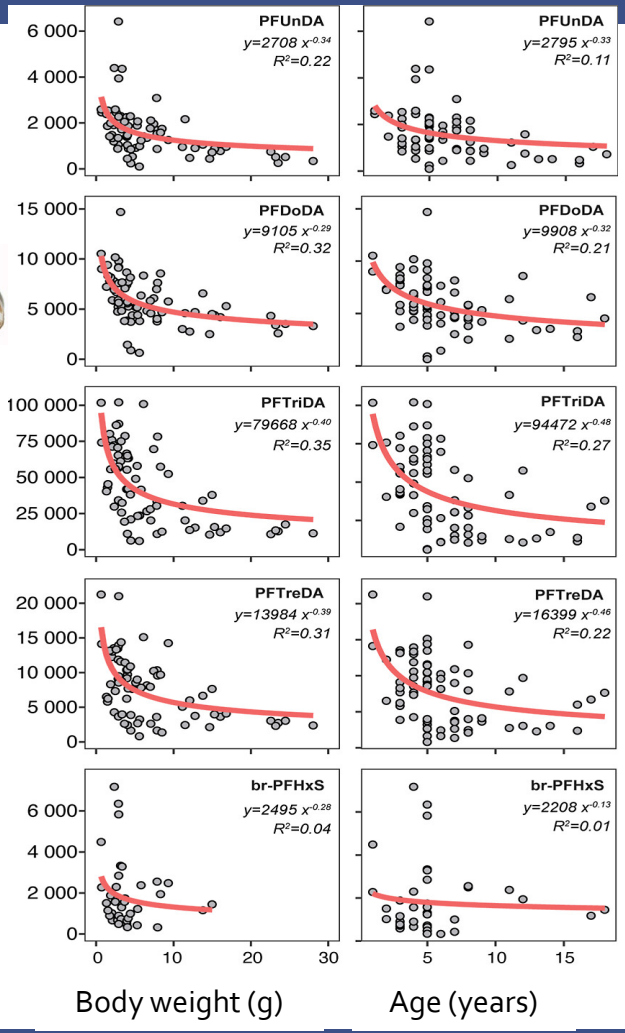
Oysters and mussels have very different PFAS profiles



What's Different Between Oysters and Mussels?

- Similarity
  - Habitat / trophic level
  - Filter similar size range Filtration

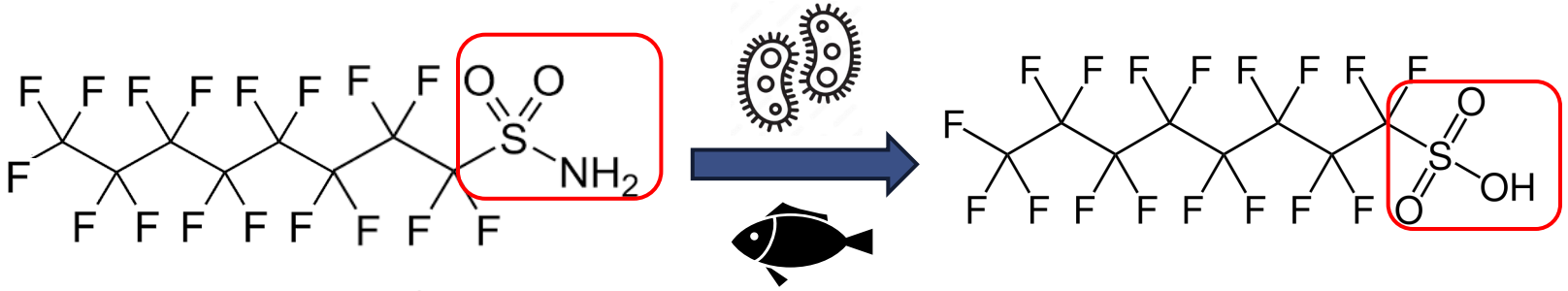
- Differences
  - Different particle sorting mechanisms
  - Oysters grow faster and have shorter lifespan than mussels
    - In this study, oysters (3.6 ± 1.2 years) and mussels (6.3 ± 3.7 years)



Bioaccumulation is affected by biological properties of bivalves

- Five most bioaccumulative PFAS in our study
- BAF decreases with body weight for mussels
- BAF decreases with age (so the trend is not because of growth dilution)

Biotransformation



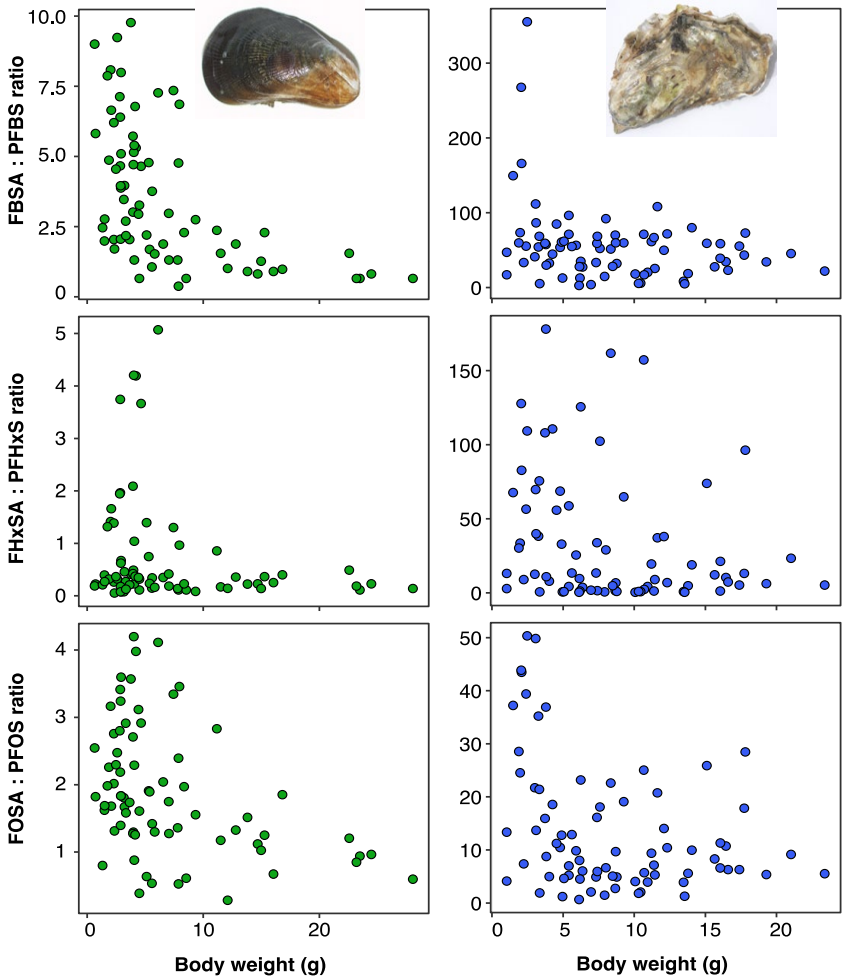
FASA : PFSA concentration ratio indicates the extent of biotransformation

Let's look at 3 ratios

FOSA : PFOS (C8)

FHxSA : PFHxS (C6)

FBSA : PFBS (C4)



- Biotransformation capacity varies by body weight for both species.
  - Age/body size matters!

- Oysters have much higher ratios than mussels (7 to 50 times).
  - Lipid and protein content?
  - Metabolic process?
  - Under investigation by our ongoing USDA project.

Stay Tuned

Implications for Biomonitoring

ΣPFAS in water, mussel, and oyster decreased from Delaware River to Bay mouth → Bivalves can be useful to reflect ΣPFAS in the environment.

High bioaccumulation potential;
Low biotransformation capacity

→ Monitoring bioavailable precursor compounds

Low bioaccumulation potential;
High biotransformation capacity

→ Monitoring terminal compounds

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Article

Assessing Bivalves as Biomonitors of Per- and Polyfluoroalkyl Substances in Coastal Environments

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DELAWARE

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- Andrea Tokranov and Zack Hopkins (USGS) and Anna Robuck (US EPA)
- All of you for listening!

Questions?