From The Bottom Up: Deciphering Bioaccumulation And Biomagnification Of PFAS In Plankton

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Introduction

- Poly- and perfluoroalkyl substances (PFAS) are omnipresent in environmental matrices[1]
- Human exposure to PFAS has been associated with immune suppression, metabolic disruption, high cholesterol levels[2]
- Seafood consumption accounts for 86% of mean chronic adult exposure to PFOS[3]
- PFAS in seawater and marine plankton governs accumulation in marine food webs[3]
- Its imperative to understand PFAS interaction in the lower trophic levels to better understand bioaccumulation patterns.

Objectives

Objective 1: Determine the uptake, transformation and bioaccumulation of PFAS in phytoplankton.
Objective 2: Determine the uptake, transformation and bioaccumulation of PFAS in zooplankton.
Objective 3: Assess bioaccumulation and magnification of PFAS from phytoplankton to zooplankton.

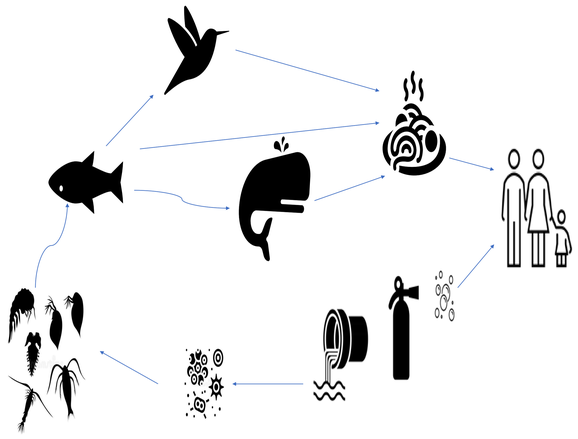
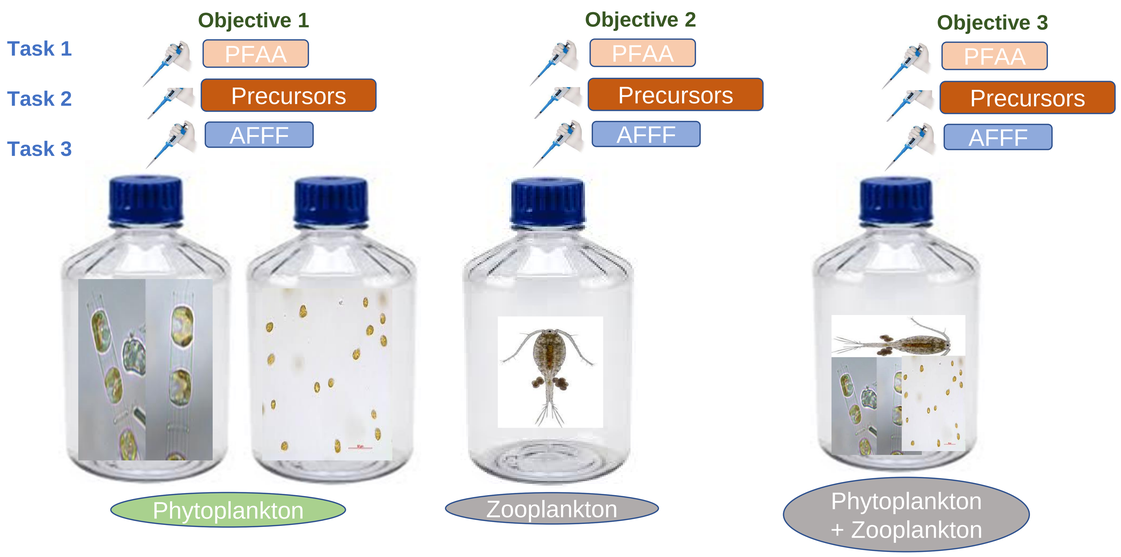


Figure 1. A very simplified path way for PFAS human exposure pathways

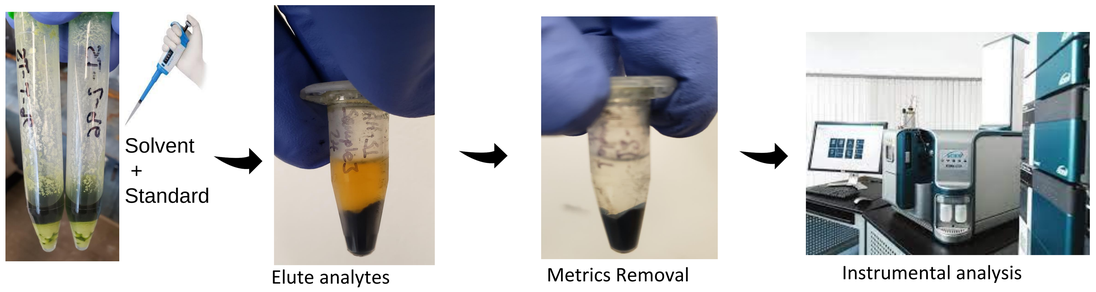
Methods and Materials

- Maintain monocultures and polycultures for spiking experiments



- Exposure length experiment to determine establishment of partitioning equilibrium and uptake kinetics (24, 48, 96, and 192 hours)
- Extraction of samples and Instrumental analysis

- Sample Elution, Concentration and Analysis



Calculation and Model Approaches

- measure $C_{plankton}$ (ng/g w.w.) and C_{water} (ng/mL)
- verify C_{water} with SPME fibers using $K_{SPME\text{-}water}$

$$K_{SPME-water} = \frac{\text{Conc. in } SPME}{\text{Conc. in } water} \quad \text{.....(Eq.1)}$$

- derive bioconcentration factors (BCF)

$$BCF = \left(\frac{\text{Conc. in plan}kton}{\text{Conc. in } water}\right), \quad \text{.....(Eq. 2)}$$

- derive bioaccumulation factors (BAF)

$$BAF = \frac{Conc.\ in\ predator}{\text{Conc. } in\ Pray} \quad \text{.....(Eq. 3)}$$

Hypothesis

- Phyto- and Zooplankton bioaccumulate PFAA
- Phyto- and Zooplankton bio-transform precursor compounds to PFAA and unaccounted EOF
- BCFs increase with increasing chain length

Assumptions

- Given the small diameter (2-8 µm) of plankton cells, PFAS equilibrate within the ~ 4 day time window
- The diverse plankton species represent different biomass and surface to volume ratios.
- Prior work shows plankton bioaccumulate PFAS

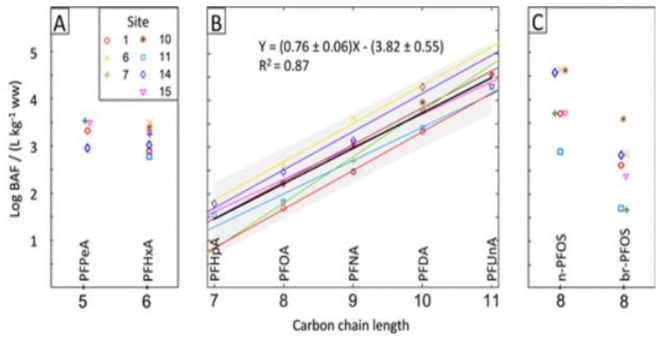


Figure 2. (A–C) Empirically derived bioaccumulation factors (BAFs) for marine plankton (L kg^{-1} wet weight) for linear perfluorocarboxylic acids (PFCAs) (A, B) and linear (n-) and branched (br-) perfluorooctane sulfonate (PFOS) (C) as a function of their carbon chain lengths. (Adapted from Zhang et. al., 2019)

Acknowledgments

Thanks to the Menden-Deuer lab group, especially Pierre Marrec and Jason Schaedler for their help in isolating and providing initial plankton cultures.
My appreciation goes to all members of the Lohmann lab group. A special gratitude for Simon Vojta for his support.

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National Institute of Environmental Health Sciences
Superfund Research Program

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