

Occurrence and fate of per- and polyfluoroalkyl substances in the environment

Lutz Ahrens

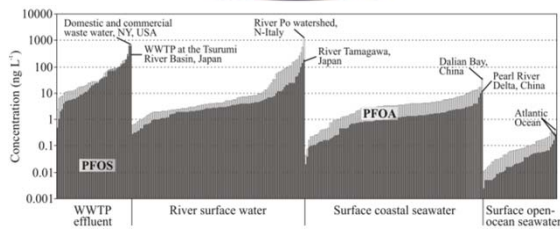
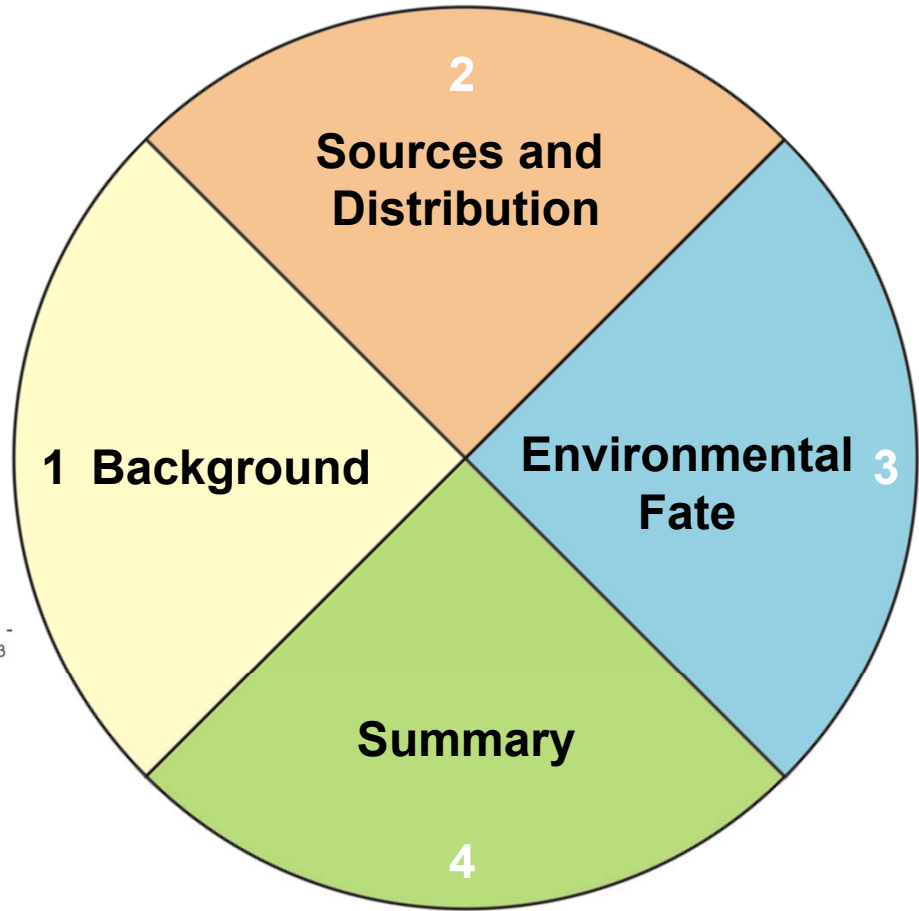
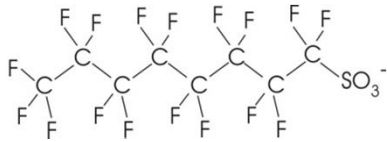
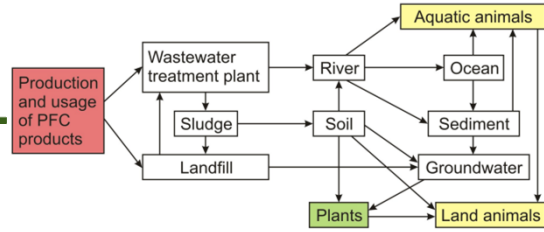
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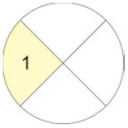
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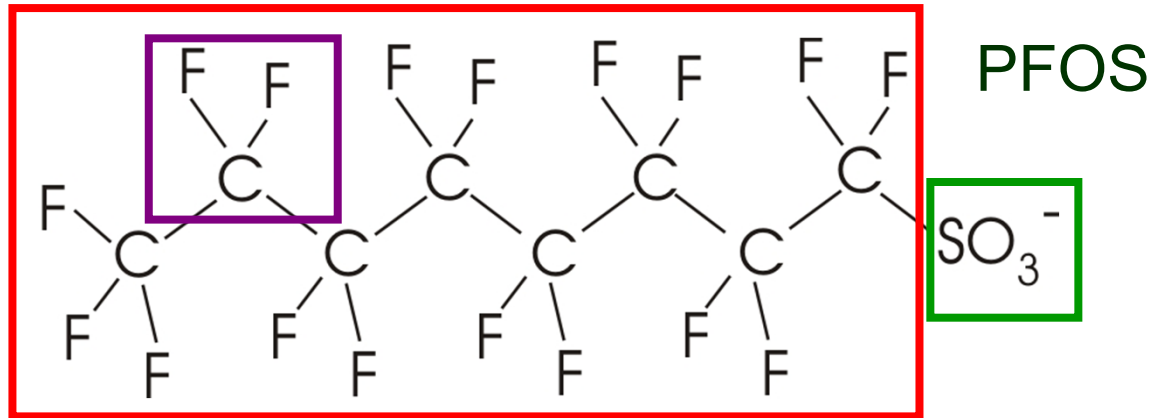


Outline





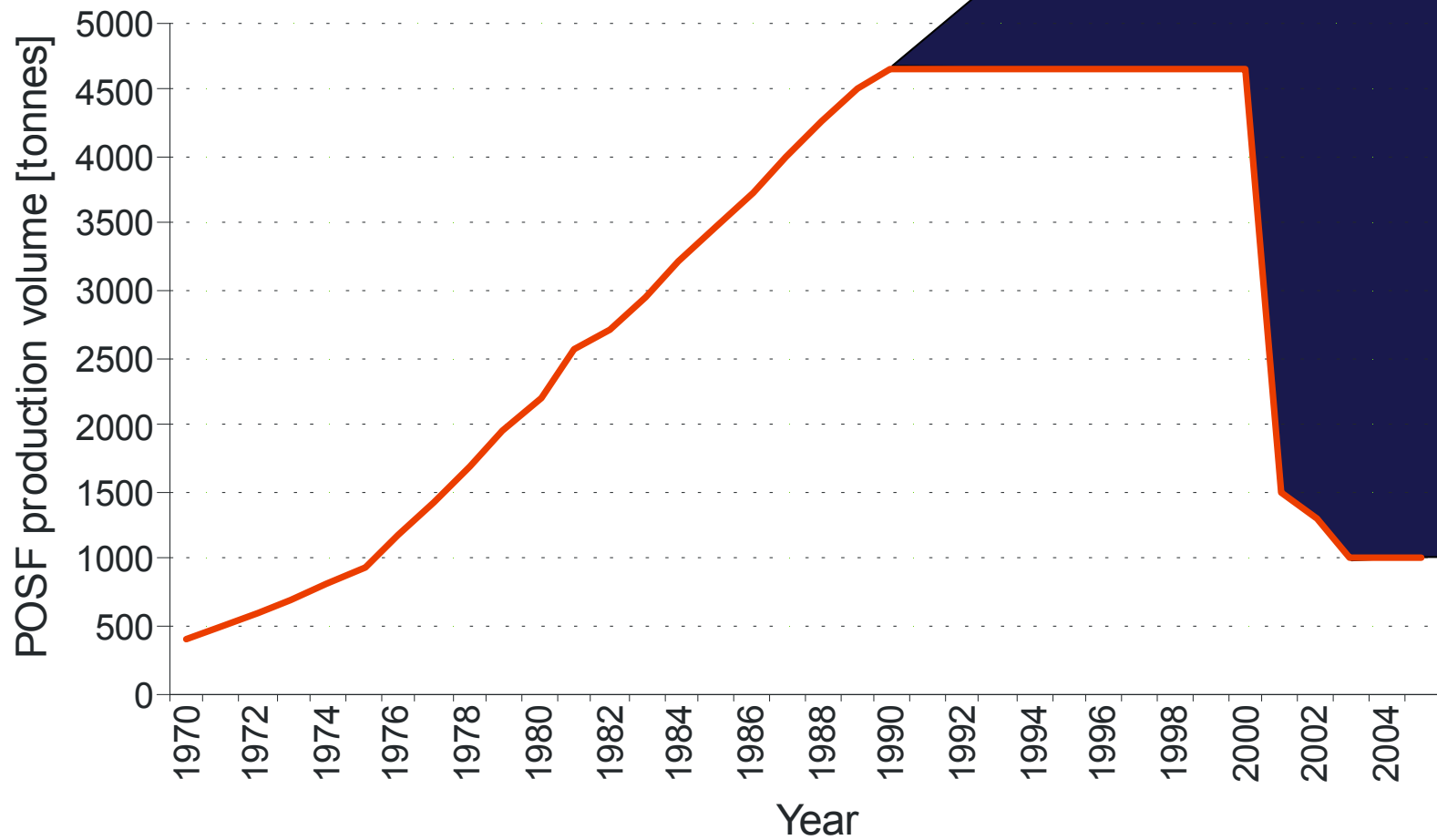
Characteristics of PFASs

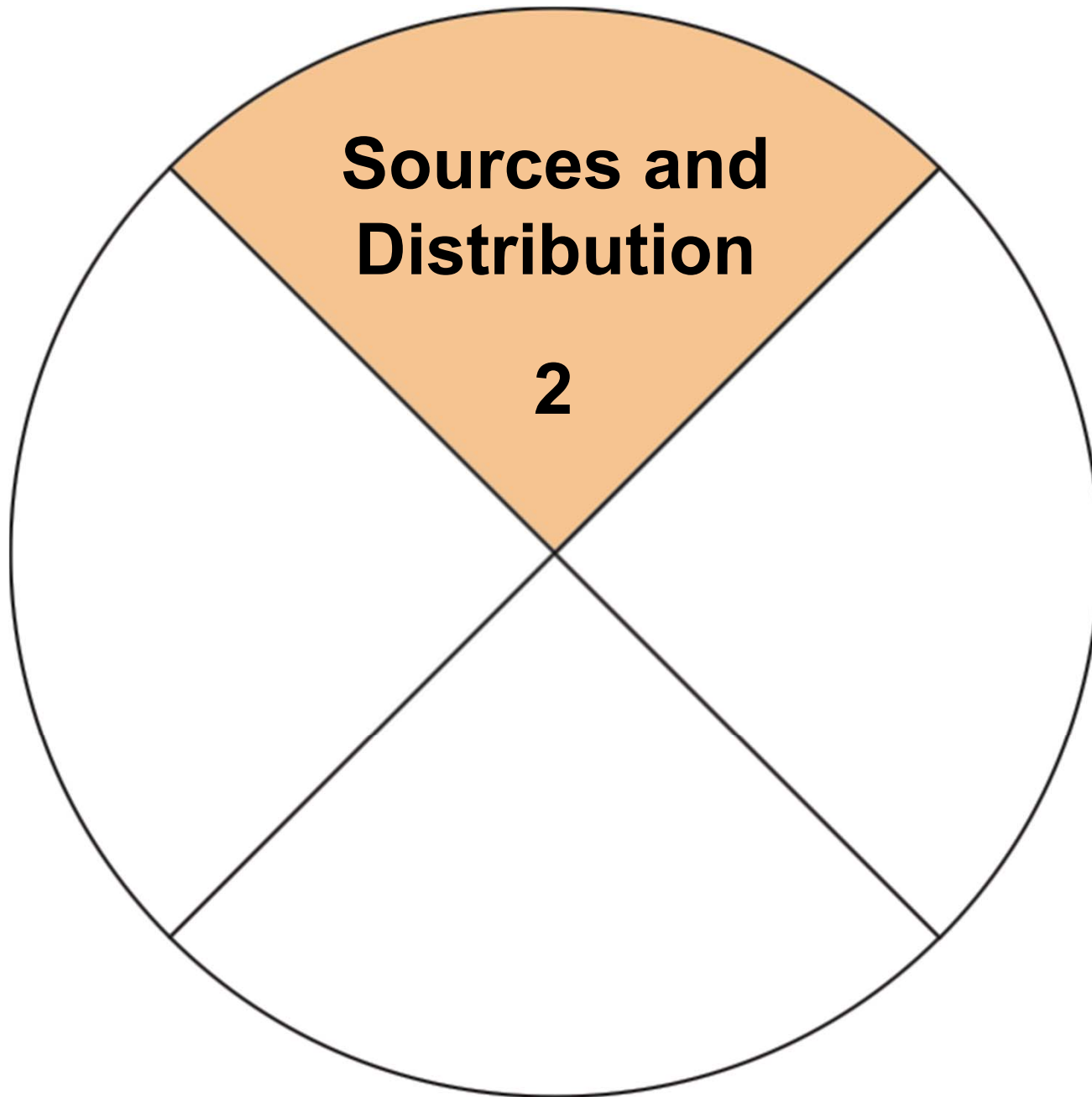


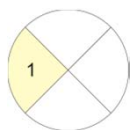
- Unique physicochemical properties
 - C–F → high bond energy
 - **Hydrophobic group** (their “tails”) and **hydrophilic group** (“their head”)
 - Ionizable
- Wide area of application
- Ubiquitous distribution in the environment



Total Global POSF Production

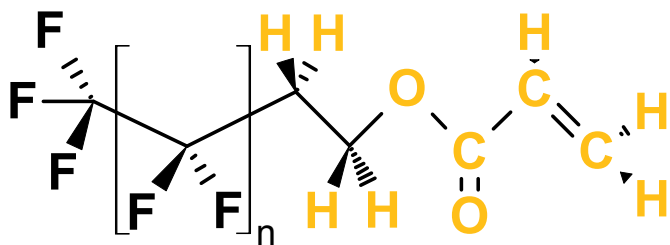




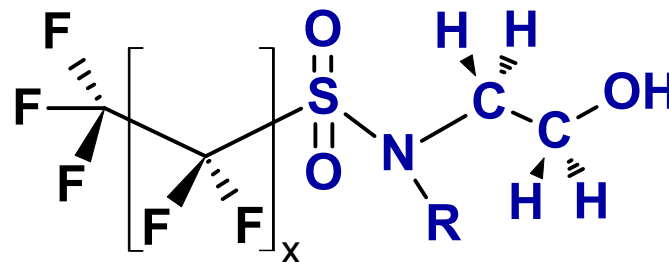


Per- and Polyfluoroalkyl Substances

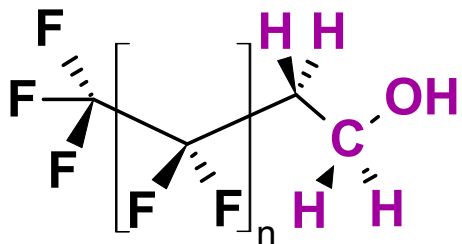
Fluorotelomer acrylates (FTACs)



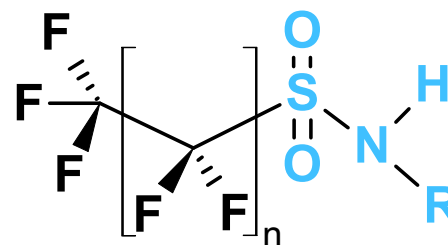
Perfluorooctane sulfonamidoethanols (FOSEs)



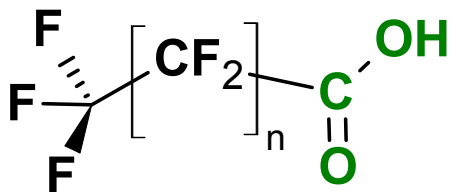
Fluorotelomer alcohols (FTOHs)



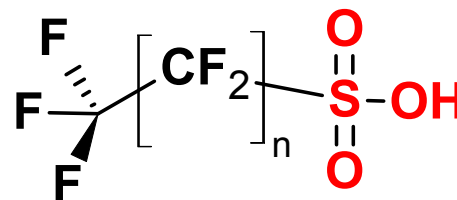
Perfluorooctane sulfonamides (FOSAs)

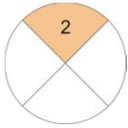


Perfluoroalkyl carboxylic acids (PFCAs)

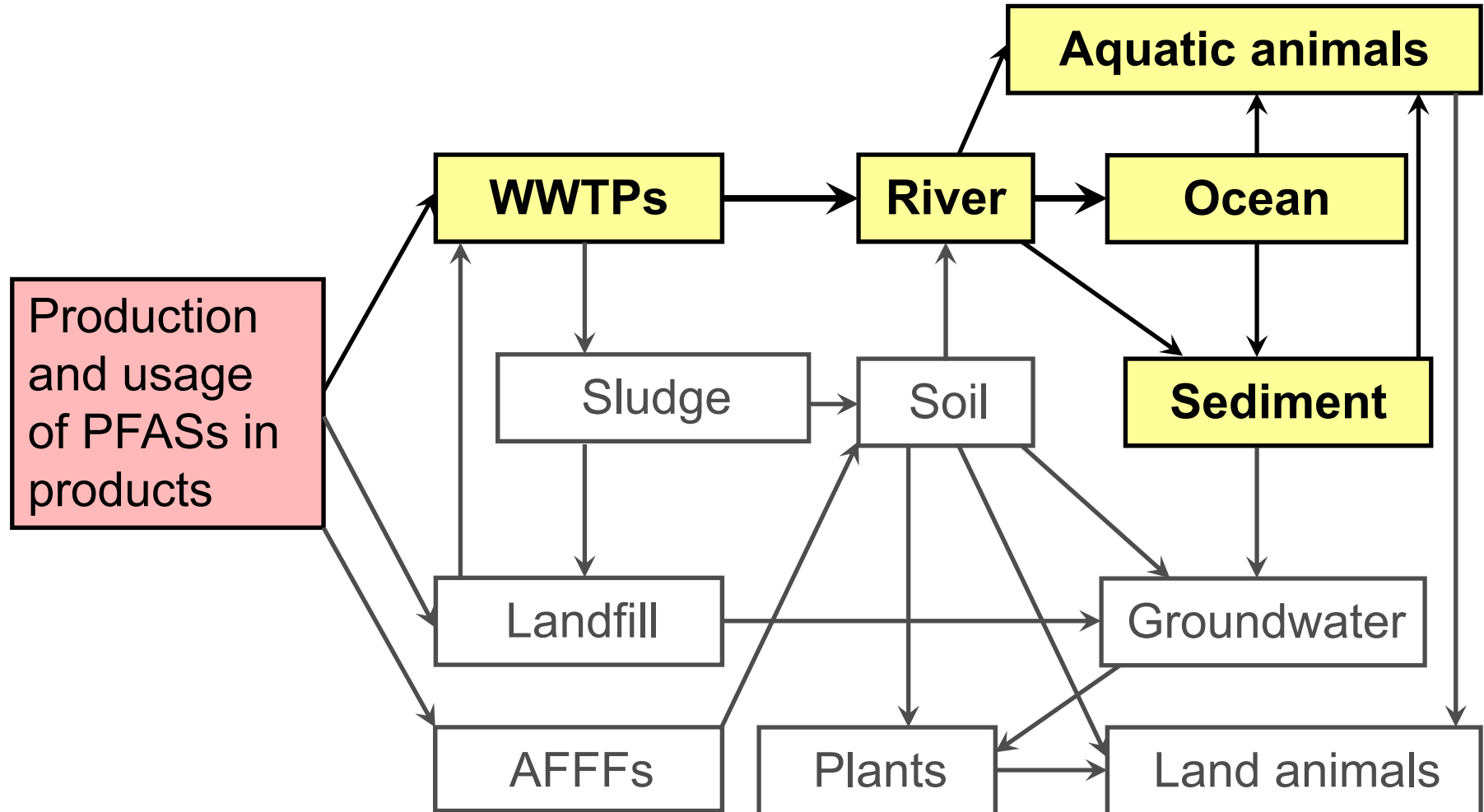


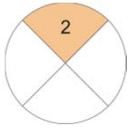
Perfluoroalkane sulfonic acids (PFSAAs)



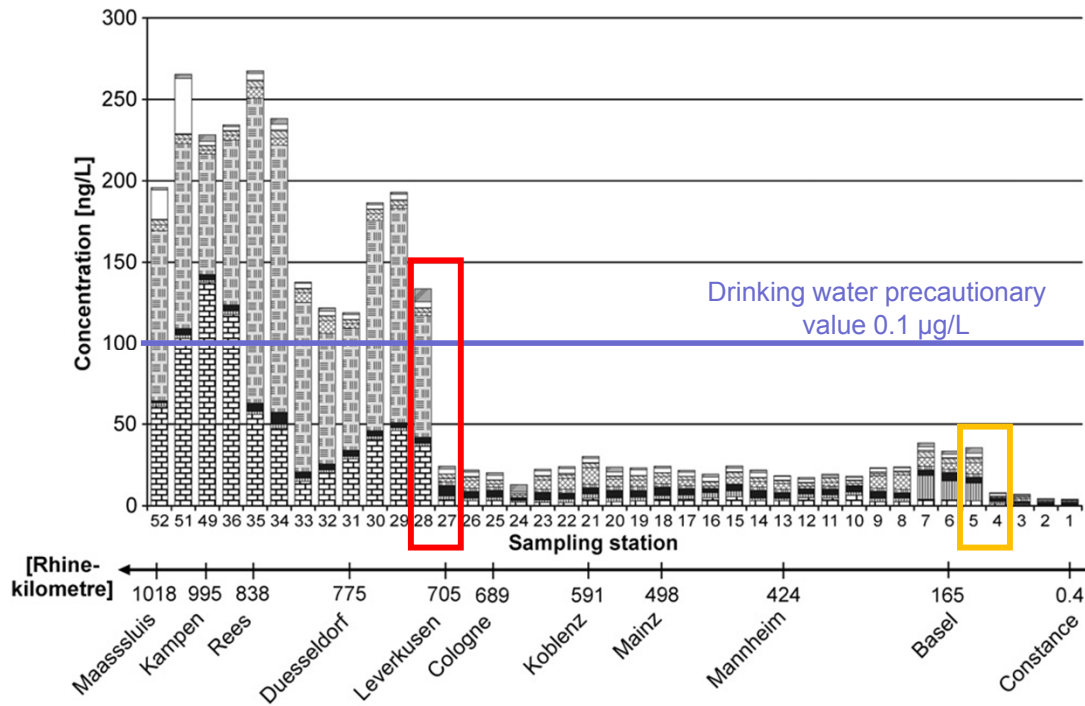


Sources and Distribution of PFASs

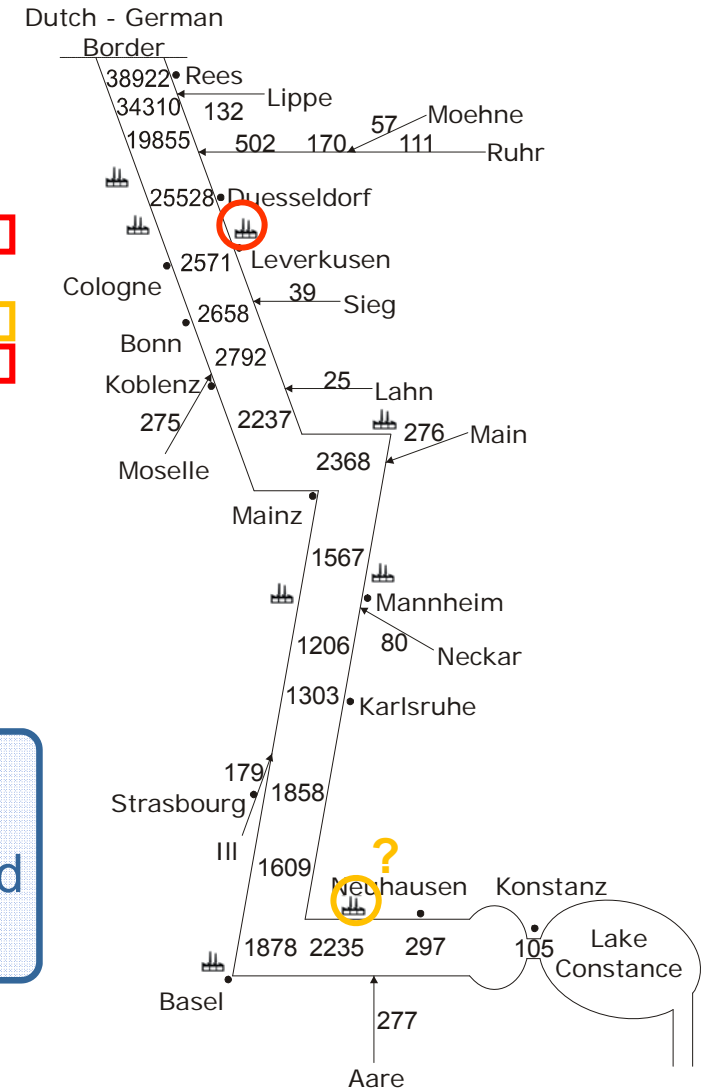




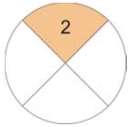
PFASs along the River Rhine



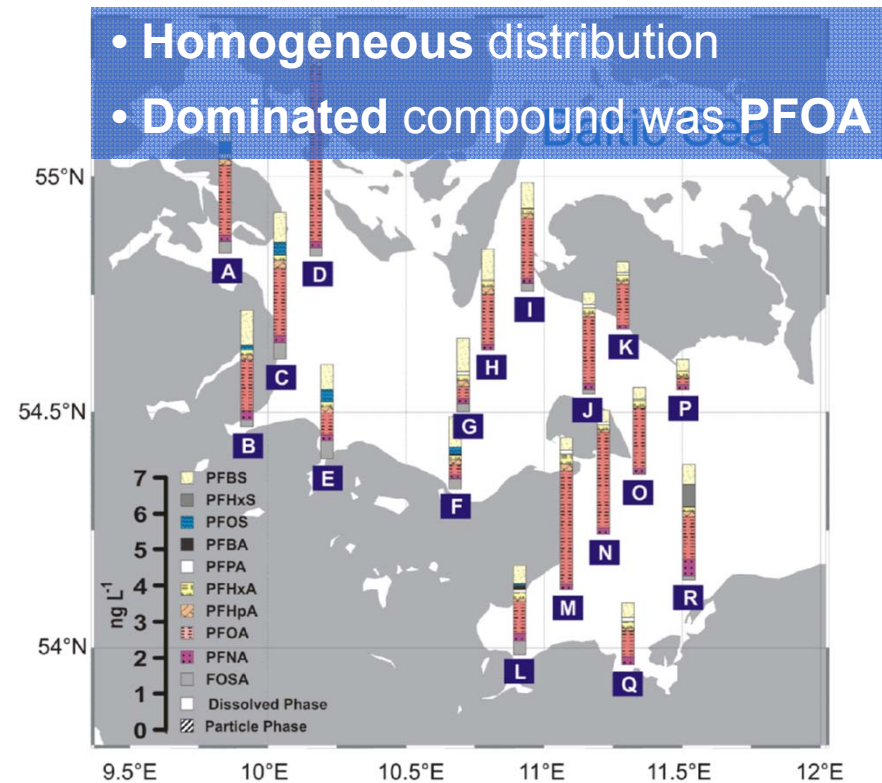
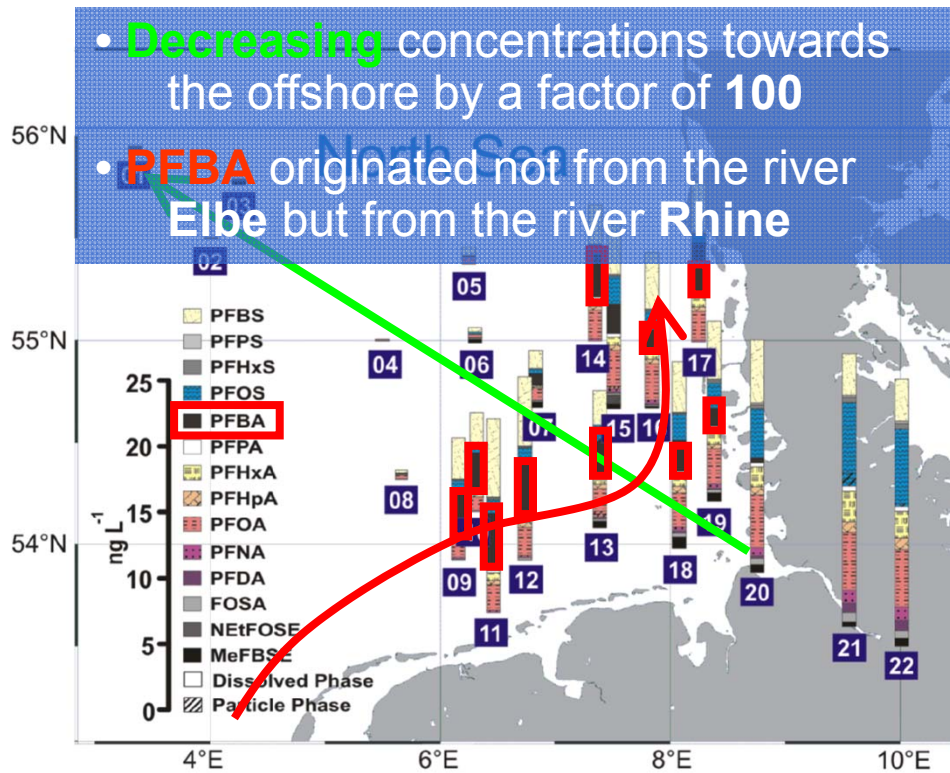
ΣPFAS mass flow in g per day



- Increasing concentrations of PFHxS
- Strong increasing concentrations of **PFBA** and **PFBS** between Leverkusen and Duesseldorf



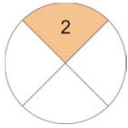
PFASs in the North and Baltic Sea



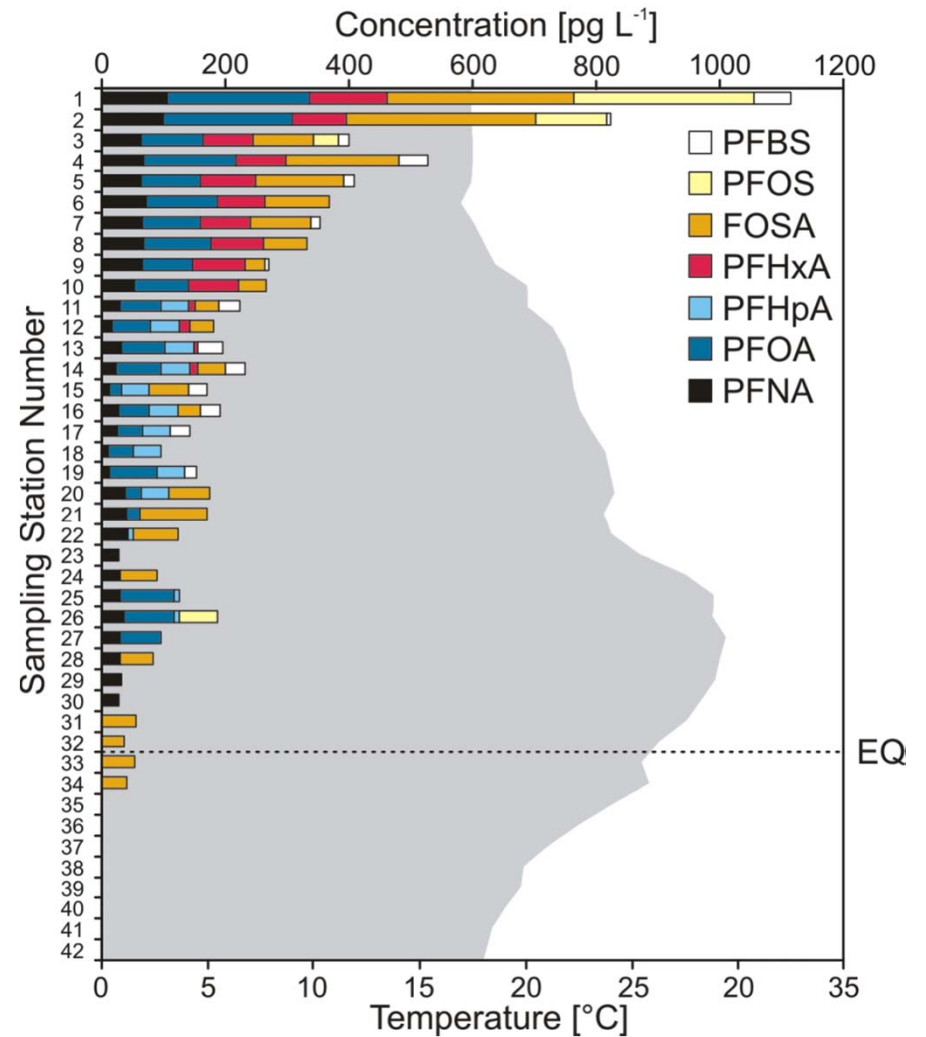
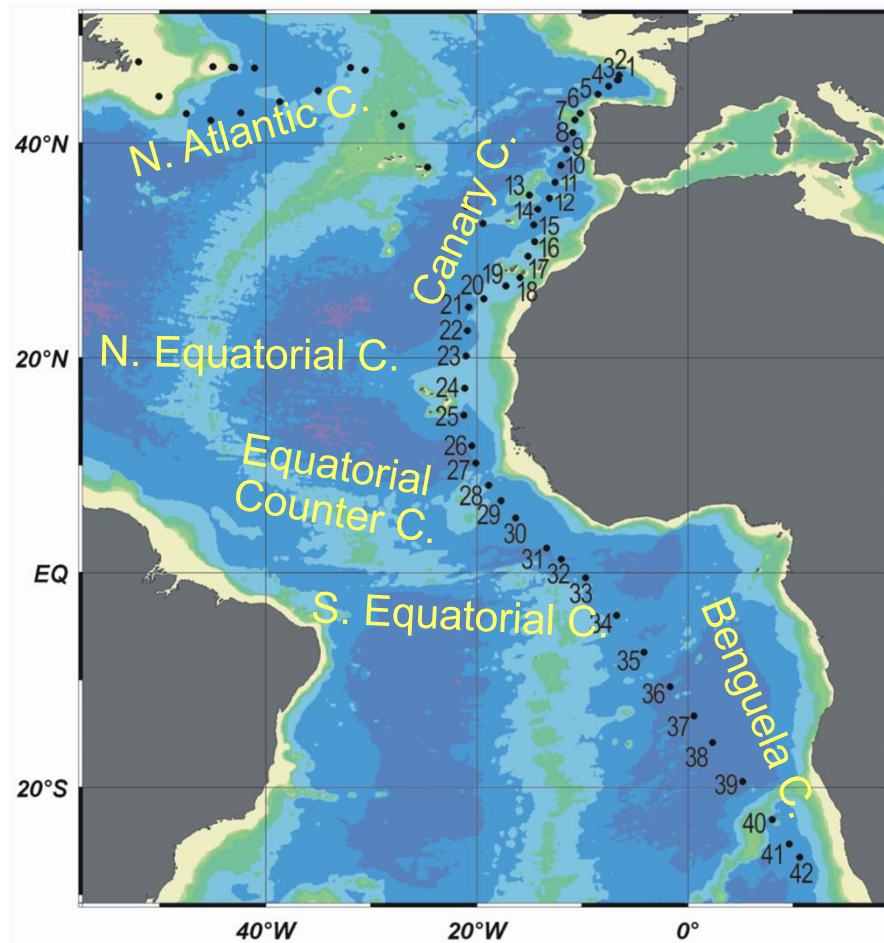
→ **PFASs** were transported by the **rivers** into the **marine environment**

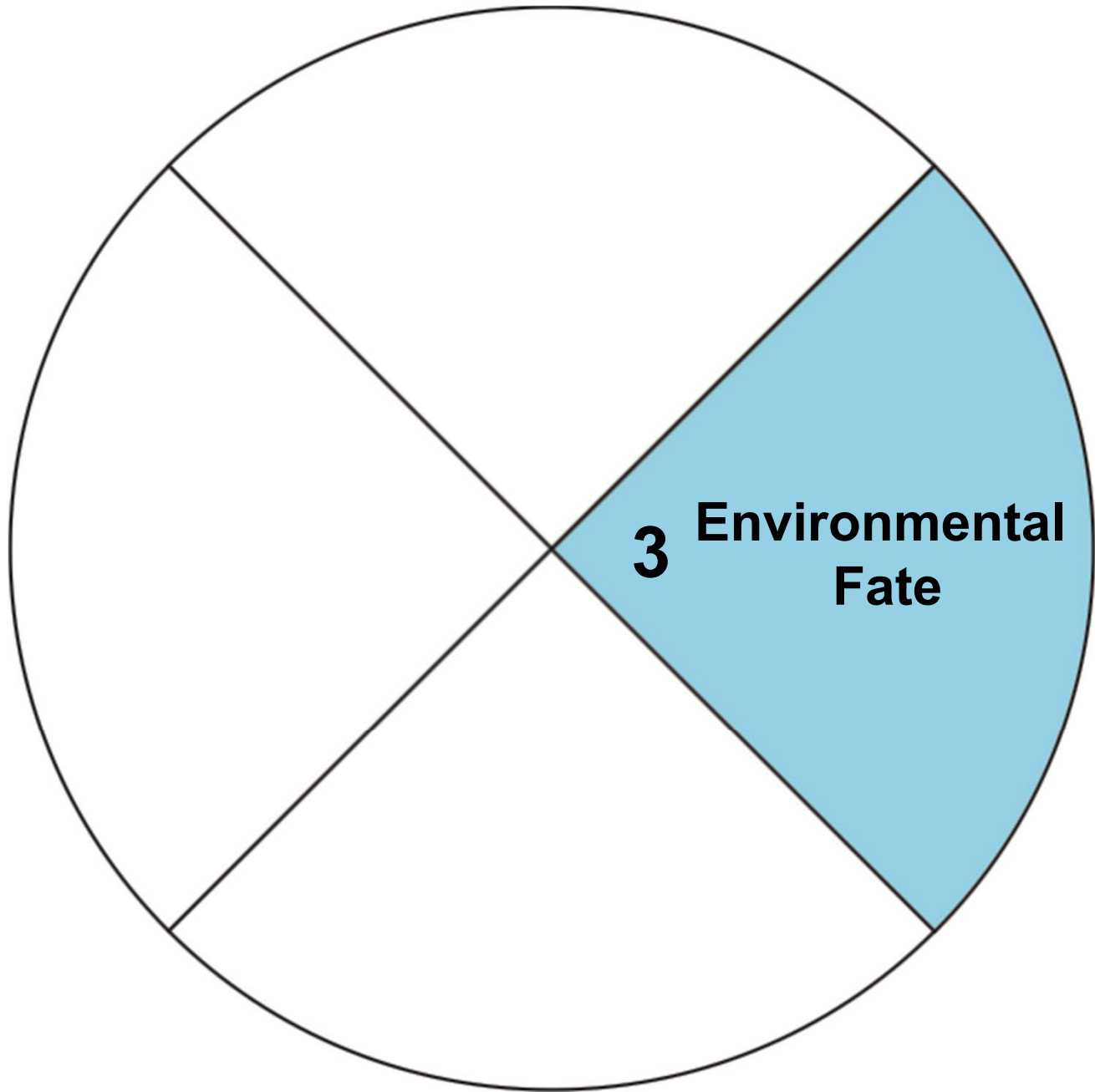
Estimation of the riverine Σ PFASs discharge:

Elbe: ~800 kg/year, **Rhine:** ~8600 kg/year, **Scheldt:** ~2500 kg/year

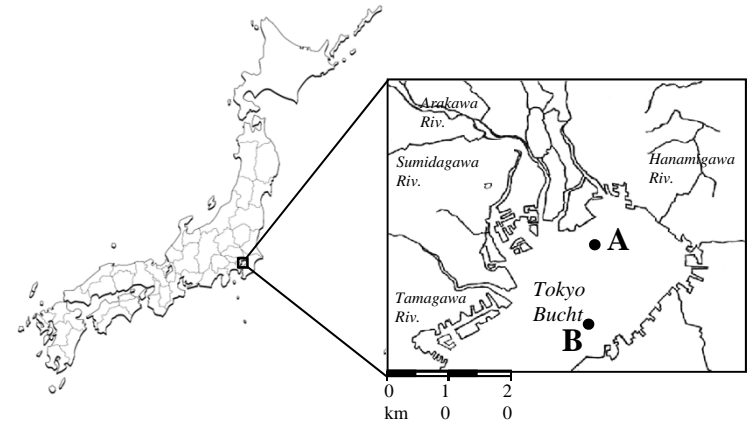
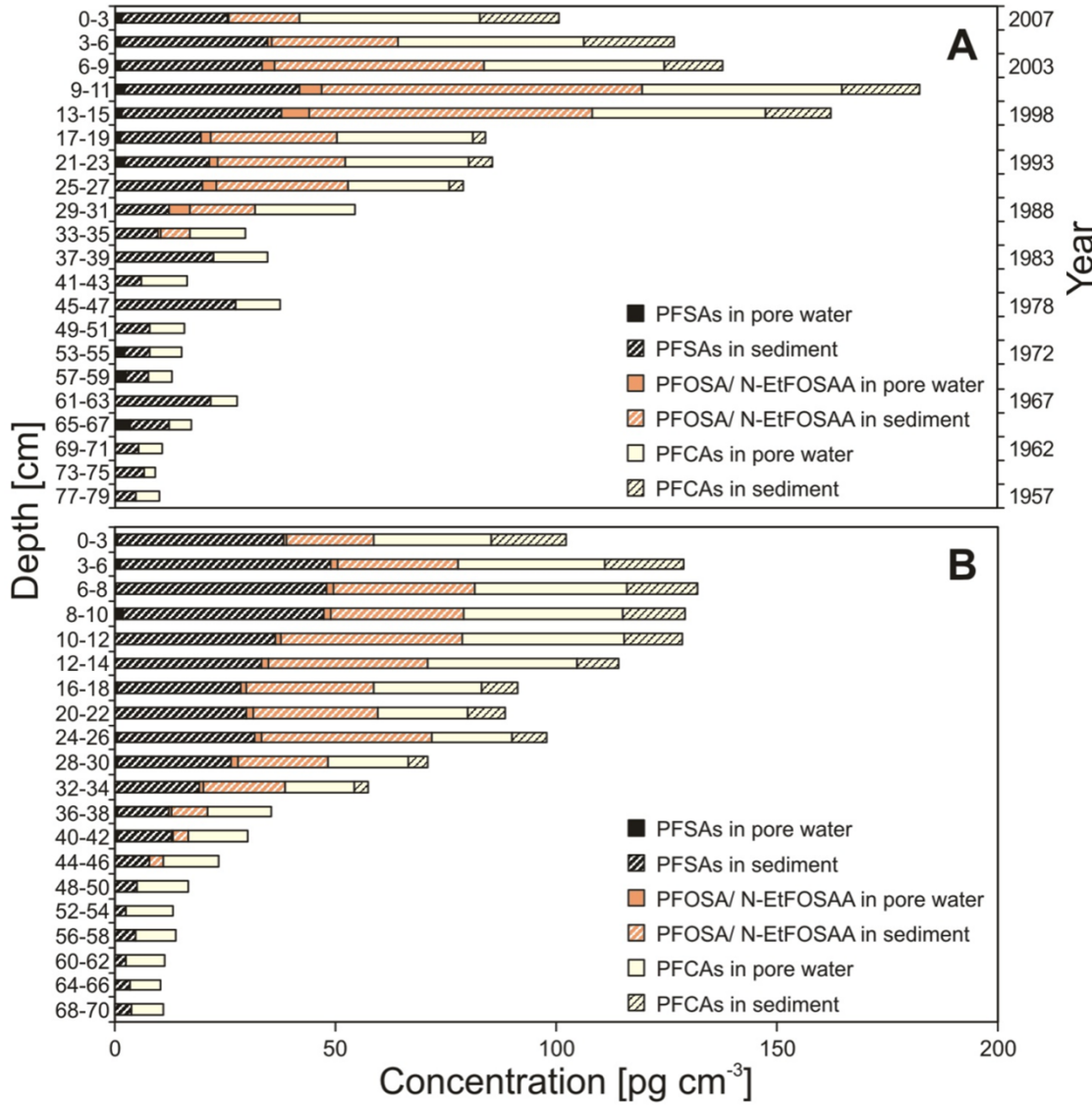


PFASs in Atlantic Ocean Surface Water

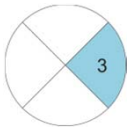




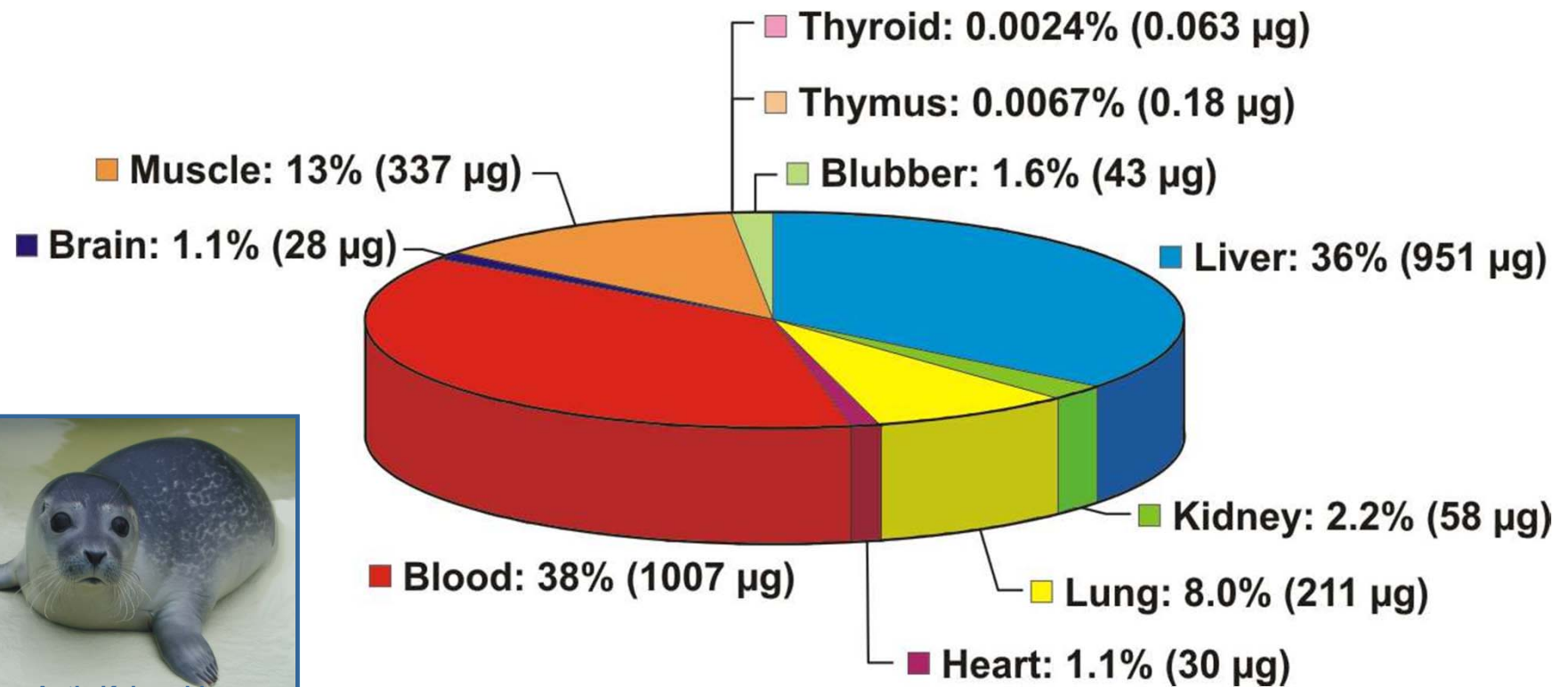
Vertical Profile of PFASs Sediment



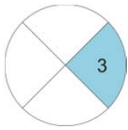
- **PFASs, and PFOSA** were the dominant PFASs in the **sediment** and short-chain **PFCAs** in the **pore water**
- The **highest flux** for the Σ PFASs was observed in **2001-2002**



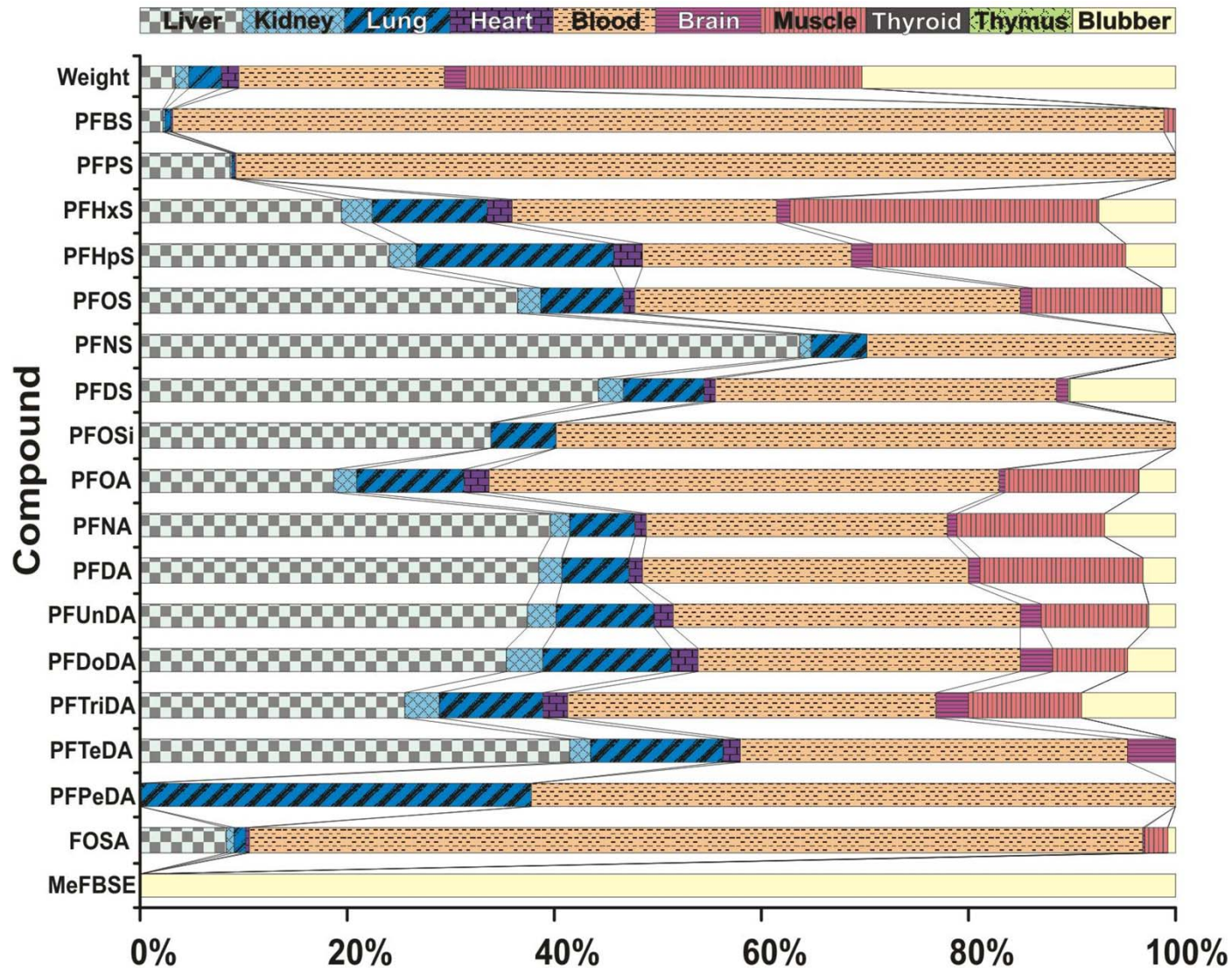
Distribution of Σ PFASs in Harbor Seals



- **Two-third** of the PFASs are distributed in **blood and liver**
- **PFOS** was the **dominated** PFAS with a contribution of **~90%**
- **Σ PFASs total body burden: ~2700 μg absolute**



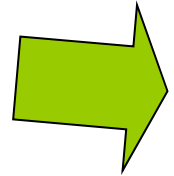
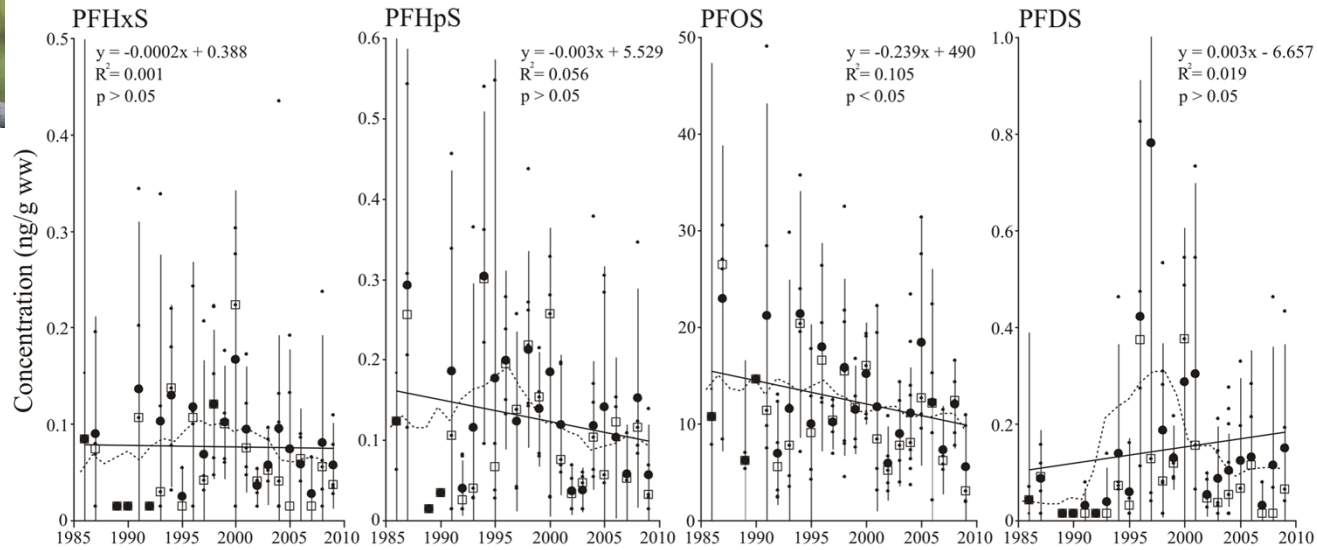
Tissue Distribution for Individual PFAS



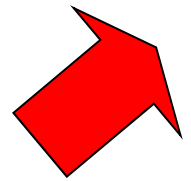
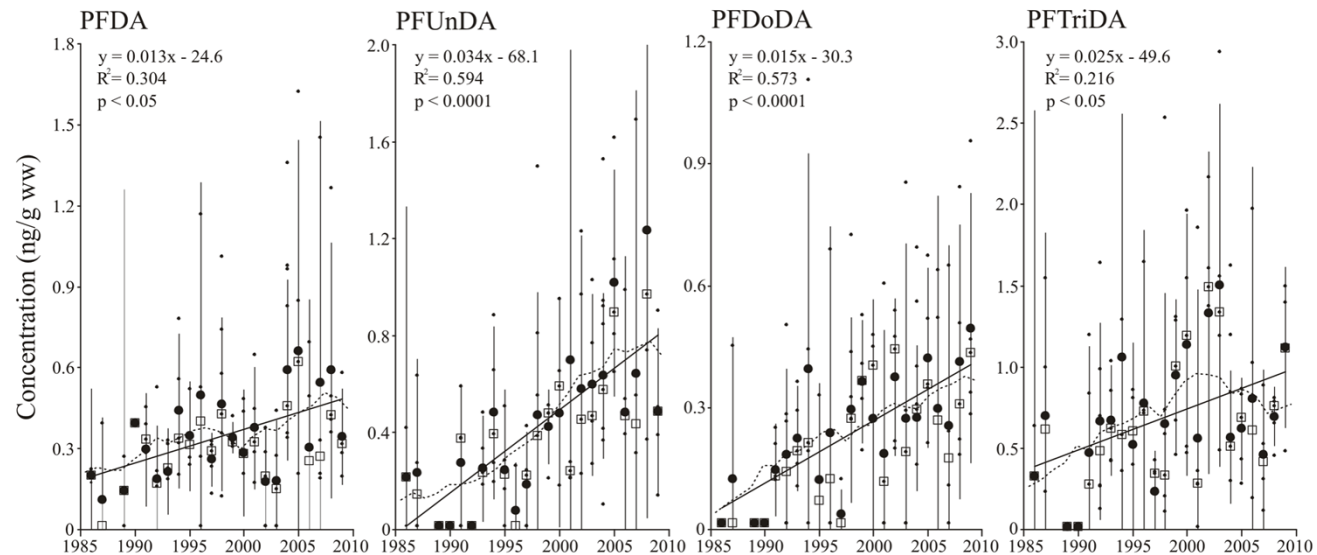


Temporal Trends in Tawny Owl Eggs from Norway

PFSAs



PFCAs





Summary

- The **waste sector** is an important source for PFASs to the environment
- **Short chain PFASs** (e.g. PFBS, PFBA) replace **PFOS and PFOA** in the environment
- **Riverine transport** into the marine environment (e.g. Elbe, Rhine, Scheldt)
- **Partition** to sediment or bioaccumulation to organisms depends on the **functional group and carbon chain length**
- **Whole body burden** in wildlife should be estimated for more precise evaluation of biomagnification
- **PFOS** levels are **decreasing**, but concentrations of their replacement compounds are **increasing** (e.g. short chain PFASs)



**Thank you for
your attention!**

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