Environmental and human exposure to PFAS

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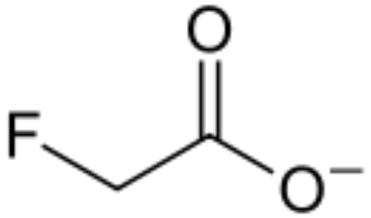
Örebro University

Fabulous Fluorine

most common form found in nature



Example of natural occuring organofluorine

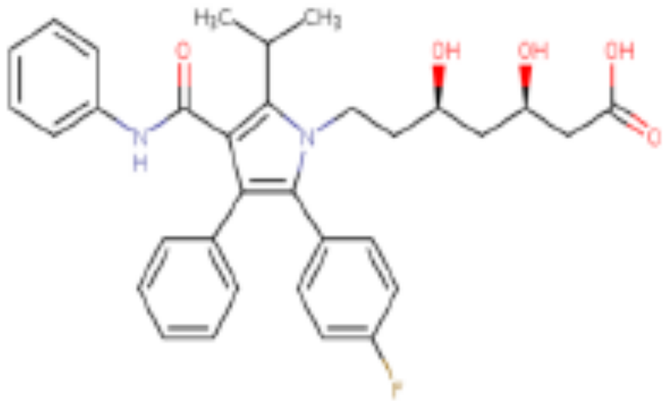
Antropogenic organofluorine

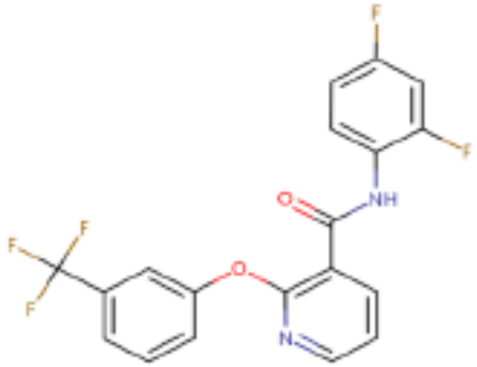
F gives increased stability, lipophilicity, and bioavailability

Organofluorine is present in:

~20% pharmaceuticals

30-40% agrochemicals

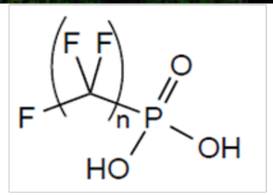




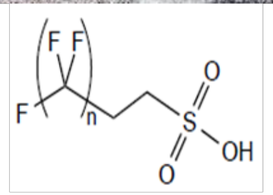
Per- and polyfluoroalkyl substances (PFAS)

4730 PFASs (CAS-numbers, OECD 2018)

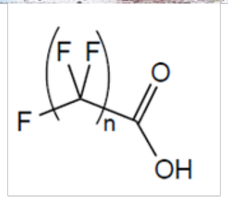
Example of PFAS groups:



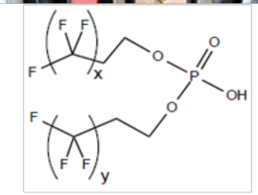
Perfluoroalkyl phosphonic acids (PFPAs)



Fluorotelomer sulfonic acids (n:2 FTSAs)



Perfluoroalkyl carboxylic acids (PFCAs)

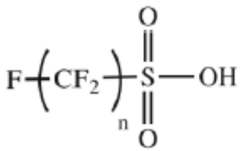


Polyfluoroalkyl phosphate diester (diPAPs)

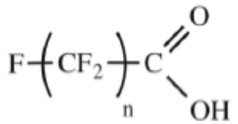
PFAS

Perfluoroalkyl acids

Examples:



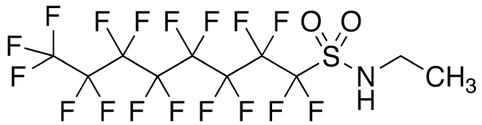
PFSAs



PFCAs

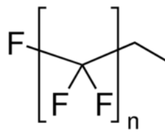
Precursors

Examples of precursors to PFSAs:

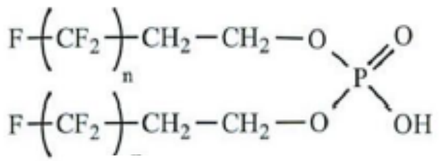


Et-FOSA

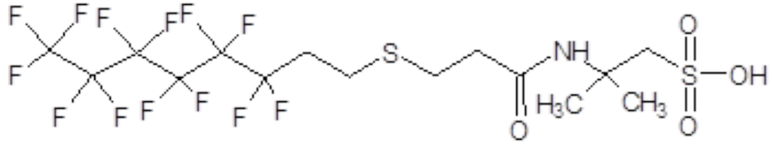
Example of precursors to PFCAs:



FTOHs



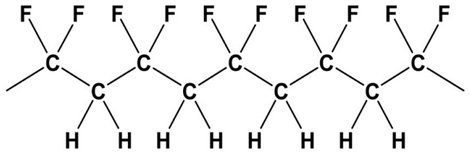
diPAPs

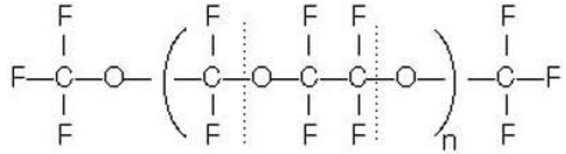


6:2 FTSAS

Others

Polymers:





What is your PFAS exposure?

	P1	P2	P3	P4
PFOS	15	66	27	349
PFHxS	2	25	2	265
PFOA	1,5	4,2	535	10

- Diet
- Indoor environment
- Drinking water

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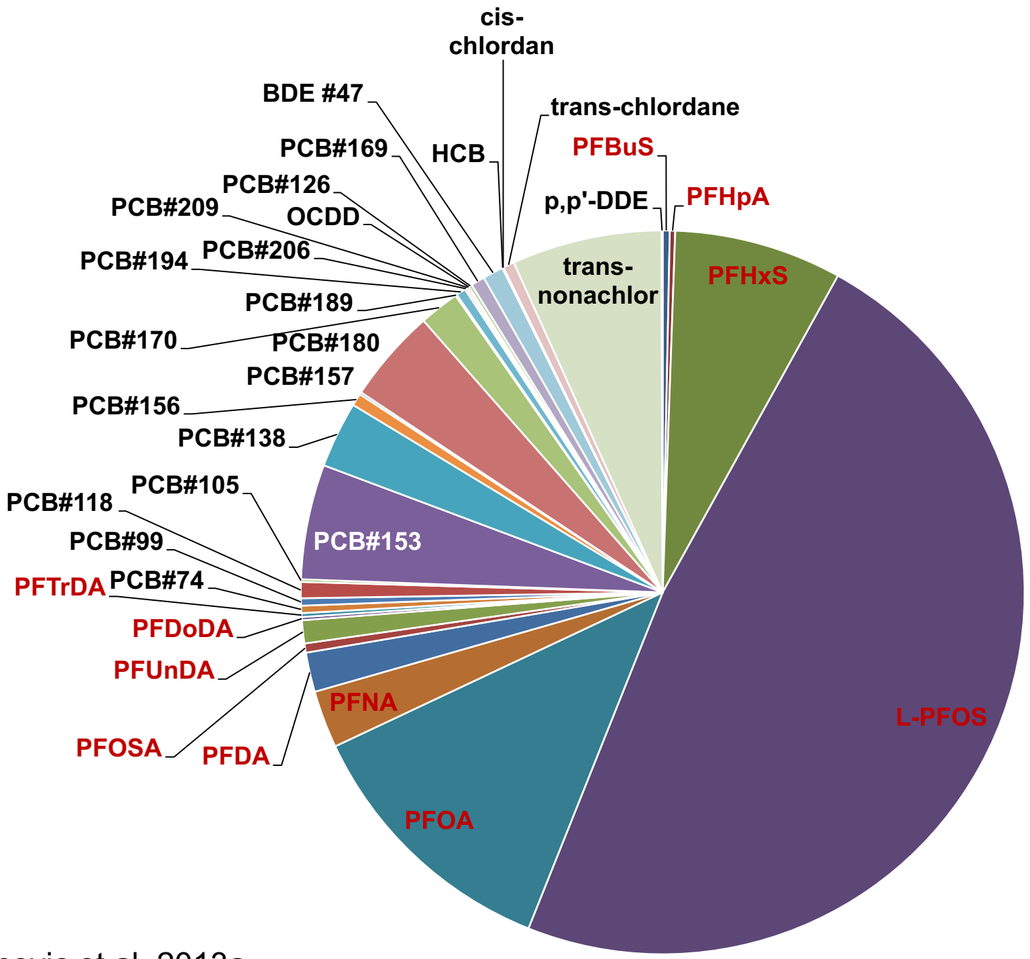
Persistent Organic Pollutants (POPs) in human sera



- 74% of the circulating POPs* are PFASs

*Volume% average contribution of total amount of POPs (Stockholm convention POPs + PFASs) in a cohort of 1 016 elderly people in Sweden

Salihovic et al. 2013a

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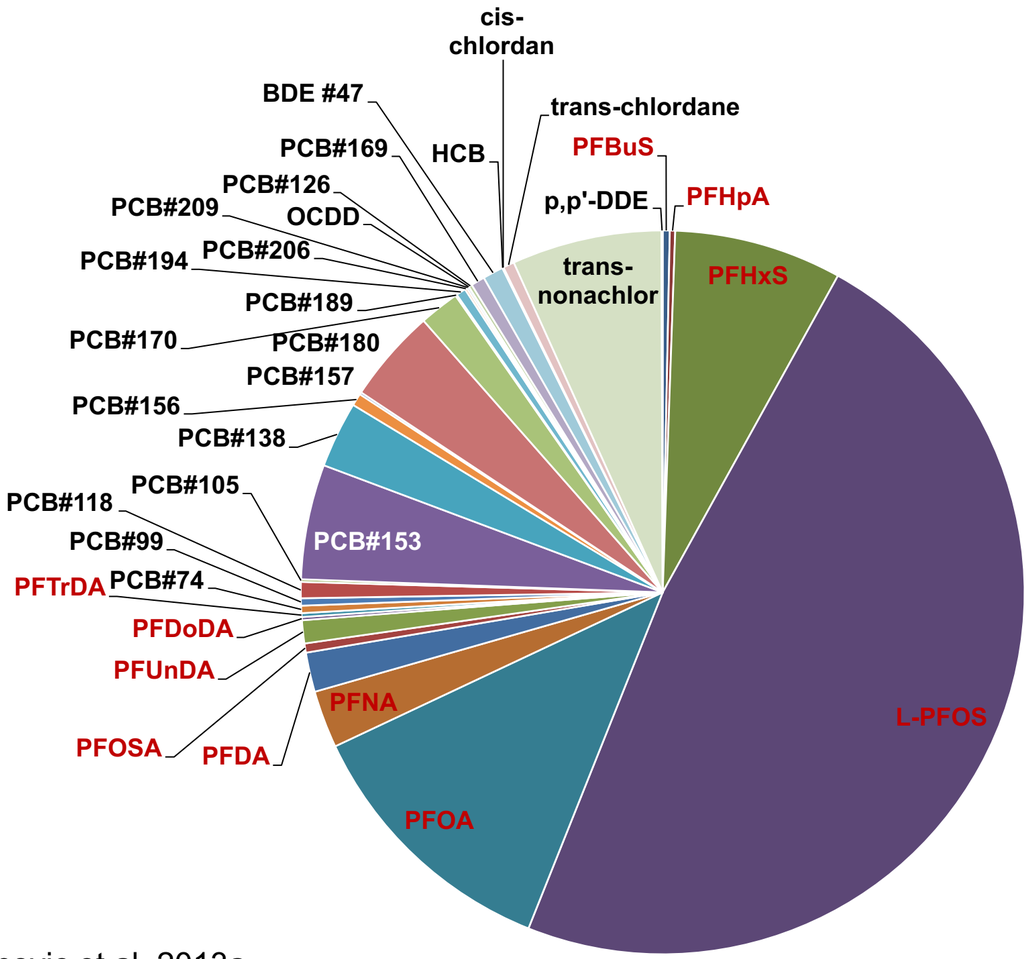


Salihovic et al. 2013a

Long elimination times

Persists

Suspected effects

- Testicular cancer
- Kidney cancer
- Ulcerative colitis
- Thyroid disease
- Pregnacy-induced hypertension/preeclampsia
- Hypercholesterolemia
- Immune response after vaccination
- ……

Environmental fate, distribution and transformation

Sources: AFFF training sites, industries, landfills, WWTPs,……

PFAS transports in both air and water

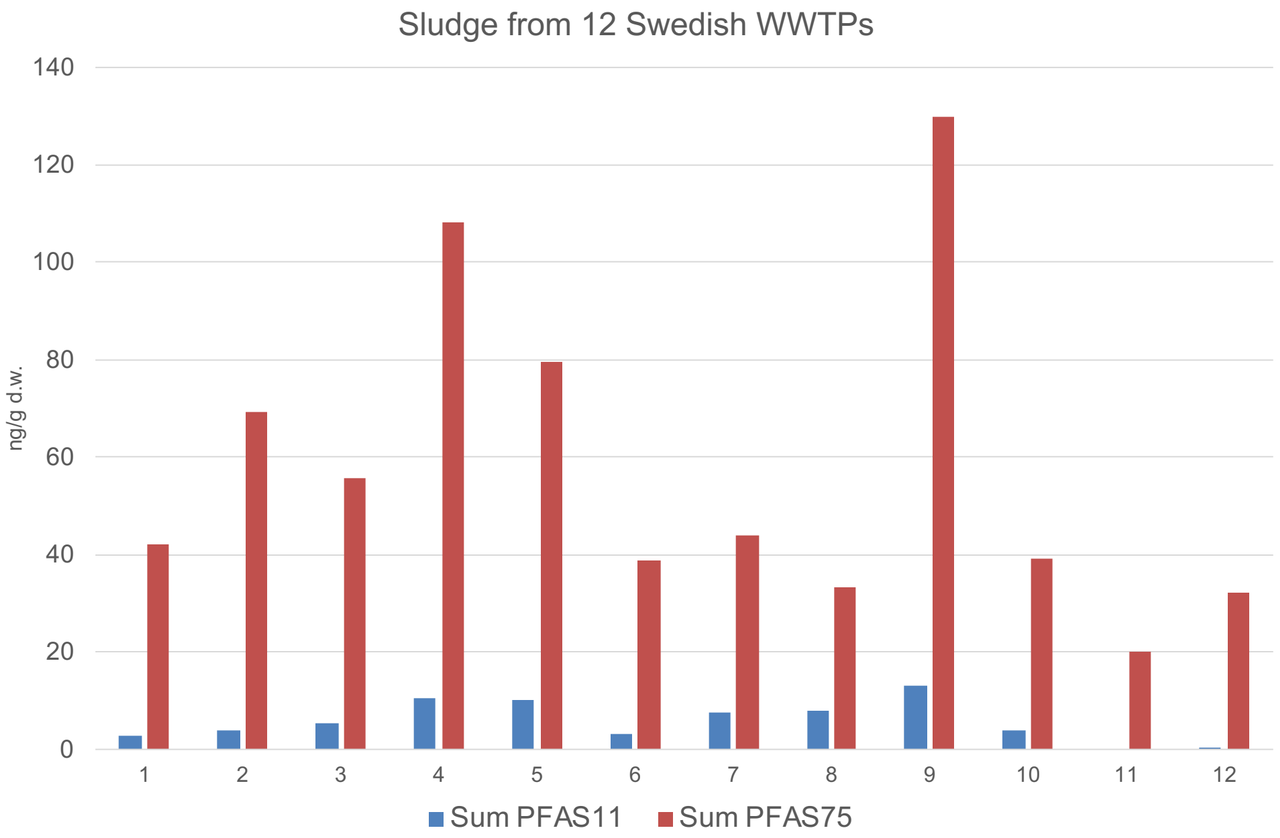
Sorption to organic carbon, charged mineral surfaces

- depends on chain lenght and functional group

Precursors transform to perfluoroalkyl acids under natural conditions

Perfluoroalkyl acids are persistent

Sludge from waste water treatment plants



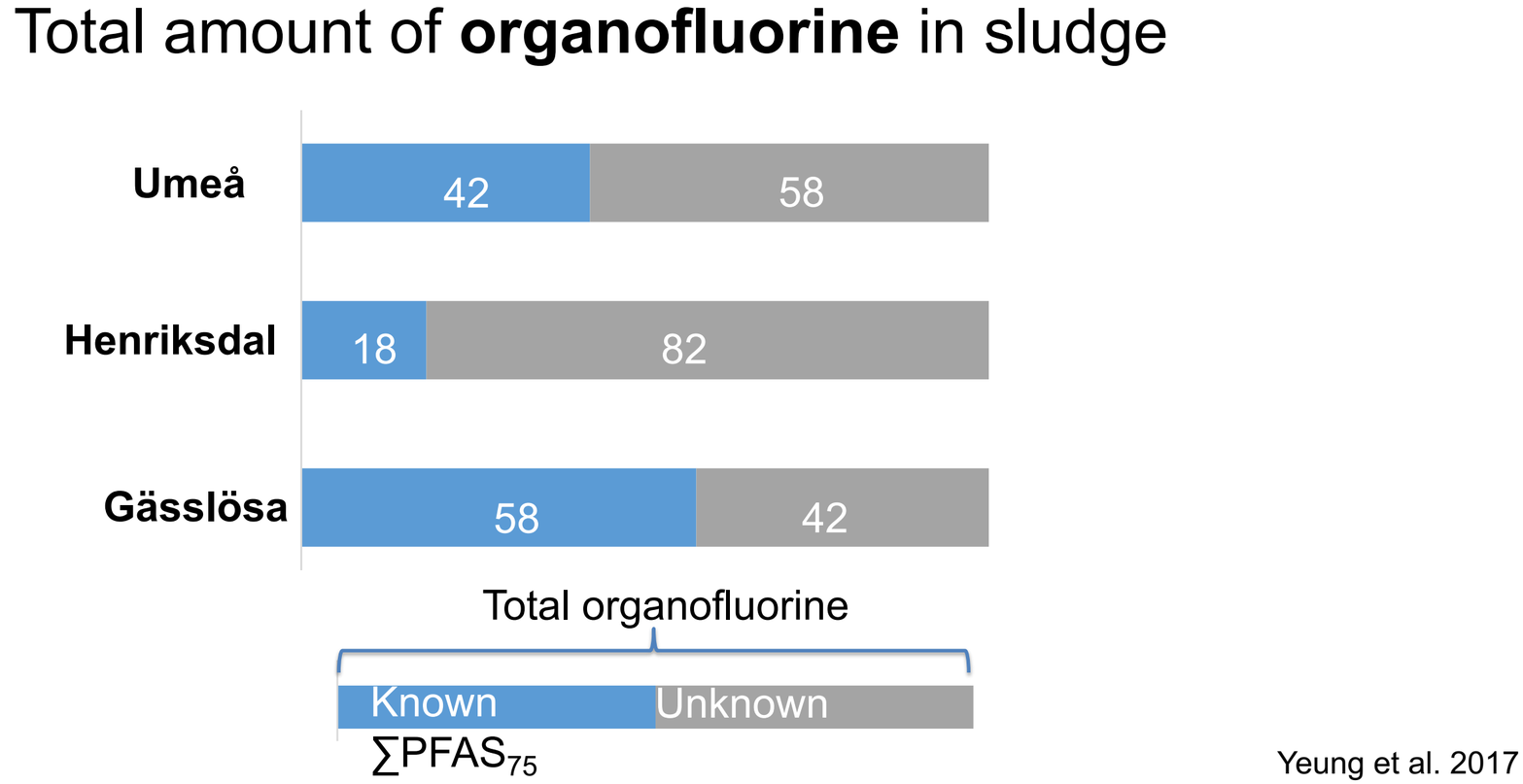
∑PFAS11:

- PFBA
- PFPeA
- PFHxA
- PFHpA
- PFOA
- PFNA
- PFDA
- PFBS
- PFHxS
- PFOS
- 6:2 FTSA

∑PFAS75:

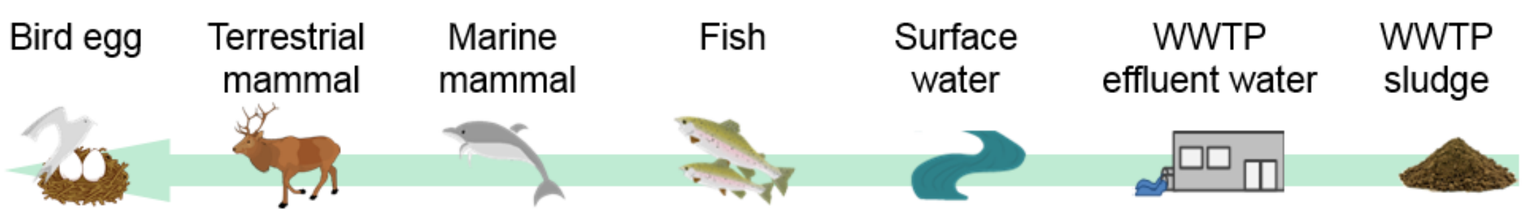
- PFCAs
- PFSAs
- Precursors: PAPs, FTSAs, FTUCA, FTCA FOSA, FOSAA, diSamPAP,
- PFPA/PFPiA
- ADONA, HFPO-DA, PFECHS, F53B

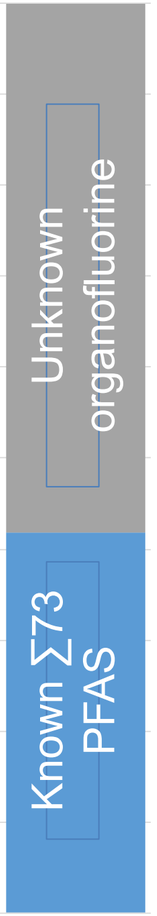
Are there more PFAS in sludge?



Yeung et al. 2017

Environmental exposure





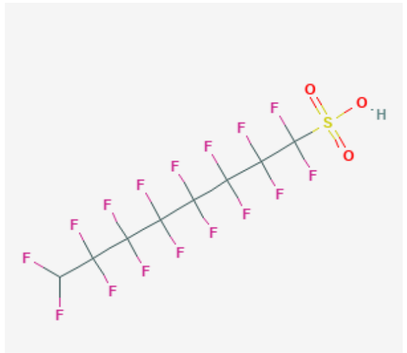
Kärrman et al. 2019. PFASs in the Nordic environment. TemaNord 2019:515

Environmental exposure

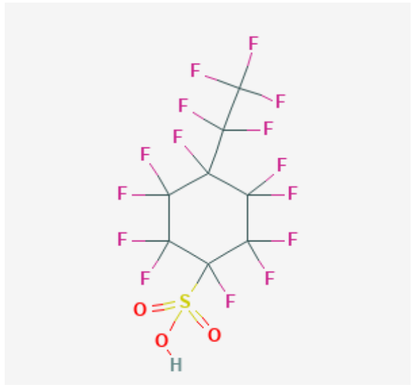
- Important to include precursor PFAS to assess the total PFAS exposure
- Still remains to identify the organofluorine in the environment
  - PFAS ∑73 in bird eggs constitute 33-102% of extractable organofluorine
  - PFAS ∑73 in surface water constitute 2-17% of extractable organofluorine

Principle of substitution works poorly for PFASs

- Regulations have effects
  - Environmental and human levels starts to decrease
  - New PFASs are introduced



PFOS



PFECHS

Thank you

EnForce
Environmental Forensics

KK-stiftelsen

norden
Nordic Council of Ministers

NordicScreening.org
Joint Nordic Screening of Chemicals

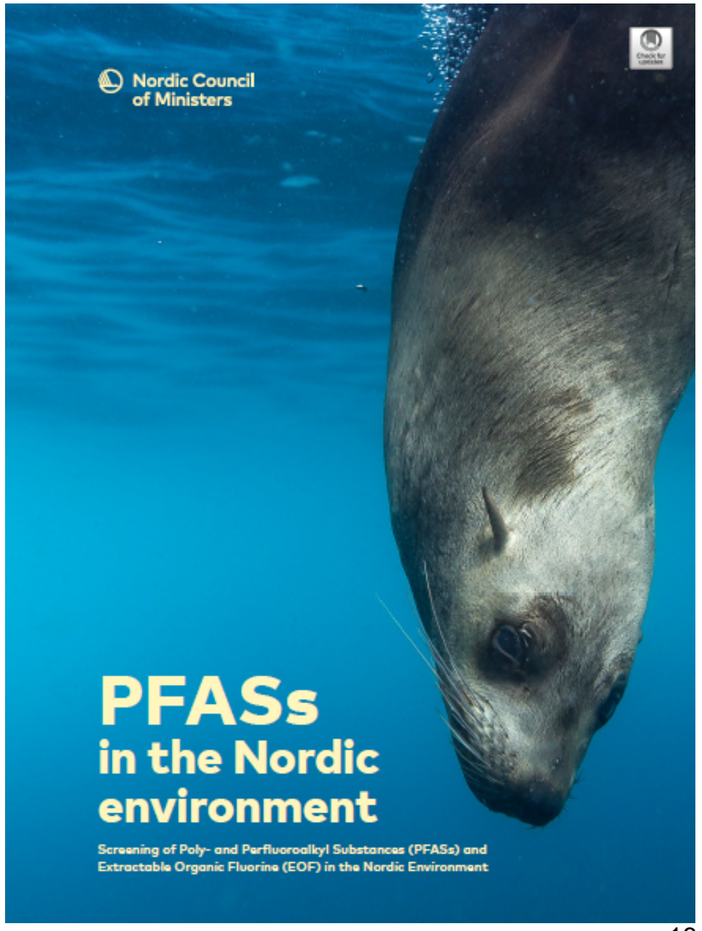

Leo Yeung


Thanh Wang

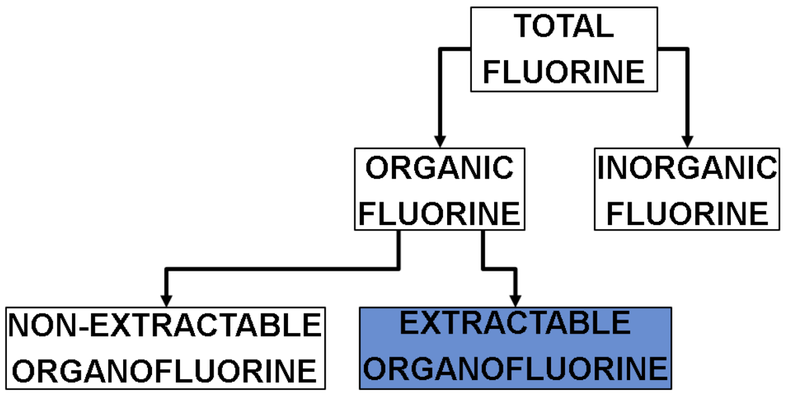

Ulrika Eriksson

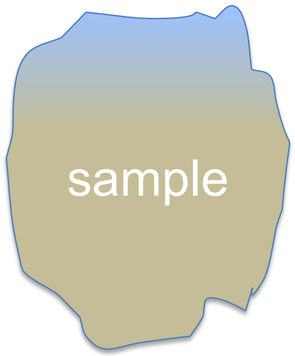

Rudolf Aro


Felicia Fredriksson

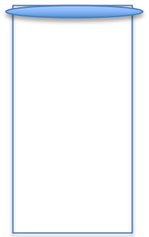


Unknown PFAS





Extraction



Fluoride measured after combustion 1100° C

Target PFAS