PFAS Status & Trends, Update

Torbjörn Synnerdahl

2023-11-09

eurofins
Testing for Life

Welcome to Eurofins Food & Feed Sweden

Eurofins Sweden – Our history

1970’s	Laboratory launches within the ”Lantmännen” organization
1987	Eurofins is founded in Nantes, France
1988	AnalyCen is founded – subsidiary to Lantmännen
1990’s	AnalyCen consolidates and acquire competitors. Expansion in Scandinavia
2004	Eurofins enters Sweden by acquiring Vadstena Kemanalys
2006	Eurofins acquires Steins Laboratory
2007	Eurofins acquires AnalyCen and becomes no 1 in Sweden

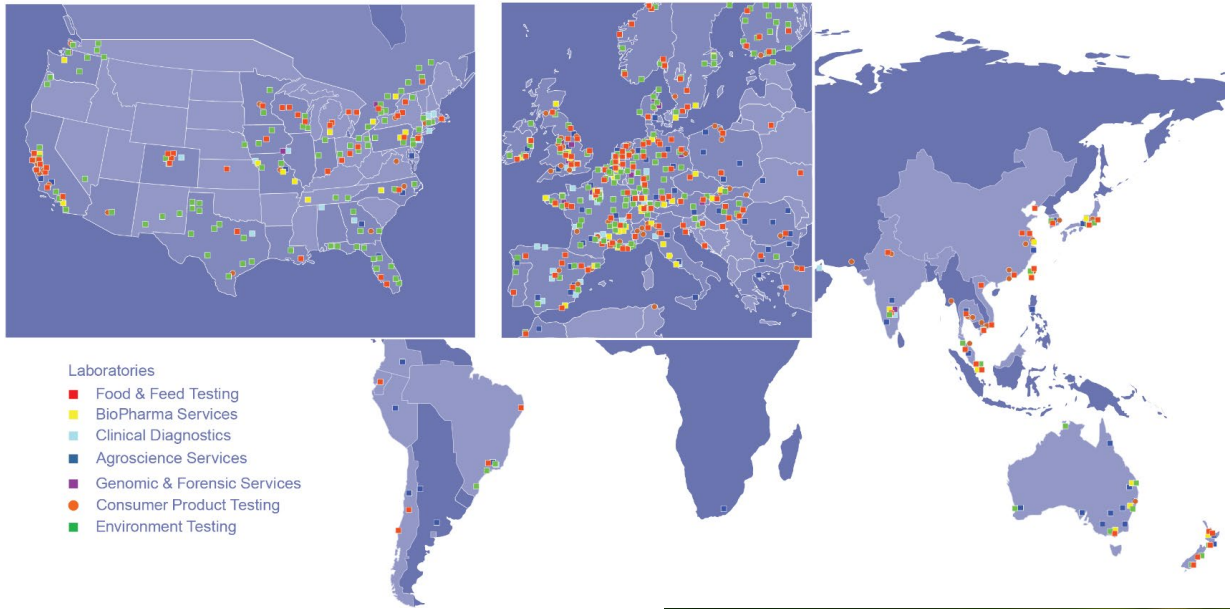
Eurofins – Today

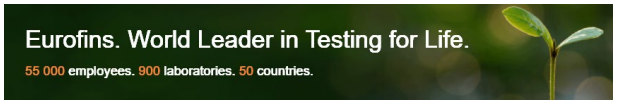
Revenue: **6 700 m€**

Employees: **>62 000**

900 Laboratories in
>61 Countries

>200 000 Validated
Analytical Methods

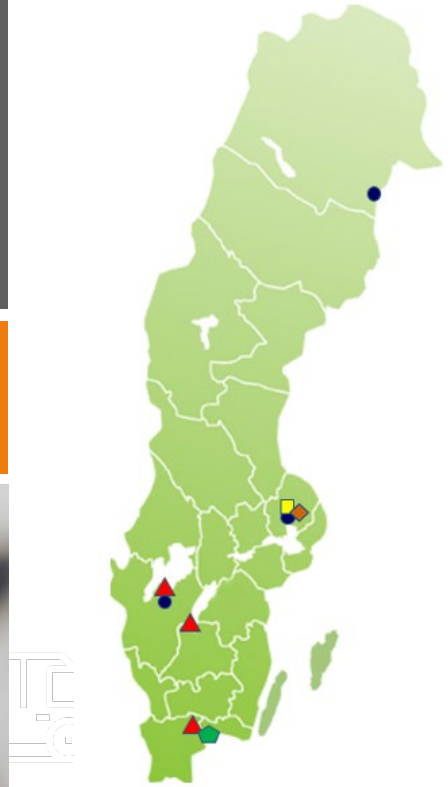




Eurofins Food & Feed Testing in Sweden

3 sites
~200 employees
5 BU's
€28M revenues
One-Stop-Shop

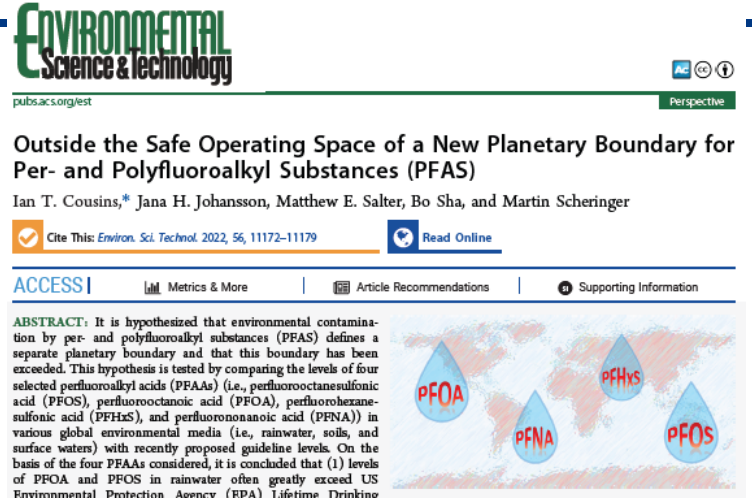
Founded in **1988**



- Food & Feed
- Environment
- BioPharma
- Clinical
- Agro

Eurofins Sweden in total **600** employees

PFAS – Planetary Boundary



Environmental Science & Technology

pubs.acs.org/est

Perspective

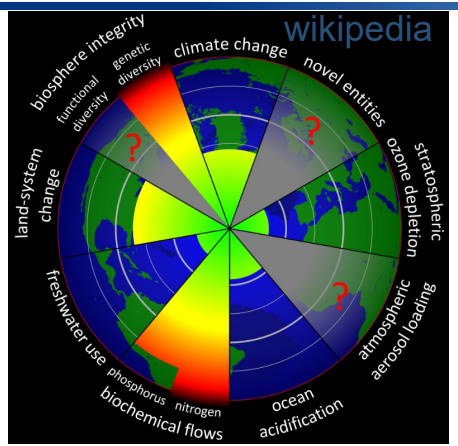
Outside the Safe Operating Space of a New Planetary Boundary for Per- and Polyfluoroalkyl Substances (PFAS)

Ian T. Cousins,* Jana H. Johansson, Matthew E. Salter, Bo Sha, and Martin Scheringer

Cite This: *Environ. Sci. Technol.* 2022, 56, 11172–11179 | Read Online

ACCESS | Metrics & More | Article Recommendations | Supporting Information

ABSTRACT: It is hypothesized that environmental contamination by per- and polyfluoroalkyl substances (PFAS) defines a separate planetary boundary and that this boundary has been exceeded. This hypothesis is tested by comparing the levels of four selected perfluoroalkyl acids (PFAAs) (i.e., perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorohexanesulfonic acid (PFHxS), and perfluorononanoic acid (PFNA)) in various global environmental media (i.e., rainwater, soils, and surface waters) with recently proposed guideline levels. On the basis of the four PFAAs considered, it is concluded that (1) levels of PFOA and PFOS in rainwater often greatly exceed US Environmental Protection Agency (EPA) Lifetime Drinking

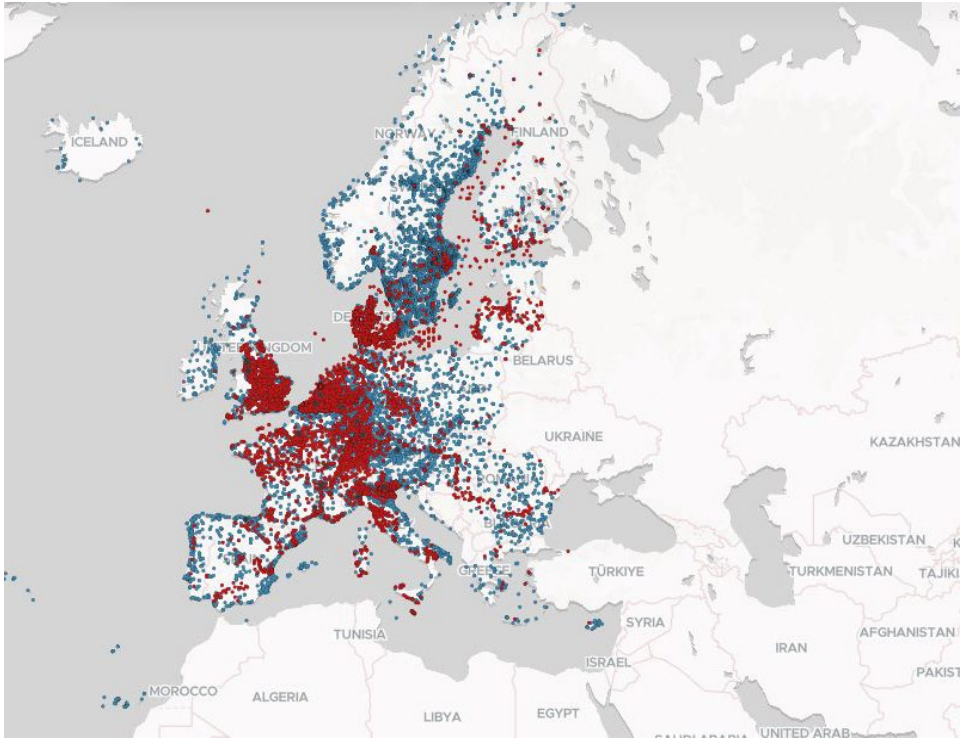


- Concept of 9 planetary boundaries
  - New entities (formerly called chemical pollutants) is one (includes microplastics).
  - Uncertainty (overall) whether the limit for "new entities" has been exceeded.
  - EST paper claims it has been exceeded for PFAS.
    - PFOS/PFAS4 in rain and surface water are very often higher than the limit values (EQS, drinking water)

- EFSA Final scientific opinion, Sep 20: TWI (tolerable weekly intake) 4.4 ng/kg BW per week.
  - SE/DK PFAS4 limits for drinking water calculated from TWI.
  - The Water Directive (WFD) EQS value for PFOS is 0.65 ng/l for surface water.
- US-EPA drinking water health advisory levels (Preliminary) 0.004 ng/l for PFOA and 0.020 ng/l for PFOS.

PFAS in Europe

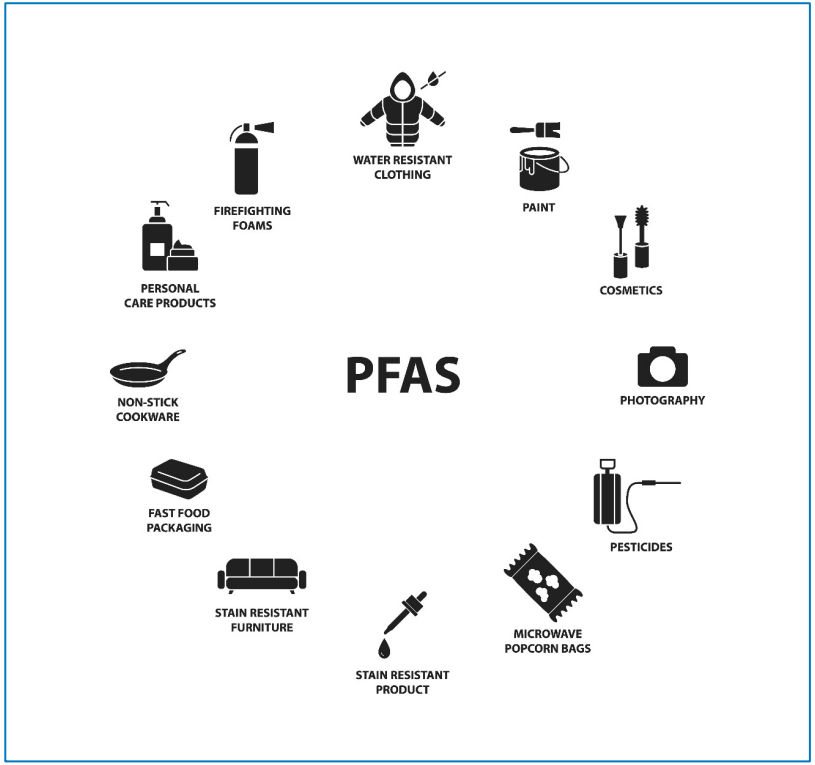
- The extent of Europe's contamination by per- and polyfluoroalkyl substances
- >17 000 sites where PFAS contamination has been detected. Additional >21 000 presumptive PFAS contamination sites
- Over 2 100 hotspots
- Each of these sites has been sampled for PFAS in water, soil or living organisms by scientific teams and environmental agencies between 2003 and 2023.
- These measures have found PFAS at levels equal to or greater than 10 nanograms per liter (ng/L)



PFAS in Food and Nature – Why?

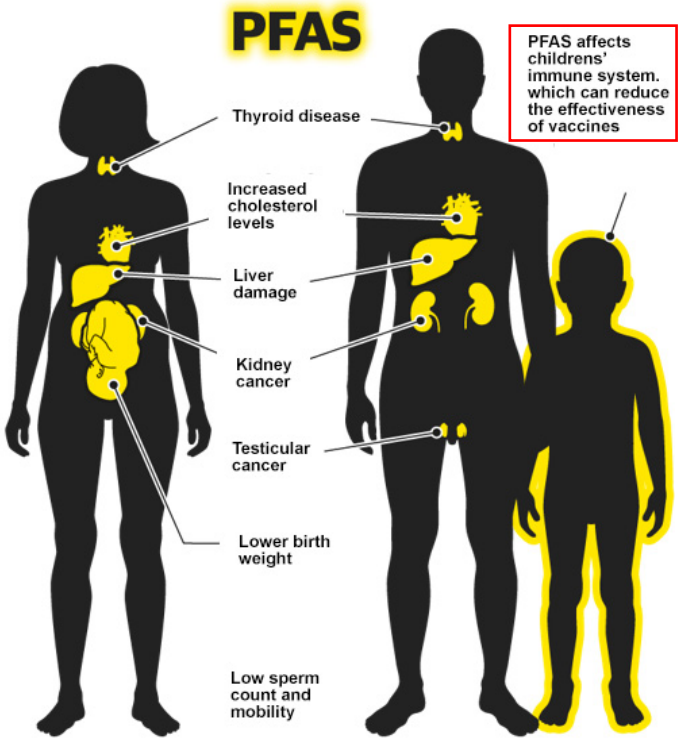
Reasons for the spread of PFAS

- Firefighting foams
- Sludge used as fertilizer
- Cosmetics
- Impregnation
- Plastics
- Packing material for food
- Fabric for furniture and electronics

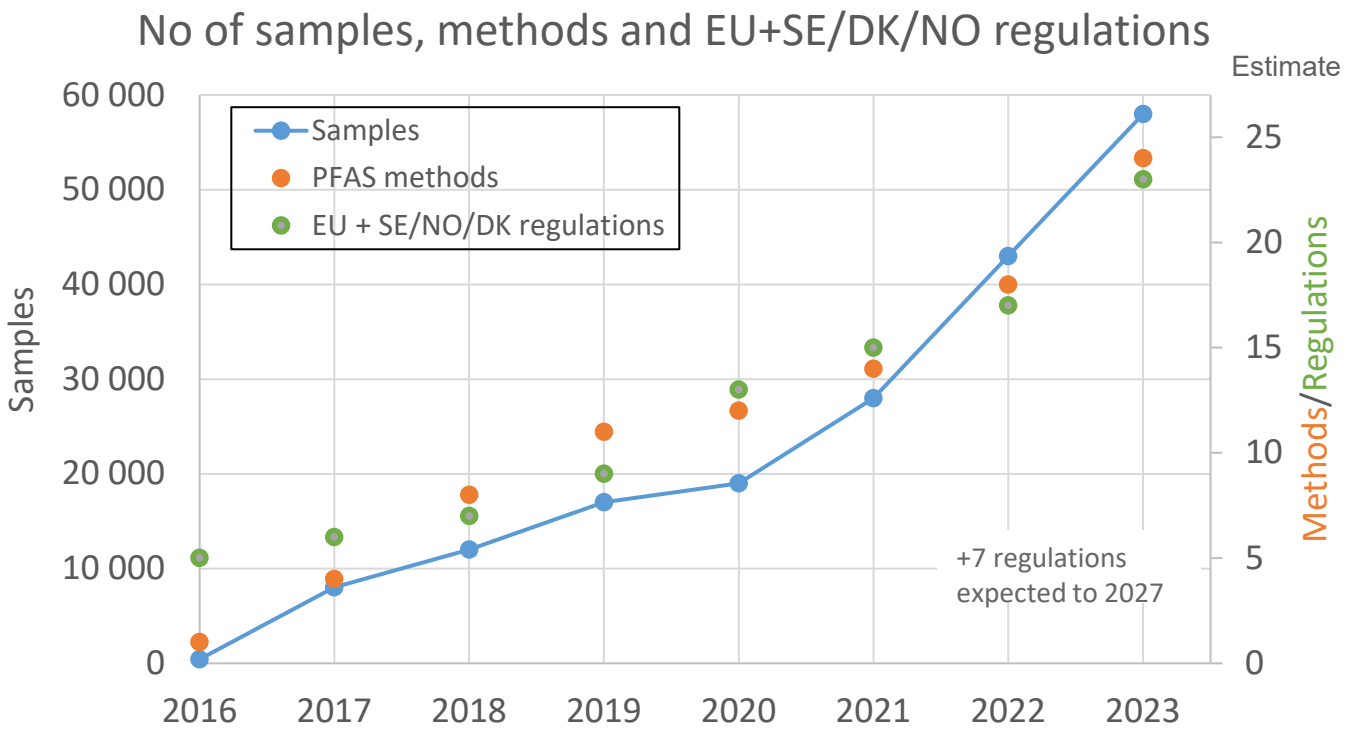


PFAS – Impact on humans

- In animal studies - impact on the immune system, brain development and altered liver weight.
  Effects on reproductive organs and levels of sex hormones and thyroid hormones
- In human studies - impact on the immune system in the form of a reduced antibody response during vaccination
- Impact on cholesterol levels, liver enzyme levels, reduced birth weight and increased risk of polycystic ovary syndrome (PCOS)
- Fetuses, infants and children are probably extra sensitive to PFAS. Can affect the immune system, birth weight, cholesterol levels in the blood and liver enzymes



Trend of PFAS Focus



PFAS regulation – Food

Foodstuffs		Maximum levels in µg/kg wet weight				
		PFOS [1]	PFOA[1]	PFNA [1]	PFHxS[1]	Sum of PFAS4[2]
10.1	Eggs	1.0	0.30	0.70	0.30	1.7
10.2	Fishery products and bivalve molluscs					
10.2.1	Fish meat					
10.2.1.1	Muscle meat of fish, except those listed under 2.1.2 and 2.1.3. Muscle meat of fish listed in 2.1.2 and 2.1.3, in case they are intended for the production of food for infants and young children.	2.0	0.20	0.50	0.20	2.0
10.2.1.2	Muscle meat of the following fish[3], in case they are not intended for the production of food for infants and young children	7.0	1.0	2.5	0.20	8.0
10.2.1.3	Muscle meat of the following fish[4], in case they are not intended for the production of food for infants and young children	35	8.0	8.0	1.5	45
10.2.2	Crustaceans and bivalve molluscs: For crustaceans the maximum level shall apply to muscle meat from appendages and abdomen. In case of crabs and crab-like crustaceans (Brachyura and Anomura) muscle meat from appendages	3.0	0.70	1.0	1.5	5.0
10.3	Meat and edible offal					
10.3.1	Meat of bovine animals, pig and poultry	0.30	0.80	0.20	0.20	1.3
10.3.2	Meat of sheep	1.0	0.20	0.20	0.20	1.6
10.3.3	Offal of bovine animals, sheep, pig and poultry	6.0	0.70	0.40	0.50	8.0
10.3.4	Meat of game animals, with the exception of bear meat	5.0	3.5	1.5	0.60	9.0
10.3.5	Offal of game animals, with the exception of bear offal	50	25	45	3.0	50

Regulation (EU) 2022/2388 now included in Regulation (EC) EU 2023/915

- Limit values (max levels) for PFAS4 in fish, egg, meat products (0.2-50 µg/kg FW and 1.3-50 for total PFAS4)
- In force since 1 Jan 2023
- Applies to wet weight, unprocessed Food

The limits are not linked to the EFSA TWI value

- 70 kg adult can consume 38 g/w of salmon with PFAS4 8 µg/kg (8000 ng/kg)
- 10 kg child can consume 22 g/w of salmon with PFAS4 2 µg/kg (2000 ng/kg)

Testfakta – Crayfish

OBEROENDE LABORATORIETEST

Kräftor
Miljögifter (PFAS)

Ullmo
Svenska signalkräftor

Smålandskräftan
Svenska signalkräftor

Smålandskräftan
Färska svenska signalkräftor

Pandalus
Vildfångade kräftor

Fisherman Seafood
Kräftlåda

Ullmo
Lousianaflodkräftor

Fiskeriet
Stora kräftor

Ullmo
Lousianaflodkräftor

Konsumentkontakt	Ullmo.se	Smalandskraftan.se	Smalandskraftan.se	pandalus.se	food4you.se	Ullmo.se	fiskeriet.se	Ullmo.se
Cirkapris per förpackning	295	249	329	149	179	120	109	175
Vikt (g) kräftor utan lag	700	500	1 000	700	1 000	700	700	1 000
Cirkapris per kg	421	498	329	213	179	171	156	175
PRODUKTFAKTA								
Typ av kräfta (art)	Svenska signalkräftor (Pacifastacus leniusculus)	Svenska signalkräftor (Pacifastacus leniusculus)	Svenska signalkräftor (Pacifastacus leniusculus)	Turkiska kräftor (Astacus leptodactylus)	Kräftor (Procambarus clarkii)	Louisianaflodkräftor (Procambarus clarkii)	Turkiska kräftor (Astacus leptodactylus)	Louisianaflodkräftor (Procambarus clarkii)
Ursprungland	Sverige (insjöar)	Sverige (Vättern)	Sverige (Vänern)	Turkiet	Spanien	Spanien	Turkiet	Egypten
Fångstmetod	Fiskade med tinor och fällor i svenska insjöar.	Burfångade i svenska sjöar och vattendrag.	Burfångade i svenska sjöar och vattendrag.	Vildfångade med mjärdar i Turkiska bergssjöar.	Vildfångade i burar i spanska sjöar.	Fångade med tinor och fällor i sötvatten i Spanien (mestadels i Guadalquivir).	Vildfångade med tinor och mjärdar i turkiska bergssjöar.	Fångade med linor och fällor i sötvatten i Egypten.
Eko-märkning	✓ KRAV	✓	✓	✓	✓	✓ KRAV	✓ KRAV	✓ KRAV
Fryst eller färsk	Upptinad	Upptinad	Färsk	Fryst	Fryst	Fryst	Fryst	Fryst
ANALYSRESULTAT								
PFAS i nanogram (ng) per kg kräftkött								
PFHxS	2 188	312	238	16	u.d.	u.d.	u.d.	u.d.
PFOA	4 101	1 476	1 567	41	58	128	30	u.d.
PFNA	1 571	999	843	53	138	58	66	u.d.
PFOS	6 202	6 324	4 080	1 192	402	71	10	20
Totalt PFAS (4)	14 062	9 111	6 728	1 303	598	257	106	20
Enligt EFSA-riktvärde om 4,4 ng/kg kroppsvikt och vecka:								
Max intag kräftkött per vecka för en person på 70 kg (g)	22	34	46	236	515	1 200	2 910	15 782
Motsvarande antal kräftstjärtar per vecka *	4	7	9	48	104	243	589	3 196
Motsvarande antal kräftor per vecka *	3	4	5	27	60	139	337	1 827

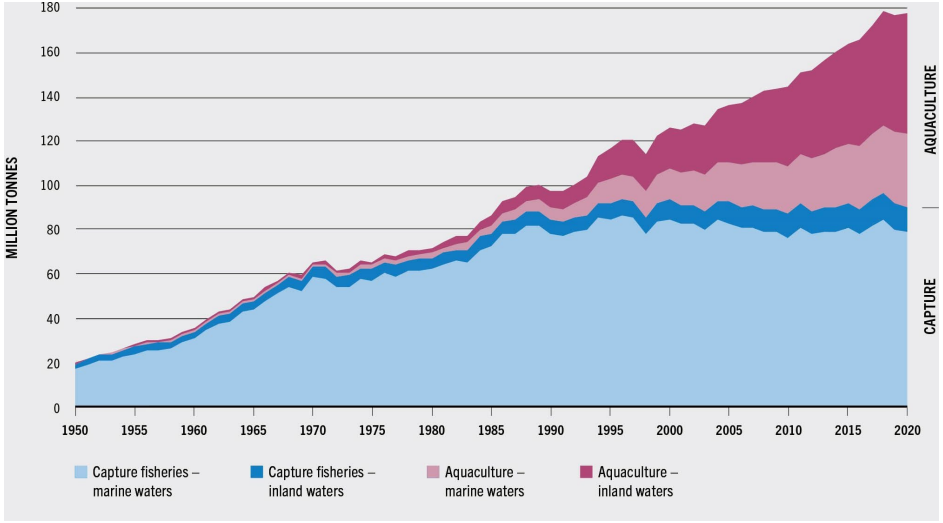
u.d. = under detektionsnivån
* Beräknat utifrån vikt för kött i kräftstjärten 4,9 g (uppmätt), klorna 2,0 g och kräftsmöret 1,7 g (uppmätt).

Testfakta

Fakta och bild: Testfakta i augusti 2022

- High level of PFAS i crayfish

PFAS and Fish



- There is a clear trend of growth over the last decades, especially in Aquaculture.

PFAS (ng/kg WW)	Norway/ Farmed	Norway/ Farmed	Kalix SE/ Wild	Lake Vänern SE/ Wild
PFBSA	4,3	3,8	190	56
PFHxSA Lin + Br	4,1	1	11	22
PFHxS Lin + Br	n.d	n.d	80	13
PFHpS	n.d	n.d	20	n.d
PFECHS	n.d	n.d	35	n.d
PFNA	n.d	n.d	73	180
FOSA Lin + Br	71	13	30	240
PFOS Lin + Br	6,3	4,1	2000	3800
PFDA	n.d	n.d	27	640
PFUdA	n.d	n.d	54	620
PFDoA	n.d	n.d	12	240
PFTrDA	n.d	n.d	17	220
PFTeDA	n.d	n.d	3	53
PFAS4	6,3	4,1	2200	4000
PFAS TOT	86	22	2600	6100
PFAS4/PFAS TOT %	7,3	19	85	66
TWI (g) PFAS4, 70kg body weight	49000	75000	140	77
TWI (g) PFAS TOT, 70kg body weight	3600	14000	118	50

PFAS in white fish

PFAS (ng/kg WW)	Pangasius, Vietnam/ Farmed	Alaska pollock, Pacific Ocean	Cod 1, Northeast Atlantic	Cod 2, Northeast Atlantic	Cod 3, Northeast Atlantic	Cod 4, Northeast Atlantic	Cod 5, Northeast Atlantic
PFBSA	7	1	11	8	13	18	20
PFHpA	n.d	n.d	n.d	n.d	n.d	n.d	n.d
PFHxSA Lin + Br	n.d	1	45	15	24	35	28
PFHxS Lin + Br	n.d	n.d	3	3	2	n.d	n.d
PFOA Lin + Br	n.d	6	17	6	9	n.d	n.d
6:2 FTS	n.d	n.d	n.d	84	n.d	n.d	n.d
PFHpS	n.d	n.d	n.d	n.d	n.d	n.d	n.d
PFECHS	n.d	n.d	n.d	n.d	n.d	n.d	n.d
PFNA	n.d	50	71	77	65	39	31
FOSA Lin + Br	n.d	10	71	41	64	110	83
PFOS Lin + Br	n.d	13	260	310	240	150	260
PFDA	n.d	27	88	61	69	47	46
PFUdA	3	120	280	170	190	130	120
PFDoA	n.d	15	40	20	26	22	15
PFTrDA	n.d	130	200	82	89	70	57
PFTeDA	n.d	6	25	8	9	17	5
PFAS4	n.d	69	350	400	320	190	290
PFAS TOT	10	380	1100	890	800	640	660
PFAS4/PFAS TOT	n.d	18	32	45	40	30	44
TWI (g) PFAS4, 70kg body weight	n.d	4500	880	780	970	1600	1100
TWI (g) PFAS TOT, 70kg body weight	30000	810	280	350	380	480	460

- Low levels in farmed fish
- Alaska pollock deviating pattern compared with Cod (PFOS)
- PFBSA found, not PFBS
- PFHxSA significantly higher than PFHXS
- C8-C14 acids found
- High percentage of PFOS, PFUdA and PFTrDA in cod
- PFAS4/PFAS TOT 18-45%
- TWI applies to adults. With children the acceptable level of consumed fish is much lower

WFD and GWD – New Prio PFAS24: Biota, surface and groundwater

Acronym	CAS number	Relative potency factors (Bil et al., 2021)	ave RPF
PFBA	375-22-4	0.05	0,05
PFPeA	2706-90-3	0.01 ≤ RPF ≤ 0.05 *	0,03
PFHxA	307-24-4	0.01	0,01
PFHpA	375-85-9	0.01 ≤ RPF ≤ 1 *	0,505
PFOA	335-67-1	1	1
PFNA	375-95-1	10	10
PFDA	335-76-2	4 ≤ RPF ≤ 10 *	7
PFUnA or PFUnDA	2058-94-8	4	4
PFDoDA or PFDoA	307-55-1	3	3
PFTrDA	72629-94-8	0.3 ≤ RPF ≤ 3 *	1,65
PFTeDA	376-06-7	0.3	0,3
PFHxDA	67905-19-5	0.02	0,02
PFODA	16517-11-6	0.02	0,02
PFBS	375-73-5	0.001	0,001
PFPeS	2706-91-4	0.001 ≤ RPF ≤ 0.6 *	0,3005
PFHxS	355-46-4	0.6	0,6
PFHpS	375-92-8	0.6 ≤ RPF ≤ 2 *	1,3
PFOS	1763-23-1	2	2
PFDS	335-77-3	2 *	2
6:2 FTOH	647-42-7	0.02	0,02
8:2 FTOH	678-39-7	0.04	0,04
HFPO-DA (Gen X)	62037-80-3 / 13252-13-6	0.06	0,06
ADONA	958445-44-8	0.03	0,03
C6O4	1190931-27-1	0.06 *	0,06

- Weighting system RPF (relative potency factors) PFOA=1, others 0.001 (PFBS) - 10 (PFNA)
  - Highest for C9-C13 PFCA, Lowest for short-chain and ethers
  - Some values are averages between analogues, or taken from similar compounds
  - Bil et al (2021), RIVM 2018-0070
- System based on liver tox (liver weight male rats),
  - Is assumed to cover for other health effects incl immune system (JRC PFAS EQS dossier, 2021; SCHEER, 2022)
  - Has been criticized with regard to relevance of endpoint, scientific approach (as such), bioaccumulation
- Sweden has already in March 23 implemented PFAS24 for groundwater (SGU FS 2023:1)

Fish – Perch from Lake Storavan (N:th SE)

(ng/kg FW)	Perch muscle (567g) A	Perch muscle (552g) B	Perch muscle (670g) C
PFOA	<10	<10	<10
PFNA	16	210	39
PFDA	130	190	130
PFUdA	460	670	350
PFDoA	130	140	120
PFTrDA	330	440	450
PFTeDA	70	56	71
PFHxS	<10	<10	<10
PFOS	230	210	62
PFOSA	27	17	43
6:2 FTS	15	<10	110
Sum PFAS excl. LOQ	1400	1900	1400
Sum PFAS 4 excl. LOQ	250	420	100
PFAS4/sum PFAS %	18%	22%	7%
WFD PFAS24 PFOA eqv	4300	7700	3900

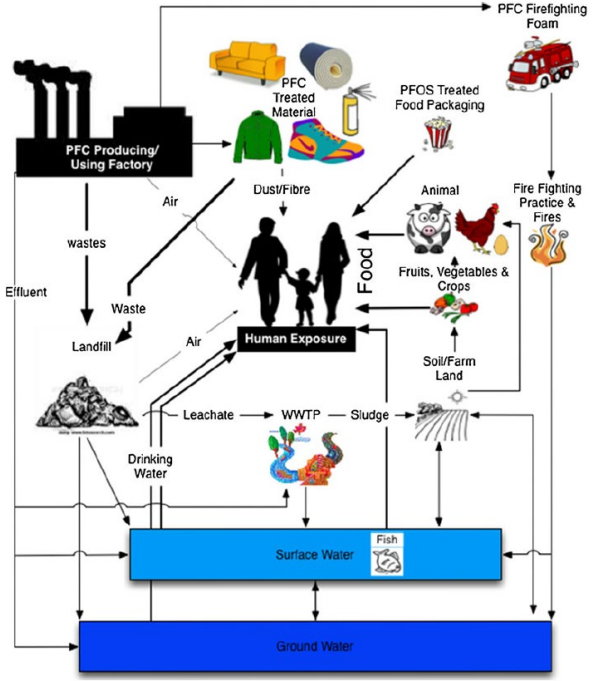
- Muscle from 3 larger perch (30-35 cm)
- About 45 PFAS analyzed (not C6O4)
- Dominated by long PFCAs (C9-C14) and PFOS
- PFAS4 corresponds to 7-22% of PFAS tot
- WFD PFAS24 sums: 50-100 times the suggested EQS (77 ng/kg PFOA eq)
- Will any fish reach the EQS of 77 ng/kg (ppt)? (no - in our experience)
- For surface and groundwater – mixed picture likely (urban vs pristine etc)

PFAS limit values in Food & Water

The more knowledge we gain, the more the requirements will increase

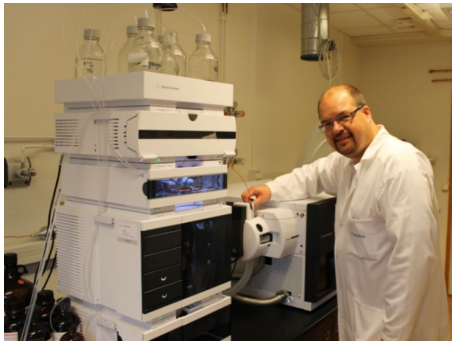
EU Regulations, Directives, Recommendations etc 2020-

- **EFSA:s final scientific opinion, 2020: TWI (tolerable weekly intake) 4,4 ng/kg BW**.
- Drinking water directive (DWD), EU 2020/2184: PFAS20
- POP regulation revision (EU) 2020/784: PFOA ban in products (25 ppb)
- **Food max limits regulation (EU) 2022/2388 incl in regulation EU 2023/915: fish, shellfish, egg, meat**
- **Monitoring of PFAS in food and feed, recommendation (EU) 2022/1431**
- Proposed revised Water framework directive (WFD), COM(2022) 540 final: PFAS24 (EQS; water and biota (fish))
- Proposed revised Groundwater directive (GWD), COM(2022) 540 final: PFAS24 (QS; already implemented in SE)
- POP regulation revision, (EU) 2022/2400 – new PFOA and PFHxS limits
- **National Drinking water directives based on TWI. (Denmark,Sweden). More coming.**
- Proposed ECHA restriction, REACH, Annex XV (2023): PFAS universal



PFAS in Lidköping

- The PFAS analysis was developed in Lidköping 2004.
- A new state of the art 350 m² PFAS lab was build Q1 2022, the new lab is built to handle 200 000 samples.
- TAT, nightshift is in place, allows us to have 16h TAT.
- Designated Competence center for Eurofins Europe.
- Line haul ready from July 2023.
- PFAS Automation with YuMi robot in place since 2020.
- Lowest Implemented LOQ in world right now, from 0,039 ng/L.
- LC-MS/MS for PFAS: Instrument to analyse +1000 samples/week.
- Innovation, development to analyze and measure other types of PFAS; Ultra short and Precursers for example.



All about PFAS

Information about PFAS and the latest news: www.eurofins.se/about-pfas

Remember: ”We” just scratch the surface!

10 000 Compounds!

Approx 100 ”We” can measure (1%)!

Legislation covers ”25”!

Thank you for your time!