Of Pigs and Men – Comparing PFAS Toxic Load Patterns in Wild Boar Liver and Human Blood Samples

Tobias Frische
German Environment Agency (UBA)
tobias.frische@uba.de

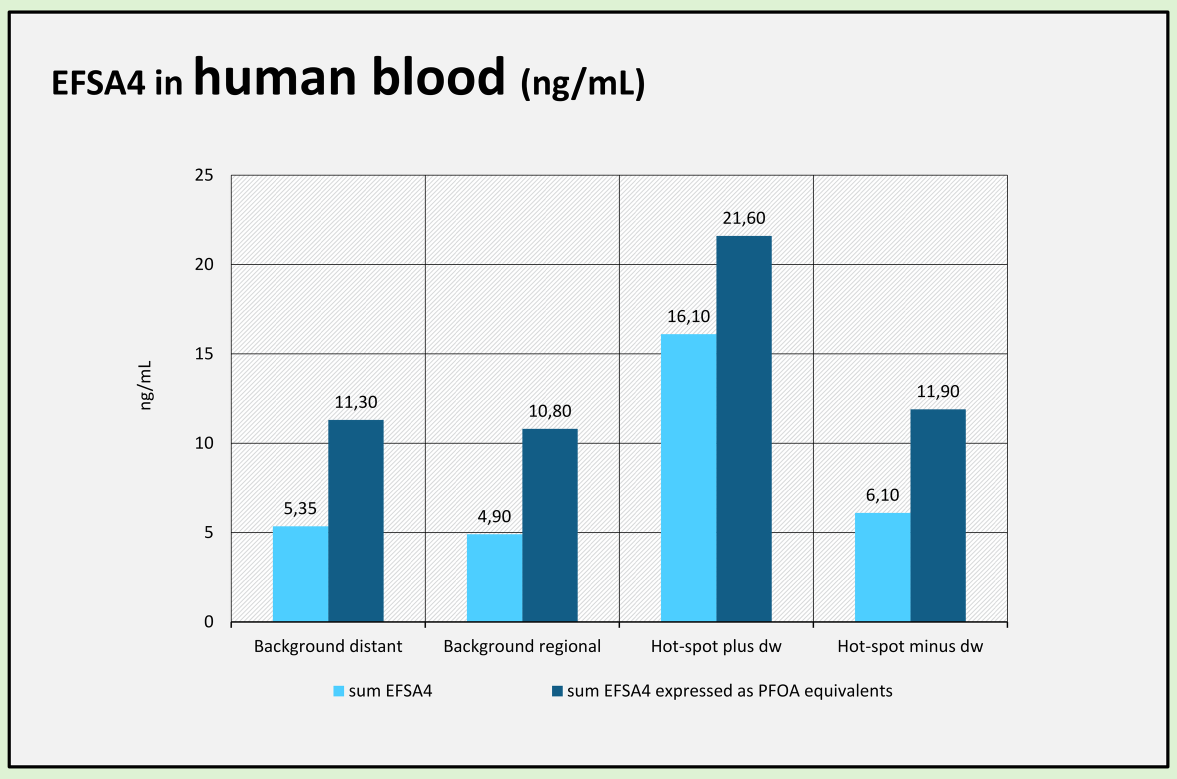
DATA AND APPROACH

A comparative analysis of published data explored similarities and differences in PFAS internal exposure and toxic load patterns between humans and wild boars (*Sus scrofa* L.). Samples include collectives thought to reflect background PFAS contamination as well as samples from a large-scale (about 200 km^2) PFAS hot-spot area in south-eastern Germany ("Rastatt case") known for severe PFAS-contamination of soil and groundwater (see tables below).

Human blood Sample collectives	Description and data source
Background distant	20 plasma samples from individuals of a region with about 400 km distance to the hot-spot area – monitored as a reference population in Germany (Göckener et al., 2020)
Background regional	100 samples from individuals considered as a reference population in the hot-spot area, i.e. their living places not PFAS-contaminated (LGA BW, 2021)
Hot-spot plus dw	100 samples from individuals living in the hot-spot area being formerly exposed to PFAS-contaminated drinking water supply until risk management was installed in 2014 (LGA BW, 2021)
Hot-spot minus dw	100 samples from individuals living in the hot-spot area but having not been formerly exposed to PFAS-contaminated drinking water supply (LGA BW, 2021)

Wild boar liver Sample collectives	Description and data source
Background distant	11 samples from wild boars culled in a region with more than 400 km distance to the hot-spot area – considered as reference region, i.e. only diffuse airborne "background" PFAS contamination (Rupp et al., 2023)
Background regional	15 samples from wild boars culled in the region with more than 100 km distance to the hot-spot area (CVUA, 2019 and personal communication)
Hot-spot area	9 samples from wild boars culled in the centre of the hot-spot area (Rupp et al., 2023)
Hot-spot plus 40km	17 samples from wild boars culled in the region with less than 40 km distance to the hot-spot area – assumed to be the typical maximum potential home range of wild boars (CVUA, 2019 and personal communication)

INTERNAL EXPOSURE

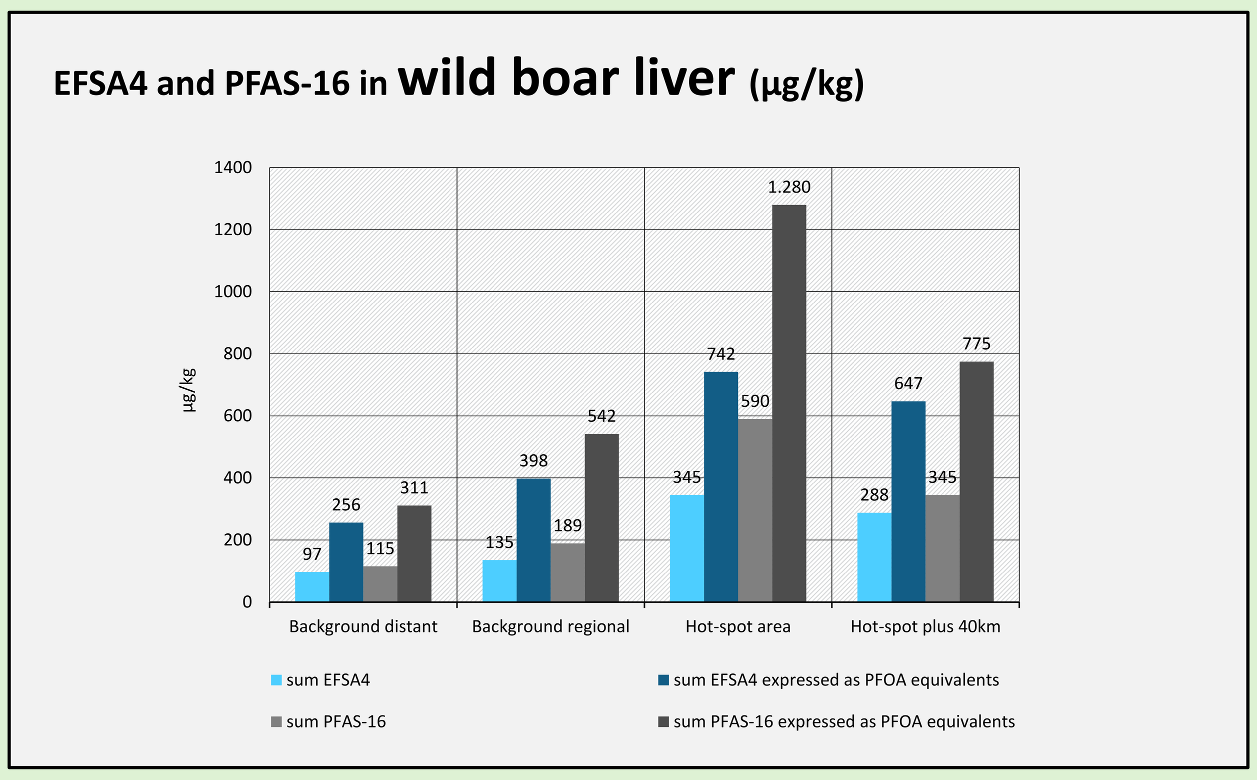


→ Internal exposure in background cohorts similar, clearly higher only in the cohort with former exposure via drinking water (**Hot-spot plus dw**)

Internal exposure of humans is indicated by the sum concentration of the four PFAS (EFSA4, i.e. PFOA, PFNA, PFHxS, PFOS) dominating in plasma samples and for wild boars as liver sum content of the EFSA4 as well as the sum of all the 16 PFAS dominating in wild boar livers (PFAS-16, see table below).

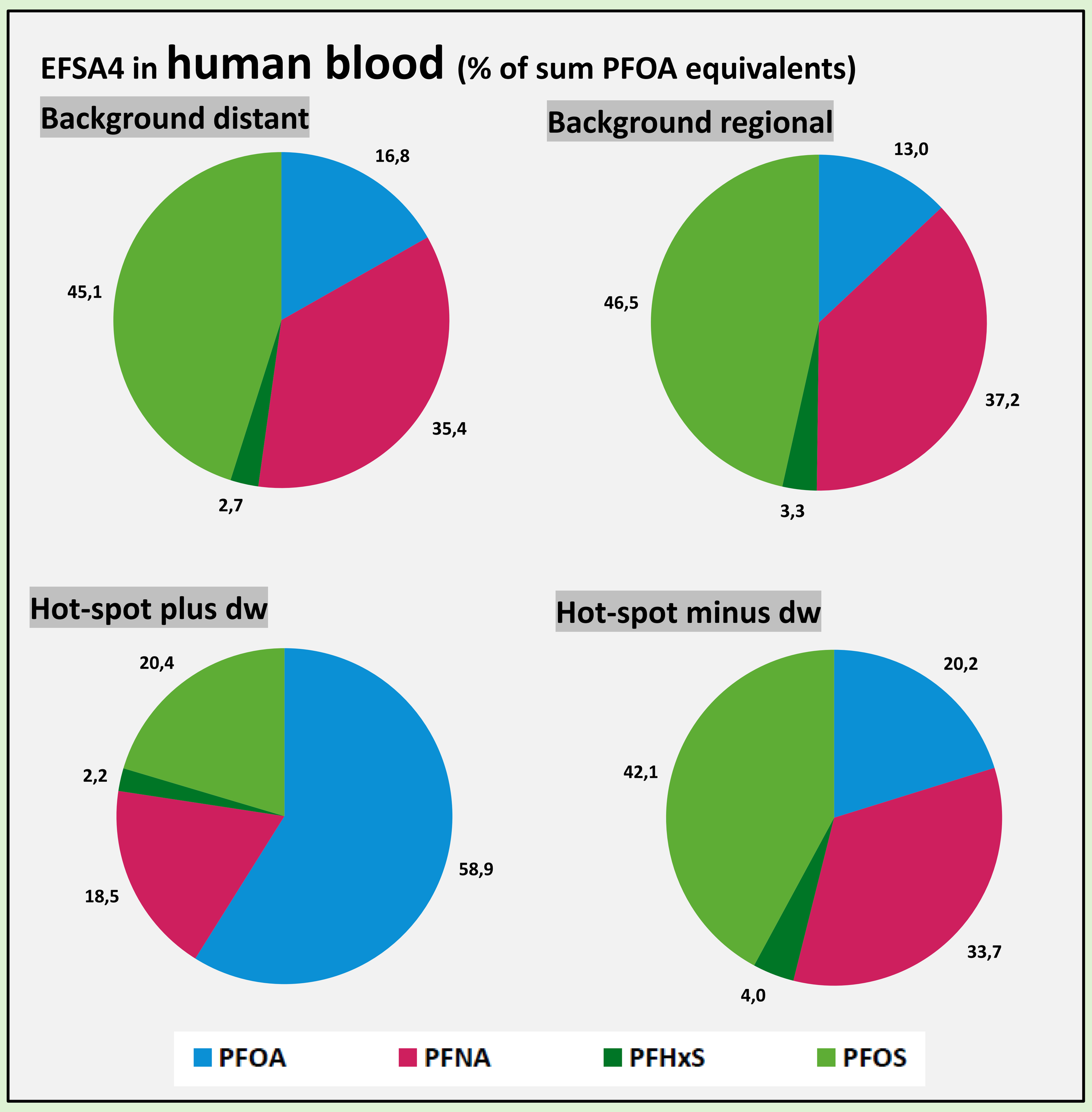
PFAS considered and their RPF-values

group	compound	RPF
11 PFCAs	Perfluorobutanoic acid (PFBA)	0,05
	Perfluoropentanoic acid (PFPeA)	0,03
	Perfluorohexanoic acid (PFHxA)	0,01
	Perfluoroheptanoic acid (PFHpA)	0,51
	Perfluorooctanoic acid (PFOA)	1
	Perfluorononanoic acid (PFNA)	10
	Perfluorodecanoic acid (PFDA)	7
	Perfluorundecanoic acid (PFUnDA)	4
	Perfluorododecanoic acid (PFDoDA)	3
	Perfluorotridecanoic acid (PFTrDA)	1,65
	Perfluorotetradecanoic acid (PFTeDA)	0,3
5 PFSAs	Perfluorobutanesulfonic acid (PFBS)	0,001
	Perfluorohexanesulfonic acid (PFHxS)	0,6
	Perfluoroheptanesulfonic acid (PFHpS)	1,3
	Perfluorooctanesulfonic acid (PFOS)	2
	Perfluorodecanesulfonic acid (PFDS)	2



→ Internal exposure in hot-spot cohorts higher than in background cohorts, in **Hot-spot area** a higher increase if comparing sum EFSA4 to sum PFAS-16

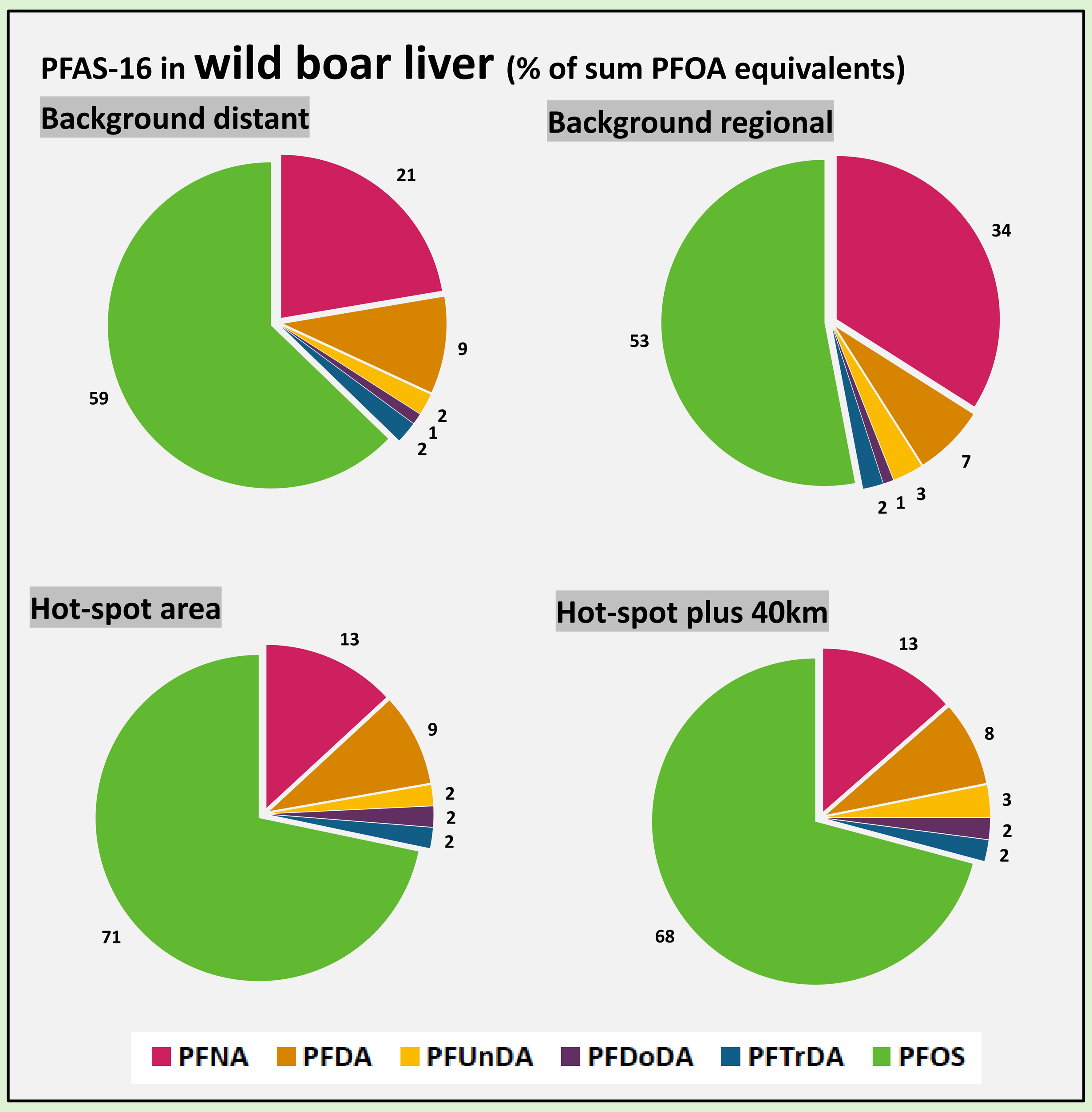
TOXIC LOAD PATTERN



→ Toxic load patterns in background cohorts and **Hot-spot minus dw** are similar with PFOS having the highest share, while the toxic load pattern of the **Hot-spot plus dw** cohort is dominated by PFOA

Additionally, PFOA-equivalents were calculated using the relative potency factor (RPF) approach suggested by Bil et al. (2021): The respective concentration or content of each of the PFAS targets is scaled relative to the index compound PFOA (see RPF-values in the table above) followed by summation of the individual PFOA equivalents yielding a measure of the total toxic load, and the relative contribution (%) of individual PFAS compounds to the summed PFOA equivalents illustrating the "toxic load pattern".

All figures and numbers are based on median values.



→ Toxic load patterns of all cohorts dominated by PFOS, but higher PFOS share at **Hot-spot area** and **Hot-spot plus 40km** indicated; further 5 long-chain PFCA make a relevant contribution (i.e. >1 %) to the overall toxic load

CONCLUSIONS

The results consistently indicate a higher internal PFAS exposure of human and wild boar populations from the hot-spot area if compared to populations being exposed to general background PFAS contamination only. Wild boars obviously accumulate higher overall PFAS loads than humans (without considering the difference in sample material, i.e. liver vs blood). PFOS and PFNA consistently make a relevant contribution to the toxic load patterns in humans and wild boars. PFOA is more relevant for human exposure while further long-chain PFAS occur in wild boars. More targeted research (biomonitoring, epidemiology) to elucidate PFAS exposure pathways at PFAS-contaminated sites is recommended.

SETAC Europe 35th Annual Meeting 11 May - 15 May 2025 Vienna (Austria)

German Environment Agency

Umwelt Bundesamt

References: Bil et al. (2021) DOI 10.1002/etc.4835 Göckener et al. (2020) https://doi.org/10.1016/j.envint.2020.106123 Rupp et al. (2023) https://doi.org/10.1016/j.scitotenv.2023.162028
CVUA (2019) https://www.ua-bw.de/pub/beitrag.asp?subid=3&Thema_ID=7&ID=3061&Pdf=No&lang=DE
LGA BW (2021) https://sozialministerium.baden-wuerttemberg.de/fileadmin/redaktion/m-sm/intern/downloads/Downloads_Gesundheitsschutz/Bericht_PFC-BlutkontrolluntersuchungLKRastatt_2020-Aug2021fin.pdf
Frische, T., et al. (2023): Per- and Polyfluoroalkyl Substances (PFAS) in Soil and Wild Boar Samples from a PFAS Hot Spot Area – a Comparative Chemical Fingerprinting Exercise. 33rd SETAC Europe Annual Meeting 2023

Photos (Headline): T. Frische