Harvard John A. Paulson School of Engineering and Applied Sciences

HARVARD SCHOOL OF PUBLIC HEALTH
Department of Environmental Health

Biogeochemistry of Global Contaminants HARVARD

PFAS in the Environment & Implications for Human Exposure

Elsie M. Sunderland

ems@seas.harvard.edu

https://bgc.seas.harvard.edu

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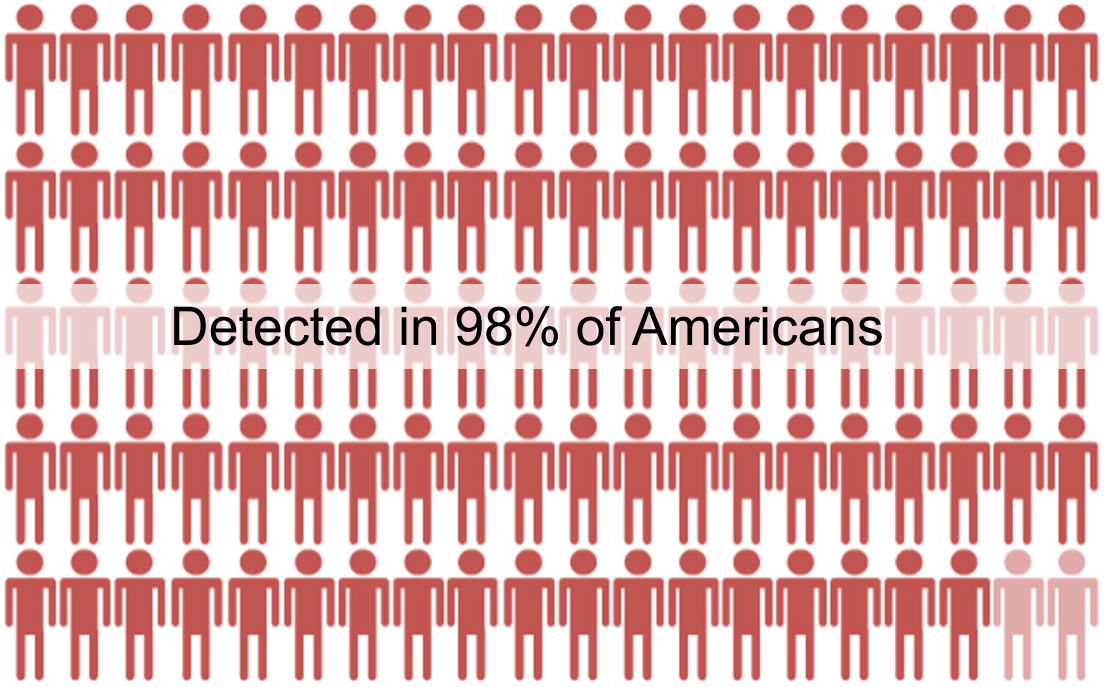
PFAS are detectable in virtually all Americans

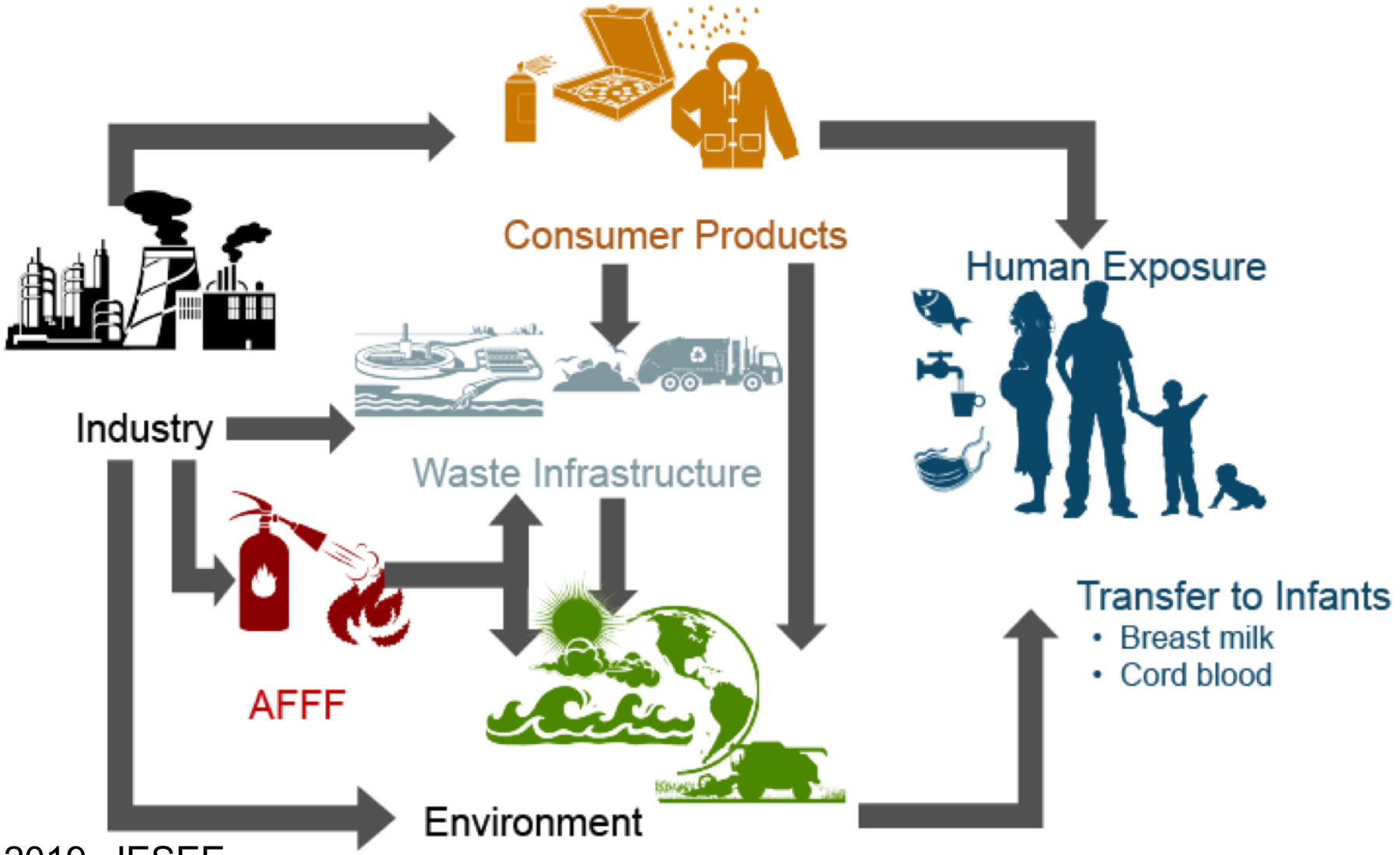


<u>Exposure linked to health risks:</u>

Cancer, elevated cholesterol, obesity, immune suppression, and endocrine disruption

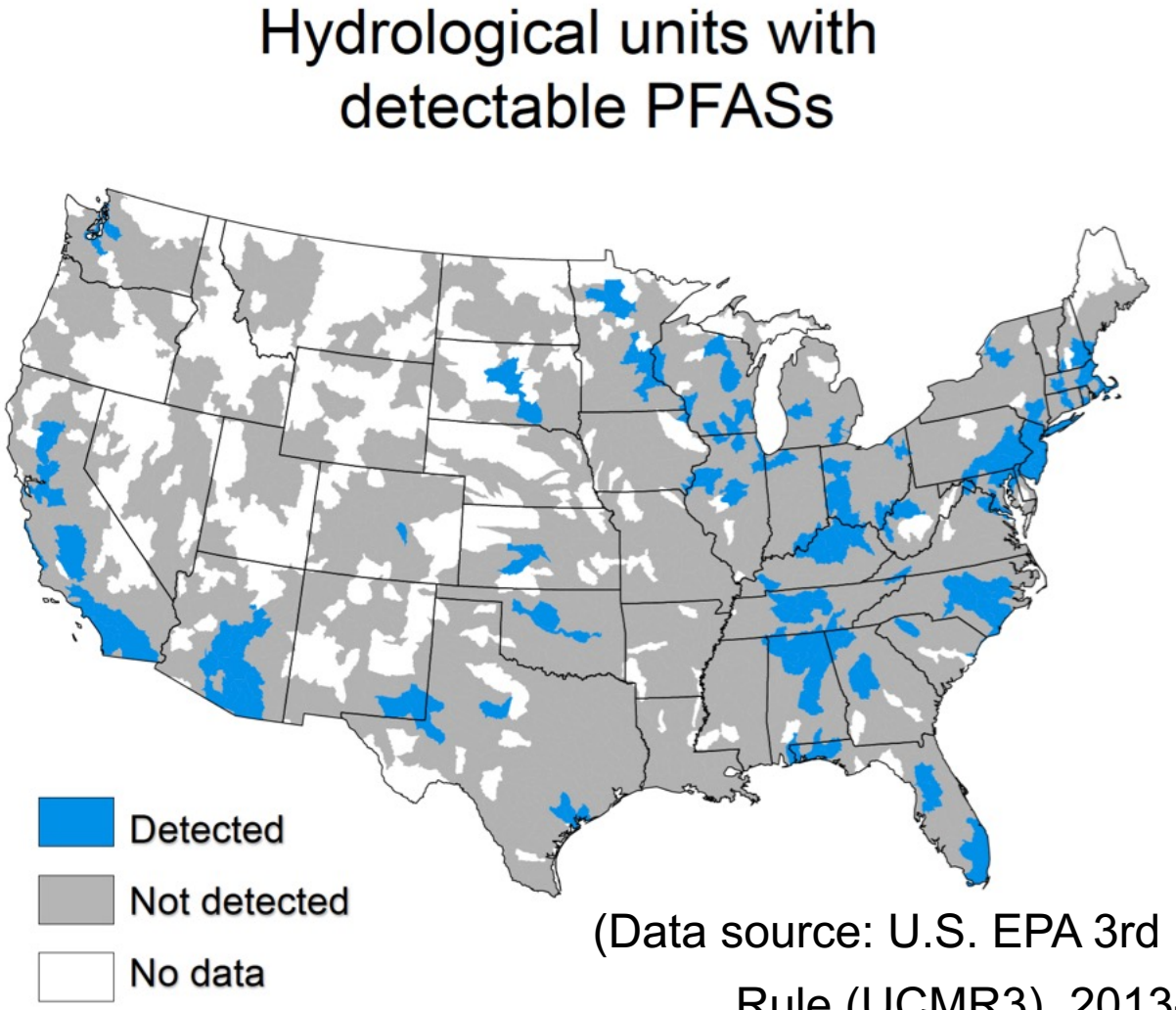
(Lewis et al., 2015; Grandjean et al., 2012; Braun et al., 2016; Barry et al., 2013)

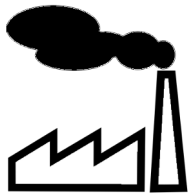
Human exposures to PFAS are diverse: Some can be addressed/mitigated faster than others



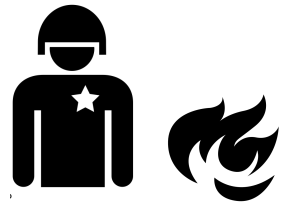
Sunderland et al., 2019, JESEE

2016 US EPA provisional lifetime health advisory for drinking water of 70 ng/L (PFOS + PFOS or sum)





Industrial sites



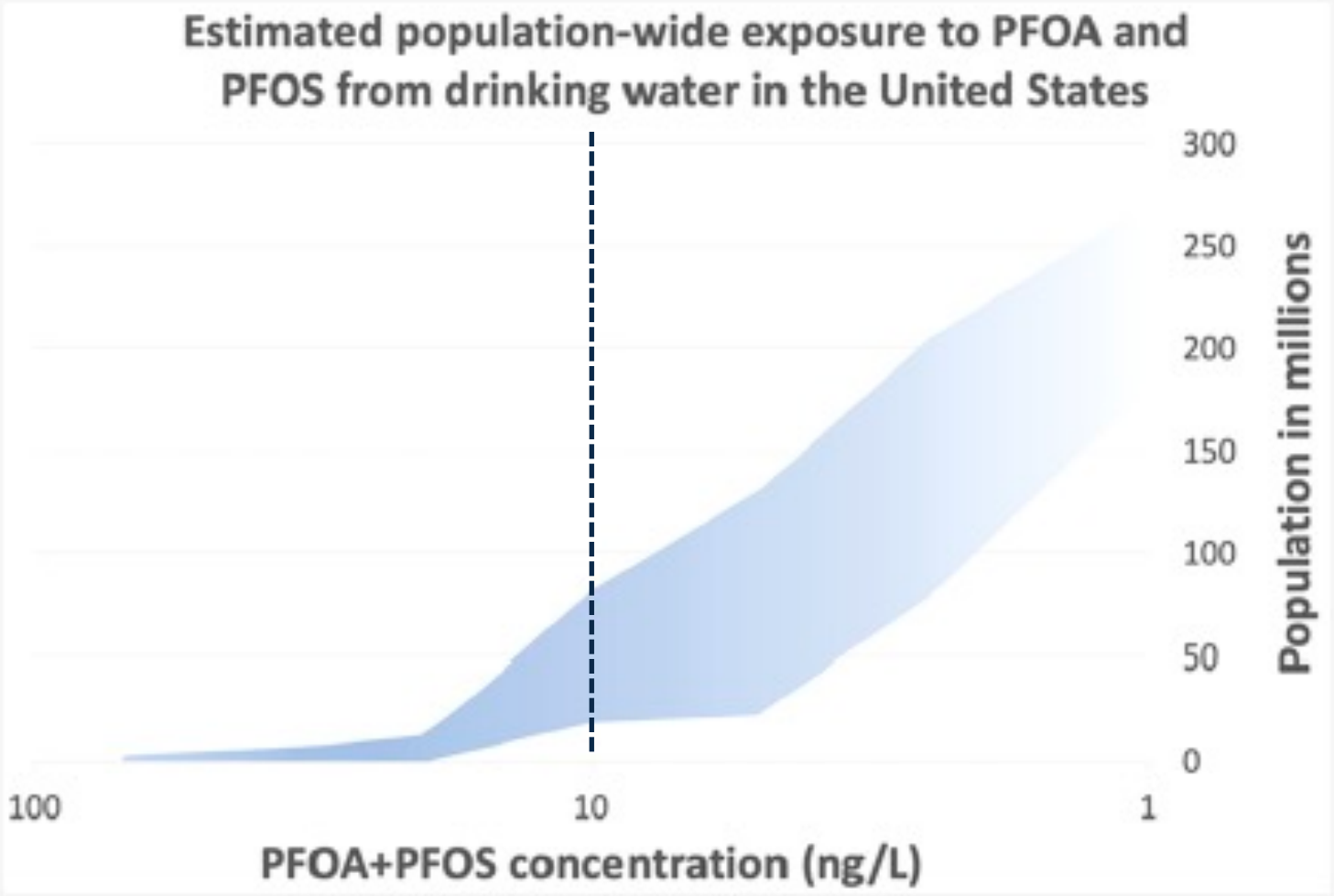
Military fire training areas

AFFF
Certified airports

Wastewater treatment plants

(Data source: U.S. EPA 3rd Unregulated Contaminants Monitoring Rule (UCMR3), 2013-2015) (Hu et al., *ES&T Letters*, 2016)

Estimated **18-80 Million** U.S. Residents have **>10 ng/L PFAS** in their tap water



Andrews and Naidenko, 2020, EST Letters

Cambridge tap water:
Current information about PFAS testing (Feburary 2021)
Test Results

PFAS Analyte PFAS6 (regulated)	Result ng/L (ppt)
Perfluorooctane Sulfonic Acid (PFOS)	Trace*
Perfluorooctanoic Acid (PFOA)	6.0
Perfluorohexane Sulfonic Acid (PFHxS)	2.3
Perfluorononanoic Acid (PFNA)	Not Detected
Perfluorohepatanoic Acid (PFHpA)	3.0
Perfluorodecanoic acid (PFDA)	Not Detected
Sum of PFAS6 - compare to MassDEP MCL of 20 ng/L	**11.3**

*Trace amounts are present, but below the minimum concentration that can be reported as a quantified value.
MCL = Maximum Contaminant Level
ng/L = nanogram per liter
ppt = parts per trillion

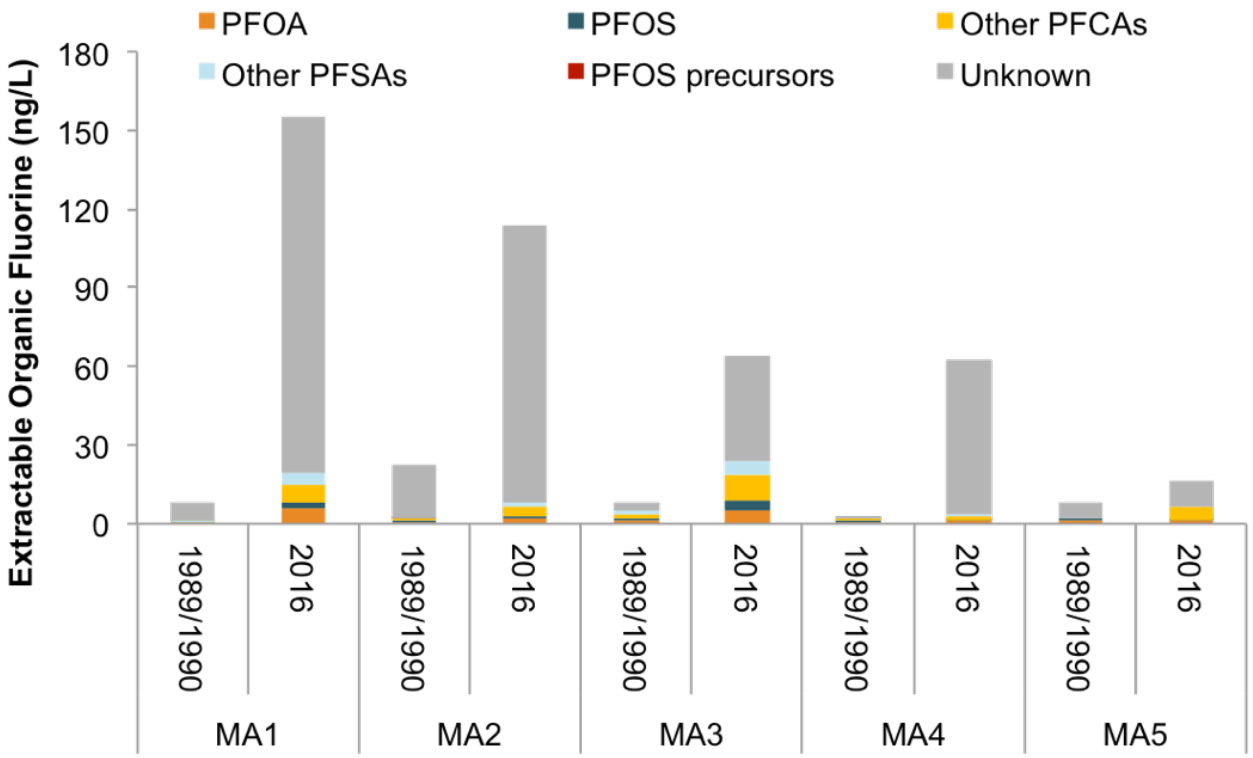
PFAS = Per and Poly Fluoroalkyl Substances

There are thousands of PFAS. Large amounts of unidentified organofluorine in surface & drinking waters

AFFF impacted watersheds in Cape Cod MA

Ruyle et al. (2021) ES&T

Drinking Water in MA

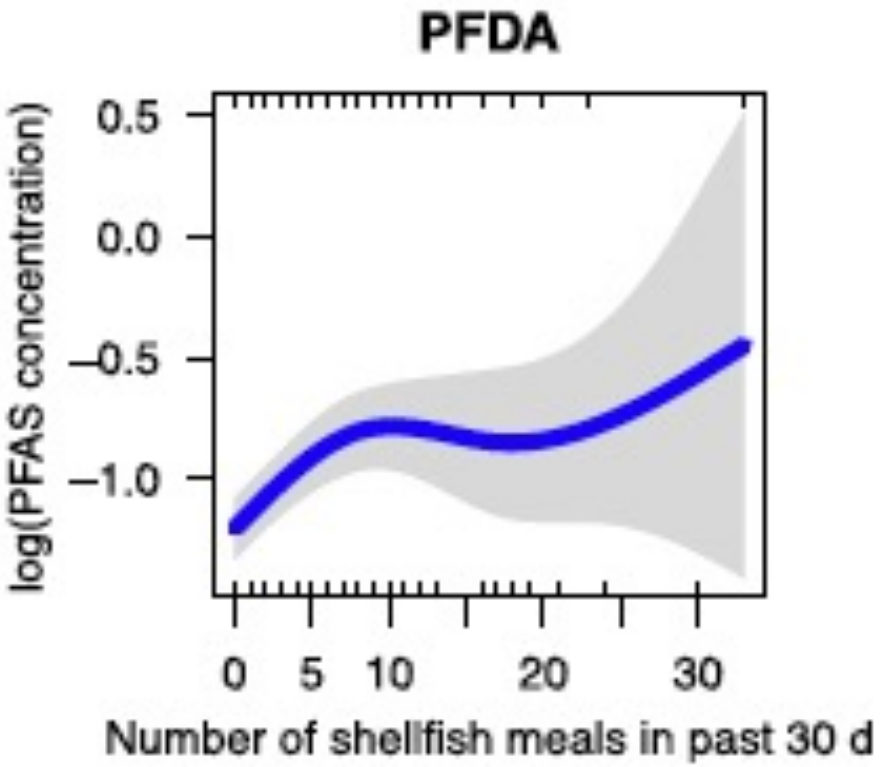


% unknown EOF: 8% - 89% in 1989/1990; 60% - 94% in 2016

Hu et al. (2019), Environmental Health Perspectives

Some PFAS accumulate in food webs & seafood: an important human exposure source

NHANES 2005-2006



Hu et al. 2018, Environmental Health

Agronomic exposure pathway for PFAS

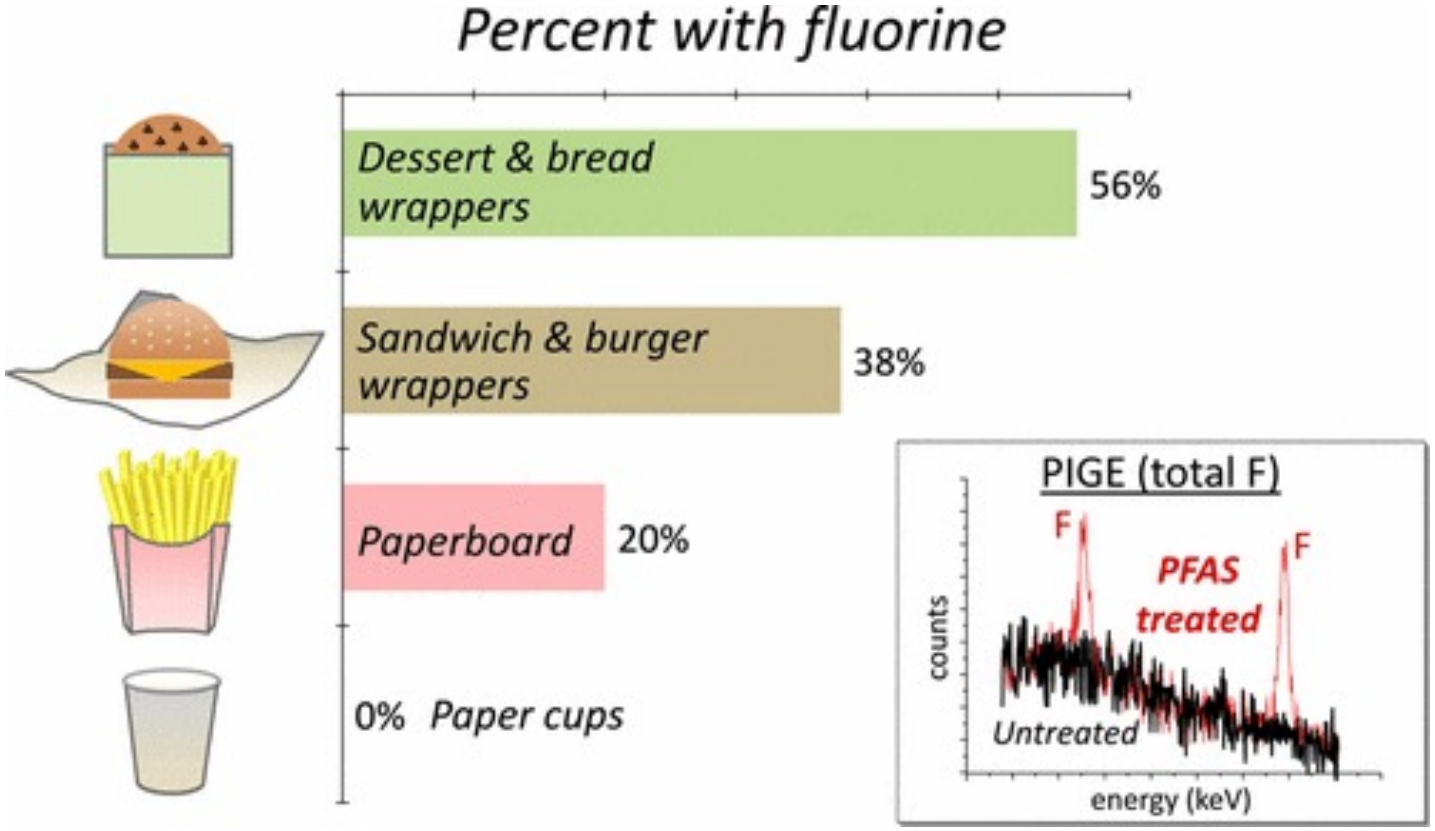
The curious case of tainted milk from a Maine dairy farm

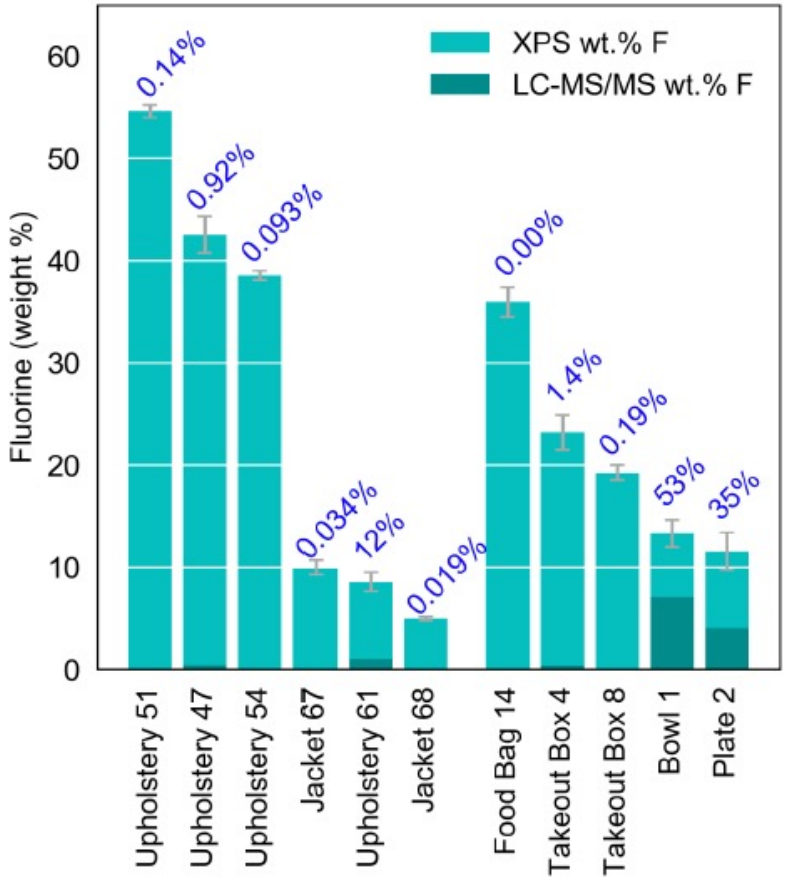
Richard Valdmanis, Joshua Schneyer

6 MIN READ

ARUNDEL, Maine (Reuters) - For Maine dairy farmer Fred Stone, the discovery in 2016 that his cows were producing tainted milk has since brought financial ruin and threatened to shut down a century-old family business.

PFAS in food packaging can contaminate food

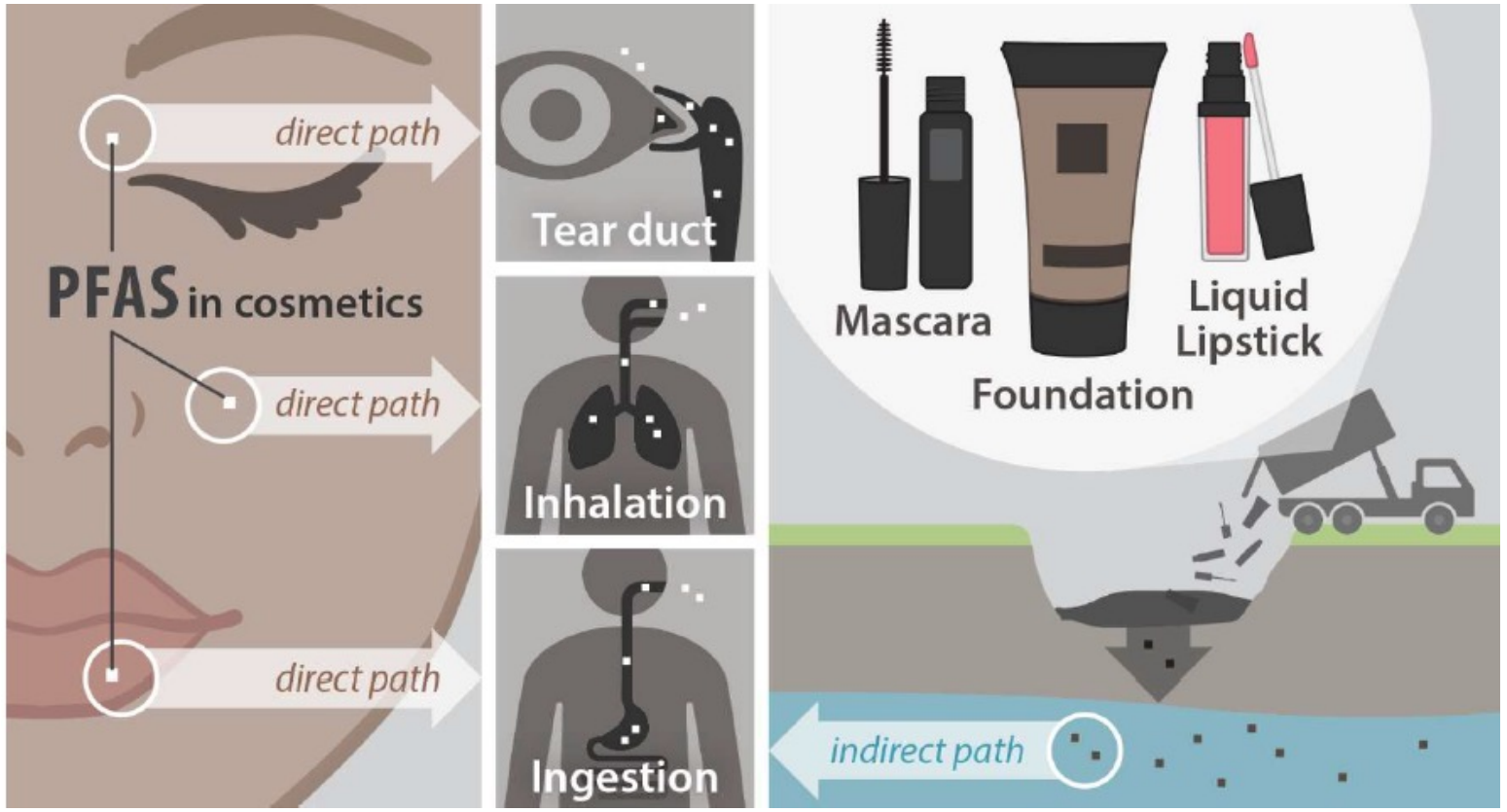




Schaider et al., 2017, ES&T Letters

Tokranov et al., 2019
ES&T Letters

Personal Care Products

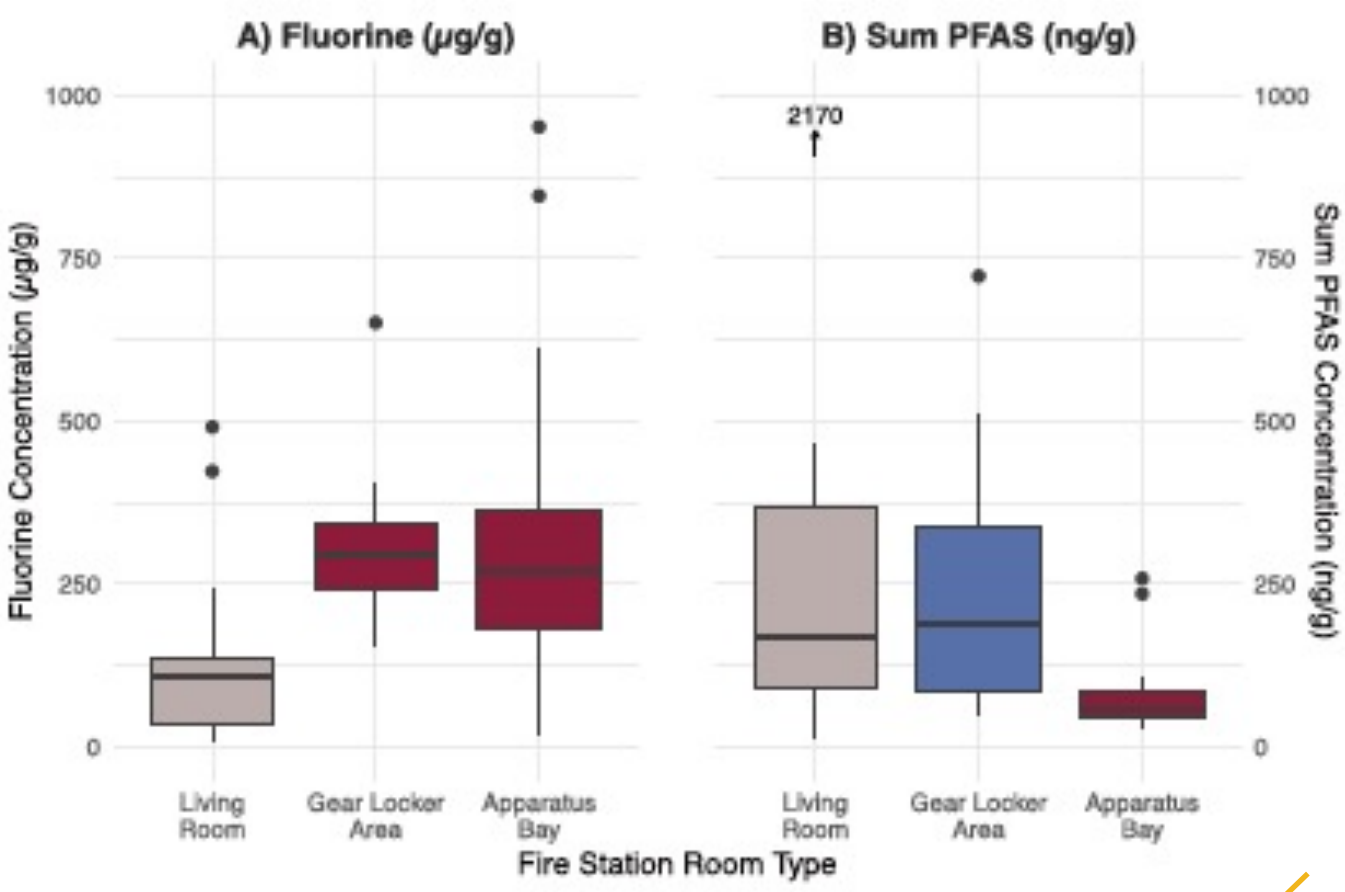


High concentrations detected of precursors to PFAS with known health effects; Gap in US and Canadian labeling laws

Whitehead et al., 2021; ES&T Letters

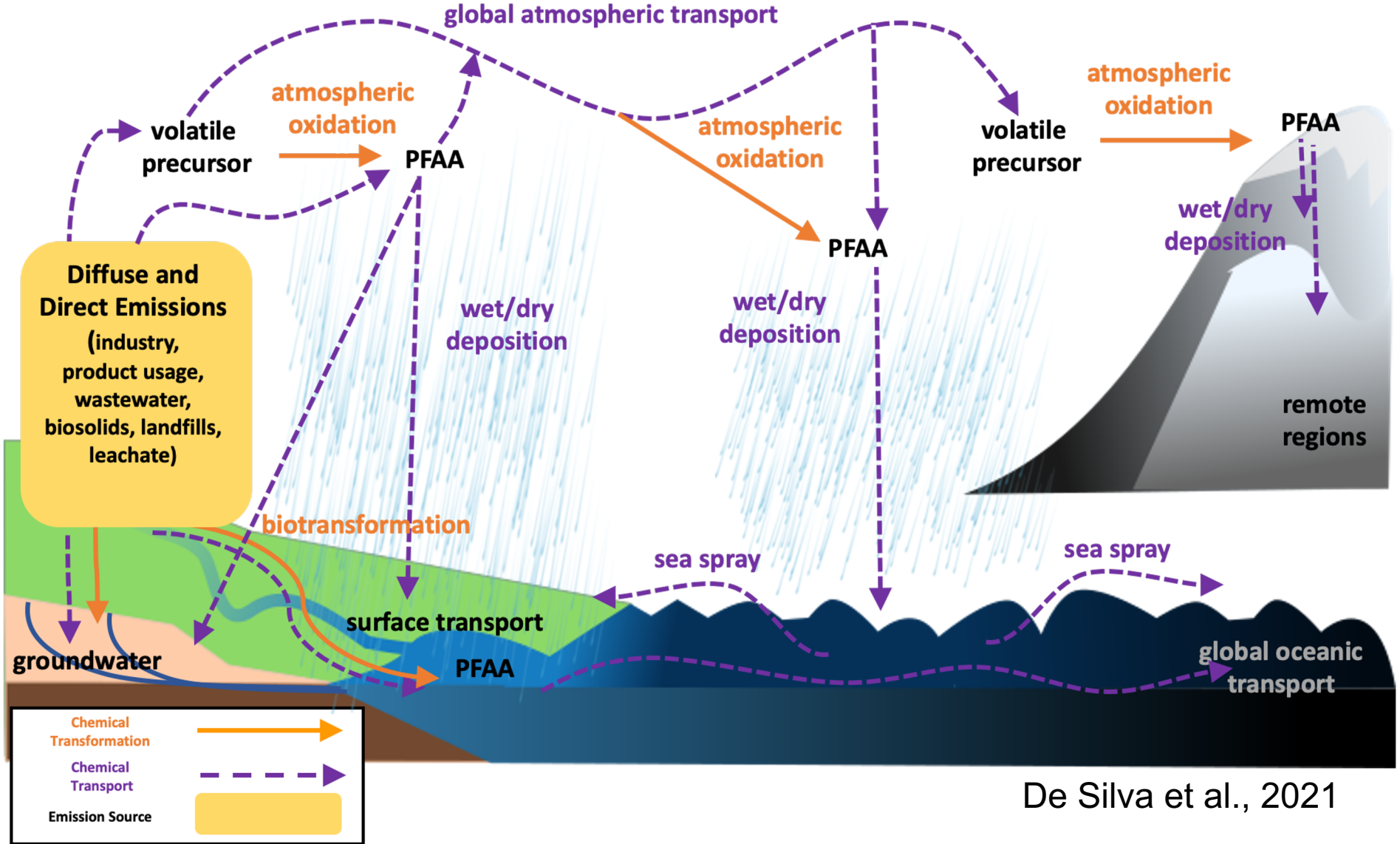
PFAS in many consumer products: Indoor environment and dust

Example: 15 Fire Stations in MA



Young et al., 2020, JESEE

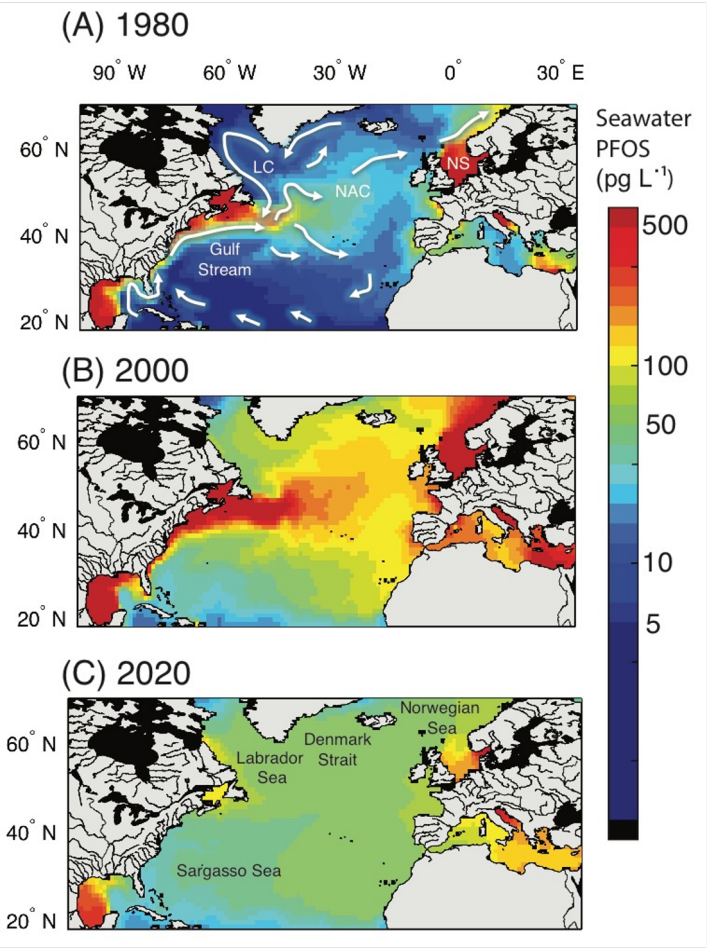
PFAS are globally distributed contaminants: The atmosphere is an important transport mechanism



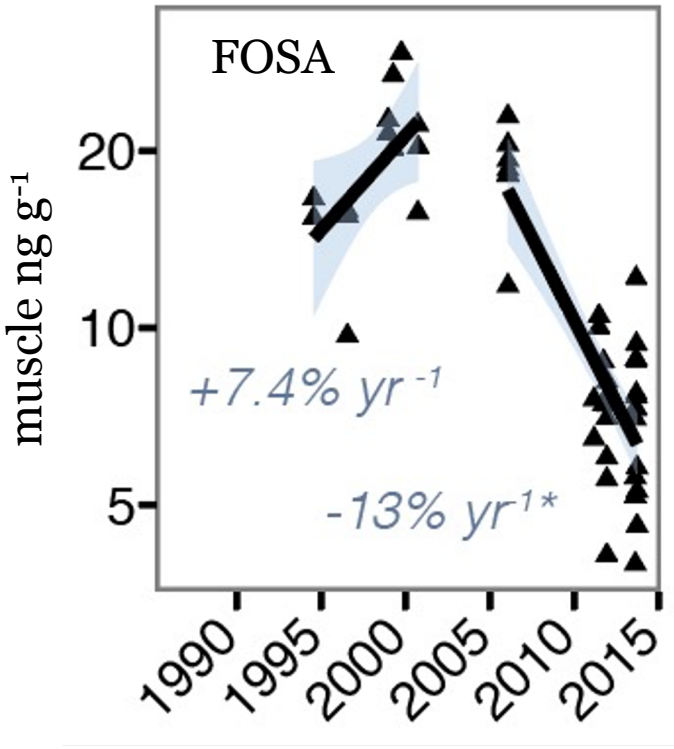
De Silva et al., 2021

Regulatory action is effective: Rapid declines in seawater, wildlife and humans after PFOS phase-out

PFOS

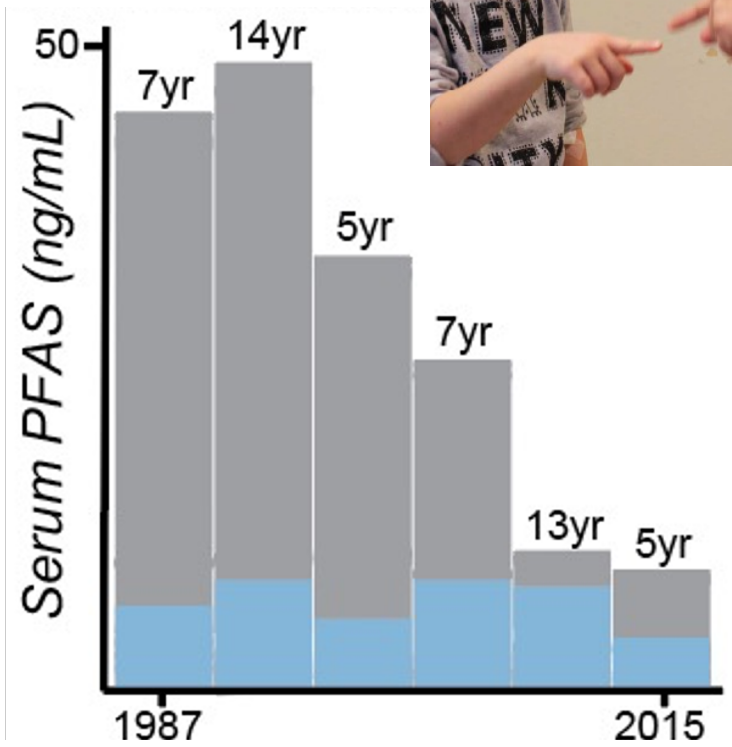


Zhang et al., 2017



Juvenile males 9-12 years

Dassuncao et al., 2017



Dassuncao et al., 2018