



Credit: Phototropy/flickr



# The Challenge of PFAS

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*Alaska Communities Against Toxics*  
*16 December 2021*

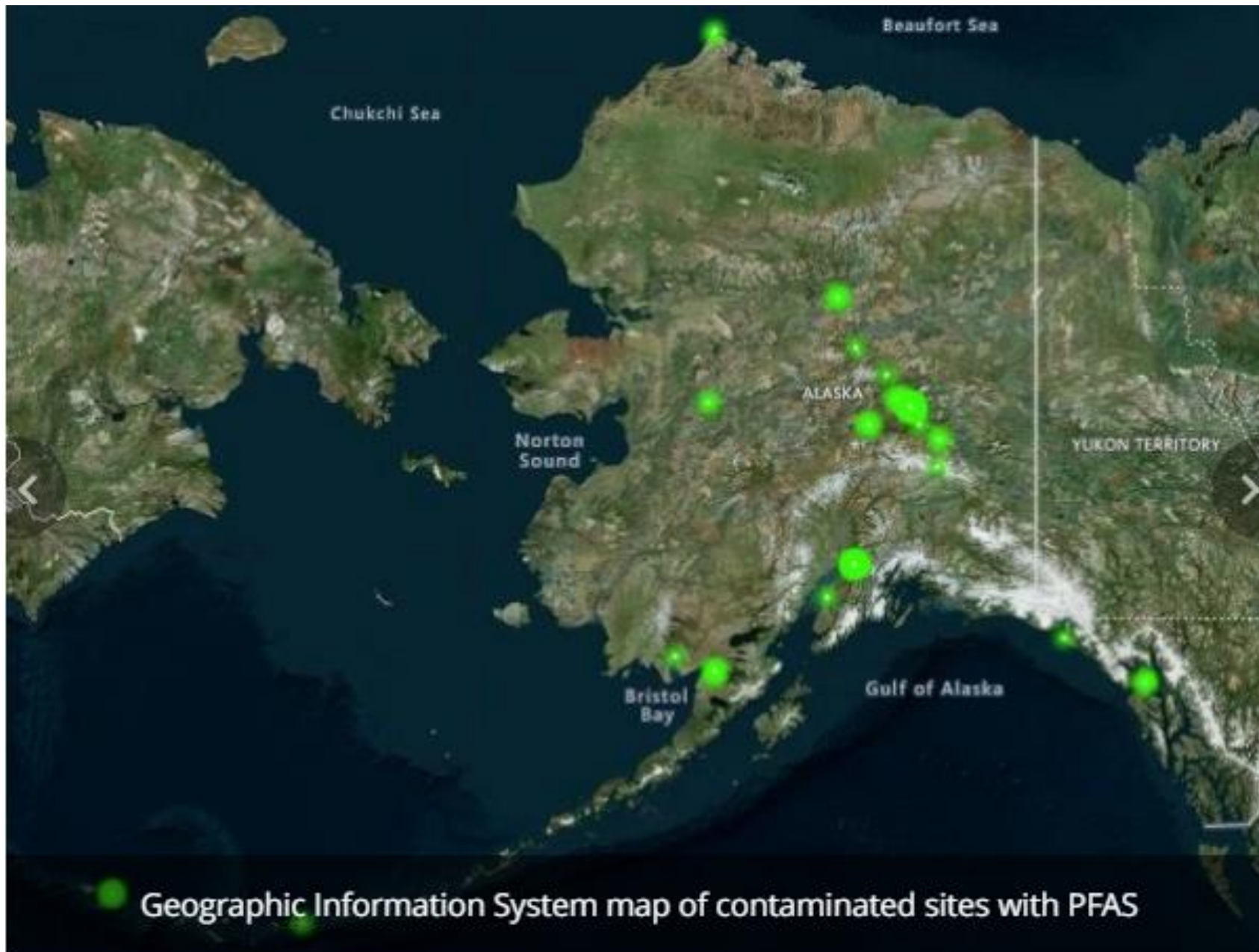


The PFAS in ski wax helps athletes slide faster down the hill. Dmitry Moichanov/Shutterstock

# Potential conflicts of interest

**I retired from  
NIEHS-10/3/19**  
**I have spoken  
publicly about my  
understanding of  
PFAS toxicity.**  
**I am serving as a  
PFAS plaintiff's  
witness**







Release of foam to the Garrison Slough  
Stacey Ri and Ron Porter (CH2MHill)



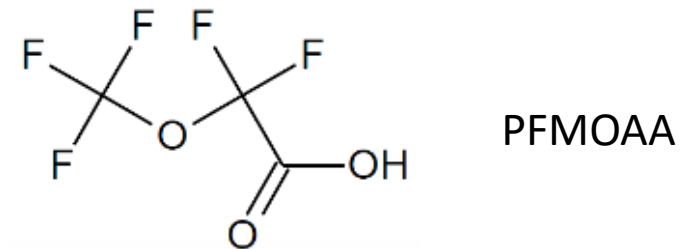
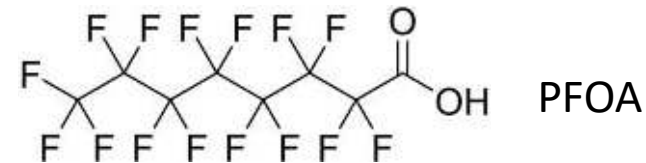
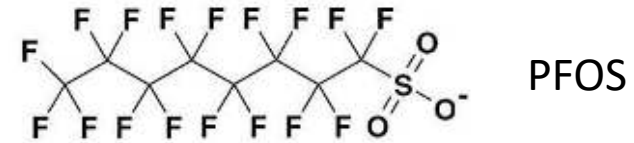
Stockpiles of PFAS contaminated soil for treatment or disposal



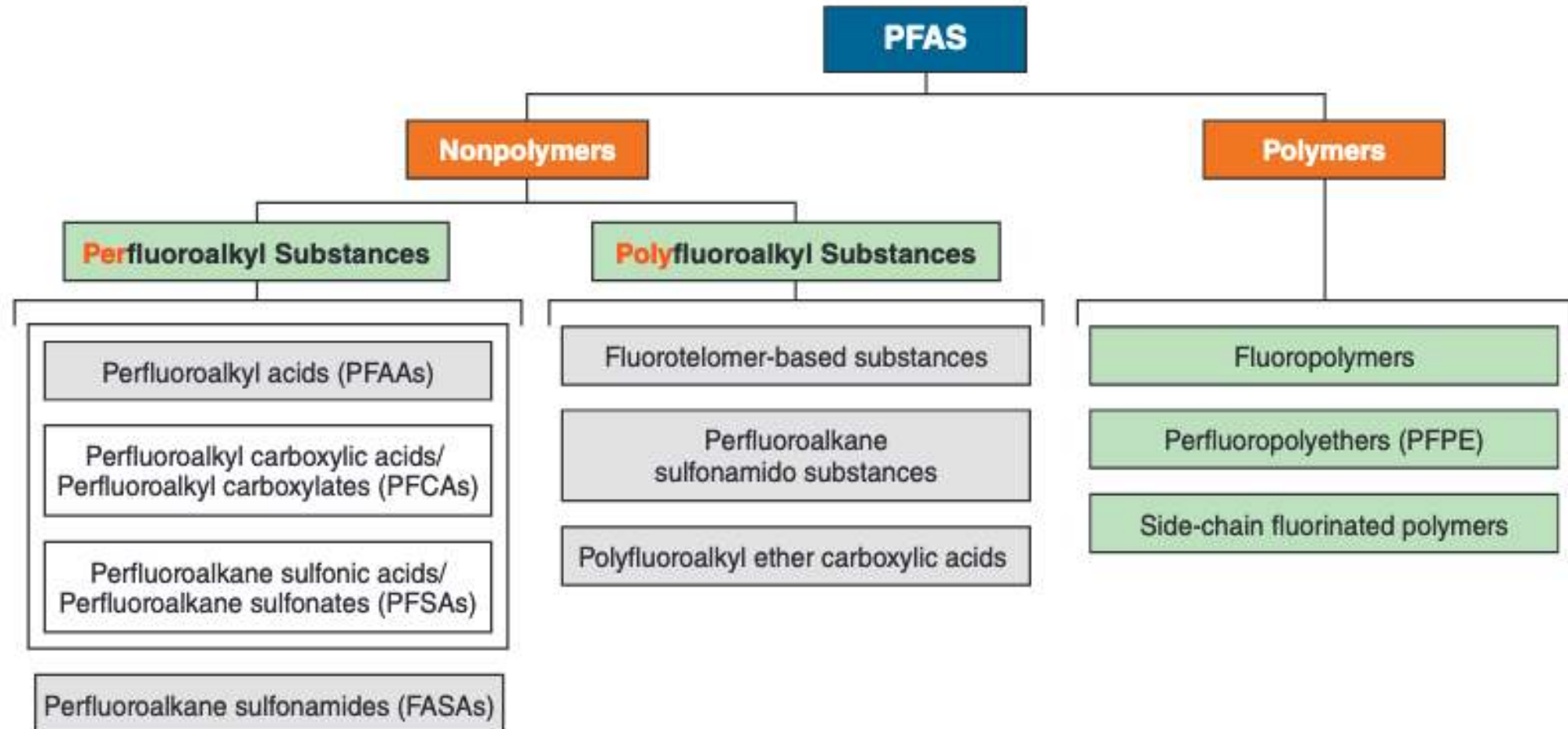
Safer States

# What are Per- and Polyfluoroalkyl Substances (PFAS)?

- **Total number of PFAS >9,000 chemicals**
  - Includes products, impurities and degradants
    - Teflon
    - Scotchguard
    - Aqueous Film Forming Foams (AFFFs)
  - Many unknown formulation
- Resistant to grease, water & oil
  - Surfactants, stain repellants
  - Fire suppression - AFFF
- Persistent, mobile and bioaccumulative
- Emergence of short-chain alternatives - less well studied
  - Few studied – same effects as long chains

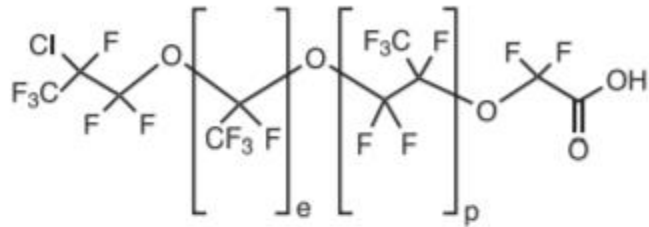


# PFAS Groupings

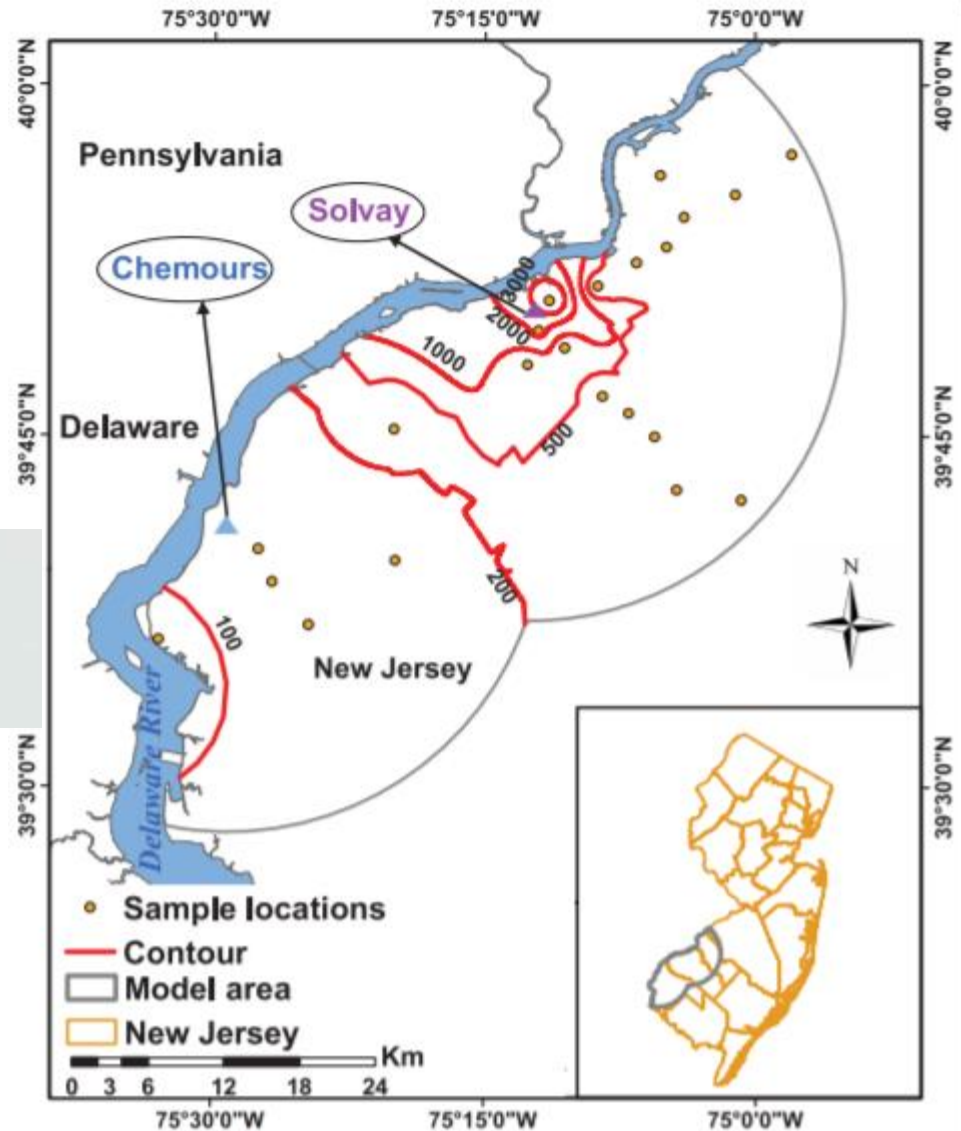




# “NEW” PFAS found all the time!



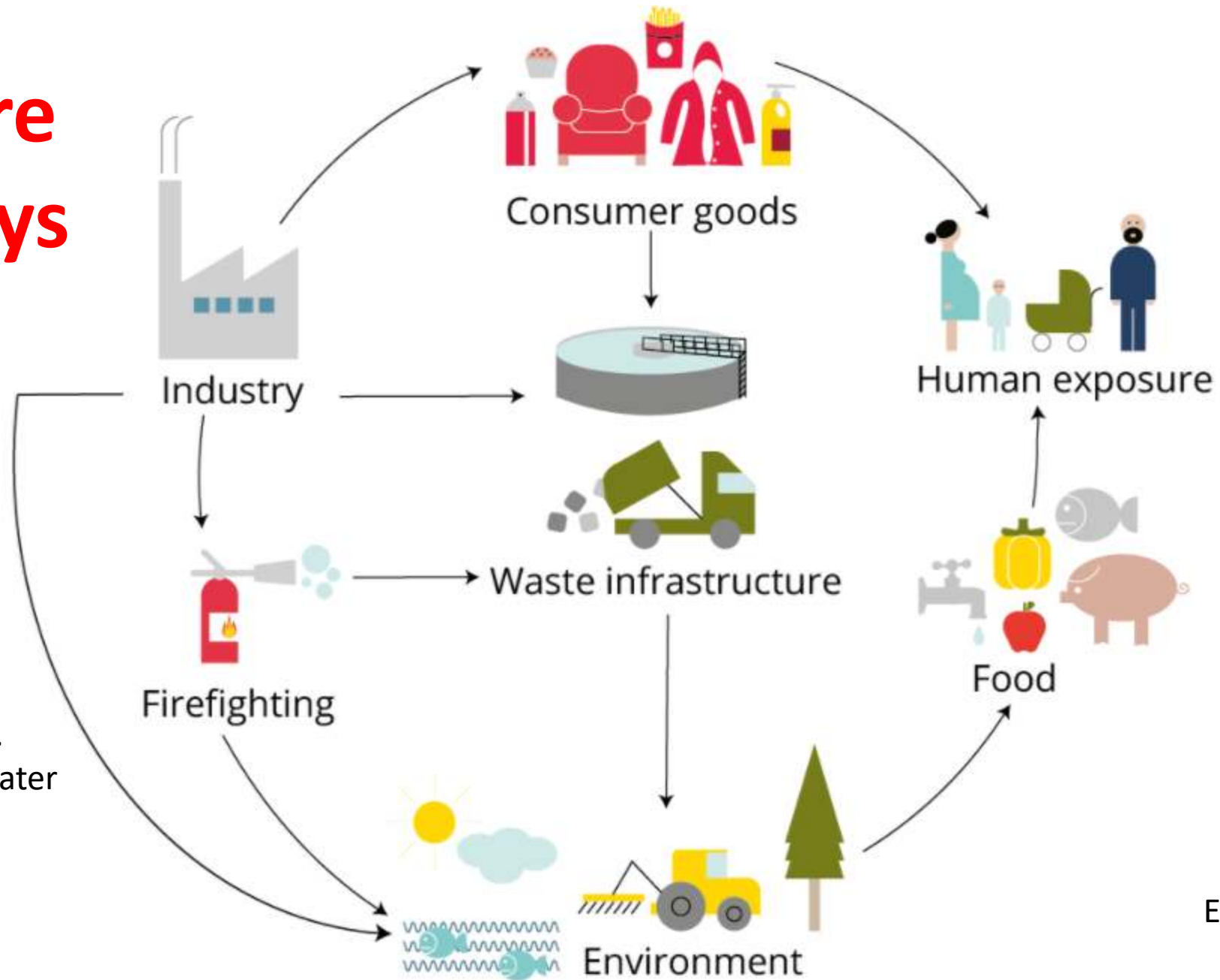
**Fig. 1. A chloroperfluoropolyether carboxylate (CIPFPECA) identified by nontargeted MS analyses in soil samples from New Jersey.** In the New Jersey samples, perfluoroethyl (e) plus perfluoropropyl (p) groups were observed to range in sum from one to four. The example congener depicted here would be designated (e,p) = 1,1. Isomers likely include an alternative terminal structure of ClCF<sub>2</sub>CF(CF<sub>3</sub>)O- (13, 14) as well as relative positions for the perfluoroethyl and perfluoropropyl groups.



**Fig. 4. Geographic distribution.** Shown are  $\Sigma$ CIPFPECAs in surface soils (picograms/gram). Contour lines were generated by using an algorithm in ArcMAP 10.6.1 that weighted the five nearest data points according to inverse-square distance. Despite some geographic sporadicity in the data and numerical artifacts where data are sparsely spaced, taken as a group the contours depict a clear pattern of increasing  $\Sigma$ CIPFPECAs with proximity to Solvay.

Washington et al., Science 2020.

# Typical Exposure Pathways



PFAS do not degrade.  
PFAS pass through Water  
Treatment Plants

*>200 Use Categories  
[Glüge et al., Environ  
Sci: Processes&Impacts,  
2020]*

# How are we exposed?

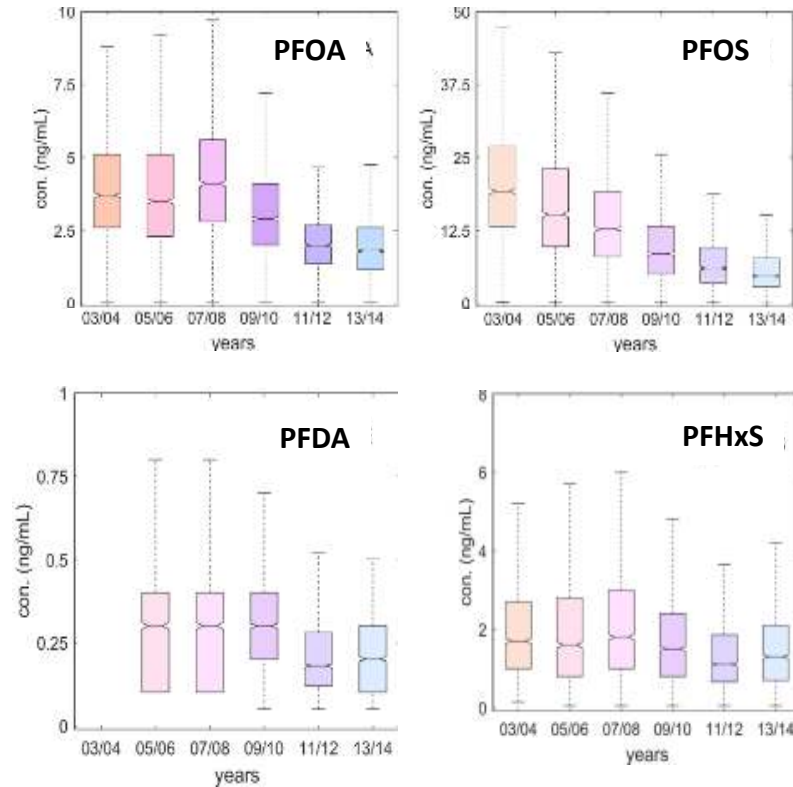
- Diverse group of chemical compounds used in industry and consumer products worldwide since 1950s
- Contaminant in Drinking water
- Found in various products:
  - Carpet and Fabric
  - Food Packaging and Food
  - Pots and Pans
  - Clothing
  - Cardboard packaging
  - Firefighting foams (AFFF)
  - Cosmetics



**Ingestion (Drinking Water, Food, Dust), Inhalation, Dermal**

# We All Have PFAS in Our Bodies

- Detected in humans globally
- >98% of people in the U.S. have measurable amounts of PFAS
- Levels of PFOA and PFOS have declined following phase-outs
- Changes in exposure to other PFAS are less pronounced

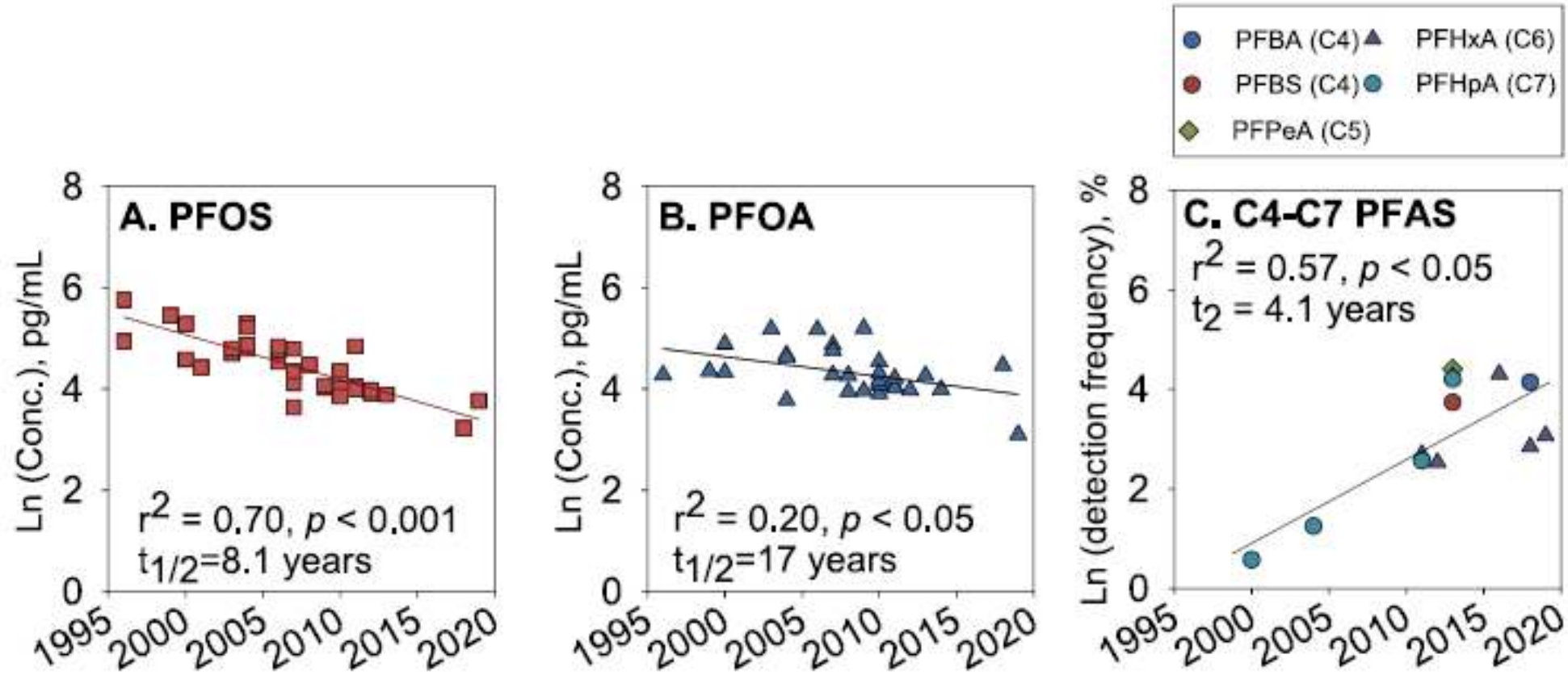


PFAS exposure trends in NHANES 2003 – 2014

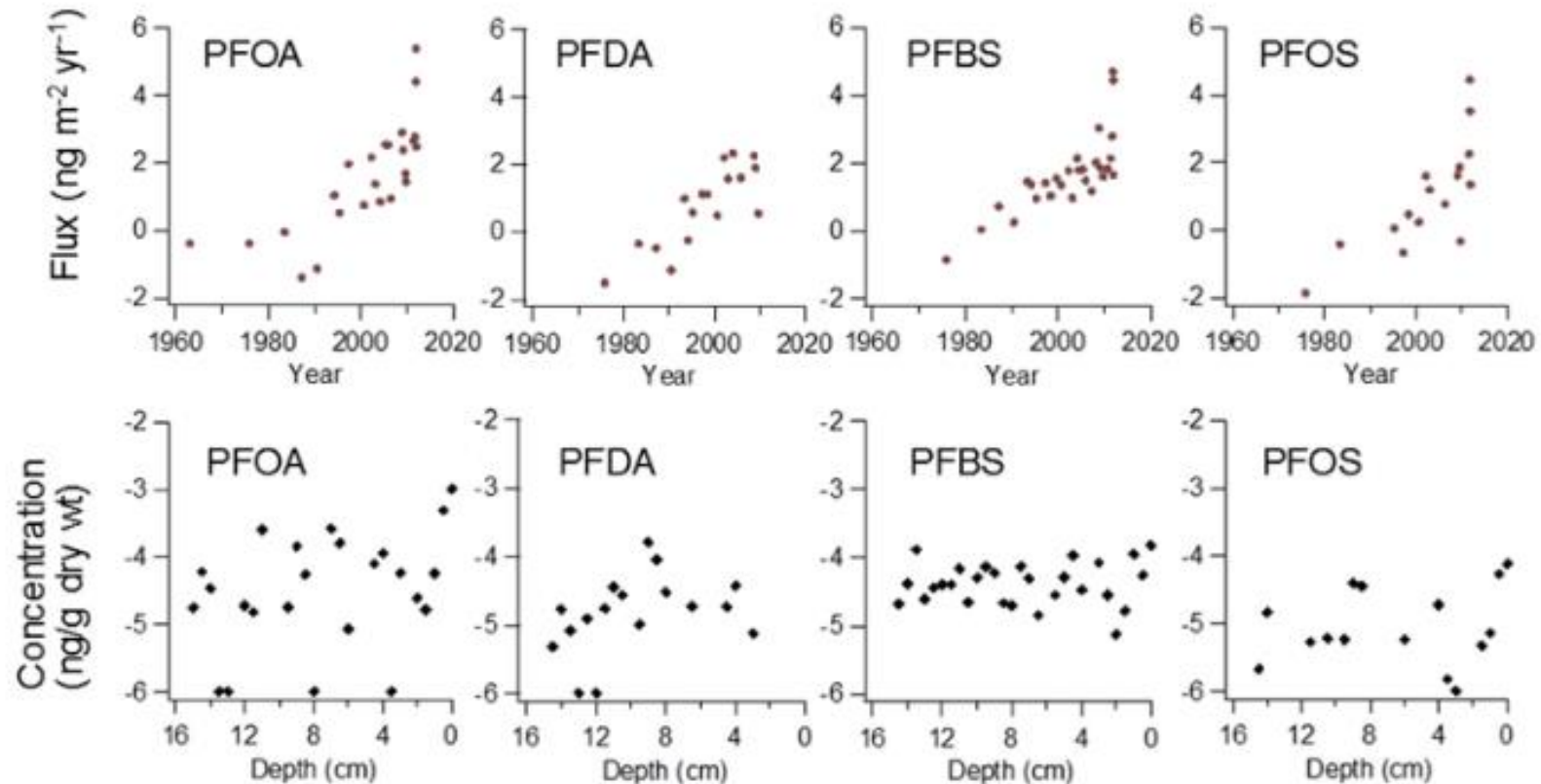
Sunderland et al., J Expos Sci & Epidemiol, 2019

Dong et al., Ecotox and Environ Safety, 2019

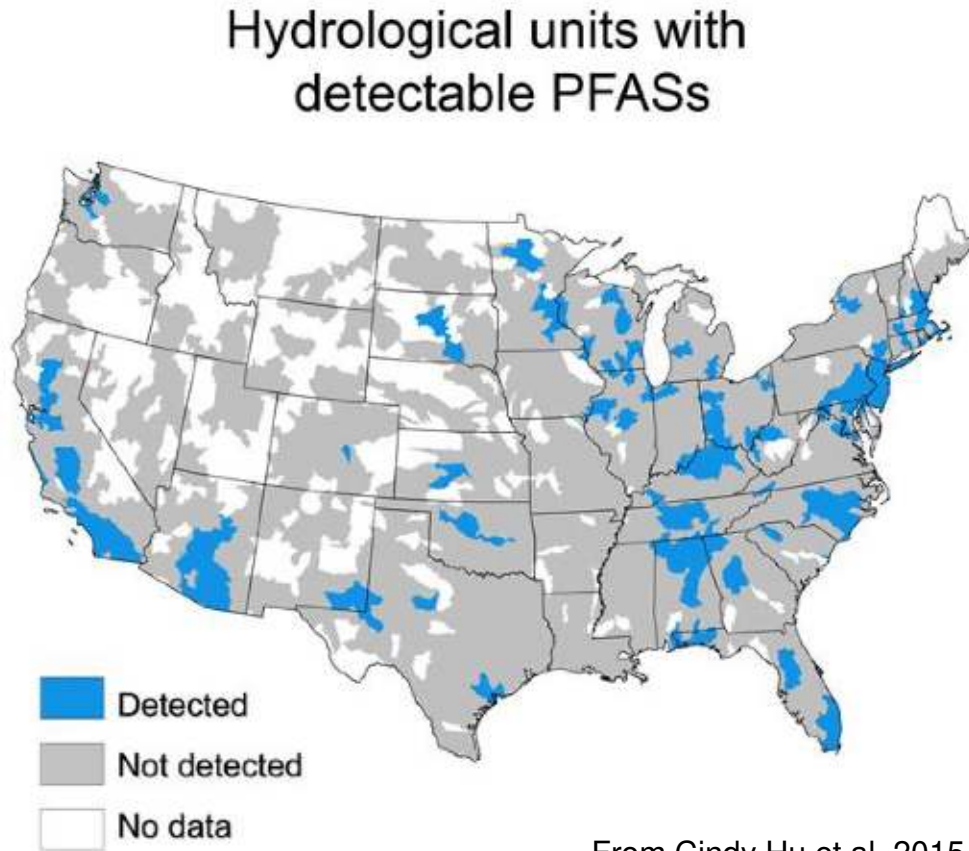
# PFAS in Human Breast Milk



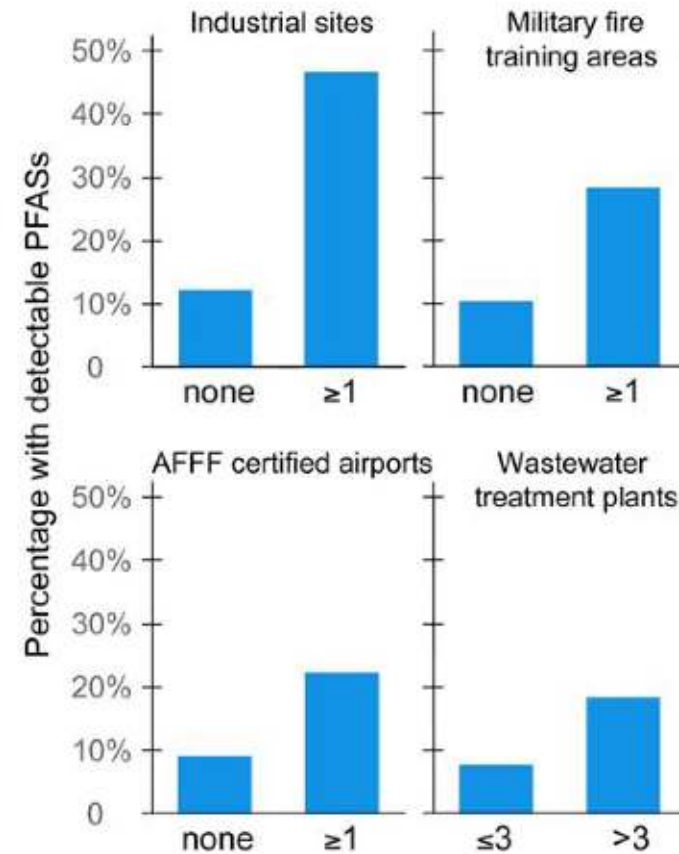
**Deposition fluxes (ng/(m<sup>2</sup>·yr)) and concentrations (ng/g dry wt) of PFOA, PFDA, PFBS and PFOS in a dated sediment core from Lake Hazen**



# Watersheds with point sources have higher detection frequencies for PFASs

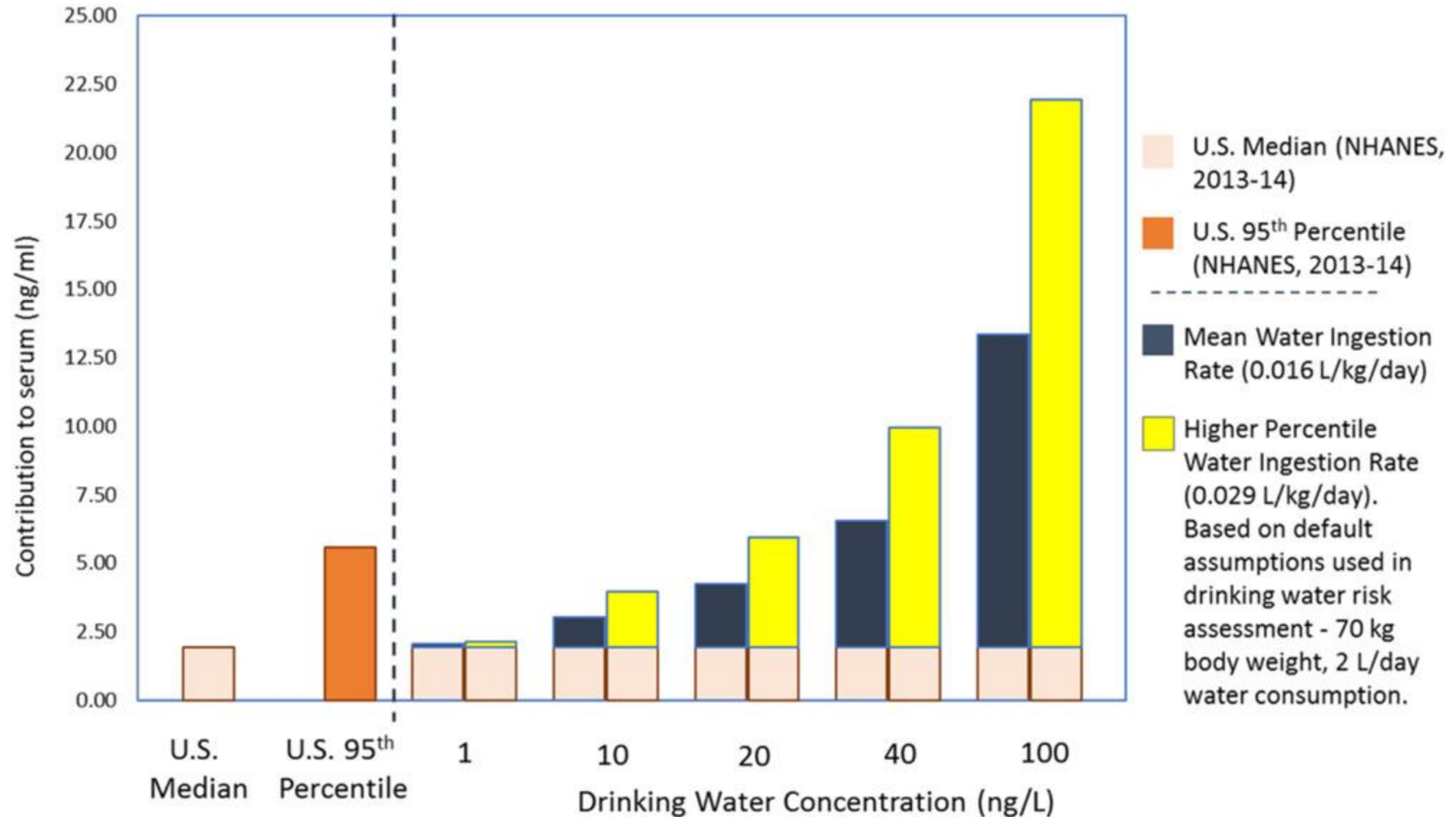


From Cindy Hu et al, 2015



Cindy Hu et al, ES&T Letters, 2016

# Predicted increases in serum perfluorooctanoic acid (PFOA) concentrations from consumption of drinking water with various concentrations of PFOA





# PFAS in Fast Food Packaging

## Report finds chemicals in one-third of fast food packaging

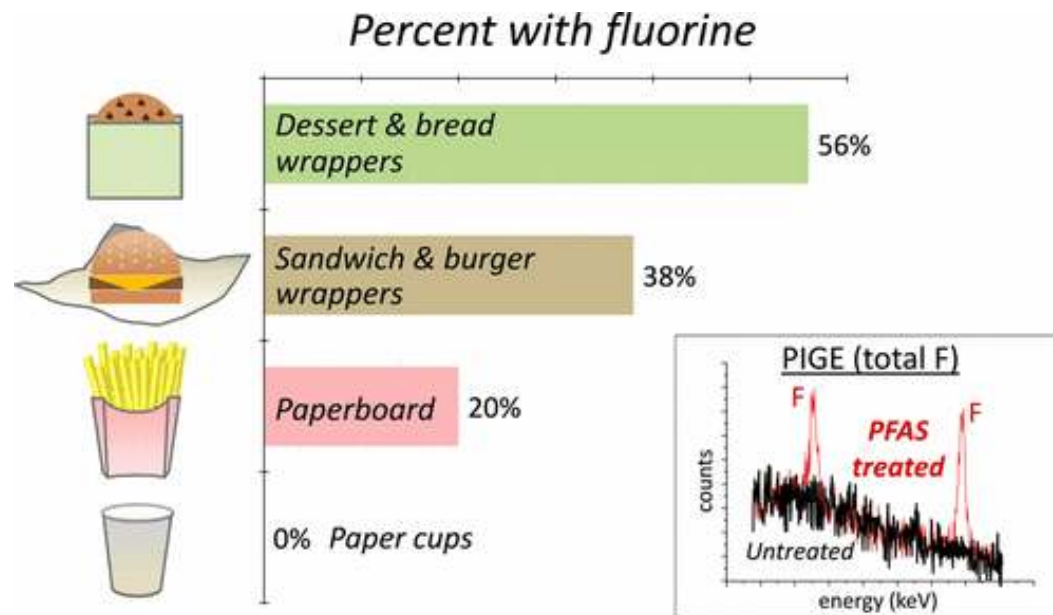
By Ben Tinker, CNN  
Updated 8:33 AM ET, Wed February 1, 2017



- Top stories
- Typhoid disease suspected in 2-year-old's death
  - Lindsay Graham: 'Hell of what Trump does is not OK'

Photos: Chemicals in fast food packaging

A study by the Silent Spring Institute found fluorinated chemicals in one-third of the fast food packaging tested. Previous studies have shown PFASs can migrate from food packaging into the food you eat. What types of packaging pose the greatest risk? Click through this gallery to find out.



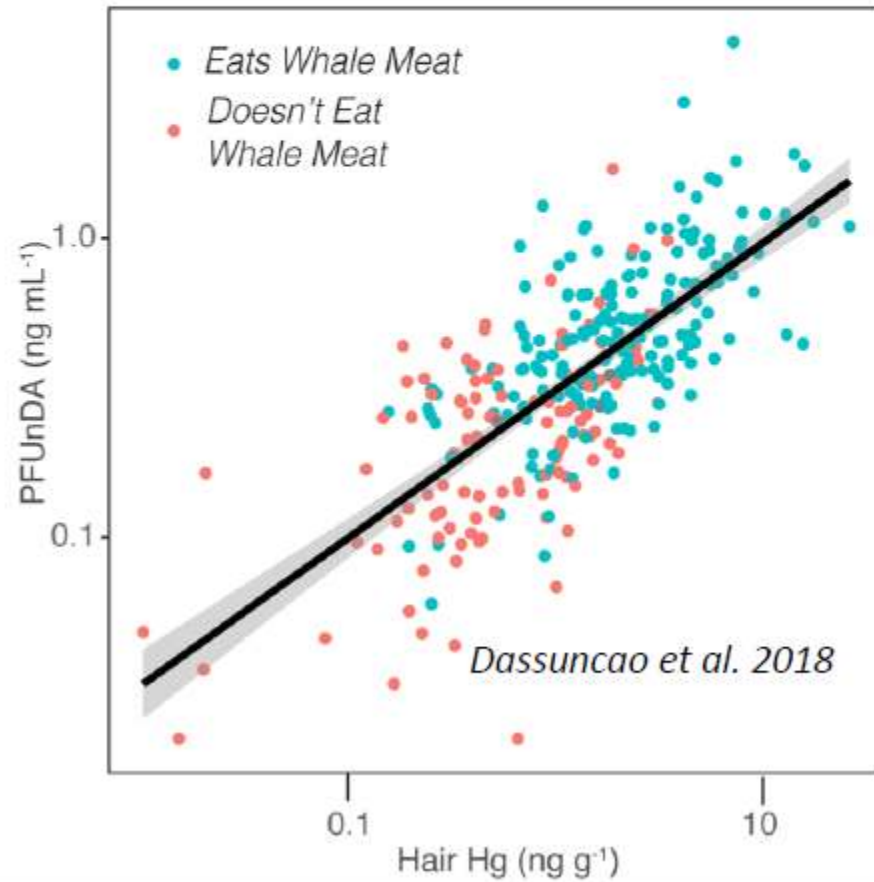
**Most common PFAS in samples: PFOA, PFHxA, PFBS, and 6:2 FTS**

### Fluorinated Compounds in U.S. Fast Food Packaging

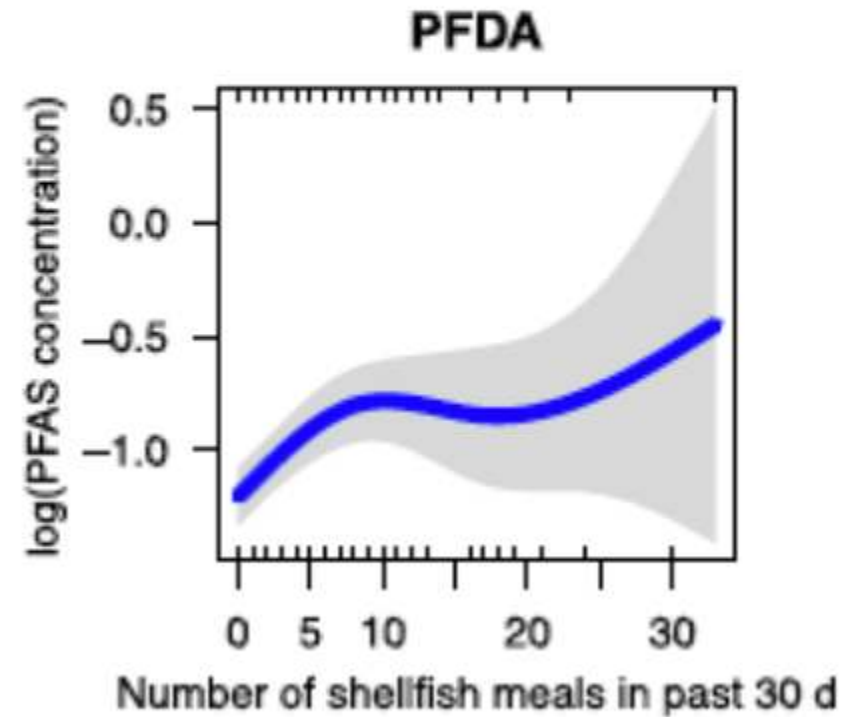
Laurel A. Schaidler,<sup>\*,†,§</sup> Simona A. Balan,<sup>‡</sup> Arlene Blum,<sup>§,||</sup> David Q. Andrews,<sup>⊥</sup> Mark J. Strynar,<sup>#,§</sup> Margaret E. Dickinson,<sup>∇</sup> David M. Lunderberg,<sup>∇</sup> Johnsie R. Lang,<sup>○</sup> and Graham F. Peaslee<sup>@</sup>

# Long-Chained PFCAs strongly associated with seafood consumption

Faroese Children



NHANES 2005-2006



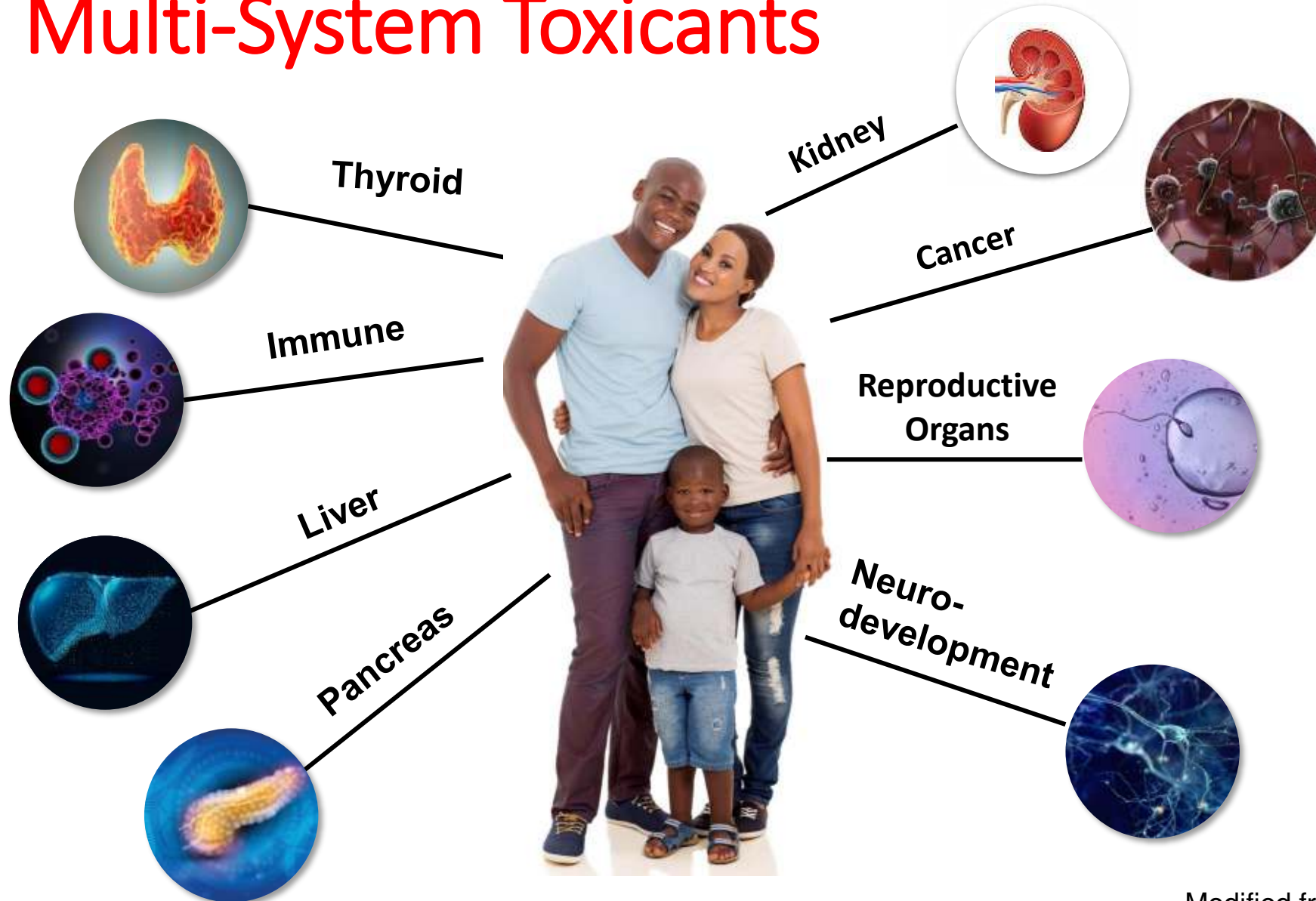


# Wide Range of Health Effects of PFAS

## *PFOS and/or PFOA*

- Testicular cancer
- Kidney cancer
- Ulcerative colitis
- High cholesterol
- Pregnancy-induced hypertension
- Thyroid disruption
- Hormonal changes
- Liver malfunction
- Obesity
- Immunotoxicity, incl. interference with child and adult vaccine response
- Lower birth weight and size
- Delayed puberty, decreased fertility, early menopause
- Reduced testosterone
- Prostate cancer
- Ovarian cancer

# PFAS: Multi-System Toxicants



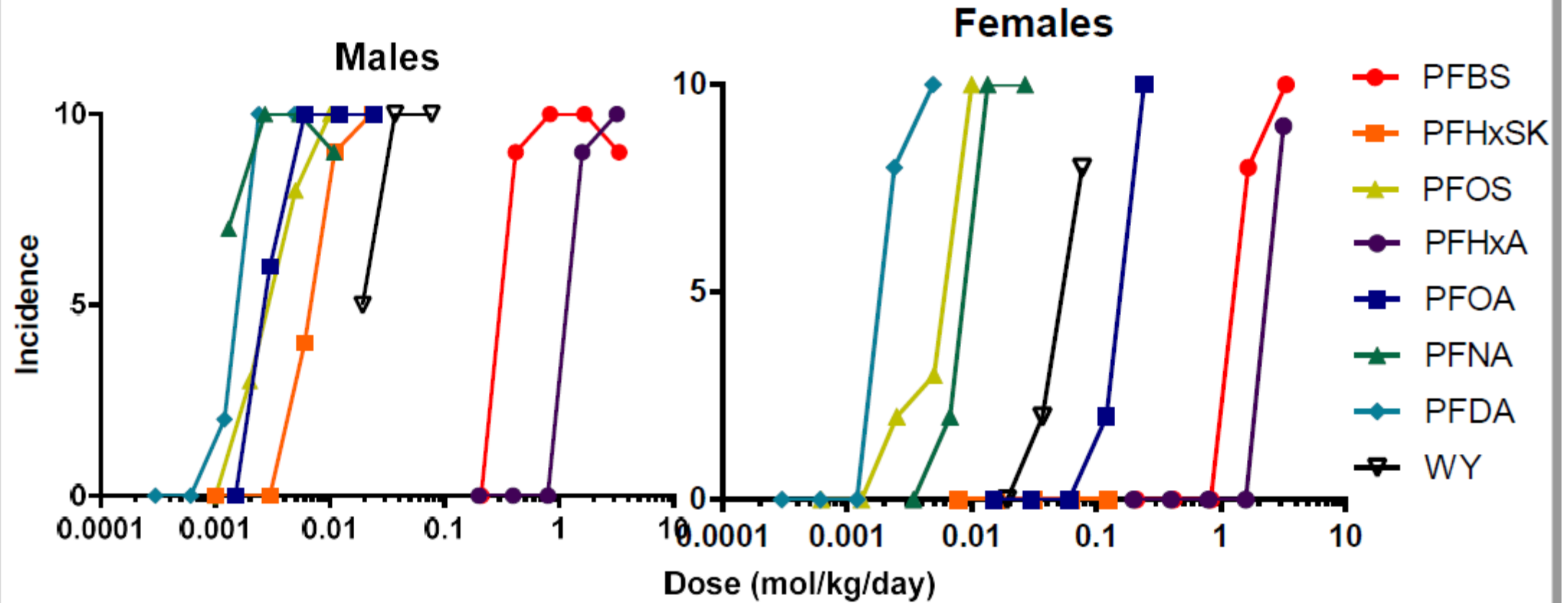
# Are Replacement PFAS Less Toxic?

- B. Blake et al., EHP 2020 – GenX~PFOA – same hepatic effects (GenX at lower internal concentration than PFOA), low birth weight, impacts on mammary gland development (mice)
- HA Cope et al., Emerg. Contam 2021 – GenX~PFOA – Prenatal exposure (1 mg/kg/d in gestation) → adverse metabolic outcomes in adult mice
- K.Y. Gebreab et al., Enviro. Pollution 2020 – GenX ~ PFOA (Zebrafish)
- J. Lang et al., Toxicology 2020 - PFESA-BP2 (Nafion BP2) – bioaccumulates and hepatotoxic (mice)
- Sheng et al., Arch Toxicol, 2017 – 6:2 FTCA & 6:2 FTSA increased inflammation and cell death (mice)
- NTP 2020 [<https://ntp.niehs.nih.gov/results/path/index.html>] - PFBS & PFHxA increased liver weights and enzymes can caused liver lesions (rats)

***New PFAS do the same thing as the older ones!***



# Liver: Hepatocyte Hypertrophy



# Key Research Questions

- **Total organic fluorine analysis** – Are we measuring 90% or 10% of PFAS present in a sample?
- **How can we get rid of PFAS?** – Filtration? Incineration? Landfill?
- **Essentiality** – Where are chemicals really needed and where can we replace with safer alternatives? (*Cousins et al., 2019*)
- **Assessing alternatives** – Are our substitutes safer?
- **PFAS as a class** – One chemical group or subclasses? (*Kwiatkowski et al., ES&T Lett. 2020; Balan et al., EHP 2021*)
  - Too many PFAS to do proper toxicity testing (including mixtures)
  - NASEM strongly “....*an approach that uses subclasses to assess the chemicals is scientifically justifiable...*” [NASEM]



# Pilot data suggest large increase in unidentified PFAS in drinking water: Consistent with production trends

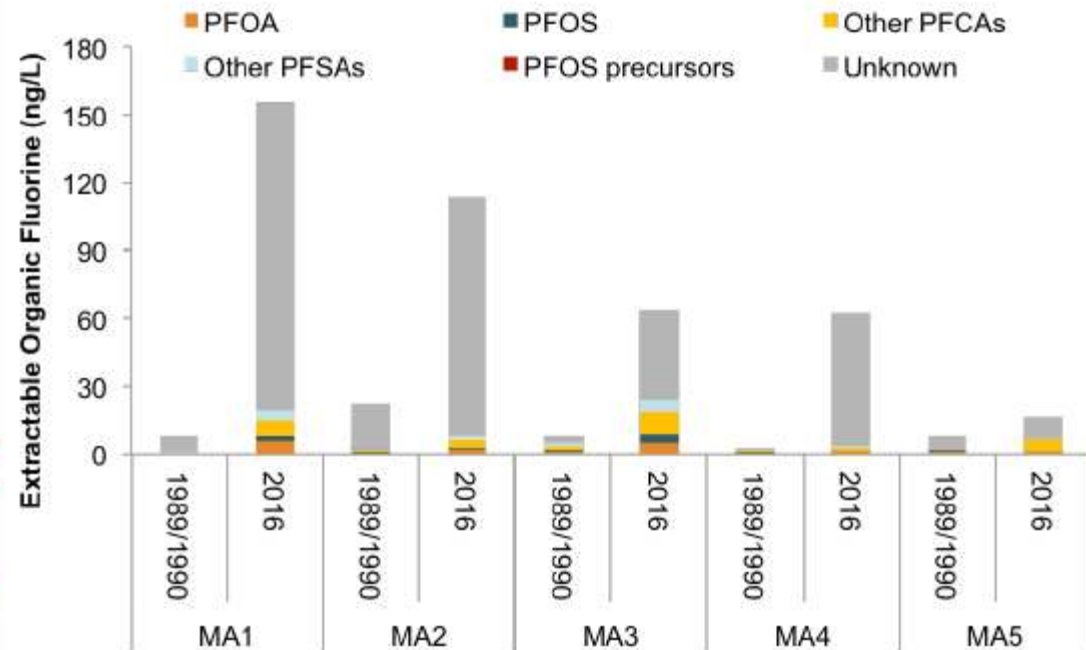
Extractable organic fluorine (EOF)

4700 PFASs

>200 detected

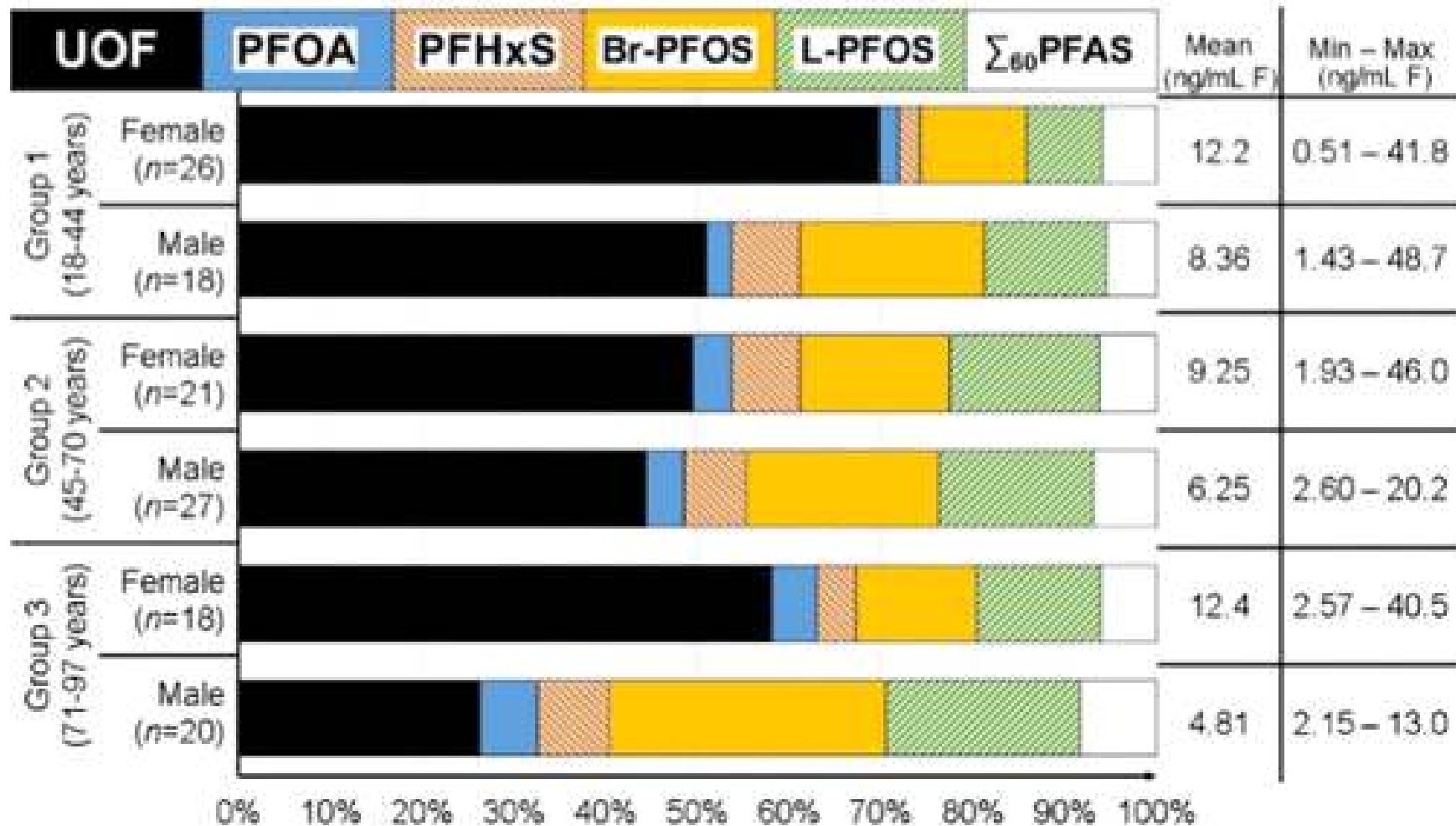
Toxicity of alternative PFASs

not well understood



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

Hu et al., 2019, EHP



**Organofluorine mass balance analysis as determined by EOF and target PFAS analysis in whole Swedish blood samples**

# Scientific Basis for Managing PFAS as a Chemical Class

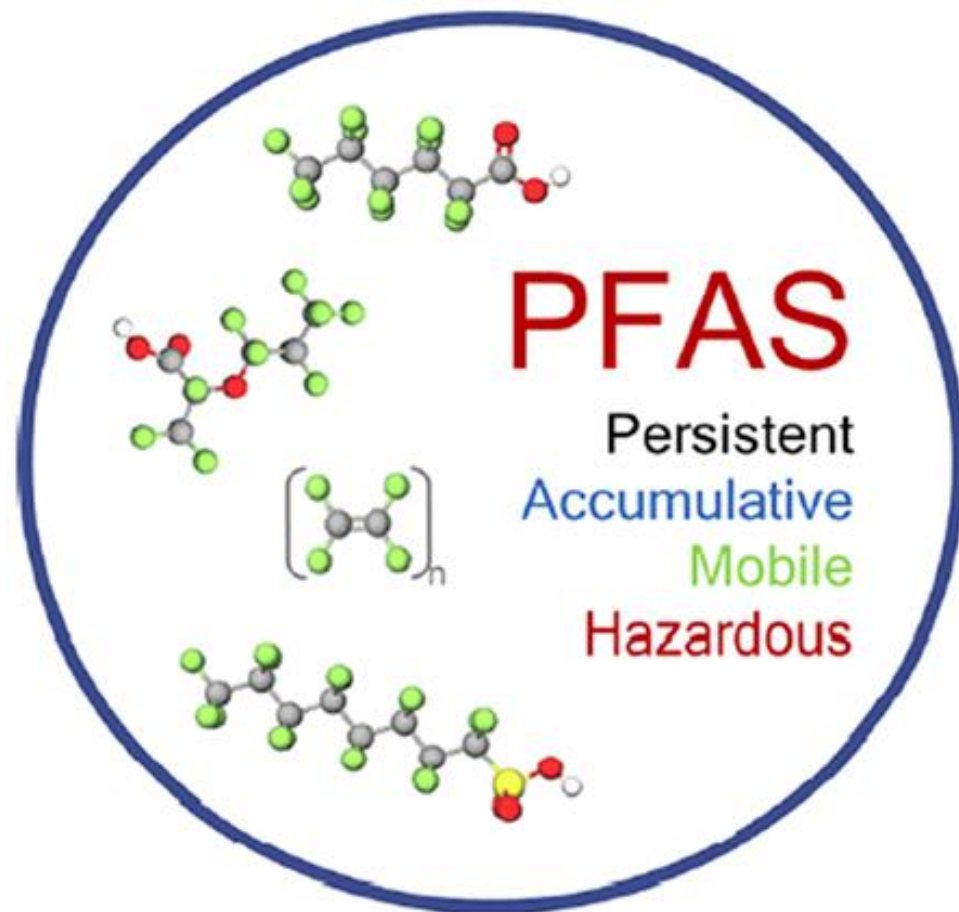
## Chemicals Strategy for Sustainability Towards a Toxic Free Environment

PFAS<sup>62</sup>

The Commission will:

- ban **all PFAS** as a group in **fire-fighting foams** as well as in **other uses**, allowing their use only where they are essential for society;
- address PFAS with a **group approach**, under relevant legislation on water, sustainable products, food, industrial emissions, and waste;
- address PFAS **concerns on a global scale** through the relevant international fora<sup>63</sup> and in bilateral policy dialogues with third countries;
- establish an EU-wide approach and provide financial support under research and innovation programmes to identify and develop **innovative methodologies for remediating PFAS contamination** in the environment and in products;
- provide research and innovation funding for safe **innovations to substitute PFAS** under Horizon Europe.

European Commission – October 10, 2020



Kwiatkowski et al, ES&T Lett 2020

# EPA's PFAS Strategic Roadmap (October 18,2021)

- PFAS Contamination poses unique challenges
  - Lifecycle Approach; Get Upstream of the Problem; Hold Polluters Accountable: Ensure Science-based Decision Making; Prioritize Protection of Disadvantage Communities
- Strategic Roadmap Goals
  - Research/Restrict/Remediate
- Next Steps
  - Work with ALL stakeholders
  - Initiate National Engagement and partnerships
  - Stakeholder Listening Sessions
  - Harness the collective resources and authorities across federal, tribal, state, and local governments-→meaningful action
  - Initiate Testing Strategy involving 24 PFAS categories

# New EPA Risk Assessments for 5 PFAS

PFAS Compound	Chronic RfD (mg/kg-day)
PFOS (Proposed 2021)	0.0000000079
PFOA (Proposed 2021)	0.0000000015
<i>PFOA/PFOS (2016)</i>	<i>0.0002</i>
GenX (2021)	0.000003
PFBS (2021)	0.00003
PFBA (Proposed 2021)	0.01

# ATSDR's MRLs (2021)

- mg/kg bw/day
- PFOA:  $3 \times 10^{-6}$  mg/kg/day
- PFOS:  $2 \times 10^{-6}$  mg/kg/day
- PFHxS:  $2 \times 10^{-5}$  mg/kg/day
- PFNA:  $3 \times 10^{-6}$  mg/kg/day
- ppt drinking water (for a child)
- PFOA: 21 ppt
- PFOS: 14 ppt
- PFHxS: 140 ppt
- PFNA: 21 ppt

MRLs are screening levels and non-regulatory

# US Federal “Regulations” on PFAS

- **EPA**
  - Lifetime Health Advisories for Drinking Water – 70 ppt PFOA+PFOS
  - NO regulation of ground water
  - NO determination of ‘Hazardous Substance’
  - 172 PFAS added to TRI (in NDAA 2020 Bill)
- **FDA**
  - Food Contamination – 7 legacy PFAS + 6,2-FTOH
- **Department of Defense**
  - No PFAS in AFFF in practice/training – total ban by 10/2024
  - No PFAS in Food Packaging
- **FAA**
  - No PFAS in AFFF in domestic airports after 10/4/2021

*PFAS-containing AFFF banned in 180 countries except for emergencies*

# States are moving ahead...



- CA EPA just recommended regulating PFAS as a class in consumer products (Balan et al., 2021)
  - Logical, necessary and forward thinking
  - Helpful to other regulatory agencies in comprehensively addressing this large class
- 11 US states considering banning PFAS in food packaging
  - Maine, Washington, California, and New York have already acted
- 27 states considering policies across >180 bills with a primary focus on PFAS
- Several major grocery and restaurant chains announced policies to reduce or eliminate PFAS and other chemicals in food packaging

***Denmark is the first country to ban PFAS in food packaging as of July 2020  
Canada has just announced they intend to approach PFAS as a single class***



# In Effect State Drinking Water MCLs for PFAS

(ppt = ng/L)

PFAS	PFOA	PFOS	PFNA	PFHxS
Michigan	8	16	6	51
New Hampshire	12	15	8	18
New Jersey	14	13	8	
Vermont*	$\Sigma=20$	$\Sigma=20$	$\Sigma=20$	$\Sigma=20$
Massachusetts and Maine**	$\Sigma=20$	$\Sigma=20$	$\Sigma=20$	$\Sigma=20$

\*PFOS,PFHxS,PFOA,PFNA,PFHpA

\*\*PFOS,PFHxS,PFOA,PFNA,PFHpA,PFDA

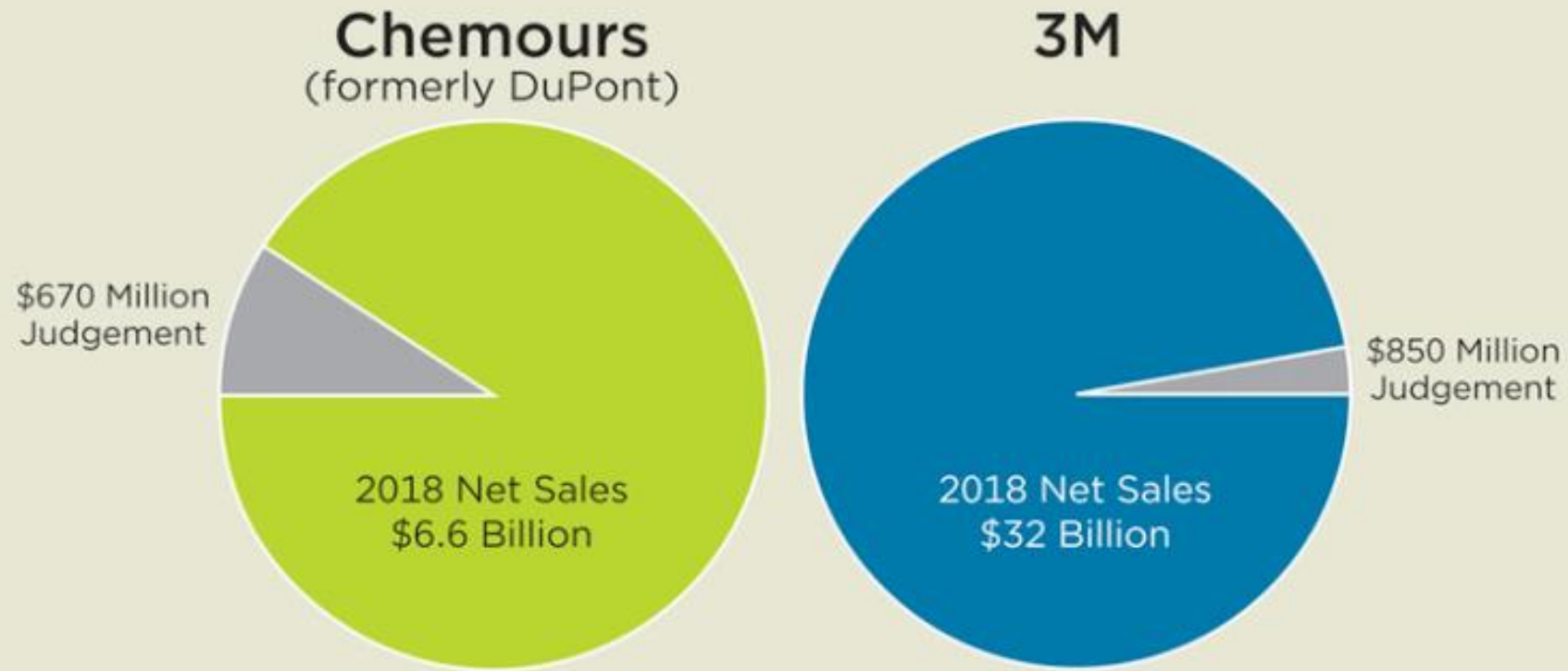
Proposed or in Devpt for NY, CT, ME,PA, RI, Va, WI  
 Non-MCL Standards Effective or proposed for Alaska, CA,WA  
 Guidance Levels in FL,MN,NC,OH

# ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION

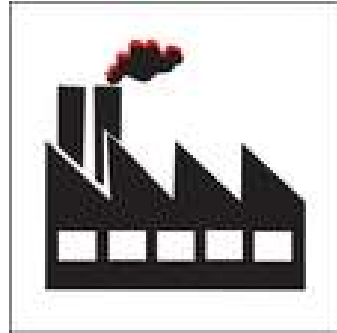


- October 2019
- “Alaska relies on and adopts the U.S. Environmental Protection Agency’s (EPA’s) drinking water maximum contaminant levels (MCLs), rather than establishing state specific MCLs”
- In 2016, EPA published lifetime health advisories (LHAs) under the SDWA for two PFAS, specifically PFOS and PFOA
- On August 20, 2018 DEC issued a Technical Memorandum that established PFAS Action Levels for groundwater and surface water used as drinking water.
  - A 0.07 µg/L action level was set for the sum of the following five (5) PFAS chemicals: perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorohexanesulfonic acid (PFHxS), and perfluoroheptanoic acid (PFHpA).
  - A separate action level for the shorter-chain, perfluorobutane sulfonate (PFBS) was set at 2.0 µg/L
- In order to align state actions to the recently announced EPA plans, DEC will use the EPA LHA (PFOS+PFOA above 0.07 µg/L) as the Action Level.

Recent court judgements against PFAS polluters are only a drop in the bucket compared to annual sales.



# Six urgent questions relevant to science, technology, and policy that must be tackled to address the “PFAS problem”



What are global production volumes of PFAS, and where are PFAS used?



Where are the unknown PFAS hotspots in the environment?



How can we make measuring PFAS globally accessible?



How can we safely manage PFAS-containing waste?

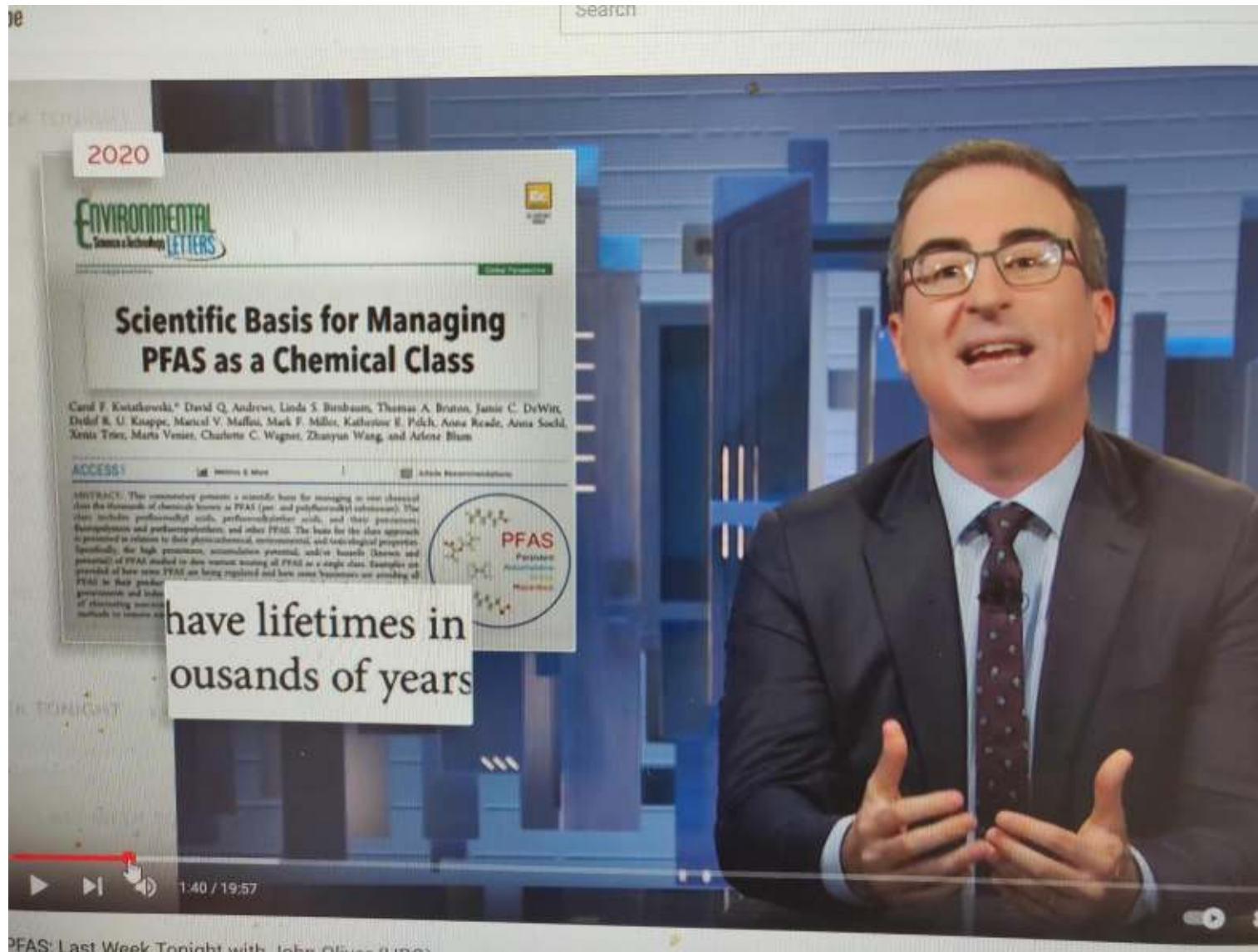


How do we describe the health effects of PFAS exposure?



How do we deal with the costs of PFAS contamination?

**THANK  
YOU!**



**Questions???**

<https://www.youtube.com/watch?v=9W74aeuqsiU>