NC STATE UNIVERSITY

Center for Human Health and the Environment

PFAS Occurrence in North Carolina

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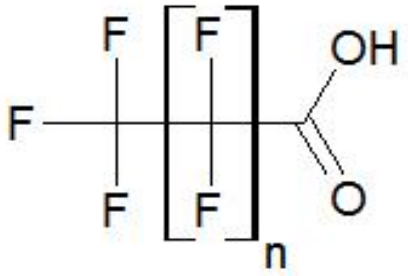
NC Secretaries' Science Advisory Board Meeting
Raleigh, NC, December 7, 2020

Outline

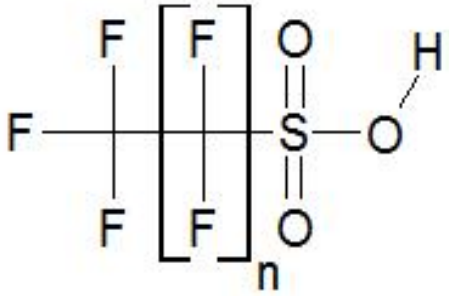
- Brief introduction to per- and polyfluoroalkyl substances (PFASs)
- PFAS occurrence in NC drinking water sources
- PFAS occurrence in blood serum of North Carolinians
- Key observations

What are per- and polyfluoroalkyl substances (PFASs)?

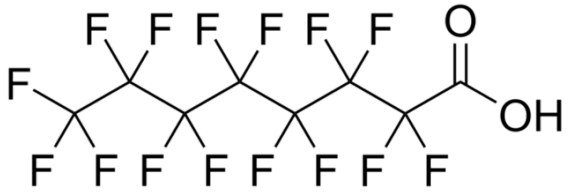
- Class of synthetic chemicals that includes several thousand compounds
- Perfluoroalkyl substances: all C-H bonds replaced by C-F bonds

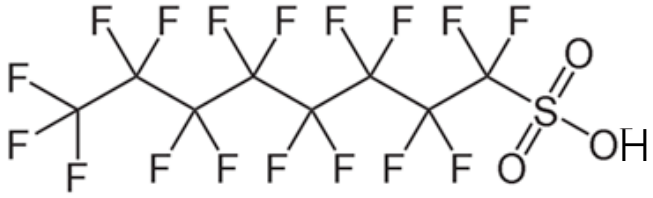


Perfluoroalkyl carboxylic acids (PFCAs)
(e.g. perfluorooctanoic acid, PFOA or C8)



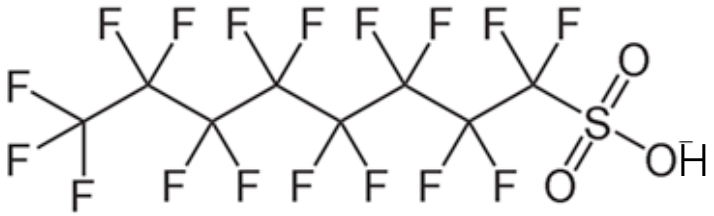
Perfluoroalkyl sulfonic acids (PFSAs)
(e.g. perfluorooctane sulfonic acid, PFOS)





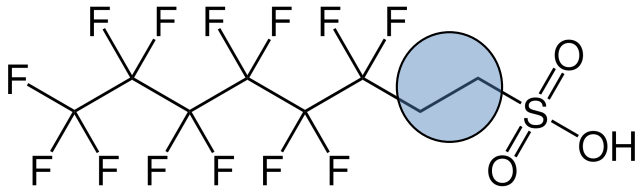
What are per- and polyfluoroalkyl substances (PFASs)?

- Polyfluoroalkyl substances: not all C-H bonds replaced by C-F bonds
  - Perfluorooctane sulfonic acid (PFOS)



Perfluorinated
(no C-H bonds)

  - 6:2 Fluorotelomersulfonic acid (6:2 FtS)

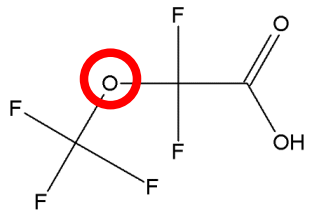


Polyfluorinated
(contains C-H bonds)

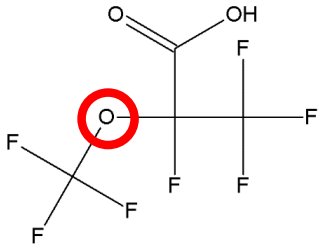
What are per- and polyfluoroalkyl substances (PFASs)?

- Per- and polyfluoro ether acids ("fluoroethers") contain at least one ether oxygen atom

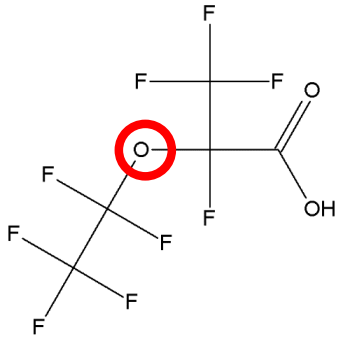
PFMOAA



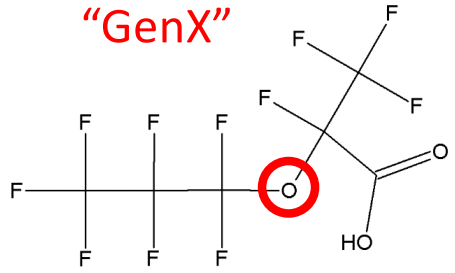
PMPA



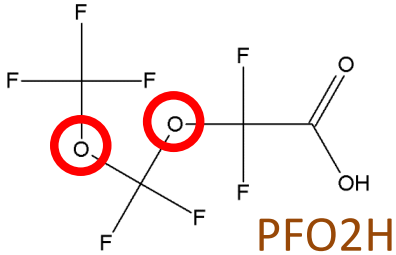
PEPA



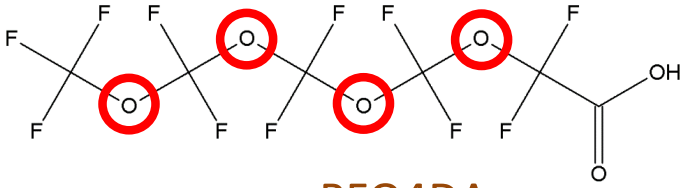
"GenX"



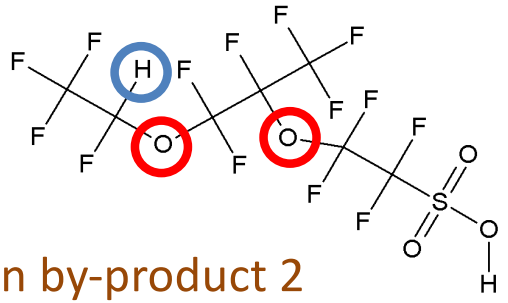
PFPrOPrA, HFPO-DA



PFO2HxA



PFO4DA



Nafion by-product 2

Non-stick coatings

Grease- and oil- resistant coatings for paper products

Some common PFAS uses

Water repellent fabrics

Stain-resistant coatings for fabrics, carpets, and leather

Aqueous film forming foams

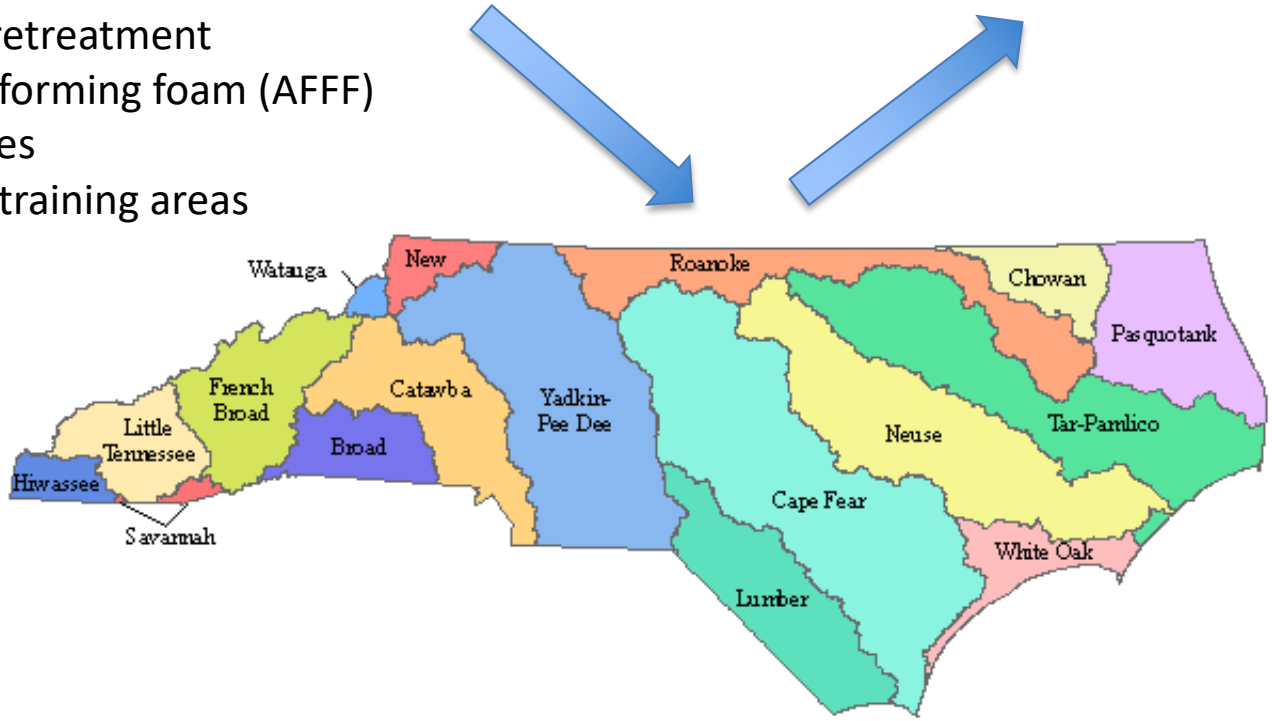
PFASs are known contaminants in some North Carolina drinking water sources

PFAS Sources:

- Industrial wastewater discharges and air emissions
  - Fluorochemical production
- Municipal wastewater discharges and land application of biosolids
  - Landfill leachate
  - Industrial pretreatment
- Aqueous film-forming foam (AFFF)
  - Military bases
  - Firefighting training areas
  - Airports

Impacts:

- PFAS-impacted private and public drinking water wells
- PFAS-impacted surface water
- Water treatment burden
- Community concerns



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NORTH CAROLINA PFAS Testing Network

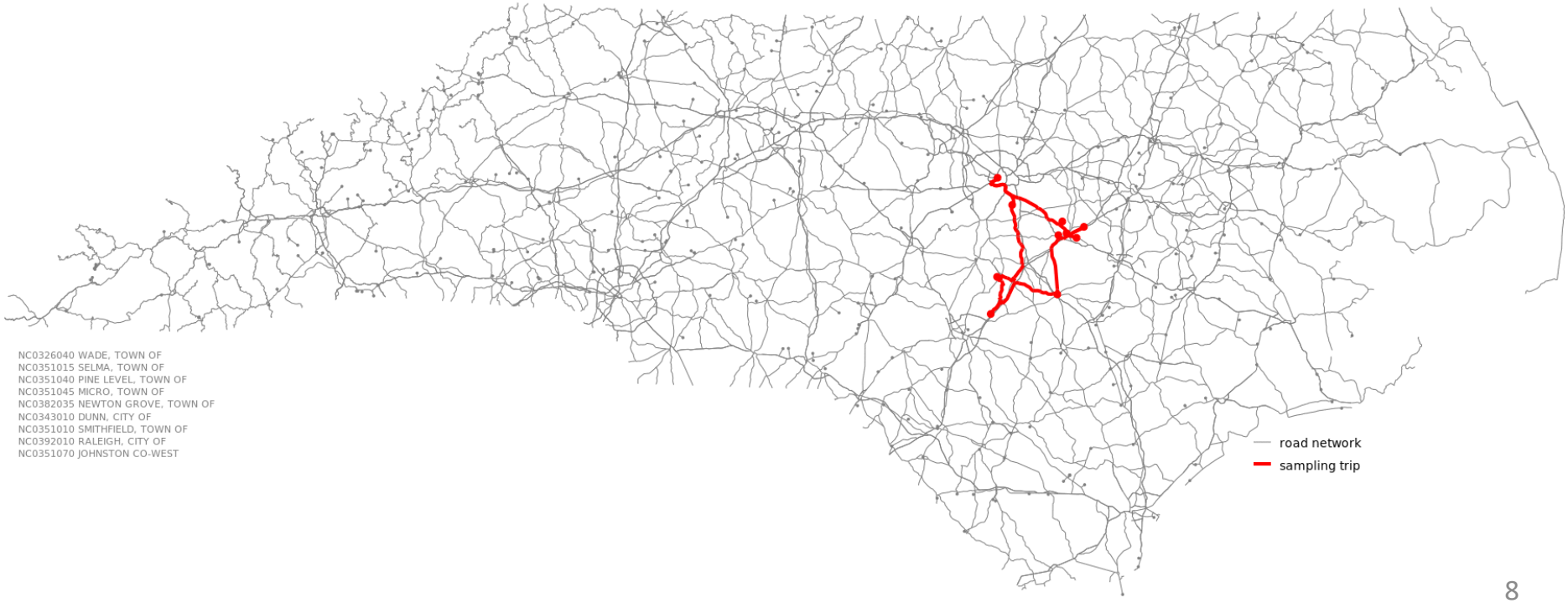
Statewide sample collection

Raw drinking water sampled from every NC Public Drinking Water Provider for PFAS quantitation, 2 rounds

- 191 municipal surface water sites
- 149 municipal ground water sites
- 58 county water sites

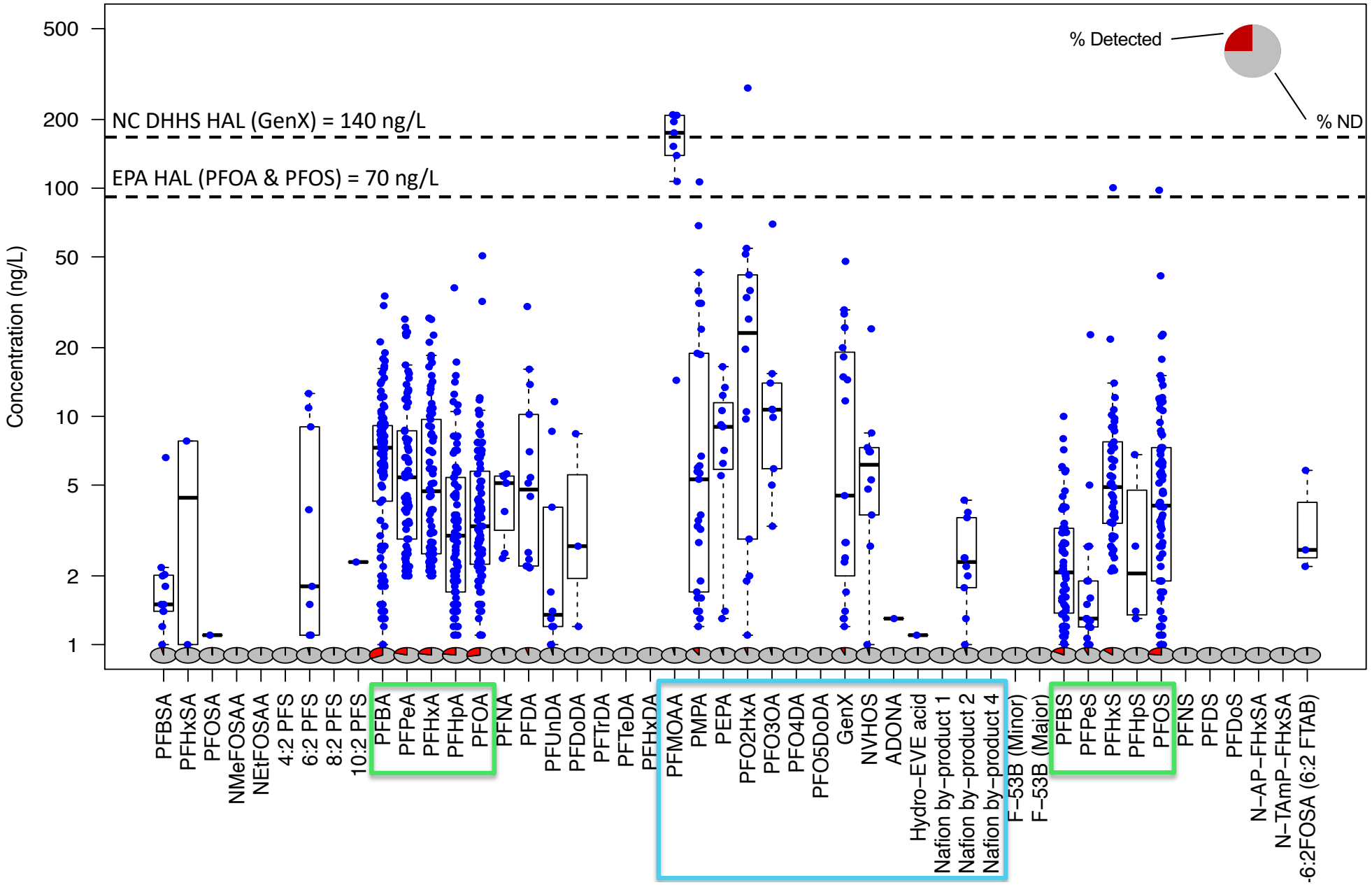
Round 1 : **COMPLETED** ✓

Round 2: **In Progress**



NC STATE UNIVERSITY Duke UNIVERSITY UNCCHARLOTTE NORTH CAROLINA PFAS Testing Network

Quantified PFAS Summary (n = 376)



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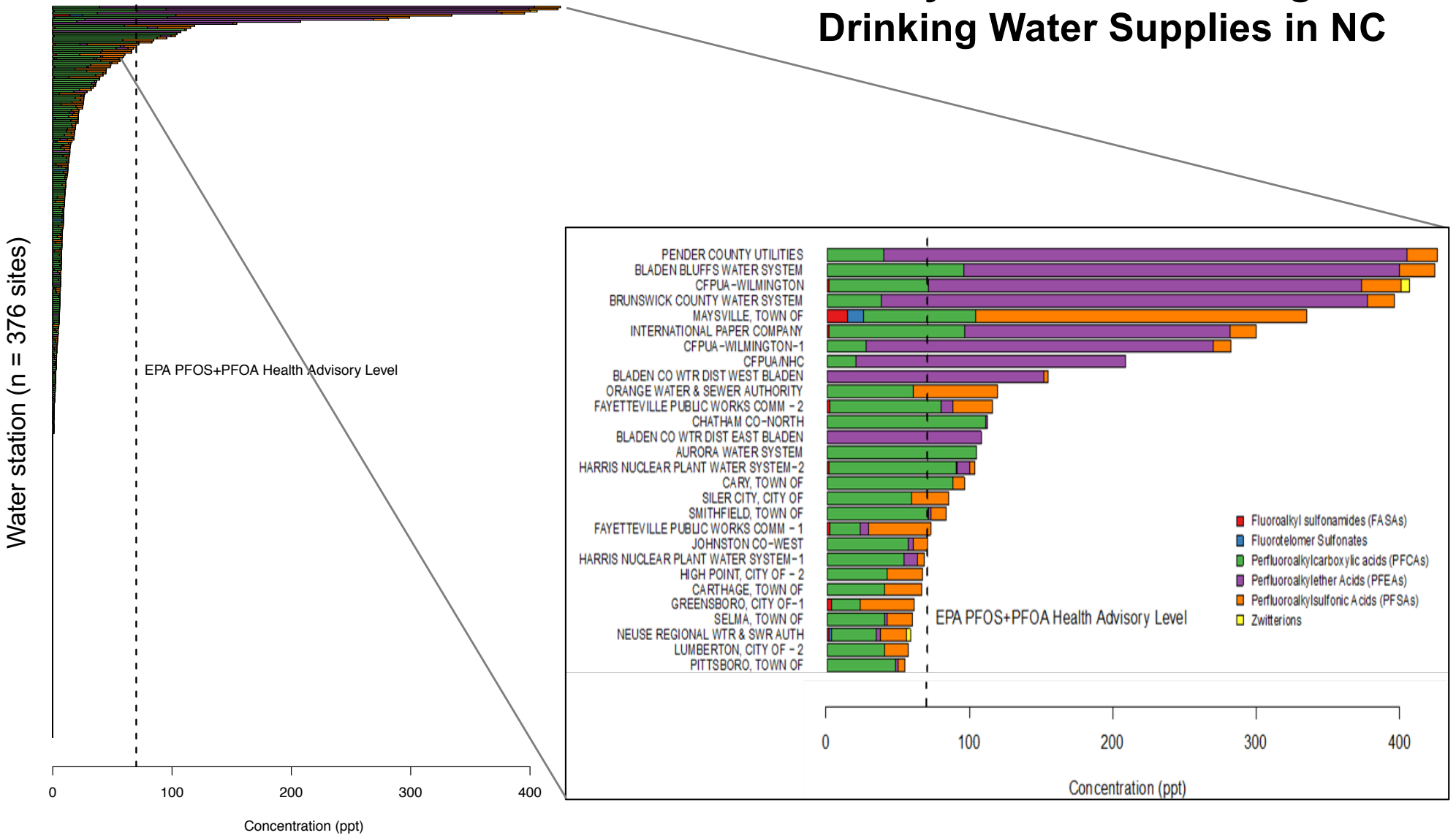
Summary of Round 1 Testing of 376 Drinking Water Supplies in NC

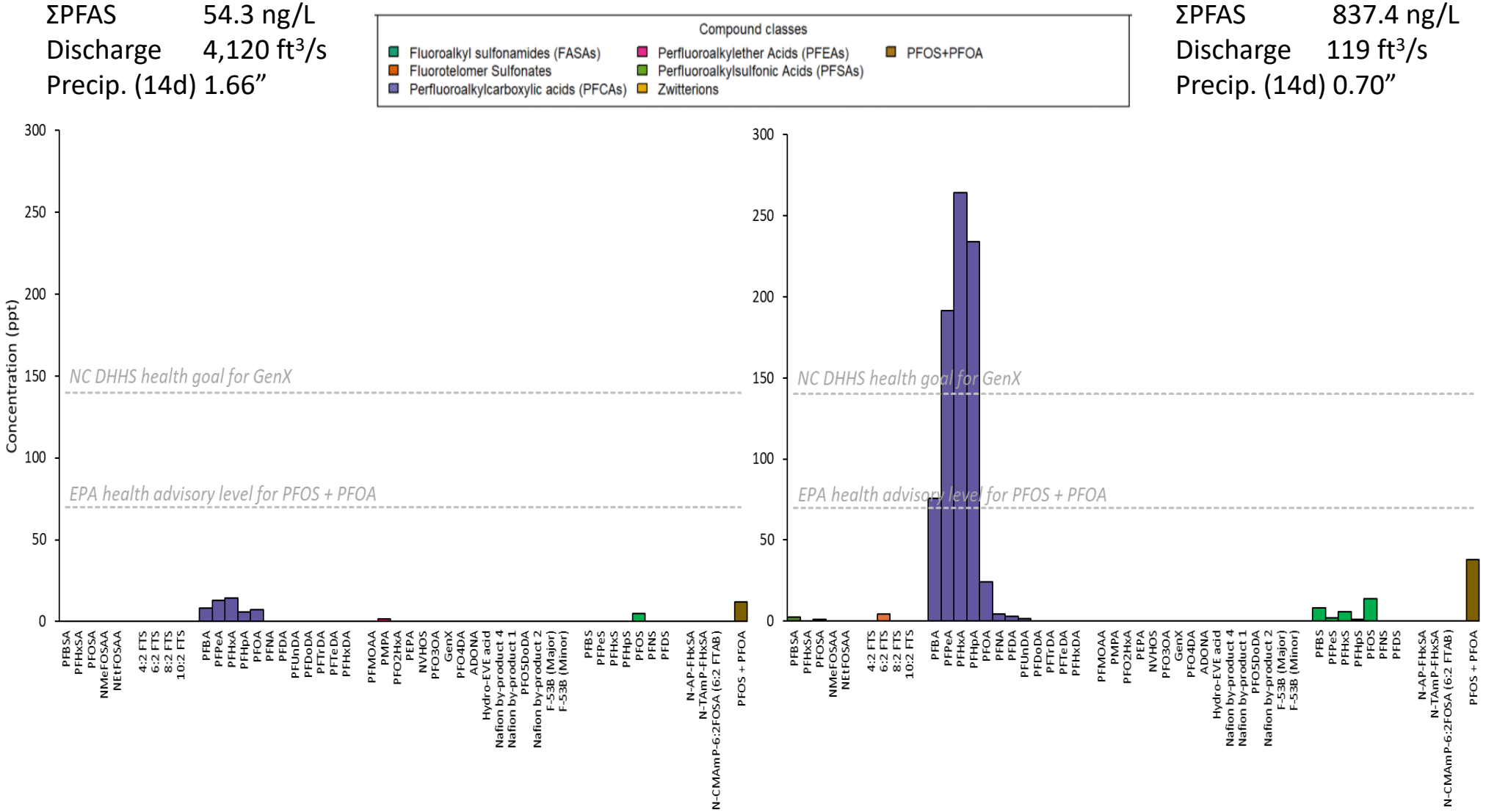


20 public water supplies with ΣPFAS > 70 ng/L

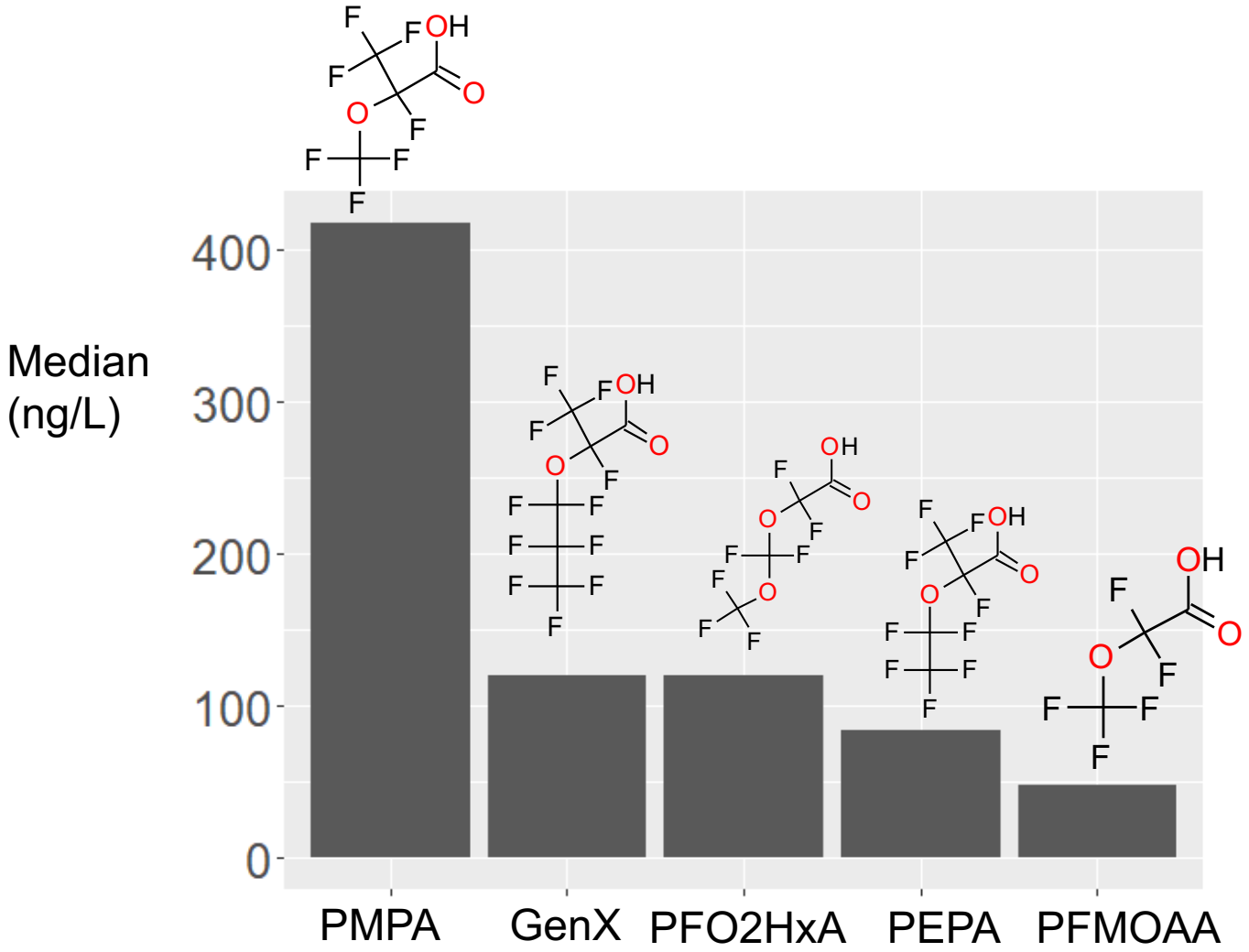
Comparison of Round 1 and 2: High temporal variability of PFAS levels in the Haw River at Pittsboro

Round 1 4/9/19
ΣPFAS 54.3 ng/L
Discharge 4,120 ft^3/s
Precip. (14d) 1.66”

Round 2 9/5/19
ΣPFAS 837.4 ng/L
Discharge 119 ft^3/s
Precip. (14d) 0.70”

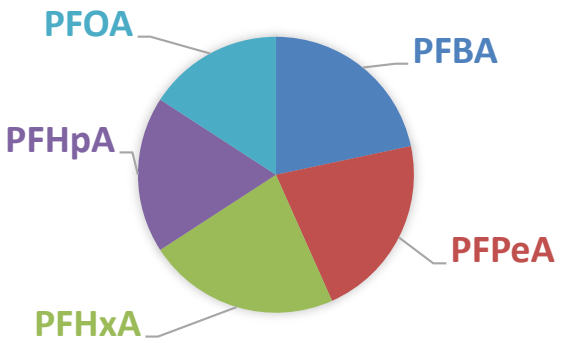


Dominant PFASs in 57 private wells near Chemours



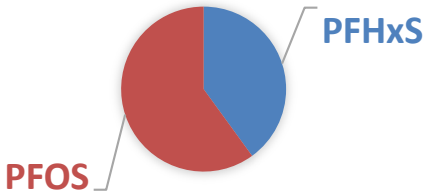
GenX Exposure Study, NCSU, unpublished data

What were the PFAS levels in Wilmington drinking water?

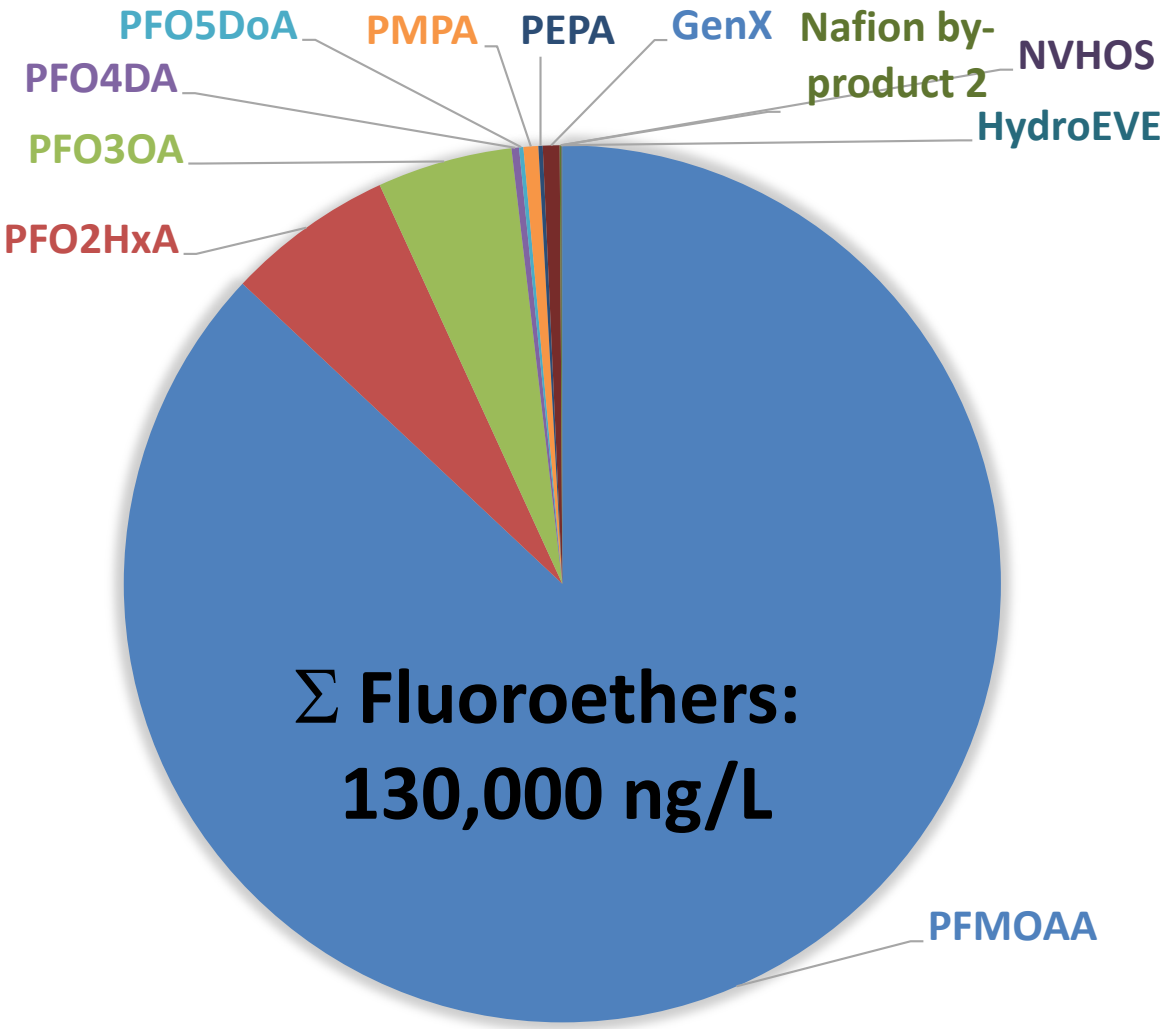


Σ PFCAs: 120 ng/L

July 2015 sample



Σ PFSAs: 45 ng/L



Zhang et al. (2019) ES&T Letters

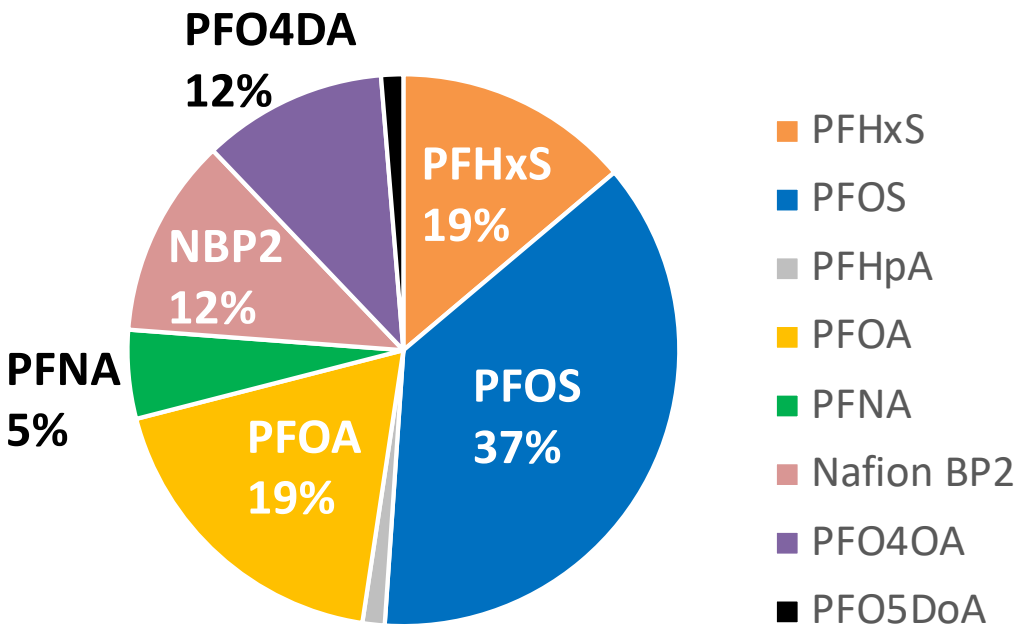
PFAS occurrence in blood serum of North Carolinians

- NCSU/ECU GenX Exposure Study: Wilmington (Kotlarz et al., EHP, 2020)
- Duke University: Pittsboro

Wilmington, NC

344 people living in Wilmington were recruited in November 2017

- 127 men, 216 women, 1 transgender
- 289 adults, 55 children
- Ages ranged from 6-86; median 50

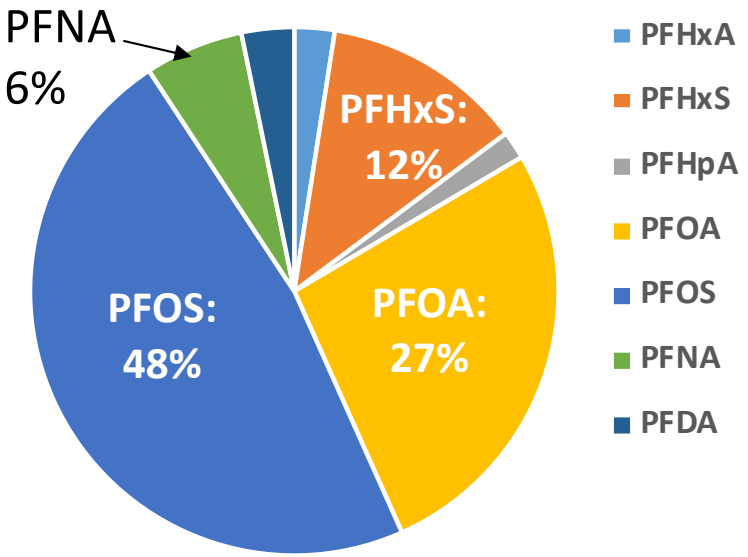


Kotlarz et al., EHP, 2020

Pittsboro, NC

49 people living in Pittsboro were recruited in November 2019

- 18 men and 31 women
- Ages ranged from 33-86; median 60



Data from Heather Stapleton, Duke University

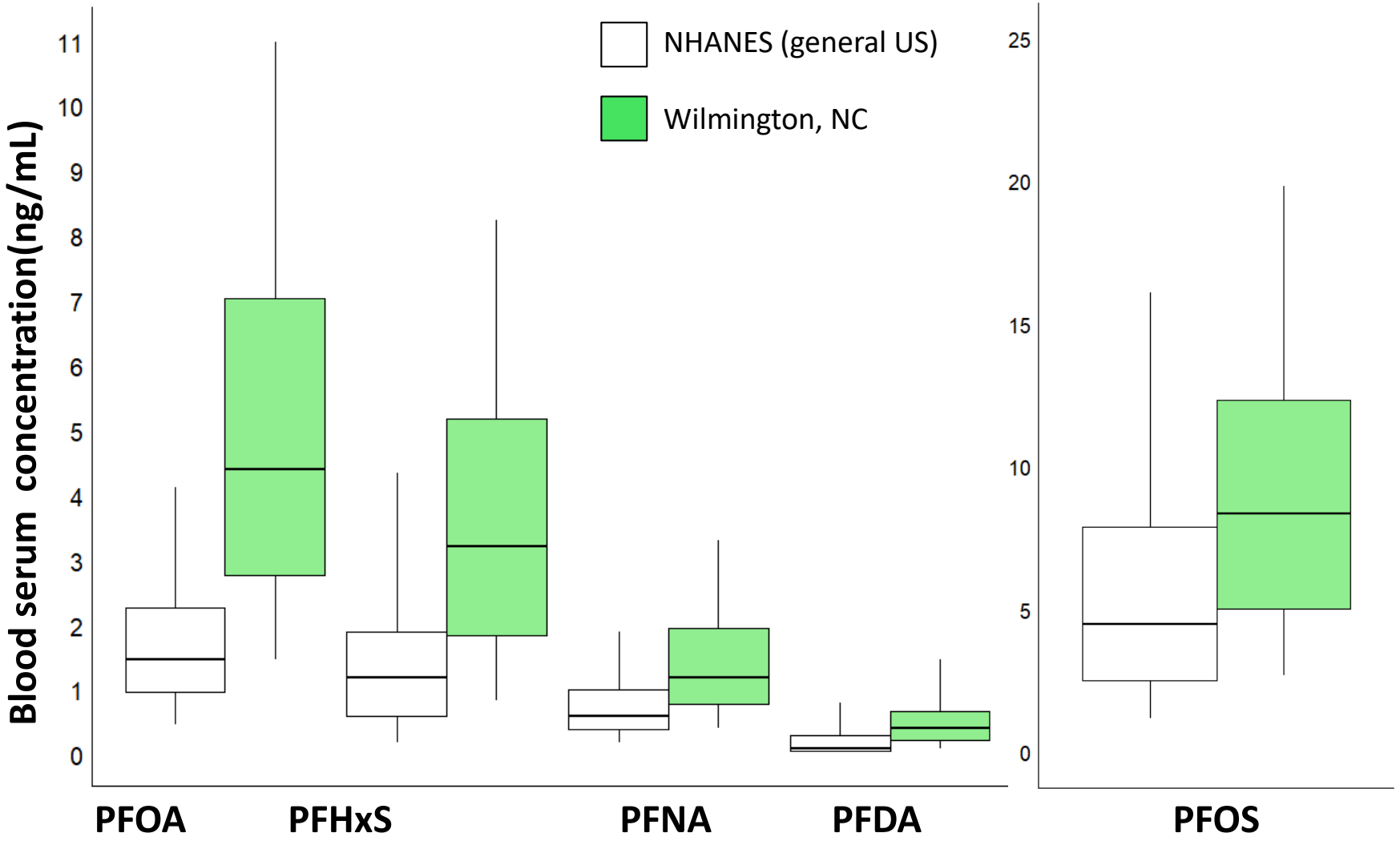
Key Observations

20 PFASs with highest detection frequencies and/or highest concentrations

	Drinking Water	Blood Serum
Perfluoroalkyl carboxylic acids	PFBA, PFPeA, PFHxA, PFHpA, PFOA	PFHxA, PFHpA, PFOA, PFNA, PFDA
Perfluoroalkyl sulfonic acids	PFBS, PFHxS, PFOS	PFHxS, PFOS
Perfluoroalkyl ether carboxylic acids	PFMOAA, PMPA, PEPA, GenX, PFO2HxA, PFO3OA, PFO4DA	PFO4DA, PFO5DoA, HydroEVE
Perfluoroalkyl ether sulfonic acids		Nafion by-product 2

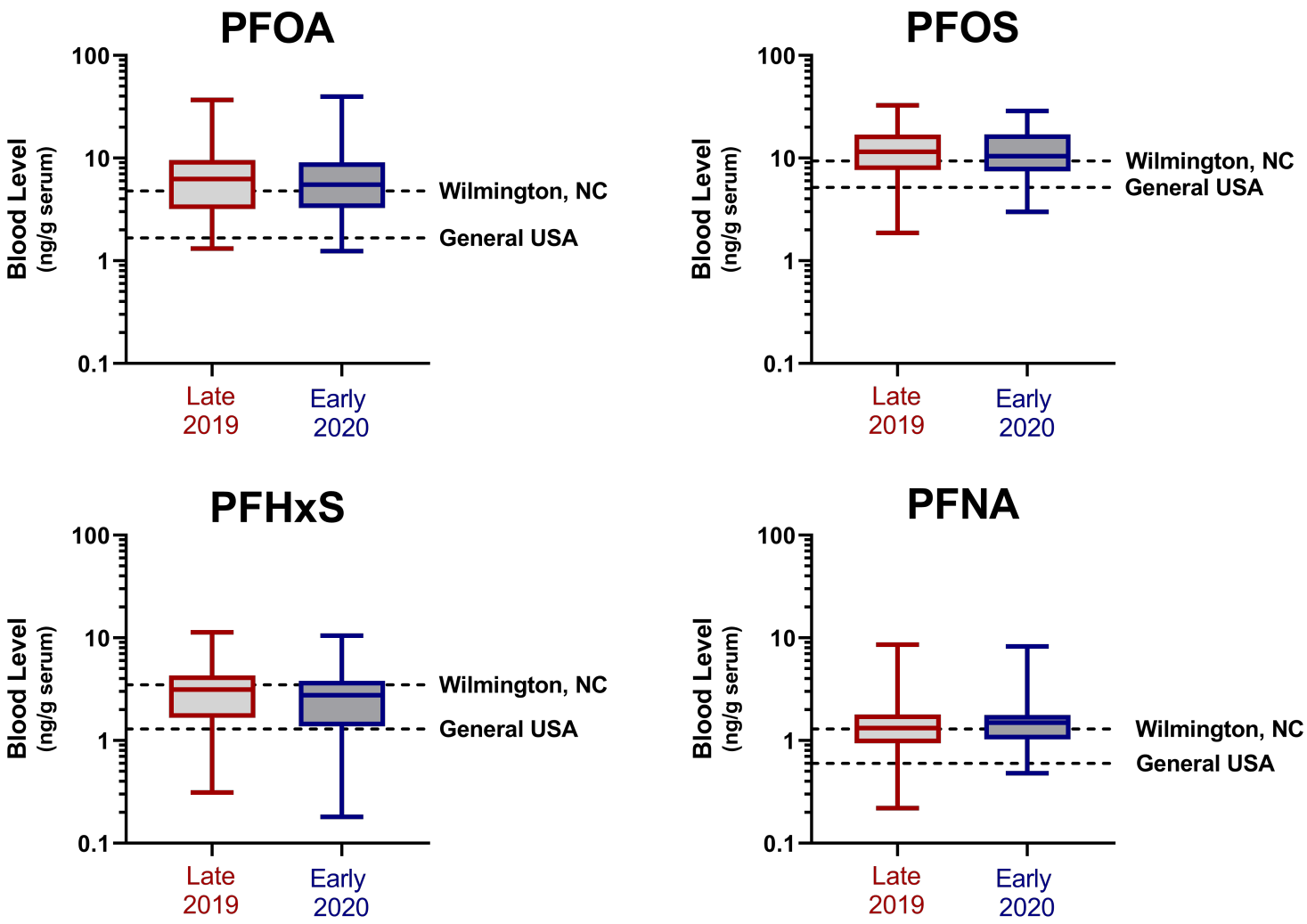
PFASs in both the drinking water and blood serum columns are important from an exposure perspective.

PFAS levels in blood serum of people living in Wilmington are higher than those of the general US population



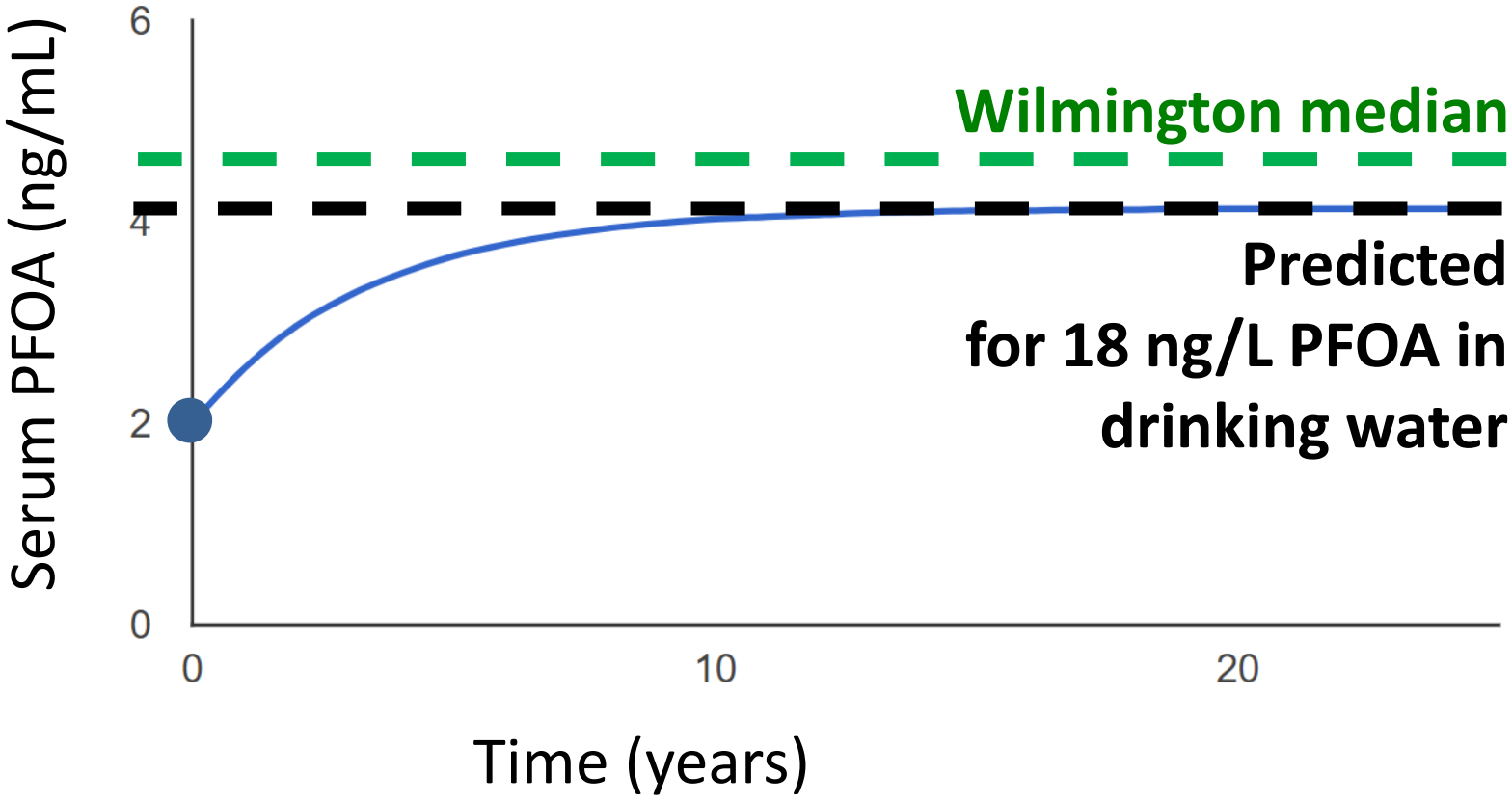
Kotlarz et al., EHP, 2020

PFAS levels in blood serum of people living in Pittsboro are higher than those of the general US population



Data from Heather Stapleton, Duke University

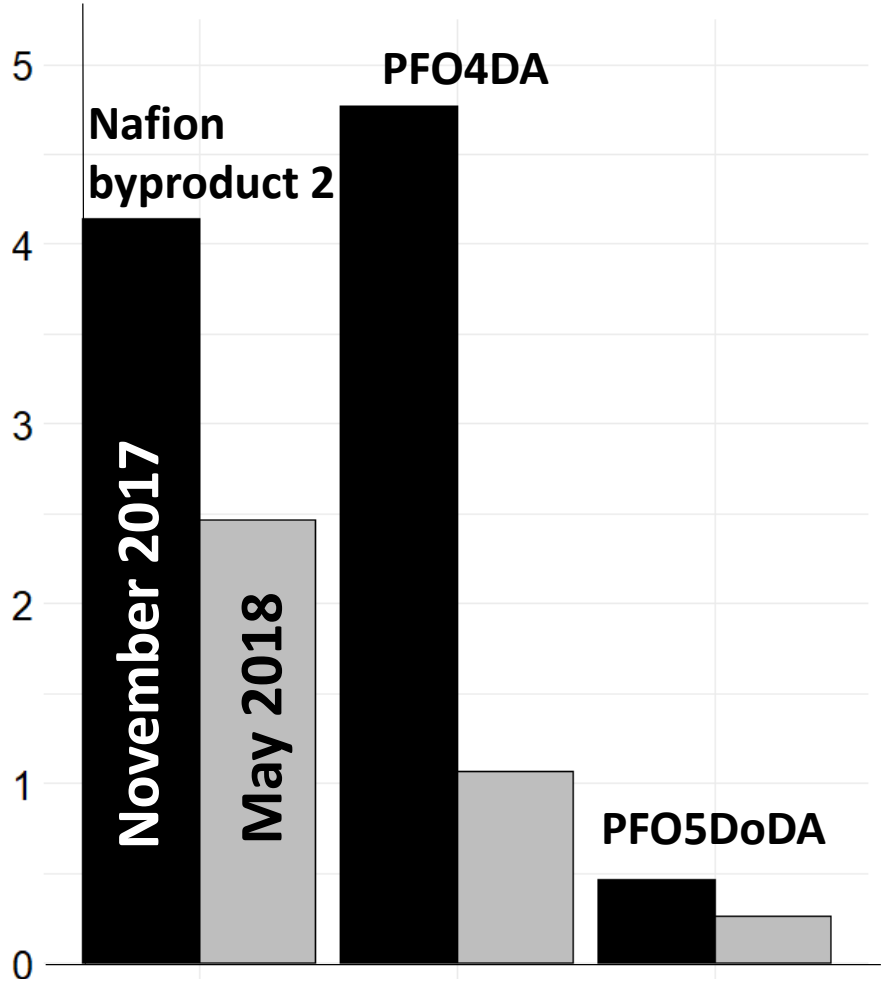
Elevated PFAS levels in blood serum are likely associated with PFAS exposure through drinking water



Data from Kotlarz et al. (2020)
PFAS calculator: https://www.ics.uci.edu/~sbartell/pfascalc.html

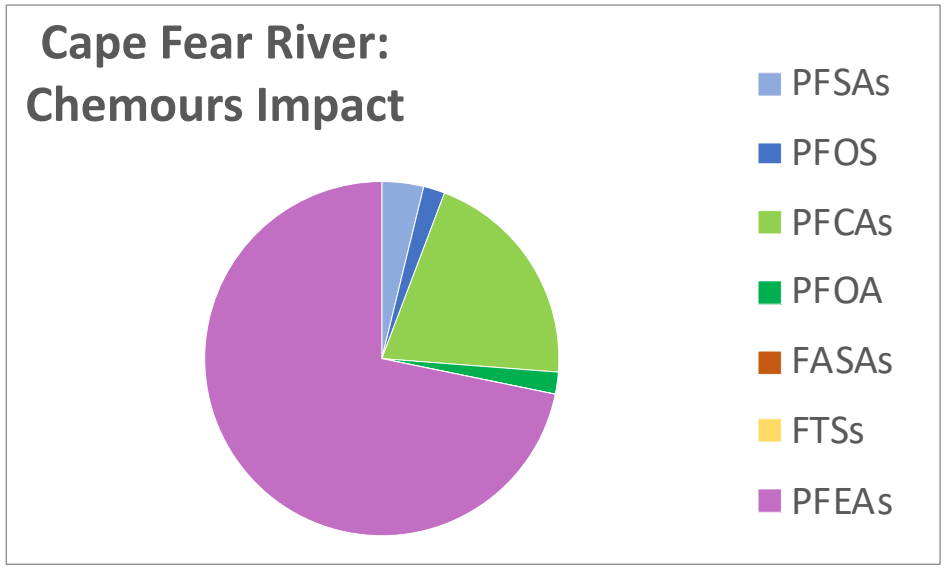
Median fluoroether levels in blood serum of people in Wilmington decreased after levels in drinking water dropped

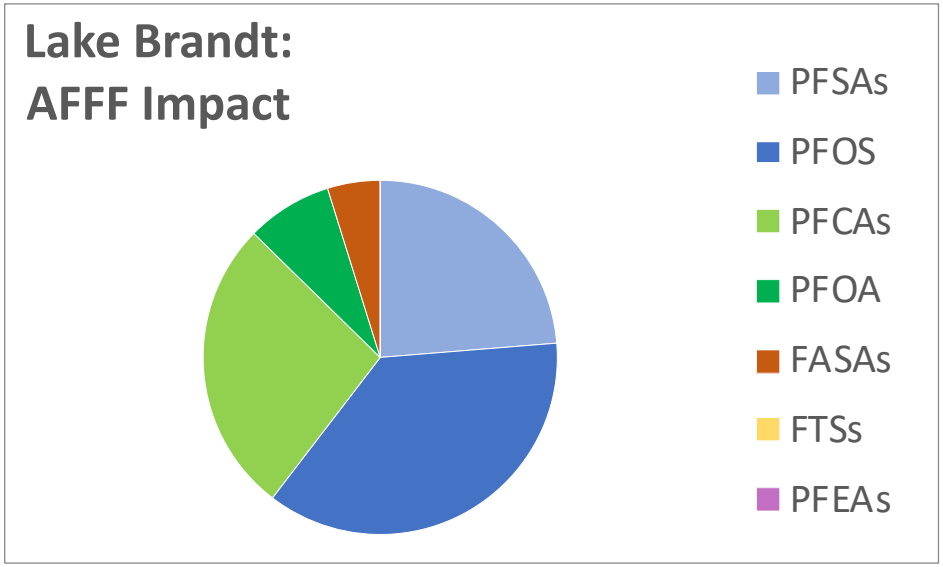
Median blood serum concentration for 44 participants (ng/mL)

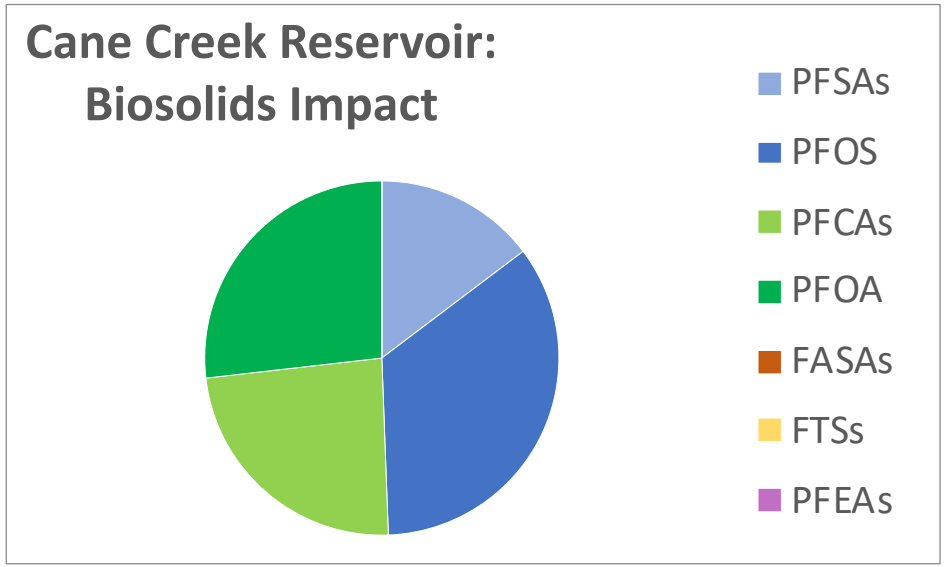


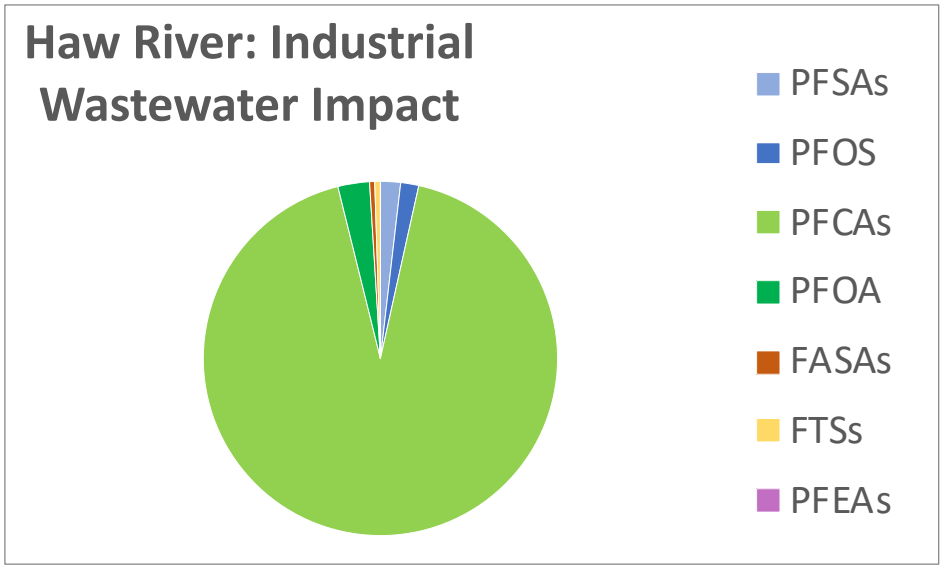
Kotlarz et al., EHP, 2020

PFASs occur as mixtures in water…

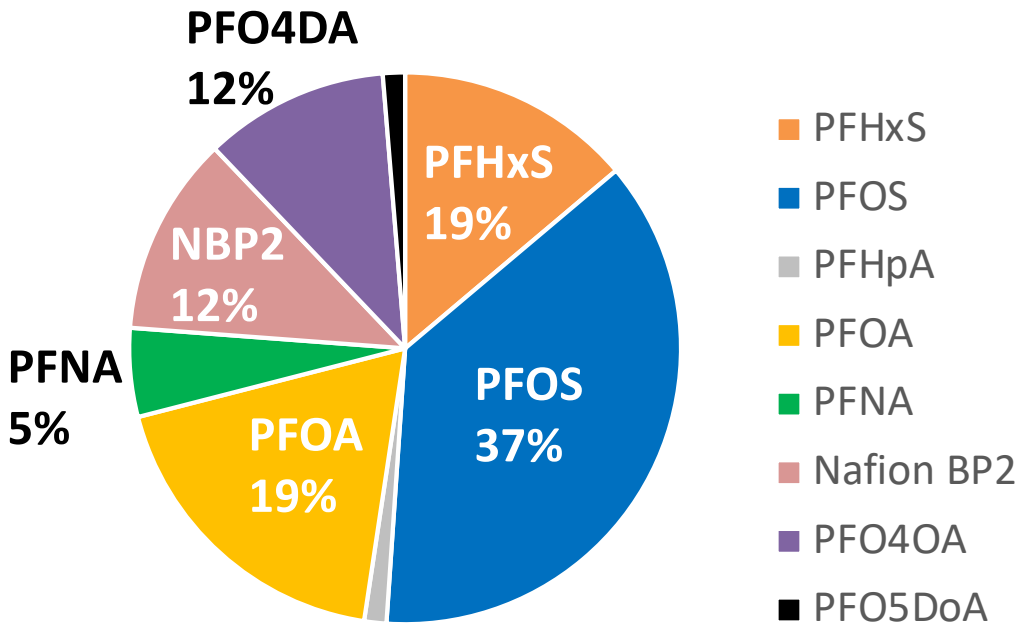








… and in people



Kotlarz et al., EHP, 2020

Take-Home Messages

- 20 PFASs are frequently detected and/or detected at high concentrations in NC drinking water sources and/or blood serum of North Carolinians
- PFAS levels in blood serum of North Carolinians living in the Cape Fear River basin are substantially higher than in the general US population
- Drinking water is an important exposure route
- PFASs occur in mixtures
- Sources of PFAS contamination vary
  - Fluorochemical manufacturing (air emissions, wastewater, contaminated groundwater discharging to surface water)
  - Industrially impacted municipal wastewater and biosolids
  - Aqueous film-forming foam

Thank you for listening!

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Acknowledgements:

Research Funding:

- NIEHS (GenX Exposure Study)
- NC Policy Collaboratory (PFAST)

Data Contributions:

- Jane Hoppin (NCSU)
- Heather Stapleton (Duke University)
- Lee Ferguson (Duke University)