Bigelow | Laboratory for Ocean Sciences

PFAS Distribution in Casco & Merrymeeting Bays

Christoph Aeppli

Sr Research Scientist, Bigelow Laboratory for Ocean Sciences

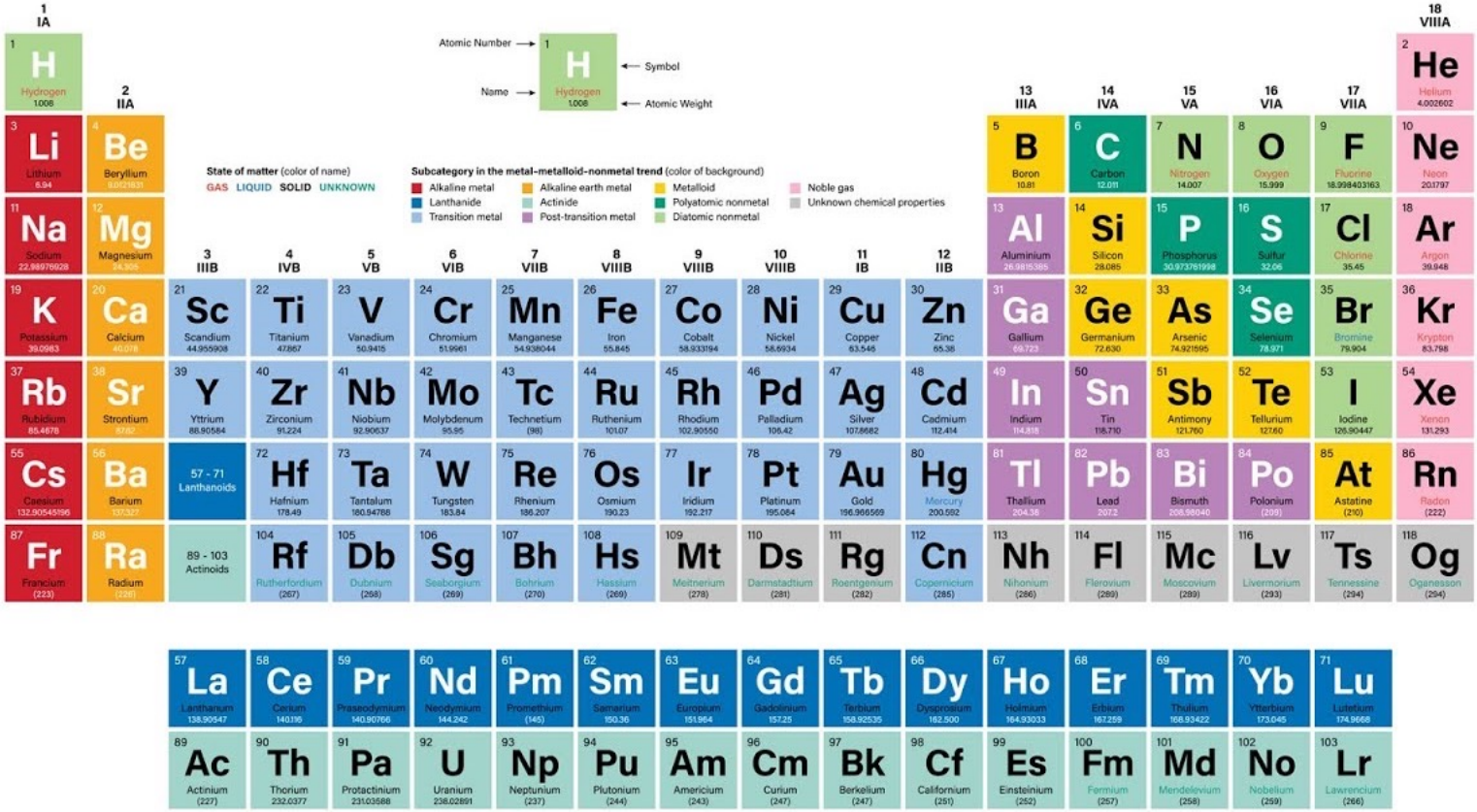
How we'll spend the next hour

- **Intro**: PFAS in the environment
- PFAS after the 2024 **BNAS Spill**
- **Sources** into Merrymeeting Bay & Casco Bay
- **Q&A**

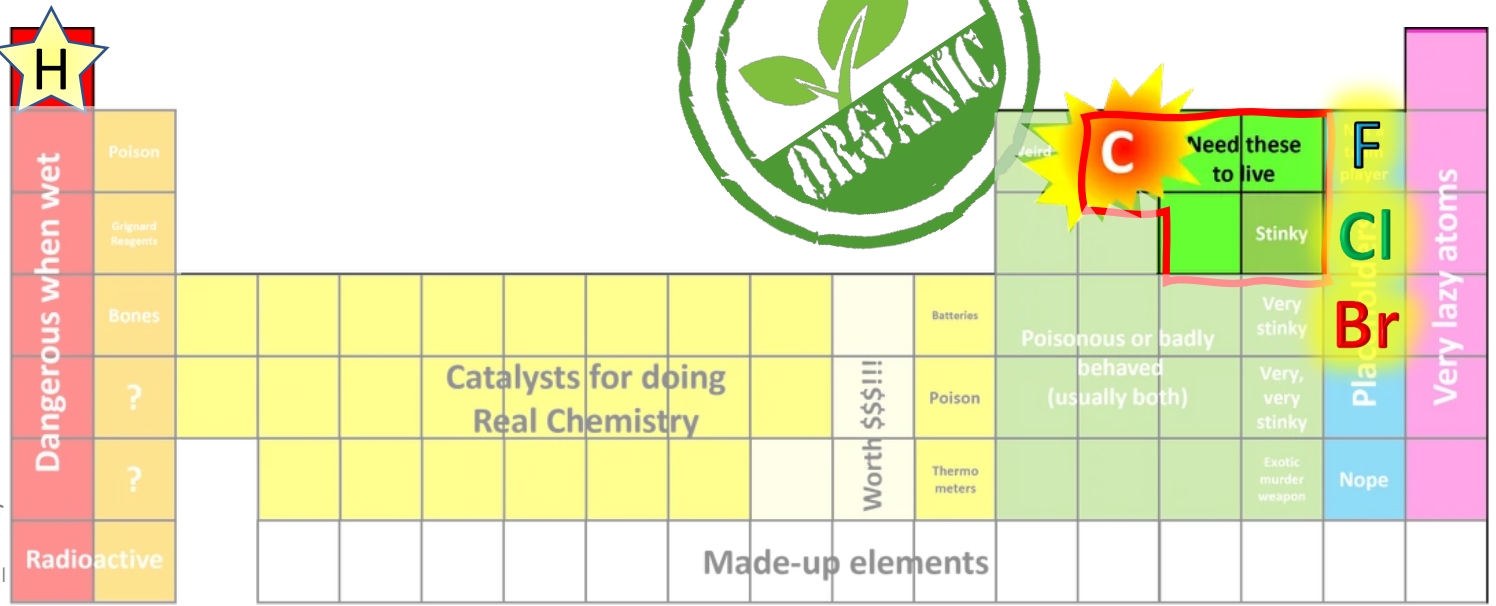
Thanks!

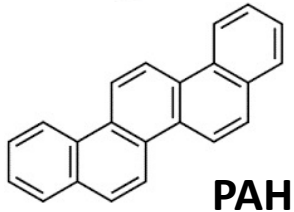
- **Friends of Merrymeeting Bay**: Ed Friedman
- **Friends of Casco Bay**: Ivy Fignoca, Heather Kenyon, Mike Doan
- **Bigelow Laboratory**: Hannah Sterling, Caitlyn Olson
- **Funding**: EPA National Estuary Program; Watershed Grant Program

Chemist


Atomic Number
Symbol
Name
Atomic Weight
State of matter (color of name)
GAS LIQUID SOLID UNKNOWN
Subcategory in the metal–metalloid–nonmetal trend (color of background)
Alkaline metal
Alkaline earth metal
Metalloid
Noble gas
Lanthanide
Actinide
Polyatomic nonmetal
Unknown chemical properties
Transition metal
Post-transition metal
Diatomic nonmetal
57 - 71 Lanthanoids
89 - 103 Actinoids

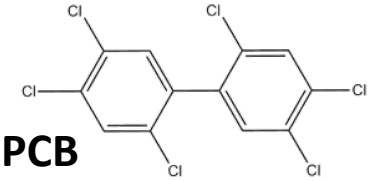
Organic Chemist



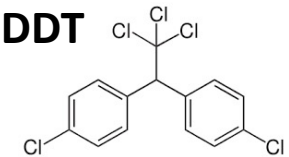


PAH

hydrocarbon

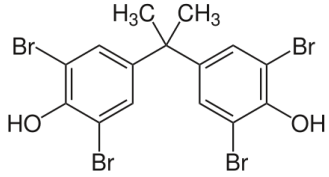


PCB



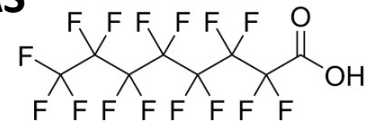
DDT

chlorinated



PBPDE

brominated



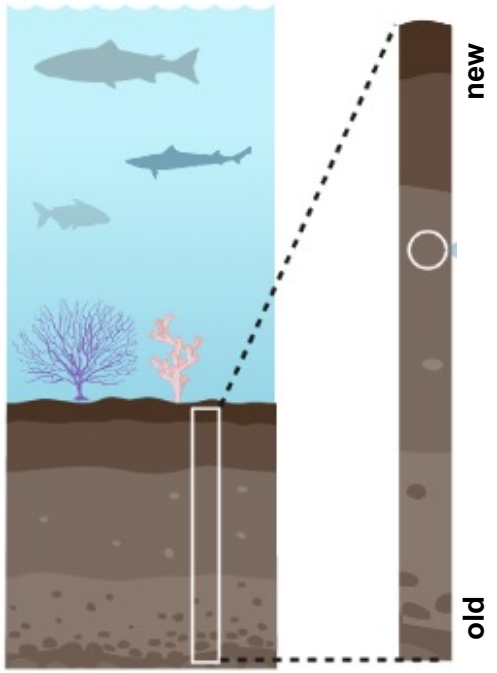
PFAS

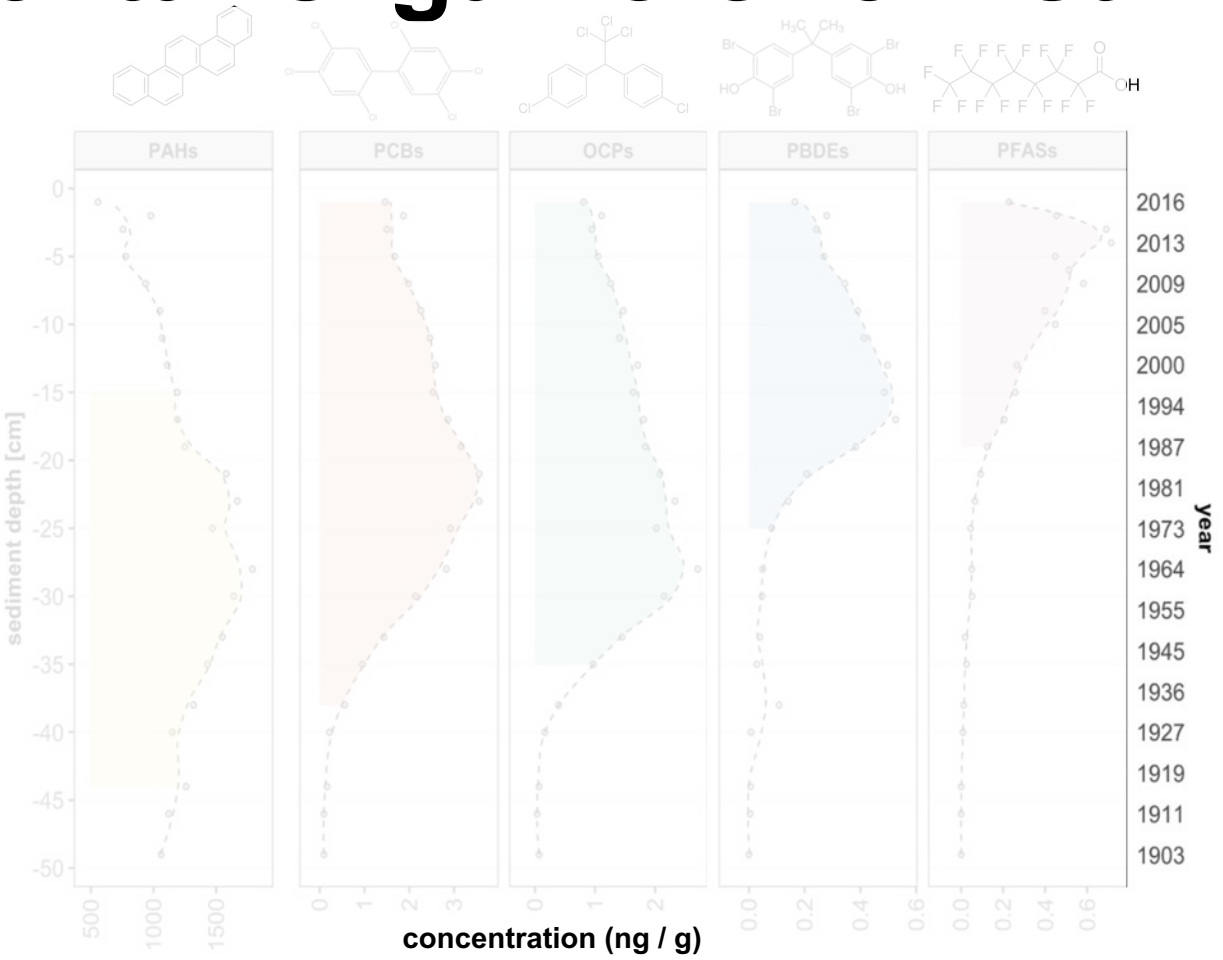
fluorinated

https://www.reddit.com/r/chemistrymemes/comments/y999vw/organic_chemists_periodic_table/

Environmental Organic Chemist

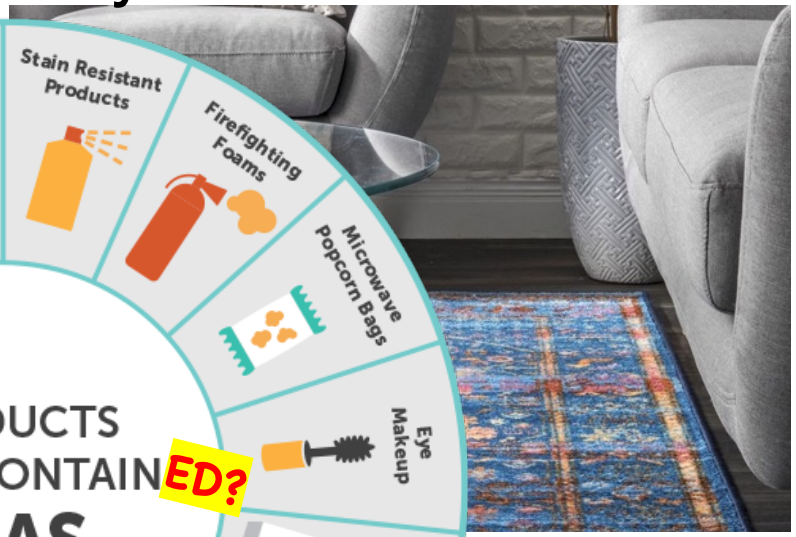
Pollutants ‘Archived’
in a Sediment Core



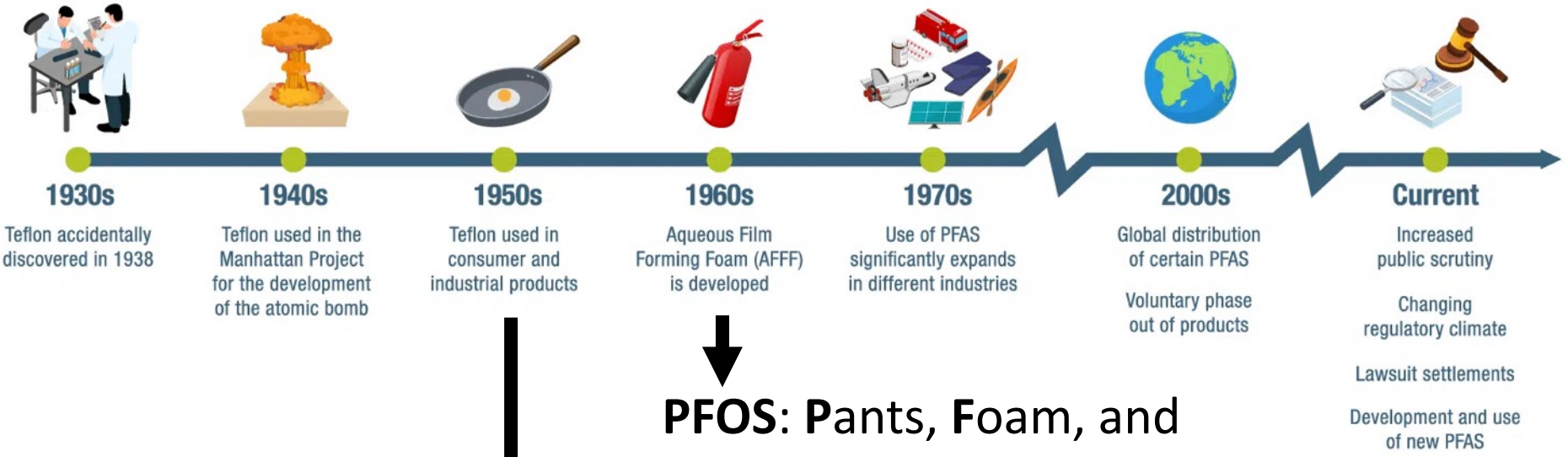


Logemann A, Reininghaus M, Schmidt M, Ebeling A, Zimmermann T, Wolschke H, Friedrich J, Brockmeyer B, Pröfrock D, Witt G (2022). Environ Pollut 302:119040.

PFAS: **P**er- and **P**oly**F**luoro**A**lkyl **S**ubstances



PFAS Development ... ...and Evolution

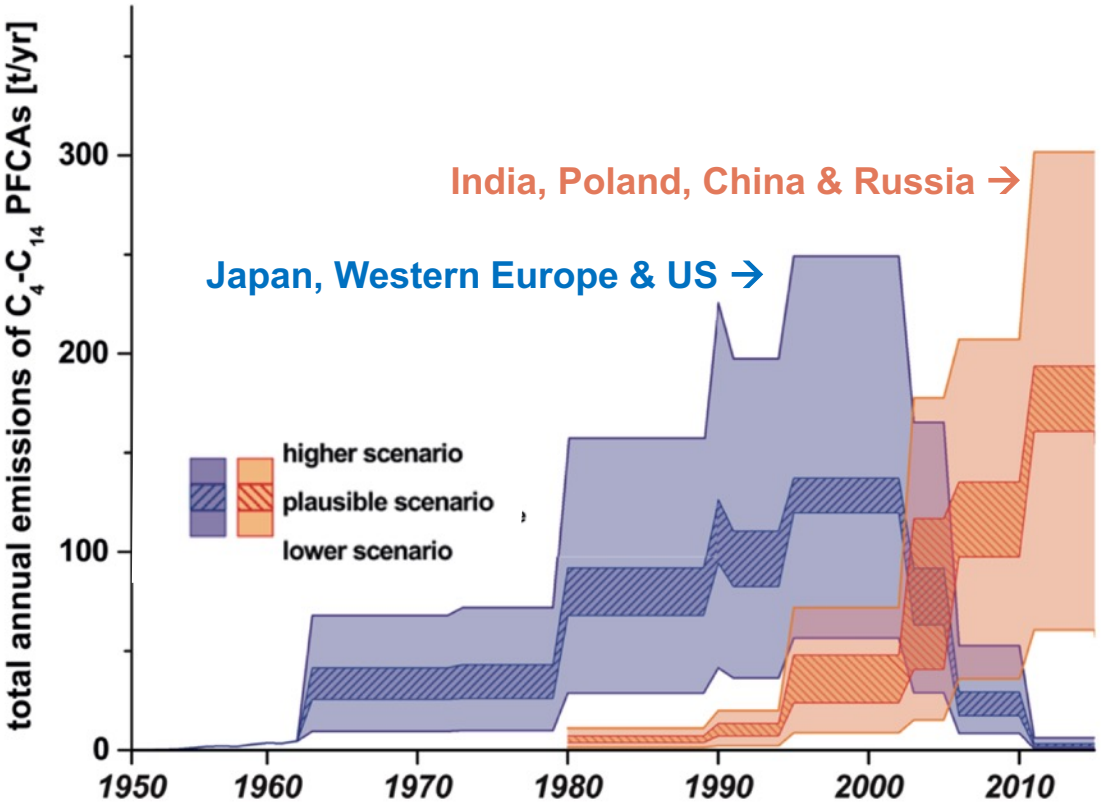


PFOS: **P**ants, **F**oam, and **O**n **S**urfaces (**P**er**F**luoro**O**ctane **S**ulfonate)

PFOA: **P**ioneering **F**luorochemical **O**f **A**trocity (**P**er**F**luoror**O**ctanoic **A**cid)

https://www.kimley-horn.com/news-insights/perspectives/what-is-pfas/

PFAS Production Worldwide

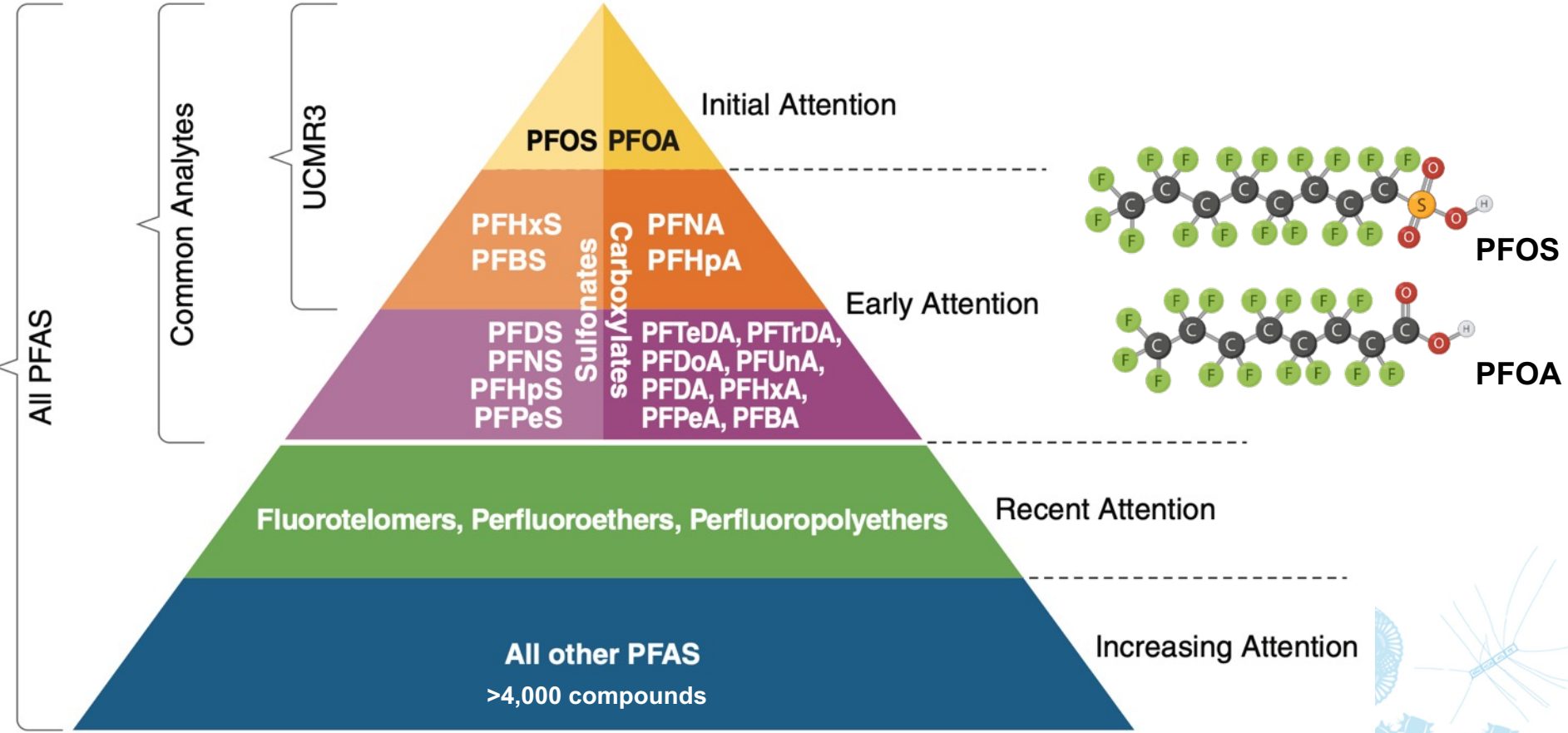


Some countries started banning <u>some</u> PFAS

… but they are still produced.

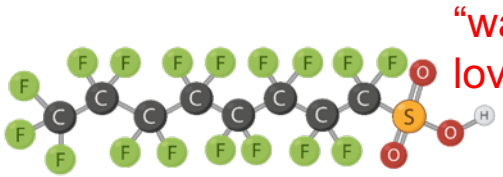
Figure from "Working towards a Global Emission Inventory of PFASs: Focus on PFCAs - Status Quo and the Way Forward," © OECD, 2015, p. 39 (OECD/UNEP 2015).

PFAS: 4000+ Compounds



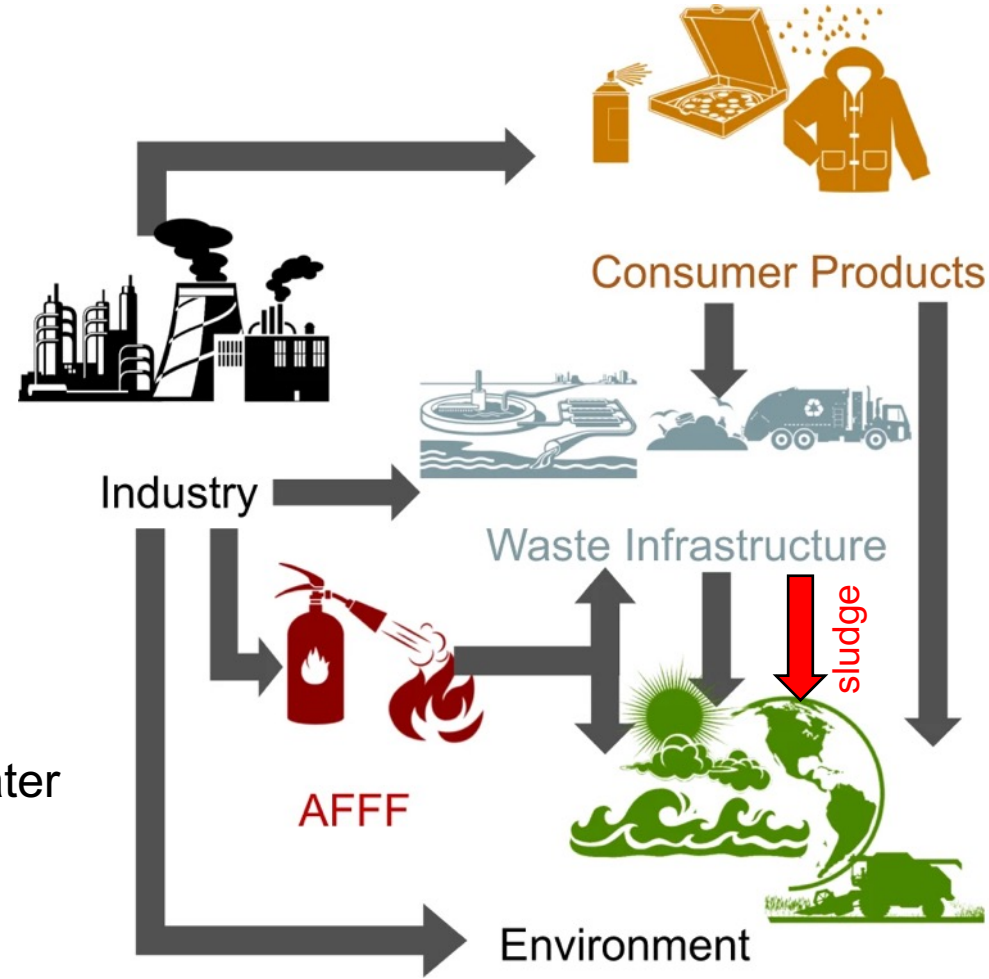
https://pfas-1.itrcweb.org/2-3-emerging-health-and-environmental-concerns/

How Do PFAS Get into the Environment?



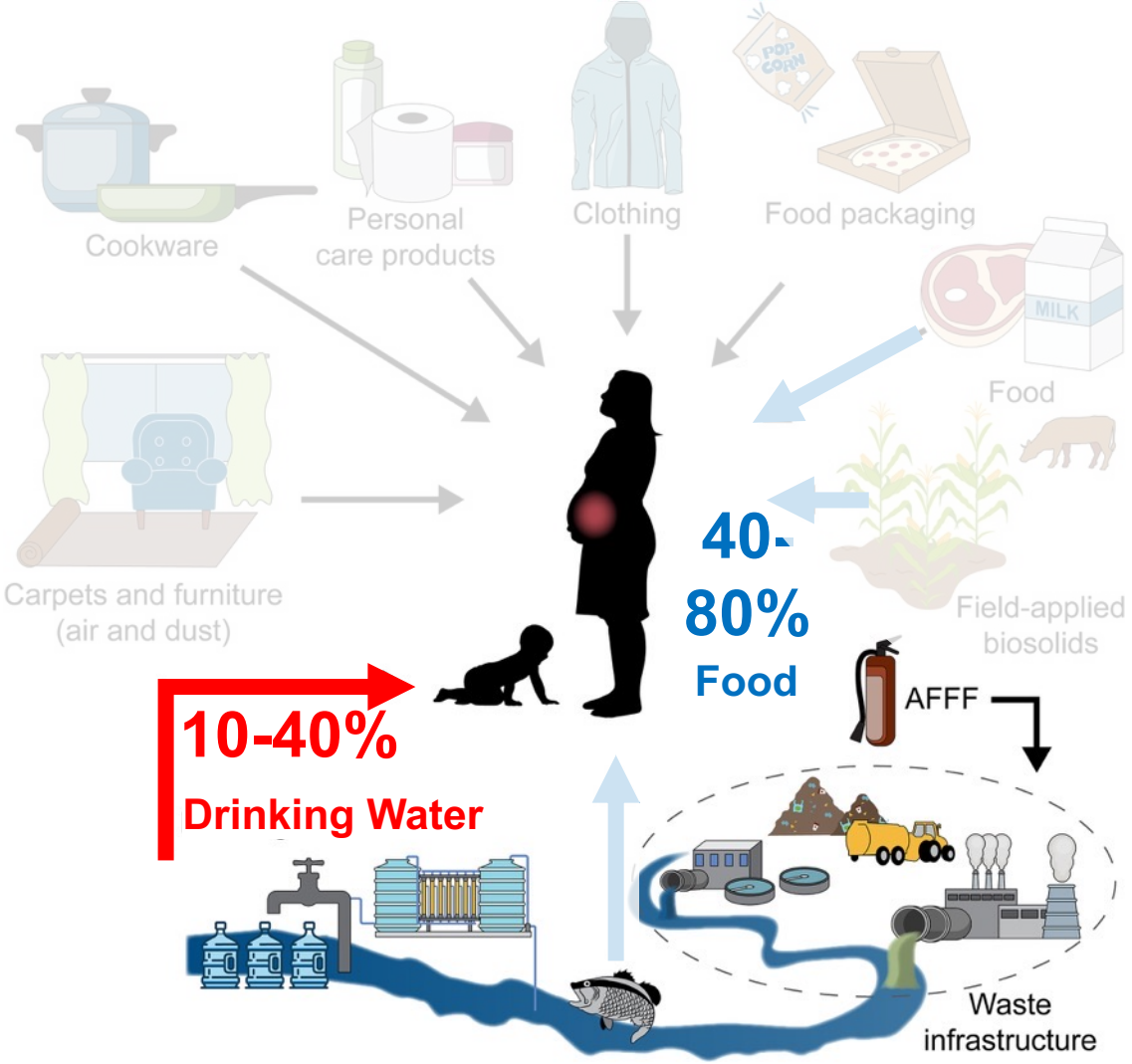
AFFF: Aqueous Film-Forming Foams (firefighting foams)

Sludge (“biosolids”): Wastewater treatment solids; was used for fertilizing agricultural fields



Sunderland et al (2019) J Expo Sci Environ Epidemiol 29:131–147.

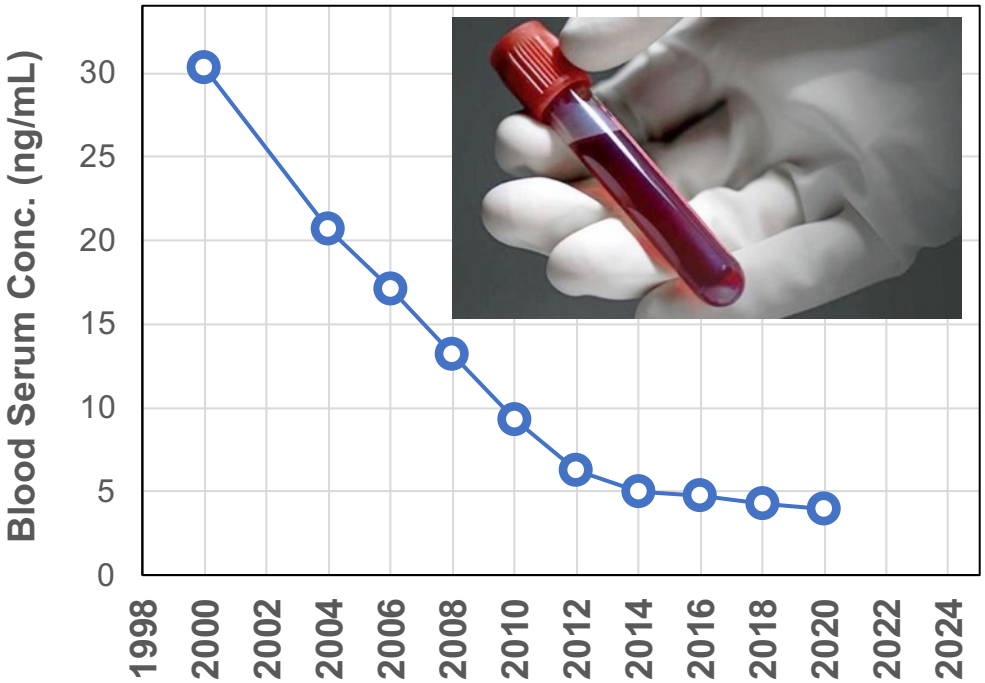
How Do We Get Exposed to PFAS?



Yang J, Vahapoglu L, Aga DS (2024). One Earth 7:946–950.

PFOS in our Blood

1 ng = 0.000,000,001 g
one billionth of a gram

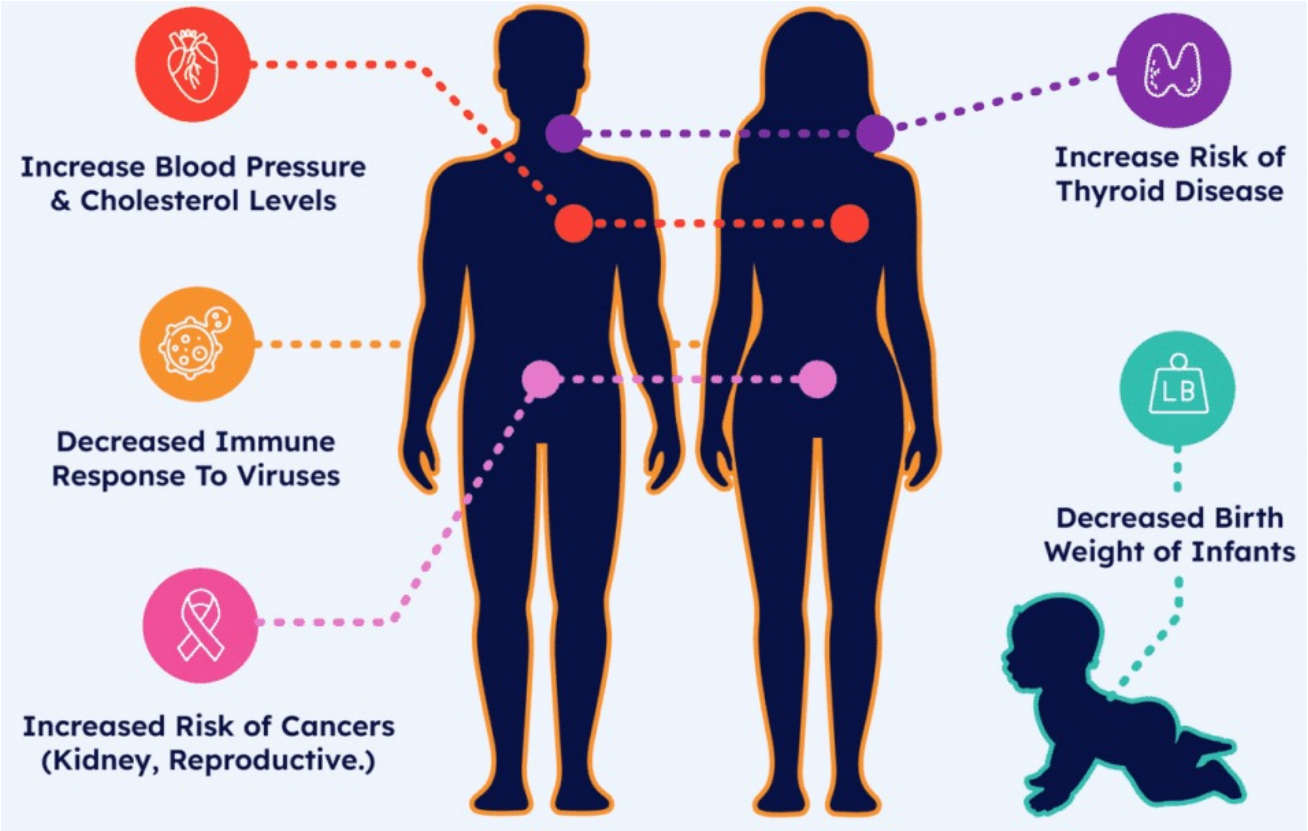


Detected in **>99%** of US Population
(US CDC NHANES study 2017-2020; *n*=3072)

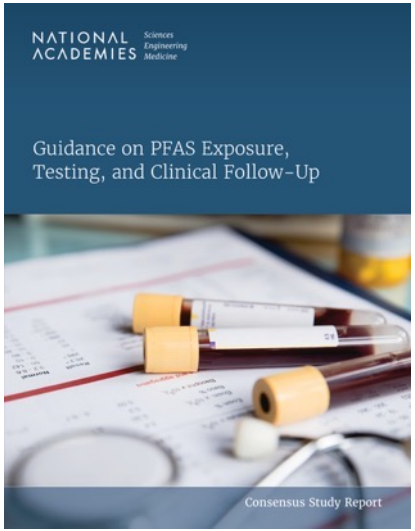
80% Decrease in Concentration from 1999 to 2020

https://www.cdc.gov/exposurereport/data_tables.html

Health Effects of PFAS



Increased risk at serum concentrations **> 20 ng/mL**



https://www.nationalacademies.org/our-work/guidance-on-pfas-testing-and-health-outcomes

PFAS in Drinking Water

2023-2025 EPA

15% of large and
8% of small
drinking water
facilities
> 4 ng/L

* January 2025 UCMR5 summary

https://www.istockphoto.com/photo/young-boy-outside-drinking-from-a-water-bottle-gm108271746-10467369


660,000 gal
2,500,000 L

4 ng / L (4 ppt; 0.000,000,004 g per L)

1 Pinch of Salt into 10 Olympic-sized Swimming Pools

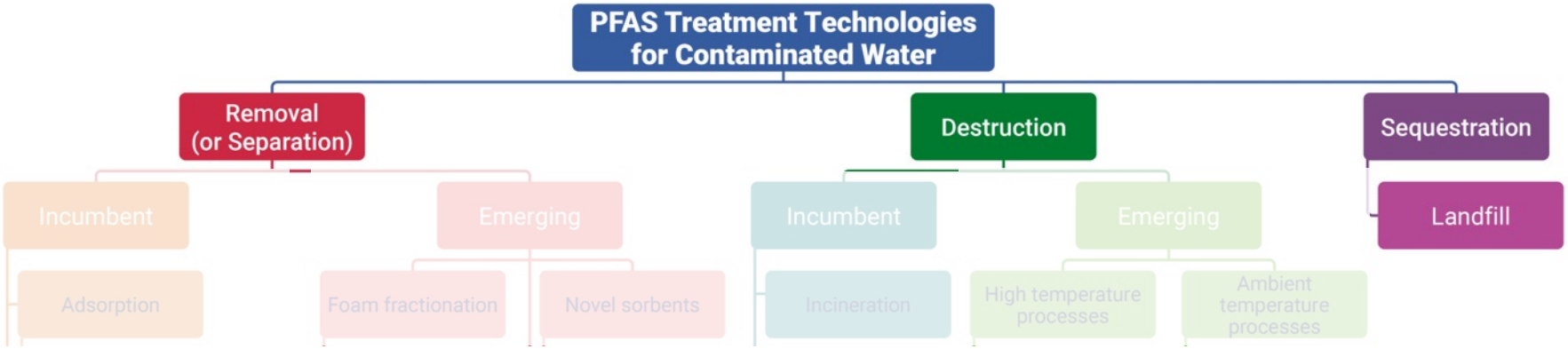


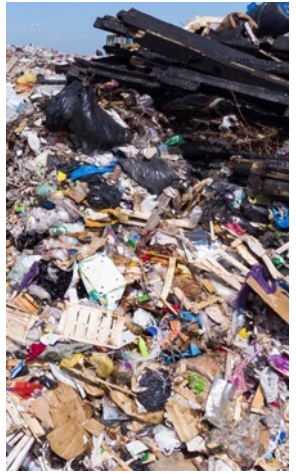







PFAS Removal

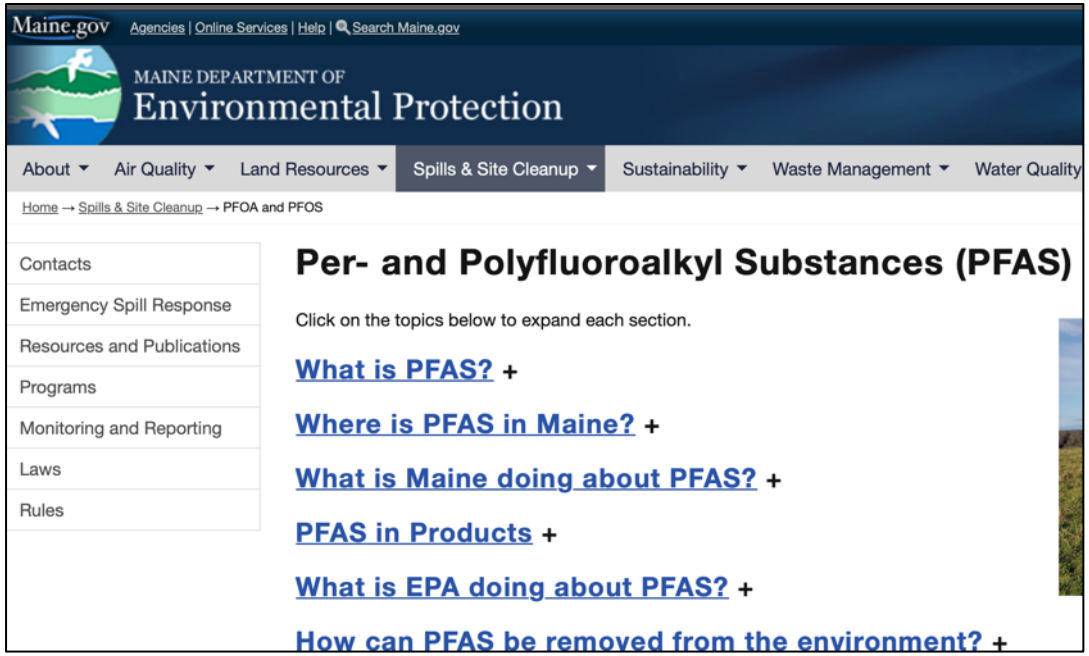




What Can I Do?

Get Information

https://www.maine.gov/dep/spills/topics/pfas/



Use PFAS-Free Product

PFOA FREE

PFAS FREE

Reduce Exposure

PFAS Water Sampling for Homeowners

Can I sample my own water?

Sampling your drinking water for per- and polyfluoroalkyl substances (PFAS) can be challenging due to the prevalence of PFAS in consumer products such as water-resistant clothing, boots, gloves, sunscreen, lotions, cosmetics, and food packaging. All of these products may contain PFAS and can contaminate samples. To ensure a quality, representative sample, make sure your sample area is free of any PFAS-containing material.

How much does it cost?

The cost of PFAS analysis typically ranges between $250 and $500, depending on the laboratory.

Can I be reimbursed?

The DEP will reimburse the cost of this testing up to a certain amount only if sampling was conducted in general accordance with the DEP's sampling guidance, a Maine-accredited and DEP-approved laboratory was used, you provide the laboratory results to the DEP for review, and the source of PFAS can be tied to a DEP-licensed sludge or septage land application site or other remediation-type site as verified by the DEP.

How do I find a laboratory?

Maine does not have in-state laboratories accredited to conduct PFAS testing. The DEP has compiled a list of Maine Laboratories that will subcontract for these services. Maine Laboratories that Subcontract Residential

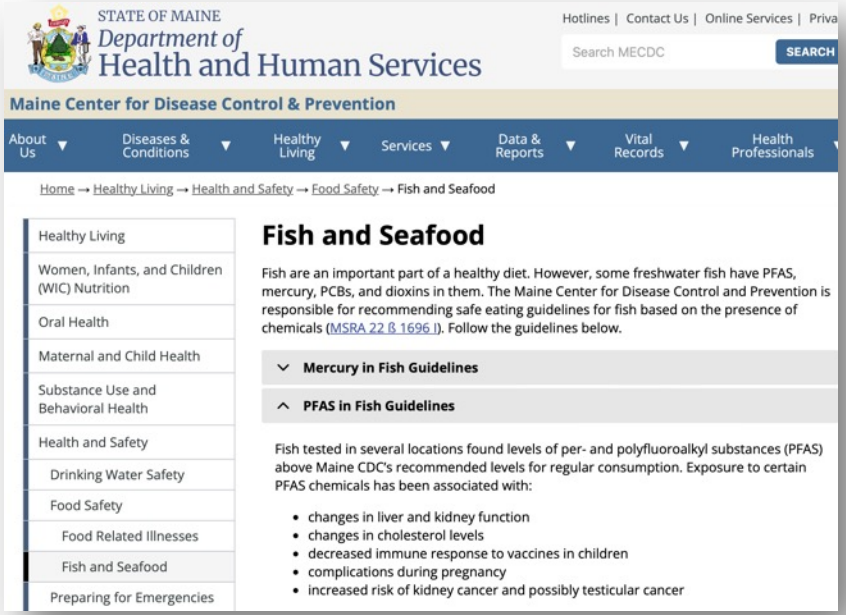
What do I ask for from the lab?

1. Explain that you want to self-test your own drinking water for PFAS.
2. Ask for "Method 537.1, modified with isotope dilution." The compound list should include a list of 28 PFAS.

Note: To prevent contamination of your sample, make sure your hands are free of lotion and thoroughly washed. Do not wear waterproof clothing. Use nitrile gloves.

3. Ask that the laboratory reports include all quality control information. This is generally referred to as a "Level 2 Report."
4. Ask the laboratory for an electronic deliverable data (EDD) in DEP's latest format. This is important if you wish to seek reimbursement.

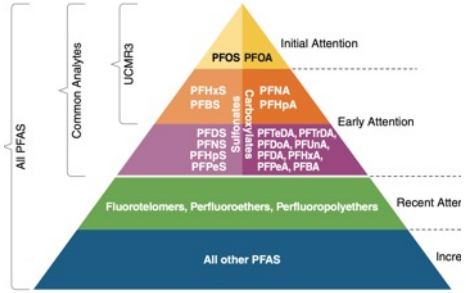
Recreational Freshwater Fish Anglers



https://www.maine.gov/dhhs/mecdc/healthy-living/health-and-safety/food-safety/fish-and-seafood

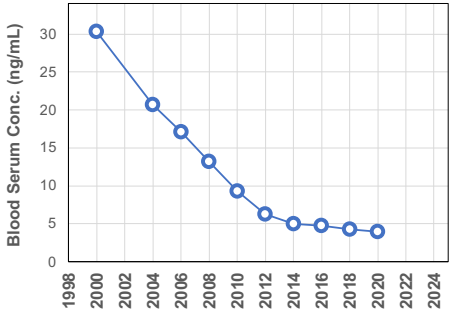
https://www.maine.gov/dep/spills/topics/pfas/

Key Takeaways



Many different compounds. **Not all are equally "bad"**

Detected and can have health effects at low doses. **What is the level of concern?**



Regulation works (for PFAS that are regulated…). But it takes time

Remediation technology exists for water and wastewater

Monitoring PFAS in Casco Bay

Do-Not-Eat
Advisories for Fish

August 2024
AFFF Spill
50k gal foam

Bigelow Laboratory for Ocean Sciences

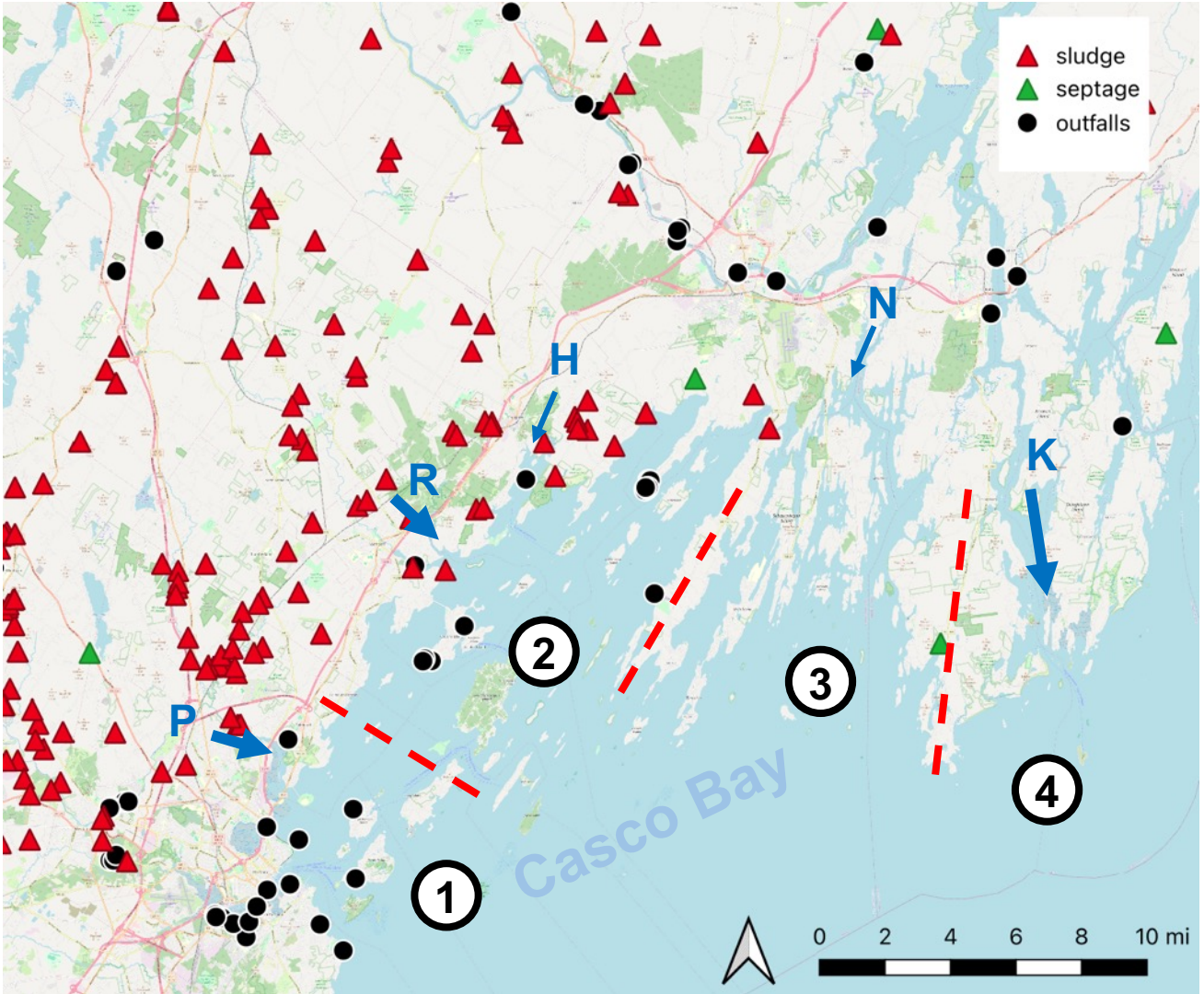
Portland, ME

Casco Bay Estuary

Machias
Great Spruce
RAM
Flint
Little Drisko
Dyer Point
Western Isl
Bunker Harbor
Petit Manan
Schoodic Island
Acadia
Natl. Park
Little Duck
Merchant
Long Island
Marshall
Hurricane
Isle au Haut
South Bristol Co
Allen
Metinic
Pemaquid Point
Thrumcap
Damariscove
Bold Dick
Seguin
Jewel
Cape Small
Cape Liz

PFAS in estuarine and coastal environments

- Receive cumulative inputs from diverse sources
- PFAS sources & fate remain understudied
- Limited data on PFAS.

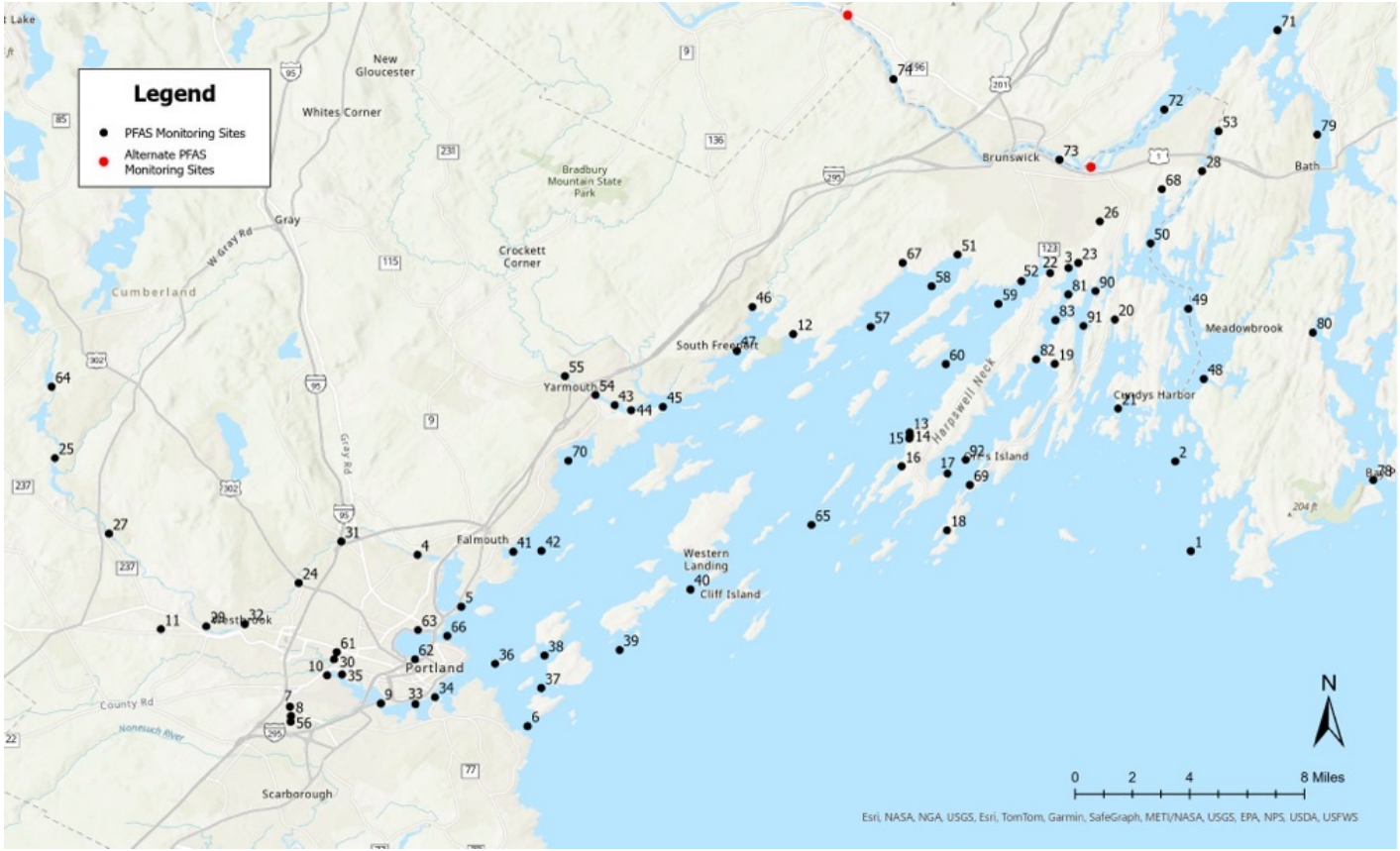


Study Area: Casco Bay

Potential PFAS Sources

1) **Stormwater** & Industrial effluent
2) Agricultural runoff from **sludge spreading** sites
3) BNAS **superfund** site
4) Kennebec & Androscoggin **River** (runoff, WWTP)

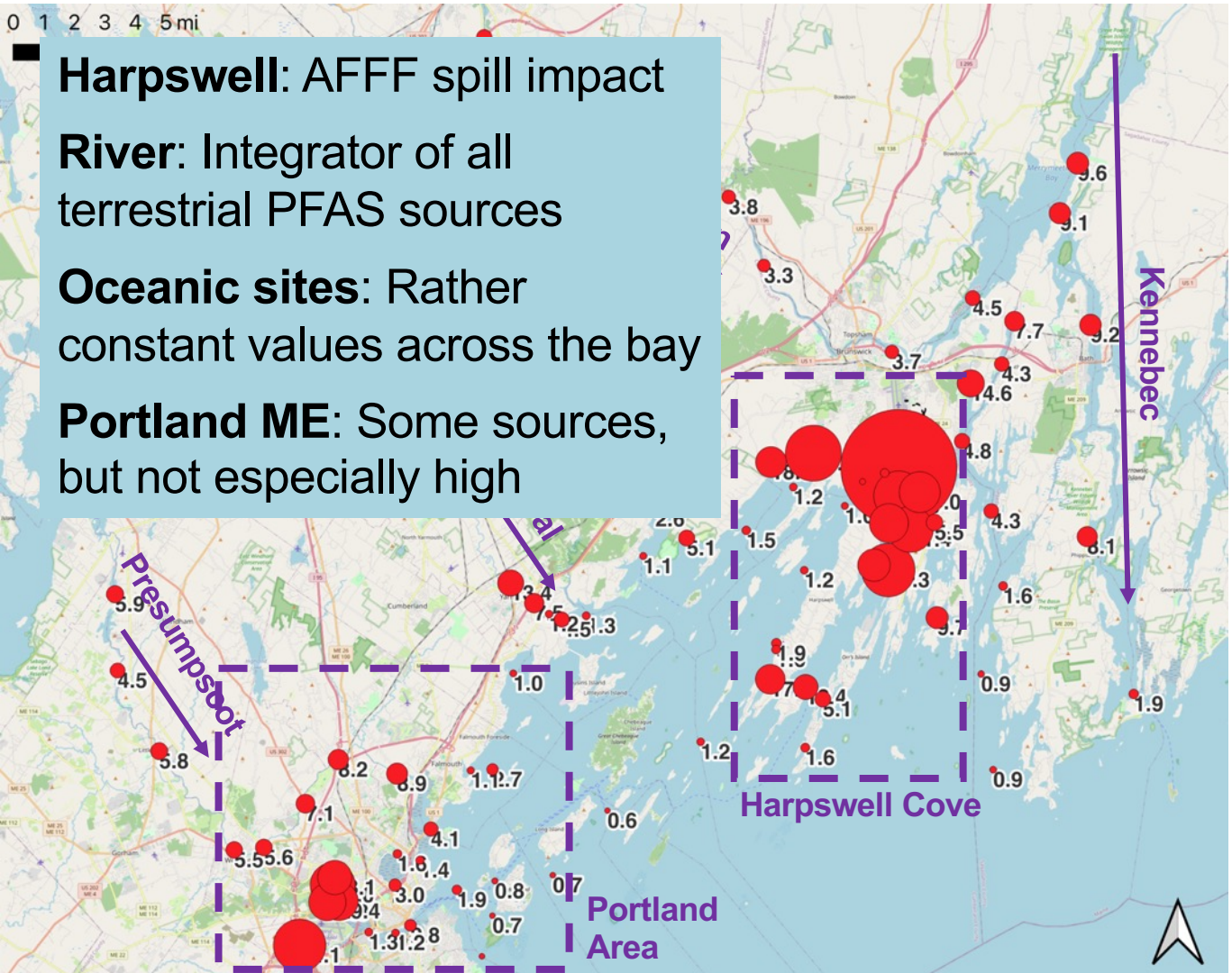
Aqueous Sampling Campaigns



Stake-holder input to select 90 stations

Bay-wide: 3x (Sept / Oct ‘24 and June ’25)

AFFF spill: 10x select 7 stations



Results Overview

Sept 9-13, 2024
Sum of 8 PFAS (ng/L)

Method EPA 1633
Isotope dilution
40 PFAS compounds
Bigelow PFAS Facility
www.bigelow.org/pfas

Most 8 commonly detected
PFOS, PFOA
PFHxS
PFHxA, PFHpA, PFNA
FOSA, 6:2FTS

PFAS after AFFF Spill

$3.00
Tuesday,
August 20, 2024

Portland Press Herald

pressherald.com

WEATHER:
Partly sunny with showers
High 68
Details, D6

Shawn Patrick Ouellette/Staff Photographer

Firefighting foam blows through the air as workers try to clean up from a massive accidental discharge Monday at Brunswick Executive Airport. The foam filled a hangar big enough for two 747s and spilled out into the parking lot.

Forever chemicals spew from foam spill at Brunswick airport

A malfunctioning fire suppression system discharged 1,600 gallons of firefighting foam at the former Naval Air Station. It was 4 to 5 feet deep in some places, workers said.

By PENELOPE OVERTON
Staff Writer
KRISTIAN MORAVEC
The Times Record

A fire suppression system malfunctioned inside a large airport hangar at the former Brunswick Naval Air Station ear-

8/19/2024 PFAS Spill

$3.00
Tuesday, August 20, 2024

Portland Press Herald

WEATHER: Partly sunny with showers High 68
Details, D6

pressherald.com

Shawn Patrick Ouellette/Staff Photographer

Firefighting foam blows through the air as workers try to clean up from a massive accidental discharge Monday at Brunswick Executive Airport. The foam filled a hangar big enough for two 747s and spilled out into the parking lot.

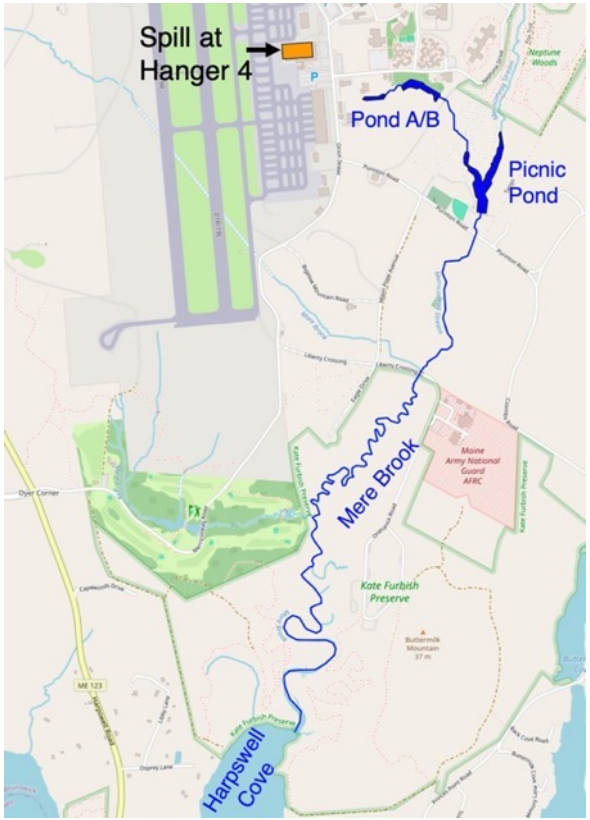
Forever chemicals spew from foam spill at Brunswick airport

A malfunctioning fire suppression system discharged 1,600 gallons of firefighting foam at the former Naval Air Station. It was 4 to 5 feet deep in some places, workers said.

By PENELOPE OVERTON
Staff Writer
KRISTIAN MORAVEC
The Times Record

A fire suppression system malfunctioned inside a large airport hangar at the former Brunswick Naval Air Station ear-

BRUNSWICK



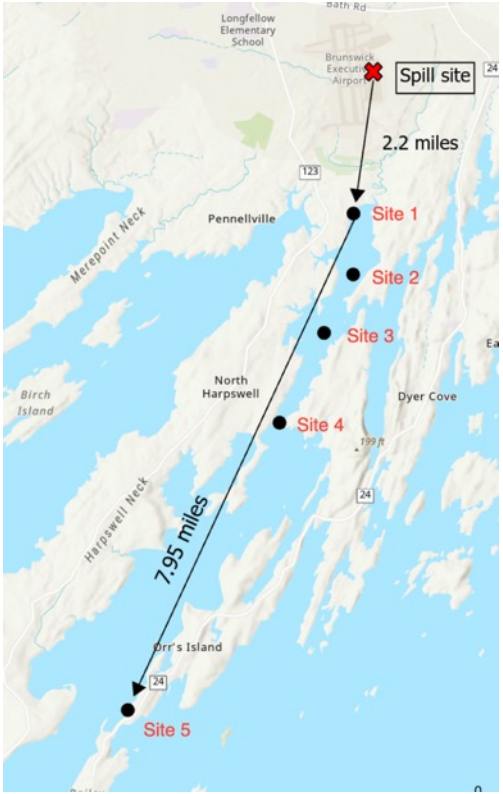
Former Brunswick Naval Air Station (**BNAS**)

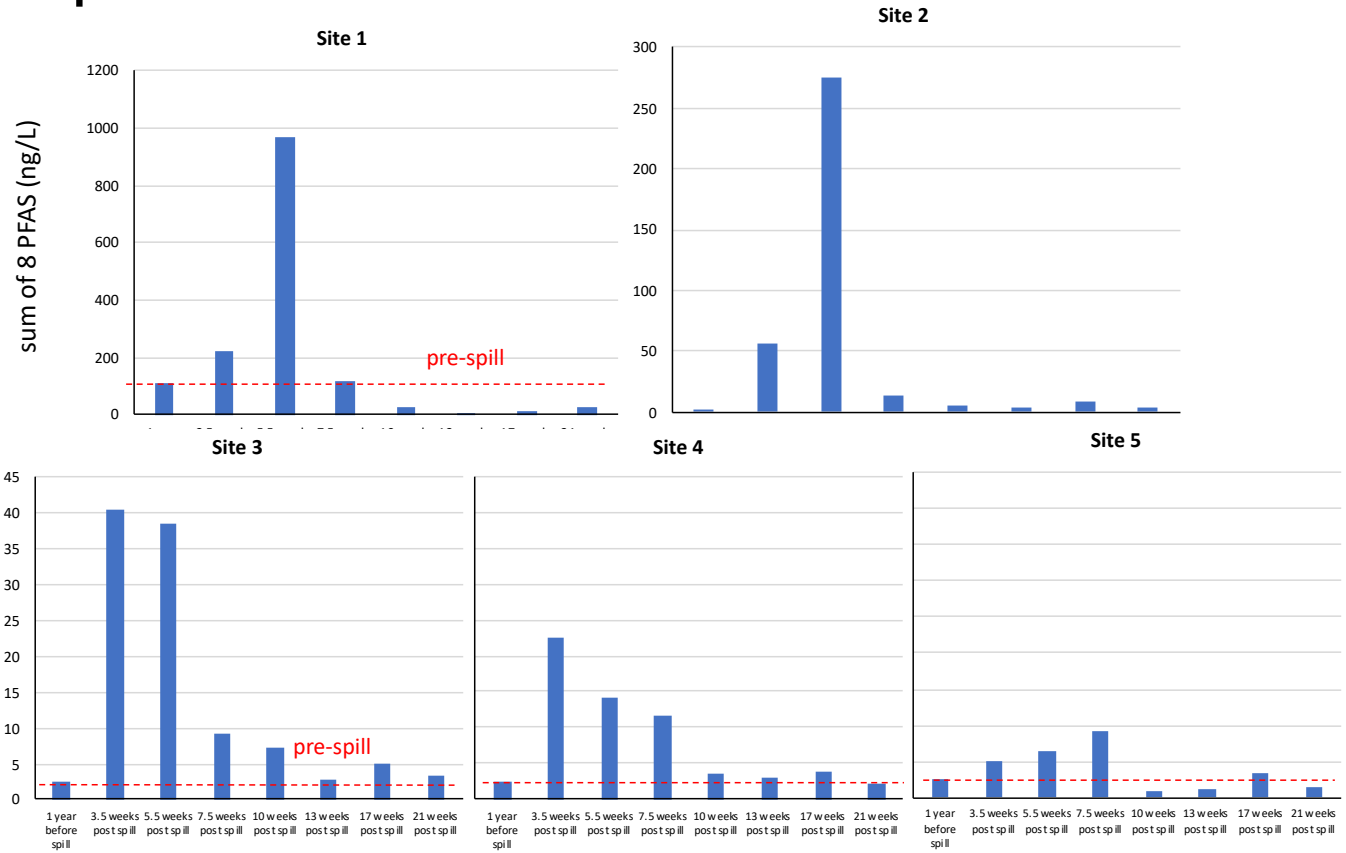
Malfunctioning fire suppression system

1,450 gal. of aqueous film-forming foam (AFFF) mixed with **50,000 gal.** of water

Largest AFFF spill in ME, and the 6th in the U.S. in the past 30 years

AFFF Impact: Harpswell Cove Transect





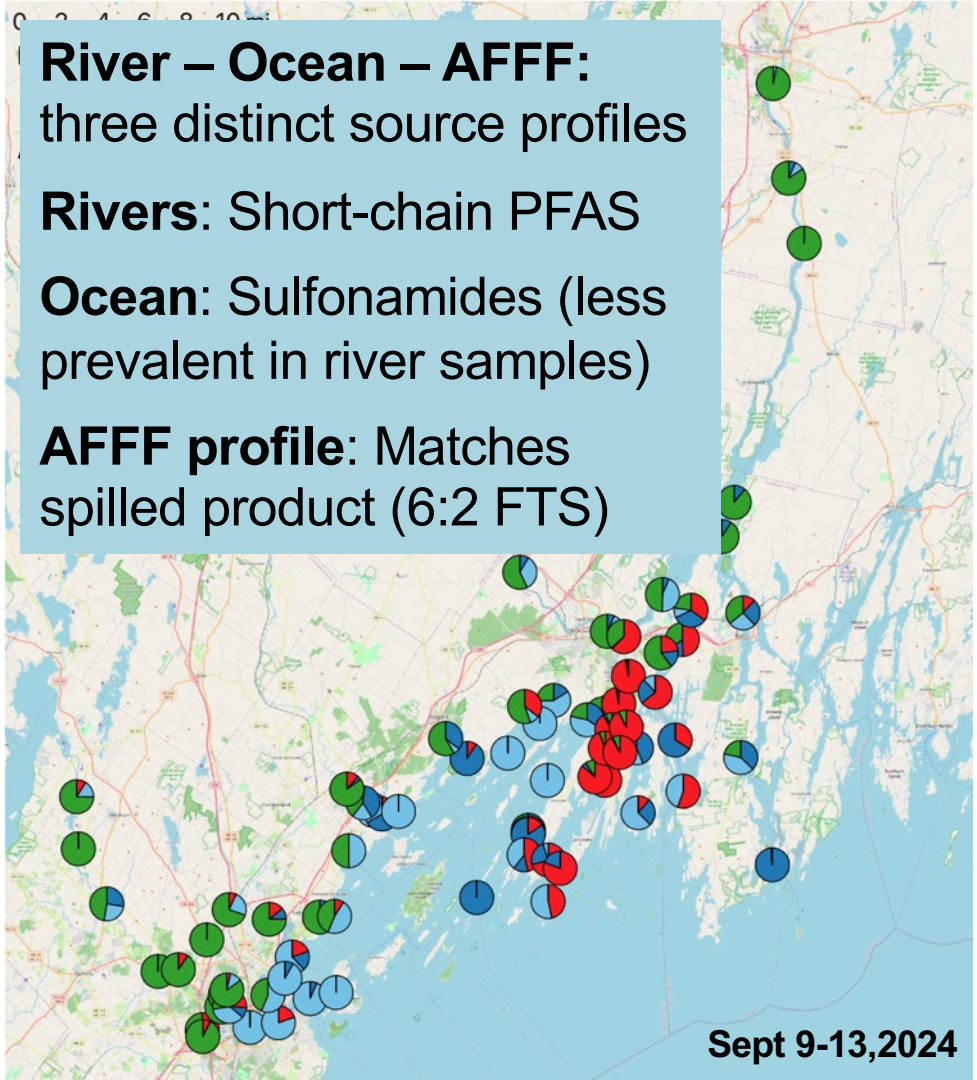
Concentrations at "pre-spill" levels after 3-4 months

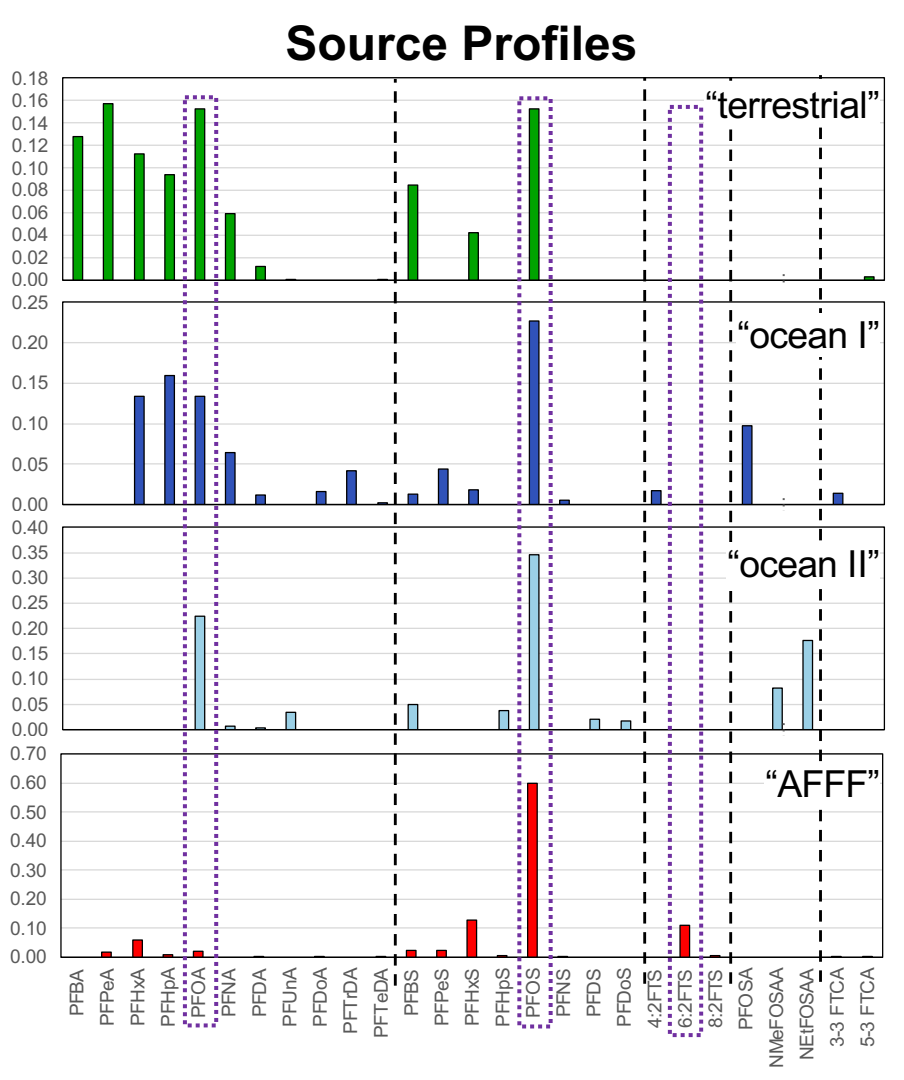
River – Ocean – AFFF:
three distinct source profiles

Rivers: Short-chain PFAS

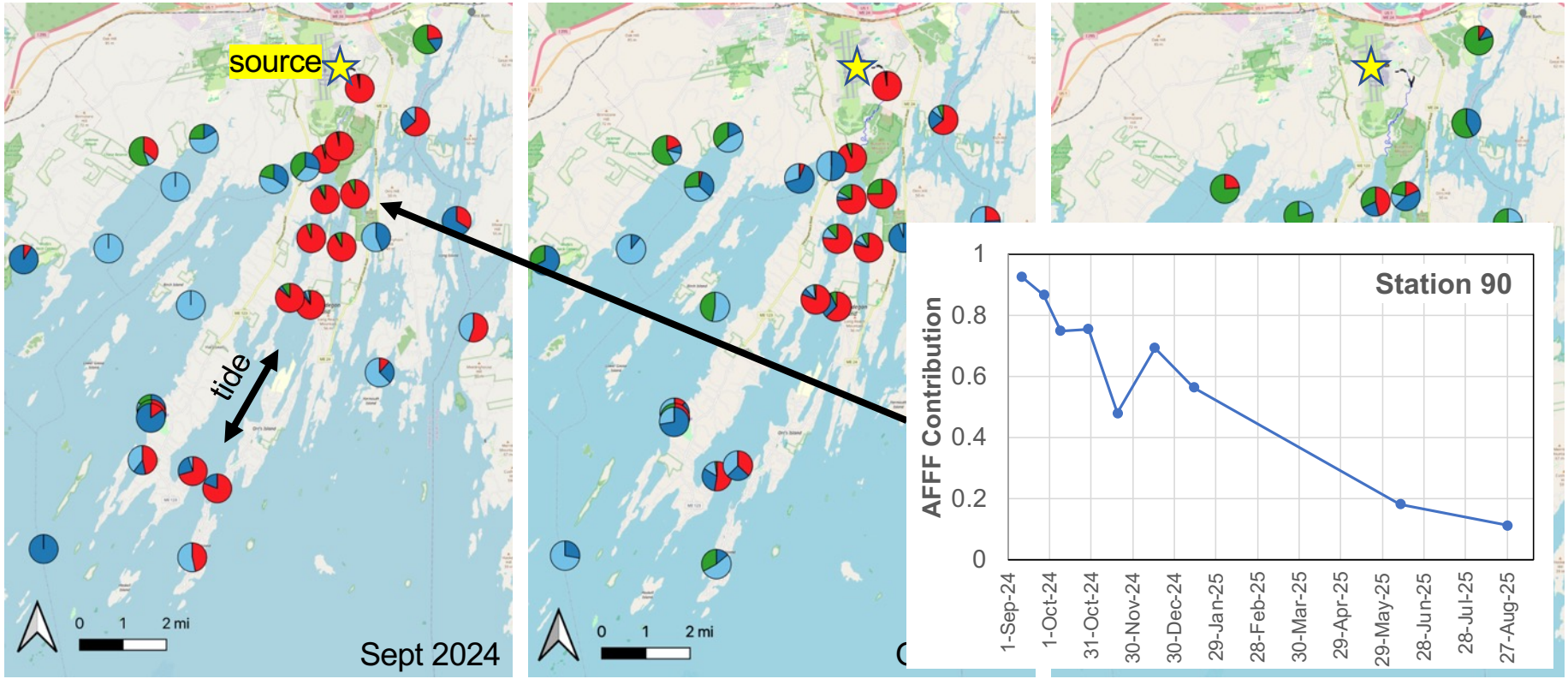
Ocean: Sulfonamides (less prevalent in river samples)

AFFF profile: Matches spilled product (6:2 FTS)





Tracking of spill-related PFAS into Casco Bay



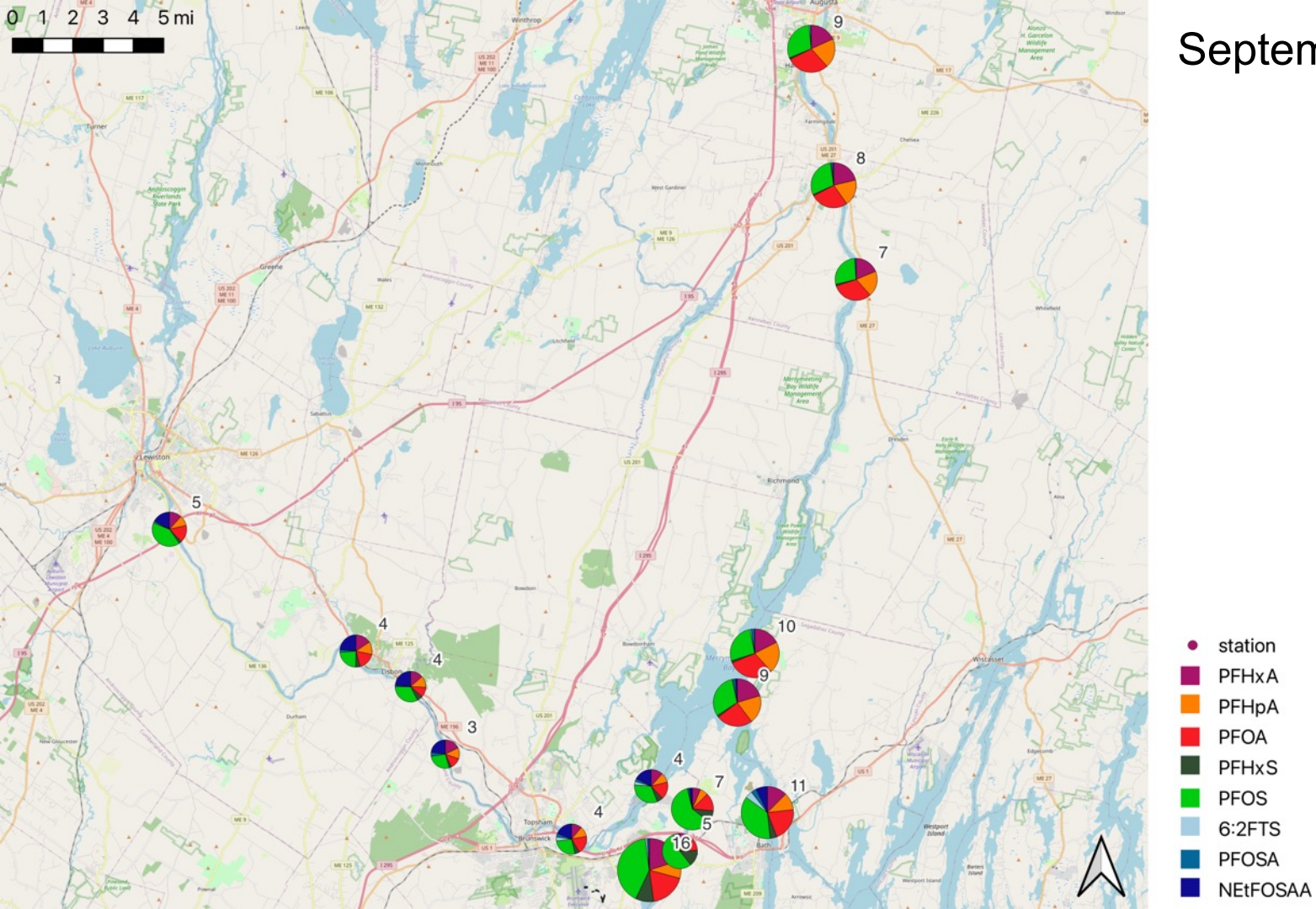
Dynamic AFFF source contribution over time. Decreasing AFFF signal over time.

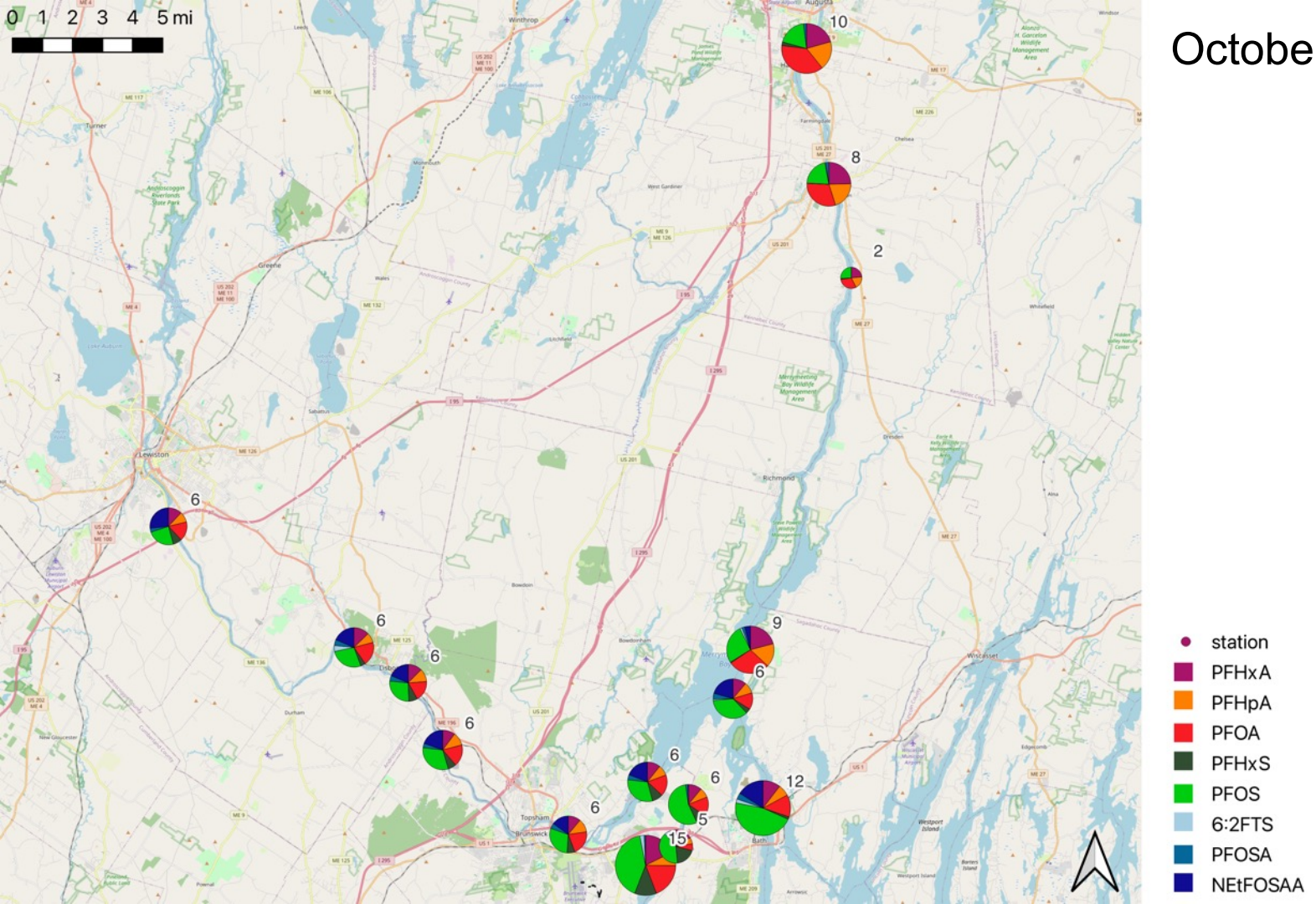
PFAS in Kennebec and Androscoggin


N232AA

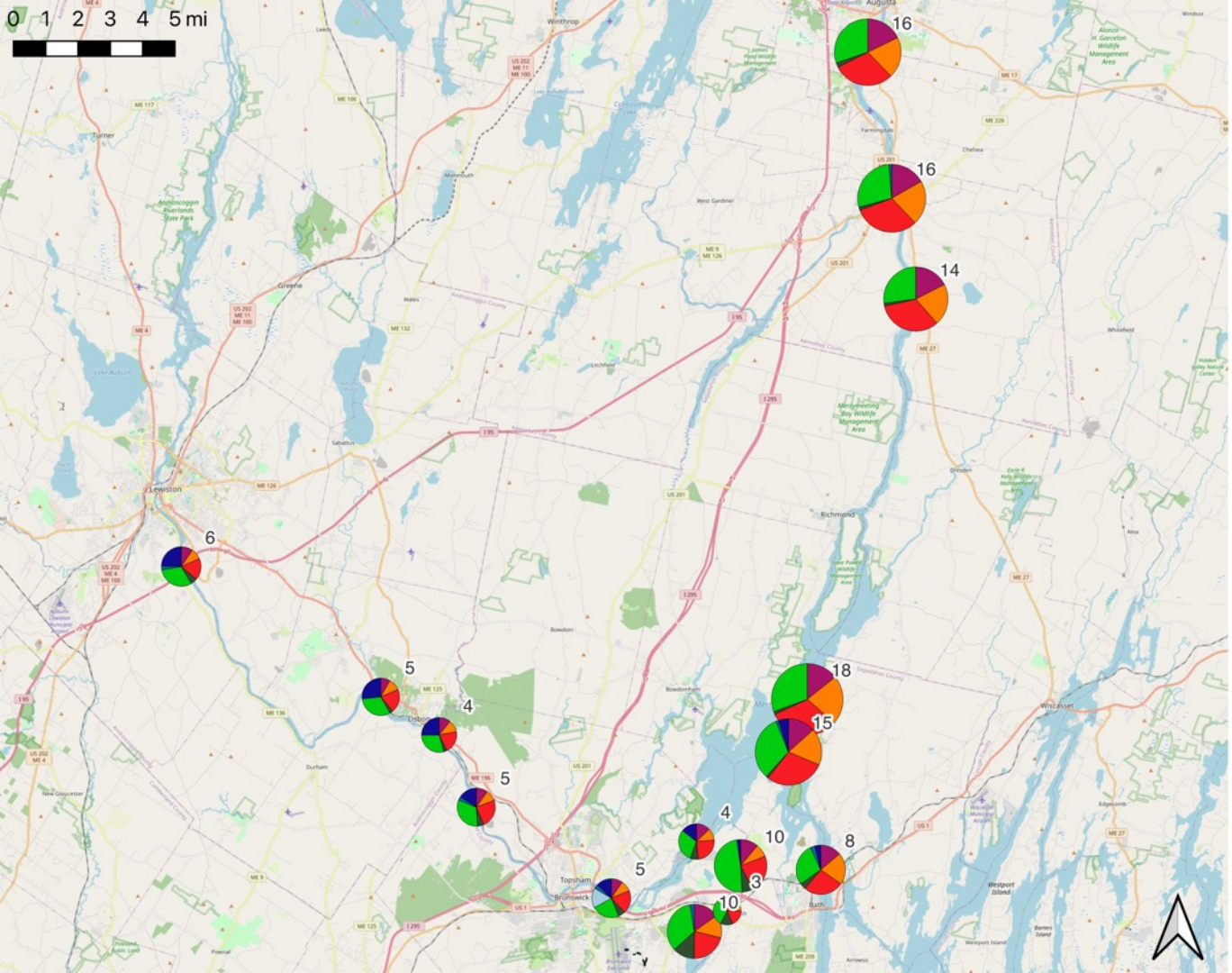

NO
SMOKING


BOSE
Coleman
INSTRUCTIONS


0 1 2 3 4 5 mi
9
8
7
5
4
4
3
10
9
4
7
11
4
5
16
September 2024
station
PFHxA
PFHpA
PFOA
PFHxS
PFOS
6:2FTS
PFOSA
NEtFOSAA

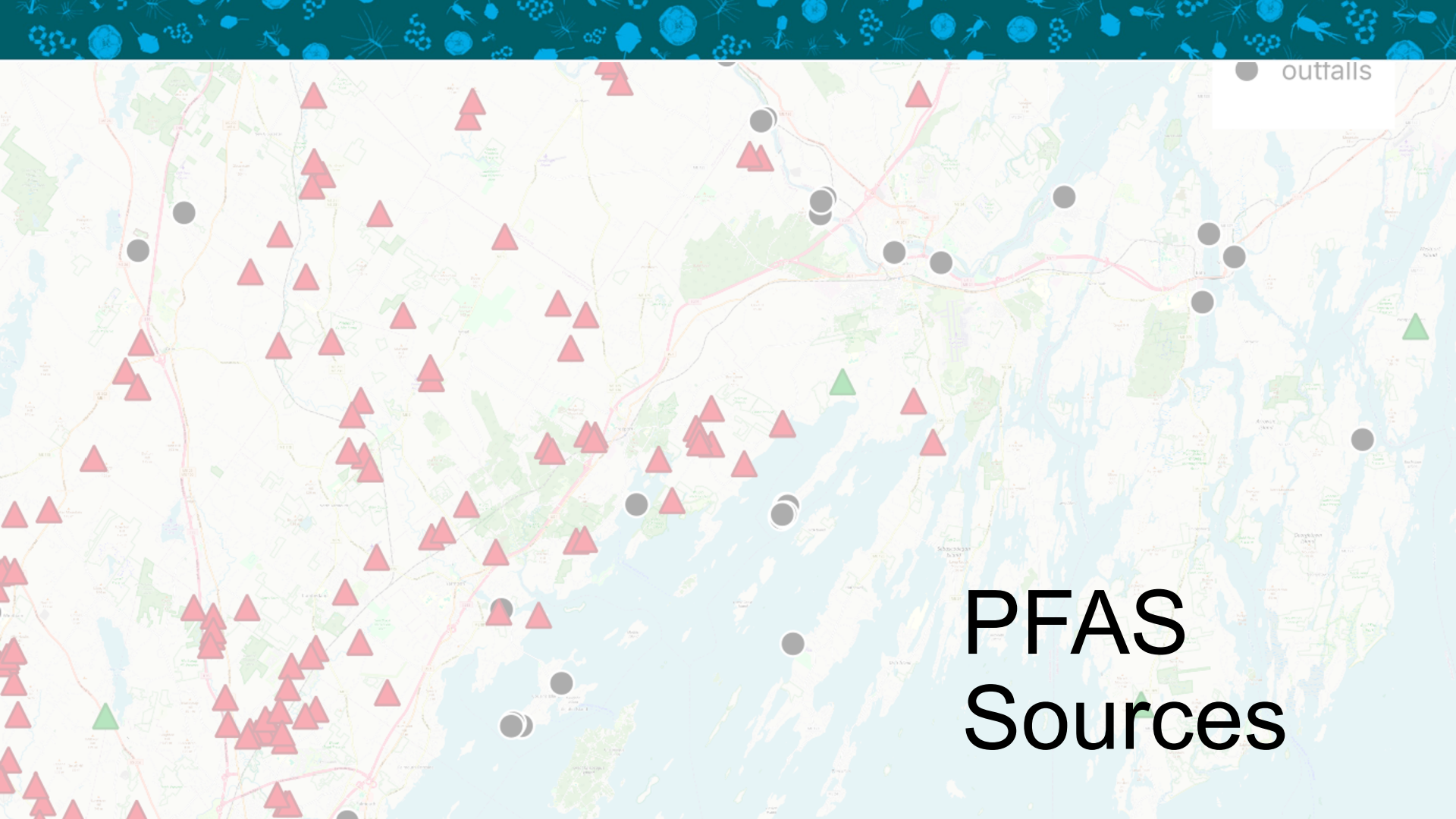


October 2024

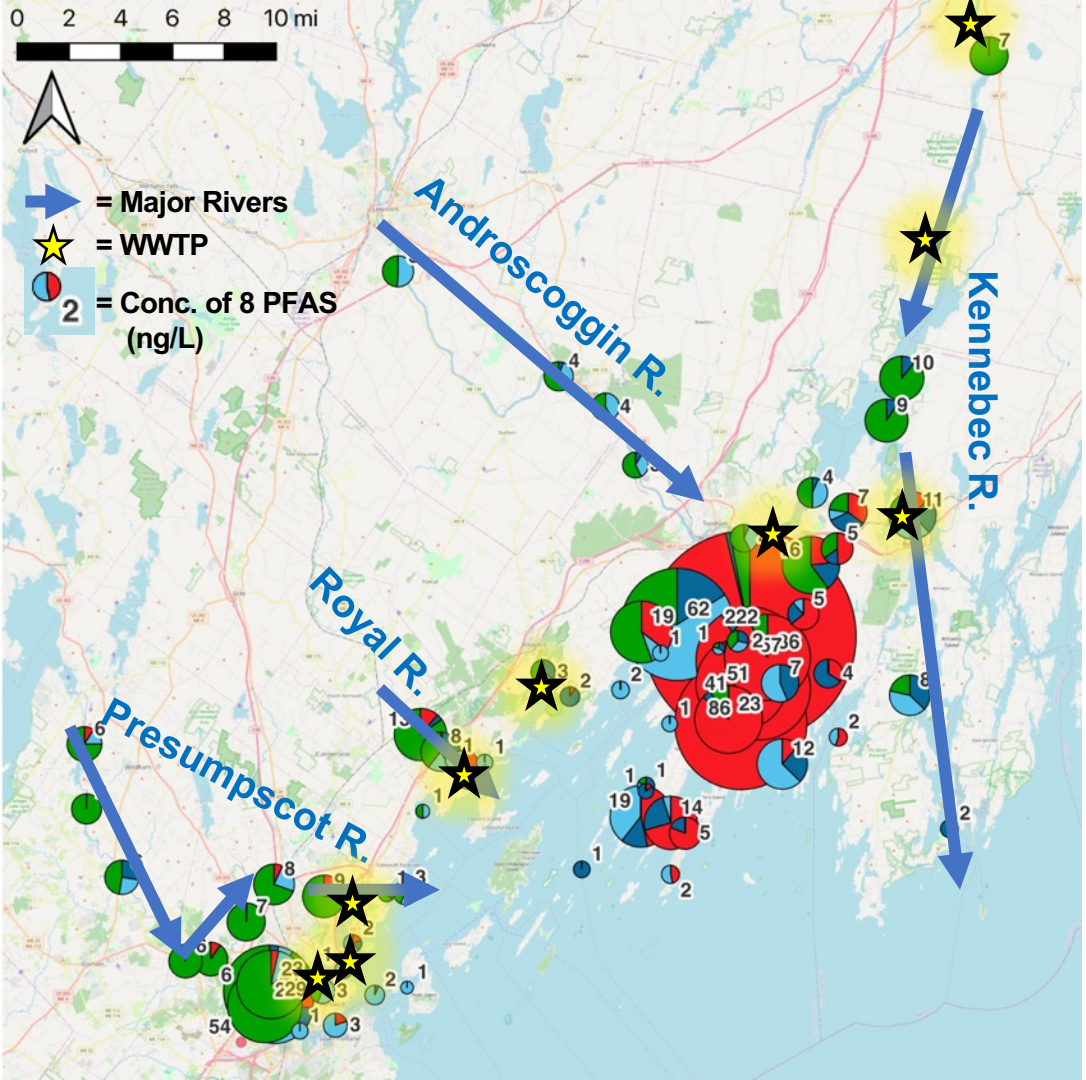


June 2025

- Relative **uniform concentration** along rivers
- **Distinct Kennebec vs Androscoggin** PFAS profiles
- No large temporal variation

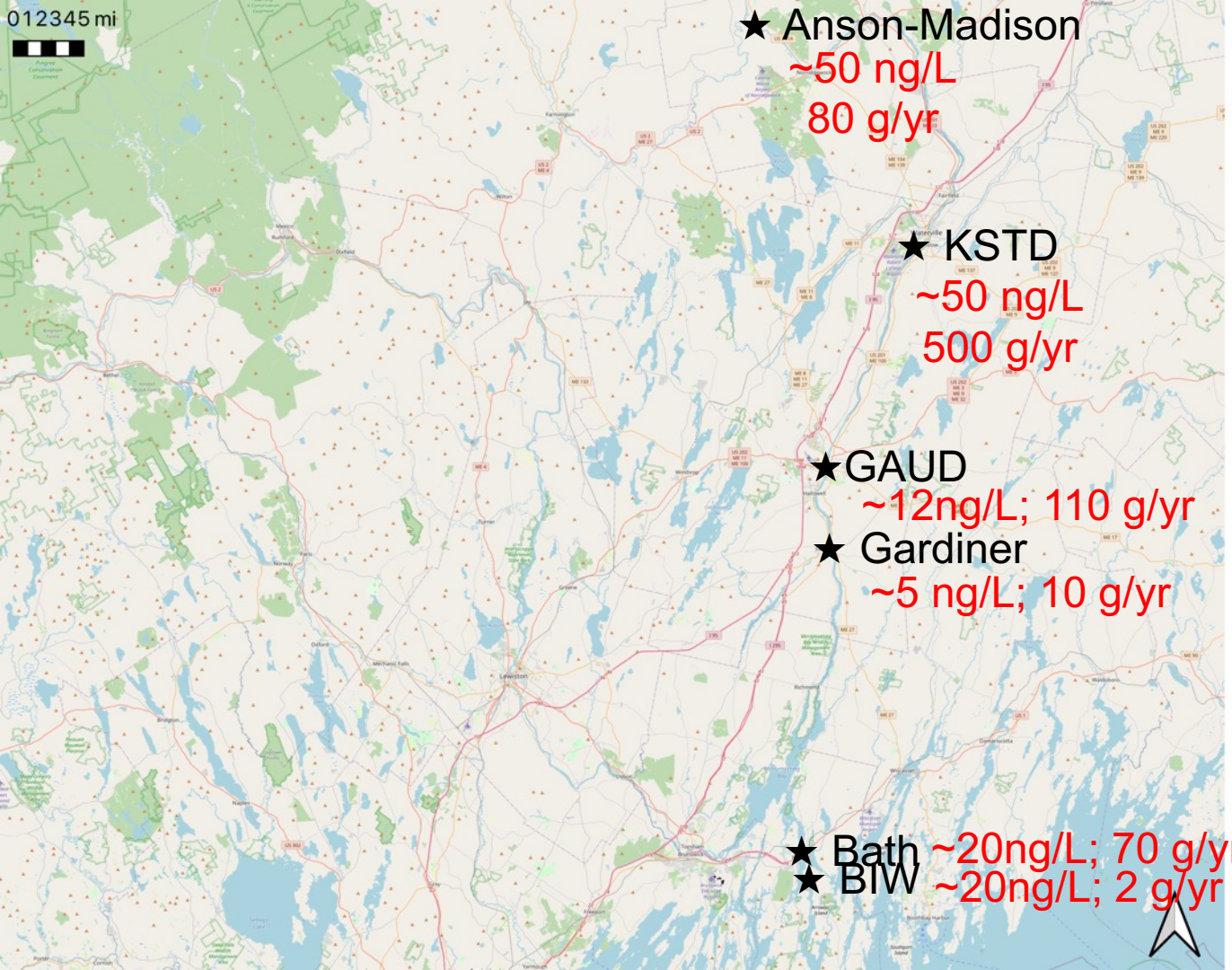


PFAS Sources



How important are sources for the input of PFAS into the estuary?

- **AFFF spill** input: Spilled amount as max (20 kg PFOS)
- **Rivers**: Annual flow x [PFOS]
- **WWTP into Bay**: 5 WWTP are discharging into the Bay
- **WWTP into Rivers**: 6 larger facilities into Kennebec River

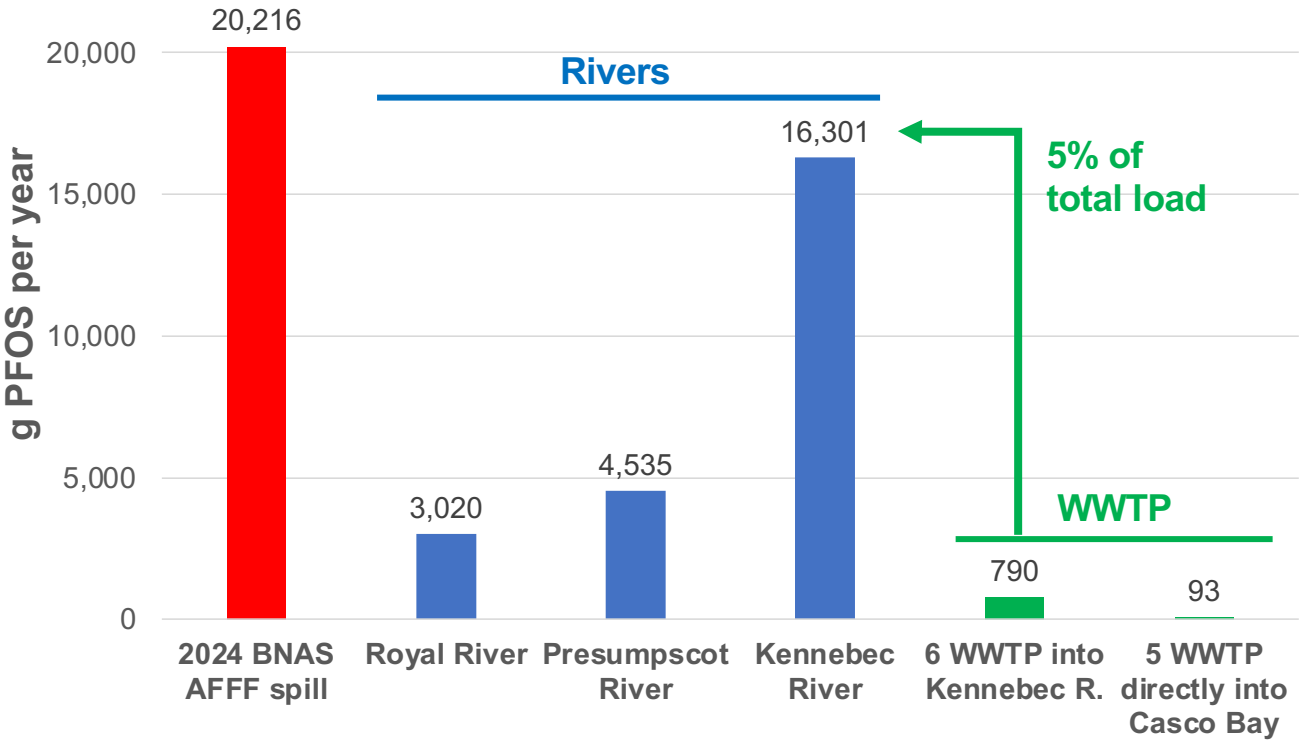


ME-DEP PFAS Data on WWTP Effluent

ng/L PFOS in effluent;

and estimated annual load of PFOS into the Kennebec

Estimation: Annual PFOS Mass Flow in Casco Bay



AFFF spills can be a large (and preventable) source of PFOS

Rivers integrate many terrestrial sources

Considered **WWTPs** account for a small fraction of PFOS input

Unidentified sources: agricultural runoff, old landfills, other diffuse sources (groundwater? atmospheric deposition?)

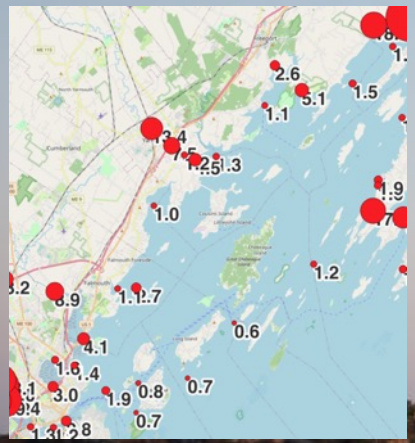
Summary

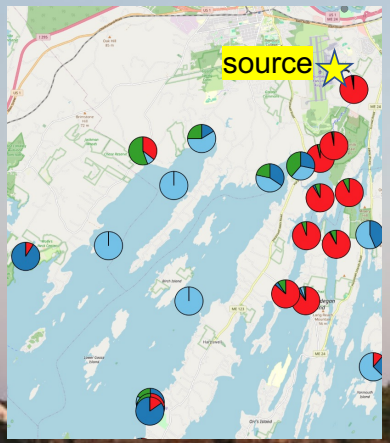
Funding

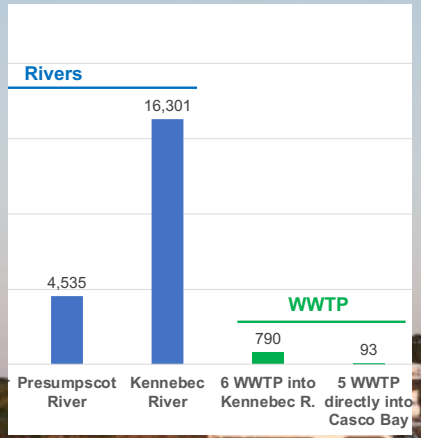
EPA

RESTORE AMERICA'S ESTUARIES

National Estuary Coastal Watershed Grant Program







prevalent at low concentrations

tracking AFFF-related PFAS

WWTP minor input in bay

Thanks for your Attention!

caeppli@bigelow.org