Per- and Polyfluoroalkyl Substances in Florida's Water

FLORIDA KEYS NATIONAL MARINE SANCTUARY
Water Quality Protection Program Steering Committee Meeting

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July 24, 2025
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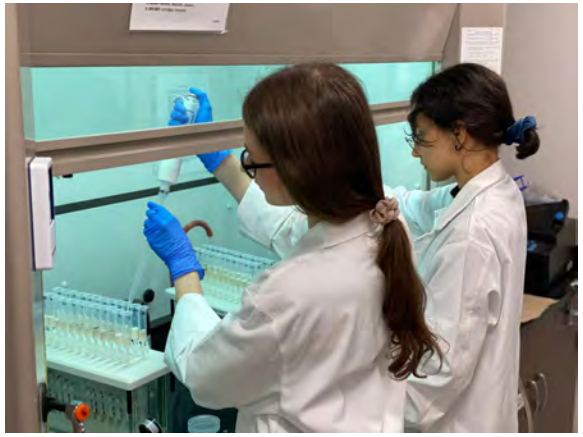
Bowden Laboratory at UF

My laboratory focuses on the “Life Cycle” of legacy and emerging chemicals

Service and collaboration



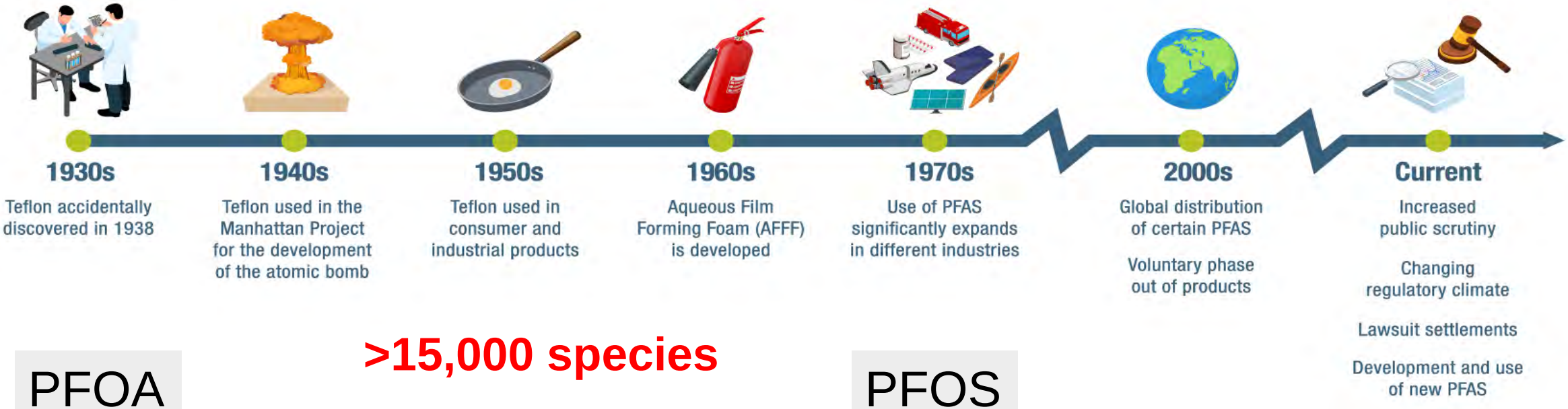
Education and training

Community engagement

Community awareness

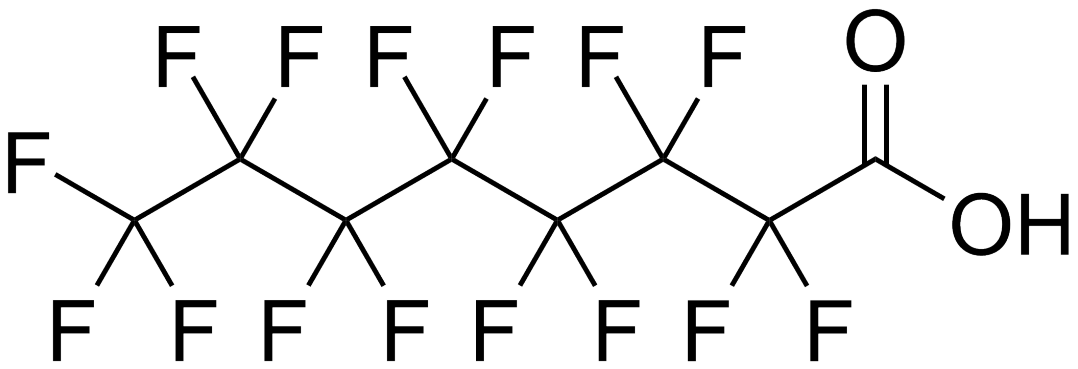
>60 PFAS publications to date plus >25 ongoing PFAS projects
(>140 pubs overall)

Per- and Polyfluoroalkyl Substances (PFAS) History

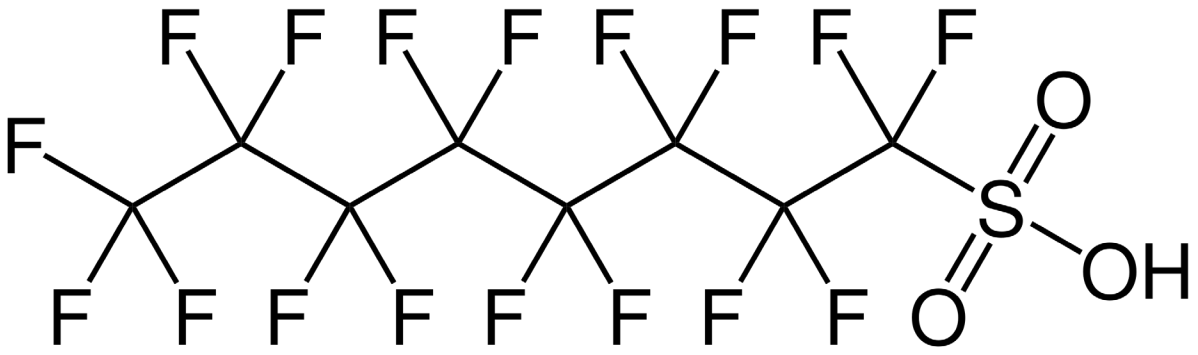


>15,000 species

PFOA



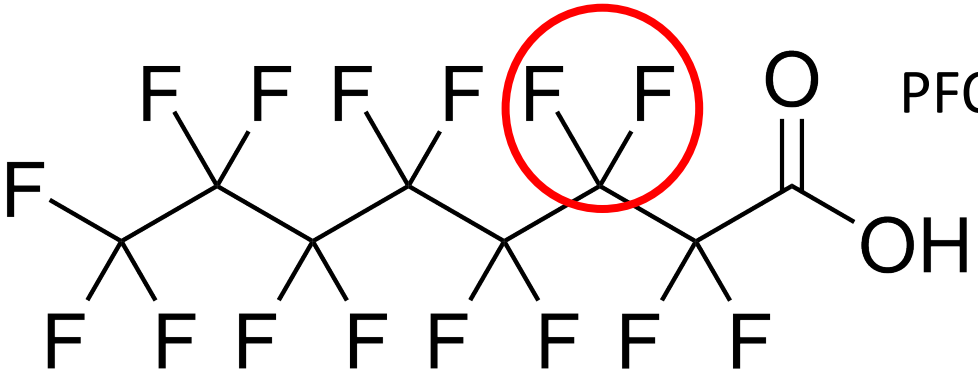
PFOS

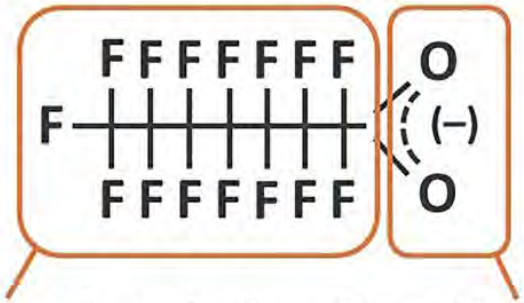


https://www.kimley-horn.com/what-is-pfas/

Common PFAS Uses

"forever chemicals"





Fluorocarbon tail
- Strong bonds
- Hydrophobic

Functional group
- Hydrophilic

Bandaids

Toilet paper

Watch bands

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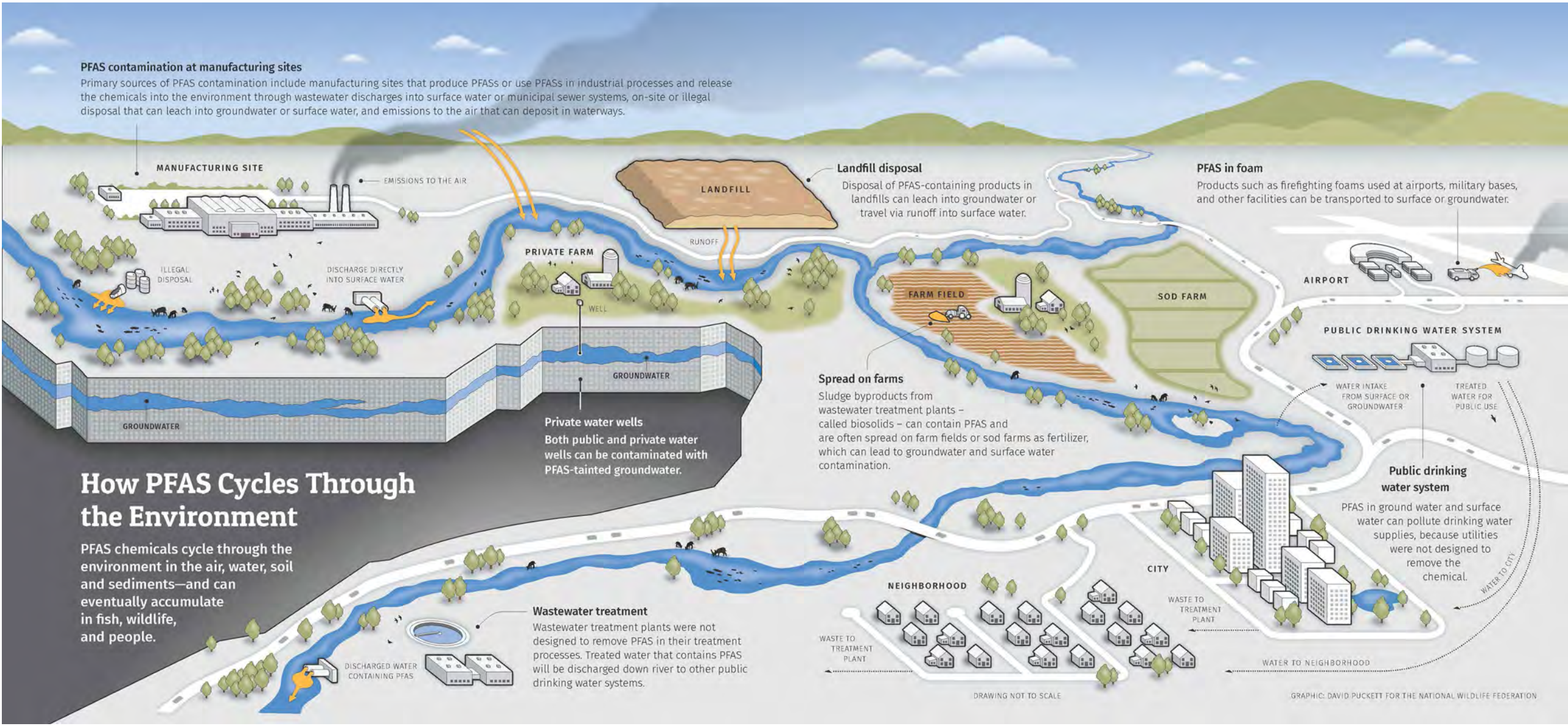
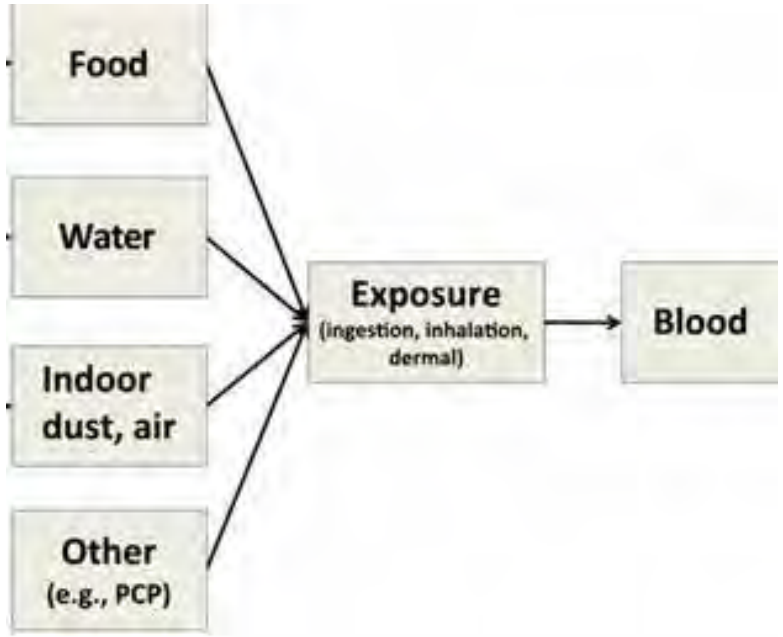
The PFAS Cycle



via [The National Wildlife Federation]

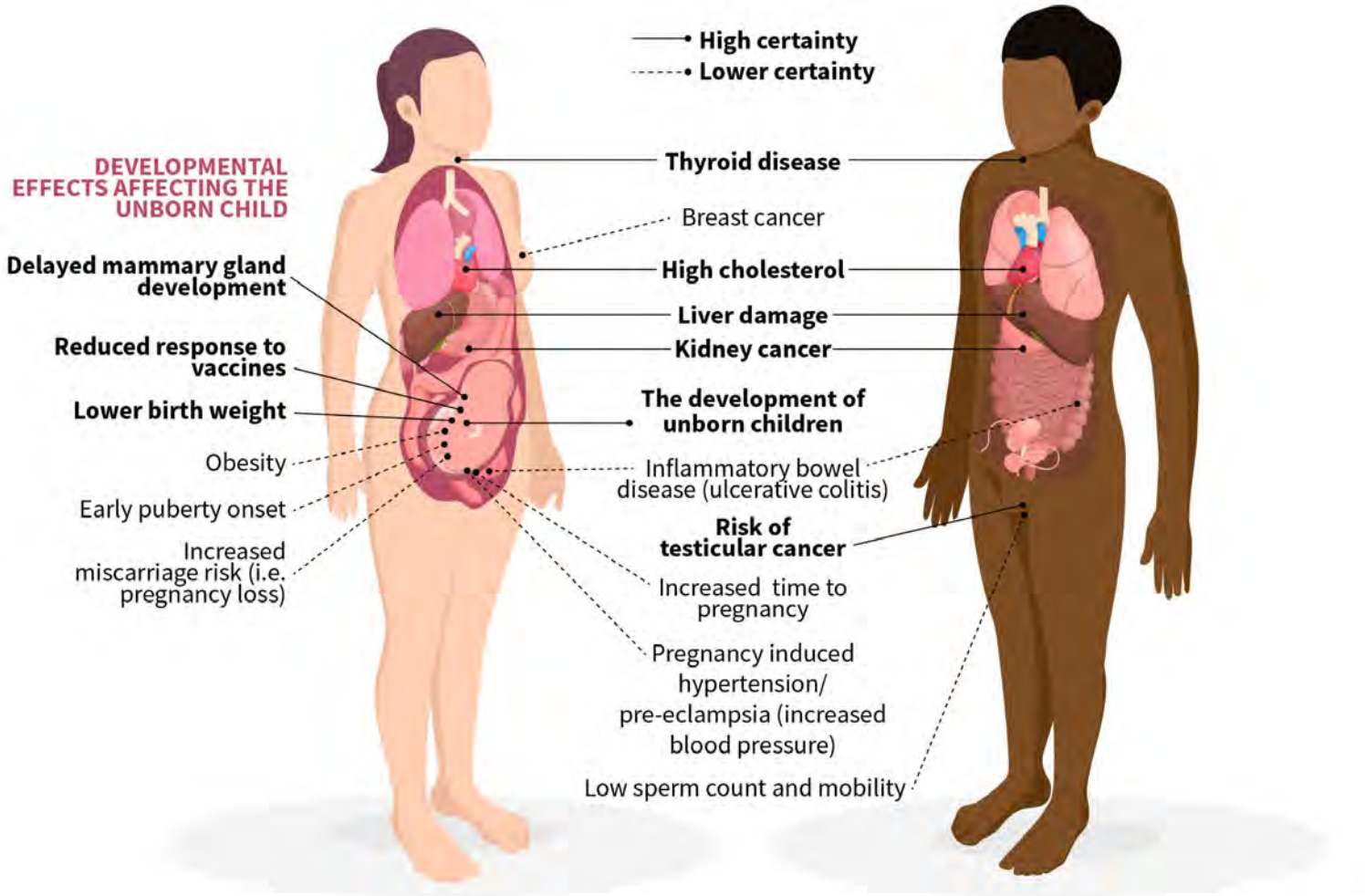
Our PFAS Work

PFAS Health Concerns



….NHANES…98% of US population has PFAS…..

…endocrine disruptors, metabolism disruptors, obesogens….



PFAS are:

- Not readily metabolized
- Bioaccumulate in plasma
- Elimination half-life > years
- Cross placental
- Found in breast milk

https://www.rsc.org/policy-evidence-campaigns/environmental-sustainability/sustainability-reports-surveys-and-campaigns/cleaning-up-uk-drinking-water/

US EPA PFAS Initiatives

2009

Provisional Health Advisory
Developed to assess potential risk from exposure to these chemicals through drinking water
Matrix: Drinking Water

2016

Drinking Water Guidance
Non-enforceable guidance adopted by several states
Matrix: Drinking Water
PFOA: 70 ng/L
PFOS: 70 ng/L

Interim Health Advisory Levels
Identify levels to protect humans from adverse health effects resulting from PFAS exposure
Matrix: Drinking Water
PFOA: 0.004 ng/L
PFOS: 0.02 ng/L
PFBS: 2,000 ng/L
Gen-X: 10 ng/L

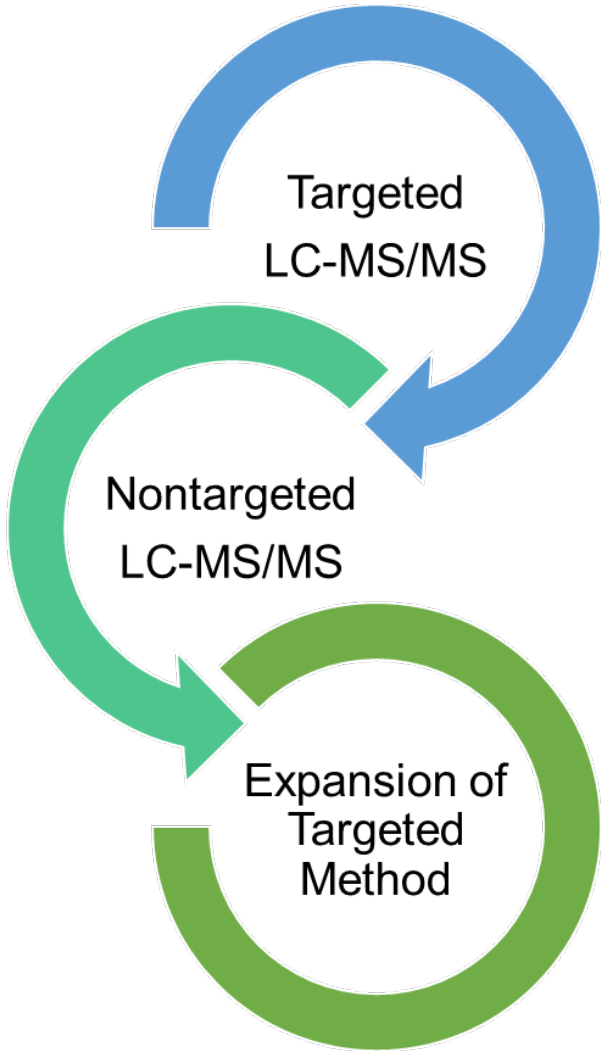
Proposed Maximum Contaminant Level
Enforceable National Primary Drinking Water Regulation. Proposed goal of zero.
Matrix: Drinking Water
PFOA: 4 ng/L
PFOS: 4 ng/L
PFNA, PFHxS, Gen-X: 10 ng/L

PFAS
Agency-wide plan to address PFAS concerns through 2024

Regional Screening Levels
PFAS concentrations developed for Superfund site remediation
Matrices: Tapwater, Residential and Industrial Soil
PFprA, PFBA, PFHxA, PFOA, PFNA, PFUnDA, PFDoDA, PFTetDA, PFODA, PFBS, PFHxS, PFOS, Gen-X

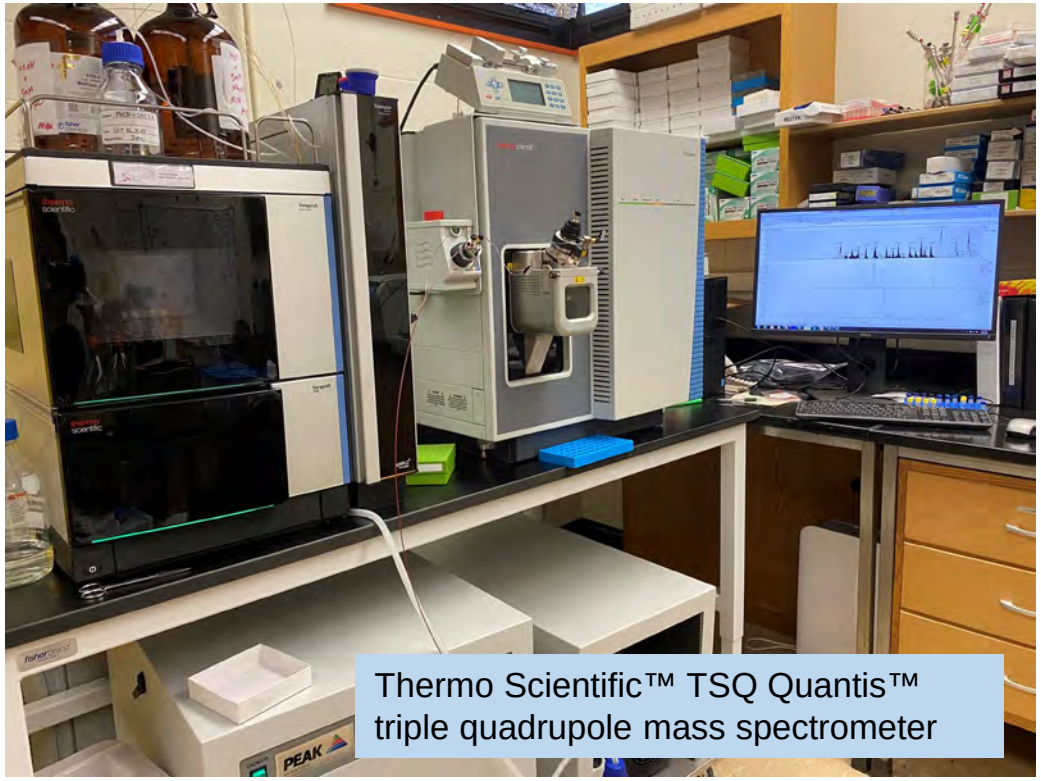
Under current political climate, "wait and see"

Our Analytical Workflows for PFAS



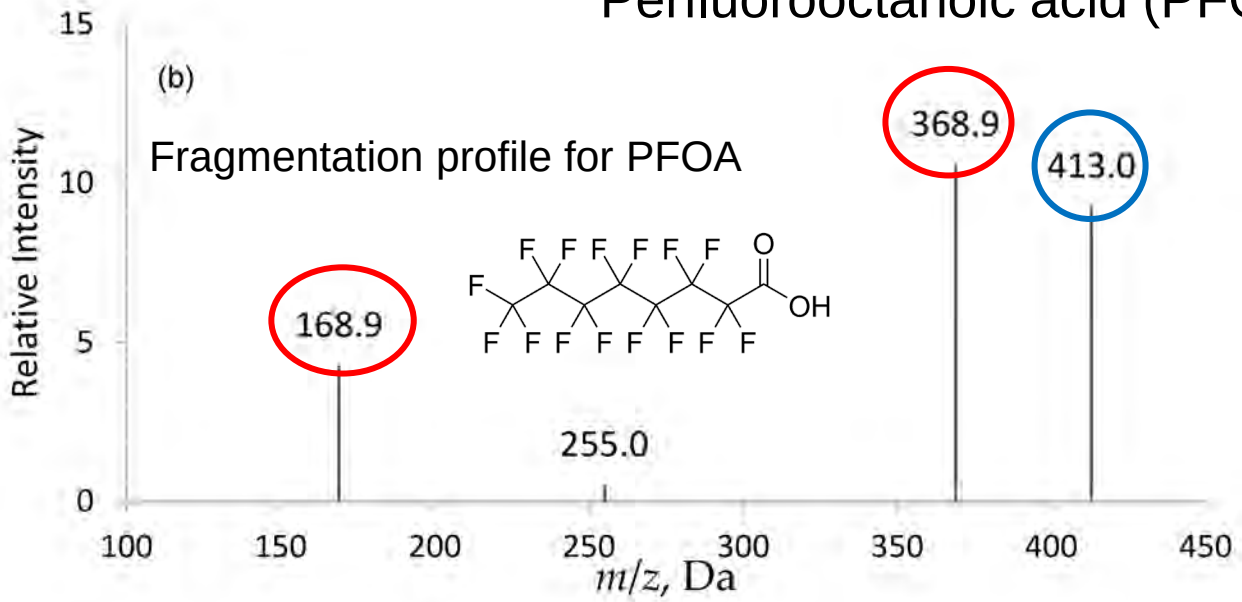
Graduate student Brian Martinez and undergraduate Allison Oldnettle performing solid-phase extraction for PFAS

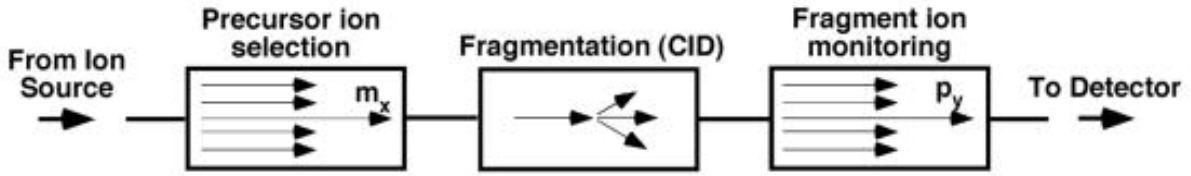
PFAS Measurement: Traditional Workflow



Thermo Scientific™ TSQ Quantis™ triple quadrupole mass spectrometer

Perfluorooctanoic acid (PFOA)





Targeted methods are "hypothesis testing"

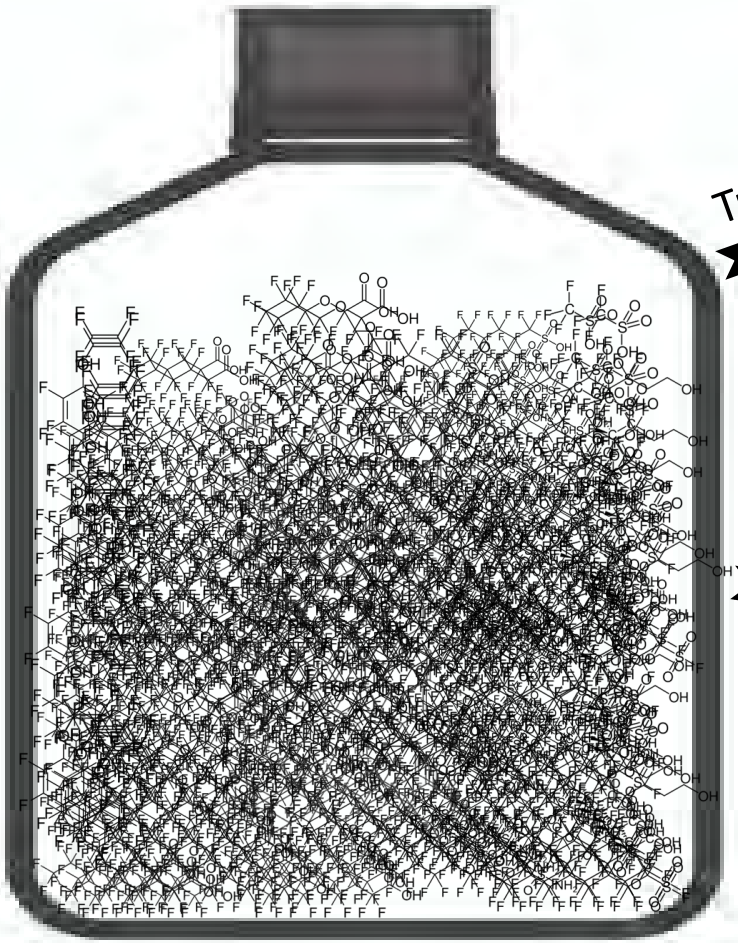
- Validated by standards (EPA methods)
- Quantitative via isotope dilution
- Capable of being routine/robust
- Detection down to low ppt

413.0 ✂ 168.9 Confirm

413.0 ✂ 368.9 Quant

Precursor -> Fragment Transition

PFAS Measurement: New Strategies (Total Fluorine)



Remember >15,000 PFAS

Traditional PFAS Testing

'Targeted (~50-100 PFAS)'

Table 1. Concentrations and Frequencies of Individual PFAS (and Sum, Σ) across the State of Florida[a]

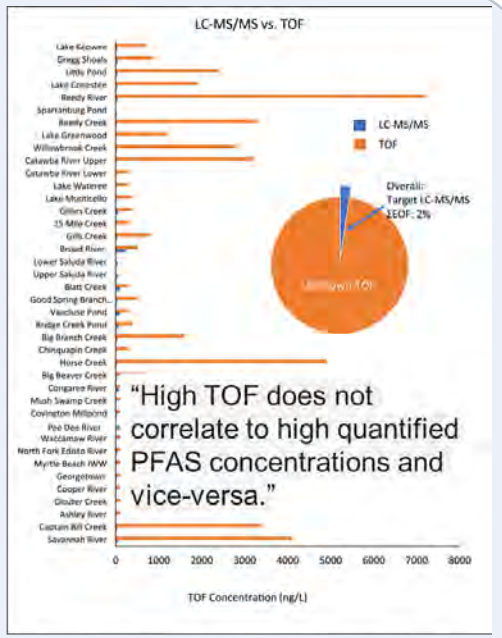
PFAS	frequency detection	frequency quantified	frequency by county	mean (ng/L)	max (ng/L)
PFOA	94%	83%	100%	5	81
PFBS	65%	64%	93%	5	48
PFHxA	61%	61%	82%	6	180
PFNA	54%	39%	96%	2	352
PFOS	53%	48%	91%	10	1135
PFHpA	53%	44%	87%	5	84
PFHxS	50%	17%	94%	17	365
PFDA	33%	16%	90%	2	27
Syn35	24%	1%	75%	6	24
PFHxPA	16%	14%	54%	15	322
FBSA	11%	11%	42%	5	85
Syn32	9%	6%	21%	1	7
PFPrS	5%	3%	51%	5	24
PFUdA	4%	4%	42%	3	114

Calculation #1 = Fluorine with Targeted Assay

Total Fluorine (PIGE)

Upper boundary of fluorine-containing compounds

Calculation #2 = Total Fluorine



Forster, A.L., Geiger, T.C., Pensari, G.D., Justen, P.T. and Richardson, S.D., 2024. Identifying PFAS Hotspots in Surface Waters of South Carolina Using a New Optimized Total Organic Fluorine Method and Target LC-MS/MS. *Water Research*, p.1215/0.

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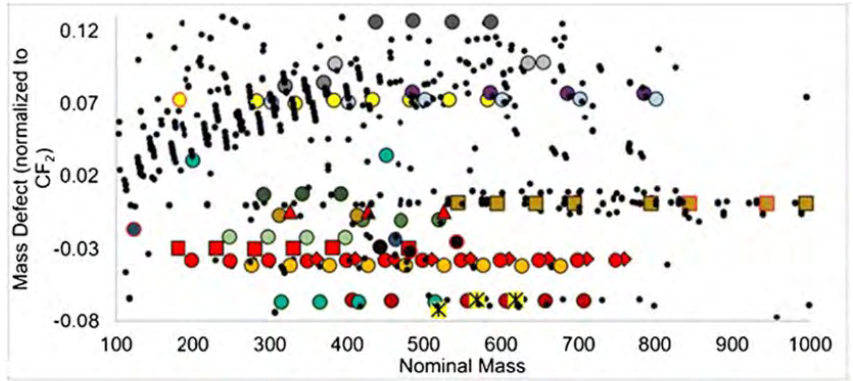
PFAS Measurement: New Strategies (NTA)

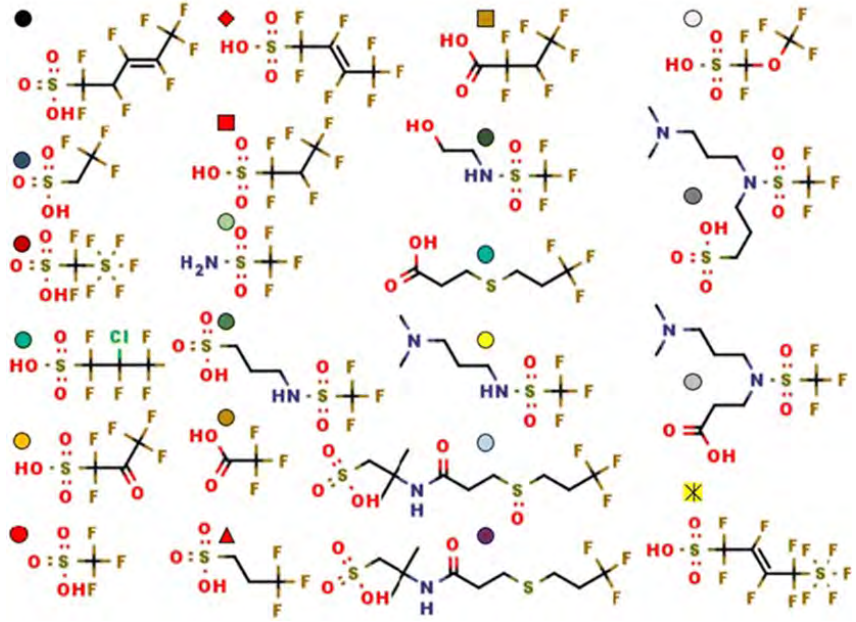
Total TF

Targeted TF

Estimate of how many other PFAS are present and are currently undetected/monitored

Thermo Scientific™ Q Exactive™ Orbitrap™ series mass spectrometer (**high resolution MS**)





Nontargeted Analysis methods are **“hypothesis generating”**

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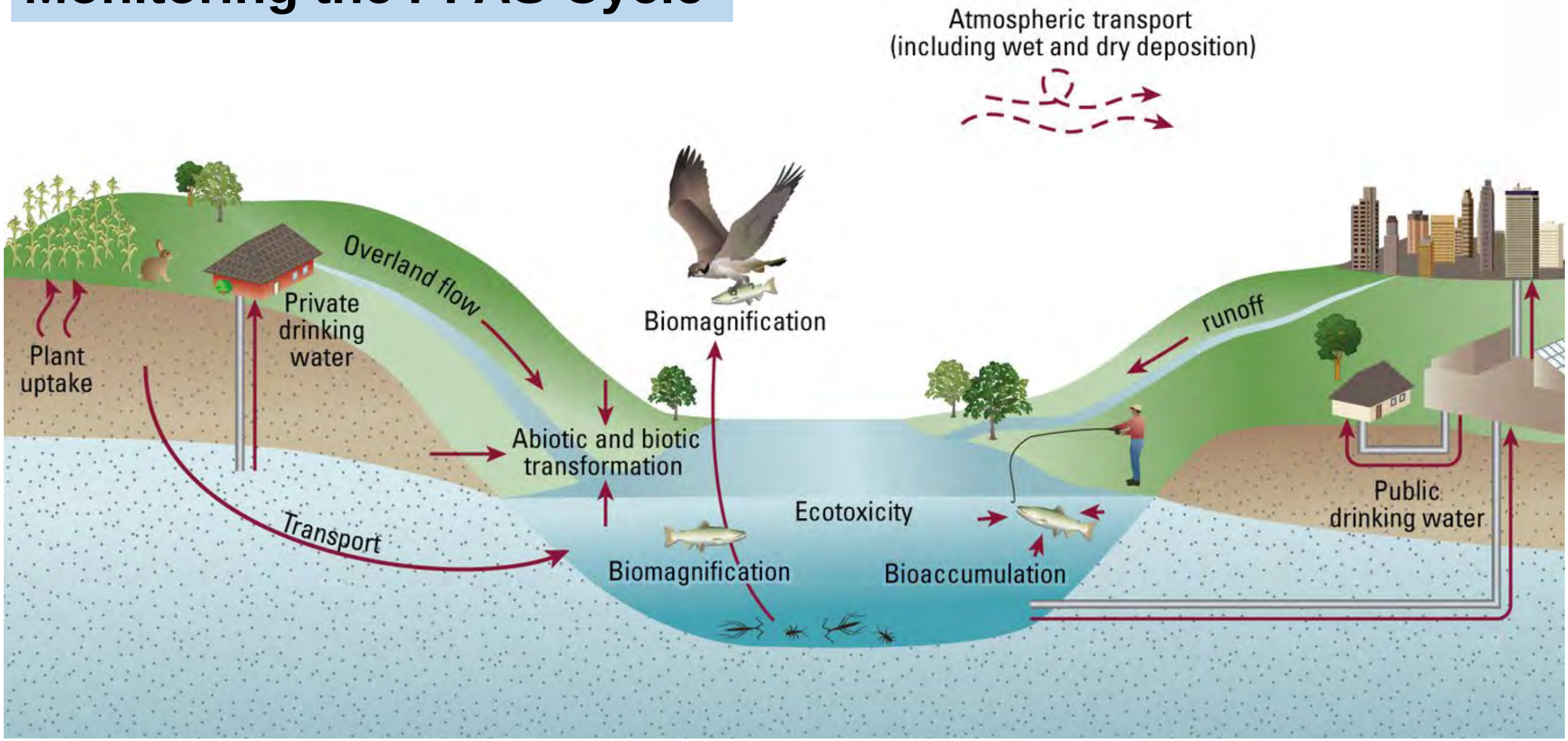
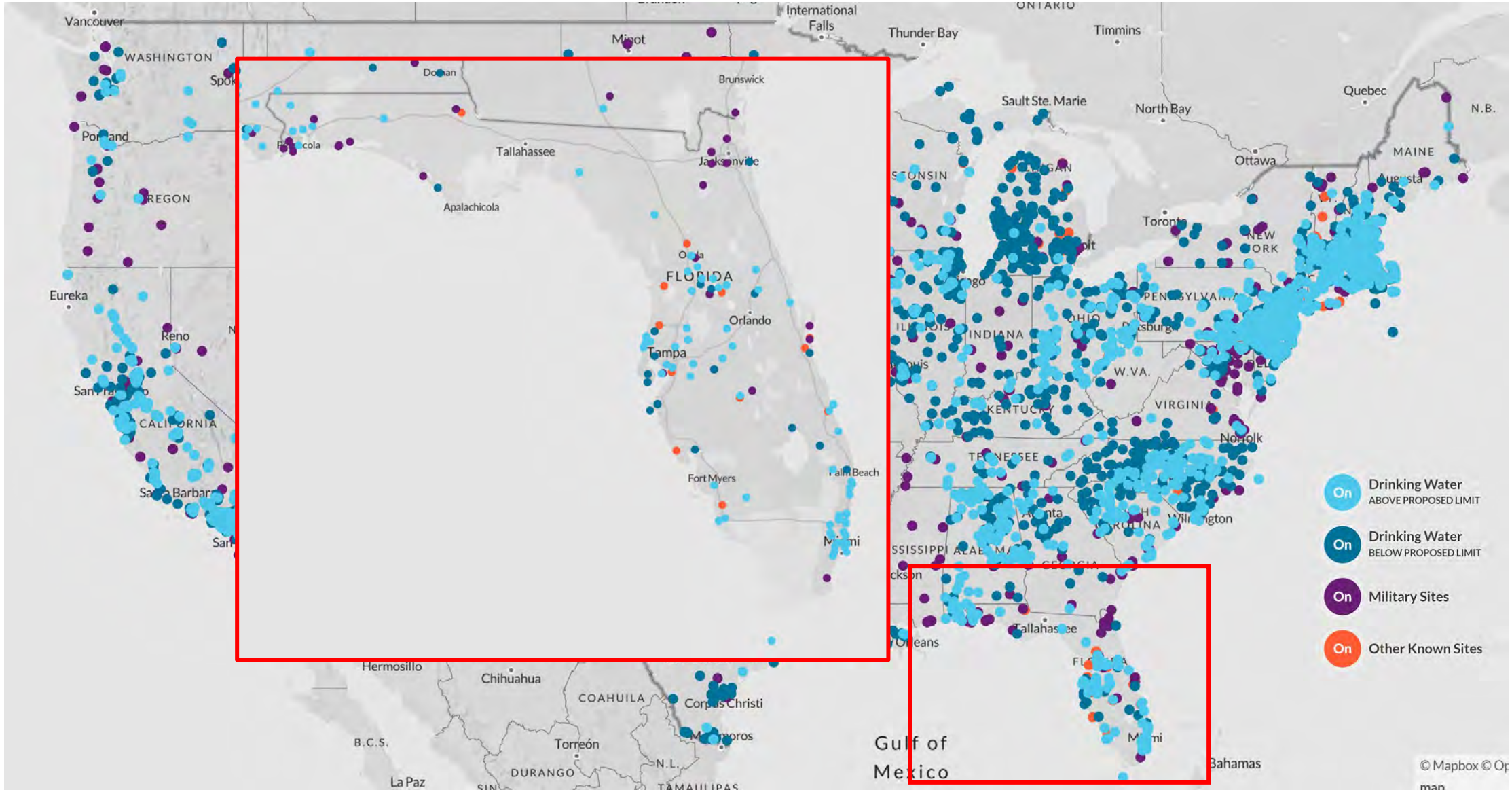
Monitoring the PFAS Cycle



USGS PFAS Website

PFAS Surveillance in Water



Interactive Map: PFAS Contamination Crisis: New Data Show 2,854 Sites in 50 States (ewg.org)

“Crowdsourcing” – PFAS Distribution in Florida Surface Water

Water is important resource in Florida but there is a scarcity of PFAS data

Started with campus funding during pandemic in 2020

Provide PFAS baselines for prospective monitoring and potential hotspots

Get Florida educated on PFAS and create sampling network

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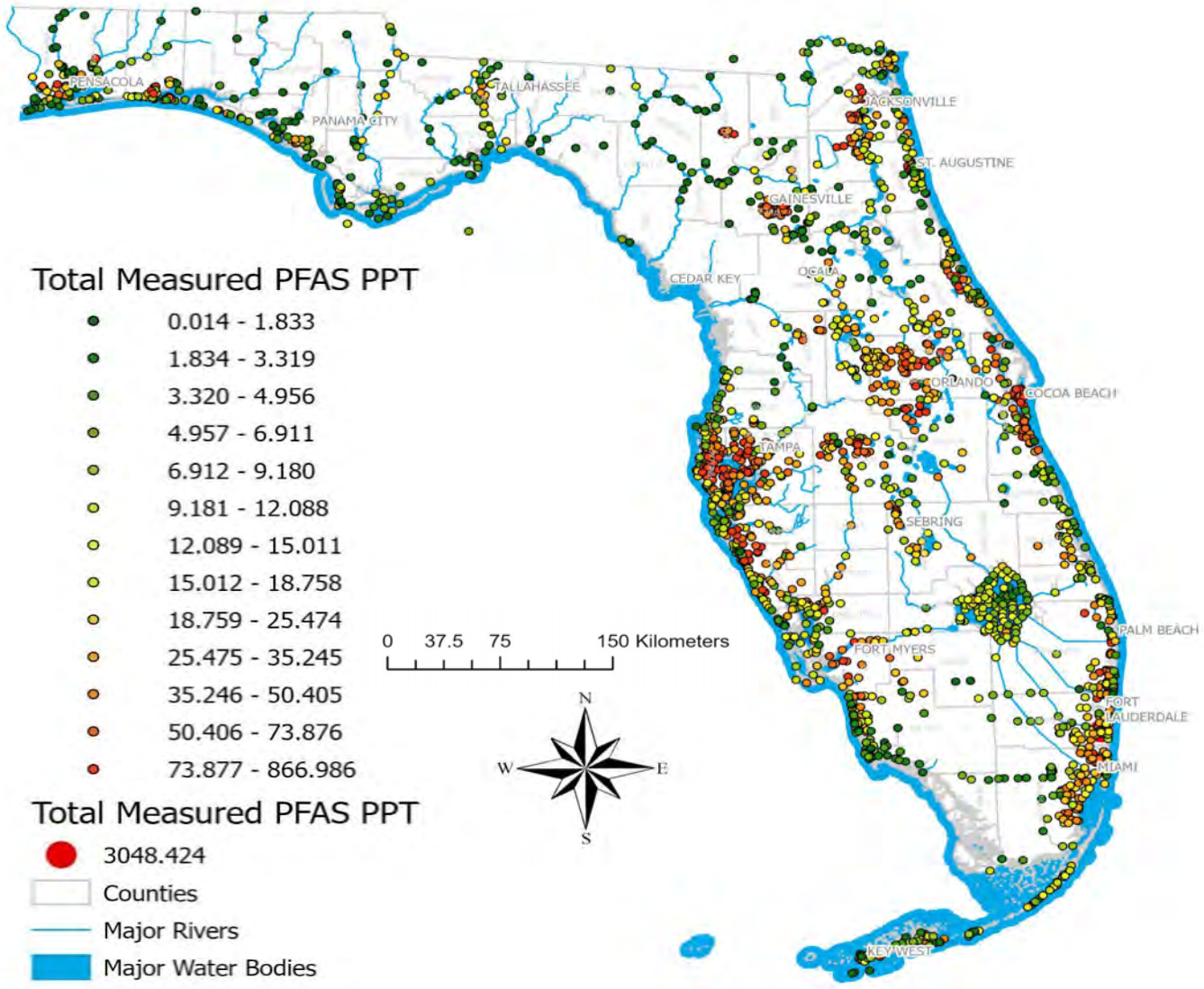
> 130 undergraduate students, > 75 engaged citizen scientists and organizations

>2,323 sites sampled across state from July 2020 to early 2022

PFAS Distribution in Surface Water

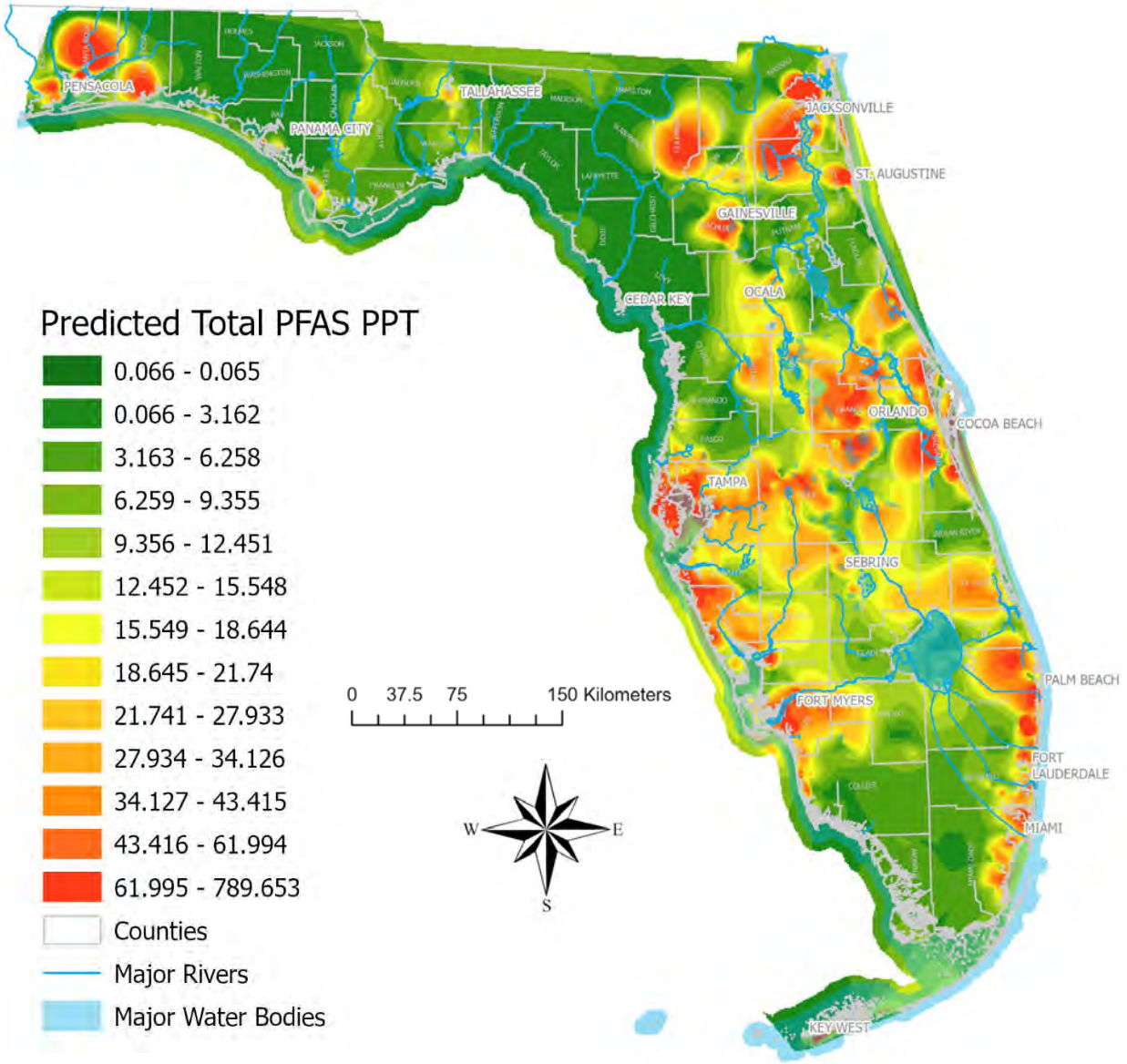


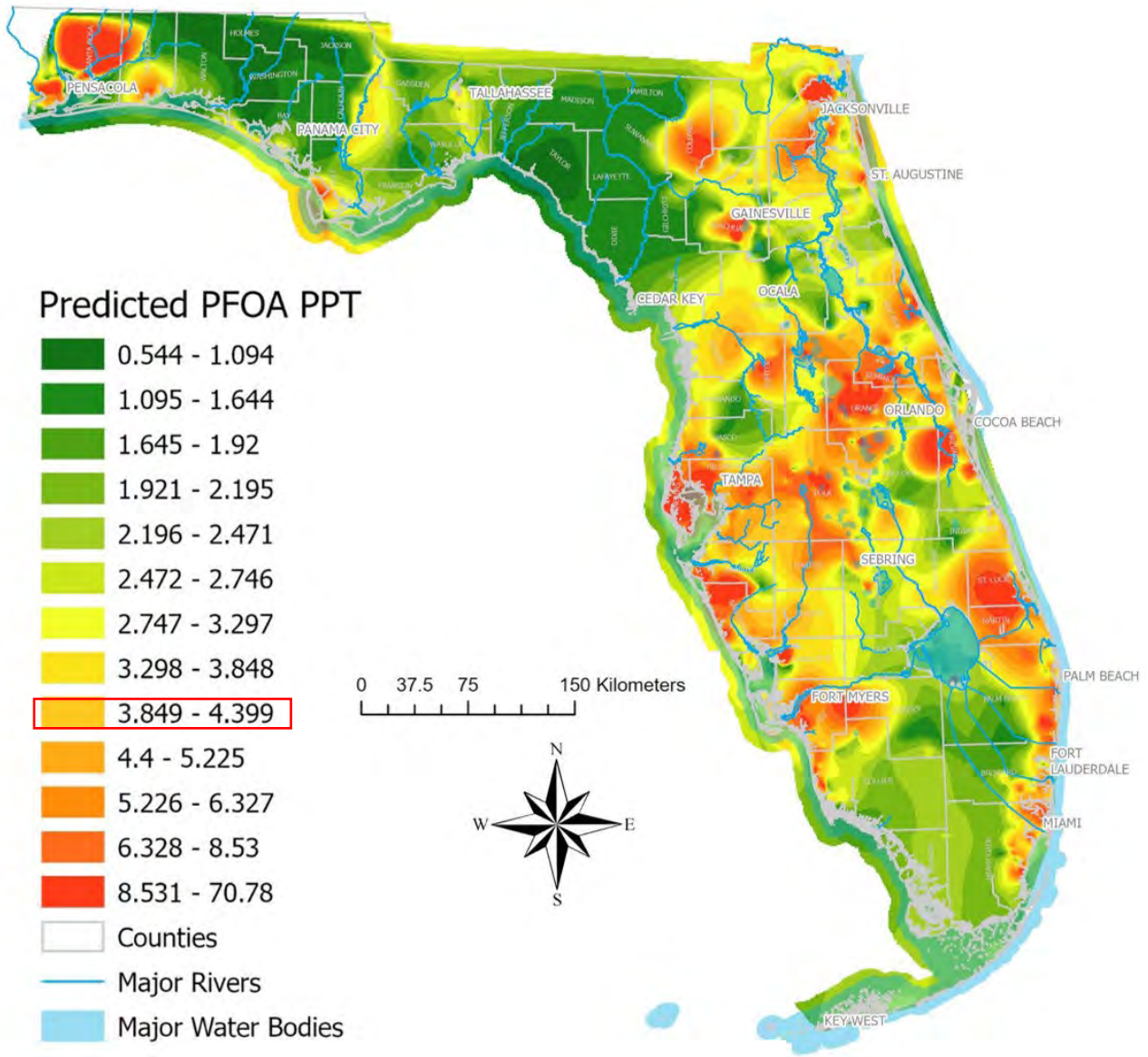
- 92 PFAS monitored
- 33 unique PFAS detected
- ΣPFAS max was 3048 ppt
- ΣPFAS mean was 29 ppt

https://www.bowdenlaboratory.com/

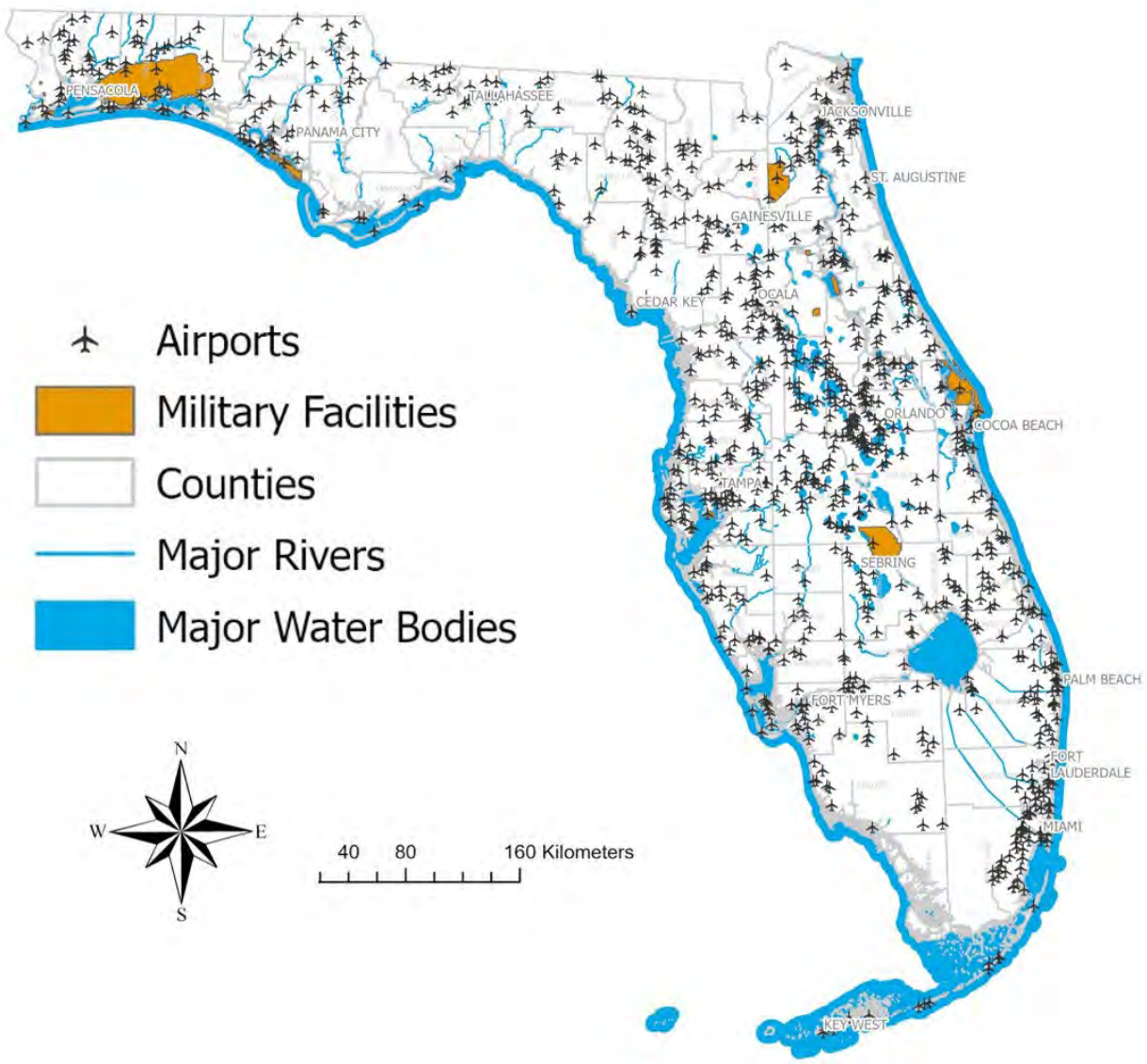
ACS EST Water 2024, 4, 10, 4343–4355

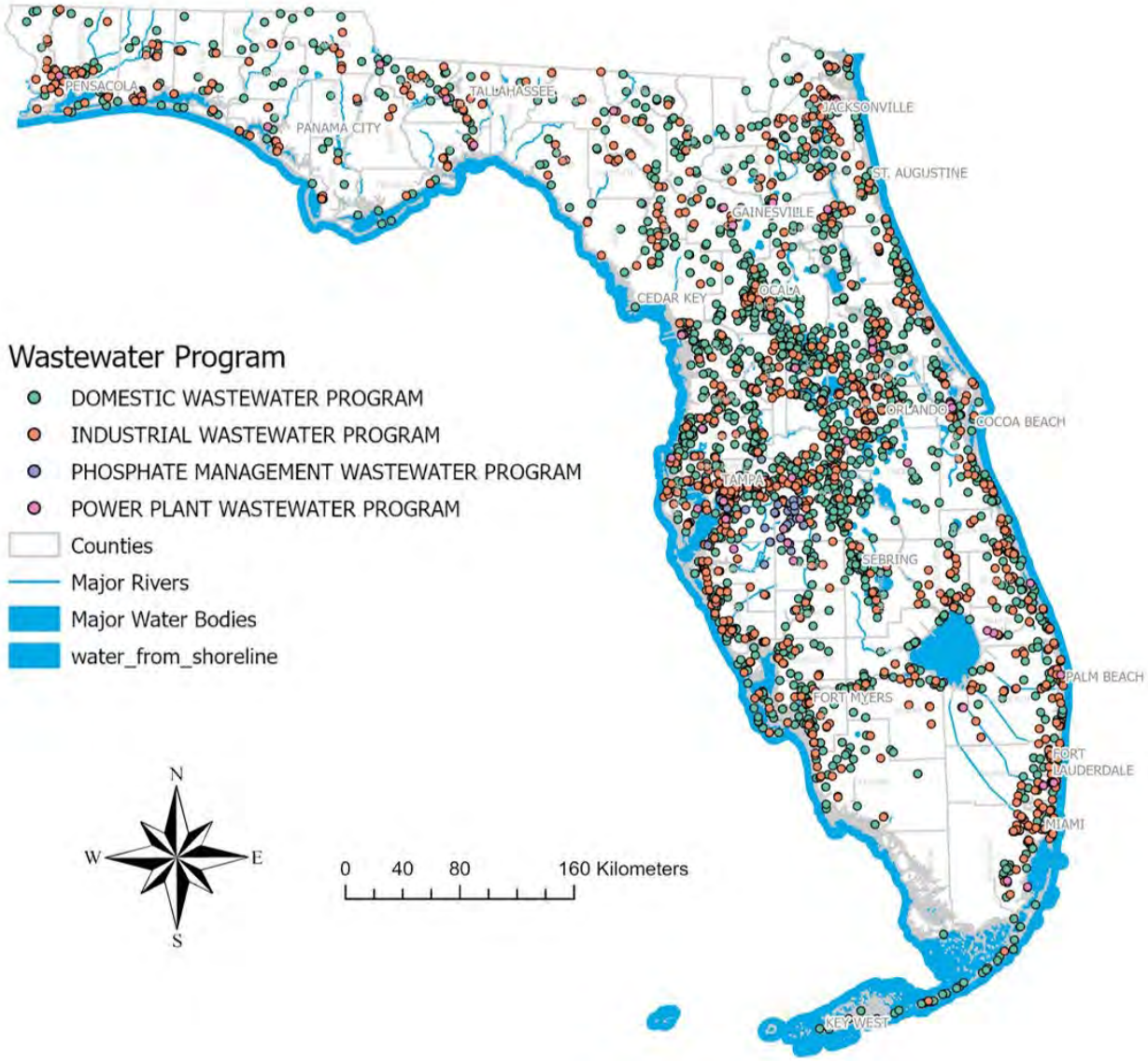
PFAS Prediction Maps for Florida Surface Water



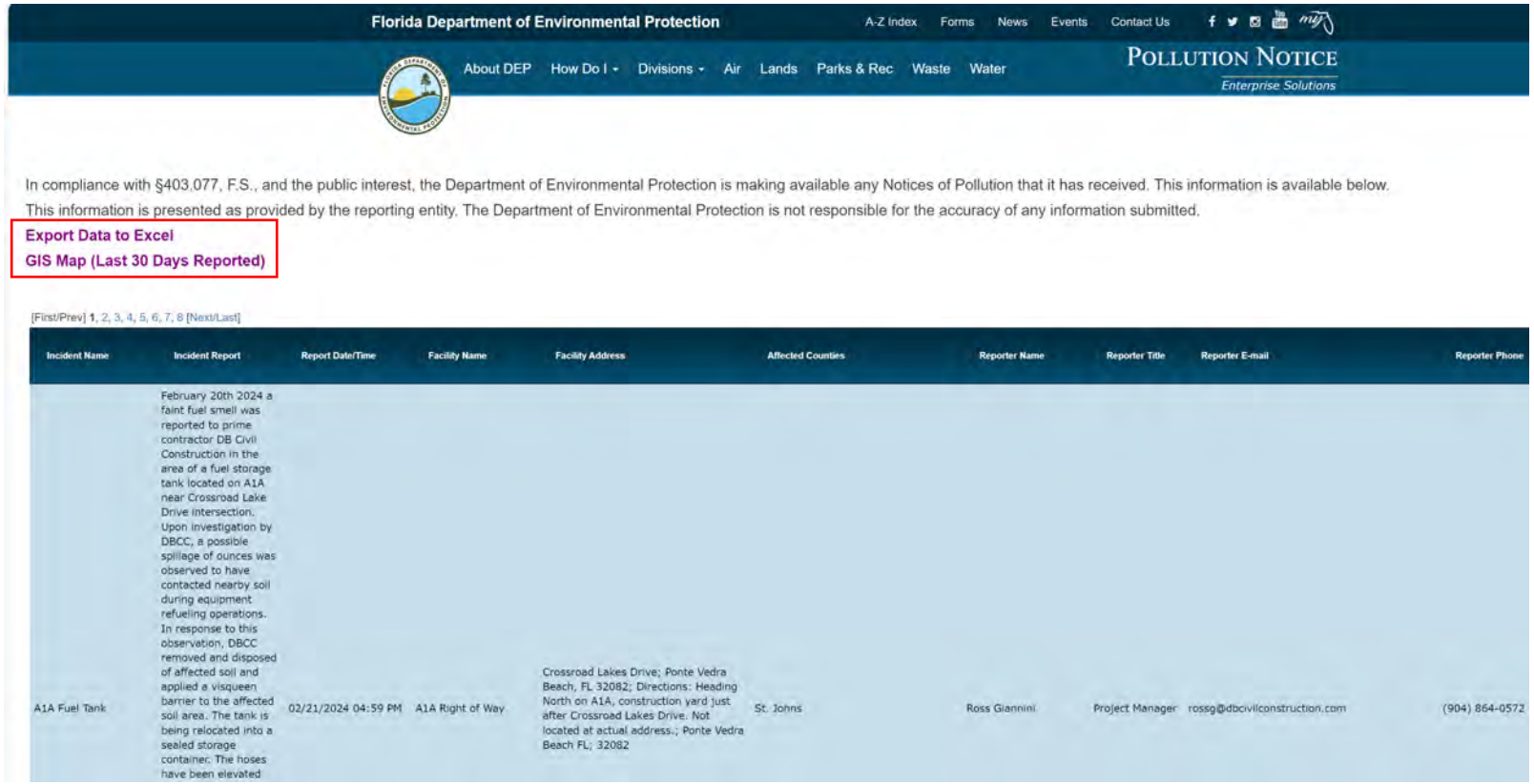


PFAS Sources in Florida Surface Water?





PFAS Sources in Florida Surface Water: Spills



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POLLUTION NOTICE
Enterprise Solutions

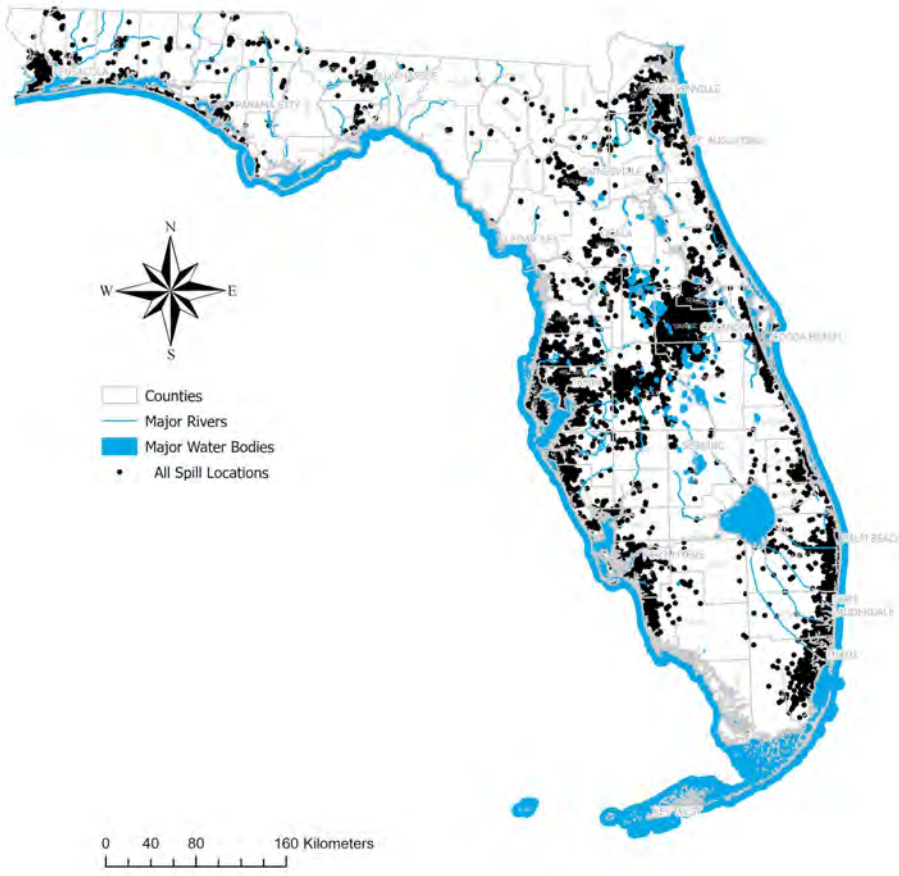
In compliance with §403.077, F.S., and the public interest, the Department of Environmental Protection is making available any Notices of Pollution that it has received. This information is available below.
This information is presented as provided by the reporting entity. The Department of Environmental Protection is not responsible for the accuracy of any information submitted.

Export Data to Excel
GIS Map (Last 30 Days Reported)

[First/Prev] 1, 2, 3, 4, 5, 6, 7, 8 [Next/Last]

Incident Name	Incident Report	Report Date/Time	Facility Name	Facility Address	Affected Counties	Reporter Name	Reporter Title	Reporter E-mail	Reporter Phone
A1A Fuel Tank	February 20th 2024 a faint fuel smell was reported to prime contractor DB Civil Construction in the area of a fuel storage tank located on A1A near Crossroad Lake Drive intersection. Upon investigation by DBCC, a possible spillage of ounces was observed to have contacted nearby soil during equipment refueling operations. In response to this observation, DBCC removed and disposed of affected soil and applied a visqueen barrier to the affected soil area. The tank is being relocated into a sealed storage container. The hoses have been elevated	02/21/2024 04:59 PM	A1A Right of Way	Crossroad Lakes Drive; Ponte Vedra Beach, FL 32082; Directions: Heading North on A1A, construction yard just after Crossroad Lakes Drive. Not located at actual address.; Ponte Vedra Beach FL; 32082	St. Johns	Ross Giannini	Project Manager	rossg@dbcivilconstruction.com	(904) 864-0572

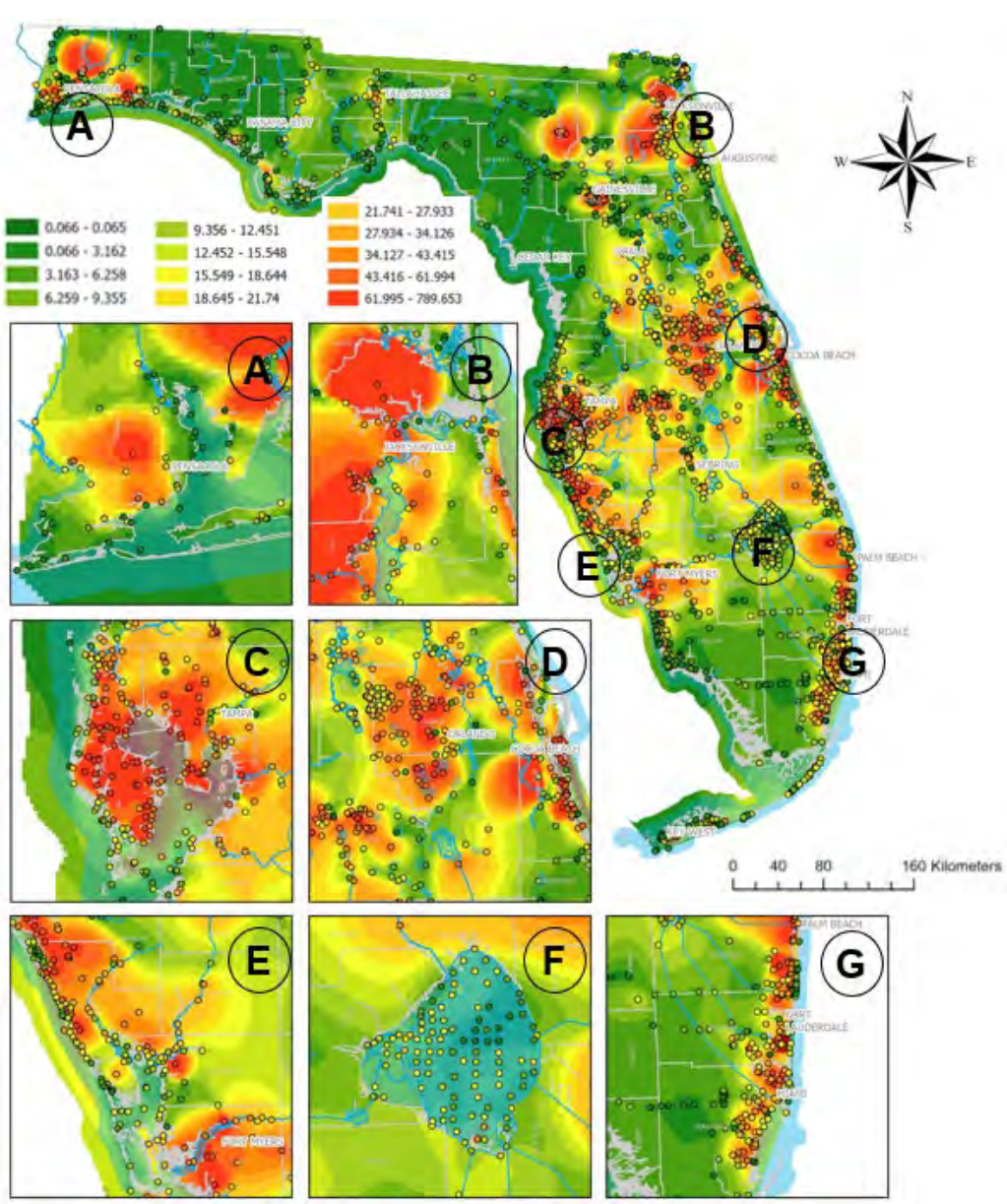
All spill locations (n = 10,959)

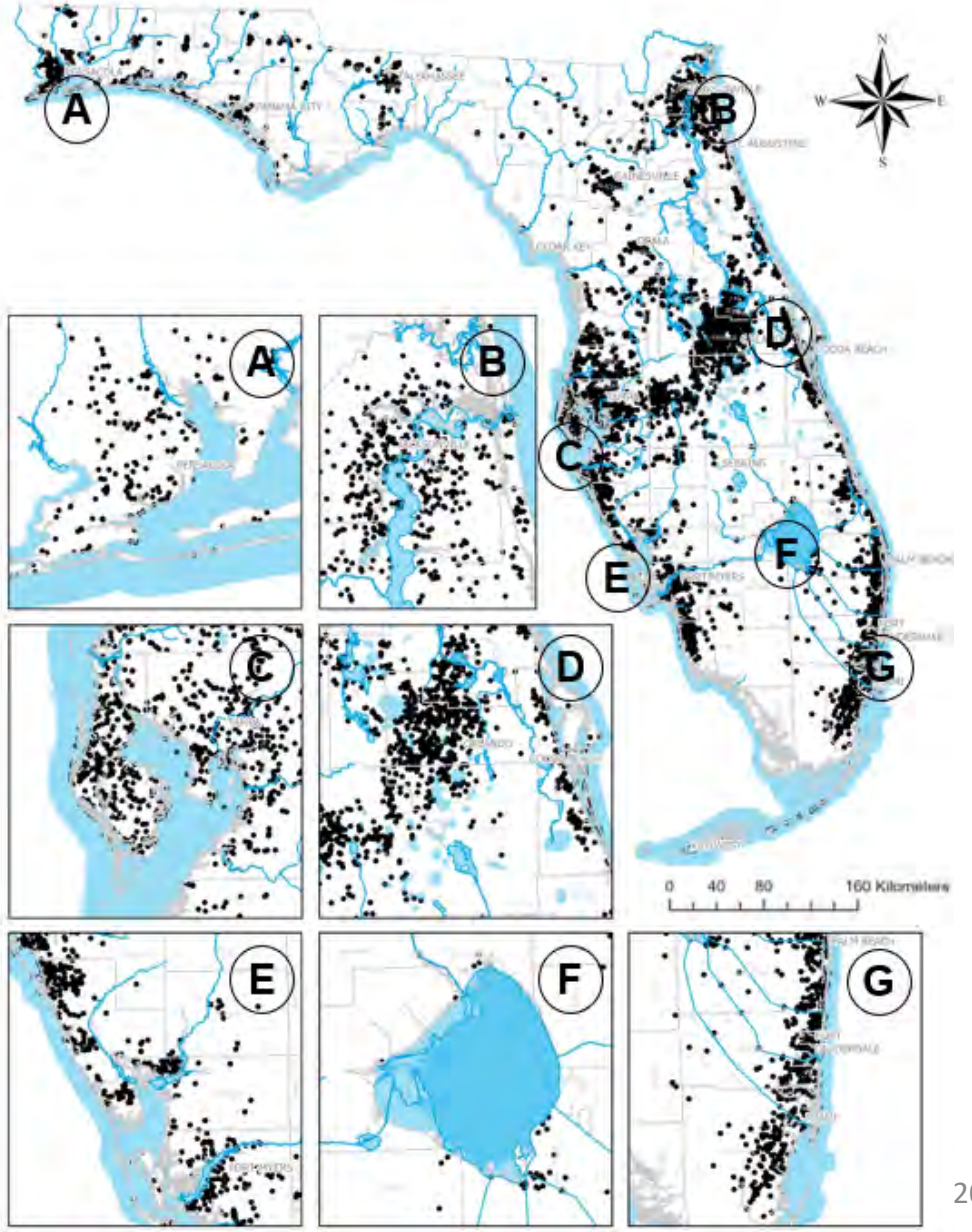


Reporting 2017-2022
7,395 Spills
1.4 billion gallons

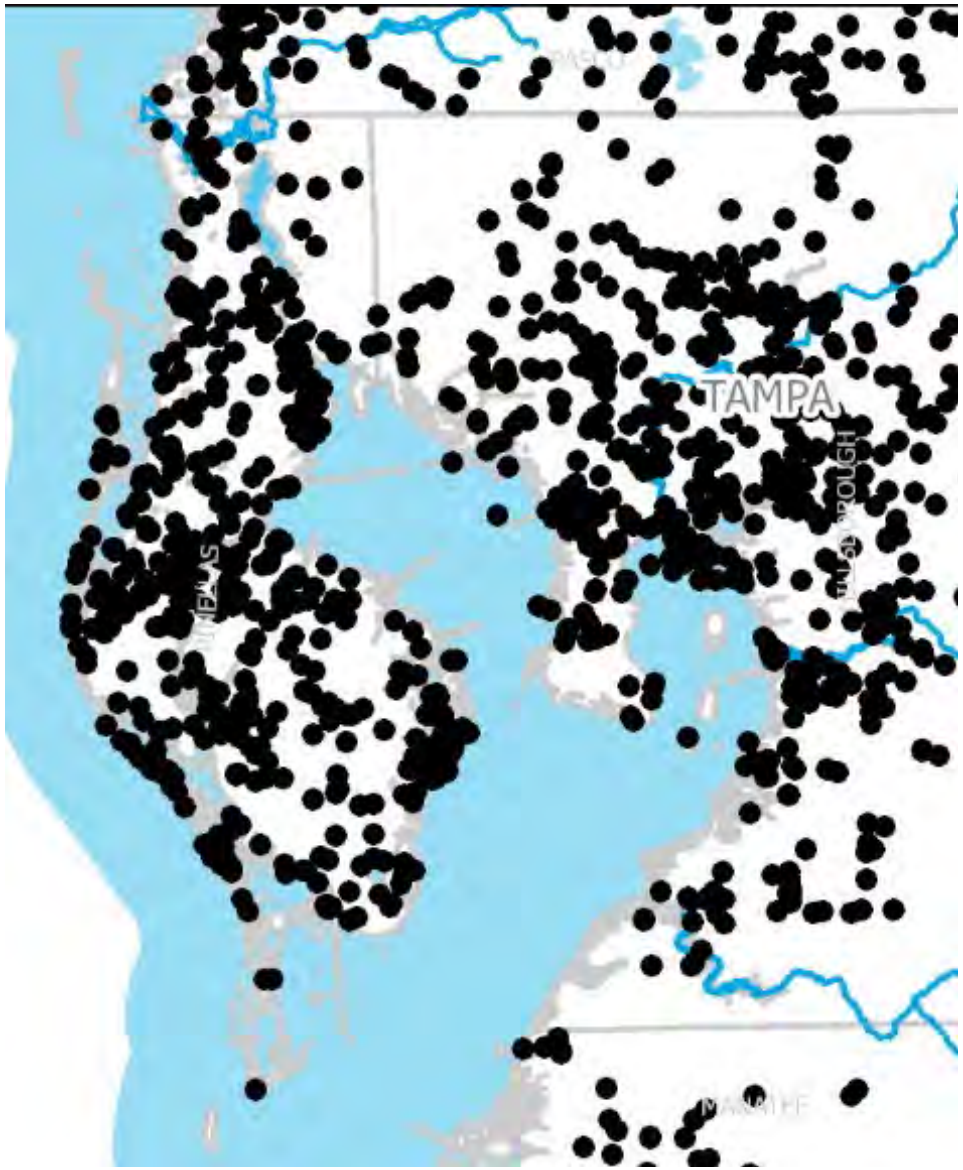
https://prodenv.dep.state.fl.us/DepPNP/reports/viewIncidentDetails?page=1

PFAS Sources in Florida Surface Water: Spills?

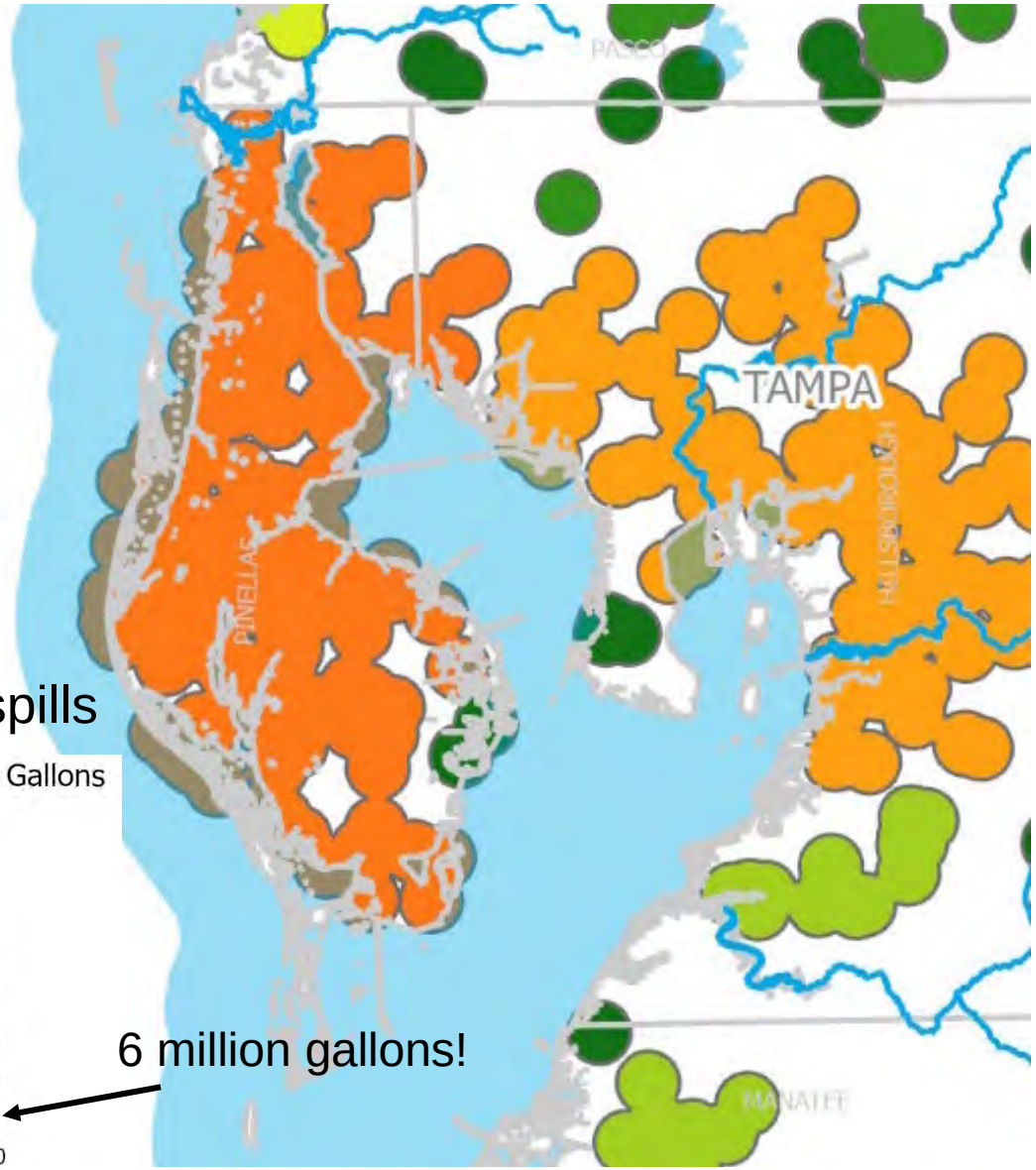




PFAS Sources in Florida Water: Raw Sewage



All spills



Raw sewage spills

Sum All Raw Sewage in Gallons

- 10.00 - 27000.00
- 27000.01 - 80218.00
- 80218.01 - 167579.00
- 167579.01 - 343945.00
- 343945.01 - 598650.00
- 598650.01 - 1055350.00
- 1055350.01 - 1598919.00
- 1598919.01 - 3717000.00
- 3717000.01 - 6058314.00
- 6058314.01 - 73988500.00

6 million gallons!

Results – PFOA and PFOS Mass Loading

Category	Units	Influent	Effluent	Wet sludge	Total
Spill volume 2017- 2022	Gallons	445,000,000	970,000,000	2,300,000	1,417,300,000
Spill volume post study	Gallons	273,000,000	30,000,000	700,000	303,700,000
Concentration PFOA[a]	ng/L	11	8.4	1,200	
Concentration PFOS[a]	ng/L	35	31.8	11,700	
Mass of PFOA released 2017 - 2022	g	18.5	30.8	10.4	59.7
Mass of PFOA released post study	g	11.4	1.0	3.2	15.5
Mass of PFOS released 2017 - 2022	g	59.0	116.8	101.4	277.2
Mass of PFOS released post study	g	36.2	3.6	30.9	70.7

[a]Concentrations obtained from historical meta-analysis of PFAS in waste (Thompson et al. 2022)

Data Dissemination

www.bowdenlaboratory.com
https://www.bowdenlaboratory.com/florida-surface-water.html

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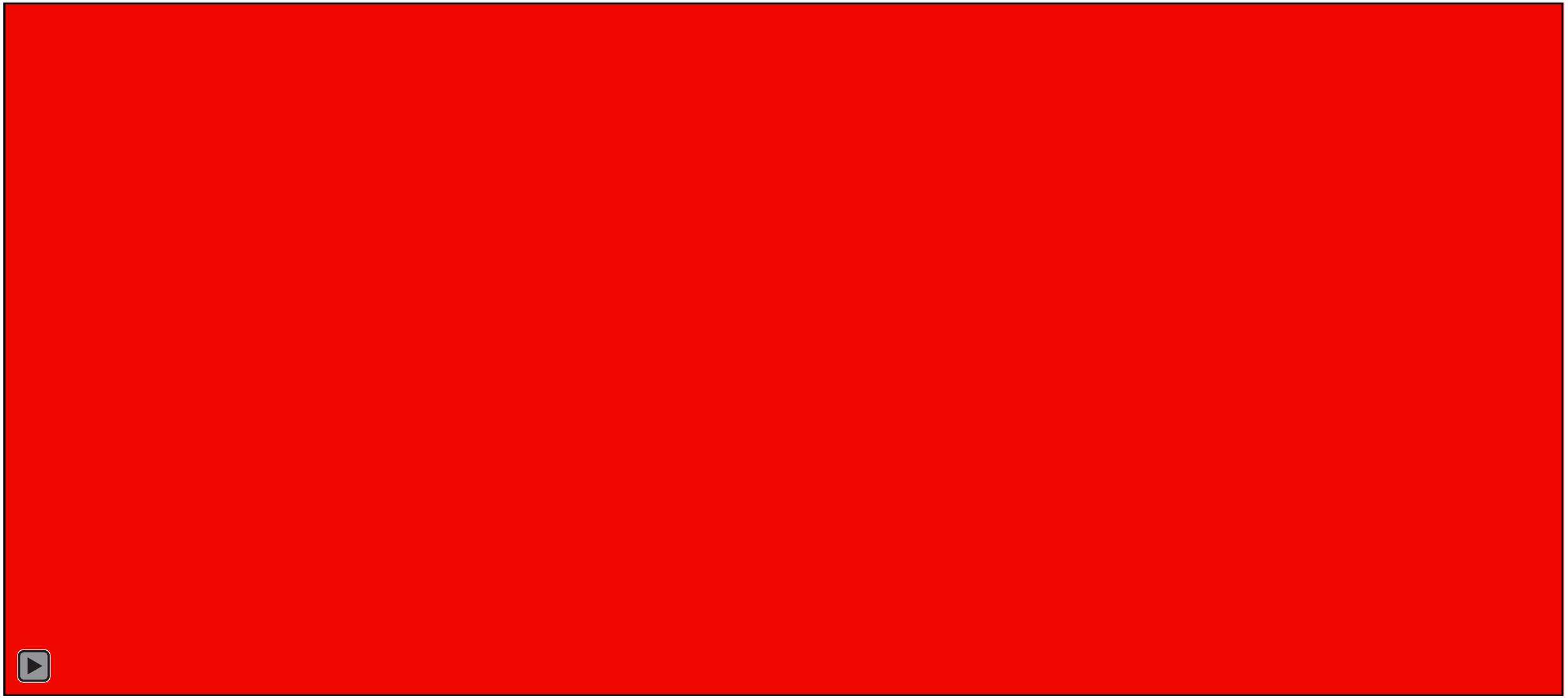
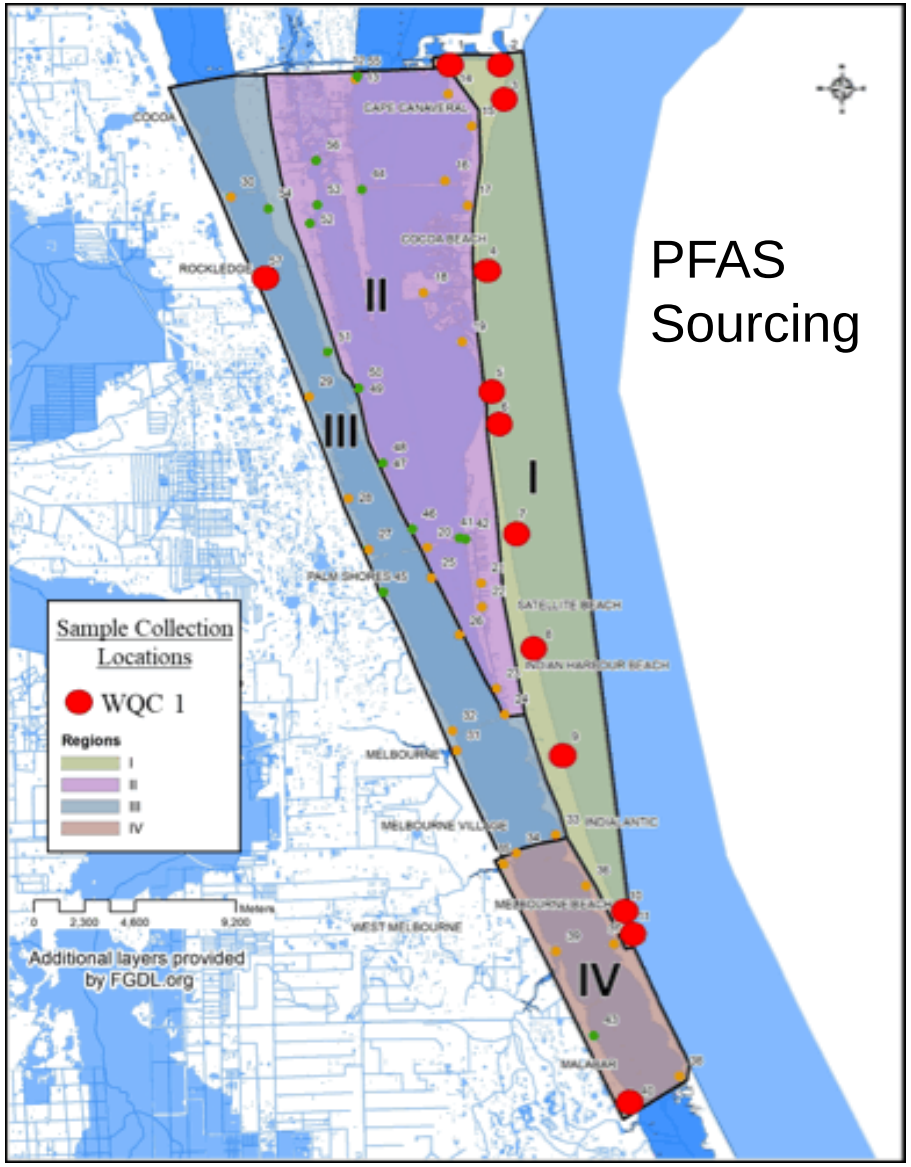
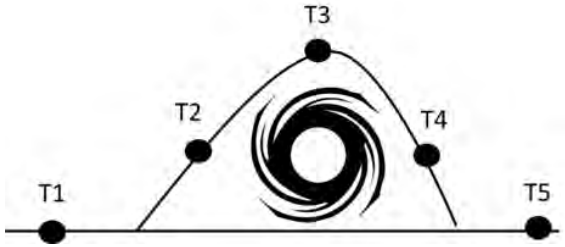


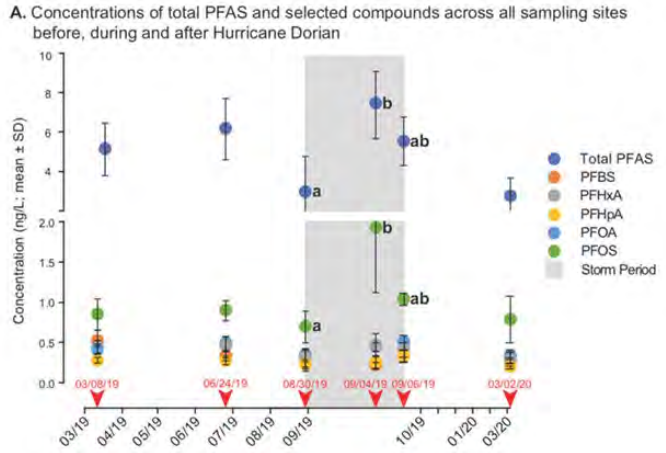
PFAS: Other Projects



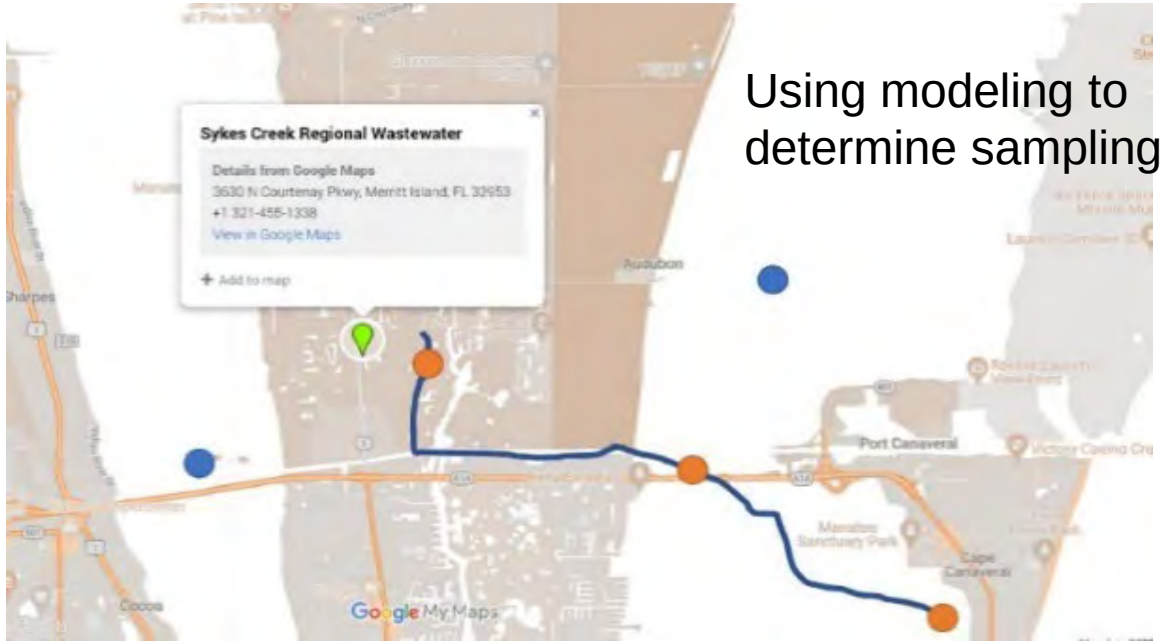
Chemosphere. 2022 Aug 1;301:134478.

Tracking PFAS with large episodic weather events





Environmental Research. 2022 May 15;208:112635.



Using modeling to determine sampling sites

Figure 5. *Sampling locations at a suspected site with model trajectory. Orange=high PFAS, blue=low PFAS*

PFAS in Florida Springs

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

Short Communication

Have per- and polyfluoroalkyl substances (PFAS) infiltrated Florida's freshwater springs?

Mackenzie M. Holden [a], Alina Timshina [b], Qaim Mehdi [c], Lindsey Aman Cromwell [d], Todd Osborne [e], Joe Aufmuth [f], John A. Bowden [b,c,g,*]

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HIGHLIGHTS

- To the best of our knowledge, this is the first comprehensive study highlighting PFAS in Florida's springs.
- PFBS was the most detected PFAS across all springs.
- The three most contaminated springs were all within a 10-mile radius in Deltona, Florida.
- PFAS were detected in both the spring vents and runs
- Seven sites exceeded the EPA's Drinking Water Maximum Contaminant Level for either PFOA, ∑PFOS, or both.

GRAPHICAL ABSTRACT

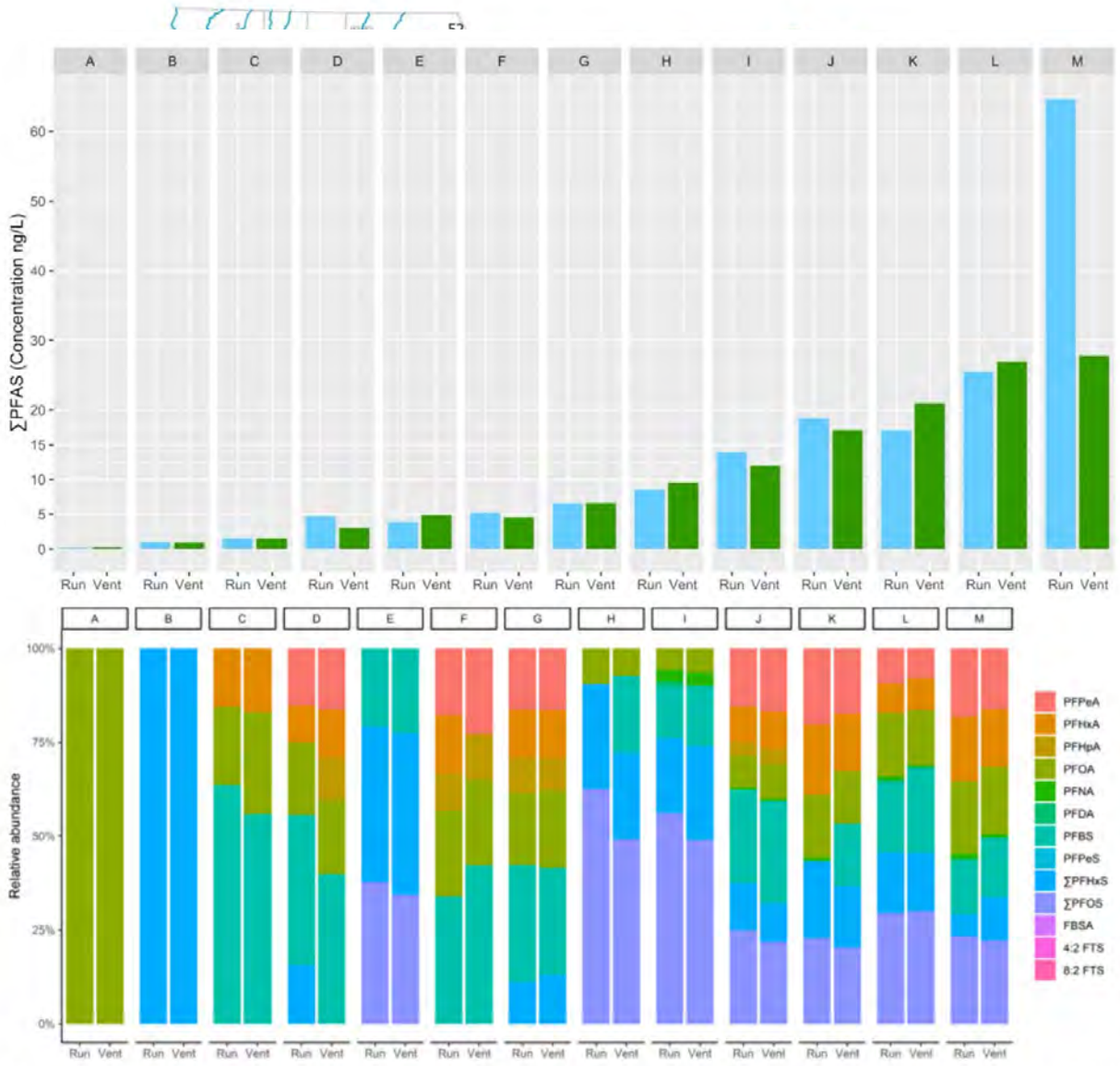
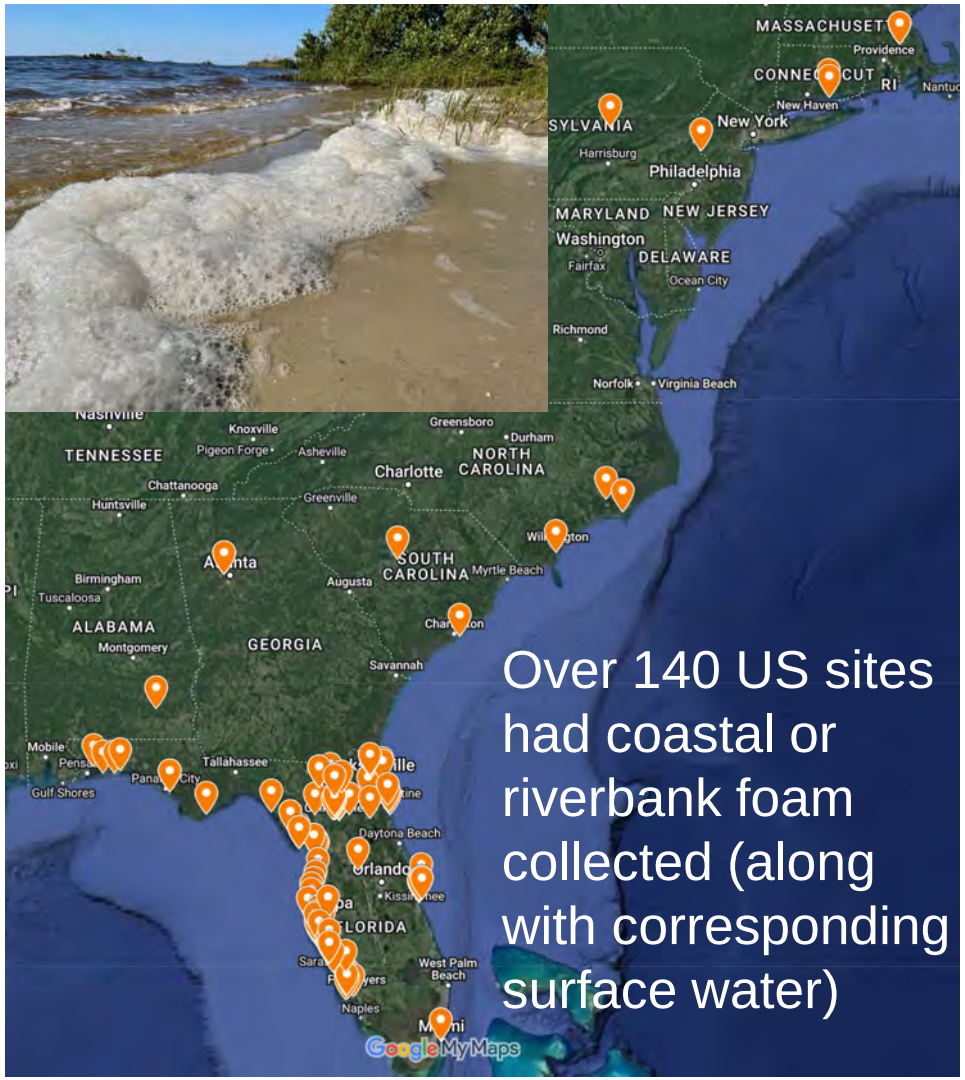


Fig. 2. Sum PFAS concentrations of vent and run samples for sites in which both samples had quantifiable PFAS, as well as relative abundances of different PFAS in each sample.
A: Gainer Spring B: Blue Hole Spring C: Ginnie Spring D: Devil's Eye Spring (Near Ginnie) E: Devil's Eye Spring (Ichetucknee) F: Gilchrist Main Spring G: Naked Spring H: DeLeon Spring I: Poe Spring J: Weeki Wachee Spring K: Gemini Spring L: Volusia Blue Spring M: Green Spring.

Foam in Fresh and Salt Waters



Over 140 US sites had coastal or riverbank foam collected (along with corresponding surface water)

in preparation…

The range of ΣPFAS in foam was between 30x to 1000x higher in comparison to adjacent surface water

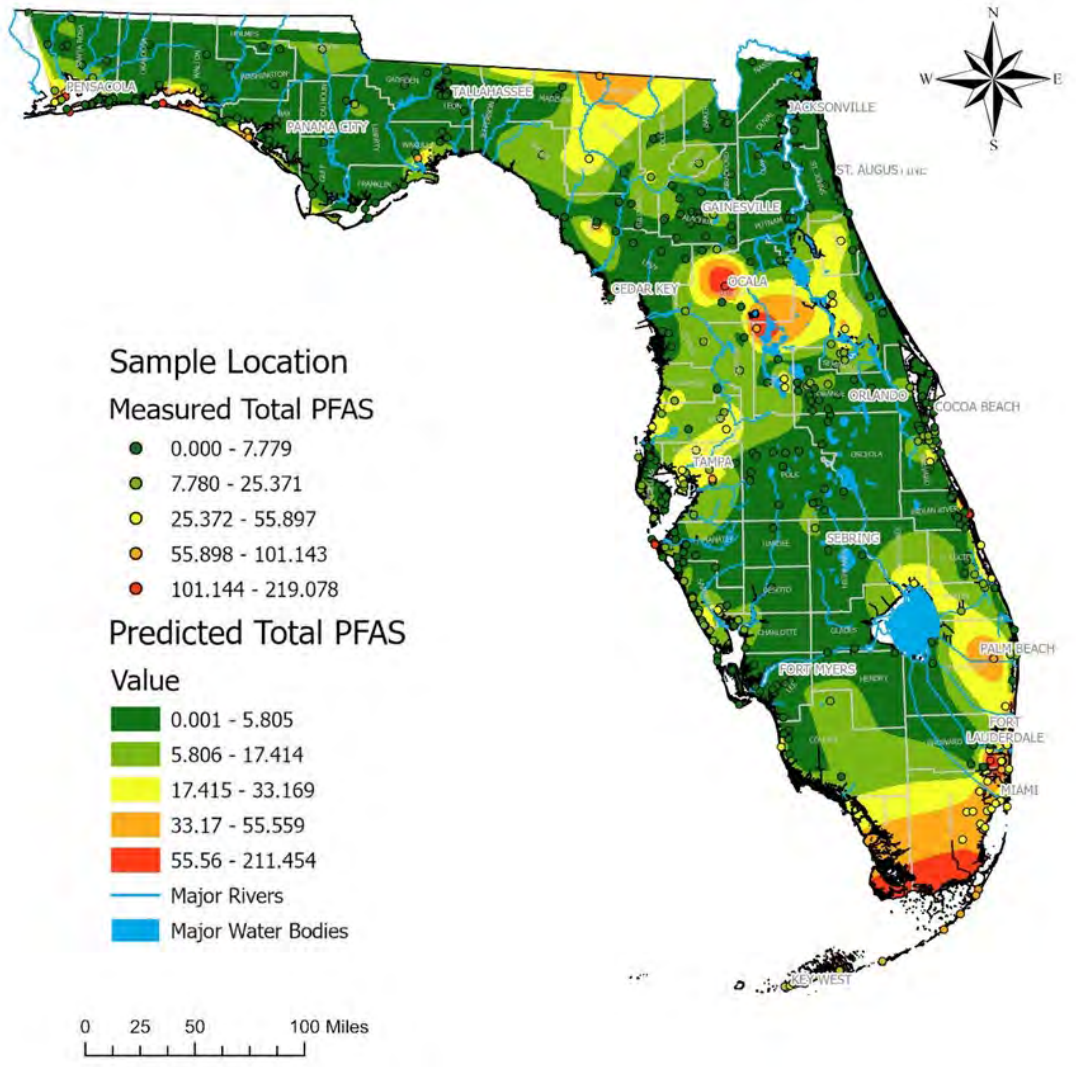
Highest ΣPFAS was 100 ppb, with most ranging from 5 ppb to 50 ppb in foam

“Crowdsourcing” – PFAS in Florida Drinking Water

As public awareness increases in FL, so does interest to test Florida drinking water

Started late 2022, sampled >450 taps in state of Florida with sampling network

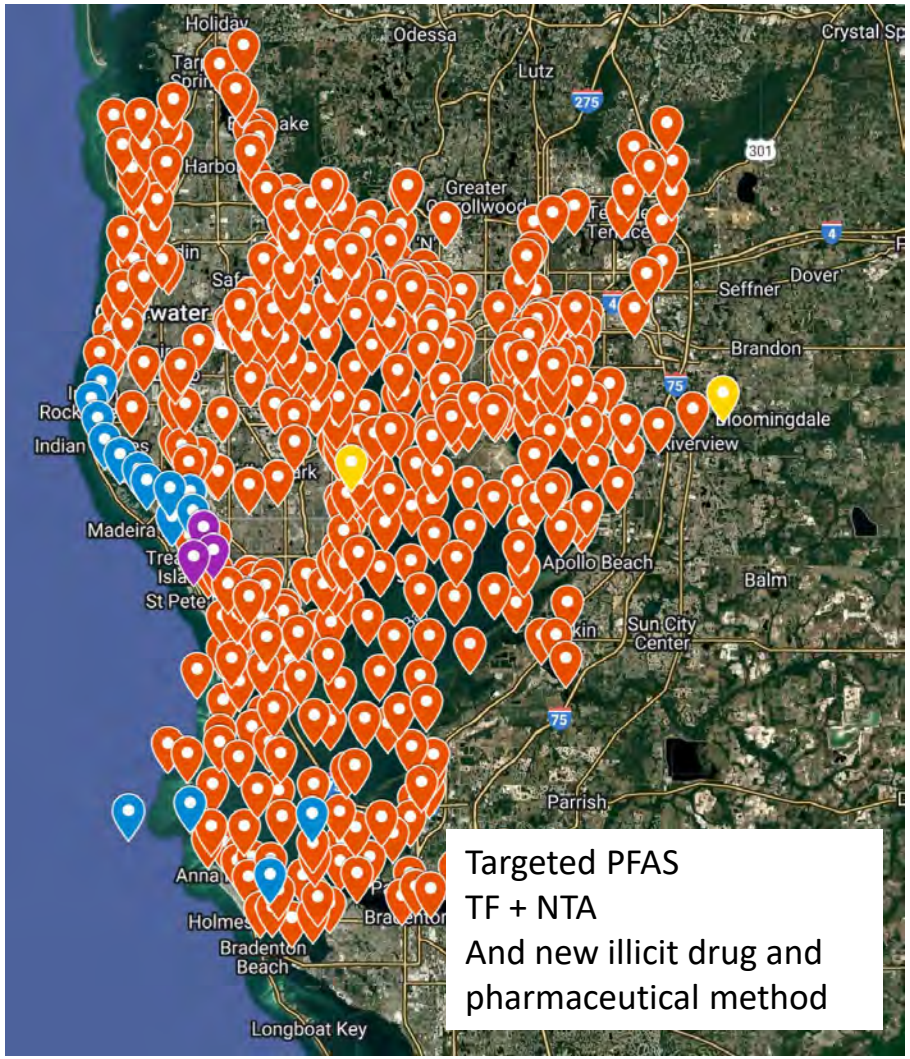
At least one in every county (n=67), from city water, well, and bottled water sources



Sci Total Environ. 2024, 926:171932

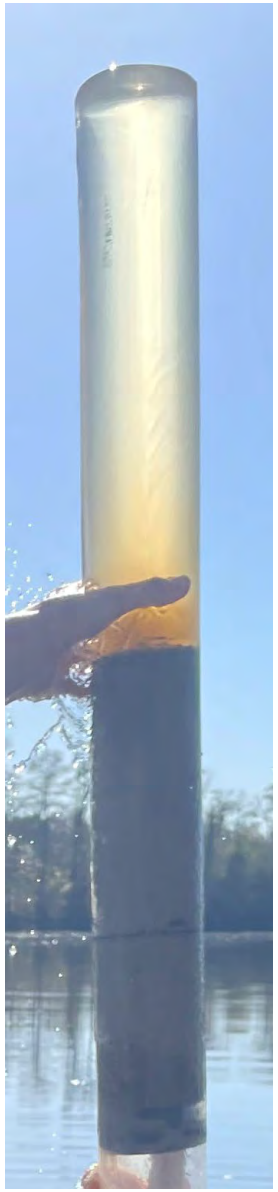
What's next?

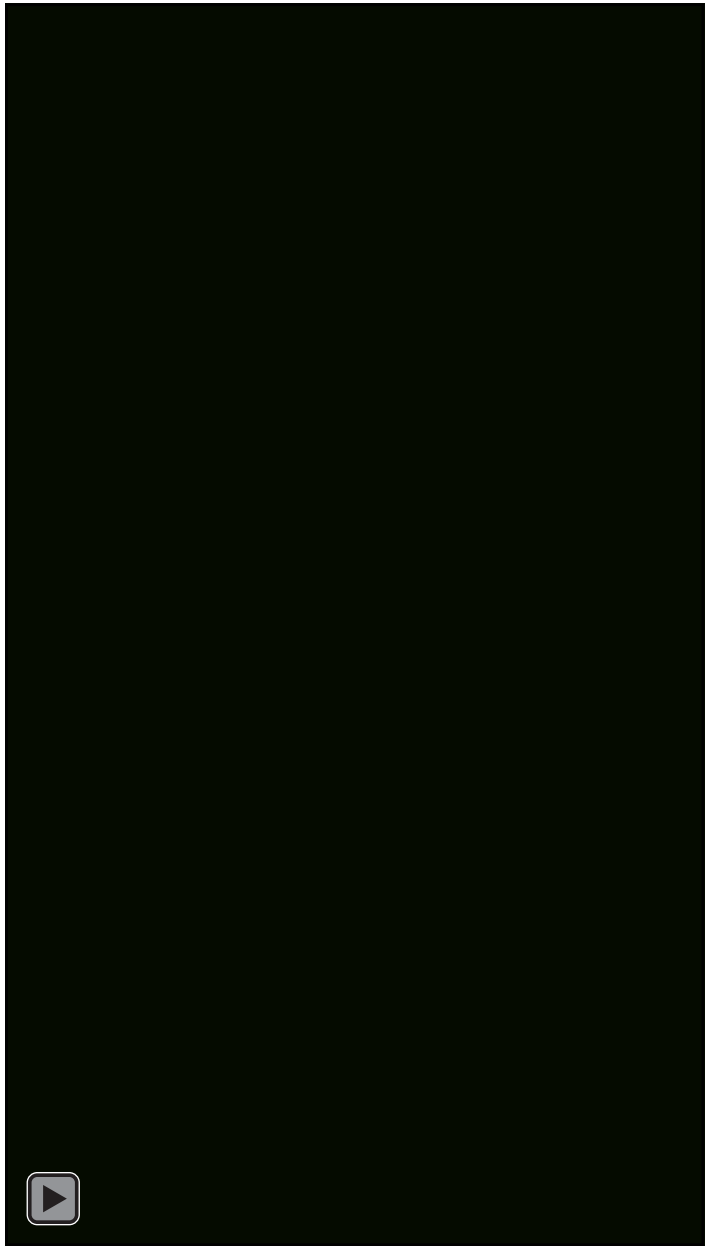
Model site – Tampa Bay (heat map of PFAS)



Fish consumption advisories (PFAS)

Retrospective PFAS analysis with cores





Body burden via blood measurement

Marine wildlife studies in Florida

Marine Pollution Bulletin
Volume 140, March 2019, Pages 610-615

Per- and polyfluoroalkyl substances (PFAS) in plasma of the West Indian manatee (*Trichechus manatus*)

Kady Palmer [a], Jacqueline T. Bangma [b], Jessica L. Reiner [c], Robert K. Bonde [d], Jeffrey E. Korte [e], Ashley S.P. Boggs [c], John A. Bowden [c f]

Journal of the American Society for Mass Spectrometry > Vol 34/Issue 9 > Article

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RESEARCH ARTICLE | May 10, 2023

Aquatic Vegetation, an Understudied Depot for PFAS

Emily K. Griffin, Lauren M. Hall, Melynda A. Brown, Arielle Taylor-Manges, Trisha Green, Katherine Suchanec, Bradley T. Furman, Victoria M. Congdon, Sara S. Wilson, Todd Z. Osborne, Shawn Martin, Emma A. Schultz, Mackenzie M. Holden, Dylan T. Lukacsa, Justin A. Greenberg, Katherine Y. Deliz Quiñones, Elizabeth Z. Lin, Camden Camacho, and John A. Bowden*

ECOTOXICOLOGY AND PUBLIC HEALTH | July 17, 2025

Occurrence and Maternal Transfer of Per- and Polyfluoroalkyl Substances (PFAS) in Pregnant Sharks from Florida Coastal Waters

Qaim Mehdi, Thomas D. Sinkway, Lauren E. Blackman, Adriana L. Iorfida, Avery M. Pittman, Corinna Sutterer, Hailey L. Hinchliffe, Kira A. Zautcke, Meg E. Morrow, Neel Shah, Ines A. Chambrier-Athias, Karly E. Cohen, Gareth J. Fraser, Douglas H. Adams, and John A. Bowden*

Science of The Total Environment
Volume 927, 1 June 2024, 171758

Species-specific profiles of per- and polyfluoroalkyl substances (PFAS) in small coastal sharks along the South Atlantic Bight of the United States

Qaim Mehdi [a], Emily K. Griffin [a], Juliette Esplugas [a], Jim Gelsleichter [b], Ashley S. Galloway [c], Bryan S. Frazier [c], Alina S. Timshina [d], R. Dean Grubbs [e], Keyla Correia [a], Camden G. Camacho [f], John A. Bowden [a d f]

Marine Pollution Bulletin
Volume 213, April 2025, 117673

Sand dollars (*Mellita quinquiesperforata*): A new bioindicator for tracking PFAS in coastal waters

John A. Bowden [a b], Qaim Mehdi [a], Lauren E. Blackman [a], Keyla Correia [a], Thomas D. Sinkway [b], Jana Marcin [b], Bradley T. Furman [c], Victoria Congdon [c], Joe Aufmuth [d]

Science of The Total Environment
Volume 809, 25 February 2022, 151143

Detection of long chain *per*- and polyfluoroalkyl substances (PFAS) in the benthic Golden tilefish (*Lopholatilus chamaeleonticeps*) and their association with microscopic hepatic changes

Erin L. Pulster [a 1], Amanda E. Wichterman [b 1], Susan M. Snyder [a], Susan Fogelson [c], Bianca F. Da Silva [d], Kaylie A. Costa [d], Joe Aufmuth [e], Kristina L. Deak [a 2], Steven A. Murawski [a], John A. Bowden [d 3]

Thank you

Questions?
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