PFAS Fate in Coastal Rivers and Wetlands: Current Research in Kent County, Delaware

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What are PFAS?

PFAS = **p**er- and poly**f**luoro**a**lkyl **s**ubstances

Class of nearly 15,000 synthetic organic compounds

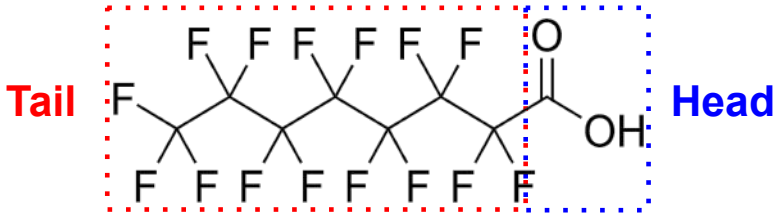
- Acid headgroup
- Fully fluorinated carbon tail

Used in commercial and industrial applications

- Non-stick coatings
- Firefighting foams

Several PFAS identified as immunotoxic and carcinogenic in humans

Example: PFOA (C8)



Why study PFAS in coastal ecosystems?

1. Ocean is the major final sink

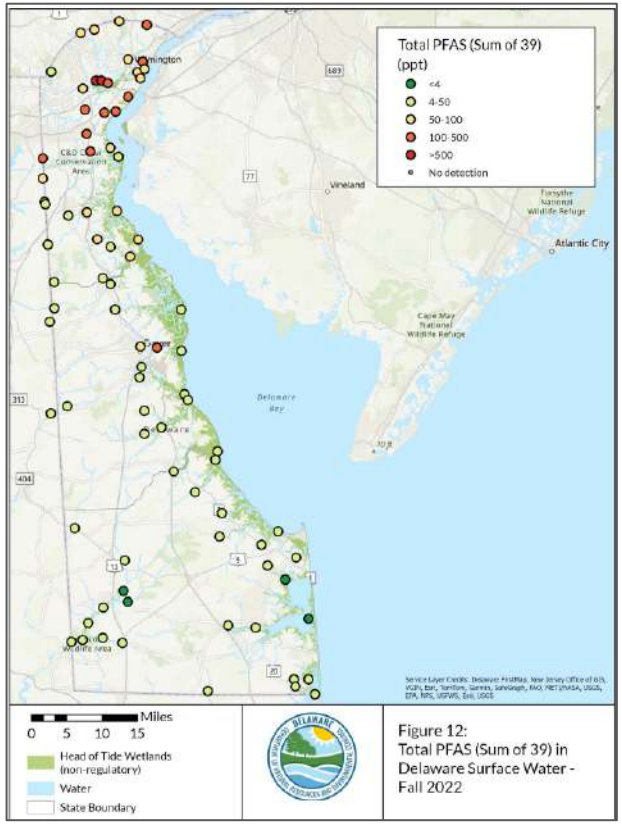
2. Unique physical and geochemical properties

3. High population density

4. Bioaccumulate in coastal wildlife

PFAS are widely detected in sediment and water in coastal systems!

Previous Research in Delaware

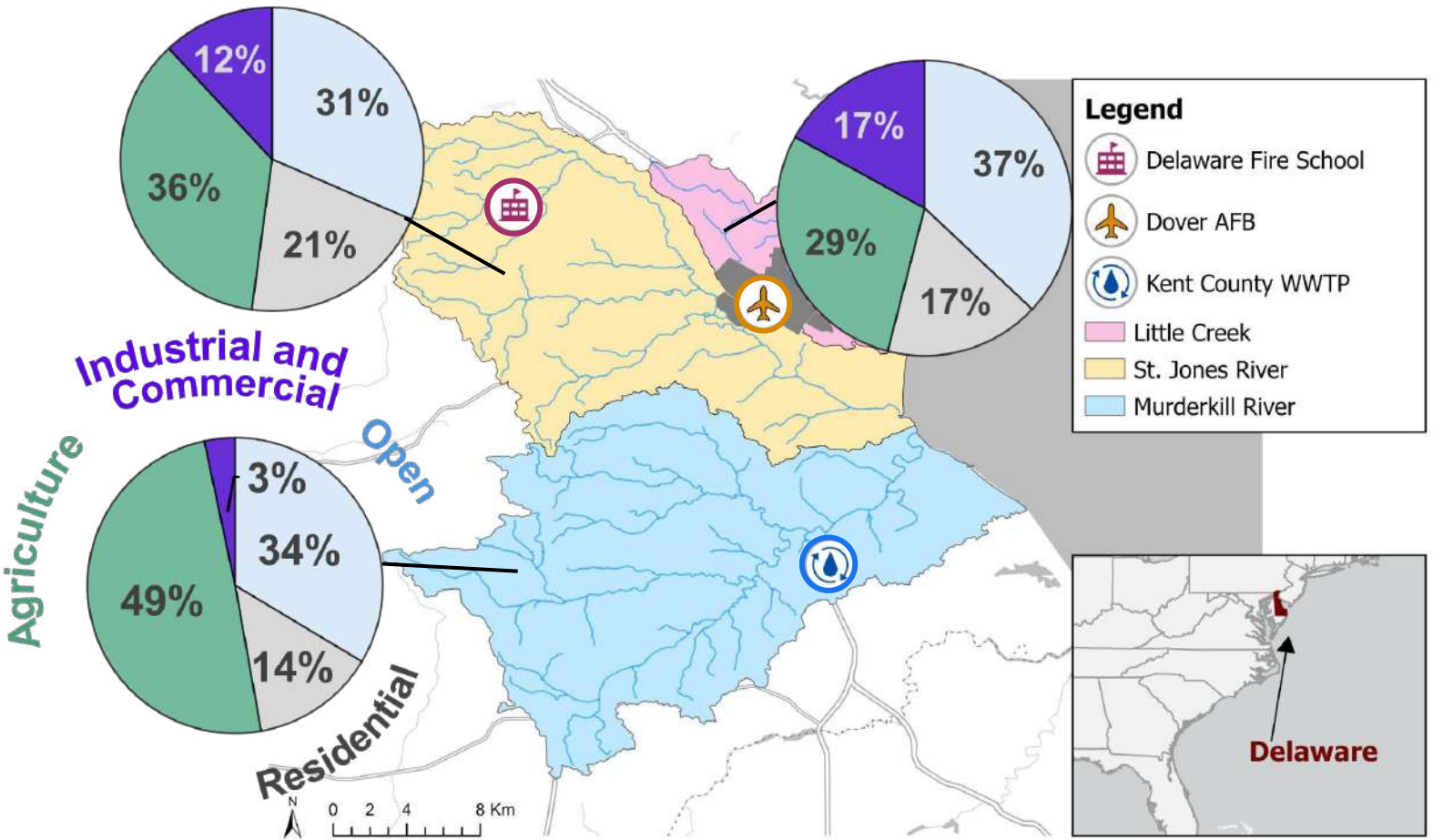


2022 DNREC Survey of Delaware Surface Waters

Dr. Mi-Ling Li's CHEER (**C**hemicals, **H**ealth, **E**cotoxicology **R**esearch) group at the University of Delaware

PFAS in oysters, mussels, and water from the Delaware Bay

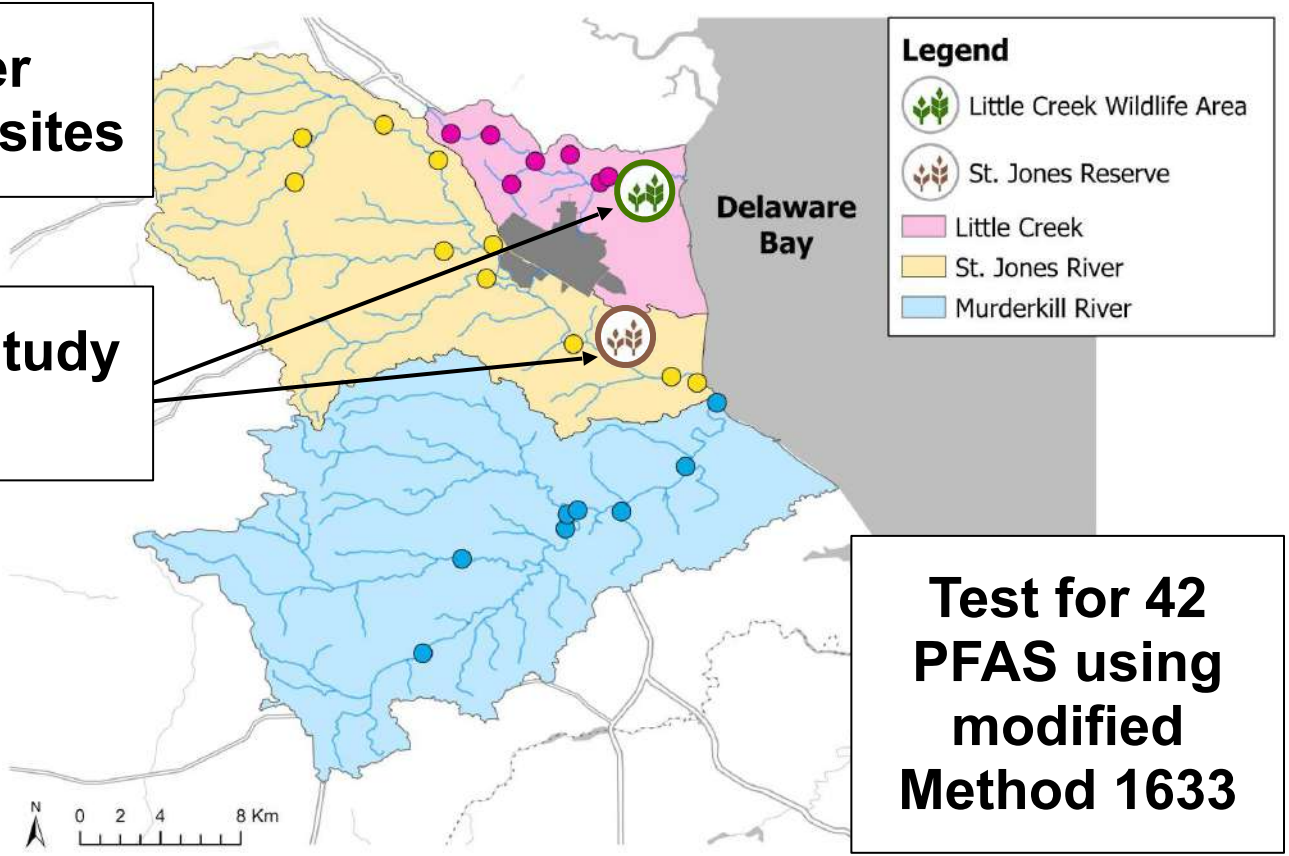
Current research focuses on three watersheds in Kent County, DE



Current research focuses on three watersheds in Kent County, DE

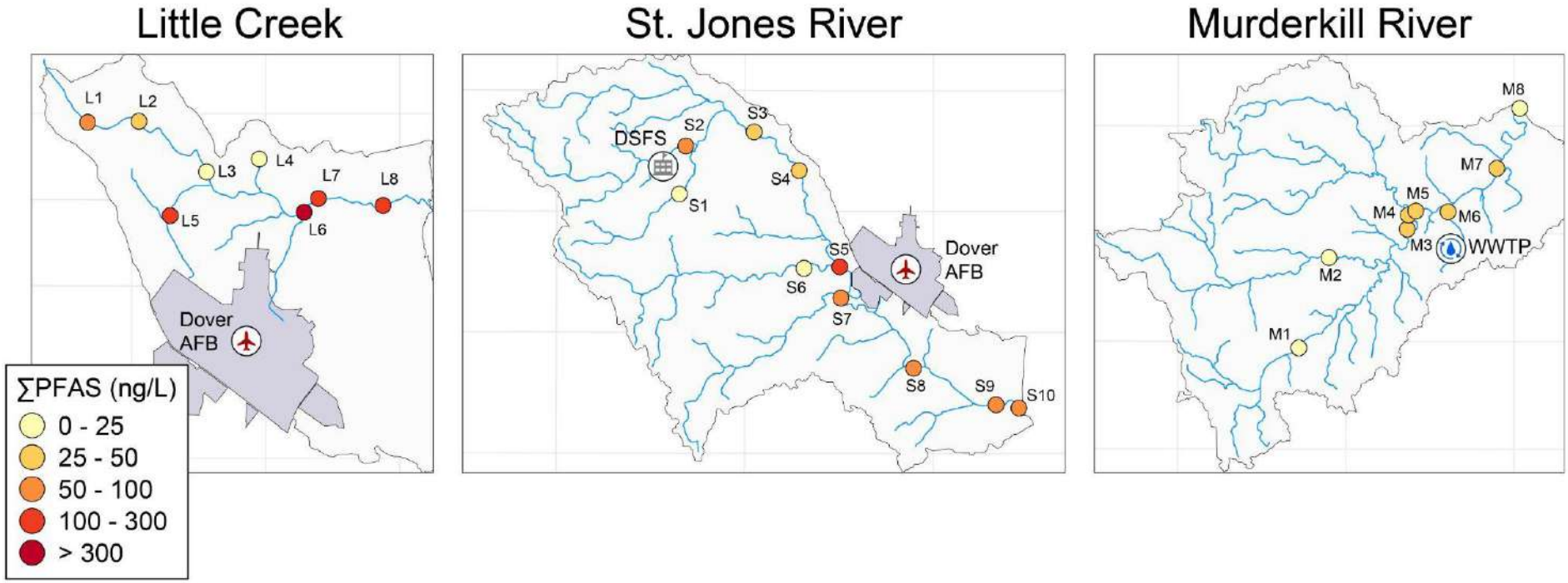
26 river sampling sites

2 marsh study sites

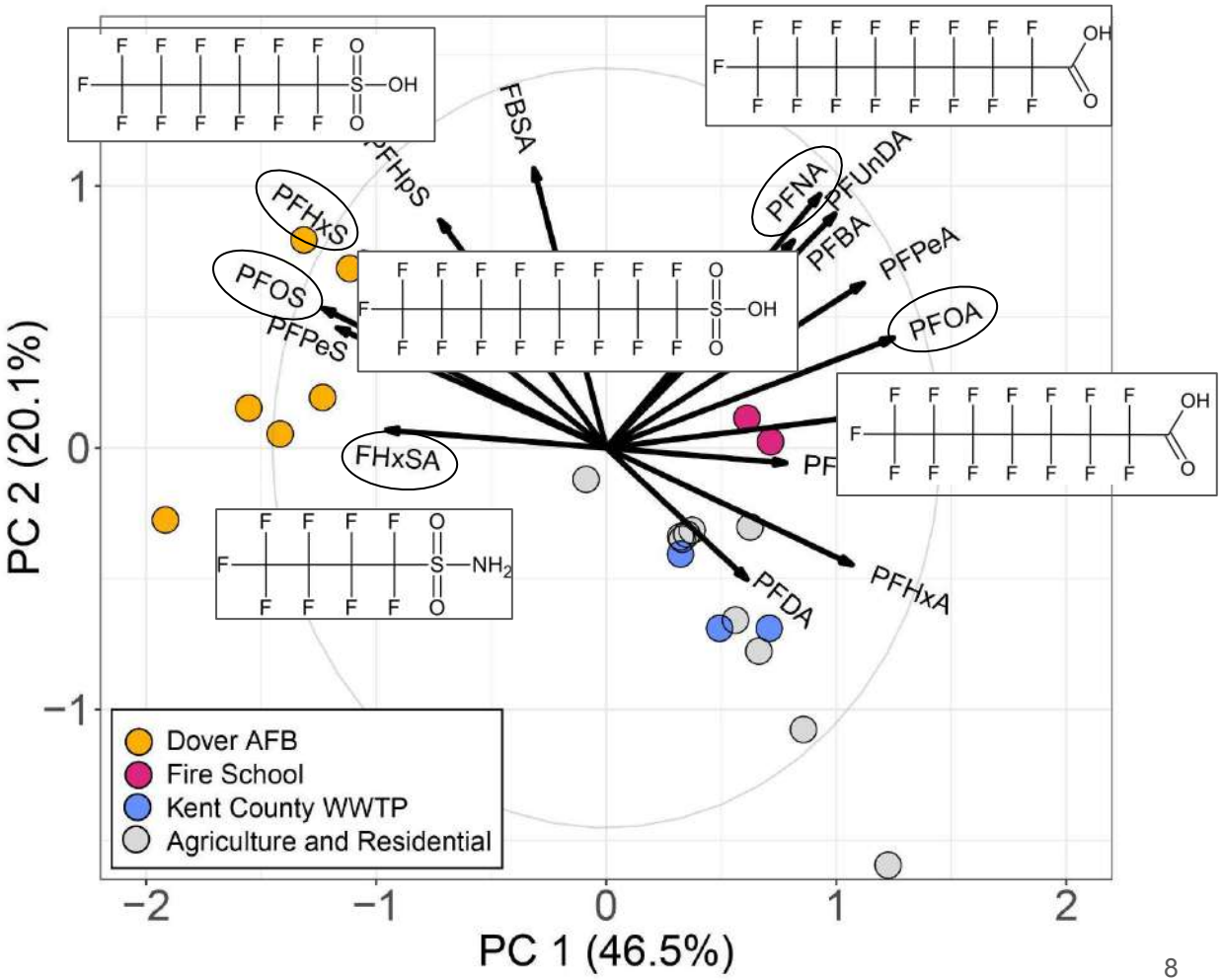


Test for 42 PFAS using modified Method 1633

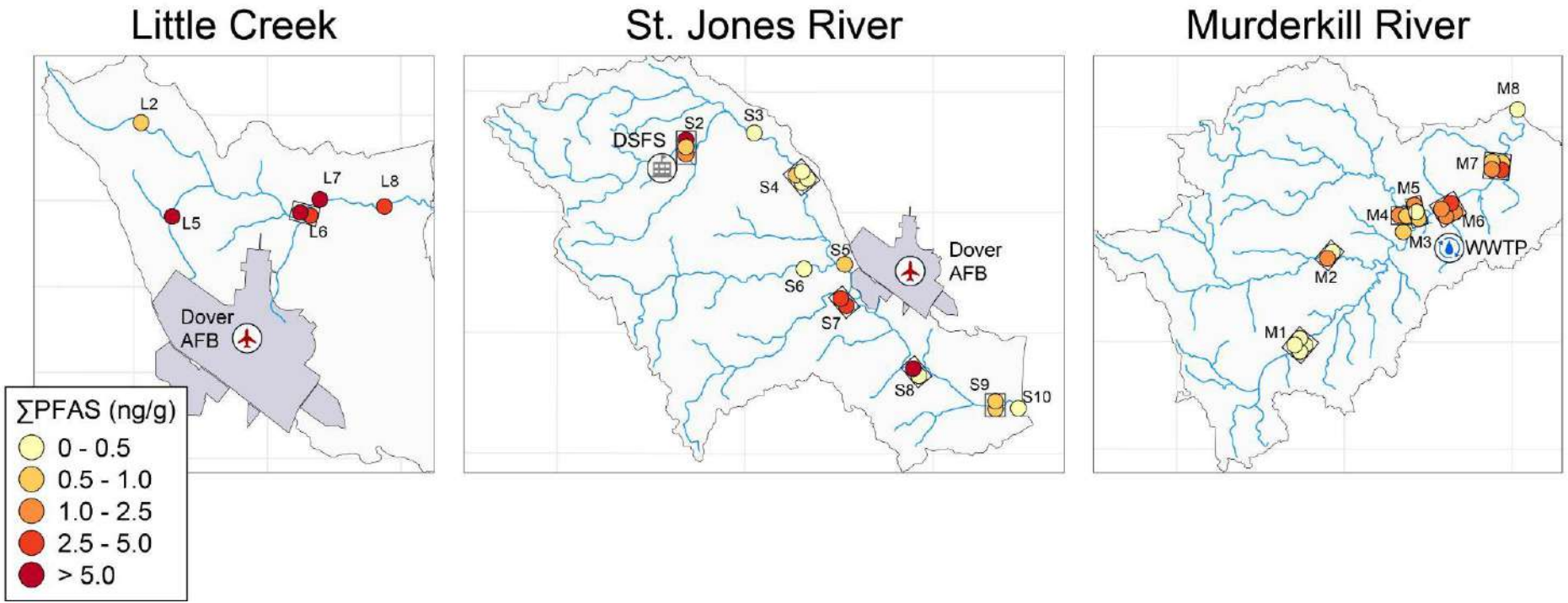
Highest concentrations in surface water are downriver AFFF usage sites



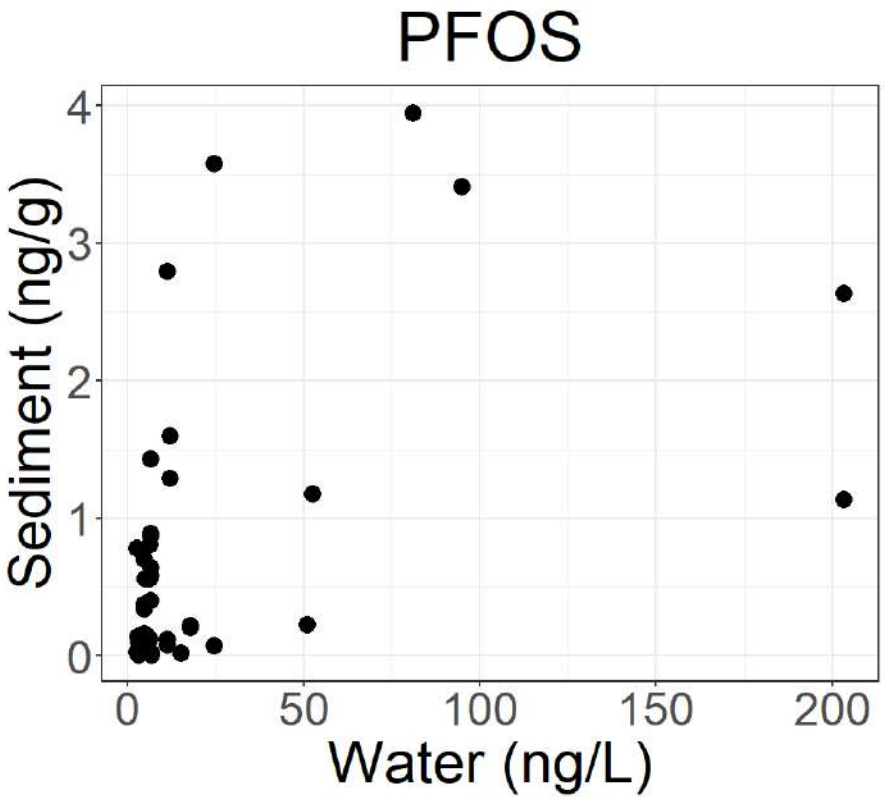
In surface water, differences in PFAS compositions are related to proximity to sources



Highest concentrations in sediment are also downriver AFFF usage sites



Water concentrations explain little about sediment concentrations



Many other factors influence sediment accumulation:

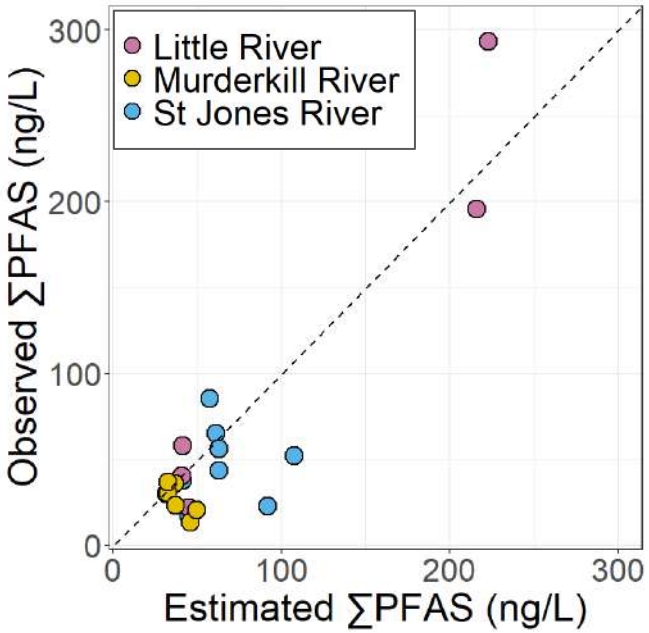
1. Water chemistry
   - Salinity
   - Dissolved organic carbon
2. Sediment properties
   - Organic carbon
3. Depositional dynamics
   - River bank

Can we reduce the information collection burden in rivers using spatial models?

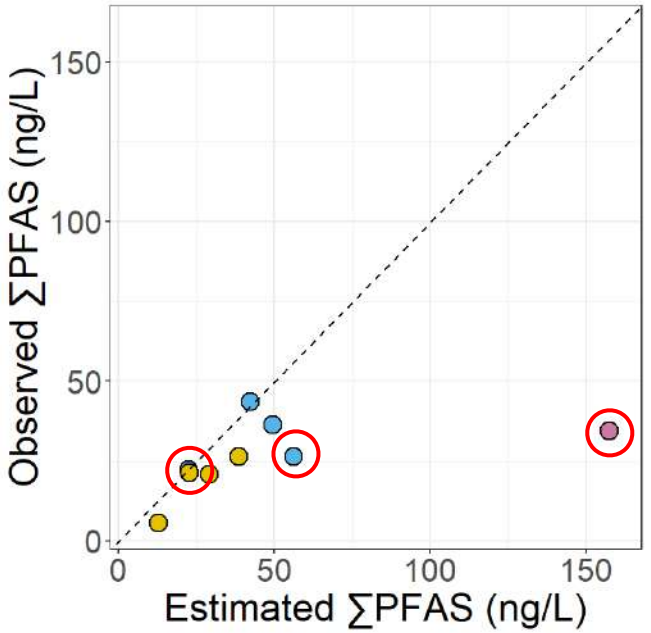
- PFAS are both mobile and persistent
- Multiple river sampling locations may be impacted by the same source
- Spatial Stream Networks (SSNs)- Regression models that accounts for flow connectivity between sites

Considering spatial connectivity improves estimates of ∑PFAS at unsampled locations

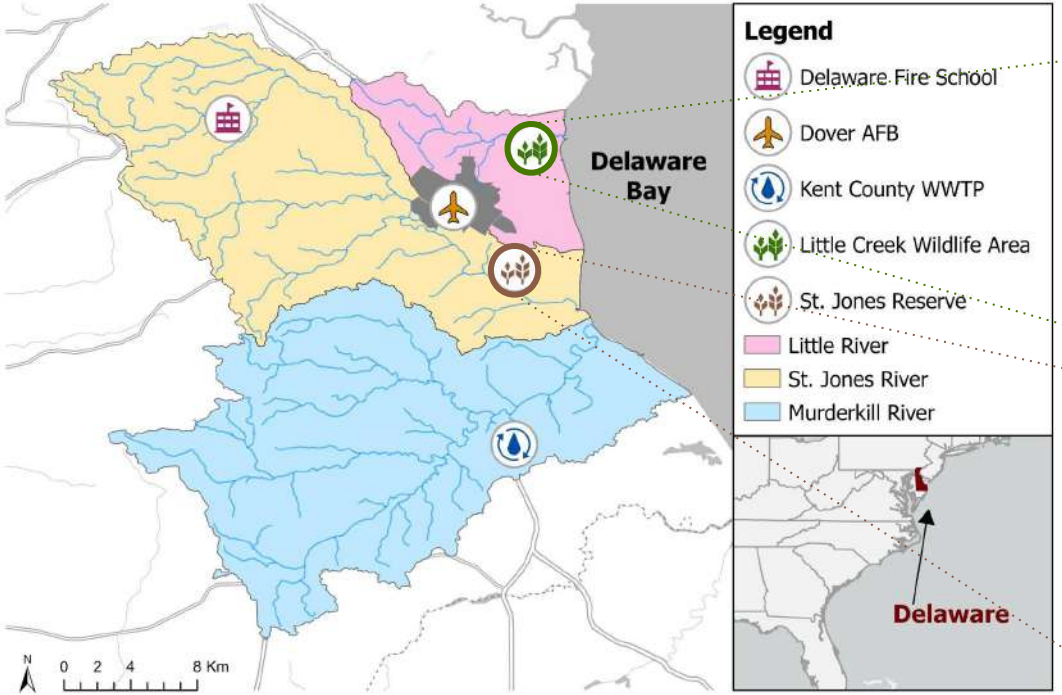
Leave-one-out Cross Validation



DNREC Fall 2022 Campaign



Investigating PFAS distributions in salt marshes



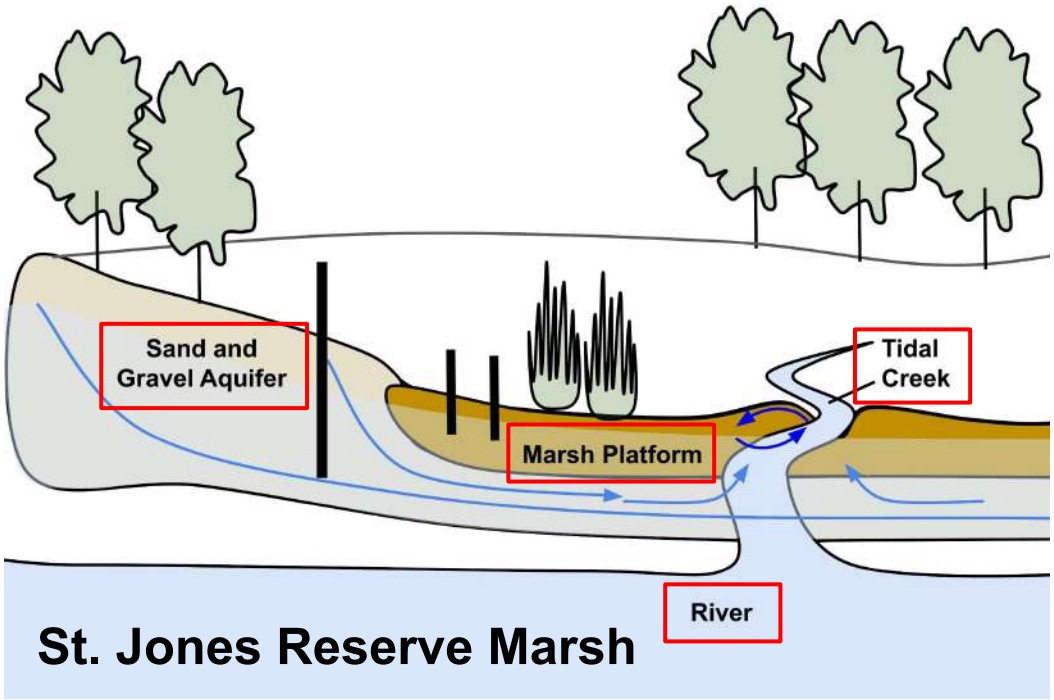
Little Creek Wildlife Area

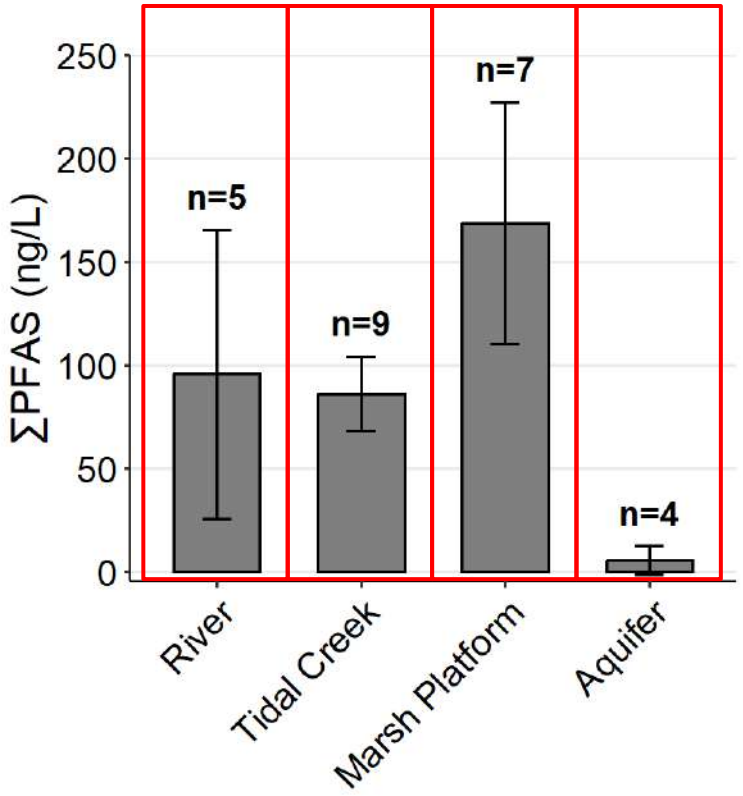
- Management Practices
- Site History

St. Jones Reserve

- Hydrologic processes
- Geochemical conditions

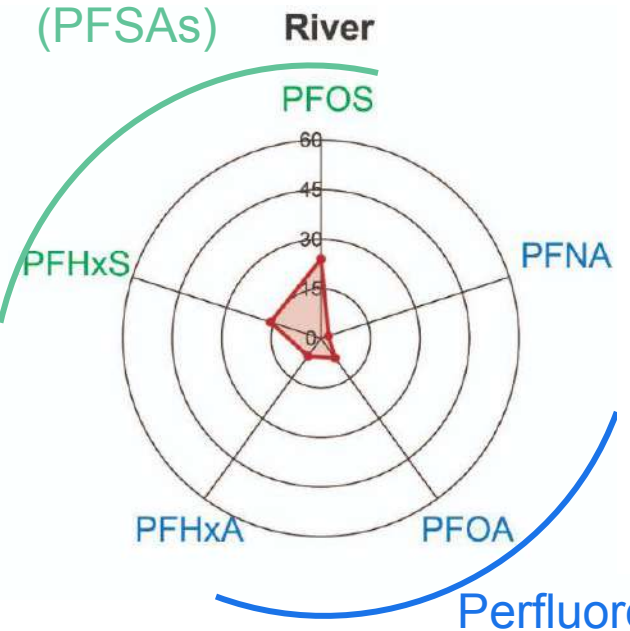
Elevated concentrations in shallow groundwater from marsh platform





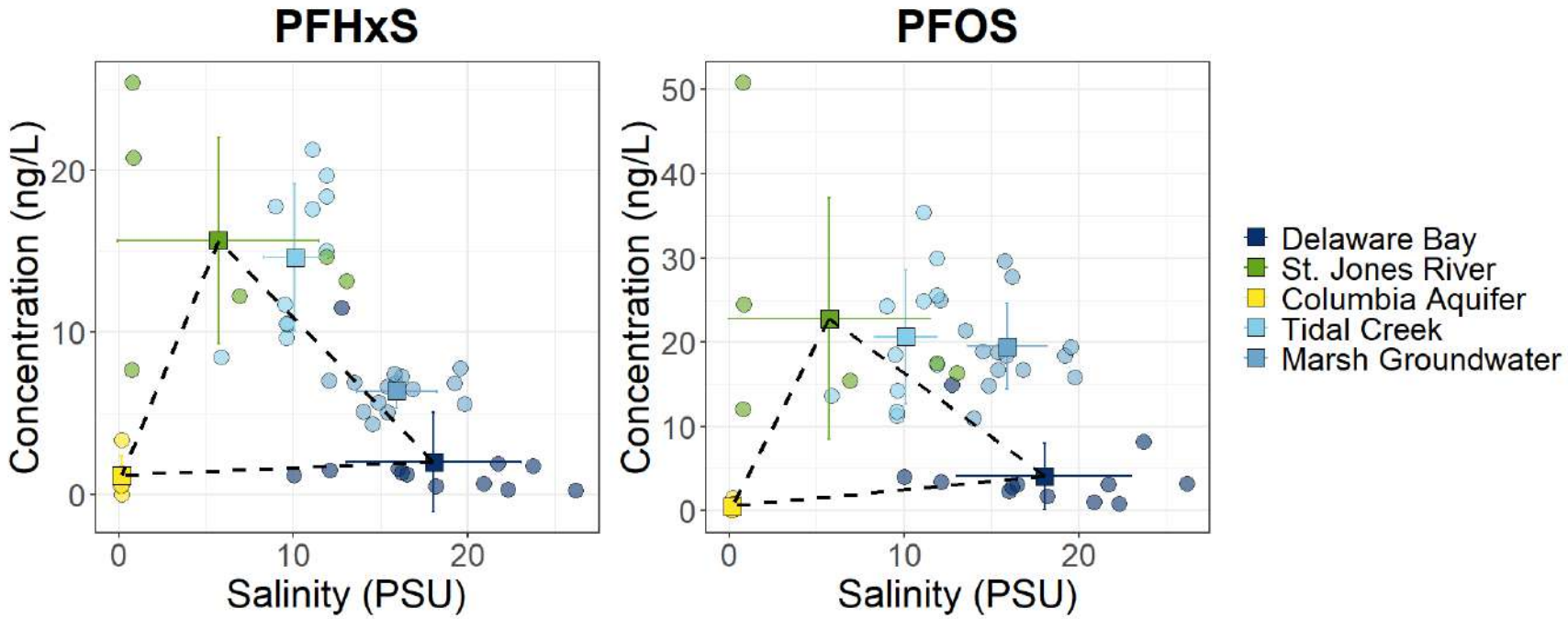
Shallow groundwater is enriched in perfluorocarboxylic acids (PFCAs)

Perfluorosulfonic acids (PFSAs)

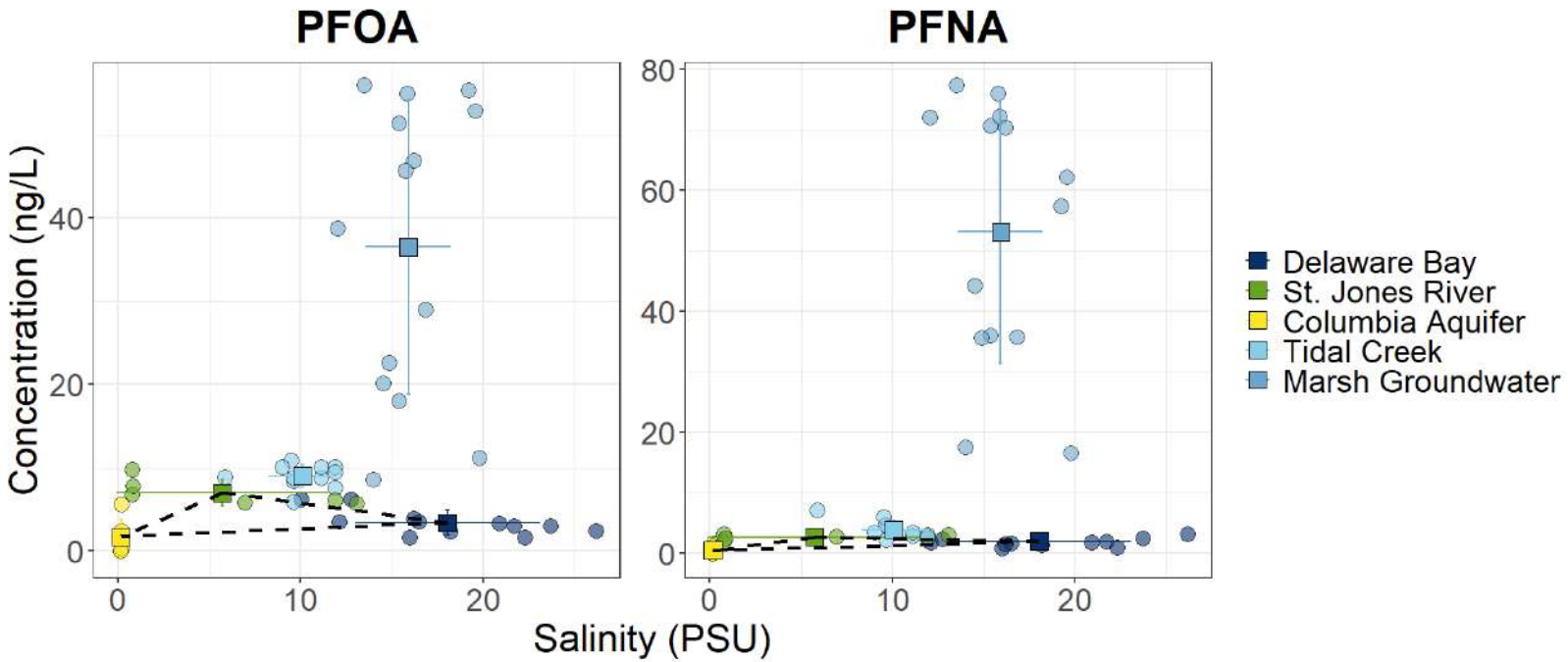


Perfluorocarboxylic acids (PFCAs)

Mixing of Delaware Bay and St. Jones River explains PFSA concentrations in the marsh



Unexplained source of PFCAs to the marsh



Takeaways

- PFAS are mobile in surface waters, and river flow is a major transport pathway to locations further downstream, including tidal wetlands
- Concentrations in our study area in Kent County, DE, are similar to other AFFF-impacted watersheds
- The type and amount of PFAS observed at a sampling locations can provide useful information about point sources
- Considering connectivity between sampling sites using SSNs can improve estimates of ∑PFAS at unsampled locations

Acknowledgements

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Thank you! Questions?

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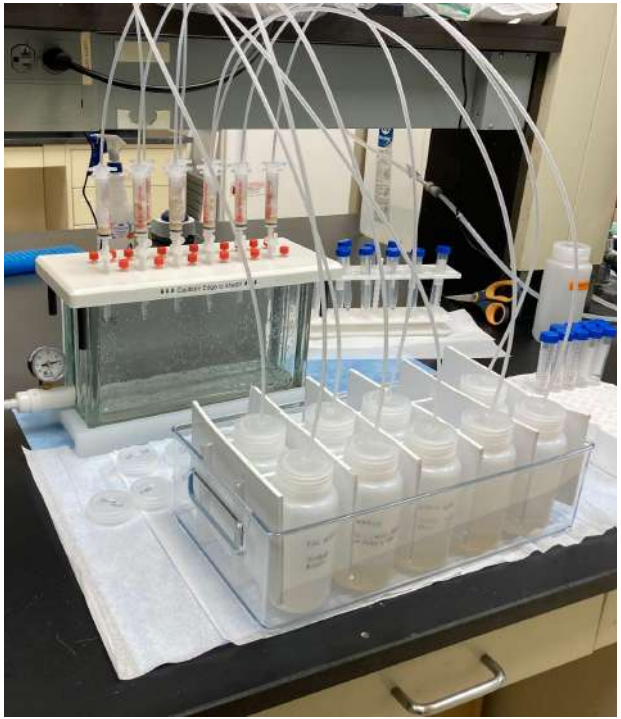
How do we test for PFAS?

PFAS present at low concentrations in the environment

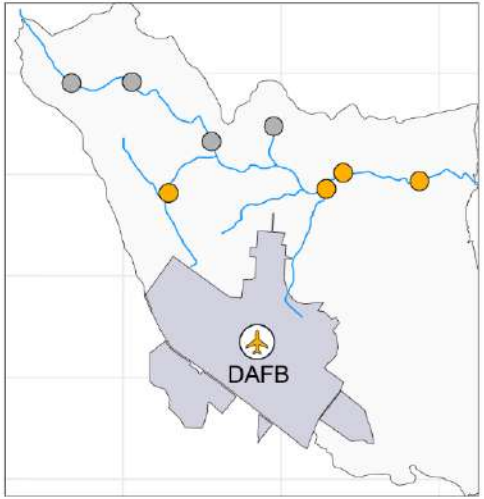
- Parts per trillion (ppt)

EPA Method 1633

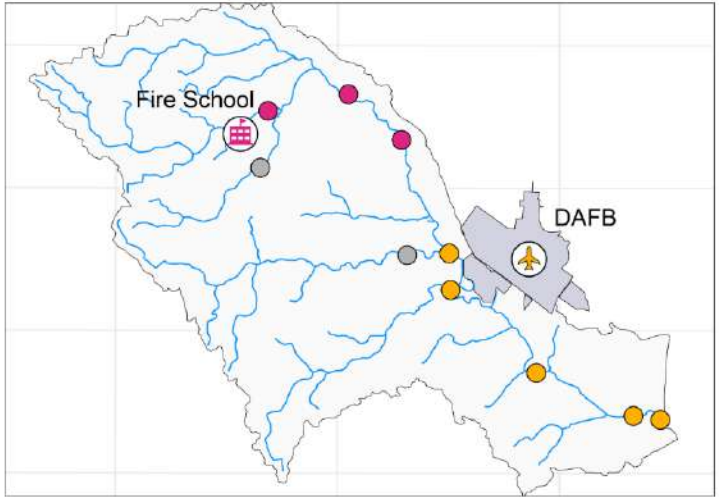
- Finalized in 2024
- Aqueous, solid, biosolids, and tissue samples
- Uses liquid-chromatography tandem mass spectroscopy (LC-MS/MS)
- A “targeted” method – 40 PFAS



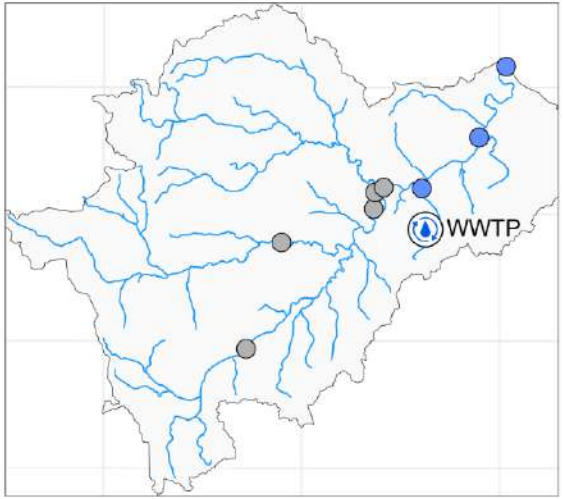
Little River



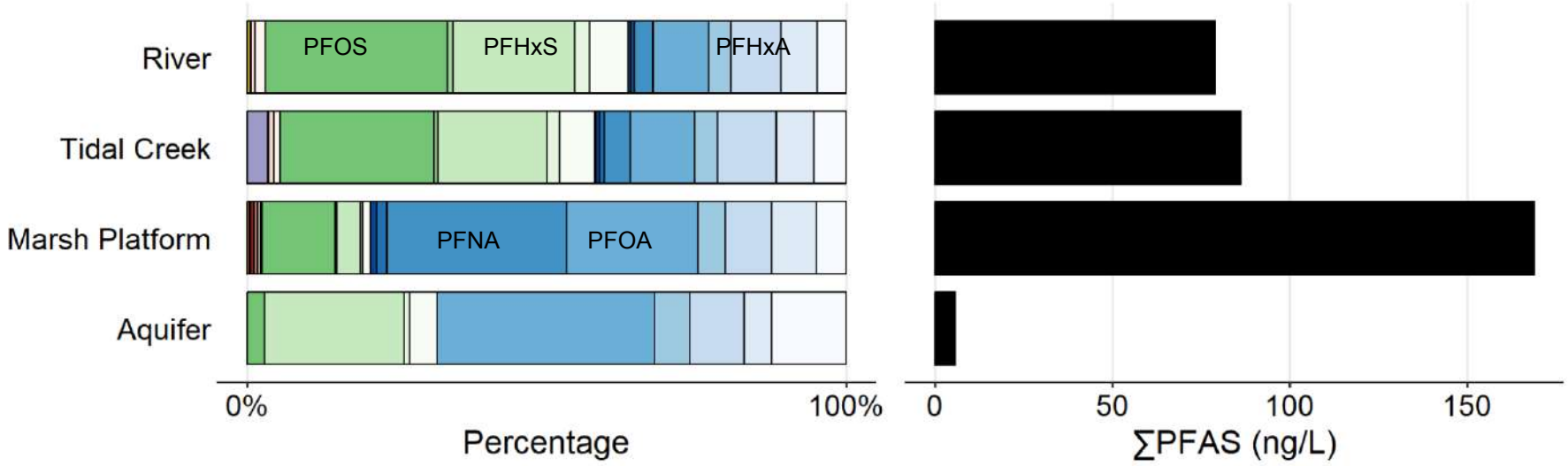
St. Jones River

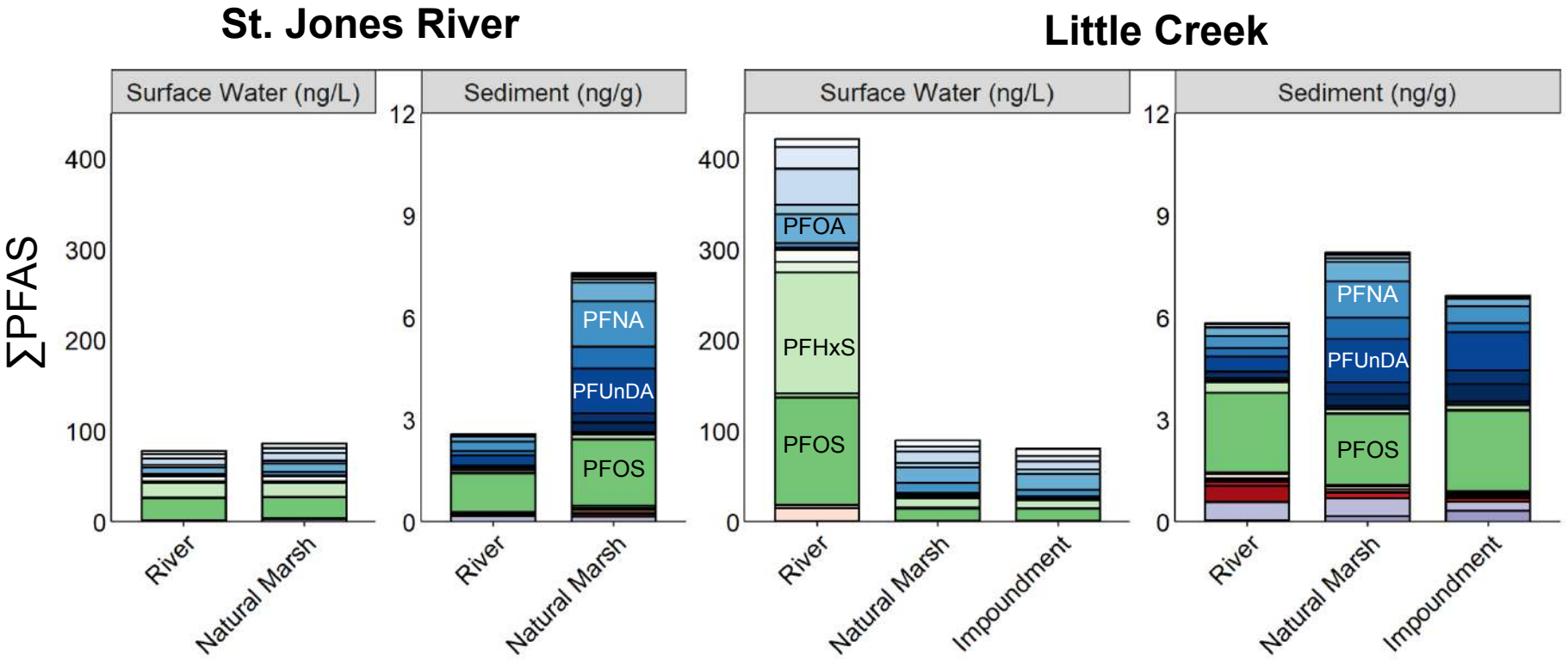


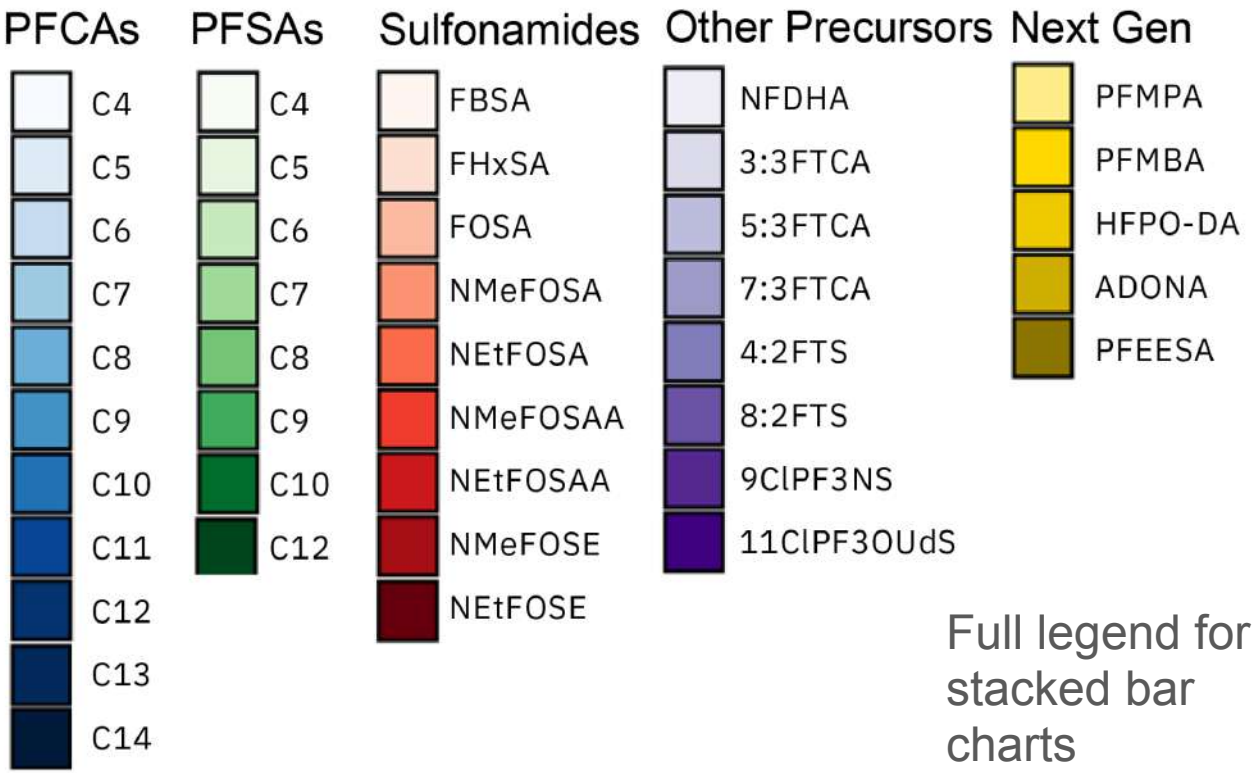
Murderkill River



PCA Groups


River
Tidal Creek
Marsh Platform
Aquifer
PFOS
PFHxS
PFHxA
PFNA
PFOA
0%
100%
Percentage
0
50
100
150
∑PFAS (ng/L)


St. Jones River
Little Creek
Surface Water (ng/L)
Sediment (ng/g)
∑PFAS
400
300
200
100
0
12
9
6
3
0
PFOA
PFHxS
PFOS
PFNA
PFUnDA
River
Natural Marsh
Impoundment



Full legend for stacked bar charts