Spatial and Temporal Variation and Tissue Distribution of PFAS Concentrations in Smallmouth Bass

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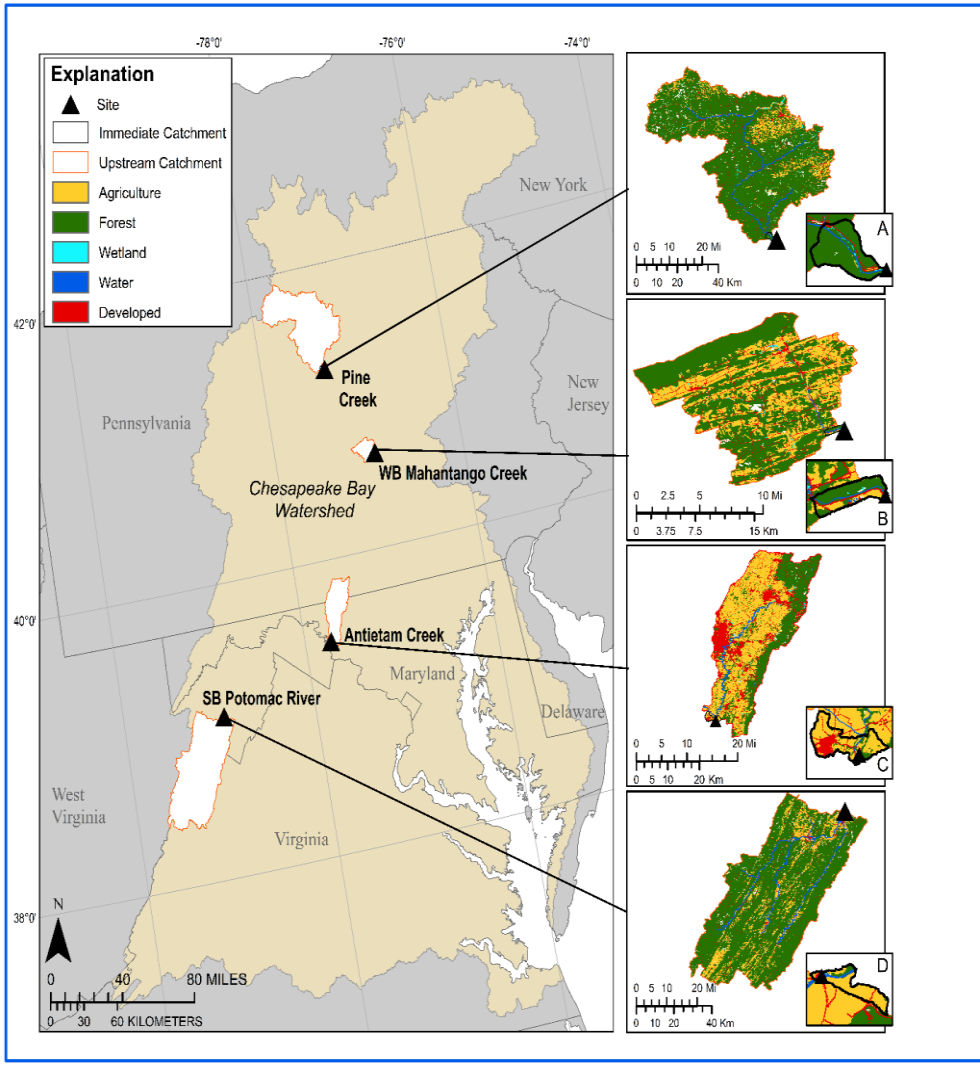
Smallmouth Bass Health Monitoring and Assessment

- **In response to fish kills, observed endocrine disruption (intersex) and population declines in certain areas of the Chesapeake Bay watershed, fish health was assessed at numerous sites from 2013-2021**
- **In addition to biological endpoints, tissues were saved for chemical analyses**
- **Initially analyzed archived plasma samples collected at the four integrator sites during 2018 to determine if PFAS might be a concern in these populations**
  - **13 PFAS analytes were measured by SGS AXYS**

Long Term Integrated Monitoring

- 2013-2019
- Biological monitoring of adults in spring and fall and young-of-year in early summer
- Surface water sampling for hormones, pesticides, phytoestrogens monthly (bimonthly in spring)
- Two in the Potomac (mouth of Antietam Creek and South Branch Potomac near Moorefield)
- Two in the Susquehanna (mouth of Pine Creek and mouth of West Branch Mahantango Creek)



Compounds Detected in Smallmouth Bass Plasma

- **Four compounds were detected in every plasma sample**
  - **PFOS (perfluorooctane sulfonate) – 8 carbon sulfonate**
    - ***Ranged from 20 – 574 ng/ml***
  - **PFUnA (perfluoroundecanoate) – 11 carbon carboxylic acid**
    - ***Ranged from 3 – 55 ng/ml***
  - **PFDA (perfluorodecanoate) – 10 carbon carboxylic acid**
    - ***Ranged from 2 – 37 ng/ml***
  - **PFDoA (perfluorododecanoate) – 12 carbon carboxylic acid**
    - ***Ranged from 1 – 34 ng/ml***
- **Additional compounds were detected in some samples**
  - **PFOSA (perfluorooctane sulfamide) – 8 carbon sulfonate**
    - ***Ranged from BD – 1.7 ng/ml***
  - **PFNA (perfluorononanoic acid) – 9 carbon carboxylic acid**
    - ***Ranged from BD – 1.3 ng/ml***

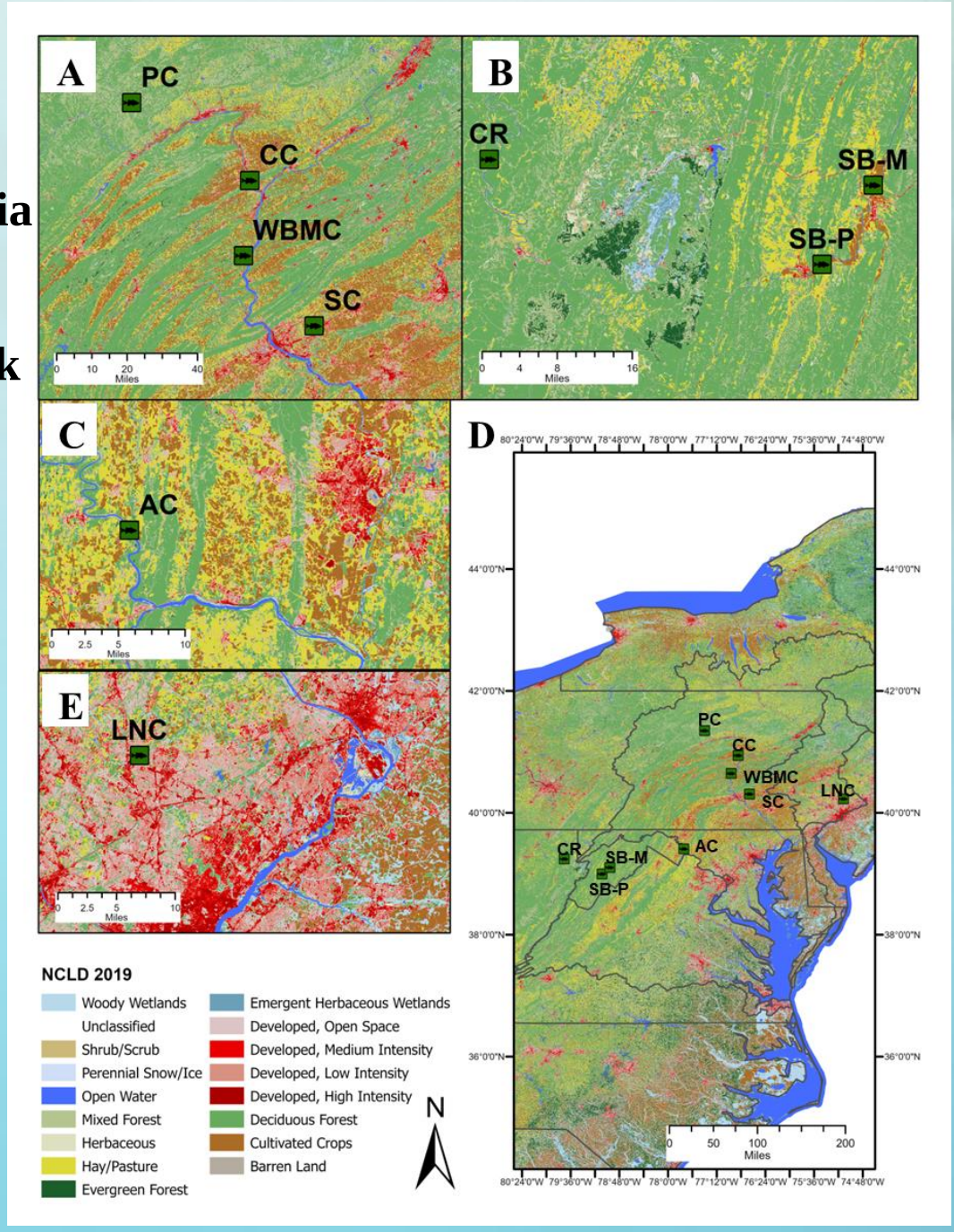
Site Locations
Spatial Comparisons

A. Susquehanna River –Pennsylvania
- Pine Creek
- Chillisquaque Creek
- West Branch Mahantango Creek
- Swatara Creek

B. West Virginia sites
- Cheat River
- South Branch Potomac
- Moorefield
- South Branch Potomac
- Petersburg

C. Potomac River – Maryland
- Antietam Creek

E. Delaware River - Pennsylvania
- Little Neshaminy Creek



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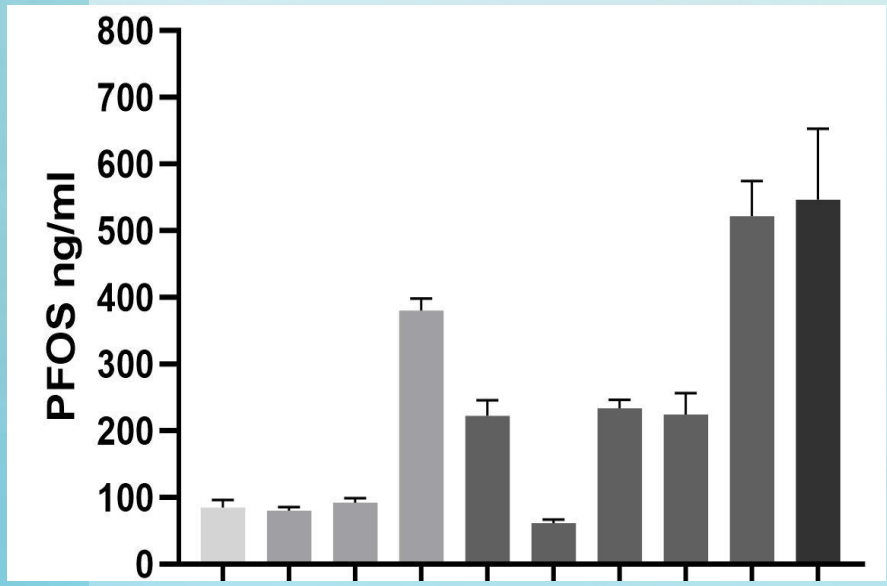
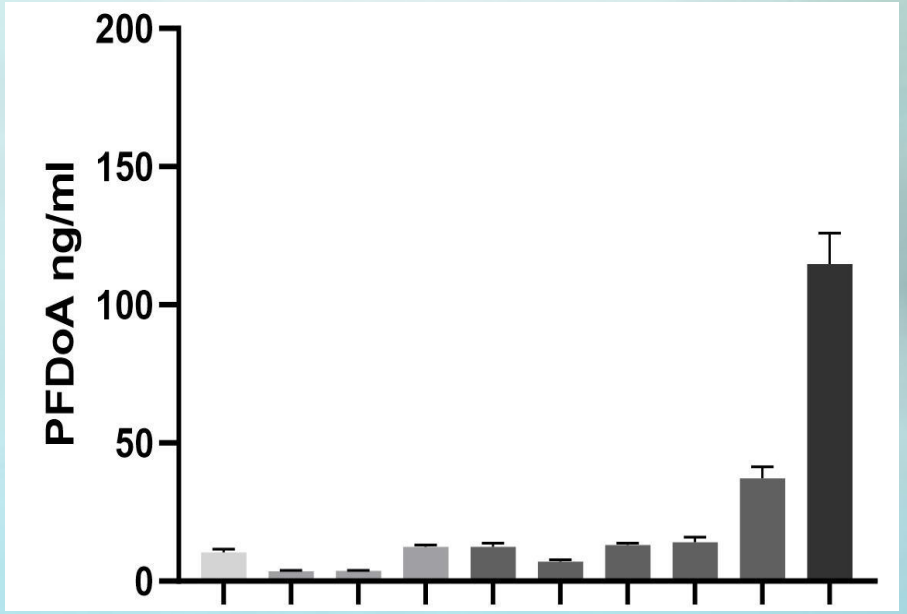
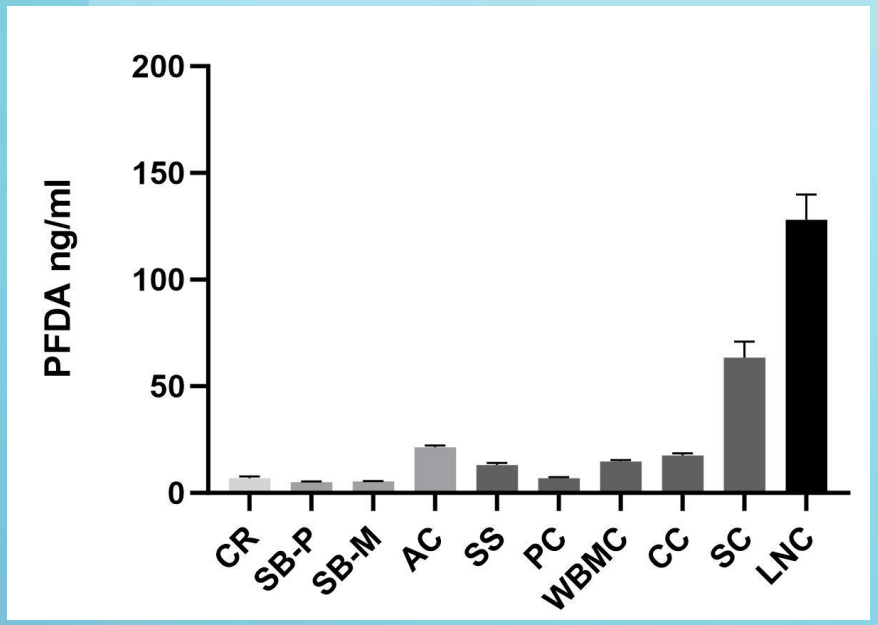
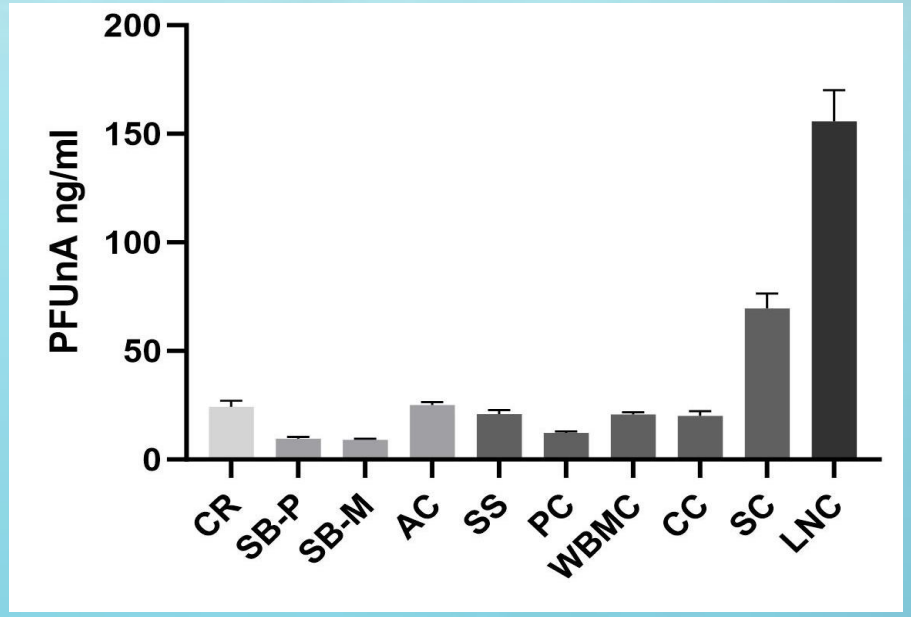
Spatial Comparison





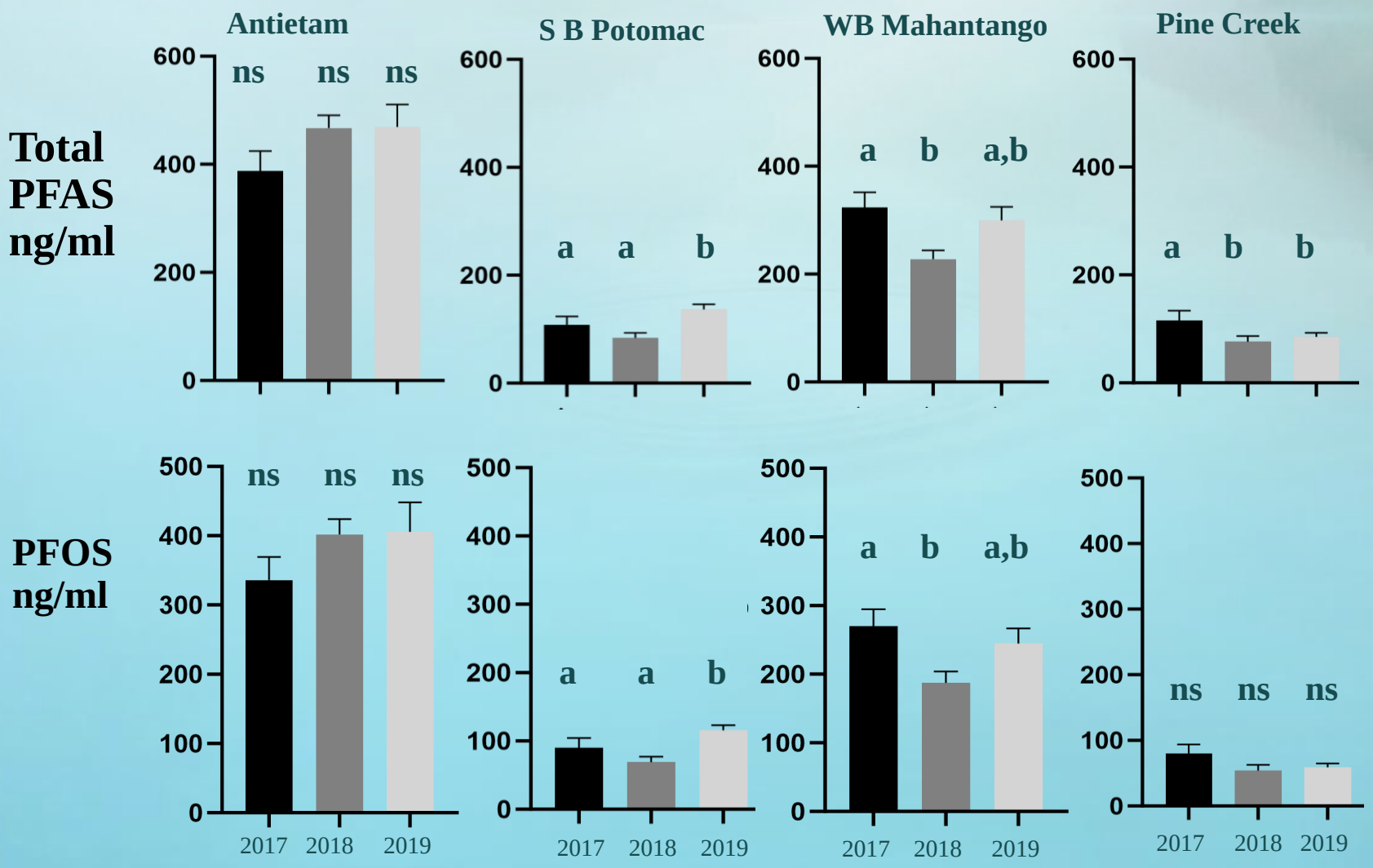




Land Cover/Land Use Attributes Upstream Catchment

Site	Developed	Agriculture	Forest	EPA - PFAS Facilities
Little Neshaminy	70.7	9.4	15.9	60
Swatara	13.9	39.8	42.2	39
Antietam	17.3	49.1	32.2	25
WB Mahantango	6.8	31.6	60.1	2
Chillisquaque	6.9	59.4	30.5	0
South Branch - P	3.7	15.8	78.7	2
South Branch -M	3.2	14.0	80.6	2
Pine	3.5	8.5	84.3	23
Cheat River	4.5	2.8	84.8	4

Temporal Comparisons



Sex Differences – Combined Years Four Temporal Sites

Males consistently had higher levels, except for PFOS at Antietam Creek

Site	PFOS	PFDA	PFUnA	PFDoA
Pine Creek	ns	ns	$p < 0.001$	$p = 0.0006$
WB Mahantango Creek	$p = 0.0210$	ns	$p < 0.001$	$p < 0.0001$
Antietam Creek	$p = 0.0278$	ns	$p < 0.001$	$p = 0.0022$
South Branch Potomac	ns	ns	$p < 0.001$	$p < 0.0001$

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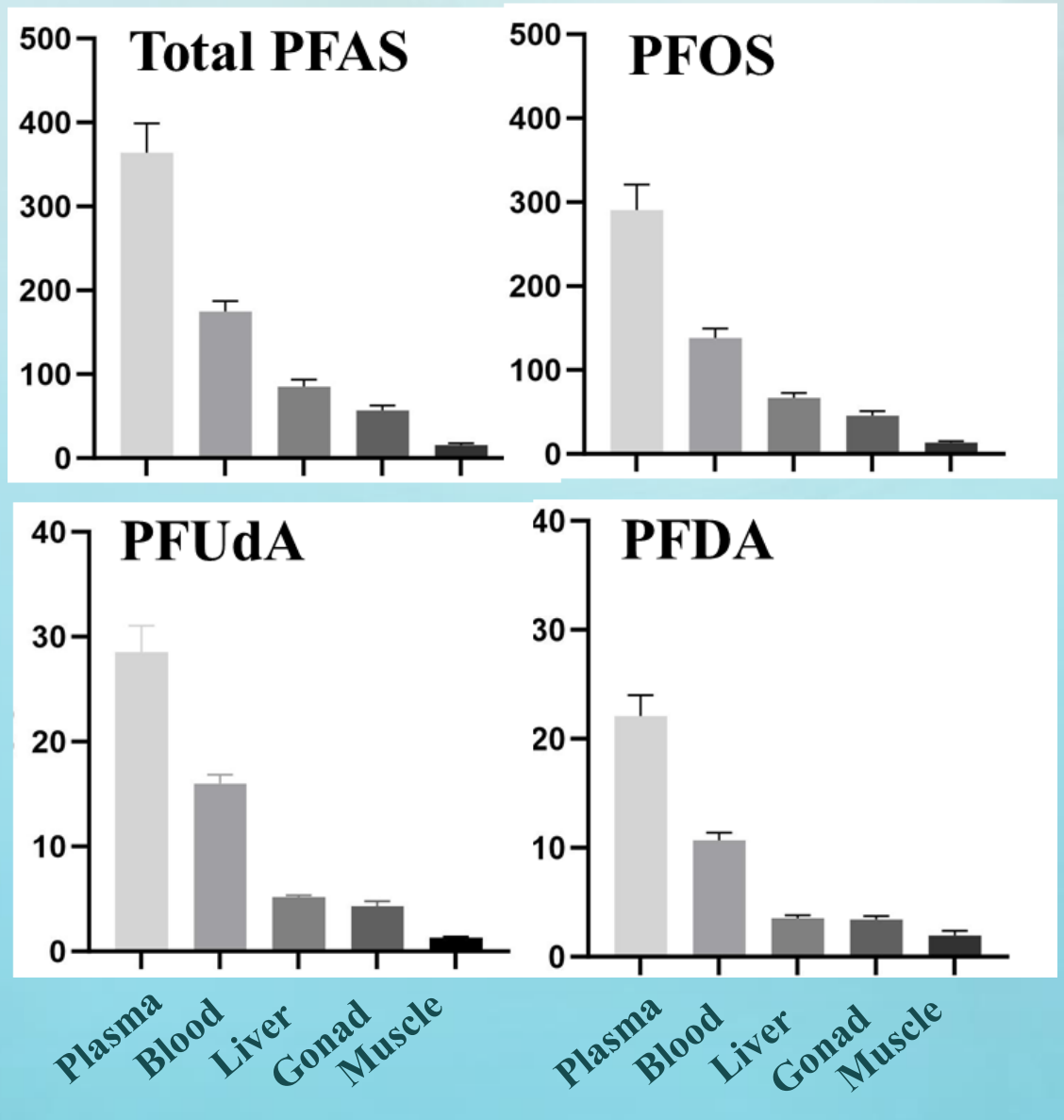
Tissue Comparisons at Swatara Creek Frequency (%) of Detections

Compound	*Plasma*	*Blood*	*Liver*	*Gonad*	*Muscle*
PFOS	**100**	**100**	**100**	**100**	**100**
PFDA	**100**	**100**	**100**	**82**	**24**
PFUnA	**100**	**100**	**100**	**100**	**71**
PFDoA	**88**	**47**	**47**	**0**	**0**
PFDS	**94**	**24**	**18**	**18**	**0**
PFTeDA	**94**	**12**	**29**	**18**	**0**
6:2 FTS	**71**	**0**	**0**	**88**	**0**

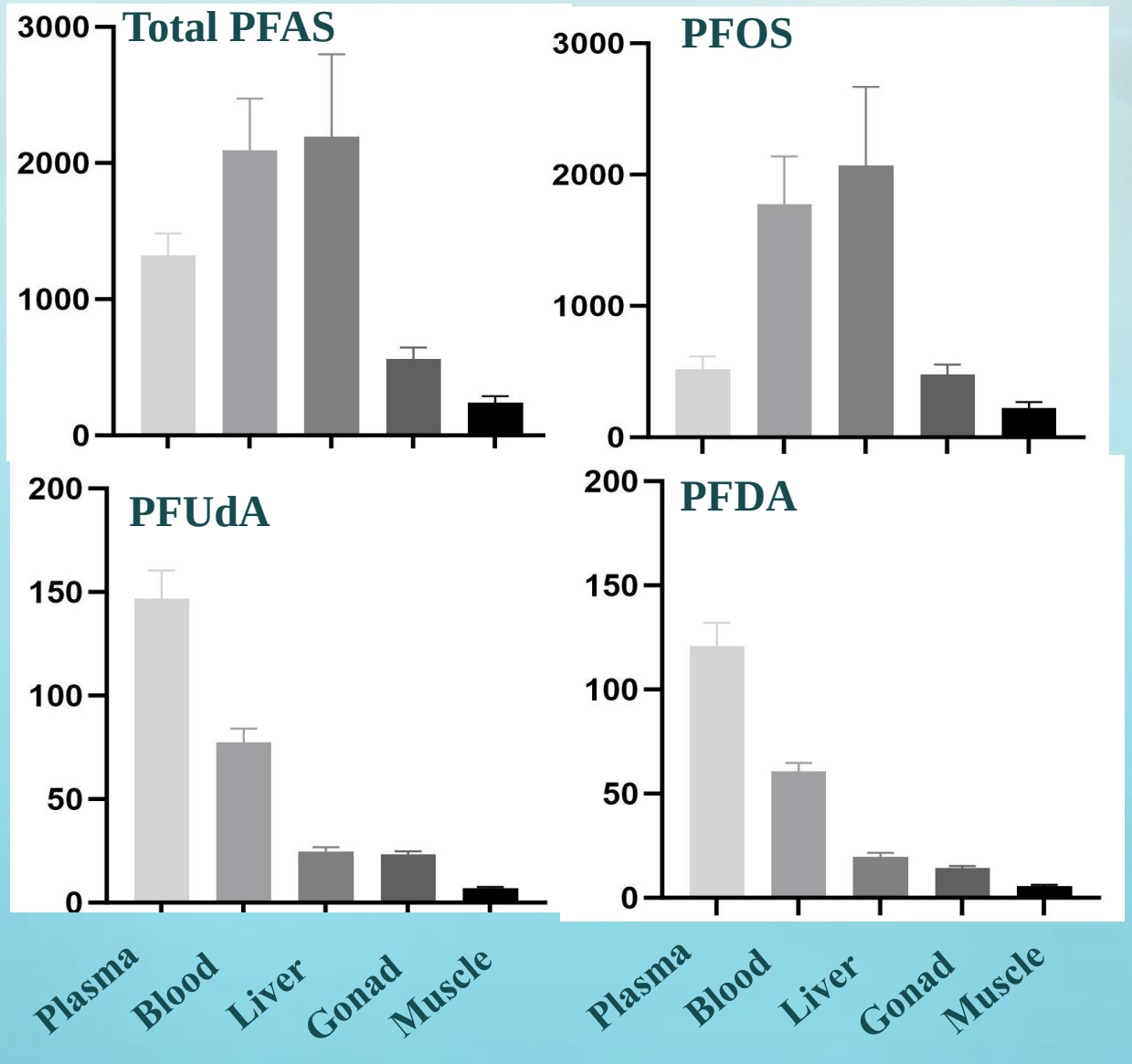
Tissue Comparisons at Little Neshaminy Creek Frequency (%) of Detections

Compound	*Plasma*	*Blood*	*Liver*	*Gonad*	*Muscle*
PFOS	**100**	**100**	**100**	**100**	**100**
PFDA	**100**	**100**	**100**	**100**	**100**
PFUnA	**100**	**100**	**100**	**100**	**100**
PFDoA	**100**	**91**	**100**	**100**	**18**
PFDS	**100**	**91**	**100**	**100**	**45**
PFTeDA	**91**	**91**	**100**	**91**	**64**
6:2 FTS	**100**	**100**	**100**	**0**	**0**

Mean Tissue Concentrations Swatara Creek Smallmouth Bass



Mean Tissue Concentrations
Little Neshaminy Creek Smallmouth Bass



Conclusions

- **Four of the 13 PFAS analyzed for were found in all plasma samples with PFOS having the highest concentrations**
- **There was spatial variation with the highest concentrations measured in watersheds with the highest percentage of developed and agricultural land cover and the presence of military installations and/or airports**
- **At four sites there was some temporal variation but often not significant**
- **Tissue comparisons (40 PFAS analytes) at two sites indicated site differences in the pattern of detections among sites that may be related to exposure routes, habitat, food sources etc.**

Ongoing Analyses
Identification of Adverse Effects

- **Biological Endpoints**
  - **Visible abnormalities, condition factors, age, sex documented**
  - **Blood was collected for plasma vitellogenin and plasma aliquots frozen for future analyses**
  - **Histopathology of all the organs**
  - **Molecular analyses – gene expression in liver, gonad, anterior kidney**
  - **Cheyenne Smith has immune function (macrophages and lymphocytes) and transcript abundance of > 60 genes in the anterior kidney at a subset of sites**
  - **Exposure to complex mixtures of bioaccumulative chemicals such as mercury, PCBs as well as varying concentrations of pesticides, phytoestrogens, hormones**

Acknowledgements

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