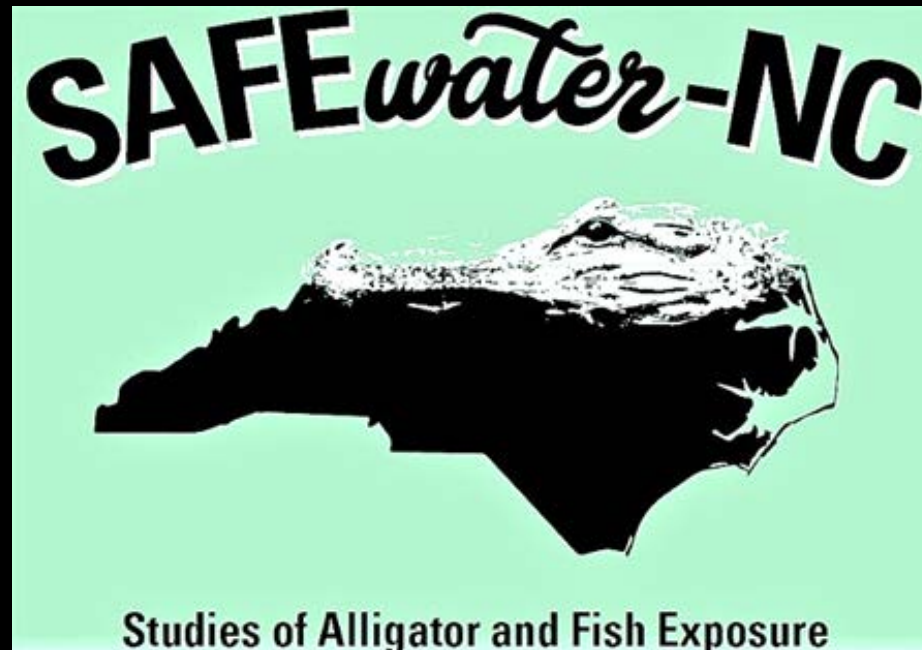


# Insight into toxicity of PFAS through analysis of aquatic wildlife: the SAFEwaterNC Study

## Cape Fear River Striped Bass Update



Scott Belcher, PhD  
North Carolina State University

## Acknowledgements:

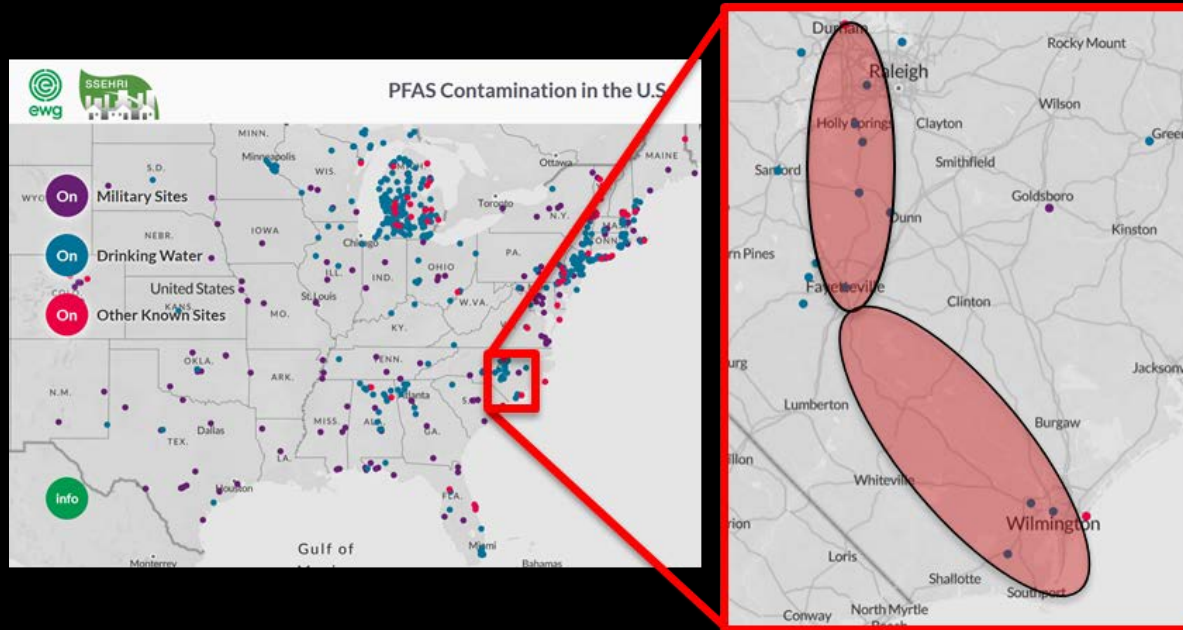
- **Belcher Lab:**  
Theresa Guillette, PhD  
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Madi Polera  
Thomas Jackson  
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Chris Scheibly  
Gabe Bendfeldt  
Aubrey Sasser
- Ben Reading – NCSU/PAFL
- Mark Strynar, PhD
- James McCord, PhD



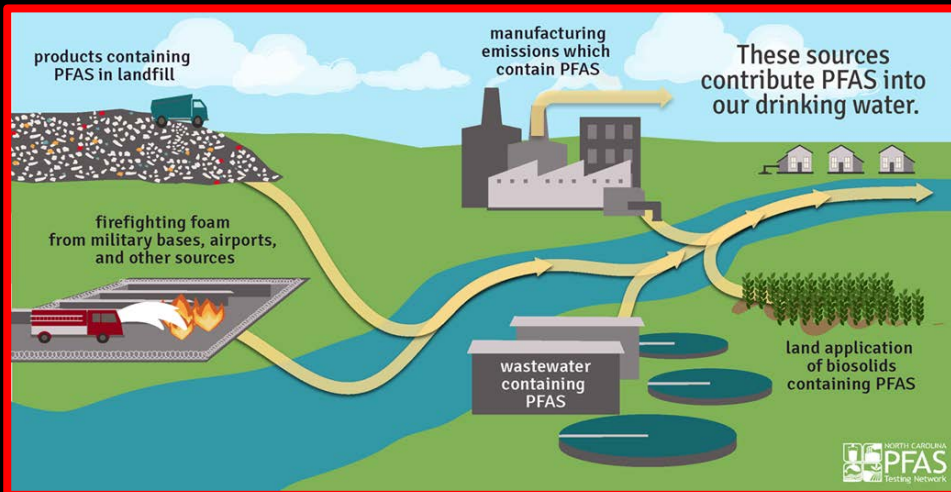
- Alicia Davis
- Kyle Rachels
- Clint Morgenson



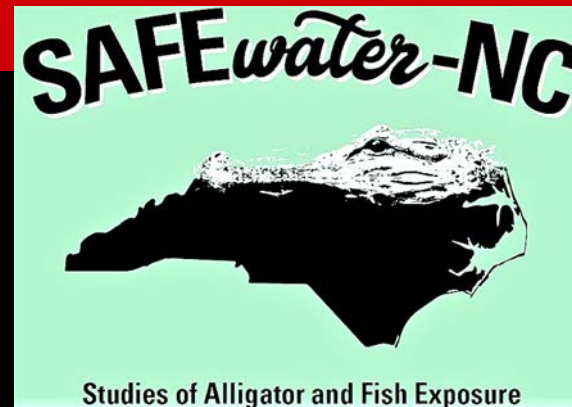
# PFAS contamination is pervasive



- PFAS are detectable throughout the Cape Fear watershed
- Contamination concern is focused downstream of known manufacturing site
- Other sources of PFAS
- Contamination of drinking water
  - GenX
  - Nafion by products
  - Others, known & unknown







## Study goals:

**Characterize levels of PFASs** in blood/serum and water (LC/MS/MS)

- Alligator
- Striped Bass
- Identify reference populations for comparisons
- Muscle/Tissue of other fish that are eaten

**Evaluate:**

- 1) Exposure
- 2) Bioaccumulation – paired water samples
- 3) Impacts on health (biomarkers)

**Communicate findings to stakeholders – Community Engagement**



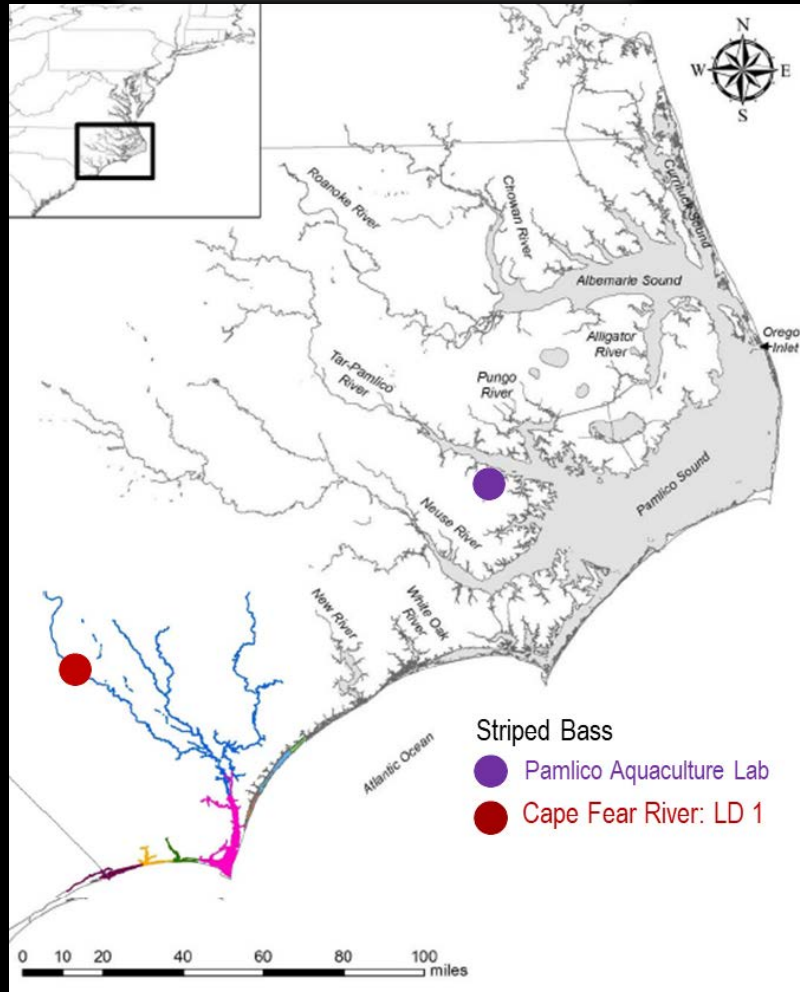
## Striped Bass: *Morone saxatilis*

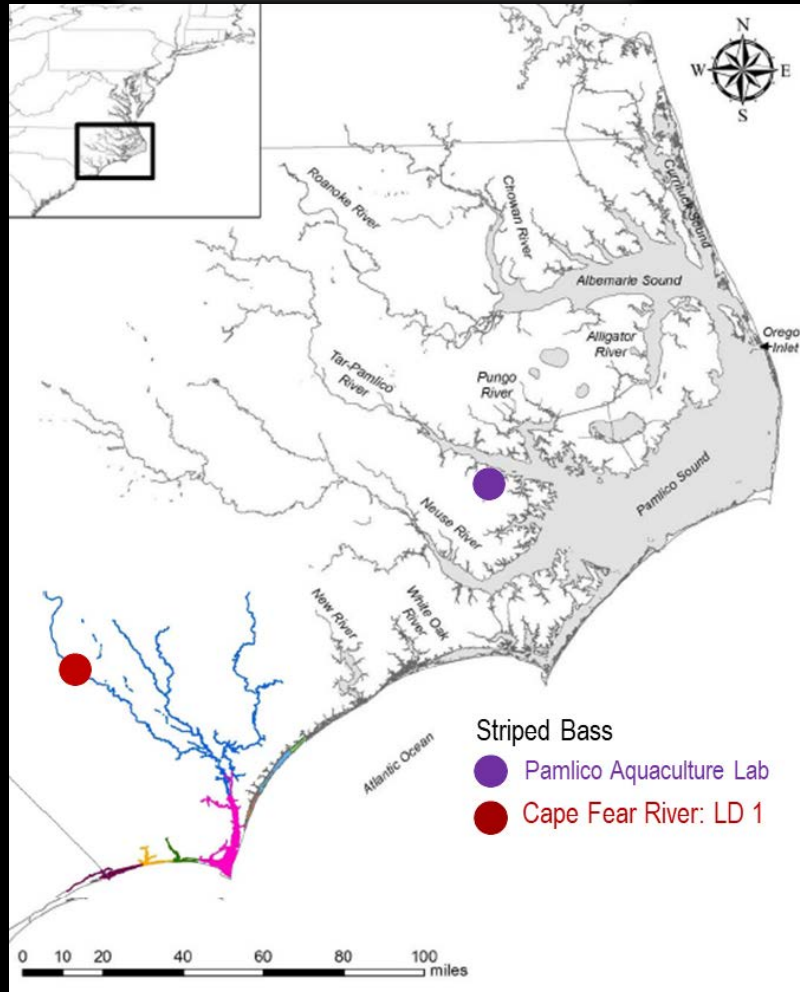
### Commercial and recreational fishery in North Carolina

- valued at more than **\$94 million annually (2016)**

### Striped Bass: can live in both salt and fresh water

- Cape Fear River Population**
  - Do not migrate
  - No natural reproduction in the Cape Fear River
  - 100% are hatchery progeny (genetics)
- Good model of Cape Fear contaminants**
- Aquaculture facility as a reference population for exposure**



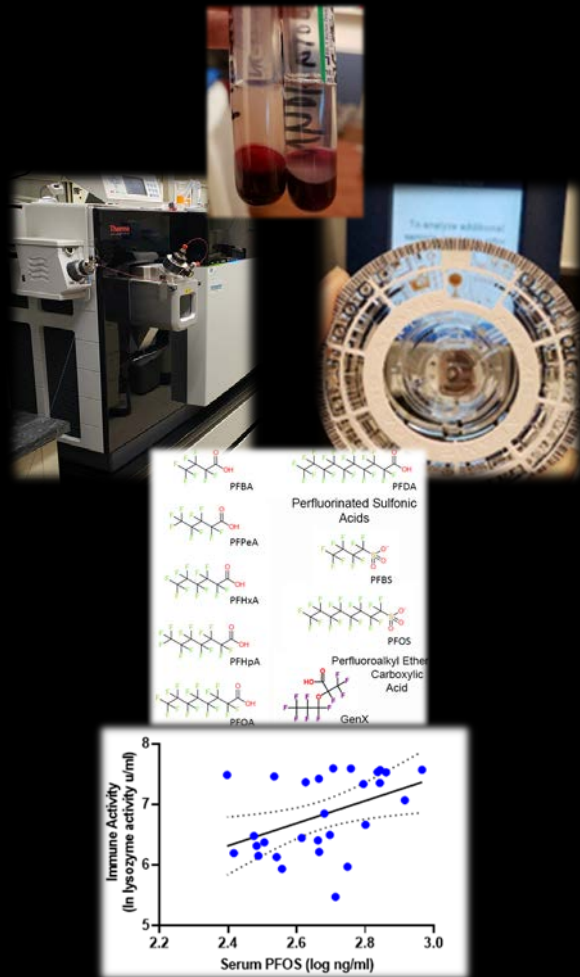


- May 2018 Striped Bass from Cape Fear River by electrofishing
  - LD1 & 3
- Blood/Serum Collected
- Analyzed fish were between ~2-7 year old
  - Residents of the Cape Fear River from 1-6 years
- Exposure compared to aquaculture-reared fish (background)

# Fish Serum Collection Standard Operating Procedure



- Caudal tail venipuncture
- Collect 2-3 ml serum and plasma tubes
- Serum allowed to clot for 30 minutes
- Stored on ice, return to lab
- Centrifuged and aliquoted into cryovials
- Store frozen at -80C



- **Analytical Approach**

- **Untargeted high-resolution LC-mass spectrometry  
Orbitrap Fusion**

- **Measure known: 23 PFAS calibration standards**
- **Detect unknown PFAS**

- **Blood chemistry and health-related biomarkers (14)**

- **Liver**
- **Kidney**
- **Immune system - lysozyme**
- **Hormones**

- **Regression analysis to detect associations between  
PFAS concentrations and health endpoints**



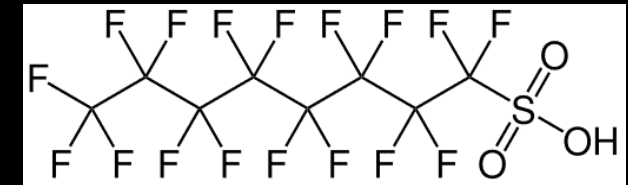
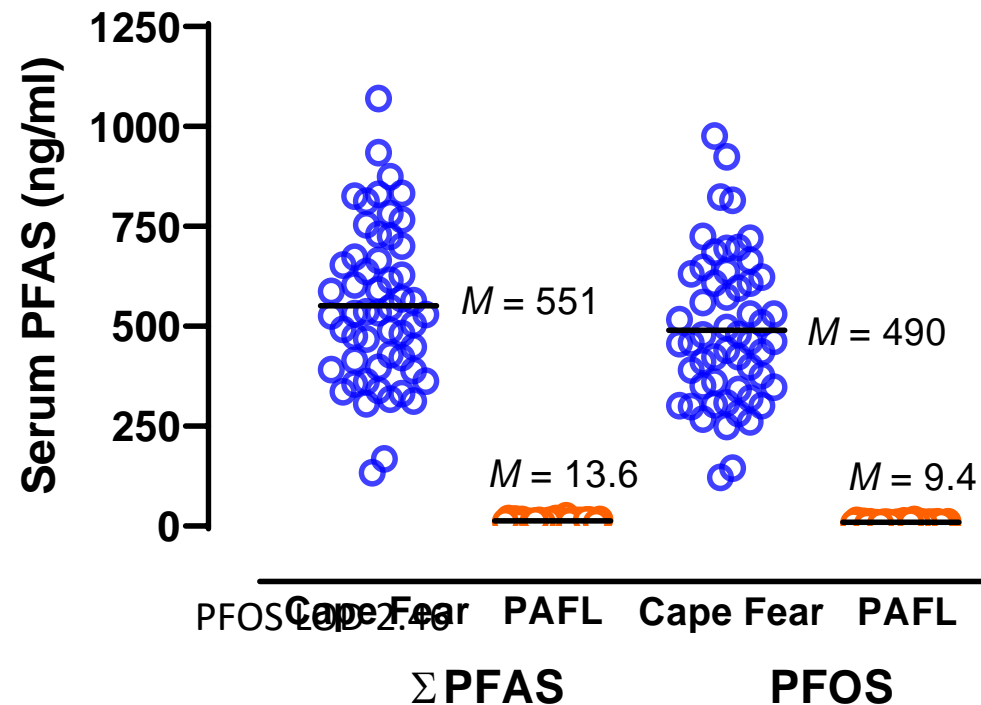
Table 2

PFAS detection frequency and concentration in Striped Bass serum.

	LOD (ng/mL)	CFR % > LOD (n=58)	PAFL % > LOD (n=29)	Concentration (ng/mL) mean (range)	
				Cape Fear	PAFL
PFNA	0.34	100	96.9	4.49 (0.81-11.6)	0.48 (0.34-0.82)
PFDA	1.68	100	96.9	68.0 (10.2-146)	2.5 (1.68-4.6)
PFOS	2.47	100	100	490 (122-977)	9.41 (4.62-16.5)
PFHxS	0.09	98.3	3.4	0.78 (0.15-2.23)	0.59
Nafion byproduct 2	0.25	77.6	0	0.30 (0.25-1.03)	All < LOD
GenX	0.24	48.3	10.3	1.91 (0.31-5.85)	1.64 (0.24-2.3)
PFBS	0.01	24.1	44.8	0.15 (0.01-1.35)	0.01 (0.01-0.2)
PFO5DoDA	0.01	22.4	0	0.49 (0.01-1.35)	All < LOD
PFOA	0.16	15.1	13.8	0.57 (0.16-4.29)	0.16 (0.16-1.14)
PMPA	0.12	13.8	10.3	0.12 (0.12-0.19)	0.12 (0.12-0.14)
PFBA	0.11	13.8	0	0.11 (0.11-0.18)	All < LOD

LOD, limit of detection; CFR, Cape Fear River; PAFL, Pamlico aquaculture field laboratory

# PFOS accounted for 89% of PFAS present in serum of Striped Bass from the Cape Fear River



## PFAS are also present in Striped Bass Tissue (muscle/filet)

### PFAS detected in muscle

Table 2

PFAS detection frequency and concentration in Striped Bass serum.

	LOD (ng/mL)	CFR % > LOD (n=58)	PAFL % > LOD (n=29)	Concentration (ng/mL) mean (range)	
				Cape Fear	PAFL
PFNA	0.34	100	96.9	4.49 (0.81-11.6)	0.48 (0.34-0.82)
PFDA	1.68	100	96.9	68.0 (10.2-146)	2.5 (1.68-4.6)
PFOS	2.47	100	100	490 (122-977)	9.41 (4.62-16.5)
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GenX	0.24	48.3	10.3	1.91 (0.31-5.85)	1.64 (0.24-2.3)
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PMPA	0.12	13.8	10.3	0.12 (0.12-0.19)	0.12 (0.12-0.14)
PFBA	0.11	13.8	0	0.11 (0.11-0.18)	All < LOD

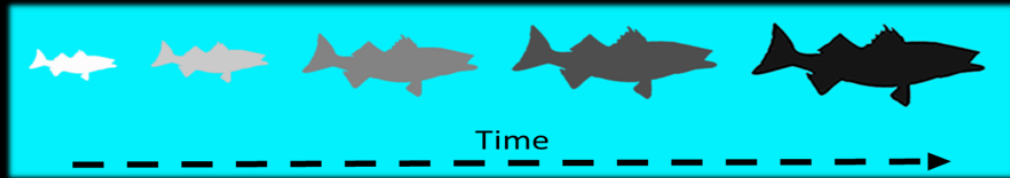
LOD, limit of detection; CFR, Cape Fear River; PAFL, Pamlico aquaculture field laboratory

	LOD (ng/g)	CFR % > LOD (n=5)	Concentration (ng/g) mean (range)
			Cape Fear
PFNA	0.3	100	0.55 (0.17-1.44)
PFOS	0.1	100	7.02 (2.80-13.3)
NVHOS	0.01	100	1.14 (0.59-3.05)
PFBA	0.01	100	0.35 (0.11-0.84)
PFHxS	0.09	100	4.35 (0.3-18.9)
PFDA	0.1	80	20.1 (15.9-27.8)
PFHpA	0.02	80	37.8 (25.1-61.6)
HFPO-DA (GenX)	0.04	60	1.63 (0.3-5.09)
PMPA	0.01	20	0.06
Nafion byproduct 2	0.02	20	0.43
PFBS	0.01	20	18.7
PFO3DoDA	0.01	20	9.74
PFO5DoDA	0.01	20	0.21
PFO2HxA	0.05	0	ND
PFO4DA	0.01	0	ND

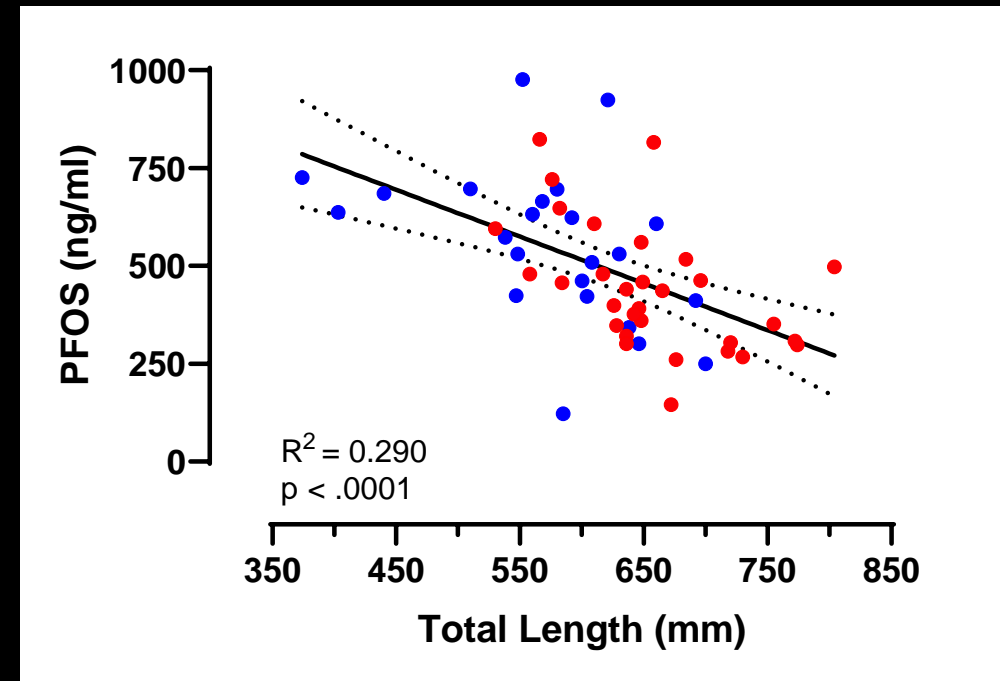
N = 5 May 2019, Lock and Dam #1  
(unpublished)

# PFAS do not increase with body weight/length/age

Persistent Organic Pollutants (POPS) or Toxic Metals

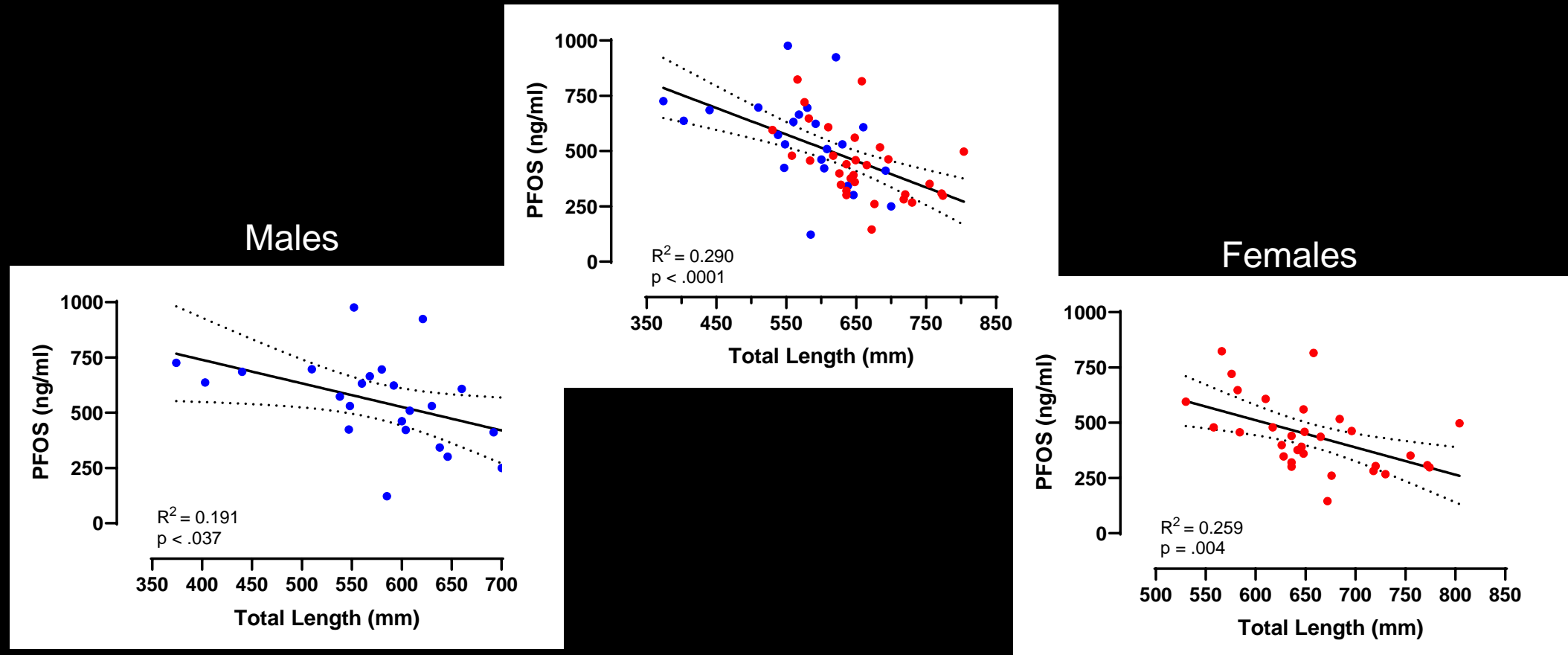


Contaminant is eliminated much slower than it is absorbed





# PFAS Decrease with Body Size in Both Males and Females



**Are PFAS partitioning to germ cells and impacting reproduction?**

## PFAS Exposures Striped Bass

- High levels of PFAS present in Striped Bass from the Cape Fear
- Most serum PFAS is PFOS
- PFAS exposure is associated with *adverse effects* on liver and immune function of Striped Bass
- Both exposure and effects mirror known toxic impacts of PFAS
- **Ongoing analysis:** has determined tissue PFAS distribution in Catfish, American Shad, Sunfish and Striped bass
- Analyzing PFAS in Striped Bass serum 2019: CFR vs Roanoke
- Planned for Spring 2020:
  - Resampling from all NC watershed
  - Experiments to investigate PFAS impacts on reproduction
- Paired analysis humans consumption and PFAS in fish caught

