Ecotoxicological assessment of perfluorooctancesulfonate (PFOS) and temperature on two estuarine fish species

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Introduction:

Forever chemicals, collectively known as PFAS, have been used in food packaging, cosmetics, and water- and oil-resistant products. PFAS have toxic effects on aquatic and terrestrial species[1], binding to serum proteins and partitioning in blood-rich organs, like the liver and kidneys[3,6]. PFAS also affects immune response[4], thyroid function[2], and reproductive hormones[2]. One PFAS, perfluorooctanesulfonate (PFOS), has a long carbon chain and sulfonic group, both of which have been shown to increase toxicity[5]. Only one study has examined the interaction between PFOS toxicity and temperature[7]. This study is increasingly applicable with climate change and rising seawater temperatures.

Test Species:

Cyprinodon variegatus (sheepshead minnow) is a hardy, standard toxicity test organism. They are ecologically important, live in estuaries, and act as food for larger trophic levels. *Sciaenops ocellatus* (red drum) are a commercially and recreationally important fishery in S.C. and along the east coast of the United States. They spend their larval and juvenile life stages in estuaries, such as Charleston Harbor, before moving offshore in adulthood. The use of these two estuarine species will offer insights to differences in species sensitivity to PFOS and the influence of temperature on toxicity.

Figure 1. Adult male *C. variegatus* (far left). Larval *S. ocellatus* (left).

Objectives:

To determine toxicity of PFOS at 20°C and 30°C on juvenile *Sciaenops ocellatus* and adult *Cyprinodon variegatus* at various endpoints.

Endpoints:

1. Mortality thresholds (LC50 values)
2. Biouptake of PFOS in tissues
3. Biomarkers (LPX and GSH in liver, AChE in brain), thyroid (T3, T4) in blood (*C. variegatus*) and gills (*S. ocellatus*)
4. Oxygen uptake via respirometry

Methods:

LC50s at 20°C and 30°C:

- 6 concentrations of PFOS + control
- 3 replicates (18 tanks/T); 20 ppt salinity
- 5 individuals per exposure chamber
- Dissect and collect gill, brain, liver for biomarkers
- Collect and measure water chemistry for validation
- Flash freeze one fish per chamber for body burden analysis

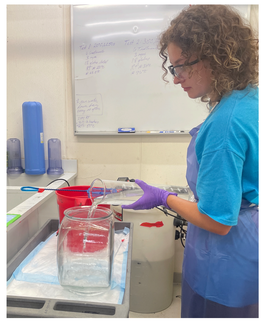
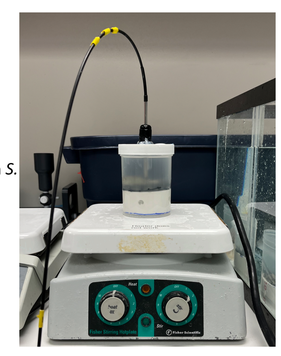


Figure 2. Adding FPOS dose into exposure chamber (above). Preparing PFOS dose (top right). Mortality test layout (bottom right).

Multi-stressor (PFOS + T):

- 3 concentrations of PFOS (3, 9, 27 mg/L) + control
- 4 replicates (16 chambers/T), 20 ppt salinity
- 5 individuals per exposure chamber
- Dissect and collect gill, brain, liver for biomarkers
- Measure respiration rates
- Collect and measure water chemistry for validation
- Flash freeze one fish per chamber for body burden analysis

Figure 3. Dissecting brain, liver, and gill in *S. ocellatus* (left). Respirometry setup (right).



Current Results:

- Mortality data:
  - LC50s for *S. ocellatus* at 20°C and 30°C and *C. variegatus* at 20°C are > 81 mg/L.
- Water chemistry:
  - Reasonable agreement with target doses, lower at higher doses approaching limit of PFOS solubility
- Respirometry, biomarkers, and body burden data are being processed.

Mortality Testing*

Nominal Concentration (mg/L)	Measured Concentration (mg/L)	
	Mean (mg/L) (± SD)	% Nominal
0.0	0.031 (0.037)	0
1.0	0.788 (0.072)	78.8
3.0	2.376 (0.157)	79.2
9.0	7.019 (1.422)	78.0
27.0	20.565 (2.665)	76.2
81.0	59.798 (6.613)	73.8

*from mortality tests on S. ocellatus (20°C & 30°C) and C. variegatus (20°C)

Anticipated Results:

Based on survival data, juvenile red drum are not more sensitive to PFOS than adult sheepshead minnows. There was no acute mortality in either species up to the limit of solubility for PFOS. Analyses to assess biouptake of PFOS and sublethal effects on fish respiration and enzyme function are ongoing. These endpoints may reveal differences between species and temperatures. This study will yield data on how a persistent environmental contaminant impacts estuarine fish health and how toxicity will be affected by rising temperatures. Understanding how estuarine fishes are impacted by multi-stressors will benefit management plans.

Acknowledgements:

This research would not have been possible without the resources and assistance offered by the Slocum-Lunz Foundation, NCCOS, the Beers Lab at the College of Charleston, and SCDNR.

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