NC DEPARTMENT OF HEALTH AND HUMAN SERVICES

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Appendix B. Calculation of Fish Advisories (July 2023)

Calculation of Fish Advisories

The Fish Consumption Advisories (FCA) described here were calculated to address public health concerns regarding consumption of fish from the Middle and Lower Cape Fear River. FCAs are developed on a site-specific basis, and since the Cape Fear River is a moving water body, fish were collected throughout a 160-kilometer section of the river in accordance with methods described in Appendix A to inform the development of PFAS-specific Fish Consumption Advisories (Figure 1).

Table 1 shows the average concentrations of PFAS chemicals for each species. Although multiple PFAS were detected in low concentrations in multiple species, concentrations of PFOS were consistently the highest amongst all species sampled. These consistently elevated concentrations in conjunction with the new, lower reference dose for PFOS released by the United States Environmental Protection Agency (USEPA) in March 2023 informed the decision to base the derived fish advisories on PFOS concentrations. Additionally, we considered both cancer and noncancer toxicological information published by the USEPA for our calculations (USEPA 2023). However, use of the non-carcinogenic reference dose resulted in more protective fish consumption advisories and thus drove our calculations. As new toxicological data becomes available for other PFAS detected, the data will be revaluated to ensure that fish consumption advisories remain protective of public health.

Based on analysis from the North Carolina Department of Environmental Quality (NCDEQ) there was no statistical difference in PFAS concentrations from each site, with fish species being the only significant variable affecting PFAS concentrations (Appendix A). Therefore, we first calculated an average PFOS concentration for each species, using data from all sites (Table 1), and then meal limits for each species using Equations 1 and 2. Values for the other variables used in Equations 1 and 2 were taken from OEEB's Fish Consumption Advisory Standard Operating Procedure. We then averaged similar species-specific meal limits within two categories to develop the final values in Tables 2 and 3.

American Shad were included in the calculation of the less restrictive meal limit tier because they are a migratory species that can be found throughout the Cape Fear River system depending on the time of year, thus concentrations of PFAS in American Shad are assumed to be representative of other American Shad caught throughout the Cape Fear River.

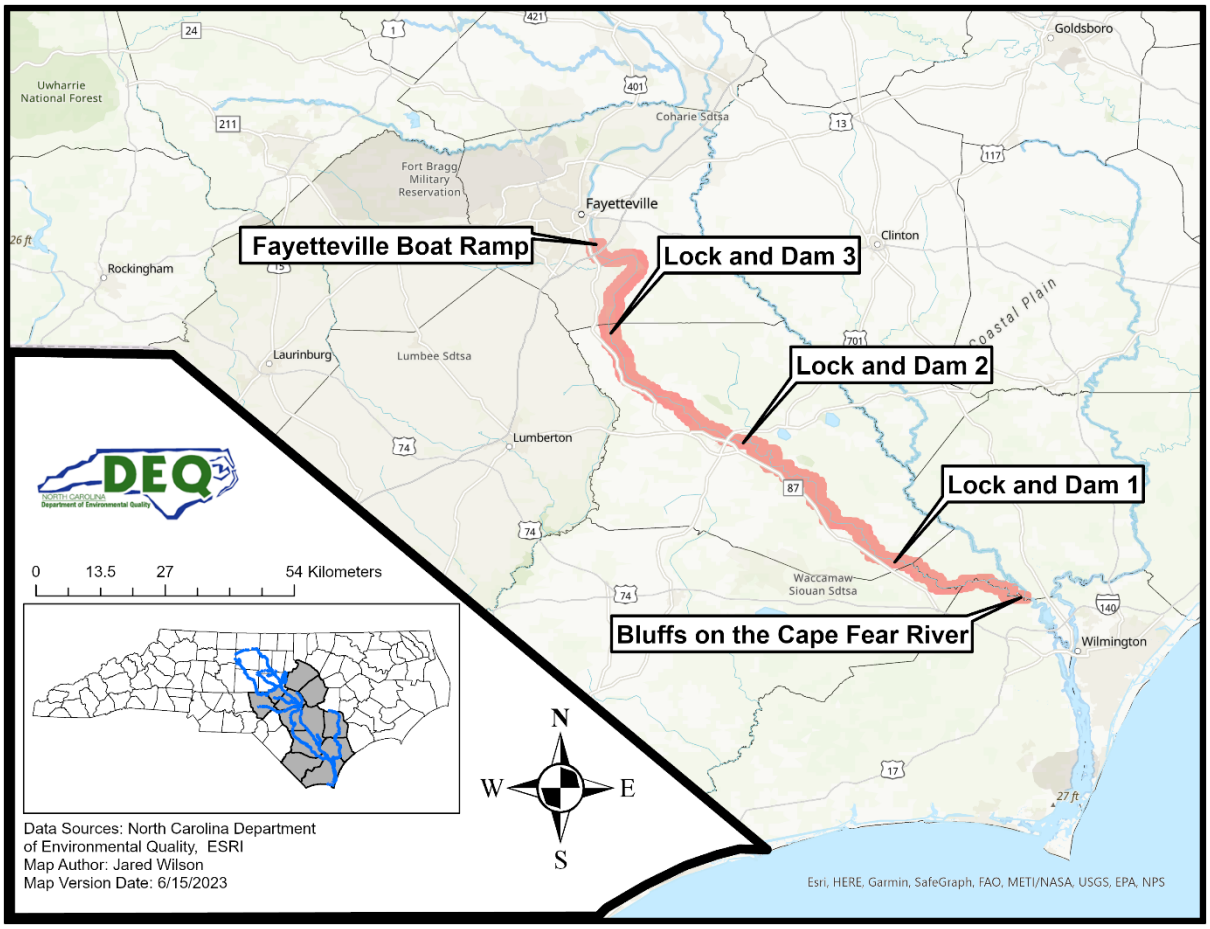

Figure 1:
A map of the middle and lower regions of the Cape Fear River, NC, annotated to highlight the region that the Fish PFAS Advisory pertains to which is bounded by the Fayetteville Boat Ramp and the Bluffs on the Cape Fear. The map was created by Jared Wilson (NCDEQ) using ArcPro (ESRI).

Limitations of the Fish Consumption Advisories:

1. Fish consumption evaluations rely on the fish that are collected being representative of the contaminant levels throughout the water body for that specific species or trophic level.

Equation 1: North Carolina Department of Health and Human Services (NCDHHS) equation for calculating meal limits for fish consumption advisories for non-carcinogenic chemicals.

$$\boldsymbol{ML_{nc}} = \frac{RfD \times BW \times Tap}{C \times MS \times LF \times week/month}$$

- ML_{nc} = non-cancer fish consumption meal limit (meals/week)
- RfD = reference dose (mg/kg/day) = 1 x 10^{-7} for PFOS
- BW = body weight (kg) = 80kg
- T_{ap} = time averaging period (days/month) = 30.44 days/month
- C = average contaminant concentration (mg/kg) = Obtained from the appropriate Table
- MS = size of one fish meal (kg/meal) = 0.17 kg/meal
- LF = loss factor due to trimming and cooking = 1.0 for PFAS chemicals
- Week/month = 4.33 weeks/month

Equation 2: NCDHHS equation for calculating meal limits for fish consumption advisories for non-carcinogenic chemicals specific to vulnerable populations (women of childbearing age (15 to 44 years), pregnant women, nursing mothers and children).

$$\boldsymbol{ML_{nc}} = \frac{RfD \times BW \times Tap}{C \times MS \times LF \times week/month} \times MF$$

- ML_{nc} = non-cancer fish consumption meal limit (meals/week)
- RfD = reference dose (mg/kg/day) = 1 x 10^{-7} for PFOS
- BW = body weight (kg) = 80kg
- T_{ap} = time averaging period (days/month) = 30.44 days/month
- C = average contaminant concentration (mg/kg) = Obtained from the appropriate Table
- MS = size of one fish meal (kg/meal) = 0.17 kg/meal
- LF = loss factor due to trimming and cooking = 1.0 for PFAS chemicals
- Week/month = 4.33 weeks/month
- MF = meal size modifying factor = 0.17

Fish Tissue Data and Calculations Used to Determine Fish Consumption Advisories for the Middle and Lower Regions of the Cape Fear River

Table 1: Average tissue concentrations of PFAS chemicals detected in fish species sampled across the 160-km section of the Cape Fear River during the summer of 2022. This data was provided by NCDEQ in Appendix A and was converted from ng/g to mg/kg, which is the appropriate unit for use in the NCDHHS Fish Advisory Equations 1 and 2. Only the detected PFAS were included in the Table. Also, "ND" signifies that a particular PFAS was not detected in the species indicated.

Fish Species	Average PFAS Concentration Across the 160-km River Section (mg/kg)																
	N-MeFOSAA	NEt FOSAA	PFDA	PFDS	PFDoA	PFHxS	PFMOAA	PFOS	PFOSA	PFTA	PFTriA	PFUnA	6:2 FTS	PFNA	PFO5DA	PFOA	PFBA
Largemouth Bass	0.0003	0.0006	0.0011	0.0006	0.0016	0.0002	0.0005	0.0248	0.0002	0.0009	0.0012	0.0017	*ND*	*ND*	*ND*	*ND*	*ND*
Bluegill Sunfish	0.0004	0.0004	0.0008	0.0005	0.0013	0.0002	*ND*	0.0230	0.0003	0.0007	0.0009	0.0014	*ND*	*ND*	*ND*	*ND*	*ND*
American Shad	*ND*	*ND*	*ND*	*ND*	0.0002	*ND*	*ND*	0.0040	0.0002	0.0002	0.0002	0.0002	*ND*	*ND*	*ND*	*ND*	*ND*
Redear Sunfish	0.0004	0.0004	0.0008	0.0004	0.0010	0.0002	*ND*	0.0204	0.0003	0.0007	0.0009	0.0011	0.0026	0.0004	0.0005	0.0003	*ND*
Blue Catfish	*ND*	0.0003	0.0003	*ND*	0.0004	0.0002	*ND*	0.0015	0.0003	0.0004	0.0004	0.0004	*ND*	*ND*	*ND*	*ND*	0.0004
Flathead Catfish	*ND*	0.0007	0.0009	0.0005	0.0017	*ND*	*ND*	0.0130	0.0004	0.0009	0.0013	0.0018	*ND*	*ND*	*ND*	*ND*	*ND*
Channel Catfish	*ND*	*ND*	0.0004	0.0002	0.0006	*ND*	*ND*	0.0027	0.0003	0.0004	0.0005	0.0007	*ND*	*ND*	*ND*	*ND*	*ND*
Striped Bass	*ND*	*ND*	0.0011	0.0003	0.0008	*ND*	*ND*	0.0143	0.0023	0.0004	0.0006	0.0012	0.0014	*ND*	*ND*	*ND*	*ND*

Table 2: Meal limits calculated for women of childbearing age (15 to 44 years), pregnant women, nursing mothers and children, using Equation 2 for non-carcinogenic health effects related to exposure to PFOS, for fish species caught in the Cape Fear River.

Meal Limit (meals/year) based on PFOS		
Fish Species	**Middle and Lower Cape Fear River Meal Limits**	**Combined Meals/Year Recommendations**
American Shad	0.74	**1**
Blue Catfish	2.01	
Channel Catfish	1.07	
Bluegill Sunfish	0.13	**Do Not Eat**
Flathead Catfish	0.23	
Large Mouth Bass	0.12	
Redear Sunfish	0.14	
Striped Bass	0.20	

Table 3: Meal limits calculated for all other individuals, using Equation 1 for non-carcinogenic health effects related to exposure to PFOS, for fish species caught in the Cape Fear River.

Meal Limit (meals/year) based on PFOS		
Fish Species	**Middle and Lower Cape Fear River Meal Limits**	**Combined Meals/Year Recommendations**
American Shad	4.32	**7**
Blue Catfish	11.8	
Channel Catfish	6.32	
Bluegill Sunfish	0.76	**1**
Flathead Catfish	1.33	
Large Mouth Bass	0.68	
Redear Sunfish	0.85	
Striped Bass	1.20	

Example Use of Meal Limits

Using Table 3 as an example, a combined meals/year of 7 meals per year of American Shad, Blue Catfish, and Channel Catfish means that only 7 meals of any/and/or the other species within the yellow color block should be consumed.

Examples of combined meal per year recommendations

3 American Shad, 2 Blue Catfish, 2 Channel Catfish = 7 meals
3 Blue Catfish, 4 Channel Catfish = 7 meals
7 American Shad = 7 meals