NORTH CAROLINA DIVISION OF PUBLIC HEALTH REVIEW OF ROUNDS 4 AND 5 FISH TISSUE METALS DATA FOR THE DAN RIVER FOLLOWING THE FEBRUARY 2014 DUKE ENERGY COAL ASH SPILL NEAR EDEN, NC

Division of Public Health
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Human Health Summary

The North Carolina Department of Environmental Quality (DEQ) has periodically collected fish from the Dan River to evaluate potential environmental impacts resulting from the February 2, 2014 Duke Energy Dan River plant coal ash spill near Eden, North Carolina. DEQ collected two rounds of baseline fish samples (round 1 from February 24 to March 5, 2014; round 2 from April 9-24, 2014). DEQ considers the "baseline" data to represent conditions prior to potential uptake of coal ash related metals into the fish tissue. A third round of fish tissue samples, not identified by DEQ as baseline, was collected from November 12 through December 3, 2014. Data from the first three rounds of sampling were previously assessed by the North Carolina Department of Health and Human Services (DHHS) Division of Public Health (N.C. DPH) [DPH 2014, DPH 2015a, DPH 2015b].

This report will evaluate data from round 4 collected from April 28 to May 6, 2015 and from round 5 collected April 27 to Jun 2, 2016. Round 4 and 5 fish were collected at four locations in the North Carolina waters of the Dan River: Eden, Berry Hill, Milton, and the Kerr Reservoir near the Satterwhite Point Recreation Area (See Figure 1 and Table 3 in Appendix). The Eden location is upstream of the coal ash spill and fish from this area are blocked from moving downstream by a dam, so this area serves as a background or control site.

N.C. DPH is evaluating fish tissue data collected in the Dan River to determine if eating fish from the river poses a health risk to fishermen in the area. The only human health screening level exceedances in round 4 fillet tissue samples were in 5 of 11 striped bass from the Milton location. The human health screening level (SL) exceedances for round 4 are summarized in table 1. A more detailed summary of round 4 data can be found in the Appendix in tables 4 and 5. The only screening level exceedances in round 5 fillet tissue samples were in 3 of 9 largemouth bass from Kerr Reservoir and 6 of 10 striped bass from the Milton location. The human health screening level exceedances for round 5 are summarized in table 2. A more detailed summary of round 5 data can be found in the Appendix in tables 6 and 7.

Table 1. N.C. DEQ Dan River Round 4 (April 28- May 6, 2015) fish tissue samples exceeding N.C. DPH screening levels.

Species	# Fillets Analyzed	No. of SL exceedances (%)	SL Exceeded	Average Concentration (mg/kg)	Collection Location with Exceedance
Striped Bass	11	3 (27%)	Mercury	0.3	Milton
		2 (18%)	Arsenic	0.2	

Table 2. N.C. DEQ Dan River Round 5 (April 27- June 2, 2016) fish tissue samples exceeding N.C. DPH screening levels.

Species	# Fillets Analyzed	No. of SL exceedances (%)	SL Exceeded	Average Concentration (mg/kg)	Collection Location with Exceedance
Largemouth Bass	9	3 (33%)	Mercury	0.4	Kerr Res.
Striped Bass	10	6 (60%)	Mercury	0.4	Milton

Based on the evaluation of fish tissue samples over time, DPH makes the following recommendations regarding consumption of fish caught from Dan River downstream from the coal ash spill:

1. N.C. DEQ continue sampling fish and shellfish tissue from the Dan River for metals every other year starting in 2018 to ensure that changes in environmental conditions over time do not result in elevated metal concentrations.
2. N.C. DPH lift its current "do not eat" fish consumption recommendation that had been issued for all species immediately after the spill. The consumption of two fish species is still recommended to be limited, as outlined in recommendations 3 and 4 below.
3. People follow the statewide fish consumption advisory for mercury which states:
   Women of Childbearing Age (15-44 years), Pregnant Women, Nursing Women, and Children under 15:
   Do not eat fish high in mercury, including largemouth bass caught in the state. Eat up to two meals per week of fish low in mercury. A meal is 6 ounces of uncooked fish for adults, or 2 ounces of uncooked fish for children under 15.
   All Other Individuals:
   Eat no more than one meal per week of fish high in mercury, including largemouth bass caught in the state. Eat up to four meals per week of fish low in mercury. A meal is 6 ounces of uncooked fish for adults, or 2 ounces of uncooked fish for children under 15.
4. People follow an additional advisory for striped bass caught from the N.C. portion of the Dan River that runs through Caswell county, downstream from Danville, VA. Women of childbearing age, pregnant women, nursing women, and children less than 15 years old should not eat striped bass in this area due to high mercury, and all others should eat no more than one meal per week due to mercury.

<u>Public Health Implications of DEQ's Round 4 and 5 Fish Tissue Data</u>

N.C. DPH is responsible for recommending fish consumption advisories for people that eat fish caught in N.C. waters. N.C. DPH uses fillet data for fish tissue evaluations because this best represents the part of the fish most commonly eaten. Some contaminants may be present at different concentration in other parts of the fish, such as in eggs or the liver. Fillet samples were

analyzed for 16 metals selected by the Dan River interagency work group, which was formed to address ecological and public health issues associated with the coal ash spill. The work group includes N.C. DPH and N.C. DEQ representatives, as well as representatives from Virginia state environmental and public health agencies, the U.S. Environmental Protection Agency (EPA) and the U.S. Fish and Wildlife Service (FWS).

Coal ash related metals may be present in the water, in the sediment, or in the organisms living in the river. Fish can take up metals through their gills, by eating other contaminated organisms in the river, or through their skin from direct contact with the water or the sediment. The presence of a metal in fish tissue does not necessarily mean it is harmful. All metals, even those needed in small amounts for good health, can be harmful if accumulated to elevated levels.

Evaluation of Fish Tissue Data for Consumption Advisories

N.C. DPH compares the concentrations of contaminants found in fish fillet tissue to human health screening levels to determine if a fish consumption advisory is needed. Screening levels are developed using laboratory and epidemiological study data and represent concentrations of a substance that are not anticipated to be harmful to people eating contaminated fish over very long periods of time. Children may be more sensitive to the potential harmful effects of some metals, such as mercury. We also know that some contaminants stay in the body longer than others and some can be passed from the mother to an unborn child, or to an infant through breast milk. These factors are considered when screening levels are developed.

Fish consumption advisories are presented as a recommended maximum number of meals of fish on a per-week or per-month basis for a specific species. N.C. DPH uses health-protective considerations when identifying how much fish is safe for people to eat. The N.C. DPH advisory method is protective of people who will eat fish daily throughout their lifetime. Prior to the Dan River coal ash spill, N.C. DPH had statewide fish tissue action levels for the metals mercury and selenium. N.C. DPH developed fish tissue screening levels for additional metals to be analyzed in response to the coal ash spill. The Dan River fish tissue screening levels are listed in the Appendix in Table 8.

Uncertainties in the Public Health Evaluation Process

There are inherent uncertainties in any evaluation of environmental data for potential human exposures. Not all metals in the water or sediment may be bioavailable, or present in a form that can be taken up by organisms. However, as environmental conditions in the river change, the bioavailability of metals can change. As the coal ash is buried deeper in the river sediment, the influence of sediment depth-related microbial and chemical changes may alter the bioavailability of the coal ash-associated metals. In addition, metal bioavailability may be influenced by conditions such as storm flows, drought, hurricanes, or significant sediment disturbances such as dredging. The potential impact of these conditions on bioavailability will vary with each metal.

In addition, distinct species of fish, and fish at different ages, may take up metals at different rates.

Additionally, there is uncertainty in the evaluation of the potential health impacts associated with thallium because the analytical method is not sensitive enough to detect thallium levels that could be harmful to human health.

Public Health Conclusions for Round 4 and 5 Dan River Fish Tissue Samples

1. Daily consumption of striped bass from the Milton site in the Dan River or largemouth bass from Kerr Reservoir could harm people's health due to elevated levels of mercury in fish tissue.
2. With the exception of striped bass and largemouth bass, no other fish species tested from the four sites along the Dan River had elevated levels of metals that would warrant a continued fish consumption advisory at this time.

Public Health Recommendations for Round 4 and 5 Dan River Fish Tissue Samples

1. N.C. DEQ continue sampling fish and shellfish tissue from the Dan River for metals every other year starting in 2018 to ensure that changes in environmental conditions over time do not result in elevated metal concentrations.
2. N.C. DPH lift its current "do not eat" fish consumption recommendation that had been issued for all species immediately after the spill. The consumption of two fish species is still recommended to be limited, as outlined below.
3. People follow the statewide fish consumption advisory for mercury which states:

   Women of Childbearing Age (15-44 years), Pregnant Women, Nursing Women, and Children under 15:

   Do not eat fish high in mercury, including largemouth bass caught in the state. Eat up to two meals per week of fish low in mercury. A meal is 6 ounces of uncooked fish for adults, or 2 ounces of uncooked fish for children under 15.

   All Other Individuals:

   Eat no more than one meal per week of fish high in mercury, including largemouth bass caught in the state. Eat up to four meals per week of fish low in mercury. A meal is 6 ounces of uncooked fish for adults, or 2 ounces of uncooked fish for children under 15.
4. People follow an additional advisory for striped bass caught from N.C. portions of the Dan River that runs through Caswell county downstream from Danville, VA. Women of childbearing age, pregnant women, nursing women, and children less than 15 years old should not eat striped bass in this area due to high mercury, and all others should eat no more than one meal per week due to mercury.
5. Fishermen be aware of fish consumptions advisories in this waterway issued by the Virginia Department of Health since the river flows through both states. VDH fish

consumption advisories can be found online: http://www.vdh.virginia.gov/environmental-epidemiology/public-health-toxicology/fish-consumption-advisories/

Public Health Action Plan

N.C. DPH will:

1. Issue a site specific advisory for striped bass at the Milton site in Dan River with the following recommendations:

   Women of Childbearing Age (15-44 years), Pregnant Women, Nursing Women, and Children under 15:

   Do not eat fish high in mercury, including striped bass caught in the N.C. portion of the Dan River that runs through Caswell county downstream from Danville, VA.

   All Other Individuals:

   Eat no more than one meal per week of fish high in mercury, including striped bass caught in the N.C. portion of the Dan River that runs through Caswell county downstream from Danville, VA. A meal is 6 ounces of uncooked fish for adults.
2. Collaborate with local health departments and other partners to produce educational materials and programs to educate local fishermen about the statewide mercury advisory and site-specific fish consumption advisories.
3. Coordinate with local health departments and N.C. DEQ to lift the “do not eat” recommendation that had been issued immediately after the spill.
4. Continue to evaluate fish tissue data collected by N.C. DEQ from the Dan River to determine if eating fish from the river poses a health risk to fishermen in the area.

References

[DPH 2014] *Health Evaluation of Baseline Fish Tissue Data for the Dan River – November 13, 2014*. North Carolina Division of Public Health. November 2014. http://epi.publichealth.nc.gov/oee/hace/docs/DanRiverFishReport.pdf

[DPH 2015a] *Health Evaluation of 2nd Baseline Fish Tissue Data for the Dan River – April 17, 2015*. North Carolina Division of Public Health. April 2015. http://epi.publichealth.nc.gov/oee/hace/docs/DanRiverRound2Fish.pdf

[DPH 2015b] *Health Evaluation of 3rd Round of Fish Tissue Data for the Dan River – July 13, 2015*. North Carolina Division of Public Health. July 2015. http://epi.publichealth.nc.gov/oee/hace/docs/DanRiverRound3Fish.pdf

Appendix

Figure 1. N.C. DEQ Rounds 4 and 5 collection locations in the Dan River. Round 4 fish collected April 28 – May 6, 2015. Round 5 collected April 27 – June 2, 2016. J1: Eden (upstream background location), D1: Berry Hill; F1: Milton; and Kerr Reservoir. Source: N.C. DEQ

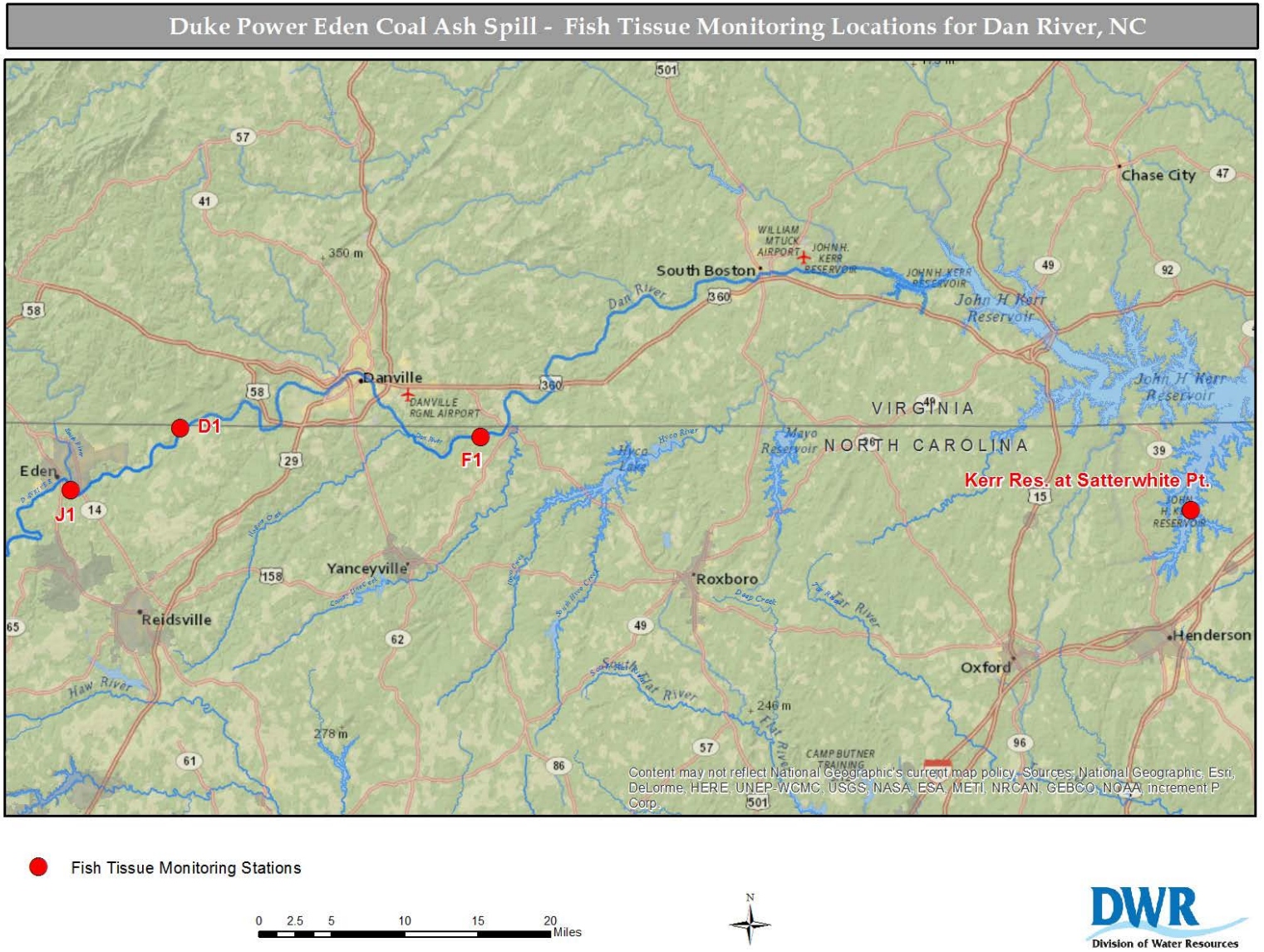

Table 3. N.C. DEQ Round 4 and 5 Dan River fish collection locations and sampling dates. Locations listed upstream to downstream.

Location Description	County / State	Site ID	Round 4 Collection Date	Round 5 Collection Date
Eden [a]	Rockingham / NC	J1	April 29, 2015	April 28, 2016
Berry Hill	Rockingham / NC	D1	May 6, 2015	June 1, 2016
Milton	Caswell / NC	F1	April 28, 2015	April 27, 2016
Kerr Reservoir near Satterwhite Point Recreational Area	Vance / NC	Kerr Res.	April 30, 2015	June 2, 2016

[a] The fish collected at the Eden, NC location are isolated by a dam from the downstream area of the Dan River impacted by the coal ash spill.
ID = identification

Table 4. Dan River round 4 fish fillet metals sample summary by species and sample location. Locations arranged upstream to downstream. Fish collected April 28 – May 6, 2015. Numbers are total number of samples, and values in parenthesis are the number of composite fillet samples.

Species	Eden NC	Berry Hill NC	Milton NC	Kerr Res. NC	Total number analytical samples
Blue Catfish			11		11
Channel Catfish		2	4 (1)		6
Gizzard Shad		1			1
Golden Redhorse	7	6 (1)			13
Largemouth Bass				9	9
Notchlip Redhorse			3		3
Quillback			3		3
Redbreast Sunfish	7 (2)	2	1		10
Redear Sunfish				3	3
Shorthead Redhorse			5		5
Striped Bass			11		11
V-lip Redhourse	5	1	1		7
Yellow Perch				6	6
Total No. Fillet Samples	19	12	39	18	88
No. Species	3	5	8	3	13

No. = Number

Table 5. Human health screening level analysis summary for the Dan River round 4 fish fillet metals data. Fish collected April 28 – May 6, 2015. All samples collected in North Carolina segments of the Dan River.

Species	No. of Fillets Analyzed	No. of SL exceedances (%)	SL Exceeded	Average Concentration (mg/kg)	Collection Location with Exceedance
Blue Catfish	11	0			
Channel Catfish	6	0			
Gizzard Shad	1	0			
Golden Redhorse	13	0			
Largemouth Bass	9	0			
Notchlip Redhorse	3	0			
Quillback	3	0			
Redbreast Sunfish	10	0			
Redear Sunfish	3	0			
Shorthead Redhorse	5	0			
Striped Bass	11	3 (27%)	Mercury	0.3	Milton
		2 (18%)	Arsenic	0.2	
V-lip Redhourse	7	0			
Yellow Perch	6	0			

No. = Number

SL = N.C. DPH human health screening level for fish ingestion

mg/kg = milligram of metal per kg of fish tissue

Table 6. Dan River round 5 fish fillet metals sample summary by species and sample location. Locations arranged upstream to downstream. Fish collected April 27 – June 2, 2016. Numbers are total number of samples, and values in parenthesis are the number of composite fillet samples.

Species	Eden NC	Berry Hill NC	Milton NC	Kerr Res. NC	Total Number analytical samples
Black Crappie		1			1
Blue Catfish			7		7
Bluegill Sunfish				1	1
Brown Bullhead				1	1
Channel Catfish		3	6 (1)	1	10
Gizzard Shad			2 (1)		2
Golden Redhorse	10	9			19
Largemouth Bass				9	9
Notchlip Redhorse			6		6
Quillback			2		2
Redbreast Sunfish	5	5			10
Redear Sunfish				3	3
Striped Bass			10		10
V-lip Redhourse	3		2		5
Walleye			1		1
White Bass			1		1
White Sucker	1				1
Yellow Perch				3	3
Total No. Fillet Samples	19	18	37	18	92
No. Species	4	4	9	6	18

No. = Number

Table 7. Human health screening level analysis summary for the Dan River round 5 fish fillet metals data. Fish collected April 27 – June 2, 2016. All samples collected in North Carolina segments of the Dan River.

Species	No. of Fillets Analyzed	No. of SL exceedances (%)	SL Exceeded	Average Concentration (mg/kg)	Collection Location with Exceedance
Black Crappie	1	0			
Blue Catfish	7	0			
Bluegill Sunfish	1	0			
Brown Bullhead	1	0			
Channel Catfish	10	0			
Gizzard Shad	2	0			
Golden Redhorse	19	0			
Largemouth Bass	9	3 (33%)	Mercury	0.4	Kerr Res.
Notchlip Redhorse	6	0			
Quillback	2	0			
Redbreast Sunfish	10	0			
Redear Sunfish	3	0			
Striped Bass	10	6 (60%)	Mercury	0.4	Milton
V-lip Redhourse	5	0			
Walleye	1	0			
White Bass	1	0			
White Sucker	1	0			
Yellow Perch	3	0			

No. = Number
SL = N.C. DPH human health screening level for fish ingestion
mg/kg = milligram of metal per kg of fish tissue

Table 8. N.C. DPH human health screening levels for metals in Dan River fish fillet tissue. Source: N.C. DPH September 2014.

Metal	Fish Tissue Screening Levels for Ingestion (mg/kg)
Aluminum	410
Antimony	0.16
Arsenic (as inorganic As)	0.027
Arsenic (as total As)[a]	0.27
Barium	82
Beryllium	1.6
Boron	82
Cadmium	0.41
Calcium	Not Available
Chromium (VI)	1.2
Cobalt	0.12
Copper	16
Iron	290
Lead	Not Available
Lithium	0.82
Magnesium	Not Available
Manganese	58
Nickel	8.2
Silver	2.1
Sodium	Not Available
Thallium	0.00412
Vanadium	2.1
Zinc	120

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Table 8 continued.

Mercury (mg/kg) [b]	Women of Childbearing Age (15 to 44 years) and Children (< 15 years)	Others
<0.4	2 meals per week	4 meals per week
0.4 to 1.0	Do not eat	1 meal per week
>1.0 to 3.0	Do not eat	1 meal per month
>3.0	Do not eat	Do not eat

Selenium (mg/kg)	Advisory
<10.0	No advisory
10 to 20	1 meal per week
>20 to 50	1 meal per month
>50	Do not eat

[a] Fish were analyzed for total arsenic

[b] 0.4 mg/kg was the screening level used for mercury

Notes:

mg/kg = milligrams of metal per kilogram wet weight fillet tissue

N.C. DPH fish ingestion screening levels are based on one 170 gram (6 ounces, uncooked weight) fish meal per day for a 70 kg (154 pound) adult and an acceptable cancer risk level of 1E-04 (1 excess cancer in 10,000 persons)

< = "less than"