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**Fish Tissue Metals Analysis in the Tri-State Mining Area
Follow-up Study**

FY 2006

Final Report

Submitted by:

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Executive Summary

The Customer Services Division (CSD) of the Oklahoma Department of Environmental Quality (ODEQ) performed a followup study to confirm results and answer further questions as a result of a 2003 ODEQ report concerning the safety of consuming fish caught in Oklahoma waters affected by runoff from the Tri-State Mining District and the Tar Creek Superfund Site. Responding to concerns by local residents and tribes, this study was designed to determine levels of metals in fish tissue that would be harmful to human health if consumed in excess amounts. Local tribes from the Tar Creek area indicated traditional customs involve eating fish preparations that include bones, which include fish canned by means of pressure-cooking and the preparation of non-game fish for which it is difficult to obtain boneless fillets. Since metals are known to accumulate in the bones and organs of fish, there was a concern that these traditional methods of preparation would be unsafe. Local tribes advised ODEQ they believed fish consumption rates were higher among tribal members than among the general public.

CSD field personnel worked to collect fish from the Neosho and Spring Rivers, Grand Lake, and local ponds in Ottawa County receiving mine waste runoff. Paddlefish were also provided by the Peoria Tribe and Oklahoma Department of Wildlife Conservation (ODWC). The State Environmental Laboratory developed sample preparation and analysis methods specifically for this study. CSD risk assessment personnel used EPA guidance to develop safe consumption levels for cadmium and zinc in fish, and utilized the Integrated Exposure Uptake Biokinetic (IEUBK) Model for evaluating lead concentrations in fish that would be safe for the public to consume.

The scope of this study was expanded to include Grand Lake which is utilized by many people living outside the Tar Creek area. The IEUBK model used to develop consumption advisory levels evaluates exposure to lead from multiple sources. Because people living in the Tar Creek area are exposed to higher background levels of lead than citizens living outside the area, advisory levels were determined for both groups using different exposure assumptions.

Consumption of some preparations of fish caught in waters affected by contaminated runoff from abandoned lead and zinc mines in the Oklahoma portion of the Tri-State Mining District have levels of lead that could potentially cause adverse health effects.

Carcass preparations of (1) game fish and sunfish from Mill Ponds, (2) non-game fish from the Neosho River, (3) catfish, non-game fish and sunfish in the Spring River, and (4) non-game fish from Grand Lake have lead concentrations high enough to warrant recommendations for Tar Creek area residents to restrict consumption. Additionally, fillet samples in non-game fish from Spring River warrant similar recommendations for Tar Creek area residents

Carcass preparations of (1) sunfish for Mill Ponds, (2) non-game fish and sunfish from the Spring River, and (3) non-game fish from Grand Lake have lead concentrations high

enough to warrant recommendations for non-residents of the area to restrict consumption.

Flesh and roe preparations of paddlefish from the area have low concentrations of lead, cadmium, and zinc. While it was unclear if skinless fillets have higher levels of lead and cadmium, skinless fillets have lower levels of zinc. A conservative approach to reducing one's exposure would be to only consume skinless fillets.

Table of Contents

Background and Statement of Issues	7
Monitoring Methods	8
Sample Collection	8
Laboratory Analysis	11
Quality Assurance	12
Results	13
Data Analysis	13
Determination of Safe Consumption Levels	13
Cadmium and Zinc	14
Lead	15
Sample Results	17
Lead	17
Cadmium	19
Zinc	21
Comparison of Results to Consumption Rate Levels	23
Comparison of Skinless and Skin-On Fillet Samples	24
Conclusions and Recommendations	26
References	28
Appendix A: Data Summary	30
Figures and Tables	
Figure 1. River and Millpond Sampling Locations	9
Figure 2. Grand Lake Sampling Locations	10
Table 1. Site Locations	8
Table 2. Comparison of 2003 and 2007 Analytical Reporting Limits.	12
Table 3. Inputs for calculating acceptable consumption levels for cadmium and zinc.	14
Table 4. Allowable contaminant concentrations for cadmium and zinc.	15
Table 5. IEUBK Inputs	16
Table 6. Allowable contaminant concentrations for lead.	17
Table 7. Sample values for lead by species, preparation, and site type.	18
Table 8. Sample values for cadmium by species, preparation, and site type.	20

Table 9. Sample values for zinc by species, preparation, and site type.	22
Table 10. Species groupings for consumption advisory evaluaton.	24
Table 11. Calculated consumption limits for waterbody, preparation, and species group.	25
Table 12. Comparison of skinless and skin-on fillets	26

Background and Statement of Issues

The Tri-State Mining District located in northeast Oklahoma, southeast Kansas, and southwest Missouri was once a major provider of lead and zinc ores from the late 19th to the mid 20th century. Since the cessation of mining in the area, the mines remain closed and abandoned. Metals located both in the mines and in waste materials on the surface can become mobilized and transported by ground and surface waters. Water discharging from the closed mines and surface materials is a major source of contamination to Tar Creek, the Neosho and Spring Rivers, ponds within the Superfund area and, ultimately, Grand Lake.

The Spring and Neosho Rivers and their tributaries (particularly Tar Creek) have been impacted by runoff from these abandoned lead and zinc mines. Additionally, the percolation of rainwater through chat piles can transport metals laden materials into local ponds, many of which are millponds at abandoned ore processing sites. Fish caught locally in the rivers, ponds, and Grand Lake make up a significant portion of the diets of some citizens in the area. Furthermore, area tribal members report that fish are prepared and consumed using techniques that result in the potential ingestion of bone material. These preparation techniques could increase their exposure to metals that might accumulate in fish. Additionally, local tribes advised that they believe fish consumption rates are higher among tribal members than the general public. Questions have been raised about the safety of eating fish from these waters.

The consumption of fish containing elevated levels of metals is a concern because chronic exposure to heavy metals can cause health problems. Chronic lead exposure has been linked to anemia, neurological dysfunction and renal impairment. Chronic cadmium exposure has been linked to renal damage, hypertension, and cardiovascular effects. Although zinc is an essential nutrient required for proper growth and development, the presence of excess zinc can affect the body's metabolism of other metals (e.g. copper), especially when combined with zinc nutritional supplements.

In 2003, the ODEQ conducted a study¹ that examined metals concentrations in fish tissue from the Spring and Neosho Rivers, as well as mill ponds in the Tar Creek Superfund site. That study recommended that people living in the Tar Creek area not consume portions of fish that contained bones. It also was determined that fillets were safe to consume at rates up to six 8-ounce meals per month. The ODEQ was unable to recommend higher consumption rates for boneless fillet portions because analytical reporting limits for lead were not low enough to make that determination.

The findings of the 2003 report identified several areas requiring follow-up study. These included repeating the study to confirm the initial findings, extending the study downstream into Grand Lake, more emphasis on species likely to be consumed in a manner that would increase metals exposure, and the use of lower analytical reporting limits to allow for refined consumption recommendations. This study addresses those issues.

The scope of this study was expanded to include Grand Lake which is utilized by many people living outside the Tar Creek area. The IEUBK model used to develop consumption advisory levels evaluates exposure to lead from multiple sources. Because people living in the Tar Creek area are exposed to higher background levels of lead than citizens living outside the area, advisory levels were determined for both groups using different exposure assumptions.

Monitoring Methods

Sample Collection

The 2003 study examined fish that were collected from 4 ponds and 6 river sites. The river sites were evenly split with 3 sites on Spring River and 3 sites on the Neosho River. Two of the pond sites were millponds at former ore processing locations and 2 pond sites were adjacent to and received runoff from chat piles. The ponds are located in the Tar Creek Superfund area while the stream sites are outside the Superfund area proper but within the larger Tri-state Mining District. This study repeats sample collections at those same sites for the rivers and ponds. In addition, fish were collected at 7 sites extending throughout the length of Grand Lake and 1 site located in the Grand Neosho River directly below Pensacola Dam which impounds Grand Lake.

Table 1. Site Locations

Site #	Site Name	Latitude	Longitude
TC-MPACP	Atlas Chat Pile Pond	36 ⁰ 58' 52"	94 ⁰ 51' 20"
TC-MPBG	Blue Goose Mill Pond	36 ⁰ 58' 06"	94 ⁰ 51' 47"
TC-MPNWWCP	Northwest Western Chat Pile Pond	36 ⁰ 59' 05"	94 ⁰ 51' 21"
TC-MPWCP	Western Chat Pile Mill Pond	36 ⁰ 58' 55"	94 ⁰ 51' 26"
TC-NRCB	Neosho River at Conner Bridge	36 ⁰ 47' 51"	94 ⁰ 49' 15"
TC-NRECC	Neosho River at Elm Creek Confluence	36 ⁰ 53' 27"	94 ⁰ 55' 43"
TC-NRRP	Neosho River at Riverview Park	36 ⁰ 51' 45"	94 ⁰ 52' 43"
TC-SRBH	Spring River at Blue Hole	36 ⁰ 57' 29"	94 ⁰ 43' 07"
TC-SRMB	Spring River at Moccasin Bend	36 ⁰ 56' 11"	94 ⁰ 44' 40"
TC-SRTB	Spring River at Twin Bridges State Park	36 ⁰ 48' 00"	94 ⁰ 45' 11"
TC-GLSC	Grand Lake at Sycamore Cove	36 ⁰ 45' 11"	94 ⁰ 44' 27"
TC-GLPP	Grand Lake at Paradise Point	36 ⁰ 40' 32"	94 ⁰ 46' 30"
TC-GLCP	Grand Lake at Catfish Point	36 ⁰ 28' 29"	94 ⁰ 49' 44"
TC-GLSL	Grand Lake at Shangri La	36 ⁰ 33' 27"	94 ⁰ 50' 18"
TC-GLATB	Grand Lake above Tynon Bluffs	36 ⁰ 32' 59"	94 ⁰ 56' 07"
TC-GLBTB	Grand Lake below Tynon Bluffs	36 ⁰ 29' 51"	94 ⁰ 58' 40"
TC-GLDA	Grand Lake at Dam Area	36 ⁰ 29' 56"	95 ⁰ 02' 32"
TC-GNRBD	Grand Neosho River below Grand Lake	36 ⁰ 26' 21"	95 ⁰ 02' 47"

Figure1. River and Millpond Sampling Locations

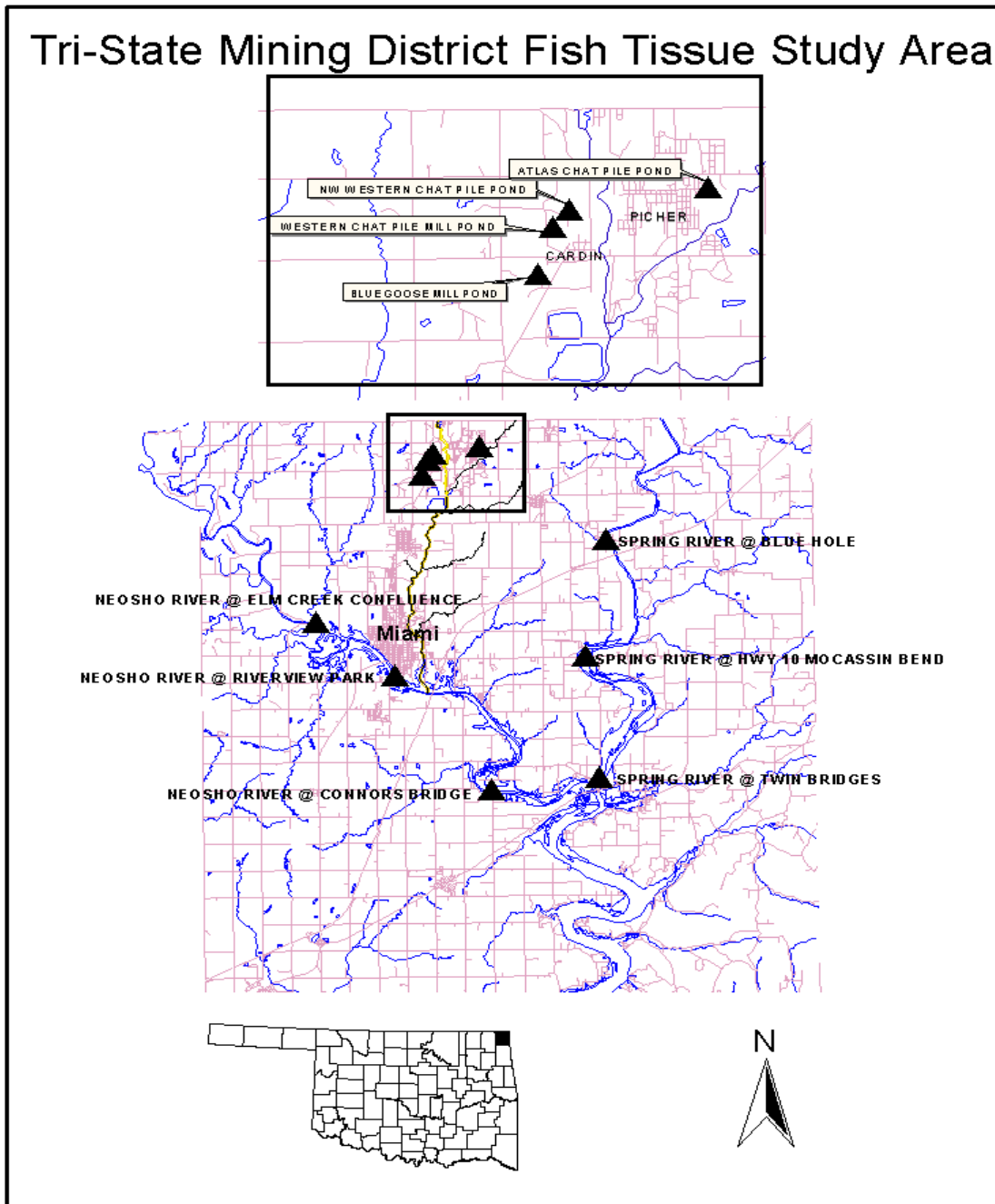
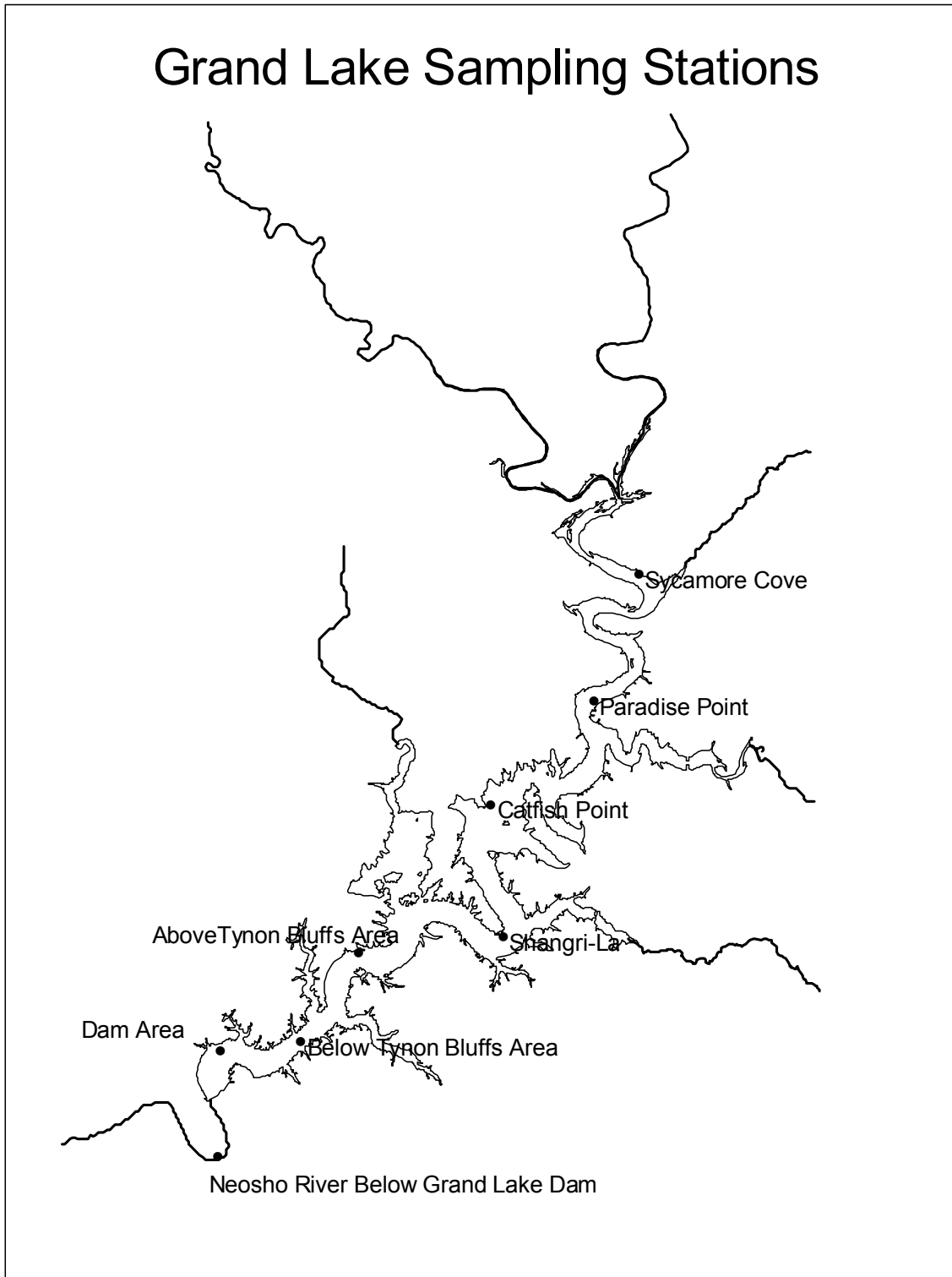


Figure 2. Grand Lake Sampling Locations



In addition, paddlefish fillet samples collected by the Peoria Tribe and the Oklahoma Department of Wildlife Conservation (ODWC) were analyzed and used for this study. The paddlefish provided by the Peoria Tribe were collected in May, 2006 in the Spring and Neosho Rivers. The paddlefish provided by ODWC were collected in January and February of 2007 in Grand Lake.

Analysis was performed on composite samples of fillet and carcass preparations of the ODEQ collected fish. The fillet samples were generally boneless and skinless. However, a small number of boneless, scaled, skin-on fillet samples were analyzed to compare to the more prevalent boneless, skinless preparations. Carcass preparations consisted of scaled, skin-on, headless, eviscerated fish.

Because of the size and availability of paddlefish, analysis was performed on individual fish. Paddlefish have a cartilaginous bone structure that makes boneless fillet portions difficult to obtain. Preparations consisted of skinless cross-cut sections laterally across the fish with the vertebrae removed. For the purposes of this report these preparations will be referred to as "skinless fillets". In addition, analysis was performed on 8 samples of roe (eggs) from the individual paddlefish.

A total of 195 composite and individual fish samples representing 15 species were collected for this study. ODEQ collected stream and lake samples by electrofishing and the ponds by rod and reel. ODWC collected paddlefish from Grand and Hudson Lakes by electrofishing. The Peoria Tribe collected paddlefish from the Spring and Neosho Rivers by rod and reel.

A maximum of 5 species was collected at each site. Limited species were present in the pond sites. Emphasis was placed on species that are commonly consumed including non-game species that local fishing practices such as gigging target. These would include paddlefish, carp, smallmouth buffalo, and redhorse sucker. Consistent size ranges within species were collected at each site.

Laboratory Analysis

Fish collections were delivered to ODEQ's State Environmental Laboratory where they were sorted by site, species, and size. Fish were then sorted into composites consisting of 3 to 5 individuals with the smallest fish in the composite at least 75 percent of the length of the largest fish in the composite. Composite samples of similar mean length were assembled for the different preparation methods: boneless skinless fillets, boneless skin-on fillets and carcasses.

A sample preparation technique² developed for the 2003 study was used to prevent cross-contamination between samples as metals are found in both the mucous and scales of fish. Only stainless steel cutting utensils were used and the preparation surfaces were sheeted in polyethylene. All utensils and equipment were thoroughly cleaned and polyethylene sheeting replaced between the preparations of each sample.

Fish were filleted and skinned, scaled and filleted, or eviscerated and the head removed by cutting anterior to the gill plate as appropriate. A commercial grade food grinder with stainless steel cutting blades was used to macerate samples. The ground tissue was then homogeneously mixed before being sent through the food grinder a minimum of three more times. A subsample of the ground tissue was then collected for analysis.

A 1 gram aliquot was digested in accordance with EPA Method 200.3³. Digestion was accomplished by adding concentrated nitric acid (HNO₃) and heating to a temperature of 95 °C for 1 hour before allowing the digestate to cool. This process was repeated 6 times until all tissue, including bone material, was in solution. The samples were then diluted with 50 ml of ultrapure water and allowed to settle overnight before filtering with a 2 micron Filtermate device. Laboratory fortified matrix (LFM) and laboratory fortified blank (LFB) samples were prepared appropriately for internal quality assurance and control measures. A 1 ml. aliquot of the digestate was added to ultrapure water along with an internal standard solution to complete the sample preparation.

In accordance with EPA Method 200.7⁴, a 10 ml aliquot was injected into inductive-coupled plasma mass spectrometer (ICP-MS) and 3 readings of each element were recorded. The mean of the 3 readings as well as the standard deviation was calculated. The mean of the readings was used to calculate the amount of each element in the 1 gram aliquot of digested fish flesh. This value was then converted to mg/kg units and entered into the AQUARIUS laboratory information system.

By using a different digestion technique that allowed a larger sample aliquot and more sensitive instrumentation, analytical reporting limits were improved by nearly an order of magnitude over the 2003 study for cadmium and lead. Reporting limits were improved 3 fold for zinc. A comparison is shown in Table 3.

Table 2. Comparison of 2003 and 2007 Analytical Reporting Limits.

Metal	2003 Study (mg/kg)	2007 Study
Cadmium	0.3	0.05
Lead	0.25	0.05
Zinc	0.3	0.1

Quality Assurance

A total of 12 field replicate samples were submitted for fish. These consisted of duplicate composite samples of the same species, similar in size, collected at the same site. There were 4 replicates of carcass samples and 8 replicates of skinless fillet samples. All precision values for lead and cadmium were within acceptable limits. For zinc, 3 of the 4 precision values for carcass samples and 2 of 8 values for boneless fillet samples fell outside acceptable limits as outlined in the Quality Assurance Project Plan⁵ for this study. Because it was determined that even with the increased variance in

precision, zinc is not the determining factor with regards to safe consumption levels. The project manager chose to accept and report the zinc values in this study.

A total of 21 laboratory duplicate samples of fish tissue were prepared. These consisted of duplicate subsamples of the ground composited tissue. All precision values fall within acceptable limits for laboratory duplicates as outlined in the Quality Assurance Project Plan for this study.

Results

Results for all analyses are included in Appendix A.

Data Analysis

Determination of Safe Consumption Levels

Allowable contaminant concentrations for various consumption rate scenarios were calculated based on methods outlined in the 2003 Tar Creek Fish study. The determination of safe fish consumption levels for lead, zinc, and cadmium was performed using 2 different methods. Zinc and cadmium levels were determined by using methods described in the U.S. EPA document *Guidance For Assessing Chemical Contaminant Data For Use in Fish Advisories*⁶. This method utilizes Reference Dose values (RfDs) to calculate contaminant exposure levels that would likely not result in an appreciable risk of adverse health effects over a lifetime. The level for lead was determined using EPA's Integrated Exposure Uptake Biokinetic (IEUBK) Model for Lead⁷. This model considers total environmental lead exposure and predicts the blood lead levels for children up to 84 months of age. A method similar to one utilized by the Washington State Department of Health⁸ was used to establish the allowable levels of lead in fish tissue. Since children are more sensitive to the deleterious effects of lead, the consumption recommendations for lead are based on the protection of children. It is assumed that levels that are protective of children are also protective of adults.

Allowable concentrations were calculated based on consumption rates of 8-ounce meals per month for both children and adults. Consumption rates for children up to 100 percent of the national mean meat consumption for children⁷ (109 oz./month) were used. Consumption rates of up to 16 meals per month were calculated for adults for cadmium and zinc.

Cadmium and Zinc

For cadmium and zinc, safe consumption levels were calculated using the following equations:

$$C_m = (RfD \times BW) / CR_{lim}$$

Where

C_m = allowable concentration of chemical contaminant m in a given species of fish (mg/kg)

RfD = reference dose (mg/kg-day)

BW = consumer body weight (kg)

CR_{lim} = maximum allowable fish consumption rate (kg/d)

and:

$$CR_{lim} = (CR_{mm} \times MS) / T_{ap}$$

Where

CR_{mm} = maximum allowable fish consumption rate (meals/month)

MS = meal size (kg fish/meal)

T_{ap} = time averaging period (days/month)

To calculate the allowable fish consumption rate (in meals/month) based on the concentration of cadmium or zinc in fish, the previous formula is rearranged to:

$$C_m = (RfD \times BW \times T_{ap}) / (CR_{mm} \times MS)$$

Reference dose values were obtained from the EPA Integrated Risk Information System (IRIS) database^{9,10}. Default values obtained from EPA's *Guidance For Assessing Chemical Contaminant Data For Use in Fish Advisories*⁵ were used for body weight and meal size. Equation inputs are illustrated in Table 3.

Table 3. Inputs for calculating acceptable consumption levels for cadmium and zinc.

Input	Value
Reference Dose	Cadmium = 0.001mg/kg-day Zinc = 0.3 mg/kg-day
Body Weight	Children = 14.5 kg (32lb) Adults = 70 kg (154 lb)
Meal Size	0.227 kg (8 oz)
Consumption Rate	1 to 16 meals/month
Time Averaging Period	30.42 days/month

Allowable levels in fish tissue for zinc and cadmium are illustrated in Table 4.

Table 4. Allowable contaminant concentrations for cadmium and zinc.

8 oz. meals per month	Children		Adults	
	Cadmium (mg/kg)	Zinc (mg/kg)	Cadmium (mg/kg)	Zinc (mg/kg)
1	1.94	583	9.38	2814
2	0.97	291	4.70	1407
3	0.65	194	3.13	938
4	0.48	146	2.35	703
5	0.39	117	1.88	562
6	0.32	97	1.56	469
7	0.28	83	1.34	402
8	0.24	73	1.17	352
9	0.22	65	1.04	313
10	0.19	58	0.93	281
11	0.18	53	0.85	255
12	0.16	49	0.78	234
13	0.15	45	0.72	216
14	0.14	42	0.67	201
15	0.13	39	0.62	188
16	0.12	36	0.58	176

Lead

Allowable concentration levels for lead based on various consumption rates were derived using EPA's Integrated Exposure Uptake Biokinetic (IEUBK) model for assessing exposures in children from multiple sources. The model generates a protective level at which no more than 5 percent of modeled blood lead levels exceed the EPA Intervention Level¹¹ of 10 ug/dl (micrograms/deciliter). Blood lead concentrations above the Intervention Level indicate action should be taken to determine the cause of the elevated concentration. This risk assessment methodology is more conservative than that used for cadmium and zinc in that total lead exposure is accounted for through estimates of exposure from soil, house dust, air, water, and diet. EPA default values were used for all inputs to the IEUBK except for soil and house dust lead concentrations, and factors related to fish consumption and concentration.

The soil concentration used for Tar Creek area residents in the IEUBK was 165 mg/kg. This reflects the 95th upper confidence level of the mean lead concentration of residential yards and high access areas in the Tar Creek Area after remediation efforts were concluded^{12, 13, 14}. The IEUBK default ratio is 0.7 for soil concentration to house dust concentration. Using this ratio, the house dust concentration input was calculated to be 115 mg/kg. These values were used in both the 2003 and 2007 studies. The soil concentration value used for non-residents was 16 mg/kg which is reported as the national background soil level¹⁵. This yielded a house dust value of 11.2 m/kg. IEUBK inputs are shown in Table 5.

Table 5. IEUBK Inputs

Input	Value
Drinking Water	4.00 ug/L (EPA default value)
Soil	Residents - 165 mg/kg (based on the 95% UCL of the mean of yard soil levels and high access area soil levels) Non-residents – 16 mg/kg (national background soil level)
House Dust	Residents - 115 ug/g (based on soil level) Non-residents – 11.2 (based on soil level)
Paint	0 per day (EPA default)
Maternal Blood Contribution	2.5 ug/dl (default in the infant model)
Outdoor Air Concentration	0.100 ug/m ³ (EPA default)
Indoor Air	30% of outdoor air concentration (EPA default)
Time Outdoors	1 to 4 hours per day (EPA defaults based on age)
Ventilation Rates	2 to 7 m ³ /day (EPA defaults based on age range)
Lung Absorption	32 percent (EPA default)
Diet Uptake	50% (EPA default varies slightly with age)
Water Uptake	0.36 to 1.13 ug/day (EPA default, varies with age)
Soil and Dust Uptake	5.1 to 5.67 ug/day (EPA default varies with age)
Percentage of Meat Intake Consisting of Locally Caught Fish	7.34 to 100 percent (based on one to sixteen 8-ounce meals per month as a percentage of median EPA default daily meat consumption of 101.57 g/day based on age)

The allowable lead concentration for a given meals-per-month scenario was determined by setting the consumption rate as a percentage of total meat consumption and varying the fish tissue concentration value to a level that resulted in just less than five percent of the target population with a blood lead level of 10 ug/dl.

For example, a consumption rate of one 8-oz meal per month equals 7.34 percent of the average meat consumption for children. The model was initially run with this value in the *Percentage of Meat Intake Consisting of Locally Caught Fish* input and the *Lead in Fish* concentration set to 0 mg/kg resulting in 0.44 percent of the target population with a blood lead level greater than 10 ug/dl. The *Lead in Fish* concentration was incrementally increased until just below 5 percent of the target population had a blood lead level of more than 10 mg/dl. That final *Lead in Fish* concentration was 1.59 mg/kg. This means that fish with lead levels above 1.6 mg/kg are a concern for children who consume up to 7 percent of their meat as locally caught fish. The process was repeated for each consumption rate scenario up to the mean monthly meat consumption for children of 109 oz.

There is not a method available to calculate safe fish tissue lead concentration levels for adults. The IEUBK model only addresses blood lead levels in children. There is no reference dose for lead in IRIS. EPA's Adult Lead Model does not have provisions for lead exposures from diet. Because of this, the IEUBK derived values for children were also used for adult recommendations.

The allowable concentrations for lead, cadmium, and zinc in children and adults are illustrated in Table 6.

Table 6. Allowable contaminant concentrations for lead.

8 oz. meals per month	Percentage of child's meat intake	Tar Creek Area Residents Children and Adults	Non-Residents Children and Adults
		Lead (mg/kg)	Lead* (mg/kg)
1	7.34	1.59	2.87
2	14.68	0.79	1.44
3	22.02	0.53	0.96
4	29.36	0.40	0.72
5	36.70	0.32	0.58
6	44.04	0.27	0.48
7	51.38	0.23	0.41
8	58.72	0.20	0.36
9	66.06	0.18	0.32
10	73.40	0.16	0.29
11	80.73	0.15	0.26
12	88.07	0.14	0.24
13	95.41	0.13	0.22
13.6	100	0.12	0.21

Sample Results

A total of 195 samples representing 15 species of fish were collected at 3 sites on Spring River, 3 sites on the Neosho River, 2 ponds receiving runoff from chat piles, 2 millponds at former ore processing sites, 7 sites in the main body of Grand Lake, and 1 site on the Grand Neosho River directly downstream of Grand Lake. Sample analysis was performed on preparations of boneless skinless fillets, scaled headless skin-on eviscerated carcasses, boneless scaled skin-on fillets, and roe (eggs).

All sample results can be found in Appendix A.

Lead

Table 7 lists the number of samples as well as minimum, maximum and mean values for lead by species, preparation, and site type. Mean values were calculated by substituting one half the analytical reporting limit for results less than the reporting limit. For this grouping, the Grand Neosho River site was included with the Grand Lake sites.

Mean lead values ranged from < 0.05 mg/kg to 0.74 mg/kg. The highest concentrations were found in carcass preparations of Millpond sunfish species and carcass preparations of carp and buffalo from the Spring River. Skinless fillet preparations

were below the analytical reporting limit of 0.05 mg/kg except for Millpond sunfish, Spring River carp and drum, and Neosho River smallmouth buffalo.. All samples of Paddlefish eggs were below the reporting limit.

Table 7. Sample values for lead by species, preparation, and site type.

WaterBody Type	Preparation	Species	Sample Count	Lead Minimum mg/kg	Lead Maximum mg/kg	Lead Mean mg/kg
Mill Pond	Carcass	Bluegill Sunfish	4	0.07	1.25	0.54
Mill Pond	Carcass	Green Sunfish	1	0.66	0.66	0.66
Mill Pond	Carcass	Hybrid Sunfish	1	0.73	0.73	0.73
Mill Pond	Carcass	Largemouth Bass	5	< 0.05	0.24	0.12
Mill Pond	Skinless Fillet	Bluegill Sunfish	4	< 0.05	0.12	0.07
Mill Pond	Skinless Fillet	Green Sunfish	2	0.06	0.17	0.12
Mill Pond	Skinless Fillet	Hybrid Sunfish	1	0.23	0.23	0.23
Mill Pond	Skinless Fillet	Largemouth Bass	5	< 0.05	0.07	< 0.05
Mill Pond	Skin-On Fillet	Green Sunfish	1	0.10	0.10	0.10
Neosho River	Carcass	Blue Catfish	1	< 0.05	< 0.05	< 0.05
Neosho River	Carcass	Carp	3	< 0.05	0.23	0.11
Neosho River	Carcass	Channel Catfish	3	< 0.05	0.11	0.08
Neosho River	Carcass	Smallmouth Buffalo	3	0.22	0.40	0.28
Neosho River	Carcass	White Bass	4	< 0.05	< 0.05	< 0.05
Neosho River	Carcass	White Crappie	2	< 0.05	< 0.05	< 0.05
Neosho River	Skinless Fillet	Blue Catfish	1	< 0.05	< 0.05	< 0.05
Neosho River	Skinless Fillet	Carp	3	< 0.05	< 0.05	< 0.05
Neosho River	Skinless Fillet	Channel Catfish	3	< 0.05	< 0.05	< 0.05
Neosho River	Skinless Fillet	Paddle Fish	1	< 0.05	< 0.05	< 0.05
Neosho River	Skinless Fillet	Smallmouth Buffalo	3	< 0.05	0.13	< 0.05
Neosho River	Skinless Fillet	White Bass	5	< 0.05	< 0.05	< 0.05
Neosho River	Skinless Fillet	White Crappie	2	< 0.05	< 0.05	< 0.05
Neosho River	Skin-On Fillet	White Bass	1	< 0.05	< 0.05	< 0.05
Spring River	Carcass	Black Crappie	1	< 0.05	< 0.05	< 0.05
Spring River	Carcass	Bluegill Sunfish	2	0.21	0.38	0.30
Spring River	Carcass	Carp	3	0.18	1.60	0.74
Spring River	Carcass	Channel Catfish	3	0.14	0.21	0.17
Spring River	Carcass	Freshwater Drum	1	0.13	0.13	0.13
Spring River	Carcass	Largemouth Bass	1	< 0.05	< 0.05	< 0.05
Spring River	Carcass	Redhorse Sucker	1	< 0.05	< 0.05	< 0.05
Spring River	Carcass	Smallmouth Buffalo	3	0.05	1.03	0.54
Spring River	Carcass	White Bass	2	< 0.05	< 0.05	< 0.05
Spring River	Skinless Fillet	Black Crappie	1	< 0.05	< 0.05	< 0.05
Spring River	Skinless Fillet	Bluegill Sunfish	2	< 0.05	< 0.05	< 0.05
Spring River	Skinless Fillet	Carp	3	0.06	0.74	0.29
Spring River	Skinless Fillet	Channel Catfish	3	< 0.05	< 0.05	< 0.05
Spring River	Skinless Fillet	Freshwater Drum	1	0.08	0.08	0.08
Spring River	Skinless Fillet	Largemouth Bass	1	< 0.05	< 0.05	< 0.05

WaterBody Type	Preparation	Species	Sample Count	Lead Minimum mg/kg	Lead Maximum mg/kg	Lead Mean mg/kg
Spring River	Skinless Fillet	Paddle Fish	2	< 0.05	< 0.05	< 0.05
Spring River	Skinless Fillet	Redhorse Sucker	1	< 0.05	< 0.05	< 0.05
Spring River	Skinless Fillet	Smallmouth Buffalo	3	< 0.05	0.44	0.16
Spring River	Skinless Fillet	White Bass	2	< 0.05	< 0.05	< 0.05
Spring River	Skinless Fillet	White Crappie	1	< 0.05	< 0.05	< 0.05
Spring River	Skin-On Fillet	White Crappie	1	< 0.05	< 0.05	< 0.05
Grand Lake	Carcass	Blue Catfish	1	0.05	0.05	0.05
Grand Lake	Carcass	Bluegill Sunfish	6	< 0.05	0.07	< 0.05
Grand Lake	Carcass	Carp	3	0.10	0.86	0.36
Grand Lake	Carcass	Channel Catfish	7	< 0.05	0.11	< 0.05
Grand Lake	Carcass	Freshwater Drum	2	< 0.05	< 0.05	< 0.05
Grand Lake	Carcass	Largemouth Bass	7	< 0.05	0.11	< 0.05
Grand Lake	Carcass	Smallmouth Buffalo	5	0.15	0.60	0.28
Grand Lake	Carcass	Spotted Bass	4	< 0.05	< 0.05	< 0.05
Grand Lake	Carcass	White Bass	4	< 0.05	0.06	< 0.05
Grand Lake	Carcass	White Crappie	2	< 0.05	< 0.05	< 0.05
Grand Lake	Eggs	Paddle Fish	8	< 0.05	< 0.05	< 0.05
Grand Lake	Skinless Fillet	Blue Catfish	1	< 0.05	< 0.05	< 0.05
Grand Lake	Skinless Fillet	Bluegill Sunfish	7	< 0.05	< 0.05	< 0.05
Grand Lake	Skinless Fillet	Carp	3	< 0.05	0.09	< 0.05
Grand Lake	Skinless Fillet	Channel Catfish	7	< 0.05	< 0.05	< 0.05
Grand Lake	Skinless Fillet	Freshwater Drum	4	< 0.05	< 0.05	< 0.05
Grand Lake	Skinless Fillet	Largemouth Bass	8	< 0.05	< 0.05	< 0.05
Grand Lake	Skinless Fillet	Paddle Fish	8	< 0.05	< 0.05	< 0.05
Grand Lake	Skinless Fillet	Smallmouth Buffalo	5	< 0.05	0.10	< 0.05
Grand Lake	Skinless Fillet	Spotted Bass	4	< 0.05	< 0.05	< 0.05
Grand Lake	Skinless Fillet	White Bass	4	< 0.05	< 0.05	< 0.05
Grand Lake	Skinless Fillet	White Crappie	2	< 0.05	< 0.05	< 0.05
Grand Lake	Skin-On Fillet	Bluegill Sunfish	1	< 0.05	< 0.05	< 0.05
Grand Lake	Skin-On Fillet	Largemouth Bass	1	0.24	0.24	0.24

Cadmium

Table 8 lists the number of samples as well as minimum, maximum and mean values for cadmium by species, preparation, and site type. Mean values were calculated by substituting one half the analytical reporting limit for results less than the reporting limit. For this grouping, the Grand Neosho River site was included with the Grand Lake sites.

Mean cadmium values ranged from < 0.05 mg/kg to 0.23 mg/kg. The highest concentrations were found in carcass preparations of Spring River carp. All fillet and egg sample preparations were below the analytical reporting limit.

Table 8. Sample values for cadmium by species, preparation, and site type.

WaterBody Type	Preparation	Species	Sample Count	Cadmium Minimum mg/kg	Cadmium Maximum mg/kg	Cadmium Mean mg/kg
Mill Pond	Carcass	Bluegill Sunfish	4	< 0.05	< 0.05	< 0.05
Mill Pond	Carcass	Green Sunfish	1	< 0.05	< 0.05	< 0.05
Mill Pond	Carcass	Hybrid Sunfish	1	< 0.05	< 0.05	< 0.05
Mill Pond	Carcass	Largemouth Bass	5	< 0.05	< 0.05	< 0.05
Mill Pond	Fillet	Bluegill Sunfish	4	< 0.05	< 0.05	< 0.05
Mill Pond	Fillet	Green Sunfish	2	< 0.05	< 0.05	< 0.05
Mill Pond	Fillet	Hybrid Sunfish	1	< 0.05	< 0.05	< 0.05
Mill Pond	Fillet	Largemouth Bass	5	< 0.05	< 0.05	< 0.05
Mill Pond	Skin-On Fillet	Green Sunfish	1	< 0.05	< 0.05	< 0.05
Neosho River	Carcass	Blue Catfish	1	< 0.05	< 0.05	< 0.05
Neosho River	Carcass	Carp	3	< 0.05	< 0.05	< 0.05
Neosho River	Carcass	Channel Catfish	3	< 0.05	< 0.05	< 0.05
Neosho River	Carcass	Smallmouth Buffalo	3	< 0.05	0.08	< 0.05
Neosho River	Carcass	White Bass	4	< 0.05	< 0.05	< 0.05
Neosho River	Carcass	White Crappie	2	< 0.05	< 0.05	< 0.05
Neosho River	Fillet	Blue Catfish	1	< 0.05	< 0.05	< 0.05
Neosho River	Fillet	Carp	3	< 0.05	< 0.05	< 0.05
Neosho River	Fillet	Channel Catfish	3	< 0.05	< 0.05	< 0.05
Neosho River	Fillet	Paddle Fish	1	< 0.05	< 0.05	< 0.05
Neosho River	Fillet	Smallmouth Buffalo	3	< 0.05	< 0.05	< 0.05
Neosho River	Fillet	White Bass	5	< 0.05	< 0.05	< 0.05
Neosho River	Fillet	White Crappie	2	< 0.05	< 0.05	< 0.05
Neosho River	Skin-On Fillet	White Bass	1	< 0.05	< 0.05	< 0.05
Spring River	Carcass	Black Crappie	1	< 0.05	< 0.05	< 0.05
Spring River	Carcass	Bluegill Sunfish	2	< 0.05	< 0.05	< 0.05
Spring River	Carcass	Carp	3	< 0.05	0.55	0.23
Spring River	Carcass	Channel Catfish	3	< 0.05	< 0.05	< 0.05
Spring River	Carcass	Freshwater Drum	1	< 0.05	< 0.05	< 0.05
Spring River	Carcass	Largemouth Bass	1	< 0.05	< 0.05	< 0.05
Spring River	Carcass	Redhorse Sucker	1	< 0.05	< 0.05	< 0.05
Spring River	Carcass	Smallmouth Buffalo	3	< 0.05	< 0.05	< 0.05
Spring River	Carcass	White Bass	2	< 0.05	< 0.05	< 0.05
Spring River	Fillet	Black Crappie	1	< 0.05	< 0.05	< 0.05
Spring River	Fillet	Bluegill Sunfish	2	< 0.05	< 0.05	< 0.05
Spring River	Fillet	Carp	3	< 0.05	0.06	< 0.05
Spring River	Fillet	Channel Catfish	3	< 0.05	< 0.05	< 0.05
Spring River	Fillet	Freshwater Drum	1	< 0.05	< 0.05	< 0.05
Spring River	Fillet	Largemouth Bass	1	< 0.05	< 0.05	< 0.05
Spring River	Fillet	Paddle Fish	2	< 0.05	< 0.05	< 0.05
Spring River	Fillet	Redhorse Sucker	1	< 0.05	< 0.05	< 0.05
Spring River	Fillet	Smallmouth Buffalo	3	< 0.05	< 0.05	< 0.05
Spring River	Fillet	White Bass	2	< 0.05	< 0.05	< 0.05
Spring River	Fillet	White Crappie	1	< 0.05	< 0.05	< 0.05

WaterBody Type	Preparation	Species	Sample Count	Cadmium Minimum mg/kg	Cadmium Maximum mg/kg	Cadmium Mean mg/kg
Spring River	Skin-On Fillet	White Crappie	1	< 0.05	< 0.05	< 0.05
Grand Lake	Carcass	Blue Catfish	1	< 0.05	< 0.05	< 0.05
Grand Lake	Carcass	Bluegill Sunfish	6	< 0.05	< 0.05	< 0.05
Grand Lake	Carcass	Carp	3	< 0.05	0.08	< 0.05
Grand Lake	Carcass	Channel Catfish	7	< 0.05	< 0.05	< 0.05
Grand Lake	Carcass	Freshwater Drum	2	< 0.05	< 0.05	< 0.05
Grand Lake	Carcass	Largemouth Bass	7	< 0.05	< 0.05	< 0.05
Grand Lake	Carcass	Smallmouth Buffalo	5	< 0.05	< 0.05	< 0.05
Grand Lake	Carcass	Spotted Bass	4	< 0.05	< 0.05	< 0.05
Grand Lake	Carcass	White Bass	4	< 0.05	< 0.05	< 0.05
Grand Lake	Carcass	White Crappie	2	< 0.05	< 0.05	< 0.05
Grand Lake	Eggs	Paddle Fish	8	< 0.05	< 0.05	< 0.05
Grand Lake	Fillet	Blue Catfish	1	< 0.05	< 0.05	< 0.05
Grand Lake	Fillet	Bluegill Sunfish	7	< 0.05	< 0.05	< 0.05
Grand Lake	Fillet	Carp	3	< 0.05	< 0.05	< 0.05
Grand Lake	Fillet	Channel Catfish	7	< 0.05	< 0.05	< 0.05
Grand Lake	Fillet	Freshwater Drum	4	< 0.05	< 0.05	< 0.05
Grand Lake	Fillet	Largemouth Bass	8	< 0.05	< 0.05	< 0.05
Grand Lake	Fillet	Paddle Fish	8	< 0.05	< 0.05	< 0.05
Grand Lake	Fillet	Smallmouth Buffalo	5	< 0.05	< 0.05	< 0.05
Grand Lake	Fillet	Spotted Bass	4	< 0.05	< 0.05	< 0.05
Grand Lake	Fillet	White Bass	4	< 0.05	< 0.05	< 0.05
Grand Lake	Fillet	White Crappie	2	< 0.05	< 0.05	< 0.05
Grand Lake	Skin-On Fillet	Bluegill Sunfish	1	< 0.05	< 0.05	< 0.05
Grand Lake	Skin-On Fillet	Largemouth Bass	1	< 0.05	< 0.05	< 0.05

Zinc

Table 9 lists the number of samples as well as minimum, maximum and mean values for zinc by species, preparation, and site type. Mean values were calculated by substituting one half the analytical reporting limit for results less than the reporting limit. For this grouping, the Grand Neosho River site was included with the Grand Lake sites.

Mean zinc values ranged from 1.6 mg/kg to 29.6 mg/kg. The highest concentrations were found in carcass preparations of Neosho River, Spring River, and Grand Lake carp as well as carcass preparations of green and bluegill sunfish from the Millponds.

Table 9. Sample values for zinc by species, preparation, and site type.

WaterBody Type	Preparation	Species	Sample Count	Zinc Minimum mg/kg	Zinc Maximum mg/kg	Zinc Mean mg/kg
Mill Pond	Carcass	Bluegill Sunfish	4	15.2	29.2	22.9
Mill Pond	Carcass	Green Sunfish	1	26.4	26.4	26.4
Mill Pond	Carcass	Hybrid Sunfish	1	15.4	15.4	15.4
Mill Pond	Carcass	Largemouth Bass	5	7.5	13.1	9.6
Mill Pond	Fillet	Bluegill Sunfish	4	6.0	9.2	7.7
Mill Pond	Fillet	Green Sunfish	2	5.7	11.0	8.3
Mill Pond	Fillet	Hybrid Sunfish	1	8.6	8.6	8.6
Mill Pond	Fillet	Largemouth Bass	5	3.0	6.7	5.2
Mill Pond	Skin-On Fillet	Green Sunfish	1	11.8	11.8	11.8
Neosho River	Carcass	Blue Catfish	1	8.3	8.3	8.3
Neosho River	Carcass	Carp	3	23	41.7	29.6
Neosho River	Carcass	Channel Catfish	3	8.0	11.6	9.8
Neosho River	Carcass	Smallmouth Buffalo	3	10.7	14.3	12.3
Neosho River	Carcass	White Bass	4	10.2	14.7	11.6
Neosho River	Carcass	White Crappie	2	8.3	11.0	9.7
Neosho River	Fillet	Blue Catfish	1	3.3	3.3	3.3
Neosho River	Fillet	Carp	3	7.7	11.7	9.2
Neosho River	Fillet	Channel Catfish	3	4.0	5.5	4.5
Neosho River	Fillet	Paddle Fish	1	1.9	1.9	1.9
Neosho River	Fillet	Smallmouth Buffalo	3	2.7	4.9	4.1
Neosho River	Fillet	White Bass	5	3.0	4.1	3.5
Neosho River	Fillet	White Crappie	2	3.6	3.7	3.7
Neosho River	Skin-On Fillet	White Bass	1	7.2	7.2	7.2
Spring River	Carcass	Black Crappie	1	8.5	8.5	8.5
Spring River	Carcass	Bluegill Sunfish	2	16.0	19.8	17.9
Spring River	Carcass	Carp	3	23.7	24.3	23.9
Spring River	Carcass	Channel Catfish	3	10.1	12.6	11.0
Spring River	Carcass	Freshwater Drum	1	8.7	8.7	8.7
Spring River	Carcass	Largemouth Bass	1	6.5	6.5	6.5
Spring River	Carcass	Redhorse Sucker	1	11.1	11.1	11.1
Spring River	Carcass	Smallmouth Buffalo	3	3.8	16.2	10.8
Spring River	Carcass	White Bass	2	8.4	10.1	9.3
Spring River	Fillet	Black Crappie	1	3.1	3.1	3.1
Spring River	Fillet	Bluegill Sunfish	2	5.2	5.2	5.2
Spring River	Fillet	Carp	3	7.3	14.2	9.6
Spring River	Fillet	Channel Catfish	3	3.7	4.5	4.1
Spring River	Fillet	Freshwater Drum	1	3.9	3.9	3.9
Spring River	Fillet	Largemouth Bass	1	4.2	4.2	4.2
Spring River	Fillet	Paddle Fish	2	3.8	4.73	4.3
Spring River	Fillet	Redhorse Sucker	1	4.0	4.0	4.0
Spring River	Fillet	Smallmouth Buffalo	3	3.1	17.9	12.0
Spring River	Fillet	White Bass	2	2.0	2.8	2.4
Spring River	Fillet	White Crappie	1	3.0	3.0	3.0

WaterBody Type	Preparation	Species	Sample Count	Zinc Minimum mg/kg	Zinc Maximum mg/kg	Zinc Mean mg/kg
Spring River	Skin-On Fillet	White Crappie	1	4.9	4.9	4.9
Grand Lake	Carcass	Blue Catfish	1	9.9	9.9	9.9
Grand Lake	Carcass	Bluegill Sunfish	6	15.0	20.5	18.2
Grand Lake	Carcass	Carp	3	20.2	31.7	24.1
Grand Lake	Carcass	Channel Catfish	7	6.6	12.9	9.2
Grand Lake	Carcass	Freshwater Drum	2	8.5	14.5	11.5
Grand Lake	Carcass	Largemouth Bass	7	4.6	10.7	7.6
Grand Lake	Carcass	Smallmouth Buffalo	5	7.7	13.8	11.1
Grand Lake	Carcass	Spotted Bass	4	7.2	10.6	9.2
Grand Lake	Carcass	White Bass	4	9.9	15.3	12.5
Grand Lake	Carcass	White Crappie	2	10.1	10.8	10.4
Grand Lake	Eggs	Paddle Fish	8	18.9	26.3	21.7
Grand Lake	Fillet	Blue Catfish	1	6.1	6.1	6.1
Grand Lake	Fillet	Bluegill Sunfish	7	4.6	13.1	7.5
Grand Lake	Fillet	Carp	3	8.2	13.1	9.9
Grand Lake	Fillet	Channel Catfish	7	3.3	7.7	4.5
Grand Lake	Fillet	Freshwater Drum	4	1.8	8.2	4.2
Grand Lake	Fillet	Largemouth Bass	8	2.5	6.9	4.3
Grand Lake	Fillet	Paddle Fish	8	1.3	1.8	1.6
Grand Lake	Fillet	Smallmouth Buffalo	5	2.5	7.6	5.3
Grand Lake	Fillet	Spotted Bass	4	4.1	5.7	5.0
Grand Lake	Fillet	White Bass	4	3.4	7.0	5.1
Grand Lake	Fillet	White Crappie	2	3.2	5.1	4.2
Grand Lake	Skin-On Fillet	Bluegill Sunfish	1	14.0	14.0	14.0
Grand Lake	Skin-On Fillet	Largemouth Bass	1	6.3	6.3	6.3

Comparison of Results to Consumption Rate Levels

For the evaluation of sample results in relation to consumption rate levels, samples were combined into species groupings and evaluated by sample preparation and site type. Species groupings are shown in Table 10.

A comparison of mean metals concentrations of the various preparations of species groups by site to calculated consumption limit levels is provided in Table 11. Mean values were calculated by substituting one half the analytical reporting limit for results less than the reporting limit.

Table 10. Species groupings for consumption advisory evaluation.

Species Group	Species
Catfish	Blue Catfish Channel Catfish
Game Fish	Black Crappie Largemouth Bass Spotted Bass White Bass White Crappie
Paddle Fish	Paddle Fish
Non-Game Fish	Carp Freshwater Drum Redhorse Sucker Smallmouth Buffalo
Sunfish	Bluegill Sunfish Green Sunfish Hybrid Sunfish

Our evaluation shows the following:

- consumption limit levels for several group means were exceeded for lead and in 1 instance cadmium. No group means exceed the consumption limits for zinc.
- skinless fillet fish from mill ponds, the Neosho River, and the Grand Lake are safe to eat. Consumption of fish from these waterbodies does not need to be limited if the fish are filleted and the skin removed.
- skinless fillet fish from the Spring River are safe to eat except for non-game fish (carp, freshwater drum, redhorse sucker, smallmouth buffalo). Consumption should be limited to no more than nine 8 oz meals per month of skin-less non-game fish for people living in the Tar Creek area.
- the consumption of skin-on non-game fish should be limited depending upon where they are caught. Table 10 shows the allowable number of meals.
- the consumption of sunfish from the mill ponds should not exceed two 8 oz meals per month for people living in the Tar Creek Area. Non-residents should not exceed five 8 oz. meals per month.
- carcass preparations had consistently higher levels of lead than skinless fillet samples.
- the only skinless fillet samples exceeding consumption limit levels were in non-game fish from Spring River for people living in the Tar Creek area.
- carcass preparations of non-game fish exceed consumption limit levels in all waterbodies where they are present for people living in the Tar Creek area.
- game fish carcasses exceeded consumption limit levels only in the Mill Ponds
- sunfish carcasses exceeded consumption limit levels in both Spring River and the Mill Ponds.
- catfish carcasses exceeded consumption limit levels only in Spring River

Table 11. Calculated consumption limits for waterbody, preparation, and species group.

WaterBody Type	Sample Preparation	Species Group	Lead			Cadmium			Zinc		
			Mean (mg/kg)	Tar Creek Area Residents Children and Adult Consumption Limit (8 oz. meals per month)	Non-Residents Children and Adult Consumption Limit (8 oz. meals per month)	Mean (mg/kg)	Children Consumption Limit (8 oz. meals per month)	Adult Consumption Limit (8 oz. meals per month)	Mean (mg/kg)	Children Consumption Limit (8 oz. meals per month)	Adult Consumption Limit (8 oz. meals per month)
Mill Pond	Carcass	Game Fish	0.12	14	Unlimited	< 0.05	Unlimited	Unlimited	9.6	Unlimited	Unlimited
		Sunfish	0.59	2	5	< 0.05	Unlimited	Unlimited	22.3	Unlimited	Unlimited
	Skinless Fillet	Game Fish	< 0.05	Unlimited	Unlimited	< 0.05	Unlimited	Unlimited	5.2	Unlimited	Unlimited
		Sunfish	0.11	Unlimited	Unlimited	< 0.05	Unlimited	Unlimited	8.0	Unlimited	Unlimited
	Skin-On Fillet	Sunfish	0.10	Unlimited	Unlimited	< 0.05	Unlimited	Unlimited	11.8	Unlimited	Unlimited
Neosho River	Carcass	Catfish	0.06	Unlimited	Unlimited	< 0.05	Unlimited	Unlimited	9.4	Unlimited	Unlimited
		Game Fish	< 0.05	Unlimited	Unlimited	< 0.05	Unlimited	Unlimited	11.0	Unlimited	Unlimited
		Non-Game Fish	0.19	8	Unlimited	< 0.05	Unlimited	Unlimited	21.0	Unlimited	Unlimited
	Skinless Fillet	Catfish	< 0.05	Unlimited	Unlimited	< 0.05	Unlimited	Unlimited	4.2	Unlimited	Unlimited
		Game Fish	< 0.05	Unlimited	Unlimited	< 0.05	Unlimited	Unlimited	3.6	Unlimited	Unlimited
		Paddle Fish	< 0.05	Unlimited	Unlimited	< 0.05	Unlimited	Unlimited	1.9	Unlimited	Unlimited
	Skin-On Fillet	Non-Game Fish	0.05	Unlimited	Unlimited	< 0.05	Unlimited	Unlimited	6.6	Unlimited	Unlimited
		Game Fish	< 0.05	Unlimited	Unlimited	< 0.05	Unlimited	Unlimited	7.2	Unlimited	Unlimited
Spring River	Carcass	Catfish	0.17	9	Unlimited	< 0.05	Unlimited	Unlimited	11.0	Unlimited	Unlimited
		Game Fish	< 0.05	Unlimited	Unlimited	< 0.05	Unlimited	Unlimited	8.4	Unlimited	Unlimited
		Non-Game Fish	0.50	3	5	0.10	Unlimited	Unlimited	15.5	Unlimited	Unlimited
		Sunfish	0.35	5	8	< 0.05	Unlimited	Unlimited	17.9	Unlimited	Unlimited
	Skinless Fillet	Catfish	< 0.05	Unlimited	Unlimited	< 0.05	Unlimited	Unlimited	4.1	Unlimited	Unlimited
		Game Fish	< 0.05	Unlimited	Unlimited	< 0.05	Unlimited	Unlimited	3.0	Unlimited	Unlimited
		Paddle Fish	< 0.05	Unlimited	Unlimited	< 0.05	Unlimited	Unlimited	4.3	Unlimited	Unlimited
		Non-Game Fish	0.18	9	Unlimited	< 0.05	Unlimited	Unlimited	9.1	Unlimited	Unlimited
		Sunfish	< 0.05	Unlimited	Unlimited	< 0.05	Unlimited	Unlimited	5.2	Unlimited	Unlimited
	Skin-On Fillet	Game Fish	< 0.05	Unlimited	Unlimited	< 0.05	Unlimited	Unlimited	4.9	Unlimited	Unlimited
Grand Lake	Carcass	Catfish	< 0.05	Unlimited	Unlimited	< 0.05	Unlimited	Unlimited	9.3	Unlimited	Unlimited
		Game Fish	< 0.05	Unlimited	Unlimited	< 0.05	Unlimited	Unlimited	9.5	Unlimited	Unlimited
		Non-Game Fish	0.26	6	11	< 0.05	Unlimited	Unlimited	15.1	Unlimited	Unlimited
		Sunfish	< 0.05	Unlimited	Unlimited	< 0.05	Unlimited	Unlimited	18.2	Unlimited	Unlimited
	Eggs	Paddle Fish	< 0.05	Unlimited	Unlimited	< 0.05	Unlimited	Unlimited	21.7	Unlimited	Unlimited
	Skinless Fillet	Catfish	< 0.05	Unlimited	Unlimited	< 0.05	Unlimited	Unlimited	4.7	Unlimited	Unlimited
		Game Fish	< 0.05	Unlimited	Unlimited	< 0.05	Unlimited	Unlimited	4.6	Unlimited	Unlimited
		Paddle Fish	< 0.05	Unlimited	Unlimited	< 0.05	Unlimited	Unlimited	1.6	Unlimited	Unlimited
		Non-Game Fish	< 0.05	Unlimited	Unlimited	< 0.05	Unlimited	Unlimited	6.1	Unlimited	Unlimited
		Sunfish	< 0.05	Unlimited	Unlimited	< 0.05	Unlimited	Unlimited	7.5	Unlimited	Unlimited
	Skin-On Fillet	Game Fish	0.24	6*	12*	< 0.05	Unlimited	Unlimited	6.3	Unlimited	Unlimited
		Sunfish	< 0.05	Unlimited	Unlimited	< 0.05	Unlimited	Unlimited	14.0	Unlimited	Unlimited

*Based on a single sample

Comparison of Skinless and Skin-On Fillet Samples

ODEQ was asked to compare values of skin-on versus skinless fillets in order to further refine consumption advice. In order to achieve this, composite paired samples of same-species skin-on and skinless fillets were collected at various sites. The results of these samples are shown in Table 12.

The results for lead and cadmium were inconclusive. All cadmium values fell below the analytical reporting limit so no comparison could be made. The same was true for 3 of the pairs for lead. In the case of the other 2 pairs, the skinless fillets were higher by a factor of 1.7 in one pair while the skin-on fillets were higher by a factor of 10 in the other pair.

Zinc showed the most clear difference with all skin-on fillet concentrations higher than skinless fillets by an average factor of 1.7

Table 12. Comparison of skinless and skin-on fillets.

Site ID	Species	Preparation	Lead (mg/kg)	Cadmium (mg/kg)	Zinc (mg/kg)
TC-GLCP	Largemouth Bass	Skinless Fillet	< 0.05	< 0.05	3.0
		Skin-On Fillet	0.24	< 0.05	6.3
TC-GLDA	Bluegill Sunfish	Skinless Fillet	< 0.05	< 0.05	6.5
		Skin-On Fillet	< 0.05	< 0.05	14.0
TC-MPACP	Green Sunfish	Skinless Fillet	0.17	< 0.05	11.0
		Skin-On Fillet	0.10	< 0.05	11.8
TC-NRECC	White Bass	Skinless Fillet	< 0.05	< 0.05	4.1
		Skin-On Fillet	< 0.05	< 0.05	7.2
TC-SRTB	White Crappie	Skinless Fillet	< 0.05	< 0.05	3.0
		Skin-On Fillet	< 0.05	< 0.05	4.9

Conclusions and Recommendations

Consumption of some preparations of fish caught in waters affected by contaminated runoff from abandoned lead and zinc mines in the Oklahoma portion of the Tri-State Mining District have levels of lead that potentially could cause adverse health effects for residents living near the Tar Creek Superfund site and non-residents from outside the area, particularly children. Residents of the Tar Creek area are more at risk based on evidence that people in the area are exposed to higher levels of lead than those living elsewhere.

Lead is the only metal for which group means exceed consumption limit levels. No group means exceed the consumption limits for cadmium or zinc. Skinless fillet fish from mill ponds, the Neosho River, and the Grand Lake are safe to eat. Consumption of fish from these waterbodies does not need to be limited if the fish are filleted and the skin removed. Skinless fillet fish from the Spring River are safe to eat except for non-

game fish (carp, freshwater drum, redhorse sucker, smallmouth buffalo). Consumption of fillets of non-game fish should be limited to no more than nine 8 oz meals per month for residents of the Tar Creek area..

Carcass preparations (headless eviscerated fish preparation with the bones) of game fish and sunfish from the Mill Ponds, non-game fish from the Neosho River, catfish, non-game fish and sunfish in the Spring River, and non-game fish from Grand Lake have lead concentrations high enough to warrant consumption restriction recommendations.

Additional observations include the following:

Flesh and roe preparations of paddlefish from the area have low concentrations of lead, cadmium, and zinc.

It was unclear if skinless fillets have higher levels of lead and cadmium. The data indicate skinless fillets have lower levels of zinc. A conservative approach to reducing one's exposure would be to only consume skinless fillets.

A consumption advisory will be issued for people eating fish from waters affected by runoff from the Tri-States Mining District. Because there is a need to balance a message that both informs the public and remains simple enough to understand and remember, the ODEQ will consult with local, national, and tribal health officials to craft an effective educational campaign.

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Appendix A Data Summary

STATION ID		TC-GLATB	Site Name	Grand Lake above Tynon Bluffs				
Water Temperature (Degrees C)		Dissolved Oxygen (mg/l)	pH (Std Units)	Specific Conductance (umhos/m3)				
16.6		8.87	7.48	319.9				
Sample ID	Species	Sample Preparation	Mean Length (mm)	Mean Weight (grams)	Lead in Fish (mg/kg)	Cadmium in Fish (mg/kg)	Zinc in Fish (mg/kg)	
415704	Channel Catfish	Skinless Fillet	397	463	< 0.05	< 0.05	4.0	
415705	Channel Catfish	Carcass	402	558	< 0.05	< 0.05	9.0	
415706	Largemouth Bass	Skinless Fillet	289	303	< 0.05	< 0.05	4.6	
415707	Largemouth Bass	Carcass	328	550	< 0.05	< 0.05	8.8	
415708	Smallmouth Buffalo	Skinless Fillet	508	2116	< 0.05	< 0.05	2.5	
415709	Smallmouth Buffalo	Carcass	504	2295	0.16	< 0.05	7.7	
415710	Bluegill Sunfish	Skinless Fillet	161	81	< 0.05	< 0.05	5.3	
415711	Bluegill Sunfish	Carcass	171	95	< 0.05	< 0.05	20.5	
415712	Freshwater Drum	Skinless Fillet	449	1242	< 0.05	< 0.05	3.4	
415713	Freshwater Drum	Carcass	471	1504	< 0.05	< 0.05	8.5	

STATION ID TC-GLBTB **Site Name** Grand Lake below Tynon Bluffs

Water Temperature (Degrees C) 14.8
Dissolved Oxygen (mg/l) 13.02
pH (Std Units) 8.33
Specific Conductance (umhos/m3) 314

Sample ID	Species	Sample Preparation	Mean Length (mm)	Mean Weight (grams)	Lead in Fish (mg/kg)	Cadmium in Fish (mg/kg)	Zinc in Fish (mg/kg)
415714	Channel Catfish	Skinless Fillet	469	1198	< 0.05	< 0.05	4.4
415715	Channel Catfish	Carcass	529	1580	< 0.05	< 0.05	6.6
415716	Largemouth Bass	Skinless Fillet	342	580	< 0.05	< 0.05	4.4
415717	Largemouth Bass	Carcass	422	1441	< 0.05	< 0.05	7.2
415718	Bluegill Sunfish	Skinless Fillet	158	70	< 0.05	< 0.05	6.3
415719	Bluegill Sunfish	Carcass	175	100	0.06	< 0.05	17.8
415720	Spotted Bass	Skinless Fillet	307	430	< 0.05	< 0.05	4.7
415721	Spotted Bass	Carcass	340	530	< 0.05	< 0.05	10.2
415722	Freshwater Drum	Skinless Fillet	398	814	< 0.05	< 0.05	3.4
415723	Freshwater Drum	Carcass	466	1369	< 0.05	< 0.05	14.5

STATION ID TC-GLCP **Site Name** Grand Lake at Catfish Point

Water Temperature (Degrees C) 17.9 **Dissolved Oxygen (mg/l)** 8.01 **pH (Std Units)** 7.49 **Specific Conductance (umhos/m3)** 312.3

Sample ID	Species	Sample Preparation	Mean Length (mm)	Mean Weight (grams)	Lead in Fish (mg/kg)	Cadmium in Fish (mg/kg)	Zinc in Fish (mg/kg)
415680	Carp	Skinless Fillet	498	1733	0.09	< 0.05	13.1
415681	Carp	Carcass	565	2578	0.13	< 0.05	31.7
415682	Freshwater Drum	Skinless Fillet	381	694	< 0.05	< 0.05	1.8
415683	Freshwater Drum	Skinless Fillet	458	1165	< 0.05	< 0.05	8.2
415684	White Crappie	Skinless Fillet	316	557	< 0.05	< 0.05	3.2
415685	White Crappie	Carcass	360	835	< 0.05	< 0.05	10.1
415686	Channel Catfish	Skinless Fillet	430	593	< 0.05	< 0.05	3.6
415687	Channel Catfish	Carcass	458	815	< 0.05	< 0.05	7.8
415688	Channel Catfish	Skinless Fillet	428	598	< 0.05	< 0.05	3.7
415689	Channel Catfish	Carcass	501	1162	< 0.05	< 0.05	8.4
415690	Largemouth Bass	Skinless Fillet	415	1230	< 0.05	< 0.05	3.0
415691	Largemouth Bass	Carcass	477	1991	< 0.05	< 0.05	4.6
415692	Largemouth Bass	Skin-On Fillet	415	1132	0.24	< 0.05	6.3
415693	Largemouth Bass	Skinless Fillet	415	1132	< 0.05	< 0.05	2.5

STATION ID TC-GLDA **Site Name** Grand Lake at Dam Area
Water Temperature (Degrees C) 14.3 **Dissolved Oxygen (mg/l)** 12.79 **pH (Std Units)** 8.02 **Specific Conductance (umhos/m3)** 309.9

Sample ID	Species	Sample Preparation	Mean Length (mm)	Mean Weight (grams)	Lead in Fish (mg/kg)	Cadmium in Fish (mg/kg)	Zinc in Fish (mg/kg)
415724	Bluegill Sunfish	Skinless Fillet	174	99	< 0.05	< 0.05	10.3
415725	Bluegill Sunfish	Carcass	170	92	< 0.05	< 0.05	19.1
415726	Bluegill Sunfish	Skinless Fillet	185	117	< 0.05	< 0.05	6.5
415727	Bluegill Sunfish	Skin-On Fillet	185	117	< 0.05	< 0.05	14.0
415728	White Bass	Skinless Fillet	349	602	< 0.05	< 0.05	5.7
415729	White Bass	Carcass	343	608.	< 0.05	< 0.05	9.9
415730	White Bass	Skinless Fillet	313	462	< 0.05	< 0.05	4.4
415731	White Bass	Carcass	344	618	< 0.05	< 0.05	15.3
415732	Smallmouth Buffalo	Skinless Fillet	473	1902	< 0.05	< 0.05	4.1
415733	Smallmouth Buffalo	Carcass	532	2648	0.23	< 0.05	9.7
415734	Spotted Bass	Skinless Fillet	255	245	< 0.05	< 0.05	5.7
415735	Spotted Bass	Carcass	302	377	< 0.05	< 0.05	10.6
415736	Largemouth Bass	Skinless Fillet	407	1220	< 0.05	< 0.05	4.8
415737	Largemouth Bass	Carcass	488	1743	0.11	< 0.05	10.7

STATION ID TC-GLPP **Site Name** Grand Lake at Paradise Point

Water Temperature (Degrees C) 19.5 **Dissolved Oxygen (mg/l)** 6.19 **pH (Std Units)** 6.94 **Specific Conductance (umhos/m3)** 273.4

Sample ID	Species	Sample Preparation	Mean Length (mm)	Mean Weight (grams)	Lead in Fish (mg/kg)	Cadmium in Fish (mg/kg)	Zinc in Fish (mg/kg)
415758	Bluegill Sunfish	Skinless Fillet	161	90	< 0.05	< 0.05	6.1
415759	Bluegill Sunfish	Carcass	164	96	0.07	< 0.05	19.4
415760	White Crappie	Skinless Fillet	285	359	< 0.05	< 0.05	5.1
415761	White Crappie	Carcass	327	573.3	< 0.05	< 0.05	10.8
415762	Largemouth Bass	Skinless Fillet	399	1128	< 0.05	< 0.05	6.9
415763	Largemouth Bass	Carcass	481	2202	< 0.05	< 0.05	8.8
415764	Channel Catfish	Skinless Fillet	376	383	< 0.05	< 0.05	7.7
415765	Channel Catfish	Carcass	448	777	0.11	< 0.05	12.9
415766	Smallmouth Buffalo	Skinless Fillet	444	1368	0.10	< 0.05	7.6
415767	Smallmouth Buffalo	Carcass	498	1942	0.15	< 0.05	11.7

STATION ID TC-GLSC **Site Name** Grand Lake at Sycamore Cove

Water Temperature (Degrees C) 19.9 **Dissolved Oxygen (mg/l)** 6.83 **pH (Std Units)** 7.13 **Specific Conductance (umhos/m3)** 291

Sample ID	Species	Sample Preparation	Mean Length (mm)	Mean Weight (grams)	Lead in Fish (mg/kg)	Cadmium in Fish (mg/kg)	Zinc in Fish (mg/kg)
415748	Channel Catfish	Skinless Fillet	457	846	< 0.05	< 0.05	5.1
415749	Channel Catfish	Carcass	500	1264	< 0.05	< 0.05	9.6
415750	White Bass	Skinless Fillet	388	781	< 0.05	< 0.05	3.4
415751	White Bass	Carcass	411	956	0.06	< 0.05	14.3
415752	Smallmouth Buffalo	Skinless Fillet	464	1529	< 0.05	< 0.05	6.3
415753	Smallmouth Buffalo	Carcass	498	1961	0.60	< 0.05	13.8
415754	Carp	Skinless Fillet	505	1583	< 0.05	< 0.05	8.2
415755	Carp	Carcass	530	2061	0.86	0.08	20.2
415756	Blue Catfish	Skinless Fillet	553	1696	< 0.05	< 0.05	6.1
415757	Blue Catfish	Carcass	624	2774	0.05	< 0.05	9.9

STATION ID	TC-GLSL	Site Name	Grand Lake at Shangri La					
Water Temperature (Degrees C)	Dissolved Oxygen (mg/l)	pH (Std Units)	Specific Conductance (umhos/m3)					
0	0	0						
Sample ID	Species	Sample Preparation	Mean Length (mm)	Mean Weight (grams)	Lead in Fish (mg/kg)	Cadmium in Fish (mg/kg)	Zinc in Fish (mg/kg)	
413778	Paddle Fish	Eggs	1114	20450	< 0.05	< 0.05	21.8	
413779	Paddle Fish	Eggs	1115	18350	< 0.05	< 0.05	21.6	
413780	Paddle Fish	Eggs	1035	19300	< 0.05	< 0.05	21.7	
413781	Paddle Fish	Eggs	1190	26700	< 0.05	< 0.05	20.8	
413782	Paddle Fish	Eggs	1065	18600	< 0.05	< 0.05	19.6	
413786	Paddle Fish	Skinless Fillet	1114	20450	< 0.05	< 0.05	1.5	
413787	Paddle Fish	Skinless Fillet	1115	18350	< 0.05	< 0.05	1.3	
413788	Paddle Fish	Skinless Fillet	1035	19300	< 0.05	< 0.05	1.4	
413789	Paddle Fish	Skinless Fillet	1190	26700	< 0.05	< 0.05	1.5	
413790	Paddle Fish	Skinless Fillet	1065	18600	< 0.05	< 0.05	1.8	
415694	Largemouth Bass	Skinless Fillet	372	858	< 0.05	< 0.05	3.4	
415695	Largemouth Bass	Carcass	399	1125	< 0.05	< 0.05	5.0	
415696	Bluegill Sunfish	Skinless Fillet	154	63	< 0.05	< 0.05	4.6	
415697	Bluegill Sunfish	Carcass	159	78	< 0.05	< 0.05	15.0	
415698	Spotted Bass	Skinless Fillet	326	460	< 0.05	< 0.05	4.1	
415699	Spotted Bass	Carcass	372	760	< 0.05	< 0.05	7.2	
415700	Channel Catfish	Skinless Fillet	451	858	< 0.05	< 0.05	3.3	
415701	Channel Catfish	Carcass	555	1539	< 0.05	< 0.05	9.8	
415702	Carp	Skinless Fillet	520	1944	< 0.05	< 0.05	8.3	
415703	Carp	Carcass	569.	2637	0.10	< 0.05	20.5	

STATION ID TC-GNRBD **Site Name** Grand Neosho River below Grand Lake

Water Temperature (Degrees C) 11.7 **Dissolved Oxygen (mg/l)** 11.68 **pH (Std Units)** 7.73 **Specific Conductance (umhos/m3)** 314

Sample ID	Species	Sample Preparation	Mean Length (mm)	Mean Weight (grams)	Lead in Fish (mg/kg)	Cadmium in Fish (mg/kg)	Zinc in Fish (mg/kg)
415738	Smallmouth Buffalo	Skinless Fillet	447	1484	< 0.05	< 0.05	6.2
415739	Smallmouth Buffalo	Carcass	471	1686	0.28	< 0.05	12.8
415740	Spotted Bass	Skinless Fillet	381	949	< 0.05	< 0.05	5.5
415741	Spotted Bass	Carcass	427	1450	< 0.05	< 0.05	8.7
415742	Largemouth Bass	Skinless Fillet	420	1348	< 0.05	< 0.05	4.4
415743	Largemouth Bass	Carcass	482	2110	< 0.05	< 0.05	8.3
415744	White Bass	Skinless Fillet	342	636	< 0.05	< 0.05	7.0
415745	White Bass	Carcass	356	680	< 0.05	< 0.05	10.6
415746	Bluegill Sunfish	Skinless Fillet	165	98	< 0.05	< 0.05	13.1
415747	Bluegill Sunfish	Carcass	170	106	0.05	< 0.05	17.1

STATION ID TC-MPACP **Site Name** Atlas Chat Pile Pond
Water Temperature (Degrees C) 17.2 **Dissolved Oxygen (mg/l)** 7.98 **pH (Std Units)** 7.74 **Specific Conductance (umhos/m3)** 2192

Sample ID	Species	Sample Preparation	Mean Length (mm)	Mean Weight (grams)	Lead in Fish (mg/kg)	Cadmium in Fish (mg/kg)	Zinc in Fish (mg/kg)
415768	Largemouth Bass	Skinless Fillet	315	331	< 0.05	< 0.05	5.2
415769	Largemouth Bass	Carcass	331	408	0.12	< 0.05	11.2
415770	Largemouth Bass	Skinless Fillet	318	316	< 0.05	< 0.05	6.7
415771	Largemouth Bass	Carcass	325	394	0.24	< 0.05	13.1
415772	Bluegill Sunfish	Skinless Fillet	154	75	0.07	< 0.05	8.1
415773	Bluegill Sunfish	Carcass	176	117	1.25	< 0.05	15.2
415774	Green Sunfish	Skinless Fillet	172	101	0.17	< 0.05	11.0
415775	Green Sunfish	Skin-On Fillet	172	101	0.10	< 0.05	11.8

STATION ID TC-MPBG **Site Name** Blue Goose Mill Pond
Water Temperature (Degrees C) 14.6 **Dissolved Oxygen (mg/l)** 8.62 **pH (Std Units)** 8.17 **Specific Conductance (umhos/m3)** 1154

Sample ID	Species	Sample Preparation	Mean Length (mm)	Mean Weight (grams)	Lead in Fish (mg/kg)	Cadmium in Fish (mg/kg)	Zinc in Fish (mg/kg)
415776	Largemouth Bass	Skinless Fillet	312	444	0.07	< 0.05	4.7
415777	Largemouth Bass	Carcass	364	701	0.07	< 0.05	7.5
415778	Green Sunfish	Skinless Fillet	170	102	0.06	< 0.05	5.7
415779	Green Sunfish	Carcass	180	129	0.66	< 0.05	26.4
415780	Bluegill Sunfish	Skinless Fillet	175	110	0.12	< 0.05	7.6
415781	Bluegill Sunfish	Carcass	181	130	0.23	< 0.05	23.4

STATION ID TC-MPNWWCP **Site Name** Northwest Western Chat Pile Pond
Water Temperature (Degrees C) 16.1 **Dissolved Oxygen (mg/l)** 13.24 **pH (Std Units)** 8.38 **Specific Conductance (umhos/m3)** 857

Sample ID	Species	Sample Preparation	Mean Length (mm)	Mean Weight (grams)	Lead in Fish (mg/kg)	Cadmium in Fish (mg/kg)	Zinc in Fish (mg/kg)
415782	Largemouth Bass	Skinless Fillet	391	988	< 0.05	< 0.05	3.0
415783	Largemouth Bass	Carcass	406	1064	0.12	< 0.05	7.6
415784	Bluegill Sunfish	Skinless Fillet	156	80	0.07	< 0.05	6.0
415785	Bluegill Sunfish	Carcass	166	101	0.61	< 0.05	24.1
415786	Hybrid Sunfish	Skinless Fillet	155	85	0.23	< 0.05	8.6
415787	Hybrid Sunfish	Carcass	162	98	0.73	< 0.05	15.4

STATION ID TC-MPWCP **Site Name** Western Chat Pile Mill Pond

Water Temperature (Degrees C) 16.5 **Dissolved Oxygen (mg/l)** 8.74 **pH (Std Units)** 7.81 **Specific Conductance (umhos/m3)** 1692

Sample ID	Species	Sample Preparation	Mean Length (mm)	Mean Weight (grams)	Lead in Fish (mg/kg)	Cadmium in Fish (mg/kg)	Zinc in Fish (mg/kg)
415788	Largemouth Bass	Skinless Fillet	294	335	< 0.05	< 0.05	6.4
415789	Largemouth Bass	Carcass	328	469	< 0.05	< 0.05	8.4
415790	Bluegill Sunfish	Skinless Fillet	187	113	< 0.05	< 0.05	9.2
415791	Bluegill Sunfish	Carcass	189	129	0.07	< 0.05	29.2

STATION ID TC-NRCB **Site Name** Neosho River at Conner Bridge

Water Temperature (Degrees C) 15.8 **Dissolved Oxygen (mg/l)** 16.91 **pH (Std Units)** 8.69 **Specific Conductance (umhos/m3)** 332

Sample ID	Species	Sample Preparation	Mean Length (mm)	Mean Weight (grams)	Lead in Fish (mg/kg)	Cadmium in Fish (mg/kg)	Zinc in Fish (mg/kg)
414871	Paddle Fish	Skinless Fillet	1378	9409	< 0.05	< 0.05	1.9
414872	White Crappie	Carcass	354	749.	< 0.05	< 0.05	8.3
414873	White Crappie	Skinless Fillet	303	534	< 0.05	< 0.05	3.7
414874	Carp	Carcass	595	2374	< 0.05	< 0.05	23.0
414875	Carp	Skinless Fillet	492	1710	< 0.05	< 0.05	8.2
414876	White Bass	Carcass	399	1005	< 0.05	< 0.05	10.2
414877	White Bass	Skinless Fillet	382	865	< 0.05	< 0.05	3.6
414878	Smallmouth Buffalo	Carcass	485	1784	0.22	< 0.05	10.7
414879	Smallmouth Buffalo	Skinless Fillet	442	1390	< 0.05	< 0.05	4.9
414880	Channel Catfish	Carcass	416	578	0.11	< 0.05	11.6
414881	Channel Catfish	Skinless Fillet	387	438	< 0.05	< 0.05	4.0

STATION ID TC-NRECC **Site Name** Neosho River at Elm Creek Confluence

Water Temperature (Degrees C) 16.2 **Dissolved Oxygen (mg/l)** 12.53 **pH (Std Units)** 8.72 **Specific Conductance (umhos/m3)** 340.9

Sample ID	Species	Sample Preparation	Mean Length (mm)	Mean Weight (grams)	Lead in Fish (mg/kg)	Cadmium in Fish (mg/kg)	Zinc in Fish (mg/kg)
414833	Smallmouth Buffalo	Carcass	481	1795	0.40	0.08	14.3
414834	Smallmouth Buffalo	Skinless Fillet	429	1357	0.07	< 0.05	4.6
414835	Carp	Carcass	492	1660	0.23	< 0.05	41.7
414836	Carp	Skinless Fillet	458	1075	< 0.05	< 0.05	7.7
414837	Blue Catfish	Skinless Fillet	464	862.	< 0.05	< 0.05	3.3
414838	Blue Catfish	Carcass	509	1239	< 0.05	< 0.05	8.3
414839	Channel Catfish	Carcass	492	942	< 0.05	< 0.05	8.0
414840	Channel Catfish	Skinless Fillet	455	723	< 0.05	< 0.05	4.1
414841	White Bass	Carcass	362	619	< 0.05	< 0.05	10.3
414842	White Bass	Skinless Fillet	310	419	< 0.05	< 0.05	3.4
414843	White Bass	Carcass	324	493	< 0.05	< 0.05	14.7
414844	White Bass	Skinless Fillet	295	376	< 0.05	< 0.05	4.1
414845	White Bass	Skinless Fillet	294	361	< 0.05	< 0.05	3.5
415679	White Bass	Skin-On Fillet	294	361	< 0.05	< 0.05	7.2

STATION ID **TC-NRRP** **Site Name** Neosho River at Riverview Park

Water Temperature **Dissolved Oxygen** **pH (Std Units)** **Specific Conductance**
 (Degrees C) (mg/l)

0 0 0 0

Sample ID	Species	Sample Preparation	Mean Length (mm)	Mean Weight (grams)	Lead in Fish (mg/kg)	Cadmium in Fish (mg/kg)	Zinc in Fish (mg/kg)
402985	Paddle Fish	Skinless Fillet	1072	20910	< 0.05	< 0.05	4.7
414846	Carp	Carcass	441	1100	0.07	< 0.05	24.1
414847	Carp	Skinless Fillet	421	967	< 0.05	< 0.05	11.7
414848	White Crappie	Carcass	313	519	< 0.05	< 0.05	11.0
414849	White Crappie	Skinless Fillet	304	504	< 0.05	< 0.05	3.6
414850	White Bass	Carcass	381	887	< 0.05	< 0.05	11.3
414851	White Bass	Skinless Fillet	379	324	< 0.05	< 0.05	3.0
414852	Smallmouth Buffalo	Carcass	422	1305	0.22	< 0.05	12.0
414853	Smallmouth Buffalo	Skinless Fillet	428	1268	0.13	< 0.05	2.7
414854	Channel Catfish	Carcass	434	692	0.09	< 0.05	9.8
414855	Channel Catfish	Skinless Fillet	380	423	< 0.05	< 0.05	5.5

STATION ID TC-SRBH **Site Name** Spring River at Blue Hole
Water Temperature (Degrees C) 15.7 **Dissolved Oxygen (mg/l)** 9.67 **pH (Std Units)** 8.19 **Specific Conductance (umhos/m3)** 400.1

Sample ID	Species	Sample Preparation	Mean Length (mm)	Mean Weight (grams)	Lead in Fish (mg/kg)	Cadmium in Fish (mg/kg)	Zinc in Fish (mg/kg)
414892	Smallmouth Buffalo	Skinless Fillet	467	1504	0.44	< 0.05	17.9
414893	Smallmouth Buffalo	Carcass	461	1595	1.03	< 0.05	16.2
414894	White Bass	Skinless Fillet	347	602	< 0.05	< 0.05	2.0
414895	White Bass	Carcass	358	630	< 0.05	< 0.05	10.1
414896	Channel Catfish	Skinless Fillet	444	708	< 0.05	< 0.05	4.5
414897	Channel Catfish	Carcass	466	953	0.21	< 0.05	12.6
414898	Carp	Skinless Fillet	502	1597	0.07	0.06	7.3
414899	Carp	Carcass	510	1811	0.18	0.10	23.9
414900	Redhorse Sucker	Skinless Fillet	394	898	< 0.05	< 0.05	4.0
414901	Redhorse Sucker	Carcass	466	126	< 0.05	< 0.05	11.1

STATION ID TC-SRMB **Site Name** Spring River at Moccasin Bend

Water Temperature (Degrees C) 15.4
Dissolved Oxygen (mg/l) 7.97
pH (Std Units) 7.93
Specific Conductance (umhos/m3) 409.5

Sample ID	Species	Sample Preparation	Mean Length (mm)	Mean Weight (grams)	Lead in Fish (mg/kg)	Cadmium in Fish (mg/kg)	Zinc in Fish (mg/kg)
414882	Black Crappie	Skinless Fillet	245	255	< 0.05	< 0.05	3.1
414883	Black Crappie	Carcass	284	408	< 0.05	< 0.05	8.5
414884	Carp	Skinless Fillet	504	1668	0.74	< 0.05	14.2
414885	Carp	Carcass	527	2256	0.45	< 0.05	24.3
414886	White Bass	Skinless Fillet	343	574	< 0.05	< 0.05	2.8
414887	White Bass	Carcass	3435	572	< 0.05	< 0.05	8.4
414888	Smallmouth Buffalo	Skinless Fillet	424	1221	< 0.05	< 0.05	15.0
414889	Smallmouth Buffalo	Carcass	465	1698	0.05	< 0.05	3.8
414890	Channel Catfish	Skinless Fillet	510	1277	< 0.05	< 0.05	4.0
414891	Channel Catfish	Carcass	568	2226	0.15	< 0.05	10.4

STATION ID TC-SRTB **Site Name** Spring River at Twin Bridges State Park

Water Temperature (Degrees C) 15.1 **Dissolved Oxygen (mg/l)** 8.85 **pH (Std Units)** 7.95 **Specific Conductance (umhos/m3)** 379.5

Sample ID	Species	Sample Preparation	Mean Length (mm)	Mean Weight (grams)	Lead in Fish (mg/kg)	Cadmium in Fish (mg/kg)	Zinc in Fish (mg/kg)
414856	Largemouth Bass	Carcass	424	1381	< 0.05	< 0.05	6.5
414857	Largemouth Bass	Skinless Fillet	347	703	< 0.05	< 0.05	4.2
414858	Freshwater Drum	Carcass	426	1084	0.13	< 0.05	8.7
414859	Freshwater Drum	Skinless Fillet	398	814	0.08	< 0.05	3.9
414860	Smallmouth Buffalo	Skinless Fillet	423	1236	< 0.05	< 0.05	3.1
414861	Smallmouth Buffalo	Carcass	458	1496	0.54	< 0.05	12.4
414862	Carp	Carcass	518	2116	1.60	0.55	23.7
414863	Carp	Skinless Fillet	496	1524	0.06	0.06	7.3
414864	Channel Catfish	Carcass	455	792	0.14	< 0.05	10.1
414865	Channel Catfish	Skinless Fillet	426	622	< 0.05	< 0.05	3.7
414866	Bluegill Sunfish	Carcass	154	74	0.38	< 0.05	19.8
414867	Bluegill Sunfish	Skinless Fillet	141	54	< 0.05	< 0.05	5.2
414868	Bluegill Sunfish	Carcass	153	74	0.31	< 0.05	16.0
414869	Bluegill Sunfish	Skinless Fillet	143	58	< 0.05	< 0.05	5.2
414870	White Crappie	Skinless Fillet	310	493	< 0.05	< 0.05	3.0
415678	White Crappie	Skin-On Fillet	310	493	< 0.05	< 0.05	4.9