2011-13 Tennessee Coalfields Fish Tissue and Water Quality Study

Tennessee Department of Environment and Conservation
Division of Water Resources

William R. Snodgrass TN Tower
312 Rosa L. Parks Ave, 11th Floor
Nashville, TN 37243

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By

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December 2014

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TABLE OF CONTENTS

PAGE

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGMENTS

Fish tissue and water column collection and analyses for metals were funded by two EPA 106 supplemental grants. Nutrient analyses and macroinvertebrate surveys were funded by the Tennessee Valley Authority (TVA) and are not presented in this report but will be used for water quality assessments as part of the 305(b)/303(d) report. The study was coordinated by the Planning and Standards Unit, Division of Water Resources, Tennessee Department of Environment and Conservation, Greg Denton manager. Deborah Arnwine was project coordinator. Michael Graf and Kim Sparks were responsible for processing data as well as GIS mapping.

Assistance with site selection was provided by the Division of Water Resources, Mining Section in Knoxville as well as the Knoxville and Chattanooga Field Offices. Paul Schmierbach (retired) was manager of the Knoxville offices and Dick Urban (retired) was manager of the Chattanooga Office at the time of the study. TDEC Mining Section Staff Jonathon Burr (current manager), Dave Turner and Dan Murray provided land-use and background information on sites and reviewed the report.

All 2011 sample collection was conducted by the Tennessee Valley Authority (TVA) under the direction of Tyler Baker. The 2013 and 2014 fish tissue samples were collected by the Aquatic Biology Section, Tennessee Department of Health Environmental Laboratory (TDH); Pat Alicea is the section manager. Fish tissue samples were analyzed by the TDH inorganic chemistry laboratory in Nashville, under the supervision of Craig Edwards. Water quality samples were analyzed by Environmental Science Corporation (ESC) in Mount Juliet Tennessee under contract through TVA.

Cover photo of backpack shocking on Big Creek provided by Aquatic Biology Section, Environmental Laboratory, TDH.

EXECUTIVE SUMMARY

Tennessee has a history of surface coal mining in the Cumberland Plateau and Cumberland Mountain regions. Over 1000 miles of 45 streams are on the 303(d) list of impaired waters due coal mining activities. Most of the impaired stream miles are downstream of surface mines that were abandoned prior to the Surface Mining Reclamation and Control Act of 1977.

Biologists with the Division of Water Resources routinely collect macroinvertebrate and water chemistry samples downstream of inactive mines while active permits require in-stream monitoring. However since coal can be locally enriched in trace elements such as arsenic, mercury and selenium, there is the potential for human health or environmental effects from the bioaccumulation in fish tissue.

In 2011, 2013 and 2014, the Division of Water Resources used EPA 106 supplemental funds (I-95463510-0 and I-00447010-4) to study potential bioaccumulation of metals in native game fish in streams draining four land-use categories (active, abandoned/reclaimed coal mines, non-coal mining activities and reference).

Mercury in fish fillets at nine sites had concentrations above 0.3 ppm (precautionary level for human consumption). Three sites had elevated mercury concentrations in multiple species. Smallmouth bass were generally the largest fish collected and tended to have the highest levels of mercury. Although not present at all sites, smallmouth were found in all land-use categories. Mercury levels tended to be highest in the smallmouth collected at reference sites and those downstream of inactive coalfields.

Typically, selenium levels were highest downstream of active coal mines followed by non-coal mining activities. Fish size, diet and species had little influence in selenium concentrations. None of the levels exceed the EPA draft 2004 or 2013 (currently under peer review) guidelines for selenium in fish fillets, ovaries or whole-body fish.

Eight other metals were analyzed from the fish fillet samples collected in 2011. Arsenic, total chromium, copper, iron and zinc were found in low levels in some fish fillets. Cadmium, lead, and thallium were not detected in any fish. Arsenic and iron were higher downstream of active coal mines. Arsenic was generally below detection at other sites except for the site downstream of historic copper mining. Except for mercury, metal concentrations from all sites were below levels of concern.

Water column samples were collected concurrent with the 2011 fish collection. Results from most sites were well below levels of concern. Monitoring stations with elevated zinc, iron and manganese are already listed as impaired for that parameter from abandoned mines.

1. INTRODUCTION

Tennessee has a history of surface coal mining in the Cumberland Plateau and Cumberland Mountain regions. Over 1000 miles from 45 streams are on the 303(d) list of impaired waters due coal mining activities. Most of the impaired stream miles are downstream of surface mines that were abandoned prior to the Surface Mining Reclamation and Control Act of 1977 (Figure 1).

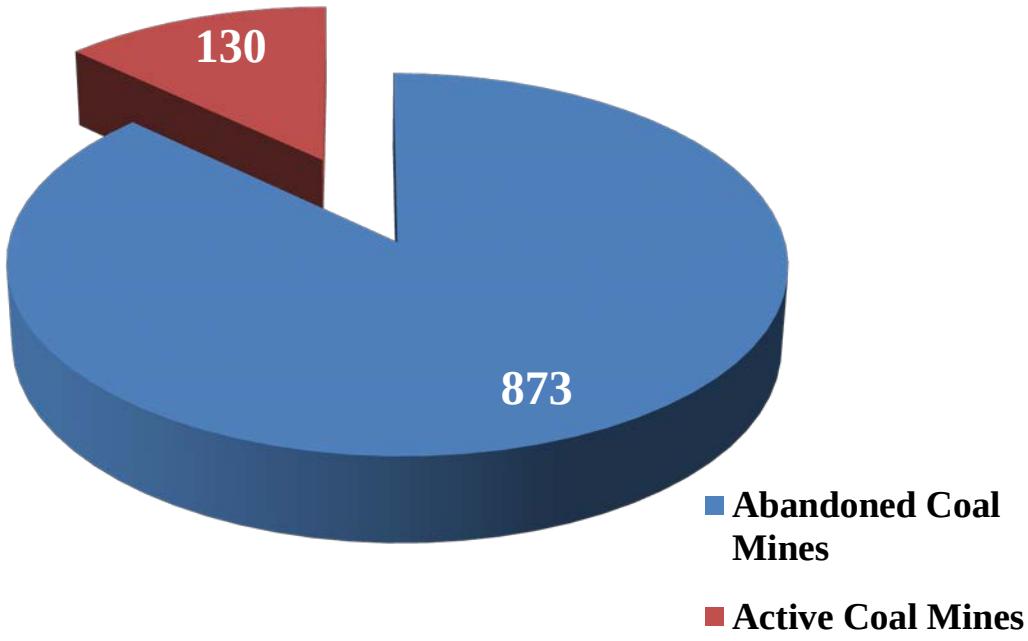


Figure 1: Number of impaired stream miles due to mining activities.

In streams draining abandoned coalfields, most are impaired by pH followed by iron, manganese and silt (Figure 2). Manganese, habitat alteration and silt are the most common pollutants affecting streams draining active coal mines (Figure 3).

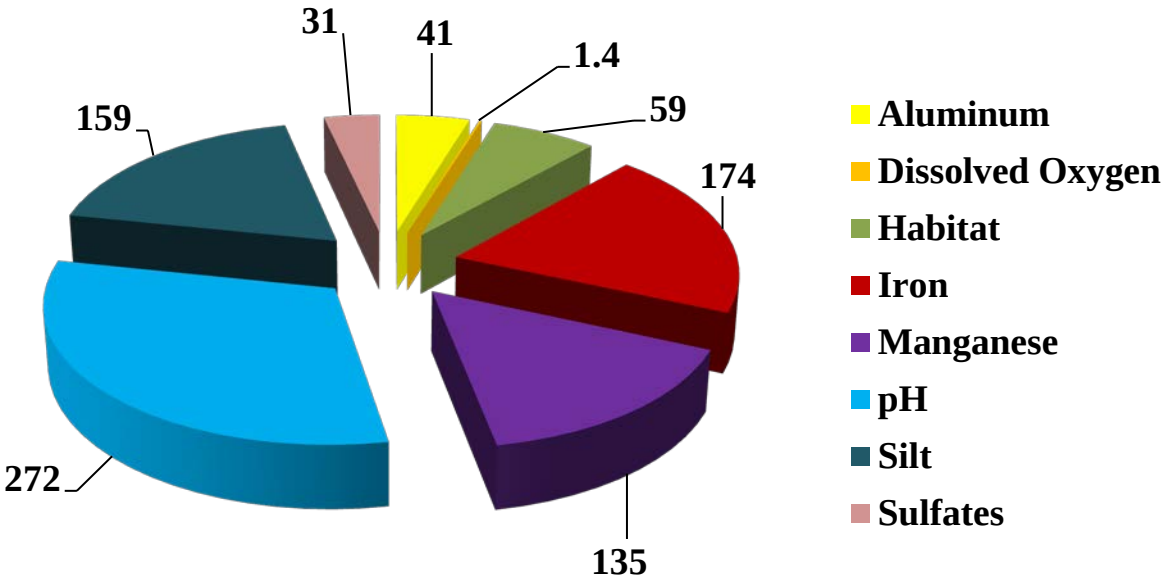


Figure 2: Stream miles impaired by various pollutants downstream of abandoned coalfields.

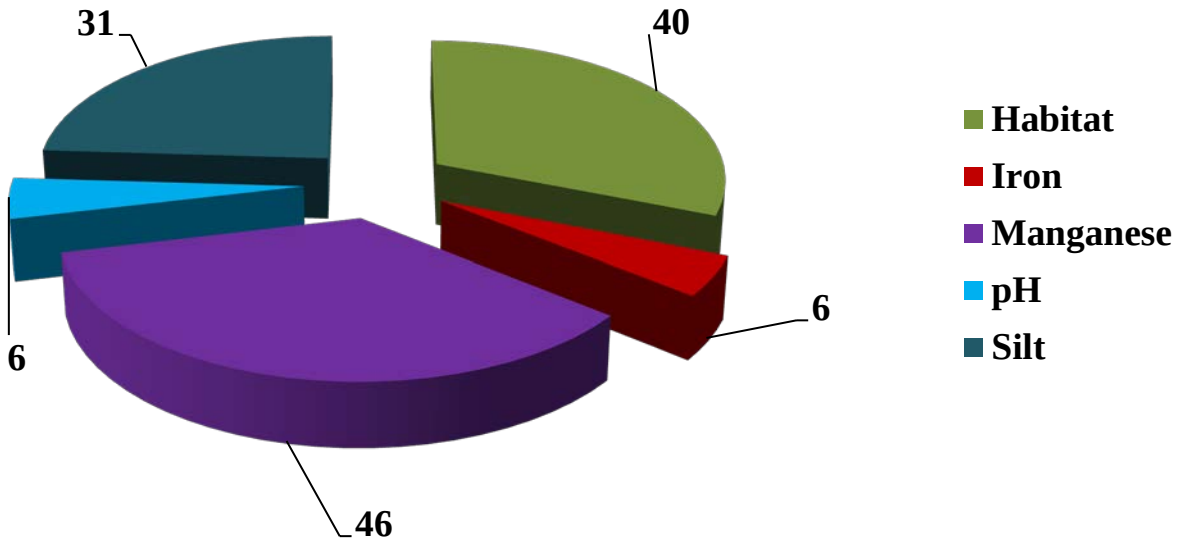


Figure 3: Stream miles impaired by various pollutants downstream of active coalfields.

Biologists with the Division of Water Resources routinely collect macroinvertebrate and water chemistry samples downstream of inactive mines while active permits require in-stream monitoring. Since coal can be locally enriched in trace elements such as arsenic, mercury and selenium, there is also the potential for human health or environmental effects from bioaccumulation in fish.

In 2011, 2013 and 2014, the Division of Water Resources used EPA 106 supplemental funds (I-95463510-0 and I-00447010-4) to study potential bioaccumulation of metals in native game fish at 48 study sites in east Tennessee. The sites included streams draining active, abandoned and reclaimed coal mines as well as non-coal mining activities and reference sites.

The primary objectives of the study were to:

1. Assess possible bioaccumulation of 106 priority metals in game fish fillets in 3rd order or larger streams draining Tennessee coalfield regions.

2. Determine selenium levels of fish ovaries in 3rd order or larger streams draining Tennessee coalfield regions.

3. Determine water column concentrations of 106 priority metals in 3rd order or larger streams draining Tennessee coalfield regions.

4. Obtain data for assessment of designated uses of fish and aquatic life and recreation for the 303(d) and 305(b) reporting.

5. Provide information to support regulatory decision-making in surface mining permits.

6. Determine the potential for human risk through consumption of fish fillets.

7. Determine the potential for environmental risk for wildlife consumption of fish in the streams.

8. Evaluate additional monitoring needs.

2. SITE SELECTION

Coal mining in Tennessee is restricted to the coal bearing strata in the Southwestern Appalachian (68) and Central Appalachians (69) ecoregions (Figure 4). An ecoregion is a relatively homogenous area defined by similarity of climate, landform, soil, potential natural vegetation, hydrology and other ecologically relevant variables (Griffith et al, 1977). The majority of active coal mining in Tennessee occurs in the northern coalfields of ecoregion 69. While there are some sites that are permitted to discharge in ecoregion 68, most are not currently extracting coal.

The majority of watersheds within the coal bearing areas of Tennessee contain some pre-law (state or federal Surface Mining Control and Reclamation Act) abandoned mine lands. These are often in the same watersheds as reclaimed mines, so it is sometimes difficult to separate effects on streams. Streams that drain abandoned and/or reclaimed areas have been classified as inactive coal mining for this study.

In 2011, forty-three study sites were selected to represent streams draining both active and inactive surface mines in Tennessee coalfields as well as non-coal mining activities. Four additional sites were added in 2013. Streams large enough to support game fish were targeted. Fifteen of the sites were located in watersheds with active coal mine permits which have been mined within the last ten years. Twenty-six drained non-active coalfields which included inactive permits, reclaimed and abandoned mines. Three stations were downstream of non-coal surface mining including active sand and mica mines and a large-scale historic copper mine currently under reclamation. Two of these sites were in non-coal ecoregions; the Ridge and Valley (67) and the Blue Ridge Mountains (66). Three reference sites were sampled within the coalfields regions. These sites were in relatively un-disturbed areas of ecoregions 68 and 69 with limited historic coal mining. A site list is provided in Appendix A.

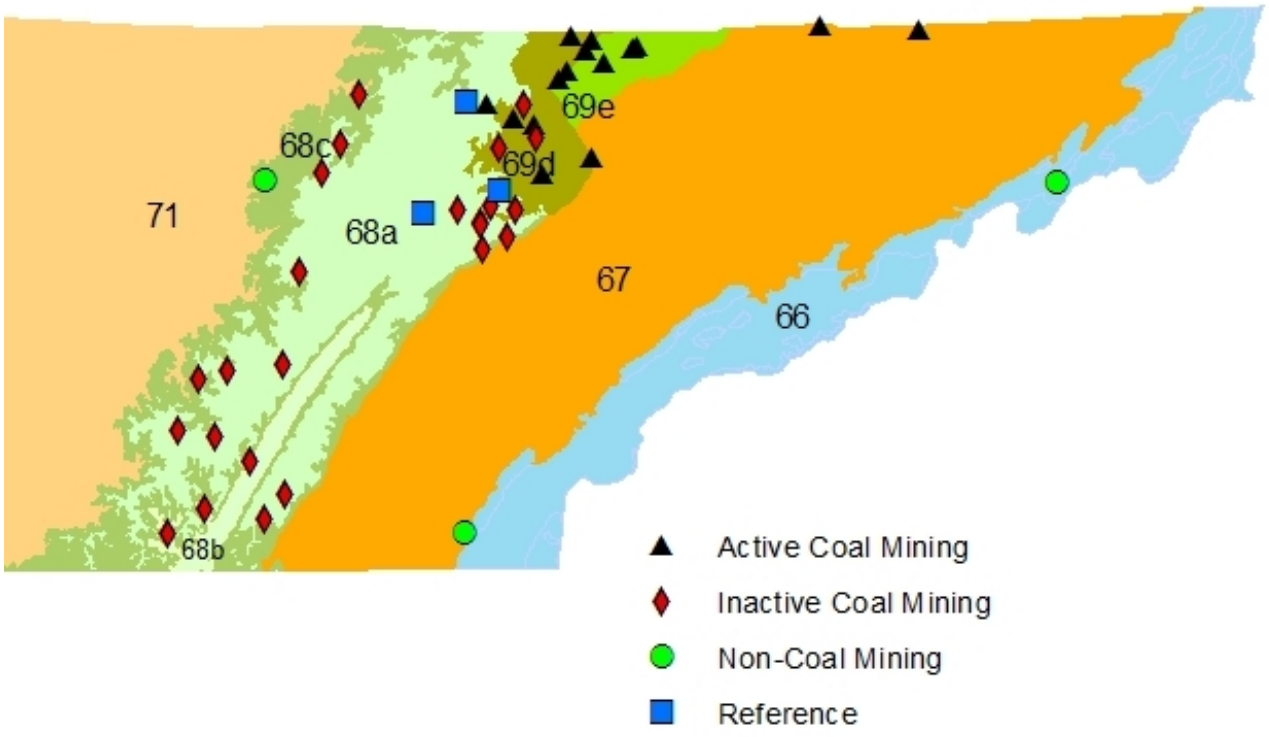


Figure 4: Location of study sites by ecoregion and land-use.

Study sites were located in both the Cumberland and Tennessee River Basins (Figure 5) and represented the nine HUC 8 watersheds with impaired waters due to coal mining. Stations downstream of active surface coal mines were within six of these watersheds while inactive mining stations were located in all nine watersheds. Non-coal mining sites were within three watersheds including two with no historic coal mining, the Nolichucky and Ocoee Rivers. These were sampled for comparison of land disturbance from mining activities unrelated to coal. Reference sites were in the South Fork Cumberland and Emory River watersheds both of which have a history of coal mining.

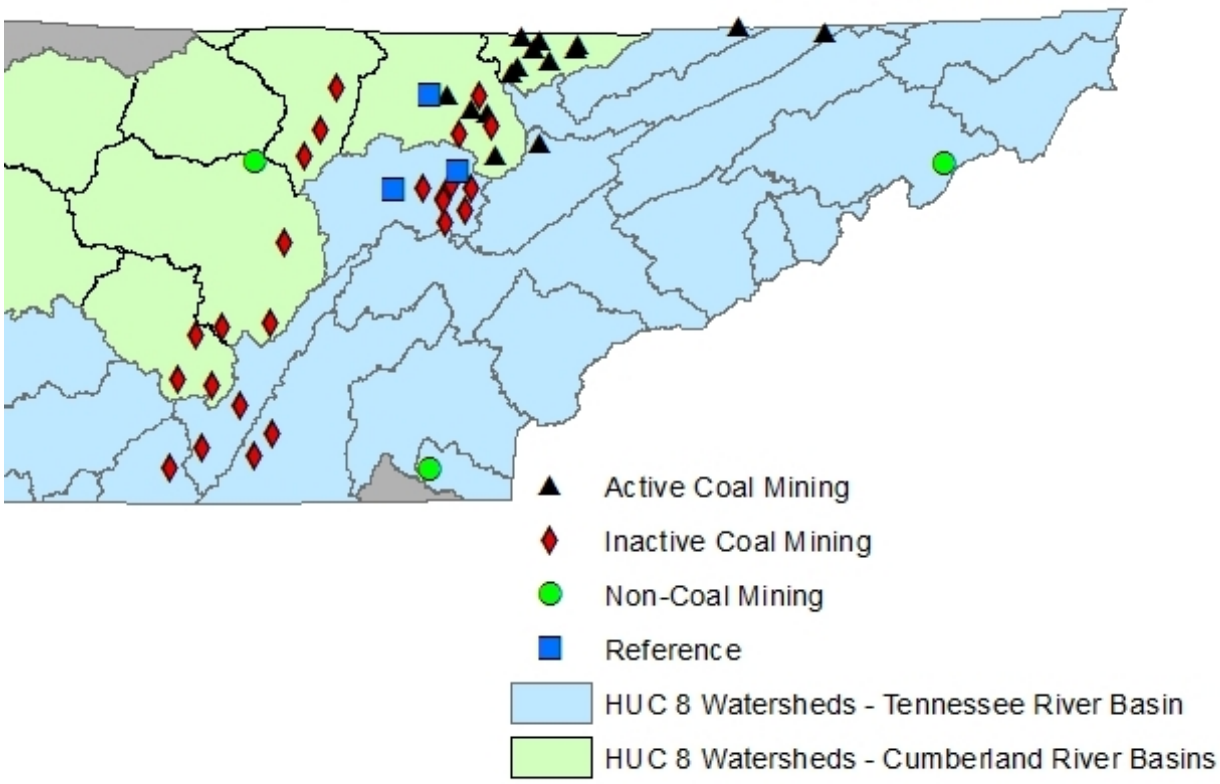
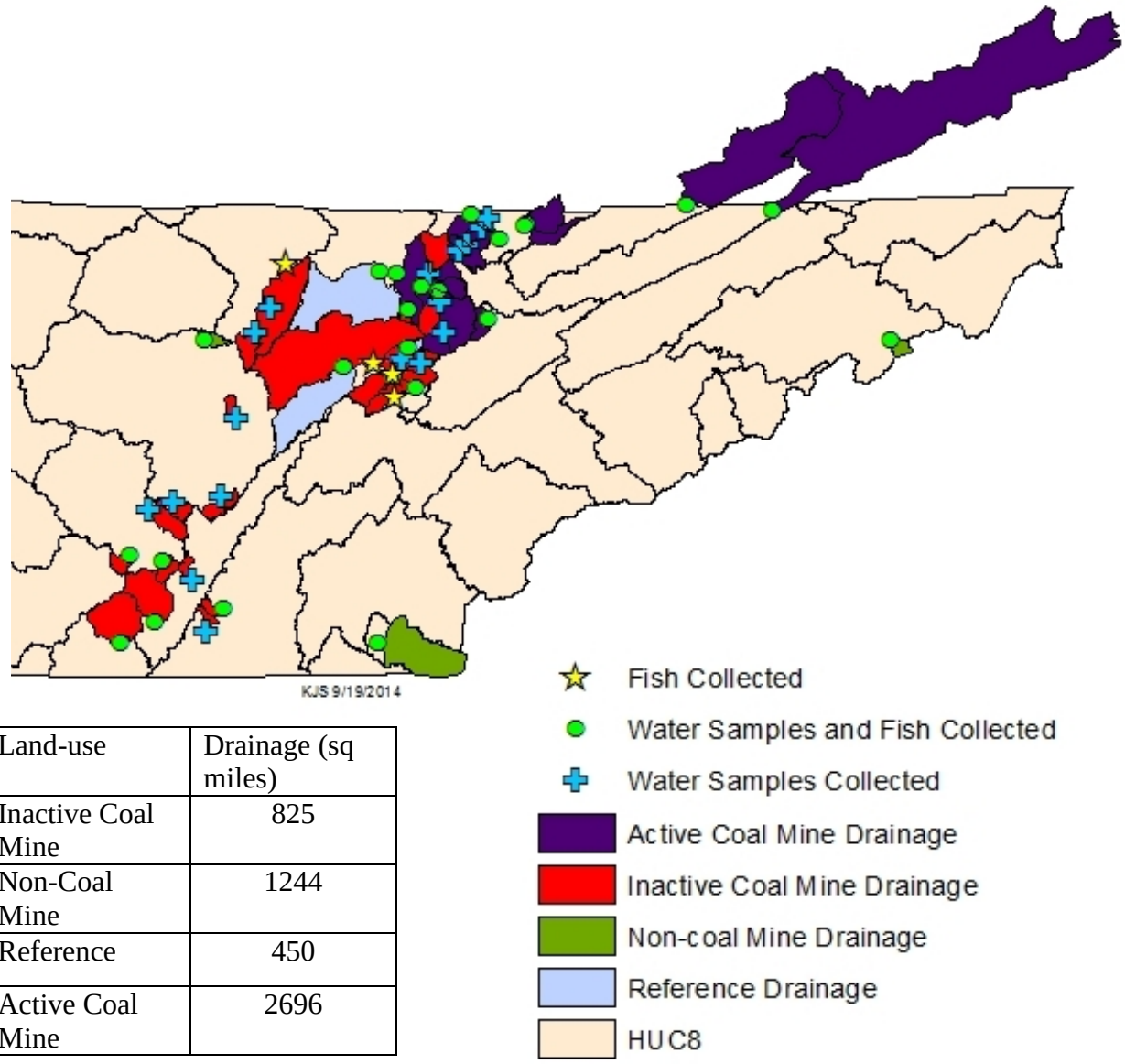


Figure 5: Location of study sites by watershed and land-use.

Although more study sites were located below inactive coalfields, the stations downstream of active coal mining and non-coal mining sites represented larger drainage areas (Figure 6). The entire drainage for two of the study sites on the Clinch (1,155 square miles) and Powell (467 square miles) Rivers were in Virginia. Both of these sites drain coalfields outside of Tennessee and represent the largest drainage areas in the study.



Land-use	Drainage (sq miles)
Inactive Coal Mine	825
Non-Coal Mine	1244
Reference	450
Active Coal Mine	2696

Figure 6: Drainage area upstream of study sites.

3. SAMPLE METHODOLOGY

In summer/fall 2011 native game fish composites were collected at 23 sites where target species were present and of sufficient size to process. Both fillets and ovaries were analyzed. Additional fish (fillets) were collected in summer 2013 at seven sites where mercury was above 0.3 ppm and from five new sites downstream of inactive mines. Whole-body fish samples were collected in winter 2013-14 from four sites where selenium in 2011 exceeded the draft 5.85 ug/g dry weight summer screening values (USEPA 2004). TVA fisheries biologists (2011) and TDH aquatic biologists (2013-14) collected the samples.

Fish were weighed and measured prior to processing. Fillets included the belly flap and were scaled with skin left on. Ovaries were harvested from females to be analyzed as a separate composite. Sample handling followed EPA protocols (USEPA 2000). All fish samples were analyzed by the Tennessee Department of Health (TDH) Environmental Laboratory in Nashville, Tennessee. Fish data are provided in Appendix B.

Water column samples were collected by TVA in 2011 from 43 sites. All water chemistry samples were analyzed by Environmental Science Corporation (ESC) in Mount Juliet, Tennessee per TVA contract. Instantaneous flow, temperature, dissolved oxygen, conductivity and pH were measured concurrent with water column sample collections. Data are provided in Appendix C.

Fish fillet and water column samples were analyzed for mercury, selenium, arsenic, cadmium, chromium, copper, iron, lead, manganese and zinc. Water column samples were also analyzed for alkalinity, hardness, total dissolved solids, total suspended solids, sulfates and chlorides. Ovaries and whole-body fish samples were analyzed for mercury and selenium.

Although not included in the grant project plan, nutrient and level I benthics (family level screening) were collected in 2011 as part of a cooperative agreement with TVA. These data are not included in this report but were used for watershed assessment purposes.

4. FISH TISSUE RESULTS

Fish were collected from 28 sites in 2011-2014 (Table 1). Ten sites were downstream of active coal mines and 13 were below inactive mine sites which included permitted, abandoned and reclaimed mines. Three sites were below non-coal mining activities including active sand and mica mines and a reclaimed large-scale copper mine. Fish were collected at two of the reference sites. The remaining sites were dry, had no fish present, did not have target fish species or fish were too small to analyze.

Ovaries were harvested from fish at eight of the stations draining active mines and seven of the inactive sites. Ovaries were analyzed at all of the non-coal mining and reference stations. Whole-body fish samples were collected in winter and analyzed for selenium at three sites below active coal mines and one below a sand mine.

Table 1: Fish samples collected at project sites 2011 - 2014.

Site Id	Species	# Fish Fillets	Mn Fish Wt (lbs)	# Whole Fish	Mn Fish Wt (lbs	# Ovaries	Land-use
BFGIZ000.6MI	BLUEGILL	6	0.1	0		2	Inactive Coal
BIG007.2GY	BLUEGILL	7	0.1	0		4	Inactive Coal
BRIMS013.9SC	ROCKBASS	17	0.2	0		3	Inactive Coal
	SMALLMOUTH BASS	1	0.1	0		0	
CAPUC001.9CA	ROCKBASS	5	0.2	0		4	Active Coal
CFORK003.8SC	SMALLMOUTH BASS	6	1	0		1	Reference
CLEAR030.5CA	ROCKBASS	3	0.3	0		3	Active Coal
CLINC199.0HK	ROCKBASS	5	0.3	0		0	Active Coal
CLINC199.0HK	SMALLMOUTH BASS	5	0.7	8	1.2	3	
CLINC199.0HK	LARGEMOUTH BASS	0		2	0.7	0	
COAL005.4AN	ROCKBASS	10	0.1	6	0.1	5	Active Coal
COAL005.4AN	SMALLMOUTH BASS	0		6	0.1	0	
COLLI061.7GY	BLUEGILL	7	0.1	0		1	Inactive Coal
COLLI061.7GY	LARGEMOUTH BASS	3	0.8	0		1	
CORCH000.2MG	ROCKBASS	4	0.1	0		0	Inactive Coal
ECO68A26	ROCKBASS	14	0.2	0		5	Reference
ECO68A26	SMALLMOUTH BASS	11	0.4	0		1	
ECO69D03	ROCKBASS	5	0.2	0		4	Reference
EFOBE012.6FE	ROCKBASS	10	0.2	0		0	Inactive Coal
EFOBE012.6FE	SMALLMOUTH BASS	2	0.5	0		0	
EMORY014.5MG	LARGEMOUTH BASS	2	0.5	0		0	Inactive Coal
EMORY014.5MG	SMALLMOUTH BASS	5	1.1	0		0	
EMORY022.0MG	LARGEMOUTH BASS	1	0.8	0		0	Inactive Coal
EMORY022.0MG	SMALLMOUTH BASS	2	0.7	0		0	
EMORY027.7MG	SMALLMOUTH BASS	9	0.3	0		0	Inactive Coal
FWATE040.1PU	SMALLMOUTH BASS	2		11	0.4	2	Sand (Active)
LEMOR004.3MG	LARGEMOUTH BASS	5	0.6	0		0	Inactive Coal
LEMOR004.3MG	SMALLMOUTH BASS	2	1.1	0		0	

Site Id	Species	# Fish Fillets	Mn Fish Wt (lbs)	# Whole Fish	Mn Fish Wt (lbs	# Ovaries	Land-use
LSEQU009.0MI	ROCKBASS	18	0.2	0		7	Inactive Coal
LSEQU009.0MI	SMALLMOUTH BASS	6	1.0	0		3	
NCHIC026.4HM	BLUEGILL	7	0.2	0		3	Inactive Coal
NEW008.8SC	SPOTTED BASS	4	0.6	0		2	Active Coal
NEW025.0SC	ROCKBASS	2	0.1	0		0	Active Coal
NEW025.0SC	SMALLMOUTH BASS	18	0.3	0		3	
NEW032.0SC	ROCKBASS	2	0.1	0		0	Active Coal
NEW032.0SC	SMALLMOUTH BASS	16	0.3	0		4	
NOLIC097.5UC	ROCKBASS	14	0.3	0		4	Mica (Active)
NOLIC097.5SU	SMALLMOUTH BASS	12	1.0	0		2	
OCOEE11.9PO	SPOTTED BASS	5	3.2	0		3	Copper (Historic)
POWEL115.7HK	ROCKBASS	9	0.2	5	0.2	5	Active Coal
POWEL115.7HK	SMALLMOUTH BASS	3	0.5	8	0.4	1	
STINK000.3CA	ROCKBASS	7	0.2	0		3	Active Coal
STINK000.3CA	SMALLMOUTH BASS	2	0.5	0		1	
TACKE000.5CA	ROCKBASS	6	0.2	0		3	Active Coal
TACKE000.5CA	SMALLMOUTH BASS	5	0.4	0		4	

Fish fillet, ovary and whole-body samples were collected from Coal Creek.

Photo provided by Aquatic Biology Section, TDH.

a. Mercury

Mercury in fish fillets ranged from 0.06 to 0.7 ppm. Nine sites had concentrations above 0.3 ppm (precautionary level for human consumption). Three sites had elevated mercury concentrations in multiple species. Sites below active coal mines had the lowest concentrations, with only one site, the New River mile 32, at 0.3 ppm. Fish from reference sites followed by inactive coal mining tended to have the highest mercury levels (Figure 7).

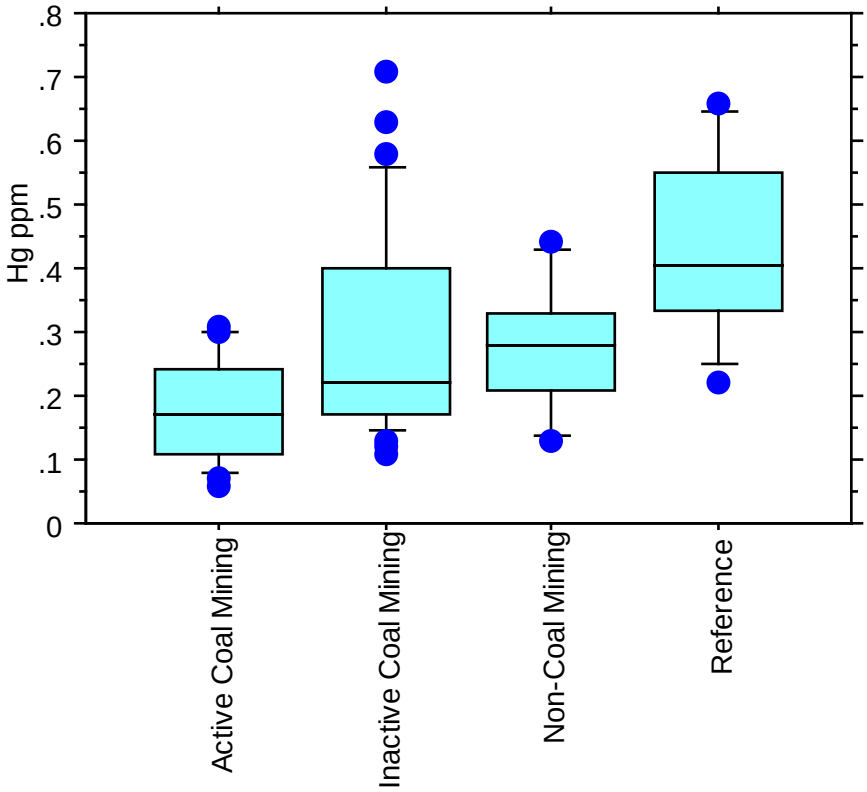


Figure 7: Mercury in fish fillet composites by land-use.

Mercury concentrations by species were difficult to compare since the same species were not present at every site. Smallmouth bass were the most common fish, collected at 18 sites in all land-use categories. Rockbass were also collected in all categories (14 sites). Largemouth bass were collected from four inactive and one active coal mine site. Spotted bass were collected at one active coal mine site and one non-coal site. Bluegill was the only species found at three of the inactive mine sites. Due to the nature of the streams, most of the fish were small, generally under one pound. Mercury levels above 0.3 ppm were measured in rockbass, smallmouth bass and largemouth bass (Figure 8).

Smallmouth bass were generally the largest fish collected and had the highest levels of mercury. Although not present at all sites, they were found in all land-use categories. Mercury levels tended to be highest in the smallmouth collected at reference sites and those downstream of inactive coalfields (Figure 9).

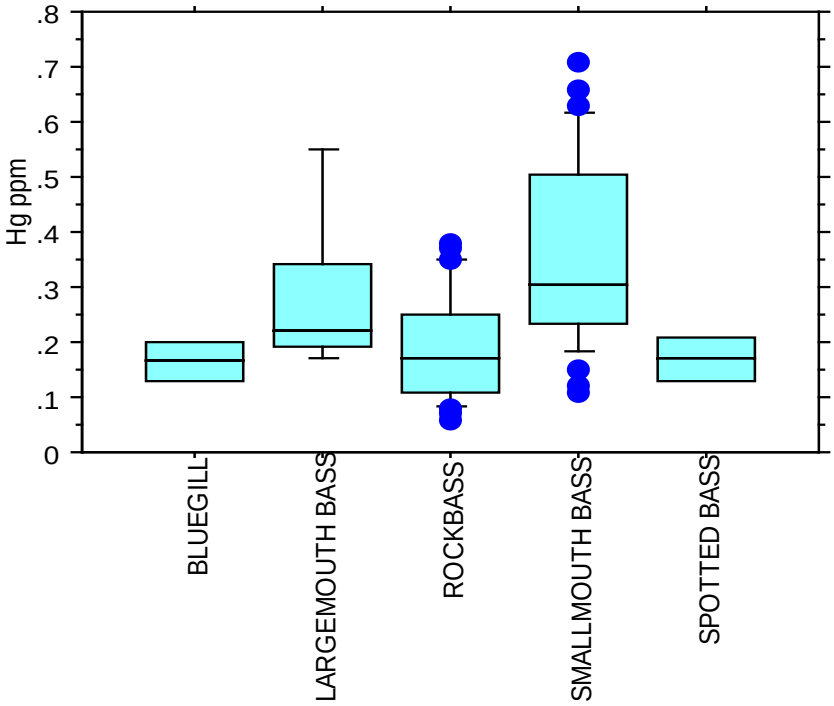


Figure 8: Mercury in fish fillet composites by species.

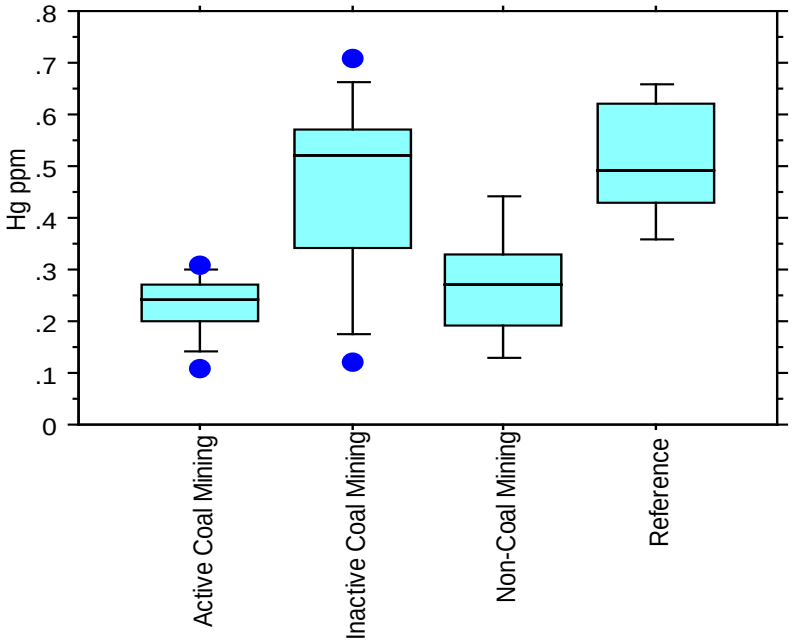


Figure 9: Mercury in smallmouth bass collected from 18 study sites.

b. Selenium

Selenium is a naturally occurring element that is nutritionally essential, but can be toxic to aquatic life where concentrations are excessive. Being a natural element, selenium can be found throughout the environment. Risks stem from aquatic life eating food that is contaminated with selenium rather than from direct exposure to selenium in the water. It is also toxic to herons and other birds that consume aquatic organisms containing excessive levels of selenium.

Fish fillets from 28 sites, ovaries from 21 sites and whole-body samples from the four sites with the highest selenium levels were analyzed. Dry weight was calculated from wet weight analysis by assuming 78.5% moisture content and multiplying by 4.65 (USEPA 1999). None of the samples exceeded 2014 EPA draft criterion presented in Table 2 (USEPA 2014). Ovaries had the highest selenium levels followed by whole-body fish and fillets (Figure 10). It should be noted this criterion is still under peer review and is subject to revision.

When the study began in 2011, the 2004 draft criterion was the most current selenium guidelines (USEPA 2004). This criterion was based on whole-body fish samples collected in winter. Fish ovary samples from four sites collected in summer 2011 exceeded the recommended 2004 selenium levels of 7.91 ug/L. Since ovaries tend to be higher in selenium, whole-body fish samples were collected at these sites in winter 2013-14 for verification. All samples were below the 2004 draft criterion.

Selenium levels were generally highest downstream of active coal mines followed by non-coal mining activities (Figure 11). The Powell River, which drains active coal mines in Virginia, had the highest selenium levels.

Fish size had little influence on selenium concentrations. Smaller species such as bluegill and rockbass had higher levels than largemouth and smallmouth bass collected at the same site. Diet seemed to have more of an affect. Unlike mercury, which is higher in top piscivores, selenium levels were higher in fish species lower on the food chain. Bluegill feed primarily on midge larvae and microcrustaceans, seasonally eating terrestrial insects. Rockbass diet consists of crayfish, large aquatic insect nymphs and small fish. The other species collected are primarily piscivores.

Table 2: Excerpt from summary of the external peer review draft freshwater selenium ambient chronic water quality criterion for protection of aquatic life (Adapted from USEPA 2014). *(Draft document subject to revision).*

Fish Filet	Ovary/Egg*	Whole-body Fish
11.8 mg/kg	15.2 mg.kg	8.1 mg.kg

*Ovary overrides whole-body or fillet.

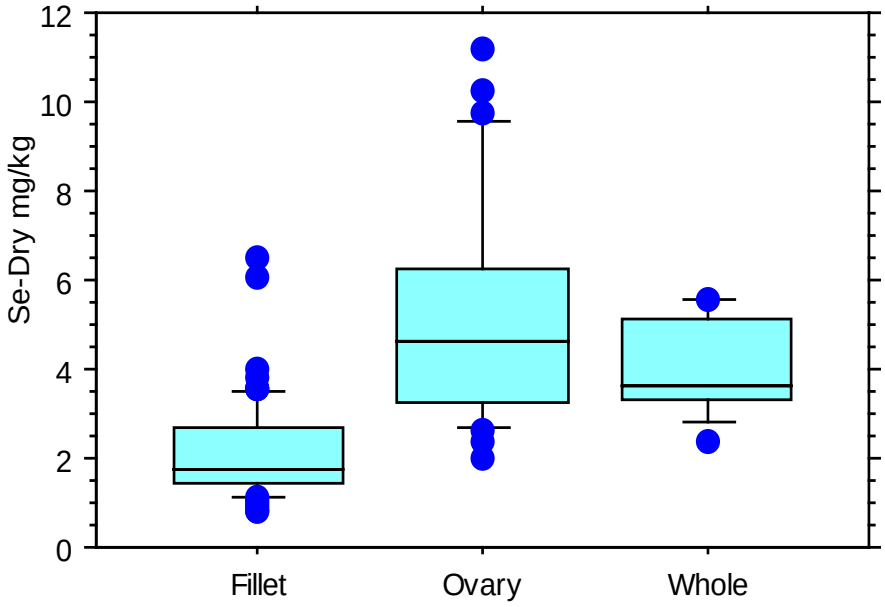


Figure 10: Comparison of selenium concentrations by fish tissue type.

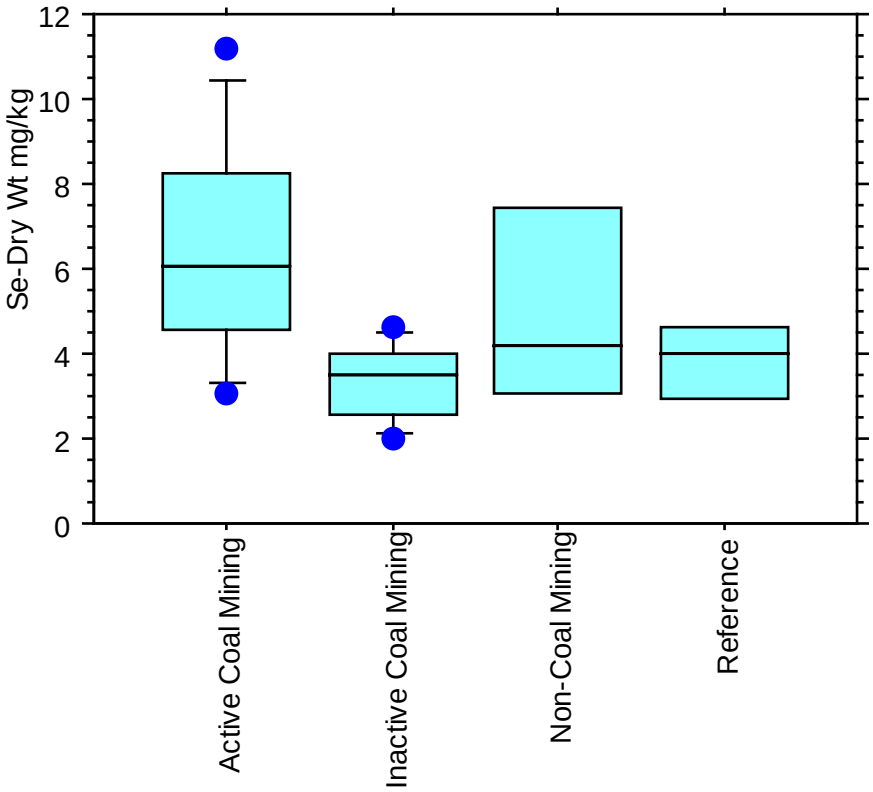


Figure 11: Selenium in fish ovaries by land-use.

a. Other Metals

Eight other metals were analyzed from the fish fillet samples collected in 2011. Arsenic, total chromium, copper, iron and zinc were found in low levels in fish fillets (Figures 12 through 16). Cadmium, lead, and thallium were not detected in any fish. Arsenic and iron were higher downstream of active coal mines. Arsenic was generally below detection at other sites except for the site downstream of the historic copper mining. Other than mercury, metal concentrations in fish fillets from all sites were below levels of concern.

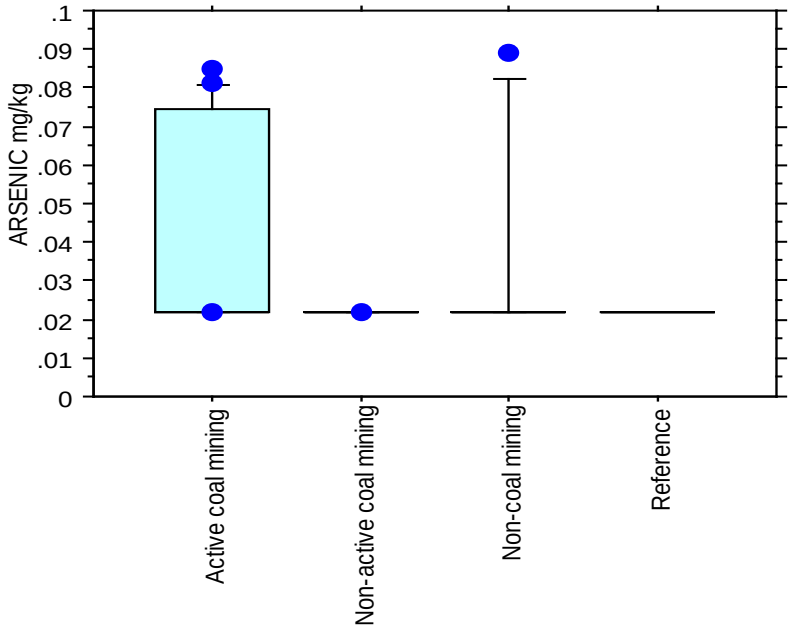


Figure 12: Arsenic in fish fillets by land-use.

Bioaccumulation of arsenic was not evident near the headwaters of the Collins River, which drains inactive coalfields. Low levels were found in the water column.

Photo provided by Aquatic Biology Section, TDH

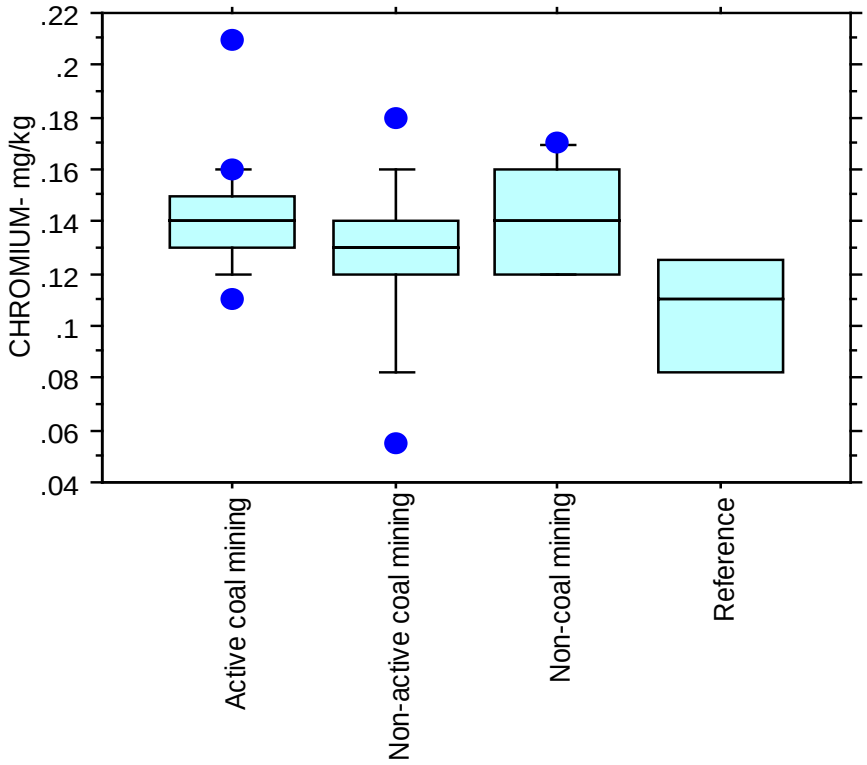


Figure 13: Total chromium in fish fillets by land-use.

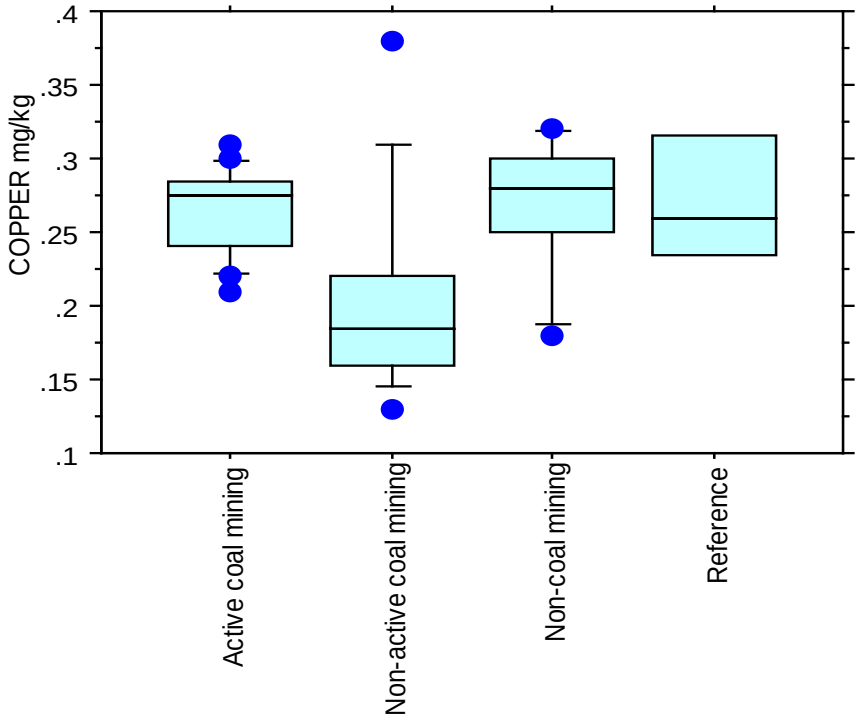


Figure 14: Copper in fish fillets by land-use.

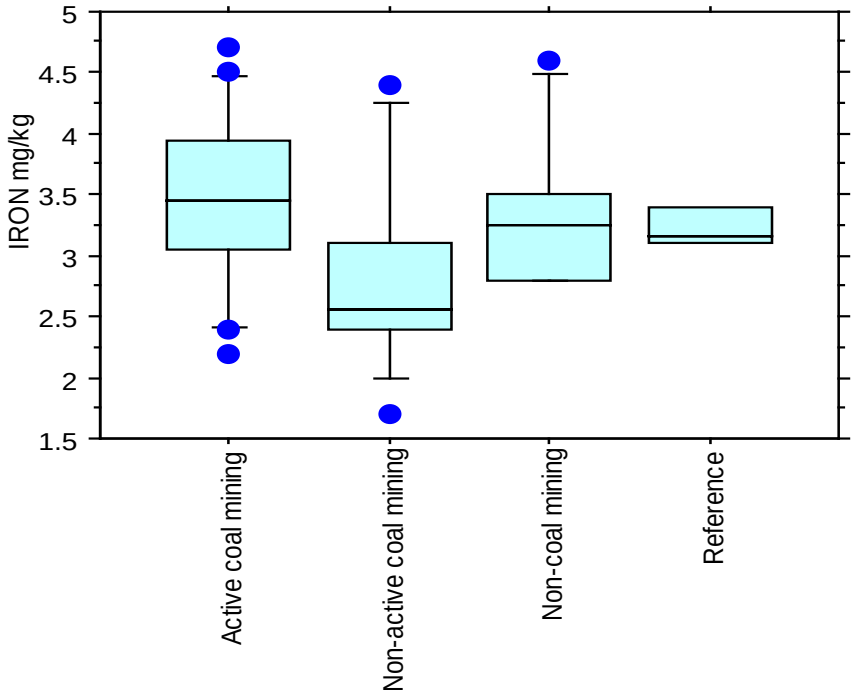


Figure 15: Iron in fish fillets by land-use.

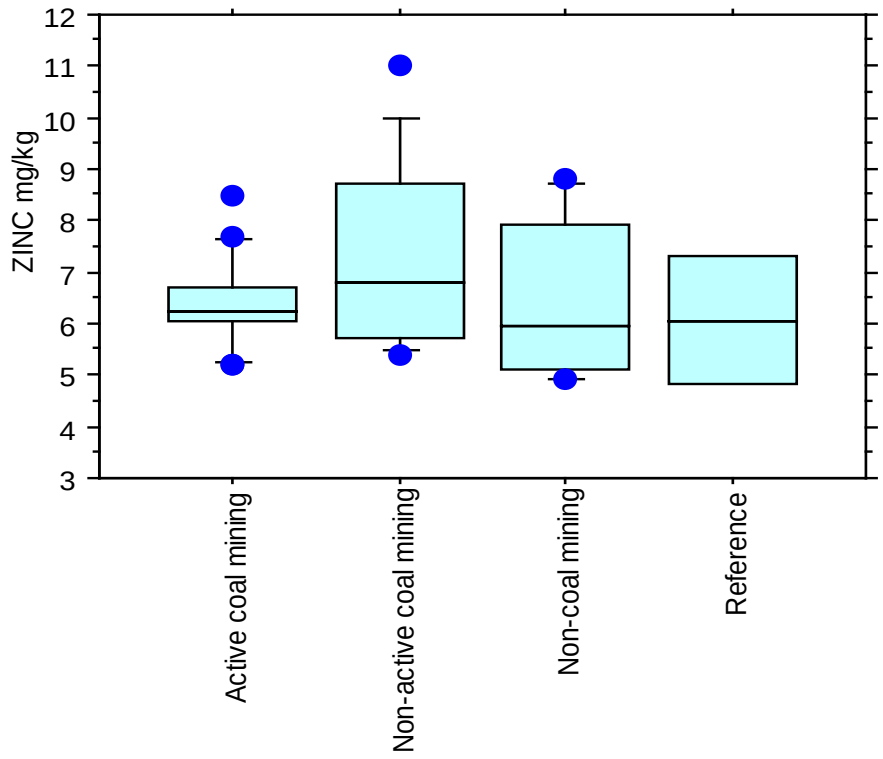


Figure 16: Zinc in fish fillets by land-use.

5. WATER CHEMISTRY RESULTS

Water column samples were collected at 41 of the stations in 2011. Two of the study sites, Hicks Creek and Woodcock Creek in Sequatchie County had insufficient flow, with water levels confined to pools during the initial sampling period. These sites were revisited to obtain a fish sample, but water samples were not collected on the second visit.

a. pH

The only site falling below the 6.0 fish and aquatic life criterion was Little Laurel Creek which drains abandoned mines in the Obey River Watershed. This stream is on the 303(d) list for pH, manganese and iron. EPA has approved iron and pH TMDLs to address these pollutants in this watershed.

Land-use	Min	Max	Mdn	M	SD
Active Coal Mining	6.76	7.98	7.20	7.25	0.33
Inactive Coal Mining	2.89	7.41	6.48	6.34	0.92
Non-Coal Mining	6.41	7.27	6.91	6.86	0.43
Reference	6.13	7.65	6.63	6.80	0.77

b. Conductivity

Conductivity downstream of active coal mines was below 300 umhos except at the Clinch River (423 umhos.) Unlike the other sites, the Clinch River is in ecoregion 67 (Ridge and Valley). Reference streams in this region typically range from 200-500 umhos. Two sites draining abandoned mines exceeded 500 umhos. Little Laurel Creek which has an impaired biological community was 827 umhos while Falling Water River which supports a healthy benthic community at this location was 524 umhos.

Land-use	Min	Max	Mdn	M	Stand. Dev.
Active Coal Mining	114.4	423	237.5	229.8	80.3
Inactive Coal Mining	25	827.4	107.4	140.8	167.4
Non-Coal Mining	62.8	509.7	103.1	225.2	247.2
Reference	37.7	69.7	56.0	54.5	16.1

c. Hardness

Hardness tended to be higher below active coal mines. However, the highest hardness (800 mg/L) was measured at Dry Creek which drains abandoned mines in the Collins River watershed. Hardness values in reference streams were very low (Figure 17).

Land-use	Min	Max	Mdn	M	SD
Active Coal Mining	49	210	120	117	38.0
Inactive Coal Mining	26	810	67	113	171.0
Non-Coal Mining	40	300	62	134	144.3
Reference	6	20	29	27	6.2

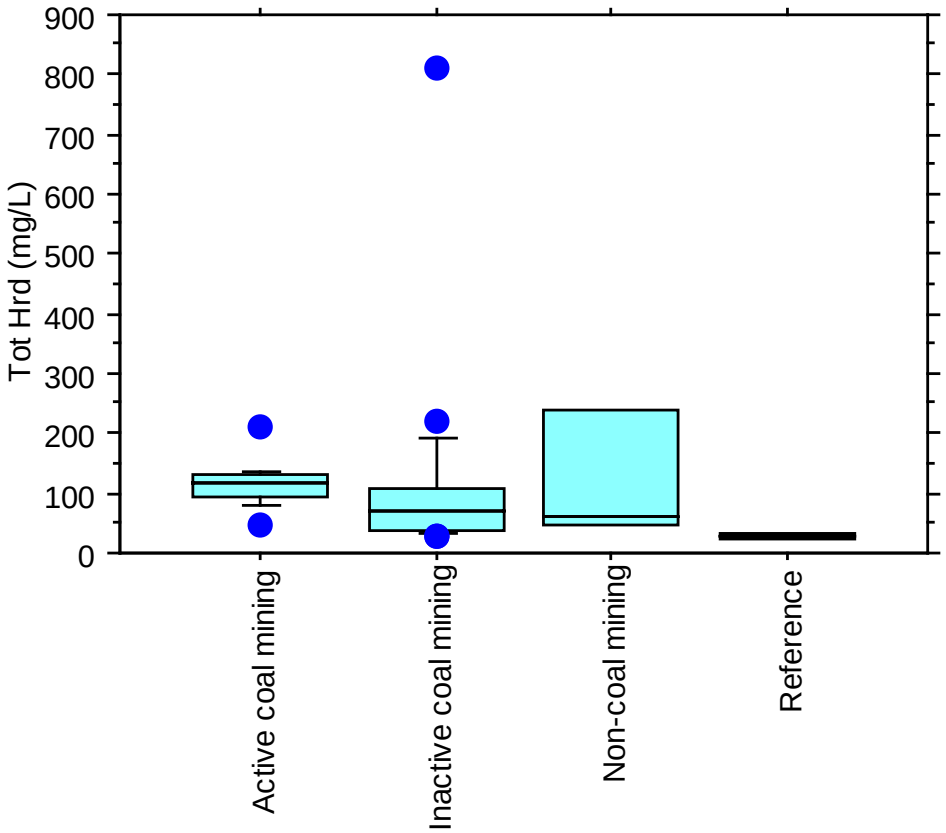


Figure 17: Stream hardness grouped by land-use.

d. Sulfate

Land-use	Min	Max	Mdn	M	S D
Active Coal Mining	<0.4	97	48	50.1	22.8
Inactive Coal Mining	6.7	860	24.5	91.7	198.6
Non-Coal Mining	5.3	15.3	10	10.2	5.0
Reference	6.2	7.2	6.9	6.8	0.51

Sulfate concentrations below active mine sites did not vary significantly (Figure 18). They were usually above levels found in the other land-use categories. The highest levels were measured at a few of the non-active coal mining sites. Dry Creek in the Collins River watershed had the highest concentration of sulfate. Dry Creek is the only stream in Tennessee on the 303(d) list for sulfates and is also listed for other pollutants associated with abandoned mining, including pH, Aluminum, Iron, and Manganese.

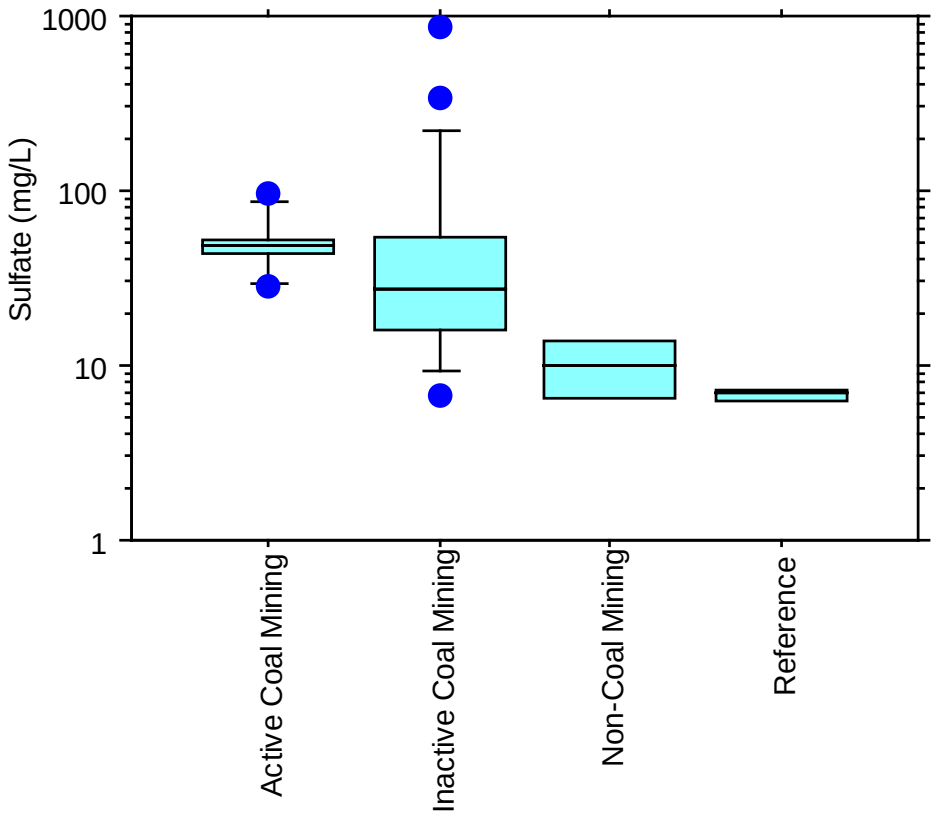


Figure 18: Stream sulfate grouped by land-use. (Log 10 scale)

e. Chloride

Chloride ranges were fairly similar between the different land-use categories (Figure 19). The highest values were 12 mg/L at both the Clinch River downstream of active coal mines and the East Fork Obey River downstream of historic coalfields.

Land-use	Min	Max	Mdn	M	SD
Active Coal Mining	0.17	12.0	3.7	3.78	3.03
Inactive Coal Mining	0.95	12.0	2.65	3.00	2.65
Non-Coal Mining	1.4	8.7	2.9	4.3	3.86
Reference	0.82	4.1	3.5	2.8	1.74

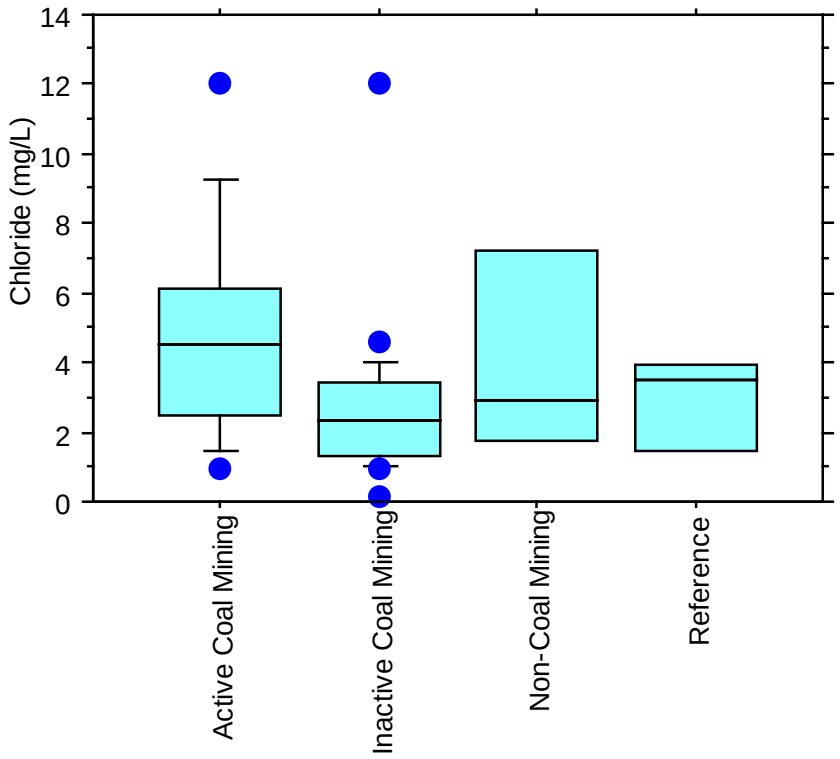


Figure 19: Stream chloride grouped by land-use.

f. Dissolved Residue

Dissolved residue levels at disturbed sites (active, inactive and non-coal mining) tended to be much higher than those at reference sites (Figure 20). Active coal mining sites generally had the highest concentration of dissolved solids. However, the highest level was measured at Dry Creek which drains abandoned mines in the Collins River Watershed.

Land-use	Min	Max	Mdn	M	SD
Active Coal Mining	69	230	140	147	50.4
Inactive Coal Mining	25	1200	79	262	262.2
Non-Coal Mining	40.3	270	64	124.8	126.3
Reference	26.7	43	32	33.9	8.3

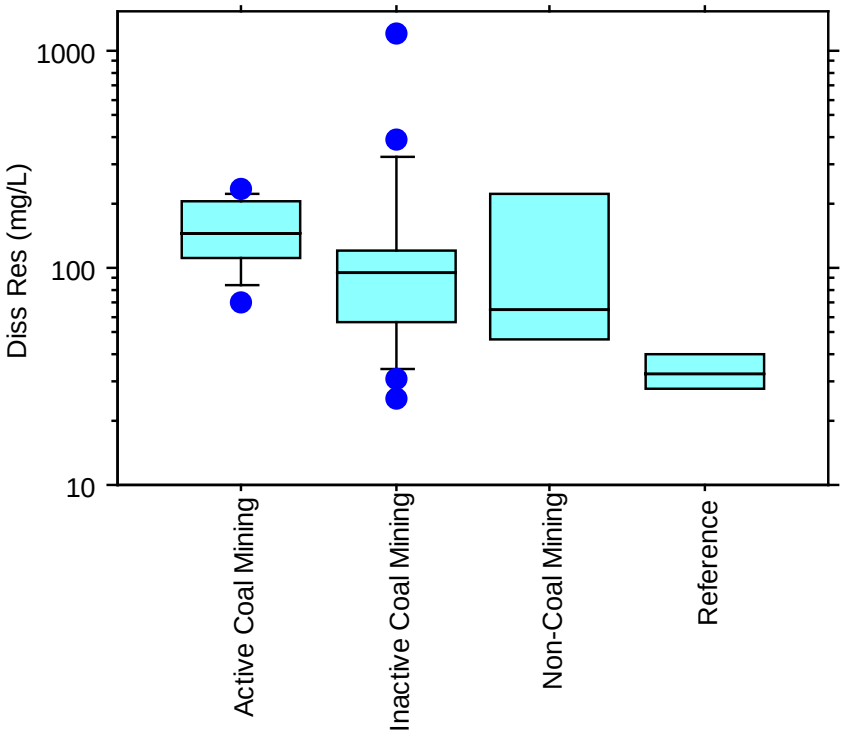


Figure 20: Stream dissolved residue grouped by land-use. Log 10 scale.

g. Suspended Residue

Suspended residue tended to be highest at the non-coal mining sites (Figure 21). Reference sites had very little suspended residue.

Land-use	Min	Max	Mdn	M	SD
Active Coal Mining	0.3	19.7	1.9	3.5	4.9
Inactive Coal Mining	0.1	2.2	0.6	0.8	0.6
Non-Coal Mining	1.3	56	4.0	20.4	30.8
Reference	0.4	0.7	0.6	0.6	0.1

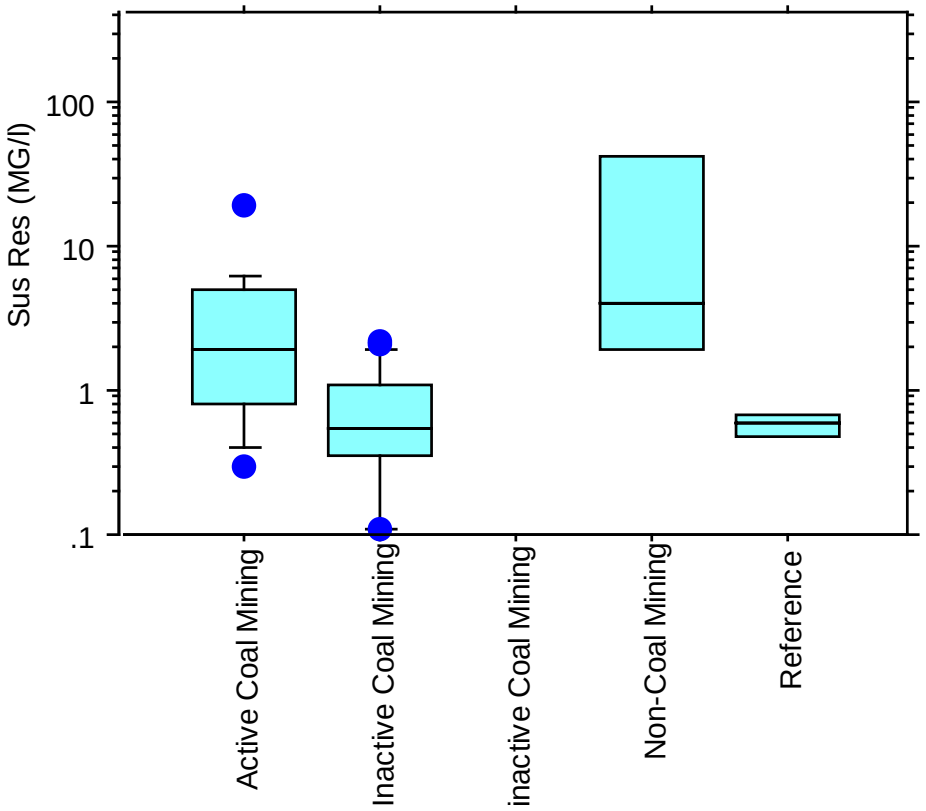


Figure 21: Stream suspended residue grouped by land-use. Log 10 scale.

h. Metals

All metals were analyzed as total. Where appropriate (chromium, copper, lead and zinc), values were adjusted using hardness and total suspended solids for comparison to water quality criteria. It should be noted that a single water sample may not be representative of water quality and cannot be used for assessment purposes.

Mercury

Mercury was not detected in the water column at any of the monitoring sites. The detection limit was 0.02 ug/L.

Selenium

Selenium was detected at 11 of the 41 sites. Concentrations were below the 0.32 ug/L detection limit at 73% of sites including all reference sites. Data ranges were similar between the three categories representing disturbance (Figure 22). The highest value (1.3 ug/L) was measured at Elk Fork Creek in the Clear Fork watershed which drains active coalfields. None of the values approached the monthly average water column exposure of 4.8 ug/L for lotic systems outlined in the 2014 draft criterion which is currently under external peer review and subject to revision (USEPA 2014).

Land-use	Min	Max	Mdn	M	SD
Active Coal Mining	<0.32	1.3	<0.32	0.30	0.16
Inactive Coal Mining	<0.32	0.67	<0.32	0.26	0.16
Non-Coal Mining	<0.32	0.64	<0.32	0.32	0.28
Reference	<0.32	<0.32	<0.32	<0.32	0

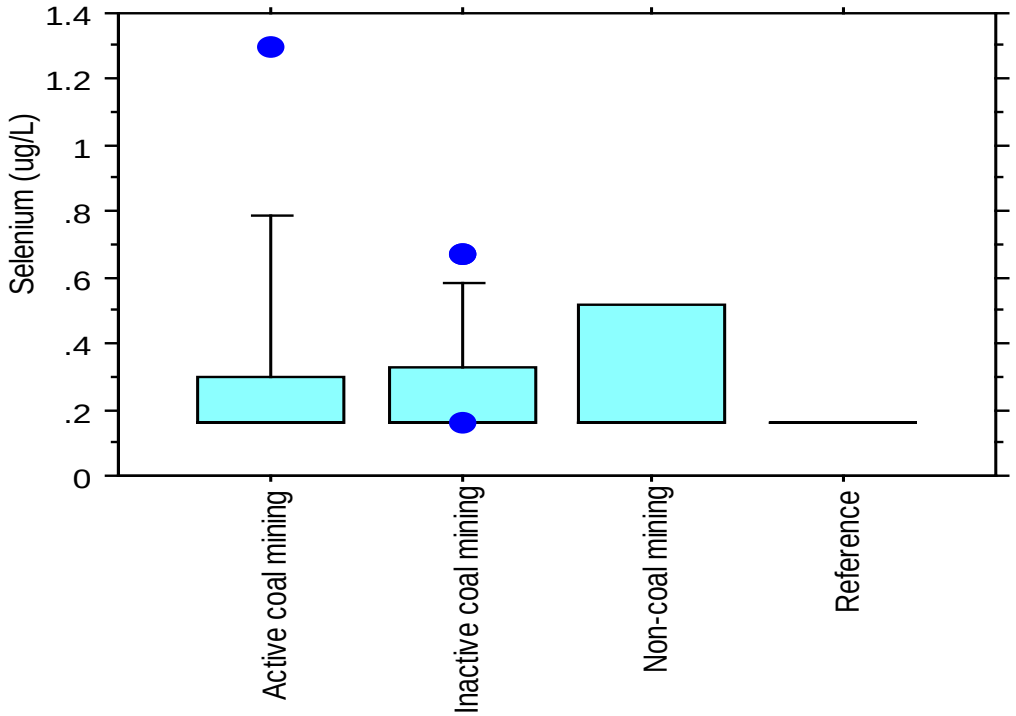


Figure 22: Stream selenium grouped by land-use.

Arsenic

Arsenic levels were generally higher at the non-coal mining sites (Figure 23). The highest measurement (5.7 ug/L) in the East Fork Obey River which drains inactive coalfields was well below the recreation criterion of 10 ug/L.

Land-use	Min	Max	Mdn	M	SD
Active Coal Mining	0.31	1.8	0.77	0.87	0.41
Inactive Coal Mining	<0.17	5.7	0.94	1.19	0.94
Non-Coal Mining	<0.17	5.4	0.25	1.91	3.02
Reference	0.4	1.1	0.65	0.72	0.35

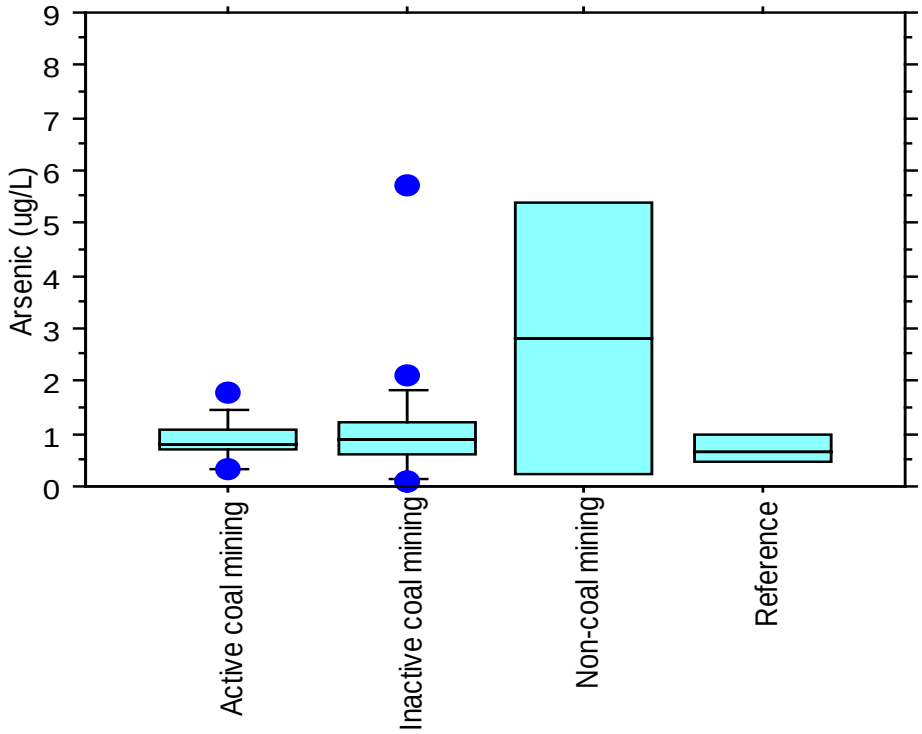


Figure 23: Stream arsenic grouped by land-use.

Cadmium

Land-use	Min	Max	Mdn	M	SD
Active Coal Mining	<0.22	0.22	<0.22	0.12	0.03
Inactive Coal Mining	<0.22	0.43	<0.22	0.16	0.10
Non-Coal Mining	<0.22	<0.22	<0.22	<0.22	0
Reference	<0.22	0.38	<0.22	0.2	0.16

After compensation for hardness and total suspended solids, the single samples collected at five sites were slightly above the chronic criterion for cadmium. Most of these were downstream of non-active coal mining lands except for one reference site in the Emory River Watershed (Figure 24). However, since only one sample was collected, direct comparison to chronic criterion which is based on an average is not appropriate and additional samples would need to be collected to confirm. All samples measurements were well below the acute criterion.

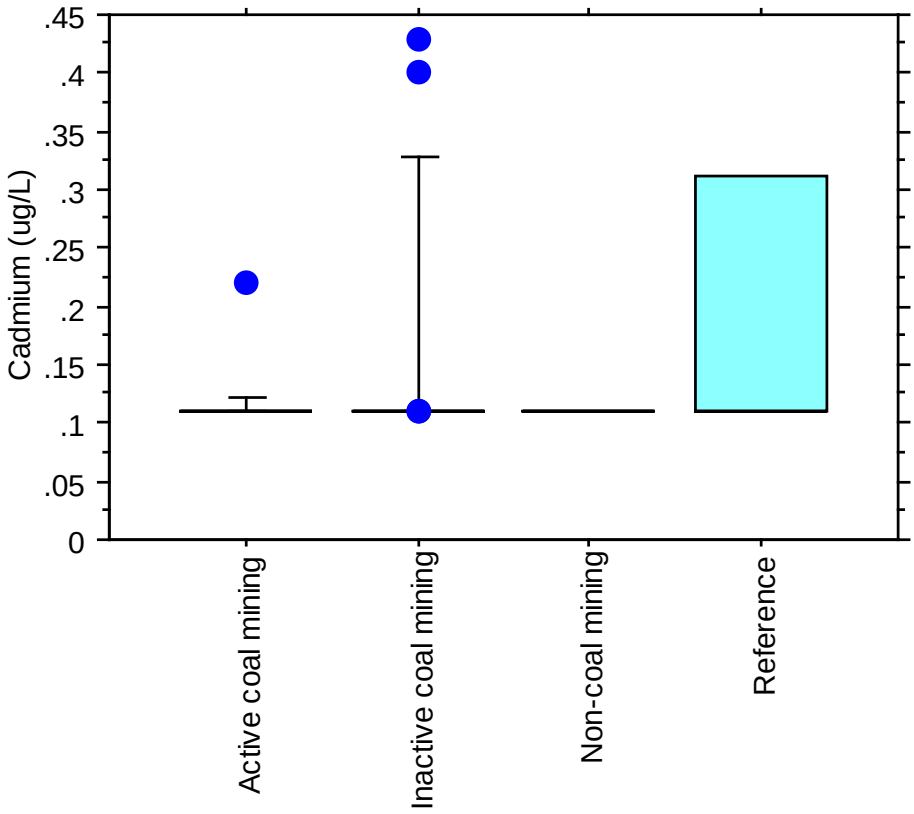


Figure 24: Stream cadmium grouped by land-use.

Zinc

Zinc concentrations were very low at most of the sites, rarely exceeding 5 ug/L. Little Laurel Creek with zinc levels of 130 ug/L is assessed as having impacts from abandoned mines.

Land-use	Min	Max	Mdn	M	SD
Active Coal Mining	<1.8	6.0	2.2	2.8	1.7
Inactive Coal Mining	<1.8	130	2.2	12.2	29.6
Non-Coal Mining	3.5	3.6	3.5	3.5	0.06
Reference	<1.8	<1.8	<1.8	<1.8	0

Chromium

Chromium concentrations were very low, generally falling below 1 ug/L. The highest sites were the 303(d) listed Little Laurel Creek which drains inactive coalfields and the New River below active mines. No site was above the criterion for fish and aquatic life.

Land-use	Min	Max	Mdn	M	SD
Active Coal Mining	<0.32	4.7	<0.32	0.55	1.20
Inactive Coal Mining	<0.32	4.8	<0.32	0.51	1.00
Non-Coal Mining	<0.32	1.4	<0.32	0.57	0.72
Reference	<0.32	0.75	0.30	0.40	0.31

Copper

Copper concentrations were similar between all site categories with the exception of two streams below inactive mine, Little Laurel Creek in the Obey and Big Creek in the Collins River watersheds (Figure 25). Levels were below water quality criterion for fish and aquatic life at all sites.

Land-use	Min	Max	Mdn	M	SD
Active Coal Mining	<0.27	2.2	0.8	0.9	0.7
Inactive Coal Mining	<0.27	6.3	0.3	1.0	1.6
Non-Coal Mining	<0.27	1.2	1.2	0.8	0.6
Reference	<0.27	2.8	<0.27	0.27	0.05

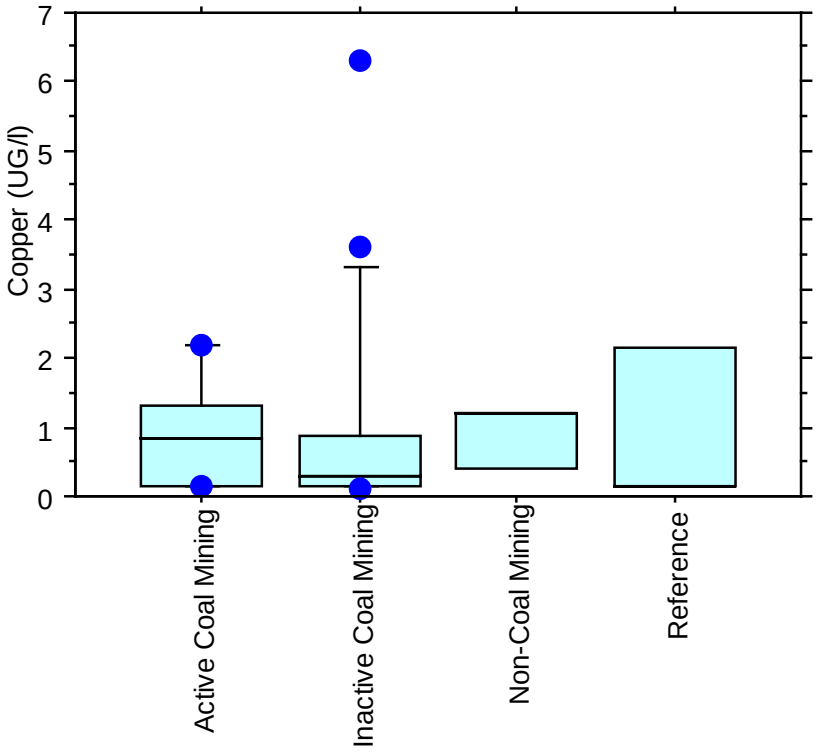


Figure 25: Stream copper grouped by land-use.

Lead

Lead was low in all water column samples. After adjusting for hardness and suspended solids, none approached the acute or chronic criteria for fish and aquatic life. Little Laurel Creek had the highest value of 1.7 ug/L.

Land-use	Min	Max	Mdn	M	SD
Active Coal Mining	<0.26	0.72	<0.26	0.24	0.18
Inactive Coal Mining	<0.26	1.7	<0.26	0.31	0.36
Non-Coal Mining	<0.26	<0.26	<0.26	<0.26	0
Reference	<0.26	0.62	<0.26	0.29	0.28

Iron

Land-use	Min	Max	Mdn	M	SD
Active Coal Mining	47	1267	260	373	260
Inactive Coal Mining	<21	8400	125	628	1843
Non-Coal Mining	37	1100	117.7	418.2	591.8
Reference	41	190	76	102.3	77.9

Iron is the most common metal to be associated with pollution from abandoned coal mines in Tennessee with 174 miles on the 303(d) list. An additional six miles are listed for iron impacts from active coal mines. Impairment is generally associated with precipitate and iron bacteria that coat substrate making the habitat unavailable for benthic colonization. Little Laurel Creek, an inactive mining site on the 303(d) list for iron, had the highest iron levels with 8400 ug/L All other sites were well below this level, the next highest (1267 ug/L) being Elk Fork Creek near river mile 7 which drains active mine sites and is assessed as fully supporting fish and aquatic life.

Manganese

Land-use	Min	Max	Mdn	M	SD
Active Coal Mining	8	150	39	62	51.9
Inactive Coal Mining	1	2400	43	318	662.5
Non-Coal Mining	35	120	51	69	45.0
Reference	3	11	3.3	6	4.6

Manganese is the second most common metal associated with run-off from Tennessee coalfields. There are 135 stream miles impaired by manganese from abandoned mines and 46 miles from active mines. Like iron, manganese precipitates out, coating the substrate rendering it unsuitable for colonization by aquatic life. There is no numeric criterion for manganese. Concentrations at most sites were relatively low with the exception of Little Laurel Creek in the Obey, Rocky River in the Caney Fork River and Dry Creek in the Collins watersheds which drain abandoned coalfields and are on the 303(d) list of impaired waters for manganese.

6. SUMMARY

Fish downstream of active mines had higher levels of some contaminants associated with coal mining activities. All were well below levels of concern for human consumption and environmental protection.

Mercury in fish fillets at nine sites had concentrations above 0.3 ppm (precautionary level for human consumption). Three sites had elevated mercury concentrations in multiple species. Smallmouth bass were generally the largest fish collected and usually had the highest levels of mercury. Mercury levels tended to be highest in the smallmouth collected at reference sites and those downstream of inactive coalfields.

Selenium concentrations were generally highest downstream of active coal mines followed by non-coal mining activities. Fish size had little influence in selenium concentrations. Species which consume macroinvertebrates were generally higher than piscivores from the same site. None of the levels exceed the EPA draft 2004 or 2014 (currently under peer review) guidelines for selenium in fish fillets, ovaries or whole-body fish.

Eight other metals were analyzed from the fish fillet samples collected in 2011. Arsenic, total chromium, copper, iron and zinc were found in low levels in some fish fillets. Cadmium, lead, and thallium were not detected in any fish. Arsenic and iron were higher downstream of active coal mines. Arsenic was generally below detection at other sites except for the site downstream of historic copper mining. Other than mercury, metal concentrations from all sites were below levels of concern.

Water column samples were collected concurrent with the 2011 fish collection. Results from most sites were well below levels of concern. Monitoring stations with elevated zinc, iron and manganese are already listed as impaired for that parameter from abandoned mines.

Biologists collect fish in winter on the New River for whole-body selenium analysis.

Photo provided by Aquatic Biology Section, TDH.

REFERENCES

Griffith, G.E., J.M. Omernik and S. Azevedo. 1977. *Ecoregions of Tennessee.* EPA/600/4-90/030. NHREEL, Western Ecological Division, U.S. Environmental Protection Agency, Corvalis, Oregon.

Tennessee Board of Water Quality, Oil and Gas. 2013. *Rules of the Tennessee Department of Environment and Conservation, General Water Quality Criteria, Chapter 0400-40-03*, Nashville, TN.

Tennessee Department of Environment and Conservation. 2014. *Draft 2014 303(d) List*, Division of Water Resources. Nashville, TN.

_____. 2011. *Quality System Standard Operating Procedure for Chemical and Bacteriological Sampling of Surface Water.* Division of Water Pollution Control. Nashville, TN.

United States Environmental Protection Agency. 2014. *Peer Review Draft Aquatic Life Ambient Water Quality Criterion for Selenium – Freshwater.* EPA822-8-14-01. Office of Water. Washington D.C.

_____. (2014, Sept 22) Retrieved from http://water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm

_____. 2004. *Draft Aquatic Life Water Quality Criteria for Selenium.* Office of Water. Washington, D.C.

_____. 2000. *National Guidance for Assessing Chemical Contamination Data for Use in Fish Advisories. Volume 1: Fish Sampling and Analysis.* 3rd ed. EPA823-B-00-007. Office of Water, Washington D.C.

_____. 1999. *The National Survey of Mercury Concentrations in Fish Data Base Summary."* Office of Water. Washington, D.C

Appendix A: Site Locations and Mining Status (Land-use)

STATION ID	STREAM	LOCATION	LATITUDE	LONGITUDE	DRAINAGE AREA MI^2	LAND-USE	COMMENT
BFGIZ000.6MI	BIG FIERY GIZZARD CREEK	OFF US HIGHWAY 64 AT BRIDGE CROSSING WHERE CREEK IS SPLIT INTO 2 SEPARATE CHANNELS	35.10729	-85.7437	52.25	Inactive coal mining	Largemouth present but too small, bluegill collected.
BIG007.2GY	Big CREEK	Highway 56	35.41289	-85.7056	20.49	Inactive coal mining	Habitat looks good only small fish observed. No fish sample.
BRIMS001.5SC	BRIMSTONE CREEK	Brimstone Road crossing U/S MILL CK AND INDIAN CK	36.36349	-84.5335	51.36	Inactive coal mining	
BUFFA000.8SC	Buffalo Creek	Hwy 297	36.37499	-84.4413	64.54	Inactive coal mining	Only small fish. Hybrid sunfish common, many appear stunted. No black bass or Rockbass observed. No fish sample.
CANE023.2BL	CANE CREEK	State Hwy 103/Old CC Rd	35.63735	-85.3316	49.71	Inactive coal mining	Only small fish. Bluegill present but very small. No fish sample.
CAPUC001.9CA	CAPUCHIN CREEK	U/S intersection of Capuchin and Whistle Creek Rds	36.5836	-84.2328	27.67	Active Coal Mining	
CFORK003.8SC	CLEAR FORK RIVER	BURNT MILL BR	36.3877	-84.6295	271.99	Reference	
CLEAR028.9CA	CLEAR FORK (OF THE CUMBERLAND RIVER)	HWY 90 BRIDGE AT ANTHRAS	36.29766	-84.8023	78.34	Active Coal Mining	
CLIFT001.0WH	CLIFTY CREEK	EASTLAND RD. (MOURBERRY ROAD)	35.88667	-85.2522	13.00	Inactive coal mining	Good flow but mostly bedrock with small pools. Only small bluegill observed – no sample collected.
CLINC199.0HK	CLINCH RV	HORTON FORD Road EAST OF CONFLUENCE WITH WAR CREEK	36.5725	-82.9378	1155.24	Active Coal Mining	
COAL005.4AN	COAL CREEK	AT THE WYE (Wye Ln)	36.21591	-84.1661	14.55	Active Coal Mining	
COLLI061.7GY	COLLINS RIVER	Cullen Savage Rd	35.3925	-85.5661	20.88	Inactive coal mining	

STATION ID	STREAM	LOCATION	LATITUDE	LONGITUDE	DRAINAGE AREA MI^2	LAND-USE	COMMENT
CORCH000.2MG	CRAB ORCHARD CREEK	D/S OF MILL CK	36.0208	-84.5822	49.96	Inactive coal mining	
CROOK008.4MG	CROOKED FORK EMORY RIVER	BR AT LIBERTY RD - CF-2	36.0819	-84.5397	30.08	Inactive coal mining	
CROOK016.9MG	CROOKED FORK EMORY RIVER	HWY 62 BRIDGE D/S OF PETROS	36.0672	-84.4536	11.83	Inactive coal mining	
DRY002.1WA	DRY CREEK	HILLS CREEK RD	35.56577	-85.6261	41.57	Inactive coal mining	
ECO68A26	DADDYS CREEK	U/S HEBBERTSBURG RD CROSSING CATOOSA TN DEVILS BREAKFAST TABLE	36.05861	-84.7914	168.60	Reference	
ECO69D03	FLAT FORK	JUST U/S FLAT FORK RD CROSSING AND JUST U/S ROCKY FORK BRANCH CONF.	36.1235	-84.5122	9.40	Reference	
EFOBE012.6FE	EAST FORK OBEY RIVER	D/S HIGHWAY 52	36.416667	-85.026945	201.19	Inactive coal mining	Site added 2013. Fish fillet only.
EFOB025.8FE	EAST FORK OBEY RIVER	HWY 85/WILDER ROAD	36.2734	-85.0443	116.44	Inactive coal mining	No fish present. Iron-orange rocks, little flow, few pools. Side trib contributing iron.
EFOB039.6OV	EAST FORK OBEY RIVER	CLIFF SPRINGS ROAD	36.18389	-85.1647	34.61	Inactive coal mining	
EFORK000.1CA	ELK FORK CREEK	HWY 297 Immediately U/S Confl Little Elk Ck	36.5383	-84.18	28.51	Active Coal Mining	Several small smallmouth observed but too small to analyze. No fish sample collected.
EFORK007.2CA	ELK FORK CREEK	NEAR ELK FORK COMMUNITY	36.53683	-84.1791	28.49	Active Coal Mining	Small fish. Deep silt, entrenched, poor habitat. No fish collected.
EFORK010.6CA	ELK FORK CREEK	U/S CONFLUENCE WITH LICK FORK	36.51048	-84.2096	26.92	Active Coal Mining	Small fish. Numerous hybrids. Loose silt and sand, poor habitat. No fish sample collected.
ELK004.6CA	ELK CREEK	OLD OSWEGO RD	36.5674	-84.1543	47.64	Active Coal Mining	Poor habitat – silt/embedded. Redbreast dominant. No fish sample collected.

STATION ID	STREAM	LOCATION	LATITUDE	LONGITUDE	DRAINAGE AREA MI^2	LAND-USE	COMMENT
EMORY014.5MG	EMORY RIVER	U/S HARRIMAN	35.9480	-84.5747	793.81	Inactive coal mining	Site added 2013, fish fillet only.
EMORY022.0MG	EMORY RIVER	CAMP AUSTIN BRIDGE DEERMONT RD	36.0293	-84.5803	705.13	Inactive coal mining	Site added 2013, fish fillet only.
EMORY027.7MG	EMORY RIVER	NEMO BRIDGE CATOOSA	36.0689	-84.6623	616.64	Inactive coal mining	Site added 2013, fish fillet only
FWATE040.1PU	FALLING WATER RIVER	MACEDONIA	36.15908	-85.3833	13.39	Inactive coal mining	
HICKS001.4SE	HICKS CREEK	CARTWRIGHT LOOP RD	35.27984	-85.4564	14.48	Inactive coal mining	Creek dry. No samples collected.
LEMOR004.3MG	LITTLE EMORY RIVER	D/S CONFLUENCE WITH BITTER CREEK	35.9882	-84.4821	21.43	Inactive coal mining	Habitat looks good. Bluegill present but too small to analyze. TVA has sampled this stream since mid-1990's. Spotted bass were present but have disappeared. No fish sample collected in 2011. Largemouth and Smallmouth collected 2013.
LLAUR000.4FE	LITTLE LAUREL CREEK	Off HWY 85 /WILDER ROAD/ VINE RIDGE RD BRIDGE	36.27028	-85.1	3.49	Inactive coal mining	No fish present. Iron-orange rocks, small, shallow stream. No fish sample collected.
LSEQU009.0MI	LITTLE SEQUATCHIE CREEK	Off Coppinger Cove Rd at RM 9.0 (working downstream for fish tissue)	35.17647	-85.6025	96.71	Inactive coal mining	
NCHIC026.4HM	NORTH CHICKAMAUGA CREK	Vanderguff Rd	35.25688	-85.257	53.91	Inactive coal mining	Bluegill collected. No ovary sample due to small size.
NEW008.8SC	NEW RIVER	Hwy 27 bridge - gaging station	36.383	-84.5533	371.47	Active Coal Mining	
NEW025.0SC	NEW RIVER	U/S OF BRIDGE AT CORDELL	36.33622	-84.4516	198.50	Active Coal Mining	
NEW032.0SC	NEW RIVER	U/S OF MONTGOMERY FORK / NEAR LOWE BRANCH	36.31787	-84.3805	154.56	Active Coal Mining	
NEW048.7AN	NEW RIVER	U/S DOUBLE CAMP CREEK NEAR ROSEDALE	36.17048	-84.3521	28.13	Active Coal Mining	Only small fish observed. No fish sample collected.

STATION ID	STREAM	LOCATION	LATITUDE	LONGITUDE	DRAINAGE AREA MI^2	LAND-USE	COMMENT
NOLIC097.5UC	NOLICHUCKY RIVER	u/S OF CHESTOA BRIDGE	36.10278	-82.4478	636.80	Non-coal Mining (sand)	
NSUCK000.1MI	NORTH SUCK CREEK	Off HWY 27 100 Yds U/S Confluence of North and South Suck Creeks	35.14669	-85.3879	13.37	Inactive coal mining	No target fish observed – only redbreast. No fish sample collected.
OCOEE011.9PO	OCOEE RIVER	BELOW PARKSVILLE DAM (Ocoee # 1)	35.0975	-84.6556	594.29	Non-coal Mining (historic copper)	
POWEL115.7HK	POWELL RIVER	BALDWIN FORD	36.5961	-83.3056	466.92	Active Coal Mining	Numerous smallmouth and Rockbass but typically small. No ovaries collected.
ROCKY024.5VA	ROCKY RIVER	MINING/NEAR CHALYBEATE - U/S PLEASANT HILL CEMETARY RD	35.59248	-85.52135	16.79	Inactive coal mining	No fish at all. Iron-orange rocks. Small creek approximately 10 feet wide. No fish sample collected.
SMOKY000.8SC	SMOKY CREEK	SMOKY CK RD	36.28124	-84.3689	33.33	Inactive coal mining	Few small smallmouth and Rockbass present. Very poor habitat – silty, entrenched. No fish sample collected.
STINK000.3CA	STINKING CREEK	1500 FT U/S HICKORY CREEK	36.4974	-84.1136	34.61	Active Coal Mining	
TACKE000.5CA	TACKETT CREEK	U/S HWY 90 BRIDGE	36.53902	-84.0057	34.21	Active Coal Mining	
WOODC003.4SE	WOODCOCK CREEK	OFF BAILEY RD	35.32228	-85.4408	14.48	Inactive coal mining	

Appendix B: Fish Tissue Data

Station	Date	Species	Composite/ Individual	# of Fish	Weight (lbs)	Length (Inch)	Sample Type	Hg	Fe	As	Cd	Cr	Cu	pH	Se - Wet	Se - Dry*	Tl	Zn	Mn
BFGIZ000.6MI	09-22-2011	BLUEGILL SUNFISH	COMP	6	0.1	5.0	FILLET	0.11	1.7	0.044U	0.017U	0.13J	0.13	0.032U	0.25J	1.16J	0.028U	7.6	0.13
BFGIZ000.6MI	09-22-2011	BLUEGILL SUNFISH	COMP	2	0.1	6.0	OVARY								0.43J	2.00J			
BIG007.2GY	09-28-2011	BLUEGILL SUNFISH	COMP	7	0.1	5.8	FILLET	0.18	2.4	0.044U	0.017U	0.14J	0.22	0.032U	0.38J	1.77J	0.028U	9.0	0.95
BIG007.2GY	09-28-2011	BLUEGILL SUNFISH	COMP	4	0.1	5.4	OVARY								0.60	2.79J			
BRIMS013.9SC	12-01-2011	ROCKBASS	COMP	5	0.2	7.0	FILLET	0.38	4.1	0.044U	0.017U	0.11J	0.19	0.032U	0.26J	1.21J	0.028U	5.6	0.77 J
BRIMS013.9SC	12-02-2011	ROCKBASS	COMP	3	0.2	7.0	OVARY								0.82	3.81J			
BRIMS013.9SC	11-06-2013	ROCKBASS	COMP	6	0.2	7.0	FILLET	0.37							0.33	1.5			
BRIMS013.9SC	11-06-2013	ROCKBASS	COMP	6	0.1	5.7	FILLET	0.22							0.35	1.6			
BRIMS013.9SC	11-06-2013	SMALLMOUTH BASS	IND	1	0.1	6.4	FILLET	0.35							0.4	1.9			
CAPUC001.9CA	10-25-2011	ROCKBASS	COMP	5	0.2	6.5	FILLET	0.17	2.6	0.044U	0.017U	0.11J	0.24	0.032U	0.28J	1.30J	0.028U	5.2	0.4
CAPUC001.9CA	10-25-2011	ROCKBASS	COMP	4	0.2	6.4	OVARY								0.66	3.07J			
CFORK003.8SC	12-05-2011	SMALLMOUTH BASS	COMP	4	1.0	12.4	FILLET	0.61	3.1	0.044U	0.017U	0.14J	0.28	0.032U	0.30J	1.40J	0.028U	6.6	0.11
CFORK003.8SC	10-28-2013	SMALLMOUTH BASS	COMP	2	0.9	12.2	FILLET	0.66							0.23	1.1			
CFORK003.8SC	12-05-2011	SMALLMOUTH BASS	IND	1	0.8	11.7	OVARY								0.71	3.30J			
CLEAR030.5CA	10-25-2011	ROCKBASS	COMP	3	0.3	7.2	FILLET	0.11	3.8	0.044U	0.017U	0.14J	0.29	0.032U	0.56	2.60J	0.028U	6.1	0.09 J
CLEAR030.5CA	10-25-2011	ROCKBASS	COMP	3	0.3	7.2	OVARY								1.0	4.65J			

Station	Date	Species	Composite/ Individual	# of Fish	Weight (lbs)	Length (Inch)	Sample Type	Hg	Fe	As	Cd	Cr	Cu	pH	Se - Wet	Se - Dry*	Tl	Zn	Mn
CLINC199.0HK	11-10-2011	ROCKBASS	COMP	5	0.3	7.4	FILLET	0.10	3.7	0.085J	0.017U	0.21J	0.30	0.032U	0.53	2.46J	0.028U	8.5	0.17
CLINC199.0HK	11-10-2011	SMALLMOUTH BASS	IND	1	1.4	14.1	FILLET	0.26	3.2	0.074J	0.017U	0.16J	0.31	0.032U	0.71	3.30J	0.028U	7.7	0.06 J
CLINC199.0HK	11-10-2011	SMALLMOUTH BASS	COMP	4	0.5	10.3	FILLET	0.20	2.2	0.063J	0.017U	0.15J	0.21	0.032U	0.59	2.74J	0.028U	6.3	0.11
CLINC199.0HK	11-10-2011	SMALLMOUTH BASS	COMP	3	0.5	10.0	OVARY								1.3	6.04J			
CLINC199.0HK	03-07-2014	LARGEMOUTH BASS	COMP	2	0.7	11.4	WHOLE	0.12							0.51	2.4J			
CLINC199.0HK	03-07-2014	SMALLMOUTH BASS	COMP	4	1.5	14.6	WHOLE	0.23							0.76	3.5			
CLINC199.0HK	03-07-2014	SMALLMOUTH BASS	COMP	4	0.9	11.6	WHOLE	0.12							0.74	3.4			
COAL005.4AN	11-26-2011	ROCKBASS	COMP	5	0.1	6.1	FILLET	0.11	4.7	0.044U	0.017U	0.12J	0.29	0.032U	0.71	3.30J	0.028U	6.3	0.26
COAL005.4AN	11-26-2011	ROCKBASS	COMP	5	0.1	5.5	FILLET	0.06	4.3	0.081J	0.017U	0.14J	0.24	0.032U	0.72	3.35J	0.028U	6.5	0.53
COAL005.4AN	11-26-2011	ROCKBASS	COMP	5	0.1	6.1	OVARY								1.3	6.04J			
COAL005.4AN	02-25-2014	ROCKBASS	COMP	6	0.1	5.1	WHOLE	0.03							0.71	3.3			
COAL005.4AN	02-25-2014	SMALLMOUTH BASS	COMP	6	0.1	4.3	WHOLE	0.07							0.7	3.3			
COLLI061.7GY	12-05-2011	BLUEGILL SUNFISH	COMP	7	0.1	6.2	FILLET	0.22	3.1	0.044U	0.017U	0.14J	0.18	0.032U	0.32J	1.49J	0.028U	11	0.88
COLLI061.7GY	12-05-2011	BLUEGILL SUNFISH	IND	1	0.1	5.4	OVARY								0.75	3.49J			
COLLI061.7GY	09-27-2011	LARGEMOUTH BASS	COMP	2	0.7	11.2	FILLET	0.55	2.5	0.044U	0.017U	0.13J	0.16	0.032U	0.33J	1.53J	0.028U	5.8	0.07 J
COLLI061.7GY	09-27-2011	LARGEMOUTH BASS	IND	1	0.8	11.9	OVARY								0.51	2.37J			
COLLI061.7GY	09-30-2013	LARGEMOUTH BASS	IND	1	0.9	12.3	FILLET	0.2							0.29	1.3			

Station	Date	Species	Composite/ Individual	# of Fish	Weight (lbs)	Length (Inch)	Sample Type	Hg	Fe	As	Cd	Cr	Cu	pH	Se - Wet	Se - Dry*	Tl	Zn	Mn
CORCH000.2MG	12-12-2011	ROCKBASS	COMP	4	0.1	4.9	FILLET	0.17	2.5	0.044U	0.017U	0.11U	0.38	0.032U	0.37J	1.72J	0.028U	8.7	0.9
ECO68A26	11-09-2011	ROCKBASS	COMP	8	0.2	6.1	FILLET	0.35	3.2	0.044U	0.017U	0.11J	0.23	0.032U	0.34J	1.58J	0.028U	8.0	0.27
ECO68A26	11-09-2011	ROCKBASS	COMP	5	0.1	6.1	OVARY								1.0	4.65J			
ECO68A26	10-05-2011	SMALLMOUTH BASS	COMP	3	0.4	9.3	FILLET	0.49	3.1	0.044U	0.017U	0.11U	0.35	0.032U	0.20J	0.93J	0.028U	4.2	0.05 J
ECO68A26	10-05-2011	SMALLMOUTH BASS	IND	1	0.4	9.9	OVARY								0.56	2.60J			
ECO68A26	08-27-2013	ROCKBASS	COMP	6	0.2	7	FILLET	0.32							0.54	2.5			
ECO68A26	08-27-2013	SMALLMOUTH BASS	COMP	4	0.5	10.5	FILLET	0.45							0.36	1.7			
ECO68A26	08-27-2013	SMALLMOUTH BASS	COMP	4	0.2	7.3	FILLET	0.36							0.54	2.5			
ECO69D03	11-30-2011	ROCKBASS	COMP	5	0.2	6.3	FILLET	0.22	3.6	0.044U	0.017U	0.11J	0.24	0.032U	0.32J	1.49J	0.028U	5.5	0.18
ECO69D03	11-30-2011	ROCKBASS	COMP	4	0.2	6.4	OVARY								1.0	4.65J			
EFOBE012.6FE	10-29-2013	ROCKBASS	COMP	5	0.2	6.9	FILLET	0.15							0.28	1.3			
EFOB3012.6FE	10-29-2013	ROCKBASS	COMP	5	0.1	6.1	FILLET	0.27							0.33	1.5			
EFOB3012.6FE	10-29-2013	SMALLMOUTH BASS	COMP	2	0.5	10.6	FILLET	0.12							0.29	1.3			
EMORY014.5MG	08-19-2013	LARGEMOUTH BASS	COMP	2	0.5	10	FILLET	0.22							0.53	2.5			
EMORY014.5MG	08-19-2013	SMALLMOUTH BASS	IND	1	1.8	15.5	FILLET	0.71							0.45	2.1			
EMORY014.5MG	08-19-2013	SMALLMOUTH BASS	COMP	4	0.9	12.3	FILLET	0.55							0.54	2.5			
EMORY22.0MG	08-20-2013	LARGEMOUTH BASS	IND	1	0.8	11.6	FILLET	0.27							0.5	2.3			

Station	Date	Species	Composite/ Individual	# of Fish	Weight (lbs)	Length (Inch)	Sample Type	Hg	Fe	As	Cd	Cr	Cu	pH	Se - Wet	Se - Dry*	Tl	Zn	Mn
EMORY022.0MG	08-20-2013	SMALLMOUTH BASS	COMP	2	0.7	11.6	FILLET	0.63							0.5	2.3			
EMORY027.7MG	08-26-2013	ROCKBASS	COMP	2	0.1	7.8	FILLET	0.19							0.58	2.7			
EMORY027.7MG	08-26-2013	SMALLMOUTH BASS	COMP	4	0.4	9.5	FILLET	0.54							0.46	2.1			
EMORY027.7MG	08-26-2013	SMALLMOUTH BASS	COMP	5	0.2	7.7	FILLET	0.42							0.37	1.7			
FWATE040.1PU	01-05-2012	SMALLMOUTH BASS	COMP	2		8	FILLET	0.21	2.8	0.044U	0.017U	0.12J	0.29	0.032U	0.73	3.39J	0.028U	8.8	0.12
FWATE040.1PU	01-05-2012	SMALLMOUTH BASS	COMP	2		8	OVARY								2.1	9.76J			
FWATE040.1PU	02-13-2014	SMALLMOUTH BASS	COMP	9	0.3	8.4	WHOLE	0.13							0.9	4.2			
LEMOR004.3MG	09-17-2013	LARGEMOUTH BASS	COMP	5	0.6	10.8	FILLET	0.17							0.49	2.3			
LEMOR004.3MG	09-17-2013	SMALLMOUTH BASS	COMP	2	1.1	11.7	FILLET	0.21							0.55	2.6			
FWATE040.1PU	02-13-2014	SMALLMOUTH BASS	COMP	2	0.7	10.9	WHOLE	0.23							0.81	3.8			
LSEQU009.0MI	09-20-2011	ROCKBASS	COMP	7	0.2	6.4	FILLET	0.19	2.6	0.044U	0.017U	0.12J	0.18	0.032U	0.25J	1.16J	0.028U	6.0	0.25
LSEQU009.0MI	09-20-2011	ROCKBASS	COMP	7	0.2	6.4	OVARY								1.0	4.65J			
LSEQU009.0MI	09-20-2011	SMALLMOUTH BASS	COMP	3	1.4	14.6	FILLET	0.34	2.3	0.044U	0.017U	0.13J	0.19	0.032U	0.31J	1.44J	0.028U	5.7	0.07 J
LSEQU009.0MI	09-20-2011	SMALLMOUTH BASS	COMP	3	0.5	10.3	FILLET	0.52	4.4	0.044U	0.017U	0.18J	0.24	0.032U	0.33J	1.53J	0.028U	5.4	0.04 J
LSEQU009.0MI	09-20-2011	SMALLMOUTH BASS	COMP	3	1.4	14.6	OVARY								0.91	4.23J			
LSEQ009.0MI	09-10-2013	ROCKBASS	COMP	2	0.4	7.9	FILLET	0.25							0.32	1.5			
LSEQU0009.0MI	09-10-2013	ROCKBASS	COMP	9	0.1	6.3	FILLET	0.13							0.34	1.6			

Station	Date	Species	Composite/ Individual	# of Fish	Weight (lbs)	Length (Inch)	Sample Type	Hg	Fe	As	Cd	Cr	Cu	pH	Se - Wet	Se - Dry*	Tl	Zn	Mn
NCHIC026.4HM	09-29-2011	BLUEGILL SUNFISH	COMP	7	0.2	6.8	FILLET	0.15	3.0	0.044U	0.017U	0.13J	0.16	0.032U	0.48J	2.23J	0.028U	8.3	1.3
NCHIC026.4HM	09-29-2011	BLUEGILL SUNFISH	COMP	3	0.2	6.3	OVARY								0.75	3.49J	3.49J		
NEW008.8SC	10-19-2011	SPOTTED BASS	COMP	4	0.6	10.7	FILLET	0.21	3.0	0.044U	0.017U	0.13J	0.24	0.032U	0.38J	1.77J	0.028U	6.0	0.23
NEW008.8SC	10-19-2011	SPOTTED BASS	COMP	2	0.6	11.0	OVARY								0.73	3.39J			
NEW025.0SC	11-02-2011	SMALLMOUTH BASS	COMP	6	0.4	10.0	FILLET	0.26	3.5	0.044U	0.017U	0.15J	0.22	0.032U	0.65	3.02J	0.028U	6.3	0.18
NEW025.0SC	11-02-2011	SMALLMOUTH BASS	COMP	3	0.4	9.9	OVARY								1.5	6.98J			
NEW025.0SC	11-05-2013	ROCKBASS	COMP	2	0.1	5.8	FILLET	0.16							0.82	3.8			
NEW025.0SC	11-05-2013	SMALLMOUTH BASS	COMP	5	0.3	9.1	FILLET	0.31							0.77	3.6			
NEW025.0SC	11-05-2013	SMALLMOUTH BASS	COMP	7	0.1	6.7	FILLET	0.24							0.77	3.6			
NEW032.0SC	11-03-2011	SMALLMOUTH BASS	COMP	6	0.5	10.4	FILLET	0.30	3.3	0.044U	0.017U	0.15J	0.28	0.032U	0.69	3.21J	0.028U	6.1	0.24
NEW032.0SC	11-03-2011	SMALLMOUTH BASS	COMP	4	0.5	10.4	OVARY								1.3	6.04J			
NEW032.0SC	11-04-2013	ROCKBASS	COMP	2	0.1	5.8	FILLET	0.1							0.77	3.6			
NEW032.0SC	11-04-2013	SMALLMOUTH BASS	IND	1	1.1	15.4	FILLET	0.24							0.69	3.2			
NEW032.0SC	11-04-2013	SMALLMOUTH BASS	IND	1	0.7	11.4	FILLET	0.23							0.57	2.7			
NEW032.0SC	11-04-2013	SMALLMOUTH BASS	COMP	8	0.2	7.7	FILLET	0.3							0.86	4.0			
NOLIC097.5UC	11-15-2011	ROCKBASS	COMP	5	0.4	8.1	FILLET	0.33	4.6	0.044U	0.017U	0.12J	0.32	0.032U	0.17J	0.79J	0.028U	7.9	0.09 J
NOLIC097.5UC	12-14-2011	ROCKBASS	COMP	4	0.2	6.6	FILLET	0.17	3.0	0.044U	0.017U	0.12J	0.25	0.032U	0.17J	0.79J	0.028U	5.6	0.28

Station	Date	Species	Composite/ Individual	# of Fish	Weight (lbs)	Length (Inch)	Sample Type	Hg	Fe	As	Cd	Cr	Cu	pH	Se - Wet	Se - Dry*	Tl	Zn	Mn
NOLIC097.5UC	12-14-2011	ROCKBASS	COMP	4	0.2	6.6	OVARY								0.69	3.21J			
NOLIC097.5UC	11-15-2011	SMALLMOUTH BASS	COMP	4	1.4	14.5	FILLET	0.58	3.5	0.044U	0.017U	0.16J	0.27	0.032U	0.21J	0.98J	0.028U	5.1	0.11
NOLIC097.5UC	11-15-2011	SMALLMOUTH BASS	COMP	2	1.7	15.2	FILLET	0.44	3.5	0.044U	0.017U	0.17J	0.30	0.032U	0.19J	0.88J	0.028U	6.3	0.10 J
NOLIC097.5UC	11-15-2011	SMALLMOUTH BASS	COMP	2	1.7	15.2	OVARY								0.62	2.88J			
NOLIC097.5UC	10-22-2013	ROCKBASS	COMP	5	0.3	7.3	FILLET	0.15							0.24	1.1			
NOLIC097.5UC	10-22-2013	SMALLMOUTH BASS	IND	1	1.2	13.1	FILLET	0.27							0.27	1.3			
NOLIC097.5UC	10-22-2013	SMALLMOUTH BASS	COMP	5	0.3	8.8	FILLET	0.29							0.29	1.3			
OCOEE011.9PO	09-22-2011	SPOTTED BASS	COMP	5	3.2	17.6	FILLET	0.13	2.8	0.089J	0.017U	0.16J	0.18	0.032U	0.67	3.12J	0.028U	4.9	0.04 J
OCOEE011.9PO	09-22-2011	SPOTTED BASS	COMP	3	2.8	16.9	OVARY								1.1	5.12J			
POWEL115.7HK	11-08-2011	ROCKBASS	COMP	9	0.2	6.4	FILLET	0.08	4.0	0.044U	0.017U	0.13J	0.27	0.032U	1.4	6.51J	0.028U	7.1	0.23
POWEL115.7HK	11-08-2011	ROCKBASS	COMP	5	0.2	6.0	OVARY								2.4	11.2J			
POWEL115.7HK	11-08-2011	SMALLMOUTH BASS	COMP	3	0.5	10.5	FILLET	0.15	3.9	0.078J	0.017U	0.14J	0.25	0.032U	1.3	6.04J	0.028U	6.9	0.10 J
POWEL115.7HK	11-08-2011	SMALLMOUTH BASS	IND	1	0.3	8.6	OVARY								2.2	10.2J			
POWEL115.7HK	02-24-2014	ROCKBASS	COMP	5	0.2	7.2	WHOLE	0.06							1.2	5.6			
POWEL115.7HK	02-24-2014	SMALLMOUTH BASS	COMP	4	0.6	11	WHOLE	0.14							1.1	5.1			
POWEL115.7HK	02-24-2014	SMALLMOUTH BASS	COMP	4	0.3	8.6	WHOLE	0.06							1.2	5.6			
STINK000.3CA	10-13-2011	ROCKBASS	COMP	7	0.2	6.4	FILLET	0.11	4.5	0.044U	0.017U	0.12J	0.28	0.032U	0.32J	1.49J	0.028U	6.2	0.67

Station	Date	Species	Composite/ Individual	# of Fish	Weight (lbs)	Length (Inch)	Sample Type	Hg	Fe	As	Cd	Cr	Cu	pH	Se - Wet	Se - Dry*	Tl	Zn	Mn
STINK000.3CA	10-13-2011	ROCKBASS	COMP	3	0.1	5.9	OVARY								0.91	4.23J			
STINK000.3CA	11-09-2011	SMALLMOUTH BASS	COMP	2	0.5	9.7	FILLET	0.20	2.4	0.044U	0.017U	0.13J	0.26	0.032U	0.32J	1.49J	0.028U	5.2	0.07 J
STINK000.3CA	11-09-2011	SMALLMOUTH BASS	IND	1	0.7	11.1	OVARY								2.0	9.30J			
TACKE000.5CA	10-13-2011	ROCKBASS	COMP	6	0.2	6.4	FILLET	0.07	3.1	0.075J	0.017U	0.15J	0.28	0.032U	0.55	2.56J	0.028U	6.1	0.68
TACKE000.5CA	10-13-2011	ROCKBASS	COMP	3	0.2	6.1	OVARY								1.7	7.90J			
TACKE000.5CA	11-09-2011	SMALLMOUTH BASS	COMP	5	0.4	9.0	FILLET	0.11	3.4	0.063J	0.017U	0.16J	0.28	0.032U	0.63	2.93J	0.028U	5.7	0.25
TACKE000.5CA	11-09-2011	SMALLMOUTH BASS	COMP	4	0.3	8.6	OVARY								1.7	7.90J			

All units mg/kg
U is undetected
J is estimated value between mdl and mql
* Wet Selenium x 4.65 to get dry

Appendix C: Water Column Data

Station	Sample Date	pH	Cond umho	DO ppm	Flow CFS	Temp °C	Tot Alk*	Chloride*	Sulfate*	TDS*	TSS*	Tot Hrd*	NH3*	NO2_3*	TKN*	TP*	TOC*	As ug/L	Cd ug/L	Cr ug/L	Cu ug/L	Fe ug/L	Pb ug/L	Mn ug/L	Hg ug/L	Se ug/L	Zn ug/L
BFGIZ000.6MI	09-16-2011	6.5	102	7.3	0.11	15.3	86	2.3	10	120	1.1	120	0.04U	0.44	0.16	0.003J	0.97J	0.17U	0.2U	0.3U	0.27U	94J	0.3U	23	0.024U	0.32U	1.9U
BIG007.2GY	09-26-2011	7.2	70	6.3	< 0.1	15.2	2.2U	3.2	61	110	0.5J	87	0.051J	0.035	0.21	0.001U	2.6	1	0.2U	0.7J	3.6	74J	0.3U	62	0.024U	0.32U	3.3
BRIMS013.9SC	11-01-2011	6.4	115	10.5	13.8	9.1	24	1.3	27	73	1	65	0.04U	0.01U	0.19	0.001U	1.2	1.2	0.2U	0.3U	1.0J	400	0.3U	75	0.024U	0.32U	2.1J
BUFFA002.9SC	10-24-2011	6.7	118	9.93	21.5	12.4	25	1.3	27	68	1J	64	0.07J	0.07J	0.25	0.002J	1.2	1	0.2U	0.3U	0.71J	460	0.3U	51	0.024U	0.32U	1.9U
CANE023.2BL	10-10-2011	6.4	74	5.76	0.06	13.4	2.2U	1.7	15	56	0.2U	36	0.05J	0.02J	0.3	0.001U	3.9	0.6J	0.2U	0.3U	0.27U	64J	0.26J	68	0.024U	0.32U	1.9U
CAPUC001.9CA	11-08-2011	7.4	168	11.4	13.3	9.2	20J	2	52	110	0.8J	82	0.14	0.03J	0.04U	0.001U	1.5	0.84J	0.2U	0.3U	0.27U	260	0.5J	21	0.024U	0.32U	1.9U
CFORK003.8SC	11-15-2011	6.6	56	10.4	110	10.8	2.2U	3.5	6.2	32	0.7J	29J	0.05J	0.06J	0.04U	0.01	2	0.4J	0.2U	0.3U	0.27U	190	0.3U	11	0.024U	0.32U	1.9U
CLEAR030.5CA	11-08-2011	7.1	248	11.5	232	9.4	37	2.5	76	140	0.8J	110	0.04U	0.04J	0.06J	0.001U	2	0.35J	0.22U	0.3U	0.27U	200	0.3U	61	0.024U	0.32U	3.3J
CLIFT001.0WH	10-10-2011	6.6	74	7.6	<0.1	14.6	26	2.5	6.7	50	0.5J	40	0.05J	0.01J	0.21	0.001U	1.2	0.8J	0.2U	0.3U	0.27U	110	0.4J	30	0.024U	0.32J	1.9U
CLINC199.0HK	10-12-2011	8.0	423	8.8	275	17.8	140	12	46	230	2.3	210	0.04U	0.34	0.38	0.001U	1.8	0.31J	0.2U	0.3U	0.27U	47J	0.3U	7.5J	0.024U	0.32U	1.9U
COAL005.4AN	10-13-2011	7.7	324	9.1	8.78	17.4	100	6.1	49	200	0.8J	120	0.12	0.09J	0.44	0.01	2.1	2	0.5J	0.3U	1.7	350	0.3U	40	0.024U	0.32U	6
COLLI061.7GY	09-26-2011	6.3	78	5.8	<0.1	14.6	26	4	12	57	0.8J	56	0.04U	0.02J	0.29	0.002J	3.2	1.2	0.2U	0.52J	0.79J	370	0.3U	120	0.024U	0.41J	4.7J
CORCH000.2MG	11-02-2011	5.5	58	11.8	32.1	7	2.2U	1.3	18	37	0.6J	26J	0.04U	0.03J	0.06J	0.001U	1.3	0.64J	0.2U	0.65J	3	140	0.3U	30	0.024U	0.32U	1.9U
CROOK008.4MG	11-02-2011	6.5	180	10.1	17.4	8.9	27	3.4	51	110	2.1	82	0.12	0.13	0.09J	0.001U	1.4	1.4	0.4J	0.46J	0.27U	840	0.5J	400	0.024U	0.32U	10
CROOK016.9MG	11-02-2011	6.9	192	10.1	7.48	11.8	39	3.3	46	110	1.8	87	0.04U	0.15	0.08J	0.001U	0.95J	1.4	0.4J	0.3U	0.27U	590	0.4J	100	0.024U	0.32U	5.2J
DRY002.1WA	09-28-2011	6.6	150	9.1	1.07	14.9	2.2U	1.7	860	1200	1.2	810	0.04U	0.06J	0.12	0.001U	0.74J	0.87J	0.2U	0.3U	0.27U	21U	0.3U	1300	0.024U	0.32U	36

Station	Sample Date	pH	Cond umho	DO ppm	Flow CFS	Temp ℃	Tot Alk*	Chloride*	Sulfate*	TDS*	TSS*	Tot Hrd*	NH3*	NO2_3*	TKN*	TP*	TOC*	As ug/L	Cd ug/L	Cr ug/L	Cu ug/L	Fe ug/L	Pb ug/L	Mn ug/L	Hg ug/L	Se ug/L	Zn ug/L
ECO68A26	11-02-2011	7.6	70	11.5	F	8.6	2.2U	4.1	6.9	43	0.6J	32	0.08J	0.16	0.12	0.005	1.7	1.1	0.38J	0.75J	0.27U	76J	0.6J	3.3J	0.024U	0.32U	1.9U
ECO69D03	11-02-2011	6.1	38	9.9	3.9	11.9	2.2u	0.78J	7.2	26	0.4J	22J	0.04U	0.01U	0.04U	0.001U	0.83J	0.45J	0.22U	0.57J	2.8	23J	0.36U	2J	0.024U	0.32U	1.9U
EFOBE039.6OV	10-25-2011	6.4	126	10.8	11.7	9.5	2.2U	12	27	69	0.4J	50	0.08J	0.12	0.24	0.001U	1.7	5.7	0.25J	0.61J	0.27U	200	0.3U	62	0.024U	0.48J	2.2J
EFORK000.1CA	10-24-2011	7.3	238	10.6	24.5	10.8	61	4.9	44	140	5.8	120	0.06J	0.25	0.44	0.01	1.6	1.3	0.22U	0.3U	1	470	0.26U	28	0.024U	0.73J	2J
EFORK007.2CA	10-24-2011	6.8	245	9.0	F	11.6	55	4.1	53	150	27	130	0.07J	0.23	0.32	0.03	1.6	1.5	0.22U	0.3U	1	1100	0.3U	140	0.024U	0.32U	2.7J
EFORK010.6CA	10-24-2011	6.8	168	9.2	4.39	11.2	48	3.7	30	98	5.7	95	0.09J	0.12	0.4	0.01J	1.1	1.8	0.22U	0.3U	0.71J	790	0.3U	120	0.024U	1.3	2.1J
ELK004.6CA	11-08-2011	6.98	247	10.6	32	9.9	58	5.6	48	150	3	120	0.04U	0.10J	0.14	0.003J	2.4	0.48J	0.22U	0.32J	0.36J	690	0.3U	150	0.024U	0.32U	4.3J
FWATE040.1PU	10-25-2011	6.4	510	3.6	< 0.1	10.4	240	2.9	5.3	270	4	300	0.08J	0.63	0.4	0.02	2.1	5.4	0.22U	1.4	0.27U	37J	0.3U	120	0.024U	0.64J	3.6J
LEMOR004.3MG	10-11-2011	6.9	150	8.0	3.32	16.8	35	4.6	22	84	0.9J	72	0.04U	0.01U	0.28	0.001U	2.2	0.28J	0.22U	0.3U	0.27U	260	0.3U	37	0.024U	0.32U	1.9U
LLAUR000.4FE	10-25-2011	2.9	827	10.5	1.4	9.8	2.2U	3.6	340	390	0.2U	160	0.07J	0.01U	0.63	0.001U	1.3	2.1	0.28J	4.8	6.3	8400	1.7	2400	0.024U	0.67J	130
LSEQU009.0MI	09-26-2011	6.1	69	8.7	0.95	15.5	77	1.4	16	110	1.4	100	0.13	0.21	0.14	0.001U	1.1	2.1	0.26J	0.68J	0.88J	79J	0.8J	25	0.024U	0.46J	4.8J
NCHIC026.4HM	09-27-2011	6.5	112	7.3	0.21	14.2	2.2U	2.8	16	34	0.2U	32	0.11	0.03J	0.08J	0.08	1.2	1.1	0.22U	0.37J	0.78J	58J	0.3U	27	0.024U	0.32U	2.0J
NEW008.8SC	11-15-2011	7.3	181	10.5	224.15	11.6	35	0.17J	0.4U	110	2.7	83	0.04U	0.01J	0.04U	0.001U	1.4	0.91J	0.22U	0.43J	1.1	370	0.4J	42	0.024U	0.41J	2.2J
NEW025.0SC	10-24-2011	7.1	172	10.5	274	11.7	38	0.96J	39	97	1.7	92	0.04J	0.08J	0.19	0.001U	0.88J	0.72J	0.22U	0.3U	0.84J	160	0.3U	17	0.024U	0.32U	1.9U
NEW032.0SC	11-01-2011	7.1	201	10.8	282	8.2	44	1.3	48	120	0.6J	110	0.06J	0.05J	0.18	0.001U	1.2	2.2	0.22J	4.7	2.2	160	0.7J	19	0.024U	0.32U	Lab error
NEW048.7AN	11-01-2011	7.5	257	11.0	32.6	10.1	47	2	72	160	0.3J	130	0.04U	0.09J	0.13	0.001U	1.8	0.99J	0.22U	0.3U	1.4	120	0.3U	39	0.024U	0.32U	3.3J
NOLIC097.5UC	10-13-2011	7.3	103	9.0	839	17.4	2.2U	8.7	10	64	56	62	0.04U	0.08J	0.48	0.05	2.4	0.2U	0.22U	0.3U	1.2	1100	0.3U	51	0.024U	0.32U	3.5J

Station	Sample Date	pH	Cond umho	DO ppm	Flow CFS	Temp ℃	Tot Alk*	Chloride*	Sulfate*	TDS*	TSS*	Tot Hrd*	NH3*	NO2_3*	TKN*	TP*	TOC*	As ug/L	Cd ug/L	Cr ug/L	Cu ug/L	Fe ug/L	Pb ug/L	Mn ug/L	Hg ug/L	Se ug/L	Zn ug/L
NSUCK000.1MI	10-07-2011	6.1	69	8.7	0.18	15.5	2.2U	3.8	17	25	0.2UN	29J	0.04U	0.11	0.04U	0.001U	0.56J	0.87J	0.22U	0.3U	0.28J	21U	0.4J	3.1J	0.024U	0.52J	1.9U
OCOEE011.9PO	10-13-2011	6.9	63	8.2	592	20.2	2.2U	1.4	16	42	2.1N	42	0.04U	0.05J	0.3	0.001U	0.99J	0.22J	0.22U	0.3U	1.2	140	0.3U	44	0.024U	0.32U	4.7J
POWEL115.7HK	12-29-2011	7.4	144	10.1	1100	10.2	110	4	69	230	6.2	170	0.04U	0.92	0.46	0.02	1.4	0.55J	0.22U	0.3U	1.1	330	0.3U	18	0.015	0.32U	3.2J
ROCKY024.5VA	09-28-2011	7.4	72	8.6	< 0.1	13.6	2.2U	2.8	220	320	0.5J	220	0.04U	0.15	0.15	0.001U	2.3	0.85J	0.22U	0.3U	0.27	42	0.3J	1800	0.024U	0.32U	36
SMOKY000.8SC	11-01-2011	6.7	153	11.2	37.5	7.89	40	0.95J	33	92	0.3J	87	0.04U	0.05J	0.2	0.001U	1.3	0.88J	0.22U	0.3U	0.87J	220	0.3U	29	0.024U	0.32U	2.3J
STINK000.3CA	11-08-2011	7.0	114	11.0	53.4	10.8	2.2U	6.5	28	69	1.9	49	0.12	0.03J	0.18	0.02	2.1	0.77J	0.22U	0.3U	0.27U	240	0.4J	140	0.024U	0.32U	4.8J
TACKE000.5CA	11-08-2011	7.3	317	11.1	28.9	10.5	51	0.92J	97	210	0.4J	130	0.085J	0.1	0.34	0.001U	0.91J	0.7J	0.22U	0.3U	0.27U	130	0.3U	37	0.024U	0.32U	1.9U
WOODC003.4SE	11-22-2011	6.2	25	10.2	9.01	12.6	2.2U	2.3	9.4	31	0.4J	34	0.04U	0.04J	0.04U	0.0017J	2.1	0.18J	0.22U	0.3U	0.27U	64	0.3J	14	0.024U	0.32U	1.9U

*Units in mg/L for these parameters
U is undetected
J is estimated value between mdl and mql