Assessment of Ohio River Water Quality Conditions

2012 - 2016

Ohio River Valley Water Sanitation Commission
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June 2018

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EXECUTIVE SUMMARY

The Ohio River is one of the nation's great natural resources. The Ohio not only provides drinking water for over five million people, but serves as a warm water habitat for aquatic life, provides numerous recreational opportunities, is used as a major transportation route, and is a source of water for the manufacturing and power industries. The Ohio River takes its headwaters in Pittsburgh, Pennsylvania at the confluence of the Allegheny and Monongahela Rivers and flows southwesterly for 981 miles, joining the Mississippi River near Cairo, Illinois. The first 40 miles of the Ohio River are wholly within the state of Pennsylvania. The remaining 941 miles forms the state boundaries between Illinois, Indiana, and Ohio to the north and Kentucky and West Virginia to the south.

The Ohio River Valley Water Sanitation Commission (ORSANCO; the Commission) is an interstate agency charged with abating existing pollution in the Ohio River basin and preventing future degradation of its waters. ORSANCO was created in 1948 with the signing of the Ohio River Valley Water Sanitation Compact. The Ohio River Valley Water Sanitation Compact commits each state to, "place and maintain the waters of the basin in a satisfactory sanitary condition, available for safe and satisfactory use by public and industrial water supplies after reasonable treatment, suitable for recreation, capable of maintaining fish and other aquatic life…."

Every two years, ORSANCO completes an assessment of Ohio River designated uses in cooperation with the Ohio River 305(b) Coordinators Work Group composed of representatives from each of the main stem states. This biennial assessment reports the conditions of Ohio River water quality and the ability to which the river supports each of its four designated uses; warm water aquatic life, public water supply, contact recreation, and fish consumption. The 305(b) report fulfills the following requirements of the Compact:

- To survey the district to determine water pollution problems.
- To identify instances in which pollution from a state(s) injuriously affects waters of another state(s).

Three classifications are used in this assessment to describe the attainment of Ohio River designated uses; fully supporting (good water quality), partially supporting (fair water quality), and not supporting (poor water quality). ORSANCO conducts water quality monitoring and assessments on behalf of Ohio River main stem states (Illinois, Indiana, Kentucky, Ohio, Pennsylvania, and West Virginia). This report provides a status of water quality generally over the period from 2012 – 2016; however in some cases, historical data outside this range was used in assessments. In addition, a proposed Integrated List containing waters in need of Total Maximum Daily Loads (TMDLs) is completed in an effort to promote interstate consistency for Ohio River TMDLs. The states use ORSANCO's assessments in developing their integrated lists of waters requiring total maximum daily loads (303(d) lists). Not all 303(d) lists produced by the states will coincide with ORSANCO's 305(b) assessments.

A "weight of evidence" approach was utilized in the 2018 Ohio River use assessments. A weight of evidence (WOE) approach involves using professional judgment to make the best, most accurate assessment using data and information which are believed to be most relevant to override other conflicting information. For instance, in a situation where water data might indicate impairment while biological data do not, the water body may still be classified as "Fully Supporting" for the aquatic life use because biological data are a more direct indicator of the aquatic life status. United States Environmental Protection Agency's (US EPA) guidance indicates "Independent Application" should be used when two or more contradictory data sets exist. The weight of evidence approach is directly opposed to US EPA's policy of independent application, which stipulates that if any one data set indicates impairment, then the water body should be designated as impaired. Although not consistent with EPA, ORSANCO concluded that a direct measurement of aquatic life using biological data is the most effective way of determining whether or not the Ohio River supports its aquatic life use designation. Use of the WOE approach had an effect on assessments of aquatic life, fish consumption, and public water supply uses.

AQUATIC LIFE USE SUPPORT

The Ohio River warm water aquatic life use was assessed based on fish population surveys and water chemistry data collected through the Bimonthly and Clean Metals Monitoring Programs. These results were then compared to applicable criteria for the protection of aquatic life. Water quality criteria violations found in greater than ten percent of samples at a monitoring station would indicate impairment on their own. Aquatic life criteria for total iron are exceeded in greater than ten percent of samples in several segments of the river. Violations of aquatic life criteria were also observed for both dissolved oxygen and temperature in the lower river. Although physical and chemical criteria violations exist, the Commission utilized the WOE approach. Based on an assessment of fish population and macroinvertebrate surveys for 2012-2016, which indicate full support for every pool, the entirety of the Ohio River is assessed as fully supporting the aquatic life use.

CONTACT RECREATION USE SUPPORT

The Ohio River contact recreation use was assessed in this report based on bacteria data from river-wide longitudinal surveys completed since 2003, as well as bacteria data collected annually from the six largest combined sewer overflow (CSO) urban areas during the contact recreation season from 2010-2014. Although this report assesses the river based on the past five years, all available bacteria longitudinal survey data from 2003 to 2008 were included due to the influence of precipitation on bacteria, as rain events cause a high degree of variability.

Impairments are based on exceedances of the Commission's stream criteria for bacteria. Bacteria criteria violation rates in excess of ten percent result in an impaired designation. Approximately two-thirds of the Ohio River, 636.5 miles, is classified as impaired, either partially supporting or not supporting the contact recreation use. This evaluation is consistent with previous assessments.

PUBLIC WATER SUPPLY USE SUPPORT

The Ohio River public water supply use was assessed based on chemical water quality data collected from the Bimonthly and Clean Metals Sampling Programs, bacteria monitoring, and questionnaires sent to Ohio River drinking water utilities to assess impacts on those utilities caused by source water conditions. A summary of finished water maximum contaminant level (MCL) violations as well as intake closures and application of non-routine treatment caused by unusual river conditions is included in this report. The river is considered to be impaired if human health criteria violations for one or more pollutants are exceeded in greater than 10 percent of the samples collected, or if source water quality caused finished water MCL violations, resulting in noncompliance with provisions of the Safe Drinking Water Act (1974). Six utilities had MCL violations for trihalomethanes. Because these compounds can be formed during the water treatment process, as opposed to directly resulting from river conditions, these MCL violations do not result in an impaired assessment. The entire river is therefore designated as fully supporting the public water supply use.

FISH CONSUMPTION USE SUPPORT

The Ohio River fish consumption use was assessed based on fish tissue data as well as PCBs, dioxin, and mercury water quality data. Impairment exists if water quality criteria for one or more pollutants are exceeded in greater than ten percent of samples. Based on these criteria, the entire river is designated as partially supporting fish consumption use for PCBs and dioxin. This determination is based on historic monitoring results that were two or more orders of magnitude greater than the applicable criteria.

Violations of the total mercury water quality criterion in excess of ten percent of samples would on their own, indicate impairment in the lower half of the river. Three water quality monitoring stations in the lower half of the river had violations of the 0.012 ug/L criterion in excess of ten percent of the samples. Eleven stations had at least one violation of the total mercury water quality criterion. The water quality criterion for total mercury in the water column is established to protect against undesirable accumulation of methylmercury in fish tissue in excess of 0.3 mg/kg using a consumption-weighted approach. Using a WOE approach, fish tissue measurements of methyl mercury are a more direct measure of whether the fish consumption use is met. In this report, fish tissue methyl mercury data were evaluated using an approach contained in the USEPA's *Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion* (but noting that USEPA does not support a weight of evidence approach). The assessment of methyl mercury fish tissue data is applied on a pool by pool basis utilizing a fish consumption-weighted approach to average the methyl mercury fish tissue concentrations from multiple samples of fish of trophic levels three and four. Based on this assessment, the fish tissue data do not indicate impairment, and utilizing a weight of evidence where the fish tissue data are considered a more reliable indicator of impairment than the water quality criterion, the entire river is assessed as fully supporting the fish consumption use for mercury.

USE SUPPORT SUMMARY

The following table is a state-by-state summary of impaired uses of the Ohio River.

Table 1. State by state summary of impaired uses.

State	River Mile (Total Miles)	Aquatic Life Use Impairment	Contact Recreation Use Impairment	Public Water Supply Use Impairment	Fish Consumption Use Impairment
PA	0.0-40.2 (40.2)	0.0	40.2	0.0	40.2
OH-WV	40.2-317.1 (276.9)	0.0	242.2	0.0	276.9
OH-KY	317.1-491.3 (174.2)	0.0	69.3	0.0	174.2
IN-KY	491.3-848.0 (356.7)	0.0	243.3	0.0	356.7
IL-KY	848.0-981.0 (133.0)	0.0	41.5	0.0	133.0
TOTAL	981.0	0.0	636.5	0.0	981.0

PART I: INTRODUCTION

The Ohio River Valley Water Sanitation Commission (ORSANCO; the Commission) is an interstate water pollution control agency for the Ohio River. ORSANCO was established in 1948 after the Ohio River Valley Water Sanitation Compact was signed by governors from eight member states; Illinois, Indiana, Kentucky, New York, Ohio, Pennsylvania, Virginia, and West Virginia and approved by Congress. Under the terms of the Compact, the states pledged to cooperate in controlling water pollution within the Ohio River basin. Article VI of the Compact states that, "Pollution by sewage or industrial wastes originating in a signatory state shall not injuriously affect the various uses of the interstate waters". To address this principle, ORSANCO carries out a variety of programs, primarily focusing on the Ohio River main stem. General program areas include water quality monitoring and assessment, emergency response, pollution control standards, and public information and education. The Commission also provides a forum for information exchange and technology transfer among the states' water pollution control and natural resources agencies.

The Compact designates the Ohio River to be, "available for safe and satisfactory use as public and industrial water supplies after reasonable treatment, suitable for recreational usage, capable of maintaining aquatic life…and adaptable to such other uses as may be legitimate." No degradation of Ohio River water quality, which would interfere with or become injurious to these uses, shall be permitted. ORSANCO monitors and assesses the Ohio River on behalf of the compact states. This report focuses on the water quality of the Ohio River main stem. However, monitoring is also conducted on tributaries to the Ohio.

This report generally covers the time between January, 2012, and December, 2016, although certain assessments use older (historical) data where no new data has been generated. Methodologies and supporting data used to generate this assessment are contained within this report and its appendices. Ohio River water quality is evaluated by the degree of support for each of the following designated uses; warm water aquatic life habitat, public water supply, contact recreation, and fish consumption. Each designated use is evaluated using specific numeric water quality criteria, surveys and questionnaires, and direct measurements of biological communities within the Ohio River. Based on water quality condition, the Ohio River is classified as fully, partially, or not supporting each of its designated uses. "Fully supporting" indicates minor or no water quality problems. A designation of "partial support" indicates impairment, but data suggest fair water quality. A designation of "not supporting" also indicates impairment; however, in this case data also indicate poor water quality.

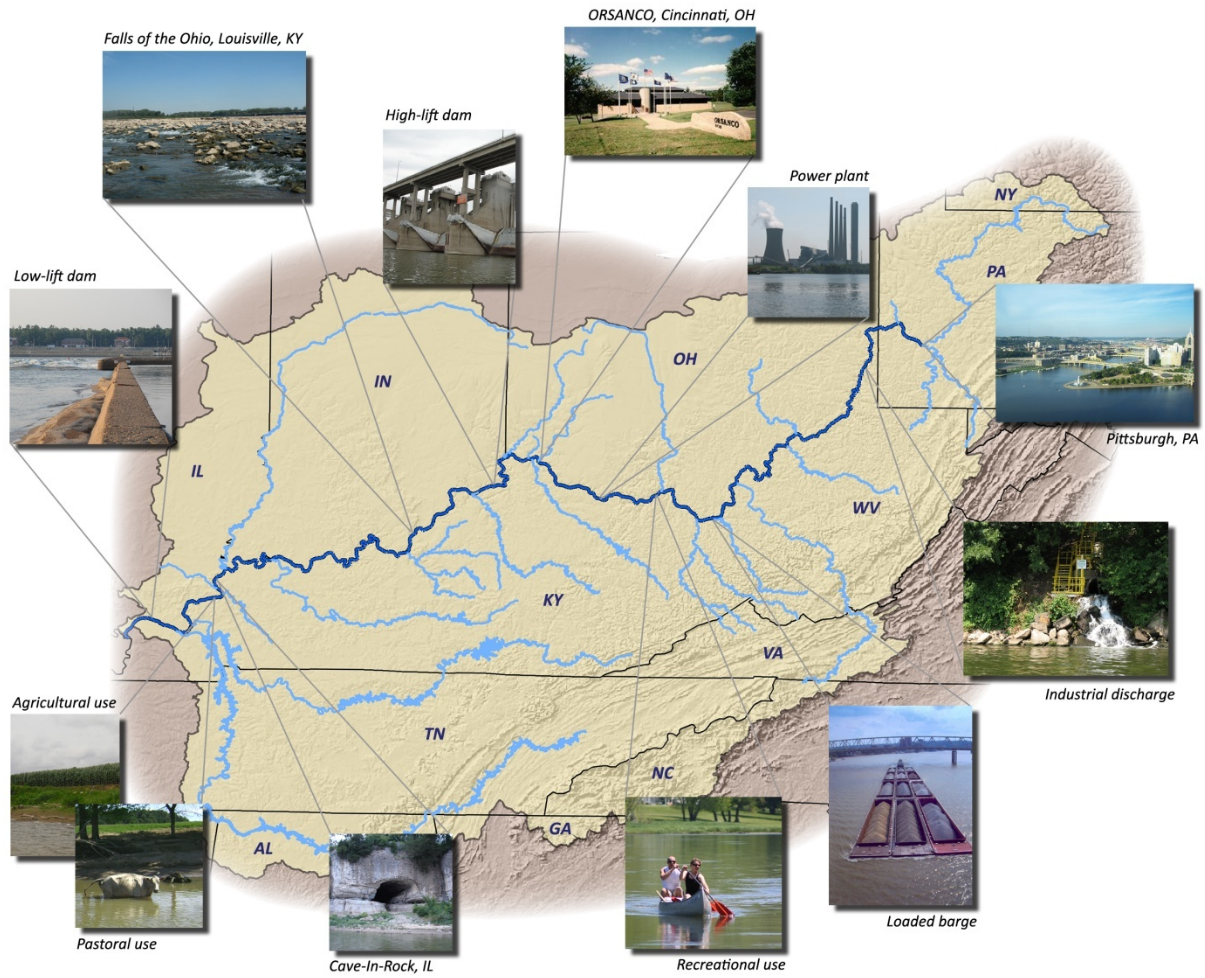


Figure 1. Ohio River Basin.

PART II: BACKGROUND

CHAPTER 1: OHIO RIVER WATERSHED

BASIN CHARACTERISTICS

The Ohio River is 981 miles long and borders or runs through six states in the eastern region of the United States. The Ohio takes its headwaters in Pittsburgh, Pennsylvania at the confluence of the Allegheny and Monongahela Rivers and flows southwesterly to its confluence with the Mississippi River in Cairo, Illinois. The river basin stretches across a 203,940 square mile area, including parts of an additional eight states; New York, Maryland, Virginia, North Carolina, Tennessee, Georgia, Alabama, and Mississippi (Figure 2). Numerous tributaries feed the Ohio including the Allegheny, Monongahela, Kanawha, Wabash, Green, Cumberland, and Tennessee Rivers. In fact, more than 90% of Ohio River flow is from tributaries. Approximately ten percent of the US population resides in the basin, equating to more than 30 million people, five million of which rely on the river as a source of drinking water (Tetra Tech Inc. 2007).

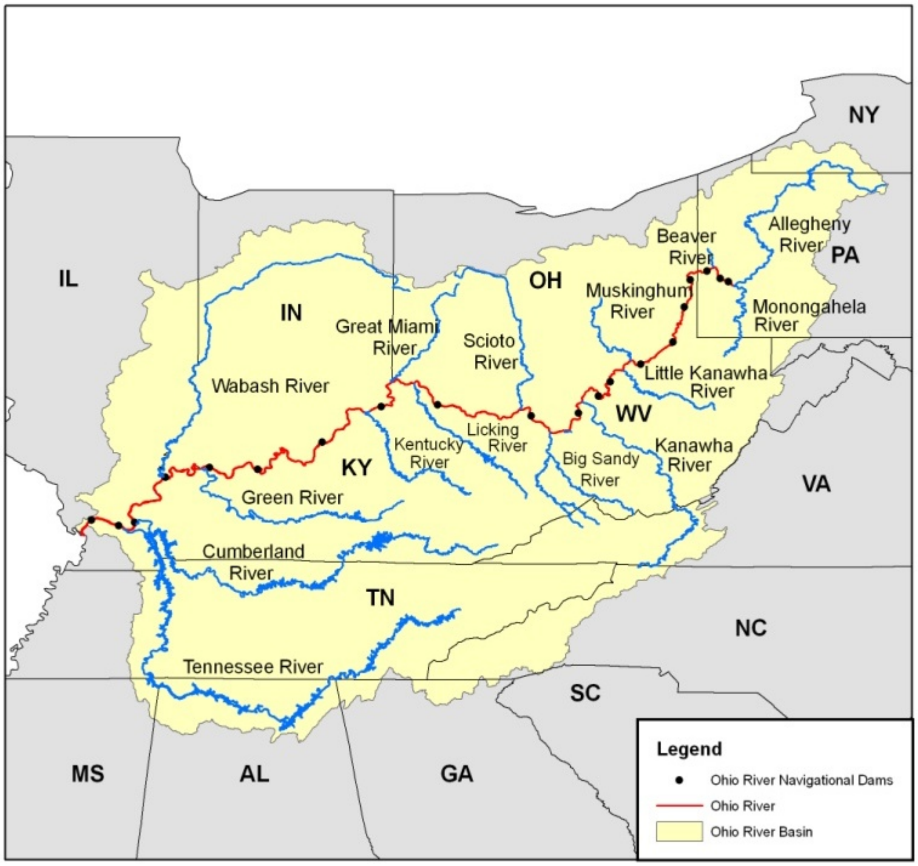


Figure 2. The Ohio River basin, including 19 high-lift locks and dams and tributaries.

Nineteen high-lift locks and dams installed by the US Army Corps of Engineers for navigation purposes maintain a nine-foot minimum river depth and regulate flow, facilitating the transport of more than 230 million tons of cargo on the river every year (Tetra Tech Inc. 2007). The dams create pools, the area of water between them, and are typically named for the downstream dam. The river has an average depth of 24 feet with an average width of 0.5 miles (ORSANCO 1994).

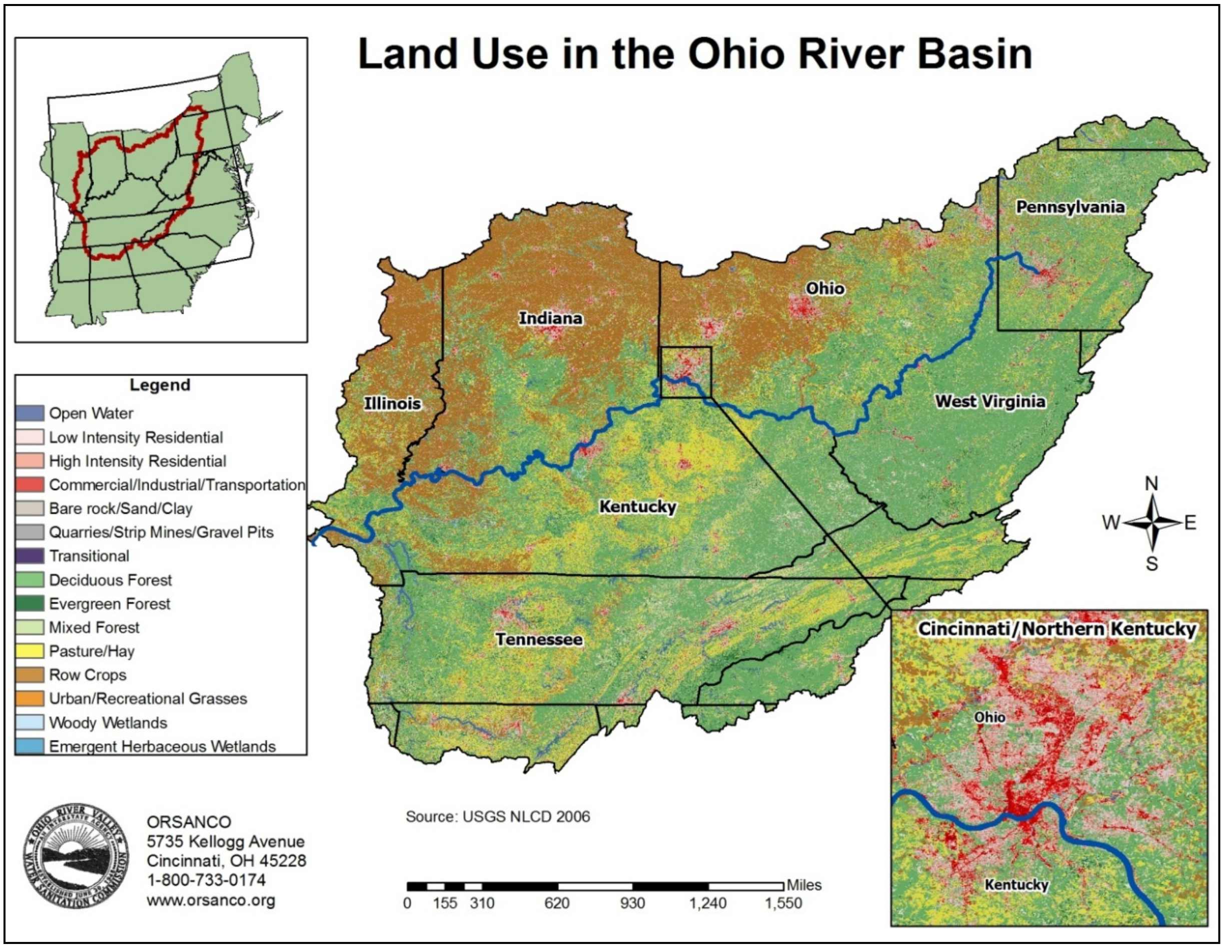


Figure 3. Land use in the Ohio River Basin (USGS NLCD 2006).

Deciduous forests comprise the majority of the land cover in the Ohio River watershed, while pastures, row crops, and urban development make up the major land uses (Figure 3). Land use is an important factor in determining both the runoff characteristics of a drainage basin and the water quality of its streams. Land uses such as agriculture, industry, and mining may contribute to impairments in water quality. Like most of the Midwest, states such as Ohio and Indiana are dominated by agriculture. Highly populated regions of the river are characterized by residential, commercial, and industrial land use types. Nonpoint source pollution from both urban and agricultural areas is a large contributor to degraded water quality. Several point source pollution issues also exist along the Ohio. There are approximately 580 permitted discharges into the Ohio River.

DESCRIPTION OF OHIO RIVER POOLS

The Ohio River is a series of pools connected by 19 high-lift locks and dams installed for navigational purposes. These dams are effective in maintaining a minimum river depth and regulating flow, but also affect water quality and aquatic communities of the river. The modern, high-lift dams have resulted in a deeper, slower moving river than existed prior to their construction. Because each pool has its own unique characteristics, these water bodies have often been used for assessment and reporting purposes in the past. For the 2016 Biennial Assessment, aquatic life and fish consumption use attainment is determined using the navigational pools as independent assessment units; however, the degree of use support for the remaining uses is assessed on a river mile basis. The following descriptions include the boundaries of each water body as well as other relative information.

- **Pittsburgh Point-Emsworth** (mile point 0-6.2). This water body is bounded by the confluence of the Allegheny and Monongahela Rivers (the origin of the Ohio River) on the upstream end and by Emsworth Locks & Dam on the downstream end. Chartiers Creek, with a drainage area of 277 square miles, intersects this water body at mile point 2.5.
- **Emsworth-Dashields** (mile point 6.2-13.3). This 7.1-mile-long water body encompasses the entire Dashields Pool and is bounded by Emsworth Locks & Dam upstream and Dashields Locks & Dam on the downstream end.
- **Dashields-Montgomery** (mile point 13.3-31.7). This 18.4-mile-long water body is bounded by Dashields Locks & Dam upstream and Montgomery Locks & Dam on the downstream end. Two tributaries that enter this navigational pool include the Beaver and Raccoon Rivers at river miles 25.4 and 29.6 respectively.
- **Montgomery-New Cumberland** (mile point 31.7-54.4). This 22.7-mile-long water body is bounded by Montgomery Locks & Dam upstream and New Cumberland Locks & Dam downstream. The Ohio River leaves Pennsylvania to be bordered by Ohio to the north and West Virginia to the south at river mile 40.2. The Little Beaver River, with a drainage area of 510 square miles, intersects this water body at mile point 39.5. Yellow Creek, with a drainage area of 240 square miles, enters the Ohio at river mile 50.4.
- **New Cumberland-Pike Island** (mile point 54.4-84.2). This 29.8-mile-long water body encompasses the entire Pike Island Pool and is bounded by New Cumberland Locks & Dam upstream and Pike Island Locks & Dam on the downstream end. The following tributaries intersect this pool; Buffalo Creek at mile point 74.7 with a drainage area of 160 square miles and Short Creek at mile point 81.4 with a drainage area of 147 square miles.
- **Pike Island-Hannibal** (mile point 84.2-126.4). This 42.2-mile-long water body encompasses the entire Hannibal Pool and is bounded by Pike Island Locks & Dam upstream and Hannibal Locks & Dam on the downstream end. The following tributaries intersect this water body; Wheeling Creek in Ohio at mile point 91.0 with a drainage area of 108 square miles, Wheeling Creek in West Virginia at mile point 91.0 with a drainage area of 300 square miles, McMahon Creek at mile point 94.7 with a drainage area of 91 square miles, Grave Creek at mile point 102.5 with a drainage area of 75 square miles, Captina Creek at mile point 109.6 with a drainage area of 181 square miles, Fish Creek at mile point 113.8 with a drainage area of 250 square miles, and Sunfish Creek at mile point 118.0 with a drainage area of 114 square miles.
- **Hannibal-Willow Island** (mile point 126.4-161.7). This 35.3-mile-long water body encompasses the entire Willow Island Pool and is bounded by Hannibal Locks & Dam upstream and Willow

Island Locks & Dam on the downstream end. The following tributaries intersect this water body; Fishing Creek at mile point 128.3 with a drainage area of 220 square miles, Middle Island Creek at mile point 154.0 with a drainage area of 560 square miles, and Little Muskingum River at mile point 168.3 with a drainage area of 315 square miles.

- **Willow Island-Belleville** (mile point 161.7-203.9). This 42.2-mile-long water body is bounded by Willow Island Locks & Dam on the upstream side and Belleville Locks & Dam downstream. Duck Creek, with a drainage area of 228 square miles, intersects this water body at mile point 170.7. The Muskingum River has a drainage area of 8,040 square miles and enters the Ohio River at mile point 172.2. Other tributaries intersecting this pool include the Little Kanawha River at mile point 184.6 with a drainage area of 2,320 square miles, Little Hocking River at mile point 191.8 with a drainage area of 103 square miles, and Hocking River at mile point 199.3 with a drainage area of 1,190 square miles.
- **Belleville-Racine** (mile point 203.9-237.5). This 33.6-mile-long water body encompasses the entire Racine Pool and is bounded by Belleville Locks & Dam upstream and Racine Locks & Dam on the downstream end. The following tributaries intersect this water body; Shade River at mile point 210.6 with a drainage area of 221 square miles, Shady Creek at mile point 220.6 with a drainage area of 115 square miles, and Mill Creek at mile point 231.5 with a drainage area of 230 square miles.
- **Racine-Robert C. Byrd** (mile point 237.5-279.2). This 34.7-mile-long water body is bounded by Racine Locks & Dam upstream and Robert C. Byrd (R.C. Byrd, formerly Gallipolis) Locks & Dam on the downstream end. Leading Creek, with a drainage area of 151 square miles, intersects this water body at mile point 254.2. Two other major tributaries empty into this pool, the Kanawha River with a drainage area of 12,200 square miles and Raccoon Creek, intersecting Racine at mile point 276.0 with a drainage area of 684 square miles.
- **Robert C. Byrd-Greenup** (mile point 279.2-341.0). This 61.8-mile-long water body is bounded by RC Byrd Locks & Dam on the upstream end and Greenup Locks & Dam downstream. The following tributaries intersect this water body; the Guyandotte River at mile point 305.2 with a drainage area of 1,670 square miles, Symmes Creek at mile point 308.7 with a drainage area of 356 square miles, and Twelvepole Creek at mile point 313.2 with a drainage area of 440 square miles. The Big Sandy River, forming the border between West Virginia and Kentucky, enters the Ohio River at mile point 317.1 with a drainage area of 4,280 square miles. The Little Sandy River, with a drainage area of 724 square miles, enters at Ohio River mile 336.4.
- **Greenup-Meldahl** (mile point 341.0-436.2). This 95.2-mile-long water body is bounded by Greenup Locks & Dam upstream and Meldahl Locks & Dam on the downstream end. The following tributaries intersect this water body; Pine Creek at mile point 346.9 with a drainage area of 185 square miles, Little Scioto River at mile point 349.0 with a drainage area of 233 square miles, Tygarts Creek at mile point 353.3 with a drainage area of 336 square miles, the Scioto River at mile point 356.5 with a drainage area of 6,510 square miles, Kinniconnick Creek at mile point 368.1 with a drainage area of 253 square miles, Ohio Brush Creek at mile point 388.0 with a

drainage area of 435 square miles, Eagle Creek at mile point 415.7 with a drainage area of 154 square miles, and White Oak Creek at mile point 423.9 with a drainage area of 234 square miles.

- **Meldahl-Markland** (mile point 436.2-531.5). This 95.3-mile-long water body is bounded by Meldahl Locks & Dam upstream and Markland Locks & Dam on the downstream end. Major tributaries intersecting this water body include the Little Miami River at river mile 464.1 with a drainage area of 1,670 square miles, the Licking River at mile point 470.2 with a drainage area of 3,670 square miles, and the Great Miami River at mile point 491.1 with a drainage area of 5,400 square miles.
- **Markland-McAlpine** (mile point 531.5-604.4). This 72.9-mile-long water body is bounded by Markland Locks & Dam upstream and McAlpine Locks & Dam on the downstream end. The Kentucky River, which empties into this navigational pool, has a drainage area of 6,970 square miles. Other tributaries include the following; Little Kentucky River at mile point 546.5 with a drainage area of 147 square miles, Indian Kentucky River at mile point 550.5 with a drainage area of 150 square miles, and Silver Creek at mile point 606.5 with a drainage area of 225 square miles.
- **McAlpine-Cannelton** (mile point 604.4-720.7). This 113.9-mile-long water body is bounded by McAlpine Locks & Dam upstream and Cannelton Locks & Dam on the downstream end. Several tributaries intersect this portion of the Ohio River including the Salt River with a drainage area of 2,890 square miles. Other tributaries intersecting this pool include Big Indiana Creek at mile point 657 with a drainage area of 249 square miles, Blue River at mile point 663 with a drainage area of 466 square miles, and Sinking Creek at mile point 700.9 with a drainage area of 276 square miles.
- **Cannelton-Newburgh** (mile point 720.7-776.1). This 55.4-mile-long water body is bounded by Cannelton Locks & Dam upstream and Newburgh Locks & Dam on the downstream end. The following tributaries intersect this water body; Anderson River at mile point 731.5 with a drainage area of 276 square miles, Blackford Creek at mile point 742.2 with a drainage area of 124 square miles, and Little Pigeon Creek at mile point 773 with a drainage area of 415 square miles.
- **Newburgh-John T. Myers** (mile point 776.1-846.0). This 69.9-mile-long water body is bounded by Newburgh Locks & Dam upstream and John T. Myers Locks & Dam (J.T. Myers, formerly Uniontown) on the downstream end. The Green River empties into this pool at river mile 784.2 and has a drainage area of 9,230 square miles. Pigeon Creek, with a drainage area of 375 square miles, intersects this water body at mile point 792.9.
- **John T. Myers-Smithland** (mile point 846.0-918.5). This 72.5-mile-long water body is bounded by J.T. Myers Locks & Dam upstream and Smithland Locks & Dam on the downstream end. The Wabash River, with a drainage area of 33,100 square miles empties into this pool at Ohio River mile 848. Other tributaries to this navigational pool include the Saline River at mile point 867.3 with a drainage area of 1,170 square miles and the Tradewater River at mile point 873.5 with a drainage area of 1,000 square miles.
- **Smithland-Lock & Dam 52** (mile point 918.5-938.9). This 20.4-mile-long water body is bounded by Smithland Locks & Dam upstream and Lock & Dam 52 on the downstream end. The Cumberland River drains into the Ohio at river mile 920.4 and has a drainage area of 17,920 square

miles. The Tennessee River also empties into the Ohio River in this pool at river mile 932.5 with a drainage area of 40,910 square miles.

- **Lock & Dam 52-Cairo** (mile point 938.9-981). This 42.1-mile-long water body is bounded by Lock & Dam 52 upstream and the Mississippi River on the downstream end (the mouth of the Ohio River). Lock & Dam 52 as well as Lock & Dam 53 are currently being replaced by a single lock and dam facility called Olmsted Locks & Dam at river mile 964.4.

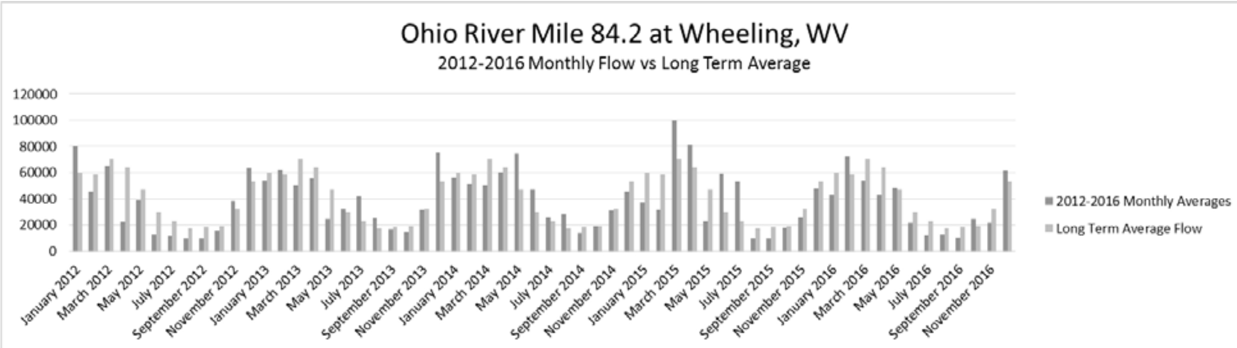
Appendix A contains additional data on basin characteristics including locations of locks and dams, locations of tributaries, and hydrologic data for 2010-2014.

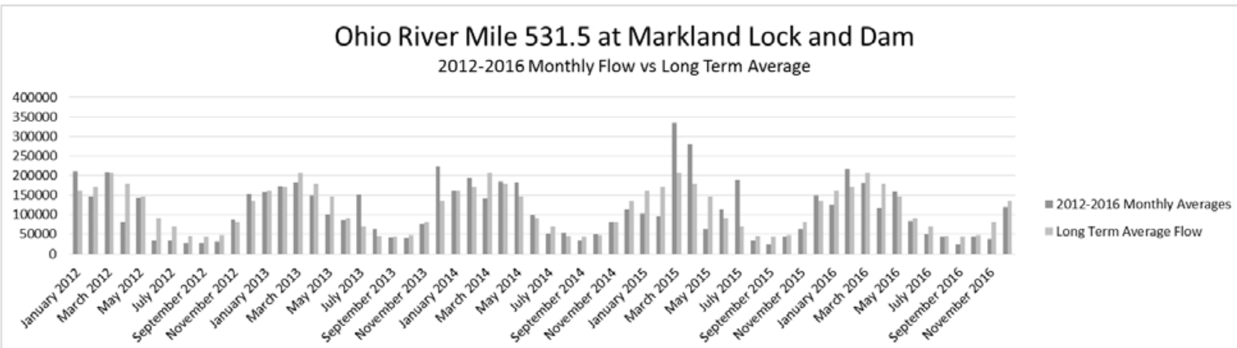
USES OF THE OHIO RIVER

According to the Federal Clean Water Act (1972), states must assess the degree to which their waters meet their designated uses. The Ohio River Basin encompasses 14 states and as such, is known for a variety of different uses. Designated uses for the Ohio River include aquatic life, contact recreation, public water supply, and fish consumption. Specifically, through 33 drinking water utilities, the river provides drinking water to approximately five million people. Approximately forty-five power-generating facilities located along the river provide greater than five percent of the United States' power-generating capacity. In addition, the river acts as a transportation highway for commercial navigation. Each year, barges carry in excess of 280 million tons of cargo down the main stem. The majority of commercial cargo consists of coal, oil, and petroleum. As a great natural resource, the Ohio River provides warm water habitat for over 140 species of fish, drawing fishermen and nature enthusiasts to its banks throughout the basin. Additionally, the Ohio serves as a source of recreation for swimmers and boaters and adds aesthetic value as a majestic backdrop for dining and festivals.

FLOWS

A series of locks and dams, operated and maintained by the United States Army Corps of Engineers, regulates pool elevation on the Ohio River. These dams create 20 pools with guaranteed, regulated minimum flows to assure commercial navigation at all times. Long-term monthly average flows in the Ohio River, depending on location and time of year, range from 5,600 to 821,000 cubic feet per second (cfs). Hydrologic conditions varied considerably over the reporting period. Flow data, reported on a monthly basis by the United States Army Corp of Engineers, are contained in Appendix A. Figure 4 provides a comparison of flow over the reporting period compared to long-term average flows at three locations; Wheeling, WV, Markland, KY, and Smithland, KY. At Wheeling and Markland the average monthly flows appear lower than long-term averages from 2012 to 2016, while at Smithland the average monthly flows were lower than long-term averages in 2012 but equal to historical averages from 2013-2016. Both high and low flow conditions may adversely affect the various uses of the Ohio River. Aquatic biota, for example, may experience lower dissolved oxygen levels during low flow periods. During high flow conditions, bacteria levels often increase due to wet weather sources including combined sewer overflows (CSOs).





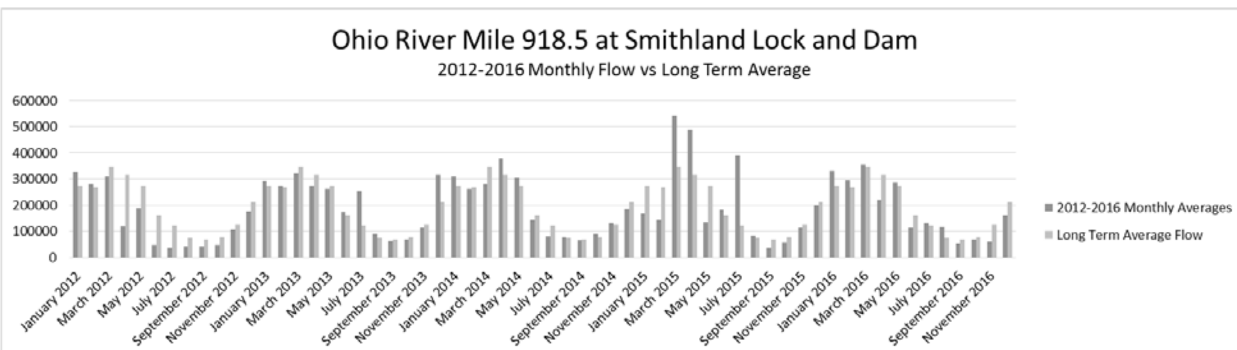


Figure 4. Ohio River flow data at Wheeling, WV; Markland, KY; and Smithland, KY.

CHAPTER 2: GENERAL WATER QUALITY CONDITIONS

Figure 4 presents box and whisker plots of all Ohio River Bimonthly and Clean Metals monitoring data for the period January 2010 through December 2014. The data generally represents 30 sampling events conducted over the five year period, consisting of one round of sampling every other month, beginning in January and alternating months. The data in Figure 5 are presented from upstream to downstream stations, which is left to right on the graphs. River mile points for each station as well as individual sample results can be found in Appendix B. The box and whisker plots depict the maximum, minimum, 25th

percentile, median, and 75th percentile values of the data. In many cases the minimum value will be the analytical detection level.

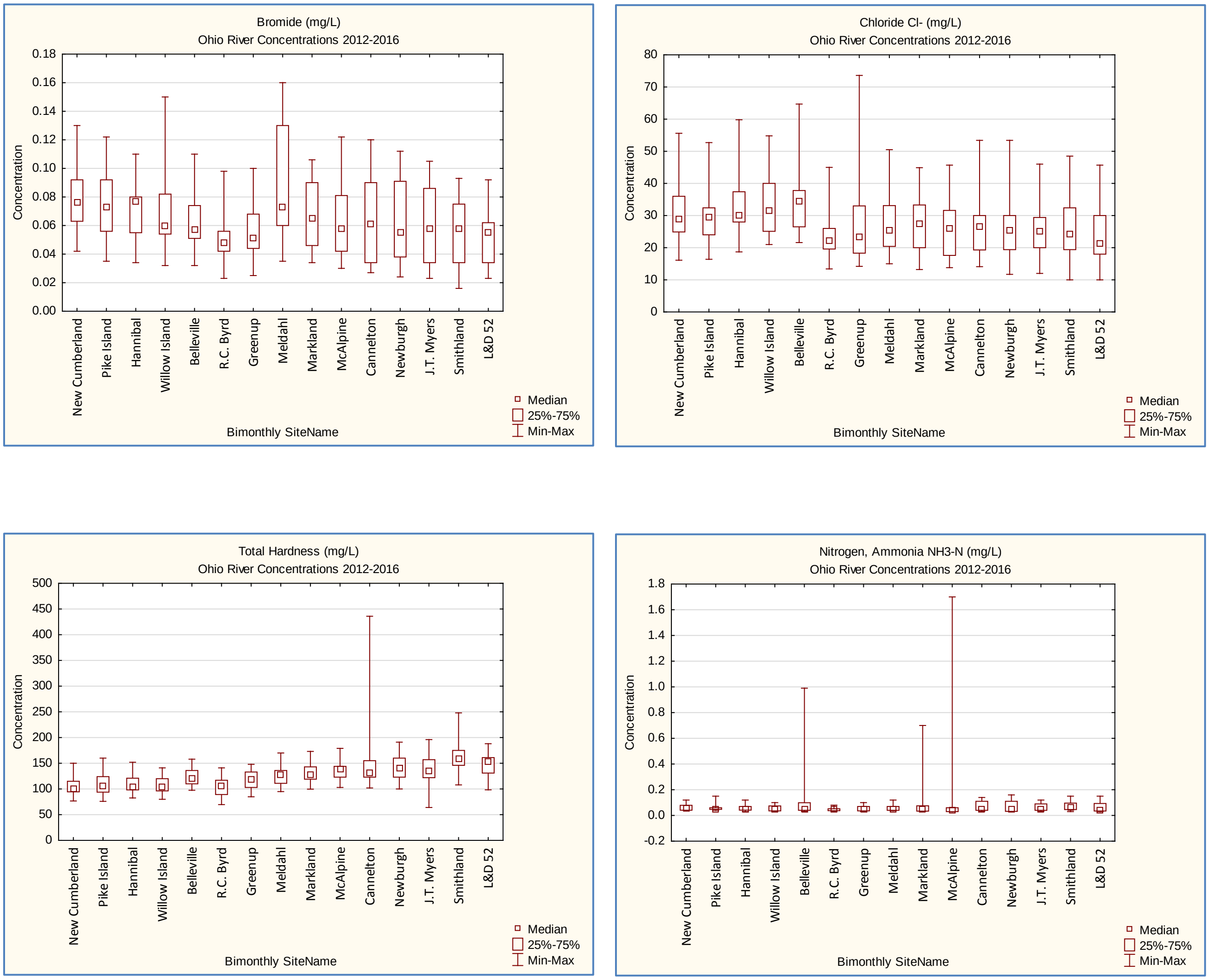
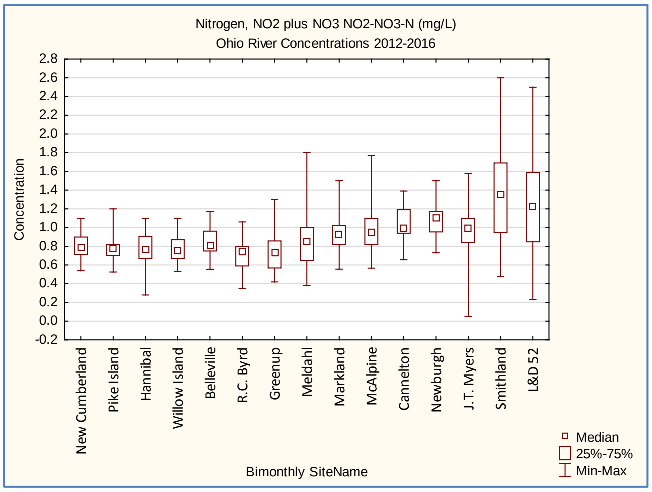
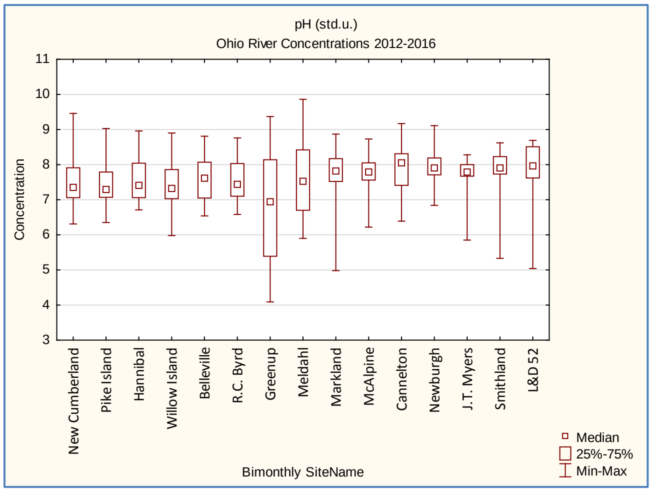
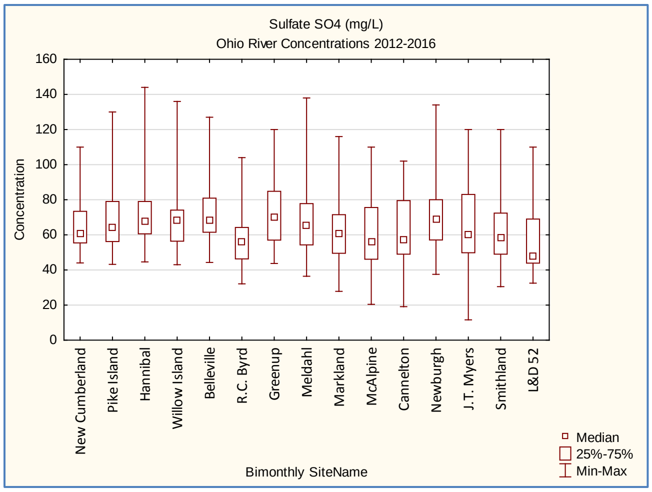
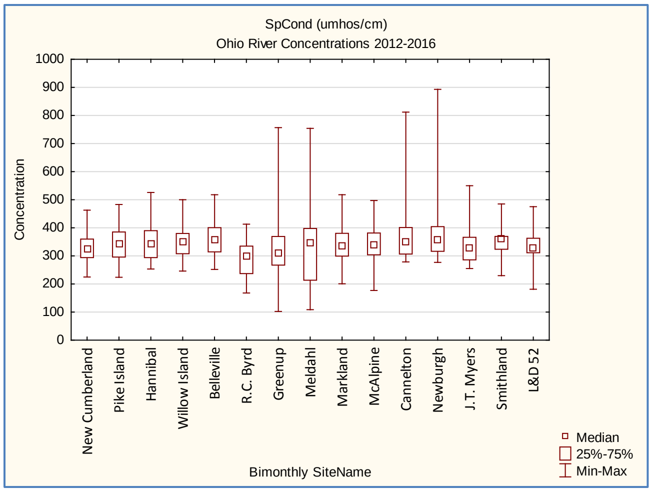


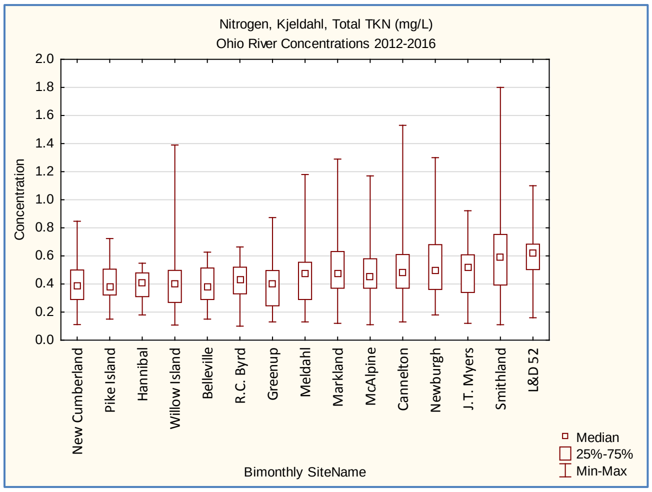
Figure 5. Bimonthly and Clean Metals Data, 2012-2016.











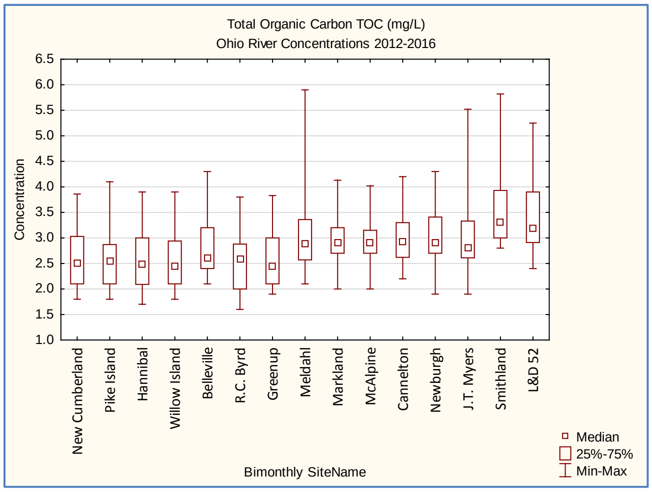
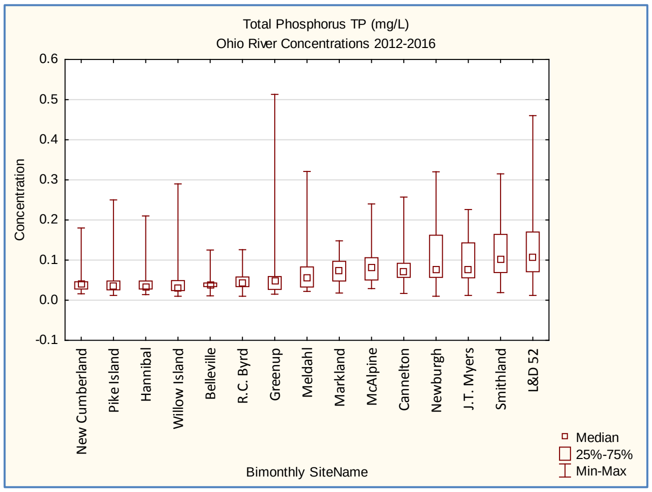
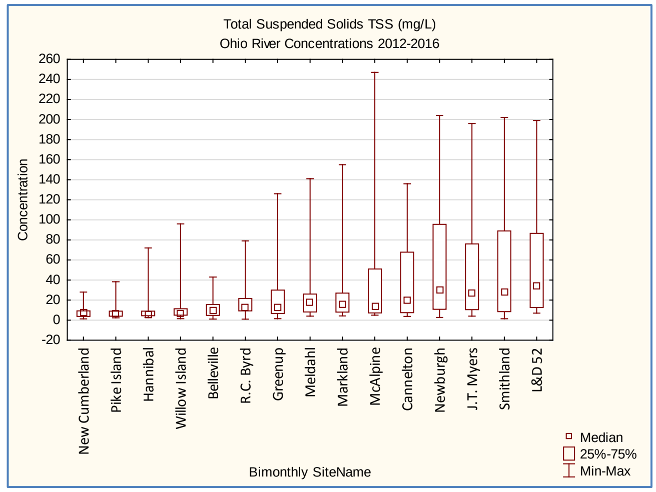
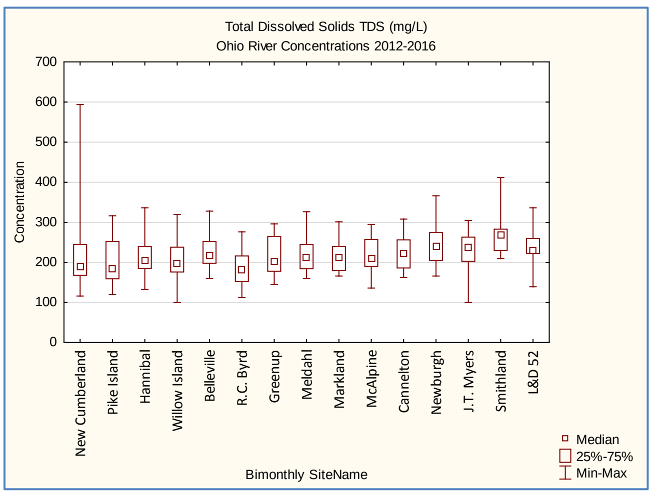
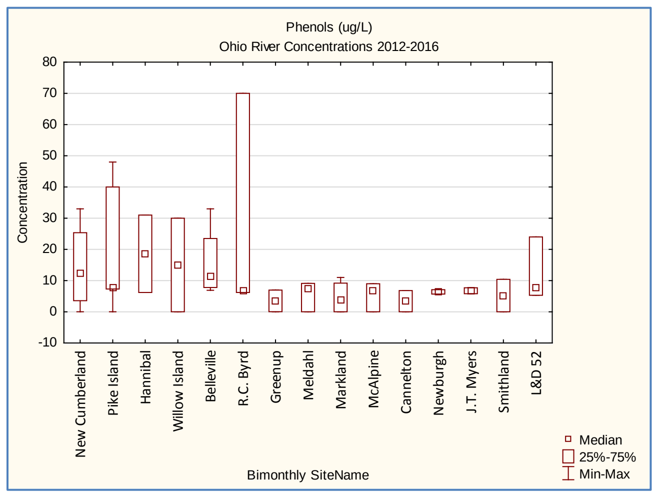


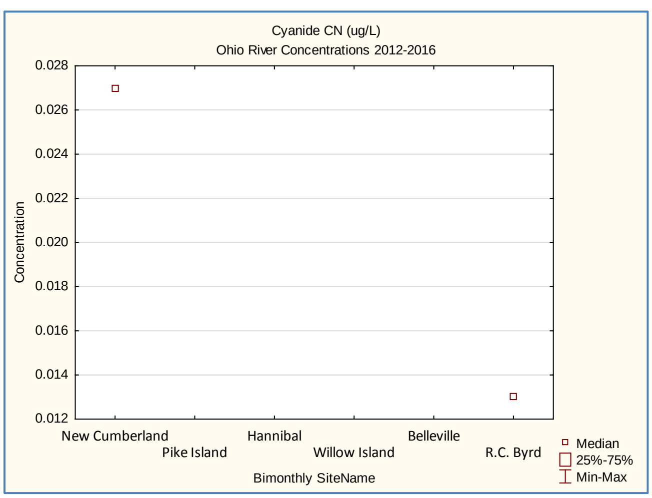
Figure 5. Bimonthly and Clean Metals Data, 2012-2016.











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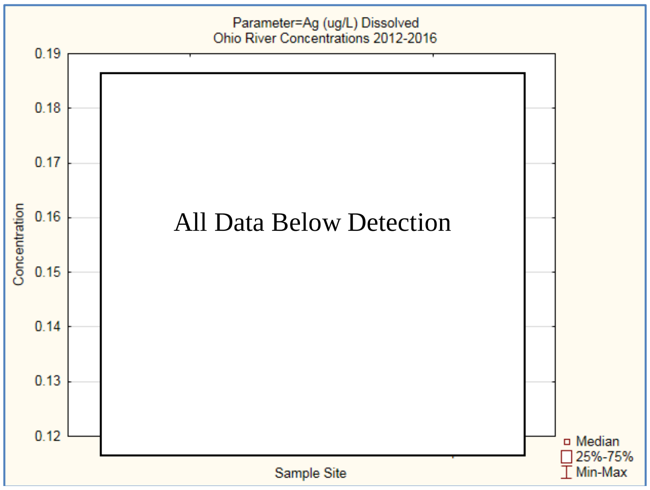
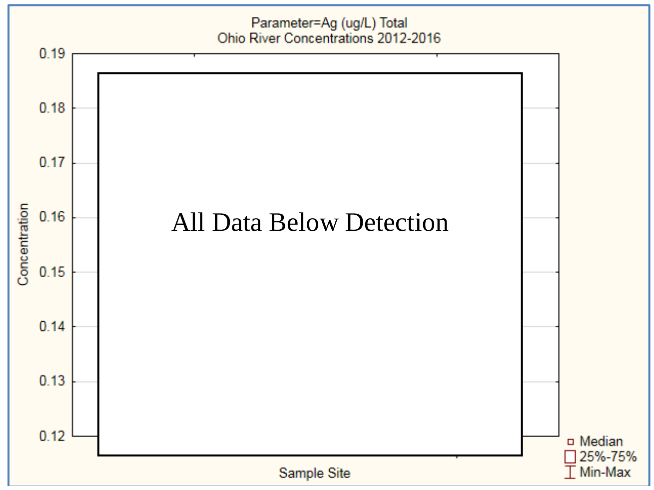
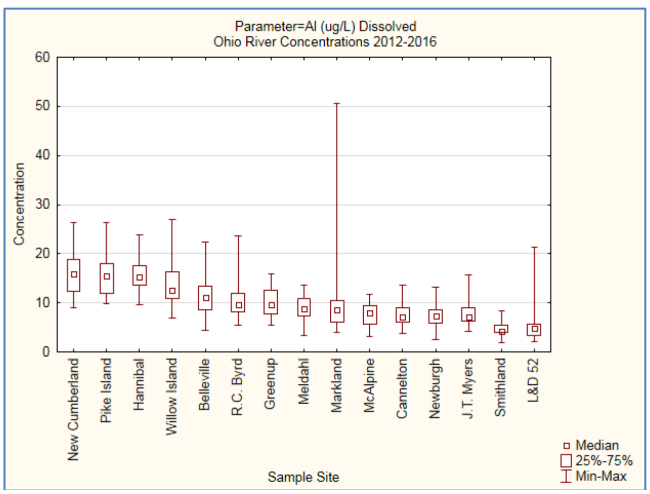
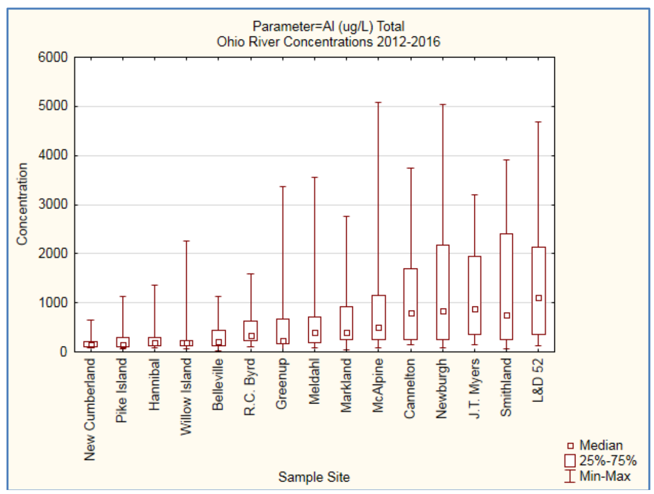
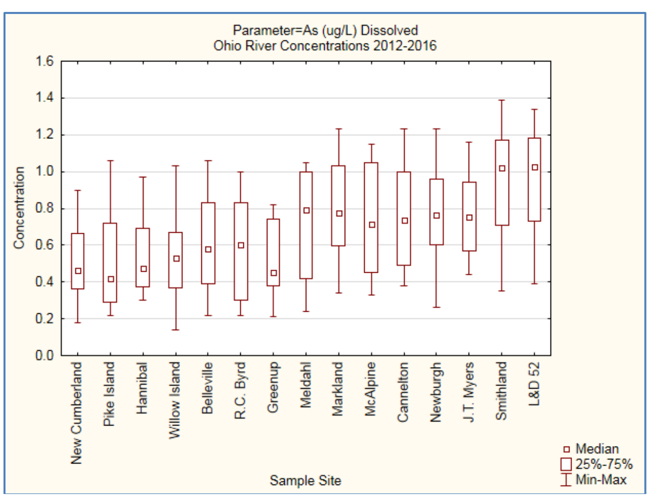










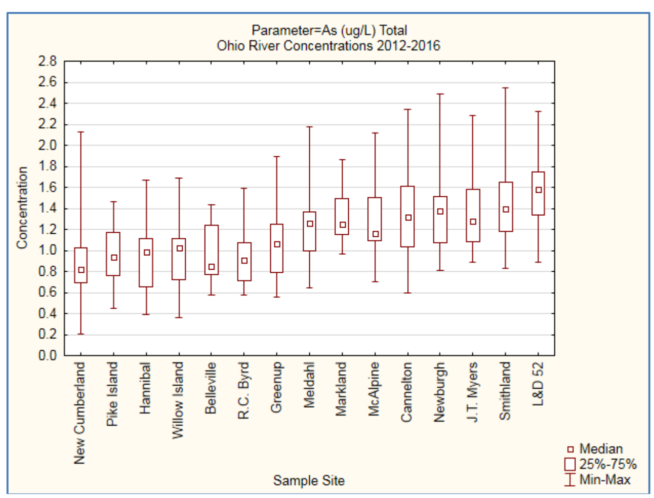
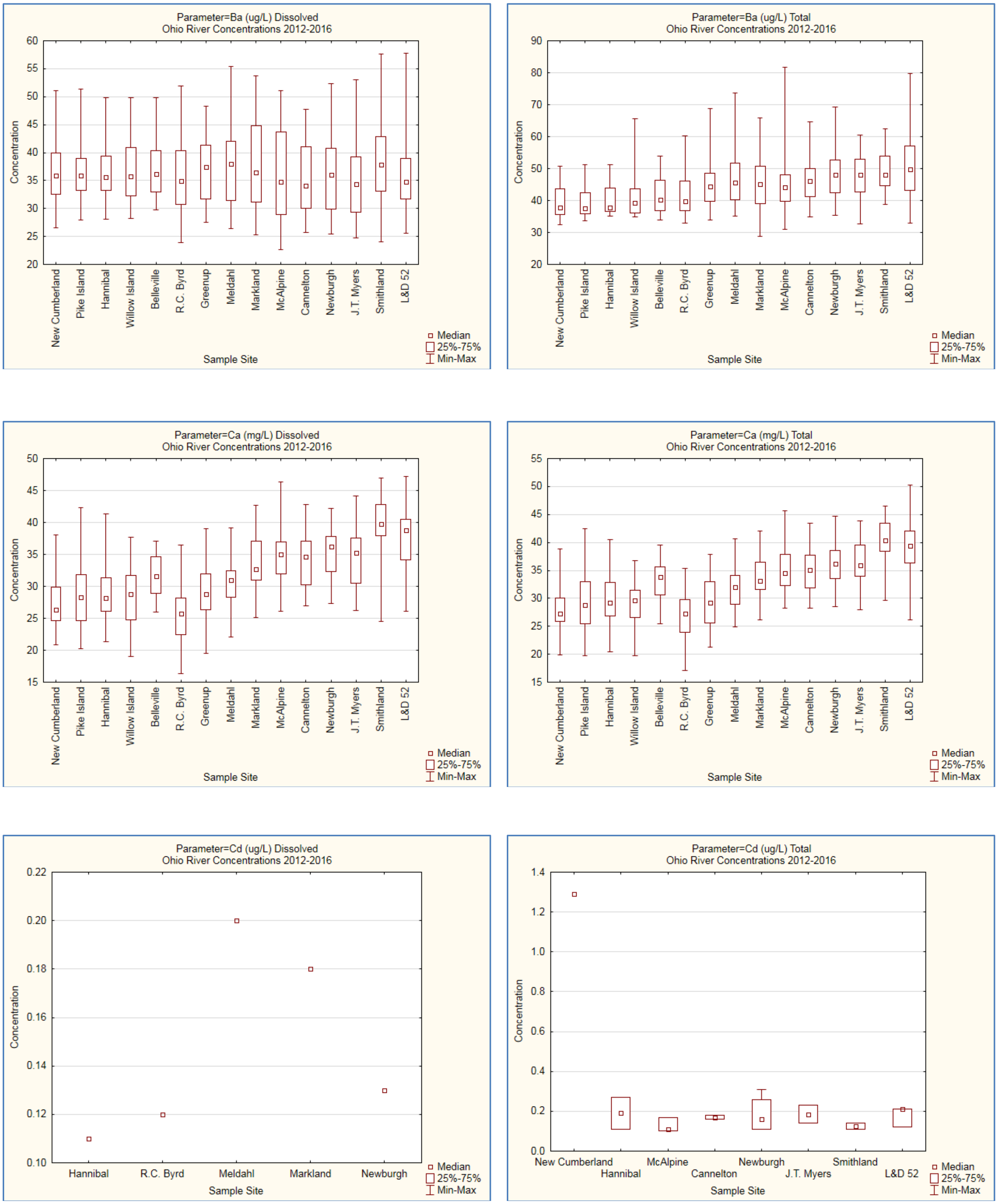


Figure 5. Bimonthly and Clean Metals Data, 2012-2016.



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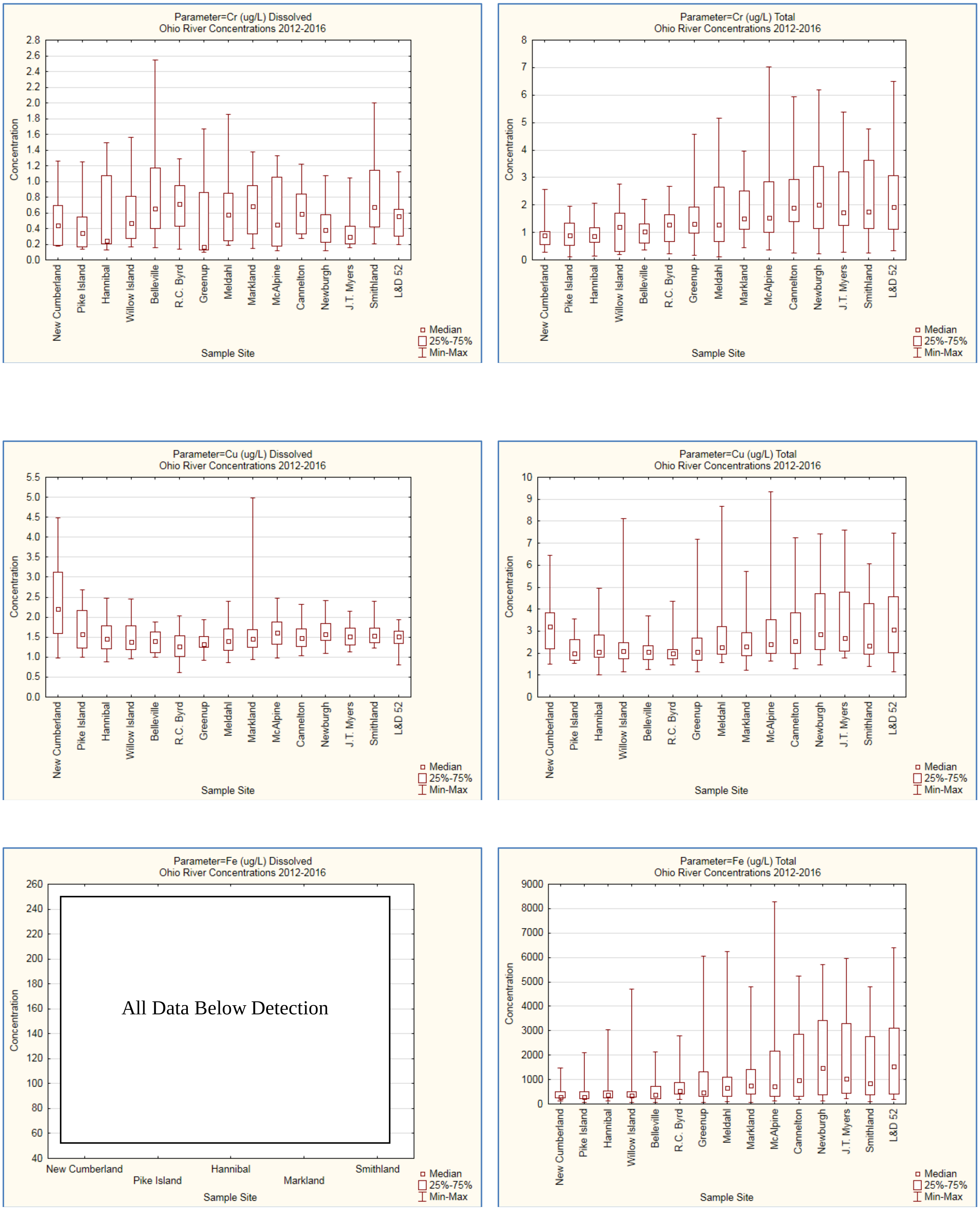

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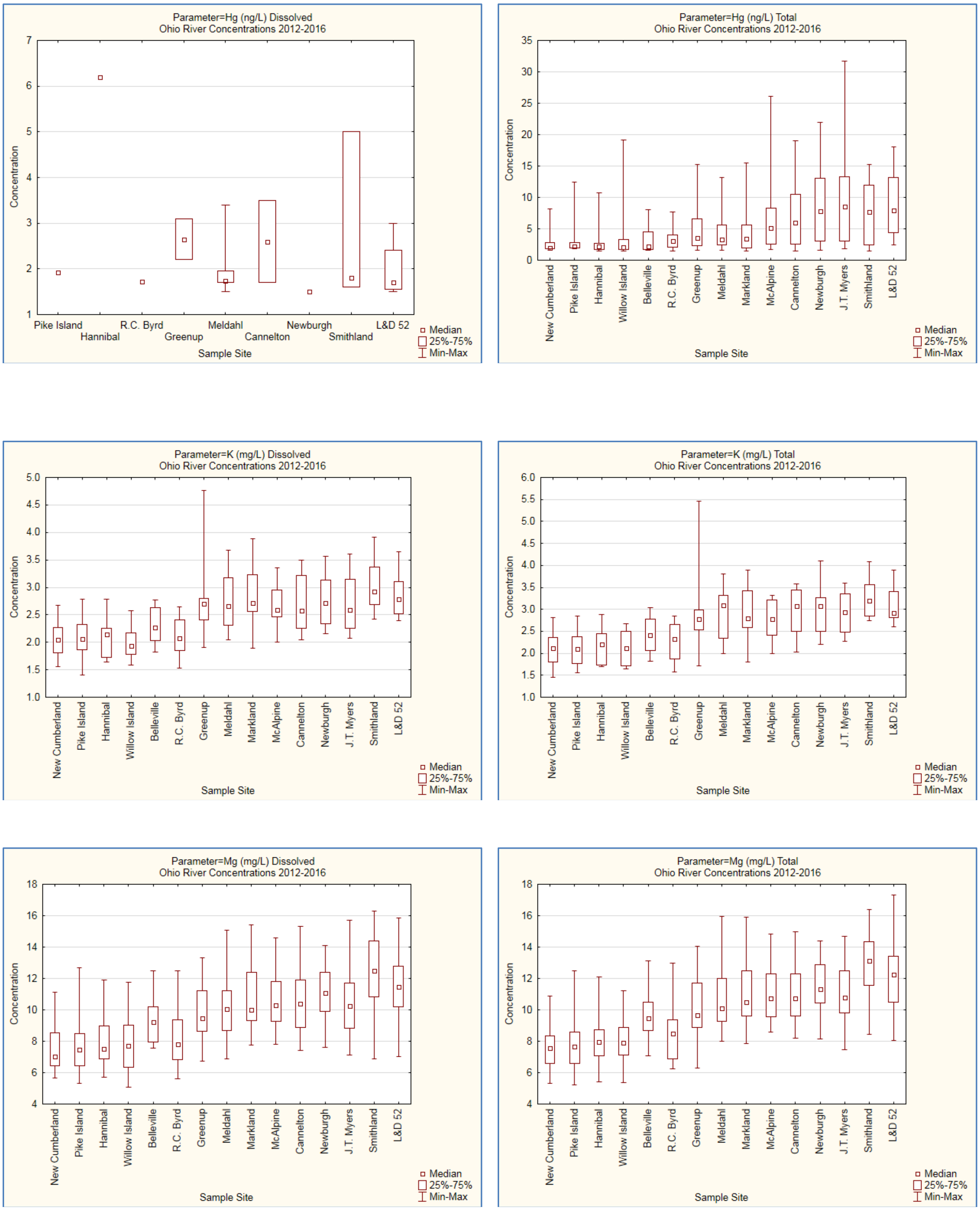

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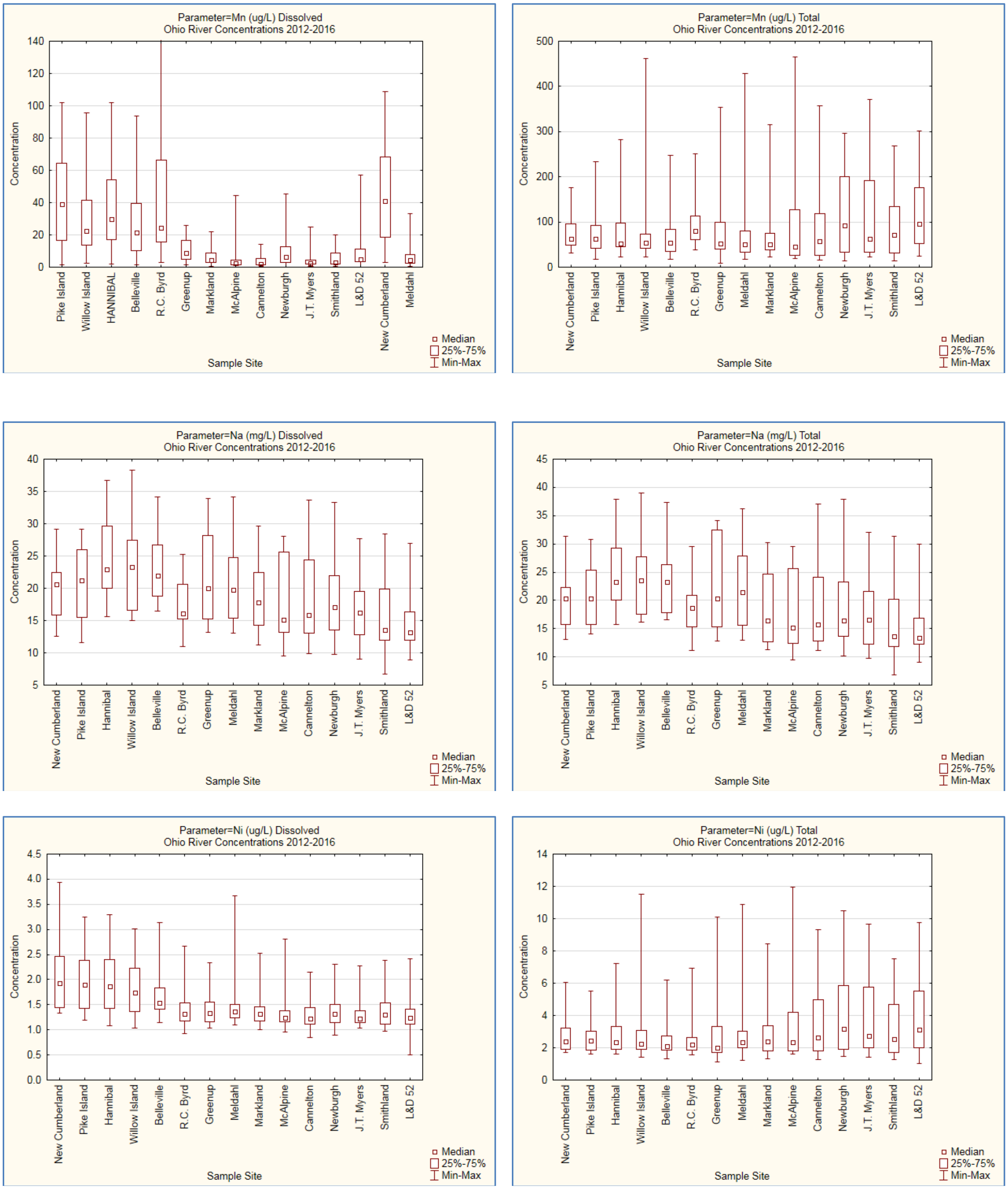

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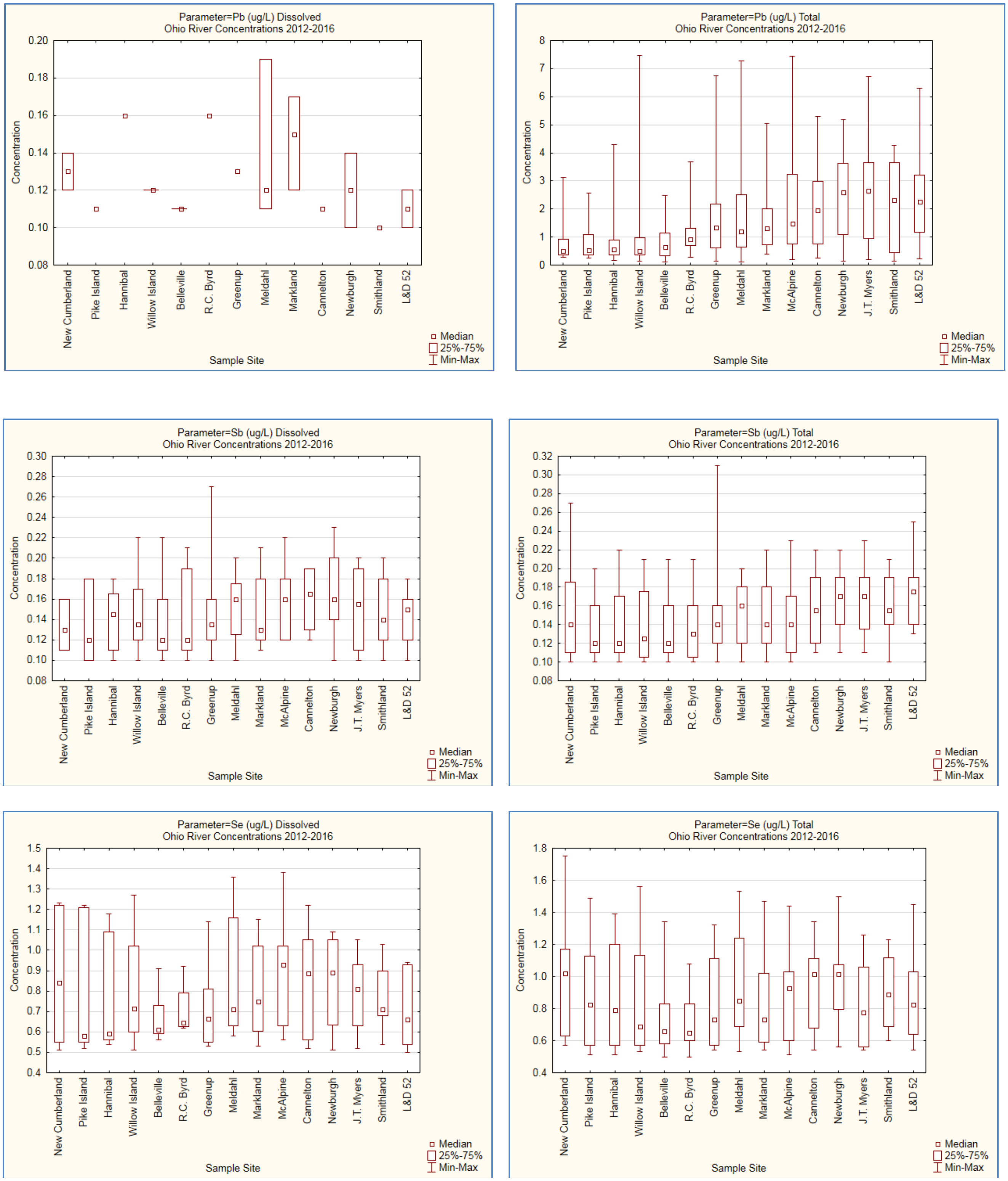

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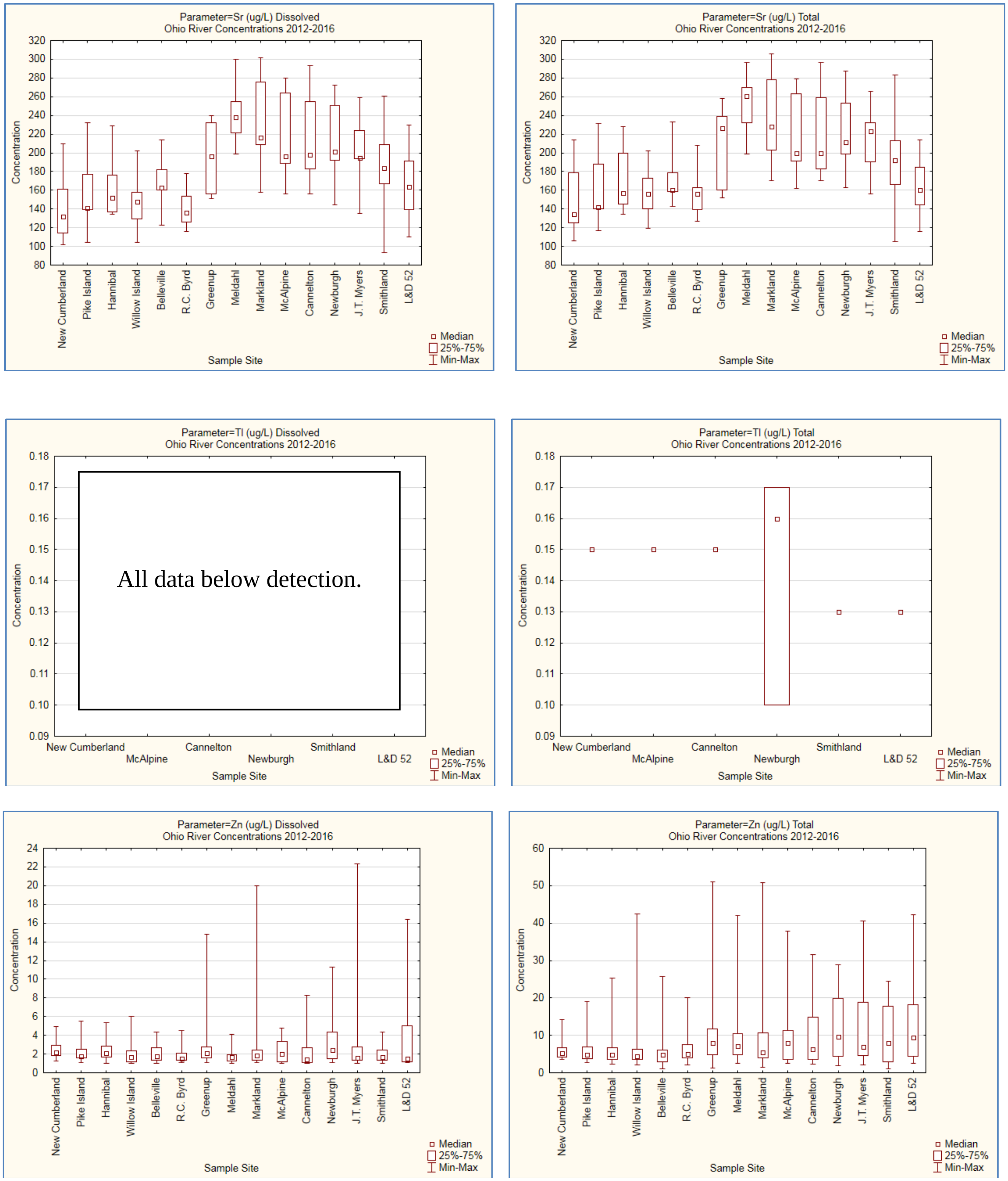


Figure 5. Bimonthly and Clean Metals Data, 2012-2016.

PART III: SURFACE WATER MONITORING AND ASSESSMENT

CHAPTER 1: MONITORING PROGRAMS DESIGNED TO ASSESS OHIO RIVER DESIGNATED USE ATTAINMENT

MONITORING PROGRAMS

The Ohio River Valley Water Sanitation Compact requires that the Ohio River be capable of maintaining fish and other aquatic life, suitable for recreational usage, and in safe and satisfactory condition for public and industrial water supply. The Commission operates a number of monitoring programs that can be used to assess water quality, including:

- Bimonthly Sampling (nutrients/ions)
- Clean Metals Sampling
- Temperature and Dissolved Oxygen Monitoring (operated by the US Army Corps and Hydropower Facilities)
- Fish Population Monitoring
- Contact Recreation Bacteria Monitoring
- Longitudinal and Tributary Bacteria Surveys
- Fish Tissue Sampling
- High Volume PCBs and Dioxin Sampling
- Algae and Nutrients

Some inherent difficulties exist when monitoring a river system as expansive as the Ohio. Challenges related to both spatial and temporal coverage of the river must be approached in order for the Commission to be most effective with its monitoring programs. To best assess the attainment status of the Ohio River's designated uses, ORSANCO combines multiple monitoring programs. Water quality criteria used to assess use support are contained in the 2013 Revision of *Pollution Control Standards for Discharges to the Ohio River* (Table 4).

BIMONTHLY AND CLEAN METALS SAMPLING

The Bimonthly and Clean Metals Sampling Programs are used to assess aquatic life and public water supply uses. These programs collect water column grab samples from 15 Ohio River stations once every other month (Table 2). Samples collected by ORSANCO staff and hired contractors are analyzed for certain chemical and physical parameters by a contract laboratory. In October of 2000, ORSANCO changed the aquatic life use criteria for metals to utilize dissolved metals rather than total recoverable metals. Dissolved metals are available to aquatic life because they are dissolved in the water column, making these data more accurate and representative for assessments. Dissolved metals criteria for the protection of aquatic life have very low concentrations, some in only single parts per billion. Therefore, collecting uncontaminated samples and performing low-level analyses using clean techniques is essential. However, although dissolved criteria are used, every sample is analyzed for both total recoverable and dissolved metals. The Commonwealth of Virginia state laboratory provides the clean metals sampling equipment and analyses. Clean Metal parameters as well as Bimonthly Sampling Program analytes are used in conjunction with biological data to determine the degree of support for aquatic life (Table 3). Applicable results from main stem stations were compared to established stream criteria. For this 2018 report, Bimonthly and Clean Metals data from Jan 2012 to Dec. 2016 were used to make use assessments. Data from these programs were also used to assess the public water supply use. With the exception of mercury which will be discussed in the fish consumption chapter, there were no other violations of ORSANCO's water quality criteria.

Table 2. Station Locations for Bimonthly and Clean Metals Sampling

Station	River Mile	Period of Record
New Cumberland	54.4	Jul-92 to Present
Pike Island	84.2	Jul-92 to Present
Hannibal	126.4	Sept-77 to Present
Willow Island	161.8	Nov-75 to Present
Belleville	203.9	Nov-75 to Present
R.C. Byrd	279.2	Nov-75 to Present
Greenup	341.0	Jul-92 to Present
Meldahl	436.2	Jul-92 to Present
Anderson Ferry	477.5	Jul-92 to 2011
Markland	531.5	Nov-75 to Present
Louisville	600.6	Nov-75 to 2011
McAlpine	606.8	Jul-92 to May-97, Jul 2011 to Present
West Point	625.9	Nov-75 to 2011
Cannelton	720.7	Nov-75 to Present
Newburgh	776.0	Jul-92 to Present
J.T. Myers	846.0	Nov-75 to Present
Smithland	918.5	Jan-83 to Present
Lock and Dam 52	938.9	Jul-93 to Present

Table 3. Clean Metals and Bimonthly sampling parameters.

Parameter	Analysis	Detection Limit (µg/L)
Aluminum	EPA 1638	1.0
Antimony	EPA 1638	0.5
Arsenic	EPA 1638	0.1
Barium	EPA 1638	10.0
Cadmium	EPA 1638	0.1
Calcium	EPA 200.7	500.0
Copper	EPA 1638	0.1
Chromium	EPA 1638	0.5
Iron	EPA 200.7	50.0
Lead	EPA 1638	0.1
Magnesium	EPA 200.7	500.0
Manganese	EPA 1638	0.1
Mercury	EPA 245.7	0.0015
Nickel	EPA 1638	0.1
Selenium	EPA 1638	0.5
Silver	EPA 1638	0.1
Thallium	EPA 1638	0.1
Zinc	EPA 1638	1.0

Parameter	Analysis	Detection Limit
Ammonia as Nitrogen	EPA 350.1	0.03 mg/L
Chloride	SM 4500 Cl E	2.0 mg/L
Hardness as CaCO3	SM 2340 B	3.0 mg/L
Nitrate-Nitrite as N, by FIA	EPA 353.2	0.05 mg/L
Phenolics	EPA 420.4	0.01 ug/L
Sulfate	ASTM D516-90	12.5 mg/L
Total Dissolved Solids	SM 2540 C	5.0 mg/L
Total Kjeldahl Nitrogen	EPA 351.2	0.1 mg/L
Total Organic Carbon	SM 5310 C	0.5 mg/L
Total Phosphorus	EPA 365.3	0.01 mg/L
Total Suspended Solids	SM 2540 D	1.0 mg/L
Total Cyanide	EPA 335.4	0.005 mg/L

DISSOLVED OXYGEN AND TEMPERATURE MONITORING

Dissolved oxygen and temperature data from 2010-2014 are presented in this report but are not used to assess support of the aquatic life use. In addition to metals and nutrients/ions, both dissolved oxygen and temperature levels play a role in whether or not the river has the ability to support aquatic life. However, because monitoring for these parameters takes place only for a portion of the year (summer), it is believed that these data will not provide an adequate picture of the degree to which the aquatic life use is supported. This position is further supported by the availability of biological data which is a more direct measure of aquatic life. Inasmuch as this is the position regarding utilization of dissolved oxygen and temperature data, the data is nevertheless useful in identifying areas of concern for further investigation. Dissolved oxygen and temperature in the Ohio River main stem is monitored by ORSANCO, United States Army Corps of Engineers and electric utility/hydropower agencies at 13 river stations. Measurements are taken in hourly, 30-minute or 15-minute increments by ORSANCO, US Army Corps of Engineers and Hydropower or other electric power utilities operating on the Ohio River as outlined in Table 4 below.

Table 4. Dissolved oxygen and temperature monitoring stations.

Station	River Mile	Operating Agency	Frequency	Date of Operation
MONTGOMERY	31.7	USACE	Hourly	2011-2014
NEW CUMBERLAND	54.4	ORSANCO	15 Min	Sept 2012-2013
PIKE ISLAND	84.2	ORSANCO	15 Min	Sept 2012-2013
HANNIBAL	126.4	Hydropower ORSANCO	Hourly 15 min	2010-2013 2012-2014
RACINE	237.5	Hydropower	Hourly	2010-2014
GREENUP	341	Hydropower	Hourly	2010-2014
MARKLAND	531.5	Hydropower	15 Min	2010-2014
McALPINE	606.8	Hydropower	Hourly	2011-2014
CANNELTON	720.7	USACE ORSANCO	Hourly 15 Min	2010 Sept 2012-2014
NEWBURGH	776.1	USACE ORSANCO	Hourly 15 Min	2010 Sept 2012-2014
J. T. MYERS	846	USACE ORSANCO	Hourly 30 Min	2010 2011-2014
SMITHLAND	919	USACE ORSANCO	Hourly 30 Min	2010 2011-2014
OLMSTEAD	964.6	USACE	Hourly	2014

BIOLOGICAL MONITORING

Fish and macroinvertebrate (macro) population pool surveys data were used to assess support of aquatic life use. ORSANCO biologists monitor fish populations annually from July through October and macro populations from September through early November. The monitoring strategy includes both fixed station and probability-based sampling using boat electrofishing and both passive artificial substrate samplers and active netting for macros along 500-meter shorelines. Because both biological populations differ depending on their environment, habitat types within the 500-m zones are also noted (Figure 6). Routine biological assessments are conducted at 15 randomly chosen sites in three pools each field season, providing complete coverage of the river every six years. Data from the 15 random sites are used to extrapolate information about the entire pool. If impairment is found, pools may be re-sampled the following year. In 2012, Emsworth, Pike Island, Meldahl, Cannelton, and Newburgh pools were sampled. Dashields, Hannibal, R.C. Byrd, and Smithland pools were surveyed in 2013. In 2014, Belleville, Markland, McAlpine, and Olmsted were sampled. Montgomery, Racine, and John T. Myers were sampled in 2015. Pools sampled in 2016 included Willow Island, Greenup, and Cannelton. The only pool not sampled during this 5-year cycle was New Cumberland. Therefore the data from the most recent New Cumberland survey in 2011 will be presented.

At the conclusion of each field season, ORSANCO uses two indices of biological integrity (IBI) to assess the condition of the Ohio River. The modified Ohio River Fish Index (*m*ORFIn) and Ohio River Macroinvertebrate Index (ORMIn) were established in 2003 and 2012, respectively. Both indices include various measures (metrics) of the fish and macro communities including: diversity, abundance, feeding and reproductive guilds, pollution tolerance, habits, and health. Biologic condition ratings are assigned to Ohio River pools corresponding IBI scores and are then assessed as either supporting or failing to support the aquatic life use designation based on criteria.

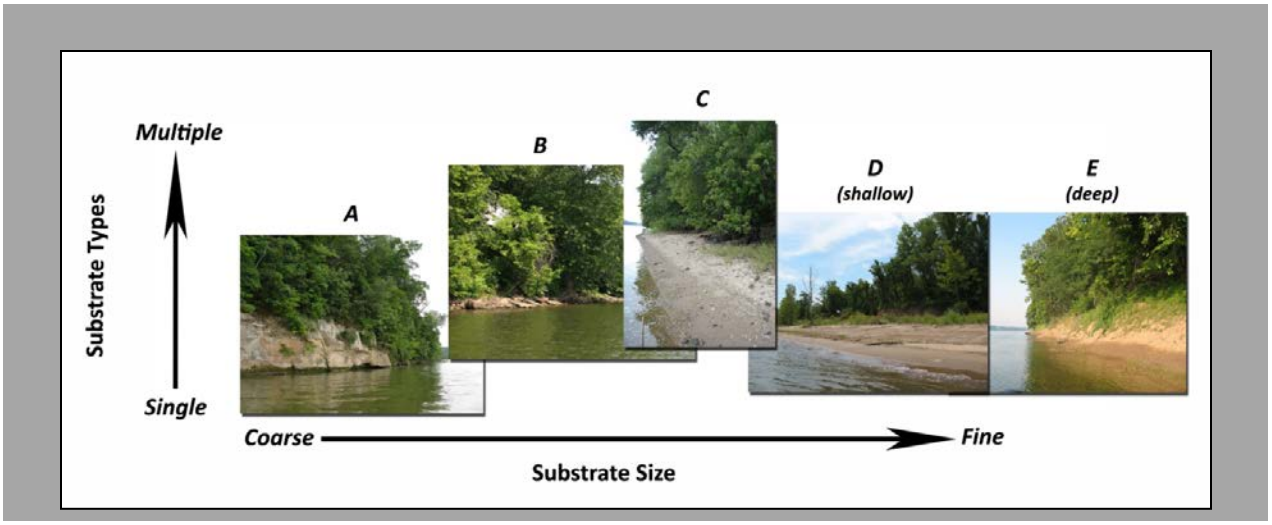


Figure 6. Fish and macroinvertebrate population scores are based on habitat class, ranging from substrates that are highly coarse to fine.

CONTACT RECREATION BACTERIA SAMPLING

The Commission collects bacteria samples from April through October in six large urban communities with combined sewer systems to evaluate support of the contact recreation use. Locations include Pittsburgh, Wheeling, Huntington, Cincinnati, Louisville, and Evansville. Five rounds of sampling are completed monthly for each urban community sampling location and analyzed for fecal coliform and *E. coli*. There were at least two sites in each community sampled; one being upstream of the CSO community and one downstream of the system. In addition to routine bacteria sampling, the Commission conducted longitudinal surveys for bacteria from May to October in 2003-2007. For this work the Ohio was broken down into three segments: an upper, middle, and lower segment. For each segment five rounds of samples were collected, one round each week for five consecutive weeks. Sampling sites begin in Pittsburgh (Ohio River Mile 0) and end in Cairo (Ohio River Mile 981) with one river cross-section sample collected approximately every five miles. Each site was sampled fifteen times from 2003-2006, allowing for the calculation of three geometric means per site. In 2007 and 2008 one round of sampling was completed each year for the entire river in a consecutive order beginning at mile 0 and ending at mile 981. Samples were analyzed for *E.coli* by the ORSANCO staff using Colilert, a Most Probable Number method. A minimum of ten percent duplicate samples were sent to a contract laboratory for analyses by the membrane filtration method for *E. coli* and fecal coliform. Through intensive longitudinal monitoring, the Commission has been able to monitor the entire river for bacteria and the contact recreation use.

FISH TISSUE SAMPLING

The Commission harvests fish from July to October for tissue analysis to determine pollutant levels in commonly consumed Ohio River fish. Tissue contaminants analyzed include PCBs, chlordane, mercury, cadmium, lead, and certain pesticides. Within the past several years, mercury contamination has come to the forefront of the fish consumption arena. In 2009, ORSANCO expanded the fish tissue program to include methyl mercury analyses, primarily focusing on large, hybrid striped bass that would be most likely to contain higher concentrations than most other species. Results indicated that these fish were exceeding methyl mercury concentrations in forty percent of samples. In 2010, the mercury program began to routinely collect methyl mercury and was expanded to include not only large hybrid striped bass, but channel catfish, freshwater drum, and other species. Pollutant contamination in fish tissue based on samples composed of generally three fillets from a single species. States also use tissue data collected by the Commission to develop and issue appropriate fish consumption advisories.

ORSANCO collaborated with the six main stem states in an effort to develop a uniform fish consumption advisory protocol in order to better advise the public on safe consumption of Ohio River fish. Working with state and USEPA representatives, the Commission developed the Ohio River Fish Consumption Advisory Protocol (ORFCAP). Thresholds have been agreed upon by a panel that will allow for standardization in consumption advisories across Ohio River basin states. Within the ORFCAP, the river is divided into four reporting units and identifies two primary contaminants of concern, PCBs and mercury. Fish consumption advisories are specifically designed to protect sensitive populations using five advisory groupings for PCBs and four for mercury. ORSANCO also developed a website to serve as an electronic reference source for residents of the Ohio River basin. The site provides an explanation of fish consumption advisories, outlines various Ohio River contaminants, explains how to follow the advisory, and offers an interactive map with an option to click on a particular river area to view consumption advice. Please visit the consumption advisory website at the following address: www.orsanco.org/fca.

ALGAE AND NUTRIENTS

Nutrients (nitrogen and phosphorus) have been identified as the third most common impairment to waters of the United States (US EPA 2010). Excess nutrients can have impacts within the receiving stream and also in downstream waters as nutrients are exported from the system. An abundance of nitrogen and phosphorus in the Ohio has the potential to affect all designated uses of the river. One side effect of these nutrients is their contribution to low dissolved oxygen levels that can have a negative impact on the biological community. Not only are there negative ecological impacts, but associated problems for drinking water utilities may occur as a result of this influx to river systems. An abundance of nutrients can cause algae-related taste and odor problems for water utilities and have the potential to produce toxins that may lead to illness in people who come in contact with the water.

Many streams in the Mississippi River watershed are listed as impaired by excess nutrients in the system and do not reach their aquatic life use designation (Turner and Rabalais 2003). All of these streams lead to the Mississippi River and finally the Gulf of Mexico off the coasts of Louisiana and Texas. As a result of excess nutrients entering the northern Gulf of Mexico, a hypoxia zone now exists ranging from 8,000 to about 22,000 km^2 since 1985 (Hill, et al. 2011). These nutrients can cause algal blooms, leading to large fluctuations in dissolved oxygen, falling below 2 mg O_2 per liter in the summer (Turner and Rabalais 2003) (Dodds 2006). The low dissolved oxygen levels lead to the creation of a "dead zone" which has adverse affects for aquatic life and their habitat. In 2008, the Gulf Hypoxia Action Plan identified the Ohio River as the largest contributor of both nitrogen and phosphorus to the Gulf of Mexico. A major tributary of the Ohio, the Wabash River, was identified in a 2005 ORSANCO study to be a significant source of nutrients to the Ohio, Mississippi, and Gulf of Mexico and has been continually studied since 2010.

In August and September 2010 and again in 2012, algal blooms were reported in both the upper and lower Ohio River. Drinking water utilities reported taste and odor issues and filter clogging, which adds to the cost of treating water. Algae problems have been reported throughout the Ohio River Basin, including the state of Ohio, where three lakes were closed to recreation due to toxic algae. In order to limit problems associated with algal blooms on a national scale, US EPA has asked states to develop numeric nutrient criteria for lakes, rivers, and streams. To support this effort, samples were collected twice per month at seven water utilities covering the upper, middle, and lower reaches of the river, and tested for both algae (identified to lowest taxa possible) and nutrients (nitrogen and phosphorous).

The Commission operated a special monitoring program for nutrients which has been discontinued. Samples were collected twice monthly at seven Ohio River water utilities from March through November for Total Kjeldahl Nitrogen, Ammonia-Nitrogen, Nitrate/Nitrite Nitrogen, Total Phosphorus, and Chlorophyll. Summary results for the period March, 2010 through June, 2013 are presented in Figure 7. Individual results are included in Appendix C. The Commission has a water quality criterion of 10 mg/L for Nitrate/Nitrite Nitrogen which was never exceeded. The Commission also has an ammonia criterion of 1.0 mg/L which was equaled on one occasion. Table 5 presents ORSANCO's water quality criteria for the Ohio River.

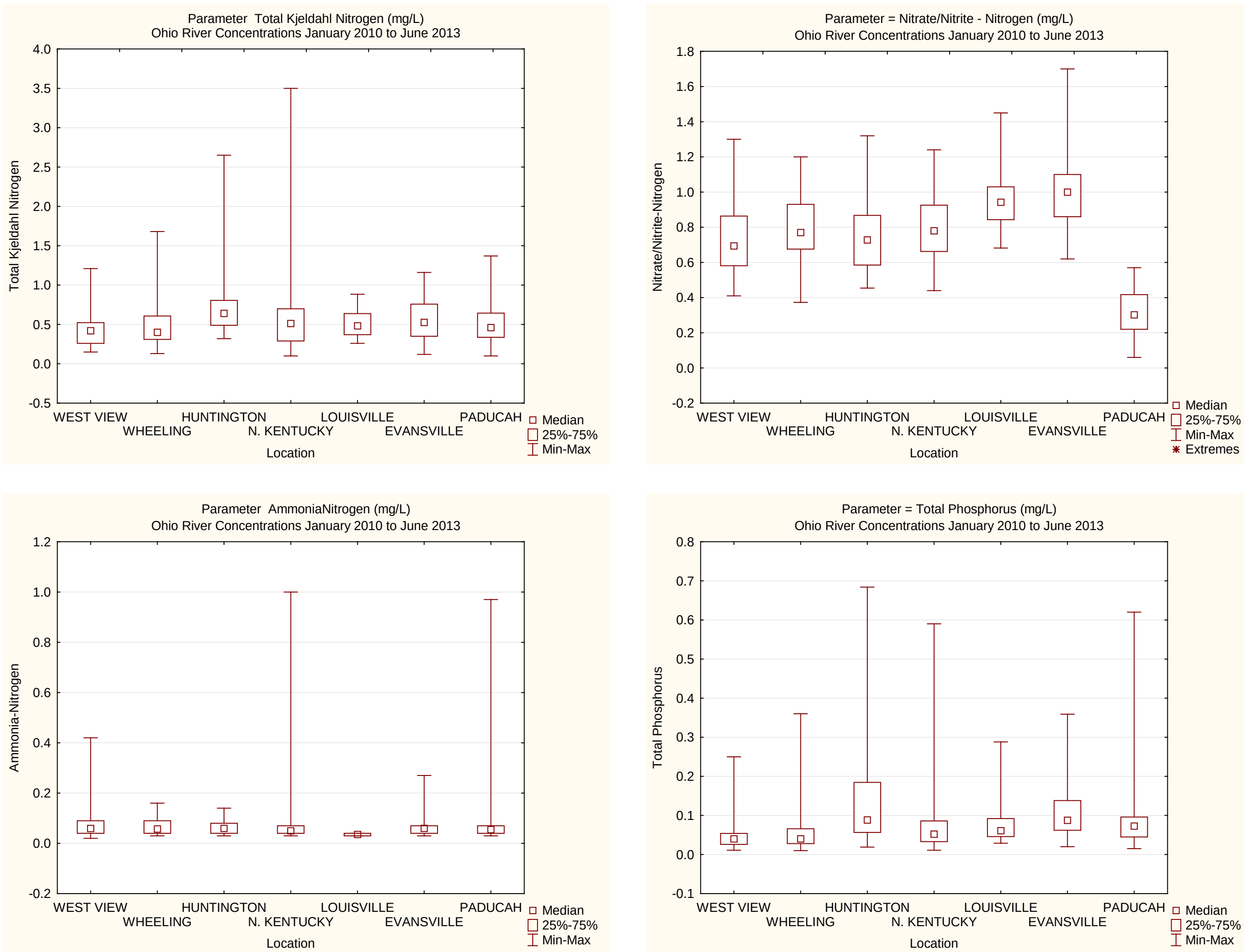


Figure 7. Summary of Nutrients Data, 2010 through June 2013.

Table 5. ORSANCO water quality criteria for the Ohio River.

Pollutant	Human Health		Aquatic Life		All Other Uses (e.g. Taste & Odor)
	Carcinogenic (ug/L)	Non-Carcinogenic (ug/L)	Acute (ug/L)	Chronic (ug/L)	
Acenaphthene		670[A,B]			
Acrolein		190			
Acrylonitrile	0.051A,[C]				
Aldrin	0.000049A,C				
alpha-BHC	0.0026A,C				
alpha-Endosulfan		62A			
Ammonia		1.0 mg/L[D]	7.3 mg/L[E]	1.0 mg/LE	
Anthracene		8300A			
Antimony		5.6A			
Arsenic		0.010 mg/L	340[F]	150F	
Asbestos		7 million fibers/L[G]			
Barium		1.0 mg/L			
Benzene	2.2A,C				
Benzidine	0.000086A,C				
Benzo(a) Anthracene	0.0038A,C				
Benzo(a) Pyrene	0.0038A,C				
Benzo(b) Fluoranthene	0.0038A,C				
Benzo(k) Fluoranthene	0.0038A,C				
beta-BHC	0.0091A,C				
beta-Endosulfan		62A			
Bis(2-Chloroethyl) Ether	0.03A,C				
Bis(2-Chloroisopropyl) Ether		1400A			
Bis(2-Ethylhexyl)Phthalate	1.2A,C				
Bromoform	4.3A,C				
Butylbenzyl Phthalate		1500A			
Cadmium			2.01[H]	0.25H	
Carbon Tetrachloride	0.23A,C				
Chlordane	0.0008A,C				
Chloride					250 mg/L
Chlorobenzene		130B,[I]			
Chlorodibromomethane	0.4A,C				
Chloroform	5.7C,[J]				
Chromium III			570H	74.1H	
Chromium VI			15.712F	10.582F	

Pollutant	Human Health		Aquatic Life		All Other Uses (e.g. Taste & Odor)
	Carcinogenic (ug/L)	Non-Carcinogenic (ug/L)	Acute (ug/L)	Chronic (ug/L)	
Chrysene		0.0038A,C			
Copper		1300B	13.4H	8.96H	
Cyanide		140[K]			
Cyanide (free)			22[L]	5.2L	
Dibenzo(a,h) Anthracene	0.0038A,C				
Dichlorobromomethane	0.55A,C				
Dieldrin	0.000052A,C				
Diethyl Phthalate		17000A			
Dimethyl Phthalate		270000			
Di-n-Butyl Phthalate		2000A			
Dissolved Oxygen			> 4.0 mg/L[M]	> 5.0 mg/LM	
E. Coli		<130 CFU/100mL (GM)[N], <240 CFU/100mL (max)			
Endosulfan Sulfate		62A			
Endrin		0.059			
Endrin Aldehyde		0.29A			
Ethylbenzene		530			
Fecal Coliform		<200 CFU/100mLN, <2,000 CFU/100mL			
Flouride		1.0 mg/L			
Fluoranthene		130A			
Fluorene		1100A			
gamma-BHC (Lindane)		0.98			
Heptachlor	0.000079A,C				
Heptachlor Epoxide	0.000039A,C				
Hexachlorobenzene	0.00028A,C				
Hexachlorobutadiene	0.44A,C				
Hexachlorocyclopentadiene		40B			
Hexachloroethane	1.4A,C				
Ideno(1,2,3-cd) Pyrene	0.0038A,C				
Isophorone	35A,C				
Lead			64.6H	2.52H	
Mercury		0.000012 mg/L	1.45F	0.774F	

Pollutant	Human Health		Aquatic Life		All Other Uses (e.g. Taste & Odor)
	Carcinogenic (ug/L)	Non-Carcinogenic (ug/L)	Acute (ug/L)	Chronic (ug/L)	
Methyl Bromide		47A			
Methylene Chloride	4.6A,C				
Methylmercury		0.3 mg/kg[O]			
Nickel		610A	469H	52H	
Nitrite Nitrate Nitrogen		10 mg/L			
Nitrite Nitrogen		1 mg/L			
Nitrobenzene		17A			
N-Nitrosodimethylamine	0.00069A,C				
N-Nitrosodi-n-Propylamine	0.005A,C				
N-Nitrosodiphenylamine	3.3A,C				
Pentachlorophenol	0.27A,C				
pH				>6.0 and <9.0	
Phenol	21000A,B				
Phenolics					0.005 mg/L
Polychlorinated Biphenyls	0.000064A,C,[P]				
Pyrene		830A			
combined radium-226 and radium 228	4 pCi/L				
gross total alpha	15 pCi/L				
total gross beta	50 pCi/L				
total gross strontium-90	8 pCI/L				
Selenium	170I			5L	
Silver	0.05 mg/L		3.22H		
Sulfate					250 mg/L
Temperature		110 Deg F			
Tetrachloroethylene	0.69C				
Thallium		0.24			
Toluene		1300I			
Total dissolved solids					500 mg/LD
Toxaphene	0.00028A,C				
Trichloroethylene	2.5C				
Vinyl Chloride	0.025C,[Q]				
Zinc		7400B	117H	118H	
1,1,2,2-Tetrachloroethane	0.17A,C				
1,1,2-Trichloroethane	0.59A,C				
1,1-Dichloroethylene		330			
1,2,4-Trichlorobenzene		35			
1,2-Dichlorobenzene		420			

Pollutant	Human Health		Aquatic Life		All Other Uses (e.g. Taste & Odor)
	Carcinogenic (ug/L)	Non-Carcinogenic (ug/L)	Acute (ug/L)	Chronic (ug/L)	
1,2-Dichloroethane	0.38[A,C]				
1,2-Dichloropropane	0.5[A,C]				
1,2-Diphenylhydrazine	0.036[A,C]				
1,2-Trans-Dichloroethylene		140[I]			
1,3-Dichlorobenzene		320			
1,3-Dichloropropene	0.34[C]				
1,4-Dichlorobenzene		63			
2,3,7,8-TCDD (Dioxin)	0.000000005[C]				
2,4,6-Trichlorophenol	1.4[A,C]				
2,4-Dichlorophenol		77[A,B]			
2,4-Dimethylphenol		380[A]			
2,4-Dinitrophenol		69[A]			
2,4-Dinitrotoluene	0.11[C]				
2-Chloronaphthalene		1000[A]			
2-Chlorophenol		81[A,B]			
2-Methyl-4,6-Dinitrophenol		13			
3,3-Dichlorobenzidine	0.021[A,C]				
4,4'-DDD	0.00031[A,C]				
4,4'-DDE	0.00022[A,C]				
4,4'-DDT	0.00022[A,C]				

[A] This criterion has been revised to reflect The U.S. EPA's q1* or RfD, as contained in the Integrated Risk Information System (IRIS) as of May 17, 2002. The fish tissue bioconcentration factor (BCF) from the 1980 Ambient Water Quality Criteria document was retained in each case.

[B] The organoleptic effect criterion is more stringent than the value for priority toxic pollutants.

[C] This criterion is based on carcinogenicity of 10^{-6} risk. Alternate risk levels may be obtained by moving the decimal point (e.g., for a risk level of 10^{-5}, move the decimal point in the recommended criterion one place to the right).

[D] Criteria applies at intakes

[E] Criteria dependant on pH or pH and temp, see formulas in section 3.2.E. and Appendix A1, A2, A3 of Pollution Control Standards, 4-day average rule (shown at pH 7.0 + most restrictive temperature)

[F] Presented in the dissolved form

[G] This criterion for asbestos is the Maximum Contaminant Level (MCL) developed under the Safe Drinking Water Act (SDWA).

[H] Presented in the dissolved form and shown at Hardness 100, specific formulas in 3.2.F.

[I] U.S. EPA has issued a more stringent MCL. Refer to drinking water regulations (40 CFR 141) or Safe Drinking Water Hotline (1-800-426-4791) for values.

[J] Although a new RfD is available in IRIS, the surface water criteria will not be revised until the National Primary Drinking Water Regulations: Stage 2 Disinfectants and Disinfection Byproducts Rule (Stage 2 DBPR) is completed, since public comment on the relative source contribution (RSC) for chloroform is anticipated.

[K] This recommended water quality criterion is expressed as total cyanide, even though the IRIS RFD we used to derive the criterion is based on free cyanide. The multiple forms of cyanide that are present in ambient water have significant differences in toxicity due to their differing abilities to liberate the CN-moiety. Some complex cyanides require even more extreme conditions than refluxing with sulfuric acid to liberate the CN-moiety. Thus, these complex cyanides are expected to have little or no 'bioavailability' to humans. If a substantial fraction of the cyanide present in a water body is present in a complexed form (e.g., Fe4[Fe(CN)6]3), this criterion may be over conservative.

[L] Criteria shown to be applied in total recoverable form

[M] Dissolved oxygen minimum 5.0 mg/L April 15 – June 15

[N] Criteria based on 5-sample per month geometric mean

[O] This fish tissue residue criterion for methylmercury is based on a total fish consumption rate of 0.0175 kg/day.

[P] This criterion applies to total PCBs, (e.g., the sum of all congener or all isomer or homolog or Aroclor analyses).

[Q] This recommended water quality criterion was derived using the cancer slope factor of 1.4 (LMS exposure from birth).

CHAPTER 2: AQUATIC LIFE USE SUPPORT ASSESSMENT

The Ohio River Valley Water Sanitation Compact calls for the Ohio River to be in a satisfactory sanitary condition capable of maintaining fish and other aquatic life. The Commission assesses the degree of use support every two years, as the states are required by section 305(b) of the Federal Clean Water Act. Data from a number of monitoring programs are used in making use attainment assessments, including Bimonthly and Clean Metals sampling data, and fish population and macroinvertebrate data used in the assessment.

AQUATIC LIFE USE ASSESSMENT METHODOLOGY

Bimonthly, Clean Metals, Dissolved Oxygen, and Temperature Monitoring

Both clean metals and nonmetal parameters are analyzed through ORSANCO's monitoring program. Data are collected from 15 fixed stations along the river (Appendix B). Grab samples are collected from these stations once every other month. Continuous monitoring for dissolved oxygen and temperature is performed by the United States Army Corps of Engineers as well as hydropower plant operators at ten Ohio River locations. The dissolved oxygen and temperature data are presented in this section but not utilized in the assessment as it has in the past. This is because the ORSANCO 305b Workgroup determined that it was inappropriate to base an assessment on these data that are only collected during summer conditions when worst-case conditions are most likely to be present.

For a given monitoring station, if no pollutant exceeds any water quality criteria for the protection of aquatic life in greater than ten percent of samples, then that station is considered "Fully Supporting" the aquatic life use and not impaired. Stations having any pollutant exceed a water quality criterion for the protection of aquatic life in greater than ten percent of samples but less than twenty-five percent of samples is determined to be "Partially Supporting" the aquatic life use and impaired. Stations having any pollutant exceed a criterion in greater than twenty-five percent of samples is classified as "Not Supporting" and impaired. However, using a WOE approach, fish population data indicating full support would outweigh physical and chemical monitoring data in these assessments such that assessments will be based primarily on the conclusions of the biological data assessments.

Biological Population Monitoring

While monitoring chemical parameters is a common and valuable strategy used to determine impairment, it is also useful to expand the focus beyond water chemistry and directly examine effects of pollution on aquatic life. To further understand the status of the river and the degree to which it is meeting its aquatic life use, ORSANCO conducts biological assessments of the Ohio River. The Commission uses boat electrofishing and both passive artificial substrate samplers and active netting for macroinvertebrates order to characterize the biological populations of the Ohio River and consequently determine if the Ohio River is meeting its aquatic life use designation.

Since 2004, aquatic life has been assessed on a pool-by-pool basis. For aquatic life assessments, the river has been divided into 19 independent Assessment Units (AUs), based on the pools created by 19 high-lift dams as well as the area below the lowest existing high-lift dam (Smithland) to the high-lift dam currently under construction (Olmsted). Three to five of these AUs are sampled each year on a rotating basis, providing complete coverage of the river every five to six years. Fifteen site locations in each pool were randomly selected to represent each AU as a whole. Following each fish community assessment, biologists attempt to determine the fish community potential of that AU.

As mentioned previously, ORSANCO evaluates biological condition using two indices specifically designed for the Ohio River, the *modified* Ohio River Fish Index (*m*ORFIn) and Ohio River Macroinvertbrates Index (ORMIn). The indices combine various attributes of each community to separately assign a score to the river based on biological characteristics. Both indices include various metrics, which serve as surrogate measures of more complicated processes (Table 6).

Table 6. List and descriptions of the 13 metrics included in the *modified* Ohio River Fish Index (*m*ORFIn) and the 8 metrics included in the Ohio River Macroinvertebrate Index (ORMIn)

13 metrics used to generate *m*ORFIn scores	
Fish Metric	***Definition***
Native Species	Number (No.) of species native to the Ohio River
Intolerant Species	No. of species intolerant to pollution and habitat degradation
Sucker Species	No. of sucker species (e.g. redhorse and buffalo)
Centrarchid Species	No. of black bass, sunfish, and crappie species
Great River Species	No. of species primarily found in large rivers
% Piscivores	% of individuals (ind) that consume other fish
% Invertivores	% of ind that consume invertebrates
% Detritivores	% of ind that consume detritus (dead plant material)
% Tolerants	% of ind tolerant to pollution and habitat degradation
% Lithophils	% of ind belonging to breeding groups that require clean substrates for spawning
% Non-natives	% of ind not native to the Ohio River, including both exotics and hybrids
No. *DELT* anomalies	No. of ind with *D*eformities, *E*rosions, *L*esions, and *T*umors present
Catch per unit	Total abundance of individuals (minus exotics, hybrids, and tolerants)
8 metrics used to generate ORMIn scores	
Macro Metric	**Definition**
No. Taxa	Number (No.) of unique taxa
EPT Taxa	No. of taxa that belong to are either the Ephemeroptera, Plecoptera, or Trichoptera
Predator Taxa	No. of taxa that are predators
% Collector-	% of taxa that feed on fine particulate organic matter
% Caenids	% of individuals (ind) that belong to the pollution tolerant Ephemeropterans
% Odonates	% of ind that belong to the Odonata order
% Intolerants	% of ind intolerant to pollution and habitat degradation
% Clingers	% of ind that cling to instream habitat

After a *m*ORFIn score is calculated at each site in a survey pool, those individual scores are averaged to determine one score for the pool. Biologic condition ratings are then assigned to a pool based on the average *m*ORFIn score. Biological condition ratings for each pool are then assigned based on final *m*ORFIn scores. To determine the overall condition of a pool, the 15 individual *m*ORFIn scores were averaged and then compared to an established biocriterion (*m*ORFIn = 20.0). If a pool has an average score greater than or equal to 20.0, the pool attains its aquatic life-use designation. Conversely, if the average is below 20.0, the pool is assessed as failing (Figure 8).

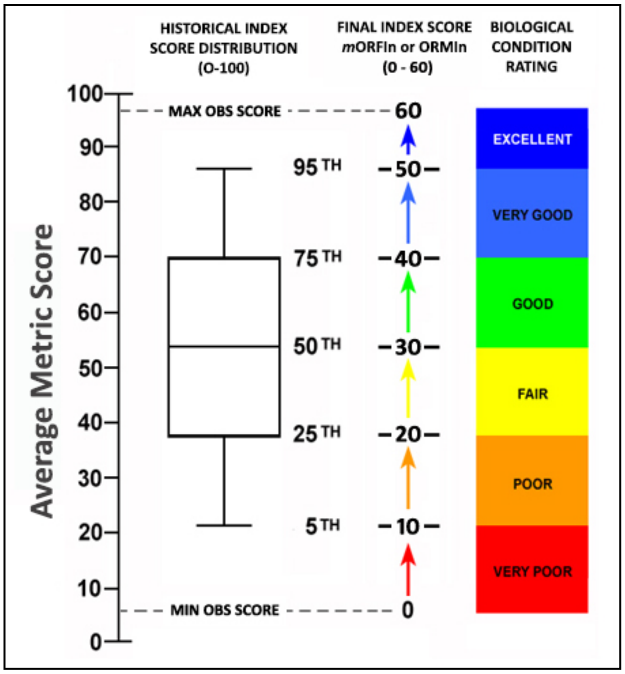


Figure 8. Conversion of raw biological metric score to *m*ORFIn and ORMIn score and rating based on varying habitat class expectation.

Aquatic life use assessment was determined using the two types of monitoring programs described above. Attainment was assessed as either "fully supporting" indicating no impairment, "partially supporting" meaning the segment is impaired due to violations of chemical water quality criteria for the protection of aquatic life or biological data, or "not supporting" meaning biological and water quality data indicate impairment. A full description of each designation follows:

Fully Supporting

- If both the mORFIn and ORMIn scores are greater than or equal to 20.0 (i.e. a biological rating of 'Fair', 'Good', 'Very Good', or 'Excellent').

Impaired-Partially Supporting

- If only one of the indices scores greater than or equal to 20.0, while the other index score falls within 10.0 - 19.9 (i.e. a 'Poor' rating).

Impaired-Not Supporting

- Any pool in which both indices score below a 20.0 (i.e. a biological condition rating of poor).

OR

- If either index receives a score below 10.0 (i.e. a 'Very Poor' rating).

BIMONTHLY AND CLEAN METALS MONITORING RESULTS

ORSANCO monitors a number of pollutants having water quality criteria for the protection of aquatic life through its Bimonthly and Clean Metals Sampling Programs. These data can be found in Appendix B. While there were no violations of ORSANCO's water quality criteria for the protection of aquatic life, however there were violations of the states' total iron criteria in excess of ten percent of total samples (Table 7).

Table 7. Summary of States' Total Iron Criteria Violations, 2012-2016.

Site Name	River Mile	Criteria (µg/L)	Total Samples	WQC Violations	% Violations
Sewickly*	11.8	PA (1500 ug/L)	35	1	3%
East Liverpool*	42.6	PA (1500 ug/L)	35	3	9%
New Cumberland	54.2	WV (1500 ug/L)	30	0	0%
Pike Island	84.2	WV (1500 ug/L)	30	2	7%
Hannibal	126.4	WV (1500 ug/L)	29	2	7%
Willow Island	161.8	WV (1500 ug/L)	30	2	7%
Belleville	203.9	WV (1500 ug/L)	29	3	10%
R.C. Byrd	279.2	WV (1500 ug/L)	30	3	10%
Greenup	341.0	KY (3500 ug/L)	30	2	7%
Meldahl	436.2	KY (3500 ug/L)	30	3	10%
Markland	531.5	KY (3500 ug/L)	30	1	3%
McAlpine	606.8	KY (3500 ug/L)	30	5	17%
Cannelton	720.7	KY (3500 ug/L)	30	4	13%
Newburgh	776.0	KY (3500 ug/L)	29	7	24%
J.T. Myers	846.0	KY (3500 ug/L)	30	4	13%
Smithland	918.5	KY (3500 ug/L)	30	6	20%
L&D 52	938.9	KY (3500 ug/L)	30	6	20%
* PADEP data					

DISSOLVED OXYGEN AND TEMPERATURE MONITORING RESULTS

The ORSANCO 305b Workgroup determined that dissolved oxygen and temperature monitoring results should not be utilized in making impairment decisions since monitoring only occurs during certain periods of the year, generally when worst case conditions would be expected to occur. Therefore, the data does not represent reflect accurately the all conditions over the assessment period. Nevertheless, the data is reported here and can be used to identify areas of concern needing further investigation. Dissolved oxygen and temperature data are collected by ORSANCO, Corps of Engineers and hydropower operators at certain locks and dams. ORSANCO collects the data and assesses it against its water quality criteria. This criterion is to protect aquatic life and shall maintain a minimum concentration of 5.0mg/L during the spawning period. Outside the spawning period the average concentration of 5.0mg/L should be achieved for each calendar day. Table 8 below shows the percent of days that were monitored which exceeded the applicable dissolved oxygen criterion. Individual results can be found in Appendix D. Most stations experienced a fairly low percentage of days when dissolved oxygen was below 5 mg/L and no station had violations in excess of ten percent over the entire reporting period.

Table 8. Ohio River dissolved oxygen criteria violations.

Ohio River Station	Mile Point	2012 % Days Exceeding	2013 % Days Exceeding	2014 % Days Exceeding	2015 % Days Exceeding	2016 % Days Exceeding	2012-2016 % Days Exceeding
Montgomery	31.7	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Hannibal	126.4	0.0%	0.0%	0.0%	NA	NA	0.0%
Willow Island	161.7						
Upstream		NA	NA	NA	NA	0.0%	0.0%
Downstream		NA	NA	NA	NA	0.0%	0.0%
Racine	237.5	2.6%	2.6%	0.0%	0.0%	9.7%	3.1%
Ironton	325	NA	NA	NA	NA	0.0%	0.0%
Greenup	341						
Upstream		4.8%	0.0%	14.0%	13.6%	0.0%	8.7%
Downstream		2.0%	0.0%	2.0%	9.7%	4.4%	4.0%
Meldahl	436.2						
Upstream		NA	NA	NA	NA	0.0%	0.0%
Downstream		NA	NA	NA	NA	0.0%	0.0%
Markland	531.5						
US Hydro		2.7%	0.0%	4.0%	21.9%	11.1%	9.0%
DS Hydro		10.0%	0.8%	5.6%	12.8%	5.9%	6.9%
DS Lock		0.9%	0.0%	0.0%	5.9%	NA	1.7%
US Lock		1.7%	0.8%	0.0%	1.8%	NA	0.8%
McAlpine	606.8	3.7%	0.0%	4.6%	2.4%	19.8%	6.8%
Cannelton	720.7						
Upstream		NA	NA	NA	NA	0.0%	0.0%
Downstream		NA	NA	NA	NA	3.0%	3.0%
John T. Myers	846	0.0%	0.0%	0.0%	NA	NA	0.0%
Smithland	919						
Upstream		18.0%	0.0%	3.7%	NA	0.0%	3.9%
Downstream		NA	NA	NA	NA	7.0%	7.0%
Olmstead	964.6	NA	NA	0.0%	8.4%	2.5%	4.0%

ORSANCO's allowable maximum temperature criteria are specified for six separate periods in a year as identified by Julian days shown in Table 9. Individual results can be found in Appendix E. While a number of stations had water quality violations, no stations had violations in excess of ten percent for the entire reporting period. The lower river tends to have greater numbers of violations of the temperature criteria for the protection of aquatic life. Cooler summers as occurred in 2013 and 2014 generated very few days where temperature criteria were exceeded.

Table 9. Ohio River temperature criteria violations.

		Montgomery	Pike Island	Hannibal	Willow Island US	Willow Island DS	Racine	Ironton
		31.7	84.2	126.4	161.7	161.8	237.5	325.0
	Julian day							
2012	1-49							
	50-166	10.0%		10.0%			0.0%	
	167-181	0.0%		0.0%			0.0%	
	182-243	0.0%		0.0%			0.0%	
	244-258	0.0%		0.0%			0.0%	
	259-366	0.0%	0.0%	0.0%			0.0%	
	2012 Total	**1.0%**	**0.0%**	**0.5%**			**0.0%**	
2013	1-49		0.0%	0.0%				
	50-166	0.0%	0.0%	0.0%			0.0%	
	167-181	0.0%	0.0%	0.0%			0.0%	
	182-243	0.0%	0.0%	0.0%			0.0%	
	244-258	0.0%	0.0%	0.0%			0.0%	
	259-366	0.0%	0.0%				0.0%	
	2013 Total	**0.0%**	**0.0%**	**0.0%**			**0.0%**	
2014	1-49							
	50-166	0.0%		0.0%			0.0%	
	167-181	0.0%		0.0%			0.0%	
	182-243	0.0%		0.0%			0.0%	
	244-258	0.0%		0.0%			0.0%	
	259-366	0.0%		0.0%			0.0%	
	2014 Total	**0.0%**		**0.0%**			**0.0%**	
2015	1-49							
	50-166	0.0%					0.0%	
	167-181	0.0%					0.0%	
	182-243	0.0%					0.0%	
	244-258	0.0%					0.0%	
	259-366	0.0%					0.0%	
	2015 Total	**0.0%**					**0.0%**	
2016	1-49							
	50-166	0.0%			0.0%	0.0%	0.0%	0.0%
	167-181	0.0%			0.0%	0.0%	0.0%	0.0%
	182-243	0.0%			0.0%	0.0%	0.0%	0.0%
	244-258	0.0%			0.0%	0.0%	0.0%	0.0%
	259-366	0.0%			0.0%	0.0%	0.0%	0.0%
	2016 Total	**0.0%**			**0.0%**	**0.0%**	**0.0%**	**0.0%**
2012-2016 Total		**0.2%**	**0.0%**	**0.5%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**

Table 9. Ohio River temperature criteria violations.

Year	Julian day	Greenup US 341.0	Greenup DS 341.1	Meldahl US 436.2	Meldahl DS 436.3	Markland US-Lock 531.5	Markland DS-Lock 531.6	Markland US-Hydro 531.5	Markland DS-Hydro 531.6
2012	1-49								
	50-166	0.0%	4.1%			0.0%	0.0%	0.0%	0.0%
	167-181	0.0%	0.0%			0.0%	0.0%	0.0%	0.0%
	182-243	0.0%	0.0%			0.0%	0.0%	0.0%	0.0%
	244-258	0.0%	0.0%			0.0%	0.0%	0.0%	0.0%
	259-366	0.0%	0.0%			0.0%	0.0%	0.0%	0.0%
	2012 Total	**0.0%**	**1.0%**			**0.0%**	**0.0%**	**0.0%**	**0.0%**
2013	1-49								
	50-166	0.0%	0.0%			0.0%	0.0%	0.0%	0.0%
	167-181					0.0%	0.0%	0.0%	0.0%
	182-243					0.0%	0.0%	0.0%	0.0%
	244-258					0.0%	0.0%	0.0%	0.0%
	259-366					0.0%	0.0%	0.0%	3.0%
	2013 Total	**0.0%**	**0.0%**			**0.0%**	**0.0%**	**0.0%**	**0.8%**
2014	1-49								
	50-166	0.0%	0.0%			0.0%	0.0%	0.0%	0.0%
	167-181	0.0%	0.0%			0.0%	0.0%	0.0%	0.0%
	182-243	0.0%	0.0%			0.0%	0.0%	0.0%	0.0%
	244-258	0.0%	0.0%			0.0%	0.0%	0.0%	0.0%
	259-366	0.0%	0.0%			0.0%	0.0%	0.0%	0.0%
	2014 Total	**0.0%**	**0.0%**			**0.0%**	**0.0%**	**0.0%**	**0.0%**
2015	1-49								
	50-166	0.0%	0.0%			0.0%	0.0%	0.0%	0.0%
	167-181	0.0%	0.0%			0.0%	0.0%	0.0%	0.0%
	182-243	0.0%	0.0%			0.0%	0.0%	0.0%	0.0%
	244-258	0.0%	0.0%			0.0%	0.0%	0.0%	0.0%
	259-366	0.0%	0.0%			0.0%	0.0%	0.0%	0.0%
	2015 Total	**0.0%**	**0.0%**			**0.0%**	**0.0%**	**0.0%**	**0.0%**
2016	1-49								
	50-166	0.0%	0.0%	0.0%	0.0%			0.0%	0.0%
	167-181	0.0%	0.0%	0.0%	0.0%			0.0%	0.0%
	182-243	0.0%	0.0%	0.0%	0.0%			0.0%	0.0%
	244-258	0.0%	0.0%	0.0%	0.0%			0.0%	0.0%
	259-366	58.0%	0.0%	0.0%	0.0%			0.0%	0.0%
	2016 Total	**13.0%**	**0.0%**	**0.0%**	**0.0%**			**0.0%**	**0.0%**
2012-2016 Total		**4.0%**	**0.3%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**

Table 9. Ohio River temperature criteria violations.

Year	Julian day	McAlpine 606.8	Cannelton US 720.6	Cannelton DS 720.7	JT Myers 846.0	Smithland US 919.0	Smithland DS 919.1	Olmstead 964.6
2012	1-49							
	50-166	0.0%						
	167-181	0.0%			0.0%	50.0%		
	182-243	0.0%			22.4%	3.2%		
	244-258	0.0%			0.0%	0.0%		
	259-366	0.0%	0.0%		0.0%	0.0%		
	2012 Total	**0.0%**	**0.0%**		**16.4%**	**2.5%**		
2013	1-49		0.0%					
	50-166	0.0%	0.0%					
	167-181	0.0%	0.0%		0.0%	0.0%		
	182-243	0.0%	0.0%		0.0%	0.0%		
	244-258	0.0%	0.0%			0.0%		
	259-366	0.0%	0.0%		0.0%	0.0%		
	2013 Total	**0.0%**	**0.0%**		**0.0%**	**0.0%**		
2014	1-49							
	50-166	0.0%						0.0%
	167-181	0.0%			0.0%	0.0%		0.0%
	182-243	0.0%			0.0%	0.0%		0.0%
	244-258	0.0%			0.0%	0.0%		0.0%
	259-366	0.0%			0.0%	0.0%		0.0%
	2014 Total	**0.0%**			**0.0%**	**0.0%**		**0.0%**
2015	1-49							
	50-166	0.0%						10.0%
	167-181	0.0%						0.0%
	182-243	0.0%						0.0%
	244-258	0.0%						0.0%
	259-366	0.0%						0.0%
	2015 Total	**0.0%**						**2.5%**
2016	1-49							
	50-166	0.0%	0.0%	0.0%		3.0%	7.0%	0.0%
	167-181	0.0%	0.0%	0.0%		0.0%	0.0%	0.0%
	182-243	0.0%	0.0%	0.0%		0.0%	0.0%	0.0%
	244-258	0.0%	0.0%	0.0%		0.0%	0.0%	0.0%
	259-366	0.0%	0.0%	0.0%		0.0%	0.0%	3.0%
	2016 Total	**0.0%**	**0.0%**	**0.0%**		**1.0%**	**2.0%**	**0.9%**
2012-2016 Total		**0.0%**	**0.0%**	**0.0%**	**5.7%**	**1.0%**	**2.0%**	**1.7%**

Represents no data available

FISH POPULATION MONITORING RESULTS

From 2012-2016, 18 of the 19 Ohio River pools were sampled (New Cumberland was not sampled due to budgetary constraints, the 2011 survey data are presented) for fish and macroinvertebrates (macro). Based on both index scores, all pools were assessed as fully supporting the aquatic life use (Figure 9). The biological condition rating of each surveyed pool was above the established statistical threshold, thus indicating there is no impairment based on Ohio River fish population data. All fish and macro population survey data may be viewed in Appendix F. Macro data from 2010 was excluded from the assessment process as it was used during the calibration of the index. Therefore 2010 ALU assessment was completed using only *m*ORFIn scores.

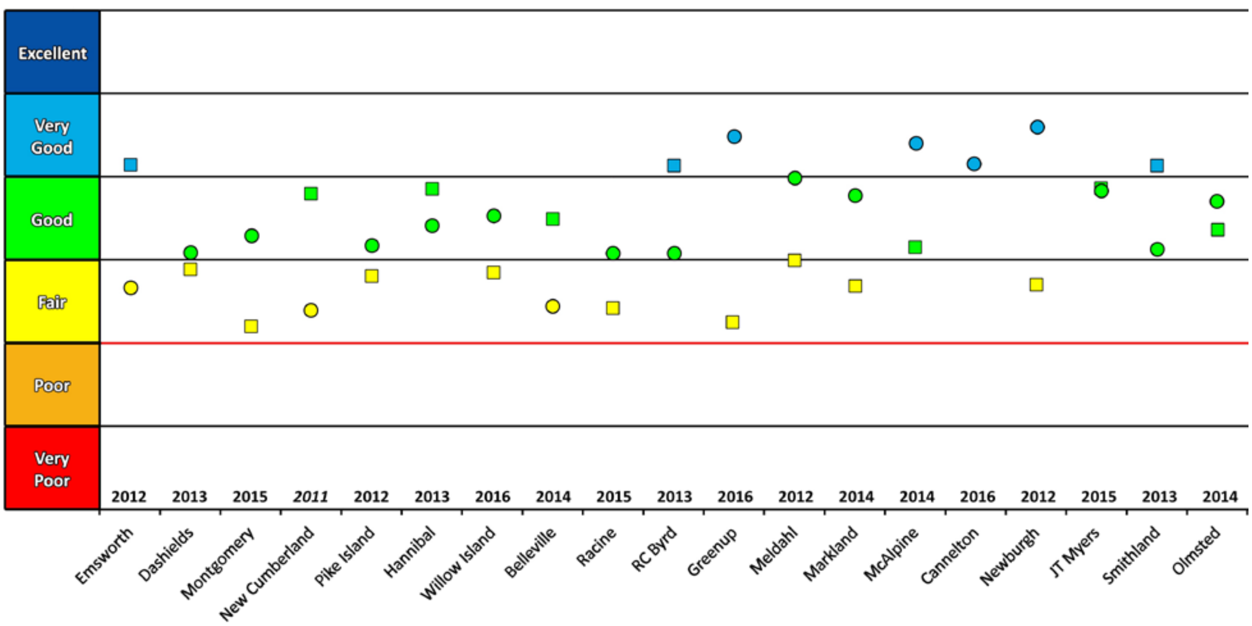


Figure 9. Ohio River fish (○) and macroinvertebrate (□) population index scores by pool, 2012-2016.

AQUATIC LIFE USE ASSESSMENT SUMMARY

Aquatic life criteria determined by the states for total iron (ORSANCO has no iron criteria) are exceeded in greater than ten percent of samples in several segments of the river. Violations of aquatic life criteria were also observed for both dissolved oxygen and temperature in the lower river. Although physical and chemical criteria violations exist, the Commission utilized the Weight Of Evidence (WOE) approach, and based on an assessment of fish and community surveys from 2012-2016 and macroinvertebrates community surveys from 2012-2016, assessed the entirety of the Ohio as fully supporting the aquatic life use.

CHAPTER 3: PUBLIC WATER SUPPLY USE SUPPORT ASSESSMENT

The Ohio River Valley Water Sanitation Commission Compact requires that the Ohio River be available for safe and satisfactory use as public and industrial water supplies after reasonable treatment. The Ohio River serves as a drinking water source for over five million people through 32 public and private drinking water treatment facilities. In order to ensure that the public water supply use is protected, the Commission operates a number of monitoring programs including Bimonthly, Clean Metals, and bacteriological sampling, as well as an Organics Detection System (ODS) for spills detection.

PUBLIC WATER SUPPLY USE ASSESSMENT METHODOLOGY

The bimonthly and clean metals programs are comprised of 15 sampling stations along the Ohio River. Grab samples are collected from sites once every other month. Parameters monitored by ORSANCO for which there are in-stream water quality criteria for public water supply protection include arsenic, barium, silver, copper, nickel, selenium, thallium, zinc, cyanide, chloride, fluoride, nitrates, nitrites, phenolics, and sulfates. Data included in this report were collected from Jan. 2012 to Dec. 2016. Bacteriological data are compared against the fecal coliform criterion for drinking water—2,000 colonies/100 ml as a monthly geometric mean (Table 10). From 2012 through 2016, bacteria data were collected during the contact recreation season (April through October) in Pittsburgh, Wheeling, Huntington, Cincinnati, Louisville, and Evansville. In addition, the Commission mailed surveys to all Ohio River water utilities, requesting information about their source water quality. ORSANCO received responses from 8 utilities. Questionnaires asked utilities if there were intake closures due to spills, whether violations of finished drinking water maximum contaminant levels (MCLs) occurred due to source water quality, or whether "non-routine" or extraordinary treatment due to source water quality was necessary to meet finished water MCLs. In addition to the questionnaires, MCL violations were identified from EPA's data base, the Safe Drinking Water Information System (SDWIS). Assessment of these data is as follows:

Fully Supporting

- Pollutant criteria are exceeded in 10 percent or less of the samples collected, and
- There are no finished water MCL violations caused by Ohio River water quality.

Partially Supporting-Impaired

- One or more pollutants exceed the criteria in 11 to 25 percent of the samples collected, and there was a corresponding finished water MCL violation caused by Ohio River water quality.
  OR
- Frequent intake closures due to elevated levels of pollutants are necessary to protect water supplies and comply with provisions of the Safe Drinking Water Act (meet MCLs).
  OR
- Frequent "non-routine" additional treatment was necessary to protect water supplies and comply with provisions of the Safe Drinking Water Act (meet MCLs).

Not Supporting-Impaired

- One or more pollutants exceed the criteria in greater than 25 percent of samples collected, and there was a corresponding finished water MCL violation caused by Ohio River water quality,

PUBLIC WATER SUPPLY USE ASSESSMENT SUMMARY

There were exceedances of the in-stream water quality criteria for the protection of public water supply over the 2012 to 2016 period for Nitrate-Nitrite and Fecal Coliform (Table 10). ORSANCO's criterion for fecal coliform of 2000 colonies/100 mL as a monthly geometric mean for the protection of public water supplies was exceeded in Pittsburgh in greater than seven percent of the months, however there were no corresponding MCL violations at Pittsburgh area water utilities. There were also two Fecal coliform exceedances at Wheeling, also with no corresponding MCL violations at Wheeling-area water utilities. As a result, none of these occurrences represent impairment of the public water supply use.

Thirty-four public and private water utilities use the Ohio River as a drinking water source (Table 11). Based on questionnaire surveys completed by water utilities and the US EPA's drinking water data base, six utilities had MCL violations for total trihalomethanes (TTHMs) and one utility had violations of the MCL for Haloacetic acid (HAA5). Because these occurrences are related to treatment issues, they do not represent impairment of the public water supply use for the Ohio River. These occurrences are related to issues with disinfection treatment.

Based on the above assessments, the entire river is designated as fully supporting the public water supply use.

Table 10. Ohio River Water Quality Criterion Violations for Public Water Supply

Station	River Mile	Date	Parameter	Human Health WQC	Result (mg/L)	Total Samples	WQC Violations	% Violations
Pittsburgh	4.3	Aug-12	Fecal Coliform	2000 CFU/100mL	2,198	28	2	7%
Pittsburgh	4.3	Jun-15	Fecal Coliform	2000 CFU/100mL	2,008			
Wheeling	92.8	Jul-13	Fecal Coliform	2000 CFU/100mL	2,261	33	2	6%
Wheeling	92.8	Jun-15	Fecal Coliform	2000 CFU/100mL	2,208			

Table 11. Summary of Drinking Water Utilities.

				Email Survey Results			EPA Database	
Utility Location	Mile Point	State	Replied to Survey	Did your plant have any MCL violations caused in whole or part by Ohio River water quality conditions?	Did you Close your intake as a result of Ohio River water quality conditions in order to avoid MCL violations?	Was "nonroutine" treatment necessary to comply with SDWA MCLs as a result of Ohio River water quality conditions?	MCL Violation (EPA Website)[1]	Contaminants Causing MCL Violation (EPA Website results)[# of times]
West View	5	PA	No				No	
Robinson	8.6	PA	Yes	No	No	No	No	
Moon	11.7	PA	No				No	
Beaver Valley (NOVA)	29	PA	No				No	
Center Township Water Authority	27.4	PA	No				No	
Midland	36	PA	No				Yes	TTHM (5)
East Liverpool	40.2	OH	Yes	No	No	No	No	
Buckeye	74.1	OH	No				No	
Toronto	59.2	OH	Yes	No	No	No	No	
Arcelor Mittal	61.7	WV	No				No	
Weirton	62.5	WV	No				Yes	TTHM (1)
Steubenville	65.3	OH	No				No	
Follansbee (H.H.)	70.8	WV	Yes	No	No	No	No	
Wheeling	86.8	WV	Yes	No	No	No	No	
Village of Bellaire	93.9	OH	Yes	No	No	No	No	
New Martinsville (Bayer)(Covestro)	121.9	WV	No				No	
Sistersville	137.2	WV	No				No	
Parkersburg	182.5	WV	No					
Huntington	304	WV	No				Yes	TTHM (1)
Ashland	319.7	KY	No				Yes	TTHM (8), HAA5 (3)
Ironton	327	OH	No				No	
Russell	327.6	KY	No				Yes	TTHM (1)
Portsmouth	350.8	OH	No				No	
Maysville	407.8	KY	No				No	
Cincinnati	462.8	OH	No				No	
Northern Kentucky Water	462.9	KY	No				No	
Louisville	600	KY	No				No	
Evansville	791.5	IN	Yes	No	No	No	No	
Henderson	803	KY	No				No	
Mt Vernon	829.3	IN	No				No	
Morganfield	842.5	KY	No				No	
Sturgis	871.4	KY	Yes	No	No	No	No	
Paducah (WTP)	935.5	KY	No				Yes	TTHM (2)
Cairo	978	IL	No				No	

1. Source: Safe Drinking Water Information System (SDWIS) http://www.epa.gov/enviro/facts/sdwis/search.html, 10-20-2017

CHAPTER 4: CONTACT RECREATION USE SUPPORT ASSESSMENT

The Compact requires that the Ohio River remain in a satisfactory sanitary condition suitable for recreational usage. The Commission operates two bacteria monitoring programs to assess the degree of contact recreational use support during the contact recreation season (May-October 2012 and April-October 2013-2016): routine contact recreation bacteria sampling and longitudinal bacteria surveys conducted through the Watershed Pollutant Reduction Program. Contact recreation season data from 2012 through 2016 and longitudinal bacteria survey data from 2003 through 2008 were used in the assessment. Longitudinal survey data outside the 2012-2016 timeframe was used in order to be able to make a comprehensive assessment of the entire river.

CONTACT RECREATION USE ASSESSMENT METHODOLOGY

There are 48 communities with combined sewer systems located along the Ohio. Combined sewer overflows (CSOs) and other non-point sources have been identified as significant causes of bacteria problems in the Ohio River, particularly during heavy rain events. Bacteria data is collected from six urban communities along the Ohio River with combined sewer systems to assess the degree of contact recreation use support in these areas. All data can be found in Appendix G. Five rounds of sampling are completed monthly in these communities: Cincinnati, OH, Evansville, IN, Huntington, WV, Pittsburgh, PA, Wheeling, WV and Louisville, KY. There were at least two sites in each community sampled; one site downstream of the community as well as a site within the major metropolitan area where combined sewer overflow (CSO) events are likely to occur during the 2012-2016 season. Samples were analyzed for both fecal coliform and *E. coli* at the Wheeling and Huntington sites. Samples were analyzed for E. coli at the Pittsburgh, Cincinnati, Louisville, and Evansville sites.

In 2003, ORSANCO expanded its bacteria monitoring program to include areas outside of the CSO communities. During the contact recreation season in 2003 - 2008, the entire length of the Ohio River was sampled at least fifteen times at five-mile intervals (Appendix G). Every five miles, three-point cross-sectional samples were collected and analyzed for *E. coli*. The river was divided into three sections (upper, middle, and lower) and each section was sampled weekly during a five-week period, allowing for the calculation of a monthly geometric mean. This was repeated for each section in a subsequent year, allowing for the calculation of three geometric means for each section of the river.

Impairments are based on exceedances of ORSANCO's stream criteria for bacteria. In 2012 ORSANCO revised its Pollution Control Standards for Human Health Protection for bacteria. Fecal Coliform is no longer an indicator and used only for protection of public water supply. The standard for *E. coli* state that measurements should not exceed 130/100mL as a 90-day geometric mean (at least five samples required per month). ORSANCO used the more stringent criteria when assessing the Ohio River for Contact Recreation which was a monthly geometric mean used by the States. Using these monthly geometric mean values, sites were classified as "Full Support" (not more than 10 percent of samples exceeded criteria), "Partial Support" (11-25 percent of samples exceeded criteria), or "Not Supporting" (greater than 25 percent of sites exceeded criteria). Assessment of these data is as follows:

Fully Supporting

- Criteria are exceeded in not more than 10 percent of the time.

Partially Supporting - Impaired

- Criteria are exceeded 11-25 percent of the time.

Not Supporting-Impaired

- Criteria are exceeded greater than 25 percent of the time.

CONTACT RECREATION USE ASSESSMENT SUMMARY

On a state by state basis, a total of 344.5 river miles (35%) were assessed as "Fully Supporting", 404.9 river miles (41%) as "Partially Supporting, and 231.6 river miles (24%) as "Not Supporting" the contact recreation use (Table 12). Peaks in *E. coli* levels often correspond with the location of major metropolitan areas such as Pittsburgh (Ohio River mile 1.4), Cincinnati (ORM 470), and Evansville (ORM 793.7). Violations of the monthly E. coli geometric criterion for the period 2012 through 2016 are shown (Figure 10). Between 2003 and 2006, the entire river was analyzed 15 times through longitudinal bacteria surveys, allowing for the calculation of three monthly geometric means at each site (Figure 11).

Table 12. Contact recreation use assessment summary.

Mile Point	States	% of Longitudinal Samples > SSM (03-08)	Assessment of Longitudinal Data	No. Mos. > GM '12-'16	% Mos. > GM '12-'16	Assessment of Contact Rec Data	Overall Assessment	River Mile of Assessment	Assessment Type
1.4	PA			18	64%	Not Supporting	Not Supporting	0	Reassessed
1.5	PA	41.2	Not Supporting				Not Supporting		Historical
3.3	PA	58.8	Not Supporting				Not Supporting		Historical
4.3	PA			21	75%	Not Supporting	Not Supporting		Reassessed
6.4	PA	33.3	Not Supporting				Not Supporting		Historical
9.5	PA	53.3	Not Supporting				Not Supporting		Historical
11.4	PA	53.3	Not Supporting				Not Supporting		Historical
12.5	PA	47.1	Not Supporting				Not Supporting		Historical
14.4	PA	46.7	Not Supporting				Not Supporting		Historical
17.7	PA	46.7	Not Supporting				Not Supporting		Historical
20.5	PA	46.7	Not Supporting				Not Supporting		Historical
20.8	PA	40.0	Not Supporting				Not Supporting		Historical
21.8	PA	40.0	Not Supporting				Not Supporting		Historical
22.9	PA	70.6	Not Supporting				Not Supporting		Historical

Mile Point	States	% of Longitudinal Samples > SSM (03-08)	Assessment of Longitudinal Data	No. Mos. > GM '12-'16	% Mos. > GM '12-'16	Assessment of Contact Rec Data	Overall Assessment	River Mile of Assessment	Assessment Type
25.5	PA	35.3	Not Supporting				Not Supporting		Historical
25.8	PA	52.9	Not Supporting				Not Supporting		Historical
26.4	PA	47.1	Not Supporting				Not Supporting		Historical
28.3	PA	52.9	Not Supporting				Not Supporting		Historical
32.9	PA	41.2	Not Supporting				Not Supporting		Historical
37.6	PA	41.2	Not Supporting				Not Supporting		Historical
40.2	PA							0-40.2	Historical
41.2	OH-WV	41.2	Not Supporting				Not Supporting		Historical
44.8	OH-WV	43.8	Not Supporting				Not Supporting		Historical
48.7	OH-WV	41.2	Not Supporting				Not Supporting		Historical
52.5	OH-WV	35.3	Not Supporting				Not Supporting		Historical
56.4	OH-WV	33.3	Not Supporting				Not Supporting		Historical
60.3	OH-WV	53.3	Not Supporting				Not Supporting		Historical
66.4	OH-WV	47.1	Not Supporting				Not Supporting		Historical
66.9	OH-WV	50.0	Not Supporting				Not Supporting		Historical
68.2	OH-WV	28.6	Not Supporting				Not Supporting		Historical
70.7	OH-WV	40.0	Not Supporting				Not Supporting		Historical
71.8	OH-WV	46.7	Not Supporting				Not Supporting		Historical
74.9	OH-WV	29.4	Not Supporting				Not Supporting		Historical
80.2	OH-WV	29.4	Not Supporting				Not Supporting	40.2-82.2	Historical
84.2	OH-WV						Partial Support*		Historical
85.6	OH-WV	17.6	Partial Support				Partial Support		Historical
86.8	OH-WV			7	21%	Partial Support	Partial Support	82.2-89.0	Reassessed
91.2	OH-WV	47.1	Not Supporting				Not Supporting	89.0-91.3	Historical
91.4	OH-WV						Partial Support*	91.3-92.1	Historical
92.8	OH-WV			19	56%	Not Supporting	Not Supporting		Reassessed
94.2	OH-WV	35.3	Not Supporting				Not Supporting		Historical
97.8	OH-WV	23.5	Not Supporting				Not Supporting		Historical
102.6	OH-WV	29.4	Not Supporting				Not Supporting	92.1-105.2	Historical
107.7	OH-WV	11.8	Partial Support				Partial Support		Historical
113.0	OH-WV	11.8	Partial Support				Partial Support		Historical
118.3	OH-WV	11.8	Partial Support				Partial Support		Historical
123.7	OH-WV	11.8	Partial Support				Partial Support	105.2-124.3	Historical
124.9	OH-WV	6.7	Full Support				Full Support	124.3-127.0	Historical
129.1	OH-WV	17.6	Partial Support				Partial Support	127.0-131.3	Historical
133.4	OH-WV	6.7	Full Support				Full Support	131.3-136.1	Historical

Mile Point	States	% of Longitudinal Samples > SSM (03-08)	Assessment of Longitudinal Data	No. Mos. > GM '12-'16	% Mos. > GM '12-'16	Assessment of Contact Rec Data	Overall Assessment	River Mile of Assessment	Assessment Type
138.7	OH-WV	17.6	Partial Support				Partial Support	136.1-141.5	Historical
144.2	OH-WV	6.7	Full Support				Full Support	141.5-146.9	Historical
149.6	OH-WV	11.8	Partial Support				Partial Support		Historical
155.0	OH-WV	11.8	Partial Support				Partial Support	146.9-157.7	Historical
160.4	OH-WV	0.0	Full Support				Full Support	157.7-163.1	Historical
165.8	OH-WV	17.6	Partial Support				Partial Support		Historical
171.2	OH-WV	11.8	Partial Support				Partial Support		Historical
175.1	OH-WV	17.6	Partial Support				Partial Support	163.1-177.3	Historical
179.4	OH-WV	26.7	Not Supporting				Not Supporting	177.3-181.5	Historical
183.5	OH-WV	17.6	Partial Support				Partial Support	181.5-184.7	Historical
185.9	OH-WV	5.9	Full Support				Full Support	184.7-188.4	Historical
190.8	OH-WV	11.8	Partial Support				Partial Support	188.4-193.3	Historical
195.7	OH-WV	5.9	Full Support				Full Support		Historical
200.7	OH-WV	5.9	Full Support				Full Support	193.3-203.2	Historical
205.7	OH-WV	23.5	Partial Support				Partial Support		Historical
210.7	OH-WV	23.5	Partial Support				Partial Support		Historical
215.7	OH-WV	23.5	Partial Support				Partial Support		Historical
220.4	OH-WV	23.5	Partial Support				Partial Support		Historical
225.4	OH-WV	17.6	Partial Support				Partial Support		Historical
230.4	OH-WV	17.6	Partial Support				Partial Support		Historical
235.6	OH-WV	17.6	Partial Support				Partial Support		Historical
240.4	OH-WV	18.8	Partial Support				Partial Support		Historical
245.4	OH-WV	23.5	Partial Support				Partial Support	203.2-247.9	Historical
250.4	OH-WV	35.3	Not Supporting				Not Supporting		Historical
255.5	OH-WV	29.4	Not Supporting				Not Supporting	247.9-258.0	Historical
260.6	OH-WV	23.5	Partial Support				Partial Support		Historical
265.7	OH-WV	23.5	Partial Support				Partial Support	258.0-267.8	Historical
269.8	OH-WV	41.2	Not Supporting				Not Supporting	267.8-272.5	Historical
275.2	OH-WV	11.8	Partial Support				Partial Support		Historical
280.8	OH-WV	17.4	Partial Support				Partial Support		Historical
285.9	OH-WV	21.7	Partial Support				Partial Support		Historical
291.4	OH-WV	18.2	Partial Support				Partial Support		Historical
296.6	OH-WV	15.0	Partial Support				Partial Support		Historical
302.0	OH-WV	11.1	Partial Support				Partial Support	272.5-303.6	Historical
305.1	OH-WV			1	0%	Full Support	Full Support	303.6-306.4	Reassessed
307.7	OH-WV	29.4	Not Supporting				Not Supporting		Historical

Mile Point	States	% of Longitudinal Samples > SSM (03-08)	Assessment of Longitudinal Data	No. Mos. > GM '12-'16	% Mos. > GM '12-'16	Assessment of Contact Rec Data	Overall Assessment	River Mile of Assessment	Assessment Type
308.1	OH-WV						Not Supporting*		Historical
313.3	OH-WV	41.2	Not Supporting				Not Supporting	306.4-314.1	Historical
314.8	OH-WV			6	18%	Partial Support	Partial Support	314.1-316.0	Reassessed
317.1	OH-WV							316.0-317.1	Historical
317.2	KY-OH	29.4	Not Supporting				Not Supporting	317.1-319.4	Historical
321.5	KY-OH	23.5	Partial Support				Partial Support		Historical
327.4	KY-OH	13.3	Partial Support				Partial Support		Historical
327.7	KY-OH	20.0	Partial Support				Partial Support		Historical
328.0	KY-OH	23.5	Partial Support				Partial Support		Historical
332.5	KY-OH	11.8	Partial Support				Partial Support		Historical
338.1	KY-OH	17.6	Partial Support				Partial Support	319.4-340.8	Historical
343.5	KY-OH	5.9	Full Support				Full Support		Historical
349.2	KY-OH	5.9	Full Support				Full Support		Historical
352.0	KY-OH	5.9	Full Support				Full Support		Historical
353.8	KY-OH	5.9	Full Support				Full Support	340.8-356.6	Historical
359.3	KY-OH	23.5	Partial Support				Partial Support		Historical
364.6	KY-OH	17.6	Partial Support				Partial Support		Historical
369.8	KY-OH	11.8	Partial Support				Partial Support		Historical
375.0	KY-OH	11.8	Partial Support				Partial Support	356.6-377.7	Historical
380.4	KY-OH	5.9	Full Support				Full Support	377.7-382.9	Historical
385.4	KY-OH	11.8	Partial Support				Partial Support	382.9-388.0	Historical
390.6	KY-OH	5.9	Full Support				Full Support		Historical
395.0	KY-OH	6.7	Full Support				Full Support		Historical
400.4	KY-OH	5.9	Full Support				Full Support		Historical
405.8	KY-OH	5.9	Full Support				Full Support		Historical
411.4	KY-OH	0.0	Full Support				Full Support		Historical
416.4	KY-OH	0.0	Full Support				Full Support		Historical
421.6	KY-OH	0.0	Full Support				Full Support		Historical
426.4	KY-OH	0.0	Full Support				Full Support		Historical
431.4	KY-OH	0.0	Full Support				Full Support		Historical
436.8	KY-OH	0.0	Full Support				Full Support		Historical
441.5	KY-OH	0.0	Full Support				Full Support		Historical
446.5	KY-OH	0.0	Full Support				Full Support		Historical
451.6	KY-OH	0.0	Full Support				Full Support		Historical
455.3	KY-OH	6.7	Full Support				Full Support		Historical
460.0	KY-OH	6.3	Full Support				Full Support		Historical

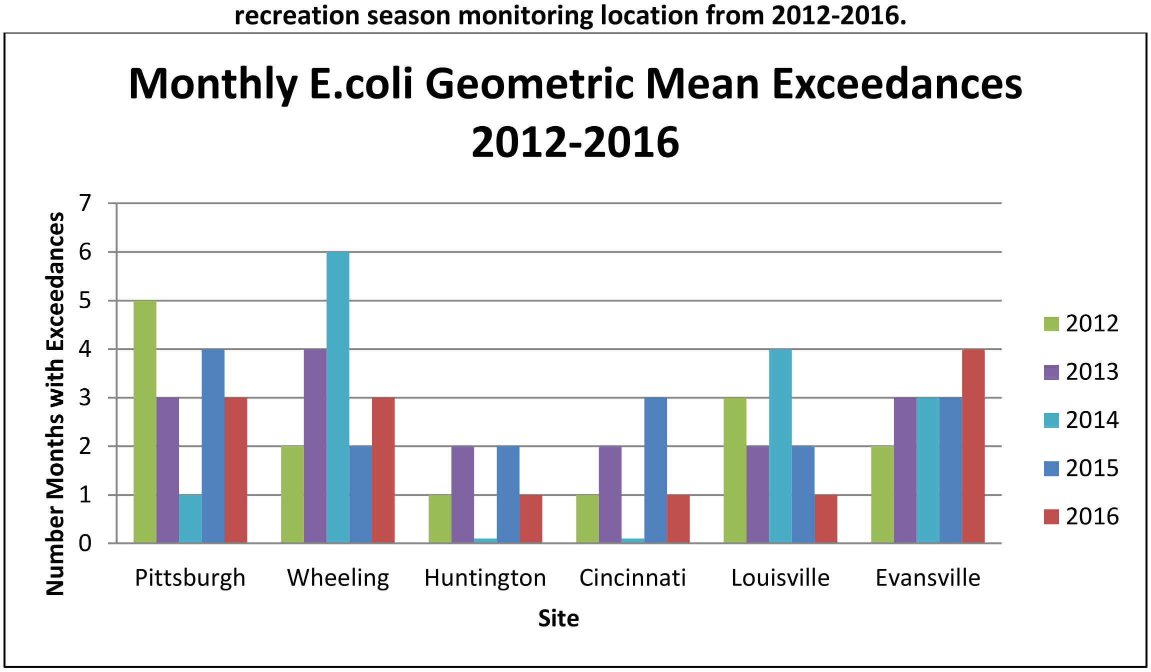
Mile Point	States	% of Longitudinal Samples > SSM (03-08)	Assessment of Longitudinal Data	No. Mos. > GM '12-'16	% Mos. > GM '12-'16	Assessment of Contact Rec Data	Overall Assessment	River Mile of Assessment	Assessment Type
462.6	KY-OH			2	6%	Full Support	Full Support		Reassessed
463.9	KY-OH						Full Support**	388.0-464.5	Historical
465.0		20.0	Partial Support				Partial Support	464.5-465.2	Historical
465.4	KY-OH	0.0	Full Support				Full Support		Historical
468.7	KY-OH	6.3	Full Support				Full Support	465.2-469.3	Historical
469.9	KY-OH						Not Supporting**	469.3-470.0	Historical
470.0	KY-OH			6	18%	Partial Support	Partial Support		Reassessed
472.7	KY-OH	18.8	Partial Support				Partial Support		Historical
477.5	KY-OH			7	21%	Partial Support	Partial Support		Reassessed
477.6	KY-OH	12.5	Partial Support				Partial Support		Historical
482.2	KY-OH	25.0	Partial Support				Partial Support		Historical
486.2	KY-OH	12.5	Partial Support				Partial Support	470.0-488.0	Historical
489.7	KY-OH	6.3	Full Support				Full Support		Historical
491.3	KY-OH							488.0-491.3	Historical
493.2	IN-KY	6.7	Full Support				Full Support		Historical
498.0	IN-KY	6.3	Full Support				Full Support		Historical
503.1	IN-KY	0.0	Full Support				Full Support		Historical
508.3	IN-KY	0.0	Full Support				Full Support		Historical
513.4	IN-KY	0.0	Full Support				Full Support		Historical
518.5	IN-KY	6.3	Full Support				Full Support		Historical
523.4	IN-KY	6.7	Full Support				Full Support		Historical
528.4	IN-KY	6.3	Full Support				Full Support		Historical
533.2	IN-KY	6.3	Full Support				Full Support		Historical
538.5	IN-KY	6.3	Full Support				Full Support		Historical
543.5	IN-KY	0.0	Full Support				Full Support		Historical
548.3	IN-KY	0.0	Full Support				Full Support		Historical
553.6	IN-KY	0.0	Full Support				Full Support		Historical
558.8	IN-KY	6.7	Full Support				Full Support		Historical
562.7	IN-KY	6.7	Full Support				Full Support		Historical
567.6	IN-KY	0.0	Full Support				Full Support		Historical
572.5	IN-KY	0.0	Full Support				Full Support		Historical
577.4	IN-KY	0.0	Full Support				Full Support		Historical
582.9	IN-KY	0.0	Full Support				Full Support		Historical
587.8	IN-KY	0.0	Full Support				Full Support		Historical
592.2	IN-KY	0.0	Full Support				Full Support	491.3-593.1	Historical
594.0	IN-KY			6	18%	Partial Support	Partial Support	593.1-595.5	Reassessed
597.1	IN-KY	0.0	Full Support				Full Support		Historical

Mile Point	States	% of Longitudinal Samples > SSM (03-08)	Assessment of Longitudinal Data	No. Mos. > GM '12-'16	% Mos. > GM '12-'16	Assessment of Contact Rec Data	Overall Assessment	River Mile of Assessment	Assessment Type
602.2	IN-KY	6.3	Full Support				Full Support	595.5-603.3	Historical
604.3	IN-KY	18.8	Partial Support				Partial Support		Historical
607.5	IN-KY	19.0	Partial Support				Partial Support	603.3-608.1	Historical
608.7	IN-KY						Full Support*	608.1-609.2	Historical
609.7	IN-KY	19.0	Partial Support				Partial Support		Historical
612.2	IN-KY	14.3	Partial Support				Partial Support	609.2-614.9	Historical
617.6	IN-KY	38.1	Not Supporting				Not Supporting		Historical
619.3	IN-KY			13	40%	Not Supporting	Not Supporting		Reassessed
623.1	IN-KY	38.1	Not Supporting				Not Supporting		Historical
628.1	IN-KY	38.1	Not Supporting				Not Supporting		Historical
630.0	IN-KY	60.0	Not Supporting				Not Supporting		Historical
631.6	IN-KY	55.0	Not Supporting				Not Supporting		Historical
637.6	IN-KY	57.1	Not Supporting				Not Supporting		Historical
643.1	IN-KY	47.6	Not Supporting				Not Supporting		Historical
648.9	IN-KY	40.0	Not Supporting				Not Supporting		Historical
654.0	IN-KY	41.2	Not Supporting				Not Supporting		Historical
659.2	IN-KY	29.4	Not Supporting				Not Supporting		Historical
664.2	IN-KY	35.3	Not Supporting				Not Supporting		Historical
669.1	IN-KY	47.1	Not Supporting				Not Supporting		Historical
674.5	IN-KY	47.1	Not Supporting				Not Supporting		Historical
680.4	IN-KY	35.3	Not Supporting				Not Supporting	614.9-683.0	Historical
685.6	IN-KY	20.0	Partial Support				Partial Support		Historical
690.7	IN-KY	23.5	Partial Support				Partial Support		Historical
695.6	IN-KY	17.6	Partial Support				Partial Support		Historical
700.9	IN-KY	23.5	Partial Support				Partial Support		Historical
706.2	IN-KY	23.5	Partial Support				Partial Support		Historical
711.5	IN-KY	17.6	Partial Support				Partial Support		Historical
717.4	IN-KY	13.3	Partial Support				Partial Support	683.0-719.5	Historical
721.5	IN-KY	28.6	Not Supporting				Not Supporting		Historical
727.0	IN-KY	29.4	Not Supporting				Not Supporting		Historical
732.5	IN-KY	35.3	Not Supporting				Not Supporting	719.5-735.7	Historical
738.8	IN-KY	13.3	Partial Support				Partial Support		Historical
742.4	IN-KY	23.5	Partial Support				Partial Support		Historical
746.4	IN-KY	17.6	Partial Support				Partial Support		Historical
750.6	IN-KY	17.6	Partial Support				Partial Support		Historical
754.8	IN-KY	11.8	Partial Support				Partial Support	735.7-756.4	Historical

Mile Point	States	% of Longitudinal Samples > SSM (03-08)	Assessment of Longitudinal Data	No. Mos. > GM '12-'16	% Mos. > GM '12-'16	Assessment of Contact Rec Data	Overall Assessment	River Mile of Assessment	Assessment Type
758.0	IN-KY	29.4	Not Supporting				Not Supporting	756.4-760.6	Historical
763.2	IN-KY	20.0	Partial Support				Partial Support		Historical
769.1	IN-KY	11.8	Partial Support				Partial Support		Historical
773.6	IN-KY	17.6	Partial Support				Partial Support		Historical
778.2	IN-KY	11.8	Partial Support				Partial Support		Historical
782.8	IN-KY	11.8	Partial Support				Partial Support		Historical
787.0	IN-KY	11.8	Partial Support				Partial Support		Historical
791.5	IN-KY			7	21%	Partial Support	Partial Support		Reassessed
792.7	IN-KY	23.5	Partial Support				Partial Support	760.6-793.2	Historical
793.7	IN-KY			15	44%	Not Supporting	Not Supporting		Reassessed
794.2	IN-KY	29.4	Not Supporting				Not Supporting	793.2-795.7	Historical
797.3	IN-KY						Full Support*	795.7-798.4	Historical
799.5	IN-KY	20.0	Partial Support				Partial Support	798.4-799.8	Historical
800.0	IN-KY	40.0	Not Supporting				Not Supporting	799.8-802.9	Historical
805.8	IN-KY	23.5	Partial Support				Partial Support		Historical
811.3	IN-KY	23.5	Partial Support				Partial Support		Historical
817.0	IN-KY	23.5	Partial Support				Partial Support	802.9-820.1	Historical
823.2	IN-KY	29.4	Not Supporting				Not Supporting	820.1-826.4	Historical
829.5	IN-KY	23.5	Partial Support				Partial Support		Historical
832.2	IN-KY	13.3	Partial Support				Partial Support		Historical
837.2	IN-KY	17.6	Partial Support				Partial Support		Historical
842.3	IN-KY	11.8	Partial Support				Partial Support		Historical
846.5	IN-KY	17.6	Partial Support				Partial Support	826.4-848.0	Historical
848.0	IN-KY							848.0-848.9	Historical
851.3	IL-KY	5.9	Full Support				Full Support	848.9-853.4	Historical
855.5	IL-KY	13.3	Partial Support				Partial Support	853.4-857.6	Historical
859.7	IL-KY	6.7	Full Support				Full Support	857.6-862.1	Historical
864.4	IL-KY	11.8	Partial Support				Partial Support		Historical
869.8	IL-KY	11.8	Partial Support				Partial Support	862.1-872.8	Historical
875.7	IL-KY	5.9	Full Support				Full Support	872.8-878.2	Historical
880.7	IL-KY	11.8	Partial Support				Partial Support	878.2-882.9	Historical
885.0	IL-KY	5.9	Full Support				Full Support		Historical
889.2	IL-KY	5.9	Full Support				Full Support		Historical
891.7	IL-KY	5.9	Full Support				Full Support	882.9-894.6	Historical
897.5	IL-KY	17.6	Partial Support				Partial Support		Historical
903.2	IL-KY	17.6	Partial Support				Partial Support		Historical

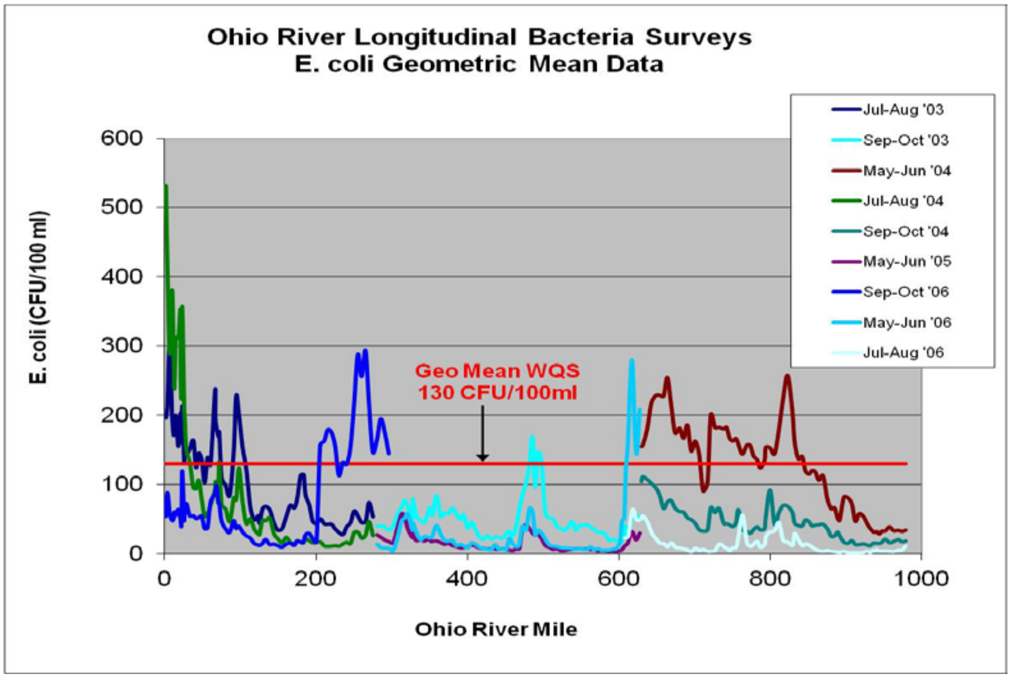
Mile Point	States	% of Longitudinal Samples > SSM (03-08)	Assessment of Longitudinal Data	No. Mos. > GM '12-'16	% Mos. > GM '12-'16	Assessment of Contact Rec Data	Overall Assessment	River Mile of Assessment	Assessment Type
908.0	IL-KY	11.8	Partial Support				Partial Support	894.6-910.3	Historical
912.6	IL-KY	5.9	Full Support				Full Support		Historical
917.6	IL-KY	5.9	Full Support				Full Support	910.3-920.5	Historical
923.4	IL-KY	11.8	Partial Support				Partial Support	920.5-925.8	Historical
928.2	IL-KY	6.7	Full Support				Full Support		Historical
932.2	IL-KY	0.0	Full Support				Full Support		Historical
936.2	IL-KY	0.0	Full Support				Full Support		Historical
937.7	IL-KY	0.0	Full Support				Full Support		Historical
940.9	IL-KY	0.0	Full Support				Full Support		Historical
944.2	IL-KY	0.0	Full Support				Full Support		Historical
947.5	IL-KY	5.9	Full Support				Full Support		Historical
952.2	IL-KY	5.9	Full Support				Full Support		Historical
957.7	IL-KY	5.9	Full Support				Full Support		Historical
963.0	IL-KY	6.3	Full Support				Full Support		Historical
969.2	IL-KY	6.3	Full Support				Full Support		Historical
974.1	IL-KY	6.3	Full Support				Full Support		Historical
979.2	IL-KY	6.3	Full Support				Full Support	925.8-981.0	Historical

Figure 10. Number of months exceeding the E. coli geometric mean criteria at each contact recreation season monitoring location from 2012-2016.



*Pittsburgh only had GM for 4 months in 2013 and 2014 due to lack of samples taken in May, June and July
*Louisville only had GM for 6 months in 2015 and 2016 due to lack of samples taken in July
*In 2013 the month of April was added to the Recreation Season which increased the number of samples from 6 to 7

Figure 11. Geometric mean results of longitudinal surveys.



CHAPTER 5: FISH CONSUMPTION USE SUPPORT ASSESSMENT

The Compact requires that the Ohio River be in a satisfactory sanitary condition and adaptable to such other uses as may be legitimate. The Commission maintains water quality criteria for the protection of human health from fish consumption and therefore evaluates this use.

FISH CONSUMPTION USE ASSESSMENT METHODOLOGY

The Commission generally collects and analyzes between 45 and 60 fish tissue samples annually. Samples comprised primarily of three-fish composites are analyzed for certain organics, pesticides, and metals. These data are then used by various agencies in each of the states bordering the river to issue fish consumption advisories to the public. Total mercury water column data were collected from 15 clean metals sites once every other month between 2010 and 2014. PCBs and dioxins were measured through high volume sampling. Collection of PCB and dioxin data was an ongoing process from 1997 through 2004; all data has been included in this assessment because that data would not be expected to have changed significantly since then. The assessment based on PCBs and Dioxin are historical and therefore have not changed since no further data has been collected. A full description of each designation for the fish consumption use is as follows:

For PCBs & Dioxin:

Fully Supporting

- Water quality criteria for the protection of human health from fish consumption are exceeded in less than ten percent of samples.

Partially Supporting-Impaired

- Criteria for the protection of human health from fish consumption are exceeded in more than ten percent of samples.

For Fish Tissue Methyl Mercury:

The Commission began collecting fish tissue samples for methyl mercury in 2009. In 2009, 20 large, trophic-level 4 hybrid striped bass were collected and the tissue analyzed for total mercury. In 2010, ORSANCO was directed by TEC to use US EPA's approach for determining impairment based on methylmercury data. The mercury program was expanded to include not only large hybrid striped bass, but channel catfish, freshwater drum, and largemouth bass. In 2010 and 2011, the Commission began analyzing for MeHg because the human health criterion is 0.3 ppm for MeHg in fish.

ORSANCO used the *Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion* document (pgs. 61-62) prepared by US EPA to analyze data included in the fish consumption use assessment. The approach utilizes a consumption-weighted averaging of the fish tissue using each pool as an assessment unit. Average fish tissue concentrations for trophic levels (primarily 3 and 4) are weighted based on national consumption rates of 5.7 gms/day for trophic level 4 and 8.0 gms/day for trophic level 3.

The guidance includes several recommendations for agencies when deciding which fish should be included in a fish consumption study. EPA suggests that perhaps the most important criterion is that species are commonly eaten in the study area. Selected fish species should also have commercial, recreational, or subsistence fishing value. Agencies should target walleye and largemouth bass because they accumulate high levels of methylmercury and size range should include larger fish at each site because larger (older) fish are usually most contaminated with methylmercury. When analyzing the methylmercury data, ORSANCO averaged results across trophic levels based on the aforementioned EPA guidance document which allows data to be weighted by actual consumption rates for trophic levels 3 and 4 fish (Equation 1). Impairment is indicated when C_{avg} is greater than 0.3 mg/kg of methylmercury.

$$C_{avg} = \frac{8.0 * C_3 + 5.7 * C_4}{(8.0 + 5.7)}$$

Equation 1. Process used by ORSANCO as outlined by US EPA to average fish consumption data across trophic levels (Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion – US EPA).

Where:

C_3 = average mercury concentration for trophic level 3

C_4 = average mercury concentration for trophic level 4

**Calculation is based on apportioning the 13.7 grams/day national default consumption rate for freshwater fish for trophic levels 3 and 4.

FISH CONSUMPTION USE ASSESSMENT SUMMARY

The Ohio River is assessed and classified as not supporting the fish consumption use for PCBs and dioxin based on historic monitoring results that were two or more orders of magnitude greater than the applicable water quality criteria. Dioxin water concentration data were compared against the Commission's water quality criterion of 0.000000005 µg/L (0.5 fg/L). Every dioxin sample, river-wide, exceeded the water quality criterion (Figure 12). Similarly, PCB levels were compared against the 64 pg/L human health criteria set forth in the Pollution Control Standards (Figure 13). All samples were in violation of the PCB criterion as well. PCB and dioxin data were extrapolated to the entire river because data showed that all samples, at all locations along the river, exceeded the criteria for human health.

There were violations of the total mercury water quality criterion in excess of ten percent of samples (for total mercury in water, not fish tissue) primarily in the lower half of the river (Table 13). The water quality criterion for total mercury in the water column is established to protect against undesirable accumulation in fish tissue. Utilizing the USEPA's methodology for assessing the fish consumption use for methyl mercury utilizing fish tissue data, all pools had a fish consumption weighted methyl mercury fish tissue average below 0.3 mg/kg (Table 14, Appendix H). As a result, utilizing a weight of evidence approach relying on the fish tissue data as more reliable assessment methodology, the entire river is classified as fully supporting the fish consumption use for methyl mercury. The entire river remains impaired for dioxin and PCBs.

In addition, the states issue fish consumption advisories for certain species which can be found on ORSANCO's web site. The presence of fish consumption advisories is not used as a basis for the designation of use impairment.

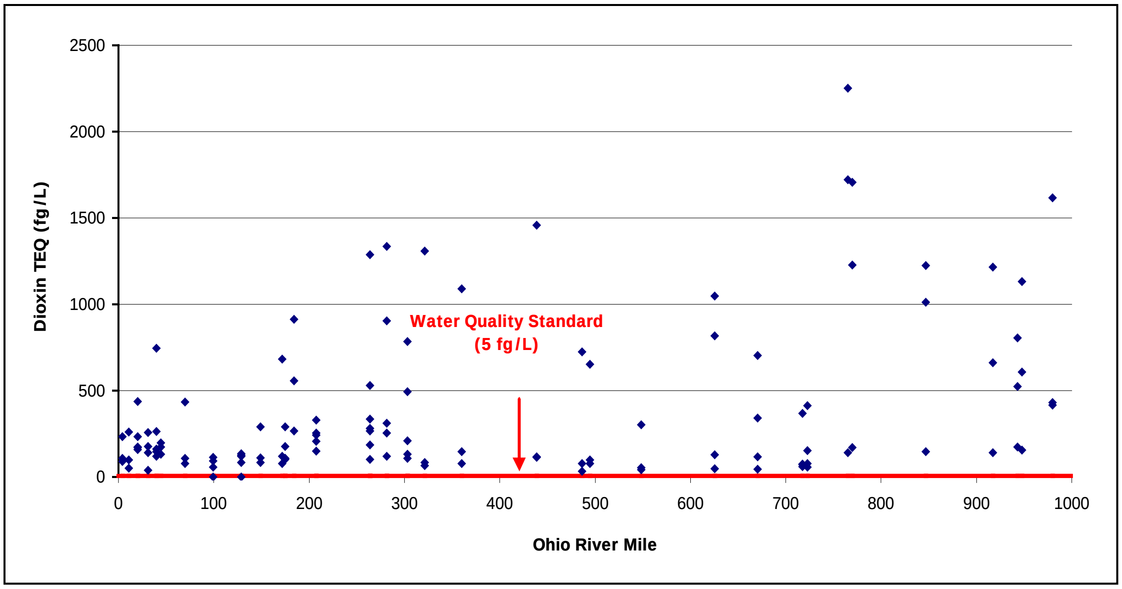


Figure 12. Dioxin TEQ concentrations in the Ohio River (1997-2004).

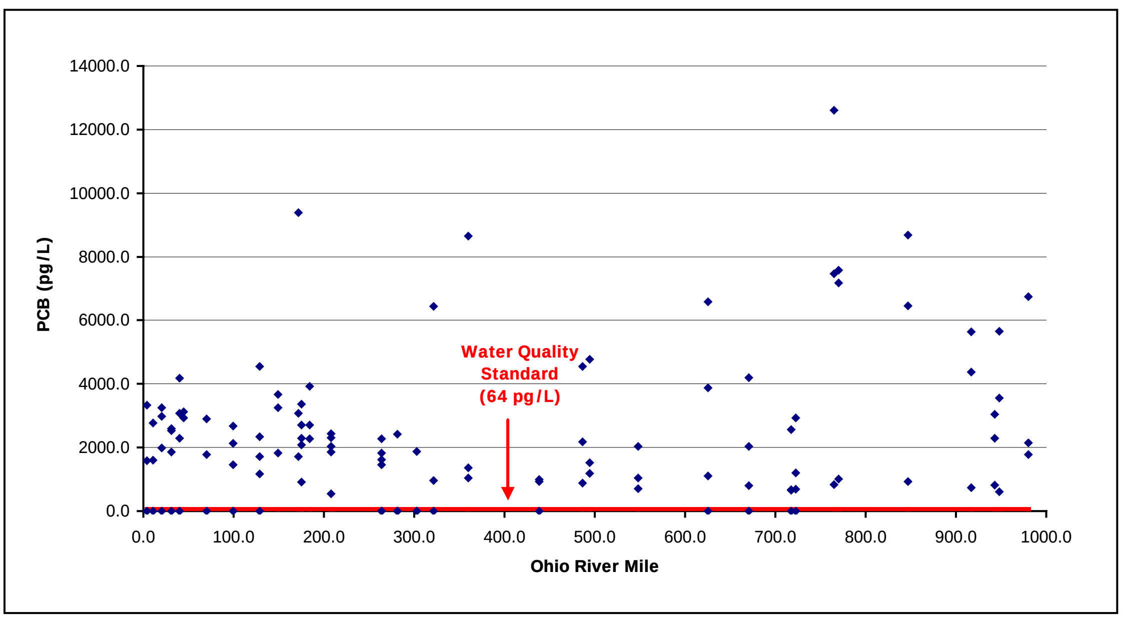


Figure 13. PCB data from the Ohio River collected from 1997-2004.

Table 13. Total Mercury Water Quality Criteria Violations

Mile Point	SiteName	Total No. Samples	# Criteria Violations	% Violations
54.4	**New Cumberland**	30	0	0%
84.2	**Pike Island**	30	1	3%
126.4	**Hannibal**	29	0	0%
161.8	**Willow Island**	30	1	3%
203.9	**Belleville**	29	0	0%
279.2	**RC Byrd**	30	0	0%
341	**Greenup**	30	1	3%
436.2	**Meldahl**	30	1	3%
531.5	**Markland**	30	2	7%
606.8	**McAlpine**	30	1	3%
720.7	**Cannelton**	30	1	3%
776	**Newburgh**	29	4	14%
846	**J.T. Myers**	30	5	17%
918.5	**Smithland**	30	4	13%
938.9	**L&D 52**	30	3	10%

Table 14. Summary of consumption-weighted pool averages for methyl mercury in fish tissue, 2012-2016.

Pool	No. Trophic Level 3 Samples	Concentration Range of Trophic Level 3 Samples, (ppm)	No. Trophic Level 4 Samples	Concentration Range of Trophic Level 4 Samples, (ppm)	Consumption-Weighted Pool Average MeHg Concentration, (ppm) **
Emsworth	4	.06-.25	3	.06-.11	0.106
Dashields	2	.17-.18	2	.18-.19	0.179
Montgomery	4	.06-.17	3	.04-.11	0.091
New Cumberland	1	.14	0	No samples	0.082
Pike Island	1	.02	1	.13	0.067
Hannibal	4	.07-.20	4	.07-.26	0.142
Willow Island	15	.03-.24	7	.11-.31	0.132
Belleville	6	.03-.11	2	.18-.29	0.149
Racine	8	.04-.26	5	.08-.30	0.156
RC Byrd	3	.13-.24	3	.13-.22	0.179
Greenup	9	.06-.23	8	.12-.44	0.172
Meldahl	3	.08-.12	2	.18-.27	0.151

Markland	8	.07-.28	11	.08-.70	0.220
McAlpine	5	.06-.28	6	.09-.28	0.177
Cannelton	2	.09-.17	0	No samples	0.230
Newburgh	4	.08-.2	3	.07-.17	0.147
JT Myers	17	.06-.37	11	.09-.61	0.175
Smithland	7	.10-.43	7	.13-.52	0.276
Olmsted	4	.05-.27	3	.05-.35	0.176

CHAPTER 6: OHIO RIVER WATER QUALITY TRENDS ANALYSIS

ORSANCO first undertook a study of long-term temporal trends using the Commission's own monitoring data in 1990, with 10-15 years of record at most monitoring stations. ORSANCO has since built another 21-year record to be tested for temporal trends. This study presents the results of that analysis and a comparison with the trends discovered in the earlier data set.

The Commission historically collected water quality samples at 17 locations on the Ohio River and near the mouth of 14 major Ohio River tributaries. Since 1990 the Commission has maintained a minimum of six sample events per year at each location. This study covers the 18-year period from January 1990 to December 2007, picking up where the previous ORSANCO trend analyses ended.

Sufficient data was available to test 18-year trends in seven non-metal water quality parameters: ammonia nitrogen, chloride, total hardness, nitrate-nitrite nitrogen, sulfate, total phosphorus, and total suspended solids. The introduction of a new sampling technique for metals in 2002 sufficiently changed the resulting data set such that this study examines only the 12-year record of total recoverable metals analysis through the end of 2002. The metals aluminum, magnesium, manganese, iron, and zinc have sufficient records for a 12-year trend test with a period ending in 2002.

A nonparametric test, the Seasonal Kendall, was performed both on direct concentrations and on a flow-adjusted basis to facilitate comparison with the Commission's earlier trend assessments. Results of the Seasonal Kendall on direct concentrations are presented in Table 1, Seasonal Kendall on Direct Concentrations. The table classifies significant trends by four trend classes with the following notation: strong significant increasing trend ("INC", $p<0.05$, $Z_{0.975} = 1.96$), significant increasing trend ("inc", $p<0.10$, $Z_{0.95} = 1.64$), strong significant decreasing trend ("DEC", $p<0.05$, $Z_{0.025} = -1.96$), significant decreasing trend ("dec", $p<0.10$, $Z_{0.05} = -1.64$). A nonparametric estimator of trend magnitude was calculated for all significant trends ($p < 0.10$).

Of 372 tests for trends (31 locations, 12 water quality parameters) 222 statistically significant ($p < 0.10$) trends were found. Analysis for the current period shows 54% increasing trends while the vast majority of trends (94%) discovered in the 1977 to 1990 studies were in the decreasing direction. One difference between the periods not indicated by that summary is that some parameters, for example copper and phenols, with decreases in the earlier period have apparently experienced declines such that infrequency of pollutant detections in the current period invalidates a test for continuing trends.

Important trends detected include increasing phosphorus concentrations at most Ohio River monitoring stations and increases in chloride concentrations at nearly all stations including tributaries. Sulfate concentrations in the Big Sandy River at the border of West Virginia and Kentucky have steadily increased and are currently reaching the level of the ORSANCO Water Quality Criterion of 250 milligrams per liter (mg/L).

Table 15. Seasonal Kendall trends in Ohio River concentrations.

Bimonthly SiteName	River	Al	Cl-	Fe	Hardness	Mg	Mn	NH3-N	NO2-NO3-N	SO4	TP	TSS	Zn
Pittsburgh	Allegheny	O	INC	DEC	INC	INC	DEC	O	INC	O	O	O	dec
South Pittsburgh	Monongahela	O	INC	O	O	INC	DEC	O	inc	O	O	O	DEC
Beaver Falls	Beaver	O	INC	DEC	O	INC	DEC	O	dec	O	INC	O	O
New Cumberland	Ohio	DEC	INC	DEC	INC	INC	DEC	O	INC	O	DEC	DEC	DEC
Pike Island	Ohio	DEC	INC	DEC	O	inc	DEC	DEC	O	O	DEC	DEC	DEC
Hannibal	Ohio	O	INC	DEC	INC	INC	dec	O	O	O	O	O	DEC
Willow Island	Ohio	dec	INC	DEC	inc	INC	DEC	DEC	O	O	DEC	DEC	O
Marietta	Muskingum	DEC	O	DEC	O	INC	DEC	O	O	O	INC	DEC	DEC
Belleville	Ohio	DEC	INC	DEC	inc	INC	DEC	O	O	O	inc	DEC	DEC
Winfield	Kanawha	O	INC	O	INC	INC	inc	O	INC	INC	DEC	O	DEC
R.C. Byrd	Ohio	O	INC	O	O	INC	O	O	O	O	INC	inc	DEC
Louisa	Big Sandy	dec	O	dec	INC	INC	dec	INC	O	INC	O	DEC	DEC
Greenup	Ohio	DEC	INC	O	INC	INC	O	O	INC	O	INC	O	DEC
Lucasville	Scioto	O	inc	O	INC	INC	O	INC	DEC	O	INC	DEC	DEC
Meldahl	Ohio	O	INC	O	DEC	O	O	DEC	DEC	INC	O	O	DEC
Newtown	Little Miami	O	INC	O	inc	INC	O	inc	DEC	O	INC	DEC	dec
Covington	Licking	O	DEC	O	DEC	O	O	DEC	DEC	DEC	O	DEC	DEC
Anderson Ferry	Ohio	dec	INC	O	O	INC	O	INC	O	O	INC	O	O
Elizabethtown	Great Miami	O	O	O	O	inc	O	O	DEC	DEC	O	DEC	O
Markland	Ohio	O	INC	DEC	DEC	O	DEC	O	DEC	inc	INC	DEC	DEC
Louisville	Ohio	O	O	O	O	INC	O	dec	O	INC	INC	O	DEC
West Point	Ohio	DEC	INC	DEC	INC	INC	O	O	O	INC	INC	O	DEC
Cannelton	Ohio	O	INC	DEC	INC	INC	DEC	O	O	INC	INC	O	DEC
Newburgh	Ohio	O	INC	O	INC	INC	O	O	INC	INC	INC	O	DEC
Sebree	Green	dec	INC	O	INC	INC	O	O	INC	INC	INC	O	DEC
J.T. Myers	Ohio	O	INC	dec	INC	INC	DEC	O	O	INC	INC	O	DEC
Route 62 Bridge	Wabash		O	O	O	O	O	O	O	O	O	O	O
Smithland	Ohio	DEC	INC	DEC	INC	INC	dec	O	O	INC	INC	O	O
Pinkneyville	Cumberland	O	INC	inc	INC	INC	O	O	O	INC	INC	O	O
Paducah	Tennessee	DEC	INC	DEC	INC	INC	DEC	O	INC	INC	DEC	O	DEC
L&D 52	Ohio	DEC	INC	DEC	INC	INC	DEC	O	inc	INC	INC	O	DEC

INC - Strong significant increasing trend ($p < 0.05$, Z0.025 = 1.96)
inc - Significant increasing trend ($p < 0.10$, Z0.05 = 1.6449))
O - No significant trend found
dec - Significant decreasing trend ($p < 0.10$, Z0.05 = 1.6449)
DEC - Strong significant decreasing trend ($p < 0.05$, Z0.025 = 1.96)

CHAPTER 7: SPECIAL STUDIES

TOTAL DISSOLVED SOLIDS STUDY

A one year monitoring study of total dissolved solids was conducted from December, 2011 through December, 2012 at 11 Ohio River sites and five major tributaries. Samples were collected weekly from drinking water, power plant and other industrial intakes. A summary of results are presented in Table 16 and shown graphically in Figure 14. No Ohio River samples exceeded the water quality criterion of 500 mg/L during the study period. There were individual TDS concentrations above 500 mg/L on the Big Sandy River and Muskingum River, however the Commission's water quality criteria apply only to the Ohio River. All results can be found in Appendix I.

Table 16. Total dissolved solids summary results.

			TDS Result, mg/L		
River	**River Mile**	**Location ID**	**Min**	**Median**	**Max**
Allegheny	8.2	AL008	62	161.5	236
Monongahela	4.5	MO005	113	218.0	362
Ohio	11.7	OH012	124	205.0	280
Beaver	6	BE002	163	276.0	386
Ohio	65.3	OH065	104	206.0	307
Ohio	86.8	OH087	106	217.0	328
Ohio	137.2	OH137	110	222.0	359
Muskingum	29	MU029	148	362.0	584
Ohio	190.5	OH191	106	227.0	364
Ohio	260	OH260	160	222.0	368
Ohio	306	OH306	126	188.5	301
Big Sandy	23.6	BS020	155	362.0	579
Ohio	462.8	OH463	150	195.0	335
Ohio	600	OH600	166	215.0	332
Ohio	791.5	OH792	160	223.0	341
Ohio	978	OH978	142	203.0	339

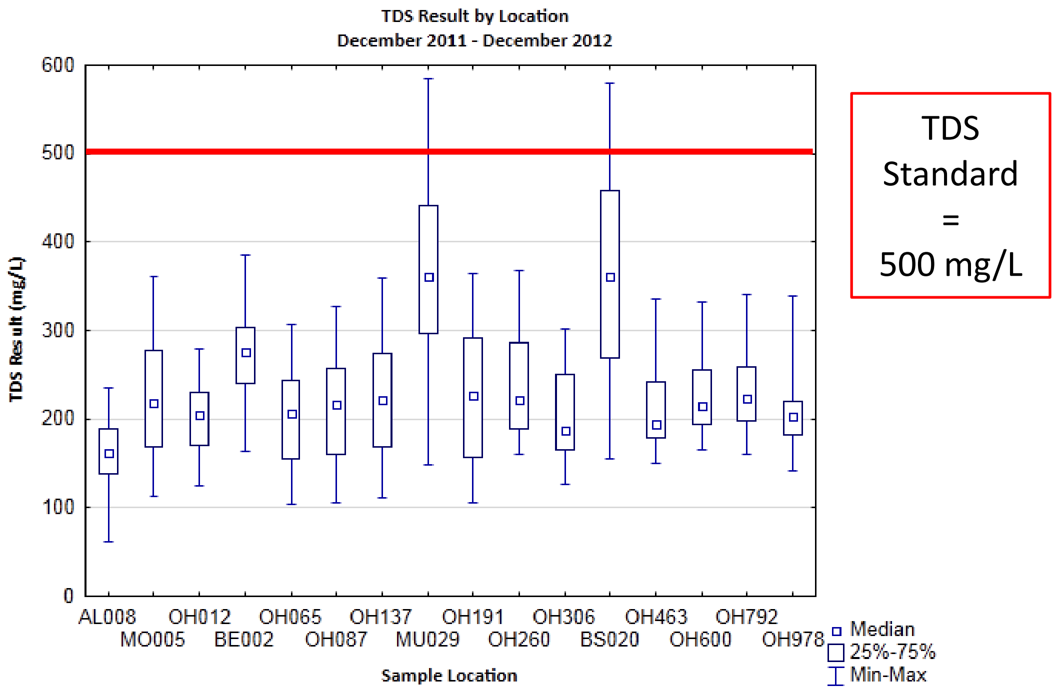


Figure 14. Summary of total dissolved solids concentrations.

305b HABs

Algae are present in the Ohio River throughout the year. During optimal conditions some algae may rapidly proliferate causing a "bloom". During a bloom the algal concentration may go from a few thousand cells per milliliter (cells/ml) of water to hundreds of thousands or even millions of cells/ml. Algae blooms are most common in the summer although they may occur at any time of the year. On the Ohio River the conditions that allow these blooms to occur are typically low and slow flow, clear water and, warm water.

Sampling on the Ohio River has identified over 300 different species of algae. These algae are divided into 8 taxonomic divisions with the most common being diatoms (Bacillariophyta), green algae (Chlorophyta) and blue-green algae (Cyanobacteria). Cyanobacteria can produce toxins which can be harmful if ingested. For this reason an algae bloom which consists primarily of Cyanobacteria is considered a Harmful Algae Bloom (HAB). These toxins can affect people and animals who ingests them, either through recreation (such as swimming), or in drinking water.

US EPA has developed Health Advisories for Microcystins and Cylindrospermopsin (Table 17). These advisories are based on a 10 day exposure.

Table 17. US EPA finished drinking water health advisories for algal toxins.

Threshold	Microcystin (ug/L)	Cylindrospermopsin (ug/L)
Children under 6 years	0.3	0.7
Children over 6 years and adults	1.6	3.0

US EPA has developed draft *Human Health Recreational Ambient Water Quality Criteria and/or Swimming Advisories for Microcystins and Cylindrospermopsins* (Table 18). These thresholds were derived from existing peer-reviewed studies.

Table 18. US EPA Draft Recreational AWQC for Cyanotoxins

Microcystin (ug/L)	Cylindrospermopsin (ug/L)
4	8

As these are draft, most States use the World Health Organization (WHO) Guidelines for managing recreational waters. WHO published guidelines for both determining the severity of a bloom and for concentrations of toxins (Tables 19 and 20).

Table 19. WHO guidelines for HABs in recreational waters.

Guidance Level	Concentration	How Guidance Level Derived	Health Risks
Low probability of health effects	20,000 cells/ml or 10 ug/L of chlorophyll *a* with cyanobacteria dominant	Human bathing epidemiological study	Short term- skin irritations, gastrointestinal illness
Moderate probability of health effects	100,000 cells/ml or 50 ug/L of chlorophyll *a* with cyanobacteria dominant	Provisional drinking water guideline value for microcystin and other cyanotoxins	Potential for long term illness as well as short term health effects
High probability of health effects	Cyanobacteria scum formation in areas where whole body contact occurs	Inference from oral animal lethal poisonings and human illness case histories	Potential for acute poisoning

Table 20. WHO guidelines for algal toxins in recreational waters

Threshold (µg/L)	Microcystin	Anatoxin-a	Cylindrospermopsin	Saxitoxin*
Recreational Public Health Advisory	6	80	5	0.8
Recreational No Contact Advisory	20	300	20	3

On August 19, 2015, ORSANCO received an NRC report of a paint-like green material on the Ohio River at Pike Island Locks and Dam (mile 84.2) which covered 100 X 200 feet. This was quickly identified as the blue-green algae *Microcystis aeruginosa*. Over the next month this bloom expanded to cover the Ohio River from Pike Island L&D to Cannelton L&D (river mile 84.2 to 720.7). Below Cannelton L&D there were intermittent patches of the bloom but not a continuous coverage. The bloom reached its peak around September 23, 2015 after which point it began to decay. The bloom was determined to be over by the last week of October.

Ohio, West Virginia, Kentucky and Indiana issued recreation advisories for the Ohio River as the bloom extended into their areas. Illinois issued a precautionary statement concerning recreation in the river due to concern that the bloom would reach their border. After the bloom ended these recreation advisories were lifted.

ORSANCO collected 150 samples from the Ohio River, which were analyzed for the toxin *microcystin*. Finished drinking water was sampled by either the water utilities or State personnel. Analysis of the samples was conducted either by ELISA or LC/MS. Full results are available in Appendix J. No toxins were detected in finished drinking water. Of the samples collected by ORSANCO, 15 (or 10%) were greater than 6 ug/L. The highest toxin concentration was 1900 ug/L at river mile 468.8 (Cincinnati, OH).

The cause(s) of this event are unknown but data is currently being compiled and analyzed.

SUMMARY

The entire 981 miles of the Ohio River is designated as impaired for the fish consumption use, caused by PCBs and dioxin. While there are a number of water quality criteria violations for total mercury and fish tissue criteria violations for methyl mercury, the consumption-weighted pool averages were all below the fish tissue criterion, therefore no impairment is indicated for the fish consumption use based on mercury. Two-thirds of the river, or 636.5 miles, is designated as impaired for contact recreation caused by *E. coli* or fecal coliform bacteria. The entire river is fully supporting the public water supply use. While several water utilities did have MCL violations for disinfection byproducts, they were more likely related to water treatment issues than to source water quality. While there are indications of aquatic life use impairments for certain segments of the Ohio River based on water quality criteria violations for total iron, at the same time there are indications of fully supporting aquatic life use for the entire Ohio River based on direct measures of the biological community. Therefore, using the weight of evidence approach, the entire Ohio River is assessed in this report at fully supporting the aquatic life use.

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