Assessment of Ohio River Water Quality Conditions

Assessment Years: 2014 - 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. Portions of its basin lie in 14 states with six of those directly bordering the main stem Ohio River. 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).

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 2014 – 2018; 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. Three classifications are used in ORSANCO's assessments 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).

To determine the status of these designated uses ORSANCO employs a "weight of evidence" approach. This approach involves using professional judgment to make the best, most accurate assessment using data and information which are believed to be most relevant to determine use attainment, sometimes overriding conflicting information. Use of the WOE approach had an effect on assessments of aquatic life, fish consumption, and public water supply uses.

SUMMARY OF USE ATTAINMENT

- **Aquatic Life Use – Entirety of Ohio River is fully supporting**
    - Total Iron exceeded criteria in greater than 10% of samples in several river segments.
    - Fish and/or macroinvertebrate assessments indicate every segment is in full support.
    - WOE approach employed favoring the direct measures of aquatic life (biological indices)

- **Contact Recreation Use – 641.5 miles (i.e. approx. 2/3) of Ohio River is classified as impaired**
    - Historical (2003-2008) longitudinal survey data was used as it provides the greatest coverage in regards to river miles sampled and precipitation events included.
    - Recent data from six largest combined sewage overflow (CSO) communities during the recreational season was also used.
    - Five additional river miles added to the 2018 impaired reaches due to recent recreational data

- **Public Water Supply Use – Entirety of Ohio River is fully supporting**
    - Water utility surveys did not indicate source water issues
    - Finished water maximum contaminant level (MCL) violations as reported to USEPA by water utilities were treatment byproducts or due to incomplete treatment.
    - WOE approach employed concluding that neither the surveys nor MCL violations indicated issues with the Ohio River source water.

- **Fish Consumption Use – Entirety of Ohio River is partially supporting (PCB/Dioxins)**
  – Entirety of Ohio River is fully supporting (Mercury)
    - Historic water quality data for PCBs and Dioxins exceeded criteria by two or more orders of magnitude.
    - Recent water quality samples exceeded the 0.012 µg/L mercury criterion in excess of ten percent of the samples at six stations, river-wide.
    - Using USEPA's approved consumption-weighted method, no exceedances of the 0.3 mg/kg methylmercury criteria occurred in fish tissue data for each pool of the Ohio R.
    - WOE approach employed favoring the direct measure of methylmercury in fish tissue as opposed to the water column mercury criteria which was derived to indirectly protect methylmercury levels in fish tissue.

Table 1. Summary of impaired state river miles for the four uses: Aquatic Life (ALU), Contact Recreation (CRU), Public Water Supply (PWSU), and Fish Consumption (FSU) uses.

State	River Mile (Total Miles)	ALU Impairment	CRU Impairment	PWSU Impairment	FCU 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	245.1	0.0	276.9
OH-KY	317.1-491.3 (174.2)	0.0	71.4	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**	**641.5**	**0.0**	**981.0**

PART I: INTRODUCTION

CHAPTER 2: THE OHIO RIVER VALLEY WATER SANITATION COMMISSION

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, 2014, and December, 2018, 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 individually using specific numeric water quality criteria, surveys and questionnaires, or 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.

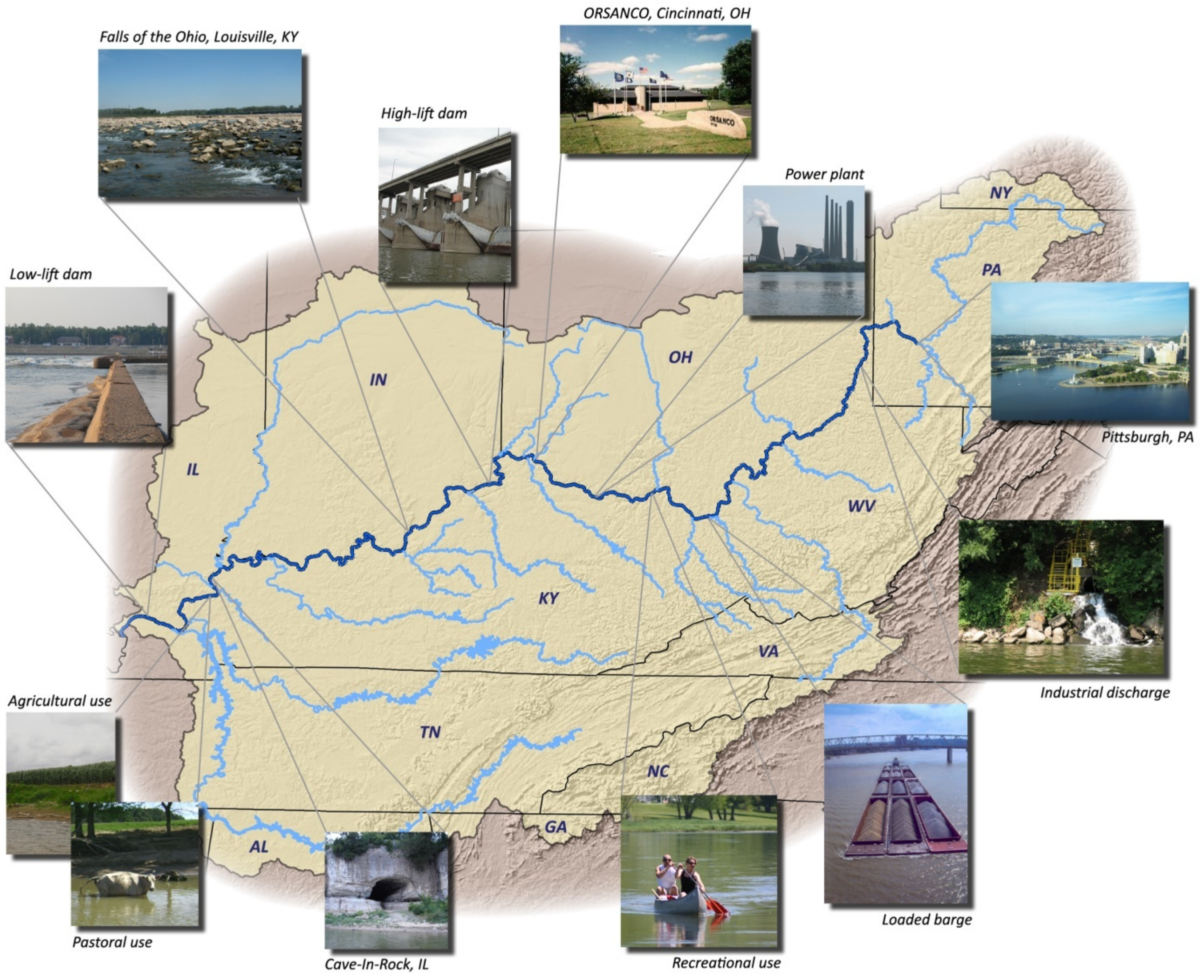


Figure 1. Ohio River Basin

CHAPTER 2: 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).

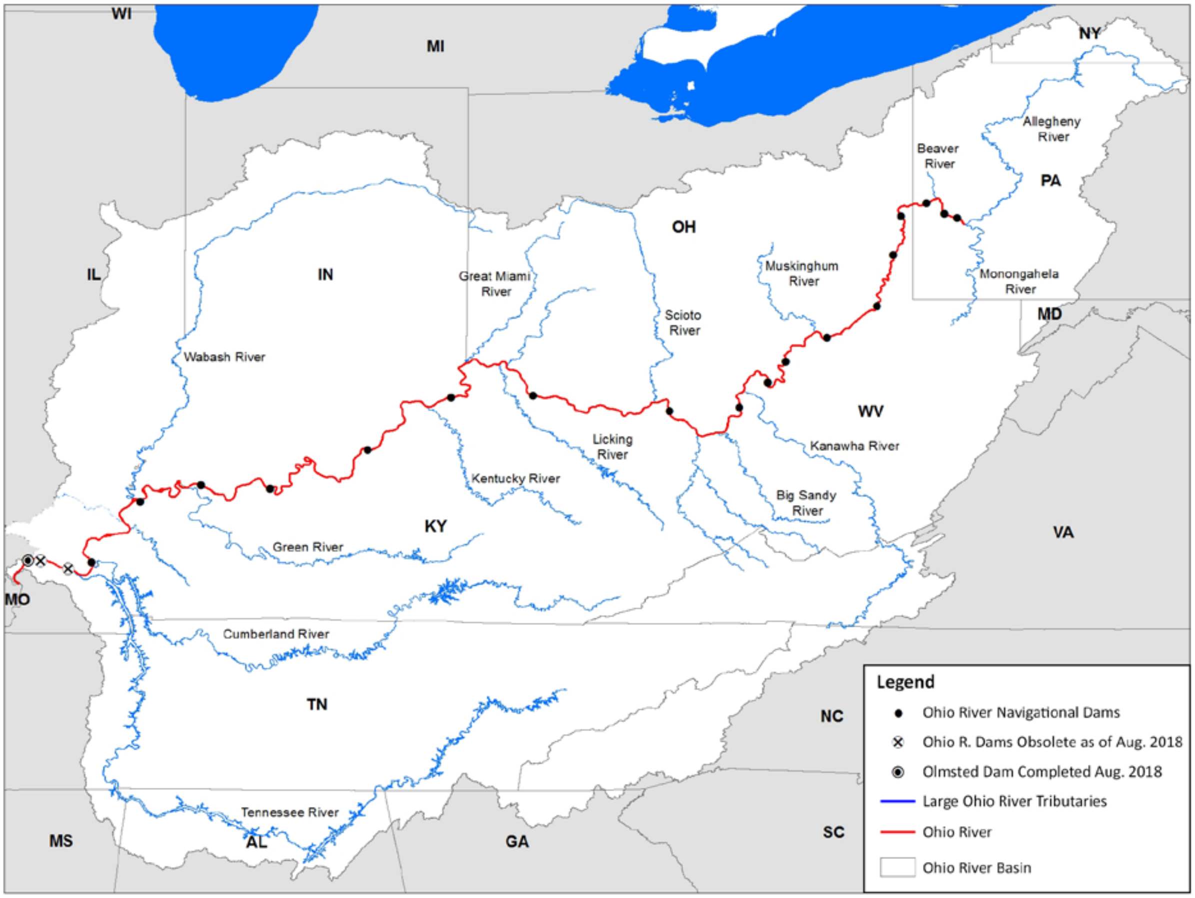


Figure 2. The Ohio River basin, including 21 lock and dams and large tributaries.

Various types of locks and dams have been installed by the US Army Corps of Engineers for navigation purposes. These structures maintain a nine-foot minimum river depth and regulate flow, facilitating the transport of cargo on the river. Two smaller wickets dams in the lower river, Lock & Dam 52 and Lock & Dam 53 were rendered obsolete with the completion of the river's newest high-lift dam, Olmsted Locks & Dam, in August of 2018. As of August 2018 the Ohio River now has 19 high-lift dams and no remaining wicket dams. Each dam creates 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).

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.

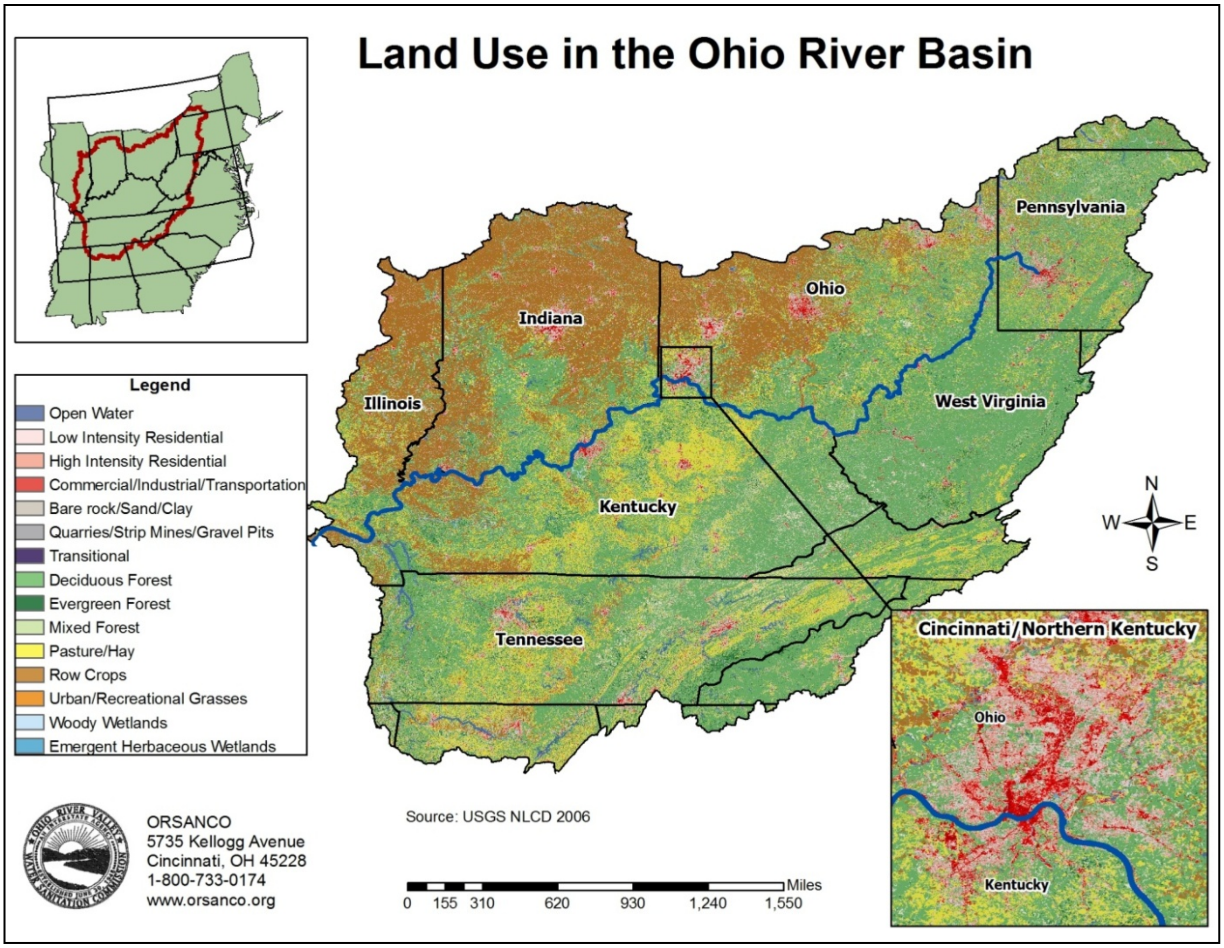


Figure 3. Land use in the Ohio River Basin (USGS NLCD 2006).

DESCRIPTION OF OHIO RIVER POOLS

The Ohio River is a series of pools connected by 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 2020 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. Within this biennial assessment period this body of water was effectively present from ***January 2014 until August 2018***, when it was rendered obsolete by the completion of Olmsted Locks & Dam at river mile 964.4.
- **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). Within this biennial assessment period this body of water was effectively present from ***January 2014 until August 2018***, when it was rendered obsolete by the completion of Olmsted Locks & Dam at river mile 964.4.

- ***Smithland-Olmsted** (mile point 918.5-964.4). Only in existence during the last several month of the assessment period (***August 2018 – December 2018***), this 45.9-mile-long water body is bounded by Smithland upstream and the newly completed Olmsted project on the downstream end. In future assessment cycles this waterbody takes the place of those formerly contained by Lock & Dam 52 and a portion of the unimpounded section down to the Mississippi River.
- ***Olmsted-Cairo** (mile point 964.4-981.0). Only in existence during the last several month of the assessment period (***August 2018 – December 2018***), this 16.6-mile-long water body is bounded by Olmsted upstream upstream and the Mississippi River on the downstream end (the mouth of the Ohio River). In future assessment cycles this waterbody comprises the lower a portion of waterbody once bounded by Lock & Dam 52 and the Mississippi River.

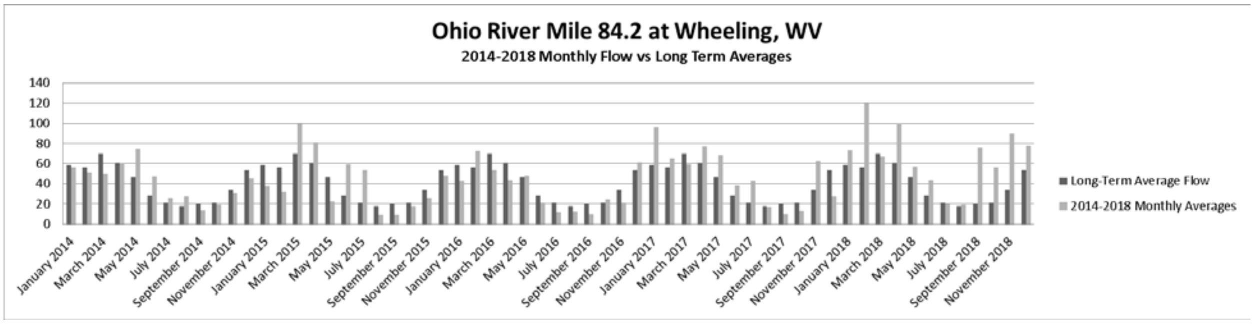
Appendix A contains additional data on basin characteristics including locations of locks and dams, locations of tributaries, and hydrologic data for 2014-2018.

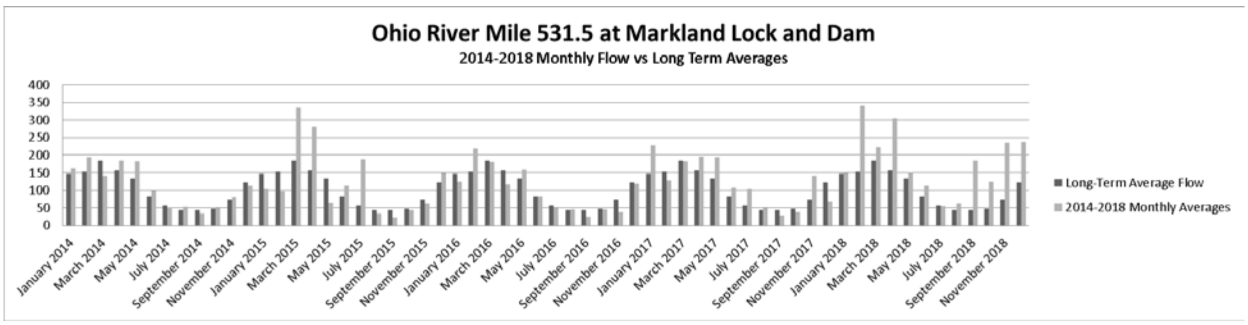
USES OF THE OHIO RIVER

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 30 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 56 to 821 kilo cubic feet per second (kcfs). 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. With the exception of a few months in 2015, monthly average flows were regularly equal to historical averages between 2014 and 2016. In the last two years of the assessment period flows were consistently higher than long-term averages, particularly in 2018. 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).





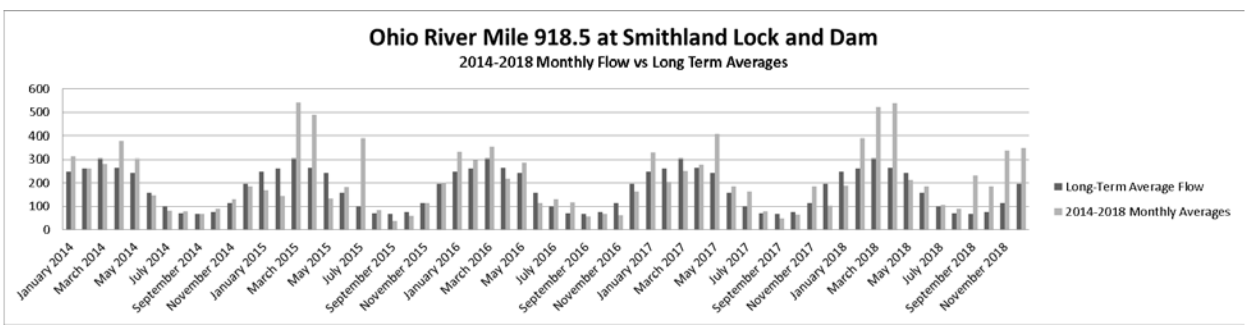


Figure 4. Ohio River flow data at Wheeling, WV; Markland, KY; and Smithland, KY. Dark gray bars represent long-term average monthly flow value; light gray bars represent measured average monthly flow value.

PART II: 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 (Appendix A) are contained in the 2013 Revision of *Pollution Control Standards for Discharges to the Ohio River* (www.orsanco.org/programs/pollution-control-standards).

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 (Olmsted was added as a 16th station in September of 2018) 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 assess 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, while 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 2020 report, Bimonthly and Clean Metals data from January 2014 to December 2018 were used to make use assessments. Data from these programs were also used to assess the public water supply use.

Table 2. Station Locations for Bimonthly and Clean Metals sampling

Station	River Mile	Period of Record
New Cumberland	54.4	July 1992 to Present
Pike Island	84.2	July 1992 to Present
Hannibal	126.4	Sept. 1977 to Present
Willow Island	161.8	Nov. 1975 to Present
Belleville	203.9	Nov. 1975 to Present
R.C. Byrd	279.2	Nov. 1975 to Present
Greenup	341.0	July 1992 to Present
Meldahl	436.2	July 1992 to Present
Markland	531.5	Nov. 1975 to Present
McAlpine	606.8	July 1992 - May 1997, July 2011 to Present
Cannelton	720.7	Nov. 1975 to Present
Newburgh	776.0	July 1992 to Present
J.T. Myers	846.0	Nov. 1975 to Present
Smithland	918.5	Jan. 1983 to Present
Lock & Dam 52	938.9	July 1993 to Present
Olmsted	964.4	Sept. 2018 to Present

Table 3. Clean Metals and Bimonthly sampling parameters

Clean Metals 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
ron	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

Bimonthly 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 µg/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 2014-2018 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), more emphasis is given to direct measures of biological integrity. The dissolved oxygen and temperature data are additionally 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, United States Geological Survey, and electric utility/hydropower agencies at 13 river stations. Measurements are taken in hourly or 30-minute increments depending on the operating agency (Table 4).

Table 4. Dissolved oxygen and temperature monitoring stations

Station	River Mile	Operating Agency	Frequency	Date of Operation
MONTGOMERY	31.7	USGS	Hourly	2014-2018
HANNIBAL	126.4	USACE	Hourly	2014
WILLOW ISLAND	161.7	Electric Utility	Hourly	2016-2018
RACINE	237.5	Electric Utility	Hourly	2016-2018
IRONTON	325.0	USGS	Hourly	2016-2018
GREENUP	341.0	Electric Utility	Hourly	2014-2016, 2018
MELDAHL	436.2	Electric Utility	Hourly	2016-2018
MARKLAND	531.5	Electric Utility	Hourly	2016-2018
McALPINE	606.8	Electric Utility	Hourly	2016-2018
CANNELTON	720.7	Electric Utility	Hourly	2016-2018
J. T. MYERS	846.0	ORSANCO	30 Min	2014
SMITHLAND	918.5	Electric Utility	Hourly	2014, 2016-2018
OLMSTED	964.6	USGS	Hourly	2014-2017

BIOLOGICAL MONITORING

Fish and macroinvertebrate (macro) population data were used to assess support of aquatic life use. ORSANCO biologists monitor fish and macro populations annually from July through October. 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 recorded (Figure 5). 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 an incomplete assessment or impairment is found, pools may be re-sampled the following year.

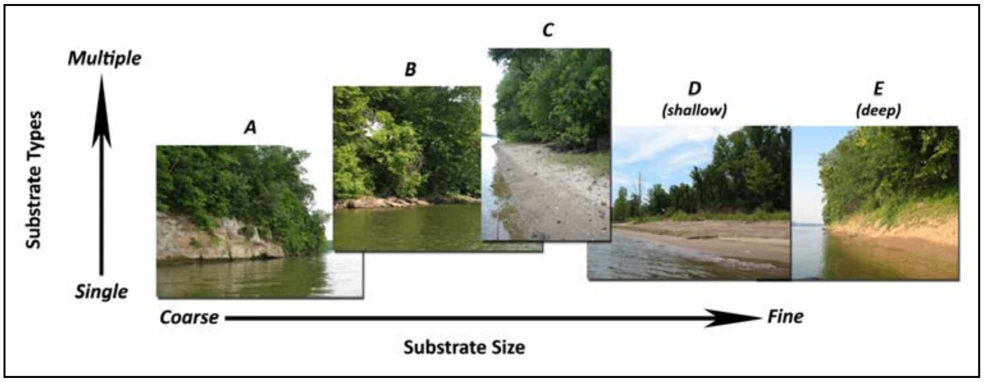


Figure 5. Fish and macroinvertebrate population scores are based on habitat classes shown.

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 2015, 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 (Table 5). 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.

Table 5. List and descriptions of the 13 and eight metrics included in *m*ORFIn and ORMIn, respectively

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

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* (fecal collections ceased at all sites outside West Virginia after 2016). 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 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 methylmercury 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 methylmercury concentrations in forty percent of samples. In 2010, the mercury program began to routinely collect methylmercury 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.

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 16 fixed stations along the river. Grab samples are collected from these stations once every other month. Continuous monitoring for dissolved oxygen and temperature is performed by ORSANCO, United States Army Corps of Engineers, United States Geological Survey, and hydropower plant operators at 14 Ohio River locations.

For a given monitoring station, if no pollutant (toxic or conventional) 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. 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 are randomly selected to represent each AU as a whole. Once each assemblage (fish and macros) is surveyed across the fifteen sites, metric scores are calculated for each of the various indicator metrics previously detailed in Chapter 1. These metric scores are converted to index scores based on how they compare to historical metric performance at sites with similar habitat features.

These final index scores (*m*ORFIn or ORMIn) are calculated at each site, for each assemblage, in a survey pool. Those individual scores are then averaged for each index separately (with each score having an associated condition rating, Figure 6). In order to generate these average index scores, data must be successfully collected from a minimum of 15 and 10 sites for the fish and macro assemblages, respectively. As loss of macro samplers can result from human interference and flow regime, pools that fail to reach the 10 site minimum may remain unassessed in a particular biological survey year.

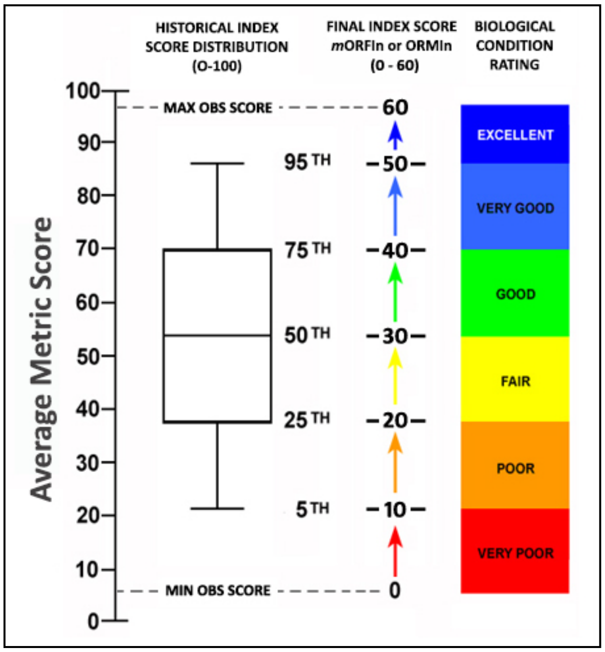


Figure 6. Conversion of raw biological metric score to *m*ORFIn and ORMIn score and rating based on varying habitat class expectation.

To determine the overall condition of a pool, the required individual index scores were averaged and then compared to an established biocriterion (Index score = 20.0). The 305b workgroup derived a methodology to combine the results of the two biological indices into a final assessment of each pool as detailed below:

Fully Supporting

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

Partially Supporting - Impaired

- 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).

Not Supporting - Impaired

- 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. Parameter results collected during this assessment period are available online (www.orsanco.org/programs/water-quality-assessment) and displayed graphically in Appendix B. There were no exceedances of ORSANCO's water quality criteria for the protection of aquatic life, however there were exceedances of the states' total iron criteria (ORSANCO does not have a criterion for total iron) in excess of ten percent of total samples (Table 6).

Table 6. Summary of states' total iron criteria exceedances, 2014-2018

Site Name	River Mile	Criteria (µg/L)	Total Samples	WQC Exceedances	% Exceedances
Sewickley*	11.8	PA (1500)	52	9	17%
East Liverpool*	42.6	PA (1500)	53	11	20%
New Cumberland	54.2	WV (1500)	30	2	7%
Pike Island	84.2	WV (1500)	30	4	13%
Hannibal	126.4	WV (1500)	30	4	13%
Willow Island	161.8	WV (1500)	30	8	27%
Belleville	203.9	WV (1500)	29	6	21%
R.C. Byrd	279.2	WV (1500)	30	6	20%
Greenup	341.0	KY (3500)	30	4	13%
Meldahl	436.2	KY (3500)	30	6	20%
Markland	531.5	KY (3500)	30	2	6%
McAlpine	606.8	KY (1000)	30	16	53%
Cannelton	720.7	KY (3500)	30	4	13%
Newburgh	776.0	KY (1000)	29	17	59%
J.T. Myers	846.0	KY (1000)	30	18	60%
Smithland	918.5	KY (1000)	30	16	53%
L&D 52	938.9	KY (3500)	29	6	21%
Olmsted	964.6	KY (3500)	1	0	0%
* PADEP data					

DISSOLVED OXYGEN AND TEMPERATURE MONITORING RESULTS

ORSANCO collects the data from the various agencies/utilities and assesses them 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 7 below shows the percent of days that were monitored which exceeded the applicable dissolved oxygen criterion. Most stations experienced a fairly low percentage of days when dissolved oxygen was below 5 mg/L and no station had exceedances in excess of ten percent over the entire reporting period. Individual results are available at (www.orsanco.org/programs/water-quality-assessment).

Table 7. Ohio River dissolved oxygen values below 5.0mg/L criteria
light blue = insufficient data available
(US = Upstream, DS = Downstream, Hydro = Hydroelectric Facility, Lock = Lock Chamber)

Ohio River Station	Mile Point	2014 % Days Below Criteria	2015 % Days Below Criteria	2016 % Days Below Criteria	2017 % Days Below Criteria	2018 % Days Below Criteria	2014-2018 % Days Below Criteria
Montgomery	31.7	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Hannibal	126.4	0.0%					0.0%
Willow Island	161.7						
US				0.0%	0.0%	0.0%	0.0%
DS				0.0%	0.0%	0.0%	0.0%
Racine	237.5	0.0%	0.0%	9.7%	0.0%	6.8%	3.1%
Ironton	325.0			0.0%	0.0%	0.0%	0.0%
Greenup	341.0						
US		14.0%	13.6%	0.0%		1.6%	8.7%
DS		2.0%	9.7%	4.4%	n/a	0.0%	4.0%
Meldahl	436.2						
US				0.0%	0.0%	2.4%	0.0%
DS				0.0%	0.0%	1.6%	0.0%
Markland	531.5						
US Hydro		4.0%	21.9%	11.1%	0.0%	2.4%	9.0%
DS Hydro		5.6%	12.8%	5.9%	6.7%	7.1%	6.9%
DS Lock		0.0%	5.9%				1.7%
US Lock		0.0%	1.8%				0.8%
McAlpine	606.8	4.6%	2.4%	19.8%	0.0%	6.6%	6.8%
Cannelton	720.7						
US				0.0%	0.0%	2.4%	0.0%
DS				3.0%	0.0%	0.0%	3.0%
John T. Myers	846.0	0.0%					0.0%
Smithland	919.0						
US		3.7%		0.0%	2.5%	7.1%	3.9%
DS				7.0%	0.0%	4.8%	7.0%
Olmsted	964.6	0.0%	8.4%	2.5%	0.0%		4.0%

ORSANCO's allowable maximum temperature criteria are specified for six separate periods in a year as identified by Julian days (Table 8). Individual results are available at www.orsanco.org/programs/water-quality-assessment. While a number of stations had temperature exceedances, no stations had in excess of ten percent for the entire reporting period. The lower river tends to have greater numbers of exceedances of the temperature criteria for the protection of aquatic life.

Table 8. Ohio River temperature criteria exceedances (light blue = insufficient available data)

		Montgomery	Hannibal	Willow Island US	Willow Island DS	Racine	Ironton	Greenup US	Greenup DS
		31.7	126.4	161.7	161.8	237.5	325.0	341.0	341.1
	Julian day								
2014	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%
	2014 Total	**0.0%**	**0.0%**			**0.0%**		**0.0%**	**0.0%**
2015	1-49								
	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%	0.0%
	2015 Total	**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%	0.0%
	167-181	0.0%		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%	0.0%
	244-258	0.0%		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	259-366	0.0%		0.0%	0.0%	0.0%	0.0%	58.0%	0.0%
	2016 Total	**0.0%**		**0.0%**	**0.0%**	**0.0%**	**0.0%**	**13.0%**	**0.0%**
2017	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%	14.3%	0.0%		
	2017 Total	**0.0%**		**0.0%**	**0.0%**	**3.7%**	**0.0%**		
2018	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%	0.0%
	182-243	0.0%		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%	0.0%
	259-366	0.0%		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	2018 Total	**0.0%**		**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**
2014-2018 Total		**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.8%**	**0.0%**	**3.7%**	**0.0%**

Table 8. Ohio River temperature criteria exceedances (light blue = insufficient available data)

Year	Julian day	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	McAlpine 606.8
2014	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%
	2014 Total			**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%
	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%
	2015 Total			**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%
	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%**
2017	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%
	2017 Total	**0.0%**	**0.0%**			**0.0%**	**0.0%**	**0.0%**
2018	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%
	2018 Total	**0.0%**	**0.0%**			**0.0%**	**0.0%**	**0.0%**
2014-2018 Total		**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**

Table 8. Ohio River temperature criteria exceedances (light blue = insufficient available data)

		Cannelton US	Cannelton DS	JT Myers	Smithland US	Smithland DS	Olmsted
		720.6	720.7	846.0	919.0	919.1	964.6
	Julian day						
2014	1-49						
	50-166						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						10.0%
	167-181						0.0%
	182-243						0.0%
	244-258						0.0%
	259-366						0.0%
	2015 Total						**2.5%**
2016	1-49						
	50-166	0.0%	0.0%		3.0%	7.0%	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%	3.0%
	2016 Total	**0.0%**	**0.0%**		**1.0%**	**2.0%**	**0.9%**
2017	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%
	2017 Total	**0.0%**	**0.0%**		**0.0%**	**0.0%**	**0.0%**
2018	1-49						
	50-166	0.0%	0.0%		46.8%	50.0%	
	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%	
	2018 Total	**0.0%**	**0.0%**		**11.9%**	**12.4%**	
2014-2018 Total		**0.0%**	**0.0%**		**3.5%**	**3.3%**	**1.1%**

FISH POPULATION MONITORING RESULTS

From 2014-2018, 15 of the 19 Ohio River pools were sampled. In 2014, Belleville, Markland, McAlpine, and Olmsted pools were sampled. Montgomery, Racine, and J.T. Myers were sampled in 2015. Pools sampled in 2016 included Willow Island, Greenup, and Cannelton. New Cumberland, Meldahl, and Newburgh were sampled in 2017. Lastly, only Emsworth and Pike Island were sampled in 2018 as staff resources for sampling a third pool were reallocated to a USEPA national survey of rivers and streams. This reallocation was approved by ORSANCO's Biological Water Quality Subcommittee and allowed staff to sample 98 sites within Ohio River basin states between 2018 and 2019 at the request of our state partners. For pools not sampled in this cycle (Dashields, Hannibal, R.C. Byrd, and Smithland) the most recent data sets available (2013) will be presented (Figure 7).

Based on both index scores, all pools were assessed as fully supporting the aquatic life use. 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 C. Macro data prior to 2015 were excluded from the assessment process as it was used during the calibration of the index and for index evaluation. Therefore, 2013 and 2014 ALU assessments were completed using only average *m*ORFIn scores.

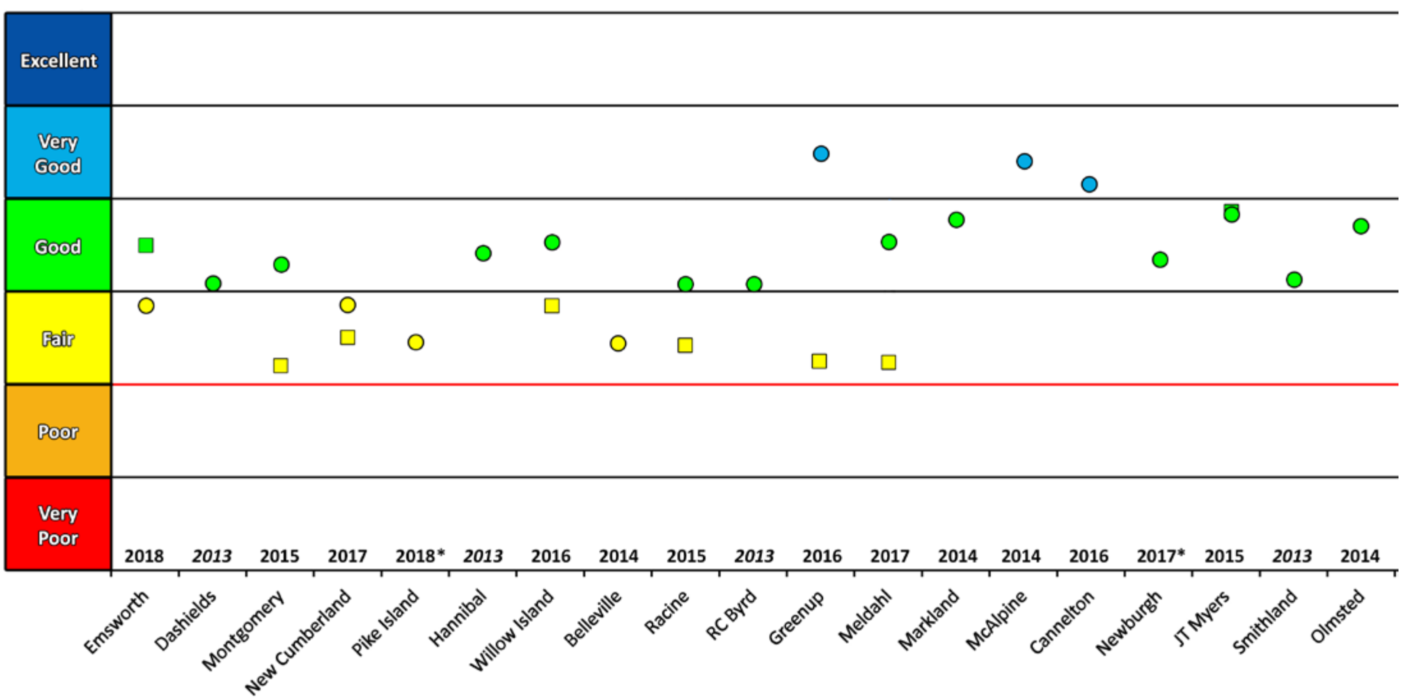


Figure 7. Ohio River fish (○) and macro (□) assemblage index scores by pool, 2014-2018, Newburgh and Pike Island did not meet the minimum site requirement for a macro assessment (*).

AQUATIC LIFE USE ASSESSMENT SUMMARY

Aquatic life criterion determined by the states for total iron (ORSANCO does not have an iron criteria for the Ohio River) are exceeded in greater than ten percent of samples in several segments of the river. No other exceedances of water quality criteria for the protection of aquatic life were observed. The Commission employed the WOE approach favoring the results of the biological indicators over the exceedances of several of the states' individual iron criterion. The assessments of fish surveys from 2014-2018 and macroinvertebrates surveys from 2015-2018 showed that the entirety of the Ohio River was 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 30 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 16 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 January 2014 to December 2018. Bacteria data were collected during the contact recreation season (April through October of each year during the cycle) in Pittsburgh, Wheeling, Huntington, Cincinnati, Louisville, and Evansville. In addition, the Commission sent surveys to all Ohio River water utilities, requesting information about their source water quality. ORSANCO received responses from seven 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 (toxic or conventional) 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 (toxic or conventional) 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 (toxic or conventional) 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

None of the 15 previously detailed public water supply parameters sampled for by ORSANCO had exceedances of their specific criteria. ORSANCO staff received limited response to the questionnaire surveys solicited from the 34 public and private water utilities use the Ohio River as a drinking water source (Table 9). Of the seven replies only two utilities reported intake closures or conditions necessitating added treatment. In all cases they were temporary isolated incidents (e.g. flooding, nearby spill, or the 2015 HAB). No utility reported chronic issues related to Ohio River source water. Based on a data compiled from the US EPA's drinking water data base, six utilities had MCL violations for total trihalomethanes (TTHMs), two utilities had violations of the MCL for Haloacetic acid (HAA5), and two utilities had violations of total coliforms (TCR). TTHM and HAA5 are byproducts of the water treatment process. Coliforms are routinely treated for in the production process; TCR presence in finished water indicates incomplete treatment. Overall, the results of these assessments indicate the entire river is designated as fully supporting the public water supply use.

Table 9. 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[1]	Contaminant Causing MCL Violation[1] (# of times)
West View	5	PA	No				No	
Robinson	8.6	PA	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 (7)
East Liverpool	40.2	OH	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	Yes	No	No	No	Yes	TTHM (6)
Steubenville	65.3	OH	No				No	
Follansbee (H.H.)	70.8	WV	No				No	
Wheeling	86.8	WV	No				No	
Village of Bellaire	93.9	OH	No				No	
New Martinsville (Bayer)(Covestro)	121.9	WV	No				No	
Sistersville	137.2	WV	Yes	No	No	No	No	
Parkersburg	182.5	WV	No					
Huntington	304	WV	No				Yes	TTHM (1)
Ashland	319.7	KY	No				Yes	TTHM (10), HAA5 (3)
Ironton	327	OH	No				No	
Russell	327.6	KY	Yes	No	No	No	Yes	TTHM (1), HAA5 (1)
Portsmouth	350.8	OH	No				No	
Maysville	407.8	KY	Yes	No	Yes[2]	Yes[3]	No	
Cincinnati	462.8	OH	Yes	No	Yes[4]	Yes[4]	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	TCR
Sturgis	871.4	KY	No				No	TCR
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, 12-17-2019

2. One temporary intake closure reported associated with a nearby spill, date and duration not reported

3. Additional treatment incident resulted from flood conditions

4. Intake closure and added treatment resulted from the 2015 harmful algal bloom, alterations were necessary for multiple weeks

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 (April-October of 2014-2018): routine contact recreation bacteria sampling and longitudinal bacteria surveys conducted through the Watershed Pollutant Reduction Program. Contact recreation season data from 2014 through 2018 and longitudinal bacteria survey data from 2003 through 2008 were used in the assessment. Longitudinal survey data outside the 2014-2018 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 River. 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 bacteria data are available at www.orsanco.org/programs/ water-quality-assessment. Five rounds of sampling are completed monthly in these communities: Pittsburgh (PA), Wheeling (WV), Huntington (WV), Cincinnati (OH), Louisville (KY), and Evansville (IN). 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 CSO events were likely to have occurred during the 2014-2018 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. 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 colonies/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 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

A total of 340.7 Ohio River miles (35%) were assessed as "Fully Supporting", 403.0 river miles (41%) as "Partially Supporting", and 237.3 river miles (24%) as "Not Supporting" the contact recreation use (Table 10). 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). Exceedances of the monthly *E. coli* geometric criterion for the period 2014 through 2018 are shown (Figure 8). 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 9).

Table 10. 2014-2018 Contact recreation use assessment summary

State	US Assessment Mile Point	Downstream Assessment Mile Point	Total Miles Assessed	Narrative Assessment	Assessment Type
PA	0.0	1.4	1.4	Not Supporting	Reassessed
PA	1.4	3.8	2.4	Not Supporting	Historical
PA	3.8	4.4	0.6	Not Supporting	Reassessed
PA	4.4	38.9	34.5	Not Supporting	Historical
PA	38.9	40.2	1.3	Not Supporting	Historical
OH-WV	40.2	82.2	42.0	Not Supporting	Historical
OH-WV	82.2	86.2	4.0	Partial Support	Historical
OH-WV	86.2	91.3	5.1	Not Supporting	Reassessed
OH-WV	91.3	92.1	0.8	Partial Support	Historical
OH-WV	92.1	105.2	13.1	Not Supporting	Historical
OH-WV	105.2	124.3	19.1	Partial Support	Historical
OH-WV	124.3	127.0	2.7	Full Support	Historical
OH-WV	127.0	131.3	4.3	Partial Support	Historical
OH-WV	131.3	136.1	4.8	Full Support	Historical
OH-WV	136.1	141.5	5.4	Partial Support	Historical
OH-WV	141.5	146.9	5.4	Full Support	Historical
OH-WV	146.9	157.7	10.8	Partial Support	Historical
OH-WV	157.7	163.1	5.4	Full Support	Historical
OH-WV	163.1	177.3	14.2	Partial Support	Historical
OH-WV	177.3	181.5	4.2	Not Supporting	Historical
OH-WV	181.5	184.7	3.2	Partial Support	Historical
OH-WV	184.7	188.4	3.7	Full Support	Historical
OH-WV	188.4	193.3	4.9	Partial Support	Historical
OH-WV	193.3	203.2	9.9	Full Support	Historical

State	US Assessment Mile Point	Downstream Assessment Mile Point	Total Miles Assessed	Narrative Assessment	Assessment Type
OH-WV	203.2	247.9	44.7	Partial Support	Historical
OH-WV	247.9	258.0	10.1	Not Supporting	Historical
OH-WV	258.0	267.8	9.8	Partial Support	Historical
OH-WV	267.8	272.5	4.7	Not Supporting	Historical
OH-WV	272.5	306.4	33.9	Partial Support	Reassessed
OH-WV	306.4	316.0	9.6	Not Supporting	Historical
OH-WV/KY	316.0	319.4	3.4	Not Supporting	Historical
OH-KY	319.4	340.8	21.4	Partial Support	Historical
OH-KY	340.8	356.6	15.8	Full Support	Historical
OH-KY	356.6	377.7	21.1	Partial Support	Historical
OH-KY	377.7	382.9	5.2	Full Support	Historical
OH-KY	382.9	388.0	5.1	Partial Support	Historical
OH-KY	388.0	461.3	73.3	Full Support	Historical
OH-KY	461.3	463.2	1.9	Partial Support	Reassessed
OH-KY	463.2	464.5	1.3	Full Support**	Historical
OH-KY	464.5	465.2	0.7	Partial Support	Historical
OH-KY	465.2	469.3	4.1	Full Support	Historical
OH-KY	469.3	471.4	2.1	Not Supporting	Reassessed
OH-KY	471.4	488.0	16.6	Partial Support	Historical
OH/IN-KY	488.0	593.1	105.1	Full Support	Historical
IN-KY	593.1	595.5	2.4	Not Supporting	Reassessed
IN-KY	595.5	603.3	7.8	Full Support	Historical
IN-KY	603.3	608.1	4.8	Partial Support	Historical
IN-KY	608.1	609.2	1.1	Full Support*	Historical
IN-KY	609.2	614.9	5.7	Partial Support	Historical
IN-KY	614.9	683.0	68.1	Not Supporting	Historical
IN-KY	683.0	719.5	36.5	Partial Support	Historical
IN-KY	719.5	735.7	16.2	Not Supporting	Historical
IN-KY	735.7	756.4	20.7	Partial Support	Historical
IN-KY	756.4	760.6	4.2	Not Supporting	Historical
IN-KY	760.6	793.2	32.6	Partial Support	Historical
IN-KY	793.2	795.7	2.5	Not Supporting	Historical
IN-KY	795.7	798.4	2.7	Full Support*	Historical
IN-KY	798.4	799.8	1.4	Partial Support	Historical
IN-KY	799.8	802.9	3.1	Not Supporting	Historical
IN-KY	802.9	820.1	17.2	Partial Support	Historical
IN-KY	820.1	826.4	6.3	Not Supporting	Historical
IN-KY	826.4	848.0	21.6	Partial Support	Historical
IL-KY	848.0	853.4	5.4	Full Support	Historical
IL-KY	853.4	857.6	4.2	Partial Support	Historical
IL-KY	857.6	862.1	4.5	Full Support	Historical
IL-KY	862.1	872.8	10.7	Partial Support	Historical
IL-KY	872.8	878.2	5.4	Full Support	Historical
IL-KY	878.2	882.9	4.7	Partial Support	Historical
IL-KY	882.9	894.6	11.7	Full Support	Historical
IL-KY	894.6	910.3	15.7	Partial Support	Historical
IL-KY	910.3	920.5	10.2	Full Support	Historical
IL-KY	920.5	925.8	5.3	Partial Support	Historical
IL-KY	925.8	981.0	55.2	Full Support	Historical

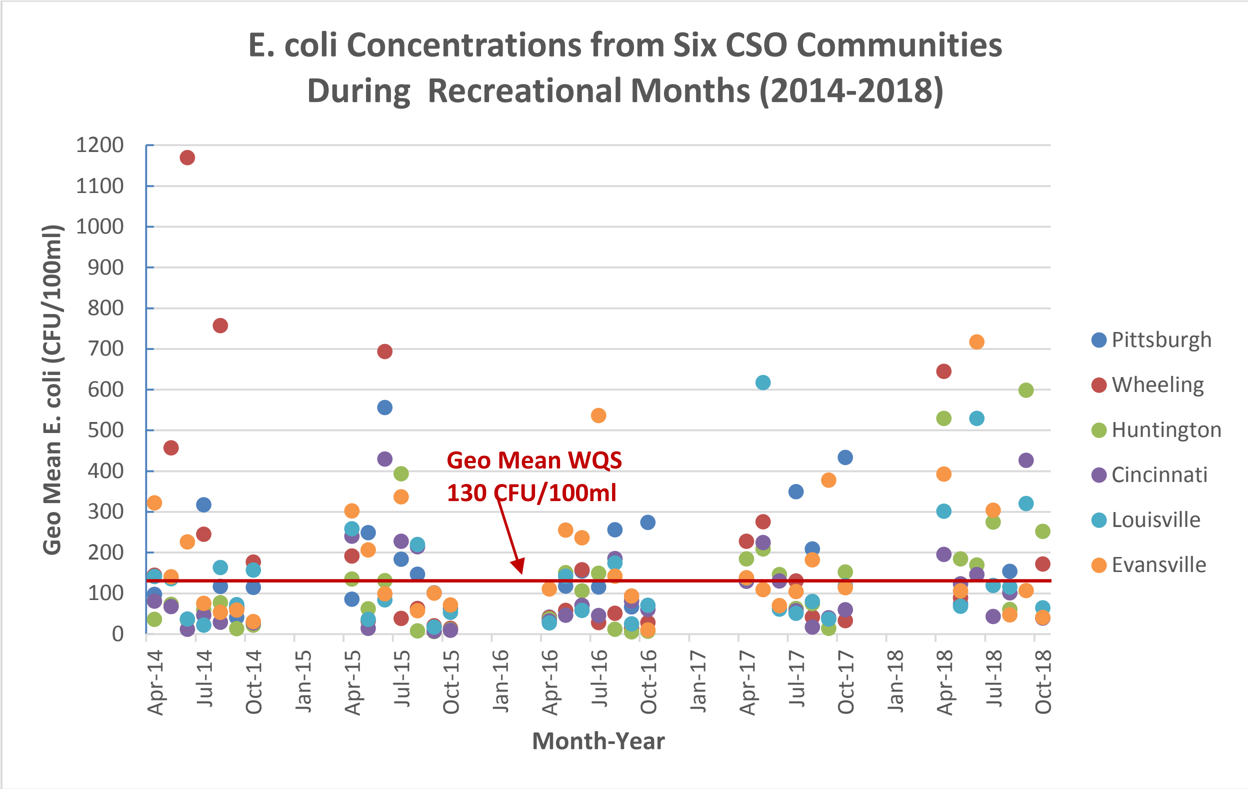


Figure 8. *E. coli* geometric mean values for six CSO Communities surveyed during each contact recreation season from 2014-2018.

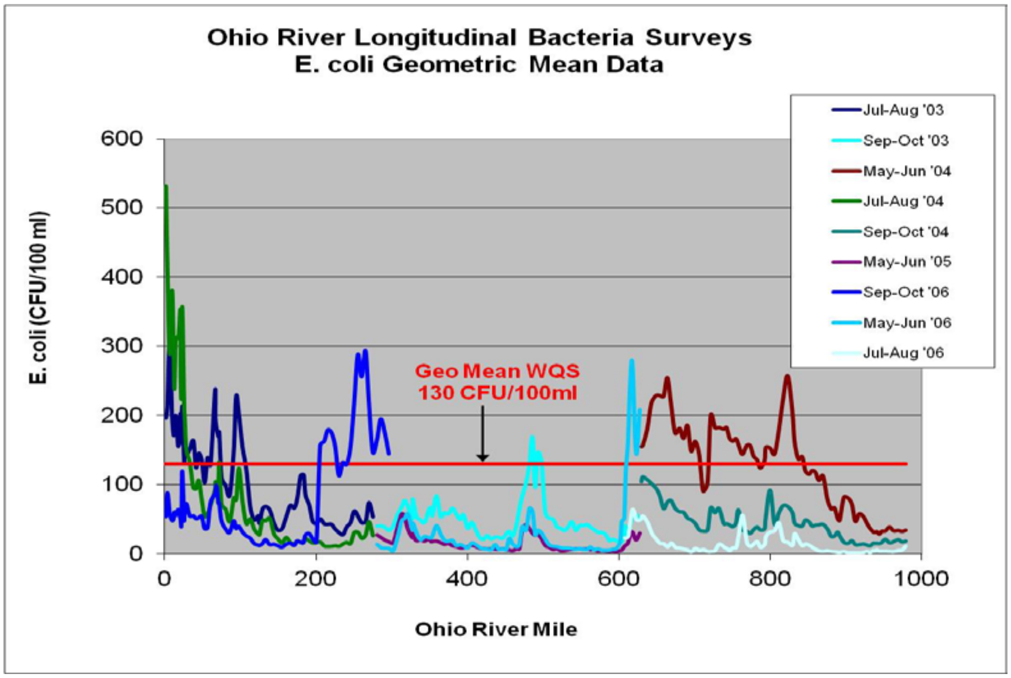


Figure 9. Geometric mean results of longitudinal surveys, 2003 - 2006.

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 primarily consisting 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 between 1997 through 2004. These data have been included in this assessment because concentrations of these chemicals are assumed to not have changed significantly since then given their persistent nature and limited remediation. The assessment based on PCBs and dioxins 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 Methylmercury:

ORSANCO has a water column mercury criteria (0.012 µg/L), derived to minimize mercury concentration in fish tissue at levels safe for human consumption. In 2010, ORSANCO was directed by the Commission's Technical Committee to use US EPA's approach for determining impairment based on methylmercury concentrations in fish tissue. 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 uses 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 gm/day for trophic level 4 and 8.0 gm/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 ORSANCO's adopted human health criterion of 0.3 mg/kg (ppm) of methylmercury.

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

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

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 10). Similarly, PCB levels were compared against the 64 pg/L human health criteria set forth in the Pollution Control Standards (Figure 11). 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.

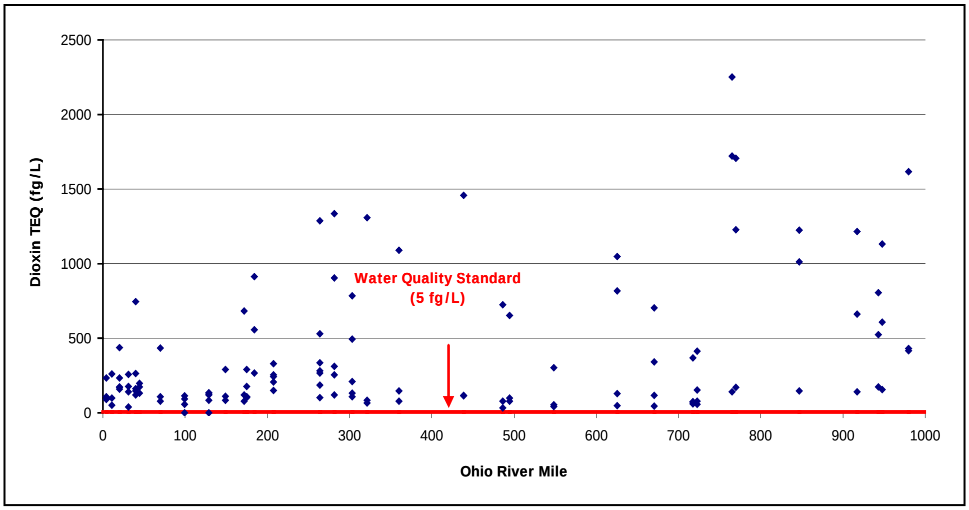


Figure 10. Dioxin TEQ concentrations in the Ohio River (1997-2004).

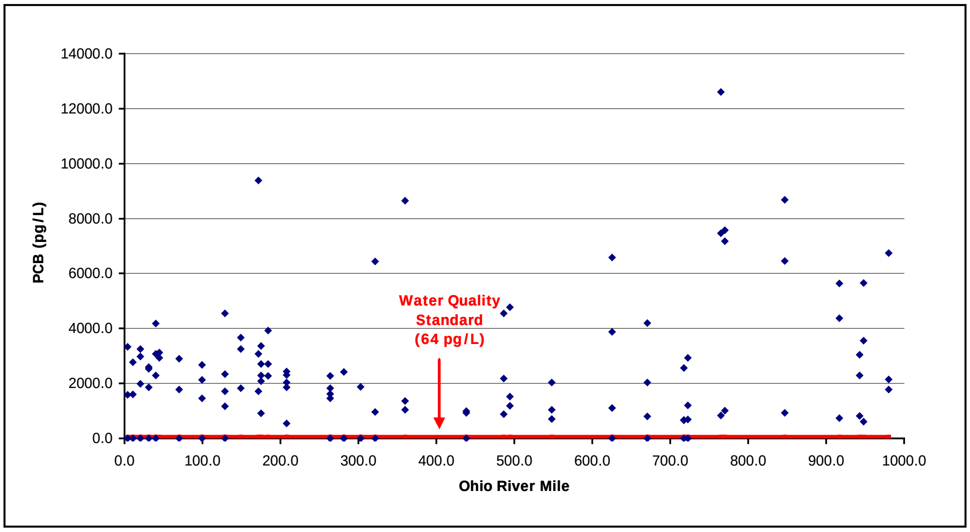


Figure 11. PCB data from the Ohio River collected from 1997-2004.

There were exceedances 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 11). The water quality criterion for total mercury in the water column is established to protect against undesirable accumulation in fish tissue. Using the USEPA's methodology for assessing the fish consumption use for methylmercury with fish tissue data (all results in Appendix E), all pools had a fish consumption weighted methylmercury fish tissue average below 0.3 mg/kg (Table 12). As a result, employing the WOE 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 methylmercury. The entire river remains impaired for dioxin and PCBs.

Table 11. Total Mercury Water Quality Criteria Exceedances 2014-2018

Mile Point	Site Name	Total No. Samples	# Criteria Exceedances	% Exceedances
54.4	New Cumberland	30	0	0%
84.2	Pike Island	30	1	3%
126.4	Hannibal	30	0	0%
161.8	Willow Island	30	2	7%
203.9	Belleville	29	0	0%
279.2	R.C. Byrd	30	2	7%
341.0	Greenup	30	5	17%
436.2	Meldahl	30	2	7%
531.5	Markland	30	1	3%
606.8	McAlpine	30	1	3%
720.7	Cannelton	30	4	13%
776.1	Newburgh	29	5	17%
846.0	J.T. Myers	30	7	23%
918.5	Smithland	30	5	17%
938.9	L&D 52	29	5	17%
964.6	Olmsted	1	0	0%

Additionally, 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.

Table 12. Summary of consumption-weighted pool averages for methylmercury in fish tissue.

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	0.02-0.25	1	0.07	0.085
Dashields	2	0.17-0.18	2	0.18-0.19	0.179
Montgomery	2	0.06-0.08	5	0.04-0.12	0.072
New Cumberland	4	0.06-0.18	2	0.14-0.3	0.136
Pike Island	0	-	1	0.02	0.009
Hannibal	0	-	4	0.06-0.26	0.052
Willow Island	3	0.07-0.24	5	0.11-0.31	0.158
Belleville	3	0.03-0.1	2	0.18-0.29	0.141
Racine	4	0.04-0.25	4	0.08-0.23	0.150
R.C. Byrd	3	0.13-0.24	3	0.13-0.22	0.179
Greenup	4	0.12-0.15	7	0.12-0.44	0.176
Meldahl	2	0-0.12	5	0.02-0.26	0.031
Markland	6	0.07-0.17	14	0.02-0.7	0.193
McAlpine	4	0.06-0.28	8	0.02-0.28	0.136
Cannelton	2	0.09-0.17	0	-	0.230
Newburgh	1	0.12	7	0.03-0.32	0.119
J.T. Myers	13	0.06-0.37	10	0.09-0.61	0.180
Smithland	5	0.03-0.6	8	0.04-0.38	0.208
Olmsted	3	0.06-0.27	2	0.06-0.28	0.202
Open Water	7	0.06-0.49	1	0.04	0.100

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 records 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 sampling 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 13, 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 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 13. 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: HARMFUL ALGAL BLOOMS (HAB)

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 and clear, warm water.

Sampling on the Ohio River has identified over 300 different species of algae. These algae are divided into eight 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 ingest them, either through recreation (such as swimming), or in drinking water.

US EPA has developed Health Advisories for Microcystins and Cylindrospermopsin (Table 14). These advisories are based on a 10 day exposure.

Table 14. US EPA finished drinking water health advisories for algal toxins.

Threshold	Microcystin (µg/L)	Cylindrospermopsin (µg/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* of 4 µg/L and 8 µg/L, respectively. These thresholds were derived from existing peer-reviewed studies. As these values are still in draft form, 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 15 and 16).

Table 15. 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 µg/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 µg/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 16. 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 an area of 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 F. No toxins were detected in finished drinking water. Of the samples collected by ORSANCO, 15 (or 10%) were greater than 6 µg/L. The highest toxin concentration was 1900 µg/L at river mile 468.8 (Cincinnati, OH).

Following the 2015 bloom, ORSANCO staff took various steps to increase the Commission's capacity to efficiently respond to future HAB events. The *ORSANCO Harmful Algae Bloom Monitoring, Response and Communication Plan* was drafted in 2016. This guidance document outlined ORSANCO's actions to monitor, anticipate, identify, and respond to HABs. The primary goals of the actions were to (1) facilitate the States and health departments to manage the Ohio River's use as a source of recreation, and (2) allow water utilities to use the Ohio River as a source of safe drinking water. To assist with achieving these goals ORSANCO assisted USEPA staff in the development of a HAB model using the 2015 data. The USEPA model allows water quality managers the ability to contrast a given year's conditions to those which preceded the 2015 event. In order to further investigate how ambient conditions affect HAB occurrence ORSANCO, through partnerships and grants from state partners, has begun installing remote sensors to collect continuous sestonic nutrient and other physical water chemistry parameters. These efforts are both useful and necessary as ORSANCO works towards a protocol for assessing the Ohio River using HAB occurrence data.

ASSESSMENT 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 exceedances for total mercury and fish tissue criteria exceedances for methylmercury, 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 640.3 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, they were more 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 exceedances for total iron, both biological indicators show the entire river is fully supporting its aquatic life use designation. Therefore, using the WOE approach, the entire Ohio River is assessed in this report as fully supporting the aquatic life use.

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