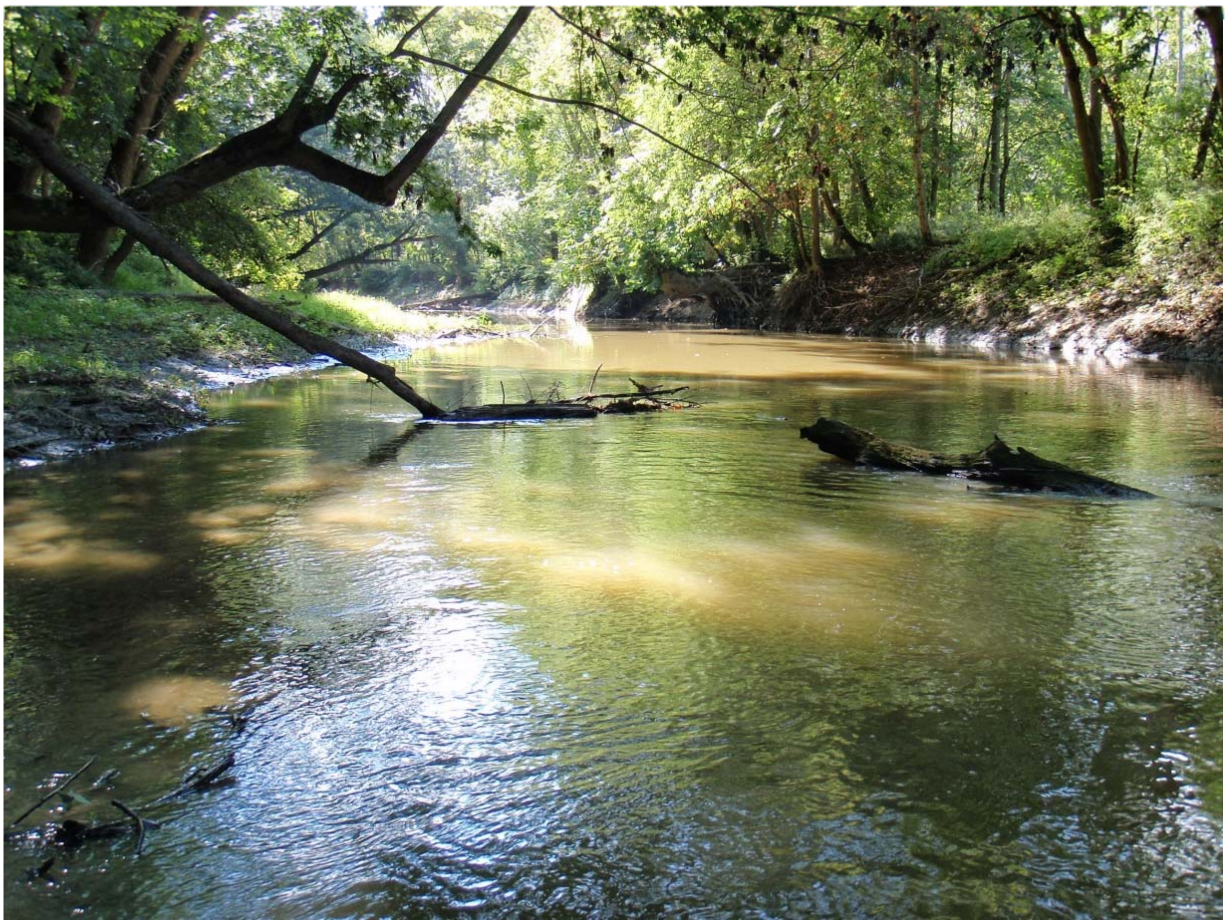
Ohio Environmental Protection Agency

Biological and Water Quality Study of the Rocky River and Select Tributaries

Cuyahoga, Summit, Lorain, and Medina Counties



Division of Surface Water
August 2020

TMDL DEVELOPMENT |

Biological and Water Quality Study of the Rocky River and Select Tributaries Sampling Years 2014-2015

Cuyahoga, Summit, Lorain, and Medina Counties

Prepared by
State of Ohio Environmental Protection Agency

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

List of Appendices (Separate Companion Document)

EXECUTIVE SUMMARY

Aquatic Life Use

The 2014 Rocky River survey included 82 monitoring stations deployed among 28 named and unnamed rivers and streams, yielding a cumulative assessment of 119.6 linear stream miles. Of these, 94.7 (79.2%) were found to fully support existing and recommended aquatic life uses (ALUs). Partial use attainment was indicated for 8.2 miles (6.8%). Wholly impaired waters (non-attainment) were limited to 16.7 miles (14%). Taken together, ALU impairment (partial and non-attainment) was identified on ten streams or stream segments of the 28 waterbodies evaluated.

With few exceptions, ALU impairments were limited to segments of smaller, higher order tributaries, as larger waters (Rocky River mainstem and East and West Branches) were found to support aquatic communities consistent with the prescribed biocriteria. The leading causes of ALU impairment were hydrologic modification and urban stormwater, both a product of the well-drained urban and suburban landscapes that typify much of the study area. Either alone or in combination with other stressors, these factors accounted for nearly 40% of impaired stream miles.

Prior to 2014, basin-wide water quality investigations of the Rocky River were undertaken in 1981, 1992, and 1997. These data allowed for a meaningful assessment of the environmental conditions of the study area through time and provided an opportunity to audit the effectiveness of the various state and federal water pollution control initiative implemented over the past 30 plus years.

Compared against historical results ALU attainment has improved significantly throughout the watershed. The baseline assessment found the Rocky River mainstem heavily impacted. Over the intervening years, aquatic communities showed step-wise gains, culminating in full restoration of WWH conditions in 2014. Although the initial frequency and magnitude of impairment was not as great as that observed on the mainstem, a similar pattern of recovery was observed on the large principal tributaries, (East and West Branches), as these too now support aquatic communities consistent with the WWH biocriteria.

The high degree ALU attainment that now typifies the basin is a product of multiple long-term water pollution control activities. First among these is the elimination of substandard publicly owned treatment works (POTWs), the wastewater formerly received by these facilities redirected to larger facilities within the basin or exported for treatment out of the watershed. Substantial reductions in the frequency, duration, and total volume of untreated sanitary waste from dry and wet weather combined sewer overflows (CSOs), sanitary sewer overflows (SSOs), or related bypasses have been realized through plant closures (as described above), increased plant capacity, and better management of and improvements to wastewater collection systems. The imposition of Water Quality Based Effluent Limits (WQBELs) through the mid-1980s and subsequent permit modification have directed significant public capital expenditures on advanced municipal wastewater treatment that has significantly improved the performance of remaining POTWs. Together, these and other actions have resulted in significant water quality gains and commensurate recovery of the ALU on most previously impaired waters.

Recovery of the smaller tributaries was not nearly as complete, but significant progress has been achieved as the trajectory of the water quality measures and biometrics are positive. However, all or portions of selected tributaries have remained impacted since the earliest investigations. Of these, Abram Creek, Baldwin Creek and Plum Creek warrant brief mention.

Through the period of record, the closure of two failing POTWs in the 1990s and improved management of stormwater and deicing wastes by the Cleveland Hopkins International Airport (CHIA), have alleviated the egregious impacts identified on Abram Creek by past surveys. The 2014 results found conditions much improved, particularly through the lower mile. Although background loads and those from CHIA appeared to limit full ALU recovery, the enclosure of a mile segment of Abram Creek by the CHIA in 2004 imposed additional limitations. The partial recovery documented through lower Abram Creek was the product of both improved water quality and open fish passage between Abram Creek and the now recovered Rocky River. The culverted segment has effectively isolated the headwaters of Abram Creek, preventing fish recolonization from both its lowest reaches and the Rocky River mainstem. Post survey background research identified an additional barrier to fish passage, in the form of an old lowhead dam located just downstream from the outlet of the enclosed segment. Given the overgrowth of vegetation and materials employed, the dam appears to have been in place for a very long period of time. This structure alone has served as an impassable barrier for many decades, or perhaps even longer, and now combined with the airport enclosure reinforces the physical isolation of the headwaters of Abram Creek.

Persistent ALU impairment of Baldwin Creek was observed between 1981 and 1997. Impairment at the time was attributed pollutant loads from two municipal WWTPs located in the headwaters, with failing home septic systems considered important secondary sources. Although incomplete, partial recovery was documented in 2014, following improved wastewater treatment (plant upgrades in the 1990s) and the recent removal in 2012 of three of the four lowhead dams on the lower mile of Baldwin Creek. In light of improved water quality, full recovery of the macrobenthos, and the rapid recovery of the fish communities following dam removal, the remaining impoundment on Baldwin Creek appeared an important barrier to fish passage, very likely precluding ALU restoration, akin to that so successfully documented near the mouth.

Plum Creek has remained impaired since first evaluated in 1981. Prior assessments identified gross organic enrichment from multiple POTWs as the primary cause and source of ALU impairment, with failing home septic systems or other unknown sources of sanitary waste considered important secondary contributors. Following the closure of two failing POTWs in late-1990s and subsequent upgrades to the remaining POTW (Plum Creek WWTP), water quality was improved and the macrobenthos recovered up to WWH levels at all 2014 sites. In contrast, poor fish communities have persisted. The absence of recovery registered in the fish community appeared a result of the natural barrier to fish passage provided by the Plum Creek gorge, at the mouth of Plum Creek. Lacking access to the West Branch or other intact source-waters from which fish may reinvade, isolation effects on Plum Creek have precluded full recovery from past impacts.

<u>2012 Cyanide Spill</u>

In the spring of 2012, waste cyanide was illegally released into East Branch, poisoning the lower eight miles and resulting in the loss of over 30,000 fish. Sampling in 2014 through the affected segment found no lingering effects attributable to the spill and associated fish kill, as community performance within this area consistently met or exceeded the WWH criteria. The rapidity and fullness of this recovery clearly demonstrates that healthy riverine systems are resilient and have a great capacity for self-repair.

<u>Fish Contaminants</u>

The 2014 survey found mercury contamination throughout the study area stable to declining, thus no new or otherwise more stringent advisories are recommended. The state-wide mercury advisory of one meal per week appeared appropriate for most species and most fishable waters within the Rocky River basin.

Transformed contaminant levels were indexed against the human heath criteria and assessments derived for six watershed assessment units that contain larger, fishable, segments within the study area. Previous assessments of these areas found four of the six impaired due to criteria exceedances for mercury or PCBs, or both. By 2014, the magnitude and extent of contamination had declined, bringing all previously impacted units into full compliance.

<u>Drinking Water</u>

The City of Berea is the only public water system directly served by surface water sources within the study area. Source water monitoring results for nitrate, atrazine and cyanotoxins (i.e., microcystins, saxitoxin and cylindrospermopsin) were indexed against the Public Water Supply (PWS) criteria. Nitrate results indicated full support watch list determination due to a single sample exceeding 80% of the criterion. Atrazine concentrations were low and remained well-below criteria for impairment or watch list status. Most cyanotoxin results were at or below detection levels, but microcyst ins and saxitoxin were detected at levels of concern in Coe Lake (a secondary source water), including a microcystin exceedance resulting in a watch list determination.

Recreational Use

Twenty-three locations were sampled for *E. coli in* 2014. Resulting colony counts exceeded the applicable recreational use criteria at 22 of the 23 monitoring stations, thus nearly all assessed waters failed to support the either class A or B, PCR uses. Over half of the impaired sites exceeded criteria by a factor of three, with maximum values exceeding the criteria by a factor of ten. The highest geometric means were observed from the lower Baldwin Creek, lower East Branch, Rocky River mainstem, upper West Branch, Porter Creek and Cahoon Creek.

Note: Beneficial use recommendations within this report were adopted into OAC 3745-1-20 and became effective 1/1/2017.

SYNOPSIS

As part of the Total Maximum Daily Load (TMDL) process, an integrated biosurvey of the Rocky River watershed was conducted by the Ohio EPA during the 2014 field sampling seasons. The study area included non-lake affected (free-flowing) segments of the Rocky River mainstem, the entire lengths of the East and West Branches, and principal affiliated tributaries. A total of 82 monitoring stations were sampled throughout the catchment, evaluating 28 named and unnamed rivers and streams, yielding a cumulative assessment of 119.6 linear stream miles. Ambient biology, macrohabitat quality and water column chemistry data were gathered from most locations. Bacterial contamination, diel water quality, fish tissue, and sediment chemistry (metals, organics, and particle size) were evaluated at selected stations on the mainstem and larger tributaries. Three headwater stations were monitored and assessed in cooperation with qualified staff from the Cleveland Metroparks. Two previously unassessed minor Lake Erie tributaries, Potter Creek and Cahoon Creek, were incorporated into the Rocky River study area. Based upon preliminary results from 2014, selected waters were subjected to additional monitoring and assessment in 2015. The general discussion of the primary and supplementary results (i.e., years 2014 and 2015) within this report shall henceforth refence only the 2014 field year. Unless otherwise stipulated, the inclusion of the 2015 data, where present and relevant, is implied.

Aquatic Life Use Attainment

Of the 119.6 stream miles assessed as part of the Rocky River study area, 94.7 (79.2%) were found to fully support existing and recommended aquatic life uses. Partial use attainment was indicated for 8.2 miles (6.8%). Wholly impaired waters (non-attainment) were limited to 16.7 miles (14%). Taken together, aquatic life use impairment (partial and non-attainment) was identified on ten streams or segments of the 28 waterbodies evaluated. Although this number would suggest that over a third of assessed waters are impaired, that impression is misleading, as the majority of streams, monitoring stations, and assessed river miles were found to support diverse and well-organized fish and benthic macroinvertebrate assemblages. Furthermore, all but a fraction of the largest, lower order streams (i.e., Rocky River, East Branch, and West Branch) consistently supported WWH communities. Excepting a small reach of the lower East Branch, ALU impairments were limited to segments of smaller, higher order tributaries. Aquatic life attainment statistics for the study area are summarized in Figure 1.

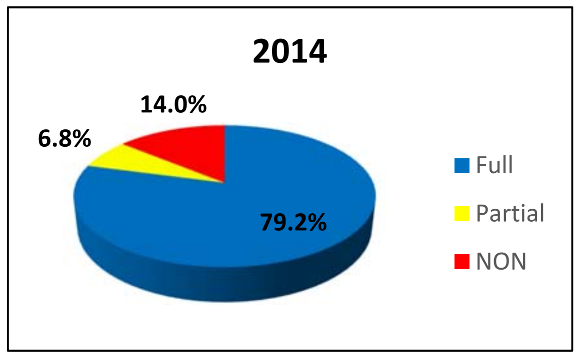


Figure 1. Cumulative aquatic life use attainment for all waters assessed as part of the Rocky River study area, 2014.

The leading associated cause and source of aquatic life use impairment were hydrologic modification and urban stormwater, both attending the well-drained urban and suburban landscapes that typify much of the Rocky River study area. Either alone or in combination with other stressors, these factors accounted for nearly 40% of impaired miles. Affected streams or segments included eight of the ten described previously. Habitat alterations and low Dissolved Oxygen (DO) were the next leading causes, each accounting for approximately 20% of impaired miles. As a causative factor, low DO had two associated sources: heavily contaminated stormwater and natural factors related to palustrine and rheopalustrine conditions. The source of habitat alterations was related exclusively to the lingering effects of prior channelization, resulting in persistent over-simplified macrohabitat. Whether anthropogenic or natural in origin, barriers to fish passage appeared the primary or contributing cause of impairment on portions of four streams, accounting for 15% of impaired miles. By isolating portions of affected streams, these barriers have either protracted or precluded ALU recovery following improved water quality by preventing the reestablishment of a well-balanced fish community from intact or subsequently recovered streams or reaches. The remaining causes accounted for just over six percent of impaired miles on two stream segments and included cyclical desiccation and sedimentation. The former was attributed to natural factors and the latter associated with excessive deposition of sand within the upper limits of low head dam pool.

ALU attainment status by waterbody and station with associated causes and source of impairment are provided in Table 1 and Figure 2.

Impaired Waters

Abram Creek

Aquatic life impairment has persisted on Abram Creek since it was first assessed in 1981. Through the period of record, this stream has been affected by a complex, shifting and interactive suite of stressors: failing STPs (sewage treatment plants), urban stormwater, deicing wastes from Cleveland Hopkins International Airport (CHIA), hydrological modification, channel realignment and enclosure, and other background sources. The elimination of two STPs from the headwaters in the mid-1990s reduced pollutant loads, but alone was insufficient to allow for full recovery given the influence of other important pollution sources. Through the late-1990s, the effects of deicing waste (urea and various glycols) entrained in stormwater proved highly toxic and rendered much of Abram Creek heavily impacted. These conditions resulted in multiple consent decrees between CHIA and Ohio EPA requiring, among other things, that the CHIA better manage deicing runoff to limit off-site impacts. To that end, CHIA installed a Centralized Deicing Facility (CDF) in 2006 to capture and store contaminated runoff. Since that time, most of the deicing wastes collected by the CDF are directed to the collection system of the Northeast Ohio Regional Sewer District (NEORSD) and treated at a regional facility outside of the watershed. Other relevant developments included the enclosure of approximate a mile of lower Abram Creek in 2004 by the CHIA to accommodate runway expansion. Aside from the immediate negative effects attending the loss of a mile of open channel, this enclosure now serves as substantial barrier to fish passage and in combination with a lowhead dam located immediately downstream from the culverted segment, has physically isolated much of Abram Creek from the Rocky River mainstem.

Compared with historical results, the 2014 survey found much evidence of recovery. Biological conditions within the headwaters, upstream from the culverted segment, remained heavily impacted, but improved by comparison. Biological performance downstream from the culverted segment showed significantly greater progress. Through the lower mile, fish communities consistently met the WWH biocriterion, and in fact achieved index scores well within the exceptional range. The performance of the macrobenthos through this reach, though improved, still failed to perform up to WWH levels. These advancements tracked with improved water quality, as the egregious conditions documented in the past have been largely abated. However, in this instance progress respecting water quality was a necessary, yet insufficient condition to have allow for the restoration of the fish community observed on lower Abram Creek. A direct and unfettered connection to the Rocky River mainstem, itself now recovered, was of nearly equal import as it allowed for rapid recolonization of lower Abram Creek following the abatement of gross pollution impacts documented up through the mid-1990s.

As prominent pollution sources have been removed or significantly lessoned over time, background loads became more apparent. Despite the progress identified above, Abram Creek still offered strong evidence of urban/industrial stormwater through its entire length (elevated metals, chlorides, TDS, etc.), including multiple water quality exceedances for specific conductance. In addition, the headwaters offered evidence of a moderate organic load. Here the DO regime was depressed, evidenced by multiple excursions below the minimum WWH criterion. Although concentrations remained below the applicable water quality criterion, ammonia too was found elevated, with station means well in excess of regional background concentrations. As Abram Creek arises from a glacial lake and marsh complex (AKA Lake Abram), the export of ammonia and an organic load from this waterbody was not unexpected or otherwise surprising, given the reductive conditions that often typify such environments. Regarding the heightened oxygen demand (inferred by low DO) downstream from Lake Abram, these observations aligned with those made independently by field investigators from NEORSD in 2012 (NEORSD 2014).

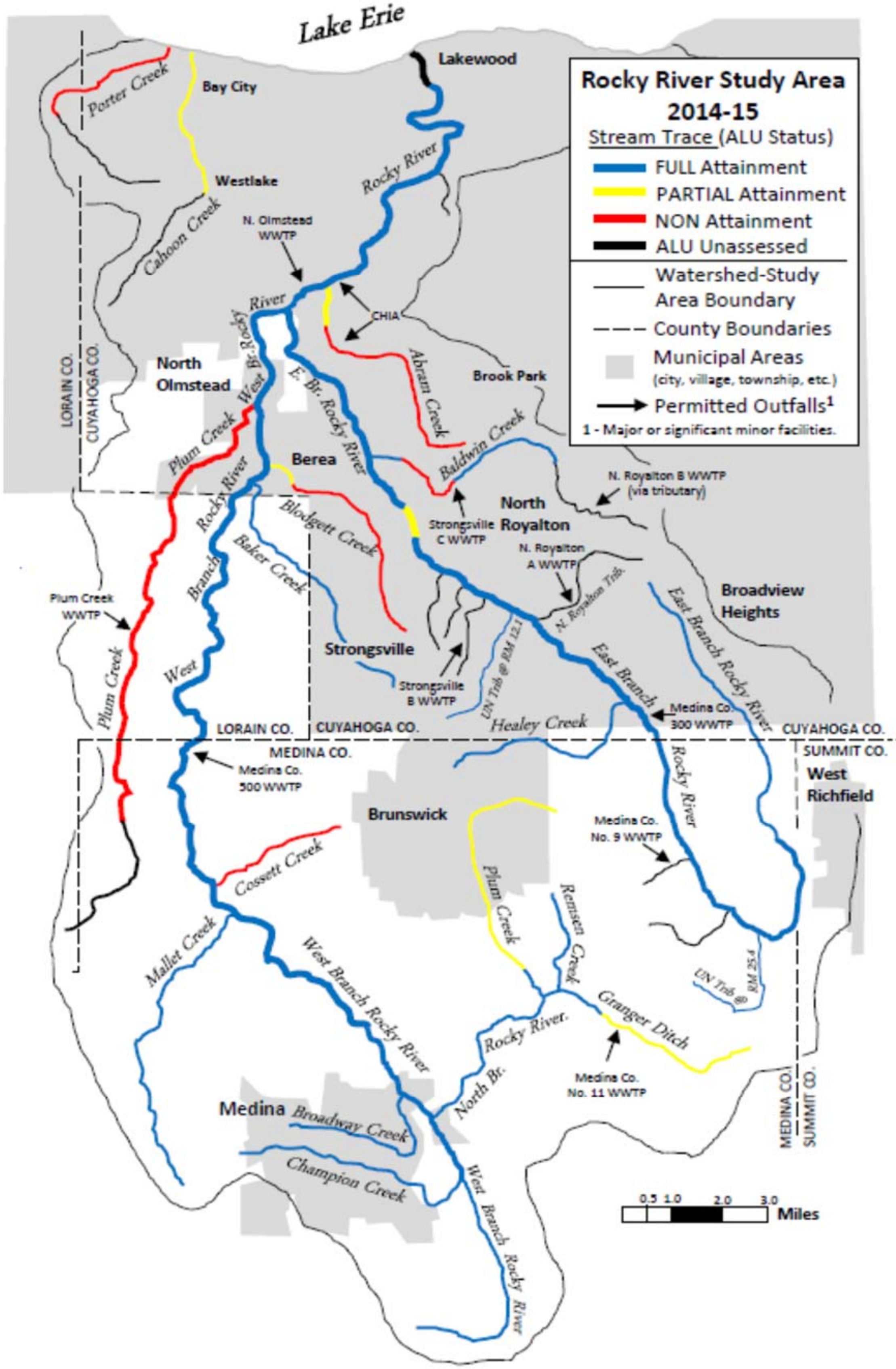


Figure 2. Rocky River study, showing political boundaries, locations of major and important minor NPDES permitees, and stream traces color-coded to ALU status, 2014-2015.

Table 1. Aquatic Life Use (ALU) attainment status, Rocky River study area June-October, 2014-15. The Rocky River study area lies wholly within the Erie-Ontario Lake Plain (ELOP) ecoregion. ALU impairments and associated causes and sources are highlighted (mat yellow).

Location	STORET (RM)[a]	Drain. (miles²)	IBI	MIwb[b]	ICI[c]	QHEI	Status[d]	Causes	Sources
Rocky River (13-001-000) WWH (Existing)									
Ust. North Olmsted WWTP, at ford	T01W19 (11.65)[W]	267.0	45	8.8	50	68.30	**FULL**		
Dst. North Olmsted WWTP, adj. Park Blvd.	501770 (11.1)[W]	268.0	40	8.1	40	60.50	**FULL**		
Brook Park Rd.	501780 (9.95)[W]	279.0	39	8.5	44	64.80	**FULL**		
At Fairview Park	T01W13 (9.0)[W]	281.0	44	9.2	G	81.00	**FULL**		
Near Mastick Golf Course, at old ford	T01W12 (7.6)[W]	282.0	47	9.2	48	71.50	**FULL**		
Dst. SR 10	T01W09 (5.8)[W]	289.0	42	8.6	40	71.80	**FULL**		
Lakewood, at Park Blvd.	501790 (3.0)[W]	291.0	44	9.0	42	83.00	**FULL**		
Ust. Lakewood WWTP bypass	T01W03 (1.8)[W]	292.0	41	8.8	46	72.50	**FULL**		
Ust. Detroit Ave., park boat ramp, dst. Lakewood WWTP bypass	T01P02 (1.39)[B]	293.0	41	7.8[ns]	32[ns]	67.00	**FULL**		
Abram Creek (13-002-000) WWH (Existing)									
Dst. Airport storm drain, at Eastland Rd.	T01W76 (3.15)[H]	6.8	<u>18</u>*	-	F*	62.0	**NON**	Low DO Other flow regime alterations Fish-Passage Barrier (enclosure/dam)	Natural sources (palustrine) Urban runoff/storm sewers Hydrostructure, Impacts on Fish Passage (enclosure/dam)
Immediately ust. Airport enclosure, at Grayton Rd.	T01P13 (1.9)[H]	8.9	<u>20</u>*	-	LF*	61.8	**NON**	Low DO Other flow regime alterations Fish-Passage Barrier (enclosure/dam)	Natural sources (palustrine) Urban runoff/storm sewers Hydrostructure, Impacts on Fish Passage (enclosure/dam)
Dst. Airport enclosure, NASA property, at Cedar Point Rd.	501830 (0.84)[H]	9.7	46	-	F*	62.0	**PARTIAL**	Other flow regime alterations	Urban runoff/storm sewers
Near mouth, at West Area Rd.	T01S04 (0.3)[H]	10.1	54	-	F*	59.0	**PARTIAL**	Other flow regime alterations	Urban runoff/storm sewers

Location	STORET (RM)[a]	Drain. (miles²)	IBI	MIwb[b]	ICI[c]	QHEI	Status[d]	Causes	Sources
Porter Creek (13-003-000) WWH (Recommended)									
Bay Village, at US 6	T01P20 (0.1)[H]	8.3	34*	-	LF*	68.3	**NON**	Other flow regime alterations	Urban runoff/storm sewers
Cahoon Creek (13-004-000) WWH (Recommended)									
Bay Village, at US 6	T01P21 (0.08)[H]	5.4	36[ns]	-	F*	58.3	**PARTIAL**	Other flow regime alterations	Urban runoff/storm sewers
East Branch Rocky River (13-100-000) WWH (Existing)									
Rising Valley: Oviatt Rd.	302627 (30.8)[H,CM]	7.3	50	-	MG[ns]	71.0	**FULL**		
SR 303, ust. Camp Hilaka	T01A52 (29.22)[H]	8.9	50	-	MG[ns]	80.5	**FULL**		
Harter Rd., ust Medina Co. WWTP No. 9	501660 (26.63)[H]	14.3	50	-	56	64.8	**FULL**		
SR 303, dst. Medina Co. No. 9 WWTP, dst. Hinckley Reservoir	T01S07 (21.98)[W]	25.4	50	9.9	54	78.5	**FULL**		
Ust. Medina 300 WWTP	T01W41 (18.3)[W]	31.6	45	8.9	48	69.0	**FULL**		
Private Lane off SR 3, dst. Medina 300 WWTP	T01W38 (17.5)[W]	31.8	47	9.2	46	65.3	**FULL**		
Bennet Rd., ust. N. Royalton WWTP (via trib.@RM 12.9)	501690 (15.15)[W]	40.0	44	9.2	46	63.8	**FULL**		
SR 82/Royalton Rd., ust Strongsville B WWTP (via trib.@RM 11.1), and dst. N. Royalton WWTP	T01W33 (11.57)[W]	53.0	43	9.4	44	76.5	**FULL**		
Mill Stream Run bridge, dst. I-71, dst. Strongsville B WWTP (via Trib. at RM 11.1)	T01W30 (10.0)[W]	57.0	38	8.2	40	53.5	**FULL**		
Strongsville, between SR 42 and I-71	T01W29 (9.35)[W]	59.0	41	8.7	F*	71.3	**PARTIAL**	Other Flow Regime Alterations Sedimentation/Siltation	Dam or Impoundment
Adj. parkway, dst. low-head (Note: cyanide fish kill, 2012 from ~RM 9.0 to mouth)	T01W27 (8.2)[W]	60.0	42	9.5	46	69.0	**FULL**		
East Branch Rocky River (13-100-000) WWH (Existing)									
Eastland Rd./US 80	T01W25 (7.35)[W]	63.0	39	9.2	48	64.0	**FULL**		

Location	STORET (RM)[a]	Drain. (miles²)	IBI	MIwb[b]	ICI[c]	QHEI	Status[d]	Causes	Sources
Berea, well ust. Baldwin Lake	501720 (6.38)[W]	63.0	45	9.5	40	55.5	**FULL**		
East Branch Rocky River (13-100-000) WWH (Existing)									
Dst. Baldwin Lake (dam modification)	T01K04 (5.1)[W]	64.0	42	8.1	40	51.5	**FULL**		
Dst. old Berea WWTP, at ford	T01P04 (3.06)[W]	75.6	51	9.8	46	68.0	**FULL**		
Spafford Rd., at ford	501740 (1.28)[W]	76.5	45	9.1	40	70.0	**FULL**		
East Br. Tributary @ RM 25.4 (13-100-011) UD, WWH (Recommended)									
Picnic Area, off State Rd.	302629 (0.1)[H,CM]	2.9	46	-	VG	69.5	**FULL**		
Healy Creek (13-104-000) WWH (Existing)									
Boston Rd.	501630 (0.7)[H]	4.9	46	-	MG[ns]	60.5	**FULL**		
East Br. Tributary @ RM 12.1 (13-100-015) UD, WWH (Recommended)									
Royalview Rd., Near Mouth	302632 (0.1)[H,CM]	1.71	40	-	G	78.0	**FULL**		
Baldwin Creek (13-101-000) WWH (Existing)									
Lucerne Rd., ust. Strongsville C WWTP (N. Royalton B WWTP well ust. at RM 7.3)	T01W53 (3.53)[H]	6.6	42	-	36 (2015)	56.8	**FULL**		
Big Cr. Parkway, dst. Strongsville C WWTP	501650 (2.61)[H]	8.3	20*	-	32[ns] (2015)	60.5	**NON**	Other flow regime alterations	Urban runoff/storm sewers
Eastland Rd.	T01W59 (1.13)[H]	9.6	26*	-	MG[ns]	61.3	**NON**	Fish-Passage Barrier Other flow regime alterations	Dam or Impoundment Urban runoff/storm sewers
Rocky R. Dr., dst. Coe Lake (dam removal)	T01G01 (0.2)[H]	10.0	46	-	MG[ns]	69.5	**FULL**		
At mouth (dam removal location)	301231 (0.1)[H]	10.0	50	-	MG[ns]	59.3	**FULL**		
W. Br. Rocky River (13-200-000) WWH (Existing)									
SR 162	501940 (33.55)[H]	9.1	46	-	52	69.0	**FULL**		
Ridgewood Rd., ust. Town & Country Co-op Inc. (via Tributary), dst. Landfill	301181 (32.26)[H]	11.4	48	-	G	73.5	**FULL**		

Location	STORET (RM)[a]	Drain. (miles²)	IBI	MIwb[b]	ICI[c]	QHEI	Status[d]	Causes	Sources
Dst. Medina, at Fenn Rd., dst. N. Br. Rocky River.	501820 (27.3)[W]	69.0	51	9.7	44	72.3	**FULL**		
W. Br. Rocky River (13-200-000) WWH (Existing)									
Abbeyville at Neff Road	501900 (21.75)[W]	85.0	46	9.1	56	61.5	**FULL**		
Grafton Rd.	501890 (16.35)[W]	123.0	41	8.9	46	61.8	**FULL**		
Adj. West River Rd., dst. Medina Co. No. 500 WWTP (via W.Br. Trib. @ RM 14.8)	T01S11 (13.3)[W]	134.0	47	9.2	48	56.5	**FULL**		
Columbia Hills Country Club, at foot bridge	501880 (11.7)[W]	-	-	-	42	-	**(FULL)**		
Adj. West River Rd.	T01W94 (7.4)[W]	145.0	44	9.6	50	61.3	**FULL**		
Dst. Baker Creek, dst Cuyahoga Landmark Inc., via Trib. at RM 4.9.	T01W90 (4.9)[W]	153.0	45	8.4	50	63.5	**FULL**		
Bagley Rd., dst. Plum Cr. WWTP (via Plum Cr.)	501860 (3.5)[W]	161.0	42 (2015)	7.4ns (2015)	42	63.8	**FULL**		
Adj. Lewis Rd.	T01S09 (2.1)[W]	181.0	47	9.2	48	64.3	**FULL**		
Lewis Rd.	501850 (0.39)[W]	190.0	48	9.1	46	64.5	**FULL**		
Blodgett Creek (13-200-003) UD, WWH (Recommended)									
Ust. old Strongsville A WWTP	T01A17 (1.61)[H]	3.1	24*	-	MG[ns]	58.8	**NON**	Other flow regime alterations Direct habitat alterations Fish passage barrier	Urban runoff/storm sewers Channelization Hydrostructure Impacts on Fish Passage (Box Culvert)
Lindbergh Rd., dst old Strongsville A WWTP	T01A23 (0.17)[H]	4.1	44	-	F*	58.0	**PARTIAL**	Other flow regime alterations Direct habitat alterations	Urban runoff/storm sewers Channelization
Champion Creek (13-200-009) UD, WWH (Recommended)									
At mouth, dst. Smith Rd.	T01A55 (0.01)[H]	7.8	48	-	MG[ns]	69.8	**FULL**		
Broadway Creek (13-200-013) UD, WWH (Recommended)									
Foot Rd.	302574 (0.28)[H]	2.0	52	-	MG[ns]	67.3	**FULL**		

Location	STORET (RM)[a]	Drain. (miles²)	IBI	MIwb[b]	ICI[c]	QHEI	Status[d]	Causes	Sources
Plum Creek (W.Br.Trib.) 13-201-000 WWH (Existing)									
Akins Rd., ust. Plum Creek WWTP	T01K11 (8.5)[H]	7.6	22*	-	MG[ns]	51.5	**NON**	Low DO Habitat Alterations	Natural sources (rheopalustrine) Channelization
Plum Creek (W.Br.Trib.) 13-201-000 WWH (Existing)									
Jaquay Rd., dst. Plum Creek WWTP	T01A33 (4.92)[H]	14.3	24*	-	MG[ns]	60.5	**NON**	Low DO Habitat Alterations	Natural sources (rheopalustrine) Channelization
Ohio Turnpike	T01P23 (2.5)[H]	16.2	22*	-	MG[ns]	69.8	**NON**	Natural (Fish passage - Plum Cr. Gorge) Other flow regime alterations	Natural sources (Plum Cr. Gorge) Urban runoff/storm sewers
Columbia Rd., dst. Old-Brentwood WWTP	501950 (0.25)[H]	17.6	20*	-	MG[ns]	69.5	**NON**	Natural (Fish passage - Plum Cr. Gorge) Other flow regime alterations	Natural sources (Fish Passage - Plum Cr. Gorge) Urban runoff/storm sewers
Baker Creek (13-202-000) WWH (Existing)									
Sprague Rd.	T01S13 (0.3)	5.8	40	-	MG[ns]	63.3	**FULL**		
Cossett Creek (13-203-000) WWH (Existing)									
SR 252	T01K12 (0.2)[H]	4.1	24*	-	G	63.3	**NON**	Natural (flow or habitat)	Natural sources
Mallet Creek (13-204-000) WWH (Existing)									
SR 57	T01K13 (3.5)[H]	13.7	48	-	MG[ns]	57.0	**FULL**		
Neff Rd.	T01S14 (0.72)[H]	16.1	52	-	MG[ns]	62.8	**FULL**		
North Branch Rocky River 13-205-000 WWH (Existing)									
Remsen Rd.	T01S15 (5.52)[H]	28.1	47	7.8[ns]	50	69.8	**FULL**		
Granger Rd.	501960 (0.45)[H]	36.3	54	9.7	E	67.5	**FULL**		
Plum Creek (N.Br. Trib.) (13-206-000) WWH (Existing)									
Carpenter Rd.	501840 (3.02)[H]	8.8	50	-	F*	69.5	**PARTIAL**	Other flow regime alterations	Urban runoff/stormwater
adj. Carpenter Rd., ust old Medina 500 WWTP	T01K14 (2.5)[H]	10.4	46	-	F*	70.8	**PARTIAL**	Other flow regime alterations	Urban runoff/stormwater

Location	STORET (RM)[a]	Drain. (miles²)	IBI	MIwb[b]	ICI[c]	QHEI	Status[d]	Causes	Sources
SR 3/I 71, near mouth	302573 (0.50)[H]	12.1	48	-	MG[ns]	73.8	**FULL**		
Remsen Creek (13-208-000) WWH (Recommended)									
Remsen Rd.	302575 (0.6)[H]	14.4	48	-	G	70.8	**FULL**		
Granger Ditch (13-208-000) WWH (Recommended)									
SR 94, ust. Medina Co No. 11 WWTP (via trib. at RM 2.1)	302577 (1.75)[H]	7.8	42	-	F*	45.5	**PARTIAL**	Natural (flow or habitat) Habitat Alterations	Natural sources(rheopalustrine) Channelization
Stoney Hill Rd., dst. Highland HS WWTP, dst. Medina Co No. 11 WWTP	302576 (0.2)[H]	13.3	38[ns]	-	G	49.3	**FULL**		

H - Headwaters: sites draining areas ≤ 20 miles².
W - Wadable streams: sites draining areas > 20 miles².
B - Boat sites: large or deep waters, necessitating the use of Boat sampling methods.
CM- Fish sampling performed by Level 3 Certified Staff of Clevleand Metroparks
ns - Non-significant departure from the bio criteria (≤4 IBI units or ≤0.5 MIwb units).
* - Significant departure from the biocriteria (>4 IBI units or >0.5 MIwb units). Poor-Very Poor results are underlined.
a - River Mile (RM) represents the Point of Record (POR), and thus may not reflect or otherwise represent Absolute Location (ALP).
b - MIwb is not applicable in headwaters (drainage areas ≤ 20 miles²).
c - Narrative evaluation of macrobenthos used in lieu of ICI (E=exceptional, G=good, MG=marginally good, F=fair, P=poor, and VP=very poor)
d - Attainment status based upon one organism group is parenthetically express.
Note: Beneficial use recommendations within this report were adopted into QAC 3745-1-20 and became effective 1/1/2017.

Erie-Ontario Lake Plain (EOLP) Ecoregion			
INDEX - Site Type	**WWH**	**EWH**	**MWH[e]**
IBI - Headwater	40	50	24
IBI - Wading	38	50	24
IBI - Boat	40	48	24
MIwb - Wading	7.9	9.4	6.2
MIwb - Boat	8.7	9.6	5.8
ICI	34	46	22
e - Modified Warmwater Habitat (MWH) for channel modified or impounded areas			

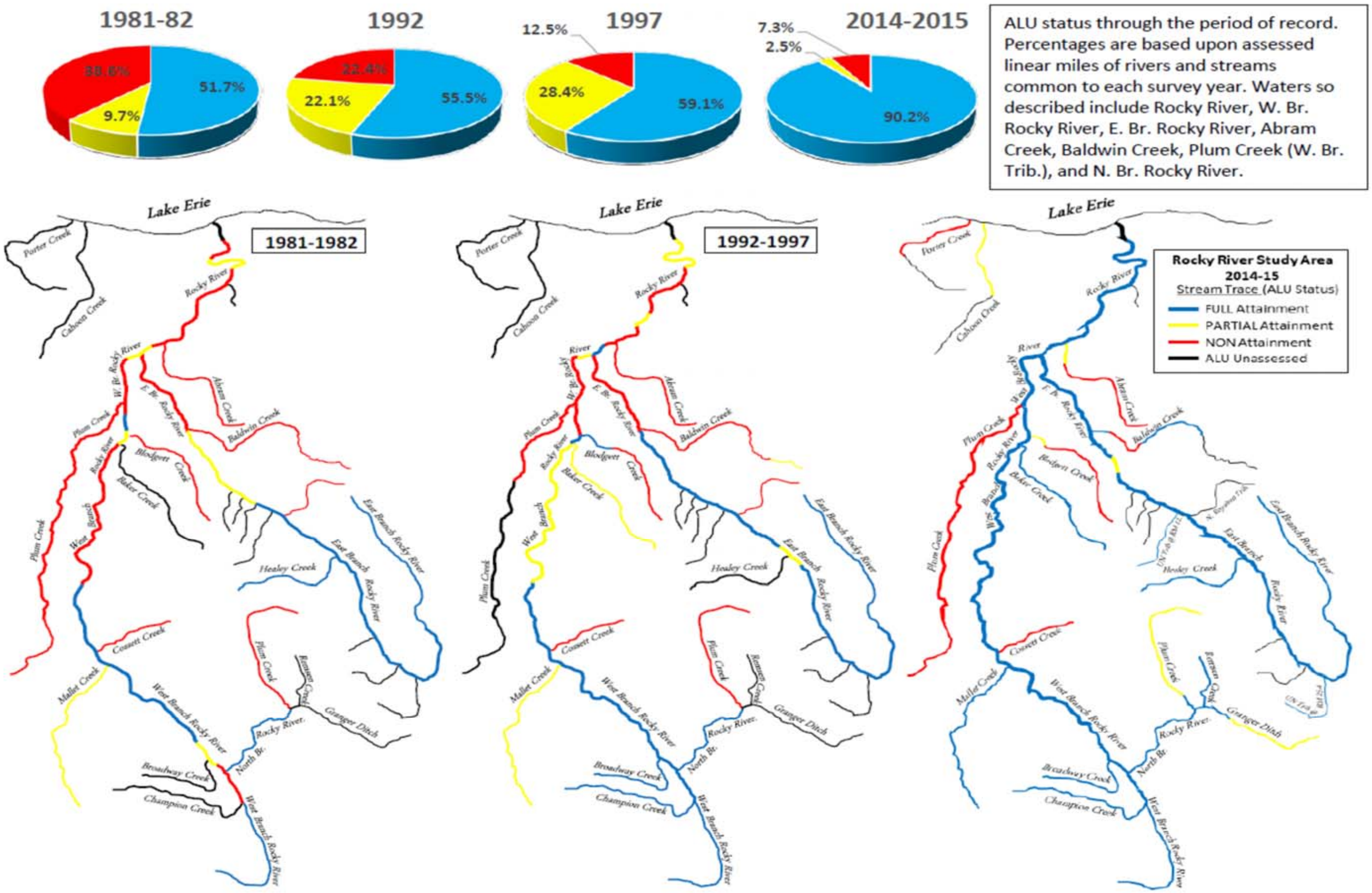


Figure 3. ALU status Rocky River, 1981-2014. Upper figures (pie graphs) are based upon the percentage of assessed stream miles common to each basin survey year. Waters so described includes the entire length of the Rocky River and East and West Branches, and portions of Abram Creek, Baldwin Creek, and Plum Creek (W. Br. tributary). Color-coded stream traces (lower figures) represents ALU status for all waters assessed for over the past 33 years. Given their similarity, results from 1992 and 1997 basin surveys were combined into a single figure to ease communication of gross trends.

Presently, ALU impairment on Abram Creek was attributed to multiple factors. Evidence of hydrological modification and diffuse pollutant loads attending urban/industrial stormwater was found at all sites. Compared to fish, aquatic invertebrates have shown a heightened sensitivity to dissolved solids, a common constituent of urban stormwater, and as such the macrobenthos appeared generally suppressed at all stations by stormwater effects and the contaminants entrained therein. Modest organic enrichment identified within the headwaters provided additional, albeit localized stress, the effects of which were likely compounded by elevated ammonia. Lastly, barriers to fish passage appeared an important impediment to recovery. Based upon habitat potential and water quality results, fish assemblages akin to those observed from the lower mile of Abram Creek should have been observed further upstream if free movement was not blocked by the aforementioned dam and culverted segment. The restorability of upper Abram Creek and the ramifications this may have upon ALU designation or redesignation are addressed within the Recommendations section of this report.

Plum Creek (direct West Branch Tributary)
Over the past four reporting cycles, Plum Creek has yet to fully support the WWH ALU. Prior assessments identified gross organic enrichment from the combined loads of multiple POTWs as the primary cause and source of ALU impairment, with failing home septic systems or other unknown sources of sanitary waste considered important secondary contributors. Following the closure of two substandard POTWs in late-1990s and subsequent upgrades to the remaining POTW (Plum Creek WWTP), significant biological improvements were anticipated in 2014. However, despite reduced pollutant loads and associated improved water quality, the most recent survey found persistent ALU impairment. These results are at odds with the overall pattern of recovery documented elsewhere within the Rocky River basin in 2014 and suggested that additional elements are at play.

Although, Plum Creek has remained impaired, both organism groups (fish and macrobenthos) required to determine ALU attainment status strongly diverged over time. Through the period of record, the trajectory of the macrobenthos was positively correlated with improved water quality and by 2014, all stations on Plum Creek supported WWH macroinvertebrate communities. In contrast, fish community performance over the same period remained within the poor range. The absence of recovery registered within this organism group appeared related to a mix of anthropogenic and natural factors. First among these is the natural barrier to fish passage provided by the Plum Creek gorge, at the mouth of Plum Creek. At some point in the past, Plum Creek was very likely depopulated or otherwise heavily impacted by significant water pollution (documented or otherwise), leaving the system with only a small number of highly tolerant, facultative fish species. Lacking access to the West Branch or other intact source-waters from which fish may reinvade, isolation effects on Plum Creek have likely precluded recovery, despite improved water quality. In-stream barriers, natural or artificial, do not impose similar constraints upon the macrobenthos, due to aerial dispersion of adults. In this way, aquatic macroinvertebrates may readily recolonize previously impacted waters from adjacent refugia, where similar recolonization by fish requires a direct physical connection to such areas.

It is also important to consider that upper Plum Creek is rheopalustrine in nature and was subjected to extensive drainage modification in the past. The combination of natural limits associated with wetlands and wetland streams (reductive water chemistry and naturally limited fish fauna) and attending drainage improvements (habitat simplification) have constrained the numbers and kinds of fish the headwaters may support, thus even if unimpacted the primary headwater of Plum Creek would likely be inadequate as a source area to recolonize the middle and lower reaches.

In addition to the structural limitations identified above, water quality in Plum Creek warrants discussion. Although improved in comparison with historical results, current water quality was not optimal. Recent surface water monitoring found evidence of incipient nutrient enrichment. Late-summer diel monitoring revealed diurnal DO spreads indicative of stimulated productivity within the upper four miles of Plum Creek, with DO concentrations near or below the WWH minimum criterion. Daytime grab samples found concentrations of ammonia, total phosphorus, nitrate+nitrite, and TKN generally elevated through the entire length of Plum Creek. Although not violations, these parameters were typically well in excess of regional reference values, and at times exceeded the 95th percentile. The upper two stations (RMs 4.92 and 8.5) yielded the highest concentrations (i.e., greatest departure from regional background). Although the Plum Creek WWTP discharges to this reach, most parameters did not vary significantly relative to the outfall, suggesting that background loads and conditions are important contributory factors regarding current water quality.

Presently, ALU impairment on Plum Creek was attributed to multiple factors. The recovery of the macrobenthos over time, yet static performance of the fish community provided clear evidence regarding the negative effects of isolation on Plum Creek by the escarpment contained within the Plum Creek Gorge. The combined effects of historical channelization, reductive condition, and low DO appeared contributory within the headwaters.

Baldwin Creek

Between 1981 and 1997, ALU impairment was consistently identified on Baldwin Creek. Prior assessments identified the two major POTWs within the headwaters (North Royalton B and Strongsville C WWTPs) as being culpable for the impacts identified during this time. Near-field toxicity was indicated immediately downstream from the upper facility, North Royalton B WWTP, and combined discharges from both dominated summer flows and contributed to substantial nutrient loads, resulting in far-field nutrient enrichment impacts. Numerous failing home septic systems were considered as secondary or tertiary sources. Nutrient enrichment effects may have been exacerbated by several small impoundments located through the lower mile. These structures also limited community performance by simplifying local macrohabitat behind each dam and as barriers to fish passage, effectively isolating nearly all of Baldwin Creek from the East Branch.

Although incomplete, recovery of WWH communities was documented in 2014 at three of the five Baldwin Creek monitoring stations, that together accounted for about half of its assessed length. Specifically, ALU attainment was identified at the upper limits of the sampling effort, between North Royalton B and Strongsville C, at RM 3.53, and through the lower mile, at RMs 0.3 and 0.1. Continuing ALU impairment was observed throughout the intervening middle reach, evaluated at RMs 2.61 and 1.13, downstream from Strongsville C WWTP. It is important to note that impairments identified in 2014 were delineated by the fish community alone, as the macrobenthos had recovered to WWH levels at all Baldwin Creek sites. These improvements followed improved POTW performance (plant upgrades in the late-1990s) and subsequent improved water quality, and the recent removal of two low head dams on the lower half-mile in 2012. Regarding the latter, ALU recovery was facilitated by dam removals, as fish from the now recovered East Branch were able to freely disperse into lower Baldwin Creek. Also, by restoring free flowing conditions to this segment, long standing local habitat limitations were also eliminated.

Current ALU impairment on middle Baldwin Creek was difficult to confidently associate with specific cause and source. The precipitous decline of the fish community downstream from the Strongsville C WWTP would at first suggest this facility as a primary source of ALU impairment documented in 2014. However, water quality monitoring did not yield compelling evidence of significant degradation (chronic low DO, highly elevated ammonia, etc.). Although conditions were generally acceptable, indicators of urban stormwater (selected metals, chlorides, TDS, etc.) were elevated at all stations, and nitrate+nitrite concentrations at most sites were among the higher values observed within the Rocky River study area. Regarding the later, nitrate+nitrite levels appeared a product of efficient nitrification at both POTWs and reflected the dominant contribution of effluent to Baldwin Creek's summer base-flow. Self-reported monitoring data from Strongsville C preceding the 2014 survey by ten years found annual loads of common pollutants either stable or declining through time. Over the same period, only 14 permit limit violations were indicated. Although not inconsequential, these violations do not represent egregious, chronic or otherwise significant non-compliance.

A small, privately owned dam located about a mile from the mouth – the last on Baldwin Creek – appeared to separate the lower, recovered reach (RMs 0.3 and 0.1, downstream dam) from the impaired middle reach (RMs 2.61 and 1.13, upstream dam). The two segments are in close proximity, as associated monitoring stations at their nearest points were separated by only 0.8 miles. Furthermore, a direct a comparison between recovered and impacted segments revealed many similarities. Stream size, as measured by drainage area, was comparable, differing at most by 1.7 square miles. Aggregate macrohabitat quality up and downstream from the dam was not substantially different, with segment average QHEIs of 60.5 and 64.4, respectively. Water quality was, by and large, comparable up and downstream from the dam, though nutrients were slightly higher within the impacted segment, immediately downstream from the Strongsville C WWTP. Regarding water quality effects, it is important to consider that pollutant loads from diffuse sources were indicated at all sites, and that those derived from upstream point sources were conveyed a relatively short distance downstream, yet these were well tolerated by fish communities near the mouth and by the macrobenthos at all Baldwin Creek sites. If these loads alone were controlling or sufficient to limit biological performance, ALU impairment on Baldwin Creek should have extended further downstream, and the macrobenthos should have offered greater indications of chronic stress. In light of the similarities identified above and the constancy of the macrobenthos, divergent performance of the fish community appeared primarily attributable isolation effects provided by the remaining low head dam. This barrier to fish passage appears to have blocked or retarded natural recolonization/recovery of middle Baldwin Creek, akin to that so successfully documented less than a mile downstream, where three dams were removed in 2012. Background pollutant loads were considered secondary or tertiary in their effects.

East Branch Rocky River (RM 9.35)

ALU impairment on the East Branch was limited to a single station located at RM 9.35. Departure from the biocriteria was very modest and delineated by the macrobenthos alone. The lower third of the site was situated within the upper limits of the Bonnie Park Dam Pool. Here, lower stream power associated with the impoundment created depositional conditions, resulting in extensive deposits of sand and other fine bedload materials. The artificial substrate sampler (Hester-Dendy) was lost to shifting and unstable conditions, thus standard qualitative methods were employed to assay the macrobenthos. Given the good performance of the fish community and the absence of significant water quality problems, the subpar condition of macrobenthos directly reflected both the instability and limited productivity of the dominant sandy substrates.

Selected West Branch Tributaries

ALU impairment on Cossett Creek was identified by the fish assemblage alone, as the macrobenthos were found consistent with the WWH biocriteria. The fish community was uncommonly simple, as nearly 90% of the assemblage was concentrated in a single highly tolerant and pioneering taxa. Pioneering species are adapted to ephemeral headwaters, and thus are among the first fish species to return to small drainages subjected to episodic desiccation or other temporary stress. Relative abundance estimate from this site were atypical as well and ranked among the lowest observed within the West Branch subbasin. Together, these characteristics suggest an ecologically improvised or otherwise recovering fish assemblage. This inference was supported by observations made by previous field investigators. Specifically, the presence of plethodontid salamanders was noted at this location in 1997. The importance of this observation is that several members of the Family Plethodontidae are typical associates of intermittent or interstitial streams, and their presence on lower Cossett Creek in 1997 reinforces the idea that the stream, or at least its lower reach, is prone to periodic desiccation. Given the absence of significant water quality problems, dominance of pioneering species, low relative abundance, and the presence of plethodontid salamanders, ALU impairment documented in 2014 was attributed to episodic desiccation resulting from natural or structural causes.

ALU impairment has persisted on Blodgett Creek since it was first evaluated in 1992. Prior assessments identified two POTWs (Strongsville A and Versailles) as primary sources of impairment. Although conditions have improved following the closure of these facilities in the mid-1990s, full recovery was not observed in 2014. Blodgett Creek drains a mix of urban, suburban, and light industrial land uses. Additionally, much of the stream was channel modified in the past and this reflected in lower QHEI scores. Like most waters within the Rocky River basin, water quality monitoring found strong evidence of urban stormwater effects, but TDS in particular was uncommonly high, with station means and peak values among the highest observed within the West Branch subbasin. Field investigators noted a pronounced petroleum odor at the upper most monitoring station (RM 1.61) and what appeared to be an emulsified surface scum atop most pools. A review of documented fish kills and industrial spills failed to yield any reported incidences on Blodgett Creek in 2014, but this does not eliminate the possibility of an unreported spill or spills, during or prior to 2014. It is difficult to ascertain if the conditions most recently observed on upper Blodgett Creek were typical or anomalous, and the degree to which they may have affected the resident biology. However, the combination of urban stormwater, artificial hydrology, and marginal habitat are very likely limiting, and the lingering effects of what appeared to be a spill event may have contributed to ALU impairment, at least within the headwaters. In addition to these observations, isolation effects similar to those already described for other Rocky River tributaries and may have served as an additional limiting factor. A large box culvert located mid-zone at the lower most site (RM 0.17), appeared as though it would function as an effective barrier to fish passage. Regarding this supposition, it is important to note that lower Blodgett Creek maintained unfettered access to the West Branch, and monitoring efforts there documented a WWH fish community. Compared to the upper segment, lower Blodgett had more than twice the number of native species, supported three environmentally sensitive fish taxa and the proportion of tolerant species was reduced by nearly half. Given their heightened sensitivity to stormwater contaminants, particularly dissolved solids, the macrobenthos performed no better than fair at the lowest station.

Selected North Branch Rocky River Tributaries

Although much improved in comparison with historical survey result from 1981 and 1997, Plum Creek was again found impaired in 2014. Previous assessments identified heavy sedimentation and excessive turbidity, attributed largely to urban storm water and construction runoff from Brunswick, as the primary causes and sources ALU impairment. At that time both the macrobenthos and fish community failed to perform up to WWH levels. Although not fully abated, condition did improve over time, and by 2014 Plum Creek had reestablished fish assemblages fully consistent with the WWH biocriterion. The macrobenthos, however, remained impacted by modified hydrology and diffuse pollution sources attending urban stormwater.

Granger Ditch was channelized near the turn of the last century and maintained for drainage purposes up until the 1950s. Prior to this modification, Granger Ditch was very likely palustrine or rheopalustrine in nature, as the gradient is low and it was found to support several relic wetland plants and fish species. Substrates reflected the stream's lacustrine origins and low energy, depositional characteristics, as they were comprised mainly of clay hardpan, silts, and accumulated organic material. Although strongly reductive conditions were not indicated, the DO regime appeared skewed to lower values. ALU impairment on Granger Ditch was attributed to the combined effects of historical channelization and natural limits associated with rheopalustrine habitats.

Porter and Cahoon Creek
Both streams offered abundant evidence of flashy urban-suburban hydrology. Regular scouring flows having given rise to unstable substrates. Water quality monitoring corroborated these observations as selected indicators of diffuse urban pollution were highly elevated (e.g., sodium and specific conductance). The combined effects of modified hydrology and urban stormwater were identified as the primary drivers of ALU impairment on these streams.

<u>ALU Attainment Trends: 1981-2014</u>
A review of historical monitoring data provided an excellent opportunity to evaluate the environmental conditions of the Rocky River basin through time. Prior to the 2014 survey, systematic water quality investigations of the entire or large portions of the watershed were undertaken in 1981, 1992, and 1997. Supporting various water quality management activities (e.g., stream regionalization, NPDES permitting, 319 project assessment, TMDL supplementation), abbreviated and geographically circumscribed monitoring was undertaken in 1982, 2001, and 2011. For this report, trends analysis was largely centered on the comparison of survey result from stations, reaches, and waterbodies common to all four basin-wide surveys. Care was taken to ensure the inclusion of the very oldest survey data available, that in most instances predated important state and federal pollution abatement or control initiatives [e.g., US EPA National Municipal Policy, adoption of WQBELs, capital improvements to POTWs (constructions grants and loans), and the broad adoption of agricultural conservation practices]. This necessitated, at times, the exclusion of data from streams or sites not represented in the larger surveys. Nine waterbodies met this criterion and included, the Rocky River mainstem, Abram Creek (a mainstem tributary), East branch Rocky River, Baldwin Creek (East Branch tributary), West Branch Rocky River and four affiliated tributaries.

In nearly every instance, fish and macrobenthos community performance has improved throughout the Rocky River watershed. Rocky River mainstem showed consistent stepwise gains through each of the four survey years. The earliest baseline results found the river to support impacted or otherwise degraded communities. Departure from the prescribed biocriteria at the time was complete, as no station supported WWH fish assemblages. Incremental improvements were observed through the intervening survey years, 1992 and 1997, culminating in full restoration of WWH conditions in 2014. Although the initial degree or magnitude of impairment was not as great as that observed on the mainstem, a similar pattern of recovery was observed on the principal tributaries, the East and West Branches, as these too now support fish assemblages fully consistent with the WWH biocriteria throughout their entire lengths. ALU attainment status of the Rocky River study area, through time is summarized in Figure 3.

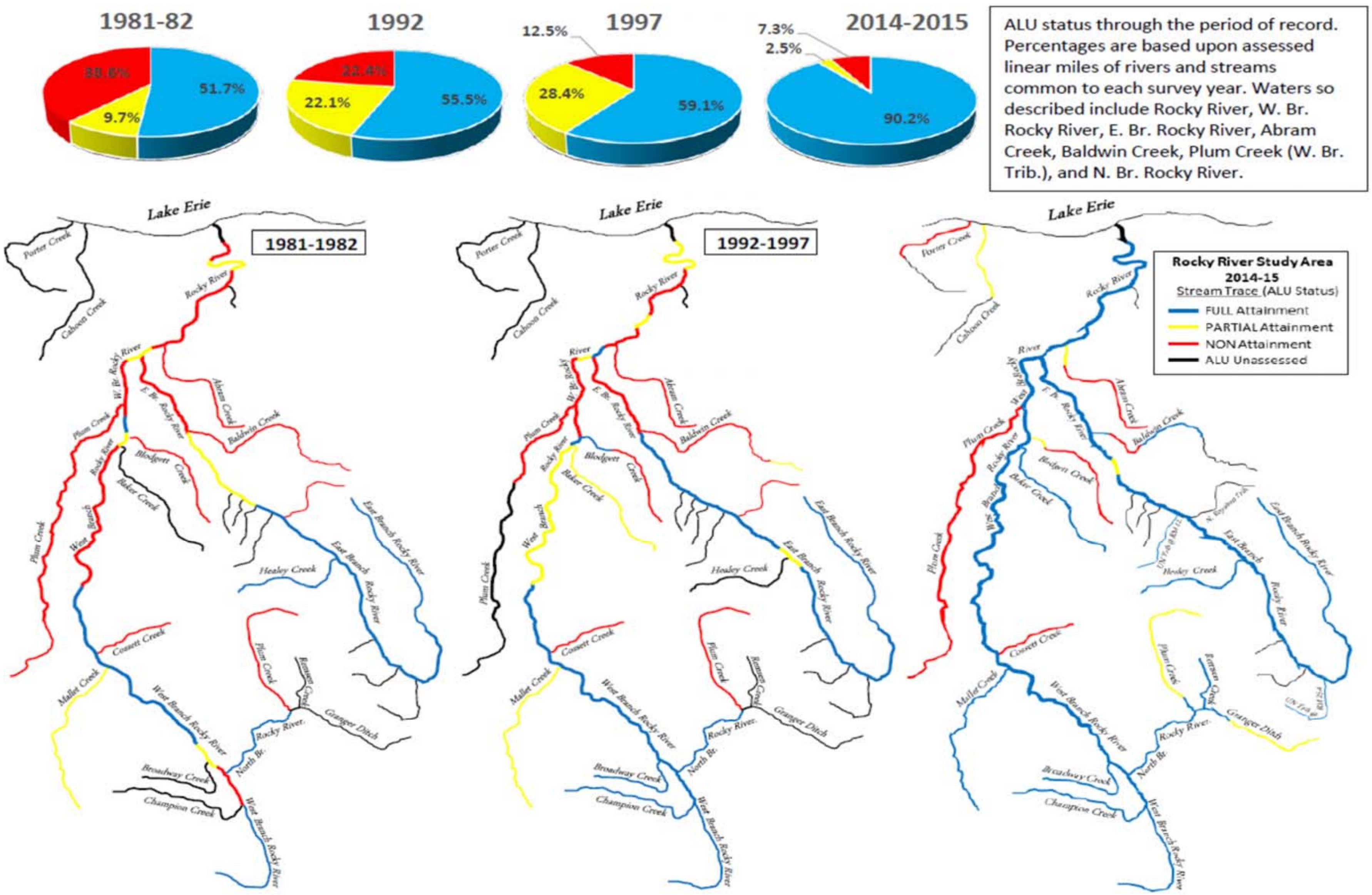


Figure 3. ALU status Rocky River, 1981-2014. Upper figures (pie graphs) are based upon the percentage of assessed stream miles common to each basin survey year. Waters so described includes the entire length of the Rocky River and East and West Branches, and portions of Abram Creek, Baldwin Creek, and Plum Creek (W. Br. tributary). Color-coded stream traces (lower figures) represents ALU status for all waters assessed for over the past 33 years. Given their similarity, results from 1992 and 1997 basin surveys were combined into a single figure to ease communication of gross trends.

Compared against the findings of the initial survey, recovery of the smaller tributaries was not nearly as complete as that documented on the larger waters. There is little doubt that significant improvements have been achieved, and that the near-term trajectory of the biometrics are positive. However, all or portions of selected tributaries have remained impacted since their initial investigation.

The high degree of recovery that presently typifies the Rocky River basin is coincidental to multiple and significant actions taken over the past 30 plus years. First among these is the elimination or decommissioning of multiple substandard POTWs. The wastewater formerly received by these facilities has been redirected to larger facilities within the basin or exported out of the watershed to either very large regional facilities (e.g., NEORSD) or treated locally and discharged directly to Lake Erie (e.g., Lakewood WWTP). Substantial reductions in the frequency, duration, and total volume of untreated sanitary waste from dry and wet weather CSOs and SSOs, have been realized through plant closures (as described above), increased plant capacity, and better management of and improvements to wastewater collection systems. Spurred by the adoption and implementation of WQBELs during the mid-1980s, public capital expenditures on advanced municipal wastewater treatment have, in most instances, significantly improved the performance of remaining POTWs. Together, these actions have resulted in significant water quality gains throughout the Rocky River watershed evidenced by improved DO regime and reduced loads of ammonia, oxygen demanding wastes, and nutrients.

Surface Water Quality

Consistent with the high degree of aquatic life use attainment documented in 2014, day-time surface water monitoring yielded surprisingly few consequential water quality criteria exceedances. Only 13% of all grab samples collected and analyzed found one or more parameters in excess of the various supporting criteria. Of these, total iron concentrations greater the statewide agricultural use criteria accounted for the vast majority, approaching 70% (36 of 52) of all exceedances documented in 2014. High iron values were broadly distributed throughout the study area, occurring with great regularity on the East and West Branches, upper mainstem, and selected tributaries. Exceedances of the aquatic life criteria for total copper and lead were observed at five and six locations, respectively. With a single exception, copper and lead exceedances were found concurrent. Elevated concentrations of metals identified above were observed exclusively during periods of elevated flow, following heavy rainfall within the study area. At these times diffuse urban, suburban, and industrial contaminants are readily mobilized in storm water runoff and rapidly delivered to nearby surface waters. Additional strong indicators of urban stormwater included elevated concentration or levels of total aluminum, chloride, sodium, specific conductance, TDS, and TSS. Although observed concentrations of these parameters did not exceed relevant water quality criteria, either singularly or in combination, station means of these parameters were at times highly elevated, exceeding background conditions as described by regional reference values.

Water quality monitoring results from Abram Creek and Plum Creek diverged significantly from typical conditions described below. Concentration of selected parameters were either highly anomalous by comparison or constituted actual criteria exceedances. As these streams were found impaired, water chemistry results are summarized separately within the preceding Impaired Waters section of this report.

Nutrient monitoring regularly found station average concentrations of nitrate+nitrite well above target values. Highest concentrations were typically observed downstream from or in association with major or consequential minor POTWs on the Rocky River mainstem, East and West Branches, or larger tributaries. Considering both, the great volume of treated wastewater the Rocky River basin receives and the generally low ambient concentrations of ammonia, elevated nitrate+nitrite observed in 2014 appeared indicative of efficient nitrification by most facilities. Station average phosphorus concentrations remained below the target values at all but four locations and even at these, values were not egregious. The overall low phosphorus loads described by these data would appear to indicate efficient removal at phosphorus limited POTWs and absence of significant landscape sources. Regarding the latter, only a small percentage (<10%) of Rocky River basin is dedicated to row crop agriculture.

Diel water quality monitoring was undertaken at selected stations throughout the study area. Continuous monitoring units were deployed mid-summer in 2014, with supplemental sampling in summer of 2015. The resulting data were screened for water quality criteria exceedances and evidence of over stimulated productivity (nutrient enrichment) or excessive oxygen demand (organic enrichment). Taken together, few water quality criteria exceedances were observed within the Rocky River study area, and these largely limited to aberrant temperatures from only three stations split among the West Branch and upper Rocky River mainstem.

<u>Sediment</u>
Surficial sediment samples were collected from a subset of monitoring sites on the Rocky River, Abram Creek, and the East and West Branches. Sample analysis included heavy metals and selected organic parameters. Concentrations of selected heavy metals generally increased with increasing drainage area, but most parameters were found below or near the low-effect thresholds or regional benchmarks provided by the various sediment quality guidelines employed by Ohio EPA. No heavy metal parameter was found in excess of their respective probable effect concentrations, therefore the risk of toxicity to aquatic organisms appeared low. Likely sources of heavy metals include urban stormwater, combined or sanitary sewer overflows, illicit discharges, and legacy pollutants.

Detections from sediment analysis for organics were limited six PAHs, five of which are priority pollutants. Concentrations of chrysene and phenanthrene were typically below their respective method reporting limits. Where measurable concentrations were found, they exceeded only the low-effects benchmark. Fluoranthene and pyrene were detected at most stations, including the entire length of the Rocky River, lower Abram Creek, and the lower East Branch. Although concentration at these locations were above the low-effects threshold, they did not exceed probable effects levels. Lacking both state reference values and sediment quality guidelines, benzo fluoranthene and benzoperylene were indexed against general guidance provided by US EPA and found to exceed the basic screening values on the lower Rocky River, lower Abram Creek, and a single location on the middle West Branch. PAHs may arise naturally, but human activities are generally considered the primary source of these compounds. The origins of most anthropogenic PAHs are either pyrogenic (combustion of biomass or fossils fuels) or petrogenic (petrochemical residues) and may enter the aquatic environment through various pathways, including urban stormwater, wastewater, atmospheric deposition, incidental contamination or spills.

<u>Fish Contaminants</u>
Fish tissue samples were collected at selected sampling stations on the Rocky River and East and West Branches. Resulting fish contaminant data are primarily used for three purposes: direct support of inter-agency fish consumption advisory program; risk assessment supporting human health use; and to describe trends in fish contaminants through the period of record.

Regrading consumption advisories, the 2014 results found mercury contamination throughout the study area stable to declining, thus new or otherwise more stringent advisories were not recommended. By and large the state-wide mercury advisory of one meal per week appeared appropriate for most species and most fishable waters within the Rocky River basin. Exceptions to this were limited to smallmouth bass taken from the West Branch Rocky River. Due to elevated mercury concentrations identified in the past, existing advisory for this waterbody recommended limiting consumption to one meal per month. Most recent data affirmed this determination. In contrast, falling levels of mercury in rockbass taken from the

East and West Branches indicated that the general state-wide advisory replace the previous and more stringent advisory of one meal per month, pending required confirmation sampling.

Transformed contaminate levels were indexed against the human heath criteria. Assessments were derived for six of the 12 watershed assessment units (HUC 12s) that comprise the Rocky River study area, as these contain the larger, fishable, segments of the Rocky River and East and West Branches. Previous human Health assays of these units found four of the six impaired due to criteria exceedances for mercury or PCBs, or both. By 2014, the magnitude and extent of contamination had declined, bringing all previously impacted subbasins into full compliance with the human health criteria.

Drinking Water

The City of Berea is the only public water system directly served by surface water sources within the study area. Although Berea maintains intakes on the East Branch Rocky River, Baldwin Creek and Coe Lake, source water is primarily obtained from the East Branch, the others used only as needed. Source water monitoring results for nitrate, atrazine and cyanotoxins (i.e., microcystins, saxitoxin and cylindrospermopsin) were indexed against the Public Water Supply (PWS) criteria. Nitrate results indicated full support watch list determination due to a single sample exceeding 80% of the criterion. Atrazine concentrations were low and remained well-below criteria for impairment or watch list status. Most cyanotoxin results were at or below detection levels. However, microcystins and saxitoxin were detected at levels of concern in Coe Lake, including a microcystin result of 0.41 mg/l, that would exceed the new Ohio EPA drinking water threshold (0.3 mg/l) adopted in 2015. These data will result in a watch list determination for future IR reporting.

Recreational Use

Water quality criteria for the assessment of recreation uses are based upon the level or degree contamination indicated by *Escherichia coli* (E. coli) colony counts. All streams within the Rocky River study area are designated Primary Contact Recreation (PCR), with three attending subclassifications (classes A, B, and C) reflecting potential frequency and intensity of recreational use or activity. Streams designated PCR class A typically have identified public access points and support primary contact recreation. Streams designated PCR Class B support, or potentially support, occasional primary contact activities. The entire length of the Rocky River and the middle and the lower segments of the East and West Branches are designated class A. All other assessed streams or segments within the study area are designated class B.

Twenty-three locations were sampled for *E. coli* 2014. Resulting colony counts exceeded the applicable recreational use criteria at 22 of the 23 monitoring stations, thus nearly all assessed waters failed to support the either class A or B, PCR uses. Over half of the impaired sites exceeded criteria by a factor three, with maximum values exceeding the criteria by a factor of ten. The highest geometric means were observed from the lower Baldwin Creek, lower East Branch, Rocky River mainstem, upper West Branch, Porter Creek, and Cahoon Creek. Only a single site on Mallet Creek did not exceed the prescribed criteria, and thus represented the only unimpaired water body within the study area.

Bacterial contamination in most streams was present during both wet and dry weather events, indicating active diffuse and permitted point sources. These would include, CSOs, SSOs, urban stormwater, treated wastewater discharges, failing home sewage treatment systems (HSTS), and to a lesser extent agricultural runoff. Potential or otherwise likely sources of significant bacterial contamination listed above and are not necessarily confirmed as a source of impairment nor are they exclusive of other sources.

Lakes Monitoring

Two publicly owned lakes, Coe Lake and Wallace Lake, were evaluated between 2014 and 2015. Both are located within the East Branch subbasin near the confluence of Baldwin Creek, within the municipal boundaries of the City of Berea. Coe Lake is owned and managed by City Berea and Wallace Lake is owned and managed by the Cleveland Metropolitan Parks District. The surveys examined water chemistry, sediment chemistry, phytoplankton, transparency, chlorophyll *a* and bacteria. Temperature, conductivity, DO, and pH were also recorded verticality through the water column. The resulting data were screened against the proposed Lake Habitat (LH) benchmarks, recreational use criteria, and a combination of Ohio reference values and consensus-based guidelines for sediment results.

The recreational component of the LH use for Coe Lake was fully supported, as bacteria counts remained below the prescribed criterion. Chemical and physical measures yielded mixed results. Transparency and total water column phosphorus were consistent with the LH criteria. Total nitrogen concentrations were intermediate, resulting in watch list status. DO measurements taken from either the summer epilimnion or the entire water column during isothermal conditions found DO below the LH criterion, and half of chlorophyll *a* sample exceeded the LH benchmark. To control nuisance aquatic plants, Coe Lake regularly treated with suite of aquatic herbicides. The data summarized above where collected over a two-year period, which included a treatment year in 2015. In many instances there were sharp differences between 2014 and 2015 results. Chemical control of macrophytes in 2015 would significantly affect, both directly and indirectly, nearly every water column measurement by radically altering nutrient cycling, productivity, and net respiration within Coe Lake.

Bacteria counts from Wallace Lake were consistent with the recreation use component of the propose LH use. Similarly, nearly every water column measurement yielded results consistent the LH benchmarks. Measurements taken from either the summer epilimnion or the entire water column during isothermal conditions found DO below the LH criterion.

RECOMMENDATIONS

Aquatic Life Use Status

The Rocky River basin has been subjected to regular monitoring and assessment since the mid-1980s and the 2014 survey marks the fourth comprehensive study of the watershed by Ohio EPA. As such, the ALU designations for the vast majority of the larger streams within the Rocky River basin have been verified through and in light of biocriteria. However, there remains selected waterbodies where designations are still based on the original 1978 and 1985 state water quality standards. The techniques in use at that time did not include standardized approaches to the collection of in-stream biological data or numeric biocriteria. While some of the recommendations may appear to constitute "downgrades" (i.e., EWH to WWH) or "upgrades" (i.e., WWH to EWH) any change should not be construed as such because these, in most instances, constitute the first application of an objective and robust data driven process to ascertain the appropriate aquatic life use designation. Ohio EPA is obligated by a 1981 public notice to review and evaluate all aquatic life use designations outside of the WWH use prior to basing any permitting actions on the existing, unverified use designations. Thus, some of the following aquatic life use recommendations constitute a fulfillment of that obligation.

Aquatic Life Uses Verified Prior to 2011

Existing ALUs verified prior to the 2014 biosurvey are affirmed for the streams or stream segments identified in Table 2. Re-endorsement is based upon either demonstrated ambient biological performance (fish and macrobenthos) consistent with the supporting biocriteria or, a use attainability analysis (UAA) if biology was found to depart from the prescribed criteria. Recommended beneficial uses were adopted prior to the final publication of this report and became effective January 1, 2017 (OAC 3745-1-20, Rocky River drainage basin, table 20-1).

Verification of Existing Aquatic Life Uses

Existing, yet unverified, ALUs for waterbodies within the Rocky River study area that were designated prior to the promulgation of biocriteria included only four streams: Remson Creek and Granger Ditch (North Branch Rocky River tributaries), and two small direct Lake Erie tributaries, Porter and Cahoon Creek. Based upon either demonstrated ambient biological performance, or a UAA, the existing WWH designation was verified for these waters.

Redesignation of Verified Aquatic Life Use – Abram Creek

Despite its verified WWH status, recent, consequential activities and discoveries within the watershed have rendered affected portions of Abram Creek open to reappraisal and possible ALU redesignation, as these factors were either unknown or post-date prior assessments and ALU rulemakings .

In 2004, CHIA enclosed a nearly one-mile reach of Abram Creek, between approximately RMs 1.9 and 1.0, to accommodate runway expansion. Furthermore, post survey research identified a six-foot (two meter) lowhead dam located immediately downstream from the airport enclosure. This structure appeared long-standing in nature and has likely been in place for many decades, if not longer. Both the enclosure and dam have effectively isolated the upper 3.3 miles of Abram Creek, between CHIA culvert and dam (~RM 1.0) and Lake Abram outlet (RM 4.3).

Compared against the existing WWH biocriteria, all of Abram Creek has remained impaired since it was first surveyed 1981. Egregious water quality and associated severe biological impacts documented by prior water quality investigations have been largely abated, and at present Abram Creek labors under the effects of urban/industrial stormwater, hydromodification, and other diffuse loads. Though improved by comparison to historical results, the degree of improvement varied longitudinally, and also reflected differing sensitivities between indicator groups (macrobenthos and fish). The 2014 survey results found the macrobenthos in fair condition at all monitoring stations. Given their heightened sensitivity to contaminants commonly entrained in stormwater (e.g., TDS), the macrobenthos reflected the constancy of stormwater effects and related diffuse loads. However, due to aerial dispersal of adults, macroinvertebrates are in general unaffected by barriers to passage, such as those provided by the stream enclosure and lowhead dam discussed previously. In contrast, fish community performance varied greatly relative to these barriers, with very good to exceptional communities observed through the lower mile and poor communities consistently observed upstream, through the isolated middle and upper reaches. Regarding the description of conditions within the uppermost segment, these observations included fish community assessments generated by the NEORSD in 2012. Monitoring by NEORSD extended a mile above the 2014 effort, up to the outlet of Lake Abram (RMs 3.7 and 4.1), and in fact, corresponded to existing sampling stations not visited by Ohio EPA since 1981. These data not only described spatial continuity, namely, a continuation of poor fish community performance upstream from the uppermost sites evaluated in 2014, but also clearly demonstrated temporal continuity, as 2012 biometrics were consistent with those generated 33 years ago by Ohio EPA in 1981.

Unimpeded access to the Rocky River mainstem was clearly a significant factor in the partial recovery documented in 2014. Following water quality improvements, fish were able to reinvade lower Abram Creek from the now recovered Rocky River. The potential benefits of this nexus are excluded from upper three plus miles due to physical isolation. Although current ALU impairment of Abram Creek was attributable largely to anthropogenic sources and activities, namely stormwater, isolation effects upon the fish have and will continued to preclude a naturally directed recovery akin to that observed on the lower segment. Even if the aforementioned lowhead dam were to be removed, the culverted segment will persist well into the foreseeable future, as it presently serves a vital socioeconomic function. The permanence of this barrier alone is sufficient to structurally limit or otherwise ecologically constrain upper Abram Creek.

In light of factors highlighted above, upper Abram Creek was functionally unassessed at the time of the 2014 survey because previous assessments and analysis that served to verify the WWH ALU did not envision future enclosure. As such, the isolated reach is eligible for redesignation to a subgoal ALU that more accurately represents attainability or biological potential (MWH or LRW). However, despite the intractable problems of pervasive stormwater and isolation, there is strong and well-organized local interest in the restoration of this waterbody. For over two decades now, interested parties (citizens and advocacy groups, etc.), throughout Ohio have organized themselves to work towards the rehabilitation of impaired waters. Although the scope, scale, and effectiveness of these citizen initiatives vary greatly, many such efforts have in fact marshalled the resources necessary to improve local waters and have, at times, succeeded in recovering lost ALUs. Of these, perhaps dam removal projects have proved the most productive, and successful examples may even be found within the Rocky River watershed (e.g., lower Baldwin Creek). Given the high degree of industrial, urban, and suburban land use within the watershed and the resulting hydromodification and stormwater impacts identified on Abram Creek, close cooperation between and among state water quality managers, regional and local authorities, advocacy groups, and citizen stakeholders is essential to any attempt to favorably resolve these nearly insoluble environmental problems. Working from the Ohio's 2001 Rocky River TMDL, the Northeast Ohio Areawide Coordinating Agency (NOACA), Cuyahoga County Soil and Water Conservation District, and the Rocky River Watershed Council (citizen-based advocacy) have together assembled and published a comprehensive action plan to address beneficial use impairment within the basin (NOACA 2006). Therefore, in full recognition of focused local and regional interest in stream restoration and to promote collaboration among all interested or affected parties, the current and verified WWH ALU shall be retained for the entire length of Abram Creek. As provided for in Ohio's monitoring strategy Abram Creek will be reevaluated in 2029, or sooner should the need arise. If by the next reporting cycle environmental conditions upstream from the CHIA culvert remain largely unchanged, redesignation of upper Abram Creek to a subgoal use shall be reconsidered through the Use Attainability Analysis (UAA) process.

<u>Abram Creek</u>

- Lower limit of CHIA enclosure (approximately RM 1.0) to the mouth - WWH (existing)
- All other segments – WWH (exiting, subject to future reevaluation)

Unlisted or Undesignated Waters

Four small waterbodies assessed as part 2014 Rocky River study are currently unlisted in the Ohio WQS. These include two unnamed direct tributaries to the Rocky River, and two indirect West Branch Rocky River tributaries. Recommendations based upon either demonstrated ambient biological performance, or a use attainability analysis (UAA), are provided below.

Unnamed Rocky River Tributary @ RM 12.1 - Undesignated to WWH
Unnamed Rocky River Tributary @ RM 25.4 - Undesignated to WWH
Broadway Creek - Undesignated to WWH
Champion Creek - Undesignated to WWH

State Resource Waters

Several of the State Resource Water (SRW) listings for waterbodies in the Rocky River basin are recommended for removal (Table 2). Ohio EPA is in the process of re-assigning waterbodies currently listed as SRW in the use designation rules (OAC 3745-1-08 to 32) to a new antidegradation tier under Ohio's antidegradation rule (OAC 3745-1-05). In 2014, Ohio EPA completed a comprehensive biosurvey of the three waterbodies in the Rocky River basin that still carry the old SRW listing (Rocky River, East Branch Rocky River (RM 15.15 to the mouth and headwaters to RM 23), Baldwin Creek). Based on an analysis of that data, along with historic data, most of these water body segments demonstrate attributes consistent with the general high-quality water (GHQW) antidegradation category. The current SRW designation, therefore, no longer has any significance for these waterbodies. Consistent with paragraph (A)(25) of rule 3745-1- 05 of the OAC, the SRW designation for the waterbody segments is recommended for removal. These specific stream reaches include:

<u>Baldwin Creek</u>

- at RM 0.48
- all other segments

<u>Rocky River</u>

- State Route 10 (RM 6.4) to the mouth
- Confluence of East and West branches (RM 12.1) to State Route 10 (RM 6.4)

<u>East Branch Rocky River</u>

Upstream boundaries of Rocky river reservation (RM 15.15) to West Branch confluence at RM 5.06
The remaining segments of the East Branch Rocky River are recommended to retain their current SRW listing until such time as the high-quality waters tables in OAC 3745-1-05 are updated, as portions of these segments show potential for inclusion in one of these categories.

Other Recommendations

- Urban stormwater and associated modified hydrology were identified as leading causes of ALU impairment in 2014. Long-term stormwater planning and implementation of applicable BMPs, were feasible, are needed to reduced total volume and increase infiltration of stormwater. Priority should be given to impaired waters affected by urban stormwater: Abram Creek, middle Baldwin Creek, Blodgett Creek, and upper Plum Creek (North Branch Tributary). So as to reflect the most current assessment of the basin, ALU attainment status and causes and sources of beneficial use impairment detailed in Rocky River Action Plan (NOACA 2006) should be reconciled with those described within this report. Thus amended, the action plan should prove an excellent guide to planning and abatement of stormwater and related diffuse causes and sources of use impairment.

- Every effort should be made to remove the remaining low head dam on Baldwin Creek, located approximately a mile from the mouth. The rapid recovery recently documented on lower Baldwin Creek following removal of three of the four dams in 2012 clearly demonstrated the importance open fish passage for ALU restoration. The elimination of these barriers has not only allowed for recolonization of lower Baldwin Creek from the now recovered East Branch, but the open connection and free movement of fish undoubtedly increases the resiliency of the fish assemblage against the vagaries of stormwater and other upstream stressors.

  The ecological subsidy of Baldwin Creek by the East Branch has and should continue to be an essential consideration regarding the recovery and conservation of the WWH ALU. In fact, following the abatement of gross impacts documented by past surveys, the presence or absences of direct connections with intact or recovered waterbodies appeared an important explanatory variable regarding the condition of many Rocky River tributaries reevaluated 2014 [e.g., Abram Creek, Plum Creek (West Branch tributary), Blodgett Creek]. Stated in even broader terms, river systems are, in general, open in this way and the movement of stream life between and among rivers and streams and their associated tributaries is inherent.

- As identified in previous investigations by Ohio EPA, home septic systems may at time serve as important sources of nutrients and fecal bacteria, particularly on Rocky River tributaries. Regarding the performance of these systems, county authorities should continue inventory, inspection, and maintenance programs.

- Although much improved in comparison with previous investigation, continued progress is needed regarding management of CSOs, SSOs, and related bypasses from Lakewood and NOERSD collection systems.

- Despite significant progress, including partial recovery through the lower mile, ALU impairment has persistent on Abram Creek. Recent gains appeared attributable to significantly improved management of deicing waste and stormwater by CHIA. However, aquatic communities throughout still appeared affected by high TDS, and other related stormwater residues, of which CHIA is a contributor.

- As wooded riparian areas serve many essential functions (e.g., buffer, sunlight attenuation, bank stability, energy source, cover and habitat enhancement), the conservation of existing riparian corridors and enhancement, where absent or minimal, should be given high priority.

- At present Plum Creek (West Branch tributary) appeared limited by a natural barrier to fish passage provided by the Plum Creek Gorge, at the mouth. As such, the restorability of this stream appeared constrained by natural factors, thus it is potentially eligible for sub-goal ALU redesignation. However, before lowering the water quality goal for this important West Branch tributary, perhaps an experimental seeding of upper Plum Creek with a representative collection of headwater fish species from adjacent waters within the basin should be considered. Too be sure, there are innumerable challenges to this proposal, but conceptually it represents a way ascertain the restoration potential of Plum Creek, and if successful may contribute to ALU restoration. A full vetting or general feasibility of this proposal is well beyond the scope of this report, but it is offered here to stimulate and test public and institutional interest in an unorthodox approach to persistent ALU impairment.

Future Monitoring

The Rocky River watershed should be revisited in 2029, as provided for in Ohio's strategic monitoring plan. If restoration activities are undertaken prior to the scheduled basin resampling, smaller sampling efforts should be deployed to document effectiveness. These efforts must provide adequate coverage, up and downstream from the project area, include historical monitoring stations as well as those directly affected. For larger efforts, post project monitoring should be postponed until such time has elapsed to allow for natural recovery (e.g., two years for dam removal), unless multi-year sampling is anticipated.

Table 2. Existing and recommended beneficial use designations from the integrated biosurvey of the Rocky River basin, 2014-15.

Water Body Segment	Use Designations													Comments
		Aquatic Life Habitat						Water Supply			Recreation			
	SRW	WWH	EWH	MWH	SSH	CWH	LRW	PWS	AWS	IWS	BW	PCR	SCR	
| | | | | | |														
Porter Creek		*/+							*/+	*/+		*/+		
Cahoon Creek		*/+							*/+	*/+		*/+		
Rocky river - State route 10 (RM 6.4) to the mouth	+	+			+				+	+		+		
- confluence of East and West branches (RM 12.1) to state route	+	+							+	+		+		
Abram Creek - CHIA enclosure (RM 1.0) to mouth		+							+	+		+		
-all other segments		+							+	+		+		Isolated segment.
East Branch - upstream boundaries of Rocky river reservation (RM 15.15) to West branch	+	+							+	+		+		
- at RM 5.06	+	+						o	+	+		+		PWS intake - Berea
- within the boundaries of Hinckley reservation	+	+							+	+	+			
- headwaters to Hinckley reservation	+	+							+	+		+		
- all other segments		+							+	+		+		
Baldwin Creek - at RM 0.48	+	+						o	+	+		+		PWS intake - Berea
- all other segments	+	+							+	+		+		
Big Brook		*							*	*		*		
Unnamed tributary at east branch RM 12.1														
North Royalton "A" tributary		+							+	+		+		
Healy Creek		+							+	+		+		
		△							△	△		△		

Water Body Segment	Use Designations													Comments
		Aquatic Life Habitat						Water Supply			Recreation			
	SRW	WWH	EWH	MWH	SSH	CWH	LRW	PWS	AWS	IWS	BW	PCR	SCR	
| | | | | | |														
| West Branch		+						+	+	+		+		PWS intake - Medina (formerly)
Plum Creek		+							+	+		+		
Blodgett Creek (Strongsville "A" tributary) (West Branch RM 4.54)		+							+	+		+		
Baker Creek		+							+	+		+		
Cossett Creek		+							+	+		+		
Mallet Creek		+							+	+		+		
Broadway Creek														
North Branch		+							+	+		+		
Plum Creek		+							+	+		+		
Remson		*/+							*/+	*/+		*/+		
Granger Ditch		*/+							*/+	*/+		*/+		
Champion Creek (West branch RM 31.47)		Δ							Δ	Δ		Δ		

Beneficial Uses: SRW = state resource water; WWH = warmwater habitat; **EWH** = exceptional warmwater habitat; MWH = modified warmwater habitat; SSH = seasonal salmonid habitat; CWH = coldwater habitat; LRW = limited resource water; PWS = public water supply; AWS = agricultural water supply; IWS = industrial water supply; PWS = Public Water Supply; BW = bathing water; PCR = primary contact recreation; SCR = secondary contact recreation

***** - Unverified beneficial use designation based on 1978 Water Quality Standards(WQS).

+ - Verified beneficial use designation based on the results of a biological field assessment performed by the Ohio EPA.

***/+** - Verification of existing, yet unverified, beneficial use designation based upon the results of this investigation.

Δ - Recommended beneficial use designation based on the results of this investigation.

INTRODUCTION

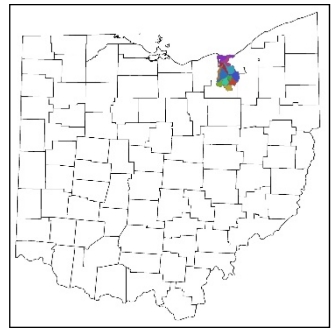


Figure 4. Location of the Rocky River study area within the political boundaries of Ohio.

The Rocky River watershed was the subject of intensive integrated survey during the summer and fall of 2014 (Figures 4 and 5). A total of 82 sampling stations were allocated to this effort and provided for the assessment of 28 named and unnamed streams. Assessed surface waters included the Rocky River mainstem, East and West Branches, and principal affiliated tributaries. Ambient biology, macrohabitat quality, water column chemistry, and bacteriological data were collected concurrently from most of these monitoring stations. Diel observations, sediment, nutrients, and fish tissue were collected and analyzed from a subset of monitoring sites. Two previously unassessed direct Lake Erie tributaries, Porter Creek and Cahoon Creek, were included within this study. Informed by preliminary results from the 2014 sampling effort, supplemental monitoring was directed to selected locations within the study in 2015. Although separate from the Rocky River sampling effort, the findings from lake monitoring on two public lakes within the study area (Coe and Wallace Lake) are summarized in this report. All monitoring activities and resulting assessments, were performed in accordance with standard Ohio EPA methods and protocols as described in Appendix A.

Primary Sampling Objectives:

1) Systematically sample and assess the principal drainage network of the Rocky River in support of both the TMDL process and NPDES permitting;
2) Ascertain the current status of existing beneficial uses (e.g., aquatic life, recreational, and water supply);
3) Verify the appropriateness of existing, unverified, beneficial use designations and recommend changes where appropriate;
4) Collect the environmental information (biological, chemical, and physical) from undesignated or unlisted waterbodies necessary to recommend appropriate suite of beneficial uses;
5) Document anticipated water quality improvements attending dam removals within study area;
6) Document condition of the fish and macrobenthos assemblages following an illicit cyanide release and subsequent fish kill on the lower East Branch Rocky River in 2012; and
7) Document any changes in the biological, chemical, and physical conditions within the study area since the early 1980s to evaluate the effectiveness of past and on-going pollution abatement efforts and to expand the Ohio EPA data base for statewide trends analysis (e.g., 305[b], 303[d] listing and de-listing);

The findings of this evaluation may factor into regulatory actions taken by the Ohio EPA (e.g. NPDES permits, Director's Orders, or the Ohio Water Quality Standards [OAC 3745-1]), and may eventually be incorporated into State Water Quality Management Plans, the Ohio Nonpoint Source Assessment, Total Maximum Daily Loads (TMDLs) and the biennial Integrated Water Quality Monitoring and Assessment Report (305[b] and 303[d] report).

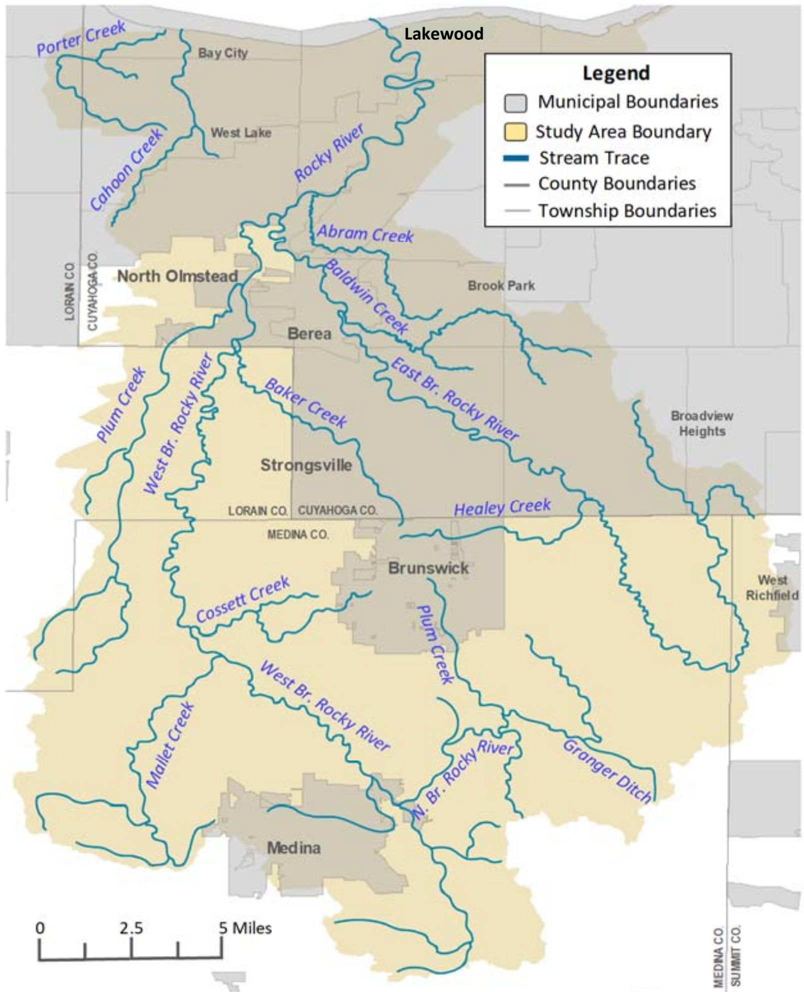


Figure 5. Principal rivers and streams, municipalities, and watershed boundary, Rocky River study area, 2014-15.

Few watersheds in Ohio have been surveyed as thoroughly and as frequently as the Rocky River. The principal waters of the basin have been regularly assessed by Ohio EPA since the early-1980s. These data not only established base-line conditions against which progress may be fully measured but have also provided iterative assessments describing the status and condition of the watershed through the early and late-1990s. The census-based integrated survey approach has and continues to yield numerous, demonstrated benefits. Chief among these is the regular provision of resource-based feedback to the regulatory process, as water quality management activities administered at the state level (permitting, planning, enforcement, disbursement of funds, etc.) are directly informed or guided by waterbody assessments derived from robust measures of water resource quality.

There are multiple pollution sources, stressors, and a wide array of other factoring affecting the quality of the water resources within study area. First among these is the large volume of treated wastewater generated by numerous permitted public and private entities the Rocky River basin must assimilate. To ensure the conservation of existing beneficial uses or recovery of those lost to impairment, oversite and careful allocation of this waste load is among the primary duties of state water quality mangers. Multiple large population centers and other areas of intensive land use within the watershed pose additional water quality challenges in the form of hydromodification, urban stormwater, impoundment, riparian encroachment, and loads from other diffuse pollution sources. Vagaries of geology and physiography also play an important role in shaping watershed processes, including those responsible for channel formation and maintenance. At multiple scales (subbasin, reach and station), channel form and function either control or directly influence many important aspects of surface water quality, from assimilative capacity to the competency of macrohabitat to support aquatic life.

Given the very long history of monitoring and assessment, the trajectory of water quality indicators through time, regulatory history, and the mix of other local and regional factors affecting the basin, a synopsis is required to provide necessary context. To that end, selected items and issues that informed the planning and execution of the 2014 Rocky River study are briefly discussed below.

TMDL

The objectives of the TMDL process are to estimate pollutant loads from the various sources within the basin, define or characterize allowable loads to support the various beneficial uses, and to allocate pollutant loads among different pollutant sources through appropriate controls (e.g., NPDES permitting, storm water management, 319 proposals, NPS controls or other pollution abatement strategies).

The components of the TMDL process supported by the findings of this survey are primarily the identification of impaired waters, verification (and resignation if necessary) of beneficial use(s), collection of ambient information that will factor into the wasteload allocation, and ascribing causes and sources of use impairment. These data are necessary precursors to the development of effective pollution control or abatement strategies.

NPDES Dischargers

The study area contains 52 NPDES permitted facilities that discharge sanitary wastewater, industrial process water, storm water, cooling water or related residual effluents into surface waters of the Rocky River basin. Well over 80% of these are classified as minor dischargers, in that their design flow is well under one MGD, and together are composed of a mix of small public and private wastewater facilities. The remaining large facilities are exclusively POTWs and serve as major sources of treated sanitary wastes within the study area. Significant minor and all major facilities were directly or indirectly evaluated as part of this study.

Over the past 20 years, numerous POTWs have been decommissioned, their waste streams redirected to expanded and upgraded subregional facilities or to regional entities outside of the watershed. Selected POTWs no longer discharge within basin, rather, treated wastewater is now directed to Lake Erie. Taken together these developments have resulted not only in improved treatment and capacity at many POTWs but also the removal of tens of millions of gallons of WWTP effluent from the Rocky River basin. Furthermore, the combination of improved wastewater treatment, expanded plant capacity, and export of wasteload out of the watershed has significantly reduced the frequency and duration of CSO, SSO, and related bypasses since the last integrated survey in 1997.

A review of pollutant loadings and plant performance data predating the 2014 survey by typically four to five years found significant compliance issues for selected entities. Although Lakewood WWTP no longer discharges finished effluent to the Rocky River, the city has been operating under consent orders regarding headworks bypassing to the Rocky River and other active relief points within the collection system. Presently, work to separate combined sewers is on-going as the city continues to implement its nine minimum controls plan for CSOs. The NEORSD Westerly WWTP primarily serves populations outside of the study area and discharges finished effluent to Lake Erie. However, the collection system has multiple relief points (CSOs) within the lower Rocky River watershed. Presently, NEORSD maintains a dedicated CSO treatment facility to which sanitary waste and stormwater may be diverted during excessive wet weather events. The facility has the capacity to store six million gallons and provide rudimentary treatment for up to 350 MGD. Since 2011 the Westerly WWTP has operated under a consent decree to enforce long-term control plans regarding wet weather discharges of untreated sewage. The decree requires that NEORSD either improved the performance of the exiting CSO treatment system or expanded its capacity.

Periods of significant non-compliance were identified for North Olmstead WWTP (a major facility on the Rocky River) and NASA Glenn Research Center (stormwater to Abram Creek and Rocky River). North Olmstead was cited for exceeding its permit limits for ammonia for two-month period. This coincided with active construction at the facility supporting improvements to the treatment works, thus treatment disruptions or irregularities attending the upgrade were not unexpected and very likely temporary. Significant noncompliance cited for NASA Glenn was the result of regular exceedances of mercury limits. This is a long-standing issue with the NASA facility and appears related to legacy contamination of their plumbing and stormwater infrastructure.

There are several issues and activities pertaining to Cleveland Hopkins International Airport (CHIA) that warrant brief introductory discussion. The first of these includes long standing ALU impairment on Abram Creek, largely attributable to stormwater runoff contaminated with deicing residues. Impacts to Abram Creek documented in the past ranged from exceedingly high oxygen demand to acute ammonia toxicity. In addition to employing a range of deicing agents, CHIA has also implemented ambitious structural improvements since the last basin survey in 1997. To capture, store, and better manage deicing runoff, CHIA installed a centralized deicing facility in 2006. Draining 70 acres, most aircraft deicing is now performed within the facility and most of the collected runoff is directed a central detention basin. Collected runoff in excess of the capacity of the detention basin is decanted to NEORSD collection system to be treated at a regional facility outside of the Rocky River watershed. Additional modifications related to CHIA include a recent runway expansion that necessitated the enclosure of approximately a mile segment of Abram Creek, between approximately RMs 1.9 and 0.9. Aside from the obvious effects attending the loss of a mile of open channel, the culverted segment now very likely serves as a barrier to fish passage, effectively isolating the upper portions of the watershed from the lower mile and indirectly the Rocky River mainstem. Among other objectives, 2014 monitoring efforts on Abram Creek were directed to evaluate both, anticipated water quality improvements attending advances made by CHIA in the management of their deicing operations and to assess the structure limitations imposed on Abram Creek by stream enclosure.

Stream Restoration

A portion of the Rocky River sampling effort was allocated to evaluate potential water quality improvements associated with the removal several dams within the lower East Fork Rocky River basin. Specifically, these include the removal of three low head dams through the lower mile of Baldwin Creek in 2012. Sponsoring partners for this project were Rocky River Watershed Council, Cuyahoga County Soil and Water District and Cleveland Metroparks, with funding secured from regional and state authorities (Ohio EPA and NEORSD).

Post Spill Assessment

A portion of 2014 monitoring effort was allocated to documenting either recovery or lingering effects of an illicit release of cyanide in 2012 on the lower eight miles of the East Branch Rocky River, resulting in the loss of 30,000 fish, including the state threaten species, bigmouth shiner. Characterization of this reach was achieved through a combination of re-sampling of existing historical sites and the addition of new stations within the affected reach.

Water Quality Trends

There exists a wealth of historical ambient monitoring data from the Rocky River basin. The 2014 sampling effort marks the fourth state sponsored comprehensive survey of the Rocky River watershed. The first integrated biosurvey was conducted in the early 1980s and subsequent comprehensive watershed investigations were undertaken for the field years 1992 and 1997. The majority of sample locations within this study were selected to comport with previous sampling efforts, to facilitate the determination of trends in ambient biology and water quality through fixed station or reach scaled monitoring. This approach allows for the practical evaluation of various pollution abatement and stream restoration efforts implemented through the period of record.

STUDY AREA DESCRIPTION

Location, Scope, and Demographics

A direct Lake Erie Tributary, the Rocky River consists of the East and West Branches converging to form the mainstem of the river at North Olmstead (RM 12.1), as well as affiliated tributaries. The 293.8 sq. miles watershed situated between the Cuyahoga River basin (to the east) and the Black River basin (to the west) and is subdivided into twelve separate 12-digit Hydrologic Units (HUCs) (Figure 6). The lower 1.4 miles of the river are considered lacustrine (non-riverine or lake affected). Basic physical features of the primary rivers and streams of the Rocky River and a complete list of all streams within the study area and annotated monitoring stations are provided Tables 3 and 4, respectively. The lay of the Rocky River study area, including Potters and Cahoon Creek, showing political boundaries (cities, towns, villages, and counties), permitted pollution sources, and the distribution of monitoring sites is provided in Figure 7.

The basin headwaters are in Medina and Summit counties and flows north through Lorain and Cuyahoga counties. The river drains sixteen cities villages and sixteen townships. Per the most current census results (U.S. Census Bureau 2010), largest urban areas, population-wise, within the study area in descending order are: Lakewood (52,131), Strongsville (44,750), Brunswick (34,255), North Olmsted (32,718), North Royalton (30,444), Medina (26,678), Rocky River (20,213), Broadview Heights (19,400), Brook Park (19,212), Berea (19,093), Fairview Park (16,826), and Bay Village (15,651) (US Census Bureau 2010).

The southern portion of the basin has seen a large increase in population since 1990, while the populations have remained stable within the highly developed area the central and northern parts of the watershed. The highest growth areas are in and around the cities of Medina, Strongsville, North Royalton, Brunswick, North Olmsted, and Olmsted Falls. Communities that drain to either East or West Branch are projected to continue to experience high growth in the future.

Table 3. Characteristics of the principal rivers and streams of the Rocky River watershed.

Tributary Name	Length (mi)	Gradient (ft/mi)	Drainage Area (mi^2)
Rocky River	12.1	13.7	293.8
Abram Creek	7.4	29.4	10.06
East Branch	34.5	16.5	80.4
Baldwin Creek	9.2	53.8	11.94
Healey Creek	5.75	48.9	4.84
West Branch	36.2	16.0	188.3
Plum Creek (WB)	14.8	16.4	18.9
Baker Creek	8.2	45.7	5.81
Cossett Creek	8.2	59.0	4.18
Mallet Creek	11.4	27.5	18.75
North Branch	5.4	22.4	37.55
Remsen Creek	6.5	30.5	14.62
Plum Creek (NB)	7.1	21.4	12.79

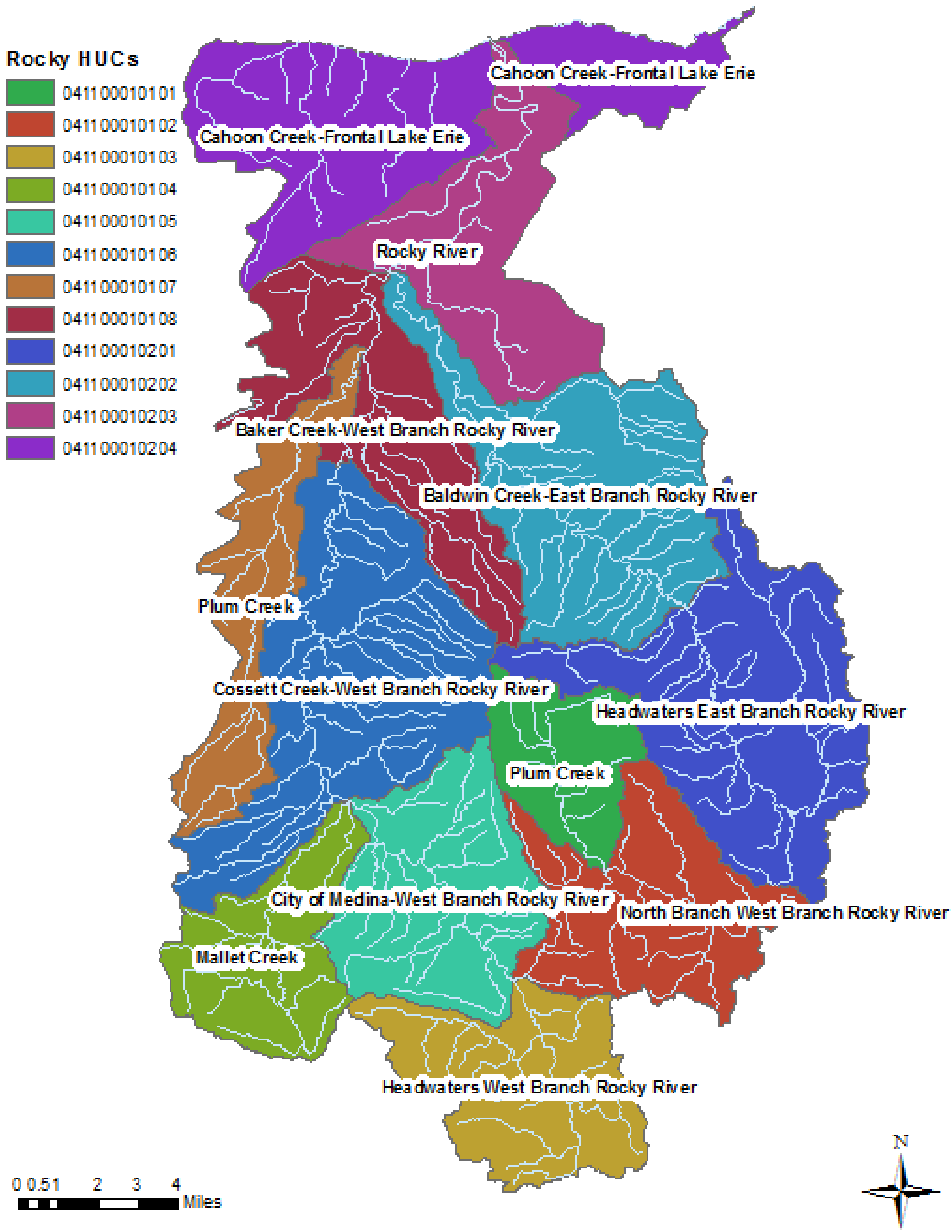


Figure 6. Thirteen, 12-digit Hydrologic Units (HUCs) that comprise the Rocky River watershed.

Table 4. Rocky River watershed sampling locations, showing station code (STORET), river mile, drainage area, sample types, and geo-coordinates, 2014-15. Map numbers (far right column) correspond to station numbers provided in Figure 7.

River Code STORET	River Mile	Area ($mile^2$)	Sample Type	Location	Lat. Long.	Map No.[b]
Rocky River 13-001-000						
T01W19	11.65	267.0	(F,M,C,B,T,D,N)	Ust. North Olmsted WWTP at ford	41.40760 -81.88240	1
501770	11.1	268.0	(F,M,C)	Adj. Park Blvd. dst. North Olmsted WWTP	41.41330 -81.87720	2
501780	9.95	279.0	(F,M,C,T,D,N)	Brook Park Rd./SR 17, dst. NASA and Abram Creek	41.41890 -81.85640	3
T01W13	9.0	281.0	(F,M,C)	Fairview Park, Near S. Mastick Picnic Area	41.42990 -81.85110	4
T01W12	7.6	282.0	(F,M,C,B,T)	Old ford near Mastick Golf Course	41.44230 -81.83940	5
T01W09	5.8	289.0	(F,M,C)	Cleveland, adj. parkway, dst. SR 10	41.46010 -81.82220	6
501790	3.0	291.0	(F,M,C,D,N)	Lakewood at Park, Valley Parkway	41.46940 -81.83170	7
T01W03	1.8	292.0	(F,M,C,B,T)	At Lakewood WWTP	41.47880 -81.82160	8
T01P02	1.39	293.0	(F,C,T,D,N)[c]	***Lacustrine - Lake Affected*** Dst. Lakewood WWTP, at Metropark Dr.	41.47830 -81.82860	9
T01K02	0.7	293.0	(C,B,T)	***Lacustrine - Lake Affected*** Lakewood, at Detroit Rd.	41.47970 -81.83330	10
Abram Creek 13-002-000						
501760	3.32	6.7	(C,D)	Eastland Rd., Background (2015 Supplemental Monitoring)	41.3931 -81.8458	11
T01W76	3.15	6.8	(F,M,C,D,N)[a]	Eastland Rd. dst. CHIA Storm Drain	41.39310 -81.84580	11
T01P12	2.87	7.3	(C,D)	Riverside Dr. (Supplemental Monitoring 2015)	41.4299 -81.9338	11
T01P13	1.9	8.9	(F,M,C)[a]	Grayton Rd.	41.39470 -81.86690	12
501830	0.84	9.7	(F,M,C)[a]	Near Berea, at Cedar Point Rd.	41.40780 -81.86940	13
T01S04	0.3	10.1	(F,M,C,S,B,D,N)[a]	West Area Rd.	41.41500 -81.86920	14
Rocky River Trib. at RM 6.9 13-001-002						
302626	0.1	0.77	(C)[CMP]	Adj. Little Met Golf Course	41.44313 -81.82822	15
West Branch Rocky River 13-200-000						
501940	33.55	9.1	(F,M,C,S)[a]	Near Medina, SR 162	41.10640 -81.80610	16
301181	32.26	11.4	(F,M,C,B,T,D,N)[a]	At Ridgewood Rd., ust. Town & Country Co-op Inc. (via Tributary), dst. Landfill	41.121378 -81.810882	17
501820	27.3	69.0	(F,M,C,T)	Dst. Medina, at Fenn Rd., dst. North Branch Rocky River.	41.17080 -81.85220	18
501900	21.75	85.0	(F,M,C,B,D,N,T)	Near Abbeyville, at Neff Rd.,	41.20810 -81.89530	19

River Code STORET	River Mile	Area ($mile^2$)	Sample Type	Location	Lat. Long.	Map No.[b]
West Branch Rocky River 13-200-000						
501890	16.35	122.0	(F,M,C)	Grafton Rd., dst. Columbia Gas Transmission Corp. (via Mallet Creek)	41.260108 -81.929712	20
T01S11	13.3	134.0	(F,M,C,S,B,T,D,N)	Adj. West River Rd., dst. Medina Co. No. 500 WWTP, via W.Br. Trib. at RM 14.0	41.28420 -81.93250	21
501880	11.7	138.0	(M,C)	Columbia Hills Country Club, at foot bridge	41.29500 -81.917500	22
T01W94	7.4	145.0	(F,M,C,B,T,D,N)	North of Columbia Hills, adj. West River Rd., dst. from the following WWTPs: Columbia Hill Country Club, Sundaes in the Park, and Columbia School	41.33100 -81.91820	23
T01W90	4.9	153.0	(F,M,C,T)	At West View, dst. Baker Creek, dst Cuyahoga Landmark Inc., via Trib. at RM 4.9	41.35480 -81.89820	24
501860	3.5	161.0	(F,M,C,D)	At Olmstead Falls, at Bagley Rd., dst. Plum Cr. WWTP - via Plum Cr. (2015 Supplemental Monitoring)	41.37280 -81.89860	25
T01S09	2.1	181.0	(F,M,C)	North of Olmstead Falls, adj. Lewis Rd.	41.38920 -81.89310	26
501850	0.39	190.0	(F,M,C,S,B,T,D,N)	Near North Olmstead, at Lewis Rd., dst. Columbia Park Water System MHP (via Trib. at RM 1.78)	41.40440 -81.89310	27
Champion Creek 13-200-009						
T01A55	0.01	7.8	(F,M,C)[a]	East of Medina, at Mouth, South of Smith Rd.	41.129408 -81.817467	28
Broadway Creek 13-200-013						
302574	0.28	2.0	(F,M,C)[a]	Foot Rd.	41.156462 -81.842868	29
North Branch Rocky River 13-205-000						
T01S15	5.52	28.1	(F,M,C)	East of Weymouth, at Remsen Rd.	41.18610 -81.78390	30
501960	0.45	36.3	(F,M,C,B,D)	Near Medina, at Granger Rd.	41.15250 -81.78390	31
Plum Creek (N. Br. Trib.)13-206-000						
501840	3.02	8.8	(F,M,C)[a]	South of Sleepy Hollow Lake, at Carpenter Rd. (2015 Supplemental Monitoring)	41.21690 -81.80940	32
T01K14	2.5	10.4	(F,M,C)[a]	Adj. Carpenter Rd., ust old Medina 500 WWTP (2015 Supplemental Monitoring)	41.21060 -81.80670	33
302573	0.5	12.1	(F,M,C,B,D)[a]	SR 3/I 71, near mouth (2015 Supplemental Monitoring)	41.193713 -81.790982	34
Remsen Creek 13-206-001						
302575	0.6	14.4	(F,M,C)[a]	Remsen Rd.	41.188017 -81.776745	35
Granger Ditch 13-208-000						
302577	1.75	7.5	(F,M,C)[a]	SR 94, ust. Medina Co No. 11 WWTP (via Granger Ditch Trib. at RM 2.1)	41.172309 -81.74169	36
302576	0.2	13.3	(F,M,C)[a]	Stoney Hill Rd., dst. Highland HS WWTP, dst. Medina Co No. 11 WWTP (via Granger Ditch Trib. at RM 2.1)	41.183328 -81.765397	37

River Code STORET	River Mile	Area (mile²)	Sample Type	Location	Lat. Long.	Map No.[b]
Mallet Creek 13-204-000						
T01K13	3.5	13.7	(F,M,C)[a]	At Lester, at SR 57	41.180815 -81.938345	38
T01S14	0.72	16.1	(F,M,C,B,D)[a]	North-west of Abbeyville, at Neff Rd.	41.207684 -81.914259	39
Cossett Creek 13-203-000						
T01K12	0.2	4.1	(F,M,C)[a]	South of Valley City, at SR 252	41.227233 -81.921145	40
Baker Creek 13-202-000						
T01S13	0.3	5.80	(F,M,C)[a]	West View, at Sprague Rd.	41.35080 -81.90030	41
Blodgett Creek 13-200-003						
T01A17	1.61	3.1	(F,M,C)[a]	Ust. (old) Strongsville A WWTP	41.34870 -81.87410	42
T01A23	0.17	4.1	(F,M,C)[a]	West View, at Lindbergh Rd., dst old Strongsville A WWTP	41.35720 -81.89290	43
Plum Creek (W. Br. Trib.)13-201-000						
T01K11	8.5	7.6	(F,M,C)[a]	South of Columbia Station, at Akins Rd. (2015 Supplemental Monitoring)	41.289507 -81.952024	44
T01A33	4.92	14.3	(F,M,C,D,N)[a]	North of Columbia Station, at Jaquay Rd., dst. Plum Creek WWTP (2015 Supplemental Monitoring)	41.33490 -81.93380	45
T01P23	2.5	16.2	(F,M,C)[a]	South of Olmstead Falls, at Ohio Turnpike (2015 Supplemental Monitoring)	41.35940 -81.91500	46
302622	0.4	17.0	(C,B,D,N)	WQ Modeling Sentinel Site: Mill St. (2015 Supplemental Monitoring)	41.374232 -81.90380	47
501950	0.25	17.6	(F,M)[a]	North Olmstead, at Columbia Rd.	41.37780 -81.90110	48
East Branch Rocky River 13-100-000						
302627	30.8	7.34	(F,M,C)[CMP,a]	Adj. subdivision off Oviatt Rd., West of county line. (2015 Supplemental Monitoring)	41.25276 -81.69393	49
T01A52	29.22	8.9	(F,M,C,S)[a]	Dst. SR 303, ust. Camp Hilaka, St. Bernard Golf Course and Crowell WWTPs (via Trib. at RM 29.3)	41.238288 -81.687480	50
501660	26.63	14.3	(F,M,C,B,D,N)[a]	At Harter Rd., ust. Medina Co. SD No 9 WWTP (via Trib. at RM 22.5)	41.2100583 -81.6847444	51
T01S07	21.98	25.4	(F,M,C,D,N)	SR 303, dst. Medina Co. SD No. 9, Hinckley Elem. School, and Fosters Tavern of Hinckley WWTPs (via Trib. at RM 22.5)	41.24080 -81.72780	52
T01W41	18.3	31.6	(F,M,C,D,N)	Ust. Medina 300 WWTP	41.27320 -81.74110	53
T01W38	17.5	31.8	(F,M,C,B,D,N)	At private drive off SR 3, dst. Medina 300 WWTP	41.27970 -81.74080	54
501690	15.15	40.0	(F,M,C,D,N)	Near North Royalton, at Bennett Rd., ust. North Royalton WWTP A (via Trib. at RM 12.9)	41.29530 -81.75940	55

River Code STORET	River Mile	Area (mile^2)	Sample Type	Location	Lat. Long.	Map No.[b]
East Branch Rocky River 13-100-000						
T01W33	11.57	53.0	(F,M,C,T,D,N)	Strongsville, at SR 82/Royalton Rd., ust. Strongsville B WWTP (via Trib. at RM 11.1), dst. North Royalton WWTP A (via Trib. at RM 12.9)	41.31320 -81.79720	56
T01W30	10.0	57.0	(F,M,C,S,T,D,N)	At Mill Stream Run bridge, dst. I-71, dst. Strongsville B WWTP (via Trib. at RM 11.1)	41.32440 -81.81680	57
T01W29	9.35	59.0	(F,M,C)	Strongsville, between SR 42 and I-71 (2015 Supplemental Monitoring)	41.328085 -81.827699	58
T01W27	8.2	60.0	(F,M,C,B)	Near Strongsville, adj. parkway, dst. SR 42	41.33660 -81.83570	59
T01W25	7.35	61.0	(F,M,C,D,N)	Eastland Rd./I-80	41.343026 -81.836913	60
501720	6.38	63.0	(F,M,C,T)	Berea, well ust. Baldwin Lake	41.351432 -81.845816	61
T01K04	5.1	64.0	(F,M,C,T)	At Berea, dst. Baldwin Lake	41.36560 -81.85640	62
302628	5.06	64.0	PSW Analysis	Berea PWS Intake, dst. Baldwin Lake	41.365852 -81.856691	63
T01P04	3.06	75.6	(F,M,C,T)	Dst. (old) Berea WWTP, at ford	41.38610 -81.86720	64
501740	1.28	76.5	(F,M,C,S,B,T,D,N)	At Spafford Rd. ford	41.39610 -81.88330	65
East Branch Trib. at RM 25.4 13-100-011						
302629	0.1	2.9	(F,M,C)[CMP, a]	At mouth, dst. Ledge Rd.	41.20911 -81.69693	66
East Branch Trib. at RM 24.2 13-100-005						
302630	0.1	0.34	(C)	Picnic Area Lane off State Rd.	41.218844 -81.706145	67
Healey Creek 13-104-000						
501630	0.7	4.9	(F,M,C)[a]	Near North Royalton, at Boston Rd.	41.27500 -81.75830	68
East Branch Trib. at RM 12.9 13-100-003						
302631	0.2	2.98	(C)	Dst. Edgerton Rd., ust. Brecksville-Royalton Parkway	41.308456 -81.780219	69
East Branch Trib. at RM 12.1 13-100-015						
302632	0.1	1.71	(F,M,C)[CMP, a]	Royalview Rd., near mouth	41.31037 -81.79597	70
East Branch Trib. at RM 11.1 13-100-001						
302648	0.1	1.39	(C)	Dst. SR 82, opposite Camp Cheerful	41.31460 -81.80293	71
East Branch Trib. at RM 10.6 13-100-020						
302649	0.2	0.47	(C)	Dst. I-71	41.31966 -81.81091	72
East Branch Trib. at RM 10.2 13-100-019						
302650	0.3	0.16	(C)	Dst. I-71	41.32113 -81.81284	73

River Code STORET	River Mile	Area ($mile^2$)	Sample Type	Location	Lat. Long.	Map No.[b]
Baldwin Creek 13-101-000						
T01W53	3.53	6.6	(F,M,C,D,N)[a]	Lucerne Rd., ust. Strongsville C WWTP (2015 Supplemental Monitoring)	41.35690 -81.81610	74
501650	2.61	8.3	(F,M,C)[a]	Big Creek Parkway, dst. Strongsville C WWTP (2015 Supplemental Monitoring)	41.34940 -81.82580	75
T01W59	1.13	9.6	(F,M,C,D,N)[a]	Near Berea, at Eastland Rd. (2015 Supplemental Monitoring)	41.35750 -81.84390	76
204492	0.5	10.0	PSW Analysis (S)	Berea PWS intake, Coe Lake, Baldwin Creek impoundment (2015 Supplemental Monitoring)	41.361183 -81.851331	77
302651	0.48	10.0	PSW Analysis	Berea PWS Intake, immediately dst. Coe Lake (2015 Supplemental Monitoring)	41.360960 -81.851965	78
T01G01	0.38	10.0	(F,M,C,B,D,N)[a]	Rocky River Dr., dst. Coe Lake - dam removal location (2015 Supplemental Monitoring)	41.36110 -81.85370	79
301231	0.1	10.0	(F,M,C)[a]	Berea, at mouth - dam removal location (2015 Supplemental Monitoring)	41.366048 -81.85469	80
Porter Creek 13-003-000 (Direct Lake Erie Tributary)						
T01P20	0.1	8.3	(F,M,C,B)[a]	Bay Village, at US 6	41.48940 -81.93190	81
Cahoon Creek 13-004-000 (Direct Lake Erie Tributary)						
T01P21	0.08	5.4	(F,M,C,B)[a]	Bay Village, at US 6	41.48890 -81.92560	82

a - Stations draining an area less than 20 mi^2: 1X fish and qualitative Macrobenthos sampling. Unless otherwise indicated all other stations draining an area greater than 20 mi^2, and thus 2X Fish and quantitative Macrobenthos sampling is prescribed.
b - Corresponds to station numbers in Figure 2. Note: Two or more stations in very close proximity are represented by a single station number.
c - Fish station with transitional area between lake affected and riverine.
CMP - Cleveland Metroparks: Sites so identified wee included at the request of CMP, three of which were sampled through the combined effort of Cleveland Metropoarks and Ohio EPA, DSW staff.
F - Fish Community
M - Macrobenthos
C - Water Column Chemistry
N - Nutrients: sampling in support of nutrient monitoring and assessment.
D - Datasonde®, contious data logger.
B - Bacteria sampling in support of recreational use assessment.
S - Sediment: Full Organic Scan [Pesticides (including Chlordane), BNAs, TOC and PCBs], Metals Scan (excluding Hg), Percent Solids.
T - Fish tissue station
PWS - Public Water Supply monitoring

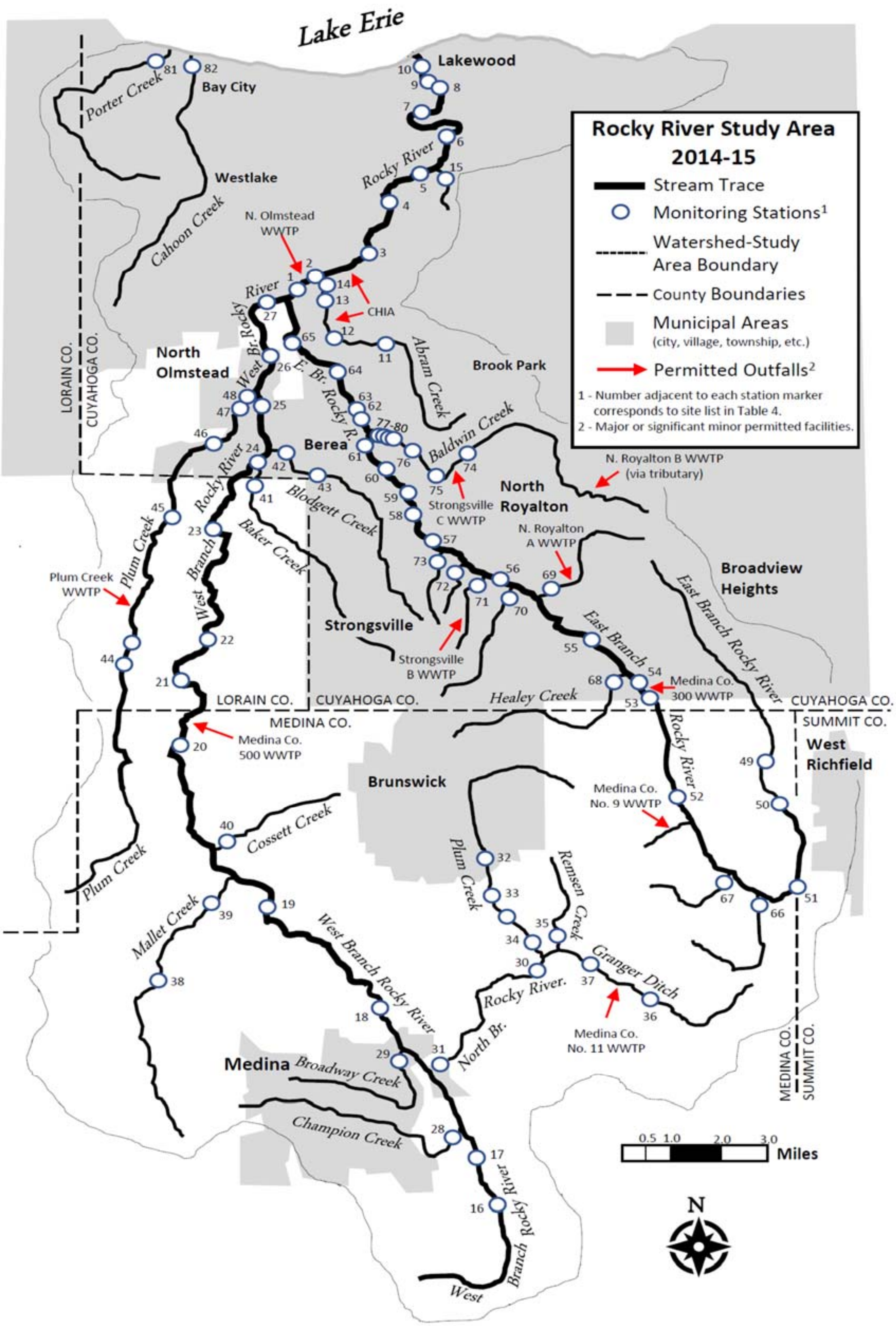


Figure 7. Monitoring stations and sample type Rocky River watershed, 2014-15. Note: station numbers correspond to those itemized in Table

Ecoregion, Geology, and Soils

The watershed lies in the Erie-Ontario Lake Plain Plateau (EOLP) ecoregion and is characterized by glacial plains interspersed with higher remnant beach ridges, drumlins, glacial till ridges, till plains, and outwash terraces (Omernik 1987 and Omernik and Gallant 1988). The geology of the Rocky River watershed is mainly composed of shale and siltstone layers. Two major coarse formations are the Berea Sandstone and the Sharon Conglomerate. The northwestern portion of the watershed is relatively flat and underlain by shale bedrock (Ohio DGS 2006). The remaining portion of the watershed is underlain by alternating shale and sandstone layers. The glaciation of northern Ohio led to deposits of unconsolidated clay, sand, and gravel.

High content clay soils are the dominant feature throughout, contributing to high storm water runoff and soil erosion. More than 90% of the watershed is covered by hydric soil types (Figure 8). The soils are formed from a combination of sandy, silty, and loamy glacial tills as well as lacustrine, alluvial, or glacial outwash deposits. The majority of the soils in the watershed are not well suited for traditional septic tanks, that rely on the absorption of waste into the ground.

Climate

Temperature fluctuations characterize the climate throughout the Rocky River watershed. Summers are generally moderately warm and humid, while winters are cloudy and cold. Temperatures below zero generally occur 5-10 times throughout the winter. Low winter temperatures can freeze the ground to a depth of 1 foot or more in certain areas, causes a temporal increase in precipitation runoff. Precipitation varies from year to year, with monthly fluctuations ranging from 2.5 to 3.5 inches. Syetematic hydrological observations have been made by the USGS from the Rocky River at Berea (gage 201404201500) since 1923 (USGS 2015). The long-term flow data is useful in creating flow duration curves, which shows the percentage of time flow in a river is likely to equal or exceed a specified value.

Lakes and Dams

Quarrying operations in Berea led to the formation of several lakes and ponds the watershed. Coe, Wallace, and Baldwin Lakes are all relicts from sandstone quarries. These lakes are currently publicly owned, and a section of Wallace Lake is maintained as a swimming beach. There are many other lakes within the Rocky River watershed, with a heavier distribution of small, private lakes in Medina county. Additional publicly owned lakes in the watershed include Lake Medina and Hinckley Lake both of which originated as impoundments. These five lakes all are larger than 5 acres and most are categorized as eutrophic or under stress from the surrounding environment. Lake Isaac, located in Middleburg Heights and managed by the Metroparks, is classified as a glacial pothole.

There are two lowhead dams along the mainstem of the Rocky River, both within Cleveland Metropark property. A single lowhead dam is located on Abram creek, about one mile up from the mouth, just downstream from CHIA enclosure. Three of the four dams on the lower mile of Baldwin Creek were removed prior to the 2014 survey. Four dams are located through the entire length of the East Branch Rocky River.

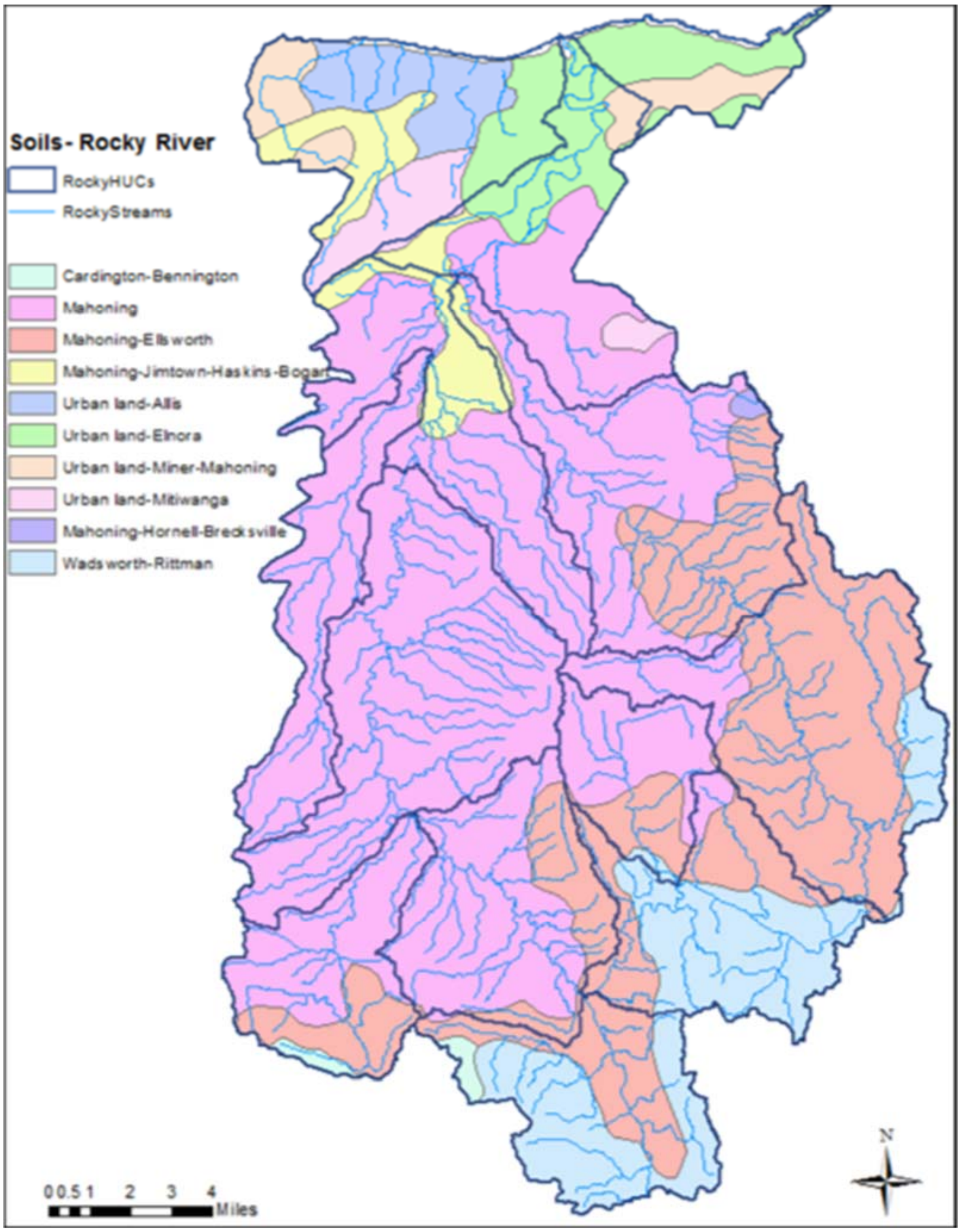


Figure 8. Soil series of the Rocky River watershed.

Land Use

Riparian habitats along the river are maintained in a forested condition along most of its length. Estimates of less than 10% of the watershed have vegetation in a highly disturbed state. Large portions of the mainstem and East Branch are contained in park reservations. The vegetated corridors in some of the heavily urbanized subwatersheds have decreased in riparian functionality. Current and ongoing development is primarily focused in the southern portion of the watershed, where headwaters streams are being destroyed. These streams serve as an integral part of the watershed's overall health and, in time, will result in the inability of downstream sections to meet water quality criteria. Land use within the watershed is described below (Table 5, Figure 9).

Table 5. Percent Land Use in the Rocky River watershed (NLCD 2011)

Landuse	Percent
Barren	0.1%
Crop	9.9%
Hay/Pasture	8.1%
Deciduous Forest	25.7%
Evergreen Forest	0.8%
Mixed Forest	<0.1%
Herbaceous	0.8%
Herbaceous Wetlands	0.1%
Woody Wetland	4.4%
Shrub/Scrub	0.1%
Developed, High Intensity	1.4%
Developed, Medium Intensity	6.3%
Developed, Low Intensity	19.6%
Developed, Open Space	22.1%
Water	0.7%

The Rocky River basin in Medina, Lorain, and Summit Counties still contain a substantial amount of land for agricultural purposes. Approximately 20,000 acres are devoted to this use. Large portions of the watershed currently exist as protected lands. Cleveland Metroparks manages land along a sizable section of the East Branch and most of the mainstem. Lorain County and Medina County Metroparks have additional land holdings in the watershed. Community parks are also prevalent across the basin. Conservation easements are held by both the Western Reserve Land Conservancy and the Cuyahoga County Soil and Water Conservation District.

Watershed Partners

The Rocky River Watershed Council exists "to protect, restore and perpetuate a healthy watershed through public education, watershed planning, communication and cooperation among stakeholders." A Watershed Action Plan was completed in 2006, with updates in 2010, for the entire river. The plan is available online from the group's website http://myrockyriver.ning.com/plans-reports. Public involvement has a major influence within the watershed, since much of the watershed is protected by various metropark districts.

All four counties, and sixteen villages or cities, and ten of the sixteen townships in the watershed are Phase II Storm Water Communities. Phase II communities are required to develop public involvement and public education programs (PIPE) related to storm water management and watershed protection. In addition, the Northeast Ohio Areawide Coordination Agency (NOACA) Regional Storm Water Task Force recommends that communities pool PIPE efforts to increase efficiency. Summit County's Regional Planning Agency is the Northeast Ohio Four County Regional Planning and Development Agency (NEFCO). There are numerous other educational opportunities that focus on watershed protection and stewardship, such as the various Soil and Water Conservation Districts, county health departments, Cleveland Metroparks, Lorain County Metroparks, Medina County Metroparks, NEORSD, NASA, and universities such as Baldwin Wallace and Cuyahoga Community College.

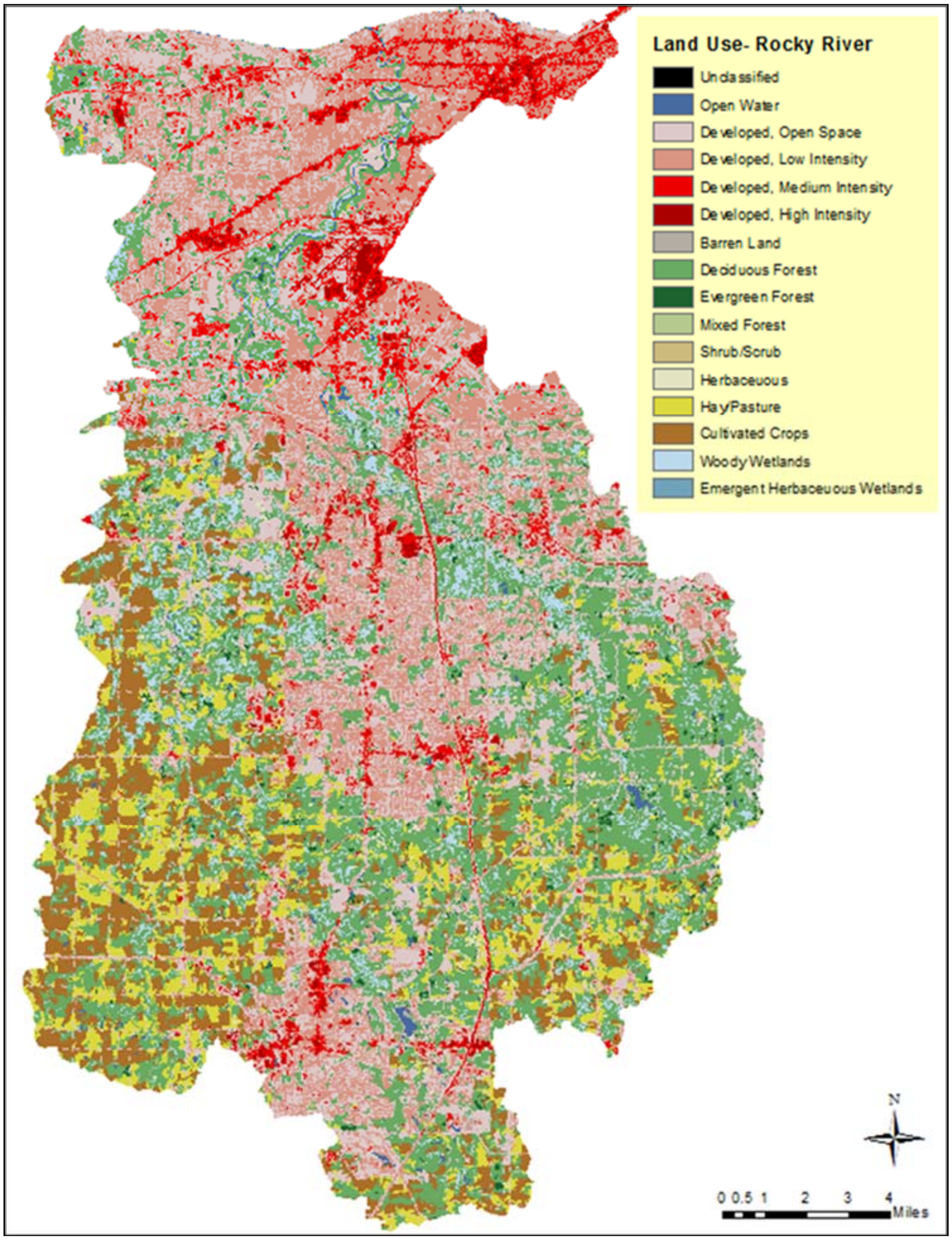


Figure 9. Land use in the Rocky River watershed from National Land Cover Dataset, 2011.

NPDES PERMITTED FACILITIES

The following paragraphs include figures, summaries and loading information for 14 of the 52 National Pollutant Discharge Elimination System (NPDES) permitted facilities that discharge either sanitary wastewater and/or industrial process water mixed with industrial storm water into the Rocky River watershed. These facilities have had significant permit compliance issues or are major dischargers (greater than 1 million gallons per day). All permitted entities within the Rocky River study area are listed or plotted in Table 6 and Figure 10 shows all of the NPDES permitted facilities in the watershed. Each facility is required to monitor their discharges according to sampling and monitoring conditions specified in their NPDES permit and submit Discharge Monitoring Reports (DMR) to Ohio EPA.

In addition to the loading summaries from the dischargers, NPDES violations were evaluated using SWIMS (Surface Water Information Management System), when possible from 2005 through 2015. SWIMS violations fall within three categories and are defined as follows:

- A numeric limit violation is a violation of a permit limit.
- A frequency violation is a failure to monitor the correct number of times per month.
- A code violation is the use of a wrong code or an inappropriate code.

Table 6. All major and minor facilities regulated under NPDES within the Rocky River study area.

Facility	NPDES	Type[a]	Class[b]	Receiving Stream	RM[c]	County
Rocky River WWTP	3PE00009	P	Major	Lake Erie	NA	Cuyahoga
Westerly Adv WWTP	3PE00001	P	Major	Lake Erie	NA	Cuyahoga
Cleveland Division of Water, Crown WTP	3IV00060	I	Minor	Sperry Creek (Lake Erie Tributary)	0.6	Cuyahoga
North Olmsted WWTP	3PD00016	P	Major	Rocky River	11.4	Cuyahoga
NASA Glenn Research Center	3IO00001	I	Minor	Rocky River	10.4 - 10.2	Cuyahoga
				Abram Creek	0.5 - mouth	
Cleveland Hopkins International Airport	3II00179	I	Minor	Rocky River	10.4 - 9.9	Cuyahoga
				Abram Creek	3.2 - mouth	
Air BP - Cleveland Hopkins Airport	3IN00060	I	Minor	Rocky River	9.5	Cuyahoga
Moen Inc.	3IN00241	I	Minor	Rocky River	-	Cuyahoga
Air BP - Cleveland Hopkins Airport	3IN00060	I	Minor	Rocky River	9.5	Cuyahoga
Lakewood WWTP	3PE00004	P	Major	Rocky River	1.77	Cuyahoga
Town & Country Co-op Inc.	3IG00087	I	Minor	West Br. Tributary (at RM 31.4)	~5.0-5.2	Medina
RPM Intl Inc.	3PR00395	P	Minor	West Br. Tributary (at RM 24.5/1.1)	24.5/1.0	Medina
Republic Powdered Metals Inc.	3IN00255	I	Minor	West Br. Tributary (at RM 24.5/1.1)	24.5/1.0	Medina
Medina Co. SD No. 500 Liverpool WWTP	3PK00004	P	Major	West Br. Tributary (at RM 14.8/0.3)	14.8/0.2	Medina
Columbia Hills Country Club	3PR00277	P	Minor	West Br. Rocky River	10.9	Lorain

Facility	NPDES	Type[a]	Class[b]	Receiving Stream	RM[c]	County
Sundaes in the Park WWTP	3PR00339	P	Minor	West Br. Rocky River	~9.6-9.7	Lorain
Columbia School	3PT00087	P	Minor	West Br. Rocky River	~9.6-9.7	Lorain
Cuyahoga Landmark Inc.	3IN00104	I	Minor	West Br. Tributary (at RM 4.9)	4.9/3.9	Cuyahoga
Columbia Park Water System MHP	3PV00013	P	Minor	West Br. Tributary (at RM 1.78/.0.4)	1.78/0.3	Cuyahoga
Plum Creek WWTP	3PG00052	P	Minor	Plum Creek (West Br. Tributary)	6.78	Lorain
Columbia Gas Transmission Corp.	3IN00301	I	Minor	Mallet Creek Tributary (at RM 0.1)	0.1/1.5	Medina
Highland High School	3PT00111	P	Minor	Granger Ditch	1.6	Medina
Medina County Sewer District No 11	3PG00043	P	Minor	Granger Ditch Tributary (at RM 1.0)	1.0/3.1	Medina
St Bernard Golf Course	3PR00293	P	Minor	East Br. Tributary (at RM 29.3)	29.3/0.1	Summit
Camp Hilaka & Crowell WWTP	3PX00000	P	Minor	East Br. Tributary (at RM 29.3)	29.3/0.2	Summit
Medina Co. SD No 9 WWTP	3PG00042	P	Minor	East Br. Tributary (at RM 22.5/1.0)	22.5/0.1	Medina
Hinckley Elem School	3PT00114	P	Minor	East Br. Tributary (at RM 22.5)	22.5/2.5	Medina
Fosters Tavern of Hinckley	3PR00489	P	Minor	East Br. Tributary (at RM 22.5)	22.5/2.4	Medina
Medina Co. SD 300 Hinckley WWTP	3PK00003	P	Major	East Br. Rocky River	18.28	Medina
North Royalton WWTP A	3PD00030	P	Major	East Br. Tributary (at RM 12.9)	12.9/0.5	Cuyahoga
Strongsville B WWTP	3PB00047	P	Minor	East Br. Tributary (at RM 11.1/0.39)	11.1/0.1	Cuyahoga
Strongsville C WWTP	3PB00048	P	Minor	Baldwin Creek (East Br. Tributary)	2.9	Cuyahoga
North Royalton WWTP B	3PC00018	P	Minor	Baldwin Cr. Tributary (at RM 7.0)	7.3/0.2	Cuyahoga

a - Publicly Owned Treatment Works (POTW)=P and Private Industrial Entity=I
b - Entity classified by conduit flow: < 1 MGD=Minor and $\geq$ 1 MGD=Major.
c - Where two RMs are indicated, the first represents the point at which an unnamed tributary joins its receiving stream. The proceeding RM demarks the NPDES permitted entity's point of discharge (001) on the tributary.

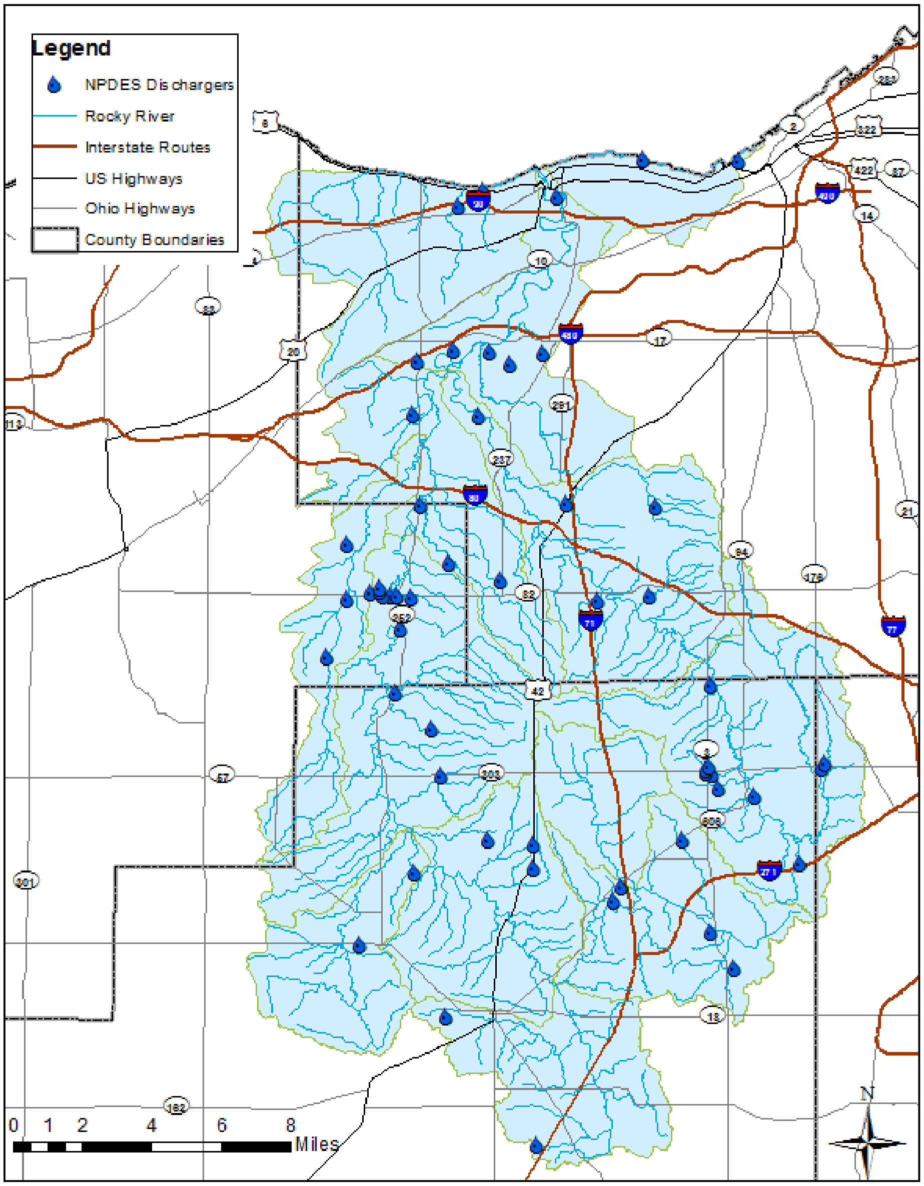


Figure 10. Major and minor NPDES permitted facilities, Rocky River study area, 2014-15.

Pollutant Loadings

Monthly effluent loadings are reported to Ohio EPA by all NPDES permitted discharging entities. Third quarter (July-September) electronic Discharge Monitoring Report (eDMR) data provided the pollutant loadings from 2005 through 2015 for certain dischargers evaluated in the Rocky River Study Area. Because of the large number of entities in the study area, only those facilities classified as major dischargers and/or significant impactors were included in the loading discussion. In certain cases, when available, data obtained in 1980 through 2015 was included in the trend analysis. Pollutant loading trend analysis includes the 95th and 50th percentiles of key parameters where available: Nitrate-nitrite, ammonia (NH_3-N), total suspended solids (TSS), total phosphorus, and effluent flow.

Lakewood WWTP (Ohio EPA Permit #3PE00004) *Rocky River CSOs, discharge to Lake Erie*
The Lakewood WWTP has an average daily discharge of 18.0 MGD and discharges treated effluent to Lake Erie. A mercury variance is currently implemented at the facility. The WWTP provides service to Lakewood, as well as small portions of Cleveland and Rocky River. The treatment process consists of preliminary screening, grit removal, primary settling, activated sludge process, secondary clarification, phosphorus removal, and UV disinfection. The treated effluent is discharged to Lake Erie.

Waste sludge generated from the wet-stream process operations is thickened in two gravity thickeners, stabilized by two-stage anaerobic digestion, and dewatered utilizing a belt filter press. The dewatered Class B sludge is land applied for agronomic beneficial use.

The NPDES permit identifies nine active combined sewer overflows (CSOs) in the collection system. The following CSOs discharge to the Rocky River: 052 (Riverside at Madison), 053 (WWTP at West Drive), and 054 (Scenic Drive). With six CSOs discharging to Lake Erie: 002 (WWTP headworks), 055 (16504 Edgewater), 056 (15120 Edgewater), 057 (Lakewood Park), 058 (13919 Edgewater), and 059 (12900 Lake Ave).

The city of Lakewood has developed and is implementing a Nine Minimum Controls Plan (NMCP) for CSOs. The headworks bypass and the respective collection system overflows have been subjects of ongoing Consent Order negotiations between Lakewood, USEPA, and Ohio EPA.

Violations of the NPDES permit were reviewed from 1/1/2005 through 12/1/2015. For the ten years evaluated, 37 limit violations were reported for the following parameters: E. coli, mercury, phosphorus, and TSS. During this time period, the facility experienced one (1) Storm Sewer Overflow (SSO) event.

Negotiations on the CSO Consent Decree are continuing. A CSO Public Notification Plan was accepted by Ohio EPA on October 11, 2018. In addition, on September 19, 2018 a PTI was issued to Lakewood for the construction of a hi rate treatment facility (HRT) to address CSO's at CSO 002.

NEORSD Westerly WWTP (Ohio EPA Permit #3PE00001) *Rocky River CSOs, discharge to Lake Erie*
The NEORSD Westerly WWTP serves a population of greater than 100,000 on the west side of Cleveland through a combined sewer system. The facility has a design flow of 35 MGD, with peak capacities of 100 MGD for primary and 70 MGD for secondary treatment, and discharges treated effluent to the Lake Erie outer harbor (>4,000 ft.) via NPDES Outfall 001.

The treatment processes include screening, grit removal, primary settling, a trickling filter/solids contact biological process, final settling, chlorination and dechlorination. Waste sludge from the facility is gravity-thickened, mechanically dewatered utilizing centrifuges, and incinerated prior to landfill disposal.

During excessive wet weather events, flow can be diverted to the Combined Sewer Overflow Treatment Facility (CSOTF). CSOTF provides storage for 6 million gallons and preliminary treatment and settling for up to 300 MGD during wet weather flows. The effluent from the CSOTF is discharged to Lake Erie via NPDES outfall 002.

Violations of the NPDES permit were reviewed from 1/1/2005 through 12/1/2015. For the ten years evaluated, 4 limit violations were reported for the following parameters: residual chlorine, oil and grease, and pH. On December 22, 2011, Consent Decree No. 1:10-cv-02895 was lodged in the U.S. District Court. The Decree addresses the long-term plan that will enable NEORSD to control discharges of untreated sewage during wet weather and comply with the Clean Water Act standards and included the following specific control measures at the Westerly WWTP: 1) demonstration and testing of chemically enhanced high rate treatment (CE-HRT) within the existing four CSOTF quads to assess performance and ability to achieve effective TSS and *E. coli* controls, and 2) if demonstration testing of the existing four quads using CE-HRT meets performance criteria, construction of two additional quads to provide 411 MGD wet weather capacity, or 3) if demonstration testing of the existing four quads using CE-HRT does not meet performance criteria, construction of a 150 MGD ballasted flocculation system to provide 450 MGD wet weather capacity. "

Additional review of NPDES effluent data was conducted for the January 2016 thru November 2019 time period. Five permit violations were noted (1-Chlorine, 4-TSS). The most recent TSS violations were a loading and limit exceedance in June of 2019. The facility continues to remain in general compliance with its NPDES permit.

NASA Glenn Research Center (Ohio EPA Permit #3IO00001) *Rocky River, Abram Creek*

The NASA Glenn Research Center discharges sanitary and process wastewater to the Northeast Ohio Regional Sewer District (NEORSD) Southerly Wastewater Treatment Center. The facility has an NPDES permit for storm water discharge from 3 outfalls (001, 003, and 004) to the Rocky River, and 3 outfalls (006, 007, and 008) to Abram Creek.

Violations of the NPDES permit were reviewed from 1/1/2005 through 12/1/2015. For the ten years evaluated, 233 limit violations were reported, broken down by year as follows: 34 limit violations in 2005, 48 limit violations in 2006, 19 limit violations in 2007, 28 limit violations in 2008, 26 limit violations in 2009, 28 limit violations in 2010, 19 limit violations in 2011, 8 limit violations in 2012, 9 limit violations in 2013, 5 limit violations in 2014, and 9 limit violations in 2015. Reported parameter violations during this time period are as follows: residual chlorine (144 violations), mercury (16 violations), oil and grease (2 violations), and pH (71 violations).

In 2015, the facility was in Significant Non-Compliance (SNC) for significantly exceeding mercury limits for two months. The facility believes that high levels of mercury in their storm water discharge is due to the historical use of chemicals at the facility in the 1930's and 1940's.

The most recent NPDES permit inspection of the facility was on February 25, 2019. The findings from this found the facility in compliance with its NPDES permit.

Cleveland Hopkins International Airport (Ohio EPA Permit# 3II00179) *Abram Creek*

The Cleveland Hopkins Airport (CHIA) has an NPDES permit to discharge storm water associated with various airport operations (airplane deicing, runway deicing, etc.) to Rocky River, Abram Creek, and Silver Creek. Violations of the NPDES permit were reviewed from 1/1/2005 through 12/1/2015. For the ten years evaluated, 55 limit violations were reported for pH.

The most recent permit issued on 4/1/2013, Part 1.C.c states: The permittee shall develop and implement a long-term ADM (Anti-icing and De-icing Materials) runoff managements program to eliminate the contribution to the nuisance biofilm growth problem in Abram Creek and/or the Rocky River. The program shall submit a report that: 1) describes evaluated alternatives; 2) describes and provides the basis for the selected long-term ADM runoff management alternative or alternatives proposed for the implementation by the permittee; and 3) provides a schedule for implementing the selected long-term ADM runoff management alternative(s).

Since 2001, less toxic de-icing agents have been utilized by CHIA in an effort for biofilm reduction. A central detention basin was also installed to increase the holding times of de-icing compounds during periods of high flows (Outfall 012). Sampling to further investigate this issue is ongoing. Selected water quality parameters are summarized in Table 7.

The most recent permit was issued on December 4, 2018. This permit also includes language on the requirement for continued implementation of the long-term ADM plan. Ohio EPA continues to work with CHIA on compliance with the NPDES permit.

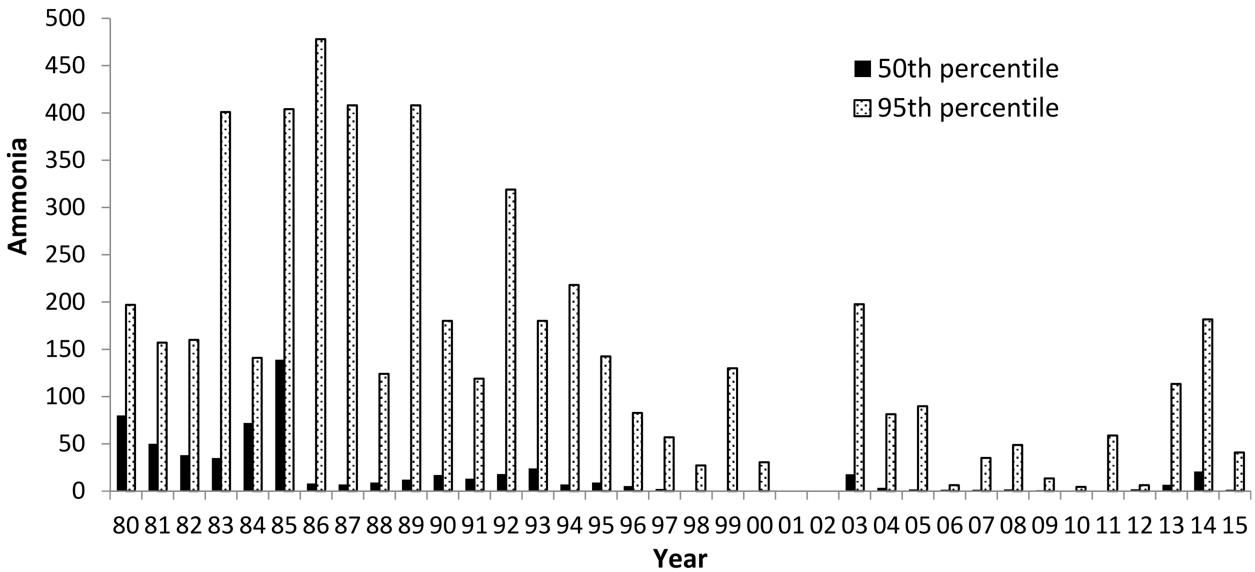
Table 7. The 50th and 95th percentile for selected water quality parameters from three CHIA outfalls that discharge into Abram Creek, 2005-2015. Note: $CBOD_5$ data from 2012-2015).

	Cleveland Hopkins International Airport					
	Outfall 003 (RM 3.31)		**Outfall 012 (RM 1.2)**		**Outfall 006 RM (0.66)**	
Parameter	**50th%**	**95th %**	**50th%**	**95th %**	**50th%**	**95th %**
Flow (MGD)	0.10	1.41	0.51	4.22	0.11	0.65
Ammonia (mg/l)	0.43	1.03	0.32	1.05	0.47	1.08
$CBOD_5$ (mg/l)	12.88	31.77	66.14	132.96	7.73	20.48
DO (mg/l)	7.74	9.74	7.02	9.22	8.16	10.21
TSS (mg/l)	6.46	33.87	10.82	104.07	3.30	23.12

North Olmsted WWTP (Ohio EPA Permit #3PD00016) *Rocky River*

The North Olmsted WWTP has a design flow of 7.0 MGD and discharges treated effluent to the Rocky River. Major improvements were completed at the facility and commenced in December, 2012. The treatment works consists of preliminary screening, grit removal, flow equalization, a vertical loop biological reactor, secondary clarification, tertiary disc filters, chemical phosphorus removal, and UV disinfection. The facility has sludge aerated holding tanks and a sludge centrifuge to aid in sludge dewatering. Annual third-quarter loading of ammonia and total phosphorus through the period of record are presented in Figure 11.

Violations of the NPDES permit were reviewed from 1/1/2005 through 12/1/2015. For the ten years evaluated, 135 limit violations were reported, broken down by year as follows: 4 limit violations in 2005, 7 limit violations in 2007, 19 limit violations in 2008, 8 limit violations in 2009, 3 limit violations in 2010, 11 limit violations in 2011, 9 limit violations in 2012, 27 limit violations in 2013, 45 limit violations in 2014, and 2 limit violations in 2015. Reported parameter violations during this time period are as follows: CBOD (9 violations), residual chlorine (2 violations), copper (1 violation), *E. coli* (1 violation), fecal coliform (1 violation), mercury (29 violations), ammonia (21 violations), pH (17 violations), phosphorus (29 violations), and TSS (25 violations). During this time period, the facility had 156 SSO events. The facility is currently in SNC for significantly exceeding ammonia limits for 2 months.



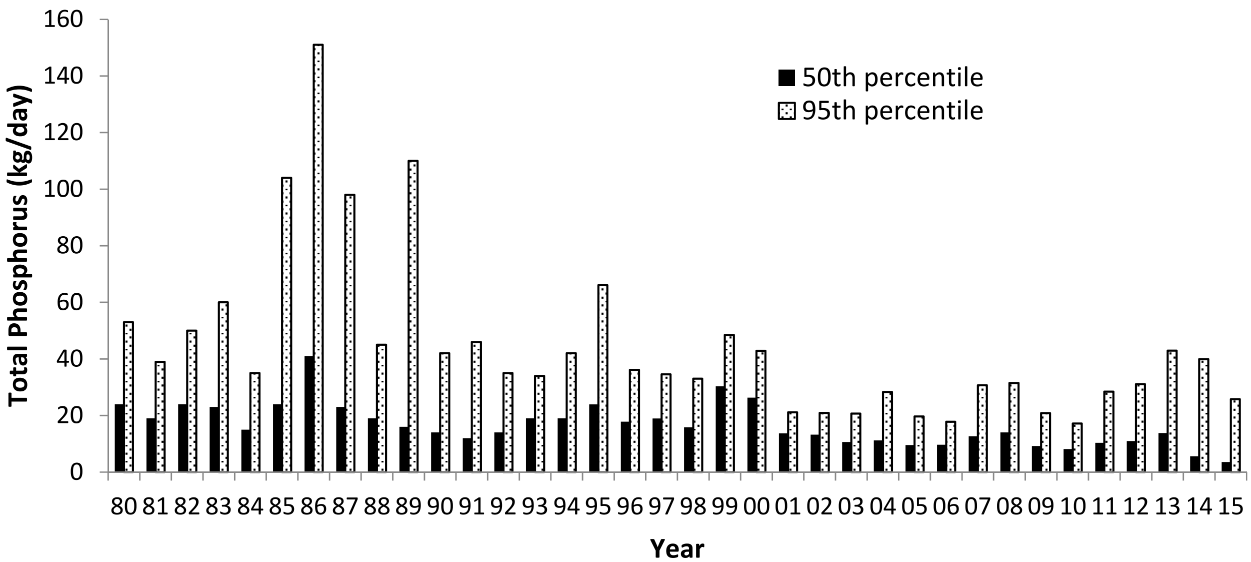


Figure 11. Annual third-quarter loadings of total phosphorus and ammonia for the North Olmsted WWTP in the Rocky River watershed study area, 1980-2015.

A review of NPDES violations for the time period January 2016 thru November 2019 indicated nine NPDES permit limit violations (1-total nitrogen, 3-mercury, and 5-ammonia) most recently in June 2019. Plant upgrades and operational improvements have improved compliance at the facility.

<u>Columbia Mobile Home Park (Ohio EPA Permit #3PV00013) *West Branch tributary*</u>

The Columbia Park WWTP is a gated land-lease community and adjacent strip plaza that's served by a 250,000 gpd WWTP. Both the water distribution and wastewater treatment systems are regulated public utilities pursuant to Ohio Revised Code (ORC) Chapter 4905. The facility discharges treated effluent to an unnamed tributary of the West Branch of the Rocky River.

Sanitary wastewater is conveyed to the Ash Drive lift station prior to being pumped to the WWTP. The WWTP consists of a rotostrainer, a parallel run 125,000 gpd Cantex treatment unit and 125,000 gpd Aero-Mod treatment unit, tertiary rapid sand filter, and chlorination/dechlorination contact tank. Sludge handling equipment consists of aerated sludge holding and sludge drying beds. The dewatered sludge is disposed by landfilling.

Violations of the NPDES permit were reviewed from 1/1/2005 through 12/1/2015. For the ten years evaluated, 1019 limit violations were reported, broken down by year as follows: 306 limit violations in 2005, 165 limit violations in 2006, 167 limit violations in 2007, 91 limit violations in 2008, 19 limit violations in 2009, 35 limit violations in 2010, 97 limit violations in 2011, 43 limit violations in 2012, 7 limit violations in 2013, 30 limit violations in 2014, and 59 limit violations in 2015. Reported parameter violations during this time period are as follows: CBOD (45 violations), residual chlorine (137 violations), dissolved oxygen (DO) (406 violations), *E. coli* (4 violations), fecal coliform (13 violations), ammonia (143 violations), pH (6 violations), and TSS (268 violations). The facility is currently in SNC for exceeding ammonia limits for 8 months and *E. coli* limits for 2 months.

A review of permit violations indicates the facility remains in noncompliance. There were 287 violations noted between January 2016 and November 2019. The facility has gone into bankruptcy and is awaiting new ownership. Ohio EPA has referred the entity to the Ohio Attorney General's Office for enforcement.

Plum Creek WWTP (Ohio EPA Permit #3PG00052) *Plum Creek*

Plum Creek WWTP has a design flow of 0.40 MGD and discharges treated effluent to Plum Creek. The treatment works consists of influent pumping, a trash trap, aerated flow equalization basin, extended aeration activated sludge treatment process, secondary clarification, up flow fixed media clarifier, slow surface sand filters, chlorination/de-chlorination disinfection, and post aeration. Waste-activated sludge is stored in an aerated sludge holding tank until it is hauled away for final disposal.

Violations of the NPDES permit were reviewed from 1/1/2005 through 12/1/2015. For the ten years evaluated, 296 limit violations were reported, broken down by year as follows: 41 limit violations in 2005, 29 limit violations in 2006, 45 limit violations in 2007, 12 limit violations in 2008, 19 limit violations in 2009, 24 limit violations in 2010, 65 limit violations in 2011, 20 limit violations in 2012, 11 limit violations in 2013, 17 limit violations in 2014, and 13 limit violations in 2015. Reported parameter violations during this time period are as follows: CBOD (40 violations), DO (18 violations), fecal coliform (9 violations), ammonia (19 violations), pH (8 violations), and TSS (202 violations). During the time period January 2016 thru November 2019 the facility had 13 reported permit violations, no reported violations in 2019. Ohio EPA's compliance inspection on March 20, 2018 found the plant operating in compliance with it's NPDES permit. Much of the plant performance problems may be attributed to issues with sewer laterals. In a December 5, 2016 Return to Compliance letter, Ohio EPA noted that 99% of the laterals in the subdivision had been replaced.

Medina County SD #500 WWTP (Ohio EPA Permit #3PK00004) *West Branch Tributary*

The Medina County Sewer District #500 WWTP has a design flow of 15.0 MGD. The treatment works consists of influent screening, grit removal, primary settling, biological phosphorus removal with the ability to perform chemical addition as backup, extended aeration activated sludge treatment process, powdered activated carbon addition, secondary settling, tertiary sand filtration, chlorination, and dechlorination. The facility also has an additional 2.8 million gallons (approximately) of wet weather storage. Treated effluent is discharged to an unnamed tributary which flows approximately 1,000 feet and into the West Branch of the Rocky River. Waste-activated sludge is processed via gravity thickening, wet air oxidation, ash separation, and a filter press before being hauled away for final disposal via land application.

Violations of the NPDES permit were reviewed from 1/1/2005 through 12/1/2015. For the ten years evaluated, 21 limit violations were reported for the following parameters: TSS, pH, mercury, fecal coliform, oil and grease, chlorine, and phosphorus. During this time period, the facility had 396 SSO events. A permit to install was issued on for improvements to the sludge management system on May 16, 2018. The facility continues to experience compliance issues, a review of permit data from January 2016 thru November 2019 indicated 73 permit violations, with 3 overflow occurrences reported under the overflow monitoring station (300). Ohio EPA continues to work with the facility on operational improvements.

Medina County Sewer District No. 11 WWTP (3PG00043) *West Branch tributary*
The Medina County Sewer District No. 11 has a design flow of 12,500 gpd with an annual average flow to the plant of approximately 7,900 gpd. Treated effluent is discharged to an unnamed tributary of Granger Ditch, which is a tributary to the West Branch of the Rocky River.

The treatment works consists of a trash trap, extended aeration tank, settling tank, chlorination and dechlorination. Sludge generated at the Medina Sewer District No. 11 WWTP is hauled by a Medina County Sanitary Engineer to the Medina Sewer District No. 300 WWTP for treatment and disposal.

Violations of the NPDES permit were reviewed from 1/1/2005 through 12/1/2015. For the ten years evaluated, only one (1) limit violation was reported, which was for TSS in 2015.

Strongsville C WWTP (Ohio EPA Permit #3PB00048) *Baldwin Creek*
The Strongsville C WWTP has a design flow of 1.8 MGD where treated effluent discharges to a tributary of Baldwin Creek. The treatment process consists of preliminary treatment, primary clarification, rotating biological contactors, secondary clarification, tertiary sand filtration, chlorination/ dechlorination, and post aeration prior to discharging to the receiving stream. Sludge handling consists of anaerobic digestion and mechanical dewatering using a filter press. The dewatered sludge is presently land applied by AgriSludge. Third-quarter loadings of selected water quality parameters are presented in Figure 12.

Violations of the NPDES permit were reviewed from 1/1/2005 through 12/1/2015. For the ten years evaluated, 14 limit violations were reported for the following parameters: CBOD, mercury, ammonia, oil and grease, and TSS. During this time period, the facility had 5 SSO events. There are no “volume discharged” records in the eDMR (4 events in 2011 and 1 event in 2011).

During the time period January 2016 thru November 2019 the facility had six reported permit violations. The current effective NPDES permit was issued on June 21, 2018. This permit requires the facility to conduct a Toxicity Reduction Evaluation (TRE) at the plant, the general plan for this TRE was submitted on July 31, 2019.

North Royalton B WWTP (Ohio EPA Permit #3PC00018) *Baldwin Creek Tributary*
The North Royalton B WWTP has a design flow of 1.0 MGD where treated effluent is discharged to Baldwin Creek via an unnamed tributary. The WWTP presently serves a population of approximately 6,600 people within North Royalton’s Sewer District B. Originally constructed in 1967, the last major modification to the facility was in 1990. The treatment processes consist of influent pumping (screw pumps), mechanical screening, grit removal, fine-bubble extended aeration activated sludge biological treatment, secondary clarification, disinfection using sodium hypochlorite, and dechlorination utilizing sodium bisulfite. Phosphorus removal is achieved through the addition of ferrous chloride. An off-line flow equalization basin is used to divert and store excess wastewater flows during wet weather events.

Sludge handling consists of a sludge holding tank. The sludge is presently being trucked to the North Royalton A WWTP for additional processing. The dewatered sludge is presently hauled to the PPG Reclamation site in Barberton, Ohio.

Violations of the NPDES permit were reviewed from 1/1/2005 through 12/1/2015. For the ten years evaluated, 17 limit violations were reported for the following parameters: residual chlorine, copper, *E. coli*, mercury, phosphorus, and TSS. During this time period, the facility had 81 SSO events. Third-quarter loadings of selected water quality parameters are presented in Figure 13.

During the time period January 2016 thru November 2019 the facility had five reported permit violations. A February 14, 2018 compliance inspection found operation and maintenance to be satisfactory.

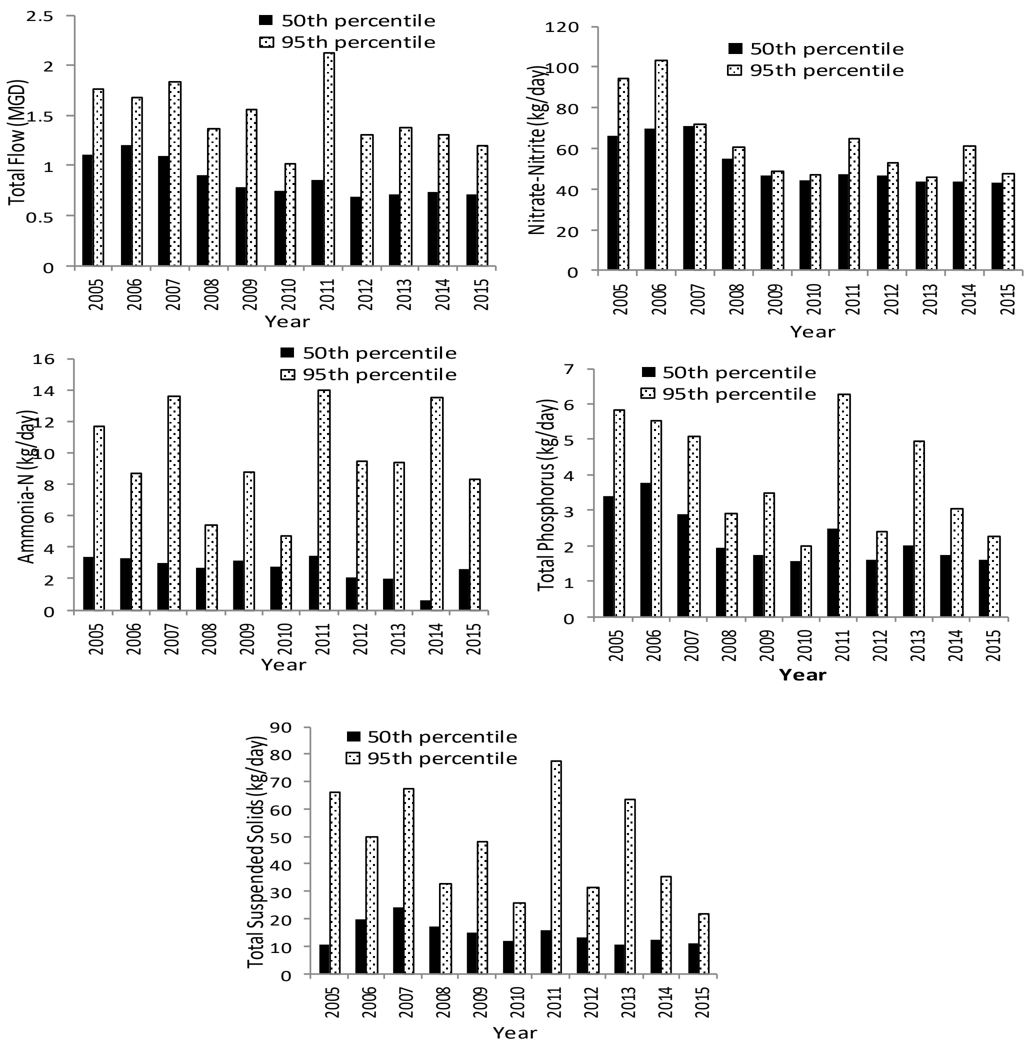


Figure 12. Annual third-quarter loadings of total flow, nitrate-nitrite-N, total phosphorus, ammonia, and total suspended solids for the Strongsville C WWTP in the Baldwin Creek subwatershed, 2005-2015.

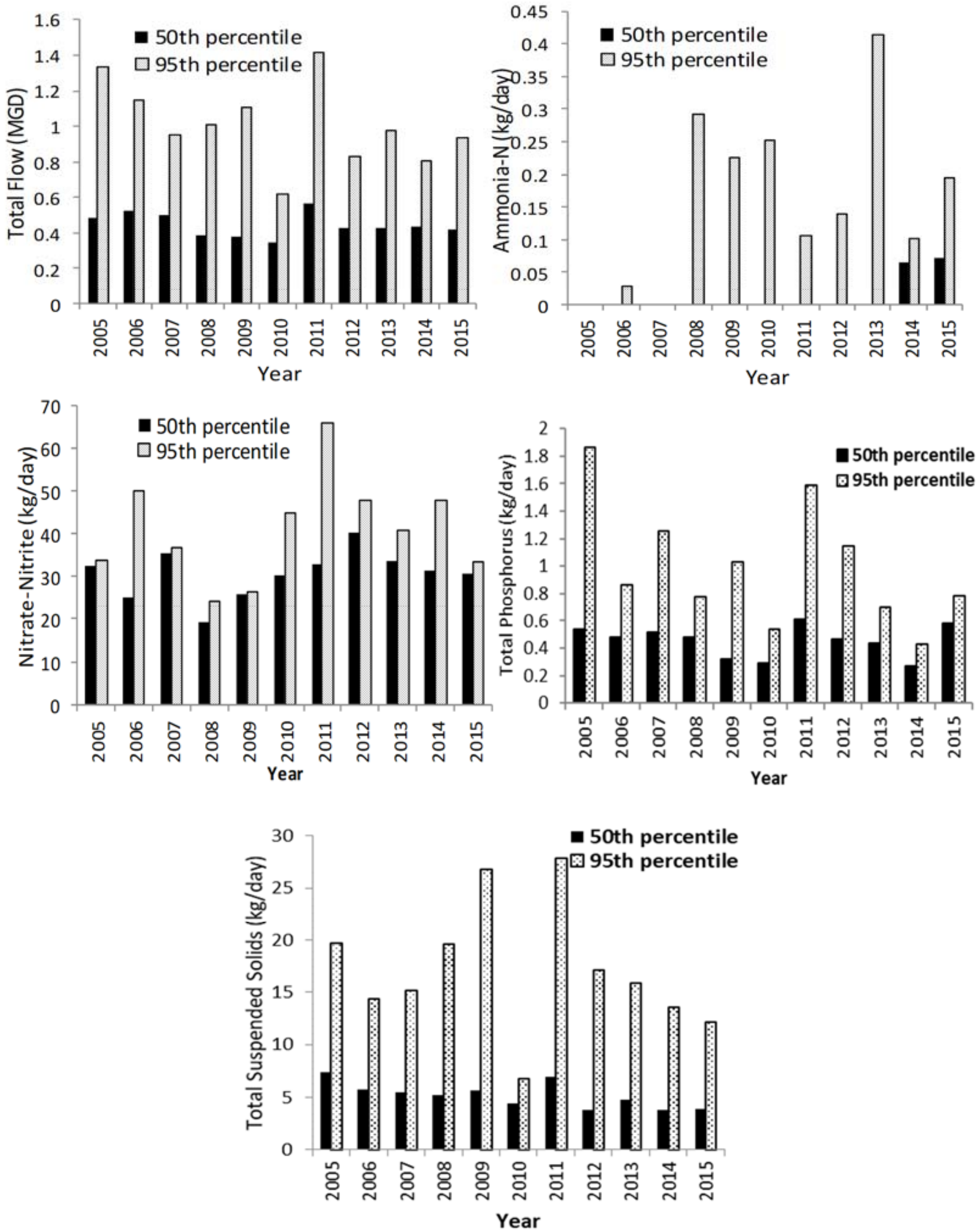


Figure 13. Annual third-quarter loadings of total flow, nitrate-nitrite-N, total phosphorus, ammonia, and total suspended solids for the North Royalton B WWTP in the Baldwin Creek subwatershed, 2005-2015

Strongsville B WWTP (Ohio EPA Permit #3PB00047) *East Branch Tributary*

The Strongsville B WWTP has a design flow of 2.1 MGD. The wet stream treatment process consists of preliminary treatment, primary clarification, rotating biological contactors (RBCs), secondary clarification, tertiary sand filtration, chlorination/dechlorination, and post aeration prior to discharging to the East Branch of the Rocky River. Sludge from the primary clarifiers and secondary clarifiers are thickened and dewatered through a belt filter press. The processed biosolids are currently land applied by AgriSludge.

Violations of the NPDES permit were reviewed from 1/1/2005 through 12/1/2015. For the ten years evaluated, 20 limit violations were reported for the following parameters: phosphorus, ammonia, TSS, mercury, CBOD, copper, and fecal coliform.

During the time period January 2016 thru November 2019 the facility had six reported permit violations, all in 2017. A compliance inspection on March 14, 2018 did not identify any ongoing compliance issues.

North Royalton A WWTP (Ohio EPA Permit #3PD00030) *East Branch Tributary*
North Royalton A WWTP has an average daily design flow of 3.3 MGD where treated effluent is discharged to an unnamed tributary of the East Branch of the Rocky River.

The North Royalton A collection system is comprised of separate sanitary sewers serving approximately 21,000 people in the North Royalton A district and 600 people in Strongsville. The cities are responsible for maintenance of their respective collection systems. No significant industrial users discharge to the treatment plant. North Royalton does not implement an Ohio EPA-approved industrial pretreatment program at the A plant.

The treatment process consists of influent pumping, preliminary screening, grit removal, primary settling, activated sludge biological treatment, phosphorus removal, final clarification, tertiary sand filtration, UV disinfection, and post-aeration. Sludge handling consists of aerobic digestion and mechanical dewatering using a filter press. The dewatered sludge is presently hauled to the PPG Reclamation site in Barberton, Ohio.

Violations of the NPDES permit were reviewed from 1/1/2005 through 12/1/2015. For the ten years evaluated, 10 limit violations were reported for the following parameters: copper, oil and grease, pH, and TSS. During this time period, the facility had 12 SSO events.

During the time period January 2016 thru November 2019 the facility had one reported permit violation, the facility also reported four overflow events under monitoring station 300. A compliance inspection on September 11, 2018 did not identify any ongoing compliance issues.

Medina Co. SD 300 Hinckley WWTP (Ohio EPA Permit #3PK00003) *East Branch*
The Medina County SD 300 Hinckley WWTP has a design flow of 3.25 MGD where treated effluent is discharged to the East Branch of the Rocky River. The treatment works consists of influent screening, comminution, extended aeration activated sludge treatment process, ferrous chloride addition, secondary clarification, rotating biological contactors, rapid sand filtration, chlorination and dechlorination disinfection. Waste-activated sludge is aerobically digested, mechanically dewatered using a belt filter press, and hauled away for final disposal via land application.

Violations of the NPDES permit were reviewed from 1/1/2005 through 12/1/2015. For the ten years evaluated, nine limit violations were reported for the following parameters: DO, ammonia, and TSS. During this time period, the facility had one (1) SSO event.

During the time period January 2016 thru November 2019 the facility had three reported permit violations, the facility also reported zero overflow events under monitoring station 300. A compliance inspection on September 11, 2018 did not identify any ongoing compliance issues.

SURFACE WATER CHEMISTRY

Water Column Chemistry

Surface water chemistry samples were collected from the Rocky River study area from May through December 2014 at seventy-eight locations (Figure 14). Stations were established in free-flowing sections of the stream and were primarily collected from bridge crossings. Surface water samples were collected directly into appropriate containers, preserved and delivered to Ohio EPA's Environmental Services laboratory. Collected water was preserved using appropriate methods, as provided by Ohio EPA (2013, 2012a, and 2015c). Interactive maps of surface water chemical data, downloadable to Excel files, are available at the following link: http://www.epa.ohio.gov/dsw/gis/index.aspx

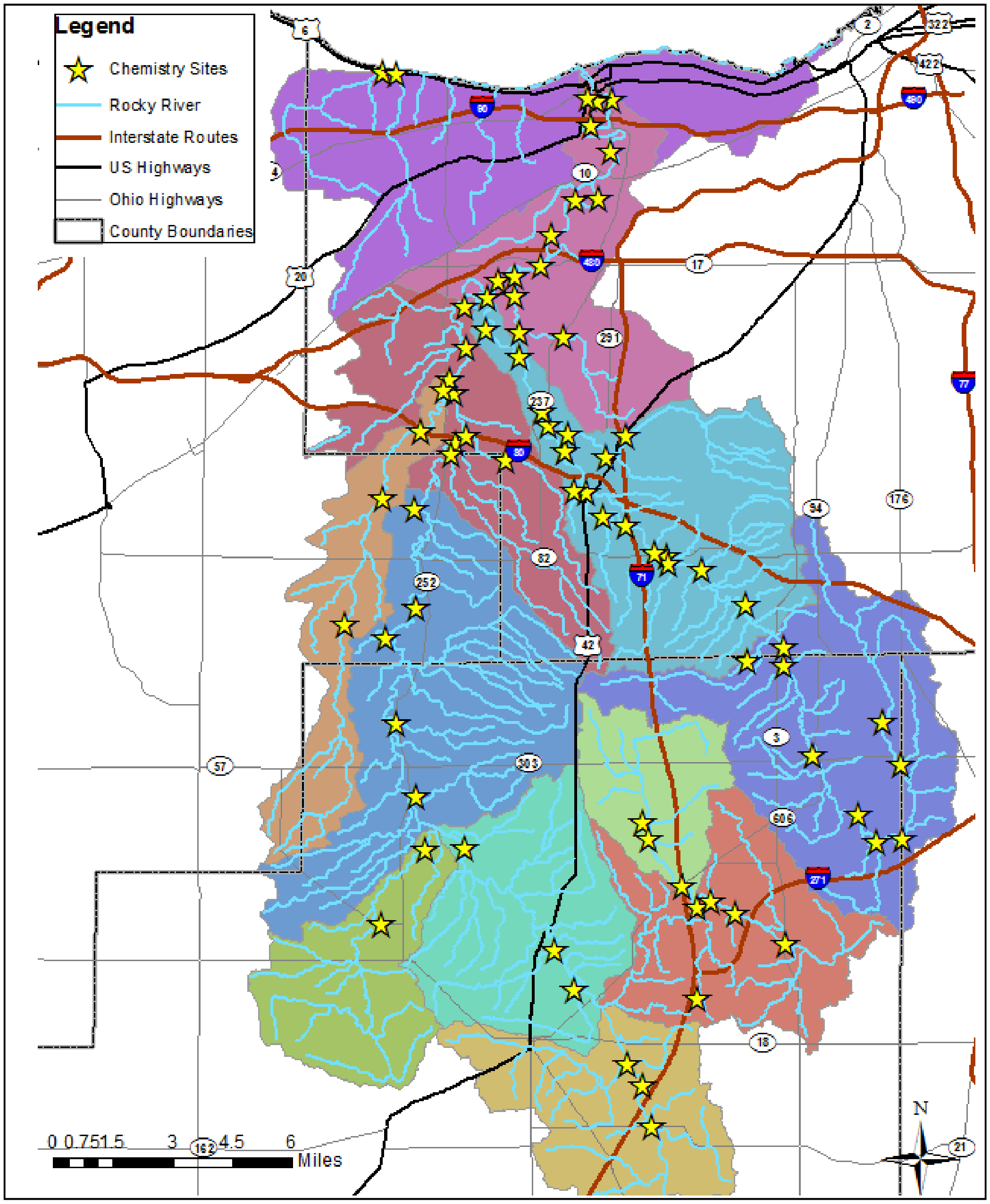


Figure 14. Chemistry sites sampled in the Rocky River by Ohio EPA, 2014.

USGS gage data from the Rocky River, just below the confluence of the East and West branches, was used to show flow trends in the Rocky River watershed during the 2014 survey (Figure 15). Flow data beginning in 1923 was used to generate historal median flow values. Dates when water samples were collected in the study area are noted on the graph. Flow conditions during the beginning of the field season were well above typical flow values, with elevated flows occurring in mid-May and June. Low flow conditions were recorded from July through October with some rain events elevating flow above the historic median. Water samples captured a variety of flow conditions in the study area during the field season. Bacteria was collected during the recreation use season (May 1 through October 31) and was typically collected during low flows.

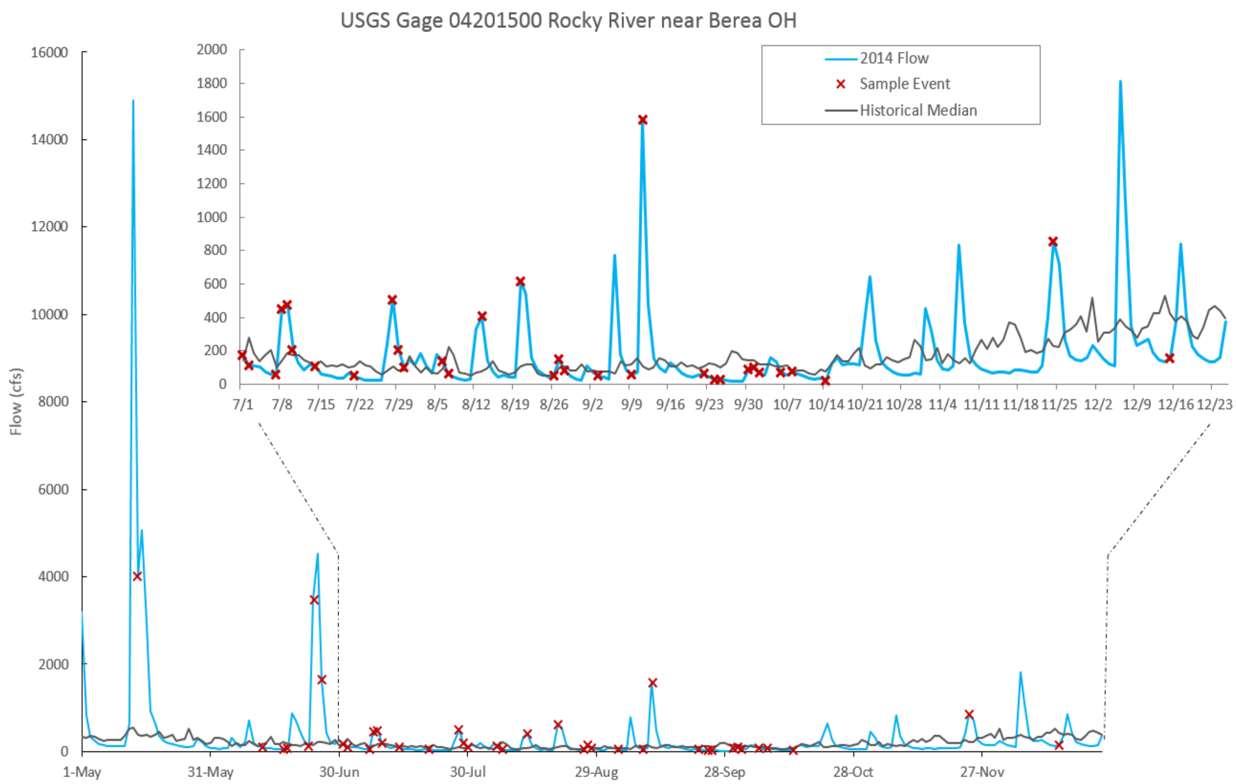


Figure 15. Flow conditions in the Rocky River during the 2014 sampling season, the upper inset showing July through December at finer streamflow scale (USGS 2014).

Surface water samples were analyzed for metals, nutrients, bacteria, pH, temperature, conductivity, dissolved oxygen (DO), percent DO saturation, and suspended and dissolved solids (Appendix Tables E). Exceedances of the Ohio Water Quality Standard (WQS) criteria are reported in Table 8. Bacteriological samples were collected from twenty-one locations, and the results are reported in the Recreation Use Section.. Grab water samples were collected from the seventy-eight locations a minimum of five times from mid-June through mid-December 2014. Additional water quality samples were collected in certain locations in July and August 2015. All samples within the same hydrological unit code (HUC) were collected on the same day to allow for longitudinal comparison of data, upstream and downstream from point sources, under similar stream flow conditions.

Table 8. Exceedances of Ohio Water Quality Standards criteria (OAC 3745-1) for chemical/physical parameters measured in the Ohio Tributaries to the Rocky River Watershed study areas, 2014. Bacteria Exceedances are presented in the Recreation Use Section.

***Stream* RM**	**Location**	**Parameter (value - µg/L unless noted)**
Rocky River		
11.65	Ust. North Olmsted WWTP	Iron (12200[c]), Lead (8.8[b])
Abram Creek		
3.15	At Eastland Rd., near Railroad	Dissolved Oxygen (3.09[a], 3.26[a], 3.59[a], 3.76[a], 3.8[a] mg/l)
West Branch Rocky River		
32.26	At Ridgewood Rd, dst. landfill	Iron (8660[c], 9910[c])
21.75	Near Abbeyville, at Neff Rd	Iron (18200[c], 18300[c])
13.3	Adj. West River Rd, dst. Medina Co #500	Iron (10600[c])
7.4	North of Columbia Hills, adj. West River Rd	Iron (16100[c])
4.9	At West View, dst. Baker Creek	Iron (16400[c]), Copper (13.2[b]), Lead (10.8[b])
3.5	At Bagley Rd, Olmsted Falls	Iron (5990[c], 26800[c]), Copper (15.6[a])
2.1	North of Olmsted Falls, adj. Lewis Rd	Iron (65800[c]), Copper (26.9[ab]), Lead (40.2[b])
0.39	At Lewis Rd, near North Olmsted	Iron (10700[c], 11800[c], 28500[c]), Copper (16.6[a])
North Branch Rocky River		
0.45	Near Medina, at Granger Rd	Iron (16800[c], 21600 [c])
Mallet Creek		
0.72	At Neff Rd, NW of Abbeyville	Iron (6820[c], 12000[c])
Plum Creek (West Branch trib.)		
8.5	At Akins Rd, S. of Columbia Station	Iron (10100[c])
4.92	At Jaquay Rd, N. of Columbia Station	Iron (5020[c], 17800 [c])
0.4	At Mill St	Lead (3.6[b])
East Branch Rocky River		
26.63	At Harter Rd	Iron (6820[c], 8220[c])
18.3	Ust. Medina 300 WWTP (Access via plant)	Iron (8910[c], 7340[c])
17.5	At private Dr. off SR 3 (bridge on driveway)	Iron (21600[c], 9470[c], 9280[c]); Copper (13[b]); Lead (16.2[b])
15.15	At Bennett Rd., near N. Royalton	Iron (8180[c], 7160[c])
11.57	At SR 82/Royalton Rd, ust. N. Royalton A WWTP	Iron (6100[c], 11100[c])
10.0	At Mill Stream Run bridge, dst. Strongsville B WWTP	Iron (5680[c], 12100[c])
9.35	Between SR 42 and I-71, at Strongsville	Iron (11400[c])
1.28	At Spafford Rd, at ford	Iron (16800[c]), Lead (12[b])

a - Exceedance of the aquatic life Outside Mixing Zone Maximum criterion (for DO below minimum).
b - Exceedance of the aquatic life Outside Mixing Zone Average water quality criterion (for DO below 24-hour average).
c - Exceedance of the statewide water quality criteria for the protection of agricultural uses.

Metals were measured at seventy-eight locations with seventeen parameters tested *(*Appendix Table E). Iron exceedances were observed at twenty-one locations and corresponded to high flow events throughout the sampling season. Fluxes of aluminum and total suspended solids (TSS) were also observed during these high flow events, indicating influences of storm water and sediment inputs into the watershed. Additional exceedances for copper (Outside Mixing Zone Average-OMZA) occurred at the same high flow events at locations along the West and the East Branches. Lead exceedances of the OMZA occurred six times throughout the watershed (n=1, for all exceedances). Locations include Rocky River mainstem, West Branch, East Branch, and Plum Creek (West Branch tributary) and corresponded to the same high flow events. There were three copper values that exceeded the Outside Mixing Zone Maximum (OMZM), found in the West Branch. No other metal exceedances were found throughout the study area.

Summary statistics for select inorganic water quality parameters compared against the 90th percentile reference sites from the Erie Ontario Lake Plain (EOLP) are presented in Table 9. Nutrients were measured at each water sampling location, and included ammonia, nitrate-nitrite-N, total phosphorus (TP), and total Kjeldahl nitrogen (TKN). Summary statistics for nutrients measured in the Rocky River watershed are detailed in Table 10.

Rocky River Mainstem

Grab surface water samples from ten locations on the mainstem revealed most water quality parameters falling well below WQS. An exception was an exceedance of iron at RM 11.6 (12200 µg/L) and lead (8.8 µg/L), which occurred during a high flow event on 5/14/2014. The lead value was just over the OMZA standard of 8.5 µg/L, with a hardness of 125 mg/l. Sodium and chloride levels were above 90th percentile background data at every location and are likely the result of urban runoff. Every site sampled had average levels of nitrate-nitrite-N higher than Ohio EPA’s nutrient target value of 1.5 mg/l. Total phosphorus and ammonia averages were below both Ohio EPA targets and EOLP reference values (Ohio EPA 1999 and 2014).

Abram Creek

Multiple exceedances of the 4.0 mg/l DO criterion were recorded at RM 3.2 from grab samples. The upper portion of Abram Creek has been extensively urbanized resulting in significant habitat modification. Much of the stream has been channelized or culverted, resulting in little to no access to floodplains. In the early 2000s, approximately one mile (RMs 1.9 to 0.9) of stream was culverted to accommodate runway expansion at CHIA. The next downstream site (RM 1.9), just above the CHIA culvert, yielded no water quality criteria exceedances. Downstream of RM 0.9, Abram Creek falls rapidly to meet the mainstem of the Rocky River. No exceedances of water quality standards were observed in this area. Elevated levels of sodium and specific conductivity above the 90th percentile EOLP were maintained throughout Abram Creek. Average nutrient concentrations remained below Ohio EPA target values at all sites sampled.

Runoff of ice abatement agents from the CHIA has been a long-standing source of water quality impacts to Abram Creek (Ohio EPA 1999 and 2001). Investigations of this subject by CHIA include EnvrioScience (2016 and 2018) and Hull and Associates (2004). Although the nature of water quality impacts has varied overtime, reflecting the specific agents employed for a given period, recent investigations have sought to address nuisance biofilm growth, via a long-term anti-icing and de-icing materials runoff management program, and to documented additional findings in Abram Creek. From EnviroScience (2016), water quality monitoring between February 2014 and July 2015, found BOD_5 upstream from CHIA never greater than 17 mg/l. Concentrations downstream from CHIA were and order of magnitude greater, reaching 180 mg/l during the winter period. From these results, oxygen demand was positively correlated with the

Table 9. Summary statistics for select inorganic water quality parameters sampled in the Rocky River watershed, 2014. The 90th percentile value from reference sites within the Erie Ontario Lake Plain (EOLP) is shown for comparison. Values above reference conditions are shaded. Samples per station ranged between 4 and 10.

		Aluminum	Chloride	Iron	Sodium	SPC[1]	TSS[2]
Units		µg/L	mg/l	µg/l	mg/l	umhos/cm	mg/l
Stream	RM	Mean	Mean	Mean	Mean	Mean	Mean
Rocky River	11.65	684	111	1549	73	738	42.8
Rocky River	11.1	100	263	238	161	1187	4.5
Rocky River	9.95	380	116	854	77	723	23.3
Rocky River	9.0	326	115	639	75	704	13.3
Rocky River	7.6	365	120	779	79	739	26.4
Rocky River	5.8	500	113	995	74	695	28.5
Rocky River	3.0	434	118	949	78	728	19.3
Rocky River	1.8	430	103	831	69	650	17.3
Rocky River	1.39	455	113	917	75	686	22.8
Rocky River	0.7	528	105	1046	71	655	23.8
Trib. to RR (6.51)	0.1	100	475	114	272	2001	6.3
Abram Creek	3.15	320	245	1100	148	1043	17.6
Abram Creek	1.9	384	247	1043	154	1075	16.5
Abram Creek	0.84	248	230	585	147	1063	7.9
Abram Creek	0.3	218	260	492	164	1190	8.4
West Branch	33.55	237	67	704	44	590	12.0
West Branch	32.26	751	88	1656	56	861	45.7
West Branch	27.3	282	97	676	65	715	10.1
West Branch	21.75	1175	97	2461	62	739	74.9
West Branch	16.35	199	88	447	58	650	7.4
West Branch	13.3	1037	100	2111	65	723	60.9
West Branch	11.7	319	105	825	69	739	17.6
West Branch	7.4	2992	91	7092	61	715	266.2
West Branch	4.9	1669	89	3779	57	623	114.3
West Branch	3.5	2408	89	5070	57	612	134.3
West Branch	2.1	6767	85	13655	54	556	589.2
West Branch	0.39	1278	95	2805	62	683	79.2
Champion Creek	0.01	129	83	189	55	685	3.4
Broadway Creek	0.28	160	164	491	111	952	13.6
North Branch	5.52	407	82	1088	53	578	13.4
North Branch	0.45	1120	92	2626	59	672	80.4
Plum Creek (NB)	3.02	339	91	800	60	551	12.0
Plum Creek (NB)	2.5	391	92	845	62	567	13.8
Plum Creek (NB)	0.5	501	94	1057	64	562	23.6
Remsen Creek	0.6	475	85	1750	56	713	20.7
Granger Ditch	1.75	393	56	1813	33	554	16.0
Granger Ditch	0.2	207	78	1158	48	640	8.9
Mallet Creek	3.5	224	54	423	39	610	4.9
Mallet Creek	0.72	860	66	1426	44	609	32.1
Cossett Creek	0.2	100	64	210	47	669	2.5
Baker Creek	0.3	431	119	835	78	719	12.8
Blodgett Creek	1.61	254	185	524	115	962	4.7

		Aluminum	Chloride	Iron	Sodium	SPC[1]	TSS[2]
Units		**µg/L**	**mg/l**	**µg/l**	**mg/l**	**umhos/cm**	**mg/l**
Stream	**RM**	**Mean**	**Mean**	**Mean**	**Mean**	**Mean**	**Mean**
Blodgett Creek	0.17	316	173	715	111	897	6.8
Plum Creek (WB)	8.5	1660	74	2568	44	558	52.5
Plum Creek (WB)	4.92	2405	67	3818	40	504	185.3
Plum Creek (WB)	2.5	630	59	1057	35	493	15.5
Plum Creek (WB)	0.4	358	95	785	59	678	10.1
East Branch	30.8	883	103	2185	65	675	35.0
East Branch	29.22	820	87	1832	56	566	24.4
East Branch	26.63	1429	81	2899	49	540	63.9
East Branch	21.98	1135	72	2049	45	516	42.9
East Branch	18.3	1794	72	3717	47	538	112.6
East Branch	17.5	1325	81	2654	52	609	75.8
East Branch	15.15	1427	78	2859	49	574	101.1
East Branch	11.57	1436	88	3039	57	594	84.8
East Branch	10.0	1422	98	3061	63	621	93.4
East Branch	8.2	650	108	1361	70	654	30.8
East Branch	735	724	109	1515	72	658	48.0
East Branch	6.38	528	109	1072	70	659	20.2
East Branch	5.1	802	114	1818	73	654	33.8
East Branch	3.06	223	131	668	83	759	8.1
East Branch	1.28	735	138	1659	88	811	41.4
Healey Creek	0.7	269	55	412	37	449	7.5
Trib.to EB (25.4)	0.1	813	92	1855	60	669	33.0
Trib.to EB (24.2)	0.1	100	41	98	20	428	8.0
Trib.to EB (12.9)	0.2	100	126	205	82	785	2.5
Trib.to EB (12.1)	0.1	127	147	196	99	814	2.5
Trib.to EB (11.1)	0.1	100	161	540	101	897	7.9
Trib.to EB (10.2)	0.3	100	349	241	185	1317	9.4
Trib.to EB (10.6)	0.2	100	390	877	202	1434	4.3
Baldwin Creek	3.53	297	130	770	83	657	10.5
Baldwin Creek	2.61	279	156	711	101	820	6.8
Baldwin Creek	1.13	371	156	865	96	767	20.0
Baldwin Creek	0.38	387	149	1401	95	757	15.1
Baldwin Creek	0.1	317	120	1094	77	705	12.3
Porter Creek	0.1	100	204	210	130	1032	3.0
Cahoon Creek	0.08	100	160	136	99	850	2.5
Ohio Reference Values							
Headwater			436.5	2849	31.1	940	43.2
Wading		750[a]	63.1	1872	43.8	729.8	42.3
Small River			26.6	3426	20.7	578.2	44.7

Table 10. Summary statistics for select nutrient water quality parameters sampled in the Rocky River watershed, 2014. Highlighted values are above statewide nutrient target values for total phosphorus and nitrate-nitrite-N (Ohio EPA, 1999) and above the 90th percentile value from reference sites within the Erie Ontario Lake Plain (EOLP) for ammonia. n=4-10.

		Ammonia	Nitrate-Nitrite -N	Total Phosphorus
Units		mg/l	mg/l	mg/l
Stream	RM	Mean	Mean	Mean
Rocky River	11.65	0.04	2.83	0.05
Rocky River	11.1	0.17	4.14	0.22
Rocky River	9.95	0.06	3.11	0.06
Rocky River	9.0	0.07	2.86	0.07
Rocky River	7.6	0.04	2.83	0.05
Rocky River	5.8	0.04	2.83	0.07
Rocky River	3.0	0.03	2.56	0.05
Rocky River	1.8	0.03	2.18	0.05
Rocky River	1.39	0.04	2.48	0.05
Rocky River	0.7	0.03	2.31	0.05
Trib. to RR (6.51)	0.1	0.04	1.39	0.05
Abram Creek	3.15	0.17	0.46	0.11
Abram Creek	1.9	0.06	0.69	0.08
Abram Creek	0.84	0.05	0.53	0.05
Abram Creek	0.3	0.09	0.60	0.07
West Branch	33.55	0.03	0.35	0.02
West Branch	32.26	0.03	0.35	0.04
West Branch	27.3	0.03	0.43	0.01
West Branch	21.75	0.03	0.30	0.03
West Branch	16.35	0.03	0.55	0.01
West Branch	13.3	0.13	5.16	0.09
West Branch	11.7	0.12	4.95	0.05
West Branch	7.4	0.10	3.32	0.12
West Branch	4.9	0.03	2.91	0.06
West Branch	3.5	0.03	2.43	0.07
West Branch	2.1	0.03	2.49	0.10
West Branch	0.39	0.04	2.49	0.08
Champion Creek	0.01	0.03	0.45	0.01
Broadway Creek	0.28	0.13	0.82	0.02
North Branch	5.52	0.03	0.40	0.03
North Branch	0.45	0.03	0.42	0.04
Plum Creek (NB)	3.02	0.03	0.40	0.02
Plum Creek (NB)	2.5	0.03	0.44	0.02
Plum Creek (NB)	0.5	0.03	0.33	0.02
Remsen Creek	0.6	0.04	0.33	0.07
Granger Ditch	1.75	0.06	0.34	0.06
Granger Ditch	0.2	0.04	0.36	0.04
Mallet Creek	3.5	0.03	0.66	0.02
Mallet Creek	0.72	0.03	0.66	0.04
Cossett Creek	0.2	0.03	0.56	0.01

		Ammonia	Nitrate-Nitrite -N	Total Phosphorus
Units		mg/l	mg/l	mg/l
Stream	RM	Mean	Mean	Mean
Baker Creek	0.3	0.03	0.81	0.02
Blodgett Creek	1.61	0.03	1.09	0.02
Blodgett Creek	0.17	0.03	1.63	0.03
Plum Creek (WB)	8.5	0.21	3.11	0.14
Plum Creek (WB)	4.92	0.13	2.18	0.19
Plum Creek (WB)	2.5	0.05	1.66	0.09
Plum Creek (WB)	0.4	0.04	0.90	0.08
East Branch	30.8	0.04	0.49	0.03
East Branch	29.22	0.03	0.53	0.04
East Branch	26.63	0.03	0.44	0.04
East Branch	21.98	0.05	0.32	0.02
East Branch	18.3	0.05	0.57	0.06
East Branch	17.5	0.03	3.61	0.10
East Branch	15.15	0.03	2.86	0.08
East Branch	11.57	0.03	3.51	0.07
East Branch	10.0	0.05	3.71	0.07
East Branch	8.2	0.04	4.12	0.05
East Branch	7.35	0.04	3.13	0.05
East Branch	6.38	0.03	3.75	0.04
East Branch	5.1	0.03	3.84	0.05
East Branch	3.06	0.03	4.06	0.03
East Branch	1.28	0.03	3.92	0.03
Healey Creek	0.7	0.03	0.72	0.02
Trib.to EB (25.4)	0.1	0.04	0.47	0.02
Trib.to EB (24.2)	0.1	0.03	1.27	0.01
Trib.to EB (12.9)	0.2	0.03	14.75	0.16
Trib.to EB (12.1)	0.1	0.03	0.87	0.01
Trib.to EB (11.1)	0.1	0.35	14.48	0.26
Trib.to EB (10.2)	0.3	0.03	1.05	0.01
Trib.to EB (10.6)	0.2	0.04	0.62	0.02
Baldwin Creek	3.53	0.05	4.09	0.08
Baldwin Creek	2.61	0.09	6.73	0.16
Baldwin Creek	1.13	0.07	5.10	0.10
Baldwin Creek	0.38	0.09	4.12	0.09
Baldwin Creek	0.1	0.11	3.24	0.03
Porter Creek	0.1	0.04	1.07	0.05
Cahoon Creek	0.08	0.03	0.51	0.02
Ohio Target or Reference				
Headwater		0.19	1.0	0.8
Wading		0.56	1.0	0.1
Small River		0.25	1.5	0.17

CHIAs primary deicing material, propylene glycol, the use of which obviously spikes in the during the winter months. Additionally, the report documented pulses of ammonia entering above RM 3.2, upstream from and independent of various CHIA outfalls from. Four water quality criterion exceedances were documented. Ohio EPA found similar indications of ammonia pulses, however, did not document a water quality violation at any of the locations sampled in Abram Creek. Grab organic water samples at RMs 3.2 and 1.9 in July and August 2015 did not yield any violations of Ohio EPA's aquatic life criteria. However, at RM 1.9, two organic compounds were detected above detection limits: Chloroform (1.95 and 1.16 µg/L) and Dichlorobromomethane (1.01 and 0.6 µg/L) on 7/20/15 and 8/25/15, respectively.

West Branch Rocky River and Select Tributaries

Grab surface water samples from twelve locations on West Branch Rocky River revealed iron exceedances at eight locations. These exceedances (concentrations greater than the water quality standard of 5000 µg/L, for the protection of agricultural uses) all occurred during high flow events. Copper and/or lead values above WQS were observed at four locations, starting from RM 4.9 and moving downstream towards the convergence with the East Branch Rocky River. The highest copper and lead levels recorded in the survey (26.9 and 40.2 µg/L, respectively, with a hardness of 136 mg/l) were observed at RM 2.1, adjacent to Lewis Rd on 6/24/14. On that same date further upstream at RM 4.9, copper and lead values (13.2 and 10.8 µg/L, respectively) exceeded OMZA standards, suggesting a potential source above that location. Two additional copper values exceeding the OMZM criteria were observed at RM 3.5 and 0.4 (15.6 and 16.6 µg/L, respectively) on 6/24/14. Mean concentrations of the following parameters exceeded background conditions in the majority of the locations sampled: aluminum, chloride, sodium, and total suspended solids (TSS). Nitrate-nitrite-N levels above the Ohio EPA WWH target for the protection of aquatic life (1.0 mg/l) began from RM 13.3 to the mouth. There was a discernible change in concentrations downstream of the Medina County #500 WWTP (RM 14.7), as was documented in a 1999 report. Median values of total phosphorus were all below the suggested WWH target (0.1 mg/l), with the exception of RMs 13.3, 11.7, and 7.4 (0.13, 0.12, and 0.10 mg/l, respectively).

North Branch Rocky River had exceedances of iron (16800 and 21600 µg/L) during the field season, corresponding to high flow events within the watershed. Elevated levels of copper (11.1 µg/L) and lead (11.4 and 14.3 µg/L) were also observed during these high flow evets, however the results did not exceed the OMZA or the OMZM for copper and lead, respectively. The North Branch converges with the South Branch to form West Branch Rocky River in Medina, and is comprised of Plum Creek, Granger Ditch, and Remsen Creek. The most downstream site on North Branch had aluminum and TSS concentrations greater than background levels. Median sodium concentrations were above EOLP background levels at all locations that comprise North Branch. This downstream site, RM 0.45, is just below a low-head dam that once served a nearby water treatment plant. Nutrient trends for North Branch Plum Creek, Granger Ditch, Remsen Creek, and North Branch Rocky River all fell below target levels and within background EOLP nutrient values.

Plum Creek (enters West Branch at RM 3.06) had WQS exceedances of iron (10100, 5020, 17800 µg/L) that occurred during high flow events. Previous reporting by Ohio EPA noted exceedances of lead near the mouth of Plum Creek, with unknown sources (Ohio EPA 1999). Results from this survey, at the mouth of Plum Creek, found a one-time lead level of 3.6 µg/L that, combined with a low hardness of 62 mg/l, resulted in an OMZA lead standard of 3.49 µg/L. However, a hardness value of less than 100 mg/l (average hardness of 223 mg/l in Plum Creek watershed) is uncommon in the Rocky River watershed, therefore the lead exceedance is suspect. Plum Creek at Jaquay Rd. crossing (RM 4.92) had an average lead value, in June 2014, of 9.5 µg/L at a hardness of 137 mg/l, which was just slightly below the lead standard (9.58 µg/L). The averages were driven up by a single lead sample collected during a high rain event on 6/24/14

(14.7 µg/L). The upper portion of the watershed is a low-gradient and former wetland area, with historical channelization. The lower portion is highly urbanized and falls rapidly into West Branch (thus Olmsted Falls). Aluminum, iron, sodium, TSS, and lead were elevated in the upper portion of the watershed, compared to background levels. The lower segment had median sodium concentrations greater than background concentrations, attributed to urban runoff. Elevated concentrations of nitrate-nitrite-N were prevalent in 3 of 4 sites sampled. The most downstream site (RM 0.45) had an average nitrate-nitrite-N concentration of 0.9 mg/l, very near to the target value of 1.0 mg/l. Plum Creek WWTP discharges into Plum Creek at RM 6.82 and has had a long history of permit violations, including TSS, CBOD, DO, ammonia, and fecal coliform (see Permit Section).

East Branch Rocky River and Select Tributaries

Grab surface water samples were collected from sixteen different locations on East Branch of the Rocky River. Iron exceedances from WQS for the protection of agricultural uses (5000 µg/L) were observed at eight separate locations and all occurred during high flow events. In addition to iron exceedances (21600, 9470, 9280 µg/L) at RM 17.5, there were copper (13 µg/L) and lead (16.2 µg/L) exceedances of WQS. This site is just downstream of Medina County #300 WWTP outfall 001 at RM 18.2. Mean concentrations of the following parameters exceeded background EOLP values for the majority of sites in the East Branch: aluminum, chloride, sodium, and TSS. Median nutrient values just downstream of Medina #300 were elevated above Ohio EPA targets for nitrate-nitrite-N and total phosphorus. High vales for nitrate-nitrite-N remain for all sites downstream of RM 17.5.

Baldwin Creek (enters East Branch at RM 4.94) is a heavily urbanized stream that has been modified extensively over time. Two major WWTPs are located within this 11.94 mi^2 drainage area subwatershed. There were no exceedances of WQS for the five sites sampled. High median sodium values were observed at all five sites and can be attributed to the heavy influence of urban runoff. Additionally, elevated levels of nitrate-nitrite-N were prevalent throughout Baldwin Creek.

Select East Branch tributaries chosen by Cleveland Metroparks were sampled in the 2014 survey. These seven tributaries did not exceed any WQS, however, two of the tributaries had the highest nitrate-nitrite-N values in the survey (14.75 and 14.48 mg/l). The tributary at RM 12.9 was sampled just downstream of North Royalton's A WWTP and the tributary at RM 11.1 was sampled downstream of Strongsville's B WWTP discharge. In addition to a high median concentration of nitrate-nitrite-N, the tributary at RM 11.1 has an ammonia median of 0.35 mg/l, which exceeds the background level of 0.19 mg/l.

Direct Lake Erie tributaries

Porter and Cahoon Creek, located in Bay Village, are direct Lake Erie tributaries just west of the Rocky River. These tributaries drain highly urban and industrial areas, which is reflected in the water chemistry grabs taken in 2014. No WQS were exceeded, however, sodium and conductivity values were above background conditions and are indicative of urban runoff. In addition, high values of *E. coli* were present during the recreation season with aging pipes and runoff being the probable sources (See Recreation Use Section).

Water Quality Trends

Rocky River

Previous basin-wide surveys of Rocky River watershed ware conducted by the Ohio EPA in 1981, 1992, and 1997 (Ohio EPA 1983, 1993, and 1999). A review of Rocky River mainstem water quality data from 1992 through 1997 indicated an overall decrease in median total phosphorus, median ammonia, and median COD concentrations in 2014. A significant reduction in CSO events (see Permit Section) may account for the decreased ammonia concentrations. Longitudinal performance of selected water quality parameters on the Rocky River are provided in Figures 16 and 17.

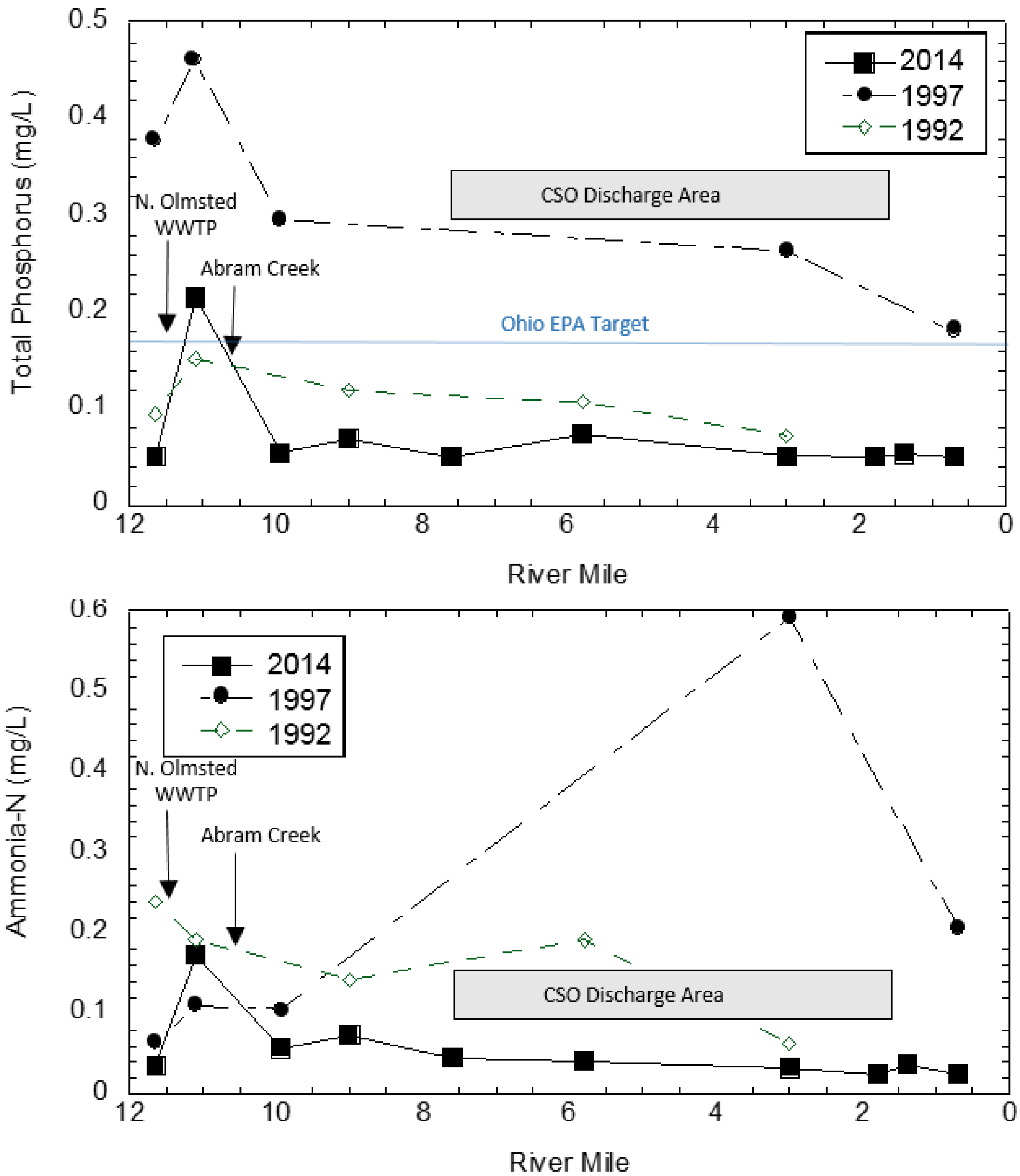


Figure 16. Longitudinal median concentrations of phosphorus and ammonia, Rocky River, 1992-2014.

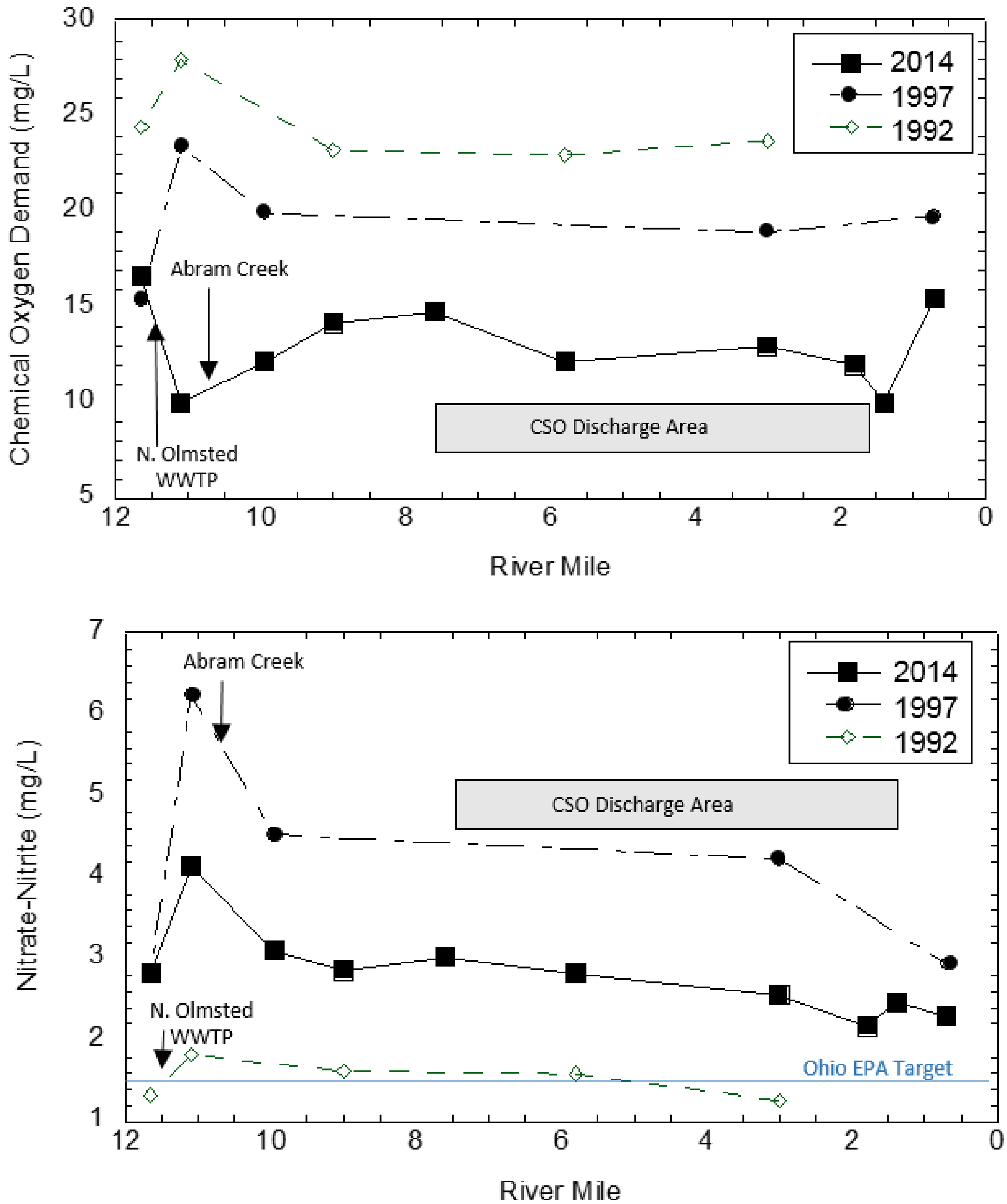


Figure 17. Longitudinal median concentrations of Chemical Oxygen Demand (COD) and nitrate-nitrite-N, Rocky River, 1992-2014.

Median nitrate-nitrite-N concentrations have decreased since 1997, yet still are above levels in 1992. This appeared to reflect increased design flow of the North Olmsted WWTP and attending efficient nitrification, as well as increases, temporal or otherwise, in diffuse sources upstream may have been contributory. There were no other apparent differences in the chemical/physical water quality of the mainstem from 1992 to 2014.

<u>Abram Creek</u>

Major improvements were observed in 1997 survey of Abram Creek with the elimination of two WWTPs (Brookpark and Middleburg Heights in 1993). Ammonia levels decreased substantially between 1992 and 1997, however winter sampling in 1998 showed elevated ammonia during baseflow conditions. One source of ammonia was determined to be the seepage of urea-based chemicals (which readily decompose into ammonia) used for de-icing at CHIA. Since the 1997 sampling, CHIA has switched from urea and ethylene glycol based deicing chemicals to propylene glycol, potassium acetate, and sodium acetate. Ammonia concentrations taken during the 2014 field season have shown major overall reductions compared with 1992 and 1997. Conductivity levels have increased steadily since 1992, with increased runoff from roadways and urban/industrial areas being a probable source. Overall DO concentrations have improved over time, however RM 3.2 remains relatively unchanged with average levels around 5 mg/l, and numerous water quality exceedances of less than 4 mg/l documented in additional 2015 sampling. Longitudinal performance of selected water quality parameters on Abram Creek are provided in Figures 18 and 19.

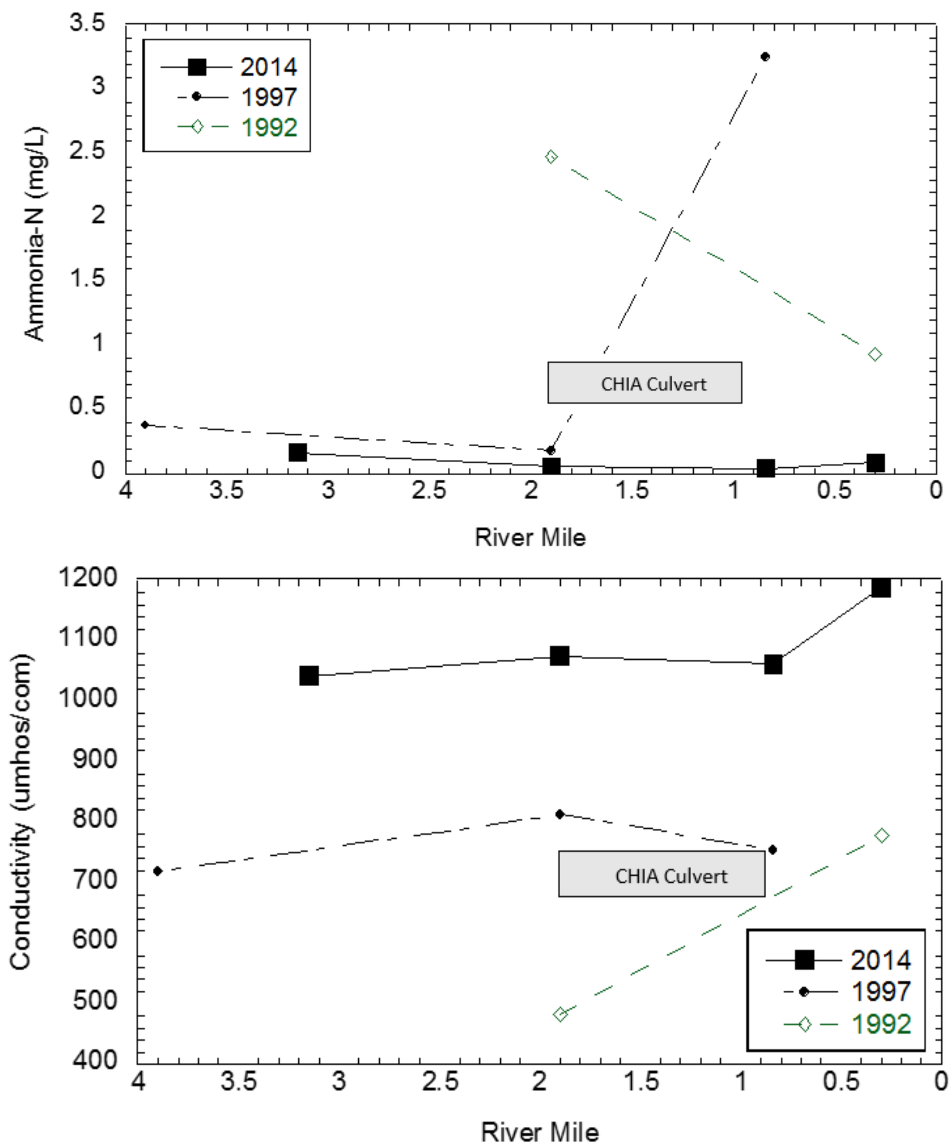


Figure 18. Longitudinal median concentrations of ammonia and conductivity from Abram Creek, 1992-2014.

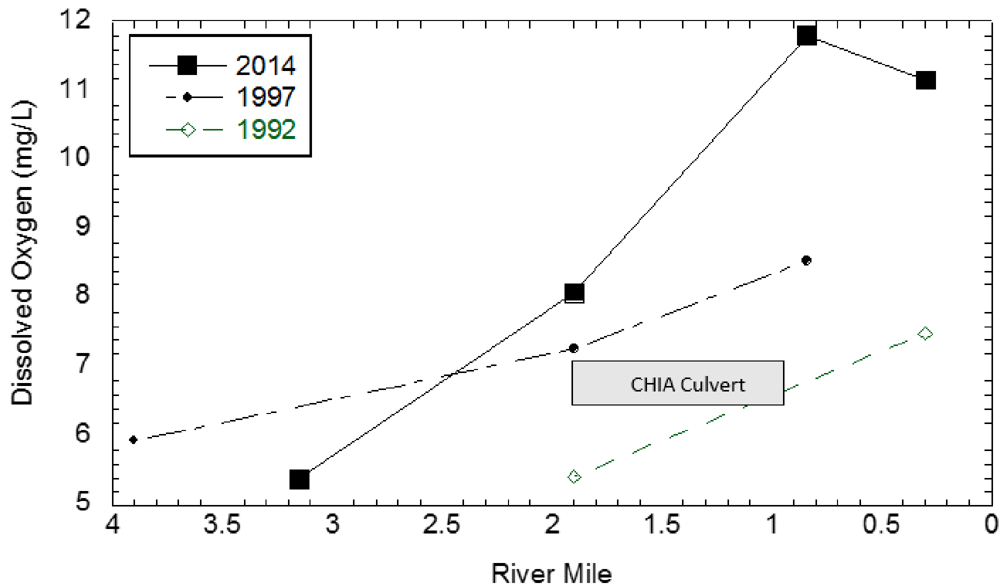


Figure 19. Longitudinal median concentrations of dissolved oxygen, Abram Creek, 1992-2014.

West Branch Rocky River

Water quality studies in 1992 and 1997 document major improvements from the elimination of various WWTPs, improved operating conditions of Medina 500 WWTP, and the remediation of the Montville solid waste landfill in the upper reaches of the West Branch. Ammonia concentrations highlight these changes over time, with significant reductions from 1992 to 1997. The median concentrations of ammonia in 2014 fell well below the chronic toxicity values at the measured temperature and pH, and are similar to those observed in 1997. Nutrient data from 2014 follows similar trends to 1997 data, with increases downstream of Medina 500 WWTP. However, the nutrient enrichment does not negatively impact the biological integrity of the stream, with the entire West Branch maintaining full attainment of aquatic life use. TSS concentrations in the lower half of the watershed have increased over time and may indicate more substantial influences of urban runoff. No other significant differences in the chemical quality of the West Branch were measured. Longitudinal performance of selected water quality parameters on the West Branch Rocky River are provided in Figures 20 and 21.

Plum Creek

Since the last water quality survey in 1997, three WWTPs have been discontinued in Plum Creek (Brentwood, Western Ohio Utility, and ODOT Park 3-39). Spikes of total lead were first documented in 1997, and lead was detected at two locations in 2014. Based on the lead levels found in 1997 near the mouth (38 µg/L at a hardness of 158 mg/l) and the lead levels found in 2014 at RM 4.92, it appears that the lead concentrations have decreased over time. However, the source(s) of lead is still unknown, but is likely not a point source, as the 2014 levels above WQS are all associated with large storm events. No other major changes were observed.

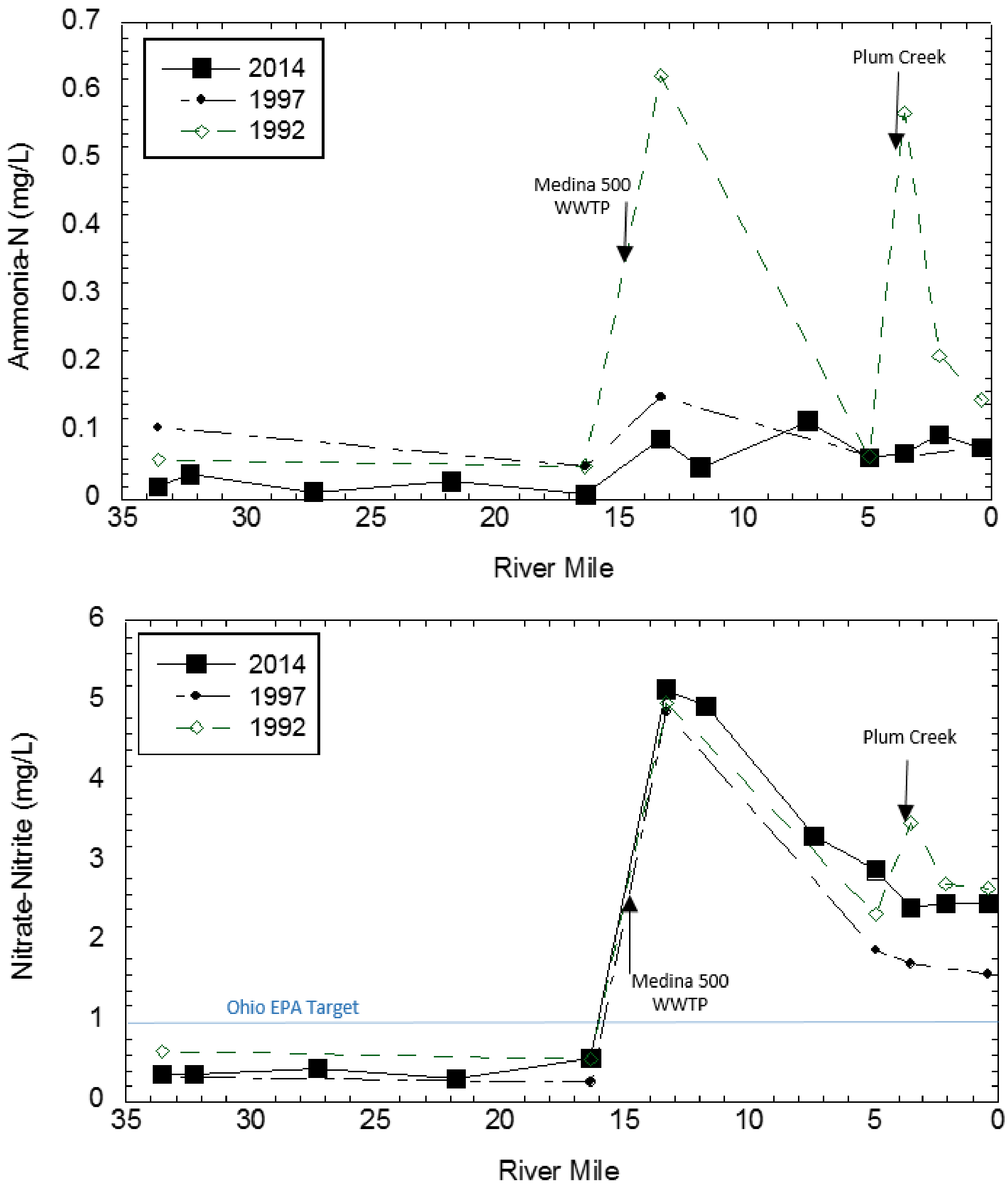


Figure 20. Logintundinal median concentrations of ammonia and nitrate-nitrite-N, West Branch Rocky River, 1992-2014.

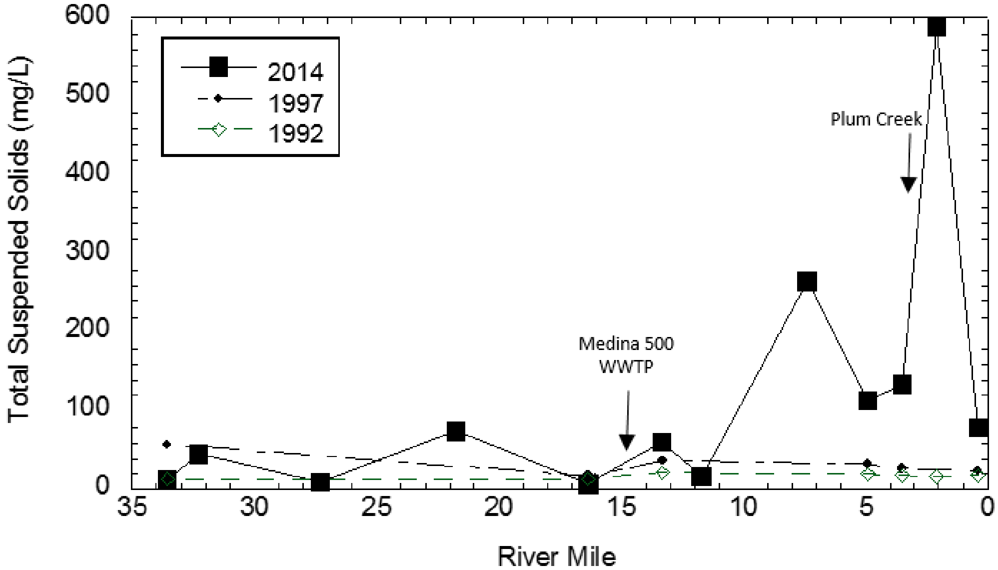


Figure 21. Longitudinal median concentrations of total suspended solids, West Branch Rocky River, 1992-2014.

East Branch Rocky River

There has been little change in the upper reaches of the East Branch, upstream from any WWTP outfalls, over the three sampling events the watershed. After RM 23, there is a slight increase of median total phosphorus that reaches a maximum level for 2014 just downstream of Medina 300 WWTP. However, compared with 1997 data, median levels are lower for the entire watershed. Trends for nitrate-nitrite-N follow data collected in 1992 and 1997, with levels tripling downstream four WWTPs that discharge to the East Branch mainstem or small direct tributaries. TSS levels are generally higher in 2014 compared with 1992 and 1997 and may be a result of the intense rain events in May and June of that year, increasing the sediment load within the river. There were no other apparent differences in the chemical water quality of the East Branch from 1992 to 2014. Longitudinal performance of selected water quality parameters on the West Branch Rocky River are provided in Figures 22 and 23.

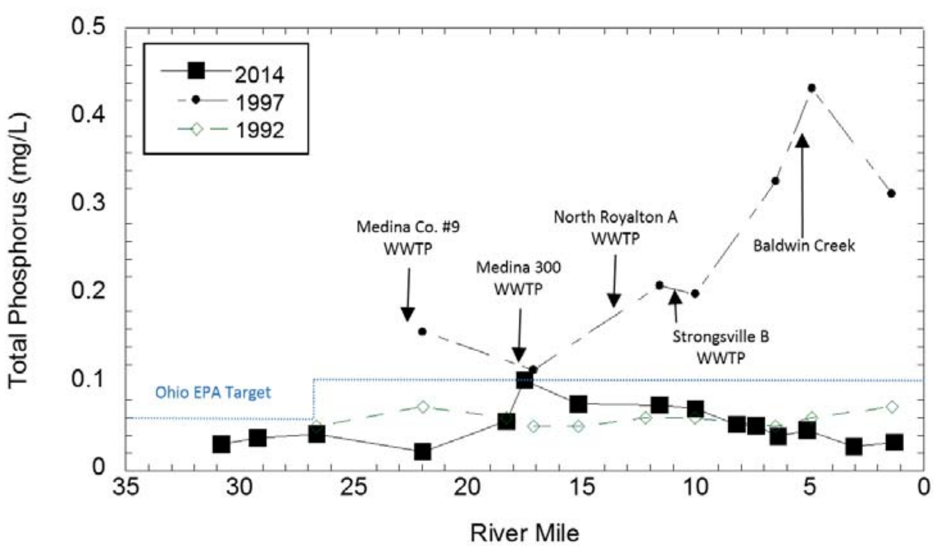


Figure 22. Longitudinal median concentrations of phosphorus, East Branch Rocky River, 1992-2014.

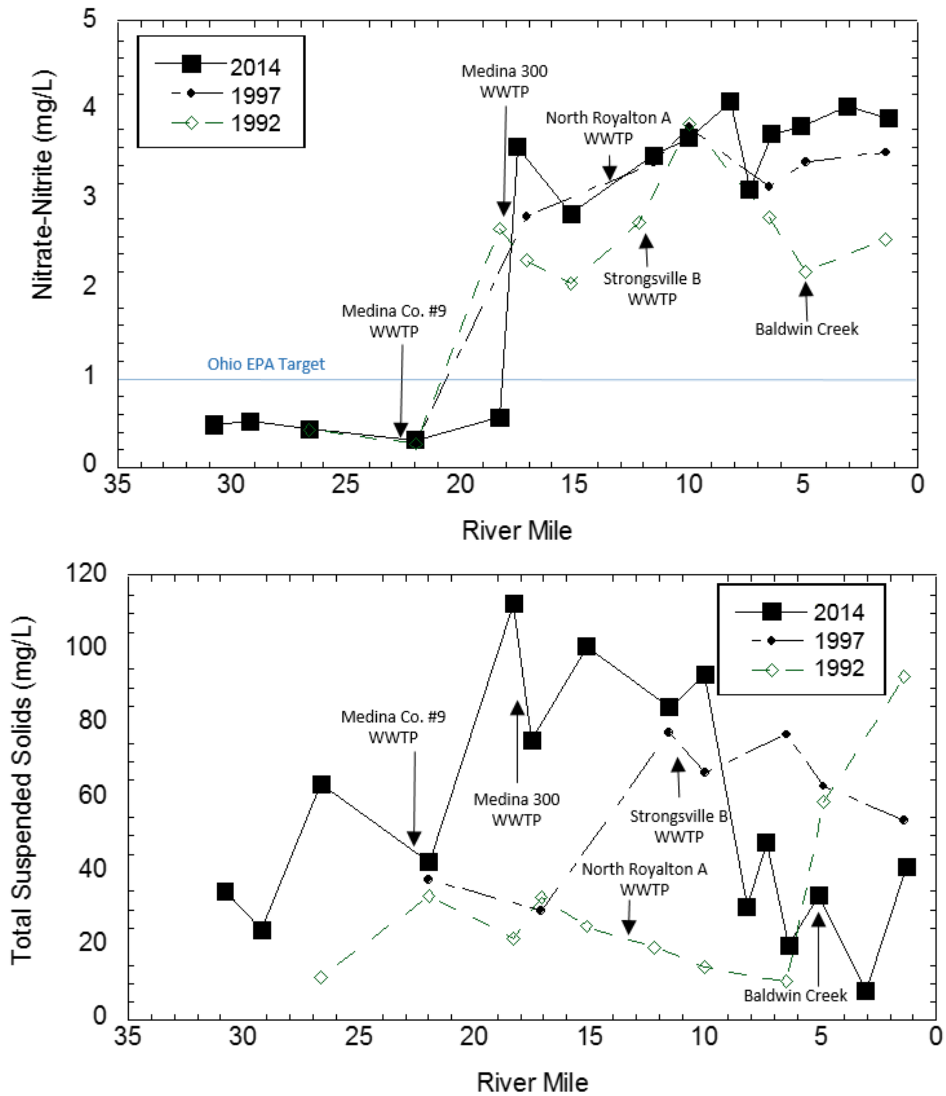


Figure 23. Longitudinal median concentrations of nitrate-nitrite-N and total suspended solids, East Branch Rocky River, 1992-2014.

Diel Water Quality Summary

Multi-parameter continuous water quality monitors were deployed to measure temperature, dissolved oxygen (DO), pH and specific conductance (conductivity). Temperature, DO and pH are influenced by diel patterns. These diel patterns have the greatest impact on streams during certain critical conditions that include stable low stream flow. Specific conductance is not influenced by the same diel triggers; it is monitored because it is a strong indicator of changes in stream flow. The sondes collect water quality readings hourly monitoring parameters throughout the 24-hour diel cycle. Grab readings differ from sonde deployments because they only represent one point on the diel curve. While grabs are effective at characterizing water quality parameters that change based on hydrologic regime or season, they can miss or not fully characterize parameters that exhibit diel patterns. When the diel fluctuations are of concern, continuous monitoring at regular intervals throughout the diel cycle is needed to characterize the parameter of concern.

Diel patterns in temperature reflect air temperature, solar radiation, base flow (groundwater), discharge, and shading. In general, diel fluctuations in temperature increase as base flow, discharge, and shading decrease. The inverse is also true.

All things being equal, DO and temperature exhibit similar diel patterns, as they are affected by similar factors. In addition, DO trends are directly dependent on temperature. As temperatures increase, the solubility of oxygen in water decreases resulting in an inverse relationship between temperature and solubility of oxygen in water. Without the influence of other environmental conditions, this would cause the two parameters to follow opposite trends. However, the DO produced by photosynthesis is, in most instances, enough to overwhelm the inverse relationship, causing the trends to follow similar trajectories. Increasing diel fluctuation relates to an increase in productivity; DO concentrations reach super saturation during the day and subsequently deplete by respiration at night. The result is a diel trend that typically reaches a maximum in the early evening and a minimum preceding sunrise. In some cases, DO does not exhibit strong diel trends in low flow, warm conditions. Either primary productivity is limited or decomposition of organic matter in the stream is controlling the DO concentrations. Sonde monitoring contributes to the body of evidence used to identify DO trends that are influenced by primary productivity and/or decomposition.

Diel patterns in pH are also reflective of primary productivity. Carbon dioxide, which is dissolved in water as carbonic acid, is consumed during photosynthesis raising the pH of the stream. The result is a maximum pH value observed at a similar time to the maximum DO value.

Twenty-nine sites were sampled with continuous water quality monitors to characterize both the general watershed area and target areas of concern (i.e. point sources or historically impaired areas). Due to extensive rain during the first deployment in June 2014, all 29 sites were revisited in September 2014. A third deployment occurred in July 2015.

Critical conditions for temperature and DO are times when flows are low, temperatures are high, and daylight is long. These are the times that streams are most sensitive to organic and nutrient enrichment. To capture these conditions, sondes are typically deployed in low flow conditions from June to September. Sondes were deployed June 17-19, 2014 and September 9-11, 2014 (Figure 24) in the mainstem and select tributaries of the Rocky River. Sondes were deployed September 28-30, 2015 in select tributaries to the Rocky River. The summer for 2014 was generally cool and wet; the conditions sampled were not ideal to document enrichment. During the 2015 survey, air temperatures were higher than the normal daily air temperature, and flows were near median flow, which is lower than the flow observed in the weeks preceding the survey. The plots are of hourly readings taken for temperature, DO, pH, and conductance.

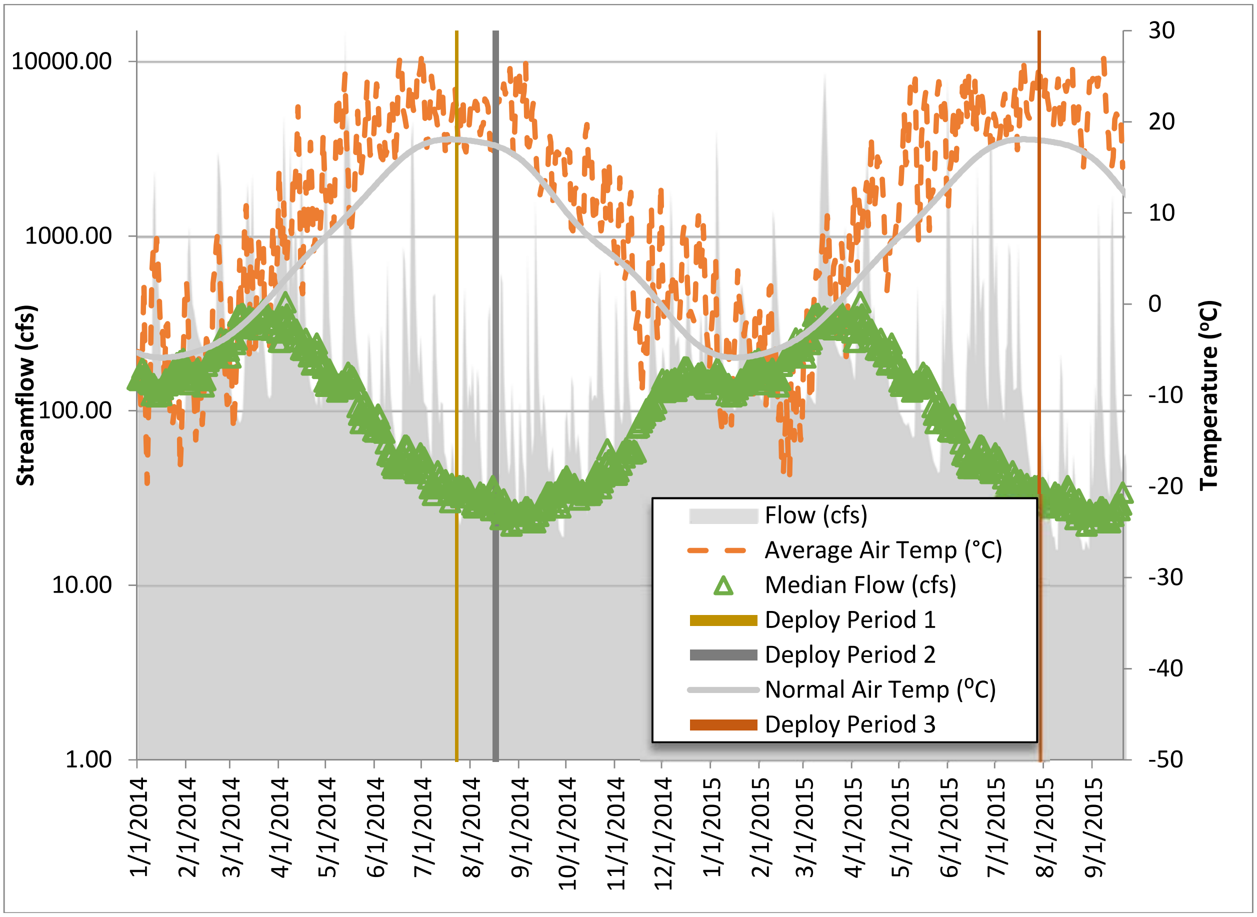


Figure 24. Graph of average daily streamflow relative to the daily median streamflow (USGS 04201500 Rocky River near Berea OH) including the average daily stream temperature (USGS 04201500 Rocky River near Berea OH), average daily air temperature and normal daily air temperature (NOAA-GHCND:USW00014820) for the sampling season.

Ohio promulgates water quality standards through Ohio Administrative Code Chapter 3745-1. The data collected during the sonde deployments were sufficient to evaluate exceedances of the standards for the protection of aquatic life for: maximum daily temperature, minimum DO, 24-hour average DO, pH, and specific conductance. Absolute minima or maxima exceedances are compared directly to hourly readings reported from the water quality sondes. The 24-hour average DO criteria are compared to a rolling 24-hour average calculated for the duration of the deployment. An exceedance of the water quality criteria does not represent stream impairment; rather if biological impairment is present the exceedances help develop a body of evidence that identifies the conditions that are stressing aquatic life.

In 2014, sondes were deployed at 29 sites and all sites were sampled twice. The first deployment was 6/17-19/2014 and 44-54 hours of data were collected at each site. Some DO data was discarded due to poor performance due to quality assurance post-checks or inaccurate field measurements. The second sampling was done 9/9-11/2014 resulting in an additional 23-48 hours of data collection at each site.

In 2015, sondes were deployed at 21 sites. The selection of 2015 sites focused on streams that showed potential impairment during the 2014 surveys. The 2015 deployment occurred 7/28-30/2015 and 45-57 hours of data were collected at each site. Rain occurred within the stream basin on 7/29/2015 beginning around 7:00 PM. A summary of the exceedances is presented in Table 11. The table includes comments about exceedances that are made based on Ohio EPA staff's best professional judgment.

Table 11. Exceedances of Ohio Water Quality Standards criteria (OAC 3745-1) for chemical and physical parameters derived from diel monitoring, 2014. (Exceedances from 2015 are in italics.) Continuous water quality monitors (Sonde) take and record hourly readings for the duration of the deployment. Consequently, exceedances can be presented as both a measure of magnitude and duration. Rolling 24-hour averages were calculated using the hourly readings for comparison against the average DO criteria. The magnitude of an exceedance is presented as the most extreme value measured that exceeds the criteria. The duration is the count of consecutive hours that exceeded the criteria and is presented in parenthesis after the measure of magnitude. Applicable water quality criteria include: minimum DO[a], average DO[b], maximum temperature[c], pH[d] and specific conductance[e].

RM	Location	Parameter, Exceedance (DO mg/l, Temp.°C, Sp. Cond. µS/cm)	Comments
Rocky River - EOLP, Warmwater Habitat (Existing)			
11.65	Ust. N. Olmstead WWTP	Temp max[c]: 3(29.9)	Shallow and wide bedrock channel; downstream of confluence of West and East Branch. Sampled 2014.
9.95	SR 17, dst NASA	None	Sampled 2014.
3.0	Lakewood at Park Blvd	None	Sampled 2014.
1.39	At Metropark Dr., dst Lakewood WWTP	None	Lacustrine - lake affected. Sampled 2014.
Abram Creek - EOLP, Warmwater Habitat (Existing)			
3.32	Eastland Rd., background	DO avg [b]: 23(3.83) DO min[a]: 1(3.72), 15(3.03), 1(3.82), 1(3.81), 4(3.27)	Low gradient, heavy hydro-modification, watershed urbanization, palustrine headwaters (Lake Abram). Sampled 2015
3.15	Eastland Drive, dst. CHIA storm drain	None DO min[a]: 1(3.72), 2(3.75), 2(3.99) Sp. Cond[e]: 1(2528), 3(2833)	Low gradient, heavy hydro-modification, and watershed urbanization. Sampled 2014 and 2015.
2.87	Riverside Drive	DO min[a]: 1(3.77)	Sampled 2015.
1.9	Grayton Rd., ust. Airport Enclosure	None	Sampled 2015.
Abram Creek - EOLP, Warmwater Habitat (Existing)			
0.84	At NASA, dst. Enclosure	None	Sampled 2015.
0.3	N. of Berea at W. Area Rd.	Sp. Cond[e]: 1(2407)	Sampled 2014.
West Branch Rocky River - EOLP, Warmwater Habitat (Existing)			
32.26	At Ridgewood Road	None	Sampled 2014.
21.75	Near Abbeyville at Neff Rd.	Temp. Max[c]: 5(30.3)	Shallow and wide bedrock channel. Sampled 2014.
West Branch Rocky River - EOLP, Warmwater Habitat (Existing)			
13.3	Adj. West River Rd.	None	Sampled 2014.
7.4	N. of Columbia Hills	None	Sampled 2014.

RM	Location	Parameter, Exceedance (DO mg/l, Temp.°C, Sp. Cond. µS/cm)	Comments
3.5	Olmstead Falls, at Bagley Rd.	None	Dst. Blodgett Creek. Sampled 2014 and 2015.
0.39	Near North Olmstead at Lewis Rd.	Temp Max[c]: 3(29.75)	Shallow and wide bedrock channel. Sampled 2014.
North Branch Rocky River - EOLP, Warmwater Habitat (Existing)			
0.45	Near Medina, at Granger Rd.	None	Sampled 2014.
Plum Creek (North Br. Trib.) - EOLP, Warmwater Habitat (Existing)			
3.02	At Sleepy Hollow	None	Sampled 2015.
2.5	SE Brunswick	None	Sampled 2015.
0.5	SR 3/I 71	None	Sampled 2014 and 2015.
Mallet Creek - EOLP, Warmwater Habitat (Existing)			
0.7	Neff Rd.	None	Sampled 2014.
Plum Creek (West Br. Trib.) - EOLP, Warmwater Habitat (Existing)			
8.5	At Akins	DO Min[a]: *3(3.79)* None	Sampled 2015.
4.92	Jaquay Rd.	DO Min[a]:*4(3.76)* None	Rheopalustrine, channelized. Sampled 2014 and 2015.
2.5	Ohio Turnpike (I-80)	None	Sampled 2015.
0.4	Olmstead Falls at Mill St.	None	Sampled 2014 and 2015.
East Branch Rocky River - EOLP, Warmwater Habitat (Existing)			
30.8	Oviatt Rd.	None	Sampled 2015.
26.63	At Harter Rd., ust. Medina Co. SD No 9 WWTP	None	Sampled 2014.
21.98	At SR 303, dst. Medina Co. SD No 9 WWTP	None	Sampled 2014.
18.3	Ust. Medina 300 WWTP	None	Sampled 2014.
17.5	Dst Medina 300 WWTP, private drive off SR 3	None	Sampled 2014.
15.15	Near N. Royalton, at Bennett Rd.	None	Sampled 2014.
11.57	Strongsville, at SR 82/Royalton Rd.	None	Sampled 2014.
10.0	At Mill Stream Run Bridge	None	Sampled 2014.
9.35	Between SR42 and I-71	None	Sampled 2015.
7.35	Eastland Rd./I-80	None	Sampled 2014.
1.28	At Spafford Rd.	None	Sampled 2014.
Baldwin Creek - EOLP, Warmwater Habitat (Existing)			
3.53	Middleburg Heights, at Lucerne Rd.	None	Sampled 2014 and 2015.
2.61	At Big Creek Parkway	None	Sampled 2015.
1.13	Near Berea, at Eastland Rd.	None	Sampled 2014 and 2015.
0.38	Berea, at Rocky River Dr.	None	Sampled 2014 and 2015.

RM	Location	Parameter, Exceedance (DO mg/l, Temp.°C, Sp. Cond. µS/cm)	Comments
0.1	At Mouth	None	Sampled 2015.

Notes: EOLP - Erie/Ontario Drift and Lake Plain
a - Minimum DO criterion - WWH: 4.0 mg/l, MWH: 3.0 mg/l.
b - Minimum 24-hour average DO criterion - WWH: 5.0 mg/l, MWH: 4.0 mg/l.
c - General Lake Erie basin daily maximum temperature criteria apply; See OAC 3745-1-07, Table 7-14(G).
d - The criteria for pH requires waters be within the range of 6.5-9.0 S.U.
e - The criteria for maximum specific conductivity is 2400 µS/cm.

Temperature

The temperature standards for the general Lake Erie Basin are applicable in the Rocky River watershed. Temperature exceedances were observed in June 2014, even though the air temperature was lower than the normal. Temperature exceedances were measured on Rocky River at RM 11.6 and on West Branch Rocky River at RM 21.7 and 0.4. Both of these rivers have a wide, shallow bedrock channel upstream of their assessment sites with the documented exceedances. Additionally, both streams drain primarily developed areas albeit with relatively intact riparian corridor upstream. Due to the streams' wide channels however, riparian shading is limited.

Dissolved oxygen

Originating as the outlet of Abram Lake, Abram Creek is characterized by low gradient, heavy hydro-modification and watershed urbanization. Much of the riparian zone and wetland habitat within the watershed has been developed (Ohio EPA, 2001). The stream is enclosed by CHIA between RM 1.9 and RM 0.9 and impounded immediately downstream from the lower limits of the enclosure.

Sites showing depressed DO regime were upstream of the airport enclosure. During the September 2015 survey, average DO was 3.83 mg/l at RM 3.32, the uppermost site. Here DO was found below 5.0 mg/l for 23 consecutive hours of sampling and below 4.0 mg/l for 21 non-consecutive hours, with values as low as 3.03 mg/l observed. Twenty-four hour average concentration was 4.91 mg/l at Abram Creek at RM 3.15 during June 2014 survey. While Abram Creek exhibited DO concentrations that are indicative of organic enrichment the reductive lacustrine and palustrine characteristics of the uppermost reaches of the watershed undoubtedly contributed to the depressed DO regime.

Three of the five permitted stormwater discharges from CHIA (3II00179) and half of the NASA Glenn Research Center's (3IO00001) six outfalls discharge to Abram Creek. There are two MS4 storm water discharges under Eastland Road (RM 3.32). High conductivity spikes were observed on Abram Creek at around the time that rain was recorded indicating that at least some of these dischargers are contributing contaminated stormwater to the stream. The combination of background sources, stormwater, and wastewater appeared to carry a high in BOD load. Low DO, including values below 4.0 mg/l were observed on Abram Creek in 2015 and 2014

In 2015, DO minimum criteria exceedances were observed on Plum Creek (tributary to West Branch Rocky River) at RM 8.5 and RM 4.9. The Plum Creek WWTP (3PG00052) discharges in between these assessment sites at RM 6.8. Sonde data indicate that the WWTP is not the sole cause of the DO concentration within this stream reach because there are DO exceedances upstream and downstream of the plant.

The upper and middle reaches of both Abram Creek and the Plum Creek discussed above have shallow channel gradient and a large proportion of stagnant/pooled sections, these feature reflecting palustrine and rheopalustrine conditions that in the past typified the upper reaches of these watersheds. Slack water conditions and extant wetlands are most likely the causes of the observed low DO. Low gradient streams have limited reaeration and export organic material slowly. Therefore, they are naturally prone to organic enrichment and additional anthropogenic sources of organic material are often poorly assimilated. In general, these anthropogenic sources of organic material include poorly operating municipal wastewater treatment plants and HSTSs.

pH

The Erie/Ontario Drift and Lake Plain ecoregion is characterized by drift and lacustrine deposits, superimposed on shales and sandstones of Devonian and Mississippian age. While the composition of the surface material is lower in lime than other glacial deposits, there were no pH exceedances within the Rocky River watershed. Based on stream survey and sonde data, point sources do not appear to be significantly influencing pH in the streams within the study area.

Specific conductance

Specific conductance does not undergo the same diel processes as the other parameters monitored with the water quality sondes. Conductance generally increases from higher to lower streamflow. The presence of point sources influences conductance at low streamflows because streams typically have lower conductance than point sources. Exceedances were measured at Abram Creek at RM 3.2 and RM 0.3 during the 6/17-19/2014 survey. During the 9/28-30/2015 survey, there were three measurements of specific conductivity exceedances at RM 3.2. During the 9/9-11/2014 survey, the conductivity in Abram Creek was higher than the surrounding streams; with a maximum exceedance of 2883 µs/cm observed at Abram Creek, RM 3.2 in 2015 and a maximum exceedance of 2407 µs/cm observed at Abram Creek RM 0.3 in 2014. There are no permitted dischargers to Abram Creek upstream of RM 3.2, but it drains an area of high-intensity development. The NASA Glenn Research Center and the Cleveland Hopkins International Airport discharge are upstream of the lower Abram Creek assessment site at RM 0.3. Though there were few exceedances, there were indications of specific conductivity elevating during the first flush of rain events at East Branch Rocky River at RM 9.35, Baldwin at RM 0.2 and 0.1, Abram Creek at RMs 3.32, 3.2, 2.9, 1.9, 0.84 and 0.3), West Branch Rocky River at RM 3.5 and Plum Creek at RM 2.5 and 0.45. The elevation of conductivity due to rain events is a signature of runoff from urban development.

SEDIMENT CHEMISTRY

Surficial sediment samples were collected at eleven locations in the Rocky River watershed (4 on the mainstem; one on Abram Creek, three on the East Branch; and three on the West Branch) by the Ohio EPA in 2014 (Figures 25 and 26). Sampling locations were co-located with water chemistry and biological sampling sites. Samples were collected following the *Sediment Sampling Guide and Methodologies, 3rd Edition* with a focus on obtaining a representative sample composed of >30% silt and clay particles (Ohio EPA, 2012c). Individual samples were collected by focusing on depositional areas of fine grain material, mostly silts and clays. Compared to sands and gravels, silt and clays typically represent higher contamination levels. Sampling locations with predominant silt and clay particles were found for all sampling locations, with the exception of Abram creek, where coarser material predominated.

Samples from the Rocky River watershed were analyzed for total organic carbon (TOC), semi-volatile organic constituents [base neutral acid extractables (BNAs), and polycyclic aromatic hydrocarbons (PAHs)], polychlorinated biphenyls (PCBs), and metals including mercury, in certain locations. Specific chemical parameters tested with results are listed in Tables 12 and 13. Sediment data were evaluated using Tier I procedures for aquatic life according to the *Guidance on Evaluating Sediment Contaminant Results* (Ohio EPA, 2010a). Aquatic life use impairment was not observed at any of the sediment sampling locations, therefore a Tier II assessment was not warranted.

Three levels of ecological sediment quality guidelines (SQGs) were applied to the sediment samples. Specific guidelines established in *Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems* (MacDonald *et.al*. 2000) were utilized to assess the sediment. These guidelines define two levels of ecotoxic effects on sediment dwelling organisms. A *Threshold Effect Concentration* (TEC) is a level of sediment chemical quality below which harmful effects are unlikely to be observed and is comparable to background conditions. A *Probable Effect Concentration* (PEC) indicates a level above which harmful effects are likely to be frequently observed. *Ohio Specific Sediment Reference Values (SRVs)* were developed for sediment metals using the same set of statewide ecoregion-based reference sites for aquatic life use biocriteria (Ohio EPA 2003) and were also utilized to assess the samples.

Certain metals exceeded one or more of the SQGs described above. Several heavy metals in the analysis exceeded the SRVs and/or the TEC. Elevated concentrations of heavy metals generally increased with movement downstream for both the East and West Branches of the Rocky River, however levels remained at or near the lower TEC or SRV thresholds. Arsenic levels above the TEC (9.79 mg/kg) was observed at nine of eleven sites but remained below SRV and PEC concentrations. Two observed concentrations of cadmium were above both the TEC and the SRV (1.09 mg/kg and 1.67 mg/kg, at Rocky River mainstem RM 11.65 and West Branch RM 0.39, respectively). Zinc was also elevated above the TEC and SRV threshold at West Branch RM 0.39. None of these analytes exceeded their respective PEC concentrations, therefore the risk of toxicity to aquatic organisms appears to be low. Potential sources of heavy metals include urban runoff, combined or sanitary sewer overflows (CSOs and SSOs), illicit discharges, and legacy pollutants from past activities.

No PCBs were detected in any of the sediment samples. Six PAHs were observed above the reporting limit, five of which are listed as priority pollutants (Appendix A, 40 CFR Part 423). Fluoranthene and Pyrine were detected above TEC levels (0.423 and 0.195 mg/kg, respectively) in 7/11 sites. No SRV, PEC, or TEC values exist for benzofluoranthene and benzoperylene, therefore, USEPA ecological screening levels (USEPA, 2003) served as the benchmark for contamination. All detected samples for benzofluoranthene and benzoperylene were above the Ecological Screening Levels for Region 5 (0.240 and 0.170 mg/kg, respectively). The sites with these detections were restricted to the lower Rocky River, Abram Creek, and a single location on the West Branch. PAHs are found both naturally and anthropocentrically in the environment, however high PAH concentrations are often closely related to local and regional sources. These compounds, as documented by USGS, are found in high concentrations in stormwater runoff, especially from coal-tar-based sealants. Additionally, combustion engines release various PAHs and are ubiquitous in urban areas, as well as near roadsides. Other fuel-based activities that utilize petrochemicals like coal and motor oil contribute to PAHs found in sediment.

Analysis of the surface water data did not reveal elevated metals or organic concentrations in the water column that could be contributing to the concentrations observed in the sediment. In addition, full biological attainment was obtained at every sediment site sampled, with the exception of Abram Creek. Only partial aquatic life use attainment was observed at Abram Creek, due to the fair classification of macroinvertebrate communities. However, due to the high-volume flows and channel characteristics, it is unlikely that sediment deposits remain stable and would have any lasting effect on the biological communities. Based upon the site-specific analysis, the risk of sediment toxicity to aquatic organisms from the Rocky River watershed is low.

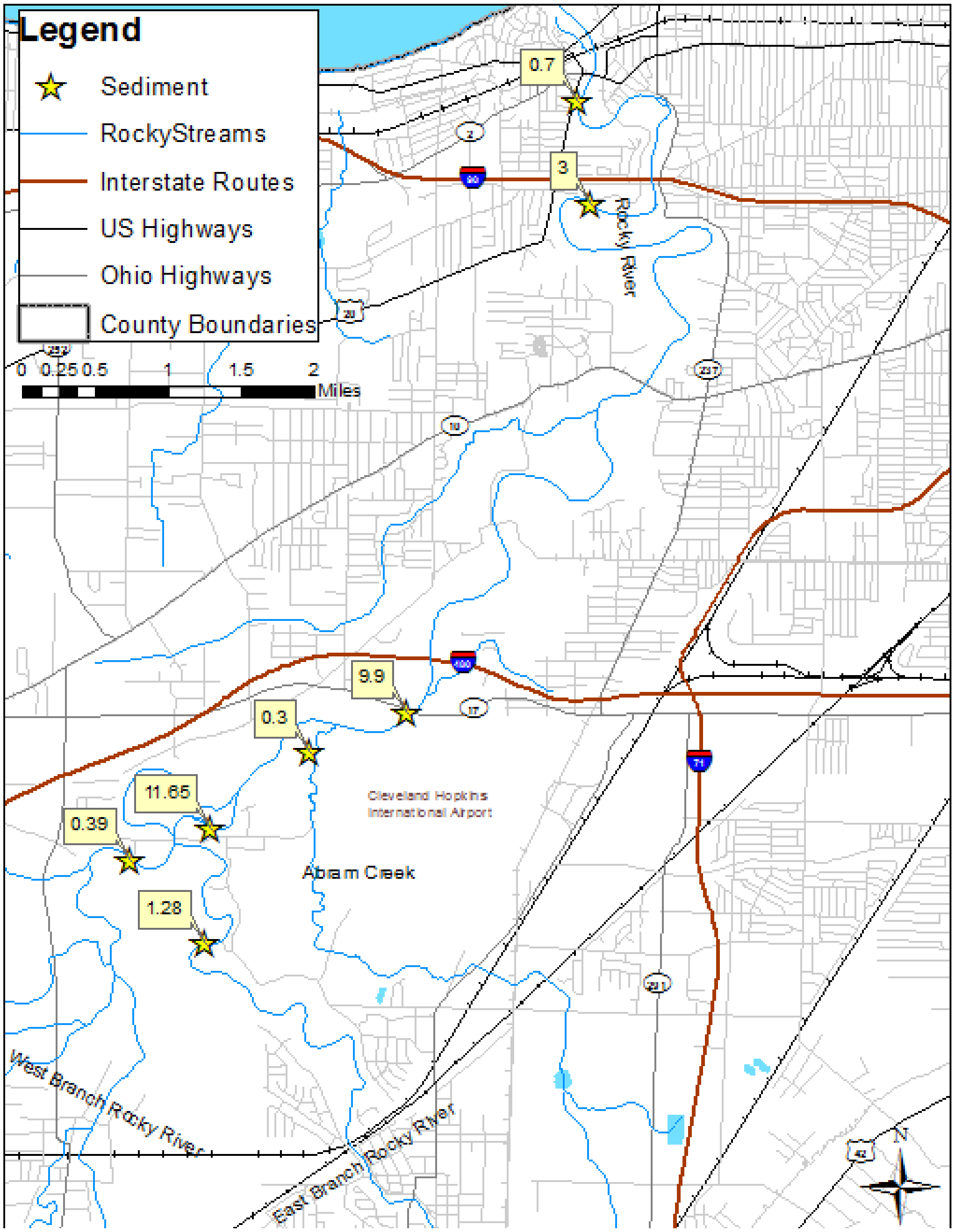


Figure 25. Sediment sampling locations for Rocky River mainstem, Abram Creek, and furthest downstream sites of the East and West branches, 2014.

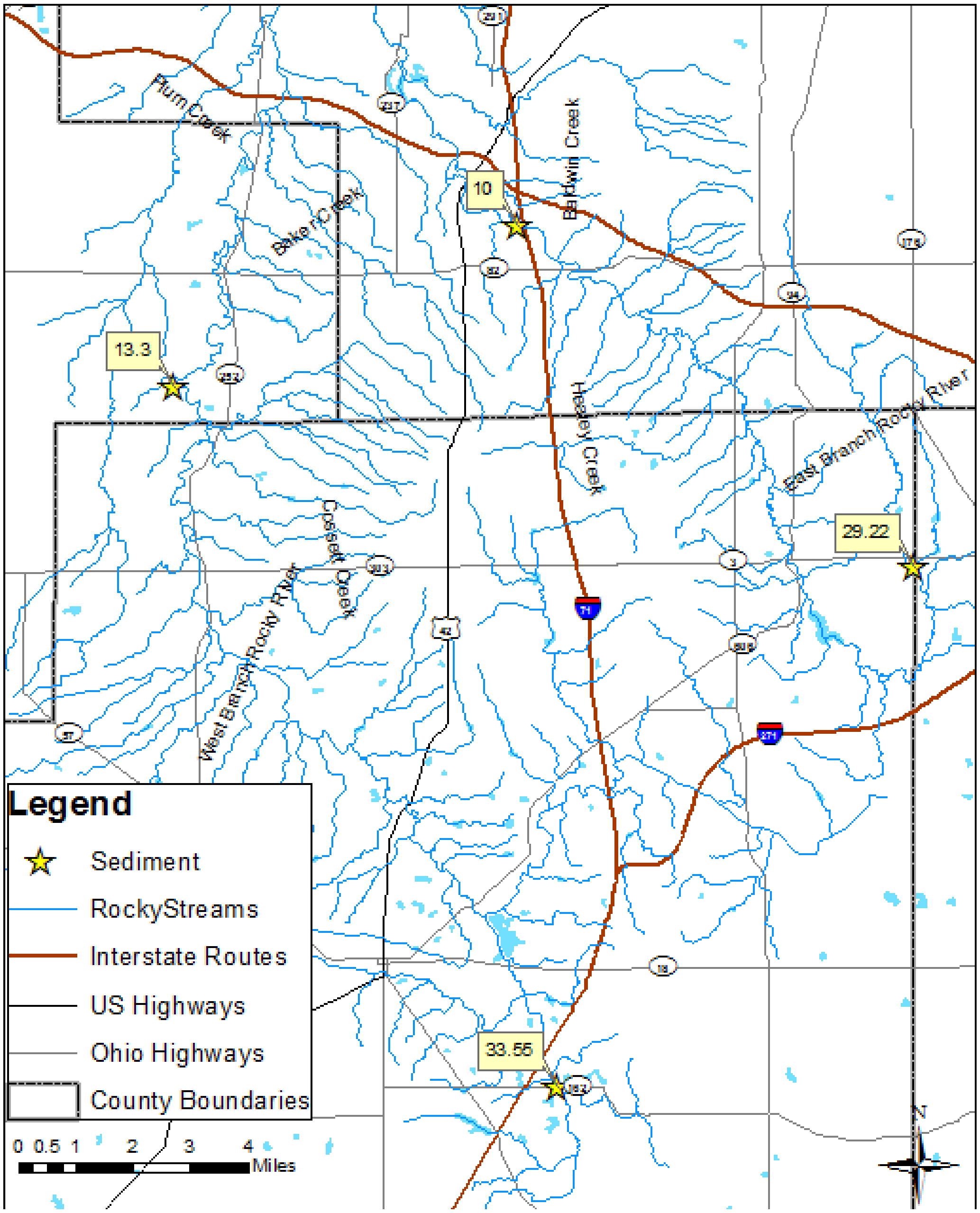


Figure 26. Sediment sampling locations for the East and West branches of the Rocky River, 2014.

Table 12. Analytical results by stream and monitoring station from surficial sediments, Rocky River, Abram Creek, and upper East Branch Rocky River, 2014. Results were evaluated against benchmarks values from the Ohio Sediment Reference Values (SRVs) and consensus-based sediment quality guidelines (MacDonald, et al. 2000). Color shading corresponds to the following: SRVs (red), Probable Effect Concentration (PEC) (yellow), and Threshold Effect Concentration (TEC) (green). Gray shaded values indicate that more than one of the above thresholds was exceeded. Sampling locations are indicated by river mile (RM). Samples with < RL are not detected at or above reporting limit, and *a* - concentration exceeding US EPA Region 5 Ecological Screening Levels.

Parameter	units	SRV	PEC	TEC	Rocky River (RM 11.65)	Rocky River (RM 9.95)	Rocky River (RM 3.0)	Rocky River (RM 0.7)	Abram Creek (RM 0.3)	East Branch (RM 29.22)
% Solids	%	--	--	--	42.1	51.4	63	61.9	75.5	76
Total Organic Carbon	%	--	--	--	2.0	1.8	2.1	2.2	1.7	1.2
Arsenic	mg/kg	25.1	33	9.79	15.9	13.1	13.6	13.2	11.8	7.31
Cadmium	mg/kg	0.8	5	0.99	1.09[1,3]	0.761	0.887	0.78	0.891	0.294
Chromium	mg/kg	53	111	43.4	15.3	13.2	13.7	15.3	14.3	6.76
Copper	mg/kg	33	--	32	22.2	18.2	18.6	21.4	21.2	10.4
Lead	mg/kg	47	128	23	21.7	15.5	22.6	17.8	16.4	10.5
Nickel	mg/kg	61	49	23	29.1	22.8	25.8	24.4	18	12.7
Selenium	mg/kg	2.6	--	--	< 1.87	< 1.44	< 1.14	< 1.35	1.59	< 1.15
Aluminum	mg/kg	53000	--	--	9580	6800	7850	8150	6810	4430
Barium	mg/kg	360	--	--	69.4	52.1	61.4	57.4	39.7	35.9
Calcium	mg/kg	27000	--	--	11300	7650	8790	12500	10200	13700
Iron	mg/kg	51000	--	--	29000	22600	23300	24500	28000	13700
Magnesium	mg/kg	9900	--	--	4670	3330	3860	4640	3730	4040
Manganese	mg/kg	3000	--	--	658	461	317	440	331	435
Potassium	mg/kg	14000	--	--	< 1870	< 1440	1460	1690	1400	< 1150
Strontium	mg/kg	250	--	--	30	< 22	23	30	23	20
Zinc	mg/kg	170	459	121	121	109	133	128	154	46.8
Mercury	mg/kg	0.12	1.06	0.18	-	0.086	0.05	0.072	<0 .03	-
Benzo(b)fluoranthene	mg/kg	--	--	--	.65	.6	0.61[a]	< RL	0.64[a]	< RL
Benzo (g,h,i)perylene	mg/kg	--	--	--	< RL	< RL	1.09[a]	1.13[a]	< RL	< RL
Chrysene	mg/kg	--	1.29	0.166	< RL	< RL	0.68	< RL	0.65	< RL
Fluoranthene	mg/kg	--	2.23	0.423	1.16	0.99	1.42	1.02	1.29	< RL
Phenanthrene	mg/kg	--	1.17	0.204	< RL	< RL	< RL	< RL	0.54	< RL
Pyrene	mg/kg	--	1.52	0.195	0.91	0.76	1.1	0.77	0.99	< RL

Table 13. Analytical results by stream and monitoring station from surficial sediments, East and West Branch Rocky River, 2014. Results were evaluated against benchmarks values from the Ohio Sediment Reference Values (SRVs) and consensus-based sediment quality guidelines (MacDonald, et al. 2000). Color shading corresponds to the following: SRVs (red), Probable Effect Concentration (PEC) (yellow), and Threshold Effect Concentration (TEC) (green). Gray shaded values indicate that more than one of the above thresholds was exceeded. Sampling locations are indicated by river mile (RM). Samples with < RL are not detected at or above reporting limit, and *a* - concentration exceeding US EPA Region 5 Ecological Screening Levels.

Parameter	units	SRV[1]	PEC[2]	TEC[3]	East Branch (RM 10.0)	East Branch (RM 1.28)	West Branch (RM 33.55)	West Branch (RM 13.3)	West Branch (RM 0.39)
% Solids	%	--	--	--	63.4	46.5	66	72.1	59
Total Organic Carbon	%	--	--	--	1.6	2.8	2.1	0.7	1.8
Arsenic	mg/kg	25.1	33	9.79	11.5	13.8	11.3	8.58	18
Cadmium	mg/kg	0.8	5	0.99	0.439	0.872	0.372	0.272	1.67[1,3]
Chromium	mg/kg	53	111	43.4	12.8	13.4	8.61	7.24	15.1
Copper	mg/kg	33	--	32	17.9	19.4	12.9	8.7	24.2
Lead	mg/kg	47	128	23	16.2	18.3	9.73	8.24	22.3
Nickel	mg/kg	61	49	23	20.3	27.6	16.3	11.4	29.8
Selenium	mg/kg	2.6	--	--	< 1.36	< 1.55	< 1.14	< 1.05	< 2.16
Aluminum	mg/kg	53000	--	--	8750	7740	6410	4650	9230
Barium	mg/kg	360	--	--	56.4	56.4	41.8	31	79
Calcium	mg/kg	27000	--	--	8970	10300	20600	4360	14600
Iron	mg/kg	51000	--	--	23700	25500	19600	16400	30400
Magnesium	mg/kg	9900	--	--	4560	4850	5600	2310	4590
Manganese	mg/kg	3000	--	--	538	404	422	238	712
Potassium	mg/kg	14000	--	--	1480	< 1550	< 1140	< 1050	< 2160
Strontium	mg/kg	250	--	--	23	< 23	31	< 16	39
Zinc	mg/kg	170	459	121	84.7	114	55.3	57.1	190[1,3]
Mercury	mg/kg	0.12	1.06	0.18	-	-	-	<0 .021	-
Benzo(b)fluoranthene	mg/kg	--	--	--	< RL	< RL	< RL	< RL	< RL
Benzo (g,h,i)perylene	mg/kg	--	--	--	< RL	< RL	< RL	0.65[a]	< RL
Chrysene	mg/kg	--	1.29	0.166	< RL	< RL	< RL	< RL	< RL
Fluoranthene	mg/kg	--	2.23	0.423	.82	1.13	< RL	< RL	< RL
Phenanthrene	mg/kg	--	1.17	0.204	< RL	< RL	< RL	< RL	< RL
Pyrene	mg/kg	--	1.52	0.195	.64	.88	< RL	< RL	< RL

RECREATION USE

Water quality criteria for determining attainment of recreation uses are established in the Ohio Water Quality Standards (Table 7-13 in OAC 3745-1-07) based upon the presence or absence of bacteria indicators (*Escherichia coli*) in the water column. Collection and evaluation of these data were in accordance with Ohio EPA (2012a, 2012d,and 2013)

Escherichia coli (*E. coli*) bacteria are microorganisms that are present in large numbers in the feces and intestinal tracts of humans and other warm-blooded animals. *E. coli* typically comprises approximately 97 percent of the organisms found in the fecal coliform bacteria of human feces (Dufour, 1977), but there is currently no simple way to differentiate between human and animal sources of coliform bacteria in surface waters, although methodologies for this type of analysis are becoming more practicable. These microorganisms can enter water bodies where there is a direct discharge of human and animal wastes or may enter water bodies along with runoff from soils where these wastes have been deposited.

Pathogenic (disease causing) organisms are typically present in the environment in such small amounts that it is impractical to monitor them directly. Fecal indicator bacteria by themselves, including *E. coli*, are usually not pathogenic. However, some strains of *E. coli* can be pathogenic; capable of causing serious illness. Although not necessarily agents of disease, fecal indicator bacteria such as *E. coli* may indicate the potential presence of pathogenic organisms that enter the environment through the same pathways. When *E. coli* are present in high numbers in a water sample, it invariably means that the water has received fecal matter from one source or another. Swimming or other recreational-based contact with water having a high fecal coliform or *E. coli* count may result in ear, nose, and throat infections, as well as stomach upsets, skin rashes, and diarrhea. Young children, the elderly, and those with depressed immune systems are most susceptible to infection.

The streams of the Rocky River watershed and direct Lake Erie tributaries evaluated in this survey are designated as a Primary Contact Recreation (PCR) use in OAC Rule 3745-1-24. Water bodies with a designated recreational use of PCR "...are waters that, during the recreation season, are suitable for one or more full-body contact recreation activities such as, but not limited to, wading, swimming, boating, water skiing, canoeing, kayaking and SCUBA diving" [OAC 3745-1-07 (B)(4)(b)]. There are three classes of PCR use to reflect differences in the potential frequency and intensity of use. Streams designated PCR Class A typically have identified public access points and support primary contact recreation. Streams designated PCR Class B support, or potentially support, occasional primary contact recreation activities. The Rocky River mainstem is designated Class A PCR waters, as well as the East and West Branches from river miles 12.7 and 16.35 to the mouths, respectively; all other streams assessed during this survey are designated Class B PCR waters. The *E. coli* criteria that apply to PCR Class A and B streams include a geometric mean of 126 and 161 cfu/100 ml, and a maximum value of 298 and 523 cfu/100 ml, respectively. The geometric mean is based on two or more samples and is used as the basis for determining attainment status when more than one sample is collected. Summarized bacteria results are listed in Table 14. Downloadable bacteria results are also available from the Ohio EPA GIS interactive maps at the following link: http://www.epa.ohio.gov/dsw/gis/index.aspx .

Table 14. A summary of E. coli data for locations sampled in the Rocky River watershed, June 10 – October 15, 2014. Recreation use attainment is based on comparing the geometric mean to the Primary Contact Recreation (PCR) Classes A or B geometric mean water quality criterion of 126 or 161 cfu/100 ml (Ohio Administrative Code 3745-1-07). All values are expressed in colony-forming units (cfu) per 100 ml of water. Shaded values exceed the applicable PCR Class A or B geometric mean criterion.

HUC 10 / 12	Location	River Mile	Recreation Use*	No. of Samples	Geometric Mean	Max Value	Recreational Use Attainment	Possible Source(s) of Bacteria
0411000102								
03	ROCKY RIVER AT FORD	11.65	A	16	618	22000	**NON**	Failing HSTS, Urban Stormwater
03	ROCKY RIVER NEAR MASTICK GOLF COURSE	7.60	A	8	914	20000	**NON**	WWTP, CSO, Urban Stormwater
03	ROCKY RIVER UST LAKEWOOD WWTP	1.8	A	8	1154	24000	**NON**	WWTP, CSO, Urban Stormwater
03	ROCKY RIVER AT DETROIT RD	0.7	A	8	1190	27000	**NON**	WWTP, CSO, Urban Stormwater
03	ROCKY RIVER TRIB. ADJ. LITTLE MET GOLF COURSE	0.1	B	5	264	630	**NON**	CSO, Urban Stormwater
03	ABRAM CREEK AT BROOK PARK RD	0.3	B	5	430	11000	**NON**	Urban Stormwater
04	PORTER CREEK AT RT. 6	0.1	B	8	1184	31000	**NON**	Urban Stormwater, aging pipes
04	CAHOON CREEK AT RT. 6	0.08	B	8	873	8700	**NON**	Urban Stormwater, aging pipes
01	EAST BRANCH ROCKY RIVER AT HARTER RD	26.63	B	8	663	6900	**NON**	Failing HSTS
01	EAST BRANCH ROCKY RIVER AT PRIVATE DR	17.5	B	8	205	930	**NON**	Agricultural Runoff, Failing HSTS
02	EAST BRANCH ROCKY RIVER AT BENNETT RD	15.15	B	8	455	3300	**NON**	Failing HSTS, Urban Stormwater
02	EAST BRANCH ROCKY RIVER ADJ. PARKWAY	8.2	A	8	1981	8700	**NON**	Urban Stormwater
02	EAST BRANCH ROCKY RIVER AT SPAFFORD RD	1.28	A	17	645	20000	**NON**	Failing HSTS, Urban Stormwater
02	BALDWIN CREEK AT ROCKY RIVER DR	0.38	B	8	2792	20000	**NON**	WWTP, SSO, Urban Stormwater, Failing HSTS
0411000101								
03	WEST BRANCH ROCKY RIVER ATRIDGEWOOD RD.	32.26	B	16	992	11000	**NON**	Agricultural Runoff, Urban Stormwater
05	WEST BRANCH ROCKY RIVER AT NEFF RD.	21.75	B	14	250	4800	**NON**	Failing HSTS, Agricultural Runoff
06	WEST BRANCH ROCKY RIVER ADJ WEST RIVER RD.	13.3	A	7	234	930	**NON**	WWTP, SSO, Agricultural Runoff

HUC 10 / 12	Location	River Mile	Recreation Use*	No. of Samples	Geometric Mean	Max Value	Recreational Use Attainment	Possible Source(s) of Bacteria
0411000101 (cont.)								
06	WEST BRANCH ROCKY RIVER AT BEND ADJ WEST RIVER RD	7.4	A	2	308	430	**NON**	Agricultural Runoff
08	WEST BRANCH ROCKY RIVER AT LEWIS RD.	0.39	A	15	485	17000	**NON**	Urban Stormwater, Agricultural Runoff
07	PLUM CREEK SENTINEL SITE AT MILL ST.	0.4	B	15	631	4400	**NON**	Urban Stormwater, HSTS
04	MALLETT CREEK NW OF ABBEYVILLE AT NEFF RD.	0.72	B	14	137	12000	FULL	
02	NORTH BRANCH ROCKY RIVER AT GRANGER RD.	0.45	B	13	510	4500	**NON**	Failing HSTS, Agricultural Runoff
01	PLUM CREEK (N. BR. TRIB.) AT SR 3	0.50	B	8	553	2300	**NON**	Failing HSTS, Urban Runoff

* Recreation class may include primary contact recreation classes (A, B or C); bathing waters (BW); or secondary contact recreation (SCR).

† Attainment status is determined based on the seasonal geometric mean. The status cannot be determined at locations where fewer than two samples were collected during the recreation season.

Twenty-three locations in the Rocky River study were sampled for *E. coli* two to seventeen times, from June 10 through October 15, 2014. Evaluation of *E. coli* results revealed that 22 of the 23 locations did not attain the applicable criterion, and thus were in non-attainment of the recreation use. Over half of the impaired sites exceeded the geometric mean criteria by a factor of at least three times. Certain sites had maximum values exceeding criteria by a factor of 10. The only site that did not exceed Ohio's water quality standards, Mallet Creek, lies in the western headwaters portion of the West Branch and has the lowest percentage of urbanized land cover of the sub watersheds sampled for bacteria as well as a primarily agricultural and forested drainage area of 16.1 mi^2.

The causes of non-attainment within the Rocky River are the result of point and nonpoint polluters and may include CSOs, SSOs, urban runoff, wastewater treatment plant (WWTP) discharges, failing home sewage treatment systems (HSTS), and agricultural runoff. Significant bacteria loading from failing HSTS, urban discharge, and CSOs are the probable causes for the extremely elevated maximum values (i.e., 31,000 cfu/100ml). Bacterial contamination in most streams was present during both wet and dry weather events, indicating both nonpoint and point source influence. Some of the potential sources of bacteria (Table 15) are not necessarily confirmed as a source of impairment nor are they exclusive of other sources.

There are ten (10) identified combined sewer overflows (CSOs) within the watershed, located between RM 1.5 and 7.5 in the Rocky River mainstem (Figure 28). Numerous wet weather CSO events were observed during the sampling season. Three of the CSOs, located near RM 1.5, are owned by the City of Lakewood. The City of Lakewood will eliminate two of the identified CSOs within the current NPDES permit period (expiration 2019). The Northeast Ohio Regional Sewer District (NEORSD) monitors seven (7) other CSOs within the Rocky River mainstem, between RM 2.8 and 7.5. NEORSD is presently under a Consent Decree that contains provisions and schedules for implementation of the CSO Long-Term Control Plan for its collection system and treatment plants. The Consent Decree requires completion of construction and full implementation of all remedial and control measures by 2035. Table 16 compares the estimated overflows per year given by NEORSD to eDMR data generated for 2014.

The study area also includes several municipalities and thus is highly affected by urban runoff. High growth areas, like the cities of Medina, Strongsville, and North Royalton are especially susceptible to increased urban runoff during precipitation events. Smaller tributaries like Baldwin Creek, Plum Creek, and the two direct tributaries to Lake Erie, with extensive modification to their riparian zones, are further affected by bacterial inputs from urban runoff.

In addition to CSOs, there are numerous NPDES dischargers regulated along the river. The facilities with major effluents are the wastewater treatment plants (WWTP) located within the watershed. Since the previous water quality studies in 1992 and 1997, nine (9) WWTP have been abandoned (RR TSD, 1999). However, fourteen separate WWTPs remain active. There were several limit violations throughout the sampling season in 2014, with elevated *E. coli* levels discharging into Rocky River mainstem, West Branch, East Branch, and Baldwin Creek (North Olmsted WWTP, Columbia Park Mobile Homes, Camp Hilaka WWTP, and North Royalton WWTP, respectively).

Separate sewer overflows (SSOs) from the sewage collection system of the WWTPS also contribute to the elevated bacteria levels. SSOs are overflows, spills, releases, or diversions of wastewater from a sanitary sewer system. SSOs are prohibited except under emergency conditions and all occurrences must be reported in the eDMR.

Table 15. lists reported SSO events during the 2014 sampling survey and the location of each WWTP. SSOs are system-wide unless otherwise noted.

Facility (POTW)	Stream Name (RM)	SSO Events - 2014
North Olmsted	Rocky River Trib. (mainstem RM 11.2)	21
Lakewood	Rocky River (RM 1.7)	0
Strongsville “C”	Baldwin Creek (RM 2.9)	1
North Royalton “B”	Baldwin Creek Trib. (RM 7.3)	0
Strongsville “B”	East Branch Trib. (RM 11.1)	0
North Royalton “A”	East Branch Trib. (RM 12.9)	1
Medina Co. #300	East Branch (RM 18.28)	0
Medina Co. # 9	East Branch Trib. (RM 22.5)	0
Medina Co. #500	West Branch Trib. (mainstem AT RM14.8)	0

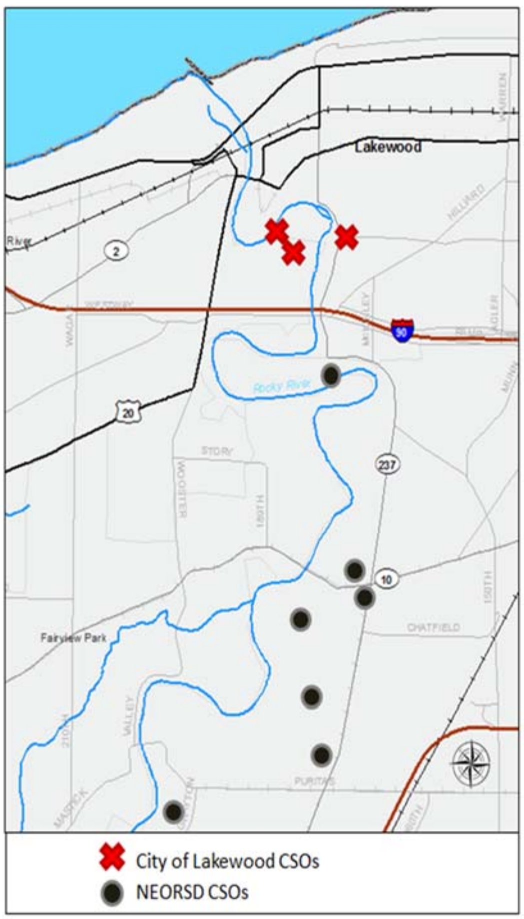


Figure 27. Rocky River combined sewage overflow (CSO) locations owned by the City of Lakewood and Northeast Ohio Regional Sewer District (NEORSD).

Table 16. Estimated Northeast Ohio Regional Sewer District combined sewage overflows (CSO) per year and actual electronic discharge monitoring report (eDMR) data for 2014.

Outfall No.	Estimated Overflow/Year	eDMR overflow/year
062	0	Abandoned 2014
064	4	No discharge reported
065	1	No discharge reported
066	0	No discharge reported
067	6	No discharge reported
068	47	10
238	20	3

Failing home sewage treatment systems (HSTS) play a significant role as a nonpoint source polluter. Previous studies indicate there are estimates of nearly 17,000 HSTS within the watershed. Of these, between 35-60% are either failing or near the end of their 20-year average life span. The townships of Hinckley, Granger, York, Columbia, and Liverpool (affecting both the East and West Branches) are projected to remain unsewered and potential problems with HSTS would thus affect a large portion of the watershed (Rocky River WAP, 2006).

Agricultural areas throughout the watershed and equestrian trails within Metropark property may also be factors in the high bacteria loads found in portions of the watershed. The mid- western and eastern fringes of the watershed remain heavily influenced by agriculture. Equestrian recreational areas are located on upper and lower portions of the East and West branches. There may also be the influence of wildlife, particularly waterfowl, on bacteria loadings, with a prevalence of golf courses and open land to serve as ideal habitats. Geese were observed at nearly every sampling in the mainstem.

Implementation actions to address these impairments are evident throughout the watershed. Steps such as addressing CSOs, as planned for the city of Lakewood and NEORSD, will reduce the volume of untreated discharge going to the river. Other initiatives like transitioning from unsewered to sewered services in larger communities will improve the effect of failing HSTS. Other, less expensive, actions include improving, maintaining, and adding riparian buffers, applying the fertilizer in the appropriate amount and time of year, reducing yard and street waste with green infrastructure.

PHYSICAL HABITAT FOR AQUATIC LIFE

In total, the 2014 biological assessment of the Rocky River study area included 71 sampling stations, deployed to and among 21 waterbodies, yielding a cumulative assessment of approximately 119.6 linear stream miles. This effort included the entire length of the East and West Branches and their associated principal tributaries. Biological monitoring on the Rocky River mainstem was limited to the upper 10.8 miles, from its formation at the confluence of the East and West Branches, down to approximately RM 1.4. The lower limit of the mainstem sampling effort marked the point at which the Rocky River transitions from higher gradient, free-flowing conditions, to lower energy lake-affected conditions. Given the absence of reliable biological measurements for water so described, the lower 1.4 miles were left unassessed against Ohio's biocriteria. In addition to sampling the principal rivers, streams, and tributaries that constitute the Rocky River watershed, two previously unassessed minor Lake Erie tributaries, Potter Creek and Cahoon Creek, were incorporated into the study area.

Discussion of the influence of physical habitat and riparian conditions on ambient biological performance, or potential, of the Rocky River study area will take two basic forms: longitudinal (upstream to downstream, for larger waterbodies) and aggregate assessments. The discussion of tributaries will either be treated in the aggregate, or if sufficiently large, tributaries or subbasins will be broken-out separately for discussion. In addition to the use of a standardized habitat measurement (QHEI), analysis may also consider or describe consequential regional, subregional, and local factors (physiography, geology, drainage practices, land use and soils, etc.).

Previous statewide investigations have found that the QHEI's power to predict ambient biological performance is best viewed and most informative when analyzed in the aggregate (Rankin 1989). In the absence of a profound disruption (e.g., impoundments), ambient biological performance does not necessarily directly parallel measures of macrohabitat quality at the station or small reach scale. Rather, community performance generally reflects aggregate or typical conditions of large contiguous stream segment, with deficient sites or reaches, if present, serving as biological sinks, and higher quality sites or reaches functioning as biological sources. For sufficiently large data sets, the operative variable is the proportion of sink and source habitat.

For rivers, streams, or segments draining areas greater than 20 square miles, mean QHEI values equal to or greater than 60 generally indicate a level of macrohabitat quality adequate to support an assemblage of aquatic organisms consistent with the typical WWH aquatic life use designation. Average or aggregated values at or greater than 75.0 are generally considered adequate to support fully exceptional (EWH) communities (Rankin 1989, Rankin 1995 and Ohio EPA 2006). Values between 55 and 45 indicate that limiting components of physical habitat are present and may exert a negative influence upon ambient biological performance. However, due to the potential for compensatory stream features (e.g., strong ground water influence) or other watershed variables, QHEI scores within this range do not necessarily exclude WWH or even EWH assemblages. Values below 45 indicate a higher probability of habitat derived ALU impairment but should not be viewed as being determinant.

For waters draining less than 20 square miles (headwaters), associated habitat narratives and aquatic life potential, as measured and appraised by the QHEI, vary slightly from those established for larger waters (Ohio EPA 2009). Exceptional conditions are generally indicated by QHEI values greater than 70. Macrohabitat quality ranked as good or otherwise associated with WWH communities, ranges between 70 and 55. QHEI scores between 54 and 43 are considered fair, indicating limiting factors are present and may exert a negative influence upon community performance. Values below 43 demark macrohabitat in the poor to very poor range. The accrual of multiple high influence negative features typical of waters so characterized, indicates significant habitat deficit and an associated higher probability of habitat related ALU impairment, again, in the absence of compensatory features

At the basin scale, QHEI values from the study area ranged between 45.5 and 83.0, with a mean score of 65.8 (±14.96, two SD). Narratively, these statistics describe a range of macrohabitat quality from fair to exceptional, and typical conditions as being good, or otherwise compatible with the basic WWH use designation. A matrix of QHEI scores and macrohabitat features, by station and ecoregion, are presented in Table 17. Distribution and performance of the QHEI by basin, subbasin, or site are presented in Figures 28, 29, and 30.

Of the 68 habitat assessments made within the study area, over 80% (55 sites) yielded QHEI scores equal to or greater than 60, and of these, nearly 25% exceeded 70. Observed QHEI values below 60 were limited to 13 stations (19.1%) distributed among all or segments of eight waterbodies. Disaggregated and screened by drainage benchmarks (headwaters and wading) the distribution of QHEI scores were similar to that described above, namely, a very high proportion of site scores at or greater than the WWH QHEI benchmark. However, compared against headwater and wading benchmarks (55 and 60, respectively) the number of sites and waterbodies identified as potentially habitat limited was reduced by nearly half.

These statistics indicate that a remarkably large proportion of sites offered macrohabitat fully capable of supporting diverse and well-structured assemblages of aquatic organisms consistent with the WWH biocriteria. Most sites contained a full complement of positive channel, substrate, and riparian features typical of the better-quality rivers and streams draining northeast Ohio. The channel configuration of most assessed streams was in a natural or recovered state. Where evidence of previous channel modification was found, the process of natural restoration or recovery of complex channel features, although incomplete, appeared well underway. Well-developed riffle-run complexes were commonly observed as were associated trench and lateral pools. Dominant substrates were typically coarse, comprised of a mix of native stone and glacial alluvium, and were largely unencumbered with extensive deposits of clayey silts.

Given the positive central tendency within the basin, the remainder of the macrohabitat discussion will focus on all or portions of the four streams (seven stations) where subpar QHEI scores were observed: East Branch Rocky River (RMs 10.0, 6.3, and 5.1), West Branch Rocky River (RM 13.3), upper Plum Creek (W. Br. Trib., RM 8.5), Granger Ditch (RM 1.8-0.2).

East Branch Rocky River

Macrohabitat deficits identified on the East Branch, were related to a combination of natural and anthropogenic factors. Limits at RM 10.0 where related to lingering effects of historical channel modification, which has over-simplified much of the reach sampled. The QHEI at RM 6.3 was reflective of monotonous conditions as well; however, these were derived primarily from natural factors, as much of this segment consisted of shallow bedrock glide. Conditions at RM 5.2 were the result of the combined effects of historical channel modification and impoundment. The station was situated between the Baldwin Lake dam and a smaller municipal water in-take weir, the later impounding a portion of the monitoring reach. Again, channel monotony was the primary driver of subpar QHEI. If the conditions identified at these three stations were typical or otherwise representative of the East Branch, the probability of habitat derived use impairment would be higher. However, as these scores departed sharply from the central tendency of the East Branch as a whole (Figure 30), ALU impairment derived solely from deficient habitat did not appear likely, given the overall high-quality conditions that presently describe most of the East Branch Rocky River.

Table 17. A matrix of QHEI scores and important macrohabitat features, Rocky River study area, 2014-15.

Key QHEI Components

Stream RM	QHEI	Gradient (ft./mile)	WWH Atttributes: Not Channelized or Recovered	WWH Atttributes: Boulder/Cobble/Gravel Substrates	WWH Atttributes: Silt Free Substrates	WWH Atttributes: Good/Excellent Development	WWH Atttributes: Moderate/High Sinuosity	WWH Atttributes: Extensive/Moderate Cover	WWH Atttributes: Fast Current/Eddies	WWH Atttributes: Low/Normal Embeddedness	WWH Atttributes: Max Depth>40cm	WWH Atttributes: Low/Normal Riffle Embeddedness	**WWH Attributes**	Modified Attributes, High Influence: Channelized/No Recovery	High Influence: Silt/Muck Substrates	High Influence: No Sinuosity	High Influence: Sparse/No Cover	High Influence: Max Depth <40cm	**High-influence Modified Attributes**	Moderate: Recovering Channel	Moderate: Heavy/Moderate Silt Cover	Moderate: Sand Substrates	Moderate: Hardpan Substrate Origin	Moderate: Fair/Poor Development	Moderate: Low Sinuosity	Moderate: Only 1 or 2 Cover Types	Moderate: Intermittent/Poor Pools	Moderate: No Fast Current	Moderate: High/Moderate Embeddedness	Moderate: High/Mod. Riffle Embeddedness	Moderate: No Riffle	**Mod. Influence Modified Attributes**	MWH H.I.+1/WWH+1 Ratio	MWH M.I./WWH Ratio
Rocky River 13-001-000																																			
11.65	68.3	7.25	X							X	X	X	4				X		1		X			X	X			X				4	0.40	1.20
11.1	60.5	7.25	X							X	X	X	4			X	X		2					X	X		X	X				4	0.60	1.20
9.95	64.8	8.55	X							X	X	X	4			X	X		2					X				X				2	0.60	0.80
9.0	81.0	6.13	X	X		X	X	X	X	X	X	X	9						0		X				X				X			3	0.10	0.50
7.6	71.5	6.13	X	X		X		X		X	X	X	7				X		1	X				X	X			X				4	0.38	0.75
5.8	71.8	7.63	X	X						X	X	X	5				X		1					X	X			X				3	0.33	0.83
3.0	83.0	8.85	X	X		X	X	X	X		X	X	8						0		X				X				X			3	0.11	0.56
1.8	72.5	4.54	X	X		X		X	X		X	X	7				X		1		X			X	X				X			4	0.25	0.75
1.39	67.0	4.54	X	X		X					X		4	X			X		2		X				X			X	X	X		5	0.60	1.40
Abrams Creek 13-002-000																																			
3.15	62.0	19.23		X							X		2				X		1	X	X			X	X			X	X	X		7	1.00	3.00
1.9	61.8	40.00		X				X			X	X	4				X		1	X	X			X	X			X	X		X	7	0.60	1.80
0.84	62.0	111.11	X	X		X	X		X	X	X	X	8				X		1								X			X		2	0.22	0.33
0.3	59.0	41.60	X	X						X	X	X	5				X		1					X	X		X	X				4	0.33	0.83
Porters Creek 13-003-000																																			
0.1	68.3	20.00	X	X		X	X	X		X	X	X	8				X		1					X			X	X				3	0.22	0.44
Cahoon Creek 13-004-000																																			
0.08	58.3	71.42	X		X	X	X		X	X	X	X	8				X		1					X			X					2	0.22	0.33
East Branch Rocky River 13-100-000																																			
30.8	71.0	64.00	X	X		X	X		X	X	X		7				X		1		X									X		2	0.25	0.50
29.22	80.5	26.32	X	X		X	X	X	X	X	X	X	9						0		X											1	0.10	0.30
26.63	64.8	19.23	X	X				X			X	X	5				X		1		X			X	X		X	X	X	X		7	0.33	1.50
21.98	78.5	12.19	X	X		X	X	X	X		X	X	8						0		X								X			2	0.11	0.44
18.3	69.0	5.71	X	X		X	X	X	X		X	X	8				X		1		X			X					X	X		4	0.22	0.67
17.5	65.3	5.71				X	X	X			X		4				X		1	X	X			X				X	X	X		6	0.60	1.60
15.15	63.8	4.74		X				X			X		3				X		1	X	X			X	X			X	X	X		7	0.75	2.25
11.57	76.5	32.26	X	X		X		X	X		X		6						0		X				X				X	X		4	0.14	0.71
10.0	53.5	6.33		X						X	X	X	4			X	X		2	X	X			X	X		X	X	X	X		8	0.80	1.80

Table 17. continued.

Key QHEI Components

			WWH Atttributes											Modified: *High Influence*						Modified: *Moderate*														
Stream RM	QHEI	Gradient (ft./mile)	Not Channelized or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Development	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low/Normal Embeddedness	Max Depth>40cm	Low/Normal Riffle Embeddedness	**WWH Attributes**	Channelized/No Recovery	Silt/Muck Substrates	No Sinuosity	Sparse/No Cover	Max Depth <40cm	**High-influence Modified Attributes**	Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrates	Hardpan Substrate Origin	Fair/Poor Development	Low Sinuosity	Only 1 or 2 Cover Types	Intermittent/Poor Pools	No Fast Current	High/Moderate Embeddedness	High/Mod. Riffle Embeddedness	No Riffle	**Mod. Influence Modified Attributes**	MWH H.I.+1/WWH+1 Ratio	MWH M.I./WWH Ratio
East Branch Rocky River 13-100-000																																		
9.35	71.3	6.17	X			X		X			X	X	5						0		X				X			X	X			4	0.17	1.00
8.2	69.0	7.58	X	X				X	X		X	X	6				X		1		X			X	X		X		X			5	0.29	0.86
7.35	64.0.	7.58	X						X		X	X	4			X	X		2		X			X	X		X		X	X		6	0.60	1.40
6.38	55.5	4.29	X								X	X	3				X		1		X			X	X		X	X	X			6	0.50	1.75
5.1	51.5	4.31									X		1	X		X	X		3	X	X			X				X	X		X	6	2.00	4.00
3.06	68.0	43.48	X						X	X	X	X	5				X		1					X	X							2	0.33	0.67
1.28	70.0	8.47	X							X	X	X	4				X		1		X			X	X			X				4	0.40	1.00
E. Br. Tributary at RM 25.1 13-100-011																																		
0.1	69.5	100.00	X	X		X	X	X	X		X		7						0		X								X	X		3	0.13	0.63
E. Br. Tributary at RM 12.1 13-100-015																																		
0.1	78.0	50.00	X	X		X	X	X	X	X	X	X	9						0													0	0.10	0.20
Baldwin Creek 13-101-000																																		
3.53	56.8	58.82		X				X		X	X	X	5				X		1	X				X	X			X				4	0.50	1.00
2.61	60.5	6.25						X		X	X	X	4				X		1	X	X			X	X			X	X			6	0.60	1.60
1.13	61.3	7.52		X		X		X			X	X	5				X		1	X	X			X	X			X	X		X	7	0.50	1.33
0.38	69.5	7.52		X		X		X			X		4				X		1	X				X	X			X	X	X		6	0.60	1.40
0.1	59.3	7.52		X					X		X		3				X		1	X				X	X	X	X		X	X		7	0.75	2.00
Healy Creek 13-104-000																																		
0.7	68.3	35.71	X	X				X		X	X	X	6				X		1					X	X		X	X				4	0.29	0.71
West Branch Rocky River 13-200-000																																		
33.5	69.0	13.33	X	X		X	X	X		X	X	X	8				X		1		X			X				X	X	X		5	0.22	0.67
32.26	73.5	13.70	X	X		X	X	X		X	X	X	8						0		X							X	X	X		4	0.11	0.67
27.3	72.3	3.48	X	X		X		X	X	X	X	X	8				X		1		X				X				X			3	0.22	0.44
21.75	61.5	15.15	X		X					X	X	X	5				X		1					X	X		X	X				4	0.33	0.83
16.35	61.8	8.77	X								X		2				X		1		X			X	X			X	X	X		6	0.67	2.33
13.3	56.5	2.65	X				X	X			X	X	5				X		1		X			X	X			X	X			5	0.33	1.17
7.4	61.3	2.05	X			X			X		X		4				X		1		X				X		X		X	X		5	0.40	1.20
4.9	63.5	8.77	X						X	X	X	X	5				X		1		X			X	X		X		X			5	0.33	1.00
3.5	69.8	14.49	X			X	X		X	X	X	X	7				X		1					X								4	0.25	0.63
2.1	64.3	16.67	X			X				X	X	X	5				X		1					X	X			X				3	0.33	0.67
0.39	64.5	11.63	X						X	X	X	X	5				X		1					X	X							2	0.33	0.50

Table 17. continued.

Key QHEI Components

			WWH Atttributes											Modified Attributes																				
														High Influences						*Moderate*														
Stream RM	QHEI	Gradient (ft./mile)	Not Channelized or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Development	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low/Normal Embeddedness	Max Depth>40cm	Low/Normal Riffle Embeddedness	**WWH Attributes**	Channelized/No Recovery	Silt/Muck Substrates	No Sinuosity	Sparse/No Cover	Max Depth <40cm	**High-influence Modified Attributes**	Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrates	Hardpan Substrate Origin	Fair/Poor Development	Low Sinuosity	Only 1 or 2 Cover Types	Intermittent/Poor Pools	No Fast Current	High/Moderate Embeddedness	High/Mod. Riffle Embeddedness	No Riffle	**Mod. Influence Modified Attributes**	MWH H.I.+1/WWH+1 Ratio	MWH M.I./WWH Ratio
Blodgett Creek 13-200-003																																		
1.61	58.8	16.67		X				X			X	X	4		X		X		2	X	X			X	X			X	X	X		7	0.80	1.60
0.17	58.0	39.53	X							X	X	X	4				X		1	X				X	X		X	X				5	0.60	1.20
Champion Creek 13-200-009																																		
0.01	69.8	17.24	X	X	X	X	X	X	X	X	X	X	10				X		1	X				X	X							3	0.27	0.46
Broadway Creek 13-200-013																																		
0.28	67.3	35.71	X	X		X	X	X		X	X	X	8				X		1		X			X			X	X	X			5	0.22	0.67
Plum Creek 13-201-000																																		
8.5	51.5	9.26	X										1				X	X	2	X	X			X	X			X	X	X		7	2.00	4.50
4.92	65.0	6.17		X							X		2				X		1	X	X			X	X			X	X	X		7	1.00	3.00
2.5	69.8	12.05	X	X			X	X			X		5						0		X			X	X		X	X	X	X		7	0.17	1.33
0.25	69.5	20.41	X	X	X			X		X	X	X	7						0					X	X		X	X				4	0.13	0.63
Baker Creek 13-202-000																																		
0.3	63.3	37.03	X	X			X			X	X	X	6				X		1					X			X	X				3	0.29	0.57
Cossett Creek 13-203-000																																		
0.2	63.3	23.33	X	X			X			X	X	X	6				X		1		X			X	X		X	X	X			6	0.29	1.00
Mallet Creek 13-204-000																																		
3.5	57.0	4.74	X				X			X	X	X	5				X		1		X			X			X	X				4	0.33	0.83
0.7	62.8	37.04	X				X	X		X	X	X	6				X		1					X				X				2	0.29	0.43
North Branch Rocky River 13-205-000																																		
5.52	69.8	12.05	X	X			X	X		X	X	X	7				X		1		X			X				X	X			4	0.25	0.75
0.45	67.5	18.52		X			X	X		X	X	X	6				X		1	X	X			X	X			X	X			6	0.43	1.00
Plum Creek 13-206-000																																		
3.02	69.5	14.71	X	X			X	X		X	X	X	7				X		1					X				X				2	0.25	0.50
2.5	70.8	10.00	X	X		X	X	X			X	X	7				X		1		X			X				X	X			4	0.25	0.75
0.5	73.8	20.00	X	X			X	X		X	X	X	7				X		1	X				X				X				3	0.38	0.63

Table 17. continued.

Stream RM	QHEI	Gradient (ft./mile)	WWH Atttributes: Not Channelized or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Development	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low/Normal Embeddedness	Max Depth>40cm	Low/Normal Riffle Embeddedness	WWH Attributes	Modified – High Influence: Channelized/No Recovery	Silt/Muck Substrates	No Sinuosity	Sparse/No Cover	Max Depth <40cm	High-influence Modified Attributes	Modified – Moderate: Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrates	Hardpan Substrate Origin	Fair/Poor Development	Low Sinuosity	Only 1 or 2 Cover Types	Intermittent/Poor Pools	No Fast Current	High/Moderate Embeddedness	High/Mod. Riffle Embeddedness	No Riffle	Mod. Influence Modified Attributes	MWH H.I.+1/WWH+1 Ratio	MWH M.I./WWH Ratio
Remson Creek 13-207-000																																		
0.6	70.8	6.33	X	X						X	X	X	5				X		1	X				X	X		X	X				5	0.50	1.00
Granger Creek 13-208-000																																		
1.75	45.5	7.46						X			X		2		X		X		2	X	X			X	X			X	X		X	7	1.33	3.00
0.2	49.3	6.33					X				X		2				X		1	X	X			X	X			X	X		X	7	1.00	3.00

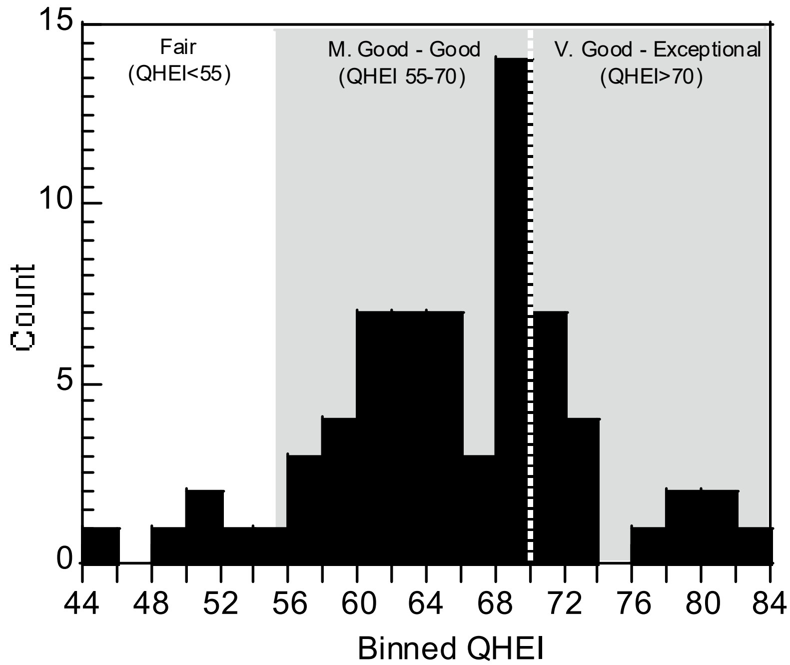


Figure 28. Frequency histogram of binned site QHEI scores, Rocky River study area, 2014. Figure annotations describe macrohabitat narratives based upon QHEI ranges. Note high frequency of site scores equal to or greater than the WWH minimum.

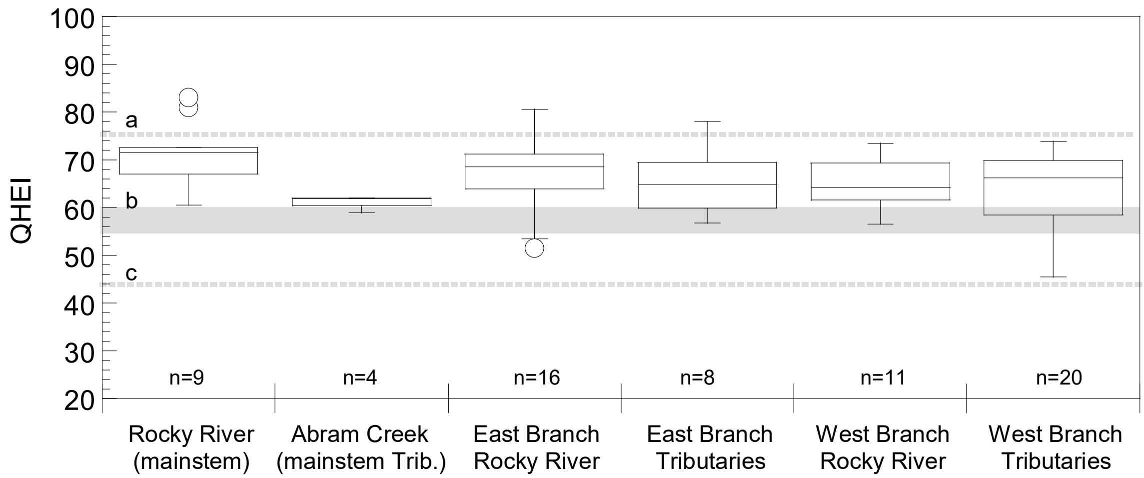


Figure 29. Performance of the QHEI by subbasin and affiliated tributaries, Rocky River watershed, 2014. Dashed lines a and c define generic exceptional and deficient habitat benchmarks. Shaded area b defines WWH benchmark for headwaters and wading streams, 55 and 60, respectively.

<u>West Branch Rocky River</u>

Departure from the wading WWH benchmark on the West Branch at RM 13.3 was modest and wholly natural in origin. As is common within northeast Ohio, the prevalence of bedrock substrates at this station can give rise to relatively large segments of shallow and monotonous glide habitat. As observed on the East Brach, conditions here departed from the high-quality conditions that typified most of the West Branch, thus impacts or ALU impairment derived solely from deficient habitat did not appear likely.

<u>Plum Creek and Granger Ditch</u>

Both upper Plum Creek and Granger Ditch labor under the effects of historical channel modification. Both streams appeared rheopalustrine in nature and were likely ditched at some point in the past to lower the local water table. Due to low functional gradient, channel incision, and an abundance of fine sediment, these streams appeared to be among most depositional tributaries within the Rocky River study area. Numerous observations by field staff provided good evidence of past wetland conditions, including the presence of selected plant species found in and adjacent to these streams [e.g., spatterdock (*Nuphar sp.*), button bush (*Cephalothins occidentals*), pondweed (*Potamogeton sp.*)] and relic palustrine fishes (e.g., mud minnow and brook stickleback). QHEI scores from these streams, particularly those from Granger Ditch, remained within the low-fair range and constituted the lowest observed from the entire Rocky River basin. In the absence of compensatory features, macrohabitat quality through upper Plum Creek and the entire length of Granger Ditch may serve to limit ambient biological performance.

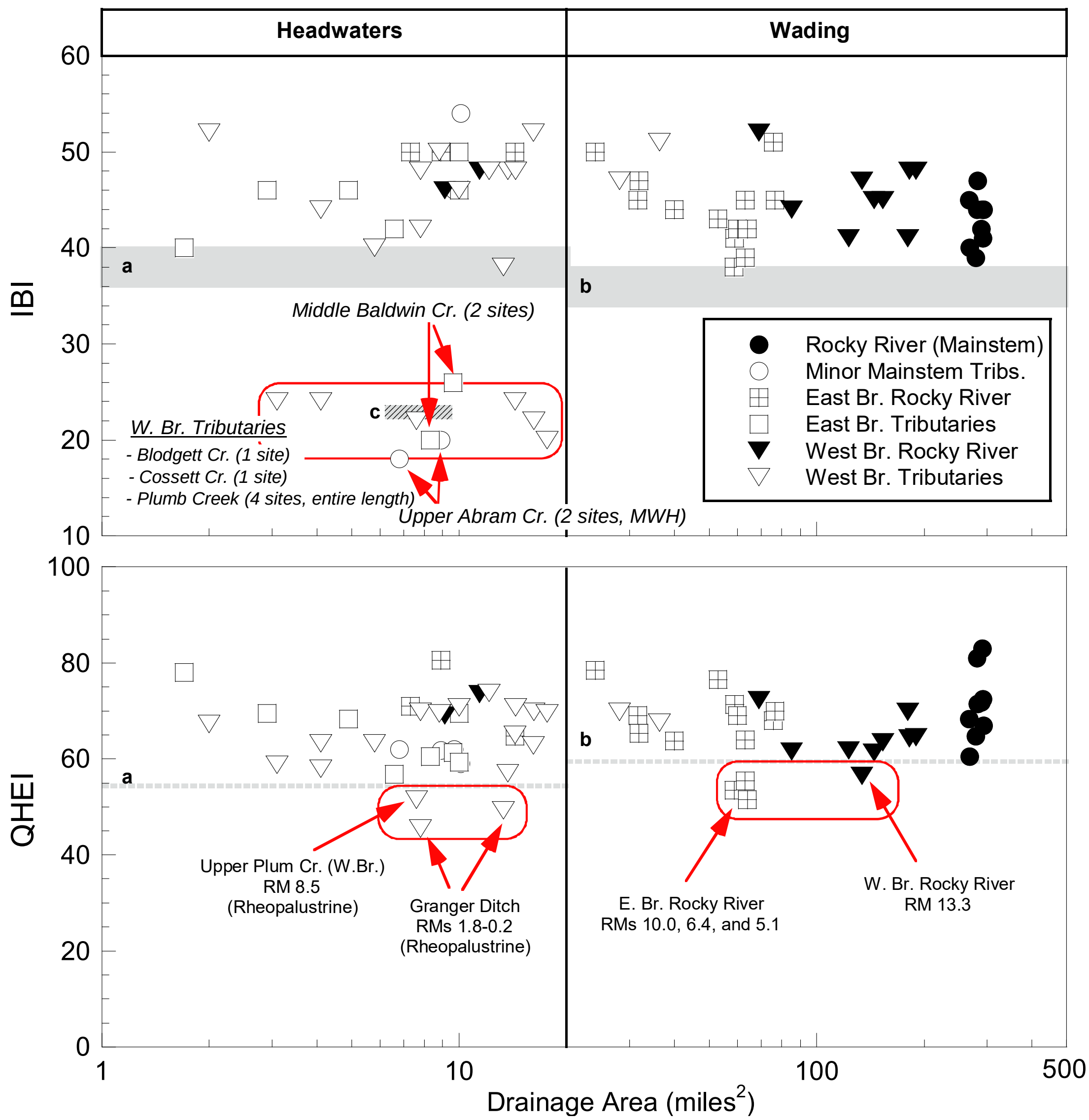


Figure 30. Distributions of Index of Biotic Integrity (IBI) and Qualitative Habitat Evaluation Index (QHEI) scores from the Rocky River study area, by stream size (drainage area). Vertical lines demark headwaters (≤20 miles^2) and wading (>20 miles^2) sites. Shaded areas a and b identify prescribed EOLP WWH biocriteria for headwater and wading sites, respectively. Hashed line c identifies the headwater MWH criterion, applied to upper Abram Creek. Dashed lines a and b with QHEI plot identify headwater and wading QHEI benchmarks, respectively.

Cahoon and Porter Creek

Cahoon Creek and Porter Creek were each evaluated at a single sampling location at RMs 0.2 and 0.4, respectively. Located just west of the Rocky River basin, these contiguous small Lake Erie tributaries drain the well-developed suburban and urban landscapes of Bay Village and West Lake

As measure by the QHEI, Cahoon and Porter Creek both were found to contain a suite of substrate, channel, and riparian features, consistent with headwater WWH benchmark (QHEI ≥ 55). Both streams possessed adequate pool habitat (depth and extent), good-fair channel development, coarse substrates, and were either unmodified or found to have recovered from previous channel modification. Together, these positive characteristics yielded low MWH/WWH attribute ratios.

Cahoon Creek was naturally deeply incised, losing considerable elevation as it courses downstream to Lake Erie. In form and function, the reach sampled consisted of series of shallow bedrock riffles, runs, and glides, with deep plunge pools associated with larger escarpments. Porter Creek's descent to Lake Erie was more gradual and less energetic. Substrates here were typically coarse, composed of native gravel and cobble. Although present, bedrock was not dominant, with exposures limited to areas of bed degradation (scoured pools and related features). As such, the streambed was largely composed of alluvium, deposited atop bedrock, forming numerous riffle-run sequences.

Despite adequate habitat scores, it is important to note that the QHEI is not particularly sensitive to many of the various structural and hydrological limitations attending well-drained urban-suburban areas. Limited water storage within these landscapes gives rise to flashy, feast or famine, hydrology, characterized by short duration, but exaggerated peak flows, and diminished discharge during the drier months. Diffuse pollution loads entrained by storm water may exert additional stress.

Fish Community Assessment

A total of 82,942 fish comprising 55 species and eight hybrids was collected from the Rocky River study area between July and September 2014. The survey effort included 71 monitoring stations distributed among 21 waterbodies, evaluating 119.6 cumulative linear stream miles. In addition to sampling the principal rivers, streams, and tributaries that constitute the Rocky River watershed, two previously unassessed minor Lake Erie tributaries, Potter Creek and Cahoon Creek, were incorporated into the study area. Raw catch summaries by station, index scores, index metrics, and related data may be found in Appendix Tables C and D.

Fish species classified as rare, threatened, endangered, or otherwise recognized for special conservation status by the Ohio DNR (2017) included bigmouth shiner. A post glacial xerothermic relic, distribution of this species is circumscribed within Ohio, limited to three Lake Erie drainages: lower Cuyahoga River, Black River, and the Rocky River (Trautman 1981). In total, 738 individuals (905.5/0.3km) were collected in 2014 from 18 stations, on four named streams (Rocky River mainstem, Abram Creek, East Branch Rocky River, and Baldwin Creek). Cumulative abundance by subbasin appeared generally lower than peak observations from 1980-90s, but as documented in the past, the upper East Branch and its principal tributary, Baldwin Creek, continue to support the strongest populations. Given the paucity of records from larger waters, this species appeared to show a marked preference for streams draining less than 80 miles^2. These and other data regarding the distribution of the bigmouth shiner in the Rocky River system are summarized in Figure 31. Other intolerant, rare, declining or otherwise ecologically important species found within the study area were, river chub, mimic shiner, rosyface shiner, stonecat madtom, and reside dace (Ohio EPA 1987b, 2015a, and 1996). Although not presently imperiled, species so defined have experienced a significant reduction in their historical distributions statewide or have been found to be sensitive to a wide range of environmental disturbances, or both, and as such, are generally associated with good water quality and intact riverine habitats in Ohio.

Round goby, an invasive exotic species, were first collected from the upper Great Lakes in 1990, with the first Ohio specimens taken from Lake Erie in 1994 (Fuller et al. 1999). Subsequently, this species has experienced a population explosion and is now commonly taken throughout much of Lake Erie and from the lower reaches of most tributaries. Within the Rocky River basin, Ohio EPA first reported this species from the lower mainstem in 1997, and since that time it has expanded deeper into the watershed. The 2014 survey captured 4155 individuals (6257/0.3km) at 24 locations on three waterbodies. Specifically, round goby were taken from the entire length of the Rocky River mainstem, nearly every station on the East Branch, and a single location on the lower West Branch, with peak abundance observed on the East Branch. The high frequency and density of round goby on the East Branch was surprising, given that three low-head dams are located on lower ten miles. These structures served as effective barriers to upstream invasion from the Rocky River mainstem. However, the first collections of round goby on the East Branch were not made at the mouth, as would be expected, but instead from a monitoring site 22 miles upstream, immediately downstream from Hinkley Reservoir in 2002. Despite the prohibition against possession and transport of round goby, it would appear they were inadvertently introduced into the upper East Branch, most likely as a bait bucket release by fisherman. From its putative introduction to the headwaters, the round goby's invasion of the East Branch has proceeded rapidly downstream, circumventing the barriers to upstream movement posed by multiple low-head dams, and is now firmly established as a non-trivial component of the resident fish community. These observations and other relevant data are summarized in Figure 32.

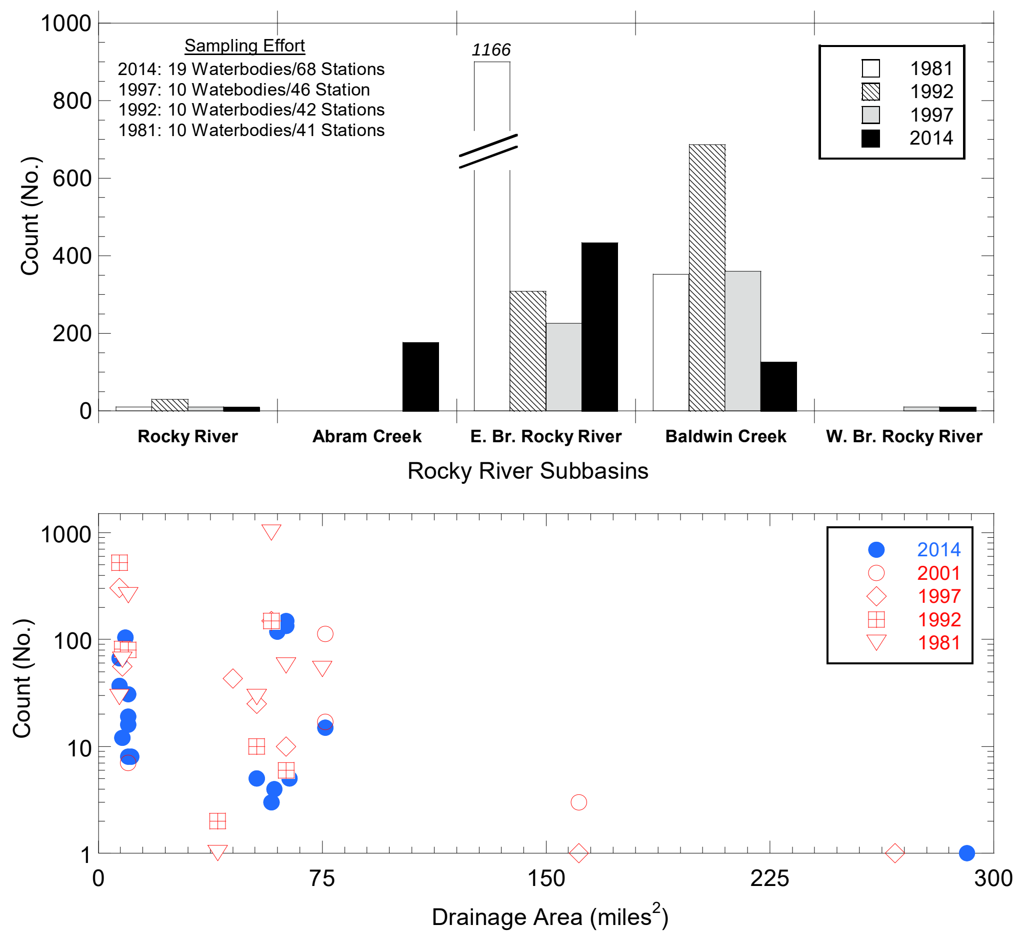


Figure 31. Frequency by subbasin and distribution of the state threatened bigmouth shiner (Notropis dorsalis), Rocky River watershed, 1981-2014.

Based upon size, as measured by drainage area, the waters that together comprised the Rocky River study area may be divided into four standardized stream classes: primary headwaters (<5 miles^2), headwaters (5<20 miles^2), wadable streams (20<200 miles^2), and small rivers (200-1000 miles^2). In minimally disturbed settings, species composition, structure and functional organization of lotic warm-water fish communities often exhibit strong longitudinal zonation. From headwaters to larger lowland drainages, assemblages are regulated by a range of natural environmental factors [e.g., drainage area, gradient, temperature, discharge, local and regional physiography, valley type, productivity (use, transport, and storage of organic carbon)]. Together, these factors are responsible for, among other community characteristics, successive species replacement and net accrual of taxa with increasing drainage. Deviation from this expected pattern or ecological continuum may be indicative of chronic stress, physical disturbance, or consequential shifts in productivity.

Primary headwaters were found to support 22 species. In term of relative abundance, 22% of the assemblage was classified as environmentally sensitive, and were represented by four species: N. hog sucker, smallmouth bass, greenside darter, and rainbow Darter. Tolerant and generalist taxa accounted for 48%. Numerically dominant species were, creek chub (25%), central stoneroller (20%), greenside darter (11%), and bluntnose minnow/rainbow darter (9%).

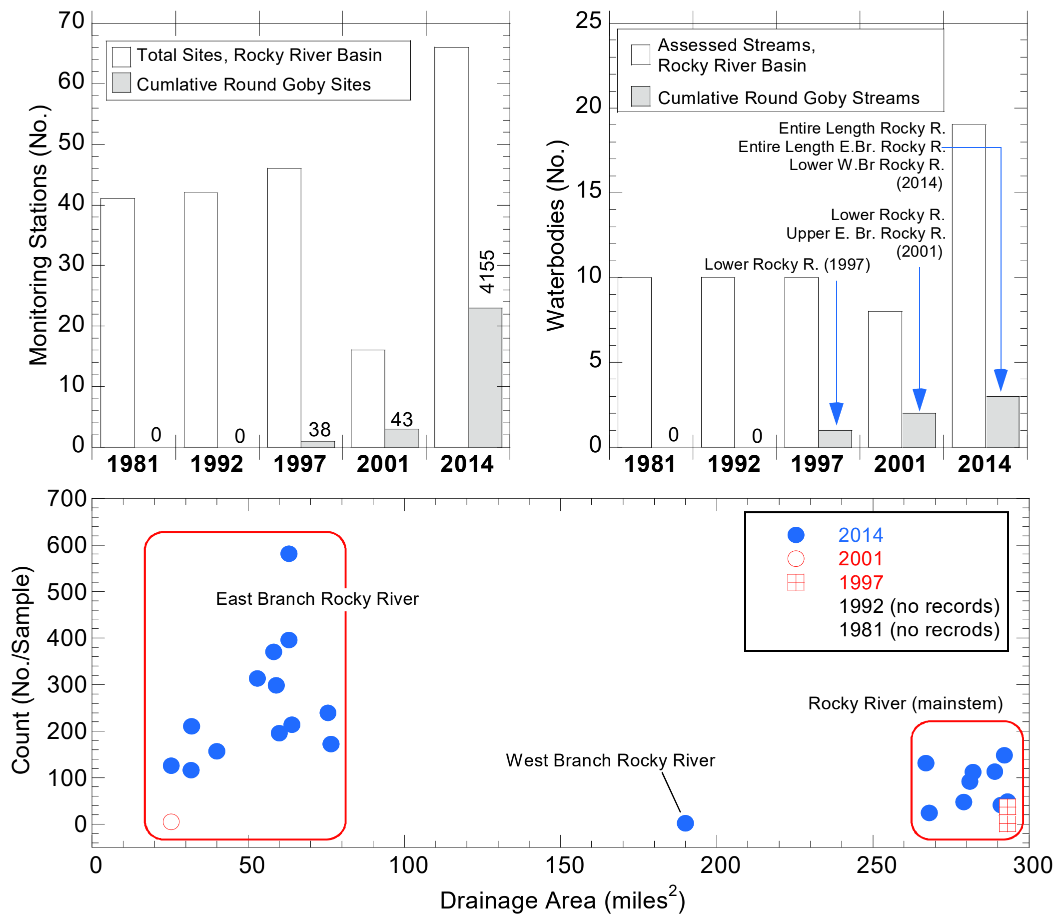


Figure 32. Sampling effort, frequency, and distribution of the exotic and invasive round goby (Neogobiius melanostomus), Rocky River watershed, 1981-2014. Sampling effort and goby frequency (top left figure): cumulative number of round goby taken per field year are placed atop the shaded bars.

Rocky River headwaters supported a total 44 species, eleven of which were classified as being environmentally sensitive. In terms of numerical abundance, these accounted for 23% of the assemblage, and included several rare or highly intolerant fish: river chub, rosyface shiner, reside dace, bigmouth shiner, and mimic shiner. Thirty-six percent of fish taken within the headwaters were classified as tolerant. Dominant species included, creek chub/central stoneroller (15-16%), striped shiner/rainbow darter/bluntnose minnow (6-7%), and sand shiner/johnny darter/bigmouth shiner (3-5%). Interesting to note the high degree of numerical evenness within the headwaters, thus no simple suite of dominant taxa.

Collectively, 43 species were taken from wading stations. Of these, 11 taxa were classified as sensitive and together accounted for 31% of the assemblage. As observed in the headwaters, rare and highly intolerant species were well represented within the "sensitive" group (e.g., river chub, rosyface shiner, bigmouth shiner, and mimic shiner). Thirty-four percent of all fish taken from wading sites were tolerant and generalist taxa. Dominant species were, round goby/central stoneroller (12%), bluntnose minnow (9%), and striped shiner/common shiner/greenside darter/sand shiner (5-6%). The rank of round goby, an exotic and invasive species, is noteworthy. Round goby were first taken by Ohio EPA from the Rocky River system in 1997, near the mouth of the mainstem. Seventeen years later, this species now occupies a dominant position throughout much of the watershed and is presently among the most common fish at many wading sites.

Forty-two species were taken from the largest waters within the Rocky River basin (small rivers). Remarkably, 40% of the fish assemblage was classified as environmentally sensitive, including five rare or highly intolerant species: black redhorse, rosyface shiner, bigmouth shiner, mimic shiner, and stonecat madtom. The proportion of tolerant and generalist taxa accounted for only 8%, less than a quarter of what was observed within all preceding size classes. Numerically dominant species were, emerald shiner (17%), smallmouth bass (10%), striped shiner (8%), round goby (7%), and sand shiner/greenside darter/central stoneroller (~6%).

As measured by the IBI, and MIwb where applicable, community performance and accompanying narratives within the Rocky River watershed ranged from *exceptional* (IBI=55 and MIwb=9.9) to *poor-marginally good* (IBI=18 and MIwb=7.4), with typical conditions characterized as *good-exceptional* (IBI=42.0 and MIwb=8.9, ±two SDs, 18.35 IBI units and 1.203 MIwb units, respectively). Summarized index scores and descriptive community statistics, by station, are presented in Table 18.

Several basic observations may be drawn from these rudimentary statistics. Average or typical conditions within the basin were consistent with the prescribe WWH biocriteria, but the range and SD of the IBI was quite large. By comparison, the MIwb showed lower variation and all scores either met or exceeded the WWH criterion. An examination of the distribution of these biometrics offered additional insights (Figure 34). Binned site IBI scores revealed discontinuous, bimodal distribution, identifying two distinct groupings. The first and largest group was composed exclusively of sites that yielded IBI scores at or greater than the WWH criteria. The second grouping consisted of sites with associated IBI scores that strongly diverged from the WWH criteria, narratively described as poor. Distribution of the MIwb scores was unimodal, showed less variation and, though skewed to higher values, was distributed normally or nearly so. Binned by subbasin and scaled to drainage area, the distribution of IBI scores identified the divergent sites as a subset of headwaters, clearly separated from the central tendency of the of the basin (Figure 30). Waters so described included all or portions of Abram Creek, Baldwin Run, Blodgett Creek, Cossett Creek, and Plum Creek (direct West Branch tributary).

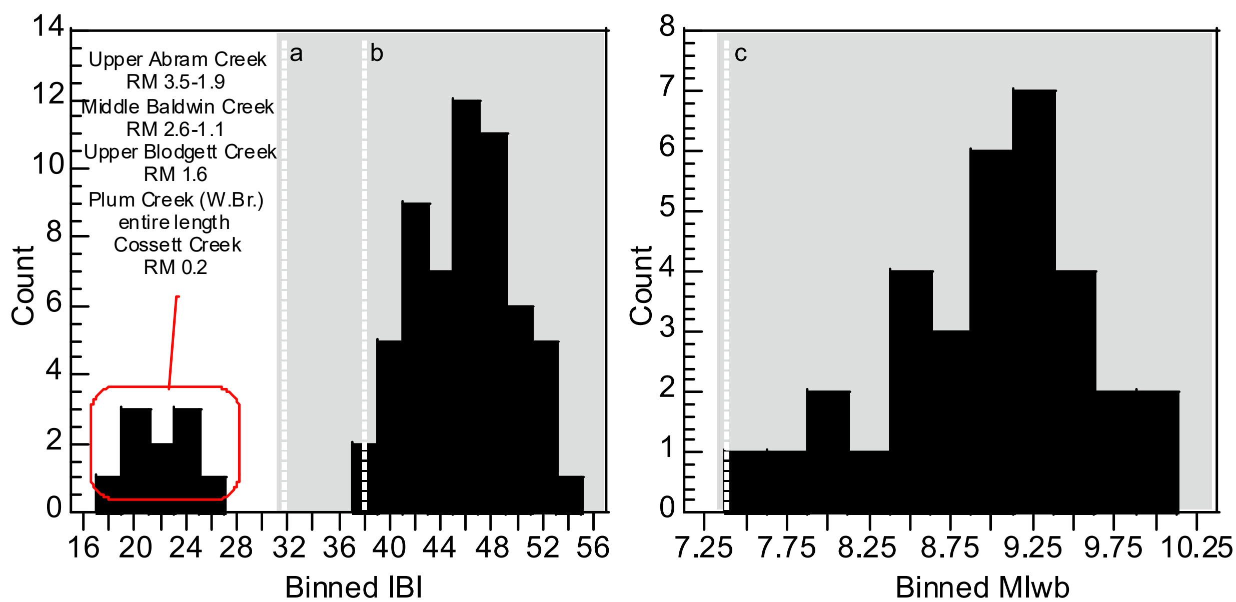


Figure 33. Frequency histograms of binned IBI and MIwb scores, Rocky River watershed, 2014. Dashed lines a and b denote minimum headwater and wading IBI biocriteria, respectively. Dashed line c denotes the minimum MIwb criterion.

Table 18. Sampling stations, descriptive statistics, fish community indices, and narratives, Rocky River study area, 2014.

Stream River Mile	Drain. Area (miles^2)	Cumulative Species	Rel. No. (kg./km)[a]	Rel. Wt. (No./km)[a]	IBI[b]	MIwb[b]	QHEI	Narrative
Rocky River (13-001-000) EOLP, WWH (Existing)								
11.65[W]	267.0	29	812.3	21.9	45	8.8	68.3	*Good*
11.1[W]	268.0	19	895.5	10.3	40	8.1	60.5	*Good*
9.95[W]	279.0	26	486.0	41.0	39	8.5	64.8	*Good*
9.0[W]	281.0	27	890.3	22.8	44	9.2	81.0	*Good/Very Good*
7.6[W]	282.0	24	733.5	29.1	47	9.2	71.5	*Very Good*
5.8[W]	289.0	25	513.8	25.1	42	8.6	71.8	*Good*
3.0[W]	291.0	25	769.5	16.2	44	9.0	83.0	*Good/Very Good*
1.8[W]	292.0	25	795.8	17.0	41	8.8	72.5	*Good*
1.39[B]	293.0	24	640.0	47.1	44	8.4[ns]	67.0	*Good/Fair*
Abram Creek (13-002-000) EOLP, WWH/MWH (Existing/Recommended)								
3.15[H]	6.8	7	1404.0	-	18*	-	62.0	*Poor*
1.9[H]	8.9	5	1146.0	-	20*	-	61.8	*Poor*
WWH (Existing)								
0.84[H]	9.7	21	1696.7	-	46	-	62.0	*Very Good*
0.3[H]	10.1	23	4417.5	-	54	-	59.0	*Exceptional*
Porters Creek (13-003-000) EOLP, WWH (Verified)								
0.1[H]	8.3	20	1054.5	-	34*	-	68.3	*Fair*
Cahoon Creek (13-004-000) EOLP, WWH (Verified)								
0.08[H]	5.4	17	2078.5	-	36[ns]	-	58.3	*Marginally Good*
East Branch Rocky River (13-100-000) EOLP, WWH (Existing)								
30.8[H]	7.3	16	1461.7	-	50	-	71.0	*Exceptional*
29.22[H]	8.9	15	858.0	-	50	-	80.5	*Exceptional*
26.63[H]	14.3	19	1006.5	-	50	-	64.8	*Exceptional*
21.98[W]	25.4	27	1488.3	23.2	50	9.9	78.5	*Exceptional*
18.3[W]	31.6	26	790.0	15.8	45	8.9	69.0	*Good/Very Good*
17.5[W]	31.8	25	1192.8	17.0	47	9.2	65.3	*Very Good*
15.15[W]	40.0	22	1329.0	15.8	44	9.2	63.8	*Good/Very Good*
11.57[W]	53.0	29	1541.05	17.8	43	9.4	76.5	*Good/Exceptional*
10.0[W]	57.0	24	1421.3	23.6	38	8.2	53.5	*Good*
9.35[W]	59.0	28	950.3	17.0	41	8.7	71.3	*Good*
8.2[W]	60.0	20	2141.3	12.7	42	9.5	69.0	*Good/Exceptional*
7.35[W]	63.0	26	2496.8	15.1	39	9.2	64.0	*Good/Very Good*
6.38[W]	63.0	25	3267	25.0	45	9.5	55.5	*Good/Exceptional*
5.1[W]	64.0	30	1131.8	49.0	42	8.1	51.5	*Good*
3.06[W]	75.6	26	1171.5	28.5	51	9.8	68.0	*Exceptional*
1.28[W]	76.5	25	1286.3	29.1	45	9.1	70.0	*Good/Very Good*
E. Br. Trib. at RM 25.1 (13-100-011) EOLP, WWH (Recommended)								
0.1[H]	2.9	13	1262.5	-	40	-	69.5	*Good*
E. Br. Trib. at RM 12.1 (13-100-015) EOLP, WWH (Recommended)								
0.1[H]	1.7	13	849.2	-	40	-	78.0	*Good*

Table 18. continued.

Stream River Mile	Drain. Area (miles²)	Cumulative Species	Rel. No. (kg./km)[a]	Rel. Wt. (No./km)[a]	IBI[b]	MIwb[b]	QHEI	Narrative
Baldwin Creek (13-101-000) EOLP, WWH (Existing)								
3.53[H]	6.6	13	2901.9	-	42	-	56.8	*Good*
2.61[H]	8.3	11	922.5	-	20*	-	60.5	*Poor*
1.13[H]	9.6	11	967.5	-	26*	-	61.3	*Poor*
0.38[H]	10.0	19	451.0	-	46	-	69.5	*Very Good*
0.1[H]	10.0	18	769.5	-	50	-	59.3	*Exceptional*
Healy Creek (13-104-000) EOLP, WWH (Existing)								
0.7[H]	4.9	12	2434.0	-	46	-	68.3	*Very Good*
West Branch Rocky River (13-200-000) EOLP, WWH (Existing)								
33.55[H]	9.1	23	1293.5	-	46	-	69.0	*Very Good*
32.26[H]	11.4	19	1017.0	-	48	-	73.5	*Very Good*
27.3[W]	69.0	29	1499.3	19.0	52	9.7	72.3	*Exceptional*
21.75[W]	85.0	20	1169.3	11.4	44	9.1	61.5	*Very Good*
16.35[W]	123.0	22	759.8	25.4	41	8.9	61.8	*Good/Very Good*
13.3[W]	134.0	25	990.8	19.9	47	9.2	56.5	*Very Good*
7.4[W]	145.0	27	717.0	41.0	45	9.6	61.3	*Good/Exceptional*
4.9[W]	153.0	21	886.0	29.5	45	8.4	63.5	*Good*
3.5[W, 2015]	161.0	17	341.2	11.5	42	7.4[ns]	69.8	*Good/Marginally Good*
2.1[W]	181.0	24	1283.3	19.3	48	9.2	64.3	*Very Good*
0.39[W]	190.0	27	909.0	29.0	48	9.1	64.5	*Very Good*
Blodgett Creek (13-200-003) EOLP, WWH (Existing)								
1.61[H]	3.1	7	2186.0	-	24*	-	58.8	*Poor*
0.17[H]	4.1	16	3456.0	-	44	-	58.0	*Good*
Champion Creek (13-200-009) EOLP, WWH (Recommended)								
0.01[H]	7.8	19	904.0	-	48	-	69.8	*Very Good*
Broadway Creek (13-200-013) EOLP, WWH (Recommended)								
0.28[H]	2.0	20	1414.0	-	52	-	67.3	*Exceptional*
Plum Creek (13-201-000) EOLP, WWH (Existing)								
8.5[H]	7.6	12	2104.0	-	22*	-	50.0	*Poor*
4.92[H]	14.3	11	1153.5	-	24*	-	65.0	*Poor*
2.5[H]	16.2	12	2821.0	-	22*	-	69.8	*Poor*
0.25[H]	17.6	9	538.5	-	20*	-	69.5	*Poor*
Baker Creek (13-202-000) EOLP, WWH (Existing)								
0.3[H]	5.8	18	1679.5	-	40	-	63.3	*Good*
Cossett Creek (13-203-000) EOLP WWH (Existing)								
0.2[H]	4.1	7	498.0	-	24*	-	63.3	*Poor*
Mallet Creek (13-204-000) EOLP, WWH (Existing)								
3.5[H]	13.7	19	1897.0	-	48	-	57.0	*Very Good*
0.72[H]	16.1	23	1298.5	-	51	-	62.8	*Exceptional*
North Branch Rocky River (13-205-000) EOLP, WWH (Existing)								
5.52[W]	28.1	22	488.3	16.9	47	7.8[ns]	69.8	*V. Good/M. Good*
0.45[W]	36.3	28	1302.8	27.0	54	9.7	67.5	*Exceptional*
Plum Creek (13-206-000) EOLP, WWH (Existing)								
3.02[H]	8.8	16	1072.5	-	50	-	67.5	*Exceptional*
2.5[H]	10.4	19	1923.3	-	46	-	75.5	*Very Good*
0.5[H]	12.1	21	750.0	-	48	-	73.8	*Very Good*

Table 18. continued.

Stream River Mile	Drain. Area (miles²)	Cumulative Species	Rel. No. (kg./km)[a]	Rel. Wt. (No./km)[a]	IBI[b]	MIwb[b]	QHEI	Narrative
Remsen Creek (13-207-000) EOLP, WWH (Verified)								
0.6[H]	14.4	21	894.0	-	48	-	70.8	*Very Good*
Granger Creek (13-208-000) EOLP, WWH (Verified)								
1.75[H]	7.8	20	751.5	-	42	-	45.5	*Good*
0.2[H]	13.3	20	658.5	-	38[ns]	-	49.3	*Marginally Good*

H - Headwaters: sites draining <20 miles².
W - Wadable streams: sites typically draining an area between 20 and 200 miles².
B - Boat sites: large or deep waters necessitating the use of boat methods. Typical drainage >200 miles².
* - Significant departure from applicable biocriteria (≤4 IBI units or ≤0.5 MIwb units)
ns - Non=significant departure from applicable biocriteria (>4 IBI units or >0.5 MIwb units)
a - Relative number and weight estimates are extrapolated to standard distances based upon sample type: 0.3 km (headwater and wading) and 1 km (boat).
b - Poor and Very Poor index narratives are underlined.

Applicable Biocriteria – Erie-Ontario Lake Plain (EOLP) Ecoregion

INDEX - Site Type	WWH	EWH	MWH[c]
Headwater IBI	40	50	24
Wading IBI	38	50	24
Boat IBI	40	48	24
MIwb Wading	7.9	9.4	6.2
MIwb Boat	8.7	9.6	5.8

c - Modified Warmwater Habitat (MWH) for channel modified or impounded waterbodies.

Rocky River

Fish sampling efforts on the Rocky River included nearly the entire length of the mainstem and its primary tributary, Abram Creek. Together, 13 monitoring sites were deployed to these waters, nine on the mainstem and four on Abram Creek, evaluating 12.1 and four stream miles, respectively.

All mainstem stations were found to support fish communities fully consistent with the prescribed biocriteria, showing species richness, functional organization and community structure consistent with regional reference conditions. These results indicated both, the overall competency of macrohabitat to support WWH assemblages and safe assimilation of diffuse and point-source pollutant loads delivered to the Rocky River mainstem. Longitudinal performance of the IBI and MIwb on the Rocky River mainstem are presented in Figure 34.

Of the four monitoring stations deployed to Abram Creek, only the lower two sites, evaluating the lower mile, were found to support fish communities consistent with the WWH bicriterion. Despite adequate macrohabitat quality, the upper three miles supported only poor communities. The resulting IBI scores sharply departed, not only from the prescribed biocriteria, but also from the central tendency of the Rocky River watershed as a whole (Figures 30 and 35). The fish assemblages at these sites were characterized by low species richness (half of that observed on most Rocky River tributaries of a similar size), dominance of tolerant and facultative species, and the absence of sensitive taxa.

The impacted area extended from the uppermost headwaters to the point of enclosure of Abram Creek at CHIA (~RM 1.9). From that point, the culverted reach extends nearly a mile, with the stream emerging at RM 0.9, near the NASA research facility. Both the point of entry and outlet were monitored, and these data defined the area of transition between impacted communities and those meeting the prescribed

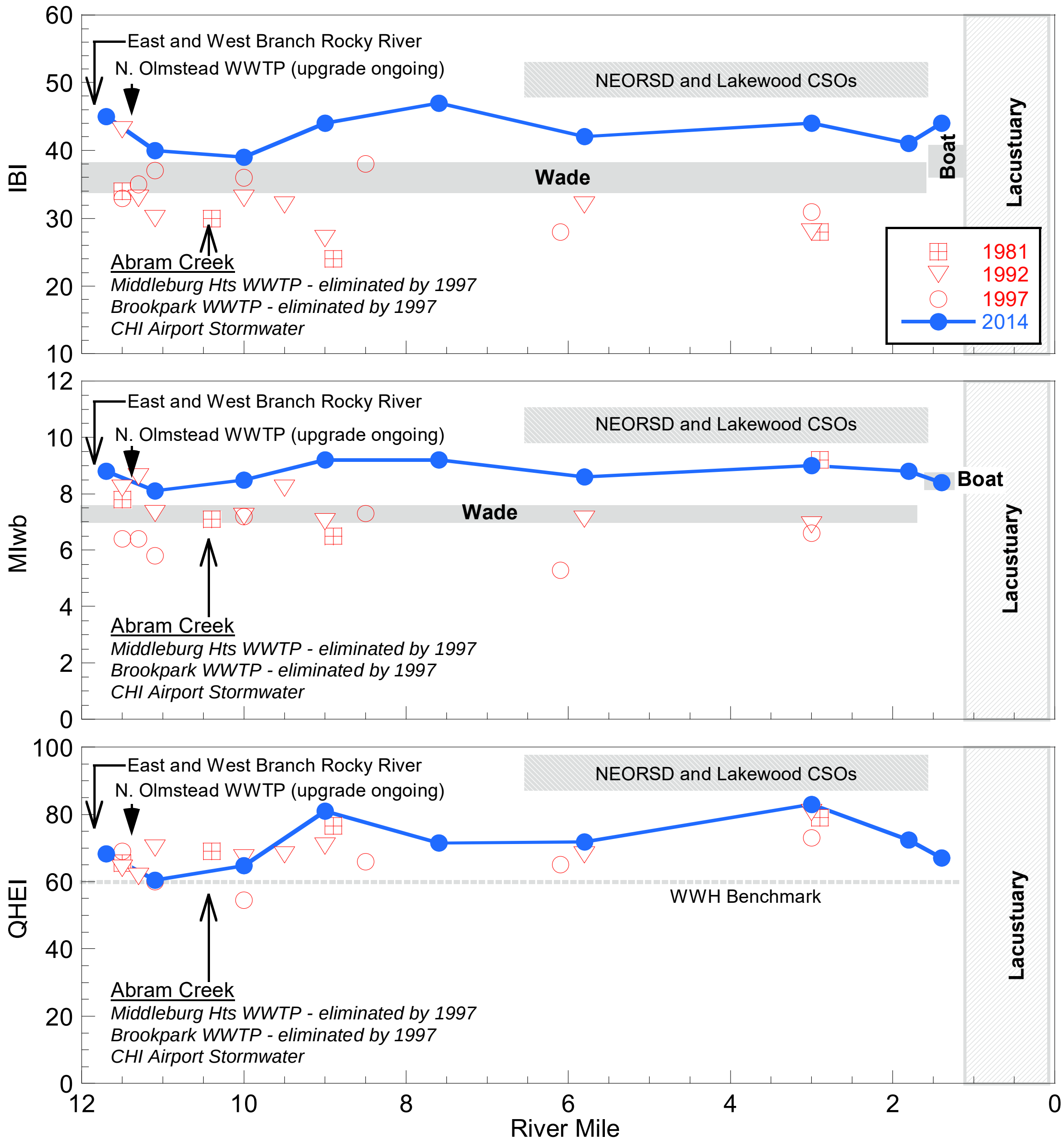


Figure 34. Longitudinal performance of the IBI, MIwb, and the QHEI, Rocky River mainstem 1981-2016. Grey-scale horizontal bars represent the WWH and EWH biocriteria and areas of non-significant departure for IBI and MIwb. Arrows identify significant direct points of discharge for NPDES permitted entities or confluence(s) of direct tributaries. Horizontal dashed lines indicate WWH benchmark. The lower lake affected segment of the Rocky River (Lacustuary) is represented by rectangular area of grey-scale hatch marks. All constituent waters of the Rocky River study area are contained within the ELOP ecoregion.

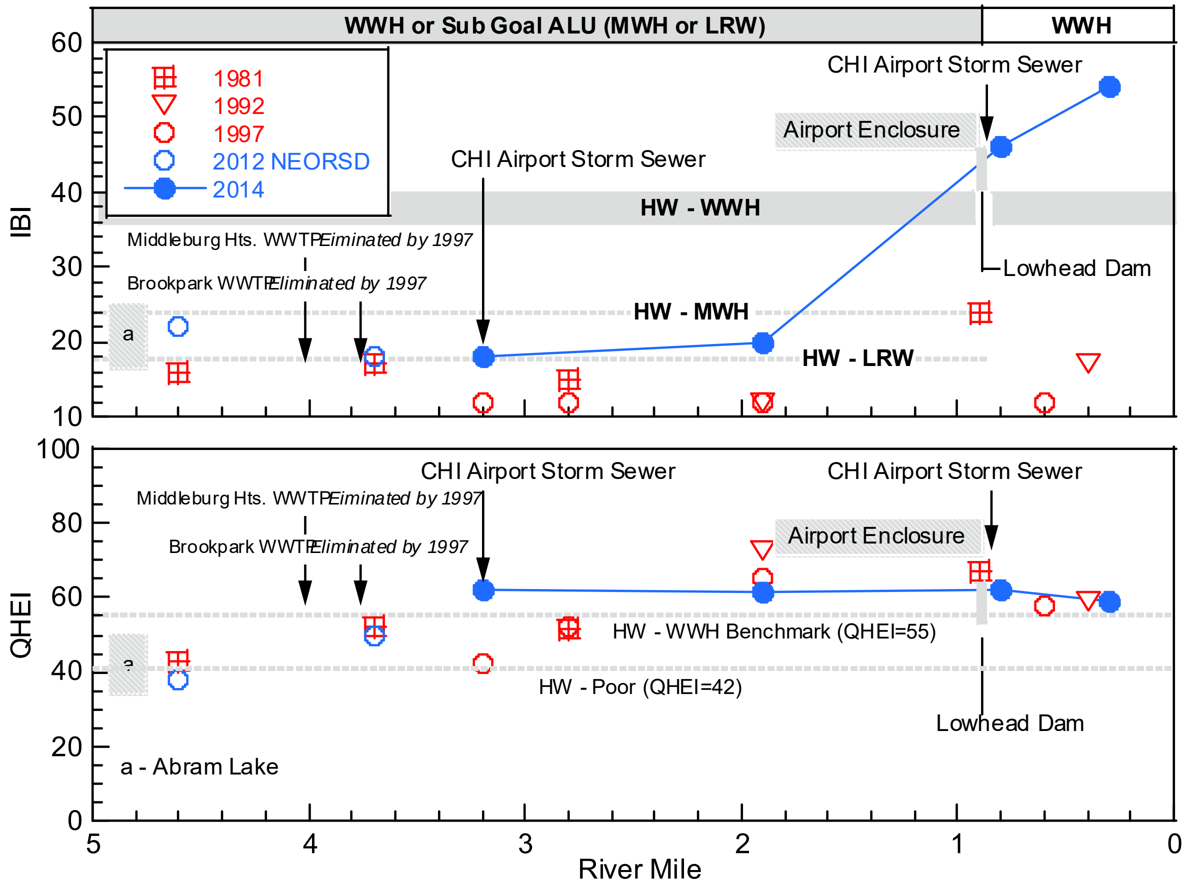


Figure 35. Longitudinal performance of the IBI and QHEI, Abram Creek, 1981-2016. Grey-scale horizontal bar represent the headwater (HW) WWH biocriteria and areas of non-significant departure for the IBI. Horizontal dashed line on IBI plot demarks MWH and LRW criteria and narrative benchmark, respectively. Arrows identify significant direct points of discharge for NPDES permitted entities, confluence(s) of direct tributaries, or other pollution sources. Horizontal dashed line on QHEI plot indicates WWH benchmark and narrative equivalent of poor. All constituent waters of the Rocky River study area are contained within the ELOP ecoregion.

bicriterion. The culverting of Abram Creek has effectively isolated the heavily urbanized headwaters from its lower segment. Primary stressors and limiting factors within the headwaters included stormwater runoff from the greater urban areas drained by upper Abram Creek, including the CHIA. Isolation of the headwaters due to stream enclosure represents an additional and important limiting factor, particularly when contemplating the restorability of the impacted area. Given the high degree of modification, artificiality of the hydrology, and background pollutant loads attending urban and industrial landscapes, the likelihood of recovery of upper Abram Creek is further reduced by the barrier to fish passage provided by the culverted segment. As such, sub-goal aquatic life uses, either LRW or MWH, would more accurately reflect current potential for upper Abram Creek.

East Branch Rocky River

Twenty-four monitoring stations were deployed to the East Branch subbasin, 16 on the East Branch mainstem and eight distributed among its primary tributaries, Baldwin Creek, Healy Creek, and two unnamed waterbodies. Taken together, the survey effort sampled and evaluated 31 stream miles of the East Branch subbasin. Longitudinal performance of the relevant biometrics for the East Branch Rocky River and Baldwin Creek are presented in Figures 36 and 37.

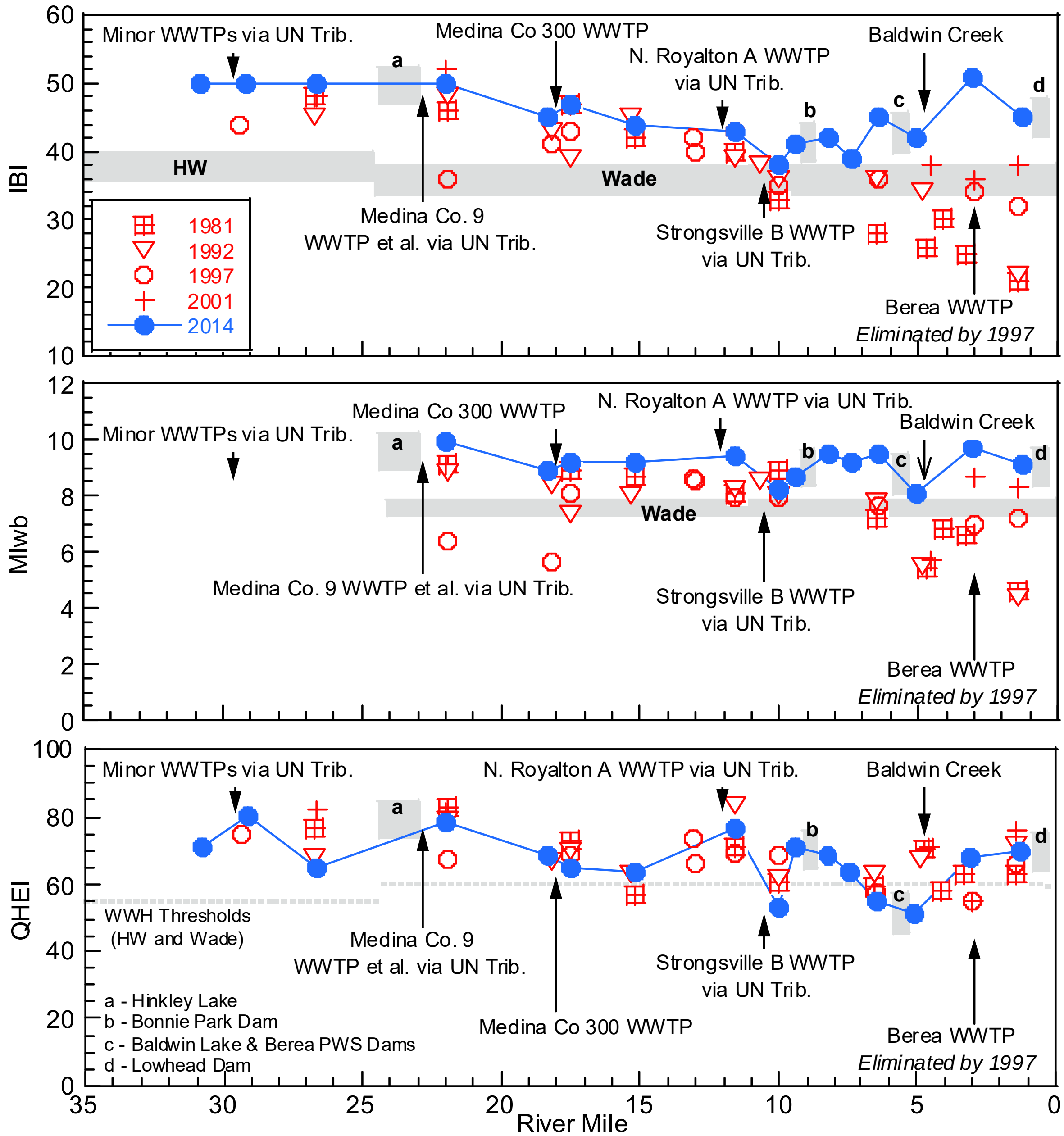


Figure 36. Longitudinal performance of the IBI, MIwb, and the QHEI, East Branch Rocky River, 1981-2016. Grey-scale horizontal bars represent the WWH biocriteria and areas of non-significant departure for IBI and MIwb. Arrows identify significant direct points of discharge for NPDES permitted entities, confluence(s) of direct tributaries, or other pollution sources. Horizontal dashed lines indicate WWH benchmarks for headwater and wading sites. All constituent waters of the Rocky River study area are contained within the ELOP ecoregion.

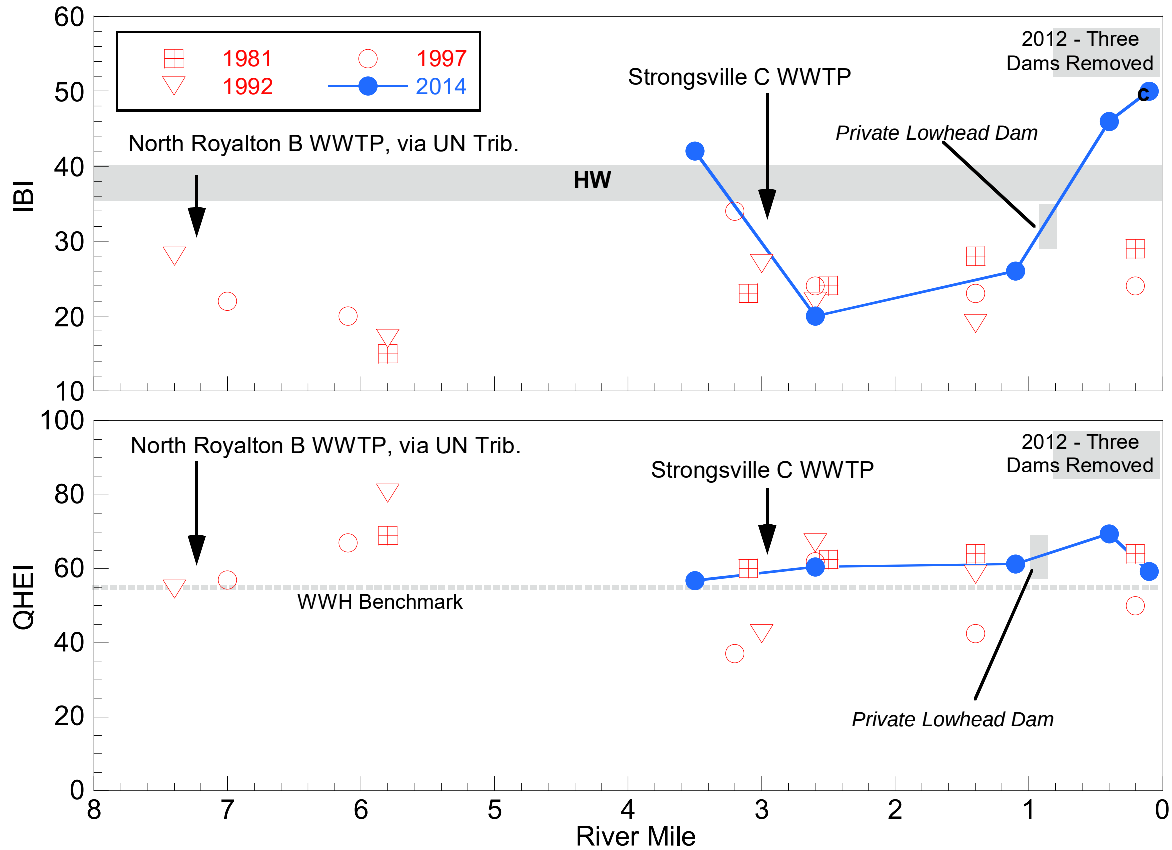


Figure 37. Longitudinal performance of the IBI, QHEI, Baldwin Creek, 1981-2016. Grey-scale horizontal bars represent the WWH and EWH biocriteria and areas of non-significant departure for IBI. Arrows identify significant direct points of discharge for NPDES permitted entities or confluence(s) of direct tributaries. Horizontal dashed lines indicate QHEI, WWH benchmark. All constituent waters of the Rocky River study area are contained within the ELOP ecoregion.

Almost without exception, East Branch monitoring stations were found to support fish communities fully consistent with the WWH biocriteria. Waters so described included, the entire length of East Branch Rocky River, Healy Creek, two unnamed East Branch tributaries, and upper and lower reaches of Baldwin Creek. As measured by the performance of the fish community, these results indicated both the overall competency of macrohabitat to support WWH assemblages and the safe assimilation of diffuse and point-source pollutant loads delivered to the East Rocky subbasin.

Departure from the WWH biocriteria within the subbasin was limited to middle Baldwin Creek at RMs 2.6 and 1.1. Compared against adjacent reaches up and downstream, significant shifts were observed within the fish community at these two locations. Changes included a near doubling of the proportions tolerant, omnivorous, or generalist species, an increase in pioneering species, and a loss of environmentally sensitive taxa and specialized feeding guilds. At the site and reach scale, habitat effects were ruled-out as possible causal factors, as macrohabitat complexity through this segment appeared compatible with WWH communities. Furthermore, QHEI scores through this segment were comparable to better performing sites on Baldwin Creek, both up and downstream from the impacted area.

Potential sources of stress on Baldwin Creek may include treated wastewater, as two POTWs discharge to the system: the Strongsville C WWTP (RM 3.1) and North Royalton B WWTP (RM 7.3). Negative effects from North Royalton are less likely as the facility is over 3.5 miles upstream from the upper limits of the 2014 sampling effort. Aside from the great distance, community performance at the uppermost Baldwin Creek site (RM 3.5) easily met the WWH biocriteria. If North Royalton B was culpable in the declines observed further downstream, negative effects should have been first detected at this location. Given its position relative to the string of 2014 monitoring station, Strongsville C WWTP is a more probable source of stress. The facility was bracketed in 2014, and community performance declined precipitously approximately 0.7 mile downstream from the outfall. These conditions persisted for over three miles until full recovery was documented near the mouth at RM 0.3. An additional and potentially consequential limiting factor within this reach is a privately held low-head dam located at approximately RM 0.7. As has been observed elsewhere in Ohio, the recovery of historically degraded surface waters is often predicated on an active connection to either unimpacted reaches up or downstream, or larger and more intact rivers or streams. These refuge areas serve as ready sources of aquatic organisms should condition on the impacted waterbody improve. The impoundment on Baldwin Run at RM 0.7 referenced previously, serves as a barrier to fish passage, which may protract recovery. Furthermore, this structure may also serve to degrade local physical habitat and water quality behind the dam, through reduced current velocities, decreased assimilative capacity, increase deposition of fine bedload sediment, and habitat homogenization.

West Branch Rocky River

Fish sampling efforts within the West Branch Rocky River subbasin included the entire length of the West Branch mainstem and eleven primary tributaries. Together, 31 monitoring sites were deployed to these waters, eleven on the mainstem and 20 distributed among the tributaries, evaluating a total 34 stream miles. Longitudinal performance of the relevant biometrics for the West Branch Rocky River and Plum Creek are presented in Figures 38 and 39**.**

The entire length of the West Branch supported WWH fish communities, as did all or portions of Champion Creek, Broadway Creek, Mallet Creek, Blodgett Creek, and the collected waters of the North Branch subbasin (i.e., North Branch Rocky River, Plum Creek, Remsen Creek, and Granger Ditch). As measured by the performance of the fish community, these results indicated both, the overall competency of macrohabitat to support WWH assemblages and safe assimilation of diffuse and point-source pollutant loads delivered to these waters.

Significant departures from the WWH biocriteria were observed on the entire length of Plum Creek (direct West Branch tributary), upper Blodgett Creek, and Cossett Creek. In keeping with impacted streams identified elsewhere within the study area, significant departures from the WWH biocriteria on these streams were sharp, deviating not only from the regional biocriteria, but also from the central tendency of the Rocky River.

As measured by the IBI, community performance on Plum Creek was remarkably consistent. The results from all four sites were equally depressed, regardless of their position on the stream. The fish assemblages at each station shared a suite of common features indicative of pervasive chronic stress or other limiting factors or a combination of both. All sites lacked headwater adapted species, failed to support any environmentally sensitive species, and were dominated (numerically) by tolerant taxa. Regarding the latter, proportions here were very high, ranging from 76% to 92%. Rheopalustrine conditions in the headwaters appeared to have necessitated hydrological modification, undertaken at some point in the past to meet local drainage needs. The combination of low functional gradient and historical channelization, lowered QHEI scores within the upper limits of Plum Creek, and as such, some

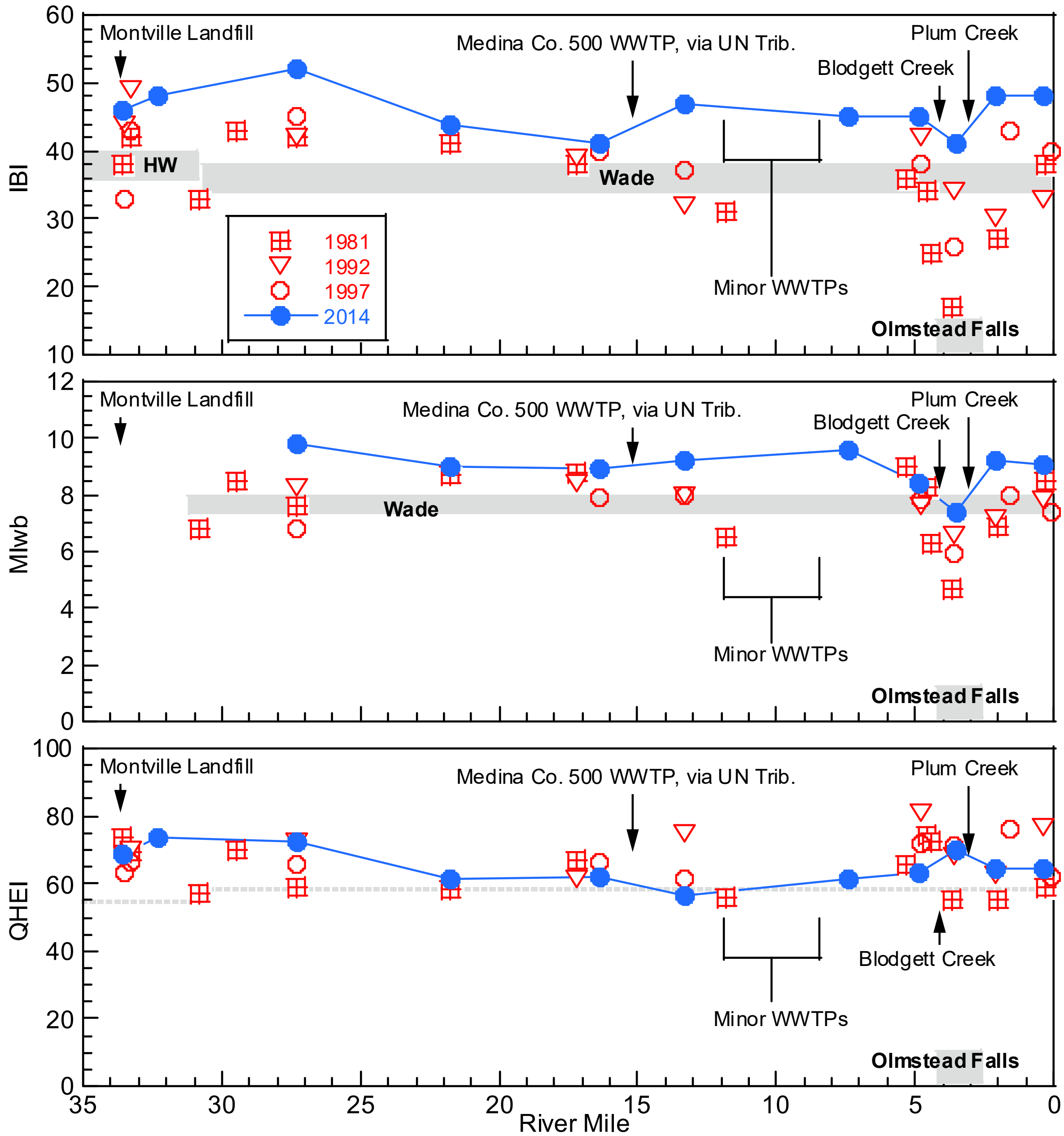


Figure 38. Longitudinal performance of the IBI, MIwb, and the QHEI, West Branch Rocky River, 1981-2016. Grey-scale horizontal bars represent the WWH biocriteria and areas of non-significant departure for IBI and MIwb. Arrows and brackets identify significant direct points of discharge for NPDES permitted entities or confluence(s) of direct tributaries. Horizontal dashed lines indicate QHEI, WWH benchmark. All constituent waters of the Rocky River study area are contained within the ELOP ecoregion.

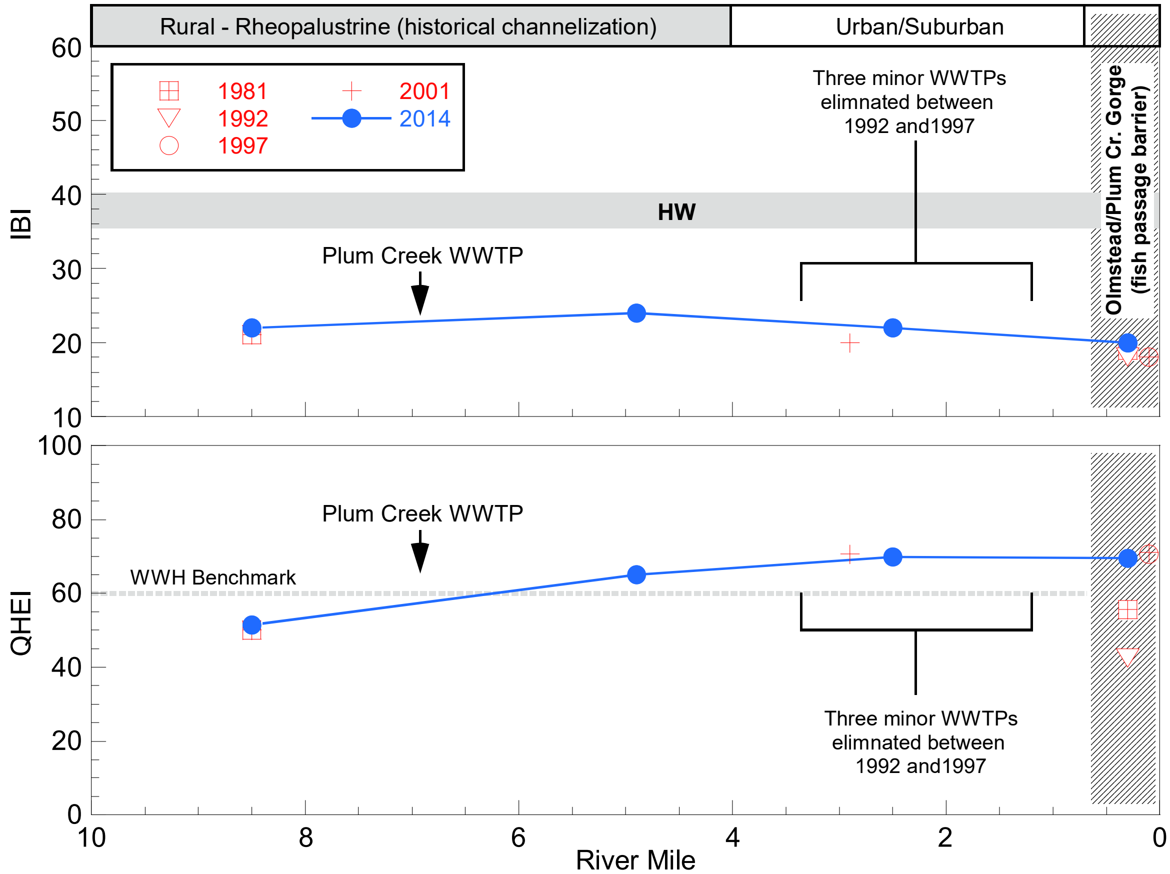


Figure 39. Longitudinal performance of the IBI and the QHEI, Plum Creek (West Branch Tributary), 1981-2016. Grey-scale horizontal bars represent the WWH biocriteria and areas of non-significant departure for IBI. Arrows and brackets identify significant direct points of discharge for NPDES permitted entities or confluence(s) of direct tributaries. Horizontal dashed line indicates QHEI, WWH benchmark. A significant barrier to fish passage, the Plum Creek gorge, is represented by rectangular area of hatch marks at the mouth of Plum Creek. All constituent waters of the Rocky River study area are contained within the ELOP ecoregion.

negative habitat effects were anticipated. However, habitat effects in the headwaters alone would not explain the equal degree of community simplification observed throughout the system. Presently, a single POTW (Plum Creek WWTP) discharges to Plum Creek near RM 7.0, as other facilities were decommissioned or otherwise eliminated between 1992 and 1997. The Plum Creek WWTP was bracketed in 2014 by far field monitoring stations, but the fish community registered little longitudinal change relative to the facility. The apparent absence of local or reach scaled effects suggests conditions throughout Plum Creek are controlled by larger, more systemic factors.

It is important consider that Plum Creek is physically isolated from the West Branch Rocky River as it enters and courses through the Plum Creek Gorge, near Olmstead Falls. Due to a series of cascades at the mouth, the stream gains several meters of elevation over a very short distance. These escarpments serve as an impassable natural barrier to fish entering Plum Creek from the West Branch, thus effectively isolating this tributary. The pervasive poor conditions that presently typify entire length of Plum Creek may reflect the cumulative effects of disturbances accrued by this stream over many decades. At some point in the past, Plum Creek may very well have been substantially depopulated due to the combined effects of drainage practices within the rheopalustrine headwater and, more consequentially, significant water pollution through the middle and lower reaches. As a result, the fish assemblage of Plum Creek is overly simplified, composed of a few tolerant species that have persisted through a period of maximum disturbance. Furthermore, due to the prevalence of slack water habitat and naturally reductive conditions, palustrine and rheopalustrine environments, even if undisturbed, typically support a limited fish fauna. Although situated well upstream from any significant pollution sources, the uppermost headwaters would prove inadequate as a refuge or source assemblage needed to repopulate the more classically lotic portions of the middle and lower Plum Creek, due to the simple fish communities associated with wetland or swamp streams. Restoration or recovery of the fish community following successful pollution abatement efforts of the 1990s, has likely been hindered or even prevented by both, the isolation provided by the Plum Creek Gorge at the mouth and the naturally constrained fauna of the headwaters.

Of the two monitoring stations allocated to Blodgett Creek, the uppermost site (RM 1.3) failed to support a WWH fish community. The site had obviously been channel modified in the past and presently drains an intensely developed urban and suburban landscape. Physical recovery was limited to the reestablishment of a few poorly developed riffles, as most of upper Blodgett Creek was found deeply incised, with pool and glide habitat dominant. Despite multiple storm drains identified through the reach sampled, the stream offered no strong visual evidence of excessive storm water (e.g., large quantities of flotsam and jetsam). However, this location was permeated by a pronounced petroleum odor, which was particularly acute approximately 75 meters upstream from the point of entry, just upstream from N. Marks Rd. Although no oily sheen or iridescent film was observed, what appeared to be an emulsified surface scum was present atop most pools. A review of documented fish kills and industrial spills failed to yield any reported incidences on Blodgett Creek in 2014, but this does not eliminate the possibility of an unreported spill or spills, during or prior to 2014. It is difficult to ascertain with any certainty if the conditions most recently observed on upper Blodgett Creek were typical or anomalous, and the degree to which they may have affected the resident biology. However, the combination of stormwater, artificial hydrology and marginal habitat are very likely limiting, and the lingering effects of what appeared to be a spill event may have been contributory. In addition, isolation effects, akin to those described on Plum Creek, may have been an additional factor regarding community performance on upper Blodgett Creek. A large box culvert was located mid-zone at the lower most site (RM 0.2), and the configuration of this structure would allow it to function as an effective barrier to fish passage. Regarding this supposition, it is important to note that lower Blodgett Creek maintained unfettered access to the West Branch, and monitoring efforts at RM 0.2 documented a WWH fish community. Compared to the impacted upper segment, lower Blodgett had more than twice the number of native species (7 to 16), supported three environmentally sensitive fish taxa, and the proportion of tolerant species was reduced by nearly half (75% to 43%).

Evaluated at a single location near the mouth, Cossett Creek gave the impression of a stream prone to desiccation. The stream appeared unmodified but was naturally very shallow. Dominant substrate was shale bedrock, over which coarse alluvium (native and glacial) was selectively deposited. Overall, substrates were typically unburdened by fine sediment. Together these and other riparian and channel features yielded a QHEI score fully consistent with the WWH benchmark, and as such, macrohabitat limitations, per se, did not appear likely.

Although, the fish community shared characteristics with other impacted headwaters within the West Branch subbasin, the simplicity of the assemblage was unique among these waters. Although species richness was adequate and comparable to many of the minor tributaries, nearly 90% of assemblage was concentrated in a single, highly tolerant species, creek chub. The proportion of pioneering taxa was among the highest observed within the Rocky River study area. Pioneering fish are adapted to ephemeral headwaters, and thus are among the first fish species to return to small drainages subjected to episodic desiccation or other temporary stress (Smith 1979). Relative abundance estimate from this site was less than half of what was typically encountered and ranked among the lowest observed within the West Branch subbasin. Together, these characteristics suggest an ecologically improvised fish assemblage, following a period of desiccation or some other temporary stress. Aside from the observations offered above, this inference is supported by observations made by previous Ohio EPA field investigators. Specifically, the presence of plethodontid salamanders was noted at this location in 1997. The importance of this observation is that several members of the Family Plethodontidae are typical associates of intermittent or interstitial streams, and their presence on lower Cossett Creek in 1997 reinforces the idea that the stream, or at least its lower reach, is prone to periodic desiccation. Furthermore, the 1997 survey also found lower Cossett Creek to support WWH communities. Compared to the 2014 results, the 1997 survey found nearly double the number of species (11 to 7), additional sensitive taxa (including the highly intolerant brook specialist, reside dace), greater structural evenness among the species present (i.e., less concentration) and rudimentary functional organization. These features appear to reflect a period of relative hydrological stability predating the 1997 sample and of a sufficient duration to allow for the establishment of a minimally structured resident assemblage. These data suggest that Cossett Creek may not be desiccated annually, but instead occasionally. In the absence of known anthropogenic stress or stressors, community performance over a given period (perhaps 5-10 years) would likely vacillate in and out of ALU attainment depending upon the constancy of the flow regime.

Cahoon and Porter Creek

A single monitoring station was deployed to each, Cahoon and Porter Creeks. Both sites were located upstream from US 6, approximately 0.1 miles upstream from the outlet. These streams are small direct Lake Erie tributaries, draining well-developed areas of suburban Bay Village, just west of the Rocky River basin. Descriptive statistics, biometrics, and community narratives are presented in Table 18.

Both streams offered abundant evidence of flashy urban-suburban hydrology. Regular scouring flows have given rise to unstable substrates. Deposits of alluvium within the channel were exclusively coarse and appeared “fresh”, lacking normal biofilms, with little or no accompanying finer material (clayey silts). Although not observed directly, waters so affected typically labor under a feast or famine hydrology, with peak flows, violent and exaggerated, but of a short duration. Given the systematic nature and necessity of the drainage improvements within these minor catchments, summer flow is greatly reduced or at times eliminated resulting in ephemerality during drier months, or at least periods of stressful low flow.

Cahoon Creek supported 17 fish species. The stream was naturally incised and consisted of a series of bedrock riffles, runs, and glides, with plunge pools associated with significant escarpments. These features appeared to isolate most of Cahoon Creek from Lake Erie, as stream elevation declined rapidly as it makes its way to the mouth. This observation was affirmed by the absence of round goby, at least upstream from US 6. In terms of numerical abundance, tolerant species accounted for 42% of the assemblage. As a proportion of the whole, sensitive taxa were very poorly represented (0.2%), but this category did include two species. Over 80% of all fish captured were concentrated in only two species: creek chub and central stoneroller. Despite the obvious structural and hydrologic limitation, the resulting IBI from Cahoon Creek, just met the minimum WWH biocriteria, achieving an IBI of 36 (marginally good).

Porter Creek supported 20 species. Although contained for much of its lower length within stone walls, Porter Creek’s descent to Lake Erie was gradual compared to Cahoon. As a result, an active connection with the lake was evidenced by the presence of round goby and three young-of the-year rainbow trout. The latter apparently a result of limited natural reproduction by lake-run rainbow trout (AKA Steelhead), stocked by Ohio DNR in larger Lake Erie tributaries. Like Cahoon Creek, 44% of fish taken from Porter Creek were classified as tolerant, and sensitive taxa accounted for only a fraction of the assemblage

(1.3%). Regarding evenness, Porter Creek was similarly skewed, with nearly 80% of the assemblage concentrated into three species. Despite numerous similarities with Cahoon Creek, Porter Creek failed to support a fish community minimally consistent with WWH biocriterion. It must be noted, however, that this shortfall was very modest, as the IBI missed the criterion by only two IBI units (high-fair, IBI=34). Differences in IBI scores between Porter and Cahoon Creek came down to a single metric, relative number less tolerant species. Comparing the performance of this metric, both Porter and Cahoon Creek were very near the breakpoint between a metric subscore of 3 and 5. Nearly all other IBI metrics and other independent community measurements were similar, or nearly so. This was not too surprising given that both streams appeared equally affected by the structural limits (largely hydrological in nature) described above.

FISH COMMUNITY TRENDS: 1981-2014

A review of historical monitoring data provided an excellent opportunity to evaluate the environmental conditions of the Rocky River basin through time. Prior to the 2014 survey, systematic water quality investigations of the entire or large portions of the watershed were undertaken in 1981, 1992, and 1997. Supporting various water quality management activities (e.g., stream regionalization, NPDES permitting, 319 project assessment, TMDL supplementation), abbreviated and geographically circumscribed monitoring was undertaken in 1982, 2001, and 2011. For this report, trends analysis was largely centered on the comparison of survey result from stations, reaches, and waterbodies common to all four basin-wide surveys completed over the past 33 years. Results from smaller efforts were brought into the discussion on an as needed basis. The review of these data also drew heavily upon prior assessments provided in Ohio EPA (1983, 1985, 1993 and 1999).

In order to succinctly summarize and evaluate conditions between field years, analysis of trends will take three basic forms: aggregated annual trends, examining the performance of selected measures and indexes from comparable data through time; longitudinal comparison of indexes and other biometrics relative to the principal associated stressors or pollution sources within the study area; and where information is limited to a few sampling stations or waterbodies, trends assessment will take the form of a narrative, as these data do not lend themselves to statistical treatment, aggregation, or longitudinal presentation. A very great deal of site overlap exists between and among the survey years, allowing for direct comparisons at site, reach, and subbasin scales. Through these data, meaningful changes in the structure and composition the fish assemblage of the Rocky River watershed are quantified and described.

Aggregate Community Performance

Nine waterbodies aligned with or were identified as being common to the basin-wide surveys conducted by Ohio EPA between 1981 and 2014. Rivers and streams so described included, the Rocky River mainstem, Abram Creek (mainstem tributary), East Branch Rocky River, Baldwin Creek (East Branch tributary), West Branch Rocky River and four associated tributaries. Organized by subbasin and binned by field year, these data served to describe the overall trajectory of the watershed through the period of record (Figure 40). Care was taken to ensure the inclusion of the very oldest survey data available, that in most instances predated important state and federal pollution abatement or control initiatives [e.g., US EPA National Municipal Policy, adoption of Water Quality Based Effluent Limits (WQBELs), capital improvements to POTWs (constructions grants and loans), and incentives-based agricultural conservation practices]. This necessitated, at times, the exclusion of data from streams or sites not represented in all four large surveys.

In nearly every instance, community performance has improved throughout the Rocky River watershed. Rocky River mainstem showed consistent stepwise gains through each of the four survey years. The earliest baseline results found the river to support only impacted or otherwise degraded communities. Departure from the prescribed biocriteria at the time was complete, as no station supported WWH fish assemblages. Incremental improvements were observed through the intervening survey years between 1992 and 1997, culminating in full restoration of WWH conditions in 2014. Although the initial degree or magnitude of impairment was not as great as that observed on the mainstem, a similar pattern of recovery was observed on the principal tributaries, the East and West Branches, as these too now support fish assemblages fully consistent with the WWH biocriteria throughout their entire lengths.

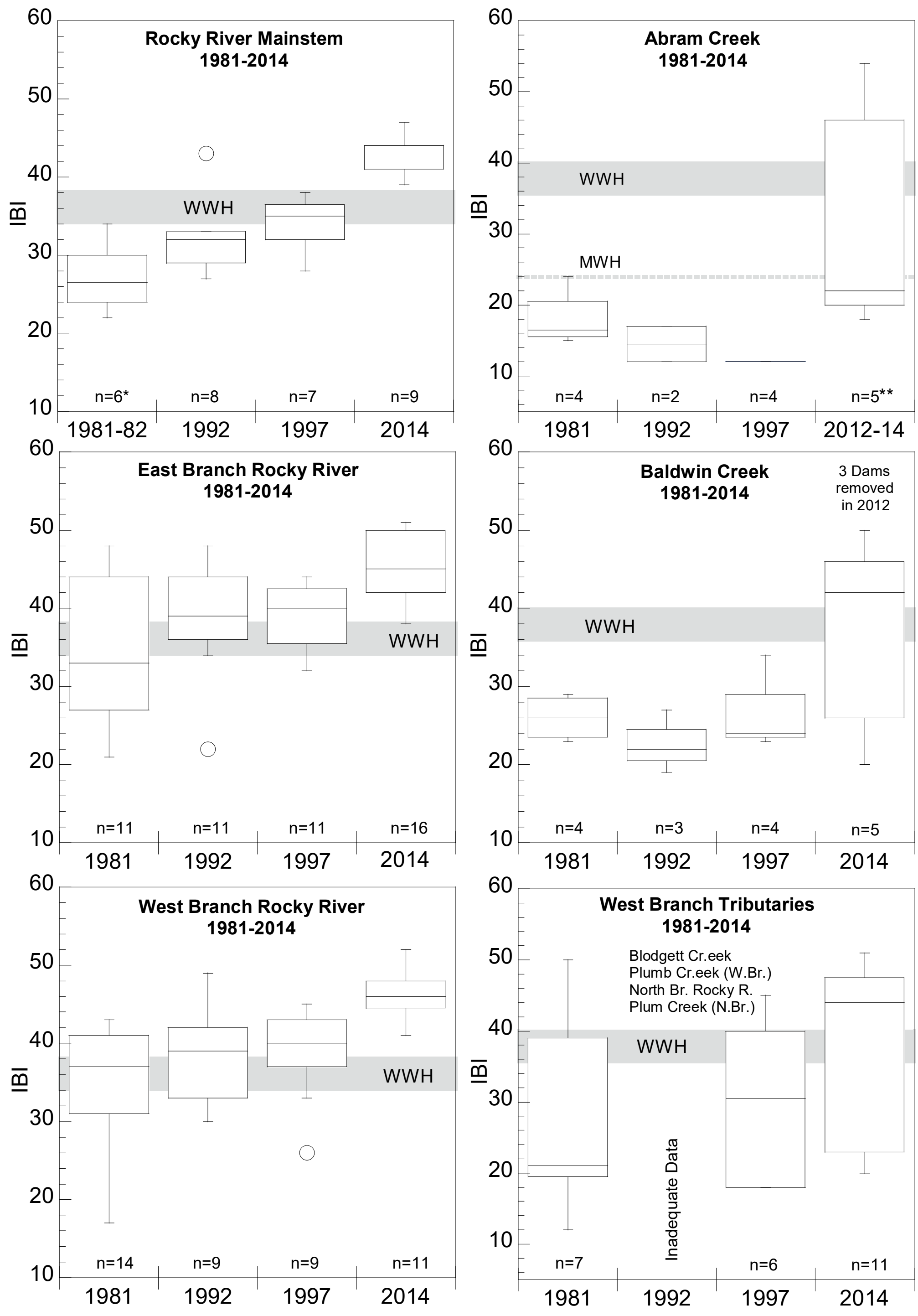


Figure 40. Performance of the IBI for the Rocky River mainstem, East Branch Rocky River, West Branch Rocky River, and selected tributaries, 1981-2014. Data aggregation based upon actual or functional correspondence between and among sites, waterbodies and survey years. Horizontal grey-scale bars represent the EOLP WWH biocriteria and areas of non-significant departure for the IBI. * - includes data generated by Ohio EPA in 1982 from two sites on the lower Rocky River. These data were added to 1981 results to increase the assessed length of the baseline survey. ** - includes data collected by NEORSD in 2012 from a single location within the upper limits Abram Creek (RM 4.4).

Compared against the findings of the initial survey, recovery of the smaller tributaries was not nearly as complete as that documented on the larger waters. There is little doubt that significant improvements have been achieved, and that the near-term trajectory of the fish biometrics are positive. Unfortunately, all or portions of selected tributaries have remained impacted since their initial investigation.

ALU impairments have persisted on Abram Creek since 1981, and in fact, community performance steadily declined through the 1990s. At its lowest point, conditions were so egregious that much of Abram Creek was rendered nearly fishless in 1997. Despite generally improved conditions in 2014, including the full restoration of WWH fish communities at selected sites, the majority Abram Creek has remained impacted since 1981.

Similarly, the first integrated biosurvey of Baldwin Run identified significant and pervasive ALU impairment. Strong departure from the prescribed biocriteria persisted on this stream through the 1992 and 1997 reporting cycles. Significant yet Incomplete recovery was documented in 2014.

Common West Branch tributaries included, Plum Creek (direct West branch tributary), Blodgett Creek, North Branch Rocky River, and Plum Creek (North Branch tributary). Unfortunately, the 1992 survey did not include all four tributaries, thus associated survey results for this year were not aggregated and plotted. Based upon the remaining survey years' results, the range of aggregated IBI scores from these waters did not vary greatly, showing areas of persistent impairment. However, the central tendency or trajectory of annual median values showed steady improvement at selected sites and on selected streams.

<u>Longitudinal Trends</u>

Unlike the aggregate descriptions, where only sites, reaches or streams common to multiple survey years were compared, all relevant fish community data collected by Ohio EPA may be applied to longitudinal assessment. The great advantage to this approach is that spatial and temporal relationships within these data are conserved. This allows relational variables and other relevant features of the study area (e.g., permitted entities, ecoregion, biocriteria, sampling method, associated biocriteria, impoundments, and tributaries) to be displayed not only concurrently, but with the additional benefit of adequate spatial accuracy, resulting in figures that are simultaneously information dense, yet easily comprehended. Longitudinal performance of the community indices, biometrics, and other measures, from the principal rivers and streams of the study area, through time, are presented in Figures 34 through 39, and 42. The reader will note that figures previously cited within this report are referenced here as well. To avoid unnecessary duplication, historical results were included on the initial longitudinal plots as part of the 2014 fish community section.

Consistent with the gross trends described thus far, longitudinal performance of fish community indexes and various supporting biometrics portrayed significant recovery since the initial survey in 1981. For the larger waters of the study area, improvements were incremental and cumulative, reflecting in most instances, the net accrual of species, increased numerical abundances and biomass, improved structural evenness, reductions in the proportion of tolerant taxa, improved proportions of positive functional groups (e.g., lithophiles, specialist insectivores, top carnivores), and improved heath or condition as measured by the frequency of gross external anomalies.

Rocky River

Compared against the 1981 baseline assessment, limited recovery was documented through the upper four miles of the Rocky River mainstem in 1992 and 1997, but the lower eight miles remained impaired, supporting only fair to poor communities. Per Ohio EPA (1993 and 1999), the Rocky River was at that time impacted by the cumulative effects of a very high proportion of treated effluent (approaching 95% of summer base flow), active CSOs and dry weather sanitary overflows, secondary over enrichment effects downstream from selected POTWs, and additional pollutant loads from diffuse urbans sources. Full restoration of WWH fish communities on the Rocky River was indicated in 2014.

The high degree of recovery that presently typifies the Rocky River is coincidental to multiple and significant actions taken over the past 30 plus years. First among these is the elimination or decommissioning of multiple substandard POTWs. The wastewater formerly received by these facilities has been redirected to larger facilities within the basin or exported out of the watershed to either very large regional facilities (e.g., NEORSD) or treated locally and discharged directly to Lake Erie (e.g., Lakewood WWTP). Substantial reductions in the frequency, duration, and total volume of untreated sanitary waste from dry and wet weather CSOs and SSOs, have been realized through plant closures (as described above), increased plant capacity, and better management of and improvements to wastewater collection systems. Spurred by the adoption and implementation of WQBELs during the mid-1980s, public capital expenditures on advanced municipal wastewater treatment have, in most instances, significantly improved the performance of remaining POTWs. Together, these actions have resulted in significant water quality gains throughout the Rocky River watershed in 2014, evidenced by improved DO regime and reduced loads of ammonia, oxygen demanding wastes, and nutrients.

Abram Creek

ALU impairment has persisted through most of Abram Creek since it was first surveyed and assessed in 1981. From that time to the early-1990s, Abram Creek was affected by a complex suite of stressors: several small failing STPs within the headwaters, pervasive urban and industrial stormwater, hydrological modifications, direct channel modifications, and contaminated stormwater from CHIA (Ohio EPA 1985 and 1993). Despite the elimination of two substandard STPs (Middleburg Heights and Brook Park) and subsequent load reductions in the mid-1990s, very poor conditions prevailed in 1997, and in fact declined by comparison. This was attributed to heavy ammonia loads from CHIA associated with deicing operations, resulting instream concentrations well in excess of the acute threshold and rendering much of Abram Creek nearly devoid of fish in 1997 (Ohio EPA 1999). The use of urea was discontinued by CHIA in 1998 and replaced by ethylene glycol. However, this compound was phased-out in 2002 due its toxicity and high oxygen demand and has been subsequently replaced by other deicing agents. In addition to changing its deicing regime, CHIA has implemented structural improvements as well. To capture, store, and better manage deicing runoff, CHIA installed a Centralized Deicing Facility (CDF) in 2006. Draining 70 acres, most aircraft deicing is now performed within the CDF and most of the collected runoff is sent to the NEORSD collection system (Hull and Associates 2004 and EnviroScience 2018). The lowest CHIA stormwater outfall (006) on Abram Creek was eliminated in 2017, and now carries stormwater directly to the CHIA Central Detention Basin (CDB). Stormwater in excess of the CDB is decanted through outfall 012 to Abram Creek at RM 1.2.

Additional modifications related to CHIA included a recent runway expansion that necessitated the enclosure of approximately a mile segment of Abram Creek, between approximately RMs 1.9 and 0.9. Aside from the obvious effects attending the loss of a mile of open channel, the culverted segment now very likely serves as a barrier to fish passage, effectively isolating the upper portions of the watershed from the lower mile and indirectly the Rocky River mainstem.

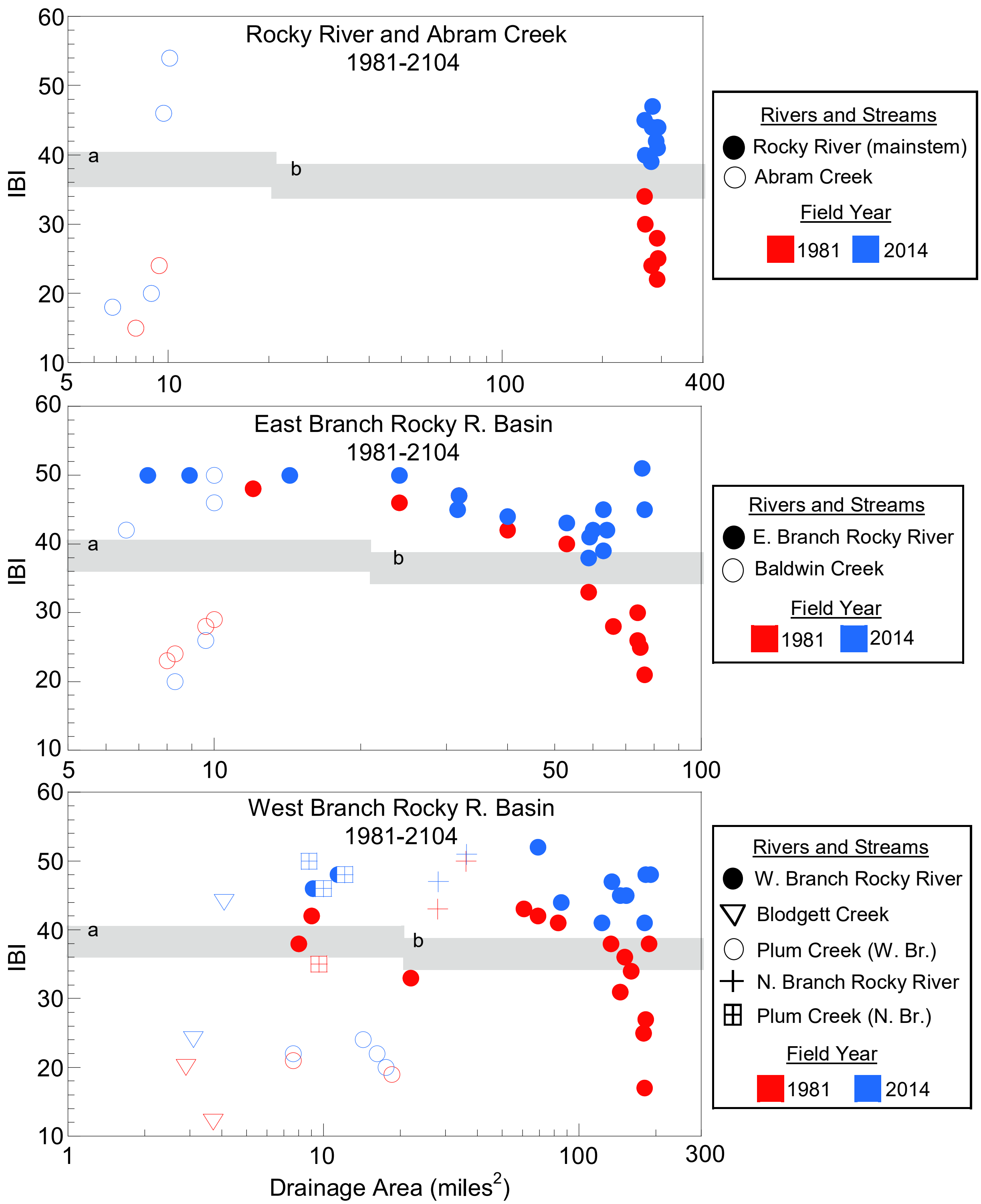


Figure 41. Longitudinal performance of the IBI on common waters and reaches, Rocky River study area, 1981 and 2014. Grey-scale horizontal bars *a* and *b* represent headwater and wading WWH biocriteria and areas of non-significant departure, respectively.

In addition to tracking conditions against baseline assessments, sampling stations on Abram Creek in 2014 were so arranged as to audit both, advances made by CHIA in the management of runoff from deicing operations and the effects of enclosure. The 2014 survey found significant recovery at the two sites placed on the lower mile of Abram Creek at RMs 0.8 and 0.3, respectively. The reestablishment of WWH fish assemblages at these locations was attributed to improved water quality attending better management of deicing wastes at the CHIA. Unimpeded access to the Rocky River mainstem appeared an important factor, as fish were able to freely reinvade lower Abram Creek following the water quality gains. Although improved compared to the depauperate conditions identified in 1997, stations located upstream from the culverted segment continued to support poor communities. The effects of stormwater, including but not limited to runoff from CHIA, and hydrological modification continued to be consequential, if not controlling. Even if stormwater related impacts are mitigated or otherwise abated at some point in the future, the recent isolation of the headwaters due to enclosure very likely precludes or at least will greatly protract the recovery of upper Abram Creek into the foreseeable future.

It is also important to consider that the significant reduction in the loads of ammonia and oxygen demanding wastes previously delivered to Rocky River from Abram Creek, has undoubtedly contributed to improvements on the mainstem, at least locally. Although Abram Creek still bears a high load of TDS and in many ways is structurally constrained by the combined effects of urban stormwater, hydrological modification, and isolation, measurable improvements in the environmental conditions of this stream have been realized, particularly on the lower mile.

East Branch Rocky River

Between 1981 and 1997, departures from the WWH biocriteria were largely limited to the lower five miles of the East Branch Rocky River. At the station or reach scale, some temporal variation was evident on the upper East Branch during this period, but depressed community performance was consistently identified through the lower segment. Per Ohio EPA (1993 and 1999), the East Branch was significantly impacted by the cumulative effects of pollutant loads from multiple permitted point and diffuse sources. Longitudinally, modest effects were first observed downstream from the Strongsville B WWTP (~RM 11.0) and conditions worsened as the East Branch received additional loads from POTWs on Baldwin Run and the Berea WWTPs. By far the most significant wastewater source within East Branch basin at that time, the Berea WWTP, was decommissioned in 1993 and its load redirected out of the Rocky River basin to the NEORSD. Subsequent improvements in water quality resulted in much improved fish biometrics in 1997. Full restoration of WWH fish communities was documented in 2014. As discussed previously for the mainstem, recovery was attributed to improved WWTP performance, improvements to the sanitary waste collection systems, and a net reduction in the volume of wastewater received by the East Branch. As the East Branch is a significant tributary to the Rocky River mainstem, improved water quality on this stream contributed directly to improvements documented on the mainstem.

Although not related directly to the broad suite of water quality management objectives that have animated long-term state monitoring activities within the Rocky River basin, a portion of the 2014 sampling effort on the East Branch Rocky River was allocated to evaluate the degree of biological recovery from an illicit cyanide spill in the spring of 2012. Waste cyanide from a now defunct metal plating operation was deliberately released into an adjacent storm sewer that joined the East Branch near Bonnie Park. This action poisoned the lower eight miles of the East Branch, resulting in the loss of over 30,000 fish. Examining the structure and composition of the fish assemblage, no long-lasting effects that could be reasonably attributed to the spill and associated fish kill were evident in the 2014 data. Community performance through the affected reach consistently met or exceeded the WWH biocriteria. Furthermore, these data and resulting biological indices, represent the highest degree of biological integrity yet recorded on the East Branch. These observations are not intended to diminish the significance of the fish kill in 2012; rather, they strongly affirmed the robustness and general high quality of the fish assemblages that presently inhabit the East Branch. It has been repeatedly demonstrated throughout Ohio that healthy aquatic communities have a great capacity for self-repair, and recovery from any number of temporary yet significant disturbances typically proceeds rapidly. As the East Branch also supports the state threatened bigmouth shiner, frequency and density of this species were also reviewed for the lower eight miles. Abundance estimates from the previously affected stations were remarkable consistent in 2014, averaging 111.8/0.3km per site (±22.5/0.3km). However, abundance estimates through the period of record showed much greater variation. Although 2014 estimates from the East Branch were substantially lower compared against peak numbers observed in the early 1980s, survey results from the intervening years (1992 and 1997) were below that observed in 2014. These data would suggest that stochastic factors may play an important role in structuring Bigmouth Shiner populations, particularly considering the equally high degree of variation observed within other portions of the Rocky River watershed since 1981. Given this apparent randomness it was difficult to discern any effects from the 2012 fish kill in the results from the 2014 survey, except to say that the bigmouth shiner is presently well-represented at all previously affected sites, indicating an ostensible recovery. Heavier pollutant loadings in the past, coupled with hydrological factors may have influenced annual abundance of this species as well.

Baldwin Creek

Between 1981 and 1997, ALU impairments have been consistently identified on Baldwin Creek. Two major POTWs within the headwaters were identified as being culpable for the impacts identified during this time (Ohio EPA 1993). Longitudinally, these facilities were North Royalton B and Strongsville C WWTPs, with treated wastewater from these facilities joining Baldwin Creek at RMs 7.3 and 2.9, respectively. Near-field instream toxicity was indicated immediately downstream from the upper facility, North Royalton B WWTP. The combined discharges from both dominated summer flows, and contributed to substantial nutrient loads, resulting in far-field nutrient enrichment impacts. Numerous failing home septic systems were considered as possible secondary or tertiary sources. Nutrient enrichment effects may have been exacerbated by several small impoundments located through the lower mile. These structures also limited community performance by simplifying local macrohabitat behind each dam and as barriers to fish passage, effectively isolating much of Baldwin Creek from the East Branch mainstem.

Although incomplete, recovery of WWH communities was documented in 2014 at three of the five Baldwin Creek monitoring stations, that together accounted for about half of its assessed length. Specifically, improved conditions were found at the upper limits of the 2014 effort, between North Royalton B and Strongsville C, at RM 3.5, and through the lower mile, at RMs 0.3 and 0.1. Continuing ALU impairment was observed throughout the intervening reach, evaluated at RMs 2.6 and 1.1, downstream from Strongsville C. Improvements on Baldwin Creek were coincidental with better POTW performance (plant upgrades in the late-1990s), subsequent improved water quality, and the recent removal of three low head dams on the lower half-mile in 2012. Recovery through the lower mile was facilitated by dam removals, as fish from the now recovered East Branch were able to freely disperse into Baldwin Creek. Also, long standing local habitat limitations were eliminated by restoring free flowing conditions to this segment.

West Branch Rocky River

Survey results from 1981 identified significant ALU impairment on the West Branch. Impacted areas included the upper five miles near Montville and the lower 15 miles, from the Medina Co. 500 WWTP, through Olmstead Fall, downstream to the East Branch confluence. The intervening middle stations, accounting for roughly 15 river miles, have consistently supported WWH fish communities. Conditions were incrementally improved in 1992, and with few exceptions, additional improvements were indicated in 1997. The 2014 survey revealed further improvements of a degree and magnitude sufficient to bring the entire length of the West Branch up to WWH levels. As observed on the Rocky River and the East Branch, recovery on the West Branch was coincidental to pollution abatement activities undertaken over the past 30 years (abandonment of substandard POTWs, improved wastewater treatment at extant facilities, improvements to the collection systems, etc.). Furthermore, as the West Branch is the largest Rocky River tributary, improved water quality within this subwatershed undoubtedly contributed to improvements on the mainstem.

Selected West Branch Rocky River Tributaries

West Branch tributaries common to at least two of the four survey years included Plum Creek (W. Br. tributary), Blodgett Creek, Cossett Creek, Mallet Creek, North Branch Rocky River, and Plum Creek (N. Br. tributary).

Community performance was remarkably consistent on the direct West Branch tributary, Plum Creek. Monitoring results from 1981, 1992, 1997 and 2014 surveys indicated complete ALU impairment. At no time and at no location have fish communities performed at a level better than poor. Ohio EPA (1993 and 1999), identified gross organic enrichment and associated chronic toxicity from the combined loads of multiple POTWs as the primary cause and source of ALU impairment. Private home septic systems or unknown sources of sanitary waste were, at that times, considered important secondary contributors. Given the closure of three substandard POTWs in late-1997 and recent upgrades at the remaining POTW (Plum Creek WWTP), significant biological improvements were anticipated in 2014 (Ohio EPA 2001). Despite improved water quality, poor biological conditions have persisted. These results are at odds with the pattern of recovery documented elsewhere within the Rocky River basin in 2014 and suggest that additional elements are at play.

Regarding the unexpected persistence of subpar fish communities, a range of natural and anthropogenic factors may be controlling or a least contributory. As discussed previously, upper Plum Creek is rheopalustrine in nature and has subjected to extensive drainage modification. The combination of natural limits associated with wetland streams and attending drainage improvements (e.g., simplified macrohabitat and natural reducing conditions) have ecologically constrained the numbers and kinds of fish the headwaters may support. Furthermore, at some point in the past, middle and lower Plum Creek may very well have been substantially depopulated due to significant water pollution (documented or otherwise), leaving the system with only a small number of highly tolerant species. At the mouth, the Plum Creek Gorge serves as a substantial natural barrier to fish passage, effectively isolating Plum Creek from the West Branch Rocky River. Lacking access to the West Branch or other intact source-waters from which fish may reinvade previously impacted areas, isolation effects on Plum Creek have very likely constrained, retarded, or perhaps now exclude natural recovery, despite the closure of several POTWs and improved treatment at the remaining facilities and improved water quality.

In addition to the structural factors identified above, water quality in Plum Creek warrants separate discussion. Although improved in comparison with historical results, water quality was not optimal. Surface water monitoring in 2014 and follow-up monitoring in 2015, found evidence of incipient nutrient enrichment. Late-summer diel monitoring revealed diurnal DO spreads indicative of stimulated productivity within the upper four miles of Plum Creek, evaluated at RMs 4.9 and 8.5. Furthermore, low or minimal values from these diel sets approached or fell below the WWH minimum in DO criterion. In total, seven DO observations from these diel monitoring stations subceeded the minimum criteria of 4 mg/l. Day-time grab samples found concentrations of ammonia, total phosphorus, nitrate+nitrite, and TKN generally elevated through the entire length of Plum Creek. Although non-violatory, the concentrations of these parameters were typically greater than the 75th percentile of regional reference values, and at times exceeded the 95th percentile. It is important to note that the upper two stations (RMs 4.9 and 8.5) yielded the highest concentrations (i.e., greatest departure from background reference values). Although the Plum Creek WWTP discharges to this reach, most parameters did not vary significantly, relative to the outfall of this facility, strongly suggesting that background loads and conditions are important contributory factors regarding contemporary water quality.

Ohio EPA (1999), identified a water quality exceedance for total lead (38 ug/l) at the mouth of Plum Creek noteworthy, as concentrations that high are uncommon in water column samples. This prompted a review of water column lead data predating 1997. The earliest available monitoring through the early and mid-1980s found that total lead on lower Plum Creek ranged between five and 51 ug/l, with average of 11.7 ug/l. A single lead exceedance of 14.7 ug/l was observed on Plum Creek in 2014, one of only two documented within the entire watershed. This result was found to coincide with a period of elevated flow within the Rocky River basin. Time did not permit indexing historical results against concurrent USGS stream gauge data to establish if previous high values were also associated with elevated flow, but given the variability, these too were likely coincidental to high flow. The source of lead contamination remains unknown, but it appeared associated with a wet weather. Taken together, maximum observed water column lead concentrations showed a declining trend between the 1980s and 2104, suggesting a gradual subsidence. Given the complexity of Plum Creek, it is difficult to gauge the effects of lead contamination on performance of the fish community through time, but its gradual diminution over the past 30 plus years indicates, at a minimum, the lessening of a potential stressor.

Although the headwaters of Blodgett Creek have remained impacted since this waterbody was first evaluated in 1981, recovery of the lower reach was documented in 1992, and WWH fish communities have persisted here since that time. Improvements were attributed to the elimination of two POTWs (Strongsville A and Versailles) and subsequent improvements in water quality.

Cossett Creek was first evaluated in 1997 and again in 2014. The most current results mark the only instance of significant decline within the Rocky River basin. However, as discussed previously, the composition of the fish assemblage coupled with site observations from 1997 and 2014 strongly suggested that Cossett Creek is prone to periodic desiccation. Over a given period, Cossett Creek likely vacillates in and out of WWH attainment based upon the prevailing flow regimes predating any given sampling event. As such, departure from the WWH criterion was viewed a cyclical and attributed to natural causes.

Initially surveyed and assessed in 1992 near the mouth, Mallet Creek was reevaluated in 2014, with monitoring extended nearly three miles upstream into its headwaters. Both 1992 and 2014 efforts found Mallet Creek to support WWH fish communities, showing composition, structure, and functional organization comparable to ecoregional reference.

All or portions of the North Branch Rocky River subbasin have been found to consistently support good to exceptional fish communities since first surveyed in 1981. Plum Creek, one of the North Branch's principal tributaries, failed to support WWH communities in 1981 and 1997. Departures from the prescribed biocriterion were modest in nature, the fish assemblage performing narratively no worse than fair. Seventeen years hence, monitoring in 2014 found Plum Creek to support very good to exceptional communities, fully consistent with the WWH ALU. Per Ohio EPA (1999), Plum Creek appeared to labor under the effects of heavy sedimentation and excessive turbidity, attributed largely to urban storm water and construction runoff from Brunswick. Although not discussed in that report, conditions observed in 1997 may have also been related to the draining of Sleepy Hollow Lake. Despite a concerted effort, specific information regarding the history of this Lake was unavailable. However, the reach of Plum Creek immediately upstream from the historic sampling location appears to course through a former lakebed. Limited riparian vegetation and decades of accumulated sediment could have potentially affected downstream segments in the manner described previously (i.e., heavy sedimentation and turbidity). Perhaps the affected portion of Plum Creek has finally achieved a state equilibrium with its immediate floodplain, in terms of stream power, sediment transport/storage, and channel form. The natural rehabilitation of Plum Creek, including the reestablishment of a stable functional channel, would contribute significantly to the abatement of the sedimentation, turbidity, and related water quality and habitat impacts observed in the past. The structural changes postulated above are not intended to counter the previous assessment but are instead intended as supplementary.

MACROINVERTEBRATE COMMUNITY

Macroinvertebrate communities were evaluated at 72 stations in the Rocky River study area (Appendices B, C). The community performance was evaluated as exceptional at 20 stations, very good at 8, good at 13, marginally good at 19, fair at 9, and low fair at 3. The station with the highest total mayfly (Ephemeroptera), stonefly (Plecoptera), and caddisfly (Trichoptera) taxa richness (EPT) was on East Fork Rocky River at SR 303 (RM 21.9) with 24 taxa. The station with the highest number of total sensitive taxa was on East Fork Rocky River at Harter Road (RM 26.6) with 26 taxa.

Fifteen uncommonly collected sensitive taxa (including two species of freshwater mussels) were collected during this study and their collection locations are listed in Table 19. No state listed invertebrate species were collected during this study. A relatively low number of uncommonly collected sensitive taxa were collected during this study which is an indication of the moderate impact to the aquatic resource quality in the Rocky River basin from the highly urbanized nature of especially the lower part of the basin.

Three species of freshwater mussels were documented (as fresh-dead shells only, as no live mussels were observed) during this study (Table 19). Watters et al. (2009) documented historic records (before 1980) of 13 species (including the three species found in this study) and a recent record (live or fresh-dead) of one species (creeper, *Strophitus undulatus*) in the basin. The non-native bivalve zebra mussel (*Dreissena polymorpha*) was found in the East Branch Rocky River and Rocky River downstream from Hinkley Lake. This species is established throughout Ohio in all downstream river reaches that are connected to a lake or river large enough to support boat access by a boat ramp.

Rock *River Mainstem*

The Rocky River mainstem was sampled at nine stations in 2014 (Figure 42, Table M2). All the stations were meeting or marginally meeting WWH ICI expectations. The average ICI score was 42.75. The qualitative sample EPTs were all at or slightly above WWH expectations with an average of 13.3. Qualitative sensitive taxa diversity (ST) was about at WWH expectations or slightly below with an average of 10.2.

The North Olmsted WWTP discharge (RM 11.4) was having a mild to moderate impact on the macroinvertebrate community with a 10-point decline in the ICI score, 3 taxa decline in EPT and a 1 taxon increase in sensitive taxa diversity, all the time remaining at or above WWH expectations. The ICI and EPT improved farther downstream to near what they were upstream of the WWTP.

The Lakewood WWTP discharge (RM 1.77) had a mild to moderate impact on the macroinvertebrate community, with a 14-point decline in the ICI score, 3 taxa decline in EPT and a 1 taxon decline in sensitive taxa diversity, all the time remaining at or above WWH expectations.

Rocky River Tributary: Abram Creek

Four stations were sampled in Abram Creek (Figure 43, Table 20). The macroinvertebrate communities in Abram Creek were performing below WWH expectation with low EPT (3-6) and very low sensitive taxa (0-2) diversity. Abram Creek flows through a highly urban area including being culverted under the Cleveland Hopkins International Airport runways. The low EPT and sensitive taxa diversity, low organism density and predominance of facultative and tolerant taxa are consistent with the effects of unrestrained and untreated urban runoff.

Table 19. Uncommon sensitive macroinvertebrate taxa and all freshwater mussel species, Rocky River basin, 2014.

Taxa	Collection Location by River Mile
Mayflies	
Plauditus sp.	E.Br. Rocky R.: 26.63.
Stoneflies	
Acroneuria carolinensis	E.Br. Rocky R.: 26.63.
Caddisflies	
Leucotrichia pictipes	Rocky R.: 3.0, 1.8, 1.39; E.Br. Rocky R.: 26.63, 21.75.
Ochrotrichia sp.	E.Br. Rocky R.: 15.15; W.Br. Rocky R.: 13.3, 11.7, 4.9.
Ceraclea cf. spongillovorax	Rocky R.: 11.1, 7.6.
Oecitis avara	W.Br. Rocky R.: 21.75, 16.35.
True Flies	
Dicranota sp.	E.Br. Rocky R.: 1.28; W.Br. Rocky R.: 32.26, 27.3; N. Br. Rocky R.: 5.52; Remsen Cr.: 0.6.
Paratrichocladius sp.	E.Br. Rocky R.: 26.63.
Demicryptochironomus sp.	W.Br. Rocky R.: 16.35.
Polypedilum (Cerobregma) ontario	E.Br. Rocky R.: 21.98.
Cladotanytarsus vanderwulpi group sp. 4	E.Br. Rocky R.: 8.2; W.Br. Rocky R.: 27.3; Granger Ditch: 0.2.
Sublettea coffmani	Rock R.: 11.1; E.Br. Rocky R.: 26.63.
Neoplasta sp.	Champion Cr.: 0.01.
Freshwater Mussels	
Anodontoides ferussacianus (Cylindrical Papershell)	Plum Cr. (N.Br. trib.): 3.02.
Lampsilis radiata luteola (Fatmucket)	W.Br. Rocky R.: 27.3.
Lasmigona costata (Fluted-Shell)	W.Br. Rocky R.: 27.3, 16.35.

Lake Erie Tributaries: Porter Creek, Cahoon Creek

Porter and Cahoon Creeks were both sampled at one station near their mouths. The macroinvertebrate communities in both streams were not meeting WWH expectations with low EPT (3 and 5, respectively) and very low sensitive taxa (0) diversity. The community conditions in both of these streams were consistent with the effects of urban runoff.

East Branch Rocky River

The East Branch Rocky River was sampled at 16 stations in 2014 (Figure 44, Table 20). All the stations with quantitative data had ICI scores in the good to exceptional range. An exceptional evaluation was at least partially supported by the qualitative sample EPT and sensitive taxa (ST) diversity at three stations in the upper half of the stream. The EPT and sensitive taxa diversity generally declined in the lower half of the stream (downstream about RM 11.2) with the lowest diversity found at RM 9.4 (EPT=6, ST=3). This decline corresponds with the increased urbanization in this area.

Table 20. Summary of macroinvertebrate data collected from artificial substrates (quantitative sampling) and natural substrates (qualitative sampling) in the Rocky River basin, June to October, 2014.

Stream RM	Dr. Ar. (sq. mi.)	Data Notes	Qual. Taxa	EPT Ql. / Total	Sensitive Taxa Ql. / Total	Density Ql. / Qt.	CW Taxa	Predominant Organisms on the Natural Substrates with Tolerance Categories	ICI	Narrative Evaluation
Rocky River (13-001-000)										
11.65	267	-	53	15/15	11/13	M / 1206	0	Midges (F,MI), caddisflies (F,MI)	50	
11.1	268	-	56	12/14	12/15	M / 1254	0	Midges (F,MI), hydropsychid caddisflies (MI,F)	40	
9.95	279	6,13	47	12/13	9/11	M / 905	0	Hydropsychid caddisflies (MI,F), flatworms (F), midges (F,MI)	44	
9.0	281	-	50	13	7	M	0	Midges (F), Hydropsychid caddisflies (MI,F), baetid mayflies (F)	-	Good
7.6	282	-	50	14/15	10/14	M / 1630	0	Baetid mayflies (F), midges (F), hydropsychid caddisflies (F,MI)	48	
5.8	289	-	58	13/13	9/9	M / 1059	0	Hydropsychid caddisflies (F,MI), midges (F), riffle beetles (F)	40	
3.0	291	-	54	14/16	11/15	M / 1330	0	Baetid mayflies (F), midges (F)	42	
1.8	292	-	58	15/16	12/14	M / 1334	0	Midges (F), baetid mayflies (F)	46	
1.39	293	-	49	12/15	11/14	M / 1067	0	Hydropsychid caddisflies (MI,F), bryozoan (F), midges (F)	32	
Abram Creek (13-002-000)										
3.15	6.8	-	29	5	0	L-M	0	Hydropsychid caddisflies (F), midges (F)	-	Fair
1.9	8.9	-	18	3	0	L	0	Midges (F,T), baetid mayflies (F)	-	Low Fair
0.84	9.7	-	27	5	2	L	0	Midges (F,T), leeches (MT)	-	Fair
0.3	10.1	-	31	6	1	L	0	Midges (F), sow bugs (T)	-	Fair
Porter Creek (13-003-000)										
0.1	8.3	-	33	3	0	M	0	Hydropsychid caddisflies (F), baetid caddisflies (F), blackflies (F)	-	Low Fair
Cahoon Creek (13-004-000)										
0.08	5.4	-	22	5	0	L-M	0	Blackflies (F), sow bugs (T)	-	Fair

Stream RM	Dr. Ar. (sq. mi.)	Data Notes	Qual. Taxa	EPT Ql. / Total	Sensitive Taxa Ql. / Total	Density Ql. / Qt.	CW Taxa	Predominant Organisms on the Natural Substrates with Tolerance Categories	ICI	Narrative Evaluation
East Branch Rocky River (13-100-000)										
30.8	7.3	-	44	7	5	L-M	2	Hydropsychid caddisflies (F), baetid mayflies (F)	-	Marg. Good
29.22	8.9	-	38	10	8	L-M	2	Midges (F), riffle beetles (F)	-	Marg. Good
26.63	14.3	-	51	18/22	13/26	M / 263	4	Hydropsychid caddisflies (F,MI), *Antocha* crane flies (MI), *Leuctra* stoneflies (MI)	56	
21.98	25.4	12	73	23/24	17/19	M / 588	1	Hydropsychid caddisflies (F,MI), midges (F,T)	54	
18.3	31.6	-	47	14/15	11/14	L-M / 640	1	Midges (F), hydropsychid caddisflies (F,MI)	48	
17.5	31.8	-	52	14/14	10/10	M / 979	0	Midges (F), hydropsychid caddisflies (F,MI)	46	
15.15	40.0	-	57	19/19	13/14	M-H / 986	0	Midges (F), hydropsychid caddisflies (F,MI)	46	
11.57	53.0	-	48	14/14	9/10	M / 407	0	Hydropsychid caddisflies (MI,F), midges (F)	44	
10.0	57.1	-	43	8/9	7/8	M / 520	0	Hydropsychid caddisflies (MI,F), baetid mayflies (F), blackflies (F)	40	
9.35	59.0	-	38	6	3	L-M	0	Hydropsychid caddisflies (MI,F), baetid mayflies (F), midges (F)	-	Fair
8.2	60.0	-	62	9/12	7/10	M-H/1670	1	Midges (F), hydropsychid caddisflies (MI,F)	46	
7.35	63.0	-	48	10/10	6/8	M / 1339	0	Hydropsychid caddisflies (MI,F), midges (F,T)	48	
6.38	63.0	-	59	7/8	6/8	M / 1286	0	Midges (F), hydropsychid caddisflies (MI,F)	40	
5.1	64.0	-	45	11/12	6/8	M / 1627	1	Midges (F), hydropsychid caddisflies (MI,F)	40	
3.06	75.6	-	39	9/10	5/8	M / 994	0	Midges (F), hydropsychid caddisflies (MI,F)	46	
1.28	76.5	-	41	10/11	6/7	L-M / 788	0	Midges (F), baetid mayflies (F)	40	
Tributary to East Branch Rocky River AT RM 25.4 (13-100-011)										
0.1	2.9	-	50	18	16	M	4	Hydropsychid caddisflies (F), riffle beetles (F), stoneflies (F,MI)	-	Very Good

Stream RM	Dr. Ar. (sq. mi.)	Data Notes	Qual. Taxa	EPT Ql. / Total	Sensitive Taxa Ql. / Total	Density Ql. / Qt.	CW Taxa	Predominant Organisms on the Natural Substrates with Tolerance Categories	ICI	Narrative Evaluation
Tributary to East Branch Rocky River AT RM 12.1 (13-100-015)										
0.1	1.7	-	37	11	9	L-M	1	Hydropsychid caddisflies (MI,F), baetid mayflies (F)	-	Good
Baldwin Creek (13-101-000)										
3.53[a]	6.6	12	33	6/6	1/2	L-M	0	Hydropsychid caddisflies (F,MI), flatworms (F)	36	
2.61[a]	8.3	8	41	6/6	2/4	M	1	Hydropsychid caddisflies (F), flatworms (F), midges (F)	32	
1.13	9.6	-	38	6	2	L-M	0	Flatworms (F), midges (F)	-	Marg. Good
0.38	10.0	-	33	7	3	M	0	Hydropsychid caddisflies (F), flatworms (F)	-	Marg. Good
0.1	10.0	-	37	8	3	M	0	Hydropsychid caddisflies (F), midges (F)	-	Marg. Good
Healy Creek (13-104-000)										
0.7	4.9	-	36	7	4	L-M	2	Midges (F), baetid mayflies (F), blackflies (F)	-	Marg. Good
West Branch Rocky River (13-200-000)										
33.55	9.1	-	43	12/13	8/12	L-M / 188	2	Caddisflies (F,MI), baetid mayflies (F,MI)	52	
32.26	11.4	-	62	15	11	L-M	3	Hydropsychid caddisflies (F,MI), blackflies (F)	-	Good
27.3	69.0	-	54	17/18	18/21	M / 393	2	Midges (F), hydropsychid caddisflies (F,MI)	44	
21.75	85.0	-	58	15/17	13/16	M / 608	0	Midges (F), hydropsychid caddisflies (F,MI), baetid mayflies (F)	56	
16.35	123	-	55	19/21	17/19	M / 1772	0	Midges (F), hydropsychid caddisflies (F,MI), baetid mayflies (F)	46	
13.3	134	-	37	13/16	9/13	L-M / 1032	0	Hydropsychid caddisflies (MI,F), baetid mayflies (F)	48	
11.7	139	-	44	14/14	9/10	M / 1458	0	Hydropsychid caddisflies (MI,F), baetid mayflies (F)	42	
7.4	145	-	51	16/17	12/14	L-M / 1245	0	Hydropsychid caddisflies (F,MI), riffle beetles (F), heptageniid mayflies (MI,F)	50	

Stream RM	Dr. Ar. (sq. mi.)	Data Notes	Qual. Taxa	EPT Ql. / Total	Sensitive Taxa Ql. / Total	Density Ql. / Qt.	CW Taxa	Predominant Organisms on the Natural Substrates with Tolerance Categories	ICI	Narrative Evaluation
4.9	153	-	55	17/19	14/18	M / 1249	0	Caddisflies (MI,F)	50	
3.5	161	-	55	13/16	10/14	M-H / 1405	0	Blackflies (F), flatworms (F), baetid mayflies (F)	42	
2.1	181	-	54	16/17	14/15	M / 1116	0	Hydropsychid caddisflies (MI,F), midges (F)	48	
0.39	190	-	48	14/15	11/12	M / 1363	0	Hydropsychid caddisflies (MI,F), midges (F,MI)	46	
Blodgett Creek (13-200-003)										
1.61	3.1	-	44	10	3	L-M	0	Baetid mayflies (F), midges (F)	-	Marg. Good
0.17	4.1	-	24	7	2	L-M	0	Blackflies (F)	-	Fair
Champion Creek (13-200-009)										
0.01	7.8	-	38	11	6	L-M	3	Blackflies (F), baetid mayflies (F)	-	Marg. Good
Broadway Creek (13-200-013)										
0.28	2.0	-	49	10	4	L-M	2	Hydropsychid caddisflies (F,MI), riffle beetles (F)	-	Marg. Good
Plum Creek (W.Br. trib.) (13-201-000)										
8.5	7.6	-	44	9	1	L-M	0	Midges (F) flatworms (F), hydropsychid caddisflies (F)	-	Marg. Good
4.92	14.3	-	43	9	1	M	0	Hydropsychid caddisflies (F), midges (F)	-	Marg. Good
2.5	16.2	-	39	8	0	M	0	Hydropsychid caddisflies (F), midges (F)	-	Marg. Good
0.25	17.6	-	34	10	4	M	0	Hydropsychid caddisflies (F,MI), baetid mayflies (F), blackflies (F)	-	Marg. Good
Baker Creek (13-202-000)										
0.3	5.8	-	38	10	3	L-M	0	Blackflies (F), hydropsychid caddisflies (F)	-	Marg. Good
Cossett Creek (13-203-000)										
0.2	4.1	-	46	13	6	L-M	2	Hydropsychid caddisflies (F,MI), heptageniid mayflies (F)	-	Good
Mallet Creek (13-204-000)										
3.5	13.7	-	46	11	8	L-M	0	Hydropsychid caddisflies (F,MI), midges (F)	-	Marg. Good

Stream RM	Dr. Ar. (sq. mi.)	Data Notes	Qual. Taxa	EPT Ql. / Total	Sensitive Taxa Ql. / Total	Density Ql. / Qt.	CW Taxa	Predominant Organisms on the Natural Substrates with Tolerance Categories	ICI	Narrative Evaluation
0.72	16.1	-	32	10	7	L-M	0	Baetid mayflies (F)	-	Marg. Good
North Branch Rocky River (13-205-000)										
5.52	28.1	-	59	13/16	10/15	L-M / 1152	2	Caddisflies (F,MI), baetid mayflies (F)	50	
0.45	36.3	-	57	19	16	M	1	Hydropsychid caddisflies (F,MI), baetid mayflies (F), midges (F)	-	Exceptional
Plum Creek (N.Br. trib.) (13-206-000)										
3.02	8.8	-	43	8	3	M	0	Midges (F,T), hydropsychid caddisflies (F,MI)	-	Fair
2.5	10.4	-	34	7	3	L	0	Hydropsychid caddisflies (F,MI), midges (F)	-	Fair
0.5	12.1	-	40	11	6	L-M	0	Hydropsychid caddisflies (F,MI), midges (F)	-	Marg. Good
Remson Creek (13-207-000)										
0.6	14.4	-	54	14	13	M	3	Midges (F), hydropsychid caddisflies (F,MI)	-	Good
Granger Ditch (13-208-000)										
1.75	7.8	-	52	4	0	L-M	0	Midges (F,T), *Caenis* mayflies (F)	-	Fair
0.2	13.3	-	51	11	12	L-M	3	Hydropsychid caddisflies (F,MI), midges (F,MI)	-	Good

RM: River Mile.
Dr. Ar.: Drainage Area
Data Notes: 6=4HDs only, 8=non-detectable current speed over HDs (~0 fps), 12=suspected high water influence, 13=suspected disturbance by vandalism.
Ql.: Qualitative sample collected from the natural substrates.
Sensitive Taxa: Taxa listed on the Ohio EPA Macroinvertebrate Taxa List as MI (moderately intolerant) or I (intolerant).
Qt.: Quantitative sample collected on Hester-Dendy artificial substrates, density is expressed in organisms per square foot.
Qualitative sample relative density: L=Low, M=Moderate, H=High.
CW: Cold Water.
Tolerance Categories: VT=Very Tolerant, T=Tolerant, MT=Moderately Tolerant, F=Facultative, MI=Moderately Intolerant, I=Intolerant
ICI values in parentheses are invalidated due to insufficient current speed over the artificial substrates or by disturbance. The station evaluation at these sites is based on the qualitative sample narrative evaluation.
a: This station was sampled in 2015.

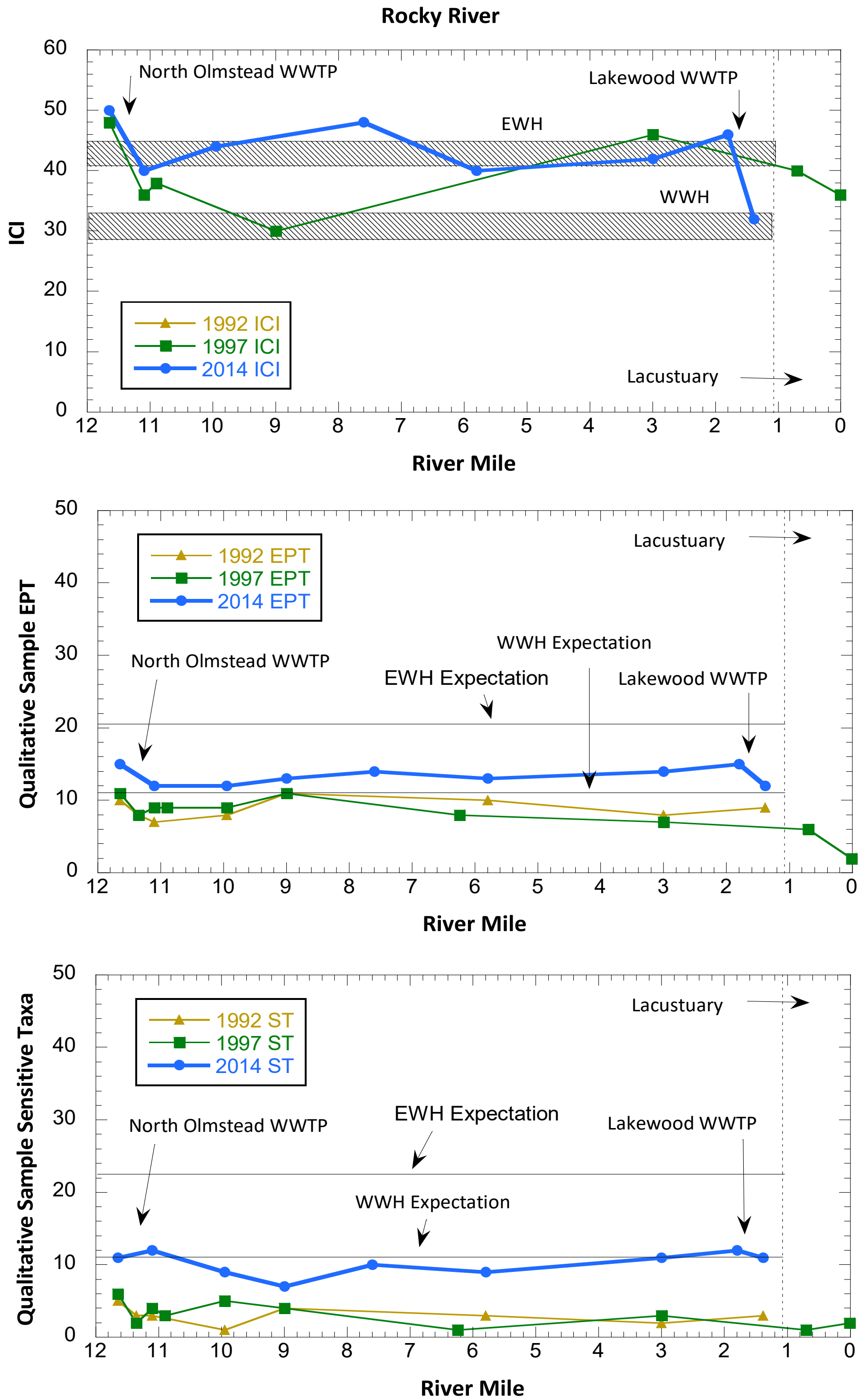


Figure 42. Longitudinal trend of the Invertebrate Community Index (ICI), number of EPT taxa (EPT) in the qualitative sample, and number of sensitive taxa (ST) in the qualitative sample in the Rocky River, 1992-2014.

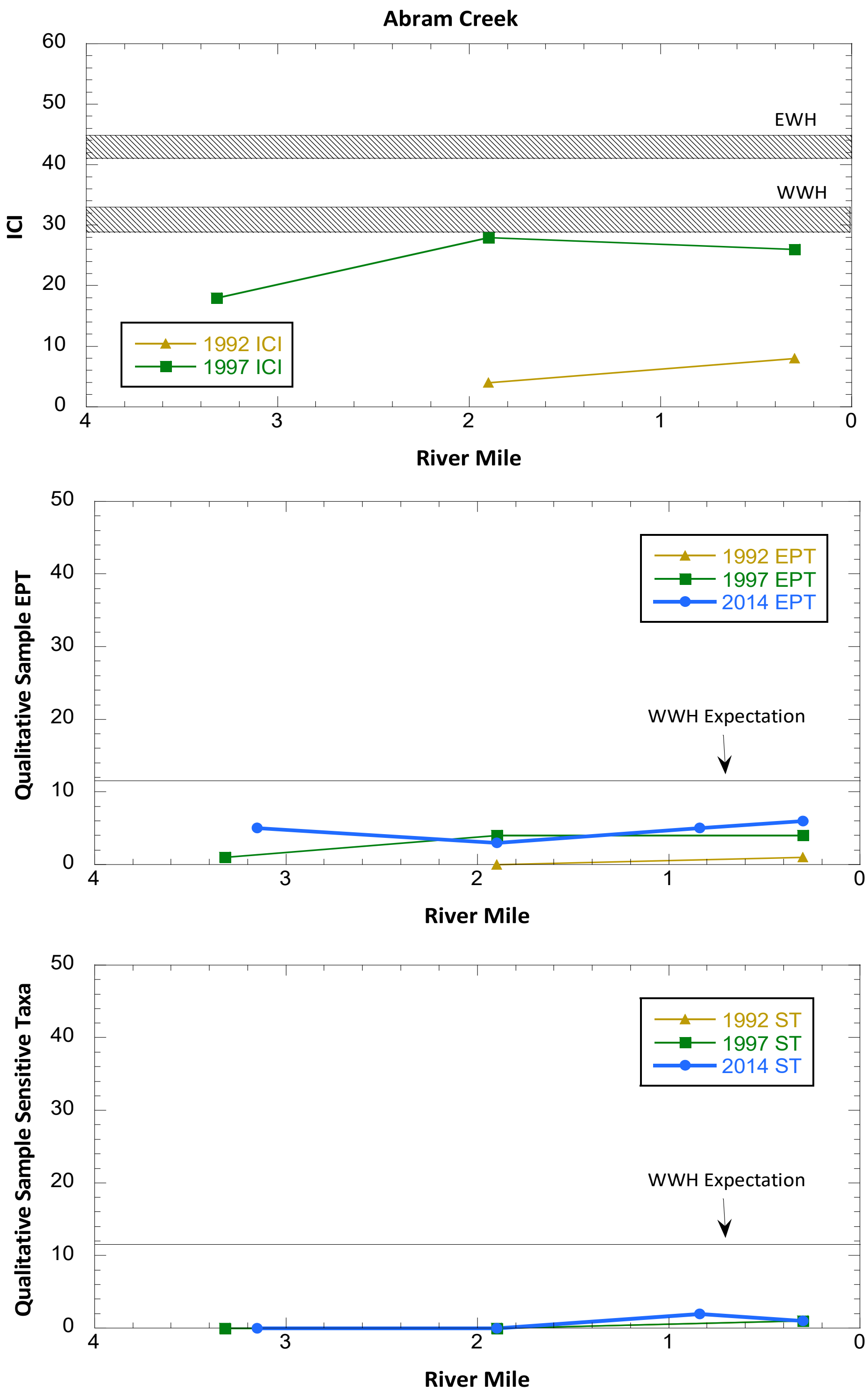


Figure 43. Longitudinal trend of the Invertebrate Community Index (ICI), number of EPT taxa (EPT) in the qualitative sample, and number of sensitive taxa (ST) in the qualitative sample in Abram Creek, 1992-2014.

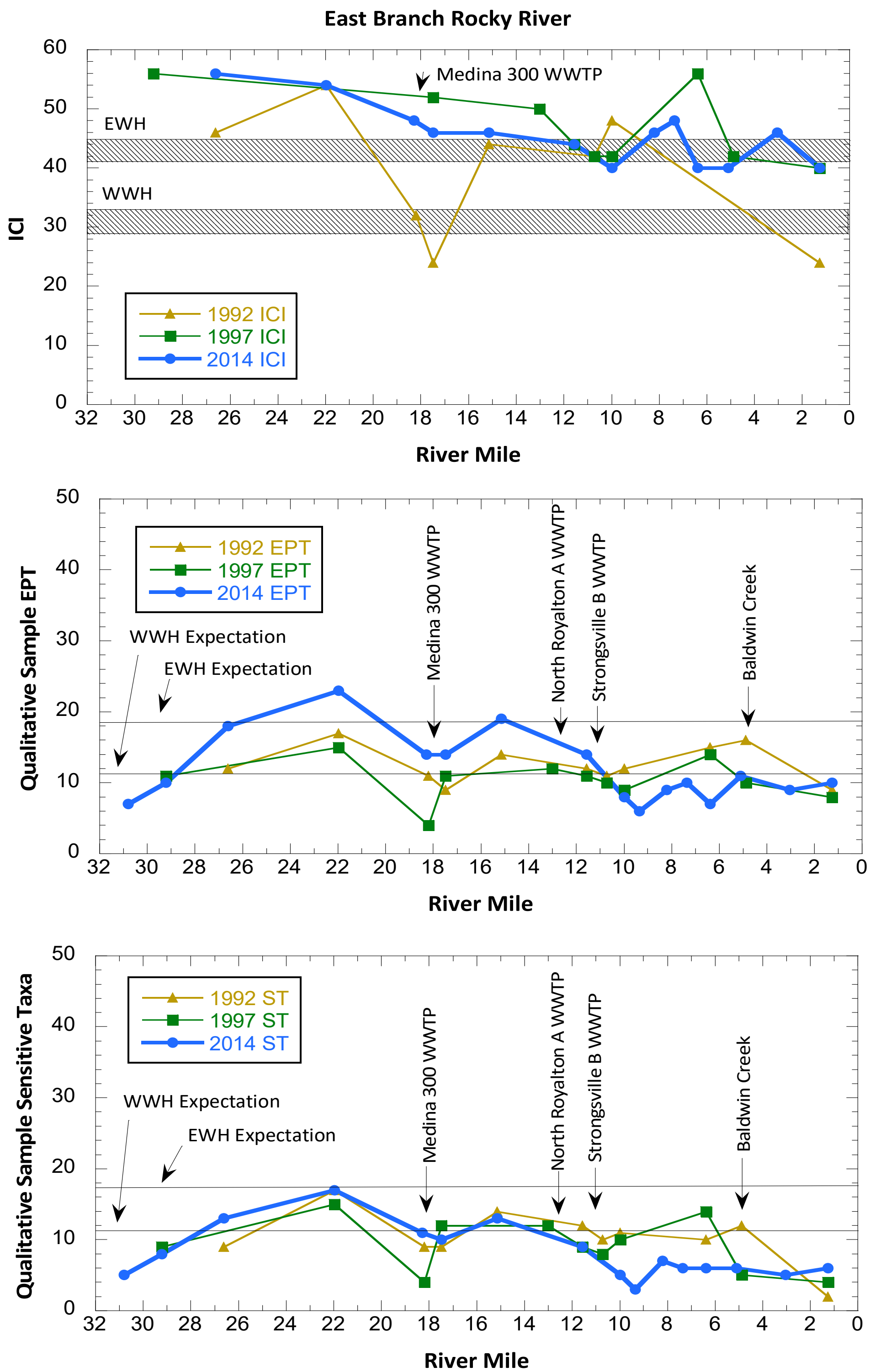


Figure 44. Longitudinal trend of the Invertebrate Community Index (ICI), number of EPT taxa (EPT) in the qualitative sample, and number of sensitive taxa (ST) in the qualitative sample in the East Branch Rocky River, 1992-2014.

East Branch Rocky River Tributaries

The Tributary to East Branch Rocky River AT RM 25.4 was a natural looking wooded stream at the sampling location near the mouth. The lower 0.5 mile of this stream was within the protected Hinckley Reservation. The EPT (18) and sensitive taxa diversity (16) were just below EWH expectations which led to the very good narrative evaluation. Four taxa of coldwater macroinvertebrate taxa were found at this station which would support a Coldwater Habitat aquatic life use designation.

The Tributary to East Branch Rocky River at RM 12.1 was a natural looking wooded stream at the sampling location near the mouth. The lower 1.4 miles of this stream was within the protected Mill Stream Run Reservation. The EPT (11) and sensitive taxa diversity (9) were a little above or at WWH expectations which led to the good narrative evaluation.

Baldwin Creek was sampled at five stations in 2014 and resampled at two of them in 2015 (Figure 45, Table 20). The two stations with quantitative data had ICI scores in the marginally good to good range. However, the qualitative sampling EPT (6-8) and sensitive taxa diversity (1-3) were not meeting WWH expectations. This stream is surrounded by urban areas which probably are an important factor in limiting its biotic integrity. Field notes indicated that this stream was impacted by altered flow regime, excess nutrients, sedimentation and habitat alterations. Parts of the lower 2.8 miles of this stream flows through the protected Big Creek and Mill Stream Run Reservations.

Healy Creek was sampled at Boston Road (RM 0.7). The adjacent land use is increasingly becoming urbanized. The macroinvertebrate community had low to moderate EPT (7) and low sensitive taxa (4) diversity which were both below WWH expectations. The community conditions in this stream were consistent with the effects of unrestrained and untreated urban runoff.

West Branch Rocky River

The West Branch Rocky River was sampled at 12 stations in 2014 (Figure 46, Table 20). All the stations with quantitative data had ICI scores in the very good to exceptional range. An exceptional evaluation was generally not supported by the qualitative sample EPT and sensitive taxa (ST) diversity. The EPT ranged from just above the good expectation (12 at RM 33.5) to the exceptional expectation (19 at RM 16.4), average EPT of 15. The sensitive taxa diversity ranged from below the WWH expectation (8 at RM 33.5, 9 at RMs 13.1 & 11.55) to the EWH expectation (18 at RM 27.3), average ST of 12. Overall, the macroinvertebrate communities in West Branch Rocky River were performing in the solidly good range.

The Medina County Sewer District No. 500 WWTP discharge (RM 14.8) was having at most a mild impact on the macroinvertebrate community with a 2-point increase in the ICI score, 6 taxa decline in EPT and an 8 taxa decline in sensitive taxa diversity (below WWH expectation). The EPT and sensitive taxa diversity improved farther downstream with the EPT approaching what it was upstream of the WWTP, but the sensitive taxa diversity remained somewhat depressed.

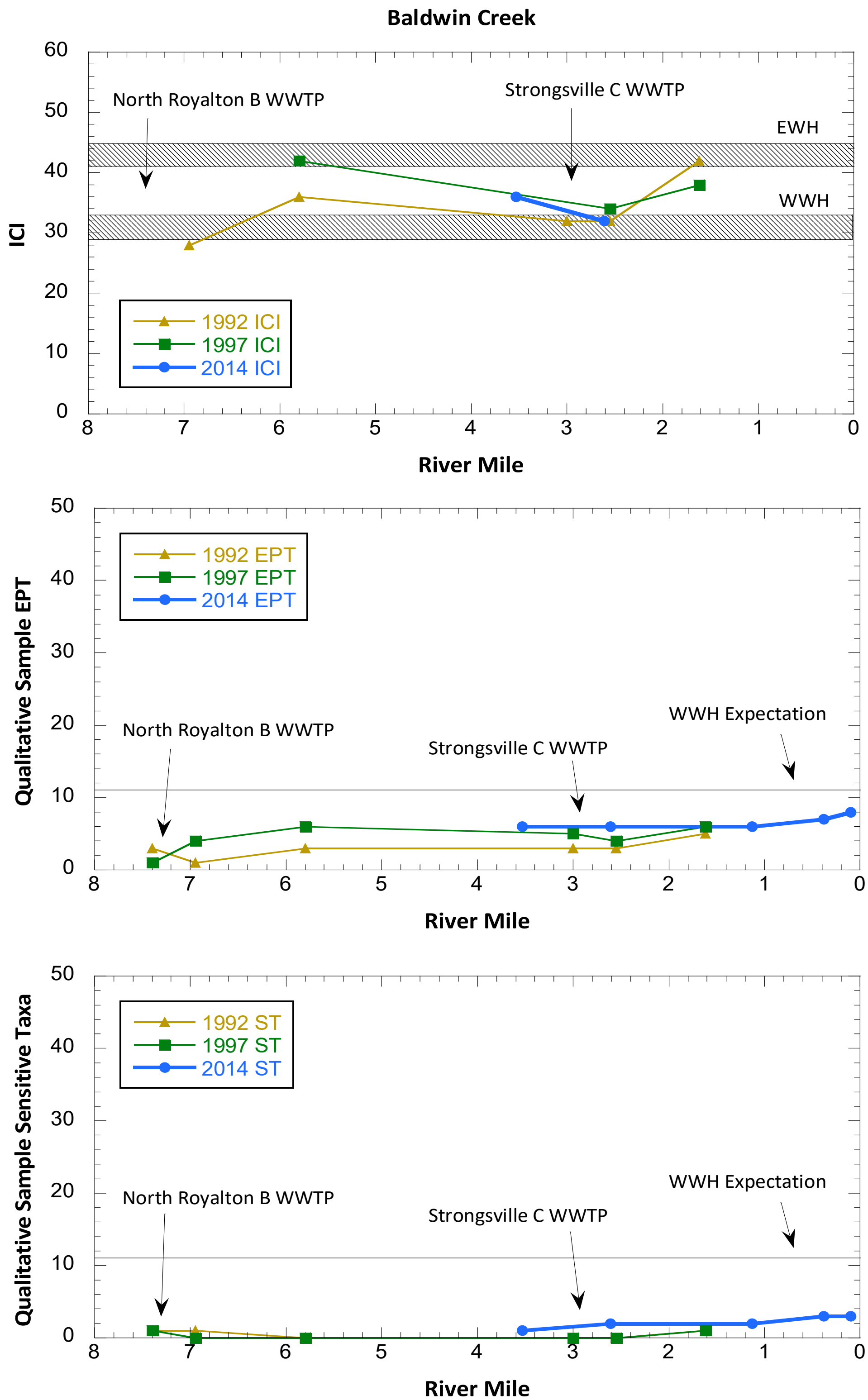


Figure 45. Longitudinal trend of the Invertebrate Community Index (ICI), number of EPT taxa (EPT) in the qualitative sample, and number of sensitive taxa (ST) in the qualitative sample in Baldwin Creek, 1992-2014.

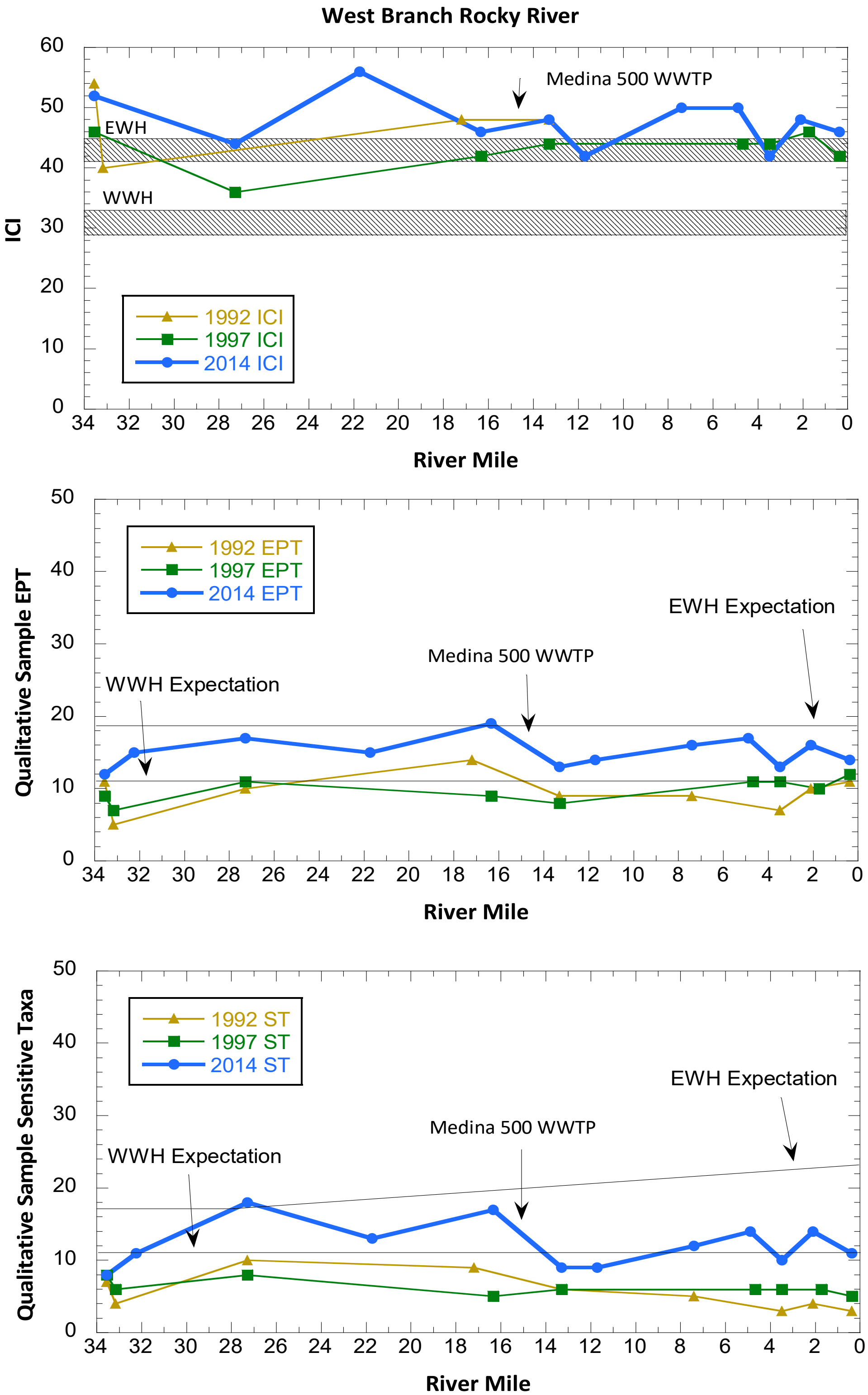


Figure 46. Longitudinal trend of the Invertebrate Community Index (ICI), number of EPT taxa (EPT) in the qualitative sample, and number of sensitive taxa (ST) in the qualitative sample in the West Branch Rocky River, 1992-2014.

West Branch Rocky River Tributaries

Blodgett Creek and Baker Creek flow through increasingly urbanizing areas. Macroinvertebrate metrics were slightly to moderately below WWH expectations. The community conditions in these streams were consistent with the effects of urban runoff.

The macroinvertebrate communities sampled in Plum Creek (North Br. Tributary) were characterized by low to moderate EPT (8-10), predominated by facultative taxa, and very low to low sensitive taxa diversity (0-4). This stream is increasingly becoming urbanized, especially the lower 3.5 miles.

The macroinvertebrate community sampled in Cossett Creek near its mouth at SR 252 retained a semblance of biotic integrity with moderate EPT (13) and low to moderate sensitive taxa diversity (6). The intact riparian corridor surrounding the lower part of the stream was the major factor in this positive situation. The upper basin is increasingly becoming urbanized which if steps are not taken will eventually degrade the entire stream.

The macroinvertebrate communities sampled in Mallet Creek and Broadway Creek were marginally meeting WWH expectations with moderate EPT (10-11) and low to moderate sensitive taxa diversity (4-8). Mallet Creek primarily has an intact riparian corridor with little adjacent development, so this level of performance is below what is expected. Broadway Creek on the other hand flows through the middle of the town of Medina, so this biological performance is probably at the upper end of what is expected considering the channel modifications and lack of runoff control and treatment associated with most urban developments.

The macroinvertebrate community sampled in Champion Creek was marginally meeting WWH expectations with moderate EPT (11) and low to moderate sensitive taxa diversity (6). Similar to Broadway Creek, this stream flows through the middle of the town of Medina, so this biological performance is probably at the upper end of what is expected considering the channel modifications and lack of runoff control and treatment associated with most urban developments.

The upper parts of Plum Creek (West Br. Tributary) and Granger Ditch were not meeting WWH expectations with low to moderate EPT (4-8) and very low to low sensitive taxa diversity (0-3). The upper part of Plum Creek was highly urbanized and channelized which probably were the main limiting factors for the biotic integrity. The upper part of Granger Ditch was channelized and had low gradient which were probably the primary limiting factors for the biotic integrity. The downstream portions of the streams in this basin improved until exceptional community conditions were present in North Branch Rocky River (19 EPT & 16 ST at RM 0.4).

MACROBENTHOS COMMUNITY TRENDS

The performance of macroinvertebrate communities in 2014 were compared to sampling efforts in 1997 and 1992. Overall, the macroinvertebrate communities in the Rocky River mainstem in 2014 showed improvement compared to previous sampling (Figure 42). The average ICI was 45.5 compared to 39.6 in 1997; the average qualitative sample EPT was 13.3 compared to 9.4 and 8.9, respectively; and the average sensitive taxa diversity was 10.2 compared to 3.3 and 3.0, respectively.

The macroinvertebrate communities in Abram Creek have consistently performed below WWH expectations (Figure 43). There was improvement from the 1992 to the 1997 sampling with the average ICI going from 6 to 27 and the average qualitative EPT from 0.5 to 4. It is unlikely that the biotic integrity of Abram Creek will improve much until comprehensive urban runoff control and treatment is implemented.

The macroinvertebrate communities in East Branch Rocky River were generally similar between 1992 and 2014 (Figure 44). One area of difference was in the lower part of the river downstream from about RM 11.2. The qualitative EPT and sensitive taxa diversity declined in this area compared to previous sampling (12.6 & 9.0 in 1992, 10.2 & 8.2 in 1997, and 8.75 & 5.75 in 2014; average diversity, respectively). This may be the result of increased urbanization in this area.

The macroinvertebrate communities in Baldwin Creek have performed consistently since 1992 (Figure 45). The ICI scores have generally ranged from marginally good to very good, while the qualitative sample EPT and sensitive taxa diversity have consistently remained below WWH expectations.

The macroinvertebrate communities in West Branch Rocky River demonstrated similar downstream trends in previous years (Figure 46). The difference was that the qualitative sample EPT and sensitive taxa diversity in 2014 demonstrated improved biotic integrity compared to 1992 and 1997 (9.6 & 5.7 in 1992, 9.8 & 6.2 in 1997, and 15.1 & 12.2 in 2014; average diversity, respectively).

FISH TISSUE CONTAMINATION

Ohio has been sampling streams annually for sport fish contamination since 1993. Fish are analyzed for contaminants that bioaccumulate in fish and that could pose a threat to human health if consumed in excessive amounts. Contaminants analyzed in Ohio sport fish include mercury, PCBs, DDT, mirex, hexachlorobenzene, lead, selenium, and several other metals and pesticides. Other contaminants are sometimes analyzed if indicated by site-specific current or historic sources. Information regarding analytes, tissue collections, or the history of the fish contaminant program are provided in Ohio EPA (2012b) http://www.epa.state.oh.us/portals/35/fishadvisory/FishAdvisoryProcedure10.pdf.

Fish contaminant data are primarily used for three purposes:

1) to determine fish advisories;
2) to determine attainment with the water quality standards; and
3) to examine trends in fish contaminants over time.

Fish advisories

Fish contaminant data are used to determine a meal frequency that is safe for people to consume (e.g., two meals a week, one meal a month, do not eat), and a fish advisory is issued for applicable species and locations. Because mercury mostly comes from nonpoint sources, primarily aerial deposition, Ohio has had a statewide one meal a week advisory for most fish since 2001. Most fish are assumed to be safe to eat once a week unless specified otherwise in the fish advisory, which can be viewed at http://www.epa.state.oh.us/dsw/fishadvisory/index.aspx.

The minimum data requirement for issuing a fish advisory is 3 samples of a single species from within the past 10 years. For the Rocky River study area, including the mainstem and east and west branches, numerous species met this requirement. For the mainstem, sufficient samples were collected to evaluate rainbow trout, rock bass, and smallmouth bass. No advisories previously existed on the mainstem, and no species were identified as needing advisories as a result of this new data, so the statewide advisory (see below) remains in effect for all species.

For the East Branch, sufficient samples were collected to evaluate common carp, largemouth bass, rock bass, smallmouth bass, and yellow bullhead. The East Branch previously had a “one meal per month” advisory in place for rock bass due to mercury. No species were identified as needing new advisories based on this new data, thus the statewide advisory remains in effect for all species other than rockbass. Rockbass mercury concentrations were low, and it was recommended that the advisory for this species be flagged for follow-up and removal, pending a confirmation round of sampling.

For the West Branch, sufficient samples were collected for bluegill sunfish, common carp, rock bass, smallmouth bass, and yellow bullhead. The west branch previously has a “one meal per month” advisory in place for rock bass and smallmouth bass due to mercury. No species were identified as needing new advisories based on this new data (so the statewide advisory remains in effect for all species other than rock bass and smallmouth bass). Rockbass mercury concentrations were low, and it was recommended that the rock bass advisory can be flagged for follow-up and removal, pending a confirmation round of sampling. Smallmouth bass mercury concentrations remained in the “one meal per month” range and the existing advisory was confirmed as appropriate.

The statewide advisories, which apply to all species without a location-specific advisory in place, are: two meals a week for sunfish (e.g., bluegill) and yellow perch, one meal a week for most other fish, and one meal a month for flathead catfish 23” and over, and northern pike 23” and over, and steelhead trout from Lake Erie and its tributaries including the Rocky River.

The vast majority of consumption advisories in Ohio’s waters are due to mercury or PCB contamination. For a listing of fish tissue mercury and PCB data collected from Rocky River mainstem and East and West Branches in support of the advisory program, and how the data compare to advisory thresholds, see Tables 21 and 22.

Fish tissue/human health use attainment

In addition to determining safe meal frequencies, fish contaminant data are also used to determine attainment with the human health water quality criteria pursuant to OAC Rule 3745-1-34. The human health water quality criteria are presented in water column concentrations of µg/l, and are then translated into fish tissue concentrations in mg/kg. [See Ohio’s 2016 Integrated Report, Section E (http://epa.ohio.gov/Portals/35/tmdl/2016intreport/SectionE.pdf) for further details of this conversion.]

In order to be considered in attainment of the water quality standards, the sport fish caught within a HUC12 must have a weighted average concentration of the geometric means for all species below 0.35 mg/kg for mercury, and below 0.023 mg/kg for PCBs within the Lake Erie basin.

Within the Rocky River study area, fish tissue data were adequate to determine attainment status at all six watershed assessment units (WAUs) that were sampled. At least 2 samples from each trophic level, 3 and 4, were needed for each WAU. Prior to the 2014 sampling (as assessed in the 2016 Ohio Integrated Report), two WAUs in the study area had an attainment status of “1” (full attainment for fish tissue contaminants — meeting human health goals; based on current data), and four WAUs had an attainment status of “5h” (impaired based on historical data; current data unavailable). After the Rocky River survey and data assessment, all six WAUs were found to be in attainment and assigned a new status of “1,” as shown in Table 23.

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Table 21. Select fish tissue mercury data from 2014 Rocky River basin sampling (mg/kg), including the east and west branches. The shading indicates the applicable advisory category: Blue=unrestricted consumption, Green=two meals per week, Yellow=one meal per week, Orange=one meal per month.

Site/Station	River Mile	Sample Type	Species	Result (mg/kg)
E. BR. ROCKY R. AT SPAFFORD RD. FORD	1.28	fillet	ROCK BASS	0.066
E. BR. ROCKY R. AT SPAFFORD RD. FORD	1.28	fillet	SMALLMOUTH BASS	0.113
E. BR. ROCKY R. AT SPAFFORD RD. FORD	1.28	fillet	YELLOW BULLHEAD	0.119
E. BR. ROCKY R. AT SPAFFORD RD. FORD	1.28	fillet	LARGEMOUTH BASS	0.119
E. BR. ROCKY R. DST (OLD) BEREA WWTP AT FORD	3.06	fillet	COMMON CARP	0.053
E. BR. ROCKY R. DST (OLD) BEREA WWTP AT FORD	3.06	fillet	COMMON CARP	0.081
E. BR. ROCKY R. DST (OLD) BEREA WWTP AT FORD	3.06	fillet	SMALLMOUTH BASS	0.086
E. BR. ROCKY R. DST (OLD) BEREA WWTP AT FORD	3.06	fillet	ROCK BASS	0.101
E. BR. ROCKY R. DST (OLD) BEREA WWTP AT FORD	3.06	fillet	SMALLMOUTH BASS	0.152
E. BR. ROCKY R. AT BEREA, UPST. BALDWIN CREEK	5.1	fillet	COMMON CARP	0.038
E. BR. ROCKY R. AT BEREA, UPST. BALDWIN CREEK	5.1	fillet	LARGEMOUTH BASS	0.067
E. BR. ROCKY R. AT BEREA, UPST. BALDWIN CREEK	5.1	fillet	SMALLMOUTH BASS	0.093
E. BR. ROCKY R. AT BEREA, UPST. BALDWIN CREEK	5.1	fillet	ROCK BASS	0.178

Site/Station	River Mile	Sample Type	Species	Result (mg/kg)
E. BR. ROCKY R. NEAR BEREA AT FORD UPST. BALDWIN LAKE	6.38	fillet	ROCK BASS	0.076
E. BR. ROCKY R. NEAR BEREA AT FORD UPST. BALDWIN LAKE	6.38	fillet	YELLOW BULLHEAD	0.11
E. BR. ROCKY R. AT MILL STREAM RUN BRIDGE, DST. I-71	10	fillet	ROCK BASS	0.069
E. BR. ROCKY R. AT STRONGSVILLE AT SR 82/ROYALTON RD.	11.57	fillet	ROCK BASS	0.335
ROCKY R. DST. LAKEWOOD WWTP AT METROPARK DRIVE.	1.39	fillet	ROCK BASS	0.096
ROCKY R. DST. LAKEWOOD WWTP AT METROPARK DRIVE.	1.39	fillet	SMALLMOUTH BASS	0.104
ROCKY R. DST. LAKEWOOD WWTP AT METROPARK DRIVE.	1.39	fillet	RAINBOW TROUT	0.105
ROCKY R. DST. LAKEWOOD WWTP AT METROPARK DRIVE.	1.39	fillet	LARGEMOUTH BASS	0.105
ROCKY R. DST. LAKEWOOD WWTP AT METROPARK DRIVE.	1.39	fillet	RAINBOW TROUT	0.136
ROCKY R. UPST. LAKEWOOD WWTP	1.8	fillet	SMALLMOUTH BASS	0.06
ROCKY R. UPST. LAKEWOOD WWTP	1.8	fillet	ROCK BASS	0.126
ROCKY R. UPST. LAKEWOOD WWTP	1.8	fillet	SMALLMOUTH BASS	0.168
ROCKY R. AT OLD FORD NEAR MASTICK GOLF COURSE	7.6	fillet	YELLOW BULLHEAD	0.052
ROCKY R. AT OLD FORD NEAR MASTICK GOLF COURSE	7.6	fillet	ROCK BASS	0.07
ROCKY R. AT OLD FORD NEAR MASTICK GOLF COURSE	7.6	fillet	SMALLMOUTH BASS	0.203
ROCKY R. NEAR BROOK PARK AT BROOK PARK RD.	9.95	fillet	CHANNEL CATFISH	0.04
ROCKY R. NEAR BROOK PARK AT BROOK PARK RD.	9.95	fillet	COMMON CARP	0.102
ROCKY R. NEAR BROOK PARK AT BROOK PARK RD.	9.95	fillet	SMALLMOUTH BASS	0.152
ROCKY R. UPST. NORTH OLMSTEAD WWTP AT FORD	11.65	fillet	SMALLMOUTH BASS	0.082
ROCKY R. UPST. NORTH OLMSTEAD WWTP AT FORD	11.65	fillet	YELLOW BULLHEAD	0.101
ROCKY R. UPST. NORTH OLMSTEAD WWTP AT FORD	11.65	fillet	SMALLMOUTH BASS	0.113
ROCKY R. UPST. NORTH OLMSTEAD WWTP AT FORD	11.65	fillet	COMMON CARP	0.123
W. BR. ROCKY R. NEAR NORTH OLMSTEAD AT LEWIS RD.	0.39	fillet	SMALLMOUTH BASS	0.119
W. BR. ROCKY R. NEAR NORTH OLMSTEAD AT LEWIS RD.	0.39	fillet	COMMON CARP	0.152
W. BR. ROCKY R. NEAR NORTH OLMSTEAD AT LEWIS RD.	0.39	fillet	SMALLMOUTH BASS	0.191
W. BR. ROCKY R. AT WEST VIEW, DST. BAKER CREEK	4.9	fillet	ROCK BASS	0.107
W. BR. ROCKY R. AT WEST VIEW, DST. BAKER CREEK	4.9	fillet	SMALLMOUTH BASS	0.376
W. BR. ROCKY R. AT WEST VIEW, DST. BAKER CREEK	4.9	fillet	SMALLMOUTH BASS	0.613
W. BR. ROCKY R. AT BEND ADJ WEST RIVER RD	7.4	fillet	YELLOW BULLHEAD	0.174
W. BR. ROCKY R. AT BEND ADJ WEST RIVER RD	7.4	fillet	COMMON CARP	0.263
W. BR. ROCKY R. AT BEND ADJ WEST RIVER RD	7.4	fillet	SMALLMOUTH BASS	0.338
W. BR. ROCKY R. AT BEND ADJ WEST RIVER RD	7.4	fillet	SMALLMOUTH BASS	0.575
W. BR. ROCKY R. AT BEND ADJ WEST RIVER RD	7.4	fillet	SMALLMOUTH BASS	0.833
W. BR. ROCKY R. ADJ WEST RIVER RD.	13.3	fillet	ROCK BASS	0.12
W. BR. ROCKY R. ADJ WEST RIVER RD.	13.3	fillet	COMMON CARP	0.124
W. BR. ROCKY R. ADJ WEST RIVER RD.	13.3	fillet	LARGEMOUTH BASS	0.168
W. BR. ROCKY R. ADJ WEST RIVER RD.	13.3	fillet	SMALLMOUTH BASS	0.439
W. BR. ROCKY R. NEAR ABBEYVILLE AT NEFF RD.	21.75	fillet	SMALLMOUTH BASS	0.162
W. BR. ROCKY R. DST. MEDINA AT FENN RD.	27.3	fillet	SMALLMOUTH BASS	0.17
W. BR. ROCKY R. DST. MEDINA AT FENN RD.	27.3	fillet	ROCK BASS	0.224

Site/Station	River Mile	Sample Type	Species	Result (mg/kg)
W. BR. ROCKY R. NEAR MEDINA AT WEYMOUTH RD.	29.39	fillet	YELLOW BULLHEAD	0.135
W. BR. ROCKY R. NEAR MEDINA AT WEYMOUTH RD.	29.39	fillet	SMALLMOUTH BASS	0.16
W. BR. ROCKY R. NEAR MEDINA AT WEYMOUTH RD.	29.39	fillet	COMMON CARP	0.178
W. BR. ROCKY R. NEAR MEDINA AT WEYMOUTH RD.	29.39	fillet	ROCK BASS	0.239

Table 22**.** Select fish tissue PCB data from 2014 Rocky River basin sampling (mg/kg), including the East and West branches. Shading indicates the applicable advisory category: Blue=unrestricted, Green=two meals per week, yellow=one meal per week, orange=one meal per month.

Waterbody/Site	River Mile	Sample Type	Species	Value (mg/kg)	Detect
E. BR. ROCKY RIVER AT SPAFFORD RD. FORD	1.28	fillet	SMALLMOUTH BASS	0.0495	No
E. BR. ROCKY RIVER AT SPAFFORD RD. FORD	1.28	fillet	LARGEMOUTH BASS	0.0495	No
E. BR. ROCKY RIVER AT SPAFFORD RD. FORD	1.28	fillet	YELLOW BULLHEAD	0.0496	No
E. BR. ROCKY RIVER AT SPAFFORD RD. FORD	1.28	fillet	ROCK BASS	0.0496	No
E. BR. ROCKY RIVER DST (OLD) BEREA WWTP AT FORD	3.06	fillet	COMMON CARP	0.0496	No
E. BR. ROCKY RIVER DST (OLD) BEREA WWTP AT FORD	3.06	fillet	SMALLMOUTH BASS	0.0498	No
E. BR. ROCKY RIVER DST (OLD) BEREA WWTP AT FORD	3.06	fillet	SMALLMOUTH BASS	0.0498	No
E. BR. ROCKY RIVER DST (OLD) BEREA WWTP AT FORD	3.06	fillet	COMMON CARP	0.0498	No
E. BR. ROCKY RIVER DST (OLD) BEREA WWTP AT FORD	3.06	fillet	ROCK BASS	0.0499	No
E. BR. ROCKY RIVER AT BEREA, UPST. BALDWIN CREEK	5.1	fillet	LARGEMOUTH BASS	0.0495	No
E. BR. ROCKY RIVER AT BEREA, UPST. BALDWIN CREEK	5.1	fillet	SMALLMOUTH BASS	0.0495	No
E. BR. ROCKY RIVER AT BEREA, UPST. BALDWIN CREEK	5.1	fillet	ROCK BASS	0.0497	No
E. BR. ROCKY RIVER AT BEREA, UPST. BALDWIN CREEK	5.1	fillet	COMMON CARP	0.05	No
E. BR. ROCKY RIVER AT FORD UPST. BALDWIN LAKE	6.38	fillet	ROCK BASS	0.0496	No
E. BR. ROCKY RIVER AT FORD UPST. BALDWIN LAKE	6.38	fillet	YELLOW BULLHEAD	0.0496	No
E. BR. ROCKY RIVER AT MILL STREAM RUN, DST. I-71	10	fillet	ROCK BASS	0.0498	No
E. BR. ROCKY RIVER AT SR 82/ROYALTON RD.	11.57	fillet	ROCK BASS	0.0497	No
ROCKY R. DST. LAKEWOOD WWTP AT METROPARK DR.	1.39	fillet	SMALLMOUTH BASS	0.0495	No
ROCKY R. DST. LAKEWOOD WWTP AT METROPARK DR.	1.39	fillet	LARGEMOUTH BASS	0.0496	No
ROCKY R. DST. LAKEWOOD WWTP AT METROPARK DR.	1.39	fillet	ROCK BASS	0.0497	No
ROCKY R. DST. LAKEWOOD WWTP AT METROPARK DR.	1.39	fillet	RAINBOW TROUT	0.1832	Yes
ROCKY R. DST. LAKEWOOD WWTP AT METROPARK DR.	1.39	fillet	RAINBOW TROUT	0.278	Yes
ROCKY RIVER UPST. LAKEWOOD WWTP	1.8	fillet	ROCK BASS	0.0494	No
ROCKY RIVER UPST. LAKEWOOD WWTP	1.8	fillet	SMALLMOUTH BASS	0.0495	No
ROCKY RIVER UPST. LAKEWOOD WWTP	1.8	fillet	SMALLMOUTH BASS	0.0495	No
ROCKY RIVER AT OLD FORD NEAR MASTICK GOLF COURSE	7.6	fillet	SMALLMOUTH BASS	0.0498	No
ROCKY RIVER AT OLD FORD NEAR MASTICK GOLF COURSE	7.6	fillet	YELLOW BULLHEAD	0.0498	No
ROCKY RIVER AT OLD FORD NEAR MASTICK GOLF COURSE	7.6	fillet	ROCK BASS	0.05	No
ROCKY RIVER AT BROOK PARK RD.	9.95	fillet	CHANNEL CATFISH	0.0495	No
ROCKY RIVER AT BROOK PARK RD.	9.95	fillet	COMMON CARP	0.0495	No
ROCKY RIVER AT BROOK PARK RD.	9.95	fillet	SMALLMOUTH BASS	0.05	No

Waterbody/Site	River Mile	Sample Type	Species	Value (mg/kg)	Detect
ROCKY RIVER UPST. NORTH OLMSTEAD WWTP AT FORD	11.65	fillet	SMALLMOUTH BASS	0.0497	No
ROCKY RIVER UPST. NORTH OLMSTEAD WWTP AT FORD	11.65	fillet	SMALLMOUTH BASS	0.0498	No
ROCKY RIVER UPST. NORTH OLMSTEAD WWTP AT FORD	11.65	fillet	YELLOW BULLHEAD	0.0499	No
ROCKY RIVER UPST. NORTH OLMSTEAD WWTP AT FORD	11.65	fillet	COMMON CARP	0.05	No
W. BR. ROCKY RIVER AT LEWIS RD.	0.39	fillet	SMALLMOUTH BASS	0.0498	No
W. BR. ROCKY RIVER AT LEWIS RD.	0.39	fillet	SMALLMOUTH BASS	0.0498	No
W. BR. ROCKY RIVER AT LEWIS RD.	0.39	fillet	COMMON CARP	0.058	Yes
W. BR. ROCKY RIVER, DST. BAKER CREEK	4.9	fillet	SMALLMOUTH BASS	0.0495	No
W. BR. ROCKY RIVER, DST. BAKER CREEK	4.9	fillet	SMALLMOUTH BASS	0.0496	No
W. BR. ROCKY RIVER AT WEST VIEW, DST. BAKER CREEK	4.9	fillet	ROCK BASS	0.0499	No
W. BR. ROCKY RIVER AT BEND ADJ WEST RIVER RD	7.4	fillet	SMALLMOUTH BASS	0.0497	No
W. BR. ROCKY RIVER AT BEND ADJ WEST RIVER RD	7.4	fillet	COMMON CARP	0.0498	No
W. BR. ROCKY RIVER AT BEND ADJ WEST RIVER RD	7.4	fillet	SMALLMOUTH BASS	0.0498	No
W. BR. ROCKY RIVER AT BEND ADJ WEST RIVER RD	7.4	fillet	SMALLMOUTH BASS	0.0499	No
W. BR. ROCKY RIVER AT BEND ADJ WEST RIVER RD	7.4	fillet	YELLOW BULLHEAD	0.05	No
W. BR. ROCKY RIVER ADJ WEST RIVER RD.	13.3	fillet	LARGEMOUTH BASS	0.0497	No
W. BR. ROCKY RIVER ADJ WEST RIVER RD.	13.3	fillet	COMMON CARP	0.0498	No
W. BR. ROCKY RIVER ADJ WEST RIVER RD.	13.3	fillet	ROCK BASS	0.0499	No
W. BR. ROCKY RIVER ADJ WEST RIVER RD.	13.3	fillet	SMALLMOUTH BASS	0.05	No
W. BR. ROCKY RIVER AT NEFF RD.	21.75	fillet	SMALLMOUTH BASS	0.05	No
W. BR. ROCKY R. DST. MEDINA AT FENN RD.	27.3	fillet	SMALLMOUTH BASS	0.0498	No
W. BR. ROCKY R. DST. MEDINA AT FENN RD.	27.3	fillet	ROCK BASS	0.0498	No
W. BR. ROCKY RIVER AT WEYMOUTH RD.	29.39	fillet	SMALLMOUTH BASS	0.0497	No
W. BR. ROCKY RIVER AT WEYMOUTH RD.	29.39	fillet	ROCK BASS	0.0497	No
W. BR. ROCKY RIVER AT WEYMOUTH RD.	29.39	fillet	COMMON CARP	0.05	No
W. BR. ROCKY RIVER AT WEYMOUTH RD.	29.39	fillet	YELLOW BULLHEAD	0.05	No

Table 23. Attainment status updates for the Rocky River study area in Ohio's 2016 Integrated Report.

Watershed Assessment Unit ID	Assessment Unit Name	Previous Status (2014)	New status (2016)	Reason for change
04110001 01 05	City of Medina-West Branch Rocky River	5h	1	New Data
04110001 01 06	Cossett Creek-West Branch Rocky River	1	1	No change
04110001 01 08	Baker Creek-West Branch Rocky River	1	1	No change
04110001 02 01	Headwaters East Branch Rocky River	5h	1	New Data
04110001 02 02	Baldwin Creek-East Branch Rocky River	5h	1	New Data
04110001 02 03	Rocky River	5h	1	New Data

Fish contaminant Trends

Fish contaminant levels can be used as an indicator of pollution in the water column at levels lower than laboratory reporting limits for water concentrations but high enough to pose a threat to human health from eating fish. Most bioaccumulative contaminant concentrations are decreasing in the environment because of bans on certain types of chemicals like PCBs, and because of stricter permitting limits on dischargers for other chemicals. However, data show that PCBs continue to pose a risk to humans who consume fish, and mercury concentrations have been increasing in some locations because of increases in certain types of industries for which mercury is a byproduct that is released to air and/or surface water.

For this reason, it is useful to compare the results from the survey presented in this TSD with the results of the previous survey(s) done in the study area. Recent data can be compared against historical data to determine whether contaminant concentrations in fish tissue appear to be increasing, decreasing, or staying the same in a water body or watershed.

Fish tissue had previously been collected from the Rocky River mainstem in 1974, 1981, 1987, 1992, 1993, 1995, 1997, 2000, 2002, 2009, and 2012, although not all analytes were assessed in all years. Mercury concentrations were low to moderate in 1974 and were low in all subsequent years (with 1992 being the next year with mercury data on record). With the exception of some samples taken in 1974, all samples on record had mercury concentrations at or below 0.2 mg/kg, which is within the “one meal per week” advisory range, which is the statewide advisory for most species in Ohio. Species averages calculated for each species in each sampling year (Figure 48) consistently trends around the 0.11 mg/kg advisory threshold, below which species can be consumed at the “two meals per week” advisory level.

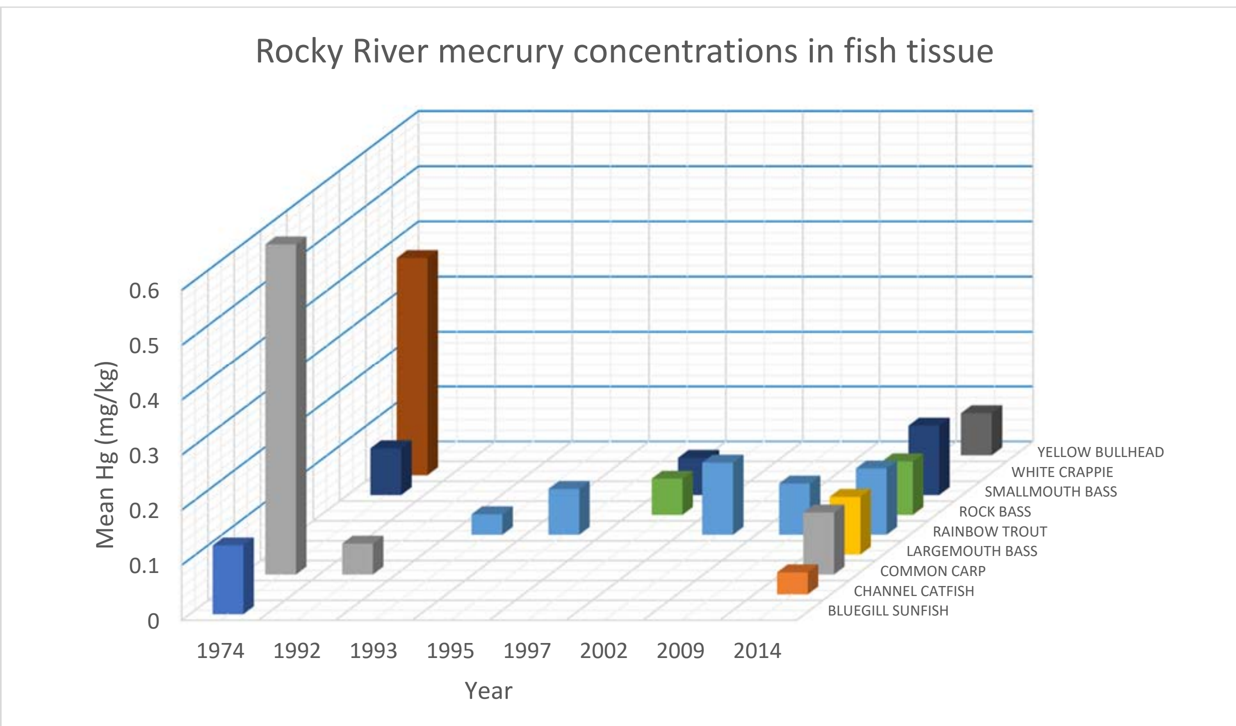

Figure 47. Mercury concentrations (mg/kg) in Rocky River fish, presented as species averages for each year.

PCB concentrations are generally low in Rocky River mainstem fish. Some species (common carp, bluegill sunfish) were observed to have moderately high PCB concentrations exceeding 1 mg/kg total PCBs in the 1980s (Figure 49). Because bluegill sunfish generally have low PCB concentrations compared to other species, it's likely that other species had elevated PCB concentrations at this time as well; however, these samples from 1981 and 1987 were analyzed as whole body samples, which tend to give elevated total PCB results due to the concentration of PCBs in the fat and organs (and not in the muscle—the primary edible portion of the fish).

Samples in subsequent years were analyzed as fillet samples (primarily skin-on fillets), which is more appropriate to the goal of assessing the risk to consumers of fish as this more closely approximates the consumed portion of the organism. Subsequent to the switch to fillet samples, observed PCB concentrations in Rocky River fish have been generally low. Although moderate concentrations of PCBs have been observed in rainbow trout over previous sampling events, these concentrations appear to be decreasing over time and are currently low. Overall, PCBs were only detected in 11% of the tissue samples in 2014, down from 100% in most previous years.

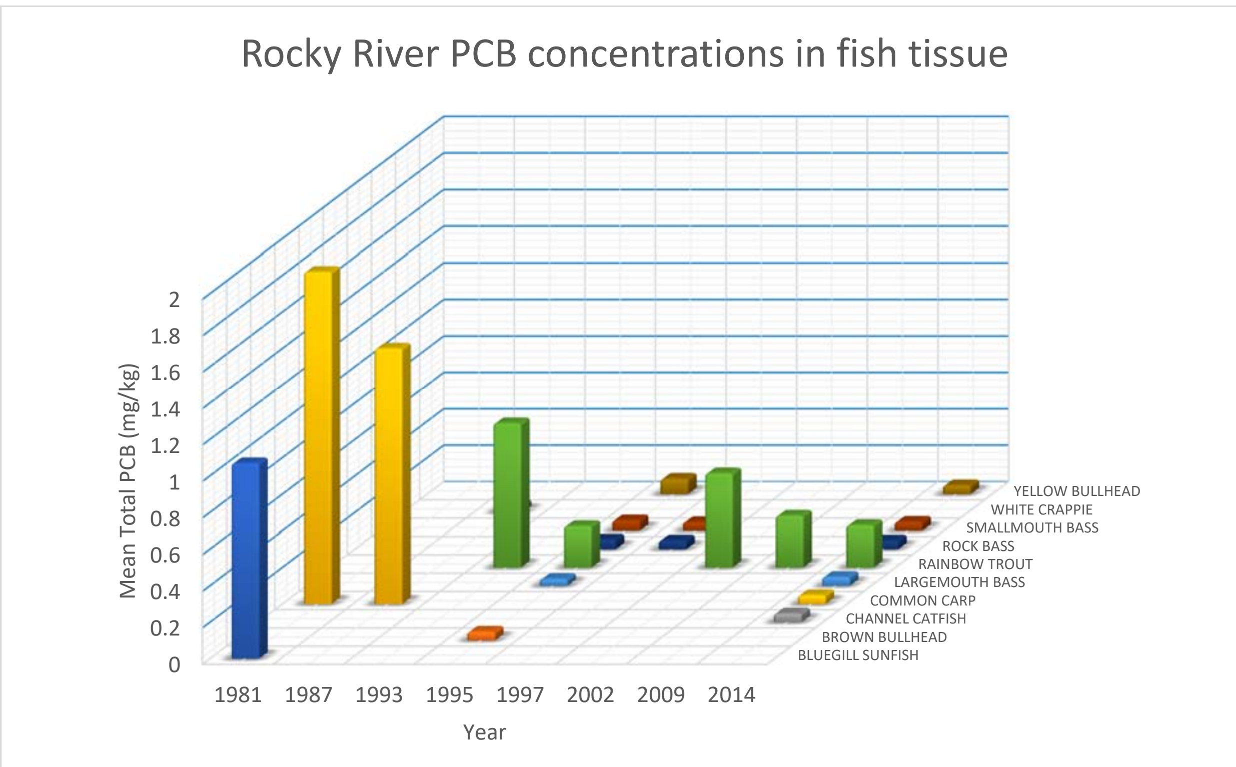

Figure 48. PCB concentrations (mg/kg) in Rocky River fish, presented as species averages for each year. Non-detects are represented at the reporting limit of approximately 0.05 mg/kg.

Fish tissue samples have been collected from the East Branch Rocky River in 1995 (one sample), 2000, 2012, and 2014. Mercury concentrations (Figure 50) were low in all years (peak 0.335 mg/kg, grand sample average of 0.125 mg/kg), with no particular trend evident in the data. At these observed mercury concentrations, the natural variation in the sample concentrations and in the analytical methods tends to dwarf any relevant trend, i.e., the noise-to-signal ratio is a substantial factor when working at the low end of the scale. Despite this, the data seems generally stable showing relatively low levels of mercury over time.

PCBs have generally not been detected in samples from the East Branch, or PCBs have been detected at relatively low levels (Figure 51). All four tissue samples collected in 1995 had PCBs detected at very low level, while only one of ten samples had PCBs detected in 2000. Of the 26 samples taken between 2012 and 2014, PCBs were not detected in any sample. The vast majority of the samples from the East Branch were at or near the threshold for the "unrestricted consumption" advisory level in all years.

Fish tissue samples have been collected from the West Branch Rocky River in 2000, 2012, and 2014 (Figure 52). Each year had a fairly large sample size (18+ samples each year), although these samples were spread across numerous species. Mercury concentrations appear to have been relatively stable across these sampling events, with most species showing average concentrations in the 0.1 to 0.2 mg/kg range (in the "one meal per week" consumption advisory range), although some species averaged between 0.2 and 0.4 mg/kg range, and some individual samples ranged as high as nearly 0.9 mg/kg (approaching the "six meals per year" consumption advisory threshold). No particular trend is evident in the data.

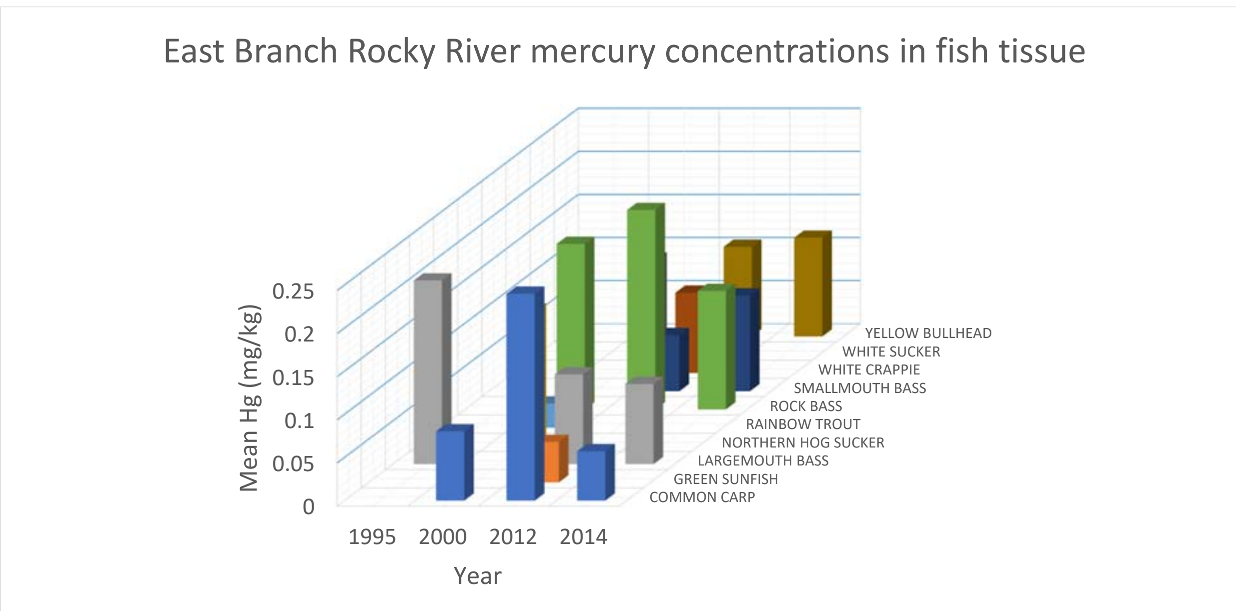

Figure 49. Mercury concentrations (mg/kg) in East Branch Rocky River fish, presented as species averages for each year.

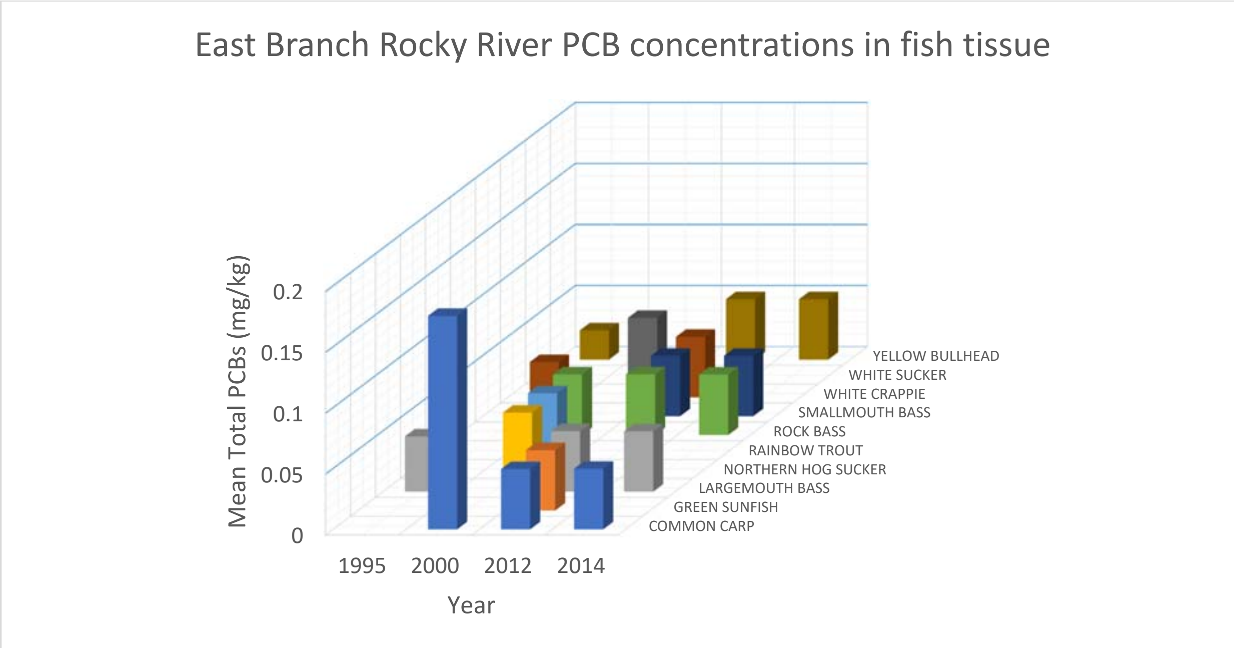

Figure 50. PCB concentrations (mg/kg) in East Branch Rocky River fish, presented as species averages for each year. Non-detects are represented at the reporting limit of approximately 0.05 mg/kg, making up the majority of these sample results. Samples collected in 1995 had a lower lab reporting limit, and samples from that year represent low-level detections.

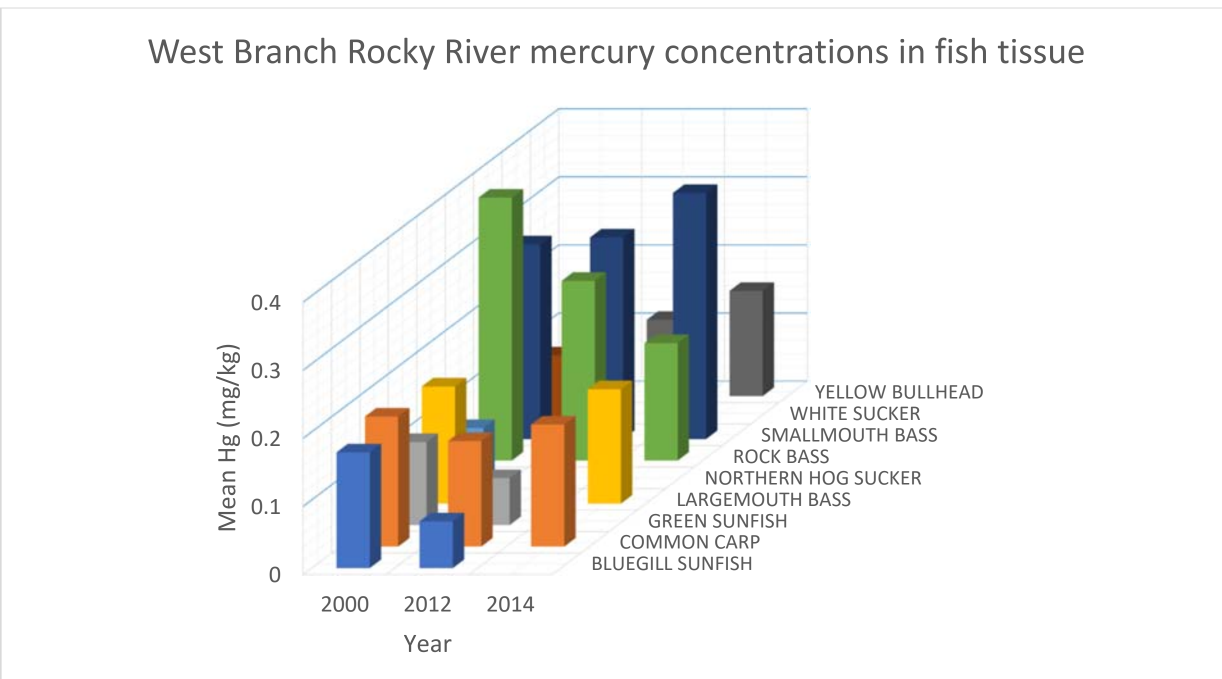

Figure 51. Mercury concentrations (mg/kg) in West Branch Rocky River fish, presented as species averages for each year.

PCBs have only rarely been detected in fish in the West Branch Rocky River (Figure 53). Between 2000 and 2014, a total of 2 detections were observed across 58 samples, both of which were in common carp, a bottom-feeding species which is highly exposed to any potential sediment-associated contaminants, such as PCBs. Despite this, even the two detections observed (in 2000 and 2014) showed very low levels of total PCBs (0.06 and 0.08 mg/kg), just slightly above the "unrestricted consumption" threshold for species below 0.05 mg/kg.

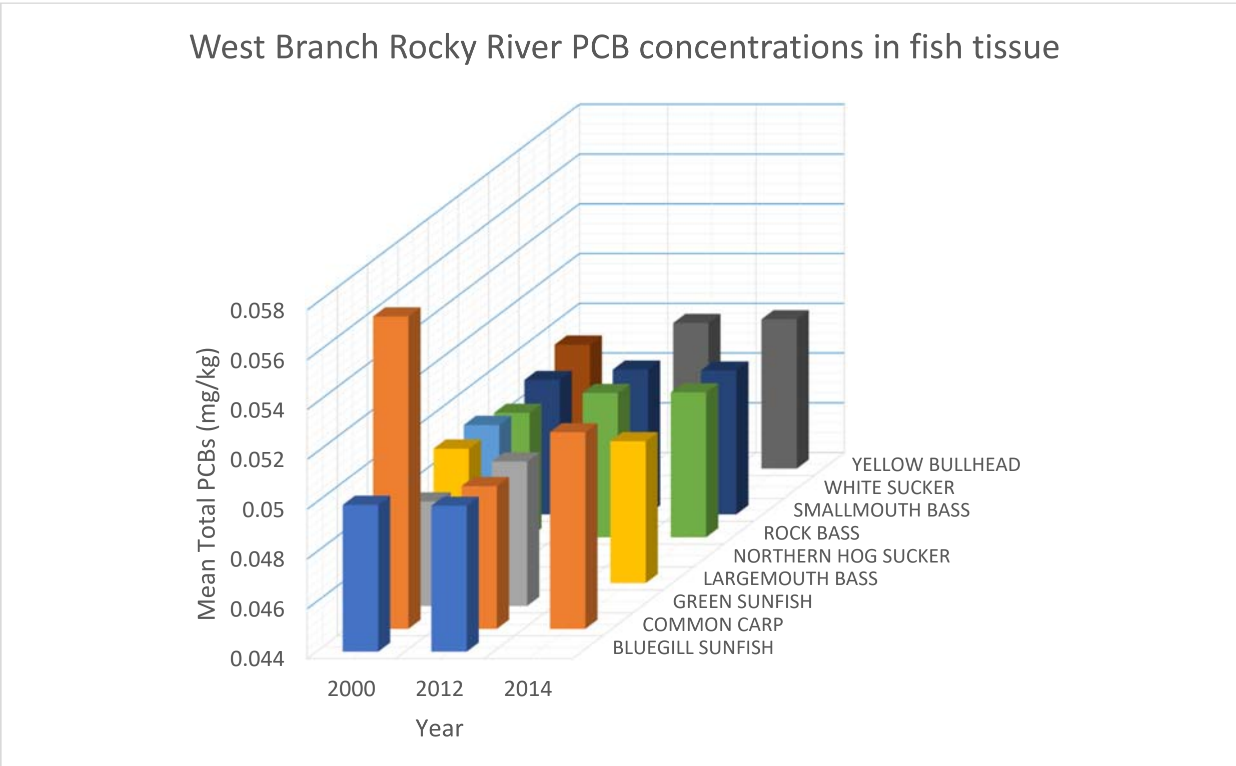

Figure 52. PCB concentrations (mg/kg) in West Branch Rocky River fish, presented as species averages for each year. Non-detects are represented at the reporting limit of approximately 0.05 mg/kg, making up the vast majority of these sample results.

PUBLIC DRINKING WATER SUPPLIES

The public drinking water supply beneficial use in the WQS (OAC 3745-1-33) currently applies within 500 yards of drinking water intakes and for all publicly owned lakes. Ohio EPA has developed an assessment methodology for this beneficial use which focuses on source water contaminants not effectively removed through conventional treatment methods. The 2014 Integrated Water Quality Report describes this methodology and is available on OEPA's website:
http://www.epa.state.oh.us/dsw/tmdl/OhioIntegratedReport.aspx.

Impaired source waters may contribute to increased human health risk or treatment costs. For the case when stream water is pumped to a reservoir, the stream and reservoir will be evaluated separately. These assessments are designed to determine if the quality of source water meets the standards and criteria of the Clean Water Act. Monitoring of the safety and quality of treated finished drinking water is regulated under the Safe Drinking Water Act and evaluated separately from this assessment. For those cases when the treatment plant processes do not specifically remove a source water contaminant, the finished water quality data may be considered representative of the raw source water directly feeding into the treatment plant.

One public water system (Berea) is directly served by surface water sources within the study area. Berea maintains intakes on the East Branch Rocky River (RM 5.06), Baldwin Creek (RM 0.48) and Coe Lake. Table 24 provides a summary of results for the PWS use while Appendices B, C, and N contain all of the water quality analytical results.

City of Berea

The City of Berea operates a community public water system that serves a population of approximately 17,900 people through 6,505 service connections. Source water is obtained from the East Branch Rocky River. Source water can also be drawn from Coe Lake and Baldwin Creek if needed. The system's treatment capacity is approximately 3.6 million gallons per day, but current average production is about 2.4 million gallons per day. The City of Berea treatment processes include potassium permanganate addition, carbon treatment, lime softening, coagulation/flocculation, sedimentation, sand filtration, fluoridation, UV with chlorine disinfection and orthophosphate addition.

Ohio EPA collected water quality samples from the East Branch Rocky River (just upstream intake), Baldwin Creek and Coe Lake (L-1 site) during 2014 and 2015. To assess the PWS beneficial use, samples were analyzed for nitrate, atrazine and cyanotoxins (microcystins, saxitoxin and cylindrospermopsin). The PWS assessment unit is HUC 04110001 02 02 - Baldwin Creek - East Branch Rocky River.

Thirty-six nitrate sample results ranged from below 0.14 mg/l to 9.26 mg/l. The average was 2.61 mg/l. Nitrate results would lead to a full support watch list determination due to a single result exceeding 80% of the WQ criterion for nitrate. Nitrate was listed on the full support watch list determination in the 2014 Ohio IR for this HUC watershed.

For atrazine, fourteen of seventeen sample results were below detection. No results approached criteria for impaired or watch list conditions. Atrazine was not assessed for the 2014 Ohio IR for this HUC watershed due to insufficient data.

Most cyanotoxin sample results were just at or below detection levels. However, there were microcystins and saxitoxin detections of concern from Coe Lake in 2014 and 2015. A 2015 microcystins detection (0.41

mg/l) would exceed the new Ohio EPA drinking water threshold (0.3 mg/l) established in 2015. This will result in a watch list determination for future IR reporting. The algae cyanotoxin indicator was not assessed for the 2014 Ohio Integrated Water Quality Report for this HUC watershed due to lack of source water data.

Table 24. Summary of available water quality data for Nitrate and Atrazine at sampling sites near/at PWS intakes in the study area.

Location (Station ID)	**PDWS Parameters of Interest**					
	Nitrate-Nitrite WQC = 10 mg/l[1]		**Atrazine WQC = 3.0 ug/l[2]**			
	Average (sample count)	**Maximum (#samples>WQC)**	**Average (sample count)**	**Annual Average (2014)[3]**	**Annual Average (2015)[3]**	**Maximum Instantaneous Value**
HUC 04110001 02 02 Baldwin C. - E.B. Rocky R. / Berea PWS						
E.B. Rocky River ust. intake (302628)	4.09 mg/l (13)	9.26 mg/l (0)	0.26 ug/l (5)	No Data	<0.2 ug/l	0.37 ug/l
Coe Lake L1 (204492)	0.56 mg/l (10)	1.47 mg/l (0)	0.20 ug/l (7)	<RL	<0.2 ug/l	<0.2 ug/l
Baldwin C. ust. intake (302651)	3.59 mg/L (13)	6.65 mg/L (0)	0.20 ug/l (5)	No Data	<0.2 ug/l	0.25 ug/l

1 - Nitrate Water Quality Criteria (WQC) evaluated as maximum value not to be exceeded, impaired waters defined as having two or more excursions about the criteria. Watch List conditions include maximum instantaneous value > 8.0 mg/l.
2 - Atrazine WQC evaluated as annual average based on quarterly averages. Watch List conditions include maximum instantaneous value > 12.0 ug/l.
3 - Quarterly averages assume zero for quarters without data. <RL-indicates annual average would calculate to be less than the reporting limit.

LAKE SAMPLING

Inland Lake Program

Ohio EPA has implemented a sampling strategy that focuses on evaluating chemical conditions near the surface and physical conditions in the water column of inland lakes. Physical profile measurements are summarized either for the entire water column or the epilimnion depending on the existence of thermal stratification. The sampling target consists of an even distribution of 5 sampling events over a one-year period and collected during the recreation season of May 1 through October 31.

Key parameters analyzed in lakes include chlorophyll-*a*, ammonia, DO, pH, total dissolved solids along with various metals for multiple beneficial use assessments. Other parameters used to evaluate lakes include secchi depth, total phosphorus and total nitrogen. Details of the sampling protocol used at the time of this sampling are outlined in the 2016 Inland lakes sampling Procedures Manual. Sampling objectives for inland lake surveys are defined in Ohio EPA's Inland Lakes Sampling QAPP, and the rules relative to inland lakes beneficial uses are described Ohio EPA (2010b).

Ohio EPA currently monitors up to 16 lakes per year using the strategy described in Section 2.2.1 of the 2014 Integrated Report (IR). Priority is being placed on lakes used for public drinking water or lakes used heavily for recreation and are suspected of being impaired for either of those uses. The objectives for monitoring inland lakes are to:

- Track status and trends of lake quality
- Determine attainment status of beneficial uses
- Identify causes and sources of impaired uses
- Recommend actions for improving water quality in impaired lakes

The IR discusses lake use impairment for recreation, public drinking water, and human health (fish tissue) and previews a methodology for including inland lakes in the aquatic life use listing. The aquatic life use listing is dependent on the rule changes to Ohio's water quality standards, which would include the adoption of nutrient criteria. Details of the proposed use designation, draft criteria and assessment methodology are previewed in the Ohio EPA 2014 Integrated Water Quality Monitoring and Assessment Report, available on Ohio EPAs web page at:
http://www.epa.state.oh.us/dsw/tmdl/OhioIntegratedReport.aspx#156069519-report.

Aquatic Life Use Assessment

The aquatic life use (ALU) designation for all inland lakes in Ohio is exceptional warmwater habitat (EWH) except for upground reservoirs which are designated warmwater habitat (WWH). In order to evaluate the ALU in Willard Reservoir, ammonia, dissolved oxygen, pH, total dissolved solids and various metals were analyzed. Statewide water quality Outside Mixing Zone Minimum (OMZM)criteria for these parameters are summarized in Table 35-1 of the Ohio water quality standards. Other important parameters for assessing lake condition included nutrient parameters (e.g. total phosphorus, total nitrogen) and biological response variables (e.g. chlorophyll-a).

Where criteria do not exist, a common approach to assessing relative lake condition is to compare lake water quality sampling data to a regional and lake type derived percentile (e.g. 25^{th}) of existing lake data. The lower 25^{th} percentile generally represents minimally impacted conditions protective of designated uses. For Ohio EPA, inland lake ALU benchmarks were calculated for total nitrogen (T-N), total phosphorus (T-P) and chlorophyll-a (Chl. a) based on the lower 25^{th} percentile of lake median data and for secchi depth based on the upper 75th percentile of lake median data. All data used for benchmarks were collected by Ohio EPA from Ohio inland lakes between 1989 and 2006.

Chlorophyll-a, total phosphorus, total nitrogen and Secchi depth are evaluated by first calculating a median value from the two-year dataset. This value is then compared to the ALU targets identified in table 3. Dissolved oxygen, pH and ammonia were evaluated in a manner similar to base aquatic life parameters and compared to appropriate statewide criteria (EWH or WWH). Average DO and median pH values were calculated from profile readings taken in the epilimnion during stratification and throughout the water column when stratification does not exist.

Coe Lake

During the 2014 and 2015 field seasons, a water quality survey was conducted in Coe Lake to assess and characterize the lake conditions. Methods discussed above were utilized to evaluate water quality in Coe Lake, one of three drinking water sources for the City of Berea. The main drinking water source is an intake on East Branch Rocky River at RM 5.06, but water can be drawn from Coe Lake and directly from Baldwin Creek. Coe Lake is typically only used for Berea's drinking water source when winter chloride levels from salt road runoff exceed 250 mg/l in the East Branch Rocky River.

During the summer months, algal blooms have been documented. Also, invasive macrophytes have invaded the entire lake. During the summer months of 2014, the northern section of Coe Lake was chemically treated twice a month for vegetation control. During the 2015 sampling season, the City of Berea contracted for the entire lake to be chemically treated for algae and macrophyte control. The City of Berea has a National Pollutant Discharge Elimination System (NPDES) permit for the application of copper sulfate, Reward Aquatic Herbicide, Aquathol, Harpoon, and Cibekick to control algal production and invasive macrophyte growth. Also, each section of the lake had aerators installed to assist with improving dissolved oxygen.

Coe Lake Key Attributes:
Lake Type: Dugout
Ecoregions: Erie/Ontario Lake Plain
Surface Area: 23 acres
Maximum Depth: 5 meters (15 ft.)

Study Area

Coe Lake is located on Baldwin Creek within the Rocky River watershed in Cuyahoga County, in northeast Ohio. It is owned by the City of Berea, which manages the lake levels with a dam structure and an overflow structure on Baldwin Creek. The dam structure was updated allowing Baldwin Creek waters to bypass the lake in an outside channel on the south side of the lake. This upgrade allowed the City of Berea to better control lake levels and water quality. Coe Lake Park surrounds Coe Lake and is the center for outdoor activity for the citizens of Berea. Fishing is extremely popular at Coe Lake with most fishing done from the shoreline. There is a very small boat ramp for non-motorized boats.

Coe Lake is sectioned into a northern area and southern area. Samples were collected from two locations; L-1 (41.362051 latitude and -81.851846 longitude) in the southern section and L-2 (41.365159 latitude and -81.849636 longitude) in the northern section (Figure 53). L-1 is located at the southern section and is in proximity to the City of Berea drinking water intake. Water chemistry, sediment chemistry, phytoplankton, chlorophyll *a* and bacteria were collected at L-1. Also, temperature, conductivity, DO, and pH were recorded verticality through the water column (profile data), and Secchi disk measurements documented water clarity or transparency. To investigate algaecide application impacts in the northern section of the lake, water chemistry and sediment chemistry samples were collected at L-2 only in the spring and fall sample during 2015.

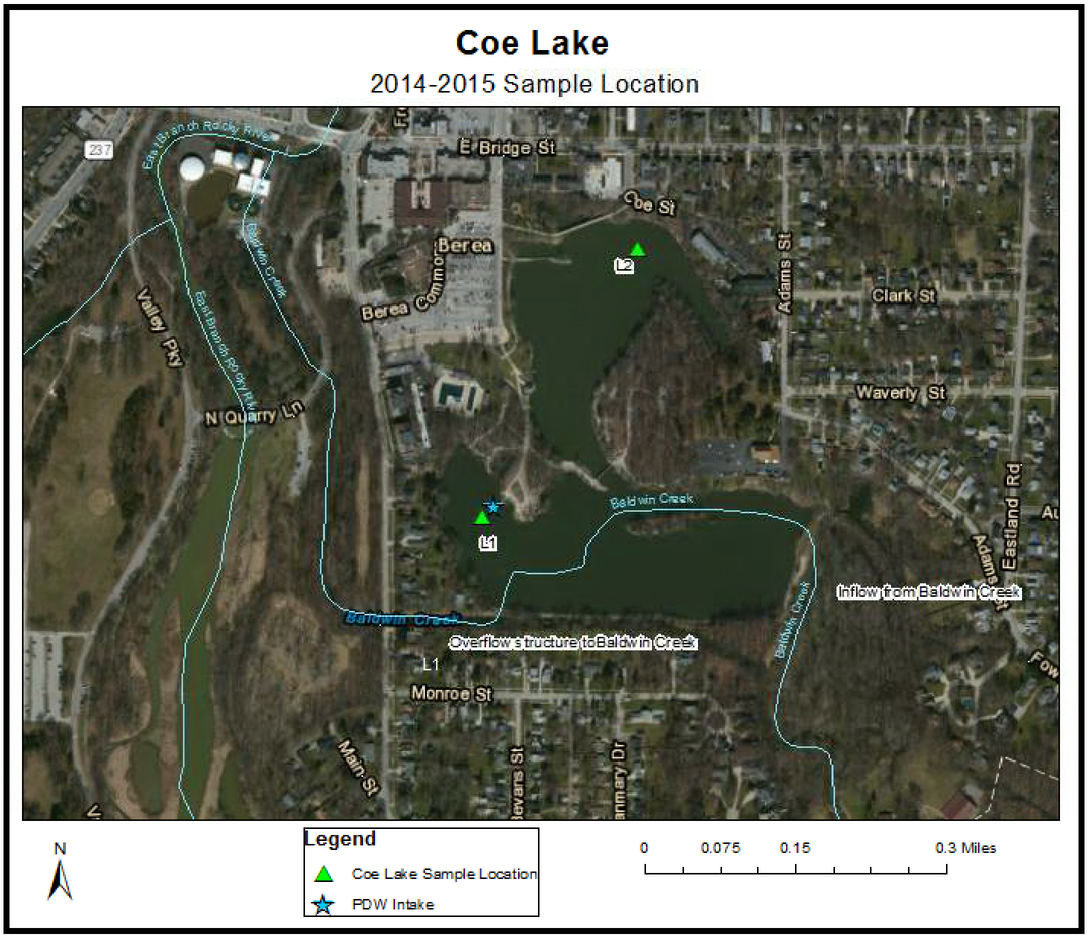

Figure 53. Coe Lake Sampling Locations.

Water Column Quality

Water column profiles were recorded during each sampling event where temperature, dissolved oxygen, conductivity and pH were measured at the surface (0.5-meter depth) and at 0.5-meter intervals with the final measurement at 0.5 meters from the bottom. During 2014 and 2015, water column profiles documented typical summer stratification setting up an anoxic hypolimnion in late spring that persisted until fall turnover produced isothermal (mixed) conditions.

Aquatic Life Use Assessment

Water quality parameters and results used to assess ALU are listed in Table 25. The methodology utilized to assess the parameters and determine attainment is outlined in the above Aquatic Life Use Methodology section. Water samples collected from 0.5 meters below the surface were analyzed for base aquatic life use parameters; dissolved solids, arsenic, cadmium, chromium, copper, lead, nickel, selenium and zinc. None of these parameters exceeded their individual OMZM numeric criteria. Additionally, individual ammonia concentrations from 0.5 meters below the surface were all below their respective ALU targets.

Two-year median values calculated from 10 sampling events for Secchi disc transparency, total nitrogen, total phosphorus, and chlorophyll *a*, were compared to the ALU benchmarks for dugout lakes. The median Secchi depth and total phosphorus median values were below their respective benchmarks. Total nitrogen, the sum of TKN and nitrate/nitrite exceeded the 25th percentile benchmark for a dugout lake. The total nitrogen median value for the two years combined was 1080 µg/l, which is over double the ALU benchmark of 450 µg/l. Elevated nitrogen could be due to upstream land uses and two major wastewater treatment plants upstream; Strongsville at RM 2.9 and North Royalton at RM 7.3. Lastly, chlorophyll *a* narrowly exceeded the ALU target of 6.0 mg/l. Individual chlorophyll *a* values had a range of 2.2-20.3 µg/l with 50% of the individual chlorophyll a values above the benchmark.

The pH (median) and dissolved oxygen (average) values calculated from profile readings taken in the epilimnion during stratification or the entire water column during isothermal conditions were compared to 75th (pH) and 25th percentile targets for dugout lakes. The median value for pH met ALU expectations. However, Coe Lake DO averages from water column profiles fell below 5.0 mg/l during more than 10% (3 of 10) of the sampling events. All three DO violations occurred in 2014. The DO difference between years could be due to changes of inflow activities to Coe Lake from Baldwin Creek. Also, in 2015 the start of algal and macrophyte treatment chemicals being applied to the L-1 area could have affected the DO concentrations.

Table 25. Summary of important lake data collected in Coe Lake during 2014-2015.

Parameter (target)	Secchi depth (m)	Chlorophyll a (µg/l)	Total Nitrogen (µg/l)	Total Phosphorus (µg/l)	DO (mg/l)	pH S.U.	NH3 (mg/l)
	Aquatic Life Benchmarks/Targets				**EWH Aquatic Life Criteria**		
Criterion/ Targets	**≥2.60**	**≤6**	**≤450**	**≤18**	**>5.0**	**6.5-9.0**	**(WQS) Table 35-3**
5/27/2014	3.2	2.2	1020	1	4.83	7.27	0.1
6/18/2014	4.2	2.9	1100	5	4.25	8.56	<0.05
7/21/2014	1.3	19.4	1020	1	9.48	8.11	0.1
8/21/2014	3.1	4.7	1300	12.2	4.53	7.78	0.1
9/22/2014	1.95	6.9	1060	5.3	8.35	7.64	0.1
5/20/2015	2.8	4.3	1650	5	9.49	8.16	0.1
6/30/2015	2.5	12.9	980	10.4	8.48	7.52	0.2
7/22/2015	2.9	8.4	610	12.2	6.7	8.56	<0.05
9/2/2015	2.6	20.3	1410	16.8	12.41	8.8	<0.05
10/5/2015	3.3	6.4	2260	3.6	7.38	7.7	0.2
Median	**2.85**	**6.65**	**1080**	**5.15**	**-**	**-**	**-**
% Exceeded	**-**	-	-	-	**30**	**0**	**0**

Recreation Use
The recreation use was evaluated by measuring levels of Escherichia coli bacteria at L1 sampling location. The bacteria results did not exceed the single sample maximum for recreational use. The recreation use is considered in support.

Sediments
Surficial sediment samples were collected at L1 and L2 during two separate sampling events with an Eckman Dredge sampler. Samples were analyzed for nutrients, metals, semivolatile organic compounds, and PCBs. Sediment data were evaluated using Ohio Sediment Reference Values (Ohio EPA 2003), along with guidelines established in Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems (MacDonald et.al. 2000), and Ecological Screening Levels (ESLs) (USEPA 2003). The consensus-based sediment guidelines define two levels of ecotoxic effects. A Threshold Effect Concentration (TEC) is a level of sediment chemical quality below which harmful effects are unlikely to be observed. A Probable Effect Concentration (PEC) indicates a level above which harmful effects are likely to be observed. ESL values, considered protective benchmarks, were derived by USEPA, Region 5 using a variety of sources and methods.

Metals and organic compounds found above screening benchmarks are presented in Table 26. Elevated levels of polycyclic aromatic hydrocarbons (PAHs) and metals are documented at L2. Sediment collected from L2 was considered likely harmful to sediment-dwelling organisms due to multiple individual PAHs and total PAHs, copper, and nickel above the PEC (MacDonald *et.al*. 2000). A source of PAHs within the sediment at L2 is likely due to urban runoff entering into Coe Lake via a storm drain located within proximity to L2 sampling location. PAHs are hydrophobic and will degrade over time, unless there is a continual input source (Baumann, 1998). At L1, arsenic and cadmium values were above TEC and copper, nickel, and lead concentrations were documented above Ohio's SRVs. In addition to urban runoff, continual application of herbicides and algaecides utilized to control algal blooms and invasive macrophyte problems may be the source of elevated levels of metals in the sediment at L1 and L2. All elevated organic parameters documented in the sediment were undetected in the water column.

Table 26. Contamination levels were determined for parameters using Ohio Sediment Reference Values (SRVs), consensus-based sediment quality guidelines (MacDonald, et.al. 2000) and ecological screening levels (USEPA 2003). Shaded numbers indicate values above the following: SRVs (blue), Threshold Effect Concentration - TEC (yellow), Probable Effect Concentration - PEC (red) and Ecological Screening Levels (orange).

Parameter	5/20/2015 L-1	10/5/2015 L-1	5/20/2015 L-2	10/5/2015 L-2
Benzo[a]anthracene µg/kg	U	U	7770	5990
Benzo[a]pyrene µg/kg	U	U	12100	8110
Chrysene µg/kg	U	U	11400	8210
Fluoranthene µg/kg	U	U	46100	17400
Pyrene µg/kg	U	U	28200	13100
Total PAHs	-	-	105570	52810
Arsenic mg/kg	20.9	15	16.2	12.9
Cadmium mg/kg	1.11	1.16	1.82	1.66
Chromium mg/kg	U	U	40	U
Copper mg/kg	53.4	48.6	203	186
Nickel mg/kg	39.7	35.7	71.8	75
Lead mg/kg	54.8	48.7	121	74.6
U=Indicates parameter was analyzed bur not detected at or above the reporting limit.				

Total Phosphorus (TP) concentrations in the sediments at L1 in Coe Lake were elevated. Figure 54 depicts Coe Lake TP sediment concentrations and the median and 75th percentile TP sediment concentrations reported from 102 Ohio lakes. Coe Lake TP sediment concentrations during all seasons are well above the TP median of 1005 mg/kg and above the TP 75th percentile of 1352 mg/kg during all seasons except the fall of 2015, where it fell just below the 75th percentile value. The median and 75th percentile TP concentrations were calculated from sediment collected during all seasons from 102 different lakes within Ohio.

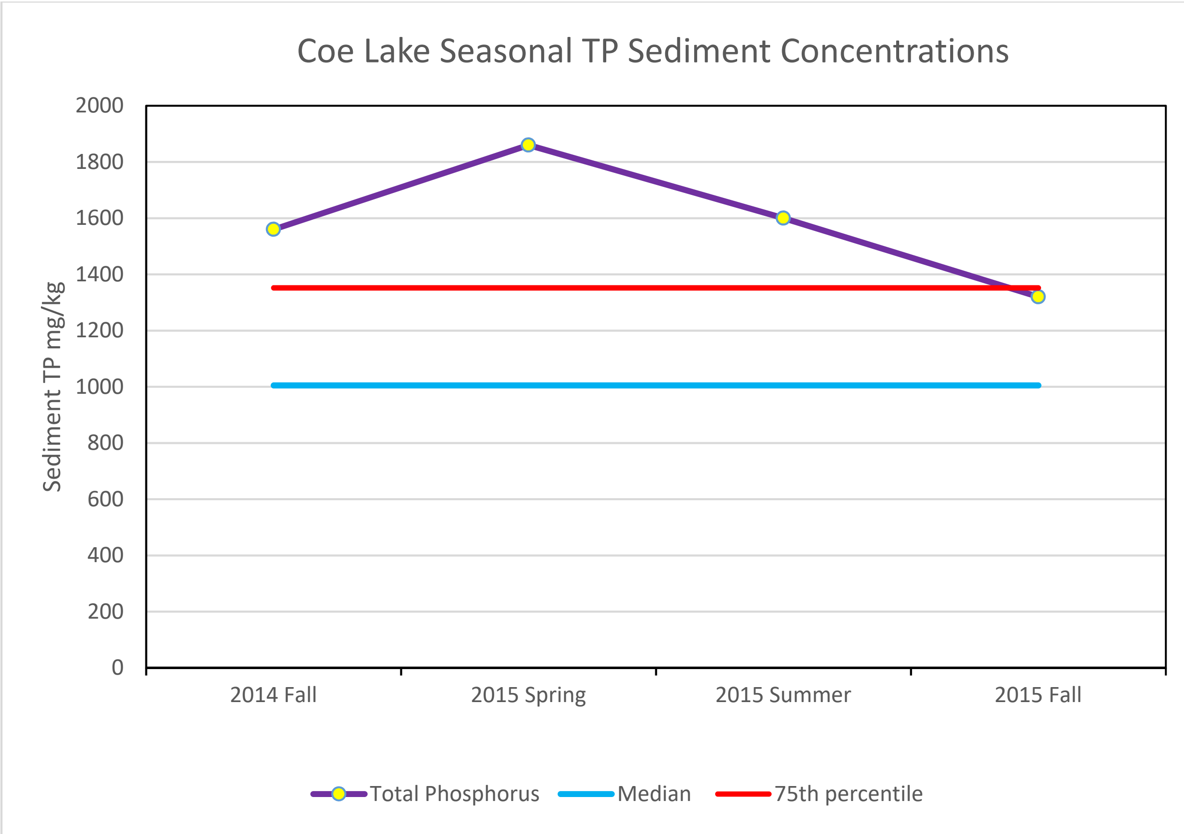

Figure 54. Seasonal sediment TP concentrations in Coe Lake compared to the TP mean and median values calculated from other Ohio lakes (N=102 lakes).

Phytoplankton

The percentages of the phytoplankton community within 2015 at Coe Lake are displayed in Figure 55. Algal community changes are based upon environmental parameters, nutrient availability, and grazing. In May, Chrysophyta, a golden-brown algae, dominated the system. As lake temperatures warmed, cyanobacteria numbers increased, peaking in August, which coincides with the highest microcystin detection of 0.41 µg/l. At the end of the sampling season, the green algae, Chlorophyta was documented as the dominant algae.

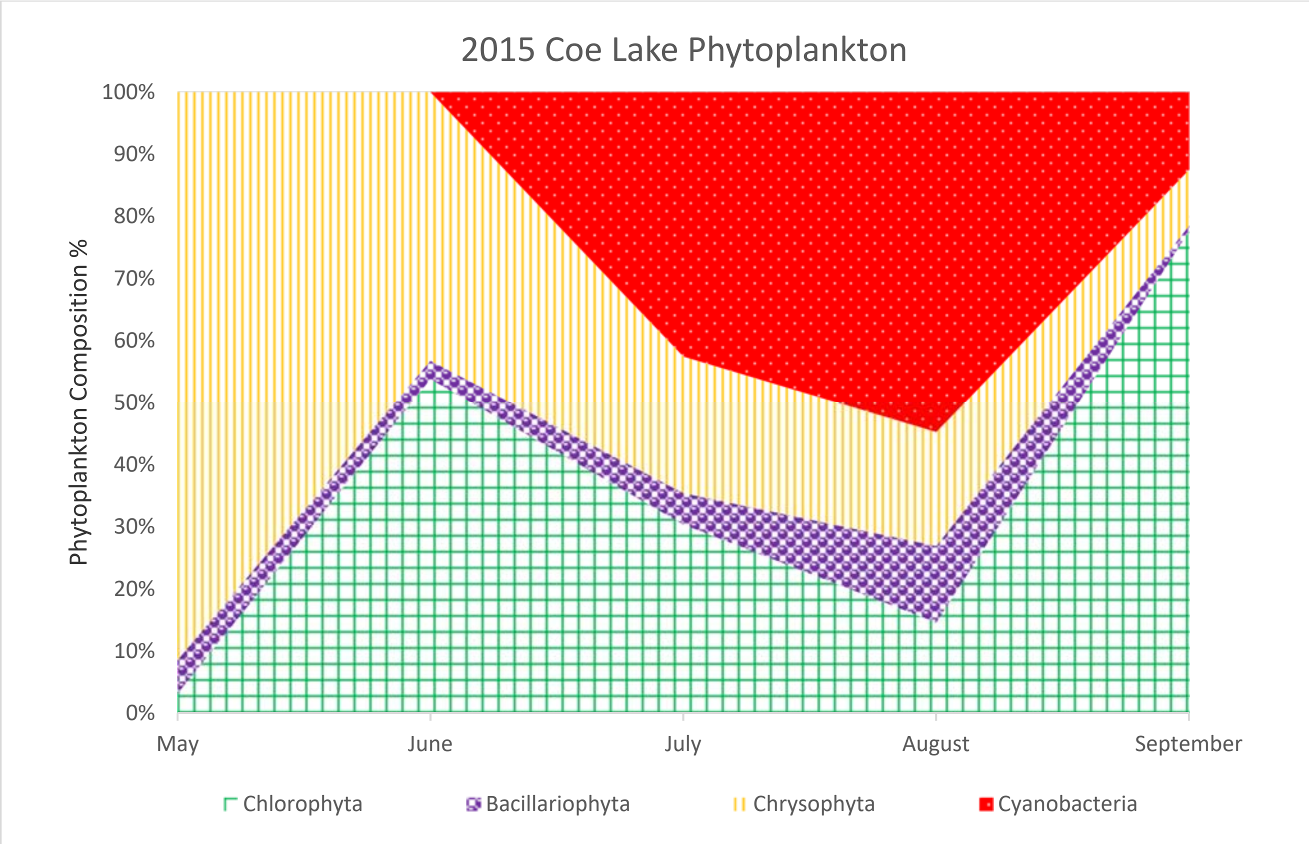

Figure 55. Phytoplankton community structure in Coe Lake

Wallace Lake

Wallace Lake is owned and managed by Cleveland Metroparks and is located in Mill Stream Reservation on the East Branch of the Rocky River. During the 2014 and 2015 field season, a water quality survey was conducted in Wallace Lake to assess and characterize lake condition. The methods discussed above were utilized to evaluate water quality in Wallace Lake. Wallace Lake has a beach for swimming and it is a popular lake for fishing. Results from this assessment will be reported in the 2016 IR.

Study Area

Wallace Lake (Figure 56) is located in the East Branch of the Rocky River watershed within Cuyahoga County. It was impounded by a spillway structure at the north end of the lake in 1941 by flooding two separate sandstone quarries. The watershed of Wallace Lake is mostly limited to surface runoff from the urban surroundings with an approximate 0.2 square mile drainage area. Lake water level is managed by the spillway structure. Wallace Lake is oblong in shape with the deeper portion located in the southern end of the lake (Figure 57). All samples were collected at the L-1 sampling location (41°21.504’ latitude and 81°51.527’ longitude), where there is a small hole that is approximately 8 meters deep.

Figure 56. Wallace Lake sampling location.

Wallace Lake Key Attributes:
Lake Type: Dammed Impoundment
Ecoregions: Erie/Ontario Lake Plain
Surface Area: 17.5 acres
Maximum Depth: 8 meters (24 ft.)

Physical Water Quality

Water column profiles were recorded during each sampling event. Temperature, dissolved oxygen, conductivity and pH were measured at the surface (0.5-meter depth) and at 0.5 meter intervals with the final measurement taken 0.5 meters from the bottom. During 2014 and 2015, water column profiles documented typical summer stratification setting up an anoxic hypolimnion in late spring persisting until fall turnover produced isothermal conditions.

Aquatic Life Use Assessment

Water quality parameters and results used to evaluate ALU Targets are listed in Table 27. The methods utilized to assess the parameters and determine attainment is outlined in the above in the ALU Methodology section. Water samples collected from 0.5 meters below the surface were analyzed for the following base aquatic life use parameters: dissolved solids, arsenic, cadmium, chromium, copper, lead, nickel, selenium and zinc. None of these parameters exceeded their individual OMZM targets. However, individual ammonia concentrations were all below ALU benchmarks.

Two-year median values calculated from 10 sampling events for Secchi disc transparency, chlorophyll *a*, total phosphorus, and total nitrogen fully met their benchmarks a for dammed impoundment lakes. Dissolved oxygen (average) and pH (median) were measured and calculated from profile readings taken in the epilimnion during stratification or the entire water column during isothermal conditions and were compared to ALU benchmarks. The median value for pH met ALU targets. However, average Wallace Lake DO fell below 5.0 mg/l during more than 10% (3 of 10) of the sampling events.

Recreation Use

The recreation use was evaluated by measuring levels of *Escherichia coli* bacteria at the L1 sampling location. The bacteria results did not exceed the single sample maximum for the recreation use.

Sediments

The same methods used to assess sediments in Coe Lake were applied to Wallace Lake. Analytes found above screening benchmarks are presented in Table 28. Arsenic concentrations (36.4 mg/kg) within the sediments collected at Wallace Lake are considered harmful to sediment-dwelling organisms (MacDonald et.al. 2000). With Wallace lake receiving water from only 0.2 sq. acres, the source of analytes above the evaluation guidelines would be considered urban runoff. Two large storm drains were documented in the southern portion of the lake. All other analytes were below the sediment evaluation guidelines.

The TP concentrations in Wallace Lake sediments exceeded the median value for TP in sediment (1005 mg/kg) for other Ohio Lakes. The sediment TP concentration on 5/20/2014 was 1140 mg/kg and on 10/27/2014 was 1080 mg/kg. Both samples were above the median TP values calculated from 102 sediment samples taken from different Ohio lakes, but below the 75th percentile.

Table 27. Summary of important lake data collected in Wallace during 2014-2015.

Parameter	Secchi depth (m)	Chlorophyll a (µg/l)	Total Nitrogen (µg/l)	Total Phosphorus (µg/l)	DO (mg/l)	pH S.U.	NH3 (mg/l)
	Aquatic Life Benchmarks/Targets				**EWH Aquatic Life Criteria**		
Criteria/ALU Targets	**≥1.19**	**≤14**	**≤930**	**≤18**	**>5.0**	**6.5-9.0**	**(WQS) Table 35-3**
5/27/2014	1.9	1.9	800	3.9	4.97	7.24	0.098
6/18/2014	1.5	17.3	480	5	4.08	7.87	0.03
7/21/2014	1.1	28.9	940	7	7.64	7.60	0.091
8/21/2014	1.4	13.7	740	5	7.27	7.65	0.065
10/27/2014	1.9	1.4	990	5	6.89	6.35	0.111
5/20/2015	2.62	0.7	620	5	9.0	8.18	0.059
6/29/2015	1.7	2.9	960	6.8	3.92	7.45	0.342
7/22/2015	1.48	9	820	5	7.03	7.34	0.112
8/31/2015	2.52	3	760	2.2	7.0	7.50	0.667
9/21/2015	2.65	1.7	800	9.4	10.47	7.39	0.215
Median	**1.8**	**2.95**	**800**	**5**	-	-	-
% Exceeded	-	-	-	-	**30**	**10**	**0**

Table 28. Contamination levels were determined for parameters using Ohio Sediment Reference Values (SRVs), consensus-based sediment quality guidelines (MacDonald, et.al. 2000) and ecological screening levels (USEPA 2003). Shaded numbers indicate values above the following: SRVs (blue), Threshold Effect Concentration - TEC (yellow), Probable Effect Concentration - PEC (red) and Ecological Screening Levels (orange).

Parameter	**5/20/2015**	**10/27/2014**
Benzo[a]anthracene	430	-
Benzo[a]pyrene	530	-
Benzo[b]fluoranthene	720	-
Benzo[g,h,i]perylene	560	-
Benzo[k]fluoranthene	450	-
Chrysene	570	-
Fluoranthene	1960	-
Phenanthrene	300	-
Pyrene	1150	-
Total PAHs	**6670**	-
Arsenic	21.6 (9.79)	36.4 (33)
Cadmium	1.23 (0.99)	1.25 (0.99)
Chromium	19.5	23.4
Copper	51.2 (32)	50.4(32)
Lead	61.1 (47)	56.1 (47)
Nickel	45.2 (33)	46.2 (33)
Zinc	242 (160)	247 (160)

Phytoplankton

The percentages of the phytoplankton community Wallace Lake during 2015 are displayed in Figure 57. Algal community changes are based upon environmental parameters, nutrient availability, and grazing. Throughout the season chlorophyta, green algae, dominated the algal community in Wallace Lake. All algal toxin samples were reported as undetected.

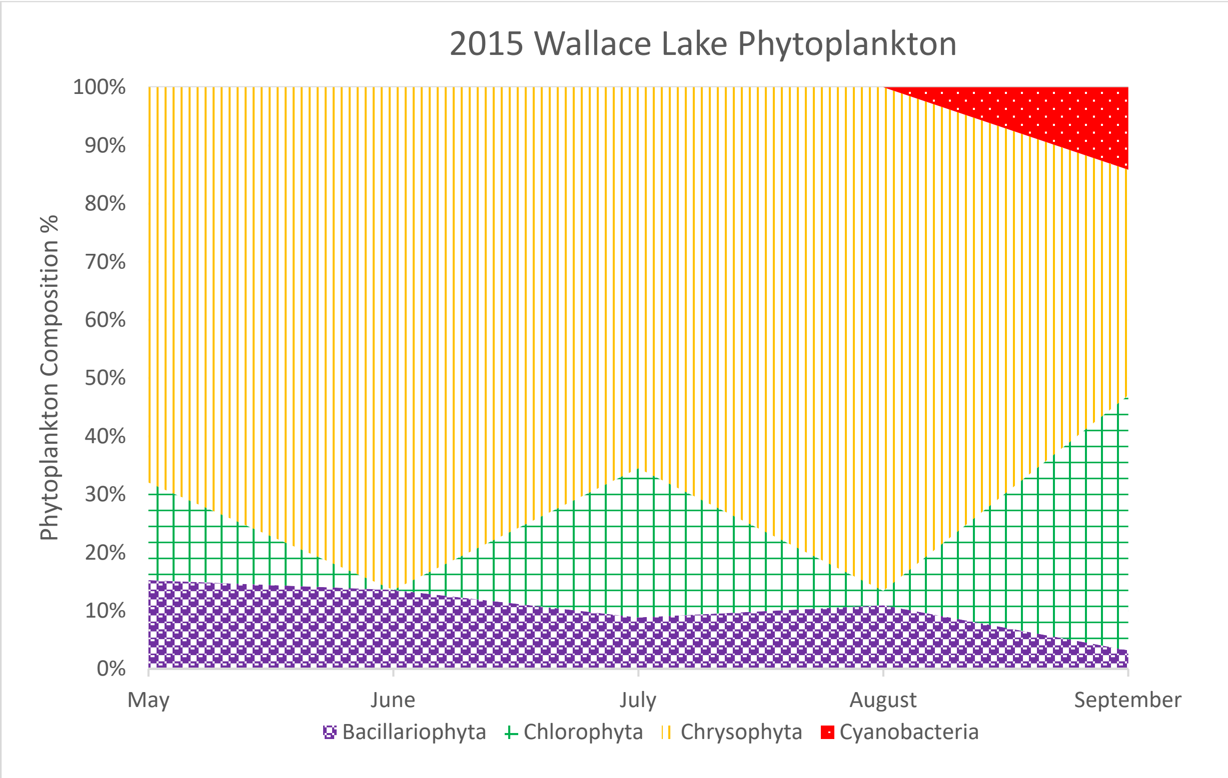

Figure 57. Wallace Lake phytoplankton community.

Conclusion

The ALU benchmarks (a.k.a. targets) for inland lakes in Ohio are based on lake types and ecoregion. Coe Lake is classified as a dugout lake type and is located in the Erie Ontario Lake Plains ecoregion. Dugout lakes typically receive input from groundwater and precipitation with little to no surface water influence. In addition to groundwater influence on the water quality of Coe Lake, water levels are controlled by two different structures allowing surface waters from Baldwin Creek to influence the water quality. Therefore, it does not display true dugout lake conditions. Ohio EPA has determined that Coe Lake will be changed to dammed impoundment type. Although the criteria will not change, this lake type classification more accurately defines actual physical lake characteristics at Coe Lake.

Wallace Lake has a "spillbox" structure at the downstream end of the lake that decants water into the East Branch of the Rocky River when the lake elevation reaches a certain level. Water from the East Branch of the Rocky River can back up over the spillbox structure, but only occurs rarely during severe flash flooding events. Typically, the water quality of Wallace Lake is influenced by activity within its urbanized 0.2 sq. mile watershed and groundwater inputs. Both lakes did not support the LH use criteria for DO. One possible cause for low DO results is that sampling dates of low DO concentrations coincide with significant precipitation events, inflows to the lakes and wind action may have mixed the water column resulting in lower DO levels in the epilimnion.

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