Biological and Water Quality Study of the Little Miami River and Selected Tributaries 2017

Little Miami River at Newtown Rd. (LM12)

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Biological and Water Quality Study of the Little Miami River and Selected Tributaries 2017

Hamilton County, Ohio

Technical Report MBI/2018-6-4

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Glossary of Terms

Ambient Monitoring	Sampling and evaluation of receiving waters not necessarily associated with episodic perturbations.
Aquatic Assemblage	An association of interacting populations of organisms in a given waterbody, for example, the fish assemblage or the benthic macroinvertebrate assemblage.
Aquatic Community	An association of interacting assemblages in a given waterbody, the biotic component of an ecosystem.
Aquatic Life Use (ALU)	A beneficial use designation in which the waterbody provides suitable habitat for survival and reproduction of desirable fish, shellfish, and other aquatic organisms; classifications specified in State water quality standards relating to the level of protection afforded to the resident biological community by the custodial State agency.
Assemblage	Refers to all of the various species of a particular taxonomic grouping (e.g., fish, macroinvertebrates, algae, submergent aquatic plants, etc.) that exist in a particular habitat. Operationally this term is useful for defining biological assessment methods and their attendant assessment mechanisms, i.e., indices of biotic integrity (IBI), O/E models, or fuzzy set models.
Attainment Status	The state of condition of a waterbody as measured by chemical, physical, and biological indicators. Full attainment is the point at which measured indicators signify that a water quality standard has been met and it signifies that the designated use is both attained and protected. Non-attainment is when the designated use is not attained based on one or more of these indicators being below the required condition or state for that measure or parameter.
Attribute	A measurable part or process of a biological system.
Beneficial Uses	Desirable uses that acceptable water quality should support. Examples are drinking water supply, primary contact recreation (such as swimming), and aquatic life support.

Benthic Macroinvertebrates	Animals without backbones, living in or on the substrates, of a size large enough to be seen by the unaided eye, and which can be retained by a U.S. Standard No. 30 sieve (0.595 mm openings). Also referred to as benthos, infauna, or macrobenthos.
Best Management Practice	An engineered structure or management activity, or combination of these that eliminates or reduces an adverse environmental effect of a pollutant, pollution, or stressor effect.
Biological Assessment	An evaluation of the biological condition of a waterbody using surveys of the structure and function of a community of resident biota; also known as bioassessment. It also includes the interdisciplinary process of determining condition and relating that condition to chemical, physical, and biological factors that are measured along with the biological sampling.
Biological Criteria (Biocriteria)	Scientific meaning: quantified values representing the biological condition of a waterbody as measured by structure and function of the aquatic communities typically at reference condition; also known as biocriteria. Regulatory meaning: narrative descriptions or numerical values of the structure and function of aquatic communities in a waterbody necessary to protect a designated aquatic life use, implemented in, or through state water quality standards.
Biological Condition Gradient	A scientific model that describes the biological responses within an aquatic ecosystem to the increasing effects of stressors.
Biological Diversity	Refers to the variety and variability among living organisms and the ecological complexes in which they occur. Diversity can be defined as the number of different taxa and their relative frequencies. For biological diversity, these taxa are organized at many levels, ranging from complete ecosystems to the biochemical structures that are the molecular basis of heredity. Thus, the term encompasses different

	ecosystems, species, and genes; also known as biodiversity.
Biological Indicator	An organism, species, assemblage, or community characteristic of a particular habitat, or indicative of a particular set of environmental conditions; also known as a bioindicator.
Biological Integrity	The ability of an aquatic ecosystem to support and maintain a balanced, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of natural habitats within a region (after Karr and Dudley 1981).
Biological Monitoring	The use of a biological entity (taxon, species, assemblage) as a detector and its response as a measure of response to determine environmental conditions. Ambient biological surveys and toxicity tests are common biological monitoring methods; also known as biomonitoring.
Biological Survey	The collection, processing, and analysis of a representative portion of the resident aquatic community to determine its structural and/or functional characteristics and hence its condition using standardized methods.
Clean Water Act (CWA)	An act passed by the U.S. Congress to control water pollution (formally referred to as the Federal Water Pollution Control Act of 1972). Public Law 92-500, as amended. 33 U.S.C. 1251 et seq.; referred to herein as the CWA.
CWA Section 303(d)	This section of the Act requires States, territories, and authorized Tribes to develop lists of impaired waters for which applicable water quality standards are not being met, even after point sources of pollution have installed the minimum required levels of pollution control technology. The law requires that these jurisdictions establish priority rankings for waters on the lists and develop TMDLs for these waters. States, territories, and authorized Tribes are to submit their list of waters on April 1 in every even-numbered year.

CWA Section 305(b)	Biennial reporting required by the Act to describe the quality of the Nation's surface waters, to serve as an evaluation of progress made in maintaining and restoring water quality, and describe the extent of remaining problems.
Criteria	Limits on a particular pollutant or condition of a waterbody presumed to support or protect the designated use or uses of a waterbody. Criteria may be narrative or numeric and are commonly expressed as a chemical concentration, a physical parameter, or a biological assemblage endpoint.
DELT Anomalies	The percentage of Deformities, Erosions (e.g., fins, barbels), Lesions and Tumors on fish assemblages (DELT). An important fish assemblage attribute that is a commonly employed metric in fish IBIs.
Designated Uses	Those uses specified in state water quality standards for each waterbody or segment whether or not they are being attained.
Disturbance	Any activity of natural or human causes that alters the natural state of the environment and its attributes and which can occur at or across many spatial and temporal scales.
Ecological integrity	The summation of chemical, physical, and biological integrity capable of supporting and maintaining a balanced, integrated adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of natural habitats in the region.
Ecoregion	A relatively homogeneous geographical area defined by a similarity of climate, landform, soil, potential natural vegetation, hydrology, or other ecologically relevant variables; ecoregions are portioned at increasing levels of spatial detail from level I to level IV.
Existing Use	A use that was actually attained in a waterbody on or after November 28, 1975, whether or not they are included in the state water quality standards (November 28, 1975 is the date on which U.S. EPA

	promulgated its first water quality standards regulation in 40CFR Part 131). Existing uses must be maintained and cannot be removed.
Index of Biotic Integrity (IBI)	An integrative expression of site condition across multiple metrics comprised of attributes of a biological assemblage. It refers to the index developed by Karr (1981) and explained by Karr et al. (1986). It has been used to express the condition of fish, macroinvertebrate, algal, and terrestrial assemblages throughout the U.S. and in each of five major continents.
MIwb	The Modified Index of Well-Being (MIwb) is based on fish assemblage measures including numbers, biomass, and two diversity indices (Shannon Index) based on numbers and biomass. The numbers and biomass metrics exclude highly tolerant species. It reflects the overall productivity and diversity of the fish assemblage and it frequently responds before the IBI to improvements in water quality and habitat.
Metric	A calculated term or enumeration representing an attribute of a biological assemblage, usually a structural aspect, that changes in a predictable manner with an increased effect of human disturbance.
Monitoring and Assessment	The entire process of collecting data from the aquatic environment using standardized methods and protocols, managing that data, analyzing that data to make assessments in support of multiple program objectives, and disseminating the assessments to stakeholders and the public.
Multimetric Index	An index that combines assemblage attributes, or metrics, into a single index value. Each metric is tested and calibrated to a scale and transformed into a unitless score prior to being aggregated into a multimetric index. Both the index and metrics are useful in assessing and diagnosing ecological condition.
Narrative Biocriteria	Written statements describing the narrative attributes of the structure and function of aquatic communities

	in a waterbody necessary to protect a designated aquatic life use.
Natural Condition	This includes the multiplicity of factors that determine the physical, chemical, or biological conditions that would exist in a waterbody in the absence of measurable impacts from human activity or influence.
Numeric Biocriteria	Specific quantitative and numeric measures of the structure and function of aquatic communities in a waterbody necessary to protect a designated aquatic life use.
Qualitative Habitat Evaluation Index	A qualitative habitat evaluation assessment tool that is applied to streams and rivers in Ohio and which is used to identify habitat variables that are important to attainment of the Ohio biological criteria.
Reference Condition	The condition that approximates natural, unimpacted to best attainable conditions (biological, chemical, physical, etc.) for a waterbody. Reference condition is best determined by collecting measurements at a number of sites in a similar waterbody class or region under minimally or least disturbed conditions (by human activity), if they exist. Since undisturbed or minimally disturbed conditions may be difficult or impossible to find in some states, least disturbed conditions, combined with historical information, models or other methods may be used to approximate reference condition as long as the departure from natural or ideal is comprehended. Reference condition is used as a benchmark to establish numeric biocriteria.
Reference Site	A site selected to represent an approximation of reference condition and by comparison to other sites being assessed. For the purpose of assessing the ecological condition of other sites, a reference site is a specific locality on a waterbody that is minimally or least disturbed and is representative of the expected ecological condition of other localities on the same waterbody or nearby waterbodies.

Regional Reference Condition	A description of the chemical, physical, or biological condition based on an aggregation of data from reference sites that are representative of a waterbody type in an ecoregion, subregion, bioregion, or major drainage unit.
Stressors	Physical, chemical, and biological factors that can adversely affect aquatic organisms. The effect of stressors is apparent in the biological responses.
Use Attainability Analysis (UAA)	A structured scientific assessment of the physical, chemical, biological or economic factors affecting attainment of the uses of waterbodies.
Use Classes	A broad capture of a designated use for general purposes such as recreation, water supply, and aquatic life.
Use Subclasses	A subcategorization of use classes into discrete and meaningful descriptions. For aquatic life this would include a hierarchy of warmwater and cold water uses and additional stratification provided by different levels of warmwater uses and further stratification by waterbody types.
TALU Based Approach	This approach includes tiered aquatic life uses (TALU) based on numeric biological criteria and implementation via an adequate monitoring and assessment program that includes biological, chemical, and physical measures, parameters, indicators and a process for stressor identification.
Tiered Aquatic Life Uses (TALUs)	As defined: The structure of designated aquatic life uses that incorporates a hierarchy of use subclasses and stratification by natural divisions that pertain to geographical and waterbody class strata. TALUs are based on representative ecological attributes and these should be reflected in the narrative description of each TALU tier and be embodied in the measurements that extend to expressions of that narrative through numeric biocriteria and by extension to chemical and physical indictors and criteria.

	As used: TALUs are assigned to water bodies based on the protection and restoration of ecological potential. This means that the assignment of a TALU tier to a specific waterbody is done with regard to reasonable restoration or protection expectations and attainability. Hence knowledge of the current condition of a waterbody and an accompanying and adequate assessment of stressors affecting that waterbody are needed to make these assignments.
Total Maximum Daily Load (TMDL)	The maximum amount of a pollutant that a body of water can receive while still meeting water quality standards. Alternatively, a TMDL is an allocation of a water pollutant deemed acceptable to attain the designated use assigned to the receiving water.
Water Quality Standards (WQS)	A law or regulation that consists of the designated use or uses of a waterbody, the narrative or numerical water quality criteria (including biocriteria) that are necessary to protect the use or uses of that particular waterbody, and an antidegradation policy.
Water Quality Management	A collection of management programs relevant to a water resource protection that includes problem identification, the need for and placement of best management practices, pollution abatement actions, and measuring the effectiveness of management actions.

List of Acronyms

ALU	Aquatic Life Use
BCG	Biological Condition Gradient
CWA	Clean Water Act
EPT	Ephemeroptera, Plecoptera, Trichoptera
IBI	Index of Biotic Integrity for fish assemblages
ICI	Invertebrate Community Index
M&A	Monitoring and Assessment
NPDES	National Pollutant Discharge Elimination System
OEPA	Ohio Environmental Protection Agency
QHEI	Qualitative Habitat Evaluation Index
TALU	Tiered Aquatic Life Use
TMDL	Total Maximum Daily Load
UAA	Use Attainability Analysis
WLA	Waste Load Allocation
WQS	Water Quality Standards
WWTP	Wastewater Treatment Plant

FOREWORD

What is a Biological and Water Quality Survey?

A biological and water quality survey, or "biosurvey", is an interdisciplinary monitoring effort coordinated on a waterbody specific or watershed scale. This may involve a relatively simple setting focusing on one or two small streams, one or two principal stressors, and a handful of sampling sites or a much more complex effort including entire drainage basins, multiple and overlapping stressors, and tens of sites. The latter is the case with this study in that Little Miami represents a watershed of 170 square miles in drainage area with a mix of overlapping stressors and sources in a highly urbanized and legacy industrial landscape. The 2017 assessment is a follow-up to previous surveys of the River and Selected Tributaries performed by MBI in 2012 and 2013 and Ohio EPA in 1983, 1993, 1998, and 2007 (Ohio EPA 1995, 2000, 2009).

Scope of the 2017 Little Miami River and Selected Tributaries Biological and Water Quality Assessment

The scope of the MSDGC 2017 Little Miami River and Selected Tributaries biological and water quality assessment included the mainstem and parts of two tributaries compared to the full watershed scope of the 2012 survey (MBI 2013). In addition to supporting the instream monitoring requirement of the CSO NPDES permit the overall objectives remained the same:

1. Determine the extent to which biological assemblages are impaired (using Ohio EPA methods and criteria);
2. Determine the categorical stressors and sources that are associated with those impairments; and,
3. Add to the broader databases for the Little Miami River study area to track and understand changes through time that occur as the result of MSDGC abatement actions or other factors.

The data presented herein were processed, evaluated, and synthesized as a biological and water quality assessment of aquatic life and recreational use support status. The assessment of the mainstem is directly comparable to that accomplished previously in 1983, 1989, 1993, 1998, and 2007 by Ohio EPA and 2012 and 2013 by MBI, such that trends in status can be examined, and causes and sources of impairment can be confirmed, appended, or removed. This study includes an assessment of chemical and physical stressors related to the biological assemblages. It is not the purpose of this study to identify specific remedial actions on a site specific or watershed basis. However, the data produced by this study contributes to the maintenance and use of the Integrated Priority System (IPS; MBI 2015) that was developed to determine and prioritize remedial projects for the MSDGC service area.

EXECUTIVE SUMMARY

Scope and Purpose

In 2010 MSDGC and MBI developed a four-year rotational watershed assessment approach that is documented in the *Watershed Monitoring and Bioassessment Plan for the MSD Greater Cincinnati Service Area, Hamilton County, Ohio; Technical Report MBI/5-11-3* (MBI 2011). Initiated in 2011 it has provided biological and water quality monitoring data that has assisted MSDGC in better understanding current water quality, trends through time, and considerations for its capital planning and implementation of Project Groundwork to further improve water quality. The 2017 bioassessment of the Little Miami River study area is Year Two of the follow-up sampling and analysis that is now being conducted primarily in support of the instream monitoring requirement of the CSO NPDES permit. The sampling and analysis in 2017 was performed by Level 3 Qualified Data Collectors and under a biological Project Study Plan approved by Ohio EPA under the specifications of the Ohio Credible Data Law.

An intensive pollution survey design that employed a high density of sampling sites and biological, chemical, and physical indicators and parameters was followed. The principal objectives of biological assessments are to assess current conditions, verify existing aquatic life and recreational use designations, assign uses to unlisted streams and stream segments, make recommendations for any changes to use designations, report attainment status following the Ohio WQS and Ohio EPA practices, and determine associated causes and sources of impairment. The determination of associated causes and sources of impairments to aquatic life and recreational uses followed practices similar to that employed by Ohio EPA. As such, these determinations are usually categorical, but can include the identification of specific pollutants. The results of this study will be incorporated in an ongoing assessment of stressors and their root causes and sources throughout the MSDGC service area via the Integrated Prioritization System (IPS; MBI 2015). The IPS includes more detailed analyses of regional patterns in stressors by relating them to the chemical, physical, and biological data generated by the surveys to ancillary data available in GIS coverages.

Highlighted Findings

Aquatic Life Use Attainability and Use Attainment Status

The key indicator of overall condition in terms of aquatic life is the status of the attainment of aquatic life use designations based on attainment of the Ohio biological criteria. The status of use attainment is portrayed as full, partial, or non-attainment at each site. The 2017 assessment of the Little Miami River mainstem, the Duck Creek watershed, and parts of Sycamore Creek provided an opportunity to update use attainment status and to gauge the effectiveness of prior and ongoing attempts to improve water quality and overall conditions by comparing the results to prior assessments. The 2012 and 2013 (fish/habitat only) by MBI and the 1983, 1993, 1998, and 2007 surveys by Ohio EPA provide the most consistent basis for comparisons in terms of spatial coverage and between indicators and parameters for the 2017 study area.

Of the 37 sites that were assessed in the 2017 Little Miami River bioassessment, 11 sites were evaluated against the Exceptional Warmwater Habitat (EWH) use, 15 sites were evaluated against the Warmwater Habitat (WWH) use, seven (7) sites against the Limited Resource Waters (LRW) use, and four (4) for the Primary Headwater Habitat (PHWH) classification. The most recent recommendations for aquatic life use changes were originally made as part of the 2012 bioassessment (Table 1; MBI 2013) and these were used to gauge attainment status in 2017. The lone recommended change from 2012 was the PHWH Class 2 assignment in the unnamed tributary to Duck Creek from PHWH Class 1.

***Table 1**. Summary of recommended aquatic life use (AQLU) changes based on use attainability analyses from the 2012 and 2017 Little Miami River biological and water quality assessments by stream segments evaluated.*

Current AQLU 2012	Segments Assessed 2012	Recom. AQLU 2012	Segments Assessed 2017	Recom. AQLU 2017	Ohio EPA AQLU Changes
None	11	WWH	2	WWH	Pending
None	1	LRW	1	LRW	Pending
None	8	PHWH3A	1	PHWH3A	Pending
None	7	PHWH2	3	PHWH2	Pending
WWH	1	PHWH3A	0	--	Pending
LRW	3	WWH	2	WWH	Pending
LRW	1	PHWH1	1	PHWH2	Pending

WWH – Warmwater Habitat; LRW – Limited Resource Waters; PHWH – Primary Headwater Habitat

Aquatic life use attainment status for 2017 is depicted in Table 2 and Figure 1. A summary of each of the Little Miami River mainstem and the Duck Creek and Sycamore Creek subwatersheds follow:

Little Miami River Mainstem

- The 2017 results showed full attainment of the Exceptional Warmwater Habitat (EWH) use at all sites downstream to the Warmwater Habitat (WWH) boundary at Beechmont Ave. All sites in the reach downstream from this boundary were in full attainment of WWH.
- The 2017 results are a marked improvement over the near complete non-attainment of EWH that was observed in 2012 and are nearly back to or in excess of the 2007 recovery documented by Ohio EPA. The 2012 non-attainment was driven mostly by declines in the fish IBI due to the severe reductions in intolerant fish species. The current recovery was incremental with the 2013 results (fish only) showing an intermediate improvement between 2012 and 2017.

***Table 2**. Aquatic life use attainment status at Little Miami River, Duck Creek, and Sycamore Creek subwatershed sites in 2017. Index of Biotic Integrity (IBI), Modified Index of Well-Being (MIwb), and Invertebrate Community Index (ICI) scores are used as the primary determinants of aquatic life use attainment status. The Qualitative Habitat Evaluation Index (QHEI) measures physical habitat quality and potential to support an aquatic life use. Causes and sources of impairment are listed at sites that did not fully attain their existing or recommended use tier – sites in full attainment EWH are blue shaded, WWH and PHWH green shaded, and LRW orange shaded. Sampling locations are organized upstream to downstream and by the large river and HUC 12 Watershed Assessment Units (WAU). Changes in attainment status from the previous reported assessment in 2012 are denoted as improving ↑, no change ⊙, or declining ↓.*

Site ID	River Mile	Drainage Area (mi.^{2})	IBI	MIwb	ICI or Narrative	QHEI/HHEI	Attainment Status	Causes	Sources
Little Miami River (EWH Aquatic Life Use –Existing)									
LM01	27.9	1069	48	10.7	58	79.5/	FULL ↑		
LM02	24.1	1085	54	11.5	56	83/	FULL ↑		
LM03	22.3	1148	46^{ns}	10.6	E	74/	FULL ↑		
LM05	21.5	1160	48	11.5	E	81.5/	FULL ↑		
LM07	18.5	1187	50	10.7	54	76/	FULL ↑		
LM08	17.7	1190	52	10.2	58	85.3/	FULL ↑		
LM09	13.1	1203	52	10.3	52	84/	FULL ⊙		
LM11	10.9	1707	50	10.7	56	80/	FULL ⊙		
LM12	8.1	1710	48	10.1	E	81/	FULL ↑		
LM13	6.83	1720	46^{ns}	10.5	54	80/	FULL ↑		
LM15	4.1	1730	46^{ns}	10.6	56	81.8/	FULL ↑		
Little Miami River (WWH Aquatic Life Use – Existing)									
LM16	3.5/3.4	1752	46	9.7	42	82.3/	FULL ⊙		
LM17	1.6	1754	38	8.8	NA	61/	FULL ⊙	Impoundment	Ohio R. backwater
Sycamore Creek (WWH Aquatic Life Use – Existing)									
LM50	1.1	12.5	30*	-	44	63.5/	Partial ⊙	Chlorides, metals, nutrients	Urban runoff
LM51	0.5	22.8	37^{ns}	7.9^{ns}	38	64.3/	FULL ↑		
LM52	0.1	23.3	47	8.1	36	74.5/	FULL ↑		
Unnamed Tributary to Unnamed Tributary to Sycamore Creek (Aquatic Life Use – Undesignated) PHW2 Recommended									
LM54	2.4	1.6	Dry	-	Dry	/66.5	PHW2		
Unnamed Tributary to Sycamore Creek (Aquatic Life Use – Undesignated) WWH Recommended									
LM55	1.2	5.3	24*	-	Good	67.5/	Partial ⊙	Chlorides, flow, unknown	Urban, natural

***Table 2**. Aquatic life use attainment status at Little Miami River, Duck Creek, and Sycamore Creek subwatershed sites in 2017. Index of Biotic Integrity (IBI), Modified Index of Well-Being (MIwb), and Invertebrate Community Index (ICI) scores are used as the primary determinants of aquatic life use attainment status. The Qualitative Habitat Evaluation Index (QHEI) measures physical habitat quality and potential to support an aquatic life use. Causes and sources of impairment are listed at sites that did not fully attain their existing or recommended use tier – sites in full attainment EWH are blue shaded, WWH and PHWH green shaded, and LRW orange shaded. Sampling locations are organized upstream to downstream and by the large river and HUC 12 Watershed Assessment Units (WAU). Changes in attainment status from the previous reported assessment in 2012 are denoted as improving ↑, no change ⊙, or declining ↓.*

Site ID	River Mile	Drainage Area (mi.^{2})	IBI	MIwb	ICI or Narrative	QHEI/HHEI	Attainment Status	Causes	Sources
LM56	0.2	5.6	34*	-	54	64.5/	Partial ⊙	Chlorides, flow	Urban, natural
Duck Creek (LRW Aquatic Life Use – Existing)									
LM71	6.1	2.2	12*	-	VP*	27.5/68	**NON** ⊙	Organic enrichment, metals	CSOs, Urban
LM72	5.14	5.1	24	-	Poor	52.5/	FULL ⊙		
LM73	4.58	5.8	12*	-	Poor	19/	**NON** ⊙	Org. enrichment, metals	CSOs, Urban
LM74A	3.9	9.6	12*	-	Fair	26.5/	**NON** ⊙	Org. enrich./D.O., metals	CSOs, Urban
LM75	3.4	11.5	12*	-	Fair	23.5/	**NON** ⊙	Org. enrichment, metals	CSOs, Urban
LM76	2.8	14.3	25	-	32	54/	FULL ⊙		
Duck Creek (WWH Aquatic Life Use – Existing)									
LM77	2.0	14.3	27*	-	42	58.5/	Partial ↑	Org. enrich./D.O., met., flow, silt.	CSOs, Urban, habitat
LM79	0.8/0.5	14.6	30*	-	34	64.3/	Partial ↑	Flow, org. enrich., met., silt., thermal	CSOs, Urban, habitat
Unnamed Tributary to Duck Creek (Aquatic Life Use – Undesignated) PHW2 Recommended									
LM83	0.8	1.2	Dry	-	Dry	/42	PHW2		
Unnamed Tributary to Duck Creek (Aquatic Life Use Undesignated) LRW Recommended									
LM80	0.1	1.4	12*	-	VP*	42.5/68	**NON** ⊙	Org. enrich.,chlor.,flow,chann., silt.	CSOs, Urban, habitat
East Fork Duck Creek (LRW Aquatic Life Use – Existing) PHW2 Recommended									
LM81	2.3	0.5	Dry	-	Dry	/43	PHW2		
East Fork Duck Creek (LRW Aquatic Life Use – Existing) WWH Recommended									
LM85	2.0	1.3	26*	-	VP*	59/74	Non ↑	Chlor., flow, org. enrich., metals	Urban runoff
LM84	0.5	2.4	24*	-	Fair	44.5/77	NON ↑	Chlorides, flow, chan., silt.	Urban, habitat
Little Duck Creek (Aquatic Life Use -- Undesignated) WWH Recommended									
LM86	2.4	0.5	36^{ns}	-	Good	52/80	FULL ↑		
LM87	1.9	0.5	34*	-	Good	50/72	Partial ⊙	Chlorides, Flow, Siltation	Urban runoff

***Table 2**. Aquatic life use attainment status at Little Miami River, Duck Creek, and Sycamore Creek subwatershed sites in 2017. Index of Biotic Integrity (IBI), Modified Index of Well-Being (MIwb), and Invertebrate Community Index (ICI) scores are used as the primary determinants of aquatic life use attainment status. The Qualitative Habitat Evaluation Index (QHEI) measures physical habitat quality and potential to support an aquatic life use. Causes and sources of impairment are listed at sites that did not fully attain their existing or recommended use tier – sites in full attainment EWH are blue shaded, WWH and PHWH green shaded, and LRW orange shaded. Sampling locations are organized upstream to downstream and by the large river and HUC 12 Watershed Assessment Units (WAU). Changes in attainment status from the previous reported assessment in 2012 are denoted as improving ↑, no change ⊙, or declining ↓.*

Site ID	River Mile	Drainage Area (mi.^{2})	IBI	MIwb	ICI or Narrative	QHEI/HHEI	Attainment Status	Causes	Sources
Little Duck Creek (Aquatic Life Use -- Undesignated) WWH Recommended									
LM90	1.0	1.1	30*	-	Good	54/87	Partial ⊙	Chlorides, Flow, Siltation	Urban runoff
LM92	0.49	1.7	Dry	-	Dry	NA	NON ⊙	Flow, D.O., organic enrich.	CSOs, Urban
Unnamed Tributary to Little Duck Creek @RM 4.42 (Aquatic Life Use Undesignated) PHW3A Recommended									
LM82	0.2	0.33	26*	-	Poor	60.5/74	PHW3A		

[1] – Fish/Macroinvertebrate site river miles.

[a] - MIwb is not applicable to headwater streams with drainage areas < 20 mi.^{2}.

[b] - VP=Very Poor; P=Poor; MF=Marginally Fair; F=Fair; MG=Marginally Good; G=Good; VG=Very Good; E=Exceptional.

[H] – Headwater Site Type: sites draining areas <20 mi.^{2}.

[W] - Wadeable Site Type: sites draining areas >20 mi.^{2} sampled with wading equipment; [B] - Boat Site Type: sampled with raft mounted electrofishing.

[ns] - Non-significant departure from the biocriteria (<4 IBI or ICI units or <0.5 MIwb units).

* - Significant departure from the biocriteria (>4 IBI or ICI units or >0.5 MIwb units).

Biological Criteria – Interior Plateau Ecoregion			
Index	**WWH**	**EWH**	**MWH-C**
IBI – Boat	38	48	24
IBI – Wading	40	50	24
IBI - Headwater	40	50	24
MIwb - Boat	8.7	9.6	5.8
MIwb – Wading	8.1	9.4	6.2
ICI	30	46	22

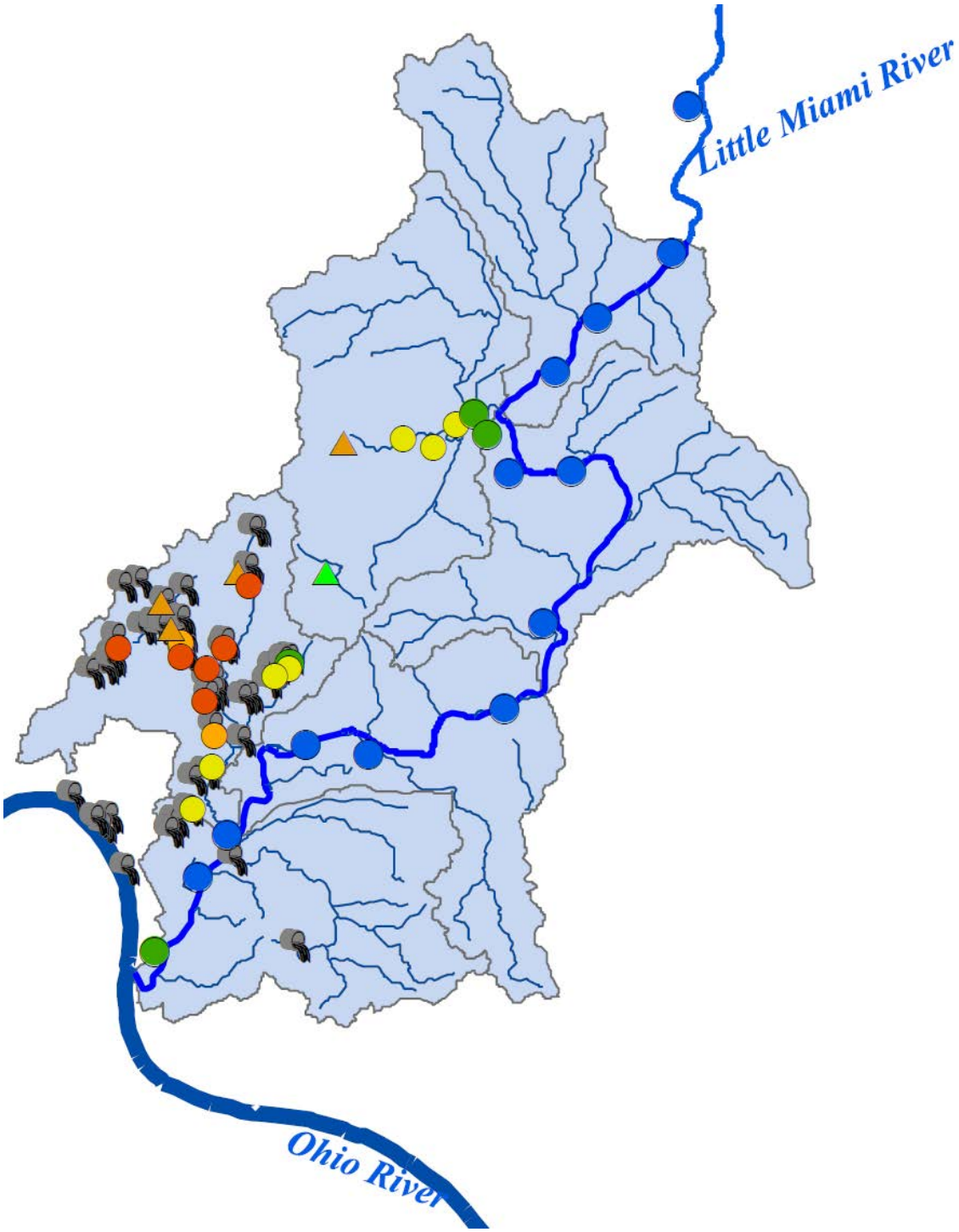

Figure 1. *Aquatic life use attainment status in the Little Miami River study area during 2017 (green circles – full attainment of aquatic life use tier; yellow – partial attainment; red – non-attainment; grey outfalls – CSO locations). Site descriptions and site codes appear in Table 5. Sites evaluated as Primary Headwater Habitat (PHWH) sites appear as triangles with their classification results (green – PHW Class III; orange – PHWH Class II).*

- The fish Modified index of Well-Being (MIwb) and the macroinvertebrate IC met their respective EWH biocriterion at most sites in 2012 and 2013 and again in 2017. However, the Area of Degradation Value (ADV)/Area of Attainment Value (AAV) showed a decline between 2007 and 2012 and then a steady recovery in 2013 and 2017, the latter showing the highest AAV among all years.
- There were no recommendations made for any existing use designation assignments for the Little Miami River mainstem.

Duck Creek Subwatershed

- The status of aquatic life use attainment improved slightly between 2012 and 2017 with a gain of approximately one mile in full attainment in the existing Limited Resource Waters designated segment (LRW; upstream Red Bank Rd., RM 2.4). No change was observed in the WWH segment downstream to the Little Miami River.
- Of the eight sites assessed in 2017 two were in full attainment of LRW, four in non-attainment of LRW, and two in partial attainment of WWH (fish assemblage limited).
- Improvements in the fish IBI and macroinvertebrate ICI (or narrative equivalents) occurred in Duck Creek mainstem between 2012 and 2017. These were evident in the reduced ADVs and increased AAVs demonstrating a detectable and incremental improvement in conditions for aquatic life.
- The fish assemblage was the more limited of the two biological assemblages an indication that the controlling factor remains those directly and indirectly associated with the highly modified habitat.
- Of the 10 sites located in Duck Creek tributaries one was in full attainment of WWH (an improvement from 2012), two in partial attainment of WWH (fish assemblage limited), three sites in non-attainment of WWH (two showing incremental improvements since 2012), one site in non-attainment of LRW, and two sites classified as Primary Headwater Habitat Class 2. The result at the site in the headwaters of the East Fork is an improvement over the PHWH Class 1 assignment in 2012.
- Causes associated with the partial and non-attainment included organic enrichment (7 sites), metals (6 sites), flow modifications (4 sites), chlorides (3 sites), and siltation (2 sites).

Sycamore Creek Subwatershed

- Of the six sites assessed in the Sycamore Creek subwatershed in 2017 two were in full attainment of WWH (an improvement since 2012), three in partial attainment of WWH (fish assemblage limited), and one site classified as a PHWH Class 2.
- Causes associated with the partial and non-attainment included chlorides, metals, and nutrients from urban runoff sources.

Recreational Use Status

Impairment of the Primary Contact Recreation (PCR) recreational use in the 2017 Little Miami study area was judged by the *Escherichia coli (E. coli)* bacterial criteria in the Ohio WQS (OAC 3745-1-07; Table 7-13). *E. coli* bacteria are normally present in the feces and intestinal tracts of

humans and other warm-blooded animals typically comprising 97 percent of the fecal coliform bacteria in humans (Dufour 1977). There is currently no practical way to differentiate between human and animal sources of coliform bacteria in surface waters, although methodologies for this type of analysis have been developed including recent research supported by MSDGC. *E. coli* enters surface waters via direct discharges of human and animal wastes, and in runoff from land surfaces where wastes have been deposited. Pathogenic (disease-causing) organisms are typically present in the environment in such small amounts that it is impractical to directly monitor each one. 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 signal the *potential* presence of pathogenic organisms that enter the environment via the same pathways. When *E. coli* are present in extremely high numbers in a water sample, it invariably means the water has received a dose of fecal matter from one or more sources.

The Ohio WQS for recreational uses were revised in early 2016 to reflect a more rigid adherence to equalizing all forms of human contact with surface waters as ensuing the same level of risk. This replaced the former framework that was stratified to account for the degree of contact with three levels of the Primary Contact Recreational (PCR) use as PCR-A, PCR-B, and PCR-C. Those subcategories are now merged into a single use. This action also obviated the recommendations made in the 2011-14 watershed assessments for the redesignation of certain streams to one of the three former subcategories. The application of the Secondary Contact Recreational (SCR) use was also changed to a more restrictive interpretation of the potential for human contact with surface waters. Existing SCR designations made prior to 2011 remain, but could potentially be reviewed and revised to PCR by Ohio EPA at any time. Any new SCR recommendations would need to document that there is virtually no human contact that is possible due to physical restrictions to accessing a surface water. As a result the evaluation of the recreational uses in the 2017 Little Miami River study area were done in accordance with the existing designations of PCR and SCR when applicable.

Rivers and streams in the 2017 study area are designated as primary contact recreation (PCR) and/or secondary contact recreation (SCR) in the Ohio WQS (OAC 3745-1- 30). Water bodies with a designated recreation use of PCR *". . . 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)). Secondary Contact includes waters that *". . . result in minimal exposure potential to water borne pathogens because the waters are: rarely used for water based recreation such as, but not limited to, wading; situated in remote, sparsely populated areas; have restricted access points; and have insufficient depth to provide full body immersion, thereby greatly limiting the potential for water based recreation activities."* The *E. coli* criterion that applies to PCR is expressed as a 90-day geometric mean of ≤126 colony forming units (cfu)/100 ml with a Statistical Threshold Value of 410 cfu/100 ml. The criterion that applies to SCR streams is ≤1,030 cfu/100 ml for both the 90 day geometric mean and the STV. The geometric mean is based on two or more samples and is used as the basis for determining the attainment status of the PCR use.

Widespread impairment of the Primary Contact (PCR) and Secondary Contact Recreation (SCR) based on *E. coli* results persisted in the Duck Creek and Sycamore Creek subwatersheds in 2017. However, direct comparisons of changes in attainment status between 2012 and 2017 are complicated by changes to the Recreation uses and criteria in early 2016. Recreational use attainment for each of the 37 sites sampled in 2017 appears later in Table 8 and on Figure 2. A narrative summary of the major portions of the 2017 study area follows:

Table 3. *E. coli criteria for Ohio streams and rivers (OAC 3745-1-07).*

	***E. coli* Counts (cfu/100 ml)**	
Recreation Use	Seasonal Geometric Mean	Statistical Threshold Value[1]
PCR	126	410
SCR	1,030	1,030

[1]These criteria shall not be exceeded in more than 10 percent of the samples taken during any 90-day period.

Little Miami River Mainstem

- Only four of 13 sites were impaired for the PCR use and these were insignificant exceedances of the Statistical Threshold Value (STV) – all geometric means were below that criterion. This a significant improvement over the 2012 results when 14 of 16 sites were impaired for the PCR-A subcategory. These would translate to exceedances of both the geometric mean and STV values under the revised PCR criteria.

Duck Creek Subwatershed

- All eight sites assessed in the mainstem of Duck Creek were impaired, five for the SCR use and three for the PCR use. All of the latter sites had maximum *E. coli* values of >2420 cfu/100 ml which contributed to the impaired status. Geometric means were generally much lower meeting the respective criteria at five sites, an indication that the high maximum values are episodic.

Sycamore Creek Subwatershed

- Of the six sites assessed in the Sycamore Creek subwatershed, three attained the SCR use criteria and three PCR sites were impaired. All of the three latter sites had maximum *E. coli* values of >2420 cfu/100 ml which contributed to the impaired status. Geometric means exceeded the criteria at two of the three PCR sites, but were only slightly above meeting the respective criteria at all three sites, a similar indication that the high maximum values are episodic.

Causes and Sources of Non-attainment

The determination of causes and sources of aquatic life use impairment was accomplished by associating the occurrence of sampling results that exceeded various chemical and physical thresholds that are known to adversely affect aquatic organisms. These categorizations are in some cases categorical (e.g., habitat alterations) and may include multiple specific types of effects and mechanisms. Others are parameter specific (e.g., dissolved oxygen) since the data are collected at that level. Yet others are at the categorical level (e.g., nutrients, toxics) which may include multiple parameters. In addition, certain stressors can be proxies for a wider range of specific causes or can mask causes that can emerge with changing conditions. Sources are

also necessarily categorical and some are broader in their inclusion of specific activities than others. The causes and sources that are listed along with the biological impairments appear in the determination of aquatic life use attainment status (Table 2) and are summarized in Table 4. Each cause and source is listed by the number of sites it was assigned in 2017 with a comparison to the occurrence in 2012. Flow modifications, chlorides, and organic enrichment were the most frequently assigned in 2017. The flow modification and chloride assignments are similar to 2012 and siltation appeared at sites where it was absent in 2012. Organic enrichment, D.O., and metals were much reduced in 2017 and are likely real reductions given the improvement in biological quality in the Little Miami River mainstem and parts of the Duck Creek and Sycamore Creek subwatersheds.

Trajectories in Key Indicators

Developing an understanding of the temporal trajectory of the different indicators and parameters that are provided by a spatially adequate monitoring design is important feedback to MSDGC, Ohio EPA, and stakeholders in the Little Miami River study area. The study area has a complex mosaic of watershed level and site-specific impacts the complexity of which makes being able to understand and then develop management responses to impairments is an immense challenge. The documentation of incremental improvements as opposed to a singular focus on the full restoration of impairments allows program effectiveness to receive credit short of achieving full restoration. Furthermore, failing to recognize if waters are improving and on a positive trajectory can lead to erroneous conclusions about the attainability of Clean Water Act (CWA) goals and the viability of restoration efforts. Simply put, a selective focus on individual and selected pollutants are insufficient in a complex setting like the Little Miami River study area. It is for these reasons that being able to detect, measure, and express incremental

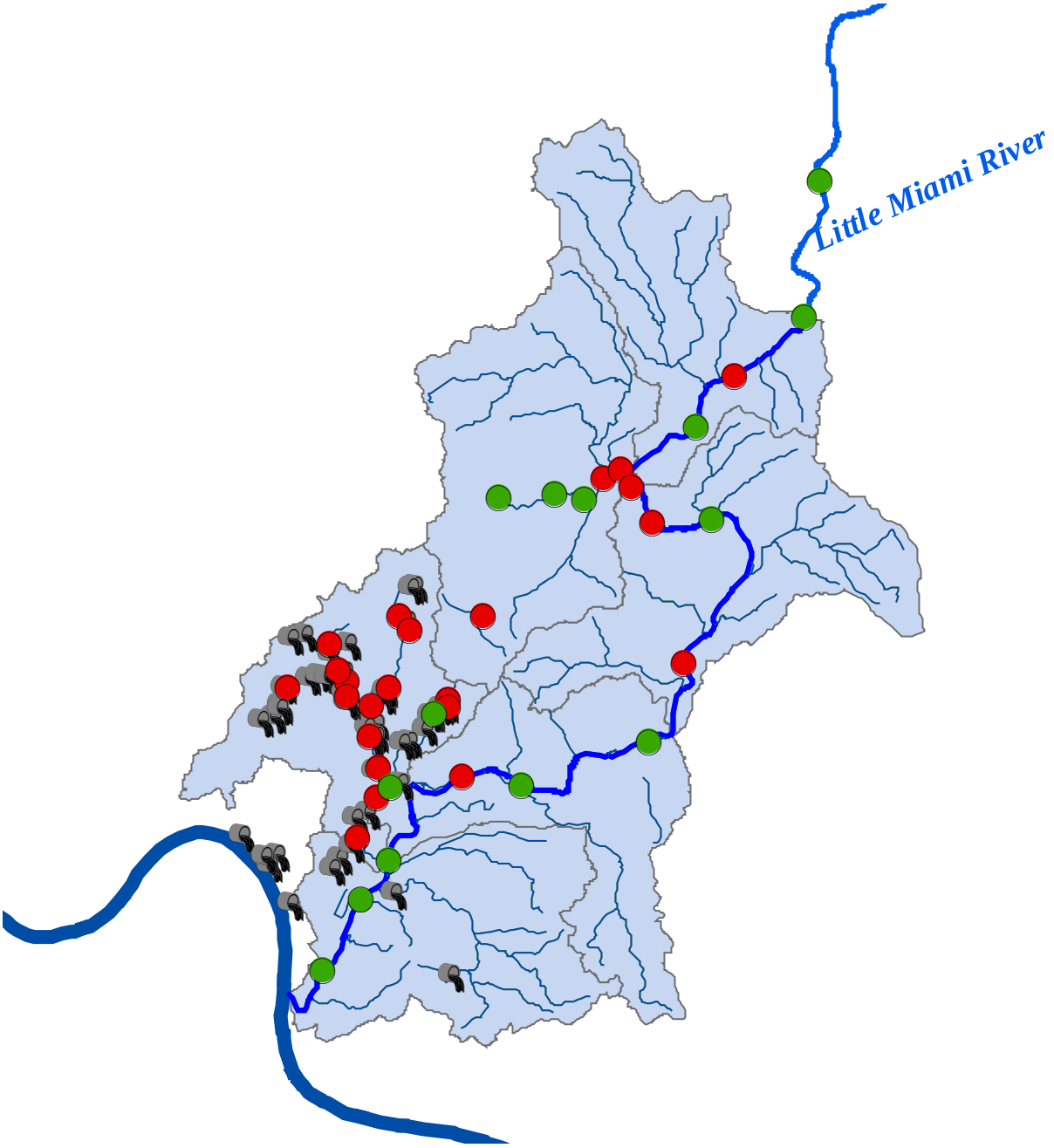

***Figure 2**. Map of recreational use attainment status for the Primary Contact Recreational and Secondary Contact uses in the 2017 Little Miami River study area expressed as attainment (green) or non-attainment (red) based on E. coli values. MSDGC CSO locations appear as grey circles.*

***Table 4**. Summary of causes and sources associated with biological impairments in the Little Miami River study area at matching sites in 2012 and 2017. Causes and sources with zero in 2012 were identified at the larger number of sites assessed in 2012.*

Cause	Number 2012/2017	Source	Number 2012/2017
Flow modification	12/10	Urban Runoff	19/15
Chlorides	11/8	Combined Sewers	8/8
Organic enrichment	20/9	Unknown	12/0
D.O.	13/2	WWTP	1/0
Nutrients	1/1	Natural	2/2
Metals	10/7	Habitat Modification	2/4
Habitat	1/2	Dam Release	0/0
Siltation	0/6	Agricultural NPS	0/0
Ammonia	1/0	Impoundment	1/0
Loss of Connectance	0/0	Unsewered	0/0
Unknown	1/0	Sewer line	1/0

improvements in key indicators is vital. Showing incremental progress not only provides confirmation that restoration efforts are working, it also provides important feedback for those programs which because of uncertainties in their control must be adaptive in order to succeed. As such, the type of monitoring and assessment that was employed in this survey was designed to provide results that could be used to demonstrate the degree and direction of incremental change.

The results of the bioassessment using the primary indices that comprise the Ohio biocriteria were used to quantify the degree to which overall aquatic life conditions have improved through time up to and including the 2017 survey. The Area of Degradation (ADV) and Attainment (AAV) methodology (Yoder et al. 2005) was used to illustrate the degree of change between the Ohio EPA surveys of 1983, 1993, 1998, and 2007 and the 2012, 2013, and 2017 MBI surveys of the mainstem of Little Miami. The ADV/AAV term is an expression of the degree to which one of the biological index values is either above or below the WWH biocriterion and the distance of the mainstem over which it occurs. As such it is a quantification of the

"quantity" of biological attainment and impairment. When normalized to a standard distance (e.g., per mile) it can be an effective indicator of the degree of change which is taking place through time.

Little Miami River Mainstem

ADV/AAV results for the fish Index of Biotic Integrity (IBI), the Modified Index of Well-Being (MIwb), and the macroinvertebrate Invertebrate Community Index (ICI) were available from the series of Ohio EPA surveys in 1983, 1993, 1998, and 2007 and the 2012, 2013 (fish only) and 2017 MSDGC surveys of the lower Little Miami River mainstem. When this was assessed after the initial 2012 MSDGC survey (MBI 2013) a substantial decline was observed between the zenith of recovery documented by Ohio EPA in 2007 and the 2012 results especially for the fish IBI (Figure 1). Ohio EPA (2010) had credited the near complete recovery in 2007 from the impaired conditions in 1998 to improved WWTP treatment and phosphorus removal at selected WWTPs along the mainstem. The 2012 results showed a return to the impaired conditions of 1998 which prompted follow-up sampling in 2013 by Ohio EPA and MSDGC. The decline was the most severe in the fish IBI which was evident only in reduced AAVs for the fish MIwb and the ICI in 2012. Follow-up sampling for fish in 2013 showed a reduction in the degree of impairment, but recovery remained incomplete. The 2013 MSDGC sampling was extended upstream into Warren County to immediately upstream from the confluence with Caesar Creek at RM 51.2 and included 24 sites downstream through the 2012 study area. IBI scores exceeded full attainment of the EWH IBI biocriterion with scores >52 downstream to RM 36.0 upstream from Lebanon downstream form which most scores declined marginally either just meeting the EWH biocriterion of 48 or in non-significant departures downstream to RM 17.7 at Miamiville and then declining to scores of 40 or less at the remaining seven sites downstream from RM 12.7 at Milford. While inconclusive about a specific cause of the decline observed in 2012, the 2013 follow-up at least demonstrated the reaches of decline and impairment. The 2017 results demonstrated a complete return to the full attainment and quality in excess of EWH in the reach of the mainstem downstream from RM 27.9 to the WWH reach at Beechmont Ave. (RM 3.0). The AAV for the fish IBI was just shy of the 2007 value and for the fish MIwb and macroinvertebrate ICI were slightly higher than in 2007.

Duck Creek

Sufficient data was available from 2012 and 2017 to conduct a trend evaluation for the Duck Creek mainstem using the ADV/AAV methodology (Figure 2). Insufficient sites were sampled by Ohio EPA in 1983, 1994, or 2007 to include in this analysis, but an examination of those scant results indicates that conditions were likely the same or worse than in 2012. Both the fish IBI and macroinvertebrate ICI results demonstrated reduced ADVs and increased AAVs between 2012 and 2017 with the largest improvement in the macroinvertebrates. Aquatic life use status between 2012 and 2017 improved only slightly gaining perhaps one mile of full attainment and this considering the Limited Resource Waters (LRW) designation of the upper two-thirds of Duck Creek. As such the improved ADV/AAVs for the fish IBI and macroinvertebrate ICI show an

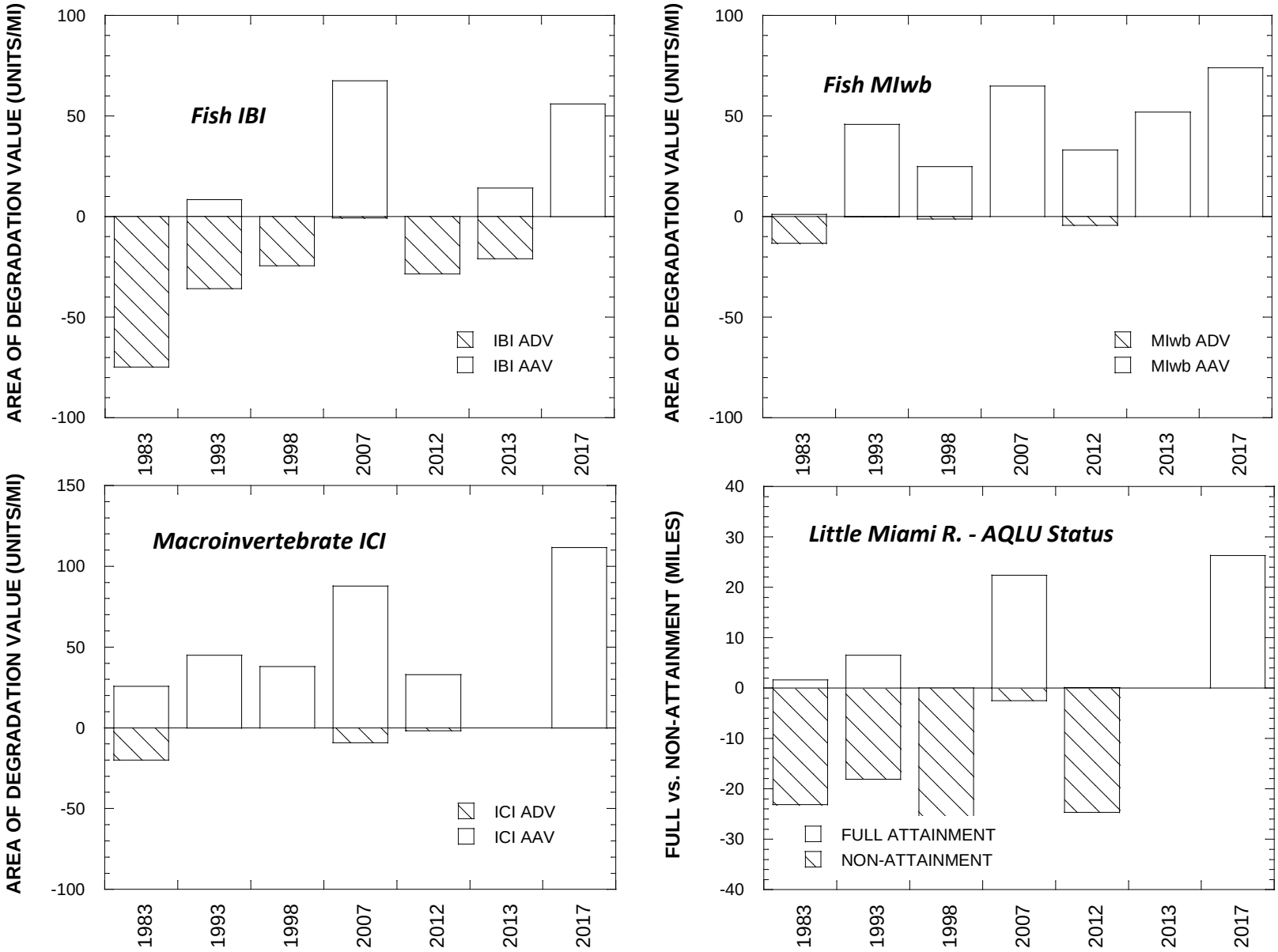

Figure 3. *Area of Degradation (ADV) and Area of Attainment (AAV) values for the IBI (upper left), MIwb (upper right), and ICI (lower right) in the Little Miami River mainstem between 1993 and 2017. The miles of full and non-attainment are depicted in the lower right panel.*

incremental improvement not revealed by the attainment status. The fish assemblage is the limiting factor in the use attainment results and an indication that the highly modified habitat of Duck Creek is a major limiting factor in Duck Creek along with multiple water quality impacts. The positive improvement in the macroinvertebrate assemblage is more likely associated with a lessening of chemical impacts.

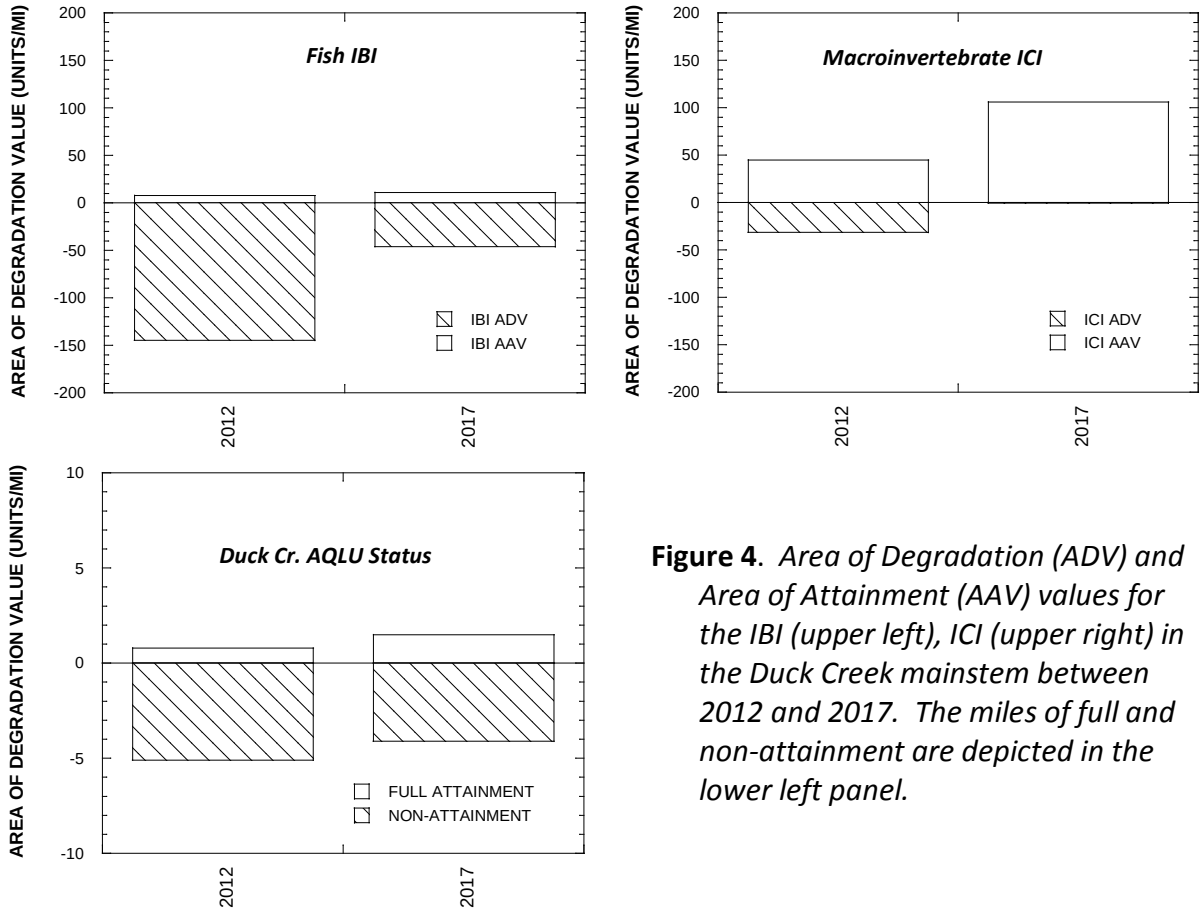

Figure 4. *Area of Degradation (ADV) and Area of Attainment (AAV) values for the IBI (upper left), ICI (upper right) in the Duck Creek mainstem between 2012 and 2017. The miles of full and non-attainment are depicted in the lower left panel.*

Recommendations

Designated Use Attainment Status

An original objective of the MSDGC service area watershed bioassessment plan was to evaluate existing aquatic life and recreational use designations and to recommend new uses for undesignated/unverified streams and changes to existing uses as a result of the series of 2011-14 baseline watershed assessments. Ohio EPA had last reviewed the aquatic life and recreational designations in the Little Miami River study area in 2007 (Ohio EPA 2010). Now, Ohio EPA has either adopted or is in the process of adopting the use designation recommendations from the 2012 MSDGC survey[1]. As such, that objective has been largely satisfied, but the same recommendations are repeated herein for resampled stream and river

[1] Find the 2012 MSDGC assessment at: http://www.msdgc.org/initiatives/water_quality/index.html.

sites. The MSDGC instream monitoring has since shifted to a more focused approach to document status, trends, and causes/sources of impairments related to pollution control efforts by Project Groundwork and related pollution source abatement efforts by MSDGC. A continued focus on documenting status and trends will inform decisions on Project Groundwork and document post-abatement improvements. The methodology can identify and track causes and sources of impairment allowing informed decisions about the allocation of pollution abatement resources by MSDGC. The 2017 Little Miami River and Selected Tributaries assessment represents the first follow-up survey five years after the 2012 Little Miami Basin baseline survey and it has revealed some positive trends.

BIOLOGICAL AND WATER QUALITY STUDY OF THE LITTLE MIAMI RIVER AND SELECTED TRIBUTARIES 2017

Introduction

The 2017 Little Miami River and Tributaries biological and water quality assessment covered more than 40 CSOs and SSOs, two municipal WWTPs, and numerous minor discharges providing the basis for documenting incremental changes against the previous 34 years of standardized monitoring of the Little Miami mainstem and major tributaries by Ohio EPA and MSDGC. The spatial and temporal sampling design and the biological, chemical, and physical indicators and parameters that were collected at each sampling site are described in the *Watershed Monitoring and Bioassessment Plan for the MSD Greater Cincinnati Service Area, Hamilton County, Ohio; Technical Report MBI/5-11-3* (MBI 2011). Biological sampling methods for fish and macroinvertebrate assemblages and habitat assessment are supported by chemical and physical measures and ancillary information about pollution sources and other stressors for the overall biological assessment. The assessment employed a targeted-intensive pollution survey design which documents changes in a longitudinal manner as the effects of multiple pollution sources accumulate in a downstream direction.

MSDGC intends to use the results and analysis of the monitoring and bioassessment program to accomplish the following:

1. Determine the status of service area rivers and streams in quantitative terms, i.e., not only if the waterbody is impaired but the spatial extent and severity of the impairment;
2. Determine the proximate stressors that contribute to the observed impairments for the purpose of targeting management actions to those stressors;
3. Evaluate the appropriateness of existing aquatic life and recreational use designations and make recommendations for any changes to those designations; and,
4. Continue the development of the Integrated Prioritization System (IPS) for a variety of purposes. Among its many uses, the IPS will assist MSDGC in making decisions about how to prioritize and design pollution abatement projects and measure their effectiveness.

To meet these objectives all data was generated by methods and implementation in conformance with the provisions of the Ohio Credible Data Law (ORC 6111.51). Under the regulations that govern the Credible Data program at Ohio EPA, data collection and analyses must be collected and performed under the direction of Level 3 Qualified Data Collectors (OAC 3745-4). MSDGC has used the data to evaluate the attainability of aquatic life and recreational uses and determine the status of service area rivers and streams since 2011. As such, the sampling and analysis of the biological and physical condition conducted herein conforms to these provisions by the development and submittal of annual Level 3 Project Study Plans (PSP).

MSDGC Watershed Bioassessment Scope and Purpose

The MSDGC watershed bioassessment project domain consists of eleven subwatersheds, three mainstem rivers, and the Ohio River mainstem within Hamilton County and parts of adjoining counties. These watersheds are impacted by a variety of stressors including municipal and industrial point source discharges of wastewater, habitat modifications in the form of modified stream channels, run-of-river low head dams, riparian encroachment, and channelization, and nonpoint source runoff from widely differing degrees of landscape modifications from rural to suburban to intensive urban development. The urban impact gradient is the strongest Lower and Middle Mill Creek lessening somewhat across the Little Miami and Great Miami River subwatersheds. Combined sewer overflows (CSOs) are the most numerous in Duck Creek and the adjacent Little Miami and some have subsumed historical streams.

2017 Little Miami River and Tributaries Assessment Scope and Purpose

The 2017 Little Miami assessment included the lower mainstem of Little Miami R., the Duck Creek subwatershed, and portions of the Sycamore Creek subwatershed that are within the scope of the MSDGC service area watershed monitoring plan (MBI 2011). In addition to the baseline purposes of the MSDGC monitoring plan, specific assessment issues in the 2017 Little Miami River study area include a high density of CSO and SSO outfalls in Duck Creek, the Exceptional Warmwater Habitat (EWH) status of the lower Little Miami, and other pollution sources including direct discharges and runoff from industrial operations, urban stormwater, and permitted municipal point sources.

Cincinnati has the fifth highest volume of CSOs in the U.S. (MSDGC 2011a). As a result, water quality has been significantly impacted in the Little Miami subwatershed. MSDGC is working to remediate these issues under a Consent Decree with the U.S. Dept. of Justice and U.S. EPA to reduce CSO volume by 2 billion gallons by 2019. To resolve the public health and water quality issues, MSDGC has implemented Project Groundwork, a multi-year and multi-billion dollar initiative that includes hundreds of sewer improvements and stormwater control projects (MSDGC 2011b). The role of the watershed monitoring program is to support these initiatives by providing current information about baseline conditions, provide feedback about the effectiveness of new and past remediation efforts via trend assessment, and to assure that restoration resources are targeted to the actions and places that have the greatest return on investment. As such the 2017 Little Miami River bioassessment is a continuation of that process.

The 2017 Little Miami River monitoring also fulfills the MSDGC National Pollution Discharge Elimination System (NPDES) CSO permit reporting requirements.

METHODS

Monitoring Design

An intensive pollution survey design that employs a high density of sampling sites and biological, chemical, and physical indicators and parameters was followed in 2017. The principal objectives of the biological assessment are to report aquatic life and recreational use attainment status, following the Ohio WQS and Ohio EPA practices, and determine associated causes and sources of impairment. To accomplish this sites were positioned upstream and downstream from major discharges, sources of potential releases and contamination, and major physical modifications to provide a "pollution profile" along the Little Miami River mainstem and within the Duck and Sycamore Creek watersheds. The result was a design that included chemical, physical, and biological sampling at a total of 37 sites in the 2017 study area. Each site was assigned a unique site code as depicted in Table 5 and Figure 5.

Biological and Water Quality Surveys

A biological and water quality survey, or "biosurvey", is an interdisciplinary monitoring effort coordinated on a water body specific or watershed scale. Biological, chemical, and physical monitoring and assessment techniques are employed in biosurveys to meet three major objectives:

1. Determine the extent to which use designations assigned in the state Water Quality Standards (WQS) or equivalent policies or procedures are either attained or not attained;
2. Determine if use designations and/or goals set for or assigned to a given water body are appropriate and attainable; and,
3. Determine if any changes in key ambient biological, chemical, or physical indicators have taken place over time, particularly before and after the implementation of point source pollution controls or best management practices.

Measuring Incremental Changes

Incremental change is defined here to represent a measurable and technically defensible, change in the condition of a water body within which it has been measured. Most commonly this is termed "incremental improvement" in which the condition of a water body that does not yet fully meet all applicable water quality standards (WQS) can be tracked as to the direction of any changes. The general principles of incremental change are defined as follows (after Yoder and Rankin 2008):

- ***measurement of incremental change*** can be accomplished in different ways, provided the measurement method is scientifically sound, appropriately used, and sufficiently sensitive enough to generate data from which signal can be discerned from noise;

Table 5. *List of sampling locations in the 2017 Little Miami River study area with site code, stream name, the biological, habitat, and chemical parameters (see footnotes) collected at each site, location description, and USGS Quadrangle. Absolute location points with latitude-longitude values for macroinvertebrates, fish, chemical, and sediment sampling locations are listed in Appendix A-1 (Ust. – upstream; Dst. – downstream).*

Site ID	Chemical Sampling Type	Biological Sample Type	River Mile Range	Site ID Latitude Longitude	Drainage Area	Location Description	USGS QUAD
Little Miami River							
LM01	C, D, N, H, O, B, S	HD, QL, FB	27.90 - 27.90	39.31976, -84.25164	1069	Dst. SR 22/3 - L. Miami State Park	Mason
LM02	C, D, N, H, O, B, S	HD, QL, FB	24.10 - 24.10	39.27530, -84.25613	1085	Ust. O'Bannon Cr.	Mason
LM03	C, D, N, H, O, B, S	QL, FB	22.30 - 22.30	39.25298, -84.28098	1148	Ust. Polk Run WWTP	Mason
LM05	C, D, N, H, O, B, S	QL, FB	21.50 - 21.50	39.24615, -84.29544	1160	Dst. Hopewell Rd. (Bridge Street)	East Cincinnati
LM07	C, D, N, H, O, B, S	HD, QL, FB	18.50 - 18.50	39.21907, -84.31564	1187	Dst. Sycamore Creek	East Cincinnati
LM08	C, D, N, H, O, B, S	HD, QL, FB	17.70 - 17.70	39.20909, -84.30566	1190	Canoe access dst. SR 126	East Cincinnati
LM09	C, D, N, H, O, B, S	HD, QL, FB	13.10 - 13.10	39.17142, -84.29842	1203	Dst. Wooster Pike - Milford	East Cincinnati
LM11	C, D, N, H, O, B, S	HD, QL, FB	10.90 - 10.90	39.14996, -84.31337	1707	intersection of Mt. Carmel & Round Bottom Rd.	East Cincinnati
LM12	C, D, N, H, O, B, S	QL, FB	8.10 - 8.10	39.13733, -84.35348	1710	Newtown Rd.	East Cincinnati
LM13	C, D, N, H, O, B, S	HD, QL, FB	6.83 - 6.83	39.14122, -84.36681	1720	Ust. R.R. Trestle/Mariemont	East Cincinnati
LM15	C, D, N, H, O, B, S	HD, QL, FB	4.10 - 4.10	39.12070, -84.39983	1730	Dst. Duck Creek	East Cincinnati
LM16	C, D, N, H, O, B, S	HD, QL, FB	3.50 - 3.50	39.10911, -84.40190	1752	Beechmont Ave.	East Cincinnati
LM17	C, D, N, H, O, B, S	HD, QL, FB	1.60 - 1.60	39.08532, -84.42195	1754	Kellogg Ave.	East Cincinnati
Sycamore Creek (LMR RM 19.2)							
LM50	C, D, N, H, O, B, S	HD, QL, FH	1.10 - 1.10	39.21783, -84.33163	12.5	Loveland Rd.	East Cincinnati
LM51	C, D, N, H, O, B, S	HD, QL, FW	0.50 - 0.50	39.22488, -84.32355	22.8	Dst. N. Fork	East Cincinnati
LM52	C, D, N, H, O, B, S	HD, QL, FW	0.10 - 0.10	39.22595, -84.32156	23.3	Dst. Sycamore Cr. WWTP	East Cincinnati

Table 5. *List of sampling locations in the 2017 Little Miami River study area with site code, stream name, the biological, habitat, and chemical parameters (see footnotes) collected at each site, location description, and USGS Quadrangle. Absolute location points with latitude-longitude values for macroinvertebrates, fish, chemical, and sediment sampling locations are listed in Appendix A-1 (Ust. – upstream; Dst. – downstream).*

Site ID	Chemical Sampling Type	Biological Sample Type	River Mile Range	Site ID Latitude Longitude	Drainage Area	Location Description	USGS QUAD
Unnamed Tributary to Sycamore Creek (RM 1.12)							
LM55	C, D, N, H, B	QL, FH	1.20 - 1.20	39.21789, -84.34608	5.3	Upstream Blome Rd bridge	East Cincinnati
LM56	C, D, N, H, B	HD, QL, FH	0.20 - 0.20	39.21625, -84.33633	5.6	Nearest 8174 Loveland Maderia Dr	East Cincinnati
Unnamed Tributary (RM 1.82) to Unnamed Tributary to Sycamore Creek (RM 1.12)							
LM54		Dry Site	2.40 - 2.40	39.21578, -84.36549	1.6	Glenover Dr and Raiders Run	East Cincinnati
Duck Creek (LMR RM 3.87)							
LM71	C, D, N, H, O, B, S	QL, FH	6.10 - 6.10	39.16152, -84.43790	2.2	Norwood/Harris Ave	East Cincinnati
LM72	C, D, N, H, O, B, S	QL, FH	5.14 - 5.14	39.16528, -84.41827	5.1	Duck Creek Road	East Cincinnati
LM73	C, D, N, H, O, B, S	QL, FH	4.58 - 4.58	39.15893, -84.41599	5.8	Steel Place	East Cincinnati
LM74a	C, D, N, H, O, B, S	QL, FH	3.90 - 3.90	39.15494, -84.40662	9.6	Eerie and Rosslyn Dr, north on access	East Cincinnati
LM75	C, D, N, H, O, B, S	QL, FH	3.40 - 3.40	39.14803, -84.40690	11.5	Erie Avenue	East Cincinnati
LM76	C, D, N, H, O, B, S	HD, QL, FH	2.80 - 2.80	39.14426, -84.40580	11.7	Red Bank Rd. and Fair Ln.	East Cincinnati
LM77	C, D, N, H, O, B, S	HD, QL, FH	2.00 - 2.00	39.13213, -84.40533	14.3	Wooster Rd.	East Cincinnati
LM79	C, D, N, H, O, B, S	HD, QL, FH	0.50 - 0.50	39.12210, -84.41100	14.6	Little Miami River Park @end of Hutton Rd.	East Cincinnati
Little Duck Creek							
LM86	C, D, N, H, O, B	QL, FH	2.40 - 2.40	39.15996, -84.38100	0.5	Camargo Road	East Cincinnati
LM87	C, D, N, H, O, B	QL, FH	1.90 - 1.90	39.15815, -84.38102	0.5	Plainville Road	East Cincinnati
LM90	C, D, N, H, O, B	QL, FH	1.00 - 1.00	39.15670, -84.38483	1.1	Settle Street	East Cincinnati
LM92	C, D, N, H, O, B	Dry Site	0.49 - 0.49	39.13578, -84.40058	1.7	Wooster @ Red Bank	East Cincinnati

Table 5. *List of sampling locations in the 2017 Little Miami River study area with site code, stream name, the biological, habitat, and chemical parameters (see footnotes) collected at each site, location description, and USGS Quadrangle. Absolute location points with latitude-longitude values for macroinvertebrates, fish, chemical, and sediment sampling locations are listed in Appendix A-1 (Ust. – upstream; Dst. – downstream).*

Site ID	Chemical Sampling Type	Biological Sample Type	River Mile Range	Site ID Latitude Longitude	Drainage Area	Location Description	USGS QUAD
Unnamed Tributary to Little Duck Creek							
LM82	C, D, N, H, O, B	QL, FH	0.20 - 0.20	39.18198, -84.37003	0.6	McDonalds Common Park foot bridge	East Cincinnati
East Fork Duck Creek							
LM81		Dry Site	2.30 - 2.30	39.18272, -84.39893	0.5	Odin Ave and Plainfield Rd	East Cincinnati
LM85	C, D, N, H, O, B, S	QL, FH	2.00 - 2.00	39.17873, -84.39532	1.3	Stewart Ave.	East Cincinnati
LM84	C, D, N, H, O, B, S	QL, FH	0.50 - 0.50	39.16481, -84.40100	2.4	End Chandler Rd, behind John P. Parker School	East Cincinnati
Unnamed Tributary to Duck Creek							
LM80	C, D, N, H, O, B	QL, FH	5.00 - 5.00	39.16637, -84.41879	1.2	Kennedy Ave	East Cincinnati
LM83		Dry Site	0.80 - 0.80	39.17405, -84.42351	1.4	Behind Home Depot	East Cincinnati

- ***measurable parameters and indicators*** of incremental change include biological, chemical, and physical properties or attributes of an aquatic ecosystem that can be used to reliably indicate a change in condition; and,
- ***a positive change in condition*** means a measurable improvement that is related to a reduction in a specific pollutant load, a reduction in the number of impairment causes, a reduction in an accepted non-pollutant measure of degradation, or an increase in an accepted measure of waterbody condition relevant to designated use support.

This was accomplished for this study by comparing the results of prior, comparable assessments. In this case there has been a series of bioassessments beginning in 1983 by Ohio EPA which serves as the baseline against which subsequent results were compared to assess incremental changes in key parameters and indicators. Subsequent to 1983, sufficient data is available from 1993 (Ohio EPA 1995), 1998 (Ohio EPA 2000), 2007 (Ohio EPA 2009), 2012 (MBI 2013), and 2013 (MBI partial assessment only), and 2017 (MBI) to inform the trend analyses.

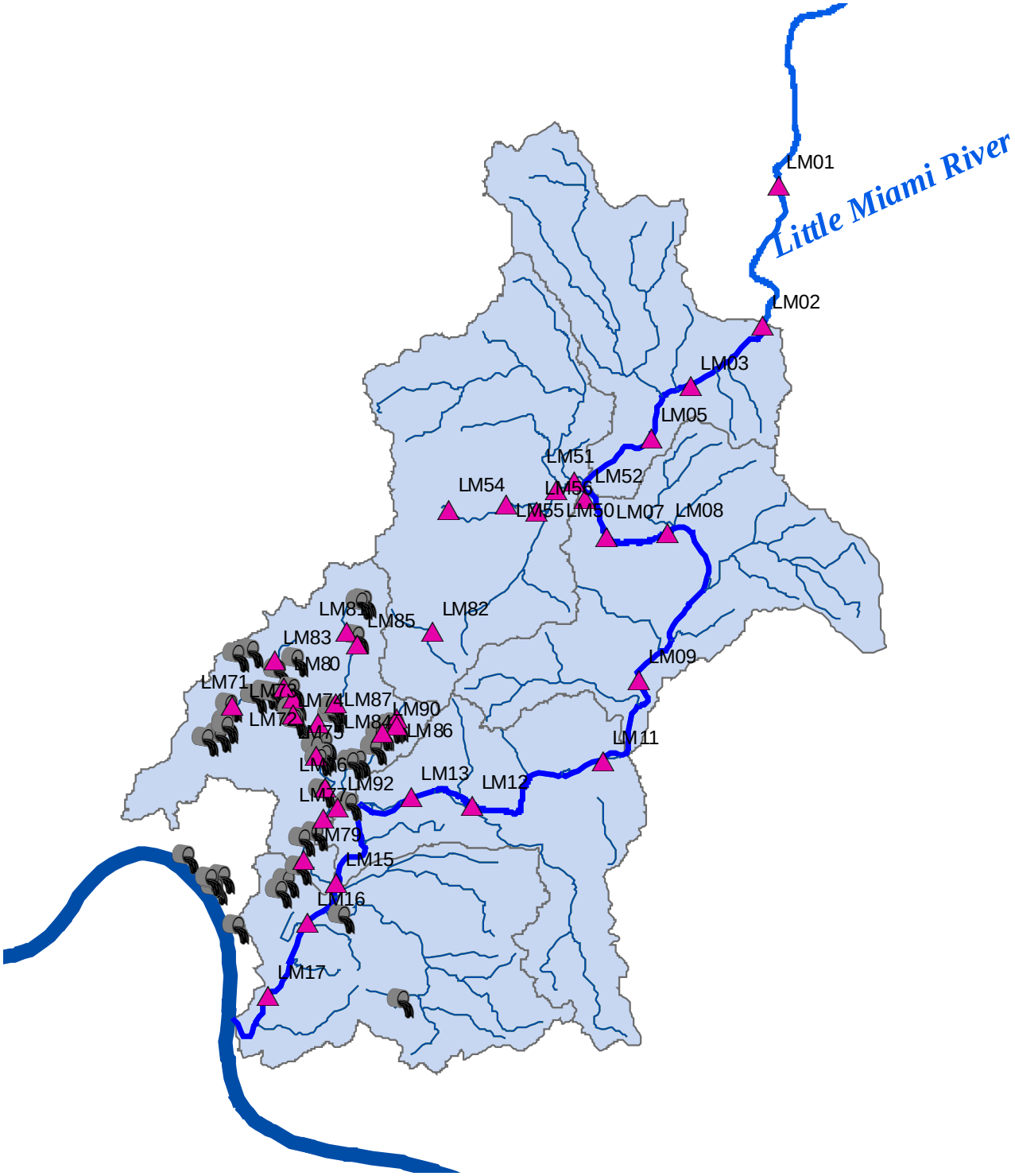

Figure 5*. The 2017 Little Miami River study area showing sampling locations by site code (see Table 5) and the occurrence of CSO locations in Duck and Sycamore Creeks and WWTP discharges to the Little Miami River mainstem.*

Biological Methods

All biological sampling methods are defined by the applicable protocols published by the Ohio EPA (1987a,b; 1989a,b; 2006, 2015 a,b). These meet the specifications of the Ohio WQS and are used to assess aquatic life and recreational use designations, to determine the extent and severity of impairments, and to document incremental changes that result from pollution abatement actions.

Fish Assemblage Methods

Methods for the collection of fish at wadeable sites was performed using a tow-barge or long-line pulsed D.C. electrofishing equipment based on a T&J 1736 DCV electrofishing unit described by Ohio EPA (1989a). A Wisconsin DNR battery powered backpack electrofishing unit was used as an alternative to the long line in the smallest streams and in accordance with the restrictions described by Ohio EPA (1989a). A three person crew carried out the sampling protocol for each type of wading equipment. Sampling effort was indexed to lineal distance and ranged from 150- 200 meters in length. Non-wadeable mainstem sites were sampled with a raft-mounted pulsed D.C. electrofishing device. A Smith-Root 5.0 GPP unit was mounted on a 15.5' Wing raft with an electrode array in keeping with Ohio EPA (1989a) electrofishing design specifications. Sampling effort for this method was 500 meters and was conducted during a June 16-October 15 seasonal index period once or twice at all sites. Variably high flows in September and October precluded a second pass at several mainstem sites. A more detailed summary of the key aspects of each method appears in the *Watershed Monitoring and Bioassessment Plan for the MSD Greater Cincinnati Service Area, Hamilton County, Ohio; Technical Report MBI/5-11-3* (MBI 2011).

Macroinvertebrate Assemblage Methods

Macroinvertebrates were sampled using modified Hester-Dendy artificial substrate samplers (quantitative sample) and a qualitative dip net/hand pick method in accordance with Ohio EPA macroinvertebrate assessment procedures (Ohio EPA 1989a, 2015a). The artificial substrates were exposed for a colonization period of six weeks between July 12 and September 14 and placed to ensure adequate stream flow over the substrates, but in general samplers should be set where flow is 0.3 feet/second over the plates. A qualitative sample using a triangular frame dip net and hand picking was collected at the time of substrate retrieval. All samples were initially preserved in a 10% solution of formaldehyde. Substrates were then transferred to the laboratory, disassembled, sieved (standard no. 30 and 40), and transferred to 70% ethyl alcohol. Laboratory sample processing of both the quantitative and qualitative samples included an initial scan and pre-pick for large and rare taxa followed by subsampling procedures in accordance with Ohio EPA (1989a, 2015a). Identifications were performed to the lowest taxonomic resolution possible for the commonly encountered orders and families, which is genus/species for most organisms. From these results, the density of macroinvertebrates per square foot is determined as well as a taxonomic richness and an Invertebrate Community Index (ICI; Ohio EPA 1987b; DeShon 1995) score for the quantitative samples and a narrative assessment for the standalone qualitative samples. A more detailed summary of the key

aspects of the methods appears in the *Watershed Monitoring and Bioassessment Plan for the MSD Greater Cincinnati Service Area, Hamilton County, Ohio; Technical Report MBI/5-11-3* (MBI 2011).

Primary Headwater Habitat (PHWH) Methods

PHWH methods were simultaneously applied to all sites draining <2.5 mi.^{2} to allow for a data driven determination of the existing use designation. Stream sites that were completely dry during any of the sampling visits were evaluated with the HHEI at a minimum. Methods for the collection of macroinvertebrates and salamanders at PHWH candidate sites followed the qualitative macroinvertebrate collection techniques used by the Ohio EPA for all stream types (Ohio EPA 1989a, 2015a) and in accordance with the most recent PHWH manual (Ohio EPA 2013). Salamander collections were made in two 30 feet subsections of the 200 feet stream reach assessed for a PHWH evaluation. Each subsection was chosen where an optimal number and size of cobble type microhabitat substrates are present. A minimum of 30 minutes was spent searching for salamanders. At least five larvae and two juvenile-adults of each species type were preserved. Adult and juvenile salamanders were placed into plastic bags with moist leaf litter. The larva were transported in stream water and placed in a cooler and returned to the lab for preparation of voucher specimens and verifications.

Area of Degradation and Attainment Values

The ADV (Yoder and Rankin 1995; Yoder et al. 2005) was originally developed to quantify the extent and severity of departures from biocriterion within a defined river reach. For reaches that exceed a biocriterion it is expressed as an Area of Attainment Value (AAV) that quantifies the extent to which minimum attainment criteria are surpassed is. The ADV/AAV correspond to the area of the polygon formed by the longitudinal profile of IBI scores and the straight line boundary formed by a criterion, the ADV below and the AAV above. The computational formula (after Yoder et al. 2005) is:

$$ADV/AAV = \sum [(aIBIa + aIBIb) – (pIBIa + pIBIb)] * (RMa – RMb), \text{ for } a = 1 \text{ to } n, \text{ where;}$$

aIBIa = actual IBI at river mile a,
aIBIb = actual IBI at river mile b,
pIBIa = IBI biocriterion at river mile a,
pIBIb = IBI biocriterion at river mile b,
RMa = upstream most river mile,
RMb = downstream most river mile, and
n = number of samples.

The average of two contiguous sampling sites is assumed to integrate biological assemblage status for the distance between the points. The intensive pollution survey design typically positions sites in close enough proximity to sources of stress and along probable zones of impact and recovery so that meaningful changes are adequately captured. We have observed biological assemblages as portrayed by their respective indices to change predictably in

proximity to major sources and types of pollution in numerous instances (Ohio EPA1987a; Yoder and Rankin 1995; Yoder and Smith 1999; Yoder et al. 2005). Thus, the longitudinal connection of contiguous sampling points produces a reasonably accurate portrayal of the extent and severity of impairment in a specified river reach as reflected by the indices (Yoder and Rankin 1995). The total ADV/AAV for a specified river segment is normalized to ADV/AAV units/mile for making comparisons between years and rivers. The ADV is calculated as a negative (below the biocriterion) expression; the AAV is calculated as a positive (above the biocriterion) expression. Each depicts the extent and degree of impairment (ADV) and attainment (AAV) of a biological criterion, which provides a more quantitative depiction of quality than do pass/fail descriptions. It also allows the visualization of incremental changes in condition that may not alter the pass/fail status, but are nonetheless meaningful in terms of incremental change over space and time. In these analyses, the Exceptional Warmwater Habitat (WWH) biocriterion for the fish and macroinvertebrate indices were used as the threshold for calculating the ADV and AAV for the Little Miami mainstem. The WWH biocriterion was used for Duck Creek as it represents the minimum goal required by the Clean Water Act (CWA) for the protection and propagation of aquatic life, thus it was used as a standard benchmark for the ADV/AAV analysis.

Habitat Assessment

Physical habitat was evaluated using the Qualitative Habitat Evaluation Index (QHEI) developed by the Ohio EPA for streams and rivers in Ohio (Rankin 1989, 1995; Ohio EPA 2006). Various attributes of the habitat are scored based on the overall importance of each to the maintenance of viable, diverse, and functional aquatic faunas. The type(s) and quality of substrates, amount and quality of instream cover, channel morphology, extent and quality of riparian vegetation, pool, run, and riffle development and quality, and gradient are some of the metrics used to determine the QHEI score which generally ranges from 20 to less than 100. The QHEI is used to evaluate the characteristics of a stream segment, as opposed to the characteristics of a single sampling site. As such, individual sites may have poorer physical habitat due to a localized disturbance yet still support aquatic communities closely resembling those sampled at adjacent sites with better habitat, provided water quality conditions are similar. QHEI scores from hundreds of segments around the state have indicated that values greater than 60 are generally conducive to the existence of warmwater faunas whereas scores less than 45 generally cannot support a warmwater assemblage consistent with baseline Clean Water Act goal expectations (e.g., the WWH in the Ohio WQS).

Physical habitat was simultaneously evaluated at sites draining <2.5 $mi.^2$ using the Headwater Habitat Evaluation Index (HHEI) developed by Ohio EPA (2013). The HHEI scores various attributes of the physical habitat that have been found to be statistically important determinants of biological community structure in primary headwater streams. Statistical analysis of a large number of physical habitat measurements showed that three QHEI habitat variables (channel substrate composition, bank full width, and maximum pool depth) are sufficient in distinguishing the physical habitat of primary headwater streams using the HHEI. The characterization of the channel substrate includes a visual assessment of a 200 feet stream

reach using a reasonably detailed evaluation of both the dominant types of substrate and the total number of substrate types. Bank full width is a morphological characteristic of streams that is determined by the energy dynamics related to flow and has been found to be a strong discriminator of the three classes of primary headwater streams in Ohio. The bank full width is the average of 3-4 separate bank full measurements along the stream reach. The maximum pool depth within the stream reach is important since it is a key indicator of whether the stream can support a WWH fish assemblage. Streams with pools less than 20 cm in depth during the low flow periods of the year are less likely to have WWH fish assemblages and thus more likely to have viable populations of lungless salamanders, which replace fish as the key vertebrate indicator in primary headwater streams.

Chemical/Physical Methods

Chemical/physical assessment for the MSDGC service area includes the collection and analysis of water samples for chemical/physical and bacterial analysis and sediment samples for determining sediment chemical quality. Methods for the collection of water column chemical/physical and bacterial samples followed the procedures of Ohio EPA (2015b) and MSDGC (2011c). Sediment chemical sampling followed that described by Ohio EPA (2015c). All laboratory analysis was performed and/or overseen by MSDGC.

Water Column Chemical Quality

Water column chemical quality was determined by the collection and analysis of grab water samples, instantaneous measurements recorded with a water quality meter, and continuous measurements recorded at 3-4 day intervals in the mainstem and larger tributary sites and at the reference sites.

Grab Sampling

Grab samples of water were collected with a stainless steel bucket from a location as close to the center point of the stream channel as possible by MBI sampling crews. Samples were collected from the upper 12-24" of the surface and then transferred to sample containers in accordance with MSDGC procedures (MSDGC 2011c) and delivered to MSDGC Mill Creek Lab for analysis. Sampling was conducted between mid-June and mid-October and under "normal" summer-fall low flows – highly elevated flows following precipitation events were avoided and sampling was delayed until flows subsided to "normal" levels. The frequency of sampling ranged from five times per season at most sites to two times per season at primary headwater sites. Water samples were collected provided there was sufficient water depth to collect a sample without disturbing the substrates. Instantaneous values for temperature (°C), conductivity (µS/cm2), pH (S.U.), and dissolved oxygen (D.O.; mg/l) were recorded with a YSI Model 664 meter at the time of grab sample collection.

Continuous Recordings

Continuous readings of temperature (°C), conductivity (µS/cm2), pH (S.U.), and dissolved oxygen (D.O.; mg/l) were recorded with a YSI 6920 V2 Sonde ("datasonde") instrument at

mainstem and major tributary locations. The Datasondes were set as close as possible to the Thalweg (i.e., deepest part of the stream channel) in a PVC enclosure that ensured no contact with the stream bottom or other solid objects. The Datasondes were positioned vertically where depth allowed by driving steel fence posts into the bottom and positioning the PVC enclosure in an upright position. Where the depth was too shallow the PVC enclosure was secured in a horizontal position in an area of the stream channel with continuous flow. All Datasondes were secured against theft or vandalism as much as possible. Datasondes were deployed for a 3-4 day continuous interval during periods of maximum summer temperatures and normal summer flows. Readings were taken at 15 minute intervals. At the time of retrieval data was downloaded to a YSI Model 650 Instrument with high memory capacity and then transferred to a PC for storage and later analysis.

Sediment Chemical Quality

Fine grain sediment samples were collected in the upper 4 inches of bottom material at each sampling location using decontaminated stainless steel spoons and excavated using nitrile gloves. Decontamination of sediment sampling equipment followed the procedures outlined in the Ohio EPA sediment sampling guidance manual (Ohio EPA 2015c).

Sediment grab samples were homogenized in stainless steel pans (material for VOC analysis was not homogenized), transferred into glass jars with Teflon® lined lids, placed on ice (to maintain 4^{o}C) in a cooler, and delivered to MSDGC Mill Creek Lab. Sediment data is reported on a dry weight basis. Sediment samples were analyzed for total analyte list inorganics (metals), nutrients, volatile organic compounds, semivolatile organic compounds, PCBs, total petroleum hydrocarbons, and cyanide.

Determining Use Attainment Status

Use attainment status is a term which describes the degree to which environmental parameters or indicators are either above or below criteria specified by the Ohio Water Quality Standards (WQS; Ohio Administrative Code 3745-1). For the 2017 Little Miami River and Tributaries assessment two use designations were evaluated, aquatic life and recreation in and on the water by humans. Hence the process herein is referred to as the determination of aquatic life and recreational status for each sampling site. The process is applied to data collected by ambient assessments and applies to rivers and streams outside of point source discharge mixing zones.

Aquatic Life

Aquatic life use attainment status is determined by the Ohio EPA biological criteria (OAC 3745-1-07; Table 7-15). Numerical biological criteria are based on multimetric biological indices which include the Index of Biotic Integrity (IBI) and modified Index of Well-Being (MIwb), which indicate the response of the fish assemblage, and the Invertebrate Community Index (ICI), which indicates the response of the macroinvertebrate assemblage. The IBI and ICI are multimetric indices patterned after an original IBI described by Karr (1981) and Fausch *et al.*

(1984) and subsequently modified by Ohio EPA (1987b) for application to Ohio rivers and streams. The ICI was developed by Ohio EPA (1987b) and is further described by DeShon (1995). The MIwb is a measure of fish community abundance and diversity using numbers and weight information and is a modification of the original Index of Well-Being originally applied to fish community information (Gammon 1976; Gammon *et al.* 1981). Numerical biocriteria are stratified by ecoregion, use designation, and stream or river size. Three attainment status results are possible at each sampling location - full, partial, or non-attainment. Full attainment means that all of the indices meet the applicable biocriteria. Partial attainment means that one or more of the indices fails to meet the applicable biocriteria. Non-attainment means that none of the indices meet the applicable biocriteria or one of the organism groups reflects poor or very poor quality. An aquatic life use attainment table (see Table 2) is constructed based on the sampling results and is arranged from upstream to downstream and includes the sampling locations indicated by river mile, the applicable biological indices, the use attainment status (*i.e.,* full, partial, or non), the Qualitative Habitat Evaluation Index (QHEI), and comments and observations for each sampling location. The use attainment table is further organized by Ohio EPA Waterbody Assessment Unit so that the results can be used by Ohio EPA for assessment purposes.

Recreation

Water quality criteria for determining attainment of recreational uses are established in the Ohio Water Quality Standards (OAC 3745-1-07; Table 7-13) based upon the quantities of bacterial indicators *(Escherichia coli)* present in the water column. *Escherichia coli (E. coli)* bacteria are microscopic organisms that are normally present 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). 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 being developed including recent research supported by MSDGC. 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 wastes have been deposited. Pathogenic (disease-causing) organisms are typically present in the environment in such small amounts that it is impractical to directly monitor each type of pathogen. 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 signal the potential presence of pathogenic organisms that enter the environment via the same pathways. When *E. coli* are present in extremely high numbers in a water sample, it invariably means the water has received fecal matter from one or more sources.

The Ohio WQS for recreational uses were revised in early 2016 to reflect a more rigid adherence to any form of contact with surface waters as ensuing the same level of risk. This replaced the former framework that was stratified to account for the degree of bodily contact with three subcategories of the Primary Contact Recreational (PCR) use as PCR-A, PCR-B, and PCR-C. Those subcategories were essentially merged into a single use category. This action

also obviated the recommendations made in the 2011-14 watershed assessments for assignment certain streams to one of the three former subcategories. The application of the Secondary Contact Recreational (SCR) use was also changed to a more restrictive interpretation of the potential for human contact with surface waters. Existing SCR designations remain, but could potentially be reviewed and revised to PCR by Ohio EPA. Any new SCR recommendations would need to document that there is no human contact possible due to physical restrictions to access a surface water. As a result the evaluation of the recreational uses in the 2017 Little Miami study were done in accordance with the existing designations of PCR and SCR where the latter remains applicable.

Streams in the Little Miami watershed are designated as primary contact recreation (PCR) and/or secondary contact recreation (SCR) use in the Ohio WQS (OAC 3745-1- 30). Water bodies with a designated recreation use of PCR *". . . 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)). Secondary Contact includes waters that *". . . result in minimal exposure potential to water borne pathogens because the waters are: rarely used for water based recreation such as, but not limited to, wading; situated in remote, sparsely populated areas; have restricted access points; and have insufficient depth to provide full body immersion, thereby greatly limiting the potential for water based recreation activities."*

The *E. coli* criterion that applies to PCR is expressed as a 90-day geometric mean of ≤126 colony forming units (cfu)/100 ml with a Statistical Threshold Value of 410 cfu/100 ml[2]. The criterion that applies to SCR streams is ≤1,030 cfu/100 ml for both the 90 day geometric mean and the STV. The geometric mean is based on two or more samples and is used as the basis for determining the attainment status of the PCR use.

Determining Use Attainability

Use designation reviews and recommendations for revisions, when necessary, were a major product of the series of 2011-14 watershed assessments conducted throughout the MSDGC service area. Since the 2017 Little Miami River and Tributaries survey is a reassessment of a portion of the 2012 study area we did not expect to have many use change recommendations. The details of the 2011-14 use recommendations are available in each watershed assessment report that can be found at: http://www.msdgc.org/initiatives/water_quality/index.html. Given the status of the 2011-14 data as Level 3 credible data it is eligible to be used by Ohio EPA to revise aquatic life use designations. All of the use recommendations made for the Warmwater Habitat suite of uses were either adopted or are in the process of being adopted by Ohio EPA into the Ohio WQS. None of the recreational use recommendations were accepted because of the subsequent revision to the recreational uses and criteria and how these are assigned to individual stream segments. None of the Primary Headwater Habitat (PHWH) use recommendations were adopted because Ohio EPA has not yet adopted PHWH as a distinct use

[2] These criteria shall not be exceeded in more than ten per cent of the samples taken during any ninety-day period.

tier. For the interim, MSDGC is assuming such streams will receive protections equivalent to WWH.

Determining Causal Associations

Using the results, conclusions, and recommendations of this report requires an understanding of the methodology used to determine biological status (i.e., unimpaired or impaired, narrative ratings of quality) and assigning associated causes and sources of impairment utilizing the accompanying chemical/physical data and source information (e.g., point source loadings, land use). The identification of impairment in rivers and streams is straightforward - the numerical biological indices are the principal arbiter of aquatic life use attainment and impairment following the guidelines of Ohio EPA (1987). The rationale for using the biological results in the role as the principal arbiter within a weight of evidence framework has been extensively discussed elsewhere (Karr *et al.* 1986; Karr 1991; Ohio EPA 1987a,b; Yoder 1991; Yoder 1995).

Describing the causes and sources associated with observed biological impairments relies on an interpretation of multiple lines of evidence including the water chemistry data, sediment chemistry data, habitat data, effluent data, land use data, and biological response signatures (Yoder and Rankin 1995; Yoder and DeShon 2003). Thus the assignment of associated causes and sources of biological impairment in this report represents the association of impairments (based on response indicators) with stressor and exposure indicators using linkages to the bioassessment data based on previous experiences within the strata of analogous situations and impacts. For example, exceedances of established chemical thresholds such as chronic and acute water quality criteria or sediment effect thresholds are grounds for listing such categories of parameters to include individual pollutants provided that they co-occur with a biological impairment. Biological effect thresholds in the recently completed *Integrated Prioritization System (IPS) Documentation and Atlas of Biological Stressor Relationships for Southwest Ohio* (Technical Report MBI/2015-12-15, MBI 2015) were also used to support causal assignments. These were used either as primary or supplemental screenings for the interpretation of biological impairments consistent with the WQS for the application of biological criteria in Ohio[3].

Hierarchy of Water Indicators

A carefully conceived ambient monitoring approach, using cost-effective indicators comprised of ecological, chemical, and toxicological measures, can ensure that all pollution sources are judged objectively on the basis of environmental results. A tiered approach that links the results of administrative actions with true environmental measures was employed in our analyses and within the limitations of the data that is currently available for certain sources. This integrated approach is outlined in Figure 6 and includes a hierarchical continuum from administrative to true environmental indicators. The six "levels" of indicators include:

1. Actions taken by regulatory agencies (permitting, enforcement, grants);

[3] OAC 3745-1-07(A)(6)(a) for full attainment and (A)(6)(b) for non-attainment.

2. Responses by the regulated community (treatment works, pollution prevention);
3. Changes in discharged quantities (pollutant loadings);
4. Changes in ambient conditions (water quality, habitat);
5. Changes in uptake and/or assimilation (tissue contamination, biomarkers, assimilative capacity); and, changes in health, ecology, or other effects (ecological condition, pathogens).

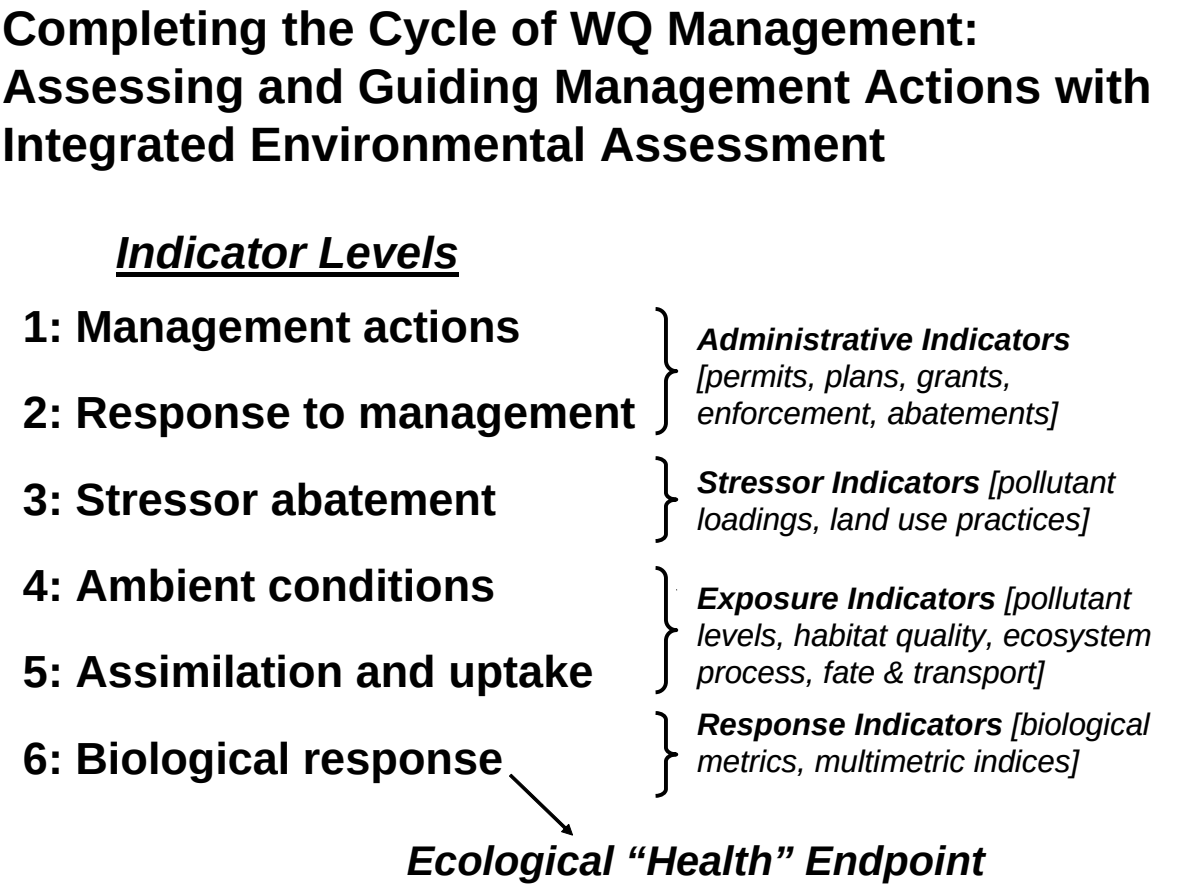

Figure 6*. Hierarchy of administrative and environmental indicators which can be used for water quality management activities such as monitoring and assessment, reporting, and the evaluation of overall program effectiveness. This is patterned after a model developed by U.S. EPA (1995a,b) and further enhanced by Karr and Yoder (2004).*

In this process the results of administrative activities (levels 1 and 2) can be linked to efforts to improve water quality (levels 3, 4, and 5) which should translate into the environmental "results" (level 6). An example is the aggregate effect of billions of dollars spent on water pollution control since the early 1970s that have been determined with quantifiable measures of environmental condition (Yoder et al. 2005). Superimposed on this hierarchy is the concept of stressor, exposure, and response indicators. *Stressor* indicators generally include activities which have the potential to degrade the aquatic environment such as pollutant discharges (permitted and unpermitted), land use effects, and habitat modifications. *Exposure* indicators are those which measure the effects of stressors and can include whole effluent toxicity tests,

tissue residues, and biomarkers, each of which provides evidence of biological exposure to a stressor or bioaccumulative agent. *Response* indicators are generally composite measures of the cumulative effects of stress and exposure and include the more direct measures of community and population response that are represented here by the biological indices which comprise the Ohio EPA biological endpoints. Other response indicators can include target assemblages, *i.e.,* rare, threatened, endangered, special status, and declining species or bacterial levels that serve as surrogates for the recreational uses. These indicators represent the essential technical elements for watershed-based management approaches. The key, however, is to use the different indicators *within* the roles which are most appropriate for each (Yoder and Rankin 1998).

STUDY AREA DESCRIPTION

General Setting

The Little Miami River basin lies within the Interior Plateau Ecoregion of southwest Ohio and is bounded by the Great Miami River basin to the northwest, Mill Creek to the west and southwest, the Scioto River basin to the north and east, Whiteoak Creek to the southeast, and the Ohio River and direct tributary watersheds to the south. The Little Miami River mainstem flows southward for 111 miles from the headwaters in Clark County through Greene, Warren, and Clermont Counties to its confluence with the Ohio River in Hamilton County draining 1757 mi2. The study area is located in the Eastern Corn Belt Plains and Interior Plateau ecoregions (see Figure 5). Along its course the stream has an average gradient of 6.35 feet per mile (ODNR 1960). Major tributaries within the 2012 and 2017 Little Miami River study area include O'Bannon Creek, Polk Run, Sycamore Creek, Dry Creek, Duck Creek, Clough Creek, and the East Fork of the Little Miami River. These tributaries enter the Little Miami River mainstem from the hillsides that characterize the watershed. The upper portion of Little Miami River mainstem located in Warren County is mostly rural, but increased suburban development has occurred over the past 3 decades. The lower portion of Little Miami River is more urban and some tributary subwatersheds are almost completely developed.

Subecoregion Characteristics

The 2017 Little Miami River study area lies within two Level III ecoregions, the Interior Plateau (IP) and the Eastern Corn Belt Plains (ECBP; Omernik 1987). More recent delineations of Level IV subregions provide more detail for the four components of ecoregions - surficial geology, soils, potential natural vegetation, and land use (Woods et al. 1995). The lower Little Miami River study area and much of the East Fork of the Little Miami River lie entirely within the Northern Bluegrass subregion (71d) of the Interior Plateau. The remainder of the study area lies within the Pre-Wisconsinan Drift Plains subregion (55d) of the Eastern Corn Belt Plains ecoregion. The southernmost portion of the study area overlies the Wisconsinan Drift Plains subregion (55d) and the northern portions and the East Fork of the Little Miami River lie within the Loamy High-lime Till Plains subregion (55b) of the ECBP ecoregion. The characteristics of each subregion appear in Table 6.

Description of Pollution Sources and Other Stressors

Pollution sources and general stressors are numerous in the Little Miami River watersheds subwatersheds. These sources include permitted discharges of municipal and industrial process wastewater, discharges from combined and sanitary sewer overflows (CSO and SSO), runoff and releases from industrial facilities, urban runoff and its associated chemical pollution and hydrological alterations, and direct and indirect habitat alterations. These are described in the following discussions and many are included in Table 7.

Point Sources

There are 23 point source discharges in the lower Little Miami River that hold NPDES permits

***Table 6**. Level IV subregions of the Little Miami River watersheds watershed and their key attributes (from Woods et al. 1995).*

Level IV Subregion	Physiography	Geology	Soils	Potential Natural Vegetation	Land Use/Land Cover
Loamy, High Lime Till Plains (55b)	Glaciated; level to rolling glacial till plain with low gradient streams; also end moraines and glacial outwash landforms.	Loamy, high lime, late-Wisconsinan glacial till and also glacial outwash and scattered loess overlie Paleozoic carbonates and shale.	Alfisols (Hapludalfs, Epiaqualfs, Endoaqualfs), Mollisols (Argiaquolls, Endoaquolls, Argiudolls), Entisols (Fluvaquents)	Mostly beech forest; also, oak-sugar maple forest, elm-ash swamp forest on poorly-drained valley bottoms and ground moraines.	Extensive corn, soybean, and livestock farming; also scattered beech-maple, pin oak-swamp, white oak woodlands. Urban-industrial activity in municipal areas.
Pre-Wisconsinan Drift Plains (55d)	Glaciated. Dissected glacial till plain with low to medium gradient streams.	Deeply leached, acidic pre-Wisconsinan clay-loam glacial till and thin loess overlie Paleozoic carbonates.	Alfisols (Fragiudalfs, Hapludalfs, Fragiaqualfs, Glossaqualfs), Entisols (Fluvaquents)	Mostly beech forest, elm-ash swamp forest; also oak-sugar maple forest.	Soybean, livestock, corn, general, and tobacco farming; where poorly-drained or rugged, pin oak-swamp, white oak flatwoods, and beech-maple woodlands.
Northern Bluegrass (71d)	Unglaciated and glaciated; dissected plains and hills with medium gradient, gravel bottom streams. Steep slopes, high relief near Ohio River.	Discontinuous loess and leached pre-Wisconsinan glacial till deposits. Ordovician limestone and shale.	Alfisols (Hapludalfs, Fragiudalfs), Mollisols (Hapludolls)	Mixed meso-phytic forest, mixed oak forest, oak-sugar maple forest; along Ohio River, bottomland hardwoods.	Mosaic of forest, agriculture, and urban-industrial activity near Cincinnati and elsewhere along Ohio River. Wooded where steep

(Table 7). Of these 10 are considered to be major discharges and all are municipal wastewater treatment plants. A total of 54.4 MGD of capacity is shared by the seven WWTPs that impact the lower Little Miami River mainstem study area. Another 17.4 MGD of capacity is shared by three WWTPs on the lower East Fork of the Little Miami River. All of these WWTPs operate at what may be termed "advanced treatment" levels for oxygen demanding substances and ammonia removal, which is typical for WWTPs with permits based on meeting the Ohio WQS. Following the 1998 bioassessment of the Little Miami River in which Ohio EPA found significant impairment of the fish assemblages in particular, upgrades to WWTPs followed and some of these included phosphorus removal, mostly in the upper one-half of the mainstem. The results of the 2007 survey (Ohio EPA 2010) reflected one of the most significant improvements in the status of any major mainstem river in the then 30 year history of these surveys by Ohio EPA. To

Table 7. *Major pollution sources in and adjacent to the 2017 Little Miami River study area.*

Receiving Stream	Length (Miles)	Gradient (ft/mi)	Drainage Area (mi^2)	River Mile	2017 Site Code/RM	Facility Name/Description	NPDES Permit No.
O'Bannon Creek	12	24	59.1	2.57		O'Bannon Creek Regional WWTP	1PK00017
Polk Run	5.5	62	10.2	0.1		Polk Run WWTP	1PK00019
Sycamore Creek	2.6	17.7	6.86	0.26	LM52/0.1	Sycamore Creek WWTP	1PK00005
East Fork Little Miami	81.7	7.6	499	20.5		US DOA William H Harsha Lake	1PN00000
East Fork Little Miami				13.5		City of Batavia WWTP	1PB00001
East Fork Little Miami				12.6		Clermont Co. Middle East Fork Regional WWTP	1PK00010
East Fork Little Miami				4.9		Clermont Co. Lower East Fork Regional WWTP	1PK00009
East Fork Little Miami				4.9		USEPA Experimental Stream Facility	1IN00116
East Fork Little Miami				1.6		Milford WWTP	1PC00005
Duck Creek	8.2	27.6	15.5	5.14	LM72/5.14	CSOs: 054, 135, 170, 187, 214, 500, 501, 549, 550, 551, 552,	1PX00022
Duck Creek				4.58	LM73/4.58	CSOs: 043, 061	1PX00022
Duck Creek				3.98	LM74/3.9	CSOs: 064, 066, 068, 188, 205, 554, 555, 556	1PX00022
Duck Creek				3.38	LM75/3.4	CSOs: 080, 136	1PX00022
Duck Creek				2.4	LM77/2.0	CSOs: 083, 084, 199, 503, Little Duck Creek	1PX00022
Little Duck Creek				1.9	LM87/1.9	CSO 071	1PX00022
Little Duck Creek				1.7	LM90/1.0	CSOs: 069, 072, 074, 075, 076	1PX00022
Little Duck Creek				1.15	LM90/1.0	CSOs: 078, 079	1PX00022
Clough Creek	5.7	67.9	8.31	2.5		CSO 182	1PX00022
Little Miami	105.5	6.5	1757	32.10		Lebanon WWTP	1PC00003
Little Miami				31.95		Mason WWTP	1PC00004
Little Miami				30.70		Deerfield-Hamilton WTP	1IY00162
Little Miami				28.14	LM01/27.9	Lower Little Miami WWTP	1PK00018
Little Miami				21.00	LM05/21.5	Arrowhead Park WWTP	1PH00014
Little Miami				18.80	LM07/18.5	Lake Remington MHP	1PV00101
Little Miami				16.80		MGS Water Sub District	1IX00030
Little Miami				16.10		Wards Corner Regional WWTP	1PK00021
Little Miami				14.20		Villiage of Indian Hill WTP	1IX00050
Little Miami				13.30	LM09/13.0	Milford Waterworks	1IW00110
Little Miami				10.00	LM12/8.1	Evans Landscaping Inc	1IN00298
Little Miami				5.90	LM15/4.1	Cincinnati Steel Treating Co; Keebler and Co.	1IN00237; 1IH00022
Little Miami				4.45	LM15/ 4.1	CSO 656	1PX00022
Little Miami				3.50	LM16/3.5	CSOs: 085, 086, 470, 471, 476, Duck Creek	1PX00022
Little Miami				0.80		GCWW Richard Miller WTP	1IV00040

quote the 2010 Ohio EPA report:

> *". . . the overall turnaround of the Little Miami River's biotic integrity can be attributed to improved treatment and operations at several Wastewater Treatment Plants (WWTPs) in the watershed. Many facilities that were previously operating at or over capacity since the last survey in 1998 were upgraded, while others began actively removing phosphorus from treated effluent. These improvements, in turn, allowed for the rebound of the fish community, which has historically borne the brunt of impacts from nutrient over-enrichment in the river."*

The MSDGC survey of 2012 showed a decline specifically with the fish assemblage to 1998 levels of impairment. Follow-up surveys by MBI in 2013 showed only partial improvements in this status and that impairments emanated upstream from Hamilton Co.

Wet Weather Sources

Wet weather sources merit description since they are prominent in the Duck Creek subbasin. The two major sources of wet weather related pollution in the 2017 study area emanate from CSOs and SSOs. These occur because the volume of sanitary wastewater and stormwater entering the MSDGC sewer system during precipitation events (i.e., during "wet weather") exceeds the capacity of the collection system. There are two types of pipes that carry wastewater in Hamilton County, "combined sewers" and "sanitary sewers." Combined sewers collect and transport both sewage and stormwater, while sanitary sewers collect and transport only sewage. Wastewater discharges that are released to the environment from sanitary sewer systems before they reach a treatment plant are known as "sanitary sewer overflows," or SSOs. The term SSO can also refer to a sanitary sewer overflow structure or outfall. Discharges that are comprised of sanitary sewage and storm water are known as "combined sewer overflows," or CSOs. Approximately one-third of MSDGC's sewers are combined and the rest are sanitary sewers (MSDGC 2006).

In the MSDGC collection system, the primary cause of SSOs is a lack of system capacity, blockages, and ineffective maintenance. This happens when the sewer system receives increased flows as a result of "infiltration and inflow," or I/I, which is the entry into the sewer system of "clean" rain water through leaks in the system caused by deteriorating pipes and tree roots growing into the sewers ("infiltration"), as well as through roof drains, manhole covers and yard drains ("inflow"), thus exacerbating the lack of capacity. As a result, during periods of rainfall or snowmelt, wastewater is frequently discharged from overflow structures into area rivers and streams. The MSDGC system has approximately 80 such overflow points, which discharge wastewater when the pipes become too full. These SSO structures were constructed many years ago, consistent with the then-acceptable approach for addressing overloaded sanitary sewer systems. In contrast, a combined sewer system is designed to transport both sewage and storm water. These systems are largely an "artifact" of an earlier way of building sewers and have not been newly constructed in the United States for decades. Combined sewers are generally not designed to be big enough to carry wastewater plus all of the rainfall from the area's larger storms. Thus, combined sewers are designed to discharge from combined

sewer overflow points, or “CSOs.” MSDGC has approximately 200 CSO discharge points in its collection system (MSDGC 2006). To remedy SSOs and CSOs, the County and City signed Consent Decrees in 2002 and 2003 with U.S. EPA, Ohio EPA, and ORSANCO that establish a judicially enforceable framework for ensuring that MSDGC develops and implements sophisticated, long-term plans for remedying the overflows resulting from the aging sewer system. The decrees also require MSDGC to implement millions of dollars of interim measures to ameliorate these problems while developing and implementing the long-term remedial measures.

RESULTS – CHEMICAL PHYSICAL WATER QUALITY

Chemical/physical water quality in the 2017 Little Miami study area was characterized by grab sample data collected from the water column two to five times at each site during base flows and within a June 16-October 15 seasonal index period. Continuous measurements were made with Datasondes over 3-4 consecutive day periods at selected mainstem and tributary sites in late July and early August. Sediment chemistry was determined from samples collected at all mainstem and selected tributaries in mid-October.

The results were evaluated by assessing exceedances of criteria in the Ohio WQS, exceedances of regionally derived biological effect thresholds (MBI 2015) for parameters that lack formal criteria in the WQS, and by exceedances of probable and threshold effect levels for sediment chemistry (MacDonald et al. 2000). The chemical/physical results also serve as indicators of exposure and stress and in support of using the biological data for assessing the attainment of aquatic life uses and assigning associated causes and sources for impairments. Bacteria data were collected by grab samples at all sites and used primarily to determine the status of recreational uses in accordance with the Ohio WQS. Recently revised Ohio EPA protocols for determining attainment of the applicable designated recreational use were followed.

Flow Regime

The flow regime in the Little Miami mainstem during the period May 1 – October 31 is depicted in Figure 7 for the years 2007, 2012, 2013, and 2017 based on the gauge operated by the U.S. Geological Survey at Milford (RM 10.0). These are the most recent years with bioassessment data in the Little Miami River mainstem and each represents a slightly different periodicity of both high and low flows. The consistently lowest flows occurred in 2012 with multiple daily values at or less than the Q7,10 critical low flow and about one-half below the 80% duration flow. The 2012 flows were well below that are referred to herein as normal summer-fall flows that are approximated by the range between statistical median (50th percentile) and 80th percentile flows. All sampling was confined to these flows avoiding high flow events and not resumed until normal base flows returned. Flows in 2017 were consistently at or above the 80th percentile flows and within the normal range about one-half the time. Sampling for fish was delayed on more than one occasion to avoid high flows and allow them to return to normal. Peak flows generally occurred in May-June following significant precipitation events, but were evident on October 2013 and 2017.

Water Column Chemistry

Water quality was assessed by grab samples collected during the summer-fall index period. Parameter groupings included field, demand, ionic strength, nutrients, heavy metals, and organic compounds. Continuous measurements over 3-4 consecutive day periods were made at all mainstem sites (excepting the downstream most sites influenced by the Ohio River) for D.O. (mg/l), pH (S.U.), conductivity (µS/cm), and temperature (°C) using YSI Datasonde continuous recorders during July 11-15 and July 20-22, 2017.

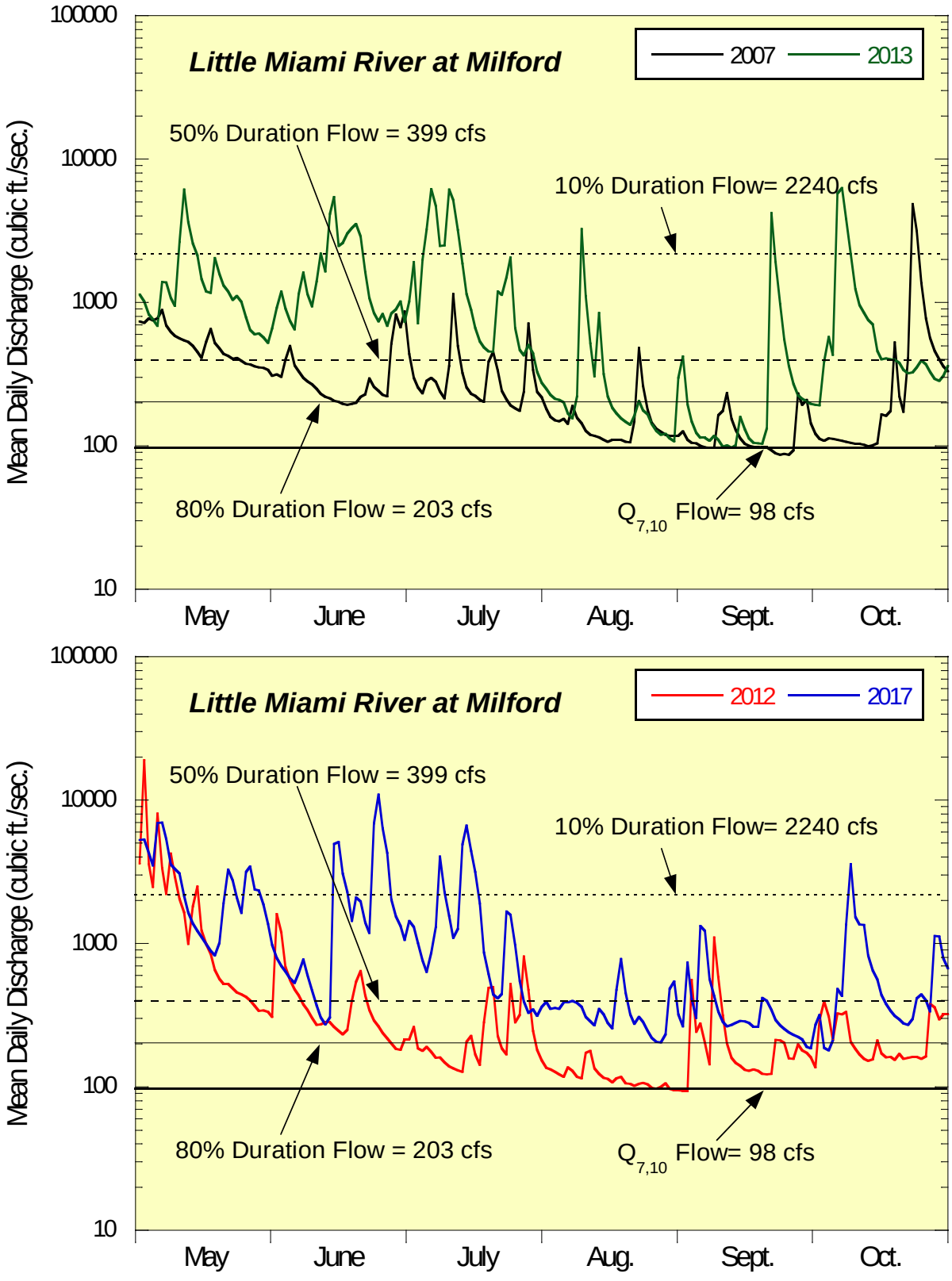

Figure 7. *Flow measured at the USGS gauge at Milford (RM) during May 1-October 31 in 2007 and 2013 (upper) and 2012 and 2017 (lower). The median, 80%, 10%, and $Q_{7,10}$ flows are indicated on each hydrograph.*

Water Quality Criteria Exceedances

Assessing exceedances of water quality criteria was done for parameters that have formal criteria codified in the Ohio WQS. For the 2017 Little Miami River survey this included criteria for the protection of aquatic life and for recreational uses.

Aquatic Life Criteria Exceedances

Measured exceedances of aquatic life water quality criteria in the Ohio WQS were limited mostly to dissolved oxygen (D.O.) and single exceedances of copper, selenium, and temperature (Table 8). D.O. exceedances occurred in daytime grab samples at multiple sites in the Duck Creek subwatershed including values below the 4.0 mg/l WWH minimum at the downstream most location in Duck Creek (RM 0.95), the Unnamed tributary to Duck Creek at RM 4.42 (RM 0.1), and the Unnamed Tributary to Sycamore Creek (RM 0.4). Both the mean and minimum WWH criteria were exceeded in the East Fork of Duck Creek at the upstream most location (RM 1.9) and at the mouth of Little Duck Creek (RM 0.2). Exceedances of the average and minimum LRW criteria occurred in the Unnamed Tributary to Duck Creek (RM 0.2). Short-term (4 days) deployment of Datasondes detected single exceedances of the LRW D.O. criterion in Duck Creek at RM 4.4 and the WWH minimum at RM 1.8. A single exceedance of the chronic criterion for copper occurred in the Little Miami River just downstream from the East Fork (RM 10.9) and a single exceedance of the selenium criterion occurred at Beechmont Ave. downstream from Duck Creek (RM 3.5). The MDL for selenium of 34 µg/L was above the criteria value of 5 µg/L thus other exceedances may have occurred that went undetected. An exceedance of the maximum temperature criterion of 29.4°C occurred in the Datasonde data at the mouth of Duck Creek with a high reading of 31.0°C.

Recreation Criteria Exceedances

Widespread impairment of the Primary Contact (PCR) and Secondary Contact Recreation (SCR) based on *E. coli* results persisted in the Duck Creek and Sycamore Creek subwatersheds in 2017 (Table 9). While, direct comparisons of changes in attainment status between 2012 and 2017 were complicated by changes to the Recreation uses and criteria in early 2016, the actual E. coli values are compared between years in Figure 8.

Little Miami River Mainstem

Only four of 13 sites were impaired for the PCR use and these were only slight exceedances of the Statistical Threshold Value (STV) – all geometric means were below the PCR criterion. This a significant improvement over the 2012 results when 14 of 16 sites were impaired for the PCR-A subcategory (which is equivalent to PCR). Mean E. coli values were comparable to those measured by Ohio EPA in 2007 and generally at or below the geometric mean PCR criterion. Values in 2012 were consistently higher than the geometric mean. None of these results indicate a serious problem with the recreational use status of the Little Miami River mainstem.

Duck Creek Subwatershed

All eight sites assessed in the mainstem of Duck Creek were impaired, five for the SCR use and

Table 8*. Exceedances of water quality criteria for aquatic life based on grab sampling and continuous monitoring in the 2017 Little Miami study area.*

Site ID	River Mile	Aquatic Life Use	Parameters (Values) Exceeding Ohio Aquatic Life Criteria[1]
Little Miami River			
LM01	28.00	EWH	
LM02	24.10	EWH	
LM03	22.80	EWH	
LM05	21.45	EWH	
LM07	18.14	EWH	
LM08	17.60	EWH	
LM09	12.98	EWH	
LM11	10.90	EWH	Cu (46.9 µg/L),
LM12	8.14	EWH	
LM13	7.30	EWH	
LM15	4.30	EWH	
LM16	3.50	WWH	Se (35.5 µg/L)
LM17	1.40	WWH	
Sycamore Creek			
LM50	1.10	WWH	
LM51	0.53	WWH	
LM52	0.20	WWH	
Unnamed Tributary to Unnamed Tributary to Sycamore Creek			
LM54	0.40	PHW2	D.O. (min 2.34 mg/L)
Unnamed Tributary to Sycamore Creek			
LM55	1.00	WWH	
LM56	0.30	WWH	
Duck Creek			
LM71	6.00	LRW	
LM72	4.70	LRW	
LM73	4.40	LRW	D.O. (Datasonde minimum; 1.61 mg/L)
LM74a	3.90	LRW	
LM75	3.30	LRW	
LM76	2.90	LRW	
LM77	1.80	WWH	D.O. (Datasonde minimum; 2.24 mg/L)
LM79	0.95	WWH	D.O. (min: 3.63 mg/L); temperature (Datasonde max. 31°C)
Unnamed Tributary to Duck Creek			
LM80	0.20	LRW	D.O. (mean: 2.32 mg/L; min: 0.76 mg/L)
Unnamed Tributary to Little Duck Creek @RM 4.42			
LM82	0.10	PHW3A	D.O. (min: 2.32 mg/L)
East Fork Duck Creek			
LM85	1.90	WWH	D.O. (mean: 3.09 mg/L; min: 0.89 mg/L)

Table 8. *Exceedances of water quality criteria for aquatic life based on grab sampling and continuous monitoring in the 2017 Little Miami study area.*

Site ID	River Mile	Aquatic Life Use	Parameters (Values) Exceeding Ohio Aquatic Life Criteria[1]
East Fork Duck Creek			
LM84	0.60	WWH	
Little Duck Creek			
LM86	2.70	WWH	
LM87	2.60	WWH	
LM90	2.40	WWH	
LM92	0.20	WWH	D.O. (mean: 4.13 mg/L; min: 2.11 mg/L)

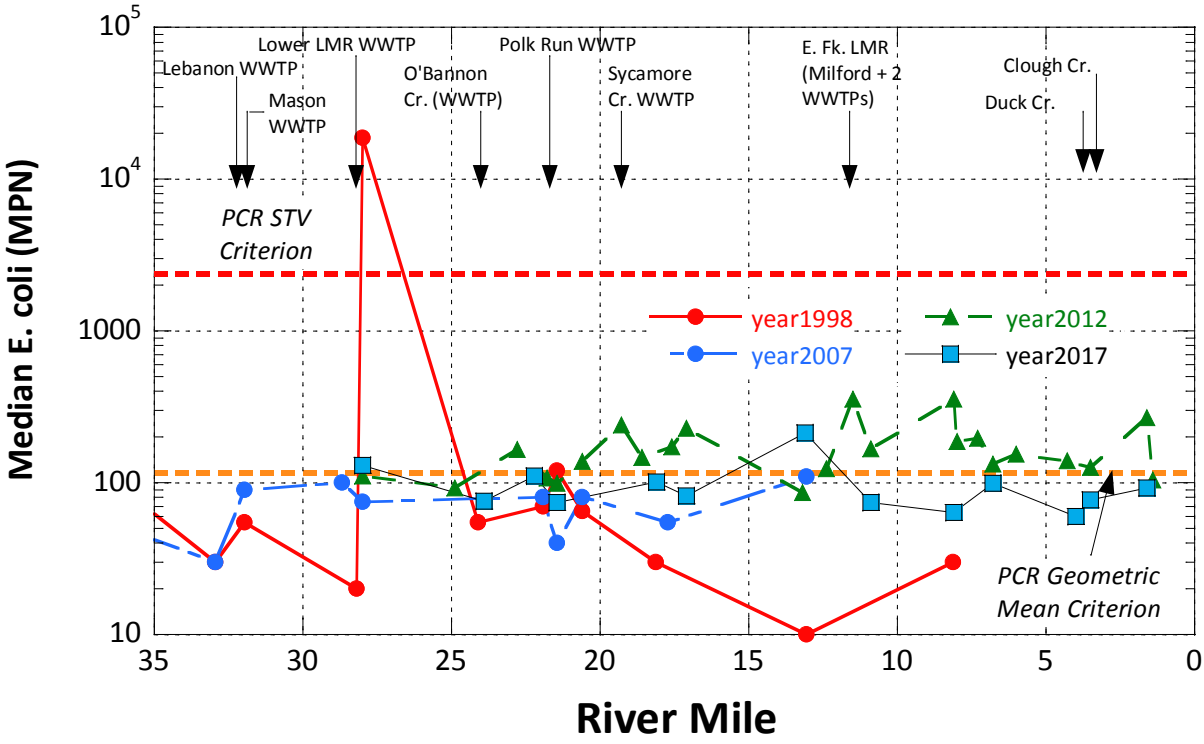

Figure 8*. E. coli values at sites sampled in the Little Miami River mainstem in 1998, 2007, 2012, and 2017. E. coli criteria for the PCR geometric mean and STV are shown by dashed lines.*

three for the PCR use. All of the latter sites had maximum E. coli values of >2420 cfu/100 ml which contributed to the impaired status. Geometric means were generally much lower meeting the respective criteria at five sites, an indication that the high maximum values are episodic.

Table 9. *Status of recreational use attainment in the 2017 Little Miami River study area as attaining or impaired based on the E. coli geometric mean and statistical threshold value at 37 sites assessed in 2017. PCR – Primary Contact Use; SCR – Secondary Contact Use.*

Site ID	River Mile	Recrea-tional Use	N	Min.	Geo-metric Mean	Max.	Geo-metric Mean	Statistical Threshold Value	Recreational Attainment
Little Miami River									
LM01	28	PCR	5	1	53.3	206	126	410	Attains
LM02	23.9	PCR	5	1	42.7	291	126	410	Attains
LM03	22.2	PCR	5	1	49.6	411	126	410	Impaired
LM05	21.45	PCR	5	1	35.3	308	126	410	Attains
LM07	18.1	PCR	5	1	49.8	435	126	410	Impaired
LM08	17.1	PCR	5	1	29	101	126	410	Attains
LM09	13.1	PCR	5	1	90.7	517	126	410	Impaired
LM11	10.9	PCR	5	1	33.5	105	126	410	Attains
LM12	8.1	PCR	5	1	32.7	107	126	410	Attains
LM13	6.8	PCR	5	1	53.4	548	126	410	Impaired
LM15	4	PCR	5	50	68.9	127	126	410	Attains
LM16	3.5	PCR	5	75	94.7	146	126	410	Attains
LM17	1.6	PCR	5	72	124.1	326	126	410	Attains
Sycamore Creek									
LM50	1.1	PCR	5	28	195.8	2420	126	410	Impaired
LM51	0.4	PCR	5	29	165	2420	126	410	Impaired
LM52	0.2	PCR	5	36	124.1	2420	126	410	Impaired
Unnamed Tributary to Unnamed Tributary to Sycamore Creek									
LM54	0.4	SC	2	461	531.6	613	1030	1030	Attains
Unnamed Tributary to Sycamore Creek									
LM55	0.9	SC	2	3	33.1	365	1030	1030	Attains
LM56	0.2	SC	2	20	93.3	435	1030	1030	Attains
Duck Creek									
LM71	6	SC	5	1	13.2	2420	1030	1030	Impaired
LM72	4.7	SC	5	517	1335.1	2420	1030	1030	Impaired
LM73	4.4	SC	5	1	199.1	2420	1030	1030	Impaired
LM74	3.9	SC	5	248	771.4	2420	1030	1030	Impaired
LM75	3.3	SC	5	172	627.8	2420	1030	1030	Impaired
LM76	2.3	PCR	5	291	665.2	2420	126	410	Impaired
LM77	1.8	PCR	5	116	278.6	2420	126	410	Impaired
LM79	0.9	PCR	5	73	163.5	517	126	410	Impaired
Unnamed Tributary to Duck Creek									
LM80	0.1	SC	5	727	1779.7	2420	1030	1030	Impaired
Unnamed Tributary to Duck Creek									
LM82	0.1	PCR	5	147	428.3	1300	126	410	Impaired

***Table 9**. Status of recreational use attainment in the 2017 Little Miami River study area as attaining or impaired based on the E. coli geometric mean and statistical threshold value at 37 sites assessed in 2017. PCR – Primary Contact Use; SCR – Secondary Contact Use.*

Site ID	River Mile	Recrea-tional Use	N	Min.	Geo-metric Mean	Max.	Geo-metric Mean	Statistical Threshold Value	Recreational Attainment
East Fork Duck Creek									
LM85	1.8	SC	5	179	1241	2420	1030	1030	Impaired
LM84	0.5	SC	5	116	512.8	1733	1030	1030	Impaired
Little Duck Creek									
LM86	2.7	PCR	2	192	236.4	291	126	410	Impaired
LM87	2.6	PCR	2	199	208.8	219	126	410	Impaired
LM90	1	PCR	2	101	116.8	135	126	410	Attains
LM92	0.2	PCR	2	111	111	111	126	410	Attains

Sycamore Creek Subwatershed

Of the six sites assessed in the Sycamore Creek subwatershed, three attained the SCR use criteria and three PCR sites were impaired. All of the three latter sites had maximum *E. coli* values of >2420 cfu/100 ml which contributed to the impaired status. Geometric means exceeded the criteria at two of the three PCR sites, but were only slightly above meeting the respective criteria at all three sites, a similar indication that the high maximum values are episodic.

Exceedances of Biological Effect Thresholds

Biological effect thresholds were employed for parameters that do and do not have formal criteria codified in the Ohio WQS to determine the risks of any exceedances to the attainment of aquatic life uses. The thresholds developed as part of the *Integrated Prioritization System (IPS) Documentation and Atlas of Biological Stressor Relationships for Southwest Ohio* (Technical Report MBI/2015-12-15, MBI 2015) were used to assess conventional, ionic strength, and nutrient parameters. These "IPS thresholds" were used in lieu of the Ohio EPA (1999) *Appendices to Association Between Nutrients and the Aquatic Biota of Ohio River and Streams* the thresholds from which were employed in a similar fashion in the 2011-14 MSDGC service area watershed assessments. The IPS thresholds are a more robust and regionally relevant analysis of biological stressor thresholds and especially in light of the Ohio EPA (1999) dataset being somewhat sparse in the Interior Plateau ecoregion. The IPS thresholds also offer discrete goals that are directly linked to the codified biological criteria and their application in the determination of aquatic life use attainment and the response to a finding of attainment and findings of non-attainment[4]. The results for selected parameters are compared to the IPS threshold goals that align with the applicable aquatic life use and stream size category and color coded in keeping with the hierarchy of the Ohio tiered aquatic life uses. The results are also

[4] OAC 3745-1-07(A)(6)(a) describe the options for a finding of full attainment and (A)(6)(b) for a finding of non-attainment.

graphically depicted along the Little Miami River mainstem as mean values and in tabular form for the tributary subwatersheds and compared to available results using prior Ohio EPA and MBI results as a historical baseline. Nutrients were also assessed using the draft Stream Nutrient Assessment Procedure (SNAP; Ohio EPA 2015d) which is a "combined criteria" consisting of the fish and macroinvertebrate biological criteria, the diel D.O. flux, benthic chlorophyll α, and total nitrate and phosphorus. Lastly, sediment chemical data was assessed using the threshold and probable effect levels of MacDonald et al. (2000).

Conventional, Demand, and Nutrient Parameters

This category includes D.O., temperature, pH, ammonia-N, total phosphorus, total nitrate, total Kjeldahl nitrogen, and BOD_5, all from grab samples collected under normal summer-fall flows. The D.O. results were comprised of both grab and short-term continuous data.

Little Miami River

D.O. values from daytime grab samples as expected did not reveal any exceedances of the average or minimum criteria in the Little Miami River mainstem (Figure 9). No maximum values were recorded that would indicate excessive diel swings resulting from excessive nutrient enrichment. Exceedances of the EWH average and excessively high daytime values were evident in 2012, thus these results show an improvement in the D.O. regime. BOD_5 values were at or near detection (2 mg/L) in 2017 and all values were below the IPS thresholds (Figure 9). This was an improvement over 2012 when several mean values exceeded both the EWH and WWH IPS thresholds. Summer-fall season flows were higher in 2017 compared to 2012 thus increased dilution likely played a role in the improved water quality.

Ammonia-N was at the detection limit for all samples in the mainstem (Table 10) a result similar to 2012. The 2017 total phosphorus and nitrate reflected consistent exceedances of both the EWH and WWH IPS thresholds (Figure 10; Table 10). Total P was elevated above the values observed in 2012, but lower than measured by prior Ohio EPA surveys in 1993 and 2007 and two sites for data available from 1975. Total nitrate showed a similar pattern excepting that they were closer to a prior Ohio EPA survey in 1993. TKN values exceeded the EWH IPS threshold in 2017, but were lower than the WWH threshold (Figure 11) and below values recorded in 2007 and 2012. 5-day biochemical oxygen demand (BOD_5) values in 2017 were at or below the minimum detection level (MDL) at all mainstem sites (Figure 11). This is a consistent reduction in values observed in 1997, 2011, and 2013 and is a positive indication of decreased loadings of carbonaceous materials. All values were well below the IPS thresholds.

Continuous D.O. data provided a more complete characterization of the dynamics of the D.O. regime in the Little Miami River 2017 (Figure 12). The results revealed no exceedances of the minimum or average EWH D.O. criterion at nine sites in Little Miami River mainstem and with no excessively wide diel swings that would be indicative of the effects of excessive algal activity. These results, too, are an improvement over 2012 when exceedances of both the average and minimum D.O. criteria occurred and diel swings were excessive indicating the effects of nutrient enrichment. Continuous temperature data revealed no exceedances of the temperature

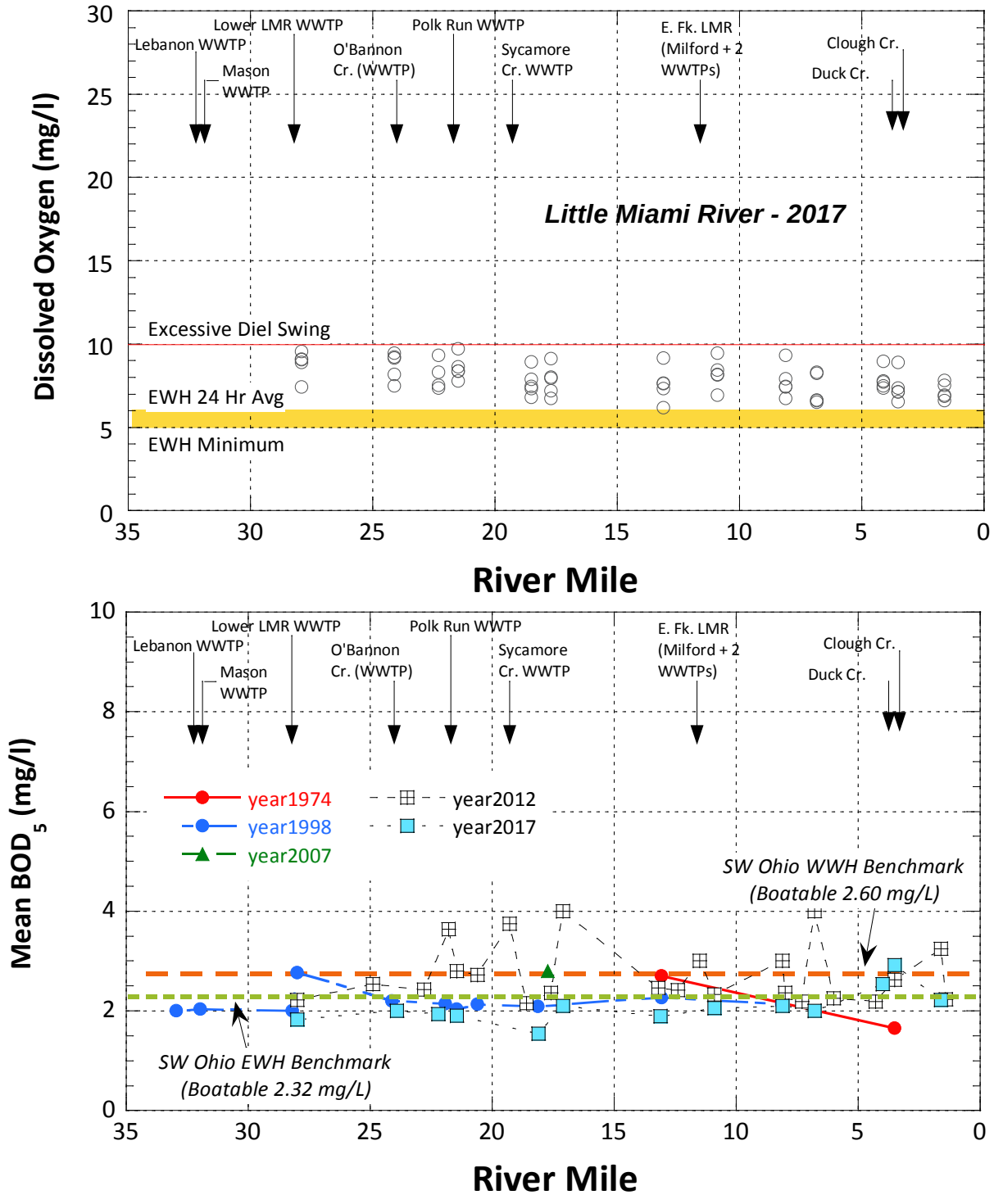

Figure 9. *Dissolved oxygen (D.O.; upper) and mean 5-day BOD (lower) at Little Miami River mainstem sites in 2017 based on daytime grab samples. The average and minimum D.O. criteria for the EWH use is shown as a shaded bar. The D.O. concentration that indicates excessive diel swings is depicted as a solid red line. IPS thresholds for BOD are shown by orange and green dashed lines.*

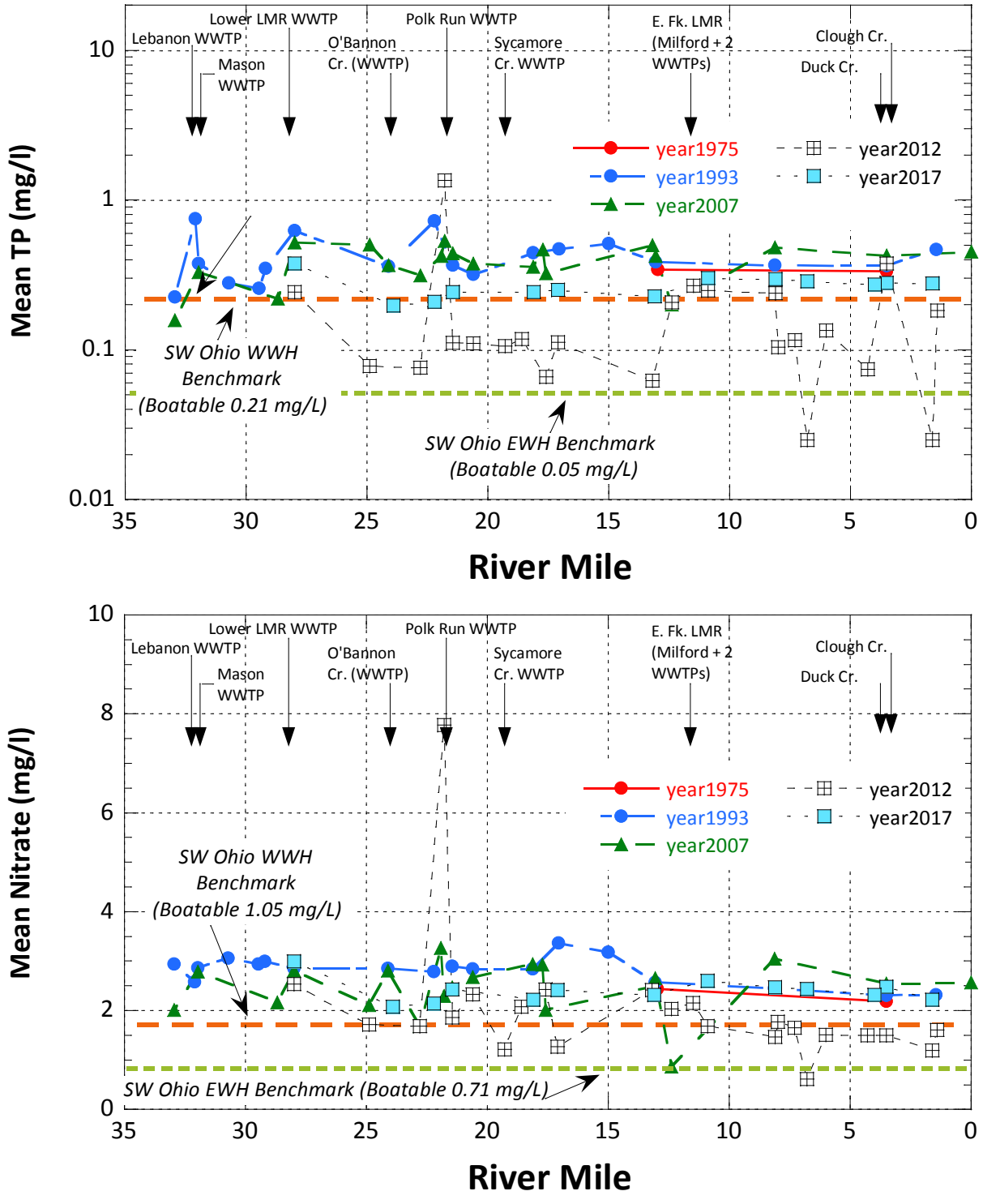

Figure 10. *Mean total phosphorus (upper) and nitrate (lower) at Little Miami River mainstem sites in 1975, 1993, 2007, 2012, and 2017. The IPS biological effect thresholds for the EWH and WWH uses are shown as green and orange dashed lines.*

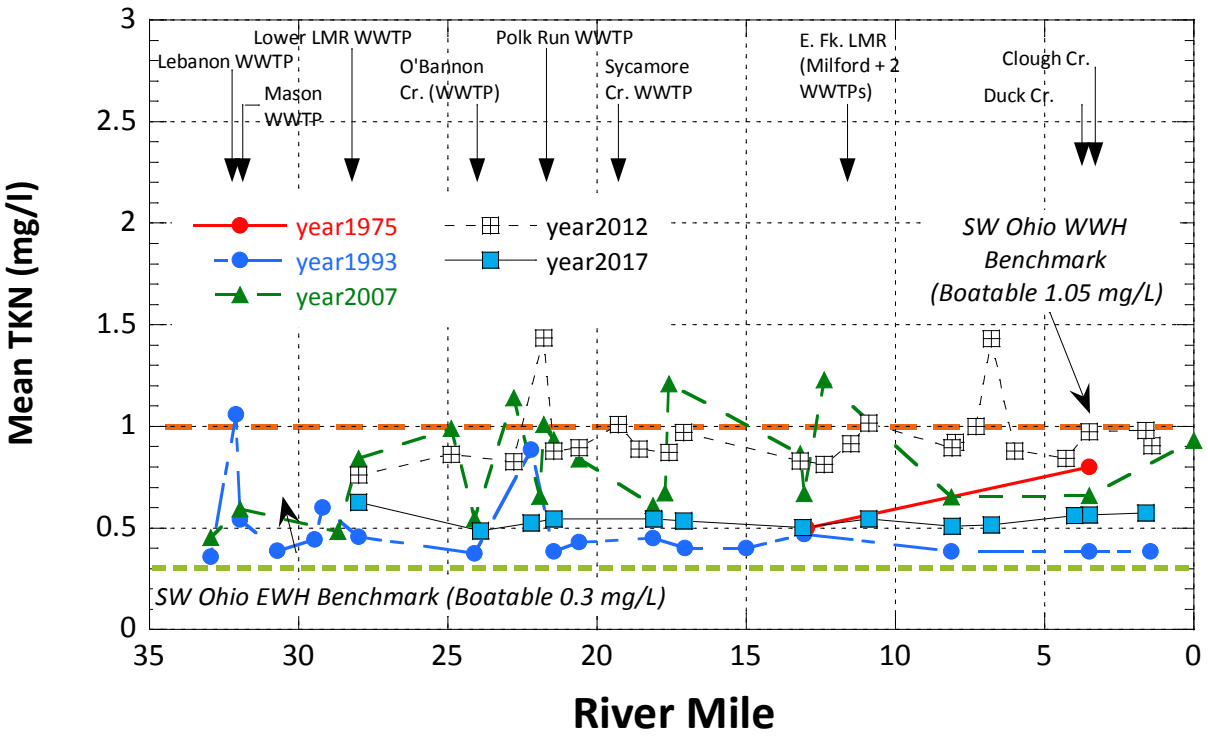

Figure 11. *Mean total Kjeldahl nitrogen at Little Miami River mainstem sites in 1975, 1993, 2007, 2012, and 2017. The IPS biological effect thresholds for the EWH and WWH uses are shown as green and orange dashed lines.*

criteria as all values were well below both the average and maximum (Figure 12). In 2012 exceedances of both values occurred downstream from the East Fork confluence persisting downstream to the Ohio River.

Conductivity values based on continuous monitoring revealed values just in excess of the EWH IPS threshold, but consistently below the WWH threshold (Figure 12). Here again, the 2017 results showed better quality than in 2012 when conductivity values regularly exceed both IPS and reference thresholds. Continuous pH data revealed no exceedances of the minimum-maximum criterion of 6.5-9.0 S.U. nor diel swings indicative of excessive nutrient enrichment.

Duck Creek Subwatershed

D.O. values from daytime grab samples revealed exceedances of the average or minimum criteria for both WWH and LRW at selected sites in the Duck Creek subwatershed (Table 8). One site in Duck Creek (RM 4.4) and three sites in the two unnamed tributaries had mean and minimum values less than the LRW criteria (Table 8). The two downstream sites (RM 1.8 and 0.95) in the WWH segment of Duck Creek and the downstream most site in Little Duck Creek RM 0.2) had exceedances of the mean and minimum WWH criteria (Table 8).

***Table 10**. Nutrient parameter results in the Little Miami River study area in 2017. Values >stressor benchmarks are shaded in yellow.*

Site ID	River Mile	Drainage Area (sq. mi.)	Median Total Ammonia (mg/L)	Median Total Nitrate (mg/L)	Mean TKN (mg/L)	Median Total Phosphorus (mg/L)	Median Benthic Chlorophyll (mg/m^3)
Little Miami River							
LM01	28	1070	0.01	2.95	0.59	0.38	1.87
LM02	23.9	1090	0.01	2.16	0.50	0.21	2.14
LM03	22.2	1150	0.01	2.19	0.54	0.22	2.67
LM05	21.45	1160	0.01	2.35	0.54	0.24	2.67
LM07	18.1	1190	0.01	2.22	0.55	0.25	3.20
LM08	17.1	1190	0.01	2.36	0.49	0.26	3.47
LM09	13.1	1200	0.01	2.26	0.52	0.23	3.21
LM11	10.9	1710	0.01	2.55	0.54	0.30	3.74
LM12	8.1	1710	0.01	2.36	0.49	0.30	4.54
LM13	6.8	1720	0.01	2.35	0.51	0.29	5.27
LM15	4	1730	0.01	2.24	0.56	0.28	4.67
LM16	3.5	1750	0.01	2.38	0.53	0.28	4.54
LM17	1.6	1760	0.01	2.02	0.57	0.26	5.34
Sycamore Creek (LMR RM 19.2)							
LM50	1.1	12.5	0.01	0.30	0.27	0.36	1.00
LM51	0.4	22.8	0.01	0.05	0.30	0.11	1.04
LM52	0.2	23.3	0.03	5.20	1.12	0.13	1.00
Unnamed Tributary to N Branch Sycamore Creek at RM 5.3							
LM54	0.4	1.6	0.01	0.01	0.56	0.13	1.00
Unnamed Tributary To Sycamore Cr. (RM 1.12)							
LM55	0.9	5.3	0.01	0.25	0.47	0.10	1.00
LM56	0.2	5.6	0.02	0.27	0.19	0.08	1.00
Duck Creek (LMR RM 3.87)							
LM71	6	2.2	0.01	0.63	0.29	0.20	1.00
LM72	4.7	5.1	0.04	0.36	0.43	0.18	1.00
LM73	4.4	5.8	0.02	0.50	0.33	0.17	1.00
LM75	3.3	11.5	0.01	1.12	0.29	0.12	1.04
LM76	2.3	11.7	0.02	0.81	0.48	0.15	3.21
LM77	1.8	14.3	0.01	0.38	0.47	0.11	1.00
LM79	0.9	14.6	0.02	0.20	0.41	0.15	1.00
Unnamed Tributary to Duck Creek at RM 4.8							
LM80	0.1	1.4	0.01	0.05	0.81	0.16	1.00
Unnamed Tributary to Little Duck Creek at RM 4.42							
LM82	0.1	0.3	0.01	0.42	0.40	0.22	2.40
East Fork Duck Creek							
LM85	1.8	1.3	0.03	0.17	0.56	0.33	1.00
LM84	0.5	2.4	0.01	0.18	0.41	0.13	1.00
LM74	0.2	9.6	0.01	0.08	0.54	0.14	1.00

***Table 10**. Nutrient parameter results in the Little Miami River study area in 2017. Values >stressor benchmarks are shaded in yellow.*

Site ID	River Mile	Drainage Area (sq. mi.)	Median Total Ammonia (mg/L)	Median Total Nitrate (mg/L)	Mean TKN (mg/L)	Median Total Phosphorus (mg/L)	Median Benthic Chlorophyll (mg/m^3)
Little Duck Creek							
LM86	2.7	0.5	0.01	0.42	0.24	0.21	1.00
LM87	2.6	0.5	0.01	0.36	0.21	0.21	1.00
LM90	2.3	1.1	0.01	0.35	0.25	0.22	1.00
LM92	0.2	1.7	0.01	0.52	0.55	0.24	1.57

IPS Derived Benchmarks

Total Ammonia: EWH,BT – 0.11; WWH, WD – 0.53; WWH, HW – 0.31; LRW, HW – 1.43; LRW, WD – 1.58.
Total Nitrate: EWH,BT – 0.71; WWH, WD – 1.38; WWH, HW – 0.96; LRW, HW – 1.51; LRW, WD – 2.50.
Total Phosphorus: EWH,BT – 0.05; WWH, WD – 0.17; WWH, HW – 0.17; LRW, HW – 2.60; LRM, WD – 1.34.
TKN: EWH,BT – 0.30; WWH, WD – 0.58; WWH, HW – 0.51; LRW, HW – 2.15; LRM, WD – 2.03.
Benthic Chlorophyll (SNAP Procedure): Low - ≤182; Moderate – >180 -320; High - >320.

Ammonia-N was at the detection limit for all except five samples in the Duck Creek subwatershed (Table 10) and these were barely above detection and not in excess of any criterion or threshold. Total phosphorus exceeded the WWH IPS threshold at five of the nine Duck Creek tributary sites with no exceedances in the Duck Creek mainstem. Total nitrate values were below all thresholds (Table 10). These results are similar to that observed in 2012. TKN values exceeded the WWH IPS threshold at four tributary sites in 2017 and none were exceeded in the Duck Creek mainstem (Table 10).

Continuous D.O. data provided a more complete characterization of the dynamics of the D.O. regime at four sites in Duck Creek (Figure 13). The results revealed one minor exceedance of the LRW minimum criterion at RM 4.58 and wide diel swings at the two sites in the LRW designated upper reach. Exceedances of the average and minimum WWH criteria were observed at RM 2.0, but none at the next downstream location (RM 0.5). Diel D.O. swings were excessive at both sites in the WWH reach of Duck Creek especially at the downstream most site. The results indicate the delivery of organic materials from upstream and excessive algal activity resulting from nutrient enrichment.

Temperature values were highest at the downstream most site with a high reading of 31.0°C that exceeded the maximum WWH criterion. A similarly high reading occurred in the LRW reach at RM 3.9, but was not an exceedance of the LRW criterion. The wide diel variation in temperatures that occurred along the length of Duck Creek reflected the lack of shading and shallow depths in the highly modified channel.

Conductivity values were within the range of the IPS thresholds for LRW, but exceeded the WWH thresholds at the two downstream sites (RM 2.0 and 0.5). pH values were within the 6.5-9.0 S.U. criteria, but reflected the effects of excessive algal activity with most readings >8.0 S.U.

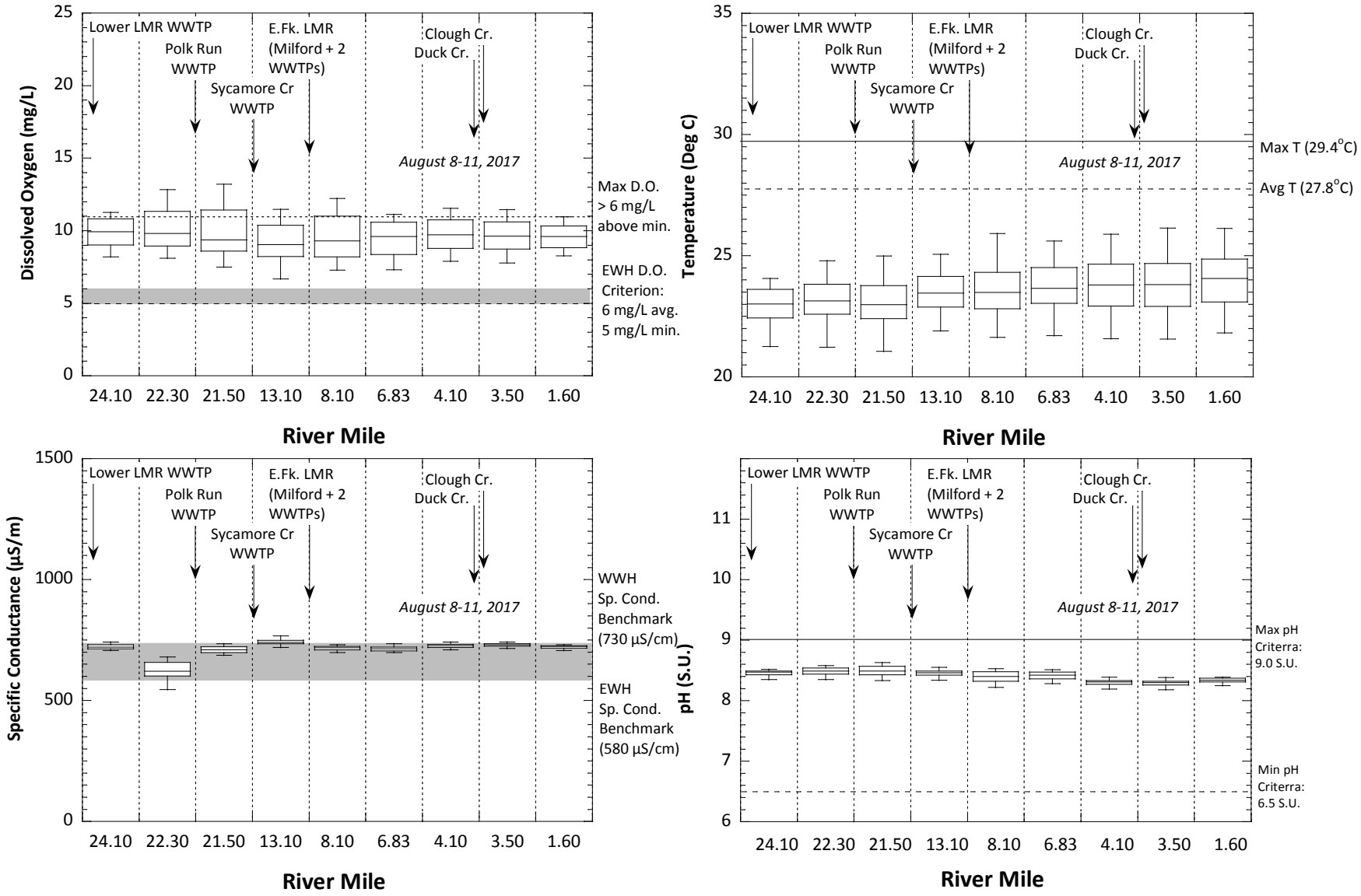

Figure 12. *Box-and-whisker plots of continuous D.O., temperature, conductivity, and pH from Datasonde continuous recorders at nine sites in the Little Miami River mainstem during August 8-11. The EWH daily average and minimum criteria are indicated by gray shaded bars, solid and dashed lines, and the maximum D.O. indicative of excessive diel swings is indicated by a black dashed line. Major discharges and tributaries are indicated across the top.*

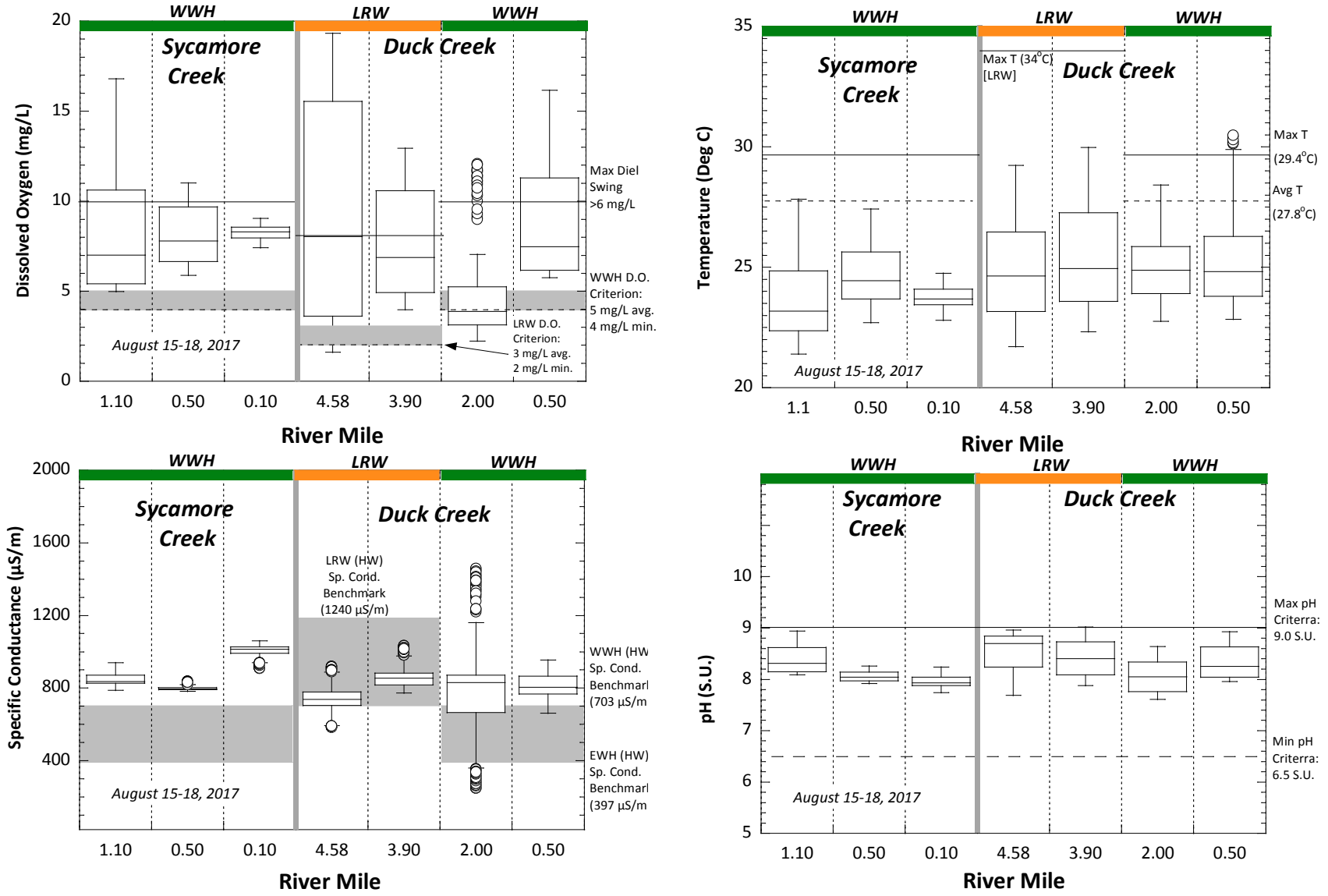

Figure 13. *Box-and-whisker plots of continuous D.O., temperature, conductivity, and pH from Datasonde continuous recorders at seven sites in Duck Creek and Sycamore Creek during August 15-18. The WWH and LRW daily average and minimum criteria are indicated by gray shaded bars, solid and dashed lines, and the maximum D.O. indicative of excessive diel swings is indicated by a black dashed line.*

Sycamore Creek

There were no exceedances of water quality criteria at any of the six sites in the Sycamore Creek subwatershed (Table 8). Ammonia-N was at the detection limit for all except two samples (Table 10) and these were barely above detection and not in excess of any criterion or threshold. This compares to a significant ammonia –N exceedance observed in 2012 at RM 0.2. Total phosphorus exceeded the WWH IPS threshold at the upstream most site in Sycamore Creek (RM 1.1) and none of the remaining five sites. Total nitrate exceeded the WWH IPS threshold only at the mouth (RM 0.2). TKN values also exceeded the WWH IPS threshold at the mouth site (Table 10). These results are similar to those observed in 2012.

Continuous data was recorded at the three mainstem Sycamore Creek sites (Figure 13). No exceedances of the WWH D.O. criteria were observed, but excessive diel swings occurred at the upstream most site (RM 1.1) with none at the next two sites downstream. Temperatures were well within the WWH average and maximum criteria. All conductivity values were in excess of the WWH IPS threshold of 703 µS/cm ranging between 800-1000 µS/cm. pH values were within the 6.5-9.0 S.U. criteria and the result of excessive algal activity at the upstream most site (RM 1.1) due to nutrient enrichment.

Nutrient Enrichment Parameters/SNAP

The draft Stream Nutrient Assessment Procedure (SNAP) developed by Ohio EPA (2015d) was also used to assess the overall effects of nutrient enrichment in the Little Miami mainstem (nine sites), Duck Creek (four sites), and Sycamore Creek (three sites). SNAP requires data for fish, macroinvertebrates, total P, total nitrate, benthic chlorophyll α, and the diel D.O. flux which was provided by the Datasonde results (Figures 12 and 13). SNAP utilizes the IBI, MIwb, and ICI, the aquatic life use attainment status (impaired or attaining), the total P and nitrate results, the maximum and minimum D.O., the diel D.O. swing, and benthic chlorophyll α to arrive at trophic status determination for sites that are impaired for the biocriteria. Biologically impaired sites are assessed for the likelihood that nutrient enrichment is a primary cause. Five of the six impaired sites assessed with SNAP were determined to be likely associated with a nutrient enrichment related cause (Table 11). All of these sites are tributaries including all of the Duck Creek and two of three Sycamore Creek watershed sites. The most important SNAP factors in making the likelihood of nutrients as a cause of the impairment were the maximum diel D.O. swing and elevated total phosphorus values, although the latter is not sufficient alone to result in a likely impaired by nutrients assignment. In fact all 16 of the sites evaluated with SNAP had total phosphorus in excess of the SNAP guideline. Benthic chlorophyll a values were either low or low-moderate an indication that sestonic algae played a larger role in producing the symptoms of excessive nutrient enrichment. Total nitrates were low at all except one of the five sites with likely nutrients, but were elevated at all Little Miami River mainstem sites, a lingering result of the high volume of treated WWTP effluent in the lower mainstem, but no association with any biological impairments in 2017. This is the first baseline assessment using SNAP in the Little Miami River study area as it was not performed in 2012.

***Table 11**. Results for parameters and indicators used in the Stream Nutrient Assessment Procedure (SNAP) to determine the role of the effect of nutrients on aquatic life use attainment in the 2017 Little Miami study area. SNAP produces a trophic status that is the likelihood of nutrients as a cause of non-attainment.*

Site ID	RM	AQLU	Drain Area (mi.²)	IBI	MIwb	ICI	AQLU Status	Total P (mg/l)[b]	Nitr-ate (mg/L)[b]	Max. D.O.	Min. D.O.[c]	Max. Diel D.O. Swing	D.O. Swing Narrative	Benthic Chl. α	Benthic Chlorophyll Narrative	Trophic Status
Little Miami River																
LM02	23.7	EWH	1150	54	11.55	56	ATTAINS	0.196	2.073	11.09	8.20	2.89	Normal-Low	5.1	Low-Mod.	No Threat
LM03	22.1	EWH	1148	46	10.57	E	ATTAINS	0.209	2.139	10.78	8.11	4.42	Normal-Low	4.7	Low-Mod.	No Threat
LM05	20.9	EWH	1161	48	11.47	E	ATTAINS	0.243	2.427	9.22	7.49	4.7.0	Normal-Low	17.6	Low-Mod.	No Threat
LM09	12.9	EWH	1200	52	10.34	52	ATTAINS	0.227	2.311	8.99	6.69	3.9.0	Normal-Low	6.0	Low-Mod.	No Threat
LM12	8	EWH	1714	48	10.15	E	ATTAINS	0.295	2.466	9.77	7.28	4.58	Normal-Low	14.6	Low-Mod.	No Threat
LM13	6.8	EWH	1720	46	10.5	54	ATTAINS	0.285	2.433	9.78	7.32	3.33	Normal-Low	6.8	Low-Mod.	No Threat
LM15	4	EWH	1730	46	10.55	56	ATTAINS	0.272	2.314	9.76	7.90	3.51	Normal-Low	7.2	Low-Mod.	No Threat
LM16	3	EWH	1752	46	9.66	42	ATTAINS	0.28	2.482	9.74	7.77	3.51	Normal-Low	6.2	Low-Mod.	No Threat
LM17	1.4	EWH	1760	38	8.81	-	ATTAINS	0.276	2.221	10.34	8.57	2.70	Normal-Low	6.2	Low-Mod.	Not Nutrients
Duck Creek.0																
LM73	4.4	LRW	5.8	12	-	P	**IMPAIRED**	0.176	0.473	8.47	2.29	16.45	Wide	7.1	Low	Likely Nutrients
LM77	1.8	WWH	14.3	27	-	42	**IMPAIRED**	0.118	0.389	3.98	2.87	9.29	Wide	7.8	Low	Likely Nutrients
LM79	0.8	WWH	14.7	30	-	34	**IMPAIRED**	0.139	0.396	6.07	5.75	10.30	Wide	10.3	Low	Likely Nutrients
East Fork Duck Creek																
LM74	0.15	WWH	3.4	12	-	F	**IMPAIRED**	0.143	0.252	6.08	3.98	7.98	Wide	8.1	Low	Likely Nutrients
Sycamore Creek																
LM50	0.64	WWH	10.5	30	-	44	**IMPAIRED**	0.312	0.298	11.33	5.32	11.71	Wide	6.9	Low	Likely Nutrient
LM51	0.24	WWH	24	25	7.88	38	**IMPAIRED**	0.116	0.102	7.96	5.88	4.32	Normal-Low	6.6	Low-Mod.	Not Nutrients
LM52	0.05	WWH	24	47	8.08	36	ATTAINS	0.240	5.289	7.96	7.41	1.25	Normal-Low	14.8	Low-Mod.	No Threat

[a] Datasonde data not available, data represent summer max and min values (i.e., no diel swing data available).
[b] Color shading for TP and nitrate based on SNAP risk levels.
[c] Red shading indicates value below D.O. minimum criteria for the applicable aquatic life use.
[d] High risk from nutrients based on combination of elevated TP and nitrate.

Urban Parameters

Urban parameters include ionic strength measures such as conductivity, total dissolved solids, total chlorides, and total sulfates and selected heavy metals such as copper, lead, and zinc. These parameters are commonly elevated in urban areas and are the result of stormwater runoff, but can also be indicative of other industrial and municipal sources of pollution. In addition to graphical depictions of these parameters the IPS biological effect thresholds (MBI 2015) were used to assess all of the urban parameters similar to the preceding analyses of nutrient and demand parameters (Table 12).

Little Miami River

The IPS biological effect thresholds (MBI 2015) were used to assess all of the urban related parameters in the same manner done for the conventional, demand, and nutrient parameters (Table 12). Conductivity was measured by grab sampling at all 2017 Little Miami River mainstem sites. All mean values exceeded the EWH IPS threshold, but were below the WWH threshold (Figure 14). The longitudinal profile from prior years showed higher values and increases immediately downstream from point sources, but values between sites were remarkably similar in 2017 and not reflective of any specific sources. This is the same conclusion reached in 2012 showing that few if any changes have taken place over the past 5 years. Total chlorides showed a similar longitudinal and temporal pattern to conductivity in 2017 and years prior (Figure 14). Total dissolved solids were likewise in excess of both the EWH and WWH IPS thresholds. No exceedances of IPS thresholds for the heavy metals cadmium, copper, lead, and zinc were observed (Table 12). With the exception of conductivity, chlorides, and total dissolved solids these results showed a lessening of exceedances for metals between 2012 and 2017.

Duck Creek Subwatershed

With only two exceptions, exceedances of urban parameters in Duck Creek occurred at the three sites in the WWH designated reach (Table 12). Conductivity values were well in excess of 1000 µg/L at RM 2.3 and 1.8 and in the East Fork and the Unnamed Tributary at RM 4.8. TDS and chlorides followed similar patterns, all typical of heavy urbanization. Exceedances of these parameters also occurred in Little Duck Creek and primarily in the upstream most three sites. No exceedances of the heavy metals were recorded and all were at lower concentrations than observed in 2012 especially for lead.

Sycamore Creek

Similar exceedances for conductivity, TDS, and chlorides occurred at most of the Sycamore Creek subwatersheds sites in 2017 with the highest values measured at RM 0.2 in Sycamore Creek (Table 12). No exceedances of heavy metals occurred, but the zinc value of 39 µg/L at RM 0.2 was only slightly below the WWH IPS threshold.

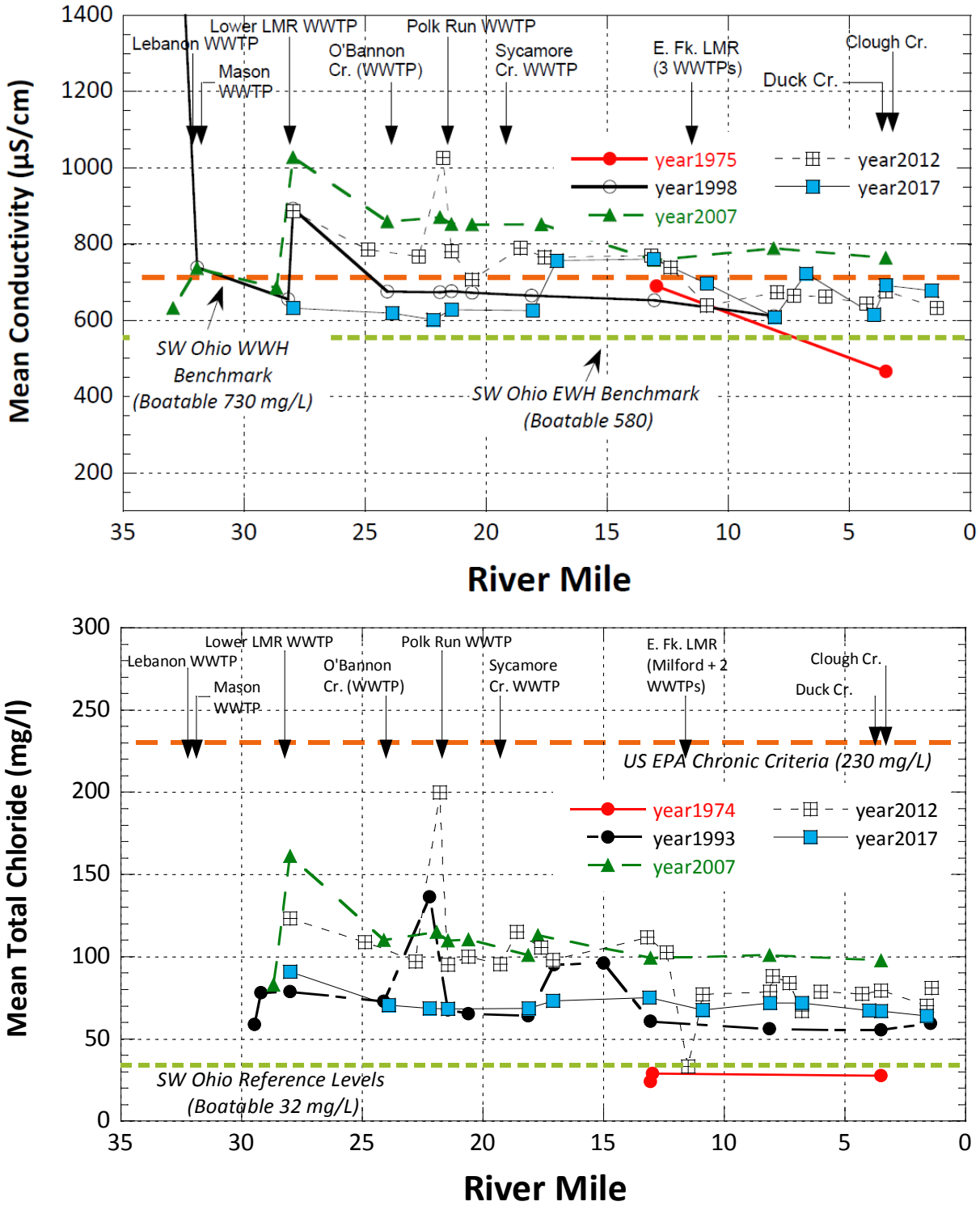

Figure 14. *Mean conductivity (upper) and total chloride at Little Miami River mainstem sites in 1975, 1998, 2007, 2012, and 2017. The IPS biological effect thresholds for the EWH and WWH uses are shown as green and orange dashed lines.*

***Table 12**.Urban parameter results in the Little Miami River study area in 2017. Values exceeding the applicable IPS thresholds are highlighted in yellow.*

Site ID	River Mile	Aq. Life Use	Drainage Area (sq. mi.)	Conduct-ivity (µS/m)	TDS (mg/L)	SSC (mg/L)	Chloride (mg/L)	TKN (mg/L)	Total Cadmium (µg6/L)	Total Cu (µg/L)	Total Pb (µg/L)	Total Zn (µg/L)
Little Miami River												
LM01	28	EWH	1075	803	468	6.2	86	0.59	0.10	2.50	2.51	8.2
LM02	23.9	EWH	1150	731.5	432	5.6	73	0.50	0.10	2.50	2.51	4.4
LM03	22.2	EWH	1148	704	412	12.0	67	0.54	0.10	2.50	2.51	5.9
LM05	21.45	EWH	1161	739.5	464	10.0	68	0.54	0.10	2.51	2.51	14.8
LM07	18.1	EWH	1190	734.5	456	24.0	67	0.55	0.10	2.50	2.51	12.4
LM08	17.1	EWH	1190	752	484	7.7	76	0.49	0.10	2.50	2.51	6.8
LM09	13.1	EWH	1200	754	480	12.0	79	0.52	0.10	2.50	2.51	11.6
LM11	10.9	EWH	1707	703	428	11.0	69	0.54	0.10	2.52	2.51	7.8
LM12	8.1	EWH	1714	674	460	8.8	76	0.49	0.10	2.50	2.51	6.6
LM13	6.8	EWH	1720	714.5	432	6.2	75	0.51	0.10	2.50	5.00	7.6
LM15	4	EWH	1730	685	452	9.4	72	0.56	0.10	2.50	2.51	7.0
LM16	3.5	EWH	1752	690.5	432	15.0	73	0.53	0.10	2.50	2.51	7.0
LM17	1.6	EWH	1760	645.5	356	15.0	70	0.57	0.10	2.50	2.51	7.1
Duck Creek												
LM71	6	LRW	2.2	678.5	376	2.0	76	0.29	0.10	2.50	2.51	5.2
LM72	4.7	LRW	5.1	817.5	468	3.7	93	0.43	0.10	2.50	2.51	8.0
LM73	4.4	LRW	5.8	827.5	428	2.9	96	0.33	0.10	2.50	2.51	7.1
LM74A	3.9	LRW	3.4	859	512	2.0	110	0.54	0.10	2.50	2.51	9.9
LM75	3.3	LRW	11.4	1008.5	540	2.0	98	0.29	0.10	2.50	2.51	6.1
LM76	2.3	WWH	11.9	1067.5	648	5.1	130	0.48	0.10	2.51	2.51	16.7
LM77	1.8	WWH	14.3	1112.5	648	2.0	130	0.47	0.10	2.50	2.51	9.5
LM79	0.9	WWH	14.7	760.5	400	2.0	90	0.41	0.10	2.50	2.51	6.7
Sycamore Creek												
LM50	1.1	WWH	10.5	747	424	3.0	76	0.27	0.10	2.50	2.51	3.5
LM51	0.4	WWH	24	698.5	344	4.6	78	0.30	0.10	2.50	2.51	3.4
LM52	0.2	WWH	24	950.5	552	2.0	130	1.12	0.10	2.50	2.51	39.0
Unnamed Tributary To Sycamore Cr.												
LM55	0.9	WWH	5.3	748	398	2.0	112.5	0.47	1.50	3.80	10.30	9.9
LM56	0.2	WWH	5.6	599.5	316	2.0	82	0.19	1.50	3.90	10.30	11.0
East Fork Duck Creek												
LM85	1.8	WWH	1.5	1110	656	2.0	150	0.56	0.10	2.50	2.51	7.8
LM84	0.5	WWH	2.4	1027	648	2.0	180	0.41	0.10	2.50	2.51	6.1
Unnamed Tributary to Duck Creek @RM 4.8												
LM80	0.1	LRW	1.4	1899	1176	4.9	370	0.81	0.10	2.50	2.51	15.4
Little Duck Creek												
LM86	2.7	WWH	0.4	727	412	3.2	65	0.24	0.10	2.50	2.51	20.3
LM87	2.6	WWH	0.5	744.5	448	7.85	67.5	0.21	0.10	2.50	2.51	8.1
LM90	2.3	WWH	0.5	729	332	2.0	66	0.25	0.10	2.50	2.51	13.5

***Table 12**.Urban parameter results in the Little Miami River study area in 2017. Values exceeding the applicable IPS thresholds are highlighted in yellow.*

Site ID	River Mile	Aq. Life Use	Drainage Area (sq. mi.)	Conduct-ivity (µS/m)	TDS (mg/L)	SSC (mg/L)	Chloride (mg/L)	TKN (mg/L)	Total Cadmium (µg6/L)	Total Cu (µg/L)	Total Pb (µg/L)	Total Zn (µg/L)
LM92	0.2	WWH	1.7	452.5	265	4.6	34	0.55	0.10	2.50	2.51	12.2
Unnamed Tributary to Little Duck Creek @RM 4.42												
LM82	0.1	PHW3A	1.4	611	392	6.7	43	0.40	0.10	2.50	2.51	4.5
Unnamed Tributary to N. Branch Sycamore Creek @RM 5.3												
LM54	0.4	PHW2	1.6	694	402	2.0	68.5	0.56	1.50	5.50	10.30	12.4

Stressor Thresholds:

Conductivity: EWH, BT – 579.7; WWH, WD – 660; WWH, HW – 703; LRW, HW – 1240; LRM, WD – 1199.
TDS: EWH,BT – 284; WWH, WD – 384; WWH, HW – 364; LRW, HW – 503; LRM, WD – 538.
SSC (used TSS): EWH,BT – 44; WWH, WD – 71; WWH, HW – 66; LRW, HW – 203; LRM, WD – 193.
Total Chloride: EWH,BT – 22; WWH, WD – 59; WWH, HW – 53; LRW, HW – 106; LRM, WD – 113.
TKN: EWH,BT – 0.30; WWH, WD – 0.58; WWH, HW – 0.51; LRW, HW – 2.15; LRM, WD – 2.03.
Metals: EWH/WWH/MWH/LRW: Cu – 5.9/8.9/10.4/14.1 µg/L; Pb – 2.7/17.4/26.8/50.3 µg/L; Zn – 16.4/39.3/50.8/79.4 µg/L

Sediment Chemistry

Sediment samples were collected from 26 sites in the Little Miami study area in October 2017 and analyzed for heavy metals and organic compounds. The results were screened with the MacDonald et al. (2000) consensus-based levels for potential adverse effects to aquatic life and Ohio Sediment Reference Values (SRVs). MacDonald et al. (2000) described two levels of contamination - a Threshold Effects Concentration (TEC) and a Probable Effects Concentration (PEC). The TEC indicates exceedances for sensitive species and taxa while the PEC indicates effects for most species and taxa. IPS thresholds have not yet been developed for sediment chemicals.

Little Miami River

The single exceedance of the TEC for cadmium was the only instance recorded at 13 sites with the measured value only 0.01 mg/kg above the threshold (Table 13). All cadmium values exceeded the Ohio SRV. In 2012 values >TEC occurred at RM 17.6 for arsenic, copper, lead, and zinc and at RM 13.8 for zinc. No PAH compounds in excess of either the TEC and PEC thresholds occurred at any site in the Little Miami River mainstem in 2017 a result similar to that observed in 2012 (Table 14).

Duck Creek Subwatershed

Exceedances of the TEC occurred for arsenic, cadmium, copper, lead, and zinc occurred at one or more sites in Duck Creek (Table 13). Most of the exceedances occurred in the LRW designated reach. Exceedances of the copper and zinc TEC occurred at the upstream site in the East Fork Duck Creek. For PAH compounds only one exceedance of the TEC for fluoranthene occurred in Duck Creek at RM 4.7. These are similar to the 2012 results.

Sycamore Creek

With exception of exceedances of the SRV for cadmium at all sites and a single site for zinc, there were no exceedances of TEC for metals or PAH compounds.

***Table 13**. Sediment metals concentrations (mg/kg) for parameters with values >detection in the Little Miami River study area in October 2017. Values above the MacDonald et al. (2000) Threshold Effect Concentration (TEL) and Probable Effect Concentration (PEC) thresholds or above Ohio Sediment Reference Values (SRVs) are shaded in accordance with the color-code key at bottom.*

Site ID	River Mile	Arsenic (mg/kg)	Cadmium (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Zinc (mg/kg)
Little Miami River						
LM01	28.0	4.60	0.93	4.6	5.5	16
LM02	23.9	5.00	1.00	5.6	6.8	21
LM03	22.2	4.50	0.90	5.4	6.3	20
LM05	21.45	4.70	0.94	4.7	7.5	20
LM07	18.1	4.80	0.95	6.9	7.0	25
LM08	17.1	4.80	0.96	4.9	5.5	20
LM09	13.1	4.80	0.95	6.5	6.0	23
LM11	10.9	4.80	0.95	6.4	7.3	25
LM12	8.1	4.30	0.85	4.7	5.8	19
LM13	6.8	4.80	0.95	8.2	0.0	30
LM15	4.0	4.40	0.87	5.5	5.5	21
LM16	3.5	4.70	0.95	14.0	15.0	49
LM17	1.6	4.80	0.97	6.9	26.0	27
Sycamore Creek						
LM50	1.1	6.30	0.95	16.0	20.0	100
LM51	0.4	5.50	0.86	8.2	10.0	36
LM52	0.2	4.40	0.88	7.4	8.8	29
Duck Creek						
LM71	6.0	4.50	0.90	30.0	82.0	120
LM72	4.7	19.00	1.40	56.0	110.0	130
LM73	4.4	20.00	0.98	57.0	41.0	110
LM74A	3.9	19.00	0.93	48.0	48.0	140
LM75	3.3	17.00	0.89	30.0	33.0	87
LM76	2.3	11.00	0.94	56.0	29.0	85
LM77	1.8	24.00	0.94	16.0	10.0	40
LM79	0.9	9.60	0.98	24.0	34.0	67
East Fork Duck Creek						
LM85	1.8	4.60	0.88	50.0	27.0	130
LM84	0.5	5.50	0.86	13.0	17.0	49
Sediment Screening Guidelines:						
MacDonald et al. 2000	TEC	9.79	0.99	31.6	35.8	121.0
	PEC	33.00	4.98	149.0	128.0	459.0
Ohio EPA 2008	SRV (IP)	11.0	0.30	25.0	47.0	100.0

Table 14. *Sediment PAH concentrations (µg/kg) for parameters with values >detection in the Little Miami River study area in October 2017. Values above the MacDonald et al. (2000) TEC and PEC thresholds are shaded in accordance with the color-code key at the bottom of the table.*

Site ID	River Mile	Acenaphthene (µg/kg)	Acenaphthylene (µg/kg)	Anthracene (µg/kg)	Benzo(a)anthracene (µg/kg)	Benzo(a)pyrene (µg/kg)	Benzo(b)fluoranthene (µg/kg)	Benzo(g,h,i)perylene (µg/kg)	Benzo(k)fluoranthene (µg/kg)	Chrysene (µg/kg)	Fluoranthene (µg/kg)	Fluorene (µg/kg)	Indeno(1,2,3-cd)pyrene (µg/kg)	Naphthalene (µg/kg)	Phenanthrene (µg/kg)	Pyrene (µg/kg)
Little Miami River																
LM01	28.0	0.20	0.20	0.20	0.10	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.10	0.20	0.20	0.20
LM02	23.9	0.20	0.20	0.20	0.10	0.20	0.20	0.20	0.20	0.20	0.22	0.20	0.10	0.20	0.20	0.20
LM03	22.2	0.20	0.20	0.20	0.10	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.10	0.20	0.20	0.20
LM05	21.45	0.20	0.20	0.20	0.13	0.20	0.24	0.20	0.20	0.20	0.32	0.33	0.12	0.20	0.20	0.26
LM07	18.1	0.20	0.33	0.20	0.10	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.10	0.20	0.20	0.20
LM08	17.1	0.20	0.20	0.20	0.10	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.10	0.20	0.20	0.20
LM09	13.1	0.20	0.20	0.20	0.24	0.31	0.44	0.23	0.20	0.32	0.84	0.20	0.27	0.20	0.38	0.63
LM11	10.9	0.20	0.20	0.20	0.10	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.10	0.20	0.20	0.20
LM12	8.1	0.20	0.20	0.20	0.10	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.10	0.20	0.20	0.20
LM13	6.8	0.20	0.20	0.20	0.10	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.10	0.20	0.20	0.20
LM15	4.0	0.20	0.20	0.20	0.10	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.10	0.20	0.20	0.20
LM16	3.5	0.20	0.20	0.20	0.25	0.25	0.44	0.20	0.20	0.34	0.60	0.20	0.10	0.20	0.27	0.42
LM17	1.6	0.20	0.20	0.20	0.13	0.20	0.25	0.20	0.20	0.22	0.34	0.20	0.11	0.20	0.20	0.27
Duck Creek																
LM71	6.0	0.20	0.20	0.48	2.30	2.60	3.70	1.60	1.20	2.70	6.40	0.20	1.90	0.20	2.60	5.00
LM72	4.7	4.30	0.20	6.10	13.00	13.00	18.00	7.20	7.00	15.00	49.00	4.00	8.10	1.80	37.00	40.00
LM73	4.4	0.20	0.20	0.25	1.30	1.60	2.50	1.10	1.10	1.80	3.80	0.20	1.20	0.20	1.40	3.40

Table 14. *Sediment PAH concentrations (µg/kg) for parameters with values >detection in the Little Miami River study area in October 2017. Values above the MacDonald et al. (2000) TEC and PEC thresholds are shaded in accordance with the color-code key at the bottom of the table.*

Site ID	River Mile	Acenaphthene (µg/kg)	Acenaphthylene (µg/kg)	Anthracene (µg/kg)	Benzo(a)anthracene (µg/kg)	Benzo(a)pyrene (µg/kg)	Benzo(b)fluoranthene (µg/kg)	Benzo(g,h,i)perylene (µg/kg)	Benzo(k)fluoranthene (µg/kg)	Chrysene (µg/kg)	Fluoranthene (µg/kg)	Fluorene (µg/kg)	Indeno(1,2,3-cd)pyrene (µg/kg)	Naphthalene (µg/kg)	Phenanthrene (µg/kg)	Pyrene (µg/kg)
LM74A	3.9	0.20	0.20	0.20	0.49	0.64	1.10	0.51	0.32	0.76	1.80	0.20	0.58	0.20	0.63	1.40
LM75	3.3	0.20	0.20	0.22	0.67	0.80	1.30	0.56	0.43	0.91	2.50	0.20	0.63	0.20	1.10	1.80
LM76	2.3	0.20	0.20	0.31	1.20	1.50	2.40	1.10	0.69	1.70	4.00	0.20	1.10	0.20	1.80	3.40
LM77	1.8	0.20	0.20	0.20	0.91	0.86	1.50	0.67	0.50	1.20	2.10	0.20	0.65	0.20	1.00	1.40
LM79	0.9	0.20	0.20	2.00	1.70	1.80	2.70	1.10	1.10	2.20	4.80	0.20	1.20	0.20	2.10	3.00
East Fork Duck Creek																
LM85	1.8	0.20	0.20	0.20	1.00	0.95	1.70	0.74	1.70	1.40	2.40	0.20	0.10	0.20	1.10	1.90
LM84	0.5	1.70	0.33	0.20	0.37	0.39	0.69	0.31	0.24	0.55	0.10	0.20	0.10	0.20	0.41	0.80
Sycamore Creek																
LM50	1.1	0.20	0.20	0.36	2.20	2.20	3.60	1.60	1.30	3.20	7.30	0.20	0.10	0.20	3.60	5.60
LM51	0.4	0.20	0.20	0.20	0.43	0.49	0.89	0.42	0.31	0.69	1.20	0.20	0.42	0.20	0.57	0.94
LM52	0.2	0.20	0.20	0.20	0.56	0.61	0.91	0.43	0.34	0.78	1.40	0.20	0.48	0.20	0.63	1.20
Sediment Screening Guidelines:																
	TEL	6.7	5.87	46.9	31.7	31.9	**None**	**None**	**None**	57.1	6.22	111	77.4	**None**	34.6	41.9
	PEL	88.9	128	245	385	782	**None**	**None**	**None**	862	135	2,355	144	**None**	391	875
MacDonald et al. 2000	TEC	**None**	**None**	57.2	108	150	240	170	240	166	33	423	77.4	200	176	204
	PEC	**None**	**None**	845	1050	1450	13,400	320	13,400	1,290	135	2,230	536	3,200	561	1,170
	LEL	**None**	**None**	220	320	150	**None**	170	240	340	60	750	190	200	None	560
	SEL	**None**	**None**	3,700	14,800	14,400	**None**	3,200	13,400	4,600	1,300	10,200	1,600	3,200	None	9,500

Stream Habitat

The assessment of stream and river habitat is based on the QHEI and its metrics, submetrics, and individual attributes (Table 15; Figure 15). Habitat quality is an important determinant of biological potential and it factors into the determination of causes of impairment and use attainability analyses, the latter of which were mostly accomplished in 2012 and verified in 2017.

Little Miami River

QHEI scores in 2017 were at or above the threshold for excellent quality (>75) in the mainstem downstream to the site that is influenced by the Ohio River (RM 1.6) in 2017 (Table 15; Figure 15). Good habitat attributes outnumbered the few moderate influence modified attributes that occurred, mostly 1-2 per site including sand substrates and low sinuosity. The 2017 results were not dissimilar to 2007 or 2012 except locally where additional sites sampled in the latter year showed lower QHEI scores. The QHEI scores at the downstream most site (RM 1.6) reflected the modifications due to the influence of the impounded Ohio River mainstem.

Duck Creek Subwatershed

QHEI scores in Duck Creek reflected the highly modified channel in the LRW designated reach and selected tributaries and with only two exceptions reflected very poor habitat quality (Figure 15). QHEI scores were fair to good in the WWH designated reach of Duck Creek and the East Fork of Duck Creek, and good in Little Duck Creek (Figure 15). High and moderate influence modified attributes predominated in the LRW designated reach of Duck Creek and the lower most site in the East Fork (Table 15). Shallow maximum pool depths <40 cm were the most pervasive high influence modified attribute at 10 of the 14 total sites.

Sycamore Creek Subwatershed

QHEI scores were good at all 5 sites sampled in the Sycamore Creek subwatershed (Table 15) with no high influence modified attributes and dominance by good attributes. The most pervasive moderate influence modified attributes were low sinuosity and no fast current types.

Biological Assemblages

Fish and macroinvertebrates were sampled at all 37 sites in 2017 following standardized procedures specified by the 2011 Plan (MBI 2011) and consistent with Level 3 specifications and the Ohio WQS. Four of these sites were recommended for the Primary Headwater Habitat (PHWH) classification, thus 33 sites were evaluated against the fish and macroinvertebrate biological criteria.

***Table 15**. Qualitative Habitat Evaluation Index (QHEI) matrix showing good and modified habitat attributes at sites in the Little Miami River study area in 2017.*

River Mile	QHEI	Good Habitat Attributes											High Influence Modified Attributes						Moderate Influence Modified Attributes													Ratios	
		No Channelization	Boulder, Cobble, Gravel	Silt Free	Good-Excellent Development	Moderate-High Sinuosity	Moderate-Extensive Cover	Fast Flow w Eddies	Little to No Embeddedness	Max Depth > 40 cm	No Riffle Embeddedness	"Good" Habitat Attributes	Channelized or No Recovery	Silt/Muck Substrates	No Sinuosity	Sparse No Cover	Max Depths <40 cm	High Influence Poor Attributes	Recovering from Channelization	Mod-High Silt Cover	Sand Substrates (Boatable sites)	Hardpan Origin	Fair- Poor Development	Low Sinuosity	≤ 2 Cover Types	Intermittent Flow or Pools <20 cm	No Fast Current Types	Mod-Extensive Embeddedness	Mod-Extensive Riffle Embeddedness	No Riffle	Poor Habitat Attributes	Ration of Poor (High) to Good	Ration of Poor (All) to Good
Little Miami River																																	
27.9	79.5	■	■		■		■	■	■	■	■	8						0		●	●			●				●			4	1.8	0.56
24.1	83.0	■	■		■	■	■	■	■	■	■	9						0						●							1	5.0	0.20
22.3	74.0	■	■				■		■	■	■	6						0			●		●	●			●				4	1.4	0.71
21.5	81.5	■	■		■		■	■	■	■	■	8						0			●			●							2	3.0	0.33
18.5	76.0	■	■		■		■	■		■	■	7						0		●	●			●				●			4	1.6	0.63
17.7	85.3	■	■		■		■	■	■	■	■	8						0						●							1	4.5	0.22
13.1	84.0	■	■		■		■	■	■	■	■	8						0						●							1	4.5	0.22
10.9	80.0	■	■		■		■	■	■	■	■	8						0			●			●							2	3.0	0.33
8.1	81.0	■	■		■		■	■	■	■	■	8						0			●			●							2	3.0	0.33
6.83	80.0	■	■		■		■	■	■	■	■	8						0			●			●							2	3.0	0.33
4.1	81.8	■	■		■	■	■	■	■	■	■	9						0			●										1	5.0	0.20
3.5	82.3	■	■		■		■	■	■	■	■	8						0			●			●					●		3	2.3	0.44
1.6	61.0	■	■				■			■		4						0		●	●		●	●			●	●		●	7	0.6	1.60
Duck Creek																																	
5.14	52.5		■		■		■		■	■		5						0	●				●	●	●		●		●		6	0.9	1.17

***Table 15**. Qualitative Habitat Evaluation Index (QHEI) matrix showing good and modified habitat attributes at sites in the Little Miami River study area in 2017.*

		Good Habitat Attributes											High Influence Modified Attributes						Moderate Influence Modified Attributes													Ratios	
River Mile	QHEI	No Channelization	Boulder, Cobble, Gravel	Silt Free	Good-Excellent Development	Moderate-High Sinuosity	Moderate-Extensive Cover	Fast Flow w Eddies	Little to No Embeddedness	Max Depth > 40 cm	No Riffle Embeddedness	"Good" Habitat Attributes	Channelized or No Recovery	Silt/Muck Substrates	No Sinuosity	Sparse No Cover	Max Depths <40 cm	High Influence Poor Attributes	Recovering from Channelization	Mod-High Silt Cover	Sand Substrates (Boatable sites)	Hardpan Origin	Fair- Poor Development	Low Sinuosity	≤ 2 Cover Types	Intermittent Flow or Pools <20 cm	No Fast Current Types	Mod-Extensive Embeddedness	Mod-Extensive Riffle Embeddedness	No Riffle	Poor Habitat Attributes	Ration of Poor (High) to Good	Ration of Poor (All) to Good
4.58	1.09			■		■						2	●			●	●	3					●		●		●	●	●		5	0.5	2.00
3.9	26.5			■					■			2	●			●	●	3					●	●	●		●		●		5	0.5	2.00
3.4	23.5			■					■			2	●			●	●	3					●	●	●		●		●		5	0.5	2.00
2.8	54.0	■	■		■		■			■		5						0		●			●	●	●		●	●	●		7	0.8	1.33
2.0	58.5	■	■		■		■			■		5						0		●			●	●			●	●	●		6	0.9	1.17
0.5	64.3	■	■		■	■	■			■		6						0		●							●	●	●		4	1.4	0.71
East Fork Duck Creek																																	
2.0	59.0	■	■		■		■		■			5					●	1						●			●		●		3	1.5	0.67
0.5	44.5		■				■					2			●		●	2	●	●			●	●	●		●	●	●		8	0.3	3.00
Unnamed Tributary to Duck Creek @RM 4.8																																	
0.1	42.5	■	■				■					3					●	1	●	●			●	●	●		●	●	●		8	0.4	2.25
Unnamed Tributary to Little Duck Creek @RM 4.42																																	
0.2	60.5	■	■		■	■	■		■			6					●	1					●				●		●		3	1.8	0.57
Little Duck Creek																																	
2.4	52.0	■	■				■		■			4					●	1					●	●			●		●		4	1.0	1.00
1.9	50.0	■	■				■					3					●	1	●	●			●	●			●	●	●		7	0.5.	2.00

***Table 15**. Qualitative Habitat Evaluation Index (QHEI) matrix showing good and modified habitat attributes at sites in the Little Miami River study area in 2017.*

		Good Habitat Attributes											High Influence Modified Attributes						Moderate Influence Modified Attributes													Ratios	
River Mile	QHEI	No Channelization	Boulder, Cobble, Gravel	Silt Free	Good-Excellent Development	Moderate-High Sinuosity	Moderate-Extensive Cover	Fast Flow w Eddies	Little to No Embeddedness	Max Depth > 40 cm	No Riffle Embeddedness	"Good" Habitat Attributes	Channelized or No Recovery	Silt/Muck Substrates	No Sinuosity	Sparse No Cover	Max Depths <40 cm	High Influence Poor Attributes	Recovering from Channelization	Mod-High Silt Cover	Sand Substrates (Boatable sites)	Hardpan Origin	Fair- Poor Development	Low Sinuosity	≤ 2 Cover Types	Intermittent Flow or Pools <20 cm	No Fast Current Types	Mod-Extensive Embeddedness	Mod-Extensive Riffle Embeddedness	No Riffle	Poor Habitat Attributes	Ration of Poor (High) to Good	Ration of Poor (All) to Good
1.0	54.0	■	■				■		■			4					●	1		●			●	●			●		●		5	0.8	1.20
Sycamore Creek																																	
1.1	63.5	■	■		■		■		■	■	■	7						0						●			●				2	2.7	0.38
0.5	64.3	■	■				■			■	■	5						0		●			●	●			●	●			5	1.0	1.00
0.1	74.5	■	■		■	■	■	■	■	■		8						0									●		●		2	3.0	0.33
Unnamed Tributary to Sycamore Creek																																	
1.2	67.5	■	■		■		■		■	■	■	7						0						●	●		●		●		4	1.6	0.63
0.2	64.5	■	■		■	■	■		■	■	■	8						0		●				●			●				3	2.3	0.44

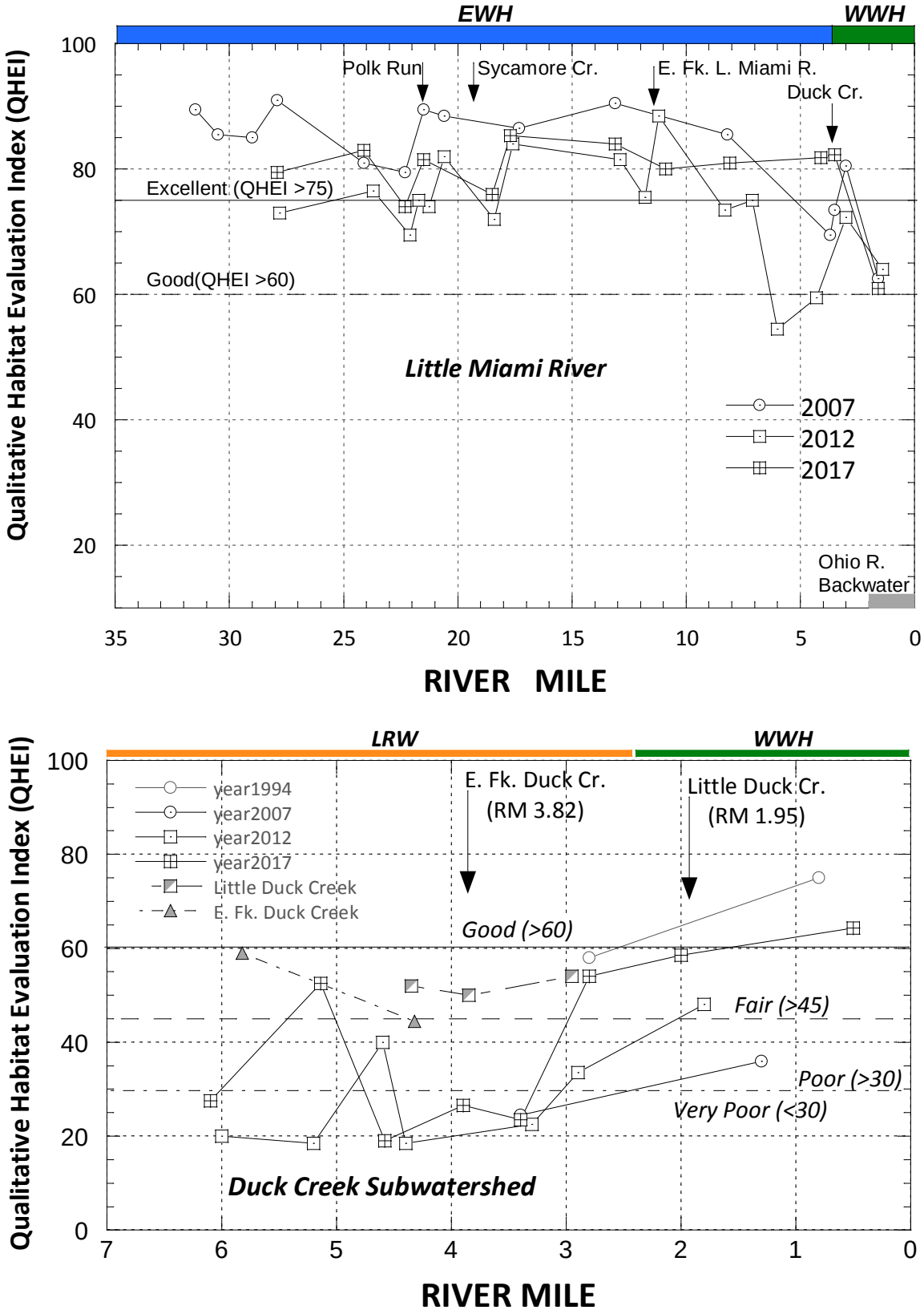

Figure 15. *Qualitative Habitat Evaluation Index (QHEI) scores in the Little Miami River mainstem (upper) and the Duck Creek subwatershed (lower) in 2017 and compared to prior years 1994, 2007, and 2012.*

Fish Assemblage Results

Key fish assemblage indices and attributes such as %DELT, sensitive species, and %tolerant species are depicted in Table 16. Of the 33 sites designated for one of the WWH suite of uses, 10 failed to attain the WWH IBI biocriteria threshold and another six failed LRW. The remaining 17 sites met their applicable biocriterion including all of the EWH designated sites on the Little Miami River mainstem.

Little Miami River

All 11 sites sampled in the EWH designated reach of the Little Miami River mainstem met that biocriterion and the remaining two sites in the WWH designated reach met that biocriterion (Table 16). This included both the IBI and MIwb with only three IBI values in the non-significant departure range for EWH (Figure 16). This was a substantial improvement over 2012 when 12 of the 15 sites sampled in the EWH reach failed to attain the IBI biocriterion with the remaining three in the non-significant departure range. Two of the 15 MIwb values failed EWH in 2012, but all were nearly a full MIwb unit lower in 2012 than in 2017 when all 11 values fully met the EWH biocriterion (Table 16; Figure 16).

Duck Creek Subwatershed

Of the 18 sites sampled in the Duck Creek watershed, three were recommended for the PHWH2 classification. Of the 15 sites designated within the WWH suite of uses, seven are designated (or recommended) LRW. Of these, only two met the LRW guideline for the IBI while five failed (Table 16). Of the eight WWH designated sites all except one failed to meet the WWH IBI biocriterion. Sensitive species were absent at all except two sites and tolerant species exceeded the toxic response threshold of >70% at all except five sites. However, %DELT anomalies were low ruling out a response to acutely toxic conditions. All of the responses instead point to organic enrichment and severe habitat limitations.

Sycamore Creek Subwatershed

One of the six sites in the Sycamore Creek subwatershed was recommended for the PHWH2 classification. Of the remaining five sites, three failed to meet the fish IBI biocriterion. Sensitive species were absent and tolerant species exceeded 70% at two sites, but most of the responses were indicative of nutrients and low flows.

Macroinvertebrate Assemblage Results

Key macroinvertebrate assemblage indices and attributes such as total taxa, sensitive taxa, %tolerant taxa, qualitative EPT taxa, %toxic tolerant taxa, and %organic enrichment taxa are depicted in Table 16. Of the 33 sites designated for one of the WWH suite of uses, only one failed to attain the WWH ICI biocriteria threshold and another two failed LRW. The remaining 30 sites met their applicable biocriterion including all of the EWH designated sites on the Little Miami River mainstem.

***Table 16**. Selected fish and macroinvertebrate assemblage attributes at 37 sites sampled in the 2017 Little Miami River study area. Color shaded cells indicate an exceedance of a threshold for the index or attribute value.*

Site ID	River Miles	DA (mi^2)	IBI	MIwb	Nat. Spec.	%DELT	Sens. Spec.	%Simp. Lith.	%Toler-ants	ICI/Narr.	Total Taxa	Sens. Taxa	%Toler-ant	Qual. EPT	%Toxic Tol. Taxa	%Org. Enrich. Taxa
Little Miami River																
LM01	27.90/27.90	1070	48	10.65	37	0.00	18	42.8	9.4	58	69	22	0.8	19	0	2.1
LM02	24.10/24.10	1090	54	11.55	34	0.00	16	46.3	6.2	56	74	25	1.3	23	0.5	2.4
LM03	22.30/22.30	1150	46	10.57	34	1.29	14	28. 5	4.3	E	50	22		23		
LM05	21.50/21.50	1160	48	11.47	35	0.67	14	30.3	3.4	E	50	16		19		
LM07	18.50/18.50	1190	50	10.71	36.5	0.00	19	38.9	7.3	54	62	20	0.0	19	0	1.1
LM08	17.70/17.70	1190	52	10.18	27	0.00	14.5	48.3	4.2	58	71	19	0.0	20	0	4.4
LM09	13.10/13.10	1200	52	10.34	30	0.00	14	49.6	2.3	52	52	22	0.0	20	0	6.7
LM11	10.90/10.90	1710	50	10.65	32	0.38	16	23.0	1.1	56	55	19	1.1	20	0.9	1.2
LM12	8.10/8.10	1710	48	10.15	33	0.00	17	20.4	0.7	E	55	23		26		
LM13	6.83/6.83	1720	46	10.50	29	0.00	13	13.3	2.8	54	59	20	0.0	20	0	10.4
LM15	4.10/4.10	1730	46	10.55	32	0.26	12	21.3	0.8	56	60	19	0.3	19	0	1.8
LM16	3.50/3.40	1750	46	9.66	31.5	0.61	14.5	13.5	1.3	42	71	18	11.4	19	2.1	15.1
LM17	1.60/ -	1760	38	8.81	20.5	0.00	5.5	3.0	3.3	-	-	-	-	-	-	-
Duck Creek																
LM71	6.10/6.10	2.24	12	-	1	0.00	0.0	0	100	VP	13	0		0		
LM72	5.14/5.14	5.05	24	-	6	0.00	0.0	13.8	96.6	P	16	0		2		
LM73	4.58/4.58	5.84	12	-	1	0.00	0.0	100	100	P	24	0		3		
LM74	3.90/3.90	9.59	12	-	0	0.00	0.0	0.0	0.00	F	21	0		4		
LM75	3.40/3.40	11.5	12	-	0	0.00	0.0	0.0	0.00	F	21	0		4		
LM76	2.80/2.80	11.7	25	-	7.5	0.00	0.0	47.0	81.3	30	29	0	32.5	3	5.3	33.4
LM77	2.00/2.00	14.3	27	-	10.5	0.00	0.5	43.3	81.3	42	42	0	14.2	6	1.7	17.3
LM79	0.50/0.50	14.6	30	-	14	0.00	2.5	10.6	55.5	34	41	0	26.2	6	0.5	43.2
East Fork Duck Creek																
LM81	2.30/-	0.48	DRY	***PHWH2***												
LM85	2.00/2.00	1.31	26	-	3	0.00	0.0	32.6	81.6	VP	12	0		1		
LM84	0.50/0.50	2.4	24	-	3	0.00	0.0	34.9	68.67	F	26	0		6		
Unnamed Tributary to Duck Creek @RM 4.8																
LM83	0.80/-	1.24	12	-	1	0.00	0.0	0.0	0.00	***PHWH2***						
LM80	0.10/0.10	1.42	12	-	1	0.00	0.0	0.0	100	VP	17	0	-	1	-	-
Little Duck Creek																
LM86	2.40/2.40	0.50	0	-	0	0.00	0.0	0.0	0.00	G	22	5	-	8	-	-
LM87	1.90/1.90	0.45	34	-	4	0.00	0.0	51.3	82.8	G	27	5	-	8	-	-

***Table 16**. Selected fish and macroinvertebrate assemblage attributes at 37 sites sampled in the 2017 Little Miami River study area. Color shaded cells indicate an exceedance of a threshold for the index or attribute value.*

Site ID	River Miles	DA (mi^2)	IBI	MIwb	Nat. Spec.	%DELT	Sens. Spec.	%Simp. Lith.	%Toler-ants	ICI/Narr.	Total Taxa	Sens. Taxa	%Toler-ant	Qual. EPT	%Toxic Tol. Taxa	%Org. Enrich. Taxa
LM90	1.00/1.00	1.10	36	-	4	0.00	0.0	63.7	78.6	G	21	3	-	7	-	-
LM92	0.49/ -	1.68	12	-	1	0.00	0.0	0.0	0.0	-	-	-	-	-	-	-
Sycamore Creek																
LM50	1.10/1.10	12.5	30	-	7.5	0.00	0.5	19.7	38.5	44	48	6	5.4	8	0	8.4
LM51	0.50/0.50	22.8	37	7.9	13.7	0.06	6.3	10.7	25.1	38	45	3	0.9	7	0	10.6
LM52	0.10/0.10	23.3	47	8.1	20.5	0.45	9.0	34.2	11.8	36	43	6	14.8	12	1.2	11.8
Unnamed Tributary to Sycamore Cr.																
LM55	1.20/1.20	5.32	24	-	2	0.00	0.0	0.0	55. 8	G	26	4		8		
LM56	0.20/0.20	5.61	34	-	7	0.00	0.0	8.1	45.5	52	53	3	3.3	8	0.6	9
Unnamed Tributary to Sycamore Creek @RM 4.42																
LM82	0.20/0.20	0.33	26	-	1	0.00	0.0	100	100	P	16	0		3		
Unnamed Tributary @1.82 to Unnamed Tributary to Sycamore Creek @RM 1.12																
LM54	2.40/ -	1.58	DRY	***PHWH2***												

Screening criteria for MIwb, Boatable Sites: Very Poor <5; Poor 5.0 - 6.3; Fair 6.4 – 8.7 [Interior Plateau ecoregion];
Screening criteria for MIwb, Wadeable Sites: Very Poor <4.5; Poor 4.5 - 5.8; Fair 5.9 – 8.1 [Interior Plateau ecoregion].
Screening criteria for fish IBI - ≤18 (Very Poor); 19-26 (Poor)
Screening criteria for macroinvertebrate ICI or narrative rating - ≤8 (Very Poor); and 16 (Poor)
Screening criteria for organic enrichment response signature - >35% (Yoder and DeShon 2003)
Screening criteria for percent toxic-tolerant taxa - >35% (Yoder and DeShon 2003)
Screening criteria for percent -tolerant fish individuals - >70% (Yoder and DeShon 2003)
Screening criteria for number of intolerant fish species - <1 (Yoder and DeShon 2003)

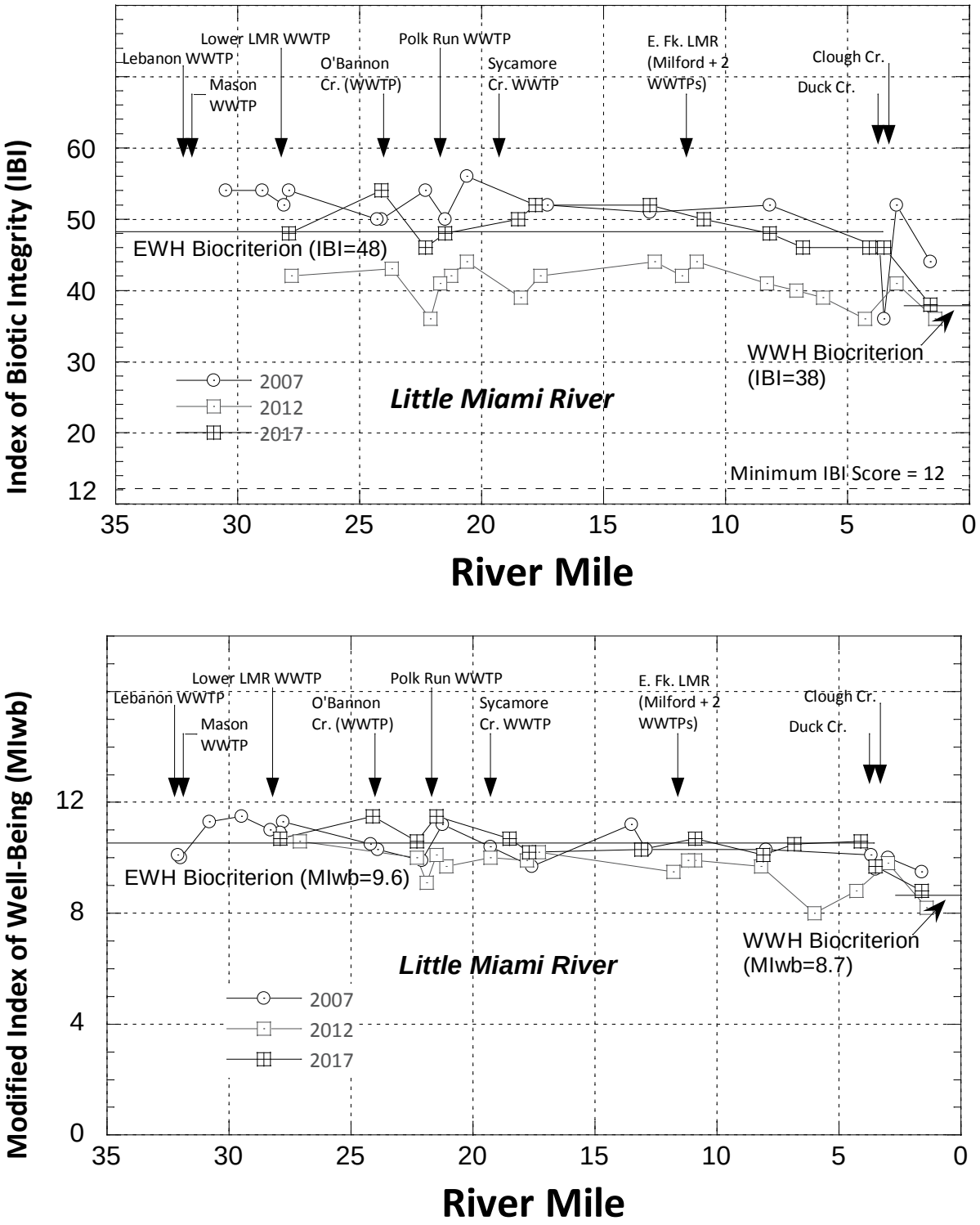

Figure 16. *Index of biotic integrity (IBI) results for the Little Miami River mainstem (upper) and the modified Index of Well-Being (MIwb) results (lower) in 2007, 2012, and 2017. The EWH and WWH biocriteria are depicted with major pollution sources and tributaries along the top of each graph.*

Little Miami River

All 11 sites sampled in the EWH designated reach of the Little Miami River mainstem met the ICI biocriterion and the remaining one site in the WWH designated reach met that biocriterion (Table 16). This included full attainment of the ICI with no values in the non-significant departure range for EWH (Figure 17). This was a substantial improvement over 2012 when eight of the 15 sites sampled in the EWH reach were in the non-significant departure range for the ICI.

Duck Creek Subwatershed

Of the 15 sites designated within the WWH suite of uses, seven are designated (or recommended) LRW. Of these, only two failed the LRW guideline for the ICI (Table 16). Of the eight WWH designated sites all except one met the WWH ICI biocriterion. The only response signatures included the two non-attaining sites in very poor condition and a single exceedance of the %organic enrichment taxa threshold at the downstream most site in Duck Creek (Table 16).

Sycamore Creek Subwatershed

With the exception of the dry site at LM 54 (Unnamed Tributary to Unnamed Tributary to Sycamore Creek) all other sites fully met the WWH ICI narrative biocriterion.

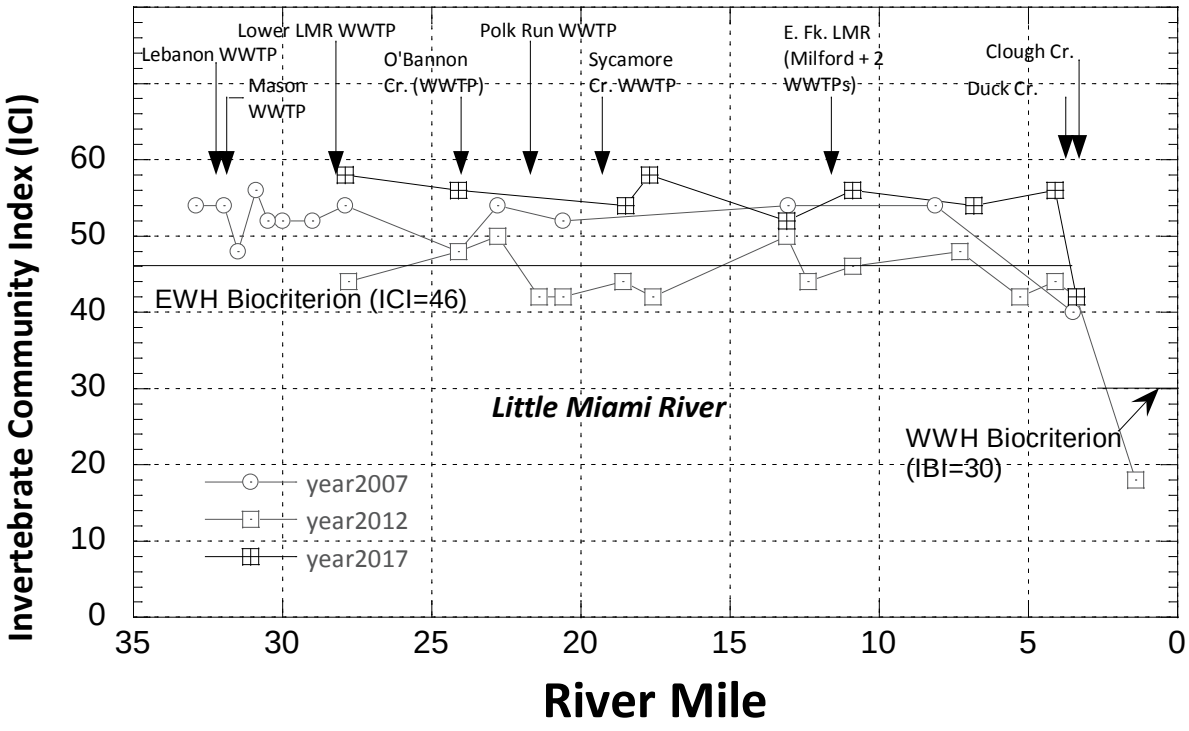

Figure 17. *Invertebrate Community Index (ICI) results for the Little Miami River mainstem in 2007, 2012, and 2017. EWH and WWH ICI biocriteria are depicted with major pollution sources and tributaries along the top.*

Comparing 2017 to Prior Results

The prior sampling conducted by Ohio EPA in 2007 (Ohio EPA 2010) and MSDGC in 2012 (MBI 2013) offers an opportunity to examine changes through time for the mainstem of Little Miami River and the Duck Creek and Sycamore Creek subwatersheds. Results for the IBI, MIwb, and selected assemblage attributes were used to assess changes in the fish assemblage and the ICI and selected assemblage attributes were used to assess changes in the macroinvertebrate assemblage. Such analyses offer the opportunity to determine not only the magnitude of any changes, but to determine the incremental changes that have taken place through time. It also provides a way to visualize the degree to which the biocriteria indices either exceed or fail to attain their respective biological criteria.

The overall results show that increases in the quality of both the fish and macroinvertebrate assemblages have taken place within the EWH designated segment of the Little Miami River within the MSDGC service area (Figures 16 and 17 upper). The increases in the IBI between 2012 and 2017 were sufficient to fully attain the EWH biocriterion and were comparable to the results obtained by Ohio EPA in 2007. The ICI also fully attained EWH in 2017 which was an improvement over the marginal EWH attainment observed in 2012 and a return to conditions observed by Ohio EPA in 2007. Biological conditions in the Duck Creek watershed were comparatively unchanged between 2012 and 2017 as were the results in Sycamore Creek.

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Appendix A

Little Miami River 2017 Fish Assemblage Data
A-1: IBI Metrics & Scores, MIwb
A-2: Fish Species Grand Report
A-3: Fish Species by Date

Appendix Table B-1. Boatable IBI scores and metrics for sites sampled in the Little Miami River by MBI during 2017.

Site ID	River Mile	Type	Date	Drainage area (sq mi)	Number of: Total species	Number of: Sunfish species	Number of: Sucker species	Number of: Intolerant species	Percent of Individuals: Rnd-bodied suckers	Percent of Individuals: Simple Lithophils	Percent of Individuals: Tolerant fishes	Percent of Individuals: Omni-vores	Percent of Individuals: Top carnivores	Percent of Individuals: Insect-ivores	DELT anomalies	Rel.No. minus tolerants /(1.0 km)	IBI	Modified Iwb	Source
Little Miami River - (11001)																			
Year: 2017																			
LM01	27.90	P	08/28/2017	1069	37(5)	3(3)	7(5)	9(5)	30(3)	43(3)	9(5)	21(3)	2(1)	72(5)	0.0(5)	830(5)	48	10.7	MBI
LM02	24.10	P	08/29/2017	1085	34(5)	3(3)	8(5)	8(5)	31(3)	46(5)	6(5)	13(5)	6(3)	73(5)	0.0(5)	726(5)	54	11.5	MBI
LM03	22.30	P	08/29/2017	1148	34(5)	5(5)	8(5)	4(5)	20(3)	28(3)	4(5)	29(1)	4(1)	63(5)	1.3(3)	444(5)	46	10.6	MBI
LM05	21.50	P	08/29/2017	1160	35(5)	3(3)	9(5)	6(5)	24(3)	30(3)	3(5)	19(3)	6(3)	71(5)	0.7(3)	574(5)	48	11.5	MBI
LM07	18.50	P	09/08/2017	1187	37(5)	4(5)	7(5)	9(5)	18(1)	28(3)	8(5)	16(3)	5(1)	73(5)	0.0(5)	592(5)	48	10.8	MBI
LM07	18.50	P	10/06/2017	1187	36(5)	2(3)	10(5)	11(5)	32(3)	50(5)	6(5)	7(5)	5(1)	78(5)	0.0(5)	452(5)	52	10.6	MBI
LM08	17.70	P	09/08/2017	1190	28(5)	2(3)	7(5)	5(5)	39(5)	44(5)	4(5)	17(3)	4(1)	72(5)	0.0(5)	522(5)	52	10.4	MBI
LM08	17.70	P	10/06/2017	1190	26(5)	1(1)	8(5)	7(5)	47(5)	53(5)	5(5)	12(5)	6(3)	74(5)	0.0(5)	318(3)	52	9.9	MBI
M05P11	13.10	P	09/11/2017	1203	30(5)	3(3)	8(5)	5(5)	44(5)	50(5)	2(5)	17(3)	5(1)	71(5)	0.0(5)	686(5)	52	10.3	MBI
LM11	10.90	P	09/11/2017	1707	32(5)	1(1)	7(5)	8(5)	17(1)	23(3)	1(5)	10(5)	13(5)	66(5)	0.4(5)	524(5)	50	10.7	MBI
LM12	8.10	P	09/11/2017	1710	33(5)	2(3)	7(5)	8(5)	14(1)	20(3)	1(5)	12(5)	4(1)	78(5)	0.0(5)	604(5)	48	10.1	MBI
LM13	6.83	P	09/11/2017	1720	29(5)	4(5)	7(5)	5(5)	7(1)	13(1)	3(5)	22(3)	4(1)	64(5)	0.0(5)	834(5)	46	10.5	MBI
LM15	4.10	P	09/11/2017	1730	32(5)	3(3)	8(5)	3(3)	16(1)	21(3)	1(5)	24(3)	7(3)	63(5)	0.3(5)	774(5)	46	10.6	MBI
LM16	3.50	P	09/10/2017	1752	36(5)	4(5)	7(5)	7(5)	5(1)	11(1)	1(5)	26(3)	6(3)	61(5)	0.4(5)	904(5)	48	9.6	MBI
LM16	3.50	P	10/04/2017	1752	27(5)	2(3)	7(5)	5(5)	11(1)	16(1)	1(5)	20(3)	6(3)	68(5)	0.8(3)	500(5)	44	9.7	MBI
LM17	1.60	P	09/09/2017	1754	23(5)	3(3)	6(5)	2(3)	2(1)	3(1)	4(5)	48(1)	5(3)	43(3)	0.0(5)	442(5)	40	9.1	MBI
LM17	1.60	P	10/04/2017	1754	18(3)	4(5)	5(3)	2(3)	2(1)	3(1)	3(5)	31(1)	3(1)	60(5)	0.0(5)	226(3)	36	8.5	MBI

♦ - IBI is low end adjusted.

* - < 200 Total individuals in sample

** - < 50 Total individuals in sample

Appendix Table B-2. Wadeable IBI scores and metrics for sites sampled in the Little Miami River watershed by MBI during 2017.

River Mile	Type	Date	Drainage area (sq mi)	Number of: Total species	Sunfish species	Sucker species	Intolerant species	Darter species	Percent of Individuals: Simple Lithophils	Tolerant fishes	Omni-vores	Top carnivores	Insect-ivores	DELT anomalies	Rel.No. minus tolerants /(0.3km)		IBI	Modified Iwb
Sycamore Creek - (11007)																		
Year: 2017																		
0.50	D	09/21/2017	24.0	17(3)	3(3)	1(1)	2(3)	3(3)	15(1)	43(3)	42(1)	1.8(3)	45(3)	0.0(5)	293(3)		32	7.2
0.50	E	07/26/2017	24.0	24(5)	2(3)	5(5)	3(3)	4(5)	17(1)	33(3)	32(3)	1.6(3)	33(3)	0.2(3)	752(5)		42	8.6
0.10	D	07/26/2017	24.0	22(5)	3(3)	2(3)	4(5)	3(3)	29(3)	8(5)	10(5)	3.6(3)	75(5)	0.9(3)	458(3)		46	8.7
0.10	D	09/21/2017	24.0	19(5)	4(5)	1(1)	3(3)	3(3)	39(5)	16(5)	14(5)	8.4(5)	76(5)	0.0(5)	165(1)	*	48	7.5

na - Qualitative data, Modified Iwb not applicable.

♦ - IBI is low end adjusted.

* - < 200 Total individuals in sample

** - < 50 Total individuals in sample

● - One or more species excluded from IBI calculation.

Appendix Table B-1. Headwater IBI scores and metrics for sites sampled in the Little Miami River watershed by MBI during 2017.

Site ID	River Mile	Type	Date	Drainage area (sq mi)	Number of: Total species	Minnow species	Headwater species	Sensitive species	Darter & Sculpin species	Simple Lithophils	Percent of Individuals: Tolerant fishes	Omni-vores	Pioneering fishes	Insect-ivores	DELT anomalies	Rel.No. minus tolerants /(0.3km)	IBI
(11-004) - Duck Creek																	
Year: 2017																	
LM71	6.10	E	07/25/2017	2.2	1(1)	1(1)	0(1)	0(1)	0(1)	0(1)	100(1)	0(1)	100(1)	0(1)	0.0(1)	0(1) * *	12
LM72	5.14	F	07/25/2017	5.1	6(3)	5(3)	1(1)	0(1)	0(1)	1(1)	97(1)	12(5)	84(1)	16(1)	0.0(5)	8(1)	24
LM73	4.58	F	07/27/2017	5.8	1(1)	1(1)	1(1)	0(1)	0(1)	1(1)	100(1)	0(1)	0(1)	0(1)	0.0(1)	0(1) * *	12
LM74	3.90	E	07/25/2017	9.6	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0.0(1)	0(1) * *	12
LM74	3.90	F	09/20/2017	9.6	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0.0(1)	0(1) * *	12
LM75	3.40	E	07/25/2017	7.3	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0.0(1)	0(1) * *	12
LM75	3.40	E	09/20/2017	7.3	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0.0(1)	0(1) * *	12
LM76	2.80	E	07/25/2017	11.8	8(3)	5(3)	1(1)	0(1)	1(1)	3(1)	80(1)	13(5)	37(3)	2(1)	0.0(5)	102(1)	26
LM76	2.80	E	09/20/2017	11.8	7(1)	5(3)	1(1)	0(1)	0(1)	2(1)	82(1)	9(5)	34(3)	3(1)	0.0(5)	54(1)	24
LM77	2.00	E	07/27/2017	14.3	9(3)	5(3)	1(1)	0(1)	0(1)	2(1)	86(1)	14(5)	43(3)	6(1)	0.0(5)	60(1)	26
LM77	2.00	E	09/20/2017	14.3	12(3)	5(3)	1(1)	1(1)	2(1)	4(3)	77(1)	12(5)	35(3)	4(1)	0.0(5)	184(1)	28
LM79	0.50	E	09/20/2017	14.6	13(3)	6(3)	1(1)	3(3)	0(1)	4(3)	62(1)	40(1)	46(3)	36(3)	0.0(5)	136(1)	28
LM79	0.50	E	07/27/2017	14.6	15(3)	8(5)	1(1)	2(1)	1(1)	5(3)	49(3)	26(3)	44(3)	36(3)	0.0(5)	186(1)	32
(11-007) - Sycamore Creek																	
Year: 2017																	
LM50	1.10	P	07/24/2017	14.7	9(3)	6(3)	2(3)	1(1)	2(1)	4(3)	41(3)	11(5)	22(5)	11(1)	0.0(5)	3734(5)	26
LM50	1.10	E	09/21/2017	14.7	6(1)	4(3)	2(3)	0(1)	1(1)	2(1)	36(3)	8(5)	17(5)	12(1)	0.0(5)	1162(5)	34
LM51	0.50	E	09/26/2017	0.0	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0.0(0)	0(0) * *	0
(11-049) - Unnamed Trib to Sycamore Creek																	
Year: 2017																	
LM55	1.20	F	07/24/2017	5.3	2(1)	2(1)	0(1)	0(1)	0(1)	0(1)	56(3)	0(5)	56(1)	0(1)	0.0(5)	260(3)	24

♦ - IBI is low end adjusted.

* - < 200 Total individuals in sample

** - < 50 Total individuals in sample

● - One or more species excluded from IBI calculation.

Appendix Table B-1. Headwater IBI scores and metrics for sites sampled in the Little Miami River watershed by MBI during 2017.

Site ID	River Mile	Type	Date	Drainage area (sq mi)	Number of: Total species	Minnow species	Headwater species	Sensitive species	Darter & Sculpin species	Simple Lithophils	Percent of Individuals: Tolerant fishes	Omni-vores	Pioneering fishes	Insect-ivores	DELT anomalies	Rel.No. minus tolerants /(0.3km)	IBI
LM56	0.20	F	07/24/2017	5.6	7(3)	5(3)	2(3)	0(1)	1(1)	2(1)	46(3)	9(5)	38(3)	3(1)	0.0(5)	744(5)	34
(11-051) - East Fork Duck Creek																	
Year: 2017																	
LM81	2.30	F	08/30/2017	0.5	1(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0.0(1)	0(1) * *	12
LM85	2.00	F	07/26/2017	1.3	3(1)	3(3)	1(1)	0(1)	0(1)	1(1)	82(1)	0(5)	49(3)	0(1)	0.0(5)	70(3)	26
LM84	0.50	F	07/27/2017	2.4	3(1)	3(3)	1(1)	0(1)	0(1)	1(1)	69(1)	0(5)	34(3)	0(1)	0.0(5)	52(1) *	24
(11-075) - Unnamed Trib to Duck Creek																	
Year: 2017																	
LM80	5.00	E	07/25/2017	1.4	1(1)	1(1)	0(1)	0(1)	0(1)	0(1)	100(1)	0(1)	100(1)	0(1)	0.0(1)	0(1) * *	12
LM83	0.80	F	07/25/2017	1.2	1(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0.0(1)	0(1) * *	12
(11-076) - Little Duck Creek																	
Year: 2017																	
LM90	2.40	F	07/26/2017	0.5	4(3)	3(3)	1(1)	0(1)	0(1)	2(5)	79(1)	1(5)	15(5)	0(1)	0.0(5)	126(5)	36
LM87	1.90	F	07/26/2017	0.5	4(3)	3(3)	1(1)	0(1)	0(1)	2(5)	83(1)	2(5)	32(3)	0(1)	0.0(5)	144(5)	34
LM89	1.00	F	07/27/2017	1.1	4(3)	3(3)	1(1)	0(1)	0(1)	2(3)	88(1)	1(5)	42(3)	0(1)	0.0(5)	48(3)	30
LM92	0.49	F	07/27/2017	1.7	1(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0.0(1)	0(1) * *	12
(11-077) - Unnamed Trib to Duck Creek																	
Year: 2017																	
LM82	0.20	F	08/30/2017	0.6	1(1)	1(1)	1(1)	0(1)	0(1)	1(3)	100(1)	0(5)	0(5)	0(1)	0.0(5)	0(1)	26
(11-086) - Unnamed Trib to Sycamore Creek																	
Year: 2017																	
LM54	2.40	F	07/26/2017	1.6	1(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0.0(1)	0(1) * *	12

♦ - IBI is low end adjusted.

* - < 200 Total individuals in sample

** - < 50 Total individuals in sample

● - One or more species excluded from IBI calculation.

Appendix B-2: Midwest Biodiversity Institute
Fish Species List - Grand Totals

Rivers: *Little Miami River; Duck Creek; Sycamore Creek; Trib. to Sycamore Creek (RM 1.12); East Fork Duck Creek; Trib to Duck Creek @ RM 4.8; Little Duck Creek; Trib to Little Duck Cr. @ RM 4.42; Trib 1.82 to Trib to Sycamore Cr RM1.12*

Years: 2017

Number of Samples: 49 Data Sources: 99 Data Types: D; E; F; P

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
10-004	LONGNOSE GAR	P		M		42	3.2	0.34	1029	2.47	326.9
18-002	MOONEYE	I	R	M		4	0.3	0.03	56	0.13	187.5
20-001	SKIPJACK HERRING	P		M		3	0.2	0.02	23	0.06	103.3
20-003	GIZZARD SHAD	O		M		739	55.4	6.01	3027	7.26	54.6
40-002	BIGMOUTH BUFFALO	I		M	C	2	0.2	0.02	414	0.99	2760.0
40-003	BLACK BUFFALO	I		M	C	54	4.1	0.44	2928	7.03	723.1
40-004	SMALLMOUTH BUFFALO	I		M	C	143	10.7	1.16	6624	15.89	617.6
40-005	QUILLBACK CARPSUCKER	O		M	C	36	2.7	0.29	936	2.25	346.9
40-006	RIVER CARPSUCKER	O		M	C	102	7.7	0.83	2373	5.69	310.1
40-008	SILVER REDHORSE	I	M	S	R	17	1.3	0.14	1162	2.79	911.7
40-009	BLACK REDHORSE	I	I	S	R	34	2.6	0.28	498	1.19	195.2
40-010	GOLDEN REDHORSE	I	M	S	R	177	13.3	1.44	1376	3.30	103.6
40-013	RIVER REDHORSE	I	I	S	R	13	1.0	0.11	1275	3.06	1307.6
40-015	NORTHERN HOG SUCKER	I	M	S	R	325	24.4	2.64	1516	3.64	62.2
40-016	WHITE SUCKER	O	T	S	W	135	3.0	1.10	55	0.45	18.5
40-023	SMALLMOUTH REDHORSE	I	M	S	R	560	42.0	4.56	4192	10.06	99.8
43-001	COMMON CARP	O	T	M	G	18	1.4	0.15	1942	4.66	1438.8
43-002	GOLDFISH	O	T	M	G	1	0.1	0.01	2	0.01	30.0
43-005	RIVER CHUB	I	I	N	N	1	0.1	0.01	0	0.00	3.0
43-006	SILVER CHUB	I		M	N	5	0.4	0.04	3	0.01	10.6
43-009	GRAVEL CHUB	I	M	S	N	17	1.3	0.14	6	0.01	4.7
43-011	WESTERN BLACKNOSE DACE	G	T	S	N	1631	35.9	13.27	32	0.27	0.9
43-013	CREEK CHUB	G	T	N	N	1314	28.9	10.69	73	0.60	2.5
43-015	SUCKERMOUTH MINNOW	I		S	N	5	0.4	0.04	1	0.00	3.0
43-020	EMERALD SHINER	I		M	N	1054	79.1	8.58	87	0.21	1.1
43-021	SILVER SHINER	I	I	S	N	35	2.6	0.28	3	0.01	1.1
43-022	ROSYFACE SHINER	I	I	S	N	126	9.5	1.03	11	0.03	1.1
43-025	STRIPED SHINER	I		S	N	32	2.4	0.26	1	0.00	0.8
43-027	RIVER SHINER	I		S	N	4	0.3	0.03	0	0.00	3.0
43-031	STEELCOLOR SHINER	I	P	M	N	40	3.0	0.33	14	0.04	4.8
43-032	SPOTFIN SHINER	I		M	N	81	6.1	0.66	14	0.03	2.3
43-034	SAND SHINER	I	M	M	N	152	11.4	1.24	18	0.04	1.6
43-035	MIMIC SHINER	I	I	M	N	425	31.9	3.46	37	0.09	1.1
43-039	SILVERJAW MINNOW	I		M	N	23	0.5	0.19	0	0.01	1.4
43-041	BULLHEAD MINNOW	O		C	N	19	1.4	0.15	3	0.01	2.5
43-042	FATHEAD MINNOW	O	T	C	N	2	0.0	0.02	0	0.00	2.0
43-043	BLUNTNOSE MINNOW	O	T	C	N	853	64.0	6.94	133	0.32	2.0
43-044	CENTRAL STONEROLLER	H		N	N	2277	170.8	18.53	282	0.68	1.6
43-063	CHANNEL SHINER	I	I	M	N	53	4.0	0.43	5	0.01	1.3

Appendix B-2: Midwest Biodiversity Institute
Fish Species List - Grand Totals

Rivers: *Little Miami River; Duck Creek; Sycamore Creek; Trib. to Sycamore Creek (RM 1.12); East Fork Duck Creek; Trib to Duck Creek @ RM 4.8; Little Duck Creek; Trib to Little Duck Cr. @ RM 4.42; Trib 1.82 to Trib to Sycamore Cr RM1.12*

Years: 2017

Number of Samples: 49 Data Sources: 99 Data Types: D; E; F; P

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
47-002	CHANNEL CATFISH			C	F	100	7.5	0.81	4285	10.28	571.4
47-004	YELLOW BULLHEAD	I	T	C		24	1.8	0.20	67	0.16	37.5
47-007	FLATHEAD CATFISH	P		C	F	11	0.8	0.09	304	0.73	369.0
47-008	STONECAT MADTOM	I	I	C		20	1.5	0.16	12	0.03	8.2
47-009	MOUNTAIN MADTOM	I	R	C		21	1.6	0.17	2	0.01	1.3
47-010	NORTHERN MADTOM	I	R	C		12	0.9	0.10	0	0.00	1.0
57-001	WESTERN MOSQUITOFISH	I		N	E	1	0.0	0.01	0	0.00	1.0
70-001	BROOK SILVERSIDE	I	M	M		5	0.4	0.04	0	0.00	0.8
74-001	WHITE BASS	P		M	F	11	0.8	0.09	146	0.35	177.2
74-005	Striped X White Bass				E	25	1.9	0.20	1518	3.64	810.0
77-001	WHITE CRAPPIE	I		C	S	35	2.6	0.28	119	0.29	45.5
77-002	BLACK CRAPPIE	I		C	S	1	0.1	0.01	6	0.01	80.0
77-003	ROCK BASS	C		C	S	3	0.2	0.02	18	0.04	80.0
77-004	SMALLMOUTH BASS	C	M	C	F	145	10.9	1.18	915	2.20	84.1
77-005	SPOTTED BASS	C		C	F	64	4.8	0.52	206	0.50	43.0
77-006	LARGEMOUTH BASS	C		C	F	19	1.4	0.15	45	0.11	31.7
77-008	GREEN SUNFISH	I	T	C	S	121	9.1	0.98	111	0.27	12.3
77-009	BLUEGILL SUNFISH	I	P	C	S	175	13.1	1.42	99	0.24	7.6
77-010	ORANGESPOTTED SUNFISH	I		C	S	2	0.2	0.02	0	0.00	1.0
77-011	LONGEAR SUNFISH	I	M	C	S	129	9.7	1.05	147	0.35	15.2
77-012	REDEAR SUNFISH	I		C	E	1	0.0	0.01	0	0.00	8.0
77-015	GREEN SF X BLUEGILL SF					2	0.0	0.02	6	0.05	145.0
80-001	SAUGER	P		S	F	21	1.6	0.17	390	0.94	248.0
80-002	WALLEYE	P		S	F	1	0.1	0.01	47	0.11	630.0
80-007	SLENDERHEAD DARTER	I	R	S	D	16	1.2	0.13	2	0.01	2.4
80-011	LOGPERCH	I	M	S	D	57	4.3	0.46	65	0.16	15.4
80-015	GREENSIDE DARTER	I	M	S	D	48	3.6	0.39	15	0.04	4.3
80-016	BANDED DARTER	I	I	S	D	47	3.5	0.38	5	0.01	1.4
80-017	VARIEGATE DARTER	I	I	S	D	8	0.6	0.07	2	0.01	4.2
80-022	RAINBOW DARTER	I	M	S	D	240	18.0	1.95	24	0.06	1.3
80-023	ORANGETHROAT DARTER	I		S	D	5	0.1	0.04	0	0.00	1.6
80-024	FANTAIL DARTER	I		C	D	266	20.0	2.16	21	0.05	1.0
80-026	SAUGER X WALLEYE	P			E	4	0.3	0.03	106	0.26	355.0
85-001	FRESHWATER DRUM		P	M		94	7.1	0.76	2415	5.80	342.6
99-997	Dry Site					0	0.0	0.00	0	0.00	*****.*
99-999	NO FISH					0	0.0	0.00	0	0.00	*****.*

No Species: 75 **Nat. Species:** 68 **Hybrids:** 3 **Total Counted:** 12288 **Total Rel. Wt. :** 41276

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-001 Little Miami River RM: 1.60 Date: 09/09/2017

Time Fished: 1670 Distance: 0.500 Drainge (sq mi): 1754.0 Depth: 0

Location: Lat: 39.08530 Long: -84.41970

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
10-004	LONGNOSE GAR	P		M		1	2.0	0.43	180	0.16	90.0
20-003	GIZZARD SHAD	O		M		92	184.0	40.00	12600	11.25	68.4
40-003	BLACK BUFFALO	I		M	C	3	6.0	1.30	8000	7.15	1333.3
40-004	SMALLMOUTH BUFFALO	I		M	C	10	20.0	4.35	31100	27.78	1555.0
40-005	QUILLBACK CARPSUCKER	O		M	C	3	6.0	1.30	360	0.32	60.0
40-006	RIVER CARPSUCKER	O		M	C	7	14.0	3.04	13000	11.61	928.5
40-010	GOLDEN REDHORSE	I	M	S	R	1	2.0	0.43	16	0.01	8.0
40-023	SMALLMOUTH REDHORSE	I	M	S	R	3	6.0	1.30	3200	2.86	533.3
43-001	COMMON CARP	O	T	M	G	6	12.0	2.61	33400	29.83	2783.3
43-020	EMERALD SHINER	I		M	N	63	126.0	27.39	64	0.06	0.5
43-032	SPOTFIN SHINER	I		M	N	1	2.0	0.43	2	0.00	1.0
43-043	BLUNTNOSE MINNOW	O	T	C	N	3	6.0	1.30	8	0.01	1.3
43-063	CHANNEL SHINER	I	I	M	N	8	16.0	3.48	10	0.01	0.6
47-002	CHANNEL CATFISH			C	F	3	6.0	1.30	4100	3.66	683.3
74-001	WHITE BASS	P		M	F	2	4.0	0.87	760	0.68	190.0
77-001	WHITE CRAPPIE	I		C	S	3	6.0	1.30	1560	1.39	260.0
77-004	SMALLMOUTH BASS	C	M	C	F	2	4.0	0.87	20	0.02	5.0
77-005	SPOTTED BASS	C		C	F	3	6.0	1.30	270	0.24	45.0
77-006	LARGEMOUTH BASS	C		C	F	2	4.0	0.87	310	0.28	77.5
77-009	BLUEGILL SUNFISH	I	P	C	S	5	10.0	2.17	120	0.11	12.0
77-011	LONGEAR SUNFISH	I	M	C	S	1	2.0	0.43	10	0.01	5.0
80-001	SAUGER	P		S	F	1	2.0	0.43	2000	1.79	1000.0
80-007	SLENDERHEAD DARTER	I	R	S	D	1	2.0	0.43	4	0.00	2.0
80-026	SAUGER X WALLEYE	P			E	1	2.0	0.43	40	0.04	20.0
85-001	FRESHWATER DRUM		P	M		5	10.0	2.17	820	0.73	82.0

No Species: 24 **Nat. Species:** 23 **Hybrids:** 1 **Total Counted:** 230 **Total Rel. Wt. :** 111954

IBI: 40.0 **MIwb:** 9.1

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-001 Little Miami River RM: 1.60 Date: 10/04/2017

Time Fished: 1705 Distance: 0.500 Drainge (sq mi): 1754.0 Depth: 0

Location: Lat: 39.08530 Long: -84.41970

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
18-002	MOONEYE	I	R	M		1	2.0	0.86	380	0.60	190.0
20-003	GIZZARD SHAD	O		M		31	62.0	26.72	3120	4.92	50.3
40-003	BLACK BUFFALO	I		M	C	2	4.0	1.72	12300	19.38	3075.0
40-004	SMALLMOUTH BUFFALO	I		M	C	7	14.0	6.03	25000	39.38	1785.7
40-005	QUILLBACK CARPSUCKER	O		M	C	2	4.0	1.72	3900	6.14	975.0
40-006	RIVER CARPSUCKER	O		M	C	1	2.0	0.86	2000	3.15	1000.0
40-023	SMALLMOUTH REDHORSE	I	M	S	R	2	4.0	1.72	1460	2.30	365.0
43-001	COMMON CARP	O	T	M	G	2	4.0	1.72	11600	18.27	2900.0
43-020	EMERALD SHINER	I		M	N	43	86.0	37.07	64	0.10	0.7
43-027	RIVER SHINER	I		S	N	2	4.0	1.72	12	0.02	3.0
43-063	CHANNEL SHINER	I	I	M	N	8	16.0	6.90	22	0.03	1.3
47-002	CHANNEL CATFISH			C	F	1	2.0	0.86	1900	2.99	950.0
74-001	WHITE BASS	P		M	F	1	2.0	0.86	260	0.41	130.0
77-001	WHITE CRAPPIE	I		C	S	1	2.0	0.86	560	0.88	280.0
77-004	SMALLMOUTH BASS	C	M	C	F	3	6.0	2.59	100	0.16	16.6
77-008	GREEN SUNFISH	I	T	C	S	1	2.0	0.86	10	0.02	5.0
77-009	BLUEGILL SUNFISH	I	P	C	S	1	2.0	0.86	10	0.02	5.0
77-011	LONGEAR SUNFISH	I	M	C	S	2	4.0	1.72	20	0.03	5.0
85-001	FRESHWATER DRUM		P	M		5	10.0	4.31	760	1.20	76.0

No Species: 19 **Nat. Species:** 18 **Hybrids:** 0 **Total Counted:** 116 **Total Rel. Wt. :** 63478

IBI: 36.0 **MIwb:** 8.5

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-001 Little Miami River RM: 3.50 Date: 09/10/2017

Time Fished: 2094 Distance: 0.500 Drainge (sq mi): 1752.0 Depth: 0

Location: L. MIAMI R. AT CINCINNATI - BEECHMONT AVE. Lat: 39.11000 Long: 84.39556

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
10-004	LONGNOSE GAR	P		M		5	10.0	1.09	4200	2.19	420.0
20-003	GIZZARD SHAD	O		M		110	220.0	24.02	19920	10.39	90.5
40-003	BLACK BUFFALO	I		M	C	4	8.0	0.87	14500	7.56	1812.5
40-004	SMALLMOUTH BUFFALO	I		M	C	1	2.0	0.22	4700	2.45	2350.0
40-005	QUILLBACK CARPSUCKER	O		M	C	5	10.0	1.09	6420	3.35	642.0
40-010	GOLDEN REDHORSE	I	M	S	R	3	6.0	0.66	4200	2.19	700.0
40-013	RIVER REDHORSE	I	I	S	R	1	2.0	0.22	4700	2.45	2350.0
40-015	NORTHERN HOG SUCKER	I	M	S	R	2	4.0	0.44	1180	0.62	295.0
40-023	SMALLMOUTH REDHORSE	I	M	S	R	19	38.0	4.15	16040	8.36	422.1
43-005	RIVER CHUB	I	I	N	N	1	2.0	0.22	6	0.00	3.0
43-006	SILVER CHUB	I		M	N	2	4.0	0.44	10	0.01	2.5
43-009	GRAVEL CHUB	I	M	S	N	1	2.0	0.22	4	0.00	2.0
43-015	SUCKERMOUTH MINNOW	I		S	N	2	4.0	0.44	12	0.01	3.0
43-020	EMERALD SHINER	I		M	N	131	262.0	28.60	312	0.16	1.1
43-021	SILVER SHINER	I	I	S	N	8	16.0	1.75	20	0.01	1.2
43-022	ROSYFACE SHINER	I	I	S	N	3	6.0	0.66	8	0.00	1.3
43-027	RIVER SHINER	I		S	N	1	2.0	0.22	6	0.00	3.0
43-032	SPOTFIN SHINER	I		M	N	1	2.0	0.22	6	0.00	3.0
43-034	SAND SHINER	I	M	M	N	2	4.0	0.44	6	0.00	1.5
43-035	MIMIC SHINER	I	I	M	N	55	110.0	12.01	104	0.05	0.9
43-043	BLUNTNOSE MINNOW	O	T	C	N	5	10.0	1.09	24	0.01	2.4
43-063	CHANNEL SHINER	I	I	M	N	16	32.0	3.49	44	0.02	1.3
47-002	CHANNEL CATFISH			C	F	14	28.0	3.06	27720	14.45	990.0
47-007	FLATHEAD CATFISH	P		C	F	1	2.0	0.22	260	0.14	130.0
74-001	WHITE BASS	P		M	F	1	2.0	0.22	320	0.17	160.0
74-005	Striped X White Bass				E	14	28.0	3.06	82700	43.12	2953.5
77-004	SMALLMOUTH BASS	C	M	C	F	6	12.0	1.31	550	0.29	45.8
77-005	SPOTTED BASS	C		C	F	14	28.0	3.06	360	0.19	12.8
77-006	LARGEMOUTH BASS	C		C	F	1	2.0	0.22	60	0.03	30.0
77-008	GREEN SUNFISH	I	T	C	S	1	2.0	0.22	10	0.01	5.0
77-009	BLUEGILL SUNFISH	I	P	C	S	8	16.0	1.75	60	0.03	3.7
77-010	ORANGESPOTTED SUNFISH	I		C	S	2	4.0	0.44	8	0.00	2.0
77-011	LONGEAR SUNFISH	I	M	C	S	6	12.0	1.31	140	0.07	11.6
80-007	SLENDERHEAD DARTER	I	R	S	D	1	2.0	0.22	4	0.00	2.0
80-011	LOGPERCH	I	M	S	D	1	2.0	0.22	6	0.00	3.0
80-022	RAINBOW DARTER	I	M	S	D	7	14.0	1.53	20	0.01	1.4
80-026	SAUGER X WALLEYE	P			E	1	2.0	0.22	800	0.42	400.0
85-001	FRESHWATER DRUM		P	M		2	4.0	0.44	2360	1.23	590.0

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

No Species:	36	**Nat. Species:**	36	**Hybrids:**	2	**Total Counted:**	458	**Total Rel. Wt. :**	191800
IBI:	48.0	**MIwb:**	9.6						

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-001 Little Miami River RM: 3.50 Date: 10/04/2017

Time Fished: 1915 Distance: 0.500 Drainge (sq mi): 1752.0 Depth: 0

Location: L. MIAMI R. AT CINCINNATI - BEECHMONT AVE. Lat: 39.11000 Long: 84.39556

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
10-004	LONGNOSE GAR	P		M		4	8.0	1.58	4200	3.36	525.0
18-002	MOONEYE	I	R	M		1	2.0	0.40	440	0.35	220.0
20-003	GIZZARD SHAD	O		M		42	84.0	16.60	8000	6.40	95.2
40-003	BLACK BUFFALO	I		M	C	3	6.0	1.19	12200	9.76	2033.3
40-004	SMALLMOUTH BUFFALO	I		M	C	12	24.0	4.74	28140	22.50	1172.5
40-005	QUILLBACK CARPSUCKER	O		M	C	5	10.0	1.98	8400	6.72	840.0
40-006	RIVER CARPSUCKER	O		M	C	1	2.0	0.40	1700	1.36	850.0
40-008	SILVER REDHORSE	I	M	S	R	1	2.0	0.40	400	0.32	200.0
40-015	NORTHERN HOG SUCKER	I	M	S	R	3	6.0	1.19	900	0.72	150.0
40-023	SMALLMOUTH REDHORSE	I	M	S	R	23	46.0	9.09	19960	15.96	433.9
43-001	COMMON CARP	O	T	M	G	1	2.0	0.40	3500	2.80	1750.0
43-006	SILVER CHUB	I		M	N	3	6.0	1.19	100	0.08	16.6
43-020	EMERALD SHINER	I		M	N	66	132.0	26.09	168	0.13	1.2
43-021	SILVER SHINER	I	I	S	N	2	4.0	0.79	4	0.00	1.0
43-034	SAND SHINER	I	M	M	N	1	2.0	0.40	4	0.00	2.0
43-035	MIMIC SHINER	I	I	M	N	33	66.0	13.04	60	0.05	0.9
43-043	BLUNTNOSE MINNOW	O	T	C	N	2	4.0	0.79	6	0.00	1.5
43-063	CHANNEL SHINER	I	I	M	N	7	14.0	2.77	20	0.02	1.4
47-002	CHANNEL CATFISH			C	F	3	6.0	1.19	400	0.32	66.6
74-005	Striped X White Bass				E	6	12.0	2.37	23020	18.41	1918.3
77-004	SMALLMOUTH BASS	C	M	C	F	8	16.0	3.16	1640	1.31	102.5
77-005	SPOTTED BASS	C		C	F	3	6.0	1.19	140	0.11	23.3
77-009	BLUEGILL SUNFISH	I	P	C	S	4	8.0	1.58	40	0.03	5.0
77-011	LONGEAR SUNFISH	I	M	C	S	1	2.0	0.40	40	0.03	20.0
80-001	SAUGER	P		S	F	1	2.0	0.40	300	0.24	150.0
80-011	LOGPERCH	I	M	S	D	2	4.0	0.79	100	0.08	25.0
80-016	BANDED DARTER	I	I	S	D	1	2.0	0.40	2	0.00	1.0
80-022	RAINBOW DARTER	I	M	S	D	8	16.0	3.16	20	0.02	1.2
85-001	FRESHWATER DRUM		P	M		6	12.0	2.37	11140	8.91	928.3

No Species: 28 **Nat. Species:** 27 **Hybrids:** 1 **Total Counted:** 253 **Total Rel. Wt. :** 125044

IBI: 44.0 **MIwb:** 9.7

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-001 Little Miami River RM: 4.10 Date: 09/11/2017

Time Fished: 2200 Distance: 0.500 Drainge (sq mi): 1730.0 Depth: 0

Location: At. Otto Armlender Park Canoe Lauch Lat: 39.11804 Long: -84.39967

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
10-004	LONGNOSE GAR	P		M		6	12.0	1.54	10700	7.71	891.6
20-003	GIZZARD SHAD	O		M		83	166.0	21.28	13200	9.51	79.5
40-003	BLACK BUFFALO	I		M	C	3	6.0	0.77	11400	8.21	1900.0
40-004	SMALLMOUTH BUFFALO	I		M	C	6	12.0	1.54	24700	17.79	2058.3
40-005	QUILLBACK CARPSUCKER	O		M	C	2	4.0	0.51	2300	1.66	575.0
40-006	RIVER CARPSUCKER	O		M	C	7	14.0	1.79	12000	8.64	857.1
40-008	SILVER REDHORSE	I	M	S	R	1	2.0	0.26	700	0.50	350.0
40-010	GOLDEN REDHORSE	I	M	S	R	4	8.0	1.03	2380	1.71	297.5
40-015	NORTHERN HOG SUCKER	I	M	S	R	23	46.0	5.90	13180	9.49	286.5
40-023	SMALLMOUTH REDHORSE	I	M	S	R	33	66.0	8.46	22850	16.46	346.2
43-001	COMMON CARP	O	T	M	G	1	2.0	0.26	2100	1.51	1050.0
43-009	GRAVEL CHUB	I	M	S	N	3	6.0	0.77	20	0.01	3.3
43-015	SUCKERMOUTH MINNOW	I		S	N	1	2.0	0.26	6	0.00	3.0
43-020	EMERALD SHINER	I		M	N	132	264.0	33.85	264	0.19	1.0
43-027	RIVER SHINER	I		S	N	1	2.0	0.26	6	0.00	3.0
43-032	SPOTFIN SHINER	I		M	N	3	6.0	0.77	8	0.01	1.3
43-035	MIMIC SHINER	I	I	M	N	2	4.0	0.51	4	0.00	1.0
43-041	BULLHEAD MINNOW	O		C	N	1	2.0	0.26	4	0.00	2.0
43-043	BLUNTNOSE MINNOW	O	T	C	N	1	2.0	0.26	6	0.00	3.0
43-044	CENTRAL STONEROLLER	H		N	N	3	6.0	0.77	40	0.03	6.6
43-063	CHANNEL SHINER	I	I	M	N	2	4.0	0.51	4	0.00	1.0
47-002	CHANNEL CATFISH			C	F	10	20.0	2.56	11904	8.58	595.2
47-009	MOUNTAIN MADTOM	I	R	C		3	6.0	0.77	14	0.01	2.3
74-001	WHITE BASS	P		M	F	1	2.0	0.26	180	0.13	90.0
74-005	Striped X White Bass				E	2	4.0	0.51	1560	1.12	390.0
77-004	SMALLMOUTH BASS	C	M	C	F	7	14.0	1.79	3180	2.29	227.1
77-005	SPOTTED BASS	C		C	F	9	18.0	2.31	640	0.46	35.5
77-008	GREEN SUNFISH	I	T	C	S	1	2.0	0.26	4	0.00	2.0
77-009	BLUEGILL SUNFISH	I	P	C	S	7	14.0	1.79	160	0.12	11.4
77-011	LONGEAR SUNFISH	I	M	C	S	11	22.0	2.82	300	0.22	13.6
80-001	SAUGER	P		S	F	6	12.0	1.54	2640	1.90	220.0
80-011	LOGPERCH	I	M	S	D	5	10.0	1.28	200	0.14	20.0
80-022	RAINBOW DARTER	I	M	S	D	6	12.0	1.54	20	0.01	1.6
85-001	FRESHWATER DRUM		P	M		4	8.0	1.03	2140	1.54	267.5

No Species: 33 **Nat. Species:** 32 **Hybrids:** 1 **Total Counted:** 390 **Total Rel. Wt. :** 138814

IBI: 46.0 **Mlwb:** 10.6

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-001 Little Miami River RM: 6.83 Date: 09/11/2017

Time Fished: 2437 Distance: 0.500 Drainge (sq mi): 1720.0 Depth: 0

Location: Ust. Train Tracks below boulder field Lat: 39.13926 Long: -84.37492

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
10-004	LONGNOSE GAR	P		M		2	4.0	0.47	1200	0.74	300.0
20-003	GIZZARD SHAD	O		M		72	144.0	16.78	11900	7.37	82.6
40-003	BLACK BUFFALO	I		M	C	6	12.0	1.40	20400	12.63	1700.0
40-004	SMALLMOUTH BUFFALO	I		M	C	11	22.0	2.56	33600	20.81	1527.2
40-005	QUILLBACK CARPSUCKER	O		M	C	1	2.0	0.23	1300	0.81	650.0
40-006	RIVER CARPSUCKER	O		M	C	14	28.0	3.26	21900	13.56	782.1
40-010	GOLDEN REDHORSE	I	M	S	R	8	16.0	1.86	5400	3.34	337.5
40-015	NORTHERN HOG SUCKER	I	M	S	R	6	12.0	1.40	660	0.41	55.0
40-023	SMALLMOUTH REDHORSE	I	M	S	R	16	32.0	3.73	10200	6.32	318.7
43-001	COMMON CARP	O	T	M	G	4	8.0	0.93	23400	14.49	2925.0
43-009	GRAVEL CHUB	I	M	S	N	8	16.0	1.86	80	0.05	5.0
43-020	EMERALD SHINER	I		M	N	134	268.0	31.24	320	0.20	1.1
43-022	ROSYFACE SHINER	I	I	S	N	8	16.0	1.86	14	0.01	0.8
43-032	SPOTFIN SHINER	I		M	N	4	8.0	0.93	16	0.01	2.0
43-035	MIMIC SHINER	I	I	M	N	18	36.0	4.20	56	0.03	1.5
43-043	BLUNTNOSE MINNOW	O	T	C	N	4	8.0	0.93	12	0.01	1.5
43-044	CENTRAL STONEROLLER	H		N	N	33	66.0	7.69	360	0.22	5.4
43-063	CHANNEL SHINER	I	I	M	N	8	16.0	1.86	28	0.02	1.7
47-002	CHANNEL CATFISH			C	F	7	14.0	1.63	20000	12.38	1428.5
47-009	MOUNTAIN MADTOM	I	R	C		1	2.0	0.23	4	0.00	2.0
74-005	Striped X White Bass				E	1	2.0	0.23	6800	4.21	3400.0
77-001	WHITE CRAPPIE	I		C	S	2	4.0	0.47	480	0.30	120.0
77-004	SMALLMOUTH BASS	C	M	C	F	8	16.0	1.86	760	0.47	47.5
77-005	SPOTTED BASS	C		C	F	6	12.0	1.40	620	0.38	51.6
77-008	GREEN SUNFISH	I	T	C	S	4	8.0	0.93	40	0.02	5.0
77-009	BLUEGILL SUNFISH	I	P	C	S	5	10.0	1.17	140	0.09	14.0
77-011	LONGEAR SUNFISH	I	M	C	S	25	50.0	5.83	720	0.45	14.4
80-011	LOGPERCH	I	M	S	D	1	2.0	0.23	20	0.01	10.0
80-016	BANDED DARTER	I	I	S	D	7	14.0	1.63	10	0.01	0.7
80-022	RAINBOW DARTER	I	M	S	D	3	6.0	0.70	6	0.00	1.0
85-001	FRESHWATER DRUM		P	M		2	4.0	0.47	1040	0.64	260.0

No Species: 30 **Nat. Species:** 29 **Hybrids:** 1 **Total Counted:** 429 **Total Rel. Wt. :** 161486

IBI: 46.0 **MIwb:** 10.5

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-001 Little Miami River RM: 8.10 Date: 09/11/2017

Time Fished: 1383 Distance: 0.500 Drainge (sq mi): 1710.0 Depth: 0

Location: At Bass Island Canoe Launch Lat: 39.13726 Long: -84.35433

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
18-002	MOONEYE	I	R	M		1	2.0	0.33	280	0.21	140.0
20-001	SKIPJACK HERRING	P		M		1	2.0	0.33	60	0.04	30.0
20-003	GIZZARD SHAD	O		M		31	62.0	10.20	5700	4.23	91.9
40-003	BLACK BUFFALO	I		M	C	5	10.0	1.64	31100	23.07	3110.0
40-004	SMALLMOUTH BUFFALO	I		M	C	10	20.0	3.29	42000	31.16	2100.0
40-005	QUILLBACK CARPSUCKER	O		M	C	1	2.0	0.33	2100	1.56	1050.0
40-006	RIVER CARPSUCKER	O		M	C	3	6.0	0.99	5100	3.78	850.0
40-013	RIVER REDHORSE	I	I	S	R	1	2.0	0.33	5000	3.71	2500.0
40-015	NORTHERN HOG SUCKER	I	M	S	R	23	46.0	7.57	4360	3.23	94.7
40-023	SMALLMOUTH REDHORSE	I	M	S	R	18	36.0	5.92	13080	9.70	363.3
43-001	COMMON CARP	O	T	M	G	1	2.0	0.33	5600	4.15	2800.0
43-009	GRAVEL CHUB	I	M	S	N	3	6.0	0.99	28	0.02	4.6
43-015	SUCKERMOUTH MINNOW	I		S	N	1	2.0	0.33	8	0.01	4.0
43-020	EMERALD SHINER	I		M	N	111	222.0	36.51	314	0.23	1.4
43-022	ROSYFACE SHINER	I	I	S	N	3	6.0	0.99	6	0.00	1.0
43-031	STEELCOLOR SHINER	I	P	M	N	4	8.0	1.32	50	0.04	6.2
43-034	SAND SHINER	I	M	M	N	4	8.0	1.32	12	0.01	1.5
43-035	MIMIC SHINER	I	I	M	N	20	40.0	6.58	66	0.05	1.6
43-043	BLUNTNOSE MINNOW	O	T	C	N	1	2.0	0.33	4	0.00	2.0
43-044	CENTRAL STONEROLLER	H		N	N	12	24.0	3.95	80	0.06	3.3
47-002	CHANNEL CATFISH			C	F	1	2.0	0.33	1300	0.96	650.0
47-008	STONECAT MADTOM	I	I	C		2	4.0	0.66	12	0.01	3.0
47-009	MOUNTAIN MADTOM	I	R	C		6	12.0	1.97	14	0.01	1.1
47-010	NORTHERN MADTOM	I	R	C		2	4.0	0.66	2	0.00	0.5
70-001	BROOK SILVERSIDE	I	M	M		1	2.0	0.33	2	0.00	1.0
74-001	WHITE BASS	P		M	F	1	2.0	0.33	400	0.30	200.0
74-005	Striped X White Bass				E	2	4.0	0.66	6100	4.53	1525.0
77-004	SMALLMOUTH BASS	C	M	C	F	5	10.0	1.64	6300	4.67	630.0
77-005	SPOTTED BASS	C		C	F	5	10.0	1.64	1680	1.25	168.0
77-009	BLUEGILL SUNFISH	I	P	C	S	1	2.0	0.33	6	0.00	3.0
77-011	LONGEAR SUNFISH	I	M	C	S	7	14.0	2.30	200	0.15	14.2
80-011	LOGPERCH	I	M	S	D	1	2.0	0.33	20	0.01	10.0
80-016	BANDED DARTER	I	I	S	D	6	12.0	1.97	20	0.01	1.6
80-022	RAINBOW DARTER	I	M	S	D	6	12.0	1.97	20	0.01	1.6
85-001	FRESHWATER DRUM		P	M		4	8.0	1.32	3780	2.80	472.5

No Species: 34 **Nat. Species:** 33 **Hybrids:** 1 **Total Counted:** 304 **Total Rel. Wt. :** 134804

IBI: 48.0 **MIwb:** 10.1

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-001 Little Miami River RM: 10.90 Date: 09/11/2017

Time Fished: 2016 Distance: 0.500 Drainge (sq mi): 1707.0 Depth: 0

Location: L. MIAMI R. S OF TERRACE PARK - MT. CARMEL RD. Lat: 39.15000 Long: 84.31333

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
10-004	LONGNOSE GAR	P		M		10	20.0	3.77	1300	0.69	65.0
20-001	SKIPJACK HERRING	P		M		1	2.0	0.38	80	0.04	40.0
20-003	GIZZARD SHAD	O		M		8	16.0	3.02	3000	1.58	187.5
40-003	BLACK BUFFALO	I		M	C	8	16.0	3.02	37300	19.68	2331.2
40-004	SMALLMOUTH BUFFALO	I		M	C	8	16.0	3.02	28700	15.14	1793.7
40-006	RIVER CARPSUCKER	O		M	C	16	32.0	6.04	24400	12.87	762.5
40-008	SILVER REDHORSE	I	M	S	R	1	2.0	0.38	3300	1.74	1650.0
40-010	GOLDEN REDHORSE	I	M	S	R	12	24.0	4.53	13000	6.86	541.6
40-015	NORTHERN HOG SUCKER	I	M	S	R	14	28.0	5.28	3700	1.95	132.1
40-023	SMALLMOUTH REDHORSE	I	M	S	R	19	38.0	7.17	11660	6.15	306.8
43-020	EMERALD SHINER	I		M	N	68	136.0	25.66	166	0.09	1.2
43-021	SILVER SHINER	I	I	S	N	1	2.0	0.38	6	0.00	3.0
43-031	STEELCOLOR SHINER	I	P	M	N	2	4.0	0.75	20	0.01	5.0
43-032	SPOTFIN SHINER	I		M	N	6	12.0	2.26	34	0.02	2.8
43-043	BLUNTNOSE MINNOW	O	T	C	N	3	6.0	1.13	20	0.01	3.3
43-044	CENTRAL STONEROLLER	H		N	N	6	12.0	2.26	80	0.04	6.6
43-063	CHANNEL SHINER	I	I	M	N	2	4.0	0.75	8	0.00	2.0
47-002	CHANNEL CATFISH			C	F	21	42.0	7.92	53960	28.47	1284.7
47-008	STONECAT MADTOM	I	I	C		1	2.0	0.38	20	0.01	10.0
47-009	MOUNTAIN MADTOM	I	R	C		7	14.0	2.64	10	0.01	0.7
47-010	NORTHERN MADTOM	I	R	C		3	6.0	1.13	10	0.01	1.6
77-004	SMALLMOUTH BASS	C	M	C	F	13	26.0	4.91	1800	0.95	69.2
77-005	SPOTTED BASS	C		C	F	9	18.0	3.40	350	0.18	19.4
77-009	BLUEGILL SUNFISH	I	P	C	S	9	18.0	3.40	380	0.20	21.1
80-001	SAUGER	P		S	F	1	2.0	0.38	920	0.49	460.0
80-007	SLENDERHEAD DARTER	I	R	S	D	2	4.0	0.75	12	0.01	3.0
80-011	LOGPERCH	I	M	S	D	1	2.0	0.38	40	0.02	20.0
80-015	GREENSIDE DARTER	I	M	S	D	4	8.0	1.51	30	0.02	3.7
80-016	BANDED DARTER	I	I	S	D	1	2.0	0.38	4	0.00	2.0
80-017	VARIEGATE DARTER	I	I	S	D	1	2.0	0.38	10	0.01	5.0
80-022	RAINBOW DARTER	I	M	S	D	4	8.0	1.51	12	0.01	1.5
85-001	FRESHWATER DRUM		P	M		3	6.0	1.13	5200	2.74	866.6

No Species: 32 **Nat. Species:** 32 **Hybrids:** 0 **Total Counted:** 265 **Total Rel. Wt. :** 189532

IBI: 50.0 **MIwb:** 10.7

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-001 Little Miami River RM: 13.10 Date: 09/11/2017

Time Fished: 1784 Distance: 0.500 Drainge (sq mi): 1203.0 Depth: 0

Location: Lat: 39.17190 Long: -84.29560

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
10-004	LONGNOSE GAR	P		M		1	2.0	0.28	1400	0.91	700.0
20-003	GIZZARD SHAD	O		M		53	106.0	15.10	11440	7.41	107.9
40-003	BLACK BUFFALO	I		M	C	2	4.0	0.57	2900	1.88	725.0
40-004	SMALLMOUTH BUFFALO	I		M	C	9	18.0	2.56	29600	19.17	1644.4
40-008	SILVER REDHORSE	I	M	S	R	2	4.0	0.57	4160	2.69	1040.0
40-009	BLACK REDHORSE	I	I	S	R	2	4.0	0.57	3500	2.27	875.0
40-010	GOLDEN REDHORSE	I	M	S	R	24	48.0	6.84	10530	6.82	219.3
40-013	RIVER REDHORSE	I	I	S	R	1	2.0	0.28	1900	1.23	950.0
40-015	NORTHERN HOG SUCKER	I	M	S	R	47	94.0	13.39	14270	9.24	151.8
40-023	SMALLMOUTH REDHORSE	I	M	S	R	79	158.0	22.51	46000	29.80	291.1
43-020	EMERALD SHINER	I		M	N	46	92.0	13.11	192	0.12	2.0
43-022	ROSYFACE SHINER	I	I	S	N	7	14.0	1.99	16	0.01	1.1
43-025	STRIPED SHINER	I		S	N	1	2.0	0.28	4	0.00	2.0
43-031	STEELCOLOR SHINER	I	P	M	N	7	14.0	1.99	72	0.05	5.1
43-032	SPOTFIN SHINER	I		M	N	3	6.0	0.85	16	0.01	2.6
43-035	MIMIC SHINER	I	I	M	N	1	2.0	0.28	4	0.00	2.0
43-043	BLUNTNOSE MINNOW	O	T	C	N	5	10.0	1.42	12	0.01	1.2
43-044	CENTRAL STONEROLLER	H		N	N	11	22.0	3.13	140	0.09	6.3
47-007	FLATHEAD CATFISH	P		C	F	1	2.0	0.28	4	0.00	2.0
77-004	SMALLMOUTH BASS	C	M	C	F	11	22.0	3.13	2180	1.41	99.0
77-005	SPOTTED BASS	C		C	F	1	2.0	0.28	100	0.06	50.0
77-006	LARGEMOUTH BASS	C		C	F	2	4.0	0.57	630	0.41	157.5
77-008	GREEN SUNFISH	I	T	C	S	3	6.0	0.85	140	0.09	23.3
77-009	BLUEGILL SUNFISH	I	P	C	S	2	4.0	0.57	40	0.03	10.0
77-011	LONGEAR SUNFISH	I	M	C	S	3	6.0	0.85	100	0.06	16.6
80-011	LOGPERCH	I	M	S	D	1	2.0	0.28	60	0.04	30.0
80-015	GREENSIDE DARTER	I	M	S	D	1	2.0	0.28	16	0.01	8.0
80-016	BANDED DARTER	I	I	S	D	5	10.0	1.42	16	0.01	1.6
80-022	RAINBOW DARTER	I	M	S	D	4	8.0	1.14	8	0.01	1.0
85-001	FRESHWATER DRUM		P	M		16	32.0	4.56	24930	16.15	779.0

No Species: 30 **Nat. Species:** 30 **Hybrids:** 0 **Total Counted:** 351 **Total Rel. Wt. :** 154380

IBI: 52.0 **MIwb:** 10.3

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-001 Little Miami River RM: 17.70 Date: 09/08/2017

Time Fished: 1607 Distance: 0.500 Drainge (sq mi): 1190.0 Depth: 0

Location: Adj. Kelly Nature Preserve Lat: 39.20942 Long: -84.30300

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
10-004	LONGNOSE GAR	P		M		4	8.0	1.48	4700	2.59	587.5
20-003	GIZZARD SHAD	O		M		36	72.0	13.28	10620	5.85	147.5
40-003	BLACK BUFFALO	I		M	C	3	6.0	1.11	15300	8.43	2550.0
40-004	SMALLMOUTH BUFFALO	I		M	C	12	24.0	4.43	34800	19.16	1450.0
40-008	SILVER REDHORSE	I	M	S	R	4	8.0	1.48	11900	6.55	1487.5
40-010	GOLDEN REDHORSE	I	M	S	R	5	10.0	1.85	5400	2.97	540.0
40-013	RIVER REDHORSE	I	I	S	R	1	2.0	0.37	3900	2.15	1950.0
40-015	NORTHERN HOG SUCKER	I	M	S	R	26	52.0	9.59	7140	3.93	137.3
40-023	SMALLMOUTH REDHORSE	I	M	S	R	70	140.0	25.83	54620	30.08	390.1
43-009	GRAVEL CHUB	I	M	S	N	2	4.0	0.74	40	0.02	10.0
43-020	EMERALD SHINER	I		M	N	40	80.0	14.76	236	0.13	2.9
43-022	ROSYFACE SHINER	I	I	S	N	9	18.0	3.32	24	0.01	1.3
43-031	STEELCOLOR SHINER	I	P	M	N	2	4.0	0.74	20	0.01	5.0
43-032	SPOTFIN SHINER	I		M	N	2	4.0	0.74	10	0.01	2.5
43-034	SAND SHINER	I	M	M	N	4	8.0	1.48	16	0.01	2.0
43-035	MIMIC SHINER	I	I	M	N	2	4.0	0.74	6	0.00	1.5
43-043	BLUNTNOSE MINNOW	O	T	C	N	10	20.0	3.69	50	0.03	2.5
43-044	CENTRAL STONEROLLER	H		N	N	3	6.0	1.11	44	0.02	7.3
47-002	CHANNEL CATFISH			C	F	7	14.0	2.58	19100	10.52	1364.2
47-008	STONECAT MADTOM	I	I	C		2	4.0	0.74	20	0.01	5.0
47-010	NORTHERN MADTOM	I	R	C		2	4.0	0.74	2	0.00	0.5
74-001	WHITE BASS	P		M	F	2	4.0	0.74	1380	0.76	345.0
77-004	SMALLMOUTH BASS	C	M	C	F	6	12.0	2.21	2080	1.15	173.3
77-009	BLUEGILL SUNFISH	I	P	C	S	2	4.0	0.74	60	0.03	15.0
77-011	LONGEAR SUNFISH	I	M	C	S	4	8.0	1.48	200	0.11	25.0
80-011	LOGPERCH	I	M	S	D	1	2.0	0.37	50	0.03	25.0
80-015	GREENSIDE DARTER	I	M	S	D	1	2.0	0.37	20	0.01	10.0
85-001	FRESHWATER DRUM		P	M		9	18.0	3.32	9860	5.43	547.7

No Species: 28 **Nat. Species:** 28 **Hybrids:** 0 **Total Counted:** 271 **Total Rel. Wt. :** 181598

IBI: 52.0 **MIwb:** 10.4

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-001 Little Miami River RM: 17.70 Date: 10/06/2017

Time Fished: 1320 Distance: 0.500 Drainge (sq mi): 1190.0 Depth: 0

Location: Adj. Kelly Nature Preserve Lat: 39.20942 Long: -84.30300

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
10-004	LONGNOSE GAR	P		M		1	2.0	0.60	900	0.50	450.0
20-003	GIZZARD SHAD	O		M		10	20.0	5.99	3800	2.11	190.0
40-003	BLACK BUFFALO	I		M	C	5	10.0	2.99	18900	10.47	1890.0
40-004	SMALLMOUTH BUFFALO	I		M	C	12	24.0	7.19	49140	27.22	2047.5
40-005	QUILLBACK CARPSUCKER	O		M	C	1	2.0	0.60	2000	1.11	1000.0
40-006	RIVER CARPSUCKER	O		M	C	1	2.0	0.60	1700	0.94	850.0
40-010	GOLDEN REDHORSE	I	M	S	R	6	12.0	3.59	3740	2.07	311.6
40-013	RIVER REDHORSE	I	I	S	R	2	4.0	1.20	10600	5.87	2650.0
40-015	NORTHERN HOG SUCKER	I	M	S	R	13	26.0	7.78	5080	2.81	195.3
40-023	SMALLMOUTH REDHORSE	I	M	S	R	57	114.0	34.13	51480	28.52	451.5
43-020	EMERALD SHINER	I		M	N	11	22.0	6.59	64	0.04	2.9
43-022	ROSYFACE SHINER	I	I	S	N	1	2.0	0.60	2	0.00	1.0
43-035	MIMIC SHINER	I	I	M	N	3	6.0	1.80	2	0.00	0.3
43-043	BLUNTNOSE MINNOW	O	T	C	N	8	16.0	4.79	10	0.01	0.6
43-044	CENTRAL STONEROLLER	H		N	N	4	8.0	2.40	140	0.08	17.5
47-002	CHANNEL CATFISH			C	F	8	16.0	4.79	25040	13.87	1565.0
47-008	STONECAT MADTOM	I	I	C		1	2.0	0.60	20	0.01	10.0
47-009	MOUNTAIN MADTOM	I	R	C		1	2.0	0.60	6	0.00	3.0
47-010	NORTHERN MADTOM	I	R	C		0	0.0	0.00	0	0.00	*****.*
77-004	SMALLMOUTH BASS	C	M	C	F	6	12.0	3.59	320	0.18	26.6
77-011	LONGEAR SUNFISH	I	M	C	S	3	6.0	1.80	100	0.06	16.6
80-001	SAUGER	P		S	F	1	2.0	0.60	1400	0.78	700.0
80-011	LOGPERCH	I	M	S	D	3	6.0	1.80	120	0.07	20.0
80-015	GREENSIDE DARTER	I	M	S	D	3	6.0	1.80	40	0.02	6.6
80-016	BANDED DARTER	I	I	S	D	2	4.0	1.20	6	0.00	1.5
80-026	SAUGER X WALLEYE	P			E	2	4.0	1.20	2000	1.11	500.0
85-001	FRESHWATER DRUM		P	M		2	4.0	1.20	3900	2.16	975.0

No Species: 26 **Nat. Species:** 26 **Hybrids:** 1 **Total Counted:** 167 **Total Rel. Wt. :** 180510

IBI: 52.0 **MIwb:** 9.9

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-001 Little Miami River RM: 18.50 Date: 09/08/2017

Time Fished: 2265 Distance: 0.500 Drainge (sq mi): 1187.0 Depth: 0

Location: Lat: 39.21310 Long: -84.31360

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
10-004	LONGNOSE GAR	P		M		1	2.0	0.31	1100	1.21	550.0
18-002	MOONEYE	I	R	M		1	2.0	0.31	400	0.44	200.0
20-003	GIZZARD SHAD	O		M		24	48.0	7.43	6200	6.83	129.1
40-003	BLACK BUFFALO	I		M	C	1	2.0	0.31	3000	3.31	1500.0
40-004	SMALLMOUTH BUFFALO	I		M	C	5	10.0	1.55	18100	19.95	1810.0
40-006	RIVER CARPSUCKER	O		M	C	1	2.0	0.31	1800	1.98	900.0
40-008	SILVER REDHORSE	I	M	S	R	2	4.0	0.62	5700	6.28	1425.0
40-010	GOLDEN REDHORSE	I	M	S	R	10	20.0	3.10	3860	4.25	193.0
40-015	NORTHERN HOG SUCKER	I	M	S	R	21	42.0	6.50	6540	7.21	155.7
40-023	SMALLMOUTH REDHORSE	I	M	S	R	26	52.0	8.05	20220	22.28	388.8
43-020	EMERALD SHINER	I		M	N	48	96.0	14.86	200	0.22	2.0
43-022	ROSYFACE SHINER	I	I	S	N	5	10.0	1.55	10	0.01	1.0
43-031	STEELCOLOR SHINER	I	P	M	N	6	12.0	1.86	80	0.09	6.6
43-032	SPOTFIN SHINER	I		M	N	5	10.0	1.55	26	0.03	2.6
43-035	MIMIC SHINER	I	I	M	N	41	82.0	12.69	112	0.12	1.3
43-041	BULLHEAD MINNOW	O		C	N	1	2.0	0.31	8	0.01	4.0
43-043	BLUNTNOSE MINNOW	O	T	C	N	26	52.0	8.05	86	0.09	1.6
43-044	CENTRAL STONEROLLER	H		N	N	11	22.0	3.41	140	0.15	6.3
47-002	CHANNEL CATFISH			C	F	8	16.0	2.48	13000	14.33	812.5
47-008	STONECAT MADTOM	I	I	C		8	16.0	2.48	140	0.15	8.7
47-009	MOUNTAIN MADTOM	I	R	C		2	4.0	0.62	6	0.01	1.5
47-010	NORTHERN MADTOM	I	R	C		3	6.0	0.93	4	0.00	0.6
77-003	ROCK BASS	C		C	S	1	2.0	0.31	20	0.02	10.0
77-004	SMALLMOUTH BASS	C	M	C	F	9	18.0	2.79	4580	5.05	254.4
77-005	SPOTTED BASS	C		C	F	1	2.0	0.31	120	0.13	60.0
77-008	GREEN SUNFISH	I	T	C	S	1	2.0	0.31	30	0.03	15.0
77-009	BLUEGILL SUNFISH	I	P	C	S	14	28.0	4.33	220	0.24	7.8
77-011	LONGEAR SUNFISH	I	M	C	S	13	26.0	4.02	240	0.26	9.2
80-001	SAUGER	P		S	F	3	6.0	0.93	1460	1.61	243.3
80-007	SLENDERHEAD DARTER	I	R	S	D	2	4.0	0.62	10	0.01	2.5
80-011	LOGPERCH	I	M	S	D	5	10.0	1.55	200	0.22	20.0
80-015	GREENSIDE DARTER	I	M	S	D	7	14.0	2.17	40	0.04	2.8
80-016	BANDED DARTER	I	I	S	D	5	10.0	1.55	12	0.01	1.2
80-017	VARIEGATE DARTER	I	I	S	D	1	2.0	0.31	10	0.01	5.0
80-022	RAINBOW DARTER	I	M	S	D	2	4.0	0.62	10	0.01	2.5
80-024	FANTAIL DARTER	I		C	D	1	2.0	0.31	4	0.00	2.0
85-001	FRESHWATER DRUM		P	M		2	4.0	0.62	3060	3.37	765.0

No Species: 37 **Nat. Species:** 37 **Hybrids:** 0 **Total Counted:** 323 **Total Rel. Wt. :** 90748

IBI: 48.0 **MIwb:** 10.8

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-001 Little Miami River RM: 18.50 Date: 10/06/2017

Time Fished: 1851 Distance: 0.500 Drainge (sq mi): 1187.0 Depth: 0

Location: Lat: 39.21310 Long: -84.31360

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
10-004	LONGNOSE GAR	P		M		1	2.0	0.41	1000	0.74	500.0
20-003	GIZZARD SHAD	O		M		1	2.0	0.41	420	0.31	210.0
40-003	BLACK BUFFALO	I		M	C	4	8.0	1.66	23000	17.07	2875.0
40-004	SMALLMOUTH BUFFALO	I		M	C	7	14.0	2.90	28400	21.08	2028.5
40-005	QUILLBACK CARPSUCKER	O		M	C	3	6.0	1.24	5200	3.86	866.6
40-006	RIVER CARPSUCKER	O		M	C	1	2.0	0.41	1500	1.11	750.0
40-008	SILVER REDHORSE	I	M	S	R	1	2.0	0.41	3000	2.23	1500.0
40-009	BLACK REDHORSE	I	I	S	R	2	4.0	0.83	1020	0.76	255.0
40-010	GOLDEN REDHORSE	I	M	S	R	6	12.0	2.49	2880	2.14	240.0
40-013	RIVER REDHORSE	I	I	S	R	1	2.0	0.41	2400	1.78	1200.0
40-015	NORTHERN HOG SUCKER	I	M	S	R	24	48.0	9.96	10120	7.51	210.8
40-023	SMALLMOUTH REDHORSE	I	M	S	R	44	88.0	18.26	31200	23.16	354.5
43-020	EMERALD SHINER	I		M	N	30	60.0	12.45	166	0.12	2.7
43-021	SILVER SHINER	I	I	S	N	2	4.0	0.83	16	0.01	4.0
43-022	ROSYFACE SHINER	I	I	S	N	13	26.0	5.39	34	0.03	1.3
43-031	STEELCOLOR SHINER	I	P	M	N	4	8.0	1.66	42	0.03	5.2
43-032	SPOTFIN SHINER	I		M	N	1	2.0	0.41	4	0.00	2.0
43-035	MIMIC SHINER	I	I	M	N	8	16.0	3.32	18	0.01	1.1
43-043	BLUNTNOSE MINNOW	O	T	C	N	13	26.0	5.39	60	0.04	2.3
43-044	CENTRAL STONEROLLER	H		N	N	16	32.0	6.64	140	0.10	4.3
47-002	CHANNEL CATFISH			C	F	1	2.0	0.41	3900	2.89	1950.0
47-008	STONECAT MADTOM	I	I	C		1	2.0	0.41	20	0.01	10.0
47-009	MOUNTAIN MADTOM	I	R	C		1	2.0	0.41	4	0.00	2.0
47-010	NORTHERN MADTOM	I	R	C		1	2.0	0.41	4	0.00	2.0
77-004	SMALLMOUTH BASS	C	M	C	F	9	18.0	3.73	2760	2.05	153.3
77-005	SPOTTED BASS	C		C	F	1	2.0	0.41	100	0.07	50.0
77-008	GREEN SUNFISH	I	T	C	S	2	4.0	0.83	10	0.01	2.5
77-011	LONGEAR SUNFISH	I	M	C	S	9	18.0	3.73	260	0.19	14.4
80-001	SAUGER	P		S	F	1	2.0	0.41	500	0.37	250.0
80-007	SLENDERHEAD DARTER	I	R	S	D	3	6.0	1.24	12	0.01	2.0
80-011	LOGPERCH	I	M	S	D	11	22.0	4.56	220	0.16	10.0
80-015	GREENSIDE DARTER	I	M	S	D	4	8.0	1.66	12	0.01	1.5
80-016	BANDED DARTER	I	I	S	D	5	10.0	2.07	12	0.01	1.2
80-017	VARIEGATE DARTER	I	I	S	D	1	2.0	0.41	4	0.00	2.0
80-022	RAINBOW DARTER	I	M	S	D	3	6.0	1.24	4	0.00	0.6
85-001	FRESHWATER DRUM		P	M		6	12.0	2.49	16300	12.10	1358.3

No Species: 36 **Nat. Species:** 36 **Hybrids:** 0 **Total Counted:** 241 **Total Rel. Wt. :** 134742

IBI: 52.0 **MIwb:** 10.6

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-001 Little Miami River RM: 21.50 Date: 08/29/2017

Time Fished: 2682 Distance: 0.500 Drainge (sq mi): 1160.0 Depth: 0

Location: Lat: 39.24670 Long: -84.24500

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
10-004	LONGNOSE GAR	P		M		1	2.0	0.34	6600	3.54	3300.0
20-001	SKIPJACK HERRING	P		M		1	2.0	0.34	480	0.26	240.0
20-003	GIZZARD SHAD	O		M		23	46.0	7.74	5680	3.05	123.4
40-003	BLACK BUFFALO	I		M	C	4	8.0	1.35	15700	8.43	1962.5
40-004	SMALLMOUTH BUFFALO	I		M	C	12	24.0	4.04	36900	19.82	1537.5
40-005	QUILLBACK CARPSUCKER	O		M	C	5	10.0	1.68	6600	3.54	660.0
40-006	RIVER CARPSUCKER	O		M	C	22	44.0	7.41	29100	15.63	661.3
40-008	SILVER REDHORSE	I	M	S	R	2	4.0	0.67	7500	4.03	1875.0
40-009	BLACK REDHORSE	I	I	S	R	1	2.0	0.34	1600	0.86	800.0
40-010	GOLDEN REDHORSE	I	M	S	R	26	52.0	8.75	14580	7.83	280.3
40-015	NORTHERN HOG SUCKER	I	M	S	R	28	56.0	9.43	7530	4.04	134.4
40-023	SMALLMOUTH REDHORSE	I	M	S	R	13	26.0	4.38	8600	4.62	330.7
43-001	COMMON CARP	O	T	M	G	1	2.0	0.34	7200	3.87	3600.0
43-020	EMERALD SHINER	I		M	N	26	52.0	8.75	120	0.06	2.3
43-021	SILVER SHINER	I	I	S	N	1	2.0	0.34	2	0.00	1.0
43-022	ROSYFACE SHINER	I	I	S	N	5	10.0	1.68	10	0.01	1.0
43-031	STEELCOLOR SHINER	I	P	M	N	2	4.0	0.67	20	0.01	5.0
43-032	SPOTFIN SHINER	I		M	N	15	30.0	5.05	64	0.03	2.1
43-034	SAND SHINER	I	M	M	N	19	38.0	6.40	68	0.04	1.7
43-035	MIMIC SHINER	I	I	M	N	8	16.0	2.69	18	0.01	1.1
43-041	BULLHEAD MINNOW	O		C	N	2	4.0	0.67	6	0.00	1.5
43-043	BLUNTNOSE MINNOW	O	T	C	N	4	8.0	1.35	12	0.01	1.5
43-044	CENTRAL STONEROLLER	H		N	N	3	6.0	1.01	20	0.01	3.3
47-002	CHANNEL CATFISH			C	F	5	10.0	1.68	12000	6.44	1200.0
47-007	FLATHEAD CATFISH	P		C	F	3	6.0	1.01	16750	9.00	2791.6
74-001	WHITE BASS	P		M	F	2	4.0	0.67	1140	0.61	285.0
77-004	SMALLMOUTH BASS	C	M	C	F	9	18.0	3.03	3080	1.65	171.1
77-005	SPOTTED BASS	C		C	F	1	2.0	0.34	280	0.15	140.0
77-006	LARGEMOUTH BASS	C		C	F	1	2.0	0.34	6	0.00	3.0
77-008	GREEN SUNFISH	I	T	C	S	5	10.0	1.68	80	0.04	8.0
77-009	BLUEGILL SUNFISH	I	P	C	S	13	26.0	4.38	240	0.13	9.2
77-011	LONGEAR SUNFISH	I	M	C	S	17	34.0	5.72	560	0.30	16.4
80-011	LOGPERCH	I	M	S	D	8	16.0	2.69	240	0.13	15.0
80-016	BANDED DARTER	I	I	S	D	4	8.0	1.35	16	0.01	2.0
80-017	VARIEGATE DARTER	I	I	S	D	2	4.0	0.67	12	0.01	3.0
85-001	FRESHWATER DRUM		P	M		3	6.0	1.01	3380	1.82	563.3

No Species: 36 **Nat. Species:** 35 **Hybrids:** 0 **Total Counted:** 297 **Total Rel. Wt. :** 186194

IBI: 48.0 **MIwb:** 11.5

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-001 Little Miami River RM: 22.30 Date: 08/29/2017

Time Fished: 1723 Distance: 0.500 Drainge (sq mi): 1148.0 Depth: 0

Location: upst. Polk Run WWTP Lat: 39.25310 Long: -84.28080

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
10-004	LONGNOSE GAR	P		M		1	2.0	0.43	20	0.01	10.0
20-003	GIZZARD SHAD	O		M		33	66.0	14.22	7610	5.55	115.3
40-004	SMALLMOUTH BUFFALO	I		M	C	7	14.0	3.02	27400	19.98	1957.1
40-005	QUILLBACK CARPSUCKER	O		M	C	8	16.0	3.45	13620	9.93	851.2
40-006	RIVER CARPSUCKER	O		M	C	19	38.0	8.19	34000	24.79	894.7
40-008	SILVER REDHORSE	I	M	S	R	2	4.0	0.86	7200	5.25	1800.0
40-009	BLACK REDHORSE	I	I	S	R	5	10.0	2.16	1820	1.33	182.0
40-010	GOLDEN REDHORSE	I	M	S	R	30	60.0	12.93	26570	19.38	442.8
40-015	NORTHERN HOG SUCKER	I	M	S	R	5	10.0	2.16	790	0.58	79.0
40-023	SMALLMOUTH REDHORSE	I	M	S	R	4	8.0	1.72	910	0.66	113.7
43-001	COMMON CARP	O	T	M	G	1	2.0	0.43	1260	0.92	630.0
43-020	EMERALD SHINER	I		M	N	16	32.0	6.90	100	0.07	3.1
43-031	STEELCOLOR SHINER	I	P	M	N	1	2.0	0.43	4	0.00	2.0
43-032	SPOTFIN SHINER	I		M	N	1	2.0	0.43	4	0.00	2.0
43-034	SAND SHINER	I	M	M	N	2	4.0	0.86	8	0.01	2.0
43-035	MIMIC SHINER	I	I	M	N	1	2.0	0.43	4	0.00	2.0
43-043	BLUNTNOSE MINNOW	O	T	C	N	6	12.0	2.59	40	0.03	3.3
43-044	CENTRAL STONEROLLER	H		N	N	3	6.0	1.29	20	0.01	3.3
47-002	CHANNEL CATFISH			C	F	2	4.0	0.86	4404	3.21	1101.0
70-001	BROOK SILVERSIDE	I	M	M		3	6.0	1.29	6	0.00	1.0
77-001	WHITE CRAPPIE	I		C	S	29	58.0	12.50	590	0.43	10.1
77-002	BLACK CRAPPIE	I		C	S	1	2.0	0.43	160	0.12	80.0
77-003	ROCK BASS	C		C	S	1	2.0	0.43	220	0.16	110.0
77-004	SMALLMOUTH BASS	C	M	C	F	3	6.0	1.29	20	0.01	3.3
77-005	SPOTTED BASS	C		C	F	2	4.0	0.86	1180	0.86	295.0
77-008	GREEN SUNFISH	I	T	C	S	3	6.0	1.29	80	0.06	13.3
77-009	BLUEGILL SUNFISH	I	P	C	S	19	38.0	8.19	200	0.15	5.2
80-001	SAUGER	P		S	F	1	2.0	0.43	560	0.41	280.0
80-002	WALLEYE	P		S	F	1	2.0	0.43	1260	0.92	630.0
80-007	SLENDERHEAD DARTER	I	R	S	D	5	10.0	2.16	30	0.02	3.0
80-011	LOGPERCH	I	M	S	D	5	10.0	2.16	100	0.07	10.0
80-015	GREENSIDE DARTER	I	M	S	D	2	4.0	0.86	6	0.00	1.5
80-016	BANDED DARTER	I	I	S	D	3	6.0	1.29	6	0.00	1.0
80-022	RAINBOW DARTER	I	M	S	D	3	6.0	1.29	10	0.01	1.6
85-001	FRESHWATER DRUM		P	M		4	8.0	1.72	6920	5.05	865.0

No Species: 35 **Nat. Species:** 34 **Hybrids:** 0 **Total Counted:** 232 **Total Rel. Wt. :** 137132

IBI: 46.0 **MIwb:** 10.6

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-001 Little Miami River RM: 24.10 Date: 08/29/2017

Time Fished: 2832 Distance: 0.500 Drainge (sq mi): 1085.0 Depth: 0

Location: L. MIAMI R. 0.1 MI. UPST CONFL O'BANNON CREEK Lat: 39.27111 Long: 84.25944

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
20-003	GIZZARD SHAD	O		M		30	60.0	7.75	8620	3.66	143.6
40-003	BLACK BUFFALO	I		M	C	1	2.0	0.26	3400	1.44	1700.0
40-004	SMALLMOUTH BUFFALO	I		M	C	13	26.0	3.36	30130	12.79	1158.8
40-006	RIVER CARPSUCKER	O		M	C	8	16.0	2.07	13500	5.73	843.7
40-009	BLACK REDHORSE	I	I	S	R	6	12.0	1.55	15080	6.40	1256.6
40-010	GOLDEN REDHORSE	I	M	S	R	25	50.0	6.46	18160	7.71	363.2
40-013	RIVER REDHORSE	I	I	S	R	6	12.0	1.55	25900	10.99	2158.3
40-015	NORTHERN HOG SUCKER	I	M	S	R	28	56.0	7.24	10200	4.33	182.1
40-023	SMALLMOUTH REDHORSE	I	M	S	R	56	112.0	14.47	32390	13.75	289.1
43-020	EMERALD SHINER	I		M	N	12	24.0	3.10	80	0.03	3.3
43-022	ROSYFACE SHINER	I	I	S	N	31	62.0	8.01	84	0.04	1.3
43-031	STEELCOLOR SHINER	I	P	M	N	5	10.0	1.29	44	0.02	4.4
43-032	SPOTFIN SHINER	I		M	N	7	14.0	1.81	44	0.02	3.1
43-035	MIMIC SHINER	I	I	M	N	4	8.0	1.03	12	0.01	1.5
43-043	BLUNTNOSE MINNOW	O	T	C	N	12	24.0	3.10	80	0.03	3.3
43-044	CENTRAL STONEROLLER	H		N	N	7	14.0	1.81	200	0.08	14.2
47-002	CHANNEL CATFISH			C	F	7	14.0	1.81	22400	9.51	1600.0
47-007	FLATHEAD CATFISH	P		C	F	3	6.0	0.78	9870	4.19	1645.0
47-008	STONECAT MADTOM	I	I	C		2	4.0	0.52	20	0.01	5.0
74-001	WHITE BASS	P		M	F	1	2.0	0.26	600	0.25	300.0
77-004	SMALLMOUTH BASS	C	M	C	F	10	20.0	2.58	3710	1.57	185.5
77-006	LARGEMOUTH BASS	C		C	F	5	10.0	1.29	50	0.02	5.0
77-008	GREEN SUNFISH	I	T	C	S	12	24.0	3.10	140	0.06	5.8
77-009	BLUEGILL SUNFISH	I	P	C	S	44	88.0	11.37	620	0.26	7.0
77-011	LONGEAR SUNFISH	I	M	C	S	8	16.0	2.07	210	0.09	13.1
80-001	SAUGER	P		S	F	4	8.0	1.03	2500	1.06	312.5
80-007	SLENDERHEAD DARTER	I	R	S	D	2	4.0	0.52	10	0.00	2.5
80-011	LOGPERCH	I	M	S	D	8	16.0	2.07	260	0.11	16.2
80-015	GREENSIDE DARTER	I	M	S	D	4	8.0	1.03	40	0.02	5.0
80-016	BANDED DARTER	I	I	S	D	4	8.0	1.03	16	0.01	2.0
80-017	VARIEGATE DARTER	I	I	S	D	1	2.0	0.26	16	0.01	8.0
80-022	RAINBOW DARTER	I	M	S	D	4	8.0	1.03	16	0.01	2.0
80-024	FANTAIL DARTER	I		C	D	1	2.0	0.26	4	0.00	2.0
85-001	FRESHWATER DRUM		P	M		16	32.0	4.13	37220	15.80	1163.1

No Species: 34 **Nat. Species:** 34 **Hybrids:** 0 **Total Counted:** 387 **Total Rel. Wt. :** 235626

IBI: 54.0 **MIwb:** 11.5

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-001 Little Miami River RM: 27.90 Date: 08/28/2017

Time Fished: 2475 Distance: 0.500 Drainge (sq mi): 1069.0 Depth: 0

Location: Lat: 39.31810 Long: -84.25170

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
10-004	LONGNOSE GAR	P		M		1	2.0	0.22	700	0.46	350.0
20-003	GIZZARD SHAD	O		M		39	78.0	8.52	10760	7.04	137.9
40-002	BIGMOUTH BUFFALO	I		M	C	2	4.0	0.44	11040	7.22	2760.0
40-004	SMALLMOUTH BUFFALO	I		M	C	1	2.0	0.22	9040	5.91	4520.0
40-006	RIVER CARPSUCKER	O		M	C	1	2.0	0.22	1900	1.24	950.0
40-009	BLACK REDHORSE	I	I	S	R	10	20.0	2.18	27520	18.00	1376.0
40-010	GOLDEN REDHORSE	I	M	S	R	7	14.0	1.53	6680	4.37	477.1
40-015	NORTHERN HOG SUCKER	I	M	S	R	45	90.0	9.83	8810	5.76	97.8
40-023	SMALLMOUTH REDHORSE	I	M	S	R	77	154.0	16.81	63390	41.47	411.6
43-015	SUCKERMOUTH MINNOW	I		S	N	1	2.0	0.22	4	0.00	2.0
43-020	EMERALD SHINER	I		M	N	15	30.0	3.28	60	0.04	2.0
43-021	SILVER SHINER	I	I	S	N	10	20.0	2.18	70	0.05	3.5
43-022	ROSYFACE SHINER	I	I	S	N	25	50.0	5.46	64	0.04	1.2
43-031	STEELCOLOR SHINER	I	P	M	N	5	10.0	1.09	24	0.02	2.4
43-032	SPOTFIN SHINER	I		M	N	18	36.0	3.93	92	0.06	2.5
43-034	SAND SHINER	I	M	M	N	11	22.0	2.40	36	0.02	1.6
43-035	MIMIC SHINER	I	I	M	N	71	142.0	15.50	176	0.12	1.2
43-041	BULLHEAD MINNOW	O		C	N	15	30.0	3.28	86	0.06	2.8
43-043	BLUNTNOSE MINNOW	O	T	C	N	41	82.0	8.95	240	0.16	2.9
43-044	CENTRAL STONEROLLER	H		N	N	15	30.0	3.28	280	0.18	9.3
43-063	CHANNEL SHINER	I	I	M	N	2	4.0	0.44	6	0.00	1.5
47-002	CHANNEL CATFISH			C	F	1	2.0	0.22	2960	1.94	1480.0
47-004	YELLOW BULLHEAD	I	T	C		1	2.0	0.22	20	0.01	10.0
47-007	FLATHEAD CATFISH	P		C	F	3	6.0	0.66	3294	2.15	549.0
47-008	STONECAT MADTOM	I	I	C		3	6.0	0.66	80	0.05	13.3
47-010	NORTHERN MADTOM	I	R	C		1	2.0	0.22	2	0.00	1.0
70-001	BROOK SILVERSIDE	I	M	M		1	2.0	0.22	2	0.00	1.0
77-005	SPOTTED BASS	C		C	F	5	10.0	1.09	650	0.43	65.0
77-008	GREEN SUNFISH	I	T	C	S	1	2.0	0.22	20	0.01	10.0
77-009	BLUEGILL SUNFISH	I	P	C	S	2	4.0	0.44	60	0.04	15.0
77-011	LONGEAR SUNFISH	I	M	C	S	2	4.0	0.44	50	0.03	12.5
80-011	LOGPERCH	I	M	S	D	2	4.0	0.44	80	0.05	20.0
80-015	GREENSIDE DARTER	I	M	S	D	4	8.0	0.87	30	0.02	3.7
80-016	BANDED DARTER	I	I	S	D	4	8.0	0.87	20	0.01	2.5
80-017	VARIEGATE DARTER	I	I	S	D	2	4.0	0.44	16	0.01	4.0
80-022	RAINBOW DARTER	I	M	S	D	9	18.0	1.97	54	0.04	3.0
85-001	FRESHWATER DRUM		P	M		5	10.0	1.09	4540	2.97	454.0

No Species: 37 **Nat. Species:** 37 **Hybrids:** 0 **Total Counted:** 458 **Total Rel. Wt. :** 152856

IBI: 48.0 **MIwb:** 10.7

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-004 Duck Creek RM: 0.50 Date: 07/27/2017

Time Fished: 1795 Distance: 0.150 Drainge (sq mi): 14.6 Depth: 0

Location: Lat: 0.00000 Long: 0.00000

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
10-004	LONGNOSE GAR	P		M		3	6.0	1.63	160	4.74	26.6
40-010	GOLDEN REDHORSE	I	M	S	R	2	4.0	1.09	8	0.24	2.0
40-016	WHITE SUCKER	O	T	S	W	4	8.0	2.17	600	17.77	75.0
43-011	WESTERN BLACKNOSE DACE	G	T	S	N	3	6.0	1.63	6	0.18	1.0
43-013	CREEK CHUB	G	T	N	N	16	32.0	8.70	440	13.03	13.7
43-020	EMERALD SHINER	I		M	N	24	48.0	13.04	92	2.73	1.9
43-025	STRIPED SHINER	I		S	N	2	4.0	1.09	2	0.06	0.5
43-032	SPOTFIN SHINER	I		M	N	5	10.0	2.72	32	0.95	3.2
43-039	SILVERJAW MINNOW	I		M	N	7	14.0	3.80	10	0.30	0.7
43-043	BLUNTNOSE MINNOW	O	T	C	N	43	86.0	23.37	200	5.92	2.3
43-044	CENTRAL STONEROLLER	H		N	N	44	88.0	23.91	280	8.29	3.1
47-004	YELLOW BULLHEAD	I	T	C		11	22.0	5.98	980	29.03	44.5
77-006	LARGEMOUTH BASS	C		C	F	4	8.0	2.17	80	2.37	10.0
77-008	GREEN SUNFISH	I	T	C	S	14	28.0	7.61	480	14.22	17.1
80-022	RAINBOW DARTER	I	M	S	D	2	4.0	1.09	6	0.18	1.5

No Species: 15 **Nat. Species:** 15 **Hybrids:** 0 **Total Counted:** 184 **Total Rel. Wt. :** 3376

IBI: 32.0 **MIwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-004 Duck Creek RM: 0.50 Date: 09/20/2017

Time Fished: 1307 Distance: 0.150 Drainge (sq mi): 14.6 Depth: 0

Location: Lat: 0.00000 Long: 0.00000

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
40-010	GOLDEN REDHORSE	I	M	S	R	3	6.0	1.69	40	1.07	6.6
40-016	WHITE SUCKER	O	T	S	W	13	26.0	7.34	860	22.97	33.0
43-001	COMMON CARP	O	T	M	G	1	2.0	0.56	240	6.41	120.0
43-011	WESTERN BLACKNOSE DACE	G	T	S	N	7	14.0	3.95	40	1.07	2.8
43-013	CREEK CHUB	G	T	N	N	6	12.0	3.39	140	3.74	11.6
43-020	EMERALD SHINER	I		M	N	25	50.0	14.12	152	4.06	3.0
43-025	STRIPED SHINER	I		S	N	2	4.0	1.13	20	0.53	5.0
43-043	BLUNTNOSE MINNOW	O	T	C	N	56	112.0	31.64	220	5.88	1.9
43-044	CENTRAL STONEROLLER	H		N	N	30	60.0	16.95	400	10.68	6.6
47-004	YELLOW BULLHEAD	I	T	C		7	14.0	3.95	600	16.03	42.8
57-001	WESTERN MOSQUITOFISH	I		N	E	1	2.0	0.56	2	0.05	1.0
77-004	SMALLMOUTH BASS	C	M	C	F	1	2.0	0.56	10	0.27	5.0
77-008	GREEN SUNFISH	I	T	C	S	19	38.0	10.73	700	18.70	18.4
77-009	BLUEGILL SUNFISH	I	P	C	S	3	6.0	1.69	40	1.07	6.6
77-011	LONGEAR SUNFISH	I	M	C	S	3	6.0	1.69	280	7.48	46.6

No Species: 15 **Nat. Species:** 13 **Hybrids:** 0 **Total Counted:** 177 **Total Rel. Wt. :** 3744

IBI: 28.0 **MIwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-004 Duck Creek RM: 2.00 Date: 07/27/2017

Time Fished: 2128 Distance: 0.150 Drainge (sq mi): 14.3 Depth: 0

Location: Lat: 0.00000 Long: 0.00000

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
40-016	WHITE SUCKER	O	T	S	W	7	14.0	3.35	200	11.06	14.2
43-011	WESTERN BLACKNOSE DACE	G	T	S	N	81	162.0	38.76	380	21.02	2.3
43-013	CREEK CHUB	G	T	N	N	56	112.0	26.79	580	32.08	5.1
43-039	SILVERJAW MINNOW	I		M	N	1	2.0	0.48	4	0.22	2.0
43-043	BLUNTNOSE MINNOW	O	T	C	N	23	46.0	11.00	60	3.32	1.3
43-044	CENTRAL STONEROLLER	H		N	N	28	56.0	13.40	120	6.64	2.1
47-004	YELLOW BULLHEAD	I	T	C		2	4.0	0.96	80	4.42	20.0
77-005	SPOTTED BASS	C		C	F	1	2.0	0.48	4	0.22	2.0
77-008	GREEN SUNFISH	I	T	C	S	10	20.0	4.78	380	21.02	19.0

No Species: 9 **Nat. Species:** 9 **Hybrids:** 0 **Total Counted:** 209 **Total Rel. Wt. :** 1808

IBI: 26.0 **MIwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-004 Duck Creek RM: 2.00 Date: 09/20/2017

Time Fished: 1305 Distance: 0.150 Drainge (sq mi): 14.3 Depth: 0

Location: Lat: 0.00000 Long: 0.00000

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
40-016	WHITE SUCKER	O	T	S	W	2	4.0	0.50	120	3.98	30.0
43-011	WESTERN BLACKNOSE DACE	G	T	S	N	169	338.0	42.46	740	24.54	2.1
43-013	CREEK CHUB	G	T	N	N	82	164.0	20.60	1060	35.15	6.4
43-039	SILVERJAW MINNOW	I		M	N	1	2.0	0.25	4	0.13	2.0
43-043	BLUNTNOSE MINNOW	O	T	C	N	44	88.0	11.06	190	6.30	2.1
43-044	CENTRAL STONEROLLER	H		N	N	83	166.0	20.85	560	18.57	3.3
47-004	YELLOW BULLHEAD	I	T	C		1	2.0	0.25	40	1.33	20.0
77-006	LARGEMOUTH BASS	C		C	F	1	2.0	0.25	60	1.99	30.0
77-008	GREEN SUNFISH	I	T	C	S	8	16.0	2.01	220	7.29	13.7
77-009	BLUEGILL SUNFISH	I	P	C	S	1	2.0	0.25	8	0.27	4.0
80-022	RAINBOW DARTER	I	M	S	D	2	4.0	0.50	4	0.13	1.0
80-023	ORANGETHROAT DARTER	I		S	D	4	8.0	1.01	10	0.33	1.2

No Species: 12 **Nat. Species:** 12 **Hybrids:** 0 **Total Counted:** 398 **Total Rel. Wt. :** 3016

IBI: 28.0 **MIwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-004 Duck Creek RM: 2.80 Date: 07/25/2017

Time Fished: 1063 Distance: 0.150 Drainge (sq mi): 11.8 Depth: 0

Location: Lat: 39.14330 Long: -84.40470

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
40-016	WHITE SUCKER	O	T	S	W	12	24.0	4.63	1000	28.01	41.6
43-011	WESTERN BLACKNOSE DACE	G	T	S	N	102	204.0	39.38	520	14.57	2.5
43-013	CREEK CHUB	G	T	N	N	70	140.0	27.03	1180	33.05	8.4
43-020	EMERALD SHINER	I		M	N	1	2.0	0.39	4	0.11	2.0
43-043	BLUNTNOSE MINNOW	O	T	C	N	22	44.0	8.49	80	2.24	1.8
43-044	CENTRAL STONEROLLER	H		N	N	49	98.0	18.92	720	20.17	7.3
77-008	GREEN SUNFISH	I	T	C	S	2	4.0	0.77	60	1.68	15.0
80-023	ORANGETHROAT DARTER	I		S	D	1	2.0	0.39	6	0.17	3.0

No Species: 8 **Nat. Species:** 8 **Hybrids:** 0 **Total Counted:** 259 **Total Rel. Wt. :** 3570

IBI: 26.0 **MIwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-004 Duck Creek RM: 2.80 Date: 09/20/2017

Time Fished: 988 Distance: 0.150 Drainge (sq mi): 11.8 Depth: 0

Location: Lat: 39.14330 Long: -84.40470

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
40-016	WHITE SUCKER	O	T	S	W	5	10.0	3.27	420	17.30	42.0
43-011	WESTERN BLACKNOSE DACE	G	T	S	N	71	142.0	46.41	380	15.65	2.6
43-013	CREEK CHUB	G	T	N	N	40	80.0	26.14	720	29.65	9.0
43-039	SILVERJAW MINNOW	I		M	N	2	4.0	1.31	8	0.33	2.0
43-043	BLUNTNOSE MINNOW	O	T	C	N	8	16.0	5.23	100	4.12	6.2
43-044	CENTRAL STONEROLLER	H		N	N	25	50.0	16.34	780	32.13	15.6
77-008	GREEN SUNFISH	I	T	C	S	2	4.0	1.31	20	0.82	5.0

No Species: 7 **Nat. Species:** 7 **Hybrids:** 0 **Total Counted:** 153 **Total Rel. Wt. :** 2428

IBI: 24.0 **MIwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-004 Duck Creek RM: 3.40 Date: 07/25/2017

Time Fished: 476 Distance: 0.150 Drainge (sq mi): 7.3 Depth: 0

Location: Rosslyn Rd. Lat: 39.11730 Long: -84.40810

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
99-999	NO FISH					0	0.0	***.**	0	0.00	*****.*

No Species: 0 **Nat. Species:** 1 **Hybrids:** 0 **Total Counted:** 0 **Total Rel. Wt. :** 0

IBI: 12.0 **Mlwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-004 Duck Creek RM: 3.40 Date: 09/20/2017

Time Fished: 518 Distance: 0.150 Drainge (sq mi): 7.3 Depth: 0

Location: Rosslyn Rd. Lat: 39.11730 Long: -84.40810

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
99-999	NO FISH					0	0.0	***.**	0	0.00	*****.*

No Species: 0 **Nat. Species:** 1 **Hybrids:** 0 **Total Counted:** 0 **Total Rel. Wt. :** 0

IBI: 12.0 **Mlwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-004 Duck Creek RM: 3.90 Date: 07/25/2017

Time Fished: 413 Distance: 0.150 Drainge (sq mi): 9.5 Depth: 0

Location: Lat: 0.00000 Long: 0.00000

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
99-999	NO FISH					0	0.0	***.**	0	0.00	*****.*

No Species: 0 **Nat. Species:** 1 **Hybrids:** 0 **Total Counted:** 0 **Total Rel. Wt. :** 0

IBI: 12.0 **MIwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-004 Duck Creek RM: 3.90 Date: 09/20/2017

Time Fished: 501 Distance: 0.150 Drainge (sq mi): 9.5 Depth: 0

Location: Lat: 0.00000 Long: 0.00000

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
99-999	NO FISH					0	0.0	***.**	0	0.00	*****.*

No Species: 0 **Nat. Species:** 1 **Hybrids:** 0 **Total Counted:** 0 **Total Rel. Wt. :** 0

IBI: 12.0 **MIwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-004 Duck Creek RM: 4.58 Date: 07/27/2017

Time Fished: 468 Distance: 0.150 Drainge (sq mi): 5.8 Depth: 0

Location: Lat: 0.00000 Long: 0.00000

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
43-011	WESTERN BLACKNOSE DACE	G	T	S	N	4	8.0	100.00	20	100.00	2.5

No Species: 1 **Nat. Species:** 1 **Hybrids:** 0 **Total Counted:** 4 **Total Rel. Wt. :** 20

IBI: 12.0 **MIwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-004 Duck Creek RM: 5.14 Date: 07/25/2017

Time Fished: 892 Distance: 0.120 Drainge (sq mi): 5.0 Depth: 0

Location: Lat: 0.00000 Long: 0.00000

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
43-011	WESTERN BLACKNOSE DACE	G	T	S	N	12	30.0	13.79	0	0.00	0.0
43-013	CREEK CHUB	G	T	N	N	49	122.5	56.32	0	0.00	0.0
43-039	SILVERJAW MINNOW	I		M	N	1	2.5	1.15	0	0.00	0.0
43-043	BLUNTNOSE MINNOW	O	T	C	N	10	25.0	11.49	0	0.00	0.0
43-044	CENTRAL STONEROLLER	H		N	N	2	5.0	2.30	0	0.00	0.0
77-008	GREEN SUNFISH	I	T	C	S	13	32.5	14.94	0	0.00	0.0

No Species: 6 **Nat. Species:** 6 **Hybrids:** 0 **Total Counted:** 87 **Total Rel. Wt. :** 0

IBI: 24.0 **MIwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-004 Duck Creek RM: 6.10 Date: 07/25/2017

Time Fished: 644 Distance: 0.150 Drainge (sq mi): 2.2 Depth: 0

Location: Lat: 0.00000 Long: 0.00000

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
43-013	CREEK CHUB	G	T	N	N	1	2.0	100.00	8	100.00	4.0

No Species: 1 **Nat. Species:** 1 **Hybrids:** 0 **Total Counted:** 1 **Total Rel. Wt. :** 8

IBI: 12.0 **MIwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-007 Sycamore Creek RM: 0.10 Date: 07/26/2017

Time Fished: 2734 Distance: 0.200 Drainge (sq mi): 24.0 Depth: 0

Location: at mouth Lat: 39.22030 Long: -84.31940

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
20-003	GIZZARD SHAD	O		M		15	22.5	4.55	2145	22.93	95.3
40-009	BLACK REDHORSE	I	I	S	R	3	4.5	0.91	675	7.22	150.0
40-023	SMALLMOUTH REDHORSE	I	M	S	R	1	1.5	0.30	270	2.89	180.0
43-021	SILVER SHINER	I	I	S	N	11	16.5	3.33	10	0.11	0.6
43-022	ROSYFACE SHINER	I	I	S	N	7	10.5	2.12	7	0.08	0.7
43-025	STRIPED SHINER	I		S	N	7	10.5	2.12	1	0.02	0.1
43-032	SPOTFIN SHINER	I		M	N	6	9.0	1.82	16	0.18	1.8
43-034	SAND SHINER	I	M	M	N	44	66.0	13.33	94	1.01	1.4
43-035	MIMIC SHINER	I	I	M	N	72	108.0	21.82	112	1.20	1.0
43-043	BLUNTNOSE MINNOW	O	T	C	N	17	25.5	5.15	25	0.27	1.0
43-044	CENTRAL STONEROLLER	H		N	N	36	54.0	10.91	61	0.66	1.1
47-002	CHANNEL CATFISH			C	F	1	1.5	0.30	1200	12.83	800.0
47-004	YELLOW BULLHEAD	I	T	C		2	3.0	0.61	60	0.64	20.0
77-004	SMALLMOUTH BASS	C	M	C	F	8	12.0	2.42	2955	31.59	246.2
77-005	SPOTTED BASS	C		C	F	2	3.0	0.61	273	2.92	91.0
77-008	GREEN SUNFISH	I	T	C	S	6	9.0	1.82	105	1.12	11.6
77-009	BLUEGILL SUNFISH	I	P	C	S	10	15.0	3.03	210	2.25	14.0
77-011	LONGEAR SUNFISH	I	M	C	S	7	10.5	2.12	180	1.92	17.1
80-001	SAUGER	P		S	F	2	3.0	0.61	795	8.50	265.0
80-015	GREENSIDE DARTER	I	M	S	D	4	6.0	1.21	45	0.48	7.5
80-022	RAINBOW DARTER	I	M	S	D	62	93.0	18.79	105	1.12	1.1
80-024	FANTAIL DARTER	I		C	D	7	10.5	2.12	6	0.06	0.5

No Species: 22 **Nat. Species:** 22 **Hybrids:** 0 **Total Counted:** 330 **Total Rel. Wt. :** 9354

IBI: 46.0 **MIwb:** 8.7

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-007 Sycamore Creek RM: 0.10 Date: 09/21/2017

Time Fished: 0 Distance: 0.200 Drainge (sq mi): 24.0 Depth: 0

Location: at mouth Lat: 39.22030 Long: -84.31940

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
20-003	GIZZARD SHAD	O		M		4	6.0	3.05	885	12.81	147.5
40-009	BLACK REDHORSE	I	I	S	R	3	4.5	2.29	1185	17.16	263.3
43-022	ROSYFACE SHINER	I	I	S	N	1	1.5	0.76	1	0.02	1.0
43-031	STEELCOLOR SHINER	I	P	M	N	2	3.0	1.53	10	0.15	3.5
43-032	SPOTFIN SHINER	I		M	N	2	3.0	1.53	7	0.11	2.5
43-034	SAND SHINER	I	M	M	N	2	3.0	1.53	6	0.09	2.0
43-035	MIMIC SHINER	I	I	M	N	11	16.5	8.40	21	0.30	1.2
43-042	FATHEAD MINNOW	O	T	C	N	1	1.5	0.76	3	0.04	2.0
43-043	BLUNTNOSE MINNOW	O	T	C	N	13	19.5	9.92	30	0.43	1.5
43-044	CENTRAL STONEROLLER	H		N	N	1	1.5	0.76	6	0.09	4.0
77-003	ROCK BASS	C		C	S	1	1.5	0.76	180	2.61	120.0
77-004	SMALLMOUTH BASS	C	M	C	F	9	13.5	6.87	3105	44.95	230.0
77-005	SPOTTED BASS	C		C	F	1	1.5	0.76	255	3.69	170.0
77-008	GREEN SUNFISH	I	T	C	S	7	10.5	5.34	150	2.17	14.2
77-009	BLUEGILL SUNFISH	I	P	C	S	12	18.0	9.16	255	3.69	14.1
77-011	LONGEAR SUNFISH	I	M	C	S	5	7.5	3.82	270	3.91	36.0
77-015	GREEN SF X BLUEGILL SF					1	1.5	0.76	375	5.43	250.0
80-015	GREENSIDE DARTER	I	M	S	D	4	6.0	3.05	30	0.43	5.0
80-022	RAINBOW DARTER	I	M	S	D	43	64.5	32.82	120	1.74	1.8
80-024	FANTAIL DARTER	I		C	D	8	12.0	6.11	12	0.17	1.0

No Species: 19 **Nat. Species:** 19 **Hybrids:** 1 **Total Counted:** 131 **Total Rel. Wt. :** 6907

IBI: 48.0 **MIwb:** 7.5

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-007 Sycamore Creek RM: 0.50 Date: 07/26/2017

Time Fished: 1739 Distance: 0.150 Drainge (sq mi): 24.0 Depth: 0

Location: Lat: 39.22330 Long: -84.32640

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
20-003	GIZZARD SHAD	O		M		1	2.0	0.18	160	1.63	80.0
40-008	SILVER REDHORSE	I	M	S	R	1	2.0	0.18	3000	30.63	1500.0
40-009	BLACK REDHORSE	I	I	S	R	2	4.0	0.36	520	5.31	130.0
40-010	GOLDEN REDHORSE	I	M	S	R	5	10.0	0.89	390	3.98	39.0
40-015	NORTHERN HOG SUCKER	I	M	S	R	9	18.0	1.61	840	8.58	46.6
40-016	WHITE SUCKER	O	T	S	W	13	26.0	2.33	1400	14.29	53.8
43-013	CREEK CHUB	G	T	N	N	2	4.0	0.36	8	0.08	2.0
43-020	EMERALD SHINER	I		M	N	12	24.0	2.15	36	0.37	1.5
43-022	ROSYFACE SHINER	I	I	S	N	1	2.0	0.18	4	0.04	2.0
43-025	STRIPED SHINER	I		S	N	18	36.0	3.22	16	0.16	0.4
43-032	SPOTFIN SHINER	I		M	N	1	2.0	0.18	2	0.02	1.0
43-034	SAND SHINER	I	M	M	N	21	42.0	3.76	62	0.63	1.4
43-035	MIMIC SHINER	I	I	M	N	41	82.0	7.33	94	0.96	1.1
43-039	SILVERJAW MINNOW	I		M	N	1	2.0	0.18	2	0.02	1.0
43-043	BLUNTNOSE MINNOW	O	T	C	N	165	330.0	29.52	792	8.09	2.4
43-044	CENTRAL STONEROLLER	H		N	N	184	368.0	32.92	1040	10.62	2.8
77-004	SMALLMOUTH BASS	C	M	C	F	7	14.0	1.25	938	9.58	67.0
77-006	LARGEMOUTH BASS	C		C	F	2	4.0	0.36	20	0.20	5.0
77-008	GREEN SUNFISH	I	T	C	S	3	6.0	0.54	130	1.33	21.6
77-009	BLUEGILL SUNFISH	I	P	C	S	10	20.0	1.79	180	1.84	9.0
80-011	LOGPERCH	I	M	S	D	2	4.0	0.36	40	0.41	10.0
80-015	GREENSIDE DARTER	I	M	S	D	3	6.0	0.54	20	0.20	3.3
80-022	RAINBOW DARTER	I	M	S	D	42	84.0	7.51	80	0.82	0.9
80-024	FANTAIL DARTER	I		C	D	13	26.0	2.33	20	0.20	0.7

No Species: 24 **Nat. Species:** 24 **Hybrids:** 0 **Total Counted:** 559 **Total Rel. Wt. :** 9794

IBI: 42.0 **MIwb:** 8.6

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-007 Sycamore Creek RM: 0.50 Date: 09/21/2017

Time Fished: 1745 Distance: 0.200 Drainge (sq mi): 24.0 Depth: 0

Location: Lat: 39.22330 Long: -84.32640

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
20-003	GIZZARD SHAD	O		M		1	1.5	0.29	285	6.25	190.0
40-015	NORTHERN HOG SUCKER	I	M	S	R	8	12.0	2.35	2175	47.73	181.2
43-022	ROSYFACE SHINER	I	I	S	N	7	10.5	2.06	16	0.36	1.5
43-025	STRIPED SHINER	I		S	N	1	1.5	0.29	3	0.07	2.0
43-034	SAND SHINER	I	M	M	N	42	63.0	12.35	112	2.47	1.7
43-035	MIMIC SHINER	I	I	M	N	34	51.0	10.00	72	1.58	1.4
43-042	FATHEAD MINNOW	O	T	C	N	1	1.5	0.29	3	0.07	2.0
43-043	BLUNTNOSE MINNOW	O	T	C	N	141	211.5	41.47	453	9.94	2.1
43-044	CENTRAL STONEROLLER	H		N	N	37	55.5	10.88	210	4.61	3.7
77-004	SMALLMOUTH BASS	C	M	C	F	5	7.5	1.47	825	18.10	110.0
77-006	LARGEMOUTH BASS	C		C	F	1	1.5	0.29	7	0.16	5.0
77-008	GREEN SUNFISH	I	T	C	S	3	4.5	0.88	90	1.97	20.0
77-009	BLUEGILL SUNFISH	I	P	C	S	3	4.5	0.88	30	0.66	6.6
77-011	LONGEAR SUNFISH	I	M	C	S	2	3.0	0.59	90	1.97	30.0
77-012	REDEAR SUNFISH	I		C	E	1	1.5	0.29	12	0.26	8.0
77-015	GREEN SF X BLUEGILL SF					1	1.5	0.29	60	1.32	40.0
80-015	GREENSIDE DARTER	I	M	S	D	7	10.5	2.06	45	0.99	4.2
80-022	RAINBOW DARTER	I	M	S	D	28	42.0	8.24	45	0.99	1.0
80-024	FANTAIL DARTER	I		C	D	17	25.5	5.00	22	0.49	0.8

No Species: 18 **Nat. Species:** 17 **Hybrids:** 1 **Total Counted:** 340 **Total Rel. Wt. :** 4557

IBI: 32.0 **MIwb:** 7.2

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-007 Sycamore Creek RM: 1.10 Date: 07/24/2017

Time Fished: 1634 Distance: 0.150 Drainge (sq mi): 14.7 Depth: 0

Location: Lat: 39.21730 Long: -84.33160

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
40-016	WHITE SUCKER	O	T	S	W	17	113.3	1.79	2200	7.88	19.4
43-002	GOLDFISH	O	T	M	G	1	6.7	0.11	200	0.72	30.0
43-011	WESTERN BLACKNOSE DACE	G	T	S	N	170	1133.4	17.86	2266	8.11	2.0
43-013	CREEK CHUB	G	T	N	N	120	800.0	12.61	5800	20.76	7.2
43-025	STRIPED SHINER	I		S	N	1	6.7	0.11	13	0.05	2.0
43-039	SILVERJAW MINNOW	I		M	N	7	46.7	0.74	133	0.48	2.8
43-043	BLUNTNOSE MINNOW	O	T	C	N	84	560.0	8.82	1093	3.91	1.9
43-044	CENTRAL STONEROLLER	H		N	N	457	3046.8	48.00	15534	55.61	5.0
80-022	RAINBOW DARTER	I	M	S	D	2	13.3	0.21	26	0.10	2.0
80-024	FANTAIL DARTER	I		C	D	93	620.0	9.77	666	2.39	1.0

No Species: 10 **Nat. Species:** 9 **Hybrids:** 0 **Total Counted:** 952 **Total Rel. Wt. :** 27934

IBI: 26.0 **MIwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-007 Sycamore Creek RM: 1.10 Date: 09/21/2017

Time Fished: 1857 Distance: 0.150 Drainge (sq mi): 14.7 Depth: 0

Location: Lat: 39.21730 Long: -84.33160

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
40-016	WHITE SUCKER	O	T	S	W	25	50.0	2.76	1120	9.81	22.4
43-011	WESTERN BLACKNOSE DACE	G	T	S	N	151	302.0	16.67	960	8.41	3.1
43-013	CREEK CHUB	G	T	N	N	103	206.0	11.37	1680	14.71	8.1
43-043	BLUNTNOSE MINNOW	O	T	C	N	46	92.0	5.08	340	2.98	3.6
43-044	CENTRAL STONEROLLER	H		N	N	469	938.0	51.77	7040	61.65	7.5
80-024	FANTAIL DARTER	I		C	D	112	224.0	12.36	280	2.45	1.2

No Species: 6 **Nat. Species:** 6 **Hybrids:** 0 **Total Counted:** 906 **Total Rel. Wt. :** 11420

IBI: 34.0 **MIwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-049 Trib. to Sycamore Creek (RM 1.12) RM: 0.20 Date: 07/24/2017

Time Fished: 2067 Distance: 0.150 Drainge (sq mi): 5.6 Depth: 0

Location: Ust. Loveland Maderia Rd. Ust. OEPA site Lat: 39.21629 Long: -84.33609

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
40-016	WHITE SUCKER	O	T	S	W	24	48.0	3.51	0	0.00	0.0
43-011	WESTERN BLACKNOSE DACE	G	T	S	N	31	62.0	4.54	0	0.00	0.0
43-013	CREEK CHUB	G	T	N	N	219	438.0	32.06	0	0.00	0.0
43-039	SILVERJAW MINNOW	I		M	N	3	6.0	0.44	0	0.00	0.0
43-043	BLUNTNOSE MINNOW	O	T	C	N	37	74.0	5.42	0	0.00	0.0
43-044	CENTRAL STONEROLLER	H		N	N	355	710.0	51.98	0	0.00	0.0
80-024	FANTAIL DARTER	I		C	D	14	28.0	2.05	0	0.00	0.0

No Species: 7 **Nat. Species:** 7 **Hybrids:** 0 **Total Counted:** 683 **Total Rel. Wt. :** 0

IBI: 34.0 **MIwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-049 Trib. to Sycamore Creek (RM 1.12) RM: 1.20 Date: 07/24/2017

Time Fished: 1320 Distance: 0.150 Drainge (sq mi): 5.3 Depth: 0

Location: Lat: 0.00000 Long: 0.00000

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
43-013	CREEK CHUB	G	T	N	N	164	328.0	55.78	0	0.00	0.0
43-044	CENTRAL STONEROLLER	H		N	N	130	260.0	44.22	0	0.00	0.0

No Species: 2 **Nat. Species:** 2 **Hybrids:** 0 **Total Counted:** 294 **Total Rel. Wt. :** 0

IBI: 24.0 **MIwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-051 East Fork Duck Creek RM: 0.50 Date: 07/27/2017

Time Fished: 656 Distance: 0.150 Drainge (sq mi): 2.4 Depth: 0

Location: Lat: 39.16310 Long: -84.40220

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
43-011	WESTERN BLACKNOSE DACE	G	T	S	N	29	58.0	34.94	0	0.00	0.0
43-013	CREEK CHUB	G	T	N	N	28	56.0	33.73	0	0.00	0.0
43-044	CENTRAL STONEROLLER	H		N	N	26	52.0	31.33	0	0.00	0.0

No Species: 3 **Nat. Species:** 3 **Hybrids:** 0 **Total Counted:** 83 **Total Rel. Wt. :** 0

IBI: 24.0 **MIwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-051 East Fork Duck Creek RM: 2.00 Date: 07/26/2017

Time Fished: 1122 Distance: 0.150 Drainge (sq mi): 1.3 Depth: 0

Location: Lat: 0.00000 Long: 0.00000

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
43-011	WESTERN BLACKNOSE DACE	G	T	S	N	62	124.0	32.63	0	0.00	0.0
43-013	CREEK CHUB	G	T	N	N	93	186.0	48.95	0	0.00	0.0
43-044	CENTRAL STONEROLLER	H		N	N	35	70.0	18.42	0	0.00	0.0

No Species: 3 **Nat. Species:** 3 **Hybrids:** 0 **Total Counted:** 190 **Total Rel. Wt. :** 0

IBI: 26.0 **MIwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-051 East Fork Duck Creek RM: 2.30 Date: 08/30/2017

Time Fished: 0 Distance: 0.150 Drainge (sq mi): 0.5 Depth: 0

Location: RM 2.3 Lat: 39.18249 Long: -84.39899

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
99-997	Dry Site					0	0.0	***.**	0	0.00	*****.*

No Species: 1 **Nat. Species:** 1 **Hybrids:** 0 **Total Counted:** 0 **Total Rel. Wt. :** 0

IBI: 12.0 **Mlwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-075 Trib to Duck Creek @ RM 4.8 RM: 0.80 Date: 07/25/2017

Time Fished: 0 Distance: 0.150 Drainge (sq mi): 1.2 Depth: 0

Location: RM 0.8 Lat: 39.17404 Long: -84.42355

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
99-997	Dry Site					0	0.0	***.**	0	0.00	*****.*

No Species: 1 **Nat. Species:** 1 **Hybrids:** 0 **Total Counted:** 0 **Total Rel. Wt. :** 0

IBI: 12.0 **Mlwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-075 Trib to Duck Creek @ RM 4.8 RM: 5.00 Date: 07/25/2017

Time Fished: 789 Distance: 0.150 Drainge (sq mi): 1.4 Depth: 0

Location: Lat: 0.00000 Long: 0.00000

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
43-013	CREEK CHUB	G	T	N	N	1	2.0	100.00	4	100.00	2.0

No Species: 1 **Nat. Species:** 1 **Hybrids:** 0 **Total Counted:** 1 **Total Rel. Wt. :** 4

IBI: 12.0 **MIwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-076 Little Duck Creek RM: 0.49 Date: 07/27/2017

Time Fished: 0 Distance: 0.150 Drainge (sq mi): 1.6 Depth: 0

Location: Lat: 0.00000 Long: 0.00000

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
99-997	Dry Site					0	0.0	***.**	0	0.00	*****.*

No Species: 1 **Nat. Species:** 1 **Hybrids:** 0 **Total Counted:** 0 **Total Rel. Wt. :** 0

IBI: 12.0 **MIwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-076 Little Duck Creek RM: 1.00 Date: 07/27/2017

Time Fished: 532 Distance: 0.150 Drainge (sq mi): 1.1 Depth: 0

Location: at mouth Lat: 39.37690 Long: -84.21890

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
40-016	WHITE SUCKER	O	T	S	W	2	4.0	0.96	0	0.00	0.0
43-011	WESTERN BLACKNOSE DACE	G	T	S	N	94	188.0	45.19	0	0.00	0.0
43-013	CREEK CHUB	G	T	N	N	88	176.0	42.31	0	0.00	0.0
43-044	CENTRAL STONEROLLER	H		N	N	24	48.0	11.54	0	0.00	0.0

No Species: 4 **Nat. Species:** 4 **Hybrids:** 0 **Total Counted:** 208 **Total Rel. Wt. :** 0

IBI: 30.0 **MIwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-076 Little Duck Creek RM: 1.90 Date: 07/26/2017

Time Fished: 1408 Distance: 0.150 Drainge (sq mi): 0.4 Depth: 0

Location: Lat: 0.00000 Long: 0.00000

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
40-016	WHITE SUCKER	O	T	S	W	9	18.0	2.15	0	0.00	0.0
43-011	WESTERN BLACKNOSE DACE	G	T	S	N	206	412.0	49.16	0	0.00	0.0
43-013	CREEK CHUB	G	T	N	N	132	264.0	31.50	0	0.00	0.0
43-044	CENTRAL STONEROLLER	H		N	N	72	144.0	17.18	0	0.00	0.0

No Species: 4 **Nat. Species:** 4 **Hybrids:** 0 **Total Counted:** 419 **Total Rel. Wt. :** 0

IBI: 34.0 **MIwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-076 Little Duck Creek RM: 2.40 Date: 07/26/2017

Time Fished: 904 Distance: 0.150 Drainge (sq mi): 0.5 Depth: 0

Location: at Settle Rd. Lat: 39.15639 Long: -84.38515

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
40-016	WHITE SUCKER	O	T	S	W	2	4.0	0.68	0	0.00	0.0
43-011	WESTERN BLACKNOSE DACE	G	T	S	N	186	372.0	63.05	0	0.00	0.0
43-013	CREEK CHUB	G	T	N	N	44	88.0	14.92	0	0.00	0.0
43-044	CENTRAL STONEROLLER	H		N	N	63	126.0	21.36	0	0.00	0.0

No Species: 4 **Nat. Species:** 4 **Hybrids:** 0 **Total Counted:** 295 **Total Rel. Wt. :** 0

IBI: 36.0 **MIwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-077 Trib to Little Duck Cr. @ RM 4.42 RM: 0.20 Date: 08/30/2017

Time Fished: 918 Distance: 0.150 Drainge (sq mi): 0.5 Depth: 0

Location: Lat: 0.00000 Long: 0.00000

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
43-011	WESTERN BLACKNOSE DACE	G	T	S	N	253	506.0	100.00	0	0.00	0.0

No Species: 1 **Nat. Species:** 1 **Hybrids:** 0 **Total Counted:** 253 **Total Rel. Wt. :** 0

IBI: 26.0 **MIwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: River: 11-086 Trib 1.82 to Trib to Sycamore Cr RM: 2.40 Date: 07/26/2017

Time Fished: 0 Distance: RM1.12 0.150 Drainge (sq mi): 1.5 Depth: 0

Location: Lat: 0.00000 Long: 0.00000

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
99-997	Dry Site					0	0.0	***.**	0	0.00	*****.*

No Species: 1 **Nat. Species:** 1 **Hybrids:** 0 **Total Counted:** 0 **Total Rel. Wt. :** 0

IBI: 12.0 **MIwb:** N/A

Appendix B

Little Miami River 2017 Macroinvertebrate Assemblage Data
B-1: ICI Metrics & Scores
B-2: Macroinvertebrate Taxa by Site

Appendix Table A-1. ICI metrics and values from the Little Miam River watershed study area during 2017.

River Mile	Drainage Area (sq mi)	Number of: Total Taxa	Mayfly Taxa	Caddisfly Taxa	Dipteran Taxa	Percent: Mayflies	Caddis-flies	Tany-tarsini	Other Dipt/NI	Tolerant Organisms	Qual. EPT	ICI or Narrative
Little Miami River (11-001)												
Year: 2017												
27.90	1069.0	50(6)	12(6)	8(6)	20(6)	33.2(6)	33.9(6)	19.3(4)	12.3(6)	0.8(6)	19(6)	58
24.10	1085.0	46(6)	11(6)	7(6)	16(6)	29.0(6)	26.2(4)	28.1(6)	16.5(6)	1.3(4)	23(6)	56
22.30	1148.0										23	
21.50	1160.0										19	
18.50	1187.0	39(6)	7(4)	9(6)	15(6)	18.8(4)	59.1(6)	13.5(4)	7.4(6)	0.0(6)	19(6)	54
17.70	1190.0	42(6)	11(6)	8(6)	14(6)	29.5(6)	43.6(6)	13.4(4)	8.2(6)	0.0(6)	20(6)	58
13.10	1203.0	31(4)	8(6)	8(6)	9(4)	19.5(4)	55.4(6)	14.1(4)	10.4(6)	0.0(6)	20(6)	52
10.90	1707.0	38(6)	10(6)	7(6)	14(6)	21.7(6)	27.9(4)	31.6(6)	17.9(4)	1.1(6)	20(6)	56
8.10	1710.0										26	
6.83	1720.0	40(6)	11(6)	9(6)	12(6)	20.3(4)	52.7(6)	10.4(4)	15.8(4)	0.0(6)	20(6)	54
4.10	1730.0	36(6)	9(6)	8(6)	12(6)	16.8(4)	42.8(6)	22.1(6)	17.2(4)	0.3(6)	19(6)	56
3.40	1752.0	50(6)	8(6)	9(6)	24(6)	40.0(6)	6.8(2)	10.0(4)	42.1(0)	11.4(0)	19(6)	42
Duck Creek (11-004)												
Year: 2017												
6.10	2.2										0	
5.14	5.1										2	
4.58	5.8										3	
3.90	9.6										4	
3.40	7.3										4	
2.80	11.8	25(4)	2(0)	4(6)	15(4)	25.1(6)	5.8(6)	12.5(4)	56.4(2)	32.4(0)	3(0)	32
2.00	14.3	33(4)	3(2)	3(6)	21(6)	39.7(6)	21.8(6)	5.3(2)	33.1(4)	14.2(4)	6(2)	42
0.50	14.6	27(4)	3(2)	3(6)	17(4)	31.8(6)	4.8(6)	6.4(2)	57.0(2)	26.2(0)	6(2)	34
Sycamore Creek (11-007)												
Year: 2017												
1.10	14.7	32(4)	3(2)	6(6)	19(4)	4.9(2)	29.0(6)	23.7(6)	41.8(4)	5.4(6)	8(4)	44
0.50	24.0	36(4)	4(2)	4(6)	18(4)	12.9(2)	18.3(6)	18.5(4)	49.4(2)	0.9(6)	7(2)	38
0.10	24.0	27(4)	3(2)	5(6)	13(2)	4.4(2)	33.1(6)	5.9(2)	56.6(2)	14.8(4)	12(6)	36
Unnamed Trib to Sycamore Creek (11-049)												
Year: 2017												
1.20	5.3										8	
0.20	5.6	38(6)	4(2)	4(6)	24(6)	35.2(6)	2.2(6)	20.3(6)	41.8(4)	3.3(6)	8(4)	52
East Fork Duck Creek (11-051)												
Year: 2017												
2.00	1.3										1	

†

Appendix Table A-1. ICI metrics and values from the Little Miam River watershed study area during 2017.

River Mile	Drainage Area (sq mi)	Number of				Percent:						
		Total Taxa	Mayfly Taxa	Caddisfly Taxa	Dipteran Taxa	Mayflies	Caddis-flies	Tany-tarsini	Other Dipt/NI	Tolerant Organisms	Qual. EPT	ICI or Narrative
0.50	2.4										6	
Unnamed Trib to Duck Creek (11-075)												
Year: 2017												
5.00	1.4										1	
Little Duck Creek (11-076)												
Year: 2017												
2.40	0.5										8	
1.90	0.5										8	
1.00	1.1										7	
Unnamed Trib to Duck Creek (11-077)												
Year: 2017												
0.20	0.6										3	

Appendix Table C-2. Macroinvertebrate data collected by Ohio EPA in the Little Miami watershed during 2017.

River Code: **11-001** River: ***Little Miami River*** Coll. Date: *09/19/2017* RM: **27.90**

Site ID: **LM01** Location: Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.	
01801	Turbellaria		F	65	+
03360	Plumatella sp		F	1	+
03600	Oligochaeta		T	1	+
11119	Plauditus dubius or P. virilis		I	23	+
11130	Baetis intercalaris		F	546	+
13400	Stenacron sp		F	69	+
13510	Maccaffertium exiguum		MI	287	+
13521	Stenonema femoratum		F	4	+
13540	Maccaffertium mediopunctatum		MI	159	
13550	Maccaffertium mexicanum integrum		MI	6	
13561	Maccaffertium pulchellum		MI	231	+
13570	Maccaffertium terminatum		MI	255	+
16700	Tricorythodes sp		MI	346	+
17200	Caenis sp		F	8	
21200	Calopteryx sp		F		+
22001	Coenagrionidae		T		+
22300	Argia sp		F	1	+
23600	Aeshna sp		MT		+
34700	Agnetina capitata complex		MI	1	+
48410	Corydalus cornutus		MI		+
50315	Chimarra obscura		MI	1	+
51300	Neureclipsis sp		MI		+
51600	Polycentropus sp		MI	17	
52200	Cheumatopsyche sp		F	1009	+
52430	Ceratopsyche morosa group		MI	786	+
52510	Hydropsyche aerata		MI	144	
54160	Ochrotrichia sp		MI	19	+
59970	Petrophila sp		MI	69	+
68075	Psephenus herricki		MI		+
68901	Macronychus glabratus		F	1	
69400	Stenelmis sp		F		+
74100	Simulium sp		F		+
77120	Ablabesmyia mallochi		F	20	
77750	Hayesomyia senata or Thienemannimyia norena		F	117	+
78140	Labrundinia pilosella		F	16	
78450	Nilotanypus fimbriatus		F	8	
80310	Cardiocladius obscurus		MI	20	+
80360	Corynoneura floridaensis		MI	16	
80420	Cricotopus (C.) bicinctus		T	20	
80430	Cricotopus (C.) tremulus group		MT	20	
81231	Nanocladius (N.) crassicornus or N. (N.) "rectinervis"		F		+
83040	Dicrotendipes neomodestus		F	58	+
84300	Phaenopsectra obediens group		F	58	+
84450	Polypedilum (Uresipedilum) flavum		F	175	+
84470	Polypedilum (P.) illinoense		T		+
85615	Rheotanytarsus pellucidus		MI	39	+
85625	Rheotanytarsus sp		F	838	+
85752	Sublettea coffmani		MI	78	+
85821	Tanytarsus glabrescens group sp 7		F	78	
85840	Tanytarsus sepp		F	97	+
87501	Empididae		F		+
93200	Hydrobiidae		F		+
93900	Elimia sp		MI	10	+
96900	Ferrissia sp		F	26	
65800	Berosus sp		MT		+
18100	Anthopotamus sp		MI		+
34605	Perlinella drymo		MI		+
03040	Fredericella sp		F		+
05900	Lirceus sp		MT		+
11620	Paracloeodes minutus		MI		+
11014	Acentrella turbida		I	11	+
59407	Nectopsyche candida		MI	1	+
00401	Spongillidae		F		+
51206	Cyrnellus fraternus		F	8	
69000	Microcylloepus pusillus		MI	8	
82101	Thienemanniella taurocapita		MI	16	
82130	Thienemanniella similis		MI	32	
78750	Rheopelopia paramaculipennis		MI	20	
81200	Nanocladius sp		F	20	

No. Quantitative Taxa:	50	Total Taxa;	69
No. Qualitative Taxa:	49	ICI:	58
Number of Organisms:	5859	Qual EPT:	19

Appendix Table C-2. Macroinvertebrate data collected by Ohio EPA in the Little Miami watershed during 2017.

River Code: **11-001** River: ***Little Miami River*** Coll. Date: *09/19/2017* RM: **24.10**

Site ID: **LM02** Location: Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.
01320	Hydra sp		F	1
01801	Turbellaria		F	12 +
03600	Oligochaeta		T	20
05800	Caecidotea sp		T	1
06700	Crangonyx sp		MT	+
11119	Plauditus dubius or P. virilis		I	+
11130	Baetis intercalaris		F	92 +
12200	Isonychia sp		MI	1 +
13400	Stenacron sp		F	7 +
13510	Maccaffertium exiguum		MI	104 +
13521	Stenonema femoratum		F	37 +
13540	Maccaffertium mediopunctatum		MI	178 +
13550	Maccaffertium mexicanum integrum		MI	3
13561	Maccaffertium pulchellum		MI	183 +
13570	Maccaffertium terminatum		MI	235 +
16700	Tricorythodes sp		MI	167 +
17200	Caenis sp		F	4
22001	Coenagrionidae		T	+
22300	Argia sp		F	+
23700	Anax sp		MT	1
23909	Boyeria vinosa		F	+
34700	Agnetina capitata complex		MI	3 +
44501	Corixidae		F	+
48410	Corydalus cornutus		MI	+
50315	Chimarra obscura		MI	+
51300	Neureclipsis sp		MI	5 +
52200	Cheumatopsyche sp		F	762 +
52430	Ceratopsyche morosa group		MI	83 +
53501	Hydroptilidae		F	9 +
57400	Neophylax sp		MI	+
58505	Helicopsyche borealis		MI	+
59970	Petrophila sp		MI	4 +
68075	Psephenus herricki		MI	+
68601	Ancyronyx variegata		F	+
68708	Dubiraphia vittata group		F	+
68901	Macronychus glabratus		F	1
69400	Stenelmis sp		F	1 +
74100	Simulium sp		F	3 +
77120	Ablabesmyia mallochi		F	16
77750	Hayesomyia senata or Thienemannimyia norena		F	80
78655	Procladius (Holotanypus) sp		MT	+
80310	Cardiocladius obscurus		MI	+
80410	Cricotopus (C.) sp		F	16
80430	Cricotopus (C.) tremulus group		MT	16
82730	Chironomus (C.) decorus group		T	+
83040	Dicrotendipes neomodestus		F	+
84300	Phaenopsectra obediens group		F	64
84450	Polypedilum (Uresipedilum) flavum		F	113 +
84470	Polypedilum (P.) illinoense		T	16 +
84540	Polypedilum (Tripodura) scalaenum group		F	48 +
85500	Paratanytarsus sp		F	16
85615	Rheotanytarsus pellucidus		MI	724
85625	Rheotanytarsus sp		F	193
85752	Sublettea coffmani		MI	+
85800	Tanytarsus sp		F	+
85821	Tanytarsus glabrescens group sp 7		F	32
85840	Tanytarsus sepp		F	16 +
87540	Hemerodromia sp		F	32
93200	Hydrobiidae		F	+
93900	Elimia sp		MI	24 +
96900	Ferrissia sp		F	9 +
97601	Corbicula fluminea		F	88 +
98600	Sphaerium sp		F	+
00401	Spongillidae		F	+
18100	Anthopotamus sp		MI	+
13100	Nixe sp		MI	+
11620	Paracloeodes minutus		MI	+
59407	Nectopsyche candida		MI	6 +
03040	Fredericella sp		F	+
52510	Hydropsyche aerata		MI	45 +
51206	Cyrnellus fraternus		F	5
84100	Paracladopelma sp			+
85720	Stempellinella fimbriata		MI	+
78750	Rheopelopia paramaculipennis		MI	16

No. Quantitative Taxa:	46	Total Taxa;	74
No. Qualitative Taxa:	55	ICI:	56
Number of Organisms:	3492	Qual EPT:	23

Appendix Table C-2. Macroinvertebrate data collected by Ohio EPA in the Little Miami watershed during 2017.

River Code: **11-001** River: ***Little Miami River*** Coll. Date: *09/20/2017* RM: **22.30**

Site ID: **LM03** Location: Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.
01801	Turbellaria		F	+
03600	Oligochaeta		T	+
05900	Lirceus sp		MT	+
11119	Plauditus dubius or P. virilis		I	+
11130	Baetis intercalaris		F	+
12200	Isonychia sp		MI	+
13400	Stenacron sp		F	+
13510	Maccaffertium exiguum		MI	+
13521	Stenonema femoratum		F	+
13540	Maccaffertium mediopunctatum		MI	+
13550	Maccaffertium mexicanum integrum		MI	+
13570	Maccaffertium terminatum		MI	+
16700	Tricorythodes sp		MI	+
17200	Caenis sp		F	+
21300	Hetaerina sp		F	+
22001	Coenagrionidae		T	+
22300	Argia sp		F	+
34700	Agnetina capitata complex		MI	+
50315	Chimarra obscura		MI	+
51300	Neureclipsis sp		MI	+
52200	Cheumatopsyche sp		F	+
52430	Ceratopsyche morosa group		MI	+
52510	Hydropsyche aerata		MI	+
53400	Protoptila sp		I	+
53501	Hydroptilidae		F	+
59580	Oecetis persimilis		MI	+
59970	Petrophila sp		MI	+
68075	Psephenus herricki		MI	+
68130	Helichus sp		F	+
69400	Stenelmis sp		F	+
74100	Simulium sp		F	+
79100	Thienemannimyia group		F	+
80310	Cardiocladius obscurus		MI	+
80440	Cricotopus (C.) trifascia		F	+
82730	Chironomus (C.) decorus group		T	+
84300	Phaenopsectra obediens group		F	+
84450	Polypedilum (Uresipedilum) flavum		F	+
85625	Rheotanytarsus sp		F	+
85800	Tanytarsus sp		F	+
85821	Tanytarsus glabrescens group sp 7		F	+
85840	Tanytarsus sepp		F	+
93900	Elimia sp		MI	+
96900	Ferrissia sp		F	+
97601	Corbicula fluminea		F	+
18100	Anthopotamus sp		MI	+
34300	Neoperla clymene complex		I	+
26700	Macromia sp		MI	+
06904	Synurella dentata		MT	+
11014	Acentrella turbida		I	+
84100	Paracladopelma sp			+

No. Quantitative Taxa:	0	Total Taxa;	50
No. Qualitative Taxa:	50	ICI:	
Number of Organisms:	0	Qual EPT:	23

Appendix Table C-2. Macroinvertebrate data collected by Ohio EPA in the Little Miami watershed during 2017.

River Code: **11-001** River: ***Little Miami River*** Coll. Date: *09/20/2017* RM: **21.50**

Site ID: **LM05** Location: Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.
01320	Hydra sp		F	+
01801	Turbellaria		F	+
03360	Plumatella sp		F	+
03600	Oligochaeta		T	+
11119	Plauditus dubius or P. virilis		I	+
11130	Baetis intercalaris		F	+
12200	Isonychia sp		MI	+
13000	Leucrocuta sp		MI	+
13400	Stenacron sp		F	+
13510	Maccaffertium exiguum		MI	+
13521	Stenonema femoratum		F	+
13540	Maccaffertium mediopunctatum		MI	+
13570	Maccaffertium terminatum		MI	+
16700	Tricorythodes sp		MI	+
17200	Caenis sp		F	+
21200	Calopteryx sp		F	+
21300	Hetaerina sp		F	+
22001	Coenagrionidae		T	+
22300	Argia sp		F	+
44501	Corixidae		F	+
50315	Chimarra obscura		MI	+
52200	Cheumatopsyche sp		F	+
52430	Ceratopsyche morosa group		MI	+
53800	Hydroptila sp		F	+
60900	Peltodytes sp		MT	+
68075	Psephenus herricki		MI	+
68901	Macronychus glabratus		F	+
69400	Stenelmis sp		F	+
74100	Simulium sp		F	+
80310	Cardiocladius obscurus		MI	+
81231	Nanocladius (N.) crassicornus or N. (N.) "rectinervis"		F	+
82730	Chironomus (C.) decorus group		T	+
84000	Parachironomus sp		MT	+
84450	Polypedilum (Uresipedilum) flavum		F	+
84470	Polypedilum (P.) illinoense		T	+
84700	Stenochironomus sp		F	+
85230	Cladotanytarsus mancus group		F	+
85625	Rheotanytarsus sp		F	+
85800	Tanytarsus sp		F	+
85840	Tanytarsus sepp		F	+
87540	Hemerodromia sp		F	+
93900	Elimia sp		MI	+
95100	Physella sp		T	+
96900	Ferrissia sp		F	+
97601	Corbicula fluminea		F	+
98600	Sphaerium sp		F	+
18100	Anthopotamus sp		MI	+
59407	Nectopsyche candida		MI	+
34300	Neoperla clymene complex		I	+
11014	Acentrella turbida		I	+

No. Quantitative Taxa:	0	Total Taxa;	50
No. Qualitative Taxa:	50	ICI:	
Number of Organisms:	0	Qual EPT:	19

Appendix Table C-2. Macroinvertebrate data collected by Ohio EPA in the Little Miami watershed during 2017.

River Code: **11-001** River: ***Little Miami River*** Coll. Date: *09/21/2017* RM: **18.50**

Site ID: **LM07** Location: *Adj. Glendale Milford Rd.* Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.	
01801	Turbellaria		F	30	+
03360	Plumatella sp		F	1	
03600	Oligochaeta		T		+
11130	Baetis intercalaris		F	294	+
13000	Leucrocuta sp		MI		+
13400	Stenacron sp		F		+
13510	Maccaffertium exiguum		MI	167	
13521	Stenonema femoratum		F		+
13540	Maccaffertium mediopunctatum		MI	11	
13550	Maccaffertium mexicanum integrum		MI	2	
13561	Maccaffertium pulchellum		MI	107	+
13570	Maccaffertium terminatum		MI	32	+
16700	Tricorythodes sp		MI	356	+
17200	Caenis sp		F		+
21300	Hetaerina sp		F		+
22300	Argia sp		F		+
34700	Agnetina capitata complex		MI	7	+
50315	Chimarra obscura		MI	24	+
51300	Neureclipsis sp		MI	9	
52200	Cheumatopsyche sp		F	1378	+
52430	Ceratopsyche morosa group		MI	1384	+
52510	Hydropsyche aerata		MI	72	+
52570	Hydropsyche simulans		MI	70	
53400	Protoptila sp		I	16	
53800	Hydroptila sp		F	11	+
59970	Petrophila sp		MI	38	+
68075	Psephenus herricki		MI		+
68901	Macronychus glabratus		F	5	+
69400	Stenelmis sp		F	6	+
71900	Tipula sp		F		+
74100	Simulium sp		F	13	+
77500	Conchapelopia sp		F	11	
77750	Hayesomyia senata or Thienemannimyia norena		F	11	
77800	Helopelopia sp		F	11	
80310	Cardiocladius obscurus		MI	32	+
80410	Cricotopus (C.) sp		F		+
80420	Cricotopus (C.) bicinctus		T		+
80430	Cricotopus (C.) tremulus group		MT	11	
82121	Thienemanniella lobapodema		F	16	
82220	Tvetenia discoloripes group		MI	42	+
82730	Chironomus (C.) decorus group		T		+
83040	Dicrotendipes neomodestus		F		+
83820	Microtendipes "caelum" (sensu Simpson & Bode, 1980)		MI		+
84450	Polypedilum (Uresipedilum) flavum		F	84	+
84470	Polypedilum (P.) illinoense		T		+
84540	Polypedilum (Tripodura) scalaenum group		F	11	
85615	Rheotanytarsus pellucidus		MI	84	+
85625	Rheotanytarsus sp		F	612	+
87540	Hemerodromia sp		F	65	
93900	Elimia sp		MI	12	
97601	Corbicula fluminea		F	1	
25010	Hagenius brevistylus		F		+
11620	Paracloeodes minutus		MI		+
68130	Helichus sp		F		+
18600	Ephemera sp		MI		+
26700	Macromia sp		MI		+
18100	Anthopotamus sp		MI		+
59407	Nectopsyche candida		MI		+
34605	Perlinella drymo		MI		+
82130	Thienemanniella similis		MI	16	
82101	Thienemanniella taurocapita		MI	16	
52801	Potamyia flava		MI	74	

No. Quantitative Taxa:	39	Total Taxa;	62
No. Qualitative Taxa:	43	ICI:	54
Number of Organisms:	5142	Qual EPT:	19

Appendix Table C-2. Macroinvertebrate data collected by Ohio EPA in the Little Miami watershed during 2017.

River Code: **11-001** River: ***Little Miami River*** Coll. Date: *09/21/2017* RM: **17.70**

Site ID: **LM08** Location: Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.
01801	Turbellaria		F	197 +
03360	Plumatella sp		F	+
03600	Oligochaeta		T	+
08601	Hydrachnidia		F	+
11119	Plauditus dubius or P. virilis		I	1 +
11130	Baetis intercalaris		F	479 +
12200	Isonychia sp		MI	3
13400	Stenacron sp		F	21 +
13510	Maccaffertium exiguum		MI	211 +
13521	Stenonema femoratum		F	45
13540	Maccaffertium mediopunctatum		MI	105 +
13561	Maccaffertium pulchellum		MI	133 +
13570	Maccaffertium terminatum		MI	451 +
16700	Tricorythodes sp		MI	67 +
17200	Caenis sp		F	8 +
21300	Hetaerina sp		F	1 +
22001	Coenagrionidae		T	+
22300	Argia sp		F	+
27400	Neurocordulia sp		F	1
34700	Agnetina capitata complex		MI	1 +
44501	Corixidae		F	+
48410	Corydalus cornutus		MI	1
50315	Chimarra obscura		MI	+
51300	Neureclipsis sp		MI	22 +
52200	Cheumatopsyche sp		F	1560 +
52430	Ceratopsyche morosa group		MI	493 +
52510	Hydropsyche aerata		MI	130
52801	Potamyia flava		MI	29
53501	Hydroptilidae		F	16
59500	Oecetis sp		F	+
59700	Triaenodes sp		MI	+
59970	Petrophila sp		MI	264 +
68075	Psephenus herricki		MI	+
68130	Helichus sp		F	+
68601	Ancyronyx variegata		F	8
68901	Macronychus glabratus		F	1 +
69400	Stenelmis sp		F	+
74100	Simulium sp		F	32 +
77120	Ablabesmyia mallochi		F	+
77800	Helopelopia sp		F	19
78350	Meropelopia sp	X	F	10
80310	Cardiocladius obscurus		MI	29 +
80440	Cricotopus (C.) trifascia		F	+
81231	Nanocladius (N.) crassicornus or N. (N.) "rectinervis"		F	+
82100	Thienemanniella sp			19
82220	Tvetenia discoloripes group		MI	19
82730	Chironomus (C.) decorus group		T	+
82820	Cryptochironomus sp		F	+
83820	Microtendipes "caelum" (sensu Simpson & Bode, 1980)		MI	10
84300	Phaenopsectra obediens group		F	10 +
84450	Polypedilum (Uresipedilum) flavum		F	78
84470	Polypedilum (P.) illinoense		T	+
85615	Rheotanytarsus pellucidus		MI	19
85625	Rheotanytarsus sp		F	643 +
85818	Tanytarsus glabrescens group sp 4		F	+
85821	Tanytarsus glabrescens group sp 7		F	10
85840	Tanytarsus sepp		F	19
87540	Hemerodromia sp		F	2
93200	Hydrobiidae		F	+
93900	Elimia sp		MI	1 +
96900	Ferrissia sp		F	+
97601	Corbicula fluminea		F	+
98600	Sphaerium sp		F	+
18100	Anthopotamus sp		MI	+
59407	Nectopsyche candida		MI	1 +
24700	Dromogomphus sp		F	+
23804	Basiaeschna janata		F	+
34300	Neoperla clymene complex		I	+
52570	Hydropsyche simulans		MI	3
52521	Hydropsyche bidens or H. orris		MI	+

No. Quantitative Taxa:	42	Total Taxa;	70
No. Qualitative Taxa:	51	ICI:	58
Number of Organisms:	5172	Qual EPT:	20

Appendix Table C-2. Macroinvertebrate data collected by Ohio EPA in the Little Miami watershed during 2017.

River Code: **11-001** River: ***Little Miami River*** Coll. Date: *09/19/2017* RM: **13.10**

Site ID: **LM09** Location: Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.	
01801	Turbellaria		F	39	+
03360	Plumatella sp		F	1	+
11119	Plauditus dubius or P. virilis		I	9	+
11130	Baetis intercalaris		F	704	+
13400	Stenacron sp		F		+
13510	Maccaffertium exiguum		MI	101	
13540	Maccaffertium mediopunctatum		MI	10	+
13561	Maccaffertium pulchellum		MI	83	+
13570	Maccaffertium terminatum		MI	3	+
16700	Tricorythodes sp		MI	8	+
17200	Caenis sp		F		+
21300	Hetaerina sp		F		+
22001	Coenagrionidae		T		+
22300	Argia sp		F		+
34700	Agnetina capitata complex		MI	3	
50315	Chimarra obscura		MI	1	+
51300	Neureclipsis sp		MI	2	+
51600	Polycentropus sp		MI		+
52200	Cheumatopsyche sp		F	994	+
52430	Ceratopsyche morosa group		MI	1538	+
52510	Hydropsyche aerata		MI	42	+
52570	Hydropsyche simulans		MI	2	
52801	Potamyia flava		MI	37	
53800	Hydroptila sp		F	8	+
59407	Nectopsyche candida		MI		+
59970	Petrophila sp		MI	15	+
68075	Psephenus herricki		MI		+
68130	Helichus sp		F		+
68901	Macronychus glabratus		F	6	
69400	Stenelmis sp		F		+
74100	Simulium sp		F	279	+
77750	Hayesomyia senata or Thienemannimyia norena		F	8	
80310	Cardiocladius obscurus		MI	16	+
80430	Cricotopus (C.) tremulus group		MT	8	
82220	Tvetenia discoloripes group		MI	96	
82730	Chironomus (C.) decorus group		T		+
84450	Polypedilum (Uresipedilum) flavum		F	24	
85615	Rheotanytarsus pellucidus		MI	16	+
85625	Rheotanytarsus sp		F	653	+
85800	Tanytarsus sp		F		+
87540	Hemerodromia sp		F	16	
93900	Elimia sp		MI		+
96900	Ferrissia sp		F		+
97601	Corbicula fluminea		F		+
98600	Sphaerium sp		F	8	
18100	Anthopotamus sp		MI		+
65800	Berosus sp		MT		+
26700	Macromia sp		MI		+
11620	Paracloeodes minutus		MI		+
34300	Neoperla clymene complex		I		+
11014	Acentrella turbida		I	8	+
25600	Stylurus sp		MI		+

No. Quantitative Taxa:	31	Total Taxa;	52
No. Qualitative Taxa:	41	ICI:	52
Number of Organisms:	4738	Qual EPT:	20

Appendix Table C-2. Macroinvertebrate data collected by Ohio EPA in the Little Miami watershed during 2017.

River Code: **11-001** River: ***Little Miami River*** Coll. Date: *09/22/2017* RM: **10.90**

Site ID: **LM11** Location: Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.	
01801	Turbellaria		F	18	+
03360	Plumatella sp		F	3	+
03600	Oligochaeta		T		+
00401	Spongillidae		F		+
06904	Synurella dentata		MT		+
11119	Plauditus dubius or P. virilis		I	33	+
11130	Baetis intercalaris		F	285	+
13000	Leucrocuta sp		MI		+
13400	Stenacron sp		F	15	
13510	Maccaffertium exiguum		MI	120	+
13540	Maccaffertium mediopunctatum		MI	4	+
13561	Maccaffertium pulchellum		MI	152	+
13570	Maccaffertium terminatum		MI	79	+
16700	Tricorythodes sp		MI	231	+
17200	Caenis sp		F	16	+
21200	Calopteryx sp		F	19	
21300	Hetaerina sp		F		+
22001	Coenagrionidae		T		+
34700	Agnetina capitata complex		MI		+
44501	Corixidae		F		+
50315	Chimarra obscura		MI	17	+
51300	Neureclipsis sp		MI	33	+
52200	Cheumatopsyche sp		F	859	+
52430	Ceratopsyche morosa group		MI	207	+
52510	Hydropsyche aerata		MI	6	+
52801	Potamyia flava		MI	28	
53800	Hydroptila sp		F	57	+
59970	Petrophila sp		MI	15	
65800	Berosus sp		MT		+
68601	Ancyronyx variegata		F		+
68901	Macronychus glabratus		F	5	
69400	Stenelmis sp		F		+
74100	Simulium sp		F	33	+
77750	Hayesomyia senata or Thienemannimyia norena		F	40	
80310	Cardiocladius obscurus		MI	29	+
80350	Corynoneura sp			16	
80430	Cricotopus (C.) tremulus group		MT	79	
82730	Chironomus (C.) decorus group		T		+
84450	Polypedilum (Uresipedilum) flavum		F	416	+
84470	Polypedilum (P.) illinoense		T	40	+
85615	Rheotanytarsus pellucidus		MI	79	+
85625	Rheotanytarsus sp		F	1090	
85800	Tanytarsus sp		F		+
85821	Tanytarsus glabrescens group sp 7		F	198	
87540	Hemerodromia sp		F	32	
93900	Elimia sp		MI	2	+
96900	Ferrissia sp		F	8	+
18100	Anthopotamus sp		MI	4	+
59407	Nectopsyche candida		MI		+
11600	Paracloeodes fleeki		MI		+
34300	Neoperla clymene complex		I		+
80480	Cricotopus (Isocladius) sp		MT		+
78750	Rheopelopia paramaculipennis		MI	20	
80470	Cricotopus (C.) or Orthocladius (O.) sp			20	
84040	Parachironomus frequens		F	20	

No. Quantitative Taxa:	38	Total Taxa;	55
No. Qualitative Taxa:	41	ICI:	56
Number of Organisms:	4328	Qual EPT:	20

Appendix Table C-2. Macroinvertebrate data collected by Ohio EPA in the Little Miami watershed during 2017.

River Code: **11-001** River: ***Little Miami River*** Coll. Date: *09/27/2017* RM: **8.10**

Site ID: **LM12** Location: Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.
01801	Turbellaria		**F**	+
03360	Plumatella sp		**F**	+
03600	Oligochaeta		**T**	+
06700	Crangonyx sp		**MT**	+
11020	Acerpenna pygmaea		**MI**	+
11119	Plauditus dubius or P. virilis		**I**	+
11130	Baetis intercalaris		**F**	+
11155	Iswaeon anoka		**MI**	+
13000	Leucrocuta sp		**MI**	+
13400	Stenacron sp		**F**	+
13521	Stenonema femoratum		**F**	+
13540	Maccaffertium mediopunctatum		**MI**	+
13561	Maccaffertium pulchellum		**MI**	+
13570	Maccaffertium terminatum		**MI**	+
16700	Tricorythodes sp		**MI**	+
17200	Caenis sp		**F**	+
21300	Hetaerina sp		**F**	+
22001	Coenagrionidae		**T**	+
22300	Argia sp		**F**	+
24900	Gomphus sp		**F**	+
34700	Agnetina capitata complex		**MI**	+
44501	Corixidae		**F**	+
50315	Chimarra obscura		**MI**	+
51600	Polycentropus sp		**MI**	+
52200	Cheumatopsyche sp		**F**	+
52430	Ceratopsyche morosa group		**MI**	+
52560	Hydropsyche orris		**MI**	+
53800	Hydroptila sp		**F**	+
59970	Petrophila sp		**MI**	+
68075	Psephenus herricki		**MI**	+
69400	Stenelmis sp		**F**	+
71900	Tipula sp		**F**	+
74100	Simulium sp		**F**	+
77120	Ablabesmyia mallochi		**F**	+
80420	Cricotopus (C.) bicinctus		**T**	+
80430	Cricotopus (C.) tremulus group		**MT**	+
80440	Cricotopus (C.) trifascia		**F**	+
84450	Polypedilum (Uresipedilum) flavum		**F**	+
84470	Polypedilum (P.) illinoense		**T**	+
85625	Rheotanytarsus sp		**F**	+
93900	Elimia sp		**MI**	+
96900	Ferrissia sp		**F**	+
97601	Corbicula fluminea		**F**	+
59407	Nectopsyche candida		**MI**	+
34605	Perlinella drymo		**MI**	+
03040	Fredericella sp		**F**	+
18100	Anthopotamus sp		**MI**	+
65800	Berosus sp		**MT**	+
52510	Hydropsyche aerata		**MI**	+
11014	Acentrella turbida		**I**	+
34300	Neoperla clymene complex		**I**	+
23804	Basiaeschna janata		**F**	+
11620	Paracloeodes minutus		**MI**	+
85230	Cladotanytarsus mancus group		**F**	+
84155	Paralauterborniella nigrohalteralis		**F**	+

No. Quantitative Taxa:	0	Total Taxa;	55
No. Qualitative Taxa:	55	ICI:	
Number of Organisms:	0	Qual EPT:	26

Appendix Table C-2. Macroinvertebrate data collected by Ohio EPA in the Little Miami watershed during 2017.

River Code: **11-001** River: ***Little Miami River*** Coll. Date: *09/29/2017* RM: **6.83**

Site ID: **LM13** Location: Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.	
01801	Turbellaria		F	611	+
03360	Plumatella sp		F	1	+
03600	Oligochaeta		T		+
04985					+
08601	Hydrachnidia		F		+
11119	Plauditus dubius or P. virilis		I	2	+
11130	Baetis intercalaris		F	479	+
12200	Isonychia sp		MI	45	
13400	Stenacron sp		F	28	+
13510	Maccaffertium exiguum		MI	762	+
13540	Maccaffertium mediopunctatum		MI	73	+
13561	Maccaffertium pulchellum		MI	364	+
13570	Maccaffertium terminatum		MI	68	+
16700	Tricorythodes sp		MI	97	+
17200	Caenis sp		F	8	
21300	Hetaerina sp		F	2	+
22001	Coenagrionidae		T		+
22300	Argia sp		F		+
34700	Agnetina capitata complex		MI	1	+
50315	Chimarra obscura		MI	1	+
51300	Neureclipsis sp		MI	27	+
52200	Cheumatopsyche sp		F	3346	+
52430	Ceratopsyche morosa group		MI	1350	+
52510	Hydropsyche aerata		MI	64	+
52560	Hydropsyche orris		MI	56	
52570	Hydropsyche simulans		MI	53	
53400	Protoptila sp		I		+
53800	Hydroptila sp		F	47	+
59407	Nectopsyche candida		MI		+
59970	Petrophila sp		MI	61	+
68075	Psephenus herricki		MI		+
68901	Macronychus glabratus		F	9	
69400	Stenelmis sp		F	2	+
74100	Simulium sp		F	373	+
77750	Hayesomyia senata or Thienemannimyia norena		F	35	
78450	Nilotanypus fimbriatus		F	8	
78655	Procladius (Holotanypus) sp		MT		+
80310	Cardiocladius obscurus		MI	87	
80440	Cricotopus (C.) trifascia		F	17	
81240	Nanocladius (N.) distinctus		MT		+
82220	Tvetenia discoloripes group		MI	69	
82730	Chironomus (C.) decorus group		T		+
84450	Polypedilum (Uresipedilum) flavum		F	139	
84470	Polypedilum (P.) illinoense		T		+
84540	Polypedilum (Tripodura) scalaenum group		F		+
85625	Rheotanytarsus sp		F	988	+
87540	Hemerodromia sp		F	96	
93900	Elimia sp		MI		+
97601	Corbicula fluminea		F		+
98600	Sphaerium sp		F		+
00401	Spongillidae		F		+
03121	Paludicella articulata		MI	1	+
52801	Potamyia flava		MI	54	+
69000	Microcylloepus pusillus		MI		+
18700	Hexagenia sp		F		+
11014	Acentrella turbida		I	2	+
84040	Parachironomus frequens		F	17	+
82130	Thienemanniella similis		MI	8	
82101	Thienemanniella taurocapita		MI	32	

No. Quantitative Taxa:	40	Total Taxa;	59
No. Qualitative Taxa:	45	ICI:	54
Number of Organisms:	9483	Qual EPT:	20

Appendix Table C-2. Macroinvertebrate data collected by Ohio EPA in the Little Miami watershed during 2017.

River Code: **11-001** River: ***Little Miami River*** Coll. Date: *09/28/2017* RM: **4.10**

Site ID: **LM15** Location: Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.	
01801	Turbellaria		F	5	
03360	Plumatella sp		F	1	+
03600	Oligochaeta		T	16	
08601	Hydrachnidia		F		+
11119	Plauditus dubius or P. virilis		I	34	+
11130	Baetis intercalaris		F	150	+
12200	Isonychia sp		MI	12	
13000	Leucrocuta sp		MI		+
13400	Stenacron sp		F		+
13510	Maccaffertium exiguum		MI	347	+
13540	Maccaffertium mediopunctatum		MI	91	+
13561	Maccaffertium pulchellum		MI	198	+
13570	Maccaffertium terminatum		MI	91	+
16700	Tricorythodes sp		MI	19	+
21300	Hetaerina sp		F	1	
22001	Coenagrionidae		T		+
27400	Neurocordulia sp		F		+
34700	Agnetina capitata complex		MI	7	
44501	Corixidae		F		+
50315	Chimarra obscura		MI	58	+
52200	Cheumatopsyche sp		F	1348	+
52430	Ceratopsyche morosa group		MI	800	+
52510	Hydropsyche aerata		MI	8	
52801	Potamyia flava		MI	114	+
53800	Hydroptila sp		F	27	+
59970	Petrophila sp		MI	4	
68075	Psephenus herricki		MI		+
68901	Macronychus glabratus		F	49	+
69400	Stenelmis sp		F		+
74100	Simulium sp		F	83	+
77120	Ablabesmyia mallochi		F		+
77750	Hayesomyia senata or Thienemannimyia norena		F	100	+
78350	Meropelopia sp	X	F	20	
78450	Nilotanypus fimbriatus		F	16	
80310	Cardiocladius obscurus		MI	261	+
80440	Cricotopus (C.) trifascia		F	40	
82220	Tvetenia discoloripes group		MI	100	
82820	Cryptochironomus sp		F		+
83040	Dicrotendipes neomodestus		F		+
83820	Microtendipes "caelum" (sensu Simpson & Bode, 1980)		MI		+
84000	Parachironomus sp		MT		+
84450	Polypedilum (Uresipedilum) flavum		F	261	
84470	Polypedilum (P.) illinoense		T		+
85615	Rheotanytarsus pellucidus		MI	20	
85625	Rheotanytarsus sp		F	1245	
87540	Hemerodromia sp		F	49	
93900	Elimia sp		MI		+
95100	Physella sp		T		+
96900	Ferrissia sp		F		+
18100	Anthopotamus sp		MI		+
59407	Nectopsyche candida		MI		+
34300	Neoperla clymene complex		I		+
11600	Paracloeodes fleeki		MI		+
11014	Acentrella turbida		I	17	+
24501	Gomphidae		F		+
70501	Tipulidae				+
84040	Parachironomus frequens		F		+
52521	Hydropsyche bidens or H. orris		MI	79	
52570	Hydropsyche simulans		MI	14	
82130	Thienemanniella similis		MI	32	

No. Quantitative Taxa:	36	Total Taxa;	60
No. Qualitative Taxa:	42	ICI:	56
Number of Organisms:	5717	Qual EPT:	19

Appendix Table C-2. Macroinvertebrate data collected by Ohio EPA in the Little Miami watershed during 2017.

River Code:**11-001** River: Coll. Date: / / RM: **3.40**

Site ID: Location: Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.	
01801	Turbellaria		F	30	
03360	Plumatella sp		F		+
03600	Oligochaeta		T	382	+
04985				1	
11130	Baetis intercalaris		F	2	+
12200	Isonychia sp		MI	1	+
13510	Maccaffertium exiguum		MI	648	+
13521	Stenonema femoratum		F	23	
13540	Maccaffertium mediopunctatum		MI	51	+
13561	Maccaffertium pulchellum		MI	446	+
13570	Maccaffertium terminatum		MI	157	+
16700	Tricorythodes sp		MI	395	
21300	Hetaerina sp		F	3	+
22001	Coenagrionidae		T		+
22300	Argia sp		F	9	+
27400	Neurocordulia sp		F	1	+
34700	Agnetina capitata complex		MI		+
50315	Chimarra obscura		MI	1	+
51300	Neureclipsis sp		MI	8	+
52200	Cheumatopsyche sp		F	195	+
52430	Ceratopsyche morosa group		MI	8	+
52801	Potamyia flava		MI	11	+
52530	Hydropsyche depravata group		F	17	
52550	Hydropsyche frisoni		MI		+
53800	Hydroptila sp		F	29	
59970	Petrophila sp		MI	2	
68601	Ancyronyx variegata		F	3	+
68901	Macronychus glabratus		F	28	+
69400	Stenelmis sp		F		+
74100	Simulium sp		F		+
77100	Ablabesmyia sp				+
77120	Ablabesmyia mallochi		F	36	
77750	Hayesomyia senata or Thienemannimyia norena		F	614	
77800	Helopelopia sp		F	18	
78140	Labrundinia pilosella		F	56	
80310	Cardiocladius obscurus		MI		+
80360	Corynoneura floridaensis		MI	16	
80410	Cricotopus (C.) sp		F	36	
80420	Cricotopus (C.) bicinctus		T	18	+
80430	Cricotopus (C.) tremulus group		MT	18	
80440	Cricotopus (C.) trifascia		F		+
81240	Nanocladius (N.) distinctus		MT	18	
82730	Chironomus (C.) decorus group		T		+
82820	Cryptochironomus sp		F		+
83040	Dicrotendipes neomodestus		F	109	
83050	Dicrotendipes lucifer		MT	18	
83300	Glyptotendipes (G.) sp		MT	36	
84300	Phaenopsectra obediens group		F	36	+
84450	Polypedilum (Uresipedilum) flavum		F	36	+
84470	Polypedilum (P.) illinoense		T	73	+
84520	Polypedilum (Tripodura) halterale group		MT		+
84540	Polypedilum (Tripodura) scalaenum group		F	73	
84790	Tribelos fuscicorne		F	36	
85625	Rheotanytarsus sp		F	254	
85800	Tanytarsus sp		F		+
85821	Tanytarsus glabrescens group sp 7		F	22	
85840	Tanytarsus sepp		F	137	
87540	Hemerodromia sp		F	82	
95100	Physella sp		T		+
97601	Corbicula fluminea		F		+
59407	Nectopsyche candida		MI	10	+
18100	Anthopotamus sp		MI		+
03040	Fredericella sp		F		+
34605	Perlinella drymo		MI		+
13100	Nixe sp		MI		+
11620	Paracloeodes minutus		MI		+
11014	Acentrella turbida		I		+
51206	Cyrnellus fraternus		F	13	
84060	Parachironomus pectinatellae		MI	54	
83410	Harnischia curtilamellata		F	18	
85700	Stempellina sp		MI	16	

No. Quantitative Taxa:	50	Total Taxa;	71
No. Qualitative Taxa:	43	ICI:	42
Number of Organisms:	4304	Qual EPT:	19

Appendix Table C-2. Macroinvertebrate data collected by Ohio EPA in the Little Miami watershed during 2017.

River Code: **11-004** River: ***Duck Creek*** Coll. Date: *08/31/2017* RM: **6.10**

Site ID: **LM71** Location: Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.
01801	Turbellaria		**F**	+
03600	Oligochaeta		**T**	+
03600	Oligochaeta		**T**	+
77500	Conchapelopia sp		**F**	+
82730	Chironomus (C.) decorus group		**T**	+
82770	Chironomus (C.) riparius group		**T**	+
84470	Polypedilum (P.) illinoense		**T**	+
04960	Erpobdella sp (= Mooreobdella)		**MT**	+
72150	Pericoma sp		**MT**	+
84960	Pseudochironomus sp		**F**	+
77250	Alotanypus venustus		**VT**	+
83003	Dicrotendipes fumidus		**F**	+
80470	Cricotopus (C.) or Orthocladius (O.) sp			+

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.

No. Quantitative Taxa:	0	Total Taxa;	13
No. Qualitative Taxa:	13	ICI:	
Number of Organisms:	0	Qual EPT:	0

Appendix Table C-2. Macroinvertebrate data collected by Ohio EPA in the Little Miami watershed during 2017.

River Code: **11-004** River: ***Duck Creek*** Coll. Date: *08/31/2017* RM: **5.14**

Site ID: **LM72** Location: Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.
01801	Turbellaria		**F**	+
03600	Oligochaeta		**T**	+
11120	Baetis flavistriga		**F**	+
11130	Baetis intercalaris		**F**	+
74100	Simulium sp		**F**	+
77500	Conchapelopia sp		**F**	+
80420	Cricotopus (C.) bicinctus		**T**	+
80430	Cricotopus (C.) tremulus group		**MT**	+
80510	Cricotopus (Isocladius) sylvestris group		**T**	+
84470	Polypedilum (P.) illinoense		**T**	+
95100	Physella sp		**T**	+
28705	Pachydiplax longipennis		**T**	+
82700	Chironomus sp		**MT**	+
84960	Pseudochironomus sp		**F**	+
83003	Dicrotendipes fumidus		**F**	+
83003	Dicrotendipes fumidus		**F**	+

No. Quantitative Taxa:	0	Total Taxa;	16
No. Qualitative Taxa:	16	ICI:	
Number of Organisms:	0	Qual EPT:	2

Appendix Table C-2. Macroinvertebrate data collected by Ohio EPA in the Little Miami watershed during 2017.

River Code: **11-004** River: ***Duck Creek*** Coll. Date: *08/30/2017* RM: **4.58**

Site ID: **LM73** Location: Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.
01801	Turbellaria		**F**	+
11120	Baetis flavistriga		**F**	+
11130	Baetis intercalaris		**F**	+
21200	Calopteryx sp		**F**	+
22001	Coenagrionidae		**T**	+
52200	Cheumatopsyche sp		**F**	+
63900	Laccophilus sp		**T**	+
67800	Tropisternus sp		**T**	+
69400	Stenelmis sp		**F**	+
74100	Simulium sp		**F**	+
77500	Conchapelopia sp		**F**	+
80420	Cricotopus (C.) bicinctus		**T**	+
80430	Cricotopus (C.) tremulus group		**MT**	+
80510	Cricotopus (Isocladius) sylvestris group		**T**	+
82770	Chironomus (C.) riparius group		**T**	+
84450	Polypedilum (Uresipedilum) flavum		**F**	+
84470	Polypedilum (P.) illinoense		**T**	+
95100	Physella sp		**T**	+
64800	Uvarus sp		**MT**	+
04960	Erpobdella sp (= Mooreobdella)		**MT**	+
84960	Pseudochironomus sp		**F**	+
80470	Cricotopus (C.) or Orthocladius (O.) sp			+
83003	Dicrotendipes fumidus		**F**	+
04985				+

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.

No. Quantitative Taxa:	0	Total Taxa;	24
No. Qualitative Taxa:	24	ICI:	
Number of Organisms:	0	Qual EPT:	3

Appendix Table C-2. Macroinvertebrate data collected by Ohio EPA in the Little Miami watershed during 2017.

River Code: **11-004** River: ***Duck Creek*** Coll. Date: *08/30/2017* RM: **3.90**

Site ID: **LM74** Location: Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.
01801	Turbellaria		**F**	+
03600	Oligochaeta		**T**	+
11120	Baetis flavistriga		**F**	+
11130	Baetis intercalaris		**F**	+
13521	Stenonema femoratum		**F**	+
52200	Cheumatopsyche sp		**F**	+
69400	Stenelmis sp		**F**	+
72700	Anopheles sp		**F**	+
72900	Culex sp		**T**	+
77500	Conchapelopia sp		**F**	+
80420	Cricotopus (C.) bicinctus		**T**	+
80430	Cricotopus (C.) tremulus group		**MT**	+
82730	Chironomus (C.) decorus group		**T**	+
83040	Dicrotendipes neomodestus		**F**	+
84450	Polypedilum (Uresipedilum) flavum		**F**	+
84470	Polypedilum (P.) illinoense		**T**	+
84540	Polypedilum (Tripodura) scalaenum group		**F**	+
27000	Corduliidae or Libellulidae			+
04901	Erpobdellidae		**MT**	+
71300	Limonia sp		**F**	+
84960	Pseudochironomus sp		**F**	+

No. Quantitative Taxa:	0	Total Taxa;	21
No. Qualitative Taxa:	21	ICI:	
Number of Organisms:	0	Qual EPT:	4

Appendix Table C-2. Macroinvertebrate data collected by Ohio EPA in the Little Miami watershed during 2017.

River Code: **11-004** River: ***Duck Creek*** Coll. Date: *08/30/2017* RM: **3.40**

Site ID: **LM75** Location: Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.
01801	Turbellaria		**F**	+
03600	Oligochaeta		**T**	+
11120	Baetis flavistriga		**F**	+
11130	Baetis intercalaris		**F**	+
13521	Stenonema femoratum		**F**	+
21200	Calopteryx sp		**F**	+
21300	Hetaerina sp		**F**	+
22300	Argia sp		**F**	+
52530	Hydropsyche depravata group		**F**	+
74100	Simulium sp		**F**	+
77500	Conchapelopia sp		**F**	+
80420	Cricotopus (C.) bicinctus		**T**	+
80430	Cricotopus (C.) tremulus group		**MT**	+
80510	Cricotopus (Isocladius) sylvestris group		**T**	+
82770	Chironomus (C.) riparius group		**T**	+
83000	Dicrotendipes sp		**F**	+
84470	Polypedilum (P.) illinoense		**T**	+
84540	Polypedilum (Tripodura) scalaenum group		**F**	+
07800	Cambarus sp			+
84960	Pseudochironomus sp		**F**	+
04985				+

No. Quantitative Taxa:	0	Total Taxa;	21
No. Qualitative Taxa:	21	ICI:	
Number of Organisms:	0	Qual EPT:	4

Appendix Table C-2. Macroinvertebrate data collected by Ohio EPA in the Little Miami watershed during 2017.

River Code: **11-004** River: ***Duck Creek*** Coll. Date: *09/14/2017* RM: **2.80**

Site ID: **LM76** Location: Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.		Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.
01801	Turbellaria		F	91	+					
03600	Oligochaeta		T	826	+					
04666	Helobdella papillata		MT		+					
11120	Baetis flavistriga		F	97	+					
11130	Baetis intercalaris		F	740	+					
21200	Calopteryx sp		F		+					
22300	Argia sp		F		+					
52200	Cheumatopsyche sp		F	84						
52430	Ceratopsyche morosa group		MI	1						
52530	Hydropsyche depravata group		F	88	+					
53800	Hydroptila sp		F	21						
69400	Stenelmis sp		F		+					
74100	Simulium sp		F	48	+					
77120	Ablabesmyia mallochi		F	27	+					
77500	Conchapelopia sp		F	187	+					
78350	Meropelopia sp	X	F	14						
80420	Cricotopus (C.) bicinctus		T	67	+					
80430	Cricotopus (C.) tremulus group		MT	13	+					
82730	Chironomus (C.) decorus group		T	13	+					
84450	Polypedilum (Uresipedilum) flavum		F	256						
84470	Polypedilum (P.) illinoense		T	175	+					
84540	Polypedilum (Tripodura) scalaenum group		F	135	+					
85500	Paratanytarsus sp		F	13						
85800	Tanytarsus sp		F	27						
85821	Tanytarsus glabrescens group sp 7		F	378	+					
87540	Hemerodromia sp		F	24						
04964	Erpobdella microstoma		MT		+					
74650	Atrichopogon sp		F	1						
04968	Erpobdella tetragon			3						
04985				3						

No. Quantitative Taxa:	25	Total Taxa;	30
No. Qualitative Taxa:	19	ICI:	32
Number of Organisms:	3332	Qual EPT:	3

Appendix Table C-2. Macroinvertebrate data collected by Ohio EPA in the Little Miami watershed during 2017.

River Code: **11-004** River: ***Duck Creek*** Coll. Date: *09/14/2017* RM: **2.00**

Site ID: **LM77** Location: Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.	
01801	Turbellaria		F	34	+
03600	Oligochaeta		T	587	+
11120	Baetis flavistriga		F	49	+
11130	Baetis intercalaris		F	1887	+
13521	Stenonema femoratum		F	7	+
21200	Calopteryx sp		F		+
21300	Hetaerina sp		F	1	
22001	Coenagrionidae		T		+
22300	Argia sp		F	1	+
52200	Cheumatopsyche sp		F	588	+
52530	Hydropsyche depravata group		F	473	+
53800	Hydroptila sp		F	8	+
69400	Stenelmis sp		F	1	+
71900	Tipula sp		F		+
74100	Simulium sp		F	42	
77120	Ablabesmyia mallochi		F		+
77500	Conchapelopia sp		F	305	+
77750	Hayesomyia senata or Thienemannimyia norena		F	18	
78450	Nilotanypus fimbriatus		F	9	
80370	Corynoneura lobata		F	32	
80420	Cricotopus (C.) bicinctus		T	18	+
80430	Cricotopus (C.) tremulus group		MT	9	
80440	Cricotopus (C.) trifascia		F		+
81650	Parametriocnemus sp	X	F	9	
82141	Thienemanniella xena		F	9	
82730	Chironomus (C.) decorus group		T	9	+
82820	Cryptochironomus sp		F		+
83040	Dicrotendipes neomodestus		F	18	+
84210	Paratendipes albimanus or P. duplicatus		F	9	+
84300	Phaenopsectra obediens group		F	18	
84450	Polypedilum (Uresipedilum) flavum		F	231	+
84460	Polypedilum (P.) fallax group		F	9	
84470	Polypedilum (P.) illinoense		T	55	+
84540	Polypedilum (Tripodura) scalaenum group		F	157	+
85800	Tanytarsus sp		F	18	+
85821	Tanytarsus glabrescens group sp 7		F	240	+
87540	Hemerodromia sp		F	24	
96120	Menetus (Micromenetus) dilatatus		MT		+
05900	Lirceus sp		MT		+
04985				3	+
04964	Erpobdella microstoma		MT		+
83051	Dicrotendipes simpsoni		T	18	

No. Quantitative Taxa:	33	Total Taxa;	42
No. Qualitative Taxa:	30	ICI:	42
Number of Organisms:	4896	Qual EPT:	6

Appendix Table C-2. Macroinvertebrate data collected by Ohio EPA in the Little Miami watershed during 2017.

River Code: **11-004** River: ***Duck Creek*** Coll. Date: *09/14/2017* RM: **0.50**

Site ID: **LM79** Location: Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.	
01801	Turbellaria		F	33	+
03600	Oligochaeta		T	993	+
04964	Erpobdella microstoma		MT	1	+
11120	Baetis flavistriga		F	141	+
11130	Baetis intercalaris		F	1125	+
13521	Stenonema femoratum		F	10	+
21200	Calopteryx sp		F		+
22001	Coenagrionidae		T		+
22300	Argia sp		F		+
50315	Chimarra obscura		MI	1	
52200	Cheumatopsyche sp		F	166	+
52530	Hydropsyche depravata group		F	25	+
53800	Hydroptila sp		F		+
69400	Stenelmis sp		F		+
72700	Anopheles sp		F		+
74100	Simulium sp		F	2	+
77120	Ablabesmyia mallochi		F	39	+
77500	Conchapelopia sp		F	252	+
77800	Helopelopia sp		F	22	
80410	Cricotopus (C.) sp		F		+
80420	Cricotopus (C.) bicinctus		T	39	+
80430	Cricotopus (C.) tremulus group		MT	20	
82820	Cryptochironomus sp		F		+
83040	Dicrotendipes neomodestus		F	20	
83300	Glyptotendipes (G.) sp		MT	20	
84210	Paratendipes albimanus or P. duplicatus		F	20	
84300	Phaenopsectra obediens group		F	39	+
84450	Polypedilum (Uresipedilum) flavum		F	98	+
84470	Polypedilum (P.) illinoense		T	20	+
84540	Polypedilum (Tripodura) scalaenum group		F	664	+
85500	Paratanytarsus sp		F		+
85625	Rheotanytarsus sp		F	20	
85800	Tanytarsus sp		F	20	+
85821	Tanytarsus glabrescens group sp 7		F	215	
27307	Epitheca (Epicordulia) princeps		MT		+
27000	Corduliidae or Libellulidae				+
23804	Basiaeschna janata		F		+
78601	Pentaneura inyoensis		F		+
83003	Dicrotendipes fumidus		F		+
87501	Empididae		F	1	
04968	Erpobdella tetragon			4	

No. Quantitative Taxa:	27	Total Taxa;	41
No. Qualitative Taxa:	31	ICI:	34
Number of Organisms:	4010	Qual EPT:	6

Appendix Table C-2. Macroinvertebrate data collected by Ohio EPA in the Little Miami watershed during 2017.

River Code: **11-007** River: ***Sycamore Creek*** Coll. Date: *09/15/2017* RM: **1.10**

Site ID: **LM50** Location: Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.	
01801	Turbellaria		F	155	+
03600	Oligochaeta		T	20	
01900	Nemertea		F	40	
05900	Lirceus sp		MT		+
11120	Baetis flavistriga		F	14	+
11130	Baetis intercalaris		F	80	+
13521	Stenonema femoratum		F	49	+
21200	Calopteryx sp		F		+
22001	Coenagrionidae		T		+
22300	Argia sp		F		+
50301	Chimarra aterrima		MI		+
50315	Chimarra obscura		MI	10	+
51600	Polycentropus sp		MI	1	
52200	Cheumatopsyche sp		F	414	+
52430	Ceratopsyche morosa group		MI	270	+
52530	Hydropsyche depravata group		F	74	
53800	Hydroptila sp		F	71	+
59970	Petrophila sp		MI	16	+
68075	Psephenus herricki		MI		+
70600	Antocha sp		MI	4	
71900	Tipula sp		F	9	+
74100	Simulium sp		F		+
74501	Ceratopogonidae		T	16	
77120	Ablabesmyia mallochi		F		+
77500	Conchapelopia sp		F	17	
77800	Helopelopia sp		F		+
78450	Nilotanypus fimbriatus		F	40	
80370	Corynoneura lobata		F	8	
80410	Cricotopus (C.) sp		F	34	
80420	Cricotopus (C.) bicinctus		T	137	+
80440	Cricotopus (C.) trifascia		F	86	+
82820	Cryptochironomus sp		F		+
83040	Dicrotendipes neomodestus		F	69	+
83820	Microtendipes "caelum" (sensu Simpson & Bode, 1980)		MI		+
83840	Microtendipes pedellus group		F	17	
84210	Paratendipes albimanus or P. duplicatus		F		+
84300	Phaenopsectra obediens group		F		+
84450	Polypedilum (Uresipedilum) flavum		F	411	+
84470	Polypedilum (P.) illinoense		T		+
84960	Pseudochironomus sp		F	17	+
85260	Cladotanytarsus vanderwulpi group				+
85500	Paratanytarsus sp		F	17	
85625	Rheotanytarsus sp		F	565	
85818	Tanytarsus glabrescens group sp 4		F		+
85821	Tanytarsus glabrescens group sp 7		F	103	+
87540	Hemerodromia sp		F	25	
80470	Cricotopus (C.) or Orthocladius (O.) sp			17	+
82101	Thienemanniella taurocapita		MI	86	

No. Quantitative Taxa:	32	Total Taxa;	48
No. Qualitative Taxa:	33	ICI:	44
Number of Organisms:	2892	Qual EPT:	8

Appendix Table C-2. Macroinvertebrate data collected by Ohio EPA in the Little Miami watershed during 2017.

River Code: **11-007** River: ***Sycamore Creek*** Coll. Date: *09/15/2017* RM: **0.50**

Site ID: **LM51** Location: Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.	
01801	Turbellaria		F	127	+
03600	Oligochaeta		T	16	+
06201	Hyalella azteca		F		+
08601	Hydrachnidia		F		+
11120	Baetis flavistriga		F	2	+
11130	Baetis intercalaris		F	119	+
13521	Stenonema femoratum		F	86	+
17200	Caenis sp		F	24	+
21300	Hetaerina sp		F		+
22300	Argia sp		F	2	+
50315	Chimarra obscura		MI	17	+
52200	Cheumatopsyche sp		F	222	+
52430	Ceratopsyche morosa group		MI	84	
52530	Hydropsyche depravata group		F	4	
53501	Hydroptilidae		F		+
60900	Peltodytes sp		MT		+
68075	Psephenus herricki		MI	2	+
69400	Stenelmis sp		F	11	+
71900	Tipula sp		F	2	+
74100	Simulium sp		F		+
77500	Conchapelopia sp		F	18	
77800	Helopelopia sp		F	53	
78450	Nilotanypus fimbriatus		F	8	
80310	Cardiocladius obscurus		MI	12	
80430	Cricotopus (C.) tremulus group		MT	71	
80440	Cricotopus (C.) trifascia		F		+
81650	Parametriocnemus sp	X	F	24	
82121	Thienemanniella lobapodema		F		+
82820	Cryptochironomus sp		F	12	+
83820	Microtendipes "caelum" (sensu Simpson & Bode, 1980)		MI	130	+
84210	Paratendipes albimanus or P. duplicatus		F	47	
84450	Polypedilum (Uresipedilum) flavum		F	236	
84540	Polypedilum (Tripodura) scalaenum group		F	47	
85200	Cladotanytarsus sp				+
85615	Rheotanytarsus pellucidus		MI	35	
85625	Rheotanytarsus sp		F	236	
85800	Tanytarsus sp		F	12	
85821	Tanytarsus glabrescens group sp 7		F	47	+
97601	Corbicula fluminea		F	1	+
98001	Pisidiidae			1	
01900	Nemertea		F	16	+
05900	Lirceus sp		MT	1	+
68025	Ectopria sp		F	1	
82101	Thienemanniella taurocapita		MI	44	
80363	Corynoneura sp 12		MI	16	

No. Quantitative Taxa:	36	Total Taxa;	45
No. Qualitative Taxa:	27	ICI:	38
Number of Organisms:	1786	Qual EPT:	7

Appendix Table C-2. Macroinvertebrate data collected by Ohio EPA in the Little Miami watershed during 2017.

River Code: **11-007** River: ***Sycamore Creek*** Coll. Date: *09/20/2017* RM: **0.10**

Site ID: **LM52** Location: Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.	
01801	Turbellaria		**F**	56	+
03600	Oligochaeta		**T**	136	+
06201	Hyalella azteca		**F**	11	+
11120	Baetis flavistriga		**F**	12	+
11130	Baetis intercalaris		**F**	116	+
13521	Stenonema femoratum		**F**	66	+
17200	Caenis sp		**F**		+
22300	Argia sp		**F**		+
50301	Chimarra aterrima		**MI**	1	+
50315	Chimarra obscura		**MI**		+
51600	Polycentropus sp		**MI**		+
52200	Cheumatopsyche sp		**F**	480	+
52430	Ceratopsyche morosa group		**MI**	901	+
52530	Hydropsyche depravata group		**F**	27	+
53800	Hydroptila sp		**F**	36	+
68075	Psephenus herricki		**MI**		+
69400	Stenelmis sp		**F**		+
71900	Tipula sp		**F**	1	+
74100	Simulium sp		**F**	16	+
77120	Ablabesmyia mallochi		**F**		+
77500	Conchapelopia sp		**F**		+
77750	Hayesomyia senata or Thienemannimyia norena		**F**	51	
80420	Cricotopus (C.) bicinctus		**T**	461	
80430	Cricotopus (C.) tremulus group		**MT**	128	
82141	Thienemanniella xena		**F**	48	
82730	Chironomus (C.) decorus group		**T**		+
83040	Dicrotendipes neomodestus		**F**	307	+
83820	Microtendipes "caelum" (sensu Simpson & Bode, 1980)		**MI**		+
84210	Paratendipes albimanus or P. duplicatus		**F**		+
84300	Phaenopsectra obediens group		**F**		+
84450	Polypedilum (Uresipedilum) flavum		**F**	1178	+
84470	Polypedilum (P.) illinoense		**T**	51	+
85615	Rheotanytarsus pellucidus		**MI**	26	
85625	Rheotanytarsus sp		**F**	102	
85821	Tanytarsus glabrescens group sp 7		**F**	128	+
85840	Tanytarsus sepp		**F**		+
95100	Physella sp		**T**		+
05900	Lirceus sp		**MT**	2	+
51206	Cyrnellus fraternus		**F**		+
70501	Tipulidae				+
65800	Berosus sp		**MT**	1	
01320	Hydra sp		**F**	8	
82101	Thienemanniella taurocapita		**MI**	16	

No. Quantitative Taxa:	27	Total Taxa;	43
No. Qualitative Taxa:	34	ICI:	36
Number of Organisms:	4366	Qual EPT:	12

Appendix Table C-2. Macroinvertebrate data collected by Ohio EPA in the Little Miami watershed during 2017.

River Code: **11-049** River: ***Unnamed Trib to Sycamore Creek*** Coll. Date: *08/28/2017* RM: **1.20**

Site ID: **LM55** Location: Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.
01801	Turbellaria		**F**	+
03600	Oligochaeta		**T**	+
06700	Crangonyx sp		**MT**	+
11120	Baetis flavistriga		**F**	+
11130	Baetis intercalaris		**F**	+
13521	Stenonema femoratum		**F**	+
17100	Sparbarus sp		**MI**	+
21200	Calopteryx sp		**F**	+
22300	Argia sp		**F**	+
50301	Chimarra aterrima		**MI**	+
50315	Chimarra obscura		**MI**	+
51600	Polycentropus sp		**MI**	+
52530	Hydropsyche depravata group		**F**	+
68075	Psephenus herricki		**MI**	+
72700	Anopheles sp		**F**	+
74100	Simulium sp		**F**	+
77120	Ablabesmyia mallochi		**F**	+
83000	Dicrotendipes sp		**F**	+
84210	Paratendipes albimanus or P. duplicatus		**F**	+
84450	Polypedilum (Uresipedilum) flavum		**F**	+
84470	Polypedilum (P.) illinoense		**T**	+
85500	Paratanytarsus sp		**F**	+
05900	Lirceus sp		**MT**	+
78601	Pentaneura inyoensis		**F**	+
84315	Phaenopsectra flavipes		**MT**	+
79720	Diamesa sp	**X**	**F**	+

No. Quantitative Taxa:	0	Total Taxa;	26
No. Qualitative Taxa:	26	ICI:	
Number of Organisms:	0	Qual EPT:	8

Appendix Table C-2. Macroinvertebrate data collected by Ohio EPA in the Little Miami watershed during 2017.

River Code: **11-049** River: ***Unnamed Trib to Sycamore Creek*** Coll. Date: *09/15/2017* RM: **0.20**

Site ID: **LM56** Location: Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.
01801	Turbellaria		F	68 +
03600	Oligochaeta		T	28
11120	Baetis flavistriga		F	49 +
11130	Baetis intercalaris		F	286 +
13521	Stenonema femoratum		F	107 +
16700	Tricorythodes sp		MI	1
17200	Caenis sp		F	+
21200	Calopteryx sp		F	+
22001	Coenagrionidae		T	+
22300	Argia sp		F	+
50301	Chimarra aterrima		MI	+
50315	Chimarra obscura		MI	2 +
51600	Polycentropus sp		MI	1
52200	Cheumatopsyche sp		F	+
52430	Ceratopsyche morosa group		MI	24
52530	Hydropsyche depravata group		F	1
53501	Hydroptilidae		F	+
59970	Petrophila sp		MI	4
68075	Psephenus herricki		MI	1 +
69400	Stenelmis sp		F	+
72700	Anopheles sp		F	+
74100	Simulium sp		F	4 +
77120	Ablabesmyia mallochi		F	+
77500	Conchapelopia sp		F	13
77750	Hayesomyia senata or Thienemannimyia norena		F	7
78140	Labrundinia pilosella		F	7
78450	Nilotanypus fimbriatus		F	34
80370	Corynoneura lobata		F	15
80410	Cricotopus (C.) sp		F	7
80420	Cricotopus (C.) bicinctus		T	7
80430	Cricotopus (C.) tremulus group		MT	65
80440	Cricotopus (C.) trifascia		F	13
81231	Nanocladius (N.) crassicornus or N. (N.) "rectinervis"		F	13
81825	Rheocricotopus (Psilocricotopus) robacki		F	7
82121	Thienemanniella lobapodema		F	21
82141	Thienemanniella xena		F	19
83040	Dicrotendipes neomodestus		F	13 +
84210	Paratendipes albimanus or P. duplicatus		F	+
84300	Phaenopsectra obediens group		F	+
84450	Polypedilum (Uresipedilum) flavum		F	65
84460	Polypedilum (P.) fallax group		F	7
84470	Polypedilum (P.) illinoense		T	+
85500	Paratanytarsus sp		F	13
85625	Rheotanytarsus sp		F	118
85821	Tanytarsus glabrescens group sp 7		F	124
87540	Hemerodromia sp		F	38
01900	Nemertea		F	26 +
05900	Lirceus sp		MT	5 +
77250	Alotanypus venustus		VT	+
84960	Pseudochironomus sp		F	+
80363	Corynoneura sp 12		MI	7
84315	Phaenopsectra flavipes		MT	7
82101	Thienemanniella taurocapita		MI	30

No. Quantitative Taxa:	38	Total Taxa;	53
No. Qualitative Taxa:	25	ICI:	52
Number of Organisms:	1257	Qual EPT:	8

Appendix Table C-2. Macroinvertebrate data collected by Ohio EPA in the Little Miami watershed during 2017.

River Code: **11-051** River: ***East Fork Duck Creek*** Coll. Date: *09/11/2017* RM: **2.00**

Site ID: **LM85** Location: Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.
01801	Turbellaria		**F**	+
03600	Oligochaeta		**T**	+
11120	Baetis flavistriga		**F**	+
74100	Simulium sp		**F**	+
77120	Ablabesmyia mallochi		**F**	+
77500	Conchapelopia sp		**F**	+
82730	Chironomus (C.) decorus group		**T**	+
82770	Chironomus (C.) riparius group		**T**	+
83040	Dicrotendipes neomodestus		**F**	+
84470	Polypedilum (P.) illinoense		**T**	+
95100	Physella sp		**T**	+
65700	Anacaena sp		**MT**	+

No. Quantitative Taxa:	0	Total Taxa;	12
No. Qualitative Taxa:	12	ICI:	
Number of Organisms:	0	Qual EPT:	1

Appendix Table C-2. Macroinvertebrate data collected by Ohio EPA in the Little Miami watershed during 2017.

River Code: **11-051** River: ***East Fork Duck Creek*** Coll. Date: *09/11/2017* RM: **0.50**

Site ID: **LM84** Location: Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.
01801	Turbellaria		**F**	+
03600	Oligochaeta		**T**	+
11120	Baetis flavistriga		**F**	+
11130	Baetis intercalaris		**F**	+
13521	Stenonema femoratum		**F**	+
21200	Calopteryx sp		**F**	+
22001	Coenagrionidae		**T**	+
22300	Argia sp		**F**	+
52200	Cheumatopsyche sp		**F**	+
52530	Hydropsyche depravata group		**F**	+
53800	Hydroptila sp		**F**	+
74100	Simulium sp		**F**	+
77500	Conchapelopia sp		**F**	+
79400	Zavrelimyia sp	**X**	**F**	+
80420	Cricotopus (C.) bicinctus		**T**	+
80430	Cricotopus (C.) tremulus group		**MT**	+
82730	Chironomus (C.) decorus group		**T**	+
82820	Cryptochironomus sp		**F**	+
83040	Dicrotendipes neomodestus		**F**	+
84470	Polypedilum (P.) illinoense		**T**	+
85500	Paratanytarsus sp		**F**	+
85800	Tanytarsus sp		**F**	+
28800	Pantala sp			+
84960	Pseudochironomus sp		**F**	+
78601	Pentaneura inyoensis		**F**	+
04985				+

No. Quantitative Taxa:	0	Total Taxa;	26
No. Qualitative Taxa:	26	ICI:	
Number of Organisms:	0	Qual EPT:	6

Appendix Table C-2. Macroinvertebrate data collected by Ohio EPA in the Little Miami watershed during 2017.

River Code: **11-075** River: ***Unnamed Trib to Duck Creek*** Coll. Date: *08/31/2017* RM: **5.00**

Site ID: **LM80** Location: Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.
03600	Oligochaeta		**T**	+
11120	Baetis flavistriga		**F**	+
72700	Anopheles sp		**F**	+
77500	Conchapelopia sp		**F**	+
78702	Psectrotanypus dyari		**VT**	+
79400	Zavrelimyia sp	**X**	**F**	+
80420	Cricotopus (C.) bicinctus		**T**	+
82730	Chironomus (C.) decorus group		**T**	+
82770	Chironomus (C.) riparius group		**T**	+
84470	Polypedilum (P.) illinoense		**T**	+
95100	Physella sp		**T**	+
89800	Lispe sp			+
86501	Stratiomyidae			+
89501	Ephydridae		**F**	+
72160	Psychoda sp		**T**	+
04901	Erpobdellidae		**MT**	+
77250	Alotanypus venustus		**VT**	+

No. Quantitative Taxa:	0	Total Taxa;	17
No. Qualitative Taxa:	17	ICI:	
Number of Organisms:	0	Qual EPT:	1

Appendix Table C-2. Macroinvertebrate data collected by Ohio EPA in the Little Miami watershed during 2017.

River Code: **11-076** River: ***Little Duck Creek*** Coll. Date: *08/16/2017* RM: **2.40**

Site ID: **LM86** Location: Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.
11120	Baetis flavistriga		**F**	+
11130	Baetis intercalaris		**F**	+
13521	Stenonema femoratum		**F**	+
21200	Calopteryx sp		**F**	+
22300	Argia sp		**F**	+
50301	Chimarra aterrima		**MI**	+
51600	Polycentropus sp		**MI**	+
52200	Cheumatopsyche sp		**F**	+
52430	Ceratopsyche morosa group		**MI**	+
52530	Hydropsyche depravata group		**F**	+
68075	Psephenus herricki		**MI**	+
69400	Stenelmis sp		**F**	+
77120	Ablabesmyia mallochi		**F**	+
77500	Conchapelopia sp		**F**	+
77800	Helopelopia sp		**F**	+
83040	Dicrotendipes neomodestus		**F**	+
83820	Microtendipes "caelum" (sensu Simpson & Bode, 1980)		**MI**	+
84210	Paratendipes albimanus or P. duplicatus		**F**	+
85800	Tanytarsus sp		**F**	+
05900	Lirceus sp		**MT**	+
68130	Helichus sp		**F**	+
04960	Erpobdella sp (= Mooreobdella)		**MT**	+

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.

No. Quantitative Taxa:	0	Total Taxa;	22
No. Qualitative Taxa:	22	ICI:	
Number of Organisms:	0	Qual EPT:	8

Appendix Table C-2. Macroinvertebrate data collected by Ohio EPA in the Little Miami watershed during 2017.

River Code: **11-076** River: ***Little Duck Creek*** Coll. Date: *08/16/2017* RM: **1.90**

Site ID: **LM87** Location: Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.
01801	Turbellaria		**F**	+
03600	Oligochaeta		**T**	+
11120	Baetis flavistriga		**F**	+
11130	Baetis intercalaris		**F**	+
13521	Stenonema femoratum		**F**	+
21200	Calopteryx sp		**F**	+
21300	Hetaerina sp		**F**	+
50301	Chimarra aterrima		**MI**	+
51600	Polycentropus sp		**MI**	+
52200	Cheumatopsyche sp		**F**	+
52430	Ceratopsyche morosa group		**MI**	+
52530	Hydropsyche depravata group		**F**	+
68075	Psephenus herricki		**MI**	+
70600	Antocha sp		**MI**	+
72700	Anopheles sp		**F**	+
74100	Simulium sp		**F**	+
77120	Ablabesmyia mallochi		**F**	+
77500	Conchapelopia sp		**F**	+
77800	Helopelopia sp		**F**	+
78140	Labrundinia pilosella		**F**	+
78450	Nilotanypus fimbriatus		**F**	+
80410	Cricotopus (C.) sp		**F**	+
83040	Dicrotendipes neomodestus		**F**	+
84210	Paratendipes albimanus or P. duplicatus		**F**	+
84470	Polypedilum (P.) illinoense		**T**	+
85500	Paratanytarsus sp		**F**	+
05900	Lirceus sp		**MT**	+

No. Quantitative Taxa:	0	Total Taxa;	27
No. Qualitative Taxa:	27	ICI:	
Number of Organisms:	0	Qual EPT:	8

Appendix Table C-2. Macroinvertebrate data collected by Ohio EPA in the Little Miami watershed during 2017.

River Code: **11-076** River: ***Little Duck Creek*** Coll. Date: *08/16/2017* RM: **1.00**

Site ID: **LM90** Location: Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.
03600	Oligochaeta		**T**	+
11120	Baetis flavistriga		**F**	+
11130	Baetis intercalaris		**F**	+
13521	Stenonema femoratum		**F**	+
21200	Calopteryx sp		**F**	+
50301	Chimarra aterrima		**MI**	+
51600	Polycentropus sp		**MI**	+
52200	Cheumatopsyche sp		**F**	+
53800	Hydroptila sp		**F**	+
68075	Psephenus herricki		**MI**	+
69400	Stenelmis sp		**F**	+
72700	Anopheles sp		**F**	+
77120	Ablabesmyia mallochi		**F**	+
77500	Conchapelopia sp		**F**	+
84210	Paratendipes albimanus or P. duplicatus		**F**	+
84450	Polypedilum (Uresipedilum) flavum		**F**	+
84470	Polypedilum (P.) illinoense		**T**	+
84540	Polypedilum (Tripodura) scalaenum group		**F**	+
85500	Paratanytarsus sp		**F**	+
05900	Lirceus sp		**MT**	+
68025	Ectopria sp		**F**	+

No. Quantitative Taxa:	0	Total Taxa;	21
No. Qualitative Taxa:	21	ICI:	
Number of Organisms:	0	Qual EPT:	7

Appendix Table C-2. Macroinvertebrate data collected by Ohio EPA in the Little Miami watershed during 2017.

River Code: **11-077** River: ***Unnamed Trib to Duck Creek*** Coll. Date: *08/28/2017* RM: **0.20**

Site ID: **LM82** Location: Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.	Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.
01801	Turbellaria		F	+					
03600	Oligochaeta		T	+					
11120	Baetis flavistriga		F	+					
52200	Cheumatopsyche sp		F	+					
52530	Hydropsyche depravata group		F	+					
74100	Simulium sp		F	+					
77800	Helopelopia sp		F	+					
78599	Pentaneura sp		F	+					
79400	Zavrelimyia sp	X	F	+					
83040	Dicrotendipes neomodestus		F	+					
84210	Paratendipes albimanus or P. duplicatus		F	+					
84470	Polypedilum (P.) illinoense		T	+					
84520	Polypedilum (Tripodura) halterale group		MT	+					
85800	Tanytarsus sp		F	+					
07800	Cambarus sp			+					
05900	Lirceus sp		MT	+					

No. Quantitative Taxa:	0	Total Taxa;	16
No. Qualitative Taxa:	16	ICI:	
Number of Organisms:	0	Qual EPT:	3

Appendix C

Little Miami River 2017 Habitat Data
C-1: QHEI Metrics & Scores

Appendix C-1. QHEI metric scores for sites sampled in the Little Miami River by MBI during 2017.

River Mile	QHEI	QHEI Metrics: Substrate	Cover	Channel	Riparian	Pool	Riffle	Gradient & Score	Narrative
(11001) Little Miami River									
Year: 2017									
27.90	**79.50**	15.0	13.0	16.0	7.50	11.0	7.0	6.60 - (10)	**Excellent**
24.10	**83.00**	17.0	13.0	17.5	7.00	12.0	6.5	6.51 - (10)	**Excellent**
22.30	**74.00**	16.0	15.0	13.0	6.00	9.0	5.0	6.39 - (10)	**Good**
21.50	**81.50**	16.0	14.0	18.0	6.00	11.0	6.5	6.43 - (10)	**Excellent**
18.50	**76.00**	14.0	14.0	14.0	6.00	11.0	7.0	6.35 - (10)	**Excellent**
17.70	**85.25**	18.0	14.0	16.0	7.25	12.0	8.0	6.24 - (10)	**Excellent**
13.10	**84.00**	18.0	13.0	16.0	7.50	12.0	7.5	6.19 - (10)	**Excellent**
10.90	**80.00**	16.0	13.0	15.0	7.00	12.0	7.0	6.14 - (10)	**Excellent**
8.10	**81.00**	16.0	15.0	15.0	6.50	12.0	6.5	6.08 - (10)	**Excellent**
6.83	**80.00**	16.0	16.0	14.0	5.50	12.0	6.5	6.07 - (10)	**Excellent**
4.10	**81.75**	16.0	15.0	17.0	5.25	12.0	6.5	6.18 - (10)	**Excellent**
3.50	**82.25**	16.0	13.0	17.0	7.75	12.0	6.5	6.16 - (10)	**Excellent**
1.60	**61.00**	14.0	15.0	10.0	6.00	6.0	0.0	6.18 - (10)	**Good**
1.20	**67.50**	21.0	9.0	14.0	8.00	9.0	3.5	65.00 - (4)	**Good**
0.50	**64.25**	13.5	12.0	12.0	6.75	9.0	5.0	38.00 - (6)	**Good**
0.20	**64.50**	14.0	11.0	16.5	8.00	6.0	5.0	66.30 - (4)	**Good**
0.10	**74.50**	16.0	14.0	16.0	7.00	11.0	4.5	38.20 - (6)	**Good**
(11004) Duck Creek									
Year: 2017									
6.10	**27.50**	0.5	4.0	9.0	4.00	4.0	2.0	65.30 - (4)	**Very Poor**
5.14	**52.50**	17.0	9.0	11.5	4.50	4.0	2.5	48.10 - (4)	**Fair**
4.58	**19.00**	-1.0	1.0	8.0	3.00	2.0	2.0	43.70 - (4)	**Very Poor**
3.90	**26.50**	2.0	1.0	7.0	6.50	2.0	2.0	37.50 - (6)	**Very Poor**
3.40	**23.50**	2.0	1.0	7.0	5.50	2.0	2.0	64.80 - (4)	**Very Poor**
2.80	**54.00**	13.5	9.0	13.0	5.00	5.0	2.5	31.40 - (6)	**Fair**
2.00	**58.50**	14.0	11.0	12.0	5.50	5.0	3.0	29.80 - (8)	**Fair**
0.50	**64.25**	14.0	12.0	15.0	4.25	8.0	3.0	26.00 - (8)	**Good**
(11007) Sycamore Creek									
Year: 2017									
1.10	**63.50**	18.0	10.0	14.0	6.50	6.0	5.0	53.80 - (4)	**Good**
(11051) East Fork Duck Creek									
Year: 2017									
2.00	**59.00**	18.0	13.0	13.0	4.50	4.0	2.5	132.0 - (4)	**Fair**
0.50	**44.50**	14.0	9.0	8.5	4.00	3.0	2.0	123.0 - (4)	**Poor**

Appendix C-1. QHEI metric scores for sites sampled in the Little Miami River by MBI during 2017.

River Mile	QHEI	QHEI Metrics: Substrate	Cover	Channel	Riparian	Pool	Riffle	Gradient & Score	Narrative
(11075) Trib to Duck Creek @ RM 4.8									
Year: 2017									
0.10	**42.50**	12.0	9.0	11.5	0.00	4.0	2.0	114.0 - (4)	**Poor**
(11076) Little Duck Creek									
Year: 2017									
2.40	**52.00**	16.0	11.0	12.0	4.00	4.0	1.0	333.0 - (4)	**Fair**
1.90	**50.00**	14.0	12.0	11.5	3.50	4.0	1.0	384.0 - (4)	**Fair**
1.00	**54.00**	17.0	10.0	11.0	6.00	4.0	2.0	312.0 - (4)	**Fair**
(11077) Trib to Little Duck Cr. @ RM 4.42									
Year: 2017									
0.20	**60.50**	18.0	12.0	14.0	6.00	4.0	2.5	87.60 - (4)	**Good**

Appendix D

Little Miami River 2017 Primary Headwater Habitat Data
D-1: PHWH Evaluation
D-2: HHEI Metrics & Scores

Appendix D-1. Primary Headwater Aquatic Life Use information for the Little Miami River study area in 2017.

Site ID	RM	Year	River	Location:
LM71	**6.10**	**2017**	Duck Creek	Norwood/Harris Ave

HHEI Info: HHEI Score: ***68.0*** Substrate: **18.0** Pool: **20.0** Bankfull **30.0** Channel: ***Recent*** Flow: ***Flowing***

QHEI Info: QHEI Score: ***27.5*** Substrate: **0.5** Pool: **4.0** Max Z.: **20-40 cm** Channel **9.0** Flow: ***Flowing***

Drainage Size: **2.24** Riffle: **2.0** Ripar: **4.0** Cover: **4.0** PHW Class: **LRW**

FISH Info: IBI Score: **12.0** Species: **1.0** Sensitive Sp.: **0.0** % Pioneer: **100** Headwater Sp. **0.00**

MACRO Info: ICI Score: QUAL EPT: **0** Coldwater Taxa.: **0** Intols: Sens. **0** Toler: **1** V. Tol. **1.0**

Salamanders: Adults: Larvae:

LM81	**2.30**	**2017**	East Fork Duck Creek	

HHEI Info: HHEI Score: ***43.0*** Substrate: **28.0** Pool: Bankfull **15.0** Channel: ***Recovered*** Flow: ***Ephem.***

QHEI Info: QHEI Score: Substrate: Pool: Max Z.: Channel Flow:

Drainage Size: **0.48** Riffle: Ripar: Cover: PHW Class: **PHW2**

FISH Info: IBI Score: **Dry** Species: Sensitive Sp.: % Pioneer: Headwater Sp.

MACRO Info: ICI Score: QUAL EPT: **0** Coldwater Taxa.: **0** Intols: Sens. **0** Toler: V. Tol.

Salamanders: Adults: Larvae:

LM85	**2.00**	**2017**	East Fork Duck Creek	Stewart Avenue

HHEI Info: HHEI Score: ***74.0*** Substrate: **24.0** Pool: **20.0** Bankfull **30.0** Channel: ***Natural*** Flow: ***Flowing***

QHEI Info: QHEI Score: ***59.0*** Substrate: **18.0** Pool: **4.0** Max Z.: **20-40 cm** Channel **13.0** Flow: ***Flowing***

Drainage Size: **1.31** Riffle: **2.5** Ripar: **4.5** Cover: **13.0** PHW Class: **PHW?**

FISH Info: IBI Score: **26.0** Species: **3.0** Sensitive Sp.: **0.0** % Pioneer: **49.0** Headwater Sp. **1.00**

MACRO Info: ICI Score: QUAL EPT: **1** Coldwater Taxa.: **0** Intols: Sens. **0** Toler: V. Tol.

Salamanders: Adults: Larvae:

LM84	**0.50**	**2017**	East Fork Duck Creek	Behind John P. Parker School

HHEI Info: HHEI Score: ***77.0*** Substrate: **22.0** Pool: **25.0** Bankfull **30.0** Channel: ***Recent*** Flow: ***Flowing***

QHEI Info: QHEI Score: ***44.5*** Substrate: **14.0** Pool: **3.0** Max Z.: **< 20 cm** Channel **8.5** Flow: ***Flowing***

Drainage Size: **2.40** Riffle: **2.0** Ripar: **4.0** Cover: **9.0** PHW Class: **WWH**

FISH Info: IBI Score: **24.0** Species: **3.0** Sensitive Sp.: **0.0** % Pioneer: **33.7** Headwater Sp. **1.00**

MACRO Info: ICI Score: QUAL EPT: **6** Coldwater Taxa.: **1** Intols: Sens. **0** Toler: V. Tol.

Salamanders: Adults: Larvae:

Appendix D-1. Primary Headwater Aquatic Life Use information for the Little Miami River study area in 2017.

Site ID	RM	Year	River	Location:
LM83	**0.80**	**2017**	Unnamed Trib to Duck Creek	

HHEI Info: HHEI Score: ***42.0*** Substrate: **12.0** Pool: Bankfull **30.0** Channel: ***Natural*** Flow: ***Ephem.***

QHEI Info: QHEI Score: Substrate: Pool: Max Z.: Channel Flow:

Drainage Size: **1.24** Riffle: Ripar: Cover: PHW Class: **PHW2**

FISH Info: IBI Score: **12.0** Species: **1.0** Sensitive Sp.: **0.0** % Pioneer: **0.00** Headwater Sp. **0.00**

MACRO Info: ICI Score: QUAL EPT: **0** Coldwater Taxa.: **0** Intols: Sens. **0** Toler: V. Tol.

Salamanders: Adults: Larvae:

LM80	**0.10**	**2017**	Unnamed Trib to Duck Creek	

HHEI Info: HHEI Score: ***68.0*** Substrate: **28.0** Pool: **20.0** Bankfull **20.0** Channel: ***Recent*** Flow: ***Flowing***

QHEI Info: QHEI Score: ***42.5*** Substrate: **12.0** Pool: **4.0** Max Z.: Channel **11.5** Flow: ***Interst.***

Drainage Size: **1.42** Riffle: **2.0** Ripar: **0.0** Cover: **9.0** PHW Class: **LRW**

FISH Info: IBI Score: **12.0** Species: **1.0** Sensitive Sp.: **0.0** % Pioneer: **100** Headwater Sp. **0.00**

MACRO Info: ICI Score: QUAL EPT: **1** Coldwater Taxa.: **1** Intols: Sens. **0** Toler: **2** V. Tol. **2.0**

Salamanders: Adults: Larvae:

LM86	**2.40**	**2017**	Little Duck Creek	Camargo Road

HHEI Info: HHEI Score: ***80.0*** Substrate: **25.0** Pool: **25.0** Bankfull **30.0** Channel: ***Recovering*** Flow: ***Flowing***

QHEI Info: QHEI Score: ***52.0*** Substrate: **16.0** Pool: **4.0** Max Z.: **20-40 cm** Channel **12.0** Flow: ***Flowing***

Drainage Size: **0.50** Riffle: **1.0** Ripar: **4.0** Cover: **11.0** PHW Class: **WWH**

FISH Info: IBI Score: **36.0** Species: **4.0** Sensitive Sp.: **0.0** % Pioneer: **14.9** Headwater Sp. **1.00**

MACRO Info: ICI Score: QUAL EPT: **8** Coldwater Taxa.: **0** Intols: Sens. **5** Toler: V. Tol.

Salamanders: **X** Adults: Larvae: **2** *Eurycea cirrigera*

LM87	**1.90**	**2017**	Little Duck Creek	Plainville Road

HHEI Info: HHEI Score: ***72.0*** Substrate: **22.0** Pool: **20.0** Bankfull **30.0** Channel: ***Recovering*** Flow: ***Flowing***

QHEI Info: QHEI Score: ***50.0*** Substrate: **14.0** Pool: **4.0** Max Z.: **20-40 cm** Channel **11.5** Flow: ***Flowing***

Drainage Size: **0.45** Riffle: **1.0** Ripar: **3.5** Cover: **12.0** PHW Class: **WWH**

FISH Info: IBI Score: **34.0** Species: **4.0** Sensitive Sp.: **0.0** % Pioneer: **31.5** Headwater Sp. **1.00**

MACRO Info: ICI Score: QUAL EPT: **8** Coldwater Taxa.: **0** Intols: Sens. **5** Toler: V. Tol.

Salamanders: **X** Adults: **1** Larvae: **2** *Eurycea cirrigera*

Appendix D-1. Primary Headwater Aquatic Life Use information for the Little Miami River study area in 2017.

Site ID	RM	Year	River	Location:
LM90	**1.00**	**2017**	Little Duck Creek	Settle Street

HHEI Info: HHEI Score: ***87.0*** Substrate: **27.0** Pool: **30.0** Bankfull **30.0** Channel: ***Recovering*** Flow: ***Flowing***

QHEI Info: QHEI Score: ***54.0*** Substrate: **17.0** Pool: **4.0** Max Z.: **20-40 cm** Channel **11.0** Flow: ***Flowing***

Drainage Size: **1.10** Riffle: **2.0** Ripar: **6.0** Cover: **10.0** PHW Class:**WWH**

FISH Info: IBI Score: **30.0** Species: **4.0** Sensitive Sp.: **0.0** % Pioneer: **42.3** Headwater Sp. **1.00**

MACRO Info: ICI Score: QUAL EPT: **7** Coldwater Taxa.: **0** Intols: Sens. **3** Toler: V. Tol.

Salamanders:**X** Adults: **1** Larvae: **2** *Eurycea cirrigera*

Site ID	RM	Year	River	Location:
LM82	**0.20**	**2017**	Unnamed Trib to Duck Creek	@ Baseball Field

HHEI Info: HHEI Score: ***74.0*** Substrate: **29.0** Pool: **20.0** Bankfull **25.0** Channel: ***Recovering*** Flow: ***Flowing***

QHEI Info: QHEI Score: ***60.5*** Substrate: **18.0** Pool: **4.0** Max Z.: **20-40 cm** Channel **14.0** Flow: ***Flowing***

Drainage Size: **0.33** Riffle: **2.5** Ripar: **6.0** Cover: **12.0** PHW Class:**PHW3A**

FISH Info: IBI Score: **26.0** Species: **1.0** Sensitive Sp.: **0.0** % Pioneer: **0.00** Headwater Sp. **1.00**

MACRO Info: ICI Score: QUAL EPT: **3** Coldwater Taxa.: **1** Intols: Sens. **0** Toler: V. Tol.

Salamanders:**X** Adults: **1** Larvae: **3** *Eurycea cirrigera*

Site ID	RM	Year	River	Location:
LM54	**2.40**	**2017**	Unnamed Trib to Sycamore Creek	

HHEI Info: HHEI Score: ***66.5*** Substrate: **31.5** Pool: **5.0** Bankfull **30.0** Channel: ***Recovering*** Flow: ***Ephem.***

QHEI Info: QHEI Score: Substrate: Pool: Max Z.: Channel Flow:

Drainage Size: **1.58** Riffle: Ripar: Cover: PHW Class:**PHW2**

FISH Info: IBI Score: **Dry** Species: Sensitive Sp.: % Pioneer: Headwater Sp.

MACRO Info: ICI Score: QUAL EPT: **0** Coldwater Taxa.: **0** Intols: Sens. **0** Toler: V. Tol.

Salamanders: Adults: Larvae:

Appendix D-2. Headwater habitat evalation index metrics and scores for the Little Miami River study area in 2017.

Site ID	RM	Year	Drainage Size:	HHEI Score:	Substrate:	Pool:	Bankfull	Channel:	Flow:	Location:
(11-004) - Duck Creek										
LM71	**6.10**	**2017**	2.24	***68.0***	**18.0**	**20.0**	**30.0**	***Recent***	***Flowing***	Norwood/Harris Ave
(11-051) - East Fork Duck Creek										
LM81	**2.30**	**2017**	0.48	***43.0***	**28.0**		**15.0**	***Recovered***	***Ephem.***	
LM85	**2.00**	**2017**	1.31	***74.0***	**24.0**	**20.0**	**30.0**	***Natural***	***Flowing***	Stewart Avenue
LM84	**0.50**	**2017**	2.40	***77.0***	**22.0**	**25.0**	**30.0**	***Recent***	***Flowing***	Behind John P. Parker School
(11-075) - Unnamed Trib to Duck Creek										
LM83	**0.80**	**2017**	1.24	***42.0***	**12.0**		**30.0**	***Natural***	***Ephem.***	
LM80	**0.10**	**2017**	1.42	***68.0***	**28.0**	**20.0**	**20.0**	***Recent***	***Flowing***	
(11-076) - Little Duck Creek										
LM86	**2.40**	**2017**	0.50	***80.0***	**25.0**	**25.0**	**30.0**	***Recovering***	***Flowing***	Camargo Road
LM87	**1.90**	**2017**	0.45	***72.0***	**22.0**	**20.0**	**30.0**	***Recovering***	***Flowing***	Plainville Road
LM90	**1.00**	**2017**	1.10	***87.0***	**27.0**	**30.0**	**30.0**	***Recovering***	***Flowing***	Settle Street
(11-077) - Unnamed Trib to Duck Creek										
LM82	**0.20**	**2017**	0.33	***74.0***	**29.0**	**20.0**	**25.0**	***Recovering***	***Flowing***	@ Baseball Field
(11-086) - Unnamed Trib to Sycamore Creek										
LM54	**2.40**	**2017**	1.58	***66.5***	**31.5**	**5.0**	**30.0**	***Recovering***	***Ephem.***	

Appendix E

Little Miami River 2017 Chemical Water Quality Data

E-1: 2017 Sampling Sites
E-2: Raw Chemical Data

(Contact Chris Hall, MSDGC at Chris.Hall@cincinnati-oh.gov for Excel files)

Appendix E-1: 2017 Little Miami River Sites and Parameters

Site ID	Priority	Basin	Stream	River_Stream Name	AQL Use	Lat	Long	RM	SubType	Location Description	CSO/SSO/PSO/WWTP	Drain. Area	Geo. Level	Fish[1]	Macroinverts.[2]	Habitat[3]	Field Chem.[4]	Demand[5]	Nutrients[6]	Metals[7]	Organic[8]	Supplemental[9]	Sed. Metals[10]	Sed. Organics[11]
LM01	M	11	001	Little Miami River	EWH	39.31820	-84.25200	27.90	OHEPA	Dst. SR 22/3 - L. Miami State Park		1140	1	A	HD	QHEI	5X	5X	5X	5X	3X	Bact (6X)	X	X
LM02	H	11	001	Little Miami River (RF06)	EWH	39.271300	-84.259400	24.10	OH EPA	Ust. O'Bannon Cr.		1145	1	A	HD	QHEI	5X	5X	5X	5X	3X	Bact (6X)	X	X
LM03	H	11	001	Little Miami River	EWH	39.253100	-84.280800	22.30	OH EPA	Ust. Polk Run WWTP		1150	1	A	HD	QHEI	5X	5X	5X	5X	3X	Bact (6X)	X	X
LM05	H	11	001	Little Miami River	EWH	39.246900	-84.294700	21.50	OH EPA	Hopewell Rd. (Bridge Street)		1160	1	A	HD	QHEI	5X	5X	5X	5X	3X	Bact (6X)	X	X
LM07	H	11	001	Little Miami River	EWH	39.213100	-84.313600	18.50	OH EPA	Camargo Rd.		1187	1	A	HD	QHEI	5X	5X	5X	5X	3X	Bact (6X)	X	X
LM08	H	11	001	Little Miami River	EWH	39.208600	-84.306900	17.70	OH EPA	Canoe access dst. SR 126		1190	1	A	HD	QHEI	5X	5X	5X	5X	3X	Bact (6X)	X	X
LM09	H	11	001	Little Miami River	EWH	39.172500	-84.298600	13.10	OH EPA	Wooster Pike - Milford		1203	1	A	HD	QHEI	5X	5X	5X	5X	3X	Bact (6X)	X	X
LM11	H	11	001	Little Miami River	EWH	39.150000	-84.313300	10.90	OH EPA	intersection of Mt. Carmel & Round Bottom Rd.		1707	1	A	HD	QHEI	5X	5X	5X	5X	3X	Bact (6X)	X	X
LM12	H	11	001	Little Miami River	EWH	39.136700	-84.351900	8.10	OH EPA	Newtown Rd.		1710	1	A	HD	QHEI	5X	5X	5X	5X	3X	Bact (6X)	X	X
LM13	H	11	001	Little Miami River	EWH	39.13896	-84.37478	6.83	MSDGC	R.R. Trestle/Mariemont		1720	1	A	HD	QHEI	5X	5X	5X	5X	3X	Bact (6X)	X	X
LM15	H	11	001	Little Miami River	EWH	39.118340	-84.399626	4.10	OH EPA	Ust. Duck Creek		1740	1	A	HD	QHEI	5X	5X	5X	5X	3X	Bact (6X)	X	X
LM16	H	11	001	Little Miami River	WWH	39.108900	-84.401700	3.50	OH EPA	Beechmont Ave. dst. Duck Cr., ust. Clough Cr.	CSO 476, 470, 471	1752	1	A	HD	QHEI	5X	5X	5X	5X	3X	Bact (6X)	X	X
LM17	H	11	001	Little Miami River	WWH	39.085300	-84.419700	1.60	OH EPA	Kellog Ave.	CSO 476, 470, 471	1754	1	A	na	QHEI	5X	5X	5X	5X	3X	Bact (6X)	X	X
LM50	H	11	007	Sycamore Creek	WWH	39.217300	-84.331600	1.10	OH EPA	Loveland Rd.	WWTP, SSO 1008, 579	12.5	5	E	HD	QHEI	4X	4X	4X	4X	4X	Bact (4X)	X	X
LM51	H	11	007	Sycamore Creek	WWH	39.223300	-84.326400	0.50	OH EPA	Dst. N. Fork	WWTP, SSO 1008, 579	24	4	D,E	HD	QHEI	4X	4X	4X	4X	4X	Bact (4X)	X	X
LM52	H	11	007	Sycamore Creek	WWH	39.225800	-84.322500	0.10	OH EPA	Dst. Sycamore Cr. WWTP	WWTP, SSO 1008, 579	24	4	D,E	HD	QHEI	4X	4X	4X	4X	4X	Bact (4X)	X	X
LM54	H	11	086	Unnamed Trib to Sycamore Creek	PHW2	39.21564	-84.36543	2.40	Geometric	Glenover Dr and Raiders Run		1.58	8	F	QL/PH	QHEI/HHEI	2X	2X	2X			Bact (2X)		
LM55	H	11	049	Unnamed Trib to Sycamore Creek	WWH	39.21558	-84.34907	1.20	Geometric	Upstream Blome Rd bridge	SSO 705, 647	4.22	7	E	QL	QHEI	2X	2X	2X			Bact (2X)		
LM56	H	11	049	Unnamed Trib to Sycamore Creek	WWH	39.21622	-84.33615	0.20	Geometric	Nearest 8174 Loveland Maderia Dr	SSO 705, 647	5.61	6	E	HD,QL	QHEI	2X	2X	2X			Bact (2X)		
LM71	H	11	004	Duck Creek	LRW	39.16167	-84.43787	6.10	MSDGC	Norwood/Harris Ave	CSO 170, 500, 501	0.29	9	F	QL/PH	QHEI/HHEI	4X	4X	4X	4X	2X	Bact (4X)	X	X
LM72	H	11	004	Duck Creek	LRW	39.16528	-84.41806	5.14	Stantec	Duck Creek Road	CSO 43, 671, 553	1.8	8	E,F	QL/PH	QHEI/HHEI	4X	4X	4X	4X	2X	Bact (4X)	X	X
LM73	H	11	004	Duck Creek	LRW	39.16037	-84.41668	4.58	MSDGC	Steel Place	CSO 188, 61, 43	1.91	8	E,F	QL/PH	QHEI/HHEI	4X	4X	4X	4X	1X	Bact (4X)	X	X
LM74	H	11	004	Duck Creek	LRW	39.15633	-84.40772	3.90	Geometric	dst. E. Fork Duck Creek	CSO 68, 66, 556	9.56	6	E	HD	QHEI	4X	4X	4X	4X	1X	Bact (4X)	X	X
LM75	H	11	004	Duck Creek	LRW	39.149308	-84.407592	3.40	OH EPA	Erie Avenue	CSO 136, 80, 205	10.2	5	E	HD	QHEI	4X	4X	4X	4X	2X	Bact (4X)	X	X
LM76	H	11	004	Duck Creek	WWH	39.143300	-84.404700	2.80	OH EPA	Red Bank Rd. and Fair Ln.	CSO 84, 83, 199	11.6	5	E	HD	QHEI	4X	4X	4X	4X	2X	Bact (4X)	X	X
LM77	H	11	004	Duck Creek	WWH	39.132778	-84.404722	2.00	OH EPA	Wooster Rd.	CSO 84, 83, 199	14.4	5	E	HD	QHEI	4X	4X	4X	4X	2X	Bact (4X)	X	X
LM79	H	11	004	Duck Creek	WWH	39.121700	-84.410800	0.90	OH EPA	Ust. Wooster Rd.	CSO 86, 85, 84	14.7	8	E	QL/PH	QHEI/HHEI	4X	4X	4X	4X	4X	Bact (4X)	X	X
LM80	H	11	075	Unnamed Trib to Duck Creek	LRW	39.16710	-84.41973	5.00	MSDGC	Kennedy Avenue	CSO 556, 554, 555	1.4	8	F	QL/PH	QHEI/HHEI	2X	2X	2X	2X	2X	Bact (2X)		
LM83	H	11	075	Unnamed Trib to Duck Creek	PHW2	39.17404	-84.42356	0.80	Geometric	Behind Home Depot	CSO 556, 554, 555	1.2	8	F	QL/PH	QHEI/HHEI	2X	2X	2X	2X	2X	Bact (2X)		
LM82	H	11	077	Unnamed Trib to L. Duck Creek	PHW3	39.18326	-84.37000	0.20	Geometric	At baseball field	CSO 556, 554, 555	1.4	9	F	QL/PH	QHEI/HHEI	2X	2X	2X			Bact (2X)		
LM81	H	11	004	East Fork Duck Creek	PHW1	39.18249	-84.39899	2.30	Geometric	End of Tamworth Dr.		0.29	8	F	QL/PH	QHEI/HHEI	2X	2X	2X			Bact (2X)	X	X
LM84	H	11	051	East Fork Duck Creek	WWH	39.164718	-84.400937	0.70	OH EPA	Behind John P. Parker School - site moved 2017		2.2	8	E,F	QL/PH	QHEI/HHEI	4X	4X	4X	4X	4X	Bact (4X)	X	X
LM85	H	11	051	East Fork Duck Creek	WWH	39.17944	-84.39604	2.00	UC	Stewart Ave.	CSO 556, 554, 555	1.3	8	F	QL/PH	QHEI/HHEI	4X	4X	4X	4X	4X	Bact (4X)		
LM86	H	11	076	Little Duck Creek	WWH	39.15989	-84.38088	2.40	Geometric	Camargo Road	SSO 1014, 1057	0.22	9	F	QL/PH	QHEI/HHEI	2X	2X	2X			Bact (2X)		
LM87	H	11	076	Little Duck Creek	WWH	39.15833	-84.38139	1.90	Stantec	Plainville Road	SSO 1014, 1057	0.5	9	F	QL/PH	QHEI/HHEI	2X	2X	2X			Bact (2X)		
LM90	H	11	076	Little Duck Creek	WWH	39.15635	-84.38509	1.00	UC	Settle Street	CSO 69, 72, 71	0.55	9	F	QL/PH	QHEI/HHEI	2X	2X	2X			Bact (2X)		
LM92	H	11	076	Little Duck Creek	WWH	39.13611	-84.40000	0.49	Stantec	Wooster @ Red Bank		14.5	5	E	HD	QHEI	4X	4X	4X	4X	2X	Bact (4X)	X	X
																							27	**27**

Level 1 (>300 mi^2): 13
Level 2 (164 mi^2): 0
Level 3 (82 mi^2): 0
Level 4 (42 mi^2): 2
Level 5 (21 mi^2): 5
Level 6 (10 mi^2): 6
Level 7 (5.0 mi^2): 7
Level 8 (2.5 mi^2): 9
Level 9 (1.0 mi^2): 5

Sites Summary:
Total Sites: **37**

Fish:
A (2X) - 13
D&E (2X) - 8 (rose shaded)
E (1X) - 3
E,F (1X) - 3
F (1X) - 11
Total: **37**

Bugs:
HD - 16
HD,QL- 1
QL - 1
QL/PH - 18
Total: **37**

Chem WQ:
5X: 13
4X: 14
2X: 10
Total: **37**