Report on Conditions in the Great Miami River Near Downtown Dayton, Ohio After Low Dam Modifications and Construction of Kayak Chutes (2017-2018)

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Executive Summary

1) This report describes the physical and biological conditions in the Great Miami River near downtown Dayton, OH following the modification of one low dam into a kayak chute and the construction of another completely new kayak chute near Riverscape.

2) Measurements of river conditions include: Boat electroshocking for fish in dam pools, wading-shocking for fish in shallow water below the kayak chutes, collection of macroinvertebrates using hester-dendy artificial substrates, kick nets and sweep nets, the assessment of the physical habitat around the dams, the collection of water chemistry parameters, and measurements of stream velocity.

3) Data collected in fall 2017 and fall 2018 (MBI study) were used to calculate various indices including the MAIS, IBI, ICI, and QHEI.

4) Sampling strategy involved collecting in the same locations and using the same methods as the pre-modification study conducted in 2014 (Kavanaugh, 2016) to describe the biota living in a wide range of aquatic habitats.

5) The conditions described in the report represent post-dam modification conditions and are intended to serve as a comparison to pre-modification data reported in Kavanaugh, 2016 to assess the effects of low dam modifications.

6) Over 22,000 macroinvertebrate specimens were collected and 32 different families of macroinvertebrates were identified.

7) The data show all metrics improved from the Pre-modification conditions in 2014 to post-modification conditions in 2017.

8) The results show from 2014 to 2017 the QHEI, MAIS, IBI, EPT taxa, and Total # of taxonomic groups **all** improve. In no case did an index decrease. In one case the Total # of taxonomic groups remained at 31 in 2014 and 2017 based on kick/sweep net samples; but this metric also increased based on hester-dendy samples at both locations.

9) Data for 2017 are also shown for the Riverscape (RS) kayak chute which was not present in 2014, so no comparisons can be made at this time (it was finished in spring 2017).

10) While the physical habitat and fish community near the RS kayak chute are excellent as measured by the QHEI and IBI, the macroinvertebrate community is poorly developed at this time based on a low MAIS score. A post-installation comparison of data in 2019 or 2020 would be predicted to show improved macroinvertebrate metrics as the organisms fully colonize the area.

11) Water chemistry data including temperature, pH, DO, and conductivity were considered within acceptable values.

Acknowledgments

Section 1.0. Introduction

This report describes the biotic and abiotic conditions following alteration of the Monument Avenue low dam into a kayak chute on the Great Miami River (GMR) near downtown Dayton, Ohio. Pre-modification conditions were reported earlier in Kavanaugh (2016). The sampling sites for this report correspond to locations in Kavanaugh (2016) and are located immediately below the Monument Avenue bridge at RM 80.6 and in the pool above the dam at RM 81.1 (see Figure 1). This report also includes data associated with the construction of a second kayak chute immediately adjacent to Riverscape at RM 81.3.

Section 2.0. Sampling Methods

Data was collected on fish, macroinvertebrates, physical habitat, and water quality.

Fish Sampling Methods

Two methods were used to collect fish. Below the dam in wadeable, shallow water a portable fish-shocking device was used following methods based on the Ohio EPA method described in *Volume III: Standardized Biological Field Sampling and Laboratory Methods for Assessing Fish and Macroinvertebrate Communities* (OHEPA, 1989). The areas sampled were limited by excessive water depth; i.e., approximately 3 feet deep. Below Monument Avenue dam, habitats around two gravel bars were sampled including riffles, runs, the shallow edge of a pool below the bridge, and inside the vegetated edges of the gravel bars. See Kavanaugh (2016) for more detailed photos of sampling locations.

The electroshocker unit used is identical to equipment used by Ohio EPA and was an engine-driven electric generator designed for DC "fish shocking" service built by Baldor Generators, 3815 Oregon Street, Oshkosh, WI 54902, phone 920-236-4200. The generator consists of a 4-cycle overhead valve 5.5 HP Honda gasoline engine with low-oil shutdown, single cylinder, air-cooled, directly coupled to a DC125/250 volt generator. It provides 750 watt 125/250 volt DC at 3600 rpm.

For sampling fish in the dam pool, methods described in OHEPA (1989) were followed. Boat and shocking equipment owned and operated by Midwest Biodiversity Institute was used for sampling the dam pool. UD personnel assisted MBI during boat-shock sampling.

Macroinvertebrate Sampling Methods

A variety of methods were used to sample for macroinvertebrates. For calculation of the Macroinvertebrate Aggregated Index for Streams (MAIS) kick net and sweep net samples were taken in the shallow areas below each dam following the methods described in Johnson (2007), *Field and Laboratory Methods for using the MAIS in Rapid Bioassessment of Ohio Streams*. Kick net samples were taken in 3 riffles per site and sweep net samples of 20 "jabs" were taken in all available habitats. For the dam pool areas above both dams, it was not possible to take either kick net or sweep net samples due to excessive water depth so hester-dendy samples were collected instead following methods described in OHEPA (1989), *Volume III: Standardized Biological Field Sampling and Laboratory Methods for Assessing Fish and Macroinvertebrate Communities*. For comparison purposes, hester-dendy samples were also taken below the dams. All macroinvertebrate samples were preserved in 70% ethanol in the field and returned to the laboratory for identification.

Water Chemistry Methods

Basic water chemistry parameters were measured using hand-held meters. Values were recorded above and below both dams for a period of two months beginning in September of 2015. Recordings were made in early morning to ensure primary production from algae did not produce super-saturated values of dissolved oxygen. Hand-held meters were used for measuring pH, conductivity, temperature, TDS, and dissolved oxygen.   A YSI Pro ODO, Professional Optical

Dissolved Oxygen meter was used to measure temperature and DO. A Hanna Instruments HI 98129 pH/EC/TDS/Temperature tester was used for pH, conductivity, TDS.

Physical Habitat Measurement Method

The quality of the physical river habitat was assessed above and below both dams using Ohio EPA (2006) *Methods for Assessing Habitat in Flowing Waters: Using the Qualitative Habitat Evaluation Index (QHEI)*.

Stream Velocity Method

The float method was used to measure surface water velocity. US Forest Service website www.fs.fed.us/ARMdata/PDFfiles/floatmethod.doc

Section 3.0. Sampling locations and dates.

Figure 1. Sampling Locations and dates for 2017 post-dam modification project.
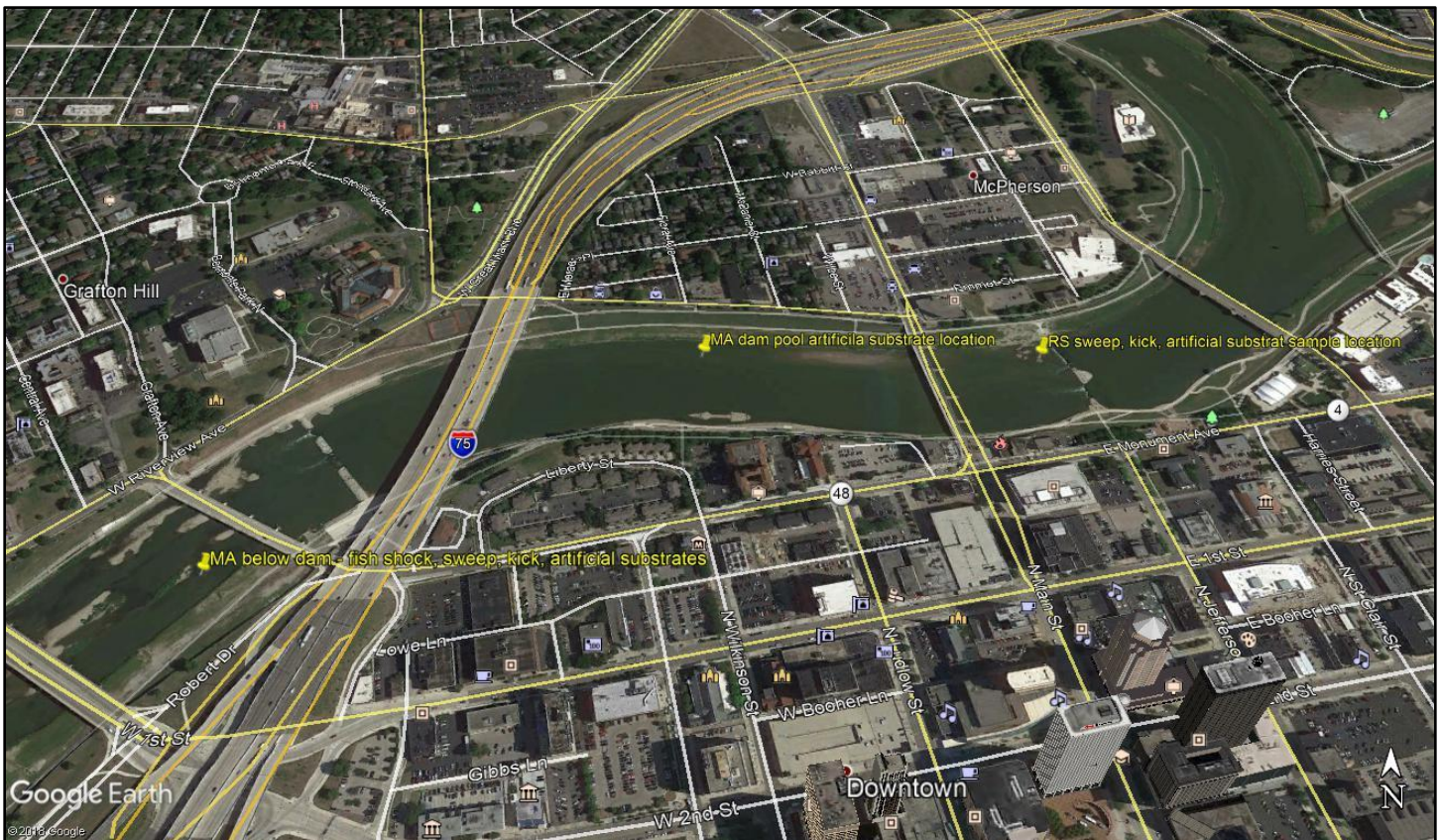
MA-below sweep net, kick net collected on 9/29/17.

MA-below artificial substrates (hester-dendy) collected after six weeks colonization on 9/30/17.

MA-below wading fish shocking conducted on 10/15/17.

MA-above artificial substrates collected on 9/30/17.

RS sweep net, kick net, artificial substrates all collected on 9/30/17.

Figure 2. Riverscape (RS) kayak chute sampling locations and dates.
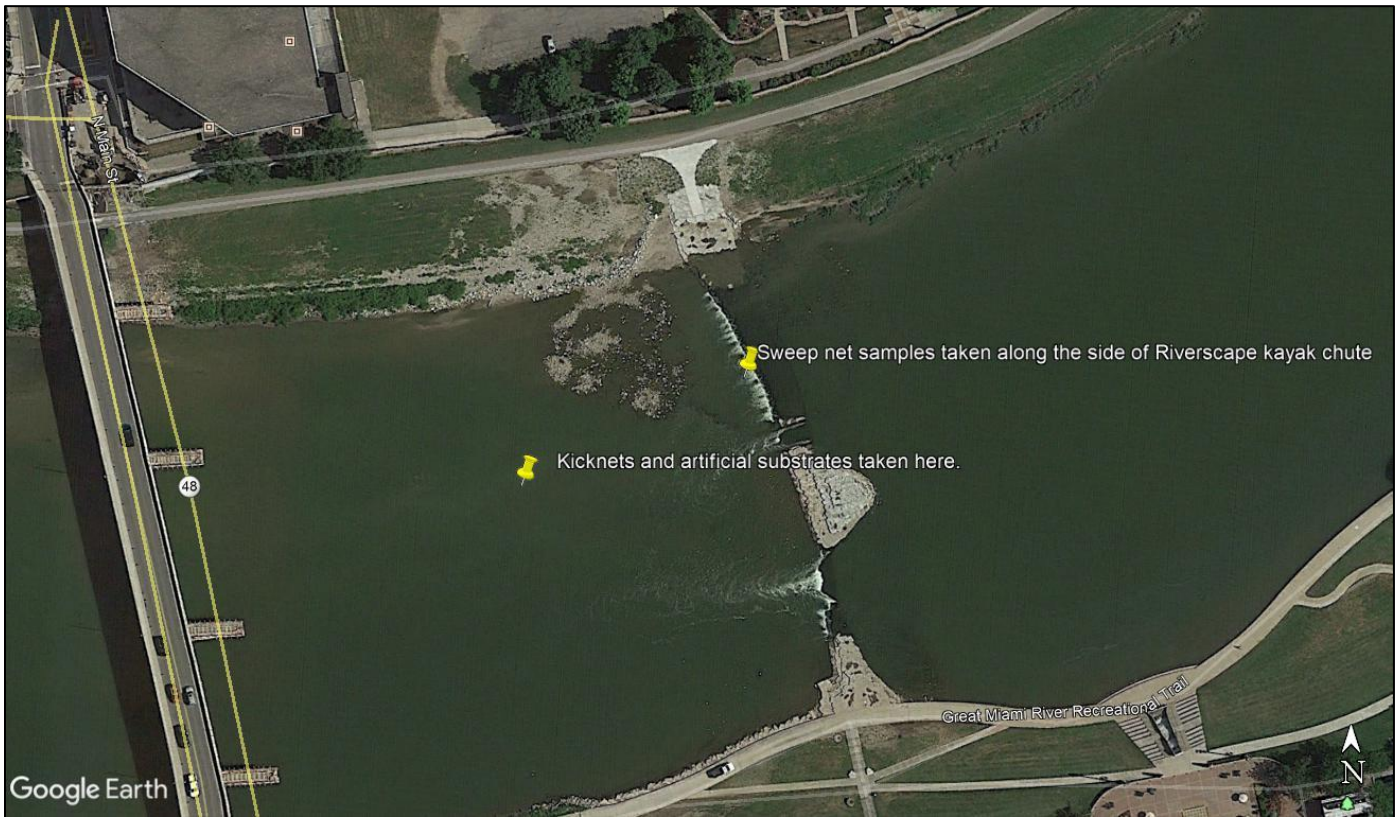
RS sweep net, kick net, artificial substrates all collected on 9/30/17.

Section 4.0. Results and Discussion

The overall results can be seen in Tables 1 and 2.

The data show all metrics improved from the Pre-modification conditions in 2014 to post-modification conditions in 2017. An unexpected variable that probably helped improve the physical habitat and positively impacted fish biodiversity is the Riverscape (RS) kayak chute and its influence on the upper reaches of the MA dam pool.

Tables 1 and 2 show from 2014 to 2017 the QHEI, MAIS, IBI, EPT taxa, and Total # of taxonomic groups **all** improve. In no case did an index decrease. In one case the Total # of taxonomic groups remained at 31 in 2014 and 2017 based on kick/sweep net samples; but this metric also increased based on hester-dendy samples at both locations.

 The Riverscape (RS) kayak chute data doesn't have a comparable data set to compare to since its construction was finished in spring 2017, the same year of the sampling; i.e., in September 2017. A post-installation comparison of data in 2019 or 2020 is predicted to show improved metrics. The RS data do show excellent physical habitat (QHEI), but the poor MAIS shows the macroinvertebrates haven't colonized the structure or disturbed area around it yet. However, the fish IBI score was excellent indicating the fish responded faster to the changes. Note that the upper end of the boat-shocking zone goes right up to the RS kayak chute.

Table 1.   Summary of All Index Values Comparing 2015-2015 to 2017-2018.

Location	Year	Habitat QHEI	Invertebrate MAIS	Fish IBI	Comments
Index Comparisons for Pre- and Post-dam modifications at MA-Below					
MA - Below	2014	65 - good	11 – good	34 – fair	UD – wading shock (IBI)
MA - Below	2017	73 – good**+**	12 – good**+**	40 – good**+**	UD – wading shock (IBI)
Index Comparisons for Pre- and Post-dam modifications at MA-Above					
MA - Above	2014	43 -- poor	--[1]	30 – fair	5-Rivers Metro./UD – boat shock (IBI)
MA - Above	2017-18	60.5 – good+	--[1]	51–exceptional**+**	MBI/UD boat shock results positively affected by RS kayak chute (IBI)
Riverscape (RS) Kayak Chute – New Installation (no comparisons)					
RS – kayak chute	2017	75.5 - excellent	10 - poor	--[2]	MAIS (poor) score result of new structure (< 1 year), not yet fully-colonized, though habitat excellent.

"+"Indicates increase in metric from pre-modification samples.

[1]Kick/sweep net samples could not be taken in deep water.

[2]Fish samples for MA-Above apply here too.

Table 2. Summary of Additional Macroinvertebrate Taxa Comparisons

| Location | Year | Kick/Sweep Net Samples | | Artificial Substrates | |
		Total # Taxonomic Groups	EPT Taxa	Total # Taxonomic Groups	EPT Taxa
Comparisons for Pre- and Post-dam modifications at MA-Below					
MA – Below	2014	31	8	10	6
MA - Below	2017	31	11+	13+	7+
Comparisons for Pre- and Post-Dam modifications at MA-Above					
MA - Above	2014	--[1]	--[1]	10	4
MA - Above	2017	--[1]	--[1]	16+	6+
Riverscape (RS) Kayak Chute – New Installation (no comparisons)					
RS – kayak chute	2017	13	6	12	7

Section 4.1 Macroinvertebrate Results and Discussion

Tables 1 and 2 show all macroinvertebrate metrics either improve from 2014 to 2017 or, in one case, remained the same. The MA-below MAIS increased from 11 to 12 and was ranked "good". An MAIS couldn't be calculated for the MA-above pool because the index is based on kick and sweep net samples which couldn't be taken in the pool area. At MA-below, the sensitive EPT taxa improved from 8 groups in 2014 to 11 groups in 2017 based on kick/sweep net samples and increased from 6 to 7 based on artificial substrates. At MA-above the EPT taxa also increased, from 4 in 2014 to 6 in 2017 based on artificial substrate samples. At MA-below, the total # of taxonomic groups stayed at 31 in 2017 based on kick/sweep net samples (only metric which did not increase), but increased there based on artificial substrates from 10 to 13. The total # of taxonomic groups showed a large increase at MA-above from 10 to 16 groups. See Tables 3 and 4 for individual MAIS metrics and Table 5 and Figure 3 and Kavanaugh (2016) for explanation of the index and its metrics. All macroinvertebrate data is shown in Table 6. A total of 22,756 specimens were collected.

Data for 2017 are also shown for the Riverscape (RS) kayak chute which was not present in 2014 so no comparisons can be made at this time (it was finished in spring 2017). The MAIS value for RS was low, a 10 "poor". This is likely a result of the structure only having recently been completed, the disturbance to the substrates in the area would have impacted the macroinvertebrates so they need time to recover and colonize the area. EPT taxa, based on kick/sweep net samples were also lower at RS than at MA-below. The total number of taxonomic groups was also lower at RS than at MA-below or MA-above based on artificial substrates. However, RS EPT taxa based on artificial substrates were equal to MA-below and exceeded by one group the EPT taxa at MA-above. It is expected that all macroinvertebrate metrics at RS should improve as the habitat stabilizes.

Table 3. MAIS Score for MA-Below.

Metric	Value	Rounded	MAIS Value
% 5 Dominant Taxa	84	84	1
Modified HBI	5.67	5.67	0
% Haptobenthos	71	71	1
EPT Index	11	11	2
# Ephemeroptera	5	5	2
% Ephemeroptera	27	27	2
SDI	0.80	0.80	1
# Intolerant Taxa	15	15	2
% Scrapers	10	10	1
Total			12

Table 4. MAIS Calculations for RS Kayak Chute

Metric	Value	Rounded	MAIS Value
% 5 Dominant Taxa	93	93	1
Modified HBI	5.48	5.48	1
% Haptobenthos	54	54	1
EPT Index	6	6	1
# Ephemeroptera	3	3	1
% Ephemeroptera	24	24	2
SDI	0.72	0.72	1
# Intolerant Taxa	7	7	1
% Scrapers	8	8	1
Total			10

Table 5. Explanation of MAIS metrics.

	METRIC	DEFINITION
1	EPT richness	Number of caddisfly, stonefly and mayfly families
2	# Emphemeroptera	Number of mayfly families
3	% Ephemeroptera	% abundance of mayflies
4	% 5 dominant taxa	5 most dominant taxa combined
5	Simpson Diversity Index	Integrates richness and evenness
6	Modified Hilsenhoff Biotic Index	Taxa are weighted by pollution tolerance
7	# intolerant taxa	# of families with tolerance values of 5 or less (very sensitive)
8	% scrapers	Abundance of macros that feed on periphyton
9	% haptobenthos	Abundance of macros that require clean, coarse, firm substrates

From: Johnson, Kelly S., Field and Laboratory Methods for using the MAIS (Macroinvertebrate Aggregated Index for Stream Rapid Bioassessment of Ohio Streams, June, 2007.

Figure 3. MAIS value rankings in the Western Allegheny Plateau in southeastern Ohio.
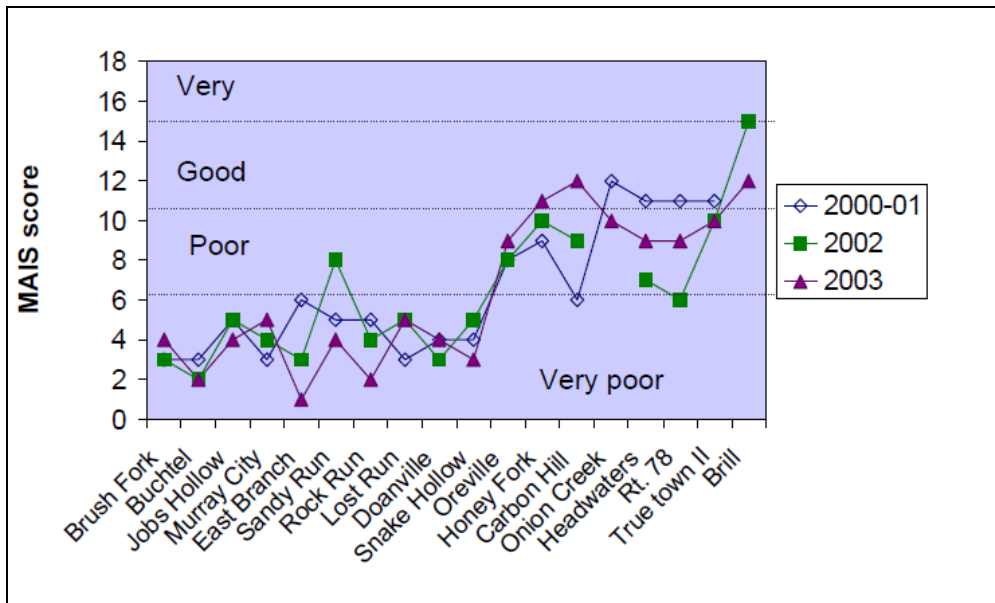
From Johnson, 2007.

Table 6. Combined macroinvertebrate data for 2017.

Summary of Macroinvertebrate Data for 2017.

Phylum	Class	Order	Family	RS – On and Near Kayak Chute: Kick Net	RS Sweep Net	RS Kick/Sweep (Combined for MAIS)	RS Artificial Substrate (HD)	MA – Below Kayak Chute: Kick Net	MA Sweep Net	MA Kick/Sweep (Combined for MAIS)	MA Artificial Substrate (HD)	MA – Above K.C. (pool) Artificial Substrate (HD)
Cnidaria (Jellies)			Hydridae									
Platyhelminthes (Flatworms)	Turbellaria	(Turbellaria)	(Turbellaria)	4		4			3	3		
Ectoprocta (Bryozoans)												
Entoprocta			Barentsiidae									
Annelida (Segmented worms)	Oligochaeta (aquatic earthworms)		(Oligochaeta)				6					
	Hirudinea (leeches)		Erpobdellidae									1
Mollusca	Gastropoda (snails)		Viviparidae					4	1	5		1
			Pleuroceridae	20	38	58		58	183	241	2	217
			Physidae						1	1	2	1
			Ancylidae (limpets)									
	Bivalvia (mussels, clams)		Sphaeridae	84		84		80	1	81		2
			Corbiculidae					230		230		
Arthropoda	Malacostraca	Amphipoda (scuds, sideswimmers)	Talitridae (=Hyalellidae)	6		6			15	15		102
			Gammaridae						7	7		
		Decapoda (crayfish)	Cambaridae					2		2		2
	Arachnida	Trombidiformes	Hydrachnidae (Hydracarina, Water mites)					94	16	110		
	Insecta	Ephemeroptera (Mayflies)	Baetidae	248	103	351	46	1446	129	1575	223	
			Isonychiidae	396	6	402	20	58	4	62	22	
			Heptageniidae	238	2	240	402	518	38	556	144	174
			Tricorythidae (=Leptohyphidae)				60	942	44	986		32
			Caenidae						1	1		2
			Potamanthiidae									
			Ephemeridae									
		Odonata – Suborder Zygoptera	Calopterygidae						72	72	4	
			Coenagrionidae					2		2		1
			Argidae									
			Lestidae									
		Suborder Anisoptera	Aeshnidae						1	1		2
		Trichoptera (Caddisflies)	Hydropsychidae	868	184	1052	2654	3438	909	4347	1096	4
			Glossomatidae					148		148		
			Hydroptilidae		9	9	18	58		58	4	1
			Leptoceridae					4	1	5		4
			Polycentropodidae									
			Rhyacophilidae									
			Philopotamidae									
		Plecoptera (stoneflies)	Perlidae	2	10	12	2	12		12		
		Coleoptera (beetles)	Hydrophilidae	32	4	36	2	2		2		
			Elmidae (riffle beetles)					190	9	199		11
			Psephenidae (water pennies)									
			Gyrinidae (whirligig beetles)									
		Hemiptera (true bugs)	Corixidae (water boatmen)						2	2	2	
			Gerridae (water striders)					14	1	15	4	
			Veliidae (smaller water striders)						12	12	2	
			Belostomatidae (giant water bugs)									
		Lepidoptera (moths and butterflies)	Pyralidae (=Crambidae) (snout moths)									
		Diptera	Simuliidae (black flies)	60	32	92	176	732	293	1025	54	4
			Tipulidae (crane flies)				2					
			Empididae (dance flies)									
			Ceratopogonidae (biting midges)									
			Tabanidae (horse flies)									
			Chironomidae (midges)	1612	251	1863	784	1896	167	2063	146	273
			Total No. specimens	3570	639	**4209**	4172	9928	1911	**11839**	1705	831
			Total No. Taxonomic Groups	12	10	**13**	12	21	24	**31**	13	16
			EPT (# of EPT families)	5	6	**6**	7	10	7	**11**	7	6

Section 4.2. Fish Results and Discussion

The fish community, as measured by the IBI index, improved both above and below the MA kayak chute in 2017/2018 (Table 1). At MA-below, the IBI improved from 34 "fair" to 40 "good". This is partly due to the 2017 sample being comprised of fewer "highly tolerant" species as a proportion of the entire community (Table 8) and see Kavanaugh (2016). An improvement in the boat-shock IBI was measured at MA-above, increasing from a score of 30 "fair" to 51 "exceptional". Various factors may affect the IBI such as improved habitat, improved water quality, current weather and river conditions, experience of boat crews and the quality of their equipment (see Kavanaugh, 2016 for a discussion of comparing IBI scores). In this case, the large increase was probably partly due to the improved physical habitat provided by the newly-constructed Riverscape kayak chute. The upstream end of the fish sampling area was immediately below the kayak chute and would have benefited from the fast-flowing whitewater and improved substrates added to the area during construction.   Table 7 shows the quality ranking of IBI scores provided by OHEPA.

Table 7. Quality ranking of fish community by IBI score.

IBI			MIwb		ICI	Narrative Evaluation
Headwater	Wading	Boat	Wading	Boat	All	
50-60	50-60	48-60	≥9.4	≥9.6	46-60	Exceptional
46-49	46-49	44-47	8.9-9.3	9.1-9.5	42-44	Very Good
Eastern Corn Belt Plains						
40-45	40-45	42-43	8.3-8.8	8.5-9.0	36-40	Good
36-39	36-39	38-41	7.8-8.2	8.0-8.4	32-34	Marginally Good
28-35	28-35	26-37	5.9-7.7	6.4-7.9	14-30	Fair

[1]For this study, see columns under "IBI, Wading and Boat". All values are for the Eastern Corn Belt Plains, the ecoregion in which the low dam in this study is located.

[2]This table is excerpted from *2008 Updates to Biological Criteria for the Protection of Aquatic Life: Volume II and Volume II Addendum. User's Manual for Biological Field Assessment of Ohio Surface Waters.* (OHEPA, 2008).

Table 8. Fish Data from MA-below.

MA Below
October 15, 2017
River Mile: RM 80.6
Collection Method: Longline Electrofishing
Drainage Area: 2511 miles²
Collection Distance: 0.052 km

Ohio EPA Index of Biotic Integrity Metrics

Code	Species	Number	Weight (kg)	Pollution Tolerance	DELT #	DELT Description	1 Number of Native Species	2 Number of Darter Species	3 Number of Sunfish Species	4 Number of Sucker Species	5 Number of Intolerant Species	6 Proportion of Tolerant Species	7 Proportion of Omnivores	8 Proportion of Insectivores	9 Proportion of Top Carnivores	10 Number of Individuals	11 Proportion of Simple Lithophils	12 Proportion w/ DELTs
40-008	Moxostoma anisurum — Silver Redhorse	1	0.14	Moderately Intolerant	0	---	y			y							y	
40-010	Moxostoma erythrurum — Golden redhorse	28	1.626	Moderately Intolerant	0	---	y			y				y			y	
40-015	Hypentelium nigricans — Northern hog sucker	5	0.395	Moderately Intolerant	0	---	y			y				y			y	
43-021	Notropis photogenis — Silver shiner	4	0.037	Common Intolerant	0	---	y				y			y			y	
43-025	Notropis chrysocephalus — Striped shiner	11	0.225	--	0	---	y							y			y	
43-043	Pimephales notatus — Bluntnose minnow	7	0.025	Highly Tolerant	0	---	y					y	y			T		
77-003	Ambloplites rupestris — Northern rockbass	1	0.04	--	0	---	y		y						y			
77-004	Micropterus dolomieui — Smallmouth bass	3	0.23	Moderately Intolerant	0	---	y								y			
77-006	Micropterus salmoides — Largemouth bass	1	0.013	--	0	---	y								y			
80-011	Percina caprodes — Northern logperch darter	7	0.19	Moderately Intolerant	0	---	y	y						y			y	
80-014	Etheostoma nigrum — Johnny darter	12	0.035	--	0	---	y	y						y				
80-015	Etheostoma blenniodes — Greenside darter	1	0.009	Moderately Intolerant	0	---	y	y						y			y	
80-022	Etheostoma caeruleum — Rainbow darter	3	0.03	Moderately Intolerant	0	---	y	y						y			y	
80-016	Etheostoma zonale — Banded Darter	3	0.03	Intolerant	0	---	y	y			y			y			y	
80-023	Etheostoma spectabile — Orangethroat Darter	3	0.012	--	0	---	y	y						y			y	
	Totals	90	3.037		0		15	6	1	3	2	7.778	7.778	86.667	5.556	479	73.333	0.000
	Metric Scores						3 +	3 +	1 +	1 +	1 +	3 +	5 +	5 +	5 +	3 +	5 +	5

IBI Score = 40

*DELT anomalies were observed on 0.00 % of the fish collected.
Index of Biotic Integrity (IBI) = 40 (Good)
Modified Index of Well-Being (MIwb) = 8.4 (Good)
Shannon Diversity Index, no. 2.239
Shannon Diversity Index, wt. 1.659
N 478.8
B 17.38

Section 4.3 QHEI Results and Discussion

Tables 10-12 show QHEI scores for MA-below, MA-above, and RS kayak chute. Quality rankings are shown below in Table 9.

Various factors can affect QHEI scores, most important are improved habitat features but assessments can also be affected by weather (rainfall patterns) and water levels that obscuring features that observable when levels recede. Silts and unsorted substrates can be flushed out and re-sorted following large rain events.

The QHEI for MA-below is shown in Table 10, it improved slightly from a score of 65 "good" in 2014 to 73 "good" in 2017. The most significant factor increasing the score was that more instream cover was observed in 2017; root mats, root wads, boulders macrophytes, woody debris in "functional" roles were present and overall the cover was more extensive than in 2014.

The QHEI for MA-above improved by a large amount from a score of 43 "poor" in 2014 to 60.5 "good" in 2017. Several factors were responsible. Probably through a combination of re-sorting substrates from high-water events in the three years prior plus slightly lower water levels due to the Monument Avenue low dam being converted into a kayak chute downstream the habitat improved. The QHEI was affected in several areas by these events: most importantly much less silt was evident exposing a higher quality substrate consisting of sand and gravel. The lower levels of silt substantially affected the "substrate" metric. Instream cover was improved and more widespread, certain features such as woody debris that was present in 2014 but not "functional" was functional in 2017 adding to the score. Another significant change was the obvious appearance of some riffles that were not evident in 2014. This improved the "channel morphology", and "Riffle" metric substantially.

The Riverscape kayak chute area was added in 2017 but no comparisons were possible since it was not present in 2014. In general the zone included in this QHEI is excellent habitat, the deep water with strong velocity below the kayak chute, the large substrates, other areas with shallow riffles and a variety of flow regimes (slow and fast), the confluence with the Mad River providing additional complex channel morphology – all contribute to a very high QHEI score.

Table 9. QHEI Index Values Ranked

Table 2. General narrative ranges assigned to QHEI scores. Ranges vary slightly in headwater ($\leq$ 20 sq mi) vs. larger waters.			
Narrative Rating		**QHEI Range**	
		Headwaters	Larger Streams
Excellent		$\geq$ 70	$\geq$ 75
Good		55 to 69	60 to 74
Fair		43 to 54	45 to 59
Poor		30 to 42	30 to 44
Very Poor		< 30	< 30

From: Ohio Environmental Protection Agency. 2006. Technical Bulletin EAS/2006-06-1. Methods for Assessing Habitat in Flowing Waters: Using the Qualitative Habitat Evaluation Index (QHEI). Division of Surface Water, June 2006.

Table 10. QHEI from MA-Below.

MA-below

OhioEPA — Qualitative Habitat Evaluation Index and Use Assessment Field Sheet **QHEI Score: 73**

Stream & Location: MA - Below Kayak chute   RM: 80.6 Date: 10/04/0617

Scorers Full Name & Affiliation: ____

River Code: _ - _ - ____ STORET #: ____ Lat./ Long.: ____ . ____ / 18 . ____ (NAD 83 - decimal °) Office verified location ☐

1] SUBSTRATE Check ONLY Two substrate TYPE BOXES; estimate % or note every type present   Check ONE (Or 2 & average)

BEST TYPES (POOL RIFFLE)
- ☐☐ BLDR /SLABS [10]
- ☐☐ BOULDER [9]
- ☐☐ COBBLE [8]
- ☑☐ GRAVEL [7]
- ☐☑ SAND [6]
- ☐☐ BEDROCK [5]

OTHER TYPES (POOL RIFFLE)
- ☐☐ HARDPAN [4]
- ☐☐ DETRITUS [3]
- ☐☐ MUCK [2]
- ☐☐ SILT [2]
- ☐☐ ARTIFICIAL [0]

(Score natural substrates; ignore sludge from point-sources)

ORIGIN
- ☐ LIMESTONE [1]
- ☑ TILLS [1]
- ☐ WETLANDS [0]
- ☐ HARDPAN [0]
- ☐ SANDSTONE [0]
- ☐ RIP/RAP [0]
- ☐ LACUSTURINE [0]
- ☐ SHALE [-1]
- ☐ COAL FINES [-2]

SILT / EMBEDDEDNESS

QUALITY
- ☐ HEAVY [-2]
- ☑ MODERATE [-1]
- ☑ NORMAL [0]
- ☑ FREE [1]
- ☐ EXTENSIVE [-2]
- ☑ MODERATE [-1]
- ☑ NORMAL [0]
- ☐ NONE [1]

Substrate 15 Maximum 20

NUMBER OF BEST TYPES: ☑ 4 or more [2] ☐ 3 or less [0]

Comments

2] INSTREAM COVER Indicate presence 0 to 3: 0-Absent; 1-Very small amounts or if more common of marginal quality; 2-Moderate amounts, but not of highest quality or in small amounts of highest quality; 3-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

- ___ UNDERCUT BANKS [1]
- ___ OVERHANGING VEGETATION [1]
- ✓ SHALLOWS (IN SLOW WATER) [1]
- ✓ ROOTMATS [1]
- ✓ POOLS > 70cm [2]
- ✓ ROOTWADS [1]
- ✓ BOULDERS [1]
- ✓ OXBOWS, BACKWATERS [1]
- ✓ AQUATIC MACROPHYTES [1]
- ✓ LOGS OR WOODY DEBRIS [1]

AMOUNT Check ONE (Or 2 & average)
- ☐ EXTENSIVE >75% [11]
- ☑ MODERATE 25-75% [7]
- ☐ SPARSE 5-<25% [3]
- ☐ NEARLY ABSENT <5% [1]

Cover 15 Maximum 20

Comments Good functional areas of riparian vegetation plus gravel bars vegetation

3] CHANNEL MORPHOLOGY Check ONE in each category (Or 2 & average)

SINUOSITY
- ☐ HIGH [4]
- ☑ MODERATE [3]
- ☑ LOW [2]
- ☐ NONE [1]

DEVELOPMENT
- ☐ EXCELLENT [7]
- ☑ GOOD [5]
- ☑ FAIR [3]
- ☐ POOR [1]

CHANNELIZATION
- ☐ NONE [6]
- ☑ RECOVERED [4]
- ☐ RECOVERING [3]
- ☐ RECENT OR NO RECOVERY [1]

STABILITY
- ☑ HIGH [3]
- ☑ MODERATE [2]
- ☐ LOW [1]

Channel 13 Maximum 20

Comments

4] BANK EROSION AND RIPARIAN ZONE Check ONE in each category for EACH BANK (Or 2 per bank & average)

River right looking downstream

EROSION (L R)
- ☑☑ NONE / LITTLE [3]
- ☐☐ MODERATE [2]
- ☐☐ HEAVY / SEVERE [1]

RIPARIAN WIDTH (L R)
- ☐☐ WIDE > 50m [4]
- ☐☐ MODERATE 10-50m [3]
- ☑☑ NARROW 5-10m [2]
- ☑☑ VERY NARROW < 5m [1]
- ☐☐ NONE [0]

FLOOD PLAIN QUALITY (L R)
- ☐☐ FOREST, SWAMP [3]
- ☐☐ SHRUB OR OLD FIELD [2]
- ☐☐ RESIDENTIAL, PARK, NEW FIELD [1]
- ☐☐ FENCED PASTURE [1]
- ☐☐ OPEN PASTURE, ROWCROP [0]

(L R)
- ☐☐ CONSERVATION TILLAGE [1]
- ☑☑ URBAN OR INDUSTRIAL [0]
- ☐☐ MINING / CONSTRUCTION [0]

Indicate predominant land use(s) past 100m riparian.

Riparian 4.5 Maximum 10

Comments

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH Check ONE (ONLY!)
- ☑ > 1m [6]
- ☐ 0.7-<1m [4]
- ☐ 0.4-<0.7m [2]
- ☐ 0.2-<0.4m [1]
- ☐ < 0.2m [0]

CHANNEL WIDTH Check ONE (Or 2 & average)
- ☑ POOL WIDTH > RIFFLE WIDTH [2]
- ☑ POOL WIDTH = RIFFLE WIDTH [1]
- ☐ POOL WIDTH < RIFFLE WIDTH [0]

CURRENT VELOCITY Check ALL that apply
- ☐ TORRENTIAL [-1] ☑ SLOW [1]
- ☐ VERY FAST [1] ☐ INTERSTITIAL [-1]
- ☐ FAST [1] ☐ INTERMITTENT [-2]
- ☑ MODERATE [1] ☐ EDDIES [1]

Indicate for reach - pools and riffles.

Recreation Potential Primary Contact Secondary Contact (circle one and comment on back)

Pool / Current 10.5 Maximum 12

Comments

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: ☐ NO RIFFLE [metric=0]

Check ONE (Or 2 & average).

RIFFLE DEPTH
- ☑ BEST AREAS > 10cm [2]
- ☑ BEST AREAS 5-10cm [1]
- ☐ BEST AREAS < 5cm [metric=0]

RUN DEPTH
- ☑ MAXIMUM > 50cm [2]
- ☑ MAXIMUM < 50cm [1]

RIFFLE / RUN SUBSTRATE
- ☑ STABLE (e.g., Cobble, Boulder) [2]
- ☑ MOD. STABLE (e.g., Large Gravel) [1]
- ☐ UNSTABLE (e.g., Fine Gravel, Sand) [0]

RIFFLE / RUN EMBEDDEDNESS
- ☐ NONE [2]
- ☑ LOW [1]
- ☐ MODERATE [0]
- ☐ EXTENSIVE [-1]

Riffle / Run 5 Maximum 8

Comments

6] GRADIENT (5 ft/mi)
- ☐ VERY LOW - LOW [2-4]
- ☐ MODERATE [6-10]
- ☒ HIGH - VERY HIGH [10-6]

DRAINAGE AREA (____ mi²)

%POOL: 15 %GLIDE: 5 %RUN: 35 %RIFFLE: 45

Gradient 10 Maximum 10

EPA 4520   06/16/06

Table 11. QHEI from MA-Above (dam pool)

MA Dam Pool

OhioEPA — Qualitative Habitat Evaluation Index and Use Assessment Field Sheet — **QHEI Score:** 60.5

Stream & Location: MA- Above (dam pool) RM: 81.1 Date: 10/04/06-17

Scorers Full Name & Affiliation:

River Code: _ _ _ _ - _ STORET #: _ _ _ _ _ Lat./ Long.: _ _ _ . _ _ _ _ 18 . _ _ _ _ (NAD 83 - decimal °) Office verified location ☐

1] SUBSTRATE Check ONLY Two substrate TYPE BOXES; estimate % or note every type present Check ONE (Or 2 & average)

BEST TYPES	POOL	RIFFLE	OTHER TYPES	POOL	RIFFLE	ORIGIN	QUALITY
☐☐ BLDR /SLABS [10]			☐☐ HARDPAN [4]			☐ LIMESTONE [1]	☐ HEAVY [-2]
☐☐ BOULDER [9]		✓	☐☐ DETRITUS [3]			☑ TILLS [1]	☑ MODERATE [-1]
☐☐ COBBLE [8]	✓		☐☐ MUCK [2]	✓		☐ WETLANDS [0]	☐ NORMAL [0]
☑☐ GRAVEL [7]			☐☐ SILT [2]		✓	☐ HARDPAN [0]	☐ FREE [1]
☐☑ SAND [6]			☐☐ ARTIFICIAL [0]			☐ SANDSTONE [0]	☐ EXTENSIVE [-2]
☐☐ BEDROCK [5]						☐ RIP/RAP [0]	☑ MODERATE [-1]

SILT EMBEDDEDNESS Substrate

NUMBER OF BEST TYPES: ☑ 4 or more [2] ☐ 3 or less [0] (Score natural substrates; ignore sludge from point-sources) ☐ LACUSTURINE [0] ☐ SHALE [-1] ☐ COAL FINES [-2] ☐ NORMAL [0] ☐ NONE [1]

Substrate Maximum 20 — **14**

Comments: SILT reduced, sand, gravel more evident

2] INSTREAM COVER Indicate presence 0 to 3: 0-Absent; 1-Very small amounts or if more common of marginal quality; 2-Moderate amounts, but not of highest quality or in small amounts of highest quality; 3-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

AMOUNT Check ONE (Or 2 & average)

☐ EXTENSIVE >75% [11]
☑ MODERATE 25-75% [7]
☑ SPARSE 5-<25% [3]
☐ NEARLY ABSENT <5% [1]

_____ UNDERCUT BANKS [1] ✓ POOLS > 70cm [2] _____ OXBOWS, BACKWATERS [1]
_____ OVERHANGING VEGETATION [1] _____ ROOTWADS [1] _____ AQUATIC MACROPHYTES [1]
✓ SHALLOWS (IN SLOW WATER) [1] ✓ BOULDERS [1] _____ LOGS OR WOODY DEBRIS [1]
_____ ROOTMATS [1]

Cover Maximum 20 — **9**

Comments: Macrophytes/Logs in water not functional—no score

3] CHANNEL MORPHOLOGY Check ONE in each category (Or 2 & average)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
☐ HIGH [4]	☐ EXCELLENT [7]	☐ NONE [6]	☑ HIGH [3]
☐ MODERATE [3]	☐ GOOD [5]	☑ RECOVERED [4]	☑ MODERATE [2]
☑ LOW [2]	☑ FAIR [3]	☐ RECOVERING [3]	☐ LOW [1]
☐ NONE [1]	☐ POOR [1]	☐ RECENT OR NO RECOVERY [1]	

Channel Maximum 20 — **11**

Comments: some riffles evident, more stable substrates

4] BANK EROSION AND RIPARIAN ZONE Check ONE in each category for EACH BANK (Or 2 per bank & average)

River right looking downstream

EROSION (L R)	RIPARIAN WIDTH (L R)	FLOOD PLAIN QUALITY (L R)	(L R)
☑☑ NONE / LITTLE [3]	☐☐ WIDE > 50m [4]	☐☐ FOREST, SWAMP [3]	☐☐ CONSERVATION TILLAGE [1]
☐☐ MODERATE [2]	☐☐ MODERATE 10-50m [3]	☐☐ SHRUB OR OLD FIELD [2]	☑☑ URBAN OR INDUSTRIAL [0]
☐☐ HEAVY / SEVERE [1]	☐☐ NARROW 5-10m [2]	☐☐ RESIDENTIAL, PARK, NEW FIELD [1]	☐☐ MINING / CONSTRUCTION [0]
	☐☑ VERY NARROW < 5m [1]	☐☐ FENCED PASTURE [1]	
	☑☐ NONE [0]	☐☐ OPEN PASTURE, ROWCROP [0]	

Indicate predominant land use(s) past 100m riparian.

Riparian Maximum 10 — **3.5**

Comments: narrowest riparian on right bank, urban floodplain

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH Check ONE (ONLY!)	CHANNEL WIDTH Check ONE (Or 2 & average)	CURRENT VELOCITY Check ALL that apply	Recreation Potential
☑ > 1m [6]	☐ POOL WIDTH > RIFFLE WIDTH [2]	☐ TORRENTIAL [-1] ☑ SLOW [1]	Primary Contact
☐ 0.7-<1m [4]	☑ POOL WIDTH = RIFFLE WIDTH [1]	☐ VERY FAST [1] ☐ INTERSTITIAL [-1]	Secondary Contact
☐ 0.4-<0.7m [2]	☑ POOL WIDTH > RIFFLE WIDTH [0]	☐ FAST [1] ☐ INTERMITTENT [-2]	(circle one and comment on back)
☐ 0.2-<0.4m [1]		☑ MODERATE [1] ☐ EDDIES [1]	
☐ < 0.2m [0]		Indicate for reach - pools and riffles.	

Pool / Current Maximum 12 — **8.5**

Comments:

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: ☐ NO RIFFLE [metric=0] Check ONE (Or 2 & average).

RIFFLE DEPTH	RUN DEPTH	RIFFLE / RUN SUBSTRATE	RIFFLE / RUN EMBEDDEDNESS
☑ BEST AREAS > 10cm [2]	☑ MAXIMUM > 50cm [2]	☐ STABLE (e.g., Cobble, Boulder) [2]	☐ NONE [2]
☐ BEST AREAS 5-10cm [1]	☐ MAXIMUM < 50cm [1]	☑ MOD. STABLE (e.g., Large Gravel) [1]	☐ LOW [1]
☐ BEST AREAS < 5cm [metric=0]		☑ UNSTABLE (e.g., Fine Gravel, Sand) [0]	☑ MODERATE [0]
			☐ EXTENSIVE [-1]

Riffle / Run Maximum 8 — **4.5**

Comments: Deep riffles visible due to low water

6] GRADIENT (5 ft/mi) ☐ VERY LOW - LOW [2-4] ☐ MODERATE [6-10] ☑ HIGH - VERY HIGH [10-6]

DRAINAGE AREA (mi²)

%POOL: 40 %GLIDE: 30 %RUN: 10 %RIFFLE: 20

Gradient Maximum 10 — **10**

EPA 4520

06/16/06

Table 12.   QHEI from RS Kayak Chute.

OhioEPA — Qualitative Habitat Evaluation Index and Use Assessment Field Sheet — **QHEI Score:** 75.5

Stream & Location: Riverscape Kayak drop – (New site)   RM: 81.5   Date: 10/04/06 17

Scorers Full Name & Affiliation: _____

River Code: _ _ _ - _ _ _ - _ _ _   STORET #: _____   Lat./ Long.: (NAD 83 - decimal °) _ _ . _ _ _ _   18 . _ _ _ _   Office verified location ☐

1] SUBSTRATE Check ONLY Two substrate TYPE BOXES; estimate % or note every type present   Check ONE (Or 2 & average)

BEST TYPES — POOL RIFFLE
- ☐☐ BLDR /SLABS [10]
- ☐☐ BOULDER [9] ___ ✓
- ☑☐ COBBLE [8]
- ☐☑ GRAVEL [7]
- ☐☐ SAND [6] ___ ✓
- ☐☐ BEDROCK [5]

NUMBER OF BEST TYPES: ☑ 4 or more [2]   ☐ 3 or less [0]

OTHER TYPES — POOL RIFFLE
- ☐ HARDPAN [4]
- ☐☐ DETRITUS [3]
- ☐☐ MUCK [2]
- ☐☐ SILT [2] ___ ✓
- ☐☐ ARTIFICIAL [0] ✓
(Score natural substrates; ignore sludge from point-sources)

ORIGIN
- ☐ LIMESTONE [1]
- ☑ TILLS [1]
- ☐ WETLANDS [0]
- ☐ HARDPAN [0]
- ☐ SANDSTONE [0]
- ☐ RIP/RAP [0]
- ☐ LACUSTURINE [0]
- ☐ SHALE [-1]
- ☐ COAL FINES [-2]

SILT — EMBEDDEDNESS

QUALITY
- ☐ HEAVY [-2]
- ☐ MODERATE [-1]
- ☑ NORMAL [0]
- ☐ FREE [1]
- ☐ EXTENSIVE [-2]
- ☐ MODERATE [-1]
- ☑ NORMAL [0]
- ☐ NONE [1]

Substrate 18   Maximum 20

Comments: Kayak drop - silt seen in backwater areas around chute (up + downstream)

2] INSTREAM COVER Indicate presence 0 to 3: 0-Absent; 1-Very small amounts or if more common of marginal quality; 2-Moderate amounts, but not of highest quality or in small amounts of highest quality; 3-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.)

- ___ UNDERCUT BANKS [1]
- ___ OVERHANGING VEGETATION [1]
- ✓ SHALLOWS (IN SLOW WATER) [1]
- ___ ROOTMATS [1]
- ✓ POOLS > 70cm [2]
- ___ ROOTWADS [1]
- ✓ BOULDERS [1]
- ___ OXBOWS, BACKWATERS [1]
- ✓ AQUATIC MACROPHYTES [1]
- ✓ LOGS OR WOODY DEBRIS [1]

AMOUNT   Check ONE (Or 2 & average)
- ☐ EXTENSIVE >75% [11]
- ☑ MODERATE 25-75% [7]
- ☑ SPARSE 5-<25% [3]
- ☐ NEARLY ABSENT <5% [1]

Cover Maximum 20   12

Comments: backwater near banks on both sides, areas w/ vegetation, functional logs

3] CHANNEL MORPHOLOGY Check ONE in each category (Or 2 & average)

SINUOSITY
- ☐ HIGH [4]
- ☐ MODERATE [3]
- ☑ LOW [2]
- ☐ NONE [1]

DEVELOPMENT
- ☐ EXCELLENT [7]
- ☑ GOOD [5]
- ☐ FAIR [3]
- ☐ POOR [1]

CHANNELIZATION
- ☐ NONE [6]
- ☑ RECOVERED [4]
- ☐ RECOVERING [3]
- ☐ RECENT OR NO RECOVERY [1]

STABILITY
- ☑ HIGH [3]
- ☐ MODERATE [2]
- ☐ LOW [1]

Channel Maximum 20   14

Comments: including confluence w/ Mad R, sinuosity good there

4] BANK EROSION AND RIPARIAN ZONE Check ONE in each category for EACH BANK (Or 2 per bank & average)
River right looking downstream

EROSION — L R
- ☑☑ NONE / LITTLE [3]
- ☐☐ MODERATE [2]
- ☐☐ HEAVY / SEVERE [1]

RIPARIAN WIDTH — L R
- ☐☐ WIDE > 50m [4]
- ☐☐ MODERATE 10-50m [3]
- ☐☐ NARROW 5-10m [2]
- ☐☑ VERY NARROW < 5m [1]
- ☑☐ NONE [0]

FLOOD PLAIN QUALITY — L R
- ☐☐ FOREST, SWAMP [3]
- ☐☐ SHRUB OR OLD FIELD [2]
- ☐☐ RESIDENTIAL, PARK, NEW FIELD [1]
- ☐☐ FENCED PASTURE [1]
- ☐☐ OPEN PASTURE, ROWCROP [0]

L R
- ☐☐ CONSERVATION TILLAGE [1]
- ☑☑ URBAN OR INDUSTRIAL [0]
- ☐☐ MINING / CONSTRUCTION [0]

Indicate predominant land use(s) past 100m riparian.

Riparian Maximum 10   3.5

Comments:

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH   Check ONE (ONLY!)
- ☑ > 1m [6]
- ☐ 0.7-<1m [4]
- ☐ 0.4-<0.7m [2]
- ☐ 0.2-<0.4m [1]
- ☐ < 0.2m [0]

CHANNEL WIDTH   Check ONE (Or 2 & average)
- ☐ POOL WIDTH > RIFFLE WIDTH [2]
- ☑ POOL WIDTH = RIFFLE WIDTH [1]
- ☐ POOL WIDTH > RIFFLE WIDTH [0]

CURRENT VELOCITY   Check ALL that apply
- ☐ TORRENTIAL [-1]   ☑ SLOW [1]
- ☑ VERY FAST [1]   ☐ INTERSTITIAL [-1]
- ☑ FAST [1]   ☐ INTERMITTENT [-2]
- ☑ MODERATE [1]   ☑ EDDIES [1]
Indicate for reach - pools and riffles.

Recreation Potential
Primary Contact
Secondary Contact
(circle one and comment on back)

Pool / Current Maximum 12   12

Comments: Variety of depths & water velocity due to chute

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (Or 2 & average).   ☐ NO RIFFLE [metric=0]

RIFFLE DEPTH
- ☑ BEST AREAS > 10cm [2]
- ☐ BEST AREAS 5-10cm [1]
- ☐ BEST AREAS < 5cm [metric=0]

RUN DEPTH
- ☑ MAXIMUM > 50cm [2]
- ☐ MAXIMUM < 50cm [1]

RIFFLE / RUN SUBSTRATE
- ☑ STABLE (e.g., Cobble, Boulder) [2]
- ☑ MOD. STABLE (e.g., Large Gravel) [1]
- ☐ UNSTABLE (e.g., Fine Gravel, Sand) [0]

RIFFLE / RUN EMBEDDEDNESS
- ☐ NONE [2]
- ☑ LOW [1]
- ☑ MODERATE [0]
- ☐ EXTENSIVE [-1]

Riffle / Run Maximum 8   6

Comments:

6] GRADIENT (5 ft/mi)   DRAINAGE AREA (mi²)
- ☐ VERY LOW - LOW [2-4]
- ☐ MODERATE [6-10]
- ☑ HIGH - VERY HIGH [10-6]

%POOL: 45   %GLIDE: 10
%RUN: 25   %RIFFLE: 20

Gradient Maximum 10   10

EPA 4520   06/16/06

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Appendix A

Stream Velocity Data

Figure 4. Water velocity sample locations.
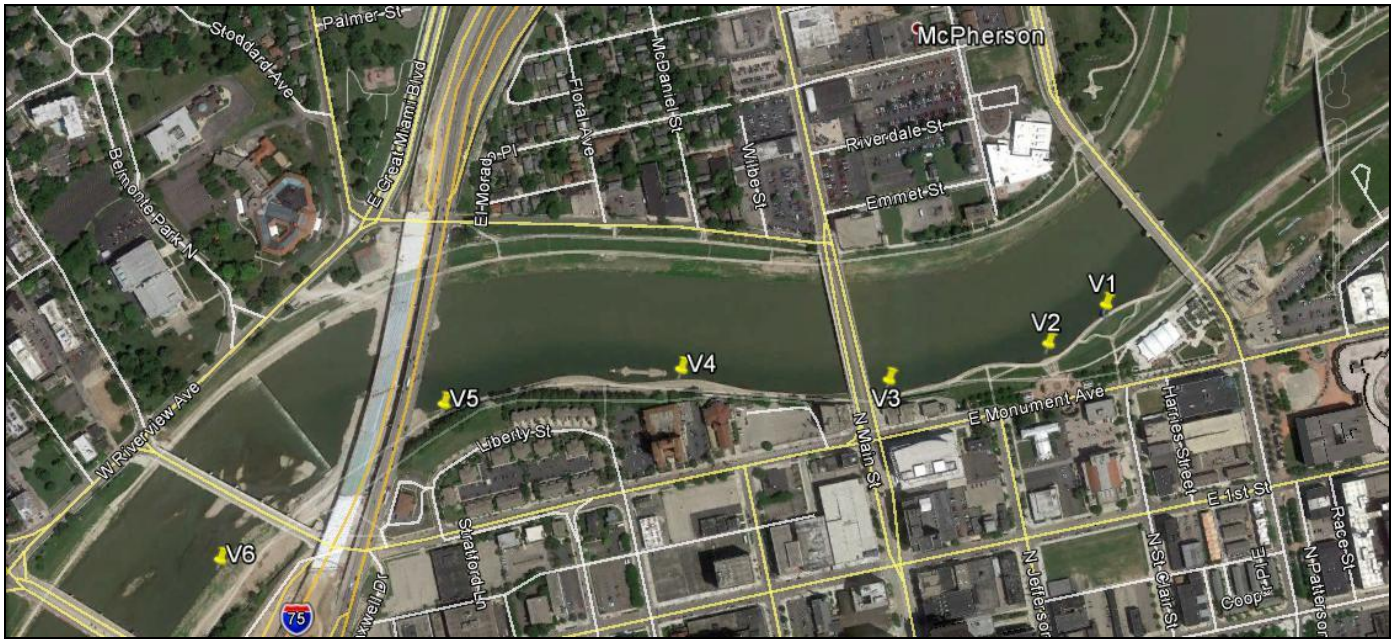
Table 13. Water Velocity Reading Compared Pre- and Post-Modification

		Monument Avenue				
		Above				Below
	V1	**V2**	**V3**	**V4**	**V5**	**V6**
	Measurements taken October 21, 2017					
	0.047	0.082	0.097	0.049	0.150	0.230
	0.117	0.070	0.067	0.067	0.100	0.200
Readings m/s	0.130	0.070	0.076	0.069	0.058	0.170
	Measurements taken November 19, 2017					
	0.043	0.105	0.160	0.068	0.058	0.470
	0.039	0.140	0.168	0.070	0.043	0.370
	0.035	0.100	0.101	0.060	0.060	0.380
mean	0.069	0.095	0.112	0.064	0.078	0.303
cm/s	**6.9[a]**	**9.5**	**11.2**	**6.4**	**7.8**	**30.3**
	Comparisons to Pre-modification water velocity data in 2014					
mean cm/s	**23[a]**	**7**	**8**	**8**	**8**	**19**

[a]Location of site "V1" changed from Kavanaugh (2016) to slightly below the gazebo to rule out the effect of water speeding up around the outside bend of the steps leading into the river. As a result the stream velocity was slower in 2017 compared to 2014.

Appendix B

Water Chemistry Data

Table 14. Water Chemistry Data

Location	Date	Time	pH	Conductivity (ms)	Total Dissolved Solids (ppm)	Dissolved Oxygen (mg/L)	Temperature (C)
MA-Below	9/25/18	7:25 AM	7.22	642	323	8.63	19.6
MA-Below	9/27/18	8:00 AM	7.3	653	327	8.98	18.7
MA-Below	9/30/18	8:10 AM	7.2	592	296	9.16	17.2
MA-Below	10/10/18	7:49 AM	7.71	707	353	7.83	21.6
MA-Below	10/11/18	7:48 AM	7.98	703	351	8.04	20.3
MA-Below	10/12/18	7:45 AM	7.83	693	346	8.90	16.4
MA-Below	10/24/18	8:02 AM	6.98	747	375	10.02	11.0
MA-Below	10/25/18	7:54 AM	8.75	725	365	10.05	11.2
MA-Below	10/31/18	7:44 AM	6.8	720	358	9.90	12.1
AVERAGES			7.53	686	343	9.06	16.5

| Location	Date	Time	pH	Conductivity (ms)	Total Dissolved Solids (ppm)	Dissolved Oxygen (mg/L)	Temperature (C)
MA-Above	9/25/18	7:32 AM	7.56	674	338	8.24	19.5
MA-Above	9/27/18	8:07 AM	7.37	656	327	8.68	18.2
MA-Above	9/30/18	8:22 AM	7.19	656	328	8.80	17.1
MA-Above	10/10/18	8:00 AM	7.54	732	366	7.41	21.0
MA-Above	10/11/18	7:58 AM	8.03	726	362	7.93	19.5
MA-Above	10/12/18	7:52 AM	7.78	720	361	8.57	15.7
MA-Above	10/24/18	8:10 AM	7.33	745	385	9.32	10.5
MA-Above	10/25/18	8:02 AM	8.17	737	369	9.35	10.6
MA-Above	10/31/18	7:51 AM	7.16	710	354	9.45	12.7
AVERAGES			7.57	706	354	8.63	16.1

Appendix C

Additional Photographs

View of Riverscape kayak chute in August, 2017

View of Monument Avenue kayak chute in August 2017.

View of MA-below in August 2017
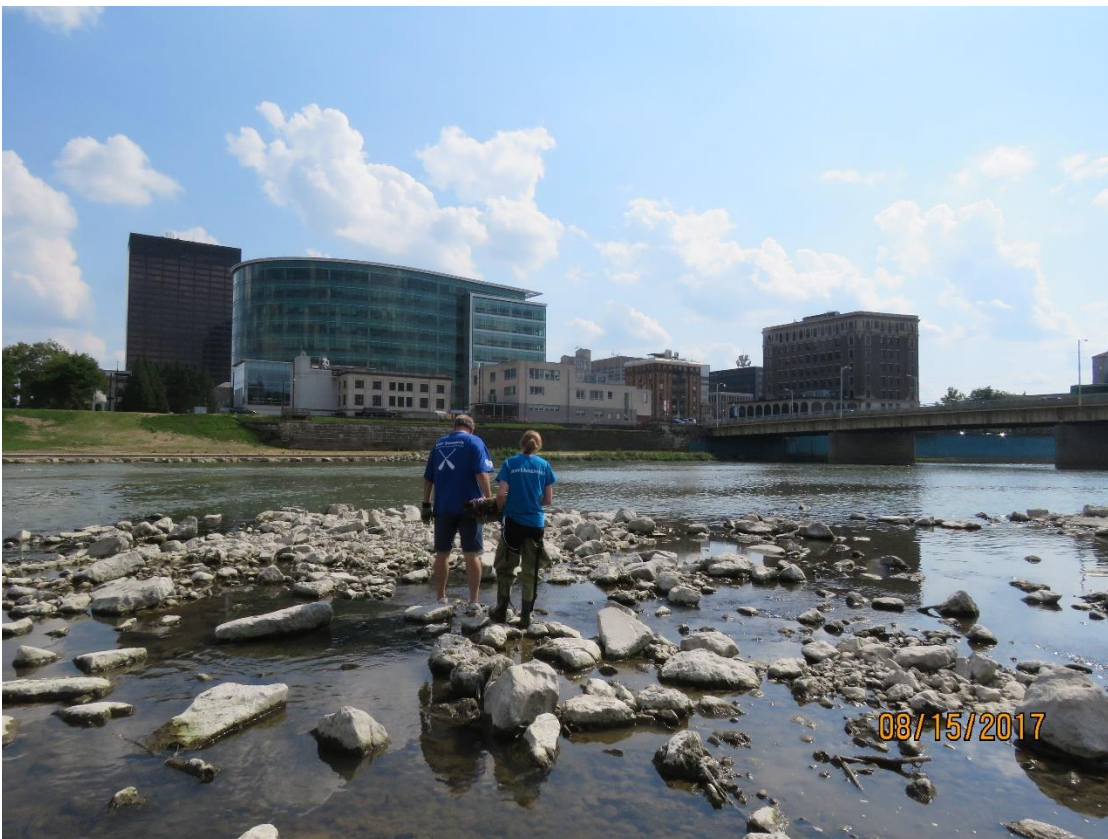
Setting artificial substrates in August 2017. Note the cinder block tied to the hester-dendys.

Students standing close to where artificial substrates placed in August 2017.

Boat shocking the Island Metropark dam pool (Steele impoundment) in September 2017.

Island Metropark dam pool in September 2017.

Island Metropark dam pool in September 2017.

Boat shocking MA dam pool immediately below RS kayak chute in September 2017.

Student boat shocking MA-above in September 2017.

Student boat shocking MA-above in September 2017.

Kick net sampling at MA-below in September 2017.

Kick net sampling MA-below in September 2017.

Kick net sampling RS kayak chute in September 2017.

Kick net sampling RS kayak chute in September 2017.

Kick net sampling RS kayak chute in September 2017.

Note kayak in background while kick net sampling RS kayak chute in September 2017.

Appendix D

Midwest Biodiversity Report

(attached separately)