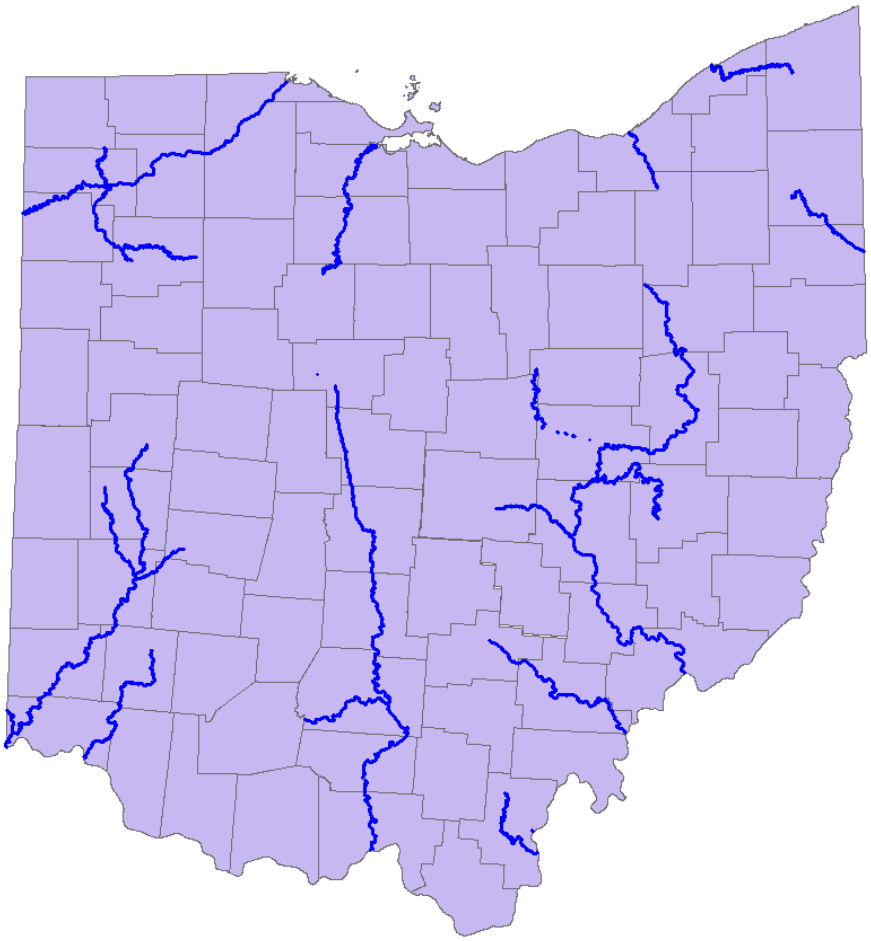
Ohio Environmental Protection Agency

Study Plan

to

Augment Data for the Development of Large River Nutrient Enrichment Indicators



Division of Surface Water
Ecological Assessment Section
June 1, 2016

Study Plan

to

Augment Data for the Development of Large River Nutrient Enrichment Indicators

June 1, 2016

State of Ohio Environmental Protection Agency
Division of Surface Water
Lazarus Government Center
122 South Front St., Columbus, OH 43215
Mail to:
P.O. Box 1049, Columbus, OH 43216-1049

&
Monitoring and Assessment Section
4675 Homer Ohio Lane
Groveport, OH 43125
614-836-8796

&

Southwest District Office
401 East Fifth Street
Dayton, Ohio 45402

Principal Investigators
Sarah Becker – (614) 728-2385
Paul Glehill – (614) 644-2881
Joshua Jackson – (937) 285-6029
Robert Miltner - (614) 836-8796

Background

Nutrient enrichment indicators for large rivers have yet to be established. To date, collection of data to support the development of large river enrichment indicators has been on an add-on basis, and has resulted in ~ 49 sites with a mostly complete set of observations (none of the large river sites has a complete set of observations). That said, lines of evidence supporting potential indicators can be drawn from existing data analyzed in light of the state of the science. For example, Minnesota found a strong relationship between sestonic chlorophyll, BOD5 and biological quality. Within our own data, a strong relationship exists between chlorophyll and BOD5, and BOD5 and biological quality, as evidenced in Figure 1. The plots in Figure 1 are drawn from 49 sites where chlorophyll, BOD5 and EPT were all sampled, and show a clear pathway from chlorophyll to BOD5 to EPT. From the larger, historic database, where matched data are lacking, a strong relationship between TSS and chlorophyll is evident, as would be expected, and between TSS and EPT richness (Figure 2). For all BOD5 data (i.e., either matched or unmatched to chlorophyll), biological indicators show strong negative correlations with BOD5 (Figure 3).

The upshot of all this is that the suite of enrichment indicators are obvious, and benchmarks that indicate over-enrichment are clearly suggested: e.g., sestonic chlorophyll > 50 ug/l, BOD5>3 mg/l, TSS>40 mg/l. However, the sample size for fully matched data is rather small, so any resulting conclusions drawn with respect to to the biological indicators is necessarily open to question. Augmenting the data set with 21 sites where a complete complement of parameters are sampled would add credibility to the results at hand and should prove sufficient to support development of a water quality standard.

A list of sites and sampling parameters is included in Table 1. Note that with the exception of stations H11W20 (Great Miami River at RM ~15) and H11S26 (Whitewater River), all access points are public.

Because drainage areas of sampling locations range from 700 to 7000 mi^2, and follow a normal distribution, benthic chlorophyll should be sampled at all locations where site-specific conditions allow collection. This will help determine the upper practical limit for the SNAP method.

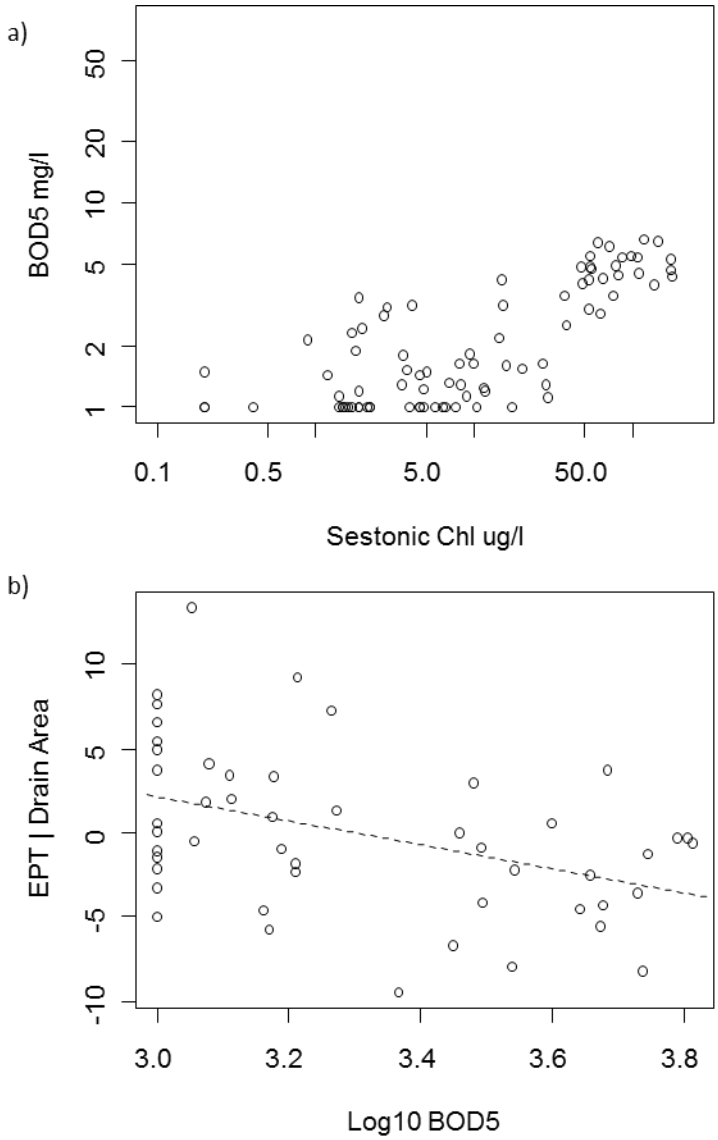


Figure 1. Relationships between a) chlorophyll and BOD5, and b) EPT richness adjusted for drainage area and BOD5. Note that these figures are drawn from matched data

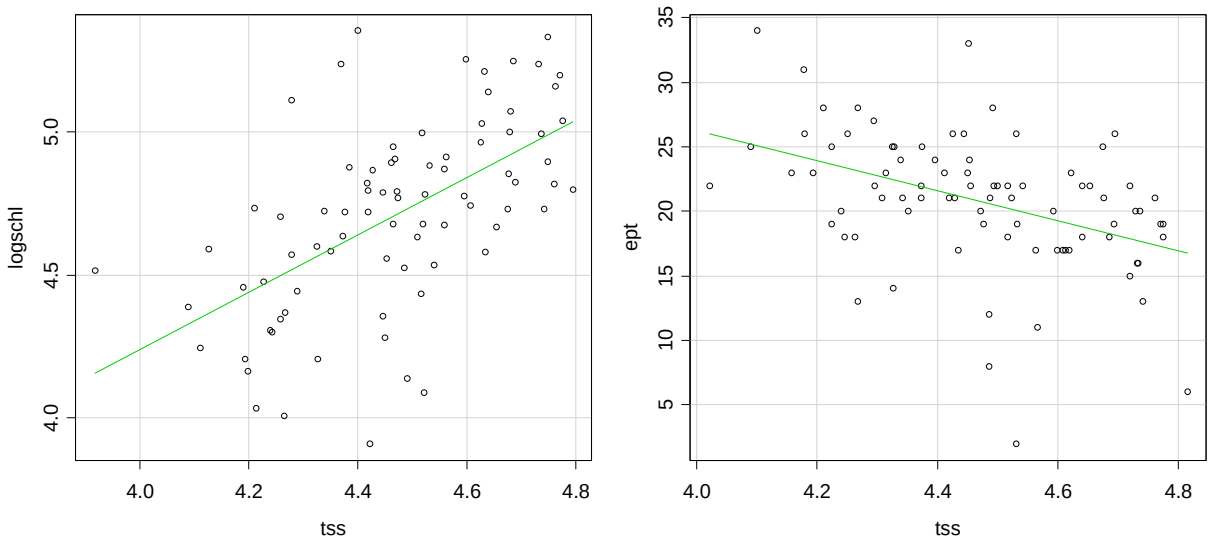


Figure 2. Relationships between TSS and chlorophyll, and TSS and EPT richness. If EPT richness is corrected for drainage area for the matched data (where the sample size is smaller), the relationship between EPT and TSS shows a negative trend.

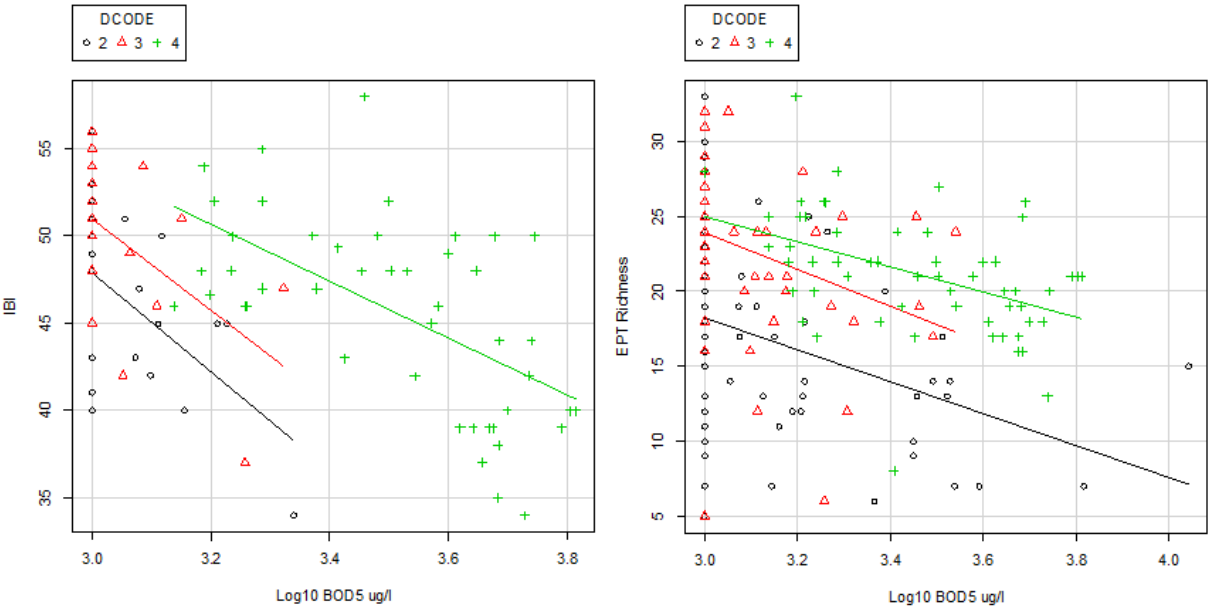


Figure 3. Scatter plots of IBI and EPT richness by BOD5, stratified by stream size (2-wadeable, 3- small rivers, 4-large rivers).

Table 1. List of proposed sampling locations to support development of large river nutrient standards. Gray-shaded sites are ambient water quality stations. The gray-shaded rows indicate monthly ambient monitoring stations. Samples: B-bugs, F-Fish, D-sondes, SC-sestonic chl, BC-benthic chl, WC-water/field chem.
[1]AD to help as needed

							Samples/Collectors					
Station	Name	rivercode	rm	da	lat	long	B[1]	F	D	SC	BC[2]	WC[3]
6003960	Scioto River @ US 22 Circleville	02-001-000	99.82	3217	39.6015	-82.9551	SM	RM	SB	SB	RM	RM,SB
V13K02	Scioto R. On North End Of Chillicothe @ U.S. Rt. 35	02-001-000	71.8	3846	39.3469	-82.9836	SM	RM	SB	SB	RM	RM,SB
V15P01	Scioto R. At Portsmouth @ U.S. Rt. 52	02-001-000	0.93	6512	38.7394	-83.0025	SM	RM	SB	SB	RM	RM,SB
P06S07	Maumee R W Of Defiance, @ Bend Rd.	04-001-000	76.15	2292	41.2753	-84.5150	SM	RM	PG	PG	RM	RM, PG
500220	Maumee R. At Florida @ Co. Rd. 17-C	04-001-000	54.87	5562	41.3206	-84.2000	SM	RM	PG	PG	RM	RM, PG
500080	Maumee R. At Waterville @ St. Rt. 64	04-001-000	20.68	6330	41.5003	-83.7141	SM	RM	PG	PG	RM	RM, PG
500110	Auglaize R. At Cloverdale @ St. Rt. 114	04-100-000	28.5	719	41.0208	-84.2889	SM	RM	PG	PG	RM	RM, PG
611740	Muskingum R. Dst. Coshocton @ St. Rt. 83	17-001-000	108.28	4861	40.2361	-81.8717	SM	RM	SB	SB	RM	RM, SB
R10S11	Tuscarawas R. Near Orange @ St. Rt. 751	17-500-000	15.25	2480	40.2856	-81.6844	SM	RM	SB	SB	RM	RM, SB
R04W27	Walhonding R. At Coshocton @ U.S. Rt. 36 notice lat and long for public access	17-600-000	0.76	2255	40.2867	-81.8738	SM	RM	SB	SB	RM	RM, SB
M05W53	L. Miami R. At Milford, 0.98 Mi Upst. Wooster Pike	11-001-000	14.05	1200	39.1821	-84.2886	CM	RM	PG	PG	RM	JJ,LM,MW
H05W33	Great Miami R. At Dayton, 0.7 Mi. Upst. Railroad	14-001-000	85.2	1171	39.7989	-84.1625	CM	RM	PG	PG	RM	JJ,LM,MW
600070	Great Miami R. @ Farmersville-West Carrollton Rd.	14-001-000	69.87	2647	39.6744	-84.2617	CM	RM	PG	PG	RM	JJ,LM,MW
H09S13	Great Miami R. At Miamisburg @ Linden Ave.	14-001-000	66.9	2711	39.6406	-84.2922	CM	RM	PG	PG	RM	JJ,LM,MW
H09S31	Great Miami R. At Franklin @ Old St. Rt. 123	14-001-000	60.58	2728	39.5631	-84.305	CM	RM	PG	PG	RM	JJ,LM,MW
600330	Great Miami R. Near Middletown @ St. Rt. 73	14-001-000	49.27	3189	39.4814	-84.4428	CM	RM	PG	PG	RM	JJ,LM,MW
610090	Great Miami R. @ Liberty-Fairfield Rd.	14-001-000	43.23	3280	39.4293	-84.4764	CM	RM	PG	PG	RM	JJ,LM,MW
201874	Great Miami R. W Of New Baltimore, Upst. Paddys	14-001-000	20.4	3815	39.2633	-84.6867	CM	RM	PG	PG	RM	JJ,LM,MW
H11W20	Great Miami R. At Miamitown @ Harrison Rd.	14-001-000	15.49	3838	39.2161	-84.7035	CM	RM	PG	PG	RM	JJ,LM,MW
H11K14	Great Miami R. At Hooven, Upst. U.S. Rt. 50, at Miami Twp Park	14-001-000	9.5	3872	39.1797	-84.7481	CM	RM	PG	PG	RM	JJ,LM,MW
H11S26	Whitewater R. W Of Hooven @ Suspension Bridge Rd.	14-300-000	1.5	1469	39.1831	-84.7928	SM	RM	PG	PG	RM	JJ,LM,MW

[2]Collect where feasible

[3]Sampling by committee in sites located outside SWDO

Table 2. Sample counts.

Media/Category	Samples	Number
Biology		
	Fish	42 boat samples
	Macroinvertebrates	21 HD; 21 quals
Chlorophyll a		
	Sestonic	21 sites x 4 events = 84 (+8 splits & 8 blanks)
	Benthic	collect where conditions permit
Sonde		42 deployments
Water Chemistry – Follow the Large River Template with cBOD5, cBOD20 and Ortho-P added		
Demand		
	BOD5, cBOD5, cBOD20	4 runs[3] x 21 sites = 84
	TSS, TDS, TOC	4 runs x 21 sites = 84
Nutrients		
	Acidity, Alk, NH3, Chloride, COD, NO2, NOx, Ortho-P, TP, SO4, TKN	4 runs x 21 sites = 84
Metals		
	ICP 1	4 runs x 21 sites = 84
Field Parameters		
	Temperature, D.O., Sp.Cond., pH	4 runs x 21 sites = 84

[3]To coincide with sestonic chlorophyll

Contacts for field access:

Harrison Avenue (H11W20), Ron Schmidt, 1-513-478-5154

Whitewater (H11S26) via Green Acres Canoe, Sharon Lutz, 1-513-353-4770

Miami Township Park (H11K14) upstream US 50, Ron Miller, 1-513-305-5787 (call needed only for boat access)

QUALITY ASSURANCE/SAMPLING METHODS

Ohio EPA Manuals

All biological, chemical, data processing, and data analysis methods and procedures adhere to those specified in the Surface Water Field Sampling Manual for water column chemistry, bacteria and flows (Ohio EPA 2015a), Biological Criteria for the Protection of Aquatic Life, Volumes II - III (Ohio EPA 1987, 1989a, 2015b), 2015 Updates to the Biological Criteria for the Protection of Aquatic Life, Volume II (Ohio EPA 2015c), The Qualitative Habitat Evaluation Index (QHEI) - Rationale, Methods, and Application (Ohio EPA 1989b, 2006) for habitat assessment, Surface Water Field Sampling Manual – Appendix III for sediment sampling (Ohio EPA 2015a), and Ohio EPA Fish Tissue Collection Guidance Manual (Ohio EPA 2012) for fish tissue sampling.

Use Attainment

The attainment status of aquatic life uses will be determined by using biological criteria codified in Ohio Administrative Code (OAC) 3745-1-07, Table 7-17. Numerical biological criteria are based on multi-metric biological indices including the Index of Biotic Integrity (IBI) and modified Index of Well-Being (MIwb), indices measuring the response of the fish community; and the Invertebrate Community Index (ICI), which indicates the response of the macroinvertebrate community. Performance expectations for the basic aquatic life uses (Warmwater Habitat [WWH], Exceptional Warmwater Habitat [EWH], and Modified Warmwater Habitat [MWH]) were developed using the regional reference site approach (Hughes et al. 1986, Omernik 1987). This fits the practical definition of biological integrity as the biological performance of the natural habitats within a region (Karr and Dudley 1981). Attainment of an aquatic life use is full if all three indices (or those available) meet the applicable criteria; partial if at least one of the indices did not attain, and performance did not fall below the fair category; and non if all indices either fail to attain or any index indicates poor or very poor performance. The results will be compared to WWH biocriteria for the Western Allegheny Plateau (WAP) ecoregion.

Recreational use attainment will be determined using *E. coli* bacteria, which are indicator organisms for the potential presence of pathogens in surface water. *E. coli* can originate from untreated human or animal wastes, and they are the basis for recreational use water quality criteria in Rule 3745-1-07 of the (OAC).

Stream Habitat Evaluation

Physical habitat is evaluated using the (QHEI) developed by the Ohio EPA for streams and rivers in Ohio (Ohio EPA 1989b). Various attributes of the available habitat are scored based on their overall importance to the establishment of viable and diverse aquatic faunas. Evaluations of the type and quality of substrate, amount of instream cover, channel morphology, extent of riparian canopy, pool and riffle development and quality, and stream gradient are among the metrics used to evaluate the characteristics of a stream segment. Individual sites may have much 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 higher than 60 were generally conducive to the establishment of warmwater faunas while those which scored in excess of 75-80 often typify habitat conditions which have the ability to support exceptional faunas.

Biological Community Assessment

Quantitative macroinvertebrate sample will be collected from artificial substrates, and qualitative samples from natural stream habitats. Artificial substrate collections will be collected at all sites with greater than

20 mi^2 drainage areas, or at reference site locations. This sample provides quantitative data and consists of a composite sample of five modified Hester-Dendy multiple-plate artificial substrate samplers which are allowed to colonize for six weeks. Qualitative sampling will be conducted at all sampling locations. This sampling effort consists of an inventory of all observed macroinvertebrate taxa from the natural stream habitats at each site with no attempt to quantify populations, other than notations on the predominance of specific taxa or taxa groups within major macrohabitat types (e.g., riffle, run, pool, and margin). Detailed macroinvertebrate assemblage sampling protocols are documented in Ohio EPA (2015b).

Fish will be sampled at each sampling location using pulsed DC headwater, wading, or boat electrofishing methods depending on watershed size at each sampling location. Sites with drainage areas greater than 20 mi^2, and at reference site locations, will be sampled twice during the sampling index period. Fish are processed in the field, which includes identifying each individual to species, counting individuals at all sites, weighing individuals at wading and boat sites, and recording any external abnormalities. Detailed fish assemblage sampling protocols are documented in Ohio EPA (2015b).

Chlorophyll

Benthic and sestonic chlorophyll-a samples will be collected and preserved using appropriate methods, as outlined in Ohio EPA (2015a Volume II), and delivered to the Ohio EPA DES lab for analysis. Alkalinity must be requested as a routine water quality parameter at all study sites along with the routine field parameters, especially temperature and pH.

Surface Water

Surface water grab samples will be collected and preserved using appropriate methods, as outlined in Ohio EPA (2015a), and delivered to the Ohio EPA Division of Environmental Services lab for analyses. Field measurements of dissolved oxygen, pH, temperature, and conductivity will be made using field meters. Automated data loggers will record hourly measurements of dissolved oxygen, pH, temperature, and conductivity. Water quality parameters to be collected at every site are noted in Table 2.

Field Quality Control Samples

Ten percent of the sediment, water, and bacteria samples will be submitted to the lab as field duplicates and field blanks; approximately 5% will be duplicates and 5 % will be blanks. One sonde recorder site will have two instruments placed in the river as field duplicates. Field blanks will occur at a minimum of 5 percent of the water samples. Field instruments will be calibrated daily, using manufacturer guidelines and requirements noted in Ohio EPA (2015a). Matrix spike duplicates will be collected for organic water samples at a minimum of 5 percent of the samples.

REFERENCES

Hughes, R. M., D. P. Larsen, and J. M. Omernik. 1986. Regional reference sites: a method for assessing stream pollution. Env. Mgmt. 10(5): 629-635.

Karr, J.R. and D.R. Dudley. 1981. Ecological perspective on water quality goals. Env. Mgmt. 5(1): 55-68.

Ohio EPA. 2015a. Surface water field sampling manual for water column chemistry, bacteria and flows. Version 5.0, July 31, 2015. Div. of Surface Water, Columbus, Ohio. 41pp.
http://epa.ohio.gov/dsw/document_index/docindx.aspx

Ohio EPA. 2015b. Biological criteria for the protection of aquatic life: Volume III. Standardized biological field sampling and laboratory methods for assessing fish and macroinvertebrate communities. Division of Surface Water, Ecological Assessment Section, Columbus, Ohio. June 26, 2015.

Ohio EPA. 2015c. 2015 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. Division of Surface Water, Ecological Assessment Section, Columbus, Ohio. May 8, 2015.

Ohio EPA. 2012. Fish tissue collection manual, cooperative fish issue monitoring program, State of Ohio. Division of Surface Water. April 12, 2012. 21pp
www.epa.state.oh.us/portals/35/fishadvisory/FishCollectionGuidanceManual12.pdf

Ohio EPA. 2006. Methods for assessing habitat in flowing waters: Using the Qualitative Habitat Evaluation Index (QHEI). Ohio EPA Tech. Bull. EAS/2006-06-1. Div. of Surface Water, Ecol. Assess. Sect., Columbus, Ohio.
http://epa.ohio.gov/portals/35/documents/QHEIManualJune2006.pdf

Ohio EPA. 1989a. Addendum to biological criteria for the protection of aquatic life: Volume II. User's manual for biological field assessment of Ohio surface waters. Division of Water Quality Planning and Assessment, Surface Water Section, Columbus, Ohio..
http://www.epa.state.oh.us/dsw/bioassess/BioCriteriaProtAqLife.html

Ohio EPA. 1989b. The qualitative habitat evaluation index (QHEI): rationale, methods, and application. Division of Water Quality Planning and Assessment, Columbus, Ohio.
http://www.epa.state.oh.us/dsw/bioassess/BioCriteriaProtAqLife.html

Ohio EPA. 1987. Biological criteria for the protection of aquatic life: Volume II. User's manual for biological field assessment of Ohio surface waters. Division of Water Quality Monitoring and Assessment, Surface Water Section, Columbus, Ohio
http://www.epa.state.oh.us/dsw/bioassess/BioCriteriaProtAqLife.html

Omernik, J.M. 1987. Ecoregions of the conterminous United States. Ann. Assoc. Amer. Geogr. 77(1): 118-125.