2015 Monitoring of Lake Erie and the Maumee River Estuary

Division of Surface Water
March 4, 2015

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Ohio Environmental Protection Agency
Division of Surface Water
Lazarus Government Center
50 West Town Street, Suite 700
Columbus, Ohio 43215

Groveport Field Office
4675 Homer Ohio Lane
Groveport, Ohio 43215

Northwest District Office
347 North Dunbridge Road
Bowling Green, Ohio 43402

Northeast District Office
2110 East Aurora Road
Twinsburg, Ohio 44087

Introduction

The Ohio EPA- Division of Surface Water (DSW) implemented an annual Lake Erie monitoring program in 2014. It was the culmination of Ohio's participation in two recent federal initiatives. The first in 2010 was the National Coastal Condition Assessment (NCCA), a probabilistic study of Great Lakes and Marine coasts. The second was a state led study funded by the Great Lakes Restoration Initiative (GLRI) done 2011-2013 titled the *Lake Erie Comprehensive Nearshore Monitoring Program*. Details about the inaugural field season are in a study plan titled *2014 Monitoring of Lake Erie and the Maumee River Estuary*.

The Ohio EPA is required by Clean Water Act Sections 305(b) and 303(d) to submit biennial reports on the general condition of waters of the state and to develop a prioritized list of those that are not meeting goals. Ohio fulfills this requirement by submitting the *Integrated Water Quality Monitoring and Assessment Report* (IR). The report summarizes the condition of streams and rivers using a system of watershed assessment units aligned with 12-digit hydrologic codes. Methods for the assessment and reporting of Lake Erie are previewed in the 2014 IR. Ten assessment units were delineated within Ohio waters of Lake Erie. Shoreline, nearshore and offshore units demarcated by water depth were defined in each of three distinct lake basins; Western, Sandusky and Central. An Islands shoreline assessment unit was also created.

Impairment in streams and rivers is based on aquatic life criteria. No such criteria exist for lakes, so a method to assess the open waters of Lake Erie was needed. Water quality targets for average spring total phosphorus and summer chlorophyll *a* were established. To set targets, Ohio EPA relied heavily on goals identified in the Great Lakes Water Quality Agreement and recommendations made by the Lake Erie Nutrient Science Task Group, under direction of the Lake Erie LaMP, in a technical document titled *Status of Nutrients in the Lake Erie Basin* (U.S. EPA, 2009). Water chemistry data collected at a series of fixed ambient stations are used to evaluate attainment of nutrient targets. The shoreline assessment units are also evaluated against biological criteria used to assess fish populations.

Few changes to the 2014 monitoring program are being proposed. Ohio EPA is committed to participating in the 2015 NCCA, but intends to maintain baseline monitoring at established mayfly, ambient and anoxia stations. Fish community assessments will be done as resources permit and efforts will be focused on completing the second pass at established Ohio DNR stations. An ambient station will be added in the Western Basin nearshore assessment unit near the City of Toledo's water treatment plant intake crib. Also, ambient stations located in shoreline assessment units and estuary stations will be sampled at a depth of 1.0m instead of 0.5m to be consistent with the surface depth sampled at nearshore and offshore stations.

Field Sampling

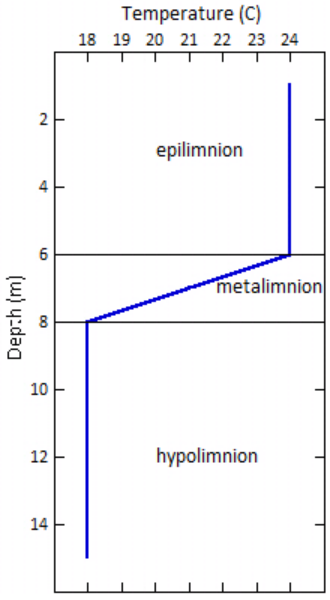
Stations that will be sampled are listed in Table 1. Sampling will be initiated after ice out in the Western Basin and in May in the Central Basin and continue through the end of September. Samples from the Maumee River estuary, Western Basin and Sandusky Basin will be collected once every two weeks and the Central Basin samples will be collected on a monthly basis. Special consideration needs to be given to safety due to the unpredictable nature of weather and sea conditions on the Great Lakes. Work scheduled in this study plan will only be done if it can be completed in a safe manner. This decision will be made by the sample collector.

Mayfly Density

Mayfly stations will be sampled once in the spring (April/May) prior to the annual hatch. A triplicate set of samples will be collected at each station using a standard Ponar® dredge. Contents from the dredge will be placed in a device (bucket or tray) equipped with a standard no. 40 sieve (0.50mm) and washed with site water until as much sediment is removed as possible and mostly benthos remains. The sample will then be placed in an individually labeled 1L HDPE container and preserved with 5% formaldehyde. Prior to enumeration a small amount of Phloxine dye (enough to cover the tip of a spatula) will be added to each container to aid in the identification of nymphs. The dyed samples will be rinsed under a fume hood with tap water through a standard no. 40 sieve and transferred to a white lab tray for sorting. Containers with large volumes of material will be processed in small aliquots until the entire sample is sorted. Nymphs from each replicate container will be removed, counted and recorded on the lab bench sheet shown in Appendix A. Once counting is complete the nymphs will be placed in a labeled glass vial and preserved with 60% ethanol so they can be archived.

Water Quality

A map of water quality sampling locations is shown in Figure 1. Water quality stations will have physical conditions measured in the field with either a SeaBird® profiler or YSI® Pro Series meter. Water depth and secchi depth measurements will also be taken. A summary of the field measurements is listed in Table 2. The SeaBird® units will be deployed at a rate of about 0.2m/second down and back through the water column and the YSI probes are simply lowered to the desired depth. Water samples submitted to the Ohio EPA Division of Environmental Services (DES) will be analyzed for the parameters listed in Table 3. Samples for analysis of Microcystins will be submitted after June 15 from stations in the Maumee River, Maumee Bay, Sandusky Bay and Western Basin nearshore assessment unit. Testing will focus on these areas because this is where harmful algae blooms are most likely to occur. Water samples for lab analysis will be collected with a vertically oriented sample bottle that can be deployed to depth and closed with a messenger. Samples collected from stations in the estuary and shoreline assessment units (Maumee River, Maumee Bay and Sandusky Bay) will be grabs collected at 1.0m below the surface.



Samples collected from stations in the nearshore and offshore assessment units will be a set of three integrated grabs mixed in a churn device fitted with a spigot. The depth of the grab samples will be based on the presence or absence of thermal stratification. Stratification is defined as greater than a 1˚C drop in temperature over a 1m change in depth. These conditions are theoretically enough to create a density barrier. SeaBird® software will be used to display a temperature profile on an external device to determine if stratification exists and where the density layers are located. A simplified profile is shown in the adjacent figure. The point at which the temperature deflects should be identified as the top of the metalimnion. In the absence of thermal stratification, grabs will be collected at 1m below the surface, mid depth and 1m above the bottom. In the presence of thermal stratification samples will be collected from the epilimnion. If the epilimnion is >4 m deep grabs will be collected 1m below the surface, mid epilimnion and 1m above the top of the metalimnion. If the epilimnion is <4m deep the sample will be collected in the middle of the layer.

Central Basin Hypoxia/Anoxia

Hypoxia/anoxia in the hypolimnion of the Central Basin reduces the amount of habitat available to aquatic life and contributes to internal cycling of phosphorus due to redox reactions that occur with phosphate molecules that are bound to iron and calcium. The transect stations listed in Table 4 will be used to measure the severity and extent of this phenomenon by collecting field measurement at a series of points along each line using a SeaBird® 19Plus CTD profiler (Figure 1). Clearly defined epilimnion, metalimnion and hypolimnion layers should be present. An effort will be made to visit all four transects either on the same day or as close together as possible. The transect stations will be visited up to three times after stratification is established, but the number of visits will be dictated by resources.

Plankton

Phytoplankton will be collected at all water quality stations once during the months of May, July and September. Samples from individual stations will be collected during the same run to minimize temporal variability. The same whole water collected for chemistry will be used for phytoplankton. The phytoplankton sample will be placed in a labeled 250ml jar and preserved with 2-3ml of Lugol's solution until stained the color of weak tea. Sample jars will be held at the district offices until an ambient run is completed. The batch of samples will then be packaged and shipped to BSA Environmental Services, Inc. for enumeration and bio-volume estimates using the chain of custody form shown in Appendix D. Ohio EPA and district name should be used for client information. Use Ohio EPA Lazarus Government Center and program coordinator (Amy Jo Klei) for invoice information. Under special instructions request results to be e-mailed to both client and invoice addresses.

Diatoms will be sampled from the shoreline fish zones when they are assessed. Diatoms will be assessed by examining deposits on natural substrates collected at a depth of ≤1m. In soft substrate sediment can be collected with either a 6.5 cm diameter push corer or a dredge sampler. Extrude the core or access the top of the dredge so the top 1cm of sediment can be carefully removed using a spoon or spatula and placed in a labeled 100ml specimen cup. The sampling equipment should be inspected between sites and rinsed to remove residue. In hard substrate rocks or vegetation can be collected by hand and the surfaces scraped clean with a small brush or plastic knife until a layer of material covers the bottom of the cup. Samples should be placed on wet ice in the field and kept cool until they can be dried. Samples should be dried within 24 hours of collection by placing the cups in an oven set at 80˚C for 24 hours. The samples can then be stored until analysis.

Fish Community Assessment

The fish community will be assessed in a cooperative effort between Ohio EPA and Ohio DNR at the stations listed in Table 5. Generally, the sampling will be done so that all of the stations will be sampled at least once every five years. The Ohio DNR stations are identified by site numbers in the station ID column. The Ohio DNR will complete one pass annually at the stations highlighted in red and one pass every five years at the remaining stations. The Ohio EPA will complete the second pass at all of these stations and will also complete two passes at 4-5 of the remaining stations. Sampling by Ohio EPA will be limited during the NCCA index period with a goal of completing the second pass at Ohio DNR stations.

Ohio EPA uses a 5.8m modified V-hull Jon Boat to conduct electrofishing. The sampling is done at night because research has shown that this is the most effective time to collect a representative sample. Electrical current will be provided by a 7,000 watt generator and Smith-Root pulsator. Controls will be set on DC current, 60 pulses per second, 240-340 volts and 5-6 amps. Anodes will be two separately charged 0.5m circumference stainless steel electrospheres positioned approximately 2.1m in front of the boat and approximately 20 degrees to either side of the center line. In most conditions, eight

cathodes will be deployed (four on each side of the boat) starting approximately 1.8m from the front of the boat and ending approximately 2.3m from the front of the boat. Each cathode will have an electrified portion of 1.6m. In areas of deeper water (such as ship channels) four cathodes will be deployed off the front of the boat. These cathodes will have an electrified portion that is 1.6m in length, but the electrified portion will be attached to a shielded cable creating an overall length of 7.3m.

A dip net will be used by each of the three members of the crew. The dip nets will be made of 6.35mm mesh and create a bag no deeper than 15cm to allow rapid elimination of fish into a live well. All fish except common carp and goldfish will be placed in one live well continuously supplied with fresh water by one or more pumps. Common carp and goldfish will be placed in their own live well to avoid excess oxygen consumption and the death of small fish that may become crushed.

The start and end of each zone will be marked by a waypoint on a GPS and with marking paint or a length of surveyor flag. Each zone will be 500m in length based on straight line measurements between the starting and ending points unless there is a distinct point of change (greater than 45 degrees) in which case a new waypoint will be created at the point of change and the distance from that point to the start and end points will be added to produce the total distance. The starting time and the time fished will be recorded on the field sheet. Sample time will vary based on the number of fish caught and the complexity of the shoreline.

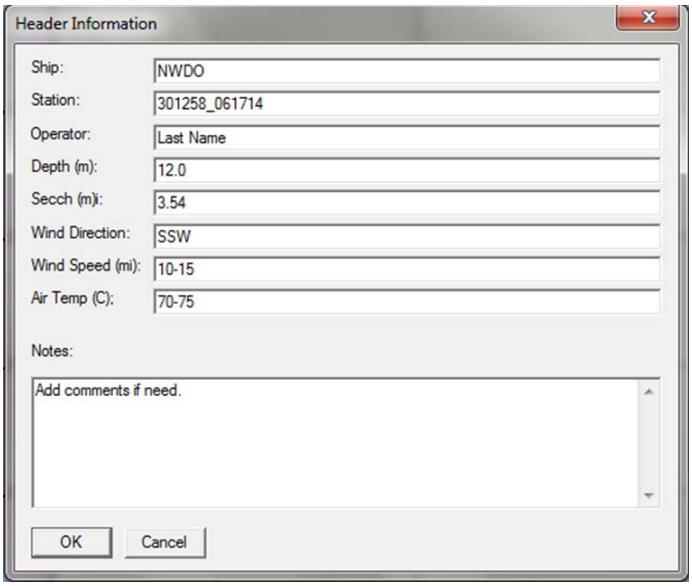
At the end of sampling all fish will be separated by species and placed in buckets. Each species will be counted, weighed and inspected for externally observable deformities, eroded fins, lesions, and tumors. The total weight per species and number of individuals will be recorded on the field sheet shown in Appendix B. An assessment of shoreline habitat will also be done by completing the Lake Qualitative Habitat Evaluation Index (QHEI) sheet shown in Appendix C.

Quality Assurance

All water quality sample collection and preservation methods will follow guidelines established in the *Surface Water Field Sampling Manual* (Ohio EPA, 2013b). Field QC requirements for duplicates and blanks are summarized in Table E-1 of the manual. An Excel Data Validation Tool will be used to determine if data needs to be rejected or qualified as estimated based on relative percent difference (RPD). Acceptable RPD is parameter specific and depends on the method reporting limit and how close the concentration is to that limit. Detailed fish assemblage sampling protocols are documented in *Biological Criteria for the Protection of Aquatic Life: Volume IV: Fish and Macroinvertebrate Indices for Ohio's Lake Erie Nearshore Waters, Harbors, and Lacustuaries* (Ohio EPA, 1999). Voucher specimens will be retained when there is a question regarding identification or the species is found outside the normal range. One mayfly station will be re-sorted by a second staff person to confirm that all nymphs are being identified.

Data Management

Knowledge of the Division of Surface Water (DSW) Cyberintern and Ecological Assessment and Analysis Application (EA3) programs is needed to manage data. The station ID numbers that are assigned to each sampling location are created using EA3. Project names are also created in EA3 so stations can be grouped together to facilitate data assessment. Sampling trips are organized using the Cyberintern program. The sample collector selects the stations to be sampled to create a run. The software assigns an external ID number and bar code specific to each sample and prints the laboratory sample submission forms and container labels. Microcystins samples should be submitted on an inorganic sample submission form separate from the other chemistry samples. DDAGW_HAB should be recorded in the Project ID space on the sample submission form. This is being done to expedite turnaround of the results and ensure that DDAGW is copied. Samples delivered to the DES are logged with a scanner that reads the external ID bar code printed on the label. The samples are then assigned a lab ID number used to track them through the system.



Field data collected with the SeaBird® is managed using Seasave V7 software. The unit needs to be connected to an external device (tablet or laptop) to accomplish this. A shot of the screen used to enter site information is displayed. The files should be named based on the station ID # and sampling date. For example, the file for station #301258 sampled on June 17, 2014 should be saved as 301258_061714. These files will be downloaded to an Ohio EPA desktop PC and housed in the State of Ohio Computer Center (SOCC). The profile data will not be imported into EA3 at this time.

The YSI® Pro Series units have an internal file storage system. A site list based on station ID # is first created using YSI® Pro Series Data Manager V1.1.8 software installed on a desktop PC. The field meter is then connected to the PC via a USB port so the site list can be uploaded to the meter. Data is saved in the field by selecting the correct station from the menu. After sampling is completed the files are downloaded to the Data Manager software. They are then exported as an Excel file to the DSWs Water Quality Data Acquisition Manager and uploaded to the Ohio EPA SQL server database.

After water samples are analyzed and the results are approved by the lab QA Officer the data will be loaded into the Laboratory Information Management System (LIMS). Individual lab sheets are also posted on a web based server accessible by the DSW. Once the lab data is available in LIMS it can be imported into EA3. Before the chemistry data is imported it is important to verify that any field data collected with YSI® meters has been uploaded since the system uses the external ID number tag to merge the two datasets. Once the sheets are imported the sample collector reviews them for accuracy, completes edits if necessary, validates field QC and approves the sheet. All data approved in EA3 is sent to the U.S. EPA Water Quality Exchange.

The original fish and QHEI data sheets will be sent to the Groveport Field Office and copies will be filed at the Northeast District Office. Data from the field sheet is manually entered into EA3 using the appropriate data entry screen. The sheets are double entered to eliminate mistakes. At this time, EA3 is not programmed to calculate Lake IBI scores. However, the data can be extracted to calculate index scores using a program developed by the DSW for that purpose.

Data Evaluation

Water Quality

Ohio EPA is required by the federal Clean Water Act to monitor and report on the quality of water resources in the state. To fulfill this requirement the agency submits an Integrated Water Quality Monitoring and Assessment Report to U.S. EPA in even numbered years. This report provides a summary of the status of the State's surface waters and includes a list of waters that do not meet established goals. The Lake Erie shoreline has been assessed and reported on in previous Integrated Reports. The 2014 Integrated Report was the first that Ohio EPA described open water assessment units and presented a method to evaluate their status.

Parameter	OAC 3745-1
Dissolved Oxygen	Table 7-1
pH	Table 7-1
Dissolved Solids	Table 7-1
Ammonia	Table 7-6
Temperature	Table 31-1

Lake Erie is defined in the Ohio Water Quality Standards (Ohio Administrative Code Chapter 3745-1) as Exceptional Warmwater Habitat (EWH). Numeric criteria for the protection of aquatic life set forth in rules 3745-1-07 (statewide criteria), 3745-1-31 (Lake Erie standards) and 3745-1-33 (Lake Erie drainage basin criteria) apply and must be met as outside mixing zone standards. The adjacent table summarizes where criteria are found in the rules for parameters with numeric criteria that will be measured in the water column.

Temperature, dissolved oxygen and pH will be evaluated using either profile or grab data measured by a field meter. Profile data will be pooled by parameter and statistically summarized. An average will be calculated for temperature and dissolved oxygen and a median for pH. These values will then be compared to the appropriate standard. If the lake is not stratified readings from the entire water column will be used. If stratified only readings from the epilimnion will be used.

Other parameters with numeric criteria are evaluated based on analysis of a water sample. Criteria for dissolved solids are a fixed value. Those for ammonia are tiered depending on the temperature and pH of the sample because more alkaline conditions favor the production of ammonium hydroxide which is toxic to aquatic life.

Assessment Unit Name	Targets (ppb)	
	TP	Chl. a
Western Basin Shoreline	30	9.8
Western Basin Nearshore	20	5.3
Western Basin Offshore	15	3.6
Islands Shoreline	30	9.8
Sandusky Basin Shoreline	30	9.8
Sandusky Basin Nearshore	20	5.3
Sandusky Basin Offshore	15	3.6
Central Basin Shoreline	20	5.3
Central Basin Nearshore	15	3.6
Central Basin Offshore	10	2.6

An ability to evaluate total phosphorus and chlorophyll a is important due to the emergence of harmful algae blooms in the last decade. In addition, the Great Lakes Water Quality Protocol of 2012 has a goal to maintain mesotrophic conditions in the open waters of the Western and Central Basins of Lake Erie. This goal is the basis of targets presented in the *Status of Nutrients in the Lake Erie Basin*. Ohio EPA relied heavily on this document to define assessment units, targets and evaluation methods previewed in the 2014 Integrated Report. Ohio EPA will continue to calculate averages for spring phosphorus (April 1-June 30) and summer chlorophyll a (July 1-Sept. 30) for each assessment unit and present the results in future Integrated Reports. Any modifications to the methods such as adjusting the seasons or using a median value instead of mean will also be discussed. Lake Erie IBI scores for the shoreline assessment units will also be updated.

Mayfly Index

To calculate burrowing mayfly density (m^2) the mean of the triplicate sample counts is divided by 0.0537. This is a constant determined based on the surface area of a standard Ponar® dredge. Since station densities can vary considerably from year to year it may also be useful to assess trends based on a median for the entire Western Basin.

Narrative Description	Nymphs/m^2 (3 yr. moving avg.)
Imperiled	>400
Good	301-400
Excellent	201-300
Good	101-200
Fair	30-100
Poor	<30

As an indicator organism, the status of mayfly populations can be used to evaluate long term changes in water and sediment quality. A metric score and narrative description of population health developed for the Lake Erie Quality Index is described by Krieger *et al*, 2004. A moving average for the Western Basin is recommended to account for annual variability.

Fish Community Status

Results from fish sampling will be used to update attainment status in the Integrated Report. Ohio EPA does not have numeric biological criteria for Lake Erie codified in the water quality standards. Volume IV of the Biological Criteria for the Protection of Aquatic Life presents a foundation to establish numeric biological targets using IBI and MIwb scores for the Lake Erie shoreline.

Lake Erie Shoreline Targets		
Habitat Type	LE-IBI	MIwb
Rubble	42	8.9
Sand	31	7.2

Status of the shoreline assessment units will be determined by the percentage of sites in narrative full attainment as sufficient data are available. Fish targets are based on the 90th percentile of index scores and are scaled to prevailing habitat type.

Phytoplankton

Phytoplankton community results obtained from the contract lab will be saved in Excel spreadsheets to an Ohio EPA desktop PC and housed in the State of Ohio Computer Center (SOCC).

References

Krieger, K.A. 2004. Mayfly Metric of the Lake Erie Quality Index: Design of an Efficient Censusing Program, Data Collection and Development of the Metric. Final Report for Ohio Lake Erie Protection Fund Grant LEQI 01-03.

Ohio EPA. 2013a. 2011-2013 Lake Erie Nearshore Monitoring Study Plan, Version 1.3, March 15, 2013. Division of Surface Water, Columbus, Ohio.

Ohio EPA. 2013b. Surface water field sampling manual for water column chemistry, bacteria and flows. Version 4.0, January 31, 2013. Division of Surface Water, Columbus, Ohio. 41pp.

Ohio EPA. 2014. 2014 Ohio Integrated Water Quality Monitoring and Assessment Report.

Ohio EPA. 1999. Draft. Biological Criteria for the Protection of Aquatic Life: Volume IV: Fish and Macroinvertebrate Indices for Ohio's Lake Erie Nearshore Waters, Harbors, and Lacustuaries. Division of Surface Water, Ecological Assessment Unit, Ohio EPA, Columbus, Ohio.

U.S. EPA, 2009. Status of Nutrients in the Lake Erie Basin.

Table 1. Water quality and mayfly stations that will be sampled in Lake Erie open waters, bays and estuaries.

Station ID	Description	Latitude	Longitude
Maumee River Estuary			
301641	Maumee River dsnt. I-280	41.661067	-83.510567
P11S32	Maumee River near Mouth	41.694300	-83.467067
Western Basin Shoreline Assessment Unit			
301788	Maumee Bay near Woodtick Peninsula	41.73300	-83.41623
302142	Maumee Bay near State Park	41.70163	-83.37407
Western Basin Nearshore Assessment Unit			
301258	Lake Erie near Toledo Lighthouse	41.76832	-83.30080
302821	Lake Erie between Toledo/Oregon WTP Intakes	41.69570	-83.26490
302502	Lake Erie North of Port Clinton	41.55781	-82.93635
Western Basin Offshore Assessment Unit			
300898	Lake Erie near West Sister Island	41.72670	-83.15000
301076	Lake Erie near Middle Bass Island	41.68500	-82.93330
302153	Lake Erie near Middle Sister Island	41.86035	-83.07294
Sandusky Basin Shoreline Assessment Unit			
300900	Sandusky Bay near Johnsons Island	41.47500	-82.73830
Sandusky Basin Offshore Assessment Unit			
301259	Lake Erie near Cedar Point	41.52774	-82.60062
300897	Lake Erie near Huron	41.44485	-82.45436
301257	Lake Erie near Lorain	41.48657	-82.23877
Central Basin Nearshore Assessment Unit			
300895	Lake Erie near Rocky River	41.50907	-81.90524
301256	Lake Erie near Wildwood	41.60404	-81.58445
301255	Lake Erie near Fairport	41.77903	-81.31017
301254	Lake Erie near Geneva	41.87507	-80.98111
300892	Lake Erie near Conneaut	41.99457	-80.52996
Mayfly stations			
301356	East of Middle Bass Island	41.69166	-82.76666
301357	Between Pelee and Kelleys Islands	41.66667	-82.66666
301358	Between Kelleys Island and Marblehead Peninsula	41.56666	-82.66666
301359	Maumee Bay	41.71383	-83.42500
301360	Maumee Bay off State Park	41.73333	-83.29716
301361	Between Port Clinton and Catawba Island	41.54866	-82.91666
301362	West of South Bass Island	41.64033	-82.94450
301363	North of Toussaint River	41.68750	-83.04033
300863	Maumee Bay off Ottawa River	41.74250	-83.44766

Table 2. List of field measurements recorded in Lake Erie open water, bay and estuary samples collected by Ohio EPA.

Parameter	PCS#	RL	Units
Water Depth	NA	0.1	m
Secchi Depth	00077	0.01	m
Temperature	00010	0.01	C
Dissolved Oxygen	00300	0.01	mg/L
Dissolved Oxygen	00301	0.01	%
Conductivity	00094	0.01	µS/cm
Specific Conductance	00095	0.01	µS/cm
pH	00400	0.1	SU
Fluorescence (SeaBird® only)	NA	0.01	mg/m^3

Table 3. List of parameters to analyze in Lake Erie open water, bay and estuary samples collected by Ohio EPA.

Parameter	PCS#	Method	RL	Units	Container	Preservative	Hold	Cost
Alkalinity, Total (as $CaCO_3$)	00410	USEPA 310.1	5	mg/L	1L LDPE	cool ≤6˚C	14d	$7.50
Bicarbonate, Total (as HCO_3)	00440	SM 2320 B	5	mg/L	1L LDPE	cool ≤6˚C	28d	$12
Carbonate, Total (as CO_3)	00445	SM 2320 B	5	mg/L	1L LDPE	cool ≤6˚C	28d	
Chloride, Total (as Cl)	00940	USEPA 325.1	5	mg/L	1L LDPE	cool ≤6˚C	28d	$11
Sulfate, Total (as SO_4)	00945	USEPA 375.2	10	mg/L	1L LDPE	cool ≤6˚C	28d	$12
Solids, Total Dissolved	70300	SM 2540 C	10	mg/L	1L LDPE	cool ≤6˚C	7d	$12
Solids, Total Suspended	00530	SM 2540 D	5	mg/L	1L LDPE	cool ≤6˚C	7d	$12
Ammonia, Total (as N)	00610	USEPA 350.1	0.05	mg/L	1L LDPE	2 ml H_2SO_4 to pH<2, cool ≤6˚C	28d	$11
Nitrite, Total (as N)	00615	USEPA 353.2	0.02	mg/L	1L LDPE	cool ≤6˚C	48 hr.	$11
Nitrate-Nitrite, Total (as N)	00630	USEPA 350.1	0.5	mg/L	1L LDPE	2 ml H_2SO_4 to pH<2, cool ≤6˚C	28d	$11
Kjeldahl, Total (as N)	00625	USEPA 351.2	0.2	mg/L	1L LDPE	2 ml H_2SO_4 to pH<2, cool ≤6˚C	28d	$12
Phosphorus, Total (as P)	00665	USEPA 365.4	1	µg/L	125ml jar	½ ml H_2SO_4 to pH<2, cool ≤6˚C	28d	$12
Orthophosphate, Dissolved (as P)	00671	US EPA 365.1	1	µg/L	125ml jar	cool ≤6˚C	48 hr.	$12
Chlorophyll a	32230	USEPA 445.0	1	µg/L	GF/C	freeze	25d	$52
Microcystins	NA	OEPA 701.0	0.3	µg/L	1L LDPE	cool ≤6˚C	36 hr.	$45

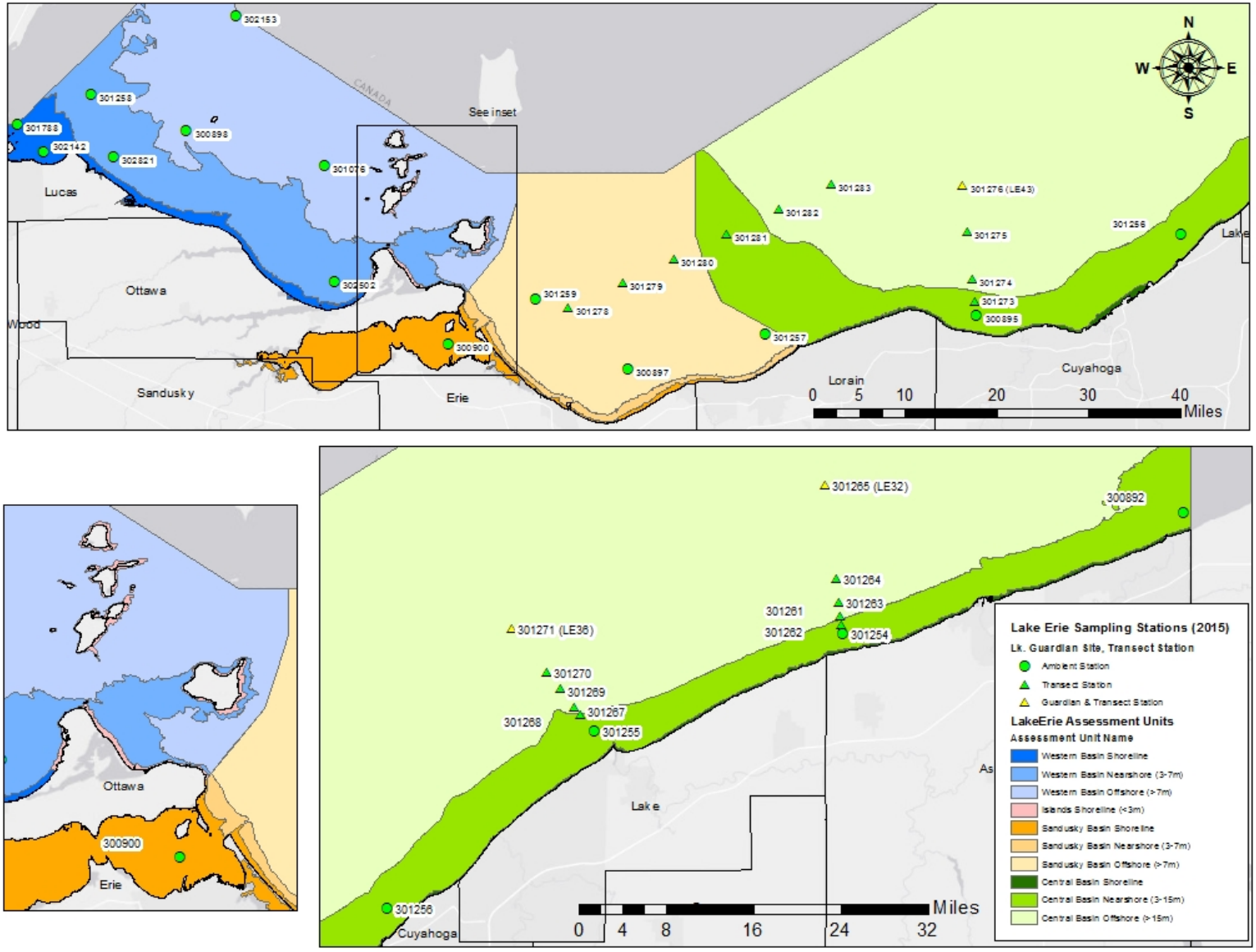
Table 4. Transect stations that will be monitored for hypoxia/anoxia by Ohio EPA.

Station ID	Description	Latitude	Longitude
Huron Transect			
301278	Huron Transect 1	41.51765	-82.54841
301279	Huron Transect 2	41.54668	-82.46346
301280	Huron Transect 3	41.57538	-82.38235
301281	Huron Transect 4	41.60471	-82.29871
301282	Huron Transect 5	41.63395	-82.21755
301283	Huron Transect 6	41.66295	-82.13396
Rocky River Transect			
300895	Rocky River Ambient Station	41.50907	-81.90524
301273	Rocky River Transect 1	41.52482	-81.90803
301274	Rocky River Transect 2	41.55140	-81.91182
301275	Rocky River Transect 3	41.60671	-81.91955
301276	Rocky River Transect 4	41.66117	-81.92725
301277	Lake Guardian Station E-43	41.78833	-81.94500
Fairport Harbor Transect			
301255	Fairport Ambient Station	41.77903	-81.31017
301267	Fairport Transect 1	41.79527	-81.32765
301268	Fairport Transect 2	41.80262	-81.33567
301269	Fairport Transect 3	41.82050	-81.35468
301270	Fairport Transect 4	41.83699	-81.37241
301271	Fairport Transect 5	41.88008	-81.41897
301272	Lake Guardian Station E-36	41.93500	-81.47833
Geneva Transect			
301254	Geneva Ambient Station	41.87507	-80.98111
301261	Geneva Transect 1	41.88411	-80.98246
301262	Geneva Transect 2	41.89177	-80.98361
301263	Geneva Transect 3	41.90566	-80.98567
301264	Geneva Transect 4	41.92939	-80.98918
301265	Geneva Transect 5	42.02101	-81.00288
301266	Lake Guardian Station E-32	42.08166	-81.01166

Table 5. Fish stations that will be sampled in the Lake Erie shoreline assessment units. Ohio DNR site numbers are shown in parenthesis next to the Station ID. Ohio EPA will complete the second pass at all stations except those marked with an asterisk.

Station ID	Description	Latitude	Longitude
Western Basin Shoreline Assessment Unit			
302439 (2)	Maumee Bay near Cullen Park along break wall	41.7035	-83.4678
204188 (3)	Maumee Bay near Immergrun	41.69	-83.4194
S03K12 (4)	Maumee Bay near Cedar Point NWR along west shore	41.7008	-83.3378
S03K10	Lake Erie near Cooley Canal	41.6756	-83.2936
302438 (5)	Lake Erie near Crane Creek State Park	41.6252	-83.175
300905 (6)	Lake Erie near Long Beach	41.6145	-83.1115
S02K08	Lake Erie near Port Clinton 2.5 mi. west of Portage R.	41.5281	-82.9778
Sandusky Basin Shoreline Assessment Unit			
302436 (13)	Sandusky Bay near Willow Inn Road	41.4807	-82.9663
302437 (14)	Sandusky Bay near Whites Landing	41.4255	-82.9101
301568 (15)	Sandusky Bay near Johnsons Island	41.4908	-82.7394
302435 (16)	Sandusky Bay near Cedar Point Causeway	41.4636	-82.6742
302432 (17)	* Sandusky Bay near City Boundary Causeway	41.4301	-82.6223
302433 (18)	* Sandusky Bay near Farthest East Point	41.4206	-82.6073
302443 (19)	Lake Erie east of Sandusky	41.4206	-82.6223
204167 (21)	Lake Erie east of Vermilion near Elberta Beach	41.4289	-82.3475
Islands Shoreline Assessment Unit			
302442 (9)	Lake Erie at Catawba Peninsula adj. Sand Road	41.5292	-82.8753
S02K07 (10)	Lake Erie at Catawba Peninsula near State Park	41.5747	-82.8592
302441 (11)	Lake Erie at Catawba Peninsula near Gem Beach	41.5756	-82.8235
302440 (12)	* Lake Erie at Catawba Peninsula near East Harbor	41.5522	-82.7988
204178	Lake Erie at Marblehead Peninsula near Lighthouse	41.5364	-82.7108
204200 (1)	Lake Erie at South Bass Island near State Park	41.6439	-82.8411
204210	Lake Erie at Kelleys Island near Northeast tip	41.6217	-82.6783
Central Basin Shoreline Assessment Unit			
301762	Lake Erie West of Miller Road Boat Ramp	41.5003	-82.0721
204141	Lake Erie West of Bay Village and East of Avon Lake	41.5086	-81.9775
204135	Lake Erie near Cuyahoga River and West Harbor	41.4992	-81.7172
F01K02	Lake Erie East of Euclid Creek	41.5928	-81.5578
204103	Lake Erie 2.1 miles West of Perry Power Plant	41.7894	-81.1767
204101	Lake Erie West of Geneva State Park	41.8517	-81.0061
A01K30	Lake Erie 0.3 miles West of OH/PA State Line	41.9756	-80.5269
302529	Lake Erie 2.0 miles East of Chagrin River	41.6951	-81.4070
302530	Lake Erie at Geneva on the Lake	41.8621	-80.9508
302531	Lake Erie West of Kent State Ashtabula Branch	41.8906	-80.8398

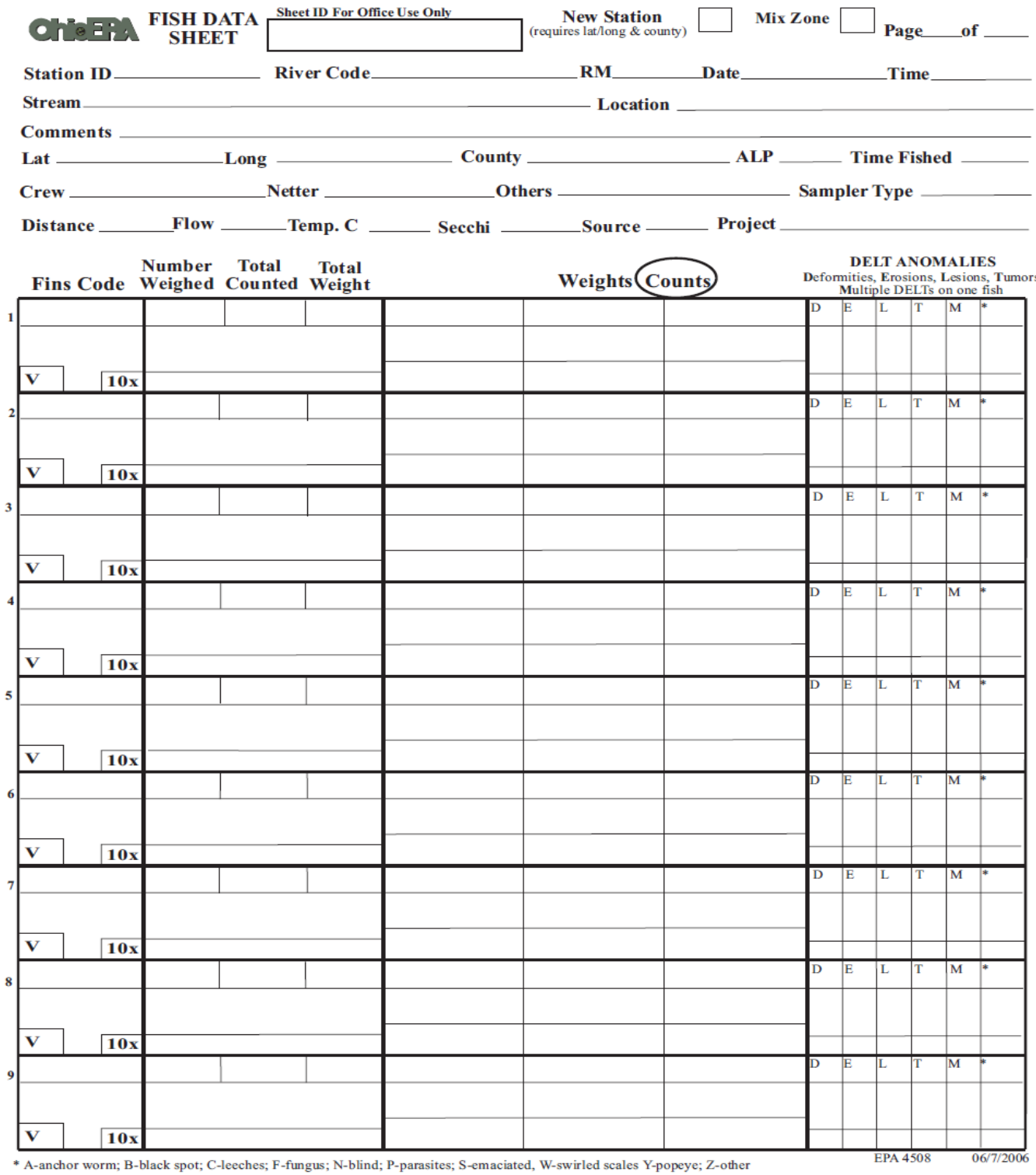
Figure 1. Lake Erie water quality and transect monitoring stations with Lake Guardian (LG) sites shown.



Appendix A. Burrowing Mayfly Lab Bench Sheet

Station ID	Sample Date	Replicate Number	Date Sorted	Sorted By	Nymph Count	Station Mean	Density (m^2) (#/0.0537)m^2	Comments
300863		1 of 3						
		2 of 3						
		3 of 3						
301356		1 of 3						
		2 of 3						
		3 of 3						
301357		1 of 3						
		2 of 3						
		3 of 3						
301358		1 of 3						
		2 of 3						
		3 of 3						
301359		1 of 3						
		2 of 3						
		3 of 3						
301360		1 of 3						
		2 of 3						
		3 of 3						
301361		1 of 3						
		2 of 3						
		3 of 3						
301362		1 of 3						
		2 of 3						
		3 of 3						
301363		1 of 3						
		2 of 3						
		3 of 3						

Appendix B. Snapshot of the fish data sheet used to record sampling results.



OhioEPA **FISH DATA SHEET** Sheet ID For Office Use Only _____ New Station (requires lat/long & county) ☐ Mix Zone ☐ Page____of____

Station ID_____ River Code_____ RM_____ Date_____ Time_____

Stream_____ Location_____

Comments_____

Lat_____ Long_____ County_____ ALP_____ Time Fished_____

Crew_____ Netter_____ Others_____ Sampler Type_____

Distance_____ Flow_____ Temp. C_____ Secchi_____ Source_____ Project_____

	Fins Code	Number Weighed	Total Counted	Total Weight	Weights	Counts	DELT ANOMALIES (Deformities, Erosions, Lesions, Tumors; Multiple DELTs on one fish) D	E	L	T	M	*
1	V 10x											
2	V 10x											
3	V 10x											
4	V 10x											
5	V 10x											
6	V 10x											
7	V 10x											
8	V 10x											
9	V 10x											

* A-anchor worm; B-black spot; C-leeches; F-fungus; N-blind; P-parasites; S-emaciated, W-swirled scales Y-popeye; Z-other

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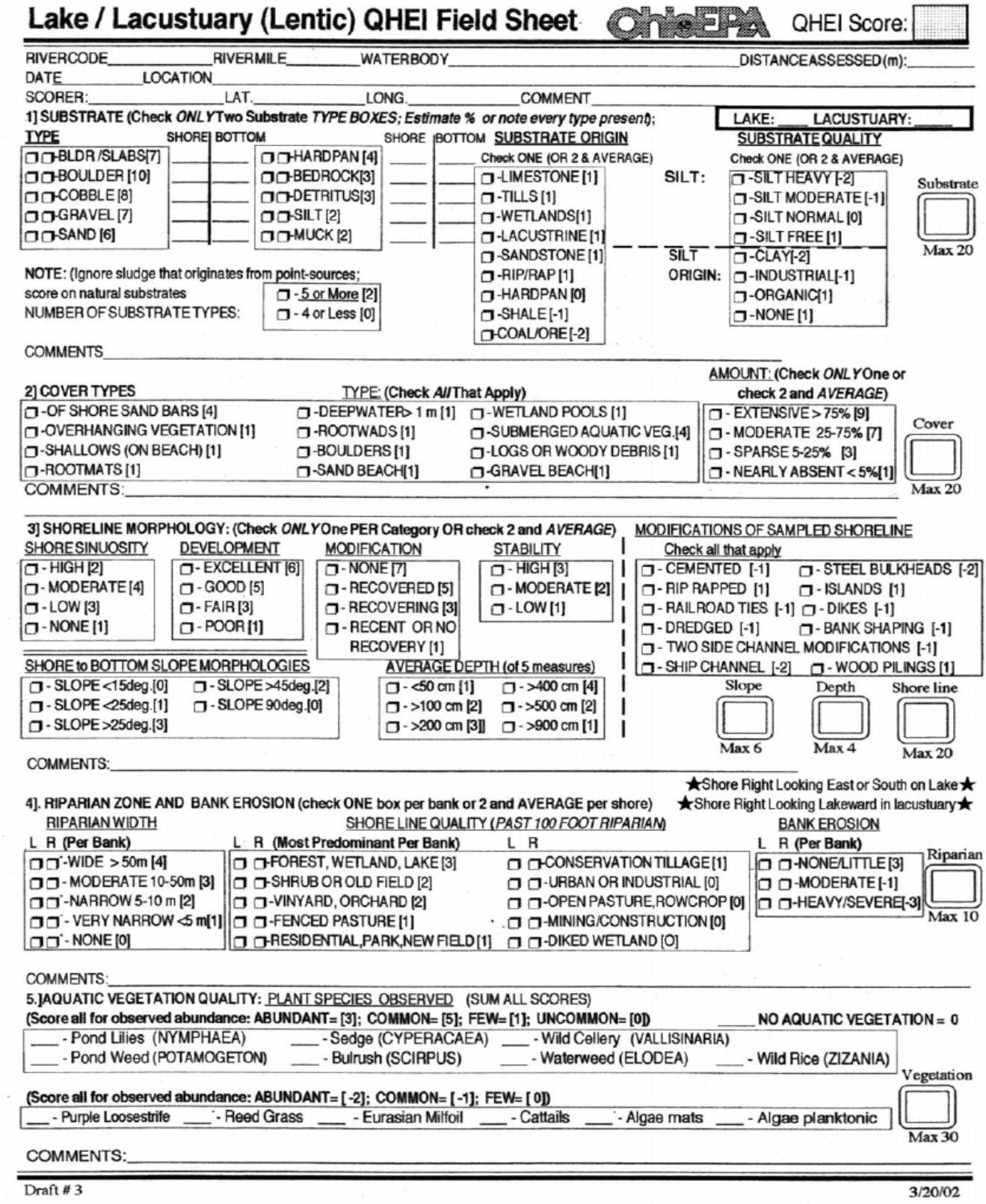
Appendix C. Snapshot of the Lake QHEI field sheet used to record shoreline habitat.



Lake / Lacustuary (Lentic) QHEI Field Sheet OhioEPA QHEI Score:

RIVERCODE_____ RIVERMILE_____ WATERBODY_____ DISTANCE ASSESSED (m):_____

DATE_____ LOCATION_____

SCORER:_____ LAT._____ LONG._____ COMMENT_____

LAKE:___ LACUSTUARY:___

1] SUBSTRATE (Check *ONLY* Two Substrate *TYPE BOXES; Estimate %* or note every type present);

TYPE	SHORE	BOTTOM	TYPE	SHORE	BOTTOM
☐☐-BLDR/SLABS [7]	___	___	☐☐-HARDPAN [4]	___	___
☐☐-BOULDER [10]	___	___	☐☐-BEDROCK [3]	___	___
☐☐-COBBLE [8]	___	___	☐☐-DETRITUS [3]	___	___
☐☐-GRAVEL [7]	___	___	☐☐-SILT [2]	___	___
☐☐-SAND [6]	___	___	☐☐-MUCK [2]	___	___

SUBSTRATE ORIGIN (Check ONE (OR 2 & AVERAGE)): ☐-LIMESTONE [1]; ☐-TILLS [1]; ☐-WETLANDS [1]; ☐-LACUSTRINE [1]; ☐-SANDSTONE [1]; ☐-RIP/RAP [1]; ☐-HARDPAN [0]; ☐-SHALE [-1]; ☐-COAL/ORE [-2]

SUBSTRATE QUALITY (Check ONE (OR 2 & AVERAGE))

SILT: ☐-SILT HEAVY [-2]; ☐-SILT MODERATE [-1]; ☐-SILT NORMAL [0]; ☐-SILT FREE [1]

SILT ORIGIN: ☐-CLAY [-2]; ☐-INDUSTRIAL [-1]; ☐-ORGANIC [1]; ☐-NONE [1]

Substrate ☐ Max 20

NOTE: (Ignore sludge that originates from point-sources; score on natural substrates

NUMBER OF SUBSTRATE TYPES: ☐ - 5 or More [2]; ☐ - 4 or Less [0]

COMMENTS_____

2] COVER TYPES

TYPE: (Check *All* That Apply)

☐-OF SHORE SAND BARS [4]; ☐-OVERHANGING VEGETATION [1]; ☐-SHALLOWS (ON BEACH) [1]; ☐-ROOTMATS [1]; ☐-DEEPWATER > 1 m [1]; ☐-ROOTWADS [1]; ☐-BOULDERS [1]; ☐-SAND BEACH [1]; ☐-WETLAND POOLS [1]; ☐-SUBMERGED AQUATIC VEG. [4]; ☐-LOGS OR WOODY DEBRIS [1]; ☐-GRAVEL BEACH [1]

AMOUNT: (Check *ONLY* One or check 2 and *AVERAGE*)

☐ - EXTENSIVE > 75% [9]; ☐ - MODERATE 25-75% [7]; ☐ - SPARSE 5-25% [3]; ☐ - NEARLY ABSENT < 5% [1]

Cover ☐ Max 20

COMMENTS:_____

3] SHORELINE MORPHOLOGY: (Check *ONLY* One PER Category OR check 2 and *AVERAGE*)

SHORE SINUOSITY: ☐ - HIGH [2]; ☐ - MODERATE [4]; ☐ - LOW [3]; ☐ - NONE [1]

DEVELOPMENT: ☐ - EXCELLENT [6]; ☐ - GOOD [5]; ☐ - FAIR [3]; ☐ - POOR [1]

MODIFICATION: ☐ - NONE [7]; ☐ - RECOVERED [5]; ☐ - RECOVERING [3]; ☐ - RECENT OR NO RECOVERY [1]

STABILITY: ☐ - HIGH [3]; ☐ - MODERATE [2]; ☐ - LOW [1]

SHORE to BOTTOM SLOPE MORPHOLOGIES: ☐ - SLOPE <15deg. [0]; ☐ - SLOPE >45deg. [2]; ☐ - SLOPE <25deg. [1]; ☐ - SLOPE 90deg. [0]; ☐ - SLOPE >25deg. [3]

AVERAGE DEPTH (of 5 measures): ☐ - <50 cm [1]; ☐ - >400 cm [4]; ☐ - >100 cm [2]; ☐ - >500 cm [2]; ☐ - >200 cm [3]; ☐ - >900 cm [1]

MODIFICATIONS OF SAMPLED SHORELINE Check all that apply

☐ - CEMENTED [-1]; ☐ - STEEL BULKHEADS [-2]; ☐ - RIP RAPPED [1]; ☐ - ISLANDS [1]; ☐ - RAILROAD TIES [-1]; ☐ - DIKES [-1]; ☐ - DREDGED [-1]; ☐ - BANK SHAPING [-1]; ☐ - TWO SIDE CHANNEL MODIFICATIONS [-1]; ☐ - SHIP CHANNEL [-2]; ☐ - WOOD PILINGS [1]

Slope ☐ Max 6; Depth ☐ Max 4; Shore line ☐ Max 20

COMMENTS:_____

★Shore Right Looking East or South on Lake★

★Shore Right Looking Lakeward in lacustuary★

4]. RIPARIAN ZONE AND BANK EROSION (check ONE box per bank or 2 and AVERAGE per shore)

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

SHORE LINE QUALITY (*PAST 100 FOOT RIPARIAN*) (L R (Most Predominant Per Bank)): ☐☐-FOREST, WETLAND, LAKE [3]; ☐☐-SHRUB OR OLD FIELD [2]; ☐☐-VINYARD, ORCHARD [2]; ☐☐-FENCED PASTURE [1]; ☐☐-RESIDENTIAL, PARK, NEW FIELD [1]; ☐☐-CONSERVATION TILLAGE [1]; ☐☐-URBAN OR INDUSTRIAL [0]; ☐☐-OPEN PASTURE, ROWCROP [0]; ☐☐-MINING/CONSTRUCTION [0]; ☐☐-DIKED WETLAND [0]

BANK EROSION (L R (Per Bank)): ☐☐-NONE/LITTLE [3]; ☐☐-MODERATE [-1]; ☐☐-HEAVY/SEVERE [-3]

Riparian ☐ Max 10

COMMENTS:_____

5.] AQUATIC VEGETATION QUALITY: PLANT SPECIES OBSERVED (SUM ALL SCORES)

(Score all for observed abundance: ABUNDANT= [3]; COMMON= [5]; FEW= [1]; UNCOMMON= [0]) ___ NO AQUATIC VEGETATION = 0

___ - Pond Lilies (NYMPHAEA); ___ - Sedge (CYPERACAEA); ___ - Wild Cellery (VALLISINARIA); ___ - Pond Weed (POTAMOGETON); ___ - Bulrush (SCIRPUS); ___ - Waterweed (ELODEA); ___ - Wild Rice (ZIZANIA)

(Score all for observed abundance: ABUNDANT= [-2]; COMMON= [-1]; FEW= [0])

___ - Purple Loosestrife; ___ - Reed Grass; ___ - Eurasian Milfoil; ___ - Cattails; ___ - Algae mats; ___ - Algae planktonic

Vegetation ☐ Max 30

COMMENTS:_____

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Appendix D. BSA Environmental Services, Inc. chain of custody form to be used for phytoplankton samples.

BSA ENVIRONMENTAL SERVICES, INC.

BSA Environmental Services, Inc.
23400 Mercantile Rd., Suite 8
Beachwood, OH 44122
P: 216-765-0582 F: 216-765-0583
Email: j.beaver@bsaenv.com

CHAIN OF CUSTODY

Client Information			Invoice Information		
Client Name:			Invoice To:		
Address:			Address:		
City:	State:	Zip:	City:	State:	Zip:
Contact:			Contact:		
Phone Number:	Fax Number:		Phone Number:	Fax Number:	
Email:			Email:		

Project Name:
Project Number:
Special Instructions:

Sample ID/Number	Site Name	Sample Date	Sample Time	Analysis Requested	Other Sample Information

Relinquished By:	Date:	Time:	Received By:	Date:	Time:
Relinquished By:	Date:	Time:	Received By:	Date:	Time:
Relinquished By:	Date:	Time:	Received By:	Date:	Time:

COMMENTS: