Cruise Report: Assessment of Ecological Condition and Stressor Impacts within Great Lakes Region Areas of Concern (AOCs): Ashtabula River and Milwaukee Estuary

(August 18-25, 2012)

NOAA Technical Memorandum NOS NCCOS 168

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Cruise Report: Assessment of Ecological Condition and Stressor Impacts within Great Lakes Region Areas of Concern (AOCs): Ashtabula River and Milwaukee Estuary

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Acting Secretary	**Acting NOAA Administrator**	**Assistant Administrator**

Summary

This cruise report is a summary of a field survey conducted within two Great Lakes Region Areas of Concern (AOCs), Ashtabula River and Milwaukee Estuary, August 18 – 25, 2012. Synoptic sampling of multiple ecological indicators was conducted in the benthos and the water column at each of 30 stations throughout these two AOCs using a random probabilistic sampling design. Twelve of the 30 stations were located in the Ashtabula River, Ohio and the remaining 18 were located in the Milwaukee Estuary and its tributaries. At each station samples were collected for the analysis of benthic macroinfauna community structure and composition; concentrations of chemical contaminants in sediments; sediment toxicity; and other basic habitat characteristics such as temperature, dissolved oxygen, turbidity, pH, sediment grain size, and organic carbon content. Other indicators, from a human-dimension perspective, were also recorded, including presence of surface trash, visible oil sheens in sediments or water, or noxious/oily sediment odors.

The overall purpose of the survey was to collect data to assess the status of ecological condition and potential stressor impacts within these two AOCs, based on these various indicators and corresponding management thresholds, and to provide this information to coastal managers for use in evaluating change in the quality of these water bodies relative to Beneficial Use Impairment (BUI) designations and corresponding AOC Remedial Action Plan (RAP) goals. While sample analysis is still ongoing, some preliminary results and observations are reported here. A final report will be completed once all data have been processed.

This was a multi-disciplinary partnership effort made possible by scientists from the following organizations:

- NOAA, National Ocean Service (NOS), National Centers for Coastal Ocean Science (NCCOS), Center for Coastal Environmental Health and Biomolecular Research (CCEHBR).
- NOAA, National Ocean Service (NOS), National Centers for Coastal Ocean Science (NCCOS), Center for Coastal Monitoring and Assessment (CCMA).
- NOAA, Oceanic and Atmospheric Research (OAR), Great Lakes Environmental Research Laboratory (GLERL).
- EPA, Great Lakes National Program Office (GLNPO).
- University of Wisconsin – Milwaukee, Great Lakes WATER Institute.

Additional copies of this cruise report can be obtained by contacting:
NOAA, CCEHBR, 219 Fort Johnson Road, Charleston, South Carolina, 29412, Telephone: 843/762-8511. Attention: Cynthia Cooksey.

1.0 Introduction

This work is an expansion of NOAA/NCCOS National Status and Trends Mussel Watch Program (MWP) which has been monitoring in the Great Lakes since 1992. MWP has established sites in Areas of Concern (AOCs) to provide biologically-relevant data to aid the assessment and removal of beneficial use impairment targets (BUIs) and delisting of AOCs in the Great Lakes. MWP was expanded in 2012 with the addition of a probabilistic sampling component with a primary objective of assessing the status of ecological condition and potential stressor impacts throughout target AOCs. Furthermore, the probabilistic sampling component will provide managers with information needed for evaluating changes in the quality of these water bodies relative to BUIs and corresponding AOC Remedial Action Plan (RAP) goals.

Surveys of benthic fauna and other multiple indicators of ecological condition and stressor impacts — including basic habitat characteristics such as depth, conductivity, temperature, dissolved oxygen, pH, sediment grain size and organic content; turbidity levels in the water column; chemical contaminants in sediments and biota; sediment toxicity — were conducted in these waters at a series of randomly selected stations using a probabilistic sampling design. Specific station locations are selected using a method called the Generalized Random-tessellation Stratified (GRTS) design (Stevens & Olsen 2004). This is a probabilistic survey design from which resulting data can be used to make unbiased statistical estimates of the spatial extent and magnitude of condition relative to various measured indicators and corresponding management thresholds. Sample sites are dispersed over the area of interest to provide a spatially balanced sample design while still incorporating a true probability approach. The consistent and systematic sampling of the different biological and environmental variables across these AOCs provides an opportunity for learning more about the spatial patterns of these resources and the processes controlling their distributions. In addition, the synoptic sampling of the variety of different indicators provides a means to support an integrative "weight-of-evidence" assessment of benthic condition across these sites, and allows the examination of potential associations between the presence of pollution-based stressors and biological responses.

The present survey was conducted within two AOCs, the Ashtabula River in Ohio and the Milwaukee estuary in Wisconsin. The lower Ashtabula River watershed, located on Lake Erie, was designated an AOC in 1985. Prior to the implementation of the Clean Water Act in the early 1970s, the Ashtabula had been heavily contaminated with PCBs, PAHs and heavy metals. The BUIs identified for Ashtabula include restrictions on fish and wildlife consumption, degradation of fish and wildlife populations, fish tumors or other deformities, degradation of benthos, restriction on dredging activities, and loss of fish and wildlife habitat. The Milwaukee Estuary, located on Lake Michigan, was designated an AOC during the mid-1980s. In 2008 the geographic boundaries of the Milwaukee AOC were expanded to include more upstream portions of the estuary's tributaries: the Milwaukee River, Menomonee River, and Kinnickinnic River. Contaminants of concern within the Milwaukee AOC include PCBs, PAHs and heavy metals. The BUIs identified for Milwaukee include restrictions on fish and wildlife consumption, eutrophication or undesirable algae, degradation of fish and wildlife populations, beach closings, fish tumors or other deformities, degradation of aesthetics, bird or animal deformities or reproduction problems, degradation of benthos, degradation of phytoplankton and zooplankton populations, restriction on dredging activities, and loss of fish and wildlife habitat.

2.0 Scientific Approach

Samples were collected aboard NOAA GLERL's 26ft Sea Ark research vessel from both the Ashtabula River and Milwaukee estuary August 18 – 25, 2012 (Figure 1 and 2, Table 1). The study design consisted of 30 stations, with 12 sites in the Ashtabula AOC and 18 sites in the Milwaukee AOC. Total number of stations sampled (30) was based on available budget while station allocation between AOC was based on overall size (sq. km) of the AOC. At each station, samples were obtained for characterization of the following core indicators: (1) community structure and composition of benthic macroinfauna (> 0.5 mm); (2) concentration of chemical contaminants in sediments (metals, pesticides, PCBs, PAHs, PBDEs); (3) multiple measures of sediment toxicity (Microtox organic extract assay, Microtox solid-phase assay, amphipod survival assay, reporter gene assay); and (4) general habitat conditions (water depth, dissolved oxygen, conductivity, temperature, pH, turbidity, % silt-clay versus sand content of sediment, organic-carbon content of sediment). Several human-dimension indicators were recorded as well including presence of surface trash, visual oil sheens in sediments or water, or noxious/oily sediment odors. Table 2 provides a list of samples collected during the cruise.

Sediment sampling was conducted using a 0.04 m^2 Young-modified Van Veen grab. Samples for benthic macro-infaunal analysis were collected in triplicate, live-sieved onboard through a 0.5 mm screen, and preserved separately in 10% buffered formalin with Rose Bengal stain. Samples for the analysis of sediment toxicity, sediment contaminants, % silt-clay, % water, and % TOC were sub-sampled from composited surface sediment (upper 2-3 cm) taken from additional grabs (typically three) independent of the macro-infaunal grabs.

A Seabird SBE 19 plus CTD was used to acquire continuous profiles of conductivity, temperature, pH, dissolved oxygen, and depth as it was lowered and raised through the water column. A Niskin bottle was used to acquire discrete water samples at two designated water depths (near surface and near-bottom) for analysis of turbidity (in Nephelometric Turbidity Units, NTU). If water depth was ≤ 1m then only one discrete water sample was collected.

Sediment toxicity is being evaluated using four types of toxicity tests: Microtox-solid-phase tests (Johnson and Long 1998), Microtox-solvent-extract tests (Microbics Corporation 1992), amphipod (*Hyalella azteca*) whole-sediment bioassays (USEPA 1999), and a reporter-gene assay. At the time of this report, preliminary results are available for all tests except the reporter-gene assay. Both types of Microtox tests (solid phase and solvent extract) measure light output in bioluminescent bacteria exposed to sediment extracts wherein contaminant exposure is associated with reduced light output (Microbics Corporation 1992). EC50s (for light output) were determined for sediment samples from Ashtabula, Milwaukee, and reference sites. Sediments were considered toxic (a hit) for the Microtox tests (solid phase or solvent extract) when EC50s were significantly ($p \leq 0.05$) lower than reference sediments. Amphipod whole-sediment bioassays measure survival in test populations exposed to field-collected sediments compared to that in synthetic control sediment. For the amphipod bioassay, sediments were considered toxic (a hit) when survival relative to the controls was significantly ($p \leq 0.05$) different and less than 80% of control survival.

3.0 Preliminary Results

A total of 30 stations were sampled for all indicators, 12 in the Ashtabula AOC and 18 in the Milwaukee AOC (Figure 1 and 2, Table 1). Both of these AOCs were in urbanized, industrial areas with heavy boat traffic (commercial and recreational). Presented here are preliminary results and observations from the field survey. A final report will be completed once all data have been processed.

3.0.1 Ashtabula

Water depths at the 12 stations averaged 4.8 m and ranged from 0.7 – 9 m. Bottom-water conductivity varied slightly across the AOC with values falling within a range of 285 - 472 µS/cm and averaging 360.5 µS/cm. Bottom-water temperature (23.4 – 24.2 ºC) and pH (7.4-8.8) were both very stable within the AOC. Turbidity ranged from 6.34 NTU to 25.9 NTU and averaged 12.4 NTU within the AOC. Bottom-water dissolved oxygen (DO) ranged from 2.48 mg/L to 8.75 mg/L and averaged 5.73 mg/L. One station (A12) had DO values in a range considered poor (< 2 mg/L) and often associated with adverse conditions for benthic fauna while an additional 4 stations (A6, A7, A9, A10) had DO values considered fair or moderate (2 – 5 mg/L range) (USEPA 2004, Diaz and Rosenberg 1995). These stations with DO levels below 5 mg/L were spatially concentrated within the middle portion of the AOC, the area between the Turning Basin and the 5th Street Bridge which generally corresponds to the area dredged in 2007-2008 (Figure 3). Bottom water-quality measurements for depth, temperature, conductivity, pH, turbidity, and DO at each station are presented in Table 1.

The toxicity results presented here are preliminary. Test results should be interpreted in light of contaminant concentrations and other controlling factors for which data are not yet available. The ultimate interpretation of these results will be made once such supporting analyses are completed. Sediments from three of the 12 Ashtabula AOC sites were determined to be toxic (a hit) relative to the Reference sediments for the Microtox-solid phase tests. Sediments from five of the 12 sites were determined to be toxic relative to the Reference sediments for the Microtox-solvent extract tests. Sediments from 11 of the 12 sites were determined to be toxic relative to the controls for the Amphipod bioassay. The number of co-occurring toxicity hits was highest at upstream sites, decreased downstream, and was the lowest in the harbor (Figure 4).

Observations of several human-dimension indicators (e.g., presence or absence of surface trash, surface oil, oily sediment, and noxious sediment odors) also were made at each station (Table 3). Surface oil slicks or oily sediment sheens were not observed at any of the stations. Surface trash was observed at two stations (07 and A10).

3.0.1 Milwaukee

Water depths at the 18 stations averaged 4.8 m and ranged from 0.8 – 8.8 m. Bottom-water conductivity varied slightly across the AOC with values falling within a range of 228 - 821 µS/cm and averaging 470 µS/cm. Bottom-water temperature ranged widely from 14.2 ºC to 26.2 ºC and averaged 22.2 ºC. Like Ashtabula, pH (7.6-8.9) was stable within the Milwaukee AOC. Turbidity ranged from 1.6 NTU to 22.2 NTU and averaged 8.12 NTU within the AOC. Bottom-water dissolved oxygen (DO) ranged from 4.25 mg/L to 10.7 mg/L and averaged 7.41 mg/L. No stations had DO values in a range considered poor (< 2 mg/L) although 3 stations (M14, M15, M16) had DO values considered fair or moderate (2 – 5 mg/L range) (USEPA 2004, Diaz and Rosenberg 1995). These stations with DO levels below 5 mg/L were spatially concentrated within the upstream portions of the AOC tributaries (Figure 5). Bottom water-quality measurements for depth, temperature, conductivity, pH, turbidity, and DO at each station are presented in Table 1.

As explained above, the toxicity test results presented here are preliminary and final interpretation is pending the completion of chemical contaminant and other related analyses. Sediments from five of the 18 Milwaukee AOC sites were determined to be toxic relative to the Reference sediments for the Microtox solid-phase tests; and sediments from nine of the 18 sites were determined to be toxic relative to the Reference sediments for the Microtox solvent-extract tests. Sediments from 14 of the 18 sites were determined to be toxic relative to the controls for the amphipod bioassay. In the Milwaukee River complex, the number of toxicity hits was higher in the upper Milwaukee and Menomonee Rivers and lower in the Kinnickinnic River. The response was variable along the harbor interface (Figure 6).

Observations of several human-dimension indicators (e.g., presence or absence of surface trash, surface oil, oily sediment, and noxious sediment odors) were made at each station (Table 3). No surface oil slicks were observed at any of the stations; however, sediment oil sheens were observed at two stations (M11, M15). Also, noxious sediment odors (sewage) were detected at two stations (M1, M13). Surface trash was observed at seven of the 18 stations. Trash was also present in many of the bottom grabs.

Data for other biological and abiotic environmental variables listed in Table 2 will be available once the processing of these samples has been completed. A final report, inclusive of all results, is expected in FY13.

4.0 Acknowledgements

Support for this project has been provided through Great Lakes Restoration Initiative funds under U.S. EPA Interagency Agreement 3RR3LGL with NOAA Great Lakes Environmental Research Laboratory (GLERL). All members of the field crew (Table 6) are commended for their high level of technical expertise, teamwork and dedication to getting the required sampling completed. Appreciation also is extended to US Army Corps of Engineers, Buffalo District, Ohio Area Office and to the University of Wisconsin-Milwaukee WATER Institute for providing logistical support.

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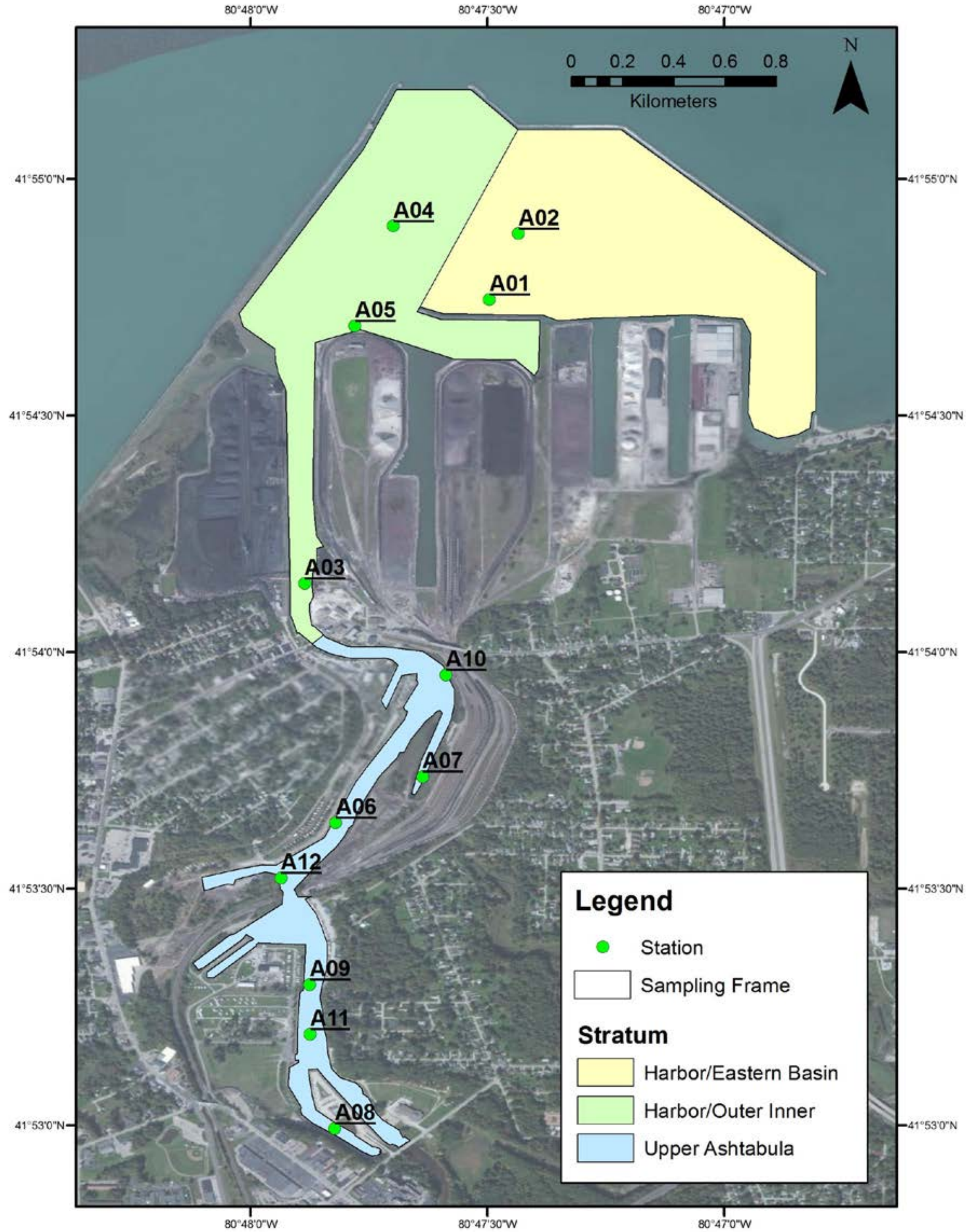

Figure 1. Station locations within the Ashtabula River Area of Concern (AOC). Three strata were established within the AOC to ensure sites were distributed throughout the length of the AOC.

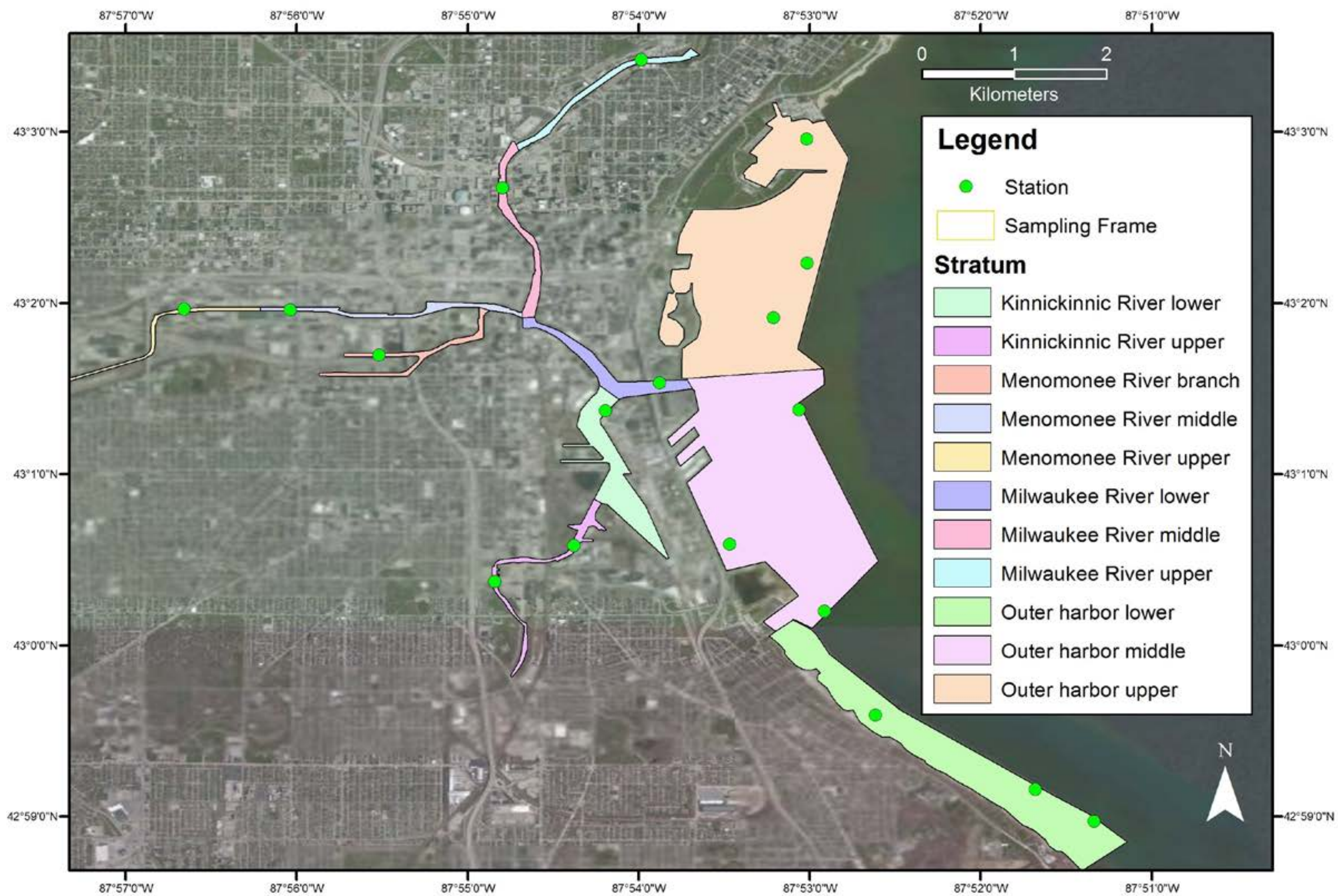

Figure 2. Station locations within the Milwaukee Estuary Area of Concern (AOC). Eleven strata were established within the AOC to ensure sites were distributed throughout the length of the AOC.

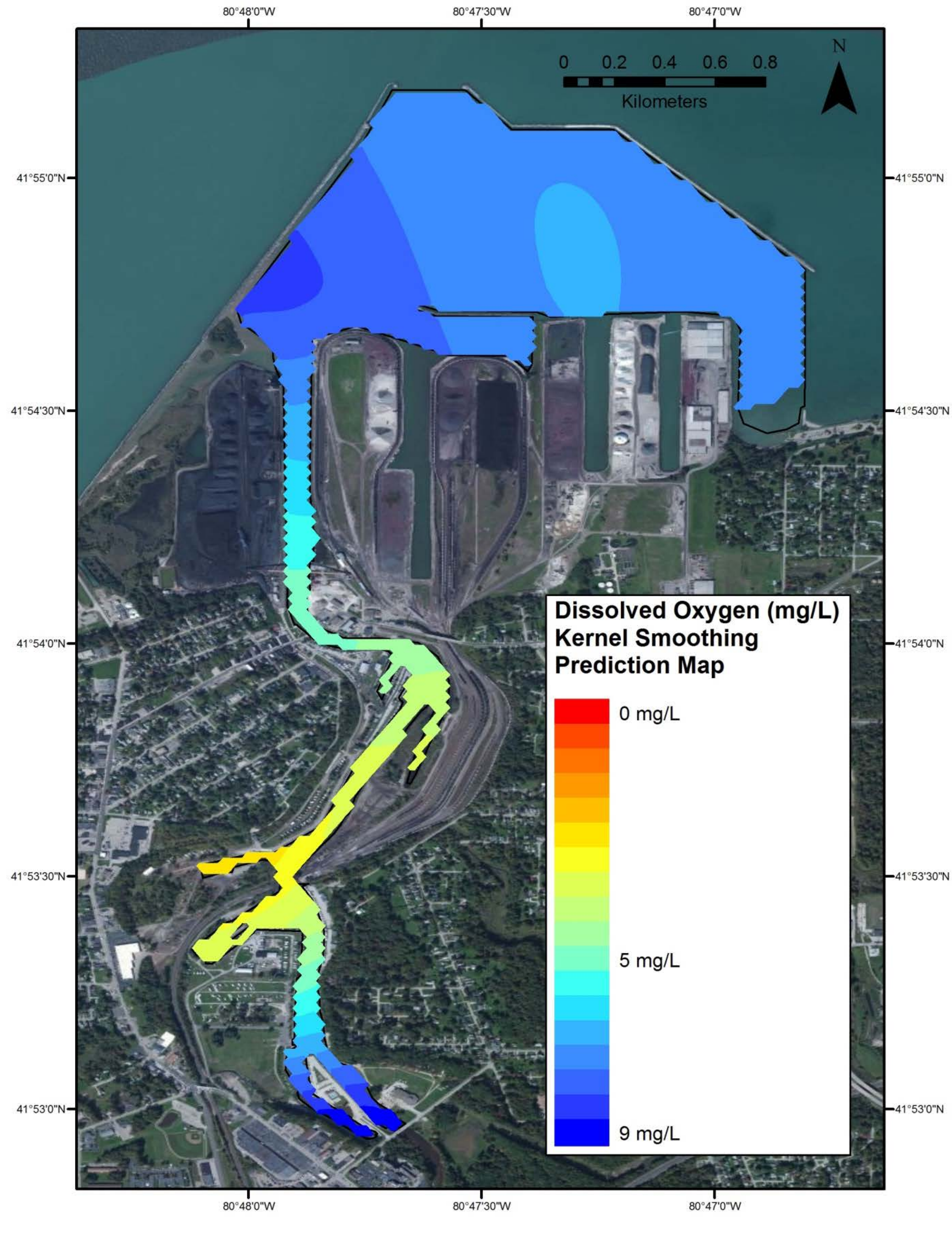

Figure 3. Dissolved oxygen (DO) levels within the Ashtabula Area of Concern. DO data was analyzed in ArcMap's Geostatisical Analyst using Kernel Smoothing with Barriers.

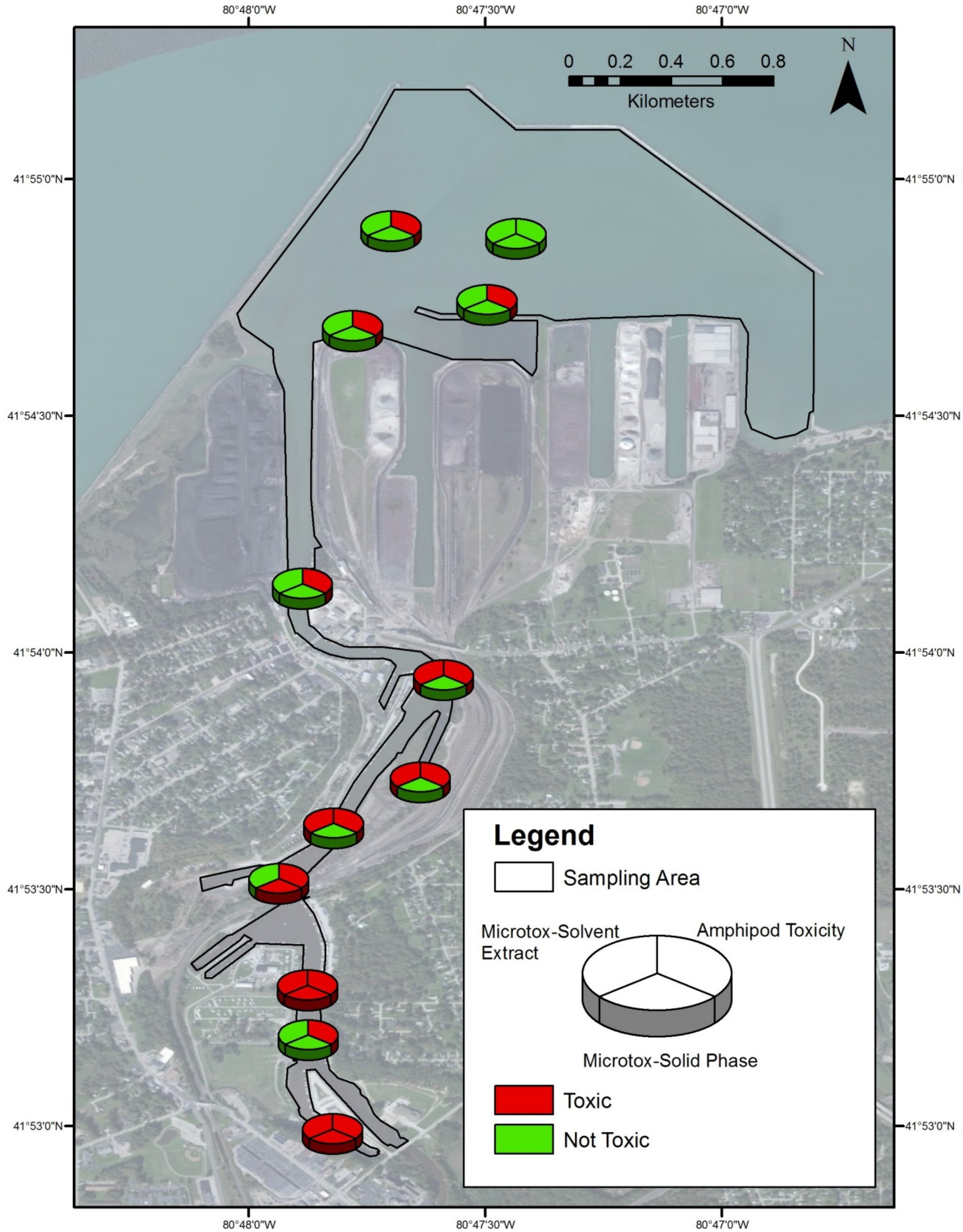

Figure 4. Toxicity hits within the Ashtabula Areas of Concern. This interpretation of the toxicity data is preliminary until results from chemical contaminant and other related analyses are available.

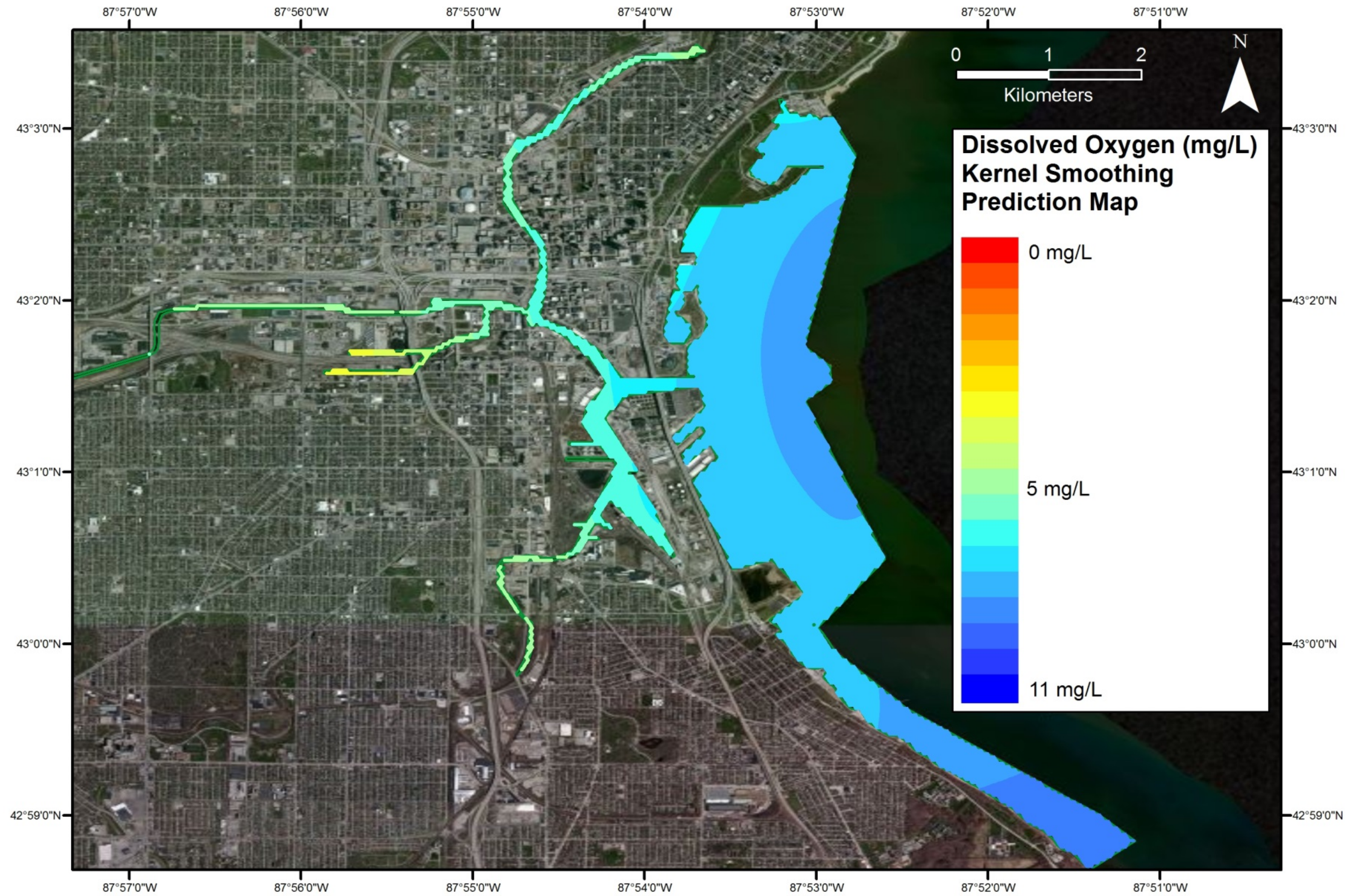

Figure 5. Dissolved oxygen (DO) levels within the Milwaukee Estuary Area of Concern. DO data was analyzed in ArcMap's Geostatisical Analyst using Kernel Smoothing with Barriers.

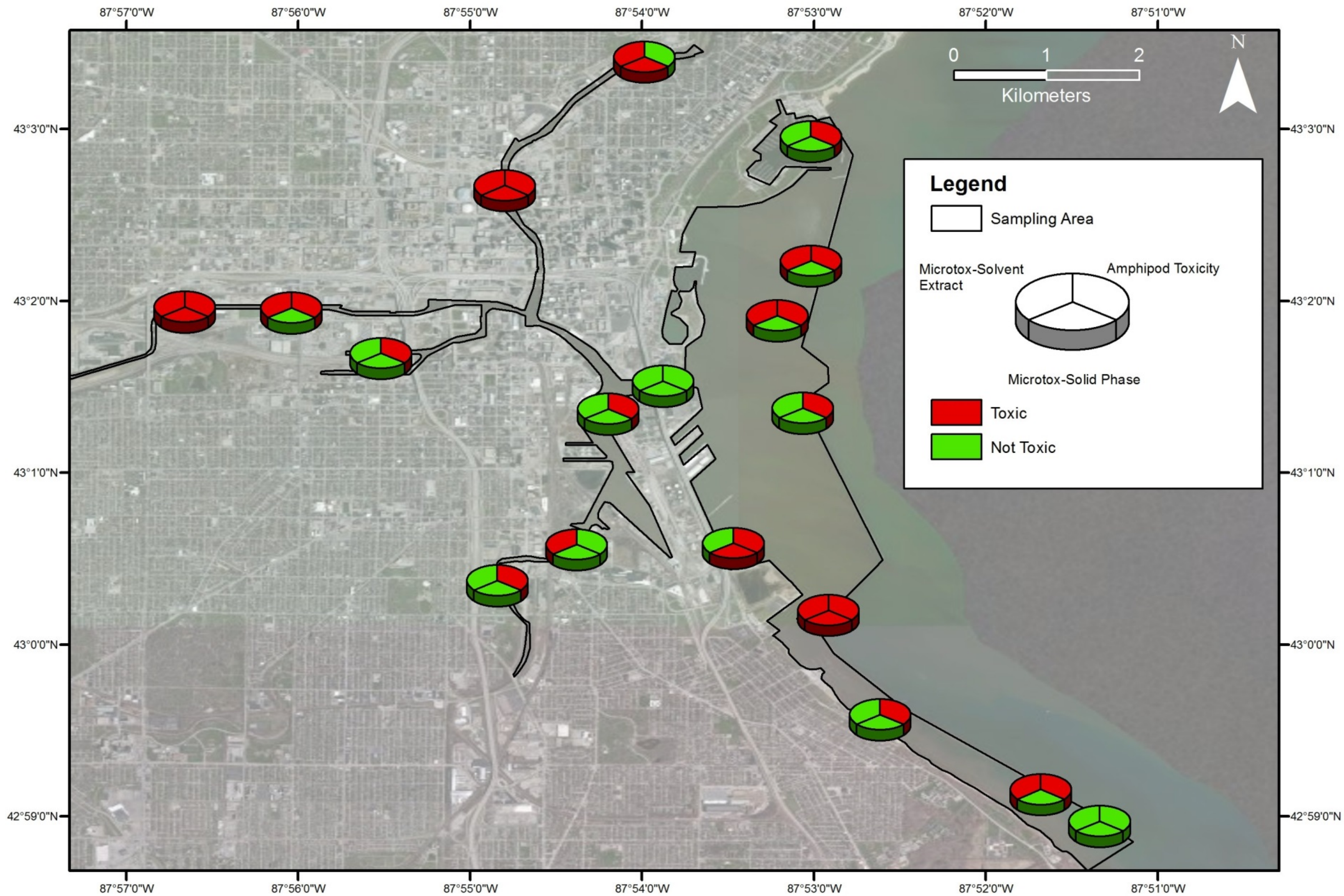

Figure 6. Toxicity hits within the Milwaukee Area of Concern. This interpretation of toxicity data is preliminary and final interpretation will be dependent on benthic community and chemical contaminant data.

Table 1. Locations, depths, and bottom water characteristics for 12 stations sampled in the Ashtabula Area of Concern (AOC) and 18 stations sampled in the Milwaukee Estuary AOC, August 18 – 25, 2012. Near-bottom water data are from the Seabird conductivity-temperature-depth (CTD) sensor except for turbidity which is from HACH Turbidimeter.

						Near-Bottom Water				
Station	Date Sampled	Latitude (DD)	Longitude (DD)	Depth (m)	% Silt-Clay	Temp. (C)	DO (mg/L)	pH	Conductivity (µS/cm)	Turbidity (NTU)
A01	8/18/2012	41.91242	-80.7916	5.55	99.5	23.7	7.16	8.8	304.1	6.34
A02	8/18/2012	41.91474	-80.79058	8.08	85.6	23.4	7.06	8.7	285.1	10.7
A03	8/19/2012	41.90243	-80.7981	5.39	96.1	23.7	5.44	8.0	315.6	13.3
A04	8/18/2012	41.91501	-80.79498	9.05	77.9	23.6	7.47	8.5	288.8	8.15
A05	8/18/2012	41.9115	-80.79633	5.46	68.5	24.2	8.05	8.7	291.7	7.77
A06	8/19/2012	41.894	-80.797	4.82	94.2	24.0	3.52	7.5	382.1	13.9
A07	8/19/2012	41.89562	-80.79395	5.64	81.4	23.9	3.57	7.5	368.1	25.9
A08	8/20/2012	41.88324	-80.79704	0.98	88.6	24.1	8.75	8.6	472.0	20.7
A09	8/20/2012	41.8883	-80.79792	2.87	75.2	23.9	4.03	7.5	428.5	10.7
A10	8/19/2012	41.89921	-80.79313	4.11	81.6	23.7	4.80	7.7	337.3	9.3
A11	8/20/2012	41.88655	-80.7979	0.67	35.9	24.0	6.43	7.9	447.5	12.1
A12	8/19/2012	41.89205	-80.79893	5.09	87.8	23.9	2.48	7.4	405.5	10.2
M01	8/23/2012	42.98596	-87.86135	3.02	53.1	21.7	9.43	8.9	279.4	2.9
M02	8/23/2012	42.98289	-87.85565	2.77	51.8	21.6	8.65	8.8	277.5	1.6
M03	8/23/2012	42.99323	-87.87693	3.35	18.9	21.6	8.62	8.6	280.6	2.6
M04	8/22/2012	43.03723	-87.88361	6.71	87.8	22.1	8.98	8.8	349.5	4.5
M05	8/22/2012	43.0493	-87.88362	3.72	77.8	21.9	7.57	8.5	327.9	7.3
M06	8/22/2012	43.03192	-87.88688	6.43	87.3	22.0	8.03	8.7	383.2	3.5
M07	8/23/2012	43.00985	-87.89114	4.08	78.0	21.9	8.50	8.3	381.1	5.2
M08	8/23/2012	43.00335	-87.88193	7.1	88.7	21.7	7.08	8.1	380.7	2.1
M09	8/22/2012	43.02295	-87.88441	8.79	99.2	22.3	9.19	8.6	365.2	2.1
M10	8/24/2012	43.057	-87.89976	1.95	63.6	23.3	5.81	8.5	817.1	11.5
M11	8/24/2012	43.04453	-87.9133	4.15	69.7	23.4	7.84	8.7	815.2	22.2
M12	8/25/2012	43.02557	-87.89796	7.8	63.9	14.2	10.70	8.2	228.0	10.3
M13	8/24/2012	43.03276	-87.94431	0.98	81.5	25.3	7.19	8.1	821.5	11..10
M14	8/24/2012	43.03267	-87.93397	4.39	91.6	25.2	4.25	7.6	813.0	21.2
M15	8/24/2012	43.02826	-87.92531	6.68	81.8	26.2	4.38	7.7	681.6	13.4
M16	8/25/2012	43.00972	-87.90633	6.89	85.1	22.1	4.25	7.6	440.5	19.1
M17	8/25/2012	43.00623	-87.91402	0.82	2.5	24.0	7.01	8.0	548.2	4.1
M18	8/25/2012	43.02287	-87.90327	7.13	93.5	19.0	5.97	8.0	281.7	4.6

Table 2. Summary of field samples collected at each station.

Parameters	# of Replicates	Container	Sample Size	Preservation
Infauna	3	1000 ml Polypropylene jar	All material retained on 0.5mm sieve	10% Buffered Formalin in the field
Metal Contaminants	1 (composited sediment)	250 ml (4 oz) polypropylene jar	2/3 full	frozen
Organic Contaminants	1 (composited sediment)	250 ml (4 oz) glass jar	2/3 full	frozen
TOC	1 (composited sediment)	125 ml (4 oz) Polypropylene jar	2/3 full	frozen
% Silt/Clay & % Moisture	1 (composited sediment)	500 ml (16 oz) HDPE jar	2/3 full	frozen
Microtox – Organic extract	1 (composited sediment)	125 ml (4 oz) Glass jar	2/3 Full	Refrigerate
Microtox – Solid phase assay	1 (composited sediment)	125 ml (4 oz) Glass jar	2/3 Full	Refrigerate
Amphipod (*Hyalella*) assay	1 (composited sediment)	2L Polypropylene jar	3/4 Full	Refrigerate
Reporter gene assay	1 (composited sediment)	125 ml (4 oz) Glass jar	2/3 Full	frozen
Water Column (Temp., D.O., pH, Sal., Cond.)	1	N/A	Profile	N/A
Turbidity	2 (water column - surface, bottom)	60 ml vial	Full	N/A

Table 3. Summary by station of human-dimension indicators at 12 stations sampled in the Ashtabula Area of Concern (AOC) and 18 stations sampled in the Milwaukee Estuary AOC, August 18 – 25, 2012.

Station	Surface Trash Present (Y/N)	Surface Oil Present (Y/N)	Sediment Oily (Y/N)	Sediment Odor?
A01	N	N	N	N
A02	N	N	N	N
A03	N	N	N	N
A04	N	N	N	N
A05	N	N	N	N
A06	N	N	N	N
A07	Y	N	N	N
A08	N	N	N	N
A09	N	N	N	N
A10	Y	N	N	N
A11	N	N	N	N
A12	N	N	N	N
M01	N	N	N	Y-sewage
M02	N	N	N	N
M03	N	N	N	N
M04	N	N	N	N
M05	N	N	N	N
M06	N	N	N	N
M07	N	N	N	N
M08	N	N	N	N
M09	N	N	N	N
M10	Y	N	N	N
M11	Y	N	Y	N
M12	N	N	N	N
M13	Y	N	N	Y-sewage
M14	Y	N	N	N
M15	Y	N	Y	N
M16	Y	N	N	N
M17	Y	N	N	N
M18	N	N	N	N

Table 4. Ashtabula Area of Concern (AOC) and Milwaukee AOC cruise participants.

Name	Affiliation
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