Victor, Elizabeth A - DNR

From: Killian, James - DNR
Sent: Tuesday, August 14, 2018 3:35 PM
To: Zhang, Xiaochun - DNR; Victor, Elizabeth A - DNR
Subject: FW: Sweet Water Science & Policy Follow-up
Attachments: Scudder Eikenberry_etal_Benthos Toxicity_SETAC 2017_poster- SWWT072018.pdf; Aquatic Organisms and Environmnetal Stressors - Eikenberry -SWWT072018.pdf

Liz and Xiaochun;

Here's some background testing from USGS. Note Kewaunee was part of their testing.

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Sediment Toxicity Assessment in Two Wisconsin Areas of Concern and Selected Lake Michigan Tributaries

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Background

Contaminated sediment is the most common cause for some river and harbor areas around the Great Lakes, Areas of Concern (AOCs), to be deemed environmentally degraded. Because of close contact with contaminated sediment, the Beneficial Use Impairment (BUI) for degraded benthos or bottom-dwelling organisms is one of the most widespread BUIs at the AOCs. In Wisconsin, sediment remediation for PCBs was complete at the Sheboygan River AOC in 2013 and remediation for PCBs and other chemicals is ongoing in the Milwaukee Estuary AOC. We conducted an assessment to provide toxicity data in a regional context and build upon benthos community studies that the USGS completed at the AOCs and two non-AOCs in 2014.

Goal and Objectives

GOAL:

- Provide data on sediment toxicity to benthos to inform decisions by the U.S. Environmental Protection Agency and Wisconsin Department of Natural Resources regarding possible removal of the "Degradation of Benthos" BUI at the Sheboygan River AOC and the Milwaukee Estuary AOC

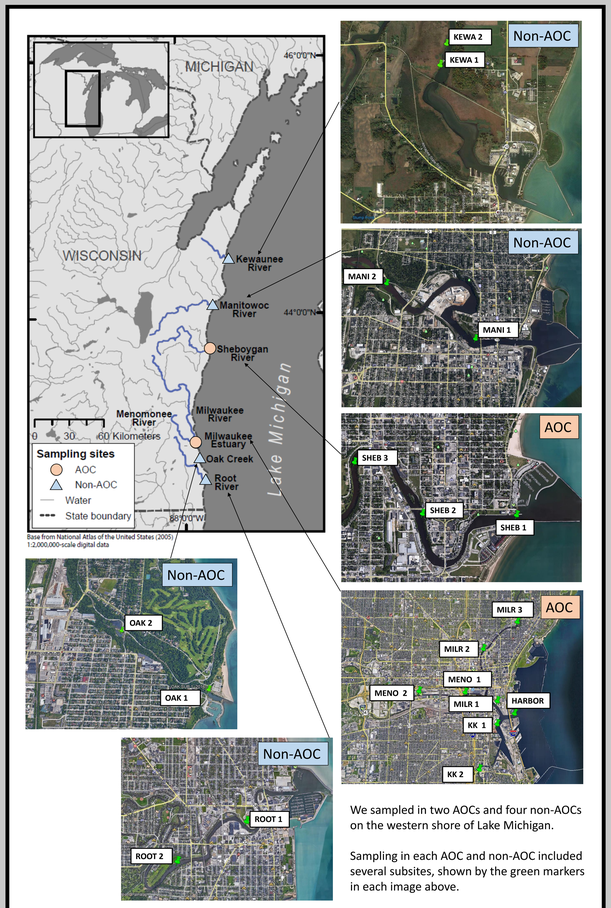
OBJECTIVES:

- Characterize sediment toxicity and relationships between toxicity and contaminant concentrations
- Compare results to previous studies of sediment contamination, toxicity, and benthic communities at the AOCs and at two non-AOC comparison study areas: the Manitowoc River and Root River
- Compare upstream and downstream results in two additional non-AOC study areas: the Kewaunee River and Oak Creek

Approach

In October 2016, we collected bottom sediment from two AOCs along the Lake Michigan shoreline and presumptively less-degraded study areas that are not AOCs (non-AOCs). The two AOCs are the **Sheboygan River AOC** and the **Milwaukee Estuary AOC** (Kinnickinnic River, Menomonee River, Milwaukee River, and Milwaukee Harbor) and the non-AOCs are the Kewaunee River, Manitowoc River, Oak Creek, and Root River. Sites are listed upstream to downstream in each study area.

Sediment collected was used for 1) short-term and long-term sediment toxicity tests with midges and amphipods, 2) chemical tests of ammonia, PCBs, PAHs, and selected metals, and 3) ancillary measures to determine whether these chemicals were present at toxic concentrations. At a subset of sites, we compared toxicity and chemical data with benthos community data that were collected in 2014 as part of an earlier USGS study.



We sampled in two AOCs and four non-AOCs on the western shore of Lake Michigan.

Sampling in each AOC and non-AOC included several subsites, shown by the green markers in each image above.

Field Collection Methods

A sonde was used at each site to collect beginning and ending measurements for:
- Water temperature
- pH
- Dissolved oxygen
- Specific conductance

At each site, a Ponar dredge and winch was used to collect from 3 to 15 sediment grabs that were composited in a clean plastic cooler

A subsample was collected for:
- **Total mercury**

The sample was homogenized. Subsamples were collected for:
- **PCBs and Arochlors**
- **PAHs**
- **Metals - Total and Simultaneously-Extracted (SEM)**
- **Organic carbon and loss-on-ignition**
- **Particle size**

Preliminary Results

STATUS:

All laboratory analyses and data reviews are complete. We are analyzing the results. A final report is in preparation and planned for completion in 2018.

PRELIMINARY RESULTS:

This information is preliminary and is subject to revision. It is being provided to meet the need for timely best science. The information is provided on the condition that neither the U.S. Geological Survey nor the U.S. Government shall be held liable for any damages resulting from the authorized or unauthorized use of the information.

- Midge toxicity showed low severity (1 endpoint) in both AOC and non-AOC samples
- Amphipod toxicity was more severe; restricted to AOC samples
- Trends in sediment contaminants (organics, metals) corresponded to severity of amphipod toxicity

Results are shown for the following AOCs and non-AOC comparison study areas with one or more subsites, listed upstream to downstream:

AOCs:
- Sheboygan River AOC (SHEB)
- Milwaukee Estuary AOC subsites:
  - Kinnickinnic River (KK)
  - Menomonee River (MENO)
  - Milwaukee River (MILR)
  - Milwaukee Harbor (MILH)

Non-AOCs:
- Kewaunee River (KEWA)
- Manitowoc River (MANI)
- Oak Creek (OAK)
- Root River (ROOT)

TOXICITY TESTING:

Summary of toxicity hazards with Probable Effects Quotients (PEQs) from sediments collected from Lake Michigan tributaries and harbors in Wisconsin, October 2016. [--, not detected/computed]

Site #	SITE	TOXICITY TESTS (1)		ORGANIC ANALYSES (2)		METAL ANALYSES (2,3)		SUMMARY SCORE (4)
		Midge	Amphipod	PAH-PEQ	PCB-PEQ	Metals-PEQ	SEM-AVS/foc	
AOC STUDY AREAS								
3	SHEB 3	0	0	0.08	1.0	1.1	-60.1	2
2	SHEB 2	0	0	0.15	1.0	1.4	-32.7	2
1	SHEB 1 (Ref)	0	0	0.08	0.31	0.51	-366.5	0
10	KK 2	0	4	3.1	1.0	1.9	-297.5	8
9	KK 1	0	3	0.98	1.1	4.3	-49.9	7
8	MENO 2	1	5	1.7	0.21	2.7	-268.9	9
7	MENO 1	0	5	2.1	0.35	3.4	-29.7	9
6	MILR 3	1	0	0.73	1.4	0.86	-87.4	2
5	MILR 2	0	1	0.63	0.72	1.8	-70.8	3
4	MILR 1	1	0	1.1	1.1	2.8	-23.7	5
11	HARBOR	0	1	1.1	1.1	2.3	85.4	5
NON-AOC STUDY AREAS								
17	KEWA 2	1	0	0	0.01	1.1	-53.4	2
16	KEWA 1	0	0	0.004	0.01	1.2	--	1
13	MANI 2 (Ref)	0	0	0.04	0.03	0.34	--	0
12	MANI 1	0	0	0.28	0.14	1.6	-101.0	2
19	OAK 2	0	0	0.40	0.05	0.88	--	0
18	OAK 1	0	0	0.68	3.21	2.1	-439.1	6
15	ROOT 2	0	0	0.55	0.03	0.86	-310.9	0
14	ROOT 1	0	0	0.39	0.13	2.0	-124.0	3

(1) Sediment toxicity scores are the numbers of endpoints affected by each sediment, relative to controls and reference sites

(2) Toxicity hazards for total PAH, total PCB, and 6 metals estimated from Probable Effect Quotients (PEQ). PEQs for chemicals were computed by dividing the dry weight sediment concentration of each chemical by its respective consensus-based Probable Effect Concentration (PEC; MacDonald *et al.*, 2000, Arch. Environm. Contam. Toxicol. 39: 20-31)

(3) Metal bioavailability scores based on sediment quality benchmarks based on Simultaneously-Extracted Metals (SEM) normalized by Acid-Volatile Sulfide (AVS) and the fraction of organic carbon in the sediment ([SEM-AVS]/foc; USEPA, 2005)

(4) Summary scores (sums of scores for toxicity, organics, and metals) were used to categorize sediment quality at each site

Component score	Ranges of component values			Summary scores	Sediment quality group
	Toxicity	Sum-PEQ	SEM-AVS/foc		
0	0	<1.0	<0.0	0 - 1	Reference
1	1	1.0 - 1.5	0.0 - 130	2 - 4	Low hazard
2	2	1.5 - 2.0	130 - 3000	4 - 6	Intermediate hazard
3	3+	>2.0	>3000	7+	High hazard

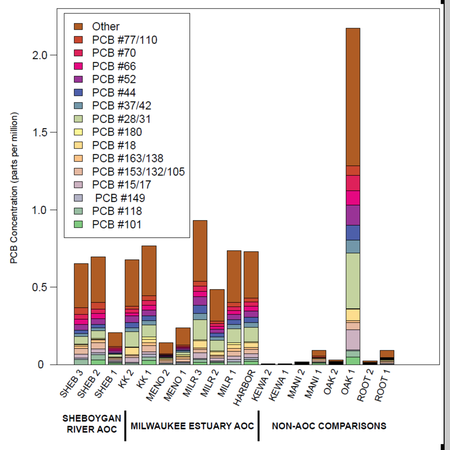
Preliminary Results (continued)

CHEMICAL CONCENTRATIONS IN SEDIMENT:

PCBs:

Most subsites in the Sheboygan River AOC and Milwaukee Estuary AOC had >10x higher total PCBs than all non-AOCs, except for the non-AOC OAK 1 (Oak Creek downstream at mouth on Lake Michigan).

PCB concentrations at AOCs were below 1 ppm but concentrations were above 2 ppm at OAK 1.

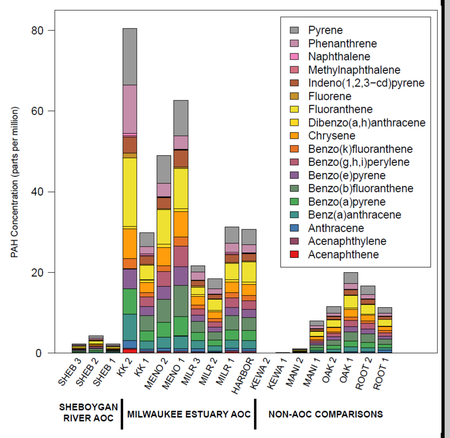


PAHs:

The highest PAH concentrations were found at subsites in the Milwaukee Estuary AOC at KK 2 (Kinnickinnic River) and at MENO 2 (Menomonee River upstream).

Lowest PAH concentrations were found in the Sheboygan River AOC at SHEB 1 (downstream at mouth) and at two non-AOCs, KEWA 1 and KEWA 2 (Kewaunee River) and MANI 2 (Manitowoc River upstream).

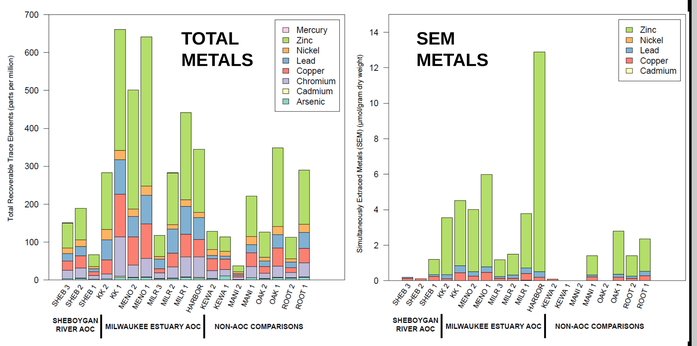
Analyses are in progress to determine source categories of PAHs.



METALS:

Although the highest concentrations of total metals were found at KK 1 (Kinnickinnic River downstream) and MENO 1 (Menomonee River downstream), SEM and not total metals are more reflective of concentrations bioavailable to the benthos.

The highest overall concentrations of simultaneously-extracted metals (SEM) were found in the Milwaukee Estuary AOC, especially at the Milwaukee Harbor (HARBOR) because of high zinc concentrations.



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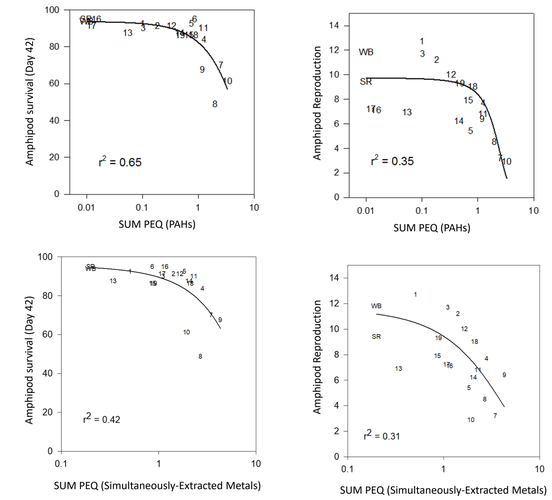
Preliminary Results (continued)

AMPHIPOD TOXICITY AND SEDIMENT CHEMISTRY:

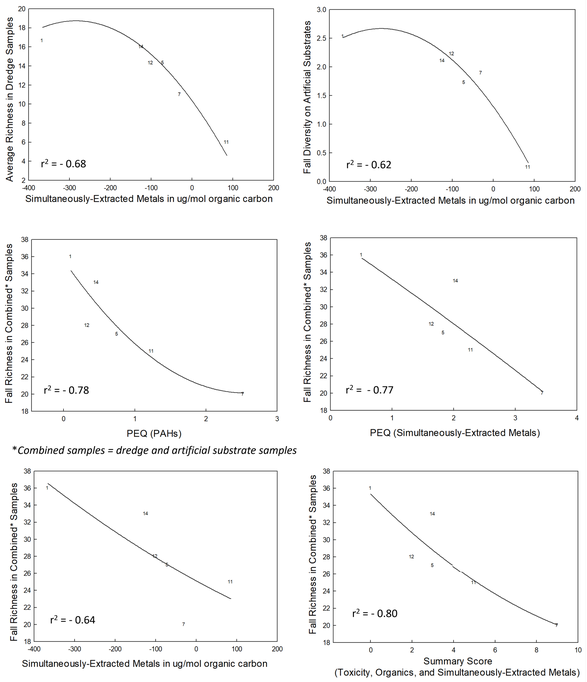
Amphipod survival and reproduction endpoints had strong associations with concentrations of total PAHs and simultaneously-extracted metals in sediments (site numbers* shown).



** WB and SR are reference sediments for comparison*

BENTHOS, TOXICITY, AND CHEMISTRY:

Biological metrics for benthos sampled in 2014 correlated with metrics for toxicity and chemistry of sediment collected in 2016 (site numbers shown).



**Combined samples = dredge and artificial substrate samples*

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Acknowledgments

This study was done in cooperation with the Wisconsin Department of Natural Resources, with Great Lakes Restoration Initiative funding through the Great Lakes National Program Office of the U.S. Environmental Protection Agency. Marsha Burzynski, Cheryl Bougie, Stacy Hron, James Killian, and Victor Pappas of the WDNR assisted with site selection.

Preliminary results – Not for public release

USGS Studies of Aquatic Organisms and Environmental Stressors in the Milwaukee Area

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PRESENTED JULY 25, 2018

SWEETWATER SCIENCE & POLICY ADVISORY COMMITTEE MEETING

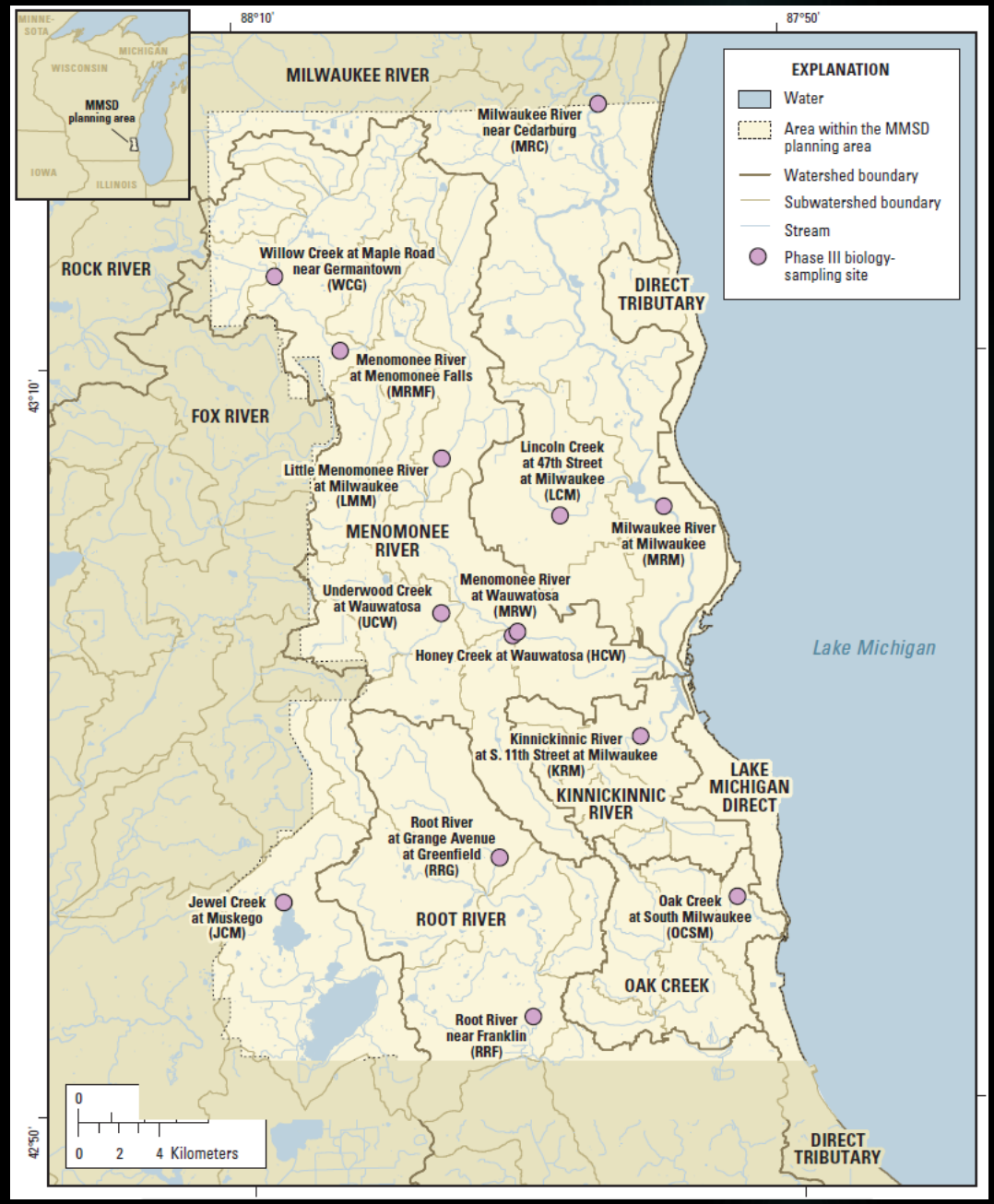
MILWAUKEE, WI

USGS

Ecological Assessments in the MMSD Area

Objectives:

- Assess the ecological status of aquatic communities at long term sites in the MMSD service area
- Evaluate relations to physical and chemical stressors
- Compare across years



Eco sites in MMSD Planning Area

2004 to present

USGS

Approach

Community & habitat sampled every 3 years (2004, 2007, 2010, 2013, 2016 …)

- Biological
  - Aquatic community data (benthic/attached algae and invertebrates, and fish)
- Physical
  - Stream habitat
  - Land Use/Land Cover
  - Stream flow (from gages)
- Chemical
  - Dissolved oxygen (DO)
  - Contaminants (bioavailable synthetic organic compounds using passive samplers)
  - Nutrients (chlorophyll-a and biomass of attached algae as surrogates)
  - Other water chemistry at selected sites (USGS and MMSD)

Methods

Algae with a cylinder scrape

Invertebrates with a Surber kick net

Habitat at transects

Reach length ~ 150 meters (smaller streams)
~ 300 meters (larger streams)

Fish with a backpack

Fish with a towed barge

Next steps – Ecological Assessments

- A report is in preparation that describes the results of our 2004-2013 assessments.
- Examine data from our 2016 ecological assessment
  - Algal, invertebrate, and fish communities
- Examine physical and chemical data from 2016 in relation to aquatic communities
  - Physical
    - Stream habitat and Land Use/Land Cover
    - Stream flow
  - Chemical
    - Dissolved oxygen
    - Synthetic organic contaminants measured by passive samplers at all sites
    - Nutrients (chlorophyll-a and algal biomass surrogates)
    - Other water chemistry at selected sites (USGS and MMSD)
- Plan for our 2019 ecological assessment

Acknowledgements

Funding provided through a cooperative agreement with Milwaukee Metropolitan Sewerage District (MMSD)

- MMSD
  - Chris & Matt Magruder
  - Beth Sauer
- USGS
  - Dan Sullivan, Michelle Lutz, Amanda Bell, Faith Fitzpatrick, Dave Alvarez, Jana Stewart, Hayley Olds, Dan Burns, Troy Rutter, Steve Corsi, and many others

USGS

Benthos Toxicity at Wisconsin's Lake Michigan Areas of Concern

Goal:

- To provide data on potential sediment toxicity to benthos (benthic invertebrates) and inform the US EPA and Wisconsin DNR regarding the "Degradation of Benthos" Beneficial Use Impairment at two Great Lakes Areas of Concern (AOCs)

Objectives:

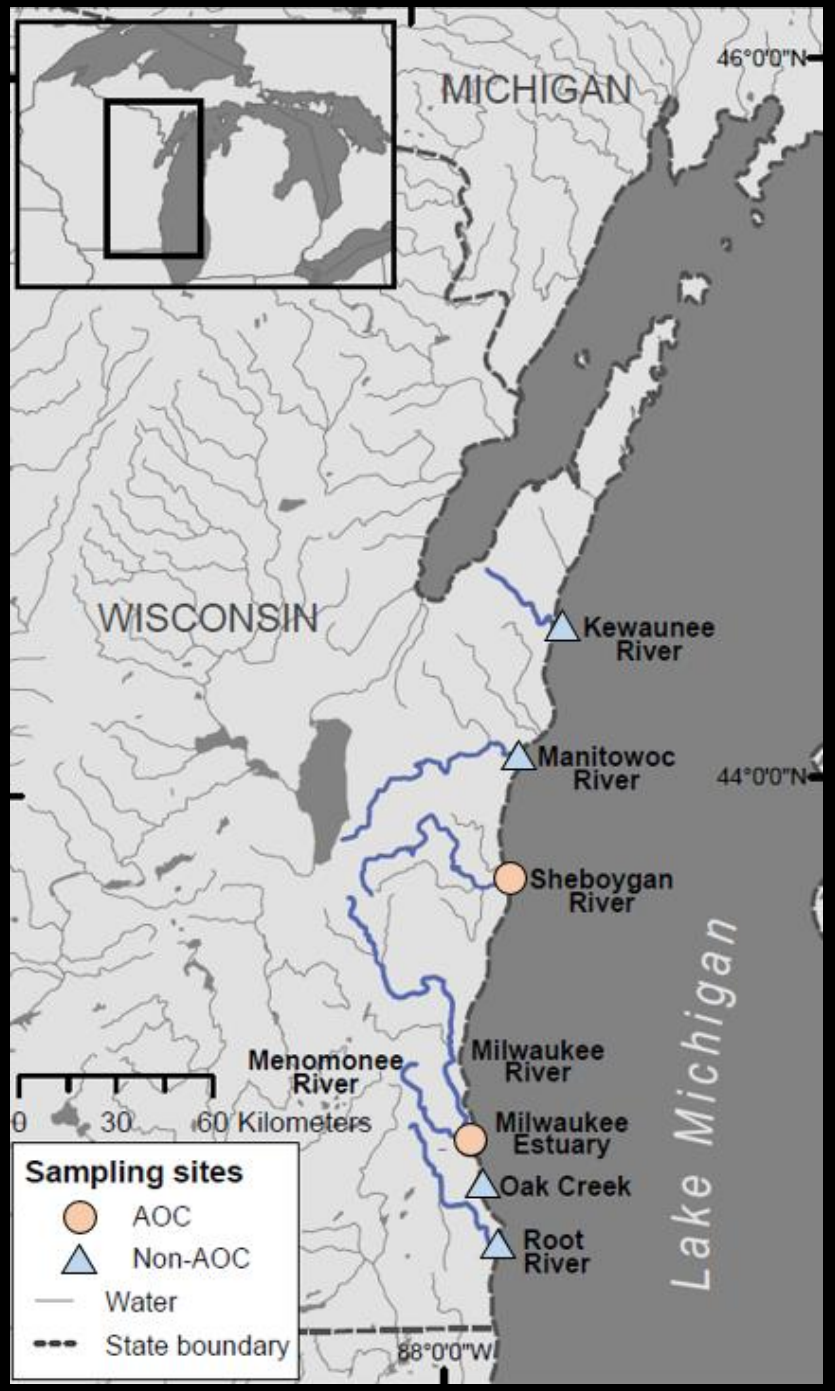
- Characterize sediment toxicity and chemical concentrations at the two AOCs and at several non-AOC comparison sites
- Compare results to benthic community data at a subset of sites

USGS

Sampling Sites

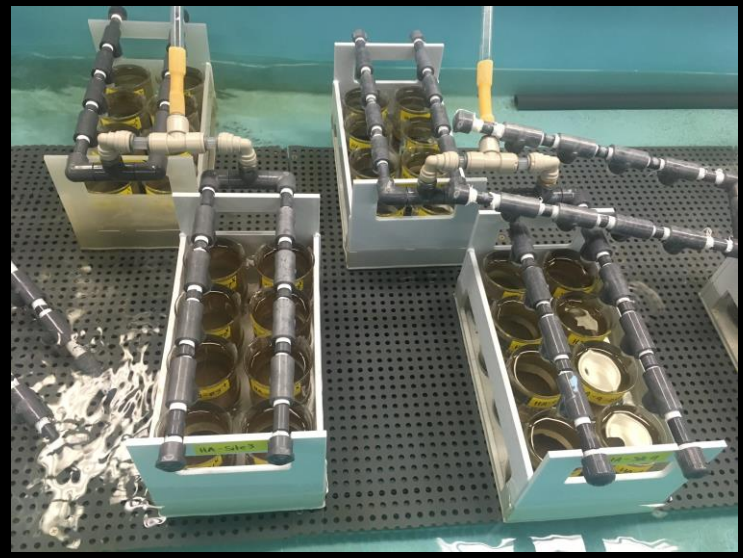
- AOC sites
  - Sheboygan River (SHEB)
  - Milwaukee Estuary
    - Milwaukee River (MILR)
    - Menomonee River (MENO)
    - Kinnickinnic River (KK)
    - Milwaukee Harbor (HARBOR)

- ▲Non-AOC sites
  - Kewaunee River (KEWA)
  - Manitowoc River (MANI)
  - Oak Creek (OAK)
  - Root River (ROOT)



Methods

- Sediment collection with dredge; subsamples removed for tests
- Chemical testing
  - PCBs and Arochlors
  - PAHs
  - Metals (Total and Simultaneously-extracted [SEM])
  - Ancillary (AVS, carbon, particle size)
- Toxicity Testing
  - 10-day midge test with *Chironomus dilutus*
  - 28-day and 42-day amphipod test with *Hyalella azteca (+UV exposure)*



USGS

Next steps

- Further evaluate relations between toxicity, chemical concentrations, benthic community, and ancillary data
- Examine land use/land cover relations to chemicals
- Assess potential endpoints for amphipods and chemicals
- Examine diagnostic ratios and proportional concentrations of PAHs for estimation of potential source types
- Final report planned for Fall 2018

Acknowledgments

This study was done in cooperation with the Wisconsin Department of Natural Resources (WDNR), with Great Lakes Restoration Initiative funding through US EPA

Marsha Burzynski, Cheryl Bougie, Stacy Hron, James Killian, and Victor Pappas of the WDNR assisted with site selection

Dan Burns, Hayley Olds, and Kas Mapel of the USGS assisted with sampling

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