Muskegon Research and Restoration Connectivity Workshop

Summary Report

November 13, 2014
Grand Valley State University Annis Water Resources Institute
Muskegon, MI

Photo Credit: Marge Beaver, www.photography-plus.com

Grand Valley State University
Robert B. Annis Water Resources Institute

NOAA
National Oceanic and Atmospheric Administration
U.S. Department of Commerce

WMSRDC
West Michigan Shoreline Regional Development Commission

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Executive Summary

The Lake Michigan-Muskegon Lake Connectivity workshops are a series of three workshops designed to develop a collaborative and coordinated long-term research program that links the watershed, Muskegon River, Muskegon Lake, and nearshore/offshore Lake Michigan (MUSkegon Interconnected eCosystem, MUSIC). Emphasis is on an integrated and interdisciplinary approach that includes hydrodynamics and hydrology, chemistry, biology and ecology, and socioeconomics across the MUSIC. The workshops are designed to bring together researchers, resource managers, and stakeholders to construct a framework with an overall goal to understand and predict the role of environmental stressors on ecosystem services, human health, and societal needs.

This summary focuses on Workshop II, which brought together resource managers, restoration specialists, and stakeholders from across the MUSIC. Workshop II was designed to ensure that the long-term research program engages diverse stakeholders and is responsive to the needs and priorities of those working on the ground in the MUSIC in habitat restoration and resource management.

Workshop II was held on November 13, 2014 at Grand Valley State University's Annis Water Resources Institute (AWRI) in Muskegon, MI. The workshop was organized and convened by AWRI, the NOAA Great Lakes Environmental Research Laboratory (GLERL), and the West Michigan Shoreline Regional Development Commission (WMSRDC). Representatives from federal, state, and local resource management and restoration organizations presented information on their unique management and restoration priorities and the research that guides management decisions and project design. These presentations were followed by an open discussion on what research is needed to advance management and restoration priorities in the MUSIC. Further discussions evaluated the state of communications between researchers, resource managers, and restoration specialists in the MUSIC in order to identify barriers to communication, exchange information on priority projects, and discuss options for future improvements in face-to-face and virtual communication pathways. There was also a presentation summarizing results from a pre-workshop survey of both researchers and management/restoration specialists working in the MUSIC.

Overall, workshop participants felt that the priorities of researchers, restoration specialists, and resource managers working in the MUSIC are well matched but that there is a need for improved communication between these groups. A number of potential actions were proposed. However, addressing barriers to communication in a manner that uses resources and time efficiently and avoids redundancy continues to present a major challenge. Particularly in the case of the proposed three dimensional hydrodynamic model for the MUSIC there needs to be an effort on the part of both researchers and management/restoration specialists to engage in two-way communication as a means of ensuring that 1) the model's design and outputs are relevant to habitat restoration and resource management efforts; and 2) stakeholders understand the inherent value of the model.

Workshop Notes

Dates: November 13, 2014 (10:00am-4:00pm)
Meeting Place: GVSU Annis Water Resources Institute
Presenters: MDEQ, MDNR, Muskegon Conservation District, Muskegon County Drain Commission, Muskegon River Watershed Assembly, NOAA, National Wildlife Federation, USGS, WMSRDC.
Other Participants: AWRI, FTCH, Muskegon County Commission, Muskegon Environmental Research and Education Society, Progressive AE, Michigan Sea Grant.
Purpose: To better connect long-term science and research activities in the Muskegon watershed (Muskegon River, Muskegon Lake, and nearshore Lake Michigan) to resource management and restoration efforts.
Goals: 1) Communicate to resource managers and stakeholders the objectives and opportunities presented by Habitat Blueprint and the Science Collaborative.
2) Understand from the perspective of resource managers and local project leads what are the priority research gaps impacting their efforts in Muskegon.
3) Solicit big picture suggestions for ensuring that the long-term science vision for Muskegon is responsive to the needs of resource managers.

Welcome (10:30-10:45)

- Welcome from Al and Katy
- Science Collaborative- Summary of the broad goals and objectives of the workshop series and the results from Workshop I. Al Steinman (AWRI)
- Habitat Blueprint – How does Habitat Blueprint relate to the Science Collaborative? Katy Hintzen (NOAA)

Summary: *The intention of this workshop series is to design a collaborative and coordinated long-term research program across the MUSIC. Workshop I brought together scientists working across the MUSIC to discuss key research priorities in the area. This second workshop focuses on bringing together resource managers and restoration specialists working in the MUSIC in order to determine how the research gaps identified during Workshop I match up with their priorities and needs. Habitat Blueprint is a separate initiative from the Science Collaborative, designed to create a strategic plan to guide NOAA research, restoration, and outreach activities in the Muskegon area over the next five years. The outcomes of the Science Collaborative and these workshops will inform the research section of the Habitat Blueprint Implementation Plan.*

State and Federal Resource Management Priorities (10:45 to 11:30)

[See *Appendix: A* for complete slide decks from individual presentations]

Questions: All presenters in this section were asked to focus their presentation on two core questions:

1) What are your agency's resource management priorities for Muskegon Lake and Muskegon River?

2) What research information guides the development of those management priorities?

Presenters included:

- Joes Duris (USGS)
- Matt Preisser (MDEQ Office of the Great Lakes)
- Jory Jonas (MDNR Fisheries)

Summary of Presentations: *Often management priorities and plans at the larger geographic scale can have significant impacts at the regional and local level. For example MI LAMP priorities, CSMI field year, and Governor Snyder's push for a state wide water strategy have important implications for the MUSIC. We need to be aware of these priorities and align our efforts with them when appropriate.*

Local Restoration Priorities (11:30-12:30)

[See *Appendix: A* for complete slide decks from individual presentations]

Questions: All presenters in this section were asked to focus their presentations on two core questions:

1) What are the local restoration priorities for Muskegon Lake and Muskegon River?
2) What research information and management priorities guide the development of projects?

Presenters included:

- Kathy Evans (West Michigan Shoreline Regional Development Commission)
- Gary Noble (Muskegon River Watershed Assembly)
- Jeff Auch (Muskegon Conservation District)
- Brenda Moore (Muskegon County Drain Commissioner)
- Mike Murray (National Wildlife Federation)

Summary of Presentations: *Building robust science into proposals can help increase a project's appeal to funders. Strong science is essential to targeting and prioritizing projects. Management/restoration specialists need to know where to focus their efforts to maximize impact. Comprehensive long-term monitoring beyond the requirements of specific projects is a continual struggle. Often management/restoration specialists are relying on local or state management documents as compilations of concise and relevant science (e.g. 319 management plan, FWS step-down management plans, LAMPs, and Muskegon Futures). "One stop shopping" sources of information are extremely useful. For example, one pagers that contain all the key technical and science information on targeted issues help management/restoration specialists plan and evaluate projects.*

LUNCH BREAK

Results from Pre-Workshop Survey (1:15-1:30)

[See *Appendix: B* for a Summary Report of Survey Results]

- Katy Hintzen (NOAA)

Summary of Presentation: *A total of 29 scientists, resource managers, and restoration specialists working in the MUSIC were asked a series of questions in an online survey. The survey was designed to assess the state of communications between researchers and management/restoration specialists and help us better understand how research priorities identified during Workshop I match up with the needs of those working on the ground in management and restoration. Survey results showed a great deal of overlap between the priorities of management/restoration specialists and researchers. However, some significant barriers to communication remain. The research gap identified most consistently by management/restoration specialists, which most urgently needs to be filled to address a number of environmental challenges in the MUSIC, was the need for an integrated watershed wide monitoring program. Researchers focused on the need for a hydrodynamic model that links the Muskegon River, Muskegon Lake, and Lake Michigan.*

Open Discussion (1:15pm -2:30pm)

Questions: Discussions were guided by three core questions.

1) Reflecting on the information presented today, to what extent do you feel research priorities in Muskegon are in line with restoration and management priorities?
2) What additional research information or tools would improve the success of advancing management and restoration priorities in Muskegon?
3) What steps should be taken to improve collaboration and communication between researchers, resource managers, and project leads working in the MUSIC?

Summary of Discussion: *At the end of Workshop I there was a consensus that a major research priority for the MUSIC is a three dimensional hydrodynamic model linking Muskegon River, Muskegon Lake, and Lake Michigan. However, a majority of those working on the ground in resource management and restoration don't know what a hydrodynamic model is or how the outputs of such a model would benefit their work. The MUSIC, like all drowned river mouth systems, is highly complex and there is a lot we still don't understand about how chemicals, sediments, and other materials move through the system. A three dimensional hydrodynamic model would have outcomes that help us understand important management issues such as fish movement and production, harmful algal blooms, and hypoxia.*

From the results of the pre-workshop survey it doesn't appear that there is a large gap between research priorities and management/restoration priorities. The challenge is increasing communication between these groups. Often it is difficult to keep track of who is working on what and opportunities for collaboration go unnoticed. We need to find ways to encourage more interaction between researchers, resource managers, and restoration specialists both formally and informally (speaker series, seminars, social gatherings, etc.)

There are a lot of efforts ongoing to create large databases or clearinghouses of information. These tend to be very time intensive and we don't want to duplicate efforts. There may be an opportunity for a more interactive platform based on what users themselves add (e.g. Facebook or Wiki). Another option would be a one pager compiling resources already available.

Considering the upstream threats to water quality is important as well. Outreach and education is another key part of the puzzle.

End of Workshop Observations

1. Overall it appears that the priorities of researchers, restoration specialists, and resource managers working in the MUSIC are well matched.
2. There is a need for more communication between researchers and management/restoration specialists. On the restoration and management end, projects backed by sound science are more effective and attractive to funders. On the research end, projects that include two-way communication with end-users will have a greater impact and take advantage of the wealth of information held by local stakeholders.
3. Often it is difficult to keep track of who is working on what projects and opportunities for collaboration go unnoticed. We need to encourage more interaction between researchers, resource managers, and restoration specialists both formal and informal (online platforms, speaker series, seminars, social gatherings, etc.).
4. How can we address barriers to communication in a way that uses resources and time efficiently and avoids redundancy?
5. Many management/restoration specialists get their information from management documents that compile several science resources. Is this the best method for communicating science? One pagers that provide a range of information on specific relevant topics would be useful (e.g. sediment loading or woody fish habitat).
6. A lot of the restoration priorities are focused on AOC delisting. What happens beyond delisting and how can a long-term science plan anticipate future needs?
7. Many stakeholders don't know what a hydrodynamic model is. There is a need to communicate clearly what outputs would come from a hydrodynamic model and how they would benefit on the ground management and restoration work in the MUSIC.
8. Education and outreach are another key part of the picture.
9. Habitat Blueprint is an opportunity to bring together research, education/outreach, and restoration in one strategic plan. The focus will be primarily on NOAA activities but the outcomes from these workshops will help inform the research elements of the plan.

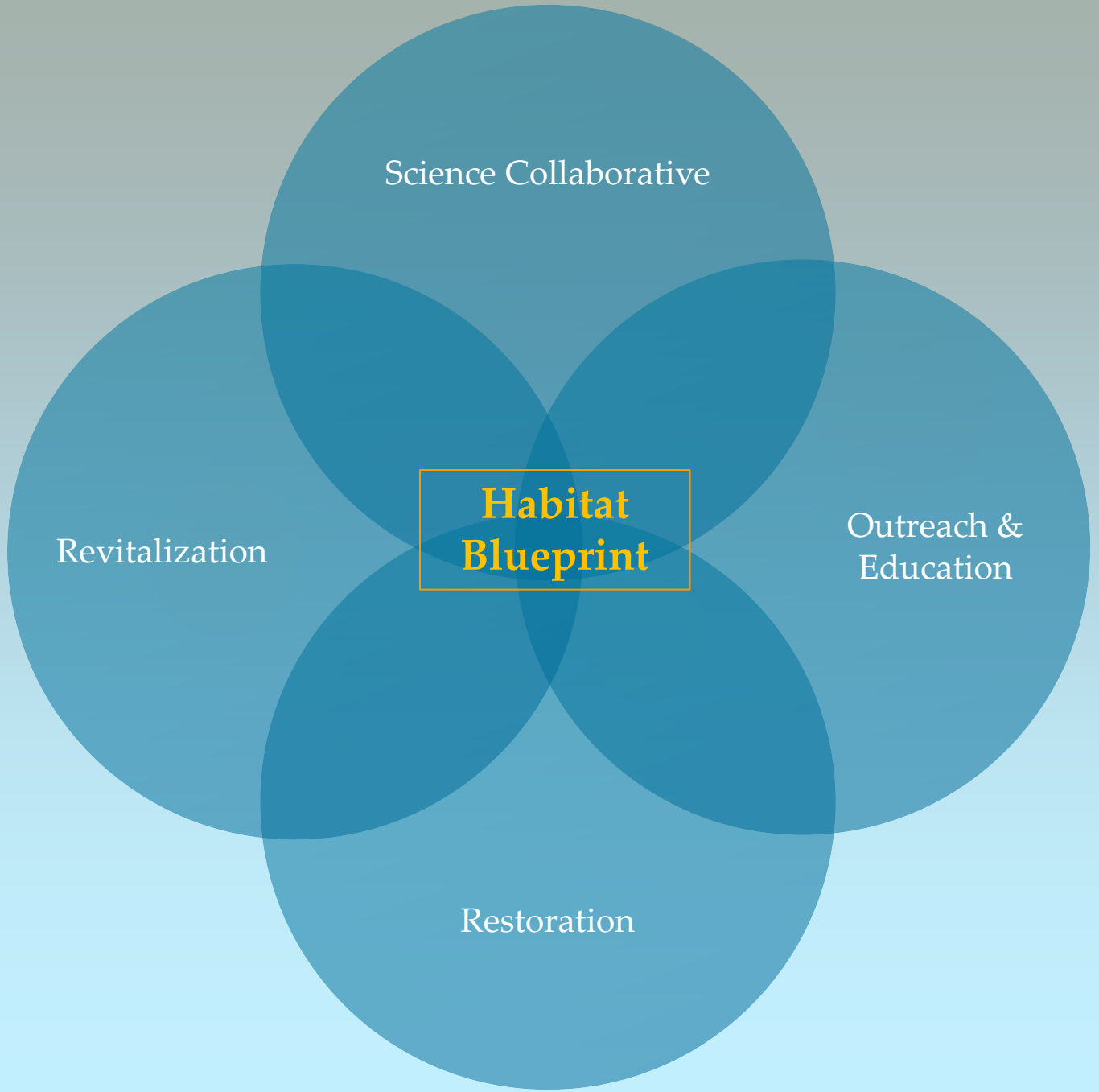
Next Steps

1. We will integrate the comments and ideas from this workshop into the final version of the long-term research plan.
2. We will hold a future workshop focused on the hydrodynamic model: what it is and how outcomes will be useful to local stakeholders.
3. We will have a final workshop to bring in last comments and formalize the ideas coming out of the entire workshop series.
4. AWRI and GLERL will continue to work on a strategic plan for research in the MUSIC and will establish a formal institutionalized partnership to better facilitate collaboration.

Participant List

First Name	Last Name	Affiliation
Kyle	Kruger	MDNR Fisheries Division
Jeff	Auch	Muskegon Conservation District
Ron	Brown	Muskegon Environmental Research & Education Society
Dennis	Donahue	NOAA LMFS
Joe	Duris	USGS
Kathy	Evans	West Michigan Shoreline Regional Development Commission
Rachael	Franks Taylor	NOAA
Paul	Hausler	Progressive AE
Terry	Heatlie	NOAA
Katy	Hintzen	NOAA
Jory	Jonas	MDNR Fisheries Division
Felix	Martinez	NOAA
Doran	Mason	NOAA
Brenda	Moore	Muskegon County Drain Commission
Greg	Mund	Muskegon River Watershed Assembly
Michael	Murray	National Wildlife Federation
Gary	Noble	Muskegon River Watershed Assembly
Matt	Preisser	MDEQ
Catherine	Riseng	Michigan Sea Grant
Ed	Rutherford	NOAA
Terry	Sabo	Muskegon County Commission
Claire	Schwartz	FTCH
Greg	Scott	Progressive AE
Al	Steinman	AWRI

Appendix A: Presentations


Science Collaborative
Revitalization
Habitat Blueprint
Outreach & Education
Restoration

Muskegon Research and Restoration Connectivity Workshop

Matt Preisser
Lake Michigan Lake Coordinator
Michigan Office of the Great Lakes
November 13, 2014

Department of Environmental Quality
PURE MICHIGAN

MICHIGAN OFFICE OF THE GREAT LAKES

Michigan Office of the Great Lakes

Michigan's *Office of the Great Lakes* assists with policy development and implements programs to protect, restore and sustain our most precious natural resource.

OGL's mission is to ensure a healthy environment, strong economy, and a remarkable quality of life with respect to our Great Lakes.

Michigan Office of the Great Lakes

Areas of Concern Program

State-wide Roles

- In Michigan, there are 12 Areas of Concern, all identified under the 1987 amendments to the1978 Great Lakes Water Quality Agreement (White Lake and Deer Lake AOCs recently delisted)
- State program staff work with federal agencies, local organizations, and others to define local environmental problems & their causes, implement remedial measures, and restore beneficial uses.
- Muskegon Lake AOC:
  - Restrictions on F& W consumption – removed ✓
  - Restrictions on DW consumption – removed ✓
  - Restrictions on dredging – removed ✓
  - Beach closings – in progress ✓
  - Eutrophication or undesirable algae
  - Degradation of F&W populations
  - Degradation of aesthetics
  - Degradation of benthos
  - Loss of F&W habitat

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Michigan Office of the Great Lakes

Areas of Concern Program

Muskegon Lake/River Management Priorities

- Removal of remaining 5 BUIs:
  - Reducing nutrients in Bear Lake
  - Clean-up and restoration of the Zephyr site
  - Assessing feasibility of restoration of Ryerson Creek

Research Needed

- Improve understanding of nutrient sources & cycling within Bear Lake
- Assessing effects of historic paper mill (Sappi)

Program Contact

- Sharon Baker, BAKERS9@michigan.gov, 517- 284-5044

MICHIGAN OFFICE OF THE GREAT LAKES

Michigan Office of the Great Lakes

Coastal Zone Management Program

State-wide Roles

- The CZM Program promotes wise management of the cultural and natural resources of Michigan's Great Lakes coast. It supports healthy and productive coastal ecosystems, and vibrant and sustainable coastal communities.

MICHIGAN OFFICE OF THE GREAT LAKES

Michigan Office of the Great Lakes

Coastal Zone Management Program

Central Program Goals
- Improved administration of state shoreline statutes
- Technical and financial assistance to local partners
- Improving governmental decision-making and coordination

Focus areas
- Public access
- Coastal habitat
- Coastal hazards
- Coastal water quality
- Coastal community development

Program Contact
- Ronda Wuycheck, WUYCHECKR@michigan.gov, 517-284-5040

MICHIGAN OFFICE OF THE GREAT LAKES

Michigan Office of the Great Lakes

Great Lakes Coordination Program

State-wide Roles

- State of Michigan representation to the Lakewide Action and Management Plan (LAMP) Partnerships for Lakes Erie, Huron, Michigan and Superior.

- Great Lakes Water Quality Agreement Annex subcommittees and task teams
- Special Projects
- Coordination & Communication – within state agencies & with external Michigan-based partners (*partnerships/networks*)

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Michigan Office of the Great Lakes

Great Lakes Coordination Program

Muskegon Lake/River Management Priorities

- Near-term Lake Michigan LAMP priorities (per GLWQA):
  - 2015: implement species/habitat protection initiatives; intensive monitoring field year (CSMI); AIS early detection
  - 2016: establish Nearshore Framework & Lake Ecosystem Objectives (LEOs)
  - 2018: Nutrients commitments
  - 2019: LAMP report

Research Needed

- Food web dynamics, including impacts of invasives
- Understanding offshore-nearshore-coastal relationships
- Climate change: monitoring, adaptation
- Assessment & attainment of LEOs

Program Contact

- Matt Preisser, preisserm@michigan.gov, 517-284-5039

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Michigan Office of the Great Lakes

Other OGL Priorities

State-Wide Michigan Water Strategy

- Positive outcomes in many areas including:
  - Healthy Systems
  - Systems Management
  - Economies, Communities and People
  - Policies

Muskegon-Area Priorities

- Harmonization of Various Science/Social/Economic Plans – e.g., habitat restoration, port initiative, broader economic development plans

Program Contact

- Emily Finnell, FinnellE@michigan.gov , 517-284-5036

MICHIGAN OFFICE OF THE GREAT LAKES

Other Michigan DEQ Divisions

Water Resources Division,
Surface Water Assessment Section, Lake Michigan Unit

State-wide Role(s)

- Assess the status and condition of surface waters of the state and determine whether water quality standards are being met
- Write Total Maximum Daily Load (TMDL) documents for water bodies not meeting water quality standards
- Measure spatial and temporal water quality trends
- Identify causes and sources of water quality problems
- Evaluate the effectiveness of water quality prevention and protection programs

MICHIGAN OFFICE OF THE GREAT LAKES

Other Michigan DEQ Divisions

Water Resources Division,
Surface Water Assessment Section, Lake Michigan Unit

Muskegon Lake/River Management Priorities

- Assure designated uses are being met in the Muskegon watershed
- Identify causes and sources of water quality problems
- Identify new and emerging water quality problems

Research Needed

- Identify nonpoint source discharges impacting water quality
- Detect aquatic invasive species and their impacts on the watershed

Muskegon River Watershed Contact

- Marcy Knoll Wilmes, Knollm@michigan.gov, (517) 284-5544

MICHIGAN OFFICE OF THE GREAT LAKES

Thank you!

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http://www.michigan.gov/deqogl

DNR Fisheries Division Muskegon Lake Priorities

Muskegon Lake Connectivity Workshop

Ann Arbor, MI

November 13

Jory Jonas

Research Biologist

MI DNR Fisheries Staff

Field

Muskegon State Game Area

- Rich O'Neal (Field Biologist)

Cadillac Office

- Scott Heintzelman (Unit Manager)

Research

Charlevoix Research Station

Station Manager:

– Dave Clapp

Biologists:

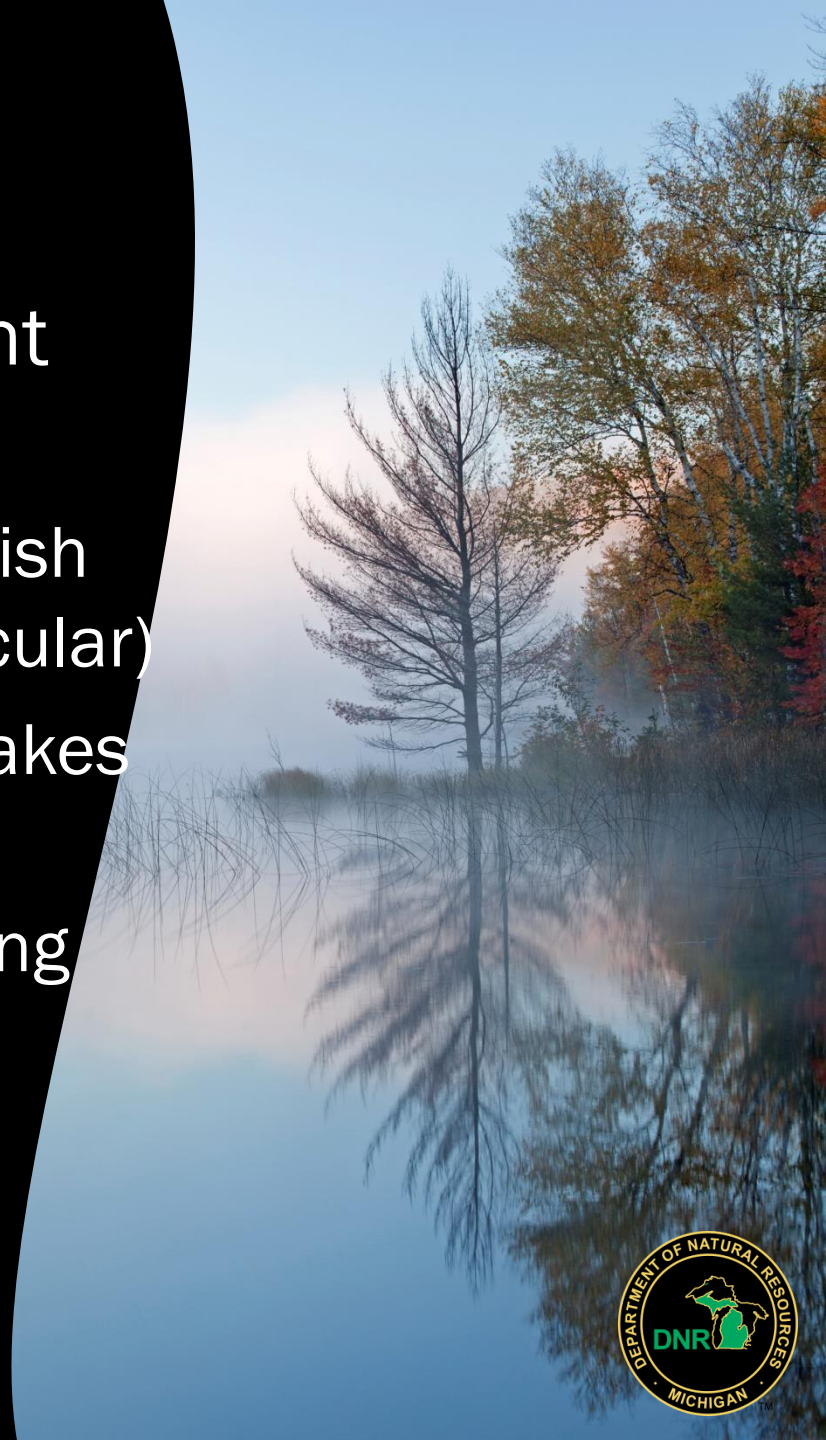
– Jory Jonas

– Randy Claramunt

Fish/Biological

Muskegon River Management Plan

- Early life stage monitoring/fish production (walleye in particular)
- Lake sturgeon, and Great Lakes Musky restoration
- Lower trophic level monitoring and assessment
- Exotic and invasive species prevention, monitoring, and assessment



Environmental/Water Quality/Habitat

- Aquatic habitat mapping
- Reconnect fragmented habitats
- Assess impacts of hydro dams
- Near shore

Societal

- Communication and collaboration among all pertinent stakeholders
- Socio-economic value of aquatic resources
- Stakeholder expectations

Areas of Concern

- Focus on opportunities and potential of Muskegon Lake
- Socio-economic benefits of delisting

Thank You!

Questions?

WMSRDC
WEST MICHIGAN SHORELINE
REGIONAL DEVELOPMENT COMMISSION

MLWP
Muskegon Lake
Watershed Partnership

Kathy Evans, Environmental Program Manager
West Michigan Shoreline Regional Development Commission
316 Morris Street, Suite 340
Terrace Plaza Building, 3rd Floor
Muskegon, Michigan 49440
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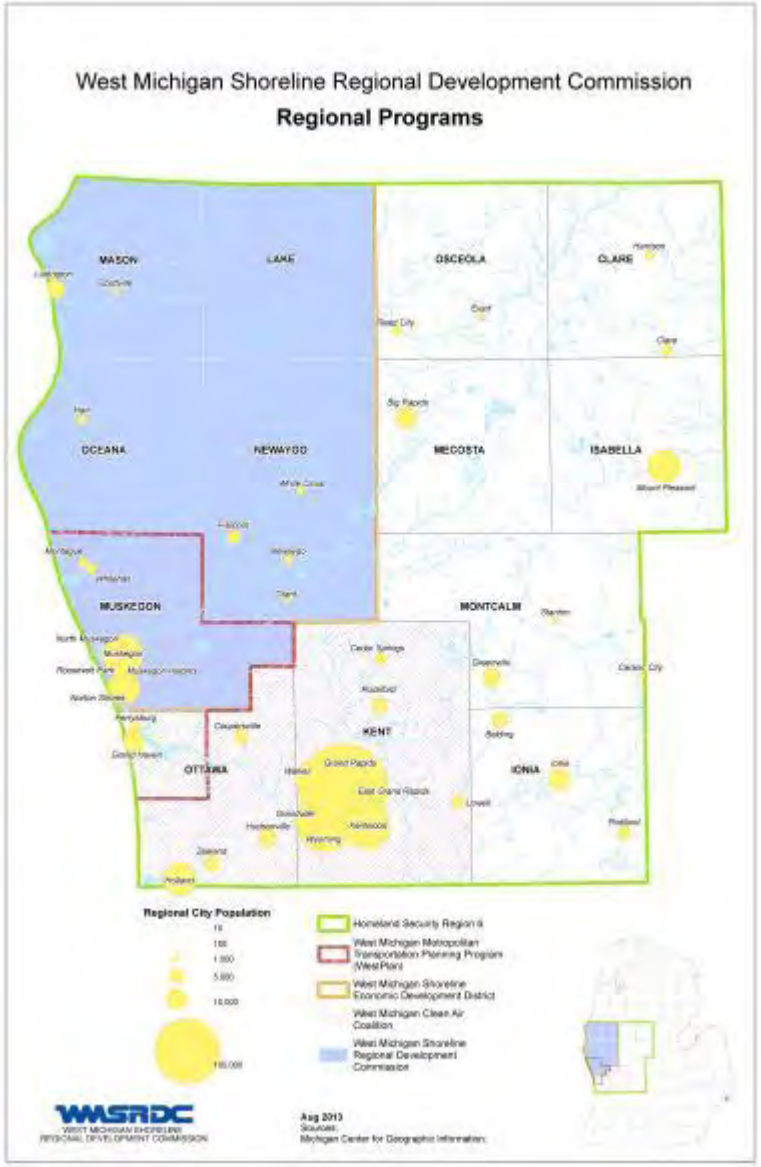
What is WMSRDC?

- WMSRDC is a Regional Planning Organization, located in Muskegon Michigan, serving the West Michigan Region.
- WMSRDC operates under enabling legislation, Michigan PA 281 and PA 46.
- WMSRDC is a federally designated Economic Development, Transportation Planning and Area-wide Water Quality Planning Agency.
- WMSRDC is home to the Muskegon and Ottawa Metropolitan Transportation Planning Program and to a Regional Rural Transportation Planning Program.
- WMSRDC is home to a 13-County Homeland Security Program serving West and West-Central Michigan.



WMSRDC Environmental Program

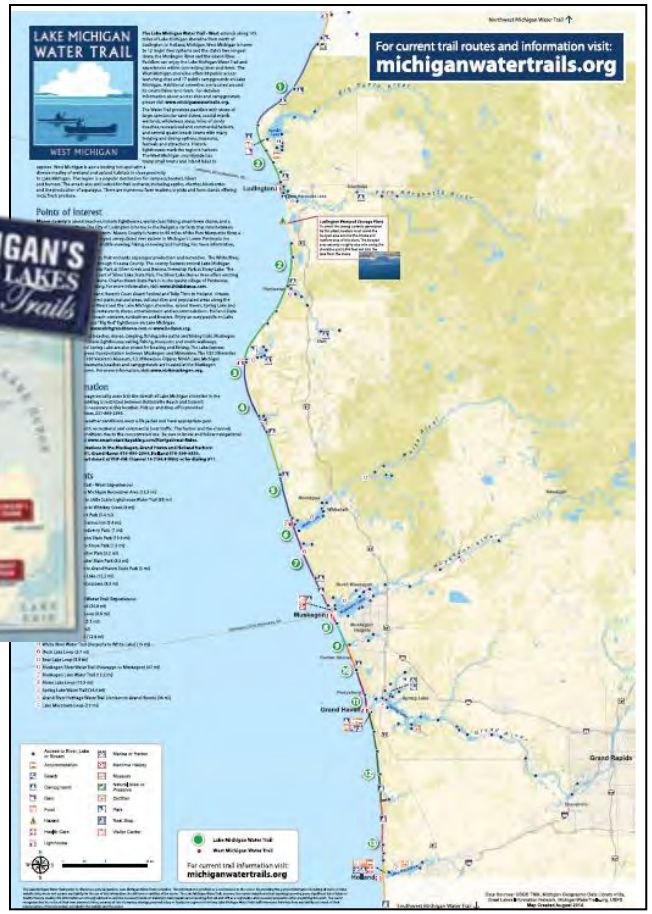
Recent Project Examples

- Lake Michigan Water Trail Plan (includes West Michigan Coastal Water Trails Plan)
- West Michigan Blueways & Greenways Plan
- Community Engagement for Contamination Cleanups in Great Lakes Areas of Concern
- Fish and Wildlife Habitat Restoration & Non-Native Invasive Plant Management
- Collaborative Planning with Local Governments & Watershed Groups (prioritize needs, maximize resources, acquire grants, implement projects)
- Facilitating Public and Private Partnership Involvement (Green Infrastructure and Stormwater Projects)
- Area-wide Water Quality Planning & West Michigan Watershed Partners Inventory

WMSRDC
WEST MICHIGAN SHORELINE
REGIONAL DEVELOPMENT COMMISSION

West Michigan Green Infrastructure Mapping ~ Blueways & Greenways Plan ~ Lake Michigan Water Trail Plan ~

Lake Michigan Water Trail Plan, Brochure, Web Site



Lake Michigan Lake Action Management Plan (LAMP)

- Can we all eat any fish, drink the water, swim in the water?
- Are all habitats healthy, naturally diverse, and sufficient to sustain viable biological communities?
- Does the public have access to abundant open space, shorelines, and natural areas, and does the public have enhanced opportunities for interaction with the Lake Michigan ecosystem?
- Are land use, recreation, and economic activities sustainable and supportive of a healthy ecosystem?
- Are sediment, air, land, and water sources or pathways of contamination that affect the integrity of the ecosystem?
- Are aquatic and terrestrial nuisance species prevented and controlled?
- Are ecosystem stewardship activities common and undertaken by public and private organizations in communities around the basin?
- Is collaborative ecosystem management the basis for decision-making in the Lake Michigan basin?
- Do we have enough information, data, understanding, and indicators to inform the decision-making process?
- What is the status of the 33 Lake Michigan 8 digit HUC watersheds? 1,467 12 digit HUC watersheds?

NOAA Question 1.
What research information and management priorities guide the development of projects?

- Michigan DNR Fisheries Division Plans
- US FWS Coastal Program Plans
- Muskegon Lake AOC Habitat Restoration Plan
- Local Studies & Research (Muskegon River Partnership *(Universities),* Sturgeon Studies *(AWRI),* Invasive Plant Management *(WMSRDC)*
- Lake Michigan LAMP
- Great Lakes Restoration Action Plan

Priorities, Research and Projects

Q. 1: What research information and management priorities guide the development of projects?

MDNR Fisheries Division

Muskegon River Watershed Assessment *(Special Report Number 19)*

Conservation Guidelines for Michigan Lakes *(Special Report 38)*

Associated Natural Resources *(Special Report Number 38)*

Base information for these documents are cited in the literature section of each document. DNR continually makes minor adjustments as new information is gathered (e.g., ongoing lake sturgeon information gathered through a joint effort with GVSU AWRI and DNR).

http://www.michigan.gov/dnr/0,4570,7-153-10364_52259_19056-333302--,00.html

Q. 2: What are the local restoration priorities for Muskegon Lake and Muskegon River?

Local Restoration Projects

Muskegon Lake Mill Debris Investigation, Design and Restoration

Muskegon River Hydrologic Reconnection and Wetland Restoration at Veterans Memorial Park

Bear Creek Hydrologic Reconnection/Water Quality and Wetland Restoration at former Bear Lake *celery flats

Muskegon River Wetland Restoration at *Bosma and Zephyr

* Muskegon County land acquisition negotiation underway with private landowners and a NOAA grant

WMSRDC Environmental & Water Quality Grant ~ Current Projects, 2014-2016

<u>Current Water Quality and Great Lakes Regional Partnership Projects:</u>

- Muskegon Lake Marine Debris and Bear Lake Hydrologic Reconnection & Wetland Restoration Projects (Research/Engineering/Design)

  $345,500

- Muskegon River Hydrologic Reconnection and Habitat Restoration at Veterans Memorial Park

  $2.5 million

- Muskegon Lake Marine Sawmill Debris Investigation / Aquatic Habitat Restoration

  $3 million

- Bear Creek Hydrologic Reconnection, Fish Passage and Wetland Restoration

  $7.7 million *(Engineering/Design FY '14, Implementation, FY '15)*

- DEQ Stormwater Asset and Wastewater Management (SAW)

  $110,000

2015-2017 WMSRDC Water Quality Grant Projects

~ Proposed Partnership Projects/Grants Pending:

- EPA Shoreline Cities Green Infrastructure

  $110,000 (1:1 Non-Federal Match Requirement w/WMSRDC DEQ SAW Grant)

- Great Lakes Restoration Initiative, Lower Muskegon River Watershed

  Non-Native Invasive Management and Education (FY 2015)

  $163,000

- GLRI/NOAA Bear Creek Hydrologic Reconnection and Wetland Restoration Implementation Project (FY 2015)

  $7.7 million

- GLRI/Bear Creek Watershed Implementation Project

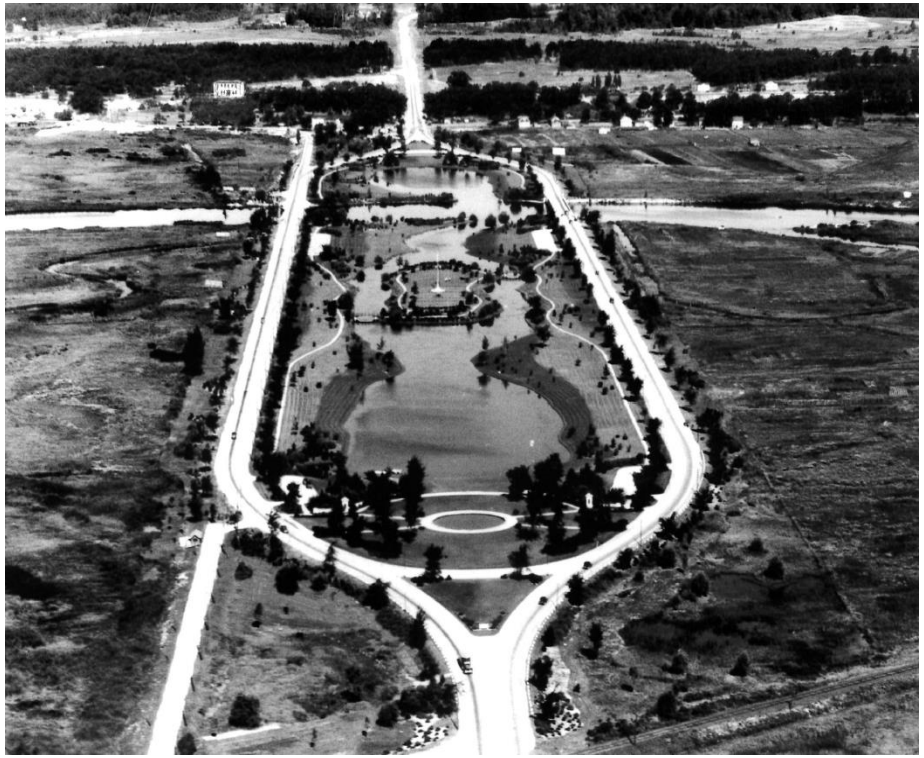
  $750,000

Mill Debris Removed

Wood Sorted and Repurposed

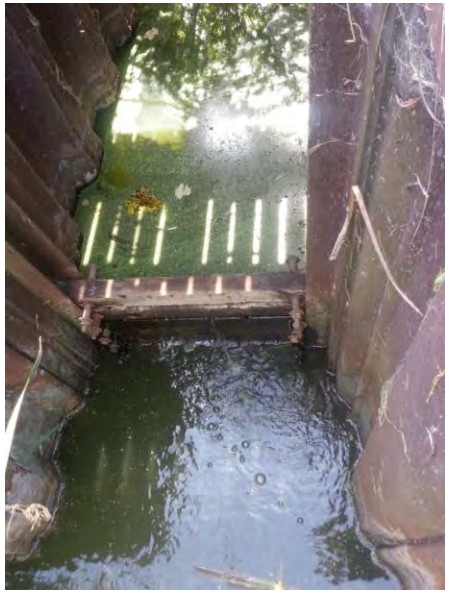
Veterans Memorial Park

Muskegon Lake AOC Habitat Restoration



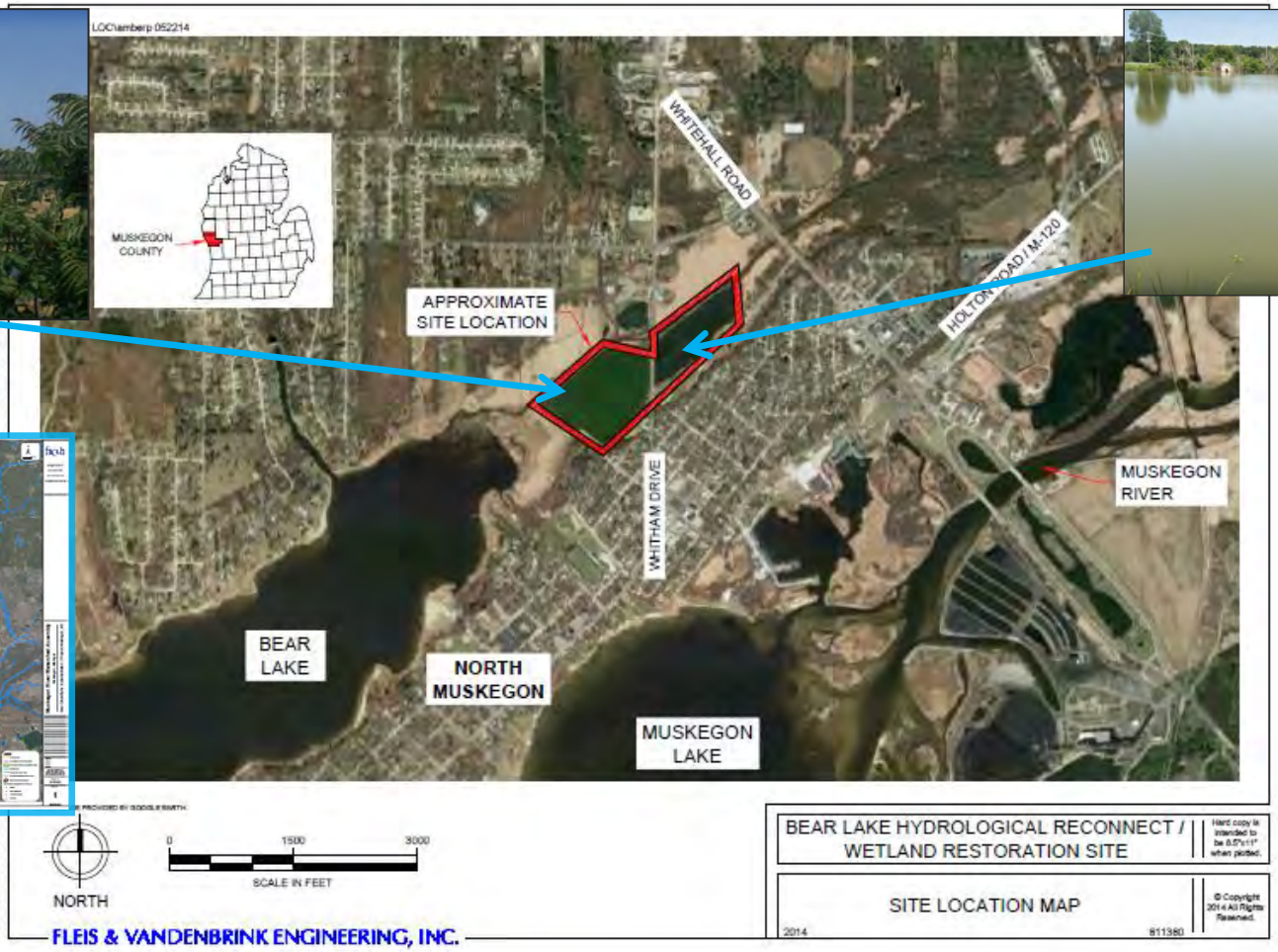
Muskegon River Fish Passage

Water control structure and berm obstructs fish passage and degrades water quality at **Veterans Memorial Park**



Bear Creek Hydrologic Reconnection Restoration

Goal: Restore fish passage between Bear Creek, its natural floodplain, Bear Lake, Muskegon Lake and Lake Michigan



Fish Passage, Habitat Restoration and Water Quality

Zephyr GLLA & Musk. River Restoration

Projects Underway

Former Zephyr Oil Refinery Tank Farm on Muskegon River

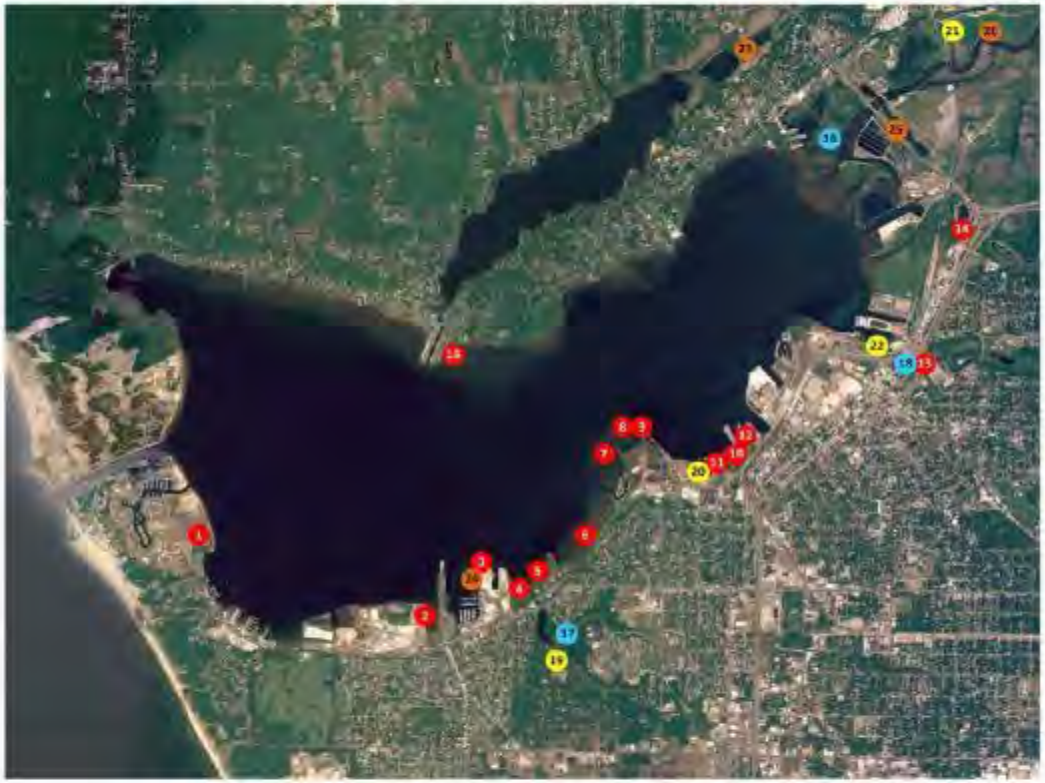
Tanks were removed previously. Soil, groundwater, wetlands and sediment have been investigated. Remedial plans are being developed for cleanup of water resources. Much of the upland property is ready for brownfield redevelopment.

WMSRDC Partners and Muskegon Lake Restoration Projects

Past, Present and Future

Restoration under the American Recovery and Reinvestment Act

1. Edgewater shoreline and wetland restoration
2. Grand Trunk shoreline, wetland, and open water habitat restoration
3. GL&V shoreline and open water habitat restoration
4. Ruddiman Creek mouth open water habitat restoration
5. Amoco Peninsula shoreline and wetland restoration
6. Lakeshore Trail shoreline and wetland restoration
7. Centerpoint Bay & Kirksey Peninsula shoreline and wetland restoration
8. Michigan Steel and Hartshorn Peninsula shoreline and wetland restoration
9. East Hartshorn Peninsula shoreline, wetland and open water habitat restoration
10. Heritage Landing Circle shoreline, wetland and open water habitat restoration
11. Heritage Landing Rotary Park shoreline, wetland and open water habitat restoration
12. Heritage Landing Scrap Bay shoreline, wetland and open water habitat restoration
13. Ryerson Creek streambank, wetland, and fish passage restoration
14. South Branch at Richards Park shoreline and wetland restoration
15. Pointe Marine shoreline and wetland restoration



Thank you to all our partners who are helping to restore Muskegon Lake!

Restoration under NOAA's Great Lakes Habitat Restoration Program

16. Muskegon Lake Nature Preserve wetland enhancement
17. Ruddiman Creek upstream shoreline, wetland restoration and invasive species management
18. Ryerson Creek wetland, riparian and fish passage restoration

Restoration under the Great Lakes Legacy Act

19. Ruddiman Creek contaminated sediment removal
20. Division Street outfall contaminated sediment removal
21. Zephyr contaminated sediment removal (upcoming)
22. Ryerson Creek contaminated sediment removal (upcoming)

Upcoming restoration under the Great Lakes Restoration Initiative

23. Bear Creek wetland and fish passage restoration and water quality improvements
24. Mill debris removal
25. Veterans Park Muskegon Lake wetland, shoreline, and fish passage restoration
26. Muskegon River wetland restoration

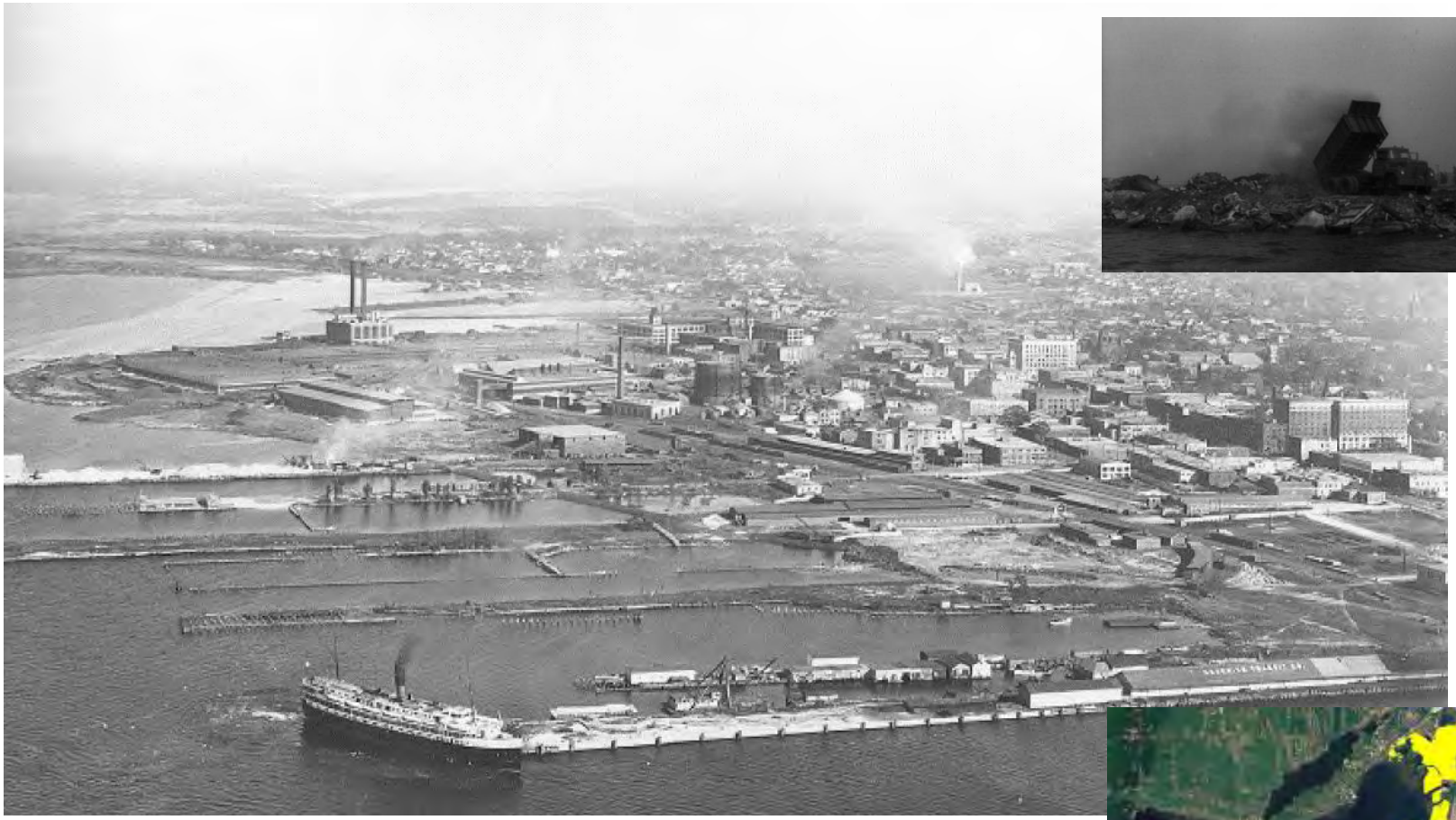
Muskegon Lake

Area of Concern Boundary Map

Early Lumbering Era

The “filling” of Muskegon Lake and its shallow, aquatic shoreline habitats began with the 47 sawmills that operated around its lakeshore. The Muskegon River, Michigan’s second longest, was heavily logged during the 1800’s.

Post World War II Industrial Era

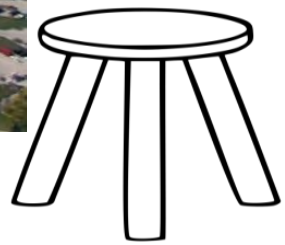


The “filling” of Muskegon Lake continued during the industrial era, until nearly 1,000 acres of the lake’s surface waters and aquatic habitats were lost.

Lake “Fill” Map Courtesy GVSU
Annis Water Resources Institute

Today's Blue Economy Era

The future economic vitality of West Michigan will be based on how well we clean up, restore and care for our valuable natural resource assets into the future.



Planning for a Sustainable Future

Muskegon Area-wide Plan

Delisting the Muskegon Lake AOC

Status of Beneficial Use Impairments

BUIs – Four Removed:

- ✓ Restrictions on Fish and Wildlife Consumption, 2013
- ✓ Restrictions on Dredging Activities, 2012
- ✓ Restrictions on Drinking Water Consumption or Taste and Odor Problems, 2013
- ✓ Beach Closings, 2014

Projects Completed & Underway for Removal of Remaining 5 BUIs:

1. Loss of Fish and Wildlife Habitat and…
2. Degradation of Fish and Wildlife Populations:

Muskegon Lake NOAA ARRA Fish and Wildlife Restoration Project (Completed via NOAA-ARRA/ GLC/WMSRDC grant agreement from 2010-2013)

Bear Creek Hydrologic Reconnection & Wetland Restoration Project (Design completed in 2014 under a NOAA/WMSRDC grant agreement; Implementation is pending GLRI funds in 2015-2016)

Muskegon River Veterans Memorial Park Fish Passage and Shoreline Restoration (Preliminary design completed by WMSRDC in 2014; Construction via a GLRI–NOAA/GLC/WMSRDC agreement in 2015-2016)

Muskegon Lake Lumber Era "Mill" Debris (Design and restoration via a GLRI–NOAA/GLC/WMSRDC grant agreement in 2015-2016)

Muskegon River Wetland Acquisition and Restoration (Preliminary design 2013-14, via NOAA/DU agreement)

3. Degradation of Benthos – EPA/DEQ Great Lakes Legacy Act Cleanup Projects:

Ruddiman Creek- completed in 2006; **Division Street Outfall -** completed in 2012; **Zephyr-** to be completed in 2015; **Ryerson** – TBD, Public/Private Partnership in 2016

4. Degradation of Aesthetics – **Bear Lake Oil Containment Feasibility Study**
5. Eutrophication or Undesirable Algae – **Bear Creek Hydrologic Restoration Project**

Early Cleanup Goals

Three "orphan sites" were identified in 2000. Contaminated sediment sites were prioritized according to social, economic and environmental benefits

1) Ruddiman Creek – *improve environmental health and public safety in a residential and recreational area*

2) Ryerson – *achieve community economic and quality of life goals by facilitating the cleanup and re-development of a large downtown shoreline brownfield*

3) DSO – *restore ecosystem health in a public fishing and boating area in the heart of downtown, adjacent to Heritage Landing and Hartshorn Marina*

Ruddiman Creek GLLA Project

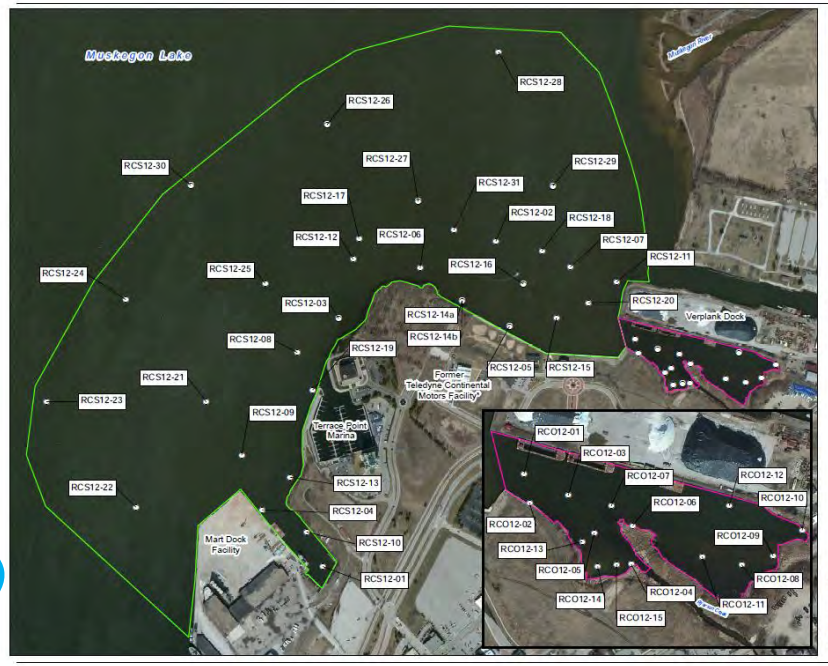
Cleanup Completed in 2006

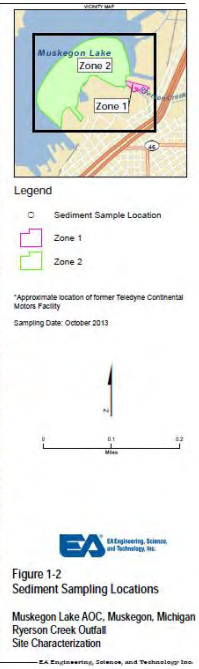
Division Street Outfall GLLA Project

Cleanup Completed in 2012

Ryerson GLLA Project

Public/Private Partnership In Place





Terrace Point Landing Development

Vision for Harbor 31 Development

GVSU Michigan Alternative and Renewable Energy Center

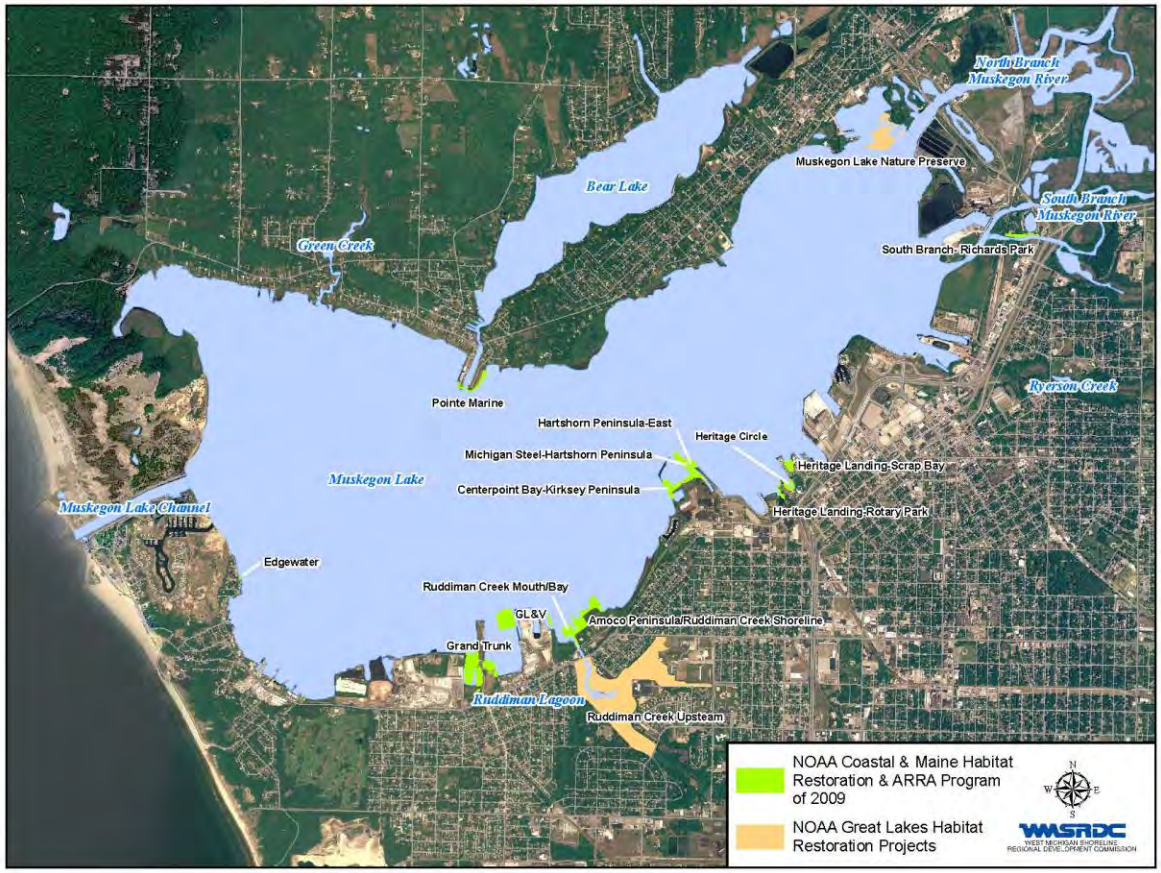
Vida Nova LEED Condos

Ryerson GLLA Project

Potential GLLA Cleanup Project

Muskegon Lake, Offshore from
Former Paper Mill
2014 Sediment Sampling Completed

Muskegon Lake Fish and Wildlife Habitat Restoration and BUI Removal Strategy, 2008



Thirty acres of fish and wildlife wetland habitat and 13,000 feet of shoreline were restored from 2010-2013. Public and private landowners provided support along with grants from the Community Foundation for Muskegon County, Muskegon River Ice Mountain Fund, Consumers Energy, NOAA ARRA, Great Lakes Commission, NOAA Great Lakes Habitat Restoration Program/Great Lakes Restoration Initiative. WMSRDC managed the project with oversight by Muskegon Lake Watershed Partnership.

Landowner Partners:

Verplank Trucking
Great Lakes Dock & Materials
Centerpoint Bay/Kirksey
Michigan Steel
City of Muskegon
Muskegon County
Michigan DNR
United Way of the Lakeshore
Muskegon Lake Nature Preserve
Pointe Marine Association
Lafarge, North America

Project Partners:

GVSU Annis Water Resources Institute
Muskegon River Watershed Assembly
Great Lakes Commission
NOAA
Michigan DEQ

Shoreline Habitats Restored

Historic “Fill” Removed from Muskegon Lake

“Softening” the Muskegon Lake Shoreline

Removal of Lake-Bottom "Scrap"

Restoration of Nearshore and Open Water Wetlands

Heritage Landing

YMCA

Restored Shoreline along the Muskegon River

South Branch at the City of Muskegon's Richards Park

A New Shoreline View for Lakeside

WMSRDC

MLWP
Muskegon Lake
Watershed Partnership

A New Shoreline Emerges

Michigan Steel, Kirksey/Centerpoint Bay and Hartshorn Marina

Heritage Landing - before, during and after

Heritage Landing

Before and After Fish and Wildlife Habitat Restoration

Educating the General Public

Interpretive signage was installed at 15 Muskegon Lake locations along the Lakeshore Trail from the Muskegon River to Lake Michigan. QR Codes are linked to the Muskegon County CVB website.

Funding for interpretive signage was part of the public outreach of the NOAA/ARRA Fish and Wildlife Habitat Restoration Grant Project, completed in 2013.

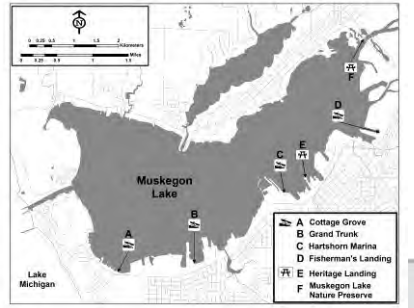
Interpretive Signage Along the Shoreline

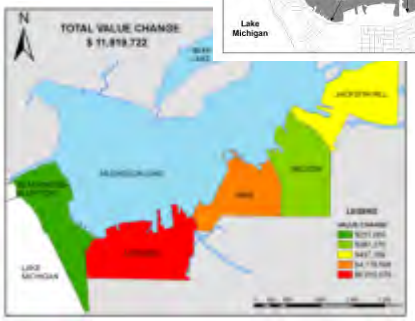
Project Benefits

Socio-Economic Benefits of Muskegon Lake Shoreline Restoration

A Few Key Findings:

- 65,000 Additional Visitors Annually
- $11.9 ml Increase in Housing Values
- $60 ml in Economic Benefits over a Ten-Year Period
- 6 to 1 Return on Investment





Project Benefits

Improved Economic Conditions and Quality of Life

Habitat restoration projects generate, on average, 17 jobs per million dollars spent which is similar to other conservation industry job impacts and is much higher than other industries, such as coal and gas.

Investing in coastal habitat restoration provides needed short-term economic stimulus via job creation.

Investing in habitat restoration also leads to future job creation in rebuilt fisheries and coastal tourism, as well as other long-term benefits to coastal economies including higher property values and better water quality.

Investing in restoring "blue infrastructure," the important coastal and marine habitats that support coastal economies, is not only a way to generate green jobs and stimulate the economy in the near-term, but also provides lasting benefits to coastal communities and society.

Edwards PET, et al. Investing in nature: Restoring coastal habitat blue infrastructure and green job creation. Mar. Policy (2012), http://dx.doi.org/10.1016/j.marpol.2012.05.020

WASRDC

Project Benefits

Renewed Potential for Public Access and Recreational Amenity Improvements

Lower Muskegon River – Proposed Muskegon County property acquisition with cleanup and restoration through GLLA and NOAA

Muskegon Lake – Grand Trunk
NOAA Restoration Improves Access

Muskegon Lake – YMCA
GLLA Paves Way for Future Recreational Access Opportunities

Muskegon Lake – Hartshorn Peninsula
NOAA Restoration Designed for Future Shoreline Public Access Improvements

MLWP Muskegon Lake Watershed Partnership

WMSRDC

Research and Monitoring

Local Students and Community Volunteers Monitor Restored Wetlands at Grand Trunk

GVSU Annis Water Resources Institute Monitors Fisheries and Macrophyte Beds at Restoration Sites

Trained, Adult Volunteers Participate in the Great Lakes Marsh Monitoring Program at Locations All Around Muskegon Lake

Stewardship Opportunities

MLWP
Muskegon Lake
Watershed Partnership

WMSRDC

Muskegon
COUNTY

Informed Elected Officials
Community Leaders are Involved at All Levels

Project Management

WMSRDC – NOAA Coastal and Marine Habitat Restoration and ARRA Program of 2009

- WMSRDC Proposal Submitted for $13 ml. Reduced to $10 ml upon NOAA's Request and a Contracts were Awarded – NOAA/GLC and GLC/WMSRDC
- WMSRDC Contracted Monitoring and Public Outreach Assistance to Grant Subrecipients – **Contracts Awarded to Subrecipients GVSU AWRI and MRWA**
- Request For Proposals for Engineering/Design and Construction Management Services
  (Mandatory Pre-Proposal Meetings and Site Visits w/ Follow Up Q&A Deadline)
  5 Major Engineering and Design Contracts Awarded
- Bid Packages for Construction of Restoration (Mandatory Pre-Bid Mtgs, Site Visits, Q&A Deadline)
  10 Major Construction Contracts Awarded
  Cost Savings realized on engineering and construction with competitive selection process and cost control during projects. Additional restoration completed through new contracts and contract amendments, exceeding original goals.
- Request for Proposals for Appraisals for Conservation Easements, Environmental Sampling, Public Outreach Signage – **Contracts and Purchase Orders**
- Followed Grant Rules (NOAA and ARRA) as well as WMSRDC's Procurement Policy - Contracts, Davis Bacon, Competitive Selection of Contractors/RFPs, Advertised and Held Public Bid Package Openings, Contract Amendments, Invoicing and Payments
- Reporting – Monthly Status Reports; Quarterly Programmatic Progress Reports; Quarterly ARRA Reports; Semi-annual Progress Reports
- Invoices and Status Reports Reviewed and Payments Authorized

Bear Lake/Bear Creek

Hydrologic Reconnection and Restoration Project
Muskegon Lake Area of Concern Priority Delisting Project

Landowner Design Input Meeting

June 12, 5:30 PM - Laketon Township Hall

Kathy Evans, West Michigan Shoreline Regional Development Commission Phone: (231) 722-7878 x17, E-Mail: kevans@wmsrdc.org

Project Partners:

NOAA

WMSRDC West Michigan Shoreline Regional Development Commission

Cardno JFNew

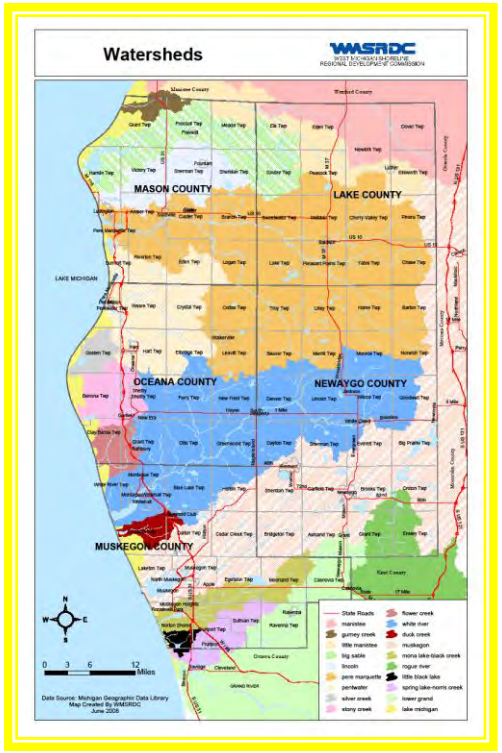
MLWP Muskegon Lake Watershed Partnership

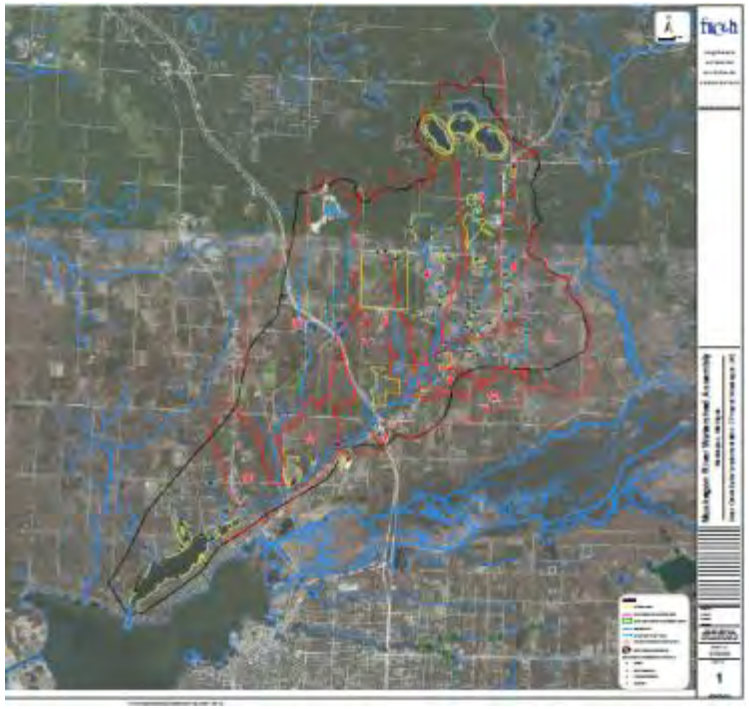
Grand Valley State University Robert B. Annis Water Resources Institute www.gvsu.edu/wri

Muskegon County

Bear Creek Watershed

The Bear Creek 319 Watershed Plan was developed to identify Best Management Practices to reduce Non-Point Sources of Pollution to Bear Lake.





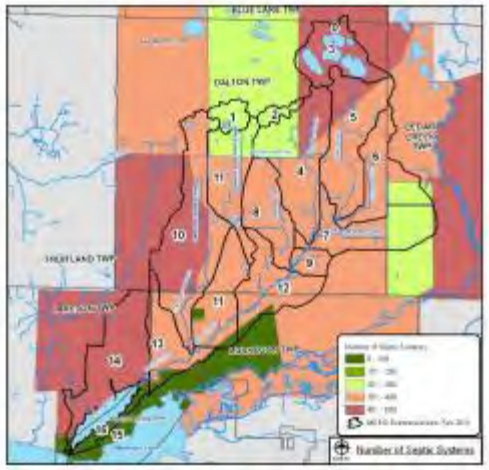
What is Non Point Source Pollution?

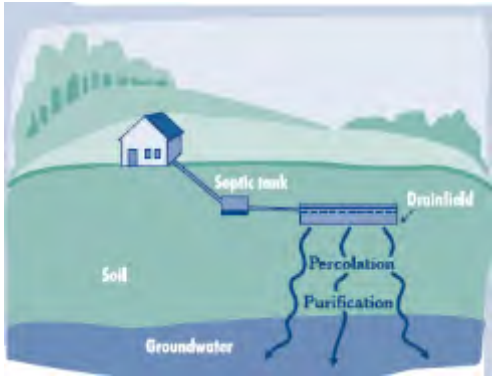
- Pollution originating from a wide area
- Most commonly polluted runoff
- Nonpoint source pollution generally results from land runoff, precipitation, atmospheric deposition, drainage, seepage or hydrologic modification

- Sediment
- Nutrients
  - Nitrogen-
  - **Phosphorus**
- Bacteria, *E. coli*
- Dissolved Oxygen
- Temperature
- Oil, Grease and Toxics

Reducing Nutrient Inputs

External sources of NPS phosphorous can include agricultural lands, failed septic systems, lawn fertilizer runoff, and sediment that washes into the water from eroding stream banks & road/stream crossings





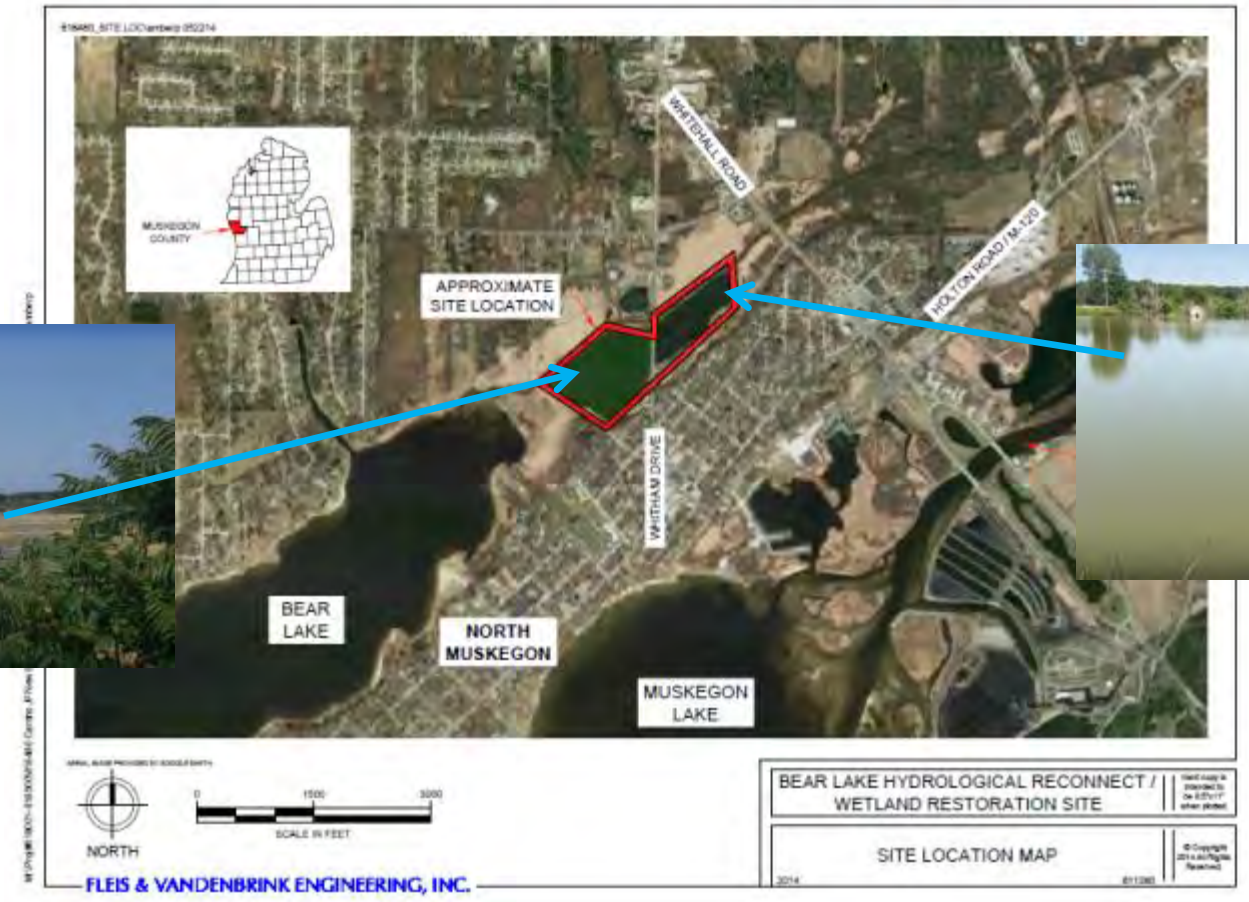
Source: JFNew

Bear Lake Internal Load Study by AWRI

Bottom Line: Controlling the external loading is the ultimate solution to cultural eutrophication for Bear Lake

The Bear Lake/Bear Creek Hydrologic Reconnection and Restoration Project

Goal: Restore fish passage between Bear Creek, its natural floodplain, Bear Lake, Muskegon Lake and Lake Michigan



Water Elevations Measured Over Time

in Bear Creek and within the Ponds

Bear Creek Water Elevation Gauge

Pond Water Elevation Gauge

Sediment Core Samples

Sediment Sampled

Determine Appropriate Disposal Options that Meet DEQ Permit Requirements

Landowner and Stakeholder Input

Fish Passage, Habitat Restoration and Water Quality

First Conceptual Restoration Design

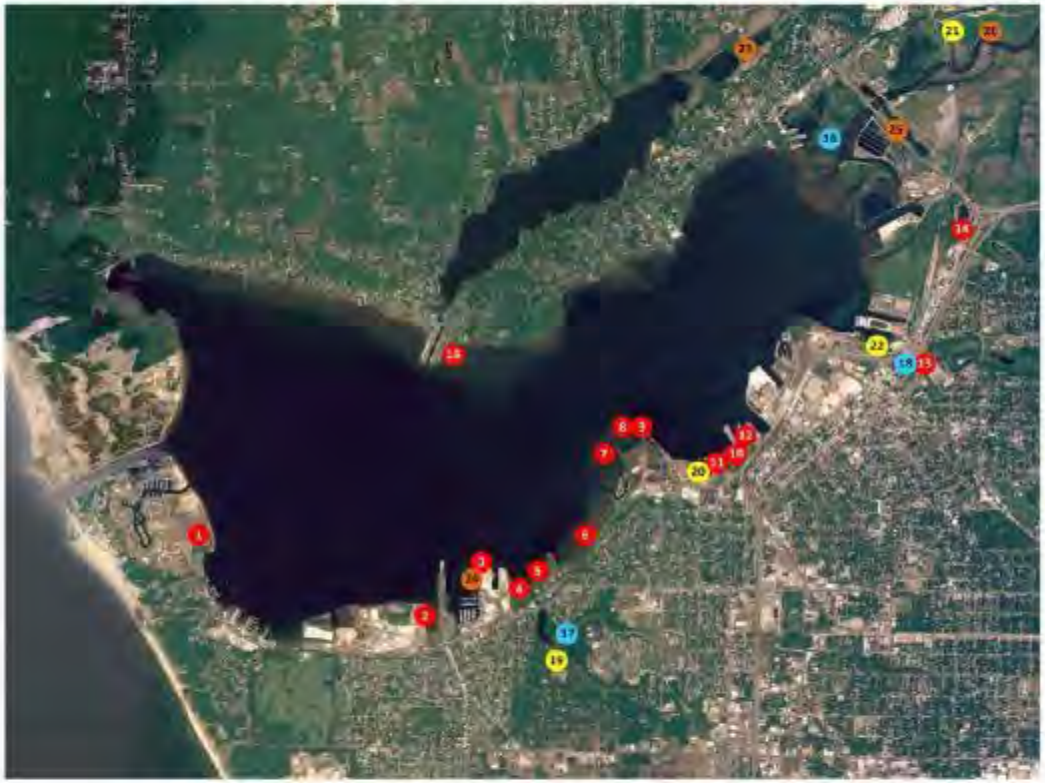
Preliminary Restoration Design after incorporating Landowner Input and Natural Resource Technical Input

WMSRDC Partners and Muskegon Lake Restoration Projects

Past, Present and Future

Restoration under the American Recovery and Reinvestment Act

1. Edgewater shoreline and wetland restoration
2. Grand Trunk shoreline, wetland, and open water habitat restoration
3. GL&V shoreline and open water habitat restoration
4. Ruddiman Creek mouth open water habitat restoration
5. Amoco Peninsula shoreline and wetland restoration
6. Lakeshore Trail shoreline and wetland restoration
7. Centerpoint Bay & Kirksey Peninsula shoreline and wetland restoration
8. Michigan Steel and Hartshorn Peninsula shoreline and wetland restoration
9. East Hartshorn Peninsula shoreline, wetland and open water habitat restoration
10. Heritage Landing Circle shoreline, wetland and open water habitat restoration
11. Heritage Landing Rotary Park shoreline, wetland and open water habitat restoration
12. Heritage Landing Scrap Bay shoreline, wetland and open water habitat restoration
13. Ryerson Creek streambank, wetland, and fish passage restoration
14. South Branch at Richards Park shoreline and wetland restoration
15. Pointe Marine shoreline and wetland restoration



Thank you to all our partners who are helping to restore Muskegon Lake!

Restoration under NOAA's Great Lakes Habitat Restoration Program

16. Muskegon Lake Nature Preserve wetland enhancement
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Upcoming restoration under the Great Lakes Restoration Initiative

23. Bear Creek wetland and fish passage restoration and water quality improvements
24. Mill debris removal
25. Veterans Park Muskegon Lake wetland, shoreline, and fish passage restoration
26. Muskegon River wetland restoration

MLWP
Muskegon Lake
Watershed Partnership

Working Together to Set Goals, Prioritize, Plan Projects, and Meet Targets

Kathy Evans, Program Manager,
West Michigan Shoreline Regional Development Commission
Phone: (231) 722-7878 x17, E-mail: kevans@wmsrdc.org

WMSRDC Environmental Program Contact Questions?

- Kathy Evans, Environmental Program Manager

  Phone: (231) 722-7878 x17

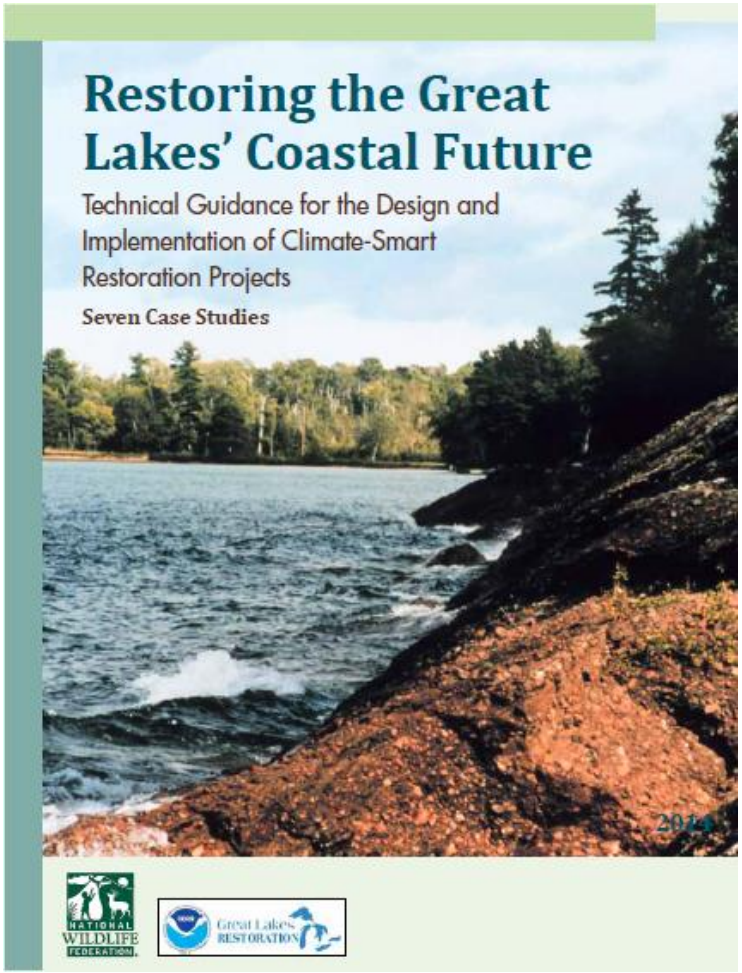
  E-Mail: kevans@wmsrdc.org

Muskegon Lake and River: Thoughts on Resource Management Priorities

Michael Murray, Ph.D.
National Wildlife Federation

Muskegon Research and Restoration Connectivity Workshop
Muskegon, MI
November 13, 2014

NWF Priorities in Muskegon Lake, River

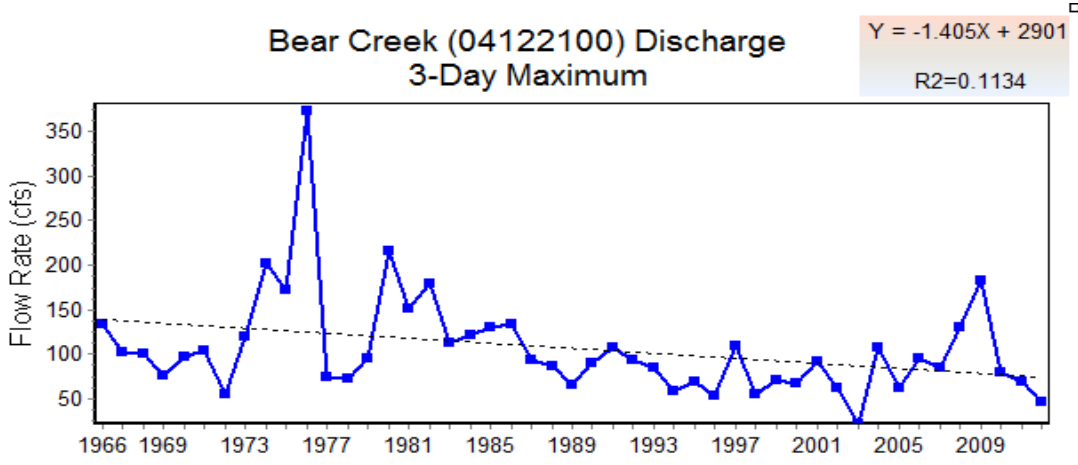


- Ensure restoration based on best science
- Restore structure, function
- Address key stresses/impairments (BUIs; habitat loss, HABs, benthos)
- Plan for climate change

NATIONAL WILDLIFE FEDERATION

Source Material Informing Priorities

- Peer-reviewed literature
- Agency data, reports (e.g. NOAA, USGS, EPA, IJC, MDEQ/DNR, WMSRDC)
- Other information (NGOs, industry)
- Advisory committee efforts – e.g., HOW Technical Advisory Committee



Contact

Michael Murray, Ph.D.
Staff Scientist
National Wildlife Federation
murray@nwf.org
734-887-7110

Appendix B: Survey Summary Report

MUSKEGON RESEARCH AND RESTORATION CONNECTIVITY WORKSHOP

NOVEMBER 13, 2014

Photo Credit: Marge Beaver

WORKSHOP ATENDEE SURVEY

SUMMARY OF RESULTS

SURVEY PROCESS

WORKSHOP CONTEXT

This survey was distributed to researchers, resource managers, and restoration specialists working in the Muskegon River watershed, Muskegon Lake, and nearshore Lake Michigan in advance of the November Muskegon Research and Restoration Connectivity Workshop. This workshop was the second in a series of three workshops intended to develop a collaborative and coordinated long-term research program that links the Muskegon River watershed, Muskegon Lake, and nearshore Lake Michigan.

SURVEY PURPOSE

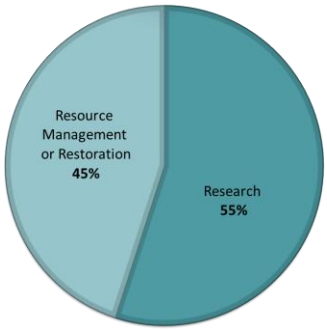
The primary purpose of the survey was to provide a springboard for discussion during the November workshop. The survey consisted of two sections. The first included questions designed to assess the state of communications between researchers, stakeholders, and resource managers working in the Muskegon area. The second section included questions intended to improve our understanding of how research gaps and priorities identified by scientists working in Muskegon match up with the needs and priorities of resource managers and restoration specialists.

SURVEY PROCESS

The survey was designed and distributed through the web based *Qualtrics* survey tool. Participants were given two weeks to complete the survey.

SURVEY PARTICIPANTS

The survey was distributed to all those who attended Workshop I in April as well as those invited to Workshop II in November, for a total of 67 individuals. We achieved a 43% response rate with 29 individuals completing the survey. Of those who completed the survey, 45% classified their work in Muskegon as primarily focused on resource management or restoration and 55% as primarily focused on research.



Breakdown of researchers and management/restoration specialists participating in survey

RESULTS

USE OF RESEARCH PRODUCTS

- When asked to estimate how often local stakeholders and resource managers in Muskegon use products produced by their research, scientists generally estimated a higher frequency of use than was reflected in answers from management/restoration specialists (see Figure 1).
- 31% of researchers surveyed were “not sure” how often local stakeholders and resource managers in Muskegon were using products produced by their research (see Figure 1).

FIGURE 1

Both researchers and management/restoration specialists were asked to estimate how often Muskegon stakeholders and resource managers use research products. This figure compares responses from both groups.

OBSTACLES TO COMMUNICATION

- Researchers, resource managers, and restoration specialists all highlighted limitations of time and face-to-face access as significant barriers to communication.
- Researchers also felt communication was hampered by the difficulty of translating technical jargon for a wide audience.
- Mismatched timelines mean that often research projects are set on very long time scales while restoration or management projects require more immediate action.
- One respondent felt that research institutions undervalue collaboration with decision makers in establishing metrics for project success and professional promotion.
- A number of participants mentioned a lack of a central online resource to access new research or connect with scientists.
- Resource managers and stakeholders, especially those covering wide geographic areas, felt an overabundance of information made it very easy for useful information to "slip through the cracks."

IMPORTANCE OF RESEARCH TOPICS TO RESTORATION & MANAGEMENT EFFORTS

- When asked to rate on a scale of 1 to 5 (5 being the highest) the importance of seven research topics to restoration and management efforts in Muskegon, researchers rated all of the topics more highly than management/restoration specialists. The average importance rating among researchers was 0.53 points higher than the average among management/restoration specialists (see Figure 2).
- Both groups rated water quality as the most important topic to restoration and management efforts. Wetlands also factored into the top three topics for both groups (see Figure 2).

- Management/restoration specialists tended to rank the topics of hydrology and hydrodynamics and economic valuation of resource and restoration impacts higher than researchers (although the absolute scores of each topic were lower; see Figure 2). Researchers, in comparison, ranked the topics of integrated assessments and food webs and fisheries higher than management/restoration specialists (see figure 2).

Researchers		
Rank	Research Priority	Average Rating
1	Water Quality	4.67
2	Food Web and Fisheries	4.47
3	Wetlands	3.87
4	Integrated Assessment	3.80
5	Hydrology and Hydrodynamics	3.73
6	Observing Systems and Remote Sensing	3.67
7	Economic valuation of resources and restoration impacts	3.53

Resource Managers/Restoration Specialists		
Rank	Research Priority	Average Rating
1	Water Quality	4.00
2	Wetlands	3.75
3	Hydrology and Hydrodynamics	3.58
4	Food Web and Fisheries	3.55
5	Economic valuation of resources and restoration impacts	3.11
6	Integrated Assessment	3.08
7	Observing Systems and Remote Sensing	2.91

FIGURE 2

Respondents were asked to rate on a scale of 1 to 5 (5 being the highest) the importance of specific research topics to restoration and management efforts In Muskegon. This figure shows the average rating for each topic assigned by researchers and management/restoration specialists as well as the topic's comparative order of importance or rank.

IMPORTANCE OF RESEARCH TOPICS TO RESTORATION & MANAGEMENT EFFORTS

- Survey participants were asked to rank a list of five research gaps in order of their importance to addressing a number of major environmental challenges facing the Muskegon River watershed, Muskegon Lake, and nearshore Lake Michigan.
- The five research gaps included:
    1) Need for a hydrodynamic model that links the Muskegon River, Muskegon Lake, and Lake Michigan
    2) Need for a better understanding of the impact of the Muskegon Lake plume in Lake Michigan
    3) Need for high frequency sampling during large weather and other episodic events
    4) Need for increased development of satellite remote sensing
    5) Need for an integrated watershed wide monitoring program

- Management/restoration specialists consistently identified the need for an integrated watershed wide monitoring program as the most urgent research gap in addressing all of the listed environmental challenges (see Figure 3).
- Researchers consistently identified the need for a hydrodynamic model that links the Muskegon River, Muskegon Lake, and Lake Michigan as the most urgent research gap in addressing all of the listed environmental challenges (see Figure 3).
- Both groups had considerable overlap in what they identified to be priority research gaps consistently ranking the same three research gaps as highest in importance 1) Integrated watershed wide monitoring program 2) High frequency sampling during large weather and other episodic events and 3) Hydrodynamic model that links the Muskegon River, Muskegon Lake, and Lake Michigan (see Figure 3).

Challenge	Priority Research Gaps Management/Restoration Specialists	Priority Research Gaps Researchers
Issues of water quality, harmful algal blooms, and hypoxia	1. Integrated watershed wide monitoring program 2. High frequency sampling during large weather and other episodic events 3. Hydrodynamic model that couples the Muskegon River, Muskegon Lake, and Lake Michigan	1. Hydrodynamic model that couples the Muskegon River, Muskegon Lake, and Lake Michigan 2. Integrated watershed wide monitoring program 3. High frequency sampling during large weather and other episodic events **AND** Understand the impact of the Muskegon Lake plume on Lake Michigan
Improve recreation angling and fisheries	1. Integrated watershed wide monitoring program 2. Hydrodynamic model that couples the Muskegon River, Muskegon Lake, and Lake Michigan 3. High frequency sampling during large weather and other episodic events	1. Hydrodynamic model that couples the Muskegon River, Muskegon Lake, and Lake Michigan 2. Integrated watershed wide monitoring program 3. Understand the impact of the Muskegon Lake plume on Lake Michigan
Address contaminant issues	1. Integrated watershed wide monitoring program 2. High frequency sampling during large weather and other episodic events 3. Hydrodynamic model that couples the Muskegon River, Muskegon Lake, and Lake Michigan	1. Hydrodynamic model that couples the Muskegon River, Muskegon Lake, and Lake Michigan **AND** High frequency sampling during large weather and other episodic events 2. Understand the impact of the Muskegon Lake plume on Lake Michigan 3. Integrated watershed wide monitoring program

FIGURE 3

Respondents were asked to rank a list of research gaps in order of their importance to addressing three major environmental challenges facing the Muskegon River watershed, Muskegon Lake, and nearshore Lake Michigan. Figure 3 compares the highest ranked research gaps among researchers to those among management/restoration specialists for each environmental challenge.