Coordinated Experiments Across the Great Lakes Basin:

Great Lakes Integrated Mesocosm Research (GLIMR)

August 2022

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Executive Summary

A CIGLR-funded summit was held on June 23, 2022 to discuss the potential development and implementation of a Great Lakes Integrated Mesocosm Research (GLIMR) network. The purpose of this network is to identify opportunities to advance Great Lakes and aquatic science through coordinated experiments leveraging geographic variation in communities, habitats, and abiotic conditions around the basin. Participants included individuals who currently use or operate mesocosms throughout the Great Lakes basin. Summit participants described their mesocosm facilities; the advantages and disadvantages of various mesocosm designs and components were discussed. This resulted in shorter-term and longer-term strategies for moving GLIMR forward. The shorter-term approach is to conduct a manipulative, nutrient amendment experiment using each of our current mesocosm facilities, to assess the influence of their type and design on ecosystem response variables, measured using standardized methods. The longer-term approach is to build a network of mesocosm facilities with identical designs to allow for coordinated experiments determining differences in ecological responses across the Great Lakes basin.

Specific experiments were identified that are relevant, tractable, and amenable to mesocosm studies, and which can serve as the basis for future proposals. The summit participants chose not to identify a governance structure for GLIMR at this time. Next steps for the group include examining best practices for governance structure from similarly coordinated networks and exploring funding opportunities both to conduct the shorter-term experiment (mesocosm effects) and to support future planning initiatives.

1. Introduction

The environmental challenges facing the Great Lakes Basin (GLB) are well-documented and vary both longitudinally and latitudinally (Allan et al. 2013). Hence, addressing these challenges across the entire GLB requires a coordinated and unified research agenda, and one which capitalizes on this spatial variability (Sterner et al. 2017). Multiple approaches can be adopted as part of this research agenda, including modeling, remote sensing, and large-scale experimental manipulations, and each has its own advantages and limitations. Another approach that has not previously been employed is the coordinated and standardized use of mesocosm facilities across the GLB.

Mesocosms are excellent vehicles to simulate a wide range of environmental conditions in controlled and replicated experimental units; in so doing, they facilitate the comprehensive assessment of ecosystem processes and allow for testing of mechanisms driving ecological structure and function. Hence, they are very useful for testing hypotheses and gaining a mechanistic understanding of how systems operate. In addition, studies have shown that mesocosm-based results can be extrapolated to natural ecosystems (Ives et al., 1996; Smith et al., 2005; Spivak et al. 2011). Mesocosms are increasingly used to test predictions from ecological or biogeochemical models (Graney et al. 1994; Strauss et al. 2017), and we see the potential for this application in the Great Lakes, as well. But like all experimental approaches, they have limitations. First, they represent a simplification of natural systems, with limited relevance to the way that nature operates (Carpenter 1996; Haag and Matschonet 2001). Second, their relatively small volume (liters to a few cubic meters) limits the types of experiments that can be conducted.

Numerous institutions have mesocosm or mesocosm-type facilities around the GLB, but the experiments being conducted at these facilities are not currently coordinated. This summit brought together representatives from organizations that currently have mesocosm facilities, as well as other individuals interested in either obtaining them or being involved in coordinated experiments across the basin (Fig. 1). The overarching goal of the summit was to develop a coordinated approach in the use of these mesocosms. To reach that goal, we had several objectives: 1) develop an organizational structure regarding the operation and governance of this network of mesocosm facilities Great Lakes Integrated Mesocosm Research (GLIMR) network; 2) identify and prioritize experiments to be conducted across this network; and 3) identify funding sources that first will allow us to conduct an initial set of experiments, and ultimately, develop a consistent array of mesocosms throughout the GLB that are all of similar construction and instrumentation to optimize the utility of our research findings.

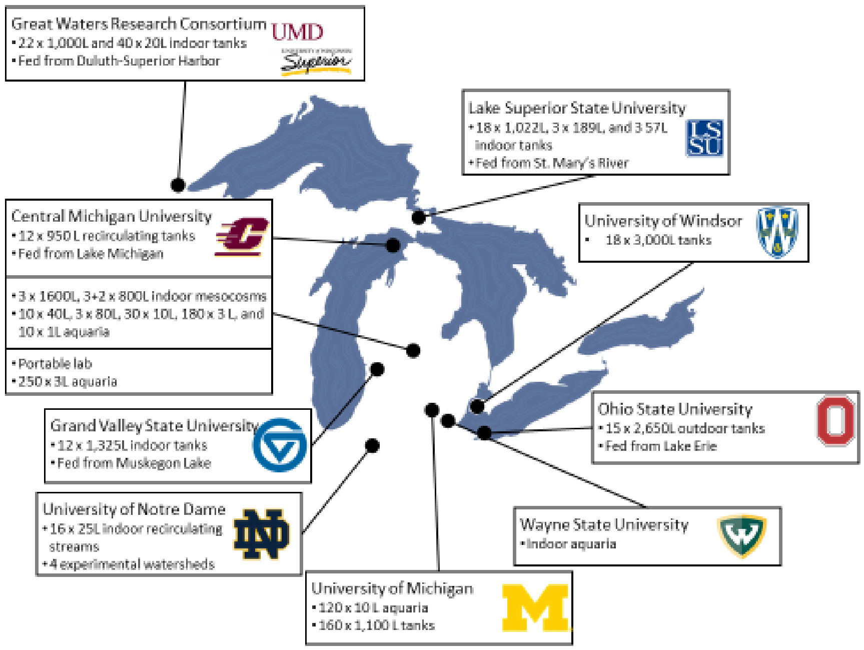

Fig. 1. Select locations of potential participants with mesocosm facilities around the Great Lakes Basin.

Our summit was designed to facilitate discussions among the participants to target the experiments and areas of research that 1) are of greatest interest; 2) have basin-wide significance, and 3) are best accommodated through mesocosms (i.e., are "mesocosm friendly"). Conceptually, the outcomes of these types of experiments can address information gaps in our understanding of Great Lakes ecology (Sterner et al. 2017) or be linked to ecosystem services and/or functions (Steinman et al. 2017; Sterner et al. 2020). Other possibilities include transplant designs (i.e., moving source water from one mesocosm facility to different ones) and portable mesocosm laboratories (see Appendix A).

The strength of a GLB-wide mesocosm approach is that experiments can be conducted using the same design, instrumentation and analytical procedures, as well as at the same time, but in different areas of the Great Lakes. Hence, they can be used to determine the degree to which different regions of the Great Lakes respond similarly to applied or natural stressors.

2. Summit Description and Methodology

The summit was funded in 2022 by the Cooperative Institute for Great Lakes Research (CIGLR), one of the NOAA-sponsored Cooperative Institutes throughout the USA. A 7-person steering committee developed the format and overall approach for the summit. The invited participants were selected based on either prior interest in the topic at a CIGLR All-Partners Meeting or knowledge that they worked on mesocosms in their home institutions. We attempted to cover as large a geographic extent of the GLB as possible. Numerous invitees could not attend due to prior commitments or health issues, but they all expressed an interest in being kept informed and involved in next steps.

The in-person summit (no virtual option) was held on June 23, 2022 on the campus of the University of Michigan. We had a 1-hr virtual meeting several weeks prior to the summit to provide an overview of expectations and also provide template slides. Participants used these templates to describe their mesocosm facilities in a consistent format (Appendix A).

The summit (Appendix B) included a brief overview of CIGLR by Casey Godwin (UM), filling in for CIGLR Director Greg Dick who was out of town. This was followed by an overview of the summit format and expectations by Al Steinman (GVSU). Summit participants then took turns giving brief overviews of their mesocosm facilities (Appendix A), based on the template introduced at the prior virtual meeting. After each presentation, there were questions from the summit attendees regarding the capabilities of the facility. Following the presentations, there was a group discussion regarding mesocosm design in general and how to proceed in terms of next steps. There was general agreement that a two-phased approach made sense, with the first, near-term phase focused on using our current facilities to address one pressing scientific question and a second, longer-term phase, that would include proposal writing to seek funding for a coordinated network of mesocosm facilities of similar design and instrumentation. After lunch, we divided into two breakout groups to identify the key scientific questions we feel are best addressed through our mesocosm facilities. A final session discussed governance issues and next steps.

3. Findings

3a. Descriptions of Current Mesocosms Facilities Around the Great Lakes Basin

Summit participants presented slides on their mesocosm facilities, which allowed everyone to see the diversity of mesocosms currently in use, as well as ask questions from each presenter. This part highlighted some of the key design considerations for mesocosms, notably: temperature regulation in outdoor systems; tradeoffs between water treatment required for vertebrates (i.e., fishes) versus maintaining intact invertebrate (e.g., plankton) communities; recirculating (closed) versus flow-through designs; source water(s) including depth of intake; and minimum replication needed to support common experimental designs. The slides are available both as Appendix A and electronically:

https://drive.google.com/drive/folders/1IzcmU7XgksvDHVLUtw3WbTXSBpMrhOMR?usp=sharing

3b. Initial Considerations of Experimental Approaches

Based on discussions following the slide presentations, summit participants discussed two approaches for future experiments:

Proposal Idea/Theme 1: “Mesocosm-Effects Experiment”

This approach takes advantage of the current diversity of mesocosm designs across the GLB to address a single research question. In this case, there was general agreement that the most tractable research question would be to determine the influence of nutrient concentration on ecosystem structure and function. In the interest of time, we did not discuss the explicit experimental design (e.g., specific nutrients and concentrations to be used). Rather, we explored the scientific value associated with using the diversity of mesocosm types available throughout the region.

By maintaining the same experimental factors and levels across all mesocosm facilities, regardless of the mesocosm configuration and specifications, we will be able to determine if the mesocosm design itself (see components below) impacts the effect of nutrient stressors across the GLB. In addition, we discussed using two different types of source water as separate treatments for the nutrient study: the local source water and a common source water (e.g., a defined medium or artificial lake water), to examine the relative influence of local ecological setting (with water source serving as a proxy) vs. mesocosm design.

Proposal Idea/Theme 2: "Consistent Design Across Locations"

This approach involves an array of mesocosms with the same exact design deployed across the GLB. Although this would require a large infrastructure-type grant, it would make comparisons across locations more straightforward and allow us to differentiate the role of local environmental drivers vs. basin-wide drivers affecting ecosystem structure and function. A number of experimental questions were proposed for this (summarized below), but some immediate considerations emerged from our discussion:

- Indoor vs. Outdoor: Upscaling from indoor to outdoor systems introduces potential concerns, including the difficulty in maintaining desired temperatures due to heat loss (air) and heat gain (solar); volume of source water; maintaining similar levels of community complexity; and increased vulnerability to invasions (cf. Vijayaraj et al. 2022). All these issues are potentially resolvable but involve increased costs and complexity.
- Number of Experimental Treatment Levels: The group acknowledged the trade-off between ideal number of experimental treatment levels vs. cost vs. replication at each level. For an experiment involving nutrients, for example, a minimum of 4 treatment levels was desirable to understand potential mechanisms but project cost grows quickly with recirculated water systems that require filtration or other disinfection treatment to maintain animal health or biosecurity (e.g., for aquaculture). Ideally, we'd design a system with the greatest flexibility, such as one where each tank has a separate, dedicated intake system (i.e., requiring stand-alone heating/cooling/recirculating/disinfection). However, escalating costs and space needs may render this approach unfeasible.
- Number of Experimental Units (tanks, streams, etc.) per Site: Summit participants seemed to agree that 15 units would be a reasonable minimum number. The final number will be influenced by statistical power to assess experimental treatment differences, and the need for replacement units if something goes awry.
- Volume: Most of the experimental tanks currently in use by summit participants contained 300 – 1000 L, though some were larger (2000L at OSU's Stone Lab), and it was recognized that larger (2000L+) systems also may be required for studies involving some species of adult fish.
- Shape: Most of the experimental tanks presented were round or circular, which avoids the heterogeneity, difficulties in cleaning, and undesirability for many active fish species (e.g., salmonids) associated with corners.

- Instrumentation: Some level of instrumentation would be required both for data acquisition and for system control; however, the specific level was left unresolved by the group.

Several other important mesocosm-related issues arose during our conversation that deserve mention. The first was the flexibility provided by *mobile mesocosm platforms*. Because these trailered systems are mobile, they can be deployed throughout the GLB and use whatever local water sources are available. They are relatively low cost to purchase and operate (except for fuel). However, they have limitations for both the size and quantity of the mesocosms that can be applied. A combination of fixed and mobile platforms may be a powerful approach. The second issue is biosecurity. This is particularly critical for aquaculture; UV light or ozone are commonly used to prevent pathogen growth when rearing fish, but such treatments may have undesirable effects on other trophic levels. Similarly, some facilities have been set up specifically for use with invasive species (or potential invaders) and this typically requires the ability to disinfect or sterilize wastewater.

3c. Science Questions to Pursue in Proposals

The summit participants developed a series of science questions amenable for mesocosms that would be of interest throughout the GLB, which we discussed and prioritized based on relevance, tractability, and interest. We list those below, in no particular order and some of which have clear overlap, which received the most positive responses from the participants.

- <u>Climate Change:</u> How do extreme temperatures influence ecosystem structure and function? Mesocosms are well-suited for manipulating the physical and chemical environment. The focus here would be the effect of extreme temperature increases, as well as changes in alkalinity and CO_2 regimes, to predict system changes to a variable future climate.
- <u>HAB and Nuisance Algae:</u> What triggers cyanobacterial dominance in summer and, separately, what triggers a bloom to be toxic? This question would benefit from different HAB organisms around the lakes, both in high nutrient places and typically low-nutrient places.
- <u>Winter Warm Up Simulation:</u> With changing climates, we are observing very fast transitions in the Great Lakes. In this experiment, we would examine the effect of an expedited temperature change; instead of a typical scenario when a springtime water temperature increase of 10 °C may take 6-8 weeks, we would accelerate this change to occur in days, and assess this effect on system behavior.
- <u>Invasion Success Experiments:</u> What causes an invasion to succeed when a ship enters a port and empties its ballast? Current research in Duluth is addressing this problem but replicating that work with different source water communities and characteristics would be useful to predict where invaders may appear next.
- <u>Larval Growth and Survival of Coregonids:</u> What are the intrinsic and extrinsic factors that determine larval growth and survival of this economically and culturally important group of fishes around the GLB? This experiment would use larvae from different areas to get at and separate effects of prey type, temperature, light, etc.

3d. Governance, Funding, and Next Steps

The penultimate group discussion focused on a possible governance structure for GLIMR and funding opportunities to initiate experiments. There was no consensus on a governance structure but recommendations were made to look at other similar networks (e.g., NutNet; Great Lakes CWC; Aquacosm: https://www.aquacosm.eu/) for best practices.

The funding discussion was more robust than governance, and several suggestions were offered:

- Great Lakes-wide foundations (e.g., Mott, Joyce) to support the 'Mesocosm Effect" effort.
- The NSF-Research Coordination Network following the 'Mesocosm Effect' effort to build the network, strategize over governance, and identify future funding. The RCN does not cover collection of new data, only analysis of existing data and planning.
- A Great Lakes-specific proposal could go to GLRI if linked to the Focus Areas and LAMPs
- Fee structure for use of shared mesocosms facilities. This has been done differently across facilities run by participants and ranges from covering electrical consumption to assigning effort to support staff.

4. Summary

Mesocosms provide an attractive vehicle to better understand mechanisms and processes. They are tractable, replicable, and allow for easy manipulation of environmental factors. A CIGLR-funded summit was convened to assess the feasibility of developing a Great Lakes Integrated Mesocosm Research (GLIMR) network. The summit participants described their own mesocosm systems; it was clear that a very diverse set of mesocosm systems exist throughout the Great Lakes basin, with their designs often driven by specific research foci.

Group discussions resulted in two complementary, and sequenced, paths forward. The first path involves taking advantage of the diverse mesocosm systems by coordinating a controlled experiment in all mesocosms to determine how mesocosm type influences the same response variable. Because this path requires no new infrastructure, it can be implemented once funding is secured. The second path requires the construction of a new network of similarly designed mesocosms, so a coordinated network would be deployed across the Great Lakes. This path will require substantial funding and planning, and would be a longer-term initiative to develop a research infrastructure network.

The group identified a series of experiments that are relevant, tractable, and amenable to a mesocosm approach. It is possible these experiments could be conducted currently among a subset of existing mesocosm arrays, while ultimately they could serve as an important component of future proposals. There was no consensus on a governance structure for GLIMR, although all the participants are willing and interested in continuing this initiative. Next steps will include fact-finding regarding both plausible governance structures and funding sources for proposal submission.

5. Acknowledgments

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Logistical support was provided by Mary Ogdahl and Aubrey Lashaway, and we extend our deep gratitude to them both.

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Appendix A. Slides of mesocosm facilities that were shown at the Summit.

University of Michigan – ES George Reserve

Facility description

- 160 outdoor 1,100L cattle tanks in Pinckney, MI
- Source water from pond (5 m) or groundwater

University of Michigan – ES George Reserve

Advantages

- High replication
- Full solar irradiance

Challenges/Limitations

- Temperature control
- Source water characteristics and control
- Invasive species precautions

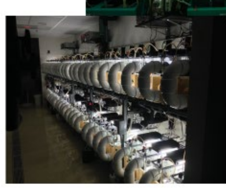
Current and past uses

- Food webs studies, esp. frogs
- Biodiversity studies with phytoplankton

University of Michigan – Dana Building

Facility description

- 160 10L aquaria
- 144 artificial stream flumes



University of Michigan – Dana Building

Advantages

- High replication
- Temperature and light control

Challenges/Limitations

- Invasive species precautions
- Many moving parts, high labor requirements

Current and past uses

- Biodiversity studies with phytoplankton, zooplankton
- Fish physiology (K. Alofs)

Great Waters Research Consortium mesocosm array, Montreal Pier, Superior Wisconsin

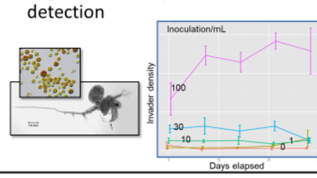
- 22 X 1 m^3, 40 X 20 L
- Closed system, recirculating
- Indoor
- Fluorescent lighting, timed
- Duluth-Superior Harbor water source, filled simultaneously
- Permitted for invasives

Great Waters Research Consortium mesocosm array, Montreal Pier, Superior Wisconsin

Advantages
- Identical fill conditions
- Non-natives allowed
- Temp/light control
- Harbor water reflects many Great Lakes conditions

Challenges/Limitations
- Not refreshed
- No winter

Current and past uses
- Ballast water risk-release relationships
- Organism density versus eDNA detection



University of Notre Dame Linked Experimental Ecosystem Facility (ND-LEEF) – South Bend, IN

Facility description
- 4 outdoor experimental watersheds each containing connected stream, pond, wetland
- Dedicated gravel pad for tank mesocosms (electric, water)
- Groundwater from reservoir
- Natural light; 90% shade cloth available
- Wireless high-speed internet; weather station

https://environmentalchange.nd.edu/resources/nd-leef/experimental-facilities/

ND – LEEF

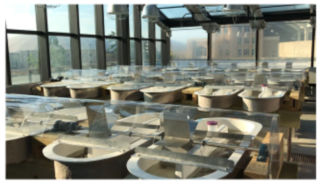
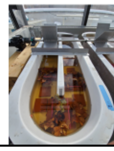
Advantages
- Setting that mimics nature, yet highly controllable and replicable
- Small grants available for pilot projects

Challenges/Limitations
- No invasive species not already present at site
- No addition of harmful pollutants that cannot be effectively contained/removed

Current and past uses
- Stream transport of:
  - Nitrogen, phosphorus, environmental DNA (eDNA), proteins, microplastics, nano-particles
- Ecosystem metabolism
  - Whole pond metabolism on DOC
  - Stream biofilm
- Public outreach/engagement

UND – Experimental Mesocosm Facility (South Bend, IN)

Facility description
- 16 streams
- 25 L
- Recirculating
- Indoor
- Natural light; supplemental high pressure sodium lights
- Well water


UND Experimental Mesocosm Facility

Advantages
- Replication
- Year-round use

Challenges/Limitations
- Not flow-through
- Accommodates invertebrates but not fish

Current and past uses
- eDNA degradation
- Antibiotic resistant gene degradation
- Possible contaminant studies (in development)

CFRE Mesocosm Lab: Sault Ste. Marie, MI

Facility description (indoor)
- Main system
  - 18 tanks, 4' (123 cm) Ø x 36" (91 cm) D, 270 gal (1,022 L)
  - 4 separate treatment systems, each with 4-5 reps
- 2 tank-rack systems
  - 3, 50 gal (189 L) rectangular tanks
  - 3, 15 gal (57) rectangular tanks
- Flow-through or RAS
- Water sources
  - St. Marys River (filtered or unfiltered)
  - Dechlorinated municipal
- Invasive species approval possible

CFRE Mesocosm Lab: Sault Ste. Marie, MI

Advantages
- It's new
- Flexibility and replication
- Temp control

Challenges/Limitations
- It's new
- Incomplete automation and alarm systems
- Manual flow control at the tank level

Current and past uses
- Tank-rack system used for studies of fish feeding behavior
  - E.g., Kapuscinski et al. (2022), JGLR
- Main system will be used to rear Lake Whitefish in 2022-2023

Central Michigan University Biological Station on Beaver Island, Lake Michigan

Facility description
- Number of mesocosms - 12
- Volume of mesocosms – 250 gallons
- Flow-through or recirculating - Either
- Indoor/Outdoor - Indoor
- Light source - Overhead tungsten-halide lamps
- Source water – Lake Michigan at either 0.5 m or 10 m depths.
- Permitting issues – Discharge Permits in place.
- Others- Temperature regulation (5 to 30°C) is maintained by pumping water from the tanks through water-cooled heat exchangers

Central Michigan University Biological Station on Beaver Island, Lake Michigan

Advantages
- Relatively pristine northern Lake Michigan

Challenges/Limitations
- Steinman in his new position

Current and past uses
- Otolith microchemistry
- Invasive species interactions
- Hydrocarbon degradation
- Climate change/temperature experiments

Central Michigan University- Vivarium (Mt. Pleasant MI)

Facility description – Flexible indoor facility- ~5000ft²
- 6 research rooms (RR) + 4 chambers (CH), large procedure rooms
  - Number of mesocosms- living 2x400 gallons, 3x200 gallons, 2x~200 gallons, 6 living streams
  - 10x 10 gallons(x3), 3x 20 gallons(x3), 30x 10 L, 180 x 3 L, 100x 1L (AHABS)
- Flow-through or recirculating: Recirculating, partial
- Indoor
- Light source: Fluorescent, CH: VHO (higher output) sunset options. All: Ramping options.
- Source water: dechlorinated softened well and RO.
- Temp ranges: ~67 and 82F (RR), 34-104F to within +/- .3 degree (CH and CH humidity control: 10% to 95% controllable to +/-2%.
- Permitting issues (invasive spp)- no just IACUC (based on individual studies); holding tanks for contaminant research/disposal pick up.
- Epoxy coated walls and floors, sound and vibration to a minimum
- Compressed airline for supplemental oxygen

Central Michigan University- Vivarium (Mt. Pleasant MI)

Advantages
- **Flexibility and replicates**
- Could be used for controls
- CMU Vivarium manager (FT)- currently Michael O'Neill
- MS and UG projects- right on campus
- Location- ~ 2 hours from all GL except Superior.
- Could be used year round if needed
- Temperature and humidity tracking with alarm notification when parameters are out of range.

Challenges/Limitations
- Water sources
- Stored water ready to go
- Natural water would need to be transported
- Temp controlled (trash cans)
- Not continual use of whole facility
- No consistent long term study

Current and past uses:
- White fish/Cisco predation study/growth rates (McNaught Galarowicz)
- Round Goby (predation –MN, trap assessment (TG), behavior with mussels (Woolnough)
- IPPC modeling climate change filtration experiments (Woolnough): https://www.journals.uchicago.edu/doi/full/10.1086/706185
- Contaminants of emerging concern (LM Bass and unionids)
- Crayfish (behavior)
- Salamander breeding
- Invasive plants
- Host fish/endangered unionids (e.g., hatchery efforts for unionids)- Woolnough

Varied physiological responses of *Amblema plicata* and *Lampsilis cardium* exposed to rising temperatures

Portable Lab- CMU- Woolnough

- 17 foot insulated, temperature control (Heat and AC) research trailer, pumps to access any natural water.
- 250 x 3L
- Flow-through or recirculating: both
- Indoor/Outdoor: In trailer
- Light source: LED programable
- Source water: Natural wherever you want
- Permitting issues: as needed (so far no issues)
- Bench space
- Generator or electrical power source





CENTRAL MICHIGAN UNIVERSITY

Portable Lab- CMU- Woolnough

Advantages
- Cost - total system < $20K
- Replicates
- EXACT system used anywhere
- Outreach options
- St. Cloud State has multiple replicates of this system (Heiko Schoenfuss' Lab)

Challenges/Limitations
- Small tanks (so far).

Current and past uses

- Maumee- Contaminants, behavior, unionids, FH minnow
- Milwaukee- Contaminants, behavior, unionids, FH minnow
- Grand R- MI (Lyons)- Snuffbox, logperch- host fish propagation (MDNR and Consumers Energy): https://www.youtube.com/watch?v=zMbyX4ToC1s
- Outreach


Journal of Great Lakes Research

Contaminants of emerging concern may pose prezygotic barriers to freshwater mussel recruitment

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Ohio State Univ. Stone Lab. South Bass Island

Facility description (examples)
- Number of mesocosms - 15
- Volume of mesocosms – 600-700 gallons (2,270 – 2,650 Liters)
- Flow-through
- Outdoor
- Light source: The sun
- Source water: Lake Erie surface – Put in Bay
- Permitting issues (invasive spp)? : No permits of any kind yet.
- Others?


Ohio State Univ. Stone Lab. Mesocosms

Advantages
- Near lab
- Open air
- Dual pumps and lines
- Flow-through with Erie

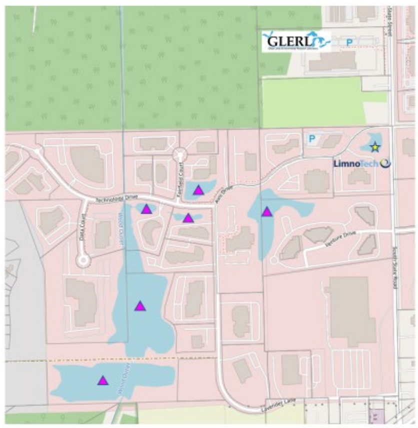
Challenges/Limitations
- PIB sewer is small, cannot handle flush. Tanks drained slowly over 4 days if altered.
- Opened in 2022. Still learning
- Open air (bugs, birds)

Current and past uses
- Past uses = a parking lot
- Summer 2022 – simple experiments to help us learn the facility. Test for tank-to-tank differences.

MESOCOSM-LIKE FACILITIES

LimnoTech

ADDITIONAL PONDS IN OFFICE PARK



GVSU – AWRI (Muskegon, MI)

Facility description

- 12 fiberglass tanks
- 350 gallon
- Recirculating
- Indoor
- 1000 W metal halide lamps; adjustable height
- Muskegon Lake (filtered)

AWRI Mesocosm Facility

Advantages

- Replication
- Year-round use
- Accessible

Challenges/Limitations

- Temperature control
- Not flow-through
- Not instrumented

Current and past uses

- Food web studies (predator-prey)
- Sediment toxicity studies
- Macrophyte/epiphyte ecology
- Holding tanks for lake sturgeon during TFM applications

Appendix B. Agenda of Summit.

Coordinated Experiments Across the Great Lakes Basin: Great Lakes Integrated Mesocosm Research (GLIMR) June 22-23; Ann Arbor, MI

AGENDA

June 22nd, 2022

Morning/afternoon	Travel to Ann Arbor
Early evening	Group dinner and social at the Earle

June 23rd, 2022

8:30 – 9:00 am	Gather at Dana Building. A light breakfast will be provided.
9:00 – 9:15 am	Welcome by Greg Dick, CIGLR Director or representative
9:15 – 9:30 am	Summit overview and goals, Steinman
9:30 – 10:30 am	Two-slide presentations by summit attendees with mesocosm facilities
10:30—10:45 am	Refreshment break
10:45 – 12:00 pm	Group discussion on coordination, governance, and next steps (proposals)
12:00 – 1:00 pm	Lunch break [Dana Building]
1:00 – 3:00 pm	Break outs into 2-3 working groups to discuss specifics on experiments
3:00 – 3:15	Break
3:15 – 4:00 pm	Report out from working groups
4:00 – 5:00 pm	General discussion on day's effort and reach consensus on next steps
5:00 pm	Adjourn
6:00 pm	Group dinner [location TBD]. Meet in hotel lobby at 6:30 to walk to restaurant.

June 24th, 2022

Departure home