## Lake Michigan Cooperative Science and Monitoring Initiative

2025 Science Priority Planning Workshop Report



Photo courtesy A. Elgin, NOAA Great Lakes Environmental Research Laboratory.

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## **Background and Project Description**

This document summarizes work completed by Illinois-Indiana Sea Grant (IISG) during the summer and fall of 2023 in support of the Great Lakes Water Quality Agreement (GLWQA) Annex 2 Lake Michigan Partnership. Specifically, IISG is supporting the Lake Michigan Partnership's activities to determine science priorities for the Cooperative Science and Monitoring Initiative (CSMI) 2025 Field Year on Lake Michigan. CSMI is a binational effort led by the U.S. Environmental Protection Agency Great Lakes National Program Office (GLNPO) and Environment and Climate Change Canada. Each year since 2002, CSMI has coordinated monitoring and research efforts to address Lake Partnership science and monitoring priorities. While work happens on all five lakes every year, only one lake is targeted for intensive field sampling in any given year. The 2020 Lake Michigan CSMI field year extended through 2021 because of COVID-19 pandemic interruptions to field and laboratory activities.

The work described herein was conducted by IISG, sponsored by the International Joint Commission, and comprised a 2-day in-person workshop plus a follow-up, online survey to collect additional information that could be helpful in developing priorities for the 2025 CSMI intensive year on Lake Michigan. The efforts by IISG were guided by a planning committee. Members included Derek Ager and Elizabeth Hinchey Malloy (EPA GLNPO), Stacy Hron (Wisconsin Department of Natural Resources), Matt Preisser (Michigan Department of Environment, Great Lakes and Energy), Titus Seilheimer (Wisconsin Sea Grant), and Paris Collingsworth and Kristin TePas (IISG). More than 200 people were invited via email to attend a 2-day in-person workshop in Milwaukee, Wisconsin on July 20–21, 2023. Ultimately, 48 people attended. The goals of this in-person workshop were to:

- 1. Reflect on recent Lake Michigan research findings.
- 2. Identify key research-related information needs that could be addressed in the 2025 field year, with a goal of aiding Lake Michigan management.

The timing of the July 2023 workshop coincided with summer field work and other obligations on the part of many invitees. To ensure that a broad range of perspectives were incorporated into this effort, IISG developed an online Qualtrics survey based on information shared during the workshop. The same 200+ email addresses were used to encourage invitees to complete the survey. Responses to the survey were accepted between August 21, 2023 and September 13, 2023. Qualtrics recorded 74 responses, though not every respondent answered every question. Of the survey respondents, 73% did not attend the 2-day workshop, thus IISG staff members feel confident that additional perspectives were successfully incorporated into the overall effort.

Information contained in this report is intended as guidance only. While primarily written to help the Lake Michigan Partnership as the group sets research priorities for the 2025 intensive field year, IISG staff members expect that other researchers and entities studying Lake Michigan might be interested in this summary. Raw notes from workshop discussions are available on request. In addition, findings from 2020/21 are summarized in a white paper that will be made available online at greatlakescsmi.org. Questions about this report can be directed to IISG staff members Carolyn Foley (cfoley@purdue.edu) or Paris Collingsworth (pcolling@purdue.edu).

## **In-Person Workshop Summary**

The Milwaukee in-person workshop was scheduled to run from 12:00 pm Central Time on July 20, 2023 through 12:00 pm Central Time on July 21, 2023. Activities on Day 1 were devoted to reviewing current knowledge about Lake Michigan.

First, Annie Scofield (U.S. EPA GLNPO) provided an overview of the efforts undertaken during the 2020/21 CSMI Field Year on Lake Michigan, including a review of the overall CSMI process. Four additional presentations summarized key findings of the 2020/21 efforts.

- Joel Hoffman (U.S. EPA Great Lakes Toxicology and Ecology Division) and Ralph Tingley (U.S. Geological Survey Great Lakes Science Center) reviewed findings related to lower trophic levels of the food web and larval fish.
- 2. Ashley Elgin (National Oceanic and Atmospheric Administration Great Lakes Environmental Research Laboratory) and Annie Scofield reviewed findings related to Lake Michigan dreissenid and benthic macroinvertebrate communities.
- 3. Darryl Hondorp (USGS Great Lakes Science Center) reviewed findings related to fish habitat associations.
- 4. Brian Lenell (U.S. EPA Great Lakes Fish Surveillance and Monitoring Program) reviewed results related to contaminants.

A series of 3-minute lightning talks followed. The topics scheduled to be covered are listed in Table 1, though some last-minute cancellations marked with \* affected the final presenter list.

Name	Affiliation	Торіс
Sandra McLellan	University of Wisconsin-Milwaukee	Beach closings and risk-based criteria
Maureen Coleman*	University of Chicago	Microbial observations and outstanding questions
Rachel Poretsky	University of Illinois Chicago	Microbial communities and carbon cycling in Lake Michigan
Carmen Aguilar	University of Wisconsin-Milwaukee, School of Freshwater Sciences	Phytoplankton dynamics
Harvey Bootsma	University of Wisconsin-Milwaukee, School of Freshwater Sciences	Nearshore benthos
Carl Ruetz	Grand Valley State University	Fish use of drowned river mouth lakes
Spencer Gardner	Purdue University	Potential larval fish monitoring program
Robin Mattheus	Illinois State Geological Survey	Offshore geological mapping along the Chicago lakefront
Mark Rowe	NOAA GLERL	Realtime biophysical models to support Lake Michigan CSMI 2020, and options for CSMI 2025
Ed Verhamme*	Limnotech	Real time buoy network along Lake Michigan shoreline
Matt Kornis	US Fish and Wildlife Service	Data collection possibilities for salmonines from Lake Michigan
John Janssen	University of Wisconsin-Milwaukee	The complex abyss

Table 1. Scheduled lightning talk presentations.

After these overview and lightning presentations, workshop attendees participated in breakout and largegroup discussions centered on the following questions.

- 1. What are big picture questions about Lake Michigan that we, collectively, may have a good handle on? What big picture questions remain?
- 2. What CSMI work so far has been most helpful to agencies responsible for managing the lake and its resources (whether in Lake Michigan or in other lakes)?
- 3. How can repeated CSMI sampling be used to answer broader questions? (Which questions is this approach best suited for?)
- 4. What are some big picture questions or needs that are not currently part of CSMI for Lake Michigan but would be important to consider including for 2025?

Key topics or themes that emerged as important to discuss were: winter sampling, social science, larval fish bottlenecks, contaminants of emerging concern, and nearshore habitat. These themes informed activities on Day 2, which were intended to help the group look forward and generate concrete ideas to share with the Lake Michigan Partnership.

Day 2 of the workshop began with a review by Paris Collingsworth of Day 1 discussions, and a review of the Lake Partnership's role in determining CSMI priorities, plus a reminder of the workshop goals by Elizabeth Hinchey Malloy and Derek Ager. Participants were then asked to self-select into one of six groups to discuss specific questions that could be answered via 2025 CSMI Field Year on Lake Michigan. The six groups were organized topically around:

- 1. Winter Sampling
- 2. Social Science
- 3. Larval Fish Bottlenecks
- 4. Contaminants of Emerging Concern
- 5. Nearshore Habitat
- 6. Miscellaneous (Other Topics)

At various points, participants took breaks from their discussion and were encouraged to join other groups. The following prompts were used for the group discussions.

- What are specific questions that could be answered via CSMI Lake Michigan 2025? These could be new or continuing questions. Please sign your name if you're comfortable, so the Lake Michigan Partnership can follow up with questions.
- What particularly are you interested in under each research topic of interest?
- Group the questions together and then try to answer the following. It is OK to leave things blank or answer with "we don't know."
  - What agencies could use the information generated by answering this (these) question(s)?
  - Is anyone already trying to answer this (these) question(s)? If so, who?
  - Can this (these) question(s) be addressed using data that were previously collected? If so, where are those data?
  - Other thoughts (e.g., key challenges or opportunities)

• Which of these big picture questions can be addressed given the constraints of CSMI sampling?

Discussions were wide-ranging, but the following are key, specific questions extracted by IISG staff members from the meeting notes. The Lake Michigan Partnership was given access to all raw meeting notes.

#### **Specific Questions Related to Winter Sampling**

- 1. How do winter conditions relate to summer plankton in the lake?
- 2. Do key biological, chemical, and physical processes occur over water or under ice?
- 3. How does nutrient cycling change over winter?
- 4. What are under-ice light conditions and how does ice quality impact light attenuation and corresponding biology?
- 5. What are baseline under-ice conditions in Lake Michigan for nutrients, biology, light conditions?
- 6. How are different fish species (e.g., lake trout, lake whitefish) affected by winter conditions?
- 7. What are potential or realized impacts of changing ice cover?

#### **Specific Questions Related to Social Science**

- 1. Who is eating what? How does that intersect with environmental justice and/or contaminant issues (e.g., subsistence fishing)?
- 2. What do coastal users value about the lakes?
- 3. What are barriers for people using Lake Michigan?
- 4. What is the baseline knowledge of Lake Michigan for various user groups?
- 5. How do different user groups of Lake Michigan perceive each other? What levels of trust exist?
- 6. How do we conduct outreach to encourage behavior change with a goal of better outcomes for the environment?
- 7. Can we engage volunteers to collect nearshore or offshore data?
- 8. How are users of the lake responding or adapting to climate change?
- 9. Are government programs and decisions commensurate with the values of those who use Lake Michigan?
- 10. What are social barriers keeping those who live within 100 km of Lake Michigan from utilizing resources?

#### **Specific Questions Related to Larval Fish Bottlenecks**

- 1. Where are hotspots for fish production and recruitment in Lake Michigan?
- 2. How do we improve previous efforts to understand bottlenecks affecting larval fish in Lake Michigan?
- 3. What quantitative contribution does the micro food web make to larval fish recruitment?
- 4. What are the impacts of episodic biophysical events on fish recruitment?
- 5. What are the effects of ice cover or lack of ice cover on fish spawning?
- 6. What limits recruitment of whitefish and cisco?
- 7. What are egg survival rates for different fish species across different Lake Michigan habitats?

#### Specific Questions Related to Contaminants of Emerging Concern (CECs)

- 1. Where is PFAS coming from?
- 2. Where is PFAS ending up (biota, fractionation)?
- 3. What are the consequences of PFAS in Lake Michigan?
- 4. What is the impact of chlorides on the Lake Michigan ecosystem?
- 5. What is the impact of neonicotinoids on the Lake Michigan system?

#### **Specific Questions Related to Nearshore Habitat**

- 1. How do physical processes that happen in the winter affect the nearshore habitat of Lake Michigan?
- 2. How have physical conditions changed along the shoreline? Near the shoreline?
- 3. How does sediment transport impact biota and habitats, chemistry, physical integrity, etc. in the very nearshore region?
- 4. How does sediment transport affect beach nourishment?
- 5. Are there beneficial uses of dredged material to create reef systems (e.g., biotic, shoreline stabilization)?
- 6. Should we conduct a nearshore assessment or otherwise map underwater topography in Lake Michigan every five years?
- 7. Are nutrient management actions in Fox River and Green Bay having the desired effect?
- 8. What are the effects of septic water system inputs on Lake Michigan water quality?

#### Specific Miscellaneous Questions Generated During the 2-day Workshop

- 1. What are groundwater contributions to Lake Michigan (quantity and quality)?
- 2. How can we collect open water fish movement data to supplement high resolution GLATOS data in Green Bay and tributaries?
- 3. Are we missing any important questions related to climate change? (e.g., temperature, storm events, harmful algal blooms)
- 4. Are there lake chemistry effects on drinking water?
- 5. Can we understand harmful algal blooms and toxins in Green Bay, especially continued work on early detection and modeling risk?
- 6. What are the effects of harmful algal bloom toxin mixtures on public health?
- 7. Are we making accurate population assessments and/or using correct methods to assess the mysid population? What fish are eating them?
- 8. Considering how we assess the Lake Michigan food web, are we accurately representing phytoplankton communities?

## **Survey Summary**

As noted in the background and project description section, IISG developed the survey to ensure that as many perspectives as possible were incorporated into this effort. The same 200+ email addresses were used to encourage invitees to complete the survey. Responses to the survey (N = 74) were accepted between August 21, 2023 and September 13, 2023;73% of survey respondents did not attend the 2-day inperson workshop. The full survey is included as Appendix 3.

Previous discussions that included Lake Michigan CSMI researchers and information end users have highlighted the differences between repeating or building directly on previous efforts during CSMI Lake Michigan years and asking entirely new research questions. All who are engaged with CSMI Lake Michigan efforts acknowledge that resources are limited and it is beneficial to generate long-term datasets around key questions, but there may also be room for growth. In 2020/21, USGS had specific projects to synthesize CSMI-generated information across multiple years and lakes. To help the Lake Michigan Partnership understand the perceived value of these general efforts, it was addressed in a survey question. The responses are summarized in Table 2. The statements were presented to the survey respondents in random order.

Statement	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
There is value in synthesizing information gathered across multiple CSMI years in a given lake or set of lakes, i.e., using long- term abiotic or biotic monitoring datasets to answer broader questions.	34	11	4	1	0
There is value in maintaining current nutrient monitoring efforts during the 2025 Field Year on Lake Michigan.	20	20	6	4	1
There is value in maintaining current food web monitoring efforts during the 2025 Field Year on Lake Michigan.	22	17	8	2	1
The 2025 Field Year on Lake Michigan sampling should focus on spatial differences.	16	22	8	5	0
The 2025 Field Year on Lake Michigan should focus on temporal differences, e.g., seasonal or finer scale temporal changes.	15	20	12	4	0

Table 2. Summary of the number of respondents' agreement with general statements about Lake Michigan CSMI efforts.

Two questions in the survey were intended to help the Lake Michigan Partnership understand whether specific topics should have more, similar, or less effort during the 2025 CSMI Field Year on Lake Michigan. Topics were generated by IISG staff members after examining breakout and summary discussion notes from the 2-day workshop. Table 3 summarizes the answers around biotic process questions while Table 4 summarizes the answers around abiotic process questions. For both questions, respondents were presented the topics in random order.

Table 3. Summary of responses to the question "How much effort should be invested in examining questions related to **biotic** processes, where some of these questions have been assessed in previous CSMI efforts in Lake Michigan."

Researchers should invest	MORE effort to INCREASE understanding of this issue	SIMILAR effort to MAINTAIN understanding of this issue	LESS effort to direct efforts elsewhere	UNSURE	Sum of "SIMILAR" and "MORE"
Nearshore food web dynamics	20	24	2	3	44
Changes to primary production in Lake Michigan	17	25	5	3	42
Seasonal food web dynamics including winter dynamics	28	14	3	5	42
Impacts of climate change on food web dynamics	27	14	7	2	41
Lake whitefish declines in Lake Michigan	22	17	4	6	39
Larval fish bottlenecks	16	22	2	9	38
Dreissenid mussel dynamics (veligers)	13	23	7	7	36
Phytoplankton communities	8	26	10	4	34
Dreissenid mussel dynamics (adult)	6	27	10	7	33
Open water fish movement data	13	19	12	5	32
Role of mysids in the food web	8	21	10	9	29
Impacts of land use change on food web dynamics	16	12	17	5	28

Table 4. Summary of answers to the question "How much effort should be invested in examining questions related to **abiotic** processes, where some of these questions have been assessed in previous CSMI efforts in Lake Michigan."

Researchers should invest	MORE effort to INCREASE understanding of this issue	SIMILAR effort to MAINTAIN understanding of this issue	LESS effort to direct efforts elsewhere	UNSURE	Sum of "SIMILAR" and "MORE"
Impacts of climate change	22	22	4	3	44
Contaminants of emerging concern, in particular PFAS/PFOAs	26	17	4	3	43
Nutrient cycling in the nearshore region	21	21	5	4	42
Effects of episodic storms on nutrient inputs to the lake (N, P, etc.)	22	18	6	4	40
Seasonal effects on nutrient dynamics	16	21	7	6	37
Nutrient changes in Green Bay	12	24	7	8	36
Shoreline resilience, sediment transport, erosion	19	17	10	5	36
Risk, detection, and understanding of harmful algal blooms, their toxins, and effects on public health	10	24	12	4	34
Impacts of land use change	11	19	12	7	30
Nutrient transfer from the Fox River to Green Bay to Lake Michigan	15	15	11	8	30
Effects of Lake Michigan water chemistry on drinking water	14	15	11	10	29
Point-source contamination	7	18	14	11	25
Quantity and quality of groundwater contributions to Lake Michigan	9	16	14	11	25

Survey respondents were then asked a series of questions related to the five key topics identified during the 2-day workshop (winter sampling, social science, larval fish bottlenecks, contaminants of emerging concern, and nearshore habitat). Survey respondents were asked to rank each specific question listed under a general topic as "high," "medium," or "low" priority, and were also invited to suggest additional, specific, key research questions that could be addressed in the 2025 CSMI Field Year. Figures 1, 2, 3, 4, and 5 summarize the rankings; additional, specific, key research questions suggested by survey respondents are included after each figure. For each question, survey respondents were presented the options for ranking in random order.



Percentage of Responses (This question is a HIGH priority for me) Percentage of Responses (This question is a MEDIUM priority for me)

Percentage of Responses (This question is a LOW priority for me)

Fig. 1. Responses to the prompt: "The following questions are related to WINTER SAMPLING. Please sort them into HIGH, MEDIUM, or LOW priority boxes. If you truly believe they are all the same priority, feel free to put them all in the same box." The options given to survey respondents were synthesized from notes on winter sampling-related priorities discussed during the 2-day workshop (see page 5 of this report). Percentages reflect respondents who selected that choice; thus the overall percentage can be higher than 100%.

Suggestions for additional, specific, key research questions related to winter sampling that could be addressed in the 2025 CSMI Field Year were generally in the form of comments rather than questions, but they are included for consideration.

- I think there is a need to separate Green Bay and nearshore ice cover from the main basin. There generally isn't that much ice cover on the main basin.
- It is dangerous to hang too many CSMI questions on ice, because you may only get ice in certain shallow parts of the lake that are basically not measurable.
- How do you define winter from the frame of reference of various biota? Some are incubating, some very active, others not?
- Given how little we know- improving baseline understanding seems like a good start.
- How does this line of inquiry get implemented? We don't currently have sufficient resources to answer questions related to the open-water period; I'm worried that a focus on winter will dilute needed resources.



51 Responses

Percentage of Responses (This question is a FIGH phony for me)
Percentage of Responses (This question is a LOW priority for me)

Fig. 2. Responses to prompt: "The following are SOCIAL SCIENCE research questions. Please sort them into HIGH, MEDIUM, or LOW priority boxes. If you truly believe they are all the same priority, feel free to put them all in the same box." The options given to survey respondents were synthesized from notes on social science-related priorities discussed during the 2-day workshop (see page 5 of this report). Percentages reflect respondents who selected that choice; thus the overall percentage can be higher than 100%.

Suggestions for additional, specific, key research questions related to social science that could be addressed in the 2025 CSMI Field Year were:

- How do people use Lake Michigan?
- How are underrepresented communities using the lake? What, if any, is their relationship to the lake? What science issues resonate with such communities?
- What can be done to understand pier fisheries and people, e.g., young anglers, who do not buy fishing licenses?
- How do interactions between people and coasts differ along saltwater coasts vs. in the Great Lakes?
- Do coastal riparian owners understand that shoreline hardening accelerates adjacent shoreline erosion?



47 Responses

Fig. 3. Responses to the prompt: "The following questions are related to LARVAL FISH BOTTLENECKS. Please sort them into HIGH, MEDIUM, or LOW priority boxes. If you truly believe they are all the same priority, feel free to put them all in the same box." The options given to survey respondents were synthesized from notes on larval fish bottleneck-related priorities discussed during the 2-day workshop (see page 5 of this report). Percentages reflect respondents who selected that choice thus the overall percentage can be higher than 100%.

Suggestions for additional, specific, key research questions related to larval fish bottlenecks that could be addressed in the 2025 CSMI Field Year included:

- What habitat conditions do Lake Trout require to successfully reproduce?
- Where are larval fish actually hatching?
- Where do most of the larval alewife come from?



Percentage of Responses (This question is a HIGH priority for me) • Percentage of Responses (This question is a MEDIUM priority for me)

Percentage of Responses (This question is a LOW priority for me)

Fig. 4. Responses to the prompt: "The following research questions focus on CONTAMINANTS OF EMERGING CONCERN (CECs). Please sort them into HIGH, MEDIUM, or LOW priority boxes. If you truly believe they are all the same priority, feel free to put them all in the same box." The options given to survey respondents were synthesized from notes on CEC-related priorities discussed during the 2-day workshop (see page 6 of this report). Percentages reflect respondents who selected that choice; thus the overall percentage can be higher than 100%.

Suggestions for additional, specific, key research questions related to CECs that could be addressed in the 2025 CSMI Field Year were:

- Are any of the known or unknown contaminants at play in the physiology of bloater?
- More research into understanding the direct and indirect effects of CECs on Young of Year fish and their recruitment into population
- More research investigating spatial and temporal dynamics of these chemicals in shallow littoral areas of the lake and their persistence in fish assemblages, especially fish that inform human consumption advisories
- Exploring how the use of technology to signature track PFAS could be expanded in fish tissue analysis, which may lead to better source input knowledge and eventual limitations on PFAS use within the Great Lakes Basin.

50 Responses



Percentage of Responses (This question is a LOW priority for me)

Fig. 5. Responses to the prompt: "The following research questions are related to NEARSHORE HABITAT. Please sort them into HIGH, MEDIUM, or LOW priority boxes. If you truly believe they are all the same priority, feel free to put them all in the same box." The options given to survey respondents were synthesized from notes on nearshore habitat-related priorities discussed during the 2-day workshop (see page 6 of this report). Percentages reflect respondents who selected that choice; thus the overall percentage can be higher than 100%.

Suggestions for additional, specific, key research questions related to nearshore habitat that could be addressed in the 2025 CSMI Field Year included:

- How is nearshore linked to all research questions? Do we really know?
- What are the impacts of erosion control (both large e.g., multimillion dollar breakwall projects, and small e.g., residential lakefront property owners dumping rocks [but all their neighbors are doing it as well, but independently]) on biota? (e.g., colonization and use by living things, and broader impacts as new habitats)
- What is the condition of nearshore wetlands in Lake Michigan?
- What are the spatiotemporal effects of human-made habitat (beneficial use of dredged material) to influence fish assemblages in near-shore and shallow littoral areas of Lake Michigan? Further, how do these habitat structures influence seasonal changes in trophic structure and resiliency of these fish communities to respond to contaminants of emerging concern?

- We don't understand the nearshore at all. Folks think rocky versus sand versus clay, but Illinois has very significant Silurian fossil bioherm reefs---tough bedrock, with cobble/boulder glacial till in between. They are very different types of rock. The sand shifts and when it does it erodes the clay. And the clay varies from the soft marl clay ridges around Michigan City to the very tough Wadsworth/Oak Creek clays at IL-WI and further north. Michigan pretty much ignores its lakebed despite early studies (1960's to 1970's) studies showing how important they are to yellow perch.

Figure 6 summarizes demographics about the survey respondents.



Fig. 6. Count of professional affiliations of the respondents to the survey. Not all respondents answered every question. Of those who answered this question, 36 respondents did not attend the 2-day workshop while 13 respondents did. The "Other" category had one respondent who described their position as "academic plus DNR."

Finally, survey respondents were asked to provide additional big picture topics they felt should be considered for inclusion as a research priority for the 2025 CSMI Field Year on Lake Michigan. Relevant responses are included below.

- Include climate change in all of these. It is here and having an impact, even if we don't call it out specifically.

- How is climate change affecting nursery habitats (wetlands, tributary streams) and potential recruitment for great lakes fishes? How has the decline in alewife or other potential prey species affect survival and potential recruitment of salmonine smolts as they outmigrate from tributary, drowned river mouth or embayment habitats into nearshore or open lake waters?
- Has the funding, effort, and design of CSMI studies, particularly those intended to answer lakescale questions, been adequate to answer the questions?
- What is the fish carrying capacity of the lakes given current conditions?
- Have past efforts to evaluate food web structure and function across the lakes revealed anything relative to things like the Lake Michigan Fish Community Objectives, which include expected biomass ranges for fish based on size-spectrum modeling of data from the late 1980s?
- What seasonal patterns, if any, exist in the distribution of fish in Lake Michigan?
- Can lakewide autonomous fish surveys during CSMI years provide benefit beyond what is possible with ships?
- Currents/waves at different locations, temperatures at different locations. These are always needed for calibration/validation of hydrodynamic models.
- Studies that seek to identify less understood biodiversity and trophic pathways could be useful to round out our appreciation and understanding of this lake.
- I believe additional research/monitoring of shallow littoral zone fish assemblages is necessary to understand how fish assemblages respond to changes in habitat, nutrients, sediment biophysical/chemical structure, and environmental exposure to contaminants over space and time
- Further, assessing lipid content and isotopes of individual species and populations in near-shore shallow littoral zones would provide additional information to seasonal and spatially-explicit trophic dynamics.
- Further, more work is needed to understand young of year recruitment into populations and how pathways of environmental exposure to contaminants of emerging concern are linked between young of year fish and other sensitive species that may forage on these fish (e.g., bald eagles, osprey, herring gulls, mink, otter).
- Connecting the influence of tributary (upstream) processes on nearshore and open lake issues
- Understanding the role of wastewater treatment plants and other point sources on chemical and microbial contaminants in nearshore environment
- Understanding bacterial pathogen contaminants in the nearshore and Lake Michigan beaches and human health risk with recreation
- Safeguarding human health and balancing beach recreation (harmful algal blooms, riptides, pathogens, *E. coli*, other CECs)
- Identify dreissenid veliger primary sources within lake depth strata. What are survival rates of abundant newly settled quagga mussels in the offshore?
- I think understanding the extent to which Green Bay contributes native fish to the main basin of Lake Michigan is important to understand as I think in some cases we assume this happens and it may not happen to a very large degree for some stocks. Lake sturgeon are one good example: improving lake sturgeon numbers in Green Bay may not necessarily result in higher numbers of lake sturgeon in Lake Michigan. I also think providing some guidance as to what factors are regulating yellow perch abundance and what might be done to improve abundance is a topic of interest for many recreational fishers, especially in southern Green Bay where walleye and whitefish are currently thriving, yet perch remain at low abundance.

- Exploration of early warning systems for changes in system stability
- Improving models that are transparent, credible and useful to the Great Lakes community. Getting ecologists, chemists, modelers, experimentalists etc. in the same room and develop modeling tools that can be useful to all.
- Nutrient inputs (P in particular) have not been well quantified since 2008 (if I remember correctly). Not sure if this is a CSMI topic, but it should be a priority moving forward.

In addition, two comments provided via the survey seem particularly noteworthy for the LAMP to consider:

- Although improving the societal aspects of all lake uses can be considered as socially aspirational goals, the CSMI portion of the GLWQA is inherently designed to obtain scientific knowledge and understanding of what is necessary in order to protect the chemical, physical and biological integrity of the lakes. As such the CSMI projects need be tailored to that goal specifically.
- We don't currently have sufficient resources to answer questions related to the open-water period; I'm worried that a focus on winter will dilute needed resources.

Illinois-Indiana Sea Grant appreciates the opportunity to support the Lake Michigan Partnership in their setting of research priorities for the 2025 CSMI Field Year on Lake Michigan.

# Appendix 1. Workshop Attendees

Name	Organization
Derek Ager	USEPA
Carmen Aguilar	UWM School of Freshwater Sciences
Erin Argyilan	Indiana University Northwest
Karen Bauuman	UW-Milwaukee SFS
Harvey Bootsma	University of Wisconsin-Milwaukee SFS
Hunter Carrick	Central Michigan University
Paris Collingsworth	Purdue University
Russell Cuhel	UW-Milwaukee Water Works
Serguisz Czezny	Illinois Natural History Survey
Patty Dieter	USGS
Rae-Ann Eifert	Wisconsin DNR
Ashley Elgin	NOAA GLERL
Spencer Gardner	Purdue University
Brett Hayhurst	USACE-ERDC-EL
Elizabeth Hinchey Malloy	US EPA GLNPO
Joel Hoffman	US EPA ORD
Stacy Hron	WI Dept. of Natural Resources
John Janssen	University of Wisconsin-Milwaukee
Sheela Johnson	US Forest Service
Matthew Kornis	USFWS Green Bay FWCO
Brian Lenell	U.S. EPA
Madeline Magee	Wisconsin DNR
Robin Mattheus	Illinois State Geological Survey
Spencer McCormack	Little Traverse Bay Bands of Odawa Indians
Sandra McLellan	University of Wisconsin-Milwaukee
Janice Milanovich	Illinois-Indiana Sea Grant
Karen Murchie	Shedd Aquarium
Samantha Oliver	USGS, Upper Midwest Water Science Center
Rachel Porestky	University of Illinois Chicago
Matt Preisser	MI EGLE
Daniel Roback	Milwaukee Water Works Linnwood
Charles Roswell	Illinois Natural History Survey
Mark Rowe	NOAA GLERL
Carl Ruetz	Grand Valley State University
Ed Rutherford	NOAA GLERL
Vic Santucci	Illinois DNR
Annie Scofield	EPA GLNPO

Michael Spinar	IN Dept. Of Environmental Management
Owen Stefaniak	U.S. Geological Survey
Kristin TePas	IL-IN Sea Grant
Ralph Tingley	USGS Great Lakes Science Center
Jack Tyler	WIDNR
Jeff Tyson	Great Lakes Fishery Commission
Lizhu Wang	IJC
Susan Wells	USFWS
Travis Wood	IDNR Coastal Management Program

## Appendix 2. Workshop Agenda

FINAL AGENDA CSMI 2025 Field Year on Lake Michigan Kickoff Workshop

July 20-21, 2023

Day 1: The Pfister Hotel, 424 E Wisconsin Ave, Milwaukee, WI 53202

Day 2: Wisconsin DNR Building, 1027 W St Paul Ave, Milwaukee, WI 53233

Agenda Day 1, Reviewing current knowledge - July 20, 2023, Pfister Hotel, Rouge Room

12:00 pm Lunch (box lunches at the hotel)

1:00 pm Welcome and overview of workshop – Paris Collingsworth, Illinois-Indiana Sea Grant

1:10 pmBrief overview of CSMI 2020/21 efforts and executive summary andCSMI process – Annie Scofield, US EPA Great Lakes National Program Office

- 1:20 pm Mini overviews on key takeaways from CSMI 2020/21 effort
  - Lower trophic level/larval fish (Joel Hoffman, US EPA Office of Research and Development and Ralph Tingley, USGS Great Lakes Science Center)
  - Dreissenids and benthos (Ashley Elgin, NOAA Great Lakes Environmental Research Laboratory, and Annie Scofield, US EPA Great Lakes National Program Office)
  - Fish habitat associations (Darryl Hondorp, USGS Great Lakes Science Center)
  - Contaminants (Brian Lenell, US EPA Great Lakes Fish Surveillance and Monitoring Program)
- 2:20 pm Short break
- 2:25 pm Lightning talks (3 minutes each)
  - Sandra McLellan, University of Wisconsin-Milwaukee, Beach closings and risk based criteria
  - Rachel Poretsky, University of Illinois Chicago, Microbial communities and carbon cycling in LM
  - Carmen Aguilar, UWM school of freshwater sciences, Phytoplankton dynamics

#### Break

- Harvey Bootsma, University of Wisconsin-Milwaukee, School of Freshwater Sciences, 1. Nearshore benthos. 2. Water quality monitoring on a high-speed ferry.
- Carl Ruetz, Grand Valley State University, Fish use of drowned river mouth lakes
- Spencer Gardner, Purdue University, potential larval fish monitoring program
- Robin Mattheus, Illinois State Geological Survey, Offshore geological mapping along the Chicago lakefront

Break

- Mark Rowe, NOAA GLERL, Realtime biophysical models to support Lake Michigan CSMI 2020, and options for CSMI 2025
- Matt Kornis, US Fish and Wildlife Service, Date collection possibilities for salmonines from Lake Michigan
- John Janssen, University of Wisconsin-Milwaukee, The complex abyss
- 3:15 pm Break (coffee/tea/snacks/restroom/networking)
- 3:30 pm Breakout session (self select but strive for a mix of LAMP partners and researchers so good representation in each group): discussion prompts below.

End goal: Identify big picture research projects that could fit in the context of CSMI 2025

- What are big picture questions about Lake Michigan that we collectively may have a good handle on? What are the big questions that remain facing Lake Michigan?
  - What CSMI work so far has been most helpful to agencies responsible for managing the lake and its resources (whether in Lake Michigan or in other lakes)?
  - How can repeated CSMI sampling be used to answer these broader questions? (Which questions is this approach best suited for)?
- Which big picture questions would be important to consider including for CSMI 2025? (Which of these big picture questions can be addressed given the constraints of CSMI sampling?)
- 4:45 pm Large group report out and facilitated discussion related to breakout; identify topics to consider on day 2
- 5:15 pm Adjourn
- 6:30 pm Optional dinner with groups.

Agenda Day 2, Looking forward - July 21, 2023, Wisconsin DNR Building

- 8:00 am Coffee/tea/light breakfast
- 8:30 am Recap of Lake Partnership role in determining CSMI priorities, reminder of Goals of Workshop – Beth Hinchey Malloy and Derek Ager, US EPA Great Lakes National Program Office
- 8:40 am Recap of Day 1 Paris Collingsworth and Kristin TePas, Illinois-Indiana Sea Grant
- 8:45 am Individual activity then small group discussion (post big ideas from Thursday)
  - What are specific questions that could be answered via CSMI Lake Michigan 2025? These could be new or continuing questions. Please sign your name if you're comfortable, so the LAMP can follow up with questions.
  - What particularly are you interested in under each research topic of interest?

Breakout Groups

- Go over individual questions, group questions together and then try to answer probing questions below. It is OK to leave things blank or answer with "we don't know".
- Which of these big picture questions can be addressed given the constraints of CSMI sampling?

Question (or general grouping of questions)	What agencies could use the information generated by answering this (these) question(s)?	Is anyone already trying to answer this (these) question(s)? If so, who?	Can this (these) question(s) be addressed using data that were previously collected? If so, where are those data?	Other thoughts (e.g., key challenges or opportunities)?
EXAMPLE: Overwinter ecology; what is dreissenid activity overwinter? Is there movement offshore? What may happen under future climate change?	Many	Winter grabs by NOAA, USGS, other agencies Monitoring equipment along the bottom (by agency/university X)	Some monitoring data already available	Sampling can be a challenge but may improve as winters get warmer Would not have much baseline data but maybe that's OK

- 10:00 am Break/gallery walk (facilitators remain to explain notes)
- 10:30 am Continued group discussion around specific questions, but can switch to other groups to help complete their tables, particularly what data sources they might have available to help answer the questions.
- 11:15 am Large group discussion where LAMP Workgroup Members can ask particular questions of attendees to help with their next steps.
- 12:00 pm Next Steps and Adjourn survey and summary report

## **Appendix 3. Survey**

# CSMI Lake Michigan 2025 Kickoff Survey

Start of Block: Default Question Block

Information This survey provides an opportunity for you to inform planning for the 2025 Cooperative Science and Monitoring Initiative (CSMI) Field Year on Lake Michigan. Information shared during a two-day workshop held in July 2023 served as the basis for the survey. You should answer the questions based on your own experience and expertise. All answers are anonymous.

Results will be incorporated into an Illinois-Indiana Sea Grant-developed workshop report and provided to the Lake Michigan Lakewide Action and Management Plan (LAMP) team. The LAMP team is responsible for setting research priorities for the 2025 CSMI Field Year on Lake Michigan. The Sea Grant-developed workshop report is expected to be made publicly-available on the CSMI website in fall 2023.

If you have trouble with any portion of this survey, contact Carolyn Foley (cfoley@purdue.edu) or Paris Collingsworth (pcolling@purdue.edu).

This survey is expected to take 10 minutes to complete. We strongly recommend that you complete the survey on a laptop or desktop computer.

End of Block: Default Question Block

**Start of Block: Ranking** 

Please identify the amount of effort you believe CSMI researchers should invest in each of the following topics during the 2025 Field Year on Lake Michigan. These topics are related to biotic processes.

	SIMILAR effort to MAINTAIN understanding of this issue	MORE effort to INCREASE understanding of this issue	LESS effort to direct efforts elsewhere	UNSURE
Dreissenid mussel dynamics (adult)	0	0	0	0
Dreissenid mussel dynamics (veligers)	$\bigcirc$	$\bigcirc$	0	$\bigcirc$
Seasonal food web dynamics including winter dynamics	0	0	0	$\bigcirc$
Nearshore food web dynamics	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$
Larval fish bottlenecks	$\bigcirc$	0	$\bigcirc$	$\bigcirc$
Impacts of climate change on food web dynamics	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$
Impacts of land use change on food web dynamics	0	0	0	$\bigcirc$
Changes to primary production in Lake Michigan	$\bigcirc$	$\bigcirc$	$\bigcirc$	0
Lake Whitefish declines in Lake Michigan	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$
Open water fish movement data	$\bigcirc$	0	$\bigcirc$	$\bigcirc$
Role of mysids in the food web	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$
Phytoplankton communities	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$

If you would like to explain why your selected these answers, please do so here.

25

Please identify the amount of effort you believe CSMI researchers should invest in each of the following topics during the 2025 Field Year on Lake Michigan. These topics are related to abiotic processes and human health concerns.

	SIMILAR effort to MAINTAIN understanding of this issue	MORE effort to INCREASE understanding of this issue	LESS effort to direct efforts elsewhere	UNSURE
Nutrient cycling in the nearshore region	0	$\bigcirc$	$\bigcirc$	$\bigcirc$
Shoreline resilience, sediment transport, erosion	$\bigcirc$	$\bigcirc$	$\bigcirc$	0
Nutrient changes in Green Bay	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$
Seasonal effects on nutrient dynamics	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$
Effects of episodic storms on nutrient inputs to the lake (N, P, etc.)	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$
Contaminants of Emerging Concern, in particular PFAS/PFOAs	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$
Point-source contamination	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$
Nutrient transfer from the Fox River to Green Bay to Lake Michigan	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$
Impacts of climate change	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$
Impacts of land use change	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$
Quantity and quality of groundwater contributions to Lake Michigan	$\bigcirc$	$\bigcirc$	0	$\bigcirc$
Effects of Lake Michigan water chemistry on drinking water	$\bigcirc$	$\bigcirc$	$\bigcirc$	0
Risk, detection, and understanding of Harmful Algal Blooms, their toxins, and effects on public health	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$

If you would like to explain why your selected these answers, please do so here.

27

	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
There is value in maintaining current food web monitoring efforts during the 2025 Field Year on Lake Michigan.	0	0	0	0	0
There is value in maintaining current nutrient monitoring efforts during the 2025 Field Year on Lake Michigan.	0	$\bigcirc$	$\bigcirc$	$\bigcirc$	0
The 2025 Field Year on Lake Michigan sampling should focus on spatial differences.	0	0	$\bigcirc$	$\bigcirc$	0
The 2025 Field Year on Lake Michigan should focus on temporal differences, e.g., seasonal or finer scale temporal changes.	0	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$
There is value in synthesizing information gathered across multiple CSMI years in a given lake or set of lakes, i.e., using long-term abiotic or biotic monitoring datasets to answer broader questions.	0	$\bigcirc$	0	$\bigcirc$	$\bigcirc$

### How much do you agree with the following statements?

End of Block: Ranking

Start of Block: Specific Questions

Five topics of interest were identified during the workshop as key areas to focus in during the 2025 CSMI Field Year on Lake Michigan. The next pages explore specific questions within these topics.

The following research questions focus on CONTAMINANTS OF EMERGING CONCERN (CECs). Please sort them into HIGH, MEDIUM, or LOW priority boxes. If you truly believe they are all the same priority, feel free to put them all in the same box.

This question is a HIGH priority for me	This question is a MEDIUM priority for me	This question is a LOW priority for me
Where is PFAS coming from?	Where is PFAS coming from?	Where is PFAS coming from?
Where is PFAS ending up (biota, fractionation)?	Where is PFAS ending up (biota, fractionation)?	Where is PFAS ending up (biota, fractionation)?
What are the consequences of PFAS in Lake Michigan?	What are the consequences of PFAS in Lake Michigan?	What are the consequences of PFAS in Lake Michigan?
What is the impact of chlorides on the Lake Michigan ecosystem?	What is the impact of chlorides on the Lake Michigan ecosystem?	What is the impact of chlorides on the Lake Michigan ecosystem?
What is the impact of neonicotinoids on the Lake Michigan system?	What is the impact of neonicotinoids on the Lake Michigan system?	What is the impact of neonicotinoids on the Lake Michigan system?

If desired, list additional, specific, key research questions related to CECs that could be addressed in the 2025 CSMI Field Year.

The following are SOCIAL SCIENCE research questions. Please sort them into HIGH, MEDIUM, or LOW priority boxes. If you truly believe they are all the same priority, feel free to put them all in the same box.

This question is a HIGH priority for me	This question is a MEDIUM priority for me	This question is a LOW priority for me
Who is eating what?	Who is eating what?	Who is eating what?
How does that intersect with	How does that intersect with	How does that intersect with
environmental justice and/or	environmental justice and/or	environmental justice and/or
contaminant issues (e.g.,	contaminant issues (e.g.,	contaminant issues (e.g.,
subsistence fishing)?	subsistence fishing)?	subsistence fishing)?
What do coastal users value about the lakes?	What do coastal users value about the lakes?	What do coastal users value about the lakes?
What are barriers for people using Lake Michigan?	What are barriers for people using Lake Michigan?	What are barriers for people using Lake Michigan?
What is the baseline	What is the baseline	What is the baseline
knowledge of Lake Michigan	knowledge of Lake Michigan	knowledge of Lake Michigan
for various user groups?	for various user groups?	for various user groups?
How do different user	How do different user	How do different user
groups of Lake Michigan	groups of Lake Michigan	groups of Lake Michigan
perceive each other? What	perceive each other? What	perceive each other? What
levels of trust exist?	levels of trust exist?	levels of trust exist?
How do we conduct	How do we conduct	How do we conduct
outreach to encourage	outreach to encourage	outreach to encourage
behavior change with a goal	behavior change with a goal	behavior change with a goal
of better outcomes for the	of better outcomes for the	of better outcomes for the
environment?	environment?	environment?
Can we engage	Can we engage	Can we engage
volunteers to collect	volunteers to collect	volunteers to collect
nearshore or offshore data?	nearshore or offshore data?	nearshore or offshore data?
How are users of the	How are users of the	How are users of the
lake responding or adapting	lake responding or adapting	lake responding or adapting
to climate change?	to climate change?	to climate change?
Are government	Are government	Are government
programs and decisions	programs and decisions	programs and decisions
commensurate with the	commensurate with the	commensurate with the
values of those who use	values of those who use	values of those who use
Lake Michigan?	Lake Michigan?	Lake Michigan?
What are social	What are social	What are social
barriers keeping those who	barriers keeping those who	barriers keeping those who
live within 100 km of Lake	live within 100 km of Lake	live within 100 km of Lake
Michigan from utilizing	Michigan from utilizing	Michigan from utilizing
resources?	resources?	resources?

If desired, list additional, specific, key SOCIAL SCIENCE research questions that could be addressed in the 2025 CSMI Field Year.

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The following research questions are related to NEARSHORE HABITAT. Please sort them into HIGH, MEDIUM, or LOW priority boxes. If you truly believe they are all the same priority, feel free to put them all in the same box.

This question is a HIGH priority for me	This question is a MEDIUM priority for me	This question is a LOW priority for me
How do physical	How do physical	How do physical
processes that happen in the	processes that happen in the	processes that happen in the
winter affect the nearshore	winter affect the nearshore	winter affect the nearshore
habitat of Lake Michigan?	habitat of Lake Michigan?	habitat of Lake Michigan?
How have physical conditions changed along the shoreline? Near the shoreline?	How have physical conditions changed along the shoreline? Near the shoreline?	How have physical conditions changed along the shoreline? Near the shoreline?
How does sediment	How does sediment	How does sediment
transport impact biota and	transport impact biota and	transport impact biota and
habitats, chemistry, physical	habitats, chemistry, physical	habitats, chemistry, physical
integrity, etc. in the very	integrity, etc. in the very	integrity, etc. in the very
nearshore region?	nearshore region?	nearshore region?
How does sediment	How does sediment	How does sediment
transport_affect beach	transport_affect beach	transport affect beach
nourishment?	nourishment?	nourishment?
Are there beneficial	Are there beneficial	Are there beneficial
uses of dredged material to	uses of dredged material to	uses of dredged material to
create reef systems (e.g.,	create reef systems (e.g.,	create reef systems (e.g.,
biotic, shoreline	biotic, shoreline	biotic, shoreline
stabilization)?	stabilization)?	stabilization)?
Should we conduct a	Should we conduct a	Should we conduct a
nearshore assessment or	nearshore assessment or	nearshore assessment or
otherwise map underwater	otherwise map underwater	otherwise map underwater
topography in Lake Michigan	topography in Lake Michigan	topography in Lake Michigan
every five years?	every five years?	every five years?
Are nutrient	Are nutrient	Are nutrient
management actions in Fox	management actions in Fox	management actions in Fox
River and Green Bay having	River and Green Bay having	River and Green Bay having
the desired effect?	the desired effect?	the desired effect?
What are the effects	What are the effects	What are the effects
of septic water system inputs	of septic water system inputs	of septic water system inputs
on Lake Michigan water	on Lake Michigan water	on Lake Michigan water
quality?	quality?	quality?

If desired, list additional, specific, key NEARSHORE HABITAT-related research questions that could be addressed in the 2025 CSMI Field Year.

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The following questions are related to LARVAL FISH BOTTLENECKS. Please sort them into HIGH, MEDIUM, or LOW priority boxes. If you truly believe they are all the same priority, feel free to put them all in the same box.

This question is a HIGH	This question is a MEDIUM	This question is a LOW	
priority for me	priority for me	priority for me	
Where are hotspots	Where are hotspots	Where are hotspots	
for fish production and	for fish production and	for fish production and	
recruitment in Lake	recruitment in Lake	recruitment in Lake	
Michigan?	Michigan?	Michigan?	
How do we improve	How do we improve	How do we improve	
previous efforts to	previous efforts to	previous efforts to	
understand bottlenecks	understand bottlenecks	understand bottlenecks	
affecting larval fish in Lake	affecting larval fish in Lake	affecting larval fish in Lake	
Michigan?	Michigan?	Michigan?	
What quantitative	What quantitative	What quantitative	
contribution does the micro-	contribution does the micro-	contribution does the micro-	
food web make to larval fish	food web make to larval fish	food web make to larval fish	
recruitment?	recruitment?	recruitment?	
What are the impacts	What are the impacts	What are the impacts	
of episodic biophysical	of episodic biophysical	of episodic biophysical	
events on fish recruitment?	events on fish recruitment?	events on fish recruitment?	
What are the effects	What are the effects	What are the effects	
of ice cover or lack of ice	of ice cover or lack of ice	of ice cover or lack of ice	
cover on fish spawning?	cover on fish spawning?	cover on fish spawning?	
What limits	What limits	What limits	
recruitment of whitefish and	recruitment of whitefish and	recruitment of whitefish and	
cisco?	cisco?	cisco?	
What are egg	What are egg	What are egg	
survival rates for different fish	survival rates for different fish	survival rates for different fish	
species across different Lake	species across different Lake	species across different Lake	
Michigan habitats?	Michigan habitats?	Michigan habitats?	

If desired, list additional, specific, key LARVAL FISH BOTTLENECK-related research questions that could be addressed in the 2025 CSMI Field Year.

The following questions are related to WINTER SAMPLING. Please sort them into HIGH, MEDIUM, or LOW priority boxes. If you truly believe they are all the same priority, feel free to put them all in the same box.

This question is a HIGH	This question is a MEDIUM	This question is a LOW	
priority for me	priority for me	priority for me	
How do winter	How do winter	How do winter	
conditions relate to summer	conditions relate to summer	conditions relate to summer	
plankton in the lake?	plankton in the lake?	plankton in the lake?	
Do key biological,	Do key biological,	Do key biological,	
chemical, and physical	chemical, and physical	chemical, and physical	
processes occur over water	processes occur over water	processes occur over water	
or under ice?	or under ice?	or under ice?	
How does nutrient cycling change over winter?	How does nutrient cycling change over winter?	How does nutrient cycling change over winter?	
What are under-ice	What are under-ice	What are under-ice	
light conditions and how does	light conditions and how does	light conditions and how does	
ice quality impact light	ice quality impact light	ice quality impact light	
attenuation and	attenuation and	attenuation and	
corresponding biology?	corresponding biology?	corresponding biology?	
What are baseline	What are baseline	What are baseline	
under-ice conditions in Lake	under-ice conditions in Lake	under-ice conditions in Lake	
Michigan for nutrients,	Michigan for nutrients,	Michigan for nutrients,	
biology, light conditions?	biology, light conditions?	biology, light conditions?	
How are different fish	How are different fish	How are different fish	
species (e.g., lake trout, lake	species (e.g., lake trout, lake	species (e.g., lake trout, lake	
whitefish) affected by winter	whitefish) affected by winter	whitefish) affected by winter	
conditions?	conditions?	conditions?	
What are potential or realized impacts of changing ice cover?	What are potential or realized impacts of changing ice cover?	What are potential or realized impacts of changing ice cover?	

If desired, list additional, specific, key WINTER SAMPLING-related research questions that could be addressed in the 2025 CSMI Field Year.

**End of Block: Specific Questions** 

Start of Block: Who and what is missing

Are there additional big picture topics that should be considered for inclusion as a research priority for the CSMI 2025 Field Year on Lake Michigan?

Who is currently not benefiting from CSMI efforts on Lake Michigan but should be included in future planning and communication efforts?

End of Block: Who and what is missing

Start of Block: Details about respondents

Did you attend the two-day workshop in Milwaukee, WI, in July 2023?

◯ Yes

🔿 No

36

Why did you not attend the workshop? Select all that apply.

		Travel was not approved		
		Did not seem relevant to me		
		Other work-related obligations prevented my attending		
		Did not receive the invitation		
		Other (please describe)		
What type of institution describes your primary professional affiliation?				
◯ Federal employee				
◯ State or provincial employee				
	◯ Tribal agency employee			

Academic institution

 $\bigcirc$  Non-profit organization

◯ Industry

Other (please describe)

Please list any additional feedback related to this effort that you wish to share here.

End of Block: Details about respondents