



REGULAR BOARD MEETING AGENDA

May 11, 2026

6:30 pm at Southside Township Hall, 8209 County Rd 3 NW, Annandale, MN 55302

Board of Directors (BOD)

OFFICERS

President Joleen Sytsma
Vice President Chuck Wachter
Treasurer Jon Bigalk
Secretary Michelle Sutton

SECTION REPRESENTATIVES

Section 1 Dennis Sjoberg
Section 2 Neysa Silver
Section 3 Mark Fournier
Section 4 John Greenwood
Section 5 Becky Wachter
Section 6 Kim Larson

REGULAR BUSINESS

1. Call To Order & Pledge of Allegiance
 - a. No recording or transcripts of Board meetings of any kind allowed (except by the Secretary for minutes creation), prior recordings/transcripts should be deleted/destroyed as not authorized – Sytsma
2. Attendance/Roll Call
3. Approval of Agenda - May 11, 2026
4. Approval of Previous Minutes - September 08, 2025 (attached pp 3 - 9)
5. Reports
 - a. Financial as of April 31, 2026 - Bigalk
 - I. QuickBooks Online conversion in process
 - b. Section Representatives - New Property Owners/Property Developments
 - c. LID Liaison Report - Kosloski
 - d. Committees
 - I. Lake Quality & Water Level Monitoring:
<https://www.dnr.state.mn.us/lakefind/showlevel.html?downum=86028800> (attached pp 10) - Kosloski
 - II. Lake Stewardship Program - Greenwood/Kosloski
 1. Request for Board Action - Consideration and approval of ordering 10 large signs for Lake Steward awards after evaluations.
 2. Possible Lake John Stewards Tour in August for a Saturday morning or early Sunday afternoon date of Award recipients to tour properties to view examples of Lake Steward efforts/native plants/landscaping firsthand.
 - III. Culverts - Greenwood

ONGOING BUSINESS

6. Migrating Bogs
7. Organization Updates
 - a. MN Coalition of Lake Associations (MN COLA) (attached pp 11 - 14) - Sytsma
 - i. MN COLA Position Statement: [MN Cola Postion Statement on Enhanced Wake Activities](#)
 - ii. St. Anthony Falls Laboratory - U of MN Phase 2 Project Summary
<https://pub.umn.edu/safl/Boat-Report-2025/> (attached pp 15 - 22)
 - b. Wright County Coalition of Lake Associations (WC COLA): <https://wrightcola.mnlakesandrivers.org> (attached pp 23 - 28) - Kosloski

- i. MLR Wake Safe Map and supplies purchase for posting at landing and handouts
- c. MN Lakes and Rivers Association (MLR) (attached pp 29) - Sytsma
- d. MN DNR Roundtable (attached pp 30 - 32) - Sytsma

- 8. Items from September's Agenda:
 - a. Electronic copy of section lists to section representatives - Bigalk
 - b. Email addresses added to LJA website for Section Reps – Fournier
 - c. 2025 Lake John Survey Results published - Sytsma
- 9. Community Updates - Sytsma
 - a. City Water/Sewer
 - b. New Developments
 - c. Solar Field: passed Wright County Planning & Zoning last fall – any update from neighbors?

NEW BUSINESS

- 10. Annual Meeting Planning – Sytsma
 - a. Electronic Voting research – C Wachter
- 11. 2026 Nominations for President, Treasurer, Section Reps 2, 4, 6
- 12. Adjournment

OPEN FORUM Lake John Association Members

LJA Meetings	LID Meetings
2026 June 8 - BOD June 27- Annual Meeting July 13 - BOD August 10 - BOD September 14 - BOD	2026 May 21 - BOD June 18 - BOD June 27 - Annual Meeting July 16 - BOD August 20 - BOD September 24 - BOD
BOD Meetings: 6:30 p.m. @ Southside Township Hall Annual Meeting: 9:00 a.m. @ South Haven City Hall	



REGULAR BOARD MEETING MINUTES

September 08, 2025

DRAFT to be Approved May 11, 2026

6:30 pm at Southside Township Hall, 8209 County Rd 3 NW, Annandale, MN 55302

Board of Directors (BOD)

OFFICERS

President Joleen Sytsma
Vice President Chuck Wachter
Treasurer Jon Bigalk
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SECTION REPRESENTATIVES

Section 1 Dennis Sjoberg
Section 2 Neysa Silver
Section 3 Mark Fournier
Section 4 John Greenwood
Section 5 Becky Wachter
Section 6 Kim Larson

BOD Present: Bigalk, Fournier, Greenwood, Silver, Sjoberg, Sutton, Sytsma, B. Wachter, C. Wachter

BOD Absent: Larson

Members Present: Kelly Kosloski

REGULAR BUSINESS

1. Call to Order
Sytsma called the meeting to order at 6:30 p.m. with those in attendance invited to recite the Pledge of Allegiance.
2. Approval of Agenda - September 08, 2025
Motion: Motion by Silver to approve the agenda as presented, **Seconded** by C. Wachter, and **passed unanimously**.
3. Approval of Minutes - July 14, 2025
Motion: Motion by Fournier To amend the minutes as presented with the addition to Agenda Item 6 to include "concern raised by Fournier - In his opinion, survey type may bias results and cause future issues," **Seconded** by Sjoberg, and **passed unanimously**.
4. Reports
 - A. Financial (January 1 through August 31, 2025)
Bigalk provided an update on the LJA's current financials.
 - B. Section Representatives - New Property Owners/Property Developments
New members reported.
 - C. LID Liaison Report – Kosloski
Kosloski reported on the July 17th meeting. An LJA member was present and raised questions regarding bogs and was informed of the LID's role and LJA's role in bog management. AIS management updates were provided with planned treatments and costs. Discussion was had on the use of LJA legacy funds from before the LID was formed in future bog removal expenses before utilizing LID funds. The next and final meeting of 2025 for the LID at 6:30 p.m. on July 17th was announced.
 - D. Committees
 - I. Lake Quality & Water Level Monitoring
Kosloski provided a detailed report provided in the agenda packet and summarized the lake quality and water level. Consideration of having the LID do a Watershed testing was raised. Discussion was had on new developments lacking required buffer, sod extending to shoreline required by developers and responsibility shifting to property owner which is not required.

- II. Lake Stewardship Program – Greenwood
Greenwood & Kosloski provided an update, they are now recognized as Lake Stewards. Program requirements were reviewed and are awaiting signage. Recommendation: include program details in the next newsletter and add a link to the website.
- III. Culverts – Greenwood
Greenwood provided an update and reported the culvert near launch is down slightly, but flowing steadily. Outflow remains stagnant.
- IV. Committee Lists Review
Committee lists were reviewed and the potential need to establish an enhanced wake activities advisory committee was discussed.

ONGOING BUSINESS

5. Migrating Bogs – Fournier

Bog status discussed: Bog location remained as it would not move so it was staked in place. It was brought up that forming a committee could be beneficial. Bog relocation options discussed. DNR advised against relocating the bog to another site; recycling facilities were discussed as an option. Fournier resigned from the bog committee.

6. Lake John Survey Results, Discussion, and Next Steps

Survey Distribution & Return statistics are as follows:

- 150 surveys were sent out; 58 returned (38.7% response rate).
- 3 surveys returned with no numbers marked
- 1 survey appeared to be cut out, uncertain if it was a duplicate copy
- Handed out Survey Results compiled, Written

Discussion on how the survey was established, the structure, scoring system, and acknowledgement that all data should be used cautiously before decisions are made. Also discussed when the next survey should be planned, end of season August 2026 was suggested.

Recommendation: Schedule an April 2026 Board working meeting, prior to May meeting to review survey results and determine potential actions.

Motion by Fournier to publish survey results for members, following review by **Sytsma and C. Wachter for sensitive information** and **Seconded** by Silver, **passed unanimously**

7. Items from July's Agenda

- Section map (GIS) topic from July, volunteer is needed if the Board wishes to proceed.
- Member list Updates, electronic copy of a specific section of the most up-to-date member list to be prepared. Bigalk will update, and send out.
- Discussion of adding email addresses to the website for Section Representatives was brought up again, this was reviewed in the past. Fournier discussed with Dana, and will take the lead, beginning with the section representative list.

8. Community Updates - Sytsma

Sytsma contacted the City of Annandale regarding the City Water/Sewer Project and shared that the grant was not approved; other funding options were being explored. Estimated costs from \$40,000 to \$60,000 per property owner. Next steps were anticipated for early October.

Community Considerations discussed, approximately 51% of residents are currently considering or in favor. Additional costs not included in estimates would include: removal or capping of existing sewer and wells, connection fees to new system, utility adjustments and potential road widening, assessments would apply to all residents, with interest charges.

9. New Developments

Update was given that the Shores of Lake John subdivision received final plat approval for 10 lake lots. The shoreline underwent extensive review and adjustments involving the Department of Natural Resources (DNR), Pollution Control Agency, Environmental Protection Agency (EPA), and Soil & Water Conservation District. Multiple requirements and corrective actions were completed to secure approval, ensuring environmental standards and conservation practices were met.

10. Solar Field

Sytsma provided an update that another meeting was held and Soil & Water expressed concern that the project may be moving too quickly. The process remains ongoing and is Wright County Planning & Zoning ongoing business with an October date pending. Sytsma has prepared a draft letter. **Motion** by Sutton to review and provide feedback by Friday, September 12th, prior to Sytsma sending the letter, **Seconded** by Watcher, **passed unanimously**.

OPEN FORUM Lake John Association Members

With the transition to QuickBooks underway, a request was raised to consider beginning the new budget cycle in May. Budget to-Actuals Tracking: This adjustment would allow the Association to align financial reporting with QuickBooks and provide clearer budget-to-actuals comparisons throughout the fiscal year

NEW BUSINESS

11. St. Anthony Falls Research Study - Phase 2 Results

Discussion included the importance of respectful dialogue, concerns about activities negatively affecting property and personal lives, and a suggestion to focus on solutions that address lake activities and reduce conflicts in alignment with the Lake John Association's objectives "to promote the care and betterment of Lake John, and to assist in the conservation and preservation of its natural resources.". The study and its recommendations were reviewed as provided in the agenda packet, and further board discussion will be needed. Handout not in agenda packet, see attached.

12. MN Coalition of Lake Associations (COLA)

Sytsma shared that there is a September Membership Meeting scheduled for September 16th, via Zoom, 10:00–11:00 a.m. The meeting follows the MPR Special Session on the U of M St. Anthony Falls Laboratory Phase 2 Report, members are asked to pre-register.

13. Wright County Coalition of Lake Association Email

Email correspondence shared.

14. Adjournment - Sytsma **motioned** to adjourn the meeting at 8:42, Sjoberg **Seconded**, **passed unanimously**.

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Frequently Asked Questions

Report Title: A Field Study of Recreational Powerboat Hydrodynamics and their Impacts on the Water Column and Lakebed. SAFL Project Report No. 611

Authors: Andrew Riesgraf, Jeffrey Marr, William Herb, Matthew Lueker, Jessica Kozarek

What was the study about?

This field-based research project focused on what occurs beneath a recreational powerboat when in motion. Specifically, we studied what happens to the water column and lakebed when different types of recreational powerboats traverse in their typical modes of operation.

Who conducted this study?

This study was conducted by a small team of professional research staff at University of Minnesota, St. Anthony Falls Laboratory (SAFL). The team included:

- Jeffrey Marr, Associate Director of Engineering and Facilities - Principal Investigator
- Andrew Riesgraf – Lead Researcher
- Dr. William Herb - Research Associate
- Matthew Lueker - Associate Engineer
- Dr. Jessica Kozarek - Research Associate

Where can I find the published report and associated data?

The report and all the associated data were published to the University of Minnesota's Digital Conservancy in July 2025. The persistent links to the full report and data are here:

Report: z.umn.edu/powerboats

Data: z.umn.edu/data_powerboats

Where and when was the study conducted?

The study took place on Lake Minnetonka's (Orono, Minnesota) North Arm Bay in 2022 and Maxwell Bay in 2023 during the months of September and October.

What recreational powerboats were tested?

Seven recreational powerboats, categorized into three common boat types, were tested:

- Deck boat with outboard engine
 1. 2016 Hurricane SS203
 2. 2021 Starcraft Limited 2000
- Bowrider with sterndrive (I/O) engine(s)
 3. 2023 Sea Ray SPX190
 4. 2021 Cobalt R5
 5. 2022 Cruisers Yachts 34GLS
- Wakeboat with inboard engine
 6. 2022 Nautique G23 Paragon
 7. 2019 Malibu VLX Wakesetter



The first four boats listed above are typical non-wakeboats that have been operated on Minnesota waters for decades. The Cruisers Yachts 34GLS was the largest boat tested in terms of power and size and fits the description of a yacht. The wakeboats are specifically designed to produce a large wake wave directly behind the boat for wakesports, such as wakesurfing.

How was the study conducted?

The boats were driven over bottom mounted acoustic-based velocity sensors at four water depths (9, 14, 16, and 27 ft) while traversing under their typical modes of operation. For the non-wakeboats (deck and bowrider) this was displacement mode (leisurely cruise) and planing mode (cruising). For the wakeboats this was semi-displacement mode (surfing) and planing mode (cruising). Each boat was driven over the sensors five times for each operational mode to gather replicate data sets for analysis. Additional data sets were collected including various water quality parameters, underwater and aerial videos, and lakebed sediment samples.

What did the study find?

This report identifies three distinct hydrodynamic phenomena produced by common recreational powerboats that have the potential to impact the water column and lakebed: 1) bow and stern pressure waves, 2) transverse gravity waves, and 3) propeller wash.

Bow and stern pressure waves are generated when water is displaced by the boat's hull during motion. The pressure wave that forms at the bow forces water forward and downward, while the stern pressure wave is a restorative motion immediately abaft where water moves upward and backward. The bow and stern waves couple together to form a short-duration orbital wave motion that can extend deep into the water column.

The bow and stern waves were found to be the primary hydrodynamic phenomena that initiated the movement of lakebed sediments but were not sufficient to cause sustained sediment resuspension and entrainment.

Transverse waves are gravity waves that result from the interaction of the bow and stern waves and are only produced at slower speeds (e.g., leisurely cruise, surfing). They travel at approximately the same speed as the boat, with the crests aligned perpendicular to the boat's direction of travel, so they appear, from a passenger's perspective, to be a stationary feature of the wake. ***The transverse waves were found to penetrate deep into the water column and persist for several minutes after the boat had passed. The generated velocities were large enough at the lakebed to resuspend and entrain sediment, but the severity was dependent upon the boat type and its mode of operation.***

Propeller wash is a complex 3-dimensional phenomena formed from the high velocity rotational jet produced by the boat propeller(s). Immediately downstream of the propeller, the jet is very powerful and travels along the same alignment as the propeller shaft. The wash expands and slows with increased distance from the propeller. For all the boats tested in this project, and most recreational boats operating today, exhaust gas from the internal combustion engine is injected into the propeller wash jet. The exhaust moves with the propeller wash, dampening energy and providing buoyancy to the propeller wash. As the boat and propeller are moving along the water surface, the direction of the propeller wash is altered by the crossflow effect of the quiescent water, bending the pathway of the propeller wash away from the bottom. The cumulative effect of the exhaust bubbles and crossflow limit the penetration depth of the propeller wash. ***Propeller wash was shown to impact the water column for several minutes after the boat had passed and, under certain modes of operation, contributed to the resuspension and entrainment of bottom sediment. It was further observed that propeller wash can directly cause shearing and complete uprooting of submerged aquatic vegetation under certain operating conditions.***



Can you summarize your findings?

The three hydrodynamic phenomena described above occur simultaneously and move with the boat. We found that the velocities of these phenomena and their depths of penetration are tightly linked to how the boat is used. ***The bow and stern pressure waves are the primary phenomena initiating the movement of lakebed sediments, while the transverse waves and propeller wash are the phenomena that lift and entrain sediment into the water column.***

What is sediment resuspension and entrainment and why does it matter?

Lakebed sediments are comprised of clastic materials (fragments of mineral and rock), organic material (plants and animals), chemical and nutrient precipitates, or combinations of these. The hydraulic phenomena of a powerboat produce water currents and turbulence that can disturb the lakebed and if large enough can cause increased turbidity (i.e., decreased water clarity) by directly resuspending sediments and by indirectly releasing nutrients like phosphorous from sediment that can stimulate excessive algae growth. Resuspension of lakebed sediments has an adverse impact to lakes.

What are your recommendations based on this research?

Based on the study findings, we developed the following recommendations to minimize impacts on the lakebed:

- When operating in ***planing mode***, it is recommended that recreational powerboats similar to the ones studied here, ***should operate in 10 ft of water or greater*** to minimize impacts on the lakebed.
- When operating in ***sustained displacement mode (e.g., slow cruising)***, recreational powerboats similar to the ones studied here, should ***operate in 10 ft of water or greater*** to minimize impacts on the lakebed.
- For most recreational boat users, traveling in waters less than 10 ft deep is unavoidable (e.g., going through channels, getting to and from boat lifts, docks, and launches, etc.). In these scenarios it is recommended to go as slowly as possible (i.e., slower than the displacement speeds tested here or no wake) to minimize the magnitude of the bow and stern pressure waves.
- ***Wakeboats should operate in 20 ft of water or greater when in semi-displacement (surfing) mode*** to minimize impacts on the lakebed.
- All boats have the potential to damage aquatic vegetation. The depth recommendations provided above are specified relative to the lakebed but could also be interpreted as relative to the top of submerged vegetation. Since vegetation grows throughout the open-water season, this is a more difficult recommendation to specify. In general, boats should avoid areas of the lake with aquatic vegetation to minimize damage.

Did this study examine the long-term environmental impacts of recreational boats?

No, this study did not look at long-term impacts to the lake by recreational boating activity. However, because the study methods included five boat passes per test condition, we were able to evaluate cumulative impacts over the short-term (e.g., sediment and nutrient resuspension, damage to submerged aquatic vegetation, etc.).



Are there plans to continue research, and what will be studied?

The final phase of this research is underway and is looking at the following:

- How do wind-driven waves differ from wake waves produced by powerboats and how do their impacts on the lake environment differ from one another?
- How do large wake waves interact with the lake environment, including the lake bottom, shorelines (natural and riprap), structures in the water like docks and lifts, vegetation, and fish habitat?

How was this study funded?

This study was funded through two sources. The first was a crowdfunding campaign through the University of Minnesota Foundation, with over 200 donors contributing. Donations were received from across the country, with the majority coming from Minnesota and other Upper Midwest states. The second source of funding was the Environmental Natural Resources Trust Fund (ENRTF) as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR). ENRTF funding enabled our team to complete additional fieldwork that was needed to publish this report.

Did the report go through a peer-review or technical review process?

This report is not published as a peer-reviewed journal article. However, it did go through an extensive independent technical review process by three external reviewers who are subject matter experts in fields related to this research. The reviewers had no previous or current collaboration with any of the research team and were identified as authors who have published similar research. The reviewers volunteered for the reviewer role.

The review process went as follows: the reviewers were provided a pre-final draft of the report and associated materials (appendix, videos). The reviewers provided detailed feedback as comments and markup. The authors integrated the feedback into a revised report that was then sent back to each reviewer individually. The reviewers reviewed the revised report and each concurred that the authors had sufficiently considered and incorporated their feedback. Each reviewer approved the publication of the final report.

Were donors or other outside groups involved in this research study (design, data analysis and interpretation, report, etc.)?

No. Individuals and organizations that contributed to the crowdfunding of this research had no input in the design or scope of this research project. The development of the report involved only the University of Minnesota - St. Anthony Falls Laboratory research team.

Is the crowdfunding campaign still accepting donations and how can I contribute?

The original crowdfunding campaign has ended but individuals or organizations can still contribute directly to the SAFL Healthy Waters Initiative through the St. Anthony Falls Laboratory website. Donations will go directly to the research program and the next phase of the project.

Donate to SAFL's Healthy Waters Initiative: z.umn.edu/give_healthy_waters

Where can I get more information?

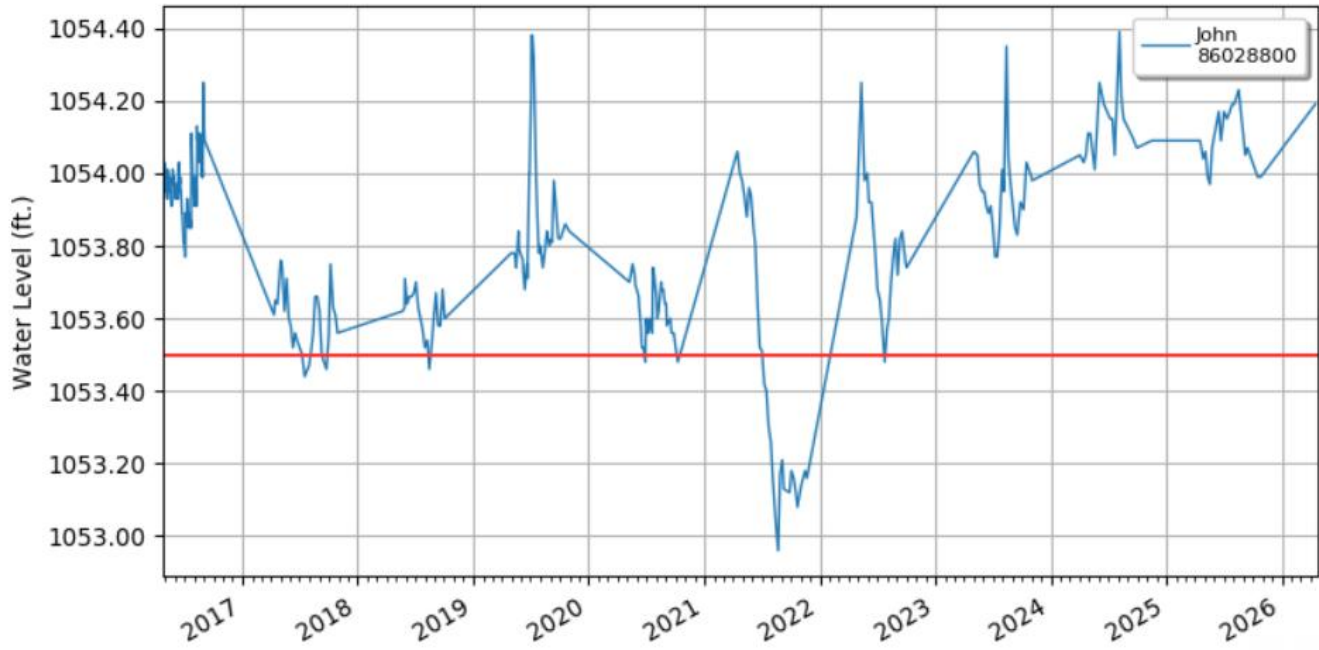
Please visit the project website for additional information.

Healthy Waters Initiative: z.umn.edu/healthy_waters

Who can I contact about this report?

Please send all media requests to **Savannah Erdman**, University Public Relations, at erdma158@umn.edu, or to the University Relations' main news line at unews@umn.edu.

Recorded Water Levels
2016-4-24 to 2026-4-24





Please forward this email to your association members so that they have this information.

Position Statement on Enhanced Wake Activities



Ice is out on many Minnesota lakes, and it won't be long until we are back on the water. But, unfortunately the angst about enhanced wake activity (surfing) will continue to be a very hot topic on Minnesota Lakes.

Last summer, we were anxiously waiting for the University of Minnesota--St. Anthony Falls Laboratory to complete their Phase 2 work on enhanced wake activity. That amazing work was released in the fall regarding the impacts of wake surfing on the lake bed. With the new insights from the Phase 2 research in hand, MN COLA was able to put together a statement of our position that includes key elements including appropriate distances from shore and the depth of water required for this fun family recreation to be done safely.

We are very pleased to communicate our [MN COLA Position Statement on Enhanced Wake Activities](#). In a nutshell, we support regulations for enhanced wake activities to occur:

- **At a minimum depth of 20 feet to minimize subsurface ecological impact, combined with**
- **A minimum distance from shore of 500 feet; however, at least 575 feet from shore is recommended to reduce the wave energy impact on shorelines to a level like non-enhanced wake watercraft.**

And while Minnesota does not seem to be ready to address state-wide regulation of enhanced wake activity, we are pleased that the DNR included some basic information on best practices in the new required Watercraft Operator's Permit.

As you talk about this issue with others, we also think it is important for you to know what's happening in other states.

Existing Enhanced Wake Law

Vermont

Currently in the process to update their existing statewide wake activity rule to better address safety concerns, reduce public use conflicts, and clarify compliance.

Connecticut

The local ban on enhanced wake activity on Lake Waramaug was challenged but the ban was upheld by the Connecticut Department of Energy and Environmental Protection.

Indiana

New law effective July 1, 2026 bans enhanced wake activity on small lakes (less than 300 acres) and on all lakes between sunset and sunrise.

Proposed Enhanced Wake Law

Michigan

Enhanced wake activity to be 500 feet from shore.

Wisconsin

Complex legislative activity with competing bills.

One, supported by the boating industry, is for a 200-300 feet from shore restriction.

Another bill supported by a coalition of over 100 organizations advocated for a minimum of 500 feet from shore and a minimum depth of 20 feet and keeping the power of local jurisdictions to enact ordinances stricter than State rules.

Oregon

Existing law on portion of Willamette to restrict enhanced wake activity being challenged; ruling has not yet made.

Neither bill passed. Currently, 78 local jurisdictions have enacted ordinances largely prohibiting enhanced wake sports, protecting over 300 lakes.

Please [read the MN COLA position statement](#) and communicate it widely. It is for your use as you have discussions with others on enhanced lake activities. And for more information, check out our [new Wake Surfing](#) section on MNCOLA.org website.

Thank you!

Joe Shneider

President, MN COLA

**MN COLA works to protect and preserve our
precious Minnesota public waters.**

Want to get MN COLA information directly? Sign up using the button below. It's free, but we'd love to have you join as a dues paying member. [Click here for membership information.](#)

Want to unsubscribe from MN COLA mailings? Reply to the sender and let them know you don't want to get this information.

Sign up for the MN COLA mailing list!

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MN COLA recognizes that wake surfing activities are fun water sports. Yet, if done where inappropriate, it/they can impact water quality, fishing, and threaten personal safety. Our goal is to keep Minnesota's public waters healthy, safe, and available for all.

Position Statement – Enhanced Wake Activities

We support best practices for watercraft users, uses, and enhanced wake activities as prescribed in the Minnesota Watercraft Operator's Permit. These best practices address approaches:

- for the personal safety of other water users
- to avoid conflict on the water
- to reduce shoreline erosion and the resultant water quality degradation
- to minimize lakebed disruption to plants and fish spawning beds, and the resuspension of embedded materials.

We support regulations for watercraft uses and wave actions intended to minimize the negative effects of enhanced wake activities based on research from the St. Anthony Falls Laboratory at the University of Minnesota.

- A **minimum depth of 20 feet** to minimize sub-surface ecological impact, combined with
- A **minimum distance from shore of 500 feet;** however, at least **575 feet from shore is recommended** to reduce the wave energy impact on shorelines to a level like non-enhanced wake watercraft.



We support an increase in funding to better address water patrol services and enforcement of enhanced wake regulations.

We support the use of readily available location technology for enhanced wake boat operators to locate the safe surfing zone as defined by water depth and distance from shore combined.



UNIVERSITY OF MINNESOTA
Saint Anthony Falls Laboratory

Published
July 2025

A Field Study of Recreational Powerboat Hydrodynamics and their Impacts on the Water Column and Lakebed



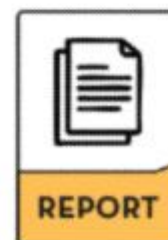
COLLEGE OF
Science & Engineering

Authors:

Andrew Riesgraf, Jeffrey Marr, William
Herb, Matthew Lueker, Jessica Kozarek

cse.umn.edu/safl

z.umn.edu/healthy_waters



z.umn.edu/powerboats

Motivation and Objectives

The recreational use of powerboats continues to increase along with increased boat size, horsepower, and new wake-enhancing technologies. This has led to concerns about the impacts of boating on the aquatic environment. In particular, the impacts of wakeboats operating in wakesurfing mode is a topic of intense public interest. This field-based study was motivated by a need to better understand the environmental impacts within the water column and at the lakebed of different types of recreational powerboats traversing under their typical modes of operation.

The objectives were to: 1) clarify and define the various hydrodynamic phenomena that are created by a recreational powerboat in motion, and how these phenomena vary with water depth and mode of operation, 2) investigate the depth of penetration and duration of emission gases (e.g., engine exhaust bubbles), 3) investigate the water column velocities and depth of penetration of the bow, stern, and transverse waves and their potential to resuspend lakebed sediment, 4) Investigate the propeller wash velocity and depth of penetration, and the potential to resuspend lakebed sediment, 5) investigate the effects of repeated boat passage on thermal stratification and mixing in the water column, 6) capture underwater and aerial video of the hydrodynamic phenomena and any subsequent impacts (e.g., sediment resuspension). This study generated a wealth of data that we used to develop recommendations for the minimum operational depth that recreational powerboats, under their typical modes of operation, should maintain to minimize impacts to the lakebed.



Design

A total of seven recreational powerboats were tested including two deck boats with outboard engines (Hurricane SS203, StarCraft Limited 2000), three bowriders with inboard/outboard engines (Sea Ray SPX190, Cobalt R5, Cruisers Yachts 34GLS), and two wakeboats with inboard engines (Nautique Super Air G23 Paragon, Malibu Wakesetter VLX). These boats are representative of those commonly operated on lakes and rivers.

Testing was performed during two fieldwork campaigns that took place in 2022 and 2023. For each campaign, acoustic-based sensors that measured pressure and velocities through the water column and at the lake bottom were deployed on the lakebed in two different locations and at two different depths. In total, data were collected at four locations of different water depths (9, 14, 16, 27 ft). Additional data were collected including various water quality parameters and lakebed sediment samples. In 2023, we also deployed underwater cameras and an aerial drone.

The boats were tested under two operational conditions that are representative of their typical usage (Figure 1). For the non-wakeboats (deck and bowrider) this was displacement mode (leisure cruise) and planing mode (cruising), and for the wakeboats this was semi-displacement mode (surfing) and planing mode (cruising). The boats were driven directly over the measurement sensors (Figure 2) a total of five times for each operational condition to gather replicate data for statistical analysis.

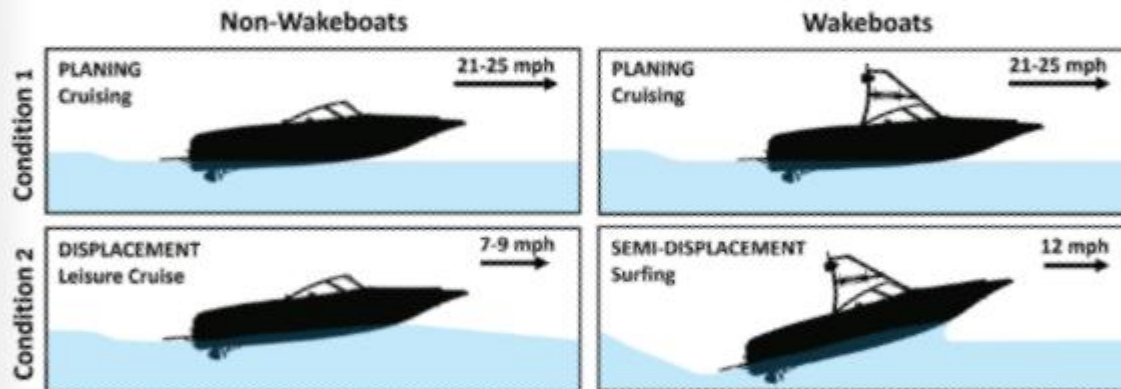


Figure 1. Illustration of the operational conditions testing in this study.



Figure 2. Wakeboat in semi-displacement mode (surfing) being driven over an acoustic-based sensor that measured water pressures and velocities through the water column and at the lake bottom.



This report identifies three distinct hydrodynamic phenomena produced by common recreational powerboats that have the potential to impact the water column and lakebed.

Findings

This report identifies three distinct hydrodynamic phenomena produced by common recreational powerboats that have the potential to impact the water column and lakebed: 1) bow and stern pressure waves, 2) transverse gravity waves, and 3) propeller wash (Figure 3).

1) Bow and Stern Pressure Waves – As the hull moves through the water, it creates elevated pressure at the bow. At the stern, water that was pushed out of the way by the hull rebounds upward creating reduced pressure. The bow and stern pressure waves merge to form a single wave motion that can extend deep below the boat and, depending on depth, can interact with the lakebed and/or submerged aquatic vegetation. The short-duration bow and stern waves were found to be the primary hydrodynamic phenomena that initiates the movement of lakebed sediments but were not sufficient to cause sustained sediment resuspension.

2) Transverse Gravity Waves – Boats that operate below planing speeds form transverse gravity waves. While most boaters are familiar with the divergent waves that make a V-shape wake behind the boat; transverse waves are less obvious, and thus less familiar. These waves have crests that are perpendicular to the travel direction of the boat and move at approximately the same speed as the boat, so they appear, from a passenger's perspective, to be a stationary feature of the wake. Transverse waves can penetrate deep into the water column, persist for several minutes after the boat has passed, and generate velocities large enough to resuspend and entrain lakebed sediment.

3) Propeller Wash – Most recreational boats in use today are powered by an internal combustion engine that generates power to rotate a propeller. The spinning propeller creates a highly complex 3-dimensional jet of water, defined as propeller wash, that pushes the boat through the water. The engine exhaust is injected into the propeller wash as entrained bubbles. The bubbles interact with the propeller wash by dampening energy and providing buoyancy. Because the boat is moving, the direction of the propeller wash is altered by a crossflow effect - the propeller wash plume bends in a direction opposite the boat travel. The cumulative effect of the exhaust bubbles and crossflow limit the penetration depth of the propeller wash. However, propeller wash was shown to impact the water column for several minutes after the boat pass and, under certain modes of operation, contributed to the resuspension and entrainment of bottom sediment. It was further observed that propeller wash can directly cause shearing and complete uprooting of submerged aquatic vegetation under certain operating conditions.

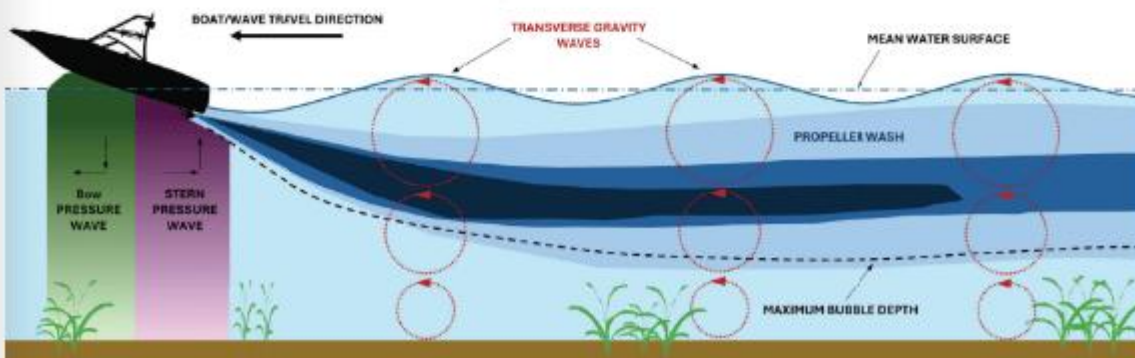


Figure 3. Illustration of the three hydrodynamic phenomena produced by a powerboat and how they interact with the water column beneath the boat.

We found that the velocities of the hydrodynamic phenomena and their depths of penetration are tightly linked to how the boat is being used.

- In planing mode (Condition 1 - cruising), the bow and stern pressure wave velocities were large enough to disturb lower density sediments (e.g., detritus, silt) at depths >10 ft; however, the absence of transverse waves and minimal propeller wash velocities at depths ≥ 10 ft prevented the sediments from resuspending and entraining in the water column.
- In displacement mode (Condition 2 – leisure cruising), the bow and stern pressure wave velocities were large enough to disturb sediments at depths >10 ft; however, the transverse wave and propeller wash velocities were minimal at depths ≥ 10 ft, which prevented these sediments from being resuspended and entrained in the water column.
- Wakeboats in semi-displacement mode (Condition 2 - surfing) produce all three phenomena at greater magnitudes compared to the other test conditions. The bow and stern pressure wave velocities were large enough to disturb lakebed sediments to depths of approximately 20 ft. The transverse wave velocities were capable of disturbing fine sediments down to a depth of 15-16 ft. By 20 ft deep the transverse wave velocities had decreased to near zero. The propeller wash velocities were significant down to depths of ~ 10 ft. After the initial prop wash jet, propeller wash currents were predominately moving towards the water surface (upwelling), which likely played a significant role in the sustained sediment suspension and entrainment into the water column. Below a depth of ~ 15 ft, propeller wash velocities decreased to near zero. Underwater video and aerial drone video confirmed that lakebed sediment (detritus) had resuspended at a depth of 14 ft.

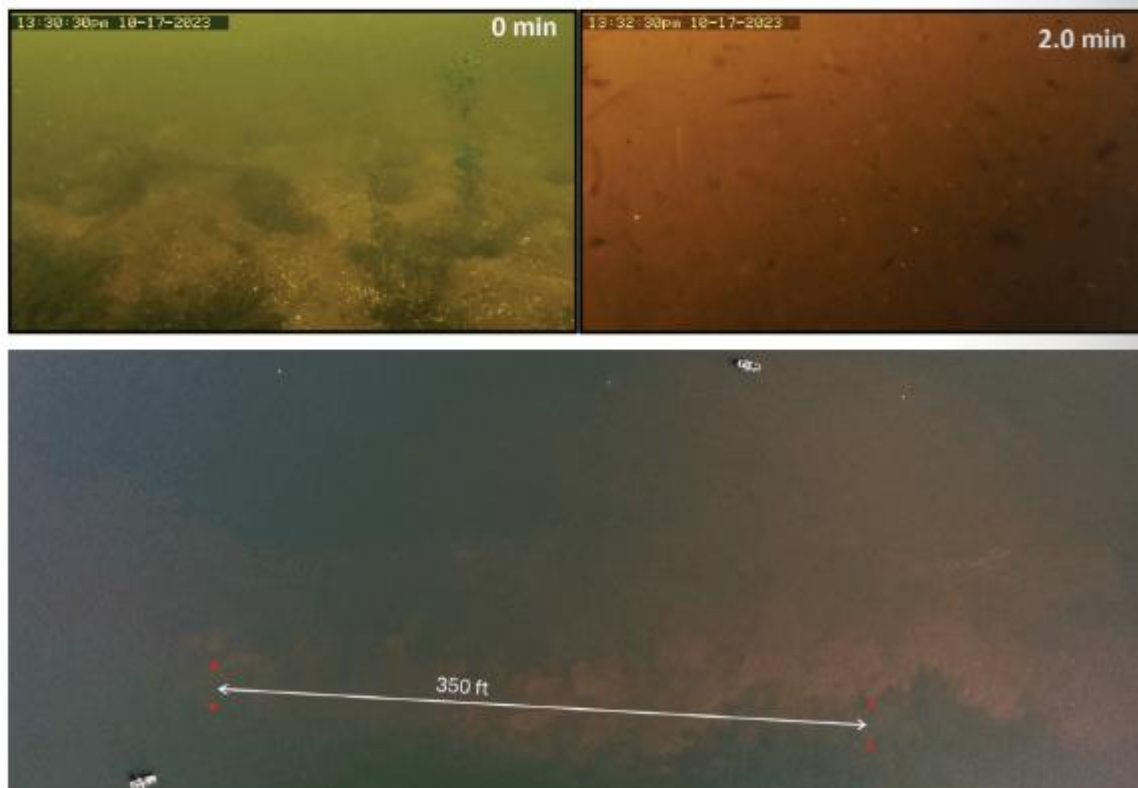


Figure 4. (Upper) Underwater video screenshots taken in 9 ft of water during the first pass of the Malibu VLX Wakesetter in surfing mode. The left image was taken immediately before the boat arrived and the right image was taken two minutes after the boat had passed. (Lower) Aerial video screenshot captured one hour after the first pass of the Malibu VLX Wakesetter under surfing conditions. The distance between the red buoys (data collection locations) is 350 ft.

Recommendations

Depth of Operation to Limit Impacts on the Lake Environment

Although these hydrodynamic phenomena are not fully visible from the water surface, powerboats can create large waves and currents that can extend deep into the water column and, depending on the water depth, can disturb the thermal regime, submerged aquatic vegetation, and lakebed. To minimize impacts to the lakebed, we provide the following depth recommendations for recreational powerboats operating in their typical modes:

- ✓ ***Recommended depth of operation for planing mode (cruising).*** Recreational boats, like the ones studied in this project, should operate in 10 ft of water or greater when planing to minimize impacts on the lakebed.
- ✓ ***Recommended depth of operation for non-wakeboats and wakeboats in displacement mode (leisure cruising).*** Recreational boats, like the ones studied in this project, should operate in 10 ft of water or greater when in sustained displacement mode to minimize impacts on the lakebed.
- ✓ ***Recommended depth of operation for wakeboats in semi-displacement mode (surfing).*** Wakeboats should operate in 20 ft of water or greater when in semi-displacement mode to minimize impacts to the lake bottom.



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Funding provided by the Minnesota Environment
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Wright County Coalition of Lake Associations

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Working together to protect and improve water quality in Wright County, Minnesota



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2026 WCCOLA Annual Meeting Presentations:

Click on links below for presentations:

- [President's Presentation](#)
- [Treasurer's Report](#)
- [Wakesurf Research Updates and WCCOLA Efforts](#)
- [Wright SWCD Updates](#)
- [MN Lakes & Rivers Lake Steward Program](#)
- [MN Watercraft Operator Permits Update](#)
- [MN Boat Wrap Recycling Program](#)
- [Wright County AIS Tool Stations](#)

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2026 WCCOLA Dues Reminder

Wright County Coalition of Lake Associations appreciates your support!
You can mail your form and payment. [Click here for a membership/dues form.](#)

Low Cost Watercraft Cleaning Stations Available in Wright County

Wright County COLA and Wright County Soil and Water have partnered to provide low cost AIS watercraft cleaning stations for Wright County lakes. The cleaning station project has been proven to enhance education and compliance and enables lake associations like yours to help keep AIS out of our lakes.



There are currently 16 of these low-cost cleaning stations and 5 high tech (CD3) stations deployed across Wright County boat launches. If your lake access does not have at least one of these options, it really should! The cost to lake associations is just \$150 per station. The visual reminder to clean boats upon ramp exit is priceless.

This is a great, practical tool to help reduce the spread of aquatic invasive species. Sign up now for your lake access!

For more information or to order, contact Alicia O'Hare at Wright County Soil and Water

alicia.ohare@mn.nacdn.net | 763-614-2919

Priorities to Protect our Public Waters



The Minnesota Coalition of Lake Associations has a fantastic resource to explain priorities for protecting our public waters: **water quality, aquatic invasive species, and enhanced wake activity**. It is great for discussions with government officials, and education for new board members and lake residents.

One page summary of priorities

Webinar (40 minutes)

Recap of the MN COLA/SafeWakes seminar

MN COLA Position Statement on Wake Surfing

Video: MN FOX 9 **Wakesurfing Critics pushing for local bans, limits on Minnesota Lakes**

Presentation slides and references



Engaging with University of Minnesota Aquatic Invasive Species Research Center

Save the date: Thursday, October 9th: **MAISRC AIS RESEARCH AND MANAGEMENT SHOWCASE**

Wright County COLA has a close relationship with the University of Minnesota Aquatic Invasive Species Research Center. We have two projects with them:

Spiny Water Flea Hunt | Curt Forst, WCCOLA President, led the hunt on Cedar Lake and Howard Lake. Good news—none of the invasive species were found. [Click here for more details about the hunt.](#)

Zebra Mussel Safari | David Glass, Cedar Lake Conservation Club, worked with a research scientist over the summer. The goal is to understand the how and why of the shifts in zebra mussel density, abundance, and distribution within a lake.

Starry Stonewort: A formidable foe

Save The Date: August 9th for **Starry Trek** a statewide event focused on searching for the very problematic AIS, Starry Stonewort.

Starry stonewort is one of the newer aquatic invaders—particularly fearsome due to its aggressive nature and ability to mat and interfere with habitat and recreation. Here are a couple of great videos to provide more information:

[Overview of Starry Stonewort from U of Minnesota Aquatic Invasive Species Research Center](#)

[4 Minute Video on How to Identify Starry Stonewort](#)

JOIN US FOR THE 2026 **MN LAKES & RIVERS** Member Social!



AT THE
**LEGACY OF THE LAKES
MUSEUM**
ALEXANDRIA, MN



JUNE 3RD
2:00-5:00 PM

Scan here
to register



What makes a lake association truly effective? It's not just commitment—it's organization, connection, and having the right support behind you.

On June 3, Minnesota Lakes & Rivers is bringing lake association leaders together at the 2026 MLR Member Social at the Legacy of the Lakes Museum in Alexandria—an event designed to help you strengthen how your association works and increase your long-term impact.

Come celebrate MLR's 32-year legacy and join us as we look ahead to the next generation of lake stewardship. For decades, MLR has helped organize and support lake associations across the state—turning local efforts into a powerful, statewide voice for clean water and healthy lakes. This gathering is your opportunity to better understand how that network works—and how to make it work for you.

You'll also hear from DNR Commissioner Sarah Strommen, receive a 2026 legislative update, hear about our MLR programs, and have time to connect with peers and explore the museum.

Event Details:

 June 3, 2026 2:00PM - 5:00PM

 Legacy of the Lakes Museum, Alexandria, MN

 \$15 (includes light snacks and museum admission)

Space is limited.

We hope you'll join us and be part of strengthening lake leadership across Minnesota.

[Register Here](#)

2026 Minnesota DNR Roundtable Summary

The Minnesota DNR held its annual Roundtable on January 9th to a crowd of more than 400 people. This was a difficult week for Minnesota, and the opportunity to focus on water, nature, and the environment for a day was appreciated. The DNR leadership made themselves available throughout the day and encouraged questions from the audience. Overall, it was pleasant to be a part of something that brings people together.

The event began with DNR Commissioner Sarah Strommen providing an [update](#) on their \$150M "Get out MORE" campaign begun in 2025 to improve outdoor infrastructure and experiences. She discussed the progress made in specific areas through small and consistent steps. She cited author Robert Collier "success is the sum of small efforts repeated day in and day out." The session then went to an open questions [presentation](#) led by WCCO Radio host Rob Drieslein and including MN State Senator Fong Hawj, chair of the MN Senate Environment, Climate, and Legacy Committee, and Peter Fischer and Josh Heintzeman, Co-Chairs of the MN House Environment and Natural Resources Finance and Policy Committee. For the legislators Drieslein queued up a number of questions around hunting and fishing, including whether the state needs another moose hunt or a Trumpeter Swan hunt. The legislators offered their policy opinions with various degrees of agreement. The presentation served to introduce questions that may be of interest to legislators in the upcoming session, but no commitments were made during the presentation. It was good to see legislators from both sides of the aisle sharing their ideas. (The House Representatives suggested continuing the discussion on a future fishing trip and extended an invitation to the Senator.) All three legislators said they would support using the lottery funds for the environment in the future. The panel received audience suggestions on wildlife management, and without making specific commitments, all stating they would rely on the "data" to inform their position.

The breakout session on wake surfing was well attended. Jeff Marr and Andy Riesgraf of the University of Minnesota's Saint Anthony Falls Laboratory (SAFL) discussed their findings and presented selected video clips of actions at the lake bottoms when boats pass over. SAFL published in 2022 their Phase I report on lateral energy and the impact on shorelines. They then published in 2025 their Phase II report on energy directed downward and the impact on lake bottoms. In the room people were genuinely shocked at the Phase 2 videos, and specifically the severe disturbance of the bottoms. Riesgraf noted that he didn't expect to see "the drama at the bottom" in the videos. The tests in both phases were conducted with boats operating in slow operation, in surfing mode, and at planing speeds. The testing found that all motorized boats create a wake, and that all boats should operate at slow speeds in ten feet of water or less, which was an important reminder regarding no wake zones. Jeff Marr explained that SAFL is a testing lab producing useful data that may be used to create policy, but that SAFL itself does not produce policy.

2026 Minnesota DNR Roundtable Summary

Starry stonewort was the predominant, but not the only concern during the first AIS breakout session. WAPOA (Whitefish Area Property Owner's Association) reported that they are hand pulling stonewort and conducting a bulbil population survey. They have 37 accesses on the chain amplifying their concern. With the reduction in and a possible future loss of state AIS funding, concerns were expressed by many in the audience. The DNR allocations have been increased but it's not enough to replace the state funding. Hybrid cattails were brought up by an audience member but there was no discussion.

Dorothy Whitmer, creator of the Lake Steward program, and Lily Carr, Minnesota Lakes and Rivers Advocates, led a breakout session on the Lake Steward program. The program was begun on the Gull Chain of Lakes and has now expanded to the state. Carr mentioned there are now 64 lake associations involved, with 80+ volunteer shoreline evaluators and 600+ stewards. Carr mentioned that branding is their goal and they are engaged with the Natural Shoreline Partnership program. Changing ideas and attitudes about what constitutes good shoreline management that is beneficial for the environment is the goal. A Kentucky Bluegrass lawn all the way down to the shore has been the 'ideal' as depicted in realtor brochures, but that is changing. There is a now CEU-qualified course for realtors, and the University of Minnesota is developing similar coursework. One of the takeaways from this session was qualifications for a Lake Steward award are easier than many thought and it's not too late to promote this opportunity.

New ideas were brought to the second AIS breakout session. Should Eurasian watermilfoil be treated after October 1st where the milfoil is still inputting resources, but most native plants have gone dormant? Are our methods of AIS treatments over time possibly leading to a monoculture that could be disastrous over time? It was noted that efforts are underway to develop methodologies to treat multiple AIS species simultaneously. Mike Verhoven of the DNR noted his team is looking for where best to place their limited resources for the best outcomes.

The final plenary session brought the DNR leadership together to answer questions. Sarah Strommen concluded the conference with encouragement to the audience to check out Minnesota's outdoor activities. She noted that fishing overall in Minnesota is a \$4B industry.

As is often the case, the best part of the entire day was networking with colleagues. With so many activities in our lives, we miss potential opportunities to engage, learn and develop. But in this event people from different parts of the state shared ideas, both large and small, that will help move the overall effort forward. One of the more prevalent networking topics was that lake managers are growing older and it's difficult to attract young people. To address that issue the DNR again hosted a subgroup of Young

2026 Minnesota DNR Roundtable Summary

Professionals. It was also good to have a Legislative presence with the attendance of the chairs of the relevant committees.

Sue Wolf, President of the Cedar Lake Conservation Club (Wright County)

Jim Kutzner, MN COLA