




MINNESOTA AQUATIC INVASIVE
SPECIES RESEARCH CENTER
UNIVERSITY OF MINNESOTA

FIELD NOTES: ANNUAL REPORT 2025



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Photo by University of Minnesota

LETTER FROM THE DIRECTOR

When I look back on the past year, I see more than projects and data points. I see collaboration, dedication, and momentum. Minnesota's scientists, managers, students, tribes, agencies, and community partners worked together to confront aquatic invasive species (AIS) with optimism and determination. We advanced research that is fundamental to solving our AIS concerns in Minnesota's lakes, rivers, and wetlands.

This annual report highlights research progress that is changing what we thought was possible. A decade ago, we were leading research on strategies to control invasive plant populations. Now, we are pioneering a future for native plant restoration - post AIS management - supporting healthy and resilient lake ecosystems. New genomic tools are revealing how zebra mussels spread and are opening doors to smarter, more precise control strategies. Innovative approaches to managing invasive common carp are moving closer to real-world implementation, with both genetic and non-genetic options under development. Research on starry stonewort and its interactions with wild rice is helping protect culturally and ecologically vital resources.

MAISRC researchers expanded surveillance tools for harmful amphibian pathogens and examined environmental DNA (eDNA) technologies to detect AIS earlier and more efficiently. The Lab to Lakes initiative is demonstrating what happens when lessons learned from research are put into management practice to support the health of our lakes. And through outreach, education programs, and the AIS Detectors network, thousands of Minnesotans contributed their time, knowledge, and leadership in protecting our waters.

All of this progress reflects a shared commitment: Minnesotans will not sit back and accept the continued spread and consequences of AIS in our waters. We are committed to understanding these challenges, finding ways to move through them, and taking action with the best available science.



We are committed to taking action with the best available science.

As we look ahead to 2026, our mission is as clear as a lake full of zebra mussels. We will continue building the scientific foundation needed to prevent new invasions, control the species that are already here, restore degraded ecosystems, and empower decision-makers with tools they can use with confidence. We will strengthen our partnerships, accelerate implementation, and ensure that Minnesota continues to be a national leader in AIS research and management.

With collaboration, investment, and collective resolve, we can protect the waters that define our state's identity, economy, and way of life. Thank you for your support, your engagement, and your trust in this work. The future of Minnesota's waters depends on all of us, and together, we are making a difference.

See you on the lake,

Nick Phelps, PhD
Director, Professor

ABOUT THE MINNESOTA AQUATIC INVASIVE SPECIES RESEARCH CENTER

Our mission is to develop research-based solutions that can reduce the impacts of aquatic invasive species in Minnesota by **preventing spread, controlling populations, and managing ecosystems**; and to advance knowledge to **inspire action by others**.

The Minnesota Aquatic Invasive Species Research Center (MAISRC) is a hub for research and management strategies, bringing together experts and resources to set clear priorities for studying aquatic invasive species and conducting research.

By playing this central role, MAISRC ensures research findings have a bigger impact, avoids duplication, fills in knowledge gaps, and helps turn innovative ideas into practical solutions.

MAISRC's team includes experts in various fields including microbiology, engineering, ecology, and genetics - creating a collaborative environment for groundbreaking research.

The goal is to find research-based solutions to Minnesota's aquatic invasive species problems.

Research projects focus on:

- **Prevention** - Stopping invasions before they happen
- **Control** - Managing invasive species once they're here
- **Management** - Restoring balance to ecosystems
- **Advancing knowledge** to inspire action by others



Photo of mystery snails by MAISRC

Funding for MAISRC is provided by the Minnesota Environment and Natural Resources Trust Fund (ENRTF) as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR); the State of Minnesota, and public donations.



INVERTEBRATES

Genomic surveillance and genetic manipulation of zebra mussels

MAISRC researchers uncovered the routes by which zebra mussels spread to Minnesota lakes, and identified the water bodies (including some surprising ones) that were the likely origins for the surge in Minnesota invasions that rose over 15 years ago.

In a study recently published in *Scientific Reports*, the research team analyzed thousands of genetic markers from zebra mussels sampled throughout Minnesota and the surrounding region. Through a combination of DNA sequencing and invasion scenario modeling, MAISRC researchers were able to infer likely source populations for dozens of lakes. **The study provides the first comprehensive map of zebra mussel invasions across North America** to be generated using genomic analysis, and was made possible by the recent sequencing of the zebra mussel genome by the University of Minnesota Genomics Center (UMGC) and MAISRC.

In another project with the UMG, researchers are working to remove specific barriers to developing genetic tools that could help control zebra mussels. A major step toward that goal is **learning how to reliably raise zebra mussels through their full life cycle in the lab**, which has never been done before.

To achieve this, the research team will identify the microbes that veligers (the microscopic larval stage of zebra mussels) eat in the wild, using DNA sequencing and microscopy to pinpoint which microbes support healthy growth. These microbes will then be cultured and tested to determine which diets help veligers survive and reach the juvenile



Zebra mussels clinging to mystery snail;
Photo by Víctor H. Hernández Elizárraga

stage. This breakthrough alone would **open the door to more advanced research and new control options**. Alongside this work, researchers will begin building a genetic toolkit for zebra mussels by identifying the DNA “switches” that turn genes on and off and by uncovering how sex is determined in this species. Using genomic sequencing, gene expression analyses, and reporter assays, the team will pinpoint regulatory elements

and sex-linked genes that are important for developing tools like gene drives or other targeted genetic controls.

Combined, these efforts will lay a critical foundation for future biocontrol strategies, giving managers more flexible, precise, and scalable options as technical and regulatory landscapes evolve.

Learn more: z.umn.edu/zm-gen

FISH

Genetic biocontrol of invasive fish species

MAISRC researchers are developing a **genetic pest control method for common carp**. It involves editing the genome of male carp that could be released to a body of water to interfere with the ability of the carp population to reproduce. Although the research is far from use in real lake situations, this method shows promise as a **species-specific, broadly applicable, and cost-effective solution for population control**.

The next phase of this project will build on promising results from earlier work to advance both technology development and regulatory readiness for managing invasive common carp in Minnesota. The research team will further evaluate genetic control agents designed to reduce common

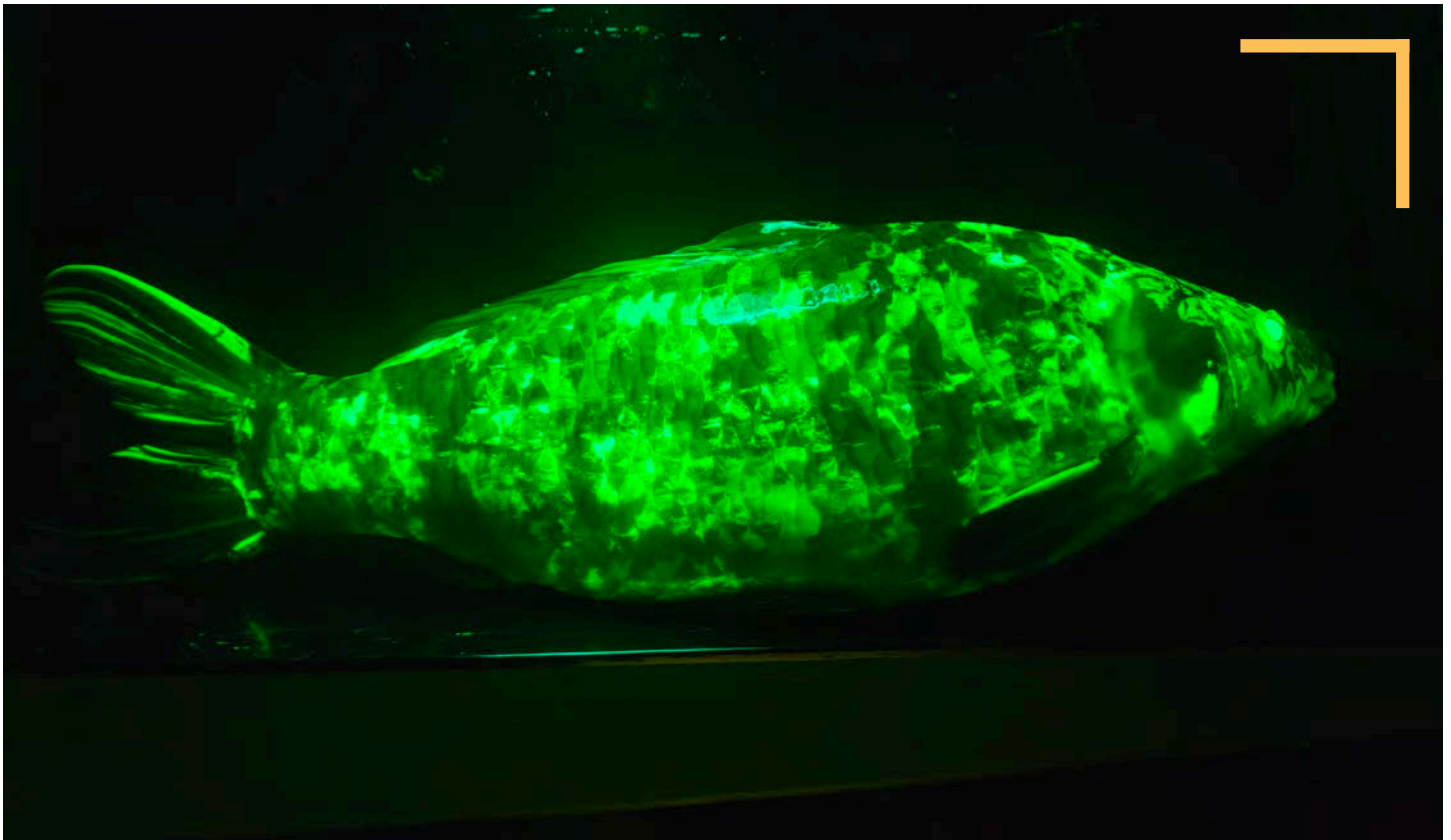
carp reproduction, with a focus on lines that bias offspring survival toward males. Laboratory studies will move beyond early-stage screening to assess mating behavior and sperm competitiveness in controlled spawning environments, using advanced machine-vision tools to better understand how lab-reared fish perform relative to wild carp.

At the same time, the project will advance a novel, non-genetically modified approach based on surrogate host technology. Researchers will work to produce male carp that generate fathead minnow sperm, resulting in **offspring that are largely nonviable, sterile, or vulnerable to predation**. This non-genetically modified

strategy could offer a self-limiting and potentially more publicly acceptable option for integrated carp management.

Another component of this project focuses on regulatory engagement. The team will work closely with the Minnesota Department of Natural Resources to establish routine fish health screening at the MAISRC Containment Lab and clarify permit pathways for future release studies. Together, these efforts aim to **move genetic control strategies closer to real-world evaluation** while ensuring ecological safety, and regulatory and public transparency.

Learn more: z.umn.edu/GBC



Glowing carp; photo by Julie Badger



Leech Lake SCUBA divers; photo by Naomi Blinick

PLANTS

Starry stonewort and wild rice: assessment and response

Starry stonewort (SSW) continues to spread in Minnesota and poses a credible threat to native aquatic plants, including wild rice. This project **advanced understanding of where SSW is likely to occur**, its ecological overlap with wild rice, and what its presence may mean for wild rice habitat. Targeted surveillance across 51 public boat launches on the Leech Lake Reservation identified three new SSW infestations, demonstrating the value of focused monitoring guided by risk-assessment tools.

Field studies showed that although SSW is expanding slowly into wild rice habitat, its

encroachment is measurable and associated with declines in native plant cover. Long-term monitoring quadrats and high-resolution plots positioned at invasion fronts **show increases in SSW percent cover and biomass throughout the growing season.**

Ongoing analyses will clarify how these changes influence wild rice stem density, height, and productivity. Time-lapse cameras are also providing new insight into the seasonal growth patterns of both species, helping managers understand when and where competition may be strongest.

Beyond data collection, the project strengthened outreach and capacity building. Team members delivered training, engaged tribal and local communities, and shared early results through workshops, public events, and the AIS Detectors program. These efforts have **improved regional readiness for SSW management and will support the Leech Lake Band of Ojibwe** and other Minnesota resource managers as they evaluate surveillance strategies and plan responses to this emerging AIS.

Learn more: umn.edu/SSW-wildrice



PLANTS

Cultivating resilience: Native revegetation for AIS resistance

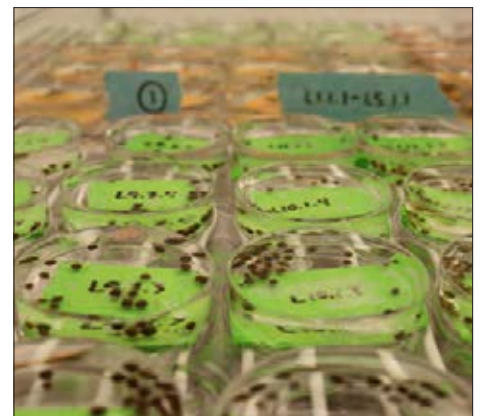
MAISRC researchers are working to address a long-standing issue in lake management: invasive plants can be reduced through herbicide treatments, but native plant communities often do not rebound, leaving lakes vulnerable to re-invasion. Evidence from terrestrial systems shows that **strong native communities can resist invasion**, suggesting that active revegetation may help lakes break the cycle of repeated treatments.

Barriers to restoration success are the small number of species currently used, the scarcity of commercially available plant materials, and the lack of standardized revegetation methods. Transplanting mature plants from donor lakes remains the common approach, but it is resource-intensive, carries cross-contamination risks, and restricts species options. **Seed-based strategies could offer more scalable and diverse solutions**, but aquatic seeds are difficult to harvest and propagate, and germination timing is not well understood.



In this next phase of research, the MAISRC team will **broaden species evaluations, study early growth and survival under different environmental conditions, and launch lake revegetation experiments** to see which species and methods are most effective at establishing invasion-resistant native plant communities. This work aims to expand the AIS management toolbox and provide clear, accessible guidance that supports wider adoption of revegetation in Minnesota lakes.

Learn more: z.umn.edu/revegetation



Top photos by Naomi Blinick; bottom photo by Abha Panda



MICROBES

Surveillance and control of Chytrid fungi in Minnesota amphibians

Amphibians worldwide are facing unprecedented declines, driven in part by emerging fungal diseases. In Minnesota, two closely related pathogens, *Batrachochytrium dendrobatidis* (Bd) and the not-yet-detected but highly lethal *B. salamandrivorans* (Bsal), pose a risk to native salamanders and frogs.

This project builds on earlier work to strengthen Minnesota's preparedness through **proactive surveillance, improved risk modeling, and expanded detection tools**. At the start of this project, the research team partnered with the Minnesota Student



Network for Amphibian Pathogen Surveillance (MN SNAPS), engaging students, volunteers, and partner organizations statewide. Together, they recruited more than 14 organizations who sampled amphibians across Minnesota, and tested over 400 samples for Bd and Bsal. While Bsal was not detected, these "negative" results are still important: they informed the first statewide Bsal risk map, shared with the Minnesota Department of Natural Resources.

The team also developed a web-based tool to streamline data sharing and

created new educational resources on pathogen transmission and prevention. The current phase of this project expands this foundation by integrating surveillance data with conservation priorities, refining risk models to guide response planning, and advancing eDNA methods to detect pathogens and vulnerable species like the Eastern Newt. Together, these efforts support **early detection, informed decision-making, and long-term protection of Minnesota's amphibians.**

Learn more: z.umn.edu/chytrid-fungi



CROSS-CUTTING

Environmental DNA

MAISRC is advancing eDNA technology as a core tool for early detection and surveillance of AIS by investing in approaches that range from laboratory-based screening to portable, field-ready technologies. Across multiple projects, researchers are focused on making eDNA methods faster, more reliable, and more practical for routine use by resource managers. Together, these efforts are building the scientific foundation and applied tools needed to detect a wide range of invasive species and harmful organisms before they become established.

One area of work centers on rapid eDNA sequencing methods that can identify multiple species from a single water sample. MAISRC researchers are developing a portable sequencing approach using Nanopore technology, supported by a growing regional DNA reference library of priority aquatic invasive invertebrates and similar native species. By compiling existing genetic data, collecting missing species with the help of managers, and testing mixed-species samples, the team is

improving the accuracy and usability of this approach. Collaboration with managers and stakeholders through workshops has helped make sure the technology is understandable, relevant, and aligned with on-the-ground monitoring needs.

MAISRC is also working to improve large-scale screening capacity through high-throughput quantitative PCR (HT-qPCR), which allows many invasive species to be detected at once using minimal sampling effort. Researchers worked with AIS managers and partners across Minnesota to identify high-priority species, including invasive plants, animals, and pathogens. Using this list, the team is developing and validating rapid laboratory tests that can efficiently screen environmental samples while minimizing false positives. This approach supports cost-effective, comprehensive monitoring programs that can inform management decisions.

Researchers with MAISRC are also exploring practical tools for detecting high-priority

microbes directly in the field, focusing on methods that are sensitive but more simple than traditional laboratory techniques. Using Loop-mediated Isothermal Amplification (LAMP), researchers evaluated the detection of viral hemorrhagic septicemia virus, largemouth bass virus, and the invasive diatom (single-cell algae) *Didymo*. While technical challenges limited full field validation, the work confirmed that eDNA can reliably detect these targets and identified promising sampling and extraction strategies for different water conditions.

Together, these projects show how applying multiple, complementary eDNA approaches strengthens AIS detection and positions MAISRC to advance practical, effective tools for prevention and management.

Learn more about these projects:

z.umn.edu/rapid-dna

z.umn.edu/HT-qPCR

z.umn.edu/field-microbes





Photo by Phelps Lab

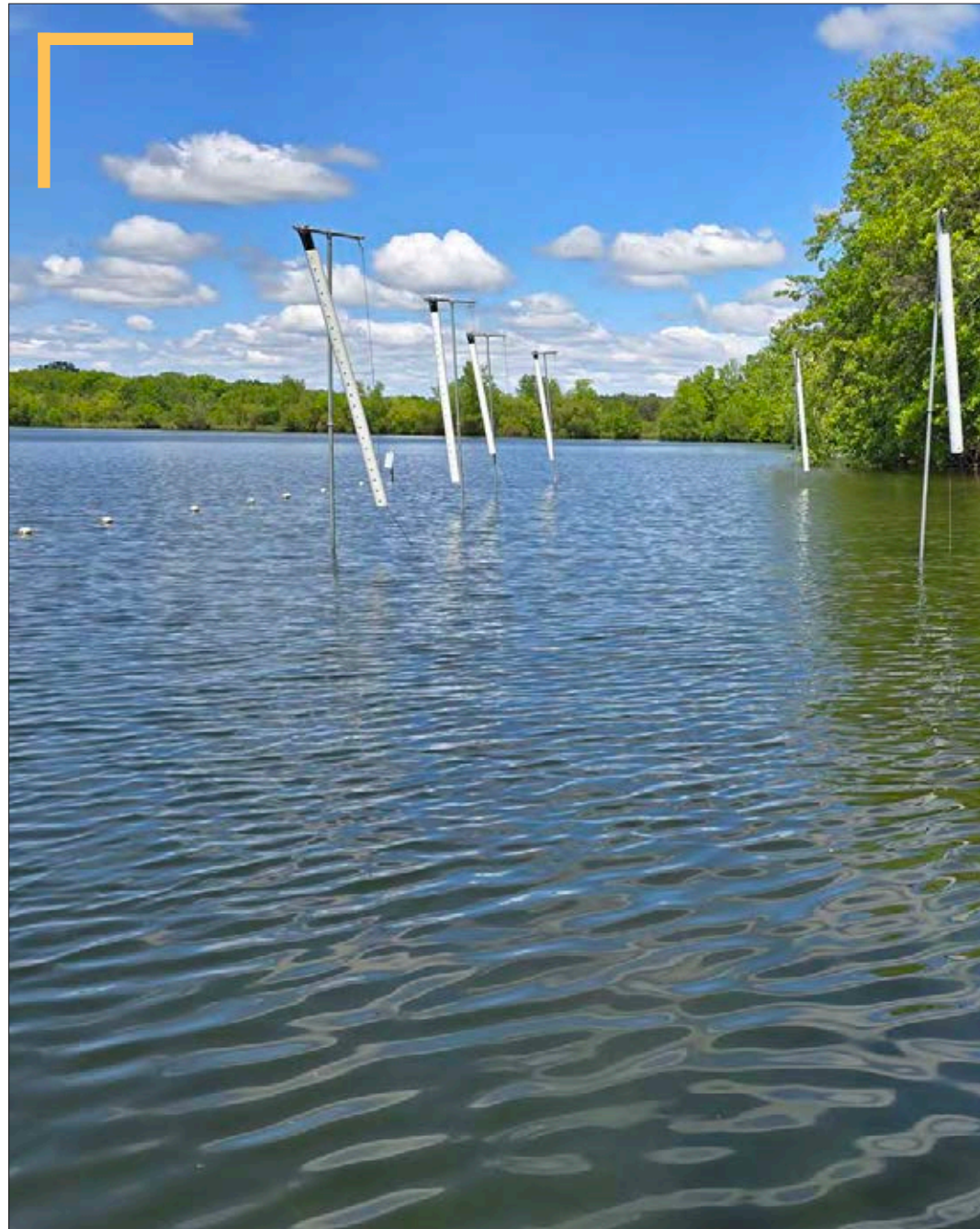
LAB TO LAKES INITIATIVE

The Lab to Lakes initiative is a significant step forward in protecting Minnesota's lakes and ensuring their ecological health for future generations.

The Lab to Lakes (L2L) Initiative is currently applying research-based strategies to **control common carp**, one of Minnesota's most damaging aquatic invasive species, in Lake Fremont and the Chisago Chain of Lakes. Over four years, MAISRC and its partners aim to restore lake health by reducing common carp populations.

In 2025, both project teams made significant progress toward their common carp management goals. In spring, each lake system used fish-tracking data to monitor spawning behavior and assess where to focus removal efforts. At Lake Fremont, the Sherburne Soil and Water Conservation District (SWCD), in collaboration with Carp Solutions, used this information to deploy eight box-net traps during the summer. With help from local volunteers, **731 carp were caught, weighing an estimated 6,140 pounds**, in the first removal effort. Box-netting has substantially reduced the Lake Fremont carp population, and the team will use lessons learned to refine the management plan for 2026.

In the Chisago Chain of Lakes, the Chisago Lakes Lake Improvement District (CLLID), in partnership with WSB, also relied on carp telemetry. However, no evidence of spawning



or migration into shallow wetlands was observed this year. Similar patterns were reported by resource managers across the region, and monitoring will continue. Future efforts will include **studying satellite lakes that may act as spawning grounds** but haven't been studied before. Now, with the colder temperatures, the telemetry data show that **carp are aggregating or swimming together in large groups**. This will allow WSB to work with commercial fishers to perform large-scale common carp removal using a procedure called winter seining.

L2L researchers also completed successful field seasons to collect pre-management

("before") data, which will be compared with post-management ("after") data to help understand **how L2L has impacted the lakes**. The Walsh Lab, led by Jake Walsh, expanded water-quality monitoring, collected zooplankton samples, and assessed aquatic plant communities in Lake Fremont and North and South Center lakes. The Gar Lab, led by Solomon David, evaluated bycatch, supported outreach events, and is analyzing trophic ecology (or what the fish are eating) to better understand lake food webs.

Learn more: labtolakes.org

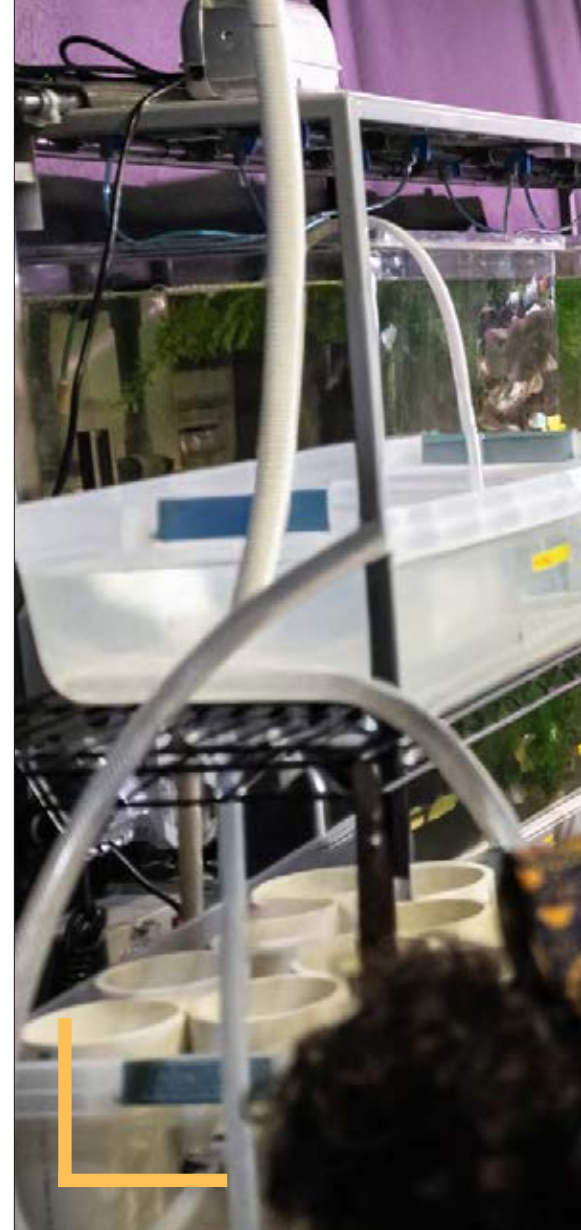


Photo by MAISRC



Top photos by GarLab; bottom photo by Dan Cibulka

OUTREACH & COLLABORATION



AIS Research and Management Showcase

MAISRC hosted its annual AIS Research and Management Showcase on October 9, 2025, on the University of Minnesota's St. Paul campus. The full-day event brought together researchers, resource managers, lake enthusiasts, and other stakeholders to explore the latest tools, research, and technologies being developed to prevent and manage AIS.

The program featured in-depth sessions on research topics such as genetic options for carp control, invasive plant management, big data approaches to predicting AIS spread, and the impacts of invasive species on ecosystems and human health. Attendees also heard lightning-round presentations highlighting new projects and emerging research and toured MAISRC's containment lab for a behind-the-scenes look at ongoing work.

Participants visited interactive demonstration stations in the afternoon, with MAISRC researchers offering hands-on learning about AIS prevention, impacts, and management solutions. Check out the photos: z.umn.edu/AIS-25-photos

Containment Lab Tours

Over 350 people toured the MAISRC Containment Lab on the University of Minnesota's St. Paul campus to get a firsthand look at the ongoing AIS research. We know that public awareness and engagement play a vital role in supporting research programs like MAISRC, which drive real solutions for addressing AIS.

Get up close and personal with aquatic invasive species with our quarterly tours in the containment lab! You'll get an inside look at our state-of-the-art facility and discover the innovative research underway.

Learn more: z.umn.edu/MCLtour





Outreach

Research Outreach Specialist **Madeline Hayden** traveled statewide to meet with lake associations and community groups, sharing research-based insights that strengthen understanding of aquatic invasive species and their impacts.

Madeline also delivered **youth education presentations** through the National Park Service and Living Lands and Waters. Public events including the Loon and Lakes Festival in Crosslake, the Otter Tail Lake Symposium, and MAISRC's Water Wednesday table at the Minnesota DNR Building during the State Fair helped showcase MAISRC's work and emphasize research-driven solutions for AIS.

Highlighted event

Researchers Amy Schrank and Claire Rude shared their work on invasive cattail removal during a dockside event at Coon Lake County Park in August 2025.

Participants learned about their research methods, the impacts of hybrid cattail, and how small-scale removal projects can support lake restoration goals and maintain important nearshore fish habitat.

Learn more: z.umn.edu/cattails



Top photo by Rebecca Slater; bottom photo by MAISRC

Outreach and science communication is a core part of MAISRC's work, and play a vital role in advancing the understanding of AIS and our progress toward real-world solutions.

To request a tour of our containment lab, visit z.umn.edu/MCLtour. To request a speaker or for other outreach opportunities, visit maisrc.umn.edu/outreach

AIS DETECTORS PROGRAM



The **AIS Detectors Program** is jointly supported by MAISRC and University of Minnesota Extension, with initial funding from the Environment and Natural Resources Trust Fund and ongoing support from the state of Minnesota. AIS Detectors aims to help protect Minnesota's life at the lake by empowering community members through its volunteer programs, events, workshops, and other educational offerings.

The **AIS Detectors Core Course** is an introductory program covering aquatic invasive species science, identification, surveillance, and reporting. Participants engage in a dynamic mix of online learning and live workshops, available in-person or online, tailored for both professionals and community members. Those in the community track become Certified AIS Detectors, joining a network of volunteers dedicated to preventing the spread of AIS through outreach, monitoring, and response efforts across Minnesota.

In 2025, the program welcomed 9 new professionals and 33 new community members to the AIS Detectors community. To date, volunteers have contributed an impressive 22,710 hours of service in Minnesota, valued at \$790,080, showcasing their vital role in protecting the state's aquatic ecosystems.

AIS Management 101 is an award-winning online course designed to foster more informed consumers of aquatic invasive species management programs. The course covers monitoring, chemical and non-chemical management options, regulations, determining success, and long-term planning. In 2025, 39 participants successfully completed this online training.

“Thanks for providing a course to educate folks on AIS. Lake management is challenging, so the more people that learn, the better we can come together and make sound decisions.”
- Core course participant

The **Aquatic Plant Identification Workshop**, hosted annually in collaboration with the Minnesota Department of Natural Resources, offers hands-on training with live plant specimens collected statewide.

In 2025, participants learned how to identify 73 species and, upon passing an identification test, contractors gained recognition on

MN DNR's list of approved aquatic plant surveyors. This often sold out workshop fosters critical skills for identifying aquatic plants in Minnesota's lakes and wetlands, serving both beginners and experts. These programs exemplify the AIS Detectors' commitment to advancing education and capacity for AIS prevention and management.

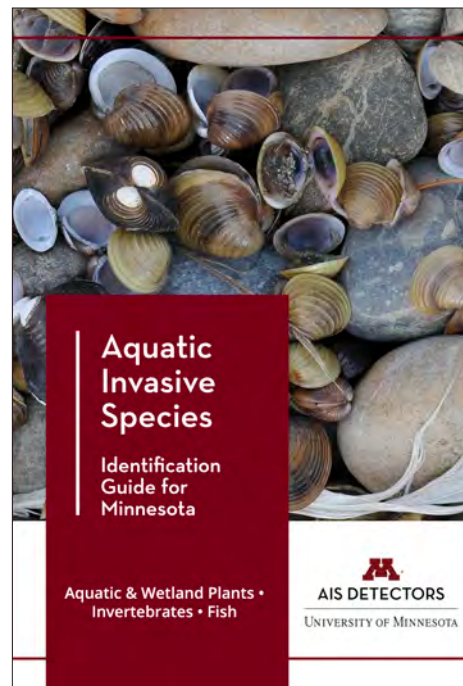
Learn more: z.umn.edu/aisdetector

Spiny Surveillance

Spiny Surveillance is a community-based early detection program focused on the tiny invasive species, spiny water flea. In 2025, 15 participants conducted 55 monitoring trips across 40 lakes. No new populations of spiny water fleas were detected.

In 2025, the program also launched two loaner kits with the necessary tools to conduct spiny water flea early detection in Park Rapids and Brainerd. These kits are available for public check-out at no cost for one week at a time. Additional loaner kits are expected to become available in 2026.

Learn more: z.umn.edu/spinysurveil



Starry Trek

Starry Trek is an annual, one-day event where the public meets at training sites across Minnesota to learn how to identify starry stonewort (SSW) and other aquatic invasive species. After the training, participants head out to local water access points to look for signs of these AIS.

Starry stonewort is an invasive algae that was first found in Lake Koronis in 2015 and has continued to slowly spread to other water bodies in Minnesota. This event is an opportunity for people to team up with the AIS Detectors program and hundreds of fellow Minnesotans to better understand SSW distribution in Minnesota.

This year, 162 participants from across Minnesota contributed to the search for aquatic invasive species. Volunteers searched 249 public accesses on 210 water bodies.

Starry stonewort was found in the following four lakes by volunteers participating in Starry Trek: Garfield Lake, Hubbard County; Gull Lake, Beltrami County; Three Island Lake, Beltrami County; Two Rivers Lake, Stearns County.

Volunteers discovered new invasive mystery snail populations in Dakota, Scott, Crow Wing, and Wright Counties. Notably, volunteers reported two new populations of Eurasian watermilfoil in Dakota County.

You can join in the quest next year! Check out starrytrek.org for more details.

Zebra Mussel Safari

Lake residents often ask why zebra mussel populations fluctuate in number, density, and distribution over time. These changes can occur during or after mussels become established, and understanding the contributing factors is complex. Zebra Mussel Safari partners with lake organizations and lakeshore residents to collect data that help clarify the factors driving these changes.

In 2025, 17 lake organizations participated in Zebra Mussel Safari and contributed data and photos that can be used to improve models predicting where mussels thrive, how they spread, and which lakes are most at risk.

Learn more: z.umn.edu/zmsafari

AIS ID Guide: 4th Edition

Whether you're a lake association member, natural resource professional, or curious Minnesotan, the **Aquatic Invasive Species Identification Guide for Minnesota** is your essential field companion for understanding what's living beneath the surface.

This full-color guide helps you identify high priority aquatic invasive species for early detection in Minnesota and their native lookalikes across plants, invertebrates, and fish. Each page features clear photographs, easy-to-follow ID keys, and distribution maps using the latest data.

Developed by the AIS Detectors program, this 4th edition provides the most current science and guidance for identifying and reporting AIS in our lakes, rivers, and wetlands.

Compact, practical, and science-based, this guide empowers everyone - from boaters to biologists - to help protect the waters that define Minnesota.

Pick up your copy: z.umn.edu/AISbook





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Contributions to MAISRC support innovative research, high quality education opportunities, and the advancement of solutions for AIS management.

To make a donation: z.umn.edu/MAISRCgift | 612-624-3333

The University of Minnesota system has campuses that are located on the homelands of the Dakota and Anishinaabe peoples, and the eleven Tribal Nations of Minnesota. It is important to acknowledge the peoples on whose land we live, learn, and work as we seek to improve and strengthen our relations with our tribal nations. We also know that words are not enough. We must ensure that our institution provides support, resources, and programs that increase access to all aspects of higher education for our American Indian students, staff, faculty, and community members.

MAISRC is committed to coordinating and collaborating with Tribal Nations in Minnesota to address AIS issues. Our aim is to work with tribal staff and community members to develop strategies for AIS prevention and management that enhance both ecological and cultural resiliency.

The University's mission, carried out on multiple campuses and throughout the state, is threefold: research and discovery, teaching and learning, and outreach and public service. The University of Minnesota is an equal opportunity educator and employer.

This publication is available in alternative formats upon request.

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