Minnesota Aquatic Invasive Species Research Center

Five years of AIS research 2012 – 2017

Greetings from MAISRC!

In 2012, the State of Minnesota took a leadership role in the fight against aquatic invasive species (AIS) and created an interdisciplinary, innovative, and forward-thinking Center to develop much-needed science to solve our AIS problems. We knew that this type of research would not be easy or fast, and expectations were high. However, after only five years, I am proud to report that the Minnesota Aquatic Invasive Species Research Center has made significant progress towards our goals – solutions are within reach.

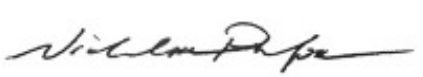
MAISRC's success has been possible through committed partnerships, productive and collaborative scientific teams, and a long-term focus on finding research-based solutions. I am encouraged every day by the results being generated and can tell you – from the front lines of research – that there are reasons to be optimistic. As you can see in the following pages, the incremental steps are beginning to lead to big wins.

What makes MAISRC unique is how closely we work with stakeholders at all levels, from research prioritization to supporting the translation of science into action. We have done this while also providing the scientific rigor needed to solve complicated problems. We have become a trusted resource and an independent voice to inform decision-making. All of this expertise, passion, and determination is making a difference in Minnesota's fight against AIS.

I became MAISRC Director in 2016 and am heavily indebted to Dr. Peter Sorensen, who founded the Center in 2012, and Dr. Susan Galatowitsch, who led the Center for two years and provided critical strategic direction. Both remain involved with MAISRC in research roles, and we wouldn't be where we are today without them.

MAISRC is deeply grateful to the Environment and Natural Resources Trust Fund as recommended by the Legislative-Citizen Commission on Minnesota Resources, the Clean Water Fund, and the Minnesota Legislature for providing funding for this research. We also thank each and every lakeshore association, corporation, foundation, and private citizen that showed their support for our research through donations. Your support is humbling and encouraging – we are inspired every day to find solutions to the problems facing our treasured lakes and rivers.

To celebrate the fifth anniversary of the MAISRC, I'm pleased to share with you this report highlighting our research findings and plans for the future. It's been an exciting five years of research accomplishments at MAISRC, and I can't wait to see what our researchers discover next. Thank you for your continued support!



Dr. Nicholas Phelps
Director, Minnesota Aquatic Invasive Species Research Center

Zebra mussels

MAISRC hired the state's first dedicated zebra mussel researcher in 2013. Since then, research efforts have intensified and expanded to use the most technologically advanced resources available. Research at MAISRC focuses particularly on finding effective and efficient ways to control them, establishing how they're spreading to better target prevention efforts, and informing management by developing early detection methods and creating survey protocols.

Key findings and accomplishments

- Completed sequencing of a draft genome of the zebra mussel in order to isolate markers to study spread and explore possible genetic weaknesses that can be targeted for control
- Determined the risk of transporting live zebra mussels in the residual water of recreational boats
- Identified the lowest effective dilution of antifreeze and the shortest period of contact time required to effectively kill zebra mussels during boat winterization
- Established best practices for using EarthTec QZ, a commercially available molluscicide, to control populations by suppressing veligers
- Wrote monitoring protocols to help lake managers plan treatments and monitor outcomes
- Developed rapid response toolkit to treat localized zebra mussel infestations based on water temperature and size of infestation
- Developed an early detection tool that simultaneously detects the presence of zebra mussels, quagga mussels, and their microscopic larvae with just one lake water sample
- Characterized the entire microbial community associated with zebra mussels in order to find pathogenic microbes and isolate them for biocontrol
- Identified zebra mussel hotspots based on environmental variables and potential spread pathways

Ongoing research

- Identifying markers in the genome to target for control
- Developing underwater population survey protocols
- Quantifying the impacts of zebra mussels on walleye growth rates and food webs
- Identifying pathogenic microbes (viruses and bacteria) associated with zebra mussels and evaluating their specificity and effectiveness as biocontrol agents
- Creating a decision-making tool to prioritize resources for optimal prevention and intervention of zebra mussels, taking into account the likelihood of arrival and establishment
- Determining the sources of new invasions in the Apostle Islands National Lakeshore

Collaborators

Brunswick Freshwater Boat Group · Carleton College · MasterCraft · Minnehaha Creek Watershed District · Minnesota Department of Natural Resources · National Park Service Tonka Bay Marina · University of Minnesota Genomics Center · Wayne State University

Researcher spotlight: Michael McCartney, PhD

"Success in dealing with zebra mussels starts with prevention, which we can target with advanced knowledge of how and where they spread, using powerful tools in genetics, genomics and modeling.

It continues with research on new ways to apply conventional controls that can cripple the ability of zebra mussel populations to grow, as well as long-term investment in biocontrol technologies that one day can be spread throughout infested lakes."

Big win:

MAISRC researchers have succeeded in using invasion genetics to identify pathways of spread of zebra mussels among lakes and rivers in Minnesota. This helps managers prioritize where to put decontamination units and inspection checkpoints.

Common carp

Common carp are one of Minnesota's most ubiquitous invasive species, but researchers at MAISRC have made significant strides toward controlling them. These accomplishments show that success with invasive species is possible. All species have weaknesses that can be targeted for control, we just have to look closely to find them.

Key findings and accomplishments

- Succeeded in controlling carp populations in the Riley and Phalen watersheds, using a combination of tools including seining, removal at barriers sites in streams, and winter aeration
- Established that native predators, such as bluegills, can control carp reproduction by consuming their eggs and larvae
- Found that carp can be trained to aggregate in specific areas of lakes using food, providing opportunities for a "bait-and-switch" method of control using toxins
- Determined the biomass threshold at which carp become damaging to lake ecosystems, which allows managers to set clear management goals
- Used winter seining to remove up to 90% of adult carp in lakes by targeting aggregations
- Discovered that common carp regenerate their reproductive organs approximately a year following gonadectomy, an unexpected finding following efforts to develop the Judas fish technique
- Conducted an analysis across hundreds of lakes and found that carp may have stronger effect on water quality than land use, and that carp removal may restore water quality even in agricultural watersheds
- Discovered that sex pheromones can be used to locate carp and attract them for removal
- Determined that common carp return to home lakes to spawn, like salmon, which is important for selecting locations to disrupt their life cycle

Ongoing research

- Harnessing naturally occurring carp viruses for biocontrol
- Adapting stream barriers to remove carp during their seasonal migrations
- Introducing a synthetic barrier to reproduction that will lead to sterile offspring
- Developing a species-specific toxin delivery system to control populations
- Testing the limits of biocontrol options to determine if they are feasible in hypereutrophic lakes

Collaborators

Minnehaha Creek Watershed District · Ramsey Washington Metro Watershed District · Rice Creek Watershed District · Riley-Purgatory Bluff Creek Watershed District · Procom Systems Whooshh Innovations

Researcher spotlight: Przemek Bajer, PhD

"How often do we get a chance to do something that actually makes a difference? We did! We have been very lucky in our quest to control common carp. The strategies we developed can already be applied in many lakes and we are now focusing on the most challenging lake systems.

It has been very gratifying to be able to apply the results of our work and see the lakes improve. Many thanks for the support over the last several years!"

Big win:

MAISRC research progressed from laboratory to field experiments and informed the effective control of carp in multiple Minnesota watersheds. These findings have transitioned into the private sector, with the formation of a University of Minnesota startup company, Carp Solutions.

Pathogens and harmful microbes

Fish diseases threaten already at-risk wild fish populations, sport fishing, and aquaculture in Minnesota. Viral hemorrhagic septicemia virus has resulted in large-scale mass mortality events throughout the eastern Great Lakes and cost millions of dollars in management efforts. Many consider the virus to be the most significant freshwater fish health threat in the world, and it's on our doorstep. Heterosporosis is a disease of at least fifteen native fish, including ecologically and economically important species such as walleye and perch. To inform effective prevention and management efforts, we must understand how diseases are transmitted, how they impact the fish hosts, and what it means for the long-term health and sustainability of fish populations in Minnesota.

Key accomplishments: Viral hemorrhagic septicemia (VHS)

- Developed a new diagnostic assay that is 1,000 times more sensitive, lowered turn-around time from 28 days to 4 hours, and reduced cost by 40% compared to the previous test
- Annually sampled about 35 high-priority bodies of water for early detection
- Created and offered training programs for veterinarians, aquaculture producers, and field biologists to effectively identify and respond to a VHS outbreak
- Developed risk management recommendations that have been implemented by the Minnesota DNR to prevent the introduction and spread of VHS
- Used predictive suitability models to show that conditions in the Great Lakes, and much of Minnesota, are still at risk for an outbreak of VHS

Collaborators

Cornell University · Department of Fisheries and Oceans Canada · Michigan State University Minnesota aquaculture industry · Minnesota Department of Natural Resources · Minnesota Veterinary Diagnostic Laboratory · USDA – Animal Plant Health Inspection Service · U.S. Fish and Wildlife Service

Key accomplishments: Heterosporosis

- Formally named and described the appearance, genetics, and pathology of *Heterosporis sutherlandae*, the causative agent of Heterosporosis
- Validated a highly sensitive and specific molecular diagnostic assay
- Developed an infection model to understand the disease over time in live fish
- Conducted surveys of Minnesota fish populations to estimate current distribution and species affected and identify long-term and seasonal infection variability
- Despite early outbreaks from 2000 – 2005, found that Heterosporosisis is now relatively rare in Minnesota among species, seasons, and lakes investigated
- Created a population model that determined heterosporis may have short-term impacts on yellow perch harvest, but long-term impacts are unlikely

Researcher spotlight: Nicholas Phelps, PhD

"Unfortunately, it is not just the plants and animals we have to worry about – it is also the harmful microbes they can carry.

Our research team has been working to identify and understand these threats to prevent spread and protect our native fish populations."

Big win:

MAISRC researchers developed a risk-based approach for early detection and prevention of VHSV. This has protected Minnesota lakes while minimizing management costs.

Bigheaded (Asian) carp

Silver and bighead carps are invasive fish that were introduced to the U.S. nearly 40 years ago. They are now on the verge of entering Minnesota waters from Iowa, where they are established. These species consume large quantities of plankton, disrupting food chains and fisheries. Additionally, silver carp can jump several feet in the air, posing a danger to public safety.

Key findings and accomplishments

- Discovered that they could be strongly deterred from passing through Mississippi River locks and dams by adjusting spillway gates due to their relatively weak peak swimming abilities
- Determined that a sweeping sound played in locks, when combined with an air curtain, should stop 99% of Asian carps from passing through while minimizing effects on native fishes
- Identified two novel viruses that have potential for biocontrol: picornavirus and paramyxovirus
- Created a numeric fish passage model that can inform the U.S. Army Corps of Engineers on ways to adjust spillway gates to stop carp while having minimal effects on native fishes
- Conducted a collaborative risk assessment for Asian carp in Minnesota waters in order to determine high-risk watersheds, potential impacts, and prioritize management recommendations
- Discovered that Asian carps use a unique set of sensory systems with novel sensitivities to food odors that can be targeted to attract them and stimulate them to consume poisoned food
- Identified a novel species-specific sex pheromone for silver carp that could be used to attract them

Ongoing research

- Testing promising lab studies on deterrents in the field
- Evaluating the acoustic deterrent system installed at Lock and Dam 8 using high-resolution imaging sonar and acoustic receivers to track movement of fishes around and through the lock chamber
- Conducting virus discovery using Next Gen Sequencing and culturing potential pathogens for biocontrol
- Evaluating new sound deterrents on Asian carps and native fish
- Using models to make recommendations to the U.S. Army Corps of Engineers for the optimization of Lock and Dams 4 and 5 to block carp with minimal effects on native fish by adjusting spillway gates

Collaborators

Fish Guidance Systems Ltd. · Minnesota Department of Natural Resources · Southern Illinois University · U.S. Fish and Wildlife Service · U.S. Geological Survey

MAISRC alumni spotlight: Dan Zielinski, PhD

"At MAISRC, my research focused on using sound and water flow to inhibit bigheaded carp movement.

Now, with the Great Lakes Fishery Commission, I use many of the same science and engineering concepts to develop bi-directional, selective fish passage solutions for Great Lakes tributaries."

Big win:

MAISRC researchers installed the first acoustic deterrent system for carp in a Lock and Dam in the U.S., and provided recommendations to the U.S. Army Corps of Engineers for adjusting spillway gate operations in ways that should reduce carp passage while still meeting their standards.

Eurasian watermilfoil

Eurasian watermilfoil grows rapidly and tends to form a dense canopy on the water surface, which can interfere with recreation and outcompete native vegetation. MAISRC research focuses on finding biological controls; integrating control with enhancement of native plants; and studying the distribution, ecology, and management of hybrid watermilfoil that arises from Eurasian watermilfoil crossing with the native species, northern watermilfoil.

Key findings and accomplishments

- Developed and evaluated techniques to selectively control Eurasian and hybrid watermilfoil using native milfoil weevils
- Conducted enclosure and mesocosm experiments, as well as lake surveys, to assess the effect of sunfish predation on milfoil weevil densities and watermilfoil abundance to inform biocontrol strategies
- Determined that weevil populations are too low to control watermilfoil in many Minnesota lakes and that other factors, in addition to sunfish predation, are limiting populations
- Determined performance and fecundity of milfoil weevils on native, hybrid and Eurasian watermilfoil and in relation to host plant chemistry and quality
- Identified hotspots for Eurasian watermilfoil based on environmental variables and potential pathways of spread

Ongoing research

- Quantifying the genetic diversity of Eurasian, hybrid, and northern watermilfoil across the state to establish if the different genetic varieties present increased invasiveness or tolerance to current control techniques
- Investigating the ecology and invasiveness of hybrid watermilfoil, in comparison to native plant communities, to evaluate impacts and develop, prioritize, and refine management strategies
- Identifying pathogenic microbes associated with Eurasian watermilfoil and evaluating their specificity and effectiveness as biocontrol agents

Collaborators

Anoka County Parks · Blue Water Science · Carver County · Chaska County · City of Eden Prairie · Minneapolis Parks and Recreation Board · Minnehaha Creek Watershed District · Minnesota Department of Natural Resources · Montana State University · Rice Creek Watershed District · Riley – Purgatory Bluff Creek Watershed District · Three Rivers Park District

Researcher spotlight: Ray Newman, PhD

"Our hybrid watermilfoil project allows us to partner with the leading national expert to assess the extent of this potential problem statewide.

And, we're doing it early enough to develop science-based approaches to managing the problem."

Big win:

MAISRC researchers determined that improving lake water clarity can help native plants re-establish after treatment of Eurasian watermilfoil, potentially reducing the need for further chemical treatments.

Starry stonewort

Starry stonewort can grow tall and dense, forming mats on the surface which can interfere with recreation and potentially displace native plant species. When it was first found in Minnesota in 2015, MAISRC researchers had to act quickly to learn the basics of invasive alga.

Key findings and accomplishments

- Convened group of international experts to synthesize what is known about the ecology, impacts, and management of starry stonewort and identify key research needs to better support management
- Evaluated efficacy of mechanical and algaecide control methods in the field
- Tested how long fragments and bulbils remain viable out of water to assess risk of overland spread
- Engaged hundreds of volunteers during *Starry Trek*, a statewide search for starry stonewort
- Provided technical assistance to lake associations and agencies on starry stonewort management
- Used locational and environmental data to predict which lakes and types of lakes in Minnesota are most vulnerable to invasion

Ongoing research

- Conducting laboratory experiments to test the efficacy and selectivity of different algaecides
- Creating a decision-making tool to prioritize resources for optimal prevention and intervention of starry stonewort, taking into account boater movement and environmental factors such as pH and temperature
- Evaluating plant community impacts and environmental factors associated with nuisance growth of starry stonewort
- Characterizing starry stonewort phenology to guide timing of management

Collaborators

AIS Detectors · Blue Water Science · Grand Lake Association · Koronis Lake Association Minnesota Department of Natural Resources New York Botanical Garden · University of Minnesota Extension · University of Wisconsin Extension · Wisconsin River Alliance

Researcher spotlight: Dan Larkin, PhD

"Integrated research and extension will allow us to better understand starry stonewort.

We'll be able to understand the risk it poses, detect populations earlier when they are more manageable, and overall improve our ability to control this aquatic invasive species."

Big win:

A group of volunteers found an early infestation of starry stonewort in Grand Lake during the 2017 Starry Trek event, which led to the lake association and the Minnesota DNR rapidly mobilizing to hand-pull the infestation. Initial results from this early intervention are very promising.

Spiny waterflea

A lot about the ecology of spiny waterflea is not yet well understood; however, concern is high that this species may cause major problems to lake ecosystems. At MAISRC, research focuses on slowing spread, identifying long-term impacts, and evaluating the food web effects of these microscopic zooplankton.

Ongoing research

- Determining what gear on boats is most likely to spread spiny waterflea, to help guide lake users in prioritizing what gear to pay most attention to when cleaning
- Quantifying the impacts of spiny waterflea on walleye growth rates and food webs
- Analyzing lake sediments to identify the types, magnitude, and timing of changes that occur to lakes after spiny waterflea invade

Researcher spotlight: Donn Branstrator, PhD

"I am privileged to be a part of the large community of Minnesotans committed to solving the problems of invasive species. It will take all hands on deck.

In my lab at the University of Minnesota — Duluth, we are working diligently to understand the threat posed by spiny waterflea and reduce their spread."

Collaborators

Minnesota Department of Natural Resources · Minnesota Sea Grant · Natural Resources Research Institute · St. Louis County University of Minnesota – Duluth · University of Regina Voyageurs National Park · Wildlife Forever

Photo: June Breneman

Phragmites

Invasive *Phragmites* (European strain) is a tall, aggressively growing grass that can take over large areas of wetland and shoreline, push out native vegetation, and reduce habitat quality for wildlife.

Ongoing research

- Determining its current distribution in Minnesota using field inspections and genetic confirmation
- Establishing whether it is producing viable seeds in Minnesota, which would complicate control
- Developing management protocols for responding to different invasion scenarios that will be customized based on the age and size of the invasion, how it's reproducing, and where it is located in relation to sensitive ecological resources

Collaborator

- Chicago Botanic Garden

Researcher spotlight: Sue Galatowitsch, PhD

"Even if it grows more than ten feet tall, Phragmites escapes notice because the European strain is easily confused with the native.

Often unreported until it is choking river corridors and overtaking wetlands, control has been impossible. We're hoping to respond sooner and have better results in Minnesota."

Curlyleaf pondweed

Curlyleaf pondweed inhibits the growth of native species, interferes with recreational activities, and disrupts valuable services provided by native plants such as stabilizing sediment, improving water quality, and providing support for fish and other animals. MAISRC research includes analyzing data to determine factors that control curlyleaf distribution and abundance, establishing how many herbicide treatments are needed for control, and finding approaches to establish native plants after control.

Key findings and accomplishments

- Determined that low-dose, early season endothall herbicide treatments can successfully control curlyleaf pondweed occurrence, biomass, and turion production by 90% without measurable negative effects on the native plant community
- Analyzed pre-existing data on curlyleaf pondweed from sixty Minnesota lakes to understand environmental factors affecting curlyleaf pondweed abundance and management outcomes
- Found that consecutive years of treatment are important for suppressing curlyleaf pondweed, and that less snow and turbid water are closely tied to more abundant populations of curlyleaf pondweed

Ongoing research

- Analyzing how many herbicide treatments are needed for effective control, what time of year to apply, and how broadly the treatments should be applied to produce the best results
- Researching how environmental conditions influence abundance
- Evaluating how native plants respond to herbicide treatments
- Conducting post-treatment monitoring, assessment of alum treatments, and transplanting native plants to treated areas to determine how to best enhance the response of native plants, particularly in lakes with poor water clarity

Collaborators

Barr Engineering · Blue Water Science · Capitol Region Watershed District Freshwater Scientific Services · Minnehaha Creek Watershed District Minnesota Department of Natural Resources · Ramsey Washington Watershed District · Rice Creek Watershed District · Riley Purgatory Bluff Creek Watershed District · Three Rivers Park District

Student spotlight: Mike Verhoeven, PhD student

"Understanding the biology of managed systems is every bit as vital as understanding the natural systems that we're working to restore them to.

Through collaboration with lake managers across the state, we are able to paint a clear picture of the broad ecology that governs our lake plant communities."

Big win:

MAISRC researchers determined that repeated large-scale treatments over several years will reduce curlyleaf pondweed turion and plant abundance, but populations retain the potential to rebound quickly if all treatment stops.

Outreach

Increasing public awareness of aquatic invasive species to inspire action by others is a key component of MAISRC's mission. One of our primary ways of reaching the public is our AIS Research and Management Showcase, held annually in September and which has now hosted over 500 AIS managers, agency representatives, scientists, and interested members of the public. MAISRC has also partnered with University of Minnesota Extension to create two unique programs, AIS Detectors and AIS Trackers, that are training volunteers and citizen scientists to be part of the solution.

AIS Detectors

- Formally launched in 2017 and certified 121 AIS Detectors in its first year
- Provides participants with high-quality training that's been developed and reviewed by AIS experts
- Equips volunteers around the state to make a difference by engaging in citizen science, outreach and education, stewardship, and other AIS programs
- Once certified, volunteers each provide a minimum of 25 hours of service every year and serve a critical role in improving Minnesota's capacity to detect, respond to, educate about, and manage AIS

AIS Trackers

- Pilot program launching in 2018 with statewide launch anticipated in 2019
- Trains volunteers to contribute data to help understand how AIS can be controlled while minimizing non-target impacts
- Data from the program helps track what is working on individual lakes and contributes to a larger database to develop recommendations to improve invasive plant control in Minnesota and beyond

Collaborators

Minnesota Department of Natural Resources
Minnesota Master Naturalist Program · River Alliance of Wisconsin · University of Minnesota Extension
University of Wisconsin Extension Lakes Program

Staff spotlight:
Megan Weber, Extension Educator

"The passion and hard work of volunteers in the AIS Detectors program and those who participated in Starry Trek is second to none!

My favorite part about my job is seeing and hearing about all the great things they are doing in the fight against aquatic invasive species to make Minnesota a better place."

Big win:

In the inaugural season of the AIS Detectors program, volunteers collectively completed over 1,650 hours of service doing citizen science, education and outreach, on-the-ground stewardship, and other program support.

Strategic Plan

The Minnesota Aquatic Invasive Species Research Center embarked on a comprehensive strategic planning process in 2015 in order to formalize our mission, vision, and plans for the future. A ten-year plan, *Reducing AIS risks by advancing research-based solutions*, resulted. Here's how we're doing so far.

Theme I:
Advancing knowledge and developing research-based AIS solutions

This theme focuses on the core MAISRC responsibility to find solutions to AIS problems. It addresses not only the research that is conducted, but also the role of MAISRC as a thought leader in the field.

- Since 2012, MAISRC has supported over 40 projects
- Supported research on 11 different species of fish, plants, invertebrates, and pathogens
- Developed an inclusive, systematic species prioritization and research needs assessment process
- Created a competitive granting process to support the best science and research possible
- Collaborated with dozens of partners from federal, state, and local agencies as well as lakeshore associations, watershed districts and other universities

Theme II:
Building statewide capacity for AIS response

This theme focuses on the ways MAISRC will provide professional-level educational and training opportunities to most effectively help others respond to AIS issues.

- MAISRC has supported over 20 students pursuing their Master's or PhD degrees
- Five MAISRC postdoctoral researchers have obtained faculty positions at universities and two are working in natural resources for federal or state agencies
- Launched the AIS Detectors program in partnership with University of Minnesota Extension in 2017 and certified 121 AIS Detectors
- AIS Trackers program will launch in 2018

Theme III:
Increasing public awareness of AIS to support research investments

Building awareness is an essential part of building support for any effort, including investments in AIS research. Greater public awareness and support will also lead to greater adoption of solutions.

- MAISRC has been featured in the news nearly 250 times, including newspaper, TV, radio, and podcasts
- Launched a new comprehensive website, e-newsletter, and social media channels to communicate research findings to the public
- Hosted hundreds of AIS managers, lakeshore association members, scientists, and concerned members of the public at our annual AIS Research and Management Showcase

Theme IV:
Supporting innovative, productive AIS research teams

This theme focuses on the work that researchers and administrative leadership can do to build an intellectually vibrant community.

- Renovated our run-down lab into a state-of-the-art research facility
- Formalized a new structure for MAISRC-affiliated researchers – MAISRC Fellows and MAISRC Grad Fellows – which will help keep expectations clear and build community
- Incentivize researchers to collaborate on projects through our competitive funding process
- Built capacity through collaborations by formalizing a Partnership Project program

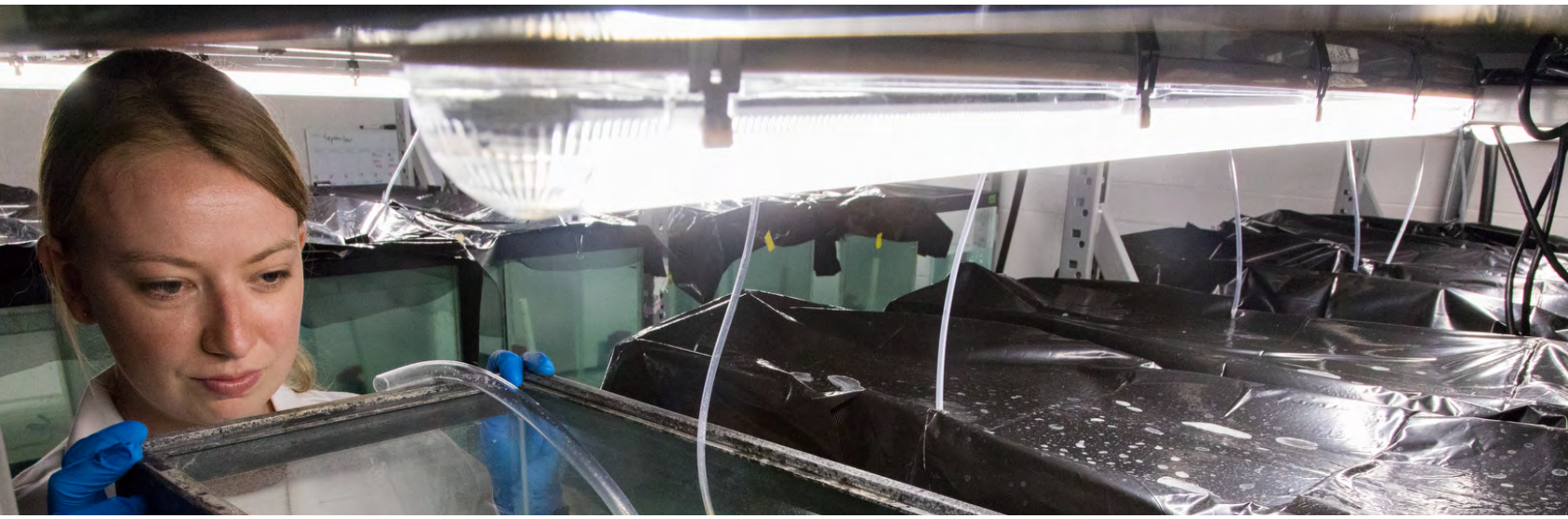
Theme V:
Sustaining the research center

This theme focuses on the scope of the resources and leadership needed for MAISRC to fulfill its mission and the promises of its founding.

- Secured funding for projects through the Environment and Natural Resources Trust Fund and base funding from the Minnesota Legislature through the Environment Bill
- Diversified our funding base with the generous support of foundations, corporations, lakeshore associations, and private citizens
- Created a Rapid Response Research Fund to help us quickly launch research if needed
- Expanded the membership of our Advisory Board to include diverse perspectives and expertise

Containment lab

The Minnesota Aquatic Invasive Species Research Center completed renovations on its lab on the St. Paul campus in 2016. Originally built as a tractor garage in 1911, it is now a state-of-the-art research facility where researchers tackle the state's foremost AIS issues.



The building

- 10,400 square feet
- 13,500 feet of pipes
- 72,500 feet of electrical wire
- 4,400 engineering hours
- Dedicated rooms to safely hold invasive plants, invertebrates, fish, and pathogens

The equipment

- Capacity for 200 gallons a minute of well water
- 27 large fish tanks, up to 15' in diameter
- 18-foot fish raceway tank
- 4 living streams
- Over 75 aquaria
- 4 plant growth chambers
- 20 water temperature zones
- 23 lighting zones

Thank you

- 2014 Minnesota Legislature
- Burns & McDonnell
- Clean Water, Land, and Legacy Amendment
- Environment and Natural Resources Trust Fund
- McGough Construction

MAISRC
by the numbers

41
projects

11
researched species

227
news stories

482
attendees of our annual Showcase

20
current and former graduate students

5
postdocs who have obtained faculty positions

401
research ideas submitted by the public

121
certified AIS Detectors

47
papers published in journals

295,336
words on our website

Learn more about aquatic invasive species in Minnesota, our research, and how you can get involved at www.MAISRC.umn.edu

Thank you!

Finding solutions to Minnesota's AIS problems is not easy, fast, or cheap. However, the support and committment to our research that MAISRC has received so far has been inspiring. Since 2012, MAISRC has been generously supported by the Environment and Natural Resources Trust Fund, as recommended by the Legislative –Citizen Commission on Minnesota Resources, the Clean Water Fund, and other funding agencies. In 2017, additional funding was provided by the state legislature through the Omnibus Environment Bill. MAISRC is also supported by donations from private citizens, lake associations, corporations, and foundations. These gifts make a big difference by allowing MAISRC to respond quickly and with flexibility to emerging AIS issues and needs. We need all hands on deck in this effort: if you're interested in supporting our work, please visit www.MAISRC.umn.edu/donate. Thank you to all of our generous supporters!

Grant funding

Army Corps of Engineers
Clean Water Fund
Environment and Natural Resources Trust Fund
Great Lakes Restoration Initiative
Hennepin County
Minnehaha Creek Watershed District
Minnesota Department of Natural Resources
National Park Service
Rice Creek Watershed District
Riley-Purgatory Bluff Creek Watershed District
State of Minnesota

$10,000 — $99,999

Brunswick Boat Group
Brunswick Public Foundation
Cornwall Foundation
Gull Chain of Lakes Association
Gabriel Jabbour
Pelican Lake Association of Crow Wing County
Whitefish Area Property Owners Association
Lee & Dorothy Whitson

$5,000 — $9,999

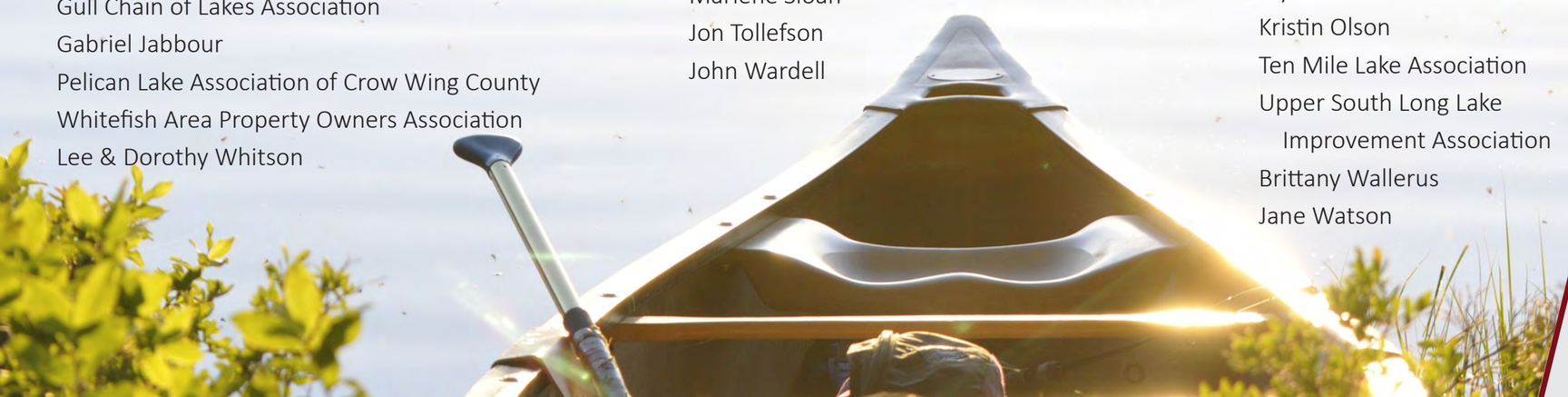
Clamshell-Bertha Lakes Association
Lake Washington Improvement Association
MasterCraft Boat Company
Timothy O'Brien
Ryan Family Donor Advised Fund
Save Our Lakes
Shorewood Yacht Club
Spicola Family Foundation

$500 — $4,999

Clitherall Lake Association
Green Lake Property Owners Association
Todd Ladwig
Craig and Maureen Norman
Clinton Roberts
Patrick Selter
Marlene Sloan
Jon Tollefson
John Wardell

$100 — $499

Ada Lake Association
Aerie Lake Environmental Fund
Association of Cass County Lakes
Ball Corp.
James Bergstrom
Big Marine Lake Association
Greg & Bridget Buckley
Center Lakes Association
Marianne D'Angelo
Lois Eberhart
Stephen & Monica Frytak
Kathryn & Orville Jonsrud
Thomas Koch
Lake Hubert Conservation Association
Lake L'Homme Dieu Association
Richard Love
Jay Maher
Kristin Olson
Ten Mile Lake Association
Upper South Long Lake Improvement Association
Brittany Wallerus
Jane Watson



Donor spotlight: Gull Chain of Lakes Association

"Gull Chain of Lakes Association (GCOLA) has, for a number of years, supported MAISRC's research to control or eradicate AIS. A number of the research projects at MAISRC are focused on early detection of AIS plants and organisms, and identifying optimal treatment options when an AIS infestation has occurred.

This type of information provided by MAISRC is very important to help lake associations, such as GCOLA, increase our ability for early detection of AIS infestations and also to take the correct steps to control or eradicate the infestation."

— Steve Allex, AIS Committee Chair

MINNESOTA AQUATIC INVASIVE SPECIES RESEARCH CENTER

UNIVERSITY OF MINNESOTA

Driven to Discover℠