



ISSUE TEN : SPRING 2018  
OPEN RIVERS :  
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The cover image is of The East Bank of the Minneapolis campus of the University of Minnesota and the Mississippi River from the Washington Avenue Bridge. Image courtesy of Patrick Nunnally.

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FEATURE

# MINNESOTA AQUATIC INVASIVE SPECIES RESEARCH CENTER

By Christine Lee and Nick Phelps

The Minnesota Aquatic Invasive Species Research Center (MAISRC) was founded in late 2012 when the Minnesota legislature and the University of Minnesota took a leadership role in the fight against aquatic invasive species (AIS) and created our interdisciplinary, innovative, and forward-thinking Center. This initiative was

led by Dr. Peter Sorensen, a well-known invasive carp researcher who is still working with the Center on several projects. Our initial funding was provided by the Environment and Natural Resources Trust Fund as recommended by the Legislative-Citizen Commission on Minnesota Resources and the Clean Water Fund.



*MAISRC researcher Przemek Bajer and his team studying the use of bluegills as a biological control for common carp. Image courtesy of Dave Hansen, University of Minnesota.*

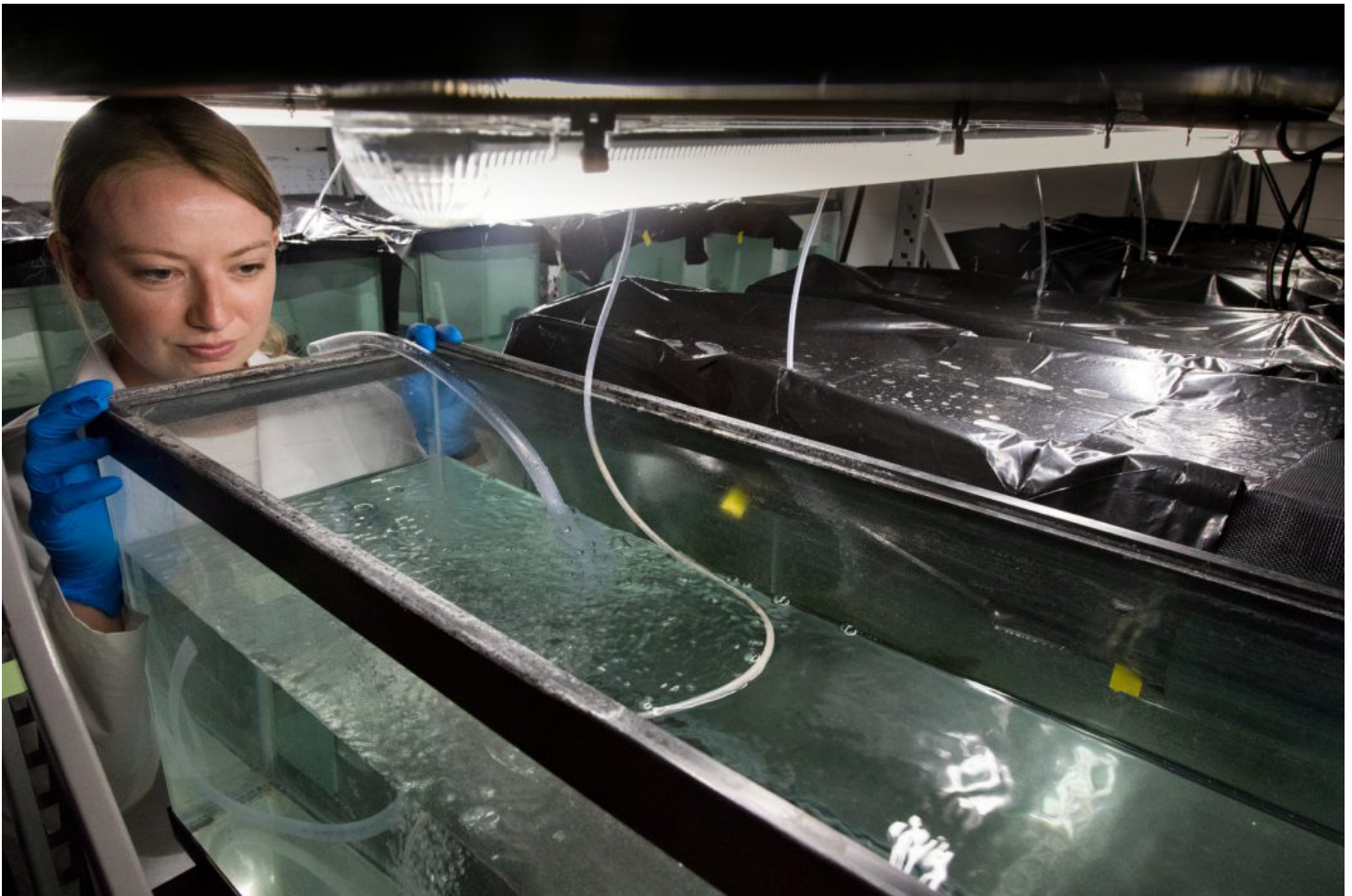


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The Center's mission is to develop research-based solutions that can reduce the impacts of aquatic invasive species in Minnesota by preventing spread, controlling populations, and managing ecosystems; and to advance knowledge to inspire action by others.

We strongly believe in the value of collaboration and coordination, which is why operating as a

Center instead of funding individual research projects is important to us. Although we are housed at the University of Minnesota, we support projects across the state. We currently have projects led by researchers at the U.S. Geological Survey, the Minnesota Department of Natural Resources (DNR), and the University of Minnesota—Duluth and Twin Cities campuses; and we also partner with researchers around



*MAISRC graduate student Megan Tomamichel in the newly renovated Minnesota Aquatic Invasive Species Containment Lab. Image courtesy of Dave Hansen, University of Minnesota.*

the world. We have spent considerable effort in these early years of MAISRC to develop a species prioritization process, an inclusive and systematic research needs assessment, and a competitive and peer-reviewed funding process to ensure that the most-needed research is being addressed.

Thanks to funding from the Minnesota legislature, we recently completed renovations to our lab and holding facility. What was once a tractor garage built in 1911 is now one of the most state-of-the-art labs in the country, at which AIS research of all kinds can be safely conducted.



*MAISRC researcher Ray Newman holds a jar of invasive plants. Image courtesy of Dave Hansen, University of Minnesota.*



# What the Center does

To date, MAISRC has supported over 40 projects on 11 different species. Our research focuses on the control and management, early detection, and prevention of key invasive species that are either already in Minnesota or considered to be high-risk to arrive in the state. Research varies greatly by the species, its life cycle, and its invasion status.

MAISRC currently conducts research on invasive plants, fish, invertebrates, and pathogens. Find out what we've learned so far and what the next steps are below.



*MAISRC researcher Peter Sorensen and his team take measurements of common carp. Image courtesy of Dave Hansen, University of Minnesota.*



# Invasive plants

## Species

### **Eurasian watermilfoil**

#### **Accomplishments so far**

MAISRC researchers have established best practices for treating this invasive plant using chemicals and biocontrol through milfoil weevils. We've also identified hotspots where Eurasian watermilfoil is most likely to be found next, in order to prioritize prevention efforts.

#### **What's next?**

Researchers are quantifying the genetic diversity of Eurasian, hybrid, and northern watermilfoil across the state to establish, develop, and prioritize management strategies. We're also identifying pathogenic microbes associated with Eurasian watermilfoil to possibly use for biocontrol.

### **Starry stonewort**

When this species was first found in Minnesota in 2015, MAISRC quickly convened a group of international experts to develop a strategic and collaborative research plan. Since then, we've evaluated the efficacy of mechanical and algaecide control methods in the field, identified hotspots for invasion and provided technical assistance to lake associations and agencies on managing this invasive alga.

Researchers are learning more about the phenology of starry stonewort to guide the timing of management, conducting lab experiments to test different algaecides, and creating a decision-making tool to prioritize resources for optimal prevention and intervention of starry stonewort.

### **Curlyleaf pondweed**

Research on this invasive plant has focused on creating best management practices, including when and how to treat without negatively impacting the native plant community.

Research is ongoing to analyze the best time of year to apply herbicide treatments and how to enhance the recovery of the lake community by transplanting native plant populations.

### ***Phragmites***

In 2017, MAISRC collaborated with citizen scientists all over the state to identify and report non-native populations of *Phragmites*. These samples are now being genetically confirmed.

Once population distribution is understood, researchers will establish whether it is sexually or asexually reproducing. Then, management protocols for responding to different invasion scenarios will be developed.

# Invasive fish

## Species

### Common carp

## Accomplishments so far

MAISRC research has progressed from laboratory to field experiments and informed the effective control of carp in multiple Minnesota watersheds. Control methods that have been successfully implemented include seining, removal at barrier sites in streams, and winter aeration. Researchers are also exploring using native predators for biocontrol.

## What's next?

Researchers are currently developing a species-specific toxin delivery system to control populations, harnessing naturally occurring carp viruses for biocontrol, introducing a synthetic barrier to reproduction that will lead to sterile offspring, and adapting stream barriers to remove carp during seasonal migrations.

### Bigheaded carps (Asian carp)

MAISRC researchers installed the first acoustic deterrent system for carp in a lock and dam in the U.S. and are providing ongoing recommendations to the U.S. Army Corps of Engineers for adjusting spillway gate operations in ways that will reduce carp passage while still meeting their standards. MAISRC also conducted a collaborative risk assessment to determine high-risk watersheds and potential impacts, and to prioritize management efforts.

To further refine the lock and dam prevention strategies, researchers are evaluating the acoustic deterrent system using high-resolution imaging sonar to track movement of fishes. We're also conducting virus discovery and culturing potential pathogens for biocontrol.



# Invasive invertebrates

## Species

### Zebra and quagga mussels

## Accomplishments so far

MAISRC set out to sequence a draft of the zebra mussel genome for the first time ever in 2015. Other genetic approaches have allowed researchers to identify relationships between zebra mussel populations across the state, which has helped to inform management strategies. In addition, connectivity networks have been created to understand boat movement and water connectivity to determine the optimal locations for decontamination units and inspection checkpoints. Research has also focused on limiting spread through residual water, establishing best practices for using commercially available molluscicides, and developing rapid response tools.

## What's next?

Researchers are working to identify markers in the genome that can be targeted for control using gene drive technologies. Researchers are also developing underwater population survey protocols, and quantifying the impacts of zebra mussels on walleye growth rates and food webs.

MAISRC is also identifying pathogenic viruses and bacteria to evaluate their specificity and effectiveness as biocontrol for both zebra and quagga mussels.

### Spiny waterflea

MAISRC launched its first spiny waterflea project in 2016. Since then, field work has been conducted on several lakes across the state, and two additional projects have launched.

Researchers are determining what gear on boats is most likely to spread spiny waterflea, quantifying their impacts on walleye-producing lakes, and analyzing lake sediments to identify the changes that occur to lakes after spiny waterflea invade.

# Pathogens and harmful microbes

## Species

### **Viral hemorrhagic septicemia (VHS)**

## Key Accomplishments

MAISRC researchers developed a new diagnostic assay for this virus 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. We also developed risk management recommendations that have been implemented by the DNR to prevent the introduction and spread of VHS.

### **Heterosporis**

MAISRC formally named and described the appearance, genetics, and pathology of *Heterosporis sutherlandae*, the causative agent of Heterosporosis. Researchers also conducted surveys of Minnesota fish populations to estimate current distribution and identify long-term and seasonal infection variability. We also developed an infection model to understand the disease over time in live fish and determined that it may have short-term impacts on yellow perch harvest, but long-term impacts are unlikely.



# Zebra mussels, a major AIS challenge in Minnesota

There are numerous factors to consider when judging the urgency and impact of an invasive species threat, including:

- Whether it is already found in Minnesota and if so, how widely established it is
- How quickly it's moving around the state

- The level of ecological and environmental damage it can cause
- Whether good options for control are available.

Considering these benchmarks, zebra mussels are particularly troubling for Minnesota. The Minnesota DNR currently considers 180 bodies of



*A SCUBA diver holding adult zebra mussels, which are covered by juveniles. Image courtesy of Naomi Blinick.*

water to be infested with zebra mussels. They are moving quickly around the state, and can often travel undetected on boats, trailers, docks, and lifts. By filtering the water, they disturb the food web and can re-engineer the entire ecosystem. Their sharp shells can cut swimmers' feet when they wash up on shore, and they can cost millions of dollars in damage at water intake systems. Although some molluscides—like EarthTec QZ and Zequanox—have been developed, they are often prohibitively expensive and have been met with limited success, especially in the relatively cold waters of Minnesota lakes.

Because of this, we focus a lot of research effort on zebra mussels. MAISRC researchers are approaching this problem from many different angles, including:

- Detecting zebra mussels early using a new molecular assay
- Predicting their spread in order to prevent it
- Establishing whether they are spreading in the residual water of recreational boats—the water that is left after boats are drained
- Testing and evaluating commercially available molluscides to develop best practices for Minnesota lakes
- Sequencing the genome in order to find weaknesses that may be targeted for control.

As more research is developed, the next significant challenge for AIS in Minnesota becomes changing behaviors and adapting to new norms.



*MAISRC researchers Mike McCartney and Sarah Baker paddle to a zebra mussel research site on Lake Minnetonka. Image courtesy of Dave Hansen, University of Minnesota.*

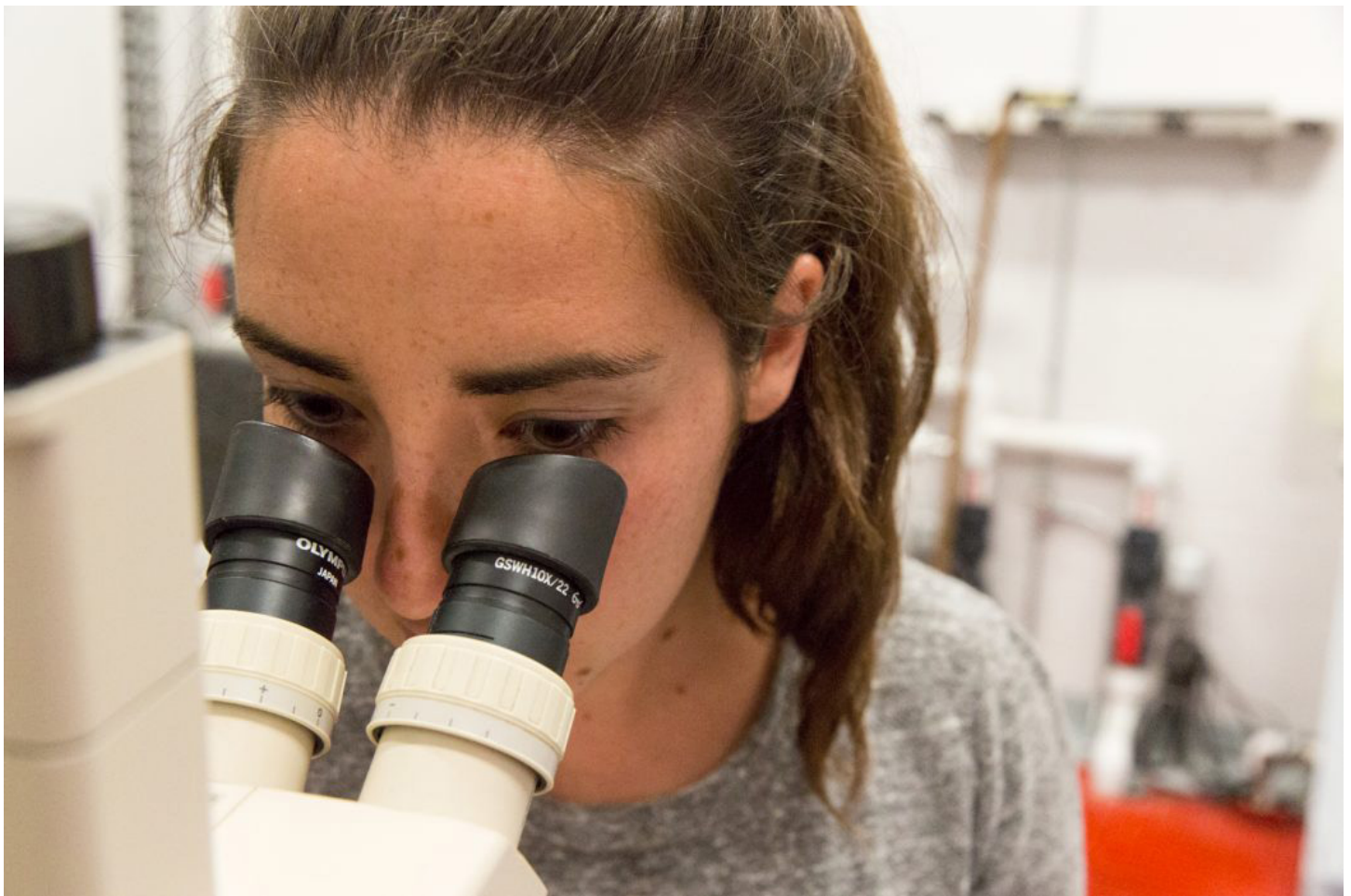


# Opportunities for breakthroughs

Scientific discoveries are often made in incremental steps towards the big breakthrough; we need the endurance to see good ideas through to the end. This is particularly true for problems as complicated as AIS. That said, we have two areas of research that are showing great promise, both in the short-term and in the long-term: creating a sophisticated model that will help prevent the spread of AIS, and using genetics to control and suppress AIS.

A diverse team of MAISRC researchers is working together to create a decision-making tool that

will help AIS managers, counties, and other agencies prioritize their resources for optimal prevention and intervention of AIS, specifically for zebra mussels and starry stonewort. The tool will answer two main questions: whether a species can get to a lake by assessing its proximity to other infested lakes, boater movement, and water connectivity; and whether it could survive there, based on lake and landscape variables such as temperature, precipitation, and pH. When complete, this one-of-a-kind model will help managers to efficiently utilize funding for AIS and improve prevention outcomes statewide.



*A MAISRC researcher looks at zebra mussel veligers through the microscope. Image courtesy of Dave Hansen, University of Minnesota.*



*Field work on Red Lake. Image courtesy of Gretchen Hansen.*





*MAISRC researcher Przemek Bajer releases a fish at a study site near Lake Phalen. Image courtesy of Dave Hansen, University of Minnesota.*





*Researcher Dan Larkin and graduate student Carli Wagner look at starry stonewort on Lake Koronis. Image courtesy of Dave Hansen, University of Minnesota.*

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Longer-term, we're looking to the growing field of genetics research, which presents numerous promising opportunities. MAISRC currently supports two projects that use genetic tools: sequencing the zebra mussel genome in order to find weaknesses that could be targeted for control, and using genetics to introduce a synthetic barrier to reproduction in common carp.

A similar technology—a genetic modification that causes offspring to die—has been deployed

in mosquitos and is undergoing trial in areas of Florida struck by the Zika virus.

Genetic technologies show promise to be very species-specific and cost-effective. However, we are taking seriously the environmental, ethical, and regulatory concerns posed by the application of genetic modification research.



*MAISRC researcher Przemek Bajer and his team studying the use of bluegills as a biological control for common carp. Image courtesy of Dave Hansen, University of Minnesota.*



# The status of invasive Asian carp research

Silver and bighead carps—often referred to as Asian carp or bigheaded—were introduced to the U.S. nearly 50 years ago and have been moving up the Mississippi River ever since. There is not yet evidence of an established, breeding population in Minnesota, although some 30 fish have been captured in Minnesota waters between 1996 and today. Asian carp pose threats to aquatic vegetation, food webs, and commercial and recreational fishing. Silver carp pose an additional threat to human health due to their propensity to leap out of the water when disturbed.

Asian carp research has been the biggest recipient of funding at MAISRC since our inception, and this investment has allowed us to move research from the lab to the field. After discovering that these fish are relatively weak swimmers at their peak, researchers developed and optimized a plan to increase water velocity by adjusting spillway gate operations at locks and dams, the details of which have been recommended to the U.S. Army Corps of Engineers.

MAISRC researchers have also installed the first acoustic deterrent system for carp in a lock and dam in the U.S., in order to capitalize on the



*This image – not taken in Minnesota – shows how invasive Silver (“Asian”) carp jump out of the river when startled. Image courtesy Asian Carp Regional Coordinating Committee. (CC-BY 2.0)*



carps' exceptionally sensitive hearing ability. The sound will deter most of the carp from moving upstream, while native fish will travel through unimpeded. Additionally, MAISRC researchers conducted a thorough risk assessment to understand the watersheds at risk for invasion in Minnesota, as well as the types of threats these invasive fish pose—both important to know when making management decisions.

Going forward, researchers are testing promising lab studies on various types of deterrents in

the field, using high-resolution imaging sonar to track the movement of fish and evaluate the acoustic deterrent system that's installed at Lock and Dam 8, and conducting virus discovery using Next Gen Sequencing to culture potential pathogens that could be used for biocontrol.

If you are interested in learning more about Asian carp work, check out the Asian Carp Regional Coordinating Committee at [www.asiancarp.us](http://www.asiancarp.us), a group that released an Asian Carp Action Plan in 2017.

## MAISRC's key programmatic and research partners

Aquatic invasive species issues are massive; solutions will require not only scientific advancement but also personal responsibility, adaptation of norms, informed policy, and effective agency management. MAISRC is one piece of this puzzle. We partner with numerous stakeholder groups, including members of the academic community,

agencies, and the public. We also receive guidance from an advisory board which includes members from the Minnesota DNR, U.S. Fish and Wildlife Service, National Park Service, local government, lake associations, tribal representatives, and sportsmen's groups.

### Universities

We are pleased to partner with University of Minnesota Extension for two citizen science programs: AIS Detectors and AIS Trackers. AIS Detectors launched in 2017 and certified 121 Detectors in its first year. It provides participants with high-quality training that's been developed by AIS experts and equips volunteers to identify, respond to, educate about, and manage AIS. AIS Trackers is being piloted in summer 2018 and will train volunteers to contribute data to help understand how AIS can be controlled while minimizing non-target impacts and informing ongoing research at MAISRC. Elsewhere on the University of Minnesota—Twin Cities campus,

we are working with researchers in the College of Food, Agriculture and Natural Resource Sciences, College of Veterinary Medicine, School of Public Health, BioTechnology Institute, and the College of Biological Sciences.

We also have research partners at several universities around the country and the world, including University of Minnesota—Duluth, Minnesota Sea Grant, Southern Illinois University, University of Wisconsin, Wayne State University, Carleton College, Cornell University, Michigan State University, Montana State University, University of Regina, and the Chinese Academy of Sciences.

## Agencies

The Minnesota Department of Natural Resources is a critical partner that we closely work with to understand the problems posed by AIS and to create and promulgate the knowledge needed to solve them.

We partner with numerous other agencies, including the U.S. Geological Survey, the U.S. Fish

and Wildlife Service, the National Park Service, Chicago Botanic Garden, New York Botanic Garden, and many others. We also work closely with watershed districts around the state, including Minnehaha Creek, Ramsey Washington, Rice Creek, and Riley-Purgatory. Counties around the state are also incredibly valuable partners.

## The public

Lake associations and their members are critical stakeholders: they are on the front lines of the aquatic invasive species invasion. They have been

essential partners from the very beginning to inform and support our research efforts.



*AIS Detectors. Image courtesy of University of Minnesota Extension.*



# Additional opportunities for growth and collaboration

Aquatic invasive species are affecting ecological and human systems; AIS research cannot be confined to one department or college. We need an all-hands-on-deck approach to solve these problems. We see very few groups on campus that wouldn't have something to bring to the

table. In the coming years, we are hoping to build capacity in the social sciences by partnering with the Carlson School of Management, the School of Journalism and Mass Communication, and the Humphrey School of Public Affairs, to name just a few.



*A volunteer throws a plant rake. Image courtesy of Megan Weber.*



# Engaging with citizens on AIS issues

MAISRC is a statewide center with projects all across the state, from Lake of the Woods on the Canadian border to the Mississippi River at the Iowa border. It's difficult to pick one project that encapsulates all of our work. But, one particularly exciting project that brings together lots of diverse stakeholders, while also informing research, is the work of our AIS Detectors and Trackers programs. Not only do these programs introduce hundreds of engaged citizens to AIS issues, they also greatly help our research. They've already had one big win: at the annual Starry Trek event, a statewide search for starry

stonewort, volunteers found a new infestation in Grand Lake. This led to the lake association and the DNR rapidly mobilizing to hand-pull the infestation, and initial results from this early intervention are very promising! Save the date for this year's Starry Trek: Saturday, August 18.

The Minnesota Aquatic Invasive Species Research Center is working diligently to solve the state's AIS problems. We're working closely with stakeholders at all levels, and have become a trusted resource and an independent voice to inform decision-making.



*Sue Galatowitsch, head of the Department of Fisheries, Wildlife, and Conservation Biology and MAISRC researcher, leads an aquatic plant identification course at the annual AIS Research and Management Showcase. Image courtesy of Christa Rittberg.*

We work hard to be inclusive of many voices, and invite you to make your voice heard through our upcoming research needs assessment. We conduct this assessment biannually to ensure we are meeting the needs of Minnesotans and funding the best research possible. This is the best opportunity to inform our work—visit [www.maisrc.umn.edu](http://www.maisrc.umn.edu) for details in a few months. Readers can also sign up there to [receive our e-newsletter](#), or find us on [Facebook](#) and [Twitter](#) to stay up to date on our research, events, and other announcements.

Anyone who wants to hear from our researchers, try hands-on demos, and get an inside-peek into our lab is invited to attend our annual AIS Research and Management Showcase. The 2018 Showcase will be held on the UMN–St. Paul

campus on Wednesday, September 12 (details and registration available on the [MAISRC website](#)).

When we took on this fight, we knew that developing much-needed science to solve our AIS problems would not be fast or easy, and that expectations were high. However, after only five years, we are finding successes. Incremental steps are beginning to lead to big wins. Research will always be a long-term investment, but progress is being made. We're deeply grateful to our funders—especially the Environment and Natural Resources Trust Fund—as well as each and every lakeshore association, foundation, corporation, and private citizen who has showed their support for us along this journey. We envision big things coming out of the research center in the next five years, so stay tuned!

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Dr. Nicholas Phelps is Director of the Minnesota Aquatic Invasive Species Research Center and Assistant Professor in the Fisheries, Wildlife, and Conservation Biology Department at the University of Minnesota. His research broadly focuses on emerging threats to aquatic ecosystem health and sustainability, including aquatic invasive species, infectious diseases of farmed and wild fish, and risk assessment. His work with MAISRC has consisted of risk assessments for Viral Hemorrhagic Septicemia Virus, invasive pathogen discovery, biological control of carp species, understanding the impacts of Heterosporosis, and predicting the spread and establishment of a variety of AIS.