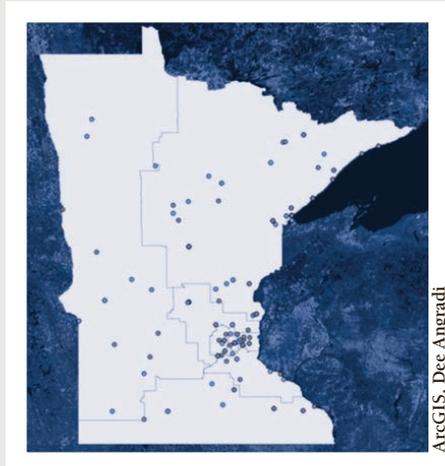


Mapping Sea Grant in Minnesota

By Sharon Moen

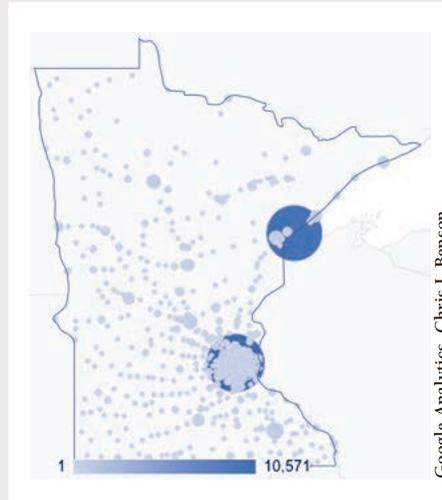
A map's ability to communicate information is so practical that The New York Times employs an entire map department and several more cartographers in their graphics department. Though Minnesota Sea Grant doesn't have a cartographer, it does have Program Analyst Dee Angradi and Information Designer Chris Benson. They occasionally make maps and two of their latest illustrate Sea Grant's expansive reach in Minnesota.



ArcGIS, Dee Angradi

Tangible Action in Minnesota: Delineated by congressional district, this map shows where Sea Grant staff or materials engaged Minnesotans from October 2016 to October 2017. Minnesota Sea Grant's nine extension educators and a handful of summer interns can reach over 31,600 individuals and 80 communities annually with products and services by:

- Conducting stormwater workshops
- Engaging educators and K-12 students
- Sharing information about aquatic invasive species at community events
- Consulting with local leaders on water-related challenges
- Facilitating discussions about aquatic issues
- Training communities and businesses to adapt to a changing climate



Google Analytics, Chris J. Benson

Minnesotans Visiting the Website: This map clarifies how Minnesota Sea Grant's website, www.seagrant.umn.edu, serves the people of Minnesota. Of more than 338,000 sessions in 2017, 73 percent originated in the United States and Minnesotans dominated the traffic (47,400 sessions, 14 percent of total). Minnesotans tend to come to the website for information on Lake Superior fish species and facts, parasites of freshwater fish and aquatic invasive species. Worldwide, from Argentina to Russia, hypothermia continues to be Minnesota Sea Grant's most popular website subject based on almost a half-million page views.

Be part of the Minnesota Sea Grant maps! Visit www.seagrant.umn.edu or contact the program (seagr@d.umn.edu; 218-726-8106) to explore ways Minnesota Sea Grant's science-based services and products might help you or your community. Tune into our biweekly podcast, The Sea Grant Files, which is in its seventh season. You can also find Minnesota Sea Grant on Facebook, Twitter and YouTube. 

Bow Watch

Navigating



John A. Downing
downing@d.umn.edu
Director, Minn. Sea Grant;
Professor, Large Lakes
Observatory and
Department of Biology,
University of Minn. Duluth

Good navigation means looking over the bow to avoid hazards, find safe harbors and stay on course in stormy weather. Because of federal budget negotiations, I stared over the bow for countless hours last year working to captain Minnesota Sea Grant through uncertainty. It is a pleasure, therefore, to take a moment at the start of 2018 to look over the stern at the turbulent waters we've passed through.

I am grateful to everyone who supported Minnesota Sea Grant during the past months, including Minnesota's congressional delegation from both sides of the aisle. This support reflects the many testimonials people wrote that highlighted how Minnesota Sea Grant helped businesses, industries and the daily lives of Minnesotans. There is the strong possibility that the President may again suggest a zero budget for Sea Grant, so we may need to call upon you again. → 2

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Food-Fish Aquaculture in Minnesota → 4

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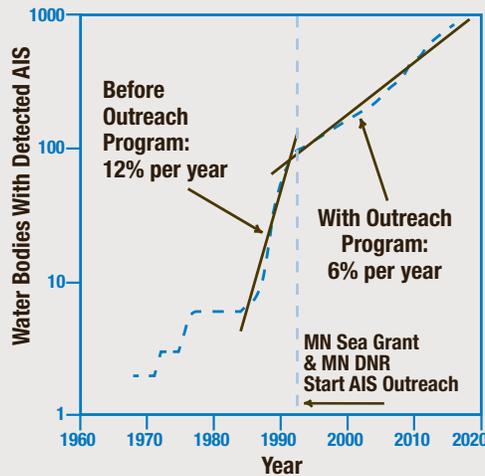
Did 'Ja Know?' → 8

← Navigating

Minnesota Sea Grant is planning an exciting future. Through a new strategic plan and details about its execution, we've charted a course toward effective and efficient ways to assist Minnesotans and coastal communities wrestling with aquatic issues. In addition to current programming, we are planning initiatives that use emerging technologies to attack water problems. Water, after all, is the most important strategic resource on the planet and Minnesotans are blessed with an amazing quantity of high-quality water!

As I write, the snow has closed in, the wood has been stacked, cabin pipes have been drained, windows shuttered, engines winterized, and docks and boat lifts have been pulled. With the end of the boating season came the unfortunate discovery that more entries need to be added to the list of waters colonized by an increasing variety of aquatic invasive species (AIS) radiating from a mounting number of water bodies. In the Itasca County lake next to where I grew up and my family has lived for 108 summers, invasive starry stonewort likely joined the banded mystery snail last year, although this is unconfirmed. In nearby lakes, three new zebra mussel infestations were confirmed. As of November 2017, 72 new infestations had been reported to the Minnesota Department of Natural Resources (DNR) in 2017 – 51 of which were zebra mussels. AIS damage to property values, industry, domestic infrastructure and sport fishing is in the millions of dollars.

Rate of Infestations in Minnesota Water Bodies Before and After Aquatic Invasive Species Outreach Programming



Graph of the logarithmic function of Minnesota waters infested with invasive species over 50 years. A straight line on this scale indicates a constant rate of infestation. Data from the Minnesota Department of Natural Resources.

Some have suggested that fighting AIS is a losing battle. I think not. Minnesota Sea Grant and our partners across the state work tirelessly using new and intensified methods to slow the spread of AIS. In epidemiology, to slow the spread of disease is to save lives. In an AIS context, it is to “save lakes.”

Wondering about the rate of expansion of invasive species in Minnesota and whether

education and outreach efforts have helped to prevent their spread, I downloaded the infested waters list from the DNR. Using this information, I graphed the rate of infestation over time. It doesn't take a statistician to see that there are two distinct rates: 12 percent per year between 1985 and 1992, and 6 percent per year since 1992.

When I asked Doug Jensen, Minnesota Sea Grant's AIS coordinator what happened to change the rate, his answer was simple: The Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990. He added that the DNR and Minnesota Sea Grant started major outreach and education efforts to help slow the spread of AIS in 1992, effectively cutting the rate of infestation in half. An average of only 45 new invaded water bodies have been added to the list annually since 2012. This number would be much higher without the efforts of our partners and volunteers across the state. If the rate of infestation had continued at 12 percent, nearly every waterbody in the state would now contain at least one aquatic invader.

Thank you again for being interested in the impacts and accomplishments of Minnesota Sea Grant. Our job is to find the water science you need and get it into your hands in a usable form. If the science does not exist, we endeavor to get it built. We are honored to have the opportunity to serve the people of this great state. 🌊

The Stop Aquatic Hitchhikers! Phenomenon

By Sharon Moen

The United States Fish and Wildlife Service and a small cadre of partners launched a successful public service campaign in 2002 in no small part because of two Minnesotans with “get ‘er done” moxie. The campaign? *Stop Aquatic Hitchhikers!*TM (<http://stopaquatichitchhikers.org>) The Minnesotans? Doug Jensen, Minnesota Sea Grant's aquatic invasive species program coordinator, and Jay Rendall, retired Minnesota Department of Natural Resources invasive species prevention coordinator. Jensen and Rendall dedicated hundreds, if not thousands, of hours examining public responses to messages designed to prevent the spread of aquatic invasive species (AIS).



STOP AQUATIC HITCHHIKERS!

Prevent transport of aquatic invasive species.
Clean all recreational equipment.

Jensen is quick to recount the history of the *Stop Aquatic Hitchhikers!* campaign, which continues to change the way Minnesota and the nation tackle one of the planet's most vexing environmental, recreational and economic problems. “The campaign formed out of dozens of conversations about natural resource protection, social science and strategic planning,” said Jensen. “Currently there about 1,400 organizations in the *Stop Aquatic Hitchhikers!* community.”

Prior to the campaign, most efforts to curtail the advance of AIS focused on raising awareness about specific species. As AIS continued to spread, states replaced information-based programs with action-oriented initiatives, which seemed like progress at first. However, the action messages were inconsistent among states. Some were too complex. A few were even misguided. It became apparent that a singular campaign that could resonate across the nation was necessary, à la Smokey the Bear, which debuted in 1944. The new campaign needed to be simple, convenient, free and most importantly effective in changing the behaviors of boaters and anglers. It needed to be *Stop Aquatic Hitchhikers!*

← The Stop Aquatic Hitchhikers! Phenomenon

But first, the federal Aquatic Nuisance Species Task Force, co-chaired by the U.S. Fish and Wildlife Service and the National Oceanic and Atmospheric Administration, needed consistent and comprehensive guidelines for preventing the spread of AIS. They achieved these guidelines by creating a Recreational Activities Committee and capitalizing on Rendall's and Jensen's studies of messaging, a message's social acceptance and its influence on behavior. The guidelines served as the cornerstone for the *Stop Aquatic Hitchhikers!* campaign.

Stop Aquatic Hitchhikers! has made a difference, particularly in "the land of 10,000 lakes" where the campaign's distinctive stop-sign-like logo and clean-drain-dry messaging can be seen on everything from billboards to bumper stickers. In a public statement in 2010, Joe Starinchak, outreach coordinator for the U.S. Fish and Wildlife Service's Branch of Invasive Species, praised Minnesota for creating a template for the rest of the country. He applauded the way the state implemented the *Stop Aquatic Hitchhikers!* campaign through a small grants program for lake associations and by using a carrot-and-stick approach that combines voluntary actions with regulatory tools.

Compared to the spread of AIS in other states, Jensen says Minnesota is doing



Chris J. Benson

Removing invasive watermilfoil from a boat trailer before leaving the landing.

exceptionally well. "If the spread of AIS was inevitable, all of our lakes would be infested by now, but they're not," he said. "A variety of assessments and surveys demonstrate significant increases in public awareness because of the campaign. We've had up to 97 percent of Minnesota boaters and anglers report taking preventative actions to protect lakes and rivers. This is up from 70 percent reported over 20 years ago."

Are behaviors actually changing? Yes. Compliance with AIS laws in Minnesota has increased to 96 percent, based on more than 102,441 watercraft inspections in 2016, according to a Minnesota

Department of Natural Resources report.* Only 5 percent of Minnesota lakes are infested with AIS, which is remarkable given that Minnesota has 866,000 registered boats, 1.5 million licensed anglers and more than 3,600 public launches.

Minnesota Sea Grant's efforts to prevent the spread of AIS through *Stop Aquatic Hitchhikers!* and Great Lakes Restoration Initiative funding were calculated to be worth more than \$6 million in 2016 by Minnesota Sea Grant's director, John Downing. This impressive sum reflects protecting lakeshore property values and sport fishing profits from invasive plants like Eurasian watermilfoil, which hampers recreational activities, and invasive fish like common carp, which damage the catch rates of more desirable fish species.

"Minnesota continues to be a leader in preventing the spread of aquatic invaders," said Jensen. "I and my colleagues at Minnesota Sea Grant are proud to have been an important part of this trajectory and we're excited about participating in innovative new ways to combat AIS."

*State of Minnesota, Department of Natural Resources. 2017. *Invasive Species 2016 Annual Report*. Minnesota Department of Natural Resources. 60pp. <http://bit.ly/2ETfUoD> 

Timeline of Aquatic Invasive Species Management in Minnesota

Acronyms

- **AIS** – aquatic invasive species
- **ANS** – aquatic nuisance species
- **MNDNR** – Minnesota Department of Natural Resources
- **MNSG** – Minnesota Sea Grant

1984: Citizens initiate grassroots efforts to curtail the spread of purple loosestrife.

1987: Eurasian watermilfoil discovered (Lake Minnetonka); MNDNR establishes purple loosestrife and Eurasian watermilfoil management programs.

1989: Zebra mussels discovered (Duluth-Superior Harbor); MNDNR establishes a Zebra Mussel Management Program.

1990: U.S. Congress passes Nonindigenous Aquatic Nuisance Prevention and Control Act forming the ANS Task Force.

1991: Great Lakes Panel on ANS convenes. MNSG forms Exotic Species Information Center.

1992: Minnesota is first state to fight spread of AIS through a program of public education, enforcement and watercraft inspection.

1994: MNSG provides baseline of awareness and behavior by conducting a survey of boaters in three states.

1998: MNSG joins Great Lakes Panel on ANS.

2000: MNSG survey of boaters shows increased awareness. ANS Task Force's Recreational Activity Guidelines are federally approved.

2002: Launch of *Stop Aquatic Hitchhikers!*TM

2006: MNSG and MNDNR actively apply *Stop Aquatic Hitchhikers!* campaign. Wildlife Forever enters as major campaign partner.

2007: MNSG survey shows campaign further raises awareness and changes behaviors.

2010-2015: Great Lakes Restoration Initiative funding accelerates *Stop Aquatic Hitchhikers!*

2011: Pull the Plug Law in Minnesota; \$250 fine for boaters who transport or launch boats with bilge plug not removed.

2013: Updated ANS Task Force's Recreational Activity Guidelines federally approved.

2017: Debut of the new *Stop Aquatic Hitchhikers!* website (<http://stopaquatichitchhikers.org>).

Food-Fish Aquaculture in Minnesota

By Don Schreiner

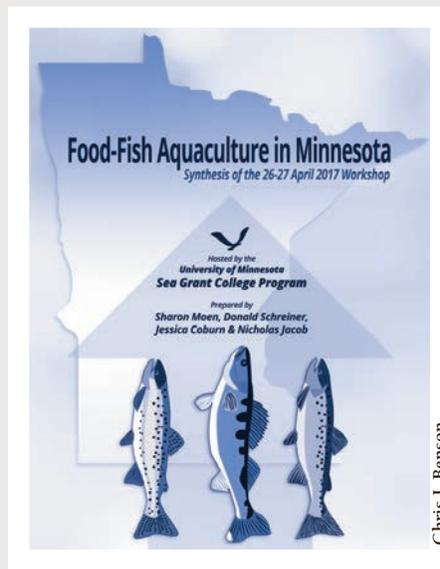
Producing baitfish and providing fish for stocking have been the major fish-rearing activities in Minnesota. However, the growth of food-fish aquaculture businesses in the United States has increased the need for more specific information on how food-fish aquaculture might best be developed in cool and cold climates like Minnesota. To address this need, Minnesota Sea Grant held a workshop to examine the status, trends and future for raising food-fish such as Walleye, Atlantic Salmon, trout and shrimp in Minnesota in 2017. The major question posed to workshop participants was:

Can an environmentally responsible and sustainable food-fish aquaculture industry be established in Minnesota and, if so, what might be the best ways to proceed?

The answer was “yes,” but it will take a balanced, thoughtful and collaborative approach among many stakeholders. The synthesis that resulted from the workshop captures the main points discussed by presenters, panel members and participants and is organized around the workshop’s themes:

1. Prioritizing production strategies and species
2. Identifying research needs and information gaps
3. Examining policy and regulatory issues

Presentations and discussions about production strategies favored recirculating aquaculture systems (RAS), followed by flow-through systems. The traditional dug and natural ponds used in Minnesota for



baitfish rearing were thought to be ineffective for food-fish since they rely on ambient water temperatures, which would make producing food-fish a lengthy process in Minnesota’s cold climate.

Workshop participants favored the idea of raising Walleye even though aquaculture systems have not yet been developed for their commercial production. The Northern Aquaculture Demonstration Facility in Bayfield, Wisconsin, is experimenting with Walleye and hybrids in RAS. Yellow Perch was also preferred, but consistent rearing and economic returns were concerns. Atlantic Salmon and Rainbow Trout are species with established markets that are well-adapted for growth in cool and cold environments. Shrimp aquaculture facilities are being developed in southwestern Minnesota

using an intense shallow water raceway system with zero water discharge. In these systems, biofilters remove nutrients; the salt remains inside of the system to be reused.

Research needs and information gaps spanned social and economic issues, and biological questions. Participants suggested Minnesota needs a food-fish aquaculture plan and a market study to determine purchasing decisions, species preference, price sensitivity, demand for local fish and industry growth potential. They said consumers need unbiased information on aquaculture so they can make informed decisions. Biological questions touched on nutrition, broodstock and breeding, disease control, facility designs and technologies.

A majority of participants agreed the regulatory climate for food-fish aquaculture in Minnesota is fair, supportive and allows flexibility. Along with a plan and a market analysis, participants said it could be useful to develop a Minnesota Aquaculture Association that can work on policies and foster success in the industry. Funding to support the food-fish aquaculture industry in Minnesota will help to ensure the industry’s success, as will working with citizens to improve the social license for aquaculture in Minnesota.

The workshop and its synthesis were supported by a grant from the National Oceanic and Atmospheric Administration Sea Grant College Program. The synthesis and videos of keynote presentations are available at www.seagrant.umn.edu/aquaculture/workshop2017.

Climate, Attribution and Lake Superior's Productivity

By Sharon Moen

2017 wasn’t an easy weather year on Earth. Southern Europe’s blistering summer, for example, included a heatwave so deadly it was nicknamed Lucifer. In a recent analysis¹, scientists reported that the chances of getting a heatwave in southern Europe increased by at least a factor of four since 1900 due to changes in Earth’s climate.¹ In other words, people in Spain a century ago could expect three-day heatwaves once every 20 years; now they can expect them every five.

Hurricanes, too, wrought death and destruction, particularly in September, which the NOAA National Hurricane Center reports was the most intense month for Atlantic Ocean tropical storms and hurricanes on record achieving an accumulated cyclone energy measure that soared about 3.5 times over average Septembers from 1981 to 2010.² NOAA scientists at the Geophysical Fluid Dynamics Laboratory are cautious in their approach to determining what portion of

hurricane intensity can be attributed to human-induced climate change. However, even these scientists project that human activities that have already added greenhouse gases to the atmosphere will likely cause tropical cyclones globally to be more intense by 2 to 11 percent by the end of the century.³

Advances in understanding the science behind extreme events has enabled climate scientists to become increasingly able to

Understanding Oil and Water in the Great Lakes

By Sharon Moen and Rachel Wachtler

"Many things in the 21st century are so complicated that you have to know a lot just to be undecided," said Minnesota Sea Grant Maritime Extension Educator Dale Bergeron. This was one of Bergeron's take-home messages from the Crude Move Oil Transportation Symposium, a meeting he helped to organize. The symposium explored the nuances of how crude oil and other petroleum-based products move through the Great Lakes region.

Citizens, businesses and communities need crude oil to move safely from one place to another. Where and how the oil travels has been the point of many recent conversations, engineering projects, some protests and several arrests.

About 130 transportation experts, petroleum industry representatives and natural resource professionals spent two days in June 2017 examining how crude oil is moved throughout the Great Lakes region with a goal of improving hazard management and decision-making while recognizing the costs and benefits associated with different modes of transport for crude oil. The Crude Move Oil Transportation Symposium was organized and facilitated by Bergeron and other Great Lakes Sea Grant staff.

One of the outcomes of that meeting is *Proceedings of Crude Move Symposium: Oil Transportation Infrastructure, Economics, Risk, Hazards and Lessons Learned* (www.glc.org/wp-content/uploads/Oil-Symposium-Proceedings-Sept-2017.pdf). Highlights include the importance of the National Oceanic and Atmospheric Administration's Office of Response and Restoration in cleaning up oil and chemical spills, the safety practices of oil transportation companies, and how regulations and insurance companies seek to mitigate risks and indemnify loss.

"There was a time before crude oil and there will be time after crude oil, too. But for now, we need to engage our best technology and most equitable processes to move oil safely throughout the Great Lakes," Bergeron said, reflecting on the outcomes of the symposium.

Director of the University of Minnesota's St. Anthony Falls Laboratory and professor of mechanical engineering, Dr. Lain Shen, is helping Sea Grant prepare for and potentially minimize risks in the event that an oil spill needs to be cleaned up in the Great Lakes. With funding from Minnesota Sea Grant, Dr. Shen is refining computer simulations that predict how oil might move in a lake like Superior. He studies

flow systems in nature by mimicking them in computer code and accessing the processing capacity of the University of Minnesota's supercomputers. When oil spills in water, weather matters. Shen says what happens at the water's surface and the nature of the oil droplet can drive where the oil ends up and therefore how it can be cleaned up. High winds and severe conditions such as flooding and high waves can make the damages worse.

"To capture wind and to capture waves and to understand the currents beneath is a complicated problem. We have learned a lot by mimicking different natural conditions, like wind, waves, eddies and currents, with computers." Shen said. "Learning these things in the field isn't practical, or possible, or for that matter, ecologically safe."

Research such as Shen's can help inform safer oil transportation practices. Outreach like Bergeron's will help people use science-based information to find their way through complicated problems.

"Complicated problems are not easily solved with a single solution, only adaptive management," Bergeron said. "Finding the best path will only be possible if we keep learning and changing our awareness." 

← 4 Climate, Attribution and Lake Superior's Productivity

attribute particular events to climate change over the past decade. The National Academy of Sciences published a report⁴ documenting these advances and the science of extreme event attribution, which seeks to tease out the influence of human-caused climate change from other factors, such as natural sources of variability like El Niño.

Some of Earth's systems more measurably reflect a changing climate than do the frequency of extreme events. Lake Superior is one of these systems. Through research partially funded by Minnesota Sea Grant, scientists with the University of Minnesota Duluth's Large Lakes Observatory discovered that an unprecedented increase in Lake Superior's algae abundance has occurred over the last century. They attribute this new productivity to warming because of human activities in a recent issue of *Nature Communications*.⁵ The surge of algae production in Lake Superior is a specific example of how the Earth is

reflecting a changing climate. "Even abrupt climate changes like those experienced in the Medieval Climate Anomaly [950-1250 AD] or the Little Ice Age [1400-1900 AD] did not influence primary production in Lake Superior like what we're seeing now," said Molly O'Beirne, lead author of the article.

O'Beirne and co-authors explain that natural weathering likely caused a slow, steady increase in primary production since the last ice age due to iron and phosphorous being released from the rocks. They found the current rate of algae growth coincides with warmer surface water temperatures and longer periods of summer stratification, in which a layer of relatively warm water rests on top of cold water. Extended stratification is related to diminishing amounts of winter ice cover. The *Nature Communications* article is available online.⁵ For a printed copy, contact Minnesota Sea Grant (seagr@d.umn.edu; 218-726-8106) and ask for JR631.

¹Cullen, H., van Oldenborgh, G.J., Karoly, D., Otto, E., and van Aalst, M., 2017. Euro-Mediterranean Heat – Summer 2017. *World Weather Attribution*. <https://www.climatecentral.org>

²NOAA National Hurricane Center. 2017. *Monthly Atlantic Tropical Weather Summary, Oct. 1*. www.nhc.noaa.gov/text/MIATWSAT.shtml

³NOAA Geophysical Fluid Dynamics Laboratory. 2017. *Global Warming and Hurricanes: An Overview of Current Research Results*. Last Revised: Aug. 30, 2017. www.gfdl.noaa.gov/global-warming-and-hurricanes

⁴National Academies of Sciences, Engineering, and Medicine. 2016. *Attribution of Extreme Weather Events in the Context of Climate Change*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/21852>

⁵O'Beirne, M.D., Werne, J.P., Hecky, R.E., Johnson, T.C., Katsev, S. and Reavie, E.D. 2017. *Anthropogenic climate change has altered primary productivity in Lake Superior*. *Nature Communications*. www.nature.com/articles/ncomms15713 

Program Updates

Welcome!



Tom Beery,
Resiliency Specialist

Beery became part of Minnesota Sea Grant's crew of extension educators in May 2017. He is collaborating with

Minnesota's coastal communities, organizations and resource managers to help people, business and governments become resilient and adaptable in a changing environment. Before returning to the University of Minnesota Duluth, where he earned a master's degree in environmental education and a doctorate in education, teaching and learning, Beery was an assistant professor at Kristianstad University in Sweden.



Christyn Buchholz,
Executive Office and
Administrative Specialist

Buchholz joined the Minnesota Sea Grant team in August 2017 to assist the director, manage student

employees and facilitate the activities of the program. Buchholz brings sales, event coordination and operations experience from nonprofit organizations and business. She earned a Bachelor of Science in communication and public relations from the University of Wisconsin-Stevens Point. One of her goals is to backpack 100 miles of the Superior Hiking Trail in one season.

Congratulations!



Dee Angradi,
Program Analyst

Angradi received a 2017 Outstanding Service Award from University of Minnesota Duluth Chancellor Lendley Black for exemplifying

the UMD core values of discovery, engagement and excellence. From creating maps, to designing spreadsheets and crunching data for reports, Angradi's skills are wide-ranging. The program's staff and partners value her quiet temperament, quick intellect and quirky humor.



Cynthia Hagley,
Environmental Quality
Extension Educator

Hagley is to be presented with the Association for the Sciences of Limnology and Oceanography Ramón

Margalef Award in Victoria, British Columbia, in June 2018. She earned this distinction for excellence in teaching and mentoring in the fields of limnology and oceanography. Her success at developing career-long relationships among scientists and educators, for impacting thousands of students, and for making environmental and aquatic data accessible to multiple audiences.



John A. Downing,
Director

Downing is one of 15 coauthors to receive the John H. Martin Award for an article published in the journal *Biogeochemistry* in 1996. Their article, Regional

nitrogen budgets and riverine N [nitrogen] & P [phosphorus] fluxes for the drainages to the North Atlantic Ocean: Natural and human influences, was the first to quantify the relationship between human activities and the amount of nitrogen entering coastal oceans. The award will be presented by the Association for the Sciences of Limnology and Oceanography in Victoria, British Columbia, in June 2018. The award honors high-impact papers at least 10 years old.



Erin Schaeffer,
Sea Grant Scholar

Schaeffer, a graduate student in Conservation Sciences at the University of Minnesota Twin Cities, received the 2017 Lake Superior

Chapter of Muskies, Inc.-Minnesota Sea Grant scholarship of \$1000. Schaeffer is studying the movement of Muskellunge in the St. Louis Estuary, a project funded by Minnesota Sea Grant. The scholarship honors Schaeffer's commitment to sharing project results, the potential impact of the outreach and the importance of the project.



Jillian Farkas,
2018 Knauss Marine
Policy Fellow

Minnesota Sea Grant is pleased to send Jillian Farkas to work in the office of Senator Gary Peters (D-MI), a ranking

member on the Subcommittee on Oceans, Atmosphere, Fisheries, and Coast Guard. Farkas was awarded a coveted Knauss Fellowship by the National Sea Grant Program while finishing a master's degree from the University of South Dakota studying the effects of tile drains on wetland fish, amphibians and invertebrates. She is one of 12 Knauss fellows who will be working within the legislative branch of the United States government for a year beginning February 1, 2018.



River Quest turned 25!

Since its inception in 1993, the St. Louis River Quest has given more than 23,000 area sixth-grade students the opportunity to see a working harbor by boat and participate in educational stations. The experience helps students understand the impact human activities have on the environmental health and the economic vitality of the harbor. It illustrates that thoughtful partnerships between industry, government and the public can result in the safe, sustainable use of natural resources. River Quest relies on the support of nearly 300 local businesses, nonprofits and individuals, and on the generosity of the Duluth Seaway Port Authority, the program's lead sponsor, and on Minnesota Sea Grant. Find details about River Quest at www.seagrant.umn.edu/riverquest.

Products and Online Resources

Order these and other publications at www.seagrant.umn.edu/publications or by calling (218-726-6191).

- **Climate Change and Lake Superior.** Sharon Moen, Hilarie Sorenson, Jennifer Gasperini and Chris Benson. 2016. (G22, free). www.seagrant.umn.edu/downloads/g022.pdf
- **Great Lakes Shipping: Great Lakes Vessels and Fuel Efficiency.** Dale Bergeron and Chris Benson. 2009. (MT2, free). www.seagrant.umn.edu/downloads/mt002_factsheet.pdf
- **Our New Age of Water.** Science Comic Strips. www.seagrant.umn.edu/news/ournewageofwater
- **Interactive Map: Lake Superior's Extreme Events.** 2016. www.seagrant.umn.edu/superior/extremes
- **2017 Workshop to Explore Food-Fish Aquaculture in Minnesota** www.seagrant.umn.edu/aquaculture/workshop2017
 - Food-Fish Aquaculture in Minnesota: A Synthesis of the 26-27 April 2017 Workshop
 - Keynote presentation videos
- **The Sea Grant Files** podcast, new episodes! www.seagrant.umn.edu/radio/sgf
- **Sea Grant Science in Minnesota** videos. <http://bit.ly/2rhj43H>

New Journal Reprints

- JR635. Branstrator, D.K., Beranek, A. E., Brown, M.E., Hembre, L.K. and Engstrom, D.R. 2017. **Colonization dynamics of the invasive predatory cladoceran, *Bythotrephes longimanus*, inferred from sediment records.** *Limnology and Oceanography*. <http://bit.ly/2mNwH54>
- JR637. Smith, J.W., Seekamp, E., McCreary A., Davenport, M.A., Kanazawa, M., Holmberg, K., Wilson, B. and Nieber, J. 2016. **Shifting demand for winter outdoor recreation along the North Shore of Lake Superior under variable rates of climate change: A finite-mixture modeling approach.** *Ecological Economics*. <http://bit.ly/2DKH0z3>
- JR638. Pastor, J., Dewey, B., Johnson, N.W., Swain, E.B., Monson, P., Peters, E.B. and Myrbo, A. 2017. **Effects of sulfate and sulfide on the life cycle of *Zizania palustris* in hydroponic and mesocosm experiments.** *Ecological Applications*. <http://bit.ly/2juJgC2>
- JR631. O'Beirne, M.D., Werne, J.P., Hecky, R.E., Johnson, T.C., Katsev, S. and Reavie, E.D. 2017. **Anthropogenic climate change has altered primary productivity in Lake Superior.** *Nature Communications*. www.nature.com/articles/ncomms15713
- JR641. Filstrup, C.T., Downing, J.A. 2017. **Relationship of chlorophyll to phosphorus and nitrogen in nutrient-rich lakes.** *Inland Waters*. <http://bit.ly/2yzfVPw>
- JR640. Brown, C.M., Staley, C., Wang, P., Dalzell, B., Chun, C. and Sadowsky, M.J. 2017. **High-throughput DNA-sequencing approach for determining sources of fecal bacteria in a Lake Superior Estuary.** *Environmental Science and Technology*. 51(15):8263-8271. <http://bit.ly/2DoNSo7>
- JR642. Beery, T.H., Raymond, C.M., Kyttä, M., Olafsson, A.S., Plieninger, T., Sandberg, M., Stenseke, M., Tengö, M., Jönsson, K. 2017. **Fostering incidental experiences of nature through green infrastructure planning.** *Ambio* 46(7):717-730. <http://bit.ly/2pxAfZp>
- JR633. Olmanson, L.C., Brezonik, P.L., Finlay, J.C. and Bauer, M.E. 2016. **Comparison of Landsat 8 and Landsat 7 for regional measurements of CDOM and water clarity in lakes.** *Remote Sensing of Environment* 185:119-128. <http://bit.ly/2DB4xVE>
- JR636. Bitsura-Meszáros, K., McCreary, A., Smith, J.W., Seekamp, E., Davenport, M.A., Nieber, J., Wilson, B., Anderson, D.H., Messer, C. and Kanazawa, M. 2015. **Building coastal climate readiness along the North Shore of Lake Superior.** *Michigan Journal of Sustainability*. <http://bit.ly/2DpL3TP>



Cindy Hagley

Shipboard Science

Teachers swabbing the deck of the tall ship S/V Denis Sullivan during the 2017 science cruise for educators. Watch for educator opportunities on the Center for Great Lakes Literacy and Minnesota Sea Grant websites (www.cgll.org; www.seagrant.umn.edu).

Seiche

A seiche (pronounced "saysh") is a series of rhythmic rocking motions triggered in a water body disturbed in some way. Seiche-generating disturbances include earthquakes, landslides, wave interactions, and changes of wind or air pressure. The pendulum-like movements within seiches are known to scientists as free-standing wave oscillations. They can continue for hours after the forces that created them have vanished. Seiches can create a range of water-level changes, from imperceptible to those that damage vessels or threaten lives.

The purpose of the *Seiche* newsletter is to provide a periodic flow of information about Lake Superior and Minnesota's inland waters. The *Seiche* is published by Minnesota Sea Grant.

The *Seiche* is available online at www.seagrant.umn.edu as we encourage paperless readers. You can subscribe for free by contacting us at 218-726-8106 or via email at seagr@d.umn.edu.

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? Did 'Ja Know?

Pipelines Move Most of the Oil in the Great Lakes Region

Over 90 percent of crude oil enters the Great Lakes-St. Lawrence Region through pipelines and approximately 20 percent of North American refineries are located in this region.

Bradley Hull, John Carroll University, presentation at the Crude Move Symposium, June 2017.

You can attend the St. Louis River Summit, March 13 and 14

For \$30 you can attend the eighth annual St. Louis River Summit at the University of Wisconsin-Superior on March 13 and 14, 2018. The Summit involves presentations and conversations about the environmental health of the estuary and related community well-being. It is hosted by Lake Superior National Estuarine Research Reserve in collaboration with partners like Sea Grant.

Dr. Wallace "J." Nichols, called "Keeper of the Sea" by GQ Magazine and 2017 recipient of the Champion of Change Award at the World Oceans Festival, will present a keynote address about achieving a blue mindset.

For details and to registration, log onto www.event.com/d/2tq1yf.

Access the online *Seiche* to catch this companion article:
"The Buzz About the Estuary."