

Dear 2015 Sea Grant Performance Review Panelist,

We want to take this opportunity to introduce you to Minnesota Sea Grant (MNSG). MNSG is a University of Minnesota system-wide program based on the Duluth campus at the western end of Lake Superior. We're dedicated to environmental stewardship, long-term economic development, and responsible use of Minnesota's waterways and coastal regions. Although challenged by the modest amount of federal Sea Grant funding our program receives (in 2010 we fell 30th out of 33 programs in core funding, according to the National Sea Grant Office), **every one of our metrics came in higher than expected**; in several categories we ranked in the top 1/3 of all programs, including number of curricula developed (ranked 4th), number of services created to improve ecosystem management (5th), and dollars of economic benefit (6th).

MNSG relies on University of Minnesota operations and maintenance money and indirect cost recovery to meet the required 1/3 state match. To supplement MNSG's core funding and exceed national expectations, our outreach staff successfully compete for grants from entities like EPA, NOAA, USDA, and NSF, and develop partnerships with organizations such as Minnesota Extension, the US Forest Service, and the National Parks Service. As a result of these efforts, MNSG has managed over \$3.6 million in leveraged funds and grew our extension staff from 5 educators and 4.5 FTE's in 2010 to 8 educators and 6.75 FTE's by the beginning of 2014. The new staff focused on climate extension to meet our Climate Change Initiative goals, expanding AIS outreach, and coordinating efforts of the NOAA Coastal Storms Program in the Great Lakes.

MNSG has cultivated impressive collaborations that belie the program's modest size. A genuine interest in working across borders and managing multi-state and bi-national projects is evident through the program's aquatic invasive species outreach and Great Lakes-St. Lawrence Seaway maritime work. MNSG has been a leader in conducting workshops and organizing opportunities for educators throughout the Great Lakes region, particularly in support of the Great Lakes Observing System and Centers for Ocean Sciences Education Excellence Great Lakes. Over the past 4 years, MNSG has **managed over \$2.8 million in Great Lakes Restoration Initiative funding** on behalf of the Great Lakes Sea Grant Network.

Our efforts have not gone un-noticed. As two examples of the 22 honors our program has received during this period, one of our Extension Educators received the first-ever National Outstanding Invasive Species Outreach and Education Award from the National Invasive Species Council (2012), and our joint efforts with Wisconsin Sea Grant on freshwater corrosion led to the Research to Application Award from the Sea Grant Association in 2014.

Please note that our Strategic Plan contains an appended Climate Change Initiative. We felt it was important to specify our intent to address the earth's changing climate. We're pleased to report that you will find climate-related impacts and accomplishments in Healthy Coastal Ecosystems, Hazard Resilient Coastal Communities, and Sustainable Coastal Development.

We thank you for your efforts to assist Sea Grant with this process, and best wishes in your review!

Jesse Schomberg and Dr. Valerie Brady
Interim Co-Directors, Minnesota Sea Grant Program

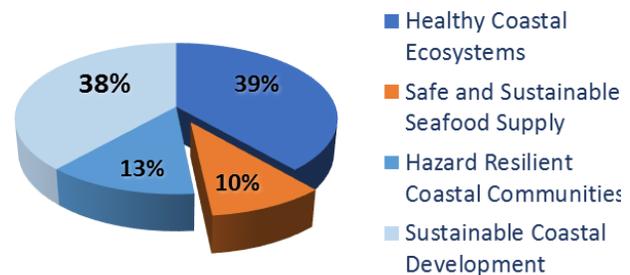


Minnesota Sea Grant Summary Report: Safe Sustainable Seafood Supply

Is it safe? Is it sustainable? Is it even seafood?

Unlike oceanic states, commercial fishermen in Minnesota primarily harvest ciscoes (netted in Lake Superior), walleyes (netted by tribes in inland lakes) and baitfish (trapped throughout the state). Minnesota has an exceedingly modest commercial “seafood” harvest (456K lbs worth \$280K in 2013) compared to the other states tracked through NOAA’s National Marine Fisheries Service, but these statistics relay only a fraction of the sizable Minnesota fishing story.

Sea Grant Investment

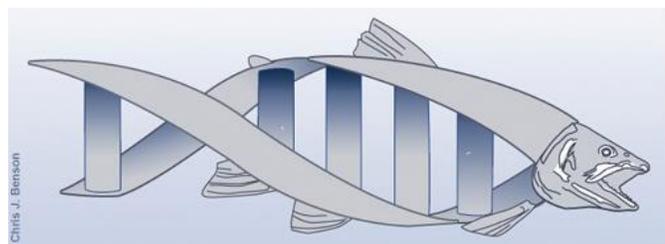


The rest of the tale involves anglers—1.5 million of them who spent over \$27 million on fishing licenses, stamps, tags and permits in 2013 alone. Of all states, Minnesota leads in fishing licenses per capita ... and many of these anglers seek live bait to catch hatchery-reared lunkers. It is illegal to bring live bait over Minnesota borders without permits, which aren’t easy to obtain since the fish-killing virus VHS struck fear into the hearts of fisheries managers and anglers. Consequently, the story also involves baitfish aquaculture and state fish hatcheries.

Like the fish in Lake Superior, Minnesota Sea Grant goes beyond state boundaries with many of its activities. The program is a Great Lakes leader in battling aquatic invasive species and an international pioneer in fish genetics and genetic engineering. Between 2010 and 2013, the program’s contributions to fisheries have been made clear and consequential in 12 journal articles generating 165 citations since publication. The program has paid attention to Lake Superior’s commercial fishery, aquaculture and extending information to anglers, and this attention has, in turn, paid off.

Contributions to Science & Technology

A testament to Minnesota Sea Grant’s fisheries investment is “**Sleeping Beauty’s**” sensational trajectory. In 1997, Minnesota Sea Grant funded a project to engineer faster-growing fish. Through this project, researchers awakened an inactive gene within the salmon family and converted it into a non-viral DNA vector—the Sleeping Beauty transposon system. The fisheries aspect was tabled as the



Bigger, better, faster, stronger? Maybe, maybe not.

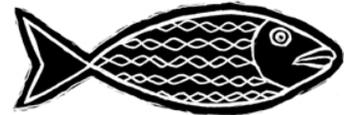
researchers discovered Sleeping Beauty’s application for human health. The technology is now used to transport normal genes into genetically damaged cells that cause problems like retinal degeneration and cancer. Recently, two biotech companies paid \$100 million to license a cancer-drug made with Sleeping Beauty; drugmaker Merck agreed to pay nearly \$1 billion, plus royalties for it. Sleeping Beauty continues to startle everyone involved in those early days of imagining bigger, better, faster, stronger fish.

The program continues to make other remarkable advances in answering questions about fish genetics. Advances like....

Clarifying the State of Science and Policy: Managing Invasive Fish with Genetic Engineering

The U.S. Army Corps of Engineers identified Asian carp and sea lamprey as potential candidates for control through genetically based technologies. Could a genetically altered fish help alleviate North America's carp and lamprey troubles? Perhaps. This is why Minnesota Sea Grant conceptualized, organized, helped to fund, and hosted the International Symposium on Genetic Biocontrol of Invasive Fish in 2010; and why the journal *Biological Invasions* published three symposium articles prior to Volume 16, Issue 6, a special issue derivative of the symposium that rolled out in 2014.

International Symposium on
Genetic Biocontrol of Invasive Fish



Focus groups clarified that Great Lakes stakeholders are excited about technological innovations, yet concerned about unintended consequences. At the symposium, over 80 scientists, risk assessment experts, fisheries managers and policy makers from the U.S., Australia and Canada, in particular, examined focus group results as well as scientific, technological, and legal issues surrounding genetic biocontrol. Of the *Biological Invasions* articles published prior to 2014, the National Sea Grant Law Center contributed to two and three former Minnesota Sea Grant Knauss Fellows and another UM alumna co-authored the third. In light of the symposium, the articles determined that:

1. The U.S. Food and Drug Administration is responsible for approving the use of genetically engineered fish for biocontrol but the U.S. Fish and Wildlife Service should be involved, too, while genetic biocontrol is still in a theoretical stage.
2. Should it become technologically possible, the genetic biocontrol of pests such as carp and certain insects will be subject to such a complex web of governance that it might warrant new international treaties. (The Cartagena Protocol oversees genetically engineered products, but the U.S. and Australia have not ratified this international treaty.)
3. Extensive environmental risk assessments would be necessary before something like a "daughterless carp" is released into U.S. waters since "attempts to control undesirable species through the introduction of non-native species have backfired in spectacular ways." (Cases in point: cane toads in Australia and mongoose in Hawaii.)

And....

Testing the Mettle of Genetically Modified Fish

In the first-ever investigation of its kind, Minnesota Sea Grant examined the long-term consequences of letting genetically modified fish mingle with wild-type populations of the same species. Prior to this study, investigators worked with hypothetical populations via computer models to study what might happen to wild populations if transgenic animals escaped captivity.

Minnesota Sea Grant's 2010 Knauss Fellow and Anne Kapuscinski, Distinguished Professor of Sustainability Science at Dartmouth College (formerly with Minnesota Sea Grant), led the study and co-authored a resulting article in *Environmental Biosafety Research*. Using the laboratory-friendly medaka, they found that after 19 months, the equivalent to nine generations, only a single fish in one of six replications still carried a growth-enhancing gene construct.

U.S. regulators are debating whether to approve the farming of transgenic salmon while other fish species with various engineered traits are being developed around the world. Sea Grant

funded this early, yet seminal, study to develop techniques so that managers and policy makers can more confidently predict the population-level impact of escaped transgenic fish.

Contributions to Society



Have you ever eaten a cisco (lake herring)? Thanks to Minnesota Sea Grant, hundreds, if not thousands, of people have—including students dining in University of Notre Dame cafeterias.

You might be able to piece the story together from the PIER Program Focus Area Report, but to make life easier here is the concise version:

Once upon a time (prior to 1940), commercial fishermen on Lake Superior primarily hauled in ciscoes. Overharvest and invasive species caused the population to plummet and the fishery to all but vanish. When populations rebounded (decades later), fishermen pushed to harvest ciscoes during the autumn when their caviar-quality roe makes them a more lucrative catch. Resource managers pushed back concerned that such harvest would impede recovery. To prevent the pushing from becoming fisticuffs, Minnesota Sea Grant supported hydroacoustic research that led to a fishery-independent method for assessing stocks based on estimates that were less biased, and therefore less contentious, than other estimates. As a consequence of careful management involving yearly assessments and harvest quotas based on consecutive years of data, Minnesota fishermen are permitted to harvest ciscoes during the spawning season.

Ciscoes are easiest to harvest when they congregate to spawn and the autumn catch is so large that much of the fish flesh is sent out-of-state to become gefilte fish. Acknowledging a new societal emphasis on eating local, sustainably produced foods, and an interest in celebrating the sustainably managed fishery, Minnesota Sea Grant created an event in 2011 to educate professional chefs and consumers about this ciscoes and their unique availability. A Salute to Lake Superior's Sustainable Fisheries was a hit. In Minneapolis, nine chefs plated cisco entrées in a fierce bid for \$1,000 and American Culinary Federation accolades. They then served about 250 guests, who came for the food, music, and to commemorate Sea Grant founder Athelstan Spilhaus, a former University of Minnesota dean. Media coverage was extensive in Duluth and the Twin Cities with millions of people receiving the messages. Survey responses indicated the event was exceptional. Nearly half of respondents raved that the venue, food, and music were "superb", "incredible" or other like-minded words. A strong consumer market for Lake Superior fish appeared; 69% of attendees indicated they would

Following the Fish

Minnesota Sea Grant researchers used hydroacoustic techniques, coupled with more standard sampling methods to discover nuances essential to understanding how the Lake Superior food web works. They've shown the importance of diel vertical migration (DVM). Prey of all sizes (from zooplankton to forage fish) move a hundred or more meters up the water column as the low light levels of dusk and night allow them to safely ascend to richer feeding grounds. Predators follow. Managers are using this information to determine sampling depths for assessing stock and forage.

eat fish from Lake Superior either at home or in restaurants, and 93% indicated they learned more about sustainable fisheries by attending.

Commercial fishermen and fishmongers were overjoyed. Several restaurants in the Twin Cities put cisco on their menus for the first time ever, the price of cisco increased by 75%, and interest skyrocketed. We were asked by commercial fishermen, chefs, judges, and attendees to conduct a similar event in 2012. We did. And again in 2013, this time partnering with Wisconsin Sea Grant in a sold-out version of the original event in Duluth, Minn. The owners of Lake Superior Magazine asked to take over the professional chef competition and tasting event as the Magazine's cornerstone celebration. Minnesota Sea Grant agreed and became a sponsor of the 2014 version of what is now known as The Lake Superior Fish Classic. ***The End***
... except that ...

Something needs to be said about Minnesota Sea Grant's Aquaculture and Angler Outreach. Minnesota has the largest baitfish aquaculture industry in the jurisdiction of the North Central Regional Aquaculture Center, which includes 12 states from Ohio to North Dakota to Missouri. Minnesota Sea Grant has been a leader in baitfish aquaculture demonstration research, helping to find brood stock, compiling annual updates, and providing information to fish farmers throughout the region. In 2010, Minnesota Sea Grant organized a regional baitfish workshop that summarized research and inspired investors to start new baitfish aquaculture businesses. After the workshop, University of Minnesota Extension worked with Sea Grant to hire an aquaculture specialist, at which point aquaculture outreach transitioned to Extension. Meanwhile, Minnesota Sea Grant's materials are being used to train employees in ways to prevent the movement of potentially invasive species in over 180 fish hatcheries in 30 states.

Minnesota Sea Grant is renowned for its aquatic invasive species programming. Much of this programming is directed at anglers through the Stop Aquatic Hitchhikers campaign, which includes the ever-popular invasive species identification cards the program designs for the Great Lakes Sea Grant Network. Since 2006, campaign partners generated 1.7 billion impressions. Post event surveys showed that exposure to Stop Aquatic Hitchhikers raised awareness among 70% of respondents and 90-100% indicated they would likely take actions to prevent the spread of AIS.

The program has also crafted magazine articles, videos, and fact sheets to help inform anglers and others about fish parasites, barotrauma, the benefits of eating heart-healthy Lake Superior fish, and the way fish sense their world. The program's web-based information about the parasites of freshwater fish is one of the site's leading pages (#7) and garners nearly 27% of the fisheries traffic.

A Word about Program Performance Measures and Objectives

The loss of fisheries extension capacity during the years covered in this review necessitated modifications to Program Performance Targets and Objectives. An economic downturn coupled with the Minnesota Sea Grant director's departure led to the reassignment of the remaining fisheries extension education to the open director position, thus cutting the program's fisheries outreach. Despite this, staff rallied to pursue ambitious goals in the Safe and Sustainable Seafood focus area. In spite of a new, more accurate but also more conservative approach to measuring "Web pages visited," the program exceeded this particular target by far.

PIER PRP Program Focus Area Report

Minnesota Sea Grant

Safe and Sustainable Seafood Supply

Program Focus Area: SAFE AND SUSTAINABLE SEAFOOD SUPPLY

Program Goals

1. Scientific Understanding â€” Develop a sound scientific understanding of factors associated with ecologically and socially sustainable production of safe seafood for human consumption and to supply baitfish and shellfish from commercial harvest, aquaculture, and recreational fisheries.
2. Integrated into Management Decisions â€” Incorporate sound scientific understanding, predictions, and risk assessment tools to assist policy and ecosystem-based management decisions and to ensure safe and sustainable fish and shellfish production from commercial harvest, aquaculture, and recreational fisheries.
3. An Informed Citizenry â€” Inform consumers, industry representatives, and policy makers of the importance of ecosystem health and sustainable harvesting/culture practices to the future of our domestic fisheries and aquaculture production, and educate people about the health benefits and safety issues associated with seafood consumption within a food-synergy approach to nutrition.

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[Full Text of Impacts](#)

[Program Performance Measures](#)

[Objectives](#)

Impacts and Accomplishments toward Program Goals

1. **Program Goal: Scientific Understanding â€” Develop a sound scientific understanding of factors associated with ecologically and socially sustainable production of safe seafood for human consumption and to supply baitfish and shellfish from commercial harvest, aquaculture, and recreational fisheries.**

Impact(s)

- o [15264](#) - Research Reignites a Historic Lake Superior Fishery in a Sustainable Way
- o [15155](#) - Sea Grant Renews Market for Lake Superior Sustainable Fishery
- o [14258](#) - Genetic Research on Sculpins Aids Fish Reintroduction Efforts
- o [13996](#) - Sea Grant Funding Critical to Aquatic Science Conducted in Lake Superior
- o [13988](#) - Potential for the Genetic Biocontrol of Invasive Fish Examined

Accomplishment(s)

- o [19413](#) - Flood Response: Lake Superior's Dark Surprise
- o [17221](#) - Mysid shrimp provide phosphorus for deep algal layer in Lake Superior.
- o [15870](#) - Researchers Verify that Lake Superior's Deep Chlorophyll Layer is Active in January
- o [15263](#) - Researchers Produce Hi-res Lake Floor Map to Find Spawning Grounds of Deep Water Lake Trout
- o [14259](#) - Carbon Recycling and Reuse Important in Supporting Oligotrophic Lake Superior Algae
- o [14202](#) - Mysid Shrimp Confirmed as Important Lake Superior Food Web Component

2. **Program Goal: Integrated into Management Decisions â€” Incorporate sound scientific understanding, predictions, and risk assessment tools to assist policy and ecosystem-based management decisions and to ensure safe and sustainable fish and shellfish production from commercial harvest, aquaculture, and recreational fisheries.**

Impact(s)

- o [18188](#) - Hazard Analysis and Critical Control Point Program Targets Aquatic Invasive Species
- o [15264](#) - Research Reignites a Historic Lake Superior Fishery in a Sustainable Way
- o [13982](#) - 11 Communities Agree to Improve a 27-mile Stretch of the Mississippi River

Accomplishment(s)

- o [17996](#) - Assessment of economic impacts of charter fishing industry in the Great Lakes and Mississippi River
- o [14204](#) - Diatoms Discern Lake Superior Productivity Trends

3. **Program Goal: An Informed Citizenry â€” Inform consumers, industry representatives, and policy makers of the importance of ecosystem health and sustainable harvesting/culture practices to the future of our domestic fisheries and aquaculture production, and educate people about the health benefits and safety issues associated with seafood consumption within a food-synergy approach to nutrition.**

Impact(s)

- o [18189](#) - Lake Superior Fish Gain Attention as Sustainable Menu Item
- o [18188](#) - Hazard Analysis and Critical Control Point Program Targets Aquatic Invasive Species
- o [16573](#) - Sea Grant Invigorates Market for Lake Superior Ciscoes
- o [15155](#) - Sea Grant Renews Market for Lake Superior Sustainable Fishery

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Full Text of Impacts and Accomplishments

19413 - Flood Response: Lake Superior's Dark Surprise

Program development funding was provided to a Large Lakes Observatory researcher to collect and analyze data in spring 2012 to assess impacts to Lake Superior from the 500-year flood event. The investigation resulted in an article in the 2013 Edition of the Lake Superior Angler magazine (E. Minor and B. Forsman. Lake Superior's Response to the Solstice Flood), a MNSG newsletter article, public and professional presentations, and a journal article that is in review.

The Lake Superior Chapter of Muskies, Inc. and the University of Minnesota Sea Grant Program awarded \$1,000 to Brandy Forsman, M.S. candidate in analytical chemistry at the University of Minnesota Duluth (UMD). Forsman earned this first-ever scholarship through her post-flood research with Elizabeth Minor, Associate Professor of Chemistry and Biochemistry and the Large Lakes Observatory, UMD, and because of her interest in communicating the results of her research. Forsman is a former high school teacher.

Forsman's research examines the biogeochemical response of Western Lake Superior to the region's major flood in 2012. Experts expected that the major influx of nutrients from the land would boost algae growth. Instead, Forsman's findings suggest that primary production declined after the flood because vast amounts of dissolved organic matter in water prevented light from penetrating much beyond the surface.

RECAP: Experts expected that the major influx of nutrients into Lake Superior after a major flood would boost algae growth. Instead, findings suggest that primary production declined after the flood because vast amounts of dissolved organic matter in water prevented light from penetrating much beyond the surface.

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18189 - Lake Superior Fish Gain Attention as Sustainable Menu Item

RELEVANCE - Lake Superior's cisco once provided a livelihood for hundreds of families until the fishery collapsed. After decades of management influenced by Sea Grant research, commercial fishermen are sustainably harvesting this fish. However, the regional market suffered during the ciscoes' 30-year absence. Currently, the bulk of the cisco catch is sent out of the region.

RESPONSE - Minnesota Sea Grant responded to the disconnection between the fishery and consumers by holding professional chef competitions and public tasting events (2011, 2012, 2013). The first two events in Minneapolis created a new awareness about Lake Superior ciscoes. In 2013, the sold-out Lake Superior Fish Classic, held in partnership with Wisconsin Sea Grant in Duluth, Minn., extended information about how Lake Superior economies are affected by the consumption of ciscoes and lake whitefish.

RESULTS -Survey responses in Minneapolis indicated over 90% learned more about sustainable fisheries by attending the events and there is a market for ciscoes in the Twin Cities. A competing chef continues to work with Minnesota Sea Grant on promoting Lake Superior fish in Minneapolis. In Duluth, 86% learned more about sustainable fisheries. Surveyed guests in both locales indicated that they plan on consuming more fish from Lake Superior. Local fish markets and chefs report more cisco and whitefish sales. As a result of the events, the cisco fishery was featured on National and Minnesota Public Radio. During the sold-out 2013 Lake Superior Fish Classic, the Minnesota Zoo's Fish Smart program produced a video to increase awareness of sustainable seafood issues throughout Minnesota. The Minnesota Department of Natural Resources and the North Shore Commercial Fishermen thanked Sea Grant for showcasing their work in a way that would sustain jobs. Lake Superior Magazine, the 2013 print sponsor, asked to take on the celebration as the magazine's cornerstone event; Sea Grant agreed. Because of Sea Grant's events, ciscoes are a seasonal special in at least seven restaurants and the University of Notre Dame serves hundreds of pounds of this species to students each year.

Accolades: [I'm] from Louisiana. Just visiting. Y'all do a great job with seafood and awareness to sustainably managed fish; Excellent concept...excellent chefs and opportunity to raise profile of Superior haute cuisine!

RECAP: MNSG reinvigorated the regional market for Lake Superior's sustainable harvested fish (cisco and lake whitefish) through three professional chef competitions/public tasting events and related public relations. The 2013 event in Duluth sold out. Because of these efforts, more restaurants are serving Lake Superior fish, more people are eating Lake Superior fish and Lake Superior Magazine has taken on the successful event as their own.

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18188 - Hazard Analysis and Critical Control Point Program Targets Aquatic Invasive Species

Relevance: The pathways used by aquatic invasive species to move into new locations are not always obvious. Problematic species, diseases, and parasites have been known to move through federal and state aquaculture operations. Understanding pathways and developing plans to reduce non-target species and prevent biological contamination is necessary to avoid unintended spread of species.

Response: In 2001, Minnesota and Michigan Sea Grant staff published an instructional manual for for wild baitfish harvesters and fish farmers (both private and public) who raise baitfish or fish for stocking into public and private waters. ANS-HACCP: Aquatic Nuisance Species-Hazard Analysis and Critical Control Point Training Curriculum were adapted from the National Seafood HACCP Alliance for Seafood Safety Training and Education. The 80-page manual and corresponding workshops identified pathways through which non-target aquatic species could enter aquaculture and baitfish operations, and methods to prevent accidental transfer of these species to new areas. The manual was updated, renamed, AIS-HACCP Training Curriculum, and reprinted in 2004.

Results: Following an ANS-HACCP training by MNSG in 2000, the US FWS became interested in ANS-HACCP as a way to prevent their employees from moving aquatic invasive species. The U.S. Fish and Wildlife Service began offering its own ANS-HACCP training courses at the National Conservation Training Center in West Virginia. (www.fws.gov/fisheries/ans/ANS-HACCP.html; <http://training.fws.gov>) As of 2013, the US FWS has registered 181 AIS-HACCP plans from 30 different states on their website (<http://www.haccp-nrm.org/plans.asp>). As a result of AIS-HACCP training for Ontario Ministry of Natural Resources personnel by MN and MI Sea Grant, every bait dealer in Ontario must now have an AIS-HACCP Plan.

RECAP: Sea Grant's Aquatic Invasive Species-Hazard Analysis and Critical Control Point (AIS-HACCP) trainings, workshops and manual lead to a U.S. Fish and Wildlife program. [Back to Goals](#)

17996 - Assessment of economic impacts of charter fishing industry in the Great Lakes and Mississippi River

Minnesota Sea Grant partnered with Ohio and other midwestern Sea Grants to survey charter boat captains and estimate the economic impact of charter fishing in the Great Lakes and Mississippi River system.

RECAP: Charter boat captains surveyed for economic impacts in Great Lakes and Mississippi River systems. [Back to Goals](#)

17221 - Mysid shrimp provide phosphorus for deep algal layer in Lake Superior.

Updates previous accomplishment: Food web analyses indicate that Mysid shrimp are responsible for more than 100% of the soluble reactive phosphorus needed by phytoplankton in Lake Superior's deep chlorophyll layer, confirming that this species of aquatic invertebrate is an important food web component.

RECAP: Mysid shrimp provide needed nutrients to support major algal food resource in Lake Superior. [Back to Goals](#)

16573 - Sea Grant Invigorates Market for Lake Superior Ciscoes

RELEVANCE - Lake Superior's cisco once provided a livelihood for hundreds of families until overfishing and invasive species caused the fishery to collapse. After decades of management influenced by Sea Grant research, commercial fishermen are sustainably harvesting this fish. However, the regional market suffered during the ciscoes' 30-year absence. The bulk of the cisco catch occurs during the November spawning run. The roe is exported to Scandinavian countries and most of the flesh is exported to Iowa for processing. An economic analysis found that if the exported cisco were processed and sold in Minnesota, it would result in 22 jobs and a \$4.5 million impact for the state.

RESPONSE - Minnesota Sea Grant responded to the disconnection between the fishery and consumers by holding a professional chef competition and public tasting event in 2011 and 2012. The Salute to Lake Superior's Sustainable Fisheries events created a public celebration of Lake Superior's fisheries and a new awareness about a seasonally abundant and local fish. The events were held in November to highlight the excess availability during this time. Because the events were so successful and well received in 2011 and 2012 when held in the Twin Cities, a third "Salute to Lake Superior's Sustainable Fisheries" is planned for 2013. Based on urging from members of the Lake Superior fisheries community and Minnesota North Shore residents, the 2013 event will be held in Duluth, Minn.

RESULTS - As a result of this project, cisco is a seasonal special in at least 5 Twin Cities restaurants and the University of Notre Dame serves hundreds of pounds of this species to students each year. Both Senator Klobuchar's office and the MN State Lt. Governor Yvonne Prettner Solon helped inform people about the value of Lake Superior and its sustainable fishery. Survey responses indicate 91% learned more about sustainable fisheries by attending the event and there is a market for ciscoes in the Twin Cities. Guests described the event as "fabulous," "memorable," and "delicious." Someone even wrote that the Salute represented the "TRUE taste of Minnesota." The majority of guests indicated that they plan on consuming more fish from Lake Superior. Through this response, Minnesota Sea Grant has met its goal in creating an event that extended ideas and information about sustainable fisheries and the importance of consuming local foods. As a result of the two events the cisco fishery was

featured on National and Minnesota Public Radio and in other media outlets. The Minnesota Department of Natural Resources and the North Shore Commercial Fishermen enthusiastically thanked Sea Grant for showcasing their work in a way that would sustain jobs and increase awareness.

RECAP: Minnesota Sea Grant stimulated the regional market for ciscoes, a sustainably managed commercial fish, through two Salute to Lake Superior's Sustainable Fisheries events. The events included a professional chef competition followed by opportunities for the public to sample the chefs' entrees and presentations by political leaders and fishery managers. [Back to Goals](#)

15870 - Researchers Verify that Lake Superior's Deep Chlorophyll Layer is Active in January

Researchers have confirmed that Lake Superior's deep chlorophyll (DCL) layer is a zone of intense biological activity. A vertically migrating copepod (zooplankton) is an important source of phosphorus to the DCL, and an important source of energy in the food web. Lake-wide cruises indicate that phytoplankton composition is consistent across major regions of the lake and that the photosynthetic capacity of the phytoplankton is remarkably consistent horizontally, vertically and seasonally. A January 2012 cruise on the Ice Breaker Alder revealed active chlorophyll at that time. This winter production may help explain why most models underestimate Lake Superior productivity.

RECAP: Winter production may explain underestimation of Lake Superior productivity. [Back to Goals](#)

15264 - Research Reignites a Historic Lake Superior Fishery in a Sustainable Way

RELEVANCE - Ciscoes provided the largest commercial fishery on Lake Superior in the 1940s. Overharvest and invasive species caused the population to plummet. Consequently, commercial harvest during autumn, when ciscoes are most valuable for their roe, was prohibited. When populations rebounded, fishermen pushed to harvest them during the autumn spawning season. Resource managers remained concerned that such harvest would impede population recovery.

RESPONSE - MNSG support of a fisheries researcher led to a more accurate method of estimating cisco biomass in the Minnesota waters of Lake Superior through hydroacoustic sampling. These hydroacoustic-based estimates are fishing gear-independent, making them less biased, and therefore less contentious, than other estimates.

RESULTS - Sea Grant's hydroacoustic work led to a fisheries management solution that meets the needs of resource managers and commercial fishermen. The Minnesota Department of Natural Resources (MNDNR) and the North Shore Commercial Fishermen recognize Sea Grant for helping them to collaborate on a sustainable management plan, which allows the harvesting of cisco during the fall spawning season. The research led to a unique partnership between academia and a resource management agency: every year the University's research vessel, crew, and scientists assist MNDNR with hydroacoustics assessments of the cisco population. The harvest quota is set using three consecutive years of fishery-independent population estimates. This quota tracks actual harvestable cisco biomass and age structure.

RECAP: Sea Grant-funded research led to advances in fisheries management and a partnership among commercial fishermen, academia, and a state resource management agency. [Back to Goals](#)

15263 - Researchers Produce Hi-res Lake Floor Map to Find Spawning Grounds of Deep Water Lake Trout

High resolution bathymetric maps and maps of Lake Superior lake floor composition were produced based on acoustic classification of multibeam sonar data. Previously unidentified deep water reef structures were identified that may be suitable as spawning substrate for deep water strains of lake trout. These maps were used to guide a remotely-operated vehicle run by collaborating agencies to investigate potential spawning of lake trout.

RECAP: Sonar-created map guides ROV to potential deepwater trout spawning grounds. [Back to Goals](#)

15155 - Sea Grant Renews Market for Lake Superior Sustainable Fishery

RELEVANCE - Lake Superior's cisco once provided a livelihood for hundreds of families until overfishing and invasive species caused the fishery to collapse. After decades of management influenced by Sea Grant research, commercial fishermen are sustainably harvesting this fish. However, the regional market suffered during the ciscoes' 30-year absence. The current catch is primarily consumed on the east coast. The roe is exported as caviar to Scandinavian countries.

RESPONSE - Minnesota Sea Grant responded to the disconnect between the fishery and consumers with a recipe contest and a professional chef competition that led into a public celebration of Lake Superior's sustainable fisheries.

RESULTS - Cisco became popular in at least three Minneapolis restaurants. The University of Notre Dame purchased 800 pounds of cisco. Becoming familiar with sustainable fisheries concepts, a representative from Senator Klobuchar's office addressed 250 people with information about the value of Lake Superior. Survey responses indicate 93% learned more about sustainable fisheries by attending the public event and there is a market for ciscoes in the Twin Cities. Chefs volunteered to work on marketing when it became clear that misperceptions were damaging the fish's image. The cisco fishery was featured on National Public Radio and in other media outlets. The Minnesota Department of Natural Resources and the North Shore Commercial Fishermen enthusiastically thanked Sea Grant for showcasing their work in a way that would sustain jobs and increase awareness.

RECAP: Through MNSG's activities highlighting Lake Superior's cisco, the regional market for this sustainably harvested fish has grown. [Back to Goals](#)

14259 - Carbon Recycling and Reuse Important in Supporting Oligotrophic Lake Superior Algae

Researchers have come closer to solving the Lake Superior missing carbon conundrum in which about 50% of the carbon supporting lake productivity cannot be attributed to a source. Researchers found a surprisingly strong control of primary production - that is, algal growth - by light and temperature, with a lack of importance of nutrients. This study provided strong support for a vertical separation between depth zone of maximal production, less than 20 m, and the depth zone of maximum biomass (the Deep Chlorophyll Maximum), between 20 and 40 m. Grazing loss rates in the surface water layer were comparable to production:biomass ratios, suggesting a rapid and tight recycling of carbon. Results are consistent with the hypothesis that grazers maintain a low algal biomass above the Deep Chlorophyll Maximum. A first image of the seasonal cycle of primary production was put together, and it shows a single mid-summer maximum. These results improve our understanding of the Lake Superior ecosystem.

RECAP: Lake Superior researchers help explain "missing" nutrients supporting the food web. Nutrients are very carefully recycled and reused in this oligotrophic lake. [Back to Goals](#)

14258 - Genetic Research on Sculpins Aids Fish Reintroduction Efforts

RELEVANCE - Reintroducing species into areas from which they have been extirpated can be difficult, in part because of the desire to match genetic strains between the extirpated population and the new potential source population. There is little genetic information available for some rare and/or endangered fish.

RESPONSE - Researchers funded by Minnesota Sea Grant developed the first microsatellite DNA markers specifically for the small native fish, the slimy sculpin (*Cottus cognatus*). The PCR primer sequences are available in a publication and international genetic database so that anyone can use them for their own genetic studies of slimy sculpins or related species.

RESULTS - This genetic information provided guidance to the Minnesota Department of Natural Resources on choosing source populations and numbers of stocked fish needed to meet minimum genetic diversity goals in reintroduced populations.

RECAP: Genetic research helps agencies reintroduce native fish that have appropriate genetics and are from the most appropriate source populations. [Back to Goals](#)

14204 - Diatoms Discern Lake Superior Productivity Trends

Researchers collected sediment cores from seven locations throughout Lake Superior during the summer of 2010. Cores from 4 core locations have been processed for ²¹⁰Pb (lead 210) dating and two sites have been chosen for diatom analyses. There was an indication of landscape use captured in the core profiles, as a taconite layer suspected to be from mine tailings from Silver Bay was observable in the core sampled near Isle Royale. Preliminary results from sedimentary diatom profiles indicate that long-term trends in lake productivity match those detected in sediment cores that were collected many decades ago.

RECAP: Shells of diatom algae preserved in sediment cores from Lake Superior are being used to tell the story of long-term trends in lake productivity and nutrient status. [Back to Goals](#)

14202 - Mysid Shrimp Confirmed as Important Lake Superior Food Web Component

Researchers were able to document the warmest summer on record for Lake Superior, and document the resulting conditions in the lake throughout the water column and food web.

Preliminary food web analyses indicate that Mysid shrimp are responsible for more than 95% of the soluble reactive phosphorus needed by phytoplankton in Lake Superior's deep chlorophyll layer, confirming that this species of aquatic invertebrate is an important food web component.

RECAP: Researchers document warmest summer on record for Lake Superior and confirm important food web component. [Back to Goals](#)

13996 - Sea Grant Funding Critical to Aquatic Science Conducted in Lake Superior

Relevance: Funding for aquatic research and ship time are critical to understanding Lake Superior. This funding is difficult to obtain. Great Lakes Sea Grant programs are a significant source of funding for research about Lake Superior.

Response: The Ecology of Lake Superior Conference, held in Duluth, Minnesota, on May 3-5, 2010, attracted about 150 scientists and managers. The Lake Superior Binational Program and the Great Lakes Regional Research Information Network supported the conference, which crossed vast disciplinary and spatial scales. The Aquatic Ecosystem Health and Management Society and the U.S. Environmental Protection Agency Mid-Continent Research Laboratory co-hosted the conference. Minnesota Sea Grant was a sponsor and provided organizational, communications, and logistical support.

Results: Of the 60 presentations, 20 credited their results fully or in part to Sea Grant funding. After the conference, Jeff Gunderson, director of MN Sea Grant, noted, "Sea Grant funding clearly plays a significant role in Lake Superior research. In fact, 30% of the presenters, including one of the most

respected Great Lakes food web researchers, Jim Kitchell, credited Sea Grant for supporting critical Lake Superior research." Even with dozens of Lake Superior scientists in the same room, one scientist appropriately said, "I'm going away scandalized by the lack of understanding of long-term chlorophyll dynamics." Obviously, there is still much to learn about Lake Superior. The Aquatic Ecosystem Health and Management Journal is producing two special issues featuring presentations from this conference. <http://www.aehms.org/>

RECAP: Thirty percent of presenters at the Ecology of Lake Superior Conference conference acknowledged Sea Grant for funding their scientific research. [Back to Goals](#)

13988 - Potential for the Genetic Biocontrol of Invasive Fish Examined

Relevance: The idea for the International Symposium on Genetic Biocontrol of Invasive Fish was born out of frustration by U.S. Fish and Wildlife managers over the lack of effective control tools for invasive fish. The managers knew work was being done in the U.S. and Australia to create genetically modified fish whose release into the wild (and subsequent interbreeding) would disrupt the survival or reproduction of invasive species.

Response: This international symposium addressed the potential use of genetic biocontrol against established invasive finfish species and the risks associated with its use. The symposium also considered the potential for control of invasive mussel species. Genetic biocontrol refers to release of genetically manipulated organisms designed to disrupt the survival or reproduction of a targeted invasive species. Genetic biocontrol strategies have the capability to be more effective and targeted than current control methods, all of which have major flaws. Turning genetic biocontrol methods into practical tools, however, requires identifying and successfully addressing obstacles, public concerns, and environmental risks.

Prior to the symposium, 8 focus groups were held in 6 Great Lakes states to assess stakeholder knowledge and concerns regarding the release of genetically modified organisms into the Great Lakes to control invasive species. Results of this effort were reported at the symposium and will be submitted for publication in a peer reviewed journal.

At the symposium organized by Minnesota Sea Grant, nearly 80 participants learned about the current status of biocontrol technology and the issues surrounding its use.

Results: A special issue of the journal Biological Invasions is being produced. The volume includes two synthesis papers. The first will focus on genetic biocontrol technologies, including a research and development agenda to achieve aquatic conservation goals. The second synthesis will include environmental risk assessment and management of genetic biocontrol applications (including existing knowledge and prioritization of needs) and regulatory and economic contexts affecting applications of genetic biocontrol technologies. In addition to two synthesis papers, several other papers presented at the symposium will be included in the special issue. The intent is to encourage more comprehensive and efficient, longer-term, or larger-scale projects than any single entity can now fund. Synthesis papers will provide decision support for future uses of genetic biocontrol. This is the first conference of its kind held in the world.

<http://www.seagrants.umn.edu/ais/biocontrol#presos>

RECAP: The International Symposium on Genetic Biocontrol of Invasive Fish [Back to Goals](#)

13982 - 11 Communities Agree to Improve a 27-mile Stretch of the Mississippi River

Relevance: By the end of the industrial revolution, the Mississippi River was viewed as America's dumping ground. Since the Clean Water Amendment Act was passed nearly 40 years ago, many river communities have rediscovered the Mississippi as a natural, recreational and economic development asset for their residents.

Response: Mississippi River Renaissance works with communities along a 27-mile stretch of the Mississippi River in Central Minnesota. These communities include: Benton County, Stearns County, Brockway Township, Langola Township, LeSauk Township, Sauk Rapids Township, Watab Township, City of St. Cloud, Sartell, Sauk Rapids and Rice. With the partnering leadership of Sea Grant's Non-point Education for Municipal Officials (NEMO), the Mississippi River Renaissance has united urban, suburban and rural stretches of the Mississippi River by bringing resources and information to the people whose decisions and actions can help keep the river healthy. NEMO efforts involved 74 participants in Lessons Across the Landscape Shoreland Zone, and Policy and Planning Tool workshops.

Results: The cities of St. Cloud, Sauk Rapids and Sartell are conducting a first ever "Urban Area Planning Process" to assist in identifying opportunities to make the Mississippi River more a part of their communities. Eleven communities adopted the Mississippi River Renaissance vision.

See: <http://stearns.server306.com/pages/MississippiRiverVision/>

RECAP: Coastal planning enables a cohesive, multi-community vision for a portion of the Upper Mississippi River. [Back to Goals](#)

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Program Performance Measures (2010 - 2013)

Program Performance Measure	Program Plan Target (2010-2013)	Reported	Program Comments
Advertising equivalency (if space/air time were purchased)for Minnesota Sea Grant mass media/Web placements related to Safe and Sustainable Seafood Supply.	140,000	130,144	2010 - charter fishing, baitfish farming, sustainable LS fisheries 2012 - Fish Cook-off impact of twin cities media. 2013 - Fish cook-off impact was on adv. eq. as well.
People trained from the discovery and/or application of new fishery or aquaculture production and management models or techniques that lead to increased sustainability and productivity of fishery resources	50	52	2010 - attendees at baitfish workshop 2011 - Aquaponics tour/meeting: Silver Bay, Duluth, Moose Lake, 2 in Twin Cities 2013 - Assume 2 people made a fish descender after MMSG barotrauma/fish descender video and article.
Potential audience reached (readership, listenership, and viewership) related to Safe and Sustainable Seafood Supply	2,800,000	21,437,895	2010 - charter fishing, baitfish farming 2011 - Order of magnitude larger due to Twin Cities press re fish fling 2012 - Audience potential high again due to twin cities press related to our Sustainable Fisheries Cook-off. 2013 - Audience potential is still high, due to all of the press related to our Fish Classic, the sustainable fisheries professional chef cook-off.
Web pages visited for Minnesota Sea Grant mass media/Web placements related to Safe and Sustainable Seafood Supply.	192,000	254,545	2010 - Page views fisheries and aquaculture 2011 - page visits fisheries and aquaculture 2012 - This is the sum of fisheries and aquaculture pageviews on www.seagrants.umn.edu 2013 - There seems to be a larger interest in aquaculture in 2013. Parasites are still popular.

[Back to Top](#)**Program Objectives (2010 - 2013)**

Program Objective	Achieved (yes/no)	Program Comments
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<p>Lake Superior anglers will demonstrate a better understanding of boating safety and effective Lake Superior fishing techniques,</p>	No	<p>2010 - This refers to a Web-based Lake Superior fishing resource. Due to retrenched positions, we could not pursue this objective. 2011 - This refers to a Web-based Lake Superior fishing resource. Due to retrenched positions, we could not pursue this objective. 2012 - This refers to a Web-based Lake Superior fishing resource. Due to retrenched positions, this objective is on hold. 2013 - 2012: This refers to a Web-based Lake Superior fishing resource. Due to retrenched positions, this objective is on hold.</p>
<p>100 people will submit recipes for Lake Superior fish, 3 local chefs will start conducting business with Lake Superior basin commercial fishermen, and consumers will understand the concept of sustainable fisheries</p>	Yes	<p>2010 - 2010-planning for Salute to Lake Superior's Sustainable Fisheries 2011 - 3 chefs in the Twin Cities now have lake herring on their menus as a seasonal special 20 recipes for Lake Superior fish generated (contest/cookoff) 93% of survey respondents learned more about sustainable fisheries at Sea Grant event. 2012 - 5 chefs in the Twin Cities now have lake herring on their menus as a seasonal special 32 recipes for Lake Superior fish generated (21 in 2011 contest/cookoff, 11 in 2012 cookoff, plus U of Notre Dame) 93% of survey respondents learned more about sustainable fisheries at Sea Grant event (2011) 91% in 2012. U of Notre Dame, Danny's Bar and Grill, Blue Water Grill and Firelake Grill seasonally serve lake herring. So does New Scenic Cafe, Sara's Table, and Nanaboujou...but they did prior to our events. 2013 - 2012: 5 chefs in the Twin Cities now have lake herring on their menus as a seasonal special 32 recipes for Lake Superior fish generated (21 in 2011 contest/cookoff, 11 in 2012 cookoff, plus U of Notre Dame) 93% of survey respondents learned more about sustainable fisheries at Sea Grant event (2011) 91% in 2012. U of Notre Dame, Danny's Bar and Grill, Blue Water Grill and Firelake Grill seasonally serve lake herring. So does New Scenic Cafe, Sara's Table, and Nanaboujou...but they did prior to our events.</p>
<p>2 new baitfish farming ventures will be started, which will create 10 new jobs and by 2013, 2 combined indoor/outdoor fish farming operations will raise at least 10,000 pounds of fish for fishing bait</p>	No	<p>2010 - 2010-held workshop for baitfish aquaculture. 2011 - Aquaculture efforts moved to University of Minnesota Extension in 2011. 2012 - Aquaculture efforts moved to University of Minnesota Extension in 2011. 2013 - 2012: Aquaculture efforts moved to University of Minnesota Extension in 2011.</p>

Each year Safe and Sustainable Seafood pages on our Web Site are viewed 82,000 times	Yes	2010 - Target should be 48,000 (see program performance measures). 2010-55,673 page visits recorded. 2011 - Target should be 48,000 (see program performance measures). Realized 56,961 in 2011. 2012 - Target should be 48,000 (see Strategic Plan program performance measures). Realized 56,961 in 2011. Realized 65,685 in 2012. 2013 - Target should be written as 48,000 (see Strategic Plan program performance measures). Realized 76,226 page views in 2013. The 4-year total: 254,545.
Each year we will reach a potential audience of 700,000 people with information related to Safe and Sustainable Seafood through the mass media,	Yes	2010 - 2010-1,726,919 potential audience. 2011 - 2011: 7,181,601 potential audience 2012 - 2011: 7,181,601 potential audience 2012: 7,332,357 potential audience 2013 - 2013: 5,197,018 4-year total = 20 million
Each year we will reach an advertizing equivalency of \$8,500 for information placed in mass media related to Safe and Sustainable Seafood,	Yes	2010 - 2010-\$1876 2011 - 2011: \$54,950 advertising equivalency 2012 - 2011: \$54,950 advertising equivalency 2012: \$47,482.98 advertising equivalency 2013 - \$25,835 4-year total = \$130,144
If the fishery develops, we expect at least 20 new commercial fishing jobs and 20 fish processing jobs will be created within the Lake Superior basin within 5 years of the workshop	Yes	2010 - The exploratory siscowet workshop was held. The fishery is still being pursued, but will not likely develop by 2014. 2011 - This effort is ongoing, but may take longer to develop because of the need for several state agency regulation changes. 2012 - It is unlikely a siscowet fishery will develop. 2013 - 2012: It is unlikely a siscowet fishery will develop.
That by 2013, 5 agencies or businesses will develop AIS-HACCP plans to prevent the spread of aquatic invasive species.	Yes	2011 - No new partners this year workshops expected in 2012 and 2013. 2012 - No new partners this year. 2013 - 2012: No new partners this year. In 2013 USFWS has taken over the HACCP training
The number of anglers fishing Lake Superior for the first time will increase each year	No	2010 - This refers to a Web-based Lake Superior fishing resource. Due to retrenched positions, we could not pursue this objective. 2011 - This refers to a Web-based Lake Superior fishing resource. Due to retrenched positions, we could not pursue this objective. 2012 - This refers to a Web-based Lake Superior fishing resource. Due to retrenched positions, we could not pursue this objective. 2013 - 2013: This refers to a Web-based Lake Superior fishing resource. Due to retrenched positions, we could not pursue this objective.
The Web resources will reduce fuel costs by	No	2010 - This refers to a Web-based

for anglers and boaters unnecessarily traveling to Lake Superior only to find it unfishable and by reducing on-the-water travel expenses getting to productive fishing grounds,

Lake Superior fishing resource. Due to retrenched positions, we could not pursue this objective.

2011 - This refers to a Web-based Lake Superior fishing resource. Due to retrenched positions, we could not pursue this objective.

2012 - This refers to a Web-based Lake Superior fishing resource. Due to retrenched positions, we could not pursue this objective.

2013 - 2013: This refers to a Web-based Lake Superior fishing resource. Due to retrenched positions, we could not pursue this objective.