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2016-18 DIRECTORY OF PROJECTS AND PEOPLE

University of Wisconsin Sea Grant Institute



Cover photo: Lake Superior, Cornucopia, Wis.

Credit: David Nevala

**2016-18 DIRECTORY OF
PROJECTS AND PEOPLE**
University of Wisconsin Sea Grant Institute

Sea Grant is a partnership with public and private sectors combining research, education, outreach and technology transfer for public service. Sea Grant is a national network of 33 university-based programs enhancing the practical use and conservation of coastal, ocean and Great Lakes resources to create a sustainable economy and environment.



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From the Director

This publication had its beginnings three years ago when Wisconsin Sea Grant started crafting a four-year strategic plan driven by solving Great Lakes challenges and capitalizing on the opportunities that come with having the world's largest freshwater system at your doorstep.

That 2014-17 strategic plan comes in at 27 pages, which is nothing at all if you consider what it reflects — hundreds of conversations with resource managers, elected officials, scientists, students, businesspeople, staff of non-governmental organizations, planners, educators and anglers on how best to commit research, education and outreach resources to meet the needs of Wisconsin citizens and their Great Lakes.

Two years ago, we funded 19 research and education projects. We revised the 2016-18 call for proposals to address any gaps in the plan that were not filled by previous projects. This led to another process, which involved a rigorous review of 83 research and education preproposals. From the original pool, 49 were encouraged to apply and 49 eventually did. Those were also thoroughly vetted by regional and international experts until they were whittled down to the 19 external research and education projects included here.

It's work that will be carried out on six campuses and involving nearly four dozen principal and co-investigators. More than 200 reviewers analyzed the proposals for technical merit and scientific rigor. Additionally, the Sea Grant Advisory Council provided insights on the relevancy of the proposals for Wisconsin.

Our education and outreach staff are constantly scanning the state's coastal and Great Lakes waters' needs. Their projects are also reflected in this book. Just as with the research projects, the education and outreach work is categorized in four major focus areas, including Healthy Great Lakes Coastal Ecosystems, Sustainable Fisheries and

Aquaculture in the Great Lakes Region, Resilient Great Lakes Communities and Economies, and Environmental Literacy and Workforce Development in the Great Lakes Region.

As the next two years unfold, please follow along through scholarly publications, social media and our quarterly newsletter, the Aquatic Sciences Chronicle, to learn how the research, education and outreach detailed here is making a difference for our state and our freshwater resources. Through it all, please always feel free to reach out to me with questions and comments. We share a commitment to the Great Lakes and these Sea Grant projects and people.


James P. Hurley
Sea Grant Director

Participating Institutions and Agencies 2016-18

University of Wisconsin Sea Grant Institute

University of Wisconsin Sea Grant
Institute

Cornell University

East Carolina University

Great Lakes Fishery Commission

Great Lakes Indian Fish and Wildlife
Commission

Green Bay Metropolitan Sewerage
District

Gustavus Adolphus College

Lake Superior National Estuarine
Research Reserve

Metropolitan Water Reclamation
District

Milwaukee Metropolitan Sewerage
District

Minnesota Department of Health

Minnesota Department of Natural
Resources

Minnesota Pollution Control Agency

NOAA Office for Coastal
Management

NOAA Coastal Storms Program

NOAA National Weather Service

NOAA Office of Ocean Exploration
and Research

National Park Service

Northern Michigan College

Northland College

Northwest Passage

Penn State

St. Norbert College

State University of New York-Stony
Brook

The Ohio State University

U.S. Army Corps of Engineers

U.S. Environmental Protection
Agency

U.S. Fish and Wildlife Service

U.S. Forest Service

U.S. Geological Survey

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Urbana-Champaign

University of Michigan

University of Minnesota-Duluth

University of Minnesota-Twin Cities
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University of Wisconsin-Stevens Point
University of Wisconsin-Superior

Western Lake Superior Sanitary
District
Wisconsin Historical Society
Wisconsin Coastal Management
Program
Wisconsin Department of Natural
Resources
Wisconsin Department of Public
Instruction
Wisconsin Department of Tourism
Wisconsin Department of
Transportation
Wisconsin Veterinary Diagnostic
Laboratory

Healthy Great Lakes Coastal Ecosystems

Fifteen of Wisconsin's 72 counties border the Great Lakes of Superior and Michigan totaling more than 800 miles of shoreline. On Lake Michigan, these ecosystems span from the state's southern border with Illinois north to the shared border with Michigan's Upper Peninsula. Wisconsin's Lake Superior habitats extend west from our shared border with Michigan's Upper Peninsula to the diverse ecosystem comprising the St. Louis Estuary at Superior. In Wisconsin, our healthy coastal ecosystems, sustained by their surrounding watersheds, are the foundation of life along the coast.

Keeping coastal ecosystems healthy is a challenge because of the diversity of stressors each system faces. This is further complicated because ecosystems do not adhere to political boundaries. Responsible management of these systems requires new kinds of thinking and actions, often termed ecosystem-based management. Ecosystem-based approaches require unprecedented levels of coordination among federal, state and local jurisdictions and the active engagement of the people who live, work and play along our coasts. They also require understanding of the characteristics of species, landscapes and their interactions within each ecosystem.

In general, increasingly rapid coastal development, greater demands on fisheries resources, climate change and other human activities are leading to water-quality degradation, increased demands on water supplies, changes to fisheries stocks, wetlands loss, proliferation of aquatic invasive species and a host of other environmental problems. It is essential for decision-makers and Great Lakes coastal residents to understand the interconnectedness and interactions of these systems in order to maintain vital habitats and inform restoration efforts within ecosystems and watersheds.

Sea Grant is a leader in regional approaches to understanding and maintaining healthy ecosystems, with planning efforts across the country to identify information gaps, implement research priorities and coordinate information and technology transfer to people who need it. Sea Grant recognizes the need to determine the value of myriad ecosystem

services that provide that maintain the conditions for life in and along the Great Lakes. Wisconsin Sea Grant and our partners are well-suited to clarifying and addressing ecosystem health at the appropriate management level.

National and Wisconsin Sea Grant Goals

- Ecosystem services are improved by enhanced health, diversity and abundance of fish, wildlife and plants.
- Ecosystem-based approaches are used to manage land, water and living resources.
- Ecosystems and their habitats are protected, enhanced or restored.

Wisconsin Sea Grant Strategies

- Support research that seeks to contribute to the understanding, management and improvement of Great Lakes ecosystem health.
- Engage researchers with the Sea Grant outreach and communications staff to effectively make available and deliver research-driven information and findings to resource managers, policy- and decision-makers and public stewards.
- Improve and enhance stakeholder access to and understanding of data, models and policy information in Wisconsin and the Great Lakes that support ecosystem-based planning, decision-making and management approaches.
- Help residents, resource managers, businesses and industries understand the effects of human activities and environmental changes on coastal resources.

-
- Train and inform residents, resource managers and businesses so that they understand and can apply the policies that apply to coastal protected species and habitats.
 - Interpret data, train and inform residents, resource managers and businesses to help them understand threats to Great Lakes ecosystems and importance of the benefits provided by preserving non-degraded ecosystems.
 - Support research to develop technologies and approaches for restoring downgraded Great Lakes ecosystems.
 - Involve stakeholders in resource management decision-making processes and to help resource managers incorporate public input in resource management decisions.

Projects

The Basis for Microbially Mediated Mercury Methylation in Oxygen-Depleted Zones of the Great Lakes

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David Krabbenhoft, USGS

Elevated levels of the potent neurotoxin methylmercury (MeHg) are present in fish throughout the Great Lakes. An inability to balance sources and sinks of MeHg in aquatic ecosystems suggests that we are missing significant processes and/or locations of MeHg production. In this project, we will test hypotheses about the organisms and their genes expected to be responsible for mercury (Hg) methylation in the Great Lakes. We will use molecular techniques to relate microbial community composition to MeHg and total Hg levels at depth-resolve intervals within the water column of all five Great Lakes, at stations known to have significant MeHg concentrations. We will also target recently identified genes known to be involved in methylation in pure cultures of anaerobic bacteria. Finally, we will evaluate the effect of thiols on methylation in lake microbial communities. This work will advance our understanding of the freshwater Hg cycle, providing evidence for the mechanisms at play in microbial communities mediating methylation. Continuing project funded from 2015-17. [R/HCE-22](#)

An In Situ Molecular Detection System for Microcystin Monitoring

Matthew Smith, UW-Milwaukee, (414) 382-1700, smith926@uwm.edu

Todd Miller, UW-Milwaukee

Human activities are increasingly causing eutrophication of water supplies, which has led to an increase in toxin-producing organisms such as cyanobacteria. Of these toxins, microcystins are a group of hepatotoxins that have been shown to cause adverse health effects in humans and animals even at low concentrations. There is a need for instruments capable of making autonomous, species-specific, microbiological measurements that can serve as early warning systems for toxic metabolites in freshwater systems. We

propose to develop a field-portable autonomous instrument that can be deployed in water bodies for extended periods (~one month) and provide near real-time detection of microcystin. The proposed instrument will decrease the labor requirements of routine monitoring, while increasing sampling resolution during dangerous or inconvenient times. Continuing project funded from 2015-17. [R/HCE-23](#)

Carbon Fixation in Lake Michigan

Harvey Bootsma, UW-Milwaukee, (414) 382-1717, hbootsma@uwm.edu

Accurate measurements of carbon fixation and the physical and chemical forces that regulate it are fundamental to any ecosystem-based management program. Recent declines in the abundance of both forage fish and apex predators in Lake Michigan appear to be related to the loss of phytoplankton resulting from grazing by Dreissenids. Dreissenid-mediated changes in nutrient cycling also appear to have altered the relationship between nutrient loading, phytoplankton production and phytoplankton biomass. However, quantitative measures of photosynthetic carbon fixation and carbon dynamics at the base of the Lake Michigan food web are very limited, and so it has been difficult to define the response of the phytoplankton community to changes in external nutrient loading and internal nutrient cycling in quantitative terms. This research will improve our understanding of these relationships and help guide the revision of nutrient management models. [R/HCE-28](#)

Population Structure and Genetic Markers of Persistent *Escherichia coli* in Beach Sand

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In this project, genomics meets beach management as we take an innovative approach to answering the complex question of what is causing elevated levels of *Escherichia coli* at Wisconsin's beaches. Fecal indicator bacteria *E. coli* and enterococci are harmless organisms meant to demonstrate that enteric pathogens may be present; however, they have been found to persist in beach sand, which can greatly influence water-quality results.

We hypothesize that *E. coli* in the sand are genetically distinct strains that have genomic traits that allow them to survive outside of the host. We will use host-specific alternative indicators to assess sewage and gull, dog and ruminant fecal pollution and distinguish recent pollution events from *E. coli* and enterococci prolonged survival. We will employ a combination of field- and laboratory-based experiments to characterize *E. coli* populations and use cutting-edge genomic tools to identify genes linked to functional pathways responsible for prolonged survival. [R/HCE-29](#)

Refining Our Understanding of Methylmercury Production and Bioavailability in the St. Louis River Estuary

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Kristofer Rolfhus, UW-La Crosse

The St. Louis River Estuary (SLRE) is a valuable fish spawning ground for the western arm of Lake Superior. However, preliminary data suggest that higher mercury levels are found in walleye that feed within the SLRE than those that feed in Lake Superior. Methylmercury, the bioaccumulative form of mercury, is primarily produced by microbial activity in anaerobic wetlands, soils and sediments that are abundant in estuarine environments, such as the SLRE. Although the underlying cause of elevated mercury levels in fish in the SLRE is unknown, it is likely due to a combination of biogeochemical factors including solid-phase mercury speciation, coupled with variations in water chemistry (e.g., dissolved sulfate and organic carbon). Developing an understanding of these fundamental biogeochemical processes is critical to the ability of resource management agencies to make effective decisions concerning the beneficial use of future dredging materials and habitat restoration in the SLRE. Jointly funded with Minnesota Sea Grant. [R/HCE-30](#)

The Role of Indirect Photolysis in the Environmental Fate of Pesticides and Pharmaceuticals

Christina Remucal, UW-Madison, (608) 262-1820, remucal@wisc.edu

The presence of biologically active anthropogenic compounds (e.g., pesticides and pharmaceuticals) in the watersheds of the Great Lakes is of emerging concern to stakeholders and water quality managers. Natural processes, such as dissolved organic matter (DOM)-mediated indirect photodegradation, can transform many of these compounds. However, predicting the photodegradation rates of target compounds is difficult because DOM varies temporally and spatially, and current approaches rely on time- and labor-intensive analyses. The overall goal of our project is to assess how the molecular composition and photochemical reactivity of DOM with anthropogenic compounds changes as it moves from the St. Louis River into the St. Louis Estuary and then into Lake Superior. We plan to develop a transferable tool that will relate the photoreactivity of DOM with simple water quality measurements and predict the photodegradation rates of target compounds in this sensitive ecosystem and other natural waters. [R/HCE-31](#)

Seasonal Depth Distribution of Round Goby in Lake Michigan, Emphasizing Cold Seasons

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Round gobies are significant in the diet of certain coldwater predators, even though they are a warmwater species (based on summer habitat and spawning). This project is evaluating these evolving predator-prey interactions by finding areas in which round gobies are most accessible to coldwater predators. An understanding of the cold season predator-prey interaction will facilitate management by allowing managers to better assess the best balance of predators, particularly the largely stocked salmon and trout. The current shallowest U.S. Geological Survey trawls are both off the preferred substrate and preferred summer depths for round gobies. In this novel and still evolving coastal ecosystem, management of round gobies is a balance between control of a nuisance species and management of the forage base. [R/HCE-32](#)

Outreach

Improving Beaches (Mednick) – Sea Grant has taken the lead in coordinating a Wisconsin coastal beaches workgroup, as well as improving and expanding the use of free Web data services and decision-support tools by working with their developers and users across the Great Lakes. These tools offer beach managers more timely, accurate and cost-effective information on water quality, lake conditions and pollution sources. [A/AS-01](#)

Wisconsin Clean Marina Program (Noordyk) – Collaborating with the Wisconsin Marine Association and Wisconsin Coastal Management Program, Sea Grant is working with lakes Michigan and Superior marinas to voluntarily adopt measures to reduce pollution from marinas, boatyards and recreational boats. Activities include business training, marina inspector training, a website, and community participation in statewide and regional clean marina planning and guidance efforts. [A/AS-01](#)

Climate Change and Green Bay Hypoxia Decision Support Tool (Noordyk) – This project, for which Sea Grant provides supportive outreach activities for two partner campuses, is creating a decision-support tool for use within the Lower Fox River watershed to support ecosystem-based management using alternative sediment and phosphorous loading and climate trend scenarios. Funding source: Graham Sustainability Institute of the University of Michigan [A/AS-01](#)

Lower Green Bay and Fox River Area of Concern Outreach (Noordyk) – Leading the Area of Concern Citizen Advisory Committee Outreach and Education Subcommittee, Sea Grant is identifying and coordinating outreach and education activities to improve watershed water quality. [A/AS-01](#)

Habitattitude Surrender Collaborative (GLRI submitted) (Campbell) – The illegal release or disposal of unwanted pets and plants into the environment is a pathway of growing frequency and concern in Wisconsin, spreading the presence of invasive species. The Great Lakes Sea Grant Network will create convenient alternatives to releasing or disposing of unwanted pets and plants into the environment through the Habitattitude Surrender Collaborative. This will involve pet stores, nurseries, hobbyist clubs and nonprofit animal rescues. A teacher training will be delivered and K-12 curriculum will be created. Finally, Sea Grant will host a follow-up to the successful 2014 Great Lakes Briefs on Invasive Organisms Traded In Commerce Symposium. [A/AS-01](#)

The Wisconsin AIS Partnership (Campbell) – The Wisconsin Aquatic Invasive Species Partnership consists of a wide variety of partners, from state and local government to nonprofits and universities, that are working to prevent the spread of aquatic invasive species (AIS) and to manage their undesirable impacts. The University of Wisconsin-Extension Environmental Resources Center (UW-EXT ERC) has historically managed this partnership by coordinating communications and developing new AIS outreach and training programs for partners. Through a joint position with the UW-EXT ERC, Sea Grant now plays a role in the partnership outreach. [A/AS-01](#)

Revising the Wisconsin AIS Management Plan (Campbell) – Much has changed since the creation of Wisconsin's 2003 aquatic invasive species management plan. Since late 2014, Sea Grant has been partnering with the UW-EXT ERC and Wisconsin Department of Natural Resources to lead an effort to revise the management plan by coordinating a core team of representative stakeholders and working with them to solicit feedback on the draft plan from the public. Implementation of the plan's objectives will be completed by 2018. [A/AS-01](#)

Extending Stop Aquatic Hitchhikers to Waterfowl Hunters (Campbell) – The Stop Aquatic Hitchhiker campaign has been very effective at raising awareness on aquatic invasive species (AIS) issues and prevention steps within the recreational boating community. However, some smaller subsets of the boating community, such as waterfowl hunters, haven't received the same Stop Aquatic Hitchhikers message. Sea Grant will be working with that community to raise awareness and will also evaluate the use of pilot AIS cleaning stations. [A/AS-01](#)

Watercraft 101: Helping Inspectors Understand What They're Inspecting (Campbell) – While the Wisconsin's Stop Aquatic Hitchhikers guidance of “Inspect, Remove, Drain, Never Move” is easily understandable, it can be more difficult to implement it across the variety of watercraft that Clean Boats, Clean Waters watercraft inspectors encounter. This combined with the fact that some inspectors have never boated can make it a challenge for them to feel confident while at the boat ramp. Building off of lessons learned through a wakeboard boat risk assessment, Sea Grant will create tools that will help inspectors. [A/AS-01](#)

Wisconsin Department of Natural Resources and Sea Grant Partnership for Aquatic Invasive Species Prevention (Seilheimer) – This project continues aquatic invasive species watercraft inspections using six people stationed at Great Lakes boating access sites. It's a partnership of Sea Grant, the Wisconsin Department of Natural Resources and University of Wisconsin-Extension. Funding source: Great Lakes Restoration Initiative [NMC00000897](#)

Asian Carp Research (Seilheimer) – This is a literature review of current research on the control of the spread of Asian carp throughout the Great Lakes and Mississippi River basin. The material will then be shared with interested members of the public, resource managers and policymakers. It will identify research gaps that can guide future investigations and management activities. Funding source: Asian Carp Regional Coordinating Committee through Ohio Sea Grant [6003744 RFO1305214](#)

Ghost Nets (Seilheimer) – Members of the Apostle Islands Sport Fisherman’s Association initiated the project, and it is being conducted in partnership with the Great Lakes Indian Fish and Wildlife Commission. The groups are developing outreach and education materials for the prevention of marine debris. The project educates not only anglers but also commercial and tribal fishers to reduce the creation of new ghost nets and presents best-management practices to commercial and tribal fishers through educational workshops. Lake Superior’s tribal fishers, an underserved group, benefit. This project also educates the group most likely to encounter commercial and ghost nets — recreational anglers, who have a stake in the quality of the fishery. Funding source: NOAA Marine Debris Grant [NA14NOS4630069](#)

Sustainable Fisheries and Aquaculture in the Great Lakes Region

The nation has witnessed the decline of many of its major fisheries while seafood consumption has increased and continues to be encouraged because of its health benefits. To fill the gap between seafood demand and domestic harvests, the United States imports 86 percent of what is consumed leading to a seafood trade deficit of more than \$10 billion per year. With global wild fisheries harvests at a plateau of around 185 metric tonnes, some 50 seafood species are now produced from aquaculture. There are no projected increases in wild capture fisheries, but global aquaculture is predicted to increase by 33 percent over the next decade. These projections create opportunities for an expanded Great Lakes basin aquaculture industry and for innovative marketing strategies and value-added products for the wild fisheries industry.

The overall economic impact of the commercial, recreational, for-hire fisheries and aquaculture industries in the Great Lakes region is \$7 billion annually. In Wisconsin, 1.4 million fishing licenses are issued each year, and fishers and the fishing industry deliver \$2.75 billion in economic impact and 30,000 jobs every 12 months. There are 70 commercial fishers in Wisconsin who rely on fewer than 10 species with a combined harvest of \$5 million annually.

Wisconsin's aquaculture industry contributes \$21 million in annual economic activity and more than 400 jobs to the state. There is definitely room for growth — additional opportunities for job creation and contributions toward meeting the demand for finfish. The Midwest consumes more than a billion pounds of seafood products per year but less than 4 percent comes from aquaculture operations in the region.

Sea Grant continues to play a leadership role in developing innovative technologies for all sectors of the seafood industry, including fishing, aquaculture, seafood processing and consumer safety, to ensure a safe and sustainable supply of seafood products now and for future generations. Seafood safety will continue to be a concern for consumers as foreign imports, some of which are associated with seafood contamination, continue to increase.

Sea Grant's partnership with NOAA Fisheries, state fisheries managers, seafood processors, fishing associations, the aquaculture industry and consumer groups will ensure safe, secure and sustainable supplies of domestic seafood and decrease our reliance on seafood imports.

National and Wisconsin Sea Grant Goals

- A safe, secure and sustainable supply of seafood to meet public demand.
- Informed consumers who understand the health benefits of seafood consumption and how to evaluate the safety and sustainability of the seafood they buy.

Wisconsin Sea Grant Strategies

- Support research to develop and improve aquaculture practice and techniques, including aquaponics, nutritional value of feeds and disease and pathogen prevention and diagnosis.
- Develop outreach products to make wild fish harvesters and aquaculture operations aware of advancements in product handling, packaging and marketing strategies.
- Support research that leads to a better understanding of the risks and benefits of consuming Wisconsin-produced fish.
- Develop outreach products for Wisconsin consumers about Wisconsin origin fish and fisheries products and other seafood choices, including nutrition benefits, risks, seafood safety and environmental impacts.

Projects

Virulence Factors and Control of the Fish Pathogen *Flavobacterium columnare*

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David Hunnicutt, St. Norbert College

Oswaldo Sepulveda-Villet, UW-Milwaukee

Flavobacterium columnare causes columnaris disease in wild and farmed freshwater fishes, resulting in significant losses in aquaculture. Although the disease has been recognized for nearly 100 years, the mechanisms of pathogenesis of the bacterium are unknown and protective measures are inadequate. We used genetic techniques to construct deletion mutants of *F. columnare*. Mutants lacking the type IX protein secretion system (T9SS) gene *gldN* were avirulent in zebrafish. They failed to secrete toxins that were secreted by the wild type strains. Preliminary results suggest that the *gldN* mutants are also avirulent in yellow perch. This project will examine the effect of deletion of *gldN* on virulence in yellow perch in greater detail. Virulence factors secreted by the T9SS will be identified, and the genes encoding these will be deleted to determine the effect on virulence. Avirulent mutants will be tested as effective vaccine strains to protect against wild type *F. columnare*. [R/SFA-11](#)

Molecular Genetic Analysis of Zooplankton Community Structure in Lake Michigan

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Rebecca Klaper, UW-Milwaukee

Carmen Aguilar, UW-Milwaukee

More than a decade of fisheries collapse in Lake Michigan has eradicated significant commercial and sport fishing businesses and upset the traditional food web. Although the near extirpation of planktivorous forage fish in the mid-2000s coincides a massive reduction in phytoplankton (largely brought about by Dreissenid mussels), the link between phytoplankton and juvenile and/or forage fish is not well developed. This proposal offers to construct a genetic sequence library of commonly occurring freshwater

zooplankton of Lake Michigan; establish the validity of preservation techniques for the genetic material; attempt molecular analysis of species composition, richness, and diversity using sequence analysis side-by-side with microscopic enumeration; and assess the likelihood that alcohol-preserved collections coinciding with hydrographic and biogeochemical time series can be queried to examine known forcing functions of zooplankton abundance and community structure. [R/SFA-12](#)

Diagnosis and Management of Viral Hemorrhagic Septicemia Virus in Wisconsin

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Kathy Toohey-Kurth, UW-Madison

Bridget Baker, WDNR

Megan Finley, WDNR

Viral hemorrhagic septicemia virus (VHSV) is an invasive pathogen that continues to threaten Wisconsin's fisheries. With previous Sea Grant support, our team developed an accurate non-lethal test for VHSV. Our current goal is to validate our test for four important fish species in Wisconsin: bluegill, yellow perch, northern pike and brown trout. We will set test thresholds using samples from known positive and known negative fish. We will then measure the development of the immune response to understand how long fish retain antibodies. Finally, we will test fish across Wisconsin, to map the distribution of VHSV in our state. The result will be new information about whether fish have been exposed to VHSV, the current immune status of populations and where in Wisconsin VHSV has spread. This information will be used to manage VHSV and reduce its impact on our economy and recreational fisheries. [R/SFA-13](#)

Optimizing Walleye Stocking Density and Nutrient Recycling in Traditional and Integrated Aquaculture Systems

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Greg Fischer, UW-Stevens Point

Emma Wiermaa, UW-Stevens Point

Water shortages and stricter environmental regulations are shifting aquaculture production to integrated aquaculture systems. Only one fish type has been extensively researched and had its production methods optimized in these systems — tilapia. The aquaculture and aquaponic industries need more fish options, and walleye is a species with substantial aquaculture potential because of its high market value and limited supply from traditional commercial sources. Our project will conduct key commercial production evaluations using traditional and integrated aquaculture systems raising walleye and hybrid walleye from fry to market size based on three stocking densities. Nutrient dynamics, nutrient removal, and plant and fish growth will be evaluated to determine optimal stocking density and production methods in both systems. Biological and economic models will be developed for producers so they can evaluate the introduction of a new fish type into their traditional and integrated aquaculture production systems. [R/SFA-14](#)

Outreach

Aquaculture and Aquaponics Curriculum and Training (Binkowski/Fischer/Hartleb/Wiermaa) – This project of Sea Grant, University of Wisconsin-Stevens Point Northern Area Aquaculture Demonstration Facility, partner individual school districts, the Wisconsin Department of Public Instruction and other groups is developing aquaculture and aquaponics curriculum — and training programs specifically directed to science and agricultural educators within Wisconsin and First Nation school systems. This education program is expanding Sea Grant involvement to more than 30 schools. [A/AS-01](#)

Cool- and Cold-Water Aquaculture (Binkowski/Fischer/Hartleb/Wiermaa) – Through this project, Wisconsin’s existing and prospective aquaculturists are gaining increased access to UW-Stevens Point Northern Area Aquaculture Demonstration Facility research, technology and information regarding fish biology, recirculating aquaculture system equipment and engineering as well as water chemistry to optimize the health and growth potential for fish species such as walleye and hybrid walleye and sauger (known as saug-eye), lake trout, lake herring, Arctic char, yellow perch and Atlantic salmon. [A/AS-01](#)

Workforce Training on Aquaculture (Binkowski/Fischer/Hartleb/Wawronowicz/Wiermaa) – This project recognizes the varied levels of expertise for those in Wisconsin’s aquaculture industry and responds with a series of teaching modules based on a three-tiered system of progressive advancement using online lectures and in-person hands-on workshops. Overall, the focus is on cold- and cool-water fish production. [A/SEA-01](#)

Aquaponics Manual (Binkowski) – This project will produce a comprehensive, region-specific aquaponics manual covering all aspects of fin fish and plant production from initial concept and system design to the final phase of marketing and processing of fin fish, plants and vegetables. This new-age aquaponics concept will be used on a regional and national level. [A/AS-01](#)

Urban Aquaculture (Binkowski) – UW-Milwaukee School of Freshwater Sciences personnel, supported by Sea Grant, are providing technical assistance in all aspects of urban aquaculture with expertise in biological, chemical, physical and economic parameters. Sea Grant is using this opportunity to involve new people and potential investors in the urban setting, which has the advantage of product availability near consumer demand, reduces transportation costs and can create jobs in central cities. [A/AS-01](#)

Enriching the Lifestyle for Carnivores at the Milwaukee County Zoo (Binkowski) – The goal of this project is to provide the necessary stimulation to trigger predatory behavior by introducing live prey organisms such as fin fish. As a result, the animals exhibit behavior patterns that are more natural such as hunting, stalking, aggression and capture. Different food presentation scenarios are being explored to determine the best approach to challenge animals' natural instincts and intelligence. This project represents a unique opportunity to utilize the "Aquaculture Tool Box" and most advanced biosecurity practices to produce fin fish to support this special application. [A/AS-01](#)

Eat Wisconsin Fish (Kline/Gen/Seilheimer/Wiermaa) – Many people are interested in purchasing more of their food from local sources, but when it comes to local fish, consumers often have questions about nutrition benefits and risk, as well as environmental sustainability. Sea Grant is continuing its Eat Wisconsin Fish campaign to educate consumers about wild Great Lakes fish and Wisconsin farm-raised fish, and the environmental impacts associated with commercial fishing and aquaculture. The project is also connecting producers and fishermen with retailers and restaurateurs. [A/AS-01](#)

Great Lakes Commercial Trap Nets Location (Seilheimer) – In order to diminish life-threatening entanglement events involving sport anglers’ equipment and commercial fishing nets, Sea Grant works with the Lake Michigan commercial whitefish fleet to make the GPS coordinates of commercial trap nets available to anglers on its website and through printed maps placed in high-use launching locations. [A/AS-01](#)

Salmon Ambassadors Wisconsin (Seilheimer) – This project is engaging Wisconsin anglers in the management of Lake Michigan Chinook salmon. Anglers are being recruited from Wisconsin ports to collect information about the fish they catch. Fish size and fin clip (an indicator of stocked versus wild) data will be collected by anglers to increase the knowledge of seasonal change in the abundance of wild salmon in Wisconsin waters. This program is also allowing for increased and more targeted collection of Chinook salmon heads for retrieval of coded wire tags, which offer information on the movement of stocked and wild salmon. [A/AS-01](#)

Commercial Trawling for Whitefish (Seilheimer) – This outreach study is investigating the capture rate of non-target species resulting from lake whitefish trawling. The research is being used to determine if trawling could be conducted without impacting other fisheries such as salmon and lake trout. Fishing will be conducted over all seasons and at a range of depths in order to identify temporal and spatial patterns in lake whitefish distribution that minimize bycatch. The study could inform winter commercial whitefish harvest. That is a time when prices are high but trap nets cannot be set. Potential conflict with recreational fishers would be reduced because fewer trap nets are in the water. [A/AS-01](#)

Resilient Great Lakes Communities and Economies

Coastal communities provide vital economic, social and recreational opportunities for millions of people within the Great Lakes basin. A 2011 study completed by the University of Michigan reported that more than 1.5 million jobs, generating \$62 billion in wages are tied to the inland seas. The job breakdown is: 994,879 in manufacturing; 217,635 in tourism; 118,550 in shipping; 118,430 in agriculture, fishing and food production; 38,085 in science and engineering; 10,980 in utilities; and 10,003 in mining. In Wisconsin, 173,969 jobs can be linked to the Great Lakes. Population migration has also transformed many natural coastal habitats into urban landscapes and intensified the use of finite coastal resources. From 2000 to 2010, the population in the 15 counties bordering Wisconsin's Great Lakes grew by 57,500. This population increase and developmental pressure has resulted in greater vulnerability of coastal communities and environments to natural and technological hazards. To accommodate more people and activity while balancing demands on coastal resources, Wisconsin must develop innovative policies, institutional capacities and management approaches to increase community resilience.

Sea Grant will continue to support cutting-edge research in the areas of marine-related energy sources, climate change, coastal processes, energy efficiency, hazards, stormwater management and tourism. In Wisconsin, Sea Grant will engage our diverse and growing coastal populations in applying the best-available scientific knowledge to address increased resource demands and vulnerability. Ultimately, Wisconsin Sea Grant will bring its unique research and engagement capabilities to support the development of resilient coastal communities that sustain diverse and vibrant economies, effectively respond to and mitigate natural and technological hazards and function within the limits of their ecosystems.

National and Wisconsin Sea Grant Goals

- Development of vibrant and resilient coastal economies.
- Communities use comprehensive planning to make informed strategic decisions.
- Improvements in coastal water resources sustain human health and ecosystem services.
- Resilient coastal communities adapt to the impacts of hazards and climate change.

Wisconsin Sea Grant Strategies

- Support research to document the socioeconomic values of open water and coastal businesses and other water-dependent industries and research that addresses natural resource valuation along Wisconsin's Great Lakes.
- Utilize Web-based technologies, publications, displays and communication dissemination using traditional and new media to make available, and distribute information, about the value of waterfront, tourism-related economic activities and other socioeconomic impacts.
- Support research to develop or enhance community planning and visualization tools that demonstrate the benefits, risks and consequences of urbanization on the coastal environment.
- Support research that assesses the economic and social well-being of Wisconsin coastal communities to document improvements in quality of life related to coastal development plan implementation.

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- Work with Wisconsin's coastal communities, community leaders and businesses to help them develop and adopt plans for responsible development.
 - Support research to assess the impacts of human activities on Great Lakes watersheds, water quality and supply.
 - Communicate alternative actions to conserve water, protect water quality and protect water supply.
 - Help communities understand the reasons and restrictions on Great Lakes water use particularly in areas peripheral to the Great Lakes basin.
 - Support research that evaluates the impacts of increased climate variability and change, including intensity and frequency of rainfall and storm events on coastal community infrastructure.
 - Develop outreach and communications tools so that communities can understand the consequences of alternative development and stormwater mitigation scenarios.
 - Work with regulatory agencies, tribal entities and communities to help them understand the vulnerability of coastal properties to storm impacts.

Projects

Sand Shrouded Shipwrecks: Archaeological Documentation of Two Ships of the Goodrich Steamboat Line

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Tamara Thomsen, Wisconsin Historical Society

Caitlin Zant, Wisconsin Historical Society

John Karl, UW-Madison

Dramatic changes in water levels, increased frequency and severity of storms, and several harsh winters have produced a unique opportunity for discovering and documenting shipwrecks. Massive amounts of sand movement have exposed a record number of vessels along Wisconsin's Lake Michigan coastline. Many of these shipwrecks have not been seen for decades and zebra and quagga mussels have not colonized the wrecks. The recently exposed shipwrecks *Atlanta* and the *Arctic* will be the focus of the work. Both were workhorses of the Goodrich Steamboat Line. Established in Wisconsin in 1856, the Goodrich Steamboat Line was an important early carrier of passengers and freight. Archaeological students from the Program in Maritime Studies at East Carolina University (ECU) and avocational archaeologists from the area will participate in the research. One of the ECU students will be designated a fellow and prepare a report on the project and shadow other Sea Grant researchers. [C/RCE-02](#)

Development of Geo-Indicators for Assessment of Coastal Bluff Ecosystem in Lake Michigan for Regional Integrated Bluff Management (IBM)

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David Mickelson, UW-Madison

William Likos, UW-Madison

Coastal bluffs along the Great Lakes are a sensitive landscape feature, often containing both vital shoreline habitat at the bluff toe and urbanized development at the crest. Sediments in the coastal bluff environment (CBE) play an important role in ecosystem function. Movements of sediment are constantly altered by natural climate factors and anthropogenic coastal development, making a sediment budget accounting for sources, sinks and pathways of sediment transport critical. In this project, we will develop three sets of geo-indicators to parameterize the CBE, quantify coastal processes on a regional sediment budget and characterize the health or function services of the CBE. The resilience of geo-indicators in response to stressors like coastal development and climate change would be examined on three sites of varying urbanization along the Wisconsin coast of Lake Michigan. The geo-indicators would help coastal managers effectively assess the health of the coastal bluff ecosystem for regional integrated bluff management (IBM) along Lake Michigan. Continuing project funded from 2015-17. [R/RCE-02](#)

Improving Upon Flash Flooding Risk Assessments and Forecasts for Great Lakes Cities

Paul Roebber, UW-Milwaukee, (414) 229-3950, roebber@uwm.edu

Great Lakes communities inevitably face heavy rainfall and flash flooding events. Although we have a significant amount of historical and future projections of precipitation data as it relates to flooding throughout the Milwaukee and Chicago regions, we lack an integration of that precipitation-flooding knowledge with critical atmospheric signals, antecedent atmospheric and soil conditions, and land-surface information. This project will develop several operational tools using both types of information that forecasters, emergency management personnel and the broader community can use when either a heavy rainfall event is predicted or as part of long-term planning. The project includes testing and dissemination of the tools. By taking the necessary steps to develop resiliency recommendations and emergency response tools to protect critical infrastructures and dwellings, these major Great Lakes cities will reduce their vulnerability to extreme precipitation, reduce loss to life and property, and increase their overall resilience to climate change. Jointly funded with Illinois-Indiana Sea Grant. [R/RCE-03](#)

Integrated Assessment and Climate Change Adaptation Planning in the Chequamegon Bay Region of Lake Superior

Randy Lehr, Northland College, (715) 682-1261, rlehr@northland.edu

Climate change adaptation planning is a critical need in the Chequamegon Bay and Apostle Islands region of Lake Superior. Because of its unique history of land use and infrastructure development, geomorphology and localized precipitation patterns, the Chequamegon Bay area is arguably the most vulnerable region in the Lake Superior basin with respect to climate change. To address these challenges, this project will implement comprehensive, integrated assessment that connects community leaders, staff from local and tribal governments, and local elected officials with scientific and subject matter experts surrounding the issue of climate change adaptation in the region. This work will

empower local governments to adapt to climate change impacts and develop a roadmap toward climate change adaptation that integrates unique local planning needs into the context of an interconnected regional system. [R/RCE-04](#)

The Hydrologic and Ecologic Effects of Green Infrastructure Within Urban Coastal Catchments

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There is increasing interest in green infrastructure strategies such as rain barrels, porous pavement, native landscaping, rain gardens and green roofs. Yet widespread adoption of these practices has been slow, in part due to lingering uncertainty in site-specific performance and lack of engagement by private homeowners. Realistic expectations of performance for sites with different fine-scaled characteristics under a range of weather scenarios is key to executing successful projects that encourage engagement by homeowners. By performing factorial modeling using ParFlow with Common Land Model, we will be able to explore these details at a larger scale than has been done before. By synthesizing our results into a visualization tool and set of guidelines, we will make these results easily accessible to planners, professionals, private residents and students and help to develop an informed citizenry that understands the impact of individual, distributed stormwater management decisions on broader hydrological and ecological outcomes.

[R/RCE-05](#)

Outreach

Resilience to Coastal Hazards and Climate Change Adaptation for Wisconsin's Coastal Communities (Hart/Clark) – Sea Grant staff works with coastal communities to inform planners and decision-makers about the current science on climate adaptation. Hart and Clark serve as co-chairs of the Coastal Resilience Working Group of the Wisconsin Initiative on Climate Change Impacts. Hart collaborates with the NOAA Digital Coast Partnership on the Great Lakes Coastal Resilience Planning Guide, greatlakesresilience.org. [A/AS-01](#)

Promote Coastal Heritage Tourism (Hart) – Sea Grant collaborates with the Wisconsin Coastal Management Program on coastal heritage tourism activities, including enhancement and maintenance of the Wisconsin Coastal Guide, an interactive map that promotes exploration of the Lake Michigan and Lake Superior Circle Tours. [A/AS-01](#)

Geospatial Technologies for Great Lakes Coastal Management (Hart) – The Wisconsin Coastal Atlas (wicoastalatlans.net/) helps people better understand coastal issues, share coastal data and inform decision-making about the Great Lakes. The atlas leverages accurate local government data to represent the coasts of Wisconsin and seeks to be a sharable resource for analyzing coastal issues that extend beyond the boundaries of the state. Ongoing activities include adding new interactive maps, decision tools and GIS data sets and updating technologies to improve data discovery and sharing. [A/AS-01](#)

Integrated Assessment on Water Level Variability and Coastal Bluffs (Hart) – A team of investigators representing disciplines including coastal engineering, geology, urban and regional planning, law, policy studies, ecology, landscape architecture and social science led by Sea Grant received a planning grant from the University of Michigan to explore the impact of changing water levels on coastal bluffs in northern Milwaukee County and southern Ozaukee County along Lake Michigan. The team will participate in a full

integrated assessment with the desired outcomes of developing a select set of policy alternatives by local governments and adaptive actions by coastal property owners that lead to a measurable increase in the resilience of bluffs to coastal erosion. Funding Source: Graham Sustainability Institute of the University of Michigan

Ports, Harbors and Marinas Initiative (Clark) – Wisconsin Sea Grant will continue to assist Great Lakes ports, harbors and marina managers and owners with all aspects of port, harbor and marina infrastructure maintenance and repair, facility management, dredging technology and dredged material disposal. A single non-advocacy source for reliable, up-to-date information to help managers and owners is critical to the operation and maintenance of ports, harbors and marinas. New techniques need to be verified and information disseminated to assist managers with project investigation studies and repairs. Sea Grant will partner with Great Lakes port, harbor and marina managers, in addition to other regional and national entities, to establish a direct link between managers experiencing operational problems and valuable resources for technical information and engineering assistance. [A/AS-01](#)

Coastal Processes Manual, Edition #3 (Clark) – The Wisconsin Sea Grant Coastal Processes Manual was first written in 1987 by the coastal engineering specialist and was extremely successful. This manual quickly became an essential resource for Great Lakes coastal engineering information that was easily understandable to property owners, coastal communities, regulators and regional and statewide coastal resource agencies. A second edition followed in 1998. Since that edition was prepared, there have been significant advances in several of the manual's topics and information sources as well as several completely new topics such as new Web-based coastal engineering tools and data sources, Federal Emergency Management Agency flood mapping results, climate change issues, coastal construction set-back guidance, and coastal structure and processes interactions understanding. A third edition would address those topics and will involve the collaboration of governmental and trade industry partners. [A/AS-01](#)

Beneficial Use of Dredged Material Outreach and Project Assistance (Clark) – The maritime industry relies on adequate water depth in harbors and connecting channels for navigation. Maintaining that depth where there is natural accumulation of sediments requires periodic dredging. Slightly more than half of the dredged sediment is typically disposed of in confined disposal facilities (CDF). Sea Grant and its private-sector and governmental partners are working to raise awareness about the value of dredged material as a sustainable resource that can be beneficially used and not deposited in a CDF.

[A/AS-01](#)

Freshwater Harbor Corrosion Study Results Outreach (Clark) – Sea Grant, along with governmental partners and the Wisconsin Commercial Ports Association, is providing education, research and outreach concerning the accelerated freshwater corrosion seen in Lake Superior port, harbor and marina structures. This includes hosting the research and outreach steering committee’s website and production of communications products detailing research and field investigations, along with mitigation strategies. [A/AS-01](#)

Great Lakes Coastal Storms Program (Noordyk/Hart) – The National Oceanic and Atmospheric Administration leads this regional effort in collaboration with the Great Lakes Sea Grant Network to make Great Lakes coastal communities safer and more resilient to storm/weather hazards and climate change. Sea Grant hosts a program outreach coordinator who plays a key role in targeting regional needs. The program currently funds projects focused on dangerous currents and waves, reducing stormwater impacts, shoreline mapping and management, and community resilience. Funding source: NOAA Coastal Storms Program [NA12OAR4170111](#) (years one through three) and [NA14OAR4170092](#) (years four through five)

Advancing Green Infrastructure Through Local Codes and Ordinances in the Great Lakes (Noordyk) – Working with 1000 Friends of Wisconsin, Sea Grant is supporting efforts to reduce the negative impacts of stormwater through the use of green infrastructure in watersheds draining to the Great Lakes. Outcomes include producing an audit tool and workshops targeted at planners, stormwater engineers and zoning administrators. Funding source NOAA Coastal Storms Program [A/AS-69](#)

Environmental Literacy and Workforce Development in the Great Lakes Region

Wisconsin provides a crucible to meet the literacy-building and workforce development demands posed by a state, region and nation transitioning to a new era of sustainability and job creation.

We will build on a renowned K-12 public education system that consistently produces students who, taken together, best the national average ACT composite score, and rank among the top three states in well-performing students. Wisconsin also has a wealth of institutions of higher learning — 33 public and private four-year colleges and 29 two-year colleges. Included in that group is the University of Wisconsin-Madison, one of the top five research schools in the country. The school also holds, as a critical tenet, the Wisconsin Idea. The Wisconsin Idea is a public-service concept that the boundaries of the university extend to the boundaries of the state and beyond. This principle is also the heart of Wisconsin Sea Grant's efforts.

Building a workforce literate in science, technology, engineering and mathematics is crucial to maintaining America's competitiveness in a rapidly changing global economy. These skills are also necessary to advance cutting-edge research and to promote enhanced resource management. In recognition of these needs, the America COMPETES Act 15 mandates that NOAA build on its historic role in stimulating excellence in the advancement of ocean and atmospheric science and engineering disciplines. The Act also mandates that NOAA provide opportunities and incentives for the pursuit of academic studies in science, technology, engineering and mathematics. Workforce needs are reflected in the broader science and technology communities of both the private and public sectors with whom Sea Grant works to fulfill its mission.

An environmentally literate person is someone who has a fundamental understanding of the systems of the natural world, the relationships and interactions between the living and non-living environment, and the ability to understand and utilize scientific evidence

to make informed decisions regarding environmental issues. Once again, Wisconsin is a crucible for these concepts. It is the home state and the epicenter of much of the research, writing and innovation of such environmental giants as John Muir, Aldo Leopold and Sen. Gaylord Nelson, the founder of Earth Day. Wisconsin Sea Grant carries on the traditions of its environmental forebears when providing stakeholders with the decision-making tools to synthesize economic, aesthetic, cultural and ethical values.

National and Wisconsin Sea Grant Goals

- An environmentally literate public supported and informed by a continuum of lifelong formal and informal engagement opportunities.
- A future workforce reflecting the diversity of Sea Grant programs, skilled in science, technology, engineering, mathematics and other disciplines critical to local, regional and national needs.

Wisconsin Sea Grant Strategies

- Work with education partners to develop K-12 curricula that address the Great Lakes Literacy Principles and adhere to science and environmental education standards, approved by the Wisconsin Department of Public Instruction.
- Engage Sea Grant-supported graduate students, scientists and informal educators to help develop educational demonstrations for Great Lakes issues and topics to promote Great Lakes literacy.

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- Establish a Wisconsin Sea Grant graduate student fellows program to help make Sea Grant-supported graduate students aware of the full range of Sea Grant activities and Great Lakes-related employment opportunities.
 - Support research projects that engage and train graduate and undergraduate students about Great Lakes coastal resources.

Projects

Recent Advances in Aquatic Sciences Seminar

Carmen Aguilar, UW-Milwaukee, (414) 382-1755, aguilar@uwm.edu

Russell Cubel, UW-Milwaukee

Graduate students in aquatic sciences must be well diversified in their views of aquatic system processes in order to bring appropriate concepts and methods to bear on today's pressing ecosystem problems. Likewise, practicing scientists pursuing Sea Grant-style research leading to stewardship and policy development need to keep up-to-date with developments in aquatic sciences, both marine and freshwater. In addition, cutting-edge aquatic science research can be an excellent hook to engage undergraduate students in STEM academic learning and workforce development. Finally, a well-presented public-access scientific forum may be attended by local stakeholders, including those working in the fishing and aquaculture industries, water and wastewater treatment, coastal resource management, public health and many other fields. This seminar will provide such opportunities, leading to far greater learning and critical interpretation development, especially for graduate students of aquatic sciences. [E/ELWD-06](#)

New Light Under the Surface: An Underwater Photography Program for At-Risk Youth Exploring Wisconsin's Great Lakes as Therapy, Art and Science

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Toben LaFrancois, Northland College

Aquatic systems are fundamental to human life, culture and our future — yet they remain largely a mystery to most people, which presents a challenge in fostering aquatic stewardship. Underwater photography brings these systems, their beauty and their function to life and fosters a sense of connection and stewardship among all who view the photos. Furthermore, experiences in nature are fundamental to healthy human development. We aim to engage at-risk youth in an innovative curriculum that blends

science, art and healing through underwater photography experiences. This program will foster learning and stewardship not only among participating youth, but also among the thousands who will experience their photos through statewide exhibitions and other high-impact outreach. This project is an expansion of a highly successful underwater photography pilot program executed in 2014 and 2015. [E/ELWD-07](#)

Integrating Climate Change Literacy Into Conservation Education

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An array of information exists related to climate change in the United States, including a variety of predictive models and professional interpretations about how the modeling results relate to natural resources. In turn, public and private agencies are developing tools to help guide adaptive strategies for natural resource management. It is challenging for natural resource managers to sift through all of the information, models and guidance to determine which are most appropriate to answer their questions and most relevant to their area of the country or environmental setting. Using the Lake Superior basin as the setting, we will familiarize natural resource professionals and students with current and predicted conditions and how to integrate this information into place-based natural resource management decision-making. Culturally relevant climate literacy and predictive tools will enable resource managers to take action that will lead to increased resiliency of local communities and natural resource systems. [E/ELWD-08](#)

Education

Grandparents University (Kline/Moser) – This Wisconsin Alumni Association two-day summer program includes coursework in a number of subject areas for children ages 7-14 and their grandparents. Sea Grant and the University of Wisconsin Center for Limnology offer a popular course on the study of lakes that includes water sampling aboard a research vessel, hands-on operation of underwater robotic technology, aquatic invasive species activities and an introduction to the Great Lakes. [A/AS-01](#)

STEM Literacy Kits (Moser/White/Gen) – As an extension of ongoing outreach programming to children ages three through 10, science, technology, engineering and math (STEM) literacy kits are being developed. Each water- and Great Lakes-themed kit contains literature, science and art together and is designed to be used by librarians and teachers to encourage science learning in library, preschool and early-elementary school settings. [A/AS-01](#)

Understanding the Changing Lake Michigan Food Web (Seilheimer) – The Lake Michigan food web is in a constant state of flux due to invasive species, pollution and changing climate. Providing the most current information on the science of Great Lakes food webs and ecosystems is necessary for creating informed policy makers and citizens. This project, in partnership with the Wisconsin Maritime Museum, has developed an outreach and education program aimed at angler and conservation groups and students. It outlines food web ecology, the structure of Lake Michigan's food web and how it has been changed by invasive species. [A/AS-01](#)

Center for Great Lakes Literacy (Kline/Moser) – The Center for Great Lakes Literacy (CGLL) is a collaborative effort led by Sea Grant educators throughout the Great Lakes watershed. The center fosters informed and responsible decisions that advance basin-wide stewardship by providing hands-on experiences, educational resources and networking opportunities that promote Great Lakes literacy among an engaged community of educators, scientists and citizens. Through CGLL, Wisconsin Sea Grant sponsors outreach opportunities for graduate student researchers, educator workshops, stipends for field trips and a Great Lakes-themed educational kit loan program. [A/AS-01](#)

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Sea Grant Fellowships/Scholarships

Dean John A. Knauss Marine Policy Fellowship

seagrant.noaa.gov/knauss

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This competitive program provides an opportunity for one-year expenses-paid internships with a federal legislator or an agency in the Washington, D.C. area. Twenty-two Wisconsin students have been among those selected for Knauss fellowships since 1982.

Sea Grant/NOAA Fisheries Graduate Fellowship

seagrant.noaa.gov/FundingFellowships/NMFSSGFellowship.aspx

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This program in population dynamics and marine resource economics was established by NOAA Sea Grant and NOAA Fisheries for Ph.D. candidates who are interested in either of these two disciplines.

Great Lakes Commission/Sea Grant Fellowship

glc.org/about/scholarships-fellowships

Contact: Terri Liebmman, assistant director for operations, Wisconsin Sea Grant, (608) 263-6747, terri@aquawisc.edu

A successful fellow will work with members of the Great Lakes' science, policy and information/education communities to advance the environmental quality and sustainable development goals of the Great Lakes states.

J. Philip Keillor Wisconsin Coastal Management – Sea Grant Fellowship

Jennifer Hauxwell, assistant director for research and student engagement, Wisconsin Sea Grant, (608) 262-0591, jennifer.hauxwell@aqu.wisc.edu

Named in honor of longtime Wisconsin Sea Grant Coastal Engineer J. Philip Keillor, this one-year opportunity provides on-the-job education and training opportunities in coastal resource management and policy.

Carl J. Weston Memorial Scholarship

Jennifer Hauxwell, assistant director for research and student engagement, Wisconsin Sea Grant (608) 262-0591, jennifer.hauxwell@aqu.wisc.edu

The Carl J. Weston Memorial Scholarship was established in 1995 to aid undergraduate students working on Wisconsin Sea Grant-supported projects. Funding source: Dr. and Mrs. Carl B. Weston

Useful Websites

University of Wisconsin Sea Grant Institute

seagrant.wisc.edu

Funding Opportunities

seagrant.wisc.edu/projects

Current and Past Projects

seagrant.wisc.edu/projects

NOAA National Sea Grant

seagrant.noaa.gov

Special Program Resources

Aquatic Sciences Chronicle

aqua.wisc.edu/chronicle

Published four times a year, this newsletter reports on the activities of Sea Grant and its complementary program, the University of Wisconsin Water Resources Institute. Visit the website to review current and past issues, and sign up for free delivery, either in print or electronically.

Sea Grant Publications

aqua.wisc.edu/publications

This well-stocked virtual publications center offers dozens of items for free download or at a reasonable cost to cover their production and shipping. Find fact sheets, posters, books and maps.

Social Media Channels

seagrant.wisc.edu

Visit the Sea Grant home page and look for the links to many social media channels, including Twitter, Flickr, Facebook, YouTube and the blog Great Lakes Takes. It's a convenient way to connect, get program information or access information in alternate formats like video or audio podcasts.

Wisconsin Water Library

aqua.wisc.edu/waterlibrary

This library contains more than 30,000 volumes of water-related information, with particular emphasis on Wisconsin and Great Lakes issues. Any state resident can access and benefit from the collection.

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SCIENCE FOR THE SUSTAINABLE USE OF WISCONSIN'S GREAT LAKES RESOURCES

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