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10-YEAR NOAA SEA GRANT WATER RESOURCES VISION

August 2018

Columbia River (K. Bareford/Mississippi-Alabama Sea Grant)

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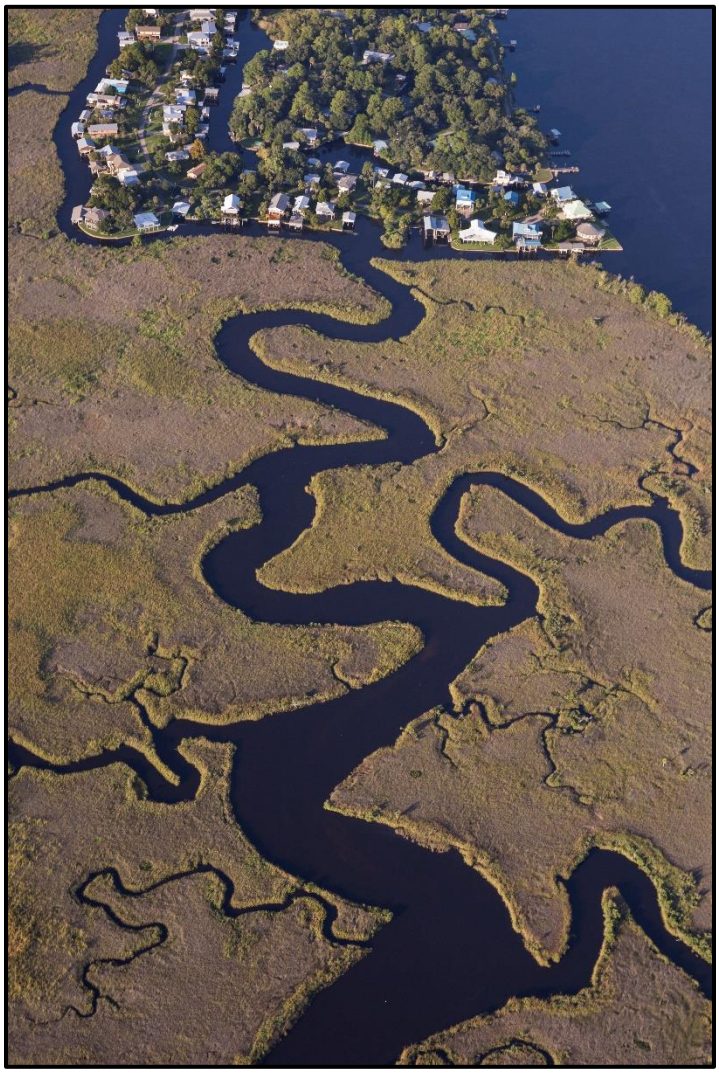


Aerial view of Suwannee, Florida (T. Jones/University of Florida Institute of Food and Agricultural Sciences)

Sea Grant's 10-Year Water Resources Vision:

The National Sea Grant College Program engages with communities on critical water resources challenges and opportunities through research, outreach, and education to facilitate knowledge-based solutions and collaborative decision-making in ocean, coastal, and Great Lakes communities and on behalf of ecosystems and economies.

INTRODUCTION

For 52 years, the National Oceanic and Atmospheric Administration's (NOAA) National Sea Grant College Program (Sea Grant) has invested in research, outreach, and education to understand and manage the nation's coastal and Great Lakes water resources.

Healthy water resources are a vital component of vibrant communities and economies, play a significant role in the sustainability of robust ecosystems and recreational resources, and underpin commerce, manufacturing, and cultural wealth.

Sea Grant, with partners, currently addresses key theme-based initiatives at the national level in the areas of healthy coastal ecosystems, sustainable fisheries and aquaculture, resilient communities and economies, and environmental literacy and workforce development. A water resources focus is a logical, and critically needed, extension of this partnership model through which Sea Grant can apply its research, outreach, and education capacity.

The purpose of the 10-year vision is to guide Sea Grant's strategic investments and decision-making related to water quality and quantity, and to proactively consider challenges and opportunities that may arise, especially those associated with climate change, economics, security, and environmental and social equity. Its purpose is also to ensure that Sea Grant's well-established core strengths – a local focus, a foundation in rigorous science, an emphasis on collaborations, and an unwavering commitment to non-advocacy – will be devoted to these vital tasks.

This plan identifies four themes and six strategic priorities that encompass current and future Sea Grant activities and includes an implementation plan to drive the actions, timelines, and resources needed to ensure success.

Harbor (Hawaii Sea Grant)

BACKGROUND

Healthy waters, watersheds, and coastal resources are vital to the communities and individuals living near them, to those who depend on them for their livelihood, and to every individual—as we all depend upon healthy water.

Students Learn about Water Science (Michigan Sea Grant)

Humans and ecosystems depend on healthy and abundant water resources to function and thrive. As the human population continues to grow, pressures on water supplies increase. In recent years, rising sea levels, aging infrastructure, the ever-evolving presence of legacy and emerging contaminants, and intensifying storm and flooding events in some regions and droughts in others, have shed light on the pressing need for enhanced research, monitoring and evaluation of local and regional water supplies and conditions. The sheer volume, interconnectedness, and cross-jurisdictional nature of these resources present management challenges. Yet, the effort is justifiable. We must continually strive to address the sustainability of our water resources in ways that preserve health and productivity while optimizing benefits for all citizens.

Why Sea Grant

Sea Grant's mission – to enhance the practical use and conservation of coastal, marine, and Great Lakes resources to create a sustainable economy and environment – is at the heart of this water resources vision. As a network, Sea Grant has the resources and expertise to help communities prepare for future water resources challenges.

Sea Grant achieves impacts through:

- Research
- Engagement, outreach, extension
- Education
- Legal and policy programming

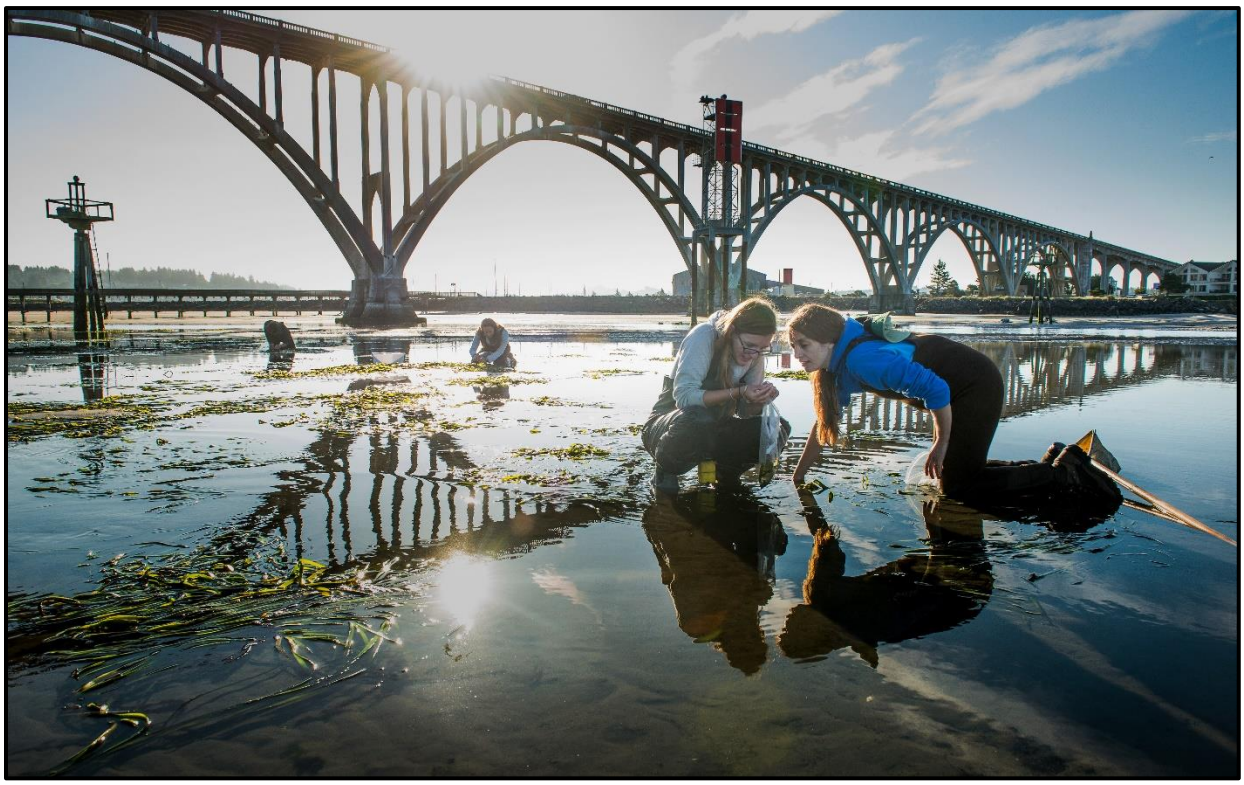
The Sea Grant model is built on establishing effective partnerships at the local, regional, and national levels. A recent compilation by the Sea Grant Association shows that Sea Grant works with over 1,300 industry and private sector, local, state, and regional partners to achieve current programming (see Appendix C for a partial list of key partners and stakeholders for water resources as identified by the Sea Grant programs). Expanding this successful partnership model to address national initiatives is a natural evolution. Further, Sea Grant is embedded in the community, which increases citizen engagement and strengthens community support for effective water planning and conservation.

Research and monitoring are crucial to understanding changing water quality and quantity conditions. To fill that need, Sea Grant provides our partners access to the nation's top research universities to resolve critical issues in water resource management.

Sea Grant also employs professionals with expertise helping communities meet these challenges today and in the future – our professional outreach efforts are firmly rooted in the "honest broker of science information" model that helps stakeholders address current and emerging issues with equitable and evidence-based solutions. Our outreach, education, and communication networks engage with and

deliver timely information to stakeholders through innovative, science-based approaches, tools, and resources to help them prepare to face water resource challenges. In addition, Sea Grant partners within NOAA with the National Weather Service to provide an extension liaison at the National Water Center to best serve community partners and stakeholders with nationally developed water science information and tools.

With an interdisciplinary network of experts, outreach, and education specialists, diverse partner groups, and strong community support, Sea Grant is well equipped to lead the process of ensuring equitable and effective water resource management.



Researchers Collecting Invertebrates at Low Tide (L. Ketchum/Oregon Sea Grant)

Development of the 10-Year Sea Grant Water Resources Vision

This 10-year visioning framework is a living document and collaborative product of the National Sea Grant Office, state Sea Grant programs, and the National Sea Grant Law Center. The plan was developed through the synthesis of information guided by our work with national, regional, and local stakeholders.

The visioning process was initiated in late 2017, with the establishment of a Water Resources Visioning Team through invitations to university-based state Sea Grant programs; 50 individuals from 23 of the 33 Sea Grant programs opted to participate. Through online surveys, programs contributed information on priorities and activities, vision and mission statements, core values, and identification of key actions and desired outcomes (Appendices B and C provide summaries of key aspects of the data collected, a visual representation of how water resources topics are captured within the themes, and key partners and stakeholders).

An additional component that informed the framework was a summary of Sea Grant water-related research activities from 2014 to 2017 from a National Sea Grant database. This summary included national and state program-level funding in water resources by topic, number of projects, and funding allocation. Further informing the framework was ad hoc engagement of water resources stakeholders and constituents within and external to Sea Grant by individual visioning team members.

The Water Resources Visioning Team met in May 2018 at the NOAA National Water Center in Tuscaloosa, Alabama, to develop the vision. In addition, the greater Sea Grant Network informed strategic priorities and actions through an online survey (see Appendix D). To the extent possible, this vision results from the collaborative integration and synthesis of these activities and embodies the dedication, commitment, and passion of Sea Grant professionals in water resources. Other Sea Grant visioning frameworks (e.g., Weather and Climate; Community Response to Flooding; Citizen Science; Diversity, Equity, and Inclusion, etc.) may overlap with the efforts outlined here (see box below for the visions for each of Sea Grants' key topic areas), and it is important to note that no work that Sea Grant conducts, or will conduct in the future, will occur independently – overlap and collaboration with other visioning teams is expected and encouraged.

Sea Grant Vision Statements

Aquaculture: Sea Grant's integration of research, outreach and education will be instrumental in creating and applying aquaculture products, tools and services to foster the expansion of a sustainable U.S. marine and Great Lakes aquaculture industry.

Citizen Science: Sea Grant Citizen Science (CS) is used widely as a place-based research, outreach and education strategy providing inclusive, and equitable opportunities for diverse participants and partners to advance science and inform decision-making. The Sea Grant Network coordinates CS initiatives nation-wide; provides professional development training for CS practitioners; shares best practices for implementing place-based CS efforts; and becomes a vital collaborator and resource in the CS field.

Coastal Tourism: Sea Grant's integration of research, outreach, and education will be instrumental in supporting sustainable coastal tourism in the United States by contributing to the environmental stewardship, long-term economic development, and responsible use of our nation's coastal, ocean, and Great Lakes resources.

Community Response to Flooding: Every community served by a Sea Grant program is making locally relevant, science-based decisions to build resilience to floods, informed by Sea Grant's research, education, extension, and communication efforts.

Diversity and Inclusion: Sea Grant champions diversity, equity, and inclusion (DEI) by proactively recruiting, retaining and preparing a diverse workforce; and engaging and serving communities that are representative of the populations where our programs operate.

Environmental Literacy: Sea Grant's integration of natural and social science research, education, and outreach will foster an environmentally literate citizenry that makes informed decisions regarding ocean, coastal and Great Lakes resilience.

Integrated Seafood: Sea Grant's research, outreach and education will be instrumental in increasing the environmental, economic, and social sustainability of U.S. ocean and Great Lakes communities through increased integration, understanding of, and capacity in recreational and commercial fisheries, aquaculture, and the post-harvest seafood sectors.

Sea Grant Vision Statements (continued)

Traditional and Local Knowledge: Local knowledge is woven throughout the Sea Grant network, guiding and informing research, education, and outreach, and respect for the stewards of local knowledge is upheld at every level.

Water Resources: The National Sea Grant College Program engages with communities on critical water resources challenges and opportunities through research, outreach, and education to facilitate knowledge-based solutions and collaborative decision-making in ocean, coastal, and Great Lakes communities and on behalf of ecosystems and economies.

Weather and Climate: Sea Grant will be a key partner in the broader weather and climate enterprise known for its role in helping coastal communities and residents build their resilience to weather and climate extremes by bridging the broader network of data and service providers with decision-makers. Its expertise in facilitating assessment of decision needs and providing capacity for planning, communications, disaster preparedness activities, disaster response, and resilience project implementation, will be nationally recognized and inform the state of knowledge on best weather and climate resilience practices.

Yaquina Head Lighthouse (P. Kight/Oregon Sea Grant)

THEMES

The first step in charting a water resources vision was to determine where individual Sea Grant programs and professionals were 1) currently dedicating their time and resources and 2) envisioning how their programs would engage in water resources issues in the future (Appendix B). Survey responses were used to categorize Sea Grant's current and potential water resources opportunities into themes. Four key themes emerged to describe current and future activities: Environmental and Human Health, Water Infrastructure, Land Management, Restoration, and Development, and Water Planning and Socioeconomics.

Figure 1. Sea Grant Water Resources Themes. Photos: Oregon coastline; Megler Bridge, Astoria, Oregon; Lake Miccosukee, Florida; Cedar Key, Florida (K. Bareford/Mississippi-Alabama Sea Grant)

Environmental and Human Health

A growing body of research has demonstrated increased detection of contaminants of emerging concern (e.g., marine debris and microplastics, pharmaceuticals) in the aquatic environment and in fish and shellfish. While the impacts of legacy contaminants like PCBs and mercury are well-documented, the ecosystem and human health effects of most of these emerging chemicals and materials are not fully known. Industry, agriculture, and development can put further stress on both water quality and availability. More traditional concerns, often the result of industrial, agricultural, and development activities, include excess nutrient loading, sedimentation, thermal stress, harmful algal blooms, hypoxia, bacteria and viruses associated with human sewage, and saltwater intrusion. These anthropogenic inputs can pollute streams, rivers, lakes, and the ocean, overload water treatment systems, and lead to impaired water quality. Secondary impacts may also arise from sea level rise (e.g., failing infrastructure, flooding).

Oysters from Aquaculture (V. Lewis/North Carolina Sea Grant)

These inputs and interactions are complex and can affect humans and the environment in a variety of ways. Therefore, community and regional water planning efforts must address both emerging and traditional water resources stressors in order to protect environmental and human health. Sea Grant is committed to helping communities deal with these challenges and identify new, integrated strategies that would augment national efforts to protect and sustain water resources for generations to come.

Water Infrastructure

The United States faces significant challenges as its water infrastructure ages and all levels of government wrestle with how to address related challenges using limited resources. In its *2018 State of the Water Industry Report*, the American Water Works Association reported that respondents ranked the "renewal and replacement of aging water and wastewater infrastructure" and "financing for capital improvements" as the top two issues facing the water industry. Similarly, in its *2017 Infrastructure Report Card*, the American Society of Civil Engineers gave the following grades to water-related infrastructure: Dams - D, Drinking Water - D, Levees - D, and Wastewater - D+. The American Society of Civil Engineers also reports that the nation is facing a $2.0 trillion, 10-year investment gap in addressing the nation's infrastructure issues.

Madison Water Utility (D. Nevala/Wisconsin Sea Grant)

An opportunity for water resources protection lies in the development of green infrastructure methods to improve water quality and reduce impacts from flooding. Municipalities, with the assistance of Sea Grant experts, are developing stormwater and flooding ordinances that incorporate green practices to enhance water resources. Such practices include installing green roofs, rain gardens, pervious-surfaced parking lots, and more native landscaping to control and improve water.

Land Management, Restoration, and Development

The linkages between land, freshwater resources, and the coastal environment are intimate, interdependent, and complex. Rainfall interacts with land, percolates into soil or becomes runoff, feeds rivers and streams, passes through lakes, and enters the coastal environment, Great Lakes, and oceans via all of these pathways to initiate the cycle again. Along this path there are many ways in which we alter the quantity and quality of the water. These alterations often impair the healthy functions of freshwater and marine coastal ecosystems, as observed in some recent U.S. Environmental Protection Agency assessments.

- Over 35 percent of lakes in the U.S. have excessive levels of some combination of nitrogen and phosphorus, which can lead to a proliferation of toxic cyanobacteria (blue green algae) and cause hazardous algal blooms (HABs) (U.S. Environmental Protection Agency (USEPA) 2016a).
- Nearly half (46%) of the nation's rivers are deemed to be in "poor" biological condition, mostly due to excessive nutrient enrichment and sediment loading from land-based activities (USEPA 2016b).
- Nearly half of the riparian or shoreline margins of the nation's rivers are unhealthy or disturbed, which further reduces the ability to control nutrient and sediment loading and increases the risk of flooding (USEPA 2015).
- Assessments of marine and Great Lakes coastlines indicated that a slim majority (~55%) were rated as having "good" biological and sediment characteristics, but only 36 percent had good water quality (USEPA 2015).

Hurricane Sandy Damage in Seaside, New Jersey, October 30, 2012
(T. Larsen/N.J. Governor's Office)

To improve and protect our water resources and ensure robust and resilient communities and economies, it is essential that we improve our understanding and implementation of the principles that govern the complex interactions between land, freshwater, and marine systems and the people and communities who use, depend on, and ultimately impact our vital water resources.

Water Planning and Socioeconomics

The true value of clean water is difficult to estimate and categorize. We all need clean water to live, but there are also economic, cultural, and recreational reasons to value clean water.

Watershed Game (C. Benson/Minnesota Sea Grant)

Effective planning for clean water, healthy waterways, and sustainable coastal ecosystems incorporates aspects of geology, hydrology, climatology, ecology. It is imperative that water planners develop systems and programs that foster wise use, provide clean water for all users, create a culture of clean water conservation, and incorporate opportunities for improvements, upgrades, and evolve with community needs as they change over time. Those engaged in water planning and policy should seek answers to a variety of

questions that foster the wise use and conservation of water resources, such as:

- What is the value of a healthy aquatic or coastal ecosystem, and do decision makers recognize and value the health of these ecosystems?
- Do communities understand the full range of ecosystem services provided by a healthy aquatic system?
- What are the socioeconomic and political barriers to better water management, and is water allocated in an equitable and socially just way?
- Are there new or better efficiencies that can be adapted in water management, particularly where they can address direct human needs and environmental health?

Implementing purposeful and effective water planning strategies and techniques, while also supporting an increased understanding of water resources, can bridge existing and potential gaps between what is environmentally and economically beneficial.

Shop at the Docks (H. O'Leary/Oregon Sea Grant)

STRATEGIC PRIORITIES

Sea Grant is actively engaged in addressing water resources issues in many communities. To expand upon these efforts and prepare for future needs, Sea Grant's Water Resources Visioning Team developed a set of six strategic priorities, with associated action items, and initial implementation step(s) where applicable based off of the key themes (see Appendix A, the Implementation Plan, for a complete listing of the actions and initial implementation steps). The strategic priorities address the current and future water resources challenges and opportunities highlighted by Sea Grant programs and professionals across the nation.

Figure 2: Sea Grant Water Resources Strategic Priorities.

Strategic Priority 1. Maintain and enhance water quality and public access to support healthy coastal ecosystems and human uses.

Description

An adequate and clean water supply is vital for organisms, ecosystems, and economies to flourish. In order to maintain healthy water resources and ensure equitable and long-term access to safe drinking water, community leaders need actionable information in an accessible format to inform integrated and successful water management and planning. It is also important for communities and individuals to understand their roles and the value of protecting water resources.

Action Items and Implementation Steps

1. Sea Grant will invest in transdisciplinary research, outreach and education to improve understanding and protection of healthy water quality. This involves:
    a. investing in social science research and needs assessments to better understand public perceptions, values and needs related to water quality, and improve messaging and communication related to water resource management;
    b. supporting efforts to identify vulnerabilities to community water resources and working in collaboration with diverse stakeholders toward building water quality resiliency; and
    c. developing applications and teams to quickly respond to water pollution events and maintaining designated funds to implement monitoring after storm, contamination, or flooding events to protect human health.

2. Sea Grant will facilitate a collaborative and regional watershed approach to address water quality needs and challenges by:
    a. utilizing and further developing Sea Grant Regional Networks, and developing and strengthening partnerships with water/natural resource agencies (e.g., USGS, USEPA, USDA, National Estuarine Research Reserves, state agencies) to respond to, inform, and mitigate water quality-related impacts and threats; and
    b. identifying upstream sources contributing to hypoxia (e.g., Gulf of Mexico hypoxia) or harmful algal blooms (HABs) in the Great Lakes and other aquatic systems, and working regionally to implement nutrient and runoff reduction strategies and increase impact in research (mechanisms, prediction, and monitoring) and extension efforts.

Case Study

Over 200,000 lbs. of Medicine Disposed through Great Lakes Community Collection Programs

Relevance: How we choose to use and dispose of pharmaceuticals and personal care products impacts water quality—the water that we drink, bathe in, and use for recreation. Most of us do not use all of the medication that we buy. Nevertheless, using the toilet or trash to dispose of medicine can put people, animals, and the environment at risk.

Response: Since 2008, Illinois-Indiana Sea Grant has helped communities establish medicine collection programs. IISG provides financial and technical support, including a comprehensive website and toolkit of information, ideas, and resources to a network of new and ongoing community single-day and permanent collection programs.

Results: Altogether, Illinois-Indiana Sea Grant has helped establish 52 permanent medicine collection programs and continues to start new programs every year. The 22,370 pounds of unwanted medicine collected in 2017 brings the total amount to a whopping 203,923 pounds, which equates to over 100 tons of properly disposed of medicines.

Recap: Since 2008, Illinois-Indiana Sea Grant's outreach and support to communities as they establish and maintain medicine collection programs has led to over 200,000 pounds of medicine collected and properly disposed.

3. Sea Grant will identify emerging contaminants, develop tools to predict their fate and transport, and raise awareness about reducing their incidence and impact by:
    a. funding or conducting research to assess and/or monitor emerging contaminants and potential impacts, and sharing information about effects of contaminants on organisms and environments with stakeholders and public health officials;
    b. developing partnerships to help communities understand, eliminate, reduce, or remove both emerging and legacy contaminants, including planning and facilitating citizen science opportunities, community cleanups, peer-to-peer outreach/training, etc.;
    c. supporting research and collaboration that helps to standardize national/multi-national microplastics and/or marine debris sampling protocols to allow for comparisons temporally and spatially; and
    d. establishing Sea Grant's commitment to reducing plastic pollution by limiting single-use plastics at Sea Grant-sponsored events.

What Does Success Look Like?

- Coastal and Great Lakes habitats, including watersheds, estuaries, and shorelines, are understood, protected, and restored.
- Communities are informed and engaged in water resources protection and planning.
- Sea Grant is engaged in communities and viewed by the public as a resource for connecting people and solving problems related to the environment and human health.

Case Study

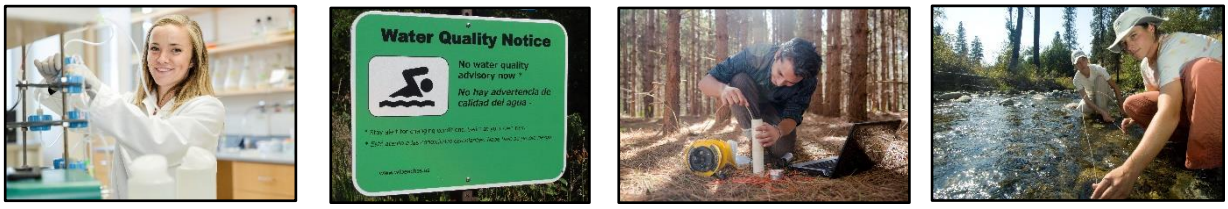
New York Sea Grant Helps Suffolk County Residents Take Action Against Harmful Algal Blooms

Relevance: The severity and incidences of harmful algal bloom outbreaks have continued to increase during the past decade, especially in Suffolk County, New York, which experiences substantial economic loss to the shellfishing industry and outdoor recreation sectors.

Response: New York Sea Grant facilitated a public symposium in 2016 followed by a year-long series of discussions with harmful algal bloom experts and an agency advisory group to establish the scientific basis for management.

Results: Information gathered through this consultative and consensus-building process was used to identify the leading contributing causes of harmful algal blooms and recommend appropriate mitigation strategies. This information was published in the Suffolk County Harmful Algal Bloom Action Plan, which was presented at a public symposium hosted by New York Sea Grant in 2018.

Recap: Increased severity and incidences of harmful algal blooms responsible for shellfish harvesting and beach closures require a systematic and coordinated approach to management.



Sea Grant Researchers Addressing Water Quality Issues, and Associated Signage (Wisconsin and Oregon Sea Grant)

Case Study

Emergency Responders use Information Synthesized by Sea Grant Oil Spill Science Outreach Team to Protect Society and Environment in Response to Oil Spills

Relevance: Emergency responders are required to complete training courses throughout their careers and regularly attend Regional Response Team and Area Committee meetings to stay informed about local, regional, and national spill response issues and best practices. Post-Deepwater Horizon oil spill, the emergency response community needed to incorporate current, relevant, and synthesized science information into response education, training, and planning activities. The NOAA Office of Response and Restoration, the U.S. Coast Guard, and the National Spill Control School invited the Sea Grant oil spill science outreach program to address this need.

Response: The Sea Grant-led program synthesized science to develop oil spill science publications, seminars, and trainings specifically for emergency responders. The National Spill Control School at Texas A & M University trains approximately 400 students annually, including courses for academic credit and individuals from industries and government agencies. The school adopted the Sea Grant oil spill science program's publications as a training tool. NOAA's Science of Spills courses help emergency responders increase their understanding of spill science when analyzing spills and making risk-based decisions. The Sea Grant program presented new science to Science of Spills' trainees. Sea Grant specialists participated in Regional Response Team and Area Committee meetings to update Area Contingency Plans and present new science.

Results: Nationally, regionally, and locally, the emergency response community is incorporating the Sea Grant program's synthesized information into their activities and trainings.

Recap: The emergency response personnel from multiple agencies and industries have invited oil spill science outreach team members to share synthesized, updated science so that responders can make informed decisions while protecting people and the environment.

Strategic Priority 2. Empower communities to make informed decisions about current and future water quality and quantity challenges.

Description

Increasingly, communities are facing water quality and water quantity challenges. As infrastructure ages and climate changes, these challenges are expected to increase in both intensity and frequency. Challenges that communities may face can include: limited or polluted drinking water supplies; stressed aquifers causing subsidence, saltwater intrusion, or other related issues; stormwater flooding that can inundate infrastructure and/or compromise drinking water supplies; and wastewater failures that allow untreated sewage to enter waterways. Each of these challenges threatens human and/or ecosystem health and can have huge impacts on communities. Further, communities often must address these challenges with limited resources, highlighting the importance of making decisions based on sound science and water policy.

Action Items and Implementation Steps

1. Sea Grant will partner with federal (USGS), state (Water Surveys, universities), and local (regional planning, economic development) agencies to improve understanding of water demand and available water supply, providing the data and leveraging expertise for water demand/supply planning.

2. Sea Grant will develop community and/or regional plans for responding to potential water issues, such as water shortages or impairments from failing infrastructure (septic, wastewater, stormwater, etc.), that could negatively impact human health by working with communities to identify vulnerabilities and work toward solutions with multiple stakeholders.

3. Sea Grant will support and conduct legal, policy, and social science research to understand what people know about their needs and connections to water resources, what values they place on various aspects of water resources, as well as what types of messaging are most effective when it comes to managing water resources and informing behavior.

4. Sea Grant will develop educational materials on current water quality and quantity issues for a variety of audiences, such as:
    a. educating residents about current state programs to monitor water quality and how water quality can affect human health;
    b. producing outreach material on current surface water and groundwater issues;
    c. providing media with information on current water quality and quantity data and issues;
    d. developing organized marketing and educational campaigns, utilizing a variety of communications tools (e.g., social media) to provide scientifically based information about the importance of understanding and acting on challenges; and
    e. developing case studies on green infrastructure projects on a regional basis, including the time they were implemented and how they are maintained, to convey to community leaders the benefits of green infrastructure to help manage stormwater.

Case Study

Oregon Sea Grant Videos Feature Case Studies on Mitigating Drought in Oregon

Relevance: The winter of 2013 in Oregon was marked by little snowpack; summer 2014 was extremely hot; and winter 2014 also had little snowpack because of warm temperatures. In 2015, Oregon experienced its warmest year on record, and the warm, dry conditions resulted in a severe drought. This drought impacted many communities and businesses and is notable because these conditions are similar to those predicted to be common in Oregon within 50 years.

Response: Oregon Sea Grant climate and communications specialists interviewed individuals and documented their answers in a series of four videos called Documenting the Drought: Mitigating the Effects in Oregon, highlighting drought mitigation activities in Treasure Valley, Mt. Ashland, and southwestern Oregon. Oregon Sea Grant posted the videos on its YouTube channel at youtube.com/user/OregonSeaGrant.

Central Oregon Vegetable Irrigation (S. Ward/Oregon Sea Grant)

Results: Oregon Sea Grant identified a variety of water conservation and restoration strategies being used that can mitigate the effects of drought, including restoring riparian areas, planting faster maturing crops, automating irrigation, and modifying business practices. Oregon Sea Grant found that the people and places that did better during the drought were the ones where investments had been made in water conservation and restoration efforts over the past decade.

Recap: Four videos produced by Oregon Sea Grant show how managers are responding to drought induced by a changing climate in Oregon.

5. Sea Grant will work to improve understanding of changes in climate impacts on water resources and help communities prepare for the future by:
    a. conducting workshops, charrettes, and other public events to educate and prepare communities to face climate-related water quality and access challenges; and
    b. evaluating water resource impacts (environmental and societal) related to sea-level rise (i.e., saltwater intrusion in ground water, surface water, wastewater infrastructure, etc.) and ocean acidification.

What Does Success Look Like?

- Sea Grant empowers all interested parties to work together efficiently and effectively to best manage water challenges.
- Communities make well-informed decisions based on sound water science and policy.
- Communities are aware of the legal structure governing the management of water resources.

Case Study

Great Lakes Sea Grant Programs Help Communities Improve Stormwater Management through Green Infrastructure

Relevance: In 2014, Wisconsin Sea Grant conducted a needs assessment of Great Lakes community planners and resource managers. They identified "stormwater runoff" as contributing to four of the top five coastal storm hazards that affect their coastal communities. In addition, 79 percent of survey respondents rated "local ordinance, zoning and building code assessment" as a top need to address coastal storm hazards.

Response: Wisconsin Sea Grant developed a green infrastructure code audit workbook (http://seagrant.wisc.edu/greeninfrastructure) to protect surface and groundwater from stormwater, in the form of rainwater or snowmelt that flows over developed areas such as streets, sidewalks, roofs or parking lots picking up concentrating pollutants that end up in waterways. The program also actively worked with municipalities to engage in code audits.

Results: Duluth, Minn., and Southfield, Clinton and Canton townships in Michigan adjusted their codes and implemented policy changes to reduce impervious surfaces and lowered other barriers to green infrastructure. Sea Grant helped attract more than $26,000 to two Wisconsin cities to complete a code audit and affect green infrastructure changes. Finally, the program has drawn in work with new partners.

Council Springs, Madison, Wisconsin
(D. Nevala, Wisconsin Sea Grant)

Recap: Great Lakes Sea Grant programs, led by Wisconsin Sea Grant, created a new code audit workbook to foster implementation of green infrastructure. It helped affect policy changes in four Great Lakes communities and helped another two communities secure external funding to conduct code audits and make changes to protect surface and groundwater from contaminants.

North Carolina Sea Grant Research Generates Guidance Products to Expand Hurricane/Wave Flooding Forecasts

Relevance: The accurate prediction of coastal flooding is essential for the safety of people and property. In North Carolina, high-resolution model forecasts for hurricane waves and flooding are provided in real-time during storm events. These forecasts are shared through a web service, but they are underutilized because they cannot be combined with other geospatial software used for decision support by emergency managers.

Response: In a project supported by North Carolina Sea Grant, researchers developed a new visualization tool to convert model results into formats compatible with GIS and Google Earth software. During the 2017 hurricane season, forecast products were shared with emergency managers at county-, state-, and region-levels within the state.

Results: The new visualization tool was incorporated into the automated modeling system, so that the new guidance products are available for every forecast. The expanded guidance is more powerful because it is placed directly into the hands of stakeholders who have participated in its development, and who will be trained in how to use it.

Recap: Using a high-resolution modeling system, researchers supported by North Carolina Sea Grant expanded the utility and accuracy of standard wave and stormsurge forecasts. New guidance products shared with and used by emergency managers in 2017 now combine flooding predictions with other geospatial data. The rapid updates and detailed visualizations will lead to better-informed decisions about evacuation and resource deployment during storm events.

Case Study

Strategic Priority 3. Use a systems approach to convey links between watersheds and coastal water resources to inform management and development decisions.

Description

Responses of coastal marine and freshwater ecosystems to the way land is used are complex and interdependent. Some systems (e.g., a car) are complicated, but behave in predictable ways that can usually be diagnosed and repaired, often rapidly. Complex systems are different, having some behaviors that are expected, and others that are not. Due to the interdependency of many, if not all, of the components that comprise environmental systems, these complexities manifest over time as the system is stressed, and different complexities may manifest as the system recovers from stress, often slowly. The working landscape is one of the most complex systems on earth, comprised not only of complex interdependent, environmental systems, but also complex socioeconomic systems. For these reasons, it is essential to take a systems approach and not just a component approach to understanding how to manage linked watershed and coastal systems.

Action Items and Implementation Steps

1. Sea Grant will work to improve understanding about the benefits of whole-watershed, integrated management of land use and land cover to protect and improve water quality by:
    a. conducting research and developing messaging and outreach about interconnections among water-related ecosystem services that are water-dependent (e.g., drinking water, food, recreation, water purification, flood management, etc.);
    b. developing regional plans to respond to potential water resource emergencies, including drought, flooding, and infrastructure failure; and

c. providing professional training for consultants, engineers, and town officials on approaches to enhance and develop natural (green, living) assets in coastal areas and tributaries.

2. Sea Grant will work to improve understanding of watershed dynamics and the connections to coastal resources by:
   a. conducting research that focuses on approaches to reduce nutrient loading from watersheds, to combat development of HABs and nearshore hypoxia;
   b. mapping and analyzing key watersheds throughout the Sea Grant Network to increase regional understanding of water resource connectivity and facilitate partnerships to restore water quality and promote wise use and resilience;
   c. funding watershed agents in these watersheds to facilitate the development of partnerships to restore water quality and promote conservation and resilience; and
   d. forming regional teams of watershed agents that will work with the legal, policy, and, social science teams in the region to coordinate efforts and help inform outreach materials.

Case Study

Application of the Soil and Water Assessment Tool (SWAT) to Estimate Discharge and Sediment Yields from the Río Grande de Añasco Watershed, Puerto Rico

Relevance: Localized increases in anthropogenic stresses are considered an important cause of the decline in living coral cover observed throughout the Caribbean. Coral reefs in the Commonwealth of Puerto Rico are among the most highly threatened of the entire Caribbean region, and pollution from land sources of contamination ranks high as a priority threat. In addition, high sediment concentration reduces the amount of light available for photosynthesis by symbiotic algae, and settling can smother existing coral or reduce the surface area suitable for new growth.

Response: Puerto Rico Sea Grant researchers applied the Soil and Water Assessment Tool (SWAT) model to estimate runoff and sediment yields in the watershed between 1998 and 2012. A high-resolution land cover map was completed and a database was developed and applied to the watershed. Erosion hotspots and land cover types contributing large quantities of sediment were identified.

Results: A northwest trend of the sediment plume originating from the Río Grande de Añasco watershed was identified. This highlights the connectivity among coffee farms, other agricultural practices, and urbanization with all marine resources located along the coast from Añasco through the municipality of Rincón. This has resulted in meetings with partners to promote efforts to control sediments, as well as to fulfill the National Water Quality Initiative of the NRCS for the RGA watershed.

Recap: To protect threatened coral reefs, Puerto Rico Sea Grant researchers identified sediment inputs from the Río Grande de Añasco watershed, connected partners to reduce inputs, and informed local and federal policy related to water resources goals for Puerto Rico.

(Puerto Rico Sea Grant)

What Does Success Look Like?

- Communities use a systems approach to coastal management that recognizes watersheds as the fundamental geographic unit, ecosystems as the fundamental environmental framework, people as the primary socioeconomic agents of change, and the interdependency of these system components.
- Sea Grant is recognized as a trusted resource for knowledge, data, and tools to manage the complex natural and human dependencies between land and coastal systems.
- There is a workforce trained to assist communities to achieve effective management of the complex natural and human dependencies between land and coastal systems.

North Carolina Sea Grant Determines Restored Marsh Habitats Measure Up to Natural Marshes at Removing Nitrogen

Relevance: Much effort and money has been invested to restore North Carolina marshes, which are critically important habitats that protect coastal waters from nutrient and sediment inputs. However, the ability of restored marshes to serve as nutrient and sediment filters takes time to develop. Studies are needed to validate this process.

Response: A collaborative team that includes researchers at the University of North Carolina at Chapel Hill's Institute of Marine Sciences and the City of Jacksonville received a Community Collaborative Research Grant, funded by North Carolina Sea Grant in partnership with NC State's William R. Kenan Jr. Institute for Engineering, Technology and Science. The team studied several restored marshes in the Wilson Bay area of the New River. The team examined marshes' ability to remove nitrogen compared to that of nearby natural marshes.

Results: The studies showed that natural and restored marshes along Wilson Bay are effective at removing nitrogen pulses delivered by the New River. This finding provides managers with confidence to continue with their strategy of using restored marshes as a tool to help alleviate the excess nitrogen within the New River system.

Recap: Marshes are critical habitats that protect coastal waters. Studies are needed to validate restored marshes' abilities to filter nutrients and sediment. A collaborative team compared several restored marshes in the Wilson Bay area of the New River to nearby natural marshes. Results show that natural and restored marshes are both effective at removing nitrogen pulses from river system. City officials are using the results to continue their successful restoration program.

Case Study

Strategic Priority 4. Establish new tools, technologies, and approaches to address water resource challenges.

Description

New tools, technologies, and approaches to address interdisciplinary water resource challenges can aid stakeholders in understanding water resource systems and developing equitable solutions. These tools can range from water resources models to assess, analyze, and visualize solutions to collaboration tools to synthesize and understand complementary and competing interests. They can include structural and policy-oriented best-management practices as well as policy and regulatory analytical approaches that aid communities or individual stakeholders in making decisions. Regardless of the type of tool, technology, or practice, it is critical that it be developed and tested in real-world conditions, and that end-users have input in the design and application of the product to ensure it has useful applications.

Action Items and Implementation Steps

1. Sea Grant will fund research projects to develop new tools, technologies, and approaches to solve water resource challenges, conduct outreach, and work with stakeholders to implement these new technologies and policies.

2. Sea Grant will work with water resource decision-support tool developers and end-users to assess, pilot test, and improve the usefulness of decision-support tools for water resource management decisions and conduct outreach to encourage greater use of tools by decision-makers.

3. Sea Grant will support the development of small-scale water quality models to assist with local and community-level decision-making.

4. Sea Grant will conduct law and policy research, integrating its legal capacity with state Sea Grant programs where possible, to identify model policies that support local government efforts to respond to water resource challenges and support decision-makers, water resource managers, and users on water policy and planning.

5. Sea Grant will develop collaborative tools (e.g., maps, websites, resources, etc.) with Sea Grant extension professionals and community partners to empower decision makers in gathering information regarding the quality of their drinking and recreational waters.

Case Study

Low-Impact Development (LID) Database Helps Communities Better Understand and Adopt Low Impact Development Practices

Relevance: The National Nonpoint Education for Municipal Officials (NEMO) Network is a collection of outreach education programs across the U.S. that educate local land use decision makers about protecting water quality as communities grow. The NEMO network provides tools and resources (http://nemonet.uconn.edu/) for working with local governments. One tool is the National Low Impact Development Atlas, an online resource of georeferenced examples of green infrastructure and low impact development for stormwater management. The purpose is to serve as a portal for planners, policy makers and interested community members to learn about alternative practices for stormwater management (e.g., green infrastructure and low impact development) with links to additional resources.

Response: Numerous Sea Grant programs have submitted practices to this atlas (more than 1,423 practices are currently in the database). The database has been highlighted at local, state, regional, and national meetings and new practices continue to be entered into the database.

Results: The database is used in numerous applications to educate and inform communities about low-impact development practices and to provide the opportunity to visit a practice. Allowing a stakeholder to locate and visit low-impact development practices leads to a greater likelihood of adoption and installation. Researchers and managers are beginning to analyze best-management practices in the database to determine long-term maintenance and operational requirements.

Recap: The LID database, frequently used and supported by Sea Grant programs, includes georeferenced data on more than 1,400 practices around the nation allowing communities and stakeholders to learn more about innovative stormwater management practices.

What Does Success Look Like?

- Stakeholders, including natural resource managers, land owners, government officials, and others, have the tools, technologies, and resources needed to address water resource challenges and develop sustainable solutions.
- Researchers and those developing tools, technologies, and resources seek opportunities to engage communities and end-users in the development and pilot testing of these new products through the Sea Grant network.
- Sea Grant Legal Extension capacity is routinely used by partners and stakeholders to effectively understand, address, and resolve water resources issues.
- Federal and state agencies involved in water resource management engage Sea Grant in seeking solutions to water resource challenges.

Case Study

Wisconsin Sea Grant Helping Farmers Protect Water from Runoff with Decision-Support Tool

Relevance: Wisconsin is second in the nation in milk production and first in cheese making, which means a great number of cows producing a lot of manure. When that manure is applied to fields too soon before a large rainfall or snowmelt event, the risk of runoff into nearby streams, rivers and lakes is amplified. Agricultural runoff is a substantial problem in Wisconsin, and across the Midwest, leading to impacts such as harmful algal blooms, fish kills, and drinking-water contamination.

Wisconsin, America's Dairyland
(B. Richter/Univ. of Wisconsin-Madison)

Response: After a series of runoff events and fish kills in the late 2000s, the Wisconsin legislature set aside funding and directed the Wisconsin Department of Agriculture Trade and Consumer Protection to develop a decision-support tool for manure application. A team of scientists and practitioners from Wisconsin and Minnesota developed the Runoff Risk Advisory Forecast (RRAF) for Wisconsin farmers and manure applicators to help them make more-informed decisions about when and where to apply manure on the land. Wisconsin Sea Grant has supported the evaluation of the tool, in the form of surveys and a focus group. The work has helped the team to understand the constraints farmers are under, if and how they have used the tool to inform their manure application decisions, and gathered valuable feedback to provide a now-updated finer-scale version of the tool.

Results: The RRAF evaluation has provided the tool developers with feedback on how to make it more user-friendly, and which data to display in the updated version of the tool, launched spring 2018. Through evaluation, the team learned that 59 percent of attendees of professional manure hauler training in January 2017 had heard of the RRAF, 32 percent had already used it and 65 percent were likely or very likely to use the RRAF in their work over the next year. In addition, the 2018 follow-up survey of North American Manure Expo attendees from Wisconsin showed that 68 percent had heard of the tool, 53 percent had visited the website and 31 percent had used the tool to help make manure-spreading decisions. As the team works to get more manure applicators to use the RRAF to make informed decisions, it means lowering the frequency and severity of manure runoff events across Wisconsin, ultimately leading to improved water quality.

Recap: Wisconsin Sea Grant provided funding support for evaluation of a decision-support tool on optimal conditions to spread manure and prevent groundwater infiltration and/or surface water contamination. The evaluation also informed an updated finer-scale version of the tool.

Strategic Priority 5. Ensure equitable and effective management of water resources by integrating social, economic, legal, and ecological factors into policy and planning.

Description

When water resources management and policy decisions are made on the basis of a single discipline, they may result in inequitable and inefficient outcomes, ranging from unsafe drinking water to investment decisions that cripple municipal budgets. These outcomes often fall on socioeconomically vulnerable communities, such as underserved and rural and urban areas, communities of color, and low- or fixed-income communities. By incorporating social, economic, legal, and ecological considerations into policy and planning, water resource managers can make informed decisions and avoid adverse impacts to the public.

Action Items and Implementation Steps

1. Sea Grant will engage communities to provide research, education, and extension support to vulnerable communities to enable informed decision-making about current and future water quality and quantity challenges and ensure safe and sustainable water resources for all.

2. Sea Grant will conduct research, create knowledge resources, develop case studies, and provide training templates that incorporate regulatory (i.e., law and policy), economic, and behavioral science into water resource management decision-making in coastal communities.

3. Sea Grant will provide scientific, socioeconomic, and legal assistance to communities to develop water balances that will help them equitably manage water resources for coastal communities.

Case Study

The Friends of Lincoln Park Gives Voice to Milwaukee Residents

Relevance: Through the Great Lakes Legacy Act, historically polluted waterways are being cleaned up and revitalized. This process provides a golden opportunity for a diversity of local residents to become involved in their own communities—fostering more community stewardship and leading to a better informed public.

Response: While engaging Milwaukee residents in focus group research, Illinois-Indiana Sea Grant's social scientist gauged interest in forming a community organization to play a role in the long-term stewardship of Lincoln Park, building on the momentum of the Great Lakes Legacy Act cleanup, and partnered with Wisconsin Sea Grant and University of Wisconsin-Extension to take action.

Results: Illinois-Indiana Sea Grant, Wisconsin Sea Grant, University of Wisconsin-Extension, Milwaukee County Parks, and the Park People helped organize the Friends of Lincoln Park, which brought together 25 diverse residents at the first two meetings. At the initial meetings, participants discussed ideas for goals and activities. The group continues to meet monthly—they have established a diverse steering committee, are meeting with park personnel, and are planning events such as a river cleanup day, an invasive plant pull day, and a fishing clinic.

Recap: Illinois-Indiana Sea Grant, Wisconsin Sea Grant, University of Wisconsin Extension, Milwaukee County Parks, and the Park People, helped facilitate the development of the Friends of Lincoln Park, an inclusive group that empowers neighborhood residents to play a role in the restoration of this popular Milwaukee park.

What Does Success Look Like?

- Sea Grant constituents receive, or have access to, the best scientific and socioeconomic research data and information on natural and human-affected water cycles and their impacts on all natural systems.
- Sea Grant constituents receive, or have access to, the best information on the wider human ecosystem that describes crucial links to natural systems.
- Sea Grant constituents receive, or have access to, information on socioeconomic drivers of water use, including fair and equitable allocation of water resources.
- Water management regimes encompass the whole range of uses and benefits provided by water resources.

Strategic Priority 6. Expand, maintain, and strengthen partnerships to engage communities in the use of integrated water information.

Description

Understanding the complex nature of water resources and all the entities dependent on them is inherently transdisciplinary. Numerous agencies, utilities, non-governmental organizations, and academic institutions each have specific portfolios of water-related programming expertise. Partnering both within NOAA and with external agencies and organizations will enable collaborative and transdisciplinary programming to better anticipate and solve complex water resources issues. Water resources partnerships are facilitated at the local, state, and regional level through implementation of each Sea Grant program's strategic plan. Bringing the breadth and depth of Sea Grant expertise to support larger, national initiatives typically beyond the scope of the National Sea Grant College Program is key to achieving this vision.

Action Items and Implementation Steps

1. Sea Grant will be an essential research, extension, education, and communication partner in the NOAA Water Initiative. This includes:
    a. empowering communities towards water resilience by using integrated water information to understand what, where, and when human activities and changing climates will impact future water quantity and quality;
    b. tapping the transdisciplinary modeling, observation, extension, education, and communications expertise from a national network of 33 Sea Grant programs and its university partners;
    c. identifying opportunities where Sea Grant's established, trusted "honest broker" professional extension capacity can be applied;
    d. leveraging capacities for integrated problem solving through Land Grant and Sea Grant collaboration, as well as the greater university enterprise to enhance service delivery to NOAA customers; and
    e. investing in personnel to create a social science team based out of the National Water Center.

2. Sea Grant will be a catalyst for facilitating functional working relationships between state Sea Grant programs, federal, state, local, NGO and corporate partners to address relevant water resources resilience issues by:
    a. building and engaging communities of practice;

b. engaging stakeholders on geographically and socially identified concerns;
c. partnering with and funding research and extension projects with USDA Cooperative Extension and with USEPA to facilitate delivery of water resource research, policy and tools to local governments and communities in ocean, coastal, and Great Lakes states; and
d. organizing knowledge as well as gaps in knowledge on topically and geographically dispersed water resources resilience issues in a context that is meaningful to stakeholders (i.e., microplastics, nutrients, flooding, integrated watershed management, water resources planning, water policy, cumulative downstream effects, emerging contaminant sources, and sinks, etc.).

3. Sea Grant will seek, develop, and nurture traditional and non-traditional partnerships with local, state, and federal entities toward innovative transdisciplinary solutions to water resources issues.

4. Sea Grant will direct programmatic investment in extension, research, education, and communications capacity focusing on water resources at the national, regional, and state levels to increase collaborative, transdisciplinary successes that help communities prepare for and respond to water issues.

Case Study

Hawaii Sea Grant Establishes an Intragovernmental Collaboration to Address Water Resources

Relevance: Two agencies of the U.S. federal government with similar state organizational structures and complementary mandates in the realm of water resources have not previously explored how collaboration with one another can increase the quality and quantity of services they provide.

Gulf of Mexico Meeting, February 2018
(M. Donohue/Hawaii Sea Grant)

Response: Hawaii Sea Grant provided regional and national leadership in connecting the U.S. Department of Commerce's National Oceanic and Atmospheric Administration Sea Grant College Program (NOAA Sea Grant) and the U.S. Department of Interior's United States Geological Survey, Water Resources Research Act Program (WRRA).

Result: For the first time, regional meetings of state and national leadership of NOAA Sea Grant and WRRA were initiated in 2017 to enhance mutual understanding of the missions and mandates of NOAA Sea Grant and WRRA. These meetings are also fostering collaboration among state Sea Grant and WRRA programs toward enhancing and amplifying outcomes to taxpayers. To date, the Pacific regional NOAA Sea Grant and WRRA programs met in fall 2017, the Gulf of Mexico regional programs met in winter 2018, and the Great Lakes regional programs met in spring 2018. Northeast, mid-Atlantic, and southeast regional meetings are in the planning stages.

Recap: Hawaii Sea Grant provided leadership in facilitating a collaboration between NOAA Sea Grant and the U.S. Geological Survey Water Resources Research Act Program, organizations with complementary mandates in water resources, resulting in the two programs engaging in regional activities to increase productivity and services while utilizing resources more effectively.

What Does Success Look Like?

- Sea Grant partners achieve access to and engagement of stakeholders through Sea Grant's "honest broker" status and trust-based relationships are developed among partners, stakeholders, and Sea Grant.
- Land Grant – Sea Grant partnerships are revitalized to facilitate information exchange, technology transfer, and innovative programming that addresses the interconnectivity of upland and coastal use impacts on water quantity and quality, ecosystem productivity, and community development.
- Funding is secured that enables a sustainable Sea Grant Water Resources Community of Practice capable of implementing strategic actions and priorities.
- Sea Grant effectively meets stakeholder and constituent needs by aiding in the development of water-related strategic plans for other national partners associated with the NOAA Water Initiative.

Case Study

State of Ohio Seeks Sea Grant's Leadership as the "Go-To" Resource for Science and Outreach to Reduce Harmful Algal Blooms

Relevance: Ohio's Harmful Algal Bloom Research Initiative is a statewide response to the threat of harmful algal blooms. The initiative was born out of the 2014 Toledo drinking water crisis, where elevated levels of the algal toxin microcystin in Lake Erie threatened drinking water for over 500,000 people in northwest Ohio. To better position the state to prevent and manage future algal issues, the Chancellor of Ohio's Department of Higher Education (ODHE) worked with Ohio Sea Grant, Ohio State University, and the University of Toledo to manage research efforts across Ohio's universities to address critical technology needs and to address knowledge gaps identified by the states agencies.

Response: The ODHE has provided Ohio Sea Grant with $4,000,000 to manage efforts aimed to: (1) improve the use of existing technologies and to develop new methods to detect, prevent and mitigate harmful algal blooms and their impacts; (2) assess the health impacts of harmful algal blooms and the associated toxins; (3) develop new treatment methods for contaminated drinking water that remove both algal particles in general and the toxins produced by cyanobacteria in particular; and (4) develop ways to reduce nutrient loads into Lake Erie and ensure these solutions are disseminated to agencies, elected officials, urban planners, and the agricultural community.

Results: ODHE funds have resulted in (1) the rapid determination of whether blooms are toxic and where toxins are moving, (2) prediction capability for the location and severity of blooms, (3) treatment facilities having effective and cost-efficient options for clearing out algal toxins using their current infrastructure, (4) the development of new, innovative techniques for producing safe drinking water, (5) insight into the effects of algal toxins at the cellular level, (6) the information needed to determine if fish from affected water bodies are safe to consume, and (6) information that establishes connections between various land management practices upstream and downstream nutrient flows.

Recap: Ohio Sea Grant's co-management of $4,000,000 in state funding has increased our ability to (1) track harmful algal blooms from their source, (2) produce safe drinking water, (3) understand toxin impact on public health, and (4) engage stakeholders in solution and disseminate research findings.

Priority Actions

Strategic Priority 1: Maintain and enhance water quality and access to support healthy coastal ecosystems and human uses.

Priority Action 1.3: Sea Grant will identify emerging contaminants, develop tools to predict their fate and transport, and raise awareness about reducing their incidence and impact.

Strategic Priority 2: Empower communities to make informed decisions about current and future water quality and quantity challenges.

Priority Action 2.1: Sea Grant will partner with federal (USGS), state (Water Surveys, universities), and local (regional planning, economic development) agencies to improve understanding of water demand and available water supply, providing the data and leveraging expertise for water demand/supply planning.

Strategic Priority 3: Utilize a system approach to convey links between watersheds and coastal water resources to inform management and development decisions.

Priority Action 3.1.c: Providing professional training for consultants, engineers, and town officials on approaches to enhance and develop natural (green, living) assets in coastal areas and tributaries.

Strategic Priority 4: Establish new tools, technologies, and approaches to address water resource challenges.

Priority Action 4.1: Sea Grant will fund research projects to develop new tools, technologies, and approaches to solve water resource challenges, conduct outreach, and work with stakeholders to implement these new technologies and policies.

Strategic Priority 5: Ensure equitable and effective management of water resources by integrating social, economic, legal, and ecological factors into policy and planning.

Priority Action 5.1: Sea Grant will engage communities to provide research, education, and extension support to vulnerable communities to enable informed decision-making about current and future water quality and quantity challenges and ensure safe and sustainable water resources for all.

Strategic Priority 6: Expand, maintain, and strengthen partnerships to engage communities in the use of integrated water information.

Priority Action 6.1: Sea Grant will be an essential research, extension, education, and communication partner in the NOAA Water Initiative.

WHAT WILL HAPPEN BY ACHIEVING THE VISION?

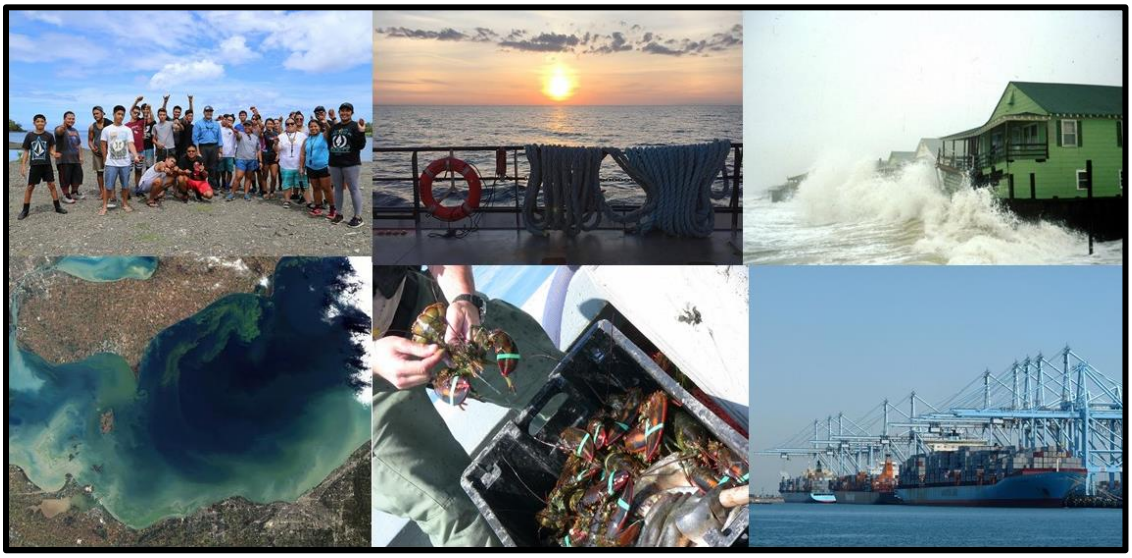
Through the efforts outlined in this vision, Sea Grant is poised to become a national catalyst to anticipate and resolve complex water resources issues by integrating research, extension, education, and communication toward more water-resilient coastal and Great Lakes communities. This will be achieved by facilitating collaborative partnerships, informing communities of sound water science and policy, funding relevant research, integrating research into outreach and education activities, and ensuring equitable access to Sea Grant tools, technologies, and products. Implementation of this vision will:

Increase

- human health and well-being
- healthy and thriving communities and ecosystems
- improved water storage, transport, and treatment options and practices
- development of safe and sustainable water infrastructure
- smart investment and economic well-being at the local to national levels
- vitality of water-based industries like agriculture, energy, shipping, fishing and aquaculture, tourism, recreation, and water utilities

Decrease

- water-borne threats to human and ecosystem health
- failing or poorly planned water infrastructure
- water-related social inequities
- poor decision-making and management of water resources
- negative impacts of droughts and floods
- wasteful spending of federal and state tax dollars



Images Clockwise from Top Right: Waves along the North Carolina coast (North Carolina Sea Grant); Cargo Vessels Lined up at Port (P. Grifman/University of Southern California Sea Grant); Lobsters (Maine Sea Grant); Lake Erie Algal Bloom (Ohio Sea Grant); Kids Participating in an Educational Program (N. Burns/Guam Sea Grant); and Sunset over the Ships' Gunnel (Illinois-Indiana Sea Grant)

CONCLUSION

This vision offers a path forward to protect our most valuable resource: water. It provides calculable goals and measurable results to safeguard and sustainably use our valuable water resources for healthy people, ecosystems, and economies. The Sea Grant Water Resources Visioning team identified four themes within water resources that Sea Grant's efforts focus on at present and should focus on in the future. To address water resource challenges related to these themes, six strategic priorities and subsequent action items were developed. These items are high-priority activities identified by programs throughout the Sea Grant network to successfully achieve the water resources vision over the next ten years on a national level.

Seine Boat (Alaska Sea Grant)

ACRONYMS

CCRG	Community Collaborative Research Grant
FEMA	Federal Emergency Management Agency
HABs	Harmful algal blooms
IISG	Illinois-Indiana Sea Grant
LID	Low Impact Development
NEMO	Nonpoint Education for Municipal Officials
NEPs	National Estuarine Programs
NERRS	National Estuarine Research Reserve Systems
NGOs	Non-Governmental Organization
NOAA	National Oceanic and Atmospheric Administration
ODHE	Ohio Department of Higher Education
RRAF	Runoff Risk Advisory Forecast
SWAT	Soil and Water Assessment Tool
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WRRA	Water Resources Research Act

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APPENDICES

Appendix A: Implementation Plan
Appendix B: Categorization of Sea Grant Water Resources Topics
Appendix C: Key Sea Grant Water Resources Partners and Stakeholders
Appendix D: Action Item Survey Responses

APPENDIX A: Implementation Plan

The following table shows the identified actions and implementation steps where appropriate as well as the highest priority identified by each strategic priority team.

Implementation Steps	Priority	Themes*	Approach**
Strategic Priority 1. Maintain and enhance water quality and public access to support healthy coastal ecosystems and human uses.			
1.1: Sea Grant will invest in transdisciplinary research, outreach and education to improve understanding and protection of healthy water quality.		EHH & LMRD	R, EOE, & E
1.1.a: Investing in social science research and needs assessments to better understand public perceptions, values and needs related to water quality, and improve messaging and communication related to water resource management.		EHH & WPS	R & EOE
1.1.b: Supporting efforts to identify vulnerabilities to community water resources and working in collaboration with diverse stakeholders toward building water quality resiliency.		EHH & LMRD	EOE
1.1.c: Developing applications and teams to quickly respond to water pollution events and maintaining designated funds to implement monitoring after storm, contamination, or flooding events to protect human health.		EHH, WI, & LMRD	R
1.2: Sea Grant will facilitate a collaborative and regional watershed approach to address water quality needs and challenges.		EHH & LMRD	EOE
1.2.a: Utilizing and further developing Sea Grant Regional Networks, and developing and strengthening partnerships with water/natural resource agencies (e.g., USGS, USEPA, USDA, National Estuarine Research Reserves, state agencies) to respond to, inform, and mitigate water quality-related impacts and threats		EHH & LMRD	EOE
1.2.b: Identifying upstream sources contributing to hypoxia (e.g., Gulf of Mexico hypoxia) or harmful algal blooms (HABs) in the Great Lakes and other aquatic systems, and working regionally to implement nutrient and runoff reduction strategies and increase impact in research (mechanisms, prediction, and monitoring) and extension efforts		EHH & LMRD	R & EOE
1.3: Sea Grant will identify emerging contaminants, develop tools to predict their fate and transport, and raise awareness about reducing their incidence and impact.	Yes	EHH	R, EOE, & E

1.3.a: Funding or conducting research to assess and/or monitor emerging contaminants and potential impacts, and sharing information about effects of contaminants on organisms and environments with stakeholders and public health officials.		EHH	R & EOE
1.3.b: Developing partnerships to help communities understand, eliminate, reduce, or remove both emerging and legacy contaminants, including planning and facilitating citizen science opportunities, community cleanups, peer-to-peer outreach/training, etc.		EHH & LMRD	EOE & E
1.3.c: Supporting research and collaboration that helps to standardize national/multi-national microplastics and/or marine debris sampling protocols to allow for comparisons temporally and spatially.		EHH	R & EOE
1.3.d: Establishing Sea Grant's commitment to reducing plastic pollution by limiting single-use plastics at Sea Grant-sponsored events.		EHH	EOE & E
Strategic Priority 2. Empower communities to make informed decisions about current and future water quality and quantity challenges.			
2.1: Sea Grant will partner with federal (USGS), state (Water Surveys, universities), and local (regional planning, economic development) agencies to improve understanding of water demand and available water supply, providing the data and leveraging expertise for water demand/supply planning.	Yes	WI & WPS	EOE & E
2.2: Sea Grant will develop community and/or regional plans for responding to potential water issues, such as water shortages or impairments from failing infrastructure (septic, wastewater, stormwater, etc.), that could negatively impact human health by working with communities to identify vulnerabilities and work toward solutions with multiple stakeholders.		WI & WPS	EOE & E
2.3: Sea Grant will support and conduct legal, policy, and social science research to understand what people know about their needs and connections to water resources, what values they place on various aspects of water resources, as well as what types of messaging are most effective when it comes to managing water resources and informing behavior.		WPS	R, EOE, & LP
2.4: Sea Grant will develop educational materials on current water quality and quantity issues for a variety of audiences.		EHH & WPS	E
2.4.a: Educating residents about current state programs to monitor water quality and how water quality can affect human health.		EHH	E
2.4.b: Producing outreach material on current surface water and groundwater issues.		EHH	EOE
2.4.c: Providing media with information on current water quality and quantity data and issues.		EHH	EOE & E

2.4.d: Developing organized marketing and educational campaigns, utilizing a variety of communications tools (e.g., social media) to provide scientifically based information about the importance of understanding and acting on challenges.		EHH	EOE & E
2.4.e: Developing case studies on green infrastructure projects on a regional basis, including the time they were implemented and how they are maintained, to share with community leaders to help convey to community leaders the benefits of green infrastructure to help manage stormwater.		WI	EOE & E
2.5: Sea Grant will work to improve understanding of changes in climate impacts on water resources and help communities prepare for the future.		EHH, LMRD, WPS, & WI	R, EOE, & E
2.5.a: Conducting workshops, charrettes, and other public events to educate and prepare communities to face climate-related water quality and access challenges.		EHH, LMRD, WPS, & WI	EOE & E
2.5.b: Evaluating water resource impacts (environmental and societal) related to sea-level rise (i.e., saltwater intrusion in ground water, surface water, wastewater infrastructure, etc.) and ocean acidification.		LMRD & EHH	R
Strategic Priority 3. Utilize a systems approach to convey links between watersheds and coastal water resources to inform management and development decisions.			
3.1: Sea Grant will work to improve understanding about the benefits of whole-watershed, integrated management of land use and land cover to protect and improve water quality.		EHH & LMRD	R
3.1.a: Conducting research and developing messaging and outreach about interconnections among water-related ecosystem services that are water-dependent (e.g., drinking water, food, recreation, water purification, flood management, etc.)		EHH & LMRD	R, EOE, & E
3.1.b: Developing regional plans to respond to potential water resource emergencies, including drought, flooding, and infrastructure failure.		LMRD, WI, & WPS	LP
3.1.c: Providing professional training for consultants, engineers, and town officials on approaches to enhance and develop natural (green, living) assets in coastal areas and tributaries.	Yes	WI & WPS	EOE & E
3.2: Sea Grant will work to improve understanding of watershed dynamics and the connections to coastal resources.		EHH & LMRD	R
3.2.a: Conducting research that focuses on approaches to reduce nutrient loading from watersheds, to combat development of HABs and nearshore hypoxia.		EHH & LMRD	R

3.2.b: Mapping and analyzing key watersheds throughout the Sea Grant Network to increase regional understanding of water resource connectivity and facilitate partnerships to restore water quality and promote wise use and resilience.		EHH & LMRD	R & EOE
3.2.c: Funding watershed agents in these watersheds to facilitate the development of partnerships to restore water quality and promote conservation and resilience.		EHH & LMRD	EOE
3.2.d: Forming regional teams of watershed agents that will work with the legal, policy, and social science teams in the region to coordinate efforts and help inform outreach materials.		LMRD & WPS	EOE & LP
Strategic Priority 4. Establish new tools, technologies, and approaches to address water resource challenges.			
4.1: Sea Grant will fund research projects to develop new tools, technologies, and approaches to solve water resource challenges, conduct outreach, and work with stakeholders to implement these new technologies and policies.	Yes	LMRD	R & EOE
4.2: Sea Grant will work with water resource decision-support tool developers and end-users to assess, pilot test, and improve the usefulness of decision-support tools for water resource management decisions and conduct outreach to encourage greater use of tools by decision-makers.		LMRD	EOE
4.3: Sea Grant will support the development of small-scale water quality models to assist with local and community-level decision makers.		EHH	R & EOE
4.4: Sea Grant will conduct law and policy research, integrating its legal capacity with state Sea Grant programs where possible, to identify model policies that support local government efforts to respond to water resource challenges and support decision-makers, water resource managers, and users on water policy and planning.		WPS	LP & EOE
4.5: Sea Grant will develop collaborative tools (e.g., maps, websites, resources, etc.) with Sea Grant extension professionals and community partners to empower decision makers in gathering information regarding the quality of their drinking and recreational waters.		EHH & LMRD	EOE
Strategic Priority 5. Ensure equitable and effective management of water resources by integrating social, economic, legal, and ecological factors into policy and planning.			
5.1: Sea Grant will engage communities to provide research, education, and extension support to vulnerable communities to enable informed decision-making about current and future water quality and quantity challenges and ensure safe and sustainable water resources for all.	Yes	EHH, LMRD, WI, & WPS	R, EOE, & E

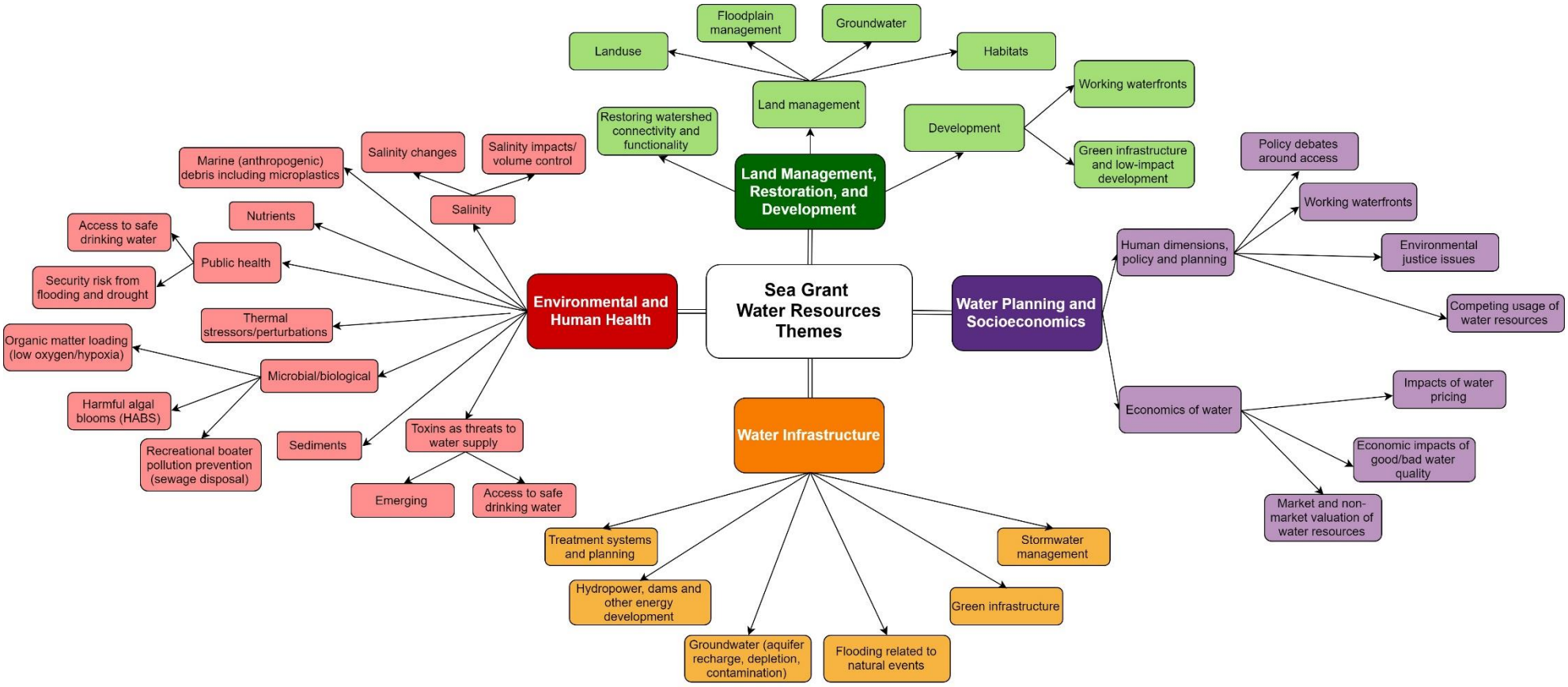
5.2: Sea Grant will conduct research, create knowledge resources, develop case studies, and provide training templates that incorporate regulatory (i.e., law and policy), economic, and behavioral science into water resource management decision-making in coastal communities.		WPS	R, E, & LP
5.3: Sea Grant will provide scientific, socioeconomic, and legal assistance to communities to develop water balances that will help them equitably manage water resources for coastal communities.		WPS	EOE & LP
Strategic Priority 6. Expand, maintain, and strengthen partnerships to engage communities in the use of integrated water information.			
6.1: Sea Grant will be an essential research, extension, education, and communication partner in the NOAA Water Initiative.	Yes	EHH, LMRD, WI, & WPS	EOE & E
6.1.a: Empowering communities towards water resilience by using integrated water information to understand what, where, and when human activities and changing climates will impact future water quantity and quality		EHH, LMRD, WI, & WPS	EOE & E
6.1.b: Tapping the transdisciplinary modeling, observation, extension, education, and communications expertise from a national network of 33 Sea Grant programs and its university partners		EHH, LMRD, WI, & WPS	R, EOE, & E
6.1.c: Identifying opportunities where Sea Grant's established, trusted "honest broker" professional extension capacity can be applied		EHH, LMRD, WI, & WPS	EOE
6.1.d: Leveraging capacities for integrated problem solving through Land Grant and Sea Grant collaboration, as well as the greater university enterprise to enhance service delivery to NOAA customers		EHH, LMRD, WI, & WPS	EOE
6.1.e: Investing in personnel to create a social science team based out of the National Water Center		EHH, LMRD, WI, & WPS	EOE
6.2: Sea Grant will be a catalyst for facilitating functional working relationships between state Sea Grant programs, federal, state, local, NGO and corporate partners to address relevant water resources resilience issues		EHH, LMRD, WI, & WPS	EOE
6.2.a: Building and engaging communities of practice		EHH, LMRD, WI, & WPS	EOE
6.2.b: Engaging stakeholders on geographically and socially identified concerns		EHH, LMRD, WI, & WPS	EOE
6.2.c: Partnering with and funding research and extension projects with USDA Cooperative Extension and with USEPA to facilitate delivery of water resource research, policy and tools to local governments and communities in ocean, coastal, and Great Lakes states		EHH, LMRD, WI, & WPS	EOE

6.2.d: Organizing knowledge as well as gaps in knowledge on topically and geographically dispersed water resources resilience issues in a context that is meaningful to stakeholders (i.e., microplastics, nutrients, flooding, integrated watershed management, water resources planning, water policy, cumulative downstream effects, emerging contaminant sources, and sinks, etc.)		EHH, LMRD, WI, & WPS	EOE & E
6.3: Sea Grant will seek, develop, and nurture traditional and non-traditional partnerships with local, state, and federal entities toward innovative transdisciplinary solutions to water resources issues.		EHH, LMRD, WI, & WPS	EOE
6.4: Sea Grant will direct programmatic investment in extension, research, education, and communications capacity focusing on water resources at the national, regional, and state level to increase collaborative, transdisciplinary successes that help communities prepare for and respond to water issues.		EHH, LMRD, WI, & WPS	R, EOE, & E

*EHH (Environment & Human Health); WI (Water Infrastructure); LMRD (Land Management, Restoration, & Development); WPS (Water Planning & Socioeconomics)
**R (Research); EOE (Engagement, Outreach, Education); E (Education); LP (Law & Policy)

APPENDIX B: CATEGORIZATION OF SEA GRANT WATER RESOURCES TOPICS

Sea Grant programs were asked about the water resources topics they address now, and plan to address in the future. Eighteen state programs, along with the National Law Center and the National Water Extension Program responded with 56 topics. A small group of the Water Resources Visioning Team worked to group and categorize the data provided; an effort which was vetted at our in-person water resources team meeting. This categorization evolved into the Water Resources Themes. The visual below identifies where the various topics fit within the Themes.



APPENDIX C: KEY SEA GRANT WATER RESOURCES PARTNERS AND STAKEHOLDERS

Sea Grant programs were asked about current and future partnerships. Reponses from 20 programs are represented below, making this only a partial listing of Sea Grant's vast network of water resources partners.

Key state water resources partners and stakeholders:

Universities/Academic institutions	Illinois Sustainable Technology Center
	Indiana University Northwest
	Land and Sea Grant Extension
	Loyola University Chicago
	Massachusetts Institute of Technology
	North Carolina Division of Water Resources
	North Carolina State University
	North Carolina Water Resources Research Institute
	Northland College
	Ohio State University
	Purdue University
	Purdue University Extension
	Purdue University Northwest
	Southern Illinois University
	State University of New York - Plattsburgh
	Tulane Institute on Water Law & Policy
	University of Connecticut Nonpoint Education for Municipal Officials Program
	University of Georgia College of Public Health
	University of Illinois
	University of Illinois Extension
	University of Maryland
	University of Montana
	University of North Carolina Chapel Hill
	University of North Carolina Environmental Finance Center
	University of Vermont
	University of Wisconsin
National Estuarine Research Reserve Systems (NERRS)	NERRS programs
	Old Woman Creek NERRS
	North Carolina NERRS
	South Carolina NERRS
NGOs	Pacific Institute
	1000 Friends of Wisconsin
	Alliance for Water Efficiency
	American Rivers
	Calumet Collaborative
	Greencorps Chicago
	Indiana Dunes Learning Center
	Lake Champlain Committee
	Local and statewide NGOs
	North Carolina Watershed Stewardship Network
	Northeast Coastal Acidification Network

NGOs	Puget Sound Partnership
	Research Conservation Districts
	Save the Dunes
	Shirley Heinze Land Trust
	The Nature Conservancy
	Trail Creek Watershed Partnership
	Watershed associations
	Wildlife Habitat Council
Community groups	Glynn Environmental Coalition
	Friends of South Shore Park
	Friends of the Parks
	Northwest Indiana Paddling Association
	Prairie Rivers Network
	Wabash River Enhancement Corporation
	Watershed groups
Local Governments	American Bottoms Regional Wastewater Treatment
	Association of Illinois Soil and Water Conservation Districts
	Beach managers
	Boston Water Commission
	Brunswick-Glynn County Joint Water and Sewer Commission
	California Coastal Commission
	California Division of Water Resources
	California Ocean Protection Council
	California Office of Planning and Research
	Chicago Metropolitan Agency for Planning
	Chicago Park District
	Cities and counties
	City of Aurora
	City of Bayfield
	City of Elgin
	City of Gary
	City of Peoria
	City planners
	Clean water agencies
	Coastal communities
	Communities
	Community drinking water managers
	Decision-makers
	Downers Grove Sanitary District
	Drinking water utilities
	DuPage County
	East Chicago Waterway Management District
	Fisheries managers
	Gary Sanitary District
	Gary Stormwater Management District
	Governor's Office of Minnesota
	Great Lakes Commission
	Great Lakes Water Safety Consortium

Local Governments	Hobart Sanitary and Stormwater District
	Illinois Council on Best Management Practices
	Illinois Counties Solid Waste Management Association
	Illinois Department of Agriculture
	Illinois Department of Natural Resources
	Illinois DNR Coastal Management Program
	Illinois Environmental Protection Agency
	Illinois Environmental Regulatory Group
	Illinois Farm Bureau
	Illinois Fertilizer and Chemical Association
	Illinois Natural History Survey
	Illinois Pollution Control Board (IPCB)
	Illinois Section of the American Waterworks Association (ILAWWA)
	Illinois State Water Survey (ISWS)
	Illinois Sustainable Technology Center
	Illinois Water Environment Association (IWEA)
	Illinois Water Resources Center
	IN State Department of Agriculture
	Indiana Department of Environmental Management
	Indiana Department of Natural Resources
	Indiana DNR Lake Michigan Coastal Program
	Indiana Household Hazardous Waste Task Force
	Lake Champlain Basin Program
	LaPorte County Soil and Water Conservation District
	Lincoln Park Advisory Council
	Lincoln Park Advisory Council
	Local governments
	Local leaders
	Local municipalities
	Local utilities
	Local/county stormwater and public works departments
	Louisiana Department of Environmental Quality
	Massachusetts Coastal Zone Management Office
	Massachusetts Water Resources Authority
	Merrillville Stormwater Utility
	Metropolitan Planning Council (MPC)
	Michigan City, IN Parks and Recreation
	Michigan City, IN Sanitary District
	Michigan Council of Governments
	Midwest Pesticide Action Center
	Milwaukee County Parks
	Minnesota Department of Health
	Minnesota Pollution Control Agency
	Muncie Sanitary District
	North Carolina Department of Agriculture
	North Carolina Department of Transportation
	North Carolina Division of Coastal Management
	North Carolina Division of Water Infrastructure

Local Governments	North Carolina Sediment Control Commission
	North Carolina Soil and Water Conservation Districts
	Northeast Regional Ocean Council (state-fed partnership)
	Northwest Regional Planning Alliance
	Northwest Suburban Municipal Joint Action Water Agency (NSMJAWA)
	Northwestern Indiana Regional Planning Committee
	Ohio Department of Natural Resources
	Oregon Department of Agriculture
	Oregon Department of Environmental Quality
	Phase 2 stormwater communities
	Regional Water Commissions
	Regulatory agencies
	Resource management agencies
	South Carolina Department of Health and Environmental Control
	Southern Lake Michigan Water Safety Task Force
	St Joseph County SWCD
	State agencies
	State and local government
	Stormwater managers
	Town environmental commissions
	Urbana-Champaign Sanitary District
	Vermont agency of Natural Resources- Department of Environmental Conservation
	Washington Department of Ecology
	Washtenaw County MI Master Rain Gardener Certification Program
	Water quality control boards
	Western Lake Superior Sanitary District
	Whiting, IN Parks and Recreation
	Wisconsin City, County, State Health Departments
	Wisconsin Department of Agriculture
	Wisconsin Department of Natural Resources
Local Community Members	Educators
	Anglers
	Boating community
	Farmers
	Fishing community
	Lake Ontario property owners
	Landowners
	Neighboring landowners
	Recreational boaters
	Residents
	Shoreline property owners
	Shoreline residents
	Sport fishermen
	Well and septic owners
	Wildlife enthusiasts

Private Sector	Shipping industry
	Ag community
	Ag production
	Agriculture
	Aquaculture community
	Arcelormittal
	Chicago Yacht Clubs
	Chicago Yachting Association
	Cranberry bog owners
	Crowley's Yacht Yard
	ECHO Lake Aquarium and Science Center
	Elevate Energy
	Farmers
	High Bridge L3C
	Illinois Corn Growers Association
	Illinois Pork Producers Association
	Legacy mill owners
	Marinas and boating facilities
	NISOURCE
	OAI Inc.
	Orion Planning and Design LLC
	Oyster growers
	Port industry and operations
	Power producers
	Private sector
	Property developers
	Recreation and tourism
	Spence Restoration Nursery
	Waterdrop Innovations LLC
	Westrec Marinas
	Wisconsin marinas
Tribes	Great Lakes Indian Fish and Wildlife Commission
	Oneida Nations
	Red Cliff Tribal Natural Resources Department
	Tribal Groups

Key national water resources partners and stakeholders:

Federal Agencies	Centers for Disease Control and Prevention
	Environmental Protection Agency (EPA)
	EPA Great Lakes Areas of Concern
	EPA Office of Environmental Justice
	EPA Region 1 (New England)
	FEMA CRS Program
	Indiana Dunes National Lakeshore - Dept. of Interior
	Massachusetts Division of Marine Fisheries
	National Park Service
	NOAA Cooperative Institute for Limnology and Ecosystems Research
	NOAA Marine Debris Program
	NOAA Maryland Program

Federal Agencies	NOAA Midwestern Regional Climate Center
	NOAA National Water Center
	NOAA National Weather Service
	NOAA Ocean Acidification Program
	NOAA's Office for Coastal Management
	Pacific Island Ocean Observing System (IOOS)
	U.S. Department of Agriculture- National Resources Conservation Service
	U.S. Department of Agriculture- National Water and Climate Center
	U.S. Department of Health and Human Services
	U.S. Drug Enforcement Agency
	USEPA Smart Management for Small Water Systems
	U.S. Fish and Wildlife Service (USFWS)
	U.S. Forest Service
	U.S. Geological Survey
	United States Coast Guard
	US Army Corps of Engineers
	USFWS Western Regional Panel on Aquatic Nuisance Species
	USGS Water Resources Research Act
International Community	Canada
	International Joint Commission
	Mexico
NGOs	Sierra Club
	Smart Growth America
	Surfrider Foundation
	The Nature Conservancy
	Water Research Foundation (WRF)
Associations	American Society of Landscape Architects
	American Veterinary Medical Association
	Audubon Society
	Environmental Working Group
	Society of Environmental Toxicology and Chemistry
	Student Conservation Association
Private sector	Agriculture
	Aqua America
	Maritime industry
Tribes	Tribes
Larger University Enterprise	Great Lakes Sea Grant Network
	Gulf Sea Grant Network
	National Center for Atmospheric Research
	National Sea Grant Law Center
	National Sea Grant Office

APPENDIX D: ACTION ITEM SURVEY RESPONSES

The Sea Grant programs were asked: "What is that one ACTION you think would position Sea Grant for maximum impact in the water resources area over the next ten years? (Feel free to submit more than one action.) If submitting more than one idea, please use a numbered list format if possible. Please also provide some context for why this ACTION is needed and why it is uniquely suited for Sea Grant." The table contains the responses, as received, from 15 programs.

A network wide program to build regional collaborations that will map and analyze watersheds so that we have the information to build upon for separate regional understanding of freshwater-to-ocean (or lake) systems.
Sea Grant programs in the Great Lakes and Gulf Coast regions will connect together and with relevant partners to take a watershed approach in addressing challenges associated with Gulf hypoxia.
Sea Grant invests in social sciences research to understand what people know about their needs and connections to water resources, what values they place on various aspects of water resources, as well as what types of messaging are most effective when it comes to managing water resources. (Invest in personnel to create a social science team stationed at the National Water Center or elsewhere?)
Sea Grant connects with other agencies that work in the water resources area (USGS, EPA, USDA, state agencies) to understand how Sea Grant's strength in outreach and extension, research and social sciences can fill a needed gap.
Sea Grant regionalizes its Great Lakes HAB efforts to make a greater impact in research (mechanisms, prediction, and monitoring) and outreach/extension efforts.
Sea Grant works to better connect our work in Water Resources to how that helps with public health as well as making sure people have enough clean water ("water security"). Making these connections is important for gaining support from legislators and voters who aren't motivated by "Healthy Coastal Ecosystems," though in many cases this focus area helps with public health and in providing enough clean water. Framing and communication challenge as well as work to be done in research, outreach and education.
Under your "Maintain and enhance water resources to support healthy coastal ecosystems and human uses", I think the most significant action we can take is to support the assessment of sources and fate of toxic chemicals, with an emphasis on chemicals that are only recently emerging as potential human and ecosystem threats.
I don't think of this as the "one key action", but something that I think is potentially overlooked that Sea Grant can help with. There are countless existing and in-development decision-support tools that are related to water resources. However, many of these tools were developed with only cursory input from end-users, resulting in tools that are (1) unintuitive to end-users, (2) don't adequately address user problems, and/or (3) are under-used by potential stakeholders. A key action is this: Sea Grant will work with decision-support tool developers and end-users to help ensure that decision-support tools are developed with a co-production model so that the final tools end up being useful for making water resources decisions.
BMPs and controls on nutrient inputs will improve water resources to a point in the near future, however, legacy issues may persist for years into the future via internal loading and cycling. Many of my stakeholders are under the impression that over time we will "solve" these issues, and unfortunately, constant attention is what some of these issues need. Sea Grant must be prepared to continue to provide messaging and education to help people understand and deal with the long-term impacts of actions that have taken place over the past 100-

200 years. Sea Grant is in a unique position to serve this role because many of the materials and infrastructure to continue this work already exist within the Sea Grant network.
In a similar line of thinking to my first comment, stakeholders need to be aware that we now live in a situation where non-native species and contaminants are ubiquitous. Managers and practitioners must continue their work in the presence of these impediments and often face decisions that are difficult. This "new normal" is something that can be changed to some degree, but at the same time, some of these deleterious factors are here to stay and we need to learn to live in their presence.
Maintain and enhance water resources to support healthy coastal ecosystems and human uses.
Ensure equitable and effective management of water resources by integrating social, economic, and ecological factors into policy and planning.
Convey links between watersheds and coastal water resources to inform management and development decisions.
Build better stormwater management and address atmospheric deposition of nutrients like N.
Sea Grant has demonstrated that it works effectively at the community level. This is an area we should continue to grow. I think that it would be worthwhile to develop community initiatives, similar to what the Gulf states do for community resilience, that focus on education and planning of water resources at a community and regional level. In this way we can work with communities to identify vulnerabilities and work toward solutions with multiple stakeholders at the table.
Work intensively on awareness, understanding, and commitment to action related to the ecological and social impacts to water quality and quantity of inadequate efforts to reduce climate warming.
Great Lakes and Gulf region Sea Grant programs coordinate on watershed-wide nutrient reduction efforts to combat HAB's and Hypoxia through addressing nutrient runoff from all sources
Sea Grant will partner and fund research and extension projects with USDA Cooperative Extension and with US EPA to facilitate delivery of water resource research, policy and tools to local governments and communities in Coastal areas.
Sea Grant will expand and promote the LID database developed by NEMO and look for opportunities to leverage the utilization of this database with other organizations.
Sea Grant will prioritize several key watersheds throughout the network and fund watershed agents in these watersheds to facilitate the development of partnerships to restore water quality and promote conservation and resilience.
Any work into the presence and impacts of pharmaceuticals and personal care products.
Efforts to reduce nutrients coming into the lake to decrease the occurrence of HABS; this information is not only important to Lake Erie but will address an issue prevalent across the country.
Sea Grant will conduct climate vulnerability assessments for all coastal communities, complete with proposed actions to help build resiliency among the most vulnerable populations.
Sea Grant will commit to making its own events (hosted by state programs and national leadership) as free from single-use plastic and other disposable items as possible. The events will be characterized by reducing and reusing hospitality items, then recycling or composting other items and donating extra food. This will broadcast

Sea Grant's commitment to minimizing plastic pollution, which is emerging as one of the most prominent threats against our nation's water bodies.
We should work on upstream causes of coastal impacts. Our focus is narrowed on what folks at the coast can do to prevent flooding or pollution, when many of those impacts could be/ must be lessened farther upstream.
Sea Grant will support the NOAA water initiative by equipping decision-makers at multiple levels with the information necessary to make informed decisions about how to keep communities safe, resilient, and prosperous in face of water related challenges (drought, floods, poor water quality).
Sea Grant Programs will partner with federal (USGS), state (Water Surveys, Universities), and local (regional planning, economic development) agencies to improve understanding of water demand and available water supply, providing the data and leveraging expertise for water demand/supply planning. As a result, communities will know their water demand/supply balance. Sea Grant is uniquely positioned to due this as it requires coordination across state lines (to address shared water resources), with federal agencies, as well as state and local input, and implementation at the local scale to address any demand/supply imbalances. It also requires multi-disciplinary teams (hydrogeologists etc. to model water supply; economists/planners to model water demand) and convening/facilitation, as well as leveraging multiple funding sources and building on existing efforts at multiple jurisdictional scales that otherwise might not be done. Sea Grant is also uniquely positioned to integrate water demand/supply plans into other planning efforts (land use/comprehensive/green infrastructure/restoration plans), and develop and lead social marketing campaigns for water conservation efficiency/fund research on water efficiency innovations.
I suggest that Sea Grant address the issue of sea level rise impacts on groundwater. The most apparent impact from sea level rise on coastal communities is surface water flooding and infrastructure impacts, with groundwater impacts remain largely undervalued. As sea levels rise, the salt wedge intrudes into groundwater sources, affecting freshwater resources required for drinking, municipal, and industry needs, as well as septic systems and water treatment facilities. The intrusion of salt water into fresh groundwater reserves can extend well inland, affecting communities beyond the coast. Freshwater resources are essential for healthy communities and economies and, therefore, Sea Grant should consider addressing impacts from sea level rise on groundwater resources, evaluating societal impacts, forecasting impacts, and developing technology and solutions for managing these impacts for the benefit of partners and stakeholders.
In the Great Lakes basin, Sea Grant programs will conduct joint research that explores the linkages between tributary plumes and nearshore water quality and biotic conditions incorporating lake and riverine hydrodynamics and hydraulic connectivity. This could include effects of lake hydrodynamics on coastal shorelines and habitats.
Sea Grant Programs will enhance (or develop) partnerships with National Estuary Programs (NEPs) and National Estuarine Research Reserves (NERRS) to coordinate expertise and capacity to support (through research, outreach, etc.) water quality improvements through non-regulatory means. This action is needed in order to align and make the best use of limited resources through existing programs. While there are many efforts underway, focusing on NERRS (within the NOAA family) and NEP (closely related EPA partnership), Sea Grant can support efforts to ensure that relevant data/research is getting incorporated into NERRS and NEP management processes. This action could be focused locally where partnerships need further support, or at a national/regional level to learn from states/sites that have robust connections already.
Sea Grant Programs will support and conduct legal, policy, and social science (i.e. sociological, anthropological, etc.) research to better understand municipal and/or community resistance to septic, wastewater, and stormwater infrastructure improvements to better tailor delivery of information to support sound decision making within locally relevant contexts. This action is needed because there are many cases where water quality

decline has been documented for decades, sources are known (point and non-point), but willingness to address the issues has not kept pace. This could be for a range of reasons (lack of federal infrastructure funding, resistance to cost/tax payer burden, individual property rights arguments, misunderstanding of the causal links, etc.). Further research to understand the drivers of the lack of implementation, or in exemplary cases research to understand what drove adoption of change would be beneficial to future science communication and decision support efforts.
Sea Grant programs will work with the National SG Law Center to help decision makers recognize their ability and responsibility to conserve critical lands, protect riparian buffers, limit impervious cover and implement low impact development (in that order of priority depending on levels or urbanization) in order to protect water quality, water quantity and coastal resources over the long term. (This action is needed because lack of political will and know-how are often cited as barriers to land use decisions that protect ecological functions and water resources. Fear of legal challenges inhibits decision makers from doing what they need to do to protect coastal resources and functions. SG is uniquely suited to do this using a non-adversarial, multi-disciplinary and integrated research-extension-education-communications approach that helps build the confidence, motivation, capacity and competence of decision makers.)
Broker policies and local practices to decrease non-point nutrient losses from agriculture by 80%. This will have huge benefits for freshwater and marine coastal systems alike.
Sea Grant programs on the West Coast will work together and with partners to address changing ocean conditions (e.g. acidification) through integrated research and outreach activities.
Climate-Food-Health Nexus within next 10 years
Water-Energy-Food Nexus within next 5 years
Sea Grant programs will work with various local, state and federal agencies to address the coming water accessibility challenges that the nation will face in the coming 10 years and beyond due to weather extremes and a changing climate. (Some areas of the country are facing water restrictions either due to drought or due to salt water intrusion. In either case, water quantity and quality is greatly diminished. There will be more pressure put on water supplies due to growing population, agricultural and industrial needs as well as maintaining to improving our current ecosystems. Now is the time to think about new technologies to reduce our impacts on our water resources as well as an opportunity an educational opportunity to raise awareness.) Research - look at new and upcoming technologies ranging from new water conservation practices to bio-agricultural, etc.
-work with local water resource managers, municipalities, and water storage entities (e.g., USACE) to manage coastal water resources more effectively, e.g., through policy development, best practices, integration of climate conditions on models.
Sea Grant will support research, collaboration and education to improve water quality and predictions about changes in world and U.S. water distribution/supply in the next century.
Invest in interdisciplinary research to address emerging and cross-jurisdictional water resource issues, such as ground water withdrawal, to inform integrated policy and management.
Create links (education, training, funding, etc.) between the private sector, municipalities and the public to integrate new ideas, methods and practices (i.e water reuse) into water resource management.
Develop regional plans for responding to potential water issues, such as shortages or impairments from failing infrastructure that could negatively impact human health.

Something that has been suggested in our program is for Sea Grant programs (or even Great Lakes SG programs) will work with relevant partners to generate an inventory of green infrastructure projects, including time they were implemented, how they are kept up, etc. This could set-up long-term assessment of how green infrastructure is being incorporated into community planning, allow for understanding of it/how it is working, what motivates people to use it, etc. If Sea Grant is the one doing this, there may be buy-in as we are seen as neutral assessors of information.
Maintain and enhance water resources to support healthy coastal ecosystems and human uses. a) I think it's pretty scary stuff to think of the cocktail of what we call water is that we interact with each day now. Given CECs like endocrine disrupting compounds, microplastics and more in the water, at a minimum, what is the latest technology for addressing not just nutrients in wastewater treatment cycles, but what are the technological advances addressing the myriad of other constituents that could be treated. (i I believe there is data suggesting that in developed countries in particular that this our exposure to the cocktail of contaminants is considered a leading hypothesis in the multidecadal decline in sperm counts in men to the point of starting to affect rates of conception. If true, that could really rock the world in our lifetimes.) b) Also, how are we addressing this from a source perspective - how is are the practices of agriculture, medicine addressing the production of safe compounds, alternative management strategies to reduce the use and need for recognized harmful compounds. How are individuals making choices on their home fronts that could affect contaminant loads (e.g., are we ever going to give up the American Lawn syndrome, how many people grow more of their own food). Diet change was noted as a legitimate BMP in Finland I believe and a watershed that was touted as having changed its diet composition was said to account for a 7% reduction in eutrophication in the estuary (I believe by reduced meat consumption and increased plant matter consumption that impacts the nutrient delivery to the Baltic) - is diet change in America and in the watershed working in a way favoring an adjustment that changes nutrient loads to the rivers and bay? c) Minimize impervious surfaces within watersheds, especially those currently degraded d) Ensure effective water quality monitoring through state and federal agencies e) Prioritize shellfish growing waters to maintain strong biofiltering populations f) Limit expansion of residence sprawl through greater purchase of agricultural easements
Empower communities to make informed decisions about current and future water quality and quantity challenges. a) Suggest looking at project ideas supporting the issue of behavior change. We have a lot to learn about marketing the issues that will engender action at many levels. b) Educate residents about current state programs to monitor water quality and provide criteria about healthy ecosystems c) Provide SG outreach to targeted media for expanded information on current water quality data and issues d) Develop organized SG social media campaigns to provide scientifically based information to citizens about importance of understanding and acting on challenges e) Support the development of small-scale water quality models, with communities asking the driving research questions
Convey links between watersheds and coastal water resources to inform management and development decisions. a) Educate engineers on how to propose living shoreline solutions in the bay as competitive, viable, sound alternatives to traditional hardened shoreline alternatives. b) Promote actions by state and local governments that make the process and support for living shoreline options of shoreline management more simple, fluid, viable. c) Consider strategies for how we will move people from the most vulnerable areas to sea level rise to new areas. There has to be a history in the bay that we can reflect on with our decision-makers and the public. A

hundred years ago there was an island with multiple families, a baseball field and more offshore from where I live. Today, the island is gone, no one living out in the bay. What happened to those families? How many more islands do we have that have undergone this succession? When are folks on the lower Eastern Shore islands going to reach the critical moment of move or be consumed? How do we create a policy that creates a lifespan for living quarters in areas destined to be underwater in 20, 50, 100 years, a phased move and undevelopment of the coast at the same time the national and global populations continue to concentrate population along coasts? d) Provide coordinated NOSG activities to educate watershed residents about development issues e) Target state and local planning and zoning boards to provide scientific information about coastal development and impacts on water bodies f) Expand information to the public on shellfish aquaculture benefits to healthy coastal waters g) Support the development of small-scale water quality models, with communities asking the driving research questions - this can help understand local BMP impacts
Establish new tools, technologies, and approaches to address water resource challenges. a) We need to understand the impact of the underground built environment and its aging infrastructure. How do we do this so we avoid the next set of Flint, Michigan scenarios? What is the strategy for revising the infrastructure that is aging and failing? b) Support the development of small-scale water quality models, with communities asking the driving research questions c) Target research funds towards advanced engineering to monitor water quality d) Develop better methods of stopping runoff of toxic and degrading materials into coastal waters e) Research environmentally benign methods of protecting shorelines from erosion and severe storm events f) Support research and outreach to examine improved methods for sustainable agriculture and aquaculture; BMPs with feedback to stakeholders on their efficiency. Improved small watershed models to assess sources and sinks for TMDL in WIPS
Ensure equitable and effective management of water resources by integrating social, economic, and ecological factors into policy and planning. a) I believe Montgomery County, MD has done some interesting work to look at development scenarios and proposed limits on reducing environmental integrity as provided by BIBI assessments. Is this the standing model? What lessons can we take away from their work that could inform how we target growth limits and land use distributions that sustain capacity and integrity of water resources with consideration for social, economic and ecologic factors? b) How do we reduce toxic burden in fishery resources available to local and regional fishers? c) How do we balance the above factors in expanding new markets like the oyster and clam aquaculture industry in the bay or changes in ag. That might impact water use (how many cannabis farms might crop up if that becomes a mainstream farming option? It sounds like there are issues with this out west, I would think such land use/water use issues could move east in time). d)Work with federal, state and local planners to identify key issues and develop research and education programs to address them e) Develop SG as a key provider of science-based data and education on diversity and inclusion issues for coastal development and management f) Create workshops/workgroups (10 people or less) that involve all stakeholders and have a clear driving problem to solve
Expand, maintain, and strengthen partnerships to engage communities in the use of integrated water information. a) Training more folks not just on the science that understands integrated water use, but on the social science of

translating and educating the public. I think there is a significant need for the extension type person that can meet one on one with landowners in the field, at the table, over a cup of coffee or a pig roast. I don't yet see that social media has overwhelmingly taken over the role that a warm body serves in that connection that people have with people, relationship building. ALEXA may answer our calls for pizza or music, but I don't think she is a warm, fuzzy face (yet...) that an individual or community connects with. So I feel like support for more extension-type positions and individuals is something that will not go out of vogue for a long time when dealing with this or many other challenging issues.
b) Continue to identify new and emerging issues and audiences for research-based education programs.
c) Develop state of the art educational materials including social media to reach new and non-traditional audiences.

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