THE STATE OF SEA GRANT

2020 BIENNIAL REPORT TO CONGRESS

NOAA NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION U.S. DEPARTMENT OF COMMERCE

Sea Grant

October 2020

Sea Grant Knauss fellows, NOAA employees, and others plant taro in Hawai'i while attending the SACNAS conference Credit: Bill Jones (NOAA) 2019

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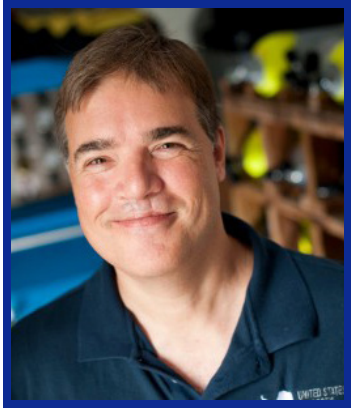
Letter from the Chair



Dr. Brian Helmuth
National Sea Grant Advisory Board Chair,
Northeastern University

Dear Members of the United States Congress:

On behalf of the *National Sea Grant Advisory Board* (Board), I am pleased to share with you The State of Sea Grant 2020 Biennial Report to Congress, developed by the Board as directed by the 2008 Sea Grant Act (PL 110-394). The State of Sea Grant 2020 provides an update on the National Sea Grant College Program (Sea Grant) over the past two years and is the sixth such report to Congress.

This year, the COVID-19 pandemic continues to create major health, economic, and social disruptions across the globe, as do the ongoing and accelerating impacts of climate change. These challenges highlight the critical need for collaboration and communication among federal, state, and local governments working together with the private sector and academia. They have further shown the indispensable value of trust and long-standing relationships, while applying the best-available science and an understanding of the needs and priorities of the American public. Sea Grant has long been a trusted arbiter that exemplifies this collaborative approach in coastal and Great Lakes communities across the nation. This report is filled with examples of how the program creates a culture that connects cutting edge, actionable science with extension and education.

This year has also witnessed a reckoning of this country's legacy of racial injustice. This report highlights Sea Grant's ongoing efforts in Justice, Equity, Diversity, and Inclusion, but also recognizes that this work is far from completed. Significantly, the report acknowledges that the needs of coastal communities—and Sea Grant's mandate to address those needs—can only be met when justice and equity for all citizens is realized, and why resilience is enhanced through diversity and inclusion in all its forms.

Committed to continuous improvement, Sea Grant completed an extensive self-evaluation in 2020, overseen by the Board. The review highlighted extraordinary program accomplishments and best practices resulting from the tireless dedication of Sea Grant staff members, extension agents, and partners. For instance, the *John A. Knauss Marine Policy Fellowship*, which places graduate-level fellows in executive and legislative offices for one year, continues to be one of Sea Grant's most impactful efforts, facilitating effective, science-based decision making. The review culminated in actionable recommendations to further strengthen Sea Grant. The best available practices that emerged from the evaluation will be shared throughout the Sea Grant network, across NOAA, and more broadly throughout the federal government via a series of cooperative, cross-agency liaison positions.

The pandemic and other recent adversities have shown that healthy, functioning, diverse coastal and Great Lakes communities and ecosystems are vital to the health, livelihood, and well-being of all Americans. The year 2021 marks the beginning of the *United Nations Decade of Ocean Science for Sustainable Development*, during which the U.S. has the opportunity to show leadership as the global community works together to face challenges ranging from climate change to feeding a protein-hungry planet. The Board finds that Sea Grant is uniquely positioned to play a leading role in the implementation of the Decade of the Ocean's priorities by continuing its commitment to scientific integrity and its focus on partnerships. The Board also recognizes and appreciates the U.S. Congress' unflagging bipartisan support for Sea Grant in the face of administrative budget cuts as well as for reauthorizing Sea Grant through 2025 (P.L. 116-221). We look forward to continuing our work with you to address critical needs of the nation. We look forward to continuing our work with you to address critical needs of the nation.

Sincerely,

Brian Helmuth

Brian Helmuth, Ph.D.
Chair, National Sea Grant Advisory Board

Sea Grant

NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

Sea Grant Programs

Sea Grant is a national network of 34 university-based programs and the National Sea Grant Library.

- Alaska
- California
- Connecticut
- Delaware
- Florida
- Georgia
- University of Guam
- University of Hawai'i
- Illinois- Indiana
- Lake Champlain
- Louisiana
- Maine
- Maryland
- Massachusetts Institute of Technology
- Michigan
- Minnesota
- Mississippi- Alabama
- National Sea Grant Law Center
- New Hampshire
- New Jersey
- New York
- North Carolina
- Ohio
- Oregon
- Pennsylvania
- University of Puerto Rico
- Rhode Island
- South Carolina
- Texas
- University of Southern California
- Virginia
- Washington
- Wisconsin
- Woods Hole

Executive Summary

The State of Sea Grant 2020 illuminates Sea Grant's contributions to the nation in 2019-2020 and offers recommendations and opportunities for continued advancements to serve America's coastal and Great Lakes communities.

Within Sea Grant, 20 national office staff, 34 university-based state programs, 646 extension staff and educators, 488 researchers, and at least 2,700 partners are funded and leveraged to cooperatively reach program goals. Sea Grant's mission is to address the needs of America's coastal and Great Lakes communities using the best available science, beginning with an understanding of the needs of diverse stakeholders. In the past two years, Sea Grant has been at the forefront of actionable science addressing priorities of national importance: sustainable fisheries and aquaculture, resilient communities and economies, healthy coastal ecosystems, and environmental literacy and workforce development. Sea Grant has coordinated efforts to solve problems locally and regionally, emphasizing partnerships, meeting stakeholder needs, and using feedback from end-users to inform research, with a $412.4 million economic benefit from an $80 million federal investment in 2019.

Sea Grant's locally based staff and specialists collaborated with governments, academia, industries, non-profit groups, and individuals to ensure thriving coastal and Great Lakes communities. Just as it has done in response to hurricanes, oil spills, and other environmental and economic challenges, Sea Grant in 2020 learned how to draw from past experiences to use its strengths to support its constituents during the COVID-19 pandemic. Sea Grant's credibility in scientific and disaster communications was an advantage to coastal and Great Lakes communities around the nation by providing online resources to enhance at-home STEM education, assisting the seafood industry and other coastal businesses with direct marketing of their products, navigating the complexities of federal and state assistance programs, and working quickly to find innovative ways to connect with and support their stakeholders.

All recommendations made in *The State of Sea Grant 2018* were addressed. Sea Grant (1) supported the development, integration, and implementation of visions generated by interdisciplinary *Network Visioning Teams*; (2) continued enhancing diversity, equity, and inclusion (DEI) so that its workforce, audiences served, programming conducted, and materials produced are more representative; (3) expanded the Sea Grant evaluation process to include the National Sea Grant Office (NSGO) and the Sea Grant program overall; and (4) expanded its capacity and continued to build greater awareness of the network's substantial role in coastal disaster and emergency preparedness as well as (5) its substantial role in aquaculture.

In 2020, the Board recommends that Sea Grant expand its capacity and continue to (1) support implementation of its Network Visioning; (2) amplify efforts to incorporate social and environmental justice, equity, diversity, and inclusion in its structure and programming; (3) seek opportunities and collaborations to leverage Sea Grant's unique strengths in building coastal community resilience; and (4) make improvements based on the findings and recommendations of the Independent Review Panel and Board Evaluation Committee.

Responses to 2018 Recommendations

The following recommendations were made by the Board in The State of Sea Grant 2018. Responses under each recommendation note the ways in which each one was addressed by Sea Grant in the succeeding biennium, and were compiled from NSGO, data from programs, and site visits. Follow-on recommendations for 2020 comprise the Board's response.

Recommendation One

Sea Grant should further support the development, integration, and implementation of emerging visions generated by interdisciplinary teams begun with the 2017 Network Visioning effort. Support for implementing the vision outcomes will optimize Sea Grant's investment and enhance Sea Grant's future program initiatives with aspirations, ideas, innovations, and expertise from both within and outside the network.

Response

In 2019, the NSGO provided a $1.4 million competitive funding opportunity to the Sea Grant programs to advance priorities identified in the *Network Visioning* plans developed in 2017-18 and enhance each program's capacity to address their 2018-2023 strategic plan. Additionally, the NSGO has established liaisons within the NSGO to support each of the 10 communities of practice that formed as a result of this effort.

Recommendation Two

Sea Grant should continue efforts to enhance diversity, equity, and inclusion (DEI) throughout the network so that its workforce, audiences served, programming conducted, and materials produced are more representative of the nation. A working group has examined the current status of diversity within Sea Grant, and the Board is looking for continuous progress toward goals for DEI.

Response

As part of the network vision implementation investment noted above, Sea Grant programs were required to focus at least 25% of the awarded funds on DEI and Traditional and Local Knowledge (TLK). Programs were further encouraged to incorporate DEI and TLK concepts in the remaining 75% of activities. The result was a suite of internal and external efforts to integrate DEI and TLK across programs. Additionally, the DEI and TLK communities of practice, which formed during the 2017-18 visioning process, are providing professional development opportunities to Sea Grant peers. A primary outcome of this investment has been the development of a new Community-Engaged Undergraduate Internship Program to broaden participation in marine and coastal professions by providing training and mentorship to the next generation of scientists, decision makers, and citizens. The program recruits, engages, and retains diverse students in place-based research, extension, education, and communication that respects and integrates local knowledge. Also, the NSGO is taking steps to improve the diversity of applicants to the Knauss fellowship and staff positions in the NSGO.

Recommendation Three

The Sea Grant evaluation process should include an assessment of the NSGO and the Sea Grant program overall. Bringing review of the NSGO into a broader program assessment will lead to consistency with how all program elements of Sea Grant, including the NSGO, are reviewed.

Response

As the National Sea Grant College Program finished its quadrennial review of the 2014-2017 cycle, the Board organized an Independent Review Panel (IRP) to assess the overall effectiveness and impact of the Sea Grant program as well as the NSGO. This review was intended to benefit from the information and assessments conducted by the recent Site Review Teams (SRTs) and to move beyond evaluating individual programs, to provide an assessment with suggestions

and recommendations for improvement of the overall Sea Grant program and the management of the program by the NSGO. The IRP comprises seven members from the Board, the National Oceanic and Atmospheric Administration (NOAA), the Sea Grant Association (SGA), and leaders from academia/industry, and State/Federal Agencies. The IRP is currently in the process of completing its charge.

Recommendation Four

Sea Grant should expand its capacity and continue to build greater awareness of the network's substantial role in coastal disaster and emergency preparedness including its ability and resources at the local level. Sea Grant can help communities become more sustainable and resilient through enhanced planning, recovery, and adaptation programs. Sea Grant has the local perspective, a national talent pool, and a reputation for assisting communities in adapting to coastal changes quickly. Important government investments in resilience, adaptation, and community planning over the next 50 years will affect all Sea Grant constituencies.

Response

The Sea Grant Network has long been a leader in disaster and emergency preparedness through nationally coordinated efforts implemented locally. In 2019 and 2020, Sea Grant funded research and engagement customized to local communities in community planning, green infrastructure, coastal inundation, and hazard mitigation and adaptation. Sea Grant programs worked with stakeholders to identify community needs and gaps, and to respond with information, tools, and services to help stakeholders adapt to changing conditions. Sea Grant has invested in working across NOAA and with external partners to leverage existing preparedness, response, and recovery efforts and build awareness of Sea Grant program capabilities. At the national level, the NSGO is forging relationships with the National Weather Service, National Ocean Service, Climate Program Office, and is focusing on opportunities with the Federal Emergency Management Agency (FEMA) to share Sea Grant's programs, products, and uniquely community-based role in disaster and emergency preparedness. The Sea Grant Network's trusted relationships help it reach and serve vulnerable or marginalized groups to assess capacity and integrate cultural awareness into information and tool designs, training, and resources.

Recommendation Five

A leader in aquaculture research and development, Sea Grant should expand its capacity and build greater awareness of the Sea Grant network's substantial role in aquaculture. Through its locally based research and extension programs, its national perspective, and its longstanding history in developing aquaculture, Sea Grant is ideally positioned to play an expanded role in helping the Department of Commerce and NOAA achieve their goals to lower the nation's seafood trade deficit by boosting domestic production.

Response

In 2018, Sea Grant initiated support of a academic national aquaculture liaison to strengthen aquaculture coordination and knowledge-sharing across federal, university-based, and industry professionals. In 2019, Sea Grant committed to investing $16 million of aquaculture appropriations over three fiscal years to support research and collaborative programs aimed at advancing sustainable aquaculture in the U.S. through three targeted programs: 1) Advanced Aquaculture Collaborative Programs, 2) Exploring New Aquaculture Opportunities, and 3) Social, Behavioral, and Economic Research Needs in Aquaculture. Sea Grant is also investing $15 million of Sea Grant base and aquaculture appropriations over two years to support local and regional aquaculture activities. These nationally-driven investments are over and above local investments by individual Sea Grant programs. In response to the effects of COVID-19, Sea Grant quickly provided $2.5 million in support of the U.S. aquaculture industry in rapid response projects. Continuing to support the university-based professionals within its network, Sea Grant's recent efforts and investments have positioned the aquaculture industry for a strong future.

Researchers funded through the Sea Grant American Lobster Initiative prepare to deploy a larval tow. Credit: Maine Sea Grant

The Sea Grant Model

In 1966, Congress passed the National Sea Grant College and Program Act, which charged the federal government to develop a network of Sea Grant Colleges modeled after the Land Grant College system. This model combines research with public engagement through its extension services and education programs. Sea Grant extension can be defined as the delivery of scientific research and knowledge to fishers, community leaders, and other Sea Grant stakeholders, as well as the collection of their needs to inform new scientific inquiry. From the beginning, it was anticipated that the three pillars (research, extension, education) and the network of cooperating universities would be mutually supportive. Time has shown that the vitality of coastal and Great Lakes communities, their habitats, and their ecosystems, together with the marine resources upon which these communities depend, have benefited from Sea Grant's programs far more profoundly than even Sea Grant's founders could have imagined.

Central to the power of the Sea Grant model is the synergistic interplay of goal-directed research conducted by many of our nation's finest scholars with the rapid and sustained delivery of that knowledge toward solving problems and making better informed choices. Sea Grant's use-inspired research agenda is informed through stakeholder input and is directed toward solving both local and national coastal and Great Lakes issues. The education and development of new generations of human resources in diverse fields is intimately integrated into both Sea Grant's research and extension activities. A balanced investment in research, extension, and education is the commitment of a multitude of individuals in academia, government, and industry through the Sea Grant network. Their contributions support the economic and environmental vitality of our nation's oceans, coasts, and Great Lakes and the communities that depend on them.

Focus Areas

Sustainable Fisheries & Aquaculture

While the global supply of wild-capture fisheries reached its limit decades ago, demand for seafood continues to increase. Currently, over 90% of seafood consumed in the U.S. is imported, resulting in an annual domestic seafood trade deficit approaching $20 billion (NOAA Fisheries). Sea Grant has been supporting wild fisheries and aquaculture for nearly its entire 54-year history by investigating science based, sustainable production methods; transferring techniques and technologies to stakeholders; and educating consumers on how responsibly farmed aquaculture products can complement our nation's robust wild fisheries.

Sea Grant Creates Tools to Advance Ecosystem-Based Management

Ecosystem-based management is a holistic approach to managing fisheries that accounts for all species in the ecosystem including humans. For decades, Sea Grant has conducted research and created tools that managers use to better manage ecosystems, such as new experimental designs to estimate reef fish abundance in the U.S. Gulf of Mexico (Mississippi-Alabama Sea Grant Consortium) and data visualization and analysis tools to better inform fisheries and resource management (MIT Sea Grant).

Sea Grant Responds to the Needs of Fishers

Texas Sea Grant promotes new materials and technology for the shrimp fishery to reduce fuel expenses and increase compliance for bycatch reduction devices. Such best practices lower incidental takes of endangered sea turtles and fish. Oregon Sea Grant's Seacast forecasting tool assists commercial fishers with decision making regarding ocean conditions such as bottom temperature and salinity. Florida Sea Grant's Florida Friendly Fishing Guide certification program increases the sustainability of recreational fishing, which contributed an estimated $100 billion to the U.S. Gross Domestic Product in 2016 (*National Marine Fisheries Service, 2018.*)

Sea Grant Assists with Siting of Aquaculture Farms

Woods Hole Sea Grant and its partners helped create an online GIS-based mapping tool called MA-ShellfAST to support siting and permitting for nearshore shellfish aquaculture. Maine Sea Grant supported researchers to launch web-based tools to help shellfish farmers, researchers, and resource managers use high-resolution satellite images to evaluate suitable sites for lease applications. Connecticut Sea Grant and its partners established an 800-acre commercial shellfish farm in the Mystic River after first-of-its-kind testing verified that water quality near a recently upgraded municipal sewage treatment plant met public health standards.

Sea Grant Assists with Aquaculture Business Development

A partnership led by the South Carolina Sea Grant Consortium gave triploid oyster seed to growers across the southeast region to supply the rapidly emerging oyster-farming industry. The total economic benefit attributable to the Consortium for 2018 and 2019 was over $4 million. Wisconsin Sea Grant advises and assists Superior Fresh, the world's largest on-land aquaponics operation that employs more than 70 people and produces about 4,000 pounds of salmon per week. When New Hampshire Sea Grant's AquaFort is deployed, it will increase investment and employment opportunities in offshore aquaculture with an annual potential of 20-tons of fresh, local seafood. AquaFort is a multi-trophic, open-ocean aquaculture system that supports steelhead trout, mussels, and kelp.

Sea Grant Works on Seafood Safety and Marketing

As in many Sea Grant programs, Maryland Sea Grant has been a leader in adapting the Hazard Analysis Critical Control Point (HACCP) program for seafood and continues to provide training for certifying seafood specialists. Virginia Sea Grant helped rewrite safety plans to allow a major supplier to sell steamed crabs, shrimp, and lobster to military commissaries in the Washington, DC area. During the COVID-19 pandemic, Sea Grant has expanded direct marketing vital to commercial fishers and aquaculture, such as **Louisiana** Direct.

> "In creating the Long Island Sound Blue Plan with Connecticut Sea Grant, "I was afforded every opportunity to offer my input, through a collaborative process that considered current and historic data as well as fishermen's direct observations and opinions. I, and the fishermen of Connecticut, wanted to be involved in order to give an accurate first-hand account of the resources we rely on, the nature and scope of our activities, and our concerns for the future."
>
> *– Joe Gilbert, Owner of Empire Fisheries*

Local seafood cooked during a Louisiana Sea Grant seafood demonstration. Credit: Louisiana Sea Grant, 2018

Amber Morris, the fish buyer for Local Ocean's restaurant and fish market in Newport, Oregon, fillets a Chinook salmon. Credit:Tiffany Woods, 2019

Resilient Communities and Economies

In 2016, 127 million people, or approximately 40% of the nation's population, lived in coastal counties employing 56.8 million people, earning $3.5 trillion in wages, and producing over $8.6 trillion in goods. Next to petroleum extraction, tourism and marine shipping-associated industries are the dominant contributors to our coastal economy, with the leisure and hospitality sector employing ~6.7 million people and adding $366 billion to the gross domestic product (NOAA Report on the Ocean and Great Lakes Economy). The growth of coastal communities and economies increases their vulnerability to extreme weather, tsunamis, and catastrophic events such as the Deepwater Horizon oil spill. Sea level rise poses risks for low-lying communities and exacerbates the impacts of storms and other hazards. Development ordinances have generally not accounted for the increasing risks of coastal flooding, the resulting impacts to natural and built environments, or the unintended consequences of the actions of one community on nearby communities. Sea Grant's research, extension, and education build capacity at the local level to assess and reduce risk to local communities.

Sea Grant Addresses Coastal Flooding

In 2018, the mayor of Charleston, SC, made addressing severe flooding his first priority. The **South Carolina Sea Grant Consortium**, working with the City directly and through the Charleston Resilience Network, secured more than $1 million in competitive funding from NOAA and the U.S. Department of Homeland Security to support mapping, community engagement, and planning to eliminate or reduce flooding impacts. When flooding from Hurricanes Florence and Michael impacted coastal shellfisheries, North Carolina Sea Grant documented the damage and assisted in accessing disaster benefits.

Sea Grant Trains Future Adaptation and Resilience Professionals

Rhode Island Sea Grant's Senior Capstone Studios is an example of how Sea Grant trains the next generation of professionals in adaptation and resilience design for coastal communities. Undergraduate students gain real-world experience working for coastal clients on projects to help communities plan for the effects of climate change on their natural and built infrastructure. Participating students reported receiving job offers before graduating, while communities are using student ideas to jumpstart planning for vulnerable areas.

Sea Grant Brings Water Quality and Quantity into Urban Planning

Illinois-Indiana Sea Grant assisted the Chicago Metropolitan Agency for Planning to research, develop, and integrate water management into their regional comprehensive plan guiding funding, regulations, and planning options. The plan continues to influence how seven counties and 284 communities in the Chicago area grow, benefiting over 8 million residents by ensuring planning for abundant and high-quality water resources.

Sea Grant Provides Tools for Adapting to Sea Level Rise

University of Hawai'i Sea Grant played a key role in developing the State Sea Level Rise Vulnerability and Adaptation Report endorsed by the Hawai'i State Climate Commission and adopted by the Governor. The report was incorporated into the Fourth U.S. National Climate Assessment. The Mayors of Honolulu and Maui directed all departments to consider sea level rise risks in future planning and decision making including environmental assessments. For the Washington Coastal Resilience Project, Washington Sea Grant and partners used data and visualizations to produce easy-to-use, updated probabilistic sea level rise projections for the entire coastline of Washington State.

> "The Washington Sea Grant team has been instrumental in helping Metro Parks Tacoma forecast sea level rise, open a dialogue with the public around climate change, and incorporate the emerging scientific data into our planning and construction projects."
>
> — Andrew Austin, City of Tacoma, Metro Parks Tacoma

Healthy Coastal Ecosystems

Sea Grant collects, translates, and applies scientific information to maintain and restore healthy coastal ecosystems.

Sea Grant Advances Restoration of Coastal Habitats

The New Jersey Sea Grant Consortium, with the U.S. Department of Agriculture and local academic institutions, produced a Dune Manual that the NSGO recognized as a Best Management Practice in 2019. Designed for groups seeking to build or restore dunes along beaches, topics include permits/permissions, preparing dunes for plants, increasing success of plantings, and sources of native plants. Virginia Sea Grant research informed a plan to stabilize and reduce erosion of marshes behind barrier islands. A local planning district commission is using their maps of marsh thickness, marsh change, and island stability to ensure the best possible use of dredge spoils in stabilization projects. Pennsylvania Sea Grant worked with private property owners, local land trusts, and state agencies to conserve 28.55 acres of environmentally sensitive land and improve recreational access to 1,931 linear feet of stream.

Sea Grant Reduces Pollution and Improves Water Quality in Local Waterways

Maryland Sea Grant researchers discovered hundreds of new chemical tracers to identify septic-system effluent in streams, providing managers with new tools to track and measure improper functioning among Maryland's nearly half a million documented septic systems. They showed that septic waste is the primary source of pollution in some streams and produced tools to evaluate the best places to improve septic systems or prioritize which should be converted to public sewer. Georgia Sea Grant trained community scientists to monitor the abundance and distribution of microplastics along the Georgia coast, and partnered with local Riverkeepers to incorporate microplastics sampling protocols in Georgia's Adopt-A-Stream program. Coastal zone managers and municipalities use the data to identify microplastic abundances, types, and contamination hot spots for future planning and decision making.

Volunteers participate in a beach cleanup in South Carolina

Sea Grant Tracks and Mitigates Harmful Algal Blooms to Reduce Their Impacts on Coastal Ecosystems and Communities

Sparked by the 2014 Toledo water crisis, when treatment of Lake Erie drinking water for 500,000 residents was shut-down due to Microsystis, the State of Ohio created a research initiative, co-managed by Ohio Sea Grant, that brought policy changes and research to water treatment plants to quickly mitigate the harmful algal bloom (HAB) problem and restore drinking water. Texas Sea Grant funded research on a new early-warning tool to predict and mitigate HABs, helping officials determine when HABs near oyster harvests necessitate fishery closures to avoid shellfish poisoning. Florida Sea Grant helped lead the response to red tide and other HABs that negatively impacted Florida's wildlife and human health in recent years. The program served on the Florida HABs Task Force; convened a HABs State of the Science Symposium; created a HABs liaison position with NOAA's National Centers for Coastal Ocean Science; published a HABs website; and educated local municipalities and residents about potential impacts.

Sea Grant Identifies, Predicts, and Prevents the Spread of Invasive Species

Minnesota Sea Grant conducted outreach that helped decrease the rate of non-native species invasions in Minnesota lakes from 12% to 6% per year, protecting recreational fisheries and shoreline property values. This outreach provided about $6 million in economic benefits to Minnesota. Michigan Sea Grant funded research in 2018-2019 on new models to predict potential habitat for two species of invasive Asian carp in Lake Michigan. The models suggest there may be more suitable habitat than previously predicted, providing essential information for natural resource managers and policymakers seeking to understand and combat the threat of Asian carp.

MIT Sea Grant hosted a marine technology interactive experience at the Cambridge Science Festival. Credit: MIT Sea Grant, 2019.

Environmental Literacy and Workforce Development

Sea Grant is committed to building a diverse and skilled workforce and an informed public engaged and enabled to address critical local, regional, and national needs, and able to thrive in a changing environment. Environmental literacy and workforce development are key to building the environmental story of the oceans, coasts, and Great Lakes, and taking that story to others in tangible, proactive ways.

Sea Grant Builds Knowledge of Marine Resources and Awareness of Career Paths within Diverse Populations of Coastal Communities

Lake Champlain Sea Grant's Watershed Alliance engages directly with K-12 students, trains their teachers, and mentors undergraduate interns and graduate students. It connects communities to higher education by bringing youth into the university and sending university students into communities. Anecdotal examples abound in Sea Grant programs to demonstrate how early environmental literacy can translate into a skilled workforce. Community science programs raise public awareness of issues and contribute needed data for science and management decisions. They combine public environmental literacy with workforce development. For example, New Hampshire Sea Grant's Coastal Research Volunteers participated in researchers' projects including oyster restoration, glass eel monitoring, horseshoe crab surveys, and sand dune restoration.

Sea Grant Trains the Current and Next Generation of Fishers and Aquaculturists

New York Sea Grant's annual Seafood Summit, Ohio Sea Grant's Ohio Charter Captains Conference, Maine Sea Grant's Aquaculture in Shared Waters Professional Training Program, and Alaska Sea Grant's Alaska Young Fishermen's Summit continue to provide mechanisms to build networks, identify mutual goals, and enhance business success through training in business management, regulatory requirements, and environmental stewardship.

PreK-graduate Courses, Internships, and Informal Education Opportunities in Sea Grant Increase Experience in Science and Management

Georgia Sea Grant worked with the City of Savannah and Delaware Sea Grant worked with Delaware Technical Community College students on green infrastructure projects that could lead to "green jobs." Projects built resilience for the coast and estuaries such as urban tree nurseries for low-lying, flood-prone neighborhoods. As in programs across the network, California Sea Grant's State Fellowship program nurtured 44 fellows in 2018-19, many of whom are planning careers in policy, resource management, private industry, and academia. In order to increase the number of trained professionals in an area of national need, Sea Grant partners with the National Marine Fisheries Service and the NOAA Office of Education to sponsor Undergraduate Population and Ecosystems Dynamics Workshops.

After participating in Minnesota Sea Grant's (Sea Grant Center for Great Lakes Literacy) Bioblitz on iNaturalist, "I pay so much more attention to my surroundings and notice so many more differences among varieties of plants and animals. I just can't think of a more effective way of harnessing technology to bring us close to nature,"

– student at K3-K5 Dual Language Montessori, J.W. Riley School, Duluth, Minnesota

Michigan SG Extension Educator Meaghan Gass helps a participant release a lake sturgeon fingerling into the Cass River. Credit: K.O.Reilly, 2018

New Partnerships and Collaborations Support Educational Goals

Woods Hole Sea Grant partnered with Earthwatch on a week-long, residential Girls in Science program to foster high school girls' skills and confidence in science, technology, engineering, and mathematics (STEM). Participants worked with Woods Hole Oceanographic Institution researchers and educators on marine mammal bioacoustics. The Palmetto Environmental Education Certification program is South Carolina Sea Grant Consortium's first environmental education professional certification designed for both formal and informal educators.

Other Focus Area summaries include examples of workforce development as well as those highlighted here. Sea Grant education benefits from the input of industry, university, non-profit, and government workers and returns a qualified and committed workforce to support the nation's coastal and Great Lakes communities, economies, and ecosystems.

Sea Grant by the Numbers

Fall 2020

Sea Grant

For over 50 years, the National Sea Grant College Program (Sea Grant) has supported coastal and Great Lakes communities through research, extension, and education.

34
University-based programs

998
businesses created or sustained

10,404
jobs created or sustained

1,825,793
Acres of habitat restored or protected

Sea Grant's mission is to enhance the practical use and conservation of coastal, marine, and Great Lakes resources in order to create a sustainable economy and environment.

252,047
Volunteer hours

In 2019, a federal investment in Sea Grant of $80 million resulted in

$412.4M
ECONOMIC BENEFIT

1,224
Resilience training events provided to communities

897,729
K-12 students reached

646 SEA GRANT EXTENSION AGENTS
are stationed in communities across the country to advance understanding of coastal and fisheries science for communities and economies that are more resilient.

Metrics are direct results of Sea Grant work between February 1, 2019 and January 31, 2020 as reported by Sea Grant programs in Summer 2020. Economic benefit = market and non-market value of Sea Grant's work; value of jobs and businesses ($316.2M) as well as total leveraged funds ($89.1M) and value of volunteer hours ($7.1M).

Photo credits: Virginia Sea Grant, Oregon Sea Grant, Georgia Sea Grant

COVID-19 Response

Teens and adult family members explore the tide pools at Seal Rock during a day camp organized by Oregon Sea Grant. Credit: Lindsay Carroll

The health, economic, and social disruptions caused by the COVID-19 pandemic highlight the need for collaboration and communication among federal, state, and local governments working together with the private sector, non-profits, academia, and communities. As in other emergencies, Sea Grant remained nimble and pivoted to assist its stakeholders in addressing the impacts of the pandemic on coastal communities and economies.

At the onset of the COVID-19 outbreak, Washington Sea Grant was among the first organizations in the state to reach out to the shellfish industry, providing an online webinar, creating webpages and a social media campaign, and providing COVID-19 resources to the fishing and shellfish industries, educators, and families. The National Sea Grant Law Center, in partnership with the Mississippi-Alabama Sea Grant Legal Program, created a webpage to serve as a clearinghouse of reliable information on CARES Act programs and other issues associated with COVID-19 for the fishing, aquaculture, and seafood industries. These resources include webinars and fact sheets to better understand the CARES Act funding including information for self-employed individuals, tax credits, and returning to work.

Sea Grant programs across the country engaged right away with assisting fishers and aquaculturists with direct marketing their products. *Sea Grant's Seafood Information and Resources* webpage for both wild harvest and aquaculture professionals provides information on news and updates, aid and relief assistance programs, distribution and marketing resources, and human health resources. While content is currently focused on challenges related to COVID-19, it is hoped that this page will serve as a valuable resource to the U.S. seafood industry well into the future.

Sea Grant's Education at Home webpage now shares coastal and marine science home learning activities from 26 Sea Grant programs. These include live and recorded events, virtual field trips, interactive games, and more.

Recent events have shown the indispensable value of trust and long-standing relationships to effectively confront global challenges, while applying the best-available science and an understanding of the needs and priorities of the American public. **University of** Guam Sea Grant created a Public Service Announcement about behaviors that will help Guam's population survive the pandemic, while encouraging activities to enhance Guam's long-term sustainability. University of Puerto Rico Sea Grant, which has been helping citizens recover from devastating hurricanes in 2017 and earthquakes in 2019, provided remote meetings and working arrangements during the pandemic to allow staff and clients to securely access virtual communications, technologies, and platforms, building resilience to future emergencies, both in infrastructure and in the fabric of society.

Featured Issues

The Blue Economy

The Blue Economy is the sustainable use of ocean resources for economic growth, improved livelihoods and jobs, and ocean ecosystem health (World Bank). Growing and sustaining a Blue Economy will require research, development of new technologies, collaborative approaches, and implementation of integrative and resilient practices. With an economic benefit of $412.4 million supporting 10,404 jobs between February 2019 and January 2020, Sea Grant is an essential component of the economic engine driving the U.S. Department of Commerce and NOAA's leadership roles in the Blue Economy. Sea Grant provides direct partnerships with our nation's top universities, and Sea Grant staff are viewed as trusted collaborators with our coastal communities and stakeholders, enabling two-way communication on needs assessments, support for pressing needs, job creation across the economic spectrum from trainees to business owners, dispute resolution, and delivery of results to help build resilient ocean, coastal, and Great Lakes economies.

Support for our nation's fishing and aquaculture industries, with the goal of sustainable seafood production, is a hallmark of Sea Grant's research and outreach. Though diverse in program breadth, the nimbleness of Sea Grant allows flexibility to strengthen local and regional investments. For instance, Sea Grant supports research and outreach for Atlantic salmon aquaculture production in New England and the Great Lakes, while supporting wild salmon production on the Alaskan and Pacific coasts. Sea Grant was also asked by Congress to lead a stock assessment, utilizing the latest technological advances, for key finfish species under multiple fishing pressures in the Gulf of Mexico.

Sea Grant has long been invested in coastal community resilience, a key to establishing a sustainable Blue Economy. With increasing storm intensities, rising sea levels, and increased coastal inundation, it is even more important to develop plans and ordinances that enable rapid economic recovery. In planning for future economic resilience, Sea Grant provides scientific support for offshore renewable energy endeavors, such as proposed wind farms. An interdisciplinary approach utilizing Sea Grant's link with university partners enables engagement of top academic researchers to work with states and municipalities in diverse fields such as coastal engineering, ecological modeling, landscape architecture, economics, and social justice.

Understanding the economic and environmental roles of tourism and recreation on our coasts is important in building a resilient Blue Economy. For example, Sea Grant has been at the forefront of establishing tourism-related trails for paddlers and kayakers, fostering understanding of fisheries heritage, and promoting seafood at the local, state, and regional levels. It offers training and professional development courses for tourism for professionals such as charter captains, ecotourism operators, tour guides, and other partners. Sea Grant's investment in the Clean Marina program encourages sustainable practices while promoting a marketable certification.

Sea Grant brings together research, extension, education, and communications experts to ensure that the best decisions are being made to build and sustain the nation's Blue Economy.

A Weather Ready Nation (WRN)

In 2016, the U.S. had more floods than any year on record, and in 2019 the Mississippi River Basin experienced its longest flood, 223 days duration, exceeding the Great Flood of 1927 (*NOAA NCEI*). The coastal zone experienced unprecedented impacts during the 2017, 2018, 2019, and 2020 hurricane seasons including Hurricanes Harvey (Texas/Louisiana, Aug 2017), Irma (Florida/Puerto Rico, Aug–Sep 2017), Maria (Puerto Rico and U.S. Virgin Islands, Sep 2017), Florence (North Carolina/Georgia/South Carolina, Sep 2018), Michael (Florida, Oct 2018), Dorian (Puerto Rico/Bahamas/Florida/Georgia/North and South Carolina, 2019), Isaias (North Carolina, Aug 2020), Laura (Louisiana and Texas, Aug 2020), and Sally (Alabama/Florida, Sep 2020). Improved forecasting for response to and mitigation of such events reduced the potential impacts of severe flooding and dangerous storm surges to communities across these coastal zones, helping to save lives and protect property. Sea Grant's actions have demonstrated the critical importance of combining improved forecasts and warnings with trusted ambassadors from place-based organizations like Sea Grant to reduce negative economic impacts and increase public safety.

Sea Grant enhances the mission of the National Weather Service (NWS) by informing, educating, and communicating with the public. At the national level, Sea Grant supports the external engagement strategy of the National Water Center by building linkages to the Sea Grant network, and Sea Grant has placed ten extension specialists in liaison positions to improve NOAA's contact with its user communities. At the state level, the Sea Grant network provides local resources to several components of the WRN program for diverse weather events including hurricanes, droughts, snow and ice storms, floods, tsunamis, lightning strikes, and tornadoes, as well as rip current awareness, improved visualization of hazard forecasts, and handbooks to improve flood resilience. Twenty Sea Grant programs currently serve as WRN Ambassadors, and all are encouraged to consider this valuable partnership. Using their trusted reputation in local communities, Sea Grant extends NWS messages of potentially life-saving information among a broader and more diverse suite of stakeholder groups. Sea Grant messaging, information, and methods directly impact the goals of the WRN Ambassador Initiative with, for example, university partnerships that promote innovative, resilient coastal design projects. Sea Grant programs have launched studies to understand climate change and adaptation strategies to broaden and enhance WRN impacts by improving storm-warning communication, using social science research to improve storm warnings and preparedness.

This challenge to Sea Grant will increase in years to come. The number of extreme weather and climate events causing at least $1 billion in economic losses has increased roughly 400% since the 1980s (*Uccellini and Ten Hoeve, 2019*). There is growing evidence that extreme weather, water, and climate events are increasing in frequency and severity, while the impacts of coastal storms are also exacerbated by rising sea levels related to our changing climate. Sea Grant is well positioned to meet these challenges.

Climate Adaptation and Mitigation: Protecting and Responding to Climate Impacts

Coastal and Great Lakes communities are increasingly concerned about climate-driven impacts on coastal ecosystems and infrastructure including follow-on social and economic impacts. However, many communities require technical support to employ the breadth of scientific, technical, and decision-making information and tools available to address their local vulnerabilities. Sea Grant works closely with partners to conduct climate-related research, co-develop products with affected stakeholders, and provide services that lead to more resilient coastal and Great Lakes communities and economies.

Sea Grant leads multidisciplinary efforts supporting climate adaptation and mitigation planning, providing locally relevant research, guided by the needs of stakeholders, that leads to scientifically sound and actionable information. This approach facilitates the ability of states, counties, and local governments to prepare for current and projected vulnerabilities through policy and regulatory changes, natural resource protection, structural and non-structural intervention and investment, and adaptive management. For instance, Sea Grant is helping states research and map climate-related impacts such as storm surge and extreme precipitation on private homes, public infrastructure, wetlands, and other resources, with the goal of creating permitting processes that require applicants to consider the impacts of current and future hazards. Since 2008, Sea Grant has invested $16 million* in research funding to increase understanding of the effects of ocean acidification and associated impacts on coastal and Great Lakes communities, ecosystems, fisheries, and other industries. As another example, Sea Grant is advancing understanding of how coastal and marine ecosystems sequester carbon in sediment and biomass, so called "blue carbon," which helps mitigate climate change.

Sea Grant informs the public and bolsters climate literacy by bringing together experts and affected communities; developing scientifically sound products that are reliable, understandable, educational, and useful to a diverse array of stakeholders and students; and distributing relevant information through a range of media and online platforms.

**Sea Grant investment is total of federal plus match*

Organizational Excellence

Local residents enjoy kayaking on Mill Creek in Hampton, Virginia on Jun 27, 2020. (Photo by Aileen Devlin | Virginia Sea Grant)

To achieve its research, extension, and education goals, Sea Grant seeks organizational excellence by investing in the following:

Sea Grant Rigorously Plans and Evaluates

Sea Grant is committed to careful planning and rigorous evaluation to ensure the program has local, state, and national impacts. Strategic plans are developed for each program, consistent with the plans of NOAA and the U.S. Department of Commerce. Quadrennial reviews are based on the goals and objectives in each program's approved Strategic Plan and comprise site visits to assess performance, management, scope and success of engagement with stakeholders, and degree of collaboration. Results, along with an assessment by an Evaluation Committee to ensure consistency across the network, are used by the NSGO to determine whether each program is: 1) qualified for recertification as a Sea Grant program, and 2) eligible for merit funding. In response to a 2018 recommendation from the Board, Sea Grant expanded its evaluations to include the NSGO and Sea Grant overall.

Sea Grant Assesses Economic Benefits and Impacts

Due to Sea Grant's matching requirement, there is at least one dollar of state and local funds for every two federal dollars spent. Sea Grant has collected economic benefits and impacts data since 2010 and began a public-private partnership in 2017 with Eastern Research Group, Inc. to increase the network-wide capacity to more reliably and more consistently value the economic benefits that Sea Grant programs provide their coastal communities. By 2020, this partnership created more than a dozen tools and best practices that can be used by non-economists in the form of methodology guides and other job aids, to help Sea Grant economically value its work.

Sea Grant Ensures a Strong Legal Framework

The National Sea Grant Law Center is a nationally recognized and respected resource on ocean, coastal, and Great Lakes law. In 2019, Sea Grant designated the Law Center a "coherent area program," elevating it from a temporary project, in recognition of its excellence. The Law Center has conducted critical law and policy research, translated scientific information for policy makers, and reduced legal barriers to the adoption of innovative management strategies that address emerging community needs. The **Sea Grant Legal Network** has programs in five states (**Alabama , Louisiana**, **Mississippi**, **North Carolina**, and **Rhode Island**) and attorneys working with Sea Grant across the country. For example, as the shellfish aquaculture industry grows, legal conflicts can arise as states seek to develop and expand the industry. In response, in 2019-2020, the Law Center and four members of the Sea Grant Legal Network examined legal impediments to shellfish aquaculture. Resulting research and outreach informed policy changes that reduced permitting barriers.

2019 Knauss fellows pose for a photo while volunteering at the 44th annual NOAA Fish Fry. (Photo: Audrey Maran)

Education is Enhanced through Sea Grant's Experiential Fellowships

On Capitol Hill and among federal agencies, Sea Grant's national fellowship programs are well known. Since 1979, the *John A. Knauss Marine Policy Fellowship* program has provided opportunities for students with advanced degrees to work at the forefront of marine science and policy. The collaborative *National Marine Fisheries Service-Sea Grant Fellowship* program has, since 1999, been placing individuals in research positions focused on either population and ecosystem dynamics or marine resource economics as a step towards workforce leadership. The *Coastal Management Fellowship* program fostered by Sea Grant for NOAA's Office for Coastal Management within the National Ocean Service enables postgraduate students to work on projects identified by individual state coastal zone management programs. In addition to national fellowships, individual Sea Grant programs provide opportunities through over 20 state *fellowship programs*.

Sea Grant Addresses Program-Wide Challenges through Visioning

Since 2017, the NSGO has funded Network Visioning to increase the capacity of Sea Grant programs to work and plan together on priority topics. The **Diversity, Equity, and Inclusion (DEI)** Network ensures that Sea Grant continues to infuse DEI principles into its leadership and culture and has led several state and national initiatives. In collaboration with the NSGO and external partners, the DEI community of practice organizes professional development opportunities for Sea Grant employees.

The Capitol Hill Ocean Week event "Increasing Diversity, Equity, and Inclusion in the Coastal, Marine and Ocean Science Workforce," hosted by the Women's Aquatic Network and Sea Grant, brought together panelists from across aquatic sectors for a discussion on workforce DEI. Credit: Audrey Maran, 2019

Two-Way Communications are Fundamental to Sea Grant

Every Sea Grant program is committed to building strong two-way communications networks that bring together Sea Grant's extensive resources with the needs and expertise of coastal businesses and communities. Delaware Sea Grant's recent Coastal Resilience Design Studio brought together educators, students, scientists, science volunteers, engineers, designers, artists, and other academic institutions to develop a large-scale green infrastructure project along a tributary to the Chesapeake Bay that provided habitat, pollution reduction, biodiversity, and recreational opportunities. Bringing together diverse groups, USC Sea Grant organized and facilitated a regional workshop on improving oil spill preparedness and response in Santa Barbara, CA as part of a workshop series with five Sea Grant programs and the National Academies of Sciences Gulf Research Program. Louisiana Sea Grant's Louisiana Discovery, Integration, and Application (LaDIA) program builds better connections among researchers, extension personnel, and constituents to: increase awareness of the sophistication of local knowledge, better target their investigations, and share results, producing more robust research and outreach plans that include input from local partners.

Sea Grant Leads National and Regional Partnerships

Sea Grant partners with other NOAA programs to bring NOAA's research to the network and its stakeholders through Sea Grant *Partnership Liaisons.* In addition to leveraging funds, the liaisons provide a pathway between new research and community audiences. Sea Grant currently hosts 10 liaisons in NOAA labs and programs and announced an opportunity to fund additional liaisons with federal science and service agencies. The Mississippi-Alabama Sea Grant Consortium is a regional and national leader in multi-state, multi-region strategic initiatives, managing $15.8 million in projects covering a broad range of topics related to fisheries, oil spills, hurricanes, flooding, waterways, and restoration. Working with the **University of Hawai'i** and Alaska Sea Grant programs, Washington Sea Grant is leading a three-year grant to advance sustainable indigenous aquaculture practices and enhance seafood production in the Pacific region. The first summit highlighted traditional Hawai'ian aquaculture practices and technologies and included representatives from 13 Pacific Northwest tribes and many more from across the globe. The immediate outcome is shared practices, shared communications, and a long-term commitment to integration of traditional and local knowledge with research, extension, and education.

"...Work with underserved communities serves all of the community." – Arthur Lawrence, Historic Charleston Foundation Oral History Project

Alaska Sea Grant extension agent presents an Alaska fisher with the book, "Fishers Changing the Sea." Credit: Alaska Sea Grant, 2019

2020 Sea Grant Recommendations

Coastal flooding is a major issue for many communities, such as this water overtaking a roadway in Hawaii. Credit: University of Hawaii Sea Grant

The Board finds that Sea Grant has made excellent progress in addressing the 2018 Recommendations and further recommends the following. The Board has no further follow-up on 2018 Recommendation Five on Aquaculture, which is now well-funded and meeting or exceeding the Board's expectations.

Recommendation One:

The National Sea Grant College Program should continue to support the implementation of the Network Vision Plans.

Building on the recommendations from the 2016 and 2018 State of Sea Grant reports, the Board further recommends that the National Sea Grant College Program continue the network vision plans created in 2017 and support their implementation. The vision plans effectively drive action on emerging opportunities and help Sea Grant collaborate with NOAA and other partners by highlighting Sea Grant's role in critical and shared goals. Now that the process is established, the Board recommends, where visioning clearly reinforces program goals, that vision plans be incorporated into Sea Grant's planning processes to support the continued implementation of these visions.

Recommendation Two:

The National Sea Grant College Program should continue and amplify efforts to incorporate social and environmental justice, equity, diversity, and inclusion in its organizational structure and programming.

Environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, religion, sex, age, disability, income, etc. with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. The needs of coastal communities, and Sea Grant's mandate to address those needs, can only be met when justice and equity for all people is realized. Community and economic resilience are enhanced when diverse voices make informed decisions about our collective future. Over the last six years, Sea Grant has developed a national community of practice across its programs to facilitate peer learning and promote leadership on justice, equity, diversity, and inclusion. This effort should be pursued until justice, equity, diversity, and inclusion move beyond being a separate priority/practice and are integrated into all other priorities.

Recommendation Three:

The National Sea Grant College Program should continue to actively seek opportunities and collaborations to leverage Sea Grant's unique strengths in building coastal community resilience.

There continues to be a gap between the nation's forecasts of extreme events and public preparedness and response to these events. Sea Grant, together with its diverse partners, provides university-based research, extension, and education programs to fill this gap, thereby enhancing community preparedness and reducing the loss of life, property, and ecological resources. Sea Grant's strength in facilitating communications and promoting community equity by bringing together scientists, managers, decision makers, and residents builds strong and safe coastal and Great Lakes communities by providing them with the basic knowledge and understanding of the interconnectivity between their lives and the environment. This is achieved by building community capacity to recognize problems and solve them through improved local planning that accomodates the features of local habitats and ecosystems. Sea Grant programs have been conducting resilience-related research and outreach programming for many years, however, impacts to our coasts are increasing and Sea Grant funds to support resilience efforts have not kept pace. Adequate funding would enable Sea Grant, as a network, to get to every coastal community with tailored information and assistance. This capability will continue to be built through partnerships. The resilience of our coastal communities depends on federal, state, local, non-profit, and private organizations all working together with communities to identify synergies and collaboration opportunities, and to clarify roles and expectations.

Recommendation Four:

The National Sea Grant College Program should make adjustments based on the findings and recommendations of the Independent Review Panel and Board Evaluation Committee.

In the 2018 State of Sea Grant report, the Board recommended that the Sea Grant evaluation process include an assessment of the NSGO and the National Sea Grant College Program overall. Reports from the latest evaluation period by the Board Evaluation Committee found (1) the site review process is working well and has matured to a level that is accepted by most of the Sea Grant community, (2) from a government accountability standpoint, the Sea Grant evaluation system is one of the more robust in the federal government, and (3) the most recent iteration of Sea Grant evaluation has continued to improve the evaluation system. Nevertheless, the Board offered a number of recommendations designed to make a good system even better, building a stronger and more effective National Sea Grant College Program and supporting its long-term commitment to continual improvement. The Independent Review Panel is currently in the process of completing its charge.

Emerging Opportunities

Sea Grant programs quickly adapted to offer audiences distance learning options when the COVID-19 pandemic hit. Credit: Woods Hole Sea Grant

Responding to Unanticipated Challenges

While a public health emergency does not normally fall within its purview, Sea Grant's strength in two-way communications and ability to respond to natural and human-made emergencies was essential during the COVID-19 pandemic. Being a trusted source of information and options, a leader in education and outreach, and a facilitator of effective partnerships enabled Sea Grant to address the immediate needs of our partners and coastal communities. During this critical time, Sea Grant advanced new ideas while reinforcing appropriate activities and long-held standards that preserve the sustainability of our nation's oceans, coasts, and Great Lakes. Sea Grant responded to challenges related to the pandemic by providing online resources to enhance at-home STEM education; assisting the seafood industry and other coastal businesses with direct marketing of their products; navigating the complexities of federal and state assistance programs; and working quickly to find innovative ways to connect with and support their stakeholders. Sea Grant has proven its ability to be nimble in order to meet the science needs of constituents as they and our country face new challenges.

Educating the Next Generation

Critical thinking, problem solving, and mastery of new technologies have become increasingly important to most trades and businesses. Education programs from kindergarten to college are challenged to provide experiences and resources that entice students to choose courses and consider careers in STEM. A STEM education teaches students how to solve emerging problems using critical thinking and blending traditional knowledge with new technologies.

Sea Grant's *Environmental Literacy and Workforce Development* efforts across the network are addressing exactly this challenge by bringing students into the real world of scientific inquiry with lessons at school, in the field, at workshops, in laboratories, and in offices. Of particular interest to Sea Grant is reaching underserved populations and encouraging them to pursue STEM careers that integrate their traditional knowledge with new technologies. In 2019, Sea Grant communities of practice in DEI and TLK worked together to develop Community-Engaged Internships (CEI). Interns in **Alaska** measured temperature and flow in streams suggested by tribes based on salmon populations to feed models for predicting salmon futures. In **North Carolina**, Sea Grant coordinated with conservation organizations to host students of color for professional development and networking with employment pathways in mind.

The Sea Grant Educators Network strives to strengthen Sea Grant's impact on education for all students at all levels: K-12, trade, undergraduate, graduate, post-graduate, and informal. Suggestions from the Sea Grant Educators Network include internal steps to build support and visibility for the education network at the national level and within individual programs:

- researching the effectiveness of Sea Grant education approaches and programs, to strengthen program support and illuminate areas in need of expansion or improvement;
- branding of network-wide education efforts to enhance visibility and promote new partnerships; and
- reviewing the Education Network's role in program input and management at the state level.

Sea Grant's education programs are essential for creating a workforce pathway that inspires people curious about the natural world to connect to STEM careers and learn how a marine science workforce can serve people and coastal communities.

Linking to International Goals and Initiatives

The international community is increasing attention to protecting and restoring ocean health, particularly as impacted by Earth's ever-changing climate. Recent international reports, negotiations, and conventions have acknowledged the need for an ocean literate society, proactive decision makers, and a comprehensive, science-based approach to ensure a robust planet capable of supporting the safety and survival of people. Sea Grant is already doing its part—and has been for decades—by remaining at the forefront of actionable science, while serving and closely partnering with coastal and Great Lakes communities across America.

In 2017, the United Nations declared that 2021-2030 would be the *Decade of Ocean Science for Sustainable Development*, to ensure ocean science provides a foundation for better ocean and coastal management around the world. NOAA personnel have played a pivotal role in the U.S. involvement in the U.N. initiative, and Sea Grant is actively engaged in supporting the effort. Sea Grant is particularly poised to advance the United Nations Sustainable Development Goal (SDG) 14, Life Below Water, to conserve and sustainably use marine resources, as well as the goals of the Decade of the Ocean focused on facilitating "the science we need for the ocean we want." SDG 14 is one of 17 SDGs adopted in 2015 toward attaining a more equitable, peaceful, economically vibrant, and environmentally sustainable world by 2030. For example, the High-Level Panel for a Sustainable Ocean Economy brought together 160 experts from 47 countries to highlight the inextricable link between ocean protection and economic prosperity. The panel has produced a series of "Blue Papers" on specific topics since November 2019 and will release a final report by the end of 2020, as resources that could guide relevant actions by global leaders from local to national levels.

Sea Grant works at the science-policy interface, provides a trusted source of information, conducts effective outreach and stakeholder engagement, and drives valuable partnerships across a range of ocean, coast, and Great Lakes issues. These attributes are core to Sea Grant's mission, making Sea Grant an important asset for fully achieving SDG 14, the Decade of the Ocean, and related initiatives.

Program Listing and Highlights

ALASKA

- Research includes ***community science*** to develop resilience to coastal change caused by flooding, erosion, and other hazards associated with a warming planet.
- Alaska Young Fishermen's Summit trains the ***next generation of commercial fishers*** to be successful and help turn the tide on Alaska's "graying of the fleet."
- State Fellowship gives graduate students their first ***career opportunity*** in marine science/policy, attracting top talent in state and federal agencies.

CALIFORNIA

- Lead an effort to inform ***climate adaptation*** planning for central California, informing CA's climate assessment, estimating an economic impact of $2.4 million in costs avoided.
- Real-time ***ocean chemistry monitoring*** helps Humboldt Bay shellfish producers protect oyster larvae by understanding the role of healthy eelgrass beds.
- State Fellowships recognized as leaders in ***workforce development***, leading to careers in policy, resource management, industry, and academia.

CONNECTICUT

- Co-lead the first ***marine spatial plan*** for Long Island Sound, with significant stakeholder input to guide development in the estuary, while protecting traditional uses and users.
- First of its kind testing verifies water quality meets standards near an upgraded sewage treatment plant, resulting in 800 acres in the Mystic River being open to ***commercial shellfishing***.
- In a course developed and taught by Sea Grant and UConn Extension, students help communities deal with real-life, local impacts of ***sea level rise*** and other climate effects.

DELAWARE

- Establish a ***Coastal Resilience*** Design Studio for educators, students, scientists, engineers, artists to provide habitat, pollution reduction, biodiversity, and recreation.
- Fund novel research to evaluate the distribution and risk of ***microplastics*** and identify "hot spots" in Delaware Bay.
- Administer a ***workforce development*** program on professional design/construction skills for coastal green infrastructure, with Delaware Technical Community College.

FLORIDA

- Educate local municipalities and residents about recent ***harmful algal blooms*** that negatively impacted coastal and wildlife populations as well as humans.
- Train more than 200 ***community scientists*** since 2019 to identify, monitor, and report the spread of Stony Coral Tissue Loss Disease, which is devastating Florida Keys Reefs.
- Togther with partners, create a Fishing Guide Certification Program for sustainable boating and fishing methods and environmental ethics to ***reduce impacts*** on fish stocks and habitats.

GEORGIA

- Legal program works with a team of experts and students to help coastal municipalities in FL, GA, SC, NC prepare for vulnerabilities based on likely ***sea level rise***.
- Engages ***community scientists*** in research to monitor the type, abundance, and distribution of microplastics along the Georgia coast for future planning.
- Leverages partnerships to provide training in landscape design and ***green infrastructure*** to decrease flood risk, beautify barren space, and build resilience in Savannah.

UNIVERSITY OF GUAM

- Champions ***justice, equity, diversity, and inclusion*** in STEM by training, recruiting, and retaining a diverse workforce and by serving all of the island's communities.
- Hosts traditional navigation courses to ***preserve Native identity and traditions***, and solve problems in import dependency, urbanization, climate change, and unemployment.
- Create a Public Service Announcement on ***practicing sustainability*** at a time when families are vulnerable to limited food, supplies, and income during the COVID-19 pandemic.

UNIVERSITY OF HAWAI'I

- Create the free ***Homeowner's Handbook to Prepare for Natural Hazards***. Eleven other Sea Grant programs have adapted the handbook for their state or territory.
- Play a key role in developing the State Sea Level Rise Vulnerability and Adaptation Report, leading to both Honolulu and Maui to include ***sea level rise*** risks in future planning.
- Create the weekly television series, Voice of the Sea, which ***highlights positive impacts*** of researchers, cultural experts, community leaders, and federal, state, and local partners.

ILLINOIS-INDIANA

- Assist the Chicago Metropolitan Agency for Planning to integrate ***water management*** into the region's comprehensive plan to guide funding, regulations, and planning.
- Install rain gardens during their Rainscaping Education Program workshops in Indiana, which have the capacity to ***reduce annual runoff*** by nearly 320,000 gallons.
- Collect and properly dispose of over 235,000 pounds, or 118 tons, of medicine through sea Grant-supported ***community programs*** in four Great Lakes states.

LAKE CHAMPLAIN

- Inform ***stormwater management*** policies as Vermont experiences more intense precipitation events, e.g., green infrastructure, rain gardens, and pervious paving.
- As a result of learnings from conferences and workshops, municipalities and the private sector apply less road salt to improve ***water quality*** in Lakes Champlain and George.
- With UVM Extension's Watershed Alliance, connects students and teachers with real-world challenges and scientific research via hands-on ***field science and stewardship***.

LOUISIANA

- A comprehensive, integrated design center with Coastal Sustainability Studio and LASG's Law & Policy Program is a model for a ***cohesive multidisciplinary approach*** to resilience.
- Facilitate the Bayou Carlin Cove Project, a $4 million fishing infrastructure facility for the Port of Delcambre to build economic resilience through ***direct marketing*** of seafood.
- Develop and implement Louisiana Discovery, Integration, and Application wherein Faculty Fellows and Graduate Student Scholars learn sophisticated ***local knowledge***.

MAINE

- The Aquaculture in Shared Waters training program ***builds capacity*** in the aquaculture workforce, stimulates new business development, and diversifies the seafood sector.
- Aquaculture research results in three new ***web-based tools*** to help shellfish farmers, researchers, and resource managers with site selection, as well as new course materials.
- Partner with economists and geo-spatial specialists to develop, pilot, and launch a publication and training to estimate the ***economic impact*** of local working waterfronts.

MARYLAND

- Researchers find hundreds of new chemical tracers to identify septic system effluent in streams, providing ***new tools*** to track and better measure septic system impact.
- ***Seafood technology*** training helps certify 71 seafood specialists in safe handling of seafood under the protocols for Hazard Analysis and Critical Control Point, or HACCP.
- Students and teachers in an ***international partnership*** with Europe share innovative instructional strategies, data, and website tools to compare harbor biodiversity.

MICHIGAN

- Expand the popular Sustainable Small Harbors program to help small coastal communities plan for a ***resilient and sustainable future***.
- Graduate student's new models predict more suitable habitat for two species of ***invasive Asian carp*** in Lake Michigan than predicted, essential information to combat the threat.
- Partner with the Sault Ste. Marie Tribe of Chippewa Indians on activities for sixth-grade students highlighting ***culturally and economically important*** species and careers.

MINNESOTA

- Research is leading to a product to protect ***marine infrastructure*** and boats from biocorrosion and biofouling more effectively, with fewer environmental consequences.
- Outreach helps decrease the rate of non-native species invasion in Minnesota lakes from 12% to 6% per year, ***protecting recreational fisheries*** and property values.
- Developing the Great Lakes Aquaculture Collaborative to assess activities in the Great Lakes, where significant barriers to ***sustainable domestic aquaculture*** remain.

MISSISSIPPI-ALABAMA

- Serve as a leader in promoting regional cooperation in FEMA's Community Rating System to raise ***flood hazard awareness*** and reduce local flood insurance premiums.
- Lead the development of a red snapper experimental design to estimate ***reef fish abundance*** in the U.S. Gulf of Mexico.
- Lead multi-state, multi-region strategic initiatives, managing $15.8 million on topics related to ***fisheries, oil spills, hurricanes, flooding, waterways, and restoration***.

MIT

- Develop an autonomous surface vessel to collect samples for ***ocean acidification*** modeling in support of healthy fisheries, aquaculture, and coastal ecosystems.
- Develop Bayesian intelligent ocean modeling and acidification prediction systems in support of resource management of ***fisheries, aquaculture, and coastal ecosystems***.
- Develop ***data visualization and analysis tools*** to better inform fisheries and resource management in support of healthy fisheries, aquaculture, and coastal ecosystems.

NATIONAL SEA GRANT LAW CENTER

- Participate in the Michigan at a Crossroads Policy Brief Series for the incoming governor on ***invasive species, crude oil transport, and water diversions*** to Great Lakes.
- Examine legal impediments for shellfish aquaculture across the United States to increase knowledge and inform policy changes in order to ***reduce permitting barriers***.
- Create a webpage clearinghouse of reliable information on ***CARES Act and COVID-19*** rules and potential funding for the fishing, aquaculture, and seafood industries.

NEW HAMPSHIRE

- Improve safety and accuracy of aquaculture monitoring with ***new genetic techniques*** to confirm cases, trace causes, and prevent introduction of infectious micro-organisms.
- Expand their integrated ***multi-trophic aquaculture system*** by design and construction of AquaFort to symbiotically support trout, mussels, and kelp in the open ocean.
- Coordinate volunteers providing ***research and education*** services to local marine science organizations and monitoring health and restoration of coastal ecosystems.

NEW JERSEY

- Produce a Dune Manual with partners to guide successful building or ***restoring dunes*** including permits, permissions, preparation, what, when, where, and how to plant.
- Host annual "State of the Shore" media event to advance ***marine and coastal science literacy*** and encourage widespread, sustainable use of the state's coastal resources.
- Support ***coastal stewardship*** by K-12 students experiencing real-world science and connecting their lives to the shore, as they restore critical Delaware Bay oyster habitat.

NEW YORK

- Release the ***Coastal Resilience*** Index to identify vulnerabilities to high-water levels around Lake Ontario, allowing communities and individuals to visualize flooding.
- Design and implement, with partners, the Jamaica Bay Community Flood Watch Program for residents to ***document nuisance flooding***, to refine models and impacts.
- Lead annual summit for professionals in the NY seafood industry to ***build networks*** among the various sectors and to promote and protect seafood resources.

NORTH CAROLINA

- Help mariculture growers ***assess losses*** after Hurricanes Florence and Michael and, with partners, lead efforts to gain state-funded disaster relief for the industry.
- Expand the utility and accuracy of ***wave and storm-surge forecasts***, combining flood predictions with other geospatial data to guide evacuations and resource deployment.
- Fund ***joint fellowships*** for graduate-student projects in Reserves to understand the ecology, nutrient cycling, geomorphology, and effects of invasive species and climate.

OHIO

- Co-manage a research initiative bringing universities and agencies together to address the issue of ***harmful algal blooms*** affecting the safety of Lake Erie drinking water.
- Use ***hands-on learning*** activities to educate thousands of students about Lake Erie, stimulating interest in science and a stewardship ethic for the Lake Erie ecosystem.
- The Ohio Charter Captains Conference helps Lake Erie charter businesses be more ***successful through training*** in business, regulations, and the environment.

OREGON

- Create the Oregon Coast Quests Book and Workshops to ***teach residents*** how to respond to an earthquake or tsunami and practice evacuations.
- Train students through the Oregon Applied Sustainability Experience internship program who, in one case, helped a local business win a national award for ***pollution prevention***.
- Support researchers to work with Fishers to improve ***coastal ocean forecasting***; SeaCast is part of the NW Association of Networked Ocean Observing Systems.

PENNSYLVANIA

- Help the Stormwater Authority of Chester with ***green stormwater infrastructure*** techniques and strategies to improve water quality, the economy, and human health.
- Expand to other states in the region the popular Pennsylvania Field Guide to AIS, for preventing spread and averting long-term ecosystem damage of ***invasive species***.
- Work with partners to conserve in perpetuity 28.55 acres of environmentally sensitive land for passive recreational uses and 1,931 linear feet of stream for ***public fishing***.

UNIVERSITY OF PUERTO RICO

- Deploy Unmanned Aerial Vehicles (UAV's) to assess and create a baseline of ***coastal erosion*** in Western Puerto Rico; and after Hurricanes Irma and Maria, for recovery.
- Implement three peer-reviewed coastal and marine ***ecosystems curriculum education guides*** to teach students the importance of preserving marine and coastal resources.
- Develop a ***climate change curricular guide*** that is being integrated into public school science curricula to foster a better informed and more resilient generation of islanders.

RHODE ISLAND

- Facilitate the development of a Shoreline Change Special Area Management Plan, the nation's first climate change plan to address ***sea level rise*** on a state's entire coastline.
- Facilitate the planning process that led to erecting the nation's first ***offshore wind farm***. Research now shows thriving sea life for anglers and boaters, and more tourists.
- Provide ***real-world experience*** to undergraduate students working with coastal communities to help plan for the effects of climate change on the natural and built environment.

SOUTH CAROLINA

- Provide assistance to the City of Folly Beach to improve its CRS Rating from Class 7 to 4, identifying ways to improve ***flood resilience*** and saving local insurance holders $444 thousand.
- Provide South Carolina Triploid Oyster Seed to oyster growers throughout the South Atlantic region for the first time to supply the ***growing oyster-farming industry***.
- Launch a first statewide Professional Environmental Education Certification program for both formal and nonformal educators to promote ***environmental literacy***.

TEXAS

- Develop a new ***early-warning tool*** to predict and mitigate harmful algal blooms, which helps state and federal government officials protect human health with safe seafood.
- Train Texas shrimp fishers to promote best practices in the use of new materials and technology that saved them money, ***increased compliance***, and reduced by-catch.
- Lead Texas Master Naturalist chapters that, in 2018 alone, contributed 68,297 volunteer hours valued at $1.7 million across Texas coastal communities to restore ***coastal habitat***.

USC

- Facilitate a report on ***climate vulnerability*** for the Los Angeles metropolitan region with stakeholder meetings to gather local knowledge and perspectives on climate change.
- Develop and administer the only comprehensive, longitudinal assessment of ***coastal adaptation*** in the country by assessing the needs of coastal professionals.
- Facilitate a West Coast regional workshop on improving ***oil spill preparedness*** and response in Santa Barbara, CA, including stakeholders and emergency responders.

VIRGINIA

- Through the Resilience Adaptation Feasibility Tool, extension partners work with more than 12 coastal states to improve ***environmental, economic, and social resilience***.
- Incorporate research on barrier islands into a plan for the best use of dredge spoils to stabilize marshes, helping control rapid deterioration due to ***erosion***.
- Rewrite relevant plans to comply with new ***national seafood safety laws***, allowing a major supplier at military commissaries to continue serving steamed seafood.

WASHINGTON

- Create, with partners, a website for the Coastal Hazards Resilience Network that features a site-specific interactive Risk Reduction Project Mapper for ***sea level rise***.
- Create COVID-19 resource webpages for WA families, educators, and the shellfish industry and to increase awareness of ***sustainably harvested*** WA seafood.
- Administer a ***volunteer-based*** early detection, monitoring, and removal program to pre-emptively prevent the settlement of invasive European green crab in the Salish Sea.

WISCONSIN

- Provide coastal engineering outreach to citizens, businesses, and communities to protect homes, coastal structures, and utility infrastructure from record ***high water***.
- Develop a ***green infrastructure*** guidebook to control stormwater. All stormwater permit applicants in Milwaukee are now required to consider green infrastructure.
- Advise and assist the world's largest on-land ***aquaponics*** operation, Superior Fresh, that employs more than 70 people and produces 4,000 pounds of salmon a week.

WOODS HOLE

- Install, with partners, sea level rise markers at two Massachussetts Audubon sites, engaging visitors in informal ***education programs***. Lesson plans are freely available.
- Work with partners to create an online GIS-based mapping tool called MA-ShellfAST to support siting and permitting of nearshore sites for ***shellfish aquaculture***.
- Create and host, with partners, a week-long, residential Girls in Science program for ten students, to develop skills and confidence to pursue a ***STEM education and career***.

"The Sea Grant Community-Engaged Internship program (CEI) offers a great opportunity for someone like me to gain real-world experience in marine and coastal professions, including science communication. What I love about science communication is that it provides the opportunity to raise awareness about conservation work and environmental issues that normally might not be as accessible to people who are outside of the scientific community. I'm excited and grateful that my internship with Sea Grant will give me the chance to develop more skills to help me pursue this career, so that I can continue on this path I've found."

- Logan Bilbrough, 2020 Sea Grant CEI intern, Maryland Sea Grant, Salisbury University

Logan photographing birds along the Millstream Park trail in Centreville, Maryland. Photo courtesy of Laura Wood, 2020

Works Cited and Other Information

Links

National Sea Grant Advisory Board: *https://seagrant.noaa.gov/About/Advisory-Board*

John A. Knauss Marine Policy Fellowship Program: *https://seagrant.noaa.gov/Knauss-Fellowship-Program*

United Nations Decade of Ocean Science for Sustainable Development: *https://www.oceandecade.org/*

State of Sea Grant Biennial Report to Congress 2018: *https://seagrant.noaa.gov/Portals/0/Documents/About/NSGAB/Reports/BiennialReport-2018-Approved-May292018-Accessible.pdf*

Sea Grant Network Visioning: *https://seagrant.noaa.gov/insideseagrant/Implementation/Network-Visioning*

National Marine Fisheries Service/Sea Grant Fellowship: *https://www.seagrant.noaa.gov/NMFS-SG-Fellowship*

Coastal Management Fellowship: *https://coast.noaa.gov/fellowship/coastalmanagement.html*

Sea Grant Fellowship Opportunities: *https://seagrant.noaa.gov/graduate-fellowships*

Sea Grant Liaison Program: *https://www.seagrant.noaa.gov/liaisons*

Sea Grant Environmental Literacy and Workforce Development: *https://www.seagrant.noaa.gov/Our-Work/ELWD*

NOAA Living Marine Resources Cooperative Science Center: *https://www.umes.edu/lmrcsc/*

Citations

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The National Sea Grant Advisory Board is the National Sea Grant College Program's Federal Advisory Committee. The Board advises the National Oceanic and Atmospheric Administration and the National Sea Grant College Program on strategies to address the nation's highest priorities for understanding, assessing, developing, managing, utilizing, and conserving ocean, coastal, and Great Lakes resources.

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On the Cover:

"As an undergraduate at Hampton University, I was funded by the NOAA Living Marine Resources Cooperative Science Center, which provided me with several summer research experiences for undergraduates, research assistantships, and conference presentation opportunities. More recently, I was awarded the NOAA Coral Reef Conservation Program Grant in 2018, which supports my dissertation research at North Carolina State University on coral reef soundscapes and habitat complexity in the Florida Keys National Marine Sanctuary."

- Kayelyn Simmons, 2021 Knauss Fellowship Fellow, North Carolina Sea Grant, North Carolina State University

A car drives through flood waters as high tide creeps into the streets during a nuissance flooding event in Norfolk, Virginia in May of 2020. Photo: Aileen Devlin, Virginia Sea Grant

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