Woods Hole Sea Grant
2018-2023 Strategic Plan

Putting Science to Work for Massachusetts' Diverse Coastal Communities

NOAA National Oceanic and Atmospheric Administration U.S. Department of Commerce

Woods Hole Sea Grant

WOODS HOLE OCEANOGRAPHIC INSTITUTION

County of Barnstable Massachusetts

1. Introduction

The Commonwealth of Massachusetts is one of the smallest states in the U.S. with only 7,800 square miles of total area, yet is the third most densely populated state, with a population of over 6.8 million people. Coastal communities in Massachusetts have seen dramatic growth when compared to the rest of the state. The population in the coastal communities of southeastern Massachusetts (Barnstable, Bristol, Dukes, Nantucket, and Plymouth counties) represents 19% of the total population, and Boston and the North Shore (Essex, Middlesex, Norfolk, and Sussex) represent another 57%. The Commonwealth's 1,980 miles of coastline include extensive wetlands, tidal flats, and salt marshes, totaling 12% of the landmass. Thus, 75% of the population places pressure on coastal watersheds and ecosystems.

The Massachusetts coast is one of the most valuable natural and economic resources of the Commonwealth, providing jobs, transportation, and recreation to residents and visitors. There are 27 distinct watersheds within Massachusetts and critical issues related to the protection of these watersheds include wise planning of both land and aquatic resources. Such planning efforts are in the hands of coastal decision makers, who range from professional natural resource managers to boards or committees consisting of elected or appointed individuals with varying levels of expertise. The fact that towns in Massachusetts have the right to self-governance in local matters (the so-called "home rule"), further highlights the need for planners of all backgrounds to have access to the latest science information to inform decision making.

Despite its small geographic size, the Commonwealth of Massachusetts has many diverse communities—cities, colonial villages, historic mill towns, and rustic farmlands. The Massachusetts marine economy is equally diverse, accounting for $7.4 billion in gross domestic product in 2016 equal to more than one-third of the northeastern U.S. Blue Economy (NOAA,

2019). Sectors include commercial and recreational fishing, tourism, shellfish aquaculture, sand and gravel mining, marine technology, marine shipping, coastal construction and real estate, and recreational boating, totaling more than 95,000 jobs (2016). In spite of a strong economy within the Commonwealth of Massachusetts, there are concerns that need to be addressed to ensure future growth and prosperity. These issues include education and job training, infrastructure for emerging and expanding industries, and balanced and sustained growth. And, at the time of writing, COVID-19 has led to fundamental changes in how these marine-focused business sectors operate, with implications for their needs moving forward.

Massachusetts is served by two Sea Grant programs – Massachusetts Institute of Technology Sea Grant and Woods Hole Sea Grant. In its extension and outreach activities, Woods Hole Sea Grant primarily serves southeastern Massachusetts, including Cape Cod, the islands of Martha's Vineyard and Nantucket, the South Shore along Cape Cod Bay and the South Coast along Buzzards Bay. This region is a center of marine science related industries, including marine instrumentation, fishing, aquaculture, and coastal tourism. People on Cape Cod and the Islands have been engaging in work to recognize and foster the concept of a "Blue Economy". The Blue Economy portfolio includes an array of projects, ranging from sustainable tourism to advanced marine technology. The Cape Cod Chamber of Commerce is defining sustainable goals for this initiative to ensure the economic and environmental vitality of the region. Woods Hole Sea Grant plays a critical role in developing the assets and policies of the Blue Economy that ensure sustainable and resilient communities, not only for southeastern Massachusetts but the entire state.

Many of the challenges identified in the Commonwealth of Massachusetts for sustainable and resilient communities mirror those facing coastal regions throughout the U.S. – discussed extensively in the Pew Oceans Commission report, *America's Living Oceans: Charting a Course*

for Sea Change, and the U.S. Commission on Ocean Policy report, *An Ocean Blueprint for the 21st Century*. In 2009, the Commonwealth of Massachusetts became the first state in the nation to pass a comprehensive Ocean Management Plan and amended this plan in 2015. The amended plan focuses on the advances made in both management and science priorities since 2009 and sets the stage for regional priorities and programs. In 2016, the Northeast Region Ocean Council (NROC) approved the first regional ocean plan, *Northeast Ocean Plan*, with major program objectives directed at improved understanding of critical coastal habitats and resources, tribal cultural resources, socioeconomic conflicts in coastal regions, coastal community vulnerability, climate change impacts to coastal habitats and communities, and ecosystem-based management. The work laid out in Woods Hole Sea Grant's 2018-2023 strategic plan not only aligns with the stakeholder needs in Massachusetts, but will also advance these larger, regionally-focused efforts.

2. Mission

Woods Hole Sea Grant's mission is **to enhance the practical use and conservation of coastal and marine resources by developing and sharing science-based knowledge to create a sustainable economy and environment for the diverse communities of Massachusetts**. To fulfill this mission, we seek input and advice from state and federal agencies, resource stakeholders, and the public, and recruit talent and expertise from public and private academic institutions throughout the Commonwealth of Massachusetts. Our outreach efforts are conducted in a cooperative partnership between the Woods Hole Oceanographic Institution and Cape Cod Cooperative Extension.

3. Strategic Plan Development

The National Sea Grant Program has initiated the development of a national strategic plan that "envisions thriving coastal ecosystems and communities that are supported by an engaged public and informed decision-makers" (*National Sea Grant College Program Strategic Plan: Charting the Course for the Future, 2018-2021*). 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. Woods Hole Sea Grant shares this vision for our coasts and supports directing efforts and resources toward sustaining "our natural resources in ways that capture the economic, environmental and cultural benefits they offer, while preserving their quality and abundance for future generations."

Achieving this goal requires: (1) acquisition of science-based information on how ecosystems function and how human activities affect habitats and living resources; (2) education of citizenry to inform them of the complexities of coastal environments and the interactions between human use and coastal ecosystem health; (3) development of decision-making processes that include the best scientific and technical information, the engagement of citizen stakeholders, and involve mechanisms to evaluate trade-offs between human and environmental needs; and (4) incorporation of the social sciences into ecosystem-based management decisions.

With these goals in mind the National Sea Grant College Program has identified four focus areas for the 2018-2021 Strategic Plan: Healthy Coastal Ecosystems (HCE), Sustainable Fisheries and Aquaculture (SFA), Resilient Communities and Economies (RCE), and Environmental Literacy and Workforce Development (ELWD). These focus areas evolved from previous strategic plans and highlight the most critical needs in coastal regions of the United States. These areas also build on strategic goals of NOAA and the unique strengths and capabilities of the Sea Grant network.

Development of the 2018-2023 Woods Hole Sea Grant Strategic Plan builds on the national plan, but also focuses on issues that are of greatest importance to the Commonwealth of Massachusetts and the Northeast region. In developing this plan, Woods Hole Sea Grant conducted a survey soliciting input on issues of concern from local citizens including coastal property owners, coastal business owners, natural resource managers, regulators, educators, researchers, commercial and recreational fisheries members, and environmental group representatives throughout the Commonwealth of Massachusetts. The plan developed by Woods Hole Sea Grant was also informed by our stakeholder advisory board, the Marine Outreach Guidance Group (MOGG). To reach our desired goal of a widely-distributed survey to engage the public and achieve a greater understanding of the needs and concerns of as many stakeholders as possible, it was sent to our main listserv, the 905-member Southeastern Massachusetts Coastal Organization (SEMCO), emailed directly to community partners and constituents, posted to our Facebook page, and distributed through communication outlets of other organizations with which we have a relationship, such as the Massachusetts Aquaculture Association. The main survey questions are listed in Table 1.

Table 1. Survey Questions

1. How familiar are you with Woods Hole Sea Grant (WHSG)?
2. Woods Hole Sea Grant staff assembled lists of issues and activities on a number of marine and coastal topics. WHSG would like to know which issues and activities you think are the most important within these topic areas. Fisheries, Aquaculture and Seafood. Please choose four specific issues and/or activities you think WHSG should allocate staff time and financial resources to in the coming years. You can add topics of your own under "Other".
3. Kindergarten-12th Grade Education: Please choose four specific issues and/or activities you think WHSG should allocate staff time and financial resources to in the coming years. You can add topics of your own under "Other".

4. Water Quality: Please choose four specific issues and/or activities you think WHSG should allocate staff time and financial resources to in the coming years. You can add topics of your own under “Other”.
5. Marine Debris: Please choose four specific issues and/or activities you think WHSG should allocate staff time and financial resources to in the coming years. You can add topics of your own under “Other”.
6. Flooding and Sea Level Rise: Please choose four specific issues and/or activities you think WHSG should allocate staff time and financial resources to in the coming years. You can add topics of your own under “Other”.
7. Storms and Erosion: Please choose four specific issues and/or activities you think WHSG should allocate staff time and financial resources to in the coming years. You can add topics of your own under “Other”.
8. Research: WHSG invests approximately $500,000 each year to fund cutting-edge research focused on addressing coastal challenges. Over the 2020-2022 period, WHSG invested in research in four topic areas: microplastics in the environment, shark-seal-human interactions, river herring life history, and shoreline/inlet management. Below is a list created by Sea Grant staff on potential research priorities to invest in for the next round of funding. Please choose four specific issues you think WHSG should focus research funding on in the coming years. You can add topics of your own under “Other”.
9. In your own words, what are the top 3 coastal and/or marine issues in Massachusetts that you care most about?
10. Woods Hole Sea Grant is committed to building inclusive research, extension, communication, and education programs that serve people with unique backgrounds, circumstances, needs, perspectives, and ways of thinking. Do you have ideas on how WHSG can engage in work that advances diversity, equity, and inclusion in marine sciences in Massachusetts?
11. How do you get news about WHSG activities? Please select all that apply.
12. Please tell us how often you use or read the following WHSG communication resources
13. Are there other communication outlets we should be using?
14. How important to you personally are the following in-person activities where you can hear directly from researchers and extension agents?
15. Are there topics for which you would like WHSG to create informational products?
16. How can WHSG support at-home learners in grades K-12 if Fall classes are not in person or held in a hybrid model (some students in the classroom, others at home)?
17. How can WHSG support teachers if K-12 Fall classes are not in person?
18. Have any of the following WHSG resources or products been useful to you in dealing with the disruption to usual life since March 2020? Please check all that apply.

Response to the survey was strong, with 317 respondents, 74 percent of whom indicated they were somewhat, very, or extremely familiar with WHSG. Of the respondents that listed their zip code, 73 percent were from the five counties in southeastern Massachusetts, 15 percent were from other MA counties, and 12 percent were from outside of the state. Respondents were asked to choose from a list developed by staff, four specific issues and/or activities they thought WHSG should allocate staff time and financial resources to in the coming years within seven specific topic areas of Fisheries, Aquaculture and Seafood, Kindergarten-12th Grade Education, Water Quality, Marine Debris, Flooding and Sea Level Rise, Storms and Erosion and Research. They were also given the opportunity to list the top three coastal and/or marine issues facing Massachusetts in their minds. The full survey and results can be found at: https://www.surveymonkey.com/results/SM-LB89PVWB7/. All responses to the survey were submitted anonymously to protect the identity of respondents.

In **Fisheries, Aquaculture and Seafood**, responses varied depending on how the respondents identified themselves. Respondents involved in aquaculture selected 1) shellfish veterinary disease monitoring and 2) growth and survival monitoring, as well as 3) working in partnership with shellfish farmers on growing techniques for native shellfish species, 4) providing technical assistance to the aquaculture industry and 5) assisting town shellfish and natural resource departments on marine science and resource management topics. Those who identified as "*commercial fisheries*" prioritized a similar set of topics but with the addition of local seafood market and product development. For both *natural resource managers* and *recreational fishers* the topic "Ocean and coastal acidification and other potential environmental impacts on shellfish growth and survival" was in the top four, and natural resource managers also prioritized, "Assist town river herring wardens, committees, and volunteer herring count programs.

Opinions on where efforts should be focused for **Kindergarten-12th Grade Education** also varied among categories of respondents. *Educators* chose as their top 4 activities: webinars on marine topics developed for students but open to all, maintain a curated list of on-line resources for educators organized by grade level/topic, professional development workshops, and virtual visit by classrooms to local scientific research facilities. *Parents or guardians* of K-12 students chose as their top four activities: educator professional development workshops, organize field trips, demonstration kits or lessons that teachers and home school educators can borrow for classroom or home-learning use, and mentoring/curriculum development support for teachers.

In the area of **Water Quality,** nitrogen remediation mitigation efforts rated highest, with habitat/ecosystem restoration a close second. Respondents also recommended WHSG efforts be directed toward the monitoring of climate change impacts and long-term water quality. **Marine Debris**-related questions indicated a strong desire for the program to focus on prevention efforts, with reducing marine debris at the source the top response, followed by behavioral change to reduce the use of plastics. The next two high-ranking responses included identification, removal and prevention of derelict fishing gear and the study of plastics in the ocean.

In **Flooding and Sea Level Rise**, survey-takers supported most WHSG efforts and ideas relatively equally. However, those that rose to the top were (1) efforts directed toward sea level visualization tools, (2) public information meetings on flooding and sea level rise risks, (3) building code and floodplain regulation assistance to towns, engineers, consultants and (4) flood risk information for property owners and realtors. Assistance with flood-specific emergency response and post-disaster plans for towns was in the top five. The subset of survey takers that identified as c*oastal or floodplain property owners* chose the same priorities.

Of all people who responded to the question on **Storms and Erosion**, the top four

recommended activities were for WHSG to (1) advise towns, engineers and consultants on coastal erosion and Wetlands Protection Act issues, (2) evaluate different types of coastal landscaping projects for erosion reduction, (3) engage members of the public on storm monitoring and documentation, and (4) work on storm damage visualization tools. *Coastal or floodplain property owners* shared these priorities with the addition of educational handout materials on erosion and coastal hazards.

For the **Research** category, respondents recommended that funding be allocated toward two climate change issues: coastal wetland vulnerability and protection and water quality impacts and mitigation. Improving the long-term viability of fisheries and coastal nutrient pollution mitigation were the next two areas of encouraged investment.

The program also asked respondents to list, in their own words, the **top three coastal and/or marine issues in Massachusetts** that they care about. Eight hundred and ten (810) responses were received, and each was assigned codes based on (1) the four Focus Areas, (2) the functional areas of Research, Education, and Outreach, and (3) whether the issue was already being addressed in some way by existing WHSG activities. Most of the responses were in the Healthy Coastal Ecosystems focus area and almost all of the issues could be addressed by all three of the functional areas. Of the responses that fit within the scope of Sea Grant's mission, 73% were issues that WHSG is already engaged in.

Responses were also parsed and summarized using word clouds for four of the survey-takers stated area of specialty including aquaculture, natural resource manager, researcher, and K-12 educator (Fig. 1). Climate change was among the top issues for all but the aquaculture stakeholders, who appear to be primarily concerned with water quality. Interestingly, plastics, presumably those associated with marine debris, was the most frequently cited key word among educators.

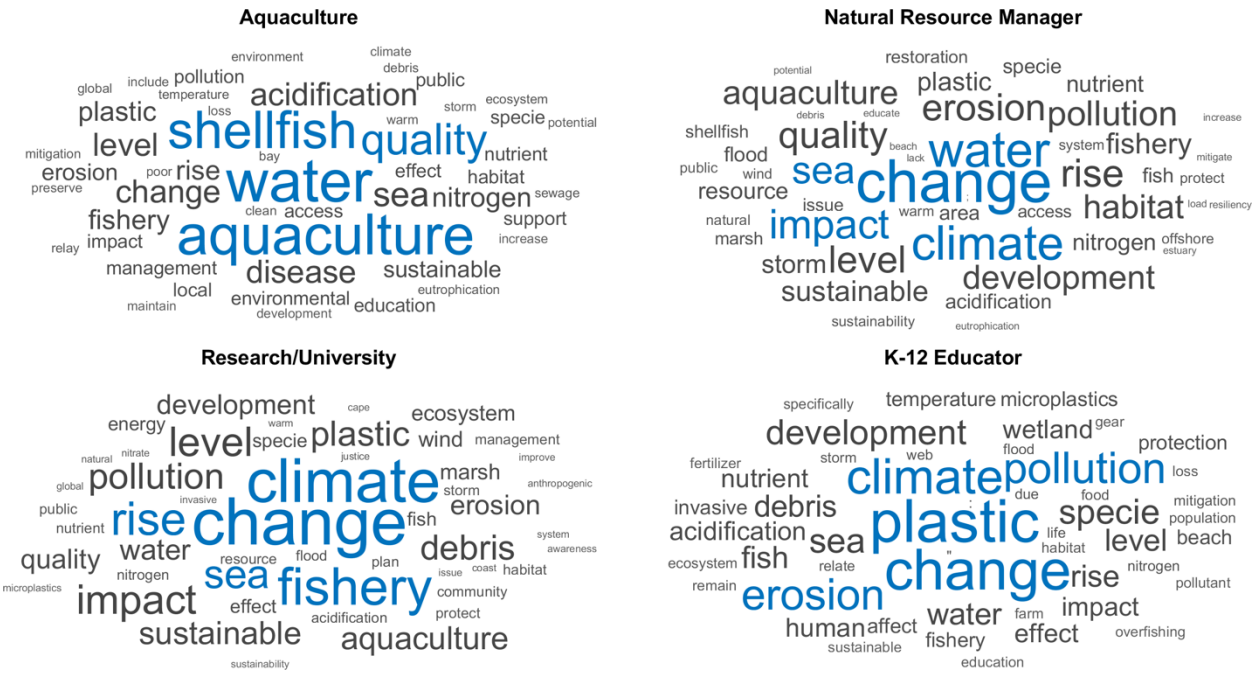

Figure 1. Word clouds separated by stakeholder area of focus for the open response survey question that asked “In your own words, what are the top 3 coastal and/or marine issues in Massachusetts that you care most about?”.

The survey also addressed the program’s commitment to addressing **diversity, equity and inclusion** (DEI) issues within the marine sciences and gleaned a number of valuable ideas to help guide and shape our future efforts in this critical area of concern, with the strongest support for student-focused programming (Fig. 2). The top three suggested areas of DEI advancement in the marine sciences were: (1) K-12 education targeting minority populations, (2) increased community partnerships/collaborations and (3) high school/college-level education/internships for underrepresented/underserved students. It was also suggested that in order to achieve these goals WHSG should consider broadening its current geographic scope to include more diverse communities in Massachusetts, for example, New Bedford and Fall River.

Figure 2. Word cloud for the open response survey question that asked "Do you have ideas on how WHSG can engage in work that advances diversity, equity, and inclusion in marine sciences in Massachusetts?".

Ideas about communications and outreach were also requested, and responses were received with suggestions for outlets and efforts that will help the **Communications** staff better tell the stories and successes emanating from the program. Examples include radio and local access television, two areas where the program has not traditionally been active.

4. Program Focus Areas and Goals

The Woods Hole Sea Grant Program is based at the Woods Hole Oceanographic Institution (WHOI) and supports research, education, outreach, and extension projects that

encourage environmental stewardship, long-term economic development, and responsible use of the nation's coastal and ocean resources. Woods Hole Sea Grant's affiliation with WHOI began in 1971 with support for several individual research projects. In 1973, WHOI was designated a Coherent Sea Grant Program and, in 1985, was elevated to its current status as an Institutional Sea Grant Program.

The Woods Hole Sea Grant Program channels the expertise of world-renowned ocean scientists and engineers toward meeting the research and information needs of users of the marine environment. Public and private institutions throughout the Commonwealth of Massachusetts, and collaborators outside of Massachusetts, participate in the Woods Hole Sea Grant Program. The program adheres to the core values inherent within the National Sea Grant College Program – visionary, collaborative, dedicated to sustainability, and accountable. Inherent in the National Sea Grant College Program and individual state programs is the integrity of being an honest broker of information, distributing information to all relevant stakeholders. Woods Hole Sea Grant embraces the core principles through the following examples:

- *Visionary* – Woods Hole Sea Grant supports innovative solutions to address coastal monitoring, resilience planning, and protection of valuable coastal resources.
- *Collaborative* – Woods Hole Sea Grant seeks partnerships that leverage our strengths, especially within southeastern Massachusetts, but also throughout the entire northeastern U.S.
- *Dedicated to Sustainability* – Woods Hole Sea Grant works with communities to promote sustainable use of natural resources.
- *Accountable* – Woods Hole Sea Grant conducts all activities with integrity and transparency in the support of research, extension, education and communication.

- *Inclusive* – Woods Hole Sea Grant is committed to building inclusive research, extension, communication and education programs that serve people with unique backgrounds, circumstances, needs, perspectives and ways of thinking.

The Woods Hole Sea Grant Program reports directly to the Deputy Director and Vice President for Research of WHOI. Woods Hole Sea Grant works collaboratively with other staff at both WHOI and the Barnstable County Cape Cod Cooperative Extension (CCCE) Service. Through a memorandum of understanding between WHOI and CCCE, the two organizations manage and administer outreach and extension programs. In addition, WHOI's Communications Department and Information Office assist in publication/multi-media preparation and teacher workshop facilitation, respectively. Thus, through these effective partnerships, Woods Hole Sea Grant's relatively small staff leverages the expertise and talent available throughout the parent organizations and extends opportunities throughout the Commonwealth of Massachusetts, with a focus on southeastern MA including Cape Cod and the Islands. Our advisory board (MOGG) provides oversight of program plans and strategic planning. Board membership includes representation from academia, industry, the public media, and government agencies. Through these efforts the Woods Hole Sea Grant Program strives to maintain organizational excellence, engage partners throughout the Northeast region to support program goals, and ensure diversity and inclusion by reaching out to underrepresented or underserved groups throughout the region.

Diversity, Equity and Inclusion

Cultivating partnerships and enhancing diversity, equity and inclusion (DEI) in all program activities will be a major point of emphasis in our implementation of this 2018-2023 Strategic Plan. Woods Hole Sea Grant views DEI as our most important cross-cutting activity, and as such our program goals in this area will guide us in our activities associated with the four

focus areas and across the three functional areas of research, extension, and education. In forming our strategic planning goals for DEI (Table 2), we used a framework offered by the Sea Grant DEI Network Visioning document, "*Reaching Outward and Looking Inward Building Sea Grant Resilience from the lens of Diversity, Equity, and Inclusion*" (2018). The goals are the culmination of three all-staff discussions about the Visioning document in July & August 2020, a breakout group during our August 2020 advisory board meeting, and the wide-ranging and extensive DEI-related responses from the survey: of the 317 respondents, 198 answered the question, "Do you have ideas on how WHSG can engage in work that advances diversity, equity, and inclusion in marine sciences in Massachusetts?". Thus, the final content of this table reflects those ideas provided by our stakeholders, and a desire by staff to (1) reach out to underserved and underrepresented (UU) groups that WHSG has not collaborated with in the past and (2) seek out training through the Sea Grant Network and other providers on best practices related to DEI.

Woods Hole Sea Grant follows the definition of underserved and underrepresented groups that is articulated in the 2018 DEI Network Visioning plan:

> *Sea Grant programs must engage underserved and underrepresented stakeholders and students in order to make more informed recommendations regarding utilization and management of coastal resources. Underserved communities are those that have historically experienced low levels of access to our programming, while underrepresented communities refer to people for whom representation in our programs is smaller than that of the general population. Communities may be underserved, for example, because staff office locations are far away, timing of meetings is not convenient, topics researched are irrelevant, or additional resources are needed to participate in programming. By more fully representing and serving our diverse Massachusetts coastal*

communities, we can begin to realize the potential of their under-tapped resources. With wide-ranging perspectives found only when we engage with UU communities, WHSG staff will find ourselves in a position of enormous opportunity, poised to drive innovation and creativity to solve our most difficult problems as identified herein.

Table 2. Program goals related to Diversity, Equity and Inclusion.

Overall Program Goal	Desired Program Outcomes	Program Vision
Woods Hole Sea Grant Staff improve their ability to reach out to underserved and underrepresented groups and initiate dialogue in a respectful, effective, and coordinated manner.	WHSG staff develop new skills and access new knowledge in the DEI space.	WHSG will incorporate best practices for engaging underserved & underrepresented groups and for developing programming inclusive of traditional knowledge.
		WHSG and its advisory board will regularly review and discuss efforts to reach underserved and underrepresented groups through their programming and activities.
National DEI Vision Goals Specific to Functional Areas	National Desired Outcomes	Program Goal
Research: Sea Grant addresses issues of diversity and underrepresentation of its research reviewers, panelists and awardees**.**	Sea Grant FFOs and RFPs include language that encourages diversity among applicants and communities served. (short-term)	Research funding competitions include language that encourages diversity among applicants as well as activities to promote DEI in the research endeavor.
	SG directors and research coordinators are aware of strategies aimed at broadening participation strategies. (short-term)	We will recruit diverse talent to apply for research and fellowship opportunities by conducting outreach to and building relationships with institutions of higher learning in the state of Massachusetts. Research and fellowship proposal reviewers reflect the
	Diverse institutions, faculty, and students including those that have been underrepresented in prior research portfolios, are	

	aware of and apply for SG research opportunities. (mid-term)	diversity of the scientific community.
		Colleges and universities that serve students from underserved and underrepresented populations are better represented in WHSG's funded research portfolio.
Research: Sea Grant takes a leadership role in stimulating research and scholarship to address topics of value to diverse communities.	FFOs and RFPs are developed to engage diverse stakeholder groups. (short-term)	Advisory board members that represent the range of stakeholder groups are engaged in the development of research funding competitions.
	Stakeholders participate in pre-proposal stage evaluation of the relevance of proposed research projects. (mid-term)	Advisory board members that represent the range of stakeholder groups in the region participate in the pre-proposal review process.
	Diverse stakeholders are engaged in SG research, including participatory or use-inspired research. (long-term)	Community science programs and funded researchers include participation from diverse stakeholders.
	Enhanced accountability and tracing of SG-supported broadening participation efforts through several mechanisms. (long-term)	Principal investigators are asked for demographic information for all project personnel associated with funded research proposals.
Extension: Sea Grant extension staff have the capacity and skills, including knowledge of best practices and demographic data to effectively serve diverse communities.	SG extension staff are aware of best practices for engaging underserved and underrepresented groups	Team members utilize best practices for engaging underserved and underrepresented groups and developing programming inclusive of traditional knowledge.
	SG extension staff have the knowledge to undertake programming that is inclusive of traditional knowledge and is culturally relevant. (short-term)	
	SG extension staff use best DEI practices to engage underserved and underrepresented groups. (mid-term)	

	SG program routinely use standardized collection and analysis of demographic data for planning and decision-making. (mid-term)	Whenever possible, demographic data will be collected as part of post-workshop or training surveys to ensure that all demographic groups are being served by Sea Grant programming.
	SG extension staff share best practices and improve their extension programming based on lessons learned from engagement with underserved and underrepresented communities. (mid-term)	Extension programming is modified using best practices to reach underserved and underrepresented groups.
	SG extension staff undertake programming that is inclusive of traditional knowledge and culturally relevant; they engage audiences and address coastal challenges with socioeconomic and historic lens. (long-term)	Team members will engage directly with demographic and socioeconomic groups not worked with in the past in order to learn more about the challenges they face and how Sea Grant resources may be able to assist.
Education: Sea Grant educators and fellowship administrators have the capacity, skills, and knowledge of best practices and demographic data to effectively serve diverse communities.	Increase in number of SG educators and fellowship administrators that have participated in education- and fellowship-related DEI programs. (short-term)	Team members will develop, facilitate, and deliver relevant STEM resources and opportunities for underserved and underrepresented-serving educational organizations.
	Administrators/faculty at K-12 institutions, homeschool groups, technical schools, community colleges, HBCUs, MSIs, tribal colleges, community-based organizations, and other underserved and underrepresented-serving organizations are aware of SG teacher trainings and student programming, internship, research, and fellowship programs. (short-term)	
	SG educators and fellowship administrators are aware of DEI best practices to build capacity for education efforts and	Team members will participate in DEI training through the Sea Grant Network and our home

	fellowship programs that incorporate DEI considerations. (mid-term)	institution to stay current with best practices.
	SG educators and fellowship administrators have strong relationships and partnerships with organizations serving underserved and underrepresented communities. (mid-term)	WHSG will build and maintain relationships with educators in underserved and underrepresented communities.
	Models of best practices for environmental education that reflect DEI considerations are widely available to SG educators. (long-term)	DEI considerations will be given for all existing and new educational programming with lessons learned to be shared with the Sea Grant Education Network to foster a culture of best practices.
Education: Sea Grant trains a coastal and marine workforce that represents the demographics of the locations where Sea Grant programs operate.	K-16 and informal educators who serve underserved and underrepresented communities are aware of coastal and marine STEM career pathways	Team members will create opportunities for high school and college students, including those from underserved and underrepresented groups, to explore and pursue careers that support coastal communities and the scientific workforce.
	Students from underserved and underrepresented groups are aware of SG fellowship, internship, and research assistantship programs, and have access to resources to be competitive applicants. (mid-term)	WHSG will maintain a list of student fellowship, internship, and research opportunities, reaching out to those from underserved and underrepresented groups through targeted communications.
Education: Sea Grant prepares an environmentally literate and informed citizenry that is reflective of diverse populations	SG educators are aware of needs of underserved and underrepresented partner organizations as related to SG focus areas. (short-term)	WHSG will engage the advisory board and conduct periodic surveys of stakeholders to assess the needs of underserved and underrepresented partner organizations and develop programming that addresses their needs.
	SG programming reflects education needs and priorities of underserved and underrepresented communities. (long-term)	

Healthy Coastal Ecosystems

The coastal ecosystems of Massachusetts are experiencing trends similar to many other areas of the U.S.: decline in water quality, loss of habitat, invasion of non-native species, and increasing pressure on coastal resources. More specifically, nutrient over-enrichment of coastal waters from wastewater and fertilizer have led to dramatic shifts in the marine ecosystems of coastal embayments, for example, loss of eelgrass beds and the commercially important species that use them for refuge. Nutrient runoff has also exacerbated ocean acidification of coastal waters, which increases the biological stress felt by shell building organisms like oysters, and the prevalence and geographic range of harmful algal blooms (HABs). These are problems that not only impact the environment, but also tourism and fisheries, two integral components of our Massachusetts coastal or Blue Economy.

Solving or mitigating these fundamental threats to healthy coastal ecosystems requires scientific and engineering based solutions. Woods Hole Sea Grant is committed to funding research that addresses these needs, and providing the extension services that will ensure that such protection, enhancement and restoration measures are put into practice by natural resource managers and other key stakeholders.

Woods Hole Sea Grant extension and outreach personnel are well positioned to provide the tools and services needed to sustain coastal ecosystems. We will continue to maintain a network of water quality sensors in southeastern Massachusetts estuaries and make the data available to the farmers that grow shellfish there. Our extension program staff will coordinate a network for river herring managers designed to help current wardens solve problems, set goals, manage conflicts, facilitate discussions with harvesters and other stakeholders, and put their work into perspective. Teacher workshops organized by our education specialist will be

designed to help the next generation of coastal stakeholders understand how climate change will impact coastal ecosystems. New techniques and approaches are added to this portfolio as reciprocal relationships between resource users/managers and scientists, social scientists and engineers identify new problems, develop or facilitate solutions to existing problems, and transfer technical information that can be used in management decisions. Specific goals, outcomes and targets for the Healthy Coastal Ecosystems focus area are listed in Table 3.

Table 3. Program goals related to the Healthy Coastal Ecosystems focus area.

National Plan Goals	National Plan Action	National Desired Outcomes	Program Goal
Habitat, ecosystems, and the services they provide are protected, enhanced, or restored.	Develop and share decision-support tools, technologies and approaches to protect and restore ecosystems.	Scientific understanding and technological solutions inform and improve conservation and the management of natural resources.	Identify, generate, and communicate technical information required to help local natural resource managers protect and restore ecosystems.
		Ecosystem science and conservation priorities developed through stakeholder participation are addressed.	Stakeholder engagement through workshops and conferences will identify priorities for research and management in coastal habitats and ecosystems.
		Greater awareness and understanding of ecosystem functions and services they provide improves stewardship efforts	Disseminate conservation and sustainable best management practices through lectures and conferences that enhance public awareness of environmental challenges that degrade coastal ecosystems.

		Biodiversity, habitats, and ecosystem functions are sustained.	Support the development of information and tools that will help coastal communities work to improve water quality such that biodiversity, habitats, and ecosystem functions are sustained or restored.
		Improved collaborative planning and decision-making leads to enhanced stewardship.	Collaborate with federal, state, and local agencies and environmental non-profit groups to address marine resource management issues.
Land, water, and living resources are managed by applying sound science, tools, and services to sustain ecosystems.	Support a sound science and management-driven framework that integrates observations, monitoring, research, and modeling to provide a scientific basis for informed decision-making.	Citizen science initiatives are utilized and contribute to improving our knowledge with respect to coastal communities, economies and ecosystems.	Stakeholders contribute directly to the social and natural science knowledge base through community science initiatives.
		Communities have access to and use sound science, data, tools, and the training to be effective in planning and decision-making processes.	Provide coastal communities with access to and understanding of long-term monitoring data and leading-edge research to improve coastal decision-making.
		Resource managers understand the risks, the options, tradeoffs, and impacts of their decisions.	Identify, generate, and demonstrate management tools for decisions on land, water and living resources protection and restoration.
	Identify and promote case studies and strategies to enhance resilient ecosystems and watersheds in the	Communities have access to and use information and understand projected changes within coastal ecosystems and how	Provide all demographic components of coastal communities with an understanding of current and future

	context of changing conditions.	changes will impact coastal ecosystems.	climate change impacts on coastal ecosystems.
		Communities can access and apply knowledge from case studies, training and tools to improve their ability to plan, prepare and adapt to future ecosystem conditions.	Identify and generate tools to help communities prepare for and adapt to climate change impacts to coastal ecosystems.

Sustainable Fisheries and Aquaculture

The southeastern Massachusetts region contains 98% and 99% of the Commonwealth's marine aquaculture growers and acreage, respectively. The industry is primarily based on two bivalve species: the quahaug, *Mercenaria mercenaria*, and the American oyster, *Crassostrea virginica*, but there is increasing interest in seaweed and several additional shellfish species. The total value of Massachusetts shellfish aquaculture production grew from $3,691,182 in 2004 to over $29,858,281 in 2019 (Division of Marine Fisheries, 2004, 2019). Since 1996, oysters have been the primary species contributing to the establishment of new shellfish farming communities throughout coastal Massachusetts. In contrast with other states, the aquaculture industry is composed mostly of independent, small scale growers.

The coastal communities of Massachusetts maintain active recreational shellfisheries and regulate them in partnership with the state Division of Marine Fisheries. Municipal shellfish departments engage in enhancement and propagation activities in order to provide a constant supply of oysters and quahogs to residents of the Commonwealth. In Barnstable County, the 15 towns issue more than 17,000 recreational permits every year.

Given the economic and cultural importance of fishing and aquaculture to the region, during this strategic planning period Woods Hole Sea Grant will continue to work with both the

aquaculture industry and municipal shellfish managers to provide technical information, engage in cooperative research, translate research results into practice, and maintain long term monitoring data sets on water quality and shellfish growth. Efforts will also be put towards assisting the industry with diversifying their crops by developing culture and marketing techniques for seaweeds and surf clams. Open communication will be maintained with industry members and natural resource managers through workshops, industry-sponsored meetings, and discussions to assess needs. WHSG's program goals for Sustainable Fisheries & Aquaculture are listed in Table 4.

Table 4. Program goals related to the Sustainable Fisheries and Aquaculture focus area.

National Plan Goals	National Plan Action	National Desired Outcomes	Program Goal
Fisheries, aquaculture, and marine and freshwater resources provide food, jobs, and economic and cultural values.	Develop a trained workforce and enhance technology transfer in domestic aquaculture.	Increased understanding and technological solutions aid aquaculture management and production.	Identify, generate, and communicate technical information to help local natural resource managers and harvesters manage the fisheries resources in their communities for continued sustainable production.
		Partnerships that enable the aquaculture industry to adapt and acquire innovative technologies.	Engage in cooperative research, monitoring, and education programs to assist the aquaculture industry with maintaining and enhancing production and adapting to changing conditions.

	Promote and support harvest and processing techniques that lead to safe, sustainable and high-quality food and economic and ecosystem benefits.	Coastal resource industries employ technologies and reinforce strategies to ensure safe and sustainable seafood and products	Identify, generate, and communicate best management practices to ensure a safe and sustainable seafood supply.
		Consumers understand the health benefits of seafood and purchase safe and sustainable products.	Provide communities with unbiased information on local seafood, how it is harvested and grown, and its health benefits.
Natural resources are sustained to support fishing communities and industries, including commercial, recreational, and subsistence fisheries, and aquaculture.	Ensure sound science, services, and tools are available and accessible for fishing and aquaculture communities	Commercial and recreational fishermen and aquaculturists are knowledgeable about efficient, sustainable, and responsible tools, techniques, and uses of coastal and freshwater resources.	
		Innovative solutions that increase understanding of climate impacts on fisheries and aquaculture are available and accessible to resource managers and fishing and aquaculture communities.	Identify, generate, and communicate climate change impacts on fisheries and aquaculture to stakeholders, both commercial and recreational.
		Resource managers and fishing and aquaculture communities have access to science and tools to increase their capability to adapt to future	Translate and communicate scientifically-defensible information about threats to resource management of commercial and recreational fisheries,

		resource management needs.	as well as the aquaculture industry.

Resilient Communities and Economies

Coastal communities in the U.S. provide a wide range of economic, social, and recreational opportunities. In Massachusetts seventy-five percent of the population lives in coastal counties. The coastal environment in the southeastern part of the Commonwealth consists primarily of thick glacial deposits in the form of outwash plains and moraines. Typically, this terrain has low topography and consists of easily erodible, unconsolidated sediment. Erosional forces (such as wave action) associated with sea level rise over geologic time have produced sandy shores fronting sea cliffs and downdrift barrier beaches. Extensive salt marshes have developed in the protected lagoons and bays that lay behind the barrier beaches. All of these landforms are particularly vulnerable to storm damage, flooding, and erosion.

Coastal ponds, embayments, open coasts, and coastal resources are impacted by commercial, recreational and residential activities. Furthermore, coastal communities are increasingly being threatened by climate change driven sea-level rise: it is estimated that the 72 coastal towns of Massachusetts together lose 65 acres (26.5 hectares) of upland annually to rising relative sea level (Giese et al., 1989). Other major impacts include shoreline erosion, conflicts between the protection of waterfront upland property and the preservation of the beneficial functions of coastal landforms and resources, conflicts between private ownership of the coast and public access, and recreational demands on the coast through boating, fishing, shellfishing, and the use of beaches for swimming and sunbathing. Emerging interests in coastal wind farms present new opportunities to gather information on scientific, social and economic concerns of their siting and development.

Our Resilient Communities & Economies efforts aim to ameliorate this resource management dilemma through education, applied research, and technical assistance. In implementing this strategic plan focus area, Woods Hole Sea Grant will share information with coastal resource managers and the general public about the forces that shape the coastal environment, provide technical information to local regulators and planners, and assist communities with applying to and maintaining participation in the Community Rating System (CRS). We will also engage in work to determine new floodplain management activities that will improve flood safety, provide technical assistance on the National Flood Insurance Program, and produce extension bulletins and other information on sea level rise, coastal erosion, flooding, hurricanes and other storms. The distribution of the Massachusetts Homeowner's Handbook to Prepare for Coastal Hazards, now in its 3rd edition will also be a focus of the program. Our program goals for Resilient Communities and Economies are listed in Table 5.

Table 5. Program goals related to the Resilient Communities and Economies focus area.

National Plan Goals	National Plan Action	National Desired Outcomes	Program Goal
Coastal communities use their knowledge of changing conditions and risks to become resilient to extreme events, economic disruptions, and other threats to community well-being.	Use innovative tools to increase the public's awareness of changing conditions and the potential impacts their communities and economies may encounter.	Members of the community, including the underserved, are aware of and understand changing conditions and hazards and the implications to their communities, and are prepared to respond, and adapt.	Identify, generate, and communicate tools and nature-based strategies that promote resilience of communities to natural hazards.

	Utilize comprehensive planning and adaptive management strategies to enhance community resilience and adapt to hazards and changing environmental and socioeconomic conditions.	Communities have access to information needed to understand the factors impacting ecosystems and participate in adaptive management planning.	Identify and communicate information on coastal hazards (climate change-driven or otherwise), community resilience, and adaptation strategies through workshops.
	Communities employ adaptive management strategies and apply tools to engage diverse members of the community to improve resilience and community sustainability.		Through improved understanding of floodplain management, coastal communities and their diverse members adopt or modify regulations to improve their resilience.
	Increase the resilience of coastal communities through diversification, growth, and strengthening of coastal economic sectors.	Members of the community, including the underserved, have access to information needed to understand how coastal economic activities and trends will impact environmental and community well-being.	Diverse members of the community are aware of changing climatic, environmental, and socio-economic conditions and use this information to improve coastal resilience and sustainability.
		Communities have access to tools, services, and technologies to adapt and grow resilient economies.	Support and educate communities in their efforts to improve coastal resilience through floodplain management.
Water resources are sustained and protected to meet existing and emerging needs of the communities,	Inform community members about how actions impact water quality and availability.	Community members understand watershed functions and the services	Identify, generate, and communicate strategies for management and protection of water resources.

economies, and ecosystems that depend on them.		they provide that support communities and economies.	
		Community members understand how actions will impact water quality and quantity and are able to make informed decisions.	Support the development of information and tools on how community actions impact water quality, and the measures that can be taken to improve it.
	Collaborate with stakeholders to develop and share best management practices (BMPs) and measures to protect and manage water resources	Communities have access to science, tools, and technologies to protect and sustain water resources and make informed decisions.	Generate and communicate data on surface water quality and its importance to coastal communities and economies.

Environmental Literacy and Workforce Development

Woods Hole Sea Grant recognizes the important role of science education in supporting, promoting, and coordinating formal and informal educational activities at all levels to enhance public awareness and understanding of coastal ocean resources. To this end, we aim for integration of research, education, and outreach to develop an environmentally literate citizenry that will make informed decisions about coastal resilience.

In Massachusetts, citizens are surrounded by coastline and use coastal and marine resources in a variety of ways. Our team members will work to improve the environmental literacy of the general public through coastal conferences that bring scientists and decision makers together. Teacher workshops will be designed to inform teachers and informal educators of new advances in science and technology and share the importance of the ocean and

incorporating marine systems in instruction. We will engage K-12 students through classroom visits and experiential learning opportunities to inspire them and give them access to our research and the marine resources in their community. Science education also plays a role in preparing students to access further training and jobs in the Blue Economy, a growing business sector in Massachusetts (Cape Cod Commission, 2019).

Trainings will be provided to inform decision makers of advances in science that inform policy, and research projects will support the research experiences of undergraduate, graduate, and postdoctoral students. Each of these diverse audiences requires a different approach in providing technical information that will enhance opportunities for learning. To this end, we aim for integration of research, education, and outreach to develop environmentally literate community members that will make informed decisions about coastal resilience, and students who are aware of the range of marine-based careers available to them and the training required to prepare from them. Our program goals for **Environmental Literacy and Workforce Development** are listed in Table 6.

Table 6. Program goals for the Environmental Literacy and Workforce Development focus area.

National Plan Goals	National Plan Action	National Desired Outcomes	Program Goal
An environmentally literate public that reflects the range of diversity of the nation's coastal communities is informed by lifelong formal and informal learning opportunities.	Enable the public to engage in informed decision-making and community planning processes enabling adaptation to changing conditions by providing the best available information.	Communities are knowledgeable and equipped with the best available science and technology to make informed decisions and contribute to adaptive management planning processes and stewardship.	Promote environmental literacy and stewardship activity in coastal communities, including those underserved, through ocean and climate education programs that utilize the latest scientific research.

	Develop and provide curriculum and other resources to pre-school through 12th grade formal and informal educators to support more effective environmental literacy instruction.	Teachers and students are better informed in science, technology, engineering, and mathematics fields and can employ their knowledge to support sustainable practices within their communities.	Develop, facilitate, and deliver relevant STEM K-12 educational resources and opportunities that support more effective environmental literacy learning and instruction.
	Increase effective environmental literacy communication to stakeholders, including how ecosystem change affects economic, social and cultural values as well as implications for conservation and management.	Stakeholders develop a sense of awareness, understanding and stewardship in order to sustain watershed, coastal and marine ecosystems and resources.	Provide stakeholders with learning opportunities and resources that will promote sustainable use of watershed, coastal, and marine resources.
	Communities implement sustainable strategies when managing natural resources and make decisions based on information acquired through informal science education.		Create or facilitate trainings of natural resource and emergency managers, as well as building officials, to understand, synthesize, and apply best available science and information to improve coastal resiliency.
A diverse and skilled workforce is engaged and enabled to address critical local, regional, and national needs.	Grow awareness among the nation's diverse population of career paths that support the needs of the nation's coastal communities.	All members of a community are enabled to explore and pursue the variety of occupations that are essential to sustain the nation's coastal communities and ecosystems.	Create opportunities for high school and college students, including those from underserved groups, to explore and pursue careers that support coastal communities and the scientific workforce.
	Increase opportunities for undergraduate and graduate students to gain knowledge and experience in the science and	College level courses and internships provide increased literacy, experience, and preparedness in areas of watershed, coastal, and marine ecosystems for all students	Develop and enhance the teaching and learning of coastal and ocean science through internships and classes at both

	management of watershed, coastal, and marine resources.	particularly those from underrepresented groups.	the undergraduate and graduate level.
	Prepare a responsive and diverse workforce to advance and benefit from sectors that support the needs of the nation's coastal communities and ecosystems (e.g. industry, research, government, etc.), and to adapt and thrive in changing conditions.	Undergraduate and graduate students, particularly those from underrepresented groups, are supported and have access to formal and experiential learning, training, and research experiences.	Support undergraduate and graduate students, including those from underserved groups, in marine science and policy who will become members of a workforce dedicated to the study and management of coastal resources.
		The existing and future workforce is able to adapt and thrive in changing environmental, social, and economic conditions.	Provide or facilitate training and continuing education opportunities for coastal decision makers to increase their ability to implement environmentally sound policies.
			Provide or facilitate training and continuing education opportunities in aquaculture that also encourage safe and sustainable growing and harvesting practices.

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