

MIT SEA GRANT STRATEGIC PLAN FY 2024 – 2027



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MIT SEA GRANT STRATEGIC PLAN

2024 – 2027

Introduction

The Massachusetts Institute of Technology (MIT) Sea Grant College Program (MIT Sea Grant) strategic plan is inspired by our vision, focused on our goals and outcomes, and enhanced by the unique educational, scientific, and technological resources of our home institution, sister institutions, state institutions, and local communities.

MIT Sea Grant Strategic Plan Process Outline

The following is an outline of the MIT Sea Grant strategic planning process:

1. Review the 2018-2023 MIT Sea Grant strategic plan
2. Retain the 2018-2023 focus
3. Review the NSGO 2024-2027 strategic plan when available to inform development of the MIT Sea Grant 2024-2027 strategic plan
4. Conduct visioning discussions with staff to gain input from the program **(February)**
 1. Determine what components, priorities, and topics of the current plan to retain
 2. Determine new components, priorities, and topics to include in the new plan
5. Staff reach out to stakeholders with a common survey to identify gaps and priorities to address in the new plan **(February)**
6. Reach out to MIT Sea Grant Advisory Committee for feedback on gaps and priorities, and review stakeholder survey results **(March)**
7. Staff review stakeholder survey results **(March-April)**
 1. Meetings to discuss survey results and incorporate responses into the new plan
 2. Determine which topics to let go and what new opportunities to include in the new plan based on stakeholder feedback
8. Determine MIT Sea Grant staff subcommittees to write specific sections of the strategic plan **(March-April)**
9. Write and compile the draft strategic plan including formatting **(May-June)**
10. MIT Sea Grant Advisory Committee review and comment on the strategic plan **(August)**
11. Send to the draft MIT Sea Grant 2024-2027 strategic plan to the National Sea Program Officer for review and comments **(August)**
12. Revise and finalize Strategic Plan based on Program Officer comments **(August)**
13. Send to the final MIT Sea Grant 2024-2027 strategic plan to the National Sea Grant Office by the deadline **(October)**

VISION

The MIT Sea Grant College Program envisions addressing ocean-related challenges of high importance to the State and the Nation with advanced technical contributions and strong commitment to scientific research dedicated to sustaining the coastal resources and communities of our Commonwealth.

We will expand knowledge of our ocean, coasts, and watersheds and establish the collaborative infrastructure to support the initiatives needed to address challenges to our fragile coastal and marine resources and the people who depend on them. Our vision was reviewed during our strategic planning constituent meetings and by our advisory committee, all of whom agreed that this vision statement accurately represents the program's strengths and ability to make meaningful contributions to ocean science and best serve our coastal communities in the Commonwealth of Massachusetts.

MISSION

Our mission is to conduct and support research and develop technology of high impact, to enable scientific investigation, education, and outreach efforts into significant problems surrounding ecosystem health and the human use of the Massachusetts coastal and marine environment.

Our education and outreach efforts disseminate the results of work conducted by MIT Sea Grant-funded researchers, Advisory Services staff, and independent labs in collaboration with our academic, industry, tribal, municipal, community, state, and federal partners. We encourage stewardship and lifelong learning, implement sustainable and useful technologies, and help answer management questions in support of public policy and industry based on relevant, evidence-based, and scientifically sound information, stakeholder engagement, education, and outreach programs. Efforts in research, education, and outreach address critical marine and coastal issues identified by Massachusetts constituents that are within the four focus areas of the National Sea Grant College Program. The goals and outcomes of these focus areas shape priorities for our biennial solicitation to fund new proposals and guide us in developing short- and long-term projects that best serve our constituents. Our advisory committee reviewed and concurred with our mission and goals.

CORE VALUES

The National Sea Grant College Program (NSGCP) core values incorporate Vision, Collaboration, Sustainability, and Accountability, as well as Diversity, Equity, Inclusion, Justice, and Accessibility (DEIJA). These values support a culture of integrity and scientific neutrality, enabling Sea Grant to serve as a trusted neutral broker of information. For over 45 years, MIT Sea Grant has brought the expertise of MIT to bear on understanding and addressing issues facing our ocean and coastal ecosystems, resource management, industry, and coastal communities. Our rigorous research, education, and outreach programs support the wise use and conservation of marine resources along the Massachusetts coastline and help create coastal stewards of tomorrow.

CROSS-CUTTING PRINCIPLES

The National Sea Grant College Program Strategic Plan 2024-2027 defines cross-cutting principles as a foundation for all focus areas and the work Sea Grant conducts. Recognizing these principles enhances Sea Grant’s capabilities for meeting future national needs. MIT Sea Grant will work towards advancing these principles:

1. Cultivate and sustain partnerships by integrating the expertise and capabilities of partners from international, federal, tribal, state, and local communities, and from academia, non-governmental organizations, and industry.
2. Embrace DEIJA by integrating diverse perspectives, to advance cultural understanding and enable the network to pursue its vision and mission among all audiences. We will actively create mechanisms to facilitate diverse participation in network activities. MIT Sea Grant will tackle problems facing coastal communities by utilizing a range of perspectives, values, and tools to develop solutions that are more innovative, creative, inclusive and responsive.

Background information about the MIT Sea Grant program, along with the MIT Sea Grant DEIJA statement, can be found in Appendix 1.

NATIONAL FOCUS AREAS THE PROGRAM INTENDS TO SUPPORT

MIT Sea Grant intends to support all four of the focus areas identified by the NSGCP:

- Environmental Literacy and Workforce Development
- Healthy Coastal Ecosystems
- Sustainable Fisheries and Aquaculture
- Resilient Communities and Economies

We will support as many of the performance measures and metrics listed on Appendix 2 of this document, and in the NSGO’s Strategic Plan, as feasible.

MIT Sea Grant Strategic Plan

Broadly speaking, our focus areas and goals and actions are aligned with those of the National Sea Grant College Program 2024-2027 strategic plan, while our desired outcomes are dictated by stakeholder input. The following sections discussing the four focus areas include a brief discussion of the continuing priorities identified for Massachusetts, as well as MIT Sea Grant’s future directions, outreach and education plans. At the end of each Section we list MIT Sea Grant’s desired outcomes.

The MIT Sea Grant College Program is committed to scientific and technical leadership to address high-priority issues for the Commonwealth of Massachusetts. MIT Sea Grant has and will continue to support research and develop innovative technologies and systems to address environmental issues of greatest concern to sustain the resources, communities, industry, and economies of the future. Impacts and adaptation for fisheries and aquaculture, coastal communities, resilient

shorelines, healthy ecosystems and economies, and education and workforce development will continue to be of concern to our stakeholders and constituents. Four focus areas address the core of the National Sea Grant College Program mission and vision, and provide a framework for our goals and outcomes: Environmental Literacy and Workforce Development, Healthy Coastal Ecosystems; Sustainable Fisheries and Aquaculture; and Resilient Communities and Economies. These focus areas reflect current needs and are consistent with goals and objectives identified in NOAA's FY 22-26 Strategic Plan, "Building a Climate Ready Nation". In creating our strategic plan for 2024-2027, MIT Sea Grant solicited input from our advisory committee, network of partners, and stakeholders representing local communities, state and federal agencies, industry, and the general public.

Through our spring 2022 online survey, 164 MIT Sea Grant stakeholders identified their most urgent issues facing Massachusetts coastal communities: (1) climate change adaptation, (2) coastal resilience, (3) fisheries sustainability, (4) sea level rise, (5) measuring shifting ecosystems, (6) habitat restoration, (7) aquaculture sustainability, (8) ocean renewable energy, and (9) resilient economies and workforce development.

In an effort to reach individuals from all Massachusetts communities, MIT Sea Grant made the survey available in 13 languages, sent to 1,697 contacts (including members of the seafood industry, educators, regulators, researchers, non-profit organizations, recreational users of the coastal environment, and others) through email and social media campaigns, and featured the survey on the program website. Our response rate for known recipients was approximately ten percent. Historically MIT Sea Grant has focused on engaging with agencies, industry, resource managers, municipalities, schools, and the public. The philosophy here being that if you can influence processes at the agency-industry-municipality level, then you have the potential for coast-wide impacts that provide greater stakeholder reach and benefits for all populations coast-wide. Although our survey was made publicly available and distributed widely through social media, our website, and stakeholder communications, we observed that the stakeholders who chose to provide demographic data represented those with existing MIT Sea Grant relationships. These respondents tended to be older, less racially diverse, and had higher salary levels associated with professional occupations than the general MA coastal population. Therefore, priorities like workforce development may have been minimized due to these demographics. These results highlight the need for increased engagement to build stronger relationships with under-represented communities. This effort would be in line with the national DEIJA cross-cutting principle.

Specific concerns highlight the need for research, data services, tools and models to predict impacts of shifting conditions (e.g., due to climate change, COVID), and new monitoring technologies to support industry and influence policy decisions surrounding ecosystem and resource management. While 'supporting research and resource management' were the top priorities of a majority of the respondents, improved community-level involvement and solutions, as well as expanded outreach, education, and stakeholder collaborations (i.e., engagement), were identified as priority areas for growth. MIT Sea Grant will continue its commitment to develop technology, research, and services in support of critical public and industry needs. Information and

technology is transferred to our stakeholders through seminars, practitioner working groups, forums that are open to the public, workshops, and conference presentations. Our commitment to education involves K-12 students and teachers, undergraduate, graduate, under-represented communities, and adult learning groups. Our programs integrate research in marine and coastal science, engineering, increase Environmental Literacy and Workforce Development, and involve all MIT Sea Grant focus areas.

MIT Sea Grant is committed to providing the best science and technological innovation to address local, state, regional and national issues. Through collaboration and engagement with faculty across MIT and local universities, and alliances with partners including regional Sea Grant programs, MIT Sea Grant taps a vast network of intellectual and financial resources to tackle major environmental issues. Our Advisory Services staff conducts research and engagement, and develops programs and materials, that transfer technology and scientific information to industry, communities, and decision makers. In doing so, we encourage stewardship as leaders strive to balance growth and sustainability of resources. MIT Sea Grant's funded research projects in marine science, ocean engineering, and technology will continue to support the priorities of the Commonwealth of Massachusetts.

FOCUS AREA: ENVIRONMENTAL LITERACY AND WORKFORCE DEVELOPMENT (ELWD)

STEM education, community science programs, public outreach and engagement, workforce development, and training for the next generation of coastal and ocean scientists, practitioners, and engineers has been and will continue to be the focus of MIT Sea Grant ELWD activities.

MIT Sea Grant Advisory Services will continue to support K-12 education initiatives and curricula through their fisheries, watershed, coastal, and marine science research collaborations that provide students and teachers with information, tools, experiences, and creative activities. One of our popular activities, the Blue Lobster Bowl, has been discontinued. We will replace it by expanding our SeaPerch program, supporting the growing interest in regional middle and high school events and competitions, and developing updated SeaPerch II designs and educational materials.

ELWD Continuing Priority Activities

1. Undergraduate and K-12 courses in coastal and marine ecology
2. Public outreach and engagement programs
3. Federal and state opportunities for undergraduate and graduate students
4. Training, facilitation, outreach, and education programs in all MIT Sea Grant program focus areas

MIT Sea Grant has a strong commitment to supporting high school through graduate level students in securing MIT, Sea Grant, state, and federal sponsored internships, fellowships and other opportunities, either by offering positions at MIT Sea Grant such as the MIT Undergraduate Research Opportunities Program (UROP), or participating in NSGCP-led opportunities such as the Knauss Fellowship.

MIT Sea Grant created and launched two new funding opportunities in 2022. In partnership with Woods Hole Sea Grant (WHSG), the Massachusetts Sea Grant Graduate Research Fellowship will support the research and professional growth of graduate students through mentorship, professional development training, participation in conferences in their field, and more. The MIT Sea Grant STREAM (Solutions Through Research, Education and Art in Massachusetts) Grant funds small projects from high school, undergraduate, and graduate educators and students, industry and nonprofit organizations, and artists that advance or explore the intersection between coastal marine science, art, and innovative research in areas of emerging interest (e.g. community resilience, microplastics). MIT Sea Grant will continue these funding opportunities through the 2024-2027 Strategic Plan period.

MIT Sea Grant Advisory staff will continue to offer courses at MIT and will introduce special curriculum for novel technologies in ocean and coastal engineering, including autonomy of surface and underwater vehicles, biomimetic physical, chemical, and biological sensors, and robotics for underwater intervention, targeting offshore aquaculture farming, ocean renewable energy, the seafood industry, coastal resilience, marine debris, and microplastics. Finally, we will support the cross-cutting DEIJA principle through the MIT Sea Grant course MIT Minority Introduction to Engineering and Technology programs.

MIT Sea Grant will continue increasing our public outreach through a variety of efforts. We will work with volunteer monitoring groups and develop community or participatory science programs on fisheries and aquaculture, restoration, Blue Carbon, ocean acidification, and assessment of coastal and marine resources. We will continue our participation in local and regional science festivals such as the Cambridge Science Festival, and will expand our outreach efforts to museums, aquaria, and other public education spaces, and support indigenous communities in their efforts to preserve cultural heritage, share knowledge, and participate in science education and training programs. Through the revival of our monthly lecture series, MIT Sea Grant-funded researchers will present their work to staff, state and federal managers, and others to foster transfer of information; all constituents are welcome to attend and participate in discussions. Finally, we will continue to develop programs for minority students and underserved and indigenous communities, which incorporate ocean and coastal science, engineering, physics, public policy, and resource management.

ELWD Future Directions

1. Increased education, outreach, and extension programming in all MIT Sea Grant focus areas
2. Increase workforce development programs in fisheries, aquaculture, and ocean technology industries
3. Develop tools and technology training for spatial models that inform and enable our partners and constituents
4. Develop classes on novel ocean engineering and technologies
5. Strategically expand community science programming in applicable MIT Sea Grant focus areas
6. Expand our ELWD efforts with indigenous and underserved communities
7. Continue to support NSGCP fellowships as well as other state and federal student opportunities.

In 2024-2027, MIT Sea Grant will increase efforts in education, outreach, extension, and training for aquaculture-related topics. Our recently added Marine Extension Specialist-Aquaculture will collaborate with WHSG on aquaculture ELWD programs for Massachusetts (MA) stakeholders.

ELWD Outreach and Education

The two subsections above provide detailed information relating to this subheading.

ELWD Goals, Actions, and Desired Outcomes

ELWD Goal 1: A diverse, environmentally literate public participates in lifelong formal, nonformal and free-choice learning opportunities.

ACTION: Create and implement educational resources and opportunities that are diverse, equitable, inclusive, just and accessible for formal, non-formal and free-choice learners to explore multiple ways of learning and knowing and to develop their curiosity and learning abilities throughout their lives.

Desired Outcome: Individuals consider themselves environmentally literate lifelong learners who utilize knowledge to support, build and restore healthy natural and human communities.

ACTION: Develop, provide, and assess research, curricula, tools and other resources for teachers, students, and lifelong learners to support personal choice, participatory decision-making and community planning processes.

Desired Outcome: Teachers, students and lifelong learners have current information and innovative tools that meet or exceed relevant standards and practices.

Desired Outcome: People know and can act on issues that impact their lives, communities and environments.

ACTION: Strengthen the ability of individuals, organizations and communities to acquire, synthesize and use knowledge in an environmentally literate way.

Desired Outcome: Coastal communities are sustainable, healthy, diverse centers of tradition, innovation and prosperity.

ELWD Goal 2: A diverse, skilled, and environmentally literate workforce that is engaged and able to build prosperous lives and livelihoods in a changing world while addressing critical local, regional, and national needs through traditional and innovative careers.

ACTION: Identify and remove barriers to accessing training and learning opportunities so that the nation's diverse population is connected to and prepared for the range of career paths that support the needs of coastal and marine communities.

Desired Outcome: All members of a community are enabled to explore and pursue the variety of occupations that are essential to sustain coastal communities, economies and ecosystems.

ACTION: Increase opportunities for students at all levels (P-12, undergraduate, graduate, post-graduate and technical and vocational) to gain knowledge and experience addressing issues that are important to our ocean, coasts and their respective watersheds.

Desired Outcome: Sea Grant student opportunities provide increased literacy, experience and preparedness in critical disciplines, skills and issues.

Desired Outcome: Students from all backgrounds and with diverse needs are thoughtfully and intentionally supported in and have access to formal and experiential learning, training and research experiences.

ACTION: Prepare a responsive and diverse workforce to advance and benefit from sectors that support the needs of coastal communities and ecosystems and to adapt and thrive in changing conditions.

Desired Outcome: Employment in coastal, marine and watershed communities expands and diversifies.

Desired Outcome: The existing and future workforce is able to adapt and thrive in changing environmental, social, and economic conditions.

FOCUS AREA: HEALTHY COASTAL ECOSYSTEMS (HCE)

Massachusetts coastal ecosystems are expected to be healthy and aesthetically pleasing, and to provide diverse ecosystem services as well as recreational and commercial opportunities for residents and visitors. However, a variety of stressors affect the health of coastal ecosystems, including degradation of water resources, climate and anthropogenic impacts on coastal resources and habitats, acidification of ocean and coastal waters, marine debris, and ocean renewable energy development.

MIT Sea Grant addresses issues that impact coastal and marine waters through conducting innovative research to improve understanding of the structure and function of ocean and coastal systems, developing tools, platforms, technologies, engineering, and ecological solutions, and increasing the efficiency and capabilities of communities and industries that depend on them. Through our outreach and education programs we assist resource managers and coastal communities with insights that inform science-based decisions that will ensure long-term viability of coastal resources and ecosystems.

HCE priority areas articulated by our stakeholders include water quality, coastal resilience processes involving carbon storage in eelgrass beds and coastal habitats, climate impacts to carbon cycling in coastal wetlands (“Blue Carbon”), ecosystem connectivity through diadromous fish migrations (and associated food webs and resource requirements), and benefits from habitat restoration and hydrologic connectivity improvements. MIT Sea Grant will continue to address these priority areas.

HCE Continuing Priority Areas

1. Supporting habitat restoration, ecosystem connectivity and diversity of native organisms
2. HCE resilience through fish passage and habitat improvements
3. Ocean acidification impacts on HCE
 - a) Monitoring and modeling
 - b) Sensor development
 - c) Assessing ocean acidification impacts on ocean/coastal resources

MIT Sea Grant will continue its work in collaboration with US EPA and researchers at MIT and other institutions to combine modeling and empirical research to characterize and quantify carbon cycling and storage in coastal habitats. MIT Sea Grant will continue its efforts to improve understanding of warming and acidification in ocean and coastal waters through development of sensors and platforms for sampling and monitoring, and through modeling physical, chemical, and biological variables. We will continue to facilitate the development of relevant technologies through machine learning for improved fisheries management in response to stakeholder needs, and in partnership with NOAA Fisheries, MA Division of Marine Resources, the Mashpee Wampanoag Tribe, and local watershed monitoring groups. Examples of areas we plan to continue and expand our efforts include development of sensors, platforms, and vehicles in our AUV Lab, and translation of biological adaptations (e.g., the role seal whiskers or fish lateral lines as sensors) for surface and underwater vehicles, through biomimetics. In addition, MIT Sea Grant currently maintains an array of cloud-based databases and application programming interfaces (APIs) that support 3D, mobile-friendly geospatial data visualization by stakeholders. These and other efforts within the HCE priority areas will support science-based risk assessments and actions identified in the Massachusetts State Hazard Mitigation and Climate Adaptation Plan (SHMCAP 2018) such as shifting species distributions, increased occurrence of non-native species, source, location, transport, and fate of marine debris and microplastics, shoreline erosion affecting coastal ecosystems, coastal resilience and hydrologic connectivity, among others.

During 2024-2027 MIT Sea Grant will build on our legacy of improving HCE in Massachusetts by expanding our work in marine debris and microplastics and their impact on HCE and coastal communities; biological research to better understand coastal and ocean systems, microbiomes, and the effects of ocean acidification on coastal and marine resources; ocean renewable energy development and its impacts to HCE and our Massachusetts stakeholders; and coastal resilience engineering, modeling, and green infrastructure improvements.

The goal will be to apply sound science towards improving the health and understanding of our coastal ecosystems and increasing resilience among coastal resources and communities. We will identify opportunities in biological research by asking key questions relevant to stakeholder challenges, reviewing recent technological developments in molecular biology and biomedical

fields (e.g., sequencing and imaging), and exploring powerful emerging technologies that can expand interdisciplinary applications towards HCE. The effects of microbiomes, microplastics, emerging contaminants (e.g., PFAS and PBDEs), marine debris, and ocean acidification on the health of ocean and coastal ecosystems are poorly understood and represent priority topics identified by our community, industry, management, and consumer stakeholder groups. Ocean renewable energy development is a complex process involving a variety of stakeholder groups. Using sound science to develop advanced technologies and engage stakeholders to provide a broader awareness of issues and processes will be at the core of MIT Sea Grant's efforts in this area. Priorities identified by some of our stakeholder groups (MA Division of Marine Fisheries; MA Office of Coastal Zone Management; and Woods Hole Oceanographic Institution) include developing protective infrastructure that is biological in nature, using traditional coastal habitat restoration and natural processes, and addressing site selection challenges and the biological aspects of green infrastructure and resilience.

HCE Future Directions

1. Marine debris and microplastics impact on coastal and marine ecosystems and resources
2. Biological and water quality research to improve the health of coastal and marine resources and ameliorate effects from ocean warming and ocean acidification, emerging contaminants, and other stressors
3. Ocean renewable energy development technology and stakeholder engagement
4. Geospatial data visualization and machine learning to create inexpensive tools and technologies for resource managers and other stakeholders

HCE Outreach and Education

Our outreach and education efforts seek to create opportunities for information exchange among researchers, MIT Sea Grant Advisory Services staff, and our stakeholders to support ecosystem-based management and HCE. We accomplish this through convening workshops individually and with other Sea Grant programs and organizations (e.g., MassBays National Estuary Partnership) on topics of interest to industry, managers, and the public. We develop community science programs that increase awareness and stewardship of ecosystem-based management of fisheries and resources, coastal habitats, watersheds, diadromous species, and climate impacts such as those from warming waters and ocean acidification, and effects on coastal and ocean resources. We are currently developing cloud-based data services for partners and stakeholders, which includes database development and APIs, and developing a web-based framework for rapid development of customized user interface tools that facilitate user queries, analyses, visualizations, and modeling. These cross-cutting data services and applications support all MIT Sea Grant focus areas and are designed to address current and future challenges among stakeholders for geospatial data storage, modeling, analysis, and visualizations. Results have been and will continue to be utilized in resource management, outreach, education, and training. Additional HCE education program components include the development of ocean engineering, fisheries, aquaculture, watershed, and coastal ecology education and training programs and teaching coastal ecology courses for K-12 students, teachers, undergraduate and graduate students. The extent and diversity of our

stakeholder pool is greatly increased through advising and collaborating with Massachusetts tribal and under-represented communities, and non-profit institutions such as Save the Harbor, Save the Bay, which specialize in outreach to underserved urban communities. Additional components include conducting informal public events, supporting undergraduate and graduate interns and postdocs, and providing community or participatory science programs that increase awareness and stewardship. The information, tools and technologies developed by MIT Sea Grant and its funded researchers directly address the needs of our stakeholders.

HCE Goals, Actions, and Desired Outcomes

HCE Goal 1: Coastal habitats, ecosystems, and the services they provide are protected, enhanced, and/or restored.

ACTION: Co-develop, improve, and share knowledge, decision-support tools, technologies, and approaches to protect and restore ecosystems.

Desired Outcome: Communities have greater awareness and understanding of ecosystem functions and the services they provide.

Desired Outcome: Coastal and marine biodiversity, habitats and ecosystem functions and services are restored and sustained.

Desired Outcome: Coastal and marine ecosystem science and conservation needs are identified and prioritized through diverse stakeholder participation.

Desired Outcome: Evidence-based science, traditional and local knowledge and innovative solutions inform and improve the management and conservation of coastal habitats.

HCE Goal 2: Land, water, and living resources are managed by applying science, tools, and services to sustain resilient coastal ecosystems.

ACTION: Support a science- and management-driven framework that integrates research, observations, monitoring and modeling and that includes stakeholder engagement and traditional and local knowledge to provide a scientific basis for informed decision-making.

Desired Outcome: Inclusive collaborations with diverse stakeholders and partners support planning, research, and innovative solutions to address coastal and marine resource management needs, especially for vulnerable communities.

Desired Outcome: Community or participatory science initiatives are utilized and contribute to improving our knowledge with respect to stewardship of ecosystems and their contributions to coastal and marine communities and economies.

Desired Outcome: Coastal and marine communities and resource managers have access to and use science, data, tools and training to be effective in planning and decision-making processes.

ACTION: Identify and advance successful strategies that enhance resilient ecosystems and watersheds in the context of changing conditions, including environmental variability and climate change.

Desired Outcome: Communities, resource managers, and decision makers share, access, understand, and use information regarding projected changes and related impacts within ecosystems with local communities and stakeholders.

Desired Outcome: Communities can apply knowledge from case studies, training and tools to improve their ability to plan, prepare and adapt to environmental variability and climate change.

FOCUS AREA: SUSTAINABLE FISHERIES AND AQUACULTURE (SFA)

Massachusetts and the Northeast region have long been associated with thriving commercial and recreational fisheries that land a diverse number of species including finfish, lobsters, and shellfish. The decline of some of the favored stocks, has led to efforts to create alternative markets for underutilized species, reduce waste, and support sustainable fisheries. Issues involving protected species and interactions with fishing, aquaculture, and ocean renewable energy gear remain a priority for conservation organizations and regulatory agencies, presenting challenges for industry. Microplastics in the marine environment and their accumulation through food webs are of increasing concern to consumers. Production processes and capacity can be increased through addressing the uncertainties associated with biological processes, aquaculture microbiomes, and wild fisheries. The public perspective is to sustain a safe supply of seafood; however, achieving this goal requires research, education, engagement, and consensus.

MIT Sea Grant is working with the NOAA Restoration Center, the NOAA Northeast Fisheries Science Center, the Massachusetts Division of Marine Fisheries, the Mashpee Wampanoag Tribe, and local fisheries monitoring groups to develop machine learning technology to improve video monitoring for fisheries assessments. Fish passage improvements and habitat restoration in support of diadromous species promotes collaborations with resource management agencies and local communities, and continues to be a focus for MIT Sea Grant SFA efforts. Resource requirements and food web associations with diadromous, recreational, and commercial fisheries is an ongoing priority for MIT Sea Grant SFA efforts to inform local, state, federal, and indigenous fisheries management and we will continue with this effort and collaboration.

SFA Continuing Priority Activities

1. Fisheries and aquaculture engineering
2. Support development of sustainable fisheries and aquaculture
3. Support working waterfronts and workforce development
4. Develop alternative markets and opportunities for underutilized species
5. Monitoring and analysis of coast-wide populations for fisheries management and stock assessments
6. Develop and transfer machine learning technology for video monitoring of fisheries

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MIT Sea Grant has been collaborating with the fishing industry in the northeast to develop alternative markets and products for underutilized species. This effort, funded by the NSGCP and MIT Sea Grant, has sustained jobs and local businesses, and developed new partnerships between local small-boat fishermen, seafood processors, state, and institutional programs. The results are new business models and opportunities in support of Massachusetts fishermen and the seafood industry. MIT Sea Grant will continue to expand on this effort.

MIT Sea Grant is collaborating with the Massachusetts fishing industry in a scoping effort to inform the Young Fishermen's Development Act funding competition planning process. MIT Sea Grant will continue to collaborate with the fishing industry on these important workforce development efforts.

7. Fish passage, habitat improvements, and monitoring programs
8. Technology development for the wild fisheries, aquaculture, and seafood industries
9. Support indigenous communities' challenges with fisheries and aquaculture
10. Support workforce development in the fishing and aquaculture industries
11. Community or participatory science, education, outreach, and engagement programs focusing on our stakeholder-driven SFA priorities
12. Support state agencies and local communities with fisheries and aquaculture spatial analysis, planning tools such as Seaglass

MIT Sea Grant is also working with state and municipalities to utilize its *Seaglass* programming framework for the collaborative development of a user-friendly, web-based system for geospatial analysis, visualization and reporting. This system will streamline operations and increase accessibility in shellfish management and provide recreational and commercial shellfishing permit holders with relevant and timely information about the status of their coastal shellfish resources. The system may also be applied to commercial and diadromous fisheries monitoring and assessments. Additional efforts in support of SFA will include the development of engineering and technology solutions and computational tools in our AUV, Design, and Bio Labs.

Supporting sustainable aquaculture has been a growing effort within MIT Sea Grant. Oyster aquaculture alone is the third most valuable seafood product in the state, yet this growing sector is encountering needs for market and product diversification, technological improvements, development of a diverse and persistent workforce, and improved clarity on the ecological interactions that occur with aquaculture to develop the most productive, community-wise and scientifically-sound regulatory constructs. Through a series of workshops and surveys, MIT Sea Grant is working with Massachusetts Bays National Estuary Partnership (MassBays) to explore the research needs and regulatory bottlenecks for enabling the best practices for interactions between aquaculture and eelgrass. Through direct observations and surveys in Massachusetts communities with high levels of seafood expansion, potential avenues for market expansion and population centers that can fuel a robust workforce are being identified.

Autonomous vehicles are under development by MIT Sea Grant researchers and students to improve the efficiency and safety of farming practices. These technologies have the potential to

expand to a variety of applications for offshore aquaculture and ocean renewable energy operations, serving multiple stakeholder groups.

During 2024-2027, MIT Sea Grant will work with stakeholders to develop biological, engineering and robotics technologies in service to aquaculture farming, sustainable fisheries, and seafood industries. Our stakeholders have expressed opportunities and support for development of automation and sensor technologies for farm operations, hatcheries, ocean- and land-based applications, and seafood processing. Every step in the aquaculture process has many pieces that could benefit from automation from seed to market, creating the need and opportunity for advancement in this area. MIT Sea Grant will work with WHSG to build partnerships with existing growers that can support, pilot, and demonstrate this work. Robotics, automation, and propulsion address production and farming needs, and integrating robotics improves safety and reduces operations costs, enabling the industry to compete and advance their capabilities. Advanced technology to improve seafood processing capabilities can reduce operational costs, increase production efficiency and yield, and improve harvest value.

MIT Sea Grant will work with partners that have identified the need for further work and guidelines on identification, control, and removal of native and non-native species associated with the aquaculture industry. For example, European green crabs have emerged as a nationally relevant, and locally pervasive threat to ecosystems and aquaculture operations. MIT Sea Grant is currently engaged with Sea Grant, industry, and community leader partners in and out of Massachusetts to develop strategies for addressing the issue.

MIT Sea Grant has recently partnered with the Mashpee Wampanoag Tribe (MWT), NOAA Office of Response and Restoration, the MA Department of Environmental Protection, and MA Division of Marine Fisheries on a project funded by the Sea Grant Special Projects C: Disaster Preparedness for Coastal Communities program. The project will develop aquaculture oil spill disaster

SFA Future Directions

1. Engineering and robotics for fisheries and aquaculture operations, including offshore aquaculture and ocean renewable energy
2. Biomimetics research and engineering in support of fisheries and aquaculture monitoring and production
3. Machine learning for fisheries and aquaculture management
4. Alternative markets development for fisheries and aquaculture
5. Assisting with fisheries monitoring and stock assessments
6. Biological research involving microbiomes and research in microplastics for fisheries and aquaculture
7. Engaging fishing communities and vessels in ocean related research
8. Fish passage and habitat improvements including monitoring and assessments
9. Workforce development for fisheries and aquaculture
10. Monitoring and assessing climate impacts to fisheries and aquaculture resources
11. Community science, education, outreach, engagement, and training programs focusing on our stakeholder-driven SFA priorities

preparedness and response program and oil spill response partner network for the MWT. MIT Sea Grant will then work with project partners to expand the program to coastal communities and aquaculture industry along the Massachusetts coast and throughout the northeast region.

MIT Sea grant will also work with partners and stakeholders to develop sound science and technologies that address microplastics in fisheries and aquaculture, and technological solutions for addressing ocean renewable energy effects on fisheries resources. Our industry stakeholders have expressed strong support for the development and transfer of these technologies.

SFA Outreach and Education

MIT Sea Grant SFA outreach efforts focus on promoting the benefits of vibrant working waterfronts, fisheries engineering, fisheries management and assessment, and aquaculture practices. Our outreach includes transferring information, tools and technologies developed by our staff, researchers, engineers, and modelers in support of fisheries, aquaculture, resource management, local communities, and industry, as well as assist with monitoring and assessment of fisheries resources. MIT Sea Grant also focuses on supporting the state's recreational and commercial fisheries, aquaculturists, and the seafood industry. We are doing this by understanding the needs of these stakeholders and responding with research and technologies to improve processing and operations. Through this we develop community supported fisheries and aquaculture opportunities for current products and alternative markets for unused or underutilized species and byproducts. Outreach and engagement with novel groups is further expanding, with the goal of engaging diverse audiences such as those in underrepresented communities and improving public understanding of the benefits offered by sustainable aquaculture practices. Our outreach activities will continue to support MIT Sea Grant SFA efforts.

SFA Goals, Actions, and Desired Outcomes

SFA Goal 1: Domestic fisheries, aquaculture and other coastal and freshwater natural resources supply food, jobs, and economic and cultural benefits.

ACTION: Promote and support harvest and processing techniques that lead to safe, sustainable, high-quality food as well as economic, social and ecosystem benefits.

Desired Outcome: Coastal and marine resource managers, residents and MA seafood consumers understand the benefits of domestically produced seafood, both wild and farmed, for individual and environmental health.

Desired Outcome: Coastal and offshore marine resource industries employ technologies and reinforce strategies to ensure safe and sustainable seafood and products.

Desired Outcome: Coastal and marine resource industries employ strategies that balance economic, community, cultural and conservation goals.

ACTION: Support development of a trained and diverse workforce and enhance technology transfer in a manner that recognizes a variety of methodologies and approaches, including those based on traditional and local knowledge.

Desired Outcome: Increased understanding and technological solutions aid management and production.

Desired Outcome: Stakeholder engagement and partnerships enable the industry to adapt and acquire innovative technologies.

SFA Goal 2: Natural resources are sustainably managed to support fishing communities and industries, including commercial, recreational, subsistence fisheries and aquaculture.

ACTION: Ensure the best available science, services and tools are available to and trusted by resource managers, the fishing and aquaculture communities, and consumers.

Desired Outcome: Commercial and recreational fishers, aquaculturists, and seafood industry members are knowledgeable about efficient, sustainable and responsible tools, techniques and uses of coastal, offshore, and freshwater resources.

Desired Outcome: Resource managers and fishing and aquaculture communities have access to and share diverse knowledge and tools to increase their capability to adapt to changing resource management needs, including those driven by climate change.

Desired Outcome: Consumers understand the health and sustainability benefits of domestically produced seafood and use that knowledge to inform their seafood purchasing decisions.

FOCUS AREA: RESILIENT COMMUNITIES AND ECONOMIES (RCE)

For decades, coastal areas have seen increased growth in development and tourism in Massachusetts. The development along the coast has brought increased runoff, sedimentation, nutrients and contaminants, and degradation of habitats and resources.

Seafood supply, ocean acidification, coastal protection, habitats, resources, and water quality, effects of sea level rise due to climate change, storm damage and coastal erosion, and threats to coastal infrastructure and resources are all concerns for Massachusetts communities. Constituents have expressed the need for guidance and resources in support of ways to adapt and mitigate these impacts. These, and other impacts associated with the

RCE Continuing Priority Activities

1. Coastal resilience, including carbon cycling and climate impact mitigation in coastal habitats
2. Support fishing communities through working waterfronts and workforce development programs
3. Assist underserved and tribal communities with development of adaptation planning to protect critical infrastructure from coastal flooding and damage
4. Contribute to multi-partner state and regional planning groups such as the Northeast Coastal Acidification Network (NECAN) and the Massachusetts Bays National Estuary Partnership with planning, assessments, analysis, monitoring, outreach, education, and training regarding impacts on ocean and coastal resources, industries, and economies
(Continued on next page)

expansion of offshore renewable energy to the northeast, bring uncertainty to fishing communities and the state seafood industry, and other sectors represented by Massachusetts coastal constituents.

Future RCE efforts will involve assessing community vulnerabilities and working to meet stakeholder needs by providing engagement, tools and technology to help coastal communities in their monitoring efforts, overcoming hurdles to increased productivity and markets, and informing their decision process.

MIT Sea Grant will work with our partners in research, design, engineering, and technology to develop solutions for improving working waterfronts and the resilience of our coastal resources and communities. Developing protective infrastructure that mimic or sustain the establishment of biological communities and support ecological processes using traditional coastal habitat restoration and knowledge of natural processes, and addressing other coastal resilience challenges are priorities identified by our stakeholder groups (e.g., MA Division of Marine Fisheries; MA Office of Coastal Zone Management; and WHOI).

Working with our seafood industry partners and constituents to develop harvest, production, and distribution technology, alternative markets, and workforce development programs will enable MIT Sea Grant to support stakeholder-driven priority needs that are vital components of resilient coastal

5. Contribute to fisheries and aquaculture monitoring and stock assessments
6. Collaborate with local fishing and aquaculture groups to develop alternative markets, products, technology, and economic benefits for industry and local communities
7. Collaborate with Massachusetts indigenous communities to advance sustainable fisheries and aquaculture production, operations, harvest, marketing, education, and outreach
8. Collaborate with industry, local communities, state, and federal agencies to establish and advance workforce development programs to support Massachusetts fisheries and aquaculture careers
9. Develop advanced technologies for decarbonization and electrification of marine craft

RCE Future Directions

1. Collaborations with partners and stakeholders to improve resilience of coastal communities through engagement, monitoring, modeling, forecasting, and engineering solutions
2. Research, technology, and outreach in support of ocean renewable energy and stakeholders in Massachusetts and the northeast
3. Research, technology, and outreach in support of working waterfronts, fishing industry workforce development, and new markets and products for underutilized species and in commercial fisheries/aquaculture
4. RCE outreach, education, and engagement with a focus on local, indigenous, and underserved communities
5. Autonomous vessel navigation for use in maritime commerce
6. Coastal and ocean sensing advancements to monitor and forecast environmental impacts on communities and economies

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communities and economies. Applying our efforts in the areas of ocean renewable energy, with focus on tidal and wave energy, and decarbonization of maritime fleets, will further enable MIT Sea Grant to develop regional partnerships and collaborations that meet the needs of our constituents and address the Sea Grant RCE focus area.

7. Seafood industry engineering and robotics to improve operations and reduce economic impacts
8. Collaborate with commercial fishing vessels to support coastal and ocean research programs
9. Research, technology, and outreach to support ocean renewable energy and stakeholder groups

The expansion of offshore renewable energy in the northeast brings with it challenges involving marine spatial planning, conflicting industry objectives, ecosystem and species conservation, regulatory processes, and community impacts and benefits. The Northeast Sea Grant Consortium (NESGC) is collaborating to provide research, outreach, and extension services that use sound science to inform stakeholders, improve awareness and understanding of issues, and advance processes associated with offshore renewable energy. MIT Sea Grant is collaborating with other northeast Sea Grant programs on this regional research and extension effort.

Working waterfronts encompass a variety of activities that promote resilient communities and economies with an emphasis on the fishing industry and supporting businesses. We will continue working with our fishing industry partners to develop alternative markets and products for underutilized species. Institutional partnerships and increased product lines will enable expansion and long-term sustainability of the community supported fish chowder program, an on-going partnership between MIT Sea Grant and the commercial fishing industry. Working with our fishing industry partners we will develop new opportunities for commercial vessels to support scientific research programs in collaboration with MIT Sea Grant, our partners, and funded researchers. We will continue to work with the fishing industry to develop technology to advance industry capabilities, and programs under the Young Fishermen's Development Act to train the next generation and provide employment opportunities to sustain commercial fishing and its valuable contribution to coastal communities in Massachusetts and the region.

Aquaculture remains at the forefront of Sea Grant priorities and MIT Sea Grant has embraced this challenge. We will continue developing programs in aquaculture workforce development, a limiting factor and priority expressed by both industry participants and those seeking to enter into the field. We will work with our constituents to develop alternative markets for aquaculture products in support business plan development and product management. MIT Sea Grant has begun working with state and industry partners to assess the needs of underserved communities for preferred aquaculture products and sources. We will continue to develop these alternative markets and collaborations to improve opportunities and benefits for aquaculture growers and underserved communities in Massachusetts. Technology development is one of MIT Sea Grant's greatest assets. We will continue developing technology to advance aquaculture production, operations, monitoring, and safety for both near-shore and offshore applications. MIT Sea Grant in partnership with NOAA and state response agencies are developing disaster preparedness

programs to improve the capabilities of tribal and non-tribal communities to avoid, minimize, and mitigate unexpected impacts to aquaculture operations and local economies. We will continue with these efforts, with the intension of developing standardized response plans to be tailored to aquaculture communities coast-wide. Finally, MIT Sea Grant will continue funding research to support the needs of our aquaculture constituents to improve resilient communities and economies in Massachusetts and the region.

Lastly, technology development in support of maritime commerce and resilient communities and economies has been a long-standing priority for MIT Sea Grant. We will continue with this endeavor by developing alternative approaches to decarbonization of commercial fleets. MIT Sea Grant continues to develop technology to advance the capabilities of autonomous surface and underwater vehicles, and autonomous navigation systems for commercial vessels, port operations, and other applications. The transfer of these technologies and supporting information will help improve the long-term resilience of coastal communities and economies of Massachusetts and beyond.

RCE Outreach and Education

During 2024-2027, we will continue to offer training workshops on coastal resilience, integrated technology, fisheries and aquaculture workforce development, and environmental topics, which support the demand for trained technical workers to meet future workforce needs. MIT Sea Grant will also engage constituent groups that include local, indigenous, and underserved communities on various RCE aspects relating to coastal resilience, fisheries and aquaculture, monitoring and analysis, modeling and forecasting, information and technology transfer, and ocean renewable energy in collaboration with our partner Sea Grant Programs in the northeast.

RCE Goals, Actions, and Outcomes

RCE Goal 1: Coastal communities have the capability and resources to prepare for and adapt to extreme and chronic weather and coastal hazards, climate change, economic disruptions and other threats to community health and well-being.

ACTION: Improve and expand exchanges of knowledge to better identify the diverse needs of communities and to increase the public's understanding of changing conditions and related impacts.

Desired Outcome: Scientific understanding, including traditional and local knowledge, provides foundational information, and all community members understand the impacts of changing conditions and coastal hazards and have the capability to prepare, respond and adapt.

Desired Outcome: Community leaders improve their understanding of changing conditions and coastal hazards and their capability to implement mitigation and adaptive strategies.

ACTION: Work with communities to advance collaborative comprehensive planning, actionable science, and adaptive management strategies.

Desired Outcome: Inclusive collaborations with diverse stakeholders and partners support mitigation and adaptation efforts built on knowledge from and responsive to the needs of all, especially the most vulnerable.

ACTION: Work with communities to explore and support diversification, strengthening, sustainability and social equity within coastal economic sectors and the blue economy.

Desired Outcome: Coastal and watershed communities have access to and share knowledge, tools, services and technologies to adapt and grow resilient economies.

Desired Outcome: Leaders in coastal and marine economic sectors understand how they can become more resilient through diversification including expanded renewable, regenerative, and clean practices.

RCE Goal 2: Water resources are enhanced, sustained, and protected to meet existing and emerging needs of the communities and economies that depend on them.

ACTION: Collaborate with diverse partners and stakeholders, especially the most vulnerable, to advance plans and management practices for protecting and managing water resources.

Desired Outcome: Communities have diverse, sustainable economies and industries that support existing and emerging water resource needs.

ACTION: Use engagement and information exchange to advance the understanding of how actions impact water quality, quantity, and availability.

Desired Outcome: Community members understand watershed and coastal functions and the ecosystem services they provide, understand how their actions will impact water resources, and are able to make informed decisions.

Appendix 1

MIT SEA GRANT DIVERSITY, EQUITY, INCLUSION, JUSTICE AND ACCESSIBILITY (DEIJA) STATEMENT

The mission of MIT Sea Grant is to promote the sustainable development of coastal and marine resources, connect communities with science, and rise to meet ocean-related challenges. In meeting these challenges through innovative technical contributions and a commitment to scientific research, we continue to gain understanding about our ocean and coasts, as well as our communities.

As expressed through the Community of Practice on Inclusion and Diversity, Sea Grant empowers coastal communities to be resilient in the face of change. MIT Sea Grant's success in providing valued research, education, and outreach is dependent on adapting to the needs of an evolving coastal population and changing social climate.

Both MIT's Department of Mechanical Engineering and the National Sea Grant College Program have developed diversity and equity working groups to ensure the advancement of these values. Diversity and inclusion are highlighted as "cross-cutting principles" in the National Sea Grant Strategic Plan. These principles – to seek and welcome diverse perspectives in order to enhance cultural understanding and better serve communities – are echoed in the MIT Sea Grant Strategic Plan as we strive to proactively engage, reflect, and serve diverse populations of communities, researchers, students, and stakeholders.

From leading ocean engineering programs with MIT's Office of Minority Education, to recruiting students through the National Sea Grant Community Engaged Internships initiative, MIT Sea Grant has a strong history of supporting students and educators from minority and underserved communities. We also work to establish a diverse and skilled workforce and collaborative infrastructure needed to protect our resources and the people who depend on them.

MIT Sea Grant is committed to maintaining an unbiased, equal opportunity environment in which all voices in our community are valued and respected in an ever-changing and increasingly diverse world.

"We celebrate these differences as enhancing features of MIT's creative, energetic, and welcoming fabric."

- MIT Mechanical Engineering Statement on Diversity

"We encourage those working with MIT Sea Grant but also beyond, to take time to educate ourselves on what injustice and systemic racism look like today."

- A Message from the Director

NATIONAL SEA GRANT COMMUNITY OF PRACTICE ON INCLUSION AND DIVERSITY

The National Sea Grant Community of Practice on Inclusion and Diversity defines diversity, equity, inclusion, and justice in the following way:

Diversity: The full representation of and collaboration between people with different identities, knowledge sets, experiences, and perspectives.

Equity: The allocation and accessibility of resources for fair distribution of services, benefits, and burdens.

Inclusion: The creation of an open and welcoming environment that recognizes and affirms the value and dignity of all people.

Justice: The systematic removal of barriers that result in equitable opportunities and outcomes for every individual in a diverse society.

APPENDIX 2: NATIONAL SEA GRANT COLLEGE PROGRAM PERFORMANCE MEASURES AND METRICS

National Performance Measures by National Focus Areas

Healthy Coastal Ecosystems (HCE)

Number of resource managers who use ecosystem-based approaches in the management of land, water, and living resources as a result of Sea Grant activities

Number of acres of coastal habitat protected, enhanced, or restored as a result of Sea Grant activities

Sustainable Fisheries and Aquaculture (SFA)

Number of fishers, seafood processors, aquaculture industry personnel or seafood consumers who modify their practices using knowledge gained in fisheries sustainability and seafood safety as a result of Sea Grant activities

Resilient Communities and Economies (RCE)

Number of communities that adopt/implement sustainable economic and environmental development practices and policies as a result of Sea Grant activities

Annual number of communities that adopt/implement hazard resilience practices to prepare for and respond to/minimize coastal hazardous events

Environmental Literacy and Workforce Development (ELWD)

Number of Sea Grant products that are used to advance environmental literacy and workforce development

Number of people (youth and adults) engaged in Sea Grant-supported nonformal education programs

Number of Sea Grant supported graduates who become employed in a job related to their degree within two years of graduation

Cross-Cutting National Focus Area Measures

Number of Sea Grant tools, technologies and information services that are used by our partners/customers to improve ecosystem-based management

Economic and societal impacts and benefits derived from Sea Grant activities market and non-market; jobs and businesses created or sustained; patents)

Cross-Cutting National Performance Metrics

Sea Grant Staffing: Number of individuals and full-time equivalents (FTEs) devoted to Sea Grant

Core Funding Proposals: Number and Origination of Core Funding Pre- and Full-Proposals

Number of Volunteer Hours

Number of Postsecondary Students and Degrees Financially-Supported by Sea Grant in Higher Education Programs (Undergraduate, Graduate)

Number of P-12 Students who participated in Sea Grant-supported formal education programs

Number of P-12 Students Reached Through Sea Grant-Trained Educators

Number of educators who participated in Sea Grant-supported professional development programs

Number of Sea Grant-Sponsored/Organized Events

Number of Attendees at Sea Grant-Sponsored/Organized Events

Number of Public or Professional Presentations

Number of Attendees at Public or Professional Presentations

Cross-Cutting National Performance Metrics, Continued

Number of individuals certified or recertified in Hazard Analysis Critical Control Point (HACCP) as a result of Sea Grant activities

Number of peer-reviewed publications produced by Sea Grant

Visitor Attendance: Number of people that visit museums, aquariums, and other informal education institutions hosting NOAA-supported exhibits or programs (NEW; Pilot)

Environmental Actions: Number of people participating in environmental actions through NOAA education programs (NEW; Pilot)