Maine Aquaculture ROADMAP 2022-2032

MAINE AQUACULTURE HUB

Citation

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About

The Maine Aquaculture Hub is a network for sustainably strengthening the aquaculture sector of Maine. It was founded by five organizations that make up the Steering Committee: Maine Sea Grant, Maine Aquaculture Association, Maine Aquaculture Innovation Center, Coastal Enterprises, Inc., University of Maine Aquaculture Research Institute.

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GRUNDÉNS
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RADITION

Executive Summary

Maine is an ocean state. Extending into the cold waters of the North Atlantic, communities have been carved into its lengthy coastline, and generations of people have built a life through hard work and ingenuity on the water. A strong maritime heritage remains today, and the ocean continues to play a notable role in the state's economy. It is a crucial piece of the story and character of Maine.

Nevertheless, Maine's waters and coastal communities are changing. More people are beginning to call Maine home, ocean temperatures are rising faster in the Gulf of Maine than anywhere else, and historic fisheries along with the fishing industry are under pressure from numerous sources. While these challenge the state's identity, they also bring opportunities to expand our rich marine heritage, provide a future for generations of working waterfront families, and create communities that work for all. One such opportunity is aquaculture: farming the sea.

Aquaculture complements the state's traditional working waterfront identity and fishing and agricultural heritage while also helping to meet the growing demand for a sustainable, traceable, domestic food supply. It is a significant contributor to the state's economy. As a network of mostly small businesses and entrepreneurs, Maine aquaculture enterprises bring jobs, local food, and associated industries to the inland and coastal communities where farms are located.

In 2010, the *Directing the Future of Maine's Aquaculture Industry: An Economic Development Plan* outlined barriers to aquaculture development in the state and offered solutions to address those barriers. Much has changed since its publication. For Maine to remain a leader in sustainable aquaculture and realize its potential, a new roadmap is needed to reflect the opportunities and challenges of the decade to come.

This 2022 *Maine Aquaculture Roadmap* offers a collaborative outlook and proposes goals to guide the aquaculture sector in Maine over the next ten years, including the steps, partners, and projected resources needed to achieve the goals. The effort, led by Maine Sea Grant and the Maine Aquaculture Association, began by assessing progress since the 2010 plan.

Aquaculture stakeholders across the state of Maine, including representatives from the aquaculture sector, commercial fishing, government, academia, environmental groups, nonprofits, and many more, were solicited for their input concerning the future of Maine's aquaculture sector. In 2020, a series of focus group meetings provided an opportunity for voices across the state, and in particular organizations involved with Maine's marine economy, to share their goals for the next decade of aquaculture in Maine. They voiced concerns, suggested solutions, and provided comments. Ten focus group meetings resulted in feedback from over 141 individuals, representing 92 different organizations and companies (*Table 2*), all of which was synthesized and incorporated into this 2022 roadmap.

Four goals were identified as imperative to sustainably strengthening Maine's aquaculture sector over the next ten years:

1. Develop a streamlined licensing and permitting process that balances the rights of an applicant and the public
2. Increase integration and understanding of aquaculture in Maine's coastal communities
3. Expand and promote the Maine seafood brand
4. Make Maine a leader in triple bottom line sustainable aquaculture: social, economic, environmental

For each of the four goals, specific action items were identified, and suggestions regarding which organization should be responsible for each action and the resources required to complete it were included (*beginning on page 16*). The following recommendations reflect the views of those stakeholders who engaged in the process (*Table 2*). Should they be implemented by the partners listed and others across Maine's marine economy, the actions outlined at the end of this summary will help the aquaculture sector strengthen opportunities with more local communities and enhance the state's working waterfront future.

Embedded within these goals, yet worth noting individually, are two cross-cutting topics of importance. First is climate change—not only preparing for the changes that are coming, but also making use of aquaculture as one solution to lessen the impact of those changes. As ocean temperatures and sea levels rise, acidification fluctuates, and fisheries respond, farming seaweeds and animals can help mitigate effects and continue to provide ocean-based livelihoods. Implementing sound solutions

through the lens of a changing climate is an important theme of this roadmap.

Second, diversity, equity, and inclusion (DEI) are paramount to the sustainable future of the aquaculture sector. Including 'new Mainers' in aquaculture opportunities and the greater marine industry will be an important component of the state's future, as Maine welcomes more people 'from away' while simultaneously struggling with a shortage in the workforce. Bringing aquaculture and awareness of its benefits to all Maine citizens, from well and underserved communities alike, can only strengthen opportunities for the sector and the people engaged. This roadmap aims to integrate DEI efforts across its goals and action items.

The ultimate purpose of this roadmap is to enable collaborative effort amongst organizations and individuals in order to implement the recommended goals and actions. The roadmap is intended to be complementary to the Seafood Economic Accelerator for Maine (SEAMaine); the Maine Economic Development Strategy 2020–2029; Maine Won't Wait, A Four-Year Plan for Climate Action; and other efforts to plan for the state's future. At the time of this report's publication, several action items have already begun to be addressed. One, an effort of the Maine Aquaculture Hub, is a call for proposals to invest in farmer-led projects that work towards the roadmap goals. Five proposals were awarded funds during the 2020 call to projects that address a range of barriers, from labor in oyster farming to expanding kelp processing. Another round of funding was awarded in 2021, and a final round is anticipated for 2022.

The organizations supporting the Maine Aquaculture Hub are committed to continued assessment and progress towards completion of the action items. To evaluate the execution of the recommendations of this report, and progress made by the identified organizations, the Maine Aquaculture Association and Maine Sea Grant, with help from the Roadmap's steering committee (*Appendix 1*), plan to conduct a halfway assessment in 2026. The evaluation will measure progress made toward the action items and will include suggested adjustments so that goals can be achieved within a ten-year timeframe.

As we enter the next decade amid significant global changes, aquaculture has the potential to be a leading force for good, benefiting people, the economy, and the environment. This roadmap aims to achieve such potential for the aquaculture sector of Maine.

Introduction

Over the past 20 years, the amount of wild-caught seafood has remained steady globally, while the amount raised through aquaculture has increased threefold (Naylor et al., 2021; NOAA, 2020; NOAA, 2021). Since 2016, aquaculture has supplied the majority of seafood produced for human consumption worldwide (FAO, 2020). Despite having one of the longest coastlines in the world, the United States lags behind in aquaculture production, ranking 17th in worldwide aquaculture production (NOAA, 2020). The U.S. imports over 80 percent of its seafood—more than any other country. In 2019, the nation imported $22.2 billion worth of edible seafood and exported $5.2 billion, resulting in a seafood trade deficit of $16.9 billion. About half of imported seafood is farmed, with global and domestic demand for seafood poised to grow (NOAA, 2020).

A compelling case can be made for strengthening aquaculture in the United States. Given its abundant natural resources, global leadership in science and technology, and heritage as an agricultural nation, the U.S. is positioned to continue to develop aquaculture through science-based strategies that simultaneously address the economic, societal, and environmental challenges facing our country (NSTC, 2021). The industry produces safe and nutritious seafood in American waters, creates new jobs, contributes to resilience in coastal communities, and maintains the coastal culture and economic working waterfront traditions that are found along the country's seaboard.

A diverse aquaculture sector in the United States that meets increasing demand for traceable, sustainable, high-quality seafood offers Americans an opportunity for profitability and economic growth in a way that generates prosperity while conserving the Nation's natural resources. With a national value of $1.5 billion in 2018 (NOAA, 2019), aquaculture currently accounts for 20 percent of the value of domestic fisheries landings. Doubling current production could result in tens of thousands of jobs in coastal communities (NOAA, 2020).

In Maine, aquaculture is a significant contributor to the state's coastal economy—supporting working waterfronts; creating local job opportunities; and producing healthy, high-quality, domestic seafood. Aquaculture in Maine began in the early 1970s, when the Maine legislature passed the first marine farm leasing statute in the modern United States. Currently, Maine aquaculture businesses produce shellfish (oysters, mussels, scallops, and clams), sea vegetables (seaweeds, namely sugar kelp and skinny kelp), and finfish (Atlantic salmon, American eels, California yellowtail, trout, tilapia, and ornamentals). The sector includes businesses across the supply chain, from aquatic farmers, distributors, and retailers to researchers and equipment manufacturers. In 2014, 107 Maine aquaculture businesses generated a statewide economic contribution of $137.6 million, including 1,078 full and part-time jobs and $56.1 million in labor income (Cole et al., 2017). Since 2014, the number of aquaculture businesses in Maine has steadily grown, bringing an increase in jobs and labor income. Maine's aquaculture producers now operate on more than 150 lease sites and nearly 700 limited purpose aquaculture (LPA) license sites (DMR, 2020; DMR, 2021). In this same time, Maine's aquaculture harvest has more than doubled in value and volume. Oysters alone were valued at $9.7 million in 2019, which made them the fourth most valuable commercial marine species in the state (DMR, 2020a).

The *Maine Economic Development Strategy 2020* identified sustainable aquaculture as a sector of opportunity for the state, one that will complement traditional fishing, meet the growing demand for a traceable food supply, and help Maine become a leader in the development of a new and sustainable blue economy (DECD, 2019). Some predict Maine aquaculture exports to net $230–$800 million by 2025 (FocusMaine, 2016). At the global level, aquaculture is commonly utilized as a tool for economic development, providing jobs and healthy, sustainable protein to local communities. In Maine, farming seafood has such potential. Beyond its employment and economic contributions, aquaculture plays a role in planning for a resilient future and adapting to a changing climate. Aquaculture is one

solution to maintaining working waterfronts and Maine's maritime character.

Farming aquatic species is one of the most efficient methods of producing food. Aquaculture has a lower carbon footprint, reduced space requirements, and smaller feed conversion ratios compared to terrestrial agriculture. In particular, growing shellfish and seaweed is especially promising as these species require no inputs—no feeding, watering, or fertilizing—and improve the surrounding ecosystem as they grow. Bivalves, such as oysters, mussels, scallops, and clams, filter seawater to feed, removing detritus and improving water quality. Seaweeds capture carbon and nitrogen as they grow, balancing ocean acidity. Aquaculture has the potential to be restorative, to have a positive impact on the environment, to mitigate the effects of climate change, and to contribute to sustainable food production (Duarte et al., 2017).

Sea farms can act as habitat for other species, providing structure, food and areas to forage, and reproductive or nursery grounds (Dempster et al., 2009; Theuerkauf et al., 2021). A new study that reviewed aquaculture globally confirms the benefits of shellfish and seaweed farming on marine habitats, finding greater numbers of fish and invertebrates and greater diversity of species on farm sites than in nearby locations, similar to findings around salmon farms in Norway. Further, integrating multiple species in one farming location, such as farming finfish and shellfish, along with seaweeds, can create a sustainable, self-supporting system as waste from one group is utilized as food by another. Known as integrated multi-trophic aquaculture (IMTA), this approach to sea farming holds significant potential (Chopin et al., 2012).

Advancements in finfish aquaculture, including feed science, best practices, and recirculating aquaculture systems (RAS), provide opportunities for Maine to continue serving as a leader in innovation, building on its history of development in the sector. In the 1990s, for example, strides were made in biosecurity, containment management systems, and fallowing practices. Offshore aquaculture and aquaponics systems are two additional emerging production methods with potential for research and development in Maine.

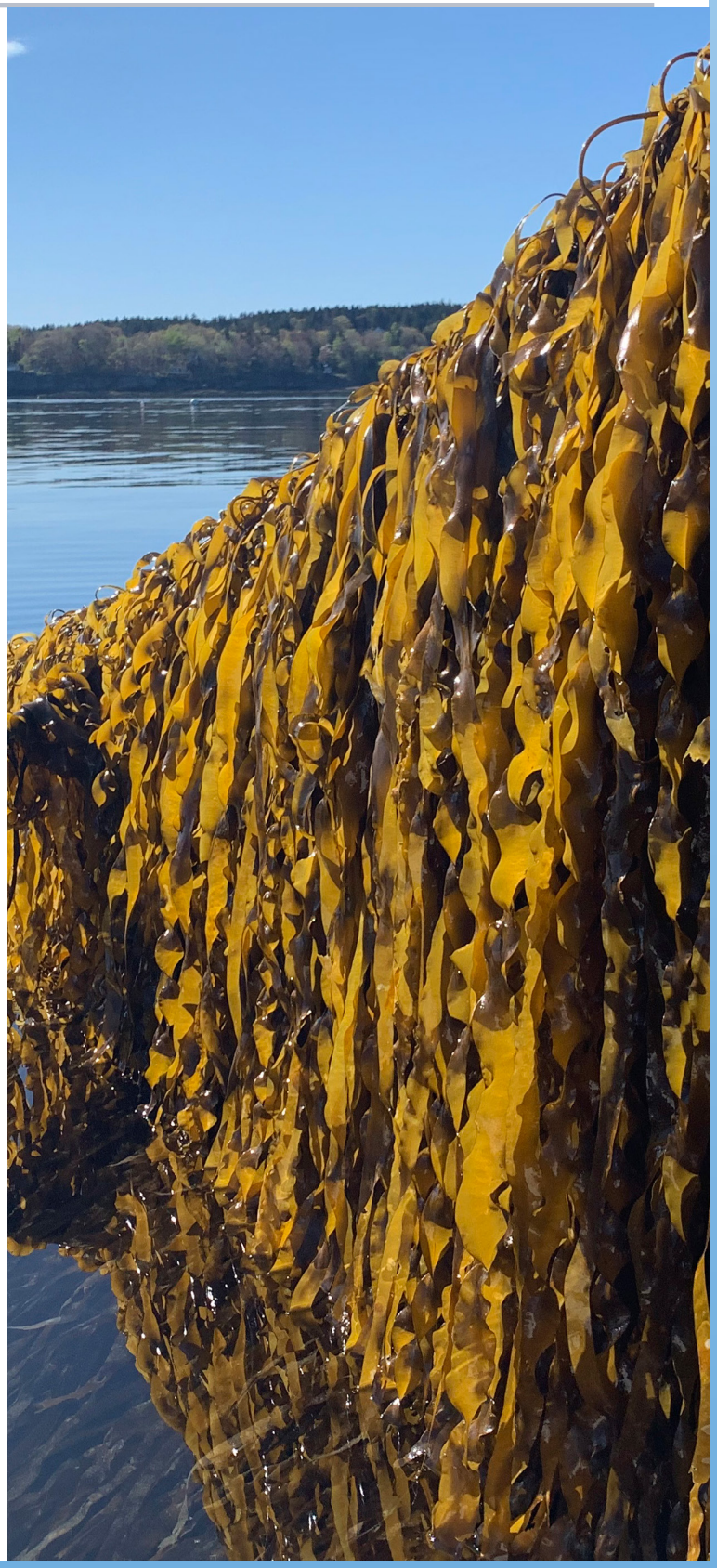
To continue development of the Maine aquaculture sector and expand on the benefits it brings to the state, while also increasing the resilience of coastal communities and maintaining cultural and economic working waterfront traditions, a plan for the next decade is necessary. The Maine Aquaculture Hub was established in response to this need. Funded by the National Oceanic and Atmospheric Administration (NOAA), the Hub was created as a collaboration between six organizations: Maine Sea Grant; the Maine Aquaculture Association; the Maine Aquaculture Innovation Center; Coastal Enterprises, Inc.; the Aquaculture Research Institute; and the University of Maine's School of Marine Sciences and Cooperative Extension. The Hub is a network that aims to sustainably strengthen Maine's aquaculture sector, connecting organizations and individuals across the state. It is working toward this goal by funding projects to address barriers to aquaculture in Maine, training the next generation of sea farmers through the Aquaculture in Shared Waters (AQSW) program, and developing a plan for the future of aquaculture in Maine and a roadmap for how to accomplish it.

In 2020, the Maine Aquaculture Hub convened to assess progress made since the 2010 *Directing the Future of Maine's Aquaculture Industry: An Economic Development Plan* and to determine the process for building an updated, shared plan for the sector. To capture input from all aquaculture stakeholders in developing this plan for the next decade, the Hub hosted a series of focus groups, which included diverse participation of over 140 individuals representing 92 organizations and companies from across the state of Maine. The outcomes of these focus groups are the foundation for the recommendations found in this report, the 2022 *Maine Aquaculture Roadmap*.

Starting with an assessment of the 2010 report

A decade has passed since the 2010 *Directing the Future of Maine's Aquaculture Industry: An Economic Plan* was finalized. The 2010 plan identified ten goals to be achieved by 2020 for economic development of the sector, along with measures of success for each to be used in tracking progress toward the goals. The Maine Aquaculture Hub conducted an assessment in spring of 2020 to evaluate performance for each 2010 metric and goal and identify areas for improvement. The results were used to inform the development of this 10-year roadmap for 2022–2032.

The first step in the evaluation process was for the Roadmap Steering Committee, composed of leaders in the aquaculture sector (*Appendix 2*), to evaluate progress against the measures of success in the 2010 plan. In addition, committee members obtained relevant data to assess each measure. The information seeking phase alone required extensive research and outreach to find accurate data, largely qualitative, on topics spanning from government prioritization to commercial fishermen views on aquaculture as an alternative to continue their maritime working heritage. The relevant data were compiled into a matrix that was separated by goal. The matrix included each individual metric, its progress data, and a judgment on metric quality. The matrix included ten goals from the 2010 plan as well as six industry clusters identified in the plan as sectors with significant opportunities for linkages with aquaculture (manufacturing, biotechnology, tourism, commercial fishing, NGOs, and renewable energy). Each goal, which contained up to nine metrics, was assessed by the Steering Committee; the assessment can be found in *Appendix 3*. Categories were given a broad rating based on progress made toward achieving that goal: green (strong), yellow (moderate), or red (poor). Then, the metrics themselves were given a green, yellow, or red rating based on the attainability and accuracy of the data used to assess progress.



Ratings & Metrics

Of the ten goals described in the 2010 plan, three were rated as green, six were rated as yellow, and one was rated as red.

Maine Aquaculture Report Card

A 2020 assessment of the Maine aquaculture industry's progress based on the 2010 Maine Aquaculture Economic Development Plan

Ratings: ● Strong ■ Moderate ◆ Poor

Goal	Overall Progress	Metric Performance
Government prioritization of aquaculture development	■	●
Effective and targeted financing programs designed to address aquaculture's unique challenges	■	◆
Significant state and federal funds invested to develop and support a world class research and training infrastructure	●	●
The attraction and/or training of a world class group of aquaculture entrepreneurs and managers	●	●
Effective measures that reduce the barriers to entry for new aquaculture producers	◆	■
Significant reductions and stabilizations in the costs and supplies of seed stock and feed	■	■
Develop, protect, and use the Maine brand in marketing Maine seafood	■	■
A licensing and permitting process that is expedient and balances the rights of an applicant and the public interest	■	■
Increased investor interest and confidence	●	■
Traditional commercial fishing constituents will view aquaculture as an attractive alternative to commercial fishing and a way to continue their maritime heritage	■	■

The following goals were rated as green, indicating strong progress was made:

1. Increased investor interest and confidence
2. Significant state and federal funds invested to develop and support a world class research and training infrastructure
3. The attraction and/or training of a world class group of aquaculture entrepreneurs and managers

The *increased investor interest and confidence* goal received a green rating for Overall Progress based on the metrics identified in the 2010 plan: number of inquiries about aquaculture leases each year, number of lease and permit applications, the ratio of inquiries to applications, and new aquaculture companies formed per year. Although several of these metrics were not explicitly tracked by the Department of Marine Resources (DMR), the increase in general interest in aquaculture, the acreage and total number of LPAs and leases, and investments in both smaller and larger aquaculture firms led to the green rating. However, since several of the metrics' data were not obtainable, thus preventing measurement, the metric

performance received a yellow rating. Conversations with DMR are underway to begin tracking information such as lease/permit inquiries, applications submitted, and new companies formed each year.

Significant state and federal funds invested to develop and support a world class research and training infrastructure received a green rating for Overall Progress based on the number and capacity of aquaculture-targeted research facilities (e.g. Aquaculture Research Center, Center for Cooperative Aquaculture Research, the Darling Marine Center, the Downeast Institute, and Bigelow Laboratory for Ocean Science, among several others); the number and expertise of researchers, teaching professionals, and extension staff focused on aquaculture; and the amount of grant dollars focused on aquaculture raised by research institutions. Other areas of success include research facilities that are geographically distributed and that have the physical capacity to do research on species and production methods at scales relevant to Maine. Last, there now exists research, training, and extension staff who can utilize research facilities and address critical industry needs, and who regularly gather a statewide aquaculture industry research summit. Data for this category were obtainable, the performance was measurable. Together, they provided a strong standard for comparison, leading to the green metrics rating.

The attraction and/or training of a world class group of aquaculture entrepreneurs and managers earned a green Overall Progress rating based on the number of new aquaculture startups per year (2019 alone saw 28 new businesses through LPAs and 8 new businesses through leases); the number of new aquaculture leases, permits, and leases issued per year; the number of new aquaculture jobs created per year; the number of full-time faculty at the UMaine Aquaculture Research Institute; the number of dedicated teaching and research assistantships; the number of students enrolled at UMaine who declare as aquaculture students; the number of students participating in industry internship programs; the number of high school students and teachers attending summer aquaculture camps; and the several hundred fishermen and others who attend farmer training academies, such as Aquaculture in Shared Waters, the Aquaculture Business Development Program, and Aquaculture Top Gun, among others. Other areas of success include the production and distribution of short videos promoting Maine as an aquaculture destination, aquaculture business recruitment specialists working to solicit new investment, and professionally designed social media. Since these metrics were also easily tracked, and provided a strong basis for comparison, they were rated as green.

Next are the goals rated as yellow, indicating that moderate progress was made in these categories:

1. *Government prioritization of aquaculture development*
2. *A licensing and permitting process that is expedient and balances the rights of an applicant and the public interest*
3. *Effective and targeted financing programs designed to address aquaculture's unique challenges*
4. *Significant reductions and stabilizations in the costs and supplies of seed stock and feed*
5. *Develop, protect, and use the Maine brand in marketing Maine seafood*
6. *Traditional commercial fishing constituents will view aquaculture as an attractive alternative to commercial fishing and a way to continue their maritime heritage*

Government prioritization of aquaculture development earned a yellow Overall Progress rating based on its performance against the metrics, including the overall increase in the number of lease applications filed per year, the number of state agency staff dedicated to promotion and development of the aquaculture sector, the total number of state budget dollars dedicated to aquaculture development, and the identification of aquaculture as a sector of opportunity by the Maine Department of Community and Economic Development (DECD, 2019). Although there were areas of success, such as the prioritization mentioned above, the status of yellow was chosen due to the lack of government-related targets, including committing significant resources to staff to facilitate aquaculture development and to restructure how aqua-

culture is managed in order to balance with equal emphasis regulatory oversight and economic development activities. The metrics themselves received a green rating due the attainability and precision of the data needed to evaluate progress.

A licensing and permitting process that is expedient and balances the rights of an applicant and the public interest received a yellow Overall Progress rating because while improvements were made, a lack of data prevented progress measurement. The number of days from completed lease application to hearing date had, based on anecdotal evidence, decreased. The number of days from completed lease application to final lease decision had also decreased, based on anecdotal evidence, but continues to be a concern voiced by growers. It is worth noting that these assessments were made before COVID-19 reached Maine. Public hearings were put on hold beginning in March 2020 due to the global pandemic and did not return until August 1, 2021. Any applications requiring a public hearing were at a standstill. As a result, the time to process lease applications has significantly increased, and continues to be a challenge due to staff shortages. However, DMR is now tracking the number of days from completed application to the lease hearing and final decision. Another goal was to track exit interviews that document investor perception of the leasing program. These interviews did not occur. The Metrics Performance also received a rating of yellow because there were no data available for any of the metrics beyond discussions with lease applicants. However, the metrics show potential to provide positive feedback if they are tracked by DMR and publicly disclosed on a regular basis.

Effective and targeted financing programs designed to address aquaculture's unique challenges received an Overall Progress rating of yellow, indicating a moderate level of achievement. The metrics used to make this assessment include the annual number of up-to-date economic benchmarking studies available—one, completed in August 2020. The metrics also called for an annual summary of financing methods used by aquaculture companies. While this annual summary has not occurred, financing methods are addressed in the benchmarking report. The number of new aquaculture start-ups per year has increased, but the precise level of increase was not tracked. The number of financial professionals attending training seminars per year provided another metric of progress. Last, the metrics measured the level of funding

for and use of the Sustainable Working Waterfront Development Fund. While this fund does not currently exist, Congresswoman Pingree's "Keeping America's Waterfronts Working Act" H.R. 3596 has passed the House of Representatives, and the last legislative session allocated $4 million to recapitalize the Working Waterfront Preservation Program. Maine community institutions such as Coastal Enterprises, Inc. and the USDA Farm Service Agency have worked with the sector to provide financing programs designed to address aquaculture's unique challenges. Performance of the metrics themselves was rated as red, due to the limited nature of data that were collectible.

Significant reductions and stabilizations in the costs and supplies of seed stock and feed was also rated as yellow in Overall Progress, as the category has seen moderate improvements. The species-specific average cost of juvenile seedstock in Maine has gone up moderately, along with demand. At this point it is unclear how cost has shifted relative to other states. However, four Maine hatcheries now offer oyster seed for sale, bringing stability as oyster farmers previously depended upon only two seed producers. Prices for oyster seed have increased along with demand. Oyster seed supply has mostly been able to keep pace with growing demand. Currently, one hatchery produces commercially available mussel seed on a limited basis. No hatcheries produce seed for scallop aquaculture. Farmers growing those species typically rely on wild collection for their seed. It is worth noting that climate change is a concern for these aquaculturists, as changing ocean temperatures affect the predictability of wild seed sets. Average cost for feed delivered to the average-sized Maine aquaculture farm was not determined. The majority of farms raise shellfish and seaweed and do not require feed, and we cannot report on the limited

number of farms requiring feed due to confidentiality issues. The Metrics Performance was rated as yellow because average costs were able to be estimated for seedstock, but not feed.

Develop, protect, and use the Maine brand in marketing Maine seafood received a yellow rating for Overall Progress. While the goal is difficult to measure, there was notable progress. The number of dollars spent to promote Maine seafood was not explicitly stated, but significant industry and federal funding was allocated to the Maine Lobster Promotion Council (renamed Maine Lobster Marketing Collaborative in 2013). Other efforts, including the Gulf of Maine Research Institute's Sustainable Seafood Program, the Alliance for Maine's Marine Economy, SEAMaine, the Maine Seafood Marketing Initiative, Expanding Maine's Blue Economy, the DMR marketing program, as well as those with the Maine Aquaculture Association, FocusMaine, and Coastal Enterprises, Inc. have all contributed to promoting the Maine seafood brand. Additionally, a number of unpaid media outlets have been citing Maine aquaculture products positively, especially on platforms such as Instagram. On average, species and product prices have increased, and they are projected to increase, according to the *Maine Farmed Shellfish Market Analysis Report* by the Hale group and the Gulf of Maine Research Institute (2016). The report also projected annual demand for oysters, mussels, and scallops to increase. But, price elasticity was not measured. Metric Performance was considered moderate (yellow), as the metrics provided measures of progress, but with room for improvement.

Traditional commercial fishing constituents will view aquaculture as an attractive alternative to commercial fishing and a way to continue their maritime heritage received a yellow rating for Overall Progress. There has been a steady increase in interest and number of attendees in both the Aquaculture in Shared Waters and Aquaculture Business Development programs, which together reached over 300 students. The number of commercial fishermen attending aquaculture outreach seminars per year from 2010 through 2020 is unclear. However, aquaculture has continued to be represented at the Fishermen's Forum, and fishermen who have LPAs have also attended LPA training courses. Additionally, while it does not speak directly to a specific goal from the 2010 plan, the aquaculture sector, and particularly the seaweed sector, has seen strong growth in entrants from commercial fishing. The Metrics Performance was rated yellow because the metrics provided general guidelines to assess progress, but did not allow for more accurate measure of improvements.

Finally, one category was rated red, indicating poor Overall Progress: *Effective measures that reduce the barriers to entry for new aquaculture producers*. The average cost and time for leasing, permitting, and environmental monitoring on a small-scale aquaculture start-up company have increased, based on discussions with producers. The COVID-19 pandemic has further exacerbated barriers to entry for new aquaculture producers, especially the time needed to obtain a lease. Between 2010 and 2020, $2.2 million was expended via the Working Waterfront Preservation Program across a total of 19 properties. The number of companies enrolled in federal crop and disaster insurance programs has likely increased, since many of the growers who did not qualify before 2010 are now eligible. The number of graduates from risk management training courses is not applicable since, to our knowledge, no courses were held. But many farmers attended a number of risk management training sessions and webinars offered in 2020 and 2021, and many more farmers downloaded aquaculture risk management tools and guides created by the Maine Aquaculture Association. The Metrics Performance of this goal was poor, but it was rated as yellow because some metrics were useful for assessment and other metrics were not.

Stakeholder Input Methods

Focus Groups

To capture feedback from the variety of groups engaged with aquaculture in Maine and ultimately expand the breadth of this Roadmap, a series of meetings were held throughout 2020. The goal of these meetings, referred to as focus groups, was to provide a platform through which stakeholders could provide input on a new 10-year roadmap for aquaculture in Maine. More specifically, this included reexamining the 2010 *Directing the Future of Maine's Aquaculture Industry: An Economic Development Plan*, assessing progress in its implementation, identifying barriers to aquaculture economic development, and constructing a new set of specific action items designed to guide the Maine aquaculture sector over the next 10 years. Information gathered from focus groups will also be used to identify immediate barriers to the sector, and define mechanisms for funding projects to fill urgent gaps, as has been done through the Maine Aquaculture Hub's 2021 call for proposals.

The focus groups were originally planned as in-person meetings for 2020; however, COVID-19 forced a transition to a virtual format, primarily via Zoom. The roadmap steering committee worked with Laura Singer of SAMBAS Consulting to design the format, agenda, outreach, and content of the focus groups. Singer also worked with the roadmap team to host and help facilitate the first focus group, which was composed of members of the aquaculture sector. After the first session, the roadmap steering committee (*Appendix* 2) decided to adopt the same format for all subsequent meetings for consistency and to enable consolidation of information upon completion of the virtual meetings. The team recognizes that holding these focus group meetings virtually, as opposed to in person, likely had an impact on who could attend. Although repeated efforts were made to contact stakeholders of each group, through email and phone calls, not all of those invited participated.

Prior to each focus group meeting, participants were emailed a survey (*Appendix* 4) and the 2010 plan for review. Information regarding their role in or relation to the aquaculture sector was collected. The survey referenced the 2010 plan and asked respondents which of the identified goals they considered relevant. Participants were also asked to rank the 2010 goals in order of importance and to suggest new goals. Last, participants were asked to share their expectations for the meeting. The results of the relevancy of the goals, their order of importance, and additional goals were presented back to participants during each focus group meeting.

The format of the focus groups—which were primarily facilitated by Heather Sadusky, Maine Aquaculture Hub Coordinator, and Gayle Zydlewski, Director of Maine Sea Grant College Program—began with the statement of the focus group's meeting objectives and an overview of the agenda (*Appendix* 5). This was then followed by a presentation of the 2010 Roadmap Report Card (*Page* 4); the results of the aforementioned pre-meeting survey, with goals ranked in order of importance based on the responses of that particular group; and additional comments from the pre-meeting survey. Several prompts guided open discussion of the presented materials, including 1) What clarifying questions or feedback do you have about the report card?, 2) Which goals do you consider a priority for the next 10 years?, and 3) What else would you add to survey results—especially focusing on barriers? Notes were taken during the discussion and used to create a poll in real-time containing both previous and newly emerging goals. Participants voted on their three most relevant goals (of ten listed in the poll), and the three to four topics that received the most votes were used to guide the small breakout group discussions. These smaller group discussions were led by members of the roadmap committee, who alternated duties of facilitator and notetaker between focus group meetings.

The goal of the breakout groups, which typically contained three to eight participants each, was to develop five to ten specific actions that would guide the development of aquaculture in the next ten years, along with a list of who should implement these action

items and on what timeline (i.e., short-term: 1–2 years, medium-term: 2–6 years, or long-term: 6–10 years). Additional time, 15–20 minutes, was allotted for the discussion of each topic. As discussion ensued, a notetaker documented the actions needed to be taken, who should be responsible, and the timeline. Five to ten minutes at the end of the breakout session were allocated for final thoughts from the group, including an opportunity to speak to issues that were not included in the top three poll topics.

Upon completion of the breakout groups and return to the main focus group meeting, either the facilitator or the notetaker provided a brief report back to the whole focus group, allowing time for additional input and comments from participants. Next steps for developing the roadmap were shared with participants, including a final regroup with all stakeholders to be held after focus groups had concluded and information from all meetings had been consolidated and re-formed into new goals and action items. Though intended to be in-person to allow for group discussion, this final meeting was held as a webinar due to COVID-19 safety precautions.

For those interested in participating but unable to attend the focus groups, Sadusky conducted one-on-one phone conversations using a format akin to the focus group meetings: a brief review of the 2010 plan and progress made in its implementation, then discussion about which goals the individual still considered important and topics of concern not previously listed.

After each focus group, notes were shared with the roadmap steering committee (*Appendix 2*) and meeting participants, inviting comments at each step. A post-meeting survey was emailed to all participants, asking about the effectiveness of the meeting format, the degree to which they felt that they were heard during the focus group, others who should be included in this process, and any additional thoughts and comments. This feedback was used to improve the process, encourage additional input from focus group participants, and expand the number of additional participants.

From May 2020 through January 2021, ten focus groups were held and 20 individuals contacted for one-on-one phone conversations. In total, 141 participants representing 92 organizations contributed input through focus groups and follow up calls.

Special attention was paid to invite participation from a diversity of people and viewpoints, particularly women, tribal communities, and other underrepresented and historically disadvantaged people, to draw on their experiences and perspectives to improve equity and inclusion in aquaculture.

Moving the meeting to a virtual platform due to COVID-19 likely influenced who was able to participate, considering the varying degree to which internet and technology are available across Maine and the level of willingness for those with internet access to participate in virtual meeting spaces. However, the virtual platform may have enabled reaching a wide variety of people who may not have otherwise joined in person due to travel time and geography. Table 2 describes the makeup of each focus group, including the number of participants per group and the associated organizations or companies represented.

Focus Group	Number of participants	Companies and Organizations	Number of additional phone calls
Aquaculture producers	23	Mook Sea Farm; Hollander & de Koning; Maine Oyster Company; Bar Harbor Oyster Co.; Maine Fresh Sea Farms; Nordic Aquafarms; Springtide Seaweed; Atlantic Sea Farms; Maine Ocean Farms; Vinalhaven Kelp, Inc.; Pemetic Sea Farms; Georgetown Island Oyster Cooperative; Mere Point Oyster; Nonesuch Oysters; Aphrodite Oysters; Getchells Ledge Oyster; Gun Point Cove Oysters; Maine Coast Sea Vegetables; University of New England; Hurricane Island Center for Science and Leadership; University of New Hampshire	
Aquaculture producers (group 2)	12	Spartan Sea Farms; Micmac Farms; Butterfield Shellfish Co.; Whole Oceans; Maine Scallop Cooperative; Deer Landing Oyster Co.; Chebeague Island Oyster Company; Cooke Aquaculture; Kingfish Zeeland; Pemaquid Oyster Company; Bangs Island Mussels; Glidden Point Oyster Farms; American Unagi; Love Point Oysters; Pine Point Oyster Company; Eros Oysters; Community Shellfish; Pemaquid Mussel Farms	9
Maine Department of Marine Resources (DMR)	9	All aquaculture program staff	
Regulatory Agencies	10	Maine Department of Marine Resources; USDA Animal and Plant Health Inspection Service; Maine Department of Economic and Community Development; Maine Department of Agriculture; Maine Department of Inland Fisheries and Wildlife; NOAA Fisheries; US Fish and Wildlife Service; Maine Department of Environmental Protection; US Army Corps of Engineers	1
NGOs & Advocacy groups	11	Maine Center for Coastal Fisheries; Manomet; Maine Coast Heritage Trust; Downeast Salmon Federation; World Wildlife Fund; Downeast Fisheries Partnership; Casco Bay Estuary Partnership; Sierra Club	1
Municipalities	10	City of Portland; Town of Brunswick; Penobscot Nation; Town of Harpswell; Lincoln County Regional Planning Commission; Brunswick Marine Resource Committee; Town of Yarmouth; Passamaquoddy Tribe	3
Investors	13	Maine Angels; First National Bank; Maine Department of Economic and Community Development; Coastal Enterprises, Inc.; Maine Technology Institute; Masthead Venture Partners; Pavan Enterprises, Inc.; Maine Venture Fund; Montserrat Group, LLC	
Researchers & Biotech organizations	18	University of Maine; USDA ARS, National Cold Water Marine Aquaculture Center; Gulf of Maine Research Institute; Bigelow Laboratory for Ocean Science; W. L. Gore & Associates; Beacon Analytical Systems, Inc.; University of New England; Kaskolos Sea Vegetables	1
Fishing Industry & Fishermen	6	Maine Lobstermen's Association; Conary Cove Lobster Co.; Maine Coast Fishermen's Association; clam digger; fishermen; lobstermen	5
Focus Group 10	9	Protect Maine's Fishing Heritage Foundation; The Nature Conservancy; Brunswick Rivers and Coastal Waters Commission; Gulf of Maine Research Institute; Friends of Casco Bay; East Coast Shellfish Growers Association; Maine Angels; Penobscot Nation; Coastal Rivers Conservation Trust; Town of Brunswick; Mook Sea Farm	

Table 2 Participants of focus group meetings, including organizations and total individuals reached

Themes & Takeaways

As the focus groups progressed, common themes became apparent. During the first two focus groups, which gathered aquaculture producers, COVID-19 was a primary topic of concern. At that time, May and June 2020, restrictions surrounding the pandemic were strong, and many in the seafood industry found their traditional sales avenues closed. Alternative channels, such as direct-to-consumer sales, were beginning to be explored. The importance of resilience and diversity in the supply chain was top of mind. Producers felt several needs had not yet been met, including a desire for a government plan on aquaculture, financing specific to aquaculture, improved education and outreach with coastal communities, and building on messaging and marketing on behalf of the sector.

In the focus group with DMR aquaculture staff, communication was a common theme. Improved education for aquaculture license applicants and for the public was recognized as a need so that the permitting process is better understood by all. Additional topics included public health, biosecurity, and the limited capacity of staff amid growth of the industry in combination with the constraining effects of COVID-19 on the aquaculture program.

Likewise, during the Regulators focus group, which included other regulatory agencies involved in aquaculture beyond DMR, licensing and permitting was a topic of discussion. There was general consensus that the expediency and balance of the permitting process is sound, but that challenges arise with public involvement. In addition, this group was mindful of all scales of aquaculture, including local planning, land-based RAS facilities, and the future possibilities of offshore aquaculture development. The other theme that arose was biosecurity—ensuring safe, sustainable sources of seed and biosecurity practices were top of mind for these regulators in thinking about the future of aquaculture in Maine.

The importance of outreach again stood out as a theme in the focus group with advocacy groups & NGOs, with the addition of enhanced community engagement. Participants noted not only the nuances of individual communities when developing outreach materials but also the involvement of communities in discussion and development of those materials. This led to conversation on regional planning, as aquaculture siting is heavily dependent on local inputs such as geography, economic drivers, and demographics. Cooperatives came up as a valuable tool for regional aquaculture development, and as a way to maintain the working waterfront. Another primary topic of discussion among this group was the overlap between fisheries and aquaculture, especially as it relates to marketing and messaging—there was strong desire to advance the Maine brand of seafood as a whole.

The idea of local planning for aquaculture surfaced during the municipalities focus group, as a way to help smooth the licensing and permitting process. This group was clear about the need for guidance at the town level when it comes to aquaculture: many participants (municipal officials) felt they were not well enough informed to make decisions on applications or to answer questions from residents, and expressed a need for direction. It was also recognized that leadership from the state is needed first and foremost in order to advance these possibilities. This group expressed concerns about limited infrastructure at the local level for working waterfront operations.

Infrastructure and supply chain needs rose to the surface in the investors focus group as well, many of whom considered gaps in these areas inextricably tied to the future of aquaculture, yet also as areas for investment. Making Maine a hotspot for aquaculture innovation, a previous goal from the 2010 plan, was recognized as an opportunity to address the previous topic and generate new solutions. However, financing and investing remain a challenge according to this group, as aquaculture is new for many investors and banks and comes with specific needs.

Some new themes emerged in the focus group with researchers and biotech organizations, including the desire for increased collaboration among those involved in aquaculture research. Improved methods for coordinating research and communicating the findings were discussed at length. This led to the topic of aquaculture education and outreach and the role that this group can play in normalizing aquaculture and communicating on behalf of the sector. Licensing and permitting was also discussed, in the context of how researchers can best support and partner with aquaculturists.

Licensing and permitting was a primary topic during the focus group meeting with fishing industry, through the lens of how fishermen can best contribute to the process. This led to discussion on increasing opportunities for balanced aquaculture information to reach people where they are and utilizing the most effective avenues of communication for the fishing industry. The final topic of concern among this group was planning for a healthy, active, non-confrontational waterfront and how those within the community can come together to develop a comprehensive plan.

Discussions during Focus Group 10 centered on several large scale topics of concern. These included the different scales of the aquaculture industry in Maine, social and environmental sustainability, carrying capacity, and climate change. Conversations in this group supported the approach of think globally, act locally.

Once all focus groups had concluded, the roadmap authors reviewed notes from all discussions and began organizing feedback by focus group. While participants of different focus groups brought different issues to the discussion (for example, effective financing programs was top of mind for investors, meanwhile the Maine brand was a recurring topic among aquaculture producers), there were also several common themes that reappeared across focus groups. Common, recurring topics of interest across focus groups included:

1. Licensing & permitting
2. Education & outreach
3. Community engagement
4. Infrastructure (working waterfront) & supply chain needs
5. Marketing & seafood messaging
6. Biosecurity
7. Climate change
8. Financing & investment
9. Government prioritization of aquaculture
10. Planning: local & regional
11. Coordination of research organizations
12. Sustainability

Figure 1 Focus Group topics of discussion: circle size corresponds to the number of focus groups in which the topic arose

New Goal Determination

The primary topics of interest from all focus groups were extracted and organized by theme, rather than by focus group meeting, with corresponding feedback from each focus group on that particular topic. After tallying the occurrence of each topic across focus groups, it became clear which were considered a priority, how some may be combined, and how some may be absorbed.

As these topics took shape, action items were grouped accordingly. During all breakout group discussions, participants identified action items for each topic they discussed. In organizing and consolidating the topics, action items followed. They were first assessed for feasibility, then added under the relevant theme, no longer tied to the specific focus group from which they originated. In this way, a list of action items was created under each of the common topics.

Ultimately, using the above themes as a guide to topics considered important across all stakeholders, four goals with corresponding action items were synthesized for the next ten years of aquaculture development in Maine. The goals were repeatedly refined and synthesized, with the direction of the Roadmap Steering Committee, to best capture the input of all stakeholders while planning for the future of the aquaculture sector.

Focus group participants were asked to identify who might best be responsible for each proposed action item. That is, which organization, company, institute, department, or agency—academic, governmental, private sector, nonprofit or otherwise—would be in the best position to address a specific action item. These suggestions were reviewed by the steering committee for relevance before final inclusion in the DRAFT Roadmap.

A final opportunity for feedback came in May 2021, when a draft of the roadmap Executive Summary, Goals, and Action Items was presented to focus group participants via Zoom webinar. All stakeholders invited to focus group meetings, whether they attended or not, received an invitation to participate, a draft of the Executive Summary, and link to an online feedback form. While input on all aspects of the draft roadmap was welcomed, respondents were asked for feedback on resources: the staff and funding their organization would need to accomplish an action item where their organization was named. The comment period was officially open for two weeks, though feedback was accepted until the end of July 2021. Over this period, 25 individuals provided detailed comments on the draft aquaculture roadmap and its goals and action items.

That input yielded tangible, attainable action items to address each goal. The resulting goals and action items are listed in the next section.

Planning for 2022–2032: Actions & Approaches

The Four Goals and Action Items

Based on focus group input and feedback, the following four goals are suggested to build over the next decade on the opportunities that aquaculture offers Maine. Each goal represents a long-term task that requires specific actions, but the large-scale nature of the four goals allows for flexibility in how the sector and its partners can work toward progress.

GOAL 1

Develop a streamlined licensing and permitting process that balances the rights of an applicant and the public

GOAL 2

Increase integration and understanding of aquaculture in Maine's coastal communities

GOAL 3

Expand & promote the Maine seafood brand

GOAL 4

Make Maine a leader in triple bottom line sustainable aquaculture: social, economic, environmental

This roadmap breaks the goals down into actionable, attainable steps. Included in each goal are a number of specific action items and activities integral to achieving the greater goal. Just as the goals were built from feedback gathered in focus group meetings, the corresponding action items come from participant input during the breakout group discussions. Some items were combined or consolidated, but all were developed in collaboration with stakeholders of Maine's aquaculture sector. Paired with each action item are the resources (funds and staff time) needed to accomplish the task, as well as the self-identified or suggested organizations to work towards completion of the action items.

GOAL 1

Develop a streamlined licensing and permitting process that balances the rights of an applicant and the public

ACTION ITEM

Increase capacity, including funding and staffing, in the Maine Department of Marine Resources (DMR) Aquaculture Program

WHO DMR, MAA (acronyms for Goal 1 are below; a full list of acronyms can be found on page 43)

MEASURE Total number of state budget dollars dedicated to aquaculture on an annual basis.

RESOURCE $200,000 annually

MEASURE Number of state agency staff or FTEs dedicated to aquaculture (use 2019 as baseline considering pandemic)

RESOURCE 2 FTEs

MEASURE Reduced amount of time taken to process permits and applications

RESOURCE $40,000 plus .25 FTE for the business process review with DMR

ACTION ITEM

Increase support for aquaculture license applicants within the permitting process

WHO DMR, MSG, ARI, MAA, Maine Aquaculture Hub, municipalities, MAIC, GMRI

MEASURE Number of successful lease applications per year

RESOURCES Partial FTE to engage with applicants • .5 FTE for application support (MAIC)

Provide informational resources for both applicants and public to visualize aquaculture (e.g. map, locations, pictures) along with peer-reviewed research about the various types of aquaculture

MEASURES Number of visits to DMR aquaculture map webpage • Creation of central location for peer-reviewed research, and number of visits to that webpage • Number of visits to MSG/ARI/MAIC/MAA education/resources pages

RESOURCES $10,000 to create a website that hosts permitting-relevant peer-reviewed research, to be included on DMR leasing webpage

Strongly encourage engagement and suggest prospective farmers speak with communities; provide newly created community engagement guide/outreach Best Management Practices (BMPs) to all applicants

MEASURES DMR support of community engagement BMPs • Sent to all applicants (or number of downloads of engagement strategy docs, per Goal 2, action item 1) • MAA to integrate BMPs into association BMPs and conduct BMP training

RESOURCES .25 FTE (included as part of 2 FTEs listed in the above action item) • .25 FTE for BMP training (MAA)

Have an industry representative (farmer) provide direction to new applicants; possibility to develop mentor program

MEASURE Establishing mentorship program

RESOURCES $5,000 for staff time to set up mentorship program • $10,000 for compensation for participation of industry representatives

Goal 1 acronyms and abbreviations

ARI=Aquaculture Research Institute; **BMP**=Best business practice; **DEP**=Maine Department of Environmental Protection; **DMR**=Department of Marine Resources; **FTE**=Full-time equivalent; **GMRI**=Gulf of Maine Research Institute; **MAA**=Maine Aquaculture Association; **MAIC**=Maine Aquaculture Innovation Center; **MCFA**=Maine Coast Fishermen's Association; **MSG**=Maine Sea Grant

ACTION ITEM

Expand opportunities for input from broader aquaculture sector and others in policy development

WHO DMR, MAA, MSG, municipalities, Manomet, MCFA

MEASURE Strategy/mechanism developed to enable conversation between aquaculture sector and DMR before rules are proposed

RESOURCE .25 FTE (included as part of 2 FTEs in first action item of Goal 1)

ACTION ITEM

Improve municipal awareness of permits moving through the process and fluency of that process

WHO DMR, DEP, MAA, MHMA, Maine Town Managers Association, MSG, municipalities, Manomet

Develop aquaculture education days for municipalities and increase distribution of info sheets

MEASURES Number of aquaculture education days for municipalities • Number of attendees at aquaculture training days

RESOURCES .5 FTE ($50,000) for staff time and project costs to develop curriculum and host training sessions • DMR education staff member • $10–20k seed grant to pilot in 3–4 communities

GOAL 2

Increase integration and understanding of aquaculture in Maine's coastal communities

ACTION ITEM

Co-create a guide with farmers, to be used by applicants and existing farmers, on how to be a good neighbor, communicate with stakeholders, and integrate with the community

WHO MAA, MSG, MAIC, GMRI (acronyms for Goal 2 are below; a full list of acronyms can be found on page 43)

MEASURES Guide created for applicants and farmers • How many farmers use/download the guide

RESOURCES $15,000 to compensate salary (partial FTE) for project lead • $7,000 for graphic layout, printing, and online distribution • $20,000 and .5 FTE per year (GMRI)

ACTION ITEM

Expand outreach at the state and local level

WHO DMR, MSG, ARI, MAA, GMRI, Manomet, DEP

Better publicize outreach events, educational courses, and materials in order to share information on benefits and risks, dispel myths, and share science-based information on all types of aquaculture

MEASURE Number of articles and posts on these topics

RESOURCES $30,000 and .4 FTE/year (GMRI)

MEASURES Engagement with social media posts • Number of short videos produced per year

RESOURCES .5 FTE (for MAIC) • $10,000 annually for media (social media, advertising, articles, and distribution) or personnel • $30,000 annually (MAA)

DMR staff dedicated to aquaculture education and outreach

MEASURES Number of education/outreach events held for general public by DMR • Number of attendees

RESOURCES $10,000 annually for planning and hosting events • 1 FTE Communications position (ARI) • Outreach displays in Orono Aquaculture Facility/Demonstration Space/ 1 FTE Outreach Assistant

MEASURES Funding for at least one DMR aquaculture education and outreach position

RESOURCES 1 FTE (in addition to 2 FTEs listed in Goal 1) requiring $100,000 annually • DMR education staff member

Goal 2 acronyms and abbreviations

AQSW=Aquaculture in Shared Waters; **ARI**=Aquaculture Research Institute; **ATEC**=Algae Technology Education Consortium; **DEP**=Maine Department of Environmental Protection; **DIFW**= Department of Inland Fisheries and Wildlife; **DMR**=Department of Marine Resources; **FTE**=Full-time equivalent; **GMRI**=Gulf of Maine Research Institute; **MAA**=Maine Aquaculture Association; **MAIC**=Maine Aquaculture Innovation Center; **MCFA**=Maine Coast Fishermen's Association; **MSG**=Maine Sea Grant

ACTION ITEM

Coordinate and consolidate existing resources to incorporate aquaculture into K-12 education

WHO MSG, MAIC, ARI, UMaine Cooperative Extension, Maine Agriculture in the Classroom, UMaine 4-H, Future Farmers of America, GMRI, Eastern Maine Skippers Program, DIFW, Algae Technology Education Consortium

Improve access to/awareness of educational materials, including technical support for schools

MEASURE Number of schools utilizing aquaculture education materials

RESOURCES The annual budget is around $100,000 and 1.2 FTE (Skippers program) • 1 FTE (MAIC) • .5 FTE $25,000 (ATEC) • 1 FTE support for outreach specialist/Outreach Assistant (ARI) • $15,000 (.25 FTE) for project lead to coordinate and consolidate resources and then improve awareness

Establish a collective scholarship fund for students interested in aquaculture to continue their education: state or industry supported

MEASURE Establishment of collective aquaculture scholarship fund

RESOURCE $50,000 to launch fund

ACTION ITEM

Engage with lobstermen and fishermen where they are to improve accessibility of aquaculture

WHO MSG, MAIC, Fishermen's Forum, MLA, MAA, Lobster Institute, fisheries groups (such as MCCF and MCFA)

Work with lobster zone councils and other fishermen-focused meetings to provide relevant aquaculture information, delivered through council leaders

MEASURE Number of fishing industry groups engaged in outreach efforts

RESOURCE $15,000 (partial FTE) fishing industry liaison (MAA)

Increase social media outreach and develop fact sheet

RESOURCE $5,000 to create and distribute fact sheets

Improve access to and awareness of training and informational resources for fishermen looking to enter aquaculture; offer assistance through co-ops

MEASURE Number of fishermen in aquaculture trainings (i.e. AQSW)

RESOURCE $5,000 for improved distribution and marketing

GOAL 2 *(continued)*

Increase integration and understanding of aquaculture in Maine's coastal communities

ACTION ITEM

Create informal outlets to showcase aquaculture research, enable researchers to communicate their science beyond publishing papers

WHO MSG, ARI, MAIC

MEASURE Development of research community newsletter for aquaculture science in Maine

RESOURCES $5,000 annually for 1 month salary (0.083 FTE) for MSG/ARI/MAIC position • $5,000 for layout, printing, and distribution • 1 FTE Communication Specialist (ARI)

Host Maine science traveling program, pub talks, research group host seminars at coffee bars and parks

MEASURE Number of participants in aquaculture community outreach events

RESOURCE $5,000 to host events

Develop workshops and methodologies for researchers on effective ways to communicate with the public

MEASURE Number of participants in communication workshops for researchers

RESOURCE $5,000 to host events

ACTION ITEM

Boost awareness of existing aquaculture liaisons across the state to field questions from and provide resources to fishermen, municipalities, landowners, and others

WHO MSG, MAIC, MAA

MEASURES Identify aquaculture liaisons on responsible organizations' (MSG, MAIC, MAA) websites • Number of individuals/calls fielded

RESOURCES $5,000 for updated webpages and increased communications and advertising

GOAL 3

Expand & promote the Maine seafood brand

ACTION ITEM

Tell the story of Maine's seafood

WHO SEAMaine, MAA, DECD, all aquaculture and seafood organizations, Maine Seafood Marketing Council (once established), MTA, DMR (acronyms for Goal 2 are on the next page; a full list of acronyms can be found on page 43)

MEASURE Number of organizations promoting the brand

RESOURCES Partial FTE for communications efforts at individual, organization level

Develop consistent messaging for the Maine brand that includes aquaculture and wild caught seafood, focuses on high quality seafood and sustainability, and educates consumers

MEASURE A recognizable, consistent, inclusive Maine seafood brand

RESOURCE $250,000 to establish MSMC

Tell aquaculture specific stories

MEASURES Logo, website, branding toolkit, social media accounts

RESOURCES Included within launch of MSMC

Illustrate the shared commitment to a working waterfront

ACTION ITEM

Develop a seafood marketing fund for Maine seafood with sustainable funding source(s)

WHO Maine Seafood Marketing Council (MSMC), SEAMaine, MAA, DECD

MEASURE Development of seafood fund with long-term funding

RESOURCES $250,000 to establish MSMC (same as above)

ACTION ITEM

Amplify aquaculture through partnerships with broader food systems, agriculture networks and movements, building on local food systems story

WHO UMaine, CEI, Focus Maine, MAA, MSG, DACF, Maine Food Convergence Network, MOFGA, DECD

MEASURES Number of partnerships between aquaculture and agriculture organizations • Number of marketing efforts between agriculture and aquaculture and local food

RESOURCES Partial FTE to make connections • Aquaculture Experiment Stations and resources for extension and outreach—can include additional experimental farms at CCAR, DEI, and DMC or support for the existing farms (i.e. personnel, boats, programming, insurance for participants, participant costs, gear etc.)

GOAL 3 *(continued)*

Expand & promote the Maine seafood brand

ACTION ITEM

Harness marketing opportunities for tasting tourism: engage Maine visitors and locals, cultivate sense of pride in communities for aquaculture and local seafood

WHO MAA, MOT, MTA, AMME, destination marketing groups, local culinary groups, local grower groups/coops, festivals, HospitalityMaine, Maine Oyster Trail, MSG

Create airport display on sea farming, posters in Kennebunk rest area, ads and events in Portland Press Herald, a billboard with website to learn about aquaculture, and an advertisement on TV show "207"

MEASURES Number of partnerships between tourism organizations or companies and aquaculture organizations or companies (e.g. Maine Oyster Trail)	**RESOURCES** Partial FTE dedicated to tourism outreach with aquaculture sector
MEASURES Money spent on aquaculture advertising • Number of items (posters, ads, shows) created • Circulation of items created	**RESOURCE** $50,000 annual funds for advertising
MEASURE Number of tourism events (parades, food festivals, markets, etc.) that include aquaculture companies	**RESOURCE** $15,000 annual funds to promote local tourism events

ACTION ITEM

Increase funding for market research on aquaculture products, including processing, distribution, product development, and customer acquisition, particularly for seaweed

WHO ARI, MSG, MAIC, UMaine Food Pilot Plant

MEASURE Money spent on market research	**RESOURCES** $250,000 in grant funds • Investment in seafood processing equipment (High pressure processing, canning, dryers, freezer technology, etc.) and personnel (process authority, pilot plant techs, trainers, etc.)
MEASURE Money spent on seaweed market research/ development	**RESOURCES** $150,000 in grant funds
MEASURE Number of projects/reports on market research and aquaculture product development	

Goal 3 acronyms and abbreviations
AMME=Alliance for Maine's Marine Economy; **ARI**=Aquaculture Research Institute; **CEI**=Coastal Enterprises, Inc.; **DACF**=Maine Department of Agriculture, Conservation and Forestry; **DECD**=Maine Department of Economic and Community Development; **DMR**=Department of Marine Resources; **FTE**=Full-time equivalent; **MAA**=Maine Aquaculture Association; **MAIC**=Maine Aquaculture Innovation Center; **MOT**=Maine Office of Tourism; **MSG**=Maine Sea Grant; **MSMC**=Maine Seafood Marketing Council; **MTA**=Maine Tourism Association

GOAL 4

Make Maine a leader in triple bottom line sustainable aquaculture: social, economic, environmental

ACTION ITEM

Support government leadership for sustainable Maine aquaculture

WHO DMR, DECD, MAA, DACF, MAIC, GMRI, Governor's Office of Policy Innovation, Maine Climate Council, aquaculture sector

Direction from state for municipalities to include working waterfront and seafood uses in their Comprehensive Plans

MEASURE State directive for municipal-level working waterfront development (DECD statewide plan)

RESOURCE $15,000 for partial FTE

Cohesive messaging on aquaculture from DMR and DECD

MEASURE Updated documents from both departments with matching language on future of aquaculture sector

RESOURCES Partial FTE for communications personnel

Designate funds to moving Maine seafood products out of state

MEASURE Increase in out-of-state sales/profits of aquaculture products

RESOURCES $150,000 total: $50,000 for supply chain analysis, and $100,000 for producer support

State sponsored consumer education effort

MEASURE Development of state aquaculture educational materials/knowledge campaign

RESOURCES $150,000 with additional $25,000 for partial FTE

Prepare for offshore aquaculture development

MEASURE A SWOT analysis and development plan for offshore aquaculture

RESOURCES $150,000 to host facilitated meetings, gather partners

ACTION ITEM

Encourage towns to include active working waterfronts in comprehensive plans (including aquaculture where appropriate)

WHO MMA, Maine Coastal Program, DMR, DACF, MSG, GMRI, DECD, SEAMaine

MEASURE Number of towns with working waterfront considerations in comprehensive plans

RESOURCES $40,000 (includes .5 FTE) (GMRI) • Partial FTE to assist towns as needed

Exploration of aquaculture development zones (note: not permitted right now) with help of municipalities, establishing areas pre-vetted through a local planning process that accounts for regional nuances

MEASURE Study examining utility of aquaculture zones in Maine with comparison to other locations

RESOURCE 1 FTE

Assess benefits of aquaculture as ecosystem health management tool

MEASURES Municipal-level trial assessing ecosystem health benefits of aquaculture (e.g. bioextraction, bioremediation)

RESOURCE $40,000 to fund trials

Develop mechanism for towns to share best practices and lessons learned

MEASURE Gatherings organized for municipal exchange (e.g. MHMA or Maine Municipal Association)

RESOURCE $5,000 annually for hosting special sessions

GOAL 4 *(continued)*

Make Maine a leader in triple bottom line sustainable aquaculture: social, economic, environmental

ACTION ITEM

Increase financing opportunities, loans, and insurance specific to aquaculture

WHO CEI, MAA, MTI, FAME, GMRI Ventures, MAIC

Develop aquaculture startup loan program

MEASURE Development of aquaculture-specific startup loan program

RESOURCE $150,000 startup funds, to start

Bring together MTI, USDA, FAME, CEI, Maine Ventures to develop financing programs that are specific to aquaculture

MEASURE Financing program for aquaculture in Maine

RESOURCE $30,000 (.5 FTE) for launch and maintenance of program

Broaden dissemination of aquaculture financing information for bankers, lenders, and investors through education campaigns, trainings, and seminars

MEASURES Number of seminars held for banks, lenders, investors on aquaculture industry • Number of banks to which aquaculture resources have been distributed • Development and distribution of brochure detailing resources for new aquaculture businesses

RESOURCES $5,000 annually for education campaigns and outreach

Ensure that State incentive programs to support small businesses are accessible to aquaculture companies

MEASURE Number of state incentive programs applicable to aquaculture

RESOURCE .25 FTE annually

Goal 4 acronyms and abbreviations

AQSW=Aquaculture in Shared Waters; **ARI**=Aquaculture Research Institute; **BIPOC**=Black, Indigenous, (and) People of Color; **BMP**=Best Management Practices; **CEI**=Coastal Enterprises, Inc.; **DACF**=Maine Department of Agriculture, Conservation and Forestry; **DECD**=Maine Department of Economic and Community Development; **DMR**=Department of Marine Resources; **EDA**=US Economic Development Administration; **FAME**=Finance Authority of Maine; **FEMA**=Federal Emergency Management Agency; **FTE**=Full-time equivalent; **GMRI**=Gulf of Maine Research Institute; **LGBTQ+**=Lesbian, Gay, Bisexual, Transgender, Questioning, and other; **MAA**=Maine Aquaculture Association; **MAIC**=Maine Aquaculture Innovation Center; **MCFA**=Maine Coast Fishermen's Association; **MSG**=Maine Sea Grant; **MTI**=Maine Technology Institute; **NACE**=Northeast Aquaculture Conference & Exposition; **SWOT**=Strengths, Weaknesses, Opportunities, and Threats

ACTION ITEM

Develop aquaculture best management practices (BMPs)

WHO DMR, ARI, MAA, FocusMaine, MSG, MAIC

Update Chapter 24 DMR regulations (importation of live marine organisms) with industry input

MEASURE Number of farms acknowledging their adoption of the BMPs.

RESOURCE Additional FTE (veterinarian) for DMR

Convene task force and update industry-wide BMPs for biosecurity

MEASURE Updated BMP document on biosecurity

RESOURCES .25 FTE and funding for graphics/report

Produce BMPs on aquaculture production and gear

MEASURES BMP document for production and gear

RESOURCES $30,000 salary (.5 FTE) to lead BMP project • $5,000 for graphic layout and distribution

Include BMPs for being a good neighbor (as described in Goal 2)

MEASURES BMP document for being a good neighbor

RESOURCES (Included in resources above)

Incorporate adoption of BMPs as a component of the leasing process

ACTION ITEM

Build on workforce training, including diversity, equity, and inclusion

WHO ARI, MSG, UMaine System, Maine Community College System, GMRI, Educate Maine, MAA, MCCF, MCFA, SEAMaine Workforce Development sub-committee, University of New England, College of the Atlantic, Bates, Colby, Bowdoin

MEASURES Number of women, BIPOC, and LGBTQ+ working in the industry (self-reported) • Number of women, BIPOC, and LGBTQ+-owned businesses

RESOURCES $30,000 .5 FTE salary and $5,000 for curriculum development • Workforce Training and Research Building in Orono (serves entire state including CTE and CC)- $7M • 4 faculty positions (Business/Economic; Engineering; Seaweed; Processing) dedicated to aquaculture: $588,000 for year 1, $470,000 for years 2 and 3, and $235,000 for subsequent years • $100,000 for advertising and marketing (bullet) $94,000 for an Education Coordinator • $100,000 for regular transportation between facilities

Inventory of aquaculture workforce development projects and increased coordination among efforts

MEASURES Report(s) produced on aquaculture workforce development projects

RESOURCES (Included in resources above)

Address training needs for seafood production and working on farms: vocational training, apprenticeship programs, occupational standards connected to wage increases, training shellfish harvesters in stock enhancement production methods

MEASURES Number of programs teaching aquaculture skills • Number of participants

GOAL 4 *(continued)*

Make Maine a leader in triple bottom line sustainable aquaculture: social, economic, environmental

ACTION ITEM

Invest in working waterfronts and expand supply chain infrastructure

WHO DACF, DMR, MSG, coastal planners, Maine Coastal Program, MTI, AQSW, FEMA, EDA

Encourage formation of cooperatives to support needed facilities, upgrades, shared space and gear

MEASURES Number of aquaculture coops in Maine

Look at linkages and overlaps between support services (supply and distribution) of fisheries and aquaculture, as well as freshwater aquaculture

MEASURES Report assessing overlap in distribution between aquaculture and wild fisheries • Potential to work with other sectors of highly-perishable products

RESOURCES $50,000 supply chain analysis, as referenced in Goal 3

Partner with other types of foods for transport, especially other highly-perishables

RESOURCES $5,000 to begin meetings • FTE for coordination

Support development of new markets and value-added products (VAP), both of which are investment opportunities

MEASURES Amount of money invested in VAP

RESOURCES $250,000 as listed in Goal 3

Funds to save and maintain working waterfronts

MEASURES Amount of funds directed through working waterfront protection program

RESOURCES $250,000 biannually

ACTION ITEM

Increased coordination and sharing among Maine aquaculture research community

WHO UMaine, DMC, ARI, MSG, MAIC; biennial R&D&E summit (joint MAIC and UMaine initiative)

Develop a centralized organization that facilitates coordination among research groups

RESOURCE Partial FTE for coordination

Create a knowledge bank/online forum for researchers to share latest and find partners, including mechanism for stakeholders and industry to find the research and contribute to research priorities

MEASURE Creation of a knowledge bank/online forum for aquaculture researchers

RESOURCE $10,000 for website creation

Expand on events and industry forums, research summits, and meeting of the minds; develop specific consortiums as needed

MEASURE Number of events/forums for aquaculture research

RESOURCE $5,000 annually for events

Short-term actions: expand ARI's annual researchers conference organize beyond a day, NACE session to improve networking

RESOURCE $25,000 annually

Formalize and expand participation in MAA round table discussions, with organizations potentially sharing hosting responsibilities

RESOURCE $1,000 annually

ACTION ITEM

Expand environmental monitoring and research on and for aquaculture across Maine

WHO ARI, Maine's institutions of Higher Education, Maine Seafood Business Council, MCC, MSG, Sierra Club, DEP, aquaculture sector

MEASURE Number of targeted funding opportunities

RESOURCE $50,000+ annually in funding awarded to relevant projects

Monitoring done on an estuary-by-estuary basis

MEASURE Number of estuary monitoring programs

RESOURCES 2 FTE per year and $25,000 for equipment and maintenance (DEP)

Work with growers and researchers to improve understanding of and mitigation measures for climate change, create specific BMPs for aquaculture as it pertains to climate change

MEASURES Develop guidelines for monitoring climate change, for farmers

RESOURCES Included in $30,000 (.5 FTE) for BMPs above

Develop monitoring system for environmental data, with effective communication chain, data reporting, and maintenance to distribute information to the businesses that need it

MEASURES Creation of central portal for Maine environmental data as it pertains to climate change

RESOURCES $25,000 to create reporting system

Implementing the Plan: Proposed Strategies

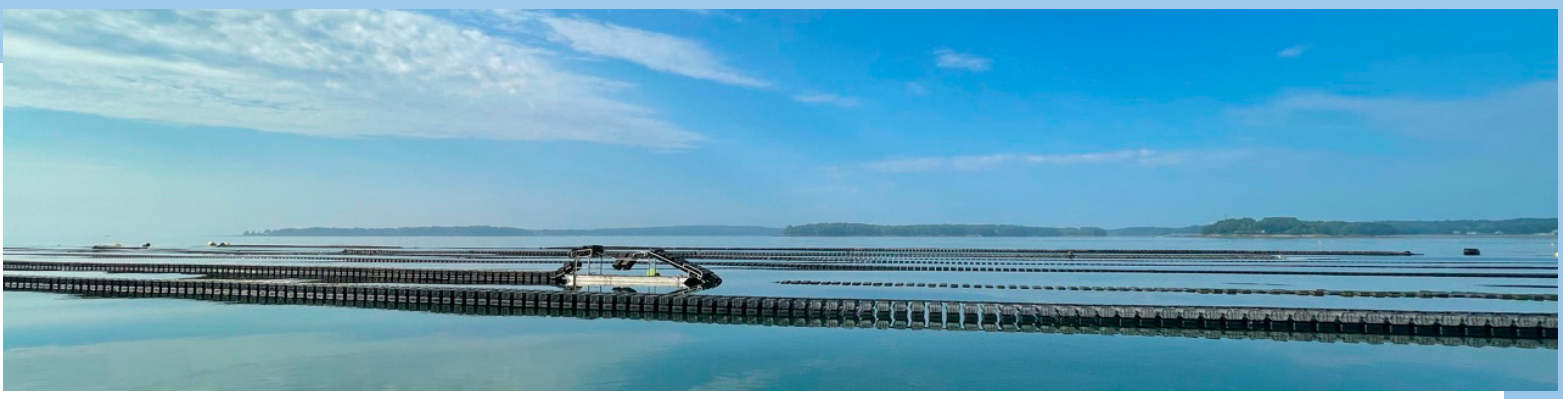
This report is intended to be a roadmap: a guide for aquaculturists and business owners, government departments and researchers, nonprofits and municipalities, investors and foundations, regulatory agencies, and more to work toward a thriving future for Maine's aquaculture sector. The roadmap will need to be carried out by a coalition of organizations and individuals across Maine. It identifies target goals and details specific actions to take, parties responsible, and resources necessary to help Maine embrace its sustainable aquaculture opportunity. To fulfill its purpose, the roadmap requires the committed engagement of the individuals and organizations who took part in building these goals and action items. Implementation will occur on an action-by-action basis. Maine Sea Grant, the Maine Aquaculture Association, and the Aquaculture Research Institute are committed to tracking and documenting progress, or lack thereof.

The roadmap is meant to be used as a guide, and the organizations and companies best suited to take on a particular action item will vary and change over time. Some actions cannot be achieved without support from state agencies, for instance, while other items can be accomplished within the aquaculture sector itself. The organizations named in this roadmap do not constitute an exhaustive list, especially as time extends from the release of this report, as there will undoubtedly be additional companies, nonprofits, foundations, and the like who join in working toward the four goals.

Within each goal, certain action items must be prioritized over others due to urgency or the sequence of steps to be taken. To account for this, action items have been broken down into the following categories of priority: short-term (1–2 years), medium-term (2–6 years), and long-term (6–10 years).

To start, the Maine Aquaculture Hub has continued with its second request for proposals (RFP) to fund projects that address barriers to strengthening the aquaculture sector. This roadmap and the four goals were used to develop the 2021 call, which included a list of action items that could be achieved by applicants. Proposals will be reviewed by a technical review panel and awarded based on merit and applicability toward achieving the goals of this roadmap.

Similarly, a number of efforts that speak to action items identified in the roadmap are already underway across the state, which are further described in the coming section. While this roadmap builds toward the future of aquaculture in Maine, aquaculture is only one piece of a greater whole that makes a successful, resilient future for the state. As Maine changes and adapts, navigating a post-COVID world, mitigating against threats from climate change, and ensuring a resilient, thriving future for all Mainers, additional planning efforts have emerged. This roadmap aims to complement those efforts, namely SEAMaine (the Seafood Economic Accelerator for Maine) and Maine Won't Wait, A Four-Year Plan for Climate Action. Members of the Steering Committee, as well as the Coordinator of the Maine Aquaculture Hub, have been actively engaged in the subcommittees of SEAMaine and have provided input during the development of the climate action plan. Collaborating with these existing plans is part of the implementation strategy of this roadmap.



Goal 1: Develop a streamlined licensing and permitting process that balances the rights of an applicant and the public

Implementing Goal 1, which is focused on the aquaculture permitting process in Maine, will require involvement from the aquaculture program at the Maine Department of Marine Resources (DMR). However, having support from other organizations will be important to achieve particular action items. Maine Sea Grant, the Maine Aquaculture Association, and the Aquaculture Research Institute are all identified as leading groups who can aid in working toward the achievement of Goal 1. Additional associations are named as key contributors to the action item of improving aquaculture licensing fluency among municipal officials.

Several steps toward the action items identified in Goal 1 are already underway, though emphasizing and building on those current efforts will enhance the chances of achieving this goal. As of the last legislative session (2021), budget and staffing in DMR's aquaculture program have increased by 2.5 FTE (full time equivalent). Aquaculture license applicants are already encouraged to engage with their neighbors and the community in which they intend to operate. It is suggested here, per focus group discussions, that more guidance is needed. The Maine Aquaculture Innovation Center recently announced they have begun the process of developing such a guide that would take steps toward achieving this action item. This guide will build upon the resources compiled in the *Maine Aquaculturist*, which was published by the Gulf of Maine Research Institute in October 2020. As for improving municipal awareness and fluency of the aquaculture process, the Maine Harbormasters Association held an aquaculture education day for its members in November 2020, and intend to make it an annual event. Ensuring a similar type of training is available for municipalities and town officials interested in aquaculture development is part of this action item, and certainly feasible with the involvement of the organizations named.

Due to the urgency associated with the current delays in the leasing process, the action item *Increase capacity, including funding and staffing, in the Maine DMR Aquaculture Program* is the top priority, and a short-term (1–2 year) action item. The action item *Expand opportunities for input from broader aquaculture sector and others in policy development* is also a short-term (1–2 year) action item, as changes are actively being discussed at the state level and must be mindful of including producers and others. *Increase support for aquaculture license applicants within the permitting process* falls in the short-term category as well. The remaining action item, which begins with *Improve municipal awareness,* is medium-term (2–6 year).

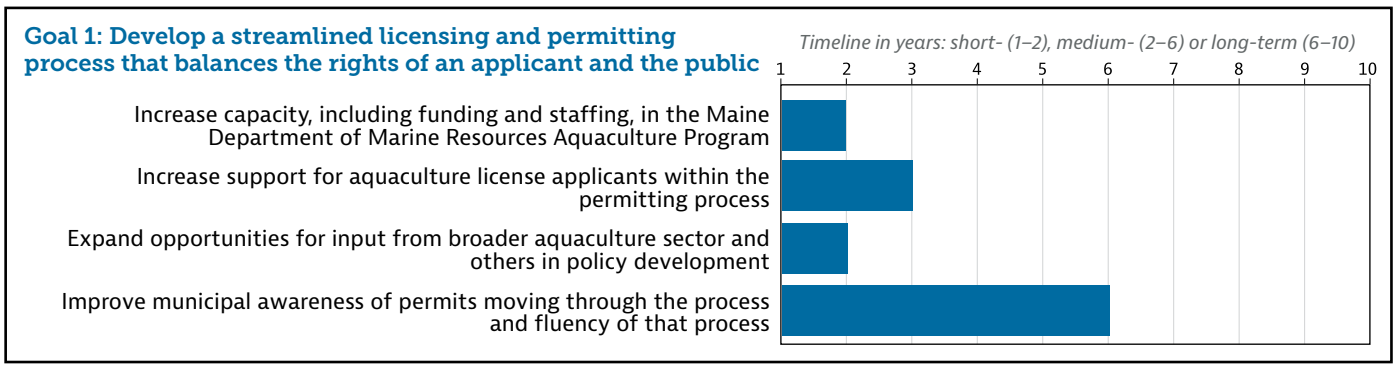


Figure 2: Goal 1 action items timeline

Goal 2: Increase integration and understanding of aquaculture in Maine's coastal communities

Numerous organizations were identified for the action items of Goal 2, as achieving *Increase integration and understanding of aquaculture in Maine's coastal communities* will require a number of different approaches. The Maine Aquaculture Association, Maine Sea Grant, Maine Aquaculture Innovation Center, Gulf of Maine Research Institute, Manomet, University of Maine, and the Aquaculture Research Institute are already working toward this goal with outreach activities, and are named as responsible organizations for multiple action items, among others. Further, individuals from these organizations who serve in positions to provide resources to fishermen, landowners, and other stakeholders are specifically named.

The Maine Department of Maine Resources is a necessary partner for outreach, and staff in its aquaculture office are working to expand discussions with the public. As noted under Goal 1, a guide for aquaculture license applicants on how to communicate with stakeholders and integrate with their local community has been undertaken by Maine Aquaculture Innovation Center, in collaboration with others.

Organizations of the fishing industry are identified to assist in reaching lobstermen and fishermen with aquaculture information. This goal identifies several existing education projects that can work to incorporate aquaculture into K–12 curricula. Toward that action item: Maine Ag in the Classroom provides aquaculture resources for educators, the Midcoast School of Technology is working with aquaculture stakeholders and other training institutions to develop aquaculture curriculum at the high school level, and Maine Sea Grant is working to develop a network known as AquacultureME to advance aquaculture education in the classroom for K–12. Connecting and building on these existing efforts will be an important step toward achieving the goal.

Two action items here, *Co-create a guide with farmers, to be used by applicants and existing farmers, on how to be a good neighbor, communicate with stakeholders, and integrate with the community* and *Engage with lobstermen and fishermen where they are to improve accessibility of aquaculture* are short-term (1–2 year) priorities. Medium-term priorities (2–6 year) include *Expand outreach at the state and local level*; *Coordinate and consolidate existing resources to incorporate aquaculture into K–12 education*; *Create informal outlets to showcase aquaculture research, enable researchers to communicate their science beyond publishing papers* and *Boost awareness of aquaculture liaisons across the state to field questions from and provide resources to fishermen, municipalities, landowners, and others*.

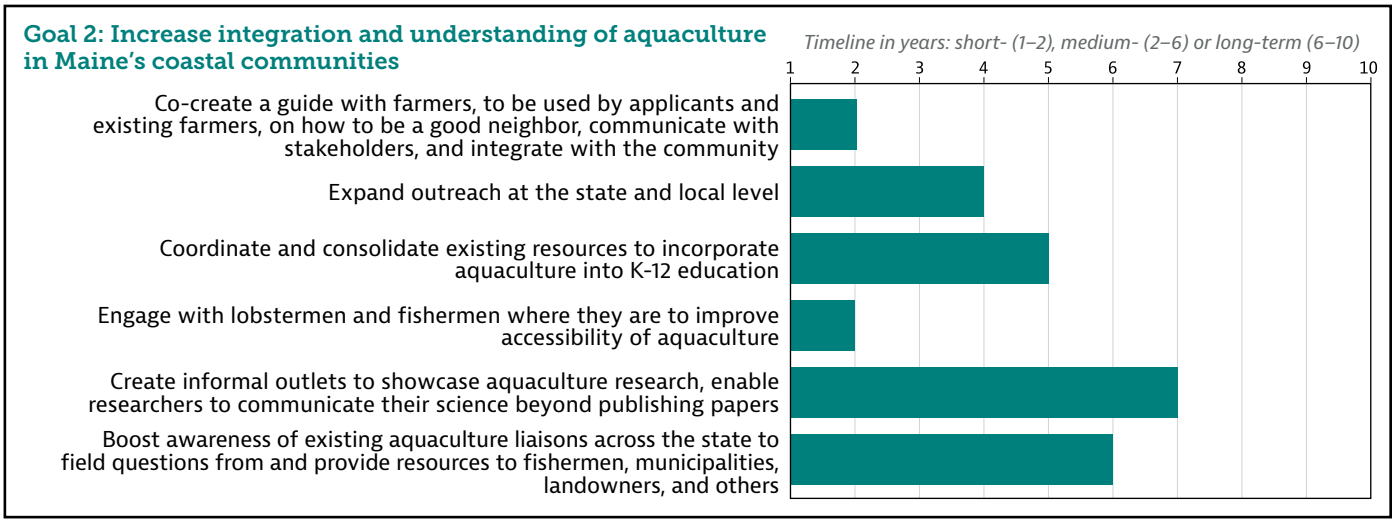


Figure 3: Goal 2 action items timeline

Goal 3: Expand and promote the Maine seafood brand

Expand and promote the Maine seafood brand reaches beyond the aquaculture sector to include seafood as a whole. While Maine Aquaculture Association (MAA) will certainly have a role on behalf of aquaculture producers, there are many companies, organizations, and government departments who will need to play a part in order to achieve this goal. In partnering with broader food systems and agriculture networks, several existing food projects have been identified, as have funding organizations. To engage Maine visitors and residents alike through tasting tourism, a number of hospitality groups and efforts have been named. To increase funding for market research on aquaculture products, research branches of Maine's Universities and Colleges are looked to, as is the private sector.

At the time of this report's publication, there are a number of projects underway that are working toward Goal 3. For example, a short-term statewide promotional effort by Maine Department of Marine Resources (*seafoodfrommaine.com*), aims to connect consumers with Maine seafood, and the Maine Seafood Marketing Initiative report identifies new markets for Maine seafood. Maine lobster has a strong presence globally, with numerous initiatives for marketing the species, including the Maine Lobster Marketing Collaborative. Launched in 2021, the Maine Oyster Trail connects consumers with Maine oyster farmers and experiences.

While individual seafood companies or producers often promote themselves individually, there is currently no concerted effort to collectively build the Maine seafood brand, inclusive of all species groups and harvest methods, over the long term. The action items detailed in Goal 3 provide clear steps to achieving this broader reach. While every effort to *Expand and promote the Maine seafood brand* is valuable, collaboration on resources and projects will be essential to achieving this goal. In particular, developing a statewide seafood marketing fund will require input from fishermen and farmers and the private sector and government, in order to determine a sustainable mechanism for funding and strategic messaging. Ultimately, that messaging should be inclusive of historically underserved communities and under-represented groups.

The priority action item under Goal 3, to be accomplished in the short-term (1–2 years), is *Develop a seafood marketing fund for Maine seafood with sustainable funding source(s)*. Once completed, this will facilitate accomplishing the medium-term priority (2–6 year) action items of *Amplify aquaculture through partnerships with broader food systems, agriculture networks and movements, building on local food systems story*; *Harness marketing opportunities for tasting tourism: engage Maine visitors and locals, cultivate a sense of pride in communities for aquaculture and local seafood*; and *Increase funding for market research on aquaculture products, including processing, distribution, product development, and customer acquisition, particularly for seaweed*. *Tell the story of Maine's seafood* is considered a long-term action, as it is ongoing throughout the life of this roadmap and beyond.

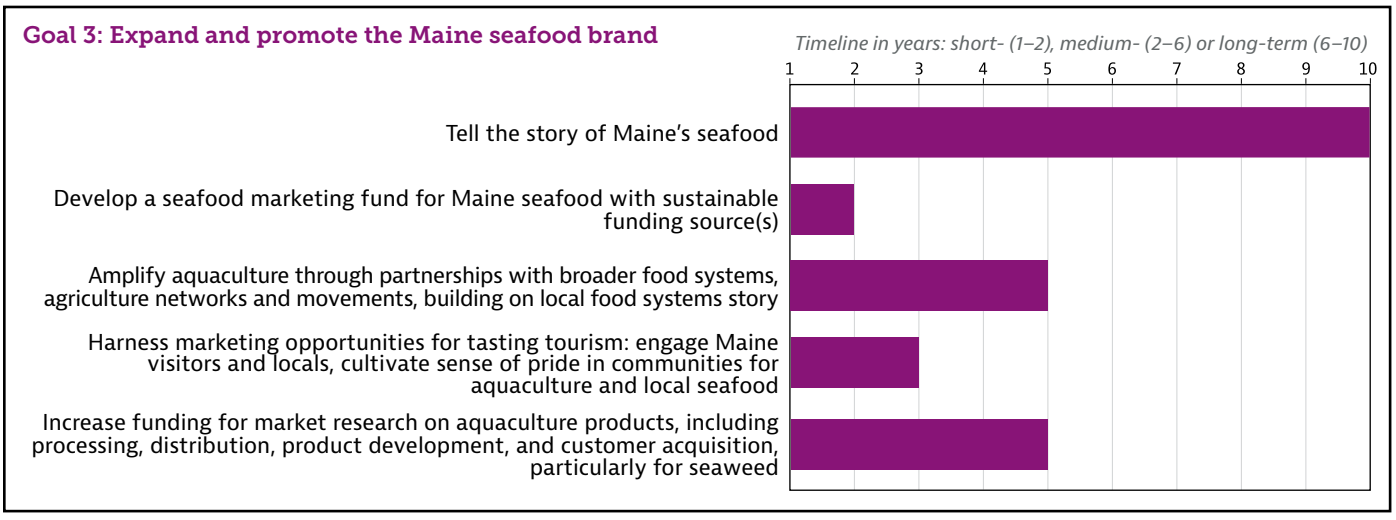


Figure 4: Goal 3 action items timeline

Goal 4: Make Maine a leader in triple bottom line sustainable aquaculture: social, economic, environmental

The final goal is all-encompassing. It speaks to the role of aquaculture statewide, and incorporates wide-reaching action items. There are many organizations, government departments, businesses, research bodies, education efforts, and climate change groups who have a role to play in achieving the action items—making Maine a leader in triple bottom line sustainable aquaculture will require involvement from all stakeholders.

Several Goal 4 action items are beginning to be addressed, including *Develop aquaculture best management practices (BMPs)* and *Build on workforce training, including diversity, equity, and inclusion*. As mentioned under Goal 1, Maine Aquaculture Innovation Center is currently working on a guide for sea farmers on being a good neighbor. Meanwhile, the SEAMaine initiative has a subcommittee dedicated to workforce and talent development. Members include those in the seafood industry, nonprofits, and educators. In July 2021, organizers of post-secondary aquaculture education programs convened for the first time to discuss ongoing efforts, share program goals, and identify overlaps.

When it comes to environmental monitoring and research, there are a number of stakeholders interested in understanding the impacts of and on aquaculture, from nonprofits to researchers to farmers. *SEANET*, a public-private partnership that brought together universities and institutions to create a research network focused on sustainable ecological aquaculture, was one such initiative. While some questions addressing nutrient loading, habitat restoration, and impacts of ocean acidification as it relates to aquaculture have been studied, many research topics remain unanswered. Further, a handful of towns across the state have started the process of assessing their coastal management or economic development plans, researching how to best incorporate aquaculture and collaborating with and residents for input.

Short-term priority (1–2 year) action items from Goal 4 include *Support government leadership for sustainable Maine aquaculture*; *Increase financing opportunities, loans, and insurance specific to aquaculture*; *Develop aquaculture BMPs*; and *Invest in working waterfronts and expand supply chain infrastructure*. The medium-term (2–6 year) items are *Build on workforce training, including diversity, equity, and inclusion* and *Encourage towns to include active working waterfronts in comprehensive plans (including aquaculture where appropriate)*, while the medium to long-term (6–10 year) items include *Increased coordination and sharing among Maine aquaculture research community* and *Expand environmental monitoring and research on and for aquaculture across Maine*.

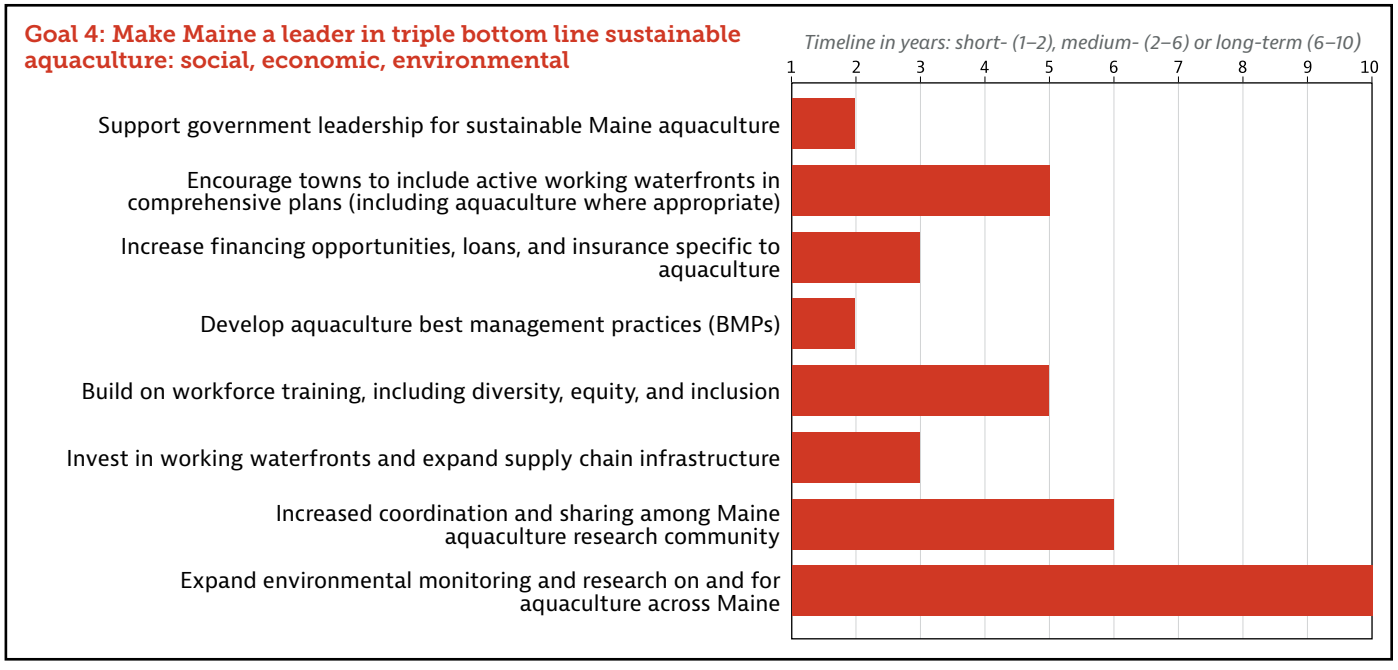


Figure 5: Goal 4 action items timeline

Suggested Responsibilities & Estimated Resources

To accomplish these actions, a number of resources are required. Foremost will be the time, effort, and leadership of those identified in the roadmap. Many of these projects will require external funding. Public and private grants may offer opportunities to secure funding for some projects, while government support may be critical for others.

A full description of the resources required to complete action items and accomplish the goals of this roadmap is detailed on pages 16–27. Time and effort is listed in terms of full-time equivalent (FTE), which is the hours worked by one employee on a full-time basis, listed in terms of dollars estimated per action. Funding will be acquired in a variety of ways, including through investments, grants, foundations, and state as well as federal sources. Projects that require financial support include educational program coordination, establishing a Maine Seafood Marketing Council, strengthening workforce development, forming an aquaculture scholarship program, performing supply chain analyses, developing a Maine aquaculture startup loan program, and more (*Figure* 3). The graphic also lists infrastructure items that will require investment. Such resources will be created or purchased to support the aquaculture sector and the greater seafood industry, and aid progress for particular action items. These include investment in seafood processing equipment, Maine's working waterfront, workforce training, and research, among others.

Measuring the Goals

The organizations of the roadmap's steering committee, namely the Maine Aquaculture Association, Maine Sea Grant, the Aquaculture Research Institute, and Maine Aquaculture Innovation Center, are committed to conducting a progress assessment of this 10-year plan at the halfway mark, in 2027. This assessment will evaluate each goal and corresponding action items, gauging progress based on resources procured and measures. After a full analysis, findings will be used to make adjustments, both to the action items as well as which organizations are involved with each, so that the goals can be achieved within the 10-year timeframe. Goals will also be adjusted, if need be, based on changes in the sector that may be unforeseen at the time of this Roadmap's publication. Additionally, the analysis will assess the relevance of the goals, actions items, and any new items of importance. Adjustments will be made as necessary.

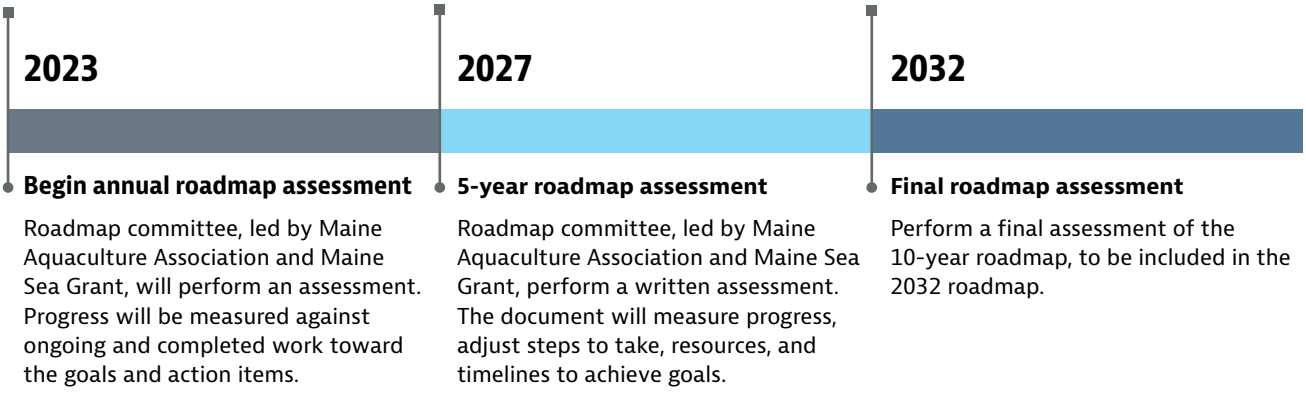


Figure 6: Maine Aquaculture Economic Roadmap assessment timeline

Conclusion

As we enter a new decade amidst a global pandemic, it is crucial to plan for the future of Maine's marine economy and coastal communities. Among future challenges, there are opportunities for collaborating and innovating to build on Maine's heritage and foster a sustainable future that is quintessentially Maine.

As it stands today, farming seaweed and animals has taken root in Maine's economy, steadily increasing in value and volume each year. This roadmap builds on that foundation to ensure an aquaculture industry that works in harmony with the existing coastal and agricultural economy and contributes to a resilient working waterfront. This document aims to assist the state's aquaculture sector in realizing its potential. It identifies needs and solutions, and lays out a roadmap for how to achieve a diverse, sustainable, and thriving aquaculture sector. The state's aquaculture sector is primed to contribute to this future, and has the potential to be a national leader.

The future of the sector will depend on aquaculture producers, researchers, investors, nonprofits, municipalities, governmental departments, industry partners, and the people of Maine. All will play a deciding role in achieving the four goals in this report within the next ten years. Initiatives and solutions will take different forms throughout the state, as public interests vary across local communities. Working in harmony with these needs, however, is fundamental to this roadmap, and to the future of aquaculture in Maine.

Appendices

Appendix 1: Maine Aquaculture Hub Steering Committee

Organization	Representative
Maine Sea Grant	Gayle Zydlewski, Ph.D.
Maine Aquaculture Innovation Center	Christopher Davis, Ph.D.
Aquaculture Research Institute	Deborah Bouchard, Ph.D.
Maine Aquaculture Association	Sebastian Belle
Coastal Enterprises, Inc.	Hugh Cowperthwaite

Appendix 2: Maine Aquaculture Roadmap Steering Committee

Organization	Representative
Maine Sea Grant	Gayle Zydlewski, Ph.D.
Maine Aquaculture Hub	Heather Sadusky
Maine Aquaculture Association	Sebastian Belle
Maine Aquaculture Association	Christian Brayden
Maine Aquaculture Innovation Center	Dr. Chris Davis, Ph.D.
Maine Sea Grant	Chris Bartlett
Aquaculture Research Institute	Deborah Bouchard, Ph.D.
Maine Sea Grant	Jaclyn Robidoux
Maine Sea Grant	Dana Morse
University of Maine	Teresa Johnson, Ph.D.
Maine Sea Grant	Keri Kaczor

Appendix 3: Report Card rating progress made toward goals of the 2010 Maine Aquaculture Economic Development Plan in the decade since its publication

Maine Aquaculture Report Card

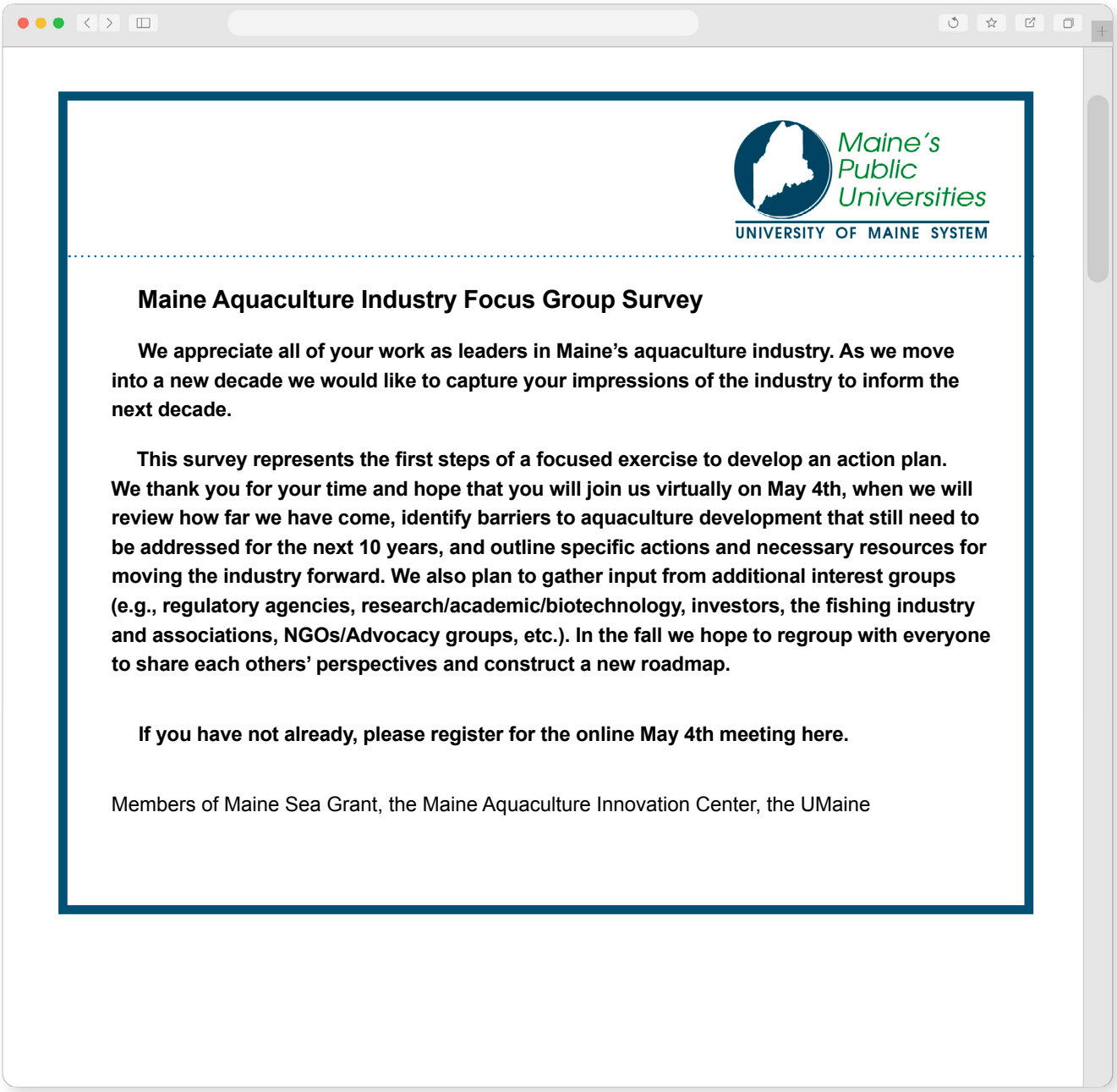
A 2020 assessment of the Maine aquaculture industry's progress based on the 2010 Maine Aquaculture Economic Development Plan

Ratings: ● Strong ■ Moderate ◆ Poor

Goal	Overall Progress	Metric Performance
Government prioritization of aquaculture development	■	●
Effective and targeted financing programs designed to address aquaculture's unique challenges	■	◆
Significant state and federal funds invested to develop and support a world class research and training infrastructure	●	●
The attraction and/or training of a world class group of aquaculture entrepreneurs and managers	●	●
Effective measures that reduce the barriers to entry for new aquaculture producers	◆	■
Significant reductions and stabilizations in the costs and supplies of seed stock and feed	■	■
Develop, protect, and use the Maine brand in marketing Maine seafood	■	■
A licensing and permitting process that is expedient and balances the rights of an applicant and the public interest	■	■
Increased investor interest and confidence	●	■
Traditional commercial fishing constituents will view aquaculture as an attractive alternative to commercial fishing and a way to continue their maritime heritage	■	■

Appendix 4: Pre-meeting survey

All focus group participants received a link to a survey along with the invitation to a focus group. What follows is the original survey sent to aquaculture producers. For other invitees, the first question was modified to reflect other possible roles in the aquaculture field.



Maine's Public Universities
UNIVERSITY OF MAINE SYSTEM

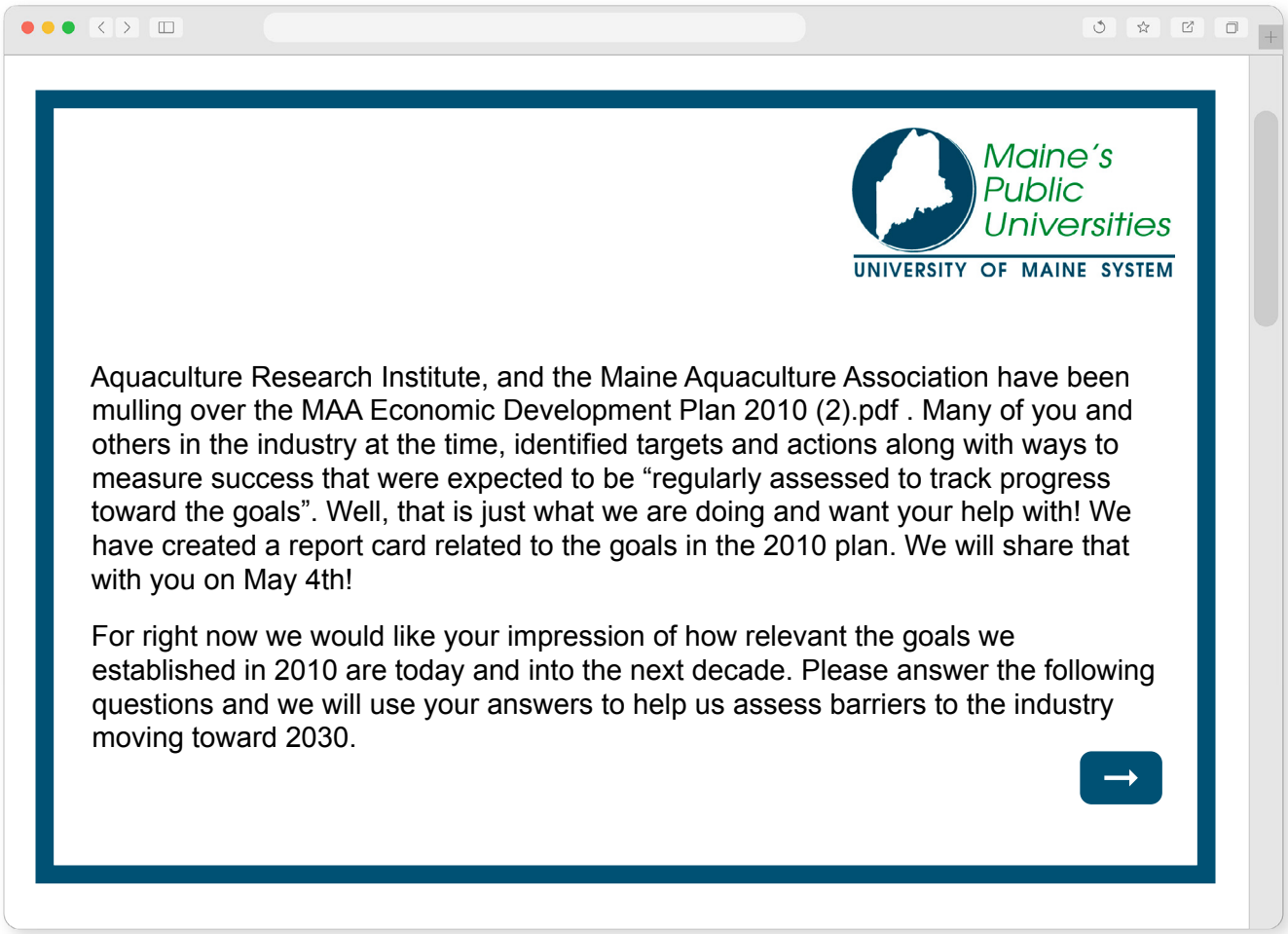
Maine Aquaculture Industry Focus Group Survey

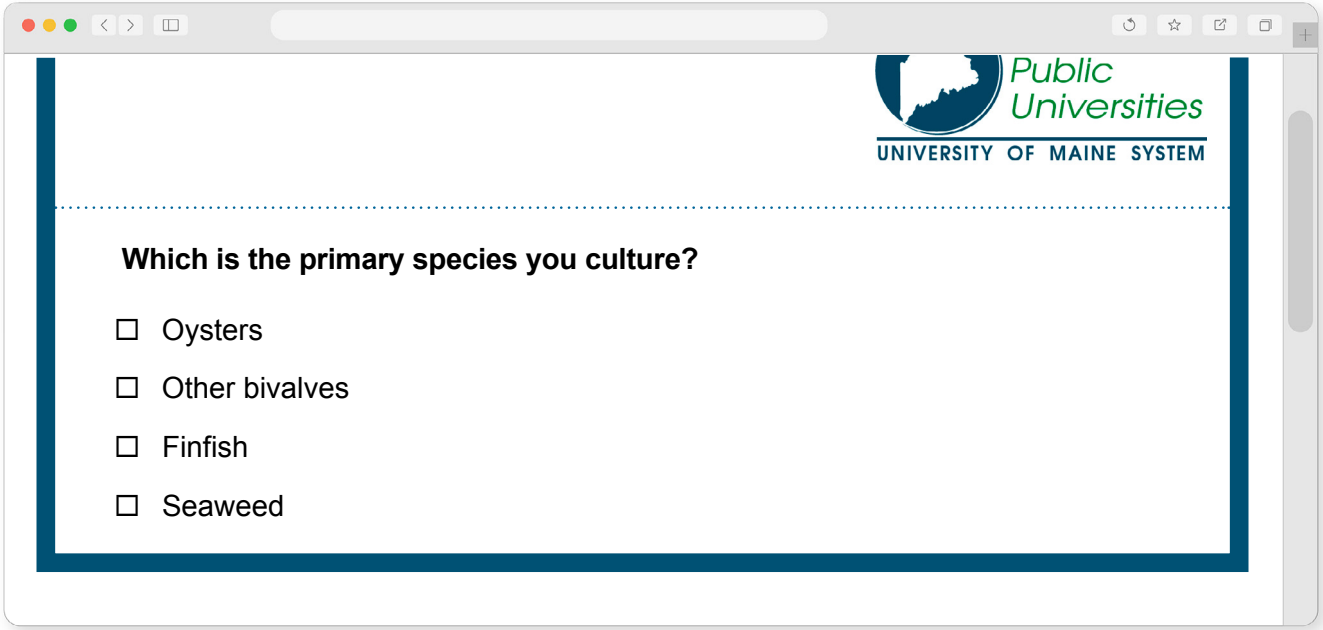
We appreciate all of your work as leaders in Maine's aquaculture industry. As we move into a new decade we would like to capture your impressions of the industry to inform the next decade.

This survey represents the first steps of a focused exercise to develop an action plan. We thank you for your time and hope that you will join us virtually on May 4th, when we will review how far we have come, identify barriers to aquaculture development that still need to be addressed for the next 10 years, and outline specific actions and necessary resources for moving the industry forward. We also plan to gather input from additional interest groups (e.g., regulatory agencies, research/academic/biotechnology, investors, the fishing industry and associations, NGOs/Advocacy groups, etc.). In the fall we hope to regroup with everyone to share each others' perspectives and construct a new roadmap.

If you have not already, please register for the online May 4th meeting here.

Members of Maine Sea Grant, the Maine Aquaculture Innovation Center, the UMaine


Maine's Public Universities
UNIVERSITY OF MAINE SYSTEM
Aquaculture Research Institute, and the Maine Aquaculture Association have been mulling over the MAA Economic Development Plan 2010 (2).pdf . Many of you and others in the industry at the time, identified targets and actions along with ways to measure success that were expected to be "regularly assessed to track progress toward the goals". Well, that is just what we are doing and want your help with! We have created a report card related to the goals in the 2010 plan. We will share that with you on May 4th!
For right now we would like your impression of how relevant the goals we established in 2010 are today and into the next decade. Please answer the following questions and we will use your answers to help us assess barriers to the industry moving toward 2030.


Public Universities
UNIVERSITY OF MAINE SYSTEM
Which is the primary species you culture?
Oysters
Other bivalves
Finfish
Seaweed

Maine's Public Universities
UNIVERSITY OF MAINE SYSTEM

In your assessment, are these goals, established in 2010, still relevant?

	Yes	No
Government prioritization of aquaculture development.	O	O
Effective and targeted financing programs designed to address aquaculture's unique challenges.	O	O
Significant state and federal funds invested to develop and support a world class research and training infrastructure	O	O
The attraction and/or training of a world class group of aquaculture entrepreneurs and managers	O	O
Effective measures that reduce the barriers to entry for new aquaculture producers	O	O
Significant reductions and stabilizations in the costs and supplies of seed stock and feed	O	O
Develop, protect, and use the Maine brand in marketing Maine seafood	O	O
Increased investor interest and confidence	O	O
A licensing and permitting process that is expedient and balances the rights of an applicant and the public interest	O	O
Traditional commercial fishing constituents will view aquaculture as an attractive alternative to commercial fishing and a way to continue their maritime heritage	O	O

Are there additional goals that you would suggest? If so, please write them in the text box below.


Maine's Public Universities
UNIVERSITY OF MAINE SYSTEM
Please read the goals listed below and then drag them into their order of importance (#1 most important, #10 least important).
Government prioritization of aquaculture development
Effective and targeted financing programs designed to address aquaculture's unique challenges
Significant state and federal funds invested to develop and support a world class research and training infrastructure
The attraction and/or training of a world class group of aquaculture entrepreneurs and managers
Effective measures that reduce the barriers to entry for new aquaculture producers
Significant reductions and stabilizations in the costs and supplies of seed stock and feed
Increased investor interest and confidence
A licensing and permitting process that is expedient and balances the rights of an applicant and the public interest
Develop, protect, and use the Maine brand in marketing Maine seafood
Traditional commercial fishing constituents will view aquaculture as an attractive alternative to commercial fishing and a way to continue their maritime heritage

Appendix 5: Generalized focus group agenda

Internal agenda used to guide all focus group meetings

AQUACULTURE ROADMAP - x FOCUS GROUP - date

MEETING GOAL: Identify barriers to aquaculture development that need to be addressed in the next Maine 10-year Economic Development Plan and outline specific actions and necessary resources for moving the industry forward.

Annotated agenda

Time	Activity	Description	Content/Tech Notes
8:30	**Set-up**	Team check-in	■ Launch the meeting ■ Add co-hosts as needed
9:00	**Participants Admitted**	Acknowledge that this is a difficult time for all of us with COVID-19; We are all adapting and navigating the "new normal" ▸ Use of **Zoom briefing slide** ▸ Orient folks to Zoom menu bar and functions link to phone ID if using phone – this is best if you have a poor wifi connection ▸ Ask people to **RENAME** in Participant screen (name, species) ▸ Call out people on phone with last 4 digits to get names ▸ Encourage WG members to **use video**, other participants will have video shut off to minimize distractions from bad actors; ▸ Please all use **mute button** when not speaking ▸ Folks on phone are automatically on mute ***6 to unmute** and ***9 to raise hand** if you'd like to speak ▸ Note technology point person for issues (Gayle) and use of Chat ▸ Comments in the **Chat** will be monitored so encourage folks to use the Chat ▸ Ask to confirm recording is OK for notetaking purposes only, share through Chat privately to Gayle ▸ **Ask people on phone** to identify themselves	■ Admit folks from waiting room ■ Open with video of participants ■ Share **Zoom instructional slides** ■ Review Zoom instruction ■ Monitor Chat for tech issues ■ Start assigning breakouts
9:10	**Welcome & Agenda Overview**	▸ Welcome ▸ Maine Aquaculture Hub overview ▸ Meeting Objectives ▸ Agenda ▸ Opening Poll #1	■ Share **Welcome slide (water)** ■ Share **Hub slide** ■ Share **Objectives slides** ■ Share **Agenda slide – STOP sharing after describing** ■ **Launch Poll #1**

Time	Activity	Description	Content/Tech Notes
9:20	**Report Card presentation & Survey Results**	▸ Background on (2010 plan) ▸ Note that this plan will define MAA plan going forward ▸ Present the report card very briefly ▸ Share results of pre-survey of the group to help gauge where there is agreement (where have we succeeded and where have there been challenges); ▸ Areas of focus – potential opportunities for the sector and threats/concerns/barriers to growth	■ **Screen share PPT slides** sharing **Econ development report slide** ■ Share Report card at a high level ■ Present results of pre-meeting survey
9:40	**Group discussion**	▸ What **clarifying questions or feedback** do you have about report card? ▸ What else would you **add to survey results** – especially focusing on barriers? ▸ Solicit feedback and clarifications as necessary ▸ Pre-break Message ▸ You will see a Poll to answer when you return to your computer ▸ We will be breaking into breakout groups to brainstorm specific actions to address these issues and the poll will inform our breakout ▸ Please be back **promptly at 10:20** to take the poll to identify the top issues to tackle	■ Facilitate discussion ■ Monitor Chat ■ Notetaker adds in comments to shared document • Link to Google Doc to capture notes
10:10	**Break**	▸ 10 minute break while Poll #2 is created and launched	■ **Slide** – we will be back at 10:20 Sharp ■ Create Poll #2 ■ Assign co-host to notetakers
10:20	**Reconvene**	▸ Welcome group back and have Poll #2 already launched ▸ Laura outlines c**harge to working groups:** ▸ Focus on specific actions ▸ Given short time together, you may not have an opportunity to describe each action, but if you can indicate who might be responsible and short, medium, long that would be helpful ▸ We understand and are sensitive to the realities of COVID-19 on your businesses and potential future, we plan to hold a discussion specifically on this near-term issue, but we do want to develop a 10-year horizon for economic develop of aquaculture in Maine	■ **Launch Poll #2** ■ Review Poll results with group and charge to breakout groups ■ Share **Charge Slide** ■ Send participants to breakout groups
10:30	**Breakout Groups Work**	▸ Participants pre-selected through meeting registration ▸ Small group work using template on Google ▸ Charge to groups: bring back 5–10 specific actions that would advance development of aquaculture in next 10 years; include a much detail as possible 1. What specific actions need to be taken to continue the development of the aquaculture sector in the state? 2. Who should implement those action items? 3. Is this short term, medium term or long term?	

Time	Activity	Description	Content/Tech Notes
11:45	**Reconvene and Review small group work**	▸ Overview of work done (How far did you get? Don't need all the details) ▸ We will not have much time for discussion here ▸ Remind folks that ALL of this is being captured; ▸ Facilitators or recorder report out (5–8 min per group) ▸ Note areas of overlap and similar ideas	■ **Call participants back** to main screen ■ Call on each facilitator/ recorder to share from each group
12:15	**Summary of where we are & next steps**	▸ Next steps to refine ideas ▸ Timeline for Roadmap ▸ Who to contact to share additional ideas ▸ How do folks stay engaged in the process?	■ Shares **slide with timeline & contact information** ■ Discuss timeline and next steps
12:30	**Close**	▸ Brief poll of group before sign-off ▸ Mention follow-up survey will come by email	■ Gayle launches **Poll #3**

Acronyms and abbreviations

AMME	Alliance for Maine's Marine Economy
AQSW	Aquaculture in Shared Waters
ARI	Aquaculture Research Institute
ATEC	Algae Technology Education Consortium
BIPOC	Black, Indigenous, (and) People of Color
BMP	Best Management Practices
CCAR	UMaine Center for Cooperative Aquaculture Research
CEI	Coastal Enterprises, Inc.
DACF	Maine Department of Agriculture, Conservation and Forestry
DECD	Maine Department of Economic and Community Development
DEP	Maine Department of Environmental Protection
DIFW	Maine Department of Inland Fisheries & Wildlife
DMR	Department of Marine Resources
EDA	US Economic Development Administration
FAME	Finance Authority of Maine
FEMA	Federal Emergency Management Agency
FTE	Full-time equivalent
GMRI	Gulf of Maine Research Institute
LGBTQ+	Lesbian, Gay, Bisexual, Transgender, Questioning, and others
MAA	Maine Aquaculture Association
MAIC	Maine Aquaculture Innovation Center
MCC	Maine Climate Council
MCCF	Maine Center for Coastal Fisheries
MCFA	Maine Coast Fishermen's Association
MHMA	Maine Harbor Masters Association
MLA	Maine Lobstermen's Association
MOFGA	Maine Organic Farmers and Gardners Association
MOT	Maine Office of Tourism
MSG	Maine Sea Grant
MSMC	Maine Seafood Marketing Collaborative
MTA	Maine Tourism Association
MTI	Maine Technology Institute
NACE	Northeast Aquaculture Conference & Exposition
RAS	Recirculating aquaculture system
SWOT	Strengths, Weaknesses, Opportunities, and Threats
UMaine	University of Maine
VAP	Value Added Products

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