
# Final Report

# Workforce Development and Critical Components for Developing a Modern Fisheries, Aquaculture, and Seafood Workforce

November 2022

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# Executive Summary

The Marine Fisheries Advisory Committee (MAFAC) was charged with developing recommendations to the National Oceanic and Atmospheric Administration (NOAA) for Workforce Development (WFD) initiatives that support individuals, businesses, and communities adapting to changing needs and conditions. A skilled workforce that meets the needs of and supports U.S. commercial and recreational fishing, aquaculture, and associated seafood industries is essential to U.S. coastal communities. Long-term challenges including "graying of the fleet" and newer ones including supply chain weaknesses highlighted during the COVID-19 pandemic, have now combined and WFD is a critical need within all regions and sectors of the U.S. seafood industry. The Workforce Development Working Group was established by MAFAC to develop recommendations to NOAA Fisheries and NOAA as a whole to assist in guiding agency efforts that support WFD across U.S. coastal communities and industry sectors.

A comprehensive needs assessment was identified as a necessary first step for NOAA to better focus future efforts for funding, training and other assistance. Assessments should be designed to effectively gauge the needs of varied regions and communities, including those historically underserved, and the various sectors within U.S. commercial and recreational fisheries, the aquaculture industry, and the associated network of businesses that support or are supported by them.

Based on the results of needs assessments, MAFAC recommends that NOAA continue and increase support for education, training, and innovation and entrepreneurship, critical components for developing a modern workforce, expanding job opportunities and ensuring sustainable business practices and resilient coastal communities.

Specific recommendations to NOAA from this report include:

**Conduct Comprehensive WFD Needs Assessments**

- Design to engage effectively with regions, communities and business sectors.
- Use existing local assets to assist in design and polling methods.
- Identify all elements necessary to support fishery and aquaculture businesses.
- Use assessments to evaluate current and future challenges. Identify immediate, near-term and long-term needs specific to communities.
- Poll communities for their vision of a resilient future and what is needed to achieve that vision.
- Reference previous MAFAC reports that address WFD and community needs.

**Education**

- Develop curricular materials for K-12 educators specific to fisheries, aquaculture and seafood industries including environmental and seafood literacy.
- Help facilitate exposure of K-12 students at all levels to fisheries including commercial, recreational and aquaculture opportunities.
- Integrate fishery and seafood industry training activities into existing vocational agriculture programs.
- Incorporate internship opportunities (paid and unpaid) into high-school programs (e.g. MATES program).

- Explore expansion of K-12 education programs focused on career development through partnerships with tribal organizations and federal agencies (e.g. Project Wild).
- Consider dual enrollment of high school students in Community and State Colleges to teach trades in fisheries, aquaculture and seafood sectors.

**Training Programs**

- Work with industry to develop, where needed, occupational standards specific to workforce skills and training needs.
- Ensure that programmatic funding and incentives for training programs, internships, apprenticeships and career pathways be elevated to expand Sea Grant and other partner initiatives.
- NOAA Sea Grant should expand partnerships with academia and industry to provide demonstration sites for training, retraining, continuing education, workshops and hands-on opportunities.
- Support new small business training programs across all sectors of commercial and recreational fishing, aquaculture and associated industries.
- Establish or support "Train the Trainer" programs where they exist and where there is significant need.
- NOAA supported training programs should include significant hands-on training, record/certificate of completion and assistance in seeking employment after.
- Support training programs in mechanical trades that are essential to many fishing and aquaculture businesses. These include motor and engine mechanics, refrigeration experts, hydraulics experts and more.
- NOAA should develop a publically available inventory of seafood training opportunities.

**Supporting Innovation and Entrepreneurship**

- Expand support of aquaculture to increase the quantity and variety of seafood and seafood products available.
- Support growth of entrepreneurship and innovative businesses. International internships and exchange programs also offer opportunities from successful programs around the world.
- Act as a catalyst for showcasing opportunities in seafood sectors. Support annual regional competitions to support innovation in seafood sectors.
- Actively support promotion of grant opportunities available through NOAA that are applicable to seafood innovation and entrepreneurship activities. Potential innovators and entrepreneurs may not be aware of NOAA or other applicable grants to support new ideas.

# I. Introduction

*"Most of the world is covered by water. A fisherman's job is simple: Pick out the best parts."*
*Charles W. Waterman*

*"It is said, give a man a fish, you would feed him for a day, but if you teach a man to fish you feed him for a lifetime. I say, teach a person how to culture fish, you will empower the entire country."*
*Dr. T. Charles John Bhaskar*

A person's job working in the seafood[1] industry is anything but simple in the current age. Long-standing and unprecedented new threats have combined to challenge the resiliency of coastal communities to continue long traditions of reliance on commercial and recreational fisheries, aquaculture, and the seafood industry as a whole. Key to a prosperous future for these communities is improving, diversifying, innovating, and creating workforce opportunities that adapt to current and future realities and the needs of all fisheries and the seafood industry. Workforce needs will change dramatically as natural resource baselines change, technologies evolve and as policy decisions around priorities evolve. The decisions made today with respect to training programs will significantly influence opportunities for future generations.

U.S. coastal communities face many challenges including extreme weather events, climate change and sea-level rise, gentrification, and multiple threats in recent years to the domestic seafood industry. Regarding the latter, some threats have persisted and grown in urgency over the last decade, including an aging workforce, limited resources, barriers to entry, regulatory uncertainty, foreign competition, remote locations, aging infrastructure, and demographic shifts. More recently, vulnerabilities have been highlighted and exacerbated by the COVID-19 pandemic including market sensitivity, supply chain weaknesses, and critically, the availability of a skilled workforce.

Over the past several years, and in particular, since the start of the COVID-19 pandemic, MAFAC members have highlighted the many challenges and opportunities related to workforce and training needs for all sectors. These areas cross commercial and recreational fisheries, aquaculture, and other various seafood enterprises, from large to small and around the nation. Improving workforce opportunities, creating new jobs, and retaining existing ones are critical to the resilience, strength and success of these industries. Strategic investment in the nation's seafood workforce through education and training will not solve *all* of the challenges noted in the previous paragraph, but in concert with other targeted actions, it will be a vital part of preparing the seafood sector to confront these challenges.

The Magnuson-Stevens Act (MSA) was enacted to encourage the development of the United States fishing industry and to manage fishery resources to their optimum yield, meaning to "provide the greatest overall benefit to the Nation, particularly with respect to food production and recreational opportunities…" while protecting marine ecosystems. It further noted the importance of fishery resources, and that they "contribute to the food supply, economy, and health of the Nation." Promoting seafood consumption for its numerous health benefits and supporting seafood industries to be healthy and sustainable into the future – to be able to weather whatever challenges arise – is important for the Nation to reap the benefits of our well-managed fisheries.

In light of this, one of NOAA's priorities is to ensure the sustainability and competitiveness of the U.S. seafood industry and improving its resilience in the face of changing climate, and demographic and other stressors to coastal ecosystems and communities. With changing conditions, the dynamics of commercial and recreational fisheries, and aquaculture and associated operations are also changing, and this is revealing new business challenges and opportunities.

[1] Note throughout this document that the term 'seafood industry' encompasses commercial and recreational fishing, aquaculture, and associated industries supporting these sectors.

## MAFAC's Charge

Consequently, MAFAC was charged with developing recommendations to NOAA for Workforce Development (WFD) initiatives that support individuals, businesses, and communities adapting to changing needs and conditions. MAFAC understands that NOAA currently has limited avenues to facilitate WFD. These recommendations may extend beyond NOAA's current abilities in order to identify future funding and initiatives.

At the May 2022 MAFAC meeting, members passed this resolution to NOAA Fisheries and the Secretary of the Department of Commerce, as a first step to address workforce needs**:**

> *NOAA should employ its regional assets, including the National Sea Grant Extension Program Network, to conduct local* ***needs assessments*** *of all industries linked to fishing and seafood production and distribution. In coastal communities, including those that are underserved, this comprises those that fish wild stock, recreational fish, or grow aquacultured products. Across the U.S. and its Territories, the needs for sustaining and improving the fishing and seafood sector's success vary widely. NOAA will benefit from local 'on the ground' expertise to define workforce segments and determine gaps and needs so that funding and other support is focused and directed appropriately for fishery and aquaculture stakeholders and workforce development.*

This report expands on this resolution and provides more background and recommendations on workforce development through training opportunities, education, and innovation and entrepreneurship.

Referencing prior MAFAC products may also assist NOAA in meeting the charge of developing new WFD initiatives including: "Vision 2020 (v2.0): Charting a Course for the Future of U.S. Marine Fisheries" (MAFAC 2012), "Abundant Seas: Making the Most of America's Marine Resources" (MAFAC 2016) and "Best Approaches and Future Needs to Prepare Fishing Communities and Fishing-dependent Sectors for the Impacts of Climate Change" (MAFAC 2017).

## Background

This report defines "resilience" and "resiliency" as: "the capacity of a system to absorb disturbance and reorganize, so as to retain essentially the same function, structure, and beneficial outcomes and therefore retain identity and capacity for use," as defined by the Science for Nature and People Partnership Working Group on Climate Resilient Fisheries (see also Kleisner et al. 2021, Endor's-Kautsky et al. 2021). In other words, resilience should include adaptability as well as transformability. WFD for U.S. fisheries, aquaculture, and the entire seafood industry is one important component of building resiliency into those industries and the extended communities that depend on them. "Communities" for this report include all parts of U.S. coastal and Great Lakes communities that depend on and support commercial and recreational fishing and aquaculture. America's seafood workforce includes, but is not limited to: captains, owner-operators, and crew of commercial and recreational fishing vessels and aquaculture farms; makers and sellers of fishing and grow-out gear; hatchery operators; owners and staff of bait and tackle shops, boat yards, and engine dealers; mechanics, welders, refrigeration technicians, electricians, and boat builders;

lumpers and ice makers; seafood processors and wholesale managers; warehouse personnel and delivery truck drivers; the seafood salesforce; fish counter clerks and managers; seafood chefs; observers; support personnel; educators; and more.

MAFAC's WFD Working Group recommends that, to be effective, seafood industry workforce development initiatives facilitated by NOAA, be guided first by conducting focused needs assessments specific to U.S. regions, industries, and sectors and focus support on specific efforts designed to serve those identified needs. Workforce needs and available services vary widely and carefully targeted needs assessments will be a necessary first step for NOAA to successfully address workforce development across the U.S.

### Equity and Environmental Justice and Workforce Development

The resilience of any system is strengthened by its diversity. A diversity of skills and people in the workforce fosters adaptation, innovation and worker longevity in fields that are often in need of new ideas and new perspectives. U.S. fisheries, aquaculture, and associated seafood industries encompass a variety of governance and economic perspectives that add both challenge and opportunity to increasing industry resilience. Where training and support mechanisms exist, NOAA can learn from and build upon such programs to help increase workforce diversity and recruitment that supports the domestic seafood industry facing a broad suite of challenges (*Equity and Environmental Justice Strategy*).

MAFAC recommendations in this report must all be considered with equity and environmental justice in mind. Historically underserved communities, including remote fishing communities in the U.S., are more at risk of suffering devastating local impacts from fishery regulation changes, climate change, disasters and outmigration or net loss of qualified, trained employees. It is imperative that NOAA prioritize its efforts to support workforce development in ways that increase diversity and preserve those communities most dependent on the U.S. seafood industry and promote diversity and career pathways for advancement where they occur.

## II. Needs Assessment

### Introduction

The MAFAC WFD Working Group recommends that an important first step for NOAA is to conduct needs assessments surveys of the varied sectors within the U.S. seafood industry. Results of these surveys will be critical to focusing NOAA support for WFD, as needed, in the various geographic regions and within the many seafood resource industries.

Needs are defined as critical components to successful business practice within sectors and regions. Examples include an available skilled workforce, training and education opportunities, mental health and wellness support, financial support, infrastructure (including ports, roads and internet access), and minimizing regulatory and other barriers to entry and success, such as technical skills, language, etc. These needs will vary in specificity depending on the communities

polled, species harvested or cultured, and current and future environmental and economic conditions.

## Recommended Guidelines for NOAA Fisheries WFD Needs Assessments

MAFAC Recommends that NOAA use the following guidelines to conduct meaningful and informative WFD needs assessments:

- Engage with communities directly to identify employers and businesses for WFD needs assessments and determine which format(s) will best serve (e.g., surveys, focus groups).
- Organize WFD needs assessments regionally or by sector to cover the broad swath of commercial and recreational fisheries, aquaculture, and associated industries, small and large.
- Give careful consideration to those not normally "at the table", and determine which regions or sectors may represent underserved groups. Examples include U.S. territories and possessions (regions) and native and indigenous communities and villages.
- Use NOAA local and regional assets to determine best practices for polling industry participants across U.S. geographic regions. Regional assets can include Sea Grant program offices, Fisheries Management Councils, and NOAA regional offices.
- Consider using outside polling expertise to conduct comprehensive surveys of regions and sectors.
- Include all elements pertinent to regions such as wild harvest, recreational and guided fisheries, aquaculture, seafood processing, seafood handling, refrigeration and cold storage, shipping, and any relevant sectors or related industries identified by the seafood industry in WFD needs assessments. All of these sectors have specific needs for workforce development.
- Ensure WFD needs assessments are adequate to evaluate current and future issues threatening the Nation's seafood industry including climate change, increasing ocean uses, and factors highlighted by the recent COVID-19 pandemic. Evaluating needs as urgent near-term (now!), mid-term (5-10 years), and long-term will assist in prioritizing NOAA initiatives and funding decisions pertinent to WFD.
- Use the WFD needs assessments to identify community visions of a resilient future. Include identifying trends that may be underway – e.g. is aquaculture currently expanding? Are there underutilized species that are starting to attract attention at an appropriate rate, but do not disrupt the natural environment?

Results compiled by WFD needs assessments will help inform and focus directed action by NOAA and others to build and maintain a strong workforce for the American seafood industry that includes commercial and recreational fisheries and aquaculture. The following sections include further recommendations and examples compiled by MAFAC that are important components for building a strong and resilient workforce. Education, training, innovation and entrepreneurship will all be critical to sustain and improve the broad spectrum of existing and future businesses in U.S. coastal communities that depend on our Nation's fisheries and aquaculture resources.

# III. Education

## Introduction

It is important that K-12 students are provided an introduction to instruction and other experiences that can help guide future career choices. Childhood and young adult experiences in the classroom and during educational field experiences can often open doors to pathways that might be unknown to younger individuals. These experiences can provide a glimpse of not only what one might enjoy doing with one's life, but how others live and how people engage with each other and with the natural environment. Equally important, educational programs need to highlight the challenges humanity faces in this generation around the need to double food supplies by 2050. With that in mind, NOAA should consider providing educational materials to assist teachers to help students engage with career opportunities in aquaculture, commercial and recreational fishing, and associated seafood resources, and help students understand how coastal and marine ecosystems function to support communities and the environment. We also recognize that many communities have a unique connection to these ecosystems and the resources available there; a direct dependence on the environment. It is also important for students to recognize that these communities represent different cultures, lifestyles and ways of knowing (Cochran et al.).

K-12 educators are constantly seeking guidance for curriculum development and materials needed to support a given curriculum. Examples of such resources provided by California State University Northridge (CSUN) include resources for teaching biology and ecology and environmental science and resources gathered from state agencies including the California Department of Environmental Education and the California Department of Fish and Game. Also available through CSUN are resources for teaching zoology, which includes links to the Monterey Bay Aquarium and teaching resources available at Sea World's Animal Resources program. Other active K-12 marine education programs include the Gulf of Maine Research Institute's Hands-on Elementary School Program and the Herring Gut Coastal Science Center in Maine. One might also consider family heritage and working waterfronts as means for demonstrating that marine resources can be sustainably utilized. More K-12 educators ought to recognize the contribution of the commercial seafood sector, with emphasis on the connection between natural resources and local communities' need for making a living and survival.[2] Most of these educational resources focus on topics including literacy, reasoning, and problem solving, which are all important learning objectives. Furthermore, there are numerous educational websites (e.g. Educational Technology and Mobile Learning) with modern visual and interactive elements including videos, podcasts and interactive games. However, there are fewer resources that provide insights on career development, especially those focused on careers in seafood resources industries. While there are resources that indicate how to put a resume together or how to do well in a job interview, resources focused on identifying a specific career path and how to help students vision what that career path looks like as a profession are lacking.

[2] Examples include National Sea Grant Programs, Barnegat Bay Partnership – Estuary Program in NJ, Jacques Cousteau National Estuarine Research Reserve in NJ, and Marine Academy of Technology and Environmental Science (MATES) in Ocean County, NJ, and Eastern Maine Skippers program at the Maine Center for Coastal Fisheries; Project Wild.

## Recommendations

NOAA can assist in the exposure of K-12 students to increase awareness of aquaculture, commercial and recreational fishing, and associated seafood industries, and the career opportunities available in these fields. In doing so, NOAA can help contribute to increased seafood literacy and enhanced workforce development needed by the industry as a whole. MAFAC recommends that NOAA focus on the specific activities listed below regarding support of K-12 educational opportunities. Funding of activities could occur using grant mechanisms in place within NOAA Sea Grant, NOAA Office of Education, and NOAA National Marine Fisheries Service. Efforts should build upon and leverage existing state and local programs as applicable.

MAFAC recommends the following specific activities:

1. Assist K-12 educators to incorporate ideas and curricular materials (including web-based and other resources) focused on fisheries, aquaculture and seafood industries into existing educational pathways.
2. Provide resources and educational materials to groups providing continuing education and professional development courses to educators. Efforts should focus on the principles of environmental and seafood literacy, career opportunities, sustainability, and coastal communities, economies, and culture. Efforts are encouraged to focus on younger (e.g., elementary) students to provide an introduction or 'spark' to students regarding seafood resources, with more detailed classroom instruction to older students regarding specific career opportunities that exist in seafood resources industries.
3. Include exposure of K-12 students at all levels to commercial and recreational fisheries, aquaculture and seafood resources industries via non-classroom activities such as field trips to industry sites.
4. Integrate fisheries, aquaculture and seafood resources industries educational and workforce training activities into existing vocational agriculture programs.
5. Incorporate fisheries, aquaculture and seafood resources industry internship opportunities (paid and unpaid) into high school education programs (e.g., MATES program).
6. Explore expansion of K-12 educational programs focusing on career development by partnering with tribal organizations and the U.S. Fish and Wildlife Service.
7. Consider dual enrollment for high school students with community and state colleges that teach trades in the fisheries, aquaculture and seafood sectors. Relevant examples include Carteret Community College in North Carolina, Indian River State College in Florida, the Marine Oceanographic Academy High School in Florida, and the Sound School in Connecticut.

# IV. Training

## Introduction

One of the challenges facing the seafood sector in general is the lack of clearly established professional occupational standards and career pathways. Entry into the sector has historically been either happenstance or linked to family traditions. Both pathways have worked and continue to exist today but the seafood sector is evolving and having to adapt to a rapidly changing world. New entrants into the seafood sector, whether they are entering wild fisheries or the aquaculture

sector have to understand and embrace new technologies and resource management circumstances. As the sector evolves in the face of new challenges, entrepreneurs and employees have to adapt their skill sets and knowledge base. Employers need to be confident that the people they are hiring have the basic skills required for them to be productive and efficient workers. Employees need to be confident that the skills and knowledge they possess will ensure they are productive workers and able to compete in a competitive workforce climate. Occupational standards[3], developed by both employers and employees and recognized broadly in an economic sector can help professionalize the sector, increase its efficiency and improve the sector's productivity and profitability.

Training in the fisheries, aquaculture and seafood supply chain sectors encompasses many needs of the industry, and can be tailored to geographical locations and workforce personnel, size of operations, levels of skills, and job types. Training can also include diversification of existing positions or retraining in different parts of the sector, for example, transitioning or training for transition of commercial fishermen to part or full time careers in aquaculture. Training in general can be formalized training in community colleges or universities or it can take place via workshops, internships, apprenticeship programs, or specialized courses. Examples of training programs that have helped transition commercial fishermen to aquaculture include the successful training of fishermen to become clam farmers in Florida, shellfish growers in North Carolina, kelp farmers in Alaska, and shellfish or seaweed farmers in Maine. Regarding the latter, the Maine Aquaculture in Shared Waters (AQSW) program focuses on commercial fishermen or working waterfront family members who have been unable to obtain fishing licenses or who are trying to diversify their income sources in the face of evolving resource challenges. Based on a similar program funded by NOAA in 2010 called the Cod Academy, the NOAA Sea Grant funded AQSW program has been conducted annually since 2013. The 12-16 week training program covers a broad range of topics including, species biology, growing methods, gear design and use, business management, production planning, financing, biosecurity, risk management, food safety, site selection, human resource management, lease and permit applications, community relations, marketing and sales. The AQSW program was developed and is taught by a public/private partnership between an industry trade association (Maine Aquaculture Association), a community development non-governmental organization (Coastal Enterprises, Inc.), a research and development nonprofit (Maine Aquaculture Innovation Center) and Maine Sea Grant. Funded in part by NOAA Sea Grant, AQSW has trained over 350 students in the fundamentals of aquaculture with over 60% starting new aquaculture businesses. One of the critical findings of the program has been the need for one-on-one business counseling follow-up and targeted financing programs that incentivize program participation.

MAFAC members have specifically noted a need for diesel, outboard and other engine technicians throughout the commercial, recreational, and aquaculture sectors. One example is Yamaha Marine's Technical School Partnership Program that helps train needed mechanics that support recreational and other fisheries.

[3] Occupational Standards set metrics that define the knowledge, skills, and attitudes required from a person for effective workplace performance.

## Recommendations

1. NOAA should work with industry to develop, where needed, occupational standards specific to workforce skills and training needs for fisheries, aquaculture, and the seafood sector. An example is Maine Aquaculture Occupational Standards for Shellfish and Sea Vegetables Farms (Maine Aquaculture Association et al.).
2. NOAA should ensure that programmatic funding and incentives for training programs (for trade skills), internships, apprenticeships, and career pathways be elevated to expand NOAA Sea Grant and other partner initiatives (e.g., "Food from the Sea").
3. NOAA Sea Grant should establish additional partnerships with academia and industry that can provide existing and new demonstration sites for training and retraining programs, continuing education, workshops, and hands-on opportunities.
4. NOAA should support existing and establishment of new small business training opportunities or programs across all sectors of commercial and recreational fishing, aquaculture, and associated industries.
5. NOAA should consider establishing or supporting "Train the Trainer" programs modeled on existing programs and designed to recreate them in areas of the country without existing programs and with significant need.
6. NOAA-supported programs should include significant hands-on training, a record/certificate of completion, and assistance in seeking out employment opportunities.
7. NOAA should work with the U.S. Department of Labor to develop national fisheries and aquaculture apprenticeship programs, based on a set of occupational standards and similar to the apprenticeship program recently developed in Maine.
8. NOAA should support training programs in mechanical trades that are essential to many of our fishing and aquaculture businesses. These include motor and engine mechanics, refrigeration experts, hydraulics experts, and more.
9. NOAA should develop a publically available inventory of seafood training opportunities.

# V. Innovation and Entrepreneurship through Education, Mentoring, and Knowledge Sharing

## Introduction

The domestic seafood market is struggling due to the shift in demand caused by unforeseen market disruptions, highlighting the need to develop and promote side streams and innovative products. At the onset of the COVID-19 pandemic, restaurants were forced to limit their offerings of fresh seafood in an effort to be more efficient with their monetary resources. The seafood industry has felt the ripple effects of the slowdown in demand. While global warming has been an increasing existential threat to the domestic fishing and aquaculture industries, the advent of the pandemic has accelerated the need for more rapid change. While restaurant sales contracted, retail sales direct to consumers increased significantly. In addition, factors such as aging of the workforce, and corresponding infrastructure, are impacting seafood resources. The seafood industry needs to accelerate its efforts in identifying and adapting to new opportunities, and more efficiently utilizing the supply chain. These cumulative impacts have forced the fishing and

aquaculture industries to acknowledge the changing seafood channels, and search for ways to reinvent itself to accommodate the shift in demand from the restaurants to the home.

Addressing these issues and supporting a domestic seafood market will require innovative ideas, entrepreneurship skills and a fundamental understanding of the process of commercialization. Simply modifying old models is a recipe for disaster. For example, enhancing infrastructure may not be a solution if a given fisheries model has shifted. The focus of efforts need to be shifted to address tomorrow's opportunities, as we cannot afford to dwell on yesterday's models. Thus, there is an urgent need for rapid transformation to address these emerging changes. One of the great things about "American" ingenuity is that when businesses are presented with problems, there is often a mad rush to solutions.

Education and training for entrepreneurship, innovation, and commercialization require different skills and knowledge than programs designed to train workers. Above all, a good understanding of the technical and operational knowledge necessary to work on a vessel or a farm and broad knowledge in business management are important for successful entrepreneurship. The development of innovation and necessary skills require training in problem identification, research and experimental design, critical thinking, collaboration and project management. Skills in intellectual property protection may be necessary for both innovation and entrepreneurship depending on the type of business an individual is interested in developing.

Numerous examples exist of public/private partnerships designed to stimulate and support innovation, entrepreneurship and commercialization of novel ideas and products. In Iceland, the Iceland Ocean Cluster - Skavarklasinn helped entrepreneurs develop economically viable production streams where they could ultimately make use of over 95% of landed catch. This included such innovations as fish-skin grafts for burn victims as well as alternative food products, and materials for garments and accessories. In Florida, the University of Florida, in concert with the Charoen Pokphand Foods Company of Thailand, established a working shrimp farm to produce domestic shrimp on land to enhance the domestic shrimp supply and reduce the carbon footprint resulting from the importation foreign shrimp. In Ireland, a public/private partnership is supporting the development of new products based on locally farmed seaweed species. Training programs are an important component of all of these programs designed to help develop new products and/or support new businesses.

## Recommendations

1. NOAA should expand its continued support of aquaculture as a means of increasing the quantity and variety of seafood available to consumers. One example has been kelp farming in Maine. That has been a great success story, as it has provided traditional lobstermen with extended opportunities to harvest a fast-growing, sustainable food year-round to supplement and diversify their income.
2. NOAA should consider support for the growth of entrepreneurship and innovative businesses. Using international models, NOAA can promote and support international internships and exchange programs where entrepreneurs can acquire necessary business and innovation skills with hands-on experience from other successful examples around the world.

3. NOAA should serve as a catalyst in showcasing the opportunities that exist in both the wild-harvest and aquaculture arenas. One suggestion is to consider offering an annual competition through Sea Grant open to business schools on the East, West, Gulf, or Alaskan coasts, and Pacific Islands to inspire and support opportunities for innovation in the seafood sector. Rather than waiting for business entities to realize economic opportunities in the seafood industry, NOAA can promote this innovation by asking for ideas and proposals. Additionally, having this and other government entities behind an entrepreneurial movement like the one proposed here would provide instant credibility and participation.
4. NOAA should identify opportunities with existing programs–both government and private sector–that would provide a template for fostering innovation in both the domestic wild-harvest and aquaculture arenas. Kelp farming and development of side stream enterprises are examples of desired outcomes.
5. NOAA should explore more active promotion of the variety of grant opportunities that are available for fisheries, aquaculture, and seafood innovation and entrepreneurship activities. We recognize that there are numerous links to Grants.gov currently on NOAA and NOAA Fisheries webpages, but there may be improved opportunities to get the word out. MAFAC is willing to work on this further with the Agency.

# VI. References


Barnhardt, Ray, and Kawagley, A.O. "Indigenous Knowledge Systems and Alaska Native Ways of Knowing." *Anthropology & Education Quarterly*, vol. 36, no. 1, Mar. 2005, pp. 8–23, https://doi.org/10.1525/aeq.2005.36.1.008.

Cochran, Patricia A., et al. "Indigenous Ways of Knowing: Implications for Participatory Research and Community." *American Journal of Public Health*, vol. 98, no. 1, 2008, pp. 22–27, https://doi.org/10.2105/ajph.2006.093641.

Enfors-Kautsky, E., Järnberg, L., Quinlan, A., & Ryan, P. Wayfinder: A new generation of resilience practice. *Ecology and Society*, *26*(2), 2021, https://doi.org/10.5751/es-12176-260239.

Kleisner, K. M., Ojea, E., Battista, W., Burden, M., Cunningham, E., Fujita, R., Karr, K., Amorós, S., Mason, J., Rader, D., Rovegno, N., & Thomas-Smyth, A. Identifying policy approaches to build social–ecological resilience in marine fisheries with differing capacities and contexts. *ICES Journal of Marine Science*, 2021, https://doi.org/10.1093/icesjms/fsab080.

Maine Aquaculture Association, et al. "Maine Aquaculture Operational Standards for Shellfish and Sea Vegetable Farms." Oct. 2021, https://maineaqua.org/wp-content/uploads/2021/10/ME-Aquaculture-Occupational-Standards-for-Shellfish-and-Sea-Vegetable-Farms.pdf.

National Oceanic and Atmospheric Administration, National Marine Fisheries Service. Equity and Environmental Justice Strategy (Draft). May 2022, https://media.fisheries.noaa.gov/2022-05/2022-05-NOAAFisheries-EEJ_508.pdf.

National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Marine Fisheries Advisory Committee. "Vision 2020 (v2.0): Charting a Course for the Future of U.S. Marine Fisheries Final Report of the Marine Fisheries Advisory Committee (Update of MAFAC Vision 2020 Report)." Dec. 2012, https://media.fisheries.noaa.gov/dam-migration/mafac_report_vision2020(v20)_2012.pdf.

National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Marine Fisheries Advisory Committee. "Abundant Seas: Making the Most of America's Marine Resources." Mar. 2017, https://media.fisheries.noaa.gov/dam-migration/mafac_rec_to_secross_budgetissues_2018.pdf.

National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Marine Fisheries Advisory Committee. "MAFAC Report: Best Approaches and Future Needs to Prepare Fishing Communities and Fishing-dependent Sectors for the Impacts of Climate Change." Nov. 2017, https://www.fisheries.noaa.gov/resource/document/mafac-report-best-approaches-and-future-needs-prepare-fishing-communities-and.