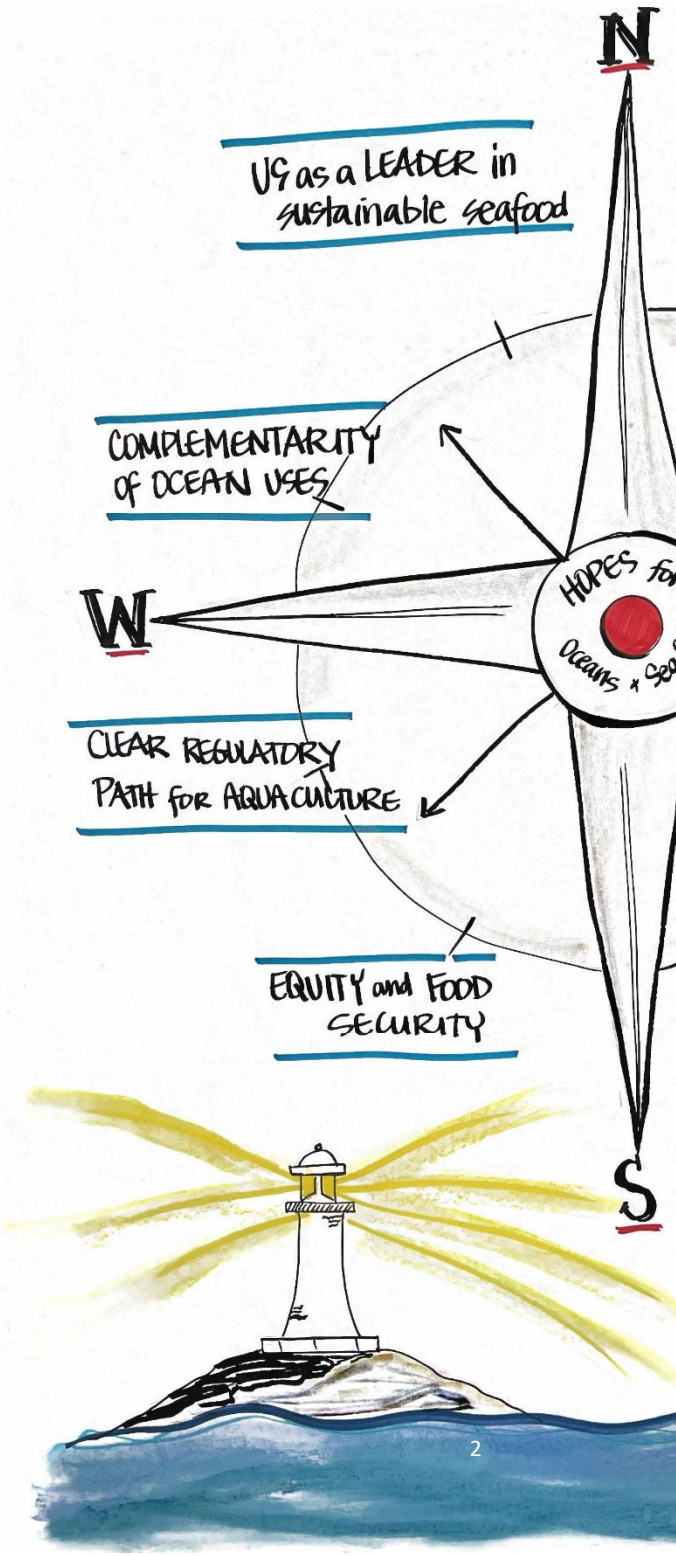
MERIDIAN INSTITUTE

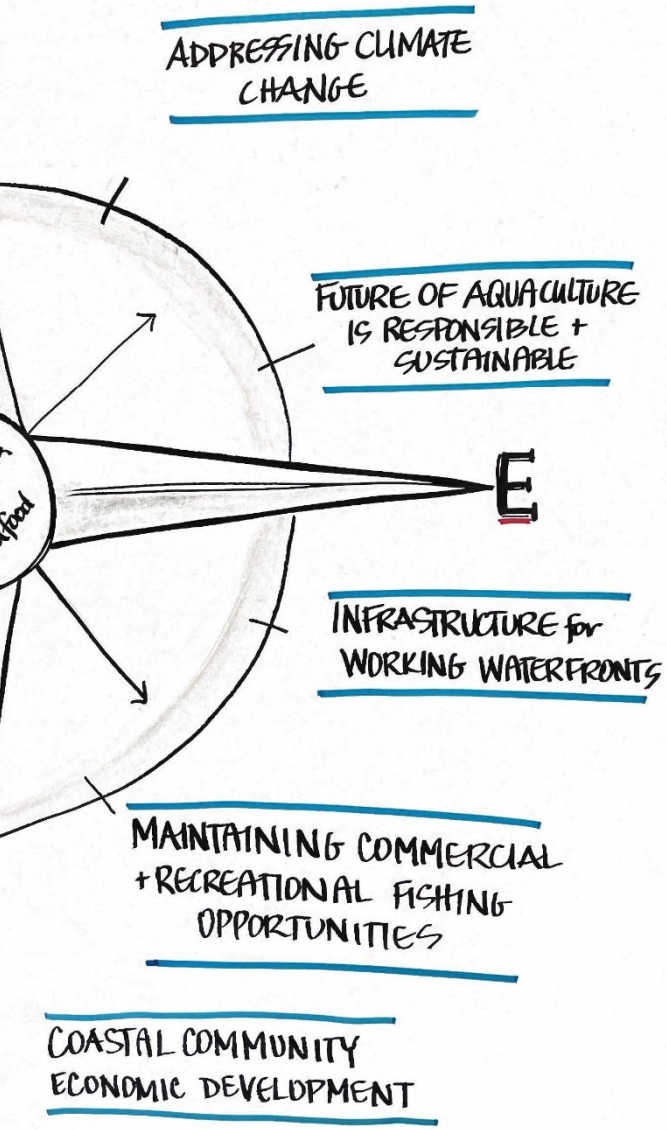
OCEAN STRATEGIES

Design Workshop Summary Report

Multisectoral Scenario Planning and Solution Building for the Future of U.S. Marine Aquaculture – Spring 2022

Contents





About this Report

This non-attributional synthesis was prepared by Meridian Institute and Ocean Strategies in Spring 2022 based on the discussions and insights gleaned from the U.S. Marine Aquaculture Multistakeholder Design Workshop, attended by 43 participants representing industry, nonprofits, finance, tribes, and other organizations.

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Acknowledgments

We would like to thank the Steering Committee that provided invaluable sectoral insights and guidance in crafting key workshop components:

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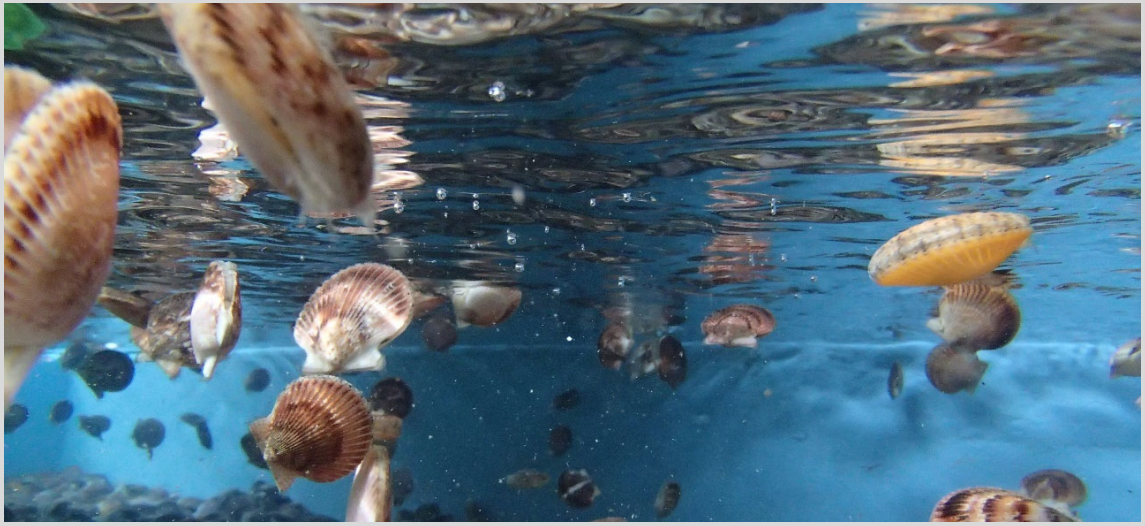
Executive Summary

Growing demand for sustainable protein has accelerated financial and political investment in aquaculture production in the United States (U.S.). However, ocean stakeholders and coastal community leaders have diverse opinions as to whether the U.S. can develop a sustainable and equitable domestic aquaculture industry and, if so, how to realize such an industry. In response to rising interest in this topic from federal agencies, Congress, investors, companies, and NGOs, Meridian Institute convened a three-day U.S. Marine Aquaculture Multistakeholder Design Workshop in April 2022. Meridian collaborated with Ocean Strategies to bring together 43 leaders across ocean sectors (aquaculture industry, ENGOs, commercial fishing, recreational fishing, aquaculture finance, seafood supply chain, and tribal/community leaders) to share perspectives and brainstorm solutions to challenges regarding the future of marine aquaculture in the U.S. Funding for the workshop was provided by Builders Initiative, a philanthropy that invests in sustainable solutions to societal and environmental challenges, including restorative aquaculture, ocean resilience, and sustainable fisheries management.

The workshop provided a neutral space for ocean stakeholders with an interest in the future of U.S. aquaculture to share perspectives and core values, learn from one another, and move toward solution-oriented conversations. This executive summary documents the range of concerns, opportunities, and solution building options that emerged from workshop discussions (more information on the ideas raised at the workshop can be found in the "Opportunities for Collaborative Solution-Building" section and Appendix A of the full workshop report). This summary also provides insights on a range of stakeholder views and ideas that may be helpful to those working to improve stakeholder engagement on marine aquaculture.

However, **this summary is *not* an authoritative document, nor a set of consensus recommendations, nor does it endorse a specific course of action**. Rather, it represents a snapshot of stakeholder discussions held at a specific time among a defined group of participants. While the perceptions and concerns of all stakeholders who participated are equally valid, their expertise and knowledge of the science and practice of aquaculture varies. Notably, this summary highlights areas where common ground began to emerge across sectors; as such, this summary can be used to guide future engagement around U.S. aquaculture development.



Shared Hopes and Unifying Concepts: Illuminating Commonalities Among Sectors

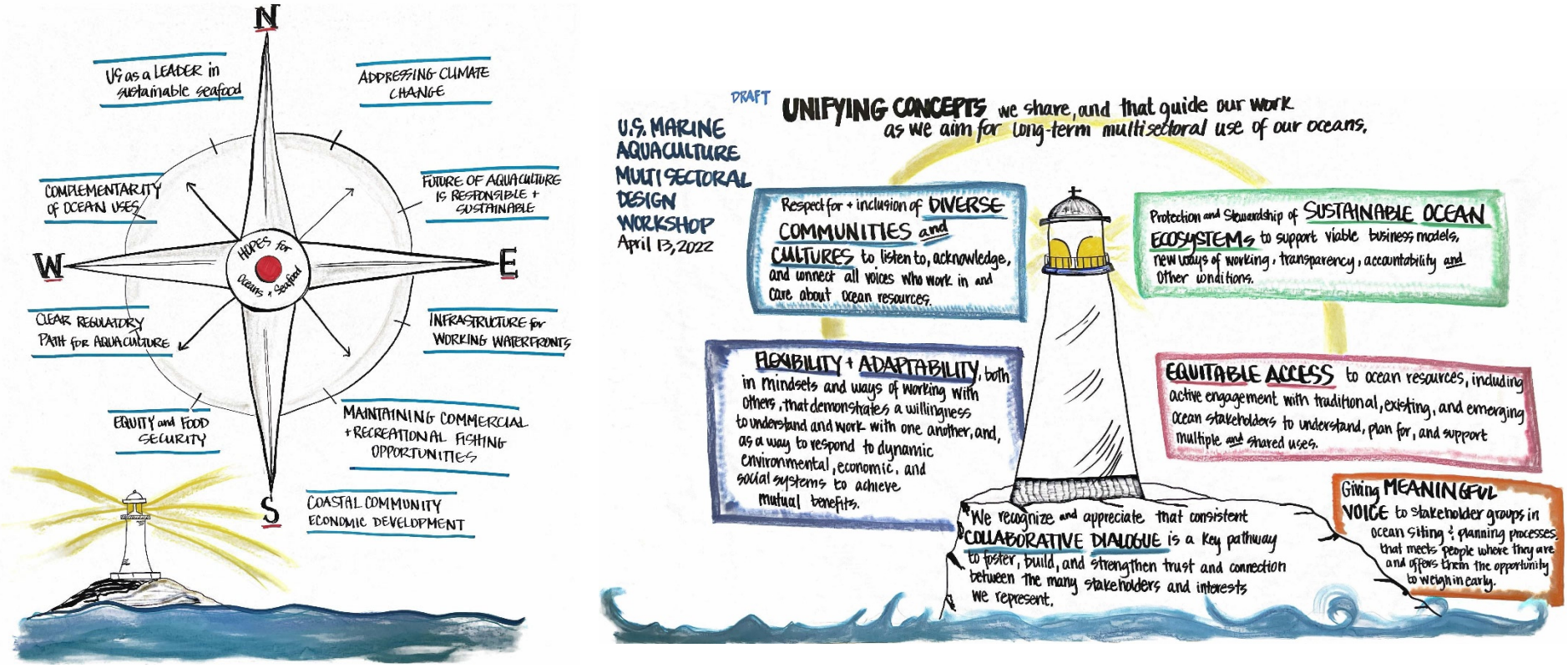


Figure ES-1. The workshop began with a focused discussion on participants' shared hopes for the future of oceans and seafood, as informed by participant responses to a pre-workshop survey. Meridian also synthesized participant sentiments raised throughout the workshop into a set of unifying concepts, shared with participants on Day 3 of the workshop. Collectively, these shared hopes and unifying concepts create a compass and a lighthouse that can help "guide" multisectoral engagement around the future of U.S. marine aquaculture.

Stakeholder Perspectives on Aquaculture: Interests and Concerns

The workshop was designed around four hypothetical marine aquaculture operations, or "scenarios," aimed at prompting discussion on U.S. aquaculture development among different stakeholder groups (more information on the scenario exercises can be found in the "Scenario Planning Insights" section and Appendix B of the full workshop summary report). These exercises created space for ocean stakeholders to learn from one another by encouraging workshop participants to share their interests and concerns on aquaculture development, including ways to meet stakeholder needs. Participant input shared in these scenario exercises can be found in Appendix C of the full workshop summary report.

Below is a snapshot of themes and key points that participants raised while going through the scenario exercises (for more details, see the "Scenario Planning Insights" section of the full workshop summary report). Throughout the exercises, numerous participants emphasized the importance of local context in shaping perspectives on aquaculture. The below points illustrate a range of insights about what is important to stakeholders, based on perceived risks and concerns, but they *do not indicate agreement across all participants or sectors*.

TYPE OF AQUACULTURE

- Participants considered shellfish, finfish, and seaweed aquaculture in the scenario exercises.
- Overall, there were fewer concerns about shellfish and seaweed farming than finfish. Participants recognized that shellfish and seaweed farming can provide net environmental benefits, such as improving water quality.
- In all cases, participants deemed local context — such as community dynamics and specific environmental parameters — to be very important.

DISTANCE FROM SHORE

- Participants varied on preferences for nearshore or offshore development.
- Some sectors raised concerns that we may not yet have the technology to farm efficiently in high-energy, open-water environments and questioned what scale of farm is required to be economically viable offshore.
- Participants also noted that farming in nearshore environments could make monitoring easier and allow for quicker responses to challenges that may arise (e.g., weather, disease).
- Others pointed out that establishing aquaculture farms further offshore can mitigate some environmental impacts and user-group conflicts (e.g., more space, fewer impacts on water quality and substrate).

FARM SCALE AND PILOTS

- In considering scale, participants explored the balance between environmental safeguards and regulatory efficiency to ensure that barriers to entry to do not unfairly impact small and historically disadvantaged farmers from entering the aquaculture industry.
- In general, participants raised more concerns about larger scale aquaculture farms.
- Some sectors expressed concern that scaling aquaculture farms to the scale needed to be profitable would impact traditional user groups.
- Others pointed out that farms have to be large enough to generate enough revenue to allow farmers to pay for environmental monitoring efforts and other technologies that reduce adverse impacts to the environment.

- Some sectors were most comfortable with starting aquaculture operations at a small or pilot scale and allowing them to grow over time as the benefits and impacts of marine aquaculture are better understood.
- Others were concerned that having a separate process for pilots would create challenges with securing financing if the tenure of the farm is less certain in that process. Some felt that the existing process is sufficient, and pilots are not needed.

SPECIES SELECTION

- Participants noted that species selection is important for all types of farms.
- Some raised that farming native species may create opportunities for cultural connection and augmenting local wild populations.
- Some sectors expressed concern that the escape of hatchery-raised species may pose a risk of interbreeding between farmed and wild populations, which might result in negative genetic impacts within wild populations.
- Some sectors also expressed concern that introducing nonnative species to marine environments could impact ecosystems and commercial fisheries.

ADDITIONAL SITING CONTEXT AND INSIGHTS ON NOAA'S AQUACULTURE OPPORTUNITY AREAS (AOA)

- Stakeholders generally voiced praise and support for NOAA's AOA process, noting that it is well-regarded as being rigorous, science-based, and informed by stakeholder input.
- Some participants noted that finer scale information on site characteristics is needed to make specific decisions about farm location and orientation, as well as monitoring and mitigation needs.
- Several participants called for more comprehensive planning to understand cumulative impacts of multiple farms in an area, as well as other new ocean uses like offshore wind development. Interactions between planning for offshore wind and planning for aquaculture were not clear to many, and participants noted that a more consistent approach to ocean space, overall, would be better for engaging many stakeholder communities.

NEARBY COMMUNITY AND STAKEHOLDER ENGAGEMENT

- Throughout the workshop, participants stressed the importance of community support for local aquaculture development and proactive engagement with communities and ocean users, including tribal governments.
- Several sectors pointed out that it can be challenging for aquaculture operators to engage in a high level of outreach and transparency because it creates opportunities for public criticism, attack, and stalling the permitting and regulatory process.

ROLE OF CERTIFICATIONS AND RATINGS

- Different sectors and communities are interested in individual farms' operational practices and would like to better understand what the "gold standard" of best management practices looks like.
- Many sectors felt that having sustainability certifications and ratings added value and certainty to projects. Some expressed that certifications and ratings help both companies and consumers understand what sustainable aquaculture means and can help companies go above and beyond regulatory requirements for sustainability.
- However, others noted that certifications are ultimately optional and, where safeguards and best practices are needed, they should be enshrined in regulations.

STATE OF THE SCIENCE

- Participants expressed a range of opinions about whether the state of the science and marine spatial planning efforts are sufficient to sustainably site and operate aquaculture farms.
- Some participants felt there was still significant uncertainty related to how aquaculture farms would impact marine environments.
- Other participants countered that there are significant bodies of research and evidence about marine aquaculture that are just not well communicated to, or understood by, sectors and communities.

SEAFOOD ECONOMICS AND MARKET DYNAMICS

- Some participants expressed concern that increasing seafood production from aquaculture would flood local markets, driving down the price of wild-caught seafood and putting commercial fishermen out of business.
- Other sectors remarked that increasing the consistency of domestic seafood supply for some species may stabilize or increase the price point of the product.
- Some sectors perceived aquaculture products as being in direct competition with wild-caught seafood, while others pointed out that U.S. aquaculture products may be in more direct competition with imported, farmed seafood products.
- Participants raised concerns about market dynamics more so for finfish than for shellfish or seaweed aquaculture.

Emerging Areas of Alignment

Meridian identified several emerging areas of alignment across sectors, based on stakeholder ideas raised during workshop discussions. While these areas do not equate to consensus, they do illuminate commonalities among workshop participants that are ripe for further exploration:

- **Local contexts are critically important for aquaculture.** Aquaculture companies, permitting agencies, and others involved in aquaculture development should meet local communities and ocean sectors "where they are at" and engage them on how aquaculture development could fit the community's/sector's vision for the future of their coasts and oceans.
- **Strengthening working waterfronts and supporting local economic development are important areas of alignment for fishing and aquaculture communities**. To build trust, ocean sectors can start working together on common issues like seafood infrastructure, working waterfronts, and shared challenges like marine debris and climate change
- **Developing the capacity of U.S. seafood production should be done in a way that increases access to the industry overall and supports equitable workforce development**. Special care should be taken to ensure that the benefits of aquaculture development (e.g., workforce and infrastructure development) are equitably distributed throughout local communities.
- **The ecological and social aspects of oceans are highly dynamic, with growing competition for space between fisheries, aquaculture, recreation, conservation, energy, and other uses**. These real and perceived conflicts can pose significant challenges for ocean users in navigating emerging ocean uses and environmental change.
- **Ocean stakeholders need more collaborative and cross-sectoral discussion spaces.** Public forums and hearings are not typically conducive to constructive dialogue. Rather, there is a need and desire for venues where different ocean sectors can come together to discuss the range of issues affecting the ocean (e.g., marine debris, climate change).
- **Upfront planning processes are needed to understand cumulative impacts** of multiple aquaculture farms in an area and competing ocean uses.
- **Aquaculture development in federal waters may require improved permitting processes** to create a clear regulatory pathway, reassure aquaculture investors on the bankability of their investment, and improve transparency and outcomes for all ocean users.
- **Pilot-scale aquaculture projects offer an opportunity for learning, innovation, and building trust with ocean stakeholders**. Some sectors were most comfortable with starting aquaculture operations at a small scale and allowing them to grow over time as the benefits and impacts of marine aquaculture are better understood.
- **Aquaculture information needs should be addressed in a collaborative and transparent manner rather than through siloed research.** For example, several farms have collaborated on aquaculture research with NGOs and universities, and NOAA's research strategy recently underwent public comment. There is a need for a collective space for ocean data and information about and relevant to aquaculture in the U.S.
- **There is a need to better communicate existing science and research around aquaculture development** to interested ocean stakeholders through channels and methods that are easily accessible.

Opportunities for Collaborative Solution Building

On Day 3 of the workshop, participants went through a small group exercise, in which they had to identify a collaborative solution that could address one of six challenges related to aquaculture development. While the solutions presented below are the outputs from this small group exercise, they do not represent all viewpoints nor the full consensus of workshop participants. They do, however, outline potential opportunities to address the needs of multiple sectors. Each of these topics is complex and requires further exploration to flesh out exact details and viable pathways toward solutions. Some of these topics are also being addressed, to varying degrees, in parallel spaces and conversations. A more detailed summary can be found in the "Opportunities for Collaborative Solution-Building" section of the full workshop summary report.

This is not a consensus document.

Rather, it captures a range of ideas developed by a multisectoral group and demonstrates the value of third-party spaces for perspective sharing.

Figure ES-2: These six Opportunities for Collaborative Solution Building represent areas where cross-sectoral collaboration could potentially address a challenge related to aquaculture development in the U.S. These opportunities emerged from themes that workshop participants raised during the scenario exercises on workshop Days 1 and 2.

Engagement and Collaboration Among Ocean Sectors — One of the most called for ideas across the workshop was opportunities to **create forums for meaningful engagement among ocean sectors** to build relationships, foster cross-sectoral communication, and advance solutions-oriented thinking. One idea raised was to create **non-project specific, community or regional roundtables** that allow sectors to come together to hold **cross-cutting ocean planning and visioning discussions**. Stakeholders often feel that project-based discussions happen so late in a development process that stakeholder input is not meaningfully accounted for; as such, project-based discussions are not set up to build cross-sector relationships.

Economic Development and Community Engagement — To enhance community engagement, **developing a guide for aquaculture companies that outlines approaches for engaging stakeholders** can help **ensure people have a voice in, and benefit from, aquaculture development in their communities**. This guide could map out ways to assess a community's economic and social characteristics (which can inform engagement strategies and practices) and provide insight to how different sectors prefer to engage in permitting processes.

Building Domestic Seafood Infrastructure — Creation of additional avenues to **catalyze investments in shoreside, transportation, workforce, and green infrastructure** to meet the needs of multiple forms of seafood production (wild-caught, farmed, recreational, subsistence) was another major takeaway from workshop discussions. Infrastructure investments could focus on prioritizing community needs, augmenting existing seafood infrastructure (e.g., building a new processing facility), and developing new technologies.

Regulatory Reform — Many (though not all) participants identified the need to create a **clear, efficient, and stepwise permitting process for aquaculture in federal waters** with mechanisms for **clear agency leadership, farm performance and accountability, and data collection**. Three complementary solutions were discussed by a subset of participants, and would need to be advanced in concert with one another to address the needs and interests of a wide range of stakeholders: 1) a multistakeholder process to establish **best management standards** for aquaculture in federal waters, 2) legislation to **designate NOAA as the lead agency** for aquaculture permitting, and, 3) **expansion of marine spatial planning** efforts for the U.S. ocean environment to include consideration of cumulative impacts and multiple ocean industries. Note that these are preliminary ideas developed by a subset of the meeting participants and do not reflect consensus. In reviewing this workshop summary, some participants expressed opposition to these ideas, as they view the current regulatory process as sufficient.

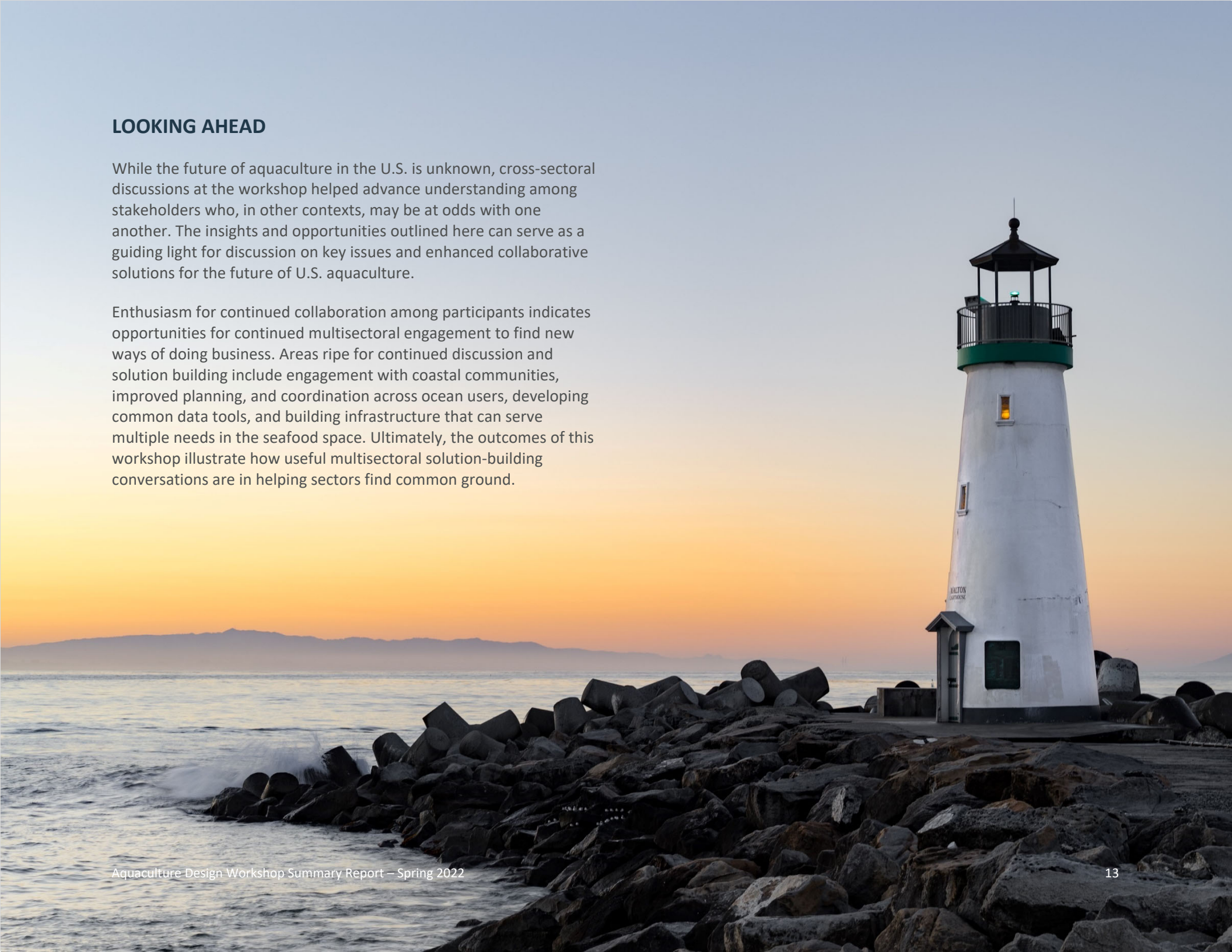
Public Education, Outreach, and Communications on Seafood — Creating a **national campaign about consuming more domestic seafood** could **educate consumers and foster local and cultural connections to seafood**. American consumers, overall, have a low awareness of the benefits of seafood (including commercial, recreational, farmed, and subsistence) and many narratives about seafood contain misinformation or do not accurately represent domestic practices. A national marketing campaign could help **shift inaccurate narratives, bolster education and awareness of US seafood, and increase seafood consumption** throughout the U.S.

Addressing Economic and Environmental Research Needs — To meet the need for distributing relevant aquaculture information and research to interested stakeholders, participants suggested building a **central web-based platform** that **integrates existing data on aquaculture from multiple sources**. This solution could address the concern that research to inform aquaculture development is not readily available to a range of stakeholders. A broad array of data and information is needed (e.g., environmental baseline data, best practices, emerging research on newer questions around species and ecological interactions) to answer key questions and collating it in a central location could facilitate understanding and advance research.

LOOKING AHEAD

While the future of aquaculture in the U.S. is unknown, cross-sectoral discussions at the workshop helped advance understanding among stakeholders who, in other contexts, may be at odds with one another. The insights and opportunities outlined here can serve as a guiding light for discussion on key issues and enhanced collaborative solutions for the future of U.S. aquaculture.

Enthusiasm for continued collaboration among participants indicates opportunities for continued multisectoral engagement to find new ways of doing business. Areas ripe for continued discussion and solution building include engagement with coastal communities, improved planning, and coordination across ocean users, developing common data tools, and building infrastructure that can serve multiple needs in the seafood space. Ultimately, the outcomes of this workshop illustrate how useful multisectoral solution-building conversations are in helping sectors find common ground.



Introduction

Introduction

Growing demand for sustainable protein and seafood has accelerated financial and political investment in aquaculture production in the United States (U.S.). However, ocean stakeholders and coastal community leaders have diverse opinions as to whether the U.S. can develop a sustainable and equitable domestic aquaculture industry and, if so, how to realize such an industry. Stakeholders differ, for instance, on whether they believe aquaculture can provide economic development opportunities in coastal communities while maintaining high environmental standards, protecting critical habitat, and managing industry expansion in an increasingly crowded working waterfront and seascape.

Because of these differences in views, building a responsible domestic aquaculture industry will require broad accounting of stakeholder interests and needs across the maritime landscape. One productive approach to this challenge is to create neutral spaces where ocean stakeholders can engage with each other, hear one another's concerns, and take part in constructive solution-building toward a vision of mutually beneficial ocean use. In this spirit, Meridian Institute — in collaboration with Ocean Strategies and with support from Builders Initiative — convened the U.S. Marine Aquaculture Multistakeholder Design Workshop in April 2022. Over three virtual sessions, the workshop brought together 43 leaders across ocean sectors and geographies to explore areas of common ground and identify solutions to key challenges regarding the future of marine aquaculture in the U.S.

This workshop is an extension of Meridian Institute's multi-year work to understand the range of perspectives on U.S. marine aquaculture development. As a trusted third party, Meridian has undertaken this work to learn about different sectors' values and needs, as well as concerns and opportunities regarding the future of aquaculture in the U.S., for the sake of better informing decision-making. We, at Meridian, have observed from our past work that ocean stakeholders with an interest in the future of U.S. aquaculture benefit from direct engagement with one another to cultivate a shared understanding of potential common interests and opportunities. Additionally, given the rising interest in aquaculture production from NOAA, Congress, investors, companies, and NGOs, holding a workshop presented a timely opportunity to build dialogue between sectors around aquaculture development *outside* of regulatory and legislative discussion spaces.

We invited representatives from following sectors to participate in the workshop: aquaculture industry (finfish, seaweed, and shellfish), the aquaculture investment and finance community, tribal and community leaders, commercial fishing, recreational fishing, the seafood supply chain, and environmental NGOs (see Appendix C for a full participant list). A Steering Committee of leaders from these sectors[1] helped plan the workshop and inform the participant list. Additionally, workshop discussions were designed to build on

[1] Rip Cunningham, Salt Water Sportsman; Glenn Delaney, Southern Shrimp Alliance; Ruth Driscoll-Lovejoy, Environmental Defense Fund; Leigh Habegger, Seafood Harvesters of America; Dane Klinger, Conservation International; Mike Leonard, American Sportfishing Association; Stacy Schultz, Fortune Fish & Gourmet; Neil Anthony Sims, Ocean Era, Inc.; Diani Taylor, Taylor Shellfish Farms; Kim Thompson, Aquarium of the Pacific

themes raised from previous stakeholder engagement, including input from more than 100 interviews with representatives across these same sectors.

The workshop was designed to provide a neutral space for representatives from various ocean sectors to share perspectives and core values, learn from one another, and move toward solution-oriented conversations. The workshop was a uniquely proactive (rather than reactive) dialogue space, aimed at achieving the following objectives:

- Fostering more productive cross-sectoral interactions through knowledge sharing and meaningful engagement;
- Examining the needs of different sectors and identifying degree of alignment across sectors on key issues; and
- Identifying policy solutions to advance areas of agreement and address areas of conflict for risks and opportunities surrounding the future of marine aquaculture in the U.S.

The workshop was held virtually across three sessions that were designed to build on one another, with knowledge gained from one session informing the approach to the subsequent sessions. These included:

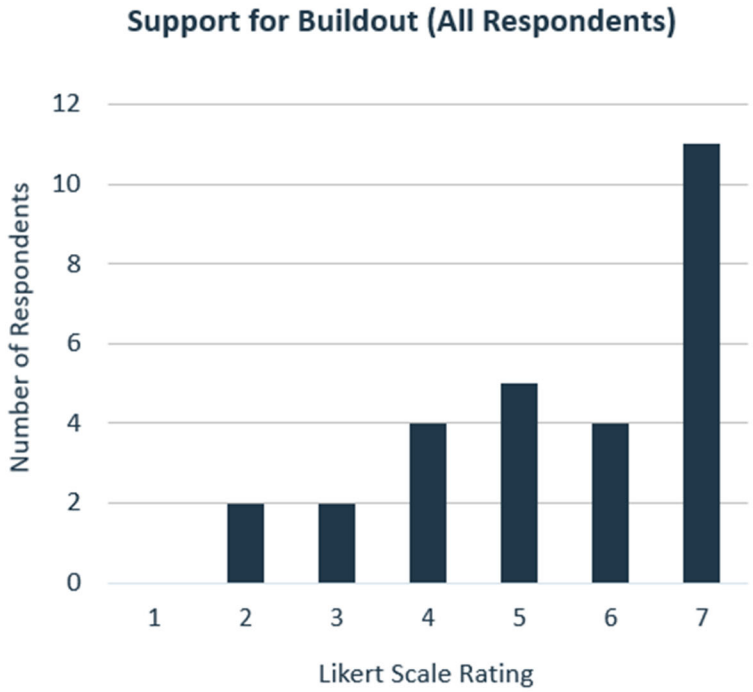
- Session 1: Visioning the Future of U.S. Aquaculture and Initial Scenario Planning
- Session 2: Scenario Planning Continued – Aquaculture in Shared Waters
- Session 3: Charting a Path Forward – Key Insights, Solution Building and Next Steps

A full meeting agenda with session descriptions can be found in Appendix D; background preparatory reading to help inform participants on context can be found in Appendix E.

The workshop was designed around the "scenario planning" exercises on Days 1 and 2. These exercises put hypothetical aquaculture operations before workshop participants for consideration, comment, and discussion. Each hypothetical operation was located either nearshore or offshore, focused on either fed or unfed aquaculture, and placed adjacent to either an urban or rural settlement. Scenario discussions focused on generating cross-sectoral exchange, particularly examining the opportunities and risks these hypothetical operations may pose, from the perspectives of different sectors. The end goal of these scenario planning exercises was to elucidate potential commonalities between stakeholders, including sector needs in the context of aquaculture development and ways to meet such needs through collaborative planning, policy, research, or industry best practices.

Understanding participant perspectives coming into the workshop was important, so Meridian and Ocean Strategies distributed a pre-workshop survey to all participants, asking (among other questions), *"How supportive are you of building out the domestic marine aquaculture sector?"* About 2/3 of workshop participants responded to the survey, and results indicated a range of perspectives, particularly between sectors (Figure 1). Additionally, written comments shared by survey respondents revealed that support for domestic marine aquaculture expansion is often contingent on several considerations, including an operation's relationship with the local community, the scale or type of aquaculture, the level of proactive planning and stakeholder engagement an operation pursues (including considerations of data and information transparency), and an operation's use of environmental best practices. These themes came up throughout the workshop, as well, and are explored further in this report.

1 - Not at all Supportive ⟷ **7 - Fully Supportive**



	Responses	Min	Max	Mean
All Respondents	28	2	7	5.4
Aquaculture Industry	7	6	7	6.9
Aquaculture Finance	1	7	7	7.0
Commercial Fishing	5	2	6	4.0
Recreational Fishing	4	3	6	4.5
Seafood Supply Chain	4	2	7	5.8
ENGO	4	4	6	5.0
Tribal and Community	3	4	7	5.3

Figure 1: Range of support among workshop participants, pre-workshop, for building out domestic marine aquaculture.

The workshop allowed participants to share diverse perspectives with one another and fostered exchange around key differences in opinion. In addition, collaborative dialogue revealed areas of common ground across sectors — including sectors that may be at odds with one another in other settings, such as public forums. We captured these observations and present them here, in non-attributional form, as a snapshot of stakeholder discussions held at a specific time among a defined group of participants.

This is not a consensus document.

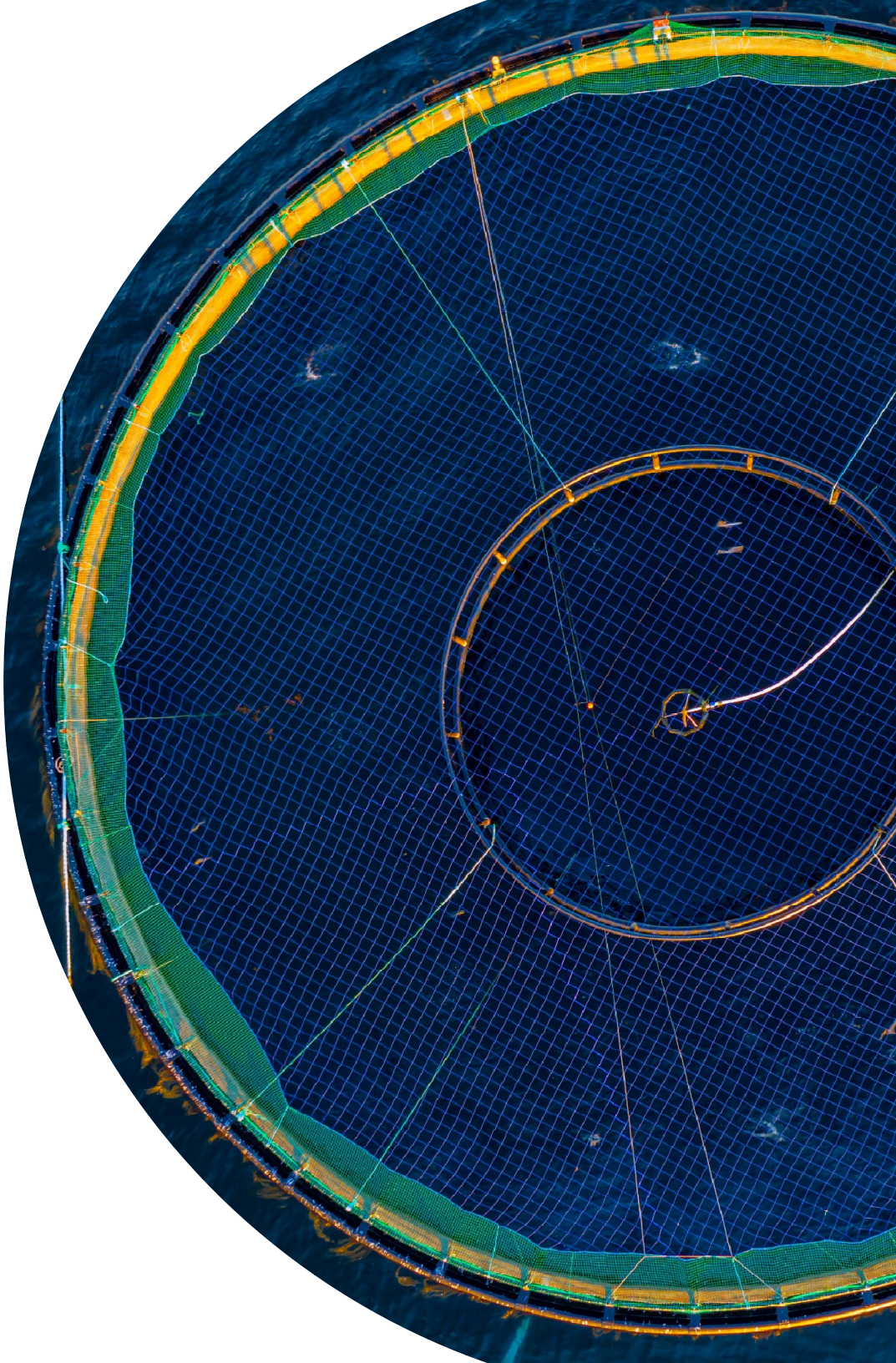
Rather, it captures a range of ideas developed by a multisectoral group and demonstrates the value of third-party spaces for perspective sharing.

This summary report is the primary output from the workshop, but what is presented here does not represent consensus among participants nor does it endorse a specific course of action. Participants shared their thoughts and viewpoints based on their existing understanding of issues and concerns, which necessarily differed across individuals.

As such, this document:

- Is designed to provide information that is relevant to a wide range of audiences, including workshop participants and others who identify with the sectors represented at the workshop;
- Provides insights and ideas that can inform policymakers on a range of stakeholder views; and
- Can serve as a foundation for shared understanding, a basis for future cross-sectoral discussions, and a collection of insights to guide ongoing stakeholder engagement on domestic marine aquaculture.

We expect that this report may be referenced, in the future, by those interested in multisectoral and cross-cutting solutions. However, we again affirm that this report should ***not*** **be treated as an authoritative document** ***nor*** **as a prescriptive set of consensus recommendations**. Rather, this document should be considered a summary of workshop discussions, where, given a specific contextual setup and subsequent exchanges across sectors, areas of common ground began to emerge across sectors for further dialogue and exploration.



Cross-Cutting Insights

Cross-Cutting Insights

Throughout the workshop, discussions resulted in an exchange of ideas across sectors, illustrating possible areas of commonality (though not necessarily consensus) across sectors. Overall, these areas of alignment emerged in three ways:

1. **Shared Hopes:** The workshop began with a presentation of key findings from the pre-workshop survey. One of the survey questions asked participants to identify their hopes for the future of oceans and seafood. This generated several key themes, and workshop discussion was built around these themes.
2. **Unifying Concepts:** Across the three days of the workshop, participants expressed sentiments about what mattered most to them in their oceans-related work. In many cases, these sentiments were shared by multiple stakeholders across sectors. We synthesized these sentiments into thematic "unifying concepts" and presented these concepts to workshop participants on Day 3. Overall, participants expressed that these unifying concepts resonated with them.
3. **Scenario Planning Exercise Insights:** Discussions around the hypothetical aquaculture operations fostered a sense of shared exploration around sector interests and needs and solutions-oriented discussion about meeting such interests and needs. Participants were able to hear one another in a forum designed for cross-sectoral learning, fostering understanding of new perspectives, and identifying potential solutions to key challenges. Several insights emerged from these discussions, as detailed below.

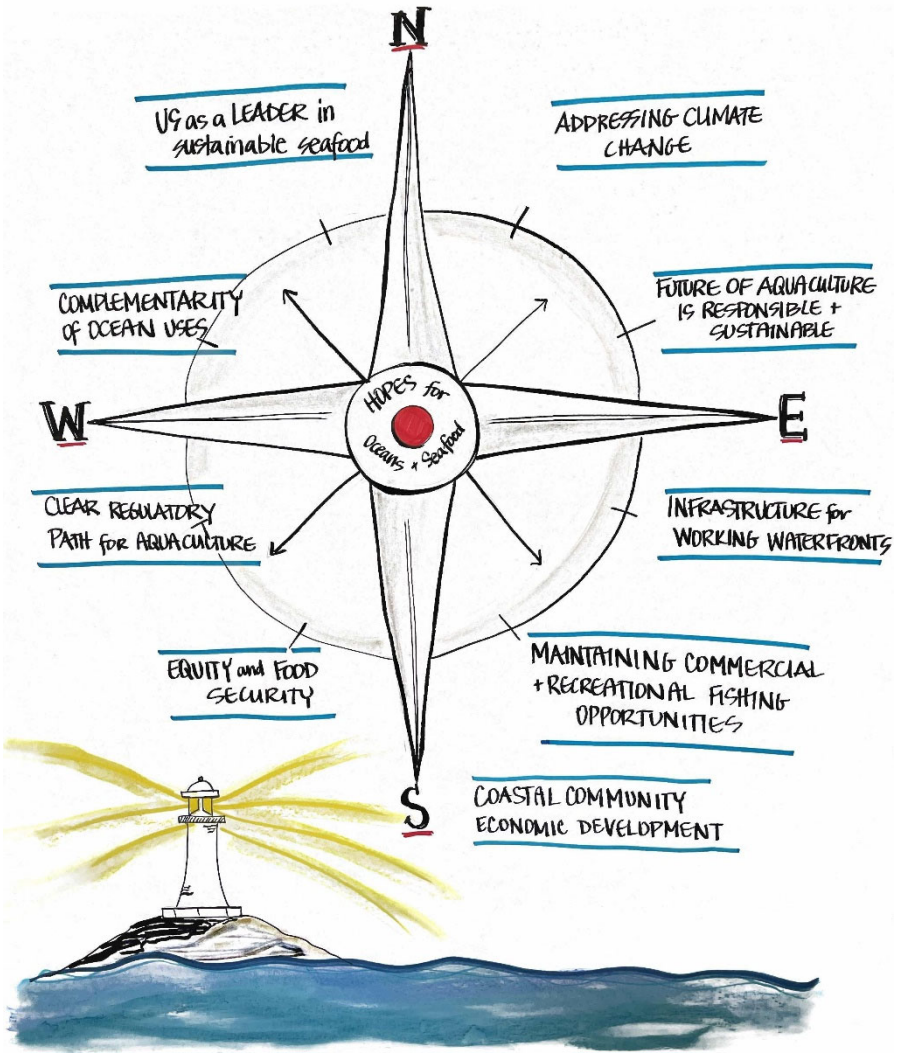


Figure 2: Shared Hopes, identified through the pre-workshop survey and discussion.

Shared Hopes & Unifying Concepts for the Future of Oceans and Seafood

Results from the pre-workshop survey laid the groundwork for workshop discussions focused on interests, sentiments, and needs that participants have in common, rather than their differences. The survey results and workshop discussions informed the development of two graphics, respectively: (1) a set of "shared hopes" for the future of oceans and seafood, and (2) a set of "unifying concepts" that workshop participants identified as being important in their ocean-based work. Collectively, these two graphics provide a compass and a lighthouse that can help "guide" multisectoral engagement around the future of U.S. marine aquaculture.

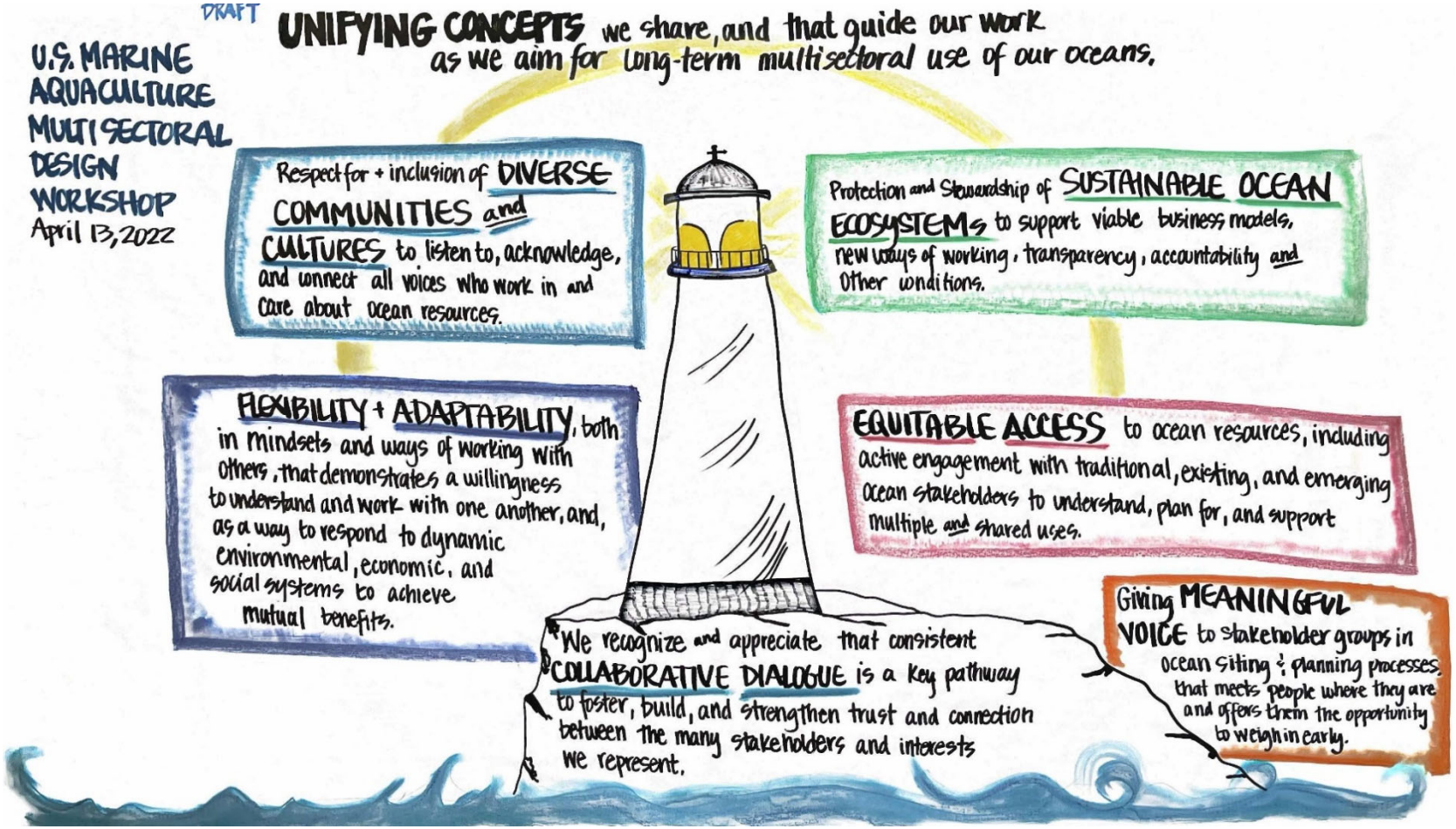


Figure 3: Unifying Concepts, identified through workshop discussions.

Additional cross-sectoral themes that emerged from workshop discussions and focused on commonalities included:

- The importance of giving meaningful voice to stakeholder groups in ocean siting and planning processes, meeting people "where they are at" and offering them the opportunity to weigh in early.
- The range of perspectives on and elements of sustainability, across sectors. Participants noted that sustainability can be broadly defined and is often subjective, such that a comprehensive definition would be helpful. Aspects of sustainability discussed include:
  - Access to, and affordability of seafood products for consumers
  - Profitability for farmers and fishermen
  - Environmental health
  - Cultural respect and honoring local values and a sense of place
  - Diversity, equity, and inclusion in the workforce
  - Utilizing advanced technology
  - Iteration/adaptability over time
- Ensuring that planning for coastal communities accounts for the range of impacts resulting from an economic development strategy.
- Finding ways to ensure that all people can benefit from economic opportunities in the seafood industry and have access to affordable, healthy seafood. This includes embracing multiple value systems and relationships to food, including cultural significance and subsistence — and considering these value systems in concert with one another.
- Emphasis on the importance of striving for complementary and cooperative existence among ocean uses, with an acknowledgment of tradeoffs between uses during decision-making processes.
- An understanding that none of the unifying concepts are static and that it will be necessary to create metrics to measure progress towards shared values and goals over time. This also creates opportunity for continuous improvement.
- Acknowledging that deployment of unifying concepts to achieve shared hopes can create benefits for multiple sectors at once. For example, a clear regulatory pathway could create value for multiple sectors (including commercial fishing, recreational fishing, and aquaculture) by:
  - Providing clarity and consistency on achieving meaningful and transparent community engagement;
  - Creating accountability for environmental impacts; and
  - Advancing complementarity between wild and farmed seafood by providing certainty and consistency.

These insights were referenced throughout the workshop and are present, thematically, in possible solutions identified later in the report (see the "Opportunities for Collaborative Solution-Building" section).

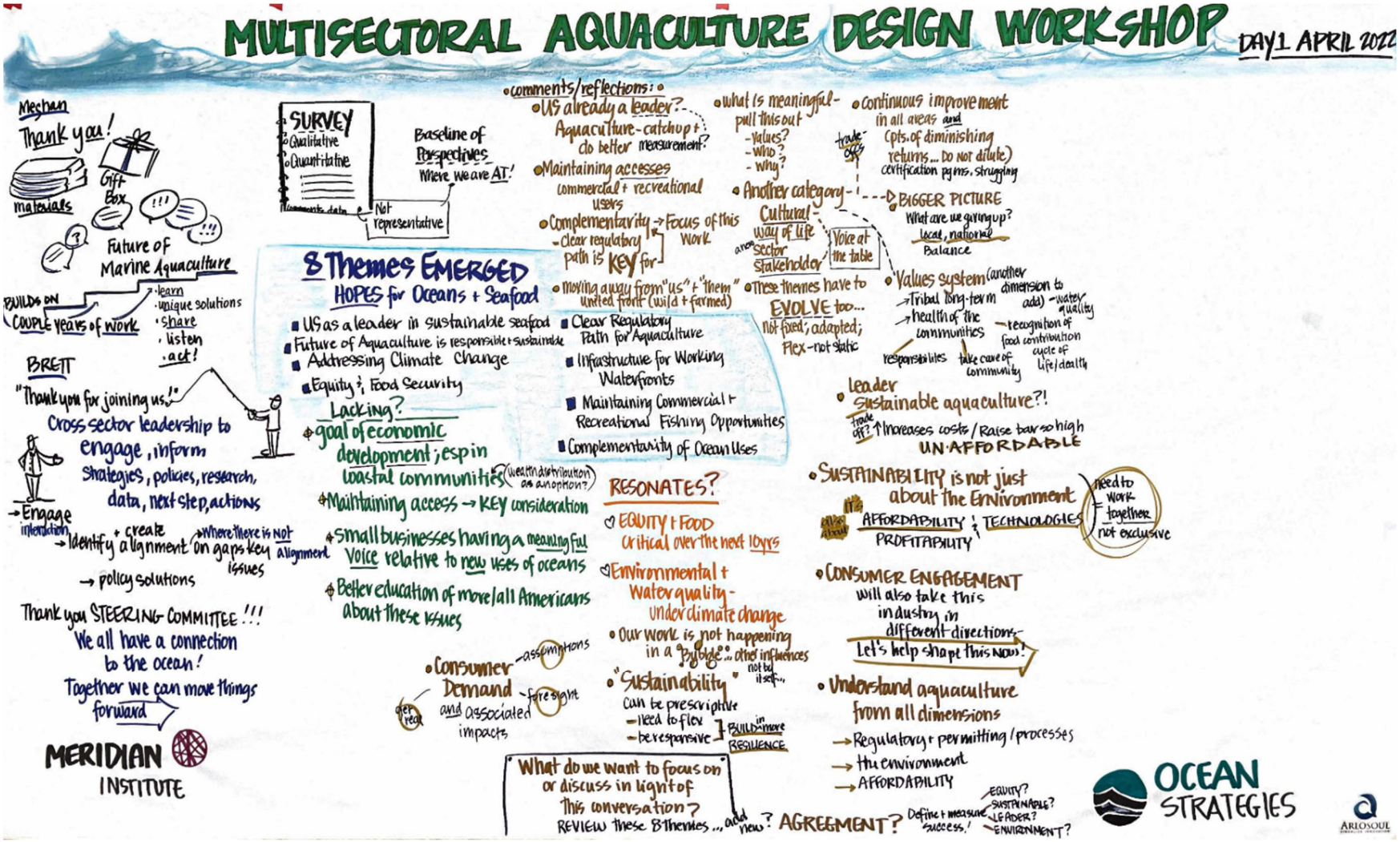


Figure 4: Example of dynamic graphic capture from workshop discussions. This graphic illustrates discussions from workshop Day 1 and notes common hopes and values.

Scenario Planning Insights

Scenario Planning Insights

The scenario planning part of the workshop featured four *hypothetical* scenarios intended to prompt discussion around the interests of different stakeholder groups in relation to U.S. marine aquaculture development. Each scenario included a proposed aquaculture farm — finfish or shellfish and seaweed, and either nearshore or offshore — and varied information about location, farm infrastructure, other existing ocean uses, and nearby community. The goal of these exercises was not to educate participants on aquaculture operations but rather to foster dialogue across sectors to help participants better understand and appreciate the viewpoints of each other. For additional details on the scenario planning exercises, see Appendix B.

These exercises created space for different ocean stakeholders to share a range of interests and concerns about the hypothetical aquaculture operations. The exercises also made space for constructive conversations about what interventions or research could meet stakeholder interests and mitigate stakeholder concerns. Participants found the structured exercise to be an illuminating way to learn from one another and exchange perspectives. An extensive compilation of ideas, challenges, and solutions raised by workshop participants during the scenario exercises can be found in Appendix A.

Summary of Issues and Opportunities Raised During Scenario Exercise Discussions

The scenario exercises invited participants to reflect on how the hypothetical aquaculture operation would impact the local community in terms of environmental, economic, and social opportunities and costs. Participants shared a range of insights, including issues they thought should be addressed and opportunities for collaboration, research, or solution-building to address the concerns raised. Listed below are the key issues that emerged through discussion, categorized as environmental, economic, or social topics.

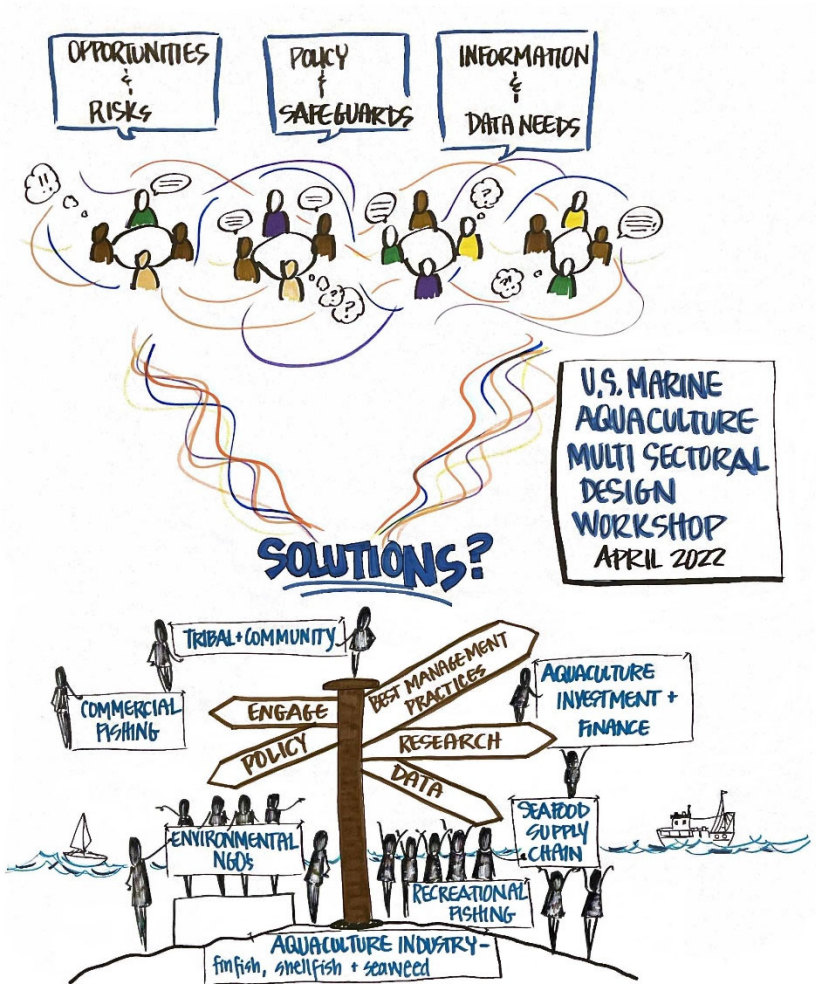


Figure 5: Graphic Representation of Scenario Planning Exercise

Table 1: High-level list of issues and opportunities raised through discussion of hypothetical scenarios. See Appendix A for more detail and corresponding solution ideas.

Environmental & Siting Dynamics

Interaction with Other Ocean Uses	• Interactions between aquaculture and commercial and recreational fishing • Stakeholder capacity to engage. • Transparency in farm planning and permitting • Clarifying cumulative impacts of multiple ocean uses
Water Quality	• Surface runoff can contaminate nearshore shellfish production • Positive water quality, carbon sequestration, and/or ocean acidification mitigation benefits of shellfish and seaweed aquaculture • Risk of over promising the benefits of shellfish and seaweed aquaculture • Impacts of antibiotics use in finfish aquaculture • Excess nutrients (feed and fish waste) from finfish aquaculture
Species Selection and Seed/Stock Sourcing	• Genetic risks with nonnative species • Genetic risks with native species • Augmenting wild fish stocks
Impacts of Farm Infrastructure	• Storm preparedness, marine debris, and farm decommissioning • Habitat impacts • Habitat creation • Noise pollution
Interactions with Other Animals	• Mitigating the impacts to protected species from multiple sectors • Interactions with marine mammals • Interactions with sea birds • Interactions with predators
Climate Changes and Food Production	• Climate-friendly way to meet growing protein needs • Impact of climate change on migratory patterns
Navigational Safety	• Potential for boat or gear collisions

Social Dynamics	
Engaging Local Communities	• Meaningful community engagement • Working with tribal governments • Aquaculture misinformation • "NIMBY"ism
Local Food Production and Community Connection to Seafood	• Increase the variety and volume of local food production • Community connection to seafood
Economic Dynamics	
Farm Economic Feasibility	• Understanding the characteristics of an economically viable farm • Permit processes and permit lengths must consider economic viability
Economics of Species Selection and Market Competition with Wild-Caught Seafood	• Impacts to seafood market dynamics and livelihoods • Species selection and market dynamics
Building Seafood Infrastructure and Working Waterfront Resilience	• Improving seafood infrastructure overall (e.g., docks and ports, seafood processing, and ground transportation) • Investing in the resilience of working waterfronts • Hatchery opportunities • Voice and influence of the seafood industry
Workforce Development	• Opportunity for new seafood job creation • Need for workforce development training • Seasonal opportunities for fishermen • High cost of entry • Community input on job creation
Community Economic Development	• Economic development zones • Lost U.S. investment opportunities • Ecotourism opportunities

Themes from Scenario Exercise Discussions

Discussions during the scenario exercises helped participants understand one another and identify solutions to shared issues in environmental, social, and economic realms. They also illustrated a range of cross-cutting insights on what aspects of seafood farming and planning are important to stakeholders. This exercise did not result in, nor was it designed to build consensus opinions on these issues. Rather it was designed to identify and document the range of perspectives among stakeholder groups, based on their current perspective and knowledge base. More importantly, the discussion allowed participants to learn from and, in many cases, appreciate or at least acknowledge the perspectives of other stakeholder groups.

Below is a summary of key insights that illustrate general themes but do not indicate agreement across all perspectives.

TYPE OF AQUACULTURE

There were fewer concerns about shellfish and seaweed farming than finfish. Participants recognized that shellfish and seaweed farming could provide net environmental benefits, such as improving water quality, but may also disrupt navigation and fishing access depending on how farms are designed. Finfish discussions had a more hypothetical tone, raising questions rather than clearly identifying solutions, whereas discussion on shellfish and seaweed aquaculture started from a place of getting the details right, rather than outright opposition. In both cases, local context was important in shaping perception.

Participants expressed a range of perspectives on species selection for finfish farms. The table below weighs the potential benefits and impacts of aquaculture farming of native versus nonnative species, and commercial target species versus non-target species.

Table 2: Range of Stakeholder Perspectives on Finfish Aquaculture Species Selection

Species Type	Positive Perceptions from Participants	Concerns from Participants
Native finfish species	Some participants thought that farming native species may create opportunities for cultural connection. Others added that farming native finfish species may create opportunities to augment local wild populations that are commercially or recreationally fished. This is done in some places in Alaska, where some farmed species are intentionally released to supplement wild fish populations.	Some participants expressed concern that the escape of hatchery-raised native species may pose the risk of interbreeding between farmed and wild populations, which might result in negative genetic impacts within wild populations. This is particularly the case for species that require high genetic integrity.
Nonnative finfish species	Some thought that farming nonnative fish species would increase the variety of local food production in an area.	Some sectors were concerned that introducing nonnative species to marine environments may results in broad ecological impacts that could impact ecosystem dynamics and commercial fisheries.
Commercially fished species	There was discussion among participants about how aquaculture of commercially fished species would impact domestic seafood prices. Some participants thought that aquaculture of popular commercial species might create price reduction for consumers due to increased supply of commercially targeted species. However, other participants pointed to research that price reductions due to an increased supply of seafood from aquaculture are short lived, and the biggest impact of aquaculture products on wild harvested products is an increase in demand driven by more consistent availability and often higher product quality. If the commercially fished species is only harvested seasonally, the farm may be able to augment with year-round production and increase the consistency of supply, desirability, and price of the species overall.	Some sectors expressed concern that increased supply of an already commercially available species may decrease the price of the species overall, negatively impacting both fishermen and farmers and reducing profitability due to reduced prices for consumers. If the impact is severe, some were concerned that aquaculture could have cultural impacts by altering fishing communities, including associated shoreside businesses.

	It was also noted that aquaculture products may be in more direct competition with imported seafood products than local wild-caught species. U.S. aquaculture may find it difficult to compete with imports given the vast array of competitive advantages imports enjoy due to lower production standards and resulting lower unit cost of production. This is a common threat that aquaculture shares with commercial fishers.	
Not commercially fished species	Some participants pointed out that farming non-commercially fished species would potentially create less direct competition with commercial fishermen.	Others pointed out that, to farm non-target species, companies would need to invest substantially in developing a new market, which increases overall costs and decreases the economic viability of the farm.

DISTANCE FROM SHORE

We constructed the scenarios as being located nearshore (within a mile of shore) or offshore (10 miles offshore) and were therefore able to identify a few key considerations regarding distance from shore. Overall, participants varied on preferences for either nearshore or offshore development. Perspectives were informed by complex discussions of interrelated variables (e.g., experience of farmer, type of aquaculture, characteristics of site). However, one consistent observation was that moving offshore (and specifically as far offshore as 10 miles) presents significant challenges, including some concerns that we may not yet have the technology to reliably farm in a high-energy, open-water environment (although offshore farms do exist in several cases). Several dynamics were noted, including:

- Monitoring would likely be easier in the nearshore environment, and nearshore farms can be accessed more quickly to respond to any challenges or disasters. There were questions about the feasibility and reliability of environmental and structural monitoring technology offshore – i.e., whether it would hold up in high energy environments, transmit data to shore reliably, and be cost effective.
- There were questions about what scale of farm is required to be economically viable in offshore environments, given the higher cost of engineering and operations. Some participants were concerned that we may not really have the technology to move as far offshore as the scenarios suggested (10 miles offshore).
- Establishing aquaculture farms further offshore can mitigate some environmental impacts and user-group conflicts (e.g., more space, less impacts on water quality and substrate).

FARM SCALE

Scale of the farm came up in several ways including economic feasibility/viability, level of community outreach/engagement, level of effort and potential burdens on small farmers/new entrants with small farms, and size and number of farms in a given area relating to cumulative impacts. The following points were discussed.

- Larger farms may have more negative connotations in the public/community's mind, at least initially.
- Planning requirements should balance creating safeguards and accountability with efficiency to ensure that small and historically disadvantaged actors can be involved in the aquaculture industry. The extent of requirements for community engagement and environmental performance (either through regulations, certifications, or best practices) may need to be flexible based on the scale of the farm and likelihood of impacts. If the farm is a small, family-owned enterprise, they may not be able to compete at the same level as larger corporations with more experience and resources.
- Furthermore, communities may prefer smaller farms with local developers, meaning we want to avoid creating large regulatory or cost barriers to entering the industry. Ensuring that requirements to enter the industry are scaled so as not to be overly prohibitive would create additional opportunities for new entrants into aquaculture, especially for communities that have historically had less access to seafood businesses. In addition, if the permitting and community engagement process is too extensive, that may exclude many non-aquaculture ocean stakeholders from engaging in the process. For these reasons, there needs to be a balance in planning requirements between caution/process requirements and efficiency.
- It was also pointed out that farms must be large enough to generate enough revenue to allow farmers to pay for environmental monitoring and technologies to reduce farm impacts. Smaller farms may have greater environmental impacts than larger farms in some cases because they cannot afford the same management tools.
- One way to address the issues of scale is to treat initial pilot projects differently than larger projects and use a pilot process for iteration to get to a commercial scale farm. A predictable stepwise process with clear stages would be essential to securing financing if pilots are to be used. That is, a pilot process could also explore ways to provide a property right more clearly to aid in securing financing.
- In the offshore environment, larger scale production may be required to be economically viable.
- There is a need to start thinking not only at the individual farm level, but more holistically about the use of ocean space in a given geographic area and how many farms that might support over time, including potential interactions among farms or cumulative impacts.

NEARBY COMMUNITY AND STAKEHOLDER ENGAGEMENT

We also varied characteristics of the nearby community, either being an urban environment or a rural environment. Some observations related to nearby community included:

- Urban community – Greater likelihood there is the existing workforce needed to staff the farm and the better transportation and processing infrastructure already in existence.
- Rural community – Greater potential for farm development to positively impact the community, particularly if workforce training programs and infrastructure are intentionally developed alongside the farm.

Regardless of community type, the importance of engaging with local community members and ocean users proactively and effectively was stressed in all cases. Participants reflected on the importance of community support for local aquaculture

development as well as proactive ways to engage with communities, provide education, and develop support for seafood.

Many participants emphasized the critical importance of potential aquaculture farm operators engaging the local community and other ocean sectors early and often to solicit feedback on a broad range of topics. Multiple sectors advised that companies should strive for transparency in communication and direct community engagement, above and beyond the existing permitting process requirements. Some sectors advised that companies should work to create communication avenues that are systematic and equitable rather than ad hoc; meet user groups where they are and utilize existing, trusted forums where possible to create efficiencies (e.g., regional fishery management councils, local industry groups and forums, etc.); and share data transparently during construction and operation of a farm. Participants also noted that companies should prioritize building long-term relationships with local tribal governments at the outset of farm development.

Several sectors pointed out that it can be challenging for aquaculture operators to engage in this level of outreach and transparency because it creates opportunities for public criticism, attack, and stalling the already-slow permitting and regulatory process. For example, some participants questioned how much decisions on farm economics and dynamics should be influenced by local stakeholders. Participants raised the need to identify ways to build both meaningful one-on-one interactions and multisector venues where different ocean sectors can come together to discuss the full range of issues affecting the ocean (e.g., ocean restoration, plastics, marine debris, climate change, etc.). These spaces are needed apart from public forums and hearings, where constructive dialogue is not always possible. However, there was uncertainty about how to create a venue that is collaborative and avoids defensive rhetoric.

The following ideas and suggestions for community engagement were raised by the participants:

- Working with local fishing groups to consider appropriate compensation if losses occur to local fish stocks due to aquaculture, which could include things like building other infrastructure to alleviate those losses (e.g., a pier or boat ramp).
- Sharing information about aquaculture permitting and leasing, including transparency on data/analysis used to site and permit the farm, what requirements must be met for environmental performance, and what activities could cause a lease or permit to be revoked.
- Allowing the local community to get to know the farm through tours or live video feeds.
- Involving citizen scientists in on-farm monitoring.
- Engaging with the community to increase familiarity with seafood and ensure/increase access to local seafood sources.
- Being clear in scoping/engagement conversations about the scale and longevity of jobs in communities, including work that is seasonal versus year-round. Ensuring that the community is qualified for/wants the types of jobs that come with the project to ensure that economic benefits remain local.

ADDITIONAL SITING CONTEXT AND INSIGHTS ON NOAA'S AQUACULTURE OPPORTUNITY AREAS

While it was valuable to have a dynamic conversation about hypotheticals, throughout the exercise participants remarked on key local details they thought would be essential to understand in the real world (e.g., exact environmental/ocean user data specific to a site). Participants largely thought the analysis done to examine

potential conflicts through NOAA's Aquaculture Opportunity Area (AOA) process does alleviate many concerns, but finer scale information on site characteristics is needed to make specific decisions — such as farm location and orientation, as well as monitoring and mitigation needs. Participants recognized that existing regulations do accomplish some of this. However, perspectives on the effectiveness of existing regulatory requirements varied among participants.

There was further discussion of the fact that aquaculture development is happening within a dynamic ocean system with environmental change and other ocean uses. It was suggested that more comprehensive thinking and planning would help to account for the impacts of multiple farms in an area, as well as other new ocean uses like offshore wind development. Several participants noted that the interactions between planning for offshore wind and planning for aquaculture were not clear and that a more consistent approach to ocean space overall would be better for engagement of stakeholder communities.

Stakeholders generally voiced praise and support for NOAA's AOA process, noting that it is well-regarded as being rigorous, science-based, and informed by stakeholder input. In addition to general support, the following points were raised for how the AOA process could be improved:

- There is some concern among the commercial and recreational fishing communities that NOAA's AOA process does not have precise data to account for current and historic fishing grounds. For example, in the Gulf AOA, two of the nine suitability areas are in locations with historically high shrimp fishing. Some participants recommended that those working to site aquaculture facilities should sit down with fishermen to look at a precise map of their catch per unit to determine areas of highest value to fishermen that should be avoided. There was also concern by some that aquaculture facilities might aggregate wild fish stocks in areas that are no longer accessible to fishermen, which was flagged for further investigation.
- Siting processes should focus on protecting critical fisheries habitat, not "essential fish habitat" (EFH). EFH can be too all-encompassing and restrictive to be meaningful.
- There is concern that the AOA process includes limited data for endangered species and is not necessarily accurate enough to minimize entanglement risk.
- There is some concern that current processes to identify sites suitable for aquaculture in the U.S. do not account for how climate change will affect wild species' migratory patterns. When and if marine species' range shifts occur as a result of climate change and ocean warming, there could be unanticipated conflicts and interactions with aquaculture farms. Accordingly, some see a need to integrate climate change predictions into NOAA's AOA process. However, others note that climate dynamics are hard to predict, and impacts on wild stock migration patterns from climate change are even more challenging, making this another potential hurdle for the aquaculture industry.
- Some stakeholders voiced that it is unclear how effective NOAA's AOA process is at addressing concerns about the potential for boat or gear collisions with aquaculture facilities if farms are not properly marked for navigational safety. Others noted that nearshore and offshore farms must acquire and abide by the US Coast Guard regulations informing a Private Aids to Navigation Permit for appropriate marking by lights and signs.

RESEARCH OPPORTUNITIES AND THE ROLE OF PILOT PROJECTS

As part of the scenario exercise, participants were asked to share perspectives on what information gaps currently exist related to aquaculture development and what studies are needed to address areas of uncertainty. Participants expressed a range of opinions about whether the state of the science and marine spatial planning efforts are currently sufficient to sustainably site and operate aquaculture farms. Some participants felt there was still significant uncertainty related to how aquaculture farms would impact marine environments, what mitigation strategies are available, and whether farm infrastructure could withstand ocean conditions. However, other participants countered that there are significant bodies of research and evidence about marine aquaculture that are just not well understood by or clearly communicated to many sectors and communities.

Participants discussed the role of pilots in both addressing areas of uncertainty around aquaculture and/or as part of a stepwise permitting process. Incorporating pilots into a permitting process could allow companies to gain permits for commercial scale areas but begin with smaller pilot farms to test whether the location and farm type is viable before scaling up. Some sectors were most comfortable with starting aquaculture operations at a small or pilot scale and allowing them to grow over time as the benefits and impacts of marine aquaculture are better understood. Others did not think that pilots were necessary, given their perspective that the existing regulatory process is sufficiently navigable and concerns that creating new procedures could introduce confusion.

Participants suggested that aquaculture pilot projects could be used to answer key questions and collect data on a range of different farm interactions and dynamics, including:

- Gathering data to show the impacts of an individual farm or multiple farms on water quality.
- Identifying and researching materials/designs that are proven to withstand wind and wave action.
- Assessing the potential for fish aggregation around aquaculture infrastructure, including the potential for predator aggregation (seabirds, sharks).
- Predicting impacts of commercial scale projects on protected species in the area.
- Verifying the market demand for aquaculture products.

While these needs were identified by some participants, others suggested that there was already an abundance of sound science that is available to address these questions. Participants also raised several research questions and opportunities that would not necessarily be addressed through pilots but could create other opportunities for collaborating between aquaculture companies, local universities, NGOs, and fish and wildlife agencies. These opportunities included:

- Developing transparent, publicly available benchmarking studies that can be used to determine whether an aquaculture farm is viable.
- Assessing lessons learned from other countries with well-developed aquaculture industries (e.g., Norway, Mexico, Chile, China, etc.) to inform U.S. regulations and reforms.
- Conducting market analyses to determine the impacts of increasing domestic farmed seafood production on wild-caught seafood markets. Analysis should explicitly consider the species type, whether it is commercially fished or not, and the seasonality (or not) of the aquaculture production.

- Creating flow models to assess whether dispersal of any excess nutrients will be sufficient.
- Improving data on commercial and recreational fishing uses.
- Researching genetic selection to domesticate farmed species, including research programs and consortia to develop and distribute local seed and brood stock.
- Creating ongoing research and monitoring programs to track the impact of aquaculture farms on wild species over time.

COMPANY CHARACTERISTICS AND THE ROLE OF CERTIFICATIONS AND RATINGS

Participants reacted to details in the scenarios around company age, experience level, and anticipated job creation, as well as their approach to sustainability. In general, participants felt that prior experience building farms was important. Even more important was knowledge of and familiarity with the local community and context; all the better if companies have a history in an area. In terms of staffing aquaculture farms, participants emphasized that companies should make every effort to hire and train staff locally, while balancing the need to bring in some expert outsiders with experience in farm operation and management. Perception of "outsiders" coming in is generally seen less favorably.

Another key element affecting perceptions of the company was whether and how they were pursuing sustainability certifications. Certifications are a service product provided to suppliers by businesses whose standards are held confidential. Certifications and ratings have largely been adopted in the US for seafood because of the significant amount of imported seafood products. Suppliers select which certification they think will assure their customers of a high level of environmental and/or social conduct commiserate with US regulations and norms. However, some aquaculture practitioners point out that US produced farmed seafood does not need certifications due to the high regulatory standards in the US. Still, different sectors and communities are interested in individual farms' operational practices and would like to better understand what the "gold standard" of best management practices looks like. Certifications help both companies and consumers understand what sustainable aquaculture means and can help companies go above and beyond regulatory requirements for sustainability.

Many felt that having certifications and ratings added value and certainty to aquaculture projects. However, others noted that certifications are ultimately optional and, where safeguards and best practices are needed, they should be enshrined in regulations.

Although certifications and ratings are ultimately optional, many seafood buyers are beginning to require them to purchase product. This can create challenges for smaller farmers, who may be asked to secure multiple certifications to satisfy different customers. The cost of going through certification and complying with audits can be difficult for small farms. As a result, some aquaculture industry groups are pushing for equivalency between certification programs and consolidation around auditing. It is also notable that sustainability certifications are sometimes limited to assessing individual farm sustainability and do not assess the cumulative impacts of all the aquaculture farms in a specific area.

SEAFOOD ECONOMIC AND MARKET DYNAMICS

Across the scenario exercises, many groups considered the market dynamics of increasing seafood production of domestic aquaculture, and the potential impacts such increased production would have on the wild-caught seafood sector. There is concern that increasing domestic aquaculture production would flood local seafood supplies, driving down the price of wild-caught seafood and putting commercial fishermen out of business. Other participants pointed out that wild catch volumes previously were far higher than current

levels, so aquaculture product would perhaps just be filling the current deficit. Other sectors speculate that increasing the consistency of domestic seafood supply for some species may stabilize or increase the price point of the product by increasing the consistency of supply, and therefore awareness and desirability of the species overall. Some sectors perceived aquaculture products as in direct competition with wild-caught seafood products, while other sectors pointed out that aquaculture products may be in more direct competition with imported, farmed seafood products. This concern is most important for finfish aquaculture and not as pressing for shellfish or seaweed aquaculture. It was also pointed out that recreational fishing has an important role in providing sustainable, domestic seafood and cultivating interest in seafood, particularly when introduced at a young age.

Some participants noted that coexistence of farmed and wild salmon in the marketplace today exemplifies how aquaculture production can increase the popularity of a seafood species and make the wild product more profitable. However, it was also mentioned that there is a need to recognize the negative impacts and dramatic price drop that farmed salmon created in wild markets when it was introduced, and the subsequent negative impacts on commercial fishermen.

To better understand how finfish aquaculture production would affect markets for wild-caught seafood, and how species selection influences these market factors, some participants advocated for commissioning more economic studies and market analyses. Participants also noted that such studies and analyses could explore the scales and types of farms that would be economically viable in the marine environment, and interactions therein with the existing seafood market.

Opportunities for Collaborative Solution-Building

Opportunities for Collaborative Solution-Building

During the third session of the workshop, participants engaged in a small group exercise to develop collaborative solutions to address one of six opportunities related to aquaculture development that were identified earlier in the workshop. These included:

- Engagement and collaboration among ocean sectors
- Regulatory reform (in federal waters)
- Building domestic seafood infrastructure
- Economic development and community engagement
- Public education, outreach, and communications on Seafood
- Addressing economic and environmental research needs

While the solutions presented below do not represent all viewpoints, nor the full consensus of workshop participants, they do indicate potential opportunities to address the needs of multiple sectors. Each of these topics is complex and will require further engagement (including additional knowledge and experience) to flesh out exact details and viable pathways to solutions. Some of these topics (e.g., marketing, regulatory reform) are also being addressed, to varying degrees, by other organizations and initiatives. The results below reflect a brief but focused discussion on these topics among stakeholders with varying degrees of knowledge and expertise. For a full list of challenges and corresponding solutions raised at the workshop, please reference Appendix A.

Figure 6: Opportunities for Collaborative Solution Building identified during workshop discussion, building on themes identified in the scenario exercises.

ENGAGEMENT AND COLLABORATION AMONG OCEAN SECTORS

The group discussed ways to create forums for meaningful engagement among ocean sectors to build relationships, foster cross-sectoral communication, and advance solutions-oriented thinking.

Possible Solution Idea: Community or regional roundtables

One solution idea raised was to create non-project specific, community or regional roundtables that allow sectors to come together to hold cross-cutting ocean planning and visioning discussions. These roundtables could take place (or be tested) in locations where aquaculture is actively occurring or has the potential to occur (e.g., Maine, communities near NOAA's AOA locations). Stakeholders often feel that project-based discussions happen so late in a farm development process that stakeholder input is not meaningfully accounted for; as such, project-based discussions are not set up to build cross-sector relationships. An alternative, therefore, is to create proactive conversational spaces where multiple sectors within a specific geography come together to identify community priorities for ocean use (e.g., workforce goals, engagement standards, community education) and learn about one another's sense of caring for (and day-to-day use of) the ocean. The output of these conversations would be a community plan, which would act as motivator to bring stakeholders to the table.

Idea Execution: The roundtables would be community-driven, and could be held by trusted entities (e.g., local NGOs or universities) and/or a neutral convenor, if the community so desires. The roundtables would *not* be led by groups with a clear stake in the outcome (e.g., interest, advocacy, or industry groups) *nor* by existing oversight bodies or entities (e.g., fisheries councils, regulators). Funding should come from non-governmental sources to avoid concerns about restrictive public processes. Budgets for this work should include compensation for people's time, as time, patience, and understanding are important resources for the process. The roundtables would involve solutions-oriented participants, aiming for a "reasonable-middle" discussion that is mindful of the need to include multiple perspectives.

To meet the needs of multiple communities, roundtables would consider the following:

- Building in process and outcome accountability from the start, to establish trust. Being transparent from the outset about how information/outcomes can be used.
- Identifying/working from commonalities, rather than setting up discussions in "win-lose" terms to avoid putting participants into default defensive positions.
- Ensure that any knowledge gaps are acknowledged. Attempt to fill those gaps, as possible and approach this in a way that considers both western science and traditional/historical knowledge from tribal communities and ocean stakeholders.
- Ensure the process has a foundation of cultural awareness for the place and the resources under consideration — and what those elements mean to different groups.

A secondary solution idea that emerged from the group was to build community exchanges: small-scale spaces where people can learn firsthand about another's life experience (particularly from someone who holds a different viewpoint). For example, fishermen and farmers could visit one another and step into each other's day-to-day to learn more about each other's challenges and successes.

ECONOMIC DEVELOPMENT AND COMMUNITY ENGAGEMENT

The group discussed how to create mechanisms that ensure people have a voice in, and benefit from, aquaculture development in their communities.

Possible Solution Idea: Create a "best practices" guide for engaging communities and stakeholders on aquaculture permitting

This solution idea raised was to develop a guide for aquaculture companies and practitioners that outlines how best to engage communities and other stakeholders in the permitting process for a new marine aquaculture operation. Such a resource has great value, given that engagement is neither intuitive nor easily learned through formal education. This guide could outline:

- How to assess a community's economic and social characteristics to inform best engagement practices (e.g., Is there a need for a community advisory board? Can you leverage existing state resources or processes?).
- Specific engagement strategies (e.g., working with trusted community leaders, carrying out face-to-face outreach, utilizing access aids to reach diverse audiences, enhancing transparency).
- Guidance about how different sectors would like to be engaged in, and provide input to, a permitting process.
- How to develop partnerships to assist with engagement (e.g., local colleges).
- How to develop a clear, accurate, and understandable "pitch" for what your company can bring to the community.

Idea Execution: The drafting of this guide could be led by one or more entities, including NGOs, Sea Grant, NOAA, and/or state agencies with an interest in economic development. Developing the content for the guide could be advised by a cross-sectoral steering committee that could review (but not write) the guide. Aquaculture farmers could contribute "lessons learned", based on experience with permitting. The guide could be a living document and posted to an online platform where it would be updated over the long term.

To ensure success, the following elements should be considered:

- Funding is needed to write the guide and host this guide on a permanent online platform. NOAA could possibly help with this.
- A cross-sector advisory committee would need to be formed to provide sector-specific input to the guide (including differing engagement strategies). While this committee can provide valuable input and review the guide, committee members cannot realistically be asked to draft sections of the guide.
- Sector engagement (beyond the advisory committee) is necessary to verify and get feedback on guide content. Given bandwidth issues in various sectors, sector engagement will likely need to go through local or regional associations.
- Possibly expanding the scope of the guide beyond just aquaculture development to focus on more cross-cutting frames like working waterfronts and/or seafood supply chain engagement could result in broader sectoral engagement in the creation of the guide.
- The guide should have a clear scope in terms of content it will cover, for what audience, and to what extent. The guide cannot be "everything to everyone." As such, there may need to be state- or region-specific supplements/addenda to the guide.
- Both information collection for, and distribution of, the guide can leverage the virtual environment. For instance, stakeholder input can be collected via video interviews, and best practices can be conveyed through video tutorials.

BUILDING DOMESTIC SEAFOOD INFRASTRUCTURE

The group discussed avenues to catalyze investments in seafood infrastructure that can benefit both wild and farmed seafood producers. “Infrastructure” was defined broadly and was inclusive of shoreside facilities, transportation/distribution infrastructure, and information infrastructure

Possible Solution Idea: Revitalize working waterfront infrastructure holistically

The solution idea raised was to build out shoreside, transportation, workforce, and green infrastructure to meet the needs of both wild-harvest fishermen and aquaculture operations. Communities ripe for such development would be those where capacity (particularly processor capacity) is already present. Infrastructure investments could focus on both utilizing and broadening this capacity (e.g., building a new processing facility) and developing new technologies. As shoreside infrastructure is developed, transportation infrastructure could also be scaled (e.g., providing sufficient roads and access) to support the needs of the working waterfront. There could also be a focus on building out workforce infrastructure, determining labor needs, and creating year-round employment opportunities. The community could also expand green infrastructure, including alternative energy sources, to enhance community resilience in the face of storms and climate change.

Idea Execution: The process could start with NGOs coordinating a needs assessment for a waterfront community to determine what infrastructure developments are needed. This should be based on community and developer interest in and priorities for the future of the blue economy, including aquaculture, commercial fishing, and other needs. Based on this evaluation, key stakeholders (including private sector entities) would be pulled in to develop a plan. State and federal government entities could provide funding to assist with both the planning process and infrastructure development (including, potentially, subsidies to build out a labor force).

To ensure success, the following elements should be considered:

- Planning must be based on a clear understanding of community needs (e.g., some communities may not find the jobs that come with infrastructure development attractive). Diverse community stakeholders should be involved to clearly outline the benefits they would like realized through investment.
- Planning and executing investments would likely benefit from collaborative efforts across stakeholders. As such, there would ideally be agreements in place on how to work together to meet common objectives, considering market-driven realities.
- Private sector entities will need to “have skin in the game,” not just be passive recipients of grants. These entities should possess the experience and impetus to survive challenges and setbacks that will arise in community development processes.
- There are both funding opportunities and challenges. Federal or state legislation protecting working waterfronts could provide avenues for investment. Additionally, sustainability investors may look to fund resilience infrastructure. However, in some regions, state support is only triggered by disaster recovery.
- Investing in technology development could require strategic partnerships with local university researchers and entrepreneurs (e.g., via innovative technology competitions).
- The investment plan will need to outline mechanisms for ensuring that investment benefits remain in the community. This could include proactively engaging the public with the seafood industry and connecting investments to tourism and other waterfront development assets.

REGULATORY REFORM

The group discussed ideas to create a clear, efficient, and stepwise permitting process for aquaculture in federal waters with mechanisms for clear agency leadership, farm performance and accountability, data collection, and developing comprehensive best management practices for aquaculture, which are agreed upon through a collaborative process. Meeting participants pointed out a lack of clarity around what the best management standards are for the aquaculture industry, and inefficiencies in the permitting process due to lack of coordination between agencies. Due to limited time, discussion did not consider dynamics in state waters. ***Please note that these are preliminary ideas developed by a subset of the meeting participants, and do not reflect consensus. In reviewing this workshop summary, some participants expressed opposition to these ideas.***

Possible Solution Idea: The group discussed three potential complementary solutions to advance regulatory reform in a way that creates clear authorities and efficiencies, while ensuring environmental protection. These solutions would need to be advanced in concert to address the needs and interests of a wide range of stakeholders:

- A multistakeholder process to establish best management standards for aquaculture in federal waters, in collaboration with NOAA. Considering the history of U.S. leadership in fisheries management, this process could result in creating a set of global best practices for aquaculture.
- Legislation to designate NOAA as the lead agency for aquaculture permitting and to allocate funding for agency staffing, existing and future marine spatial planning efforts, and advancing engineering solutions.
- Expansion of U.S. marine spatial planning efforts to include cumulative impacts and multiple ocean industries and uses.

Idea Execution – A multistakeholder process to establish aquaculture best management practices could include:

- Collecting lessons learned from aquaculture activities, other government regulatory structures, and other relevant sectors (including land-based agriculture) globally to inform U.S. regulatory reforms. This could be a study conducted by the
- This process could consider environmental considerations; farm design and engineering; farm operations; processes to minimize ocean user conflicts; standards for community engagement; and creating a shared definition for sustainable aquaculture.
- Creating a clear set of national standards to facilitate ocean stewardship overall, not just for aquaculture.

Legislation could include the following elements:

- Mechanisms to efficiently coordinate federal agencies
- A quick and simple system for submitting permit applications, while not diluting the rigorous review of applications.
- Creating a pilot component for permitted farms to begin on a small scale and evaluate the site location before scaling up, including a path towards a clear property right for financing.
- Mechanisms for piloting farms, testing engineering solutions, and generating data to inform best management practices.
- Federal funding to advance engineering solutions and spatial planning for protected species. To inform allocations, it would be helpful to build a capacity needs map for NOAA to gather data, process permits, and evaluate aquaculture performance.
- Including aquaculture in marine spatial planning efforts that consider cumulative impacts and multiple ocean industries. Given success and buy-in to the extensive engagement and analysis embedded in the NOAA AOA process, additional planning could build on this value and incorporate finer-scale and forward-looking data on protected species.

PUBLIC EDUCATION, OUTREACH, AND COMMUNICATIONS ON SEAFOOD

The group discussed coordinated efforts to educate and connect Americans to seafood production and increase seafood consumption.

Possible Solution Idea: National marketing campaign to eat more domestic seafood

One solution idea would be to create a national campaign to encourage more *domestic* seafood consumption, educate consumers, and foster local and cultural connections to seafood. American consumers have a low level of awareness of the benefits from seafood (commercial, recreational, farmed, and subsistence) and many narratives about seafood contain misinformation or do not accurately represent domestic practices. A national marketing campaign could help shift these inaccurate narratives, bolster education and awareness of US seafood, and increase seafood consumption throughout the United States.

Idea Execution: The national marketing campaign could be crafted by the currently proposed national seafood promotion council, potentially drawing funds from Saltonstall-Kennedy Grants and taxes on seafood imports (estimated funds required: $10 million). This group could include representatives from working waterfronts, commercial fishing, aquaculture, and recreational fishing communities. To meet the needs of multiple sectors, the campaign could include collaborative dialogue across stakeholders with an interest in seafood.

Messaging could focus on celebrating seafood heritage and the importance of working waterfronts and be inclusive of multiple forms of seafood production (i.e., commercial, aquaculture, recreational, and subsistence). It could also focus on creating equitable access to seafood for people in all parts of the country (not just the coasts), embrace the value of varied diets, discuss how seafood can contribute to health, and build consumer understanding as a trusted resource to combat misinformation.

In short, the campaign could:

- Keep it positive — praise US seafood rather than attacking imports.
- Keep it simple — meet consumers where they are (including children), with recreational fishing as a potential gateway.
- Keep it realistic — focus on key messages that will resonate – eat American, resilient food systems, supporting working waterfronts.

ADDRESSING ECONOMIC AND ENVIRONMENTAL RESEARCH NEEDS

The group discussed ways to advance research and development on aquaculture.

Possible Solution Idea: Create a central forum for aquaculture information and research

One solution identified was to build a central web-based platform that increases accessibility, integrates existing data from multiple sources, and houses new information as it is generated. This could address the fact that research to inform aquaculture development is not readily available for a range of stakeholders. A broad array of data and information is needed (e.g., environmental baseline data, best practices, emerging research on newer questions around species and ecological interactions) to answer key questions. Creating a central platform can bridge sectoral blind spots in current research, while increasing accessibility to all stakeholders. It could be thought of as a "Wikipedia" for aquaculture.

The platform could further support the advancement of research and benefit multiple sectors by centralizing data and information from aquaculture relevant research and increasing transparency and access to data and benefits for multiple communities (including regulators).

Idea Execution: This platform would need a central entity/leader to create and control information sharing and gather contributions. This could be governmental (e.g., NOAA) or an NGO. The platform could be established with the wealth of data/information collated for the AOA process and be built upon by reaching out to other organizations and stakeholders as initial contributors. To start, the Subcommittee on Aquaculture could create a contact list to help researchers and stakeholders engage with the concept. Additional information inputs could be quite broad (e.g., the geographic scope of contributed data could range from community-level to country-level), but a collaborative prioritization process among contributors, to determine what information to highlight on the platform, could help define the audience and goals of information-sharing. This would require outreach to raise awareness of the platform as the central research hub for aquaculture. The platform should also ensure that tribal and traditional knowledge can be incorporated and provide resources and capacity for this. It should also be focused beyond environmental information to include social science and economic information as well.

Additional Ideas: Generative discussion resulted in a range of additional ideas to advance research for aquaculture, including:

- Increase the amount of aquaculture-relevant research overall by creating models/tools that can reduce startup cost/logistics for studies to address common regulatory questions and support more research overall.
- Research species data to demonstrate market impacts on commercial fish, market equilibrium, and the seafood supply chain.
- Create a common understanding and definition for equity and advance the use of consistent terminology.

Using pilot farms to create data baselines and parameters.

Looking Ahead

Looking Ahead

While the future of aquaculture in the U.S. is unknown, cross-sectoral discussions at the workshop helped advance understanding among stakeholders who, in other contexts, may be at odds with one another. This document does not illustrate consensus, but the ideas shared here can be informative about both areas of commonality and areas where further collaboration and dialogue is needed. No single workshop can address all needs, but we were successful in creating a space for solutions-oriented dialogue and new connections. Many exchanges during the workshop illustrated how useful multisectoral solution-building conversations are for stakeholders, as well as areas where participants could benefit from further education opportunities. Some participants even communicated a desire to continue cross-sector dialogue post-workshop, including looking for in-person opportunities to do so.

Post-Workshop Perceptions

"The relationship building and networking was hugely helpful. I feel like I have a broader group of aquaculture folks with whom to talk. […] I think the conversations were helpful in building understanding across sectors and I look forward to more productive conversations around aquaculture as a result!"

"I have learned a lot about what the challenges and opportunities are for coming together on policy and this will greatly inform my work and considerations there."

"The best and most effective path for this group is to keep it simple! Stick to activities that will build and strengthen trust and relationships across sectors. In order to do that, we still very much need to dig into the how."

Enthusiasm for continued collaboration among participants indicates the opportunity for continued multisectoral engagement to address key questions and find new ways of doing business. Areas ripe for continued discussion and solution building include engagement with coastal communities, improved planning, and coordination across ocean users, developing common data tools, and building infrastructure that can serve multiple needs in the seafood space.

Our intent with this report is to empower ocean stakeholders to pursue opportunities to collaborate with other sectors on a wide range of ocean issues and to inform readers, across sectors, of the power of third-party spaces in creating positive momentum. There are still many questions to answer, many issues to tackle, and a broad array of opinions on whether and how to go about further developing marine aquaculture in the U.S. Potential future collaboration opportunities we see include:

- Sharing the strength of the scenario planning approach in creating discussion spaces where everyone is on equal footing and fostering open exchanges.
- Engaging on a regional basis to bring sectors together to learn from one another and build relationships.
- Creating opportunities for more collaborative dialogue on specific solution-building opportunities, such as augmenting domestic seafood infrastructure and engagement with existing ocean sectors.

Continued dialogue can result in finding common ground between sectors that often seem publicly at odds with one another. While this document represents a snapshot in time among a defined group of participants, it is designed to provide information that is relevant to a wide range of audiences, including workshop participants, a broader range of actors from the sectors represented at the workshop, and policymakers in the executive and legislative branches. Insights and opportunities outlined here can serve as a guiding light for discussion on key issues and enhance collaborative solutions for the future of U.S. aquaculture.

Appendices

Appendix A: Table of Challenges and Solutions

This table presents a detailed accounting of the concerns, opportunities, and potential solutions and safeguards participants raised during the finfish and shellfish scenario exercises during Days 1 and 2 of the workshop. This table does not represent full consensus of all workshop participants. Rather, it catalogues concerns, opportunities, and potential solutions to address the needs of multiple sectors related to nearshore and offshore aquaculture development, based on their existing knowledge level and perceptions. Accordingly, this table reflects a range of ideas and suggestions, not consensus recommendations. To read higher-level insights and synthesis of the discussion, please reference the "Scenario Planning Insights" section of the workshop report. To read the full scenario planning exercises, please reference Appendix B.

Environmental & Siting Dynamics

The issues explored in this section include:

- Interaction with other ocean uses
- Water Quality
- Species selection and seed/stock sourcing
- Impacts of farm infrastructure
- Interactions with other animals
- Climate change and food production
- Navigational safety

CROSS CUTTING ISSUES & SOLUTIONS

- The scale of farm and type of production greatly influence different sectors and community perceptions about a farm. Different sectors are most comfortable with starting aquaculture operations at a small or pilot scale and allowing them to grow over time as the benefits and impacts of marine aquaculture are better understood.
- Proactive engagement of other ocean users by farmers can to help them understand important farm details and how a farm can address any stakeholder concerns.
- One way to provide consistency and allay stakeholder concerns is to create clear processes for evaluation and monitoring of farm environmental performance. Accountability mechanisms that allow companies to scale if they are meeting performance expectations, or halt or scale down operations if they are not meeting expectations can provide additional transparency to ocean stakeholders. This could look like permitting a commercial scale operation but requiring pilots or smaller farms before operations to prove environmental performance and economic viability before scaling up.
- Conducting pilot projects can help answer key questions and collect data on a range of different farm interactions and dynamics, including potential genetic impacts, risks to wildlife, water quality impacts, and market viability of the product.
- Conducing cumulative impact analysis can address concerns about the development of multiple farms, combined with the impacts of any proposed offshore wind development.
- Genetic selection to domesticate farmed species can be an opportunity for research collaborations and can also help limit conservation impacts by selecting for disease resistance and fast growth.
- Identify a gold standard of best practices for different types of aquaculture production. Different sectors and communities are interested in individual farms' operational practices and would like to better understand what the "gold standard" looks like.

INTERACTION WITH OTHER OCEAN USES

Perceived Issues and/or Opportunities	Possible Solutions
Interactions between aquaculture and commercial and recreational fishing. There is a concern about conflict between aquaculture development and traditional or historic fishing grounds. The commercial and recreational fishing communities are concerned about the displacement or loss of fishing grounds due to aquaculture,	Conduct more precise site evaluations in addition to the AOA process. For example, in the Gulf AOA, two of the nine suitability areas are in locations with historically high shrimp fishing. Those working to site aquaculture facilities should sit down with fishermen to look at a precise map of their catch per unit to determine areas of highest value to fishermen that should be avoided.

and the industrializing of the U.S. Exclusive Economic Zone more broadly.	Siting processes should focus on protecting critical fisheries habitat, not “essential fish habitat” (EFH). EFH can be too all-encompassing and restrictive to be meaningful. If losses occur, work with local fishing groups to consider appropriate compensation, which could include things like building other infrastructure to alleviate those loses (e.g., a pier or boat ramp). Create opportunities for commercial fishermen to invest and partake in aquaculture development to receive benefits directly and create investment opportunities for shared growth. Improve data on commercial and recreational fishing uses. If we can clearly understand what areas are highest trafficked through transparent data sharing, they can be avoided in siting. Clarify whether fishing can happen in aquaculture areas. Explore what kinds of commercial and recreational fishing gear types may be compatible with offshore aquaculture, what gear types are incompatible, and what gear modification may be possible to expand compatibility. Create opportunities for commercial fishermen to fish in aquaculture farm areas when appropriate. Some proposed legislation establishes exclusion zones around operations, which some participants disagree with.
Stakeholder capacity to engage. It can be challenging for ocean users to plug into the many ongoing planning process. Sectors can easily become overwhelmed by the number of demands for input. Ocean users can feel frustrated when farm designs/practices change because it can feel like a “bait and switch” and a misuse of their trust and time.	Meet user groups where they are and utilize existing, trusted forums where possible to create efficiencies (e.g., regional fishery management councils, fisheries/habitat advisory panels, state fisheries advisory commissions, local shellfish advisory committees, local industry groups and forums, or NGOs).

In addition, offshore wind development is also being proposed in many areas where there is interest in aquaculture development, meaning that stakeholders are being tapped to provide input on many planning processes at the same time.	Dockside outreach may be the best way to reach recreational fishermen. Outreach should come from the farmers in addition to regulators. Identify ways to build one-on-one interactions and meaningful relationships apart from public forums and hearings, where opposition groups may prevent reasonable dialogue.
Transparency in farm planning and permitting. Ocean stakeholders feel that the current aquaculture permitting process lacks transparency, causing them to be wary of supporting aquaculture development. For example, some farms have been permitted to grow specific species, but then have expanded to grow other species.	Proactive engagement with communities is critical to build trust, both through formal and informal avenues. Work with the commercial fishing industry and other sectors to share information about aquaculture permitting and leasing, what requirements must be met for environmental performance, and what activities could cause a lease or permit to be revoked.
Clarifying cumulative impacts of multiple ocean uses. Clarify the growth of aquaculture in an area over time (both individual farm size and number of farms) and the potential for cumulative impacts. This should also include consideration of any proposed offshore wind developments in the area, and how these ocean uses interact with commercial and recreational fishing. If aquaculture permits require that there are no measurable impacts to the environment 30 meters beyond the farm, will there be cumulative impacts?	Develop a clear, long-term plan for ocean uses and aquaculture that provides transparency on how many and what size farms can go in an area. This should include an analysis of the largest potential impact that may need to be addressed. Clarify which NEPA regulations will apply to aquaculture and offshore wind development. The 2020 NEPA regulation revisions and the 2022 Council on Environmental Quality regulations have created a confusing regulatory environment. Develop a process to engage stakeholders proactively in siting/location data.

WATER QUALITY	
Perceived Issues and/or Opportunities	**Possible Solutions**
Compromised water quality can contaminate nearshore shellfish production. For nearshore, urban shellfish production, there are concerns about inputs from land and rising temperatures that could result in harmful algal blooms impacting farmed species. This could have impacts on human health and harvest. There are also concerns about unintended human health impacts if there is poaching of shellfish from the nearshore environment located close to a population center, if people are not aware of the water quality conditions.	Existing regulations on shellfish sanitation regulate the harvest of shellfish that may be contaminated through environmental conditions. Conduct public awareness campaigns to prevent poaching. Consider including positive messaging about the net value shellfish can have on water quality. Ensure there is messaging around events that could impact farms (e.g., stormwater events) and plan for contingencies to prevent contamination.
Potential positive water quality, carbon sequestration, and/or ocean acidification mitigation benefits of shellfish and seaweed aquaculture. Shellfish and seaweed aquaculture have the potential provide nutrient mitigation benefits through water filtration and nutrient use. This could reduce harmful algal blooms (HABs), improve water quality, and sequester carbon. Actualizing the potential carbon sequestration benefits of seaweed and shellfish aquaculture may require some amount to go unharvested.	Gather data to show the impacts of an individual farm or multiple farms on water quality. Ensure monitoring infrastructure is in place to monitor these potential benefits. This may mean going above and beyond what is required in permits to prove out benefits.
Risk of over promising the benefits of shellfish and seaweed aquaculture. There is concern about shellfish and/or seaweed aquaculture farms making disingenuous or misleading claims for possible impacts on water quality and the environment.	Data collection and research to verify these claims is needed.

Potential impacts of antibiotics use in finfish aquaculture. If antibiotic use becomes necessary to protect animal health in a finfish farm, some participants expressed concern that the antibiotics will end up in other species in the environment and contribute to the rise of microbial resistant microorganisms in our food supply. However, many farmers try to avoid antibiotic use unless absolutely necessary and some participants expressed that proliferation of concern about use of antibiotics in the US is a disservice to industry, given that this issue is less prevalent in the US than in other countries.	Require a clear plan for how antibiotics will be used on a farm. Note that, in the U.S., there are only two currently authorized antibiotics legal for use, they must be prescribed by a vet, and can only be used in the case of disease. Vaccinate fish against disease to limit antibiotic use. Note that U.S. finfish farms primarily manage disease through vaccines and fallowing. Genetic selection to domesticate farmed species can limit conservation impacts by selecting for disease resistance and fast growth.
Excess nutrients (feed and fish waste) from finfish aquaculture. Some participants expressed concern that finfish farms may add excess nutrients to water through the input fish waste and fish feed. There is concern by some that could exacerbate water quality issues in areas already experiencing eutrophication and harmful algal blooms. Areas with stronger currents or offshore areas are preferred by some communities for finfish farming so that any nutrient inputs to the environment are widely dispersed. For submerged pen finfish farms, it is critical that the water depth is deep enough to accommodate the structure and allow for proper current movement. It was also noted that, due to the high cost of feed, most farms minimize the use of excess feeds through cameras and acoustic monitoring to detect when fish are satiated and use feeds with high assimilation efficiency so less nutrients are released through fish waste.	Consider multitrophic forms of aquaculture where fish waste can be processed or offset by shellfish and seaweed culture. Ensure that location depth is deep enough and conduct flow models to assess whether dispersal of any excess nutrients will be sufficient. Implement water quality monitoring around farms. Existing regulations may be adequate to address concerns about water quality impacts. Consider regulations that preference offshore farm development for finfish aquaculture.

SPECIES SELECTION AND SEED/STOCK SOURCING* *Market dynamics of species selection are covered under "Economics of Species Selection & Market Competition with Wild-Caught Seafood" in the "Economics" section	
Perceived Issues and/or Opportunities	**Possible Solutions**
Risks with nonnative species (genetics, invasives, ecological impacts, etc.). Some participants expressed concern that introducing nonnative species to marine environments may result in genetic interbreeding with wild stocks and cause other ecological disruptions and impact commercial fisheries. Others noted that nonnative species cannot interbreed with native species, so the genetic risk concerns here are not relevant.	Use local species when possible and avoid sourcing brood stock (for finfish) or seed (for shellfish or seaweed cultivation) from foreign countries. Unless a species has been widely farmed, non-natives are generally off the table. Ensure permitting programs require this via existing state regulations on species coming into local waters. Consider farming sterile species that are not able to breed successfully. Create research programs and consortia to develop and distribute local seed and brood stock. Ensure ongoing research and monitoring programs to track the impact of aquaculture farms on wild species over time. Use third-party evaluators to ensure seed and brood stock are compliant with relevant certifications, standards, or regulations to which the farm is subject.

Genetic risks with native species. Mixing hatchery-raised native species with wild species poses the risk of interbreeding between farmed and wild populations, which could result in negative genetic impacts on wild populations. This is particularly the case for species that require high genetic integrity. However, farming native species may create opportunities for cultural connection.	Consider farming sterile species that are not able to breed successfully with wild populations.
Augmenting wild fish stocks. Farming native finfish species may create opportunities to augment local wild populations that are commercially or recreationally fished. This is done in some places in Alaska, where some farmed species are intentionally released to supplement wild fish populations. It was suggested that farming fish that are overfished in the wild may be the best choice to remove pressure from that fish in its native habitat.	Collaborate with local universities, NGOs, and fish and wildlife agencies to determine whether a wild stock augmentation program is viable. If implemented, such a program would require careful tracking of local population genetics to measure impacts.

IMPACTS OF FARM INFRASTRUCTURE	
Perceived Issues and/or Opportunities	**Possible Solutions**
Storm preparedness, marine debris, and farm decommissioning. There is concern about scattering of marine debris into the environment if the design materials, engineering, and anchoring system of farms cannot withstand wind and wave action in the marine environment. There is particular concern about how aquaculture farms in the Gulf of Mexico would withstand hurricanes. However, it was noted that submersed net pen cages are not subject to the full wave and wind action of above-water cages and are therefore particularly resilient to storms.	Create processes for accountability to address questions on liability and indemnities, especially offshore. Require that farms prove that their farm design, materials, operation plans, and engineering can withstand the extremes of wind and wave action possible in their location. Require that farms have remediations plan for storm damage and cleanup. Require that operators secure funding to cover farm decommissioning. There should be bonds for infrastructure removal if the company goes out of business or has financial difficulties. Advance research on and identify materials/designs that are proven to withstand wind and wave action.
Habitat impacts. There is concern about farms impacting seagrasses in the nearshore environment, and coral reefs in both the nearshore and offshore environment.	It was noted that current regulations prevent farm siting over or in proximity to submerged aquatic vegetation and live hard bottom. Prospective farm applicants can use the Aquamapper program developed by the National Centers for Coastal Ocean Science to access extensive marine GIS tools and pre-select sites that avoid any sensitive substrate.

Habitat creation and FAD effects. There is potential for farms to create habitat or create fish aggregation devices. There is some question about whether fish aggregation devices (FADs) are beneficial or not to wild fish populations and other users. It is unclear whether FADs create habitat and therefore bolster native fish populations, or whether they simply attract fish to the area**,** so they are easier to catch. Recreational fishermen may perceive aggregation as having positive benefits in terms access to catch if gear is compatible, and if they are able to access fishing around the aquaculture farm. Fish aggregation around farms (particularly finfish farms) also increase the risk of disease transmission.	Conduct research on the potential for fish aggregation around aquaculture infrastructure, including the potential for predator aggregation (seabirds, sharks). Companies should work with local partners (NGOs, state fish and wildlife agencies, etc.) to assess opportunities for habitat restoration or stock enhancement.
Noise pollution from aquaculture farms. Some participants expressed concern that aquaculture farms will create noise pollution. There was concern that machinery to disperse feed pellets for finfish farms may be noisy. Others pointed out that feed distribution must be gentle so as not to break the pellets (which wastes feed, the most expensive input for finfish farms), and therefore is not a noisy activity. Underwater net cleaning machinery may also propagate noise long distances. In addition, harvesting shellfish and biofouling cleaning shellfish farms can also be loud. This may impact marine species or the quality of life for shoreside residents, particularly for near-shore net pen farms.	Many farms avoid noise to mitigate stress on their growing fish.

INTERACTION WITH OTHER ANIMALS	
Perceived Issues and/or Opportunities	**Possible Solutions**
Mitigating the impacts to protected species from multiple sectors. If aquaculture development poses risks to protected species, this also affects other industries in the area that share accountability for avoiding losses (e.g., the commercial fishing sector). For shellfish and seaweed aquaculture, there are concerns about adding more vertical lines in the water column, especially in the Northeast, where fishermen are already being required to reduce lines.	The Clean Water Act and Rivers and Harbors Act requires that permitting agencies coordinate with the U.S. Fish and Wildlife Service and National Marine Fisheries Service about impacts to protected species via Endangered Species Act Section 7 Consultation. However, there is disagreement among stakeholders about how effective these regulations are in protecting species. Additional analysis of the predicted impacts of proposed projects on protected species in the area may help allay concerns from ocean stakeholders. Create spaces for dialogue across sectors on possible mitigation measures and solutions. Consider joint opportunities for testing solutions and finding common ground.
Interactions with marine mammals. There is concern about the risk that marine mammals or protected species will entangle with farm infrastructure. Farm infrastructure may disrupt the normal migratory or travel pathways of other ocean species. Animals of particular concern include right whales and gray seals. Although using higher diameter, tensioned lines are thought to prevent or minimize marine mammal entanglement, there are currently no proven diameter of cables to prevent marine mammal entanglement. Furthermore, the AOA process includes limited data for endangered species and is not necessarily accurate enough to minimize entanglement risk.	Collaboration between the commercial fishing, aquaculture industry, and ENGOs to understand marine mammal use of the area and consider layout and spacing of lines so that activities can coexist. Explore rope less techniques for aquaculture instead of long line systems. Consider removing lines during peak migration times for species of concern (e.g., turtles, whales). Use LED lights on aquaculture facilities to increase awareness for sea turtles. Companies should implement best practices to minimize impacts to marine mammals, in addition to complying with the Marine Mammal Protection Act. Improve the protected species data layer in the AOA process.

Interactions with sea birds. There is concern about the risk of interactions between farms and sea birds.	
Risk of disease in finfish farms. There is concern about the risk of disease from farmed species affecting wild fish populations, and vice versa. There is a lack of information about what diseases aquaculture farms may encounter in the offshore environment. If there is fish aggregation around finfish farm, there is an increased risk of disease transmission between farmed and wild fish.	Genetic selection to domesticate farmed species can limit conservation impacts by selecting for disease resistance and fast growth.
Interactions with sharks or other predatory fish species. There is concern that aquaculture farms in the offshore environment may be more likely to encounter sharks, which have bitten holes through nets in Panama.	Research predator deterrence options.

CLIMATE CHANGE AND FOOD PRODUCTION*

***The social dynamics of local food production are covered under "Local Food Production & Connection to Seafood" in the "Social Dynamics" section**

Perceived Issues and/or Opportunities	Possible Solutions
Climate-friendly way to meet growing protein needs. As compared to land-based protein production, aquaculture poses an opportunity to supply a less resource-intensive protein to a growing human population. Developing this protein farming in the U.S. would help reduce emissions of the food system overall by avoiding the import of foreign seafood, with its associated carbon footprint.	Federal regulatory reform is needed to enable the development of an U.S. marine aquaculture industry. A coordinated marine spatial planning effort is needed to maximize the production capability of the domestic marine environment.

Impact of climate change on migratory patterns. There is concern that current processes to identify sites suitable for aquaculture in the U.S. do not account for how climate change will affect wild species' migratory patterns. When and if marine species' range shifts occur due to climate change and ocean warming, there could be unanticipated conflicts and interactions with aquaculture farms.	Integrate climate change predictions into NOAA's AOA process.
NAVIGATIONAL SAFETY	
Perceived Issues and/or Opportunities	**Possible Solutions**
Potential for boat or gear collisions. There is concern about the risk of boat or gear collisions if farms are not properly marked for navigational safety. It is unclear how effective NOAA's AOA process is at addressing this concern, though bottom gear may be less impactful than surface gear. Note that all aquaculture applicants in both federal and state waters are currently required to work with ACOE and US Coast Guard to ensure adequate marking on sites.	Operators should work with the Coast Guard to ensure farms are properly marked and educate other ocean users, including use of notice to mariners – this is already required in navigational risk assessment. Ensuring the Coast Guard is aware of the project is also necessary to ensure they can provide emergency safety services should there be an accident. Ensure that farm monitoring equipment can withstand offshore ocean conditions. Limit vessel speeds to 10 knots.

Social Dynamics

The issues explored in this section include:

- Engaging local communities
- Local food production and community connection to seafood

CROSS CUTTING IDEAS AND SOLUTIONS

- There is a desire to create a venue where different ocean sectors can come together to discuss the full range of issues affecting the ocean (e.g., ocean restoration, plastics, marine debris, climate change, etc.) and consider how sectors can coexist. However, there is uncertainty about how to create a venue that is collaborative and avoids defensive rhetoric.
- One opportunity is to consider annual convening of regional or local advisory panels that include recreational fishing, commercial fishing, NGOs, and the aquaculture industry to assess the fishery dynamics based on climate and other ecosystem impacts. This would help ensure that changing dynamics and developments are fully understood by all sectors.

ENGAGING LOCAL COMMUNITIES

Perceived Issues and/or Opportunities	Possible Solutions
Meaningful community engagement. Companies should strive to build meaningful relationships with local communities that go above and beyond regulatory requirements. Companies need to do fulsome, early, and often engagement with the nearby community. The U.S. Army Corps of Engineers does not have a well-regarded community engagement process and NEPA consultation requirements should not be relied upon as the sole method of outreach. Communications should be conducted in a manner that serves multicultural communities.	Better understand what standards and practices contribute to the longevity of companies in places. Create clear expectations for how companies will engage communities and what proper engagement looks like. This would be helpful to guide companies in this process. Consider forming community advisory groups. Ensure that communications are offered in multiple languages.
Working with tribal governments. Companies looking to develop aquaculture farms and government agencies leading aquaculture siting processes should explicitly seek out nearby tribal lands and consult with those governments. Tribal consultation processes need to be clear.	Build long term relationships with local tribal governments and consider them partners early in the farm siting and development process.

Aquaculture misinformation. There can be a great deal of misinformation about aquaculture that can impact how ocean users and communities feel about potential farms. Community education is needed to combat misperceptions on seafood (particularly farmed seafood), as well as broader ocean issues. Many people in the public believe that farmed seafood is inherently not healthy for consumption.	Companies should strive for transparency in communication and through direct engagement, above and beyond the existing permitting process requirements. Create communication avenues that are systematic and equitable rather than ad hoc. Government agencies should play a role as neutral information broker. Even though companies may expend significant time, energy, and resources to educate public and dispel misinformation, there is concern that they have a vested interest and may not be honest information brokers. Create best practices for communications with different audiences. Show the farm to the local community via tours or live video feeds, let them get to know the operations and value. Involve citizen scientists in on-farm monitoring. Share data transparently during construction and operations of farm. Utilize a third-party evaluators and certification to verify company claims.
"NIMBY"ism. Aquaculture operations proposed in the coastal zone often face opposition by coastal landowners who fear that the farms' aesthetics or the increase in commercial activity near them will devalue their property or inhibit their enjoyment of the marine space.	

LOCAL FOOD PRODUCTION & COMMUNITY CONNECTION TO SEAFOOD* ***Note that the climate impacts of food production are covered under the "Climate Change and Food Production" section under "Environment"**	
Perceived Issues and/or Opportunities	**Possible Solutions**
Increase the variety and volume of local food production. Increasing the supply of locally produced, nutritious food is an opportunity that communities can benefit from. There is an opportunity for local and farmed products to work together to increase local food sourcing. Aquaculture could subsidize production outside of season and create a consistent, year-round supply of locally produced seafood.	Understand new seafood product development opportunities and local marketplace. Consider discussions locally on and timing of farmed and wild harvest and how that corresponds with for local markets & restaurants – create a campaign to for those sources to use local sources as much as possible rather than imports.
Community connection to seafood. Increasing local seafood production through aquaculture increases opportunities to connect communities to local food production. In particular, farming native species may create enhanced opportunities for cultural connection to seafood sources.	Farmers and fishermen can engage with the local community to increase familiarity with seafood and ensure access to local seafood sources. This is especially important for communities that may face cost barriers or not traditionally have access.

Economic Dynamics

The issues explored in this section include:

- Farm economic feasibility
- Economics of species selection & market competition with wild-caught seafood
- Building seafood infrastructure & working waterfront resilience
- Workforce development
- Community economic development

CROSS CUTTING IDEAS AND SOLUTIONS
• There is a clear need for economic studies and market analysis to better understand how finfish aquaculture production would affect markets for wild-caught seafood, and how species selection influences these market factors. In addition, more work is needed to understand what scales and types of farms are economically viable in the marine environment. • There is a role for government to support the development of the ecosystem needed to support a strong seafood industry overall. This could include creating economic development zones and supporting workforce development programs. • Questions remain about what role community engagement should play in dictating the economic decisions about a farm.

FARM ECONOMIC FEASIBILITY	
Perceived Issues and/or Opportunities	**Possible Solutions**
Understanding the characteristics of an economically viable farm. More information and analysis are needed to understand the characteristics of an economically viable farm, particularly for offshore aquaculture. Questions include: • What scale is required for farms to be economically viable? • How much working capital is needed to invest in a farm?	To attract investment, aquaculture operators need to understand and share the following details with investors: • Price point of the final product • Volume the farm will produce • Market demand for the product • Intended customer

• What is the market demand for the species the farm is growing? The investment and finance community can be unaware of these important metrics to assess farm viability. There is risk that companies without aquaculture expertise may assert physical and financial performance that is not possible (especially for offshore).	• Operating costs Develop transparent, publicly available benchmarking studies that can be used to determine whether an aquaculture farm is viable. Pilot farms can also help to determine and verify the market demand for aquaculture products.
Permit processes and permit lengths must consider economic viability. Permitting processes should be streamlined so they can be navigated in a timely manner. There is concern that lengthy permitting processes increase the time and cost required, increasing barriers to entry to the industry and the final cost of products for consumers. In addition, permit terms should be long enough that companies can ensure a return on their initial investments. The aquaculture industry would prefer permits of 15 – 20 years in length, with the opportunity to renew. The concern about permit lengths applies to all aquaculture development, but particularly offshore farms (which require larger capital investments to establish) and finfish farms (which are typically not profitable in the first few years).	Create a clear, coordinated, and efficient process for permitting aquaculture in both federal and state waters. Assess lessons learned from other countries with well-developed aquaculture industries (e.g., Norway, Mexico, Chile, China, etc.) to inform U.S. regulations and reforms. Create funding for NOAA to conduct a programmatic Environmental Impact Assessment that will alleviate the burden for individual companies to conduct detailed site assessments. Consider policy that allows for longer lease terms and specificity on under what conditions permits may be revocable (e.g., possible to revoke the permit if there are violations which can alleviate concerns of other sectors). Alternatively permits based on biomass caps rather than time allow for growth over time. Those financing aquaculture farm development should link the investment horizon with the production cycle of the species and the companies' track record of success.

ECONOMICS OF SPECIES SELECTION & MARKET COMPETITION WITH WILD-CAUGHT SEAFOOD	
Perceived Issues and/or Opportunities	**Possible Solutions**
Impacts to seafood market dynamics and livelihoods. There is concern from commercial fishermen that increasing seafood production from aquaculture would flood local supplies, driving down the price of wild-caught seafood and putting commercial fishermen out of business. Other sectors speculate that increasing the consistency of domestic seafood supply for some species may stabilize or increase the price point of the product. This concern is most important for finfish aquaculture and not as pressing for shellfish or seaweed aquaculture.	The U.S. Government Accountability Office or other federal agency should conduct a market analysis to determine the impacts of increasing domestic farmed seafood production on wild-caught seafood markets. Analysis should explicitly consider the species type, whether it is commercially fished or not, and the seasonality (or not) of the aquaculture production. Any negative market impacts of aquaculture should be weighed against potential benefits to the community (e.g., job creation, infrastructure investment, etc.).
Species selection and market dynamics. There are tradeoffs between farming finfish that are commercially fished versus unfished. If farms grow a fished species, increased supply may decrease the price of the species overall, negatively impacting both fishermen and farmers, but reducing prices for consumers. However, if the fished species is only harvested seasonally, the farm may be able to augment with year-round production and increase the consistency of supply, desirability, and price of the species overall. If aquaculture farm production is only seasonal, that may have different market impacts. Aquaculture products may be in more direct competition with imported, farmed seafood products than wild-caught species. If farms grow a species that is not commonly fished or marketed, companies will need to invest substantially in developing a new	Educate consumers on the difference between wild-caught and aquaculture products. The aquaculture industry should recognize the harmful impacts that aquaculture has caused for the commercial fishing industry in the past. It is critical to meet other sectors where they are when addressing concerns about aquaculture in order to build trust and credibility for the industry.

market, which increases overall costs and decreases the economic viability of the farm. There are currently only 5-8 finfish species that have been studied and determined to have life cycles suitable for farming, that may be commercially viable in U.S. offshore waters. The way farmed and wild salmon co-exist in the marketplace today is an example many use to exemplify how aquaculture production can increase the popularity of a seafood species and make the wild-caught product more profitable. However, there is a need to recognize the negative impacts and dramatic price drop that farmed salmon created when it was first introduced to the marketplace, and the subsequent negative impacts on commercial fishermen.	

BUILDING SEAFOOD INFRASTRUCTURE & WORKING WATERFRONT RESILIENCE

Perceived Issues and/or Opportunities	Possible Solutions
Improving seafood infrastructure overall. Increasing farmed seafood production can catalyze investments that improve infrastructure for seafood in an area overall. This can benefit both commercial fishermen and other industries that require the same infrastructure (e.g., cold storage and transportation). Specific examples of how this could occur are outlined below: • **Docks and ports –** Docks and ports are critical infrastructure for marine industries but are declining in many areas. Increasing their use in an area would improve their economic viability. • **Seafood processing –** There is a need to build domestic seafood processing infrastructure for both commercially fished and farmed seafood. Large quantities of seafood are	Federal, state, and local governments can consider funding opportunities to support economic development hubs and/or catalyze infrastructure investments that benefit multiple industries. Invest in expanding the capacity of local processing facilities and docks to ensure they can accommodate both wild and farmed seafood industry needs. Proactive local planning for working waterfront areas is needed to support seafood industry development, rather than allowing development for real-estate or other uses. Coastal management funding opportunities can be leveraged to support this proactive planning.

shipped overseas for processing and then back to the U.S. for sale. • **Ground transportation –** If an aquaculture farm needs to move a large quantity of seafood, there is an opportunity to partner with other fishermen or farmers in the area to share transportation infrastructure for mutual benefit. This can often benefit commercial fishermen or small businesses that need to aggregate volume to access affordable cold shipping options.	Commercial fishermen, aquaculture companies, and tribal governments can work together to address hyper-local zoning challenges that sometimes restrict local infrastructure development.
Investing in the resilience of working waterfronts. There is an opportunity to frame aquaculture as an investment in the resilience of working waterfront communities. For aquaculture to be viable, there must be capacity for local processing, port access, fuel, etc. Infrastructure development should be considered in a way that benefits multiple seafood perspectives and interests, including the aquaculture industry, commercial fishing, recreational fishing, and subsistence fishing.	Assess the supporting infrastructure in areas where aquaculture is proposed for infrastructure development. Ensure local planning efforts are thinking about how seafood infrastructure can be maintained (e.g., shoreside land area for both commercial fishing and aquaculture facilities, processing facilities, and waterfront access points). Create mechanisms (e.g., advisory panels) to engage all local sectors (e.g., transportation, energy, food service, etc.) in working waterfront planning efforts.
Hatchery opportunities for stock enhancement and needs for farms. Consider other opportunities that can be developed alongside fish hatcheries that would supply aquaculture farms. For example, opportunities to use fish waste as fertilizer or to support aquaponics systems. Hatchery fish may also be released to augment native fish populations, if deemed appropriate (see "Species Selection and Stock/Seed Sourcing for more information"). It was noted that any commercially competitive finfish aquaculture farm or company would need to develop a hatchery to allow for the domestication of finfish species.	

Enhanced voice and influence of the seafood industry through the addition of new seafood businesses in the community. Additional seafood businesses in an area will help strengthen the voice of the seafood industry in local affairs.	

WORKFORCE DEVELOPMENT

Perceived Issues and/or Opportunities	Possible Solutions
Opportunity for new seafood job creation. Farms create new job opportunities in communities. However, companies must balance the desire to hire locally and keep employment benefits in the community with the need to bring in some experienced labor and staff to operate the farm safely and successfully. Local job creation is also becoming a high-profile metric that Environmental, Social, and Governance (ESG) Investors are using to evaluate projects.	Companies should be clear about the scale and longevity of jobs in communities, including work that is seasonal versus year-round. This is linked to the initial farm scale and plans for growth, which should also be transparent where possible.
Need for workforce development training. There is a need to train people to work in aquaculture for communities to take advantage of local job creation. Seafood industry jobs are physically demanding and require specialized training. Companies may overpromise local economic benefits if employees cannot be hired from the nearest community.	Create training opportunities at community colleges and through Sea Grant in partnership with companies. These could look like certificate programs for jobs at hatcheries, farms, or seafood processing facilities. Trainings should include internships and practical on-the-water experience. This can include programs specific to supporting access to the aquaculture workforce for underrepresented populations.

The commercial fishing industry has been working on workforce development initiatives. There is an opportunity for the aquaculture industry to support this ongoing work and avoid duplicating efforts.	Develop research projects with companies and local schools and colleges to develop aquaculture expertise in students. Pass the Young Fishermen Development Act, which includes a grant program to help communities establish training programs for the fishing industry.
Seasonal opportunities for fishermen. There is an opportunity to train fishermen to own and operate aquaculture farms to supplement income from fishing, because the skillsets for fishing and aquaculture farm operation are similar.	
High cost of entry. High startup costs can present barriers to those wishing to get into aquaculture.	Implement support programs for new entrants to reduce barriers to entry and increase representation in the industry.
Community input on job creation. Need for clarity on what community workforce needs are – do the types of jobs fit the skillsets and preferences of the local community?	Ensure that the community is qualified for/wants the types of jobs that come with the project to ensure that economic benefits remain local. Include this in scoping/engagement conversations.

COMMUNITY ECONOMIC DEVELOPMENT	
Perceived Issues and/or Opportunities	**Possible Solutions**
Economic development zones. Economic development zones around aquaculture and commercial seafood could attract Environmental, Social, and Governance (ESG) Investors to projects, and help create community economic development benefits. There is an opportunity for economic development/job creation not only in the primary farm but in supporting industries that will be attracted to the community based on the adjacency to the farm. For example, if kelp is farmed there could be industry attracted for biofuel refinement, cosmetic uses, and creation of value-added products.	
Lost U.S. investment opportunities. There is growing interest in the investment community in funding aquaculture development. However, these investments are being made in foreign countries with streamlined permitting processes and government incentives for development. There is a risk of the United States missing these economic development opportunities should the regulatory structure not be reformed.	
Ecotourism opportunities. Aquaculture farms can provide opportunities for ecotourism and education about aquaculture.	

Appendix B: Scenario Exercise Descriptions

ABOUT THIS DOCUMENT

The first two days of the workshop included hypothetical scenario planning exercises to prompt discussion on the interests of different stakeholder groups related to U.S. aquaculture development. Each scenario includes a proposed aquaculture farm with details about the location, farm infrastructure, other existing ocean uses, and nearby community. The scenarios were provided ahead of the workshop for participants to prepare their initial reactions and ideas.

The first day of discussion focused on a hypothetical shellfish-seaweed aquaculture farm with the nearest community being an urban city with an estimated population of 1.5 million. The second day of discussion focused on a hypothetical finfish farm with the nearest community being a rural town with an estimated population of 35,000. On both days, half of the participants considered a farm in nearshore state waters, while the other half considered an offshore farm. We intentionally varied the type of aquaculture, type of community, and distance from shore across the exercises to tease out how these dynamics affected stakeholder perceptions, potential benefits, and concerns about proposed aquaculture developments.

Participants were broken into small groups to consider the hypothetical scenarios and engage in facilitated discussion on the prompts identified below.

What are scenario planning exercises?

These *hypothetical* scenario exercises have been developed to prompt discussion on the interests of different stakeholder groups related to U.S. aquaculture development. Each scenario includes a proposed aquaculture farm with details about the location, farm infrastructure, other existing ocean uses, and nearby community.

The purpose of these exercises is to create a space for different ocean stakeholders to share a wide range of perspectives about concerns and interests related to aquaculture development, and to have constructive conversations about what policy interventions or research could meet stakeholder needs. We are aiming for breadth of discussion to ensure we capture everyone's input, and facilitators will keep the conversation moving to allow for discussion on multiple issues or topics.

Participants will be broken into small groups to consider a hypothetical and discuss responses to the following prompts:

- **Initial reflections on the scenario and engagement dynamics:** How might this project directly or indirectly benefit the local community in terms of environmental, economic, or social opportunities or concerns?
- **Assessing opportunity and risk:** What are some of the key opportunities that this project may offer your community/sector? What aspects of this project present concerns? What impacts or risks are you worried about?

- **Identifying safeguards:** How could the farm operate to address the risks and concerns your sector has? What type of policies, regulatory safeguards, or farm practices should be in place?
- **Assessing information needs:** What studies are needed? What information critical to have prior to operation and what can be learned during operation?

DAY ONE: Nearshore Seaweed/Shellfish Scenario

Introduction

Aquaculture is increasingly being sought after to provide resource efficient and less carbon intensive food production. Several reports have stated that increasing seafood consumption, and specifically farmed seafood, can help to mitigate impacts of climate change in the future. However, these global drivers and benefits need to be developed in a responsible and sustainable way to minimize local level impacts and maximize potential benefits to communities.

With the charge of exploring how to strike this balance, you and your group members are participating in a multi-stakeholder advisory panel providing input to an aquaculture company about a proposed polyculture seaweed and shellfish farm. The company is proposing to establish the farm in an area nearshore to a rural coastal community. However, the project is still in its initial planning phases and the company has not yet filed permit applications. The company has approached the advisory panel for community input on the project early on in its development, and hopes to get feedback on the following questions:

- What feedback on do you want to share on anticipated benefits and impacts of the project? How are you thinking about this in terms of environmental, economic, or social opportunities or concerns?
- How would you recommend this permit applicant engage your stakeholder community to ensure the greatest potential to gain confidence and trust? How can the company facilitate win-win opportunities for other community stakeholders as the farm is developed and operated?
- Are there any gaps or concerns about regulatory oversight for the project that you have?
- What other guidance do you have as the company continues its planning process?

ASSUMPTIONS

There are several baseline assumptions we ask you to abide by in this exercise:

- The parameters described below are designed to prompt discussion. Participants should avoid discussing or negotiating whether the scenario details are valid.
- State regulatory review and requirements apply.
    - This includes county and city requirements.

- In this scenario, NOAA's Aquaculture Opportunity Area project has been expanded and has identified areas in state waters suitable for aquaculture.
- Participants should participate and assume that other stakeholders are participating in this advisory group in good faith and should refrain from personal attacks or criticisms.

Proposed Project

COMPANY OVERVIEW

Regen Ocean Farms is a US-based company with 200 employees that has owned and operated shellfish farms in the nearshore for over 30 years. The company recently became a certified B-Corp and has worked with environmental nonprofits in the past to study the impact of its farms on local ecosystems. The company has been interested in expanding into seaweed farming for several years and has been studying and piloting different polyculture farming methods to prepare for this commercial expansion. To successfully develop at scale, the company will need to hire four additional staff, including subject matter experts, which require masters level education; as well as staff to monitor and work the farm, which requires experience on the water. The company has several existing farms in the area where this new farm is proposed and has name recognition within the local community.

PROJECT OVERVIEW

The proposed farm is planning its development according to the Aquaculture Stewardship Council (ASC) and Marine Stewardship Council (MSC) Seaweed Standard, and the ASC bivalve standard. The farm will pursue certification by these standards. The ASC farm standards certify aquaculture operations that address the environmental impacts of aquaculture, set requirements for workers' rights, and protect communities surrounding certified farms. The standards were developed in line with FAO guidelines and the International Social and Environmental Accreditation and Labelling Codes of Good Practice and are periodically reviewed every three to five years. The company is pursuing a state submerged lands lease for seven years, with an option to extend based on performance during the initial term.

PROJECT DETAILS AND INFRASTRUCTURE

- Proposed farm infrastructure to grow kelp and mussels
  - 20 longlines for kelp cultivation, 50 m in length, with 10 m long suspended vertical lines (or "socks") for mussel cultivation
  - Floating buoys will be attached every 2-3 m to suspend the lines, and the ends of each rope will be anchored to the substrate.
  - Estimated Yield: 16,000 wet lbs. of sugar kelp and 200,000 lbs. of mussels.
  - Permit area will be 12 acres, which is on the larger size for a nearshore shellfish farm.
  - The company will source seaweed seed from a Norwegian seed supplier. Mussel seed will come from a reputable hatchery in the area. The mussel species is one that is widely cultivated in the area.

- The farm will be located in an area identified by NOAA's Aquaculture Opportunity Area project as suitable for marine aquaculture. This rigorous scientific siting process provided recommendations for areas that can best support marine aquaculture, while reducing risk to local ecosystems and conflicts with other ocean users and species.

- The purpose of the farm is primarily to produce food for US consumers with sustainability marketing. However, the company is also exploring the sale of kelp for cosmetic and biofuel markets.
- The company believes that the project will both improve water quality in the surrounding area and sequester carbon. The company is partnering with an environmental NGO to assess the environmental impacts of the project and hopes to use these environmental benefits in product marketing once they are verified.

Proposed Farm Location

ENVIRONMENTAL PARAMETERS

- **Distance from coast** – The location is 0.4 km away from the shoreline.
- **Depth and substrate type** – Mean depth is 50 m. Substrate is 97 to 99% mud-like (silt).
- **Ocean current** – Ocean current speeds rarely exceed 1.0 m/s. (Strong ocean currents are not ideal for aquaculture farm infrastructure.)
- **Water quality** – The area sometimes suffers from harmful algal blooms, which are thought to be the result of excess nutrient runoff from the nearby city. Note that NOAA considered the potential for harmful algal blooms during the AOA process.

INFRASTRUCTURE, NATURAL, AND CULTURAL RESOURCE CONSIDERATIONS

- **National Security** – All national security restricted areas were avoided.
- **Natural and cultural resources** –No overlap occurs with coral reefs, fish havens, artificial reefs, or sensitive habitats. Essential Fish Habitat includes shrimp, reef fish, coastal migratory pelagic species, and 15 highly migratory species.
- **Industry, Navigation, and Transportation** – There is a medium level of pleasure and sailing traffic in the area and the area sees occasional tanker traffic. The nearest shipping lane is 4 km away.
- **Commercial Fishing Considerations** – Commercial fishermen sometimes use the area for shrimp trawling and bandit gear fishing.

Nearby Community - Urban

OVERVIEW

The nearest community to the proposed aquaculture development is an urban city with an estimated population of 1.5 million. The city has a deep history as a "working waterfront," with nearly 50,000

people currently employed in ocean-related industries including maritime transport, national security, fisheries, research institutions, and an emerging “blue tech” industry. The area is also driven, economically, by tourism and manufacturing. The area is home to a handful of fishing companies, a local fisherman’s wharf, and a seafood market, though with the depletion of many fisheries, the sector is no longer as strong or influential as it once was. Sport fishing and recreational fishing are well established in the region.

HISTORY

The city has always been a strategic seaport location for moving goods, including internationally. While commercial fishing was once a significant industry in the area, rising costs and foreign competition caused the industry to decline over time. At its height, over 800 fishing boats were homeported in the area and around 40,000 people worked aboard fishing boats or in nearby processing plants. Today, many developing “blue economy” sectors have taken over physical spaces that fisherman used to occupy.

DEMOGRAPHICS

The poverty rate in the area mirrors the national average (around 12%) though educational attainment is higher than the national average, with about 45% possessing a bachelor’s degree or higher. The median household income in the area is more than $75,000, and the unemployment rate is 5%. The area is increasingly multicultural, with around 40% of the population speaking a language other than English at home, though gentrification has reshaped many urban neighborhoods.

DAY ONE: Offshore Seaweed/Shellfish Scenario

Introduction

Aquaculture is increasingly being sought after to provide resource efficient and less carbon intensive food production. Several reports have stated that increasing seafood consumption, and specifically farmed seafood, can help to mitigate impacts of climate change in the future. However, these global drivers and benefits need to be developed in a responsible and sustainable way to minimize local level impacts and maximize potential benefits to communities.

With the charge of exploring how to strike this balance, you and your group members are participating in a multi-stakeholder advisory panel providing input to an aquaculture company about a proposed polyculture seaweed and shellfish farm. The company is proposing to establish the farm in an offshore area that has been designated by NOAA's AOA process as suitable for aquaculture. However, the project is still in its initial planning phases and the company has not yet filed permit applications. The company has approached the advisory panel for community input on the project early on in its development, and hopes to get feedback on the following questions:

- What feedback on do you want to share on anticipated benefits and impacts of the project? How are you thinking about this in terms of environmental, economic, or social opportunities or concerns?
- How would you recommend this permit applicant engage your stakeholder community to ensure the greatest potential to gain confidence and trust? How can the company facilitate win-win opportunities for other community stakeholders as the farm is developed and operated?
- Are there any gaps or concerns about regulatory oversight for the project that you have?
- What other guidance do group members have as the company continues its planning process?

ASSUMPTIONS

There are several baseline assumptions we ask you to abide by in this exercise:

- The parameters described below are designed to prompt discussion. Participants should avoid discussing or negotiating whether the scenario details are valid.
- State regulatory review and requirements apply.
- Participants should participate and assume that other stakeholders are participating in this advisory group in good faith and should refrain from personal attacks or criticisms.

Proposed Project

COMPANY OVERVIEW

Regen Ocean Farms is a US-based company with 200 employees that has owned and operated shellfish farms in the nearshore for over 30 years. The company recently became a certified B-Corp and has worked with environmental nonprofits in the past to study the impact of its farms on local ecosystems. The company has been interested in expanding into seaweed farming for several years and has been studying and piloting different polyculture farming methods to prepare for this commercial expansion. To successfully develop at scale, the company will need to hire an additional 4 staff, including subject matter experts, which require masters level education; as well as staff to monitor and work the farm, which requires experience on the water. The company has several existing nearshore farms adjacent to the closest community and has name recognition within the community.

PROJECT OVERVIEW

The proposed farm is planning its development according to the Aquaculture Stewardship Council (ASC) and Marine Stewardship Council (MSC) Seaweed Standard, and the ASC bivalve standard. The farm will pursue certification by these standards. The ASC farm standards certify aquaculture operations that address the environmental impacts of aquaculture, set requirements for workers' rights, and protect communities surrounding certified farms. The standards were developed in line with FAO guidelines and the International Social and Environmental Accreditation and Labelling Codes of Good Practice and are periodically reviewed every three to five years. This project is pursing USACE General Permit for a 5-year term, under NWP 48 for Commercial Shellfish Mariculture Activities, with the option to renew after 5 years.

PROJECT DETAILS AND INFRASTRUCTURE

- Proposed farm infrastructure to grow kelp and mussels
  - 20 longlines for kelp cultivation, 50m in length, with 10 m long suspended vertical lines (or "socks") for mussel cultivation
  - Floating buoys will be attached every 2-3m to suspend the lines, and the ends of each rope will be anchored to the substrate.
  - Estimated Yield**:** 16,000 wet lbs. of sugar kelp and 200,000 lbs. of mussels
  - Permit area will be 25 acres in total. The company proposes to begin with an initial, 10-acre plot with the ability to expand an additional 5 acres per year, up to 25 total acres, dependent upon project success in the first two years.
  - The company will source seaweed seed from a Norwegian seed supplier. Mussel seed will come from a reputable hatchery in the area
    - The farm will be located in an area identified by NOAA's Aquaculture Opportunity Area project as suitable for marine aquaculture. This rigorous scientific siting process provided recommendations for areas that can best support marine aquaculture, while reducing risk to local ecosystems and conflicts with other ocean users and species.
- The purpose of the farm is primarily to produce food for US consumers with sustainability marketing. However, the company is also exploring the sale of kelp for cosmetic and biofuel markets.

- The company believes that the project will both improve water quality in the surrounding area and sequester carbon. The company is partnering with an environmental NGO to assess the environmental impacts of the project and hopes to use these environmental benefits in product marketing once they are verified.

Proposed Farm Location

ENVIRONMENTAL PARAMETERS

- **Distance from coast** – The proposed location is 16 km (10 miles) away from the coastline. (Not visible from the shoreline).
- **Depth and substrate type** – Mean depth is 80 m, with a gentle slope from north to south. The sediment is 90% sand and 10% gravel.
- **Ocean current** – Ocean current speeds rarely exceed 1.0 m/s. (Strong ocean currents are not ideal for aquaculture farm infrastructure.)

INFRASTRUCTURE, NATURAL, AND CULTURAL RESOURCE CONSIDERATIONS

- **National Security** – All national security restricted areas were avoided. The closest military constraint is an expansive unexploded ordnance areas 3 km to the west.
- **Natural and cultural resources** – The area does not directly overlap any species considered in the National Marine Fisheries Service Protected Resources combined data layer. However, the area does exist within the range of loggerhead, Kemp's ridley, leatherback, and green sea turtles. The area does overlap in the expansive loggerhead sea turtle NMFS critical habitat. No overlap occurs with deep sea corals, fish havens, artificial reefs, or sensitive habitats and none are within a 3-km vicinity. Essential Fish Habitat includes shrimp, reef fish, coastal migratory pelagic species, and 15 highly migratory species.
- **Industry, Navigation, and Transportation** – No direct interactions with oil and gas infrastructure. All navigational infrastructure was avoided.
- **Commercial Fishing Considerations** – The area overlaps the designated Reef Fish Longline and Buoy Gear Restricted Area, and a relatively low amount of reef fish longline gear activity has occurred in the last 15 years. There was no observed reef fish bandit gear fishing that occurred within the area over the 13-year period that data were assessed. Additionally, a relatively low amount of shrimp trawls occurred within the area over the 16-year period that data were assessed.

Nearby Community - Urban

OVERVIEW

The nearest community to the proposed aquaculture development is an urban city with an estimated population of 1.5 million. The city has a deep history as a "working waterfront," with nearly 50,000 people currently employed in ocean-related industries including maritime transport, national security,

fisheries, research institutions, and an emerging “blue tech” industry. The area is also driven, economically, by tourism and manufacturing. The area is home to a handful of fishing companies, a local fisherman’s wharf, and a seafood market, though with the depletion of many fisheries, the sector is no longer as strong or influential as it once was. Sport fishing and recreational fishing are well established in the region.

HISTORY

The city has always been a strategic seaport location for moving goods, including internationally. While commercial fishing was once a significant industry in the area, rising costs and foreign competition caused the industry to decline over time. At its height, over 800 fishing boats were homeported in the area and around 40,000 people worked aboard fishing boats or in nearby processing plants. Today, many developing “blue economy” sectors have taken over physical spaces that fisherman used to occupy.

DEMOGRAPHICS

The poverty rate in the area mirrors the national average (around 12%) though educational attainment is higher than the national average, with about 45% possessing a bachelor’s degree or higher. The median household income in the area is more than $75,000, and the unemployment rate is 5%. The area is increasingly multicultural, with around 40% of the population speaking a language other than English at home, though gentrification has reshaped many urban neighborhoods.

DAY TWO: Nearshore Waters Finfish Scenario

Introduction

Aquaculture is increasingly being sought after to provide resource efficient and less carbon intensive food production. Several reports have stated that increasing seafood consumption, and specifically farmed seafood, can help to mitigate impacts of climate change in the future. However, these global drivers and benefits need to be developed in a responsible and sustainable way to minimize local level impacts and maximize potential benefits to communities.

With the charge of exploring how to strike this balance, you and your group members are participating in a multi-stakeholder advisory panel providing input to an aquaculture company about a proposed finfish farm. The company is proposing to establish the farm in an area nearshore to a rural coastal community. However, the project is still in its initial planning phases and the company has not yet filed permit applications. The company has approached the advisory panel for community input on the project early on in its development, and hopes to get feedback on the following questions:

- What feedback on do you want to share on anticipated benefits and impacts of the project? How are you thinking about this in terms of environmental, economic, or social opportunities or concerns?
- How would you recommend this permit applicant engage your stakeholder community to ensure the greatest potential to gain confidence and trust? How can the company facilitate win-win opportunities for other community stakeholders as the farm is developed and operated?
- Are there any gaps or concerns about regulatory oversight for the project?
- What other guidance do you have as the company continues its planning process?

ASSUMPTIONS

There are several baseline assumptions we ask you to abide by in this exercise:

- Consideration of feed sustainability are not within the scope of this scenario exercises.
- State regulatory review and requirements apply.
- In this scenario, NOAA's Aquaculture Opportunity Area project has been expanded and has identified areas in state waters suitable for aquaculture.
- The parameters described below are designed to prompt discussion. Participants should avoid discussing or negotiating whether the scenario details are valid.
- Participants should participate and assume that other stakeholders are participating in this advisory group in good faith and should refrain from personal attacks or criticisms.

Proposed Project

COMPANY OVERVIEW

Deep Dive Farms is a U.S. based company with 10 employees. It was established 5 years ago, but the expertise of staff represents a combined 30 years of experience in animal husbandry, farm design, production, and marketing and sales. This will be the company's first farm at scale in US waters, following pilot testing on shore and near-shore in association with a university. To successfully develop at scale, the company will need to hire seven additional staff, including subject matter experts in brooding and nutrition, which requires masters level education; as well as staff to monitor and work the farm, which requires experience on the water. The company is new to this general area and plans to establish an office in the community nearby the development.

PROJECT OVERVIEW

The proposed project will follow the guidelines of the Global Aquaculture Alliance's Best Aquaculture Practices (BAP), which is the only third-party aquaculture certification program that encompasses the entire production chain, including the processing plan, farm, hatchery, and feed mill. BAP has four pillars of sustainability – environmental responsibility, animal health and welfare, food safety, and social accountability. Standards are developed and reviewed through an inclusive process that includes public comment and an oversight committee with representatives from conservation, academia, and industry. The company is pursuing a state submerged lands lease for five years, with an option to extend based on performance during the initial term.

PROJECT DETAILS & INFRASTRUCTURE

- The company is considering two finfish species options and would like to understand stakeholder reactions and thoughts to make the final selection. One species is native to the area but not widely caught commercially or recreationally due to a decrease in the wild population. The other is a species that is harvested on a seasonal basis. The company proposes to establish a nearby, land-based hatchery to supply juveniles for grow out at the farm.
- The farm will be located in an area identified by NOAA's Aquaculture Opportunity Area project as suitable for marine aquaculture. This rigorous scientific siting process provided recommendations for areas that can best support marine aquaculture, while reducing risk to local ecosystems and conflicts with other ocean users and species.
- Proposed farm size infrastructure

  - 10 submerged cages, each one of which will be 30 m in diameter and 15 m deep, spaced 60 m apart. The total footprint of the farm will be 500m by 500m. Maximum biomass of 30 kg/cubic meter (these spacing and biomass limits are considered standard by the aquaculture industry).
  - Up to 3,000 tons of fish production per year (1,500 tons/year is considered a minimum viable farm size for commercial production).
  - Tensioned anchors will attach each farm to the ocean floor with large diameter cables. Permit area markers and lights will be used to avoid interactions with boats. (Tensioned, large

diameter cables are utilized to secure a farm in place and to minimize entanglement/harm to a marine mammal should an interaction with the farm infrastructure occur)

- The farm will operate using best practices, gear, and monitoring protocols that are aligned with the Best Aquaculture Practices (BAP) standards and in compliance with U.S. laws and regulations. Some examples include: Automatic feeding systems that are monitored to stop feeding when fish stop eating to minimize excess feed in the ocean; farm monitoring systems that provide real-time data on water quality, animal health, and gear integrity; and limiting antibiotics use to the narrow range of approved drugs under the supervision of a veterinarian and only when absolutely necessary for animal welfare.
  - The company plans to invest in building a new land-based hatchery facility to supply the farm's fish stock, as well as purchase and re-furbish a nearby processing facility that has been out of business for several years and can support nearby fisheries in addition to aquaculture. This will create 30 jobs, a mix of full time and part time employment opportunities. The proposed location of the hatchery and processing facilities are 20 miles from the nearest major highway and 60 miles from the nearest large port city.
  - The purpose of the farm is primarily to produce food for US consumers, as well as provide coastal jobs and infrastructure. The primary market is the nearest urban area as well as regional distribution through a partnership with a regional grocery chain. Offshore cage culture was chosen by the company as the best way to produce healthy fish efficiently.

Proposed Farm Location

ENVIRONMENTAL PARAMETERSS

- **Distance from coast** – The location is 0.4 km away from the shoreline.
- **Depth and substrate type** – Mean depth is 25 m. Substrate is 97 to 99% mud-like (silt).
- **Ocean current** – Ocean current speeds rarely exceed 1.0 m/s. (Strong ocean currents are not ideal for aquaculture farm infrastructure.)
- **Water quality** – The area sometimes suffers from harmful algal blooms, which are thought to be the result of excess nutrients from agricultural runoff. Note that NOAA considered the potential for harmful algal blooms during the AOA process.

INFRASTRUCTURE, NATURAL, AND CULTURAL RESOURCE CONSIDERATIONS

- **National Security** – All national security restricted areas were avoided.
- **Natural and cultural resources** –No overlap occurs with coral reefs, fish havens, artificial reefs, or sensitive habitats. Essential Fish Habitat includes shrimp, reef fish, coastal migratory pelagic species, and 15 highly migratory species.
- **Industry, Navigation, and Transportation** –The nearest navigation and transportation infrastructure is a shipping lane 8 km away from the closest corner point of the area. There is a medium level of pleasure and sailing traffic in the area.

- **Commercial Fishing Considerations** – Commercial fishermen occasionally use the area for shrimp trawling and bandit gear fishing, although the area is not considered a prime fishing location.

Nearby Community – Rural

OVERVIEW

The nearest community to the proposed aquaculture development is a rural community with an estimated population of 35,000. The town's major industries are those that refine and ship locally produced petroleum, natural gas, and agricultural products. The top employment sectors in the city are healthcare, mining, construction, accommodation and food services, government, and social services. There are three technical community colleges in the area with specialty programs in nursing, manufacturing and services, and business. There is a small number of commercial fishermen and an active charter fishing industry serving a growing number of tourists coming to the area. The closest large urban center and port is about 60 miles away.

HISTORY

The town was initially founded to create a centralized governmental body in a predominantly rural area. The area historically consisted largely of farming operations, seafood, fur trading, and logging industries. While commercial fishing was once a significant industry in the area, rising costs of gas, stagnating seafood prices, and new jobs in manufacturing and petrochemical industries have contributed to its decline over time. At its height, the area had three seafood processing plants that serviced an estimated 75 commercial fishing vessels. Now, only one seafood processing plant remains that services an estimated 20 commercial fishing vessels.

DEMOGRAPHICS

The community exhibits higher levels of poverty and lower educational attainment than the national average, with a 25% poverty rate. The median household income in the area is $45,000, and the unemployment rate is 12%. The racial and ethnic makeup of the city is 62.1% non-Hispanic white, 23.3% Black or African American, 0.3% Asian alone, 0.1% some other race, 3.9% two or more races, and 4.3% Hispanic and Latin American of any race.

DAY TWO: Offshore Waters Finfish Scenario

Introduction

Aquaculture is increasingly being sought after to provide resource efficient and less carbon intensive food production. Several reports have stated that increasing seafood consumption, and specifically farmed seafood, can help to mitigate impacts of climate change in the future. However, these global drivers and benefits need to be developed in a responsible and sustainable way to minimize local level impacts and maximize potential benefits to communities.

With the charge of exploring how to strike this balance, you and your group members are participating in a multi-stakeholder advisory panel providing input to an aquaculture company about a proposed finfish farm. The company is proposing to establish the farm in an offshore area that has been designated by NOAA's AOA process as suitable for aquaculture. However, the project is still in its initial planning phases and the company has not yet filed permit applications. The company has approached the advisory panel for community input on the project early on in its development, and hopes to get feedback on the following questions:

- What feedback on do you want to share on anticipated benefits and impacts of the project? How are you thinking about this in terms of environmental, economic, or social opportunities or concerns?
- How would you recommend this permit applicant engage your stakeholder community to ensure the greatest potential to gain confidence and trust? How can the company facilitate win-win opportunities for other community stakeholders as the farm is developed and operated?
- Are there any gaps or concerns about regulatory oversight for the project that you have?
- What other guidance do you have as the company continues its planning process?

ASSUMPTIONS

There are several baseline assumptions we ask you to abide by in this exercise:

- Consideration of feed sustainability are not within the scope of this scenario exercises.
- State regulatory review and requirements apply.
- The parameters described below are designed to prompt discussion. Participants should avoid discussing or negotiating whether the scenario details are valid.
- Participants should participate and assume that other stakeholders are participating in this advisory group in good faith and should refrain from personal attacks or criticisms.

Proposed Project

COMPANY OVERVIEW

Deep Dive Farms is a U.S. based company with 10 employees. It was established 5 years ago, but the expertise of staff represents a combined 30 years of experience in animal husbandry, farm design, production, and marketing and sales. This will be the company's first farm at scale in US waters, following pilot testing on shore and near-shore in association with a university. To successfully develop at scale, the company will need to hire an additional 7 staff, including subject matter experts in brooding and nutrition, which requires masters level education; as well as staff to monitor and work the farm, which requires experience on the water. The company is new to this general area and plans to establish an office in the community nearby the development.

PROJECT OVERVIEW

The proposed project will follow the guidelines of the Global Aquaculture Alliance's Best Aquaculture Practices (BAP), which is the only third-party aquaculture certification program that encompasses the entire production chain, including the processing plan, farm, hatchery, and feed mill. BAP has four pillars of sustainability – environmental responsibility, animal health and welfare, food safety, and social accountability. Standards are developed and reviewed through an inclusive process that includes public comment and an oversight committee with representatives from conservation, academia, and industry. This project is pursing USACE General Permit for a 5 year term, under NW 56 for Finfish Mariculture Activities, with the option to renew after 5 years.

PROJECT DETAILS & INFRASTRUCTURE

- The company is considering two finfish species options and would like to understand stakeholder reactions and thoughts to make the final selection. One species is native to the area but not widely caught commercially or recreationally due to a decrease in the wild population. The other is a species that is harvested on a seasonal basis. The company proposes to establish a nearby, land-based hatchery to supply juveniles for grow out at the farm.
- The farm will be located in an area identified by NOAA's Aquaculture Opportunity Area project as suitable for marine aquaculture. This rigorous scientific siting process provided recommendations for areas that can best support marine aquaculture, while reducing risk to local ecosystems and conflicts with other ocean users and species.
- Proposed farm size infrastructure
    - 10 submerged cages, each one of which will be 30 m in diameter and 15 m deep, spaced 60 m apart. The total footprint of the farm will be 500m by 500m. Maximum biomass of 30 kg/cubic meter (these spacing and biomass limits are considered standard by the aquaculture industry).
    - Up to 3,000 tons of fish production per year (1,500 tons/year is considered a minimum viable farm size for commercial production).
    - Tensioned anchors will attach each farm to the ocean floor with large diameter cables. Permit area markers and lights will be used to avoid interactions with boats. (Tensioned, large

diameter cables are utilized to secure a farm in place and to minimize entanglement/harm to a marine mammal should an interaction with the farm infrastructure occur).

- The farm will operate using best practices, gear, and monitoring protocols that are aligned with the Best Aquaculture Practices (BAP) standards and in compliance with U.S. laws and regulations. Some examples include: Automatic feeding systems that are monitored to stop feeding when fish stop eating to minimize excess feed in the ocean; farm monitoring systems that provide real-time data on water quality, animal health, and gear integrity; and limiting antibiotics use to the narrow range of approved drugs under the supervision of a veterinarian and only when absolutely necessary for animal welfare.
  - The company plans to invest in building a new land-based hatchery facility to supply the farm's fish stock, as well as purchase and re-furbish a nearby processing facility that has been out of business for several years and can support nearby fisheries in addition to aquaculture. This will create 30 jobs, a mix of full time and part time employment opportunities. The proposed location of the hatchery and processing facilities are 20 miles from the nearest major highway and 60 miles from the nearest large port city.
  - The purpose of the farm is primarily to produce food for US consumers, as well as provide coastal jobs and infrastructure. The primary market is the nearest urban area as well as regional distribution through a partnership with a regional grocery chain. Offshore cage culture was chosen by the company as the best way to produce healthy fish efficiently.

Proposed Farm Location

ENVIRONMENTAL PARAMETERS

- **Distance from coast** – The proposed location is 16 km (10 miles) away from the coastline. (Not visible from the shoreline).
- **Depth and substrate type** – Mean depth is 80 m, with a gentle slope from north to south. The sediment is 90% sand and 10% gravel.
- **Ocean current** – Ocean current speeds rarely exceed 1.0 m/s. (Strong ocean currents are not ideal for aquaculture farm infrastructure.)

INFRASTRUCTURE, NATURAL, AND CULTURAL RESOURCE CONSIDERATIONS

- **National Security** – All national security restricted areas were avoided. The closest military constraint is an expansive unexploded ordnance areas 3 km to the west.
- **Natural and cultural resources** – The area does not directly overlap any species considered in the National Marine Fisheries Service Protected Resources combined data layer. However, the area does exist within the range of loggerhead, Kemp's ridley, leatherback, and green sea turtles. The area does overlap in the expansive loggerhead sea turtle NMFS critical habitat. No overlap occurs with deep sea corals, fish havens, artificial reefs, or sensitive habitats and none are within a 3-km vicinity. Essential Fish Habitat includes shrimp, reef fish, coastal migratory pelagic species, and 15 highly migratory species.

- **Industry, Navigation, and Transportation** – No direct interactions with oil and gas infrastructure. All navigational infrastructure was avoided.
- **Commercial Fishing Considerations** – The area overlaps the designated Reef Fish Longline and Buoy Gear Restricted Area, and a relatively low amount of reef fish longline gear activity has occurred in the last 15 years. There was no observed reef fish bandit gear fishing that occurred within the area over the 13-year period that data were assessed. Additionally, a relatively low amount of shrimp trawls occurred within the area over the 16-year period that data were assessed.

Nearby Community – Rural

OVERVIEW

The nearest community to the proposed aquaculture development is a rural community with an estimated population of 35,000. The town's major industries are those that refine and ship locally produced petroleum, natural gas, and agricultural products. The top employment sectors in the city are healthcare, mining, construction, accommodation and food services, government, and social services. There are three technical community colleges in the area with specialty programs in nursing, manufacturing and services, and business. There is a small number of commercial fishermen and an active charter fishing industry serving a growing number of tourists coming to the area. The closest large urban center and port is about 60 miles away.

HISTORY

The town was initially founded to create a centralized governmental body in a predominantly rural area. The area historically consisted largely of farming operations, seafood, fur trading, and logging industries. While commercial fishing was once a significant industry in the area, rising costs of gas, stagnating seafood prices, and new jobs in manufacturing and petrochemical industries have contributed to its decline over time. At its height, the area had three seafood processing plants that serviced an estimated 75 commercial fishing vessels. Now, only one seafood processing plant remains that services an estimated 20 commercial fishing vessels.

DEMOGRAPHICS

The community exhibits higher levels of poverty and lower educational attainment than the national average, with a 25% poverty rate. The median household income in the area is $45,000, and the unemployment rate is 12%. The racial and ethnic makeup of the city is 62.1% non-Hispanic white, 23.3% Black or African American, 0.3% Asian alone, 0.1% some other race, 3.9% two or more races, and 4.3% Hispanic and Latin American of any race.

Appendix C: Workshop Agenda

Scenario Planning and Solution Building |April 5, 6, & 13; 1-4pm Et

Virtual Event – See calendar invitations for zoom links

WORKSHOP OBJECTIVES

- Foster more productive cross-sectoral interactions through knowledge sharing and meaningful engagement.
- Examine the needs of different sectors and identify degree of alignment across sectors on key issues.
- Identify policy solutions to advance areas of agreement and address areas of conflict for risks and opportunities surrounding the future of marine aquaculture in the U.S.

OUTPUTS

By fostering cross sectoral exchange and examining opportunities and risks in hypothetical scenarios, the workshop will help develop a common vision between stakeholders on:

- What needs do sectors have related to US marine aquaculture development?
- How can those needs be met through federal policy and other avenues (e.g., industry best practices, science and research, collaborative deliberation)?

The primary output will be a *non-attributional* summary of key insights and themes from discussion, including:

- Stakeholder alignment across a range of issues
- Recommendations to address risk and build solutions
- Documentation of key data gaps and science needs

This non-attributional summary document will be shared with both workshop participants and other stakeholders actively considering aquaculture policy (e.g., congressional staff, NOAA).

SESSION #1: VISIONING THE FUTURE OF U.S. AQUACULTURE AND INITIAL SCENARIO PLANNING | TUESDAY APRIL 5, 1:00PM – 4:00PM ET

1:00 PM **Welcome and Agenda Review**

1:15 PM **Opening Vision Exercise**

Meridian will present insights from the pre-workshop survey, followed by group discussion that examines the vision. Discussion questions for this session include:

- What assumptions or perceptions drive priorities?
- What are the key differences that have emerged?
- Where are there areas of agreement across the sectors?

2:15 PM **Stretch Break**

2:25 PM **Scenario Exercise 1: Evaluating a Proposed Shellfish and Seaweed Farm**
Participants will be broken into small groups to consider a hypothetical exercise developed to prompt discussion on the interests of different stakeholder groups related to U.S. aquaculture development. The scenario exercise will involve a proposed shellfish/seaweed aquaculture farm with details about the location, farm infrastructure, other existing ocean uses, and nearby community.

Groups will be given an overview of how the breakouts will run and an introduction to the scenario. Scenarios and discussion questions will be delivered ahead of the workshop.

Reflecting on the scenario, small group discussions will consider:

- **Initial reflections on the scenario and engagement dynamics:** How might this project directly or indirectly benefit the local community in terms of environmental, economic, or social opportunities or concerns?
- **Assessing opportunity and risk:** What are some of the key opportunities that this project may offer your community/sector? What aspects of this project present concerns? What impacts or risks are you worried about?
- **Identifying safeguards:** How could the farm operate to address the risks and concerns your sector has? What type of policies, regulatory safeguards, or farm practices should be in place?
- **Assessing information needs**: What studies are needed? What information critical to have prior to operation and what can be learned during operation?

4:00 PM **Adjourn**

SESSION #2: SCENARIO PLANNING CONTINUED – AQUACULTURE IN SHARED WATERS | WEDNESDAY APRIL 6, 1:00PM – 4:00PM ET

1:00 PM **Welcome Back, Agenda Review**

1:10 PM **Scenario Exercise 2: Evaluating a Proposed Finfish Farm**
As above, participants will be broken into small groups to consider a second hypothetical exercise focused on finfish aquaculture farm development.

2:45 PM **Stretch Break**

2:55 PM **Social Engagement**
Informal small group activity to foster relationship building across sectors.

3:15 PM **Reflection on Scenarios and Insights from the Day**
Participants will explore and synthesize key learnings across groups on the similarities and differences that emerged from the scenario exercises.

4:00 PM **Adjourn**

SESSION #3: CHARTING A PATH FORWARD – KEY INSIGHTS, SOLUTION BUILDING AND NEXT STEPS

WEDNESDAY APRIL 13, 1:00pm – 4:00pm ET

1:00 PM **Welcome Back!**

1:10 PM **Unifying Concepts to Guide our Work**
Chris Chopyak will present a visual representation of unifying concepts to guide our work as we aim for long-term multisectoral use of our oceans. This emerged from pre-meeting survey, hopes/vision/desires-oriented discussion, and the themes of scenario planning exercise.

1:20 PM **Recap of Solutions/Discussion from Day 1 & 2**
Meridian Institute staff will present a synthesis of solutions from the scenario planning exercises, especially those that represent areas of alignment across sectors, including policy/regulatory solutions, data/research needs, and ideas for further discussion/coordination

1:35 PM **Applying Unifying Concepts to Build Collaborative Solutions - Breakouts**
The group will breakout for small group creative solution building to focus on building out promising solutions in key topic areas to carry forward the spirit of the workshop into the real world.

Based on the question you answered you'll be placed into cross-sectoral groups to discuss the following solution sets:

- Engagement & Collaboration with Existing Ocean Sectors
- Regulatory Reform
- Building Domestic Seafood Infrastructure
- Economic Development and Community Engagement
- Public Education, Outreach, and Communications on Seafood
- Addressing Research Needs (Economic & Environmental)

2:35 PM **Stretch Break**

2:45 PM **Lightning Solution Presentations**
Groups will present out their slides with actions

3:15 PM **Key Learnings & Next Steps**
Group discussion will consider:

- Where and how the ideas from this workshop can move forward
- Opportunities to take these lessons to inform on-the-ground experiences.
- Ideas for continuing the dialogue.

3:45 PM **Adjourn**

Appendix D: Participant List

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Appendix E: U.S. Marine Aquaculture Multisectoral Design Workshop – Background Reading

This background reading provides the reason for this workshop, an overview of all stakeholders involved, and a selection of articles relating to key aquaculture issues.

Note that this document is not intended to be an all-encompassing, authoritative document nor stifle discussion as we want you to bring your perspectives to the workshop. This document serves as a resource that can provide a baseline to ensure productive workshop sessions.

Table of Contents

1. Why are we having this meeting, and what will we get out of it?

The workshop is designed to bring leaders together across ocean sectors to build common ground and identify solutions to key challenges regarding the future of marine aquaculture in the US. Scope of the discussion will include both nearshore and offshore fed and unfed aquaculture, but not land-based or freshwater aquaculture. The workshop will be oriented towards generative discussion, not a series of presentations. It will give equal value to all viewpoints and create space for all voices.

Objectives for the workshop will be:

- Fostering more productive cross-sectoral interactions through knowledge sharing and meaningful engagement.
- Examining the needs of different sectors and identifying degree of alignment across sectors on key issues
- Identifying policy solutions to advance areas of agreement and address areas of conflict for risks and opportunities surrounding the future of marine aquaculture in the US.

Outputs

By fostering cross sectoral exchange and examining opportunities and risks in hypothetical scenarios, the workshop will help develop a common vision between stakeholders on:

- What needs do sectors have related to US marine aquaculture development?
- How can those needs be met through federal policy and other avenues (e.g., industry best practices, science and research, collaborative deliberation)?

The primary output will be a *non-attributional* summary of key insights and themes from discussion, including:

- Stakeholder alignment across a range of issues
- Recommendations to address risk and build solutions
- Documentation of key data gaps and science needs

This *non-attributional* summary document will be shared with both workshop participants and other stakeholders actively considering aquaculture policy (e.g., congressional staff, NOAA). It will help determine Meridian's and sector leaders' next steps (including further stakeholder engagement needs/opportunities) to build towards the common vision and develop inclusive policy solutions.

Participants

There will voices from the following 6 sectors participating in the workshop, representing a range of geographies and perspectives:

- Aquaculture Industry – finfish and shellfish, and seaweed
- Aquaculture Investment & Finance
- Commercial Fishing
- Seafood Supply Chain
- Recreational Fishing
- Environmental Non-Governmental Organizations

2. Overview of Sectoral Viewpoints

Below is a table that presents a summary of key challenges and opportunities for each sector working in the U.S. aquaculture space. For brevity these are concise categories and not intended to be comprehensive. You can review a more detailed breakdown of perspectives from each of the sectors in our *Sectoral Insights on the Future of Aquaculture in the U.S.* shared by email with your initial invitation.

Table 1: At a Glance: Selected Challenges/Concerns and Opportunities for the Sectors – Not intended to be comprehensive

AQUACULTURE INDUSTRY	
CHALLENGES/CONCERNS	**OPPORTUNITIES**
• Permitting timelines & process • Insufficient processing infrastructure • Need for qualified workforce • Social License from communities • Securing Financing	• Support innovations through government grant funding and incentives • Research to mitigate risks & address barriers • Increase consumer seafood education • Streamline permitting
AQUACULTURE INVESTMENT & FINANCE	
CHALLENGES/CONCERNS	**OPPORTUNITIES**

- Young market that lacks comparables and knowledge in investment community
- Lack of sustainability metrics
- Impacts of uncertainty in the market such as:
    - Permitting timelines
    - Workforce readiness and knowledge pool
    - Public perception and willingness to pay

- Mitigate risks and address barriers to investment to mobilize capital
- Increase knowledge/education and connectivity between banks and the aquaculture industry
- Create the market by ensuring new projects can succeed

COMMERCIAL FISHING

CHALLENGES/CONCERNS

- Market impacts between farmed and wild-caught species
- Fishing grounds conflicts and compounding restrictions due to existing and proposed ocean uses
- Siting concerns related to climate change effects (e.g., shifting stocks)
- Biased information, lack of transparency and inclusion

OPPORTUNITIES

- Robust regulatory framework, council process preferred
- Prevention and indemnification plans: bonds, insurance
- Consumer choice, seafood demand
- Working waterfront infrastructure
- Supplemental income

SEAFOOD SUPPLY CHAIN

CHALLENGES/CONCERNS

- Elevating seafood consumption overall by attracting new customers/expanding existing
- Managing purchasing for a global, highly dynamic sector and variable consumer marketplace, including influx of new products from farmed seafood
- Aquaculture sustainability certifications are farm-level, not ecosystem level, creating concerns that they may not capture cumulative impacts

OPPORTUNITIES

- Bring the right stakeholders together across production and supply chains to develop win-win opportunities for both aquaculture and wild-caught seafood
- Market aquaculture products strategically and develop consolidated seafood market strategy
- Address consumer concerns/education needs
- Look for opportunities for farmed and wild to create supply side stability in the market

RECREATIONAL FISHING

CHALLENGES/CONCERNS

OPPORTUNITIES

• Access • Navigational safety and durability • Forage fish and feed • Invasive species, genetic modification, and escapes • Disease • Habitat impacts	• Augmentation of depleted stocks • Decreased pressure on overburdened fisheries – some perceive as an opportunity to increase recreational fishing • Increase overall supply of quality seafood • Ecosystem benefits from mariculture

ENVIRONMENTAL NON-GOVERNMENTAL ORGANIZATIONS	
CHALLENGES/CONCERNS	**OPPORTUNITIES**
• Impacts of fish feed • Impacts on marine life, including the risk of marine mammal entanglement • Water quality impacts • Aquaculture siting and interaction with other ocean uses	• Economic opportunities for working waterfronts • Supplying less carbon intensive protein • Local food production & food security • Human health benefits of seafood consumption

3. Context & Supporting Articles

Below you will find a sampling of articles and resources across a range of topics to provide background information and additional context that may be helpful for the meeting. There is no expectation of needing to review all of these prior to the meeting; rather, we are providing a few resources across a range of topic areas for those that may find such helpful. This is not intended to be an authoritative list of resources.

Topic Areas with hot links include the following:

- Aquaculture Overview
- Environmental Impacts of Aquaculture
  - Impacts of inputs
  - Effects of climate change on aquaculture
- Siting and marine planning
- Socioeconomic Factors

AQUACULTURE OVERVIEW

Guide to Permitting Marine Aquaculture in the United States. NOAA. 2022.

This guide's purpose is to assist individuals with navigating the federal permitting process for marine aquaculture (finfish, shellfish, invertebrates, and seaweed).

Mapping the Global Potential for Marine Aquaculture. Nat Ecol Evol. Gentry, R.R., Froehlich, H.E., Grimm, D. et al. 2017.

This analysis maps the biological production potential for marine aquaculture across the globe.

Refuting Marine Aquaculture Myths, Unfounded Criticisms, and Assumptions. Reviews in Fisheries Science & Aquaculture. Paul Zajicek, John Corbin, Sebastian Belle & Robert Rheault. 2021.

This paper argues against common critiques of domestic aquaculture development by reviewing current policies, regulations, research, and industry production practices.

American Aquaculture: An Overview of the Current Status, Environmental Impacts, and Legislative Opportunities. Washington: Center for American Progress. Alexandra Carter and Miriam Goldstein. 2019.

This article explores economic and environmental considerations for U.S. policymakers regarding offshore aquaculture.

Piecing together the data of the U.S. marine aquaculture puzzle. Journal of Environmental Management. Froehlich, H.E., Gentry, R.R., Lester S.E., Rennick M., Lemoine H.R., Tapia-Lewin S., Gardner L. 2022.

This study is a multi-state synthesis and comparison of a suite of species, volume, and value information on U.S. marine aquaculture over time.

ENVIRONMENTAL IMPACTS OF AQUACULTURE

Marine Cage Culture & The Environment: Twenty-first Century science informing a sustainable industry. NOAA technical memorandum NOS NCCOS. Price, Carol Seals; Morris, James A., (James Adiel), Jr. 2013.

This report provides a review of some predominant environmental risks that marine fish cage culture aquaculture poses in the marine environment and designs and practices now in use to address these environmental risks in the U.S. and elsewhere.

IMPACT OF INPUTS

Marine Cage Culture and the Environment: Effects on Water Quality and Primary Production. Aquaculture Environmental Interactions. Price, C. K.D. Black, B.T. Hargrave, and J.A. Morris, Jr. 2015.

This paper summarizes knowledge regarding dissolved nutrient loading from marine fish farms globally, direct impacts on water quality, and secondary impacts on primary production, including the formation of harmful algal blooms.

Environmental Performance of Marine Net-Pen Aquaculture in the United States. Fisheries Magazine. Rust, M., K.H. Amos, A.L. Bagwill, W.W. Dickhoff, L. M. Juarez, C.S. Price, J. A. Morris Jr., M. C. Rubino. November 2014

This paper addresses how the net-pen aquaculture sector in the U.S. has improved its resource efficiency and reduced its environmental impacts while increasing production.

EFFECTS OF CLIMATE CHANGE ON AQUACULTURE

Global Change in Marine Aquaculture Production Potential Under Climate Change. Nat Ecol Evol. Froehlich, H.E., Gentry, R.R. & Halpern, B.S. 2018.

This study addresses the climate component in food security research and sustainable development planning by identifying regions that will face potentially greater climate change challenges and resilience concerning marine aquaculture in the coming decades.

Climate-Friendly Seafood: The Potential for Emissions Reduction and Carbon Capture in Marine Aquaculture. Bioscience. Alice R Jones, Heidi K Alleway, Dominic McAfee, Patrick Reis-Santos, Seth J Theuerkauf, Robert C Jones. 2022.

This paper examines the major GHG sources and carbon sinks associated with fed finfish, macroalgae and bivalve mariculture, and the factors influencing variability across sectors.

SITING AND MARINE SPATIAL PLANNING

Interactions and management for the future of marine aquaculture and capture fisheries. Fish and Fisheries. Clavelle, T., S.E. Lester, R. Gentry, and H.E. Froehlich. 2019.

This study provides a synthesis of the interactions between mariculture and wild fisheries, characterizing the types of interactions, evaluating available empirical evidence, and identifying where management (sector-specific and cooperative) can play an important role.

Marine Spatial Planning Makes Room for Offshore Aquaculture in Crowded Coastal Waters. Nat Commun. Lester, S.E., Stevens, J.M., Gentry, R.R. et al. 2018.

This paper offers a framework for guiding offshore aquaculture (bivalve, finfish, and kelp farming) development with existing sectors and environmental concerns (wild-capture fisheries, viewshed quality, benthic pollution, and disease spread) in California, USA.

Offshore Aquaculture: Spatial Planning Principles for Sustainable Development. Ecology and Evolution. Gentry, R. R., Lester, S. E., Kappel, C. V., White, C., Bell, T. W., Stevens, J. and Gaines, S. D. 2017.

This paper provides insight into the interactions between offshore aquaculture and the surrounding environment across a spectrum of spatial scales.

Shellfish aquaculture map viewers: An assessment of design, data, and functions to inform planning and siting in the United States. Journal of Shellfish Research. Wickliffe, L.C., V.C. Crothers, S.J. Theuerkauf, K.L. Riley, and J.A. Morris, Jr. 2019.

This review provides information on using map viewers and technological innovation to communicate shellfish aquaculture planning and permitting information to a variety of stakeholders.

State by State Summary of Shellfish Aquaculture Leasing/Permitting Requirements. NOAA. 2021.

This report provides an overview of permitting and leasing programs for shellfish aquaculture in United States waters.

SOCIOECONOMIC FACTORS

Economics of Aquaculture Policy and Regulation. Annual Review of Resource Economics. James L. Anderson, Frank Asche, Taryn Garlock. 2019

This manuscript reviews the contributions natural resource economics has made to evaluating aquaculture policy and regulation.

The Future of the Seafood Industry. Gunnar Knapp. 2018.

This presentation covers the rapid changes in the seafood industry and considerations for the future of the seafood industry considering these changes.

Fish to 2030: Prospects for Fisheries and Aquaculture. The World Bank. 2013.

This report offers a global view of fish supply and demand into 2030.

The Political Economics of Marine Aquaculture in the United States. Reviews in Fisheries Science & Aquaculture. Gunnar Knapp and Michael C. Rubino. 2016.

This article discusses five broad strategies and recent efforts to progress marine aquaculture in the United States.

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