# Sea Grant–NCCOS Mid-Atlantic Aquaculture Siting and Development Regional Summary

Workshop Report

Sea Grant NORTH CAROLINA

Sea Grant MARYLAND

Sea Grant

NOAA NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION U.S. DEPARTMENT OF COMMERCE

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# Executive Summary

The Mid-Atlantic Sea Grant-National Centers for Coastal Ocean Science (NCCOS) Aquaculture Siting and Development Workshop was the initial workshop for the *Connecting Sea Grant, National Centers for Coastal Ocean Science, and Coastal Stakeholders to Improve Aquaculture Siting and Development* project. The main purpose of the project is to build capacity among Sea Grant (SG), NCCOS, and other coastal-ocean user groups through a series of six regional workshops to aid in the sustainable development of marine and coastal aquaculture in the United States. Specifically, the project objectives are to (1) extend the reach of NCCOS' aquaculture planning tools and resources, (2) improve Sea Grant-NCCOS-coastal-ocean user group connections through the workshop process, and (3) inform broader Sea Grant-NCCOS marine spatial planning efforts.

Given these goals, the one-day, hybrid (i.e., simultaneous in-person and virtual attendance) workshop was a showcase of available NCCOS tools and resources relevant to the region followed by facilitated, small group discussions to solicit feedback on regional applicability and potential improvements. The agenda also included presentations on the project, co-production in aquaculture with the Maryland Shellfish Aquaculture Business Planning Tool (MSABPT), NCCOS tools and resources, engaging diverse audiences, and recommendations for the remaining workshops. The NCCOS aquaculture tools demonstrated were the Wave Exposure Modeling (WEMo) and the Best Harvest Windows and *Vibrio* Harvest Calculator.

Held in College Park, Maryland on June 30, 2022, the workshop was attended by 34 people, with most attendees from federal agencies or academia. Based on formal evaluation, the workshop content and format were well-received, participants were engaged in all discussion sessions, and all presented tools were positively rated. After analyzing workshop notes, the MSABPT was a useful example of an iterative tool whose functionality is routinely updated based on input from oyster growers. WEMo was the most popular NCCOS tool among workshop participants because of the broad applicability within the aquaculture industry (e.g., siting to production planning to storm preparation) and beyond (e.g., real estate, state agencies). Participants also appreciated the straightforward nature of the *Vibrio* tools in addition to their ability to promote seafood safety. Workshop participants discussed additional functions and data layers that could be added to enhance the application of each tool, like creating thresholds to indicate where a farm would not be advised. Participants also noted the needs to improve the accessibility of tool functionalities and communication, including increased awareness through outreach. While participants provided ample feedback for each tool, they did recommend building more time into the agenda for hands-on exploration of the tools in future workshops. Overall, the initial workshop successfully allowed the project team to test out the proposed workshop framing to prepare for future regional workshops, while also extending the reach of NCCOS tools and collecting feedback for tool developers.

# Workshop Summary

## Project Background and Purpose

In recent years, global aquaculture has surpassed commercial fisheries in total seafood production and has the potential to be a sustainable method of meeting global protein needs of increasing populations (FAO, 2024). Yet, the United States is behind in aquaculture production and depends on imported seafood (between 70 – 90% of seafood consumed in the US) to meet consumer demands (NMFS, 2022). The seafood production deficit led to the development of the Executive Order (EO) 13921 Promoting American Seafood Competitiveness and Economic Growth in 2020. As part of EO 13921, the National Centers for Coastal Ocean Science (NCCOS) were tasked with conducting and creating marine spatial planning siting analyses and tools to identify suitable locations with the least user conflicts for marine aquaculture development in a busy ocean.

As coastal and marine spaces are heavily used by a diversity of groups, NCCOS partnered with the National Sea Grant Office (NSGO) on a project, *Connecting Sea Grant, National Centers for Coastal Ocean Science, and Coastal Stakeholders to Improve Aquaculture Siting and Development*, to broadly associate with coastal-ocean user groups (i.e., stakeholders) directly involved with, or impacted by, marine aquaculture. The project is funded by the NSGO and NCCOS and led by Maryland Sea Grant (MDSG) and the current National Aquaculture Extension Coordinator, Dr. Annie Schatz (previously, Dr. Jim LaChance). The main purpose of the project is to build capacity among Sea Grant (SG), NCCOS, and other coastal-ocean user groups through a series of six regional workshops to aid in the sustainable development of marine and coastal aquaculture in the United States. Specifically, the objectives are to (1) extend the reach of NCCOS' aquaculture planning tools and resources, (2) improve SG-NCCOS-coastal-ocean user group connections through the workshop process, and (3) inform broader SG-NCCOS marine spatial planning efforts.

## Mid-Atlantic Workshop Process Overview

The project takes a three-part approach to workshop planning: (1) pre-workshop planning, including various workgroups and regular meetings; (2) a one-day, hybrid workshop; and (3) post-workshop focus groups. This approach intends to create a regionally tailored workshop agenda, gather regional sentiments on the current and future status of aquaculture, capture feedback on aquaculture planning tools and resources, and inform future workshops.

The Mid-Atlantic regional workshop was used to test the proposed framing and scoping of the workshop approach for the remaining regions and gain some understanding of regional aquaculture issues. The workshop explored the feasibility of using a co-production model (also referred to as co-creation, collaborative learning, or participatory research) to advance collaboration and two-way communication between tool developers and coastal-ocean user groups and ultimately improve outcomes and useability of aquaculture siting and planning tools. The workshop process for the Mid-Atlantic region was as follows:

### Pre-workshop planning

Pre-workshop planning included input from MDSG, NCCOS, NSGO, North Carolina Sea Grant, the NOAA Working Group, and several one-on-one conversations between the coordinator and relevant partners in the region. The MDSG-NCCOS-NSGO team were responsible for convening the NOAA Working Group, coordinating meeting logistics, and finalizing the workshop agenda and participants list. In addition to agenda and participant list guidance, the NOAA Working Group (NOAA Aquaculture Coordinators and key SG and NCCOS aquaculture specialists) provided context for the current national aquaculture landscape as well as which NCCOS tools to showcase and how they could be used for state aquaculture planning, restoration aquaculture, or nutrient mitigation plans. Pre-workshop planning also included discussions regarding the difficulty of maintaining tools or overpromising on tool capabilities. Additionally, planners held five one-on-one conversations with partners to expand on these discussions and others, including nutrient management opportunities and increasing diversity and inclusion within aquaculture.

### Workshop

The workshop included presentations on the project and background, co-production in aquaculture, NCCOS tools and resources, and engaging diverse audiences (see Appendices A and B for more details). Specifically, three aquaculture tools for siting and development were demonstrated:

- Maryland Shellfish Aquaculture Business Planning Tool (MSABPT)[1]
- Wave Exposure Modeling (WEMo) to Support Aquaculture Siting[2]
- Best Harvest Windows (Delaware) and *Vibrio* Harvest Calculator (Long Island Sound)[3]

The rest of the day consisted of facilitated, small-group discussions (i.e., breakout groups). For the NCCOS tools (WEMo and *Vibrio*), the discussion questions were organized by key themes: audience, functionality, strengths and opportunities, access and knowledge, and complementary resources. Three additional breakout discussions focused on co-production of tools using the MSABPT tool as an example, inclusion of traditionally overlooked groups, and reflection on the workshop approach for upcoming regions. Facilitators captured notes from the breakout group discussions on a flipchart for participants to view, while notetakers recorded discussion comments and notes in a Google Docs file. The breakout sessions were designed to be interactive, with each group rotating through the discussion questions and building upon previous responses. This design made it difficult to accurately capture frequency of similar responses, though notetakers captured each group's individual comments, providing some insight (Appendix A).

### Post-workshop Focus Group

Because this workshop included reflection time about how this workshop approach would work in future regions, only one post-workshop focus group was hosted with the notetakers to solicit their impressions on the day and any general improvements to the workshops and to their note taking roles.

## Participants of the Mid-Atlantic Workshop

Marine aquaculture includes and affects many coastal-ocean user groups, and a project goal is to attain equal representation from a diversity of these groups (e.g., SG Extension, scientists, aquaculture industry, NOAA employees, non-governmental organizations, etc.). Participants were asked to report their professional affiliations when they registered for the workshop. However, broadening participation was more challenging than anticipated and resulted in the attendance of only one person from industry and one from a non-governmental organization (Table 1). Additionally, evaluation data (see *Mid-Atlantic Workshop Evaluation Findings* below) showed a lack of racial diversity but a near equal divide among genders.

Table 1. Total number of people that participated throughout the Mid-Atlantic workshop process sorted by professional categories.

| Professional Category | Planning Only | Workshop | | Total |
|---|---|---|---|---|
| | | In-Person | Virtual | |
| Sea Grant | 2 | 4 | 2 | **8** |
| Academia | 0 | 11 | 1 | **12** |
| State or Local Agency | 0 | 0 | 0 | **0** |
| Federal Agency | 8 | 7 | 2 | **17** |
| Aquaculture Industry | 0 | 1 | 0 | **1** |
| Commercial Fishing Industry | 0 | 0 | 0 | **0** |
| Nonprofit/Non-governmental Organization (NGO) | 0 | 1 | 0 | **1** |
| Other | 0 | 0 | 0 | **0** |
| **Total** | **10** | **24** | **5** | **19** |

1 Information regarding the MSABPT can be found here: https://extension.umd.edu/programs/agriculture-food-systems/program-areas/animal-science/aquaculture/aquaculture-business-planning-and-management/

2 The Wave Exposure Model is no longer supported by NCCOS.

3 Both *Vibrio* tools can be found here: https://products.coastalscience.noaa.gov/vibrioforecast/

## Summary of Breakout Session Comments

The findings below include workshop results organized by the five breakout discussion sessions, which are summarized by common themes drawn from the workshop notes. Workshop data, including breakout session discussion notes from facilitators and notetakers, are available upon request.[4]

### Breakout Session 1: Co-production in Aquaculture

Co-production was an important objective of the project. Here, co-production was defined as an "iterative and collaborative processes involving diverse types of expertise, knowledge, and actors to produce context-specific knowledge (Norström et al., 2020)." In the first breakout session, participants were asked to reflect on any example of a co-produced project. Participants shared several aquaculture co-production examples (e.g., state shellfish farm siting tools, research guidance on production methods and gear) noting industry had greater buy-in to project deliverables when communication and acknowledgement of various industry concerns were included. Similarly, several participants noted collaborative tool development often leads to enriched data and information sharing that might otherwise have been overlooked, ultimately generating a better outcome or product. Participants also listed necessary actions for successful collaboration like, "following up on promises for product improvement," "knowing when to listen," and not assuming what resources people have access to (e.g., technology). Discussions then delved into the difficult aspects of co-production, like determining who needs to be involved while remaining inclusive, building in time to create relationships and a common language as "people from different backgrounds have different ways of communicating," and lastly, dividing work responsibilities and navigating scheduling complexities with larger groups. Overall, participants were generally positive about using co-production in developing sustainable aquaculture practices in the US, including tool creation, with some stating they know tool developers who work collaboratively.

Participants were then asked to specifically discuss the Maryland Shellfish Aquaculture Business Planning Tool (MSABPT), one of three aquaculture tools that were highlighted during the workshop, within the context of co-production. Participants specified how the MSABPT demonstrated the advantages of taking a co-production approach within aquaculture. In developing the MSABT, time was taken to connect industry and scientists through open communication and trust building. Using a co-production approach led the tool development process to be needs- and industry-driven, and this collaborative process afforded an opportunity for scientific data to be applied to "real world" scenarios. Some of the challenges discussed in relation to the MSABT tool were a need for more consistent data collection and reporting to improve tool reliability, clarifying industry member tasks to reduce redundant efforts, overuse of technology with non-academic members, and going through a timely iterative process. The breakout session afforded time for participants to suggest new modifications, such as integrating water quality and nutrient data into the tool. Participants were asked to reflect on their workshop discussions around co-production in the post-workshop evaluation, see *Mid-Atlantic Workshop Evaluation Findings* below for details.

#### *NCCOS Tool Discussions*

NCCOS showcased tools that were developed for the aquaculture industry: the Wave Exposure Model (WEMo), and *Vibrio* predictions (two separate, regional tools: Best Harvest Windows for Delaware and *Vibrio* Harvest Calculator for Long Island, NY). During the breakout group discussions, participants answered questions designed to assess each tool's applicability, function, and potential areas for improvement (Appendix A). All unique participant responses were categorized and listed in Tables 2 and 3 and used for the following summaries of Breakout Sessions 2 and 3. Participants were also further questioned about the NCCOS tools in the post-workshop evaluation, see *Mid-Atlantic Workshop Evaluation Findings* below for details.

### Breakout Session 2: Wave Exposure Model (WEMo)

WEMo was favorably discussed amongst participants, noting various uses of the tool within and beyond aquaculture and the credibility given to the tool from the testing and usage by the National Weather Service (Table 2).

4 For inquires about data from the Mid-Atlantic SG-NCCOS Aquaculture Siting and Development workshop, please reach out to MDSG-aquaculture@umd.edu

Table 2. *Wave Exposure Model (WEMo)*

| Summarized, unique participant responses to breakout **discussion questions pertaining to potential tool uses, audiences, strengths, and engagement methods** from the Mid-Atlantic Aquaculture Siting and Development Workshop. | |
|---|---|
| **Most Likely Tool Uses** | Aquaculture farm siting<br>Living shoreline or other conservation areas siting<br>Aquaculture gear selection or testing<br>Routine aquaculture operations planning<br>Pre-weather-event preparation planning<br>Post-weather-event evaluation<br>Risk evaluation for real estate/developers/insurers |
| **Most Useful Tool Function** | Siting<br>Testing aquaculture gear in different scenarios |
| **Tool Strengths** | Data quality<br>Synthesizing different data types<br>Testing/use by the National Weather Service<br>Real-world application for shellfish aquaculture |
| **Tool Audience** | Aquaculture farmers<br>Regulators<br>Conservation/ restoration groups<br>Resource managers<br>Extension agents<br>Aquaculture gear manufacturers<br>State/local agencies (e.g., environmental survey work)<br>Real estate<br>Insurance companies |
| **Preferred Methods of Learning About and Engaging with the Tool** | Extension agents<br>Workshops (in-person/ webinars with tool experts)<br>Exploring the tool individually<br>Quick-start guide and detailed manual<br>Video tutorials<br>Advertisements on social media and newsletters (e.g., NOAA Friday Harvest)<br>Market to industry associations (e.g., National Aquaculture Association, National Association of Realtors) |

Table 2. *Wave Exposure Model (WEMo) (cont.)*

| Summarized, unique participant responses to breakout discussion **questions pertaining to tool improvements and challenges** from the Mid-Atlantic Aquaculture Siting and Development Workshop. | |
|---|---|
| **Opportunities for Tool Improvements** | Make it more user-friendly (e.g., GIS is an advanced skill) with a web-based or phone-based app<br>Note any state regulatory requirements<br>Include a "no-go" zone to rule out areas with damaging wave heights for aquaculture<br>Expand beyond inlets to open water<br>Add temporal resolution<br>Include real-time monitoring<br>Increase data transparency<br>Make database more universal for easy comparisons with other tools<br>Integrate with existing hurricane/storm prediction and farm management tools<br>Include a feedback mechanism within tool for users to provide input<br>Place sensors in aquaculture gear to detect additional factors<br>Increase communication and outreach about potential uses |
| **Suggested Data to Include** | Estimates of food availability for shellfish<br>Soil survey data<br>Weather forecasts<br>Habitat types (e.g., SAV)<br>Bathymetry<br>Substrate composition<br>Storm surge<br>Tidal cycles (e.g., spring tides)<br>Stormwater runoff<br>Water quality<br>Oceanographic data<br>Water column light penetration<br>Climate change factors impacting shellfish disease prevalence and habitat suitability |
| **Questions About the Tool's Functionality** | How is this tool found/accessed?<br>How do people follow up if they do not understand the output?<br>Want clarification/ more details on any data inputs needed?<br>Can it incorporate additional inputs that are often used or considered in aquaculture site development?<br>Can the tool output wave energy/attenuation/velocity or just height?<br>Model validation and error/uncertainty?<br>Frequency of data updates?<br>For siting, this is more like a process of elimination tool, not showing where the best location is?<br>Who pays 'academia' to make this available to industry?<br>How does this relate to wind farming? |
| **Potential Challenges to User Engagement** | Choose language about tool purpose and output carefully |
| **Additional Knowledge Consulted to Use the Tool** | Offices of Cultural and Historic Preservation<br>Derelict gear/debris |

### *WEMo Tool Perceptions*

Within aquaculture, people mentioned that the most useful function of the tool was for farm siting, with those interested in starting a farm or those looking to expand their present footprint. One participant noted that this tool could, "help potential farmers reduce the amount of site monitoring they have to do before an application," to ultimately, "remove a barrier for entry." Other potential applications within aquaculture were discussed, like selecting the best gear-type for the location, planning daily farm operation schedules (i.e., boating to the farm), preparing the farm for a weather-related event, and modeling the resilience of various gear designs by gear manufacturers. Beyond aquaculture, participants noted that the tool could be of interest to those working in state/local government, conservation/restoration, living shorelines, real estate, and insurance for project siting, planning, and risk assessment.

### *WEMo Tool Suggestions*

As participants thought the tool was very promising, they remarked on ways the tool could reach its full potential (Table 2). Several participants noted on the need for the tool to be more user-friendly, either in a web-based or phone-app format. The tool was built to be used with a Geographic Information System (GIS), which is a barrier as it requires prior knowledge and education to use. Additionally, while participants were impressed that the tool had multiple applications beyond aquaculture and had the potential for co-development with state governments and end-users, they were concerned that access may be limited to those with high computing capabilities given the model's sophistication and complexity. To make the tool more user-friendly aside from the computing challenges, people suggested creating a "no go" designation to indicate when waves would be too damaging to locate a farm or project in specific locations but also noted that careful explanation is needed regarding the tool's output, emphasizing that the locations shown in the tool "are not the only places aquaculture can exist."

Participants mentioned that communications needed to be improved within the tool (e.g., tool manual, user feedback mechanisms, etc.), which would likely help answer lingering questions that participants had, like various in- and output needs, frequency of updates, model validation, handling of error/ uncertainty, how to access the tool, and how to get help or more information if needed. Beyond accessibility improvements, participants also had suggestions for additional functionalities, like including real-time data and integrating it with other established tools and data sources (e.g., weather forecasts, soil survey data, farm management tool) to expand the tool's applicability.

### *WEMo Tool Delivery*

Workshop participants discussed potential learning and engagement methods for the tool, especially with industry, including using social media and established newsletters as marketing opportunities. Participants also recommended workshops (in-person or webinars) with a tool expert walking the audience through a relevant example, which could be recorded and posted as a resource. One participant recommended that the tool developer have someone at the workshop to listen to and record any input from the audience. Several participants suggested creating a video tutorial. People also mentioned having one-on-one time with the tool and a detailed guide to reference.

## Breakout Session 3: Best Harvest Windows and Vibrio Harvest Calculator

The Best Harvest Windows and Vibrio Harvest Calculator tools were showcased and discussed during the breakout sessions together (Appendix A). Overall, people appreciated how the tools were "straightforward," "easy to use," and "unique" (Table 3).

### Vibrio *Tool Perceptions*

The most highly rated function of the tools was the ability to predict changes in the prevalence of Vibrio. Additionally, participants mentioned the possibility of using the tools to train growers on proper harvesting methods for shellfish sanitation, noting that the tools "could cause behavior adaptation" in harvesters if they are educated on what the tools' output means. By using the tools' capability of hindcasting, participants mentioned that growers could "analyze why problems occurred" after an infection has been detected and learn for future harvests, in real time. While most comments were in favor of using the tools for general problem-solving (i.e., heuristically) rather than daily-use, some participants noted the potential for production scheduling during the summer, especially in the shoulder months (i.e., April and November) for oyster production when there is less information regarding harvesting periods to protect against Vibrio, and therefore less regulation. Many comments around the tools' applicability and function were geared towards shellfish growers, but people also said the tools could be useful for regulators, public health officials,

Table 3. *Best Harvest Windows*/ Vibrio *Harvest Calculator*

| Summarized, unique participant responses to breakout **discussion questions pertaining to potential tool uses, audiences, strengths, and engagement methods** from the Mid-Atlantic Aquaculture Siting and Development Workshop. | |
|---|---|
| **Most Likely Tool Uses** | Summer production planning for oyster farmers<br>Vibrio training for oyster farmers<br>Best management practice testing for Vibrio control<br>Hindcast after detected Vibrio infection to learn what specific conditions were present surrounding the Vibrio event<br>Best for shoulder months (i.e., April/November) when information and regulations are lacking |
| **Most Useful Tool Function** | Heuristic (i.e., problem-solving based on practical knowledge) tool<br>*Vibrio* prediction |
| **Tool Strengths** | Potential driver for improved harvesting behavior<br>Straightforward and easy to use<br>Unique, available, and validated |
| **Tool Audience** | Regulators<br>Growers<br>Public health officials<br>Residents/recreational water users<br>Commercial fishers<br>Extension agents<br>Academia |
| **Preferred Methods of Learning About and Engaging with the Tool** | Extension agents<br>Workshops (in-person/ webinars with tool experts)<br>Exploring the tool individually<br>Video tutorials<br>Industry associations<br>Scientific conferences<br>Social media (esp. to the public)<br>Posters at piers, docks, beaches with QR code to the tool for outreach<br>State council meetings (e.g., MD Aquaculture Coordinating Council)<br>HACCP trainings/ state health departments |

Table 3. *Best Harvest Windows*/ Vibrio *Harvest Calculator (cont.)*

| **Summarized, unique participant responses to breakout discussion questions pertaining to tool improvements and challenges from the Mid-Atlantic Aquaculture Siting and Development Workshop.** | |
|---|---|
| **Opportunities for Tool Improvements** | Make graphics, colors, and units more user-friendly<br>Improve model resolution for use at farm scales<br>Testing consistency<br>Conduct a needs assessment with specific audiences for improved co-production<br>Improved communication about the tool (e.g., what output means to industry)<br>Clarify risks of temperature and salinity throughout the water column<br>Maintain historical data for site planning purpose<br>Develop hindcasts for post-harvest analysis of conditions that lead to infection<br>Understand how states are using tool as examples<br>Could pair tool with infection testing to identify ideal populations for breeding<br>Add information about *Vibrio*, testing methods, etc. for lay audiences<br>Include a line for real-time data for comparison with prediction lines<br>Integrate with WEMo<br>Include links to other useful prediction tools (e.g., HABs Forecast) |
| **Suggested Data to Include** | Improved salinity data<br>*Vibrio* flushing rates<br>Temperature<br>Rainfall |
| **Questions About the Tool's Functionality** | Is it possible to create a threshold for farmers to easily know when they cannot harvest?<br>Are historical data stored in a database that could be accessed through the tool?<br>Does the model reset every 24 hours, or does it build off data from the previous day?<br>How is uncertainty/ variability incorporated and illustrated in the tool?<br>Could this be used for a wet lab or hatchery?<br>Does the tool adjust for the various state regulations? |
| **Potential Challenges to User Engagement** | Farmers may not understand which model to use and why<br>For consumers, the output/variables do not correlate with what they need to worry about<br>Clarify that the output is presence, not infection rates to abate misinterpretation |
| **Additional Knowledge Consulted to Use the Tool** | HACCP trainings<br>Certified and uncertified waters<br>NC Shellfish temporary viewer<br>Illness death data<br>Health department and other local rules and regulations for harvest<br>Safety and control measures (e.g., what to do after exposure?)<br>Economic risk factors<br>Other pathogens (HABs)<br>NC 'Shell Cast' (GIS) |

extension agents, and academia. Beyond the aquaculture community, participants thought the tools could be useful for commercial fishers (e.g., crabbers), other recreational water users, and residents to understand their risk for infection if they were to get injured on the water.

### Vibrio *Tool Suggestions*

Participants noted the simple design and use of the tools as positive but also had suggestions for improvements to clarity and communication, including features that could be added to expand the tools' functionality (Table 3). Participants suggested that graph colors and variable units (e.g., the doubling-time unit) should be more user-friendly, and potentially a threshold for safe harvesting could be identified. Additionally, the output could be more beneficial if it was specific to "different handling conditions (e.g., sun vs. shade)." Participants also suggested more clear communication to ensure that people understand the tools' purpose and output to prevent potential misinterpretation or fear about human infection risk from Vibrio. Participants were also concerned that tool users might not know which Vibrio model or scenario to use, and that the outputs of, "doubling time and air temperature aren't really connected to an interpretation of what the consumer should be worried about." People recommended providing explanations about Vibrio and how it effects oysters, and then including links for how oysters are tested for Vibrio. Beyond communication and accessibility, participants saw potential in expanding certain functionalities, like storing historical Vibrio information to help with farm siting by showing frequencies of high Vibrio concentrations or increasing the model's resolution so users can "look into smaller, more specified areas." Participants thought that conducting a needs assessment could help gather "more input from growers, regulators, and NGOs" to ensure the tool is designed to fit the needs of the various user groups.

To help contextualize the tools' output, participants listed additional knowledge that users would need, which stimulated further questions as well as brainstorming ways to educate and engage tool users. It was suggested that tool users should be aware of Hazard Analysis Critical Control Point (HAACP) plans, certified and uncertified waters, local harvest and health department regulations, illness and death data, and economic risk factors. One participant emphasized the importance of taking HAACP trainings. Participants were then curious if the tools were, or could be, adjusted for each state's regulations for Vibrio and harvesting. Further questions arose about incorporation of uncertainty and variability, tool use by hatcheries and labs, and the model reset frequency (Table 3).

### Vibrio *Tool Delivery*

When participants discussed various ways to engage and educate tool users, similar suggestions were mentioned from the previous WEMo tool discussion (e.g., Extension agents, workshops, video tutorials, etc.). Participants had unique recommendations to use existing health and safety trainings or meetings, including demonstrating the tool at HAACP trainings, at state or local aquaculture council meetings (e.g., Maryland's Aquaculture Coordinating Council), or at local health department meetings. One participant suggested posting QR codes at local piers, docks, and harbors to direct people to the tool for easy access.

## Breakout Session 4: Engaging With a Diverse Audience

### *Routine community partners*

Participants were asked to reflect on what groups they routinely work with and then discuss what groups have not effectively been reached (Appendix A). Most workshop participants work with people from the aquaculture industry, specifically growers. Others mentioned working with regulatory agencies, academia, Extension, non-governmental organizations, the public, and those in formal and informal education. Only a handful of people mentioned working with groups from underserved communities, community colleges, Indigenous coastal communities (e.g., Gullah Geechee in North Carolina), Historically Black Colleges and Universities, and programs for underserved youth. Some participants mentioned, anecdotally, that they primarily work with oyster growers, which happen to be, "predominantly white males," which was echoed by another participant in a separate group stating that the "current demographic is that typically white men over 55 years old are dominating aquaculture in the Maryland/Delaware area." Another participant reminded others to be aware of, "stakeholder fatigue for members of under[served] groups."

### *Industry engagement*

Participants also reflected on equitable engagement within the aquaculture industry. Several participants felt "industry tends to be left out of information." Additionally, one participant mentioned industry members should have "equitable access to loans for aquaculture with respect to socioeconomic factors." Participants recognized tools can help "entry

[to the fishery] by producing more info on site suitability that does not rely on already having a connect to the fishery." However, one participant, after contemplating their own missed audiences, mentioned how to reach those without computers should be an important consideration for any tools created for industry.

### *Communities to engage*

When participants were asked to consider audiences that are not effectively being reached, participants came up with a list including two main categories, aquaculture industry and underserved and education communities, and a third category for other relevant groups (Table 4). Many people or groups that participants listed were within the aquaculture industry. Specifically, participants discussed challenges connecting with growers who "aren't as open," engaging with farm workers rather than operation owners, various political pressures, and providing information regarding leases to help with user conflicts. Broader conversations dove into topics around the complications and complexities with engagement, like directly reaching various groups and reasons behind the inability to connect or respond. Participants also mentioned the difficulty of knowing who is not being reached effectively, "an unknown unknown." Though there are challenges reaching groups that have traditionally not been included, participants did remark on the efficiency of leveraging existing connections for engagement opportunities.

Table 4. *People and groups, suggested by workshop participants, that are not being effectively reached when it comes to conversations around the development of the aquaculture industry in the United States.*

| Aquaculture Industry | Underserved and Education Communities | Other Relevant Groups |
|---|---|---|
| Growers (especially new and prospective)<br>H-2 visa workers<br>Areas without shellfish grower associations<br>Producers of newer products/species (e.g., surf clams)<br>Consumers/ local communities<br>Processors/Restaurants/Markets (e.g., fish markets)<br>Chefs<br>Communications/ media | Indigenous peoples and Tribes<br>Black watermen<br>Women<br>HBCU students<br>Community colleges/ trade schools<br>Educators<br>Apprenticeships<br>K-12 students (public and private)<br>Universities<br>Non-scientific disciplines<br>General public | Politicians/local officials/ congressional staffers (especially in coastal communities)<br>Commercial fishermen<br>Landowners<br>Nongovernmental organizations/ activist groups<br>Boundary organizations<br>Religious organizations |

Eventually, participants began discussing misinformation surrounding aquaculture and potential ways to address the misconceptions through expanded educational efforts (i.e., formal and non-formal education). Most of the non-formal suggestions were related to tourism, specifically food-based with examples like the Maine oyster trail and other agritourism approaches. Others mentioned more use of social media, whether through industry, politicians, or other community leaders or influencers. The formal and non-formal ideas involved Extension developing programs and lessons for many audiences including students (primary and secondary), politicians, community leaders, and community members to learn about how aquaculture "impacts their coastline" and to build trust with industry members through local farm and aquaculture-laboratory tours.

## Suggestions for Future Workshops

### Breakout Session 5: Looking Ahead to Workshop Number Two

In the final session of the day, as well as in the post-workshop evaluation, participants provided feedback and suggestions for the workshop approach. Participants appreciated the table assignments that intentionally brought different

backgrounds together. However, as several participants noted through the lack of industry representation, broadening participation was more challenging than anticipated. Participants requested a broader audience that would include people who have used the presented tools, among other groups, as well as being intentional about NCCOS interacting with Extension specialists. With the variety of backgrounds at the workshop, participants recognized how "bringing in so many diverse experts allowed for more creative group thinking," with a couple of participants applauding the quality of feedback the workshop format afforded tool developers. Several participants appreciated the format of the workshop that, "switch[ed] off between tool lectures and conversations," noting that the format, "broke up the day well." Other recommendations were focused more specifically on the next workshop in the Gulf of Mexico region, citing careful consideration for the diversity of aquaculture and the various challenges in the Gulf ranging from harmful algal blooms (specifically red tides) to hurricanes and tropical storms.

One of the more common pieces of feedback was to have more time with the tools. Participants had several ideas for incorporating this time into the day. The first was to send out links to the tools, and a video about the research project, in an email prior to the workshop, so participants could engage with the tools more directly and have more background coming into the workshop. The next suggestion was to allow more time for tool demonstrations, so they could be more detailed. A similar request was for the demonstrations to be done by the tool developers themselves, potentially followed by a question-and-answer session. One participant noted that more engagement and time with the tools would lead to, "a higher likelihood that the tool would be used after the workshop, it will promote more discussion and more technical feedback." Additionally, another tool demonstration format was discussed where groups would rotate through tool stations, like speed dating, with the tool developers (e.g., a tools café). Specific to the demonstrations, someone recommended using a "real-world issue that the tool could be applied to." The last suggestion related to tools was to highlight regional tools alongside the national ones from NCCOS.

### Final Considerations for Workshop Improvements

Based on recommendations and suggestions from Dr. Davis' evaluation report (see Section External Mid-Atlantic Workshop Evaluation) and Breakout Session 5, respectively, our team's plan for future workshops are as follows:

- Broaden the audience and be mindful to seasonal timing for industry
- Keep the general workshop format and strategic table assignments
- Spur intentional interactions with Extension specialists and NCCOS staff
- Focus workshop activities more directly on the theme of collaboration and co-production, if that is a project goal
- Create a short project overview presentation to send to participants prior to the workshop
- Increase time with the tools, including a Q&A with the tool developers and sending out tool links prior to the workshop
- Make tool demonstrations more active (e.g., use real-world scenarios, tool "speed-dating")
- Recognize region-specific nuances related to challenges and characteristics of the aquaculture industry

## Acknowledgements

We would like to thank Jim LaChance, Frank Lopez, Eric Herbst, and Beth Lenz for their help planning and coordinating the workshop as well as providing their aquaculture and diversity, equity, inclusion, and justice expertise and knowledge. Thank you to the SG-NCCOS-NOAA Working Group members Ken Riley, Diane Windham, Andrew Richards, Alicia Bishop, and Chris Schillaci for your input on the workshop agenda and content. A special thanks to Ken Riley, Chuck Weirich, Matt Parker, Meg Munkacsy, Ava Ellett, and Bob Daniels for presenting your work during the workshop. We would like to thank our workshop facilitators Frank Lopez, Eric Herbst, Chuck Weirich, Shannon Hood, and Brittany Wolfe-Bryant for facilitating discussions and participant engagement. Thank you to our notetakers Matt Stefanak, Sam Schiano, Reed Brodnik, Jessica Baniak, Kayla McVey, and Mya Sharpe for capturing participant input throughout the workshop. Lastly, thank you to the MDSG Communications team for your help with the workshop planning and support with development of all workshop materials. Funding was provided by the National Centers for Coastal Ocean Science and the National Sea Grant College Program (award NA21OAR4170327) to Fredrika Moser.

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# External Mid-Atlantic Workshop Evaluation

At the end of the workshop day, all participants were asked to complete a questionnaire created by the team's external evaluator, Dr. Cathlyn Davis from the University of Maryland Center for Environmental Science. The workshop questionnaire collected feedback on the workshop delivery and progress towards the project outcomes. These outcomes are listed below:

- All participants
  - feel that their needs were meet through the workshop process
  - feel all voices were equal
  - value the participatory workshop process
  - adopt a co-production method in their own work
  - understand NCCOS tools and use them where appropriate
- NOAA participants
  - understand how SG process supports actionable science
- Student participants
  - Feel they have gain valuable training

From the evaluations, Dr. Davis summarized the questionnaire results into a written report for the MDSG planning team and provided recommendations based on the participants' feedback and her informal observations throughout the workshop (Appendix B). A summary of the findings and recommendations from the evaluation report are provided below.

## Summary of Workshop Findings from the Evaluation Report

In brief and in terms of use and usefulness of these tools, workshop respondents rated the Wave Energy Model as the most useful, listing applications such as siting shellfish growing areas and assessing site risks. Respondents had a range of perspectives on the usefulness of the other two tools (Best Harvest Windows and Vibrio Harvest Calculator); some questioning if they could be applied to real-world applications while others thought they offered some potential or have already been put to use in oyster harvesting. All respondents were moderately or very confident that tool developers can work collaboratively with stakeholders. Many emphasize the value of collaboratively creating tools, and some felt this collaborative work was already happening.

In terms of the workshop format, most felt it allowed them or others to make a point, and they felt comfortable sharing their ideas. Some, but not as many, were completely confident that their input would be used. They felt the workshop structure (presentation followed by small group discussions and whole group sharing) worked well, and praised the small group format including group size, brief exercises and discussion prompts, effective facilitators, report-outs, and shifting membership. They did see room for improvement including more time to test out tools, expansion in types of workshop participants (e.g., industry-based stakeholders, extension directors, and more racially diverse individuals), and better ways to record and summarize small group discussion comments.

## Recommendations From the Evaluation Report

- The term stakeholder is used throughout the planning and implementation but lacks a concrete definition. There are a wide range of stakeholders who might be involved in this effort and each brings different expertise, needs and challenges. The absence of a clear description limits the ability to successfully recruit and engage targeted stakeholders. Given the complex project goals and limited timeline for trust building and roadmap

development, it is recommended that the project staff select and fully describe a specific type(s) of stakeholders to target such as local state natural resource staff or relevant industry staff. Note this will need to be considered in light of the outcome to involve participants from historically marginalized communities.

- At least half of the workshop focused on presenting and discussing the three tools; even with this extensive window, many participants felt there wasn't sufficient time to explore the tools. Additionally, the target outputs and outcomes are primarily centered around producing a report for each region. Thus, it is recommended that future in-person meetings are dominated by activities that advance co-creation of the reports (i.e., "list various needs, priorities, data gaps, multi-user conflicts, and potential users or adaptations, and identify priorities for the roadmaps") with exploration of the tools occurring before the in-person meetings.
- A number of participants at the June 2022 in-person meeting were already acquainted with each other. If future workshops seek to engage a broader range of stakeholders, then new bonds may need to be formed. Thus, it is recommended that more time at both virtual and in-person meetings is spent on helping participants get to know each other and built trust.
- Participants' comments indicated that they are very supportive of collaborative work around developing and applying tools and other resources for sustainable aquaculture siting. The June 2022 in-person workshop included elements of collaboration including Matt Parker's presentation on co-production in aquaculture and the session on engaging diverse audiences. However, given participants' support and the overall goal of collaboration, it is recommended that all workshop activities (virtual and in-person) center more directly on the theme of collaboration. For example, experts in co-production strategies should be invited to speak, and all other presenters should be instructed and coached to talk directly about successes and challenges associated with working together with stakeholders. Offline assignments should center on readings around collaboration (e.g., Frontiers in Ecology and the Environment special issue on "translational ecology"). Small group discussion prompts and facilitators should challenge participants to reflect on applications of co-production/collaboration strategies and approaches in their own work. As noted, this all must be done in light of the goal to ultimately produce roadmaps with participants.
- Making use of pre/post virtual meetings is key to implementing these recommendations. Fortunately, the project plan includes the option for multiple virtual meetings before and after the in-person meeting. It is recommended that this option is employed with at least two virtual meetings before and after the in-person meetings.
- The current outputs and outcomes are quite ambitious. They include engaging a diverse group of stakeholders (including those from underrepresented groups), co-producing complex roadmaps in six different regions, and using NCCOS tools. This is a lot to accomplish within each 3-part workshop. It is recommended that the outputs and outcomes are reviewed and simplified/streamlined to ensure success with the short time period. For example, co-creation of roadmaps seem to be a top priority, and existing NCCOS tools may or may not be necessary for this co-creation process. Thus, understanding NCCOS tools and ensuring their use could be dropped as an outcome.

# Appendix A: Workshop Briefing Book

# Sea Grant–NCCOS Mid-Atlantic Aquaculture Siting and Development Pilot Workshop

College Park, Maryland
June 30, 2022

Sea Grant Maryland

Sea Grant

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

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# Workshop Background and Purpose

Welcome and thank you for attending our Sea Grant–NOAA National Centers for Coastal Ocean Science (NCCOS) Mid-Atlantic Aquaculture Siting and Development Pilot Workshop. Our priority today is to extend the reach of aquaculture tools and learn more about tools that stakeholders want, while also collectively developing an effective workshop process. We request that you review our workshop guidelines on page 7, which we rely on for creating a safe and welcoming environment for all. We appreciate your participation in this effort.

## Background

This workshop is part of a four-year project that connects Sea Grant, the National Sea Grant Program, NCCOS, and coastal stakeholders engaged in aquaculture siting and sustainability. Funded primarily by a grant from the National Sea Grant College Program, this collaboration will extend the reach of NCCOS aquaculture planning resources, improve connections between scientists, extension specialists, and other coastal stakeholders through a series of regional workshops, and inform broader Sea Grant–NCCOS marine spatial planning efforts.

## Purpose

Today we are meeting to participate in the pilot workshop for this project, where we will learn about several tools available for aquaculture siting and development, hear about the broader resources available through the Coastal Aquaculture Planning Portal (CAPP)[1], and engage thoughtfully in various small-group discussions. In addition to discussions focused on tools, we will also ask you to reflect on the project's process and future efforts.

We will seek to hone a process that emphasizes co-production and encourages two-way communication about aquaculture siting and development tools. How might this tool be useful in your area? What functionality is particularly pertinent? Could this tool be useful for a certain type of stakeholder, or does it prompt ideas of how you might expand who you work with? We will ask questions like these as we share several resources, but we also intend to listen and learn from each other. To this end, the workshop will contribute to a roadmap document that outlines key themes as well as future directions, as informed by the perspectives of all attendees. We hope to improve future workshops as we proceed over the next 4 years to engage with regional stakeholders in the Gulf of Mexico, Southern California, the Pacific Northwest, the Pacific Islands, and the New England regions. Thank you for your support!

1 The Coastal Aquaculture Planning Portal (CAPP) is a consolidation of a wide range of existing tools and applications, which were created to assist managers, planners, and industry in the development of sustainable aquaculture.

# Workshop Agenda

| | |
|---|---|
| 8:30 a.m. | Check-In<br>*Light refreshments served* |
| 9:00 a.m. | **Welcome**<br>Fredrika Moser, *Maryland Sea Grant* |
| 9:05 a.m. | **Introduction and background**<br>Sea Grant and National Oceanic and Atmospheric Administration National Centers for Coastal Ocean Science (NOAA NCCOS) collaboration<br>Chuck Weirich, *National Sea Grant Office*<br>NCCOS and the Coastal Aquaculture Planning Portal (CAPP)<br>Ken Riley, *NOAA*<br>Workshop overview and approach<br>Jim LaChance, *Maryland Sea Grant*<br>Workshop and project evaluation<br>Cat Davis, *University of Maryland Center for Environmental Science, Appalachian Laboratory* |
| 9:40 a.m. | **Case Study: Co-production in aquaculture**<br>University of Maryland Online Economic Spreadsheet Tool for Oyster Aquaculture<br>Matt Parker, *University of Maryland Sea Grant Extension* |
| 10:00 a.m. | Breakout group discussions<br>*See 'Breakout group discussions' on page 5 for more information* |
| 10:20 a.m. | Lightning report outs<br>*2 minutes per group* |
| 10:30 a.m. | Break |
| 10:40 a.m. | **NCCOS tool presentation: Wave Energy Model (WEMo)**<br>Presentation and demonstration<br>Ken Riley, *NOAA*<br>Meg Munkacsy, *NOAA NCCOS Coastal Aquaculture Siting and Sustainability (CASS)* |
| 11:10 a.m. | Breakout group discussions<br>*See 'Breakout group discussions' on page 5 for more information* |
| 11:55 a.m. | Lightning report outs<br>*2 minutes per group* |

12:05 p.m. Lunch

1:00 p.m. **NCCOS tool presentation: Best harvest windows and *Vibrio* harvest calculator**

Presentation and demonstration

Bob Daniels, *I.M. Systems Group, Inc. at NOAA/National Weather Service*
Ava Ellett, *NCCOS Oxford Laboratory*

1:30 p.m. Breakout group discussions
*See 'Breakout group discussions' on page 5 for more information*

2:15 p.m. Lightning report outs
*2 minutes per group*

2:25 p.m. Break

2:40 p.m. **Engaging Diverse Audiences**

Overview and background

Jim LaChance, *Maryland Sea Grant*

Breakout group discussions
*See 'Breakout group discussions' on page 5 for more information*

Lightning report outs
*2 minutes per group*

3:25 p.m. **Looking Ahead to Workshop 2: Gulf of Mexico**

Overview and background

Jim LaChance, *Maryland Sea Grant*

Breakout group discussions
*See 'Breakout group discussions' on page 5 for more information*

Lightning report outs
*2 minutes per group*

3:45 p.m. **Concluding remarks and evaluation**

Jim LaChance, *Maryland Sea Grant*

4:00 p.m. Workshop concludes

# Workshop Logistics

## Workshop overview

As outlined in the agenda (see page 3), the first session will share introductory information about the Sea Grant–NCCOS collaboration and go into detail about the resources found in the NOAA NCCOS Coastal Aquaculture Planning Portal. There will also be a brief description of this project's approach and our collaborators. The workshop will then transition into a series of presentations and breakout group discussions that focus on co-production, aquaculture siting and development tools, inclusivity and the workshop process. We will end with an online survey from our external evaluator.

Please see the appendices beginning on page 12 for a list of attendees and additional information on this project's approach.

Below, you can find details for each breakout group discussion.

## Breakout group discussions

Each of you has been assigned to a separate breakout group for the morning and afternoon sessions. Some breakout group discussions will take place at your table, while some will involve circulating to other tables. The specific approach to each is explained below and will also be described before each discussion.

### Breakout group discussion #1: Co-production in aquaculture

Co-production is an intentionally participatory way of reaching a collective outcome and a useful approach for questions such as the siting and development of aquaculture. In this breakout session, we will ask you to think of an example of a project where you were engaged in co-production. If you can't think of an example, then consider a project where a co-production approach could have been useful. The facilitator will then ask the group to list some ideas of what works and what might be challenging with this approach. Our intention is to think about lessons learned from this example, and to bring this lens of co-production to all of our breakout group discussions throughout the day.

### Breakout group discussion #2 and #3: Discussion of aquaculture siting and development tools

In these two discussions, we aim to gather feedback on the tools as well as input on how best to improve use and dissemination of the tools. Needs can vary significantly by locality and type of user, and we appreciate hearing your unique perspective. We will explore this through a series of structured questions that focus on five key areas:

1. Tool functionality
    a. When would you most likely use this tool?
    b. Which function is most useful? Which function would you like to see improved or augmented?
    c. Do you have any further questions about its use?
2. Tool strengths and opportunities
    a. Identify a list of strengths and opportunities to improve any aspects of the tool.
3. Tool access and knowledge
    a. How do you prefer to learn about and access these types of tools? For example, from a video guide, a webinar, a written guide, or a different method altogether? Specific examples of useful tool guides (or types of guides) are also helpful.

4. Complementary resources
    a. Do any additional needs or complementary tools come to mind? Please list any examples/ideas and describe how they could complement the tool you just learned about
    b. What type of additional data or knowledge would you also consult when using this tool?
        - Where or how would you find this information. Please describe where or how you would find this information.
        - Would this data/knowledge be useful in a new tool or as an addition to the current tool?
5. Audience
    a. Who do you view as the target audience and what approach might broaden the audience that uses this tool?
    b. What group, organization, or community would you most likely consider sharing this tool with? Least likely?
    c. Do you see any opportunities or challenges to user engagement with this tool?

### Breakout group discussion #4: Engaging a diverse audience

In this breakout group discussion we will touch on the idea of engaging underrepresented groups in discussions around the topic of aquaculture siting and development. We will focus on two main questions:

- Who do you usually engage in your aquaculture programming (e.g., individuals, organizations, industries, and more)?
- Who do you think is interested in the programming but hasn't been as effectively reached?

### Breakout group discussion #5: Looking forward to future workshops

In this final breakout group discussion, we would like to take a minute to think about the workshop process as it continues. In other regions, we propose to conduct similar workshops that focus on regionally relevant tools. Some questions for reflection:

- What ideas do you have for a hands-on workshop that focuses on tools?
- What are your initial reflections on today's approach?

While you will have an opportunity to share specific reflections in the more formal evaluation, this is an opportunity to think about how tools are showcased, and how the breakout discussions on tools proceeded. Also, if you have experience working in the Gulf of Mexico, we would like to hear any thoughts on what types of tools or issues come to mind for that region.

# Workshop Guidelines

Maryland Sea Grant (MDSG) is committed to providing safe and welcoming environments for all who participate in MDSG events. MDSG prohibits and will not tolerate any form of harassment, bullying, or discrimination. Together, through the following guidelines, we can ensure that this workshop supports free expression and exchange of ideas in environments that are positive and productive for all.

We value all perspectives. We encourage everyone to share. We are here to listen and understand. If you prefer not to answer you can say pass or pass for now.

Please note that disagreement is welcome for the purpose of understanding, but not for convincing. Critique ideas, not individuals. Please actively listen to everyone. We ask that you avoid interrupting others when speaking. Please try to minimize distractions when possible.

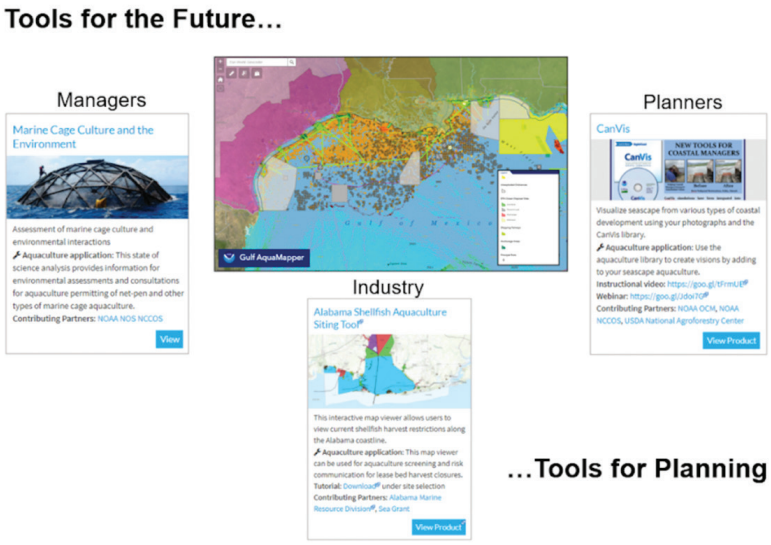
During this workshop we will be developing a shared language. It is always okay to ask what a word or phrase means or to ask for further clarification as we will be doing the same of you!

If you know that you need to leave the meeting early, please let the project team, facilitator, or notetaker know ahead of time so that we can allot your time first when doing our breakout sessions.

If you believe you are being subjected to inappropriate conduct, believe someone else is being subjected to inappropriate conduct, or have any other concerns, please do not hesitate to contact MDSG event staff who can work with MDSG leadership to resolve the situation. If the project team determines that any behavior is inappropriate or violates the above guidelines, participants will be reminded of these ethics and/or asked to leave the meeting.

# Pilot Workshop Tools and Resources

## The Coastal Aquaculture Planning Portal: An Overview of Tools for Rules




### Tool summary

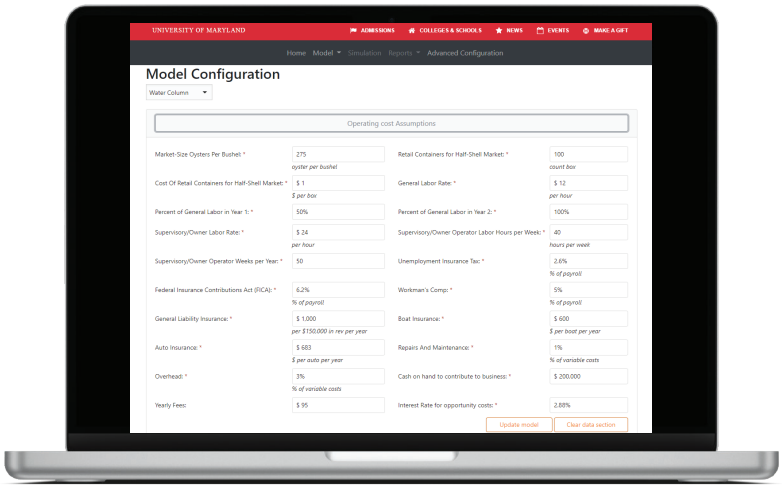
In an effort to obtain global food security, many countries, including the United States, are turning towards the expansion of marine aquaculture. This effort requires a need for support in the decision making and planning process for future site suitability and development of aquaculture infrastructure. The Coastal Aquaculture Siting and Sustainability (CASS) program, under NOAA/ National Ocean Service (NOS)/National Centers for Coastal Ocean Science (NCCOS), has developed a marine aquaculture toolbox comprised of coastal aquaculture planning tools. The Coastal Aquaculture Planning Portal (CAPP) is a consolidation of a wide range of existing tools and applications, which were created to assist managers, planners, and industry in the development of sustainable aquaculture. Private universities, state/federal government agencies, and global organizations have developed these tools to provide the most accurate and up to date data and environmental analysis possible. These tools range from state specific shellfish mappers to global geospatial ecology overviews. The portal is organized into four subcategories, each of which pertain to marine aquaculture and/or environmental interactions. The CAPP was developed in partnership with Digital Coast, a product of the NOAA/NOS Office of Coastal Management, in efforts to support the growth and expansion of resilient and sustainable marine aquaculture within the United States and abroad.

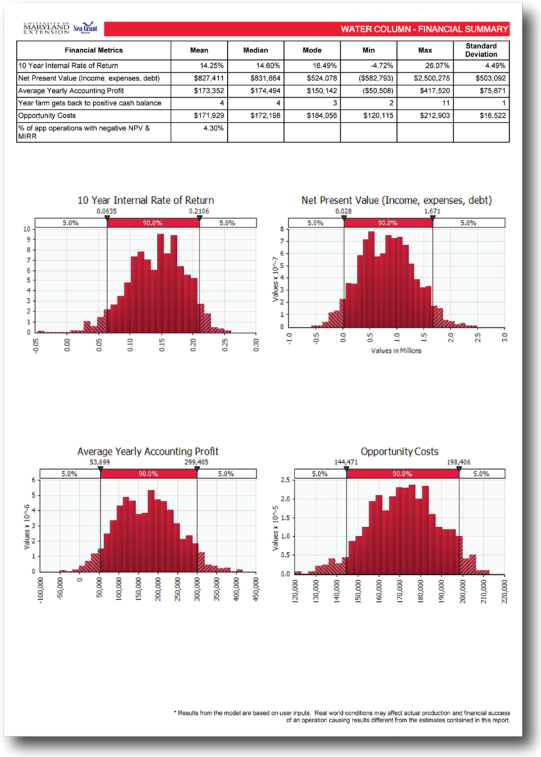
https://coastalscience.noaa.gov/research/marine-spatial-ecology/coastal-aquaculture-planning-portal-capp/

### For more information

Kenneth Riley
NOAA National Ocean Service
National Centers for Coastal Ocean Science
ken.riley@noaa.gov

# Maryland Shellfish Aquaculture Business Planning Tool




| Financial Metrics | Mean | Median | Mode | Min | Max | Standard Deviation |
|---|---|---|---|---|---|---|
| 10 Year Internal Rate of Return | 14.25% | 14.60% | 16.49% | -4.72% | 26.07% | 4.49% |
| Net Present Value (income, expenses, debt) | $827,411 | $831,664 | $524,078 | ($582,793) | $2,500,275 | $503,092 |
| Average Yearly Accounting Profit | $173,352 | $174,494 | $150,142 | ($50,508) | $417,520 | $75,871 |
| Year farm gets back to positive cash balance | 4 | 4 | 3 | 2 | 11 | 1 |
| Opportunity Costs | $171,929 | $172,198 | $184,056 | $120,115 | $212,903 | $16,522 |
| % of app operations with negative NPV & MIRR | 4.30% | | | | | |

## Tool summary

The Maryland Shellfish Aquaculture Business Tool is in the process of converting an existing Microsoft Excel based business planning tool, which uses Monte Carlo simulation to estimate a shellfish farm's likelihood of success into a web-based model. The development of a web-based model will increase the availability of the tool to Maryland stakeholders, as well as stakeholders in other regions of the United States. This tool will inform stakeholders of an estimated net present value of their operation over a 10 year period. It will also estimate the rate of return on the project. The model will be able to compare self-financed operations with the effects of debt financing on farm financial performance. These metrics will allow stakeholders to make informed financial decisions on starting a shellfish farming operation.

## For more information

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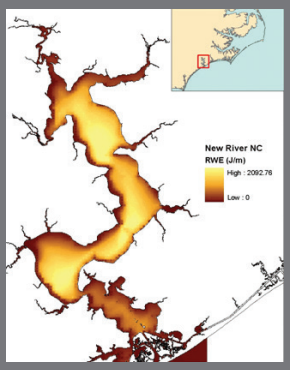
# Wave Exposure Modeling To Support Aquaculture Siting

## Tool summary

Wave energy forecasting is an essential exercise to understand its impact on engineering and biological structures. A wind wave-forecasting model, Wave Exposure Model (WEMo), was designed specifically for shallow water areas in confined water bodies with minimum effects from open ocean swells. WEMo explicitly uses wave generation, shoaling and nonlinear dissipative processes as wave breaking and bottom friction to calculate wave energy. The model works in a Geographic Information System (GIS) format in association with ArcGIS. A newer version of WEMo will soon be released with added functionality of handling batch datasets and faster processing that could make it a suitable tool for aquaculture applications.




*Representative wave energy (RWE) modeled along estuarine shorelines within the New River, North Carolina.*

Wind wave energy is an essential component in siting new or expanding aquaculture facilities.  Surface conditions such as waves and high currents during storms can add stress to aquaculture gear leading to structural failures and detrimental effects on production schedules and operational costs. WEMo could provide a wind wave energy regime for siting a potential aquaculture operation at various temporal and geographical scales. Output from WEMo along with other information will be a part of aquaculture siting tools provided by NOAA for shellfish or finfish aquaculture around the country. WEMo wave energy profiles will also give the aquaculture industry and engineers a means to calculate added stress due to waves on aquaculture structures, including nets, bags, lines, anchors, and other ground tackle.

## For more information

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NOAA National Ocean Service
National Centers for Coastal Ocean Science
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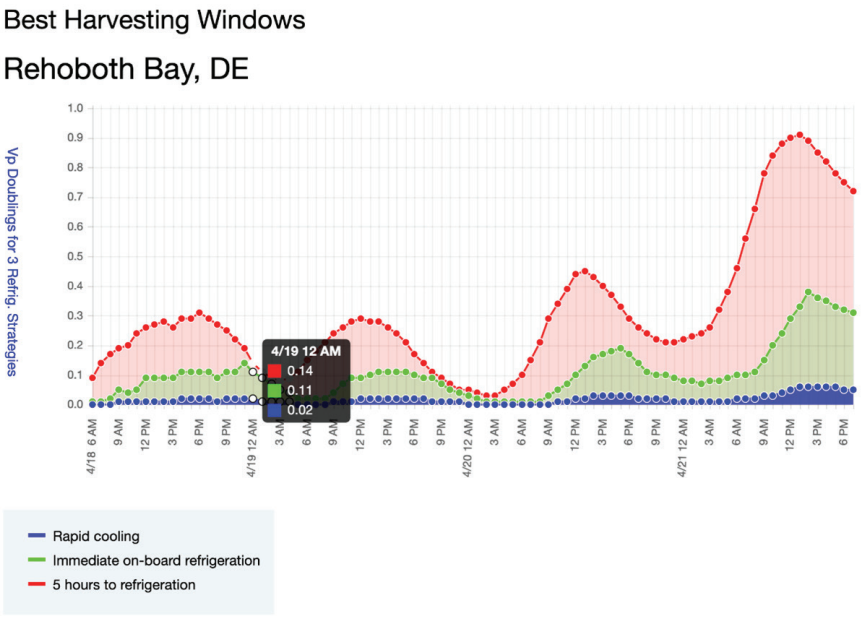
# Best Harvest Windows (Delaware) and *Vibrio* Harvest Calculator (Long Island)




## Tool summary

These two similar tools available to growers, farmers, and managers allow users to see how much *Vibrio* growth they might encounter when harvesting oysters.

NCCOS produces several *Vibrio* Predictive Models that improve the safety of oysters by assisting coastal managers and shellfish growers in oyster harvest decision making nationwide. *Vibrio* are bacteria that occur naturally in our coastal waters, but certain species and strains can also be harmful to human health.

*Vibrio parahaemolyticus* (*Vp*) can cause infection commonly associated with the consumption of raw or undercooked seafood, and usually results in an intestinal infection that will resolve itself without treatment. *Vp* has one of the fastest growth rates of all estuarine bacteria, and the population can replace itself, or double, every hour at 90°C.

The Best Harvest Windows tool for Delaware Bay and Delaware Inland Bays show the doublings of *Vp* resulting from choosing a range of cooling scenarios at common growing locations when harvesting within the next 4 days.

The *Vibrio* Harvest Calculator for Long Island Sound is an evolution of the above tool and allows the user to predict *Vp* growth scenarios based on harvest location, date, and time—up to seven days in advance—in Long Island Sound.

https://products.coastalscience.noaa.gov/vibrioforecast/

## For more information

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# Appendix A: Project Personnel and Description

## Connecting Sea Grant, NCCOS, and Coastal Stakeholders to Improve Sustainable Aquaculture Siting and Development

### Project PI

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### Project Co-PIs

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### Project Duration

December 1, 2021 – November 30, 2025

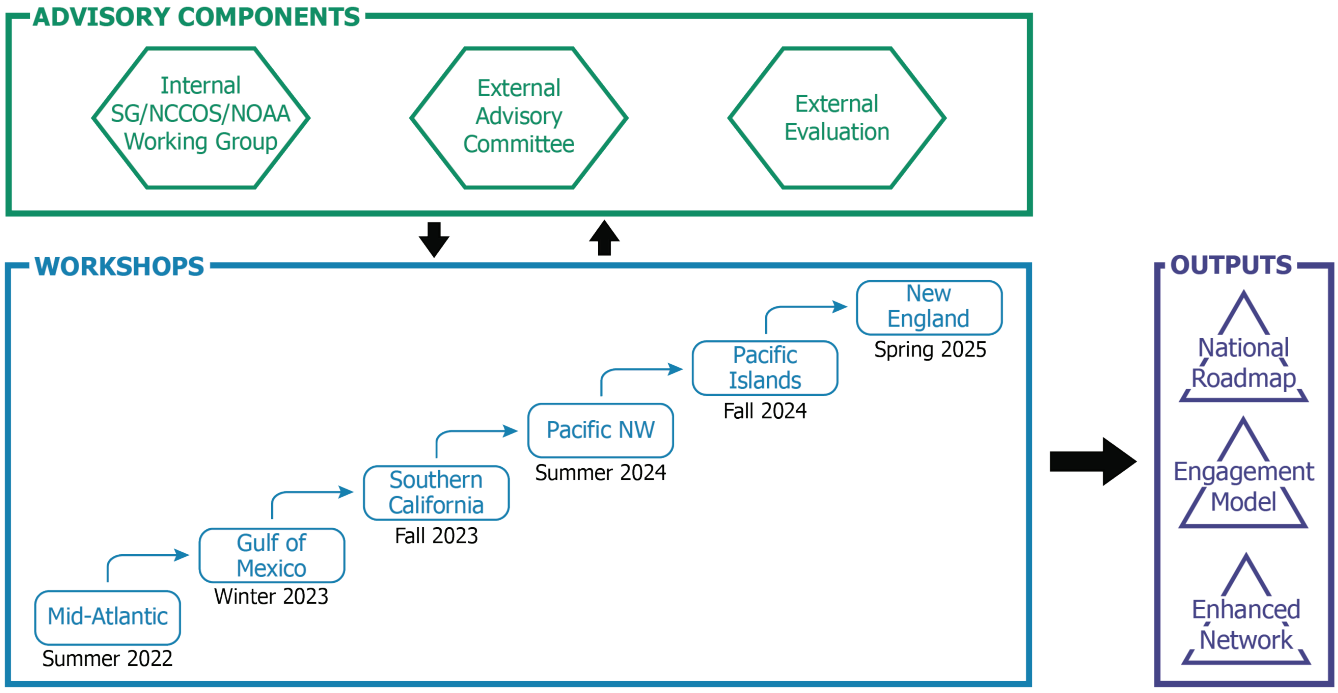
### Project Summary

Recent efforts focus on identifying Aquaculture Opportunity Areas (AOAs) in U.S. waters as Congressional interest in improving aquaculture regulation increases. Whether inshore or offshore, sustainable aquaculture wades into crowded waters where multiple, complex layers of stakeholders are present. The National Centers for Coastal Ocean Science (NCCOS)—and particularly the Coastal Aquaculture Siting and Sustainability Program (CASS)—are well equipped to meet these challenges and have created many resources to aid decision making by coastal ocean stakeholders. Key to a science-based approach, these NCCOS tools and services often use marine spatial planning as a continually evolving method to analyze and address the challenges of ecosystem and human interactions in coastal ocean areas.
The goal of this project is to build the capacity of the Sea Grant Network to assist stakeholders in using and informing the coastal science products and resources developed by NCCOS CASS. We propose a comprehensive project that will build capacity and collaboration among Sea Grant (SG), NCCOS, and other coastal ocean stakeholders for environmentally, economically, and socially equitable aquaculture development. Central to this work is the creation of a National Aquaculture Extension Coordinator position (Coordinator) to oversee extension of NCCOS resources, inform broad SG/NCCOS marine spatial planning efforts, and facilitate a series of collaborative, regionally tailored workshops to advance aquaculture siting conversations. Workshops will take place in the Mid-Atlantic (Summer 2022); Gulf of Mexico (Winter 2023); Southern California (Fall 2023); Pacific Northwest (Summer 2024); Pacific Islands (Fall 2024); and New England (Spring 2025).

### Project Objectives

1. Extend the reach of NCCOS aquaculture planning resources;
2. Improve Sea Grant–National Sea Grant Program–NCCOS–Stakeholder connections through regional workshops that co-create aquaculture siting and development roadmaps;
3. Inform broader Sea Grant/NCCOS marine spatial planning efforts.

# Appendix B: Project Components




*Graphic showing the advisory components and workshop process.*